EA02-025

TEXAS INSTRUMENTS, INC.'S

9/10/03 ATTACHMENT TO ODI

REQUEST #3

BOX 5

PARTS A - P

PART F

TI-NHTSA 7470

File Name: TPM [illegible] [redacted] [illegible]

[illegible] [redacted] [illegible] Pressure Switch
[illegible]
[illegible]

[illegible] [redacted] [illegible]

Prepared by: [illegible] [redacted]
[illegible]

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s) of Failure	O C C	Design Verification	D E T	R P N	Recommended Actions	Area/Individual Responsible & Completion Date	ACTION RESULTS Actions Taken	S	O	D	R P N
[illegible]	[illegible]	[illegible] [illegible] [illegible]	[illegible]		[illegible] [illegible]	[illegible]	[illegible] [illegible]	1	[illegible]							
	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible] [illegible]	[illegible]	[illegible]							

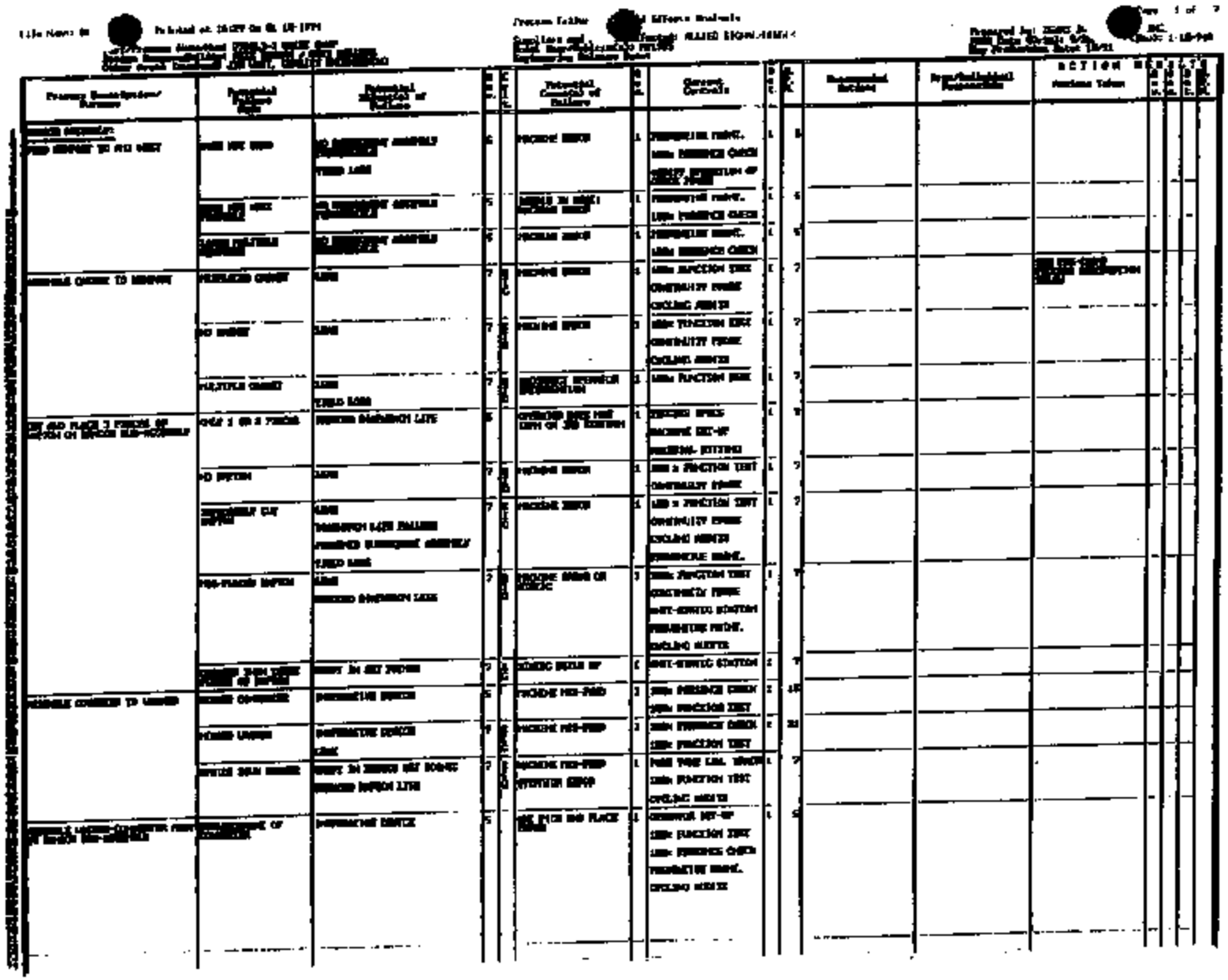
TI-NHTSA 7471

TI-NHTSA 7472

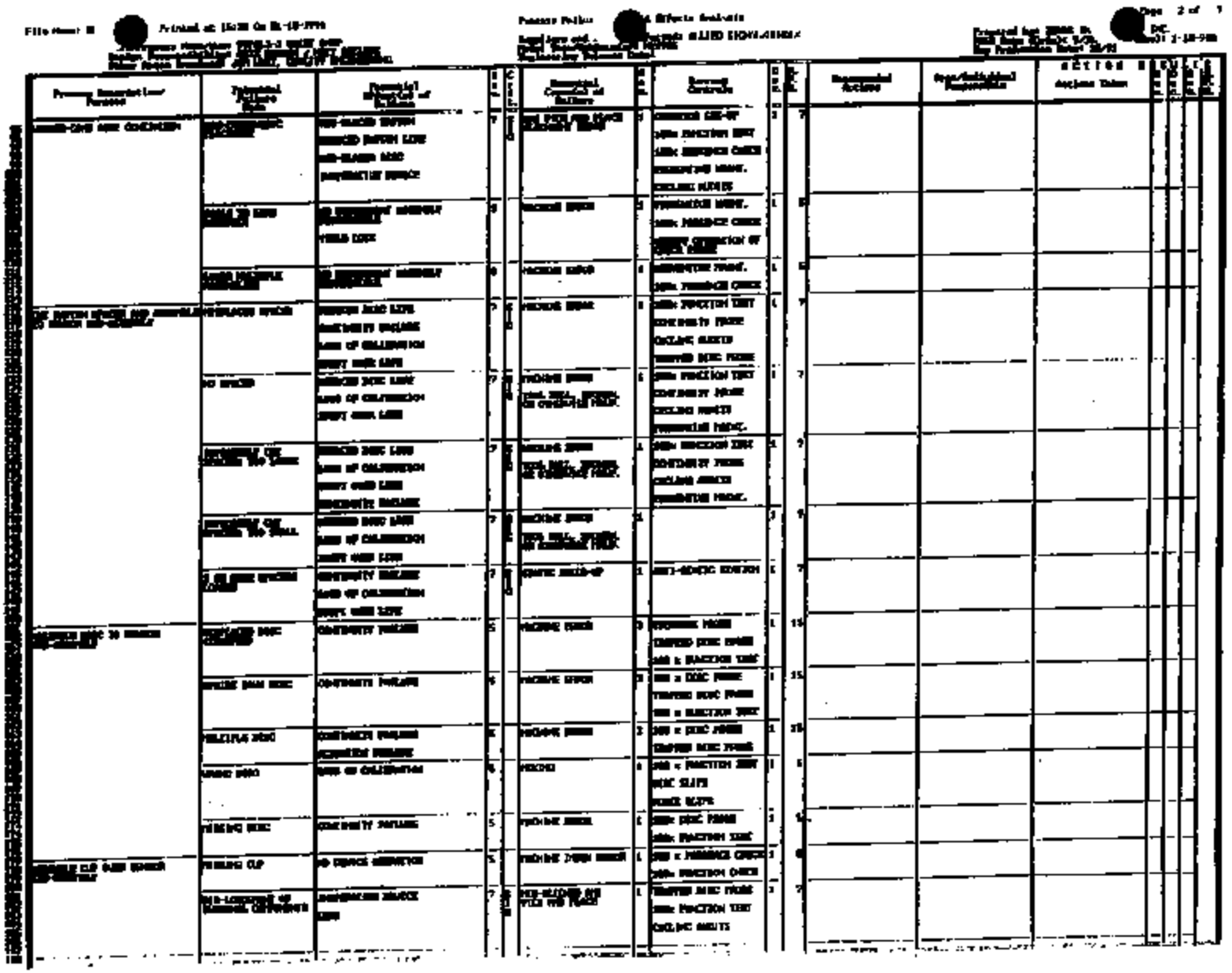
Design Failure Mode and Effects Analysis

[illegible]

Part Name, Number & Description	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s) of Failure	Occur	Design Verification	Detec	RPN	Recommended Actions	Responsibility & Completion Date	ACTION RESULTS Actions Taken	S	O	D	R
[illegible]	[illegible]	[illegible] Crushed hose [illegible]	7		[illegible]	3	[illegible]	1	21							
	[illegible]	[illegible]	5		[illegible]	3	[illegible] Environmental tests	[illegible]	[illegible]	[illegible]						
	[illegible]	[illegible] Illegible marking	7		[illegible]	1	Environmental tests	1	7							
	Insufficient information	[illegible]	5		[illegible]	3	Crimping tests	1	15							



TI-NHTSA 7474



TI-NHTSA 7475

TL-NHTSA 7478

TI-NHTBA 747

TI-NHTSA 7478

THNHTSA 7479

TI-NHTSA 7480

[illegible] GM GAGE STUDY FOR REPEATABILITY AND REPRODUCIBILITY (LONG METHOD
[illegible]-Jun-94
[illegible]CTUATION

NUMBER OF OPERATORS	3	MIN SPEC	300
NUMBER OF PARTS	4	MAX SPEC	400
NUMBER OF TRIALS	2	TOLERANCE	100

DATA SUMMARY

OPERATOR	AVERAGE	RANGE
1	331.325	1.15
2	330.75	0.05
3	331.2375	0.325
4	NA	NA
5	NA	NA
6	NA	NA
7	NA	NA
8	NA	NA
9	NA	NA
10	NA	NA
AVERAGE	331.1041	0.508333

MIN XBAR	330.75
MAX XBAR	331.325
XBARDIFF	0.575

	MEASUREMENT UNIT ANALYSIS	%TOLERANCE
REPEATABILITY:	2.320648	2.32%
REPRODUCIBILITY:	1.315456	1.32%
RPT & REPR (R&R):	2.667725	2.67%

NOTE: ALL CALCULATIONS BASED ON 5.15 SIGMA (99%)

GAGE#08
ENTER STUDY TITLES IN CELLS A8.A9.A10. MIN/MAX SPEC IN B12. B13
CPLATION

MIN SPEC 300
MAX SPEC 400
TOLERANCE 100

DATA FOR OPERATOR 1

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	329.2	330.2				329.7	1
2	326.4	326.4				326.4	0
3	339.9	336.9				338.4	3
4	331.1	330.5				330.8	0.6
5						NA	0
6						NA	0
7						NA	0
8						NA	0
9						NA	0
10						NA	0
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 331.325 AVG RNGE: 1.15
UCL FOR INDIVIDUAL RANGES 1.660725

DATA FOR OPERATOR 2

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	328.9	328.9				328.9	0
2	325.7	325.7				325.7	0
3	337.1	337				337.05	0.1
4	331.3	331.4				331.35	0.1
5						NA	0
6						NA	0
7						NA	0
8						NA	0
9						NA	0
10						NA	0
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG= 330.75 AVG RNGE: 0.05
UCL FOR INDIVIDUAL RANGES 1.660725

