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NASA Contractor Report 195408

Fiber Optic Control System Integration for Advanced Aircraft

Electro-Optic and Sensor Fabrication, Integration, and Environmental Testing for Flight Control Systems - Laboratory Test Results

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November 1994

Prepared for
Lewis Research Center
Under Contract NAS3-25796

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	November 1994	Final Contractor Report

4. TITLE AND SUBTITLE

Fiber Optic Control System Integration for Advanced Aircraft—Laboratory Test Results

5. FUNDING NUMBERS

WU–505–62–50
C–NAS3–25796

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

E–9265

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Aeronautics and Space Administration
Lewis Research Center
Cleveland, Ohio 44135–3191

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

NASA CR–195408

11. SUPPLEMENTARY NOTES

Project Manager, Robert J. Baumbick, Instrumentation and Control Technology Division, NASA Lewis Research Center, organization code 2540, (216) 433–3735.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Unclassified - Unlimited
Subject Category 35

This publication is available from the NASA Center for Aerospace Information, (301) 621–0390.

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

This report presents the data obtained in laboratory testing of the optical sensors and multiplexing architecture developed for flight testing in the NASA F-18 systems research aircraft.

14. SUBJECT TERMS

Fiber optics; Optical sensors; Optical multiplexing; Fly-by-light; Flight control

15. NUMBER OF PAGES

388

16. PRICE CODE

A17

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

FOCSI Final Report Table of Contents

1. ABSTRACT

This is the final report of the Fiber Optic Control System Integration (FOCSI) Program summarizing the integration, testing, and operation of the Electro–Optic Architecture (EOA) and optic sensors delivered by McDonnell Douglas Aerospace–East (MDA–E) to NASA–Dryden for flight testing.

2. PROGRAM OVERVIEW

The optical sensing system consists of ten optical sensors of various optical sensing technologies and one EOA to decode the ten sensors and convert the optic signals to electric signals which are sent to NASA's data acquisition system. One of the challenges in this program was to have one EOA decode as many different sensing technologies as feasible to advance a little explored area of technology. The approach until now is one EOA for each type of sensing technology which has the benefit of providing tailored decoding for that sensor resulting in excellent results. That is not a viable approach in the space limited and weight conscious aircraft environment because each sensor type needs a separate EOA. A single EOA for all sensors not only saves space and weight, it is the vehicle management system (VMS) concept of one processing area which can handle multiple tasks, and VMS systems are already the systems of choice for the next generation of military aircraft.

3. SUMMARY

The performance of the EOA and sensors is good considering one EOA decodes a several types of sensors which vary widely in their optic characteristics, however, the performance of the EOA is poor when comparing the EOA and sensor performance to the traditional electrical aircraft sensors. The performance of the EOA and digital sensors is very close to the performance of the traditional sensors while the performance of the EOA and analog and time rate of decay (TRD) sensors is very far from the performance of the traditional sensors.

The EOA and digital sensors produce consistent and stable results. EOA decoding of digital sensors is little affected by noise, is able to overcome some variations in optical code plates, and is not affected by temperature, altitude, or vibration.

The EOA and analog sensors produce noisy and varied results. EOA decoding of analog sensors is sensitive to variations in power levels, is sensitive to noise, is sensitive to some variations in code plates, and is sensitive to EOA temperature. Analog decoding is not affected by altitude or vibration.

The EOA and TRD sensors produce noisy results due to a poor optic source.

The EOA fails to meet the electromagnetic interference (EMI) emission limits due to spikes in the data, but the EOA is not an EMI threat to the aircraft since the data outages are few and the majority of the outages are small.

4. OPTIC TEST RESULTS

4.1. EOA CCD Array and TRD Sources and Receivers

The optic test results reflect the mixed success and failure of EOA performance. The data in Table 1 shows that the sources and receivers of EOA #1 and EOA #2 had only minor differences in optic performance. However, EOA #2 does perform better than EOA #1 as explained in section 4.1.1.3.

4.1.1. EOA CCD Array Source

4.1.1.1. Specification Failures

The power spectral density failure results in sensor return signals that are lower than expected which can cause problems depending upon the receiver range. Fortunately, the CCD array receiver is able to receive lower power signals than originally expected, however, signals in the lower part of the receiver bandwidth are affected by receiver noise. These signals also have less resolution when fed to an analog to digital converter than signals in the upper portion of the receiver range due to the internal workings of the CCD array. For sensors with high insertion loss, the failure of the source to meet power spectral density requirements results in a degraded ability to decode the sensors

The wavelength range failure is due to the failure to meet the power spectral density requirements. The maximum power of the source spectrum is within the correct wavelength range, however, this test records the wavelength range covered by the spectrum which meets or exceeds the minimum power spectral density. This is not a serious failure.

The excitation off leakage allowed failure may result corrupted sensor signals. The area CCD array requires the source to be off when it shifts out its information, otherwise, the optic signals will be exciting the CCD array as the information in the array is being moved through the array. The leakage failure of the source is not serious for two reasons: the sources only failed by 0.9dB and 2.0dB, and the method of measurement. Since the source is pulsed, an optic to electric converter had to be use to compare the source on and off levels. This converter had a large gain which may have introduced an error causing the leakage to appear greater than actual.

The required rise and fall time failures are due to the resolution of the oscilloscope. During the test, different resolutions resulted in different rise and fall times. As the resolution increased, the rise and fall times decreased. The resolution could not be made small enough to accurately measure the rise and fall times.

4.1.1.2. Specification Successes

These successes contribute greatly to successful sensor decoding. Meeting power variation with wavelength prevents a sensor signal which covers too much of the receiver range thus allowing the receiver dynamic range to vary with temperature and still receive the entire sensor signal. Meeting power variation with time prevents a sensor signal which varies too much and exceeds the receiver range. The power variation with time was observed to be very slow which is important to properly decode analog sensors since the effects of the source must be removed. A slowly varying source ensures that the source spectrum which the processor uses to condition the sensor signal is the same spectrum which excited the sensor.

Meeting repeatability creates sensor signals which consistently fall within a certain receiver power range. This allows consistent sensor decoding since it minimizes the effects of the receiver having better resolution at the higher power levels than at the lower power level. It also helps to keep the sensor signal in the range of the receiver at all times.

4.1.1.3. Performance Notes

The performance of the CCD array source and receiver in decoding the analog and digital sensors differs between the EOAs. EOA #2 is able to decode more sensors than EOA #1 because of a slightly different placement of an optical block which is used to reduce optical reflections. The optical block is placed near the 900nm wavelength for both EOAs, but the optical block in EOA #2 is closer to the shorter wavelengths. Because of the shape of the power spectrum, the position of the optical block causes EOA #2 to have a smaller power variation over wavelength, a higher power spectral density, and more power at the 900nm wavelength. These differences allow EOA #2 to better decode sensors which vary to the extremes within their optical specifications.

4.1.2. EOA TRD Source

The peak power and wavelength range failures cause much difficulty in decoding the temperature TRD sensor. The failure to meet the minimum peak power results in a weak sensor signal which is more susceptible to corruption by the source because the source fails wavelength range. The source wavelengths overlap the sensor signal wavelengths so the source corrupts the sensor signal. The peak power of source spectrum is from 650nm to 700nm, but the source has significant power extending to 1000nm. The sensor signal range is from 700nm to 900nm.

The source modulation depth could not be measured since the power level of the source could not be adjusted. The small source variation during normal operation aids sensor decoding because it helps provide a consistent sensor signal.

4.1.3. EOA CCD Array Receiver

The expected and actual results of these tests are in different units so the results are limited in value. The CCD receiver display relates power levels to CCD array pixel values instead of dBm, and a pixel value cannot be translated to dBm. The difference between pixel values, however, can be converted to dB so the range was calculated by this method. The calculated range is only good for room temperature since the noise and saturation levels change with temperature.

4.1.4. EOA TRD Receiver

These tests are not possible since there is no source power level adjustment or display.

WDM CCD SOURCE	SPEC.	EOA #1	P/F	EOA #2	P/F
Allowed Power Variation with Wavelength	≤ 6.0 dB	4.75 dB	P	2.4 dB	P
Allowed Power Variation with Wavelength	≤ 6.0 dB	1.75 dB	P	0.75 dB	P
Repeatability	≤ 8.0 dB	0.50 dB	P	1.125 dB	P
Power Spectral Density (PSD)	≥ –38.0 dBm/nm	–46.4 dBm/nm (max. is –41.3)	F	–45.6 dBm/nm (max. is –43.375)	F
Wavelength Range	≤ 750nm ≥ 900nm	None of the spectrum meets the PSD	F	None of the spectrum meets the PSD	F
Excitation Off Leakage	≥ 20 dB	19.1 dB	F	17.0 dB	F
Repetition Rate	100 +/– 1 pulses/sec	100 pulses/sec	P	100 pulses/sec	P
Source Duty Factor	90+/– 1%	89.6%	P	89.6%	P
Required Rise Time	< 100nsec	20.0 µsec	F	28.0 µsec	F
Required Fall TIme	< 100nsec	28.0 µsec	F	28.0 µsec	F
WDM TRD SOURCE					
Peak Power	≥–17.5dBm	-37.8 dBm	F	–34.0 dBm	F
Wavelength Range	> 650 nm < 675nm	650nm to 1000nm. None of the spectrum meets the PSD	F	650nm to 1000nm. None of the spectrum meets the PSD	F
Repetition Rate	≤ 1000 pulses/sec	996 pulses/sec	P	990 pulses/sec	P
Source Modulation Depth	≥ 15 dB	0.2dB of normal variation	N/A	source adjustment not possible	N/A
WDM CCD RECEIVER		EOA #1 and EOA #2 (Test results are the same)			
Saturation Level	≥ –60 dBm/nm	CCD array pixel value of 910 (actual value from sensor displays)			
Dark Current Level	≤ –86 dBm/nm	CCD array pixel value of 30 (value obtained from Litton)			
Dynamic Range (at room temperature only)	≥ 26 dB	29.5 dB (This is the calculated range, and it only applies at room temperature.)			
WDM TRD RECEIVER – Tests not possible: no source adjustment or receiver display.					

Optic Test Results for WDM CCD Array and TRD Source and Receiver
Table 1

4.2. Sensors

The optic sensor test results reflect the mixed success and failure of the sensors performance. In general, the digital and time rate of decay(TRD) sensors performed well, but the analog sensors performed poorly. The data in Table 2, Table 3, Table 4, and Table 5 shows the large variance in the code plate characteristics of similar sensors. Large differences even occur between the same sensors. These differences point to problems in the manufacturing process of the code plates.

4.2.1. Digital Sensors

The digital sensors meet most of the specifications, and the specifications which are not met did not prevent the EOA from decoding the sensors. However, those failures increased the difficulty of decoding the sensors. The sensor decoding algorithms had to be modified for the sensors with the worst optic failures so the EOA could decode them. Digital sensor data is in Table 2 and Table 3.

The contrast ratio failures of 5dB and below are the failures which make decoding the sensors difficult. The sensors with failures of 5dB or less – rudder 1, leading edge flap (LEF) 43 and 45, and power lever control (PLC) 1 – needed their decoding algorithms fine tuned to their optic spectrum in order for the EOA to be able to decode them. (The algorithm for PLC 1 was never revised because the optic code plate was found to be out of alignment, and it needed to be fixed before changing the algorithm. PLC 1 was not repaired.) Contrast ratio failures between 5dB and 6dB did not affect the ability of the EOA to decode those sensors.

The insertion loss failure of LEF 43 contributes to effects of its contrast ratio failure. The high insertion loss causes the sensor signal to be near the receiver noise level so the sensor signal is easily corrupted by receiver noise.

The wavelength range results for all of the sensors meet the specified range of 750nm to 900nm.

The channel width failures are either not large enough to effect sensor decoding or the widths of the channels are not an important factor in sensor decoding because the results of the channel width test do not correlate with the ability of the EOA to decode the sensors.

The guardband width results are not important. After most of the testing was completed, Litton revised their sensors' interface control documents and eliminated the specification for guardband width. This is permissible since the results do not correlate with the ability of the EOA to decode the sensors, and the locations of the guardbands in the sensor spectrums are not clear and were arbitrarily chosen during testing. The guardbands were originally specified so the EOA could easily distinguish between channels.

DIGITAL SENSORS	INSERTION LOSS (dB)			CONTRAST RATIO (dB)			WAVELENGTH RANGE (nm)		
	SPEC.	MEAS-URED	P/F	SPEC.	MEAS-URED	P/F	First Channel	Last Channel	P/F
Stabilator 1	≤ 24.0	21.0	P	≥ 6.0	6.8	P	758.6	861.8	P
Stabilator 2	≤ 24.0	16.6	P	≥ 6.0	9.0	P	759.0	864.6	P
Rudder 1	≤ 24.0	17.1	P	≥ 6.0	3.1	F	759.4	873.4	P
Rudder 2	≤ 24.0	17.6	P	≥ 6.0	6.6	P	758.6	867.4	P
Rudder Pedal 1	≤ 24.0	17.2	P	≥ 6.0	8.2	P	759.4	867.0	P
Rudder Pedal 2	≤ 24.0	21.7	P	≥ 6.0	5.4	F	765.8	867.0	P
Power Lever Control 1	≤ 24.0	22.5	P	≥ 6.0	4.8	F	753.0	877.4	P
Power Lever Control 2	≤ 24.0	19.0	P	≥ 6.0	5.9	F	760.2	885.0	P
Leading Edge Flap 43	≤ 28.0	29.4	F	≥ 6.0	5.4	F	778.6	886.6	P
Leading Edge Flap 45	≤ 27.0	22.6	P	≥ 5.0	1.6	F	777.8	888.6	P

Optic Test Results for Digital Sensors (part 1 of 2)
Table 2

DIGITAL SENSORS	NUMBER OF CHAN-NELS	CHANNEL WIDTHS (nm)				GUARDBAND WIDTHS(nm) (expect 2.5nm)	
		SPEC.	Smallest	Largest	P/F	Smallest	Largest
Stabilator 1	12	8.5 +/– 0.5	8.0	8.8	P	2.2	7.2
Stabilator 2	12	8.5 +/– 0.5	8.0	8.8	P	1.8	5.8
Rudder 1	13	8.5 +/– 0.5	8.0	8.8	P	2.2	3.8
Rudder 2	13	8.5 +/– 0.5	7.6	8.4	F	2.0	3.6
Rudder Pedal 1	13	8.5 +/– 0.5	7.6	8.8	F	2.0	3.8
Rudder Pedal 2	13	8.5 +/– 0.5	7.8	8.8	F	1.8	3.6
Power Lever Control 1	15	8.5 +/– 0.5	7.2	9.2	F	2.0	2.8
Power Lever Control 2	15	8.5 +/– 0.5	7.6	9.2	F	2.0	4.0
Leading Edge Flap 43	13	8.5 +/– **0.9**	7.6	9.6	P	N/A	N/A
Leading Edge Flap 45	13	8.5 +/– **0.9**	7.6	10.8	F	N/A	N/A

Optic Test Results for Digital Sensors (part 2 of 2)
Table 3

4.2.2. Analog Sensors

The analog sensors meet most of the specifications, and the specifications which were not met only slightly increased the difficulty of decoding the sensors. The fact that the analog sensors are noisy when decoded is mostly due to the EOA, however, the sensor dynamic range factors into the problem. Analog sensor data is in Table 4 and Table 5.

The reference integrity failures slightly increase the noise of the sensors during decoding, but they do not account for the poor integration test results. The pitch stick sensors will be used as an example. Pitch Stick 1 passes the reference integrity test by a large margin while Pitch Stick 2 fails the test by a significant margin, however, Pitch Stick 1 only performs slightly better than Pitch Stick2 in the integration tests in Table 10. The integration data contains the effects of internal EOA noise as well as the reference integrity failure effects, and the amount of noise attributed to each cannot be determined.

The dynamic range results are good, however, there are problems concerning dynamic range which include the variations between sensors. The specification of ≥7.5dB is half of the original interface control document value of 15dB. Reducing the dynamic range reduces the signal to noise ratio thus creating noisier sensor decoding. Even though the pressure sensor exceeds the specified dynamic range, the range is so small that the sensor value is greatly affected by small amounts of noise in the EOA decoding process. The pressure sensor vendor does not have this problem since they have an EOA and decoding algorithm tailored to the sensor.

The dynamic range variations between sensors resulting from an inability to produce a repeatable analog code plate is another problem affecting the sensor decoding. The trailing edge flap and nose wheel steering sensors' analog code plates were made the same yet the dynamic range varies widely. As a result, the EOA decoding algorithms were modified to work with the dynamic range of a specific sensor. This would not be necessary if the dynamic range were consistent or larger.

The insertion loss results are good except for the large variation between sensors. The only insertion loss failure, Pitch Stick 2, is very close to passing and is not a concern. The variation of insertion losses shows the inconsistency in the manufacturing process, but does not affect EOA decoding since the largest difference in insertion losses is 9.1dB which is much smaller than the ~30dB range of the EOA receiver.

The results of the number of channels, the channels widths, and the wavelength centers are satisfactory.

The rotary analog code plates of the trailing edge flap and nose wheel steering sensors all have anomalies on the ends of the optic tracks, however, the anomalies seemed to be just outside of the sensors' operational range so they are not a concern. Each end of an optic track is different, but in general, the reference and signal tracks are not consistent. In some cases, the reference is not a constant power level while the signal track is constant. In other cases, the signal track varies too much.

ANALOG SENSORS	INSERTION LOSS (dB)			DYNAMIC RANGE (dB)			REFERENCE INTEGRITY (dB)		
	SPEC.	MEAS-URED	P/F	SPEC.	MEAS-URED	P/F	SPEC.	MEAS-URED	P/F
Pitch Stick 1	≤ 20.0	15.7	P	≥ 7.5	8.0	P	≤–26.0	–67.1	P
Pitch Stick 2	≤ 20.0	20.2	F	≥ 7.5	8.2	P	≤–26.0	–13.3	F
Trailing Edge Flap 1	≤ 20.0	16.8	P	≥ 7.5	6.8	F	≤–26.0	–7.6	F
Trailing Edge Flap 2	≤ 20.0	11.1	P	≥ 7.5	9.9	P	≤–26.0	–19.4	F
Nose Wheel Steering 1	≤ 20.0	13.6	P	≥ 7.5	19.5	P	≤–26.0	–14.5	F
Nose Wheel Steering 2	≤ 20.0	19.1	P	≥ 7.5	10.6	P	≤–26.0	–1.6	F
Total Pressure 4030–32–01	≤ 17.5	16.8	P	≥ 2.7	2.9	P	≤–30.0	–59.4	P

Optic Test Results for Analog Sensors (part 1 of 2)
Table 4

ANALOG SENSORS	NUMBER OF CHAN-NELS	CHANNEL WIDTHS (nm)				WAVELENGTH CENTER (nm)	
		SPEC.	Reference	Signal	P/F	Reference	Signal
Pitch Stick 1	2	≤ 75	51.4	50.2	P	776.2	874.6
Pitch Stick 2	2	≤ 75	45.8	50.0	P	771.8	885.0
Trailing Edge Flap 1	2	≤ 75	50.6	49.8	P	777.0	875.4
Trailing Edge Flap 2	2	≤ 75	51.0	49.0	P	776.2	875.4
Nose Wheel Steering 1	2	≤ 75	50.2	49.8	P	777.4	875.4
Nose Wheel Steering 2	2	≤ 75	49.8	50.2	P	775.0	875.8
Total Pressure 4030–32–01	2	≤ 75	63.8	60.2	P	779.6	885.0

Optic Test Results for Analog Sensors (part 2 of 2)
Table 5

4.2.3. TRD Sensors

The TRD sensors pass the optic tests, and are the best sensors for providing duplicate results. The data for the TRD sensors is in Table 6.

The signal duration success is the key characteristic in determining that the sensors are performing properly. The duration of the sensor florescent time decay signal varies with temperature and determines the phase shift between the signal and the source. The EOA examines the phase shift between the signal and source signals to determine the temperature.

The power conversion efficiency for both temperature sensors actually passes if the entire sensor signal is taken into account instead of just the peak of the sensor spectrum. The test was conducted with just the peak of the source and signal spectrums and reflects a failure as a result. The test was performed this way due to the misunderstanding that the TRD receiver uses only the peak spectrum values. The TRD receiver actually uses the entire signal spectrum.

TRD SENSORS	SIGNAL DURATION(μsec) (@ room temp.)			POWER CONVERSION EFFICIENCY (dB)			CHANNEL CHARACTERISTICS		
	SPEC.	MEAS-URED	P/F	SPEC.	MEAS-URED	P/F	# of Chan.	Channel Width	Channel Center
Total Temperature 2	175 +/– 125	280	P	≥ -28	–49.7	F	1	36.0 nm	753 nm
Total Temperature 3		270	P	≥ -28	–48.0	F	1	36.0 nm	753 nm

Optic Test Results for TRD Sensors
Table 6

5. INTEGRATION TEST RESULTS

5.1. EOA

EOA #1 passed all of the functional tests. These were used to provide a quick test of EOA operation. The data is summarized in Table 7. The EOA chassis is able to thermally dissipate approximately 100 Watts without cooling air so it will be able to easily dissipate 65.4 Watts. The optic functions and the electrical data bus performed as expected. The optic to electric conversion and the sensor value decoding were not checked in the functional tests.

EOA #2 performs better than EOA #1 by decoding sensors with less noise and by operating reliably. This is due in part to optical differences explained in section 4.1.1.3. EOA #1 also has had the 1553 bus stop updating on many occasions including the altitude test, the vibration test, and when EOA #1 was powered for long periods of time with no tests being performed. This seems to be due to software halting in the decoding processor module. The root caused may be due to internal EOA noise which could be generated by many sources, several high frequency clocks, high frequency 1553 data transfers, power supply switching, or decoding modules activity. A similar problem was present before the data acquisition card's printed wiring board (PWB) was re–laid out to use better methods of electrical PWB lay out. The solution to the loss of EOA #1 1553 updates is to turn off power to EOA #1 and then turn on power; EOA #1 always returns to normal operation. EOA #2 has never had this problem. This is probably due to EOA #2's decoding modules being less receptive to internal noise. This may also explain why EOA #2 decodes sensors with less noise than EOA #1.

EOA decoding noise is dependent on the environment and may be high frequency noise affecting the CCD optic receiver. The receiver operates with very low power levels and is therefore more susceptible to noise than other electronics. Decoding noise is not as pronounced when the modules are on the vendor's development backplane as it is when the modules are in the EOA chassis. On vendor backplane, the modules are not as close to each other, the 1553 data bus does not run next to the modules, and an inherently noisy switching power supply is not used. The confined EOA chassis is a different environment than the open development backplane so it is not unusual that the modules operate a little differently in the two environments.

EOA FUNCTIONAL TEST	EOA FUNCTIONAL TEST RESULTS		
	Expected	Actual	P/F
Power Dissipation	≤ 76.5 Watts	65.4 Watts	P
1553 Multiplex Bus	No errors in transmission and good data transfer.	Good data transfer. A nuisance error is reported, but it does not affect the data transfer. Suspect the test equipment is the source of the problem since the problem has been seen on other non–FOCSI tests.	P
EOA Spectrum Analyzer Mode	Source and all sensors (except temp. sensor) visible on display.	Source and all sensors except the temperature sensor are visible on the display. Digital sensors show a good digital pattern, and the analog sensors show the reference and signal channels. The attenuation for each sensor was adjusted so all sensors fell within the receiver range.	P

Integration Test Results for EOA
Table 7

5.2. Digital Sensors

The EOA performs very well in decoding digital sensors that can be decoded, however, a small amount of noise does cause a few failures. EOA decoding noise is discussed in section 5.1. Good performance is expected since the EOA vendor also made the digital sensors except for the leading edge flap which could not be decoded.

5.2.1. Stabilizer Sensor

The EOA decodes the stabilizer sensor fairly well. The decode value is quite stable, although, there is some intermittent noise which causes the failures in the null offset and resolution tests. The overall results are good.

5.2.2. Rudder Sensor

EOA #1 cannot decode rudder 1, and EOA #2 has difficulty decoding rudder 1. This is probably due to the optical contrast ratio of less than 5.0dB. With EOA #2, the sensor output looks noisy which is reflected in the integration data, although, rudder 1 still performs fairly well. When rudder 1 was returned to the vendor for testing, the decoding algorithm was changed to so rudder 1 performed very well, however, rudder 2 cannot use the same algorithm. The flight EOA rudder decoding algorithm is dependent on which rudder is flying.

The EOA decodes rudder 2 sensor very well. The decode value is quite stable, although, there is some intermittent noise which causes the failure in the null offset test. The overall results are good. The rudder and rudder pedal sensors are the same, and the decode algorithms are only slightly different.

5.2.3. Rudder Pedal Sensor

The EOA decodes the rudder pedal sensors better than any other sensor. The range and resolution results are excellent, the linearity results are almost perfect, and there is hardly any noise in the decoded sensor signals. The only failure, by rudder pedal sensor 2, is very close to passing and is not a concern. The rudder pedal and rudder sensors are the same, and the decode algorithms are only slightly different.

5.2.4. Power Lever Control Sensor

Neither EOA can decode power lever control 1. This is probably due to an optical contrast ratio of less than 5.0dB, or the sensor may have been damaged before the integration tests. When this sensor was returned to the vendor for testing, it was reported that the sensor was broken; the code plate was shifted and the shaft did not turn as freely as it should. The sensor may have been damaged before the integration tests were performed.

EOA #2 decodes power lever control 2 very well while EOA #1 cannot decode the sensor. This is due to the different optics in the EOAs explained in section 4.1.1.3. Power lever control 2 has its last channel at a wavelength of 885nm which is close to the limit of 900nm. EOA #1 does not receive signals as well as EOA #2 at this end of the spectrum, and the performance of power lever control2 is proof.

5.2.5. Leading Edge Flap Sensor

The EOA decoding algorithms could not decode either leading edge flap sensor. Both sensors had optic failures which contributed to the decoding problem; see the optic test results in section 4.2.1. However, the main reason was due to the wide variation of the wavelength of the first channel on the code plate as the sensor was moved through its full stroke. The decoding algorithm searched for each channel, and because the location varied so much, the algorithm needed more time than the EOA update rate would allow.

The decoding algorithms were changed after integration tests were performed at McDonnell Douglas so the leading edge flap sensors could be decoded. The algorithms were written to find the data channels at specific wavelengths. As a result, the algorithms will not decode the sensors if the data channels move from their initial locations. This could occur if the code plate shifts even slightly.

DIGITAL SENSORS	NULL OFFSET (inches unless specified)			RESOLUTION (inches unless specified)		
	Specified	Measured	P/F	Specified	Measured	P/F
Stabilator 1	≤ +/–0.018	+/– 0.045	F	≤ +/–0.018	0.002	P
Stabilator 2	≤ +/–0.018	+0.052, –0.073	F	≤ +/–0.018	0.022	F
Rudder 1	≤ +/–0.0032	+0.007, –0.011	F	≤ +/–0.0032	0.001	P
Rudder 2	≤ +/–0.0032	+/–0.002	P	≤ +/–0.0032	0.002	P
Rudder Pedal 1	≤ +/–0.0045	+/–0.001	P	≤ +/–0.0045	0.002	P
Rudder Pedal 2	≤ +/–0.0045	+0.004, –0.005	F	≤ +/–0.0045	0.002	P
Power Lever Control 1	≤+/–0.325deg	Not Decoded		≤+/–0.325deg		
Power Lever Control 2	≤+/–0.325deg	+/–0.064deg	P	≤+/–0.325deg	0.079 deg	P
Leading Edge Flap 43	≤ +/–0.30deg	Not Decoded *		≤ +/–0.30deg		
Leading Edge Flap 45	≤ +/–0.30deg	Not Decoded *		≤ +/–0.30deg		

Integration Test Results for Digital Sensors (part 1 of 2)
Table 8

DIGITAL SENSORS	RANGE (inches unless specified)			LINEARITY				
				Slope	Con-stant	Standard Deviation		P/F
	Spec.	Measured	P/F			Specified	Meas.	
Stabilator 1	+/– 3.56	+/– 3.56	P	0.996	0.008	≤+/–0.0356	0.034	P
Stabilator 2	+/– 3.56	+/– 3.56	P	0.989	–0.009	≤+/–0.0356	0.051	P
Rudder 1	+/–0.665	+/– 0.665	P	0.986	–0.004	≤+/–0.0033	0.014	P
Rudder 2	+/–0.665	+/– 0.665	P	0.996	0.002	≤+/–0.0033	0.008	P
Rudder Pedal 1	+/–0.750	+/– 0.750	P	0.999	0.001	≤+/–0.0019	0.002	P
Rudder Pedal 2	+/–0.750	+/– 0.750	P	1.000	0.001	≤+/–0.0019	0.004	P
Power Lever Control 1	0.000 to 130.000 degrees			Not Decoded		≤ +/– 0.175		
Power Lever Control 2		0.000 to 130.000	P	0.993	–0.539	≤ +/– 0.175	0.563	P
Leading Edge Flap 43	+ 36, – 7 degrees			Not decoded*		≤ +/– 0.675 degrees		
Leading Edge Flap 45				Not decoded*				

* Before the decoding algorithms were changed at the EOA vendor.

Integration Test Results for Digital Sensors (part 2 of 2)
Table 9

5.3. Analog Sensors

The EOA performs poorly in decoding analog sensors for several reasons: the EOA decoding noise discussed in section 5.1., poor optical reference integrity test results slightly increase the decoding noise, and the decoding algorithms are dependant upon a consistent dynamic range (which did not occur) for the similar analog sensors. The last reason is due to the fact that the EOA vendor did not have the sensors to work with when writing the decoding algorithms so the algorithms were not tailored to the specific dynamic range of the sensors.

5.3.1. Pitch Stick Sensor

Pitch stick 2 broke during integration testing so the linearity data was not obtained. A small amount of strain was applied to the sensor and it broke apart. The mechanical design was very poor in that the two halves of the sensor were butt coupled and held together only by glue.

The EOA decoding of the pitch stick sensors is the best of the analog sensors, however, a slightly incorrect expected dynamic range caused the range and linearity results to fail. The decoding noise does not affect these sensors as much as the other analog sensors, but the noise does cause the null offset results to fail.

After the decoding algorithm was tailored to the correct dynamic range, the pitch stick sensor performs fairly well. EOA noise still prevents this sensor from providing excellent performance.

5.3.2. Trailing Edge Flap Sensor and Nose Wheel Steering Sensor

The nose wheel steering and trailing edge flap sensor code plates were made the same, and the decoding algorithms are only slightly different, yet the decoded performance of the sensors varies widely due to the wide variation in dynamic range. Only trailing edge flap 1 is decoded over the entire range with any accuracy to the amount of shaft movement. The other decoded sensor values either fail to relate to the shaft movement or only a portion of the shaft movement is decoded.

After the decoding algorithms were tailored to the dynamic ranges of these sensors, the decoded sensor performance improved, but the overall decoded performance is still poor. The decoded values are very noisy, and the sensors' linearity is poor.

5.3.3. Total Pressure Sensor

The EOA decoding algorithms could not decode the pressure sensor because the equation for the sensor signal received from the sensor vendor did not fit the location and dynamic range of the sensor as seen by the EOA CCD receiver. Modified algorithms enabled the decoded sensor value to wok over a portion of the pressure sensor range, but not enough to do integration tests on the sensor.

The decoding algorithms were changed after integration tests were performed at McDonnell Douglas so the pressure sensor could be decoded over its full range. The algorithms were written for linear operation of the pressure sensor even though the sensor vendor used a third order equation to approximate the sensor response and get the desired accuracy from the sensor. The person writing the decoding algorithm felt that there was less error in using the linear method.

ANALOG SENSORS	NULL OFFSET (inches unless specified)			RESOLUTION (inches unless specified)		
	Specified	Measured	P/F	Specified	Measured	P/F
Pitch Stick 1	≤ +/–0.010	+0.030, –0.039	F	≤ +/–0.010	0.003	P
Pitch Stick 2	≤ +/–0.010	+0.047, –0.053	F	≤ +/–0.010	0.004	P
Trailing Edge Flap 1	≤ +/–0.049in	+/– 0.123 in	F	≤+/–0.898deg	0.567deg	P
Trailing Edge Flap 2	≤ +/–0.049in	+0.075,–0.076in	F	≤+/–0.898deg	0.099deg	P
Nose Wheel Steering 1	≤ +/– 0.186 degrees	+2.273, –2.419 degrees	F	≤ +/– 0.186 degrees	0.265 degrees	F
Nose Wheel Steering 2	≤+/–0.186deg	+/– 0.953 deg	F	≤+/–0.186deg	0.773deg	F
Total Pressure 4030–32–01	Neither EOA #1 nor EOA #2 could decode the pressure sensor at the time of the integration testing at McDonnell Douglas.					

Integration Test Results for Analog Sensors (part 1 of 2)
Table 10

ANALOG SENSORS	RANGE (inches unless specified)			LINEARITY				
				Slope	Con-stant	Standard Deviation		P/F
	Spec.	Measured	P/F			Specified	Meas.	
Pitch Stick 1	+2.02 –1.01	+1.950 ** –0.763 **	F	0.976	0.047	≤+/–0.0202	0.087	F
Pitch Stick 2	+2.02 –1.01	+2.02 –0.783 **	F	Pitch Sensor 2 broke before the linearity data was taken.				
Trailing Edge Flap 1	+/– 4.05	+/– 4.05	P	1.219	–0.075	≤+/–0.0405	0.719	F
Trailing Edge Flap 2	+/– 4.05	+4.05 –0.820 **	F	–0.386	–2.558	≤+/–0.0405	0.046	F
Nose Wheel Steering 1	+/–75.00 degrees	+/–75.000 degrees *	F	0.992	18.749	≤ +/–0.188	18.383	F
Nose Wheel Steering 2	+/–75.00 degrees		F	1.067	0.459	≤ +/–0.188	7.721	F
Total Pressure 4030–32–01	Neither EOA #1 nor EOA #2 could decode the pressure sensor at the time of the integration testing at McDonnell Douglas.							

* Even though the full range is covered, the measured value has no relationship with the reference.
** These measured values are before the decoding algorithms were changed at the EOA vendor.

Integration Test Results for Analog Sensors (part 2 of 2)
Table 11

5.4. TRD Temperature Sensors

The conventional platinum resistance thermometer (PRT) elements performed well, but the optic temperature sensor decoding performed poorly as shown in the data summarized in Table 12. The accuracy of the PRT elements, tested in an ice bath, were very stable; the results were so good that a second test point was not needed. Comparing the tracking of the decoded optic sensor value to the PRT element revealed the optic decoding was not working between 360^{0}R and 410^{0}R, and the error was as much as 36^{0}R from 410^{0}R to 580^{0}R. The graphs of the optic sensor to PRT element tracking are in the temperature sensor section of the Integration Test Plan data sheets in APPENDIX A.

The poor range of the optical temperature decoding is probably due to the decoding algorithms being fine tuned to a different Rosemount optical sensor than is used in the integration tests. The decoding algorithms were later fine tuned to the optical sensors used in integration testing.

The noise and poor tracking of the optical temperature sensor is probably due in part to the optic source used to excite the fluorescent sensor. Examining the optic sensor and source data sheets in APPENDIX A show that the source wavelengths overlap the sensor signal wavelengths. Even though an optical filter was used to block the source at the sensor signal's peak wavelengths, much of the sensor signal is blended with the source. The small section of the sensor signal that is unaffected by the source may not be enough for the optic receiver to obtain a consistent signal.

<table>
<tr><th rowspan="2">TRD SENSORS</th><th colspan="4">PRT ELEMENT RESISTANCE (@ 32^{0}C)</th><th colspan="4">GEN. THERMAL. DIFFERENCE BE-TWEEN PRT & TRD</th><th colspan="3">INITIAL CHECKOUT</th></tr>
<tr><th>Spec.</th><th>PRT 1</th><th>PRT 2</th><th>P/F</th><th>Spec.</th><th>Max.</th><th>Min.</th><th>P/F</th><th>Spec.</th><th>Measured</th><th>P/F</th></tr>
<tr><td>Total Temperature S/N 2</td><td>50.00 +/− 0.05Ω</td><td>49.992 ohms</td><td>49.995 ohms</td><td>P</td><td>≤ +/− 0.50^{0}F</td><td colspan="3">No optical tests performed due to poor perfor-mance of S/N3.</td><td>≤ 2.0^{0}F</td><td rowspan="2">Unstable and noisy. Much greater than 2.0^{0}F.</td><td>F</td></tr>
<tr><td>Total Temperature S/N 3</td><td>50.00 +/− 0.05Ω</td><td>50.038 ohms</td><td>50.008 ohms</td><td>P</td><td>≤ +/− 0.50^{0}F</td><td>36^{0}R</td><td>1^{0}R</td><td>F</td><td>≤ 2.0^{0}F</td><td>F</td></tr>
</table>

Integration Test Results for TRD Sensors
Table 12

5.5. Sensor Results After Decoding Algorithms Changed

The leading edge flap (LEF), temperature, and analog sensor decoding algorithms were changed by the EOA vendor after the integration tests at McDonnell Douglas. The LEF sensors were able to be decoded, and their performance appeared to equal the performance of the other digital sensors. The temperature sensor algorithms were tuned to the individual sensors so the specified temperature range was met, but the temperature sensors are still much too noisy. The Pitch Stick, trailing edge flap, and nose wheel steering sensor algorithms were changed so those sensors met the range specifications. Their linearity performance was improved but not enough to meet the specifications. Their null offset and resolution performance was not improved.

6. ENVIRONMENTAL TEST RESULTS

6.1. Pressure Sensor

The pressure sensor was environmentally tested at MDC since Babcock & Wilcox did not complete environmental testing. The pressure sensor survived all environmental testing: temperature, altitude, and vibration. The environmental test profiles are the same as the EOA environmental profiles and are contained in the Environmental Test Plan in APPENDIX A.

6.2. EOA

6.2.1. Temperature Test

EOA #2 survived the thermal test chamber temperature range of -30^0C to 75^0C, however, the EOA did not decode all of the sensors over that range. The test results summarized in Table 13 show the EOA's success in decoding digital sensors and the EOA's difficulty in decoding analog sensors.

The EOA performance with the digital sensors during the thermal test was excellent. The digital sensors were decoded over the full EOA temperature range, and the sensor values were steady. The two exceptions, rudder and leading edge flap(LEF), were due to problems not related to the thermal test, the rudder connection to the EOA and the EOA decoding algorithm for the LEF. The ability of the EOA to decode the digital sensors is independent of the EOA temperature.

The EOA performance with the analog sensors during the thermal test was poor. The sensors were decoded over very little of the EOA temperature range, and the sensor values were noisy which is normal even at room temperature. The pitch stick was decoded over 50% of the EOA temperature range, the trailing edge flap 29%, and the nose wheel steering 14%. These results agree with the EOA vendor tests which show the EOA has decreasing dynamic range for receiving analog sensors as the EOA temperature approaches the extremes, and at the extremes, there is zero dynamic range. The ability of the EOA to decode the analog sensors is very dependent on the EOA temperature.

The reasons for the poor performance of the EOA decoding the analog sensors are that analog sensor decoding is power level dependent, and the shape of the LED output power spectrum changes with temperature. The decoding algorithms were written to try to take out the effects of the source spectrum shape but were not totally successful since the analog sensor decoding is very EOA temperature dependent.

SENSOR	SENSOR VALUE	SENSOR IS SUCCESSFULLY DECODED OVER EOA#2 TEMPERATURE RANGE OF:	
Digital Sensors			
Power Lever Control 2	97.5 deg.	Full Range of -30^{0}C to 75^{0}C	
Rudder Pedal 2	0.293 in.	Full Range of -30^{0}C to 75^{0}C	
Stabilizer 2	–3.212 in.	Full Range of -30^{0}C to 75^{0}C	
Rudder 2	–0.496 in.	Rudder is sometimes decoded throughout full range.	
Leading Edge Flap 43	Not Decoded	EOA unable to decode LEF sensor during thermal test.	
Analog Sensors			
		Successful Decoding Over EOA#2 Temp. Range Of:	Direction of Temperature Change
Pitch Stick 1	~–0.330 in.	26^{0}C to -30^{0}C+5minutes	Decreasing
		10^{0}C to 60^{0}C	Increasing
		none	Decreasing
Trailing Edge Flap 1	~1.2 in.	26^{0}C to -10^{0}C	Decreasing
		30^{0}C to 55^{0}C	Increasing
		25^{0}C+10min. to 25^{0}C+15min.	Decreasing
Nose Wheel Steering 2	~26 deg.	26^{0}C to -5^{0}C	Decreasing
		none	Increasing
		none	Decreasing
Total Pressure	Not Connected	EOA software is not able to decode the pressure sensor at room pressure during thermal test.	
TRD Sensor			
Temperature	Not Connected	EOA software is not able to decode the temperature sensor at room temperature during thermal test.	

EOA Thermal Test Results
Table 13

6.2.2. Altitude Test

EOA #1 survived the altitude test chamber range of room altitude to 50,000 feet. Room pressure was 743 Torr or 29.3 in Hg. The chamber temperature range was 23.7^{0}C to 32.5^{0}C, and the internal EOA temperature range was 24.1^{0}C to 41.5^{0}C. The EOA stopped updating the 1553 bus during a portion of the test, however, this failure was not related to the altitude test. The test results summarized in Table 14 show the EOA's success in decoding all of the sensors during the altitude test. A technical memorandum was prepared by the laboratory performing the altitude test; the memo is located in the altitude data sheets in the Environmental Test Plan in APPENDIX A.

EOA #1 performance during the altitude test was acceptable. The noisy sensor values and the loss of 1553 bus updates tarnished the results, but these problems were not a result of the altitude test. The ability of the EOA to decode the sensors is independent of the EOA altitude. Since the sensors were decoded equally well throughout the test, and in normal operation, EOA #1 reports noisy sensor values much more than EOA #2, the noisy sensor values are not a failure of the altitude test. The loss of 1553 updates is also not a failure of the altitude test and is explained in 5.1.

SENSOR	SENSOR VALUE	SENSOR IS SUCCESSFULLY DECODED OVER EOA#1 ALTITUDE RANGE OF:
Digital Sensors		
Power Lever Control 2	Not Connected	The Power Lever Control Sensor was not available for the altitude test.
Rudder Pedal 2	~0.121 in.	Full Range of 743 Torr to 50,000 feet
Stabilizer 2	–2.210 in. & –2.161 in.	Full Range of 743 Torr to 50,000 feet. The position was changed during test as part of troubleshooting.
Rudder 2	~–0.118 in.	Full Range of 743 Torr to 50,000 feet
Leading Edge Flap 43	Not Decoded	EOA unable to decode LEF sensor during altitude test.
Analog Sensors		
Pitch Stick 1	~1.2 in.	Full Range of 743 Torr to 50,000 feet
Trailing Edge Flap 1	~1.4 in.	Full Range of 743 Torr to 50,000 feet
Nose Wheel Steering 2	~41 deg.	Full Range of 743 Torr to 50,000 feet
Total Pressure	Not Connected	EOA software is not able to decode the pressure sensor at room pressure during altitude test.
TRD Sensor		
Temperature	Not Connected	EOA software is not able to decode the temperature sensor at room temperature during altitude test.

EOA Altitude Test Results
Table 14

6.2.3. Vibration Test

EOA #1 survived the vibration tests, and the vibration did not affect the sensor decoding, however, there were failures that were corrected and re–tested and one failure that was not corrected. The vibration testing consisted of a sinusoidal resonance survey, a random performance test, and a minimum structural rigidity test in each of the three axes. A technical memorandum was prepared by the laboratory performing the vibration testing; the memo is located in the vibration data sheets in the Environmental Test Plan in APPENDIX A along with sensor data for the vertical axis.

The failure that was not corrected occurred on an already environmentally qualified power supply supplied by the Navy Standard Hardware And Reliability Program (SHARP). The failure was not corrected and retested since all of the performance tests had been completed, and the failure occurred during the structural rigidity test which is not required by NASA Ames–Dryden Flight Research

Facility Process Specification No. 21–2 Environmental Testing of Electronic and Electromechanical Equipment. An examination of the power supply revealed the leads of a transformer had sheared because of inadequate support. (Adequate support was provided in later models of the power supply.)

The purpose of the three vibration tests is to determine if the EOA will survive the aircraft vibration environment. The resonance survey locates the frequencies at which the EOA is vulnerable. The performance test requires the equipment operate during the vibration profile and shows the equipment will survive at least fifty flight hours. The minimum structural rigidity test does not require the equipment to operate and verifies the equipment is structurally sound.

The first failure occurred during the vertical axis performance test. The 1553 bus stopped updating, and the failure was isolated to one of the two 1773/1553 converter modules. A loose nut and two washers were found inside the chassis, and a screw was found outside the chassis. The two converter modules were removed, and the 1553 data bus line was jumpered to bypass the 1773/1553 converter modules. The loose mounting hardware was replaced and secured with Locktite. Testing continued without the converter modules. The 1773/1553 converter module failure was attributed to an electrical short caused by the loose mounting hardware.

The second failure occurred during the vertical axis minimum structural rigidity test. The 1553 bus again stopped updating, and the failure was isolated to 1553 bus controller module; an oscillator chip had sheared at the leads. Also, several capacitors had sheared off of the optic receiver module. None of the sheared parts had glue attaching them to the printed wiring board (PWB). The modules were repaired, and on all modules, all of the components which were not glued to the PWBs were glued. This improvement was implemented on the set of flight modules. Testing continued.

The vibration testing continued through the lateral axis and through the longitudinal axis sinusoidal and performance tests without failure, however, two anomalies occurred. The first was not related to vibration testing. The 1553 bus stopped updating several times during and between vibration tests. Turning the power to the EOA off and then on always restored normal operation. This is the same anomaly explained in section 5.1. The other anomaly may have been related to the minimum structural vibration test since it occurred during part of both the vertical and longitudinal axes minimum structural vibration tests even though it did not occur during the lateral axis minimum structural vibration test. It dealt with the optic spectrums reported by the EOA CCD array receiver. A new method of monitoring the sensors was used after the last failure. Instead of monitoring the sensor positions, the raw optical sensor data was monitored. For a portion of the minimum structural rigidity tests, the optic data power levels jumped around quite a bit but maintained their shapes unless they saturated the receiver. The anomaly was not a concern since the equipment did not need to operate during the minimum structural rigidity test, and the spectrum shapes were stable.

The last failure occurred during the longitudinal minimum structural rigidity test, and has already been discussed. The power supply failed during the test.

6.2.4. Electromagnetic Interference (EMI) Test

EOA #1 failed to meet the conducted and radiated emission limits in MIL–STD–461 Part 2 due to spikes in the data; the majority of the conducted and radiated emissions data meets those limits. EMI data sheets are in the EMI section of the Environmental Test Plan in APPENDIX A. EMI experts have examined this data and do not feel that the EOA poses an EMI threat to the aircraft since the outages are few and the majority of the outages are small.

EOA #1 was a good EMI test article since it probably has more emissions than EOA #2 based on the performance of the two EOAs. EOA #2 has never failed while EOA #1 has stopped updating the 1553 bus. This was probably due to internal EOA emissions causing errors in the optic decoding modules.

The antennae types used in this test are: rod for 14kHz to 25MHz, biconical for 25MHz to 200MHz, log spiral for 200MHz to 1GHz, and a different size log spiral for 1GHz to 10GHz. The data plots in the EMI section of the Environmental Test Plan contain narrowband and broadband data for each frequency. The data taken with the biconical antenna includes horizontally and vertically polarized antenna data.

APPENDIX A Test Plans and Data Sheets for Optic, Integration, and Environmental Tests

APPENDIX A

FOCSI EOA and SENSOR TEST PLANS and DATA SHEETS

(OPTIC, INTEGRATION, AND ENVIRONMENTAL TEST PLANS)

AVIONICS INTEGRATION CENTER
MCDONNELL DOUGLAS CORPORATION
SAINT LOUIS, MISSOURI

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FOCSI EOA and Sensor Optic Test Plan

Rev. 4/15/93

1.0 SCOPE

This test plan establishes the documents, equipment, and procedures necessary to verify the optical performance of the McDonnell Douglas Corporation (MDC) Fiber Optic Control System Integration (FOCSI) Electro–Optic Architecture (EOA) and the FOCSI Fiber Optic Sensors.

2.0 APPLICABLE DOCUMENTS

The following documents of the issue shown form a part of this test plan to the extent specified.

2.1 McDonnell Douglas Corporation Documents

WS–AD–3239 Rev. A   Electro–optic Architecture Procurement Specification

WS–AD–3238 Rev. A   Fiber Optic Sensor Procurement Specification

EOA Interface Control Document (ICD) 21 May 1991 (FOCSI Electro–Optic Architecture ICD)

Stabilizer Sensor Interface Control Document (ICD) (FOCSI Fiber Optic Sensor ICD)

Rudder Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Pitch Stick Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Rudder Pedal Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Trailing Edge Flap Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Leading Edge Flap Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Power Lever Control Angle Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Nose Wheel Steering Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Total Pressure Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Air Data Temperature Sensor ICD 13 March 1991 (FOCSI Fiber Optic Sensor ICD)

3.0 SUMMARY

3.1 Test Plan Objective

The objective of the test is to verify the optical performance of the EOA and the sensors. This will be accomplished by comparing the optic performance of the EOA and sensors to the expected performance listed in the corresponding Procurement Specifications and ICDs.

3.2 Location

All tests will be performed at the MDC Avionics Laboratories or Environmental Test Facilities.

3.3 Standard Conditions

All tests shall be performed at prevailing laboratory temperatures, barometric pressures, and humidities unless otherwise specified.

3.4 Equipment

The test equipment consists of commercially available equipment and is listed in Table I. The equipment setup is shown in Figure 1.

3.5 Specific Tests

3.5.1 EOA Tests

3.5.1.1 *WDM Analog and Digital Source Tests*

3.5.1.1.1 Allowed Power Variation with Wavelength and Time Test

The source power must not vary greatly over wavelength or time so the sensors are provided with a stable power source. Examining the source fluctuations at power up and at another time many minutes after power up will determine the power variation with wavelength and time.

3.5.1.1.2 Repeatability Test

The source power must be repeatable each time it is used so the sensors are provided with a consistent power source. Comparing the source power values between a powered up state and other powered up states will determine the repeatability of the source.

3.5.1.1.3 Minimum Power Spectral Density Test

The source must provide sufficient power for the sensors to operate correctly. Examining the minimum power of the full strength source will determine the minimum power spectral density.

3.5.1.1.4 Wavelength Range Test

The source must produce power in the wavelengths needed to excite the sensors. Examining the minimum and maximum wavelengths which meet the minimum power spectral density will determine if the correct wavelength range is produced.

3.5.1.1.5 Maximum Excitation Off Leakage Allowed Test

A source which is off must not leak enough power to excite the sensors. Comparing the power generated when the source is on with the power generated when the source is off will determine if the excitation off leakage is below the maximum value allowed.

3.5.1.1.6 Repetition Rate and Source Duty Factor Test

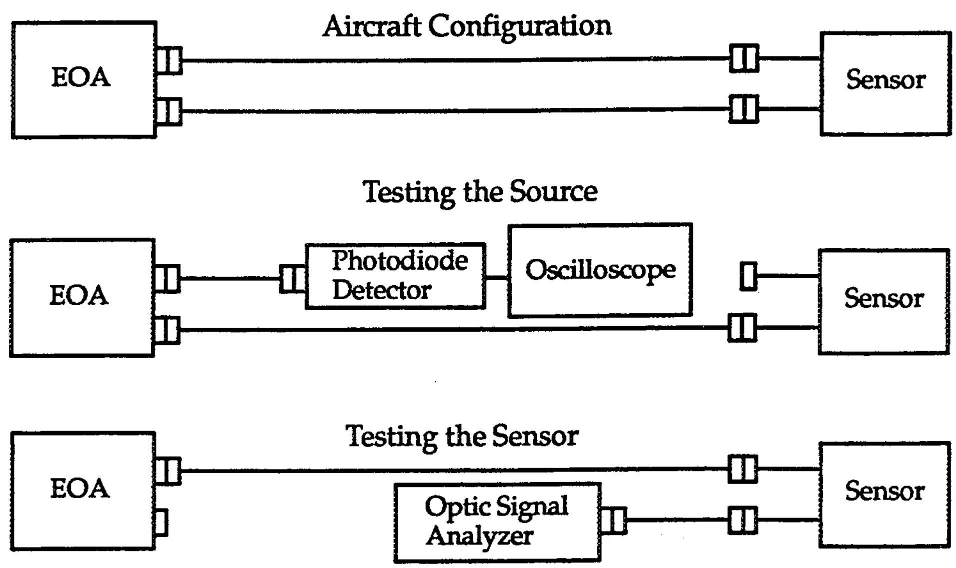
The source must produce pulsed excitation to allow the receiver to transfer information during the source off time. The source on time affects the resolution of the sensor while the frequency of the excitation affects the maximum update rate of the sensor. Examining the period and the on and off times of the excitation will determine the repetition rate and source duty factor.

3.5.1.1.7 Required Rise and Fall Time Test

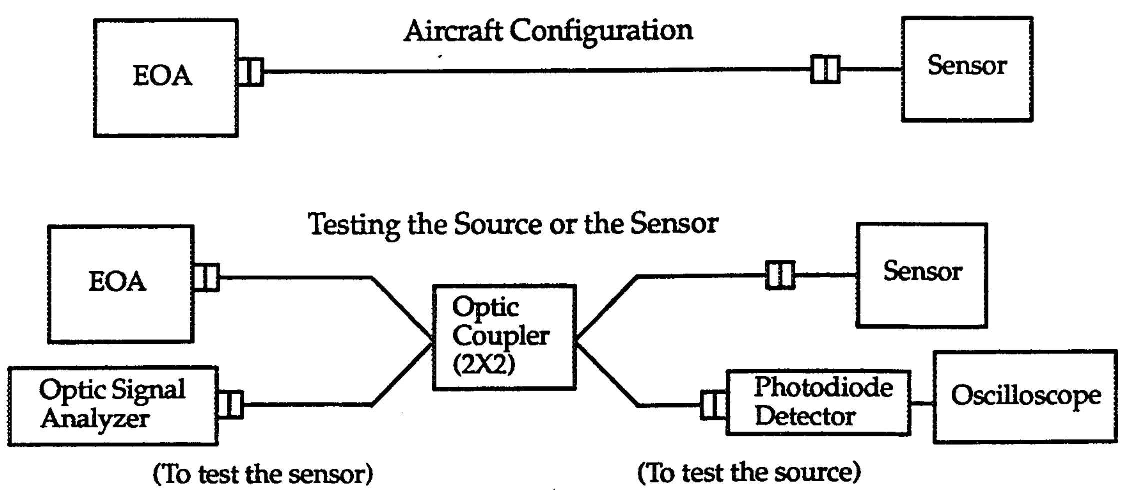
The pulsed source must produce quick on/off transitions so a source which is slow to turn on does not fail to excite the sensors or so a source which is slow to turn off does not continue to excite the sensors. Examining a rising and falling edge will determine the rise and fall times.

Optic Test Configuration for the Following Sensors (100/120/138 fiber):

Stabilizer	Rudder Pedal	Power Lever Control
Rudder	Trailing Edge Flap	Nose Wheel Steering
Pitch Stick	Leading Edge Flap	Total Pressure



Optic Test Configuration for the Temperature Sensor (200/220/235 fiber):



Note: 1. The photodiode/oscilloscope and the signal analyzer detectors can be used to test both the source and the sensor; the positions in the above diagrams are just examples.
2. The optic cable line lengths so not represent relative or specific lengths.

Optic Testing Configuration
Figure 1

3.5.1.2 *WDM Analog and Digital Receiver and WDM TRD Receiver Tests*

3.5.1.2.1 Saturation and Noise Level Test

The receiver is able to decode sensor signals if the signals are within the power density range of the receiver. Decreasing the power to the receiver while monitoring the power to the receiver as the receiver output signal changes from being clipped due to receiver saturation to not being clipped will determine the saturation level of the receiver.

Increasing the power to the receiver while monitoring the power to the receiver as the receiver output signal changes from containing noise from the receiver noise level to containing no noise from the receiver noise level will determine the noise level of the receiver.

3.5.1.2.2 Dark Current Level Test

The receiver has a noise level due to electron excitation which is dependent upon temperature even when there is no signal into the receiver. This noise level is the dark current. After the receiver has reached its operating temperature, examining the power reported by the receiver when there is no input to the receiver will determine the dark current level of the receiver.

3.5.1.3 *WDM TRD Source Tests*

3.5.1.3.1 Minimum Peak Power Test

The source must provide sufficient power for the sensors to operate correctly. Examining the smallest peak power of a full strength source will determine the minimum peak power.

3.5.1.3.2 Wavelength Range Test

The source must produce power in the wavelengths needed to excite the sensors. Examining the minimum and maximum wavelengths which meet the minimum peak power will determine if the correct wavelength range is produced.

3.5.1.3.3 Maximum Repetition Rate Test

The frequency of the sinusoidal source must be sufficient to maintain an adequate update rate but must not be too great so the sensor is saturated. Examining the period of the sine wave source will determine the maximum repetition rate.

3.5.1.3.4 Minimum Source Modulation Depth Test

The maximum strength to minimum strength range of the source determines the amount of source adjustment that can be performed to account for problems with attenuation or saturation in the system. Examining the power at the maximum source strength and at the minimum source strength will determine the source modulation depth.

3.5.2 Sensor Tests

3.5.2.1 Sensor Insertion Loss Test

The power attenuation of the sensor must not cause the sensor output to be in the receiver noise level. For the digital sensors, the insertion loss is calculated for the sensor signal wavelength. For the analog sensors, the insertion loss is calculated for the signal and reference wavelengths. Comparing the optic power output of the source and cables with the optic power output of the source, cables, and sensor will determine the sensor insertion loss.

3.5.2.2 Contrast Ratio Test

For digital sensors, the power leakage between the high and low signals within one channel must not interfere with the ability of the receiver to distinguish between high and low states. Comparing the maximum and minimum optic power output in each sensor channel will determine the contrast ratio of the sensor.

3.5.2.3 Dynamic Range Test

For analog sensors, the dynamic range of the sensor signal must be large enough and at the correct levels so the receiver can decode the sensor signal. Comparing the difference between the maximum and minimum optic power output at the signal wavelength while normalizing with respect to the reference wavelength will determine the dynamic range of the sensor.

3.5.2.4 Reference Integrity Test

For analog sensors, the reference path must reject interfering signals from the signal path. Reference integrity is a measure of this interchannel crosstalk. If the sensor reference is not corrupted and the dynamic range is sufficient, the receiver will be able to distinguish the various levels of the signal. Examining the variation of the reference wavelength power at the maximum and minimum sensor signals will determine the integrity of the reference signal.

3.5.2.5 Signal Duration Test

For time rate of decay sensor, the sensor signal duration is the amount of time the sensor outputs a meaningful signal while the source is off. The sensor must output a sufficient signal length so the receiver is able to read and decode the sensor signal. Monitoring the length of time the sensor signal continues to be output after the source pulse is off will determine the signal duration.

3.5.2.6 Channel Characteristics Test

The sensor must have proper channel characteristics so the sensor signal can be decoded properly. Examining the sensor signal on an optic signal analyzer will determine various signal characteristics: the number of channels, the center frequency of the channels, the width of the channels, the operation of the subchannels, and the spectral range of the set of channels.

3.5.2.7 Power Conversion Efficiency Test

For the time rate of decay sensor, comparing the optic power entering the sensor with the modulated optic power output by the sensor will determine the efficiency of the sensor at converting source power to signal power.

3.5.2.8 Excitation to Signal Delay Test

For the time rate of decay sensor, comparing the timing of changes in the source power with the timing of changes in the sensor output signal will determine the source excitation to sensor signal delay.

3.6 Failure Handling

Failures during the test procedure will be recorded, analyzed, and corrected. For a failure, the remaining portion of the current test will be completed provided the unit under test will not be damaged, a correction will be implemented, and the failed test will be repeated.

4.0 TEST PROCEDURES

4.1 Equipment

Table I
Optic Test Plan Equipment List

ITEM	DESCRIPTION	MANUFACTURER AND MODEL	RANGE	ACCURACY
1	FOCSI Test PC – IBM Clone PC (386) 1553 Interface Board	DTK MDC	——	——
2	Optical Signal Analyzer	Anritsu MS9030A Display MS9701B Analyzer		
3	Optical Attenuator	Photodyne 1950XR		
4	Photodiode Detector	Mitsubishi Electric FU–04–PD–N	850nm	Sensitivity 0.55 A/W
5	Digital Storage Oscilloscope	Tektronix 2432		

4.2 *WDM Analog and Digital Source Test*

4.2.1 *General Preparation for Optic Signal Analyzer Tests*

4.2.1.1 Connect together the EOA, the 100/120/138 optic fiber cables, the sensor, and the optic signal analyzer detector to test the source as shown in Figure 1.

4.2.1.2 All optic connections are assumed to be clean, low loss connections using proper methods.

4.2.2 **Allowed Power Variation with Wavelength and Time Test (Part I)**

4.2.2.1 Procedure (Part I)

4.2.2.1.1 Immediately after the EOA is turned on, record the source power at 750nm, 765nm, 780nm, 795nm, 810nm, 825nm, 840nm, 855nm, 870nm, 885nm, and 900nm. Print the graph of the spectrum.

4.2.2.2 Data Evaluation and Expected Results

4.2.2.2.1 The variations in power in the same wavelengths determine the power variation with time while the variations in power in one spectrum over different wavelengths determine the power variation with wavelength. This section, 4.2.2, along with sections 4.2.4 and 4.2.6 make up the Allowed Power Variation with Wavelength and Time Test. See section 4.2.6 for the expected results.

4.2.3 **Repeatability Test (Part I)**

4.2.3.1 Procedure (Part I)

4.2.3.1.1 After the EOA has been ON for at least five minutes, record the source power at 750nm, 775nm, 800nm, 825nm, 850nm, 875nm, and 900nm. Print the graph of the spectrum.

4.2.3.2 Data Evaluation and Expected Results

4.2.3.2.1 The variations in power at similar wavelengths determine the source repeatability. This section, 4.2.3, along with sections 4.2.7 and 4.2.9 make up the Repeatability Test. See section 4.2.9 for the expected results.

4.2.4 **Allowed Power Variation with Wavelength and Time Test (Part II)**

4.2.4.1 Procedure (Part II)

4.2.4.1.1 After the EOA has been ON for at least ten minutes, record the source power at 750nm, 765nm, 780nm, 795nm, 810nm, 825nm, 840nm, 855nm, 870nm, 885nm, and 900nm. Print the graph of the spectrum.

4.2.4.2 Data Evaluation and Expected Results

4.2.4.2.1 The variations in power in the same wavelengths determine the power variation with time while the variations in power in the same spectrum over different wavelengths determine the power variation with wavelength. This section, 4.2.4, along with sections 4.2.2 and 4.2.6 make up the Allowed Power Variation with Wavelength and Time Test. The power variations between sections 4.2.2 and 4.2.4 are due to EOA warm up.

4.2.5 **Minimum Power Spectral Density Test**

4.2.5.1 Procedure

4.2.5.1.1 With the source at full power, record the minimum power output and the wavelength at which it occurs. Print the graph of the spectrum.

4.2.5.2 Data Evaluation and Expected Results

4.2.5.2.1 The minimum power per unit wavelength over the spectrum range is the minimum power spectral density. The source must produce at least the minimum power spectral density so there is enough power for the sensors. The minimum power spectral density is listed in the EOA ICD and data sheet.

4.2.6 **Allowed Power Variation with Wavelength and Time Test (Part III)**

4.2.6.1 Procedure (Part III)

4.2.6.1.1 After the EOA has been ON for at least twenty minutes, record the source power at 750nm, 765nm, 780nm, 795nm, 810nm, 825nm, 840nm, 855nm, 870nm, 885nm, and 900nm. Print the graph of the spectrum.

4.2.6.2 Data Evaluation and Expected Results

4.2.6.2.1 The variations in power in the same wavelengths determine the power variation with time while the variations in power in the same spectrum over different wavelengths determine the power variation with wavelength. This section, 4.2.6, along with sections 4.2.2 and 4.2.4 make up the Allowed Power Variation with Wavelength and Time Test. The power variations between sections 4.2.4 and 4.2.6 are normal operating variations. The power variation over time and over the wavelength range is limited so the sensors will be supplied with a consistent and stable power source. The allowed power variation with wavelength and time is listed in the EOA ICD and the data sheet.

4.2.7 **Repeatability Test (Part II)**

4.2.7.1 Procedure (Part II)

4.2.7.1.1 Remove power from the EOA for fifteen minutes. Restore power to the EOA, and after five minutes, record the source power at 750nm, 775nm, 800nm, 825nm, 850nm, 875nm, and 900nm. Print the graph of the spectrum.

4.2.7.2 Data Evaluation and Expected Results

4.2.7.2.1 The variations in power at similar wavelengths determine the source repeatability. This section, 4.2.7, along with sections 4.2.3 and 4.2.9 make up the Repeatability Test. See section 4.2.9 for the data evaluation and expected results.

4.2.8 **Wavelength Range Test**

4.2.8.1 Procedure

4.2.8.1.1 Record the short and long wavelengths which mark the range of the source power which meets the minimum power spectral density requirement. Print the graph of the spectrum.

4.2.8.2 Data Evaluation and Expected Results

4.2.8.2.1 The source must supply sufficient power over the wavelength range to satisfy the input power requirements of the sensors. The minimum and maximum wavelengths are listed in the EOA ICD and the data sheet.

4.2.9 **Repeatability Test (Part III)**

4.2.9.1 Procedure (Part III)

4.2.9.1.1 Remove power from the EOA for fifteen minutes. Restore power to the EOA, and after five minutes, record the source power at 750nm, 775nm, 800nm, 825nm, 850nm, 875nm, and 900nm. Print the graph of the spectrum.

4.2.9.2 Data Evaluation and Expected Results

4.2.9.2.1 The variations in power at similar wavelengths determine the source repeatability. Find the largest difference between the three power values at each wavelength from sections 4.2.3, 4.2.7, and 4.2.9. The source wavelength averaged power must be repeatable from use to use to provide the sensors with a consistent power source. This section, 4.2.9, along with sections 4.2.3 and 4.2.7 make up the Repeatability Test. The repeatability value is listed in the EOA ICD and the data sheet.

4.2.10 ***General Preparation for Photodiode/Oscilloscope Tests***

4.2.10.1 Connect together the EOA, the 100/120/138 optic fiber cables, the sensor, and the photodiode and oscilloscope detector to test the source as shown in Figure 1.

4.2.10.2 All optic connections are assumed to be clean, low loss connections using proper methods.

4.2.11 **Maximum Excitation Off Leakage Allowed Test**

4.2.11.1 Procedure

4.2.11.1.1 Record the photodiode detector resistor value and the sensitivity to be able to calculate the optic power per volt gain of the photodiode detector.

4.2.11.1.2 During the source ON time, print the waveform with the minimum power per unit wavelength over the spectrum range. Record the minimum power per unit wavelength. This is the source ON minimum power spectral density.

4.2.11.1.3 During the source OFF time, print the waveform with the maximum power per unit wavelength over the spectrum range. Record the maximum power per unit wavelength. This is the source OFF maximum power spectral density.

4.2.11.2 Data Evaluation and Expected Results

4.2.11.2.1 The excitation off leakage is the maximum power spectral density of the OFF source. The maximum excitation off leakage allowed is 20dB below the minimum power spectral density of the ON source to prevent an Off source from exciting the sensors. The maximum excitation off leakage allowed is listed in the EOA ICD and the data sheet.

4.2.12 **Repetition Rate and Source Duty Factor Test**

4.2.12.1 Procedure

4.2.12.1.1 Save a waveform which shows 10 to 100 source pulses but is still able to magnify one pulse to determine its period. The oscilloscope resolution must be small enough to accurately show the period of the single pulse. The group of pulses is to show the single pulse is a typical pulse. Record the period of the single pulse. Print the graphs of the group of pulses and the magnification of the single pulse.

4.2.12.1.2 For the single pulse, record the source on time and the source off time.

4.2.12.2 Data Evaluation

4.2.12.2.1 The period of one typical pulse determines the frequency of the source; take the inverse of the period to determine the repetition rate, the number of source pulses per second.

The ratio of the time the source is on to the total period time is the source duty factor.
Duty Factor(in %) = (Source ON Time / (Source ON Time + Source OFF Time)) X 100

4.2.12.3 Expected Results

4.2.12.3.1 The source produces pulsed excitation to allow the receiver to deliver sensor information during the source off time. The source must produce a consistent repetition rate to ensure a sufficient update rate for decoding sensor information. The source duty factor must be large enough to ensure proper resolution and information transfer. The source on time determines the receiver resolution of the sensor signal while the source off time must be sufficient to allow the receiver to transfer the sensor information. The repetition rate and duty factor are listed in the EOA ICD and the data sheet.

4.2.13 **Required Rise and Fall Time Test**

4.2.13.1 Procedure

4.2.13.1.1 Save a waveform which shows one rising edge of the power ON transition and one falling edge of the power OFF transition. On the rising edge, record the rise time between 10% and 90% source power. On the falling edge, record the fall time between 90% and 10% source power. Print the graph of the rising and falling edges.

4.2.13.2 Data Evaluation and Expected Results

4.2.13.2.1 The rise and fall times determine the sharpness of the source on and off transitions. The rise and fall times must be less than 100ns to ensure the source provides relatively instantaneous full on power or full off power to the sensors. This prevents the sensors from receiving insufficient power when the source is on and too much power when the source is off which could result in ambiguous sensor values. The rise and fall times are listed in the EOA ICD and the data sheet.

4.3 *WDM TRD Source Test*

4.3.1 *General Preparation for Optic Signal Analyzer Tests*

4.3.1.1 Connect together the EOA, the 200/220/235 optic fiber cables, the optic coupler, the sensor, and the optic signal analyzer detector to test the source as shown in Figure 1.

4.3.1.2 All optic connections are assumed to be clean, low loss connections using proper methods.

4.3.2 Minimum Peak Power Test

4.3.2.1 Procedure

4.3.2.1.1 While the source is set to produce its maximum strength power output, record the smallest peak power output by the source. Print the graph of the source spectrum.

4.3.2.2 Data Evaluation and Expected Results

4.3.2.2.1 The source must produce at least the minimum peak power so there is enough power for the sensor. The minimum peak power is listed in the EOA ICD and the data sheet.

4.3.3 Wavelength Range Test

4.3.3.1 Procedure

4.3.3.1.1 Record the short and long wavelengths which mark the range of the source power which meets the minimum peak power requirement. Print the graph of the spectrum.

4.3.3.2 Data Evaluation and Expected Results

4.3.3.2.1 The source must supply sufficient power in the wavelength range to satisfy the input power requirements of the sensor. For this TRD sensor, the power can be concentrated in a portion of the range and does not have to be distributed over the full range. The minimum and maximum wavelengths are listed in the EOA ICD and the data sheet.

4.3.4 *General Preparation for Photodiode/Oscilloscope Tests*

4.3.4.1 Connect together the EOA, the 200/220/235 optic fiber cables, the optic coupler, the sensor, and the photodiode and oscilloscope detector to test the source as shown in Figure 1.

4.3.4.2 All optic connections are assumed to be clean, low loss connections using proper methods.

4.3.5 Maximum Repetition Rate Test

4.3.5.1 Procedure

4.3.5.1.1 Save a waveform which shows 10 to 100 sinusoidal source periods but is still able to magnify one period. The oscilloscope resolution must be small enough to accurately show the period of the sine wave. The group of periods is to show the single period is a typical period. Record the period. Print the graphs of the group of periods and the magnification of the single period.

4.3.5.2 Data Evaluation and Expected Results

4.3.5.2.1 The frequency of one typical period determines the frequency of the source; take the inverse of the single period to determine the repetition rate, the number of source periods per second. The source produces constant sinusoidal excitation, and the receiver decodes sensor information from the phase shift difference between the source and sensor signal. The source must produce a specific and consistent repetition rate to ensure a sufficient update rate for decoding sensor information while not saturating the sensor. The maximum repetition rate is listed in the EOA ICD and the data sheet.

4.3.6 *General Preparation for Lab Test PC / EOA Signal Analyzer Mode Tests*

4.3.6.1 Connect together the EOA, the 200/220/235 optic fiber cables, the optic coupler, the sensor, and the FOCSI Test PC to test the source as in Figure 1 (substitute the lab test PC for the photodiode and oscilloscope detector).

4.3.6.2 All optic connections are assumed to be clean, low loss connections using proper methods.

4.3.6.3 Use the FOCSI Test PC to place the EOA in the signal analyzer mode.

4.3.7 Minimum Source Modulation Depth Test

4.3.7.1 Procedure

4.3.7.1.1 Use the FOCSI Test PC to adjust the EOA source LED current to its maximum strength. Print the spectrum.

4.3.7.1.2 Use the FOCSI Test PC to adjust the EOA source LED current to its minimum strength. Print the spectrum.

4.3.7.1.3 Record the wavelength of the smallest change in power output between the maximum and minimum LED current spectrums, and record the maximum and minimum values at that wavelength.

4.3.7.2 Data Evaluation

4.3.7.2.1 The source modulation depth (SMD) is the difference in power the source outputs at its maximum LED current strength and at its minimum LED current strength.

SMD = Power During Max. LED Current – Power During Min. LED Current

4.3.7.3 Expected Results

4.3.7.3.1 The minimum source modulation depth determines the amount of source current adjustment available to correct various problems in the system. The problems may deal with the sensor, receiver, interconnecting cables, or other items which affect optic attenuation and saturation. The minimum source modulation depth is listed in the EOA ICD and in the data sheet. Due to source LED behavior, the source spectrum shape will not remain constant as the LED current is varied.

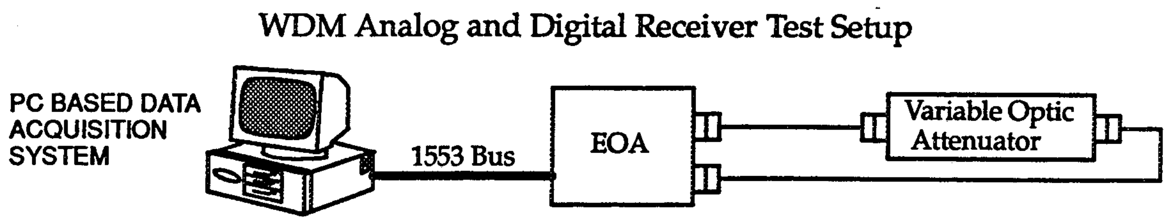
4.4 *WDM Analog and Digital Receiver Test*

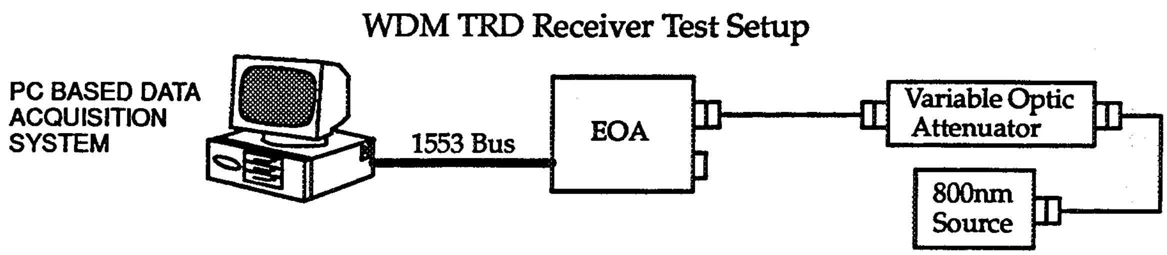
4.4.1 General Preparation

4.4.1.1 Connect together the EOA, the 100/120/138 optic fiber cables of one sensor port, the variable optic attenuator, and the FOCSI Test PC as shown in the analog and digital receiver test setup shown in Figure 2.

4.4.1.2 Adjust the source to maximum output and the attenuator to zero loss.

4.4.1.3 Configure the EOA to Spectrum Analyzer Mode, and adjust the FOCSI Test PC display to monitor the port showing the input from the attenuator.





Receiver Test Setup
Figure 2

4.4.2 Saturation and Noise Level Test

4.4.2.1 Procedure

4.4.2.1.1 Starting from zero attenuation, increase the attenuation until the receiver shows an entire source signal which is not clipped due to receiver saturation.

4.4.2.1.2 Record the port number, the maximum power level reported by the receiver on the FOCSI Test PC when the receiver shows an entire source signal which is not clipped due to receiver saturation, and the wavelength of the maximum power level.

4.4.2.1.3 Continue to increase the attenuation until the receiver noise level is evident in the source signal. Decrease the attenuation until there is no noise in the source signal.

4.4.2.1.4 Record the minimum power level reported by the receiver on the FOCSI Test PC when the receiver shows a source signal which does not contain noise from the receiver noise level, and record the wavelength of the minimum power level.

4.4.2.2 Data Evaluation and Expected Results

4.4.2.2.1 The values obtained for the saturation and noise levels should be equal to the EOA ICD values of Maximum Digital Signal Power Density and Minimum Analog Signal Power Density respectively. Those values are given in the data sheet as well as the EOA ICD. The mixture of digital and analog signal power density is used since they define the largest receiver input range and the test signal is not used as an analog or digital signal.

4.4.3 Dark Current Level Test

4.4.3.1 Procedure

4.4.3.1.1 Disconnect the attenuator from the EOA and cap the EOA optic signal receive connector, J1.

4.4.3.1.2 Record the maximum power level reported by the receiver on the FOCSI Test PC when the EOA port has no input, and record the wavelength of the maximum power.

4.4.3.2 Data Evaluation and Expected Results

4.4.3.2.1 The value obtained for dark current is only for information. The EOA ICD does not specify an expected value for the dark current. Dark current is expected to be temperature dependent.

4.5 *WDM TRD Receiver Test*

4.5.1 General Preparation

4.5.1.1 Connect together the EOA, the 200/220/235 optic fiber cables of the TRD sensor port, the variable optic attenuator, the 800nm source which simulates the sensor signal, and the FOCSI Test PC as shown in the TRD receiver test setup shown in Figure 2.

4.5.1.2 Adjust the source to maximum output and the attenuator to zero loss.

4.5.1.3 Configure the EOA to Spectrum Analyzer Mode, and adjust the FOCSI Test PC display to monitor the port showing the input from the attenuator.

4.5.2 Saturation and Noise Level Test

4.5.2.1 Procedure

4.5.2.1.1 Starting from zero attenuation, increase the attenuation until the receiver shows an entire source signal which is not clipped due to receiver saturation.

4.5.2.1.2 Record the port number, the maximum power level reported by the receiver on the FOCSI Test PC when the receiver shows an entire source signal which is not clipped due to receiver saturation, and the wavelength of the maximum power level.

4.5.2.1.3 Continue to increase the attenuation until the receiver noise level is evident in the source signal. Decrease the attenuation until there is no noise in the source signal.

4.5.2.1.4 Record the minimum power level reported by the receiver on the FOCSI Test PC when the receiver shows a source signal which does not contain noise from the receiver noise level, and record the wavelength of the minimum power level.

4.5.2.2 Data Evaluation and Expected Results

4.5.2.2.1 The values obtained for the saturation and noise levels should be equal to the EOA ICD values of Maximum Signal Power Density and Minimum Signal Power Density respectively. Those values are given in the data sheet as well as the EOA ICD.

4.5.3 Dark Current Level Test

4.5.3.1 Procedure

4.5.3.1.1 Disconnect the attenuator from the EOA and cap the EOA optic receive connector, J1.

4.5.3.1.2 Record the maximum power level reported by the receiver on the FOCSI Test PC when the EOA port has no input, and record the wavelength of the maximum power.

4.5.3.2 Data Evaluation and Expected Results

4.5.3.2.1 The value obtained for dark current is only for information. The EOA ICD does not specify an expected value for the dark current. Dark current is expected to be temperature dependent.

4.6 *Stabilizer Sensor Test Procedure*

4.6.1 General Preparation

4.6.1.1 Use the optic signal analyzer to perform the tests unless different test equipment is specified.

4.6.1.2 Prepare the optic signal analyzer to analyze signals in the 750 to 900 nm range. This range of wavelengths will be assumed in all tests.

4.6.1.3 Connect together the optic source, sensor, and signal analyzer with optic cables as shown in Figure 1. This setup will be the same for all tests unless stated otherwise.

4.6.1.4 All optic connections are assumed to be clean, low loss connections using proper methods.

4.6.1.5 Sensor measurements will include the effects of both mating halves of the connectors attached to the sensor while cable and connector losses outside of the sensor are to be about 3.0dB (or more).

4.6.2 Sensor Insertion Loss Test

4.6.2.1 Procedure

4.6.2.1.1 At the sensor output cable, print the spectrum of the sensor power output in the 750 to 900 nm wavelength range. Record the wavelengths and sensor power values at the sensor peaks.

4.6.2.1.2 Remove the sensor from the source to signal analyzer path and connect the optic cables together.

4.6.2.1.3 At the same point in 4.6.2.1.1, print the spectrum of source power output in the 750 to 900 nm wavelength range. Record the source power values at the wavelengths of the sensor peaks.

4.6.2.2 Data Evaluation

4.6.2.2.1 The sensor insertion loss (IL) for a wavelength (λ_i) is the attenuation of the sensor at that wavelength given by the formula

$$\text{Sensor IL} = \text{Source power at } \lambda_i - \text{Sensor power } \lambda_i.$$

For each wavelength which is a peak in the sensor power output, calculate the sensor insertion loss at that wavelength. Then, find the average of the insertion losses which is the insertion loss for the sensor.

The sensor insertion loss must be small enough to prevent the sensor signal from sinking into the noise level of the receiver.

4.6.2.3 Expected Results

4.6.2.3.1 The maximum sensor insertion loss is listed in the sensor ICD and data sheet.

4.6.3 Contrast Ratio Test

4.6.3.1 Procedure

4.6.3.1.1 Locate the sensor value where each bit is the same (e.g. 111111111111), and print the graph of the sensor output pattern. (Note: The first channel is for synchronization so it will always be a one.) This is the worst case position to calculate the contrast ratio since the subchannel pattern (the channels are differential) is alternating high and low signals which eliminates any greater or lesser than normal power readings due to high or low signals being next to each other, and it accounts for crosstalk.

4.6.3.1.2 At the output of the sensor, record the power of the high and low signals in each channel.

4.6.3.2 Data Evaluation

4.6.3.2.1 The contrast ratio is given by the formula

Contrast Ratio = Max. channel power – Min. channel power.

Calculate the contrast ratio for each channel, and record the minimum contrast ratio.

The contrast ratio must be large enough so the receiver can distinguish between high and low signals with no ambiguity.

4.6.3.3 Expected Results

4.6.3.3.1 The minimum contrast ratio is listed in the sensor ICD and data sheet.

4.6.4 Channel Characteristics Test

4.6.4.1 Procedure

4.6.4.1.1 Record the sensor value used as the typical sensor signal viewed on the optic signal analyzer to determine the following.

4.6.4.1.2 Record the number of discrete wavelength bands (channels) used to transmit sensor data.

4.6.4.1.3 Record the wavelength of the beginning of the first and the end of the last channel.

4.6.4.1.4 Record the widths of all channels.

4.6.4.1.5 Record the widths of the obvious guardbands, the low band between adjacent high subchannels.

4.6.4.2 Data Evaluation

4.6.4.2.1 The number of channels, the channel locations, the widths of the channels, and the widths of the guard bands must be consistent with the values given in the sensor ICD in order for the EOA to correctly interpret the sensor signals.

4.6.4.3 Expected Results

4.6.4.3.1 The number, location, and widths of the channels and the widths of the guardbands are given in the sensor ICD and data sheet.

4.7 *Rudder Sensor Test Procedure*

4.7.1 Perform test procedure 4.6 for the Rudder Sensor.

4.8 *Pitch Stick Sensor Procedure*

4.8.1 General Preparation

4.8.1.1 Use the optic signal analyzer to perform the tests unless different test equipment is specified.

4.8.1.2 Prepare the optic signal analyzer to analyze signals in the 750 to 900 nm range. This range of wavelengths will be assumed in all tests.

4.8.1.3 Connect together the optic source, sensor, and signal analyzer with optic cables as shown in Figure 1. This setup will be the same for all tests unless stated otherwise.

4.8.1.4 All optic connections are assumed to be clean, low loss connections using proper methods.

4.8.1.5 Sensor measurements will include the effects of both mating halves of the connectors attached to the sensor while cable and connector losses outside of the sensor are to be 3.0dB or less.

4.8.2 Sensor Insertion Loss Test

4.8.2.1 Procedure

4.8.2.1.1 At the sensor output cable, print the spectrum of the sensor power output in the 750 to 900 nm wavelength range. Record the wavelengths and peak values of the sensor reference and the sensor signal.

4.8.2.1.2 Remove the sensor from the source to signal analyzer path and connect the optic cables together.

4.8.2.1.3 At the same point in 4.8.2.1.1, print the spectrum of source power output in the 750 to 900 nm wavelength range. Record the source values at the wavelengths of the peak values of the sensor reference and the sensor signal.

4.8.2.2 Data Evaluation

4.8.2.2.1 The sensor insertion loss (IL) for a wavelength (λ_i) is the attenuation of the sensor at that wavelength given by the formula

$$\text{Sensor IL} = \text{Source power at } \lambda_i - \text{Sensor power } \lambda_i.$$

Calculate the insertion loss for the wavelength which contains the peak of the sensor reference and for the wavelength which contains the peak of the sensor signal.

The sensor insertion loss must be small enough to prevent the sensor signal from sinking into the noise level of the receiver.

4.8.2.3 Expected Results

4.8.2.3.1 The maximum sensor insertion loss is listed in the sensor ICD and data sheet.

4.8.3 Dynamic Range Test

4.8.3.1 Procedure

4.8.3.1.1 Locate the sensor value which produces the smallest sensor signal power, print the output spectrum, and record the power levels of the peak sensor signal and the reference value at the peak sensor signal.

4.8.3.1.2 Locate the sensor value which produces the largest sensor signal power, print the output spectrum, and record the power levels of the peak sensor signal and the reference value at the peak sensor signal.

4.8.3.2 Data Evaluation

4.8.3.2.1 Dynamic Range, in dB with the sensor signal normalized by the reference, is given by the formula

Dynamic Range = (Max. Sensor Signal Power – Reference Power at max. sensor signal) – (Min. Sensor Signal Power – Reference Power at min. sensor signal).

The lower end of the sensor dynamic range must be greater than the noise level of the sensor so valid data will be output. The upper end of the dynamic range must be less than the receiver's input dynamic range to ensure the receiver is not saturated. Sufficient dynamic range also ensures that crosstalk from the reference path to the signal path, which is actually signal wavelength light leaking through the reference path, will not affect the ability of the receiver to distinguish the various states of the sensor signal.

4.8.3.3 Expected Results

4.8.3.3.1 The minimum and maximum values of the dynamic range are given in the sensor ICD and data sheet.

4.8.4 Reference Integrity Test

4.8.4.1 Procedure

4.8.4.1.1 Use the values for the peak reference power with minimum sensor signal and maximum sensor signal recorded in the Dynamic Range Test sections 4.8.3.1.1 and 4.8.3.1.2.

4.8.4.2 Data Evaluation

4.8.4.2.1 The reference integrity determines the ratio of the reference variation to the reference value. This test deals with the reference wavelength power that leaks through the sensor signal path and is combined with the power from the reference path. Since the reference leakage passes through the gradient filter plate and is filtered depending upon the gradient of the plate, changes in the filter plate gradient which determine the sensor signal will also cause changes in the reference leakage. The reference leakage must be a very small fraction of the minimum reference value. The smallest reference value occurs at the smallest sensor signal value.

4.8.4.2.2 Reference Integrity is calculated as follows. Note the changes in units.
Reference Variation (mW) =
Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW).
Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB).

The reference variation must be small enough so that the receiver will always have a consistent reference. Sufficient reference integrity along with sufficient dynamic range will ensure that crosstalk will not affect the ability of the receiver to distinguish the various states of the sensor.

4.8.4.3 Expected Results

4.8.4.3.1 Reference integrity is given in the sensor ICD and data sheet.

4.8.5 Channel Characteristics Test

4.8.5.1 Procedure

4.8.5.1.1 At the sensor output, record the sensor signal pattern used as the typical sensor signal viewed on the optic signal analyzer to determine the following.

4.8.5.1.2 Record the number of discrete wavelength bands (channels) used to transmit sensor data.

4.8.5.1.3 Record the center wavelengths of the channels.

4.8.5.1.4 Record the widths of all channels.

4.8.5.2 Data Evaluation

4.8.5.2.1 The number of channels, the channel locations, and the widths of the channels must be consistent with the values given in the sensor ICD in order for the EOA to correctly interpret the sensor signals.

4.8.5.3 Expected Results

4.8.5.3.1 The number, location, and widths of the channels are given in the sensor ICD and data sheet.

4.9 *Rudder Pedal Sensor Test Procedure*

4.9.1 Perform test procedure 4.6 for the Rudder Pedal Sensor.

4.10 *Trailing Edge Flap Sensor Test Procedure*

4.10.1 Perform test procedure 4.8 for the Trailing Edge Flap Sensor.

4.11 *Leading Edge Flap Sensor Test Procedure*

4.11.1 General Preparation

4.11.1.1 Use the optic signal analyzer to perform the tests unless different test equipment is specified.

4.11.1.2 Prepare the optic signal analyzer to analyze signals in the 750 to 900 nm range. This range of wavelengths will be assumed in all tests.

4.11.1.3 Connect together the optic source, sensor, and signal analyzer with optic cables as shown in Figure 1. This setup will be the same for all tests unless stated otherwise.

4.11.1.4 All optic connections are assumed to be clean, low loss connections using proper methods.

4.11.1.5 Sensor measurements will include the effects of both mating halves of the connectors attached to the sensor while cable and connector losses outside of the sensor are to be 3.0dB or less.

4.11.2 Sensor Insertion Loss Test

4.11.2.1 Procedure

4.11.2.1.1 At the sensor output cable, print the spectrum of the sensor power output in the 750 to 900 nm wavelength range. Record the wavelengths and sensor power values at the sensor peaks.

4.11.2.1.2 Remove the sensor from the source to signal analyzer path and connect the optic cables together.

4.11.2.1.3 At the same point in 4.11.2.1.1, print the spectrum of source power output in the 750 to 900 nm wavelength range. Record the source power values at the wavelengths of the sensor peaks.

4.11.2.2 Data Evaluation

4.11.2.2.1 The sensor insertion loss (IL) for a wavelength (λ_i) is the attenuation of the sensor at that wavelength given by the formula

$$\text{Sensor IL} = \text{Source power at } \lambda_i - \text{Sensor power } \lambda_i$$

For each wavelength which is a peak in the sensor power output, calculate the sensor insertion loss at that wavelength. Then, find the average of the insertion losses which is the insertion loss for the sensor.

The sensor insertion loss must be small enough to prevent the sensor signal from sinking into the noise level of the receiver.

4.11.2.3 Expected Results

4.11.2.3.1 The maximum sensor insertion loss is listed in the sensor ICD and data sheet.

4.11.3 <u>Contrast Ratio Test</u>

4.11.3.1 <u>Procedure</u>

4.11.3.1.1 Locate the sensor value where each bit is the same (e.g. 1111111111111), and print the graph of the sensor output pattern. (Note: The first three channels are for synchronization so they will always be a one.) This is the worst case position to calculate the contrast ratio since the subchannel pattern (the channels are differential) is alternating high and low signals which eliminates any greater or lesser than normal power readings due to high or low signals being next to each other, and it accounts for crosstalk.

4.11.3.1.2 At the output of the sensor, record the power of the high and low signals in each channel.

4.11.3.2 <u>Data Evaluation</u>

4.11.3.2.1 The contrast ratio is given by the formula

Contrast Ratio = Max. channel power – Min. channel power.

Calculate the contrast ratio for each channel, and record the minimum contrast ratio.

The contrast ratio must be large enough so the receiver can distinguish between high and low signals with no ambiguity.

4.11.3.3 <u>Expected Results</u>

4.11.3.3.1 The minimum contrast ratio is listed in the sensor ICD and data sheet.

4.11.4 <u>Channel Characteristics Test</u>

4.11.4.1 <u>Procedure</u>

4.11.4.1.1 Record the sensor value used as the typical sensor signal viewed on the optic signal analyzer. To determine the following characteristics, the widths of the three synchronization pulses can be used to determine the location of the other channels; the other channels may be difficult to identify as they may seem to run together.

4.11.4.1.2 Record the number of discrete wavelength bands (channels) used to transmit sensor data.

4.11.4.1.3 Record the wavelength of the beginning of the first and the end of the last channel.

4.11.4.1.4 Record the widths of all channels.

4.11.4.2 <u>Data Evaluation</u>

4.11.4.2.1 The number of channels, the channel locations, and the widths of the channels must be consistent with the values given in the sensor ICD in order for the EOA to correctly interpret the sensor signals.

4.11.4.3 <u>Expected Results</u>

4.11.4.3.1 The number, location, and widths of the channels are given in the sensor ICD and data sheet.

4.12 *<u>Power Lever Control Sensor Test Procedure</u>*

4.12.1 Perform test procedure 4.6 for the Power Lever Control Sensor.

4.13 *Nose Wheel Steering Sensor Test Procedure*

4.13.1 Perform test procedure 4.8 for the Nose Wheel Steering Sensor.

4.14 *Total Pressure Sensor Test Procedure*

4.14.1 General Preparation

4.14.1.1 Use the optic signal analyzer to perform the tests unless different test equipment is specified.

4.14.1.2 Prepare the optic signal analyzer to analyze signals in the 750 to 900 nm range. This range of wavelengths will be assumed in all tests.

4.14.1.3 Connect together the optic source, sensor, and signal analyzer with optic cables as shown in Figure 1. This setup will be the same for all tests unless stated otherwise.

4.14.1.4 All optic connections are assumed to be clean, low loss connections using proper methods.

4.14.1.5 Sensor measurements will include the effects of both mating halves of the connectors attached to the sensor while cable and connector losses outside of the sensor are to be 3.0dB or less.

4.14.2 Sensor Insertion Loss Test

4.14.2.1 Procedure

4.14.2.1.1 At the sensor output cable, print the spectrum of the sensor power output in the 750 to 900 nm wavelength range. Record the wavelengths and peak values of the sensor reference and the sensor signal.

4.14.2.1.2 Remove the sensor from the source to signal analyzer path and connect the optic cables together.

4.14.2.1.3 At the same point in 4.14.2.1.1, print the spectrum of source power output in the 750 to 900 nm wavelength range. Record the source values at the wavelengths of the peak values of the sensor reference and the sensor signal.

4.14.2.2 Data Evaluation

4.14.2.2.1 The sensor insertion loss (IL) for a wavelength (λ_i) is the attenuation of the sensor at that wavelength given by the formula

$$\text{Sensor IL} = \text{Source power at } \lambda_i - \text{Sensor power } \lambda_i.$$

Calculate the insertion loss for the wavelength which contains the peak of the sensor reference and for the wavelength which contains the peak of the sensor signal.

The sensor insertion loss must be small enough to prevent the sensor signal from sinking into the noise level of the receiver.

4.14.2.3 Expected Results

4.14.2.3.1 The maximum sensor insertion loss is listed in the sensor ICD and data sheet.

4.14.3 Dynamic Range Test

4.14.3.1 Procedure

4.14.3.1.1 Locate the sensor value which produces the smallest sensor signal power, print the output spectrum, and record the power levels of the peak sensor signal and the reference value at the peak sensor signal.

4.14.3.1.2 Locate the sensor value which produces the largest sensor signal power, print the output spectrum, and record the power levels of the peak sensor signal and the reference value at the peak sensor signal.

4.14.3.2 Data Evaluation

4.14.3.2.1 Dynamic Range, in dB with the sensor signal normalized by the reference, is given by the formula

Dynamic Range = (Max. Sensor Signal Power – Reference Power at max. sensor signal) – (Min. Sensor Signal Power – Reference Power at min. sensor signal).

The lower end of the sensor dynamic range must be greater than the noise level of the sensor so valid data will be output. The upper end of the dynamic range must be less than the receiver's input dynamic range to ensure the receiver is not saturated. Sufficient dynamic range also ensures that crosstalk from the reference path to the signal path, which is actually signal wavelength light leaking through the reference path, will not affect the ability of the receiver to distinguish the various states of the sensor signal.

4.14.3.3 Expected Results

4.14.3.3.1 The minimum and maximum values of the dynamic range are given in the sensor ICD and data sheet.

4.14.4 Reference Integrity Test

4.14.4.1 Procedure

4.14.4.1.1 Use the values for the peak reference power with minimum sensor signal and maximum sensor signal recorded in the Dynamic Range Test sections 4.14.3.1.1 and 4.14.3.1.2.

4.14.4.2 Data Evaluation

4.14.4.2.1 The reference integrity determines the ratio of the reference variation to the reference value. This test deals with the reference wavelength power that leaks through the sensor signal path and is combined with the power from the reference path. Since the reference leakage passes through the gradient filter plate and is filtered depending upon the gradient of the plate, changes in the filter plate gradient which determine the sensor signal will also cause changes in the reference leakage. The reference leakage must be a very small fraction of the minimum reference value. The smallest reference value occurs at the smallest sensor signal value.

4.14.4.2.2 Reference Integrity is calculated as follows. Note the changes in units.

Reference Variation (mW) =

Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW).

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB).

The reference variation must be small enough so that the receiver will always have a consistent reference. Sufficient reference integrity along with sufficient dynamic range will ensure that crosstalk will not affect the ability of the receiver to distinguish the various states of the sensor.

4.14.4.3 Expected Results

4.14.4.3.1 Reference integrity is given in the sensor ICD and data sheet.

4.14.5 Channel Characteristics Test

4.14.5.1 Procedure

4.14.5.1.1 At the sensor output, record the sensor signal pattern used as the typical sensor signal viewed on the optic signal analyzer to determine the following.

4.14.5.1.2 Record the number of discrete wavelength bands (channels) used to transmit sensor data.

4.14.5.1.3 Record the center wavelengths of the channels.

4.14.5.1.4 Record the widths of all channels.

4.14.5.2 Data Evaluation

4.14.5.2.1 The number of channels, the channel locations, and the widths of the channels must be consistent with the values given in the sensor ICD in order for the EOA to correctly interpret the sensor signals.

4.14.5.3 Expected Results

4.14.5.3.1 The number, location, and widths of the channels are given in the sensor ICD and data sheet.

4.15 *Total Temperature Test Procedure*

4.15.1 General Preparation

4.15.1.1 Use the optic signal analyzer to perform the tests unless different test equipment is specified.

4.15.1.2 Prepare the optic signal analyzer to analyze signals in the 650 to 675 nm range for the source and the 750 to 900 nm range for the sensor. These wavelength ranges will be assumed in all tests.

4.15.1.3 Connect together the optic source, sensor, and signal analyzer with optic cables as shown in Figure 1. This setup will be the same for all tests unless stated otherwise.

4.15.1.4 All optic connections are assumed to be clean, low loss connections using proper methods.

4.15.1.5 Sensor measurements will include the effects of both mating halves of the connectors attached to the sensor while cable and connector losses outside of the sensor are to be 3.0dB or less. If necessary, the effect of the optic coupler will be accounted for in the test procedure and data evaluation.

4.15.2 Signal Duration Test and Excitation to Signal Delay Test

4.15.2.1 Procedure

4.15.2.1.1 To perform this test, use the photodiode and oscilloscope as the detector.

4.15.2.1.2 At the sensor input, record the source output as it turns on and off.

4.15.2.1.3 At the sensor output, record the rise and decay of the sensor signal as the source is on and off.

4.15.2.2 Data Evaluation

4.15.2.2.1 Compare the plots and match the rise and decay patterns to determine when the source is on and off relative to when the sensor signal responds.

4.15.2.3 Expected Results

4.15.2.3.1 The expected sensor signal duration value and excitation to signal delay value are listed in the sensor ICD and data sheet.

4.15.3 Channel Characteristics Test

4.15.3.1 Procedure

4.15.3.1.1 At the sensor output, record the sensor signal pattern used as the typical sensor signal viewed on the optic signal analyzer to determine the following.

4.15.3.1.2 Record the number of discrete wavelength bands (channels) used to transmit sensor data.

4.15.3.1.3 Record the center wavelength of the channel.

4.15.3.1.4 Record the width of the channel.

4.15.3.2 Data Evaluation

4.15.3.2.1 The number of channels, the channel locations, and the widths of the channels must be consistent with the values given in the sensor ICD in order for the EOA to correctly interpret the sensor signals.

4.15.3.3 Expected Results

4.15.3.3.1 The number, location, and widths of the channels are given in the sensor ICD and data sheet.

4.15.4 Power Conversion Efficiency Test

4.15.4.1 Procedure

4.15.4.1.1 At the sensor input (on the sensor side of the optic coupler), record the source power.

4.15.4.1.2 At the sensor output (on the EOA side of the optic coupler), record the source backreflection and the sensor modulated signal output power at the beginning of the signal decay.

4.15.4.1.3 Obtain the coupler attenuation from the vendor quality assurance report and measure the attenuation in both directions. With the optic signal analyzer, check the difference in attenuation between the two directions at the sensor signal peak.

4.15.4.2 Data Evaluation

4.15.4.2.1 Convert each measured value from dBm to mWatts so the power conversion efficiency can be calculated. Use the formula: dBm = 10log(mWatts).

4.15.4.2.2 Obtain power readings at the sensor side of the coupler by accounting for the effects of the coupler attenuation and source backreflection on the sensor signal. Source backreflection adds to the measured sensor power while the coupler attenuation subtracts from the measured sensor power.

4.15.4.2.3 Use values in mWatts in the following formula to calculate the power conversion efficiency. Power Conversion Efficiency (in %) = (((Sensor Signal Power at Coupler Output X Coupler Attenuation)/Source Backreflection at Coupler Output)/Source Power at Sensor Input) X 100.

The power conversion efficiency, the amount of power the sensor outputs relative to the source, must be large enough so the sensor output signal is larger than the receiver noise level.

4.15.4.2.4 Use values in dBm in the following formula to calculate the conversion loss.
Conversion Loss = (Sensor Signal Power at Coupler Output – Source Backreflection at Coupler Output + Coupler Attenuation) – Source Power at Sensor Input.

4.15.4.3 Expected Results

4.15.4.3.1 The expected coupler attenuation is given in the coupler quality assurance report as 3.7, 3.9, 4.1, or 4.3dB with the loss depending upon which optic coupler ports are used. The actual loss should be close to 4.0dB, but the loss may exceed the given values.

4.15.4.3.2 The minimum power conversion efficiency is given in the sensor ICD and data sheet.

4.15.4.3.3 The minimum conversion loss is the minimum power conversion efficiency stated in different units.

5.0 DATA SHEETS

Brad Kessler
EOA S/N1 Source
4/22/93

5.1 WDM ANALOG and DIGITAL SOURCE TEST DATA SHEET

5.1.1 Allowed Power Variation with Wavelength and Time Test (4.2.2) PASS ☑ FAIL ☐

5.1.1.1 Attach the graphs of the source spectrums behind this data sheet.

Source Power at Three Different Times at the Given Wavelengths

Wavelength	PART I (4.2.2)	PART II (4.2.4)	PART III (4.2.6)	Max. Difference Over Time
750nm	-45.75 dBm	-46.375 dBm	-46.5 dBm	1.75 dB
765nm	-45.0 dBm	-45.5 dBm	-45.5 dBm	0.5 dB
780nm	-44.75 dBm	-45.0 dBm	-45.125 dBm	0.375 dB
795nm	-44.625 dBm	-44.875 dBm	-44.875 dBm	0.25 dB
810nm	-44.875 dBm	-45.125 dBm	-45.0 dBm	0.25 dB
825nm	-44.875 dBm	-45.125 dBm	-45.125 dBm	0.25 dB
840nm	-44.25 dBm	-44.625 dBm	-44.625 dBm	0.375 dB
855nm	-43.375 dBm	-44.0 dBm	-44.0 dBm	0.625 dB
870nm	-42.25 dBm	-42.75 dBm	-42.75 dBm	0.5 dB
885nm	-41.25 dBm	-41.75 dBm	-41.75 dBm	0.5 dB
900nm	-42.375 dBm	-42.125 dBm	-42.0 dBm	0.375 dB

Maximum Difference Over the Wavelength Range at Three Different Times

Part I 4.5 dB Part II 4.6 dB Part III 4.75 dB

Maximum Power Variation Over Time 1.75 dB Expected: +/-3.0dB
(Actually should be +/-1.5dB but the ICD shows +/-3.0dB)

Maximum Power Variation Over Wavelength 4.75 dB Expected: +/-3.0dB
(Actually should be +/-1.5dB but the ICD shows +/-3.0dB)

Comments: ±3.0dB gives range of 6.0dB

5.1.2 Repeatability Test (4.2.3, 4.2.7, and 4.2.9) PASS ☑ FAIL ☐

5.1.2.1 Attach the graphs of the source spectrums behind this data sheet.

Source Power at Three Different Uses at the Given Wavelengths

Wavelength	PART I (4.2.3)		Wavelength	PART II (4.2.7)		Wavelength	PART III (4.2.9)		Largest Difference	
750nm	-46.25	dBm	750nm	-46.75	dBm	750nm	-46.625	dBm	0.5	dB
775nm	-45.0	dBm	775nm	-45.5	dBm	775nm	-45.125	dBm	0.5	dB
800nm	-44.875	dBm	800nm	-45.125	dBm	800nm	-44.875	dBm	0.25	dB
825nm	-45.0	dBm	825nm	-45.25	dBm	825nm	-45.0	dBm	0.25	dB
850nm	-44.125	dBm	850nm	-44.5	dBm	850nm	-44.25	dBm	0.375	dB
875nm	-42.25	dBm	875nm	-42.625	dBm	875nm	-42.5	dBm	0.375	dB
900nm	-42.0	dBm	900nm	-42.125	dBm	900nm	-41.875	dBm	0.25	dB

Maximum Difference Expected: 8.0dB

Comments:

5.1.3 Minimum Power Spectral Density Test (4.2.5) PASS ☐ FAIL ☑

5.1.3.1 Attach the graph of the source spectrum behind this data sheet.

Wavelength of the Minimum Power Spectral Density 750 nm

Minimum Power Spectral Density -46.375 dBm/nm Expected: ≥ –38.0dBm/nm

Comments: The maximum power reading is -41.25 dBm on the graph for section 4.2.2.

5.1.4 Wavelength Range Test (4.2.8) PASS ☐ FAIL ☑

5.1.4.1 Attach the graph of the source spectrum behind this data sheet.

Short Wavelength ☐ nm Expected: ≤ 750nm

Long Wavelength ☐ nm Expected: ≥ 900nm

See Comments

Comments: None of the source spectrum ~~s~~ meets the Minimum Power Spectral Density. See the Allowed Power Variation with Wavelength and Time Test, for source spectrum values.

5.1.5 Maximum Excitation Off Leakage Allowed Test (4.2.11)

PASS ☐ FAIL ☑

5.1.5.1 Attach the graphs of the source spectrums behind this data sheet.

Gain of the Photodiode Detector = $P_{det}(W)$ = Detector Voltage/($2R_f$ X Detector Sensitivty)

R_f = 100 kΩ   Detector Sensitivity = 0.55 Amp/Watt   {dB=10LogW}

Source ON Minimum Power Spectral Density (PSD) 3.24 Volt = -45.3 dB

Source OFF Maximum Power Spectral Density (PSD) 0.040 Volt = -64.4 dB

The maximum allowed Excitation Off Leakage is 20dB below the Source ON Min. PSD.

Source ON Min. PSD – Source OFF Max. PSD = 19.1 dB   Expected: ≥ 20dB

Comments:

5.1.6 Repetition Rate and Source Duty Factor Test (4.2.12)

PASS ☑ FAIL ☐

5.1.6.1 Attach the graphs of the source spectrums behind this data sheet.

Repetition Rate:

Period of a Single Pulse 10.00 msec.

Repetition Rate 100 pulses/second   Expected: 100 +/– 1 pulses/sec.

Comments:

Duty Factor:

Source ON Time 8.96 m second   Source OFF Time 1.04 m second

Duty Factor (in %) = (Source ON Time / (Source ON Time+ Source OFF Time)) X 100

Duty Factor 89.6%   Expected: 90% +/– 1%

Comments:

5.1.7 Required Rise and Fall Time Test (4.2.13)

PASS ☐ FAIL ☑

5.1.7.1 Attach the graph of the source spectrum behind this data sheet.

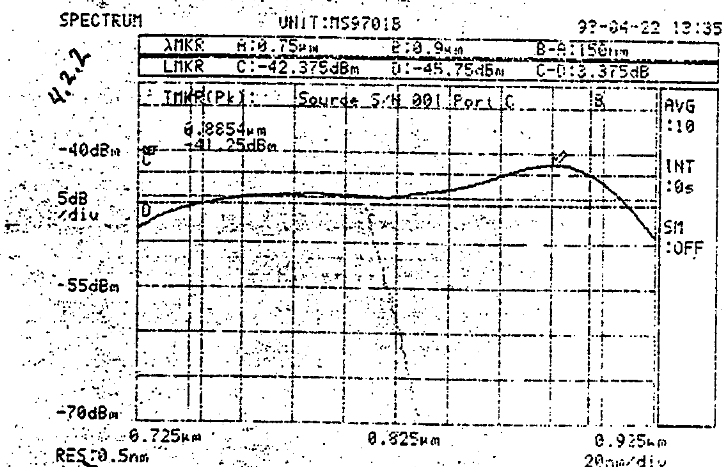
Rise Time 20.0 μsec. ~~nsec.~~   Expected: < 100nsec.

Fall Time 28.0 μsec. ~~nsec.~~   Expected: < 100nsec.

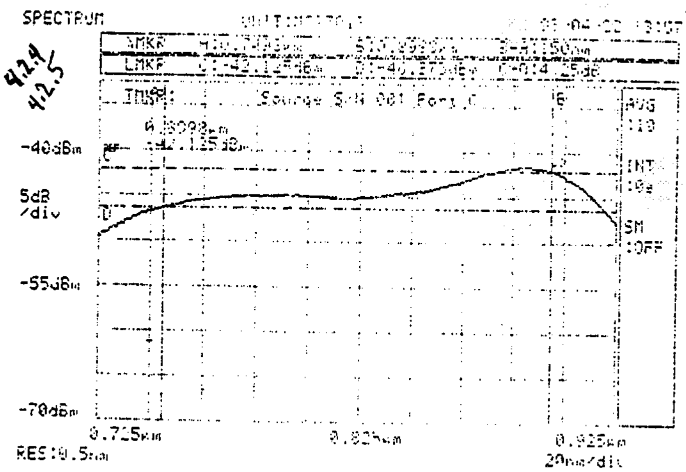
Comments: This test was affected by the oscilloscope resolution.

