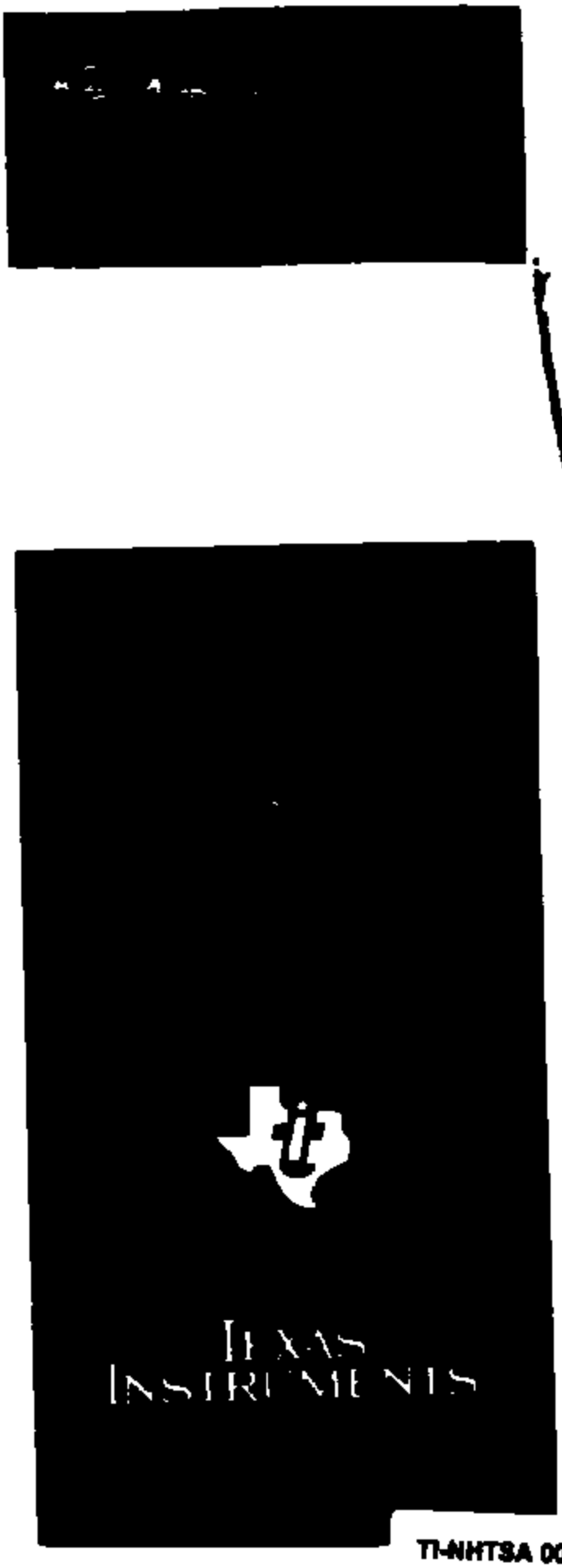

PS/91/25

REPORT OF ISIR TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH

TEXAS INSTRUMENTS INCORPORATED
CONTROL PRODUCTS DIVISION
PRECISION CONTROLS DEPARTMENT
34 FOREST STREET MS12-29
ATTLEBORO, MA 02703

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SEC.
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TABLE OF CONTENTS

1.0 **GENERAL**

1.1 Releasing Office: Ford Motor Company, Passenger Car Brake Systems Engineering

1.2 TI Part Number: 57PSL5-3

1.3 Customer Part Number: F2VC-9F924-BA

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

1.5 Applicable SREA(s): # 147660

1.6 Date of Completion: 90-12-13

1.7 Quantity of Units Tested: 72

1.8 Disposition of Tested Units:

1.8.1 One device, 99-15-31, was autopsied

1.8.2 Six devices were destroyed during Burst Test 3.5)

1.8.3 The remainder (qty. 65) are held in quarantine at TI

1.9 TI test series number: 99-15-80

2.0 TI Pressure Switch test report number: PS/91/25

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
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2.0 OBJECTIVE

This battery of tests was performed to demonstrate the ability of 57PSL5-3 to conform to specifications, in fulfillment of the requirements of the Initial Sample Inspection Report. Units tested were built using production components and production assembly equipment.

The SAE J512 metal-to-metal inverted flare hydraulic seal used on the hexport continues to be optimized by TI, Ford, and Tier-1 suppliers' engineers. Recently, the SAE committee which maintains J512 became involved. (See Appendix 4.4) The dimensional study of the J512 specification has highlighted areas of potential improvement, which is currently in review by Ford. However, in order to meet Ford's current needs, the hexport is produced to the present J512 specification by modifying standard production hexports (TI P/N 27373-1 used on 57PSF3-3 and 57PSF3-5). These parts were then plated by the end producer, Eico Industries Inc., Rockford, IL., to the TI production plating specification.

One SREA (see Appendix 4.5) which relates to this test has been filed. The final production switch will utilize a fuel-injector-style connector (may also be known as a "minitimer" or "Bosch-style") with a new, offset polarity key to foolproof. At the time this testing was started, offset-key mating connectors (i.e. harness-side) were unavailable. This SREA granted permission to conduct all testing with standard 57PS-series centered-key switch housings, production validated in 1984.

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 were subject to an initial characterization consisting of Calibration, Voltage Drop, Current Leakage, and Proof. Devices were then divided into groups per the flow chart and subject to the indicated tests in the indicated order. Finally, all tested devices were subject to a final characterization which was identical to the initial characterization.

No failure to meet given acceptance criteria was observed for any test. All switches passed.

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 30 - 160 psig, and release (contacts reclosing) at 20 psig minimum. Actuation values are recorded on the sixth cycle, after subjecting the switch to two (2) pressure cycles to 900 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 devices tested were found to be within specification.

3.1.4 **Final Results:** 66 surviving devices (6 destroyed in 3.5 Burst) were found to be within specification.

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 10.5 millivolts, and the standard deviation was 2.6. All values are significantly below the specification of 200 millivolts maximum.

3.2.3 Final results: The average voltage drop was 10.4 millivolts, and the standard deviation was 2.9.

TEST LOT NO.	TEST	REVISE
TESTED BY		
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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 8?2?B Digital Multimeter, calibrated quarterly, used to measure voltage drop across a series resistance of one megohm +-- 5%).

3.3.2 Initial results: Information could be obtained directly from inspection of the data without a need to calculate statistics. Measuring terminals to case with switch closed; measuring terminals to case with switch open; and measuring between the terminals: in no case did the leakage current exceed 1.99 microamps. All values are significantly below the specification of 100 microamps.

3.3.3 Final results: Again, no statistics. Same three measurements as 3.3.2. With the exception of three out of ?2 parts. typical current leakage values are essentially unchanged from initial results. Three parts, all undergoing Fluid Resistance Test 3.9 and Salt Spray Test 3.13, exhibited values elevated from the typcial. One was (approx.) 63.7 microamps. one was (approx.) 8.0 microamps, and one was (approx.) 4.4 microamps. The 63.7 microamp device, 99-15-31, was carefully autopsied. Before any disassembly took place, an external investigation showed a very small amount of unidentified pink-color liquid inside the connector housing. The hypothesis is that this liquid was some mixture of fluids from the Fluid Resistance Test 3.9. One possible entrance path for the fluid is past the seal on the mating connector; another, highly unlikely path is directly through the plastic housing. Upon disassembly of the device, minute evidence of the same reddish fluid was detected inside the switch cavity; however, the initial and final millivolt drop measurements (test 3.2) demonstrate no abnormality in electrical switching properties.

Current leakage for all devices was below the spec. of 100 microamps. All devices passed.

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) Hi-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.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
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3.5 BURST

3.5.1 Devices tested: 99-15-37 thru 86-15-42.

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. 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 Enerpac 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. Pressure was then increased until the failure point defined in 3.5.2. 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 33.97 and a minimum Characteristic Life (theta) of 8829.6 psig was calculated at 90% confidence. The 0.72 reliability at 90% confidence is 8544.9 psi. Thus, the parts exceed the burst specification of 7000 psig by 1544.9 psi.

3.6 VIBRATION

3.6.1 Devices tested: 99-15-43 thru 99-15-48.

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. E. 2.).

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DSC.
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3.7 VACUUM

3.7.1 Devices tested: 99-15-49 thru 99-15-54.

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. 2.1.

TEST LOT NO.	TEST	DEVICE
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3.8 TEMPERATURE CYCLE

3.8.1 Devices tested: 99-15-55 thru 99-15-60.

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 0-1500 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: 99-15-01 thru 99-15-36.

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, -01 thru -12

3.9.3.2 Terminal Strength, -13 thru -24.

3.9.3.3 Humidity, -25 thru -30.

3.9.3.4 Salt Spray, -31 thru -36.

3.10 IMPULSE

3.10.1 Devices tested: 99-15-01 thru 99-15-12 from Fluid Resistance test 3.9 and 99-15-61 thru 99-15-72 virgin devices.

3.10.2 Procedure: All 24 devices actually ran 525,001 pressure cycles. The first 475,000 is done unpowered, with the Switch Monitor Circuit functioning. From 475,001 thru 500,000 cycles one-half of the 24 devices are powered. This is due to the fact that the Load Bank only has 12 stations for cost, size, and weight considerations. From 500,001 thru 525,000 cycles the other half are powered.

3.10.3 Equipment: same as 3.8.2 with the addition of a custom TI designed and built 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: All twenty-four 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 Mz), 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: 99-15-13 thru 99-15-24.

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 assembly line in testing to TI Quality Assurance Specification 296 (see Appendix 4.3).

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		
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3.12 HUMIDITY

3.12.1 Devices tested: 99-15-25 thru 99-15-30.

3.12.2 Equipment: Humidity chamber RK model ES.

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.).

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.13 SALT SPRAY

3.13.1 Devices tested: 99-15-31 thru 99-15-36.

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		
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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	SPEC.
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Ford Engineering Specification

ART NAME

SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE

PART NUMBER

▽ ES-F2TC-9F924-AA

DATE	LET	FR	REVISIONS	DR	CK

REFERENCE

PREPARED/APPROVED BY

CHECKED BY

DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR

DESIGN ENGINEERING ASST

MANUFACTURING ENGR

QUALITY CONTROL

PURCHASING

SUPPLIER QUALITY ASSURANCE

ELECTRONICS DIVISION

FRAME 1 OF 18

REV

▽ ES-F2TC-9F924-AA

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.

QI 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-PROGRESS IP-1 Minimum Sample Size	IN-PROGRESS IP-1 Statistical Test Acceptance Criteria	IN-PROGRESS IP-2 Minimum Sample Size	IN-PROGRESS 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/No	P90 .84	4/Lot	" " "
C	Current Leakage	72	P90-.96	3/No	P90 .56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/No	P90 .84	4/Lot	" " "
F	Burst	6	P90-.72	3/No	P90 .56	4/Lot	" " "
I	Vibration	6	P90-.72	3/No	P90 .56	6/6 No	P90 .72
J	Terminal Strength	12	P90-.84	6/No	P90 .72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/No	P90 .56	6/6 No	P90 .72
L	Temperature Cycle	6	P90-.72	3/No	P90 .56	6/6 No.	P90 .72
M	Fluid Resistance	36	P90-.94	36/12No	P90 .94	36/12No	P90 .94
	Durability Tests						
III							
	Impulse	24	P90 .90	12/No	P90 .84	3/3 No	P90 .56
	Humidity	6	P90 .72	3/No	P90 .56	6/6 No	P90 .72
H	Salt Spray	6	P90 .72	1/No	P90 .56	6/6 No	P90 .72

PRODUCTION VALIDATION FLOW CHART

'2 TEST SAMPLES

III. A. CALIBRATION
B. VOLTAGE DROP
C. CURRENT LEAKAGE
D. PROOF TEST

'2

36

III. N. FLUID RESISTANCE

16

6 | 6 | 6 | 6 | 12 | 12 | 12 | 6 | 6

III. F. BURST | III. I. VIBRATION | III. K. VACUUM | III. L. TEMPERATURE CYCLE | III. M. DUPLEX | III. J. TERMINAL STRENGTH | III. G. HUMIDITY | III. H. SALT SPRAY

5 | 6 | 6 | 6 | 24 | 12 | 6 | 6

ALL MUST PASS

66

III. A. CALIBRATION
B. VOLTAGE DROP
C. CURRENT LEAKAGE
D. PROOF TEST

66

ALL MUST PASS

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) microampere

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 0 - 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.

3. 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 1.5 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 1.5 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 ± 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.

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.

V. 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 as the statistical test acceptance criteria stated for tests with 100% frequency or samples from lots, which could have a variable size.

VI. 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, N.

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 Form C-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 3

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.

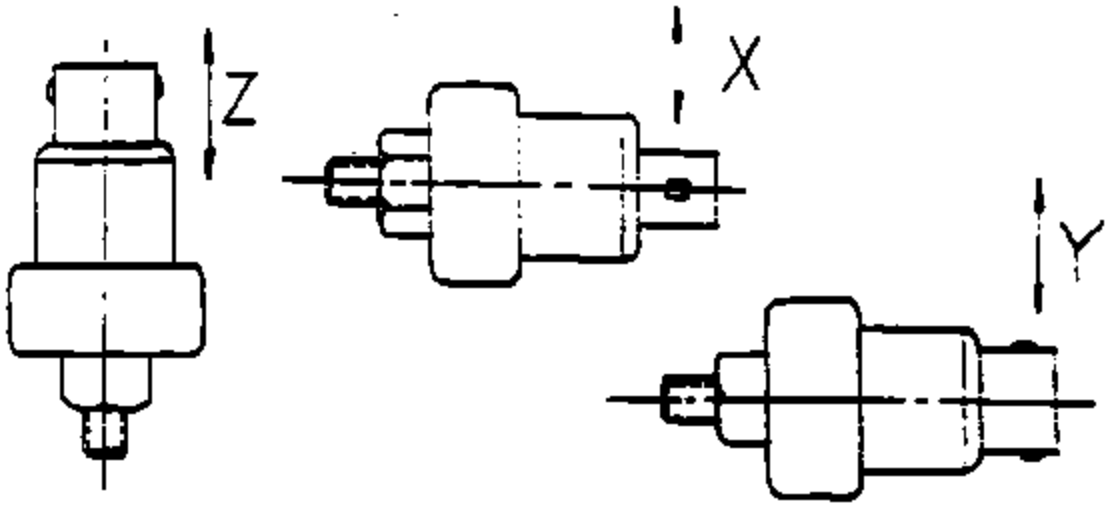
IX. COMPILATION OF REFERENCE DOCUMENTS

ASTM B-117. Salt Spray Testing

Ford Q-101. Quality System Standard 1992 Edition

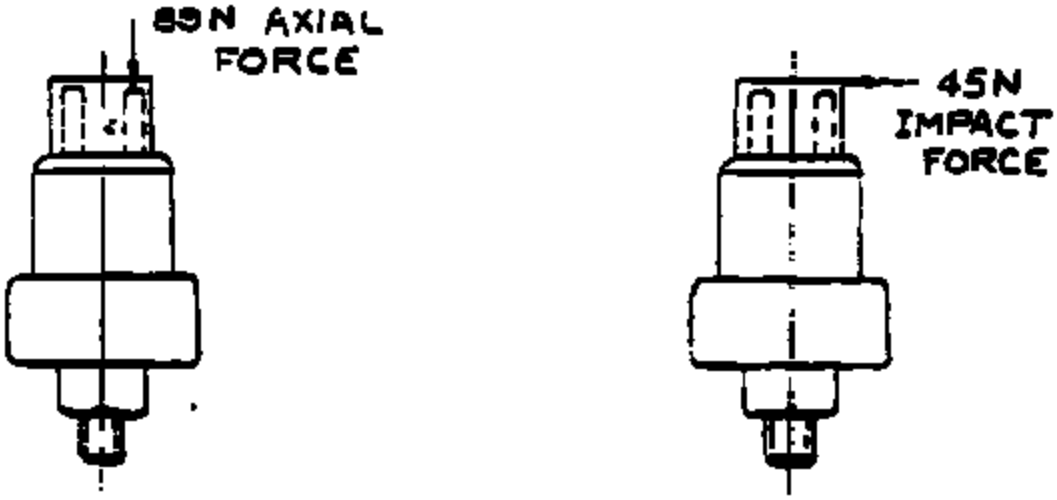
ES-F0EB-14A464-AA. Specification - SLV Assy - Wire Connector

ES-F2VF-9C735-AA. Specification - Servo Assembly Speed Contro.