LOGgesOB
DATA FOR OPERATOR 3

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	329.2	329.2				329.2	0
2	325.5	325				325.25	0.5
3	339.4	339.8				339.6	0.4
4	330.7	331.1				330.9	0.4
5						NA	0
6						NA	0
7						NA	0
8						NA	0
9						NA	0
10						NA	0
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 331.2375 AVG RNGE: 0.325
UCL FOR INDIVIDUAL RANGES 1.660725

JOSEPH GM GAGE STUDY FOR REPEATABILITY AND REPRODUCIBILITY (LONG METHOD
30-Jun-94
RELEASE

NUMBER OF OPERATORS	3	MIN SPEC	120
NUMBER OF PARTS	4	MAX SPEC	350
NUMBER OF TRIALS	2	TOLERANCE	230

DATA SUMMARY

OPERATOR	AVERAGE	RANGE
1	180.3875	0.325
2	180.0375	0.475
3	179.9875	0.075
4	NA	NA
5	NA	NA
6	NA	NA
7	NA	NA
8	NA	NA
9	NA	NA
10	NA	NA
AVERAGE	180.1041	0.291666

MIN XBAR	179.9875
MAX XBAR	180.3875
XBARDIFF	0.5

	MEASUREMENT UNIT ANALYSIS	%TOLERANCE
REPEATABILITY!	1.331634	0.58%
REPRODUCIBILITY!	1.263289	0.55%
RPT & REPR (R&R)!	1.835524	0.80%

NOTE! ALL CALCULATIONS BASED ON 5.15 SIGMA (99%)

[illegible]
ENTER STUDY TITLES IN CELLS A8.A9.A10. MIN/MAX SPEC IN B12. B13
RELEASE

MIN SPEC 120
MAX SPEC 350
TOLERANCE 230

DATA FOR OPERATOR 1

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	187.3	186.8				187.05	0.5
2	179.7	179.5				179.6	0.2
3	174.8	174.4				174.6	0.4
4	180.4	180.2				180.3	0.2
5						NA	0
6						NA	0
7						NA	0
8						NA	0
9						NA	0
10						NA	0
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG= 180.3875 AVG RNGE= 0.325
UCL FOR INDIVIDUAL RANGES 0.952675

.0000s00 DATA FOR OPERATOR 2

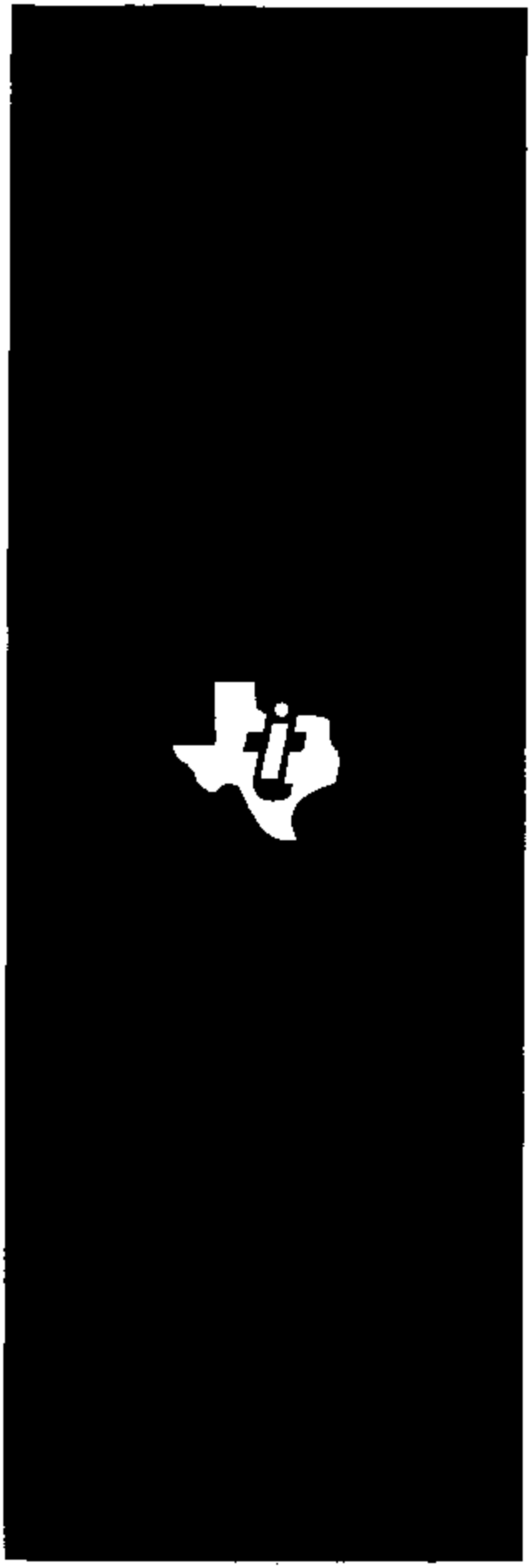
PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	186.3	186				186.15	0.3
2	179.5	179.3				179.4	0.2
3	174.9	173.6				174.25	1.3
4	180.3	180.4				180.35	0.1
5						NA	0
6						NA	0
7						NA	0
8						NA	0
9						NA	0
10						NA	0
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 180.0375 AVG RNGE: 0.475
UCL FOR INDIVIDUAL RANGES 0.952875

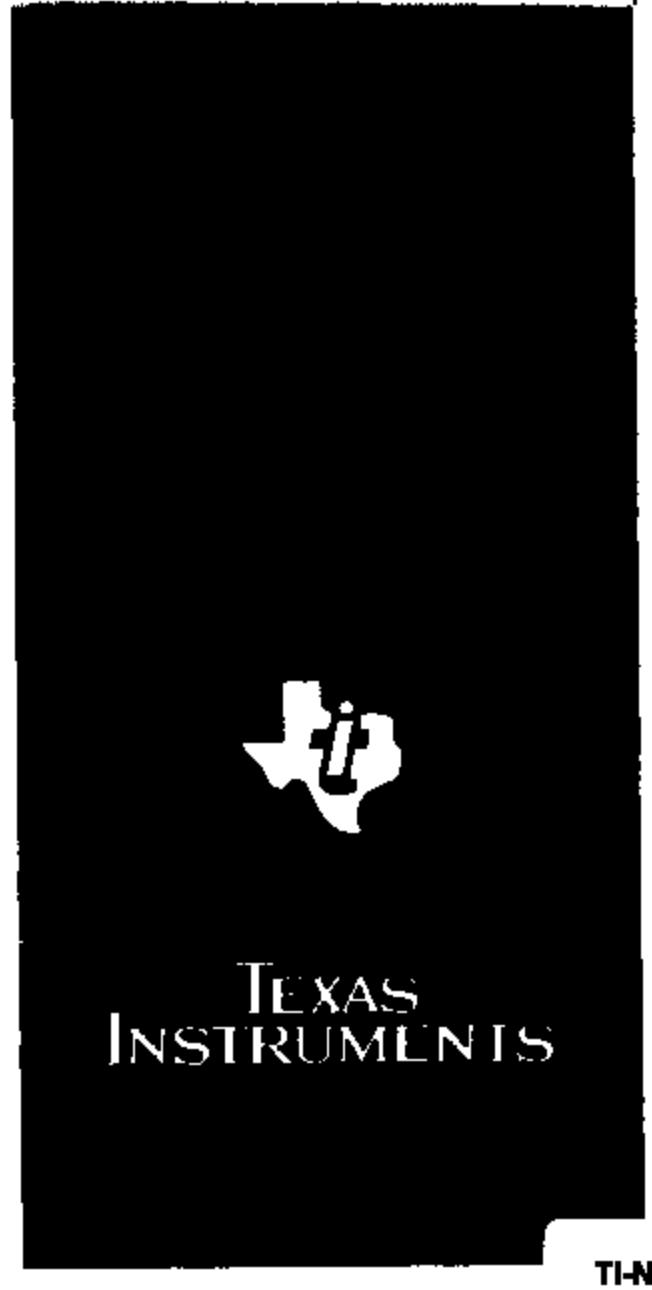
DATA FOR OPERATOR 3

PART	TRIAL 1	2	3	4	5	AVG	RANGE
1	186.1	186.2				186.15	0.1
2	178.9	179.1				179	0.2
3	174.1	174.1				174.1	0
4	180.3	180.3				180.3	0
5						NA	0
6						NA	0
7						NA	0
8						NA	0
9						NA	0
10						NA	0
11						NA	0
12						NA	0
13						NA	0
14						NA	0
15						NA	0
16						NA	0
17						NA	0
18						NA	0
19						NA	0
20						NA	0
21						NA	0
22						NA	0
23						NA	0
24						NA	0
25						NA	0

GRND AVG: 179.8875 AVG RNGE: 0.075
UCL FOR INDIVIDUAL RANGES 0.952875



MATERIAL ANAL


TEXAS
INSTRUMENTS

REPORT OF ISR TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH
PS/91/49

TEXAS INSTRUMENTS INCORPORATED
CONTROL PRODUCTS DIVISION
PRECISION CONTROLS DEPARTMENT
34 FOREST STREET
ATTLEBORO, MA 02703

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 91-09-20		PAGE 1

FORM 5215

TABLE OF CONTENTS

1.0 GENERAL

1.1 Customer: Ford Motor Company, Passenger Car Brake Systems Engineering

1.2 TI Part Number: 77PSL2-1

1.3 Customer Part Number: F2VC-9F924-AB

1.4 Specifications: Ford Engineering Specification number (delta) ES-F2VC-9F924-AA

1.5 Date of Completion: 910920

1.6 Quantity of Units Tested: 104

1.7 Disposition of Tested Units:

1.7.1 Devices 156-15-37 thru -42 were destroyed in Burst testing (3.5)

1.7.2 All other devices are retained under quarantine.

1.8 TI test series number: 156-15-104

1.9 TI Pressure Switch test report number: PS/91/49

2.0 OBJECTIVE

This battery of tests was performed to demonstrate the ability of 77PSL2-1 to conform to customer specifications given in (delta) ES-F2VC-9F924-AA, in fulfillment of the requirements of the Initial Sample Report. Units tested were built using fully qualified production components and production assembly equipment.

3.0 TEST PROCEDURES AND RESULTS

All switches were tested to Ford Engineering Specification (delta) ES-F2VC-9F924-AA. A copy of this ES is included in Appendix 4.1. Procedural details are therefore omitted from the presentation of results in most cases. In those instances where the ES procedure methodology is modified, a complete explanation of the actual procedure is presented. For all tests, raw data is included in Appendix 4.2.1.

A flow chart is included in the ES (frame 4 of 18), as follows: All test devices are to be subject to an initial characterization consisting of Calibration, Voltage Drop, Current Leakage, and Proof. Devices are then divided into groups per the flow chart and subject to the indicated tests in the indicated order. Finally, devices are subject to a final characterization. However, it became necessary to deviate from this exact procedure as described below. We believe that this alternate procedure still meets the intent of the ES.

During the first phase of Impulse (3.10) testing (12 virgin devices) it was discovered that the pressure-sensing assemblies were improperly built, resulting in a reduction in life of the diaphragm. During investigation of the root cause of diaphragm problems, it was learned that the final crimp station on the automatic assembly equipment experiences this problem only on this particular part; all other devices built on this equipment are not subject to this. Witness the good results obtained with the Light Truck (F3TA-9F924-AA) version of this test (see data in Appendix 4.2.7), built on the automatic assembly equipment, as supporting evidence.