EOA S/N 1 WDM Source Spectrums

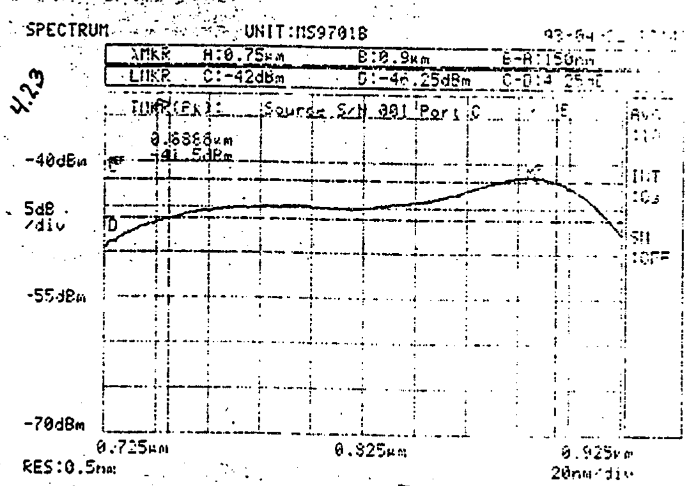
4.2.2



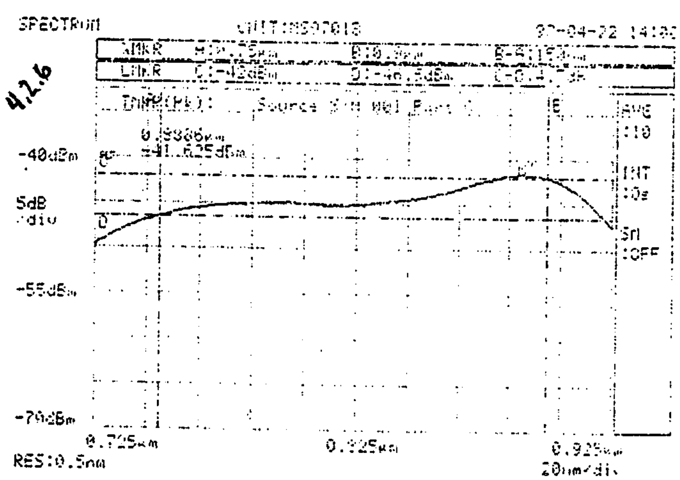
4.2.4
4.2.5



4.2.3



4.2.6



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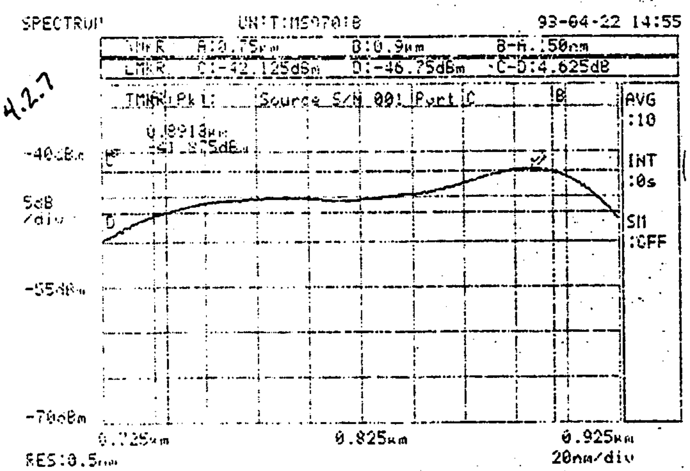
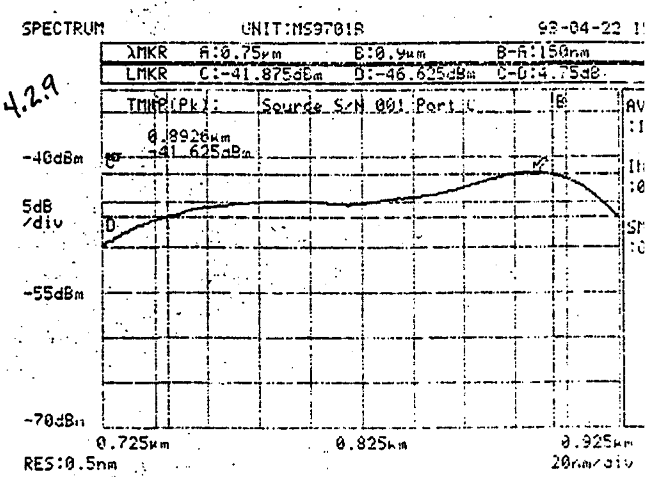
EoA S/N 1 WDM Source Spectrums

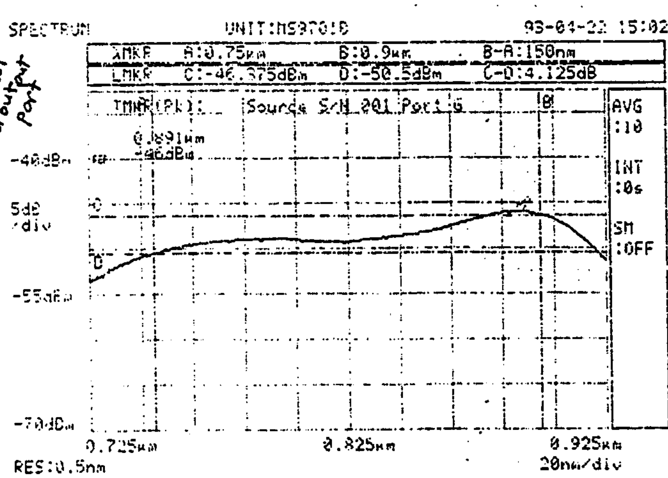
4.2.7



4.2.9



lowest power output port



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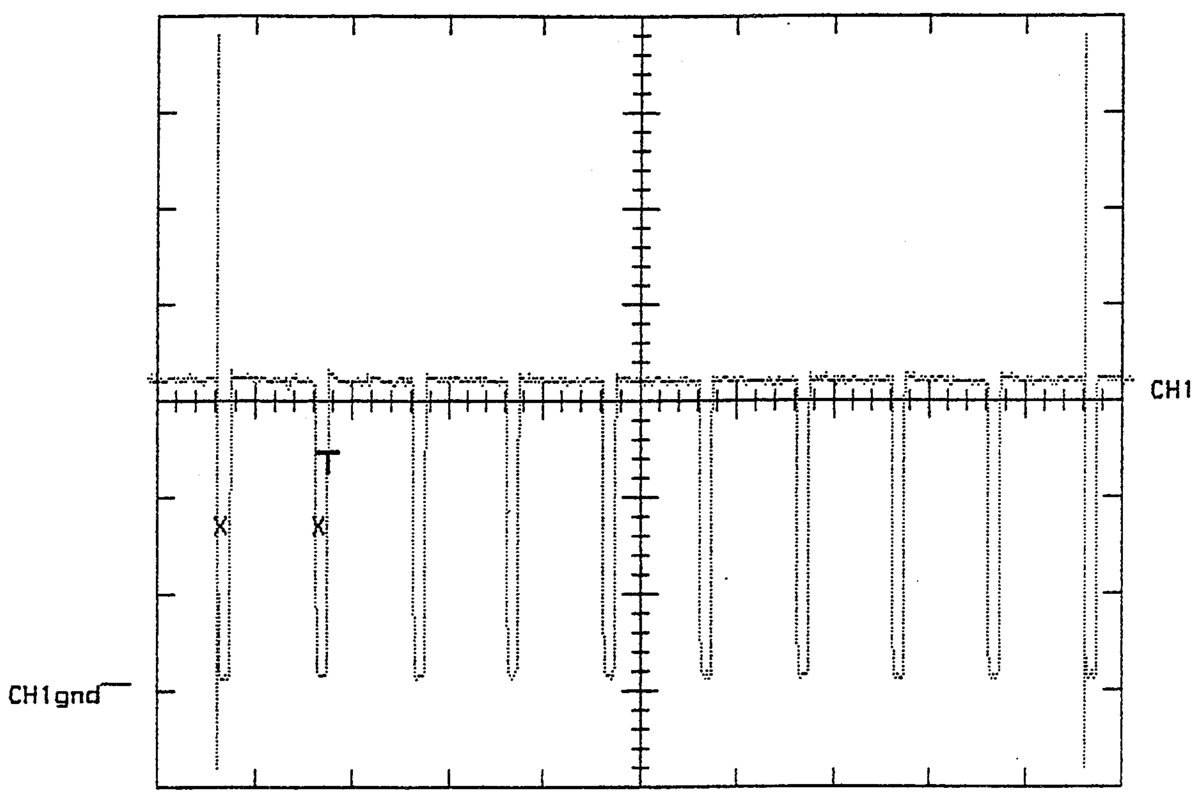
EDA S/N 001
WDM Analog/Digital Source

Repetition Rate Test

CH1 1V A 10ms 875mV VERT

90.100ms WINDOW



HISTO?

CH1 MAX = 3.2400 V
CH1 MIN = 40.000mV
CH1 PER = 10.000ms

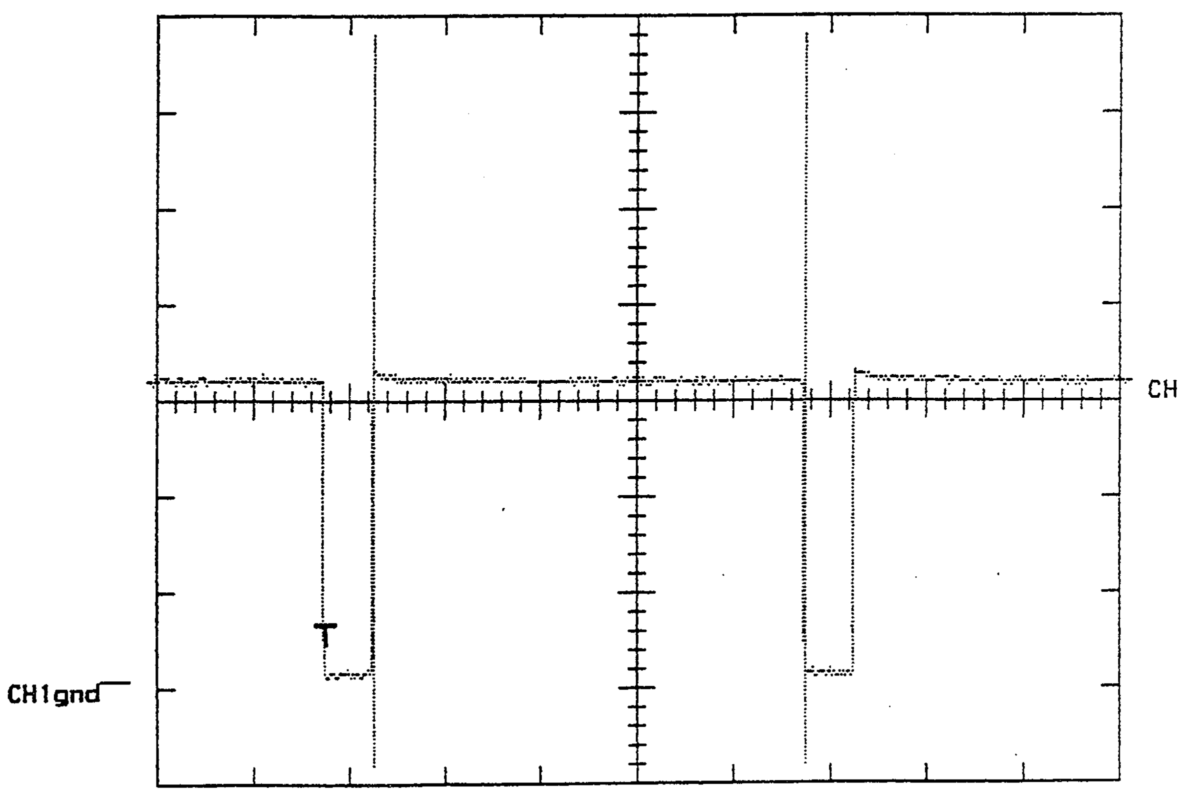
EOA S/N 001

WDM Analog/Digital Source

Duty Cycle Source ON Time

CH1 1V A 2ms 3.02 V VERT

8.9600ms WINDOW



CH1 MAX = 3.2800 V

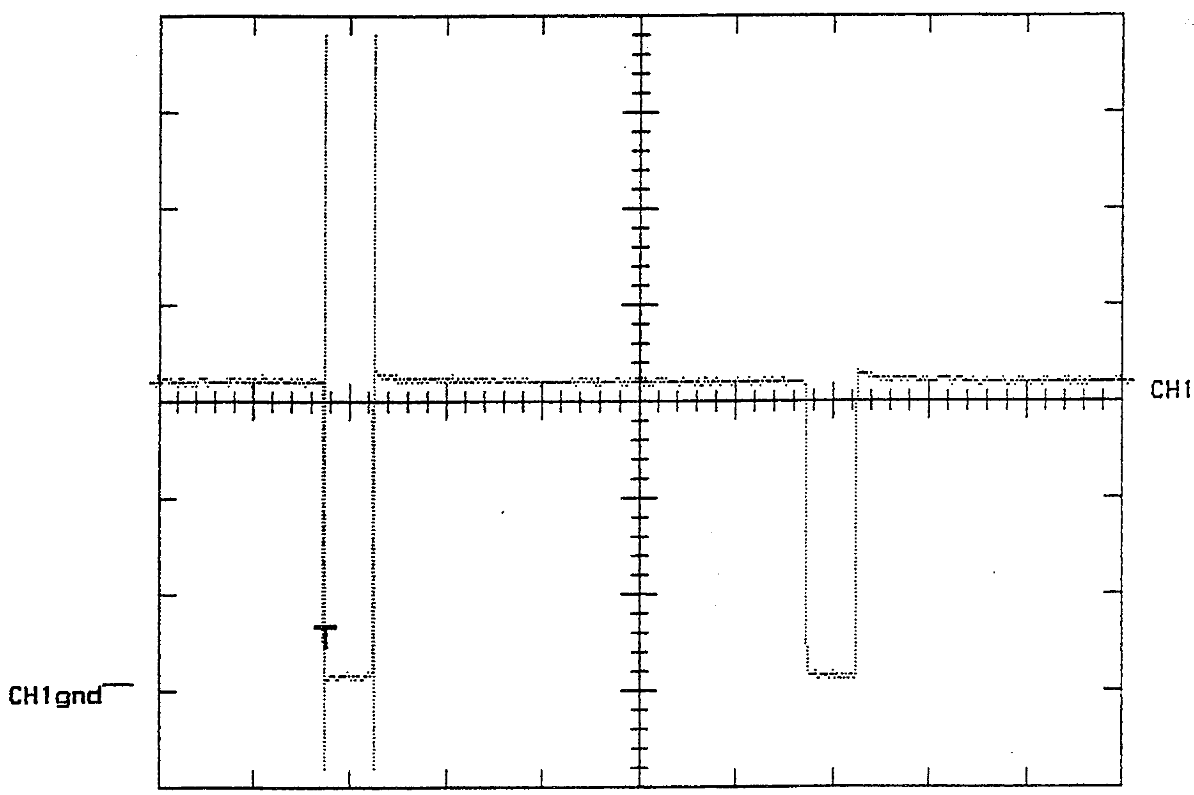
CH1 MIN = 360.00mV

EoA S/N 001
WDM Analog/Digital Source

Duty Cycle Source OFF Time

CH1 1V A 2ms 3.02 V VERT

1.0400ms WINDOW

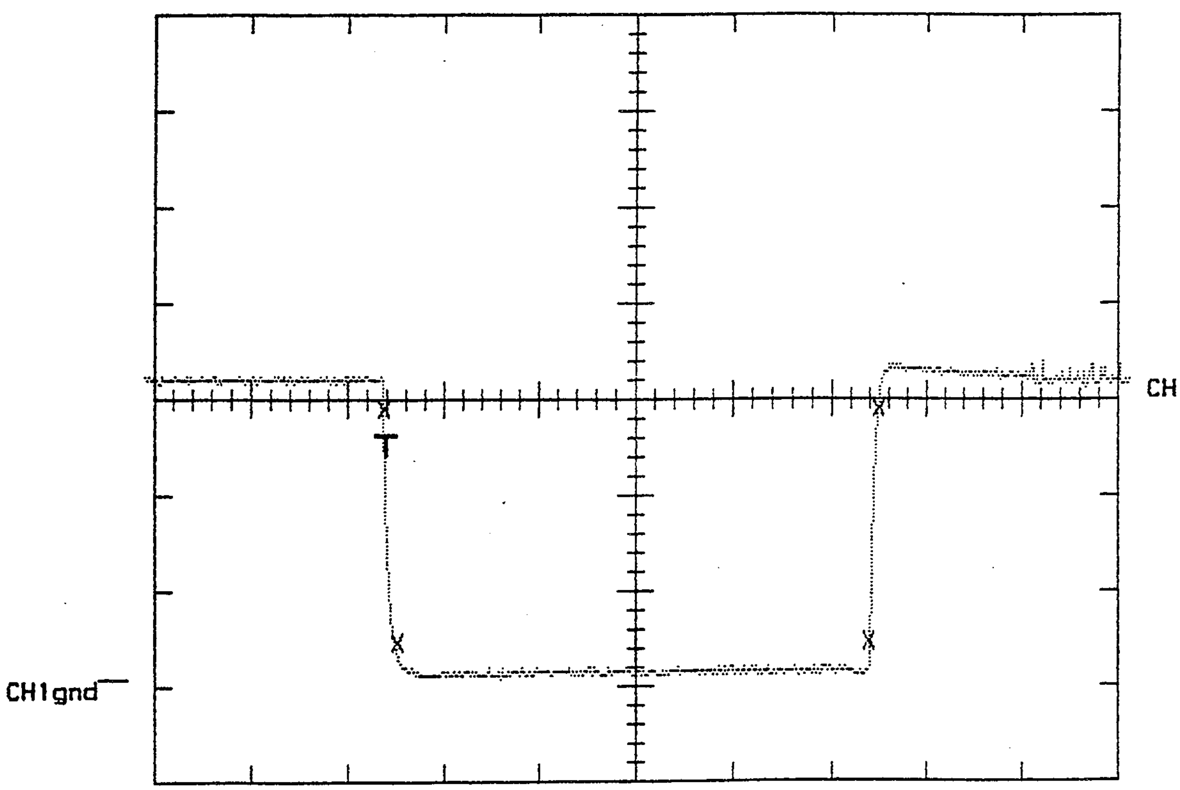


CH1 MAX = 3.2800 V
CH1 MIN = 40.000mV

EoA s/N 001
WDM Analog/Digital Source

Rise and Fall Test

CH1 1V A 200us 3.02 V VERT



LO RES? CH1 RISE = 20.000us
CH1 FALL = 28.000us

Brad Kessler
S/N 001
4/23/93

5.2 WDM TRD SOURCE TEST DATA SHEET

5.2.1 Minimum Peak Power Test (4.3.2)

PASS ☐ FAIL ☑

5.2.1.1 Attach the graph of the source spectrum behind this data sheet.

Minimum Peak Power of Source [-37.8] dBm — Expected: –17.5dBm

Comments: The 2x2 coupler attenuation is 4.0 dB. This needs to be added to the measured power to eliminate the effect of the coupler. (-41.8 + 4.0 = -37.8)

5.2.2 Wavelength Range Test (4.3.3)

PASS ☑ FAIL ☐

5.2.2.1 Attach the graph of the source spectrum behind this data sheet.

Short Wavelength [580] nm — Expected: < 675nm

Long Wavelength [1050] nm — Expected: > 650nm

Comments: None of the spectrum meets the minimum peak power test. The wavelengths where the power is 3dB down from the maximum value are 657nm to 686nm. The test data for the temperature sensors shows the full wavelength range of the source.

6/27/93

5.2.3 Maximum Repetition Rate Test (4.3.5)

PASS ☑ FAIL ☐

5.2.3.1 Attach the graphs of the source spectrums behind this data sheet.

Period of Sinusoidal Waveform [1.004] msec.

Repetition Rate [996] pulses/second — Expected: ≤1000pulses/sec.

Comments:

5.2.4 Minimum Source Modulation Depth Test (4.3.7)

PASS ☐ FAIL ☐ (See comments)

5.2.4.1 Attach the graphs of the source spectrums behind this data sheet.

Wavelength of Smallest Power Change [672.9] nm

Max. Power at Wavelength [-41.8] dBm — Min. Power at Wavelength [-42.0] dBm

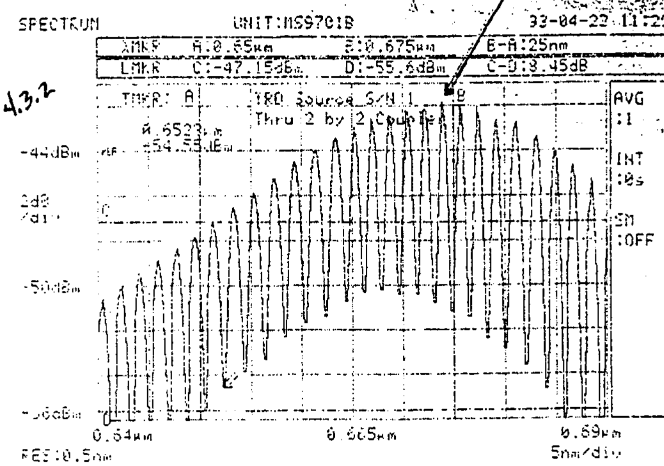
Source Modulation Depth (SMD) is the minimum range of source power adjustment
SMD = Power During Max. LED Current – Power During Min. LED Current

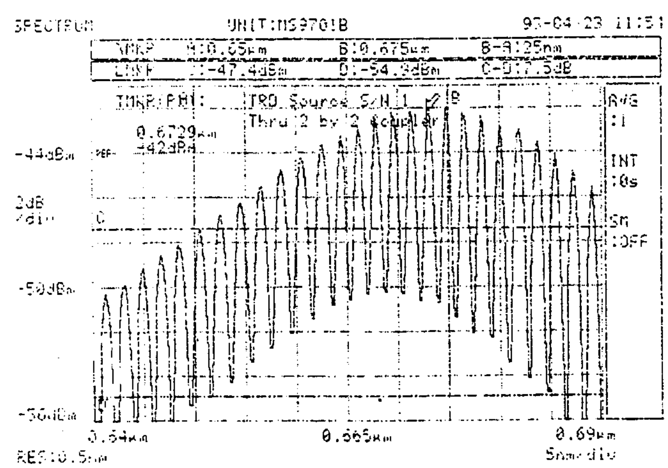
Source Modulation Depth [0.2] dB — Expected: ≥ 15dB

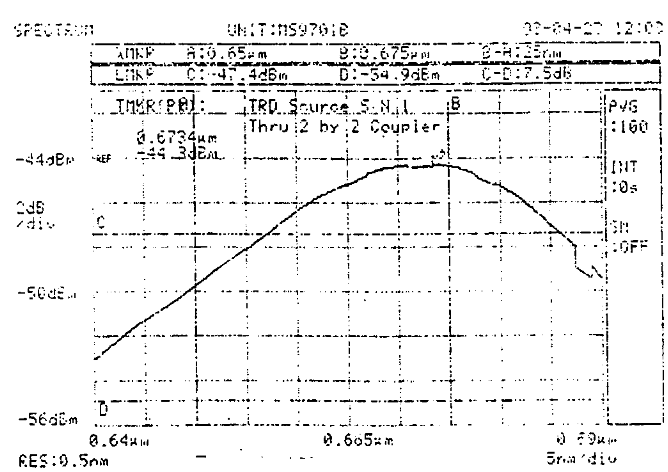
Comments: The TRD source power cannot be adjusted. It is fixed upon power up and the source output is ~~[illegible]~~ constant. The values given are the minor variations occurring in normal operation.

EDA S/N 1
TRD Source Spectrums

4.3.2







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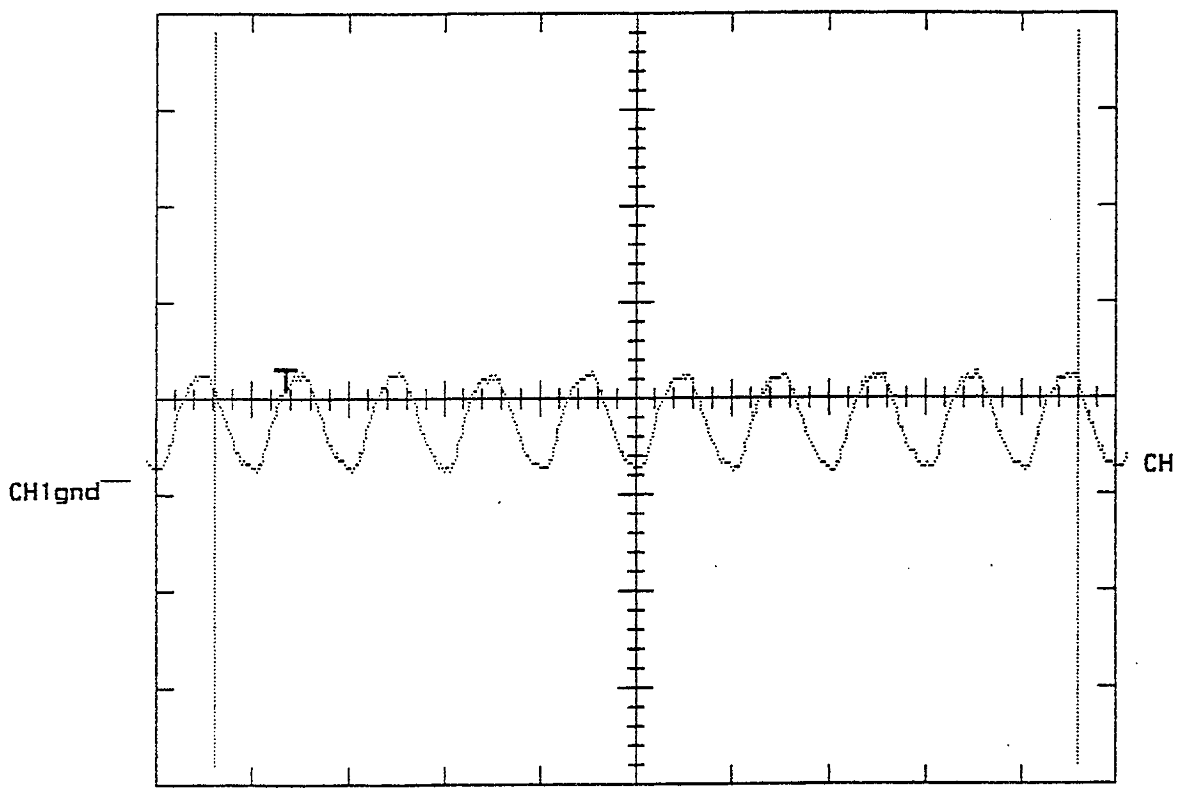
TRD Source s/N 001

Repetition Rate Test

CH1 1V A 1ms 875mV VERT

9.0000ms WINDOW



CH1 MAX = 1.1200 V
CH1 MIN = 80.000mV

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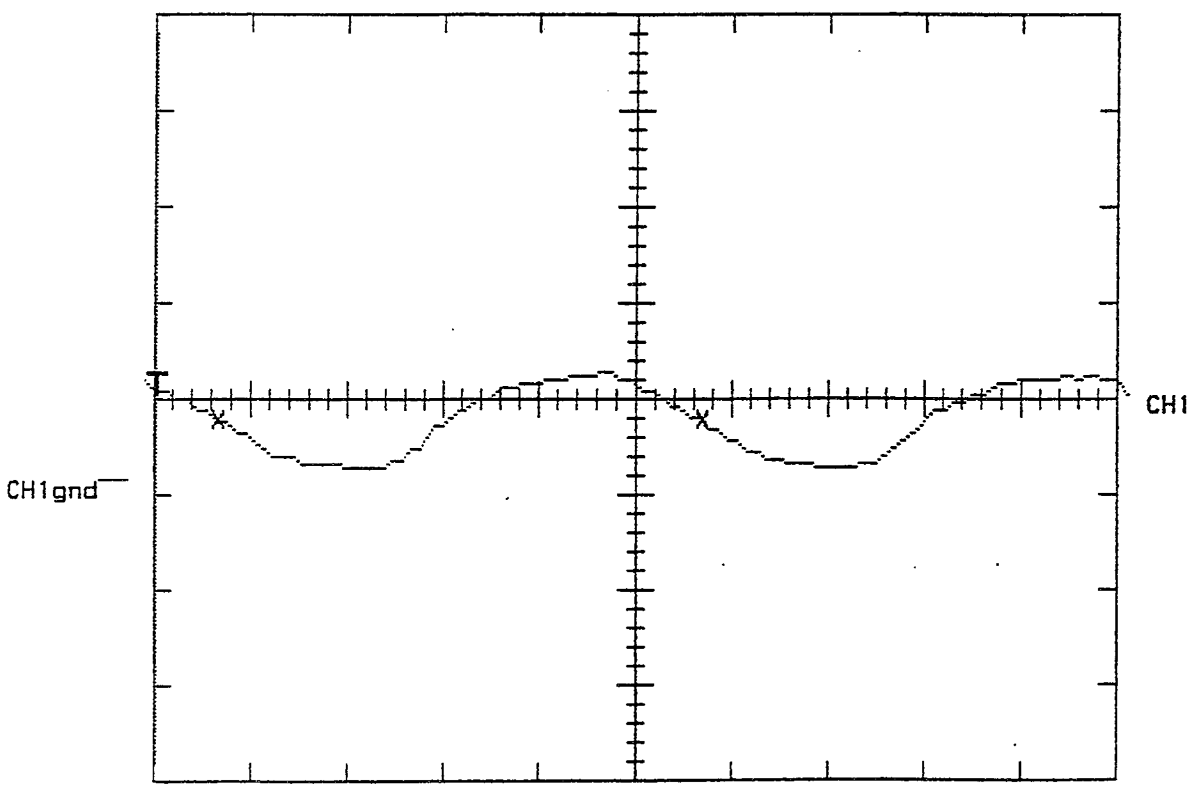
TRD Source S/N 001

Repetition Rate Test

CH1 1V A 200us 875mV VERT

2.0140ms WINDOW



CH1 MAX = 1.1200 V
CH1 MIN = 120.00mV
CH1 PER = 1.0040ms

Brad Kessler
6/27/93

EDA S/N1 and S/N2

5.3 WDM ANALOG and DIGITAL RECEIVER TEST DATA SHEET

5.3.1 Saturation and Noise Level Test (4.4.2) PASS ☑ FAIL ☐ (The range passes)

PC Display Port Number [1] Source to Receiver Wraparound ~~(The port number is equal to the connector pin number)~~

Saturation Level [910] pixel value ~~dBm~~ at [All] nm ~~Expected: -60dBm/nm~~

Noise Level [30] pixel value ~~dBm~~ at [All] nm ~~Expected: -86dBm/nm~~

The pixel values are the 1024 States that the CCD array can report.

The value of 910 was obtained from Saturating the Source.

The value of 30 was obtained from EDA ven.

Comments: The source did not saturate with the attenuator in line. Also, the EDA vendor reports that the PC display does not show the noise level; the receiver does not decode sensors below a pixel value of 30 even though the spectrum can still be seen on the display. See below for the range of the WDM Receiver.

5.3.2 Dark Current Level Test (4.4.3) PASS ☑ FAIL ☐

Dark Current Level [ ] dBm at [ ] nm No Expected Value

Comments: No source output is displayed when the receiver connector is covered.

Range of WDM Receiver (The range can be calculated even though the absolute maximum and minimum values of the range cannot be calculated)

910 - 30 = 880

Range in dB = 10 log (880) = 29.5 dB Range (This calculated range is for room temperature, and temperature effects will reduce this range.)

5.4 WDM TRD RECEIVER TEST DATA SHEET

These tests are not possible. There is no PC display for the TRD source.

5.4.1 Saturation and Noise Level Test (4.5.2) PASS ☐ FAIL ☐

Port Number [ ] (The port number is equal to the connector pin number)

Saturation Level [ ] dBm at [ ] nm Expected: TBD dBm/nm

Noise Level [ ] dBm at [ ] nm Expected: TBD dBm/nm

Comments:

5.4.2 Dark Current Level Test (4.5.3) PASS ☐ FAIL ☐

Dark Current Level [ ] dBm at [ ] nm No Expected Value

Comments:

Brad Kessler
EoASource S/N 2
4/22/93

5.1 WDM ANALOG and DIGITAL SOURCE TEST DATA SHEET

5.1.1 Allowed Power Variation with Wavelength and Time Test (4.2.2)

PASS ☑ FAIL ☐

5.1.1.1 Attach the graphs of the source spectrums behind this data sheet.

Source Power at Three Different Times at the Given Wavelengths

Wavelength	PART I (4.2.2)	Wavelength	PART II (4.2.4)	Wavelength	PART III (4.2.6)	Max. Difference Over Time
750nm	-45.5 dBm	750nm	-45.625 dBm	750nm	-45.75 dBm	0.25 dB
765nm	-44.75 dBm	765nm	-44.875 dBm	765nm	-45.0 dBm	0.25 dB
780nm	-44.625 dBm	780nm	-44.625 dBm	780nm	-44.75 dBm	0.125 dB
795nm	-44.75 dBm	795nm	-44.75 dBm	795nm	-44.75 dBm	0.0 dB
810nm	-45.125 dBm	810nm	-45.0 dBm	810nm	-45.0 dBm	0.125 dB
825nm	-45.5 dBm	825nm	-45.375 dBm	825nm	-45.375 dBm	0.125 dB
840nm	-45.5 dBm	840nm	-45.375 dBm	840nm	-45.5 dBm	0.125 dB
855nm	-45.25 dBm	855nm	-45.25 dBm	855nm	-45.375 dBm	0.125 dB
870nm	-44.0 dBm	870nm	-44.125 dBm	870nm	-44.125 dBm	0.125 dB
885nm	-43.625 dBm	885nm	-43.5 dBm	885nm	-43.5 dBm	0.125 dB
900nm	-46.0 dBm	900nm	-45.25 dBm	900nm	-45.25 dBm	0.75 dB

Maximum Difference Over the Wavelength Range at Three Different Times

Part I 2.375 dB Part II 2.125 dB Part III 2.25 dB

Maximum Power Variation Over Time 0.75 dB Expected: +/–3.0dB
(Actually should be +/–1.5dB but the ICD shows +/–3.0dB)

Maximum Power Variation Over Wavelength 2.4 dB Expected: +/–3.0dB
(Actually should be +/–1.5dB but the ICD shows +/–3.0dB)

Comments: ± 3.0dB gives range of 6.0dB

5.1.2 Repeatability Test (4.2.3, 4.2.7, and 4.2.9)

PASS ☑ FAIL ☐

5.1.2.1 Attach the graphs of the source spectrums behind this data sheet.

Source Power at Three Different Uses at the Given Wavelengths

	PART I (4.2.3)	PART II (4.2.7)	PART III (4.2.9)	Largest Difference
750nm	-45.625 dBm	-46.25 dBm	-45.25 dBm	1.0 dB
775nm	-44.625 dBm	-45.25 dBm	-44.125 dBm	1.125 dB
800nm	-44.75 dBm	-45.25 dBm	-44.25 dBm	1.0 dB
825nm	-45.375 dBm	-46.0 dBm	-44.875 dBm	1.125 dB
850nm	-45.5 dBm	-46.0 dBm	-45.125 dBm	0.875 dB
875nm	-43.75 dBm	-44.375 dBm	-43.25 dBm	1.125 dB
900nm	-45.5 dBm	-45.75 dBm	-44.875 dBm	0.875 dB

Maximum Difference Expected: 8.0dB

Comments:

5.1.3 Minimum Power Spectral Density Test (4.2.5)

PASS ☐ FAIL ☑

5.1.3.1 Attach the graph of the source spectrum behind this data sheet.

Wavelength of the Minimum Power Spectral Density 843.8 and 750.0 nm

Minimum Power Spectral Density -45.625 dBm/nm Expected: $\geq$ -38.0dBm/nm

Comments: The maximum power reading is ~~-43.25~~ -43.375 dBm on the graph for procedure section 4.2.3.

5.1.4 Wavelength Range Test (4.2.8)

PASS ☐ FAIL ☑

5.1.4.1 Attach the graph of the source spectrum behind this data sheet.

Short Wavelength ______ nm Expected: $\leq$ 750nm

Long Wavelength ______ nm Expected: $\geq$ 900nm

See Comments

Comments: None of the source spectrum meets the Minimum Power Spectral Density. See the Allowed Power Variation with Wavelength and Time test for source spectrum values.

5.1.5 Maximum Excitation Off Leakage Allowed Test (4.2.11) PASS ☐ FAIL ☑

5.1.5.1 Attach the graphs of the source spectrums behind this data sheet.

Gain of the Photodiode Detector = $P_{det}(W)$ = Detector Voltage/($2R_f$ X Detector Sensitivty)

R_f = 100 kΩ Detector Sensitivity = $0.55 \frac{A}{W}$ {dB=10LogW}

Source ON Minimum Power Spectral Density (PSD) 3.96 Volt = -44.4 dB

Source OFF Maximum Power Spectral Density (PSD) 0.08 Volt = -61.4 dB

The maximum allowed Excitation Off Leakage is 20dB below the Source ON Min. PSD.

Source ON Min. PSD – Source OFF Max. PSD = 17.0 dB Expected: ≥ 20dB

Comments:

5.1.6 Repetition Rate and Source Duty Factor Test (4.2.12) PASS ☑ FAIL ☐

5.1.6.1 Attach the graphs of the source spectrums behind this data sheet.

Repetition Rate:

Period of a Single Pulse 10.00 msec.

Repetition Rate 100 pulses/second Expected: 100 +/– 1 pulses/sec.

Comments:

Duty Factor:

Source ON Time 8.96 msecond Source OFF Time 1.04 msecond

Duty Factor (in %) = (Source ON Time / (Source ON Time+ Source OFF Time)) X 100

Duty Factor 89.6% Expected: 90% +/– 1%

Comments:

5.1.7 Required Rise and Fall Time Test (4.2.13) PASS ☐ FAIL ☑

5.1.7.1 Attach the graph of the source spectrum behind this data sheet.

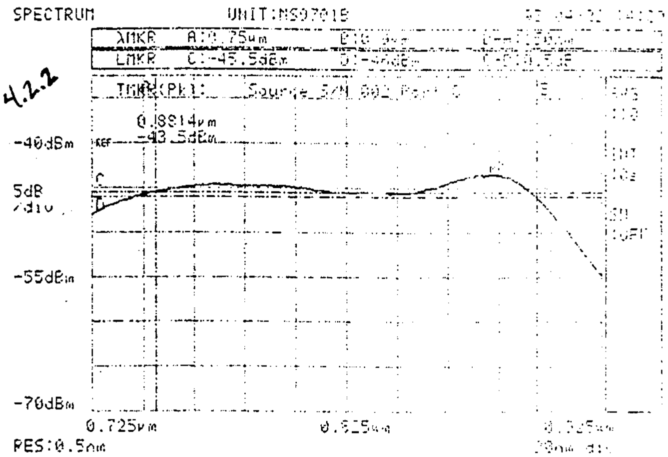
Rise Time 28.000 ~~nsec~~ μsec. Expected: < 100nsec.

Fall Time 28.000 ~~nsec~~ μsec. Expected: < 100nsec.

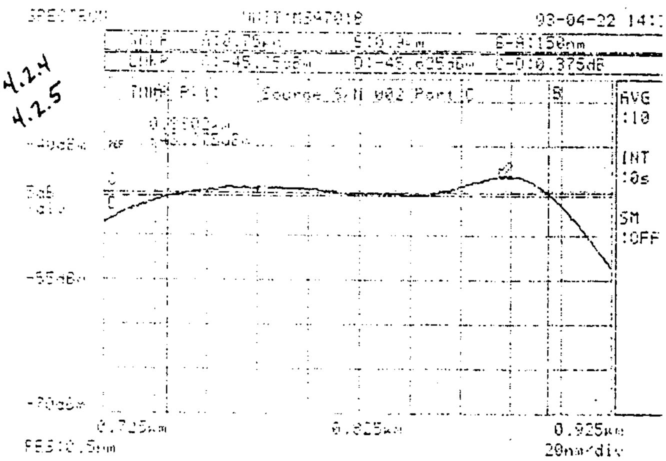
Comments: This test was affected by the oscilloscope resolution.

EDA S/N 2 WDM Source Spectrums

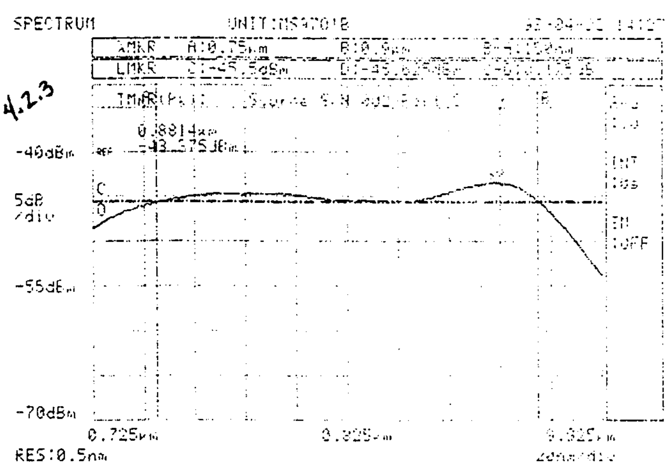
4.2.2



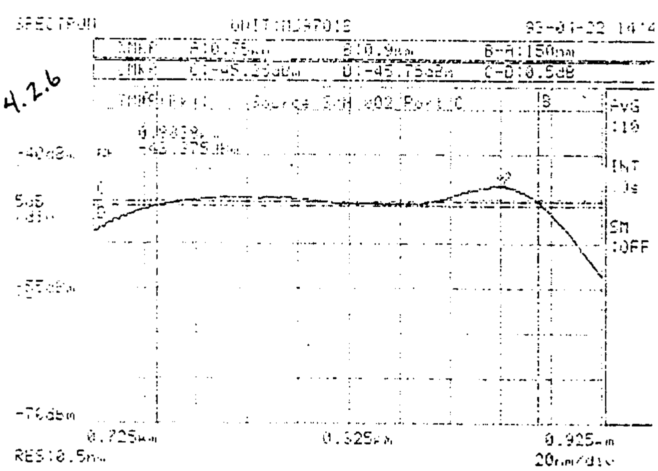
4.2.4
4.2.5



4.2.3



4.2.6



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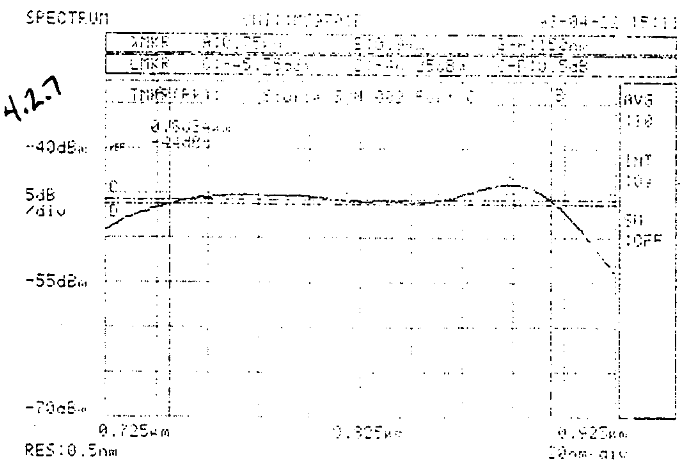
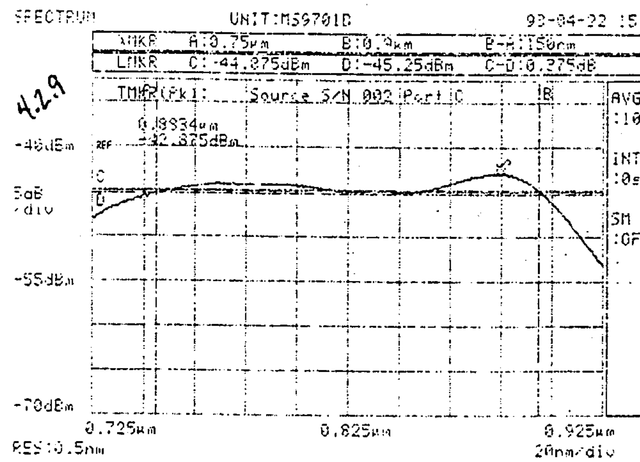
EOA S/N 2 WDM Source Spectrums

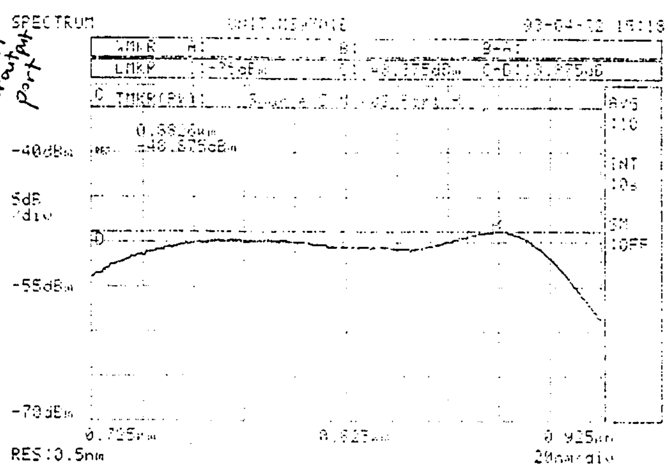
4.2.7



4.2.9



lowest power output port



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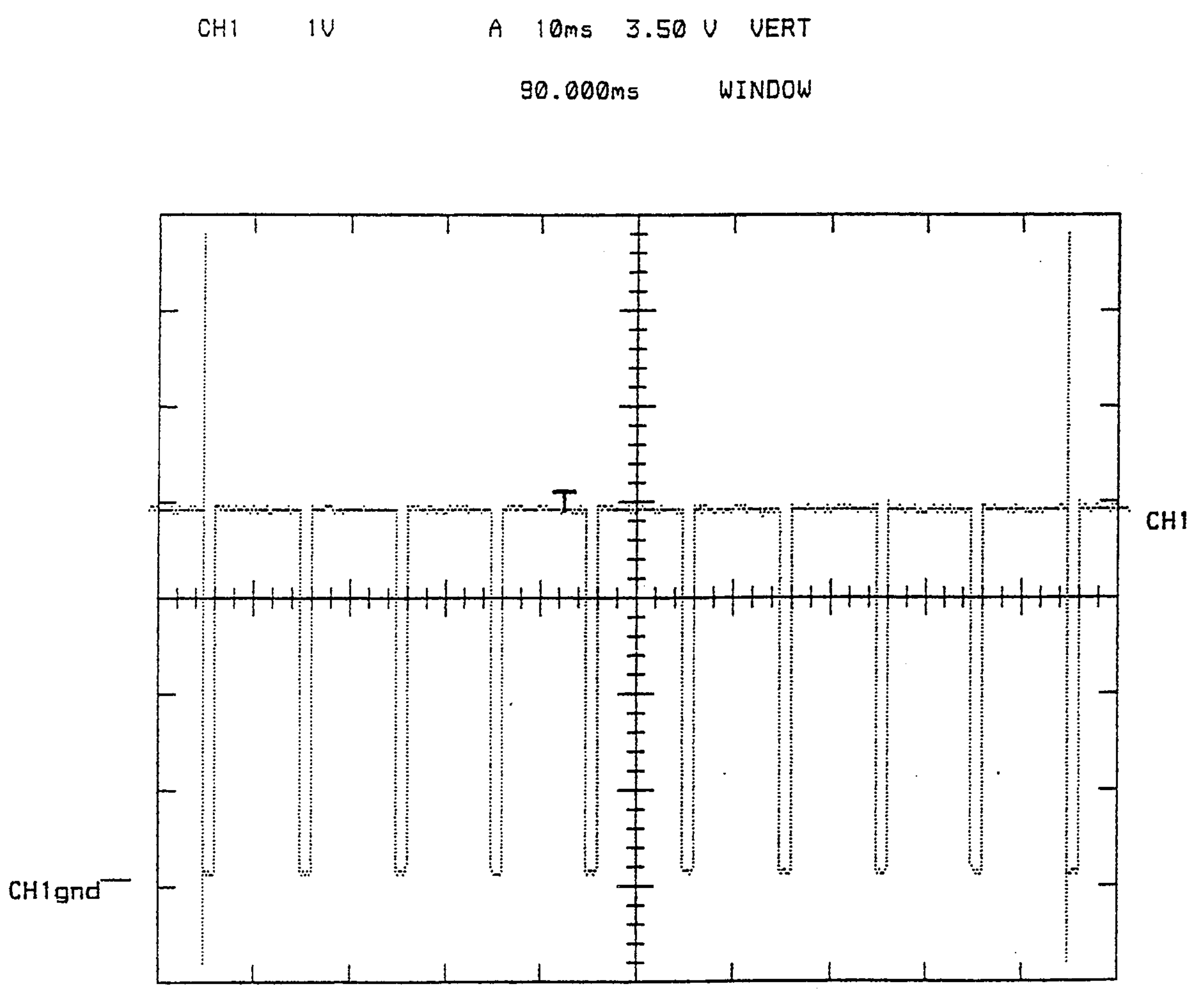
EoA S/N 002
WDM Analog/Digital Source

Repetition Rate Test



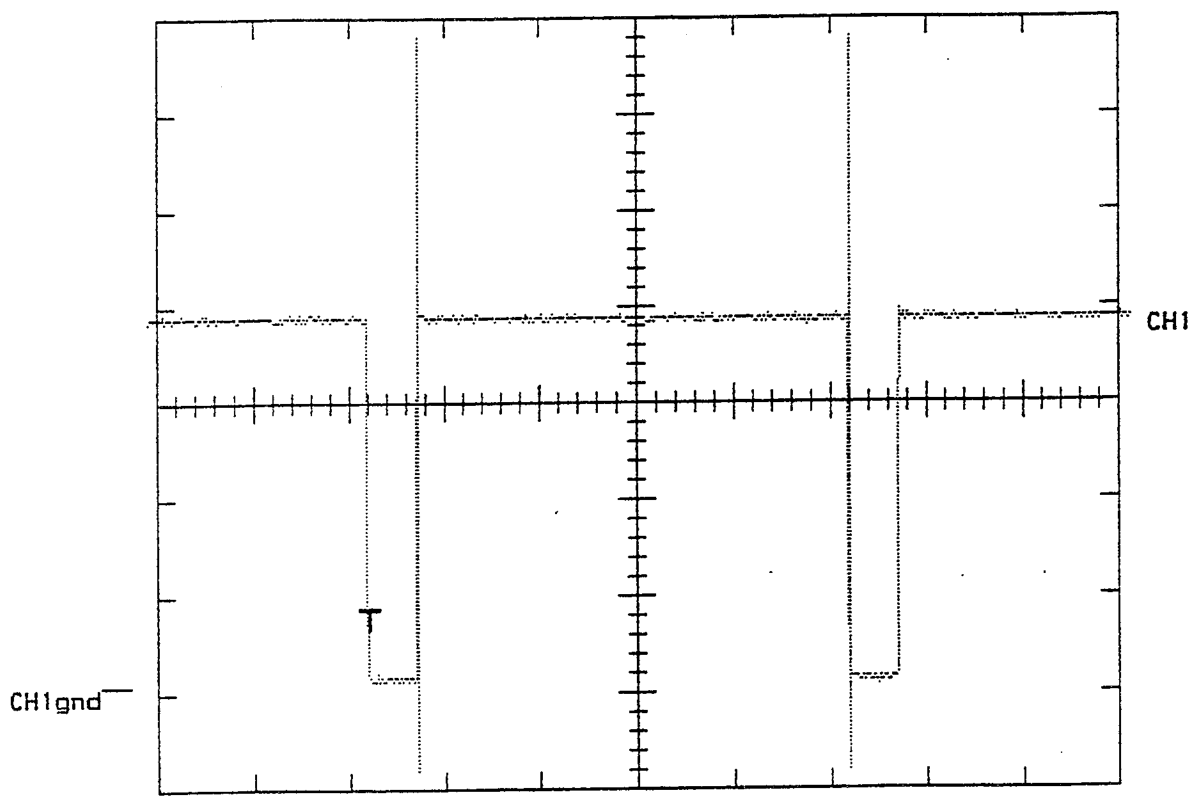
CH1 MIN = 80.000mV
CH1 MAX = 3.9600 V

EoA S/N 002
WDM Analog/Digital Source

Duty Cycle Source ON Time

CH1 1V A 2ms 3.28 V VERT

8.9600ms WINDOW



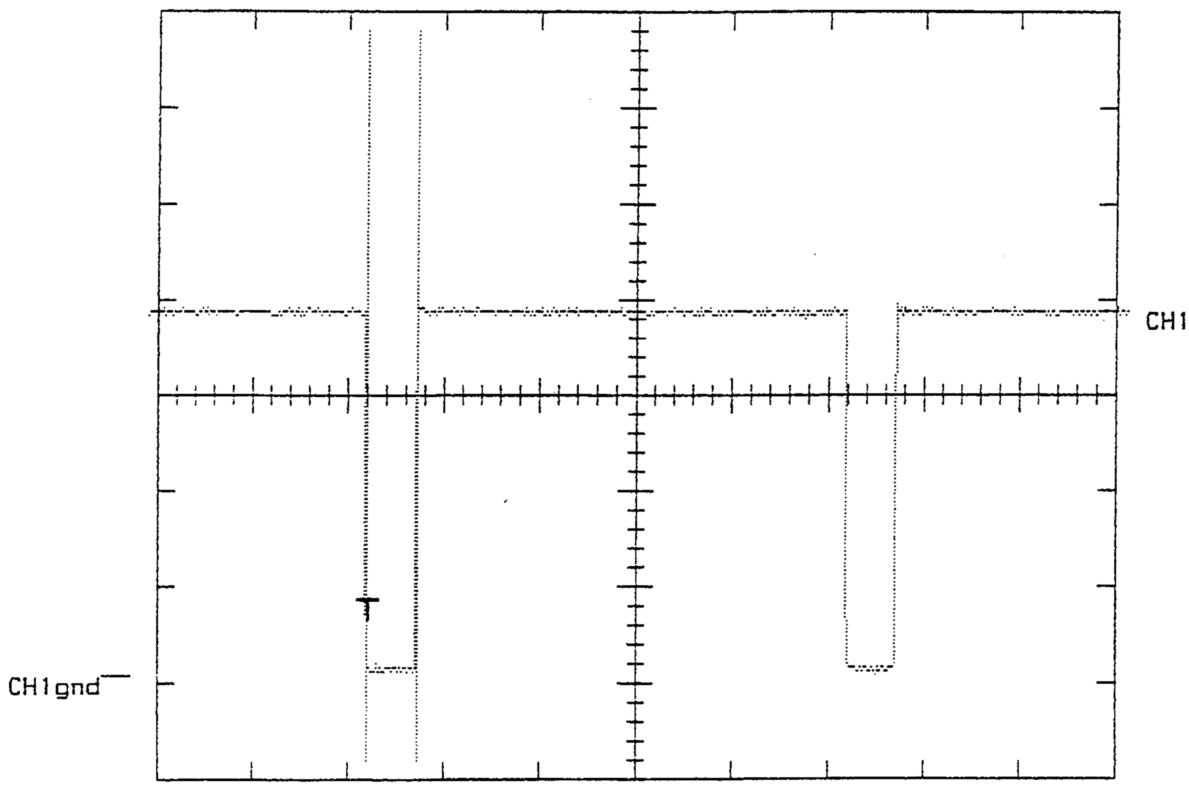
EOA S/N 002

WDM Analog/Digital Source

Duty Cycle Source OFF Time

CH1 1V A 2ms 3.28 V VERT

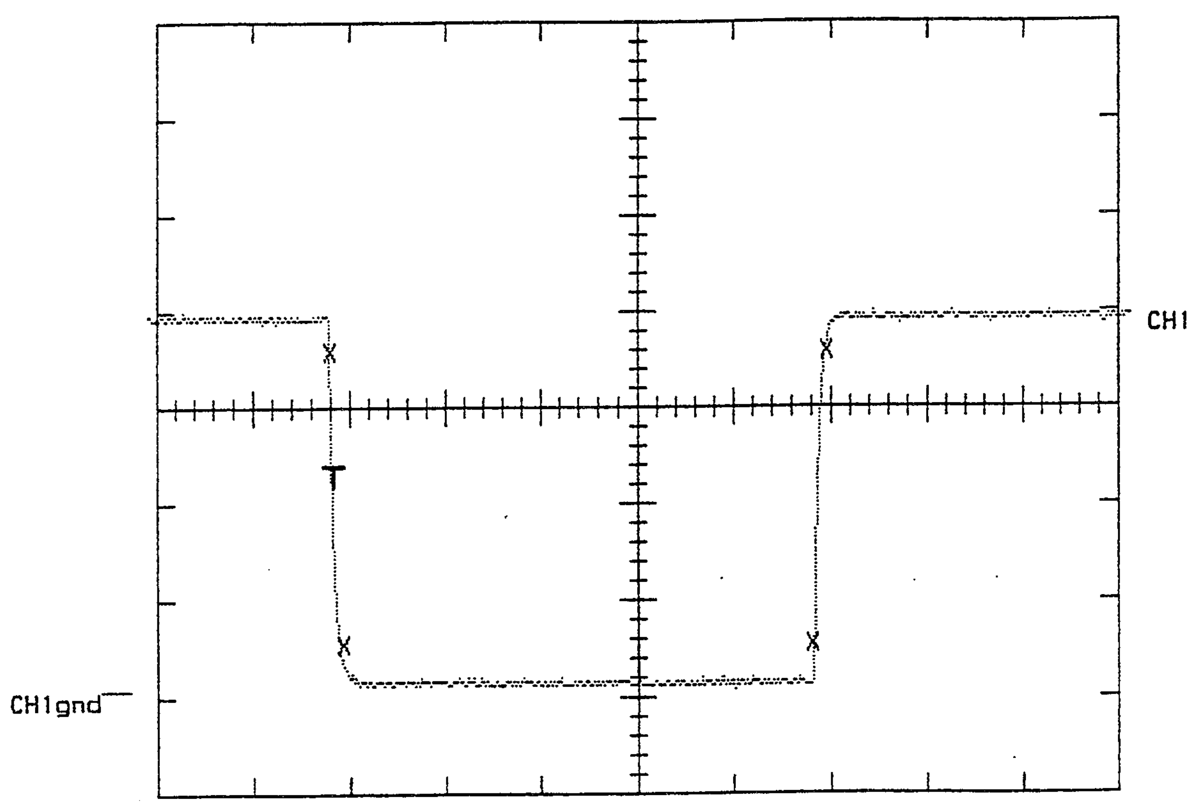
1.0400ms WINDOW



EoA S/N 002
WDM Analog/Digital Source

Rise and Fall Test

CH1 1V A 200us 2.80 V VERT



CH1 RISE = 28.000us
CH1 FALL = 28.000us

Brad Kessler
TRD S/N 002
4/23/93

5.2 WDM TRD SOURCE TEST DATA SHEET

5.2.1 Minimum Peak Power Test (4.3.2)

PASS ☐ FAIL ☑

5.2.1.1 Attach the graph of the source spectrum behind this data sheet.

Minimum Peak Power of Source [-33.95] dBm — Expected: –17.5dBm

Comments: The 2x2 coupler attenuation is 4.0dB. This must be added to the measured power to eliminate the effects of the coupler. $(-37.95 + 4.0 = -33.95)$

5.2.2 Wavelength Range Test (4.3.3)

PASS ☑ FAIL ☐

5.2.2.1 Attach the graph of the source spectrum behind this data sheet.

Short Wavelength [580] nm — Expected: < 675nm

Long Wavelength [1050] nm — Expected: > 650nm

Comments: None of the wavelengths meet the minimum power test. The wavelengths at which the power is down by 3.0dB are 655nm to 683nm. The data sheets for the temperature sensors show the full range of the TRD source.

6/27/93

5.2.3 Maximum Repetition Rate Test (4.3.5)

PASS ☑ FAIL ☐

5.2.3.1 Attach the graphs of the source spectrums behind this data sheet.

Period of Sinusoidal Waveform [1.012] msec.

Repetition Rate [990] pulses/second — Expected: $\leq$ 1000pulses/sec.

Comments:

5.2.4 Minimum Source Modulation Depth Test (4.3.7)

PASS ☐ FAIL ☐
See comments

5.2.4.1 Attach the graphs of the source spectrums behind this data sheet.

Wavelength of Smallest Power Change [ ] nm

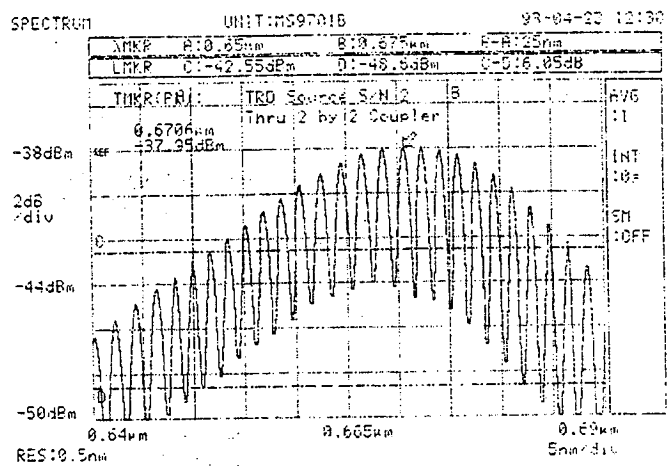
Max. Power at Wavelength [ ] dBm — Min. Power at Wavelength [ ] dBm

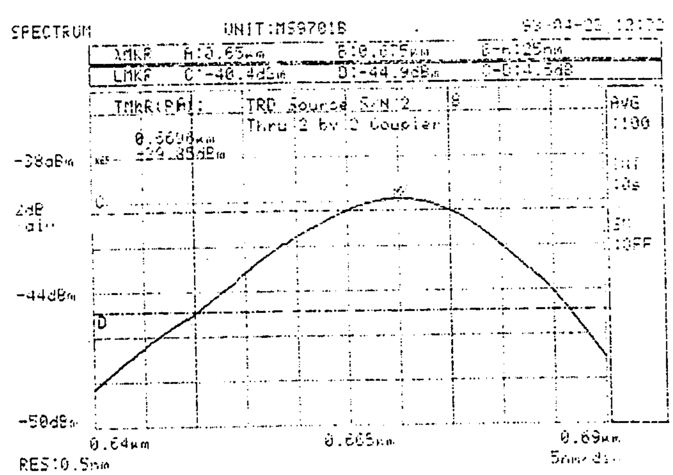
Source Modulation Depth (SMD) is the minimum range of source power adjustment
SMD = Power During Max. LED Current – Power During Min. LED Current

Source Modulation Depth [ ] dB — Expected: $\geq$ 15dB

Comments: The TRD source is not adjustable. The power output is fixed upon power up. The only variations are the small variations due to normal operation (See TRD S/N 1 data sheet for this section.)

EoA S/N 2 TRD Source Spectrums

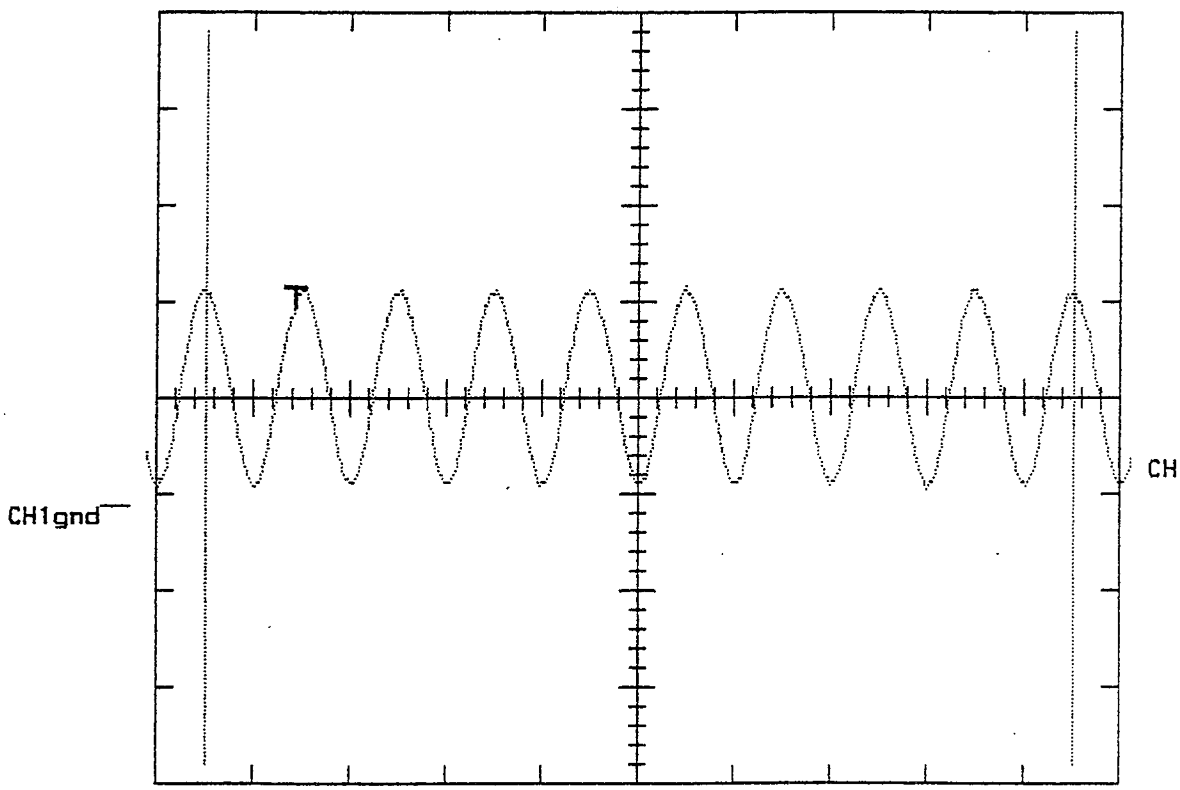




EOA S/N 002
TRD Source

Repetition Rate Test

CH1 500mV A 1ms 3.28 V VERT
9.0100ms WINDOW



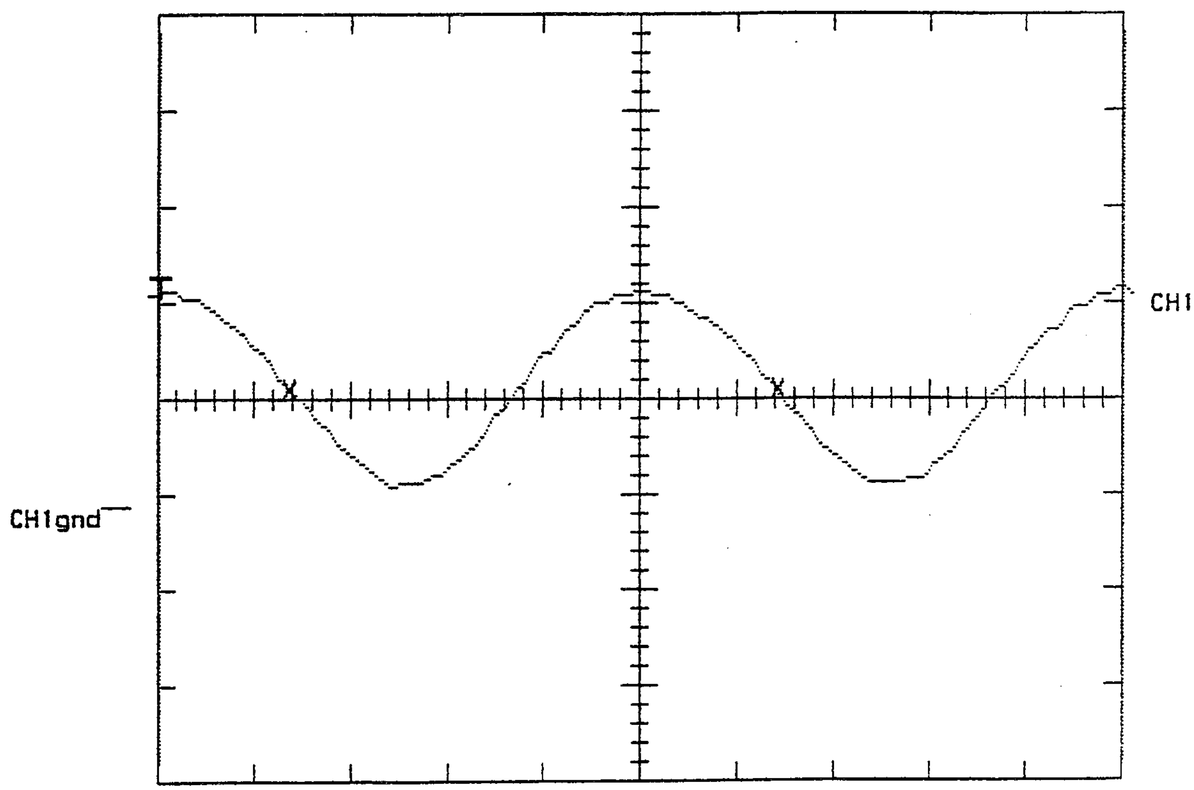
CH1 MAX = 1.1600 V
CH1 MIN = 100.00mV

EDA S/N 002
TRD Source

Repetition Rate Test

CH1 500mV A 200us 3.28 V VERT

2.0000ms WINDOW



HISTO? CH1 PER = 1.0120ms

Brad Kessler
6/27/93

EDA S/N1 and S/N2

5.3 WDM ANALOG and DIGITAL RECEIVER TEST DATA SHEET

5.3.1 Saturation and Noise Level Test (4.4.2)

PASS ☑ FAIL ☐ (The range passes)

PC Display Port Number [1] Source to Receiver Wraparound ~~(The port number is equal to the connector pin number)~~

Saturation Level [910] pixel value ~~dBm~~ at [All] nm ~~Expected: -60dBm/nm~~

Noise Level [30] pixel value ~~dBm~~ at [All] nm ~~Expected: -86dBm/nm~~

The pixel values are the 1024 States that the CCD array can report.

The value of 910 was obtained from Saturating the Source.

The value of 30 was obtained from EDA ven[dor]

Comments: The source did not saturate with the attenuator in line. Also, the EDA vendor reports that the PC display does not show the noise level; the receiver does not decode sensors below a pixel value of 30 even though the spectrum can still be seen on the display. See below for the range of the WDM Receiver.

5.3.2 Dark Current Level Test (4.4.3)

PASS ☑ FAIL ☐

Dark Current Level [ ] dBm at [ ] nm No Expected Value

Comments: No source output is displayed when the receiver connector is covered.

Range of WDM Receiver (The range can be calculated even though the absolute maximum and minimum values of the range cannot be calculated)

910 - 30 = 880

Range in dB = 10 log (880) = 29.5 dB Range

5.4 WDM TRD RECEIVER TEST DATA SHEET

These tests are not possible. There is no PC display for the TRD source.

5.4.1 Saturation and Noise Level Test (4.5.2)

PASS ☐ FAIL ☐

Port Number [ ] (The port number is equal to the connector pin number)

Saturation Level [ ] dBm at [ ] nm Expected: TBD dBm/nm

Noise Level [ ] dBm at [ ] nm Expected: TBD dBm/nm

Comments:

5.4.2 Dark Current Level Test (4.5.3)

PASS ☐ FAIL ☐

Dark Current Level [ ] dBm at [ ] nm No Expected Value

Comments:

Initial Wavelength of First Channel [758.6] nm — Expected: 750nm to 770nm

Comments:

Ending Wavelength of Last Channel [861.8] nm — Expected: 846nm to 878nm

Comments:

Channel Widths — Expected: 8.5nm +/− 0.5nm

See ① below

Channel 1 [9.8] nm	Channel 2 [11.0] nm	Channel 3 [8.8] nm
Channel 4 [8.6] nm	Channel 5 [8.6] nm	Channel 6 [8.4] nm
Channel 7 [8.4] nm	Channel 8 [8.0] nm	Channel 9 [8.4] nm
Channel 10 [8.0] nm	Channel 11 [7.8] nm → See ② below	Channel 12 [8.0] nm

Comments: Channel widths are measured from the midpoint of the valley before the channel to the midpoint of the valley after the channel.

λ
758.6
768.4
779.4
788.2
796.8
805.4
831.8
822.2
830.2
838.6
846.6
854.4
862.4

① The width of the gap between channels 1 and 2 skews these channels' widths. If measured at the beginning of the rise and at the end of the fall, the measurements are:

$766.1 - 758.1 = 8.0$ Channel 1 [8.0] $779.4 - 771.4 = 8.0$ Channel 2 [8.0]

② Channel 11 seems too small, but the equipment cursor resolution is 0.4nm, so the 7.8 could just as well be 8.0.

Guardband Widths — Expected: 2.5nm

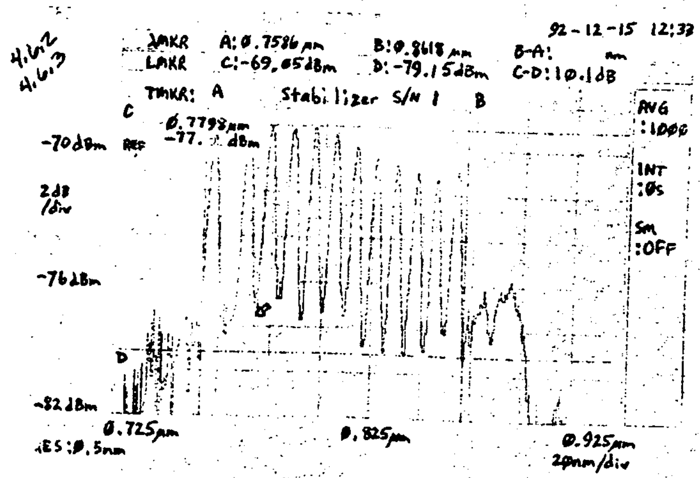
Band 1/2 [7.2] nm	Band 2/3 [2.2] nm	Band 3/4 [2.6] nm
Band 4/5 [2.8] nm	Band 5/6 [5.4] nm	Band 6/7 [2.2] nm
Band 7/8 [2.6] nm	Band 8/9 [2.8] nm	Band 9/10 [2.8] nm
Band 10/11 [2.8] nm	Band 11/12 [5.0] nm	

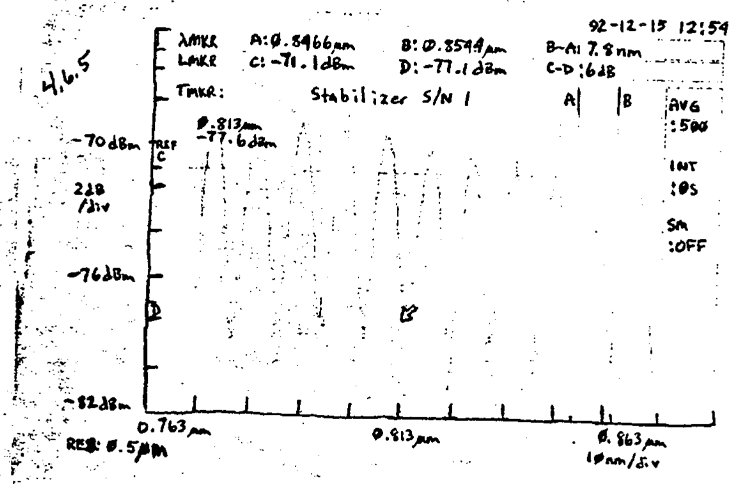
Comments:

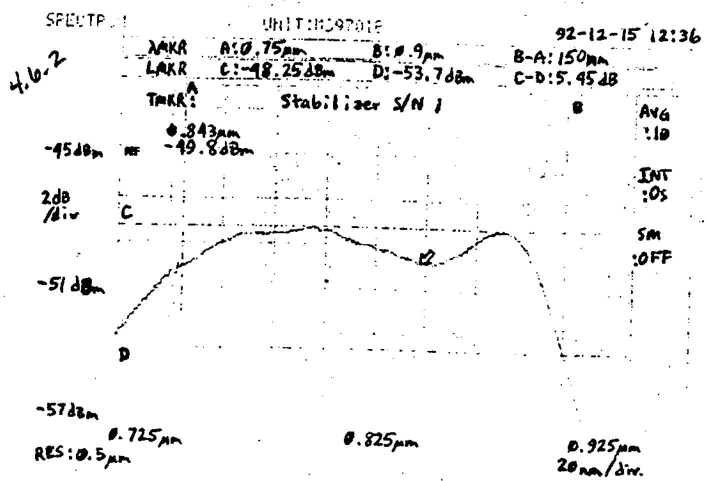
Guardband	λ	to λ
1	765.6	772.8
②	777.8	780.0
3	785.0	787.6
4	793.6	796.4
[5]	802.0	807.4
⑥	812.0	814.2
7	819.0	821.6
8	827.0	829.8
9	835.0	837.8
10	843.2	846.0
[11]	851.0	856.0

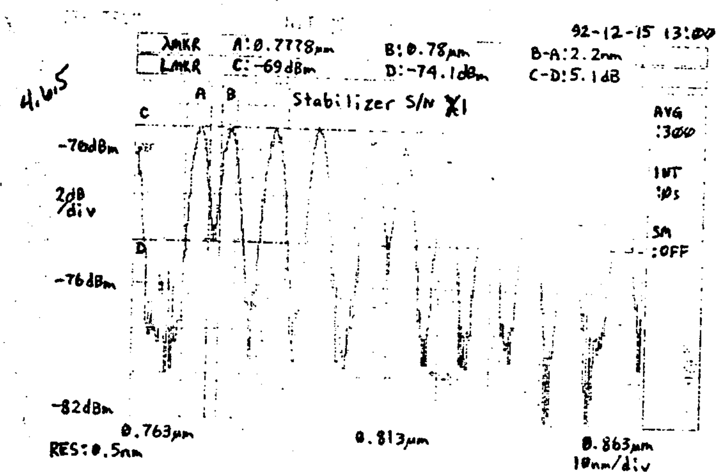
○ – between lows
□ – between highs
– between high and low

Stabilizer 1









5.5 STABILIZER SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/15/92 Test Article Serial Number: 2

5.5.1 Sensor Insertion Loss Test (4.6.2) PASS ☑ FAIL ☐

5.5.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	765	-65.15	-48.95	16.2
Peak 2	777	-64.7	-48.65	16.05
Peak 3	786	-64.85	-48.55	16.3
Peak 4	795	-64.75	-48.4	16.35
Peak 5	803	-65.1	-48.4	16.7
Peak 6	811	-65.25	-48.7	16.55
Peak 7	820	-65.7	-49.1	16.6
Peak 8	828	-65.95	-49.3	16.65
Peak 9	836	-66.8	-49.55	17.25
Peak 10	845	-66.75	-49.8	16.95
Peak 11	852	-66.6	-49.65	16.95
Peak 12	860	-66.35	-49.3	17.05

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 16.6 dB Expected: $\leq$ 24dB

Comments:

5.5.2 Contrast Ratio Test (4.6.3) PASS ☑ FAIL ☐

5.5.2.1 Attach the graphs of the sensor bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-65.2 / -75.8	dBm	Channel 2	-64.7 / -75.5	dBm	Channel 3	-64.9 / 74.6	dBm
Channel 4	-64.8 / -75.1	dBm	Channel 5	-65.1 / -75.0	dBm	Channel 6	-65.3 / -75.4	dBm
Channel 7	-65.7 / -75.5	dBm	Channel 8	-66.0 / -75.7	dBm	Channel 9	-66.8 / -75.8	dBm
Channel 10	-66.8 / -76.1	dBm	Channel 11	-66.6 / -75.9	dBm	Channel 12	-66.4 / -76.4	dBm

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	10.6	dB	Channel 2	10.8	dB	Channel 3	9.7	dB
Channel 4	10.3	dB	Channel 5	9.9	dB	Channel 6	10.1	dB
Channel 7	9.8	dB	Channel 8	9.7	dB	Channel 9	9.0	dB
Channel 10	9.3	dB	Channel 11	9.3	dB	Channel 12	10.0	dB

Minimum Contrast Ratio 9.0 dB Expected: ≥6.0dB

Comments:

5.5.3 Channel Characteristics Test (4.6.4) PASS ☑ FAIL ☐

(But note channel widths and guardband widths)

5.5.3.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels 12 Expected: 12

Comments:

Initial Wavelength of First Channel $\boxed{759}$ nm — Expected: 750nm to 770nm

Comments:

Ending Wavelength of Last Channel $\boxed{864.6}$ nm — Expected: 846nm to 878nm

Comments:

Channel Widths — Expected: 8.5nm +/− 0.5nm

Channel 1	11.0 nm → See ① below	Channel 2	10.8 nm	Channel 3	8.6 nm
Channel 4	8.8 nm	Channel 5	8.2 nm	Channel 6	8.6 nm
Channel 7	8.4 nm	Channel 8	8.0 nm	Channel 9	8.2 nm
Channel 10	8.0 nm	Channel 11	7.8 nm → See ② below	Channel 12	8.4 nm

Comments: Channel width is measured from midpoint in valley at beginning of channel to midpoint of valley at end of channel.

λ
759.8
770.8
781.6
790.2
799.0
807.2
815.8
824.2
832.2
840.4
848.4
856.2
864.6

① The large gap between channel 1 and 2 skews the widths of channels 1 and 2. If measured near the beginning of the rise and the end of the fall of the channels, the measurements are:

$$\begin{array}{r} 768.0 \\ -759.8 \\ \hline 8.2 \end{array} \quad \text{Channel 1 } \boxed{8.2}\text{ nm} \qquad \begin{array}{r} 781.6 \\ -773.6 \\ \hline 8.0 \end{array} \quad \text{Channel 2 } \boxed{8.0}\text{ nm}$$

② The equipment resolution for the data cursors is 0.4nm so the 7.8 may be 8.0. The average width of the last 3 channels is ~ 8.1nm so Channel 11 is ok.

Guardband Widths — Expected: 2.5nm

Band 1/2	5.8 nm	Band 2/3	2.6 nm	Band 3/4	2.2 nm
Band 4/5	2.4 nm	Band 5/6	2.2 nm	Band 6/7	2.6 nm
Band 7/8	1.8 nm	Band 8/9	2.4 nm	Band 9/10	3.8 nm
Band 10/11	2.6 nm	Band 11/12	3.6 nm		

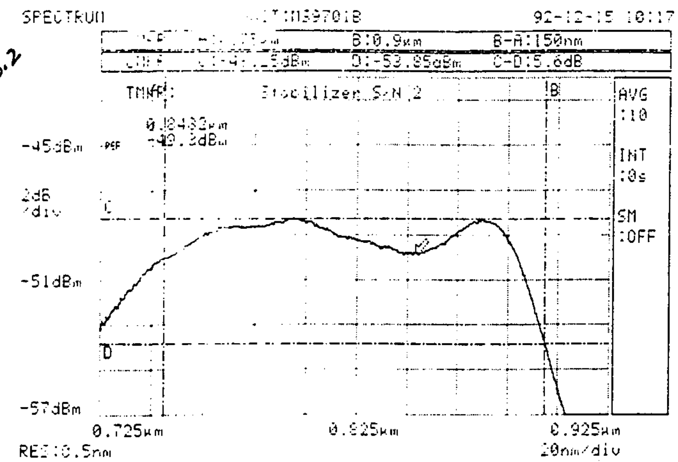
Comments: The guardbands were difficult to distinguish. Where does the guardband start and end?

Guardband	λ	to λ
1	768.8	774.6
2	780.0	782.6
3	787.8	790.0
4	798.6	801.0
5	807.2	809.4
6	814.4	817.0
7	821.8	823.6
8	829.6	832.0
9	838.2	842.0
10	847.0	849.6
11	854.2	857.8

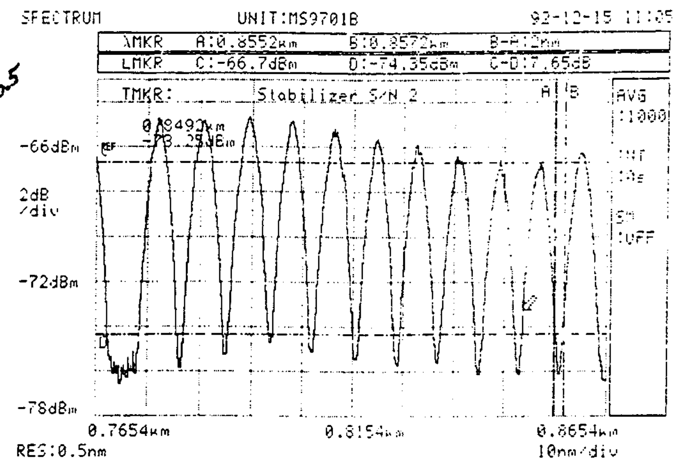
○ — guardband between highs
□ — guardband between lows
— guardband between high and low

Stabilizer 2

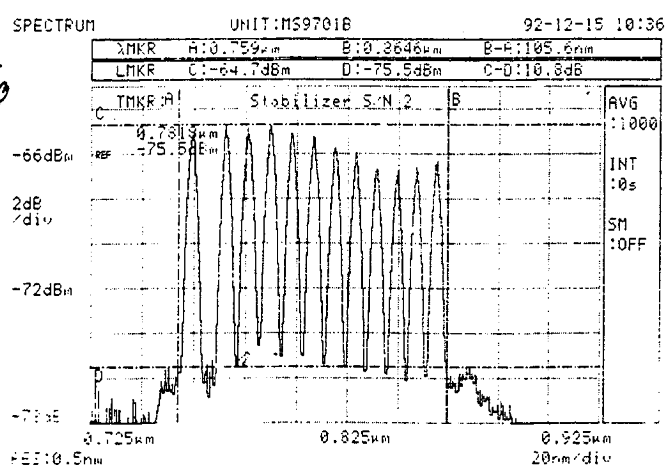
4.6.2



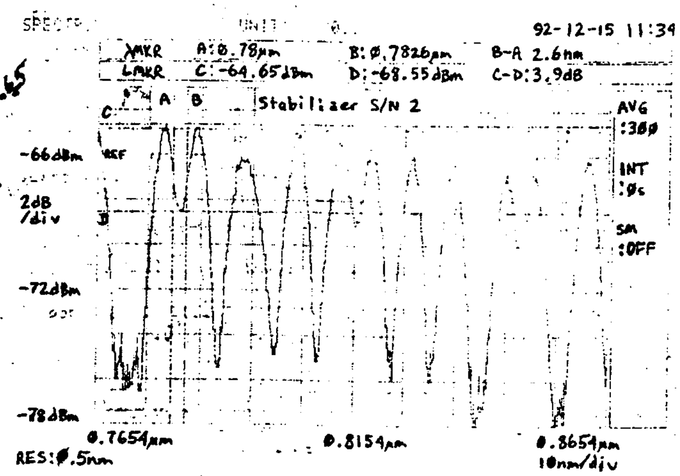
4.6.5



4.6.2
4.6.3



4.6.5



5.6 RUDDER SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/15/92 Test Article Serial Number: 001

5.6.1 Sensor Insertion Loss Test (4.7.2) PASS ☑ FAIL ☐

5.6.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	765.8	-68.9	-51.15	17.75
Peak 2	776.6	-68.3	-50.7	17.6
Peak 3	784.6	-67.9	-50.65	17.25
Peak 4	793.8	-68.0	-50.45	17.55
Peak 5	802.2	-68.05	-50.45	17.6
Peak 6	810.6	-68.1	-50.8	17.3
Peak 7	819.4	-68.45	-51.25	17.2
Peak 8	827.8	-68.55	-51.45	17.1
Peak 9	835.8	-68.2	-51.7	16.5
Peak 10	844.2	-68.5	-51.95	16.55
Peak 11	852.2	-68.25	-51.85	16.4
Peak 12	860.6	-68.0	-51.35	16.65
Peak 13	868.6	-67.05	-50.65	16.4

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 17.1 dB Expected: ≤ 24dB

Comments:

5.6.2 Contrast Ratio Test (4.7.3) PASS ☐ FAIL ☑

5.6.2.1 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-68.9 / -77.1 dBm	Channel 2	-68.3 / -72.9 dBm	Channel 3	-67.9 / -72.8 dBm
Channel 4	-68.0 / -72.4 dBm	Channel 5	-68.1 / -72.4 dBm	Channel 6	-68.1 / -72.6 dBm
Channel 7	-68.5 / -72.6 dBm	Channel 8	-68.6 / -72.6 dBm	Channel 9	-68.2 / -72.6 dBm
Channel 10	-68.5 / -72.6 dBm	Channel 11	-68.3 / -72.1 dBm	Channel 12	-68.0 / -71.1 dBm
Channel 13	-67.1 / -75.8 dBm				

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	8.2 dB	Channel 2	4.6 dB	Channel 3	4.9 dB
Channel 4	4.4 dB	Channel 5	4.3 dB	Channel 6	4.5 dB
Channel 7	4.1 dB	Channel 8	4.0 dB	Channel 9	4.4 dB
Channel 10	4.1 dB	Channel 11	3.8 dB	Channel 12	3.1 dB
Channel 13	8.7 dB				

Minimum Contrast Ratio 3.1 dB Expected: ≥6.0dB

Comments:

5.6.3 Channel Characteristics Test (4.7.4) PASS ☑ FAIL ☐

(But note channel widths and guardband widths)

5.6.3.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels 13 Expected: 13

Comments:

Initial Wavelength of First Channel 759.4 nm Expected: 750nm to 770nm

Comments:

Ending Wavelength of Last Channel 873.4 nm Expected: 854nm to 887nm

Comments:

Channel Widths Expected: 8.5nm +/– 0.5nm

Channel 1	11.2 nm → See ① below	Channel 2	9.8 nm → See ② below	Channel 3	8.8 nm
Channel 4	8.8 nm	Channel 5	8.4 nm	Channel 6	8.8 nm
Channel 7	8.4 nm	Channel 8	8.2 nm	Channel 9	8.2 nm
Channel 10	8.0 nm	Channel 11	8.0 nm	Channel 12	8.2 nm
Channel 13	9.2 nm → See ③ below				

Comments: Channel widths are measured from the midpoint of the valley before the channel peak to the midpoint of the valley after the channel peak.

λ
759.4
770.6
780.4
789.2
798.0
806.4
815.2
823.6
831.8
840.0
848.0
856.0
864.2
873.4

① The beginning wavelength is too far from the realistic start of rise of channel 1. Using a more realistic initial wavelength gives: $770.2 - 761.4 = 8.8$ Channel 1 $\boxed{8.8}$ nm

② Instead of measuring from the middle of the gap between channels 1 and 2, and instead measure near the beginning and ending of the peak, the value for channel 2 is: $780.4 - 772.2 = 8.2$ Channel 2 $\boxed{8.2}$ nm

③ The ending wavelength was too far on the end of the fall of channel 13. Using a more realistic value gives: $872.6 - 864.2 = 8.4$ Channel 13 $\boxed{8.4}$ nm

Guardband Widths Expected: 2.5nm

Band 1/2	3.8 nm	Band 2/3	2.6 nm	Band 3/4	2.6 nm
Band 4/5	3.8 nm	Band 5/6	2.4 nm	Band 6/7	3.0 nm
Band 7/8	2.6 nm	Band 8/9	2.2 nm	Band 9/10	2.2 nm
Band 10/11	3.4 nm	Band 11/12	2.8 nm	Band 12/13	3.0 nm

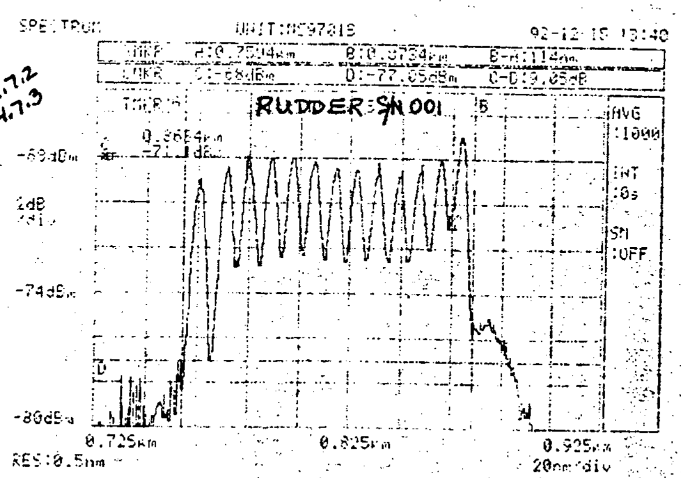
Comments:

Guardband	λ	to λ
$\boxed{1}$	768.2	772.0
2	777.8	780.4
3	785.4	788.0
4	795.2	799.0
5	804.0	806.4
6	811.0	814.0
7	819.8	822.4
8	828.0	830.2
9	836.2	838.4
$\boxed{10}$	844.8	848.2
11	853.6	856.4
12	861.2	864.2

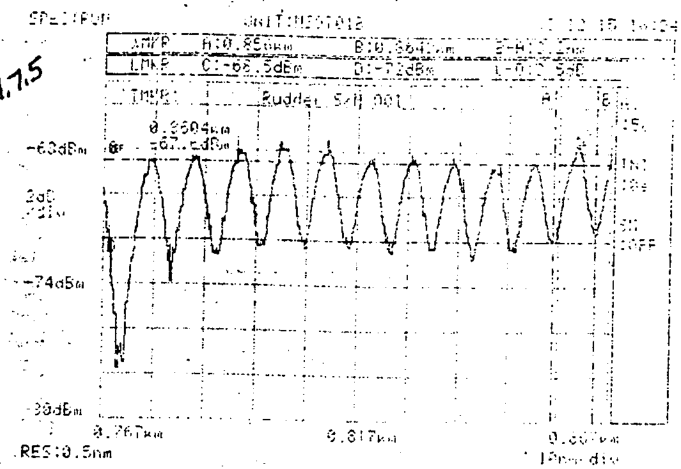
○ – between highs
□ – between lows
– between high and low

Rudder 001

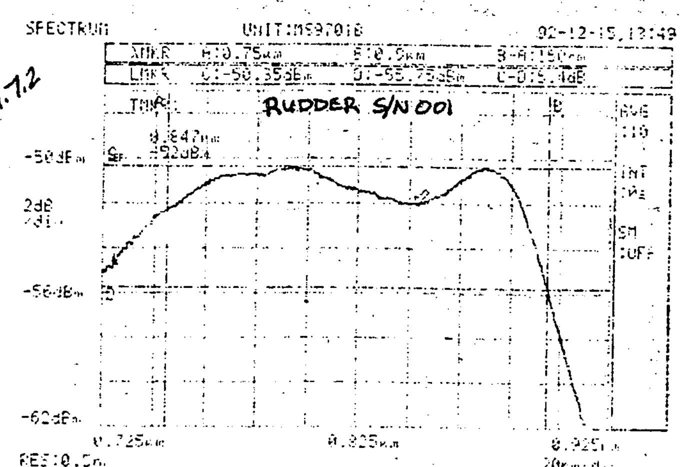
4.7.2
4.7.3



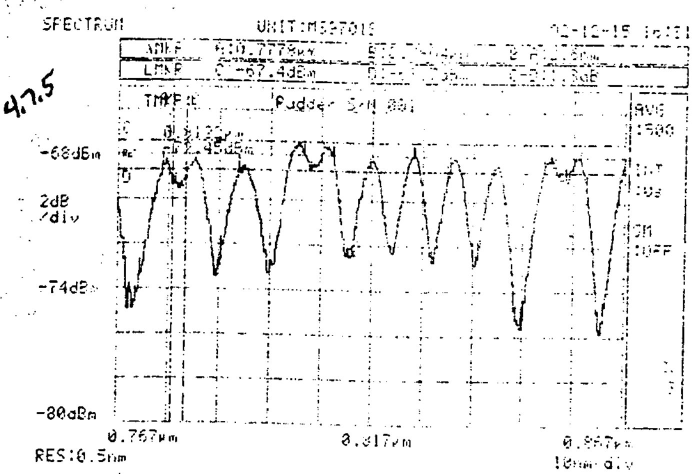
4.7.5



4.7.2



4.7.5



5.6 RUDDER SENSOR DATA SHEET

Performed by: Brad Kessler Date: 4/23/93 Test Article Serial Number: 002

5.6.1 Sensor Insertion Loss Test (4.7.2)

PASS ☑ FAIL ☐

5.6.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	763.0	-66.2	-47.45	18.75
Peak 2	773.4	-65.4	-47.0	18.4
Peak 3	781.4	-65.25	-47.0	18.25
Peak 4	790.2	-65.25	-47.05	18.2
Peak 5	798.6	-65.15	-47.05	18.1
Peak 6	806.6	-64.8	-47.2	17.6
Peak 7	815.0	-64.95	-47.45	17.5
Peak 8	823.4	-65.05	-47.65	17.4
Peak 9	831.0	-64.9 ~~-64.09~~	-47.65	17.25
Peak 10	839.0	-64.75	-47.65	17.1
Peak 11	847.4	-64.85	-47.75	17.1
Peak 12	854.6	-64.55	-47.7	16.85
Peak 13	862.6	-64.0	-47.35	16.65

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 17.6 dB Expected: ≤ 24dB

Comments:

5.6.2 Contrast Ratio Test (4.7.3) PASS ☑ FAIL ☐

5.6.2.1 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-66.2 / -74.7 dBm	Channel 2	-65.4 / -72.6 dBm	Channel 3	-65.3 / -72.2 dBm
Channel 4	-65.3 / -72.2 dBm	Channel 5	-65.2 / -72.1 dBm	Channel 6	-64.8 / -72.0 dBm
Channel 7	-65.0 / -72.1 dBm	Channel 8	-65.1 / -72.3 dBm	Channel 9	-64.9 / -71.7 dBm
Channel 10	-64.8 / -71.9 dBm	Channel 11	-64.9 / -71.5 dBm	Channel 12	-64.6 / -71.2 dBm
Channel 13	-64.0 / -73.4 dBm				

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	8.5 dB	Channel 2	7.2 dB	Channel 3	6.9 dB
Channel 4	6.9 dB	Channel 5	6.9 dB	Channel 6	7.2 dB
Channel 7	7.1 dB	Channel 8	7.2 dB	Channel 9	6.8 dB
Channel 10	7.1 dB	Channel 11	6.6 dB	Channel 12	6.6 dB
Channel 13	9.4 dB				

Minimum Contrast Ratio 6.6 dB Expected: ≥6.0dB

Comments:

5.6.3 Channel Characteristics Test (4.7.4) PASS ☐ FAIL ☑

5.6.3.1 Attach the graph of the typical sensor value behind this data sheet.

See channel widths test

Number of Discrete Channels 13 Expected: 13

Comments:

C-2.

Initial Wavelength of First Channel 758.6 nm — Expected: 750nm to 770nm

Comments:

Ending Wavelength of Last Channel 867.4 nm — Expected: 854nm to 887nm

Comments:

Channel Widths — Expected: 8.5nm +/− 0.5nm

See ① below

Channel 1	8.4 nm	Channel 2	8.0 nm	Channel 3	8.4 nm
Channel 4	8.4 nm	Channel 5	8.4 nm	Channel 6	8.4 nm
Channel 7	8.4 nm	Channel 8	8.0 nm	Channel 9	8.0 nm
Channel 10	8.0 nm	Channel 11	7.6 nm	Channel 12	8.0 nm
Channel 13	8.4 nm				

See ② below

Comments: Channel widths are measured from the midpoint of the valley before the channel peak to the midpoint of the valley after the channel peak.

	λ
1	758.6
	767.0
2	769.4
	777.4
3	785.8
⋮	794.2
	802.6
	811.0
	819.4
	827.4
	835.4
	843.4
	851.0
	859.0
	867.4

① There is a gap between the peaks of channels 1 and 2 which is not included in the channel width of either channel 1 or 2. It shows up in the guardband widths. If this gap were included in the widths of channels 1 and 2, both channels would fail the channel width range.

② **Failure** The equipment cursor resolution is 0.4nm, however, the channels on either side of channel 11 have no excess width that could be part of channel 11.

Guardband Widths — Expected: 2.5nm

Band 1/2	3.6 nm	Band 2/3	2.4 nm	Band 3/4	2.4 nm
Band 4/5	2.4 nm	Band 5/6	2.0 nm	Band 6/7	2.4 nm
Band 7/8	2.4 nm	Band 8/9	2.4 nm	Band 9/10	2.0 nm
Band 10/11	2.0 nm	Band 11/12	2.4 nm	Band 12/13	2.0 nm

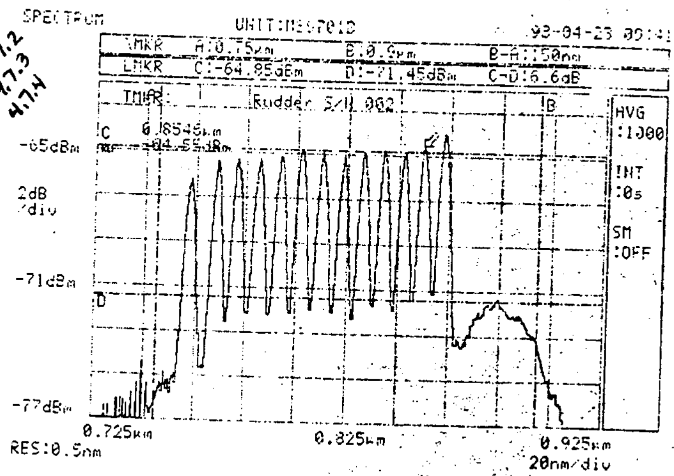
Comments:

Guardband	λ	to λ
1	766.2	769.8
2	776.2	778.6
3	784.6	787.0
4	793.4	795.8
5	801.8	803.8
6	809.8	812.2
7	818.2	820.6
8	826.2	828.6
9	834.2	836.2
10	842.2	844.2
11	849.8	852.2
12	857.8	859.8

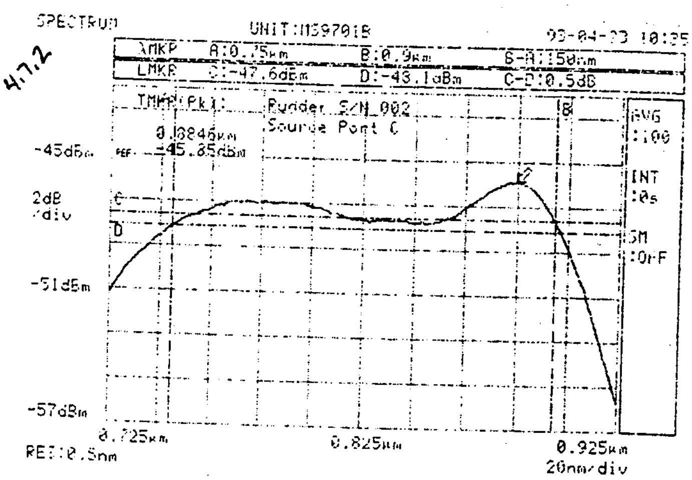
The guardbands are measured as the width of the valley between channel peaks. The edges of guardbands are arbitrarily chosen as the point on the rise of the channel peak that isn't too far away from the valley floor.

Rudder 002

4.7.2
4.7.3
4.7.4



4.7.2



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5.7 PITCH STICK SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/16/92 Test Article Serial Number: 001

5.7.1 Sensor Insertion Loss Test (4.8.2) PASS ☑ FAIL ☐

5.7.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss = Source Peak Power – Sensor Peak Power.

Reference Peak Power [-67.1] dBm at [776.2] nm

Source Peak Power at Reference Wavelength [-48.9] dBm

Reference Insertion Loss [18.2] dB Expected: ≤ TBD dB

Signal Peak Power [-64.3] dBm at [874.6] nm

Source Peak Power at Signal Wavelength [-48.6] dBm

Signal Insertion Loss [15.7] dB Expected: ≤ 20dB

Comments:

5.7.2 Dynamic Range Test (4.8.3) PASS ☐ FAIL ☑

5.7.2.1 Attach the graphs of the output power spectrums with the maximum and minimum sensor signals behind this data sheet.

Minimum Sensor Signal [-72.25] dBm

Reference Power at Minimum Sensor Signal [-67.1] dBm

Maximum Sensor Signal [-64.3] dBm

Reference Power at Maximum Sensor Signal [-67.1] dBm

Dynamic Range = (Max. Sensor Signal – Reference Power at max. sensor signal) – (Min. Sensor Signal – Reference Power at min. sensor signal)

Dynamic Range [7.95] dB Expected: Min. 15dB
Max. TBD

Comments:

5.7.3 Reference Integrity Test (4.8.4) PASS ☑ FAIL ☐

Reference Power at Min. Sensor Signal -67.1 dBm => X mW

Reference Power at Max. Sensor Signal -67.1 dBm => X mW

Reference Variation (mW) =
Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW)

Reference Variation 0.0 mW => X dB

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB)

Reference Integrity -67.1 dB Expected: ≤ –26dB

Comments:

5.7.4 Channel Characteristics Test (4.8.5) PASS ☑ FAIL ☐

5.7.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels 2 Expected: 2

Comments: Both the reference and signal contain two local peaks. The two reference peaks differ by 0.05dB while the two signal peaks differ by 1.35dB.

Center Wavelength of High Frequency Signal 776.2 nm Expected: 787nm

Comments: Reference Channel

Center Wavelength of Low Frequency Signal 874.6 nm Expected: 863nm

Comments: Signal Channel

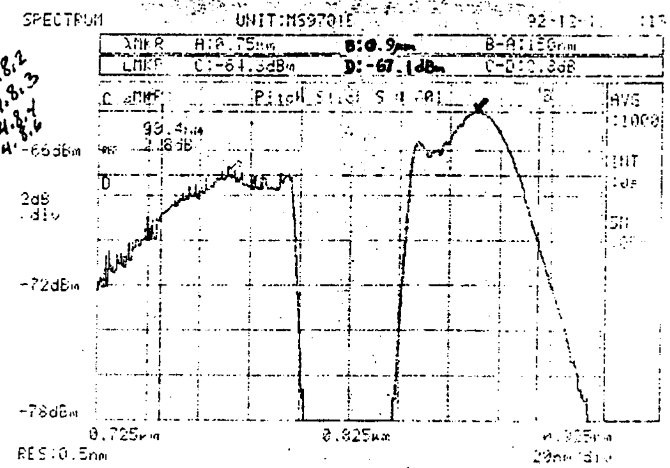
Channel Widths Expected: ≤ 75nm

High Frequency Width 51.4 nm 750 to 801.4nm Low Frequency Width 50.2 nm 849.8 to 900nm

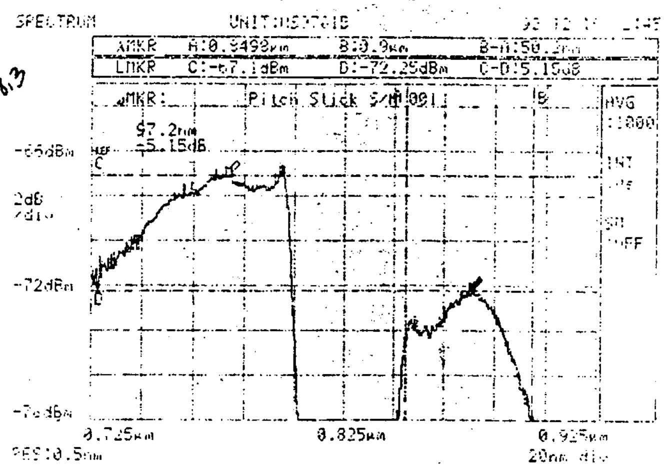
Comments:
Reference Channel Width: measured from 750nm to the point where the reference channel drops off sharply.
Signal Channel Width: measured from the point where the signal reaches a high value and levels off to the 900nm point.

Pitch Stick 001

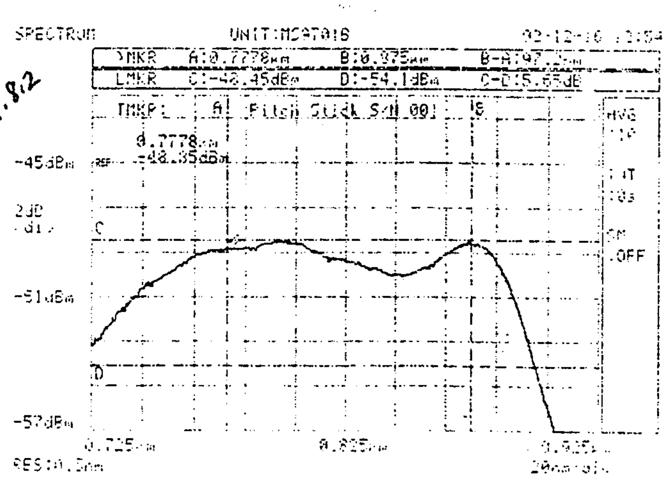
4.8.2
4.8.3
4.8.4
4.8.6



4.8.3



4.8.2



5.7 PITCH STICK SENSOR DATA SHEET

Performed by: Brad Kessler Date: 4/21/93 Test Article Serial Number: 002

5.7.1 Sensor Insertion Loss Test (4.8.2) PASS ☐ FAIL ☑

5.7.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss = Source Peak Power – Sensor Peak Power.

Reference Peak Power -69.75 dBm at 771.8 nm

Source Peak Power at Reference Wavelength -48.1 dBm

Reference Insertion Loss 21.65 dB Expected: ≤ TBD dB

Signal Peak Power -64.9 dBm at 885.0 nm

Source Peak Power at Signal Wavelength -44.7 dBm

Signal Insertion Loss 20.2 dB Expected: ≤ 20dB

Comments: The actual insertion loss is only 0.2dB over the expected value. The EOA should be able to work with this slight out of tolerance.

5.7.2 Dynamic Range Test (4.8.3) PASS ☐ FAIL ☑

5.7.2.1 Attach the graphs of the output power spectrums with the maximum and minimum sensor signals behind this data sheet.

Minimum Sensor Signal -73.3 dBm

Reference Power at Minimum Sensor Signal -69.95 dBm

Maximum Sensor Signal -64.9 dBm

Reference Power at Maximum Sensor Signal -69.75 dBm

Dynamic Range = (Max. Sensor Signal – Reference Power at max. sensor signal) – (Min. Sensor Signal – Reference Power at min. sensor signal)

Dynamic Range 8.2 dB Expected: Min. 15dB
Max. TBD

Comments:

5.7.3 Reference Integrity Test (4.8.4) PASS ☐ FAIL ☑

Reference Power at Min. Sensor Signal [-69.95] dBm => [1.01158×10^{-7}] mW

Reference Power at Max. Sensor Signal [-69.75] dBm => [1.05925×10^{-7}] mW

Reference Variation (mW) =
Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW)

Reference Variation [4.76743×10^{-9}] mW => [-83.22] dB

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB)

Reference Integrity [-13.27] dB Expected: ≤ –26dB

Comments:

5.7.4 Channel Characteristics Test (4.8.5) PASS ☑ FAIL ☐

5.7.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [2] Expected: 2

Comments: The small peaks in the reference and sensor signal were not counted as peaks. Only the large peaks ~~can~~ were counted.

Center Wavelength of High Frequency Signal [771.8] nm Expected: 787nm

Comments: Reference Channel

Center Wavelength of Low Frequency Signal [885.0] nm Expected: 863nm

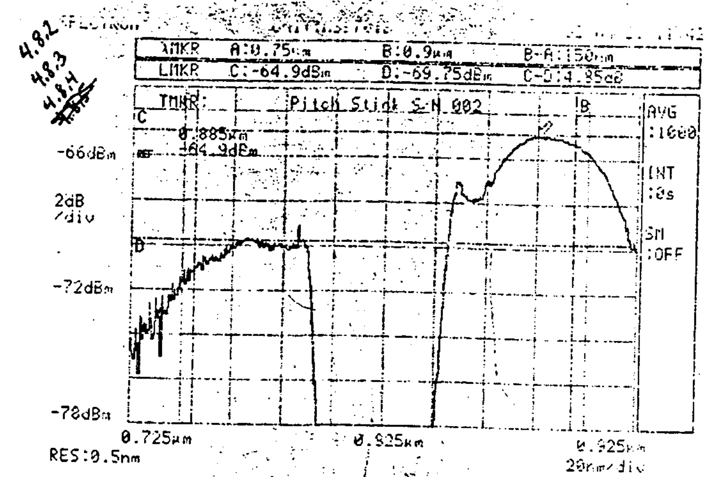
Comments: Signal Channel

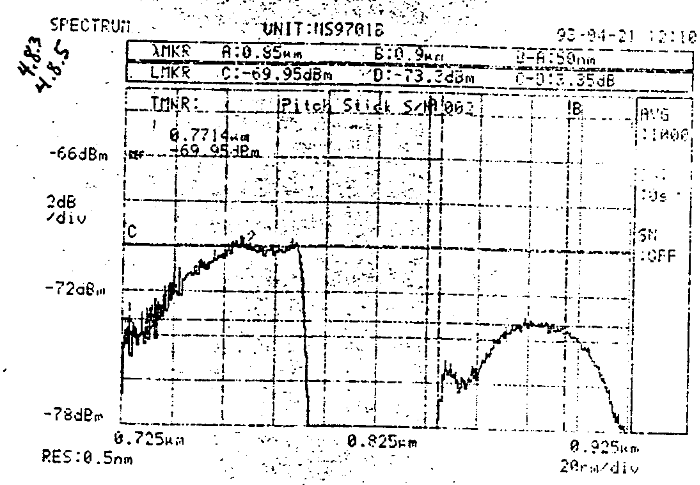
Channel Widths Expected: ≤ 75nm

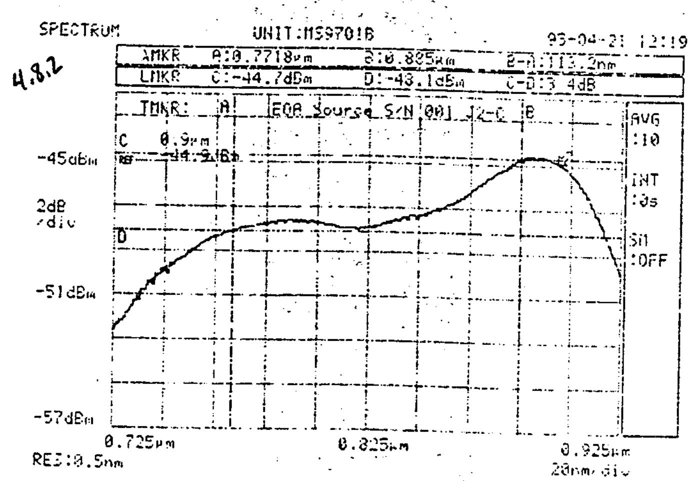
High Frequency Width [45.8] nm Low Frequency Width [50.0] nm

Comments:

Pitch Stick 002







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5.8 RUDDER PEDAL SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/16/92 Test Article Serial Number: 001

5.8.1 Sensor Insertion Loss Test (4.9.2)

PASS ☑ FAIL ☐

5.8.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	763.4	-67.35	-51.0	16.35
Peak 2	774.2	-67.15	-50.65	16.5
Peak 3	782.2	-67.25	-50.6	16.65
Peak 4	791.0	-67.15	-50.55	16.6
Peak 5	799.4	-66.8	-50.2	16.6
Peak 6	807.8	-67.55	-50.35	17.2
Peak 7	816.2	-67.95	-50.8	17.15
Peak 8	824.2	-68.45	-51.15	17.3
Peak 9	832.2	-68.9	-51.3	17.6
Peak 10	840.2	-69.4	-51.6	17.8
Peak 11	848.2	-69.6	-51.7	17.9
Peak 12	855.8	-69.35	-51.5	17.85
Peak 13	863.8	-68.85	-50.8	18.05

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 17.2 dB Expected: ≤ 24dB

Comments:

5.8.2 Contrast Ratio Test (4.9.3) PASS ☑ FAIL ☐

5.8.2.1 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1 -67.4 / -78.6 dBm	Channel 2 -67.2 / -75.8 dBm	Channel 3 -67.3 / -76.3 dBm	
Channel 4 -67.2 / -76.1 dBm	Channel 5 -66.8 / -75.9 dBm	Channel 6 -67.6 / -77.1 dBm	
Channel 7 -68.0 / -76.6 dBm	Channel 8 -68.5 / -77.0 dBm	Channel 9 -68.9 / -77.3 dBm	
Channel 10 -69.4 / -78.2 dBm	Channel 11 -69.6 / -78.0 dBm	Channel 12 -69.4 / -77.6 dBm	
Channel 13 -68.9 / -78.4 dBm			

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1 11.2 dB	Channel 2 ~~8.6~~ 8.6 dB	Channel 3 9.0 dB
Channel 4 8.9 dB	Channel 5 9.1 dB	Channel 6 9.5 dB
Channel 7 8.6 dB	Channel 8 8.5 dB	Channel 9 8.4 dB
Channel 10 8.8 dB	Channel 11 8.4 dB	Channel 12 8.2 dB
Channel 13 9.5 dB		

Minimum Contrast Ratio 8.2 dB Expected: 6.0dB

Comments:

5.8.3 Channel Characteristics Test (4.9.4) PASS ☐ FAIL ☑

(See Channel Width note guardband width)

5.8.3.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels 13 Expected: 13

Comments:

Initial Wavelength of First Channel 759.4 nm — Expected: 750nm to 770nm

Comments:

Ending Wavelength of Last Channel 867.0 nm — Expected: 854nm to 887nm

Comments:

Channel Widths — Expected: 8.5nm +/− 0.5nm

Channel 1	9.2 nm → see ① below	Channel 2	9.4 nm → see ② below	Channel 3	8.8 nm
Channel 4	8.6 nm	Channel 5	8.2 nm	Channel 6	8.4 nm
Channel 7	8.4 nm	Channel 8	7.8 nm	Channel 9	8.2 nm
Channel 10	8.0 nm	Channel 11	7.6 nm → see ④ below Fail	Channel 12	8.2 nm
Channel 13	nm				

Comments: Channel widths are measured from midpoint of valley before channel peak to midpoint of valley after channel peak.

λ
759.4
768.6
778.0
786.8
795.4
803.6
812.0
820.4
828.2
836.4
844.4
852.0
860.2

① Using measurements near the rise and fall of the peak gives 767.6 − 759.4 = 8.2 Channel 1 $\boxed{8.2}$ nm

② ——— " ——— 778.0 − 770.0 = 8.0 Channel 2 $\boxed{8.0}$ nm

③ Since the resolution of the equipment's data cursor is 0.2nm and the channels on either side of channel 8 are 8.4nm and 8.2 nm, this channel width could be 8.0nm.