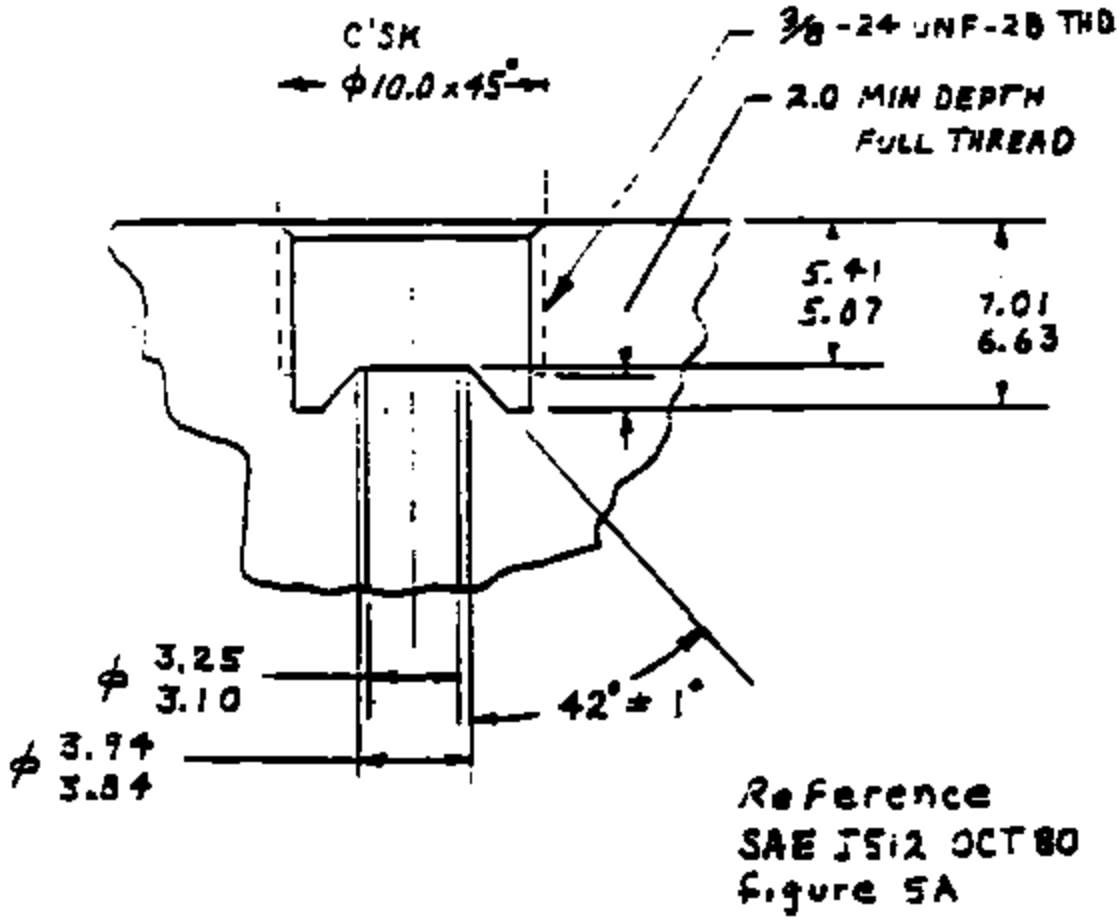
VIBRATION TEST - SWITCH ORIENTATION

FIGURE 1.



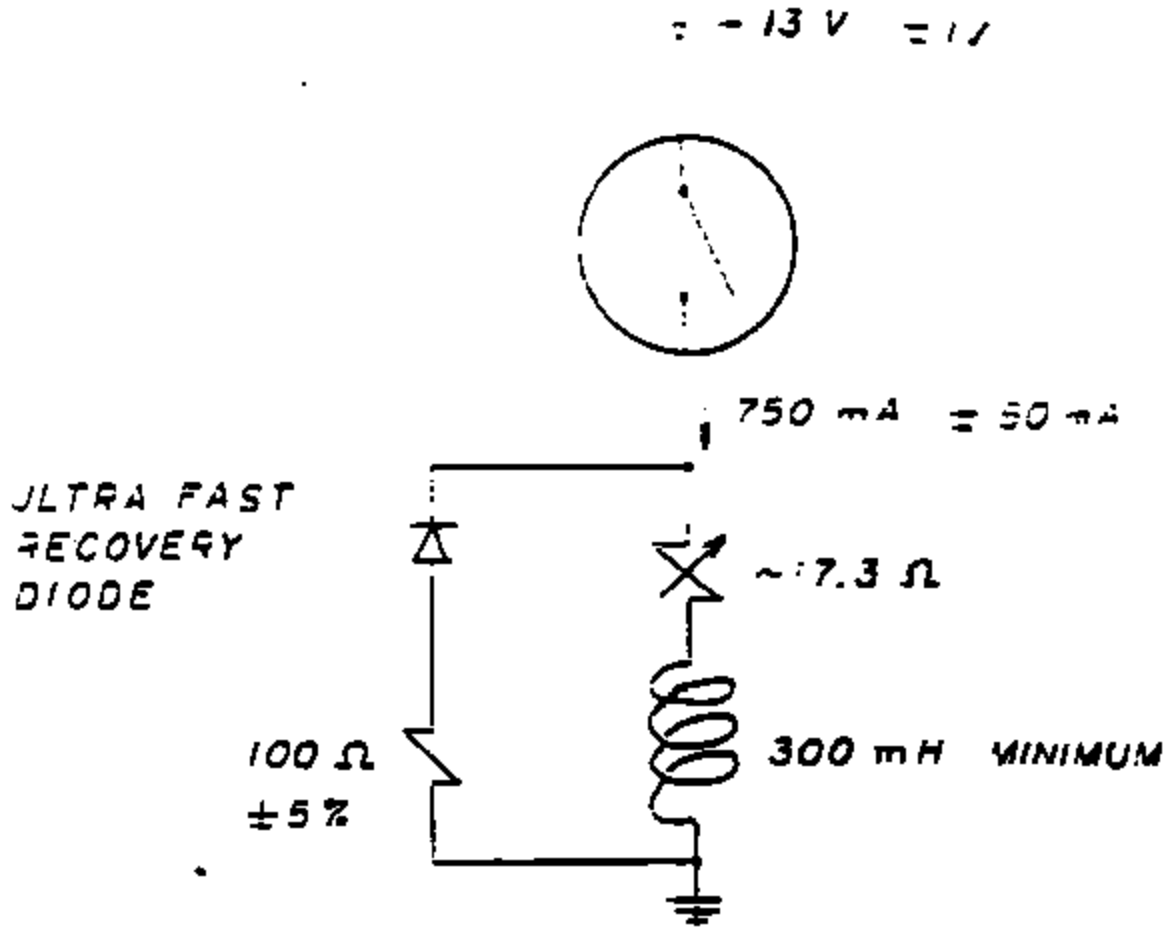
TERMINAL STRENGTH - LOAD ORIENTATION

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 91-01-11		PAGE 14

FORM 8295

PRESSURE SWITCH DATA FORM 21605 TEST NO. 99-5-80

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMP. DATE
-5X3423	10-18-90	S OFFICER	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
RAUGHERI	10-19-90	11-13-90	

PROJECT TITLE: FORD PASS-CAR REVALIDATION

CUSTOMER: FORD

PURPOSE OF TEST: PASS-CAR QUALIFICATION

PROCEDURE: SEE FORD ENGINEERING SPEC

	CHARACTERIZATION				HYST				
DEVICE NO	PROOF	ACT	PEL	mV	TO CASE TO CLOSE	TO CASE TO OPEN	BETWEEN TRIPS	TC'S	
99-5-01	PASS	123 psig	50 psig	12.30	1.778	1.295	1.517		
02		114	50	12.05	1.662	1.313	1.520		
03		116	49	12.00	1.690	1.318	1.539		
04		128	55	12.88	1.728	1.336	1.595		
05		119	53	12.12	1.692	1.326	1.520		
06		118	51	12.67	1.721	1.400	1.569		
07		122	53	13.31	1.661	1.331	1.652		
08		120	52	12.71	1.720	1.396	1.607		
09		129	52	13.19	1.685	1.328	1.609		
10		113	56	12.25	1.723	1.421	1.765		
11		117	48	12.99	1.697	1.352	1.632		
12		118	54	13.44	1.707	1.351	1.661		
13		106	45	13.60	1.665	1.348	1.566		
14		119	52	14.03	1.673	1.346	1.610		
15		123	51	13.45	1.741	1.395	1.676		
16		115	50	14.62	1.675	1.369	1.704		
17		123	52	12.55	1.660	1.318	1.561		
18		118	53	11.91	1.682	1.329	1.653		
19		125	55	12.30	1.660	1.326	1.654		
20		122	51	12.67	1.639	1.312	1.651		
21		120	51	12.41	1.695	1.346	1.616		
22		113	53	13.54	1.708	1.378	1.630		
23		113	49	2.07	1.632	1.290	1.542		
24		119	55	13.86	1.684	1.380	1.601		
25		126	52	13.50	1.668	1.305	1.630		HIGH SET
26		116	53	13.29	1.618	1.300	1.596		
27		119	53	13.30	1.665	1.340	1.633		

(OVER)

DEVICE NO	PCASE	Ac-	Rcc	mVD	TO CASE BY CASE	TO CASE 3rd [illegible]	BETWEEN TERMINALS	TCS	—
99-15-28	PASS	125mg	52mg	12.30	1.619	1.300	[illegible]	[illegible]	[illegible]
29	"	125	50	12.30	1.626	1.303	[illegible]		
30	"	140	56	13.11	1.622	1.29[illegible]	[illegible]		
31	"	118	52	12.57	1.666	1.300	[illegible]		SALT SPRAY
32	"	125	54	12.22	1.773	1.35[illegible]	[illegible]		
33	"	127	50	11.86	1.706	1.328	[illegible]		
34	"	124	53	11.48	1.615	[illegible]	[illegible]		
35	"	121	52	12.55	1.617	1.307	[illegible]		
36	"	123	55	11.27	[illegible]	[illegible]	1.601	"	"
37	"	102	49	[illegible]	[illegible]	[illegible]	[illegible]	BURST	1000[illegible]
38	"	147	55	[illegible]	1.603	1.720	[illegible]		8900
39	"	145	56	8.47	[illegible]	1.706	[illegible]		8900
40	"	143	57	8.16	[illegible]	[illegible]	[illegible]		8700
41	"	143	60	[illegible]	[illegible]	1.716	[illegible]	"	9000
42	"	142	64	8.80	1.773	[illegible]	[illegible]	"	8600
43	"	119	52	[illegible]	[illegible]	1.752	[illegible]	[illegible]	
44	"	117	48	9.17	[illegible]	[illegible]	[illegible]	-	
45	"	[illegible]	50	[illegible]	[illegible]	[illegible]	[illegible]	-	
46	"	[illegible]	48	9.01	[illegible]	[illegible]	[illegible]		
47	"	110	51	[illegible]	[illegible]	[illegible]	[illegible]	-	
48	"	120	45	[illegible]	[illegible]	[illegible]	[illegible]		
49	"	142	60	8.29	[illegible]	1.717	[illegible]	VACUUM	
50	"	142	54	8.16	1.778	1.708	[illegible]	"	
51	"	140	57	8.03	[illegible]	1.718	[illegible]	"	
52	"	139	60	8.02	[illegible]	[illegible]	[illegible]	"	
53	"	137	53	8.01	1.715	1.701	[illegible]	"	
54	"	142	61	8.31	1.713	[illegible]	[illegible]	"	
55	"	125	53	8.06	[illegible]	[illegible]	1.909	TEMP CYCLE	
56	"	[illegible]	51	8.25	[illegible]	1.726	[illegible]		
57	"	131	50	[illegible]	[illegible]	[illegible]	[illegible]		
58	"	138	53	[illegible]	1.709	1.726	[illegible]		
59	"	129	57	8.27	[illegible]	1.732	[illegible]	"	
60	"	[illegible]	57	[illegible]	[illegible]	[illegible]	[illegible]	"	
61	"	136	53	[illegible]	[illegible]	1.667	[illegible]	[illegible]	
62	"	132	61	8.37	[illegible]	[illegible]	[illegible]		
63	"	136	51	[illegible]	[illegible]	[illegible]	[illegible]		
64	"	136	53	[illegible]	[illegible]	[illegible]	[illegible]		
65	"	139	59	7.70	[illegible]	1.711	[illegible]		
66	"	13-	55	[illegible]	[illegible]	[illegible]	[illegible]		
67	"	137	55	8.31	[illegible]	[illegible]	[illegible]		
68	"	135	66	[illegible]	[illegible]	[illegible]	[illegible]		
69	"	136	56	8.10	[illegible]	1.703	[illegible]		
70	"	135	61	[illegible]	1.780	[illegible]	[illegible]		
71	"	121	49	[illegible]	[illegible]	1.711	[illegible]		
72	"	132	55	9.41	1.735	1.725	[illegible]		
73	"							[illegible]	[illegible]
74	"								
75	"								
76	"								
77	"								
78	"								
(EXTRA) 79	"	133	43	8.46	[illegible]	1.708	1.891		

FINAL CHARACTERIZATION - [illegible]

DEVICE NO	POST PROC	ACT	REC	MID	TO CASE SW CLSD	TO CASE SW OPEN	BETWEEN CLOSURES	E S	T S
99-15-01	PASS	113 010	62 min	9.58 mA	1.926	1.798	1.806	SHARES	SOMEWHAT
02	"	107	56	9.25	1.891	1.752	1.967		
03		113	52	10.01	1.965	1.847	1.903		
04		119	61	6.66	1.939	1.790	332		
05		112	60	9.19	1.924	1.776	3.300		
06		107	55	10.31	1942	1.786	929		
07		116	55	18.11	1.503	1.786	.966		
08	"	121	62	9.97	1.942	1.793	.951		
09	"	120	56	12.41	1.942	1.793	1.041		
10	"	119	57	9.29	1.788	1.697	3.396		
11	"	110	54	9.37	1.892	1.746	1.925		
12	"	110	60	9.47	1.913	1.772	4 SEC		
13	PASS	112	47	8.56	1.893	1.837	1.951		SAME AS
14		122	52	7.41	1.952	1.891	2.057		
15	"	126	53	8.89	1.924	1.825	1.930	"	
16	"	125	51	7.63	1.905	1.777	1.938	"	
17	"	129	51	8.50	1.906	1.786	1.934	"	
18		124	52	7.04	1.902	1.713	1.940	"	
19		134	57	8.77	1.926	1.806	1.931	"	
20		129	49	9.05	1.919	1.836	1.977	"	
21	"	127	51	8.93	1.908	1.789	1.944	"	
22		114	57	9.65	1.979	1.835	1.931	"	
23	"	121	46	8.93	1.939	1.798	1.935	"	
24	"	124	55	8.79	1.952	1.851	2.036		
25	PASS	135	53	9.11	1.959	1.817	1.969	"	HARDLY
26	"	127	52	8.97	2.030	1.877	1.951	"	
27		133	54	10.59	1.976	1.822	1.923	"	
28		135	57	7.57	1.959	1.817	1.902	"	
29		134	54	9.36	1.957	1.826	1.962	"	
30		131	49	9.12	1.960	1.819	1.947	"	
31	PASS	126	53	9.07	63.700	63.700	63.700	"	SAME AS
32		129	52	8.65	1.919	1.865	1.932	"	
33		135	51	7.24	4.210	4.352	4.242	"	
34		131	52	9.05	1.824	1.709	1.705	"	
35		126	52	9.53	1.946	1.845	1.897	"	
36	"	128	53	8.57	8.350	7.460	8.360	"	
37	—	—	—	—	—	—	—	BURST	
38	—	—	—	—	—	—	—	"	
39	—	—	—	—	—	—	—	"	
40	—	—	—	—	—	—	—		
41	—	—	—	—	—	—	—		
42	—	—	—	—	—	—	—	"	
43	PASS	114	45	9.24	1.953	1.792	1.915	VIBRATION	
44		113	45	8.55	1.928	1.795	1.926	"	
45	"	103	46	9.43	1.926	1.783	1.927	"	
46	"	102	46	7.27	1.892	1.802	1.928	"	
47		116	49	8.04	1.926	1.823	1.923	"	
48		117	54	9.45	1.893	1.798	1.937	"	
49	PASS	145	41	8.49	1.891	1.782	1.850	VACUUM	
50		142	44	9.44	1.926	1.807	1.936	"	
51		133	37	6.83	1.918	1.786	1.916	"	
52		139	43	9.82	1.948	1.800	1.938	—	—
53	"	143	34	8.79	1.929	1.795	1.938	"	"
54	"	147	37	8.82	1.962	1.827	1.923	"	"
							—	—	—

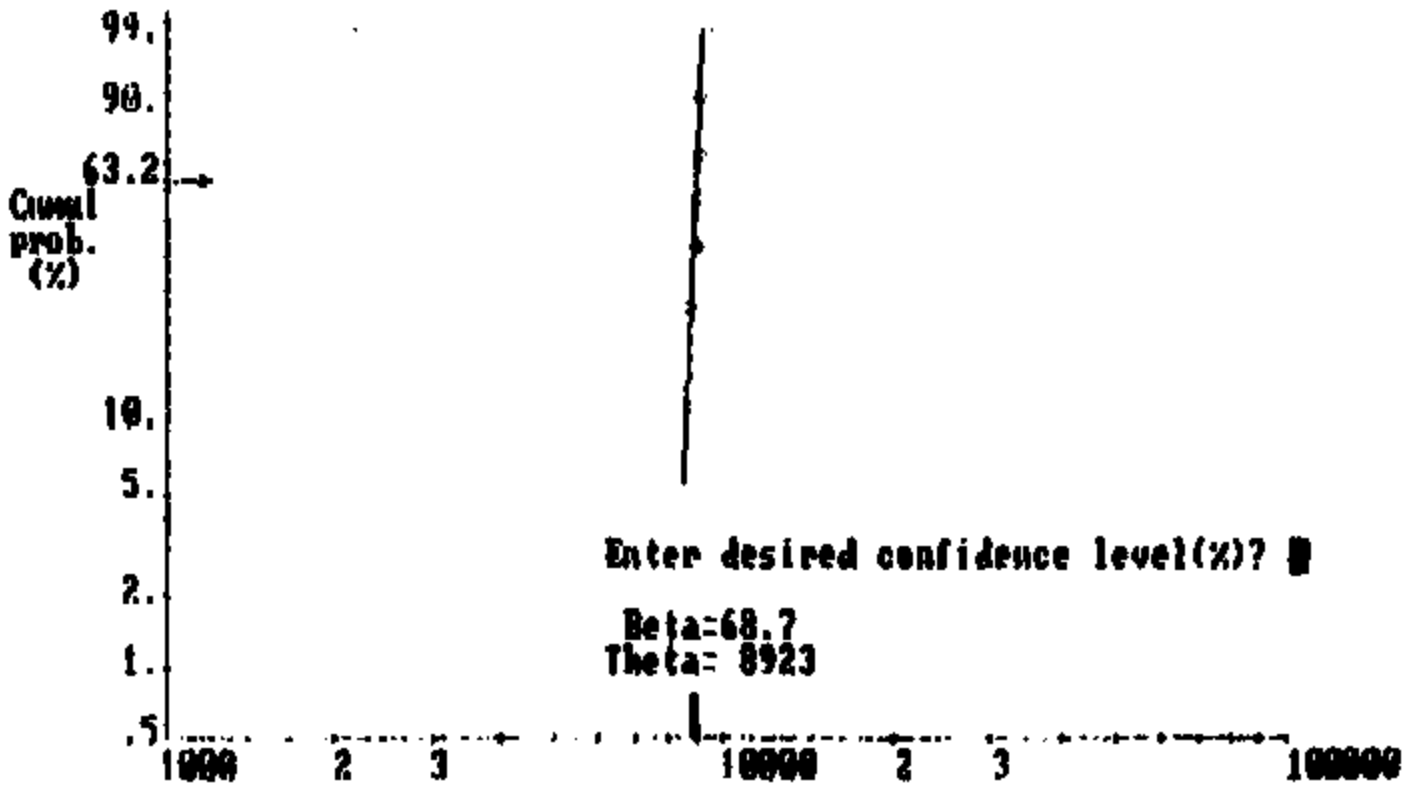
FINAL CHARACTERIZATION - HYPOT (CONT).