3.0 TEST PROCEDURES AND RESULTS, CONTINUED

While analysis and permanent corrective actions are ongoing, it was also learned that the manual assembly equipment which performs the final crimp produces pressure-sensing assemblies which have acceptable life. This equipment was used 4Q90 during validation of F2VC-9F924-BB (TI P/N 57PSL5-3) which uses exactly the same pressure sensing assembly, as well as to produce the rebuilt Impulse devices (157-15-81 thru -104) and will continue to be used until such time as the permanent corrective actions are in place on the automatic equipment and re-validation is completed.

To expedite completion of the switch validation, 12 of the rebuilt parts were not subjected to the Fluid Resistance test (3.9). However, this will not affect the results of the Impulse test in any way, since the various fluids do not come into contact with the diaphragm. Invoking similarity with the Light Truck (F3TA-9F924-AA) version of this test which was run simultaneously, all devices undergoing Fluid Resistance in this test easily passed their subsequent Impulse test.

3.1 CALIBRATION

3.1.1 Procedure: Calibration is checked at room temperature using ambient air as the pressure medium. Calibration settings, as specified on the part drawing, are actuation (electrical contacts opening) at 200 - 300 psig, and release (contacts reclosing) at 40 psig minimum. For the purpose of stabilization, actuation values are recorded on the sixth cycle, after subjecting the switch to two (2) pressure cycles to 800 psig minimum and back to zero, followed by three (3) cycles to 1.1 times actuation pressure minimum and back to zero. The change in continuity is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

3.1.2 Equipment: Custom TI designed and built pressure check station, using Heise Model CM96365 pressure gage calibrated on a regular quarterly schedule. Continuity change measured on custom TI designed and built equipment meeting the above electrical parameters.

3.1.3 Initial Results: All 72 original devices tested were found to be within specification.

3.1.4 Final Results: 42 surviving original devices were found to be within specification. 6 were destroyed in Burst (3.5), 24 were aborted from Impulse (3.10). 24 additional devices which underwent Impulse but had no initial characterization were also found to be within specification at the completion of testing.

3.2 VOLTAGE DROP

3.2.1 Equipment: Fluke Model 8020B Digital Multimeter, calibrated quarterly, used in conjunction with the continuity equipment in 3.1.2.

3.2.2. Initial results: The average voltage drop was 4.9 millivolts, and the standard deviation was 1.9. All values are significantly below the specification of 200 millivolts maximum.

3.2.3 Final results: The average voltage drop was 6.4 millivolts, and the standard deviation was 3.5.

3.3 CURRENT LEAKAGE

3.3.1 Equipment: Associated Research HyPot test unit used as power source for 500 VAC, 60 Hz test circuit. Fluke Model 8020B Digital Multimeter, calibrated quarterly, used to measure voltage drop across a series resistance of one megohm (+/- 5%).

3.3.2 Initial results: Measuring terminals to case with switch closed; measuring terminals to case with switch open; and measuring between the terminals: the maximum current leakage observed was 2.3 microamps. All values are significantly below the specification of 100 microamps.

3.3.3. Final results: Same three measurements per device as 3.3.2. All current leakage values were consistent with initial results. All values are significantly below the specification of 100 microamps.

3.4 PROOF

3.4.1 Procedure: Calibration readings were recorded only after proof testing. Test pressure was 3000 psi per the part drawing.

3.4.1 Equipment: Enerpak model P-392 hydraulic hand pump using Enerpak hydraulic fluid as the pressure medium. Hydraulic fluid is removed from the devices using a combination of vacuum and residue-free solvent Sprayon(TM) Ri-Tech 02002 TF Electrical Contact Cleaner. US Gauge #33714 reading to 5000 psig with 100 psi increments, resolvable to 50 psi., calibrated quarterly. Custom TI designed and built safety enclosure.

3.4.2 Initial Results: No evidence of fluid leakage and no drop in test pressure was observed on any device.

3.4.3 Final Results: No evidence of fluid leakage and no drop in test pressure was observed on any device.

3.5 BURST

3.5.1 Devices tested: 156-15-37 thru -42.

3.5.2 Procedure: A pressure of 7000 psig was applied and held for 30 seconds minimum. Pressure was then increased slowly until failure. Failure is typically signalled by a sudden drop in test pressure of several hundred psi, which corresponds with the first point at which some internal component reaches irreversible plastic deformation and causes an increase in internal volume. The peak pressure attained as this occurs is defined as the bursting point.

3.5.3. Equipment: same as 3.4.1., with the addition of Enerpak gauge reading to 10,000 psig with 100 psi increments, resolvable to 50 psi., calibrated quarterly.

3.5.4. Results: All six devices passed 30 seconds at 7000 psig without evidence of fluid leakage or drop in test pressure. The failure point defined in 3.5.2 was recorded, and a Weibull plot generated. See data section 4.2.2. Using the statistical acceptance criteria from the ES (frame 3 of 18), a minimum Weibull slope (beta) of 31.5 and a minimum Characteristic Life (theta) of 7680.7 psi was calculated at 90% confidence. The 0.72 reliability at 90% confidence is 7414 psi. Thus, the parts exceed the burst specification of 7000 psig by 414 psi at the Ford-specified confidence and reliability levels.

3.6 VIBRATION

3.6.1 Devices tested: 156-15-43 thru -48.

3.6.2 Equipment: Vibration table, Ling, model A395 with Hewlett-Packard model 5427 controls. Air tank with 350 psig minimum pressurized Nitrogen used to actuate devices with at least 1.1 times maximum actuation specification on part drawing; 300 psig * 1.1 = 330 psi minimum.

3.6.3 Results: All six switches met the acceptance criteria in the ES (frame 9 of 18; section III. I. 2.).

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 91-05-28		PAGE 12

FORM 9289

3.7 VACUUM

3.7.1 Devices tested: 156-15-49, -50, -52 thru -55.

3.7.2 Equipment: Kinney vacuum pump. Sensotec pressure transducer range 0-25 psia calibrated quarterly, with Fluke model 8020B Digital Multimeter readout, calibrated quarterly.

3.7.3 Results: All six devices met the acceptance criteria in the ES (frame 10 of 18; section III. K. 2.).

3.8 TEMPERATURE CYCLE

3.8.1 Devices tested: 156-15-56 thru -61.

3.8.2 Equipment: Thermotron model S-4 Mini-Max environmental chamber capable of -55 C to +200 C, humidity uncontrolled. Custom TI designed and built cycler, utilizing Enerpak integrated hydraulic pressure source, TI315 Programmable Logic Controller, Moog servovalve and controller, Simpson signal generator, and opposing-piston fluid isolators, to produce a hydraulic-fluid flow-type primary with a brake-fluid dead-end-type secondary terminated with a 24-station manifold equipped with internal heaters. Capability to 5 Hz at 0-1450 psig cycle. Custom TI designed and built 24 station Switch Monitor Circuit which automatically stops the cycler in the event of abnormal switch action, defined as continuity change which does not track the signal from the signal generator. Thermocouple readouts calibrated quarterly.

3.8.3 Results: All six devices met the acceptance criteria in ES (frame 11 of 18; section III, L, 2.). Data sheet in section 4.2.4 shows actual fluid and ambient temperatures attained at each cycle.

3.9 FLUID RESISTANCE

3.9.1 Devices tested: 156-15-01 thru -36.

3.9.2 Equipment: Fluids as called out in ES table (frame 12 of 18); appropriate beakers and storage apparatus; vented hood.

3.9.3 Results: The 36 devices were divided into groups as follows for subsequent testing. Results of these tests are reported below.

3.9.3.1 Impulse (3.10), -01 thru -12

3.9.3.2 Terminal Strength (3.11), -13 thru -24.

3.9.3.3 Humidity (3.12), -25 thru -30.

3.9.3.4 Salt Spray (3.13), -31 thru -36.

3.10 IMPULSE

3.10.1 Devices tested: 156-15-81 thru -104.

3.10.2 Procedure: 24 virgin devices were run as opposed to 12 virgins and 12 from Fluid Resistance. This is discussed in detail in section 3.0. The parameters given in the ES (frame 7 of 18, section III. E. 1.) are followed explicitly.

3.10.3 Equipment: same as 3.8.2 with the addition of a 12-station inductive load bank, per the schematic found in the ES (frame 18 of 18; figure 4.) used in the last 25K cycles.

3.10.4 Results/Discussion: Pre-characterization was not performed. After completion of the 500K cycles, all 24 devices passed the acceptance criteria found in the ES (frame 7 of 18, section III. E. 2).

This test may be regarded as the one of the most rigorous. This test is run at elevated temperature (135 C fluid), elevated pressure (1450 psig, 2 Hz), and total cycles (applying brakes 5 times per mile for 100,000 miles) which exceed conditions typically found in actual motor vehicles.

3.11 TERMINAL STRENGTH

3.11.1 Devices tested: 156-15-13 thru -24.

3.11.2 Equipment: Custom TI designed and built fixtures for gaging terminal movement after force application and for application of impact via a pendulum. This equipment is regularly used on the 57PS/77PS assembly lines in testing to TI Quality Assurance Specifications.

3.11.3 Results: All twelve devices passed the acceptance criteria found in the ES (frame 10 of 18; section III. J. 2.).

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE [illegible]		PAGE 17

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3.12 HUMIDITY

3.12.1 Devices tested: 156-15-25 thru -30.

3.12.2 Equipment: Humidity chamber RK model 5S.

3.12.3 Results/Discussion: Please note that performing a full characterization per the ES consists of actuation, release, millivolt drop, current leakage, and proof. This battery of tests when performed on six (6) devices takes approximately 2 hours to complete. Therefore "Within 15 minutes..." called out in the ES (frame 8 of 18, section III. G. 2. a.) is an acceptance requirement that is physically impossible to meet. Every effort is made to complete final characterization within the two hour period stated above.

All six devices passed the acceptance criteria found in the ES (frame 8 of 18; section III. G. 2.).

3.13 SALT SPRAY

3.13.1 Devices tested: 156-15-31 thru -36.

3.13.2 Equipment: Harshaw salt spray chamber.

3.13.3 Results: All six devices passed the acceptance criteria found in the ES (frame 8 of 18, section III. H. 2.).

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DSO.
DATE 91-08-29		PAGE 19

FORM 5288

Appendix 4.1
Ford Engineering Specification
(delta) ES-F2VC-9F924-AA

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-09-20		PAGE 20

FORM 5296

Ford **Engineering Specification**

PART NAME	PART NUMBER
SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE	▽ ES-F2VC-9F924-AA

LET																		
FR																		
LET																		
FR																		

DATE	LET	FR	REVISIONS	DR	CK

REFERENCE

PREPARED/APPROVED BY

CHECKED BY | DETAILED B

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERV

DESIGN ENGINEERING MGT

MANUFACTURING ENGRG.

QUALITY CONTROL

PURCHASING

SUPPLIER QUALITY ASSETAN

ELECTRONICS DIVISIC

SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE

I. General

This specification covers the test requirements for the speed control deactivate switch -9F924- used in the electronic speed control system. Design changes on the switch assembly or its components shall not be made without compliance to Section V of this specification and written approval from the releasing Production Engineering Office.

This engineering specification is a supplement to the released drawing on the above part, and all requirements herein must be met in addition to all other requirements of the part drawing. Minimum measures necessary for demonstrating compliance to these requirements are given in each section.

The engineering tests, sample sizes, and test frequencies contained within this engineering specification reflect the minimum requirements established to provide a regular evaluation of conformance to design intent. The engineering test program is intended as a supplement to normal material inspections, dimensional checking and in-process controls, and should in no way adversely influence other inspection operations.