④ $\boxed{\text{Channel 11 fails the width}}$: Channel 11 is too narrow, and channels 10 and 12 are just on the edge of passing so there is no room for adjusting the subjective midpoints of the channels.

Guardband Widths — Expected: 2.5nm

Band 1/2	3.2 nm	Band 2/3	2.6 nm	Band 3/4	2.2 nm
Band 4/5	3.4 nm	Band 5/6	2.6 nm	Band 6/7	2.4 nm
Band 7/8	3.8 nm	Band 8/9	2.0 nm	Band 9/10	2.4 nm
Band 10/11	2.4 nm	Band 11/12	2.2 nm	Band 12/13	3.8 nm

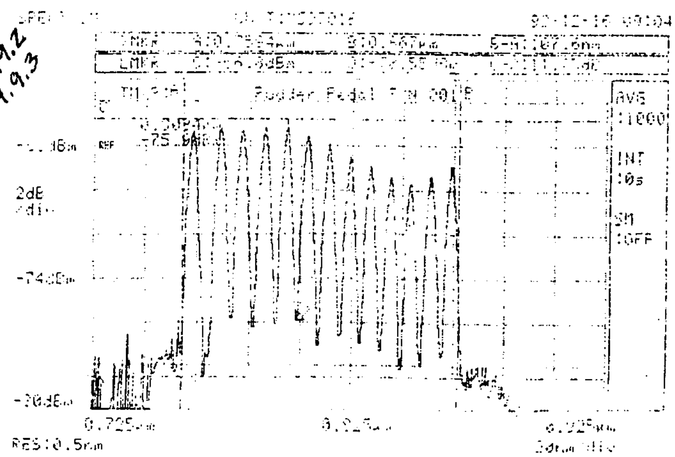
Comments:

Guardband	λ	to λ
1	768.4	771.6
2	777.0	779.6
3	784.8	787.0
$\boxed{4}$	794.4	797.8
5	803.6	806.2
6	811.0	813.4
$\boxed{7}$	818.6	822.4
8	828.8	830.8
9	835.4	837.8
10	842.4	844.8
11	850.0	852.2
$\boxed{12}$	858.6	862.4

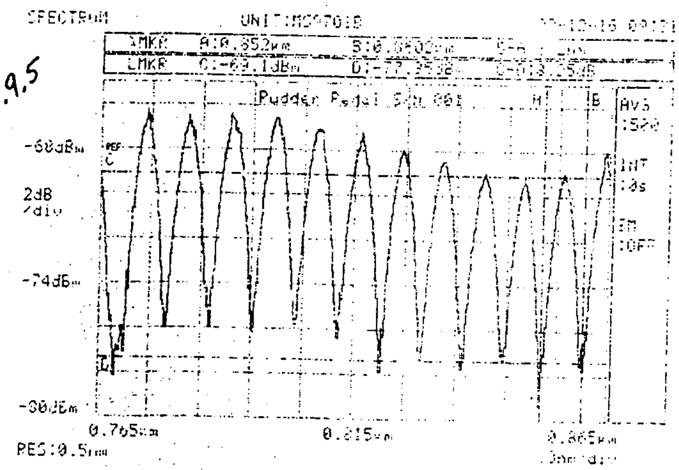
O − between highs
□ − between lows
— between high and low

Rudder Pedal 001

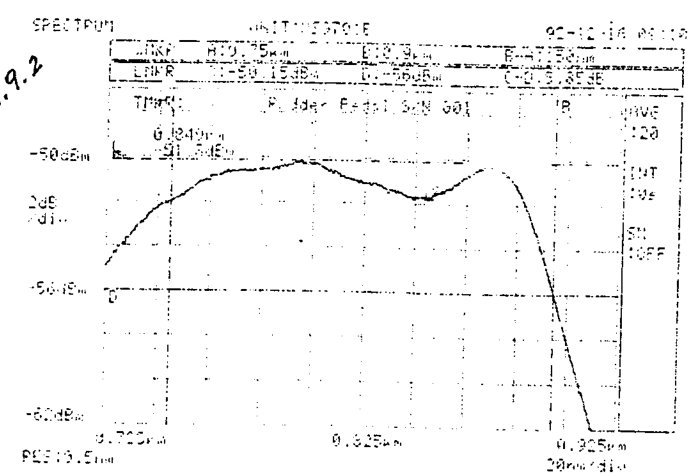
4.9.2
4.9.3



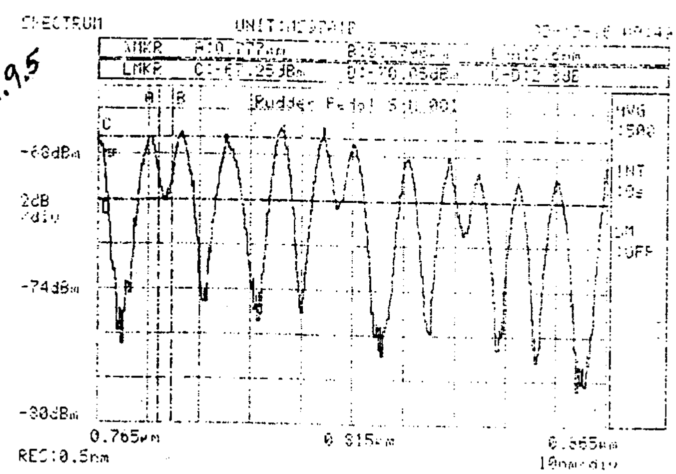
4.9.5



4.9.2



4.9.5



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5.8 RUDDER PEDAL SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/16/92 Test Article Serial Number: 002

5.8.1 Sensor Insertion Loss Test (4.9.2) PASS ☑ FAIL ☐

5.8.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	765.8	-72.95	-50.8	22.15
Peak 2	776.6	-72.3	-50.5	21.8
Peak 3	785.0	-72.45	-50.45	22.0
Peak 4	793.8	-72.3	-50.35	21.95
Peak 5	802.6	-72.5	-50.3	22.2
Peak 6	810.6	-72.55	-50.6	21.95
Peak 7	819.0	-72.5	-51.0	21.5
Peak 8	827.0	-72.6	-51.15	21.45
Peak 9	835.0	-73.1	-51.4	21.7
Peak 10	843.4	-73.35	-51.65	21.7
Peak 11	851.0	-73.3	-51.55	21.75
Peak 12	859.0	-72.65	-51.2	21.45
Peak 13	867.0	-71.95	-50.5	20.45

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 21.7 dB Expected: ≤ 24dB

Comments:

5.8.2 Contrast Ratio Test (4.9.3) PASS ☐ FAIL ☑

5.8.2.1 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-73.0/-80.3 dBm	Channel 2	-72.3/-79.0 dBm	Channel 3	-72.5/-78.9 dBm
Channel 4	-72.3/-78.3 dBm	Channel 5	-72.5/-78.6 dBm	Channel 6	-72.6/-78.5 dBm
Channel 7	-72.5/-78.8 dBm	Channel 8	-72.6/-78.2 dBm	Channel 9	-73.1/-78.5 dBm
Channel 10	-73.4/-79.6 dBm	Channel 11	-73.3/-79.2 dBm	Channel 12	-72.7/-78.7 dBm
Channel 13	-72.0/-78.8 dBm				

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	7.3 dB	Channel 2	6.7 dB	Channel 3	6.4 dB
Channel 4	6.0 dB	Channel 5	6.1 dB	Channel 6	5.9 dB
Channel 7	6.3 dB	Channel 8	5.6 dB	Channel 9	5.4 dB
Channel 10	6.2 dB	Channel 11	5.9 dB	Channel 12	6.0 dB
Channel 13	6.8 dB				

Minimum Contrast Ratio 5.4 dB Expected: 6.0dB

Comments:

5.8.3 Channel Characteristics Test (4.9.4) PASS ☐ FAIL ☑

(See channel widths note guard band widths)

5.8.3.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels 13 Expected: 13

Comments:

Initial Wavelength of First Channel 765.8 nm — Expected: 750nm to 770nm

Comments:

Ending Wavelength of Last Channel 867.0 nm — Expected: 854nm to 887nm

Comments:

Channel Widths — Expected: 8.5nm +/− 0.5nm

Channel 1	5.4 nm → see ① below	Channel 2	9.6 nm → see ② below	Channel 3	8.8 nm
Channel 4	8.8 nm	Channel 5	8.0 nm	Channel 6	8.8 nm
Channel 7	8.0 nm	Channel 8	8.0 nm	Channel 9	8.0 nm
Channel 10	8.0 nm	Channel 11	7.8 nm → see ④ below Fail	Channel 12	8.0 nm
Channel 13	4.0 nm → see ③ below				

Comments: Channel widths are measured between the midpoints of the valleys on either side of the peaks.

λ
765.8
771.2
780.8
789.6
798.4
806.4
815.2
823.2
831.2
839.2
847.2
855.0
863.0
867.0

① The beginning wavelength used was probably too long. The noise may hide the true beginning. 770.0 − 762.0 = 8.0 Channel 1 8.0

② Using measurements close to the rise and fall of the peak gives: 780.8 − 772.8 = 8.0 Channel 2 8.0 nm

③ The ending wavelength used was probably too short. The noise may obscure the true ending. 871.0 − 863.0 = 8.0 Channel 13 8.0

④ Channel 11 Fails: Even though the resolution of the equipment's data cursor is 0.2nm, the channels around channel 11 are on the edge of failing so there is no leeway on adjusting the width of channel 11.

Guardband Widths — Expected: 2.5nm

Band 1/2	2.6 nm	Band 2/3	3.2 nm	Band 3/4	3.0 nm
Band 4/5	2.8 nm	Band 5/6	2.4 nm	Band 6/7	3.6 nm
Band 7/8	2.0 nm	Band 8/9	2.8 nm	Band 9/10	3.2 nm
Band 10/11	1.8 nm	Band 11/12	2.8 nm	Band 12/13	3.6 nm

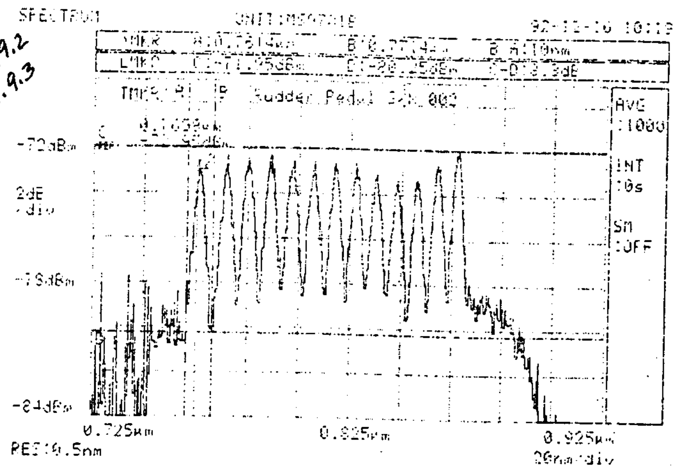
Comments:

Guardband	λ	to λ
1	768.8	771.4
2	777.8	781.0
3	787.4	790.4
4	796.0	798.8
5	803.6	806.0
6	811.6	815.2
7	822.2	824.2
8	828.4	831.2
9	836.2	839.4
10	846.2	848.0
11	852.2	855.0
12	860.0	863.6

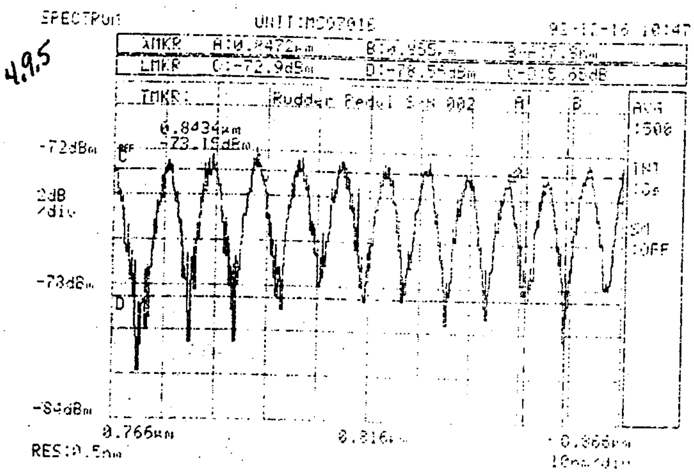
○ – between high signals
□ – between low signals
– between high and low signals

Rudder Pedal 002

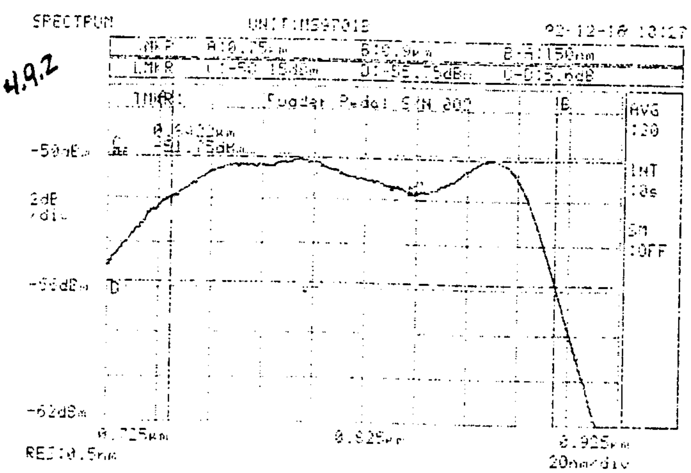
4.9.2
4.9.3



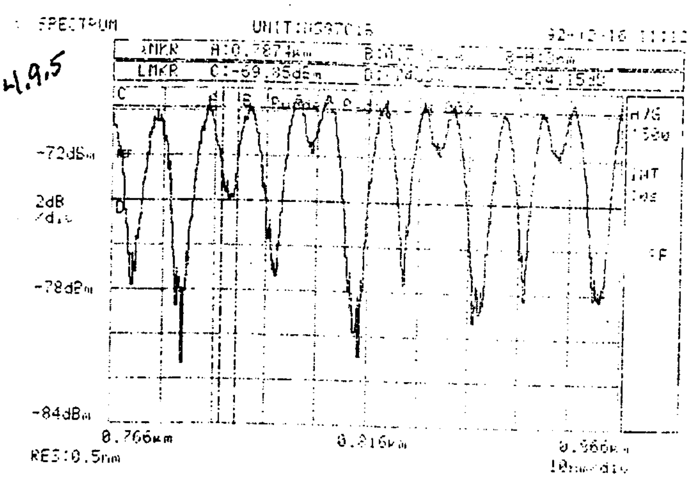
4.9.5



4.9.2



4.9.5



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5.9 TRAILING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/16/92 Test Article Serial Number: 001

5.9.1 Sensor Insertion Loss Test (4.10.2) PASS ☑ FAIL ☐

5.9.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss = Source Peak Power – Sensor Peak Power.

Reference Peak Power [-65.4] dBm at [777.0] nm

Source Peak Power at Reference Wavelength [-47.9] dBm

Reference Insertion Loss [17.5] dB Expected: ≤ TBD dB

Signal Peak Power [-64.5] dBm at [875.4] nm

Source Peak Power at Signal Wavelength [-47.7] dBm

Signal Insertion Loss [16.8] dB Expected: ≤ 20dB

Comments:

5.9.2 Dynamic Range Test (4.10.3) PASS ☐ FAIL ☑

5.9.2.1 Attach the graphs of the output power spectrums with the maximum and minimum sensor signals behind this data sheet.

Minimum Sensor Signal [-71.95] dBm at 875.8

Reference Power at Minimum Sensor Signal [-66.1] dBm at 775.8

Maximum Sensor Signal [-64.5] dBm

Reference Power at Maximum Sensor Signal [-65.4] dBm

Dynamic Range = (Max. Sensor Signal – Reference Power at max. sensor signal) – (Min. Sensor Signal – Reference Power at min. sensor signal)

Dynamic Range [6.75] dB Expected: Min. 15dB Max. TBD

Comments: The minimum signal and reference power values were taken at the edge of the code plate mentioned in the 5.9.3 comments but at a point where the reference signal seemed stable as the shaft was turned toward the middle of the code plate.

5.9.3 Reference Integrity Test (4.10.4)

(or less to no power. see "Info" printout and comments.)

PASS ☐ FAIL ☑

Reference Power at Min. Sensor Signal [-66.1] dBm => [2.4547×10^{-7}] ~~m~~W

Reference Power at Max. Sensor Signal [-65.4] dBm => [2.884×10^{-7}] ~~m~~W

Reference Variation (mW) =
Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW)

Reference Variation [4.2932×10^{-8}] ~~m~~W => [-73.67] dB

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB)

Reference Integrity [-7.6] dB Expected: ≤ –26dB

Comments: Near the edge of the code plate (lining up the arrow and the hash mark on the sensor and shaft respectively), the reference band changes dramatically toward lower power until it is not readable due to noise. The signal band in this area is still readable, however.

5.9.4 Channel Characteristics Test (4.10.5)

PASS ☑ FAIL ☐

5.9.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [2] Expected: 2

Comments:

Center Wavelength of High Frequency Signal [777.0] nm Expected: 787nm

Comments: Reference Channel

Center Wavelength of Low Frequency Signal [875.4] nm Expected: 863nm

Comments: Signal Channel

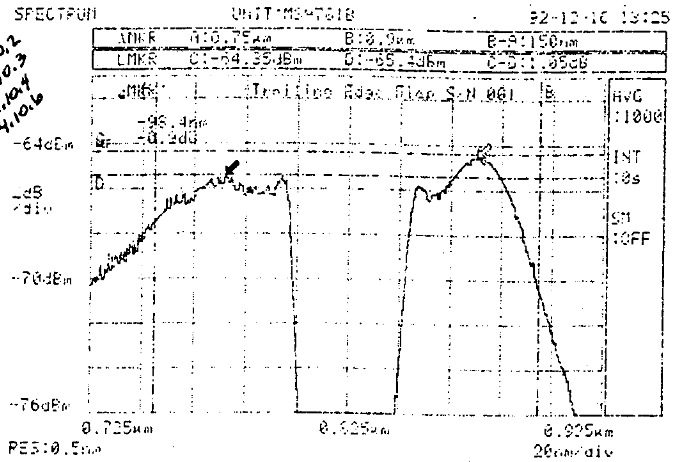
Channel Widths Expected: ≤ 75nm

High Frequency Width [50.6] nm 750.0 to 800.6nm Low Frequency Width [49.8] nm 850.2 to 900.0 nm

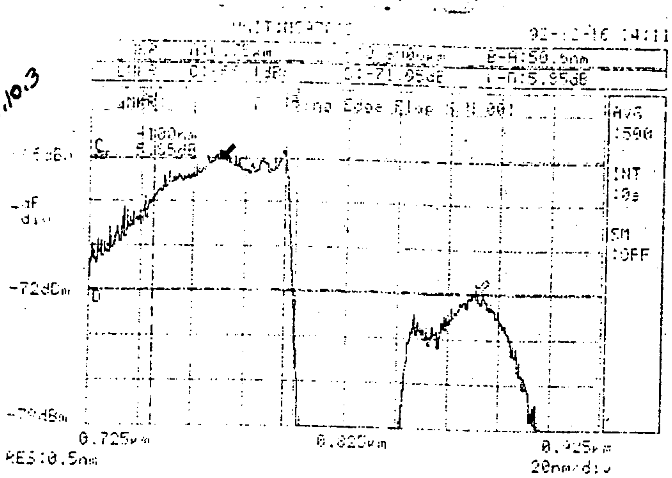
Comments:

Trailing Edge Flap 001

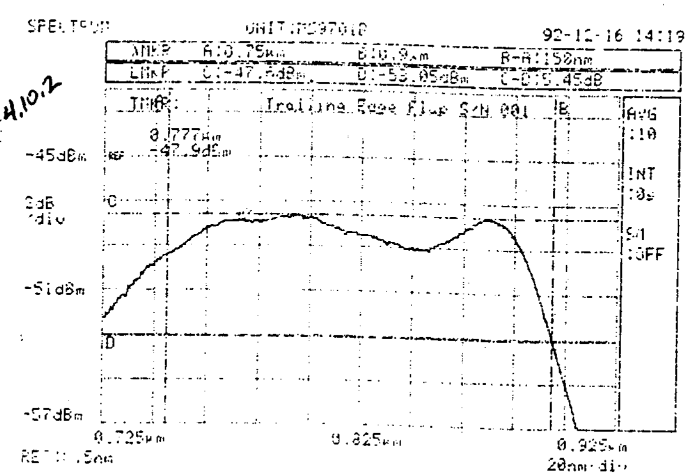
4.10.2
4.10.3
4.10.4
4.10.6



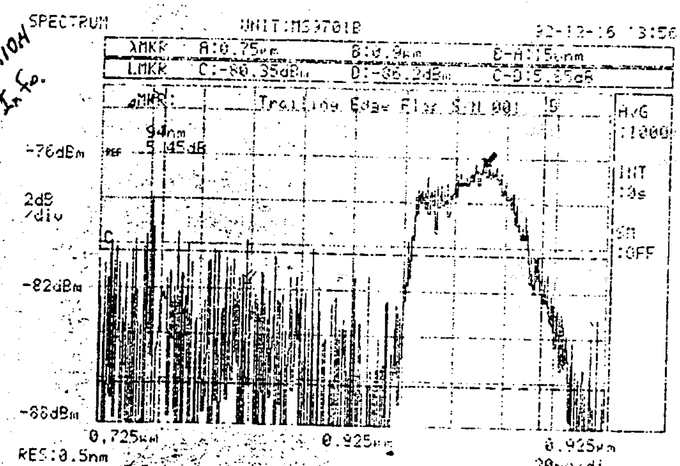
4.10.3



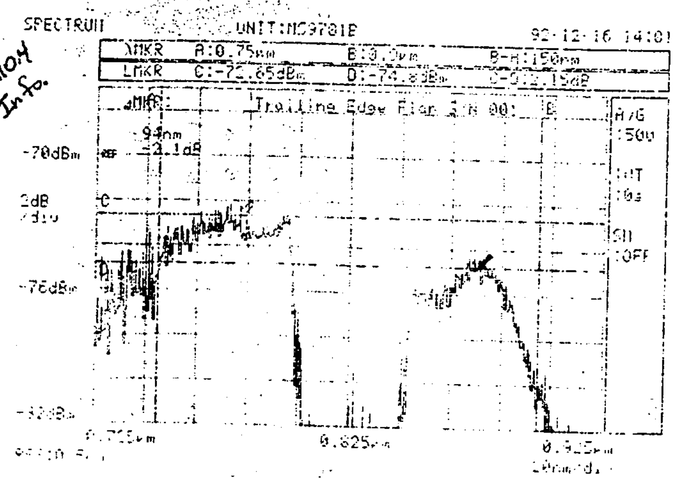
4.10.2



4.10.4
Info.



4.10.4
Info.



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5.9 TRAILING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/17/92 Test Article Serial Number: 002

5.9.1 Sensor Insertion Loss Test (4.10.2) PASS ☑ FAIL ☐

5.9.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss = Source Peak Power – Sensor Peak Power.

Reference Peak Power [-62.2] dBm at [776.2] nm

Source Peak Power at Reference Wavelength [-50.65] dBm

Reference Insertion Loss [11.6] dB Expected: ≤ TBD dB

Signal Peak Power [-61.5] dBm at [875.4] nm

Source Peak Power at Signal Wavelength [-50.4] dBm

Signal Insertion Loss [11.1] dB Expected: ≤ 20dB

Comments:

5.9.2 Dynamic Range Test (4.10.3) PASS ☐ FAIL ☑

5.9.2.1 Attach the graphs of the output power spectrums with the maximum and minimum sensor signals behind this data sheet.

Minimum Sensor Signal [-71.4] dBm at 876.6nm

Reference Power at Minimum Sensor Signal [-62.25] dBm at 776.6nm

Maximum Sensor Signal [-61.5] dBm

Reference Power at Maximum Sensor Signal [-62.2] dBm

Dynamic Range = (Max. Sensor Signal – Reference Power at max. sensor signal) – (Min. Sensor Signal – Reference Power at min. sensor signal)

Dynamic Range [9.85] dB Expected: Min. 15dB Max. TBD

Comments: Near the point on the code plate where the hash mark on the shaft aligns with the arrow on the sensor case, the reference band disappears to zero as the shaft is turned away from the code plate, moving off the tracks on the code plate. See the printout labeled "Info" for a plot of the reduced reference power. The measurements for these tests were taken at the minimum sensor signal where the reference channel remained constant over the majority of the code plate. This eliminates the anomalous area of the code plate.

5.9.3 Reference Integrity Test (4.10.4) PASS ☐ FAIL ☑

Reference Power at Min. Sensor Signal $\boxed{-62.25}$ dBm => $\boxed{5.957 \times 10^{-7}}$ ~~m~~W

Reference Power at Max. Sensor Signal $\boxed{-62.2}$ dBm => $\boxed{6.026 \times 10^{-7}}$ ~~m~~W

Reference Variation (mW) =

Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW)

Reference Variation $\boxed{6.897 \times 10^{-9}}$ ~~m~~W => $\boxed{-81.61}$ dB

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB)

Reference Integrity $\boxed{-19.4}$ dB Expected: ≤ -26dB

Comments:

5.9.4 Channel Characteristics Test (4.10.5) PASS ☑ FAIL ☐

5.9.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels $\boxed{2}$ Expected: 2

Comments:

Center Wavelength of High Frequency Signal $\boxed{776.2}$ nm Expected: 787nm

Comments:

Center Wavelength of Low Frequency Signal $\boxed{875.4}$ nm Expected: 863nm

Comments:

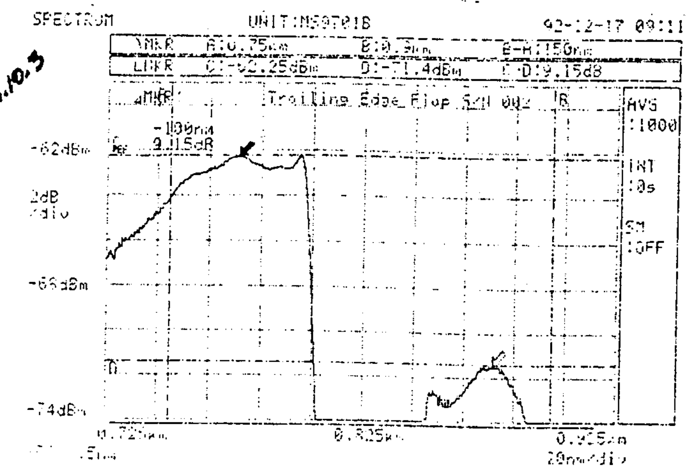
Channel Widths Expected: $\leq$ 75nm

High Frequency Width $\boxed{51.0}$ nm 750.0 to 801.0 nm Low Frequency Width $\boxed{49.0}$ nm 851.0 to 900.0 nm

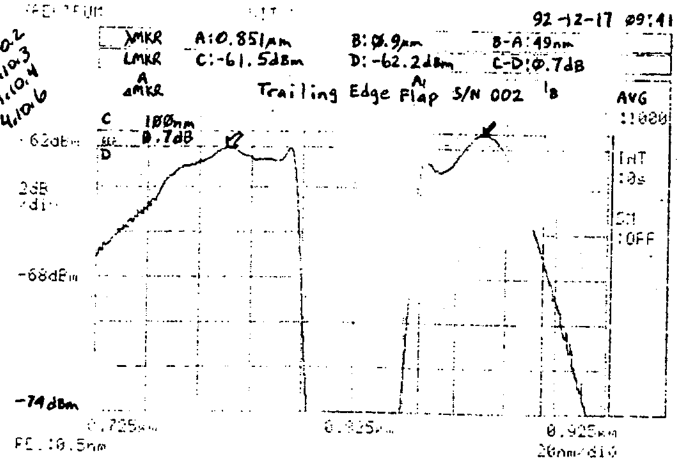
Comments:

Trailing Edge Flap 002

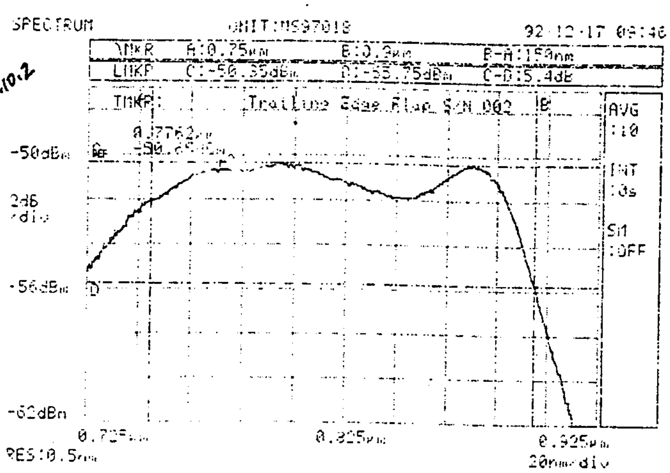
4.10.3



4.10.2
4.10.3
4.10.4
4.10.6

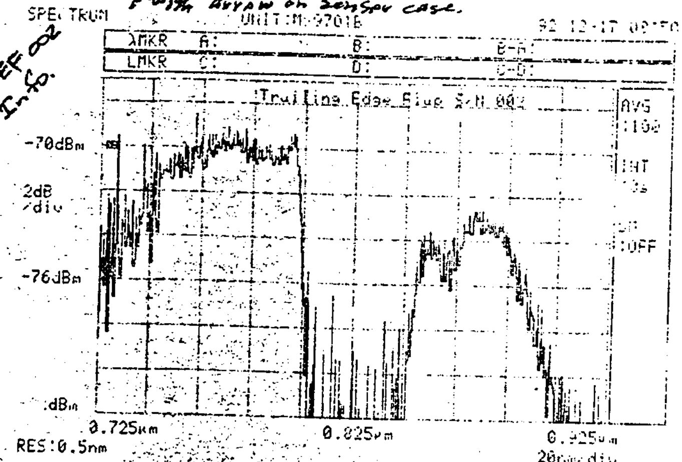


4.10.2



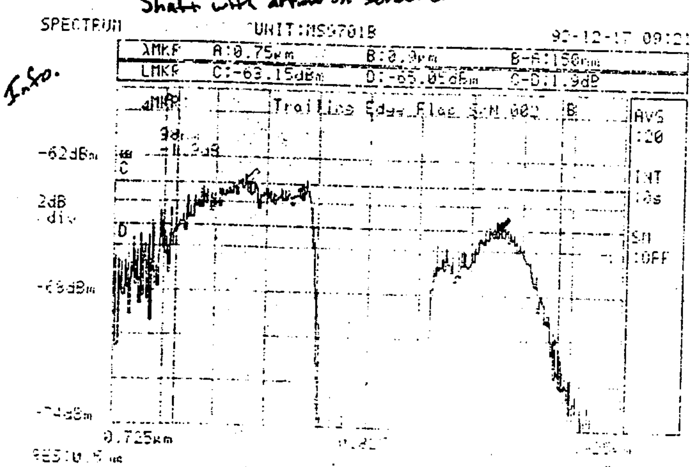
At beginning of code plate where hash mark on shaft lines up with arrow on sensor case.

TEF 002 Info.



Near far end of code plate. Away from lining up hash mark on shaft with arrow on sensor case.

Info.



5.10 LEADING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/14/92 Test Article Serial Number: 43

5.10.1 Sensor Insertion Loss Test (4.11.2) PASS ☐ FAIL ☑

5.10.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	784	-77.65	-48.2	29.45
Peak 2	792	-78.05	-48.05	30.0
Peak 3	800	-77.25	-47.9	29.35
Peak 4	807	-76.85	-48.1	28.75
Peak 5	816	-77.2	-48.5	28.7
Peak 6	825	-77.65	-48.8	28.85
Peak 7	832	-78.4	-48.95	29.45
Peak 8	840	-78.2	-49.3	28.9
Peak 9	847	-78.8	-49.4	29.4
Peak 10	855	-78.25	-49.15	29.1
Peak 11	864	-78.55	-48.55	30.0
Peak 12	872	-77.6	-48.1	29.5
Peak 13	883	-79.2	-48.5	30.7

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 29.4 dB

Expected: 28dB with 6.0dB Contrast Ratio or ≤ 27dB with 5.0dB Contrast Ratio

Comments:

5.10.2 Contrast Ratio Test (4.11.3) PASS ☐ FAIL ☑

5.10.2.1 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-77.7 / -83.1 dBm	Channel 2	-78.1 / -86.3 dBm	Channel 3	-77.3 / -84.4 dBm
Channel 4	-76.9 / -90.0 dBm	Channel 5	-77.2 / -84.0 dBm	Channel 6	-77.7 / -85.7 dBm
Channel 7	-78.4 / -88.8 dBm	Channel 8	-78.2 / -87.1 dBm	Channel 9	-78.8 / -85.6 dBm
Channel 10	-78.3 / -86.5 dBm	Channel 11	-78.6 / -88.5 dBm	Channel 12	-77.6 / -83.3 dBm
Channel 13	-79.2 / -88.4 dBm				

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	5.4 dB	Channel 2	8.2 dB	Channel 3	7.1 dB
Channel 4	13.1 dB	Channel 5	6.8 dB	Channel 6	8.0 dB
Channel 7	10.4 dB	Channel 8	8.9 dB	Channel 9	6.8 dB
Channel 10	8.2 dB	Channel 11	9.9 dB	Channel 12	5.7 dB
Channel 13	9.2 dB				

Minimum Contrast Ratio 5.4 dB

Expected: 6.0dB with 28dB Insertion Loss or 5.0dB with ≤ 27dB Insertion Loss

Comments: Noise may be affecting the contrast ratio results.

5.10.3 Channel Characteristics Test (4.11.4) PASS ☑ FAIL ☐

5.10.3.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [13] Expected: 13

Comments:

Spectral Width:
The spectral width range is 110nm minimum to 115nm maximum even though each channel may vary by +/−0.9nm; the channel errors cannot combine to exceed spectral width range.

Initial Wavelength of First Channel [778.6] nm Expected: 750nm to 785nm

Comments:

Ending Wavelength of Last Channel [886.6] nm Expected: 860nm to 900nm

Comments: Spectral Width = 886.6 − 778.6 = 108.0 nm

Channel Widths Expected: 8.5nm +/− 0.9nm

Channel 1	8.8 nm	Channel 2	8.4 nm	Channel 3	7.6 nm
Channel 4	8.0 nm	Channel 5	8.8 nm	Channel 6	7.6 nm
Channel 7	8.0 nm	Channel 8	7.6 nm	Channel 9	8.4 nm
Channel 10	8.0 nm	Channel 11	8.0 nm	Channel 12	9.6 nm → see ① below
Channel 13	9.2 nm				

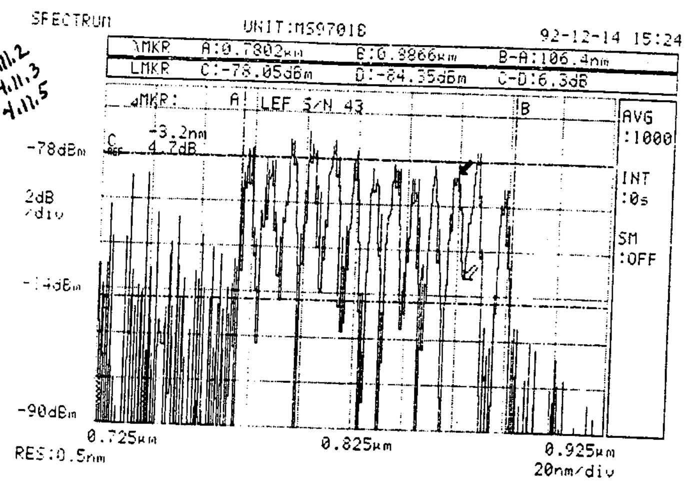
Comments:

Marker λ
778.6
787.4
795.8
803.4
811.4
820.2
827.8
835.8
843.4
851.8
859.8
867.8
877.4
886.6

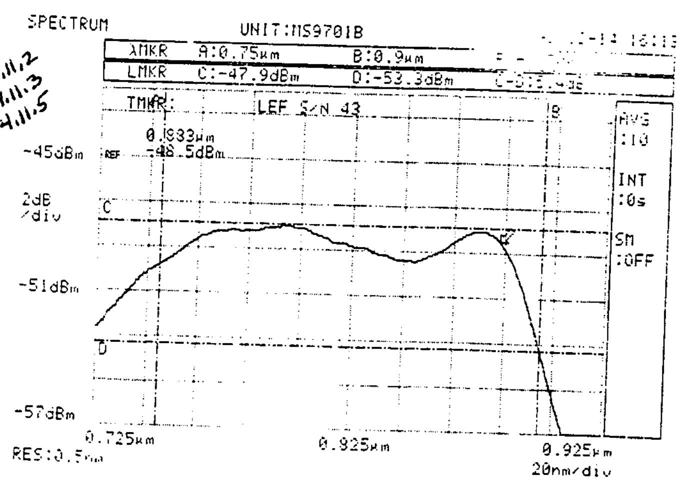
① Between the beginning of channel 12 and the end of channel 13, there is a difference of 18.8nm or a 9.4nm average. That is acceptable since the equipment did not measure in increments small enough to differentiate to less than 0.4nm.

Leading Edge Flap 0043

4.11.2
4.11.3
4.11.5



4.11.2
4.11.3
4.11.5



5.10 LEADING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler   Date: 12/14/92   Test Article Serial Number: 45

5.10.1 Sensor Insertion Loss Test (4.11.2)

PASS ☑ FAIL ☐

5.10.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	783	-71.75	-47.8	23.95
Peak 2	791	-71.65	-47.65	24.0
Peak 3	798	-70.7	-47.5	23.2
Peak 4	811	-70.6	-47.85	22.75
Peak 5	819	-70.75	-48.2	22.55
(the high spike) Peak 6	827	-70.05	-48.4	21.65
Peak 7	835	-70.95	-48.65	22.3
Peak 8	843	-71.05	-49.0	22.05
Peak 9	851	-71.0	-48.95	22.05
Peak 10	859	-70.55	-48.55	22.0
Peak 11	867	-70.2	-47.95	22.25
Peak 12	876	-69.85	-47.55	22.3
Peak 13	883	-70.95	-48.0	22.95

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss: 22.6 dB

Expected: 28dB with 6.0dB Contrast Ratio
or ≤ 27dB with 5.0dB Contrast Ratio

Comments:

5.10.2 Contrast Ratio Test (4.11.3) PASS ☐ FAIL ☑

5.10.2.1 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-71.8 / -77.5	dBm	Channel 2	-71.7 / -75.2	dBm	Channel 3	-70.7 / -75.0	dBm
Channel 4	-70.6 / -81.4	dBm	Channel 5	-70.8 / -74.2	dBm	Channel 6	-70.1 / -74.3	dBm
Channel 7	-71.0 / -74.2	dBm	Channel 8	-71.1 / -74.6	dBm	Channel 9	-71.0 / -74.3	dBm
Channel 10	-70.6 / -74.2	dBm	Channel 11	-70.2 / -73.5	dBm	Channel 12	-69.9 / -73.8	dBm
Channel 13	-71.0 / -72.6	dBm						

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	5.7	dB	Channel 2	3.5	dB	Channel 3	4.3	dB
Channel 4	10.8	dB	Channel 5	3.4	dB	Channel 6	4.2	dB
Channel 7	3.2	dB	Channel 8	3.5	dB	Channel 9	3.3	dB
Channel 10	3.6	dB	Channel 11	3.3	dB	Channel 12	3.9	dB
Channel 13	1.6	dB						

Minimum Contrast Ratio 1.6 dB

Expected: 6.0dB with 28dB Insertion Loss
or 5.0dB with ≤ 27dB Insertion Loss

Comments:

5.10.3 Channel Characteristics Test (4.11.4)

PASS ☐ FAIL ☑
(See channel widths)

5.10.3.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [13] Expected: 13

Comments:

Spectral Width:
The spectral width range is 110nm minimum to 115nm maximum even though each channel may vary by +/–0.9nm; the channel errors cannot combine to exceed spectral width range.

Initial Wavelength of First Channel [777.8] nm Expected: 750nm to 785nm

Comments:

Ending Wavelength of Last Channel [888.6] nm Expected: 860nm to 900nm

Comments: Spectral Width = 888.6 − 777.8 = 110.8nm

Channel Widths Expected: 8.5nm +/– 0.9nm

Channel 1	8.4	nm	Channel 2	8.4	nm	Channel 3	9.6	nm → See ① below
Channel 4	10.8	nm → See ① below	Channel 5	8.4	nm	Channel 6	8.0	nm
Channel 7	8.0	nm	Channel 8	8.0	nm	Channel 9	7.6	nm
Channel 10	8.4	nm	Channel 11	8.0	nm	Channel 12	8.0	nm
Channel 13	9.2	nm						

Comments: Marker λ(nm)
777.8
786.2
794.6
804.2
815.0
823.4
831.4
839.4
847.4
855.0
863.4
871.4
879.4
888.6

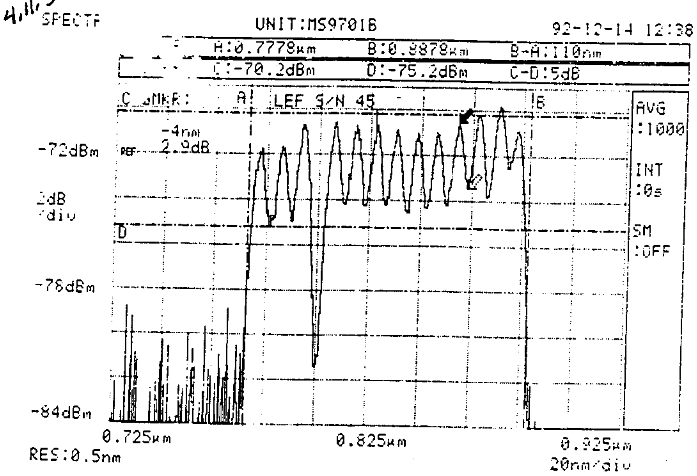
The measurements above were taken in the middle of the valleys between adjacent channels.

FAILURE ① The width of channel 3 could be ~8.4nm, and the width of channel 4 could be ~8.0nm, however, this would leave a ~4.0nm gap between channels 3 and 4.

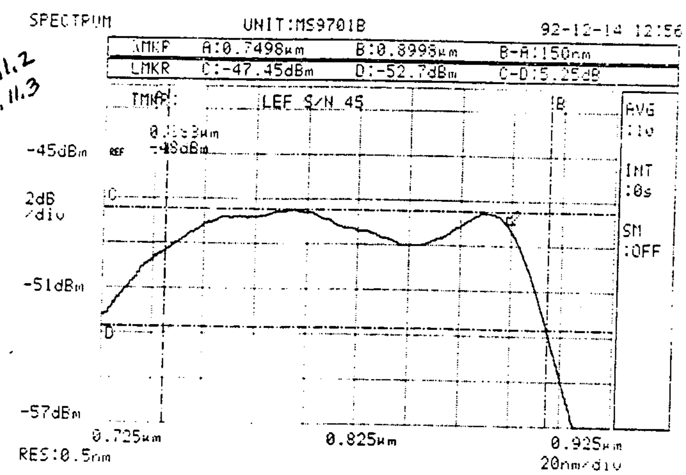
Channel 3 { 794.6, 803.0 } → 8.4nm
Gap { 803.0, 807.0 } → 4.0nm
Channel 4 { 807.0, 815.0 } → 8.0nm

Leading Edge Flap 0045

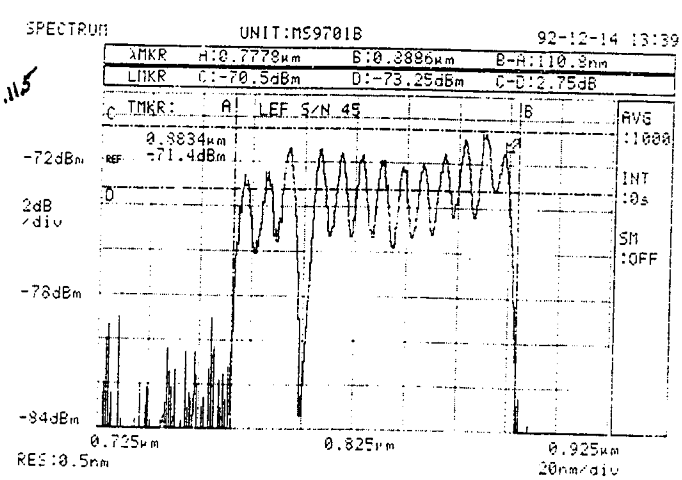
4.11.2
4.11.3



4.11.2
4.11.3



4.115



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5.11 POWER LEVER CONTROL SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/21/93 Test Article Serial Number: 001

5.11.1 Sensor Insertion Loss Test (5.12.2) PASS ☑ FAIL ☐

5.12.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	757.0	-69.75	-46.5	23.25
Peak 2	765.4	-69.25	-46.05	23.2
Peak 3	775.4	-68.65	-45.75	22.9
Peak 4	782.6	-68.35	-45.75	22.6
Peak 5	790.6	-68.6	-45.75	22.85
Peak 6	799.0	-68.55	-45.75	22.8
Peak 7	807.0	-68.55	-45.9	22.65
Peak 8	815.4	-68.75	-46.15	22.6
Peak 9	823.4	-68.3	-46.35	21.95
Peak 10	833.8	-68.75	-46.4	22.35
Peak 11	842.2	-68.8	-46.45	22.35
Peak 12	849.8	-68.9	-46.6	22.3
Peak 13	857.8	-68.6	-46.45	22.15
Peak 14	865.8	-67.75	-45.9	21.85
Peak 15	873.4	-67.2	-45.35	21.85

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 22.51 dB Expected: ≤ 24dB

Comments:

5.12.2 Contrast Ratio Test (5.12.3) PASS ☐ FAIL ☑

5.12.3 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-69.8 / -76.4	dBm	Channel 2	-69.3 / -77.5	dBm	Channel 3	-68.7 / -73.5	dBm
Channel 4	-68.4 / -74.0	dBm	Channel 5	-68.6 / -74.6	dBm	Channel 6	-68.6 / -74.7	dBm
Channel 7	-68.6 / -75.0	dBm	Channel 8	-68.8 / -75.6	dBm	Channel 9	-68.3 / -77.9	dBm
Channel 10	-68.8 / -75.3	dBm	Channel 11	-68.8 / -75.1	dBm	Channel 12	-68.9 / -74.9	dBm
Channel 13	-68.6 / -74.8	dBm	Channel 14	-67.8 / -73.6	dBm	Channel 15	-67.2 / -75.8	dBm

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	6.6	dB	Channel 2	8.2	dB	Channel 3	4.8	dB
Channel 4	5.6	dB	Channel 5	6.0	dB	Channel 6	6.1	dB
Channel 7	6.4	dB	Channel 8	6.8	dB	Channel 9	9.6	dB
Channel 10	6.5	dB	Channel 11	6.3	dB	Channel 12	6.0	dB
Channel 13	6.2	dB	Channel 14	5.8	dB	Channel 15	8.6	dB

Minimum Contrast Ratio 4.8 dB Expected: 6.0dB

Comments:

5.12.4 Channel Characteristics Test (5.12.4) PASS ☐ FAIL ☑

See channel widths

5.12.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels 15 Expected: 15

Comments:

Initial Wavelength of First Channel $\boxed{753.0}$ nm — Expected: 750nm to 765nm

Comments:

Ending Wavelength of Last Channel $\boxed{877.4}$ nm — Expected: 870nm to 900nm

Comments:

Channel Widths — Expected: 8.5nm +/− 0.5nm

Channel 1	8.0 nm	Channel 2	9.2 nm	Channel 3	8.4 nm
Channel 4	8.0 nm	Channel 5	8.0 nm	Channel 6	8.4 nm
Channel 7	8.4 nm	Channel 8	8.4 nm	Channel 9	8.8 nm
Channel 10	9.2 nm	Channel 11	8.4 nm	Channel 12	7.2 nm
Channel 13	8.4 nm	Channel 14	8.0 nm	Channel 15	8.0 nm

Comments: Channel widths are measured from the mid point of the valley before the ~~chanel~~ peak to the midpoint of the valley after the peak.

The equipment cursor resolution is 0.4nm.

λ	
753.0	853.4
761.0	861.4
770.2	869.4
778.6	877.4
786.6	
794.6	
803.0	
811.4	
819.8	
828.6	
837.8	
846.2	

Guardband Widths — Expected: 2.5nm

Band 1/2	2.4 nm	Band 2/3	2.8 nm	Band 3/4	2.4 nm
Band 4/5	2.4 nm	Band 5/6	2.4 nm	Band 6/7	2.4 nm
Band 7/8	2.4 nm	Band 8/9	2.4 nm	Band 9/10	2.8 nm
Band 10/11	2.0 nm	Band 11/12	2.0 nm	Band 12/13	2.4 nm
Band 13/14	2.0 nm	Band 14/15	2.0 nm		

Comments:

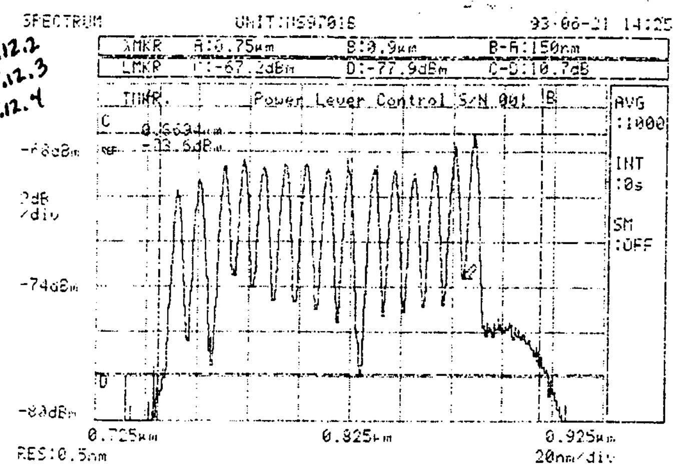
Guardband	λ	to λ
1	759.8	762.2
2	769.0	771.8
3	777.8	780.2
4	785.4	787.8
5	793.8	796.2
6	802.2	804.6
7	810.2	812.6
8	818.6	821.0

Guardband	λ	to λ
9	827.0	829.8
10	837.0	839.0
11	845.0	847.0
12	852.2	854.6
13	860.6	862.6
14	868.2	870.2

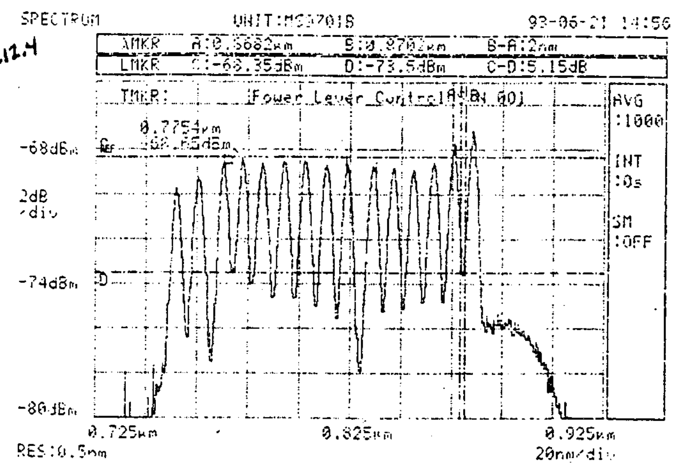
The guardbands are measured between the rises for the peaks. The guardband widths were taken to be the width of the valley between peaks. The widths are arbitrary. The widths are defined so that not much of the rise for the peak is included in the guardband width.

PLC 001

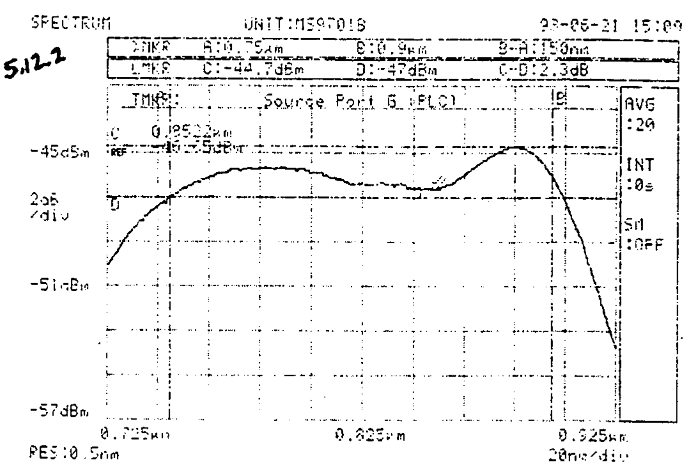
5.12.2
5.12.3
5.12.4



5.12.4



5.12.2



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5.11 POWER LEVER CONTROL SENSOR DATA SHEET

Performed by: Brad Kessler Date: 4/21/93 Test Article Serial Number: 002

5.11.1 Sensor Insertion Loss Test (5.12.2) PASS ☑ FAIL ☐

5.12.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss (IL) = Source Power at Sensor Peak – Sensor Power at Sensor Peak.

Insertion Losses at each Peak in the Sensor Output Power Spectrum (may not fill all boxes)

Peak	nm	Signal Power (dB)	Source Power (dB)	IL (dB)
Peak 1	763.8	-64.85	-47.25	17.6
Peak 2	772.6	-64.85	-46.95	17.9
Peak 3	782.6	-64.9	-46.6	18.3
Peak 4	791.0	-65.3	-46.45	18.85
Peak 5	797.8	-64.7	-46.4	18.3
Peak 6	808.6	-65.15	-46.6	18.55
Peak 7	816.6	-65.5	-46.75	18.75
Peak 8	825.0	-65.7	-46.75	18.95
Peak 9	833.0	-65.75	-46.45	19.3
Peak 10	841.4	-65.4	-46.15	19.25
Peak 11	849.0	-65.5	-45.95	19.55
Peak 12	857.0	-65.3	-45.6	19.7
Peak 13	865.0	-65.1	-45.15	19.95
Peak 14	873.0	-64.6	-44.35	20.25
Peak 15	880.6	-64.2	-43.8	20.4

Overall Sensor Insertion Loss = Average of Individual Peak Insertion Losses.

Sensor Insertion Loss 19.04 dB Expected: ≤ 24dB

Comments:

5.12.2 Contrast Ratio Test (5.12.3) PASS ☐ FAIL ☑

5.12.3 Attach the graphs of the sensor opposite bit pattern behind this data sheet.

Subchannel Amplitudes (Maximum / Minimum)

Channel 1	-64.9 / -74.9	dBm	Channel 2	-64.9 / -74.5	dBm	Channel 3	-64.9 / -71.8	dBm
Channel 4	-65.3 / -71.2	dBm	Channel 5	-64.7 / -74.8	dBm	Channel 6	-65.2 / -74.2	dBm
Channel 7	-65.5 / -74.7	dBm	Channel 8	-65.7 / -74.8	dBm	Channel 9	-65.8 / -74.3	dBm
Channel 10	-65.4 / -74.5	dBm	Channel 11	-65.5 / -74.1	dBm	Channel 12	-65.3 / -73.4	dBm
Channel 13	-65.1 / -73.2	dBm	Channel 14	-64.6 / -72.9	dBm	Channel 15	-64.2 / -72.8	dBm

Contrast Ratio = Maximum Channel Power – Minimum Channel Power.

Channel Contrast Ratios

Channel 1	10.0	dB	Channel 2	9.6	dB	Channel 3	6.9	dB
Channel 4	5.9	dB	Channel 5	10.1	dB	Channel 6	9.0	dB
Channel 7	9.2	dB	Channel 8	9.1	dB	Channel 9	8.5	dB
Channel 10	9.1	dB	Channel 11	8.6	dB	Channel 12	8.1	dB
Channel 13	8.1	dB	Channel 14	8.3	dB	Channel 15	8.6	dB

Minimum Contrast Ratio 5.9 dB Expected: 6.0dB

Comments: The actual contrast ratio of 5.9 is close enough to the expected value of 6.0. The EOA should be able to work with this 0.1dB out of tolerance.

5.12.4 Channel Characteristics Test (5.12.4) PASS ☐ FAIL ☑

See channel widths

5.12.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels 15 Expected: 15

Comments:

Initial Wavelength of First Channel 760.2 nm   Expected: 750nm to 765nm

Comments:

Ending Wavelength of Last Channel 885.0 nm   Expected: 870nm to 900nm

Comments:

Channel Widths   Expected: 8.5nm +/− 0.5nm

Channel 1 8.0 nm	Channel 2 9.2 nm	Channel 3 9.2 nm
Channel 4 7.6 nm	Channel 5 9.2 nm	Channel 6 9.2 nm
Channel 7 8.8 nm	Channel 8 7.6 nm	Channel 9 8.4 nm
Channel 10 8.0 nm	Channel 11 7.6 nm	Channel 12 8.0 nm
Channel 13 8.0 nm	Channel 14 7.6 nm	Channel 15 8.4 nm

Comments: Channel widths are measured from the midpoint of the valley before the ~~channel~~ peak to the midpoint of the valley after the ~~channel~~ peak.

λ
760.2
768.2
777.4
786.6
794.2
803.4
812.6
821.4
829.0
837.4
845.4
853.0
861.0
869.0
876.6
885.0

The equipment cursor resolution is 0.4nm.

Guardband Widths   Expected: 2.5nm

Band 1/2 2.4 nm	Band 2/3 3.2 nm	Band 3/4 2.0 nm
Band 4/5 2.0 nm	Band 5/6 4.0 nm	Band 6/7 2.8 nm
Band 7/8 2.4 nm	Band 8/9 2.4 nm	Band 9/10 2.0 nm
Band 10/11 2.0 nm	Band 11/12 2.4 nm	Band 12/13 2.4 nm
Band 13/14 2.4 nm	Band 14/15 2.4 nm	

Comments:

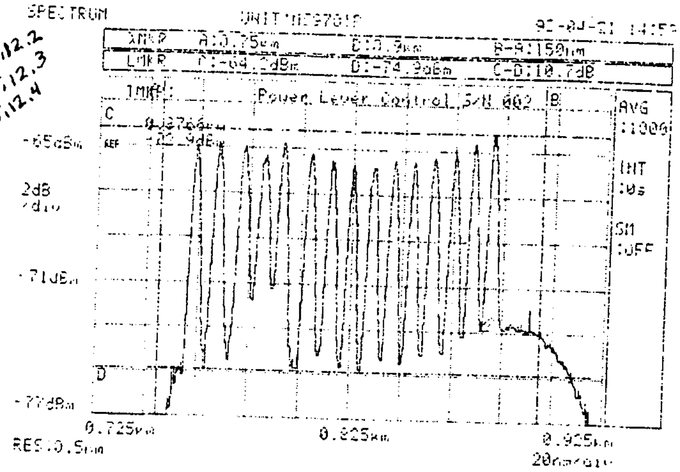
Guardband	λ	to λ
1	767.0	769.4
2	775.8	779.0
3	785.4	787.4
4	793.4	795.4
5	801.0	805.0
6	811.4	814.2
7	819.8	822.2
8	827.8	830.2
9	836.2	838.2

Guardband	λ	to λ
10	844.2	846.2
11	851.8	854.2
12	859.8	862.2
13	867.8	870.2
14	875.4	877.8

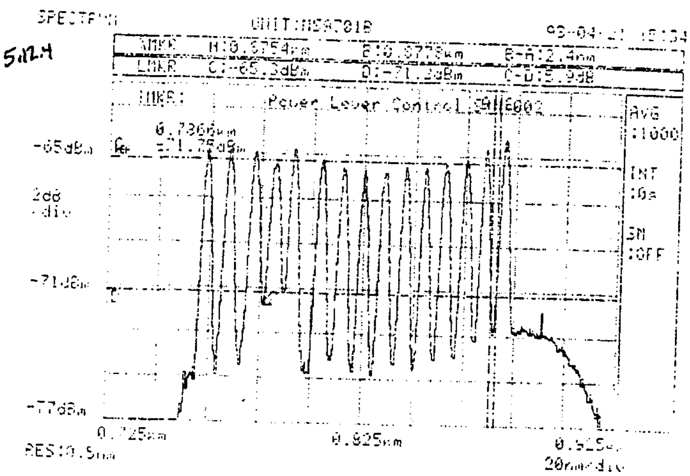
The guardbands are measured between the rises for the peaks. The guardband widths were taken to be the width of the valley between peaks. The widths are arbitrary. The widths are defined so ~~that~~ not much of the rise for the peak is included in the width.

PLC 002

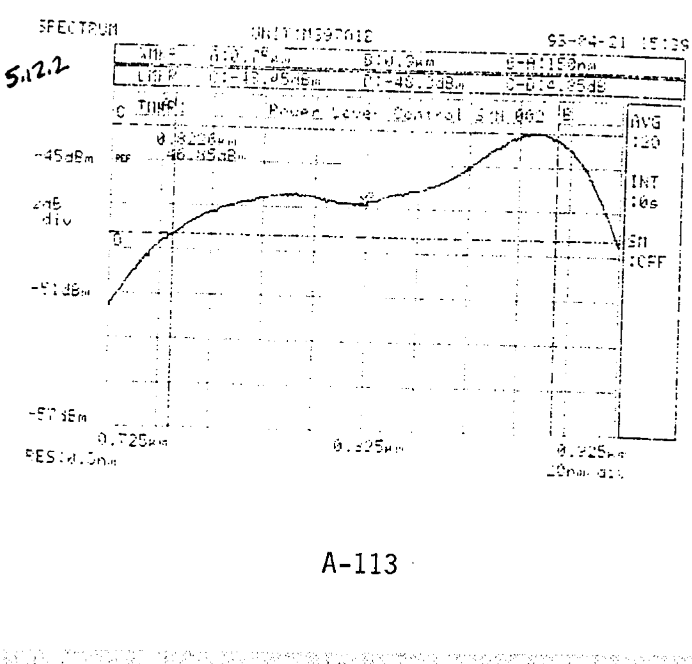
5.12.2
5.12.3
5.12.4



5.12.4



5.12.2



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5.13 NOSE WHEEL STEERING SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/17/92 Test Article Serial Number: 001

5.13.1 Sensor Insertion Loss Test (4.13.2) PASS ☑ FAIL ☐

5.13.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss = Source Peak Power – Sensor Peak Power.

Reference Peak Power [-63.9] dBm at [777.4] nm

Source Peak Power at Reference Wavelength [-51.4] dBm

Reference Insertion Loss [12.5] dB Expected: ≤ TBD dB

Signal Peak Power [-64.65] dBm at [875.4] nm

Source Peak Power at Signal Wavelength [-51.05] dBm

Signal Insertion Loss [13.6] dB Expected: ≤ 20dB

Comments:

5.13.2 Dynamic Range Test (4.13.3) PASS ☑ FAIL ☐

5.13.2.1 Attach the graphs of the output power spectrums with the maximum and minimum sensor signals behind this data sheet.

Minimum Sensor Signal [≈ -84.0] dBm → See ① below

Reference Power at Minimum Sensor Signal [-63.75] dBm

Maximum Sensor Signal [-64.65] dBm

Reference Power at Maximum Sensor Signal [-63.9] dBm

Dynamic Range = (Max. Sensor Signal – Reference Power at max. sensor signal) – (Min. Sensor Signal – Reference Power at min. sensor signal)

Dynamic Range [19.5] dB Expected: Min. 15dB Max. TBD

Comments: At the ends of the code plate, the reference band drops off to zero. These measurements were taken at the point where the reference channel leveled off and remained constant for the majority of the code plate.

① Since the sensor signal drops to virtually zero, noise covers the signal. Thus, the reading is an approximate value for the minimum.

5.13.3 Reference Integrity Test (4.13.4) PASS ☐ FAIL ☑

Reference Power at Min. Sensor Signal $\boxed{-63.75}$ dBm => $\boxed{4.2170 \times 10^{-7}}$ mW

Reference Power at Max. Sensor Signal $\boxed{-63.9}$ dBm => $\boxed{4.0738 \times 10^{-7}}$ mW

Reference Variation (mW) =

Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW)

Absolute Value

Reference Variation $\boxed{\left|-1.4316 \times 10^{-8}\right|}$ mW => $\boxed{-78.44}$ dB

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at ~~Min.~~ max. Sensor Signal(dB)

Reference Integrity $\boxed{-14.5}$ dB Expected: ≤ –26dB

Comments: Since the reference power at the maximum sensor signal is less than the reference power at the minimum sensor signal, the formulas had to be changed. Reference variation was found by subtracting the smaller power from the larger power to produce a positive number. The Reference Integrity was found by subtracting the smaller reference power from the variation.

5.13.4 Channel Characteristics Test (4.13.5) PASS ☑ FAIL ☐

5.13.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels $\boxed{2}$ Expected: 2

Comments:

Center Wavelength of High Frequency Signal $\boxed{777.4}$ nm Expected: 787nm

Comments:

Center Wavelength of Low Frequency Signal $\boxed{875.4}$ nm Expected: 863nm

Comments:

Channel Widths Expected: ≤ 75nm

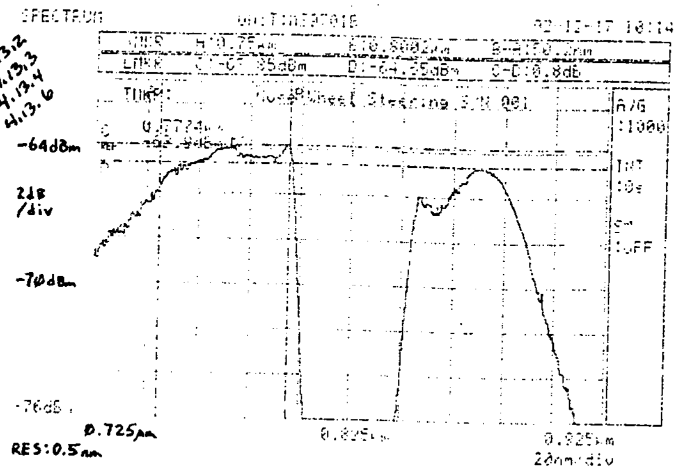
High Frequency Width $\boxed{50.2}$ nm 750.0 to 800.2nm

Low Frequency Width $\boxed{49.8}$ nm 850.2 to 900.0nm

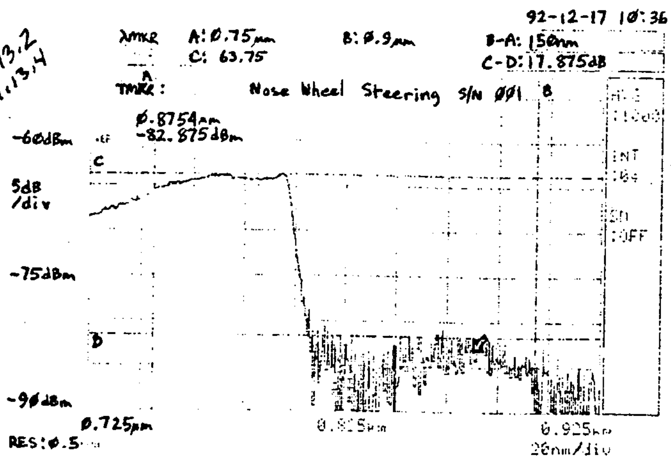
Comments:

Nose Wheel Steering 001

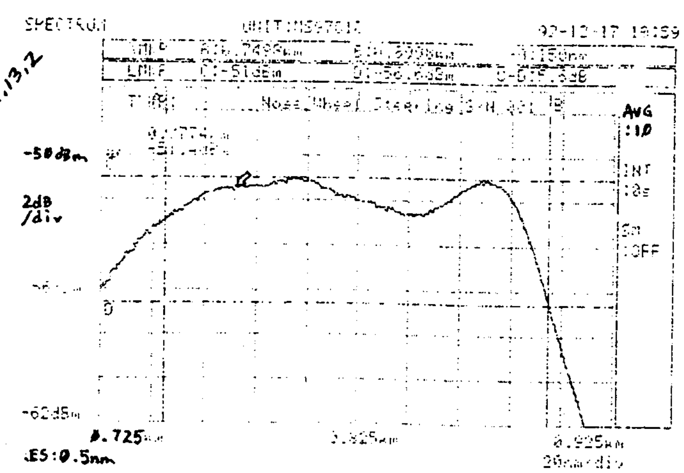
4.13.2
4.13.3
4.13.4
4.13.6



4.13.2
4.13.4

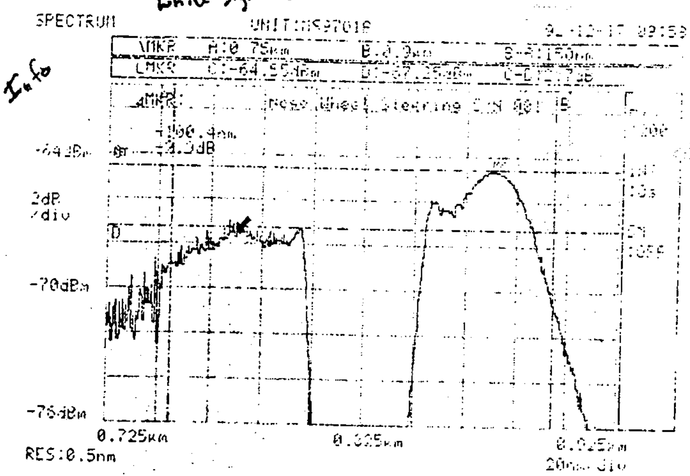


4.13.2



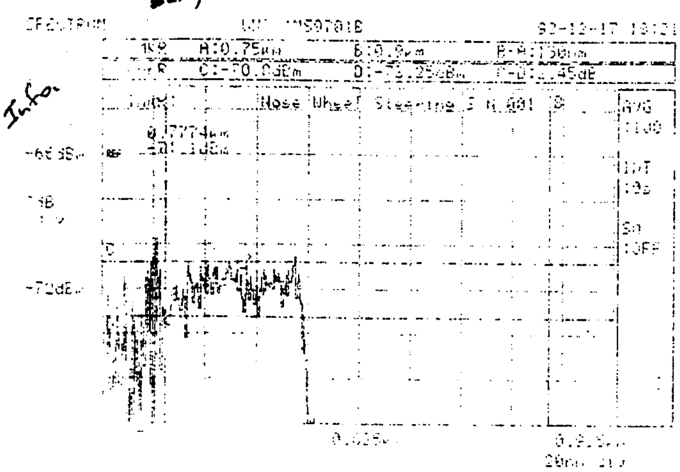
Near one end of codeplate. Ref. channel goes to zero while signal channel remains fairly constant.

Info



At low signal end of code plate, the signal drops to zero, and the reference band also drops to zero.

Info



5.13 NOSE WHEEL STEERING SENSOR DATA SHEET

Performed by: Brad Kessler Date: 12/17/92 Test Article Serial Number: 002

5.13.1 Sensor Insertion Loss Test (4.13.2) PASS ☑ FAIL ☐

5.13.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss = Source Peak Power – Sensor Peak Power.

Reference Peak Power [-71.1] dBm at [775.0] nm

Source Peak Power at Reference Wavelength [-50.75] dBm

Reference Insertion Loss [20.4] dB Expected: ≤ TBD dB

Signal Peak Power [-69.6] dBm at [875.8] nm

Source Peak Power at Signal Wavelength [-50.5] dBm

Signal Insertion Loss [19.1] dB Expected: ≤ 20dB

Comments:

5.13.2 Dynamic Range Test (4.13.3) PASS ☐ FAIL ☑

5.13.2.1 Attach the graphs of the output power spectrums with the maximum and minimum sensor signals behind this data sheet.

Minimum Sensor Signal [≈ -82.5] dBm → see below

Reference Power at Minimum Sensor Signal [-73.4] dBm

Maximum Sensor Signal [-69.6] dBm

Reference Power at Maximum Sensor Signal [-71.1] dBm

Dynamic Range = (Max. Sensor Signal – Reference Power at max. sensor signal) – (Min. Sensor Signal – Reference Power at min. sensor signal)

Dynamic Range [10.6] dB Expected: Min. 15dB
Max. TBD

Comments: The minimum sensor signal is obscured by noise so this is just an approximation.

5.13.3 Reference Integrity Test (4.13.4) PASS ☐ FAIL ☑

Reference Power at Min. Sensor Signal [-73.4] dBm => [4.5709×10^{-8}] mW

Reference Power at Max. Sensor Signal [-71.1] dBm => [7.7625×10^{-8}] ~~mW~~ W

Reference Variation (mW) =
Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW)

Reference Variation [3.1916×10^{-8}] mW => [-74.96] dB

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB)

Reference Integrity [-1.6] dB Expected: ≤ –26dB

Comments:

5.13.4 Channel Characteristics Test (4.13.5) PASS ☑ FAIL ☐

5.13.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [2] Expected: 2

Comments:

Center Wavelength of High Frequency Signal [775.0] nm Expected: 787nm

Comments:

Center Wavelength of Low Frequency Signal [875.8] nm Expected: 863nm

Comments:

Channel Widths Expected: ≤ 75nm

750.0 to 799.8nm

High Frequency Width [49.8] nm

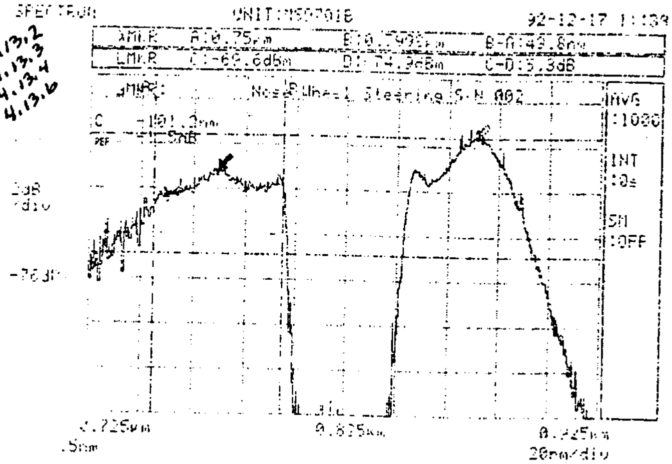
849.8 to 900.0nm

Low Frequency Width [50.2] nm

Comments:

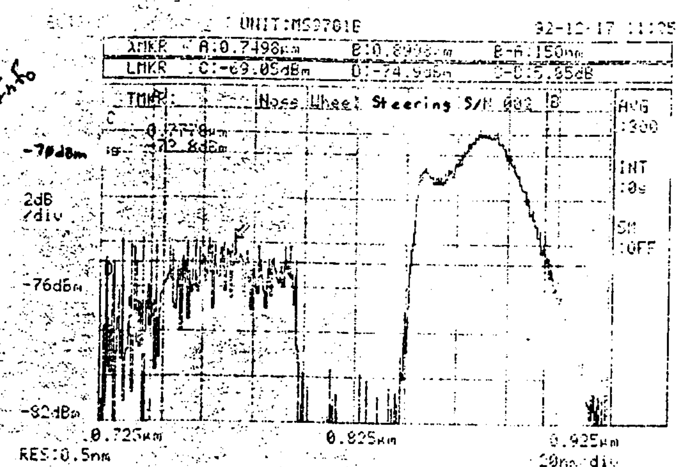
Nose Wheel Steering 002

4.13.2
4.13.3
4.13.4
4.13.6

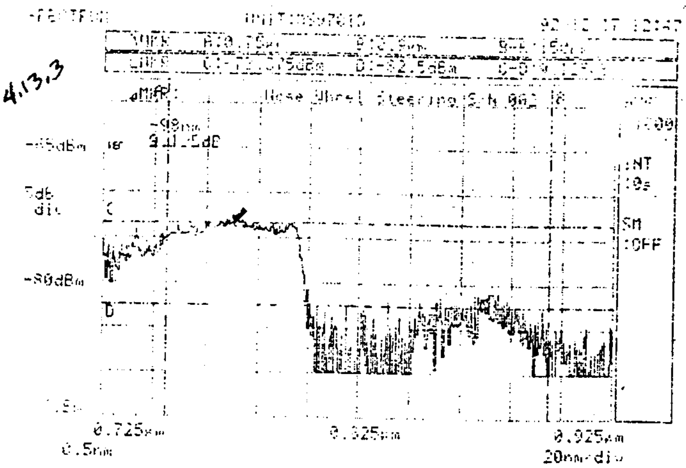


At maximum signal end of the code plate, the reference channel drops to zero but the signal channel remains fairly constant

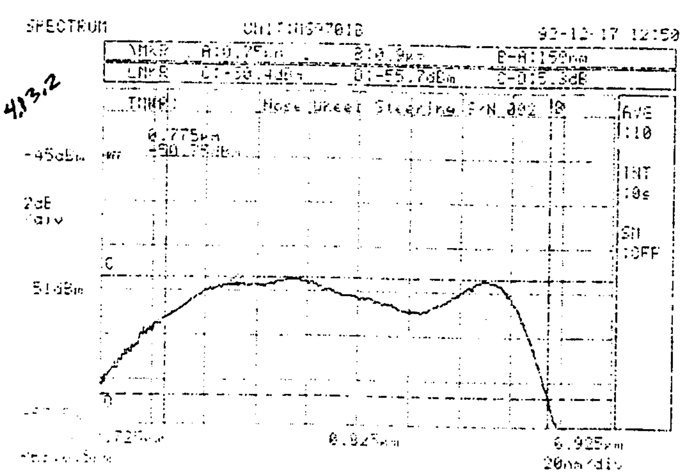
Info



4.13.3



4.13.2



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5.14 TOTAL PRESSURE SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/22/93 Test Article Serial Number: 4030-32-01

5.14.1 Sensor Insertion Loss Test (4.14.2) PASS ☑ FAIL ☐

5.14.1.1 Attach the graphs of the sensor and source output power spectrums behind this data sheet.

Insertion Loss = Source Peak Power – Sensor Peak Power.

Reference Peak Power [-59.375] dBm at [779.6] nm Actually had -59.375 from 769.8 to 789.4

Source Peak Power at Reference Wavelength [-45.625] dBm

Reference Insertion Loss [13.75] dB Expected: ≤ 18.7dB

Signal Peak Power [-60.375] dBm at [885.0] nm

Source Peak Power at Signal Wavelength [-43.625] dBm

Signal Insertion Loss [16.75] dB Expected: ≤ 17.5dB

Comments:

5.14.2 Dynamic Range Test (4.14.3) PASS ☑ FAIL ☐

5.14.2.1 Attach the graphs of the output power spectrums with the maximum and minimum sensor signals behind this data sheet.

Minimum Sensor Signal [-63.25] dBm

Reference Power at Minimum Sensor Signal [-59.375] dBm

Maximum Sensor Signal [-60.375] dBm

Reference Power at Maximum Sensor Signal [-59.375] dBm

Dynamic Range = (Max. Sensor Signal – Reference Power at max. sensor signal) –
(Min. Sensor Signal – Reference Power at min. sensor signal)

Dynamic Range [2.875] dB Expected: Min. 2.7dB
Max. 3.3dB

Comments: Maximum sensor signal occurs at ~1.000 in.Hg. Minimum sensor signal occur at ~80.000 in.Hg. } These are the actual pressure readings at the time when the maximum and minimum sensor values were taken.

5.14.3 Reference Integrity Test (4.14.4) PASS ☑ FAIL ☐

Reference Power at Min. Sensor Signal [-59.375] dBm => [X] mW

Reference Power at Max. Sensor Signal [-59.375] dBm => [X] mW

Reference Variation (mW) =
Reference Power at Max. Sensor Signal(mW) – Reference Power at Min. Sensor Signal(mW)

Reference Variation [X] mW => [0.0] dB

Reference Integrity (dB) = Reference Variation(dB) – Reference Power at Min. Sensor Signal(dB)

Reference Integrity [-59.375] dB Expected: ≤ –30dB

Comments:

5.14.4 Channel Characteristics Test (4.14.5) PASS ☑ FAIL ☐

5.14.4.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [2] Expected: 2

Comments:

Center Wavelength of High Frequency Signal [779.6] nm Expected: 780nm

Comments:

Center Wavelength of Low Frequency Signal [885.0] nm Expected: 870nm

Comments:

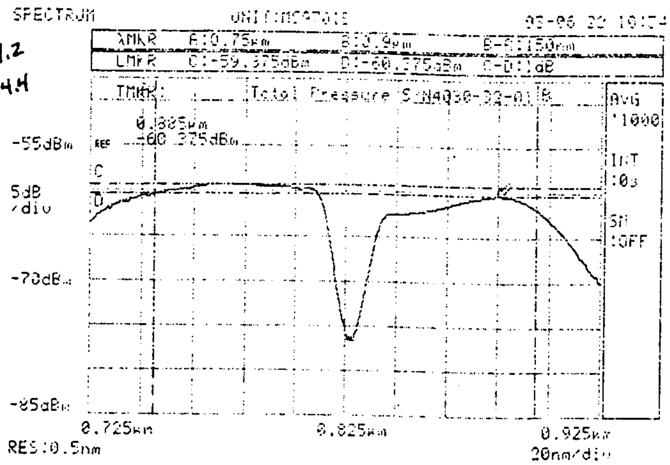
Channel Widths Expected: 55nm +0/–5nm

High Frequency Width [63.8] nm 750.0 to 813.8nm Low Frequency Width [60.2] nm 839.8 to 902.0nm

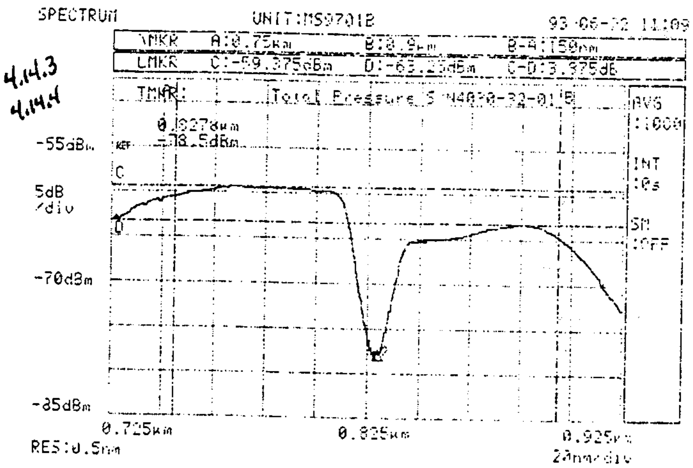
Comments: These channel widths are ≤ 75nm which is the ICD specification for all the analog sensors except the pressure sensor. The 55nm +0/-5nm was specified by Babcock and Wilcox, pressure sensor vendor. The channel widths pass the FOCSI EOA ICD for analog sensors if ≤ 75nm is used for a width.

Total Pressure

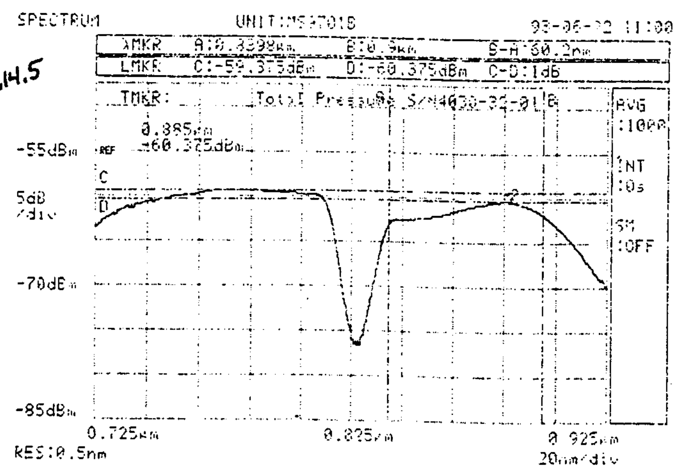
4.14.2
4.14.4



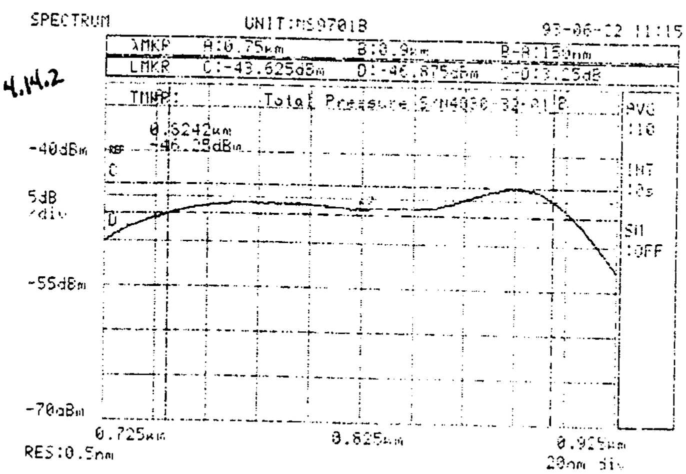
4.14.3
4.14.4



4.14.5



4.14.2



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5.15 TOTAL TEMPERATURE SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/22/93 Test Article Serial Number: 2

5.15.1 Signal Duration and Excitation to Signal Delay Test (4.15.2) PASS ☑ FAIL ☐

5.15.1.1 Attach the graphs of the sensor and source rise and decay behind this data sheet.

Sensor Signal Duration [280] μsec. Expected: 175μsec. +/− 125μsec.

Comments: At room temperature.

Excitation to Signal Delay [——] msec. Expected: 0.0μsec.

Comments: Not measured due lack of second photodiode detector during testing. It was being used for other purposes.

5.15.2 Channel Characteristics Test (4.15.3) PASS ☑ FAIL ☐

5.15.2.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [1] Expected: 1

Comments: The channel consists of a peak value and a long tail which is at least 6dB below the peak value.

Center Wavelength of Signal [753] nm Expected: 800nm

Comments: The wavelength given is the peak of the sensor signal and not the center of the whole ~~spectrum~~ sensor signal. The peak value of the sensor signal is the area of interest and not the tail of the sensor signal.

747.2 to 783.2

Channel Width [36.0] nm Expected: Maximum of 200nm (Probably Will Be Less)

Comments: The width given is the width of the peak area of the sensor signal and not the width of the whole sensor signal including the tail. The tail of the sensor signal is about 250nm wide

5.15.3 <u>Power Conversion Efficiency Test (4.15.4)</u> PASS ☐ FAIL ☑

5.15.3.1 Attach the graphs of the source power and the sensor value behind this data sheet.

5.15.3.2 After recording the spectrum analyzer power measurement, convert it to milliwatts using the formula: dBm = 10log(mWatt)

Power Measurements from Optic Spectrum Analyzer			=>	Conversion to mWatts	
Source Power at Sensor Input	-27.5	dBm	=>	1.778×10^{-6}	mW
Sensor Signal Power at Coupler Output	-65.625	dBm	=>	2.738×10^{-10}	mW
Source Backreflection PWR at Coupler Output	13.75	dB	=>	23.714	
Coupler Attenuation	4.0	dB	=>	2.512	

Use the values in mW to calculate the Power Conversion Efficiency.
Power Conversion Efficiency =
(((Sensor Signal Power at Coupler Output X Coupler Attenuation)/Source Backreflection PWR at Coupler Output)/Source Power at Sensor Input) X 100.

Minimum Power Conversion Efficiency 0.0016 %

Expected: 0.16%
Which is a sensor output power that is 28dB below the source power.

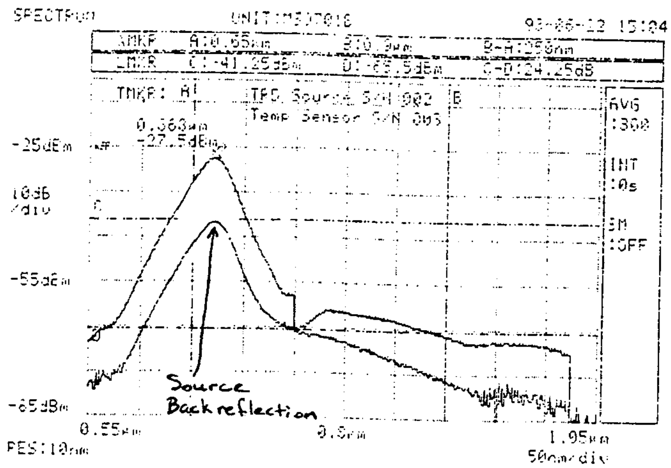
Use the values in dBm to calculate the Conversion Loss.
Conversion Loss = (Sensor Signal Power at Coupler Output – Source Backreflection PWR at Coupler Output + Coupler Attenuation) – Source Power at Sensor Input.

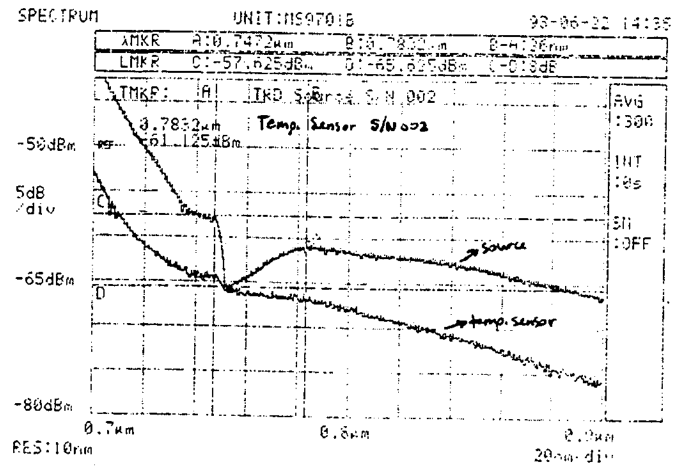
Conversion Loss -47.875 dB

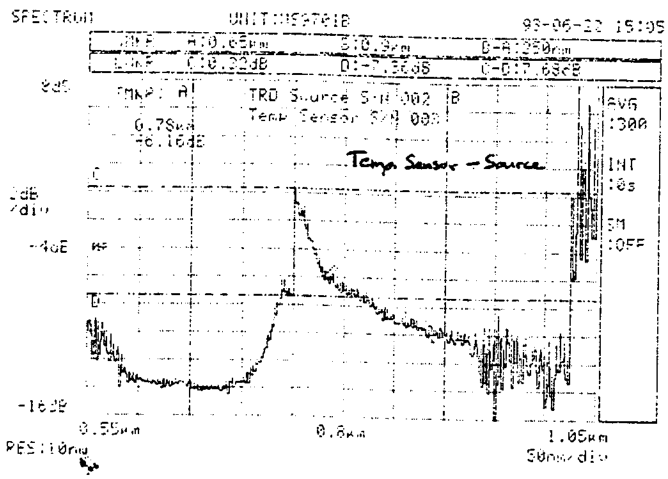
Expected: ≥ –28dB

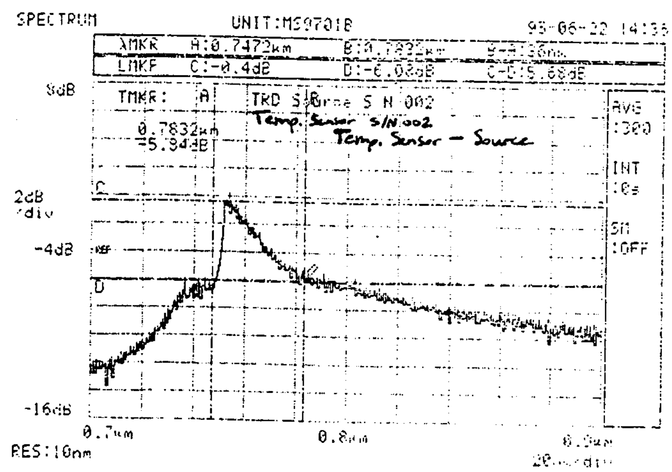
Comments: The failure may be due to the fact that these measurements were taken of the power levels at certain wavelengths (the peaks of the source and sensor signals) as opposed to the total power of ~~the~~ the source and sensor signal over their whole output spectrum, Total Indicated Temperature S/N 002

Whole TRD Source and sensor Spectrum









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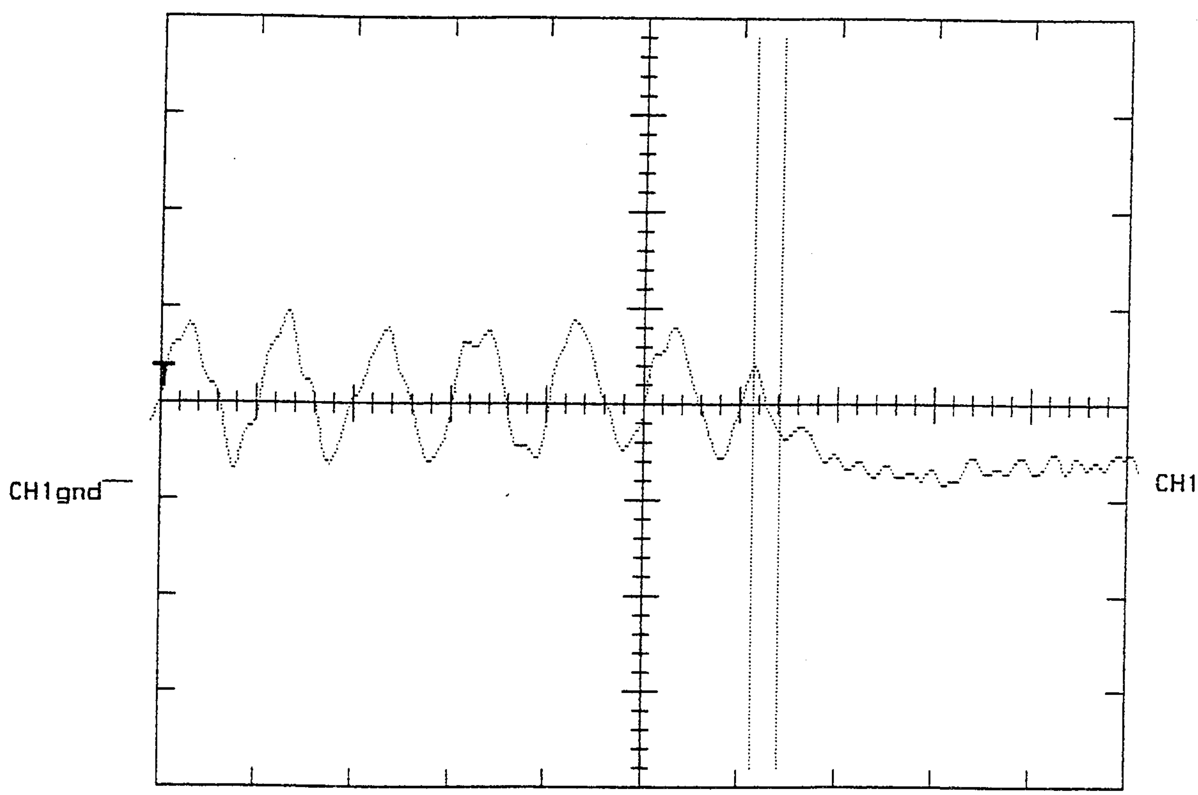
EOA S/N 002 as Source

Temperature Sensor S/N 002

CH1 50mV A 1ms 79.7mV VERT

280.00us WINDOW



CH1 MAX = 62.000mV

CH1 MIN = 26.000mV

5.15 TOTAL TEMPERATURE SENSOR DATA SHEET

Performed by: Brad Kessler   Date: 6/22/93   Test Article Serial Number: 3

5.15.1 Signal Duration and Excitation to Signal Delay Test (4.15.2)   PASS ☑ FAIL ☐

5.15.1.1 Attach the graphs of the sensor and source rise and decay behind this data sheet.

Sensor Signal Duration [270] μsec.   Expected: 175μsec. +/– 125μsec.

Comments: At room temperature

Excitation to Signal Delay [——] msec.   Expected: 0.0μsec.

Comments: Not measured due to lack of second photodiode detector. It is being used for other purposes.

5.15.2 Channel Characteristics Test (4.15.3)   PASS ☑ FAIL ☐

5.15.2.1 Attach the graph of the typical sensor value behind this data sheet.

Number of Discrete Channels [1]   Expected: 1

Comments:

Center Wavelength of Signal [753] nm   Expected: 800nm

Comments: The wavelength given is the peak of the sensor signal and not the center of the whole sensor signal. The peak value ~~of~~ of the signal is the area of interest and not the tail of the sensor signal.

Channel Width [36.0] nm 747.2 to 783.2 nm   Expected: Maximum of 200nm (Probably Will Be Less)

Comments: The width given is the width of the peak area of the sensor signal and not the width of the whole sensor signal including the tail. The tail of the sensor signal is about 250nm wide.

5.15.3 Power Conversion Efficiency Test (4.15.4) PASS ☐ FAIL ☑

5.15.3.1 Attach the graphs of the source power and the sensor value behind this data sheet.

5.15.3.2 After recording the spectrum analyzer power measurement, convert it to milliwatts using the formula: dBm = 10log(mWatt)

Power Measurements from Optic Spectrum Analyzer		=>	Conversion to mWatts
Source Power at Sensor Input	-27.5 dBm	=>	1.778×10^{-6} ~~m~~W
Sensor Signal Power at Coupler Output	-65.75 dBm	=>	2.661×10^{-10} ~~m~~W
Source Backreflection PWR at Coupler Output	13.75 dB	=>	23.714
Coupler Attenuation	4.0 dB	=>	2.512

Use the values in mW to calculate the Power Conversion Efficiency.
Power Conversion Efficiency =
(((Sensor Signal Power at Coupler Output X Coupler Attenuation)/Source Backreflection PWR at Coupler Output)/Source Power at Sensor Input) X 100.

Minimum Power Conversion Efficiency 0.0016 %

Expected: 0.16%
Which is a sensor output power that is 28dB below the source power.

Use the values in dBm to calculate the Conversion Loss.
Conversion Loss = (Sensor Signal Power at Coupler Output – Source Backreflection PWR at Coupler Output + Coupler Attenuation) – Source Power at Sensor Input.

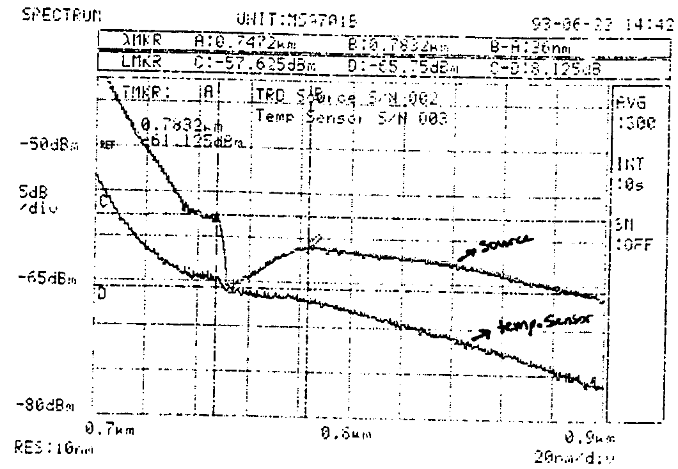
Conversion Loss -48.0 dB

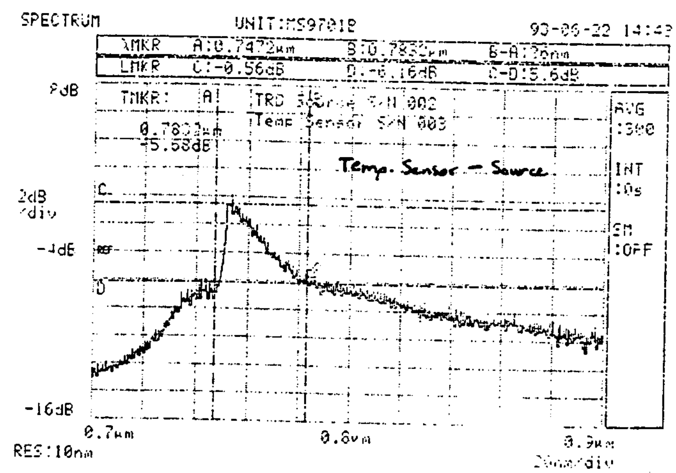
Expected: ≥ -28dB

Comments: The failure may be due to the fact that these measurements were taken of the power levels at the peak wavelengths of the source and sensor signal as opposed to the total power of the source and sensor signal over their whole output spectrum.

Total Indicated Temperature S/N 003

See data for Temp. S/N 002 for Source power and for Source backreflection power.





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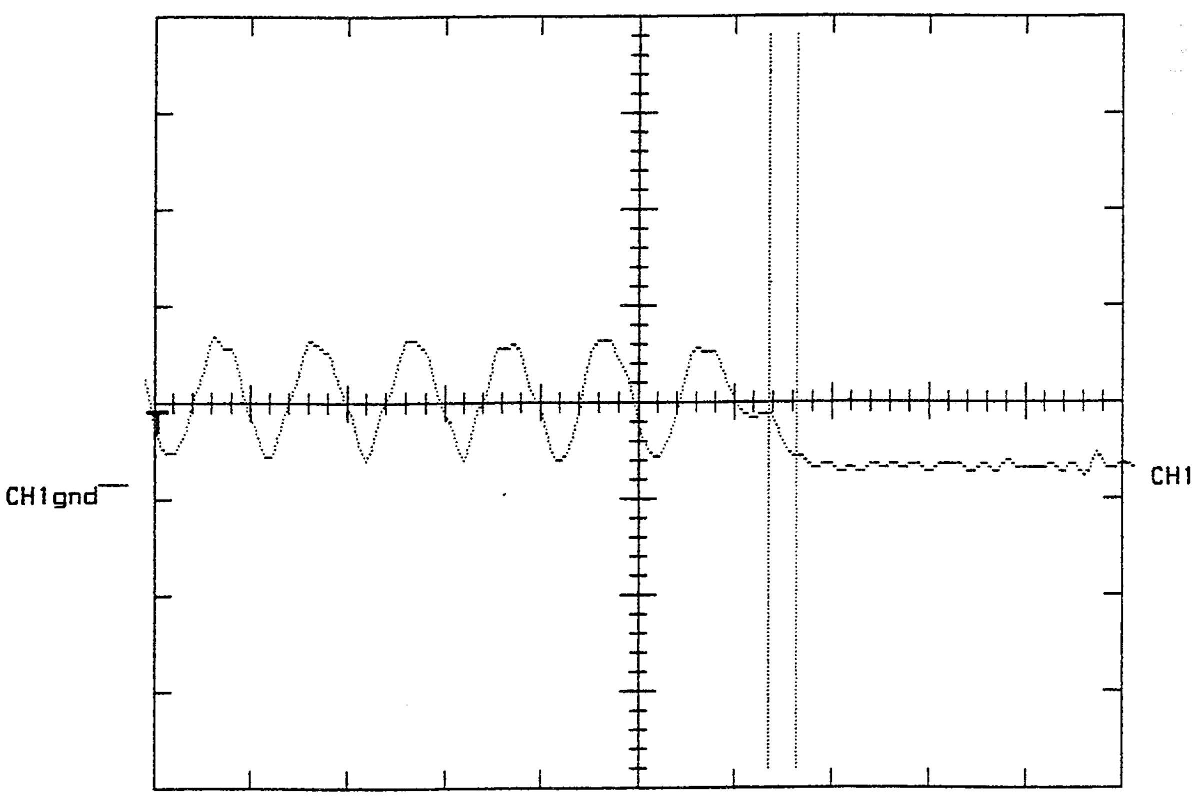
EDA S/N 002 as source

Temp. Sensor S/N 3

CH1 50mV A 1ms 65.6mV VERT

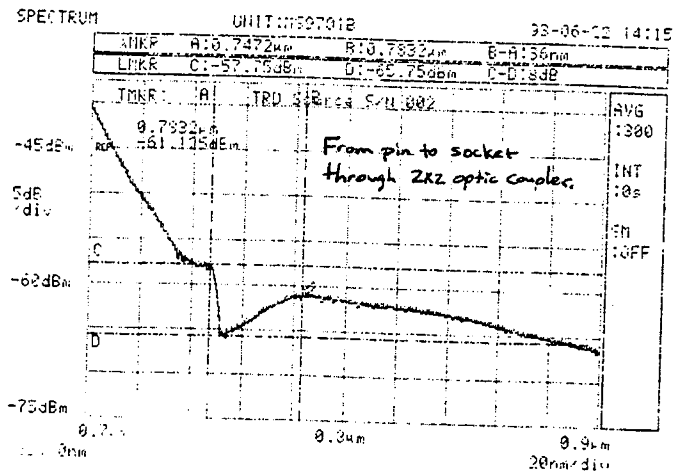
270.00us WINDOW

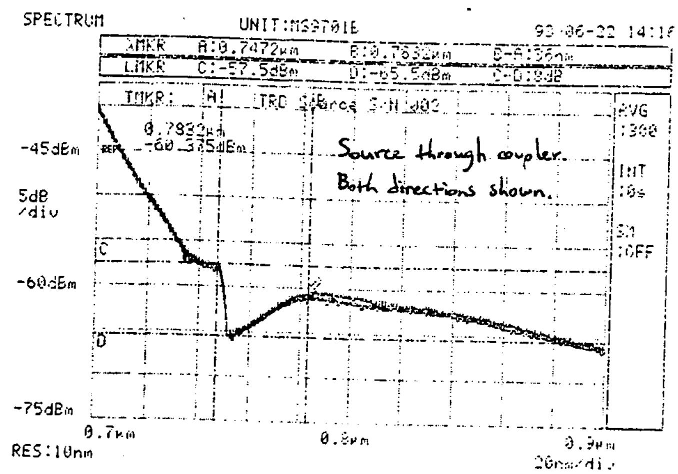


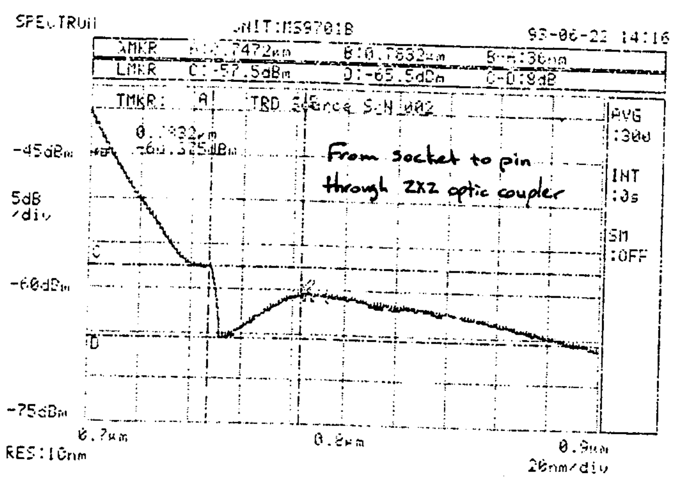
CH1 MAX = 36.000mV
CH1 MIN = 14.000mV

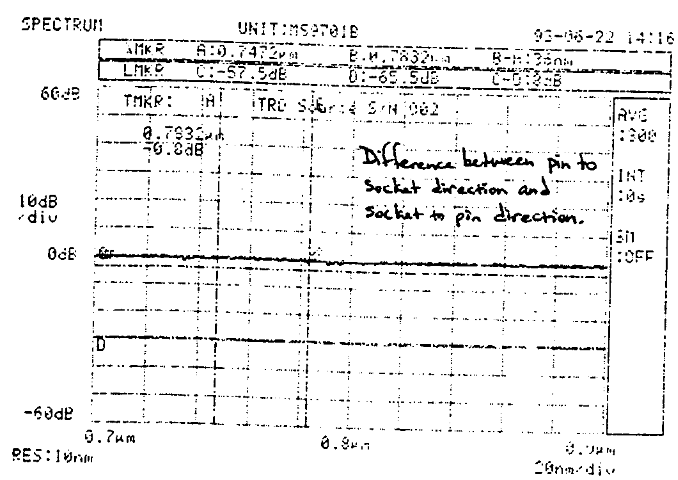
2X2 Coupler Attenuation in Both Directions Compared

2x2 Coupler attenuation difference when passing light in opposite directions.









FOCSI EOA and Sensor Integration Test Plan

Rev. 5/17/93

6.0 SCOPE

This test plan establishes the documents, equipment, and procedures necessary to verify the integrated operation of the Electro–Optic Architecture (EOA) and the Fiber Optic Sensors being developed by McDonnell Douglas Corporation (MDC) under the NASA Fiber Optic Control System Integration (FOCSI) contract NAS3–25796.

7.0 APPLICABLE DOCUMENTS

The following documents of the issue shown form a part of this test plan to the extent specified.

7.1 McDonnell Douglas Corporation Documents

WS–AD–3239 Electro–optic Architecture Procurement Specification
Rev. A8 Dec 89

WS–AD–3238 Fiber Optic Sensor Procurement Specification
Rev. A11 Dec 89

PS 74–650056 Procurement Specification for Actuator, Trim – Control System Longitudinal Feel

74J638000 Transducer, Motional Pickup Longitudinal Control Sensor

Stabilizer Sensor Interface Control Document (ICD) (FOCSI Fiber Optic Sensor ICD)

Rudder Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Pitch Stick Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Rudder Pedal Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Trailing Edge Flap Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Leading Edge Flap Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Power Lever Control Angle Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Nose Wheel Steering Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Total Pressure Sensor ICD (FOCSI Fiber Optic Sensor ICD)

Air Data Temperature Sensor ICD (FOCSI Fiber Optic Sensor ICD)

FOCSI Multiplex Bus ICD Rev. B

7.2 General Electric Company Documents

E–75.05–4B Interface Control Sheets – Actuator, Stabilizer

E–75.05–9E Interface Control Sheets – Actuator, Rudder

E–75.05–19A Interface Control Sheets – Actuator, Rudder Pedal Sensor Assembly

E–75.05–5D Interface Control Sheets – Actuator, Trailing Edge Flap

E–75.05–6C Interface Control Sheets – Servovalve Assembly, Hydraulic, Leading Edge Flap

E–75.05–24 Interface Control Sheets – Power Lever Control

E–75.05–10D Interface Control Sheets – Power Unit, Nose Wheel Steering

7.3 Government Documents

MIL–E–5400T Electronic Equipment, Airborne, General Specification for

MIL–STD–810D Environmental Test Methods and Engineering Guidelines

MIL–STD–1553B Aircraft Internal Time Division Command/Response Multiplex Data Bus (Notice 2)

8.0 SUMMARY

8.1 Test Plan Objective

The objective of the test is to verify the integrated operation of the EOA and the sensors. This will be accomplished by comparing the performance of the optic sensor to position, pressure, and temperature sensors which may be a current aircraft sensors or calibrated laboratory devices. Only the sensor being tested will be connected with the EOA. The procedures will directly verify the system output via the MIL–STD–1553 multiplex data bus and will indirectly verify the operation of the sensors, the EOA's signal processing, and the optic interface between the EOA and the sensors.

8.2 Location

All tests will be performed at the MDC Avionics Laboratories or Environmental Test Facilities.

8.3 Standard Conditions

All tests shall be performed at prevailing laboratory temperatures, barometric pressures, and humidities unless otherwise specified.

8.4 Equipment

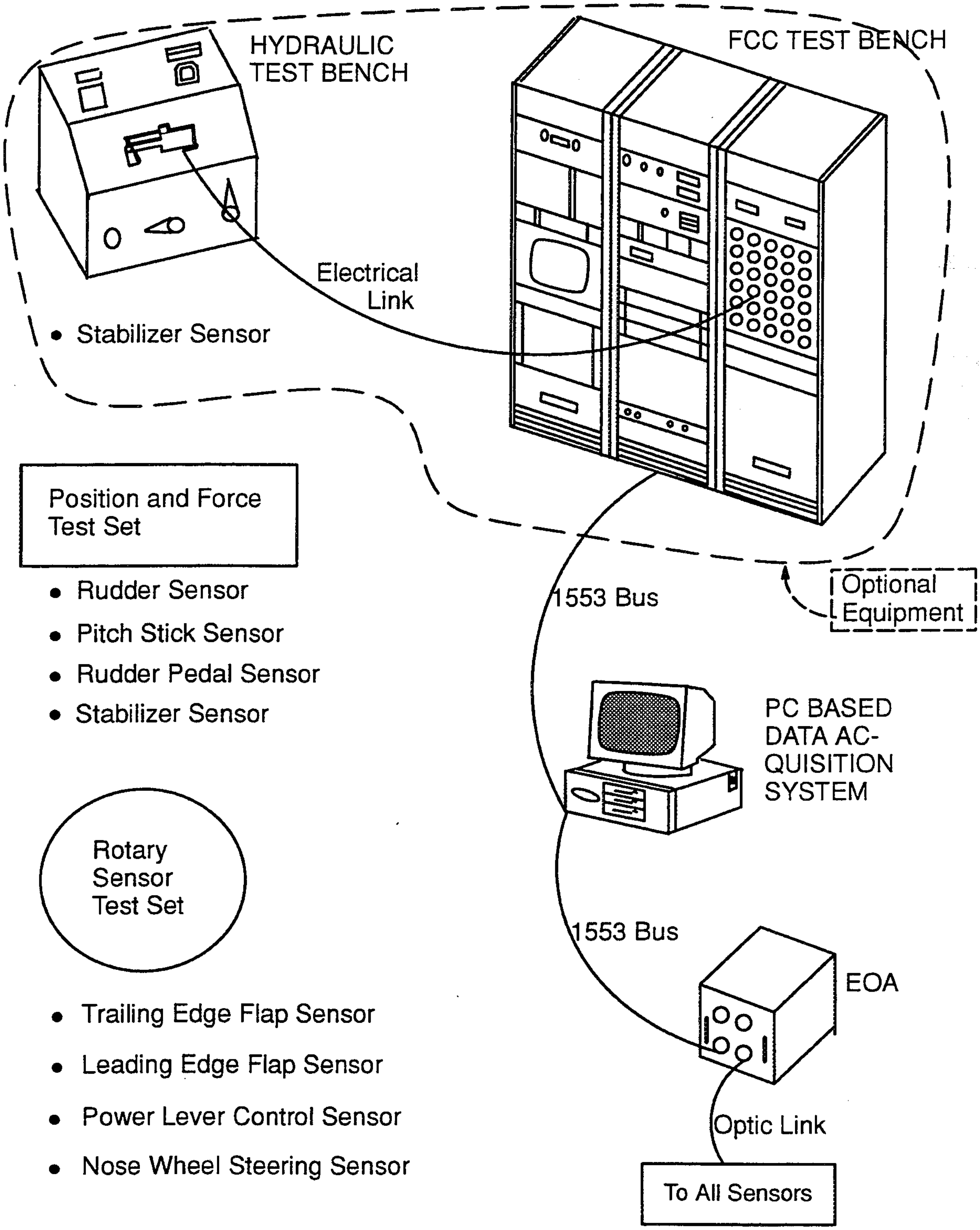
The test equipment consists of commercially available equipment and MDC designed equipment and is listed in Table I. The position sensor equipment setup is shown in Figure 1. The Pressure and Temperature equipment is shown in Figure 2 and Figure 3 respectively.