DEVICE NO	POST PROOF	ACT	REL	mVD	TO CASE SW CLSD	TO CASE SW OPEN	BETWEEN TERMS	TESTS
99-15-55	PASS	119 ASM	56 ASM	9.23 mV	1.957	1.889	1.912	FEED CIRCLE
56	"	125	52	8.93	1.981	1.869	1.904	"
57	"	124	55	8.70	1.972	1.793	1.910	"
58	"	130	63	9.31	1.885	1.864	1.896	"
59	"	123	58	8.78	1.955	1.875	1.913	"
60	"	118	57	9.79	1.883	1.802	1.860	"
61	PASS	130	61	14.11	1.933	1.780	1.939	INVOLVE
62	"	133	66	11.62	1.950	1.793	1.944	"
63	"	133	64	12.93	1.878	1.756	1.925	"
64	"	126	64	20.25	1.932	1.804	1.897	"
65	"	134	70	20.79	1.949	1.793	1.905	"
66	"	120	61	15.10	1.870	1.72	1.837	"
67	"	132	61	10.26	1.865	1.717	1.939	"
68	"	133	67	11.91	1.880	1.76	1.908	"
69	"	131	63	14.50	1.903	1.746	1.911	"
70	"	137	64	19.01	1.931	1.778	1.935	"
71	"	121	56	12.76	1.902	1.767	1.926	"
72	"	128	63	17.01	1.893	1.735	1.857	"

Appendix 4.2.2
Burst test Weibull

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 43

FORM 5298



TI-NHTSA 00197

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

SHAPE(BETA) PARAMETER	:	58.720 (median)
LOWER LIMIT	:	33.970 (low extreme @ 90%)
UPPER LIMIT	:	[illegible]
SCALE(THETA) PARAMETER	:	8923.360 (median)
LOWER LIMIT	:	8829.575 (low extreme @ 90%)
UPPER LIMIT	:	9018.143

RELIABILITY VALUES FOR SPECIFIED LEVELS OF RELIABILITY
****

* WEIBULL SLOPE :33.97
* CHARACTERISTIC LIFE : 8829.58

NO.	RELIABILITY(%)	TIME
1	72	8544.9170

Appendix 4.2.3
Vibration

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO MA 02703	DOC.
DATE 91-01-11		PAGE 14

FORM 5298

Form 9819

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/02/90

REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 11/09/90

EXTENSION 3469 MS 12-29

DEVICE 57PSL5-3

CHARGE DEPT. NO. 127 I.O. NO. 101093

REPORT NO. 1282-110

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

TESTED BY Lab

SOURCE OF TEST SAMPLES DESIGN LAB

COMPLETION DATE 11-26-90

QUANTITY OF TEST SAMPLES 6

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN VIBRATION TEST PER ATTACHED. THESE DEVICES ARE 160 PSI MAX ACTUATION, THUS I.L.C PRESSURE IS (1.1)(160 psi) = 176 psi.

TEST PERFORMED:

Per above.

TEST RESULTS:

See attached

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE:

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.

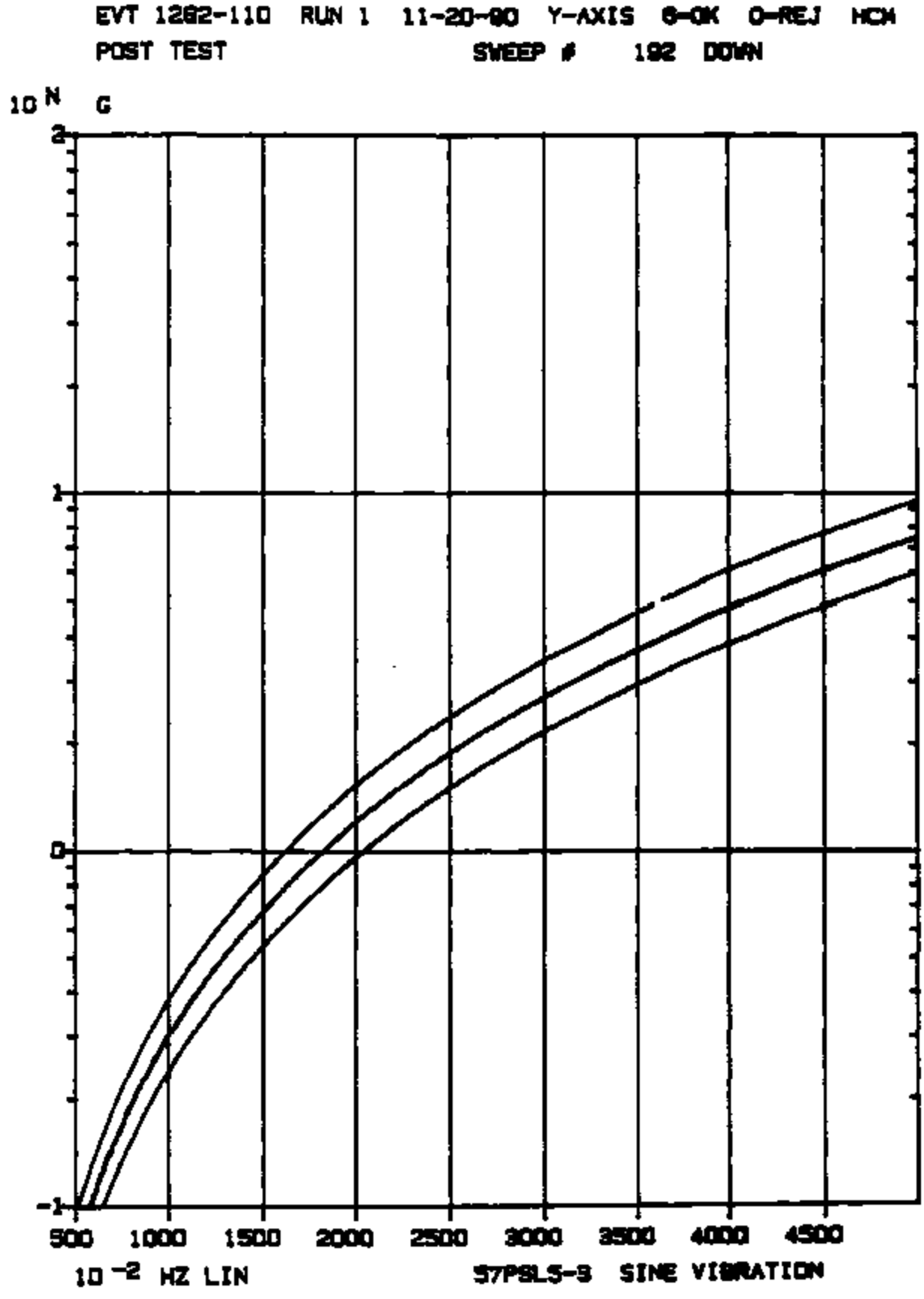
d. Vibrate the switch at 1.5 mm displacement (peak-to-peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period.

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).

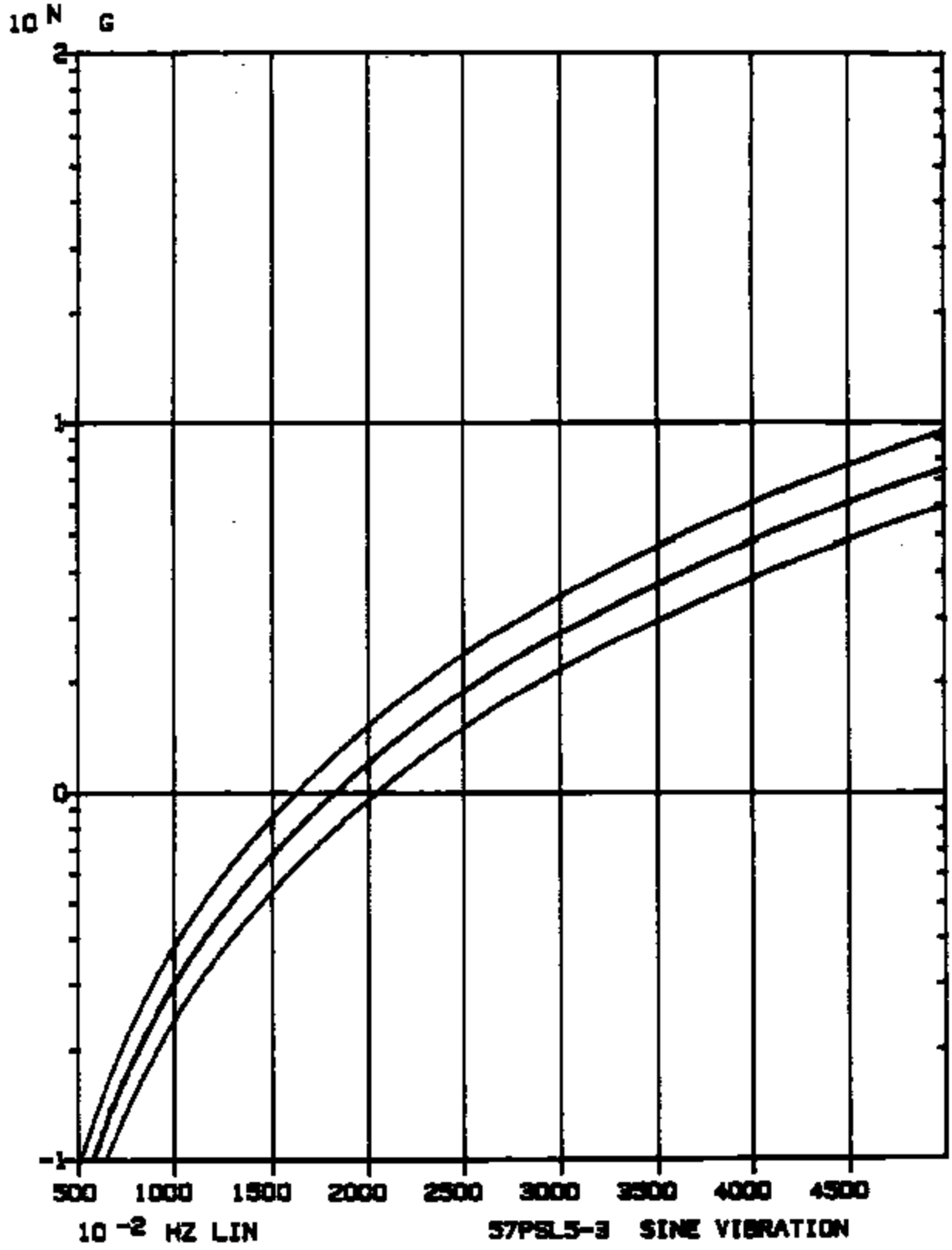
2. Acceptance Requirements

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

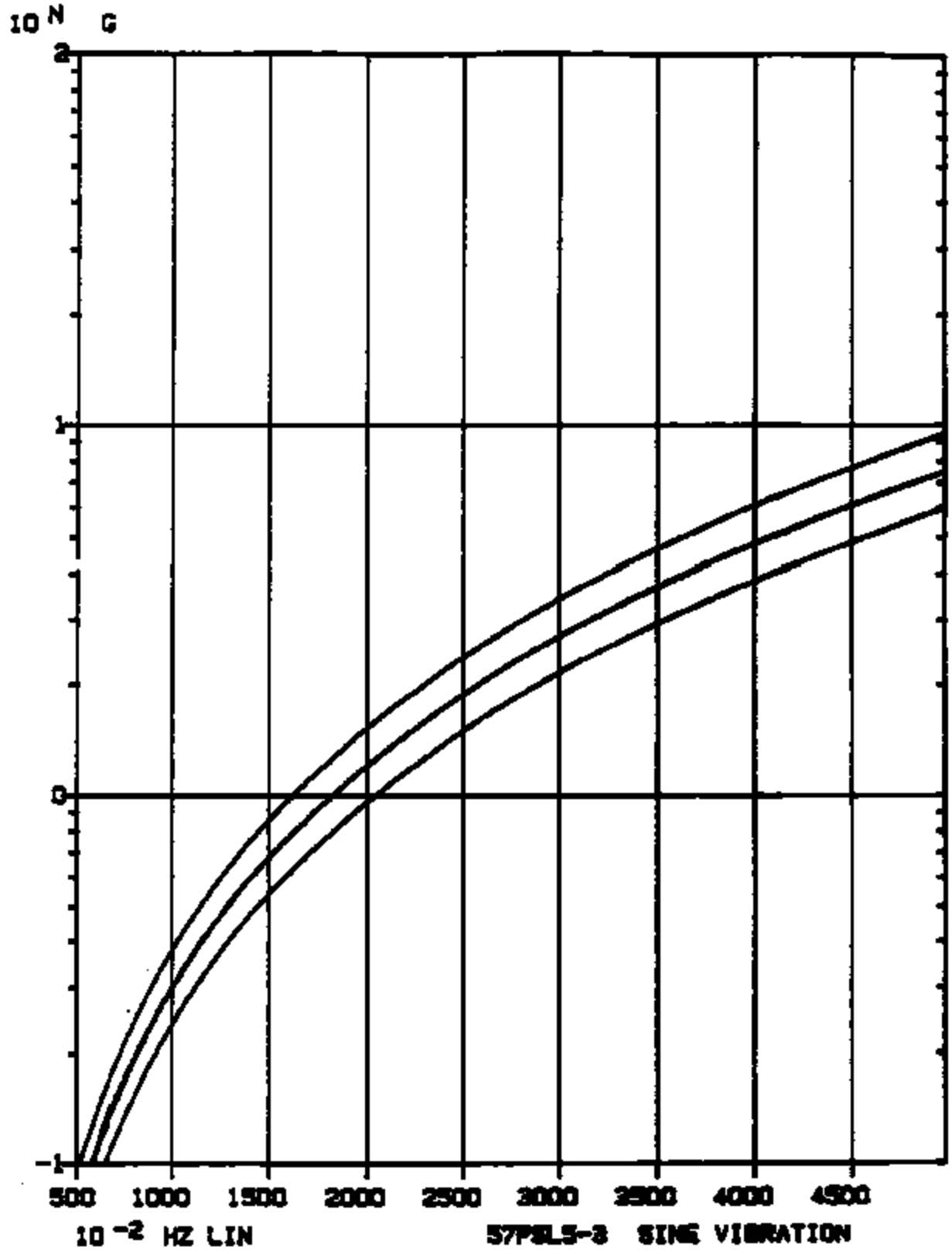
b. Nonconformance is defined as any evidence of leakage or any change in electrical continuity/discontinuity during the vibration cycles, or any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.



EVT 1262-110 RUN 2 11-20-90 Z-AXIS 6=OK 0=REJ GOO
POST TEST SWEEP # 192 DOWN



EVT 1282-110 RUN 3 11-26-90 X-AXIS 8=OK 0=REJ HCM
POST TEST SWEEP # 192 DOWN



Appendix 4.2.4
Thermal Cycle Day/Time/Temp

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SOC.
DATE 91-01-11		PAGE 32

FORM 0295

1/14/90

99/15-80

TEMP CYCLE

	← HOT →					← COLD →			
	DATE	TIME	°FLUID	AMBIENT		DATE	TIME	°FLUID	AMBIENT
1	11/ 4/90	1 45	40°C	45°C		/ /90	3 0	-40°C	-41°C
2	"	3 35	40	41		/ 90	7 50	-43	-43
3	11/ /90	9 40	40	41		"	9 55	-40	-43
4	11/ /90	10 35	41	44		"	[illegible]	-42	-42
5	" "	12 35	1 46	43		"	2 05	-41	-42
6		2 40	-42	41		"	4 00	[illegible]	[illegible]
7	"	4:25	40	41		11/6	7 55	-41	-42
8	11/6/90	8:25	42	44			3 45	[illegible]	-43
9	"	10:15	42	41			30	[illegible]	[illegible]
10	"	1 35	41	41			2 20	[illegible]	-42
11	"	3 50	40	43		"	3 [illegible]	[illegible]	-43
12	"	4 15	40	41		11/6/	2 10	[illegible]	-42
13	11/26/90	10:00	40	43			11 15	-40	-43
14	"	11 50	41	42			1 05	-40	-43
15	"	1:40	42	41			3 00	-42	-43
16	"	3 35	43	41		11/ /90	4 55	[illegible]	[illegible]
17	11/27/90	8 45	42	41		"	10 00	-40	-43
18	"	10.35	41	41			2 10	-43	-43
19	"	2:00	40	41			3 20	-40	-43
20	"	3 55	42	41		11/28/90	8 00	-43	-43
21	11/28/90	8 30	40	41		"	9 50	-41	-43
22	"	12.20	43	40			11 40	-40	-42
23	"	12 20	40	40		"	1 15	-40	-43
24	"	2:05	43	40			3 25	-40	-42
25	"	3:55	43	41		11/29/90	7:55	-43	-43
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EFFICIENCY LAB • 22-205

Appendix 4.2.5
Humidity

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 14

FORM 5295

Form 9818

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90

REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90

EXTENSION 3194 MS 12-29

DEVICE S7PS45-3

CHARGE DEPT. NO. 127 I.O. NO. 101093

REPORT NO. 1344-110

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

TESTED BY Lab

SOURCE OF TEST SAMPLES DESIGN LAB

COMPLETION DATE 12-2-90

QUANTITY OF TEST SAMPLES 6

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN HUMIDITY TEST PER ATTACHED.