Q1 suppliers may implement different test sample sizes and frequencies providing these changes have been included in an alternate Control Plan approved by the design responsible Product Engineering Office and concurred in by SQA.

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

- Production Validation (PV) Tests must be completed satisfactorily with parts from production tooling (and processes where possible) before ISIR approval and authorization for shipment of production parts can be effected. Parts must be revalidated completely, or per Section V whenever any change is made which could possibly affect part function or performance.

- In-Process Test Phase 1 (IP-1) - IP-1 tests are used to demonstrate process capability and must be completed using initial production parts from production tooling and processes prior to first production shipment approval. IP-1 tests are to continue in effect until process capability is demonstrated.

- In-Process Tests Phase 2 (IP-2) - IP-2 test program may be implemented only after process capability has been established. Tests must be completed with production parts on a continuing basis. Samples for these tests must be selected on a random basis to represent the entire production population as much as possible. In the event that any of the requirements in these tests is not met, the reaction plan specified in Ford Q101 Section III.E.3, "ES Test Performance Requirements" shall be invoked.

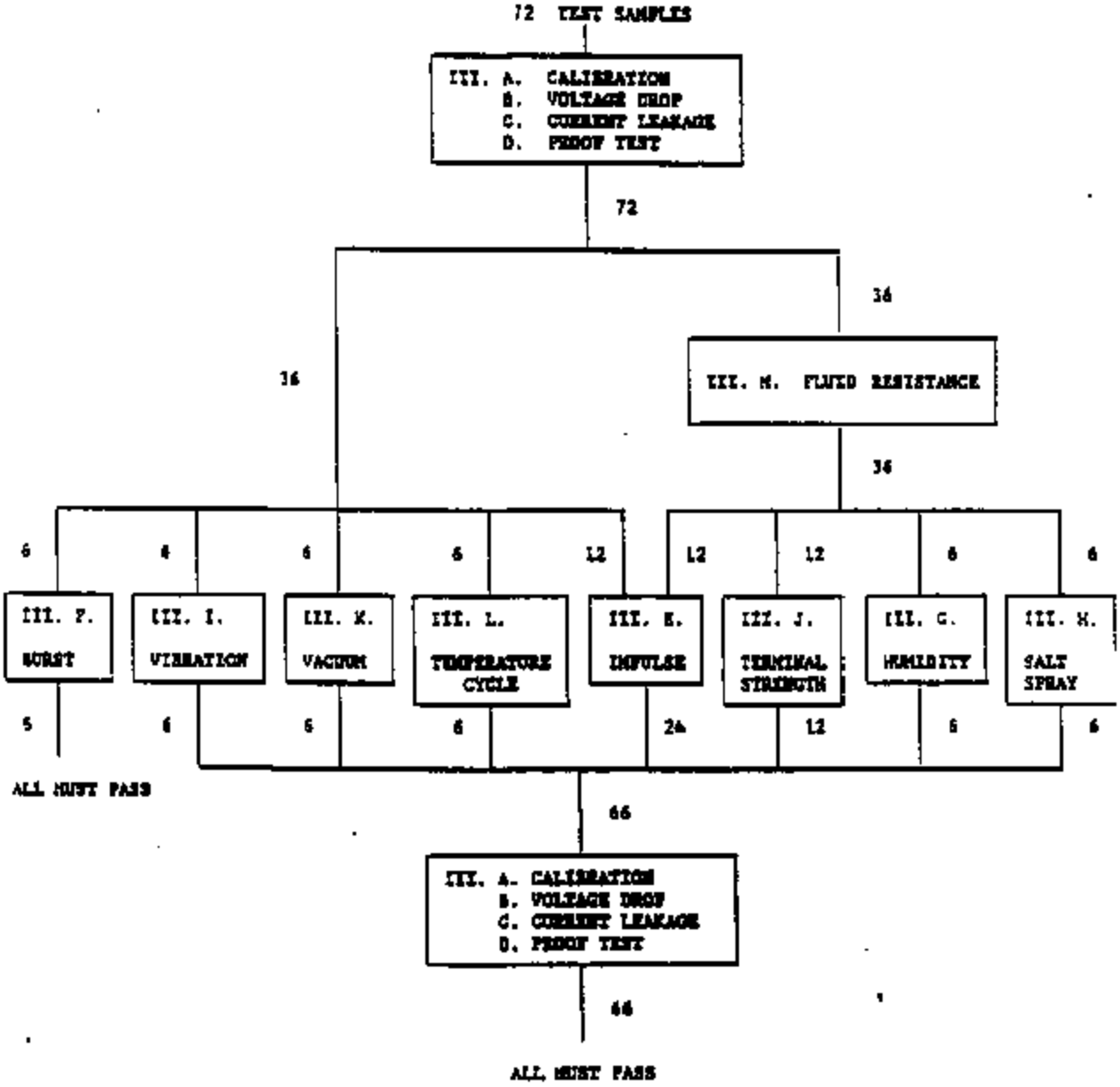
SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
▽ A	Calibration	72	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.96	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
I	Vibration	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90 .72
J	Terminal Strength	12	P90-.84	6/Mo.	P90-.72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
L	Temperature Cycle	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
M	Fluid Resistance	36	P90-.94	36/12Mo	P90-.94	36/12Mo.	P90-.94

Durability Tests

Item	Test Name	PV Minimum Sample Size	PV Criteria	IP-1 Minimum Sample Size	IP-1 Criteria	IP-2 Minimum Sample Size	IP-2 Criteria
III.							
E	Impulse	24	P90-.90	12/Mo.	P90-.84	3/3 Mo.	P90-.56
G	Humidity	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
H	Salt Spray	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72

PRODUCTION VALIDATION FLOW CHART



III. TEST PROCEDURES AND REQUIREMENTS

▽ A. Calibration

1. Test Requirements

a. Switch calibration is to be checked at room temperature (16°C-35°C) using ambient air or equivalent.

b. Calibration settings shall be specified on the part drawing with the settings checked after 2 or more pressure cycles with ambient air, or equivalent. Pressure cycle range is to be determined by the manufacturer to insure switch calibration stability. The cut-in and differential set points are to be measured while conducting 750 ± 50 milliamperes while 13.0 ± 1.0 volts D.C. is applied. The cut-in point is to be checked with increasing pressure.

c. The cut-out point is to be checked with decreasing pressure, and the differential set point is to be calculated using the cut-in pressure minus the cut-out pressure.

2. Acceptance Requirements

a. Nonconformance is defined as any switch point which falls outside the tolerance band specified on the part drawing.

B. Voltage Drop

1. Test Requirements

a. Voltage drop is to be measured after 2 or more cycles with ambient air or equivalent from 0 to 10,000 ± 172 KPa (1450 ± 25 PSI) while conducting 750 ± 50 milliamps and 13.0 ± 1.0 volts D.C. is applied to the switch. Under these conditions with the switch closed the voltage drop is to be measured. Millivolt connection interface at terminals to be less than 10 millivolts.

2. Acceptance Requirements

a. Nonconformance is defined as a voltage drop in excess of 200 millivolts.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

C. Current Leakage

1. Test Requirements

a. Current leakage is to be checked with 500 volts, 60 Hz alternating current.

b. Current leakage is to be checked:

(1) Between the switch leads with the contacts open.
(2) Between the lead and the switch housing with contacts closed.
(3) Between either lead and switch housing with the contacts open.

2. Acceptance Requirements

a. Nonconformance is defined as any leakage current in excess of one hundred (100) microampers.

D. Proof Test

1. Test Requirements

a. Subject sample switches to Section A to establish their initial switching pressures.

b. Proof test is to be conducted using brake fluid or equivalent as the pressure medium. Test pressure shall be as specified on the part drawing. Test pressure shall be isolated from pressure source and held for not less than 30 seconds.

c. Recheck the switches to Section A.

2. Acceptance Requirements

a. No evidence of fluid leakage, seepage, or drop in test pressure greater than 430 KPa.(62 PSI) is permitted.

b. A change in cut-in and cut-out pressures greater than ± 5% from the initial value is not permitted.

c. The test samples must be destroyed after testing.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

E. Impulse

1. Test Requirements

a. Test the switch for a total of 500,000 cycles. Cycle pressure between (low) 0-276 KPa (0-40 psi) and (high) 10,000 ± 345 KPa (1450 ± 50 psi).

1) 0 - 475,00 cycles: 13 ± 1 volts, trace current to monitor function.

2) 475,001 - 500,000 cycles: 13 ± 1 volts D.C., 750 ± 50 ma., per figure 4.

b. Brake fluid temperature to be 135 ± 14°C and ambient temperature to be 107°C min.

c. Cycle rate is to be 110-130 cycles per minute.

d. Switch must open and close each cycle.

2. Acceptance Requirements

a. After impulse test check to sections A, B, C, & D using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, & D.

c. Samples used for this test must be destroyed after all testing is completed.

F. Burst

1. Test Requirement

a. Burst strength is to be checked using brake fluid or equivalent as the pressure medium.

b. Pressurize the switch to 48.3 MPa (7000 PSI) minimum and hold for 30 seconds minimum.

2. Acceptance Requirements

a. Nonconformance is defined as any evidence of fluid leakage or seepage from the switch or threads. Samples used for this test must be destroyed after testing is completed.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

G. Humidity

1. Test Requirements

a. Mount the switch in the test port in a humidity chamber. Currently released mating electrical connector must be installed before start of test.

b. Subject the switch to ten (10) continuous humidity cycles as follows:

(1) Raise temperature to 65 +10/-2 °C over 2.5 hours; at 90-98% relative humidity.

(2) Hold 3 hours at 65 +10/-2 °C at 90-98% relative humidity.

(3) Lower temperature to 25 +10/-2 °C over 2.5 hours; at 80-98% relative humidity.

2. Acceptance Requirements

a. Within 15 minutes after completion of the tenth humidity cycle check the switch to sections A, B, C, D, using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D.

H. Salt Spray

1. Test Requirements

a. Mount the switch in the test port in a salt spray chamber. The currently released mating electrical connector and wiring must be installed prior to start of test.

b. Expose the switch assembly to 72 hours of salt spray per ASTM B-117.

2. Acceptance Requirements

a. After exposure, check the switch to sections A, B, C, D, using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

I. Vibration

1. Test Requirements

a. Mount the switch in the test port and attach the currently released mating electrical connector before start of test.

b. Switches are to be vibrated in all 3 planes with electrical continuity being monitored during the entire test. See Figure 1 for switch orientation in the 3 planes. Vibration tests are to be conducted at room temperature using brake fluid, ambient air, or equivalent as the pressure medium.

c. Internal pressure shall be maintained at 0 KPa G. when the switch is in the closed position and 1.1 times max actuation pressure shown on print when the switch is in the open position.

d. Vibrate the switch at 1.5 mm displacement (peak-to-peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period.

e. Vibrate the switch in alternate one-hour periods in the open and closed positions for a total of 8 hours in each plane. (Total test time is 24 hours).

2. Acceptance Requirements

a. After the entire vibration sequence check the switches to sections A, B, C, or D using the procedure established in each section.

b. Nonconformance is defined as any evidence of leakage or any change in electrical continuity/discontinuity during the vibration cycles, or any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

(1) Apply a 89 ± 9 N axial force to each terminal.

(2) With a pendulum apply a 45 ± 5 N impact force to the switch housing at the connector and, perpendicular to the centerline axis of the switch. See Figure 2 for force application point and direction.