8.5 Specific Tests

8.5.1 **EOA Tests**

8.5.1.1 Power Dissipation Test

Measuring the current and voltage on the first powering up of the complete EOA will determine the power dissipated by the EOA. Comparing the actual power dissipation to calculated power dissipation will show if the power portion of the EOA is assembled correctly.



Integration Configuration

Figure 1

8.5.1.2 1553 Multiplex Bus Test

Monitoring the 1553 Multiplex Bus while the EOA bus controller and the EOA microprocessor transmit and receive messages will determine if the 1553 Multiplex Bus is operating correctly.

8.5.1.3 Spectrum Analyzer Mode Test

Placing the EOA in spectrum analyzer mode and viewing the CCD array information gathered from the optic sensors will determine if the source, sensors, and receiver are operating correctly.

8.5.2 Linear and Rotary Position Sensor Tests

8.5.2.1 Null Offset Test

Examining the variation during a thirty second continuous recording of the EOA output while the sensor is at null position will determine the null offset of the sensor. The null offset is noise in the analog sensors and is state changes in the digital sensors. The null offset is controlled by the sensor ICD.

8.5.2.2 Resolution Test

Continuous recording of the sensor position while moving the sensor very slowly and in very small increments will determine the sensor resolution. The sensor resolution must be smaller than the maximum sensor null offset.

8.5.2.3 Range Test

Recording the sensor position at the ends of the sensor movement will determine the range of the sensor. The sensor must be able to report the full range of the actuator.

8.5.2.4 Linearity Test

Performing a linear regression on equally spaced sensor positions over the full range of the sensor will determine the nonlinearity of the sensor. The nonlinearity of the sensor is the largest deviation of the individual data points from the best straight line through those points.

8.5.3 Total Pressure Sensor Tests

8.5.3.1 Leak Test

After establishing a relatively high pressure at the sensor input, the system is isolated from the pressure controller and the rate of decreasing pressure is measured. This change in pressure is primarily attributable to leakage within the sensor assembly. The rate of change in pressure is reported as the sensor's leak rate.

8.5.3.2 Warm Up Test

Conventional pressure sensors have integrated electronics that typically warm up the entire sensor assembly after a "cold" power up. This warming can have a significant effect on the sensor accuracy during the critical time period of aircraft take-off. The warm up test is a standard procedure for conventional pressure sensor evaluation. However, since this FOCSI sensor is passive with no active electronics within the sensor assembly, no warm up effects are expected to be detected.

8.5.3.3 Room Temperature Conversion Accuracy/Hysteresis Test

Pressure sensor accuracy is measured throughout its operating range in 3.000 in. Hg increments at room temperature using a calibrated pressure controller. Each test point is reached with increasing and decreasing pressures to identify any hysteresis. Results of this test will reflect sensor accuracy/repeatability in converting the optical signal measured by the EOA to a "real" pressure reading at room temperature.

8.5.3.4 "Cold" and "Hot" Conversion Accuracy/Hysteresis Test

The same test as above only conducted at more extreme temperatures within the sensor's operating range. This test will characterize sensor accuracy/repeatability at different ambient temperatures.

8.5.3.5 G–Sensitivity Test

At room temperature and constant input pressure, the unit will be positioned along each of its 3 axes, establishing relative 2 G changes. The sensor's static output will be recorded in 6 different positions. Significant differences in sensor error, holding all test conditions except for sensor orientation constant, will be attributable to gravitational sensitivities .

8.5.3.6 "Creep" Test

Short–term sensor response to a "step" input at room temperature will be measured. The sensor will be allowed to stabilize with an input of 80.000 in. Hg. The input pressure will then be decreased to 2.000 in. Hg as quickly as possible without overshoot. Sensor output will be monitored as a function of time with the constant 2.000 in. Hg input to determine if the sensor "creeps" to a final value.

8.5.3.7 "Jitter"/Short–Term Stability Test

Determine the "scatter" in pressure readings by taking many samples of the sensor output at constant pressure. If possible with the test set–up, vary the internal update rate and relate it to the sensor's short–term stability.

8.5.3.8 Humidity Sensitivity Test

Establish relatively humid air at the sensor input with input pressure controlled at 30.000 in. Hg. Identify any sensitivity to the condition.

8.5.4 **Total Temperature Probe Tests**

8.5.4.1 Platinum Resistor Thermometer (PRT) Element Accuracy Test

Two temperature calibration test points will be used to verify the accuracy of the probe's two platinum resistor elements. An ice bath (32.0 degrees F) and a bath of boiling distilled water (212.0 degrees F) will be used to establish the test points.

8.5.4.2 Initial Room Temperature Check–Out

General operation of the probe integrated with the EOA and Air Data Computer (ADC) will be verified. Mux bus data transmitted from the EOA and the ADC will be monitored by the PC Based Data Acquisition System. This test will not focus on evaluating probe accuracy, but rather on verifying proper transmission of probe parameters. The ADC Built–In–Test (BIT) words will be monitored for failures.

8.5.4.3 Deicing Heater Operation Test

The proper operation of the probe heater will be verified by measuring the amount of power drawn after 5 minutes. The ADC will be monitored for BIT failures.

8.5.4.4 General Thermal Test

An oven will be used to expose the probe to a range of ambient temperatures. The PRT sensor will be used as a general reference to evaluate the accuracy of the optical TRD element. Both readings will be taken simultaneously at stable ambient temperature test points. The ADC will be monitored for BIT fails.

8.6 Failure Handling

Failures during the test procedure will be recorded, analyzed, and corrected. For a failure, the remaining portion of the current test will be completed provided the unit under test will not be damaged, a correction will be implemented, and the failed test will be repeated.

9.0 TEST PROCEDURES

9.1 Equipment

Table I
Integration Test Plan Equipment List

ITEM	DESCRIPTION	MANUFACTURER AND MODEL	RANGE	ACCURACY
1	Flight Control Computer Bench	MDC	——	——
2	FOCSI Test PC – IBM Clone PC (386) 1553 Interface Board	DTK MDC	——	——
3	Hydraulic Bench	Engineered Sales,Inc	3500psi	——
4	Position and Force Sensor (PFS) Test Set	MDC	+/– 3.0″	+/– 0.001″ to +/– 0.005″
5	Rotary Sensor Test Set	Klinger Scientific	360^0	——
6	Air Data Computer Bench	MDC	——	——
7	ADT-222 Pressure Controller	Sperry Flight Systems	2.000 to 80.000 in. Hg	0.001 to 0.004 in. Hg
8				

9.2 *EOA Functional Operation Test*

9.2.1 **Power Dissipation Test**

9.2.1.1 Procedure

9.2.1.1.1 Before turning on power to the EOA, connect a multimeter configured for measuring current between the the 28Volt source power and the EOA input power connector. Use another multimeter to measure the 28Volt source while under load.

9.2.1.1.2 Record the current into the EOA and the source voltage level.

9.2.1.2 Data Evaluation

9.2.1.2.1 Calculate the power dissipation of the EOA which is given by the formula
Power Dissipation = Source Voltage X Input Current

9.2.1.3 Expected Results

9.2.1.3.1 Using the calculated values of power dissipation for the EOA modules and the efficiency of the power supply, the following values were calculated.

Power Dissipation at: 5V = 38.45W, 15V = 7.29W, –15V = 7.05W. Total = 52.79W
Power Supply efficiency range = Minimum of 69% with a nominal of 72%.
Power Dissipation at 28V: 52.79W/69% = 76.51W Max., 52.79W/72% = 73.32W Nominal

9.2.2 **1553 Multiplex Bus Test**

9.2.2.1 Procedure

9.2.2.1.1 Connect together the FOCSI EOA 1553 bus and the FOCSI Test PC 1553 bus.

9.2.2.1.2 Turn on the 1553 Test PC in monitor mode and configure it for recording EOA data.

9.2.2.1.3 Turn on the FOCSI EOA with the bus controller in bus controller mode.

9.2.2.1.4 Monitor the EOA bus controller and EOA microprocessor as they transmit and receive messages.

9.2.2.2 Data Evaluation

9.2.2.2.1 Verify that the EOA bus controller sends the proper messages and that the EOA microprocessor responds with the proper messages.

9.2.2.3 Expected Results

9.2.2.3.1 The EOA bus controller and EOA microprocessor should transmit and receive messages according to the FOCSI Multiplex Bus ICD.

9.2.3 **EOA Spectrum Analyzer Mode Test**

9.2.3.1 Procedure

9.2.3.1.1 Turn on the FOCSI EOA with the bus controller in bus controller mode, and the microprocessor in spectrum analyzer mode.

9.2.3.1.2 Visually monitor the spectrum analyzer output to verify the system operation.

9.2.3.2 Data Evaluation

9.2.3.2.1 Verify the source is operating and the sensors show the characteristic output. The digital sensors will show many peaks and valleys which correspond to the digital code plate. The analog sensors will show two peaks; one peak is the sensor signal and the other is the reference.

9.2.3.3 Expected Results

9.2.3.3.1 The spectrum analyzer mode shows the correct operation of the source, sensor, receiver, and the interconnecting fiber because the raw electrical data out of the receiver is displayed.

9.3 *Stabilizer Sensor Test Procedure*

9.3.1 General Preparation

9.3.1.1 Connect together the FOCSI EOA 1553 bus and the personal computer (PC) 1553 bus.

9.3.1.2 Turn on the PC 1553 bus controller and configure it for recording sensor and EOA data.

9.3.1.3 Turn on the FOCSI EOA with the bus controller in monitor mode.

9.3.1.4 Mount the sensor on the Position and Force Sensor (PFS) Test Set.

9.3.2 **Null Offset Test**

9.3.2.1 Procedure

9.3.2.1.1 With the sensor at the null position, use the FOCSI Test PC to record the largest sensor position over thirty seconds. Monitor the PFS Test Set to ensure it is always constant for the test.

9.3.2.2 Data Evaluation

9.3.2.2.1 If the PFS Test Set ever varied, repeat this test. The largest sensor value recorded is the sensor null offset.

9.3.2.3 Expected Results

9.3.2.3.1 Regardless of the environmental conditions, the sensor null position should be equal to or less than the value stated in the sensor ICD and repeated in the data sheet.

9.3.3 **Resolution Test**

9.3.3.1 Procedure

9.3.3.1.1 Record the PFS Test Set position, and with the FOCSI Test PC, record the sensor position. (Any position is acceptable.)

9.3.3.1.2 Use the PFS Test Set to move the sensor with very small and slow increments of movement until the sensor position changes.

9.3.3.1.3 Record the PFS Test Set position, and with the FOCSI Test PC, record the sensor position.

9.3.3.2 Data Evaluation

9.3.3.2.1 Determine the smallest sensor resolution by recording the smallest increment of change reported by the sensor. Compare the smallest sensor position change with the resolution value and the maximum null offset to determine if the sensor can report a position as small as the expected resolution and null offset.

9.3.3.3 Expected Results

9.3.3.3.1 The sensor should be able to report a position equal to the resolution and equal to or smaller than the maximum null offset values given in the Fiber Optic Sensor Procurement Specification and repeated in the data sheet. The digital and analog sensors should be able to sense movement with 2^{10} bits of resolution over the specified range but the analog sensors will probably sense movement with 2^9 bits of resolution or even less resolution.

9.3.4 **Range Test**

9.3.4.1 Procedure

9.3.4.2 Use the PFS Test Set to move the sensor to one full stroke position.

9.3.4.2.1 Record the PFS Test Set position, and with the FOCSI Test Equipment, record the sensor position.

9.3.4.3 Use the PFS Test Set to move the sensor to the opposite full stroke position.

9.3.4.3.1 Record the PFS Test Set position, and with the FOCSI Test Equipment, record the sensor position.

9.3.4.4 Data Evaluation

9.3.4.4.1 The sensor readings at the full stroke positions define the range of the sensor.

9.3.4.5 Expected Results

9.3.4.5.1 The sensor readings should be greater than or equal to the range specified in the Fiber Optic Sensor Procurement Specification and repeated in the data sheet.

9.3.5 **Linearity Test**

9.3.5.1 Procedure

9.3.5.1.1 Use the PFS Test Set to move the sensor to the null position, and record the sensor and PFS Test Set positions.

9.3.5.1.2 Move the sensor to five equally spaced points from the null position up to and including a full stroke position, and record the sensor and PFS Test Set positions at those points.

9.3.5.1.3 Try to move the sensor a little beyond its full stroke position (DO NOT Force the sensor!) and then back to the full stroke position to approach that position from the opposite side. Record the sensor and PFS Test Set positions at the same points as in step 9.3.5.1.2 as the sensor is moved from the full stroke position to the null position. This introduces hysteresis.

9.3.5.1.4 Move the sensor to five equally spaced points from the null position up to and including the opposite full stroke position, and record the sensor and PFS Test Set positions at those points.

9.3.5.1.5 Try to move the sensor a little beyond the opposite full stroke position (DO NOT Force the sensor!) and then back to the opposite full stroke position to approach that position from the opposite side. Record the sensor and PFS Test Set positions at the same points as in step 9.3.5.1.4 as the sensor is moved from the opposite full stroke position to the null position. This introduces hysteresis.

9.3.5.2 Data Evaluation

9.3.5.2.1 Place the recorded sensor and PFS Test Set positions in a spreadsheet for linear reduction.

9.3.5.2.2 Use a linear regression (least squares) program to determine the best straight line (PFS Test Set position versus sensor position) through the 23 total points taken in 9.3.5.1. Also, perform a standard deviation analysis on the points.

9.3.5.2.3 Record the slope, constant, and the other statistics from the linear regression. Also, record the standard deviation.

9.3.5.2.4 Use the best straight line and the standard deviation to calculate the linear regressed range of the null and full stroke values by performing the following:

Plug the x–values of the ~~sensor~~ reference positions at null and the full stroke values into the equation of the best straight line to find the regressed y–values. Then add and subtract the standard deviation to the resulting y–values to obtain the linear regressed range of the null and full stroke values.

9.3.5.2.5 Calculate the distance between the individual points and the best straight line. Record the sensor nonlinearity which is the largest deviation of the individual data points from the best straight line.

9.3.5.3 Expected Results

9.3.5.3.1 The slope of the best straight line should be one since both the sensor and PFS Test Set should be at the same positions.

9.3.5.3.2 The actual data points at the null and full stroke positions should fall within the linear regressed range at the same points.

9.3.5.3.3 The nonlinearity of the sensors should not exceed the nonlinearity stated in the Fiber Optic Sensor Procurement Specification and repeated in the data sheet.

9.4 *Rudder Sensor Test Procedure*

9.4.1 Repeat procedure 9.3 for the Rudder sensor.

9.5 *Pitch Stick Sensor Procedure*

9.5.1 Repeat procedure 9.3 for the Pitch Stick sensor.

9.6 *Rudder Pedal Sensor Test Procedure*

9.6.1 Repeat procedure 9.3 for the Rudder Pedal Sensor.

9.7 *Trailing Edge Flap Sensor Test Procedure*

9.7.1 General Preparation

9.7.1.1 Connect together the FOCSI EOA 1553 bus and the FOCSI Test PC 1553 bus.

9.7.1.2 Turn on the PC 1553 bus controller and configure it for recording sensor and EOA data.

9.7.1.3 Turn on the FOCSI EOA with the bus controller in monitor mode.

9.7.1.4 Mount the FOCSI sensor onto the Rotary Sensor Test Set.

9.7.2 **Null Offset Test**

9.7.2.1 Procedure

9.7.2.1.1 With the sensor at the null angle, use the FOCSI Test PC to record the largest sensor position over thirty seconds. Monitor the Rotary Sensor Test Set to ensure it is always constant for the test.

9.7.2.2 Data Evaluation

9.7.2.2.1 If the Rotary Sensor Test Set ever varied, repeat this test. The largest sensor value recorded is the sensor null offset.

9.7.2.3 Expected Results

9.7.2.3.1 Regardless of the environmental conditions, the sensor null angle should be equal to or less than the value stated in the sensor ICD and repeated in the data sheet.

9.7.3 **Resolution Test**

9.7.3.1 Procedure

9.7.3.1.1 Record the Rotary Sensor Test Set angle, and with the FOCSI Test PC, record the sensor angle. (Any angle is acceptable.)

9.7.3.1.2 Use the Rotary Sensor Test Set to move the sensor with very small and slow increments of movement until the sensor angle changes.

9.7.3.1.3 Record the Rotary Sensor Test Set angle, and with the FOCSI Test PC, record the sensor angle.

9.7.3.2 Data Evaluation

9.7.3.2.1 Determine the smallest sensor resolution by recording the smallest increment of change reported by the sensor. Compare the smallest sensor angle change with the resolution value and the maximum null offset to determine if the sensor can report an angle as small as the expected resolution and null offset.

9.7.3.3 Expected Results

9.7.3.3.1 The sensor should be able to report an angle equal to the resolution and equal to or smaller than the maximum null offset values given in the Fiber Optic Sensor Procurement Specification and repeated in the data sheet. The digital and analog sensors should be able to sense movement with 2^{10} bits of resolution over the specified range but the analog sensors will probably sense movement with 2^9 bits of resolution or even less resolution.

9.7.4 **Range Test**

9.7.4.1 Procedure

9.7.4.2 Use the Rotary Sensor Test Set to move the sensor to one full stroke angle.

9.7.4.2.1 Record the Rotary Sensor Test Set angle, and with the FOCSI Test Equipment, record the sensor angle.

9.7.4.3 Use the Rotary Sensor Test Set to move the sensor to the opposite full stroke angle.

9.7.4.3.1 Record the Rotary Sensor Test Set angle, and with the FOCSI Test Equipment, record the sensor angle.

9.7.4.4 <u>Data Evaluation</u>

9.7.4.4.1 The sensor readings at the full stroke angles define the range of the sensor.

9.7.4.5 <u>Expected Results</u>

9.7.4.5.1 The sensor readings should be greater than or equal to the range specified in the Fiber Optic Sensor Procurement Specification and repeated in the data sheet.

9.7.5 <u>**Linearity Test**</u>

9.7.5.1 <u>Procedure</u>

9.7.5.1.1 Use the Rotary Sensor Test Set to move the sensor to the null angle, and record the sensor and Rotary Sensor Test Set angles.

9.7.5.1.2 Move the sensor to five equally spaced points from the null angle up to and including a full stroke angle, and record the sensor and Rotary Sensor Test Set angles at those points.

9.7.5.1.3 Try to move the sensor a little beyond its full stroke angle (DO NOT Force the sensor!) and then back to the full stroke angle to approach that angle from the opposite side. Record the sensor and Rotary Sensor Test Set angles at the same points as in step 9.3.5.1.2 as the sensor is moved from the full stroke angle to the null angle. This introduces hysteresis.

9.7.5.1.4 Move the sensor to five equally spaced points from the null angle up to and including the opposite full stroke angle, and record the sensor and Rotary Sensor Test Set angles at those points.

9.7.5.1.5 Try to move the sensor a little beyond the opposite full stroke angle (DO NOT Force the sensor!) and then back to the opposite full stroke angle to approach that angle from the opposite side. Record the sensor and Rotary Sensor Test Set angles at the same points as in step 9.3.5.1.4 as the sensor is moved from the opposite full stroke angle to the null angle. This introduces hysteresis.

9.7.5.2 <u>Data Evaluation</u>

9.7.5.2.1 Place the recorded sensor and Rotary Sensor Test Set angles in a spreadsheet for linear reduction.

9.7.5.2.2 Use a linear regression (least squares) program to determine the best straight line (Rotary Sensor Test Set angle versus sensor angle) through the 23 total points taken in 9.3.5.1. Also, perform a standard deviation analysis on the points.

9.7.5.2.3 Record the slope, constant, and the other statistics from the linear regression. Also, record the standard deviation.

9.7.5.2.4 Use the best straight line and the standard deviation to calculate the linear regressed range of the null and full stroke values by performing the following:

Plug the x–values of the ~~Sensor~~ reference angles at null and the full stroke values into the equation of the best straight line to find the regressed y–values. Then add and subtract the standard deviation to the resulting y–values to obtain the linear regressed range of the null and full stroke values.

9.7.5.2.5 Calculate the distance between the individual points and the best straight line. Record the sensor nonlinearity which is the largest deviation of the individual data points from the best straight line.

9.7.5.3 Expected Results

9.7.5.3.1 The slope of the best straight line should be one since both the sensor and Rotary Sensor Test Set should be at the same angles.

9.7.5.3.2 The actual data points at the null and full stroke angles should fall within the linear regressed range at the same points.

9.7.5.3.3 The nonlinearity of the sensors should not exceed the nonlinearity stated in the Fiber Optic Sensor Procurement Specification and repeated in the data sheet.

9.8 *Leading Edge Flap Sensor Test Procedure*

9.8.1 Repeat procedure 9.7 for the Leading Edge Flap Sensor.

9.9 *Power Lever Control Sensor Test Procedure*

9.9.1 Repeat procedure 9.7 for the Power Lever Control Sensor.

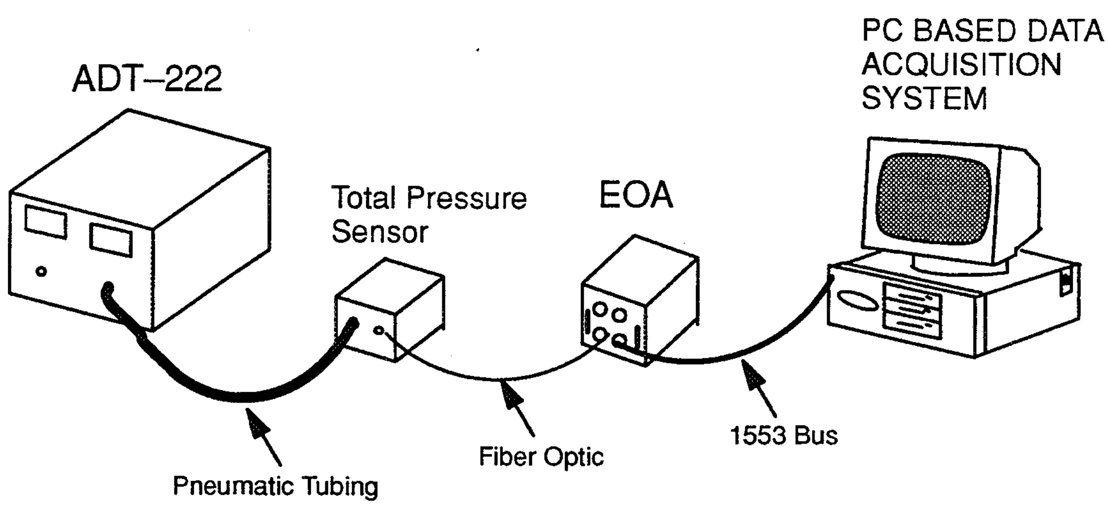
9.10 *Nose Wheel Steering Sensor Test Procedure*

9.10.1 Repeat procedure 9.7 for the Nose Wheel Steering Sensor.

9.11 *Total Pressure Sensor Test Procedure*

9.11.1 General Preparation

9.11.1.1 Connect the Total Pressure Sensor and the PC-based 1553 Bus Controller to the EOA. Connect the ADT-222 Pressure Controller/Monitor to the AN-4 pneumatic interface of the Total Pressure Sensor using metal tubing. Pneumatic tubing should not exceed 10 in^3 of volume. See Figure 2.



Total Pressure Sensor Test Set–Up

Figure 2

9.11.2 **Leak Test**

9.11.2.1 Procedure

9.11.2.1.1 Power up the unit and allow it to warm up at room temperature for at least 30 minutes. Then establish a 55.000 in. Hg input to the sensor with the ADT–222. Start recording the sensor output with the Bus Controller at 5 second intervals. After 30 seconds, put the ADT–222 into its "Measure" mode. Observe the ADT–222 display and start recording its readings at 5 second intervals. Continue to record both sensor and ADT–222 data for 2 minutes.

9.11.2.2 Data Evaluation

9.11.2.2.1 Compute the leak rate (in. Hg per minute) based on (1) the sensor output data and (2) the ADT–222 data.

9.11.2.3 Expected Results

9.11.2.3.1 The two computed leak rates should not vary by more than 0.002 in. Hg and neither should exceed 0.010 in. Hg per minute.

9.11.3 **Warm Up Test**

9.11.3.1 Procedure

9.11.3.1.1 Allow the unit to rest unpowered at room temperature for at least 2 hours with 30.000 in. Hg applied to its input. Make note of the room temperature and the sensor's orientation. Power up the sensor and start recording its output at 1 second intervals for 2 minutes. Between t=2 minutes and t=10 minutes increase interval to 3 seconds. Between t=10 minutes and t=30 minutes sample at 5 second intervals. Between t=30 minutes and t=60 minutes, use 10 second intervals.

9.11.3.2 Data Evaluation

9.11.3.2.1 Plot sensor error (Measured Pressure – Input Pressure) as a function of time.

9.11.3.3 Expected Results

9.11.3.3.1 Since the sensor is completely passive without any on–sensor electronics, there should not be any detectable warm–up effects. Observed accuracy should be within the Vendor's stated tolerance of 0.50 % of Full–Scale.

9.11.4 **Room Temperature Conversion Accuracy/Hysteresis Test**

9.11.4.1 Procedure

9.11.4.1.1 Make note of the room temperature and sensor orientation. Starting with an input pressure of 29.000 in. Hg and going down in 3.000 in. Hg increments, take 10 readings of the sensor output with the Bus Controller at each test point. When 2.000 in. Hg is reached, take readings with pressure increasing to 80.000 in. Hg and then back down to 29.000 in. Hg in 3.000 in Hg increments.

9.11.4.2 Data Evaluation

9.11.4.2.1 Develop a table showing the average, maximum (most positive), and minimum (most negative) error at each test point. Plot the average sensor error at each test point.

9.11.4.3 Expected Results

9.11.4.3.1 All measured errors at all test points should fall within the Vendor's stated tolerance of 0.50 % of Full–Scale. No significant hysteresis effects should be apparent.

9.11.5 "Cold" and "Hot" Conversion Accuracy/Hysteresis Test

9.11.5.1 Procedure

9.11.5.1.1 Place sensor in oven and allow to soak, powered up, for at least 30 minutes at a "Cold" ambient oven temperature of –32 degrees F. Follow test data collection procedure as outlined in Paragraph 9.11.4.1.1. Repeat for a "Hot" temperature of 149 degrees F. Note that care should be taken to protect the optical connector from unreasonable exposure to temperature chamber conditions.

9.11.5.2 Data Evaluation

9.11.5.2.1 Same as Paragraph 9.11.4.2.1.

9.11.5.3 Expected Results

9.11.5.3.1 Same as Paragraph 9.11.4.3.1.

9.11.6 G–Sensitivity Test

9.11.6.1 Procedure

9.11.6.1.1 Allow the sensor to stabilize in a given position at room temperature for at least 30 minutes with an input of 30.000 in. Hg. Take 10 samples of the sensor output. Rotate the sensor about its 3 axes such that a total of 6 different positions are established. Take 10 samples in each stabilized position.

9.11.6.2 Data Evaluation

9.11.6.2.1 Find the maximum and minimum errors, and compute the average sensor error in each position.

9.11.6.3 Expected Results

9.11.6.3.1 Sensitivity to gravitational forces, if any exist, should not result in errors that exceed the Vendor's stated tolerance of 0.50 % of Full–Scale.

9.11.7 "Creep" Test

9.11.7.1 Procedure

9.11.7.1.1 At room temperature, establish an input of 80.000 in. Hg to the sensor. As quickly as possible, without overshoot and without exceeding a rate of 50 in. Hg per second, drop the input to 2.000 in. Hg and start to take sensor output readings at 1 second intervals for 5 minutes.

9.11.7.2 Data Evaluation

9.11.7.2.1 Plot the sensor error as a function of time.

9.11.7.3 Expected Results

9.11.7.3.1 Sensor "Creep" should not result in errors that exceed the Vendor's stated tolerance of 0.50 % of Full–Scale.

9.11.8 **"Jitter"/Short–Term Stability Test**

9.11.8.1 Procedure

9.11.8.1.1 Power up the unit and allow it to warm–up at room temperature for at least 60 minutes. Establish a stable input pressure of 30.000 in. Hg. and take approximately 100 samples. If controllable, change the internal update rate of the sensor to support output data rates of 1 Hz and 100 Hz and take 100 readings for each. Change input pressure to the upper and lower operating extremes and repeat the data collection stated above.

9.11.8.2 Data Evaluation

9.11.8.2.1 Develop scatter plots of sensor error for each test condition.

9.11.8.3 Expected Results

9.11.8.3.1 Jitter should not be more than 0.01% of the set pressure.

9.11.9 **Humidity Sensitivity Test**

9.11.9.1 Procedure

9.11.9.1.1 Connect plastic aircraft tubing to the input of the sensor. Connect metal tubing from the pneumatic controller to the plastic tubing. Place the sensor and all of the plastic tubing into an environmental chamber and let the unit and tubing soak for 60 minutes at 149 °F. Follow test data collection procedure as outlined in Paragraph 9.11.4.1.1.

9.11.9.2 Data Evaluation

9.11.9.2.1 Same as Paragraph 9.11.9.2.2. In addition, calculate the differences seen in the Hot Conversion Accuracy Test (Paragraph 9.11.5.2.1) and this test and identify any differences in results attributable to humidity effects.

9.11.9.3 Expected Results

9.11.9.3.1 Same as Paragraph 9.11.4.3.1.

9.12 *Total Temperature Probe Test Procedure*

9.12.1 **Platinum Resistor Thermometer (PRT) Element Accuracy Test**

9.12.1.1 Procedure

9.12.1.1.1 Connect a digital multimeter to each of the 2 Platinum Resistor Thermometer (PRT) elements to measure each of their resistances. Soak the sensor in an ice bath (32.0 degrees F) and allow the PRT resistance values to stabilize. Verify the ice bath temperature with a thermocouple. Sample the PRT values 10 times each. Repeat the above in a bath of boiling distilled water (212.0 degrees F).

9.12.1.2 Data Evaluation

9.12.1.2.1 Calculate and record the average resistance of each PRT at each temperature.

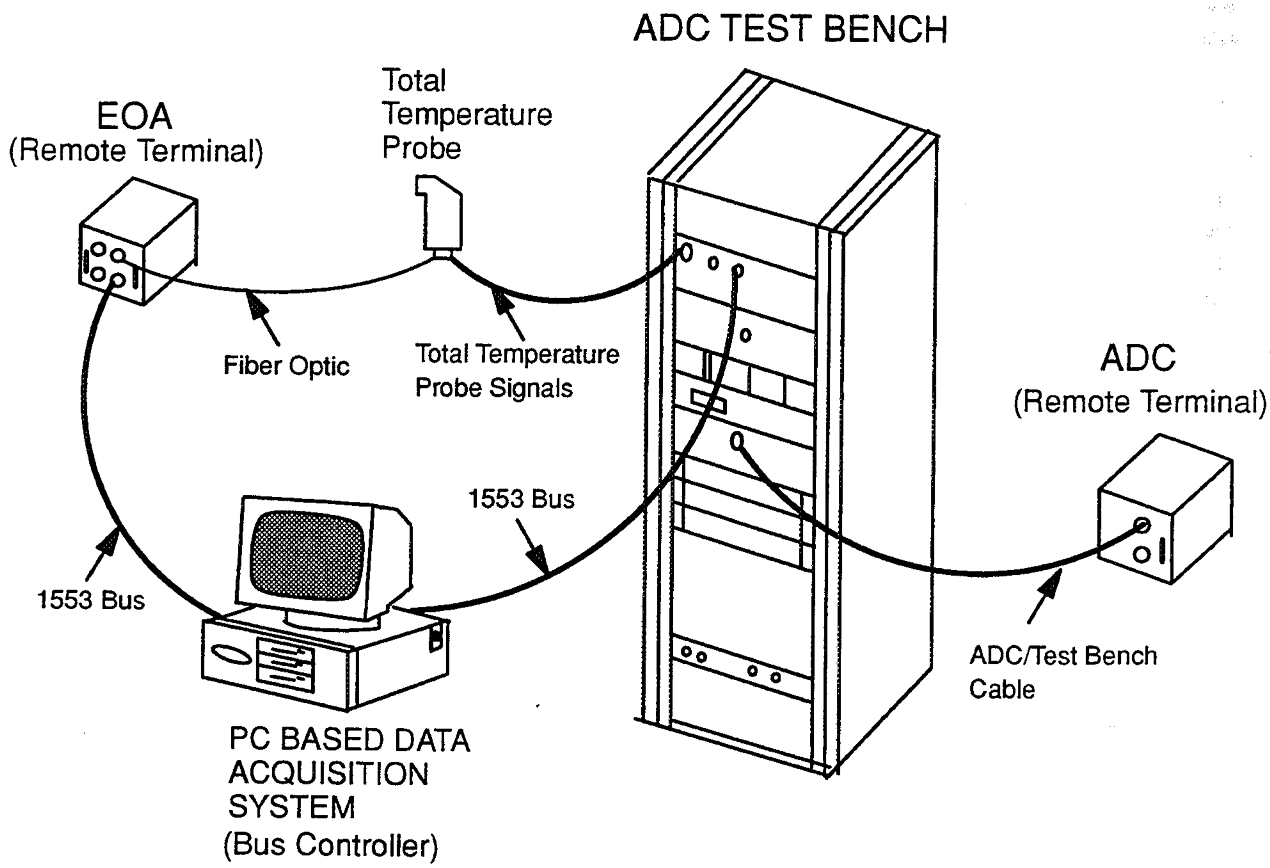
9.12.1.3 Expected Results

9.12.1.3.1 All of the individual sampled readings should fall within the following ranges: 50.00 +/– 0.05 Ohms at 32.0 degrees F and 69.63 +/– 0.15 Ohms at 212.0 degrees F.

9.12.2 <u>Initial Room Temperature Check–Out of PRT and TRD Interfaces</u>

9.12.2.1 Procedure

9.12.2.1.1 Connect PRT inputs/outputs of the probe to the Air Data Computer (ADC) through the ADC Test Bench Breakout Panel. This includes excitation and return signals. Connect the optical Time Rate of Decay (TRD) signals to the FOCSI EOA. Tie the PC–based 1553 Bus Controller to the ADC 1553 Bus (via the ADC Test Bench Breakout Panel) and to the EOA 1553 Bus. See Figure 3.



Total Temperature Probe Test Set–Up

Figure 3

9.12.2.2 Turn on power to the ADC Test Bench and apply power to the ADC. Set static and pitot pressure inputs into the ADC such that approximately 0 knot airspeed and sea level conditions are established. Record the room temperature. Monitor and record the 1553 temperature mux output of the ADC. At the same time monitor and record the TRD–derived Total Temperature reported by the EOA.

9.12.2.3 Data Evaluation

9.12.2.3.1 Calculate the average, minimum, and maximum values of the PRT–derived Total and Ambient Temperatures recorded. Since the ADC automatically performs a deicing correction on the PRT–derived measurements, compensate the recorded ADC 1553 data appropriately to remove this correction. Calculate the average, minimum, and maximum values of the TRD–derived total temperature recorded. Monitor the ADC BIT Status words.

9.12.2.4 Expected Results

9.12.2.4.1 The average temperature outputs should correspond to the room temperature and simulated ground conditions, +/– 2.0 degrees F. No BIT failures should be detected by the ADC.

9.12.3 **Deicing Heater Operation Test**

9.12.3.1 Procedure

9.12.3.1.1 Connect a 400 Hz power supply to the input of a Watt/Amp Meter and connect the meter's output to the deicing heater inputs of the probe. Turn on the 400 Hz power to the deicing heater. Starting at power up, measure the power drawn by the probe with the Watt/Amp Meter every 30 seconds for 10 minutes.

9.12.3.2 Data Evaluation

9.12.3.2.1 Plot the collected data.

9.12.3.3 Expected Results

9.12.3.3.1 Confirm that the probe heater operates within specifications, drawing < 170 Watts after 5 minutes. No BIT failures should be detected.

9.12.4 **General Thermal Test**

9.12.4.1 Procedure

9.12.4.1.1 Turn off the power to the probe deicing heater. Place the probe in a temperature chamber. Note that care should be taken to protect the optical connector and fibers from unreasonable exposure to temperature chamber conditions. Set the oven temperature such that the PRT–based total temperature reading stabilizes at –100 +/– 5 degrees F. Record the ambient oven temperature as measured by a thermocouple located in the air close to the sensor. Sample both PRT– and TRD–based temperatures with the PC Bus Controller. Repeat the process at +50 degree F intervals up to +450 degrees F.

9.12.4.2 Data Evaluation

9.12.4.2.1 Compensate the collected ADC data to remove the deicing correction. Compare the stabilized values of the PRT– and TRD–based temperature readings at all test points. Determine the difference between the two at each test point. Relate these to the stabilized ambient oven temperature at each test point.

9.12.4.3 Expected Results

9.12.4.3.1 The difference between the two probe readings at each test point should not be greater than +/– 0.5 degrees F. The ambient oven temperature should not vary from either of the probe readings by more than +/– 2.0 degrees F.

10.0 DATA SHEETS

10.1 EOA FUNCTIONAL OPERATION DATA SHEET

Performed by: Brad Kessler Date: 3/93 Test Article Serial Number: EOA #1

10.1.1 Power Dissipation Test (9.2.1) PASS ☑ FAIL ☐

Source Voltage [27.6] V Expected: 28 Volts

Input Current [2.37] A Expected: 2.6 Amps to 2.7 Amps

Power Dissipation = Source Voltage X Input Current

Power Dissipation [65.4] W Expected: 73.3 Watts to 76.5 Watts

Comments: The power draw of the flight worthy EOA modules is probably different than what was expected for the prototype EOA modules since some of the cards were redesigned. Also, the power draw should be less than what were probably worst case calculations.

10.1.2 1553 Multiplex Bus Offset Test (9.2.2) PASS ☑ FAIL ☐

10.1.2.1 Write comments on the behavior of the EOA bus controller and the EOA microprocessor.

Comments: The bus controller is requesting messages properly, and the decoding processor is responding properly, as shown on an oscilloscope display. The messages are occurring at 20Hz, and the waveforms look good for all transmissions. The transmissions alternate between the ~~[illegible]~~ A bus and the B bus due to the bus controller software changing busses when Manchester encoding/decoding errors are detected. A bus analyzer shows that the messages are being sent and received properly. An apparent status word failure is probably causing the switching between busses. This is a nuisance error only.

10.1.3 EOA Spectrum Analyzer Mode Test (9.2.3) PASS ☑ FAIL ☐

10.1.3.1 Write comments on the behavior of the EOA source and the sensors.

Comments: The source to receiver wraparound and all of the sensors are visible on the spectrum display. With a duty cycle of 9mseconds on and 1msecond off, many sensors saturate the display. As the duty cycle is decreased, the ~~[illegible]~~ source and sensor spectrums decrease in power, and fewer sensors saturate their display port.

10.2 STABILIZER SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/20/93 Test Article Serial Number: 1

EDA #1

10.2.1 Null Offset Test (9.3.2)

PASS ☐ FAIL ☑

10.2.1.1 Record the largest sensor and actuator values.

Sensor Null Offset | ± 0.045 | inches — Avg. = 0.00 — Expected: ≤ +/− 0.018 in.

PFS Test Set Value | 4.000 | inches — Expected: Any constant value.

Comments: The extremes are listed as the Null offset. The ~~most~~ value reported most of the time is 0.00.

10.2.2 Resolution Test (9.3.3)

PASS ☑ FAIL ☐

10.2.2.1 Record the smallest change in the sensor and actuator positions.

PFS Test Set Initial Position | 1.000 | in. and Ending Position | 1.002 | in.

Sensor Resolution | 0.002 | in.

Expected: ≤ +/− 0.018 in.
Estimated: $2(3.56)/2^{10} \simeq 0.0070$ in.
Proc. Spec.: 0.00174 in.

Comments: Sensor changed from avg. of 0.988 to 1.013 a difference of 0.025.

10.2.3 Range Test (9.3.4)

PASS ☑ FAIL ☐

10.2.3.1 Record the sensor and PFS Test Set full stroke positions.

		Value		Expected
Sensor Positions	− Full Stroke	-3.560	in.	Expected: −3.56in.
	+ Full Stroke	3.560	in.	Expected: +3.56in.
PFS Test Set Positions	− Full Stroke	-3.561	in.	Expected: −3.56in.
	+ Full Stroke	3.546	in.	Expected: +3.56in.

Comments: The PFS values were taken when the sensor value being reported started to read the extremes ~~[illegible]~~ fairly consistantly.

10.2.4 Linearity Test (9.3.5) PASS ☑ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	-3.560	-2.670	-1.750	-0.890	0.000	0.890	1.750	2.670	3.560
0 to +Full Stroke					0.000	0.867	1.761	2.700	3.529
+Full Stroke to 0					0.049	0.936	1.754	2.693	3.539
0 to -Full Stroke	-3.511	-2.638	-1.726	-0.842	X				
-Full Stroke to 0	-3.529	-2.711	-1.726	-0.936	-0.052				

10.2.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.2.4.2 Record the slope, constant, and standard deviation values.

Slope 0.996 Expected: 1.0 Constant 0.008 Expected: 0

Standard Deviation 0.034

Comments:

10.2.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = ~~sensor~~ reference positions

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position +0.049 / -0.052 in. Regressed Range -0.026 in. to 0.042 in.

Actual Min. Full Stroke Position -3.529 in. Regressed Range -3.505 in. to -3.573 in.

Actual Max. Full Stroke Position 3.539 in. Regressed Range 3.521 in. to 3.589 in.

Comments:

10.2.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity -0.060 in. at 0.000 Expected: ≤ +/– 0.0356 in.

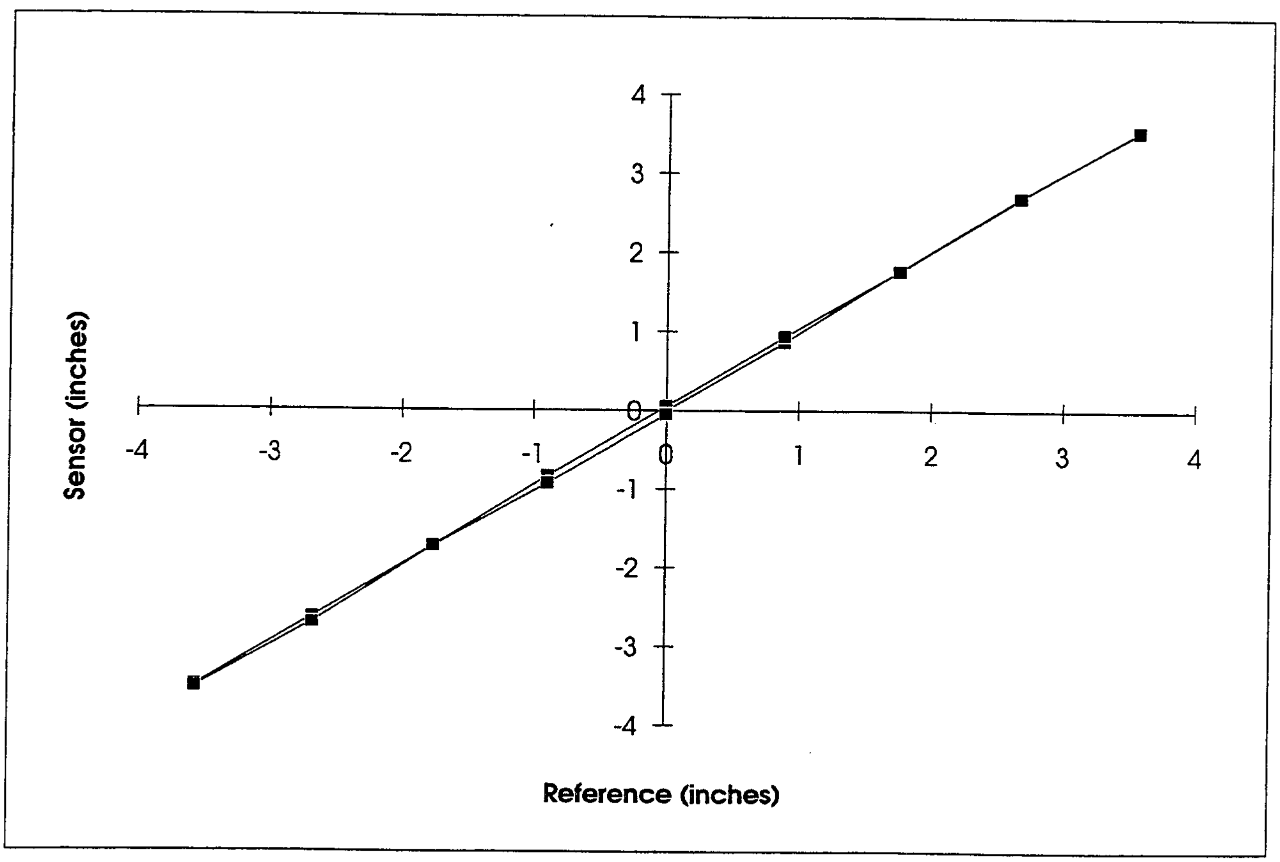
Comments:

Stabilizer Sensor S/N 001

Reference (inches)	Sensor (inches)
0	0
0.89	0.867
1.75	1.761
2.67	2.7
3.56	3.529
3.56	3.539
2.67	2.693
1.75	1.754
0.89	0.936
0	0.049
-0.89	-0.842
-1.75	-1.726
-2.67	-2.638
-3.56	-3.511
-3.56	-3.529
-2.67	-2.711
-1.75	-1.726
-0.89	-0.936
0	-0.052

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.996371	0.008263
se m	se b	0.003509	0.007832
r squared	se y	0.999789	0.034139
F	df	80604.12	17
ss reg	ss resid	93.94277	0.019813

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.2 STABILIZER SENSOR DATA SHEET

Performed by: Brad Kessler   Date: 6/17/93   Test Article Serial Number: 2

EDA#2

10.2.1 Null Offset Test (9.3.2)   PASS ☐ FAIL ☑

10.2.1.1 Record the largest sensor and actuator values.

Sensor Null Offset [+0.052 / -0.073] inches   Avg. -0.010   Expected: ≤ +/− 0.018 in.

PFS Test Set Value [2.000] inches   Expected: Any constant value.

Comments: The extremes are listed as the Null offset. The value most often reported is -0.010.

10.2.2 Resolution Test (9.3.3)   PASS ☐ FAIL ☑

10.2.2.1 Record the smallest change in the sensor and actuator positions.

PFS Test Set Initial Position [1.000] in. and Ending Position [0.978] in.

Sensor Resolution [0.022] in.

Expected: ≤ +/− 0.018 in.
Estimated: $2(3.56)/2^{10} \simeq 0.0070$ in.
Proc. Spec.: 0.00174 in.

Comments: The sensor changed from 0.985 to 0.964 for a difference of 0.021

10.2.3 Range Test (9.3.4)   PASS ☑ FAIL ☐

10.2.3.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions	– Full Stroke	- 3.560 in.	Expected: –3.56in.
	+ Full Stroke	3.560 in.	Expected: +3.56in.
PFS Test Set Positions	– Full Stroke	-3.610 in.	Expected: –3.56in.
	+ Full Stroke	3.576 in.	Expected: +3.56in.

Comments: The PFS values were taken when the sensor readings were at the extremes consistantly.

10.2.4 Linearity Test (9.3.5)

PASS ☑ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	–3.560	–2.670	–1.750	–0.890	0.000	0.890	1.750	2.670	3.560
0 to +Full Stroke					0.000	0.780	1.737	2.589	3.508
+Full Stroke to 0					0.056	0.835	1.730	2.728	3.501
0 to –Full Stroke	-3.518	-2.627	-1.726	-0.797	X				
–Full Stroke to 0	-3.568	-2.728	-1.761	-0.926	-0.035				

10.2.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.2.4.2 Record the slope, constant, and standard deviation values.

Slope [0.989] Expected: 1.0

Constant [-0.009] Expected: 0

Standard Deviation [0.051]

Comments:

10.2.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor positions

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position [+0.056/-0.035] in. Regressed Range [-0.060] in. to [0.042] in.

Actual Min. Full Stroke Position [-3.518] in. Regressed Range [-3.581] in. to [-3.479] in.

Actual Max. Full Stroke Position [3.508] in. Regressed Range [3.462] in. to [3.564] in.

Comments:

10.2.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity [0.096] in. at 2.670

Expected: ≤ +/– 0.0356 in.

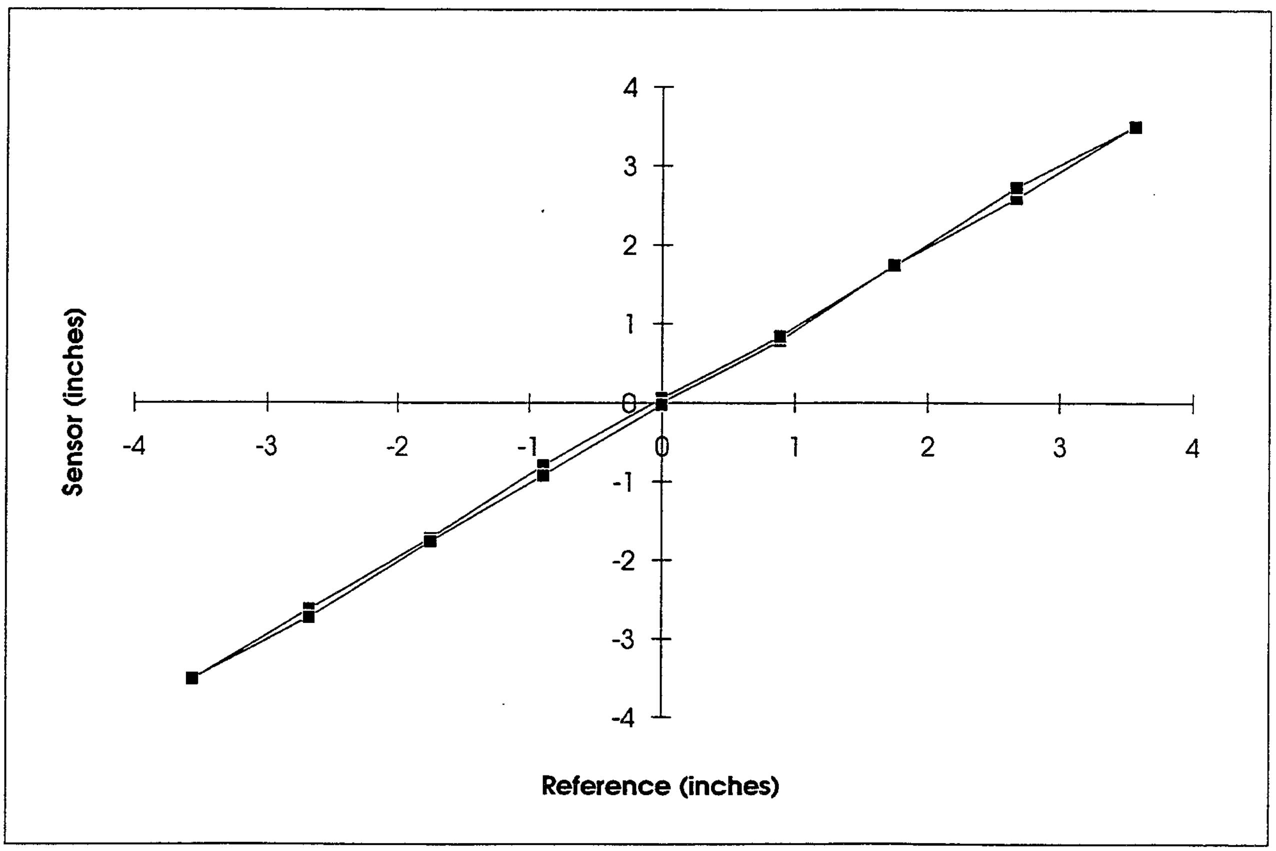
Comments:

Stabilizer Sensor S/N 002

Reference (inches)	Sensor (inches)
0	0
0.89	0.78
1.75	1.737
2.67	2.589
3.56	3.508
3.56	3.501
2.67	2.728
1.75	1.73
0.89	0.835
0	0.056
-0.89	-0.797
-1.75	-1.726
-2.67	-2.627
-3.56	-3.518
-3.56	-3.508
-2.67	-2.728
-1.75	-1.761
-0.89	-0.926
0	-0.035

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.989123	-0.00853
se m	se b	0.005225	0.01166
r squared	se y	0.999526	0.050824
F	df	35841.62	17
ss reg	ss resid	92.58111	0.043912

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.3 RUDDER SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/21/93 Test Article Serial Number: 001

EDA #2

10.3.1 Null Offset Test (9.4.2)

PASS ☐ FAIL ☑

10.3.1.1 Record the PFS Test Set value during the test and the largest sensor value.

Sensor Null Offset [+0.007 / -0.011] inches Avg. -0.002 Expected: $\leq +/- 0.0032$ in.

PFS Test Set Value [3.000] inches Expected: Any constant value.

Comments: The extremes are listed as the null offset. The value most often reported is -0.002.

10.3.2 Resolution Test (9.4.3)

PASS ☑ FAIL ☐

10.3.2.1 Record the PFS Test Set position and the smallest change in the sensor position.

PFS Test Set Initial Position [0.200] in. and Ending Position [0.201] in.

Sensor Resolution [0.001] in.

Expected: $\leq +/- 0.0032$ in.
Estimated: $2(0.665)/2^{10} \simeq 0.0013$ in.
Proc. Spec.: 0.00032 in.

Comments: The sensor changed from 0.190 to 0.192 for a difference of 0.002.

10.3.3 Range Test (9.4.4)

PASS ☑ FAIL ☐

10.3.3.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions	– Full Stroke	-0.665 in.	Expected: –0.665in.
	+ Full Stroke	+0.665 in.	Expected: +0.665in.
PFS Test Set Positions	– Full Stroke	-0.663 in.	Expected: –0.665in.
	+ Full Stroke	+0.665 in.	Expected: +0.665in.

Comments: The PFS positions were taken when the sensor value read the extreme fairly consistently.

10.3.4 Linearity Test (9.4.5) PASS ☑ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	–0.665	–0.499	–0.333	–0.166	0.000	0.166	0.333	0.499	0.665
0 to +Full Stroke					-0.001	0.173	0.330	0.442	0.659
+Full Stroke to 0					-0.003	0.166	0.332	0.493	0.661
0 to –Full Stroke	-0.661	-0.475	-0.332	-0.167	X				
–Full Stroke to 0	-0.660	-0.511	-0.335	-0.177	-0.003				

10.3.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.3.4.2 Record the slope, constant, and standard deviation values.

Slope $\boxed{0.986}$ Expected: 1.0 Constant $\boxed{-0.004}$ Expected: 0

Standard Deviation $\boxed{0.014}$

Comments:

10.3.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.
$y = mx + b$, where m = slope, b = constant, x = sensor positions
linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position $\boxed{-0.001 / -0.003}$ in. Regressed Range $\boxed{-0.018}$ in. to $\boxed{0.010}$ in.

Actual Min. Full Stroke Position $\boxed{-0.661}$ in. Regressed Range $\boxed{-0.673}$ in. to $\boxed{-0.645}$ in.

Actual Max. Full Stroke Position $\boxed{0.661}$ in. Regressed Range $\boxed{0.638}$ in. to $\boxed{0.666}$ in.

Comments:

10.3.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

at 0.499

Sensor Nonlinearity $\boxed{-0.046}$ in. Expected: ≤ +/– 0.0033 in.

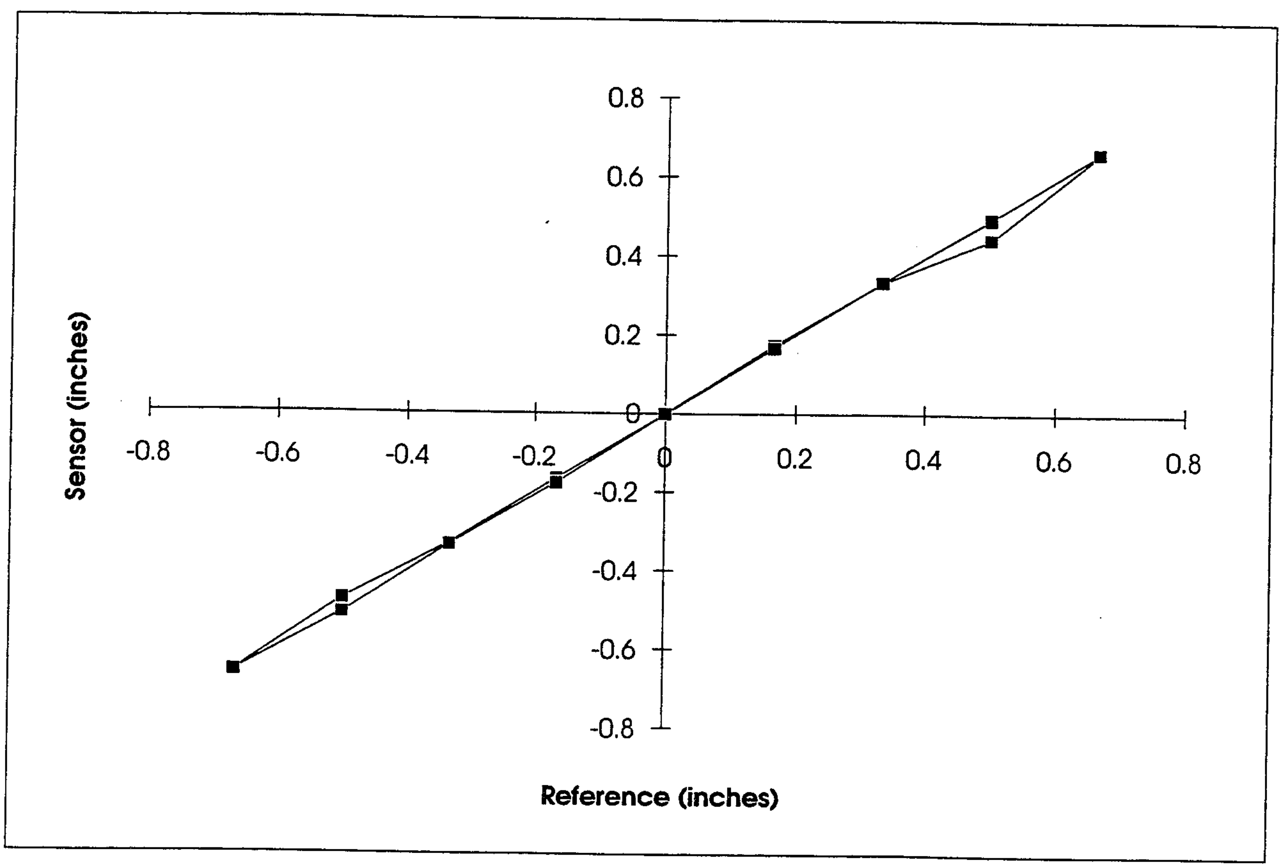
Comments:

Rudder Sensor S/N 001

Reference (inches)	Sensor (inches)
0	-0.001
0.166	0.173
0.333	0.33
0.499	0.442
0.665	0.659
0.665	0.661
0.499	0.493
0.333	0.332
0.166	0.166
0	-0.003
-0.166	-0.167
-0.333	-0.332
-0.499	-0.475
-0.665	-0.661
-0.665	-0.66
-0.499	-0.511
-0.333	-0.335
-0.166	-0.177
0	-0.003

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.985565	-0.00363
se m	se b	0.007718	0.003226
r squared	se y	0.998958	0.014061
F	df	16305.26	17
ss reg	ss resid	3.223566	0.003361

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.3 RUDDER SENSOR DATA SHEET

Performed by: Brad Kessler   Date: 6/15/93   Test Article Serial Number: 002

EOA #2

10.3.1 Null Offset Test (9.4.2)

PASS ☑ FAIL ☐

10.3.1.1 Record the PFS Test Set value during the test and the largest sensor value.

Sensor Null Offset [± 0.002] inches   Expected: $\leq +/- 0.0032$ in.

PFS Test Set Value [3.000] inches   Expected: Any constant value.

Comments:

10.3.2 Resolution Test (9.4.3)

PASS ☑ FAIL ☐

10.3.2.1 Record the PFS Test Set position and the smallest change in the sensor position.

PFS Test Set Initial Position [-0.161] in. and Ending Position [-0.163] in.

Sensor Resolution [0.002] in.

Expected: $\leq +/- 0.0032$ in.
Estimated: $2(0.665)/2^{10} \simeq 0.0013$ in.
Proc. Spec.: 0.00032 in.

Comments: Sensor changed from -0.150 to -0.151 for a difference of 0.001.

10.3.3 Range Test (9.4.4)

PASS ☑ FAIL ☐

10.3.3.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions	– Full Stroke	-0.665 in.	Expected: –0.665in.
	+ Full Stroke	0.665 in.	Expected: +0.665in.
PFS Test Set Positions	– Full Stroke	-0.672 in.	Expected: –0.665in.
	+ Full Stroke	0.668 in.	Expected: +0.665in.

Comments: The PFS values were taken when the sensor value reported the extremes consistently.

10.3.4 Linearity Test (9.4.5) PASS ☑ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	–0.665	–0.499	–0.333	–0.166	0.000	0.166	0.333	0.499	0.665
0 to +Full Stroke					0.001	0.164	0.331	0.493	0.660
+Full Stroke to 0					0.006	0.176	0.336	0.511	0.661
0 to –Full Stroke	-0.657	-0.489	-0.325	-0.151	X				
–Full Stroke to 0	-0.661	-0.509	-0.335	-0.176	-0.006				

10.3.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.3.4.2 Record the slope, constant, and standard deviation values.

Slope 0.996 Expected: 1.0 Constant 0.002 Expected: 0

Standard Deviation 0.008

Comments:

10.3.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor positions

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position ± 0.006 in. Regressed Range -0.006 in. to 0.009 in.

Actual Min. Full Stroke Position -0.661 in. Regressed Range -0.669 in. to -0.653 in.

Actual Max. Full Stroke Position 0.661 in. Regressed Range 0.657 in. to 0.672 in.

Comments:

10.3.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity 0.013 in. at -0.499 and -0.166 Expected: ≤ +/– 0.0033 in.

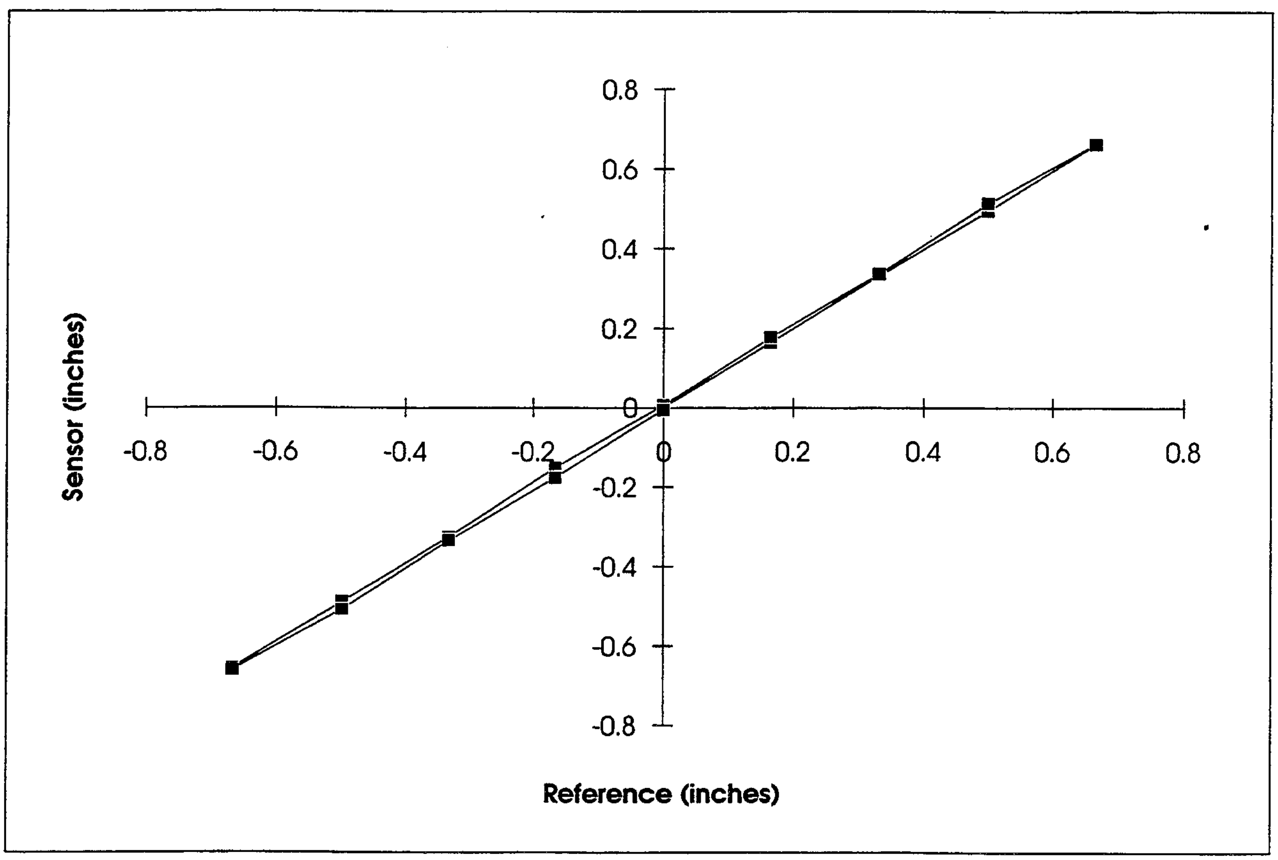
Comments:

Rudder Sensor S/N 002

Reference (inches)	Sensor (inches)
0	0.001
0.166	0.164
0.333	0.331
0.499	0.493
0.665	0.66
0.665	0.661
0.499	0.511
0.333	0.336
0.166	0.176
0	0.006
-0.166	-0.151
-0.333	-0.325
-0.499	-0.489
-0.665	-0.657
-0.665	-0.661
-0.499	-0.509
-0.333	-0.335
-0.166	-0.176
0	-0.006

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.996343	0.001579
se m	se b	0.004194	0.001753
r squared	se y	0.999699	0.00764
F	df	56443.86	17
ss reg	ss resid	3.294452	0.000992

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.4 PITCH STICK SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/19/93 Test Article Serial Number: 001
EoA#1

10.4.1 Null Offset Test (9.5.2)

PASS ☐ FAIL ☑

10.4.1.1 Record the PFS Test Set value during the test and the largest sensor value.

Sensor Null Offset [+0.030 / -0.039] inches Avg. -0.004 Expected: ≤ +/- 0.010 in.

PFS Test Set Value [4.000] inches Expected: Any constant value.

Comments: The extremes are listed as the Null offset. The value most often reported was -0.004.

10.4.2 Resolution Test (9.5.3)

PASS ☑ FAIL ☐

10.4.2.1 Record PFS Test Set position and the smallest change in the sensor position.

PFS Test Set Initial Position [1.000] in. and Ending Position [1.003] in.

Sensor Resolution [0.003] in.

Expected: ≤ +/- 0.010 in.
Estimated: $3.03/2^9 \simeq 0.0059$ in. or greater
Proc. Spec.: 0.00098 in.

Comments: The sensor changed from 1.057 to 1.068 for a difference of 0.011.

10.4.3 Range Test (9.5.4)

PASS ☐ FAIL ☑

10.4.3.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions	– Full Stroke	-0.763 in.	Expected: -1.01in.
	+ Full Stroke	~~2.010~~ 1.950 in.	Expected: +2.02in.
PFS Test Set Positions	– Full Stroke	-0.700 in.	Expected: -1.01in.
	+ Full Stroke	2.010 in.	Expected: +2.02in.

Comments: The sensor was beginning to show ~~X~~ strain due to the negative stroke end being reached so the sensor was not pushed to move any more in the negative direction. A range check done by hand so as not to possibly break the sensor revealed a range of -0.894 to 2.020.

(Note: 2.010 was mistakenly used as the full positive stroke.)

10.4.4 Linearity Test (9.5.5)

PASS ☐ FAIL ☑ Due to negative full stroke not being reached.

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	–1.010	–0.631	–0.253	+0.126	0.505	0.884	1.263	1.641	~~2.020~~
0 to +Full Stroke	The mid–stroke is 0.505, so this is used as the zero to make the linear regression linear over the full range.				0.550	0.967	1.330	1.691	1.946
+Full Stroke to 0					0.554	0.957	1.318	1.694	1.955
0 to –Full Stroke	-0.769	-0.695	-0.307	0.136	X				
–Full Stroke to 0	-0.779	-0.695	-0.284	0.117	0.552				

2.010 was mistakenly use as the full po stroke.

10.4.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.4.4.2 Record the slope, constant, and standard deviation values.

Slope 0.976 Expected: 1.0 Constant 0.047 Expected: 0

Standard Deviation 0.087

Comments: This sensor would probably pass the linearity if the decoding was adjusted to reach the full negative stroke.

10.4.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor positions

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position 0.554/0.550 in. Regressed Range 0.453 in. to 0.627 in.

Actual Min. Full Stroke Position -0.779 in. Regressed Range -1.025 in. to -0.851 in.

Actual Max. Full Stroke Position 1.955 in. Regressed Range 1.921 in. to 2.095 in.

Comments:

10.4.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity 0.159 in. at -1.010 Expected: ≤ +/– 0.0202 in.

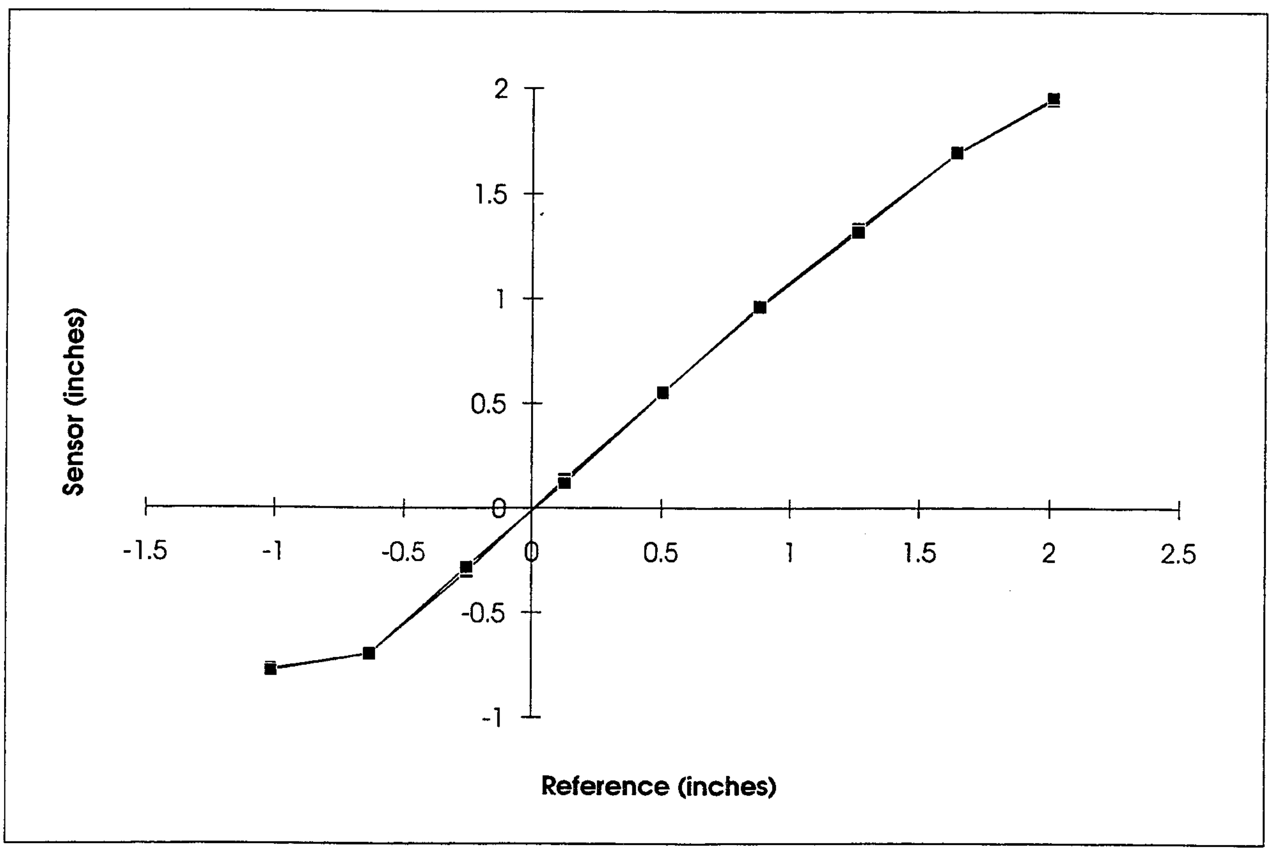
Comments:

Pitch Stick Sensor S/N 001

Reference (inches)	Sensor (inches)
0.505	0.55
0.884	0.967
1.263	1.33
1.641	1.691
2.01	1.946
2.01	1.955
1.641	1.694
1.263	1.318
0.884	0.957
0.505	0.554
0.126	0.136
-0.253	-0.307
-0.631	-0.695
-1.01	-0.769
-1.01	-0.779
-0.631	-0.695
-0.253	-0.284
0.126	0.117
0.505	0.552

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.975785	0.047098
se m	se b	0.021056	0.022647
r squared	se y	0.992147	0.08721
F	df	2147.704	17
ss reg	ss resid	16.33452	0.129295

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.4 PITCH STICK SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/19/93 Test Article Serial Number: 002

EOA #2

10.4.1 Null Offset Test (9.5.2) PASS ☐ FAIL ☑

10.4.1.1 Record the PFS Test Set value during the test and the largest sensor value.

Sensor Null Offset [+0.047 / -0.053] inches Avg. -0.003 Expected: $\leq +/- 0.010$ in.

PFS Test Set Value [4.000] inches Expected: Any constant value.

Comments: The extremes are listed as the Null offset. The most often reported value is -0.003

10.4.2 Resolution Test (9.5.3) PASS ☑ FAIL ☐

10.4.2.1 Record PFS Test Set position and the smallest change in the sensor position.

PFS Test Set Initial Position [1.210] in. and Ending Position [1.214] in.

Sensor Resolution [0.004] in. Expected: $\leq +/- 0.010$ in.
Estimated: $3.03/2^9 \simeq 0.0059$ in. or greater
Proc. Spec.: 0.00098 in.

Comments: The sensor changed from 1.131 to 1.155 for a difference of 0.024.

10.4.3 Range Test (9.5.4) PASS ☐ FAIL ☑

10.4.3.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions – Full Stroke [≈ -0.783] in. Sensor broke while measuring Expected: -1.01in.

+ Full Stroke [2.020] in. Expected: +2.02in.

PFS Test Set Positions – Full Stroke [ ] in. Expected: -1.01in.

+ Full Stroke [~~2.020~~ 2.163] in. Expected: +2.02in.

Comments:

The sensor broke while trying to reach the negative full stroke. The glue that holds the two halves (internally) failed. The end caps were forced too hard against the middle tube.

The sensor broke during the Range Test so no Linearity data was taken.

10.4.4 Linearity Test (9.5.5) PASS ☐ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	−1.010	−0.631	−0.253	+0.126	0.505	0.884	1.263	1.641	2.020
0 to +Full Stroke	The mid–stroke is 0.505, so this is used as the zero to make the linear regression linear over the full range.								
+Full Stroke to 0									
0 to −Full Stroke									
−Full Stroke to 0									

10.4.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.4.4.2 Record the slope, constant, and standard deviation values.

Slope ☐ Expected: 1.0 Constant ☐ Expected: 0

Standard Deviation ☐

Comments:

10.4.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor positions

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position ☐ in. Regressed Range ☐ in. to ☐ in.

Actual Min. Full Stroke Position ☐ in. Regressed Range ☐ in. to ☐ in.

Actual Max. Full Stroke Position ☐ in. Regressed Range ☐ in. to ☐ in.

Comments:

10.4.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity ☐ in. Expected: ≤ +/− 0.0202 in.

Comments:

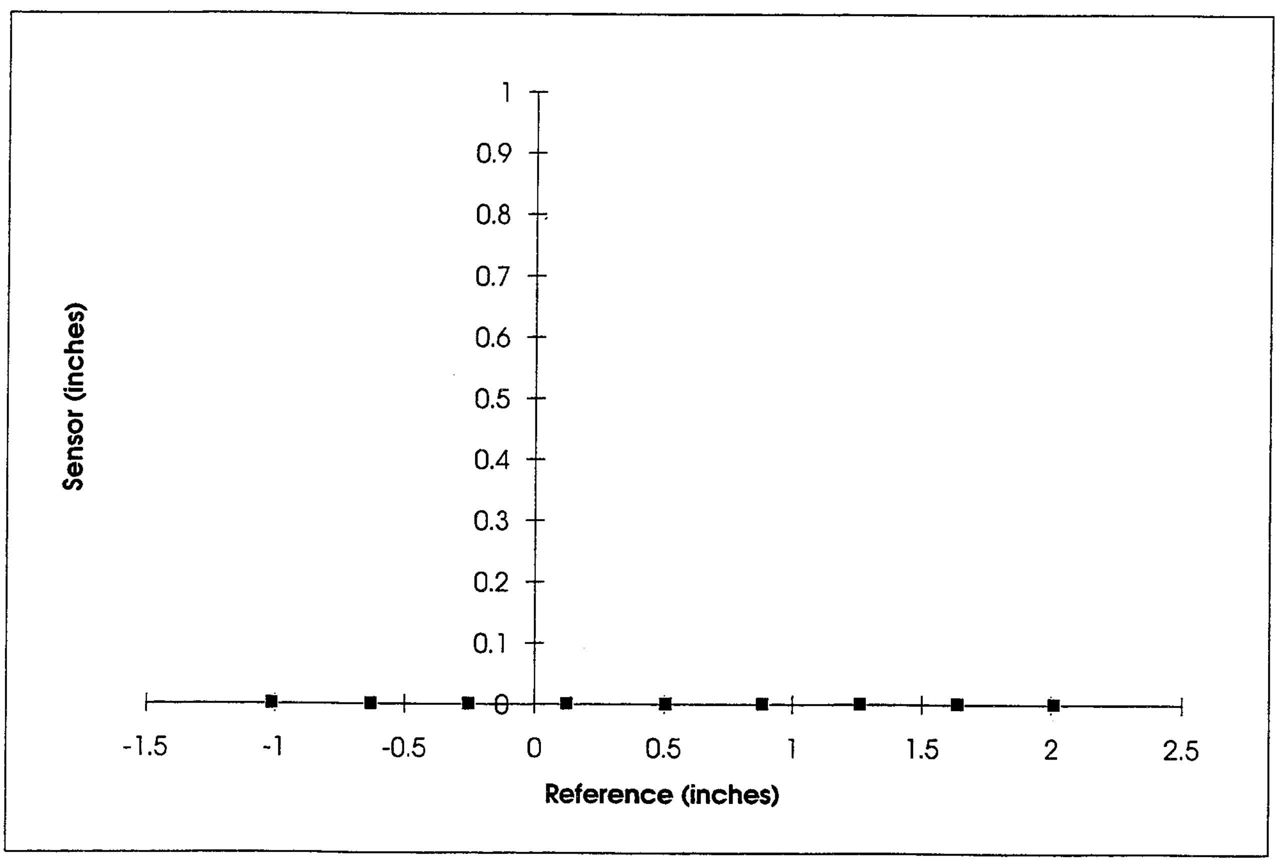
Pitch Stick Sensor S/N 002

{SENSOR BROKE DURING TESTING.}
{NO LINEARITY DATA WAS TAKEN.}

Reference (inches)	Sensor (inches)
0.505	0
0.884	0
1.263	0
1.641	0
2.01	0
2.01	0
1.641	0
1.263	0
0.884	0
0.505	0
0.126	0
-0.253	0
-0.631	0
-1.01	0
-1.01	0
-0.631	0
-0.253	0
0.126	0
0.505	0

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0	0
se m	se b	0	0
r squared	se y	1	0
F	df	#NUM!	17
ss reg	ss resid	0	0

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.5 RUDDER PEDAL SENSOR DATA SHEET

Performed by: Brad Kessler   Date: 6/21/93   Test Article Serial Number: 001

EDA #1

10.5.1 Null Offset Test (9.6.2)   PASS ☑ FAIL ☐

10.5.1.1 Record the PFS Test Set value during the test and the largest sensor value.

Sensor Null Offset [± 0.001] inches   Avg. 0.000   Expected: ≤ +/− 0.0045 in.

PFS Test Set Value [3.000] inches   Expected: Any constant value.

Comments:

10.5.2 Resolution Test (9.6.3)   PASS ☑ FAIL ☐

10.5.2.1 Record the PFS Test Set position and the smallest change in the sensor position.

PFS Test Set Initial Position [0.400] in. and Ending Position [0.402] in.

Sensor Resolution [0.002] in.

Expected: ≤ +/− 0.0045 in.
Estimated: $2(0.75)/2^{10} \simeq 0.0015$ in.
Proc. Spec.: 0.00037 in.

Comments: The sensor changed from 0.397 to 0.399 for a difference of 0.002.

10.5.3 Range Test (9.6.4)   PASS ☑ FAIL ☐

10.5.3.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions	− Full Stroke	−0.750 in.	Expected: −0.750in.
	+ Full Stroke	0.750 in.	Expected: +0.750in.
PFS Test Set Positions	− Full Stroke	−0.754 in.	Expected: −0.750in.
	+ Full Stroke	0.750 in.	Expected: +0.750in.

Comments: The PFS values were taken when the sensor reading reached the extremes.

10.5.4 Linearity Test (9.6.5) PASS ☑ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	–0.750	–0.563	–0.375	–0.188	0.000	0.188	0.375	0.563	0.750
0 to +Full Stroke					0.000	0.188	0.375	0.563	0.749
+Full Stroke to 0					0.004	0.192	0.379	0.566	0.750
0 to –Full Stroke	-0.746	-0.560	-0.372	-0.185	X				
–Full Stroke to 0	-0.750	-0.564	-0.375	-0.188	0.000				

10.5.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.5.4.2 Record the slope, constant, and standard deviation values.

Slope [0.999] Expected: 1.0 Constant [0.001] Expected: 0

Standard Deviation [0.002]

Comments:

10.5.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

y = mx + b, where m = slope, b = constant, x = sensor positions

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position [0.004/0.000] in. Regressed Range [-0.001] in. to [0.003] in.

Actual Min. Full Stroke Position [-0.750] in. Regressed Range [-0.750] in. to [-0.746] in.

Actual Max. Full Stroke Position [0.750] in. Regressed Range [0.749] in. to [0.753] in.

Comments:

10.5.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

at -0.563, 0.004, 0.188, 0.375

Sensor Nonlinearity [0.003] in. Expected: ≤ +/– 0.0019 in.

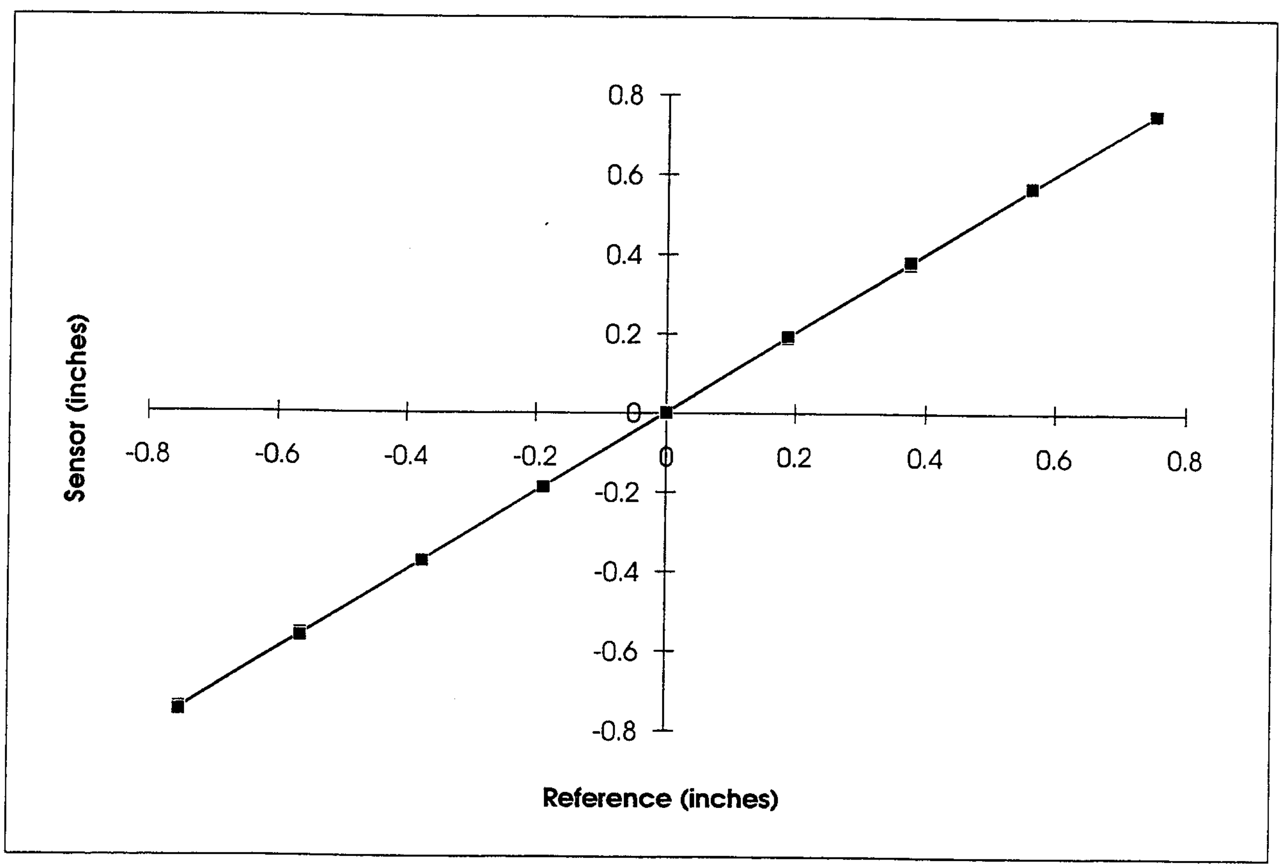
Comments:

Rudder Pedal Sensor S/N 001

Reference (inches)	Sensor (inches)
0	0
0.188	0.188
0.375	0.375
0.563	0.563
0.75	0.749
0.75	0.75
0.563	0.566
0.375	0.379
0.188	0.192
0	0.004
-0.188	-0.185
-0.375	-0.372
-0.563	-0.56
-0.75	-0.746
-0.75	-0.75
-0.563	-0.564
-0.375	-0.375
-0.188	-0.188
0	0

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.999378	0.001368
se m	se b	0.00095	0.000448
r squared	se y	0.999985	0.001952
F	df	1106351	17
ss reg	ss resid	4.216506	6.48E-05

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.5 RUDDER PEDAL SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/15/93 Test Article Serial Number: 002

EOA # 2

10.5.1 Null Offset Test (9.6.2) PASS ☐ FAIL ☑ (See comments)

10.5.1.1 Record the PFS Test Set value during the test and the largest sensor value.

Sensor Null Offset [+0.004/-0.005] inches Avg. -0.001 Expected: ≤ +/− 0.0045 in.

PFS Test Set Value [3.000] inches Expected: Any constant value.

Comments: The value of -0.005 could be from -0.0054 to -0.0045 so it is possible that the Null Offset is within the expected range if -0.005 is actually -0.0045. Even if this is not the case, the Null offset is extremely close to passing.

10.5.2 Resolution Test (9.6.3) PASS ☑ FAIL ☐

10.5.2.1 Record the PFS Test Set position and the smallest change in the sensor position.

PFS Test Set Initial Position [0.152] in. and Ending Position [0.154] in.

Sensor Resolution [0.002] in.

Expected: ≤ +/− 0.0045 in.
Estimated: $2(0.75)/2^{10} \simeq 0.0015$ in.
Proc. Spec.: 0.00037 in.

Comments: The sensor changed from 0.150 to 0.152 for a difference of 0.002.

10.5.3 Range Test (9.6.4) PASS ☑ FAIL ☐

10.5.3.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions	– Full Stroke	-0.750 in.	Expected: –0.750in.
	+ Full Stroke	0.750 in.	Expected: +0.750in.
PFS Test Set Positions	– Full Stroke	-0.757 in.	Expected: –0.750in.
	+ Full Stroke	0.750 in.	Expected: +0.750in.

Comments: The PFS readings were taken when the sensor value was at the extreme consistently.

10.5.4 Linearity Test (9.6.5) PASS ☑ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	–0.750	–0.563	–0.375	–0.188	0.000	0.188	0.375	0.563	0.750
0 to +Full Stroke					-0.002	0.186	0.375	0.562	0.748
+Full Stroke to 0					0.006	0.193	0.381	0.569	0.750
0 to –Full Stroke	-0.745	-0.558	-0.375	-0.182	X				
–Full Stroke to 0	-0.750	-0.565	-0.377	-0.188	-0.002				

10.5.4.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.5.4.2 Record the slope, constant, and standard deviation values.

Slope 1.000 Expected: 1.0 Constant 0.001 Expected: 0

Standard Deviation 0.004

Comments:

10.5.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor positions

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Position +0.006 / -0.002 in. Regressed Range -0.003 in. to +0.005 in.

Actual Min. Full Stroke Position -0.750 in. Regressed Range -0.752 in. to -0.745 in.

Actual Max. Full Stroke Position 0.750 in. Regressed Range 0.748 in. to 0.755 in.

Comments:

10.5.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

at -0.188, 0.000, 0.375, 0.563

Sensor Nonlinearity 0.005 in. Expected: ≤ +/– 0.0019 in.

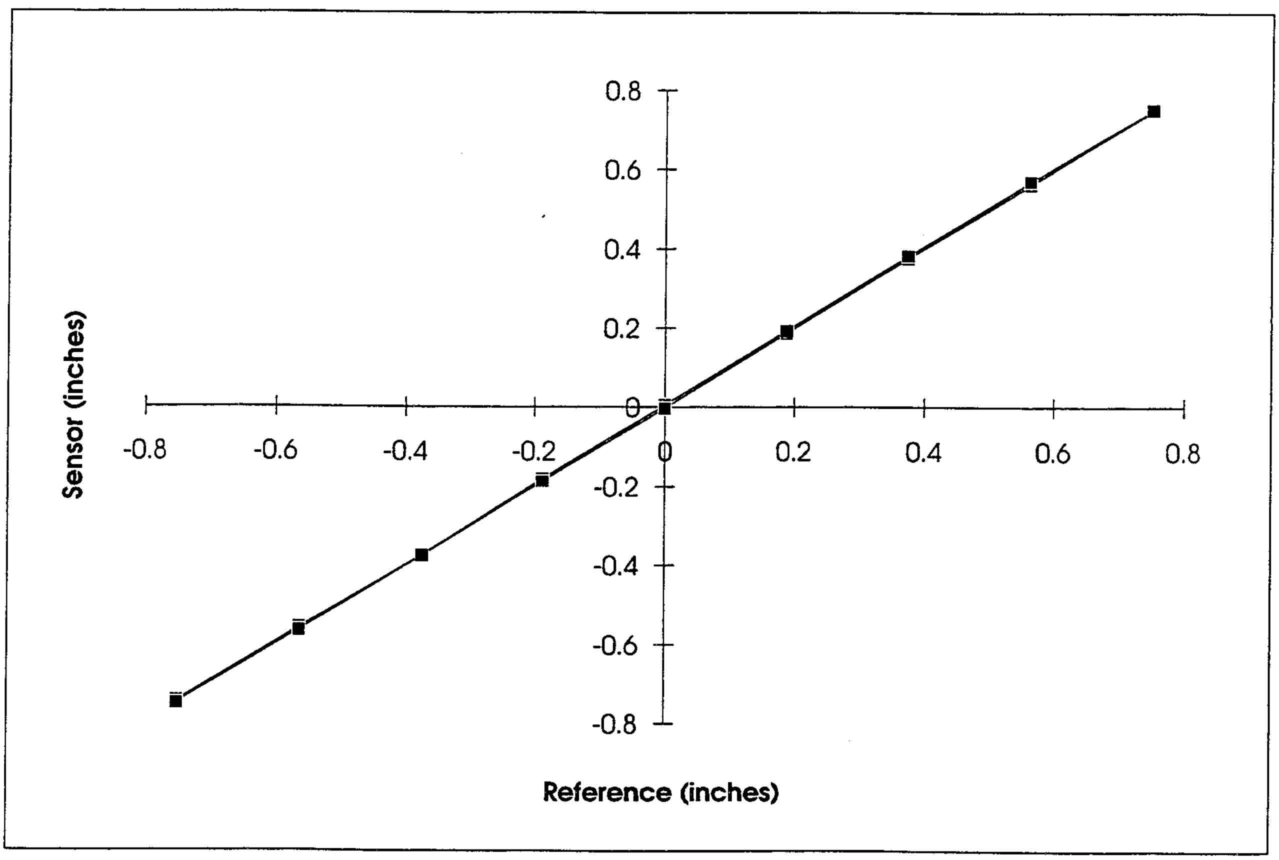
Comments:

Rudder Pedal Sensor S/N 002

Reference (inches)	Sensor (inches)
0	-0.002
0.188	0.186
0.375	0.375
0.563	0.562
0.75	0.748
0.75	0.75
0.563	0.569
0.375	0.381
0.188	0.193
0	0.006
-0.188	-0.182
-0.375	-0.375
-0.563	-0.558
-0.75	-0.745
-0.75	-0.75
-0.563	-0.565
-0.375	-0.377
-0.188	-0.188
0	-0.002

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.9996	0.001368
se m	se b	0.001701	0.000802
r squared	se y	0.999951	0.003496
F	df	345192.5	17
ss reg	ss resid	4.218377	0.000208

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.6 TRAILING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/20/93 Test Article Serial Number: 001
EoA #1

FOR THIS SENSOR: THE REFERENCE RANGE= +/–75^0, SENSOR RANGE= +/–4.050inches. For easy comparison, all values have been converted to inches.

10.6.1 Null Offset Test (9.7.2) PASS ☐ FAIL ☑

10.6.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset [± 0.123] in. Avg. = 0.000 Expected: $\leq$ +/– 0.898deg = 0.049in.

Rotary Sensor Test Set Value [0.000] deg. Expected: Any constant value.

Comments: The extremes are listed as the Null offset. The value reported most often is 0.000.

10.6.2 Resolution Test (9.7.3) PASS ☑ FAIL ☐

10.6.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle [-5.692] deg. and Ending Angle [-6.259] deg.

Sensor Resolution [0.567] deg. Expected: $\leq$ +/– 0.898 deg = 0.049in.
Estimated: $2(75)/2^9 \simeq 0.29$ deg or greater = 0.016in.
Proc. Spec.: 0.037deg = 0.002 in.

Comments: The sensor changed from -0.483 to -0.574 inches for a difference of 0.091 inches.

10.6.3 Range Test (9.7.4) PASS ☑ FAIL ☐

10.6.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	– Full Stroke	-4.050	in.	Expected: -4.050in.
	+ Full Stroke	4.050	in.	Expected: 4.050in.
RSTS Angles	– Full Stroke	-41.593	deg.	Expected: –75deg = –4.050in.
	+ Full Stroke	46.222	deg.	Expected: +75deg = 4.050in.

Comments: The reference did not reach ±75° but the sensor reached its full stroke values.

10.6.4 Linearity Test (9.7.5) PASS ☐ FAIL ☑

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	–4.050 –75.00⁰	–3.0375 –56.25⁰	–2.025 –37.50⁰	–1.0125 –18.75⁰	0.000 0.00⁰	1.0125 18.75⁰	2.025 37.50⁰	3.0375 56.25⁰	4.050 75.00⁰
0 to +Full Stroke					0.000	1.627	3.306	Over Travel	Over Travel
+Full Stroke to 0					-0.083	1.603	3.242	Over Travel	Over Travel
0 to –Full Stroke	Under Travel	Under Travel	-3.698	-1.869	X				
–Full Stroke to 0	Under Travel	Under Travel	-3.642	-1.837	-0.071				

10.6.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.6.4.2 Record the slope, constant, and standard deviation values.

Slope 1.219 Expected: 1.0 Constant -0.075 Expected: 0

Standard Deviation 0.719

Comments:

10.6.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor angles

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Angle 0.000/-0.083 in. Regressed Range -0.043 in. to +0.036 in.
(at -37.5°)

Actual Min. Full Stroke Angle -3.698 in. Regressed Range -2.511 in. to -2.434 in.

Actual Max. Full Stroke Angle 3.306 in. Regressed Range 2.426 in. to 2.503 in.
(at +37.5°)

Comments:

10.6.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

at -37.5°

Sensor Nonlinearity -1.225 in. Expected: ≤ +/– 0.75deg = 0.0405in.

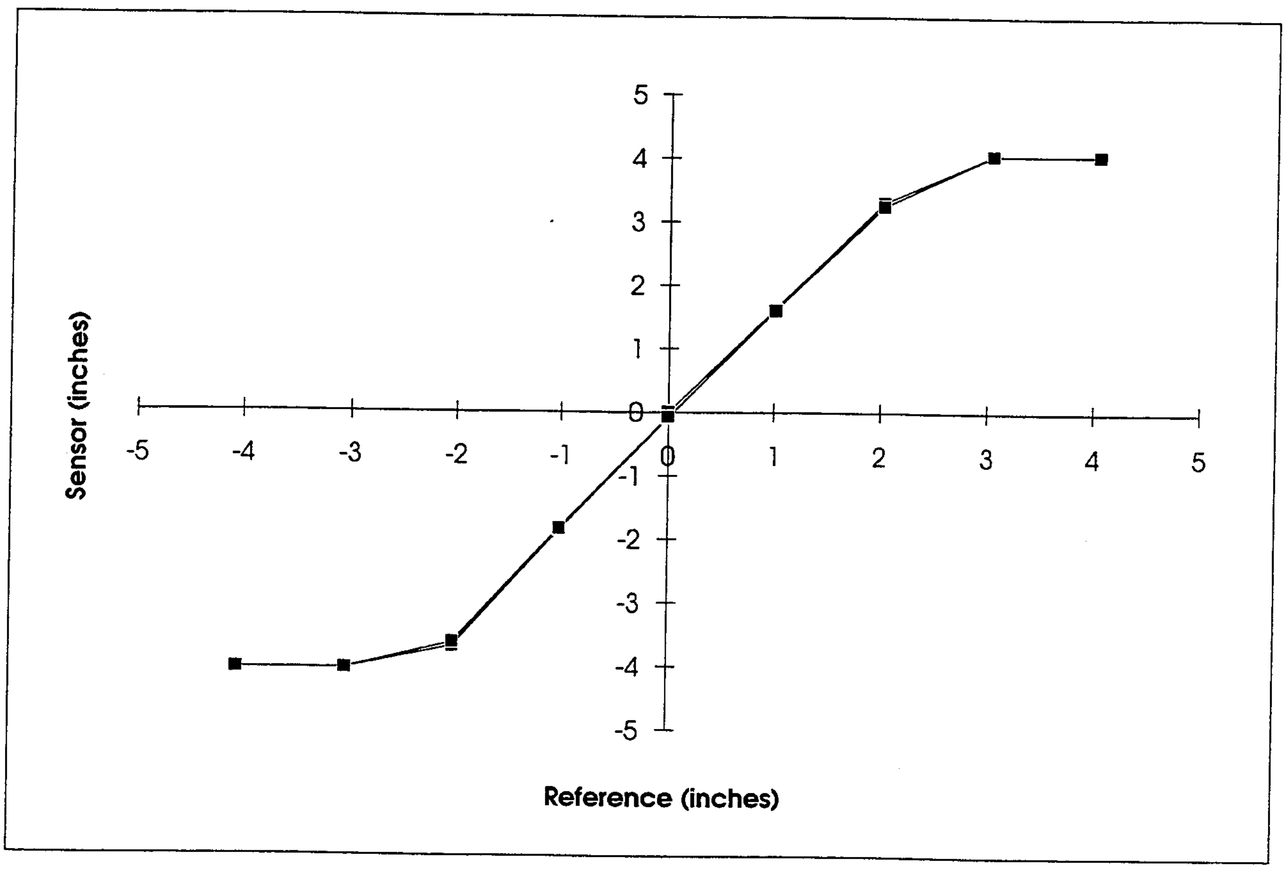
Comments:

Trailing Edge Flap Sensor S/N 001

Reference (inches)	Sensor (inches)
0	0
1.0125	1.627
2.025	3.306
3.0375	4.05
4.05	4.05
4.05	4.05
3.0375	4.05
2.025	3.242
1.0125	1.603
0	-0.083
-1.0125	-1.869
-2.025	-3.698
-3.0375	-4.05
-4.05	-4.05
-4.05	-4.05
-3.0375	-4.05
-2.025	-3.642
-1.0125	-1.837
0	-0.071

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	1.219029	-0.07484
se m	se b	0.064794	0.16487
r squared	se y	0.954174	0.718652
F	df	353.9662	17
ss reg	ss resid	182.8097	8.779836

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.6 TRAILING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler   Date: 6/19/93   Test Article Serial Number: 002
EoA #2

FOR THIS SENSOR: THE REFERENCE RANGE= +/–75^0, SENSOR RANGE= +/–4.050inches. For easy comparison, all values have been converted to inches.

10.6.1 Null Offset Test (9.7.2)   PASS ☐ FAIL ☑

10.6.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset [+0.075/ -0.076] in.   Avg. = -2.550   Expected: ≤ +/– 0.898deg = 0.049in.

Rotary Sensor Test Set Value [0.000] deg.   Expected: Any constant value.

Comments: The midpoint of this sensor is -2.550, not 0.000. The Null offset values are the differences between -2.550 and the high and low readings at -2.550. Avg. value = -2.550, max value = -2.474, and min. value = -2.625.

10.6.2 Resolution Test (9.7.3)   PASS ☑ FAIL ☐

10.6.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle [26.168] deg. and Ending Angle [26.267] deg.

Sensor Resolution [0.099] deg.   Expected: ≤ +/– 0.898 deg = 0.049in.
Estimated: $2(75)/2^9 \simeq 0.29$ deg or greater = 0.016in.
Proc. Spec.: 0.037deg = 0.002 in.

Comments: The sensor changed from -3.096" to -3.132" for a difference of 0.036 inches.

10.6.3 Range Test (9.7.4)   PASS ☐ FAIL ☑

10.6.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	– Full Stroke	-4.050 in.	Expected: –4.050in.
	+ Full Stroke	-0.820 in.	Expected: 4.050in.
RSTS Angles	– Full Stroke	65.834 deg.	Expected: –75deg = –4.050in.
	+ Full Stroke	-78.062 deg.	Expected: +75deg = 4.050in.

Comments: This sensor never reaches the positive ranges.

10.6.4 Linearity Test (9.7.5) PASS ☐ FAIL ☑

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	–4.050 –75.00°	–3.0375 –56.25°	–2.025 –37.50°	–1.0125 –18.75°	0.000 0.00°	1.0125 18.75°	2.025 37.50°	3.0375 56.25°	4.050 75.00°
0 to +Full Stroke					-2.542	-2.993	-3.333	-3.797	Over Travel
+Full Stroke to 0					-2.534	-2.981	-3.464	-3.757	Over Travel
0 to –Full Stroke	-0.934	-1.437	-1.805	-2.170	X				
–Full Stroke to 0	-0.954	-1.413	-1.797	-2.122	-2.530				

10.6.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.6.4.2 Record the slope, constant, and standard deviation values.

Slope -0.386 Expected: 1.0 Constant -2.558 Expected: 0

Standard Deviation 0.046

Comments: This sensor is fairly linear but it does not correllate with the reference. See the ~~curve~~ plot of the data.

10.6.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor angles

linear regressed range = (y – standard deviation) to (y + standard deviation)

This data was not complete due to the sensor data being so far off from the reference that the data for this section makes no sense.

Actual Null Angle ______ in. Regressed Range ______ in. to ______ in.

Actual Min. Full Stroke Angle ______ in. Regressed Range ______ in. to ______ in.

Actual Max. Full Stroke Angle ______ in. Regressed Range ______ in. to ______ in.

Comments:

10.6.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity ______ in. Expected: $\leq +/- 0.75$deg = 0.0405in.

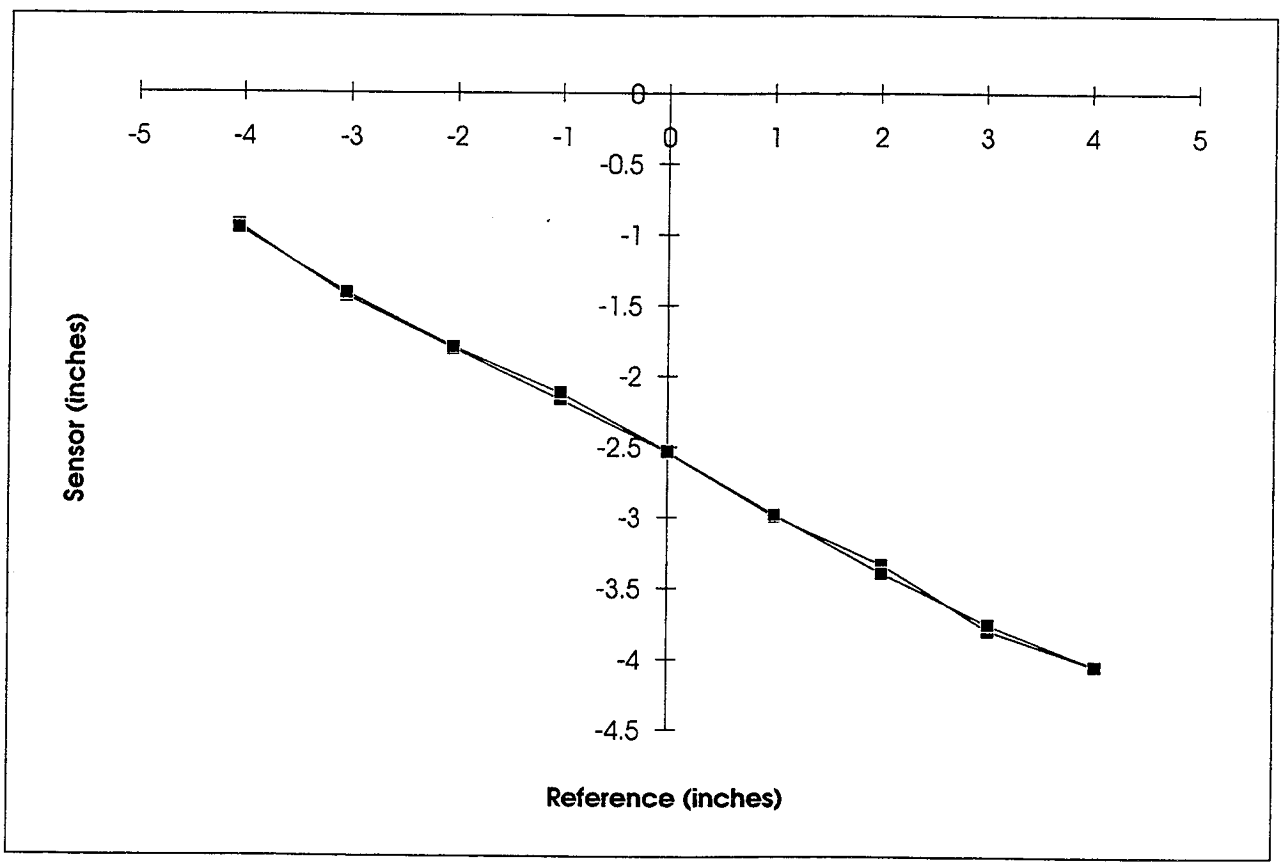
Comments:

Trailing Edge Flap Sensor S/N 002

Reference (inches)	Sensor (inches)
0	-2.542
1.0125	-2.993
2.025	-3.333
3.0375	-3.797
4.05	-4.05
4.05	-4.05
3.0375	-3.757
2.025	-3.397
1.0125	-2.981
0	-2.534
-1.0125	-2.17
-2.025	-1.805
-3.0375	-1.437
-4.05	-0.934
-4.05	-0.954
-3.0375	-1.413
-2.025	-1.797
-1.0125	-2.122
0	-2.53

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	-0.38599	-2.55768
se m	se b	0.004107	0.01045
r squared	se y	0.998079	0.04555
F	df	8833.755	17
ss reg	ss resid	18.32852	0.035272

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



Sensor is not decoded by EOA #1 or EOA #2

10.7 LEADING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/19/93 Test Article Serial Number: 0043

10.7.1 Null Offset Test (9.8.2)

PASS ☐ FAIL ☐

10.7.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset ☐ deg. Expected: $\leq +/- 0.30$ deg

Rotary Sensor Test Set Value ☐ deg. Expected: Any constant value.

Comments:

10.7.2 Resolution Test (9.8.3)

PASS ☐ FAIL ☐

10.7.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle ☐ deg. and Ending Angle ☐ deg.

Sensor Resolution ☐ deg.

Expected: $\leq +/- 0.30$ deg
Estimated: $43/2^{10} \simeq 0.042$ deg
Proc. Spec.: 0.0330 deg

Comments:

10.7.3 Range Test (9.8.4)

PASS ☐ FAIL ☐

10.7.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	– Full Stroke	☐ deg.	Expected: –21.5 (–7) deg
	+ Full Stroke	☐ deg.	Expected: +21.5 (+36) deg
RSTS Angles	– Full Stroke	☐ deg.	Expected: –21.5 deg
	+ Full Stroke	☐ deg.	Expected: +21.5 deg

Comments:

10.7.4 Linearity Test (9.8.5) PASS☐ FAIL☐

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	−21.500	−16.125	−10.750	−5.375	0.000	5.375	10.750	16.125	21.500
0 to +Full Stroke									
+Full Stroke to 0									
0 to −Full Stroke									
−Full Stroke to 0									

10.7.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.7.4.2 Record the slope, constant, and standard deviation values.

Slope ☐ Expected: 1.0 Constant ☐ Expected: 0

Standard Deviation ☐

Comments:

10.7.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor angles

linear regressed range = (y − standard deviation) to (y + standard deviation)

Actual Null Angle ☐ deg. Regressed Range ☐ deg. to ☐ deg.

Actual Min. Full Stroke Angle ☐ deg. Regressed Range ☐ deg. to ☐ deg.

Actual Max. Full Stroke Angle ☐ deg. Regressed Range ☐ deg. to ☐ deg.

Comments:

10.7.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity ☐ deg. Expected: $\leq +/- 0.675$ deg

Comments:

Sensor is not decoded by EDA #1 or EDA #2

10.7 LEADING EDGE FLAP SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/19/93 Test Article Serial Number: 0045

10.7.1 Null Offset Test (9.8.2)

PASS ☐ FAIL ☐

10.7.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset ☐ deg. Expected: $\leq +/- 0.30$ deg

Rotary Sensor Test Set Value ☐ deg. Expected: Any constant value.

Comments:

10.7.2 Resolution Test (9.8.3)

PASS ☐ FAIL ☐

10.7.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle ☐ deg. and Ending Angle ☐ deg.

Sensor Resolution ☐ deg.

Expected: $\leq +/- 0.30$ deg
Estimated: $43/2^{10} \simeq 0.042$ deg
Proc. Spec.: 0.0330 deg

Comments:

10.7.3 Range Test (9.8.4)

PASS ☐ FAIL ☐

10.7.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	– Full Stroke ☐ deg.		Expected: –21.5 (–7) deg
	+ Full Stroke ☐ deg.		Expected: +21.5 (+36) deg
RSTS Angles	– Full Stroke ☐ deg.		Expected: –21.5 deg
	+ Full Stroke ☐ deg.		Expected: +21.5 deg

Comments:

10.7.4 Linearity Test (9.8.5) PASS [ ] FAIL [ ]

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	–21.500	–16.125	–10.750	–5.375	0.000	5.375	10.750	16.125	21.500
0 to +Full Stroke									
+Full Stroke to 0									
0 to –Full Stroke									
–Full Stroke to 0									

10.7.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.7.4.2 Record the slope, constant, and standard deviation values.

Slope ______ Expected: 1.0 Constant ______ Expected: 0

Standard Deviation ______

Comments:

10.7.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor angles

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Angle ______ deg. Regressed Range ______ deg. to ______ deg.

Actual Min. Full Stroke Angle ______ deg. Regressed Range ______ deg. to ______ deg.

Actual Max. Full Stroke Angle ______ deg. Regressed Range ______ deg. to ______ deg.

Comments:

10.7.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity ______ deg. Expected: $\leq$ +/– 0.675 deg

Comments:

Sensor is not decoded by EoA#1 or EoA #2

10.8 POWER LEVER CONTROL SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/21/93 Test Article Serial Number: 001

10.8.1 Null Offset Test (9.9.2)

PASS ☐ FAIL ☐

10.8.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset ☐ deg. Expected: $\leq +/- 0.325$ deg

Rotary Sensor Test Set Value ☐ deg. Expected: Any constant value.

Comments:

10.8.2 Resolution Test (9.9.3)

PASS ☐ FAIL ☐

10.8.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle ☐ deg. and Ending Angle ☐ deg.

Sensor Resolution ☐ deg.

Expected: $\leq +/- 0.325$ deg
Estimated: $2(65)/2^{10} \simeq 0.13$ deg
Proc. Spec.: 0.0168 deg

Comments:

10.8.3 Range Test (9.9.4)

PASS ☐ FAIL ☐

10.8.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	– Full Stroke	☐ deg.	Expected: –65 deg
	+ Full Stroke	☐ deg.	Expected: +65 deg
RSTS Angles	– Full Stroke	☐ deg.	Expected: –65 deg
	+ Full Stroke	☐ deg.	Expected: +65 deg

Comments:

10.8.4 Linearity Test (9.9.5) PASS☐ FAIL☐

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	0.000	16.250	32.5000	48.750	65.000	81.250	97.5000	113.750	130.000
0 to +Full Stroke									
+Full Stroke to 0									
0 to –Full Stroke									
–Full Stroke to 0									

10.8.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.8.4.2 Record the slope, constant, and standard deviation values.

Slope ☐ Expected: 1.0 Constant ☐ Expected: 0

Standard Deviation ☐

Comments:

10.8.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor angles

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Angle ☐ deg. Regressed Range ☐ deg. to ☐ deg.

Actual Min. Full Stroke Angle ☐ deg. Regressed Range ☐ deg. to ☐ deg.

Actual Max. Full Stroke Angle ☐ deg. Regressed Range ☐ deg. to ☐ deg.