TEST PERFORMED:

START : 11:30 AM 11-29-90 (THURS.)

STOP : 8:00 PM 12-2-90 (SUN.)

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE:

(11. [illegible] (Test G)

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 80-90% 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 per 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.

Appendix 4.2.6
Salt Spray

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SPEC.
DATE 91-01-11		PAGE 57

FORM 6250

<3-76

Form 4818

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90

REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90

EXTENSION 3946 MS 12-29

DEVICE 57PSLS-3

CHARGE DEPT. NO. 127 I.O. NO. 101093

REPORT NO. 1345-116

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

TESTED BY Lab

SOURCE OF TEST SAMPLES DESIGN LAB

COMPLETION DATE 12-3-90

QUANTITY OF TEST SAMPLES 6

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN SALT SPRAY TEST PER ATTACHED.

TEST PERFORMED:

In: 0900 11-30-90

Out: 0900 12-3-90

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE:

III. TEST SEQUENCE 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.

Appendix 4.2.7
Fluid Resistance

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REV.
DATE 93-01-11		PAGE 68

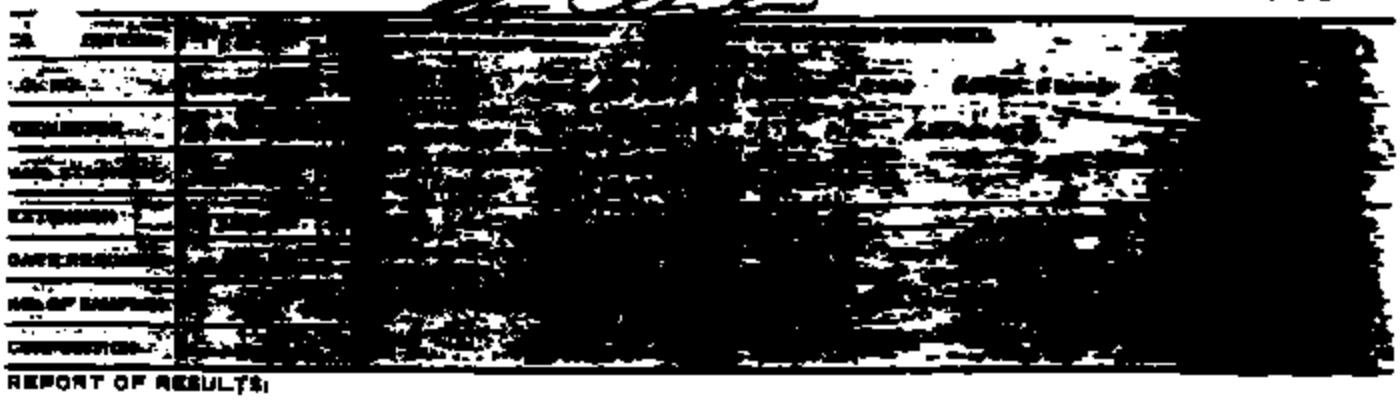
FORM 5298

FORM NO. [illegible]

TEST NO. 110077

TECHNICAL SERVICE LABS

TEST NO. 110077



REPORT OF RESULTS:

complete

DATE RECEIVED 10/13/90 DATE OUT 11-29

EMPLOYEE NO.									
JOB NO.									
NO. ANALYZED									
HOURS WORKED									

Appendix 4.3
TI QAS-296

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SPEC.
DATE 91-01-11		PAGE 12

FORM 2268

TEXAS INSTRUMENTS INCORPORATED

QAS 296

FORD MOTOR COMPANY

TI P/N	CUSTOMER P/N	CUSTOMER
57PSL2-1	ES-E53C-3N824-AA	FORD-AUTO
57PSL2-2	ES-E57A-3N824-AA	FORD-TRUCK/KELSEY HAYES
57PSF3-3	ES-E75C-3N824-AA	FORD-SURFACES/PITTS
57PSL3-1	ES-E73C-3N824-AA	ANCHOR-SWAN
57PSF3-5	ES-E80C-2C283-CA	FORD-PITTS

DEPARTMENTS AFFECTED	PREPARED K. Jones	QUALITY ASSURANCE SPECIFICATIONS	Q.A.S. NO. 296	REVISIONS # DATE
	CHK J. Haynes	TEXAS INSTRUMENTS INCORPORATED	DATE ISSUED 5/1/84	A 8/15/87
	ENGR			B 9/12/89
	APPD		PAGE 1 OF 12	

SUBJECT: Doc 1, Disc 5, QAS 296, Rev. B, Ford-57 Pressure Switch

TI-NHTSA 001536

LTR	DESCRIPTION	DATE	APPROVAL
	First issue	5/1/84	M.Gerfin
A	Typed to disc 5, and reviewed by QC engineer deleted SEC 5(In-process) added SEC 6(auditing) reliability becomes SEC 5	8/15/87	M. Gerfin
B	Cover Sheet - Add name, change part number	9/12/89	J. Haynes

2.10	Delete
2.11	Change to 2.10
3.0	Delete inspection log sentence
3.2	Add sentence
4.1.1	Change sample sizes; delete (a) (b)
4.1.1.C	Revise sentence
4.1.4	Change to 4.1.5, reword sentence
4.1.5	Change to 4.1.4, reword sentence; delete upon comp. - etc. to 4.1.1
5.2.5.4	Change P/N; Act.: cycle counts; delete (A)
8.-	Delete section entirely

1.0 SCOPE

This specification establishes the inspection criteria, methods, standards and reaction plans for the inspection of the 57PS pressure switch. It is the intent of this document to meet or exceed requirements set forth by Ford Motor Company purchase orders and engineering standards.

2.0 DEFINITIONS

2.1 This specification is applicable to all production units.

2.2 Unless otherwise noted all sampling plans allow zero defects (reject on one defect).

2.3 Every effort shall be made to employ statistical methods ($\bar{X}$ & R chart, precontrol, etc.) to assure on going process control after capability has been demonstrated.

2.4* A route card shall accompany each sublot of material, after it obtains identity.

2.5 A lot is defined as that quantity of devices which is homogenous. A lot shall not exceed 8 hours of production or 4000 devices. If one day's production exceeds 4000 devices sub-lot numbers may be used. A sub-lot of the same shift's production will be noted with a letter and will not exceed 4000 devices.

2.6 Unless otherwise specified, all tests will be conducted at room ambient conditions.

2.7 Final inspection will be accomplished in accordance with section 3 of this QAS. A Reject Notice (form no. 5341) shall be initiated and the applicable reaction plan will be initiated.

2.8 Special inspections and requirements will be accomplished in accordance with section 4.0 of this QAS.

*The route card shall indicate the link no., description, date, operator number and inspection status. (Where applicable.)

2.9 Reliability testing will be accomplished per section 5.0 of this QAS.

3.0 FINAL INSPECTION TEST

The following inspections will be accomplished on completed devices. When a discrepancy is encountered, Quality Engineering will be notified by a reject notice (Form 5341). Tear down analysis or other means will be employed to ascertain the cause of the discrepancy and to define what corrective actions will be initiated.

3.1 Post Pressure Tester Inspection

Five (5) devices per box selected at random, will be visually checked for:

A. Code - Legibility and correctness of code

B. Crimp Ring and Hexport-free of dents, nicks, scratches, surface contamination and other deformaties.

C. Check base for cracks, bent or deformed terminals and large surface dents.

D. Record results on "Inspection Log Sheet."

3.2 Packing

Check all shipping labels for current Engineering Revision No. and ensure correct customer part number is on label and device. Ensure labels on box are in correct position and legible.

4.0 SPECIAL INSPECTIONS AND REQUIREMENTS

4.1 The following chart is to be used as a guide for special testing of pilots prior to build. Results will be used as the final inspection for these attributes.

RANDOM SAMPLE - 18 PER PILOT LOT

CALIBRATION (4.1.1) - 18 DEVICES

10 DEVICES	4 DEVICES	4 DEVICES
CURRENT LEAKAGE 4.1.2	PROOF 4.1.5	DIMENSIONAL 4.1.6
IMPULSE 4.1.3	CALIBRATION 4.1.1	TERM'L STRENGTH 4.1.7
CALIBRATION 4.1.1	SCRAP	CALIBRATION 4.1.1
CURRENT LEAKAGE 4.1.2		CURRENT LEAKAGE 4.1.2
PROOF 4.1.4		PROOF 4.1.4
BURST 4.1.5		PUSH OUT 4.1.8
SCRAP		VACUUM 4.1.9
		CALIBRATION 4.1.1
		CURRENT LEAKAGE 4.1.2
		PROOF 4.1.5

4.1.1 Calibration/Creep/Voltage Drop (Automatic)

A. Eighteen (18) devices will be 100% tested for calibration, creep, and voltage drop using TI automatic test equipment.

B. All tests will be accomplished after the third cycle with the switch conducting 5 to 10ms at 14.0VDC.

C. The actuation release pressure will meet the customer requirements as indicated on Envelope Drawing.

D. The rate of pressure change (ramp-up,ramp-down) will be 10 PSI/Sec.

E. The disc snap function must occur within 30 milliseconds of the contact continuity to pass the creep function.

F. The voltage drop across the contact area is automatically checked by the test equipment.

G. The voltage drop will not exceed 200 MV with a 5.0 to 10.0ma current flow through the switch.

H. Devices which fail must be segregated from acceptable units and appropriately identified by category.

I. Results of the calibration creep voltage drop test shall be maintained by Inspection for 2 years.

NOTE: The Automatic pressure tester provides screen indications for Actuation, Release, Differential, Voltage drop, and Creep Test so discrepencies can be categorized.

4.1.2 Current Leakage Test

Ten (10) devices per sample of eighteen (18) will be measured for current leakage. The Current leakage is to be measured with 500VDC, 60 Hz alternating current applied. The current leakage is to be checked as follows:

A. Between the terminals with contacts open

B. Between each terminal and switch housing with contact open

C. Between either terminal and switch housing with contact closed

For lot acceptance the measured leakage current shall not exceed one milliampere. Record results on Inspection characteristic data sheet.

4.1.3 Impulse Test

The same ten (10) devices from test 4.1.2 will be used. The switches shall have an impulse test with 14.0 VDC applied and the switch conducting 5.0 to 10.0 ms. The pressure medium used shall be currently released power steering fluid or equivalent. The switches will be cycled as per the table in section 5.0.

NOTE: Upon completion of impulse testing the switches are to be tested per Para. 4.1.1, 4.1.2, 4.1.3. Record results on Inspection Characteristic data sheet.

4.1.4 Proof Test

The same ten (10) devices used in 4.1.3 will be used. The test is to be conducted using power steering fluid or equivalent as pressure medium. Test pressure shall be 2000 PSIG. Test pressure is to be isolated from pressure source and held for not less than 30 seconds. For lot acceptance the switches shall not show any evidence of oil leakage, seepage or drop in pressure greater than 25.0 PSIG. Record results on inspection log. Upon completion of proof testing, the switches shall be tested for Calibration.

NOTE: The test samples must be scrapped after testing.

4.1.5 Burst Test

Four (4) devices per sample of eighteen (18) will be burst tested. The burst pressure medium shall be power steering fluid or equivalent. The switch is to be pressurized to 4000 PSIG and held for 30 seconds minimum. For acceptance all switches will not show evidence of oil leakage or seepage from the switch or threads. Record data on inspection characteristics data sheet.

NOTE: Samples used for this test must be scrapped after testing is completed.

4.1.6 Dimensional Checks

Four (4) devices per pilot will be checked for dimensions as follows:

A. Gland Dimensions Dia. .312 ± .004"

B. Width .060-.080

C. Length 2.450 Max. (Go-gage)

D. Crimp Ring dia. 1.255 Max (no-go gage)

E. Hex 0.562 ± 0.005"

F. Thread (Go/no-go-gage) 3/8 -24-UNF-2A

G. Connector and dimensions (per print)

H. Terminal Location and Dimensions (Go gages)

I. Record results on Inspection Log.

4.1.7 Terminal Strength Test

A. The same four devices used in 4.1.6 will be measured for terminal strength.

B. The switch shall be mounted in a special force test gage.

C. A pendulum shall apply a 10.0 Lb. (.415 lb at 1.0 ft) impact force to the switch housing at the connector end. perpendicular to the center line axis of the switch.

D. Upon completion of the test, the switches shall be tested for Calibration, Current Leakage, and Proof Test.

E. For lot acceptance all switches shall not have any terminal or housing fracture, and must pass test defined above. Record results on "Inspection Log".

4.1.8 Push Out Test

The same four (4) devices used in 4.1.7 will be tested for push out force. The switches will be mounted in test stand with a force gage. For acceptance, the terminals will withstand a 20.0 lb. axial push force.

4.1.9 Vacuum Test

A. The same four (4) devices used in 4.1.8 will be tested for vacuum.

B. The switches will be mounted in a test port at room temperature using ambient air as a pressure medium.

C. The switches will be subjected to 5.0 cycles of vacuum from atmospheric pressure (760 mm Hg.) to an absolute pressure of 18-22 mm Hg.

D. The vacuum pressure will be maintained for 60 seconds.

E. Upon completion of the test switches will be tested for Calibration, Current Leakage, and Proof Test.

F. For acceptance, all switches must pass all tests.

4.2 Inspection of Salvaged/Reworked Material

All salvaged material will be inspected prior to use. Ten percent (10%) of the salvaged parts or sub-assemblies will be inspected to determine that they conform to print specification or engineering standards. A defect requires notification of the supervisor or group leader by a reject notice (Form #5341) and a resample after corrective action.

4.3 Records Retention

Route cards, control charts, inspection characteristic data sheets, test forms, laboratory test results, gage repeatability studies, and engineering specification test methods must be retained through the current model year and for one year thereafter. All records will be available for review by Ford Motor Co. representatives and copies of individual records will be furnished upon request.

5.0 RELIABILITY

Reliability testing will be accomplished per the following schedule.

5.1

TYPE TEST	SAMPLE SIZE	FREQUENCY	MIN REQ
Humidity	6	2/yr	P60=.85
Salt Spray	6	2/yr	P60=.85
Vibration	10	2/yr	P60=.90
Vacuum	6	2/yr	P60=.85
Temperature Cycle	6	2/yr	P60=.85

NOTE: Additional reliability testing may be accomplished to assure product conformance.

5.2 Test Procedures:

5.2.1 Humidity

5.2.1.1 Mount the switch (45 degrees from vertical) in the test port in a humidity chamber; currently released mating electrical connector must be installed before start of test.

5.2.1.2 Subject the switch to ten (10) humidity cycles as follows:

A. 8 hours at 38°C minimum at 90 to 100% relative humidity

B. Lower temperature to 24°C maximum over a 2 hour period.

C. Raise temperature to 38°C minimum at 90 to 100% relative humidity over a two hour period.

5.2.1.3 Within 15 minutes after completion of the tenth humidity cycle check the switch to sections 4.0, para 4.1.1., 4.1.2 and 4.1.4.

5.2.1.4 Nonconformance is defined as any switch not meeting the criteria in sections 4 para 4.1.1, 4.1.2 and 4.1.4.

*57PSF3-3 to be mounted horizontal

5.2.2 Salt Spray

5.2.2.1 Mount the switch horizontal 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.

5.2.2.2 Expose the switch assembly to 98 hours of salt spray per ASTM-B 117.

5.2.2.3 After exposure, check the switch to sections 4.0 para 4.1.1, 4.1.2 and 4.1.4 using the procedure established in each section.

5.2.2.4 Nonconformance is defined as any switch not meeting the criteria in section 3. Samples used for this test must be destroyed after all testing is completed.

5.2.3 Vibration

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

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

5.2.3.3 Internal pressure shall be maintained at 50 + 25 PSIG when the switch is in the opened position and 1450± 25PSIG when the switch is in the closed position.

5.2.3.4 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.

5.2.3.4 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)

5.2.3.6 After the entire vibration sequence check the switches to section 4.0, para 4.1.1, 4.1.2, and 4.1.4 using the procedures established in each section.

5.2.3.7 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 4.0, para 4.1.1, 4.1.2 and 4.1.4. Samples used for this test must be destroyed after all testing is completed.

5.2.3.8 As an alternate procedure the vibration test specified in the currently released Light Truck Engineering Power Steering Pressure Switch Specification may be used.

5.2.4 Vacuum

5.2.4.1 Mount the switch in the test port. Test to be conducted at room temperature using ambient air as the pressure medium.

5.2.4.2 Subject the switch to 5 cycles of vacuum from atmospheric pressure (760 mm Hg) to an absolute pressure of 18-22 mm Hg. Maintain the vacuum for a minimum of 60 seconds.

5.2.4.3 Check the switch to sections 4.0, para. 4.1.1., 4.1.2 and 4.1.4 using the procedure established in each section.

5.2.4.4 Nonconformance is defined as any switch not meeting the criteria in section 4.0, para. 4.1.1., 4.1.2, and 4.1.4.

5.2.5 Temperature Cycle

5.2.5.1 Mount switch in the test port. Temperature test to be run using currently released power steering fluid.

5.2.5.2 Soak switches for a minimum of 8 hours at -40°C, maximum. After soak, while the switch/fluid are still at this temperature, check the switch per sections 4.0, para 4.1.1, 4.1.2, and 4.1.4.

5.2.5.3 Gradually increase the fluid temperature to 275°F and the ambient temperature to 225°F over 2 hours time (5°F/minute maximum). Soak switches for a minimum of 8 hours at 275°F minimum fluid temperature and 225°F minimum ambient temperature. After soak, while the switch/fluid are still at this temperature, check the switch per section 4.0, para 4.1.1, 4.1.2, and 4.1.4.