2. Acceptance Requirements

a. Check the switch to sections A, B, C, and D using the procedures established in each section.

b. Nonconformance is defined as any terminal or housing fracture, or any switch not meeting the criteria in sections A, B, C, or D.

K. Vacuum

1. Test Requirements

a. Mount the switch in the test port. Vacuum tests are to be conducted at room temperature using ambient air as the pressure medium.

b. Subject the switch to 5 cycles of vacuum from atmospheric pressure (760 mm Hg) to an absolute pressure of 3-6 mm Hg. Maintain the vacuum for a minimum of 60 seconds.

2. Acceptance Requirements

a. Check the switch to sections A, B, C, and D using the procedure established in each section.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, and D.

3 mm Hg = 0.058 psi = 0.400 KPa

6 mm Hg = 0.116 psi = 0.800 KPa

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

L. Temperature Cycle

1. Test Requirements

a. Mount switches in test ports; test to be run using currently released brake fluid.

b. Repeat the following procedure 25 times.

(1) Lower the switch and fluid temperature to at least -40°C.

(2) Cycle the switches ten times at 10 seconds/cycles. One cycle consists of a pressure variation from 0 - 276 KPa.G (0-40 psi) to 10,000 ± 345 KPa.G (1450 ± 50 PSI). Note: Switch must open and close each cycle.

(3) Raise switch and fluid temperature to 38°C minimum.

(4) Repeat Step 2.

c. At completion of Step b, check switches per sections A, B, C, and D.

2. Acceptance Requirements

a. Nonconformance is defined as any evidence of switch fluid leakage, seepage, or not meeting the criteria of sections A, B, C, and D.

M. Fluid Resistance

1. Test Requirements

a. Mount the switch in the test port and orient as installed in the vehicle.

b. Install the currently released mating electrical connector (with wire leads) to the switch.

c. Sequentially, immerse the switch into each of the specified fluids, at a temperature of 23 ± 2 °C, for 5 ± 1 second. Remove the switch and drain and store the switch for the specified time at room temperature, prior to immersing into the next fluid.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

Fluid	Drain Time	Storage Time
Reference Fuel C ASTM D471	60 ± 5 min.	none
10W40 Engine Oil	24 ± 1 hour	14 days
Ethylene Glycol/ Water 50/50 by Volume	24 ± 1 hour	24 ± 1 hour
Brake Fluid DOT 3	24 ± 1 hour	48 ± 1 hour
Automatic Transmission/ Power Steering Fluid (same) ESP-M2C138-CJ	24 ± 1 hour	14 days
Isopropyl Alcohol/ Water 50/50 by Volume	24 ± 1 hour	none
Reference Fuel C, ASTM D471 with Methyl Alcohol 85/15 by Volume	24 ± 1 hour	none

d. Per the Flow Chart, subject the prescribed number of immersed switches to the post immersion tests specified below:

III. E. Impulse
III. G. Humidity
III. H. Salt Spray
III. J. Terminal Strength

Acceptance Requirements

a. Switches must fully meet the requirements of the specified post immersion test.

b. Nonconformance is defined as any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.

IV. STATISTICAL ANALYSIS METHODS

A. For PV, IP-1 and IP-2 tests, all samples tested must pass. Having all the required sample size pass will provide data to support the conclusion that the switch has a minimum reliability R, at a given confidence of C. The notation Pc-R is interpreted as minimum reliability equal to R, at a confidence C; thus P90-.80 means a minimum reliability of 80% at 90% confidence.

B. All samples must pass is the statistical test acceptance criteria stated for tests with 100% frequency; or samples from lots, which could have a variable size.

V. REVALIDATION REQUIREMENTS

A. No change in design, material, process or component supplier shall be made without prior approval from the releasing Product Engineering Office. As part of approving a change, the releasing Product Engineering Office will establish the portion of the Product Validation tests required to be run to revalidate the switch. The following table is to be used as a guide in determining the type of tests required for revalidation requirements.

RUNNING CHANGE REVALIDATION

Component	Process or Material Change or New Supplier
1. Terminals, Contacts, or Connector	III, B, C, E, G, H, I, J, L, N.
2. Case or Housing	All Tests
3. Disc or Diaphragm	III, A, D, E, F, I, K, L.
4. Fitting or Fluid Connection	III, D, E, F, H, I, M.

B. Annual revalidation is not required on carryover switches.

VI. LOT DEFINITION

A lot is defined as no more than eight (8) hours of production up to 4,000 pieces. If shifts extend beyond eight (8) hours, or more than 4,000 pieces are produced in a shift, the product must be separated into at least two lots.

VII. RECORD RETENTION

A. Recording and record retention shall conform with Ford Q-101.

B. Production Validation test results and analysis are to be forwarded to the releasing Product Engineering Office before approval for shipment of production parts can be granted.

C. In-Process test results shall be available at the supplier's manufacturing facility for the releasing Product Engineering Office and Ford SQA or its representatives to review on request.

VIII. INSTRUCTIONS AND NOTES

All switches are to be identified with the Ford part number, supplier identification, and a date code indicating final assembly.

All test equipment and test procedures for testing to this specification must be approved by the releasing Product Engineering Office and no change in equipment or procedure may be made without their written concurrence.

Test port configuration is shown in Figure 1.

O-rings, if used in the design, shall be free from cuts, nicks, abrasions or any other damage which would result in a fluid leak.

All switches must have a shipping cap installed over the port threads to prevent contamination. All shipping caps must be approved by the releasing Product Engineering Office prior to production incorporation.

All switches that do not pass the calibration test are to either be readjusted and rechecked, or scrapped. (Salvage of component parts permitted with 100% reinspection).

If product nonconformance occurs for test Sections III. B, C, D, E, F, and J, production shall be stopped and the problems corrected. All production lots shall be sorted 100% prior to shipment. Suspected nonconformance of any shipped parts shall be reported immediately to the releasing Product Engineering Office.

If nonconformance of the statistical acceptance criteria occurs for test Sections III. G, H, I, K, L and M, a cause to recall the subject weeks production and to stop production may result.

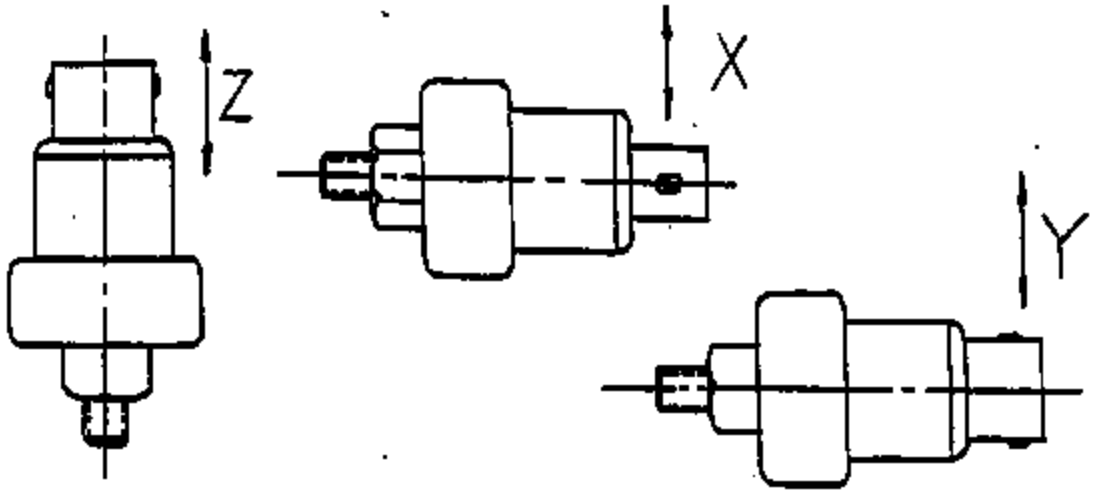
IX. COMPILATION OF REFERENCE DOCUMENTS

ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard - 1993 Edition

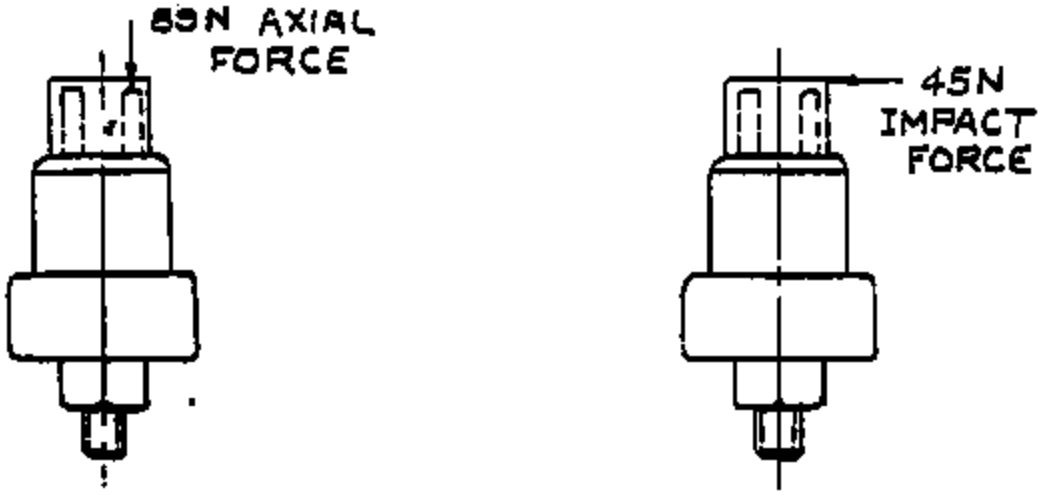
ES-F0EB-14A464-AA, Specification - SLV Assy - Wire Connector

ES-F2VF-9C735-AA, Specification - Servo Assembly Speed Control



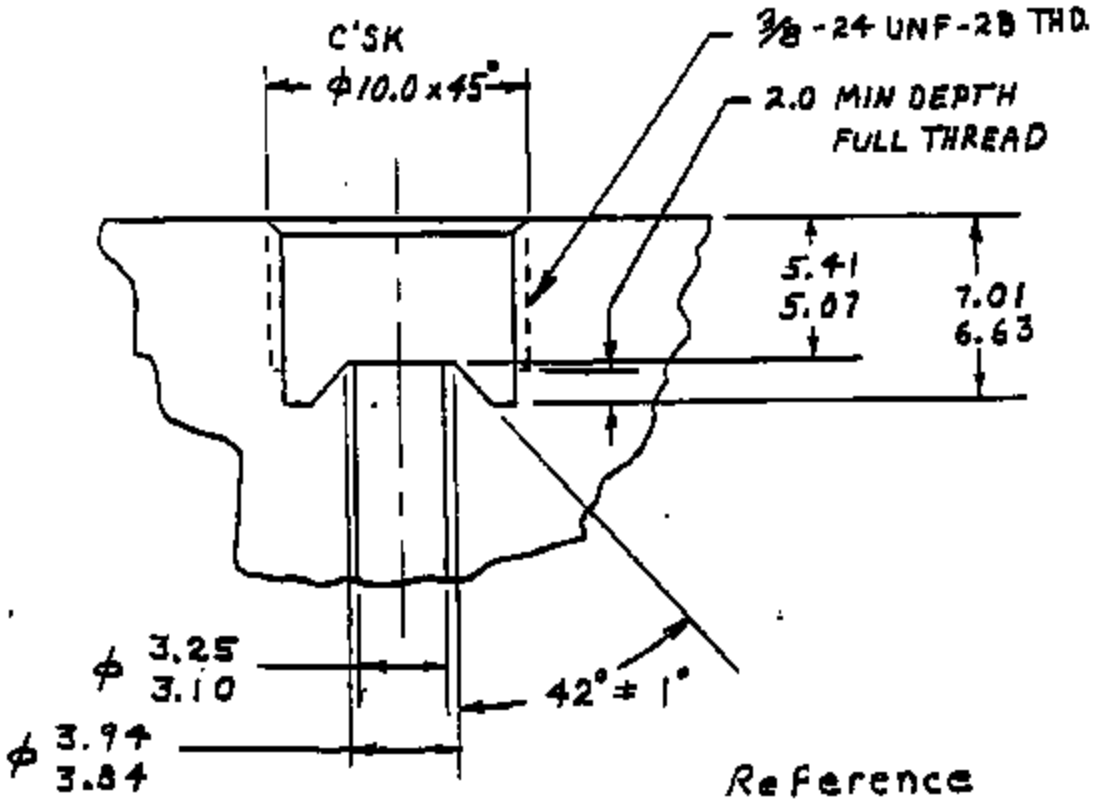
VIBRATION TEST - SWITCH ORIENTATION

FIGURE 1.