Comments:

10.8.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity ☐ deg. Expected: Linear from $\leq +/- 0.175$ deg at 0^0 to $\leq +/- 1.5$ deg at 65^0

Comments:

10.8 POWER LEVER CONTROL SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/19/93 Test Article Serial Number: 002
EoA #2

10.8.1 Null Offset Test (9.9.2)

PASS ☑ FAIL ☐

10.8.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset [± 0.064] deg. Avg. = 65.000 Expected: ≤ +/− 0.325 deg

Rotary Sensor Test Set Value [0.000] deg. Expected: Any constant value.

Comments: Mid-stroke of this sensor is 65.000° so the Null offset data is given as the difference between 65.000° and the maximum and minimum values read.
Avg = 65.000, max = 65.064, min = 64.936.

10.8.2 Resolution Test (9.9.3)

PASS ☑ FAIL ☐

10.8.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle [29.500] deg. and Ending Angle [29.579] deg.

Sensor Resolution [0.079] deg.

Expected: ≤ +/− 0.325 deg
Estimated: $2(65)/2^{10} \simeq 0.13$ deg
Proc. Spec.: 0.0168 deg

Comments: Sensor changed from 29.990 to 30.117 for a difference of 0.127.

10.8.3 Range Test (9.9.4)

PASS ☑ FAIL ☐

10.8.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	− Full Stroke	0.000 deg.	Expected: ~~−65~~ 0.000 deg
	+ Full Stroke	130.000 deg.	Expected: ~~+65~~ 130.000 deg
RSTS Angles	− Full Stroke	−1.110 deg.	Expected: ~~−65~~ 0.000 deg
	+ Full Stroke	132.030 deg.	Expected: ~~+65~~ 130.000 deg

Comments: The RSTS values were taken where the sensor value read was consistantly at the extremes.

10.8.4 Linearity Test (9.9.5) PASS ☑ FAIL ☐

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	0.000	16.250	32.5000	48.750	65.000	81.250	97.5000	113.750	130.000
0 to +Full Stroke	The mid-stroke is 65° so this is used as the zero to make the linear regression linear over the full range.				65.000	81.012	97.087	112.654	128.284
+Full Stroke to 0					63.602	79.741	95.943	112.146	128.284
0 to –Full Stroke	Under Travel	15.186	31.007	46.891	X				
–Full Stroke to 0	Under Travel	15.376	31.642	47.845	64.047				

10.8.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.8.4.2 Record the slope, constant, and standard deviation values.

Slope [0.993] Expected: 1.0 Constant [-0.539] Expected: 0

Standard Deviation [0.563]

Comments: This sensor is close to failing the linearity. The correllation to the reference could be better.

10.8.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor angles

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Angle [65.000 / 63.602] deg. Regressed Range [63.424] deg. to [64.550] deg.

Actual Min. Full Stroke Angle [15.376] deg. Regressed Range (at 16.250°) [15.030] deg. to [16.156] deg.

Actual Max. Full Stroke Angle [128.284] deg. Regressed Range [127.949] deg. to [129.075] deg.

Comments:

10.8.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity [1.013] at 65° deg. Expected: Linear from ≤ +/– 0.175 deg at 0^0 to ≤ +/– 1.5 deg at 65^0

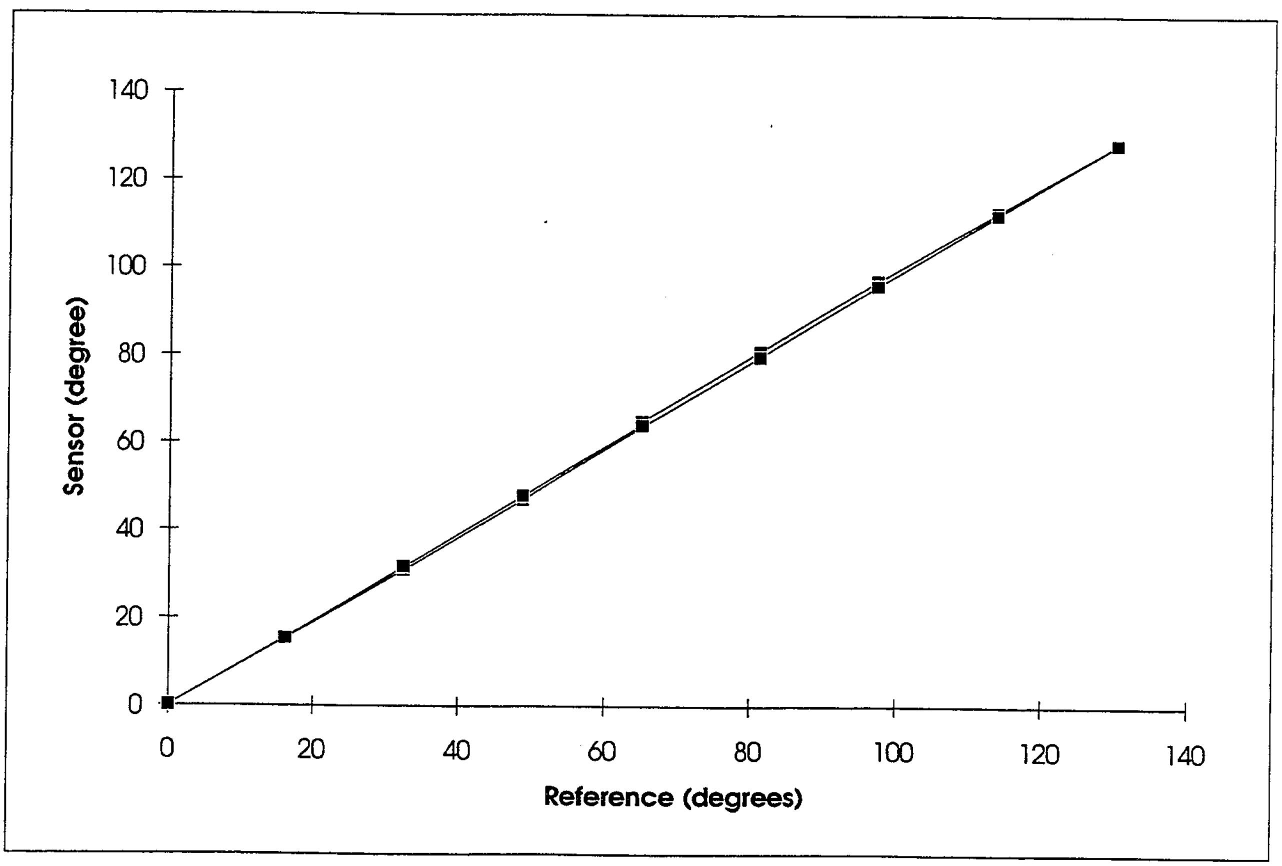
Comments:

Power Lever Control Sensor S/N 002

Reference (degrees)	Sensor (degrees)
65	65
81.25	81.012
97.5	97.087
113.75	112.654
130	128.284
130	128.284
113.75	112.146
97.5	95.943
81.25	79.741
65	63.602
48.75	46.891
32.5	31.007
16.25	15.186
0	0
0	0
16.25	15.376
32.5	31.642
48.75	47.845
65	64.047

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.9927	-0.53882
se m	se b	0.003164	0.242879
r squared	se y	0.999827	0.563215
F	df	98440.8	17
ss reg	ss resid	31226.55	5.392595

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.9 NOSE WHEEL STEERING SENSOR DATA SHEET

Performed by: Brad Kessler   Date: 6/20/93   Test Article Serial Number: 001
EOA #1

10.9.1 Null Offset Test (9.10.2)

PASS ☐ FAIL ☑

10.9.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset [+2.273/-2.419] deg. Avg. = -0.073   Expected: ≤ +/− 0.186 deg

Rotary Sensor Test Set Value [0.000] deg.   Expected: Any constant value.

Comments:

10.9.2 Resolution Test (9.10.3)

PASS ☐ FAIL ☑

10.9.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle [75.474] deg. and Ending Angle [75.739] deg.

Sensor Resolution [0.265] deg.

Expected: ≤ +/− 0.186 deg
Estimated: $2(75)/2^9 \simeq 0.29$ deg
Proc. Spec.: 0.0366 deg

Comments: Sensor changed from 28.446 to 33.504 for a difference of 5.058

10.9.3 Range Test (9.10.4)

PASS ☐ FAIL ☑

10.9.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	− Full Stroke	-75.00 deg.	Expected: −75 deg
	+ Full Stroke	75.000 deg.	Expected: +75 deg
RSTS Angles	− Full Stroke	-114.864 deg.	Expected: −75 deg
	+ Full Stroke	3.833 deg.	Expected: +75 deg

Comments: The sensor reaches full stroke for positive and negative extremes, but there is no relationship to the reference.

10.9.4 Linearity Test (9.10.5) PASS ☐ FAIL ☑

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	–75.000	–56.250	–37.500	–18.750	0.000	18.750	37.500	56.250	75.000
0 to +Full Stroke					– 0. 220	Over Travel	Over Travel	Over Travel	Over Travel
+Full Stroke to 0					0.000	Over Travel	Over Travel	Over Travel	Over Travel
0 to –Full Stroke	-48.387	-36.290	-24.047	-12.610	X				
–Full Stroke to 0	-48.754	-37.243	-24.707	-12.170	0.660				

10.9.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.9.4.2 Record the slope, constant, and standard deviation values.

Slope 0.992 Expected: 1.0 Constant 18.749 Expected: 0

Standard Deviation 18.383

Comments: The negative travel portion is fairly linear but does not correllate to the reference. The positive travel portion is ~~[illegible]~~ greatly affecting the slope, y intercept, and standard deviation.

10.9.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor angles

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Angle ______ deg. Regressed Range ______ deg. to ______ deg.

Actual Min. Full Stroke Angle ______ deg. Regressed Range ______ deg. to ______ deg.

Actual Max. Full Stroke Angle ______ deg. Regressed Range ______ deg. to ______ deg.

See comment

Comments:

10.9.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity ______ deg. Expected: Linear from ≤ +/– 0.188 deg at 0^0 to ≤ +/– 1.5 deg at 75^0

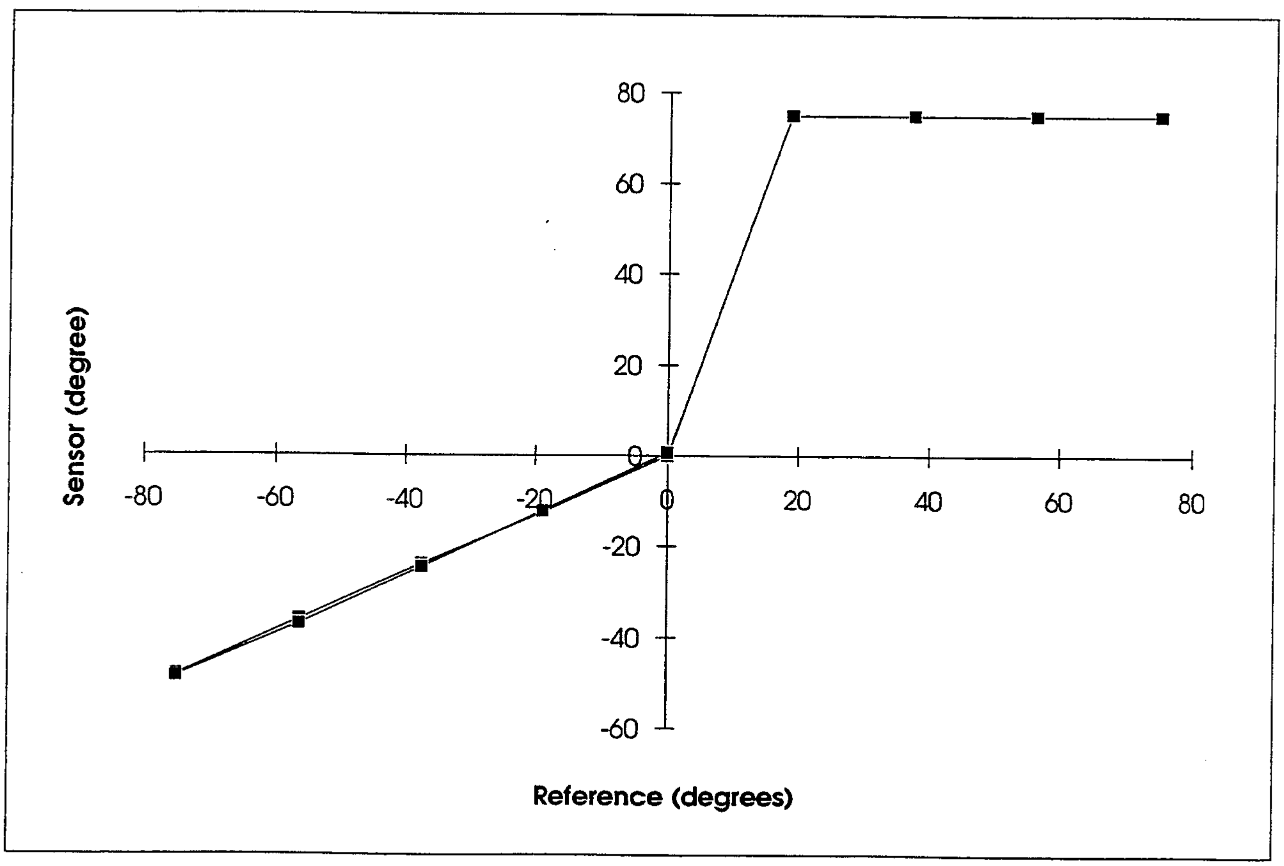
Comments: This section was not completed since the positive range being over travel affected the slope, y-intercept, and standard deviation so much that it makes this data useless.

Nose Wheel Steering Sensor S/N 001

Reference (degrees)	Sensor (degrees)
0	-0.22
18.75	75
37.5	75
56.25	75
75	75
75	75
56.25	75
37.5	75
18.75	75
0	0
-18.75	-12.61
-37.5	-24.047
-56.25	-36.29
-75	-48.387
-75	-48.754
-56.25	-37.243
-37.5	-24.707
-18.75	-12.17
0	0.66

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.991756	18.74905
se m	se b	0.089499	4.217304
r squared	se y	0.878391	18.3828
F	df	122.792	17
ss reg	ss resid	41494.78	5744.766

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



10.9 NOSE WHEEL STEERING SENSOR DATA SHEET

Performed by: Brad Kessler Date: 6/15/93 Test Article Serial Number: 002

EDA #2

10.9.1 Null Offset Test (9.10.2) PASS ☐ FAIL ☑

10.9.1.1 Record the Rotary Sensor Test Set value during the test and the largest sensor value.

Sensor Null Offset [± 0.953] deg. Expected: ≤ +/− 0.186 deg

Rotary Sensor Test Set Value [0.000] deg. Expected: Any constant value.

Comments:

10.9.2 Resolution Test (9.10.3) PASS ☐ FAIL ☑

10.9.2.1 Record the Rotary Sensor Test Set angle and the smallest change in the sensor angle.

RSTS Initial Angle [26.263] deg. and Ending Angle [27.036] deg.

Sensor Resolution [0.773] deg. Expected: ≤ +/− 0.186 deg
Estimated: $2(75)/2^9 \simeq 0.29$ deg
Proc. Spec.: 0.0366 deg

Comments: Sensor changed from 26.833 to 26.906 for a difference of 0.073°

10.9.3 Range Test (9.10.4) PASS ☐ FAIL ☑

10.9.3.1 Record the sensor and Rotary Sensor Test Set full stroke positions.

Sensor Angles	– Full Stroke	-75.000 deg.	Expected: –75 deg
	+ Full Stroke	75.000 deg.	Expected: +75 deg
RSTS Angles	– Full Stroke	-48.332 deg.	Expected: –75 deg
	+ Full Stroke	115.857 deg.	Expected: +75 deg

Comments: The sensor reaches full stroke, but does not correllate to the reference.

In the positive direction, the sensor reads ≈ 71° from RSTS 50.087° to 115.857° and then from 115.857° to 43.606°.

10.9.4 Linearity Test (9.10.5)

PASS ☐ FAIL ☑

Record Sensor Positions at the RS Positions	ROTARY SENSOR (RS) TEST SET POSITIONS								
	–75.000	–56.250	–37.500	–18.750	0.000	18.750	37.500	56.250	75.000
0 to +Full Stroke					-0.073	19.282	32.991	69.868	71.628
+Full Stroke to 0					-0.293	22.141	53.152	71.701	71.628
0 to –Full Stroke	-70.235	-61.804	-44.941	-22.067	X				
–Full Stroke to 0	-71.041	-71.848	-47.141	-17.155	2.933				

10.9.4.1 Print the spreadsheet containing the Rotary Sensor Test Set vs. sensor angles and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

10.9.4.2 Record the slope, constant, and standard deviation values.

Slope $\boxed{1.067}$ Expected: 1.0

Constant $\boxed{0.459}$ Expected: 0

Standard Deviation $\boxed{7.721}$

Comments: The hysteresis of this sensor is fairly large. The maximum and minimum strokes of this sensor are nearly reached many degrees short of the reference max. and min. values, but no overtravel occurs. There is a long range of a fairly constant value near the max. or min. stroke length.

10.9.4.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

y = mx + b, where m = slope, b = constant, x = sensor angles

linear regressed range = (y – standard deviation) to (y + standard deviation)

Actual Null Angle $\boxed{2.933 / -0.293}$ deg. Regressed Range $\boxed{-7.262}$ deg. to $\boxed{8.180}$ deg.

Actual Min. Full Stroke Angle $\boxed{-71.041}$ deg. Regressed Range $\boxed{-87.291}$ deg. to $\boxed{-71.849}$ deg.

Actual Max. Full Stroke Angle $\boxed{71.628}$ deg. Regressed Range $\boxed{72.768}$ deg. to $\boxed{88.210}$ deg.

Comments:

10.9.4.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

Sensor Nonlinearity $\boxed{12.678}$ at 37.5° deg. Expected: Linear from ≤ +/– 0.188 deg at 0^0 to ≤ +/– 1.5 deg at 75^0

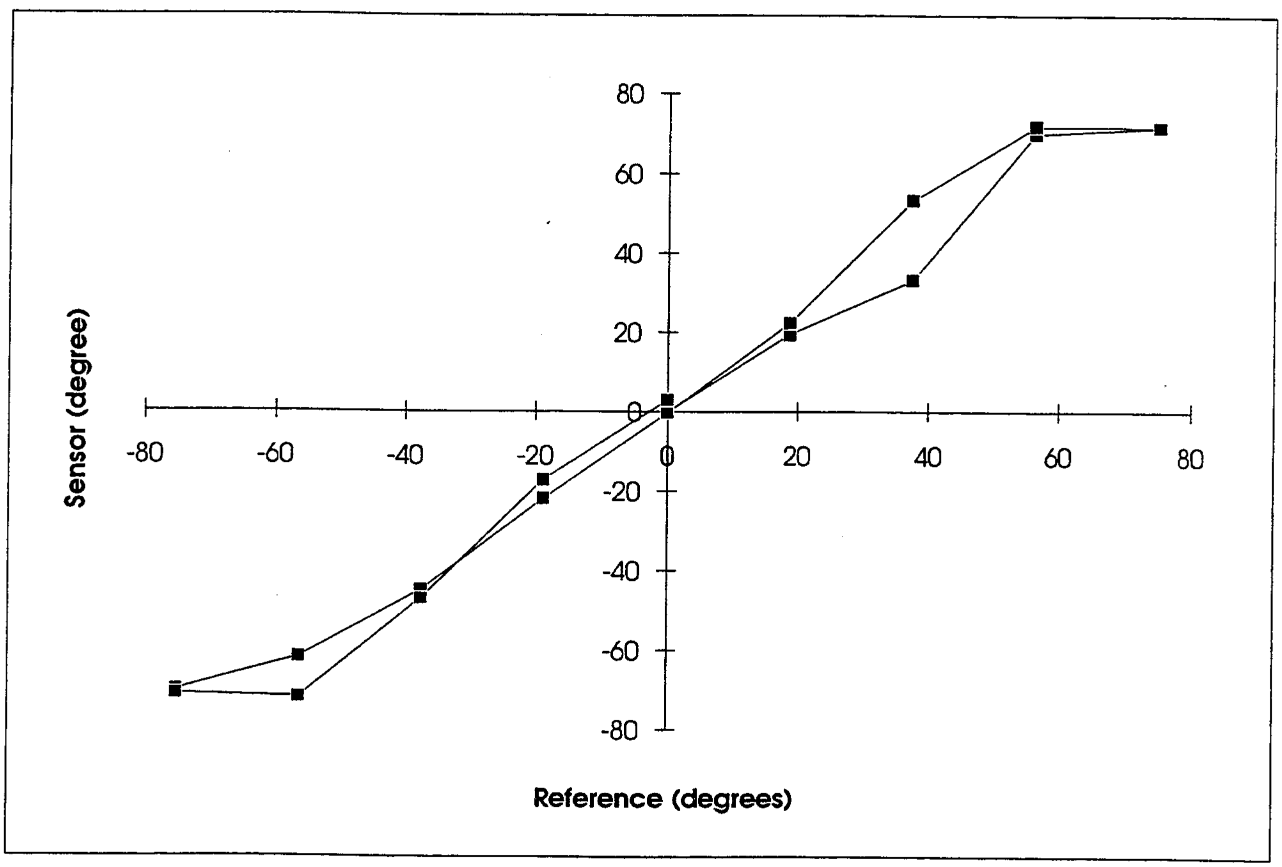
Comments:

Nose Wheel Steering Sensor S/N 002

Reference (degrees)	Sensor (degrees)
0	-0.073
18.75	19.282
37.5	32.991
56.25	69.868
75	71.628
75	71.628
56.25	71.701
37.5	53.152
18.75	22.141
0	-0.293
-18.75	-22.067
-37.5	-44.941
-56.25	-61.804
-75	-70.235
-75	-71.041
-56.25	-71.848
-37.5	-47.141
-18.75	-17.155
0	2.933

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	1.06706	0.459263
se m	se b	0.03759	1.771265
r squared	se y	0.979339	7.720767
F	df	805.8254	17
ss reg	ss resid	48035.45	1013.374

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares



Sensor is not decoded by EoA#1 or EoA#2

10.10 TOTAL PRESSURE SENSOR DATA SHEET

Performed by:________________ Date:__________ Test Article Serial Number: 4030-32-01

10.10.1 Leak Test (9.11.2) PASS☐ FAIL☐

10.10.1.1 Print the file containing the sensor output data and attach it behind this data sheet.

10.10.1.2 Attach a copy of the ADT–222 data behind this data sheet.

Sensor Data Leak Rate ☐ in. Hg per minute
Expected: ≤ 0.010 in Hg per minute.

ADT–222 Data Leak Rate ☐ in. Hg per minute
Expected: ≤ 0.010 in Hg per minute.

(Sensor Data Leak Rate minus ADT–222 Data Leak Rate) ☐ in. Hg per minute
Expected: ≤ 0.002 in Hg per minute.

Comments:

10.10.2 Warm Up Test (9.11.3) PASS☐ FAIL☐

Room Temperature ☐ degrees F

10.10.2.1 Attach to this data sheet a description/sketch of the sensor orientation.

10.10.2.2 Print the file containing the sensor output data and attach it behind this data sheet.

10.10.2.3 Attach a copy of the error plot as a function of time.

Maximum Observed Error ☐ in. Hg
Expected: ≤ 0.40 in Hg.

Comments:

10.10.3 Room Temperature Conversion Accuracy/Hysteresis Test (9.11.4) PASS☐ FAIL☐

Room Temperature ☐ degrees F

10.10.3.1 Attach to this data sheet a description/sketch of the sensor orientation.

10.10.3.2 Print the file containing the sensor output data and attach it behind this data sheet.

10.10.3.3 Attach a copy of the error plot as a function of time. Fill in the table below.

Room Temperature Test Results
(in. Hg)

Input Pressure	Maximum Error	Minimum Error	Average Error	Input Pressure	Maximum Error	Minimum Error	Average Error
29.000				56.000			
26.000				59.000			
23.000				62.000			
20.000				65.000			
17.000				68.000			
14.000				71.000			
11.000				74.000			
8.000				77.000			
5.000				80.000			
2.000				77.000			
5.000				74.000			
8.000				71.000			
11.000				68.000			
14.000				65.000			
17.000				62.000			
20.000				59.000			
23.000				56.000			
26.000				53.000			
29.000				50.000			
32.000				47.000			
35.000				44.000			
38.000				41.000			
41.000				38.000			
44.000				35.000			
47.000				32.000			
50.000				29.000			
53.000							

Maximum Observed Error ☐ in. Hg

Expected: $\leq$ 0.40 in Hg.

Comments:

10.10.4 "Cold" and "Hot" Conversion Accuracy/Hysteresis Test (9.11.5) PASS☐ FAIL☐

"Cold" Oven Temperature ☐ degrees F

10.10.4.1 Attach to this data sheet a description/sketch of the sensor orientation during "cold" test.

10.10.4.2 Print the file containing the "cold" sensor output data and attach it behind this data sheet.

10.10.4.3 Attach a copy of the "cold" error plot as a function of time. Fill in the table below.

"Cold" Temperature Test Results
(in. Hg)

Input Pressure	Maximum Error	Minimum Error	Average Error	Input Pressure	Maximum Error	Minimum Error	Average Error
29.000				56.000			
26.000				59.000			
23.000				62.000			
20.000				65.000			
17.000				68.000			
14.000				71.000			
11.000				74.000			
8.000				77.000			
5.000				80.000			
2.000				77.000			
5.000				74.000			
8.000				71.000			
11.000				68.000			
14.000				65.000			
17.000				62.000			
20.000				59.000			
23.000				56.000			
26.000				53.000			
29.000				50.000			
32.000				47.000			
35.000				44.000			
38.000				41.000			
41.000				38.000			
44.000				35.000			
47.000				32.000			
50.000				29.000			
53.000							

Maximum Observed Error ☐ in. Hg
Expected: ≤ 0.40 in Hg.

Comments:

"Hot" Oven Temperature [ ] degrees F

10.10.4.4 Attach to this data sheet a description/sketch of the sensor orientation during "hot" test.

10.10.4.5 Print the file containing the "hot" sensor output data and attach it behind this data sheet.

10.10.4.6 Attach a copy of the "hot" error plot as a function of time. Fill in the table below.

"Hot" Temperature Test Results
(in. Hg)

Input Pressure	Maximum Error	Minimum Error	Average Error	Input Pressure	Maximum Error	Minimum Error	Average Error
29.000				56.000			
26.000				59.000			
23.000				62.000			
20.000				65.000			
17.000				68.000			
14.000				71.000			
11.000				74.000			
8.000				77.000			
5.000				80.000			
2.000				77.000			
5.000				74.000			
8.000				71.000			
11.000				68.000			
14.000				65.000			
17.000				62.000			
20.000				59.000			
23.000				56.000			
26.000				53.000			
29.000				50.000			
32.000				47.000			
35.000				44.000			
38.000				41.000			
41.000				38.000			
44.000				35.000			
47.000				32.000			
50.000				29.000			
53.000							

Maximum Observed Error [ ] in. Hg

Expected: $\leq$ 0.40 in Hg.

Comments:

10.10.5 G–Sensitivity Test (9.11.6) PASS☐ FAIL☐

Room Temperature ☐ degrees F

10.10.5.1 Attach to this data sheet a description/sketch of the sensor orientation in each of its 6 positions.

10.10.5.2 Print the file containing the sensor output data and attach it behind this data sheet. Fill in the table below.

G–Sensitivity Test Results
(in. Hg)

Sensor Position	Maximum Error	Minimum Error	Average Error
1			
2			
3			
4			
5			
6			

Maximum Observed Error ☐ in. Hg
Expected: ≤ 0.40 in Hg.

Comments:

10.10.6 "Creep" Test" (9.11.7) PASS☐ FAIL☐

Room Temperature ☐ degrees F

10.10.6.1 Attach to this data sheet a description/sketch of the sensor orientation.

10.10.6.2 Print the file containing the sensor output data and attach it behind this data sheet.

10.10.6.3 Attach a copy of the error plot as a function of time.

Maximum Observed Error ☐ in. Hg
Expected: ≤ 0.40 in Hg.

Comments:

10.10.7 <u>"Jitter"/Short–Term Stability Test (9.11.8)</u> PASS☐ FAIL☐

Room Temperature ☐ degrees F

10.10.7.1 Attach to this data sheet a description/sketch of the sensor orientation.

10.10.7.2 Print the file containing the sensor output data and attach it behind this data sheet.

10.10.7.3 Attach a copy of the error plot as a function of time.

Maximum Observed Error ☐ in. Hg

Expected: ≤ 0.40 in Hg.

Comments:

10.10.8 Humidity Sensitivity Test (9.11.9)

PASS ☐ FAIL ☐

Room Temperature ☐ degrees F

10.10.8.1 Attach to this data sheet a description/sketch of the sensor orientation during "hot" test.

10.10.8.2 Print the file containing the "hot" sensor output data and attach it behind this data sheet.

10.10.8.3 Attach a copy of the Humidity Sensitivity error plot as a function of time. Also attach an error plot between this test and the "Hot" Test as a function of input pressure. Fill in the table below.

Humidity Sensitivity Test Results
(in. Hg)

Input Pressure	Maximum Error	Minimum Error	Average Error	Input Pressure	Maximum Error	Minimum Error	Average Error
29.000				56.000			
26.000				59.000			
23.000				62.000			
20.000				65.000			
17.000				68.000			
14.000				71.000			
11.000				74.000			
8.000				77.000			
5.000				80.000			
2.000				77.000			
5.000				74.000			
8.000				71.000			
11.000				68.000			
14.000				65.000			
17.000				62.000			
20.000				59.000			
23.000				56.000			
26.000				53.000			
29.000				50.000			
32.000				47.000			
35.000				44.000			
38.000				41.000			
41.000				38.000			
44.000				35.000			
47.000				32.000			
50.000				29.000			
53.000							

Maximum Observed Error ☐ in. Hg
Expected: ≤ 0.40 in Hg.

Comments:

10.11 TOTAL TEMPERATURE PROBE DATA SHEET

Performed by: Jeff Snethen Date: 6/23/93 Test Article Serial Number: 2

10.11.1 PRT Element Accuracy Test (9.12.1) PASS ☑ FAIL ☐

10.11.1.1 Ice Bath Temperature [32] degrees F

10.11.1.2 Attach the ice bath PRT data behind this data sheet.

All samples within 50.00 +/− 0.05 Ohms? YES ☑ NO ☐

10.11.1.3 Average Ice Bath Resistance of PRT 1 [49.992] Ohms

10.11.1.4 Average Ice Bath Resistance of PRT 2 [49.995] Ohms

10.11.1.5 Boiling Distilled Water Bath Temperature [ ] degrees F

10.11.1.6 Attach the boiling distilled water bath PRT data behind this data sheet.

All samples within 69.63 +/− 0.15 Ohms? YES ☐ NO ☐

10.11.1.7 Average Boiling Water Bath Resistance of PRT 1 [ ] Ohms

10.11.1.8 Average Boiling Water Bath Resistance of PRT 2 [ ] Ohms

A second point was not used since the PRT performed so well @ 32°F.

Comments: The ice bath temperature was verified with a thermocouple. The resistance readings are very stable.

NOTE: The following tests were not performed since the ESAs cannot decode the TRD element very well. For example, see results for temp. sensor S/N 3.

10.11.2 Initial Room Temperature Check-Out (9.12.2) PASS ☐ FAIL ☐

Room Temperature [ ] degrees F

10.11.2.1 Print the file containing the sensor output data and attach it behind this data sheet. Fill in the table below.

Compensated Temperature Readings
(Degrees F)

Temp Reading	Maximum Error	Minimum Error	Average Error
PRT Total Temp			
PRT Amb. Temp			
TRD Total Temp			

Average temperature outputs within +/− 2.0 degrees F of simulation? YES☐ NO☐

ADC BIT Fails? YES☐ NO☐

Comments:

10.11.3 Deicing Heater Operation Test (9.12.3) PASS☐ FAIL☐

Room Temperature ☐ degrees F

10.11.3.1 Attach the deicing heater power data and plot to the back of this sheet.

Maximum Power Drawn After 5 Minutes ☐ Watts

Expected: < 170 Watts

Comments:

10.11.4 General Thermal Test (9.12.4) PASS☐ FAIL☐

10.11.4.1 Attach all PRT and TRD temperature data to the back of this sheet.

10.11.4.2 Attach ambient oven temperature data to the back of this sheet.

10.11.4.3 Attach a listing of compensated PRT temperature data to the back of this sheet.

Maximum Difference Between PRT and TRD Readings at a Given Test Point

☐ Degrees F

Expected: ≤ +/− 0.50 degrees F

Maximum Difference Between Oven Temperature and Either PRT or TRD Readings at a Given Test Point

☐ Degrees F

Expected: ≤ +/− 2.00 degrees F

Comments:

10.11 TOTAL TEMPERATURE PROBE DATA SHEET

Performed by: Jeff Snethen Date: 6/23/93 Test Article Serial Number: 03

10.11.1 PRT Element Accuracy Test (9.12.1) PASS ☑ FAIL ☐

10.11.1.1 Ice Bath Temperature [32] degrees F

10.11.1.2 Attach the ice bath PRT data behind this data sheet.

All samples within 50.00 +/– 0.05 Ohms? YES ☑ NO ☐

10.11.1.3 Average Ice Bath Resistance of PRT 1 [50.038] Ohms

10.11.1.4 Average Ice Bath Resistance of PRT 2 [50.008] Ohms

10.11.1.5 Boiling Distilled Water Bath Temperature [ ] degrees F

10.11.1.6 Attach the boiling distilled water bath PRT data behind this data sheet.

All samples within 69.63 +/– 0.15 Ohms? YES ☐ NO ☐

10.11.1.7 Average Boiling Water Bath Resistance of PRT 1 [ ] Ohms

10.11.1.8 Average Boiling Water Bath Resistance of PRT 2 [ ] Ohms

A second point was not used since the PRT performed so well at 32°F.

Comments: The ice bath temperature was verified with a thermocouple. The resistance readings are very stable.

10.11.2 Initial Room Temperature Check–Out (9.12.2) PASS ☐ FAIL ☑

Room Temperature [ ] degrees F

10.11.2.1 Print the file containing the sensor output data and attach it behind this data sheet. Fill in the table below.

Compensated Temperature Readings
(Degrees F)

Temp Reading	Maximum Error	Minimum Error	Average Error
PRT Total Temp			
PRT Amb. Temp			
TRD Total Temp	~~36°R~~	~~7°R~~	

FOCSI Temperature Sensor Tracking

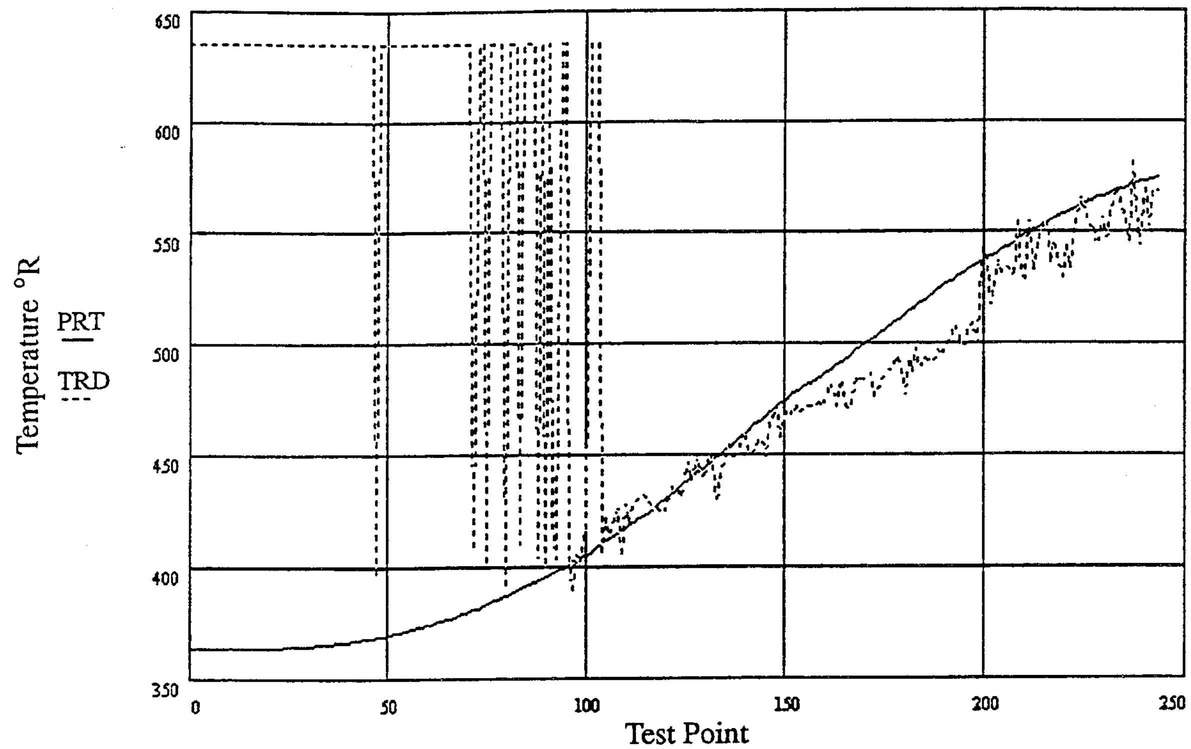


Figure 1

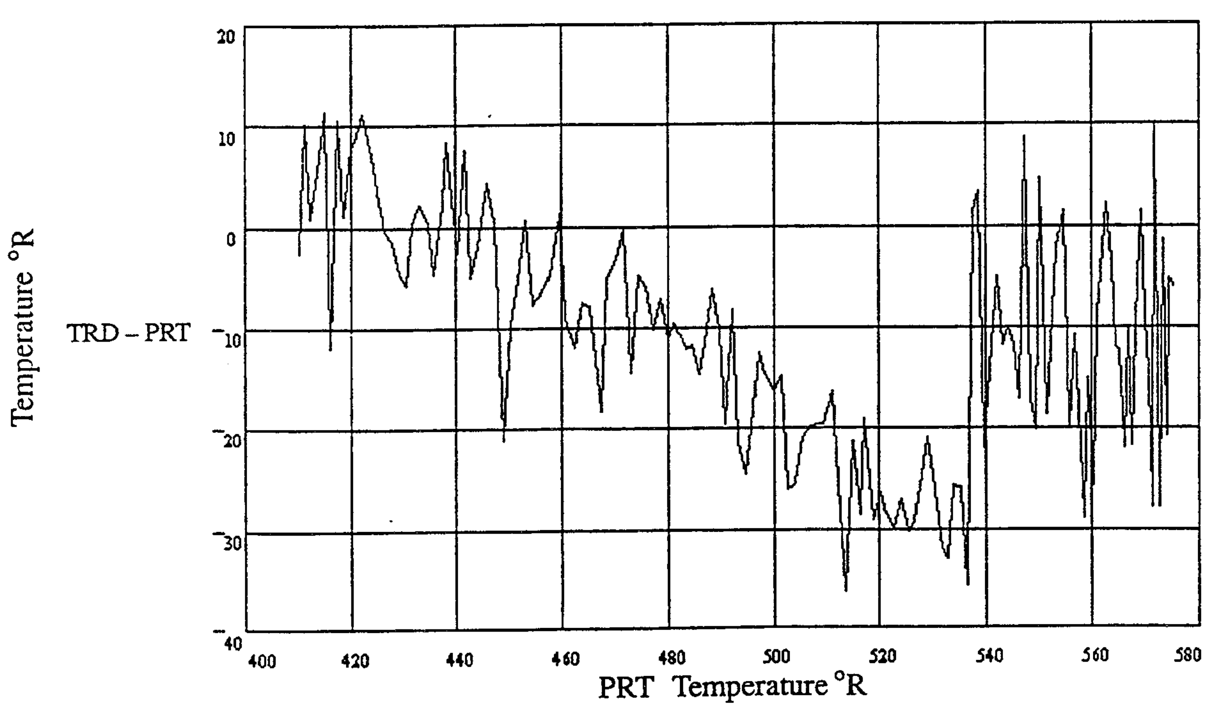


Figure 2

FOCSI EOA Environmental Test Plan

Rev. 6/28/93

11.0 SCOPE

This test plan establishes the documents, equipment, and procedures necessary to verify the operation of the Electro-Optic Architecture (EOA) under the required vibration, thermal, altitude, and electromagnetic environments.

12.0 APPLICABLE DOCUMENTS

The following documents of the issue shown form a part of this test plan to the extent specified.

12.1 McDonnell Douglas Corporation Documents

WS-AD-3239 Electro-optic Architecture Procurement Specification
Rev. A8 DEC 89

12.2 Government Documents

MIL-E-5400T Electronic Equipment, Airborne, General Specification for

MIL-STD-461C Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference

MIL-STD-462 Electromagnetic Interference Characteristics, Measurement of

MIL-STD-704D Aircraft Electrical Power Characteristics

MIL-STD-810D Environmental Test Methods and Engineering Guidelines

13.0 SUMMARY

13.1 Test Plan Objective

The objective of the test is to verify the operation of the EOA when exposed to various environmental extremes. This will be accomplished by comparing the performance of the EOA during and after the environmental test to its performance before the environmental test.

13.2 Location

All tests will be performed at the MDC Avionics Laboratories or Environmental Test Facilities.

13.3 Standard Conditions

All tests shall be performed at prevailing laboratory temperatures, barometric pressures, and humidities unless otherwise specified.

13.4 Equipment

The test equipment consists of commercially available equipment and MDC designed equipment and is listed in Table I.

13.5 Specific Tests

13.5.1 Functional Test

Recording the output of the sensors as they remain at a constant value will determine if the EOA is functioning properly. This test is performed initially to establish baseline results and then after each environmental test to verify proper operation.

13.5.2 Monitor Test

Recording the position sensors' output of a constant value as the environmental tests are performed will determine if the EOA is functioning properly during the test. This test is not listed as the Monitor Test in the procedures but is performed as part of each test procedure.

13.5.3 Vibration Test

Performing three vibration tests – sinusoidal resonance survey, sinusoidal resonance dwell and frequency cycling, and random frequency vibration – will determine the ability of the EOA to operate under the expected vibration environment.

13.5.4 Thermal Test

Cycling the temperature of the air surrounding the EOA from room temperature to 75^0C to -30^0C to room temperature will determine the ability of the EOA to operate under the expected temperature environment.

13.5.5 Altitude Test Procedure

Cycling the pressure surrounding the EOA from room pressure to sea level pressure to the pressure at 50,000 feet to room pressure will determine the ability of the EOA to operate under the expected pressure environment.

13.5.6 Electromagnetic Interference Test

Obtaining the EM radiation and conduction output of the EOA will determine how the EOA will affect the aircraft.

13.5.7 Final Verification Test

The Integration Test Procedure for one of the sensors will be performed to determine the effect of the environmental tests on the integrated operation of the EOA and a sensor.

13.6 Failure Handling

Failures during the test procedure will be recorded, analyzed, and corrected. For a failure, the remaining portion of the current test will be completed provided the unit under test will not be damaged, a correction will be implemented, and the failed test will be repeated.

14.0 TEST PROCEDURES

14.1 Equipment

Table I
Environmental Test Plan Equipment List

ITEM	DESCRIPTION	MANUFACTURER AND MODEL	RANGE	ACCURACY
1	FOCSI Test PC – IBM Clone PC (386) 1553 Interface Board	DTK 386 MDC 74T054099–1001	——	——
2	Vibration Table	MDC	——	——
3	Temperature Chamber	Delta Design 7600	125^0C + -40^0C –	——
4	Altitude Chamber	MDC	——	——
5	Electromagnetic Chamber	MDC	——	——

14.2 *Functional Test Procedure* *(Used during the environmental tests. Not a stand alone test.)*

14.2.1 Procedure

14.2.1.1 Connect the sensors to the EOA so that the sensors will not be disturbed and the sensor values will remain constant. If possible, adjust the sensors to some approximate known value to establish a baseline sensor value.

14.2.1.2 Use the FOCSI Test PC to record the position of each sensor.

14.2.2 Data Evaluation

14.2.2.1 Examine the sensor values recorded throughout the environmental test to determine if the sensor values changed or other unexpected things occurred.

14.2.3 Expected Results

14.2.3.1 The sensor values will be constant throughout testing.

14.3 *Vibration Test Procedure*

14.3.1 General Preparation

14.3.1.1 Place the EOA in its holding fixture and attach it to the vibration table. Connect to the EOA the sensors and FOCSI Test PC which are off of the vibration table.

14.3.1.2 Attach accelerometers to the EOA and record their responses.

14.3.1.3 Use the FOCSI Test PC to monitor the constant sensor values as the vibration tests are performed. Record the sensor values throughout the test, and record any sensor reading deviations.

14.3.1.4 The following tests will be performed in each of the three orthogonal axes, with each of the tests being completed in one axis before the tests are performed in the next axis.

14.3.2 **<u>Resonance Survey Test</u>**

14.3.2.1 <u>Procedure</u>

14.3.2.1.1 A sinusoidal frequency sweep shall be made over 10 minutes from 5 to 2000Hz at the lesser amplitude of 0.024 inch peak–to–peak or +/–2g.

14.3.2.1.2 Perform the Functional Test 14.2.

14.3.2.2 <u>Data Evaluation</u>

14.3.2.2.1 Note the resonant points and describe the modes of each resonant point.

14.3.2.3 <u>Expected Results</u>

14.3.2.3.1 The EOA will survive the test, and the sensor values will be constant throughout testing.

14.3.3 **<u>Performance Random Vibration Test</u>**

14.3.3.1 <u>Procedure</u>

14.3.3.1.1 Perform the random vibration profiled in Figure 1 over 30 minutes.

14.3.3.1.2 Perform the Functional Test 14.2.

14.3.3.2 <u>Data Evaluation</u>

14.3.3.2.1 Note the resonant points and describe the modes of each resonant point.

14.3.3.3 <u>Expected Results</u>

14.3.3.3.1 The EOA will survive the test, and the sensor values will be constant throughout testing.

14.3.4 **<u>Minimum Structural Rigidity Random Vibration Test</u>**

14.3.4.1 <u>Procedure</u>

14.3.4.1.1 Perform the random vibration profiled in Figure 2 over 60 minutes.

14.3.4.1.2 Perform the Functional Test 14.2.

14.3.4.2 <u>Data Evaluation</u>

14.3.4.2.1 Note the resonant points and describe the modes of each resonant point.

14.3.4.3 <u>Expected Results</u>

14.3.4.3.1 The EOA will survive the test, and the sensor values will be constant throughout testing.

14.3.5 ***Repeat 14.3 for the remaining axes.***

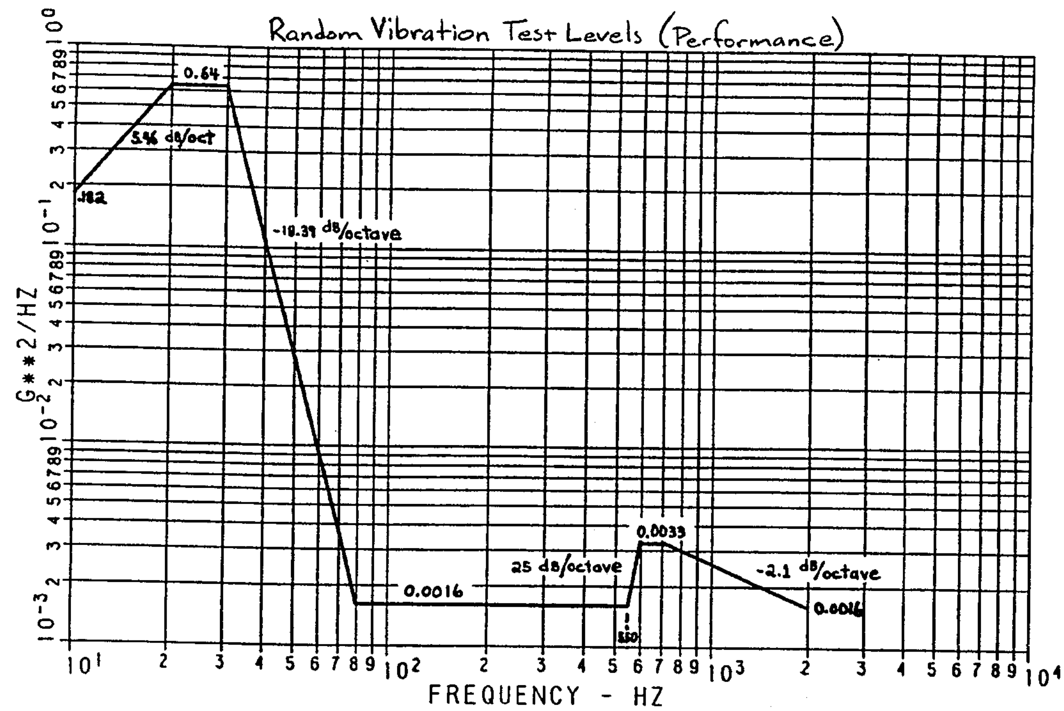


Figure 1

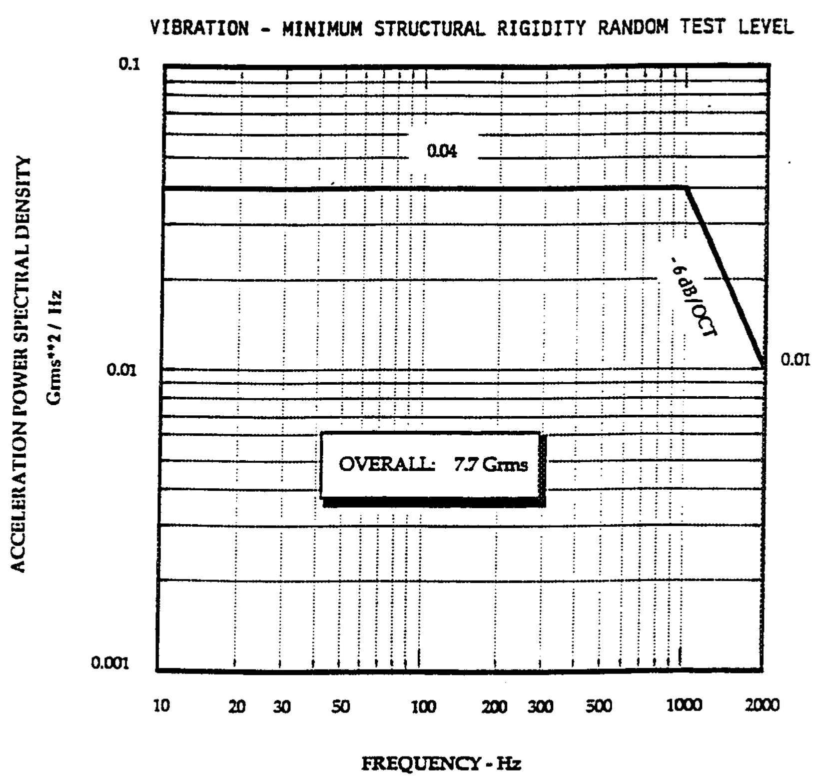


Figure 2

14.4 *Thermal Test Procedure*

14.4.1 Procedure

14.4.1.1 Place the EOA and temperature sensor into the temperature chamber, and connect the sensors and FOCSI Test PC to the EOA.

14.4.1.2 Place a thermocouple through a vent hole in the EOA chassis module access cover into the space between the front panel and the power supply to measure the EOA internal temperature. Place a thermocouple in the temperature chamber near the EOA to measure the ambient air around the EOA.

14.4.1.3 Use the FOCSI Test PC to monitor the constant sensor values as the temperature is changed from room temperature to 75^0 to -30^0C to room temperature. Record the sensor values every five degrees of chamber ambient temperature when increasing or decreasing temperature, and every five minutes when holding the chamber at -30^0 or 75^0C.

14.4.1.4 Slowly raise the temperature to 75^0C and hold for one hour while recording sensor values.

14.4.1.5 Slowly lower the temperature to -30^0C and hold for one hour while recording sensor values.

14.4.1.6 Raise the temperature of the chamber to room temperature, and monitor the sensor values for fifteen minutes while recording the sensor values.

14.4.1.7 Perform the Functional Test 14.2.

14.4.2 Data Evaluation

14.4.2.1 The recorded EOA outputs should show constant sensor values with no deviations.

14.4.3 Expected Results

14.4.3.1 The EOA will survive the test, and the sensor values will be constant throughout testing

14.5 *Altitude Test Procedure*

14.5.1 Procedure

14.5.1.1 Place the EOA and pressure sensor into the altitude chamber, and connect the sensors and FOCSI Test PC to the EOA.

14.5.1.2 Route the thermocouple through one of the the EOA chassis air and moisture equalization holes and attach the thermocouple inside the EOA near the power supply. The temperature must not greatly exceed the maximum internal operating temperature recorded in Thermal Test Procedure.

14.5.1.3 Operate the EOA until the temperature inside begins to stabilize. Abort the test if the temperature greatly exceeds the internal operating temperature recorded in Thermal Test Procedure.

14.5.1.4 Use the FOCSI Test PC to monitor the constant sensor values as the altitude is changed from room altitude to 50,000 feet to room altitude. Record the sensor values as much as possible while increasing or decreasing pressure and every 5 minutes while holding at a constant pressure.

14.5.1.5 Evacuate the chamber at a rate of 500ft/sec to a pressure equaling 50,000 feet and hold for one hour while recording sensor values.

14.5.1.6 Raise the pressure in the chamber at a rate of 1000ft/sec until room pressure is reached, and continue to monitor the sensor values for fifteen minutes while recording sensor values.

14.5.1.7 Perform the Functional Test 14.2.

14.5.2 Data Evaluation

14.5.2.1 The recorded EOA outputs should show constant sensor values with no deviations.

14.5.3 Expected Results

14.5.3.1 The EOA will survive the test, and the sensor values will be constant throughout testing

14.6 *Electromagnetic Interference Test Procedure*

14.6.1 Procedure

14.6.1.1 Place the EOA into the EMI chamber, and set up the EOA and cabling per MIL-STD-462. Make sure the EOA chassis is bonded to the ground plane. Except for the first two meters of the power and 1553 cables, shield all of those cables including the 1553 termination resistor..

14.6.1.2 When the EOA is on, check the operation of the LEDs in J2 and the operation of the 1553 bus with an oscilloscope. The LEDs should be on, and the 1553 activity should show four command words with four responses.

14.6.1.3 Measure the EM radiation and conduction from the operating EOA according to MIL-STD-462 and MIL-STD-461C (Class A1) RE02 and CE03.

14.6.2 Data Evaluation and Expected Results

14.6.2.1 The radiated and conducted emissions of the EOA should be within the limits specified by MIL-STD-461C (Class A1) RE02 and CE03.

14.7 *Final Verification Test Procedure*

14.7.1 Procedure

14.7.1.1 Perform the Integration Test Plan procedure for one of the sensors. (The Rudder Pedal Sensor.)

14.7.2 Data Evaluation

14.7.2.1 Compare the original Integration Test Plan results with the Final Verification Test results.

14.7.3 Expected Results

14.7.3.1 The Final Verification Test results will match the original Integration Test Plan results.

15.0 DATA SHEETS

15.1 VIBRATION TEST DATA SHEET

15.1.1 Resonance Survey Test (14.3.2) 6/23/93 Brad Kessler PASS ☑ FAIL ☐

15.1.2 Print each of the sensor data files for the constant values and attach them behind this data sheet.

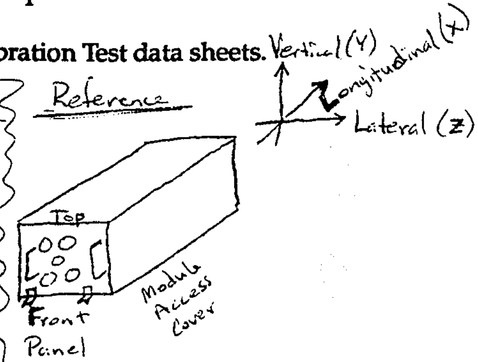
All of the Sensors values are constant YES ☑ NO ☐ Expect Yes.

15.1.3 Vibration results will be in a technical report; attach it behind the Vibration Test data sheets.

Comments:

Sensors Connected	Sensors Not Connected
Pitch Stick 001	Temperature
TEF 001	Pressure
NWS 002	PLC
LEF 0043	
Rudder Pedal 002	
Stabilizer 2	
Rudder 002	

Pressure Sensor S/N 4030-32-01 is on vibration fixture with EOA



15.1.4 Performance Random Vibration Test (14.3.3) PASS ☑ FAIL ☐

15.1.4.1 Print each of the sensor data files for the constant values and attach them behind this data sheet.

All of the Sensors values are constant YES ☑ NO ☐ Expect Yes.

15.1.4.2 Vibration results will be in a technical report; attach it behind the Vibration Test data sheets.

Comments:

15.1.5 Minimum Structural Rigidity Random Vibration Test (14.3.4) PASS ☐ FAIL ☑

15.1.5.1 Print each of the sensor data files for the constant values and attach them behind this data sheet.

All of the Sensors values are constant YES ☑ NO ☐ Expect Yes.

15.1.5.2 Vibration results will be in a technical report; attach it behind the Vibration Test data sheets.

Comments: The longitudinal minimum structural rigidity was not completed due to a failure in the power supply. The other axes did have this test run on them and successfully passed.

TECHNICAL MEMORANDUM
ENGINEERING LABORATORIES

(DEPT.YR.TM.SEQ)
TECH MEMO: 253.93.0153.01
DATE: 19 AUG 93 REV:

REPORT TYPE: FINAL

TITLE: FOCSI VIBRATION TEST

MODEL NO: CRAD MODEL TYPE: CRAD
REQ DOC: TR 705-285
TEST ART DELIVERY: 28 JUN 93
CHARGE NO: M8Q-CH-136
SET-UP START: 28 JUN 93
CONTRACT NO:
TEST START: 28 JUN 93
REQUESTING DEPT: 318 TEST COMP.: 14 JUL 93
PART NUMBER: UNKNOWN
QUANTITY: 1 TEARDOWN COMP.: 15 JUL 93

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Engr. Support**	349

*Page 1 only
**Original Report

TEST ARTICLE DESCRIPTION: Electro-Optic Architecture for the Fiber Optic Control System Integration Program
MANUFACTURER: MDA-EAST

TEST ARTICLE DISPOSITION: Returned to Project
TEST LOCATION/FACILITY/NO.: BLDG 102 VIBRATION LAB, ST. LOUIS
TEST CATEGORY: GENERAL DEVELOPMENT
TUNNEL OCCUPANCY HOURS: N/A TEST RUNS/DATA POINTS: 12/4
TYPE OF DATA ACQUIRED: ACCELERATION
NO OF DATA CHANNELS: 4
TEST VARIABLES AND CONDITIONS: Ambient Lab Conditions

OTHER LAB REPORTS: NONE
SUPPLEMENTARY REPORTS: NONE
KEYWORDS:

1. STRUCTURAL DYNAMICS	2. VIBRATION
3. ACCELERATION	4. DYNAMIC
5.	6.
7.	8.

1. TEST OBJECTIVE: The object of this test was to determine if the Electro-Optic Architecture (EOA) Unit would operate properly during the vibration test program.

2. ABSTRACT OF RESULTS: The EOA exhibited several problems during the vibration test. Any conclusions as to the ability of the EOA to operate properly during the vibration test is left to project.

H L Stewart

PREPARED BY: H.L. STEWART
LEAD ENGINEER
MATERIALS & STRUCTURES LAB

T. A. Hill

APPROVED BY: T.A. HILL
TECHNICAL SPECIALIST
MATERIALS & STRUCTURES LAB

RELEASED

3. Vibration testing was conducted on an Electro-Optic Architecture (EOA) unit, an optic to electric decoder, for the Fiber Optic Control System Integration Program (FOCSI). The object of this test was to determine if the EOA would operate properly during the vibration test program. The test program included a sinusoidal (sine) vibration resonance survey, a random vibration performance test, and a random vibration minimum structrual rigidity test.

4. The test fixture, obtained from the Navy by the Project, was attached to the vibration exciter vertical adapter for testing in the vertical axis or to the horizonal table for testing in the horizontal axes. The EOA was attached to the fixture via the normal attachment method, pins on the rear and thumb screw/hinge fastners on the front. A triaxial accelerometer was bonded to the fixture and the inline channel was used as the control accelerometer. The signals from the control accelerometer were connected, via a charge amplifier, to a digital vibration control system which used the signal in the closed-loop feedback circuit to control the vibration test environment. Three triaxial accelerometers (R1, R2, R3) were bonded to the EOA, reference Figure 1, and the inline channels were used to monitor the frequency response of the EOA at these locations. The signals from these accelerometers were connected to, via charge amplifiers, the auxiliary channels of the vibration control system to obtain the frequency response plots. During the second vertical axis test and for the remainder of the test, accelerometers R1, R2 and R3 were removed from the unit. Two uniaxial accelerometers (R4 and R5) and one triaxial accelerometer were used to monitor the the frequency response of the EOA. Accelerometer R4 was bonded to the Bus Controller (BC) Card (in the longitudinal axis), accelerometer R5 to the back plane between slots 2 and 3 (in the lateral axis) and accelerometer R6 to the front top corner (reference Figure 1) to monitor the frequency response at these locations.

5. The test program consisted of a sine resonance survey, a random vibration performance test, and a random vibration minimum structural rigidity test, as stated in MDC Report A3376 Addendum II, paragraphs, 4.2.2 and 4.2.17. The resonance survey consisted of a 10 minute sine sweep from 10 to 2000 Hz with the input levels of Figure 2 (0.024 inch double amplitude or 2 g peak whichever was less). The frequency was swept at a logarithmic rate. The performance test consisted of subjecting the EOA to the vibration spectrum of Figure 3 for 30 minutes per axis. The minimum structural test consisted of subjecting the EOA to the vibration spectrum of Figure 4 for 60 minutes per axis. A Project representative used the FOCSI Test Computer to monitor and record the the EOA constant sensor values during the vibration test.

6. The actual vibration test program conducted and the results obtained are presented in Table 1. The input (control) and

response plots obtained during the test program are presented in Figures 5 through 52. The sine frequency response plots present transfer function (Xfer Mag) versus frequency. The plots obtained during the random tests present power spectral density (g^2/Hz) versus frequency. The EOA exhibited some problems (no monitor update) after 10 minutes and 10 seconds of the performance test in the vertical axis (first axis). The problems were with the two 1773/1553 cards. The two cards were removed, the "data bus" jumpered, and testing continued. The EOA also exhibited some additional problems after 6 minutes and 38 seconds of the structural rigidity test in the vertical axis. The EOA was returned to the avionics lab for repairs and the test was reinitiated in the vertical axis. The vibration test was then completed in the vertical and lateral axes with no additional problems. However, the EOA's internal power supply failed after 23 minutes and 16 seconds of the structural rigidity test in the longitudinal axis. Project decided to stop testing at this point, since the EOA had passed the performance test requirements.

7. Any conclusions as to the ability of the EOA to operate properly during the vibration test is left to the Project.

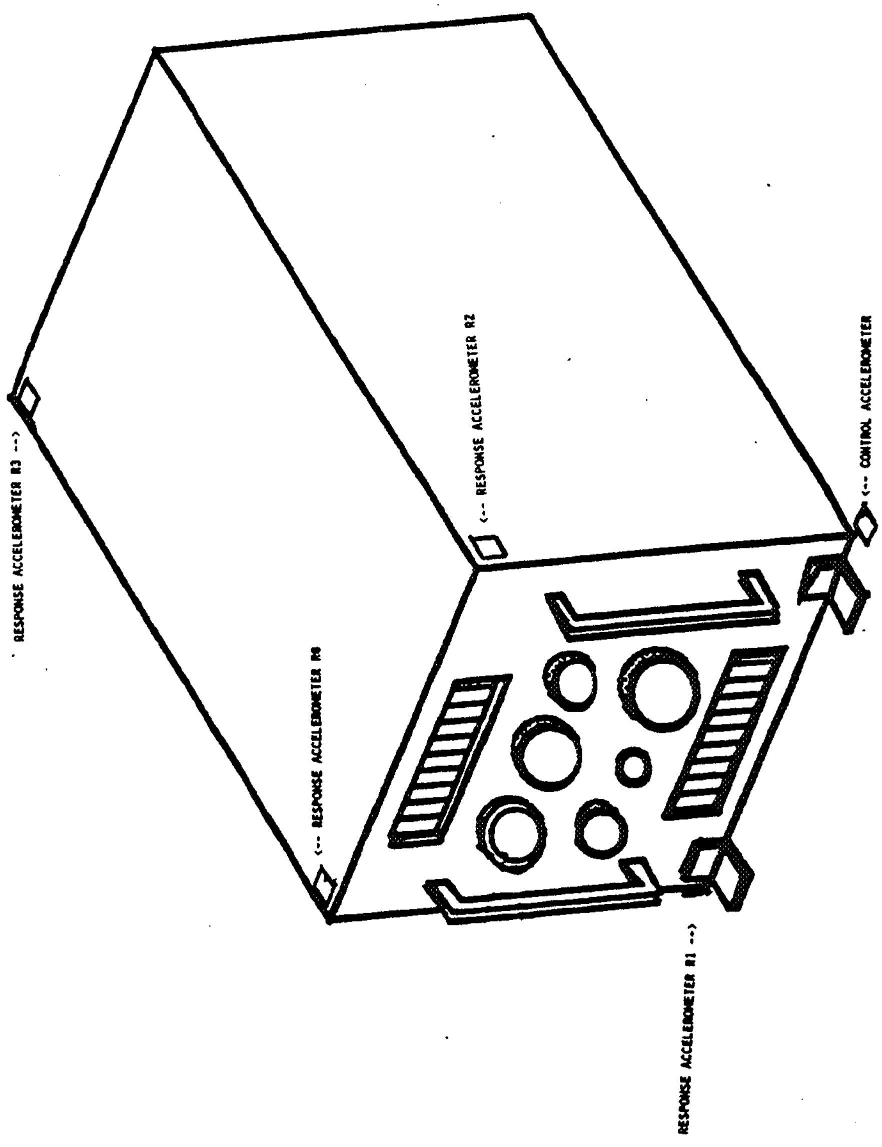


FIGURE 1 - SKETCH OF THE EOA SHOWING THE LOCATION OF THE CONTROL ACCELEROMETER AND RESPONSE ACCELEROMETERS R1, R2, R3, & R6

FIGURE 1

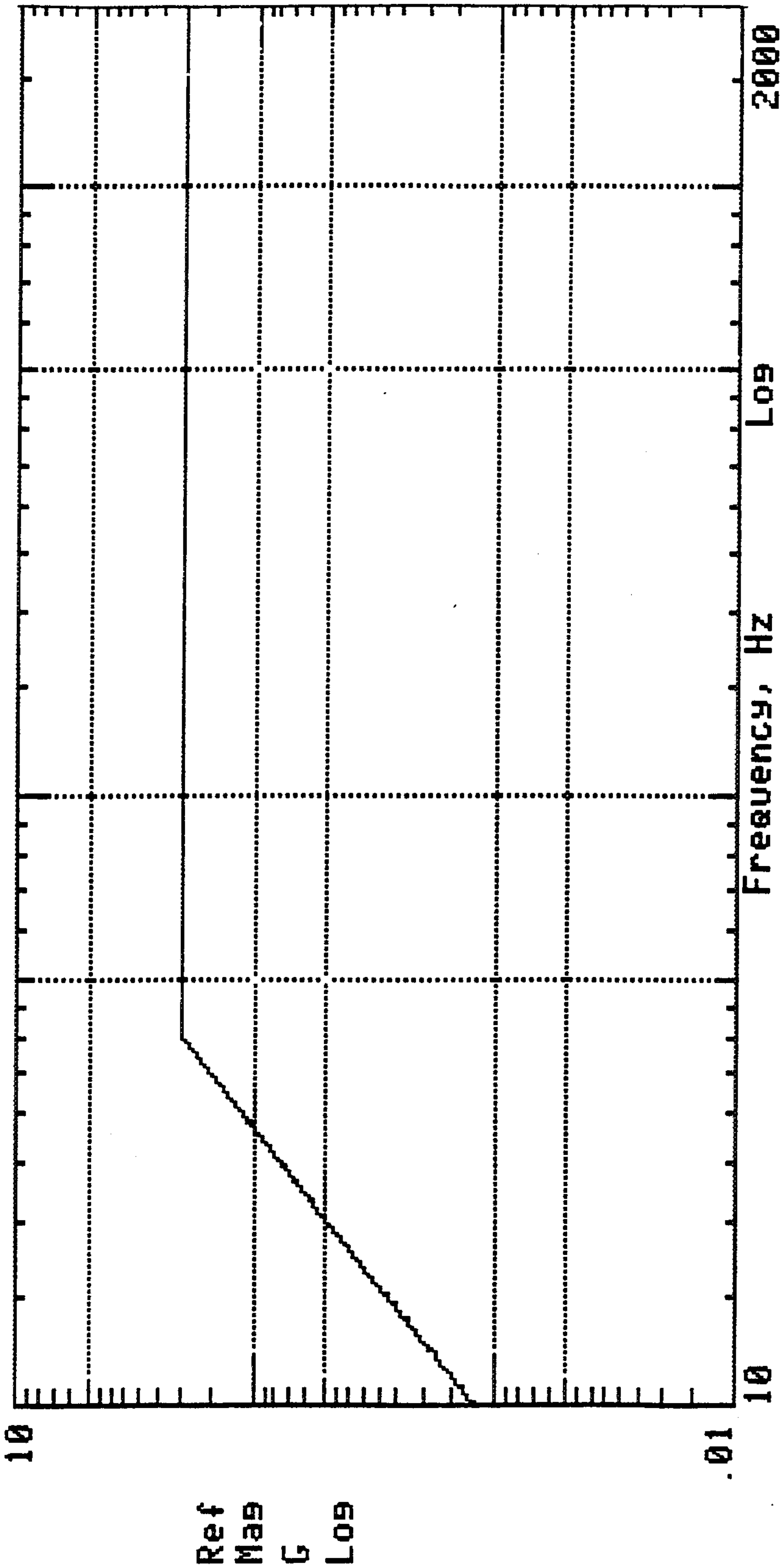
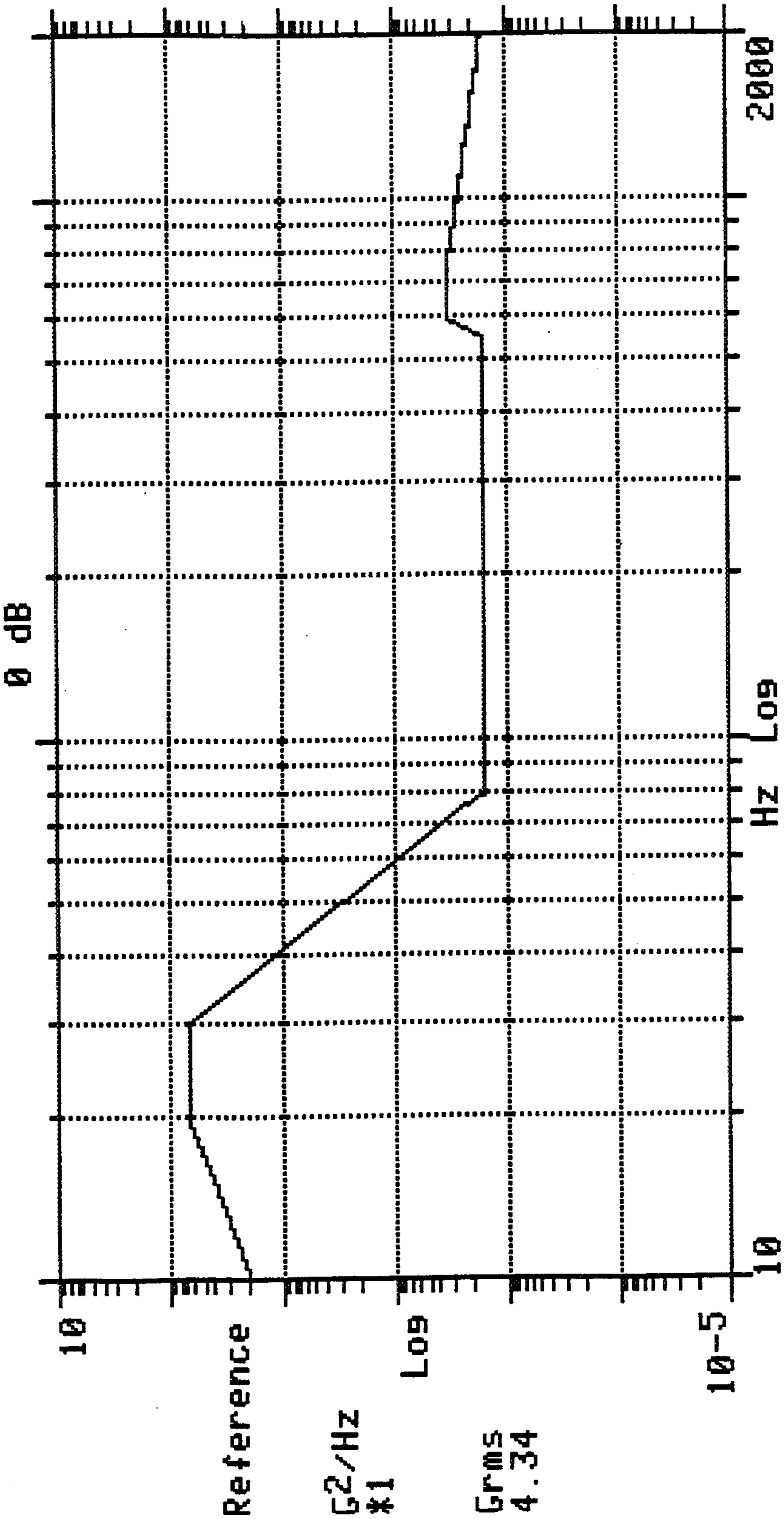


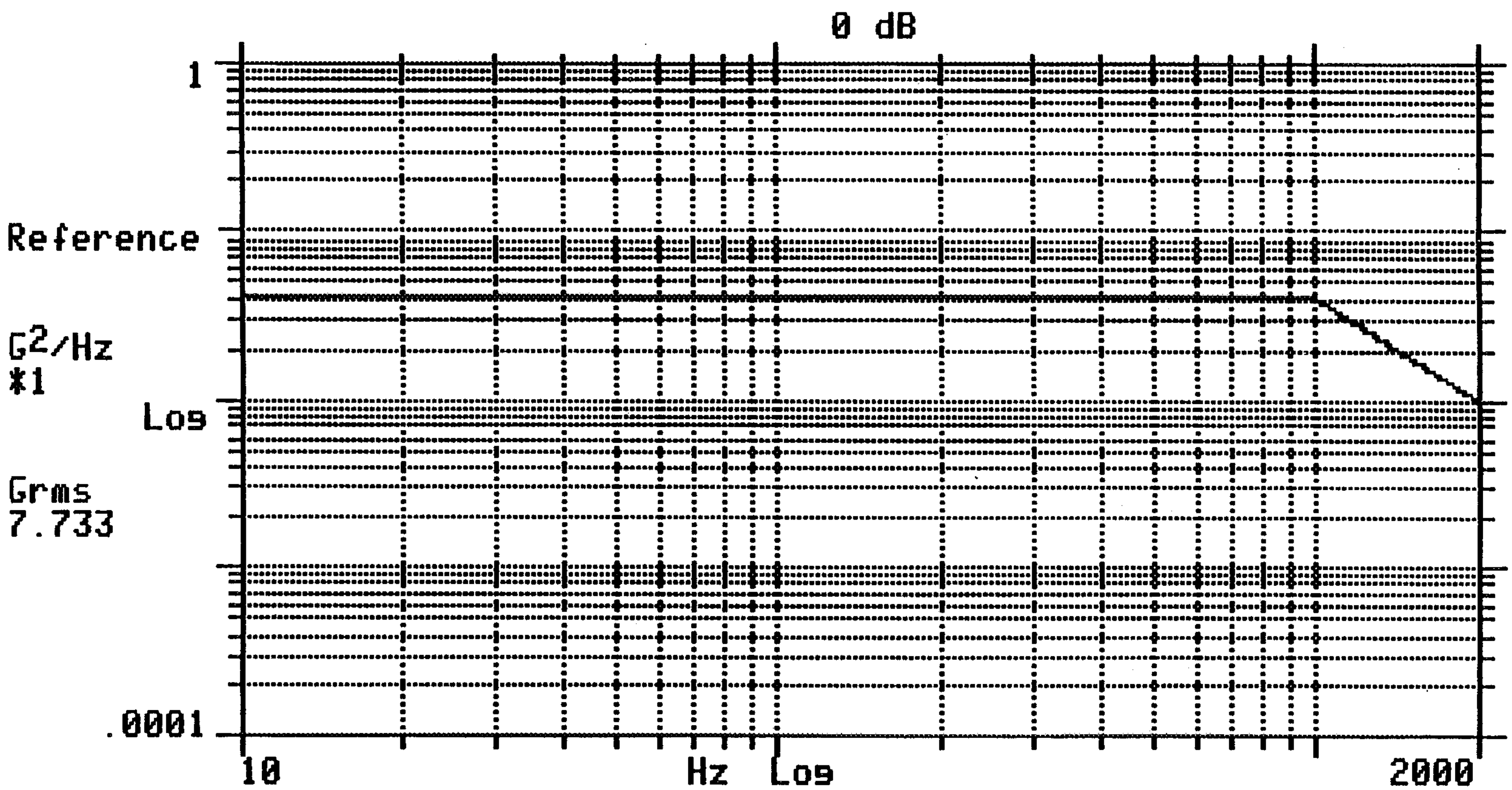
FIGURE 2 - SINE VIBRATION CONTROL
SINE RESONANCE SURVEY TEST

FIGURE 2



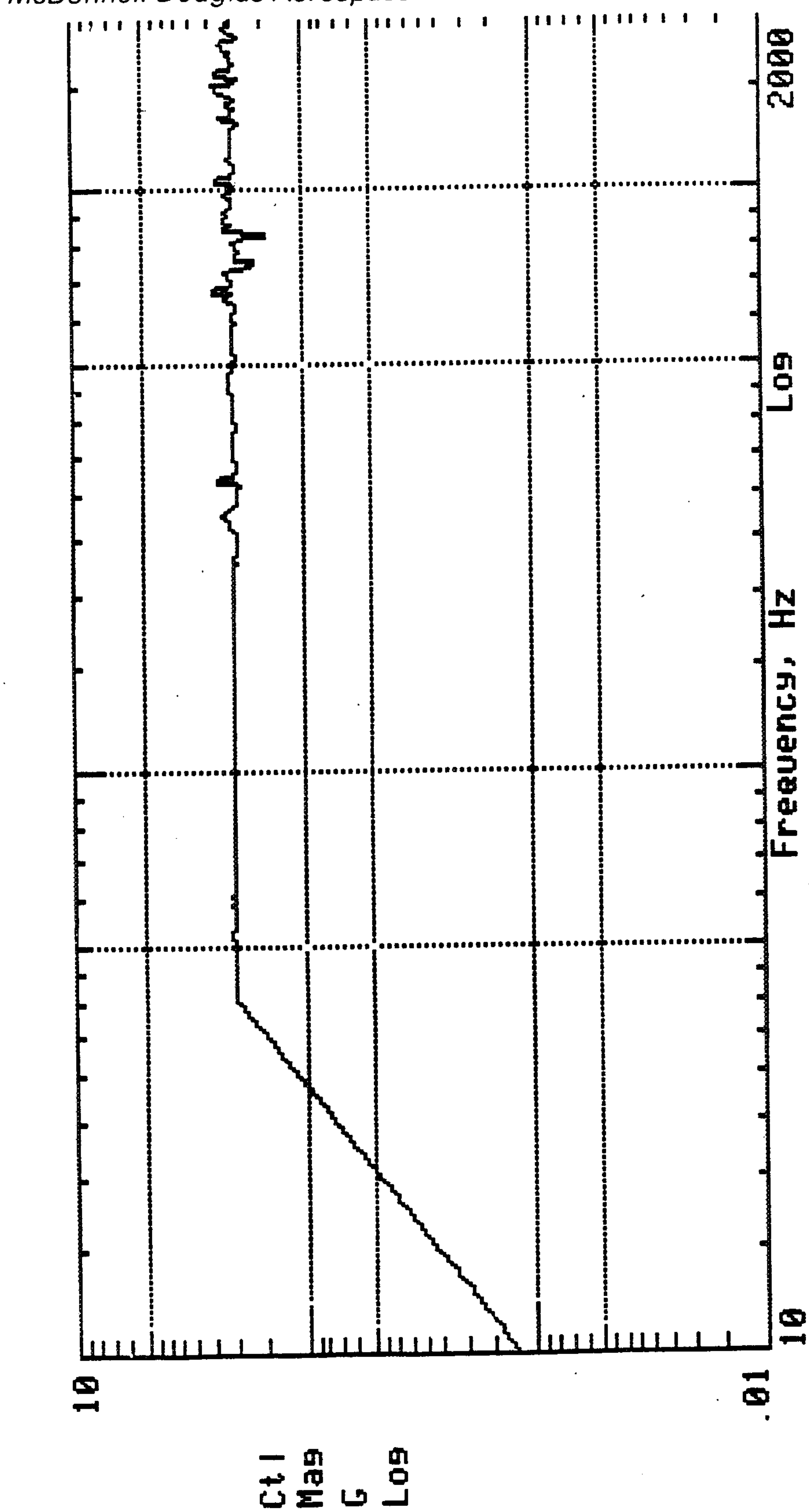
PERFORMANCE VIBRATION TEST

FIGURE 3 - RANDOM VIBRATION CONTROL SPECTRUM



MIN STRUCTURAL RIGIDITY VIB TEST
FIGURE 4 - RANDOM VIBRATION CONTROL SPECTRUM

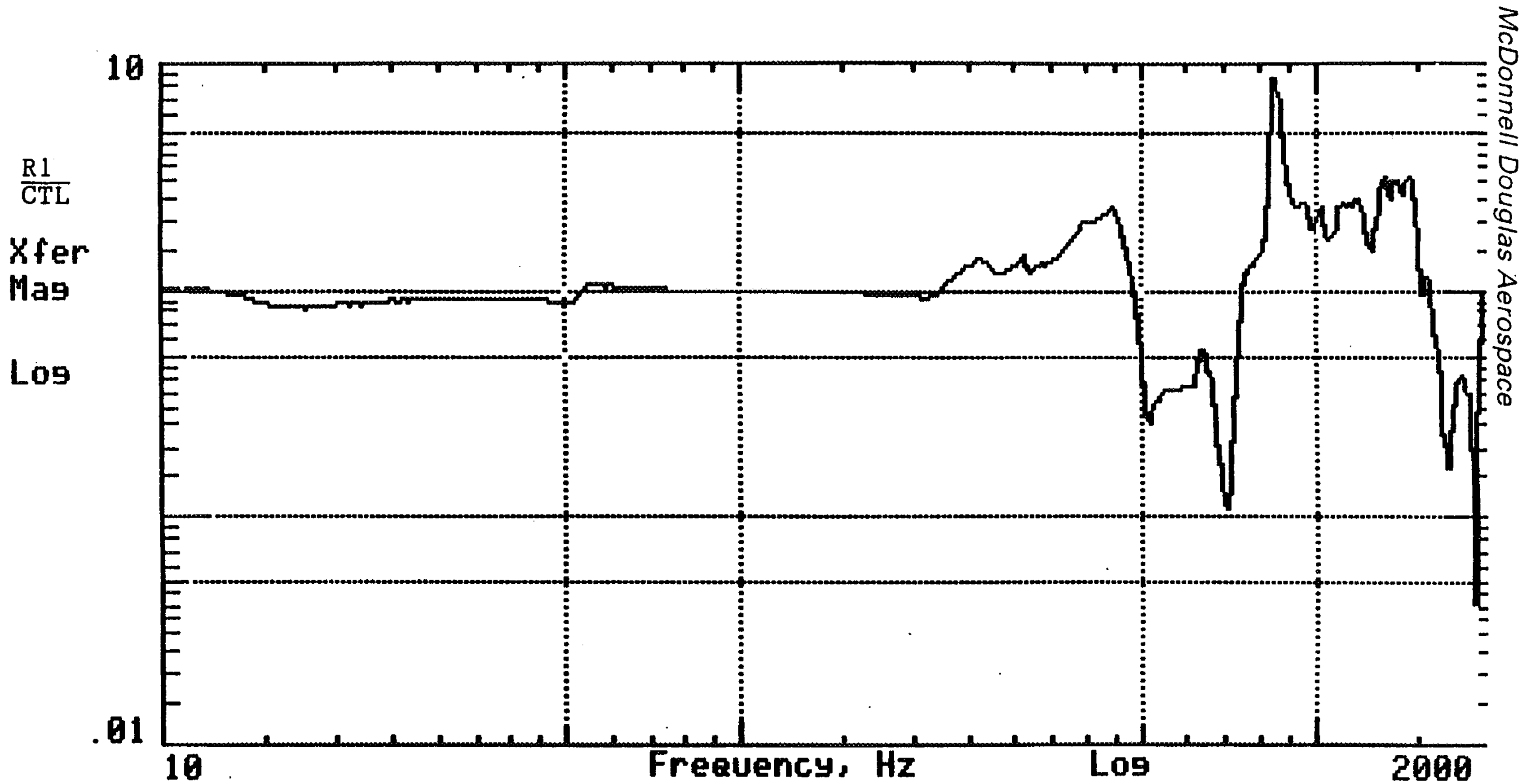
McDonnell Douglas Aerospace



T/N 1 SINE RESONANCE SURVEY VERT AXIS

FIGURE 5 – SINE VIBRATION CONTROL

FIGURE 5



29-Jun-93

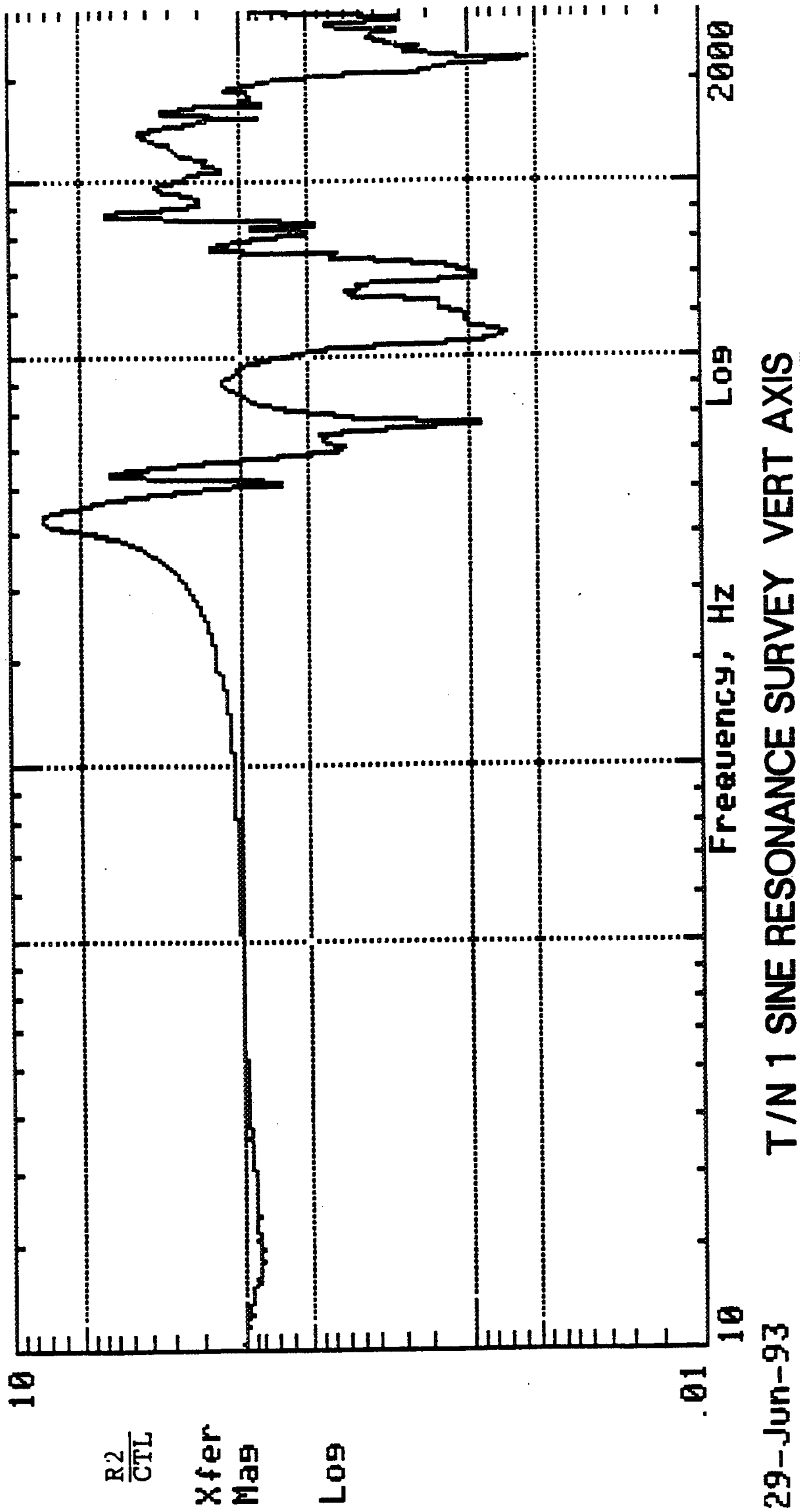
T/N 1 SINE RESONANCE SURVEY VERT AXIS

FIGURE 6 – FREQUENCY RESPONSE

MCDONNELL DOUGLAS

FIGURE 6

McDonnell Douglas Aerospace

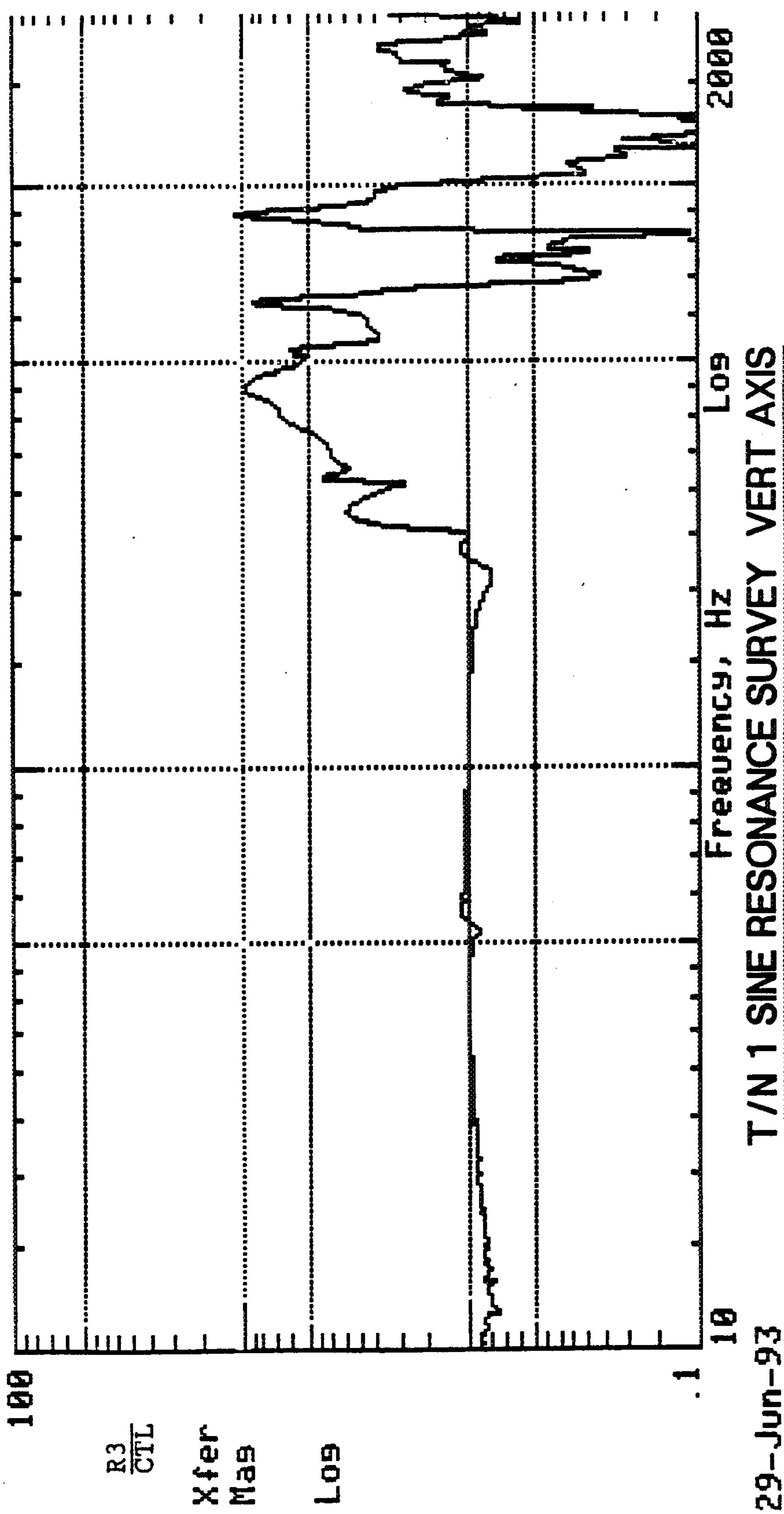


T/N 1 SINE RESONANCE SURVEY VERT AXIS

FIGURE 7 – FREQUENCY RESPONSE

FIGURE 7

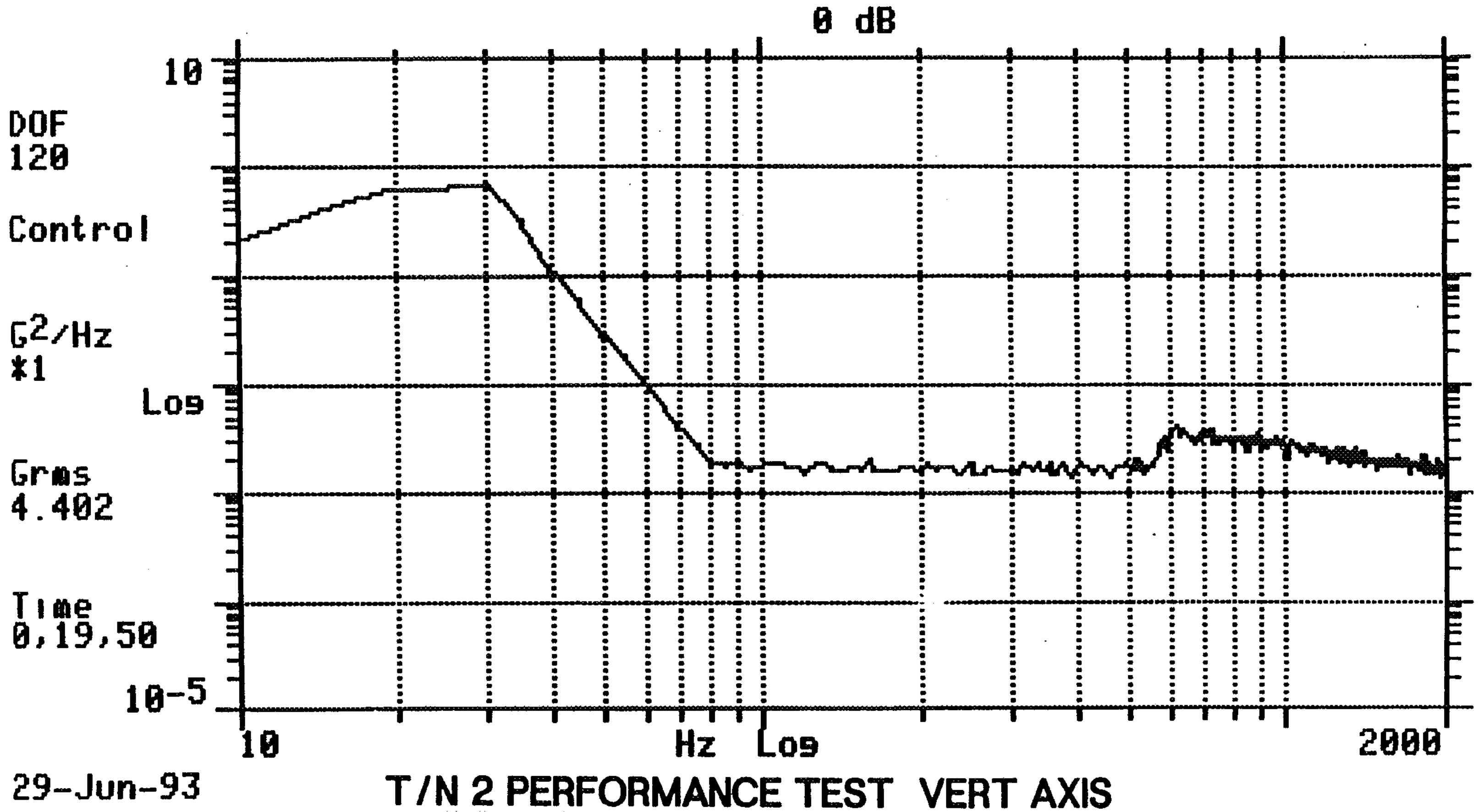
McDonnell Douglas Aerospace



T/N 1 SINE RESONANCE SURVEY VERT AXIS

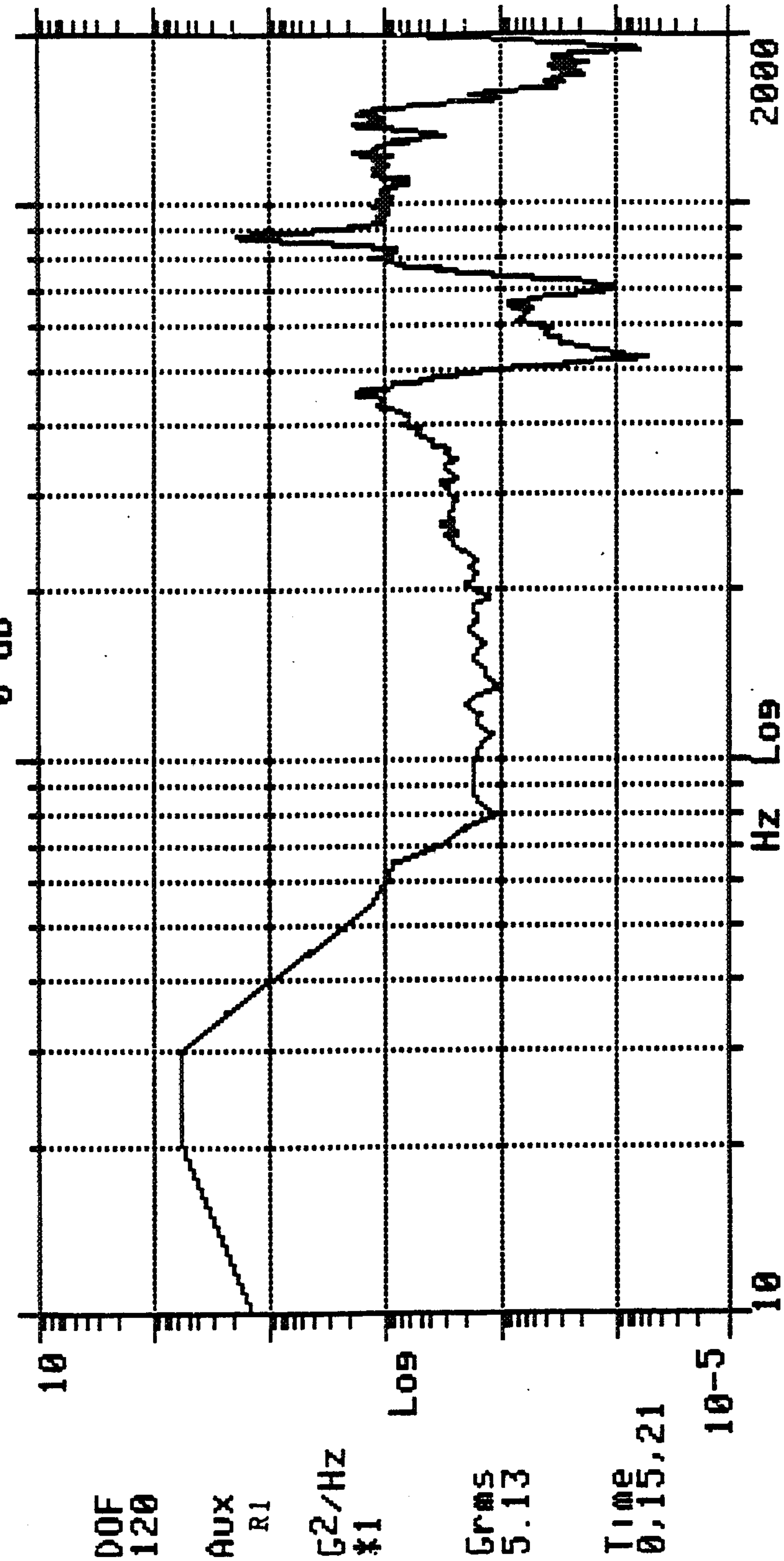
FIGURE 8 – FREQUENCY RESPONSE

FIGURE 8



T/N 2 PERFORMANCE TEST VERT AXIS

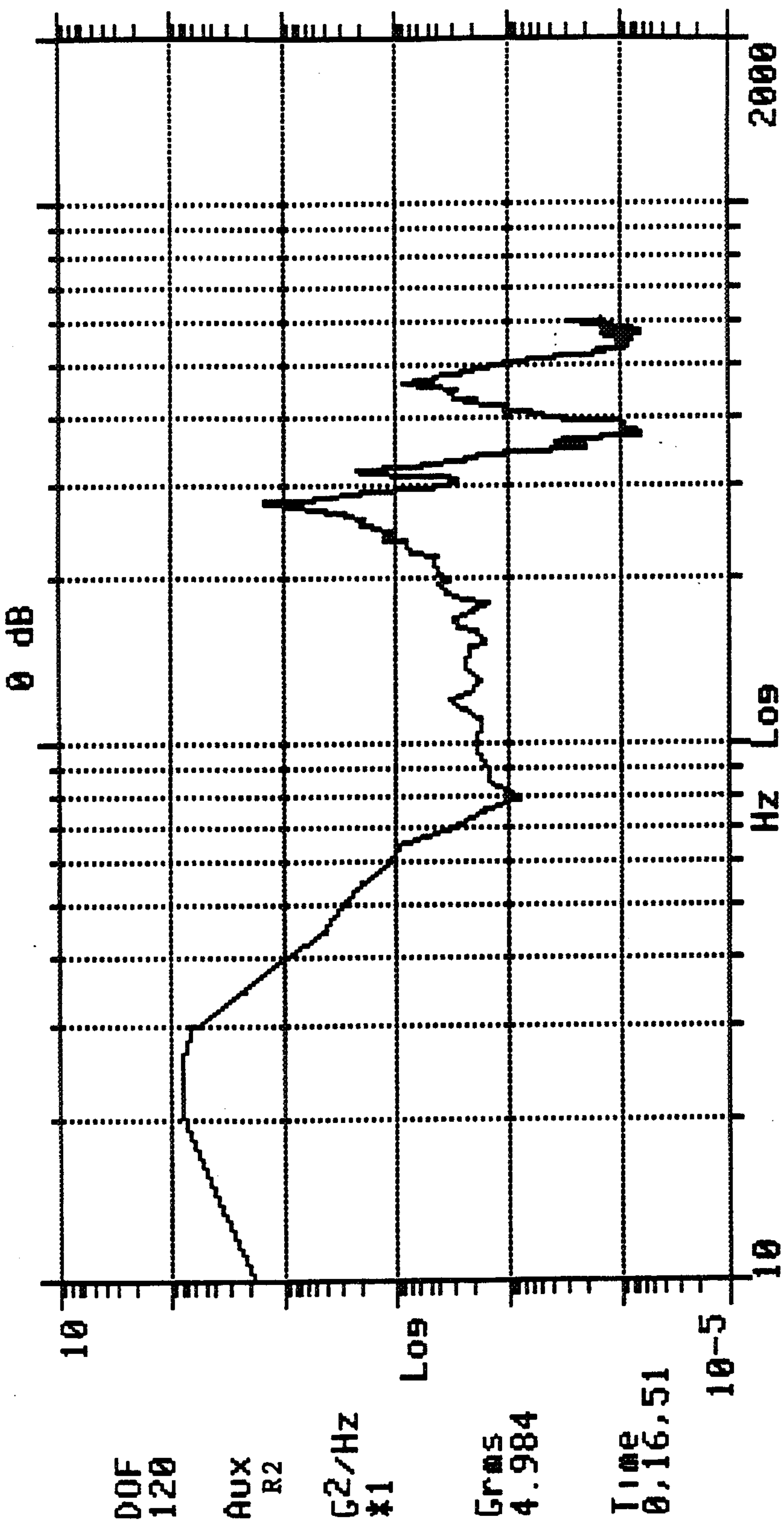
FIGURE 9 – RANDOM VIBRATION CONTROL SPECTRUM



T/N 2 PERFORMANCE TEST VERT AXIS

FIGURE 10 – POWER SPECTRAL DENSITY ANALYSIS

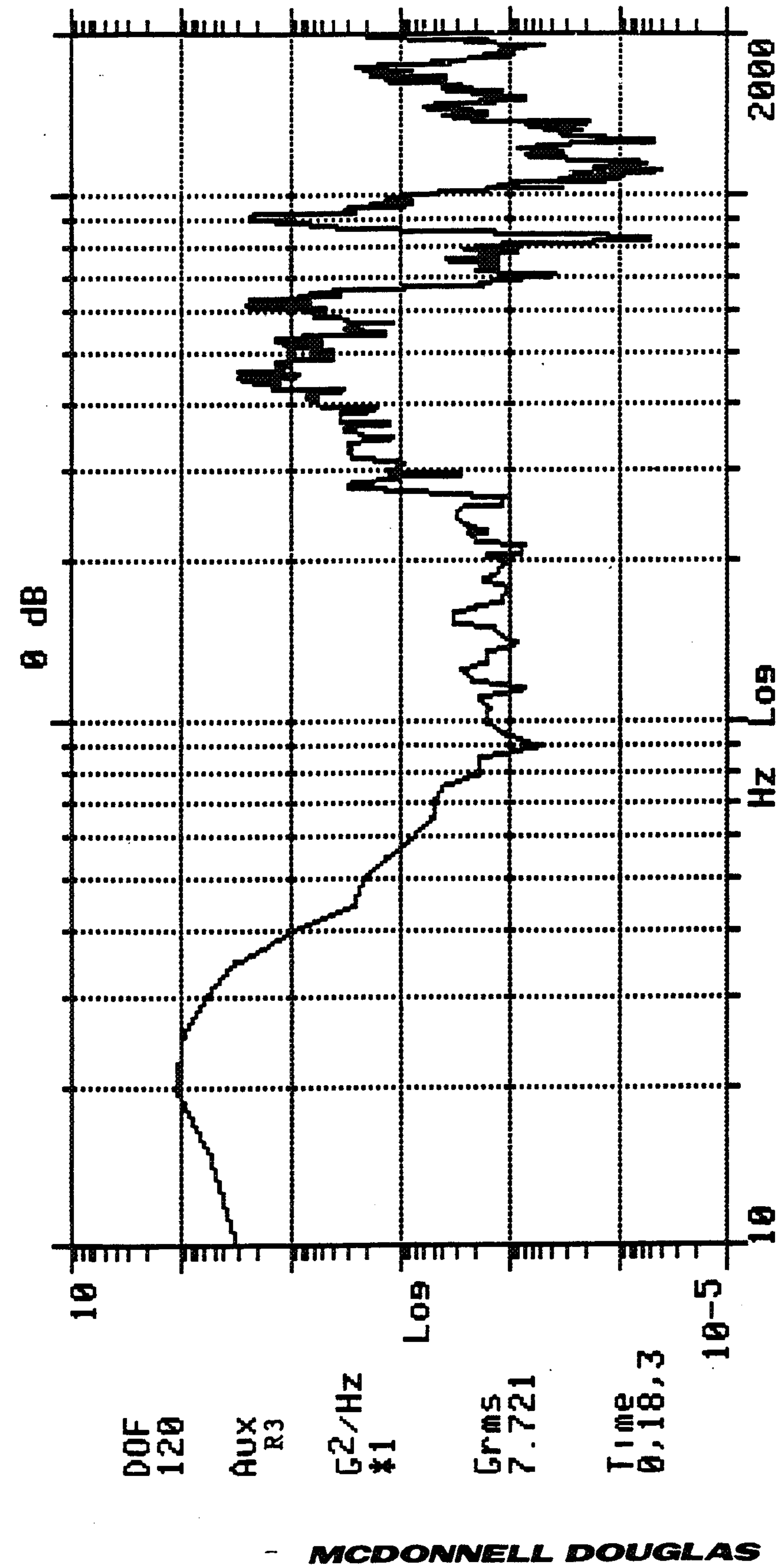
FIGURE 10



T/N 2 PERFORMANCE TEST VERT AXIS

FIGURE 11 - POWER SPECTRAL DENSITY ANALYSIS

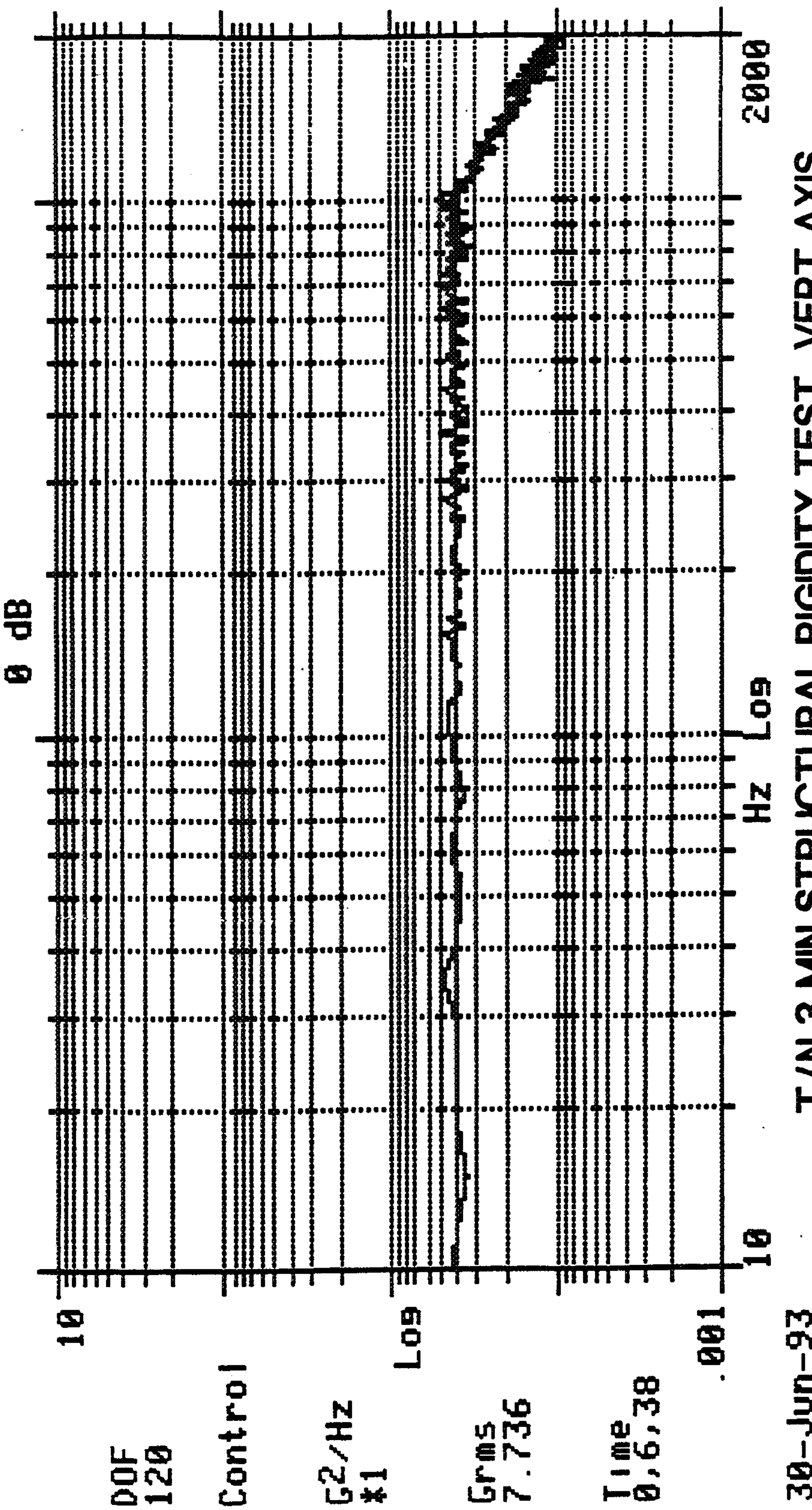
FIGURE 11



T/N 2 PERFORMANCE TEST VERT AXIS

FIGURE 12 – POWER SPECTRAL DENSITY ANALYSIS

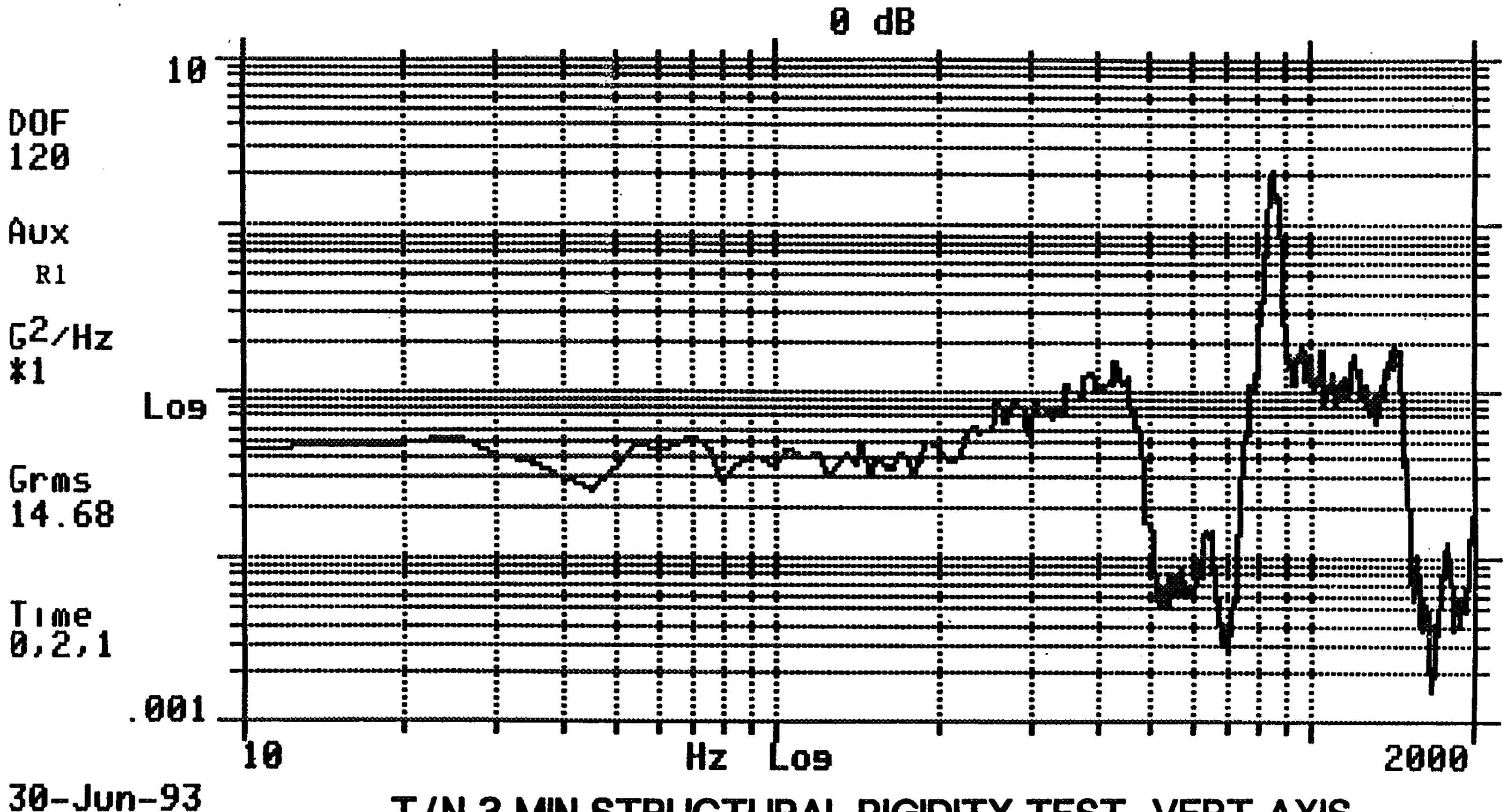
FIGURE 12



T/N 3 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

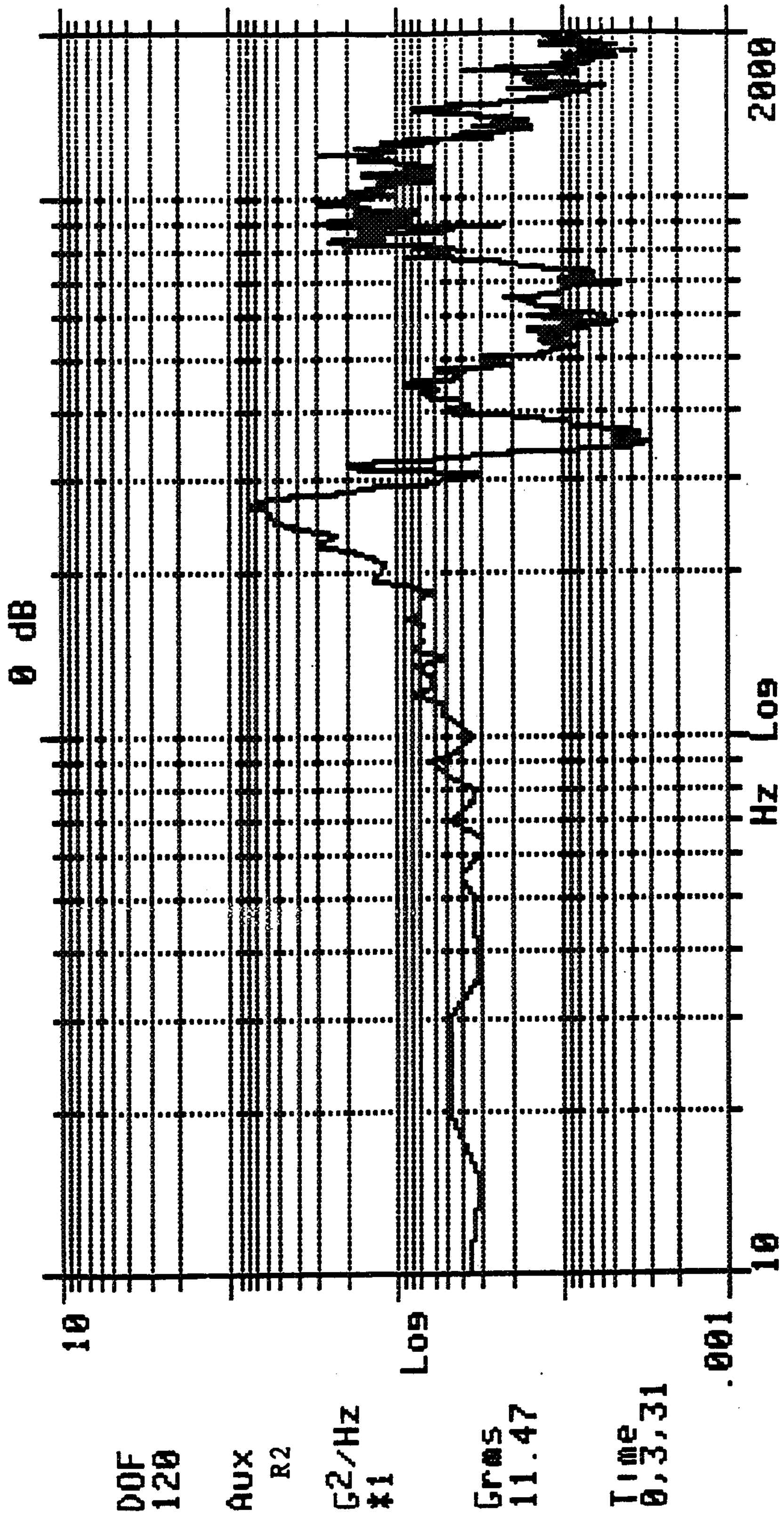
FIGURE 13 – RANDOM VIBRATION CONTROL SPECTRUM