5.2.5.4 Nonconformance is defined as any switch not meeting the criteria in sections 4.0, para 4.1.1, 4.1.2, 4.1.4 after either soak period. Calibration settings after soak period are to be as follows:

Actuation Pressure 450 PSI + or - 100 PSI
Release Pressure 200 PSI Min.
Minimum Differential Pressure 150 PSI

PN	Actuation	Release	Differential	Cycles
57PSF 3-3	400 + or - 50			500.000
57PSF 3-5	375 + or - 25			500.000
57PSL 2-1	450 + or - 50	200 Min	150 Min	225.000
57PSL 2-2	350 + or - 50	120 Min	50 Min	225.000
57PSL 3-1	450 + or - 50	200 Min	150 Min	225.000

NOTE: For calibration Test Voltage 13.0 + or - 1VDC

Test Current 5-10 Milliamps
Test Temp 16 to 35 Deg C

6.0 AUDITING

6.1 To provide uniform and systematic procedures for conducting an audit for a single operation or an entire product line. Audits will be conducted to insure all operations are in control and being performed to the latest manufacturing standards and procedures and comply to both internal and customer drawings and specifications.

6.2 The detailed instructions for conducting an Audit will be found in QAS 299.

6.3 Areas to be Audited

A. PROCESS SPECIFICATIONS (OPERATIONS)
B. SPC PROCESS SPECIFICATIONS
C. ROUTE SLIPS
D. PREVENTIVE MAINTENANCE
E. BLUE PRINTS
F. TOOLS
G. QUALITY (PRODUCE/OPERATION)
H. STATISTICAL PROCESS CONTROL (SPC)
I. HOUSEKEEPING AND MATERIAL IDENTIFICATION
J. SAFETY

Appendix 4.4
SAE J512 OCT 80 Information

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE -3

FORM 5291

-MSG M#= 00084680 FR=SBO1 TO=CPPC SENT=01/09/91 01:56 PM
R#=088 ST=C DIV=0050 CC=00175 BY=SBO1 AT=01/09/91 01:56 PM

TO: Vinney Barros VINN
Dave Czarn ZARN
Mike DeMattia PCQA
Charlie Douglas CPPC
Joe Schuck WHLZ
Matt Sellers PCME

FR: Steve Offiler SBO1

SJ: SAE J512 Update - Contact with SAE Committee members

My purpose in contacting the SAE committee which writes J512 was to discuss the issues we've run into; specifically the difficulty in producing and measuring the tight tolerance on the chamfer, and the tolerance stack-up which, at one extreme, allows a questionable hydraulic seal as J512 is presently written.

I spoke with the chairman, Harry Patel (Parker-Hannifin, 614-279-7070) who informed me that a ballot was filed on 90-12-21 to change the tolerances in the spec. from +/- .002" to +/- .005". Harry then referred me to the committee member who is most expert in automotive fittings and is the same man who wrote the ballot, Stan Bragdon (Parker-Hannifin Brass Products Div., 616-694-9411).

I spoke with Stan, who seems to be very reasonable and helpful. He explained that he received inputs (from where? is this co-incidence? or is Ford or one of the Tier-1's involved?) indicating that the +/- .002" tolerance was unrealistically tight, and suggesting a change to +/-.005". His role (until I contacted him) was to simply write the ballot, not necessarily to perform any analysis. The ballot must be approved by the rest of the committee which is made up of both "producers" and "users".

Apparently whoever suggested the tolerance change was unspecific as to how to apply it, because Stan chose to maintain the old minimum (in our size this is .233"), so the new tolerance becomes .238" +/- .005". This shifts the nominal UP by .003" which is the wrong direction by my analysis. I explained this to Stan, who is now VERY interested in seeing my tolerance stack-up analysis. I plan to immediately pull together a clear, concise report based on the many pages of calculations I've amassed and send it to Stan. He will then analyze the situation to determine if he agrees with me, and possibly modify the ballot.

What this all means is that the relaxed spec's which Bruce Pease, Jim Cossins (Kelsey-Hayes) and I have agreed upon may in fact become the SAE standard if all goes well.

Regards,
Steve O.

DRAWING 2
This drawing is a cross-section similar to Drawing 1. Shown are the female at its smallest cone seat dimensions, with two overlaid views of the male, one at max. dimension "E" and min. dimension "K" the other at min. dimension "E" and max. dimension "K" using the new, proposed dimensions.

The proposed dimension changes for "E" as shown, are: .233"-.237" (old) becomes .220" (5.59mm) - .230" (5.85mm) (new). The proposed dimension changes for "K" as shown, are: .030"-.050" (old) becomes .043" (1.10mm) - .055" (1.40mm) (new). Note on metric conversions: slight roundoff errors may be apparent. This is due to the fact that both decimal inch and metric dimensions are in use simultaneously i.e. TI's customer prefers metric while the suppliers prefer decimal inch.

Both problems explained above, bottoming and running out of thread, have been rectified. In the worst-case, no bottoming-out can occur as shown in Drawing 2, and the required position of the last full thread in the female is correctly located above the spec. requirement of .013" max.

DRAWING 3
Included for information, this drawing is the compliment to Drawing 2 where the female is shown at its largest cone seat dimensions, again with two overlaid views of the male.

****

I am presently conducting an experiment to test the integrity of the hydraulic seal using the new dimensions. Male parts have been created at each end of the new dimensions (.220"-.230"), including the maximum runout, and a quantity of off-the-shelf female parts have been measured and sorted to obtain parts near each end of the Fig. 5A dimensions. A matrix (high/high, high/low, low/high, low/low) has been assembled, proof-tested to 4000 psi, and is presently undergoing a 500K cycle life test combined with a thermal cycle test. At the time of this writing roughly 300K cycles are complete with no evidence of leakage whatsoever from any of the size combinations.

In closing, Stan, it would be greatly appreciated if the SAE J512 committee would consider the above information and recommendations as part of your existing ballot to increase the tolerance on dimension "E" from .004(total) to +/- .005.

Thanks and regards,

Stephen B. Offiler, Design Engineer
Texas Instruments Inc.
34 Forest St. MS 12-29
Attleboro, MA 02703
Phone: (508) 699-1382 Fax: (508) 699-3153

Enclosures

TEXAS INSTRUMENTS

09 January 1991

Mr. Stan Bragdon
Parker-Hannifin Brass Products Div.
300 Parker Drive
Otsego, MI 49078

Stan:

I'd like to first express my appreciation for your consideration of this matter, regarding the changes to dimensions and tolerances of Figure 8 and Table 5 of SAE J512 OCT 80. Per our telephone conversation of 08 January 1991, I have enclosed three scale drawings labelled Drawing 1, Drawing 2, and Drawing 3. Note that each of these drawings is per the 3/16" nominal tube dimensions. As I describe each of the drawings, I will simultaneously explain the reasoning behind the recommended changes to J512. This work is the result of mutual efforts between myself, and engineers at Ford Motor Co. and Kelsey-Hayes Co.

****

DRAWING 1

This is a cross-section assembly drawing of the "female" J512 Inverted Flare port per Fig. 5A and Table 4, so-called female because it is the female-threaded component and the "male" plug per Fig. 8 and Table 5. This drawing shows a potential problem in tolerance stack-up.

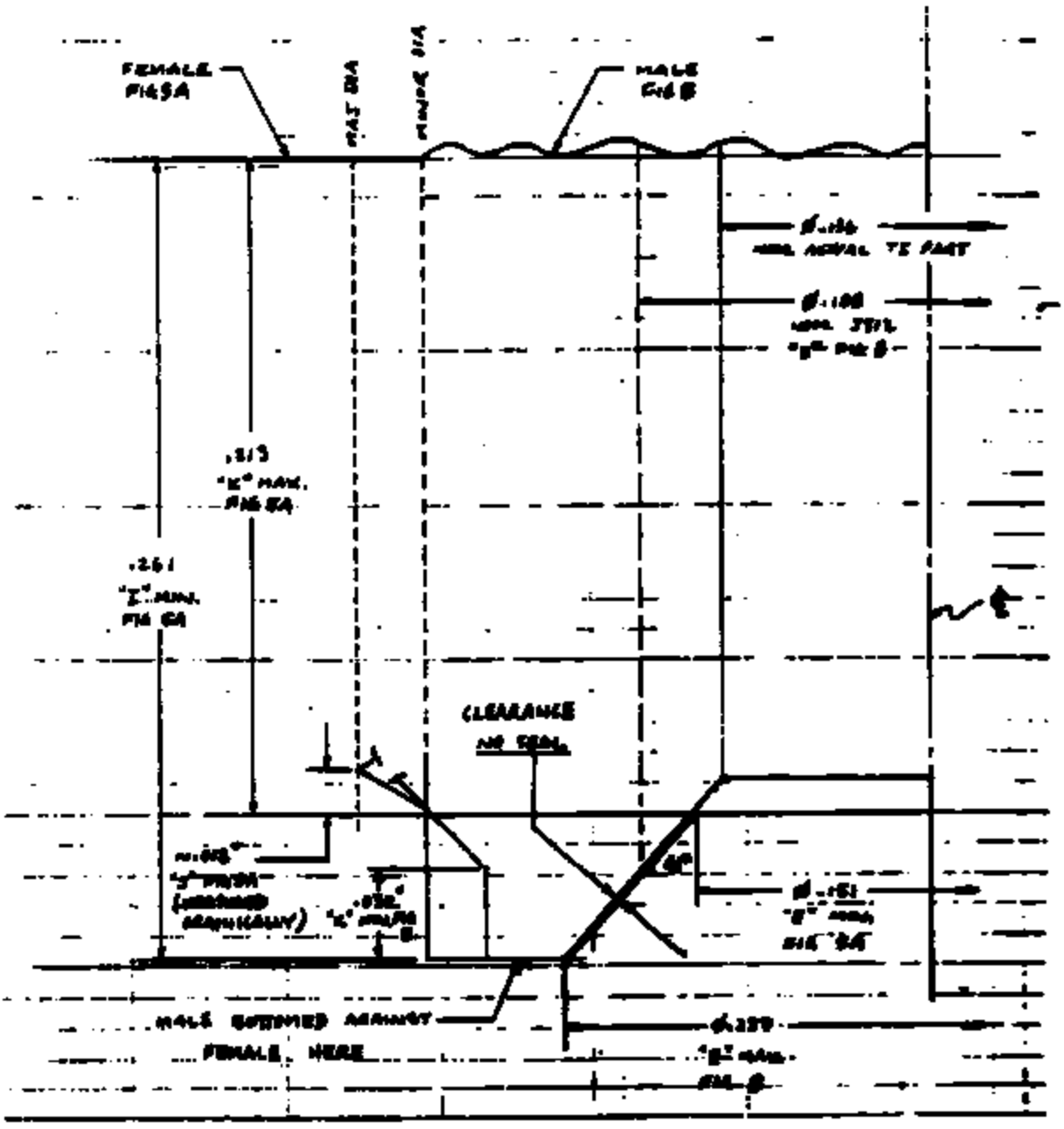
The female's cone seat is at its smallest, i.e. largest dimension "K", smallest dimension "I", smallest dimension "E" with most acute angle, 41°. The male plug's chamfer is at its largest, i.e. largest dimension "E" with most acute angle, 41°.

Two problems are shown in Drawing 1. One is that the male bottoms-out before the sealing surfaces can meet. The other is that when dimension "K" of Fig. 8 is at the maximum of .030" as shown, this puts the required location of the last female thread at .012" (dimension "J") which is below the J512 allowable size of .013". In other words, either the threads in the female are not deep enough, or conversely the male thread is too close to the end of the part.

In order to ensure that the sealing surfaces always meet first, i.e. to avoid either bottoming or running out of thread, it is proposed that dimensions be changed in two areas. One, dimension "E" of Fig. 8 be reduced, and two, dimension "K" of Fig. 8 be enlarged. Note that your present ballot to change tolerances of J512 actually *increases* the nominal of dimension "E", which is contrary to this analysis.

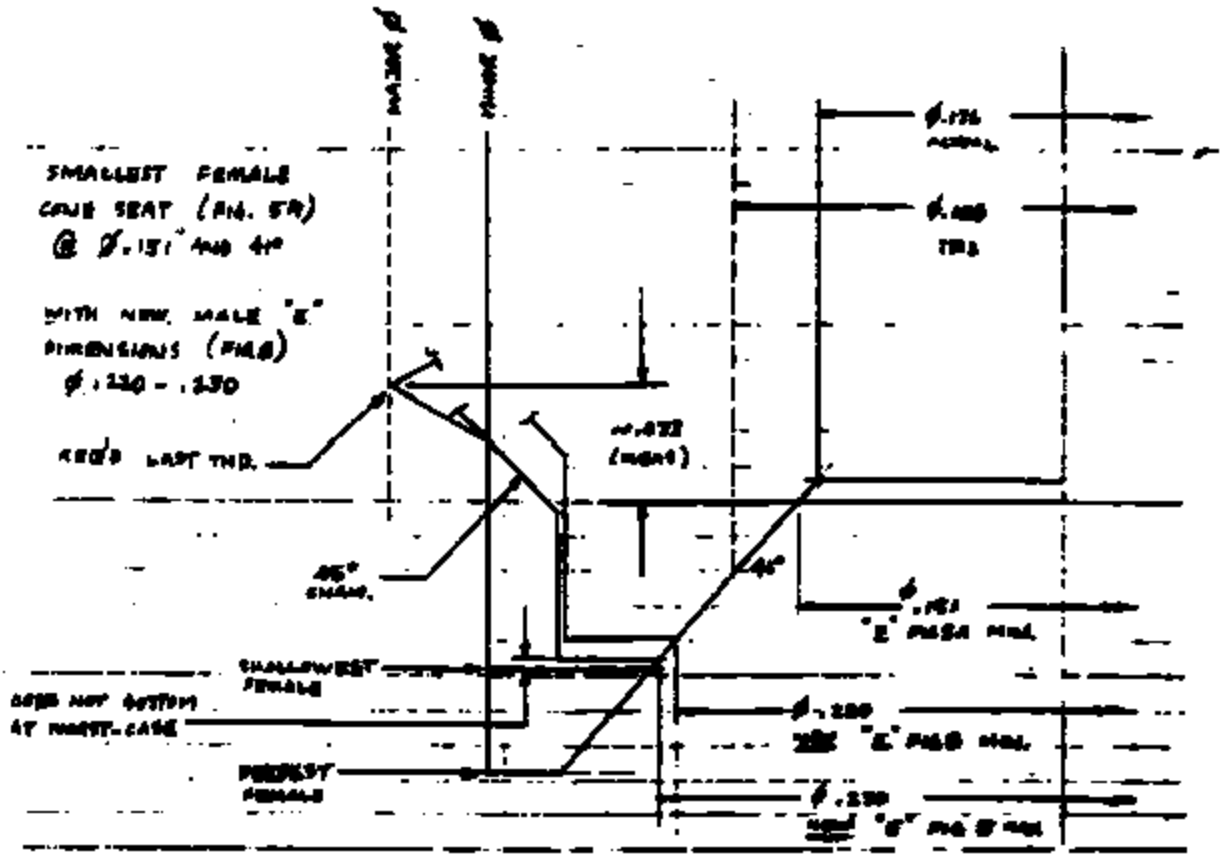
After requesting extensive quotes for producing the male part, from screw-machine houses, cold-headers, and major brake component manufacturers, TI has discovered that the J512 tolerance of .004"(total) on dimension "E" of Fig. 8 is inordinately costly to produce. Thus, another factor to consider while recommending changes is to increase the tolerance to make the part economical to produce. Yet another issue is the measurement technique for dimension "E". Neither standard chamfer gaging practices, nor optical techniques, produce acceptable Gage Repeatability and Reproducibility (R&R). The gaging issue is positively influenced by the increase in tolerance as well.