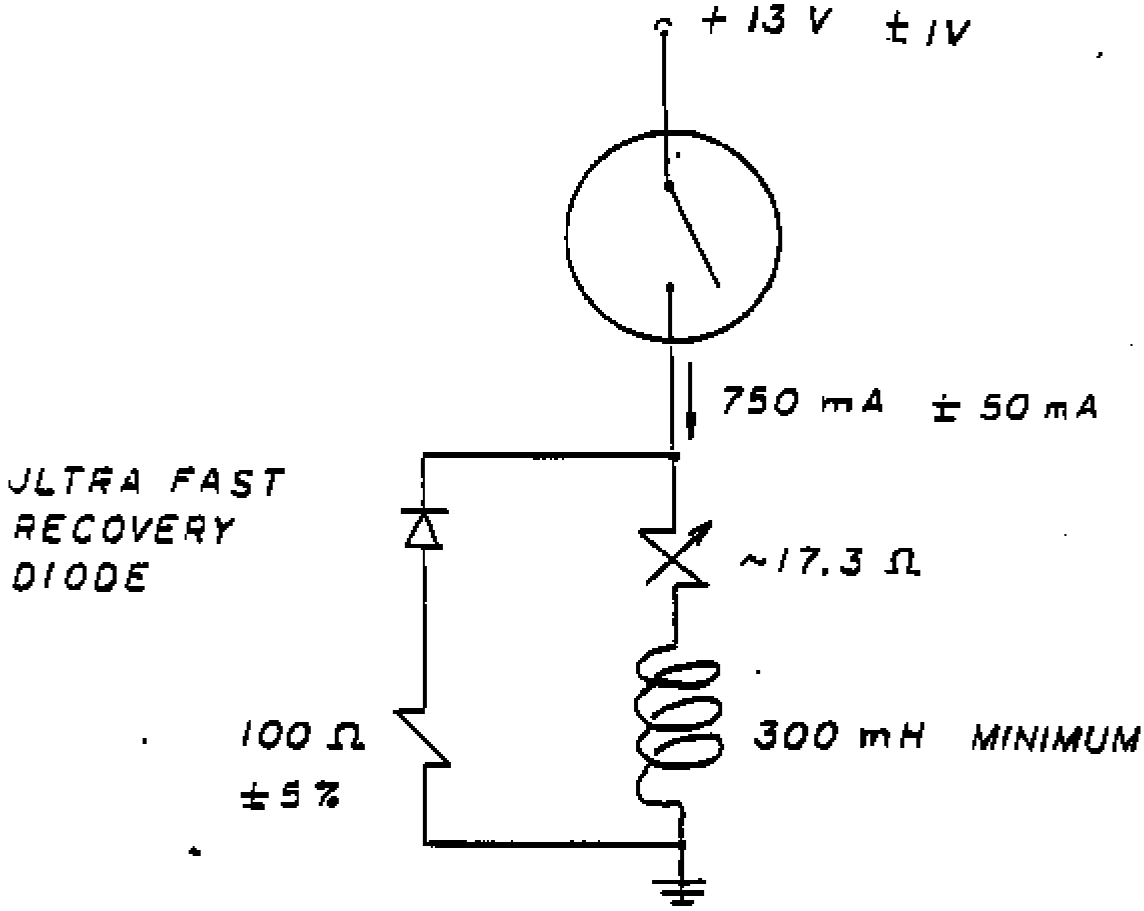
TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2.



TEST FIXTURE PORT CONFIGURATION

FIGURE 3



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

Appendix. 4.2.1
Initial and Final Characterization

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 91-09-20		PAGE 13

FORM 2268

PRESSURE SWITCH DATA Form 21605

TEST NO. 151-15-204

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PSL2-1			

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Jeffrey D[illegible]	6/14/91		

PROJECT TITLE: Ford MY'92 Electronic Speed Control Deactivate PS

CUSTOMER: Pass-Car

PURPOSE OF TEST:

Refer to Ford ES

PROCEDURE:

Current leakage

Device #	Act/Rel	-37 mV Drop	Closed Contacts to [illegible]	Open Contacts to [illegible]	Between Open Contacts	Proof	Tests
126-15-01	127/46	4.9	1.88 mA	1.43 mA	1.47 mA	Good	Fluid res & Impulse
02	137/51	4.7	2.16	1.49	1.50		Fluid res & Impulse
03	129/56	4.9	1.79	1.33	1.62		Fluid res & Impulse
04	118/52	4.4	1.67	1.32	1.79		Fluid res & Impulse
05	124/57	3.1	1.71	1.29	1.49		Fluid res & Impulse
06	130/53	3.2	1.72	1.33	1.59		Fluid res & Impulse
07	124/47	3.2	2.29	1.61	1.60		Fluid res & Impulse
08	120/51	3.6	2.00	1.49	1.87		Fluid res & Impulse
09	133/52	3.0	1.93	1.48	1.97		Fluid res & Impulse
10	118/41	5.5	1.99	1.53	1.71		Fluid res & Impulse
11	123/54	3.9	1.90	1.43	1.95		Fluid res & Impulse
12	120/49	4.9	1.85	1.42	1.81		Fluid res & Impulse
13	131/52	4.2	1.82	1.39	1.66		Fluid res & Temp. Strength
14	139/55	4.0	1.76	1.37	1.85		Fluid res & Temp. Strength
15	131/46	4.5	1.92	1.48	1.97		Fluid res & Temp. Strength
16	123/51	4.7	1.77	1.42	1.74		Fluid res & Temp. Strength
17	120/43	3.9	1.80	1.38	1.84		Fluid res & Temp. Strength
18	133/52	3.0	1.96	1.43	1.87		Fluid res & Temp. Strength
19	132/56	3.7	1.87	1.44	1.83		Fluid res & Temp. Strength
20	131/50	5.0	1.76	1.35	1.70		Fluid res & Temp. Strength
21	127/53	4.2	1.78	1.37	1.79		Fluid res & Temp. Strength
22	133/54	4.3	1.74	1.49	1.57		Fluid res & Temp. Strength
23	138/57	3.3	1.79	1.36	1.63		Fluid res & Temp. Strength
24	134/57	4.8	1.82	1.39	1.63		Fluid res & Temp. Strength
25	125/48	4.1	1.67	1.27	1.64		Fluid res & Humidity
26	124/57	5.9	1.72	1.29	1.71	Good	Fluid res & Humidity
27	123/46	4.2	1.60	1.25	1.63		Fluid res & Humidity
28	121/45	4.9	1.64	1.22	1.72		Fluid res & Humidity

Current leakage

Device #	Act/Rel	-35 mV Drop	Chassis leakage to housing [illegible]	[illegible] to housing [illegible]	Between [illegible]	Perf	Tests			
1B-15-29	123/47	3.7	1.66 nA	1.29 nA	1.44 nA	Good	Fluid res	& Humidity		
30	121/50	4.5	1.66	1.25	1.46		Fluid res	& Humidity		
31	125/36	4.7	1.65	1.24	1.61		Fluid res	& Salt Spray		
32	129/47	3.8	1.62	1.23	1.66		Fluid res	& Salt Spray		
33	121/57	5.2	1.74	1.34	1.70		Fluid res	& Salt Spray		
34	145/65	3.2	1.70	1.38	1.67		Fluid res	& Salt Spray		
35	121/51	3.4	1.67	1.27	1.77		Fluid res	& Salt Spray		
36	123/44	3.8	1.73	1.38	1.81		Fluid res	& Salt Spray		
37	125/53	3.8	1.90	1.49	1.59		Burst			
38	119/44	3.5	1.92	1.42	1.59		Burst			
39	134/60	3.5	1.66	1.31	1.58		Burst			
40	126/53	4.9	1.79	1.37	1.56		Burst			
41	130/52	3.3	1.59	1.23	1.51		Burst			
42	116/45	3.5	1.67	1.24	1.66		Burst			
43	121/40	3.8	1.68	1.23	1.64		Vibration			
44	127/47	5.7	1.60	1.20	1.65		Vibration			
45	117/33	3.6	1.56	1.23	1.65		Vibration			
46	123/49	3.4	1.59	1.21	1.63		Vibration			
47	135/62	6.8	1.65	1.24	1.63		Vibration			
48	122/45	4.1	1.68	1.32	1.49		Vibration			
49	139/65	3.5	1.61	1.21	1.43		Vacuum			
50	117/45	3.8	1.58	1.22	1.47		Vacuum			
51	Not used									
52	127/43	14.5	1.64	1.27	1.64	Good	Vacuum			
53	130/43	3.2	1.61	1.25	1.55		Vacuum			
54	122/50	5.0	1.67	1.29	1.67		Vacuum			
55	123/42	4.7	1.62	1.29	1.69		Vacuum			
56	127/47	5.7	1.63	1.29	1.72		Temp.	Cycle		
57	127/52	6.1	1.70	1.29	1.56		Temp	Cycle		
58	121/45	5.2	1.59	1.31	1.55		Temp	Cycle		
59	131/46	5.4	1.72	1.28	1.48		Temp	Cycle		
60	129/50	6.9	1.72	1.29	1.96		Temp	Cycle		
61	148/61	5.1	1.76	1.29	1.46		Temp	Cycle		
62	133/56	9.2	1.78	1.24	1.42		Impulse		Stopped @	135K
63	124/39	4.8	1.66	1.24	1.49		Impulse		Leak @	250K
64	138/53	5.2	1.69	1.25	1.41		Impulse		Stopped @	295K
65	132/55	7.9	1.69	1.25	1.44		Impulse		Leak @	151K
66	128/52	4.7	1.72	1.29	1.45		Impulse		Stopped @	159K
67	125/51	6.0	1.76	1.31	1.46		Impulse		Stopped @	394K
68	116/41	8.8	1.73	1.30	1.48		Impulse		Leak @	333K
69	124/47	10.0	1.79	1.34	1.45		Impulse		Leak @	369K
70	130/46	7.3	1.74	1.29	1.44		Impulse		Leak @	357K
71	133/45	6.7	1.78	1.26	1.43		Impulse		Leak @	358K
72	139/56	6.1	1.71	1.27	1.47		Impulse		Leak @	278K
73	139/59	3.9	1.69	1.27	1.47		Impulse		Leak @	370K
74	126/42	4.6	1.71	1.27	1.46					
75	128/59	5.3	1.73	1.28	1.50					
76	130/53	7.1	1.71	1.29	1.49					
77	130/52	7.2	1.75	1.30	1.47					
78	139/62	6.6	1.73	1.30	1.41					
79	124/42	5.4	1.76	1.29	1.49					
80	132/55	5.1	1.75	1.31	1.43					