FIGURE 13



T/N 3 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

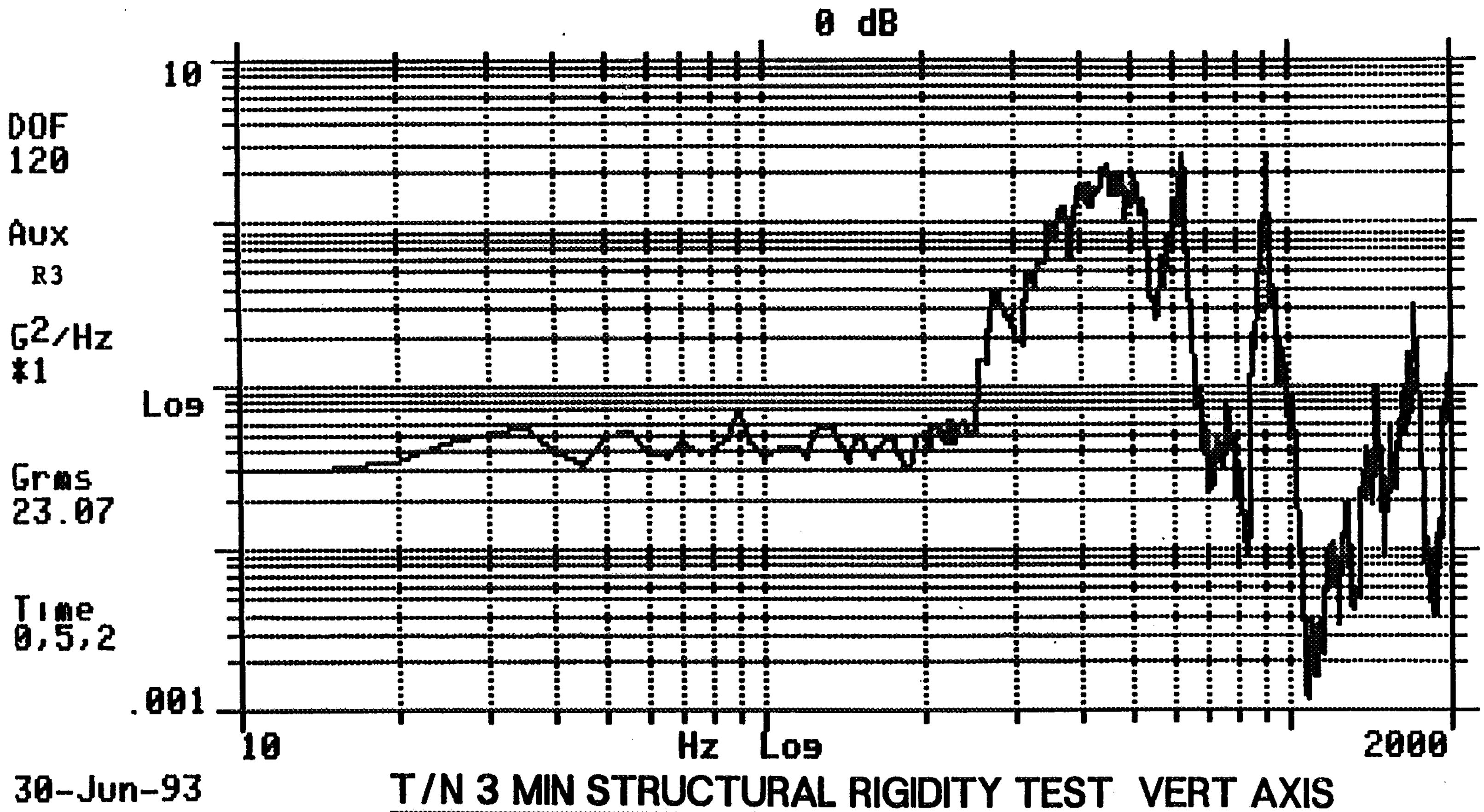
FIGURE 14 – POWER SPECTRAL DENSITY ANALYSIS



T/N 3 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

FIGURE 15 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 15



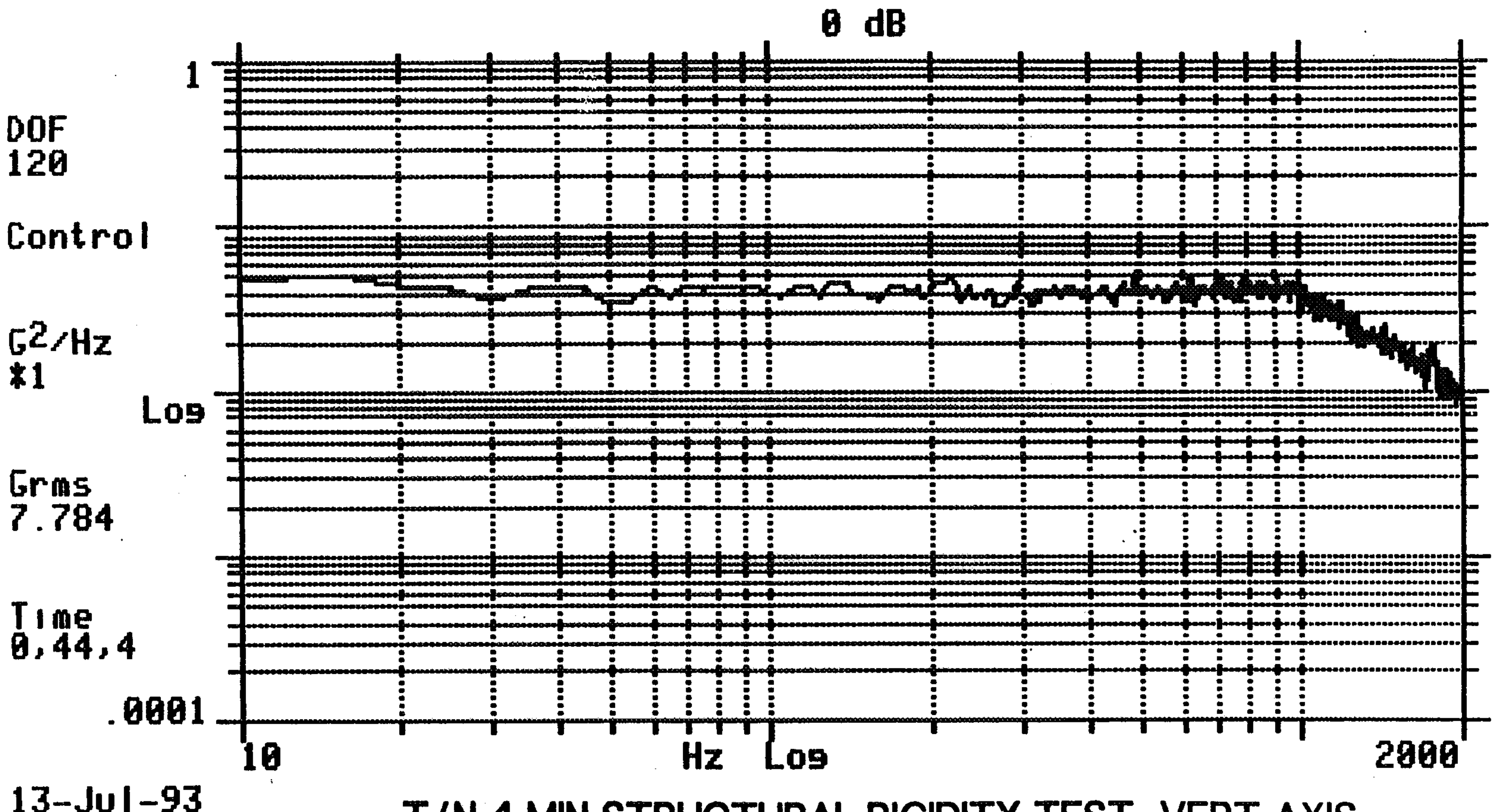
T/N 3 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

FIGURE 16 – POWER SPECTRAL DENSITY ANALYSIS

McDonnell Douglas Aerospace

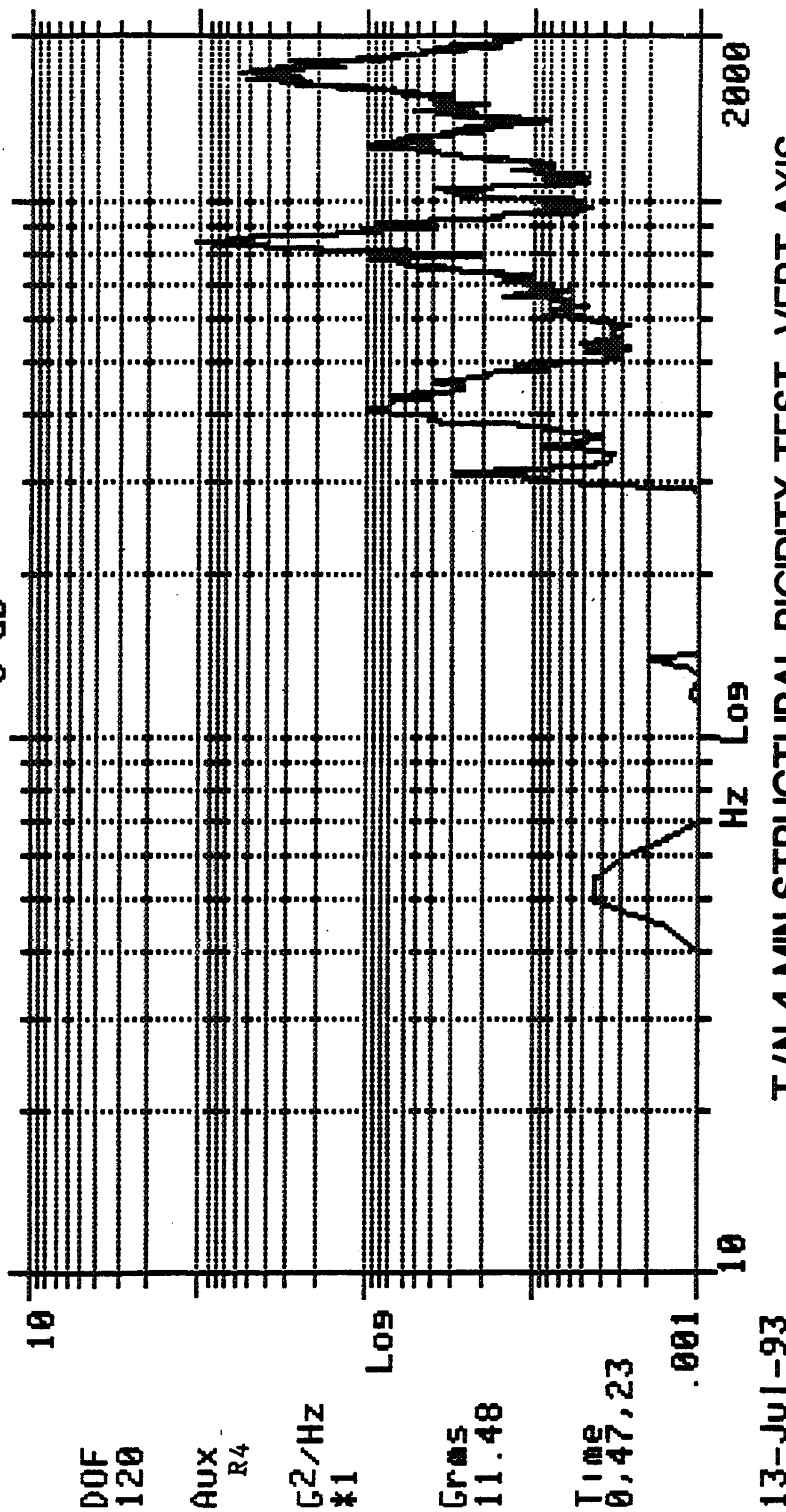
MCDONNELL DOUGLAS

FIGURE 16



T/N 4 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

FIGURE 17 – RANDOM VIBRATION CONTROL SPECTRUM

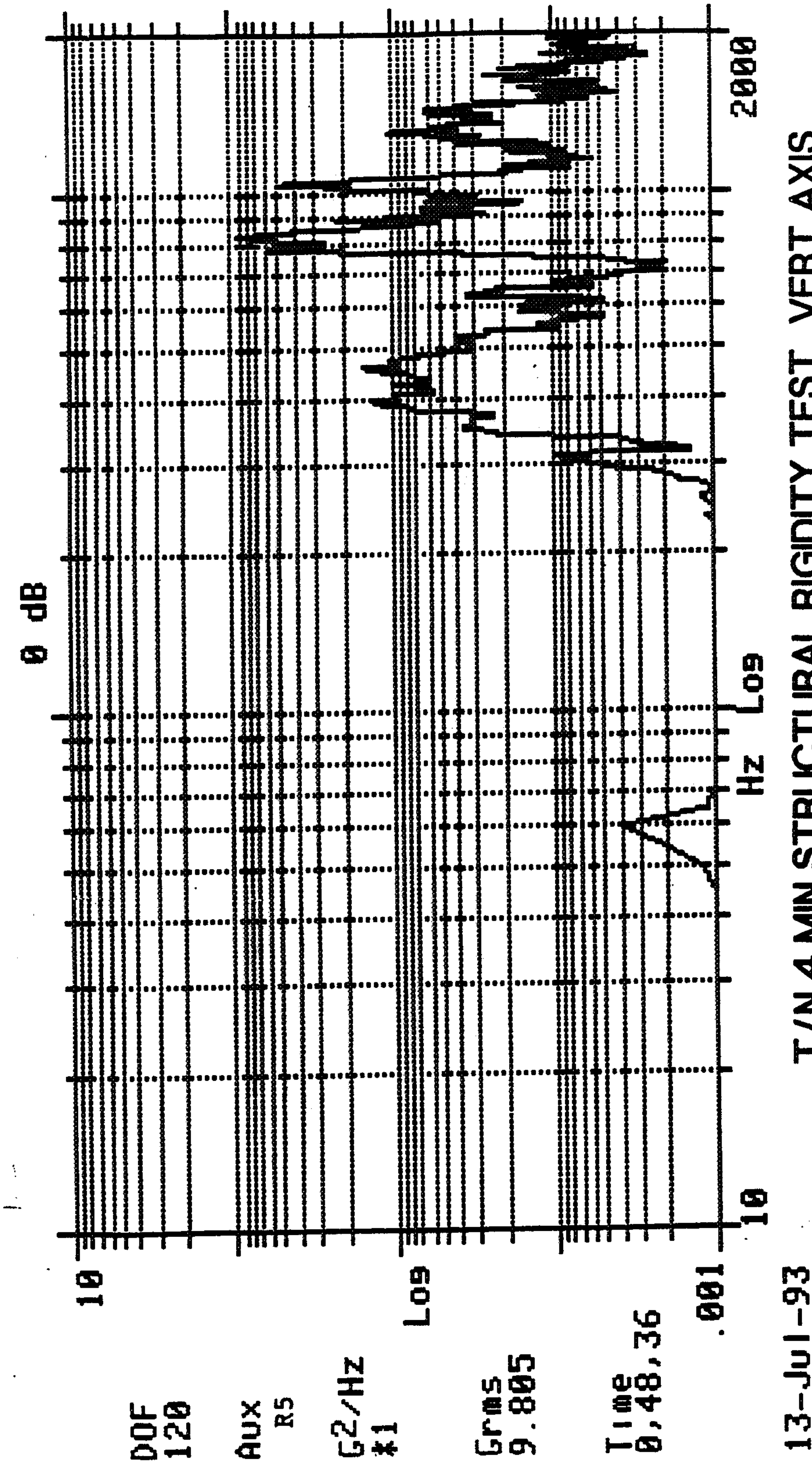


T/N 4 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

FIGURE 18 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 18

McDonnell Douglas Aerospace

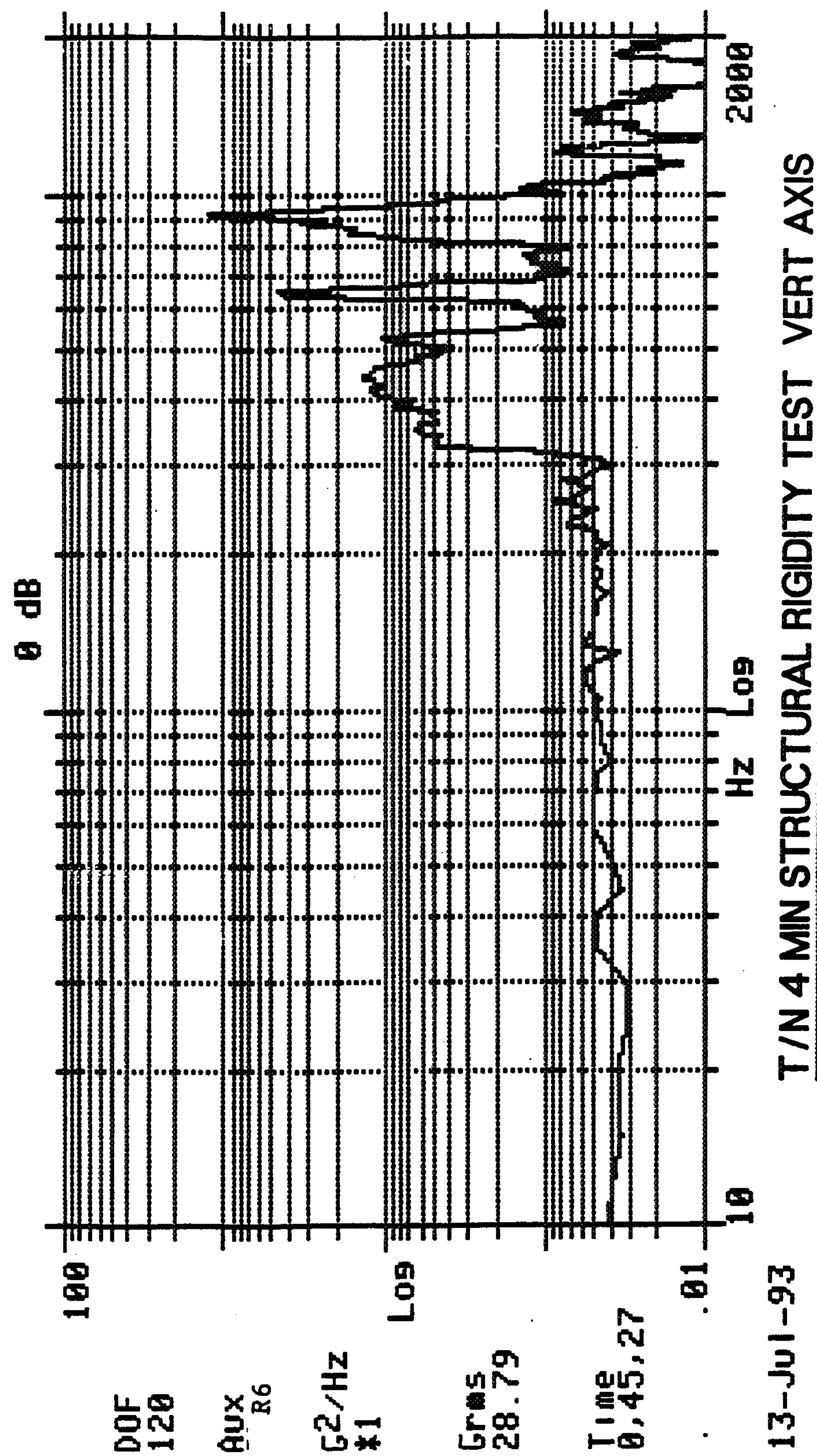


T/N 4 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

FIGURE 19 – POWER SPECTRAL DENSITY ANALYSIS

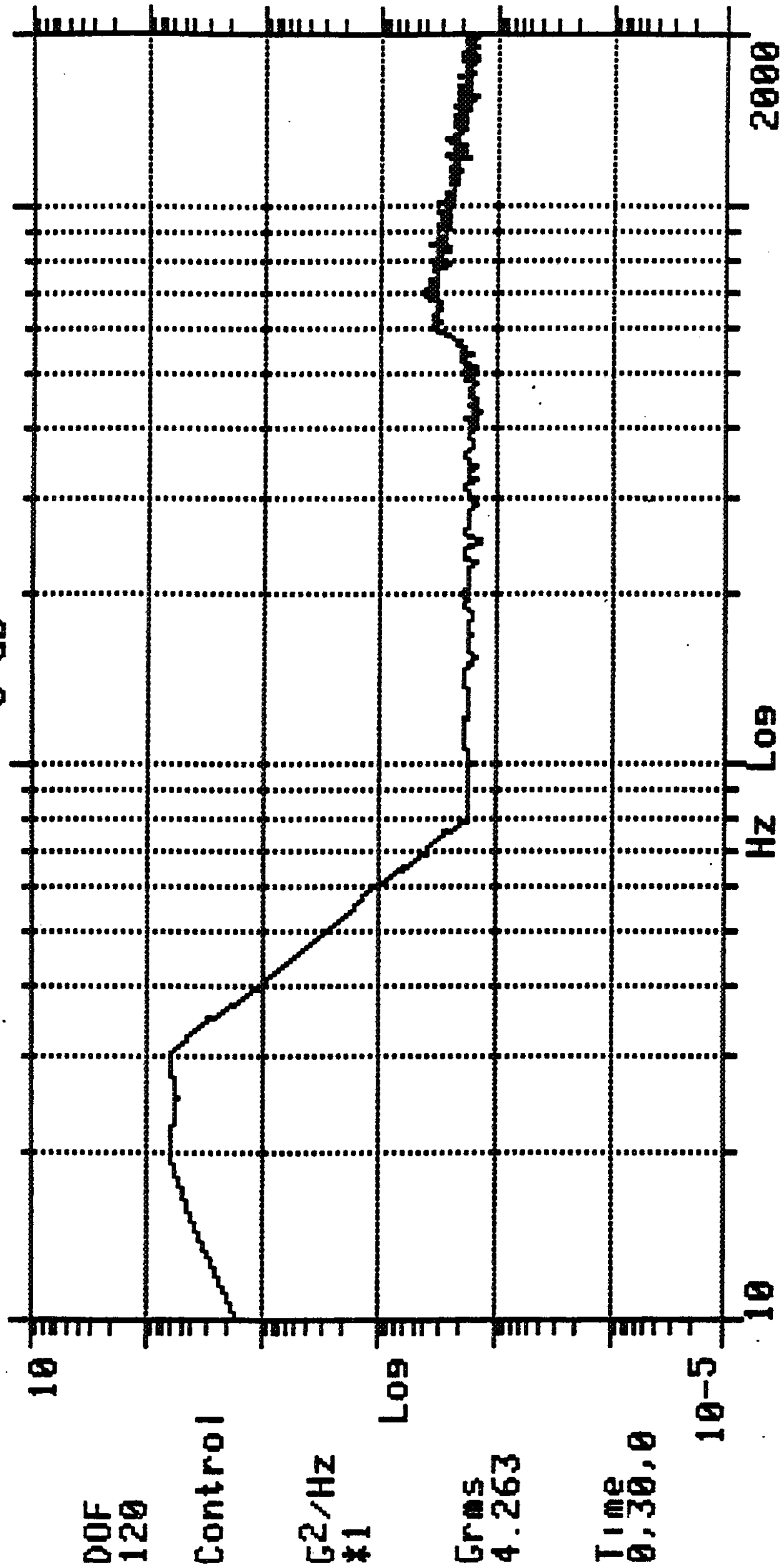
FIGURE 19

McDonnell Douglas Aerospace



T/N 4 MIN STRUCTURAL RIGIDITY TEST VERT AXIS

FIGURE 20 – POWER SPECTRAL DENSITY ANALYSIS

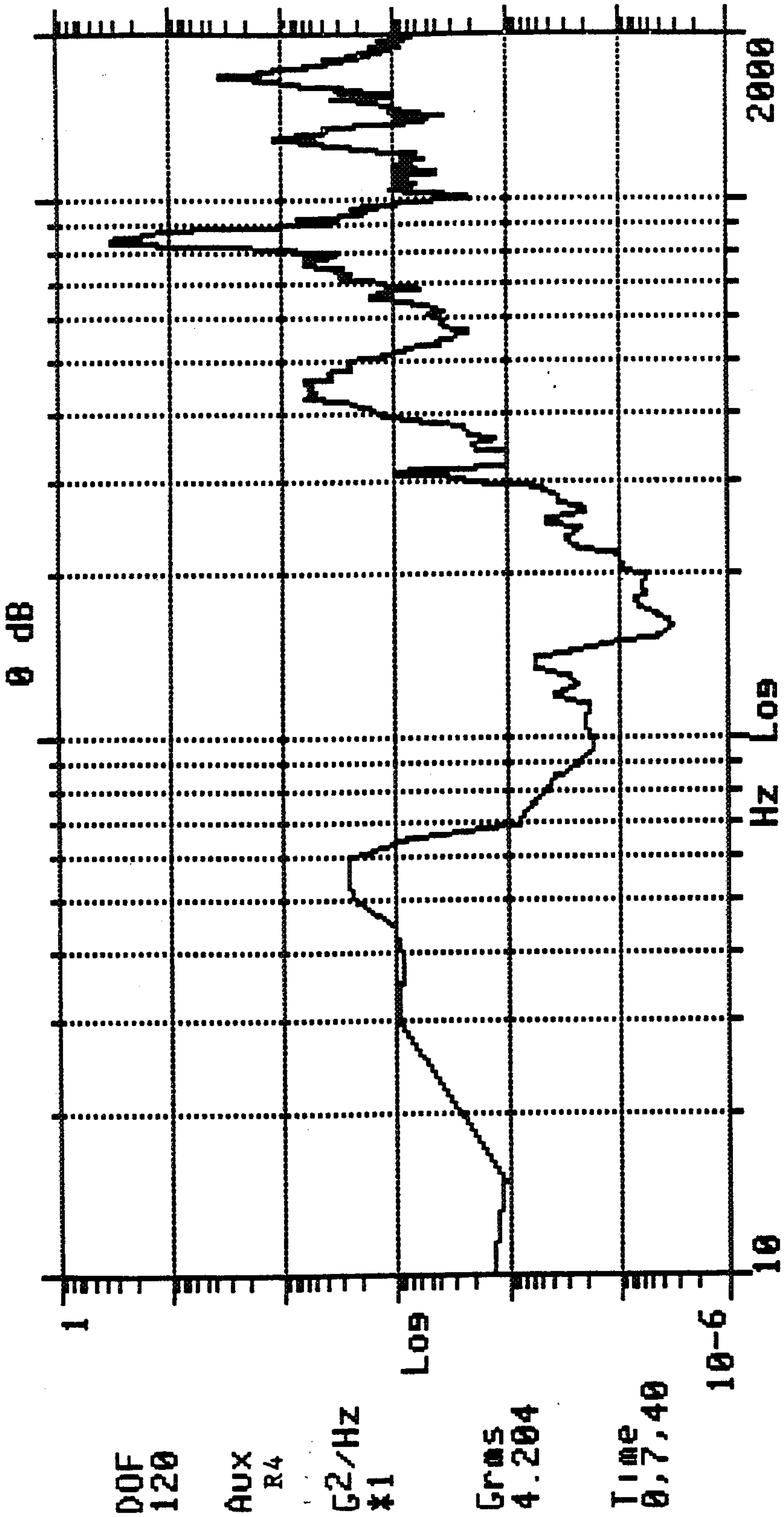


T/N 5 PERFORMANCE TEST VERT AXIS

FIGURE 21 – RANDOM VIBRATION CONTROL SPECTRUM

FIGURE 21

McDonnell Douglas Aerospace

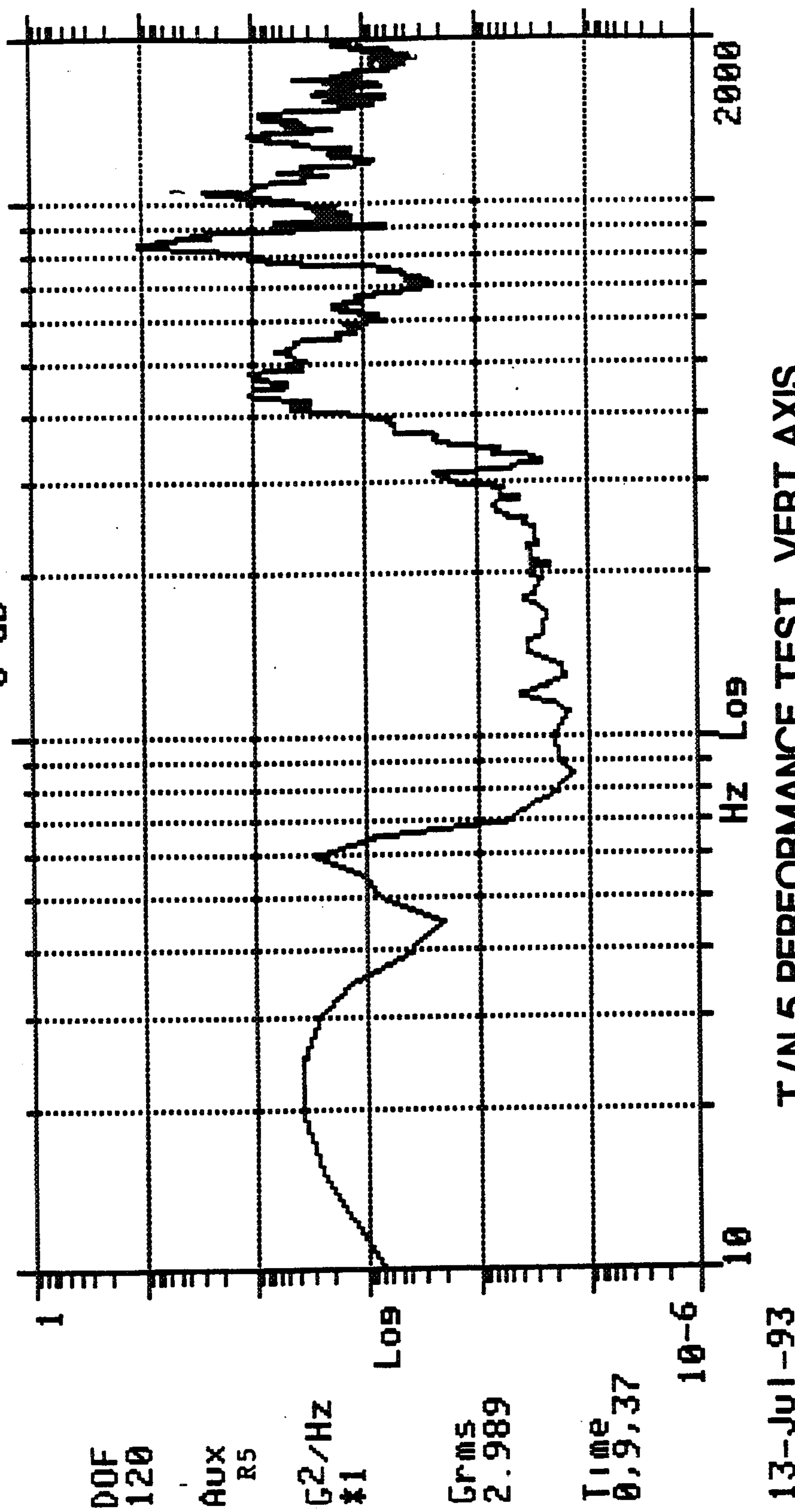


T/N 5 PERFORMANCE TEST VERT AXIS

FIGURE 22 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 22

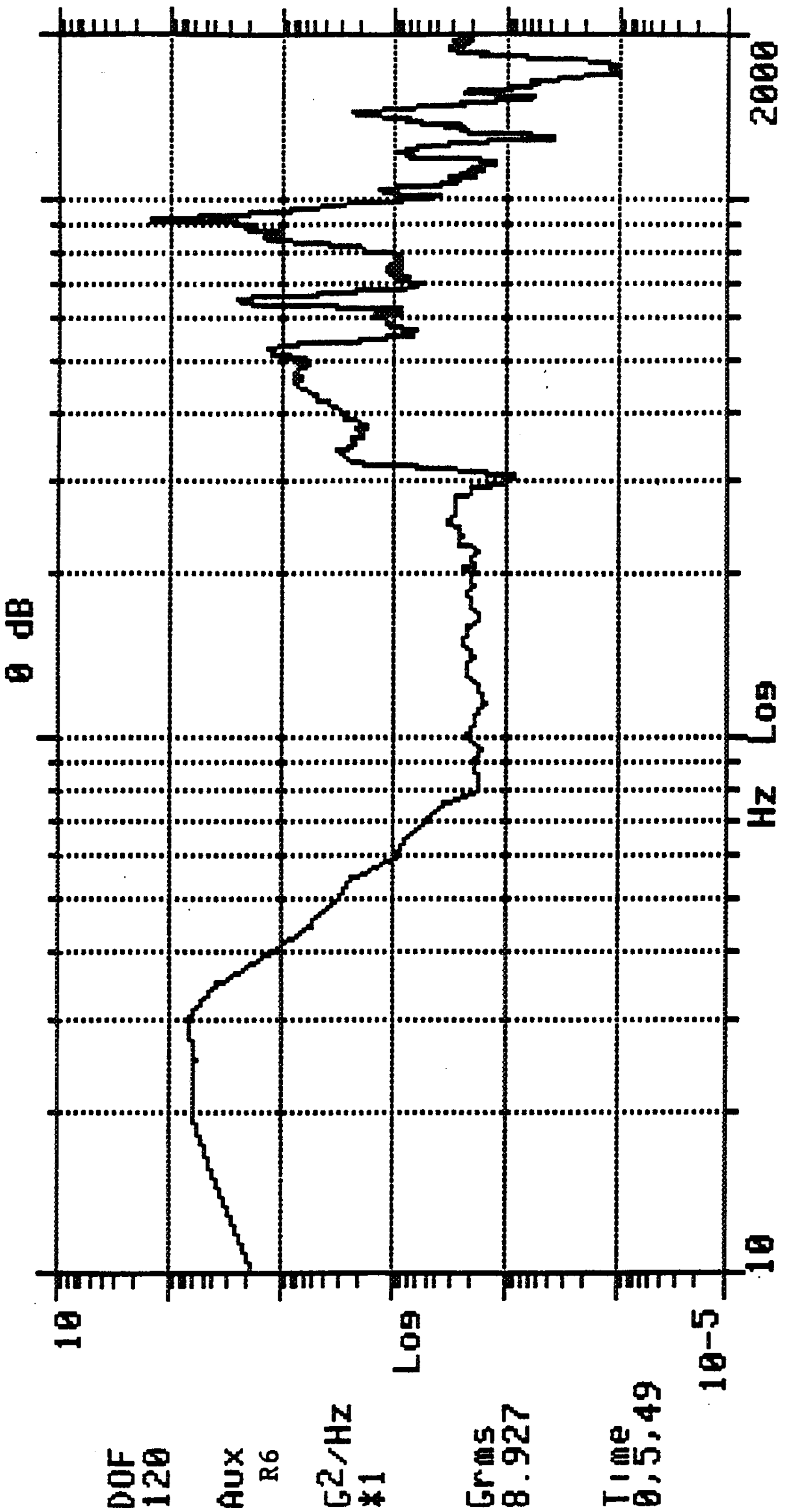
McDonnell Douglas Aerospace



T/N 5 PERFORMANCE TEST VERT AXIS

FIGURE 23 – POWER SPECTRAL DENSITY ANALYSIS

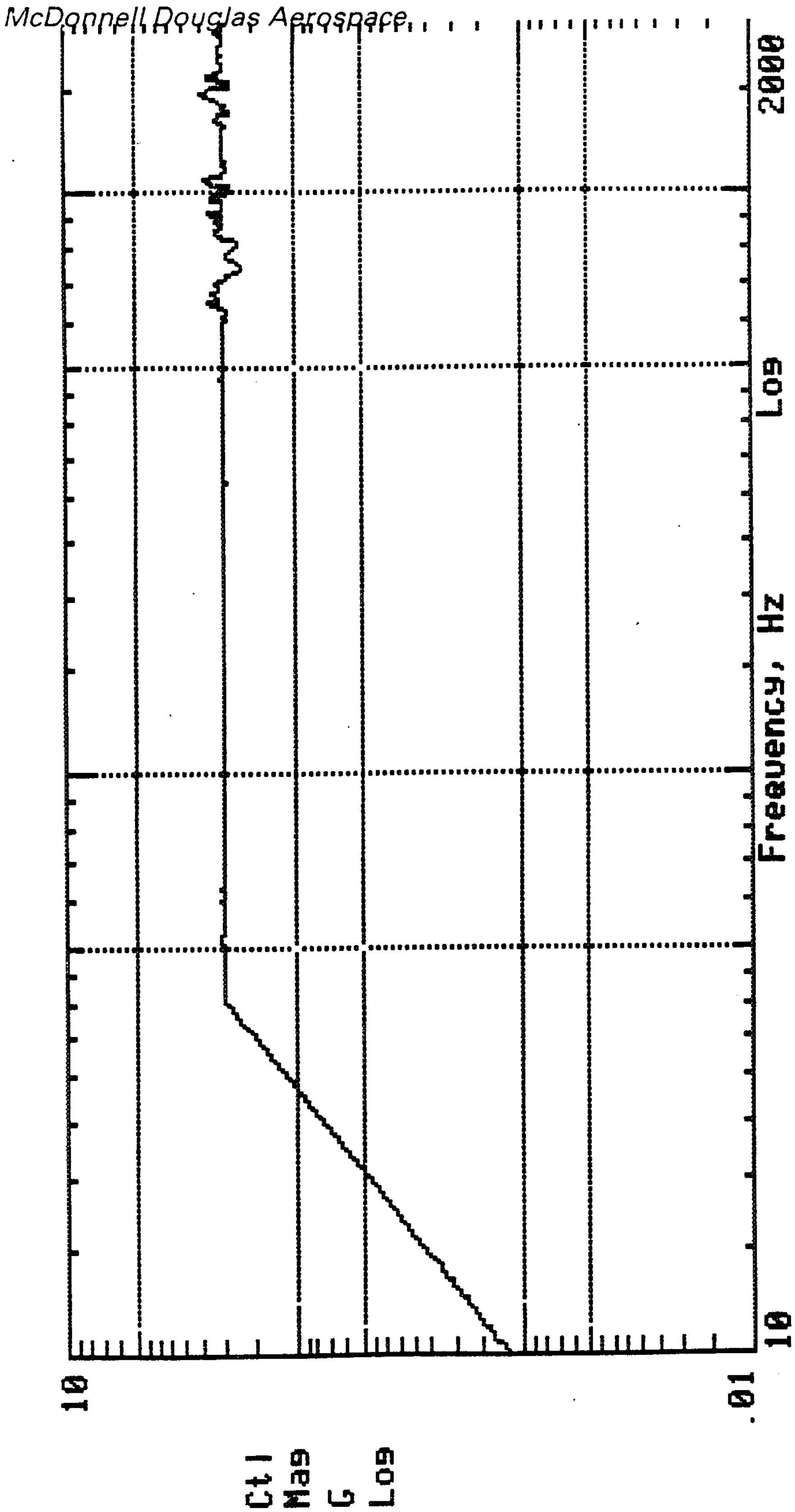
FIGURE 23



T/N 5 PERFORMANCE TEST VERT AXIS

FIGURE 24 – POWER SPECTRAL DENSITY ANALYSIS

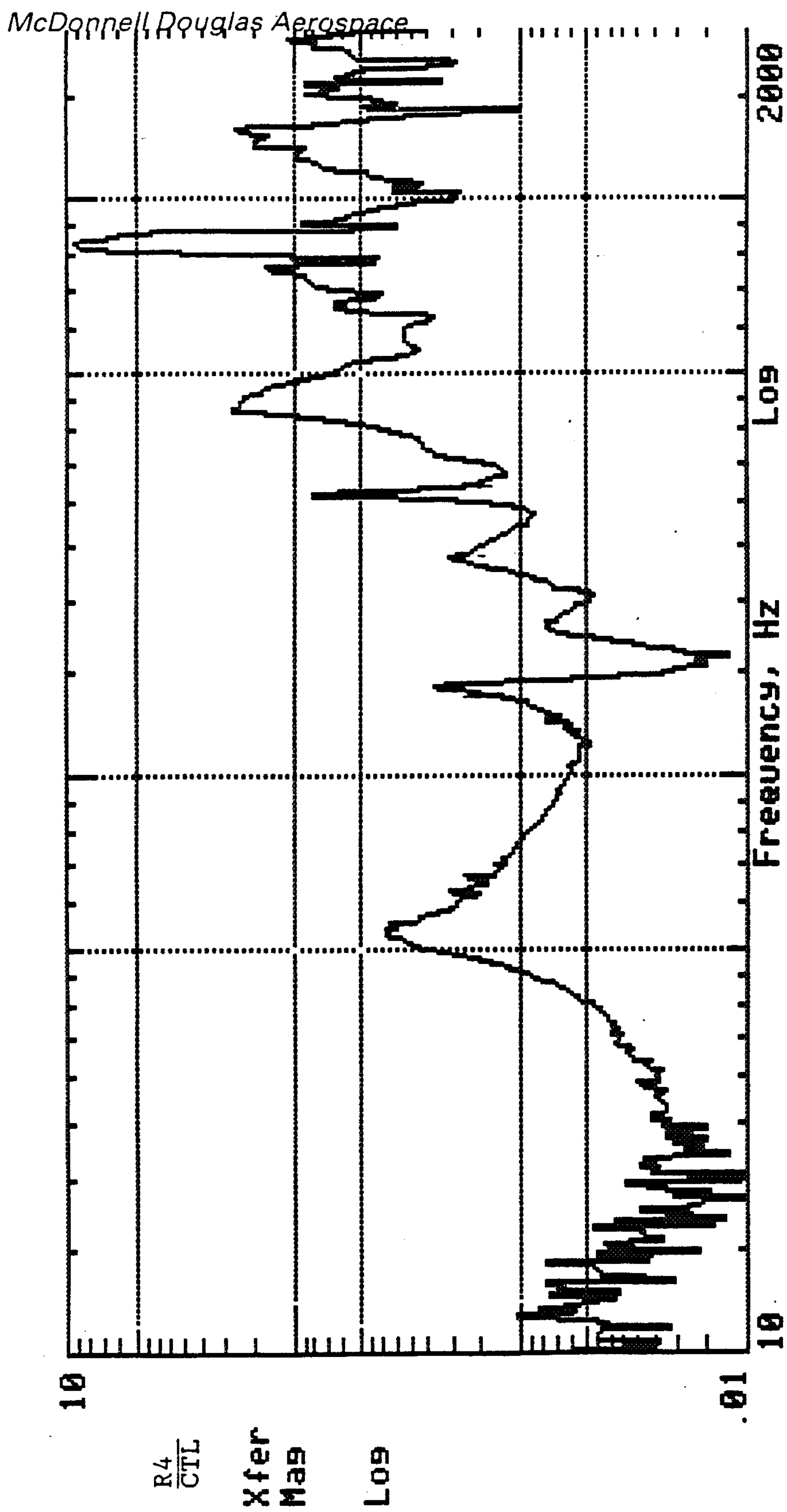
FIGURE 24



T/N 6 SINE RESONANCE SURVEY VERT AXIS

FIGURE 25 – SINE VIBRATION CONTROL

FIGURE 25

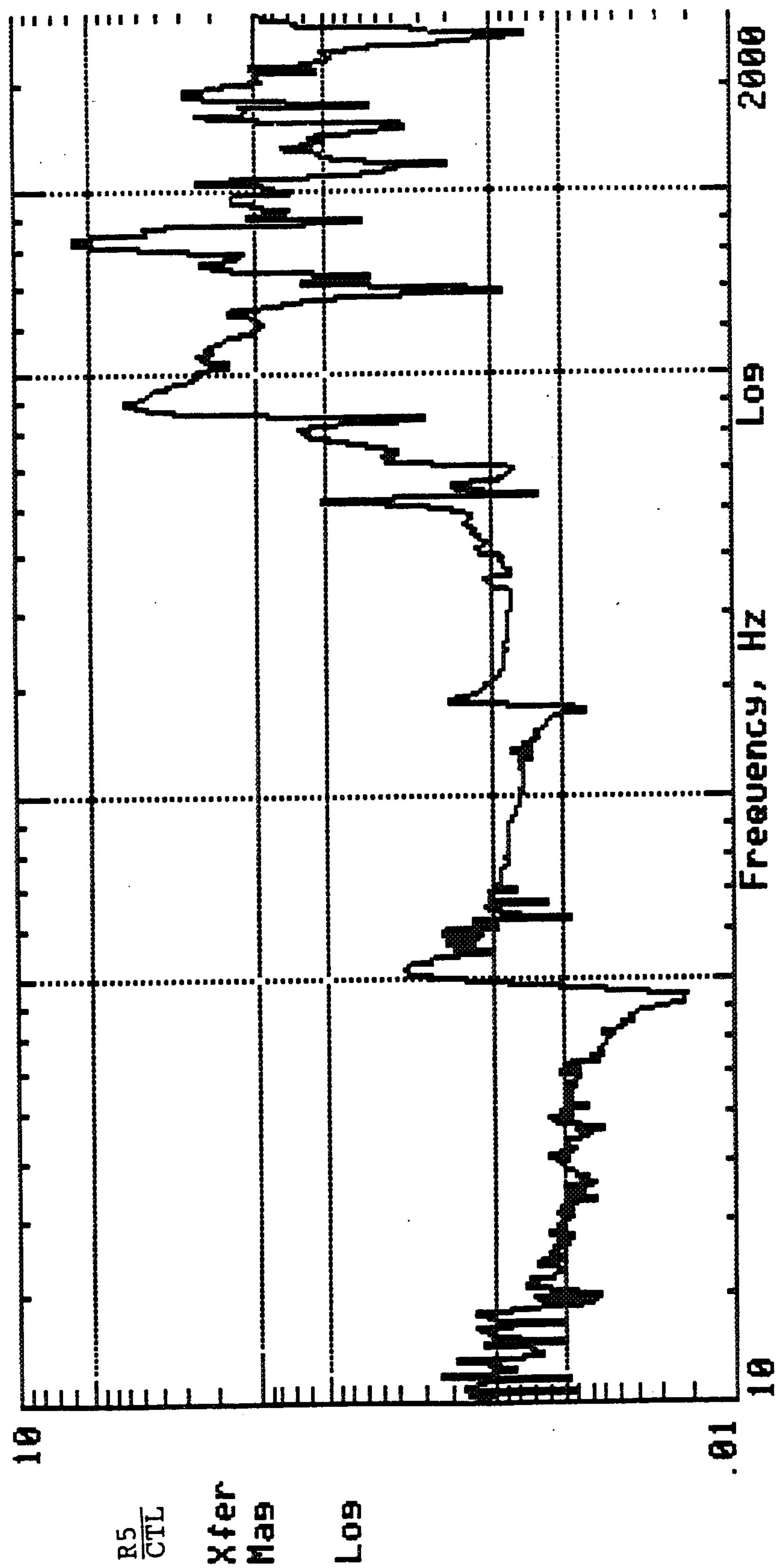


T/N 6 SINE RESONANCE SURVEY VERT AXIS

FIGURE 26 – FREQUENCY RESPONSE

FIGURE 26

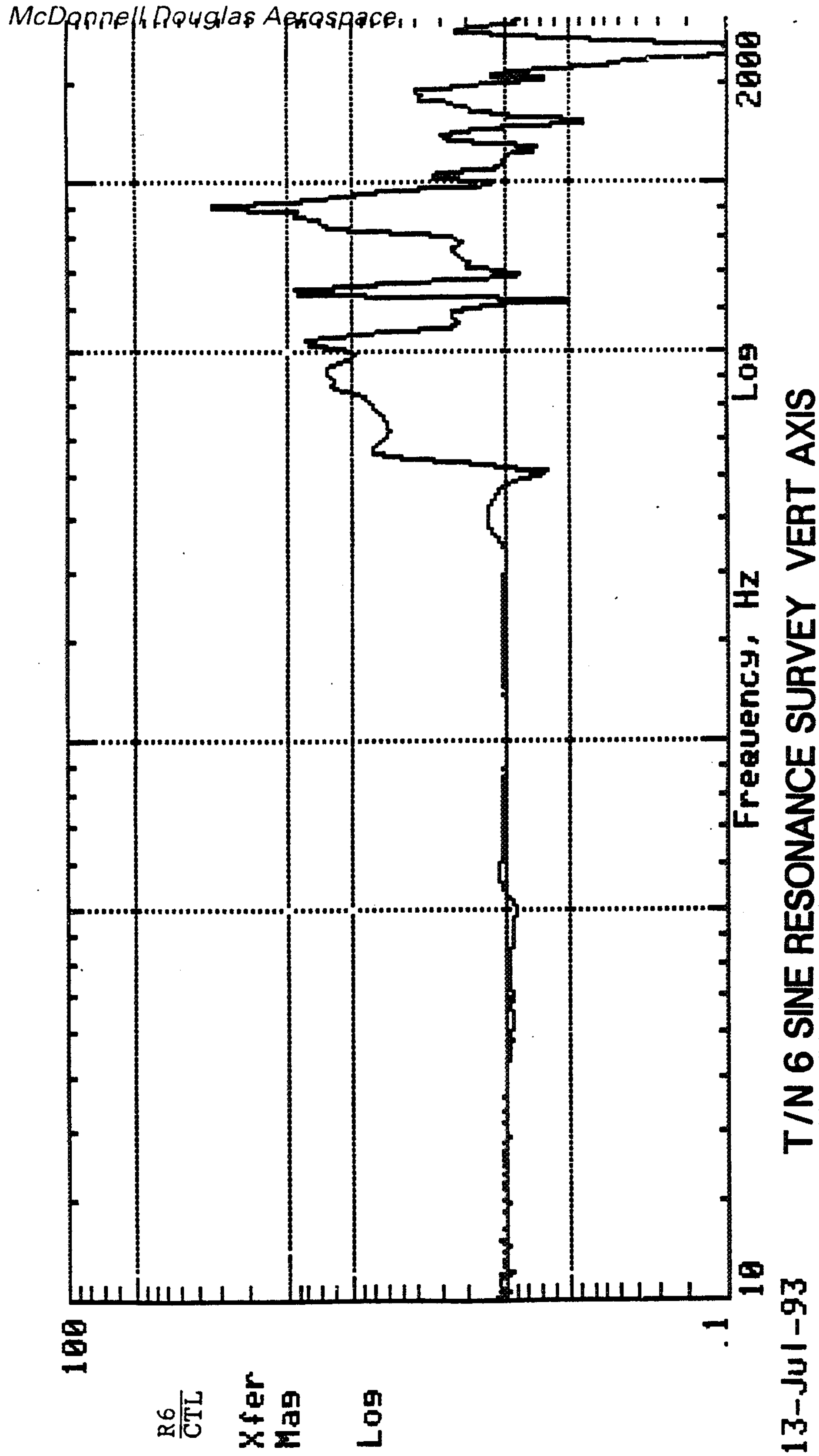
McDonnell Douglas Aerospace



T/N 6 SINE RESONANCE SURVEY VERT AXIS

FIGURE 27 – FREQUENCY RESPONSE

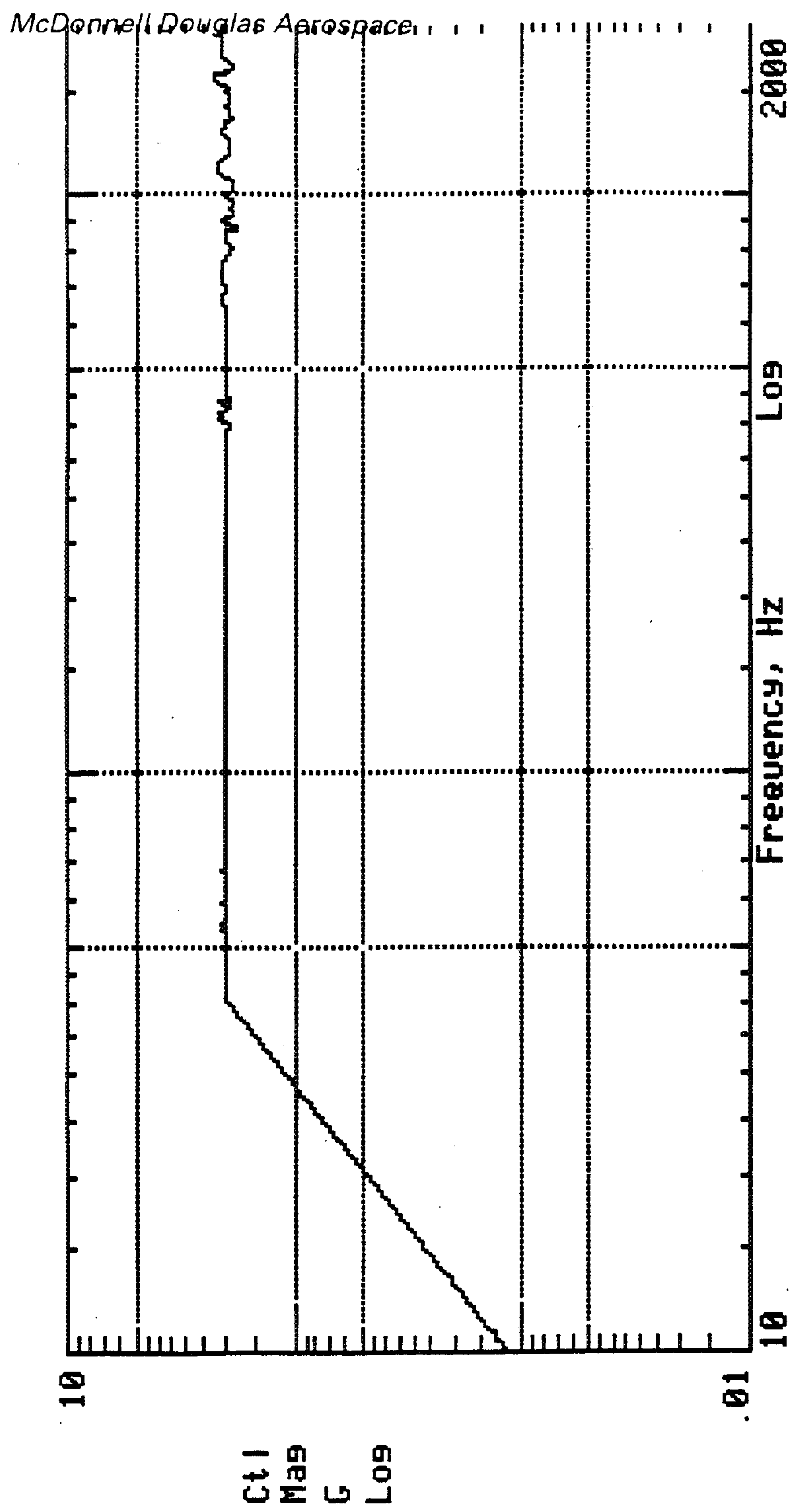
FIGURE 27



T/N 6 SINE RESONANCE SURVEY VERT AXIS

FIGURE 28 -- FREQUENCY RESPONSE

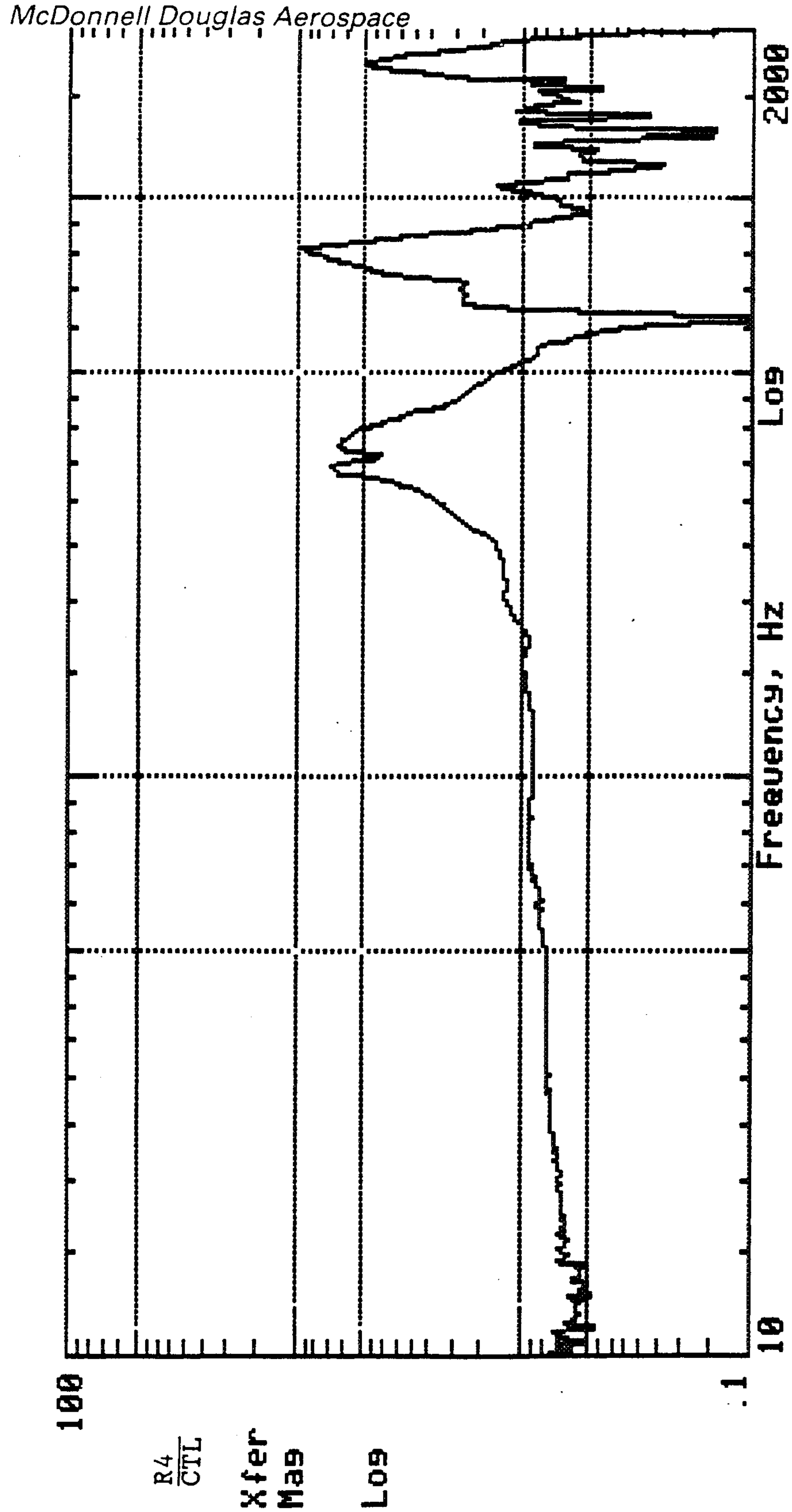
FIGURE 28



T/N 7 SINE RESONANCE SURVEY LAT AXIS

FIGURE 29 – SINE VIBRATION CONTROL

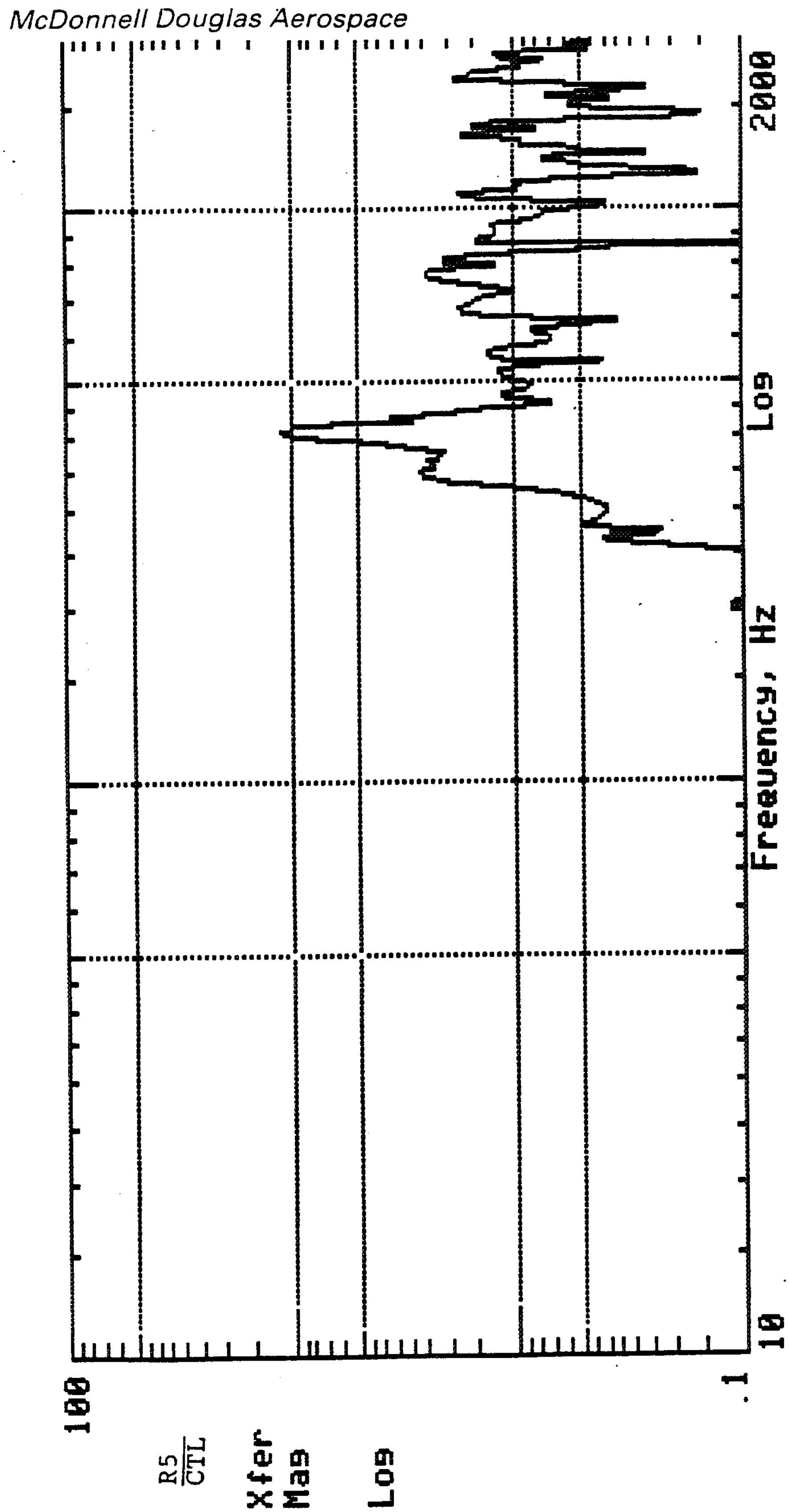
FIGURE 29



T/N 7 SINE RESONANCE SURVEY LAT AXIS

FIGURE 30 – FREQUENCY RESPONSE

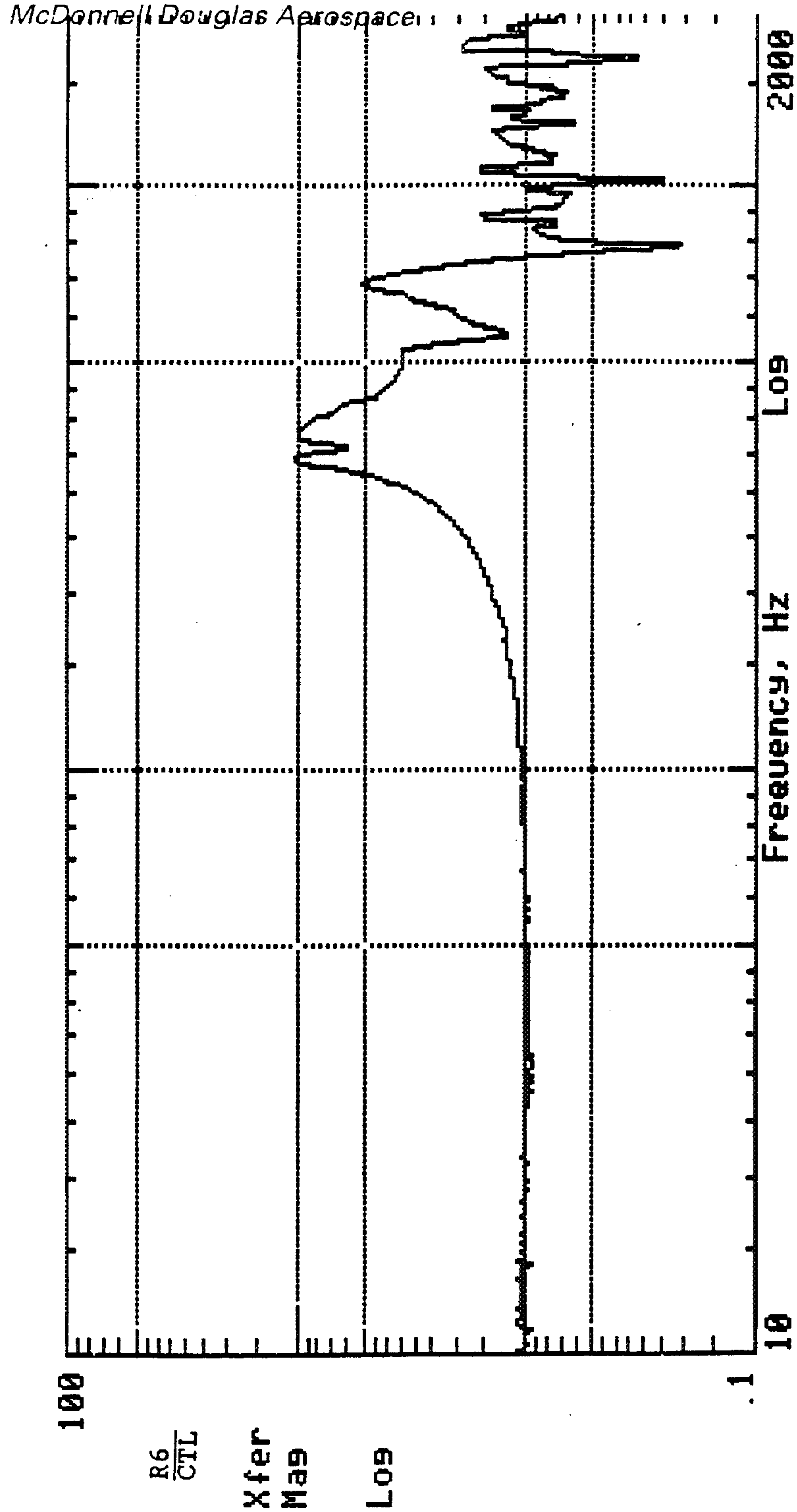
FIGURE 30



T/N 7 SINE RESONANCE SURVEY LAT AXIS

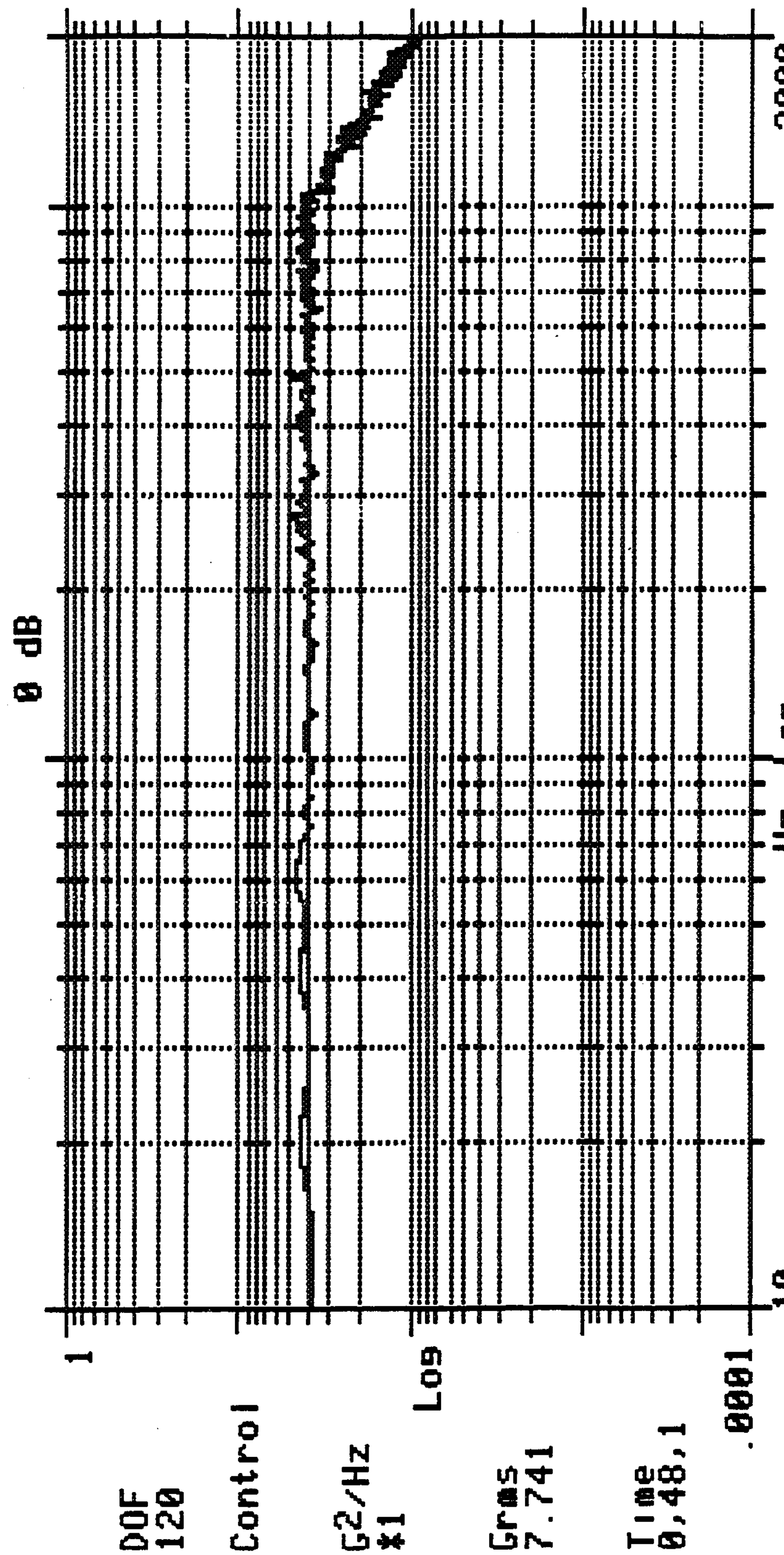
FIGURE 31 – FREQUENCY RESPONSE

FIGURE 31



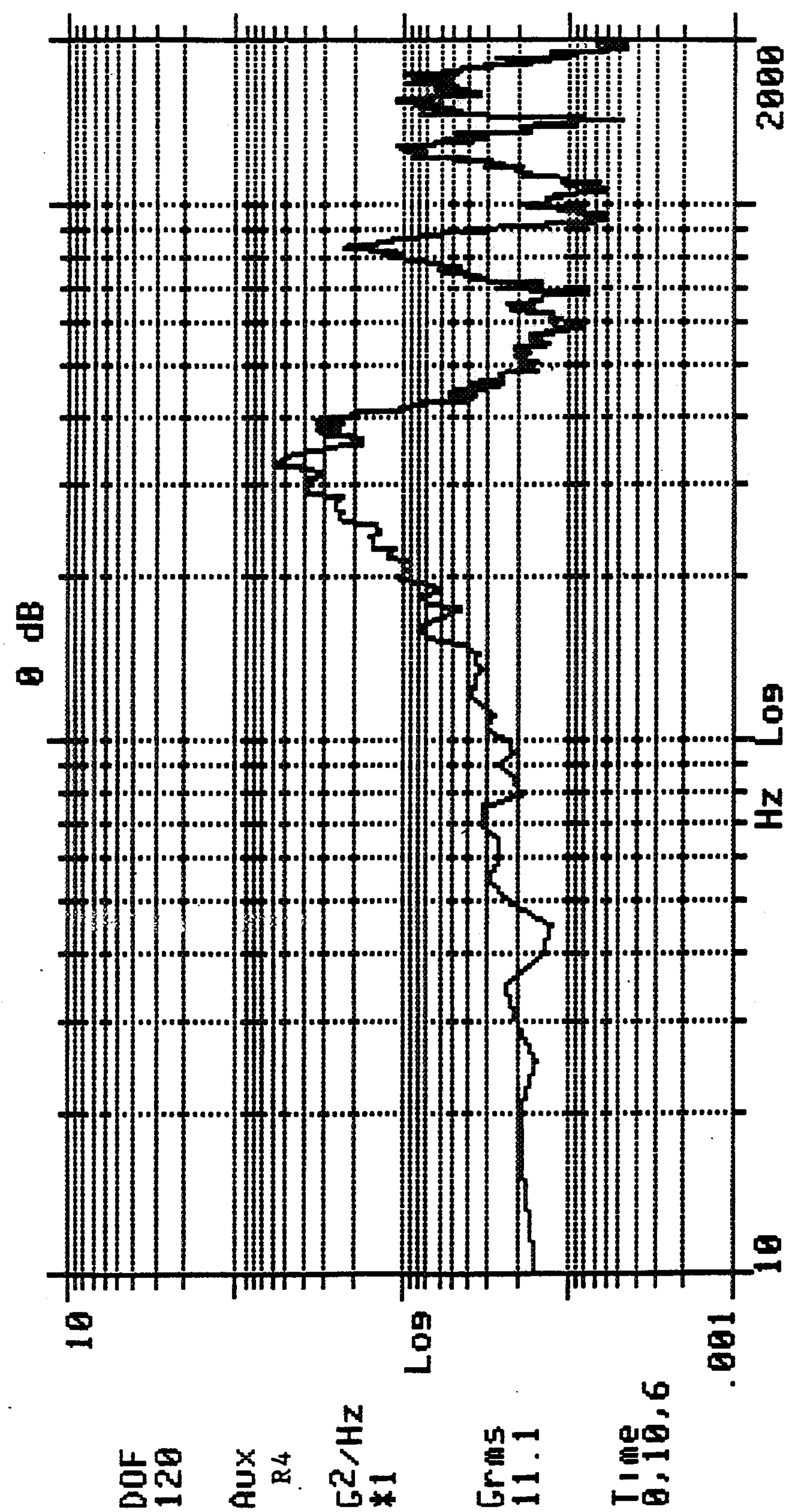
T/N 7 SINE RESONANCE SURVEY LAT AXIS

FIGURE 32 – FREQUENCY RESPONSE



T/N 8 MIN STRUCTURAL RIGIDITY TEST LAT AXIS

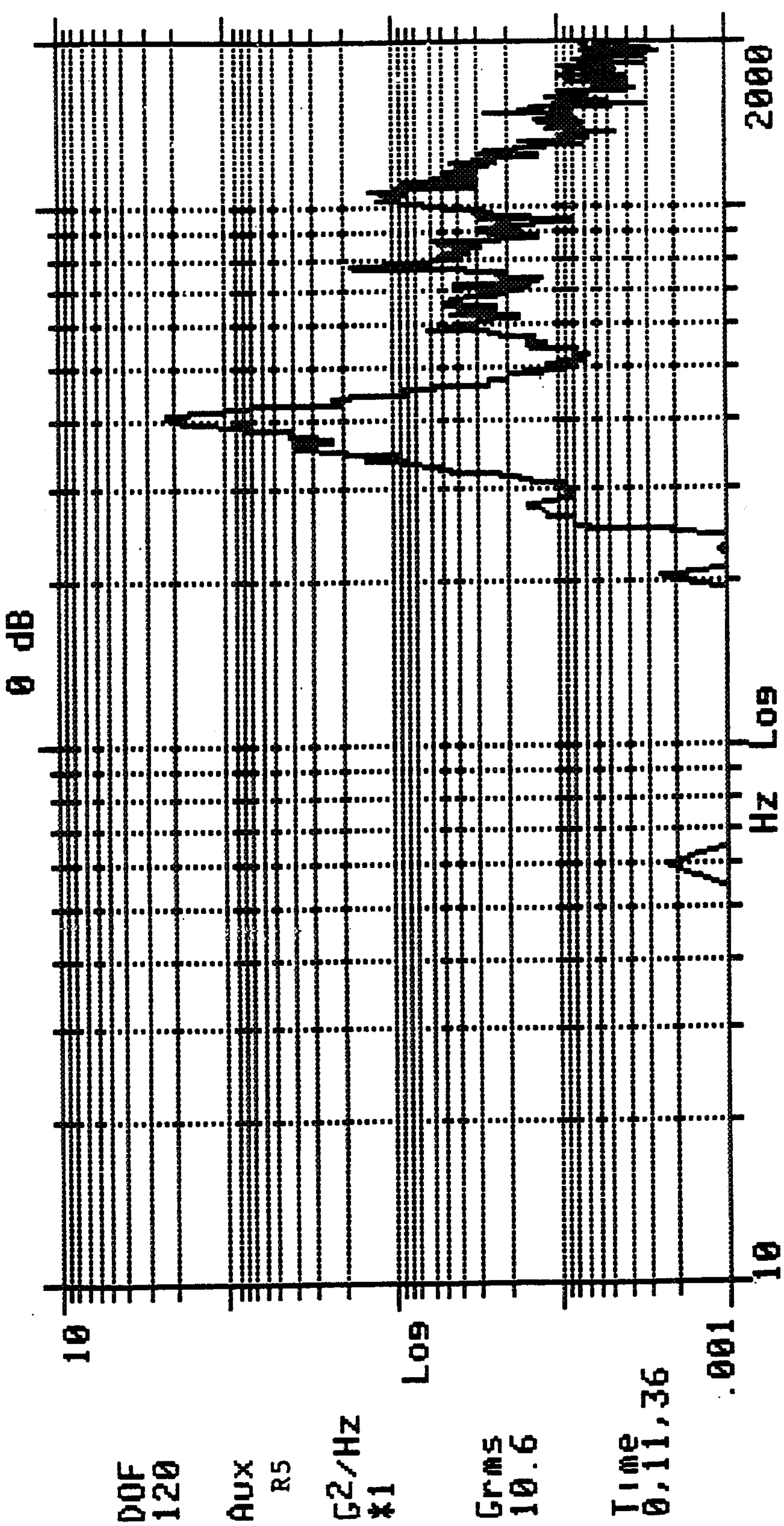
FIGURE 33 – RANDOM VIBRATION CONTROL SPECTRUM



T/N 8 MIN STRUCTURAL RIGIDITY TEST LAT AXIS

FIGURE 34 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 34

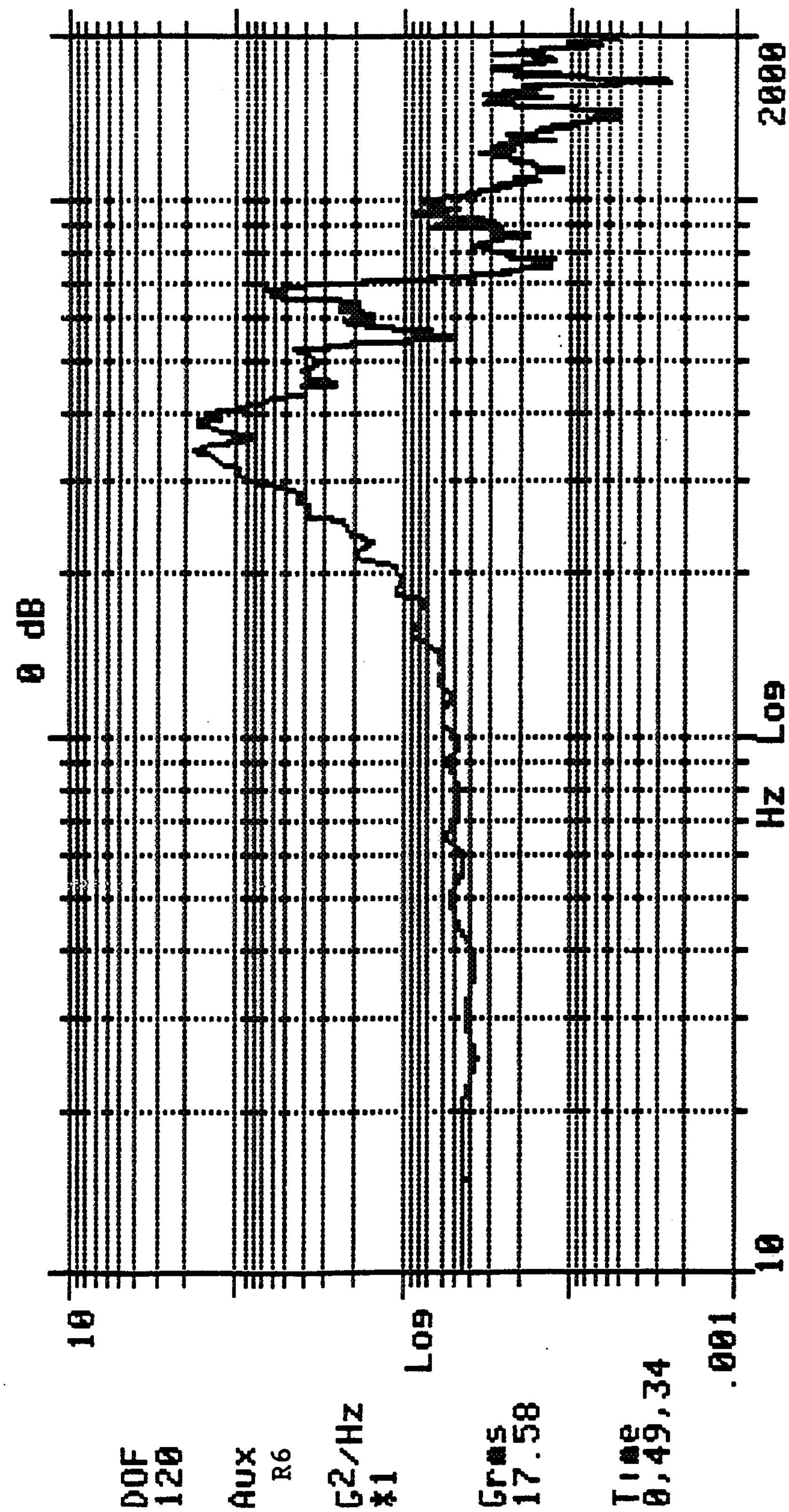


T/N 8 MIN STRUCTURAL RIGIDITY TEST LAT AXIS

FIGURE 35 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 35

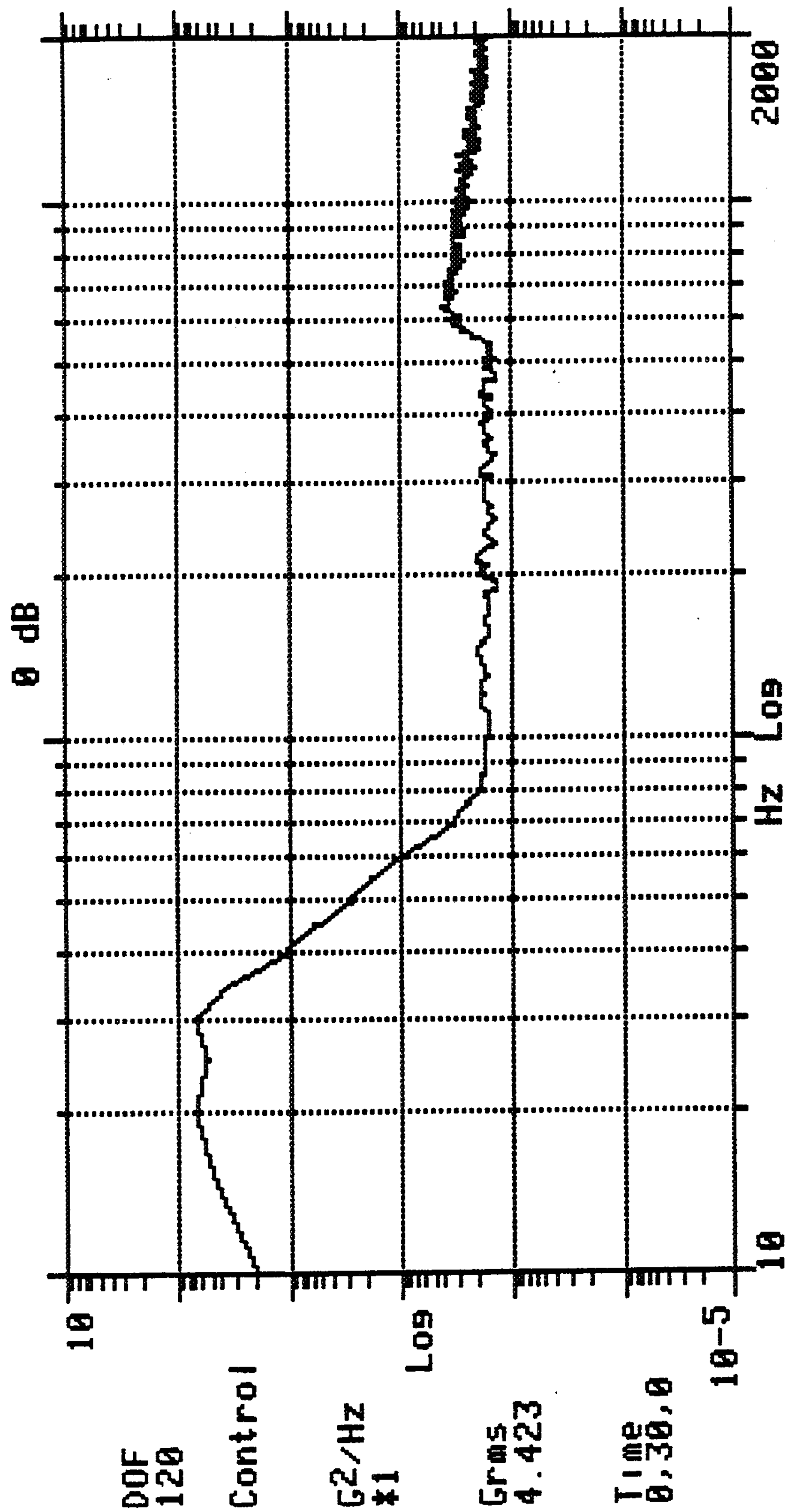
McDonnell Douglas Aerospace



T/N 8 MIN STRUCTURAL RIGIDITY TEST LAT AXIS

FIGURE 36 – POWER SPECTRAL DENSITY ANALYSIS

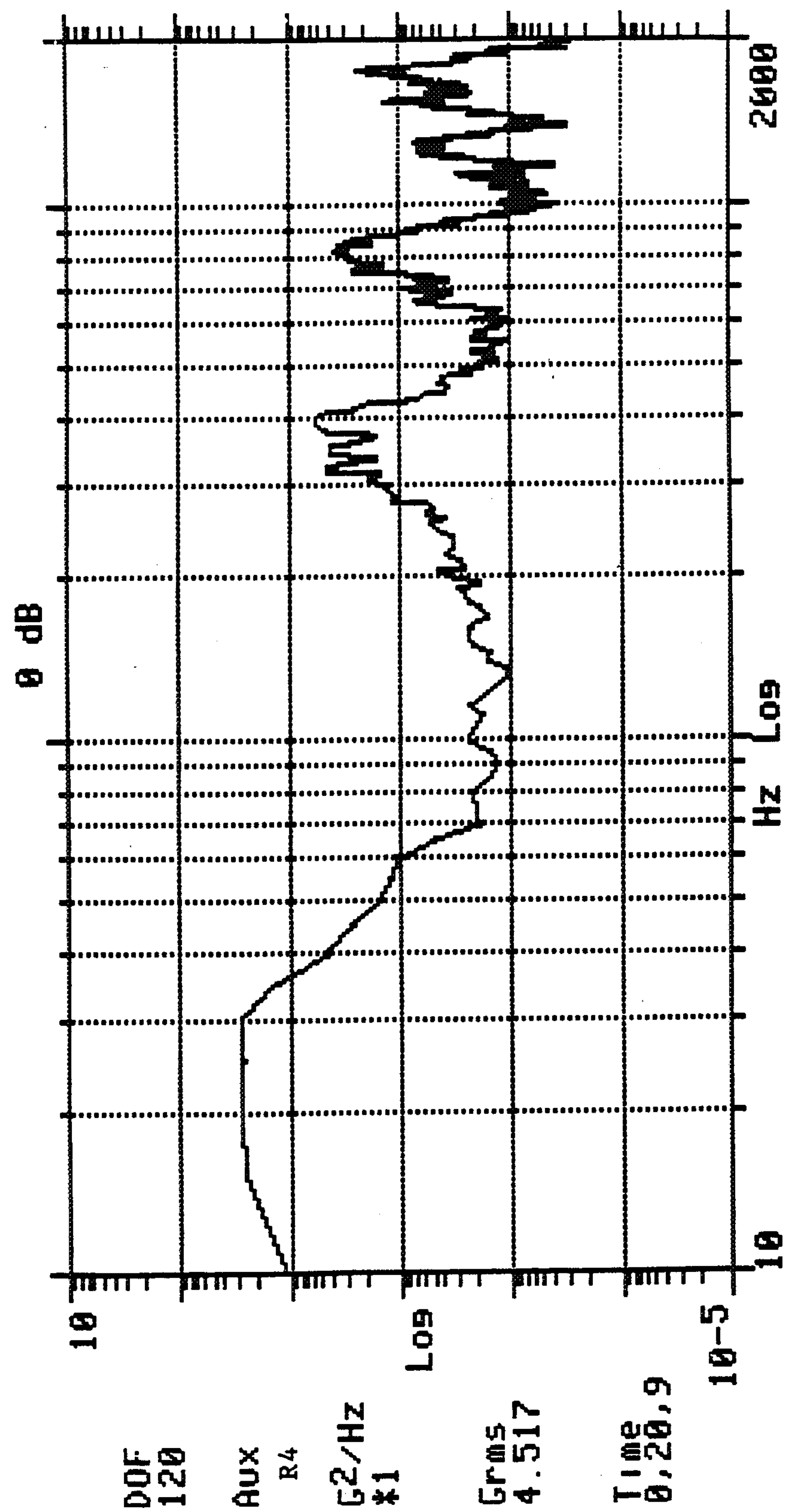
FIGURE 36



T/N 9 PERFORMANCE TEST VERT AXIS

FIGURE 37 – RANDOM VIBRATION CONTROL SPECTRUM

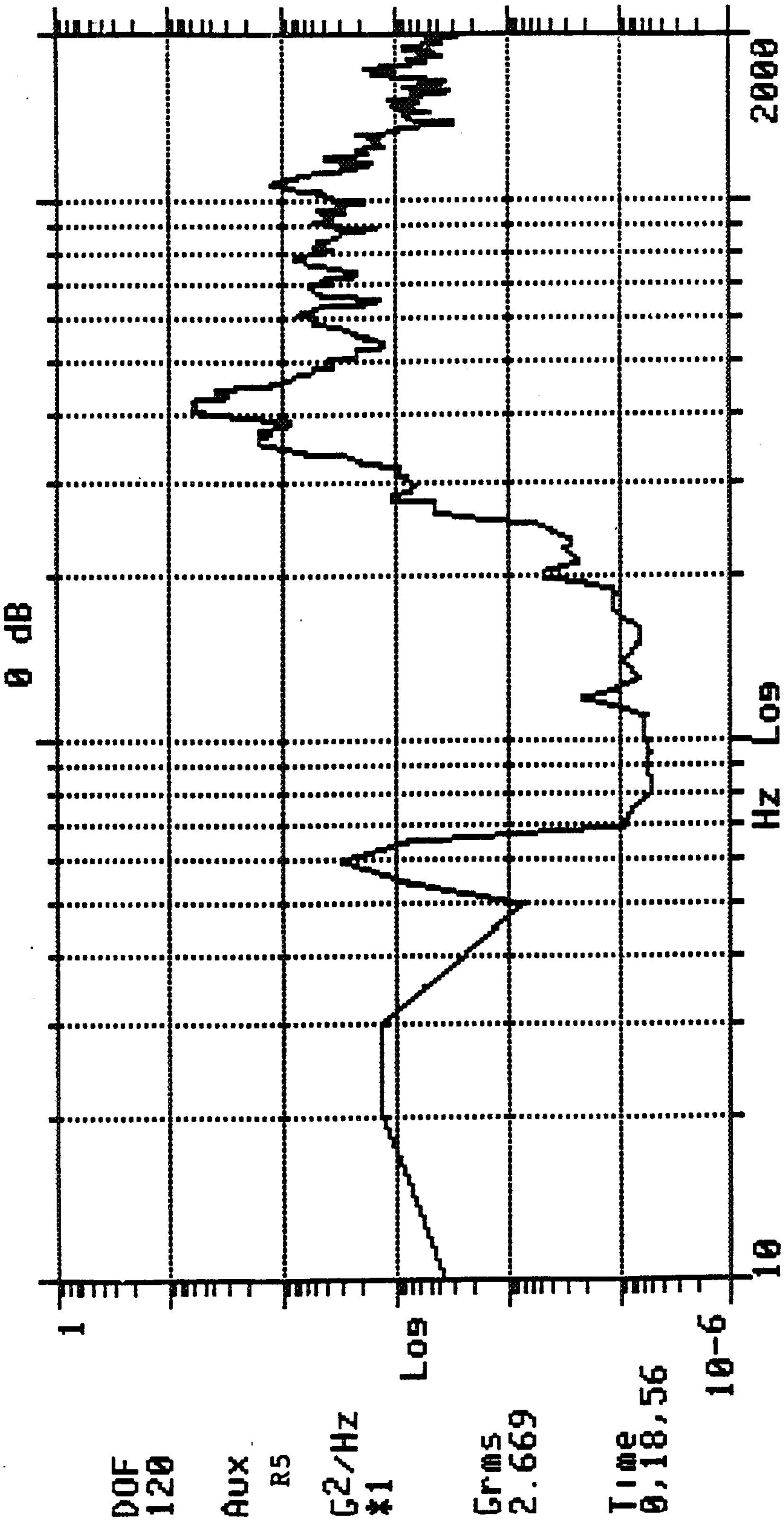
FIGURE 37



T/N 9 PERFORMANCE TEST VERT AXIS

FIGURE 38 – POWER SPECTRAL DENSITY ANALYSIS

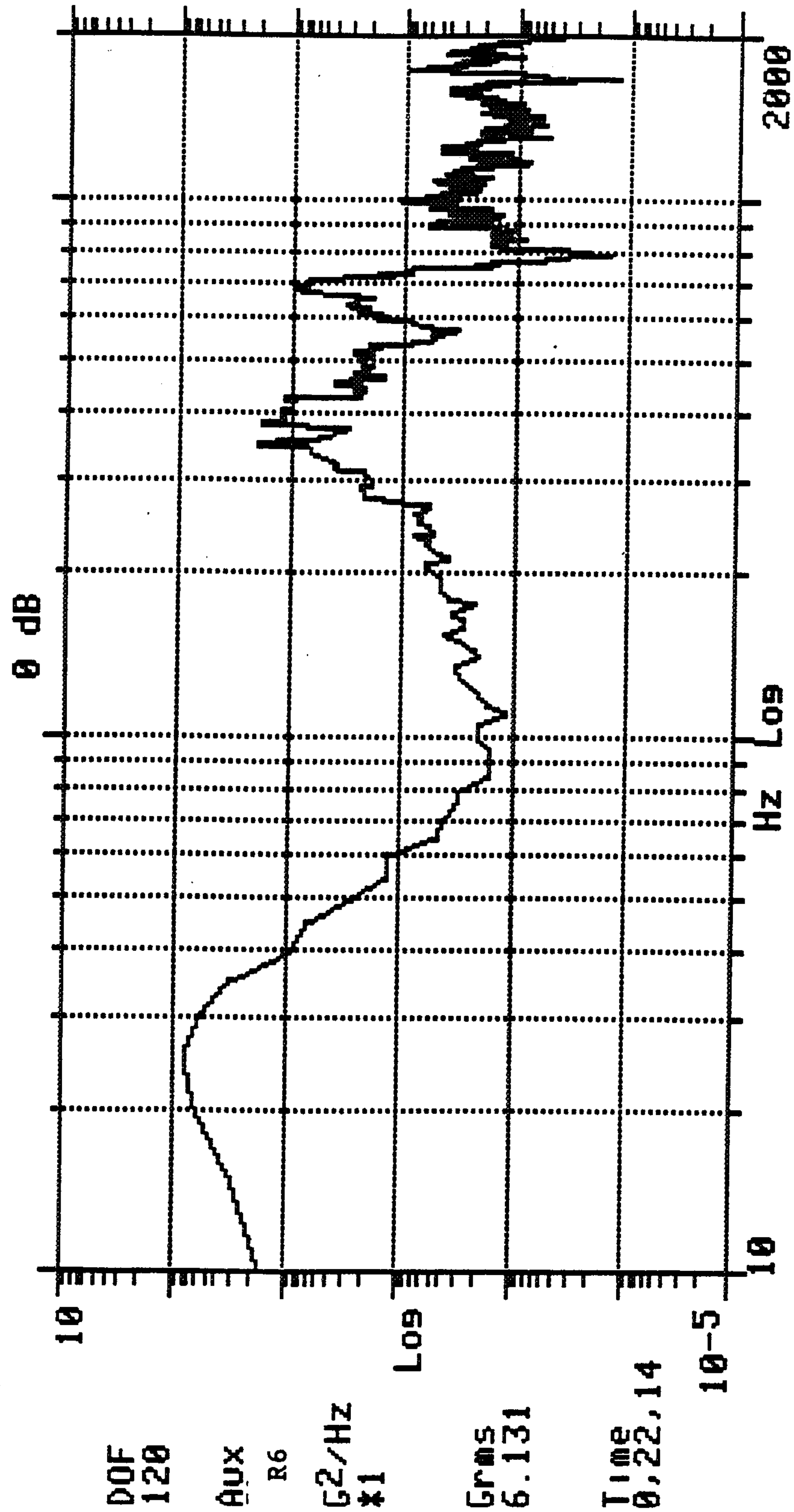
FIGURE 38



T/N 9 PERFORMANCE TEST VERT AXIS

FIGURE 39 – POWER SPECTRAL DENSITY ANALYSIS

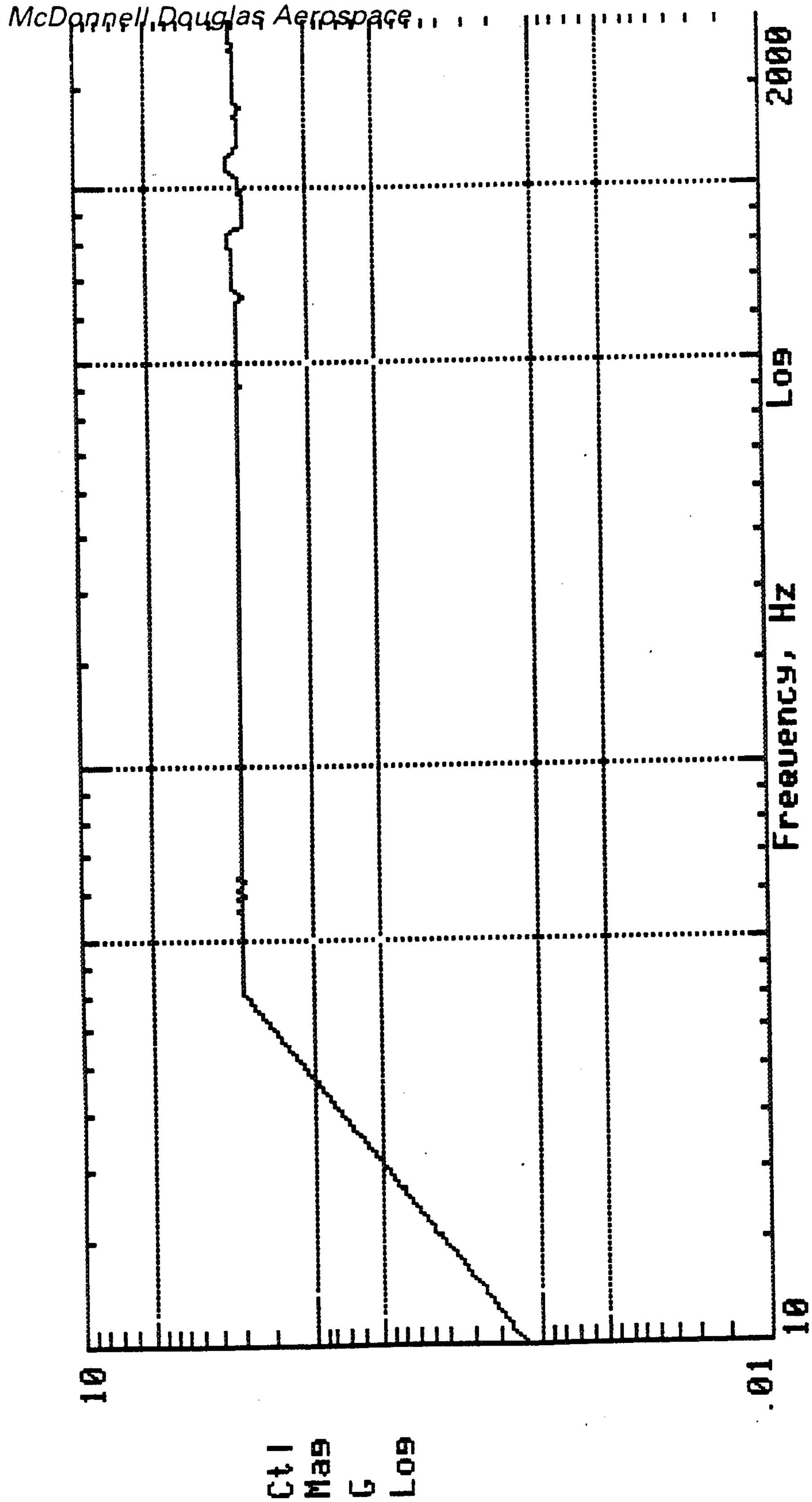
FIGURE 39



T/N 9 PERFORMANCE TEST VERT AXIS

FIGURE 40 – POWER SPECTRAL DENSITY ANALYSIS

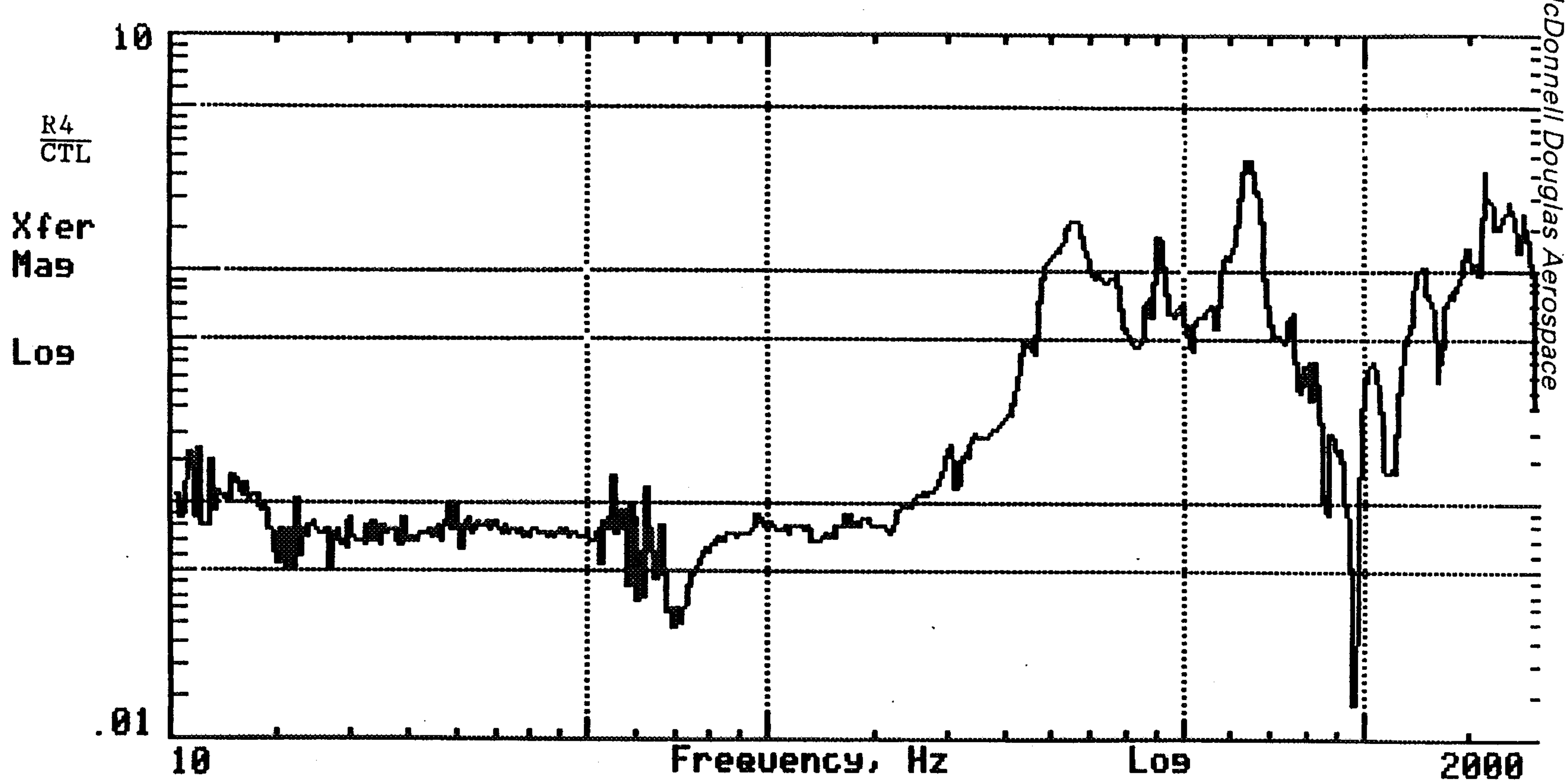
FIGURE 40



T/N 10 SINE RESONANCE SURVEY LONG AXIS

FIGURE 41 – SINE VIBRATION CONTROL

FIGURE 41



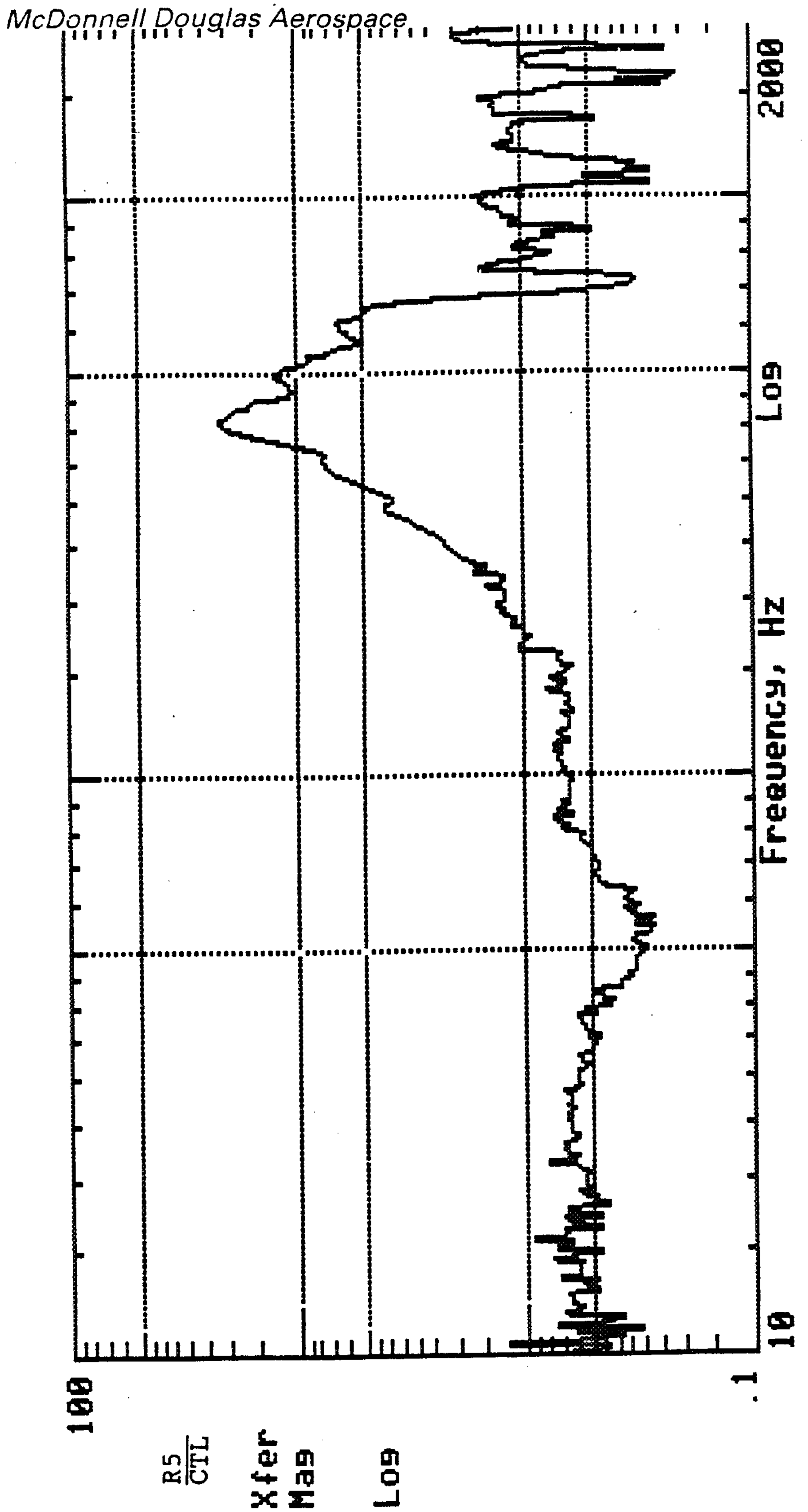
T/N 10 SINE RESONANCE SURVEY LONG AXIS
FIGURE 42 – FREQUENCY RESPONSE