DRAWING 1



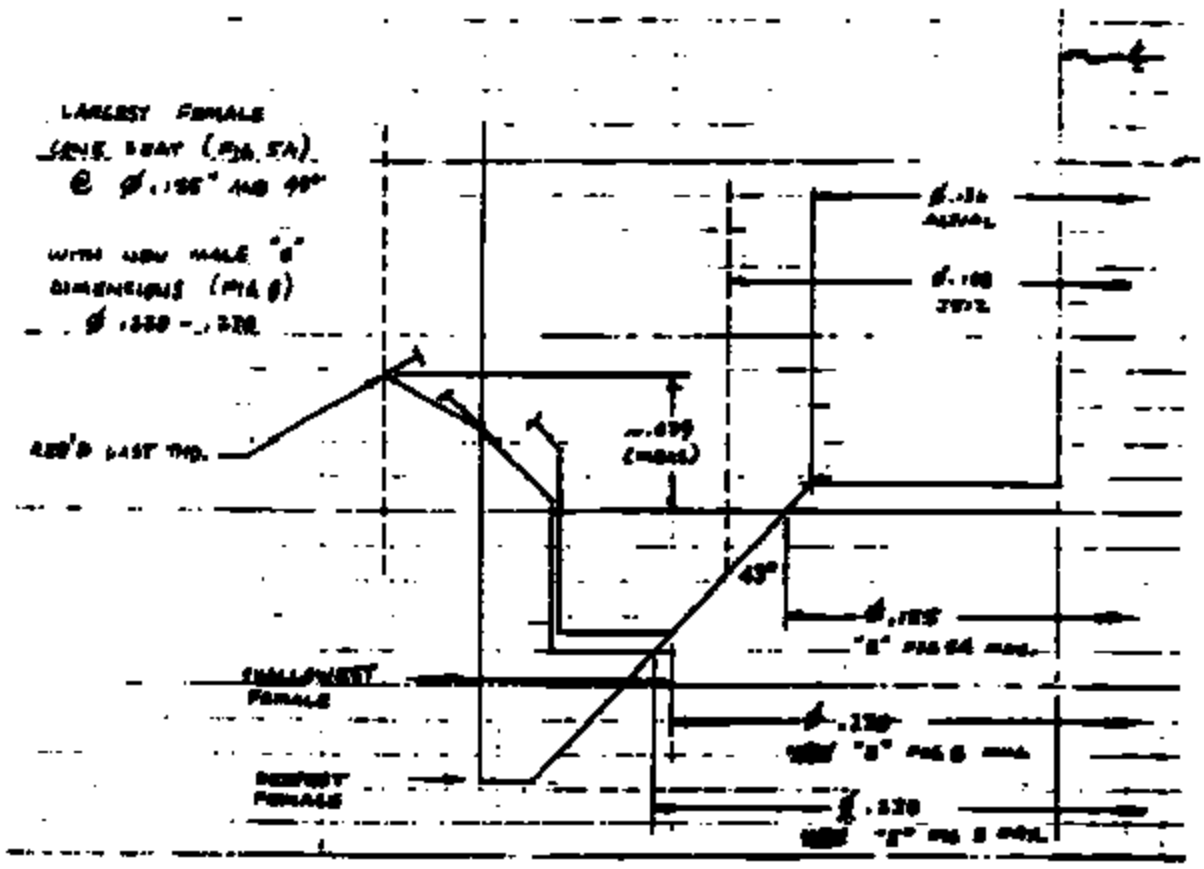
BY: STEVE OFFLOE
OF: GOODYEAR
SCALE: 20X

DRAWING 2



BY: STEVE OFFILER
DT: 900927
SCALE: 20X

DRAWING 3



BY: STEVE OPPLIGER

DT: 980527

SCALE: 2.0X

Appendix 4.5
Supplier Request for Engineering Approval

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 12

FORM 5298

1-891

No. 147660

Supplier Request for Engineering Approval

DATE November 10, 20

SUPPLIER TO COMPLETE

SUPPLIER NAME AND ADDRESS

Texas Instruments Inc., 34 Forest Street, Attleboro, MA 02703

FORD AND/OR SUPPLIER PART NAME AND PART NUMBER OF ASSEMBLY AND ITS COMPONENTS

SWITCH ASSY - SPEED CONTROL DEACTIVATE

(DELTA) F2VC - 9F924 - BA

CHANGE: ☒ DESIGN ☐ COMPOSITION ☐ PROCESSING DESCRIPTION

The production part, as shown on released drawing, utilizes an offset polarity key. At the time of ISIR ES testing, mating electrical connectors were not available. Thus, testing proceeded using a standard centered polarity key.

EFFECT OF CHANGE

The position of the polarity key has no effect on function or performance of the switch.

INTERCHANGEABILITY AFFECTED ASSEMBLY ☒ YES ☐ NO COMPONENTS ☒ YES ☐ NO	TOOLING OR FACILITY CHANGES REQUIRED ☐ YES ☒ NO IF YES, COST EFFECT $
TIME TO INCORPORATE CHANGE AFTER APPROVAL NONE	ORDER COST AFFECTED ☐ YES ☒ NO IF YES, COST EFFECT $
WILL INCORPORATION OF CHANGE AFFECT SHIPPING SCHEDULE? ☐ YES ☒ NO	SIGNATURE

PRODUCT ENGINEERING TO COMPLETE

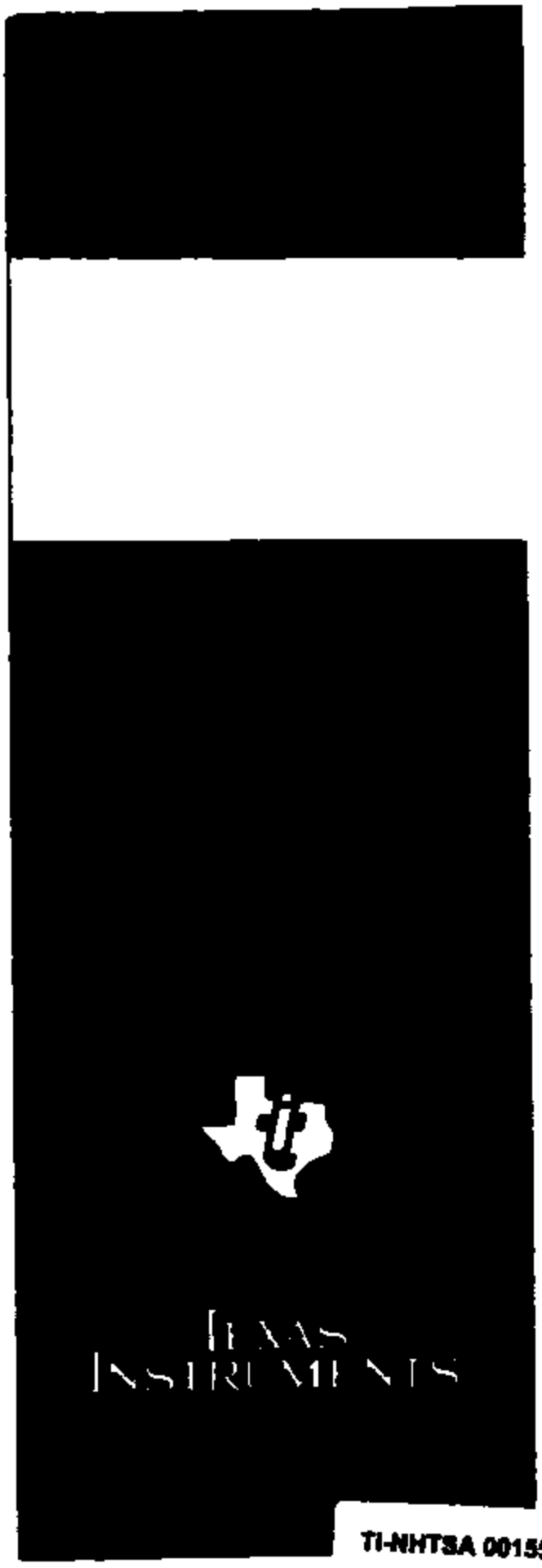
FOR IN PROCESS ☒ APPROVED ☐ REJECTED	BY B.F. Rose	DATE 9012/11	9012/11
BLANKET APPROVAL GRANTED FOR SUBSEQUENT CHANGES WHICH ARE SAME AS DESCRIBED ABOVE ☐ YES ☒ NO		SUPPLIER CONTACTED CONCERNING REJECTION ☐ YES ☒ NO	

REASON FOR REJECTION OR QUALIFYING CONDITIONS OF ACCEPTANCE

* This approval is granted upon the understanding that it is advisory in nature and in no manner changes the Seller's original responsibility for insuring that all characteristics, designated in the applicable engineering specifications and/or otherwise as complied as originally tested and approved, are maintained. Seller accepts full responsibility for the changes or types of changes listed above; and should such changes result in less satisfactory performance than experienced with the originally approved item, Seller will fully reimburse the Buyer for all expenses incurred to correct the deficiency.

C.S.S. 1638 (previous editions may NOT be used)

SUPPLIER


TEXAS
INSTRUMENTS

ADDENDUM TO:
REPORT OF ISR TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH
P8/91/49-A

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		PAGE

FORM 5295

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 : 911218

1.6 Quantity of Units Tested: 48

1.7 Disposition of Tested Units:

1.7.1 All devices are retained under quarantine.

1.8 TI test number: 172-15-24
173-15-24

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 11-12-91		PAGE

FORM 5288

2.0 OBJECTIVE

The original battery of tests reported in TI test report number PS/91/49 dated 910920 was performed to demonstrate the ability of TI P/N 77PSL2-1 to conform to customer specifications given in (delta) ES-F2VC-9F924-AA, in fulfillment of the requirements of the Initial Sample Report. During these original tests, problems were noted with diaphragm life during the Impulse test. It was discovered that these problems were related to the automatic pressure sensor assembly crimper, and furthermore that devices assembled on the manually-loaded crimper had no difficulty with diaphragm life. In the interest of meeting strict ISR deadlines, the Impulse portion of the test was successfully re-run using devices assembled on the manually-loaded crimper. However, these devices did not undergo the Fluid Resistance test due to time constraints. A 90-day Alert, # A10166193, was issued on 911002 (see Appendix 4.1). During this 90-day period, efforts to understand and correct the discrepancies of the automatic equipment have been made. The objective of this addendum is to report on the successful completion of the tests (Fluid Resistance and Impulse) which were compromised in the original ISR, using devices built both on the automatic equipment and the manually-loaded equipment. Crimp dies from the manually-loaded equipment were transferred to the automatic equipment in order to produce the successful test devices. The permanent corrective action will be to produce exact duplicates of these crimp dies for the automatic line.

3.0 TEST PROCEDURES AND RESULTS

All switches were tested to Ford Engineering Specification delta, ES-F2VC-9F924-AA, sections III. M. (Fluid Resistance) and E. (Impulse), with initial and final characterizations consisting of III. A. (Calibration), B. (Voltage Drop), C. (Current Leakage), and D. (Proof). Raw data is included in Appendix 4.2 and 4.3.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 11-13-19		PAGE 5

FORM 5286

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 90 - 160 psig, and release (contacts reclosing) at 20 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 48 devices tested were found to be within specification.

3.1.4 Final Results: All 48 devices tested were found to be within specification.

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 4.5 millivolts, and the standard deviation was 1.5. All values are significantly below the specification of 200 millivolts maximum.

3.2.3 Final results: The average voltage drop was 14.3 millivolts, and the standard deviation was 22.7. All values are significantly below the specification of 200 millivolts maximum.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 11-12-18		PAGE 1

FORM 8206

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 less than 2 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. The maximum observed was 2.7 microamps. All values are significantly below the specification of 100 microamps.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 11/12/13		PAGE

FORM 8288

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) Hi-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 FLUID RESISTANCE

3.5.1 Devices tested: 172-15-01 thru -12
173-15-01 thru -12.

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

3.5.3 Results: The 24 devices were subject to the Impulse test following completion of Fluid Resistance.

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

FORM 6285

3.6 IMPULSE

3.6.1 Devices tested: 172-15-01 thru -24
173-15-01 thru -24.

3.6.2 Procedure: 172-15-13 thru -24 and 173-15-13 thru -24 were run together on the Impulse test per the ES. Devices 172-15-01 thru -12 and 173-15-01 thru -12 were subject to the Fluid resistance test first, then run together on the Impulse test.

3.6.3 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. 12-station inductive load bank, per the schematic found in the ES (frame 18 of 18: figure 4.) used in the last 25K cycles.

3.6.4 Results: All devices passed.

Appendix 4.1
Alert

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REV.
DATE 91-12-16		PAGE 13

FORM 0206

ALERT DETAIL

PRINT DATE/TIME: 91/10/11 09:39
PAGE: 1

ALERT NUMBER
A10144193

ORIGIN ACTIVITY: 8C00 CHASSIS PWR (LHGB)
ORIGINATOR: PEARL, R. P.
CPSC: 840485

TYPE: (B) USE PPH
DATE: 91/10/02
PHONE: 32-37955
NOTICE NO:

STATUS: A
LOCATION: RA 3001, 01010?, 0
RESOLVING NOTICE:

ALERT DESC: PERMIT TEXAS INSTRUMENTS TO SHIP SPEED CONTROL REMANUFACTURED DEACTIVATION SWITCH, F2YC-9F924-AB, WITH EXCEPTION TO THE INTENDED MANUFACTURING/ASSEMBLY PROCESS CONSISTING OF

PRODUCTS AFFECTED: 1992 LINCOLN TOWN CAR, CROWN VICTORIA, GRAND MARQUIS WITH NEW GENERATION SPEED CONTROL.

MODEL CODES: CVFA CVPR CVVR
PLANTS AFFECTED: HA17
MFG CONCERN CNTRL:
PROGRAM:
QTY:
EST INCRM VAR COST: -0.02
EST INCRM VAR COST:
UNIT MEASURE:
SUPP DOCS:

MODEL YEAR: 92

ENG CONCERN CNTRL:
EFFECTIVE LN:
LINE: 900 EMISSION CODE: 0D0
EST INCRM TOOL COST: 0
EST INCRM FAC COST: 0
APPEARANCE:

INVALID:
OUT:
DISP: U
EST INCRM LBR COST: 0.04
UT EFFECT: 0.0008

---------- AFFECTED PARTS ----------

AFF PART NO:
CPSC: 840485
ACT: ENTER:

AFF PART DESC:
NOTICE:
SUPPLY/LOCAL: AVAIL:
SUPPLIER:

REL IND: N
FUNC NEED:

---------- FURTHER DESCRIPTION/ALERT RESOLUTION/REASON FOR REJECTION ETC. ----------

USERID: DFP2409 ACTIVITY: 8C00 ENTRY DATE: 91/10/02
ALERT DESC:
USING A MANUALLY LOADING SENSOR CRIMPING MACHINE VERSUS THE AUTOMATIC IN LINE LOADED CRIMPER. THE AUTOMATIC CRIMPER HAS BEEN DETERMINED TO HAVE A TOOL TO BE DEFINED DEFICIENCY THAT RESULTS IN PART FAILURE TO MEET THE REQUIRED NUMBER OF CYCLE IN THE IMPULSE TEST. THE SUPPLIER IS GIVEN A 90 DAY PERIOD TO RESOLVE THE ISSUE. THE MANUALLY CRIMPED PARTS PASS THE 60 TEST. THIS DEVIATION PERMITS INCORPORATION OF THE -AB LEVEL SWITCH AND RELEASE OF THE INTERIM -AD SWITCH FOR A COST REDUCTION OF $.02. THE -AB SWITCH IS PIN TO END STEM

USERID: DFP2407 ACTIVITY: 8C00 ENTRY DATE: 91/10/01
ALERT DESC:
PROPORTIONING VALVES F2AC-2B091-AA, F2VC-2B091-CC, AND JUNCTION BLOCK F2AC-2C320-CB.

USERID: LAZ0484 ACTIVITY: 8C00 ENTRY DATE: 91/10/04
ALERT DESC:
GK. SUPVR. APPROVAL 840-D. IF PWVSB IS AFFECTED. LAZ

USERID: BJH5348 ACTIVITY: 8C00 ENTRY DATE: 91/10/04
ALERT DESC:

-more-

TI-NHTSA 001570

ALERT DETAIL

PRINT DATE/TIME: 91/10/11 09:39
PAGE: 2

ALERT NUMBER: A10164193

ORIGIN ACTIVITY: HC00 CHASSIS PGM (AHCH)
ORIGINATOR: PEASE, D. F.
CPSC: 060403

TYPE: (U) USE PPM
DATE: 91/10/02
PHONE: 32-57955
NOTICE NO:

STATUS: A
LOCATION: RM 3001, BLD643, D
RESOLVING NOTICE:

---------- FURTHER DESCRIPTION/ALERT RESOLUTION/REASON FOR REJECTION ETC. ----------

USERID: BJH5368 ACTIVITY: HC00 ENTRY DATE: 91/10/04
ALERT DESC:
FRVGS NOT AFFECTED BJH

USERID: JLS1824 ACTIVITY: HC00 ENTRY DATE: 91/10/07
ALERT DESC:
NOTED J SIMMONS 32-57970

---------- APPROVALS ----------

REGION	DEPARTMENT	USERID	ACTIVITY	APPROVER'S NAME	DATE APPROVED	APPROVAL
W	E2667	DFP2489	HC00	PEASE, D. F.	91/10/03	
W	E2667	JLS1824	HC00	SIMMONS, J.L.	91/10/07	Y
W	E2621	LAZ0484	HC00	ZIELINSKI, L.A.	91/10/04	Y
W	E2667	BJH5368	HC00	HAEROFF, B.J.	91/10/04	Y
W	E2660	VSH5378	HC00	DEGRAZIA, V.S. (DEPT	91/10/09	Y
W	E2613	AJT0189	HC00	YURAS, A.J.	91/10/04	Y
W	E2611	MAIL	HC00	CHASSIS MAIL GATEKEE	91/10/04	Y
W	E2611	PPMALRT	HC00	PPM GATEKEEPER-CHASS	00/00/00	
W	E2667	DFP2489	HC00	PEASE, D. F.	91/10/03	
W	E2670	JAV0144	HC00	VANDERMOEI, J.C. (D	00/00/00	

THMHTBA 001571

Appendix. 4.2
Data # 172

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SHEET
DATE		PAGE 15

FORM 5288

PRESSURE SWITCH DATA Form: [illegible] TEST NO [illegible]

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
7" PSC 2-9	1/16	Steve Cole	
PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Zoltan D. Horning	1/16/01		

PROJECT TITLE: Ford MY 01 Electronic Speed Control Development II

CUSTOMER:

PURPOSE OF TEST: Review of validation testing method for the Ford Vista

PROCEDURE: Apply and Release pressure per Ford ES Series Recipe or Handbook

Part #	Cycles	Date/Init	No. Pass	Cut-in	Cut-out	Cut-out	Visual	
[illegible]	5000	1/23/42	5.9	1.50 A	1.50 A	1.4 A	Pass	
42		1/16/41	6.0	1.55	1.49	1.40		
41		1/23/41	6.1	1.61	1.49	1.48		
40		1/29/45	4.6	1.51	1.44	1.39		
45		1/15/45	4.7	1.53	1.50	1.38		Failed for
46		1/31/43	4.2	1.53	1.51	1.31		
43		1/29/42	5.4	1.54	1.51	1.34		Test Unit
44		1/23/44	5.1	1.53	1.47	1.33		
39		1/25/41	5.6	1.56	1.45	1.41		
38		1/30/47	5.7	1.51	1.49	1.36		
37		1/31/50	4.3	1.51	1.44	1.31		
36	▼	1/24/47	3.5	1.51	1.47	1.34	▼	
[illegible]	5000	1/17/42	3.7	1.52	1.39	1.29	Pass	
34		1/16/43	4.5	1.51	1.47	1.37		
35		1/25/45	2.7	1.53	1.44	1.31		
33		1/31/42	4.4	1.52	1.38	1.33		
32		1/30/51	2.3	1.53	1.36	1.26		
31		1/24/49	3.7	1.53	1.41	1.35		
30		1/31/53	2.3	1.56	1.37	1.33		Recipe
29		1/23/47	3.1	1.47	1.39	1.36		
28		1/31/47	3.6	1.51	1.40	1.35		
27		1/24/52	3.2	1.53	1.41	1.39		
26		1/31/45	4.1	1.55	1.42	1.39		
25	▼	1/31/47	3.9	1.54	1.43	1.33	▼	