770 K

Rebuild of Impulse parts / Post Cycle

Device #	Proof	Act/Rel	Hy Dev	Current leakage		
156-15-81	OK	105/53	51	1.81	1.53	1.80
-83	↓	111/53	111	1.90	1.60	1.77
-85		113/54	101	2.05	1.64	1.78
-87		108/55	47	2.14	1.66	1.70
-88		110/60	91	1.96	1.56	1.69
-91		120/64	56	1.88	1.56	1.80
-97		112/56	47	1.89	1.57	1.81
-98		110/53	114	1.91	1.56	1.80
-89		110/54	59	1.87	1.57	1.83
-92		109/55	42	1.93	1.58	1.74
-9		113/57	40	2.27	1.69	1.72
-93		116/60	47	2.03	1.58	1.66
-94		111/58	76	2.41	1.60	1.66
-96		115/56	45	2.18	1.64	1.67
-98		115/55	68	1.92	1.61	1.89
98		115/57	125	1.86	1.60	1.79
-97		115/57	111	2.20	1.68	1.78
97		112/60	104	1.75	1.52	1.73
99		114/58	128	1.96	1.64	1.75
100		109/57	86	1.93	1.64	1.80
101		115/56	108	1.78	1.47	1.73
103		117/58	97	2.05	1.61	1.76
-105		113/53	47	2.06	1.63	1.76
106	↓	112/52	132	2.17	1.65	1.73

Final Char

Device #	Test	Proof	Act/Rel	Hu/Dev	Current leakage		
156-15-01	Fluid Res & Impulse		Aborted				
02	Fluid Res & Impulse		↓				
03	Fluid Res & Impulse						
04	Fluid Res & Impulse						
05	Fluid Res & Impulse						
06	Fluid Res & Impulse						
07	Fluid Res & Impulse						
08	Fluid Res & Impulse						
09	Fluid Res & Impulse						
10	Fluid Res & Impulse						
11	Fluid Res & Impulse						
12	Fluid Res & Impulse		↓				
13	Fluid Res & Term Strength	OK	128/51	44	2.07	1.42	1.61
14	Fluid Res & Term Strength	↓	135/62	41	1.62	1.32	1.57
15	Fluid Res & Term Strength		125/53	45	1.71	1.36	1.55
16	Fluid Res & Term Strength		131/58	44	1.83	1.48	1.55
17	Fluid Res & Term Strength		125/48	49	1.62	1.34	1.54
18	Fluid Res & Term Strength		132/61	43	1.81	1.56	1.55
19	Fluid Res & Term Strength		133/60	46	1.90	1.43	1.54
20	Fluid Res & Term Strength		133/58	47	1.70	1.38	1.72
21	Fluid Res & Term Strength		137/59	43	1.81	1.44	1.53
22	Fluid Res & Term Strength		131/62	45	1.84	1.47	1.60
23	Fluid Res & Term Strength		135/64	48	1.87	1.56	1.60
24	Fluid Res & Term Strength	↓	135/63	42	1.70	1.40	1.66
25	Fluid Res & Humidity		141/58	4.1	1.79	1.57	1.78
26	Fluid Res & Humidity		131/62	5.0	2.08	1.57	1.71
27	Fluid Res & Humidity		131/63	5.1	2.04	1.65	1.71
28	Fluid Res & Humidity		125/59	10.1	2.2	1.51	1.57
29	Fluid Res & Humidity		133/58	5.9	1.87	1.58	1.73
30	Fluid Res & Humidity	↓	131/60	7.1	1.79	1.39	1.59

Device #	Test Sequence			Proof	Act/Rel	% Diff	Current Leakage CL-Housing	OP-Housing	OI-Contacts	
15145P-31	Fluid Res	Salt Spray		OK	124/41	41	1.68	1.47	1.65	
-32	Fluid Res	Salt Spray		↓	127/52	40	1.88	1.61	1.85	
-33	Fluid Res	Salt Spray		↓	125/59	42	1.71	1.43	1.64	
-34	Fluid Res	Salt Spray		↓	140/70	41	5.31	7.40	7.68	
-35	Fluid Res	Salt Spray		↓	125/57	41	1.68	1.48	1.66	
-36	Fluid Res	Salt Spray		↓	123/53	42	1.68	1.40	1.65	
-37	Burst			7800 (?)						
-38	Burst			7300						
-39	Burst			7810						
-40	Burst			7900						
-41	Burst			7700						
-42	Burst			7600						
-43	Vibration			OK	121/48	43	2.18	1.75	1.84	
-44	Vibration			↓	123/57	41	1.40	1.58	1.83	
-45	Vibration			↓	121/50	43	1.89	1.56	1.72	
-46	Vibration			↓	123/53	45	1.97	1.66	1.77	
-47	Vibration			↓	137/75	43	1.92	1.58	1.71	
-48	Vibration			↓	124/50	41	1.92	1.54	1.80	
-49	Vacuum			OK	114/67	3.2	1.97	1.60	1.63	
-50	Vacuum			OK	123/77	4.1	1.91	1.60	1.98	
-51	Not used									
-52	Vacuum			OK	118/47	17.0	1.95	1.49	1.88	
-53	Vacuum			OK	128/44	9.2	1.57	1.31	1.96	
-54	Vacuum			OK	123/55	6.5	1.82	1.54	2.13	
-55	Vacuum			OK	123/77	5.8	1.67	1.42	2.01	
-56	Temp Cycle			OK	123/53	5.6	1.47	1.27	1.75	
-57	Temp Cycle			OK	120/60	1.7	1.56	1.34	1.78	
-58	Temp Cycle			OK	110/51	5.2	1.68	1.43	1.76	
-59	Temp Cycle			OK	114/52	7.5	1.67	1.32	1.72	
-60	Temp Cycle			OK	115/57	6.6	1.70	1.43	1.71	
-61	Temp Cycle			OK	129/66	5.6	1.57	1.37	1.92	
-62	Impulse		Aborted							
-63	Impulse		↓							
-64	Impulse		↓							
-65	Impulse		↓							
-66	Impulse		↓							
-67	Impulse		↓							
-68	Impulse		↓							
-69	Impulse		↓							
-70	Impulse		↓							
-71	Impulse		↓							
-72	Impulse		↓							
-73	Impulse		↓							
-74	Not used									
-75	Not used									
-76	Not used									
-77	Not used									
-78	Not used									
-79	Not used									
-80	Not used									

Appendix 4.2.2
Burst data and Weibull

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 01-08-30		PAGE 44

FORM 5266

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS
****

SHAPE(BETA) PARAMETER	:	63.735
LOWER LIMIT	:	31.505 ← LOW EXTREME @ 90%
UPPER LIMIT	:	%128.93302917480 47
SCALE(THETA) PARAMETER	:	7768.737
LOWER LIMIT	:	7680.740 ← LOW EXTREME @ 90%
UPPER LIMIT	:	7857.741

[redacted]
[redacted] VALUES FOR SPECIFIED LEVELS OF RELIABILITY — USING LOW VALUES FOR β AND θ FROM ABOVE
****
* WEIBULL SLOPE :31.50
* CHARACTERISTIC LIFE : 7680.74

NO.	RELIABILITY(%)	[redacted]
1	72	7414.0854

TI-NHTSA 7538

Appendix 4.2.3
Vibration

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-06-20		PAGE 47

FORM 9295

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

DATE 8/5/91

REQUESTED BY Jeffrey D. Domenico

REQUIRED COMPLETION DATE ~~9/6/91~~ 9/9/91*

EXTENSION 3144 M/S 12-27

DEVICE ~~9446-001~~, 77PSL2-3

CHARGE DEPT. NO. 127 I.O. NO. 101060

REPORT NO. 0887-081

REFERENCE SPEC. NO. ES-F2VC-9F924-AA

TESTED BY Lab

SOURCE OF TEST SAMPLES Recies Lab

COMPLETION DATE 9-3-91

QUANTITY OF TEST SAMPLES ~~10~~ 12

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

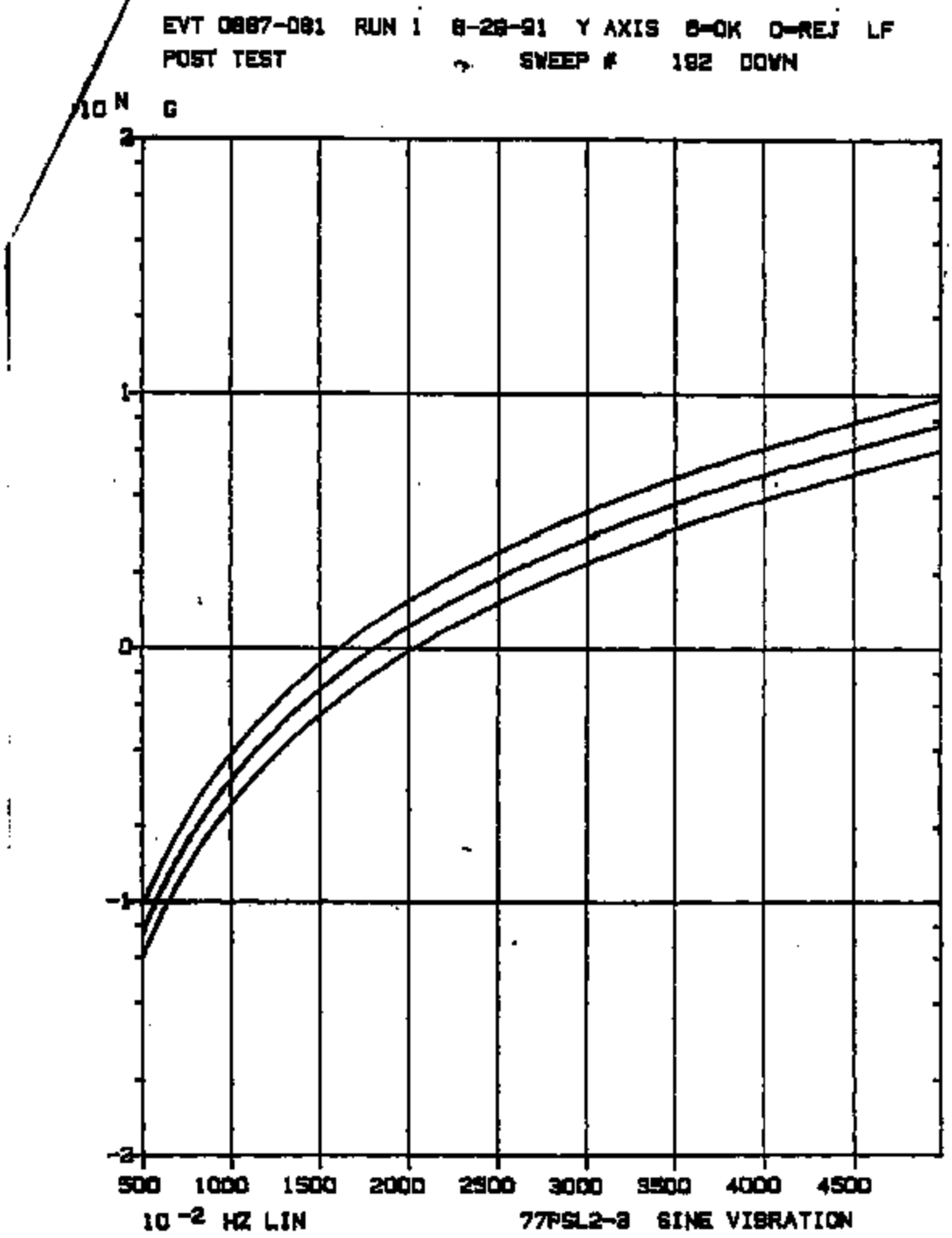
See attached, Vibration.