MCDONNELL DOUGLAS

A-259

FIGURE 42

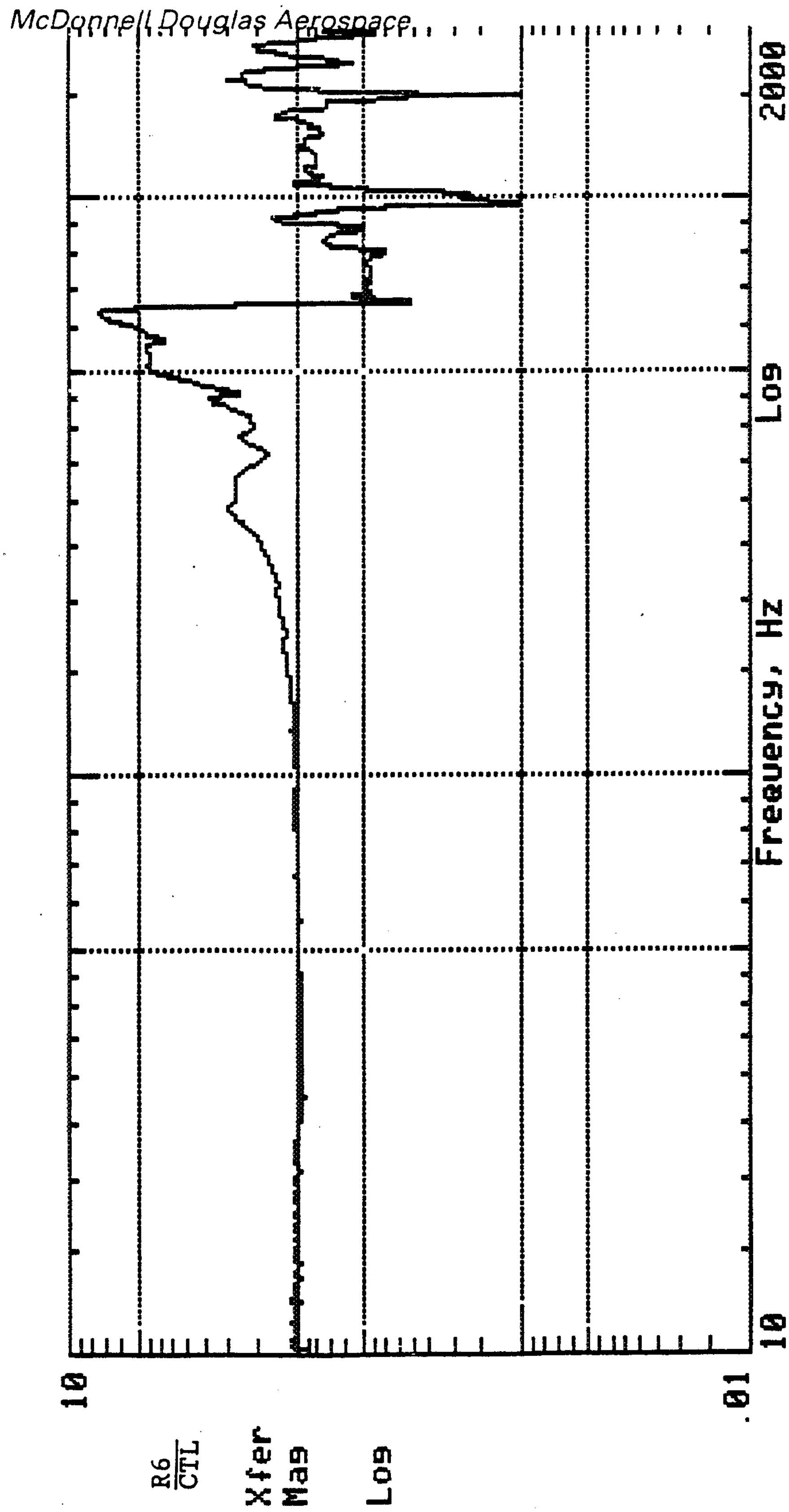
253.93.0153.01



T/N 10 SINE RESONANCE SURVEY LONG AXIS

FIGURE 43 – FREQUENCY RESPONSE

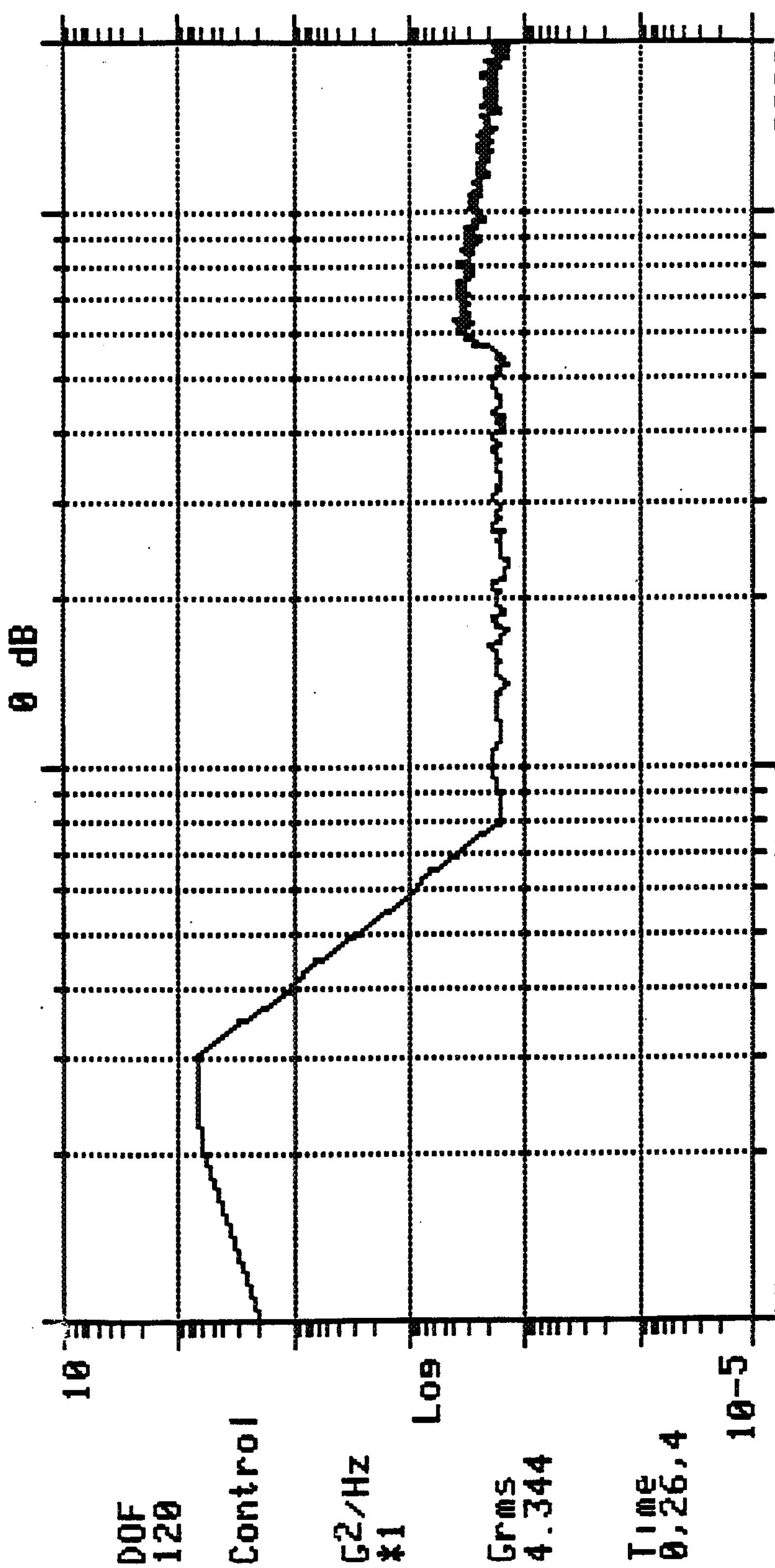
FIGURE 43



T/N 10 SINE RESONANCE SURVEY LONG AXIS

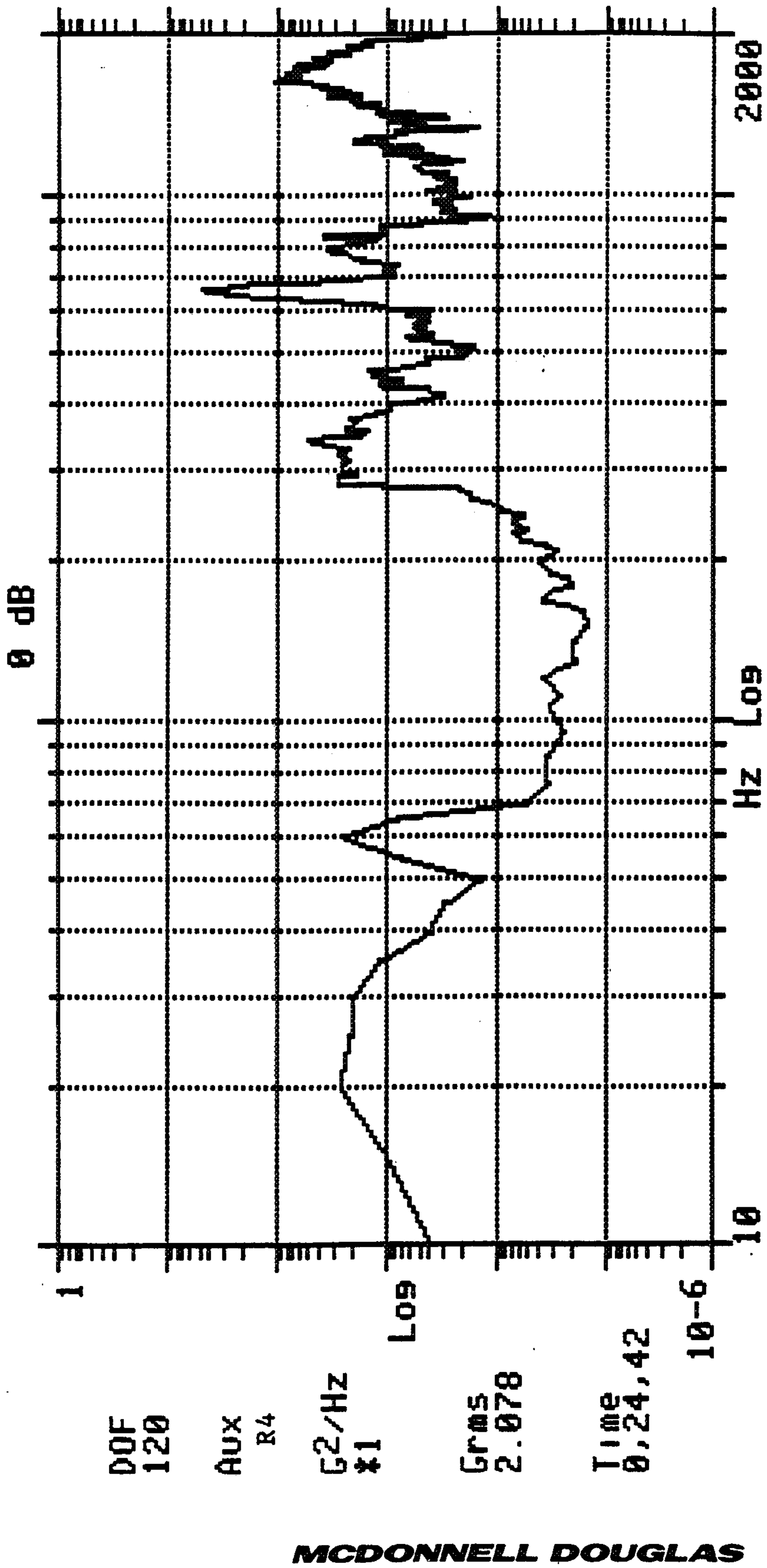
FIGURE 44 -- FREQUENCY RESPONSE

FIGURE 44



T/N 11 PERFORMANCE TEST LONG AXIS

FIGURE 45 – RANDOM VIBRATION CONTROL SPECTRUM

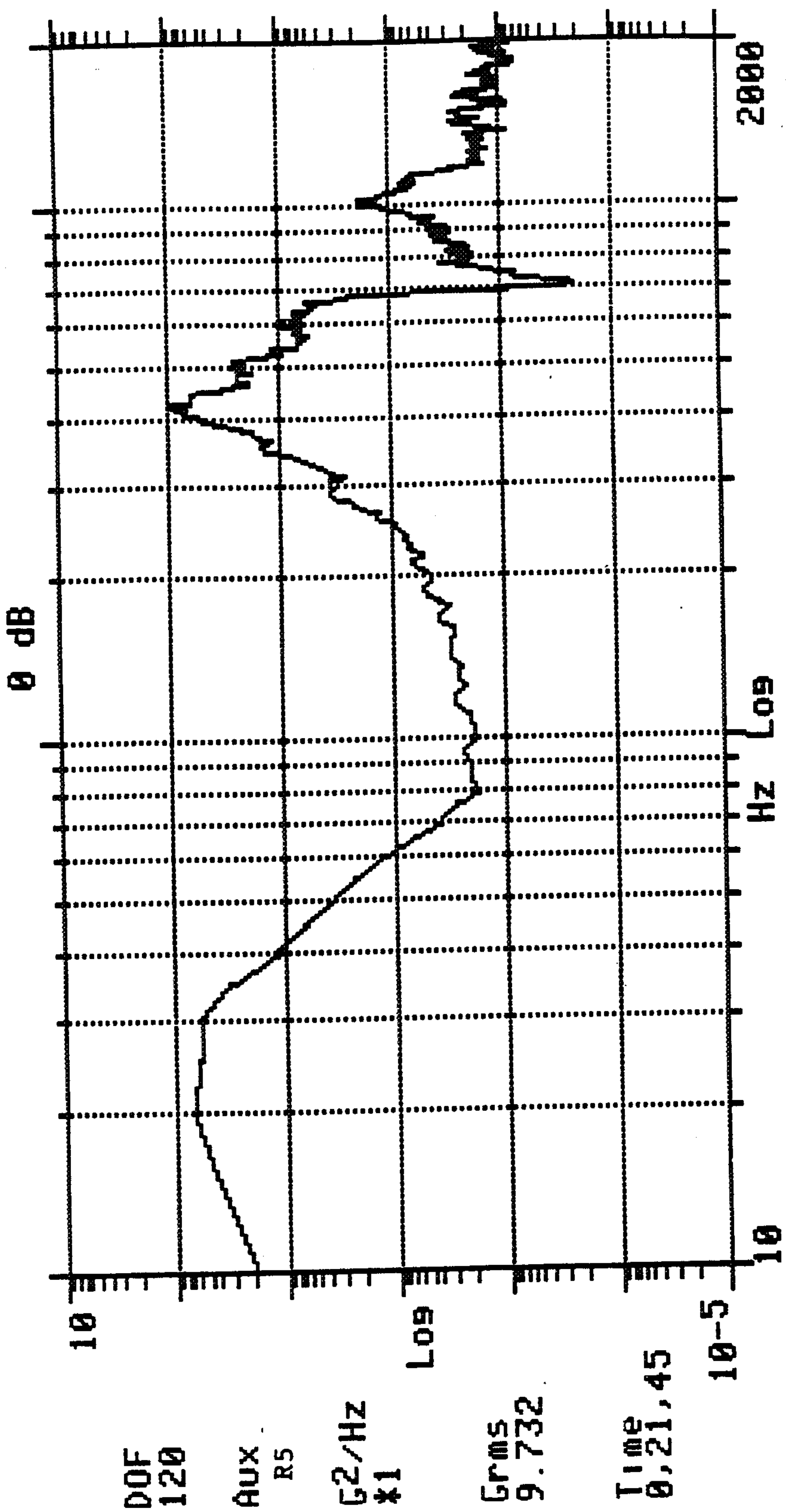


T/N 11 PERFORMANCE TEST LONG AXIS

FIGURE 46 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 46

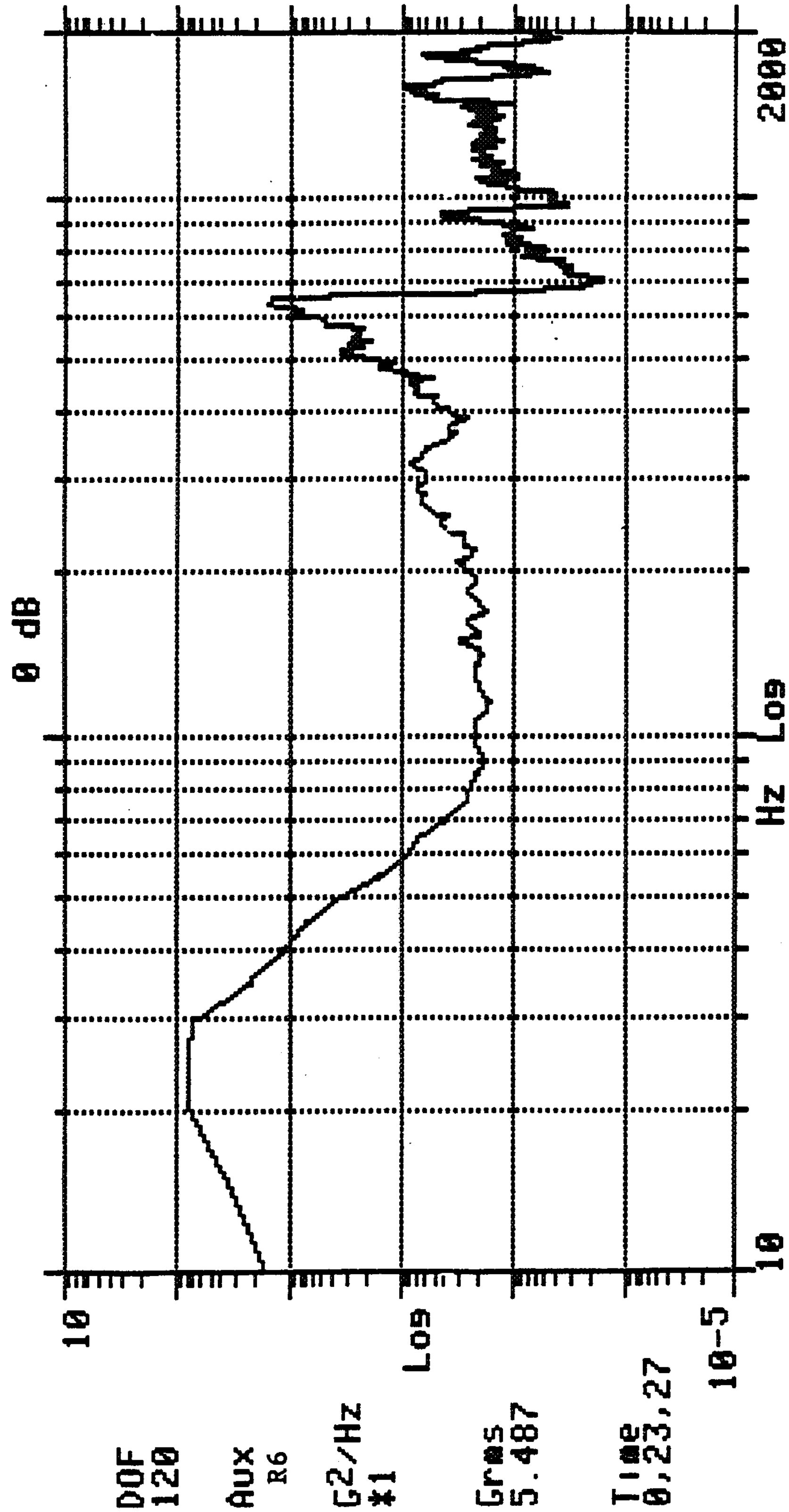
McDonnell Douglas Aerospace



T/N 11 PERFORMANCE TEST LONG AXIS

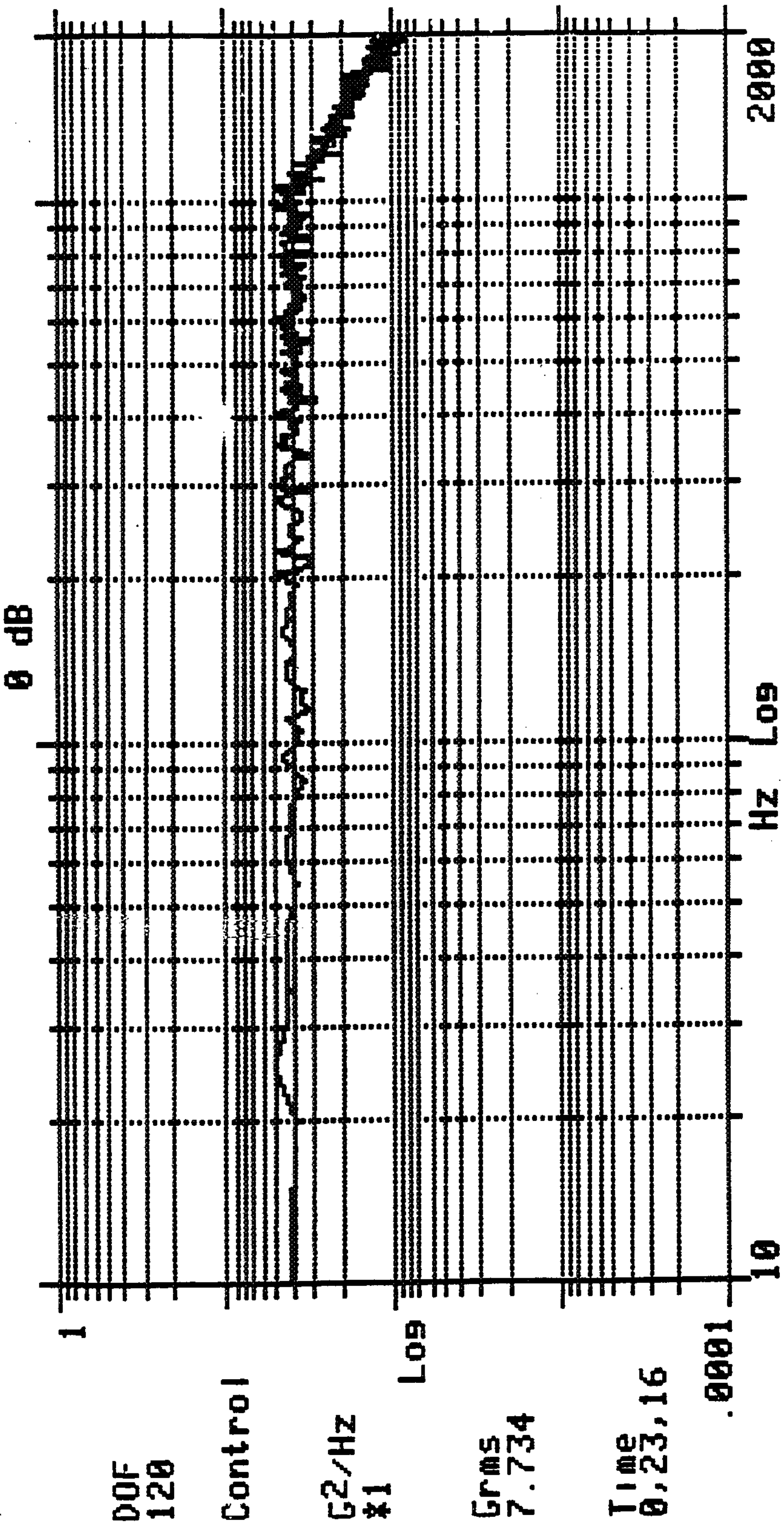
FIGURE 47 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 47



T/N 11 PERFORMANCE TEST LONG AXIS

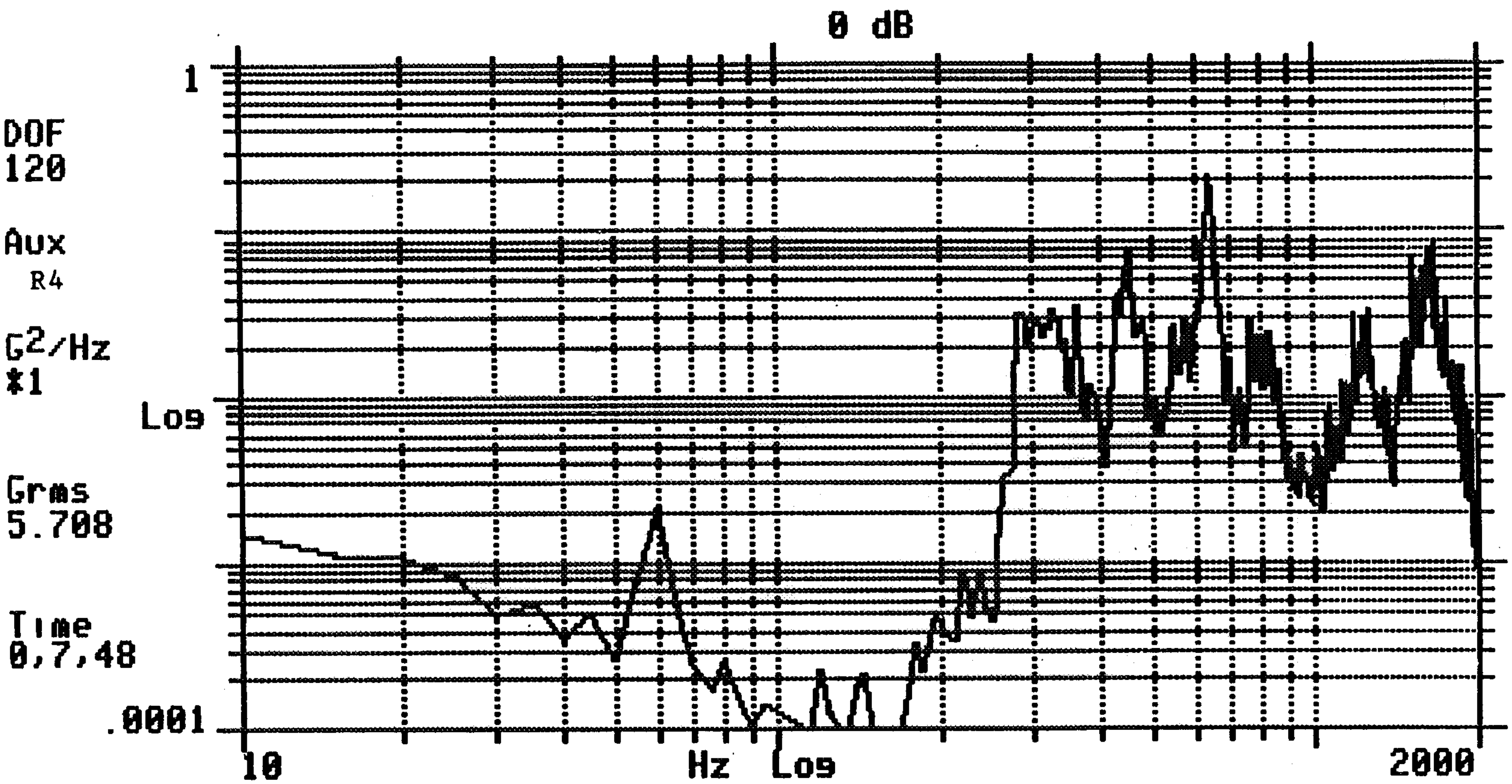
FIGURE 48 - POWER SPECTRAL DENSITY ANALYSIS



T/N 12 MIN STRUCTURAL RIGIDITY TEST LONG AXIS

FIGURE 49 – RANDOM VIBRATION CONTROL SPECTRUM

FIGURE 49

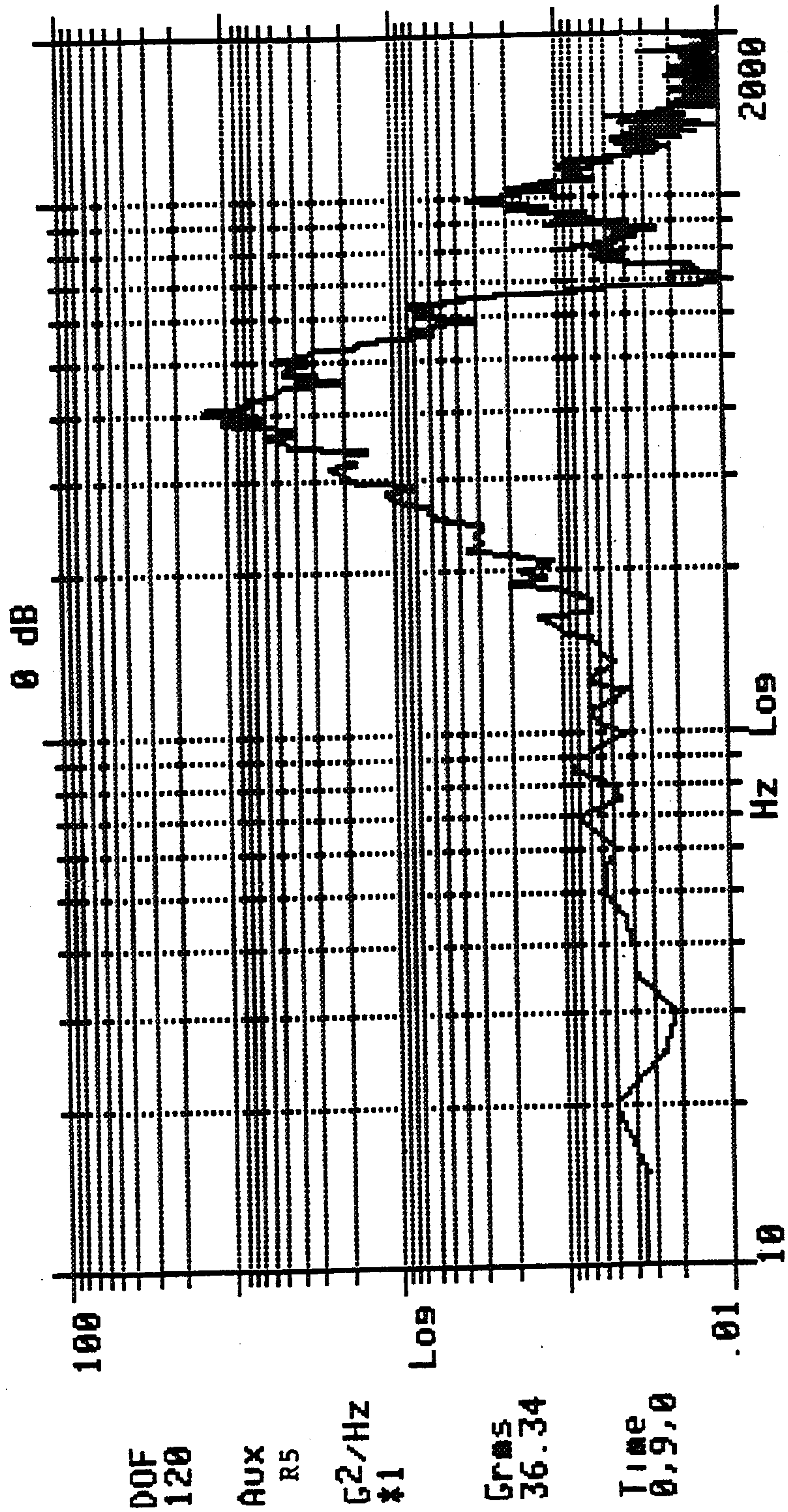


T/N 12 MIN STRUCTURAL RIGIDITY TEST LONG AXIS

FIGURE 50 – POWER SPECTRAL DENSITY ANALYSIS

McDonnell Douglas Aerospace

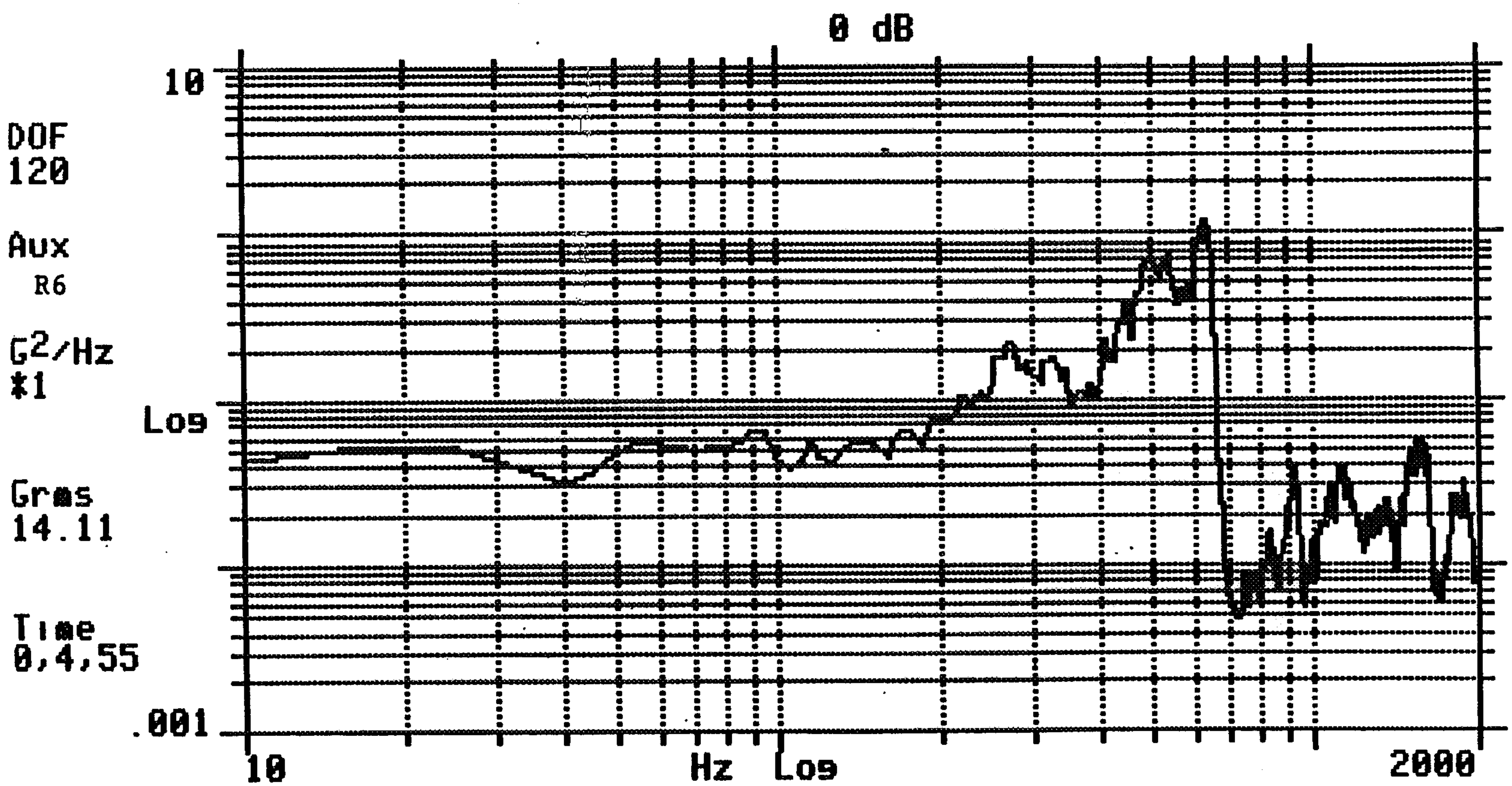
MCDONNELL DOUGLAS



T/N 12 MIN STRUCTURAL RIGIDITY TEST LONG AXIS

FIGURE 51 – POWER SPECTRAL DENSITY ANALYSIS

FIGURE 51



T/N 12 MIN STRUCTURAL RIGIDITY TEST LONG AXIS

FIGURE 52 – POWER SPECTRAL DENSITY ANALYSIS

TABLE 1 - CHRONOLOGICAL VIBRATION TEST LOG
FIBER OPTIC CONTROL SYSTEM INTEGRATION (FOCSI) PROGRAM
ELECTRO-OPTIC ARCHITECTURE (EOA) UNIT

TEST DATE	TEST AXIS	TEST NO.	TEST TYPE	TEST FREQUENCY (Hz)	VIBRATION INPUT LEVEL	TEST TIME (min)	REMARKS
06-28-93	Vert.	1	Resonant Survey	10-2000	Figure 2	20	The test was conducted in two 10 minute sweeps to obtain the frequency response plots.
06-29-93	Vert.	2	Performance	10-2000	4.4 grms	30	The test was stopped after 10 minutes & 10 seconds when the monitoring system stopped updating. The two 1553/1773 converter cards were removed, the data bus was jumpered together and testing resumed. The test was completed without additional problems.
		3	Structural Rigidity	10-2000	7.7 grms	6.6	The test was stopped after 6 minutes & 38 seconds when the monitoring system stopped updating again.
							The EOA was repaired and testing was reinitiated (without the two converter cards) in the vertical axis. Accels R1, R2, & R3 were removed and R4, R5, & R6 were installed.
07-13-93	Vert.	4	Structural Rigidity	10-2000	7.8 grms	60	No failures detected.
		5	Performance	10-2000	4.3 grms	30	No failures detected.
		6	Resonant Survey	10-2000	Figure 2	20	The test was conducted in two 10 minute sweeps to obtain the frequency response plots.
	Lat.	7	Resonant Survey	10-2000	Figure 2	10	The frequency response plots were obtained in one sweep for this test.
		8	Structural Rigidity	10-2000	7.7 grms	60	No failures detected.
07-14-93	Lat.	9	Performance	10-2000	4.4 grms	30	No failures detected.
	Long.	10	Resonant Survey	10-2000	Figure 2	10	The frequency response plots were obtained in one sweep for this test.
		11	Performance	10-2000	4.4 grms	30	No failures detected.
		12	Structural Rigidity	10-2000	7.7 grms	23.3	The test was stopped after 23 minutes & 16 seconds due to a failure of the internal power supply. Project decided to stop testing, since the EOA had successfully completed the performance level test.

TABLE 1

Sensor Values for Vibration Test in Vertical Axis

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	64FE	Total Temp	496.559	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4F2B	Long. Stick	1.392	In	-->FAULT	OSlew
4	5334	Right TEF	2.443	In	-->FAULT	OSlew
5	155A	NWS	-24.267	Deg		
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	233E	Rudder Pedal	0.467	In		
9	6501	Left Stabilator	-1.771	In	-->FAULT	OSlew
10	2954	Left Rudder	-0.223	In		

```
 3 max=  1.351 min=  1.351 avg=  1.351    8 max=  0.467 min=  0.466 avg=  0.466
 4 max=  2.118 min=  1.888 avg=  2.003    9 max= -1.771 min= -2.356 avg= -2.064
 5 max=-19.428 min=-28.519 avg=-23.974   10 max= -0.141 min= -0.226 avg= -0.183
```

ENTER DATA preXSweep

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	D7FE	Total Temp	909.462	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4F1E	Long. Stick	1.354	In	-->FAULT	OSlew
4	5323	Right TEF	2.308	In	-->FAULT	OSlew
5	5558	NWS	-24.560	Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	233D	Rudder Pedal	0.466	In		
9	64AA	Left Stabilator	-2.377	In	-->FAULT	OSlew
10	2952	Left Rudder	-0.226	In		

```
 3 max=  1.448 min=  1.300 avg=  1.374    8 max=  0.468 min=  0.466 avg=  0.467
 4 max=  2.363 min=  1.706 avg=  2.035    9 max= -1.764 min= -2.968 avg= -2.366
 5 max=-16.642 min=-29.252 avg=-22.947   10 max= -0.223 min= -0.233 avg= -0.228
```

ENTER DATA preXSweep

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	64FE	Total Temp	496.559	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0F74	Long. Stick	1.608	In		
4	5305	Right TEF	2.071	In	-->FAULT	OSlew
5	555A	NWS	-24.267	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	233D	Rudder Pedal	0.466	In		
9	2500	Left Stabilator	-1.778	In		
10	2954	Left Rudder	-0.223	In		

```
 3 max=  1.608 min=  1.519 avg=  1.564    8 max=  0.468 min=  0.466 avg=  0.467
 4 max=  2.110 min=  1.778 avg=  1.944    9 max= -1.764 min= -2.412 avg= -2.088
 5 max=-18.988 min=-27.493 avg=-23.240   10 max= -0.151 min= -0.233 avg= -0.192
```

ENTER DATA SWP,100HZ

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	74FE	Total Temp	496.559	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0F24	Long. Stick	1.371	In		
4	12C8	Right TEF	1.588	In		
5	554F	NWS	-25.880	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	233F	Rudder Pedal	0.468	In		
9	6601	Left Stabilator	0.010	In	-->FAULT	OSlew
10	2954	Left Rudder	-0.223	In		

```
 3 max=  1.448 min=  1.339 avg=  1.394    8 max=  0.468 min=  0.466 avg=  0.467
 4 max=  2.237 min=  1.588 avg=  1.912    9 max= -1.771 min= -2.412 avg= -2.091
 5 max=-18.402 min=-27.933 avg=-23.167   10 max= -0.151 min= -0.226 avg= -0.189
```

ENTER DATA SWP,500HZ

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME				
1	D7FE	Total Temp	909.462 DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250 Hg	-->FAULT	UTrav UPwr
3	4F0D	Long. Stick	1.303 In	-->FAULT	OSlew
4	52B8	Right TEF	1.461 In	-->FAULT	OSlew
5	552B	NWS	-31.158 Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000 Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000 Deg	-->FAULT	UTrav UPwr
8	233E	Rudder Pedal	0.467 In		
9	24AA	Left Stabilator	-2.377 In		
10	2954	Left Rudder	-0.223 In		

(right columns headed: WD VALUE NAME)

```
 3 max=  1.475 min=  1.371 avg=  1.423    8 max=  0.468 min=  0.436 avg=  0.452
 4 max=  2.213 min=  1.762 avg=  1.987    9 max= -1.764 min= -2.412 avg= -2.088
 5 max=-19.428 min=-26.466 avg=-22.947   10 max= -0.151 min= -0.229 avg= -0.190
```

ENTER DATA SWP,1000HZ

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			
1	64FE	Total Temp	496.559 DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250 Hg	-->FAULT	UTrav UPwr
3	4FB8	Long. Stick	1.810 In	-->FAULT	OSlew
4	52FC	Right TEF	1.999 In	-->FAULT	OSlew
5	556B	NWS	-21.774 Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000 Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000 Deg	-->FAULT	UTrav OSlew UPwr
8	233D	Rudder Pedal	0.466 In		
9	2501	Left Stabilator	-1.771 In		
10	2952	Left Rudder	-0.226 In		

```
 3 max=  1.697 min=  1.525 avg=  1.611    8 max=  0.468 min=  0.466 avg=  0.467
 4 max=  2.300 min=  1.944 avg=  2.122    9 max= -1.764 min= -2.377 avg= -2.071
 5 max=-17.815 min=-24.413 avg=-21.114   10 max= -0.223 min= -0.233 avg= -0.228
```

ENTER DATA POST SWP

```
RT  4    EOA
                                                                    * DONE
MSG  2   Sensor Values


WD VALUE   NAME                                WD VALUE   NAME

 1 74FE Total Temp       496.559 DegR    -->FAULT   UTrav
 2 4800 Pitot Pressure     1.250 Hg      -->FAULT   UTrav UPwr
 3 0EDE Long. Stick        1.164 In
 4 52A7 Right TEF          1.326 In      -->FAULT   OSlew
 5 551C NWS              -33.358 Deg     -->FAULT   OSlew
 6 5BFF Right LEF         36.000 Deg     -->FAULT   OTrav OSlew
 7 5C00 Power Lever Cntl   0.000 Deg     -->FAULT   UTrav UPwr
 8 233D Rudder Pedal       0.466 In
 9 2502 Left Stabilator   -1.764 In
10 2952 Left Rudder       -0.226 In


 3 max=  1.200 min=  1.117 avg=  1.158    8 max=  0.467 min=  0.466 avg=  0.466
 4 max=  1.920 min=  1.683 avg=  1.801    9 max= -1.737 min= -2.968 avg= -2.352
 5 max=-30.425 min=-38.783 avg=-34.604   10 max= -0.223 min= -0.226 avg= -0.224
                                                              ENTER DATA PRE RAND
```

Performance Test

```
RT  4    EOA
                                                                    * DONE
MSG  2   Sensor Values


WD VALUE   NAME                                WD VALUE   NAME

 1 64FE Total Temp       496.559 DegR    -->FAULT   UTrav
 2 4800 Pitot Pressure     1.250 Hg      -->FAULT   UTrav UPwr
 3 0EBF Long. Stick        1.072 In
 4 52BD Right TEF          1.500 In      -->FAULT   OSlew
 5 14F9 NWS              -38.490 Deg
 6 5BFF Right LEF         36.000 Deg     -->FAULT   OTrav OSlew
 7 5C00 Power Lever Cntl   0.000 Deg     -->FAULT   UTrav UPwr
 8 233E Rudder Pedal       0.467 In
 9 6502 Left Stabilator   -1.764 In      -->FAULT   OSlew
10 2954 Left Rudder       -0.223 In


 3 max=  1.185 min=  1.072 avg=  1.128    8 max=  0.468 min=  0.466 avg=  0.467
 4 max=  1.849 min=  1.469 avg=  1.659    9 max= -1.737 min= -2.968 avg= -2.352
 5 max=-27.199 min=-39.956 avg=-33.578   10 max= -0.223 min= -0.233 avg= -0.228
                                                              ENTER DATA PRE RAND
```

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	0000	Total Temp	360.000	DegR		
2	0000	Pitot Pressure	1.250	Hg		
3	0000	Long. Stick	-1.010	In		
4	0000	Right TEF	-4.050	In		
5	0000	NWS	-75.000	Deg		
6	0000	Right LEF	-7.000	Deg		
7	0000	Power Lever Cntl	0.000	Deg		
8	0000	Rudder Pedal	-0.750	In		
9	0000	Left Stabilator	-3.560	In		
10	0000	Left Rudder	-0.665	In		

1	max=360.000	min=360.000	avg=360.000	6	max= -7.000	min= -7.000	avg= -7.000
2	max= 1.250	min= 1.250	avg= 1.250	7	max= 0.000	min= 0.000	avg= 0.000
3	max= -1.010	min= -1.010	avg= -1.010	8	max= -0.750	min= -0.750	avg= -0.750
4	max= -4.050	min= -4.050	avg= -4.050	9	max= -3.560	min= -3.560	avg= -3.560
5	max=-75.000	min=-75.000	avg=-75.000	10	max= -0.665	min= -0.665	avg= -0.665

ENTER DATA RAND+5MIN

Sensor data processor activity over 1553 bus stopped updating. Removed 1773/1553 modules, jumpered 1553 bus A from EOA slot 2 to slot 3, and continued testing. 20 minutes left in Random test.

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	74FE	Total Temp	496.559	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4E75	Long. Stick	0.853	In	-->FAULT	OSlew
4	131E	Right TEF	2.268	In		
5	1595	NWS	-15.616	Deg		
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	633D	Rudder Pedal	0.466	In	-->FAULT	OSlew
9	2601	Left Stabilator	0.010	In		
10	2952	Left Rudder	-0.226	In		

3	max= 0.933	min= 0.868	avg= 0.900	8	max= 0.468	min= 0.466	avg= 0.467
4	max= 2.379	min= 2.086	avg= 2.233	9	max= 0.010	min= -2.968	avg= -1.479
5	max=-13.123	min=-17.229	avg=-15.176	10	max= -0.223	min= -0.606	avg= -0.415

ENTER DATA PRE RANDom

Restart. Actually Random+10min

~~RT 4 EOA~~

~~* DONE~~

~~MSG 2 Sensor Values~~

~~WD VALUE NAME~~ ~~WD VALUE NAME~~

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	E8FE	Total Temp	496.559	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4F89	Long. Stick	1.670	In	-->FAULT	OSlew
4	5326	Right TEF	2.332	In	-->FAULT	OSlew
5	5565	NWS	-22.654	Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	233D	Rudder Pedal	0.466	In		
9	6501	Left Stabilator	-1.771	In	-->FAULT	OSlew
10	294C	Left Rudder	-0.233	In		

3 max= 1.434 min= 0.915 avg= 1.174 8 max= 0.468 min= 0.466 avg= 0.467
4 max= 2.126 min= 1.928 avg= 2.027 9 max= -1.771 min= -2.968 avg= -2.370
5 max=-20.455 min=-22.361 avg=-21.408 10 max= -0.151 min= -0.233 avg= -0.192

ENTER DATA RAND+~~15~~MIN
+20

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	D7FE	Total Temp	909.462	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4F02	Long. Stick	1.271	In	-->FAULT	OSlew
4	5312	Right TEF	2.173	In	-->FAULT	OSlew
5	5563	NWS	-22.947	Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	233D	Rudder Pedal	0.466	In		
9	64AA	Left Stabilator	-2.377	In	-->FAULT	OSlew
10	2952	Left Rudder	-0.226	In		

3 max= 1.428 min= 0.915 avg= 1.171 8 max= 0.468 min= 0.433 avg= 0.451
4 max= 2.213 min= 1.785 avg= 1.999 9 max= -1.771 min= -2.968 avg= -2.370
5 max=-20.601 min=-23.974 avg=-22.287 10 max= -0.223 min= -0.233 avg= -0.228

ENTER DATA RAND+~~20~~MIN
+25

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	64FE	Total Temp	496.559	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0F2B	Long. Stick	1.392	In		
4	52F3	Right TEF	1.928	In	-->FAULT	OSlew
5	156A	NWS	-21.921	Deg		
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	233D	Rudder Pedal	0.466	In		
9	64AA	Left Stabilator	-2.377	In	-->FAULT	OSlew
10	2952	Left Rudder	-0.226	In		

```
 3 max=  1.442 min=  1.360 avg=  1.401    8 max=  0.467 min=  0.466 avg=  0.466
 4 max=  2.142 min=  1.928 avg=  2.035    9 max= -1.771 min= -2.968 avg= -2.370
 5 max=-21.041 min=-23.827 avg=-22.434   10 max= -0.150 min= -0.233 avg= -0.192
```

ENTER DATA POST RAND

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	64FE	Total Temp	496.559	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0F30	Long. Stick	1.407	In		
4	52F0	Right TEF	1.904	In	-->FAULT	OSlew
5	156A	NWS	-21.921	Deg		
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	6329	Rudder Pedal	0.436	In	-->FAULT	OSlew
9	6455	Left Stabilator	-2.968	In	-->FAULT	OSlew
10	2952	Left Rudder	-0.226	In		

```
 3 max=  1.448 min=  1.404 avg=  1.426    8 max=  0.467 min=  0.466 avg=  0.466
 4 max=  2.063 min=  2.015 avg=  2.039    9 max= -2.356 min= -2.968 avg= -2.662
 5 max=-21.041 min=-23.827 avg=-22.434   10 max= -0.151 min= -0.226 avg= -0.189
```

ENTER DATA POST RAND

```
RT   4     EOA
                                                                    * DONE
MSG   2    Sensor Values


WD VALUE    NAME                                WD VALUE    NAME

 1 E8FE Total Temp          496.559 DegR     -->FAULT    UTrav
 2 4800 Pitot Pressure        1.250 Hg       -->FAULT    UTrav UPwr
 3 4F17 Long. Stick           1.333 In       -->FAULT    OSlew
 4 1305 Right TEF             2.071 In
 5 1574 NWS                 -20.455 Deg
 6 5BFF Right LEF            36.000 Deg      -->FAULT    OTrav OSlew
 7 5C00 Power Lever Cntl      0.000 Deg      -->FAULT    UTrav UPwr
 8 233E Rudder Pedal          0.467 In
 9 6455 Left Stabilator      -2.968 In       -->FAULT    OSlew
10 2952 Left Rudder          -0.226 In


 3 max=  1.336 min=  1.262 avg=  1.299   8 max=  0.467 min=  0.466 avg=  0.466
 4 max=  2.356 min=  1.904 avg=  2.130   9 max= -1.764 min= -2.377 avg= -2.071
 5 max=-19.135 min=-23.827 avg=-21.481  10 max= -0.223 min= -0.226 avg= -0.224
                                                           ENTER DATA PRE STRUCT
```

```
RT   4     EOA
                                                                    * DONE
"SG   2    Sensor Values


WD VALUE    NAME                                WD VALUE    NAME

 1 64FE Total Temp          496.559 DegR     -->FAULT    UTrav
 2 4800 Pitot Pressure        1.250 Hg       -->FAULT    UTrav UPwr
 3 0F10 Long. Stick           1.312 In
 4 1317 Right TEF             2.213 In
 5 1573 NWS                 -20.601 Deg
 6 5BFF Right LEF            36.000 Deg      -->FAULT    OTrav
 7 5C00 Power Lever Cntl      0.000 Deg      -->FAULT    UTrav UPwr
 8 233D Rudder Pedal          0.466 In
 9 6455 Left Stabilator      -2.968 In       -->FAULT    OSlew
10 294C Left Rudder          -0.233 In


 3 max=  1.339 min=  1.274 avg=  1.306   8 max=  0.468 min=  0.464 avg=  0.466
 4 max=  2.245 min=  1.920 avg=  2.082   9 max= -1.764 min= -2.968 avg= -2.366
 5 max=-19.428 min=-24.120 avg=-21.774  10 max= -0.141 min= -0.233 avg= -0.187
                                                           ENTER DATA PRE STRUCT
```

```
RT  4     EOA
                                                        * DONE
MSG  2    Sensor Values

WD VALUE   NAME                                WD VALUE    NAME

 1 64FE Total Temp          496.559 DegR      -->FAULT    UTrav
 2 4800 Pitot Pressure        1.250 Hg        -->FAULT    UTrav UPwr
 3 0EA6 Long. Stick           0.998 In
 4 1303 Right TEF             2.055 In
 5 1569 NWS                 -22.067 Deg
 6 5800 Right LEF            -7.000 Deg       -->FAULT    UTrav OSlew
 7 5C00 Power Lever Cntl      0.000 Deg       -->FAULT    UTrav UPwr
 8 233F Rudder Pedal          0.468 In
 9 6502 Left Stabilator      -1.764 In        -->FAULT    OSlew
10 2952 Left Rudder          -0.226 In


 3 max=  1.031 min=  0.969 avg=  1.000   8 max=  0.468 min=  0.466 avg=  0.467
 4 max=  2.261 min=  1.952 avg=  2.106   9 max= -1.764 min= -2.377 avg= -2.071
 5 max=-19.135 min=-22.067 avg=-20.601  10 max= -0.223 min= -0.233 avg= -0.228
                                                       ENTER DATA PRE STRUCT

RT  4     EOA
                                                        * DONE
MSG  2    Sensor Values

WD VALUE   NAME                                WD VALUE    NAME

 1 E8FE Total Temp          496.559 DegR      -->FAULT    UTrav
 2 4800 Pitot Pressure        1.250 Hg        -->FAULT    UTrav UPwr
 3 4E31 Long. Stick           0.652 In        -->FAULT    OSlew
 4 5319 Right TEF             2.229 In        -->FAULT    OSlew
 5 1568 NWS                 -22.214 Deg
 6 5BFF Right LEF            36.000 Deg       -->FAULT    OTrav OSlew
 7 5C00 Power Lever Cntl      0.000 Deg       -->FAULT    UTrav UPwr
 8 6358 Rudder Pedal          0.505 In        -->FAULT    OSlew
 9 2455 Left Stabilator      -2.968 In
10 6800 Left Rudder          -0.665 In        -->FAULT


 3 max=  0.989 min=  0.583 avg=  0.786   8 max=  0.468 min=  0.466 avg=  0.467
 4 max=  2.419 min=  1.991 avg=  2.205   9 max= -1.764 min= -2.968 avg= -2.366
 5 max=-19.575 min=-23.240 avg=-21.408  10 max= -0.141 min= -0.233 avg= -0.187
                                                       ENTER DATA ST STRUCT
```

15.2 THERMAL TEST DATA SHEET

15.2.1 Thermal Test (14.4)   6/26/93   Brad Kessler   PASS ☐ FAIL ☑
See comment below

15.2.1.1 Print each of the sensor data files for the constant values and attach them behind this data sheet.

EOA Maximum Internal Operating Temperature with 75^{0}C Ambient Temperature $\boxed{78\ ^0C}$

All of the Sensors values are constant   YES ☐ NO ☑   Expect Yes.

Comments:

EOA#2 contains all its modules for this test.

Test articles

The EOA minimum operating temp. with an ambient chamber temp. of −30°C is −25°C.

EOA #2		
Pitch Stick	001	
TEF	001	
NWS	002	
LEF	0043	→ Not decoded by EOA at ~~any~~ any time or any temperature including room temperature.
PLC	002	
Rudder Pedal	002	→ Not decoded well by EOA ~~at any time~~ independent of temperature. Some good readings were taken over the full temperature range.
Stab	2	
Rudder	002	
Temperature	Not connected	
Pressure	Not connected	

Pass/Fail Comments:

The digital sensors, PLC, Stab, and Rudder, were decoded well throughout test. The EOA would pass if only the digital sensors were used.

The analog sensors, Pitch Stick, Trailing Edge Flap, and Nose Wheel Steering, were not decoded well throughout the test. The decoded value drifts as the EOA temperature moves away from room temperature.

Analog Sensor	Good Decoding over EOA temp. range of:
Pitch Stick	+26°C to −30°C + 5 minutes and +10°C to +60°C.
Trailing Edge Flap	+26°C to −10°C and +30°C to +55°C.
Nose Wheel Steering	+26°C to −5°C.

Sensor Data for Thermal Test

RT 4 EOA #2

G 2 Sensor Values

* DONE

Time 12:00pm

Not Connected

WD	HEX VALUE	NAME	Engineering Units		Error ~~WD~~ VALUE	Error NAME
1	C5FF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav UPwr
3	0CD0	Long. Stick	-0.394	In		
4	528B	Right TEF	1.105	In	-->FAULT	
5	56C1	NWS	28.372	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew → LEF Not decoded properly by EOA
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	68DE	Left Rudder	-0.376	In	-->FAULT	OSlew

Maximum, Minimum, and Average values for each sensor at the given temperature.

	max=	min=	avg=
3	-0.320	-0.394	-0.357
4	1.231	0.922	1.077
5	27.786	23.680	25.733
6	4.223	4.223	4.223
7	97.468	97.341	97.405
8	0.294	0.293	0.293
9	-3.191	-3.212	-3.202
10	-0.382	-0.496	-0.439

ENTER DATA 26C, 28C

Chamber Ambient Temperature

Internal EOA Ambient Temperature

RT 4 EOA

G 2 Sensor Values

* DONE

WD	VALUE	NAME			~~WD~~ VALUE	NAME
1	7DFF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav UPwr
3	0CE7	Long. Stick	-0.326	In		
4	1286	Right TEF	1.065	In		
5	16B9	NWS	27.199	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	62C7	Rudder Pedal	0.293	In	-->FAULT	
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	UTrav OSlew

	max=	min=	avg=
3	-0.302	-0.424	-0.363
4	1.287	0.907	1.097
5	30.425	24.120	27.273
6	4.223	4.223	4.223
7	97.468	97.214	97.341
8	0.294	0.282	0.288
9	-3.191	-3.212	-3.202
10	-0.387	-0.562	-0.475

ENTER DATA 20C, 27C

Chamber Ambient Temp.

Internal EOA Ambient Temp.

```
T  4  RT  4     EOA
                                                                                  * DONE
 G       G  2   Sensor Values

D VA  WD VALUE   NAME                                      WD VALUE   NAME

1 54   1 4800 Total Temp           360.000 DegR    -->FAULT   UTrav
2 4B   2 4BFF Pitot Pressure        80.000 Hg      -->FAULT   OTrav UPwr
3 4C   3 4CF3 Long. Stick           -0.290 In      -->FAULT   OSlew
4 52   4 1296 Right TEF              1.192 In
5 16   5 56B7 NWS                   26.906 Deg     -->FAULT
6 58   6 5800 Right LEF             -7.000 Deg     -->FAULT   UTrav OSlew
7 1E   7 1EFF Power Lever Cntl      97.468 Deg
8 22   8 22C7 Rudder Pedal           0.293 In
9 24   9 2432 Left Stabilator       -3.212 In
0 68  10 6800 Left Rudder           -0.665 In      -->FAULT   UTrav OSlew

                                                  6 max=  4.223 min=  4.223 avg=  4.223
                                                  7 max= 97.468 min= 97.214 avg= 97.341
3 ma   3 max= -0.243 min= -0.329 avg= -0.286      8 max=  0.294 min=  0.285 avg=  0.290
4 ma   4 max=  1.287 min=  1.010 avg=  1.148      9 max= -3.191 min= -3.212 avg= -3.202
5 ma   5 max= 31.452 min= 24.560 avg= 28.006     10 max= -0.376 min= -0.497 avg= -0.437
                                                                  ENTER DATA -5C, 7C

T  4  RT  4     EOA
                                                                                  * DONE
G       ,G  2   Sensor Values

D VA  WD VALUE   NAME                                      WD VALUE   NAME

  7D   1 7000 Total Temp           360.000 DegR    -->FAULT   UTrav
  4B   2 4BFF Pitot Pressure        80.000 Hg      -->FAULT   OTrav UPwr
  4C   3 0CF3 Long. Stick           -0.290 In
  52   4 128C Right TEF              1.112 In
  56   5 56A3 NWS                   23.974 Deg     -->FAULT   OSlew
  58   6 5BFF Right LEF             36.000 Deg     -->FAULT   OTrav OSlew
  1E   7 1EFF Power Lever Cntl      97.468 Deg
  22   8 22C7 Rudder Pedal           0.293 In
  24   9 2432 Left Stabilator       -3.212 In
  68  10 6800 Left Rudder           -0.665 In      -->FAULT   UTrav OSlew

                                                  6 max=  4.223 min=  4.223 avg=  4.223
                                                  7 max= 97.468 min= 97.468 avg= 97.468
 ma    3 max= -0.234 min= -0.332 avg= -0.283      8 max=  0.294 min=  0.288 avg=  0.291
 ma    4 max=  1.287 min=  1.017 avg=  1.152      9 max= -3.212 min= -3.212 avg= -3.212
 ma    5 max= 30.132 min= 24.560 avg= 27.346     10 max= -0.495 min= -0.538 avg= -0.516
                                                                  ENTER DATA -10C, 3C
```

```
RT   4     EOA
                                                               * DONE
  G   2    Sensor Values

WD VALUE   NAME                            WD VALUE   NAME

 1 4800 Total Temp       360.000 DegR    -->FAULT   UTrav
 2 4BFF Pitot Pressure    80.000 Hg      -->FAULT   OTrav
 3 0CDD Long. Stick       -0.355 In
 4 1242 Right TEF          0.527 In
 5 566A NWS               15.616 Deg     -->FAULT   OSlew
 6 5800 Right LEF         -7.000 Deg     -->FAULT   UTrav
 7 1EFF Power Lever Cntl  97.468 Deg
 8 6338 Rudder Pedal       0.458 In      -->FAULT   OSlew
 9 2432 Left Stabilator   -3.212 In
10 6800 Left Rudder       -0.665 In      -->FAULT   UTrav

                                          6 max=  4.223 min=  4.223 avg=  4.223
                                          7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.302 min= -0.391 avg= -0.347    8 max=  0.464 min=  0.293 avg=  0.378
 4 max=  0.764 min=  0.439 avg=  0.602    9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 17.522 min= 12.830 avg= 15.176   10 max= -0.495 min= -0.497 avg= -0.496
                                                         ENTER DATA -15C, -3C

RT   4     EOA
                                                               * DONE
  G   2    Sensor Values

WD VALUE   NAME                            WD VALUE   NAME

 1 7DFF Total Temp       634.731 DegR    -->FAULT   UTrav
 2 4BFF Pitot Pressure    80.000 Hg      -->FAULT   OTrav
 3 4CE7 Long. Stick       -0.326 In      -->FAULT   OSlew
 4 1243 Right TEF          0.534 In
 5 1662 NWS               14.443 Deg
 6 5800 Right LEF         -7.000 Deg     -->FAULT   UTrav OSlew
 7 1EFF Power Lever Cntl  97.468 Deg
 8 22C7 Rudder Pedal       0.293 In
 9 2432 Left Stabilator   -3.212 In
10 6800 Left Rudder       -0.665 In      -->FAULT   UTrav OSlew

                                          6 max=  4.223 min=  4.223 avg=  4.223
                                          7 max= 97.468 min= 97.468 avg= 97.468
 3 max= -0.317 min= -0.370 avg= -0.344    8 max=  0.294 min=  0.293 avg=  0.293
 4 max=  0.645 min=  0.455 avg=  0.550    9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 15.469 min= 12.243 avg= 13.856   10 max= -0.495 min= -0.496 avg= -0.495
                                                         ENTER DATA -20C, -9C
```

```
RT   4     EOA
                                                                              * DONE
  G  2    Sensor Values

WD VALUE    NAME                                  WD VALUE    NAME

 1 5400 Total Temp      360.000 DegR    -->FAULT   UTrav
 2 4BFF Pitot Pressure   80.000 Hg      -->FAULT   OTrav
 3 0CEA Long. Stick      -0.317 In
 4 1246 Right TEF         0.558 In
 5 1662 NWS              14.443 Deg
 6 5BFF Right LEF        36.000 Deg     -->FAULT   OTrav
 7 1EFF Power Lever Cntl 97.468 Deg
 8 22C7 Rudder Pedal      0.293 In
 9 2432 Left Stabilator  -3.212 In
10 6881 Left Rudder      -0.497 In      -->FAULT   OSlew


                                         7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.296 min= -0.352 avg= -0.324   8 max=  0.294 min=  0.293 avg=  0.293
 4 max=  0.661 min=  0.503 avg=  0.582   9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 16.642 min= 13.270 avg= 14.956  10 max= -0.400 min= -0.496 avg= -0.448
                                                           ENTER DATA -25C, -13C

RT   4     EOA
                                                                              * DONE
  G  2    Sensor Values
                                                                      Time 12:45pm

WD VALUE    NAME                                  WD VALUE    NAME

 1 55FF Total Temp      634.731 DegR    -->FAULT   UTrav
 2 4BFF Pitot Pressure   80.000 Hg      -->FAULT   OTrav
 3 0CEB Long. Stick      -0.314 In
 4 5239 Right TEF         0.455 In      -->FAULT   OSlew
 5 565A NWS              13.270 Deg     -->FAULT   OSlew
 6 5800 Right LEF        -7.000 Deg     -->FAULT   UTrav
 7 1EFF Power Lever Cntl 97.468 Deg
 8 62C7 Rudder Pedal      0.293 In      -->FAULT   OSlew
 9 2432 Left Stabilator  -3.212 In
10 6800 Left Rudder      -0.665 In      -->FAULT   UTrav

                                         6 max=  4.223 min=  4.223 avg=  4.223
                                         7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.290 min= -0.370 avg= -0.330   8 max=  0.294 min=  0.287 avg=  0.290
 4 max=  0.550 min=  0.321 avg=  0.435   9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 13.270 min=  9.164 avg= 11.217  10 max= -0.493 min= -0.497 avg= -0.495
                                                           ENTER DATA -30C, -17C
```

RT 4 EOA

G 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	7000	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav
3	4CE6	Long. Stick	-0.329	In	-->FAULT	OSlew
4	522D	Right TEF	0.360	In	-->FAULT	OSlew
5	564D	NWS	11.364	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	1EFF	Power Lever Cntl	97.468	Deg		
8	62C7	Rudder Pedal	0.293	In	-->FAULT	OSlew
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	UTrav

```
 3 max= -0.240 min= -0.335 avg= -0.287
 4 max=  0.693 min=  0.321 avg=  0.507
 5 max= 14.150 min=  8.138 avg= 11.144
 7 max= 97.468 min= 97.341 avg= 97.405
 8 max=  0.294 min=  0.293 avg=  0.293
 9 max= -3.212 min= -3.212 avg= -3.212
10 max= -0.493 min= -0.496 avg= -0.495
```

ENTER DATA -30+5M-20C

Ambient Chamber Temp. at -30°C ~~5~~ at 5 minutes.

Internal EOA Temp.

RT 4 EOA

G 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	7DFF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav
3	0D1C	Long. Stick	-0.169	In		
4	1284	Right TEF	1.049	In		
5	5689	NWS	20.161	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	UTrav OSlew

```
 3 max= -0.133 min= -0.255 avg= -0.194
 4 max=  1.279 min=  0.827 avg=  1.053
 5 max= 25.440 min= 17.229 avg= 21.334
 7 max= 97.468 min= 97.341 avg= 97.405
 8 max=  0.463 min=  0.293 avg=  0.378
 9 max= -3.212 min= -3.212 avg= -3.212
10 max= -0.491 min= -0.496 avg= -0.493
```

ENTER DATA -30+10M-22

Ambient Chamber Temp. at -30°C at 10 minutes.

Interal EOA Temp in °C.

```
RT   4     EOA
                                                              * DONE
  G   2    Sensor Values

WD VALUE   NAME                               WD VALUE   NAME

 1 4000 Total Temp        360.000 DegR     -->FAULT   UTrav
 2 4BFF Pitot Pressure     80.000 Hg       -->FAULT   OTrav
 3 0D34 Long. Stick        -0.098 In
 4 12C2 Right TEF           1.540 In
 5 56CF NWS                30.425 Deg      -->FAULT
 6 5800 Right LEF          -7.000 Deg      -->FAULT   UTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 633C Rudder Pedal        0.464 In       -->FAULT   OSlew
 9 2432 Left Stabilator    -3.212 In
10 6800 Left Rudder        -0.665 In       -->FAULT   UTrav OSlew

                                          7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.036 min= -0.142 avg= -0.089    8 max=  0.464 min=  0.293 avg=  0.378
 4 max=  1.572 min=  1.160 avg=  1.366    9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 31.305 min= 23.240 avg= 27.273   10 max= -0.495 min= -0.496 avg= -0.495
                                                         ENTER DATA -30+15M-23

RT   4     EOA
                                                              * DONE
  G   2    Sensor Values

WD VALUE   NAME                               WD VALUE   NAME

 1 5400 Total Temp        360.000 DegR     -->FAULT   UTrav
 2 4BFF Pitot Pressure     80.000 Hg       -->FAULT   OTrav OSlew
 3 0D3E Long. Stick        -0.068 In
 4 12CC Right TEF           1.619 In
 5 16DE NWS                32.625 Deg
 6 5800 Right LEF          -7.000 Deg      -->FAULT   UTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 6338 Rudder Pedal        0.458 In       -->FAULT   OSlew
 9 2432 Left Stabilator    -3.212 In
10 6882 Left Rudder        -0.496 In       -->FAULT   OSlew

                                          6 max=  4.223 min=  4.223 avg=  4.223
 2 max= 79.769 min= 70.301 avg= 75.035    7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.012 min= -0.104 avg= -0.058    8 max=  0.463 min= -0.438 avg=  0.012
 4 max=  1.722 min=  1.405 avg=  1.564    9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 33.504 min= 26.466 avg= 29.985   10 max= -0.493 min= -0.539 avg= -0.516
                                                         ENTER DATA -30+20M-24
```

```
RT   4     EOA
                                                                        * DONE
  G   2    Sensor Values

WD VALUE    NAME                                  WD VALUE    NAME

 1 5400 Total Temp          360.000 DegR      -->FAULT    UTrav
 2 4BE1 Pitot Pressure       77.691 Hg        -->FAULT    OSlew
 3 0D45 Long. Stick          -0.047 In
 4 12D5 Right TEF             1.690 In
 5 16E8 NWS                  34.091 Deg
 6 5800 Right LEF            -7.000 Deg       -->FAULT    UTrav OSlew
 7 1EFF Power Lever Cntl     97.468 Deg
 8 22C7 Rudder Pedal          0.293 In
 9 2432 Left Stabilator      -3.212 In
10 2882 Left Rudder          -0.496 In

 2 max= 79.846 min= 70.839 avg= 75.343   7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.006 min= -0.077 avg= -0.041   8 max=  0.464 min= -0.439 avg=  0.012
 4 max=  1.793 min=  1.580 avg=  1.687   9 max= -3.212 min= -3.226 avg= -3.219
 5 max= 34.238 min= 29.692 avg= 31.965  10 max= -0.493 min= -0.497 avg= -0.495
                                                        ENTER DATA -30+25M-24
```

```
RT   4     EOA
                                                                        * DONE
  G   2    Sensor Values

WD VALUE    NAME                                  WD VALUE    NAME

 1 7DFF Total Temp          634.731 DegR      -->FAULT    UTrav
 2 4BA3 Pitot Pressure       72.918 Hg        -->FAULT    OSlew
 3 4D4D Long. Stick          -0.024 In        -->FAULT    OSlew
 4 12DD Right TEF             1.754 In
 5 56F5 NWS                  35.997 Deg       -->FAULT    OSlew
 6 5800 Right LEF            -7.000 Deg       -->FAULT    UTrav OSlew
 7 5C00 Power Lever Cntl      0.000 Deg       -->FAULT    UTrav OSlew
 8 62C7 Rudder Pedal          0.293 In        -->FAULT    OSlew
 9 2432 Left Stabilator      -3.212 In
10 6800 Left Rudder          -0.665 In        -->FAULT    UTrav OSlew

                                         6 max= -4.394 min= -4.394 avg= -4.394
 2 max= 79.846 min= 66.452 avg= 73.149   7 max= 97.468 min= 97.341 avg= 97.405
 3 max=  0.003 min= -0.071 avg= -0.034   8 max=  0.464 min=  0.293 avg=  0.378
 4 max=  1.857 min=  1.675 avg=  1.766   9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 35.117 min= 31.452 avg= 33.284  10 max= -0.495 min= -0.497 avg= -0.496
                                                        ENTER DATA -30+30M-24
```

```
RT  4    EOA
                                                          * DONE
 'G  2   Sensor Values

WD VALUE   NAME                              WD VALUE   NAME

 1 55FF Total Temp        634.731 DegR    -->FAULT   UTrav
 2 4BB8 Pitot Pressure     74.534 Hg      -->FAULT   OSlew
 3 0D4E Long. Stick        -0.021 In
 4 12EC Right TEF           1.873 In
 5 16DC NWS                32.331 Deg
 6 5800 Right LEF          -7.000 Deg     -->FAULT   UTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 6800 Left Rudder        -0.665 In      -->FAULT   UTrav OSlew

                                       6 max= -4.394 min= -4.394 avg= -4.394
 2 max= 79.769 min= 66.067 avg= 72.918  7 max= 97.468 min= 97.468 avg= 97.468
 3 max=  0.009 min= -0.068 avg= -0.030  8 max=  0.463 min= -0.463 avg=  0.000
 4 max=  1.920 min=  1.714 avg=  1.817  9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 35.411 min= 31.305 avg= 33.358 10 max= -0.376 min= -0.496 avg= -0.436
                                                    ENTER DATA -30+35M-25

RT  4    EOA
                                                          * DONE
  G  2   Sensor Values

WD VALUE   NAME                              WD VALUE   NAME

 1 4800 Total Temp        360.000 DegR    -->FAULT   UTrav
 2 4B9C Pitot Pressure     72.379 Hg      -->FAULT   OSlew
 3 4D50 Long. Stick        -0.015 In      -->FAULT
 4 52EF Right TEF           1.896 In      -->FAULT   OSlew
 5 16E6 NWS                33.798 Deg
 6 5800 Right LEF          -7.000 Deg     -->FAULT   UTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 6800 Left Rudder        -0.665 In      -->FAULT   UTrav OSlew

                                       6 max= -4.394 min= -4.394 avg= -4.394
 2 max= 79.846 min= 64.296 avg= 72.071  7 max= 97.468 min= 97.341 avg= 97.405
 3 max=  0.021 min= -0.053 avg= -0.016  8 max=  0.463 min=  0.293 avg=  0.378
 4 max=  1.912 min=  1.683 avg=  1.797  9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 35.557 min= 32.185 avg= 33.871 10 max= -0.422 min= -0.496 avg= -0.459
                                                    ENTER DATA -30+40M-25
```

```
RT   4     EOA
                                                              * DONE
 'SG   2    Sensor Values

WD VALUE    NAME                          WD VALUE    NAME

 1 6000 Total Temp          360.000 DegR   -->FAULT    UTrav
 2 4BB3 Pitot Pressure       74.150 Hg     -->FAULT    OSlew
 3 0D51 Long. Stick          -0.012 In
 4 52DF Right TEF             1.770 In     -->FAULT    OSlew
 5 16EB NWS                  34.531 Deg
 6 5800 Right LEF            -7.000 Deg    -->FAULT    UTrav
 7 1EFF Power Lever Cntl     97.468 Deg
 8 60C4 Rudder Pedal         -0.463 In     -->FAULT    OSlew
 9 2432 Left Stabilator      -3.212 In
10 6883 Left Rudder          -0.495 In     -->FAULT    OSlew

                                             6 max= -4.394 min= -4.394 avg= -4.394
 2 max= 76.382 min= 64.450 avg= 70.416       7 max= 97.468 min= 97.341 avg= 97.405
 3 max=  0.024 min= -0.053 avg= -0.015       8 max=  0.463 min= -0.444 avg=  0.010
 4 max=  1.952 min=  1.714 avg=  1.833       9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 36.144 min= 32.185 avg= 34.164      10 max= -0.493 min= -0.497 avg= -0.495
                                                          ENTER DATA -30+45M-25

RT   4     EOA
                                                              * DONE
 'G   2    Sensor Values

WD VALUE    NAME                          WD VALUE    NAME

 1 7DFF Total Temp          634.731 DegR   -->FAULT    UTrav
 2 4B93 Pitot Pressure       71.686 Hg     -->FAULT    OSlew
 3 0D51 Long. Stick          -0.012 In
 4 12E4 Right TEF             1.809 In
 5 16EE NWS                  34.971 Deg
 6 5800 Right LEF            -7.000 Deg    -->FAULT    UTrav OSlew
 7 1EFF Power Lever Cntl     97.468 Deg
 8 22C7 Rudder Pedal          0.293 In
 9 2432 Left Stabilator      -3.212 In
10 6AED Left Rudder           0.309 In     -->FAULT    OSlew

                                             6 max= -4.394 min= -4.394 avg= -4.394
 2 max= 78.306 min= 65.605 avg= 71.956       7 max= 97.468 min= 97.341 avg= 97.405
 3 max=  0.033 min= -0.036 avg= -0.001       8 max=  0.458 min=  0.293 avg=  0.375
 4 max=  1.983 min=  1.762 avg=  1.873       9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 35.997 min= 32.625 avg= 34.311      10 max= -0.493 min= -0.496 avg= -0.495
                                                          ENTER DATA -30+~~45M~~-25
                                                                       +50M
```

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	7C00	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4B6B	Pitot Pressure	68.607	Hg	-->FAULT	OSlew
3	4D5F	Long. Stick	0.030	In	-->FAULT	OSlew
4	12E9	Right TEF	1.849	In		
5	16F1	NWS	35.411	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew
8	632C	Rudder Pedal	0.441	In	-->FAULT	OSlew
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	UTrav

					6	max= -4.394 min= -4.394 avg= -4.394
2	max= 79.538	min= 67.067	avg= 73.303		7	max= 97.468 min= 97.468 avg= 97.468
3	max= 0.036	min= -0.059	avg= -0.012		8	max= 0.464 min= 0.293 avg= 0.378
4	max= 1.968	min= 1.778	avg= 1.873		9	max= -3.212 min= -3.212 avg= -3.212
5	max= 36.437	min= 32.331	avg= 34.384		10	max= -0.493 min= -0.496 avg= -0.495

ENTER DATA -30~~+50M~~-25
+55M

RT 4 EOA

MSG 2 Sensor Values

* DONE

Time 1:45pm

WD	VALUE	NAME			WD VALUE	NAME
1	7DFF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4B7D	Pitot Pressure	69.993	Hg	-->FAULT	OSlew
3	0D54	Long. Stick	-0.003	In		
4	52E3	Right TEF	1.801	In	-->FAULT	OSlew
5	56E4	NWS	33.504	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6882	Left Rudder	-0.496	In	-->FAULT	OSlew

					6	max= -4.394 min= -4.394 avg= -4.394
2	max= 72.995	min= 68.915	avg= 70.955		7	max= 97.468 min= 97.341 avg= 97.405
3	max= 0.039	min= -0.036	avg= 0.001		8	max= 0.463 min= 0.293 avg= 0.378
4	max= 1.944	min= 1.785	avg= 1.865		9	max= -3.212 min= -3.212 avg= -3.212
5	max= 36.730	min= 32.771	avg= 34.751		10	max= -0.493 min= -0.496 avg= -0.495

ENTER DATA -30+60M-25

RT 4 EOA

G 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	7DFF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4B2B	Pitot Pressure	63.680	Hg	-->FAULT	OSlew
3	0D57	Long. Stick	0.006	In		
4	52DE	Right TEF	1.762	In	-->FAULT	OSlew
5	16EB	NWS	34.531	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	UTrav OSlew

```
 2 max= 75.381 min= 70.070 avg= 72.725
 3 max=  0.041 min= -0.036 avg=  0.003
 4 max=  1.968 min=  1.770 avg=  1.869
 5 max= 36.290 min= 32.478 avg= 34.384
 6 max= -4.394 min= -4.394 avg= -4.394
 7 max= 97.468 min= 97.341 avg= 97.405
 8 max=  0.463 min=  0.293 avg=  0.378
 9 max= -3.212 min= -3.212 avg= -3.212
10 max= -0.495 min= -0.536 avg= -0.515
```

ENTER DATA -25C, -24C

RT 4 EOA

G 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	7000	Total Temp	360.000	DegR	-->FAULT	UTrav
2	0BB9	Pitot Pressure	74.611	Hg		
3	4D58	Long. Stick	0.009	In	-->FAULT	OSlew
4	12ED	Right TEF	1.880	In		
5	56E5	NWS	33.651	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	2882	Left Rudder	-0.496	In		

```
 2 max= 75.381 min= 64.912 avg= 70.147
 3 max=  0.024 min= -0.036 avg= -0.006
 4 max=  1.912 min=  1.722 avg=  1.817
 5 max= 35.997 min= 32.625 avg= 34.311
 6 max= -4.394 min= -4.394 avg= -4.394
 7 max= 97.468 min= 97.468 avg= 97.468
 8 max=  0.464 min=  0.293 avg=  0.378
 9 max= -3.212 min= -3.212 avg= -3.212
10 max= -0.493 min= -0.496 avg= -0.495
```

ENTER DATA -20C, -21C

```
RT   4     EOA
                                                                      * DONE
  G  2    Sensor Values

WD VALUE    NAME                                      WD VALUE    NAME

 1 5400 Total Temp          360.000 DegR     -->FAULT    UTrav
 2 4B69 Pitot Pressure       68.453 Hg       -->FAULT    OSlew
 3 4D51 Long. Stick          -0.012 In       -->FAULT    OSlew
 4 12E9 Right TEF             1.849 In
 5 56EB NWS                  34.531 Deg      -->FAULT    OSlew
 6 5800 Right LEF            -7.000 Deg      -->FAULT    UTrav
 7 1EFF Power Lever Cntl     97.468 Deg
 8 62C7 Rudder Pedal          0.293 In       -->FAULT    OSlew
 9 2432 Left Stabilator      -3.212 In
10 6800 Left Rudder          -0.665 In       -->FAULT    UTrav

                                             6 max= -4.394 min= -4.394 avg= -4.394
 2 max= 79.461 min= 68.838 avg= 74.150       7 max= 97.468 min= 97.468 avg= 97.468
 3 max= -0.006 min= -0.065 avg= -0.036       8 max=  0.464 min= -0.441 avg=  0.012
 4 max=  1.873 min=  1.730 avg=  1.801       9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 34.971 min= 31.012 avg= 32.991      10 max= -0.376 min= -0.496 avg= -0.436
                                                                ENTER DATA -15C, -16C
```

```
RT   4     EOA
                                                                      * DONE
  G  2    Sensor Values

WD VALUE    NAME                                      WD VALUE    NAME

 1 5400 Total Temp          360.000 DegR     -->FAULT    UTrav
 2 4BB3 Pitot Pressure       74.150 Hg       -->FAULT    OSlew
 3 4D44 Long. Stick          -0.050 In       -->FAULT    OSlew
 4 52C9 Right TEF             1.595 In       -->FAULT    OSlew
 5 56C5 NWS                  28.959 Deg      -->FAULT    OSlew
 6 5800 Right LEF            -7.000 Deg      -->FAULT    UTrav OSlew
 7 1EFF Power Lever Cntl     97.468 Deg
 8 22C7 Rudder Pedal          0.293 In
 9 2432 Left Stabilator      -3.212 In
10 6882 Left Rudder          -0.496 In       -->FAULT    OSlew

 2 max= 79.615 min= 68.222 avg= 73.919       7 max= 97.468 min= 97.341 avg= 97.405
 3 max=  0.018 min= -0.059 avg= -0.021       8 max=  0.461 min=  0.293 avg=  0.377
 4 max=  1.793 min=  1.619 avg=  1.706       9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 33.651 min= 30.572 avg= 32.111      10 max= -0.495 min= -0.497 avg= -0.496
                                                                ENTER DATA -10C, -12C
```

RT 4 EOA

G 2 Sensor Values

* DONE

WD	VALUE	NAME				WD VALUE	NAME
1	7DFF	Total Temp	634.731	DegR		-->FAULT	UTrav
2	4B91	Pitot Pressure	71.532	Hg		-->FAULT	OSlew
3	4D39	Long. Stick	-0.083	In		-->FAULT	OSlew
4	12BB	Right TEF	1.485	In			
5	56BC	NWS	27.639	Deg		-->FAULT	OSlew
6	590B	Right LEF	4.223	Deg		-->FAULT	OSlew
7	5C00	Power Lever Cntl	0.000	Deg		-->FAULT	UTrav OSlew
8	22C7	Rudder Pedal	0.293	In			
9	2432	Left Stabilator	-3.212	In			
10	6800	Left Rudder	-0.665	In		-->FAULT	UTrav OSlew

```
 2 max= 79.846 min= 78.614 avg= 79.230     7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.039 min= -0.116 avg= -0.077     8 max=  0.463 min=  0.293 avg=  0.378
 4 max=  1.619 min=  1.279 avg=  1.449     9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 30.718 min= 24.560 avg= 27.639    10 max= -0.493 min= -0.497 avg= -0.495
```

ENTER DATA -5C, -7C

RT 4 EOA

G 2 Sensor Values

* DONE

Time 2:10pm

WD	VALUE	NAME				WD VALUE	NAME
1	55FF	Total Temp	634.731	DegR		-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg		-->FAULT	OTrav
3	4D22	Long. Stick	-0.151	In		-->FAULT	OSlew
4	52AC	Right TEF	1.366	In		-->FAULT	OSlew
5	169D	NWS	23.094	Deg			
6	5800	Right LEF	-7.000	Deg		-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg			
8	22C7	Rudder Pedal	0.293	In			
9	2432	Left Stabilator	-3.212	In			
10	6862	Left Rudder	-0.538	In		-->FAULT	OSlew

```
                                           6 max=  4.223 min=  4.223 avg=  4.223
                                           7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.118 min= -0.228 avg= -0.173     8 max=  0.294 min=  0.293 avg=  0.293
 4 max=  1.390 min=  0.970 avg=  1.180     9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 27.639 min= 20.161 avg= 23.900    10 max= -0.495 min= -0.496 avg= -0.495
```

ENTER DATA 0C, -2C

```
RT   4     EOA
                                                                    * DONE
  G  2    Sensor Values

WD VALUE    NAME                                WD VALUE    NAME

 1 47FF Total Temp         910.000 DegR      -->FAULT    UTrav
 2 4BFF Pitot Pressure      80.000 Hg        -->FAULT    OTrav
 3 0CF2 Long. Stick         -0.293 In
 4 1244 Right TEF            0.542 In
 5 1654 NWS                 12.390 Deg
 6 5800 Right LEF           -7.000 Deg       -->FAULT    UTrav OSlew
 7 1EFE Power Lever Cntl    97.341 Deg
 8 6338 Rudder Pedal         0.458 In        -->FAULT    OSlew
 9 2432 Left Stabilator     -3.212 In
10 6800 Left Rudder         -0.665 In        -->FAULT    UTrav OSlew


                                              7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.207 min= -0.344 avg= -0.275        8 max=  0.458 min=  0.287 avg=  0.372
 4 max=  0.907 min=  0.408 avg=  0.657        9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 18.842 min=  8.431 avg= 13.636       10 max= -0.376 min= -0.497 avg= -0.437
                                                               ENTER DATA 5C, 3C
```

```
RT   4     EOA
                                                                    * DONE
  G  2    Sensor Values

WD VALUE    NAME                                WD VALUE    NAME

 1 7DFF Total Temp         634.731 DegR      -->FAULT    UTrav
 2 4BFF Pitot Pressure      80.000 Hg        -->FAULT    OTrav
 3 4CD4 Long. Stick         -0.382 In        -->FAULT    OSlew
 4 1213 Right TEF            0.154 In
 5 562A NWS                  6.232 Deg       -->FAULT    OSlew
 6 5800 Right LEF           -7.000 Deg       -->FAULT    UTrav
 7 1EFF Power Lever Cntl    97.468 Deg
 8 22C7 Rudder Pedal         0.293 In
 9 2432 Left Stabilator     -3.212 In
10 2882 Left Rudder         -0.496 In


                                              7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.314 min= -0.403 avg= -0.358        8 max=  0.458 min=  0.293 avg=  0.375
 4 max=  0.447 min=  0.099 avg=  0.273        9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 11.217 min=  4.619 avg=  7.918       10 max= -0.495 min= -0.497 avg= -0.496
                                                               ENTER DATA 10C, 6C
```

RT 4 EOA

* DONE

ƷG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	55FF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav
3	0CEB	Long. Stick	-0.314	In		
4	124B	Right TEF	0.598	In		
5	166A	NWS	15.616	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	2882	Left Rudder	-0.496	In		

3 max= -0.264 min= -0.341 avg= -0.302
4 max= 0.653 min= 0.471 avg= 0.562
5 max= 15.762 min= 12.683 avg= 14.223

7 max= 97.468 min= 97.341 avg= 97.405
8 max= 0.466 min= 0.293 avg= 0.379
9 max= -3.212 min= -3.212 avg= -3.212
10 max= -0.376 min= -0.497 avg= -0.437

ENTER DATA 15C, 11C

RT 4 EOA

* DONE

ƷG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	7DFF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav UPwr
3	0CE4	Long. Stick	-0.335	In		
4	1245	Right TEF	0.550	In		
5	1663	NWS	14.589	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	OSlew

3 max= -0.302 min= -0.367 avg= -0.335
4 max= 0.637 min= 0.432 avg= 0.534
5 max= 15.469 min= 11.804 avg= 13.636

7 max= 97.468 min= 97.341 avg= 97.405
8 max= 0.294 min= 0.287 avg= 0.290
9 max= -3.212 min= -3.212 avg= -3.212
10 max= -0.376 min= -0.496 avg= -0.436

ENTER DATA 20C, 16C

RT 4 EOA

* DONE

`G 2 Sensor Values

Time 2:35pm

WD	VALUE	NAME			WD VALUE	NAME
1	7DFF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav
3	4CE3	Long. Stick	-0.338	In	-->FAULT	OSlew
4	5260	Right TEF	0.764	In	-->FAULT	OSlew
5	1691	NWS	21.334	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C8	Rudder Pedal	0.294	In		
9	2432	Left Stabilator	-3.212	In		
10	2883	Left Rudder	-0.495	In		

```
 3 max= -0.267 min= -0.361 avg= -0.314
 4 max=  0.994 min=  0.661 avg=  0.827
 5 max= 23.240 min= 17.669 avg= 20.455
 7 max= 97.468 min= 97.341 avg= 97.405
 8 max=  0.294 min=  0.293 avg=  0.293
 9 max= -3.212 min= -3.212 avg= -3.212
10 max= -0.387 min= -0.497 avg= -0.442
```

ENTER DATA 25C, 22C

RT 4 EOA

* DONE

G 2 Sensor Values

Time 2:39pm

WD	VALUE	NAME			WD VALUE	NAME
1	55FF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav
3	0CF2	Long. Stick	-0.293	In		
4	529B	Right TEF	1.231	In	-->FAULT	OSlew
5	56B9	NWS	27.199	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6883	Left Rudder	-0.495	In	-->FAULT	OSlew

```
 3 max= -0.222 min= -0.323 avg= -0.272
 4 max=  1.326 min=  1.041 avg=  1.184
 5 max= 29.252 min= 23.240 avg= 26.246
 6 max=  4.223 min=  4.223 avg=  4.223
 7 max= 97.468 min= 97.341 avg= 97.405
 8 max=  0.294 min=  0.284 avg=  0.289
 9 max= -3.191 min= -3.212 avg= -3.202
10 max= -0.385 min= -0.496 avg= -0.441
```

ENTER DATA 30C, 26C

```
RT   4     EOA
                                                                    * DONE
 G   2    Sensor Values

WD VALUE    NAME                              WD VALUE    NAME

 1 7DFF Total Temp          634.731 DegR    -->FAULT    UTrav
 2 4BFF Pitot Pressure       80.000 Hg      -->FAULT    OTrav UPwr
 3 0CEF Long. Stick          -0.302 In
 4 5297 Right TEF             1.200 In      -->FAULT    OSlew
 5 56A7 NWS                  24.560 Deg     -->FAULT    OSlew
 6 5800 Right LEF            -7.000 Deg     -->FAULT    UTrav OSlew
 7 5C00 Power Lever Cntl      0.000 Deg     -->FAULT    UTrav OSlew
 8 22C7 Rudder Pedal          0.293 In
 9 2432 Left Stabilator      -3.212 In
10 6882 Left Rudder          -0.496 In      -->FAULT    OSlew

                                              7 max= 97.468 min= 97.468 avg= 97.468
 3 max= -0.240 min= -0.352 avg= -0.296        8 max=  0.294 min=  0.287 avg=  0.290
 4 max=  1.295 min=  0.970 avg=  1.132        9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 31.891 min= 22.507 avg= 27.199       10 max=  0.254 min= -0.496 avg= -0.121
                                                              ENTER DATA 35C, 31C

RT   4     EOA
                                                                    * DONE
 G   2    Sensor Values

WD VALUE    NAME                              WD VALUE    NAME

 1 7000 Total Temp          360.000 DegR    -->FAULT    UTrav
 2 4BFF Pitot Pressure       80.000 Hg      -->FAULT    OTrav UPwr
 3 0CE7 Long. Stick          -0.326 In
 4 128B Right TEF             1.105 In
 5 16C5 NWS                  28.959 Deg
 6 5800 Right LEF            -7.000 Deg     -->FAULT    UTrav OSlew
 7 1EFF Power Lever Cntl     97.468 Deg
 8 22C7 Rudder Pedal          0.293 In
 9 2432 Left Stabilator      -3.212 In
10 6800 Left Rudder          -0.665 In      -->FAULT    UTrav

                                              7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.252 min= -0.364 avg= -0.308        8 max=  0.294 min=  0.284 avg=  0.289
 4 max=  1.263 min=  0.907 avg=  1.085        9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 30.572 min= 22.801 avg= 26.686       10 max= -0.376 min= -0.496 avg= -0.436
                                                              ENTER DATA 40C, 36C
```

RT 4 EOA

* DONE

G 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	55FF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav UPwr
3	0CDA	Long. Stick	-0.364	In		
4	5291	Right TEF	1.152	In	-->FAULT	OSlew
5	16AA	NWS	25.000	Deg		
6	590B	Right LEF	4.223	Deg	-->FAULT	OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	2882	Left Rudder	-0.496	In		

3 max= -0.278 min= -0.379 avg= -0.329
4 max= 1.334 min= 0.922 avg= 1.128
5 max= 28.812 min= 23.534 avg= 26.173
7 max= 97.468 min= 97.341 avg= 97.405
8 max= 0.294 min= 0.293 avg= 0.293
9 max= -3.191 min= -3.212 avg= -3.202
10 max= -0.376 min= -0.497 avg= -0.437

ENTER DATA 45C, 39C

RT 4 EOA

* DONE

G 2 Sensor Values

Time 2:50pm

WD	VALUE	NAME			WD VALUE	NAME
1	7DFF	Total Temp	634.731	DegR	-->FAULT	UTrav
2	4BFF	Pitot Pressure	80.000	Hg	-->FAULT	OTrav UPwr
3	0CE5	Long. Stick	-0.332	In		
4	128E	Right TEF	1.128	In		
5	16B0	NWS	25.880	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C8	Rudder Pedal	0.294	In		
9	2432	Left Stabilator	-3.212	In		
10	6882	Left Rudder	-0.496	In	-->FAULT	OSlew

3 max= -0.296 min= -0.391 avg= -0.344
4 max= 1.302 min= 1.025 avg= 1.164
5 max= 27.346 min= 23.534 avg= 25.440
7 max= 97.468 min= 97.341 avg= 97.405
8 max= 0.294 min= 0.293 avg= 0.293
9 max= -3.191 min= -3.212 avg= -3.202
10 max= -0.493 min= -0.496 avg= -0.495

ENTER DATA 50C, 43C

```
RT  4    EOA
                                                          * DONE
  G  2   Sensor Values

WD VALUE   NAME                             WD VALUE    NAME

 1 EA00 Total Temp         635.269 DegR    -->FAULT    UTrav
 2 4BFF Pitot Pressure      80.000 Hg      -->FAULT    OTrav UPwr
 3 4CD3 Long. Stick         -0.385 In      -->FAULT    OSlew
 4 5287 Right TEF            1.073 In      -->FAULT    OSlew
 5 16AC NWS                 25.293 Deg
 6 5800 Right LEF           -7.000 Deg     -->FAULT    UTrav OSlew
 7 5C00 Power Lever Cntl     0.000 Deg     -->FAULT    UTrav OSlew
 8 22C7 Rudder Pedal         0.293 In
 9 2432 Left Stabilator     -3.212 In
10 2883 Left Rudder         -0.495 In

                                            7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.302 min= -0.400 avg= -0.351      8 max=  0.294 min=  0.293 avg=  0.293
 4 max=  1.176 min=  0.978 avg=  1.077      9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 26.320 min= 22.361 avg= 24.340     10 max= -0.495 min= -0.496 avg= -0.495
                                                          ENTER DATA 55C, 47C

RT  4    EOA
                                                          * DONE
  G  2   Sensor Values

WD VALUE   NAME                             WD VALUE    NAME

 1 DA00 Total Temp         635.269 DegR    -->FAULT    UTrav
 2 4BFF Pitot Pressure      80.000 Hg      -->FAULT    OTrav UPwr
 3 0CDF Long. Stick         -0.350 In
 4 1273 Right TEF            0.915 In
 5 56A7 NWS                 24.560 Deg     -->FAULT    OSlew
 6 5800 Right LEF           -7.000 Deg     -->FAULT    UTrav
 7 1EFF Power Lever Cntl    97.468 Deg
 8 22C7 Rudder Pedal         0.293 In
 9 2432 Left Stabilator     -3.212 In
10 6800 Left Rudder         -0.665 In      -->FAULT    UTrav

                                            6 max=  4.223 min=  4.223 avg=  4.223
                                            7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.317 min= -0.450 avg= -0.384      8 max=  0.294 min=  0.284 avg=  0.289
 4 max=  1.105 min=  0.875 avg=  0.990      9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 26.173 min= 22.067 avg= 24.120     10 max= -0.376 min= -0.502 avg= -0.439
                                                          ENTER DATA 60C, 51C
```

```
RT   4     EOA
                                                                      * DONE
  G   2    Sensor Values

WD VALUE    NAME                               WD VALUE    NAME

 1 5400 Total Temp       360.000 DegR     -->FAULT    UTrav
 2 4BFF Pitot Pressure    80.000 Hg       -->FAULT    OTrav UPwr
 3 0CCC Long. Stick       -0.406 In
 4 526A Right TEF          0.843 In       -->FAULT    OSlew
 5 16A3 NWS               23.974 Deg
 6 5BFF Right LEF         36.000 Deg      -->FAULT    OTrav OSlew
 7 1EFF Power Lever Cntl  97.468 Deg
 8 22C7 Rudder Pedal       0.293 In
 9 2432 Left Stabilator   -3.212 In
10 68DD Left Rudder       -0.378 In       -->FAULT    OSlew

                                       6 max=  4.223 min=  4.223 avg=  4.223
                                       7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.305 min= -0.509 avg= -0.407  8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  1.073 min=  0.637 avg=  0.855  9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 24.707 min= 16.789 avg= 20.748 10 max= -0.495 min= -0.539 avg= -0.517
                                                          ENTER DATA 65C, 56C

RT   4     EOA
                                                                      * DONE
  G   2    Sensor Values

WD VALUE    NAME                               WD VALUE    NAME

 1 5400 Total Temp       360.000 DegR     -->FAULT    UTrav
 2 4B4B Pitot Pressure    66.144 Hg       -->FAULT    OSlew UPwr
 3 0CC9 Long. Stick       -0.415 In
 4 1254 Right TEF          0.669 In
 5 5699 NWS               22.507 Deg      -->FAULT    OSlew
 6 5800 Right LEF         -7.000 Deg      -->FAULT    UTrav
 7 1EFF Power Lever Cntl  97.468 Deg
 8 22C7 Rudder Pedal       0.293 In
 9 2432 Left Stabilator   -3.212 In
10 6874 Left Rudder       -0.514 In       -->FAULT    OSlew

                                       7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.412 min= -0.560 avg= -0.486  8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.851 min=  0.519 avg=  0.685  9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 21.334 min= 12.390 avg= 16.862 10 max= -0.493 min= -0.496 avg= -0.495
                                                          ENTER DATA 70C, 60C
```

```
RT   4     EOA
                                                                    * DONE
 'G  2    Sensor Values
```

Time 3:00pm

```
WD VALUE   NAME                               WD VALUE   NAME

 1 7DFF Total Temp        634.731 DegR    -->FAULT   UTrav
 2 4B6A Pitot Pressure     68.530 Hg      -->FAULT   OSlew UPwr
 3 4C89 Long. Stick        -0.604 In      -->FAULT   OSlew
 4 1231 Right TEF           0.392 In
 5 5652 NWS                12.097 Deg     -->FAULT   OSlew
 6 5800 Right LEF          -7.000 Deg     -->FAULT   UTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 6800 Left Rudder        -0.665 In      -->FAULT   UTrav

                                        6 max=  4.223 min=  4.223 avg=  4.223
                                        7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.471 min= -0.601 avg= -0.536  8 max=  0.294 min=  0.291 avg=  0.293
 4 max=  0.637 min=  0.368 avg=  0.503  9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 17.815 min= 11.510 avg= 14.663 10 max= -0.493 min= -0.540 avg= -0.517
                                                        ENTER DATA 75C, 65C
```

```
RT   4     EOA
                                                                    * DONE
  G  2    Sensor Values

WD VALUE   NAME                               WD VALUE   NAME

 1 4000 Total Temp        360.000 DegR    -->FAULT   UTrav
 2 48DE Pitot Pressure     18.339 Hg      -->FAULT   OSlew UPwr
 3 0C7C Long. Stick        -0.643 In
 4 5263 Right TEF           0.788 In      -->FAULT   OSlew
 5 5693 NWS                21.628 Deg     -->FAULT   OSlew
 6 5800 Right LEF          -7.000 Deg     -->FAULT   UTrav OSlew
 7 5F3B Power Lever Cntl  105.093 Deg     -->FAULT   OSlew
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 6861 Left Rudder        -0.539 In      -->FAULT   OSlew

                                        7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.533 min= -0.666 avg= -0.600  8 max=  0.294 min=  0.291 avg=  0.293
 4 max=  1.041 min=  0.590 avg=  0.816  9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 23.240 min= 16.349 avg= 19.795 10 max= -0.378 min= -0.496 avg= -0.437
                                                        ENTER DATA 75C+5M 69C
```

Ambient Chamber Temp. at 75°C at 5minutes)

Internal EOA Temp.

```
RT  4    EOA
                                                                  * DONE
  G  2   Sensor Values

WD VALUE   NAME                                WD VALUE   NAME

 1 C200 Total Temp        635.269 DegR       -->FAULT   UTrav
 2 4970 Pitot Pressure     29.578 Hg         -->FAULT   OSlew UPwr
 3 4C59 Long. Stick        -0.746 In         -->FAULT   OSlew
 4 122F Right TEF           0.376 In
 5 5657 NWS                12.830 Deg        -->FAULT   OSlew
 6 5BFF Right LEF          36.000 Deg        -->FAULT   OTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2430 Left Stabilator    -3.226 In
10 6884 Left Rudder        -0.493 In         -->FAULT   OSlew

                                        6 max=  4.223 min=  4.223 avg=  4.223
                                        7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.666 min= -0.835 avg= -0.751  8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.566 min=  0.337 avg=  0.451  9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 15.029 min=  9.018 avg= 12.023 10 max= -0.376 min= -0.497 avg= -0.437
                                                          ENTER DATA 75+10M 72C

RT  4    EOA
                                                                  * DONE
  G  2   Sensor Values

WD VALUE   NAME                                WD VALUE   NAME

 1 D7FF Total Temp        910.000 DegR       -->FAULT   UTrav
 2 4A24 Pitot Pressure     43.435 Hg         -->FAULT   OSlew UPwr
 3 4C3D Long. Stick        -0.829 In         -->FAULT   OSlew
 4 5216 Right TEF           0.178 In         -->FAULT   OSlew
 5 55FB NWS                -0.660 Deg        -->FAULT   OSlew
 6 5800 Right LEF          -7.000 Deg        -->FAULT   UTrav OSlew
 7 5EFE Power Lever Cntl   97.341 Deg        -->FAULT   OSlew
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 6874 Left Rudder        -0.514 In         -->FAULT   OSlew

                                        7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.723 min= -0.844 avg= -0.783  8 max=  0.458 min=  0.282 avg=  0.370
 4 max=  0.321 min= -0.020 avg=  0.150  9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 10.191 min= -0.953 avg=  4.619 10 max= -0.492 min= -0.562 avg= -0.527
                                                          ENTER DATA 75+15M 73C
```

```
RT  4    EOA
                                                                    * DONE
 'G  2   Sensor Values

WD VALUE   NAME                              WD VALUE   NAME

 1 4000 Total Temp       360.000 DegR        -->FAULT   UTrav
 2 4A21 Pitot Pressure    43.204 Hg          -->FAULT   UPwr
 3 4C3F Long. Stick       -0.823 In          -->FAULT   OSlew
 4 120E Right TEF          0.115 In
 5 5622 NWS                5.059 Deg         -->FAULT   OSlew
 6 590B Right LEF          4.223 Deg         -->FAULT   OSlew
 7 1EFE Power Lever Cntl  97.341 Deg
 8 22C7 Rudder Pedal       0.293 In
 9 2432 Left Stabilator   -3.212 In
10 68BB Left Rudder       -0.422 In          -->FAULT   OSlew

                                      6 max=  4.223 min=  4.223 avg=  4.223
                                      7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.758 min= -0.853 avg= -0.806  8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.265 min=  0.028 avg=  0.146  9 max= -3.191 min= -3.212 avg= -3.202
 5 max=  7.111 min=  1.540 avg=  4.326 10 max=  0.493 min= -0.535 avg= -0.021
                                                     ENTER DATA 75+20M 75C

RT  4    EOA
                                                                    * DONE
 .G  2   Sensor Values

WD VALUE   NAME                              WD VALUE   NAME

 1 4800 Total Temp       360.000 DegR        -->FAULT   UTrav
 2 49C2 Pitot Pressure    35.891 Hg          -->FAULT   UPwr
 3 4C52 Long. Stick       -0.767 In          -->FAULT   OSlew
 4 5230 Right TEF          0.384 In          -->FAULT   OSlew
 5 5651 NWS               11.950 Deg         -->FAULT   OSlew
 6 5BFF Right LEF         36.000 Deg         -->FAULT   OTrav OSlew
 7 5EFF Power Lever Cntl  97.468 Deg         -->FAULT
 8 22C7 Rudder Pedal       0.293 In
 9 2432 Left Stabilator   -3.212 In
10 6800 Left Rudder       -0.665 In          -->FAULT   UTrav OSlew

                                      7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.711 min= -0.835 avg= -0.773  8 max=  0.468 min=  0.282 avg=  0.375
 4 max=  0.360 min=  0.020 avg=  0.190  9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 14.883 min=  5.792 avg= 10.337 10 max= -0.376 min= -0.514 avg= -0.445
                                                     ENTER DATA 75+25M 76C
```

```
RT  4     EOA
                                                                    * DONE
 G  2    Sensor Values


WD VALUE    NAME                                 WD VALUE    NAME

 1 4000 Total Temp        360.000 DegR     -->FAULT    UTrav
 2 49D6 Pitot Pressure     37.430 Hg       -->FAULT    OSlew UPwr
 3 0C6B Long. Stick        -0.693 In
 4 5234 Right TEF           0.416 In       -->FAULT    OSlew
 5 5659 NWS                13.123 Deg      -->FAULT    OSlew
 6 590B Right LEF           4.223 Deg      -->FAULT    OSlew
 7 5C00 Power Lever Cntl    0.000 Deg      -->FAULT    UTrav OSlew
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 68DE Left Rudder        -0.376 In       -->FAULT    OSlew

                                            6 max=  4.223 min=  4.223 avg=  4.223
                                            7 max=104.966 min= 97.341 avg=101.153
 3 max= -0.640 min= -0.764 avg= -0.702      8 max=  0.464 min=  0.282 avg=  0.373
 4 max=  0.653 min=  0.257 avg=  0.455      9 max= -2.133 min= -3.212 avg= -2.673
 5 max= 15.762 min= 10.337 avg= 13.050     10 max= -0.493 min= -0.496 avg= -0.495
                                                             ENTER DATA 75+30M 76C
```

```
RT  4     EOA
                                                                    * DONE
 G  2    Sensor Values


WD VALUE    NAME                                 WD VALUE    NAME

 1 FCFF Total Temp        497.097 DegR     -->FAULT    UTrav
 2 49D1 Pitot Pressure     37.045 Hg       -->FAULT    OSlew UPwr
 3 0C70 Long. Stick        -0.678 In
 4 5251 Right TEF           0.645 In       -->FAULT    OSlew
 5 565B NWS                13.416 Deg      -->FAULT    OSlew
 6 5BA9 Right LEF          32.385 Deg      -->FAULT    OSlew
 7 5EFF Power Lever Cntl   97.468 Deg      -->FAULT    OSlew
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 6800 Left Rudder        -0.665 In       -->FAULT    UTrav OSlew

                                            6 max=  4.223 min=  4.223 avg=  4.223
                                            7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.575 min= -0.693 avg= -0.634      8 max=  0.468 min=  0.282 avg=  0.375
 4 max=  0.780 min=  0.527 avg=  0.653      9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 17.229 min= 11.070 avg= 14.150     10 max= -0.497 min= -0.497 avg= -0.497
                                                             ENTER DATA 75+35M 77C
```

```
RT  4     EOA
                                                                 * DONE
"SG  2    Sensor Values

WD VALUE    NAME                                  WD VALUE    NAME

 1 7DFF Total Temp          634.731 DegR    -->FAULT    UTrav
 2 4953 Pitot Pressure       27.346 Hg      -->FAULT    OSlew UPwr
 3 4CA1 Long. Stick          -0.533 In      -->FAULT    OSlew
 4 1278 Right TEF             0.954 In
 5 165B NWS                  13.416 Deg
 6 5800 Right LEF            -7.000 Deg     -->FAULT    UTrav OSlew
 7 5C00 Power Lever Cntl      0.000 Deg     -->FAULT    UTrav
 8 22C7 Rudder Pedal          0.293 In
 9 2430 Left Stabilator      -3.226 In
10 6800 Left Rudder          -0.665 In      -->FAULT    UTrav OSlew

                                             6 max=  4.223 min=  4.223 avg=  4.223
                                             7 max=105.093 min= 97.341 avg=101.217
 3 max= -0.483 min= -0.637 avg= -0.560       8 max=  0.464 min=  0.282 avg=  0.373
 4 max=  1.144 min=  0.772 avg=  0.958       9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 19.575 min= 12.243 avg= 15.909      10 max=  0.561 min= -0.496 avg=  0.033
                                                           ENTER DATA 75+40M 77C

RT  4     EOA
                                                                 * DONE
 'G  2    Sensor Values

WD VALUE    NAME                                  WD VALUE    NAME

 1 F7FE Total Temp          909.462 DegR    -->FAULT    UTrav
 2 4A04 Pitot Pressure       40.971 Hg      -->FAULT    OSlew UPwr
 3 4CCB Long. Stick          -0.409 In      -->FAULT    OSlew
 4 527A Right TEF             0.970 In      -->FAULT    OSlew
 5 5670 NWS                  16.496 Deg     -->FAULT    OSlew
 6 5BFF Right LEF            36.000 Deg     -->FAULT    OTrav OSlew
 7 5EFF Power Lever Cntl     97.468 Deg     -->FAULT    OSlew
 8 22C7 Rudder Pedal          0.293 In
 9 2432 Left Stabilator      -3.212 In
10 6AD3 Left Rudder           0.275 In      -->FAULT    OSlew

                                             6 max=  4.223 min=  4.223 avg=  4.223
                                             7 max= 97.468 min= 97.087 avg= 97.278
 3 max= -0.409 min= -0.566 avg= -0.487       8 max=  0.464 min=  0.282 avg=  0.373
 4 max=  1.429 min=  1.010 avg=  1.219       9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 21.628 min= 12.683 avg= 17.155      10 max= -0.376 min= -0.376 avg= -0.376
                                                           ENTER DATA 75+45M 78C
```

RT 4 EOA

* DONE

"SG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	77FE	Total Temp	909.462	DegR	-->FAULT	UTrav
2	4A51	Pitot Pressure	46.899	Hg	-->FAULT	OSlew UPwr
3	4CCC	Long. Stick	-0.406	In	-->FAULT	OSlew
4	52AE	Right TEF	1.382	In	-->FAULT	OSlew
5	1683	NWS	19.282	Deg		
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5EFF	Power Lever Cntl	97.468	Deg	-->FAULT	OSlew
8	62C7	Rudder Pedal	0.293	In	-->FAULT	OSlew
9	2432	Left Stabilator	-3.212	In		
10	6ABB	Left Rudder	0.244	In	-->FAULT	OSlew

```
                                              7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.382 min= -0.504 avg= -0.443        8 max=  0.468 min=  0.282 avg=  0.375
 4 max=  1.437 min=  0.986 avg=  1.211        9 max= -3.205 min= -3.226 avg= -3.215
 5 max= 20.601 min= 15.469 avg= 18.035       10 max=  0.561 min= -0.496 avg=  0.033
```

ENTER DATA 75+50M 78C

RT 4 EOA

* DONE

'G 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	EC00	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4AD7	Pitot Pressure	57.214	Hg	-->FAULT	OSlew UPwr
3	0CDD	Long. Stick	-0.355	In		
4	5292	Right TEF	1.160	In	-->FAULT	OSlew
5	5682	NWS	19.135	Deg	-->FAULT	OSlew
6	590B	Right LEF	4.223	Deg	-->FAULT	
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	UTrav

```
                                              7 max= 97.468 min= 97.468 avg= 97.468
 3 max= -0.308 min= -0.432 avg= -0.370        8 max=  0.458 min=  0.282 avg=  0.370
 4 max=  1.445 min=  1.041 avg=  1.243        9 max= -3.212 min= -3.247 avg= -3.229
 5 max= 23.827 min= 16.935 avg= 20.381       10 max=  0.257 min= -0.379 avg= -0.061
```

ENTER DATA 75+55M 78C

RT 4 EOA

* DONE

~~G 2 Sensor Values

Time 4:00pm

WD	VALUE	NAME			WD VALUE	NAME
1	5800	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4AAF	Pitot Pressure	54.135	Hg	-->FAULT	OSlew UPwr
3	4CE1	Long. Stick	-0.344	In	-->FAULT	OSlew
4	5283	Right TEF	1.041	In	-->FAULT	OSlew
5	567E	NWS	18.548	Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	2AC5	Left Rudder	0.257	In		

3 max= -0.281 min= -0.403 avg= -0.342
4 max= 1.405 min= 1.105 avg= 1.255
5 max= 23.974 min= 16.642 avg= 20.308

7 max= 97.468 min= 89.971 avg= 93.719
8 max= 0.467 min= 0.282 avg= 0.375
9 max= -3.122 min= -3.226 avg= -3.174
10 max= 0.497 min= 0.241 avg= 0.369

ENTER DATA 75+60M 78C

RT 4 EOA

* DONE

'G 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	5400	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4B0F	Pitot Pressure	61.525	Hg	-->FAULT	OSlew UPwr
3	4CFC	Long. Stick	-0.264	In	-->FAULT	OSlew
4	128C	Right TEF	1.112	In		
5	1688	NWS	20.015	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6BA8	Left Rudder	0.552	In	-->FAULT	OSlew

3 max= -0.246 min= -0.367 avg= -0.307
4 max= 1.374 min= 1.033 avg= 1.204
5 max= 22.507 min= 16.642 avg= 19.575

7 max= 97.468 min= 97.341 avg= 97.405
8 max= 0.294 min= 0.282 avg= 0.288
9 max= -3.191 min= -3.226 avg= -3.209
10 max= -0.387 min= -0.387 avg= -0.387

ENTER DATA 70C, 75C

RT 4 EOA

* DONE

G 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	4800	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4ACF	Pitot Pressure	56.598	Hg	-->FAULT	OSlew UPwr
3	0CF4	Long. Stick	-0.287	In		
4	527E	Right TEF	1.002	In	-->FAULT	OSlew
5	569B	NWS	22.801	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	6B7D	Left Rudder	0.496	In	-->FAULT	OSlew

7 max= 97.468 min= 89.971 avg= 93.719
3 max= -0.222 min= -0.403 avg= -0.312
8 max= 0.468 min= 0.282 avg= 0.375
4 max= 1.437 min= 0.986 avg= 1.211
9 max= 3.212 min= -3.226 avg= -0.007
5 max= 25.000 min= 14.883 avg= 19.941
10 max= 0.562 min= -0.493 avg= 0.034

ENTER DATA 65C, 73C

RT 4 EOA

* DONE

G 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	E900	Total Temp	497.634	DegR	-->FAULT	UTrav
2	4ABF	Pitot Pressure	55.367	Hg	-->FAULT	OSlew UPwr
3	0CC6	Long. Stick	-0.424	In		
4	127C	Right TEF	0.986	In		
5	566B	NWS	15.762	Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5EFF	Power Lever Cntl	97.468	Deg	-->FAULT	OSlew
8	22C7	Rudder Pedal	0.293	In		
9	64CD	Left Stabilator	-2.133	In	-->FAULT	OSlew
10	6857	Left Rudder	-0.552	In	-->FAULT	OSlew

6 max= 4.223 min= 4.223 avg= 4.223
7 max= 97.468 min= 97.214 avg= 97.341
3 max= -0.358 min= -0.504 avg= -0.431
8 max= 0.464 min= 0.282 avg= 0.373
4 max= 1.136 min= 0.843 avg= 0.990
9 max= -3.191 min= -3.226 avg= -3.209
5 max= 17.669 min= 13.123 avg= 15.396
10 max= 0.557 min= -0.401 avg= 0.078

ENTER DATA 60C, 68C

RT 4 EOA

* DONE

~G 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	4000	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4A54	Pitot Pressure	47.130	Hg	-->FAULT	OSlew UPwr
3	0C9C	Long. Stick	-0.548	In		
4	126F	Right TEF	0.883	In		
5	564E	NWS	11.510	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew
8	22C6	Rudder Pedal	0.291	In		
9	2432	Left Stabilator	-3.212	In		
10	6800	Left Rudder	-0.665	In	-->FAULT	UTrav

```
                                          6 max=  4.223 min=  4.223 avg=  4.223
                                          7 max= 98.485 min= 97.214 avg= 97.849
 3 max= -0.412 min= -0.575 avg= -0.493    8 max=  0.468 min=  0.282 avg=  0.375
 4 max=  1.002 min=  0.629 avg=  0.816    9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 16.642 min=  7.551 avg= 12.097   10 max=  0.557 min= -0.496 avg=  0.031
```

ENTER DATA 55C, 65C

RT 4 EOA

* DONE

'G 2 Sensor Values

Time 4:25pm

WD	VALUE	NAME			WD VALUE	NAME
1	73FF	Total Temp	910.000	DegR	-->FAULT	UTrav
2	4A56	Pitot Pressure	47.284	Hg	-->FAULT	UPwr
3	0C85	Long. Stick	-0.616	In		
4	523A	Right TEF	0.463	In	-->FAULT	
5	163E	NWS	9.164	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	OTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	2432	Left Stabilator	-3.212	In		
10	2AC2	Left Rudder	0.253	In		

```
                                          6 max=  4.223 min=  4.223 avg=  4.223
                                          7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.578 min= -0.678 avg= -0.628    8 max=  0.458 min=  0.282 avg=  0.370
 4 max=  0.487 min=  0.281 avg=  0.384    9 max= -3.191 min= -3.247 avg= -3.219
 5 max= 12.243 min=  6.525 avg=  9.384   10 max=  0.253 min= -0.496 avg= -0.122
```

ENTER DATA 50C, 61C

```
RT   4     EOA
                                                            * DONE
MSG   2    Sensor Values

WD VALUE    NAME                                WD VALUE    NAME

 1 7C00 Total Temp          360.000 DegR       -->FAULT    UTrav
 2 4A69 Pitot Pressure       48.746 Hg         -->FAULT    OSlew UPwr
 3 0C79 Long. Stick          -0.652 In
 4 1220 Right TEF             0.257 In
 5 5628 NWS                   5.938 Deg        -->FAULT    OSlew
 6 5800 Right LEF            -7.000 Deg        -->FAULT    UTrav OSlew
 7 1EFF Power Lever Cntl     97.468 Deg
 8 22C7 Rudder Pedal          0.293 In
 9 2432 Left Stabilator      -3.212 In
10 6886 Left Rudder          -0.491 In         -->FAULT    OSlew

                                          6 max=  4.223 min=  4.223 avg=  4.223
                                          7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.598 min= -0.705 avg= -0.652    8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.313 min=  0.051 avg=  0.182    9 max= -3.191 min= -3.226 avg= -3.209
 5 max=  9.457 min=  5.645 avg=  7.551   10 max= -0.376 min= -0.496 avg= -0.436
                                                            ENTER DATA 45C, 58C

RT   4     EOA
                                                            * DONE
'SG   2    Sensor Values

WD VALUE    NAME                                WD VALUE    NAME

 1 55FF Total Temp          634.731 DegR       -->FAULT    UTrav
 2 4A79 Pitot Pressure       49.978 Hg         -->FAULT    UPwr
 3 4C7B Long. Stick          -0.646 In         -->FAULT    OSlew
 4 120B Right TEF             0.091 In
 5 5627 NWS                   5.792 Deg        -->FAULT    OSlew
 6 5BFF Right LEF            36.000 Deg        -->FAULT    OTrav OSlew
 7 1EFF Power Lever Cntl     97.468 Deg
 8 22C8 Rudder Pedal          0.294 In
 9 2432 Left Stabilator      -3.212 In
10 68DE Left Rudder          -0.376 In         -->FAULT    OSlew

                                          6 max=  4.223 min=  4.223 avg=  4.223
                                          7 max= 97.468 min= 97.087 avg= 97.278
 3 max= -0.616 min= -0.717 avg= -0.666    8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.234 min= -0.036 avg=  0.099    9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 11.217 min=  4.326 avg=  7.771   10 max= -0.376 min= -0.497 avg= -0.437
                                                            ENTER DATA 40C, 53C
```

```
RT   4     EOA
                                                                    * DONE
MSG  2     Sensor Values


WD VALUE    NAME                                   WD VALUE    NAME


 1 EFFF Total Temp        910.000 DegR      -->FAULT    UTrav
 2 4A37 Pitot Pressure     44.897 Hg        -->FAULT    OSlew UPwr
 3 4C7C Long. Stick        -0.643 In        -->FAULT    OSlew
 4 5234 Right TEF           0.416 In        -->FAULT    OSlew
 5 1652 NWS                12.097 Deg
 6 5BFF Right LEF          36.000 Deg       -->FAULT    OTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 2882 Left Rudder        -0.496 In


                                            7 max= 97.468 min= 96.960 avg= 97.214
 3 max= -0.548 min= -0.714 avg= -0.631      8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.337 min= -0.099 avg=  0.119      9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 15.909 min=  6.085 avg= 10.997     10 max= -0.376 min= -0.497 avg= -0.437
                                                           ENTER DATA 35C, 49C

RT   4     EOA
                                                                    * DONE
MSG  2     Sensor Values


WD VALUE    NAME                                   WD VALUE    NAME

 1 7000 Total Temp        360.000 DegR      -->FAULT    UTrav
 2 4996 Pitot Pressure     32.504 Hg        -->FAULT    OSlew UPwr
 3 4CB0 Long. Stick        -0.489 In        -->FAULT    OSlew
 4 126D Right TEF           0.867 In
 5 5671 NWS                16.642 Deg       -->FAULT    OSlew
 6 5800 Right LEF          -7.000 Deg       -->FAULT    UTrav OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 68DD Left Rudder        -0.378 In        -->FAULT    OSlew

                                            6 max=  4.223 min=  4.223 avg=  4.223
                                            7 max= 98.358 min= 97.214 avg= 97.786
 3 max= -0.483 min= -0.572 avg= -0.527      8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.867 min=  0.614 avg=  0.740      9 max= -3.191 min= -3.226 avg= -3.209
 5 max= 21.628 min= 13.856 avg= 17.742     10 max= -0.376 min= -0.514 avg= -0.445
                                                           ENTER DATA 30C, 42C
```

RT 4 EOA

* DONE

`G 2 Sensor Values

Time 4:52pm

WD	VALUE	NAME			WD VALUE	NAME
1	7000	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4A07	Pitot Pressure	41.202	Hg	-->FAULT	OSlew UPwr
3	4C9C	Long. Stick	-0.548	In	-->FAULT	OSlew
4	522A	Right TEF	0.337	In	-->FAULT	OSlew
5	163E	NWS	9.164	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C0	Rudder Pedal	0.282	In		
9	2432	Left Stabilator	-3.212	In		
10	6882	Left Rudder	-0.496	In	-->FAULT	OSlew

```
                                             6 max=  4.223 min=  4.223 avg=  4.223
                                             7 max= 98.485 min= 97.341 avg= 97.913
 3 max= -0.474 min= -0.589 avg= -0.532      8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  0.606 min=  0.265 avg=  0.435      9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 15.616 min=  9.018 avg= 12.317     10 max= -0.491 min= -0.496 avg= -0.493
```

ENTER DATA 25C, 33C

RT 4 EOA

* DONE

G 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	7C00	Total Temp	360.000	DegR	-->FAULT	UTrav
2	4B03	Pitot Pressure	60.601	Hg	-->FAULT	OSlew UPwr
3	0CC0	Long. Stick	-0.441	In		
4	125E	Right TEF	0.748	In		
5	167F	NWS	18.695	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	1EFF	Power Lever Cntl	97.468	Deg		
8	22C7	Rudder Pedal	0.293	In		
9	64CD	Left Stabilator	-2.133	In	-->FAULT	OSlew
10	6882	Left Rudder	-0.496	In	-->FAULT	OSlew

```
                                             6 max=  4.223 min=  4.223 avg=  4.223
                                             7 max= 97.468 min= 97.341 avg= 97.405
 3 max= -0.397 min= -0.506 avg= -0.452      8 max=  0.294 min=  0.285 avg=  0.290
 4 max=  0.994 min=  0.645 avg=  0.820      9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 21.774 min= 14.736 avg= 18.255     10 max= -0.493 min= -0.496 avg= -0.495
```

ENTER DATA 25C+5M 32C

```
T   4     EOA
                                                      * DONE
SC   2    Sensor Values

D VALUE   NAME                               WD VALUE   NAME

 1 6EFF Total Temp        772.366 DegR       -->FAULT   UTrav
 2 4BFF Pitot Pressure     80.000 Hg         -->FAULT   OTrav OSlew UPwr
 3 4CBC Long. Stick        -0.453 In         -->FAULT   OSlew
 4 5292 Right TEF           1.160 In         -->FAULT   OSlew
 5 5688 NWS                20.015 Deg        -->FAULT   OSlew
 6 590B Right LEF           4.223 Deg        -->FAULT   OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
 0 6800 Left Rudder        -0.665 In         -->FAULT   UTrav

                                              6 max=  4.223 min=  4.223 avg=  4.223
                                              7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.326 min= -0.456 avg= -0.391        8 max=  0.294 min=  0.293 avg=  0.293
 4 max=  1.097 min=  0.748 avg=  0.922        9 max= -3.191 min= -3.212 avg= -3.202
 5 max= 23.534 min= 17.229 avg= 20.381       10 max= -0.495 min= -0.496 avg= -0.495
                                                           ENTER DATA 25+10M 31C

T   4     EOA
                                                      * DONE
S   2    Sensor Values                                Time 5:07 pm

D VALUE   NAME                               WD VALUE   NAME

 1 7DFF Total Temp        634.731 DegR       -->FAULT   UTrav
 2 4BD8 Pitot Pressure     76.998 Hg         -->FAULT   OSlew UPwr
 3 0CC1 Long. Stick        -0.438 In
 4 1272 Right TEF           0.907 In
 5 5683 NWS                19.282 Deg        -->FAULT   OSlew
 6 590B Right LEF           4.223 Deg        -->FAULT   OSlew
 7 1EFF Power Lever Cntl   97.468 Deg
 8 22C7 Rudder Pedal        0.293 In
 9 2432 Left Stabilator    -3.212 In
10 6800 Left Rudder        -0.665 In         -->FAULT   UTrav OSlew

                                              7 max= 97.468 min= 97.214 avg= 97.341
 3 max= -0.320 min= -0.438 avg= -0.379        8 max=  0.294 min=  0.282 avg=  0.288
 4 max=  1.089 min=  0.812 avg=  0.950        9 max= -3.212 min= -3.212 avg= -3.212
 5 max= 23.680 min= 17.815 avg= 20.748       10 max= -0.495 min= -0.496 avg= -0.495
                                                           ENTER DATA 25+15M 30C
```

15.3 ALTITUDE TEST DATA SHEET

15.3.1 Altitude Test (14.5)   6/28/93   Brad Kessler   PASS ☑ FAIL ☐

WARNING: Observe the EOA Maximum Internal Operating Temperature (→ 78°C) listed in the Thermal Test Plan Data Sheet as approaching the upper limit of safe temperatures.