-over-

	Prec	Act/Del				
	Prec	165/54	12.2	1.61	1.35	.32
		104/52	2.4	1.63	1.35	1.60
		106/56	10.6	1.69	1.55	2.73
		111/58	9.5	1.65	1.37	1.63
		105/55	1.6	1.65	1.40	1.72
		112/57	19.0	1.62	1.33	1.75
		108/55	7.6	1.58	1.32	1.72
		107/56	1.7	1.60	1.34	1.75
		111/56	2.9	1.63	1.36	1.91
		114/59	2.5	1.62	1.35	1.74
		106/60	1.4	1.57	1.33	1.98
	▼	114/56	2.3	1.61	1.35	1.67
	Prec	109/59	4.9	1.62	1.35	1.68
		110/57	3.1	1.48	1.24	1.66
		113/62	3.8	1.71	1.25	1.82
		111/58	4.2	1.52	1.27	1.75
		111/59	6.1	1.51	1.27	1.70
		116/60	7.1	1.52	1.28	1.65
		113/57	3.7	1.64	1.36	1.74
		111/62	3.2	~7	~7	.68
		112/58	2.8	1.71	1.39	1.75
		110/56	5.9	1.59	1.3	1.5
		111/59	2.4	1.63	1.0	1.69
	▼	110/58	3.0	1.59	1.32	1.4

Appendix 4.3
Data # 173

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

FORM 5296

PRESSURE SWITCH DATA Form [illegible] **TEST NO.** [illegible]

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
[illegible]	11/1/?	[illegible]	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeffrey DiDonato[illegible]	11/1/[illegible]		

PROJECT TITLE: Ford [illegible] Electronic Speed Control [illegible]

CUSTOMER:

PURPOSE OF TEST: Report of Validation testing [illegible] the first time

PROCEDURE: Impulse test and [illegible] Ford ES. All parts [illegible] on AMI

[illegible] #	[illegible]	Act/Rel	[illegible]	A	B	C	[illegible]	
[illegible]	[illegible]	121/57	2.9	1.86	1.55	1.72	[illegible]	
[illegible]		124/53	6.3	1.82	1.47	[illegible]		
[illegible]		113/52	5.3	1.84	1.57	[illegible]		
[illegible]		123/57	9.3	1.86	1.54	1.79		
[illegible]		118/52	5.6	1.86	1.52	1.77		
[illegible]		110/49	4.1	1.81	1.50	1.79		[illegible]
[illegible]		121/59	4.9	1.91	1.52	1.75		
[illegible]		120/59	4.1	1.72	1.49	1.77		[illegible]
[illegible]		124/54	9.3	1.94	1.50	1.75		
[illegible]		113/57	5.6	1.86	1.51	1.75		
[illegible]		121/58	4.9	1.88	1.54	1.57		
[illegible]		113/53	6.2	1.82	1.58	1.79		
[illegible]	[illegible]	121/56	3.7	1.78	1.36	1.79	Pass	
[illegible]		133/57	2.4	1.70	1.44	1.76		
[illegible]		118/61	4.3	1.80	1.36	1.81		
[illegible]		125/61	4.0	1.75	1.46	1.89		
[illegible]		129/55	2.6	1.70	1.41	1.69		
[illegible]		118/50	3.7	1.47	1.37	1.82		
[illegible]		128/57	4.5	1.67	1.42	1.88		Results
[illegible]		120/62	2.9	1.67	1.40	1.80		
[illegible]		118/55	3.9	1.58	1.38	1.73		
[illegible]		119/51	4.0	1.79	1.42	1.76		
[illegible]		118/60	3.7	1.57	1.39	1.52		
[illegible]		119/52	3.8	1.53	1.33	1.40		

(OVER)

TI-NHTSA 001576

	free f	[illegible]	[illegible]	[illegible]	b	c		
[illegible]	Pass	101/60	6.5	3.04^A	1.53	1.67		
		102/58	2.5	1.55	1.29	1.74		
		103/57	3.0	1.93	1.91	2.69		
		104/58	1.9	1.60	1.37	1.67		
		107/60	5.5	1.71	1.42	1.61		
		112/55	3.0	1.75	1.45	1.81		
		114/62	21.5	1.66	1.56	1.65		
		108/57	4.8	1.53	1.30	1.63		
		102/57	4.0	1.58	1.37	1.61		
		103/59	39.2	1.95	1.55	1.71		
		101/58	4.5	1.60	1.34	1.68		
		110/52	9.6	1.64	1.35	1.99		
[illegible]	Pass	102/57	2.0	.60	1.27	1.75		
		103/60	39.2	1.69	1.42	1.64		
		108/58	4.5	1.61	1.27	1.98		
		101/54	75.6	1.48	1.25	1.96		
		115/55	37.9	1.58	1.35	1.71		
		105/57	2.3	1.58	1.39	1.99		
		113/59	95.4	1.99	1.28	1.77		
		116/61	1.9	1.58	1.36	1.79		
		110/59	21.9	1.72	1.47	1.78		
		106/55	42.2	1.54	1.34	1.75		
		111/56	4.0.5	1.75	1.46	1.70		
		109/55	35.1	1.61	1.39	1.63		

Appendix 4.4
Fluid Resistance

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-12-18		PAGE 31

FORM 5268

TEST NO 109832

TECHNICAL SERVICE LABS

TEST NO 109832

	127
	181
	860
	S. OFFILLER
	12-29
	1382
	5801
	91-11-04
	91-12-12
	24
	MIXED

SYSTEM/ITEM PROBLEM
SAMPLE DESCRIPTION

SAMPLES ARE TPS MASSURE SWITCHES WITH LEADS & END PLUGS

INFORMATION DESIRED: 3548

PLEASE PERFORM FINAL RESISTANCE TEST PER EMO MEMO 88-1266 (5-FAVE-87929-AA (amended)

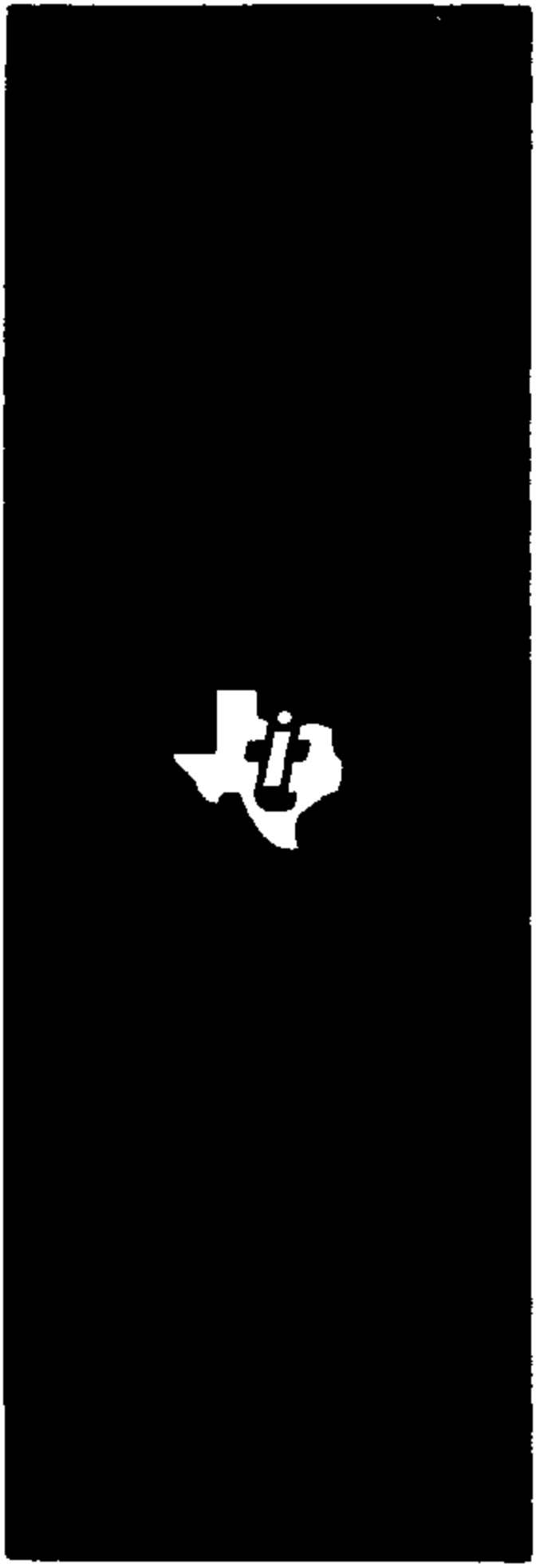
REPORT OF RESULTS:

DATE RECEIVED 11/5/91 DATE OUT 12-12

*PCC I.D.

MC=225	TM=431	JOCY=128	FACIL=614
PC=127	WIRE=432	CUSE=122	FACIL=621
VERS=188	EPC=621	CAR=664	FACIL=631
AFCC=440	PEF=622	AO DEV=288	STAFF=888
IND=430	CSO=626	EMCO=677	

DISTRIBUTION: White and Yellow - Lab Pink - Requestor



PS/91/25

REPORT OF ISIA TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH

TEXAS INSTRUMENTS INCORPORATED
CONTROL PRODUCTS DIVISION
PRECISION CONTROLS DEPARTMENT
34 FOREST STREET MS12-29
ATTLEBORO, MA 02703

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 1

FORM 8006

TABLE OF CONTENTS

TEST LOT NO.	TEST	
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DEC.
DATE 91-03-11		PAGE 3

FORM 5393

1.0 GENERAL

1.1 Releasing Office: Ford Motor Company, Passenger Car Brake Systems Engineering

1.2 TI Part Number: 57P8L5-3

1.3 Customer Part Number: F2VC-9F924-BA

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

1.5 Applicable SREA(s): # 147660

1.6 Date of Completion: 90-12-13

1.7 Quantity of Units Tested: 72

1.8 Disposition of Tested Units:

1.8.1 One device, 99-15-31, was autopsied

1.8.2 Six devices were destroyed during Burst (test 3.5)

1.8.3 The remainder (qty. 65) are held in quarantine at TI

1.9 TI test series number: 99-15-80

2.0 TI Pressure Switch test report number: PS/91/25

TEST LOT NO.	TEST	
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REQ.
DATE 91-01-11		PAGE 3

FORM 5222

2.0 OBJECTIVE

This battery of tests was performed to demonstrate the ability of 57P6L5-3 to conform to specifications, in fulfillment of the requirements of the Initial Sample Inspection Report. Units tested were built using production components and production assembly equipment.

The SAE J512 metal-to-metal inverted flare hydraulic seal used on the hexport continues to be optimized by TI, Ford, and Tier-1 suppliers' engineers. Recently, the SAE committee which maintains J512 became involved. (See Appendix 4.4) The dimensional study of the J512 specification has highlighted areas of potential improvement, which is currently in review by Ford. However, in order to meet Ford's current needs, the hexport is produced to the present J512 specification by modifying standard production hexports (TI P/N 27373-1 used on 57PSF3-3 and 57PSF3-5). These parts were then plated by the end producer, Elco Industries Inc., Rockford, IL., to the TI production plating specification.

One SREA (see Appendix 4.5) which relates to this test has been filed. The final production switch will utilize a fuel-injector-style connector (may also be known as a "minitimer" or "Bosch-style") with a new, offset polarity key to foolproof. At the time this testing was started, offset-key mating connectors (i.e. harness-side) were unavailable. This SREA granted permission to conduct all testing with standard 57PS-series centered-key switch housings, production validated in 1984.

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 were subject to an initial characterization consisting of Calibration, Voltage Drop, Current Leakage, and Proof. Devices were then divided into groups per the flow chart and subject to the indicated tests in the indicated order. Finally, all tested devices were subject to a final characterization which was identical to the initial characterization.

No failure to meet given acceptance criteria was observed for any test. All switches passed.

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 90 - 160 psig, and release (contacts reclosing) at 20 psig minimum. 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 CM86365 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 devices tested were found to be within specification.

3.1.4 Final Results: 66 surviving devices (6 destroyed in 3.5 Burst) were found to be within specification.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 4

FORM 5368

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 10.8 millivolts, and the standard deviation was 2.6. All values are significantly below the specification of 200 millivolts maximum.

3.2.3 Final results: The average voltage drop was 10.4 millivolts, and the standard deviation was 2.9.

TEST LOT NO.	TEST	
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO MA 02703	
DATE 11-01-11		PAGE 9

FORM 8291

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: Information could be obtained directly from inspection of the data without a need to calculate statistics. Measuring terminals to case with switch closed; measuring terminals to case with switch open; and measuring between the terminals: in no case did the leakage current exceed 1.99 microamps. All values are significantly below the specification of 100 microamps.

3.3.3 Final results: Again, no statistics. Same three measurements as 3.3.2. With the exception of three out of 72 parts, typical current leakage values are essentially unchanged from initial results. Three parts, all undergoing Fluid Resistance Test 3.9 and Salt Spray Test 3.13, exhibited values elevated from the typcial. One was (approx.) 63.7 microamps, one was (approx.) 8.0 microamps, and one was (approx.) 4.4 microamps. The 63.7 microamp device, 99-15-31, was carefully autopsied. Before any disassembly took place, an external investigation showed a very small amount of unidentified pink-color liquid inside the connector housing. The hypothesis is that this liquid was some mixture of fluids from the Fluid Resistance Test 3.8. One possible entrance path for the fluid is past the seal on the mating connector; another, highly unlikely path is directly through the plastic housing. Upon disassembly of the device, minute evidence of the same reddish fluid was detected inside the switch cavity; however, the initial and final millivolt drop measurements (test 3.2) demonstrate no abnormality in electrical switching properties.

Current leakage for all devices was below the spec. of 100 microamps. All devices passed.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
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FORM 8398

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) Hi-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: 99-15-37 thru 86-15-42.

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. 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. Pressure was then increased until the failure point defined in 3.5.2, 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 33.97 and a minimum Characteristic Life (theta) of 8829.6 psig was calculated at 90% confidence. The 0.72 reliability at 90% confidence is 8544.9 psi. Thus, the parts exceed the burst specification of 7000 psig by 1544.9 psi.

TEST LOT NO.	TEST	REVISED
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SEC.
DATE 91-03-11		PAGE 18

FORM 8201

3.6 VIBRATION

3.6.1 Devices tested: 99-15-43 thru 99-15-48.

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	DWG.
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FORM 8250

3.7 VACUUM

3.7.1 Devices tested: 99-15-49 thru 99-15-54.

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. E. 2.).

3.0 TEMPERATURE CYCLE

3.0.1 Devices tested: 99-15-55 thru 99-15-60.

3.0.2 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 0-1500 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.

3.0.3 Results: All six devices met the acceptance criteria in E8 (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: 99-15-01 thru 99-15-36.

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, -01 thru -12

3.9.3.2 Terminal Strength, -13 thru -24.

3.9.3.3 Humidity, -25 thru -30.

3.9.3.4 Salt Spray, -31 thru -36.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	REV.
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FORM 5206

3.10 INFOLDS

3.10.1 Devices tested: 99-15-01 thru 99-15-12 from Fluid Resistance test 3.9 and 99-15-61 thru 99-15-72 virgin devices.

3.10.2 Procedure: All 24 devices actually ran 525,000 pressure cycles. The first 475,000 is done unpowered, with the Switch Monitor Circuit functioning. From 475,000 thru 500,000 cycles one-half of the 24 devices are powered. This is due to the fact that the Load Bank only has 12 stations for cost, size, and weight considerations. From 500,001 thru 525,000 cycles the other half are powered.

3.10.3 Equipment: same as 3.8.2 with the addition of a custom TI designed and built 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: All twenty-four 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: 99-15-13 thru 99-15-24.

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 57P8 assembly line in testing to TI Quality Assurance Specification 296 (see Appendix 4.3).

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	SEC.
DATE 91-01-11		PAGE 14

FORM 1295

3.12 HUMIDITY

3.12.1 Devices tested: 99-15-25 thru 99-15-30.

3.12.2 Equipment: Humidity chamber RK model 56.

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.).