TEST PERFORMED: per attached specification.

TEST RESULTS:

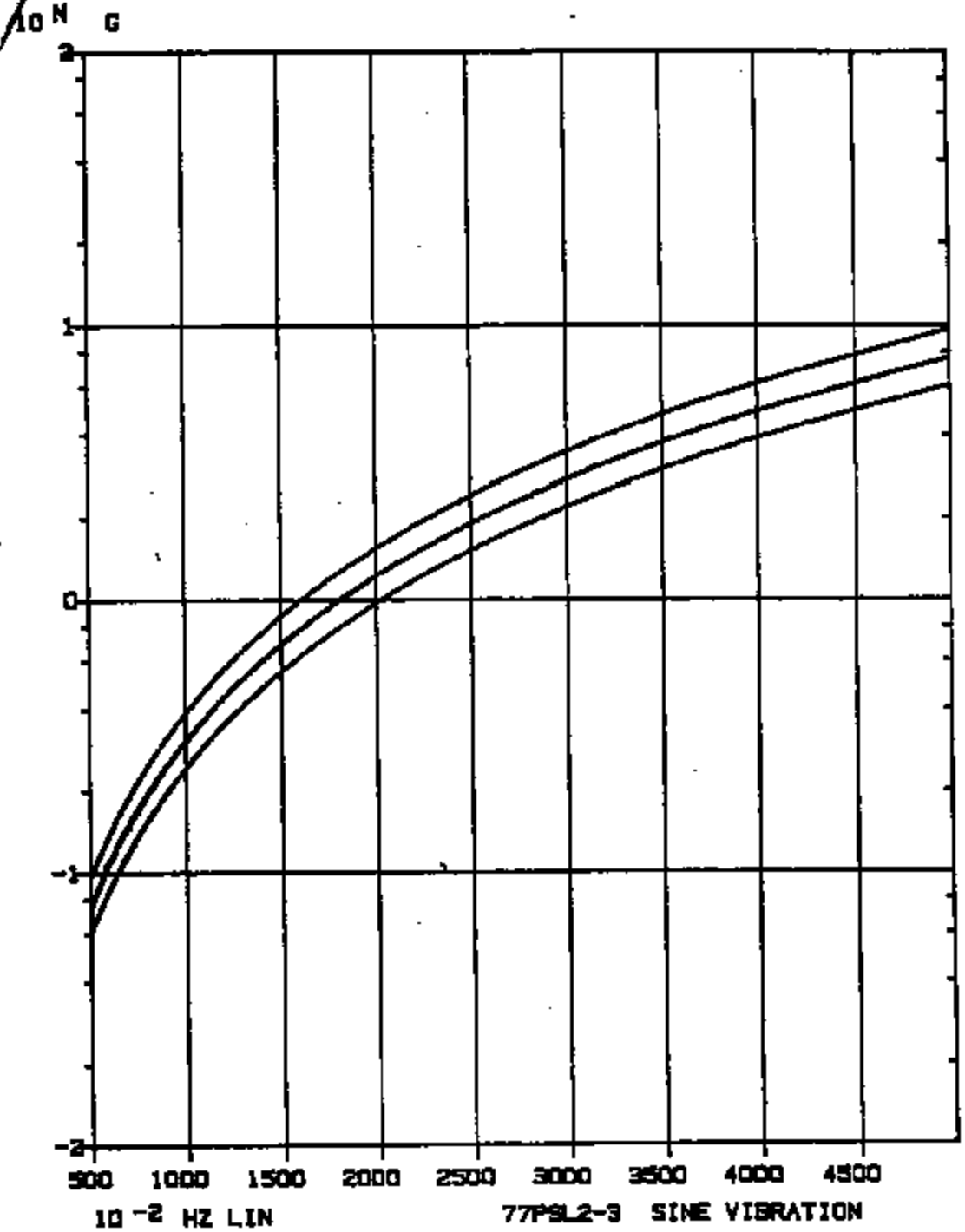
See attached sheets.

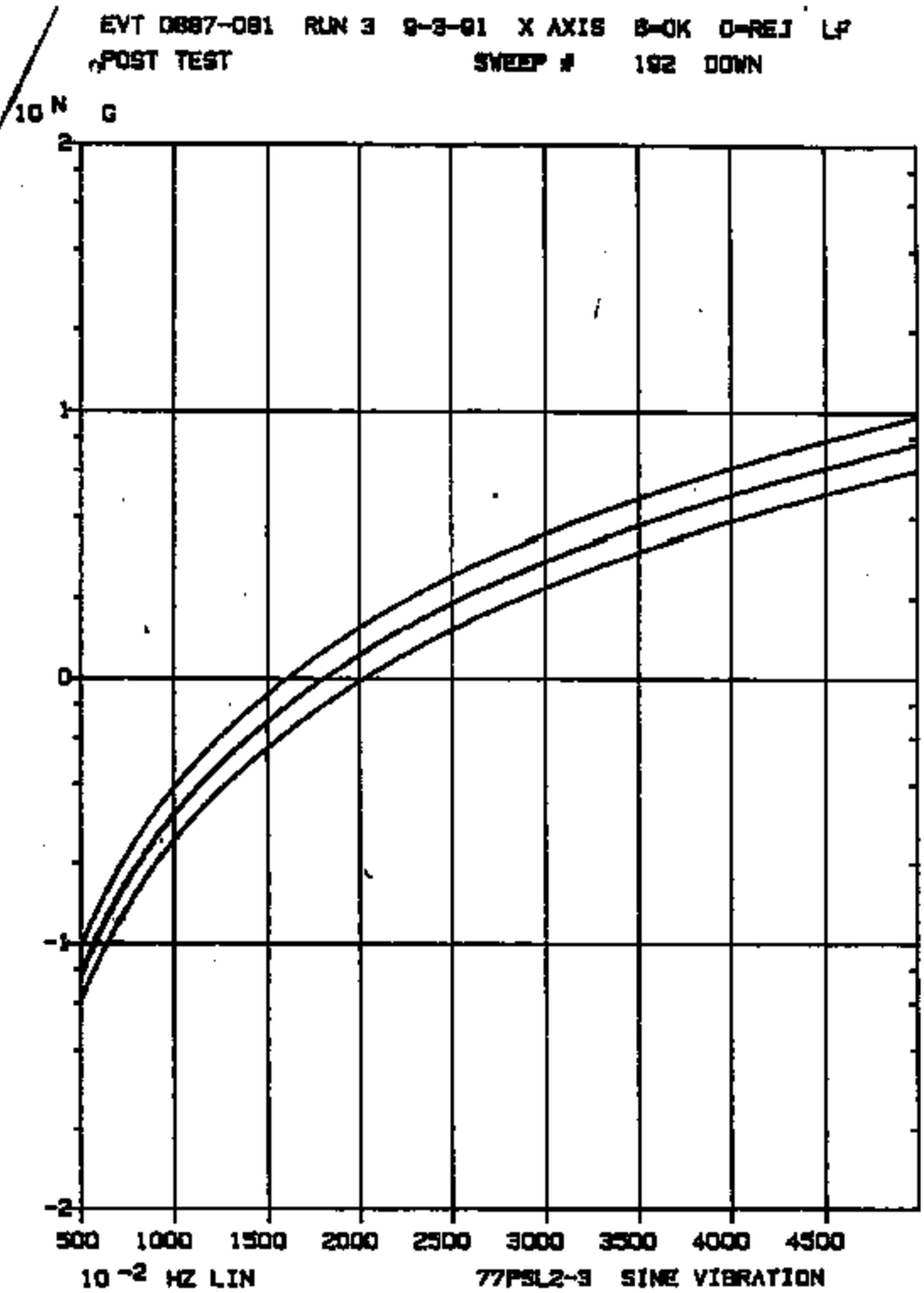
EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE:



TI-NHTSA 7541

EVT 0887-081 RUN 2 8-30-91 Z AXIS 6=OK 0=REJ LF
POST TEST SWEEP # 192 DOWN




EVT 0887-091 RUN 3 9-3-91 X AXIS G=OK O=REJ LF
POST TEST SWEEP # 192 DOWN
10 N G
2
1
0
-1
-2
500 1000 1500 2000 2500 3000 3500 4000 4500
10 -2 HZ LIN
77PSL2-3 SINE VIBRATION

Appendix 4.2.4
Thermal Cycle Day/Time/Temp

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS	DOC.
DATE 91-04-10	MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	PAGE 52

FORM 5285

77 PS Validation Testing

Temp. Cycle Test

(Low Setpt -42°C)

Cycle	1 Start Temp	2 Actual Temp	3 Time	4 Date	5	6 End Temp	7 Actual Temp	8 Time	9 Date	10	11	12	13
1	+40	+43	10:45	8/7/91		-43	-45	2:35	8/7/91				
2	43	43	1:05	"		-40	-46	2:10	"				
3	42	42	3:45	"		-42	-44	4:10	"				
4	40	40	7:35	"		-43	-44	9:15P	"				
5	41	40	7:35A	8/8/91		-41	-47	8:45	8/8/91				
6	39	41	9:20	"		-41	-44	10:15	"				
7	43	43	11:45	"		-42	-44	12:50	"				
8	41	42	1:30	"		-42	-44	3:00P	"				
9	40	43	3:20	"		-40	-45	4:40P	"				
10	42	43	5:05P	"		-42	-44	6:30P	"				
11	42	43	7:35P	"		-43	-44	9:35P	"				
12	40	43	7:50A	8/9/91		-40	-44	9:05	8/9/91				
13	42	42	9:30A	"		-40	-44	10:40	"				
14	42	43	11:15A	"		-42	-44	12:40	"				
15	42	42	1:10P	"		-40	-44	2:25	"				
16	41	43	3:45	"		-40	-44	4:00	"				
17	40	43	9:35	"		-40	-44	5:35	"				
18	41	42	11:40A	8/10/91		-43	-44	2:55P	8/10/91				
19	41	42	3:00P	"		-42	-44	4:35	"				
20	40	42	5:20P	"		-42	-44	7:15P	"				
21	43	42	8:40A	8/11/91		-43	-44	4:50P	8/11/91				
22	43	42	5:15	"		-41	-44	6:45	"				
23	40	42	7:50	8/12/91		-40	-44	9:05	8/12/91				
24	40	43	9:50	"		-40	-45	11:05	"				
25	40	43	11:50	"		-40	-44	1:05	"				
26													
27													
28													
29													
30													
31													

Appendix 4.2.5
Fluid Resistance Test

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 91-09-20		PAGE 54

FORM 8268

FORM NO. 1A002 1/86

TEST NO. 107831

TECHNICAL SERVICE LABS 8/27/91

TEST NO. 107831

COST CENTER	[redacted]	[redacted]	INFORMATION [redacted]
ACCT NO.	[redacted]		
REQUESTOR	[redacted]		
MAIL STATION	1727		
EXTENSION	3177		
DATE REQUIRED	9/6/91		
NO. OF SAMPLES	72		
COMPOSITION	Mixed		

REPORT OF RESULTS:

complete

DATE RECEIVED 8/28/91 DATE OUT 9-5

EMPLOYEE NO.									
JOB NO.									
NO. ANALYZED									
HOURS WORKED									

Appendix 4.2.6
Humidity

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-05-29		PAGE 56

FORM 6298