EOA Initial Stabilized Temperature $\boxed{30.2\,^0C}$ EOA Maximum Temp. $\boxed{41.5\,^0C}$ @ 50,000 ft. ~~in.Hg~~

15.3.1.1 Print each of the sensor data files for the constant values and attach them behind this data sheet.

All of the Sensors values are constant   YES ☑ NO ☐   Expect Yes.

15.3.1.2 Altitude results will be in a technical report; attach it behind the Altitude Test data sheets.

Comments: Total Pressure Sensor S/N 4030-32-01 is in the altitude chamber but is not connected to the EOA. The sensor values are constant but noisy. The noise is due to EOA#1 decoding and not the altitude test. The stab sensor seems to be fairly stable.

At 50,000 plus 15 minutes, the EOA stopped updating on the 1553 bus. The stab sensor position was changed to see if the EOA reported the change. No change in stab position was reported.

The EOA bus controller was checked and found to be operating. 1553 data was being output by the EOA bus controller. ~~to the EOA.~~ The 1553 cable was checked and found to be good.

The EOA LEDs still operated. The EOA current draw was still at the initial conditions of 2.5 Amps on 28 Volts input.

The EOA internal temp. is 32.7 °C, and the chamber temp. is 28.6°C

A power reset to the EOA was tried, and the EOA is now operating normally.

At 50,000 ft. + 60 minutes, the internal EOA temp. is 40.2°C, and the chamber temp. is 30.8°C.

At room pressure + 10 minutes, the internal EOA temp. is 37.1°C, and the chamber temp. is 28.5°C.

(Room Altitude = 743 Torr = ≈ 29.3 in. Hg)

TECHNICAL MEMORANDUM
ENGINEERING LABORATORIES

(DEPT.YR.TM.SEQ)
TECH MEMO: 257.93.0105.01
DATE: 20 AUG 93 REV:

REPORT TYPE: FINAL

TITLE: FOCSI ALTITUDE TEST OF EOA AVIONICS BOX

DISTRIBUTION

NAME	DEPT
B. L. Kessler	318
D. J. Williams	318
A. E. Dillard	260W
J. L. Williford	260W
R. W. Jordan	260W
T. L. Pulliam *	260W
TR Control **	

* Page 1 Only
** Original Report

MODEL NO: CRAD MODEL TYPE: CRAD
REQ DOC: TR 705-284
TEST ART DELIVERY: 28 JUN 93
CHARGE NO: M8Q-CH-136
SET-UP START: 28 JUN 93
CONTRACT NO: N/A
TEST START: 28 JUN 93
REQUESTING DEPT: 318 TEST COMP.: 28 JUN 93
PART NUMBER: NONE
QUANTITY: 1 TEARDOWN COMP.: 29 JUN 93

TEST ARTICLE DESCRIPTION: Avionics development package for fiber optics control sensor integration
MANUFACTURER: MDA-EAST

TEST ARTICLE DISPOSITION: Return to D318
TEST LOCATION/FACILITY/NO.: B103, ST. LOUIS
TEST CATEGORY: DESIGN DEVELOPMENT
TUNNEL OCCUPANCY HOURS: N/A TEST RUNS/DATA POINTS: 1/250
TYPE OF DATA ACQUIRED: PRESSURE, TEMPERATURE
NO OF DATA CHANNELS: 3
TEST VARIABLES AND CONDITIONS: Pressure altitude vs. time

OTHER LAB REPORTS: NONE
SUPPLEMENTARY REPORTS: NONE
KEYWORDS:
1. MISCELLANEOUS
2. AVIONICS
3. CHAMBER
4. PRESSURE
5. ALTITUDE
6. TEMPERATURE

1. TEST OBJECTIVE: The purpose of the test was to verify the performance of the EOA when exposed to a simulated altitude of 50,000 feet.

2. ABSTRACT OF RESULTS: The EOA was exposed to a simulated altitude of 50,000 feet while operating for a one hour period. One anomaly occurred during the test. The unit was reset and operated properly for the balance of the test.

R. W. Jordan
PREPARED BY: R. W. JORDAN
LEAD TECHNICIAN
ENVIORNMENTAL & SYSTEMS LAB

J. L. Williford
APPROVED BY: J. L. WILLIFORD
TECHNICAL SPECIALIST
ENVIRONMENTAL & SYSTEMS LAB

RELEASED

3. The test article was an Electro Optics Assembly (EOA) package which is part of the Fiber Optics Control Sensor Integration (FOCSI) program. The test article was placed in the MDA Combined Environmental Test (CET) chamber on a laboratory supplied support fixture. The cabling required to operate the EOA was brought out of the chamber on a feed-through port to the ground support equipment. One type T thermocouple was routed inside the EOA to measure internal air temperature. A second type T thermocouple was used to measure chamber air temperature. Chamber air was measured and recorded, but was not controlled. The test article installation in the CET chamber is shown in Figure 1.

4. Following a checkout at laboratory ambient pressure, the chamber was evacuated to a pressure altitude of 50,000 feet at a rate of 30,000 feet per minute. This pressure was maintained for one hour with the EOA operating. At approximately 35 minutes into the altitude test, the EOA operator reported that the unit had stopped updating. The unit was reset and functioned normally for the remainder of the test. It was not readily apparent whether the anomaly was related to the altitude exposure. At the completion of the one-hour test, the chamber pressure was adjusted to laboratory ambient at a rate of 60,000 feet per minute. The recorded pressure altitude and temperature data are presented in Figure 2.

5. Following the test, the EOA was removed from the chamber and returned to Dept. 318.

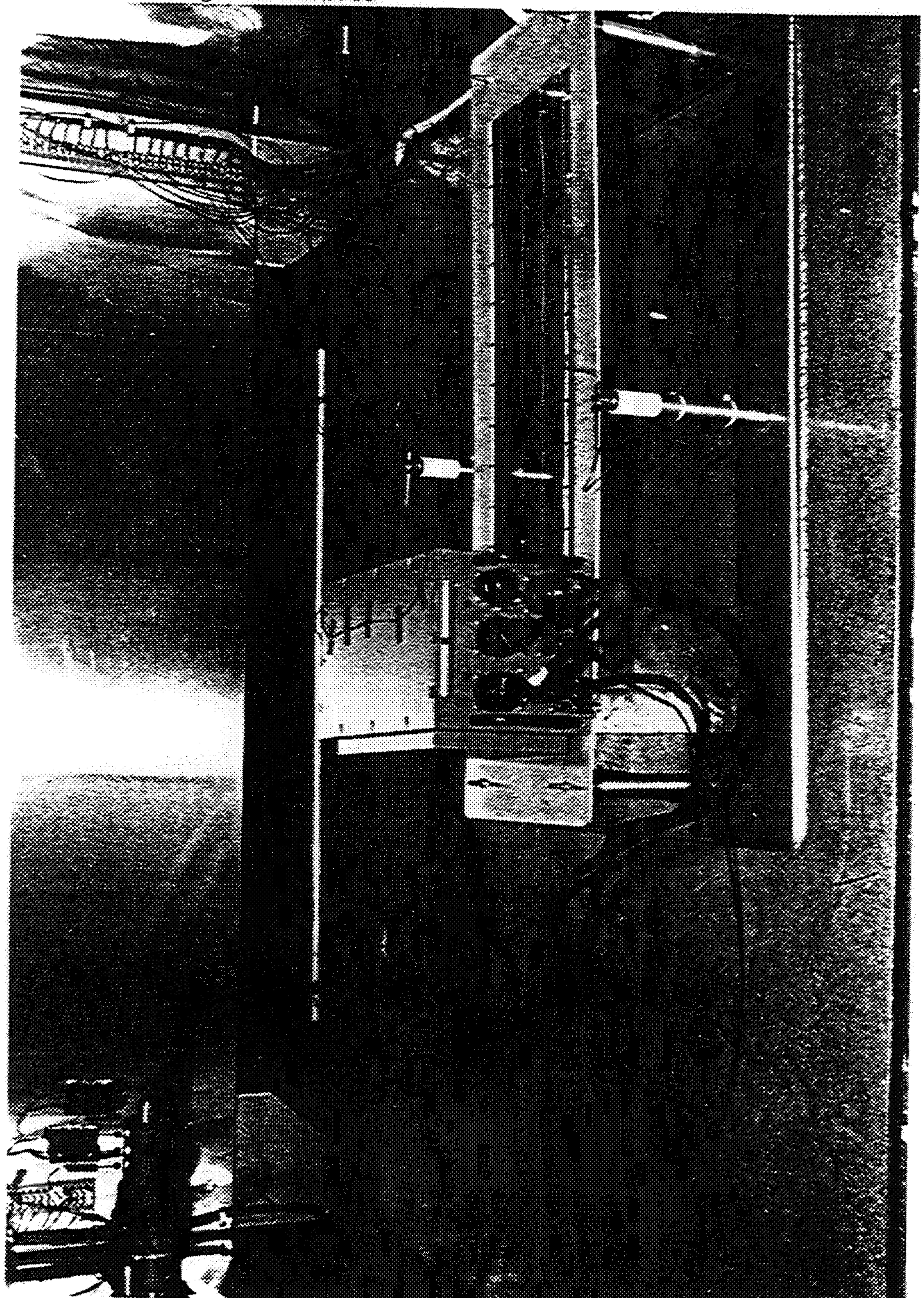


FIGURE 1 - EOA INSTALLED IN CET CHAMBER

C12-23652-1

C12-23652-1

FIGURE 1

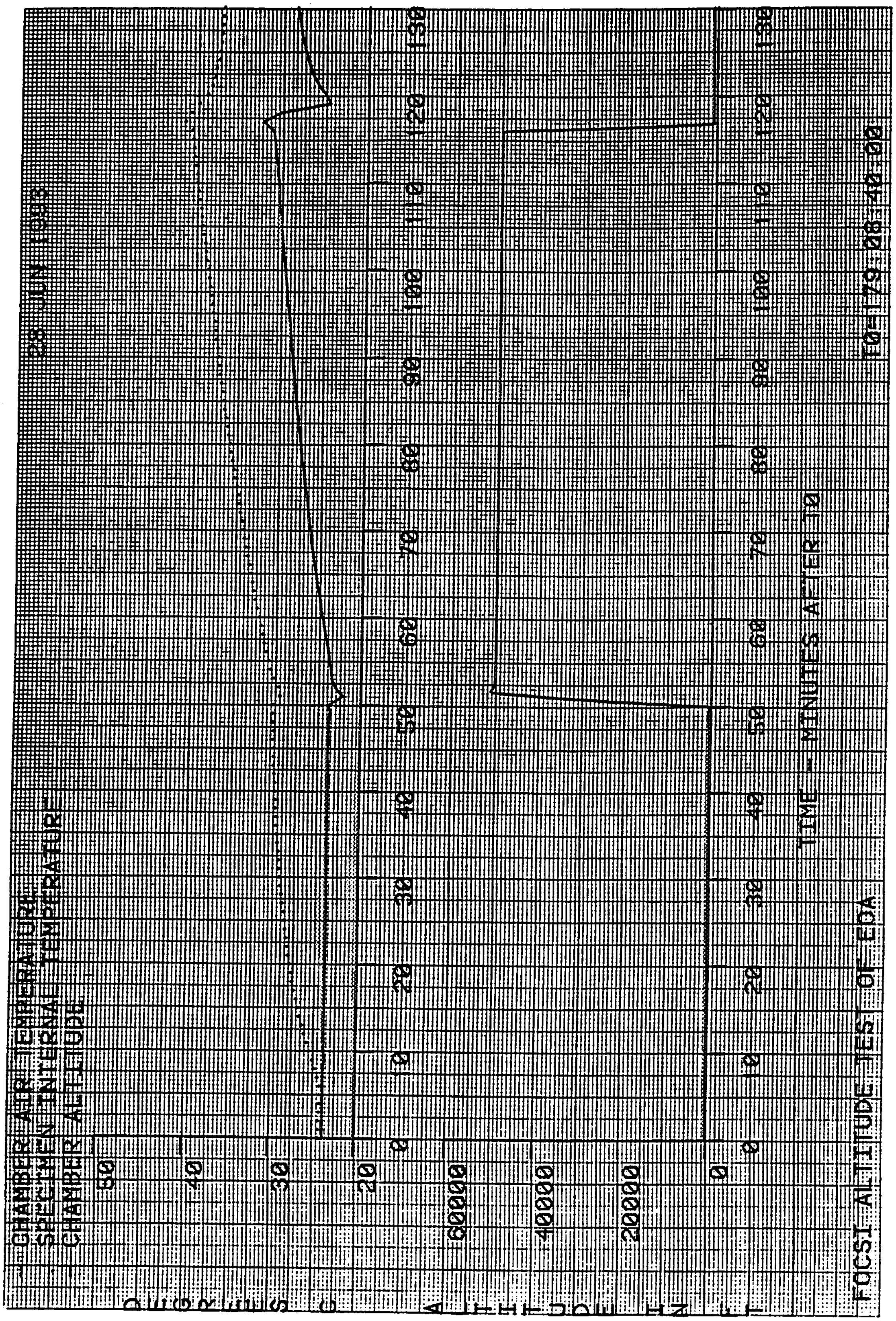


FIGURE 2 - PRESSURE ALTITUDE AND TEMPERATURE DATA

FIGURE 2

TABLE 1 - LIST OF EQUIPMENT AND INSTRUMENTS

Equipment and instruments used in this test are listed below. Applicable calibration records are available for inspection. All calibration maintenance and certification of MCAIR electrical, electronic and mechanical equipment is conducted in accordance with MIL-C-45662 and MDC Process Specification 20503.

Item	Manufacturer & Model No	Serial or Laboratory No.
Data System	MDC T-056168-7	090627
Tape Recorder	Tektronix 4923	078924
Digital Meter	Doric 400	B198486
Video Display	Hazeltine 1510	006864
Digital Printer	Epson FX 80	107123-1
Capacitance Manometer	MKS 122AA	691753
Power Supply	MKS CDR-2	691757

Sensor Data for Altitude Test

RT 4 EOA #1

* DONE

MSG 2 Sensor Values

WD	HEX VALUE	NAME			~~WD~~ Error VALUE	Error NAME
1	D2FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0ED3	Long. Stick	1.131	In		
4	52BE	Right TEF	1.508	In	-->FAULT	OSlew
5	570E	NWS	39.663	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	2252	Rudder Pedal	0.121	In		
9	64D5	Left Stabilator	-2.078	In	-->FAULT	OSlew
10	29A6	Left Rudder	-0.116	In		

```
 3 max=  1.211 min=  1.049 avg=  1.130    8 max=  0.137 min=  0.054 avg=  0.095
 4 max=  1.754 min=  1.239 avg=  1.496    9 max= -2.078 min= -2.224 avg= -2.151
 5 max= 40.689 min= 30.279 avg= 35.484   10 max= -0.001 min= -0.164 avg= -0.083
```

ENTER DATA: start ALT.

Initial Altitude

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	57FE	Total Temp	909.462	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0ED5	Long. Stick	1.137	In		
4	52D5	Right TEF	1.690	In	-->FAULT	OSlew
5	1708	NWS	38.783	Deg		
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	2253	Rudder Pedal	0.122	In		
9	64C2	Left Stabilator	-2.210	In	-->FAULT	OSlew
10	6982	Left Rudder	-0.163	In	-->FAULT	OSlew

```
                                          6 max=  5.610 min=  5.274 avg=  5.442

 3 max=  1.182 min=  1.019 avg=  1.100    8 max=  0.137 min= -0.054 avg=  0.042
 4 max=  1.667 min=  1.160 avg=  1.413    9 max= -2.078 min= -2.210 avg= -2.144
 5 max= 42.009 min= 31.158 avg= 36.584   10 max= -0.116 min= -0.164 avg= -0.140
```

ENTER DATA: LAB ALT

Laboratory Altitude

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	E7FE	Total Temp	909.462	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4E91	Long. Stick	0.936	In	-->FAULT	OSlew
4	1290	Right TEF	1.144	In		
5	572B	NWS	43.915	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	2252	Rudder Pedal	0.121	In		
9	64C2	Left Stabilator	-2.210	In	-->FAULT	
10	29A5	Left Rudder	-0.118	In		

3 max= 0.954 min= 0.841 avg= 0.897   8 max= 0.137 min= 0.098 avg= 0.117
4 max= 1.809 min= 1.057 avg= 1.433   9 max= -2.078 min= -2.210 avg= -2.144
5 max= 41.422 min= 35.557 avg= 38.490   10 max= -0.116 min= -0.164 avg= -0.140

ENTER DATA: EOA@30C

Internal EOA Temperature Stabilizing

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	D2FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4E74	Long. Stick	0.850	In	-->FAULT	OSlew
4	5294	Right TEF	1.176	In	-->FAULT	OSlew
5	571F	NWS	42.155	Deg	-->FAULT	OSlew
6	58A7	Right LEF	0.020	Deg	-->FAULT	OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	625D	Rudder Pedal	0.137	In	-->FAULT	OSlew
9	24C2	Left Stabilator	-2.210	In		
10	69EE	Left Rudder	-0.023	In	-->FAULT	OSlew

6 max= 0.020 min= 0.020 avg= 0.020

3 max= 0.930 min= 0.815 avg= 0.872   8 max= 0.144 min= 0.096 avg= 0.120
4 max= 1.738 min= 1.271 avg= 1.504   9 max= -2.078 min= -2.224 avg= -2.151
5 max= 43.768 min= 37.023 avg= 40.396   10 max= -0.116 min= -0.118 avg= -0.117

ENTER DATA: EOA@30.2C

Internal EOA Temperature Stable

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	D2FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0E77	Long. Stick	0.859	In		
4	5297	Right TEF	1.200	In	-->FAULT	OSlew
5	56FE	NWS	37.317	Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000	Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	6252	Rudder Pedal	0.121	In	-->FAULT	OSlew
9	24D5	Left Stabilator	-2.078	In		
10	6981	Left Rudder	-0.164	In	-->FAULT	OSlew

6 max= 0.020 min= 0.020 avg= 0.020

3 max= 0.974 min= 0.829 avg= 0.902   8 max= 0.137 min= 0.096 avg= 0.117
4 max= 1.722 min= 1.263 avg= 1.493   9 max= -2.078 min= -2.224 avg= -2.151
5 max= 42.302 min= 36.144 avg= 39.223   10 max= -0.116 min= -0.164 avg= -0.140

ENTER DATA:UP IN ALT

Begin Ascend in Altitude

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	F4F9	Total Temp	493.871	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4F0F	Long. Stick	1.309	In	-->FAULT	OSlew
4	52A5	Right TEF	1.310	In	-->FAULT	OSlew
5	570F	NWS	39.809	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	625D	Rudder Pedal	0.137	In	-->FAULT	OSlew
9	24C2	Left Stabilator	-2.210	In		
10	69FF	Left Rudder	-0.001	In	-->FAULT	OSlew

6 max= 5.610 min= 5.610 avg= 5.610

3 max= 1.451 min= 1.250 avg= 1.351   8 max= 0.137 min= -0.054 avg= 0.042
4 max= 1.801 min= 1.255 avg= 1.528   9 max= -2.078 min= -2.224 avg= -2.151
5 max= 42.595 min= 36.730 avg= 39.663   10 max= -0.116 min= -0.164 avg= -0.140

ENTER DATA:UP+15SEC

15 seconds after beginning ascend.

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	D2FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4F26	Long. Stick	1.377	In	-->FAULT	OSlew
4	52F8	Right TEF	1.968	In	-->FAULT	OSlew
5	572B	NWS	43.915	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	625D	Rudder Pedal	0.137	In	-->FAULT	OSlew
9	24C2	Left Stabilator	-2.210	In		
10	29A5	Left Rudder	-0.118	In		

```
 3 max=  1.442 min=  1.309 avg=  1.376    8 max=  0.137 min=  0.121 avg=  0.129
 4 max=  1.762 min=  1.366 avg=  1.564    9 max= -2.078 min= -2.210 avg= -2.144
 5 max= 42.595 min= 37.757 avg= 40.176   10 max= -0.023 min= -0.164 avg= -0.094
```

ENTER DATA UP+30SEC

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	72FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4F31	Long. Stick	1.410	In	-->FAULT	OSlew
4	12DC	Right TEF	1.746	In		
5	1717	NWS	40.982	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	625D	Rudder Pedal	0.137	In	-->FAULT	OSlew
9	24C0	Left Stabilator	-2.224	In		
10	29A6	Left Rudder	-0.116	In		

```
                                          6 max=  0.020 min=  0.020 avg=  0.020

 3 max=  1.439 min=  1.277 avg=  1.358    8 max=  0.146 min=  0.096 avg=  0.121
 4 max=  1.880 min=  1.271 avg=  1.576    9 max= -2.133 min= -2.224 avg= -2.178
 5 max= 44.795 min= 37.170 avg= 40.982   10 max= -0.001 min= -0.164 avg= -0.083
```

ENTER DATA 50,000FT

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	E7FE	Total Temp	909.462	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0F1E	Long. Stick	1.354	In		
4	52D8	Right TEF	1.714	In	-->FAULT	OSlew
5	1718	NWS	41.129	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	225D	Rudder Pedal	0.137	In		
9	24C2	Left Stabilator	-2.210	In		
10	6981	Left Rudder	-0.164	In	-->FAULT	OSlew

6 max= 0.020 min= 0.020 avg= 0.020

3 max= 1.380 min= 1.277 avg= 1.328

4 max= 1.873 min= 1.287 avg= 1.580

5 max= 45.235 min= 37.610 avg= 41.422

8 max= 0.137 min= 0.098 avg= 0.117

9 max= -2.078 min= -2.210 avg= -2.144

10 max= -0.016 min= -0.164 avg= -0.090

ENTER DATA: 50K+5MIN

50,000 ft plus 5 minutes

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME			WD VALUE	NAME
1	D2FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0EF7	Long. Stick	1.238	In		
4	12BA	Right TEF	1.477	In		
5	570B	NWS	39.223	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	6242	Rudder Pedal	0.098	In	-->FAULT	OSlew
9	24C2	Left Stabilator	-2.210	In		
10	29A5	Left Rudder	-0.118	In		

3 max= 1.407 min= 1.238 avg= 1.322

4 max= 1.706 min= 1.326 avg= 1.516

5 max= 44.062 min= 37.170 avg= 40.616

8 max= 0.137 min= 0.098 avg= 0.117

9 max= -2.078 min= -2.224 avg= -2.151

10 max= -0.023 min= -0.164 avg= -0.094

ENTER DATA 50K+10MIN

RT 4 EOA

* DONE

MSG 2 Sensor Values

EoA#1 stopped updating 1553 at 50,000 ft + 15 minutes

WD	VALUE	NAME			WD VALUE	NAME
1	72FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0F13	Long. Stick	1.321	In		
4	529B	Right TEF	1.231	In	-->FAULT	OSlew
5	1712	NWS	40.249	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	225D	Rudder Pedal	0.137	In		
9	24C2	Left Stabilator	-2.210	In		
10	29A6	Left Rudder	-0.116	In		

3 max= 1.321 min= 1.321 avg= 1.321

5 max= 40.249 min= 40.249 avg= 40.249

8 max= 0.137 min= 0.137 avg= 0.137

9 max= -2.210 min= -2.210 avg= -2.210

10 max= -0.116 min= -0.116 avg= -0.116

ENTER DATA 50K+15MIN

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	72FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0F13	Long. Stick	1.321	In		
4	529B	Right TEF	1.231	In	-->FAULT	OSlew
5	1712	NWS	40.249	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8	225D	Rudder Pedal	0.137	In		
9	24C2	Left Stabilator	-2.210	In		
10	0050	Left Rudder	-0.561	In		

3 max= 1.321 min= 1.321 avg= 1.321

5 max= 40.249 min= 40.249 avg= 40.249

8 max= 0.137 min= 0.137 avg= 0.137

9 max= -2.210 min= -2.210 avg= -2.210

10 max= -0.561 min= -0.561 avg= -0.561

ENTER DATA 50K+20MIN

```
RT   4     EOA
                                                                    * DONE
MSG   2    Sensor Values

WD VALUE    NAME                              WD VALUE    NAME

 1 72FD Total Temp         771.290 DegR     -->FAULT    UTrav
 2 4800 Pitot Pressure       1.250 Hg       -->FAULT    UTrav UPwr
 3 0F13 Long. Stick          1.321 In
 4 529B Right TEF            1.231 In       -->FAULT    OSlew
 5 1712 NWS                 40.249 Deg
 6 5800 Right LEF           -7.000 Deg      -->FAULT    UTrav OSlew
 7 5C00 Power Lever Cntl     0.000 Deg      -->FAULT    UTrav OSlew UPwr
 8 225D Rudder Pedal         0.137 In
 9 24C2 Left Stabilator     -2.210 In
10 0050 Left Rudder         -0.561 In


 3 max=   1.321 min=   1.321 avg=   1.321    8 max=  0.137 min=  0.137 avg=  0.137
                                             9 max= -2.210 min= -2.210 avg= -2.210
 5 max= 40.249 min= 40.249 avg= 40.249     10 max= -0.561 min= -0.561 avg= -0.561
                                                             ENTER DATA 50K+25MIN
```

```
RT   4     EOA
                                                                    * DONE
MSG   2    Sensor Values

WD VALUE    NAME                              WD VALUE    NAME

 1 72FD Total Temp         771.290 DegR     -->FAULT    UTrav
 2 4800 Pitot Pressure       1.250 Hg       -->FAULT    UTrav UPwr
 3 0F13 Long. Stick          1.321 In
 4 529B Right TEF            1.231 In       -->FAULT    OSlew
 5 1712 NWS                 40.249 Deg
 6 5800 Right LEF           -7.000 Deg      -->FAULT    UTrav OSlew
 7 5C00 Power Lever Cntl     0.000 Deg      -->FAULT    UTrav OSlew UPwr
 8 225D Rudder Pedal         0.137 In
 9 24C2 Left Stabilator     -2.210 In
10 0050 Left Rudder         -0.561 In


 3 max=   1.321 min=   1.321 avg=   1.321    8 max=  0.137 min=  0.137 avg=  0.137
                                             9 max= -2.210 min= -2.210 avg= -2.210
 5 max= 40.249 min= 40.249 avg= 40.249     10 max= -0.561 min= -0.561 avg= -0.561
                                                             ENTER DATA 50K+30MIN
```

Check of EOA fault reporting ~~due to~~ ~~Since~~ as part of troubleshooting.

RT 4 EOA

MSG 3 EOA Fault Management

* DONE

WD	VALUE	NAME
1	0000	Download Status
2	0001	Reference Level
3	0206	Reference Port 1
4	0288	Reference Port 2
5	0249	Reference Port 3
6	0171	Reference Port 4
7	0000	Reference Port 5
8	0000	DAC Test Results
9	0000	Feedback Results

WD VALUE NAME

ENTER DATA

RT 4 EOA

MSG 3 EOA Fault Management

* DONE

WD	VALUE	NAME
1	0000	Download Status
2	0001	Reference Level
3	0206	Reference Port 1
4	0288	Reference Port 2
5	0249	Reference Port 3
6	0171	Reference Port 4
7	0000	Reference Port 5
8	0000	DAC Test Results
9	0000	Feedback Results

WD VALUE NAME

ENTER DATA NO UPDATE

Check of sensor fault reporting
as part of troubleshooting

RT 4 EOA

* DONE

MSG 4 Sensor Error Management

WD	VALUE	NAME	WD	VALUE	NAME
1	0002	Error Total Temp			
2	0012	Err Pitot Press.			
3	0000	Err Long. Stick			
4	0004	Error TEF			
5	0000	Error NWS			
6	0006	Error LEF			
7	0016	Err Pwr Lev Cntl			
8	0000	Err Rudder Pedal			
9	0000	Error Stabilator			
10	0000	Error Rudder			

ENTER DATA NO UPDATE

RT 4 EOA

* DONE

MSG 1 Selected Mode

WD	VALUE	NAME	WD	VALUE	NAME
1	0003	Selected Mode			
2	0000	Selected Submode			

ENTER DATA NO UPDATE

RT RT 4 EOA

MSG MSG 2 Sensor Values

* DONE

WD \	WD	VALUE	NAME			WD VALUE	NAME
1 5	1	72FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2 4	2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3 C	3	0F13	Long. Stick	1.321	In		
4 5	4	529B	Right TEF	1.231	In	-->FAULT	OSlew
5 1	5	1712	NWS	40.249	Deg		
6 5	6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7 5	7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav OSlew UPwr
8 6	8	225D	Rudder Pedal	0.137	In		
9 2	9	24C2	Left Stabilator	-2.210	In		
10 2	10	0050	Left Rudder	-0.561	In		

3 m 3 max= 1.321 min= 1.321 avg= 1.321 8 max= 0.137 min= 0.137 avg= 0.137
4 m 9 max= -2.210 min= -2.210 avg= -2.210
5 m 5 max= 40.249 min= 40.249 avg= 40.249 10 max= -0.561 min= -0.561 avg= -0.561

ENTER DATA 50K+35MIN

T RT 4 EOA

SG MSG 2 Sensor Values

EOA #1 resumed 1553 updates after a power reset at 50,000 ft. + 40 minutes.

* DONE

D V	WD	VALUE	NAME			WD VALUE	NAME
1 E	1	F2F9	Total Temp	769.140	DegR	-->FAULT	UTrav
2 4	2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3 4	3	4EFC	Long. Stick	1.253	In	-->FAULT	OSlew
4 5	4	52B7	Right TEF	1.453	In	-->FAULT	OSlew
5 1	5	5707	NWS	38.636	Deg	-->FAULT	OSlew
6 5	6	58A7	Right LEF	0.020	Deg	-->FAULT	UTrav OSlew
7 5	7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8 6	8	627E	Rudder Pedal	0.185	In	-->FAULT	OSlew
9 2	9	24C9	Left Stabilator	-2.161	In		
0 6	10	69A5	Left Rudder	-0.118	In	-->FAULT	OSlew

6 max= 0.020 min= 0.020 avg= 0.020

3 m 3 max= 1.336 min= 1.176 avg= 1.256 8 max= 0.185 min= 0.096 avg= 0.141
4 m 4 max= 1.722 min= 1.128 avg= 1.425 9 max= -2.105 min= -2.224 avg= -2.165
5 m 5 max= 45.528 min= 37.903 avg= 41.716 10 max= -0.001 min= -0.164 avg= -0.083

ENTER DATA 50K+40MIN

```
4    RT   4     EOA
                                                                        * DONE
 2   MSG   2    Sensor Values

VALU WD VALUE    NAME                              WD VALUE    NAME

F4F9   1 E7FE Total Temp        909.462 DegR       -->FAULT    UTrav
480C   2 4800 Pitot Pressure      1.250 Hg         -->FAULT    UTrav UPwr
0F05   3 4EA6 Long. Stick         0.998 In         -->FAULT    OSlew
52AD   4 5278 Right TEF           0.954 In         -->FAULT    OSlew
56F3   5 56F6 NWS                36.144 Deg        -->FAULT    OSlew
580C   6 58C0 Right LEF           1.070 Deg        -->FAULT    OSlew
5C0C   7 5C00 Power Lever Cntl    0.000 Deg        -->FAULT    UTrav OSlew UPwr
5252   8 623E Rudder Pedal        0.092 In         -->FAULT    OSlew
24C9   9 24C9 Left Stabilator    -2.161 In
5981  10 29EE Left Rudder        -0.023 In


max=   3 max=   1.146 min=   1.057 avg=   1.102    8 max=   0.134 min=   0.098 avg=   0.116
max=   4 max=   1.310 min=   1.192 avg=   1.251    9 max= -2.105 min= -2.168 avg= -2.137
max=   5 max= 36.877 min= 33.358 avg= 35.117     10 max= -0.001 min= -0.164 avg= -0.083
                                                              ENTER DATA: DESC+5SEC
```

Descend in altitude + 5 seconds 5

```
4    RT   4     EOA
                                                                        * DONE
 2   MSG   2    Sensor Values

ALU  WD VALUE    NAME                              WD VALUE    NAME

2FD    1 E7FE Total Temp        909.462 DegR       -->FAULT    UTrav
80C    2 4800 Pitot Pressure      1.250 Hg         -->FAULT    UTrav UPwr
ED7    3 4ED1 Long. Stick         1.126 In         -->FAULT    OSlew
29E    4 52A6 Right TEF           1.318 In         -->FAULT    OSlew
72A    5 56E6 NWS                33.798 Deg        -->FAULT    OSlew
8CC    6 5800 Right LEF          -7.000 Deg        -->FAULT    UTrav OSlew
C0C    7 5C00 Power Lever Cntl    0.000 Deg        -->FAULT    UTrav OSlew UPwr
24E    8 624D Rudder Pedal        0.114 In         -->FAULT    OSlew
4C8    9 24C8 Left Stabilator    -2.168 In
9A6   10 29FC Left Rudder        -0.005 In


ax=    3 max=   1.155 min=   1.063 avg=   1.109    8 max=   0.184 min=   0.051 avg=   0.117
ax=    4 max=   1.200 min=   1.200 avg=   1.200    9 max= -2.161 min= -2.168 avg= -2.165
ax=    5 max= 39.076 min= 31.745 avg= 35.411     10 max= -0.001 min= -0.164 avg= -0.083
                                                              ENTER DATA DESC+15SEC
```

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	72FD	Total Temp	771.290	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	0EE1	Long. Stick	1.173	In		
4	1290	Right TEF	1.144	In		
5	56EB	NWS	34.531	Deg	-->FAULT	OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	223D	Rudder Pedal	0.090	In		
9	24C8	Left Stabilator	-2.168	In		
10	69A5	Left Rudder	-0.118	In	-->FAULT	OSlew

6 max= 1.070 min= 1.070 avg= 1.070

3 max= 1.211 min= 1.078 avg= 1.145
4 max= 1.302 min= 0.962 avg= 1.132
5 max= 36.584 min= 30.132 avg= 33.358
8 max= 0.144 min= 0.043 avg= 0.094
9 max= -2.105 min= -2.224 avg= -2.165
10 max= -0.001 min= -0.164 avg= -0.083

ENTER DATA DESC+60SEC

å

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD VALUE	NAME
1	E7FE	Total Temp	909.462	DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT	UTrav UPwr
3	4EE8	Long. Stick	1.194	In	-->FAULT	OSlew
4	528E	Right TEF	1.128	In	-->FAULT	OSlew
5	16DD	NWS	32.478	Deg		
6	5800	Right LEF	-7.000	Deg	-->FAULT	UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT	UTrav UPwr
8	6261	Rudder Pedal	0.143	In	-->FAULT	OSlew
9	24C9	Left Stabilator	-2.161	In		
10	2981	Left Rudder	-0.164	In		

6 max= 0.020 min= 0.020 avg= 0.020

3 max= 1.250 min= 1.128 avg= 1.189
4 max= 1.421 min= 0.820 avg= 1.120
5 max= 35.997 min= 28.812 avg= 32.405
8 max= 0.168 min= 0.027 avg= 0.098
9 max= -2.105 min= -2.168 avg= -2.137
10 max= -0.023 min= -0.187 avg= -0.105

ENTER DATA:ROOM ALT.

Return to Room Altitude

RT 4 EOA

MSG 2 Sensor Values

* DONE

WD	VALUE	NAME		WD VALUE	NAME
1	D2FD	Total Temp	771.290 DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250 Hg	-->FAULT	UTrav UPwr
3	4F0B	Long. Stick	1.297 In	-->FAULT	
4	5264	Right TEF	0.796 In	-->FAULT	OSlew
5	56F9	NWS	36.584 Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000 Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000 Deg	-->FAULT	UTrav UPwr
8	626D	Rudder Pedal	0.161 In	-->FAULT	OSlew
9	24C9	Left Stabilator	-2.161 In		
10	69EE	Left Rudder	-0.023 In	-->FAULT	OSlew

3 max= 1.336 min= 1.235 avg= 1.285   8 max= 0.184 min= 0.049 avg= 0.117
4 max= 1.445 min= 0.756 avg= 1.101   9 max= -2.161 min= -2.168 avg= -2.165
5 max= 36.437 min= 31.598 avg= 34.018   10 max= -0.116 min= -0.164 avg= -0.140

ENTER DATA: RM ALT+5M

Room Altitude + 5 minutes

RT 4 EOA

MSG 2 Sensor Values

Repeated Data

* DONE

WD	VALUE	NAME		WD VALUE	NAME
1	D2FD	Total Temp	771.290 DegR	-->FAULT	UTrav
2	4800	Pitot Pressure	1.250 Hg	-->FAULT	UTrav UPwr
3	4F0B	Long. Stick	1.297 In	-->FAULT	
4	5264	Right TEF	0.796 In	-->FAULT	OSlew
5	56F9	NWS	36.584 Deg	-->FAULT	OSlew
6	5BFF	Right LEF	36.000 Deg	-->FAULT	OTrav OSlew
7	5C00	Power Lever Cntl	0.000 Deg	-->FAULT	UTrav UPwr
8	626D	Rudder Pedal	0.161 In	-->FAULT	OSlew
9	24C9	Left Stabilator	-2.161 In		
10	69EE	Left Rudder	-0.023 In	-->FAULT	OSlew

3 max= 1.336 min= 1.235 avg= 1.285   8 max= 0.184 min= 0.049 avg= 0.117
4 max= 1.445 min= 0.756 avg= 1.101   9 max= -2.161 min= -2.168 avg= -2.165
5 max= 36.437 min= 31.598 avg= 34.018   10 max= -0.116 min= -0.164 avg= -0.140

ENTER DATA RM ALT+5M

~~RT 4 EOA~~

~~G 2 Sensor Values~~

~~* DONE~~

~~WD VALUE NAME~~   ~~WD VALUE NAME~~

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD	VALUE	NAME
1	CFF6	Total Temp	905.161	DegR	-->FAULT		UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT		UTrav UPwr
3	4F0D	Long. Stick	1.303	In	-->FAULT		OSlew
4	128C	Right TEF	1.112	In			
5	16DF	NWS	32.771	Deg			
6	5800	Right LEF	-7.000	Deg	-->FAULT		UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT		UTrav UPwr
8	6211	Rudder Pedal	0.026	In	-->FAULT		OSlew
9	24C8	Left Stabilator	-2.168	In			
10	69EE	Left Rudder	-0.023	In	-->FAULT		OSlew

```
 3 max=  1.333 min=  1.238 avg=  1.285    8 max=  0.168 min=  0.045 avg=  0.106
 4 max=  1.342 min=  1.033 avg=  1.188    9 max= -2.161 min= -2.168 avg= -2.165
 5 max= 35.704 min= 32.771 avg= 34.238   10 max= -0.003 min= -0.164 avg= -0.084
```

ENTER DATA RM ALT+10M

RT 4 EOA

* DONE

MSG 2 Sensor Values

WD	VALUE	NAME			WD	VALUE	NAME
1	E7FB	Total Temp	907.849	DegR	-->FAULT		UTrav
2	4800	Pitot Pressure	1.250	Hg	-->FAULT		UTrav UPwr
3	4EF5	Long. Stick	1.232	In	-->FAULT		OSlew
4	5286	Right TEF	1.065	In	-->FAULT		OSlew
5	56FA	NWS	36.730	Deg	-->FAULT		OSlew
6	5800	Right LEF	-7.000	Deg	-->FAULT		UTrav OSlew
7	5C00	Power Lever Cntl	0.000	Deg	-->FAULT		UTrav UPwr
8	6222	Rudder Pedal	0.051	In	-->FAULT		
9	24C9	Left Stabilator	-2.161	In			
10	29A5	Left Rudder	-0.118	In			

```
 3 max=  1.294 min=  1.226 avg=  1.260    8 max=  0.098 min=  0.004 avg=  0.051
 4 max=  1.374 min=  0.938 avg=  1.156    9 max= -2.161 min= -2.168 avg= -2.165
 5 max= 35.557 min= 31.305 avg= 33.431   10 max= -0.001 min= -0.119 avg= -0.060
```

ENTER DATA:RM ALT+15M

Room Altitude + 15 minutes

15.4 ELECTROMAGNETIC INTERFERENCE TEST DATA SHEET

15.4.1 Electromagnetic Test (14.6) 2/28/93 Brad Kessler / Chris Au PASS ☐ FAIL ☑

15.4.1.1 Attach the report containing the graphs of the EOA EM radiation and conduction behind this data sheet.

Expected:

The conducted emissions will meet the requirements of MIL–STD–461C (class A1) CE03.

CE03: See figures 2–2 and 2–3 of MIL–STD–461C.

Comments:

EoA #1 failed to meet the limits specified in MIL-STD-461 Part 2 CE03 limits due to spikes in the conducted emissions. The majority of the conducted emissions are below the limits in MIL-STD-461 Part 2 CE03.

EoA EMI Sources

200 to 250 kHz	-	Power supply switching frequency
1 MHz	-	1553 bus data rate
4 MHz	-	Litton optic decoding modules' clock
16 MHz	-	1750/1553 module clock
64 MHz	-	1773/1553 converter module EPLDs operating frequency

The radiated emissions will meet the requirements of MIL–STD–461C (class A1) RE02.

RE02: See figures 2–11 and 2–12 of MIL–STD–461C.

Comments:

EoA #1 failed to meet the limits specified in MIL-STD-461 Part 2 RE02 limits due to spikes in the radiated emissions. The majority of the conducted emissions are below the limits in MIL-STD-461 Part 2 RE02.

See CE03 comments for EoA EMI Sources.

1.0 EMC TESTS

MIL-STD-461C CE03 and RE02 testing was performed on the Fiber Optic Control System Integration (FOCSI) in an informal qualification test. CE07 testing was originally intended to be tested but was deferred because of questions regarding applicability.

2.0 **CE03** (Conducted Emissions on Power Leads: 15 kHz to 50 MHz)

2.1 The CE03 test consisted of measuring the narrowband and broadband conducted emissions on the 28 VDC high and return power lines of the FOCSI. Testing was performed to determine compliance with emission levels identified in MIL-STD-461C Part 2 for aircraft equipment.

2.2 The FOCSI was bonded to the ground plane with a lead weight placed on top of the unit. This weight provided sufficient bonding through the front feet of the unit. Bonding measured to be 1.5 mΩ. Power required for the operation of the FOCSI was 28 VDC and was provided through 10 uFd feed through capacitors as identified in MIL-STD-462. Bonding of the 10 uFd capacitors to the ground plane was measured to be 0.25 mΩ.

2.3 The FOCSI was in a full up configuration with the LEDs illuminated. The power and signal lines were in considerable excess of the two meters necessary to perform RE02. Because RE02 was performed prior to CE03, most of the power and signal bundles were shielded with aluminum foil. The foil shields were then grounded to the ground plane. Two meters of both power and signal lines were left unshielded. A resistive load was used to terminate the signal line output containing MUX data. This was monitored prior to testing as a functional test of the FOCSI.

2.4 The test setup consisted of using a Solar 6741 current probe transducer to detect the emissions on the power lines and an HP 85685A preselector and an HP 8566B spectrum analyzer to measure the emission amplitude and frequency. A computer controller is used to automate the test applying necessary transducer factors and cable losses, and displaying, storing, and plotting the results. The copy of the customized test file used for automating CE03 testing of the FOCSI is included in Enclosure 1. The current probe transducer and cable loss tables are also included.

2.5 Ambient levels were measured on both the 28 VDC high and return to confirm that the test set up provided emission levels well below the required specification. The 28 VDC power leads were then checked individually with the FOCSI powered on. Plots from these tests can be found in Enclosure 2.

2.6 As the test results indicate, the FOCSI does not meet MIL-STD-461C Part 2 CE03 limits. Narrowband and broadband emissions for each line were plotted in addition to the limit lines. Outages were printed for any peak above this limit. Those emissions that exceeded one limit but not the other (i.e. out of specification on the narrowband specification but passes the broadband specification and vice versa) were examined individually to determine whether it was a narrowband or broadband emission. The change in amplitude of greater or less than 3 dB at two impulse bandwidths away from the peak center frequency test was used to make this distinction. These are penciled in beside the print out of each peak.

3.0 **RE02** (Radiated Emissions from Electric Field: 14 kHz to 10 GHz)

3.1 The RE02 test consisted of measuring the narrowband and broadband emissions from the FOCSI. Because we are testing to MIL-STD-461C, testing was performed to 10 GHz.

3.2 The FOCSI was bonded to the ground plane with a lead weight placed on top of the unit. This weight provided sufficient bonding through the front feet of the unit. Bonding measured to be 1.5 mΩ. Power required for the operation of the FOCSI was 28 VDC and was provided through 10 uFd feed through capacitors as identified in MIL-STD-462. Bonding of the 10 uFd capacitors to the ground plane was measured to be 0.25 mΩ.

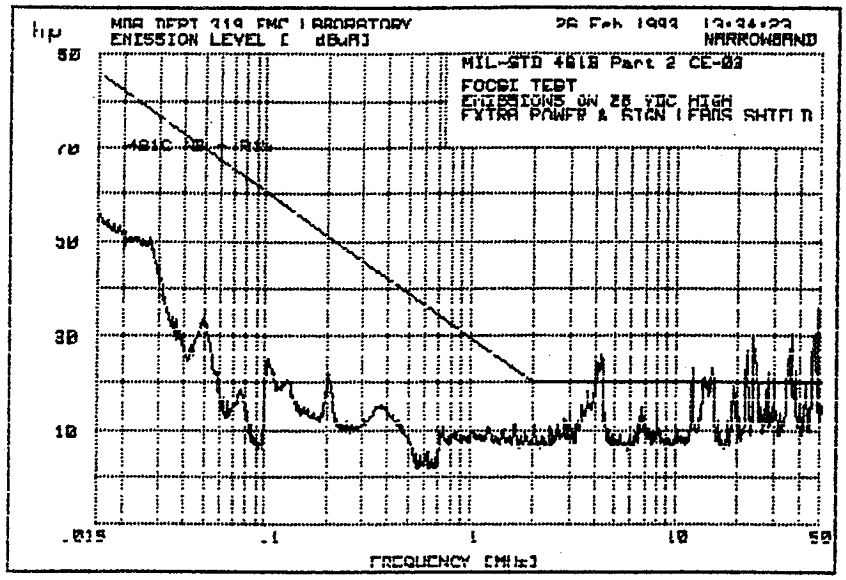
3.3 The FOCSI was in a full up configuration with the LEDs illuminated. Operation of the FOCSI was stand alone so no wires into or out of the anechoic chamber were necessary. The power and signal lines were in considerable excess of the two meters necessary to perform RE02. Preliminary RE02 measurements were taken with the power and signal bundles unshielded. These emissions were well out of specification. Because of this, most of the power and signal bundles were shielded with aluminum foil. The foil shields were then grounded to the ground plane. Two meters of both power and signal lines were left unshielded. A resistive load was used to terminate the signal line output containing MUX data. This resistive load was also shielded.

3.4 For the RE02 test, the test set, spectrum analyzer, preselector, computer, hard drive, and plotter were all located outside of the shielded anechoic room to prevent test equipment noise from corrupting the radiated emission measurements during testing of the FOCSI. The only equipment in the room during testing was the FOCSI, associated cabling, and the required receiving antennas. The EMI software and computer were used to control the test, store and plot the results, and calculate the broadband and narrow band emission levels. The setup table, antenna factors, impulse bandwidths, and cable losses used by the EMI software are all included in Enclosure 3.

3.5 Ambient levels were measured to be well below the required radiated emission specification. Power was then applied to the FOCSI and radiated emissions from the unit were measured. Plots from these tests can be found in Enclosure 4.

3.6 As the test results indicate, the FOCSI does not meet MIL-STD-461C Part 2 RE02 limits. Narrowband and broadband emissions for each line were plotted in addition to the limit lines. Outages were printed for any peak above this limit. Those emissions that exceeded one limit but not the other (i.e. out of specification on the narrowband specification but passes the broadband specification and vice versa) were examined individually to determine whether it was a narrowband or broadband emission. The change in amplitude of greater or less than 3 dB at two impulse bandwidths away from the peak center frequency test was used to make this distinction. These are penciled in beside the print out of each peak.

Enclosure 2

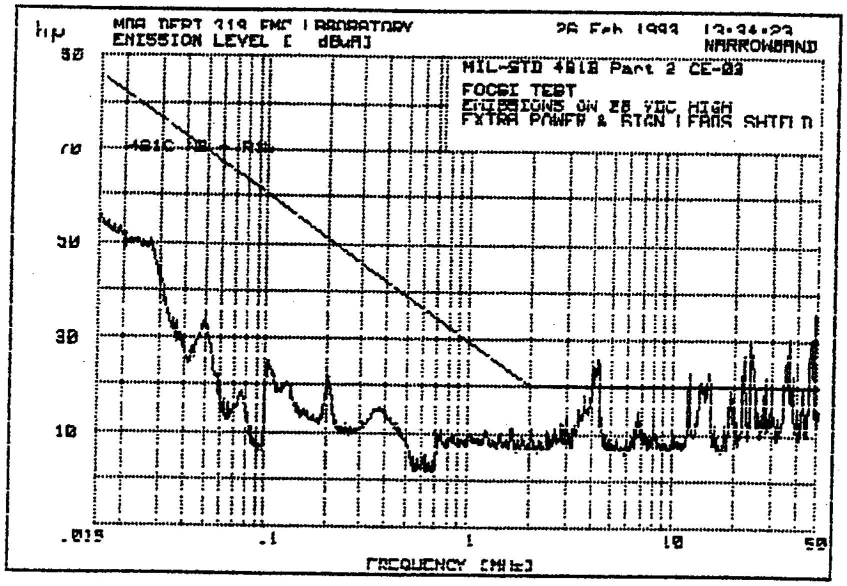


Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA)	DELTA
1	4.291	26.3	6.3
2	12.01	23	3.0 NB (data)
3	15.07	23	3.0 NB
4	22.06	26.7	6.7
5	23.92	29.6	9.6
6	27.9	22.4	2.4 NB (data)
7	30.01	22.2	2.2 NB (data)
8	36.16	30.5	10.5
9	37.96	22.8	2.8 NB (data)
10	42.18	20.2	.2 NB (data)
11	46.86	30.5	10.5
12	48.01	36.4	16.4

NB = Narrow Band Emission
BB = Broad Band Emission

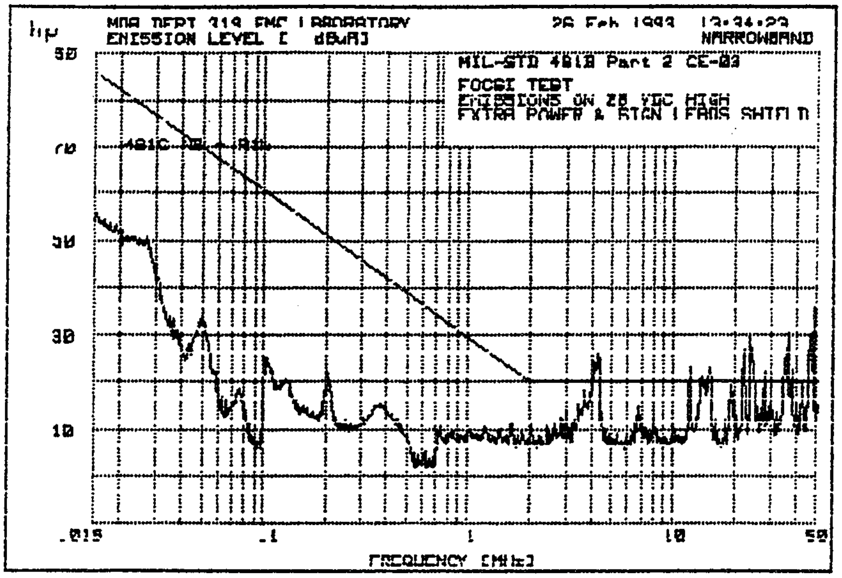
Enclosure 2



Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

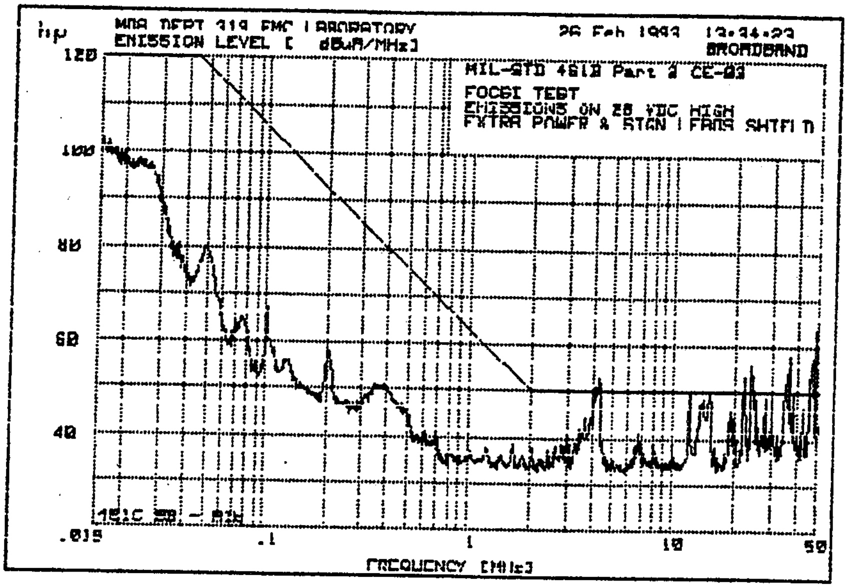
PEAK#	FREQ (MHz)	(dBuA)	DELTA
1	4.291	26.3	6.3
2	12.01	23	3.0 NB (data)
3	15.07	23	3.0 NB
4	22.06	26.7	6.7
5	23.92	29.6	9.6
6	27.9	22.4	2.4 NB (data)
7	30.01	22.2	2.2 NB (data)
8	36.16	30.5	10.5
9	37.96	22.8	2.8 NB (data)
10	42.18	20.2	.2 NB (data)
11	46.86	30.5	10.5
12	48.01	36.4	16.4

Enclosure 2



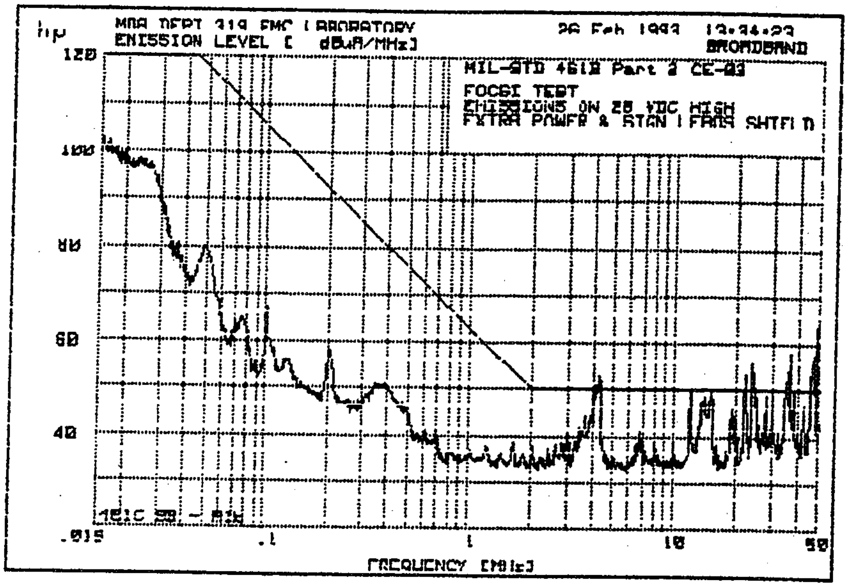
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA)	DELTA
1	4.291	26.3	6.3
2	12.01	23	3.0 NB (data)
3	15.07	23	3.0 NB
4	22.06	26.7	6.7
5	23.92	29.6	9.6
6	27.9	22.4	2.4 NB (data)
7	30.01	22.2	2.2 NB (data)
8	36.16	30.5	10.5
9	37.96	22.8	2.8 NB (data)
10	42.18	20.2	.2 NB (data)
11	46.86	30.5	10.5
12	48.01	36.4	16.4



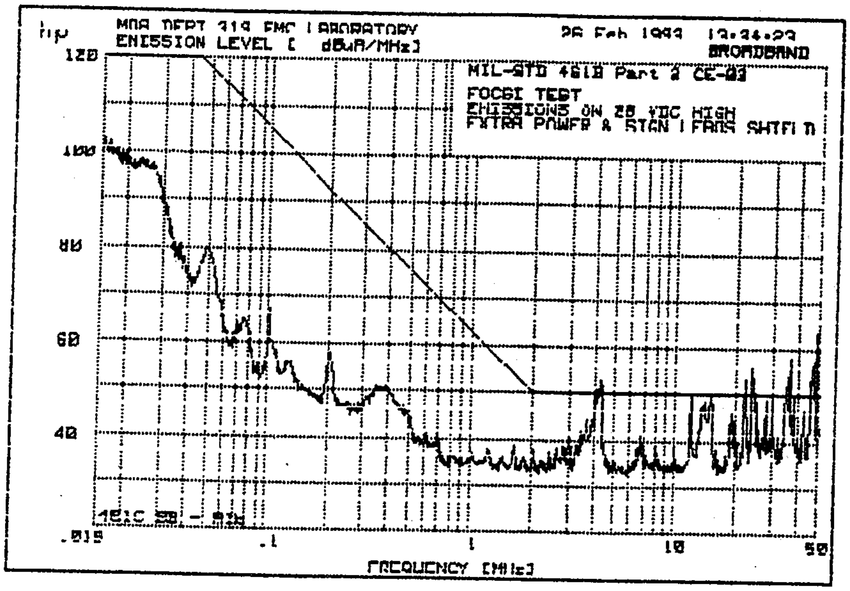
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA/MHz)	DELTA
1	4.291	53	3.0
2	15.07	50.4	.4
3	22.06	53.7	3.7
4	23.92	56.5	6.5
5	36.16	58.2	8.2
6	46.86	57.5	7.5
7	48.01	63.8	13.8



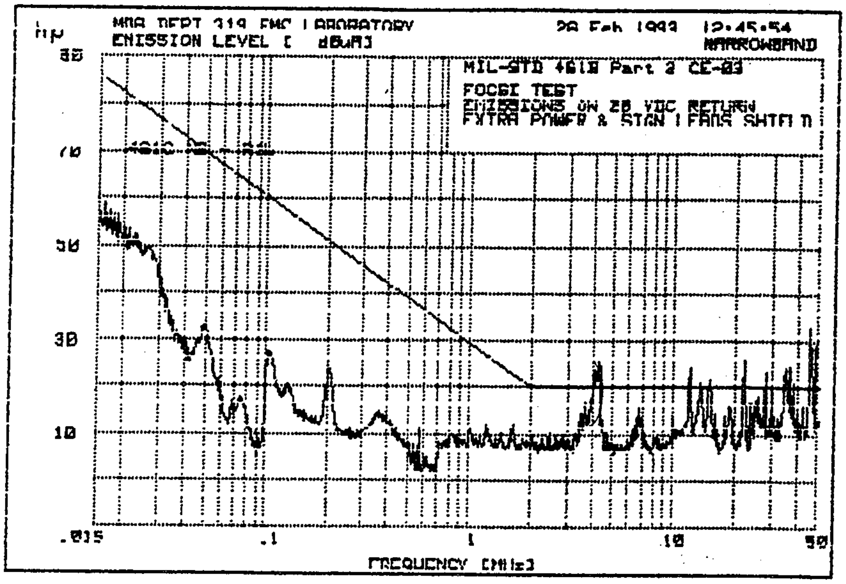
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA/MHz)	DELTA
1	4.291	53	3.0
2	15.07	50.4	.4
3	22.06	53.7	3.7
4	23.92	56.5	6.5
5	36.16	58.2	8.2
6	46.86	57.5	7.5
7	48.01	63.8	13.8



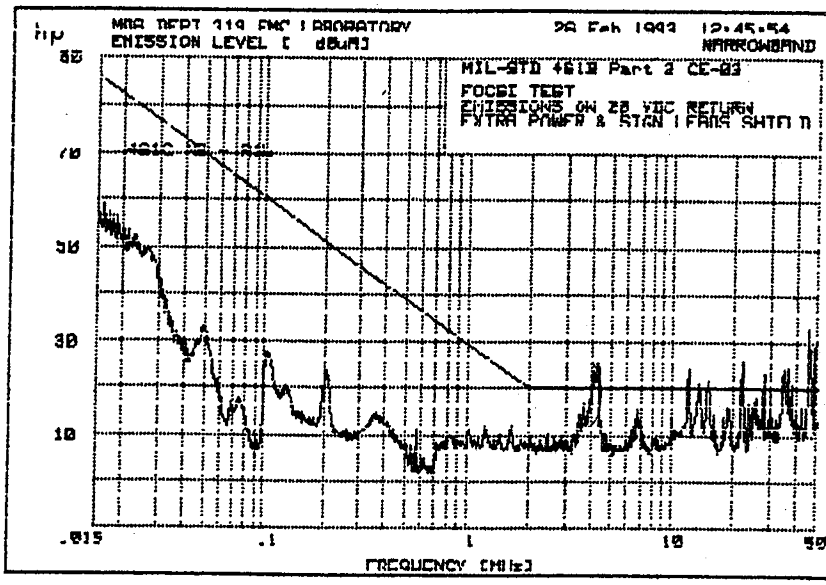
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA/MHz)	DELTA
1	4.291	53	3.0
2	15.07	50.4	.4
3	22.06	53.7	3.7
4	23.92	56.5	6.5
5	36.16	58.2	8.2
6	46.86	57.5	7.5
7	48.01	63.8	13.8



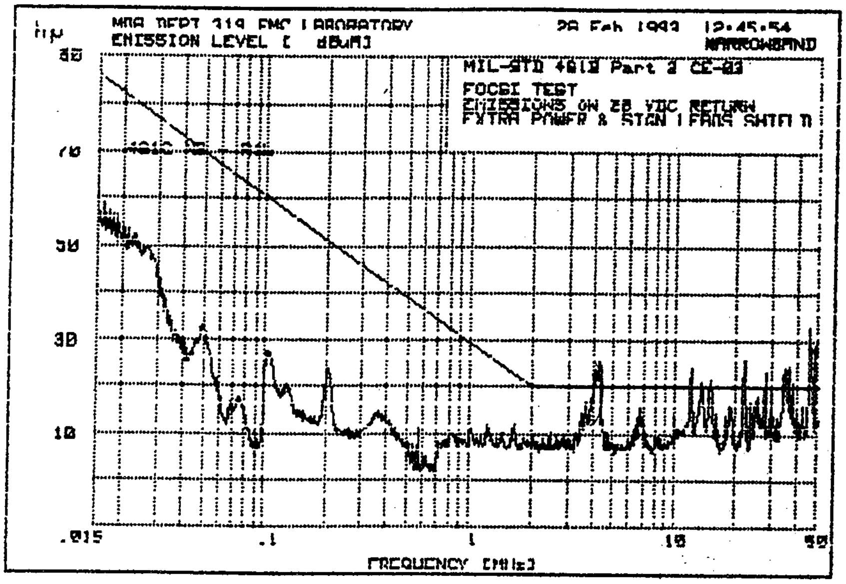
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA)	DELTA
1	4.291	25.4	5.4 NB
2	12.01	24.2	4.2
3	13.56	21	1.0 BB
4	15.07	21.7	1.7 NB
5	22.06	26.1	6.1
6	27.9	23.7	3.7 NB (data)
7	34.72	24.3	4.3 NB (data)
8	36.16	24.7	4.7
9	37.96	21.4	1.4 NB (data)
10	45.74	32.8	12.8 NB
11	48.01	29.3	9.3



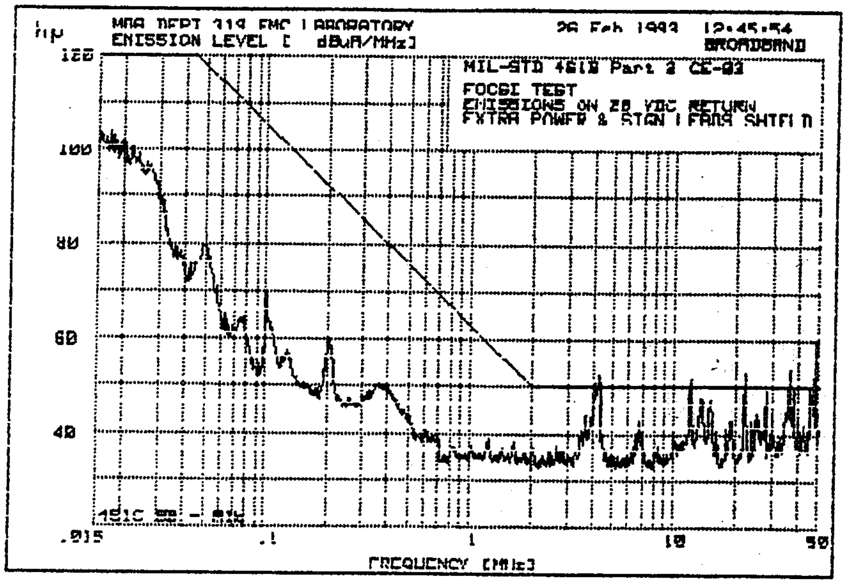
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA)	DELTA
1	4.291	25.4	5.4 NB
2	12.01	24.2	4.2
3	13.56	21	1.0 BB
4	15.07	21.7	1.7 NB
5	22.06	26.1	6.1
6	27.9	23.7	3.7 NB (data)
7	34.72	24.3	4.3 NB (data)
8	36.16	24.7	4.7
9	37.96	21.4	1.4 NB (data)
10	45.74	32.8	12.8 NB
11	48.01	29.3	9.3



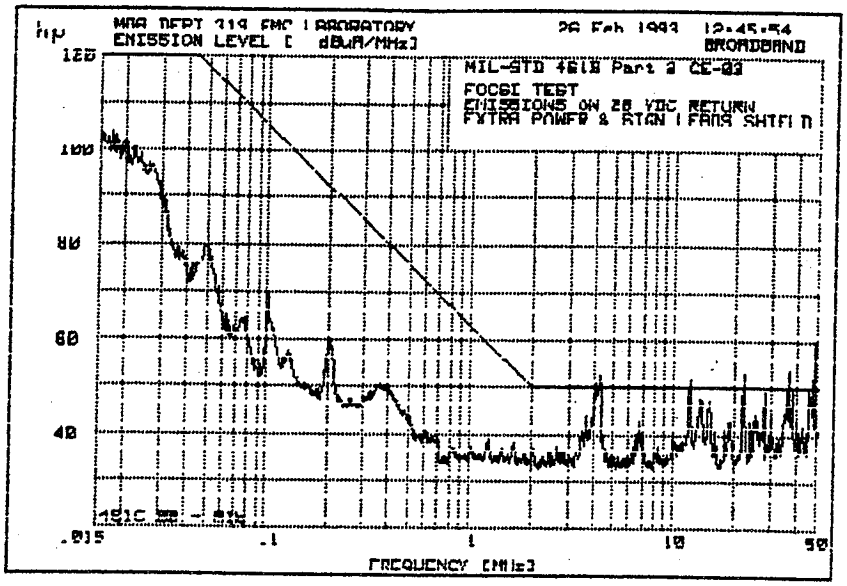
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA)	DELTA
1	4.291	25.4	5.4 NB
2	12.01	24.2	4.2
3	13.56	21	1.0 BB
4	15.07	21.7	1.7 NB
5	22.06	26.1	6.1
6	27.9	23.7	3.7 NB (data)
7	34.72	24.3	4.3 NB (data)
8	36.16	24.7	4.7
9	37.96	21.4	1.4 NB (data)
10	45.74	32.8	12.8 NB
11	48.01	29.3	9.3



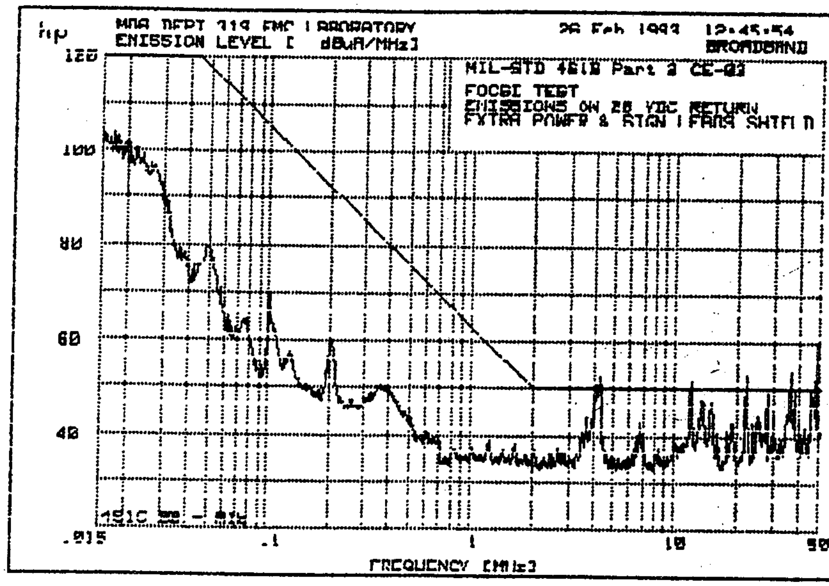
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA/MHz)	DELTA	
1	4.291	52.6	2.6	NB
2	12.01	51.7	1.7	BB
3	22.06	53	3.0	
4	36.16	53.8	3.8	
5	48.01	60.2	10.2	



Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

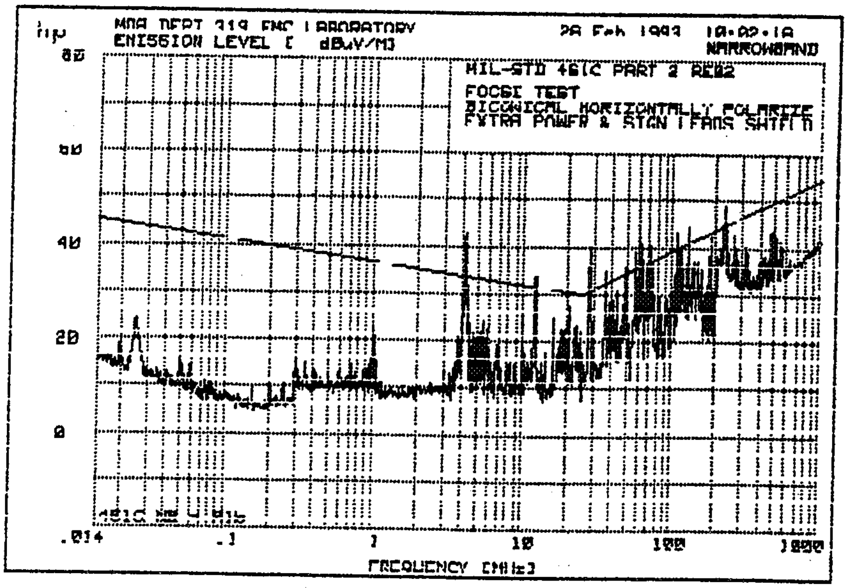
PEAK#	FREQ (MHz)	(dBuA/MHz)	DELTA	
1	4.291	52.6	2.6	NB
2	12.01	51.7	1.7	BB
3	22.06	53	3.0	
4	36.16	53.8	3.8	
5	48.01	60.2	10.2	



Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuA/MHz)	DELTA
1	4.291	52.6	2.6 NB
2	12.01	51.7	1.7 BB
3	22.06	53	3.0
4	36.16	53.8	3.8
5	48.01	60.2	10.2

Enclosure 4

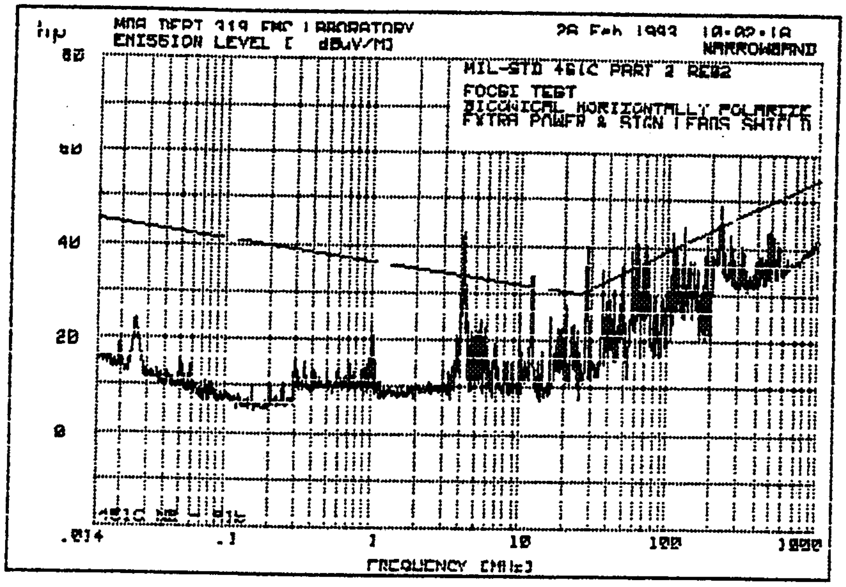


Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

NB = Narrow Band Emission
BB = Broad Band Emission

PEAK#	FREQ (MHz)	(dBuV/M)	DELTA
1	4.023	34.9	1.3 NB
2	4.16	42.5	9.0
3	12.02	33.8	2.4
4	28.07	39.7	9.0
5	36.29	34.7	2.3 NB
6	47.98	36	1.7
7	56.1	38.8	3.5
8	60.66	40.6	4.8 NB
9	64.14	37.5	1.3 NB
10	67.07	36.7	.2 NB
11	71.72	40.3	3.4 NB
12	107.2	43.2	3.6
13	128.17	44.2	3.4
14	226.51	49	4.4 NB

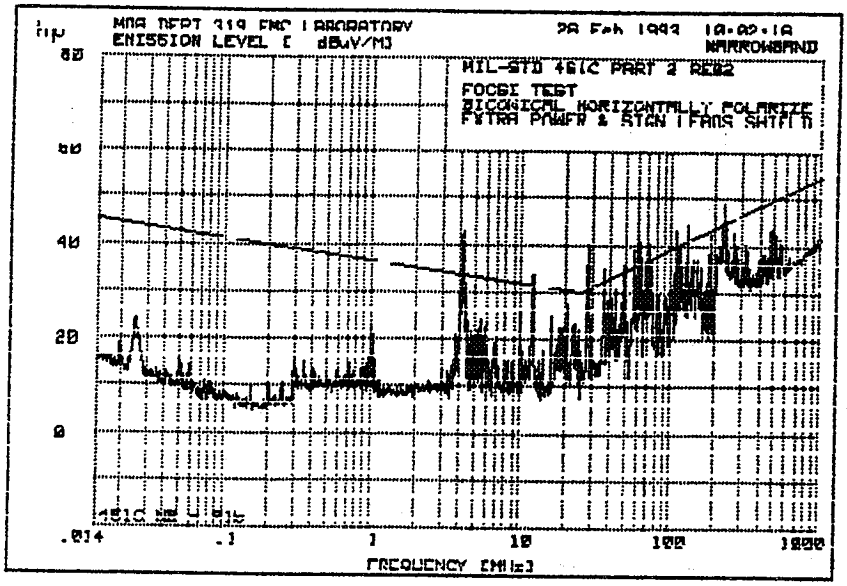
Enclosure 4



Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

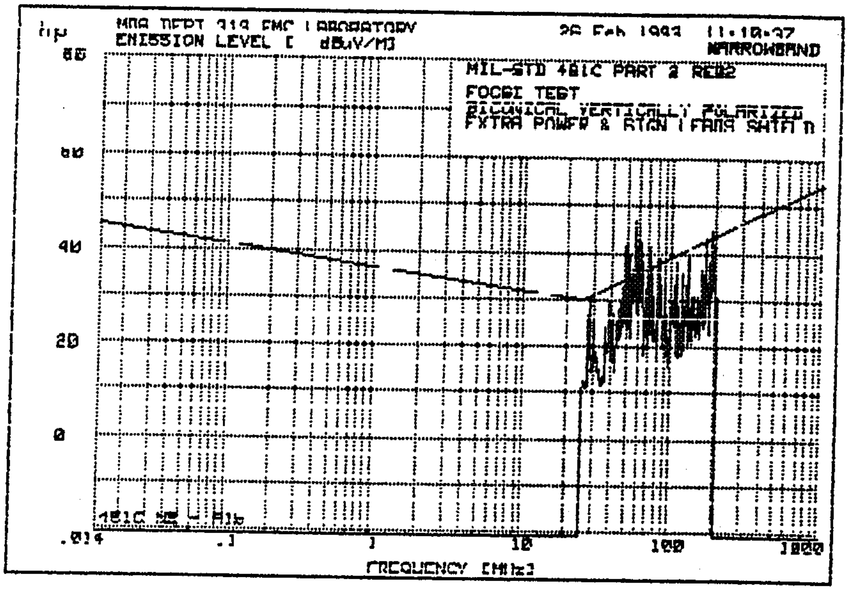
PEAK#	FREQ (MHz)	(dBuV/M)	DELTA
1	4.023	34.9	1.3 NB
2	4.16	42.5	9.0
3	12.02	33.8	2.4
4	28.07	39.7	9.0
5	36.29	34.7	2.3 NB
6	47.98	36	1.7
7	56.1	38.8	3.5
8	60.66	40.6	4.8 NB
9	64.14	37.5	1.3 NB
10	67.07	36.7	.2 NB
11	71.72	40.3	3.4 NB
12	107.2	43.2	3.6
13	128.17	44.2	3.4
14	226.51	49	4.4 NB

Enclosure 4



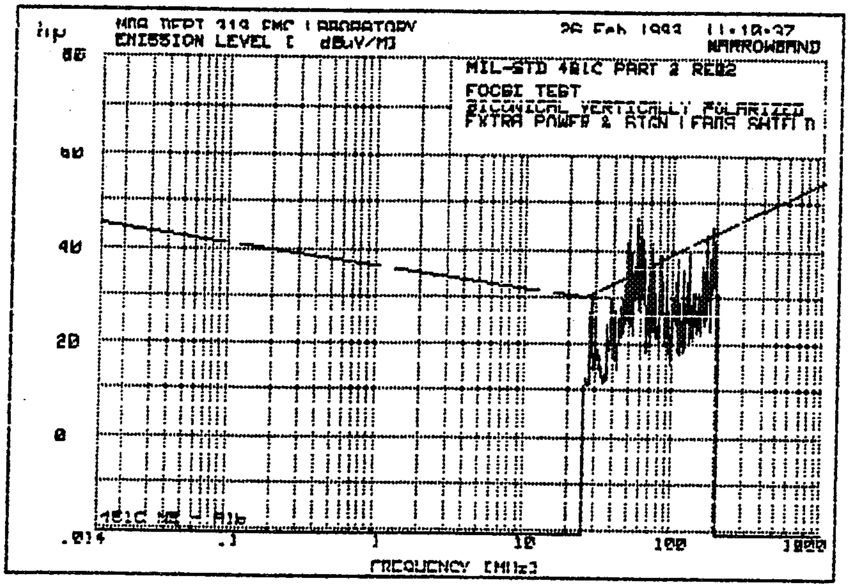
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuV/M)	DELTA
1	4.023	34.9	1.3 NB
2	4.16	42.5	9.0
3	12.02	33.8	2.4
4	28.07	39.7	9.0
5	36.29	34.7	2.3 NB
6	47.98	36	1.7
7	56.1	38.8	3.5
8	60.66	40.6	4.8 NB
9	64.14	37.5	1.3 NB
10	67.07	36.7	.2 NB
11	71.72	40.3	3.4 NB
12	107.2	43.2	3.6
13	128.17	44.2	3.4
14	226.51	49	4.4 NB



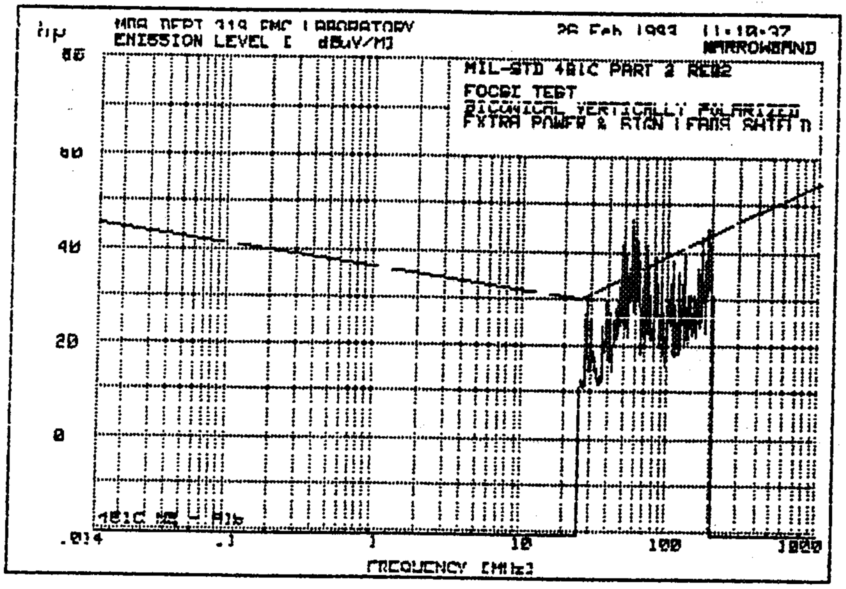
Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuV/M)	DELTA
1	47.98	41.3	7.0
2	51.88	39.5	4.7
3	56.1	46.8	11.5
4	58.01	41.3	5.8
5	59.99	43	7.2
6	62.73	36.7	.6 NB
7	64.14	38.3	2.1 NB
8	71.72	41.5	4.6 NB
9	83.85	38.9	.9 NB
10	167.55	43.3	.7
11	185.27	44.9	1.6



Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuV/M)	DELTA	
1	47.98	41.3	7.0	
2	51.88	39.5	4.7	
3	56.1	46.8	11.5	
4	58.01	41.3	5.8	
5	59.99	43	7.2	
6	62.73	36.7	.6	NB
7	64.14	38.3	2.1	NB
8	71.72	41.5	4.6	NB
9	83.85	38.9	.9	NB
10	167.55	43.3	.7	
11	185.27	44.9	1.6	



Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuV/M)	DELTA
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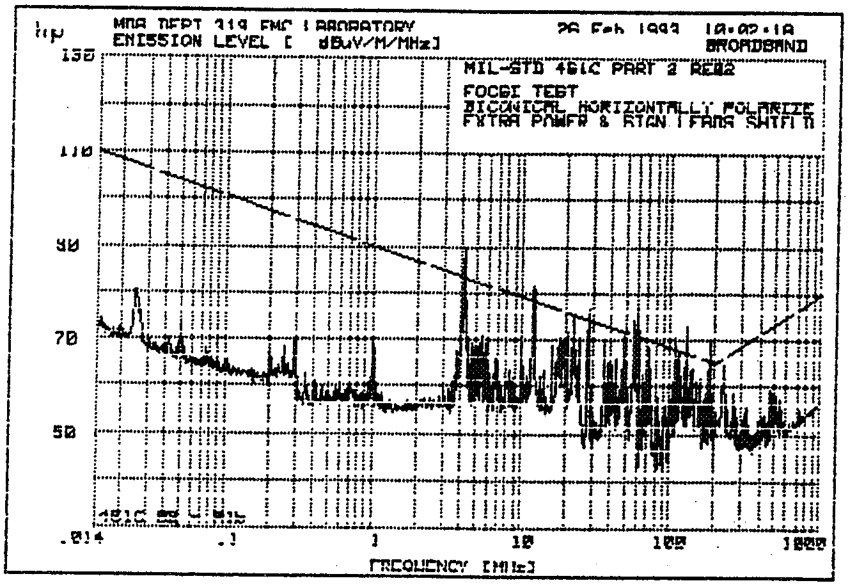
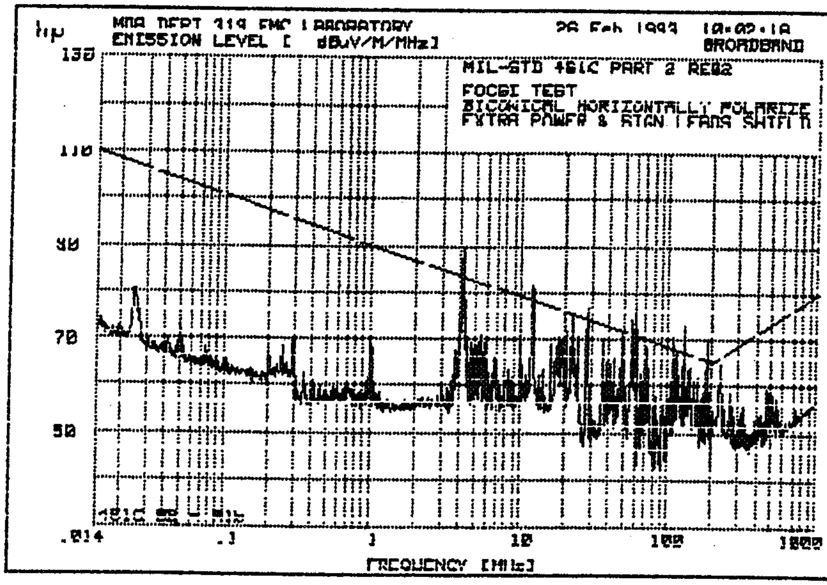


Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuV/M/MHz)	DELTA
1	4.16	89.5	6.3
2	12.02	81.5	3.3
3	21.96	75.6	.3 NB
4	28.07	76.5	2.3
5	47.98	71.8	.1
6	56.1	74	3.1
7	58.01	72.2	1.4 NB
8	59.99	76.9	6.3 NB
9	107.2	70.3	2.4
10	128.17	73	6.0
11	185.27	69.9	4.6 NB



Peaks above 0 dB of Limit Line #1
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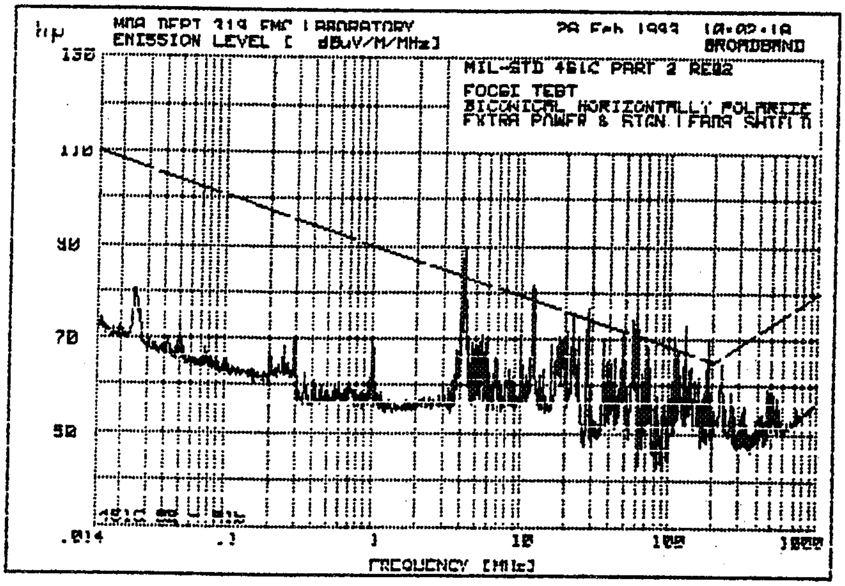
8	59.99	76.9	6.3 NB
9	107.2	70.3	2.4
10	128.17	73	6.0
11	185.27	69.9	4.6 NB



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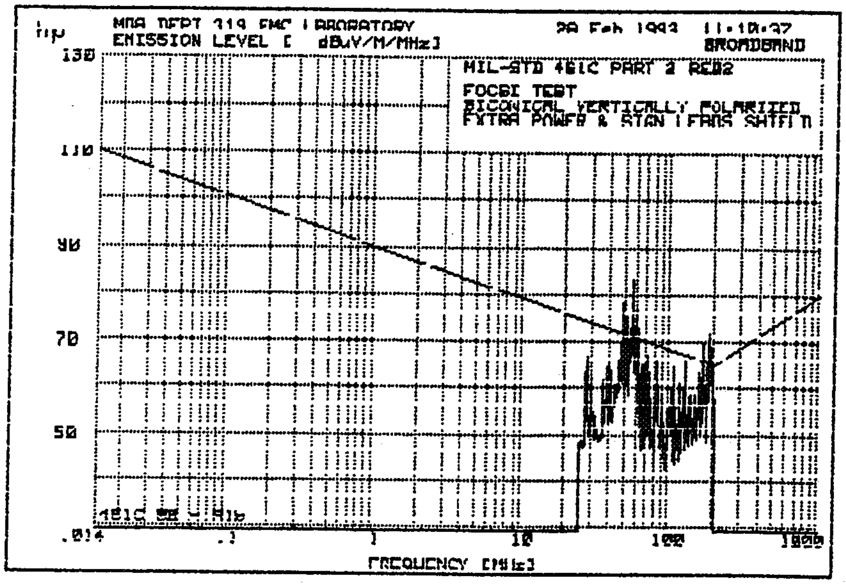
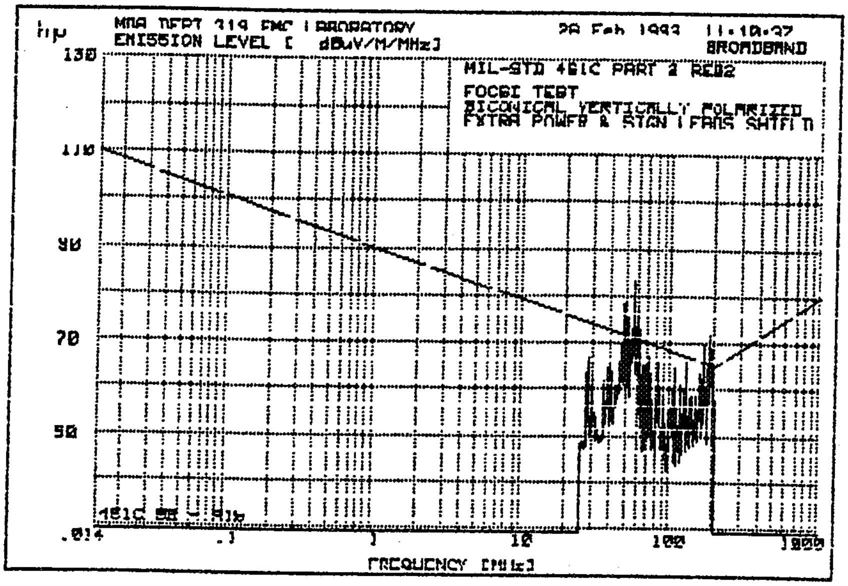


Peaks above 0 dB of Limit Line #1
peak criteria = 6 dB

PEAK#	FREQ (MHz)	(dBuV/M/MHz)	DELTA
1	47.98	78.1	6.4
2	51.88	75.3	4.0
3	56.1	83.1	12.2
4	58.01	73.5	2.7
5	59.99	77.2	6.6
6	167.55	69.8	4.0
7	185.27	71.9	6.6
8	191.58	68.7	3.5 NB



Peaks above 0 dB of Limit Line #1
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1	47.98	78.1	6.4
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3	56.1	83.1	12.2
4	58.01	73.5	2.7
5	59.99	77.2	6.6
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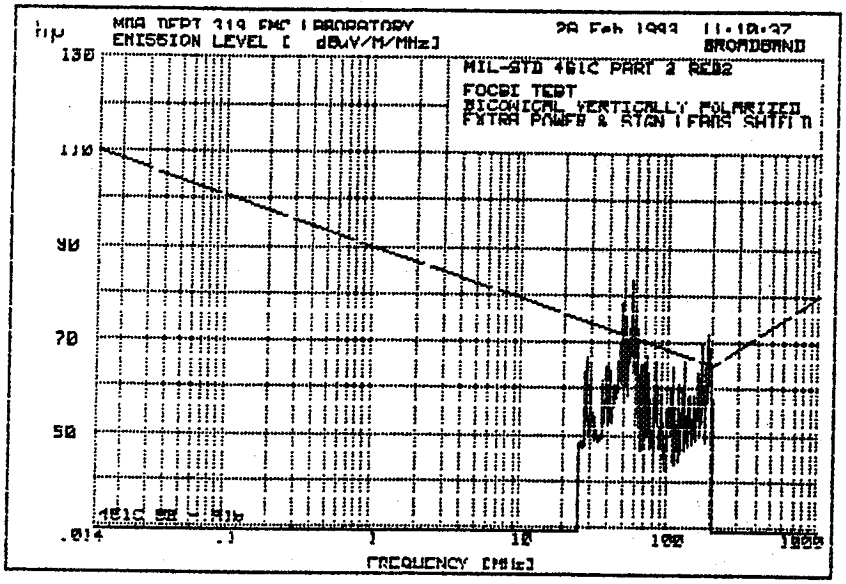

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4	58.01	73.5	2.7
5	59.99	77.2	6.6
6	167.55	69.8	4.0
7	185.27	71.9	6.6
8	191.58	68.7	3.5 NB

15.5 FINAL VERIFICATION TEST DATA SHEET (RUDDER PEDAL SENSOR)

15.5.1 Final Verification Test (14.7) PASS ☑ FAIL ☐

Performed by: Brad Kessler Date: 7/16/93 Test Article Serial Number: 001

EOA #1

15.5.2 Null Offset Test (9.6.2) PASS ☑ FAIL ☐

15.5.2.1 Record the PFS Test Set value during the test and the largest sensor value.

Sensor Null Offset [± 0.001] inches Avg. 0.000 Expected: ≤ +/− 0.0045 in.

PFS Test Set Value [2.000] inches Expected: 0.000 in.

Comments:

15.5.3 Resolution Test (9.6.3) PASS ☑ FAIL ☐

15.5.3.1 Record the PFS Test Set position and the smallest change in the sensor position.

PFS Test Set Initial Position [0.500] in. and Ending Position [0.502] in.

Sensor Resolution [0.002] in.

Expected: ≤ +/− 0.0045 in.
Estimated: $2(0.75)/2^{10} \simeq 0.0015$ in.
Proc. Spec.: 0.00037 in.

Comments: The sensor changed from 0.505 to 0.507 for a difference of 0.002.

15.5.4 Range Test (9.6.4) PASS ☑ FAIL ☐

15.5.4.1 Record the sensor and PFS Test Set full stroke positions.

Sensor Positions	– Full Stroke	−0.750 in.	Expected: −0.750in.
	+ Full Stroke	0.750 in.	Expected: +0.750in.
PFS Test Set Positions	– Full Stroke	−0.773 in.	Expected: −0.750in.
	+ Full Stroke	0.745 in.	Expected: +0.750in.

Comments: The PFS values were taken when the sensor readings reached the extremes.

a-5.

15.5.5 Linearity Test (9.6.5)

PASS ☑ FAIL ☐

Record Sensor Positions at the PFS Positions	POSITION AND FORCE SENSOR (PFS) TEST SET POSITIONS								
	−0.750	−0.563	−0.375	−0.188	0.00	0.188	0.375	0.563	0.750
0 to +Full Stroke					0.000	0.188	0.376	0.565	0.750
+Full Stroke to 0					0.006	0.198	0.381	0.569	0.750
0 to −Full Stroke	−0.740	−0.543	−0.363	−0.176	X				
−Full Stroke to 0	−0.750	−0.570	−0.381	−0.188	−0.004				

15.5.5.1 Print the spreadsheet containing the PFS Test Set vs. sensor positions and the linear regression and standard deviation analysis on those points, and attach it behind this data sheet.

15.5.5.2 Record the slope, constant, and standard deviation values.

Slope 0.998 Expected: 1.0

Constant 0.004 Expected: 0

Standard Deviation 0.007

Comments:

15.5.5.3 Calculate the linear regressed range of the null and full stroke values, and account for the standard deviation to find the linear regressed range of the null and full stroke values.

$y = mx + b$, where m = slope, b = constant, x = sensor positions

linear regressed range = (y − standard deviation) to (y + standard deviation)

Actual Null Position 0.006 / −0.004 in. Regressed Range −0.003 in. to 0.011 in.

Actual Min. Full Stroke Position −0.750 in. Regressed Range −0.738 in. to −0.752 in.

Actual Max. Full Stroke Position 0.750 in. Regressed Range 0.745 in. to 0.759 in.

Comments:

15.5.5.4 Calculate the deviations of the actual data points from the best straight line and record the largest deviation.

at −0.563

Sensor Nonlinearity 0.015 in. Expected: ≤ +/− 0.0019 in.

Comments: The sensor nonlinearity is larger than expected but the overall results are good.

Environmental Final Perfomance Test (Rudder Pedal Sensor S/N 001)

Reference (inches)	Sensor (inches)
0	0
0.188	0.188
0.375	0.376
0.563	0.565
0.75	0.75
0.75	0.75
0.563	0.569
0.375	0.381
0.188	0.198
0	0.006
-0.188	-0.176
-0.375	-0.363
-0.563	-0.543
-0.75	-0.74
-0.75	-0.75
-0.563	-0.57
-0.375	-0.381
-0.188	-0.188
0	-0.004

Least Squares Fit (y = mx + b)			
Results Map		Results	
m	b	0.997556	0.003579
se m	se b	0.003408	0.001606
r squared	se y	0.999802	0.007002
F	df	85694.03	17
ss reg	ss resid	4.201145	0.000833

Least Square Fit Results Key
m = slope
b = y-intercept
se m = standard error for slope
se b = standard error for y-intercept
r squared = coefficient of determination
se y = standard error for the y estimate (se y = standard deviation)
F = the F statistic
df = degrees of freedom
ss reg = regression sum of squares
ss resid = residual sum of squares