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO MA 02703	DWG.
DATE 91-01-11		PAGE 1

FORM 5288

3.13 SALT SPRAY

3.13.1 Devices tested: 99-15-31 thru 99-15-36.

3.13.2 Equipment: Marshaw salt spray chamber.

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

TEST LOT NO.	TEST	REVISE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REV.
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FORM 5301

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 92-01-11		PAGE 19

FORM 5395

Appendix. 4.2.1
Initial and Final Characterization

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP	DOC.
DATE 91-11-11		PAGE 34

FORM 6295

PRESSURE SWITCH DATA Form 21503 TEST NO. 99-15-80

DEVICE: EX3423	DATE RECEIVED: 10-12-90	RECEIVED BY: S OFFICER	DATE:
PERFORMED BY: L RUGGIERI	DATE STARTED: 10-12-90	DATE COMPLETED: 11-13-90	APPROVED BY:

PROJECT TITLE: FORD PASS-CAR REVALIDATION

CUSTOMER: FORD

PURPOSE OF TEST: PASS-CAR QUALIFICATION

PROCEDURE: SEE FORD ENGINEERING SPEC

	CHARACTERIZATION				HYPOT				
DEVICE NO.	ANGLE	Ac-	PEL	mV	TO CASE (Milliamps)	TO CASE (Milliamps)	BREAKDOWN (Volts)	TESTS	
99-15-01	PASS	123 mg	30 mg	12.32	1.775	1.345	1.317	Functional	
02		118	29	12.35	1.642	1.301	1.270	"	"
03		114	29	12.38	1.619	1.318	1.289	"	
04		118	25	12.38	1.788	1.316	1.285	"	
05		119	33	12.43	1.692	1.345	1.320		-
06		118	31	12.37	1.721	1.400	1.369		"
07		122	35	12.41	1.662	1.307	1.278	"	"
08		120	32	12.31	1.720	1.398	1.369	"	
09		120	32	12.39	1.692	1.378	1.349	"	
10		119	34	12.28	1.753	1.403	1.365	"	
11		117	33	12.41	1.697	1.382	1.352	"	
12		118	34	12.44	1.707	1.391	1.361	"	
13		106	25	12.60	1.615	1.308	1.276		TABLE TOP
14		120	32	12.43	1.723	1.404	1.372		
15		125	37	12.34	1.787	1.395	1.366		
16		115	30	12.43	1.675	1.368	1.338		
17		123	32	12.32	1.699	1.380	1.347		
18		118	33	12.37	1.712	1.393	1.358		
19		125	33	12.30	1.699	1.384	1.354		
20		123	31	12.41	1.689	1.373	1.341		
21		120	31	12.41	1.692	1.376	1.340		
22		115	33	12.36	1.708	1.378	1.352		
23		113	29	12.37	1.722	1.390	1.356		
24		119	33	12.36	1.710	1.386	1.347		
25		126	32	12.30	1.723	1.395	1.350		HUM SET
26		116	31	12.39	1.698	1.388	1.356		
27		119	32	12.30	1.705	1.396	1.362		

(OVER)

Device No.	Phase	Ac-	Rec	mVD	TO CASE Sol. Grid	TO CASE Sol. Grid	Between Terminals	TESTS	
98-IE-1	BASS	135 deg	57 deg	11.30	1.601	1.369	1.771	PHOTOELECTRIC	
2	"	135	56	11.50	1.625	1.403	1.776	"	
3	"	130	54	11.41	1.633	1.397	1.776	"	
4	"	128	52	11.52	1.654	1.410	1.776	"	SALT SPRAY
5	"	125	54	11.32	1.615	1.414	1.774	"	"
6	"	129	50	11.46	1.615	1.411	1.772	"	"
7	"	126	53	11.53	1.615	1.418	1.773	"	
8	"	131	58	11.55	1.617	1.417	1.777	"	
9	"	124	52	11.37	1.605	1.405	1.777	"	"
10	"	128	53	11.48	1.615	1.415	1.775	BRASS	1000
11	"	129	55	11.48	1.611	1.410	1.774	"	1300
12	"	132	56	11.47	1.611	1.414	1.774	"	1500
13	"	133	57	11.44	1.605	1.403	1.773	"	1700
14	"	134	58	11.43	1.604	1.402	1.773	"	1900
15	"	135	59	11.40	1.598	1.399	1.772	"	2100
16	"	136	60	11.39	1.596	1.397	1.771	"	
17	"	137	61	11.37	1.593	1.394	1.770	"	
18	"	138	62	11.36	1.591	1.392	1.769	"	
19	"	139	63	11.34	1.588	1.389	1.768	"	
20	"	140	64	11.33	1.586	1.387	1.767	"	
21	"	141	65	11.31	1.583	1.384	1.766	"	
22	"	142	66	11.30	1.581	1.382	1.765	"	
23	"	143	67	11.28	1.578	1.379	1.764	"	
24	"	144	68	11.27	1.576	1.377	1.763	"	
25	"	145	69	11.25	1.573	1.374	1.762	"	
26	"	146	70	11.24	1.571	1.372	1.761	"	
27	"	147	71	11.22	1.568	1.369	1.760	"	
28	"	148	72	11.21	1.566	1.367	1.759	"	
29	"	149	73	11.19	1.563	1.364	1.758	"	
30	"	150	74	11.18	1.561	1.362	1.757	"	
31	"	151	75	11.16	1.558	1.359	1.756	"	
32	"	152	76	11.15	1.556	1.357	1.755	"	
33	"	153	77	11.13	1.553	1.354	1.754	"	
34	"	154	78	11.12	1.551	1.352	1.753	"	
35	"	155	79	11.10	1.548	1.349	1.752	"	
36	"	156	80	11.09	1.546	1.347	1.751	"	
37	"	157	81	11.07	1.543	1.344	1.750	"	
38	"	158	82	11.06	1.541	1.342	1.749	"	
39	"	159	83	11.04	1.538	1.339	1.748	"	
40	"	160	84	11.03	1.536	1.337	1.747	"	
41	"	161	85	11.01	1.533	1.334	1.746	"	
42	"	162	86	11.00	1.531	1.332	1.745	"	
43	"	163	87	10.98	1.528	1.329	1.744	"	
44	"	164	88	10.97	1.526	1.327	1.743	"	
45	"	165	89	10.95	1.523	1.324	1.742	"	
46	"	166	90	10.94	1.521	1.322	1.741	"	
47	"	167	91	10.92	1.518	1.319	1.740	"	
48	"	168	92	10.91	1.516	1.317	1.739	"	
49	"	169	93	10.89	1.513	1.314	1.738	"	
50	"	170	94	10.88	1.511	1.312	1.737	"	
51	"	171	95	10.86	1.508	1.309	1.736	"	
52	"	172	96	10.85	1.506	1.307	1.735	"	
53	"	173	97	10.83	1.503	1.304	1.734	"	
54	"	174	98	10.82	1.501	1.302	1.733	"	
55	"	175	99	10.80	1.498	1.299	1.732	"	
56	"	176	100	10.79	1.496	1.297	1.731	"	
57	"	177	101	10.77	1.493	1.294	1.730	"	
58	"	178	102	10.76	1.491	1.292	1.729	"	
59	"	179	103	10.74	1.488	1.289	1.728	"	
60	"	180	104	10.73	1.486	1.287	1.727	"	
61	"	181	105	10.71	1.483	1.284	1.726	"	
62	"	182	106	10.70	1.481	1.282	1.725	"	
63	"	183	107	10.68	1.478	1.279	1.724	"	
64	"	184	108	10.67	1.476	1.277	1.723	"	
65	"	185	109	10.65	1.473	1.274	1.722	"	
66	"	186	110	10.64	1.471	1.272	1.721	"	
67	"	187	111	10.62	1.468	1.269	1.720	"	
68	"	188	112	10.61	1.466	1.267	1.719	"	
69	"	189	113	10.59	1.463	1.264	1.718	"	
70	"	190	114	10.58	1.461	1.262	1.717	"	
71	"	191	115	10.56	1.458	1.259	1.716	"	
72	"	192	116	10.55	1.456	1.257	1.715	"	
73	"	193	117	10.53	1.453	1.254	1.714	"	
74	"	194	118	10.52	1.451	1.252	1.713	"	
75	"	195	119	10.50	1.448	1.249	1.712	"	
76	"	196	120	10.49	1.446	1.247	1.711	"	
77	"	197	121	10.47	1.443	1.244	1.710	"	
78	"	198	122	10.46	1.441	1.242	1.709	"	
79	"	199	123	10.44	1.438	1.239	1.708	"	
80	"	200	124	10.43	1.436	1.237	1.707	"	
81	"	201	125	10.41	1.433	1.234	1.706	"	
82	"	202	126	10.40	1.431	1.232	1.705	"	
83	"	203	127	10.38	1.428	1.229	1.704	"	
84	"	204	128	10.37	1.426	1.227	1.703	"	
85	"	205	129	10.35	1.423	1.224	1.702	"	
86	"	206	130	10.34	1.421	1.222	1.701	"	
87	"	207	131	10.32	1.418	1.219	1.700	"	
88	"	208	132	10.31	1.416	1.217	1.699	"	
89	"	209	133	10.29	1.413	1.214	1.698	"	
90	"	210	134	10.28	1.411	1.212	1.697	"	
91	"	211	135	10.26	1.408	1.209	1.696	"	
92	"	212	136	10.25	1.406	1.207	1.695	"	
93	"							"	
94	"							"	
95	"							"	
96	"							"	
97	"							"	
98	"							"	
EXTRA '98	"	133	63	10.44	1.436	1.203	1.701		

FINAL CHARACTERIZATION - HYPOT

DEVICE NO	POST PROOF	ACT	REL	mVD	TO CASE 2nd CLIP	TO CASE 2nd BODY	BETWEEN LEADS	TESTS	
99-16-01	PASS	113 AVG	62 AVG	2.8 AVG	1.926	1.788	1.100		
02	"	107	56	2.15	1.891	1.842	1.907	"	"
03	"	113	52	1.00	1.905	1.847	1.903	"	"
04	"	119	61	1.46	1.939	1.870	1.936	"	"
05	"	112	60	2.17	1.924	1.876	1.900	"	"
06	"	107	53	1.03	1.903	1.876	1.929	"	"
07	"	116	55	1.11	1.913	1.908	1.906	"	"
08	"	121	62	2.97	1.942	1.893	1.959	"	"
09	"	120	56	1.24	1.933	1.903	1.917	"	"
10	"	112	57	2.29	1.938	1.897	1.916	"	"
11	"	116	54	2.27	1.888	1.886	1.924	"	"
12	"	110	46	2.47	1.921	1.872	1.900	"	"
13	PASS	112	47	1.56	1.921	1.897	1.917	"	
14	"	112	56	2.51	1.932	1.891	1.928	"	"
15	"	116	56	2.69	1.936	1.886	1.910	"	"
16	"	115	51	2.03	1.902	1.877	1.908	"	"
17	"	119	51	2.50	1.908	1.876	1.924	"	"
18	"	112	52	2.04	1.908	1.883	1.900	"	"
19	"	114	57	2.77	1.908	1.886	1.891	"	"
20	"	119	49	2.08	1.902	1.890	1.917	"	"
21	"	117	51	1.93	1.908	1.876	1.906	"	"
22	"	116	57	2.68	1.898	1.883	1.891	"	"
23	"	121	48	1.93	1.891	1.898	1.915	"	"
24	"	124	54	2.79	1.926	1.897	1.900	"	"
25	PASS	112	53	2.10	1.898	1.881	1.919	"	
26	"	117	54	2.71	2.030	1.877	1.891	"	"
27	"	113	56	1.07	1.916	1.886	1.919	"	"
28	"	115	57	2.55	1.942	2.007	1.908	"	"
29	"	114	56	2.30	1.927	1.896	1.902	"	"
30	"	121	59	2.16	1.920	1.876	1.897	"	"
31	PASS	116	53	2.07	1.900	1.881	1.910	"	
32	"	117	55	2.65	1.909	1.886	1.928	"	"
33	"	115	51	2.15	1.940	1.880	1.920	"	"
34	"	121	57	2.03	1.926	1.909	1.918	"	"
35	"	116	52	2.13	1.918	1.915	1.899	"	"
36	"	128	55	2.17	1.950	2.000	1.900	"	"
37	—	—	—	—	—	—	—	TEST	
38	—	—	—	—	—	—	—	"	"
39	—	—	—	—	—	—	—	"	"
40	—	—	—	—	—	—	—	"	"
41	—	—	—	—	—	—	—	"	"
42	—	—	—	—	—	—	—	"	"
43	PASS	114	45	2.24	1.923	1.896	1.919	"	
44	"	111	45	2.35	1.924	1.895	1.916	"	"
45	"	103	49	2.93	1.920	1.912	1.917	"	"
46	"	102	46	2.27	1.892	1.888	1.894	"	"
47	"	110	45	2.02	1.916	1.895	1.921	"	"
48	"	117	47	2.26	1.925	1.903	1.917	"	"
49	PASS	115	41	1.99	1.917	1.894	1.911	"	
50	"	112	52	2.35	1.926	1.907	1.925	"	"
51	"	109	47	2.03	1.908	1.916	1.916	"	"
52	"	120	43	1.86	1.928	1.902	1.916	"	"
53	"	113	52	1.99	1.899	1.905	1.918	"	"
54	"	117	47	2.02	1.902	1.897	1.905	"	"

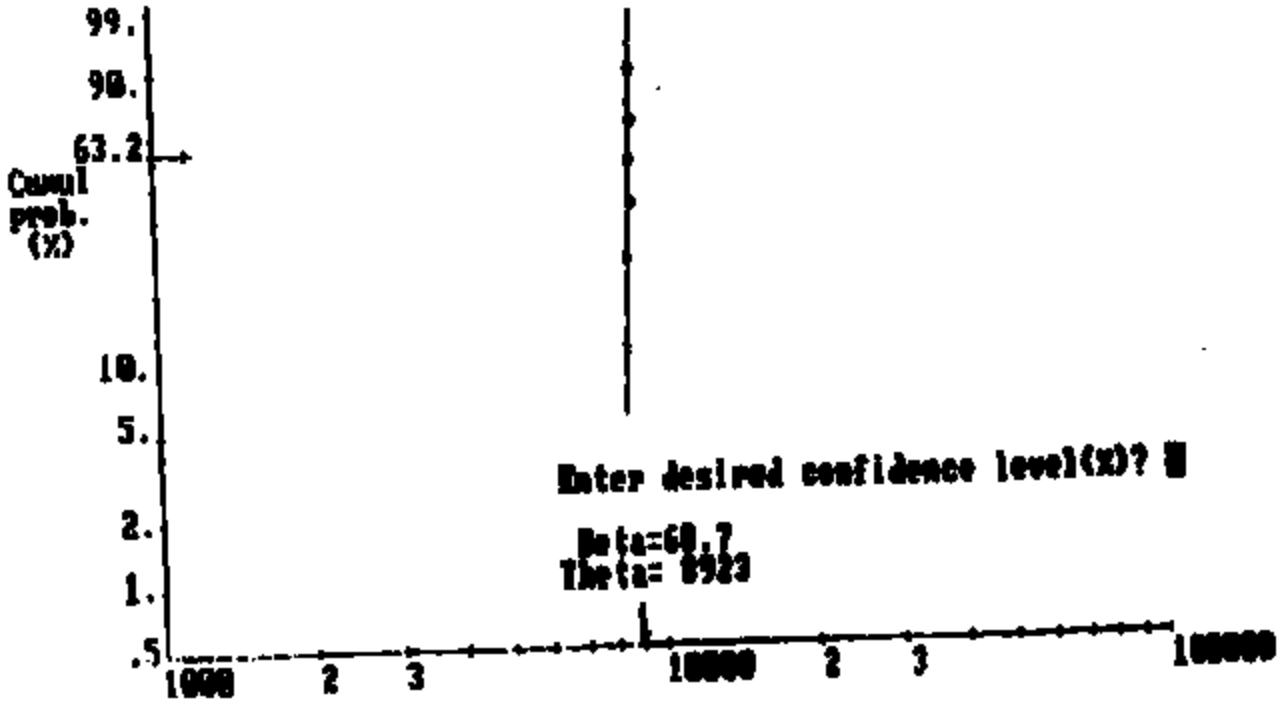
FINAL CHARACTERIZATION - HYPOT (CONT).

DEVICE NO	TEST PROBE	ACT	REL	mVD	TO CASE (+) GND	TO CASE (-) GND	BREAK DOWN VOLTS	TESTS	
05-15-85	PASS	111 mA	5 mA	1.13 mV	1.137	1.173	1.176	PASS	PASS
56	"	104	52	1.03	1.081	1.069	1.078	"	"
57	"	105	55	1.10	1.124	1.123	1.110	"	"
58	"	110	49	1.21	1.165	1.174	1.196	"	"
59	"	123	58	1.28	1.205	1.215	1.213	"	"
60	"	111	57	1.19	1.193	1.182	1.199	"	"
61	PASS	116	61	1.21	1.213	1.210	1.217	PASS	PASS
62	"	113	66	1.17	1.183	1.173	1.186	"	"
63	"	113	62	1.16	1.176	1.170	1.185	"	"
64	"	116	64	1.25	1.196	1.192	1.197	"	"
65	"	114	70	1.19	1.199	1.193	1.198	"	"
66	"	110	61	1.10	1.138	1.131	1.137	"	"
67	"	112	61	1.16	1.185	1.167	1.189	"	"
68	"	113	67	1.21	1.208	1.216	1.207	"	"
69	"	121	63	1.20	1.203	1.196	1.211	"	"
70	"	117	66	1.21	1.201	1.171	1.215	"	"
71	"	111	57	1.16	1.182	1.187	1.196	"	"
72	"	118	63	1.21	1.198	1.215	1.217	"	"

Appendix 4.2.2
Burst test Weibull

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SOC
DATE 91-01-11		PAGE 43

FORM 2296



ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS

SHAPE(BETA) PARAMETER	:	68.720 (illegible)
LOWER LIMIT	:	33.970 (illegible @ 90%)
UPPER LIMIT	:	%139.018203735351G
SCALE(THETA) PARAMETER	:	8923.360 (illegible)
LOWER LIMIT	:	8829.575 (illegible @ 90%)
UPPER LIMIT	:	9018.143

Maximum Likelihood ESTIMATES OF β AND θ @ 90% CONFIDENCE

VALUES FOR SPECIFIED LEVELS OF RELIABILITY

* WEIBULL SLOPE :33.97
* CHARACTERISTIC LIFE : 8829.56

NO.	RELIABILITY(%)	TIME
1	72	8544.9170

Appendix 4.2.3
Vibration

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO MA 02703	REV.
DATE 11-21-11		PAGE 46

FORM 8288

Form 6011

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/02/90

REQUESTED BY RON RUGGERI

REQUIRED COMPLETION DATE 11/09/90

EXTENSION 3409 MS 12-89

DEVICE 57PSL5-3

CHARGE DEPT. NO. 127 I.O. NO. 101093

REFERENCE SPEC. NO. 88-F2VC-9F924-AA

SOURCE OF TEST SAMPLES DESIGN LAB

QUANTITY OF TEST SAMPLES 6

REPORT NO. 1382-110

TESTED BY Lab

COMPLETION DATE 11-26-90

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN VIBRATION TEST PER ATTACHED. THESE DEVICES ARE 160 PSI MAX ACTUATION, THUS I.L.C PRESSURE IS (0.1)(160 PSI) = 176 PSI.

TEST PERFORMED:

Per above.

TEST RESULTS:

See attached

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

1. 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.

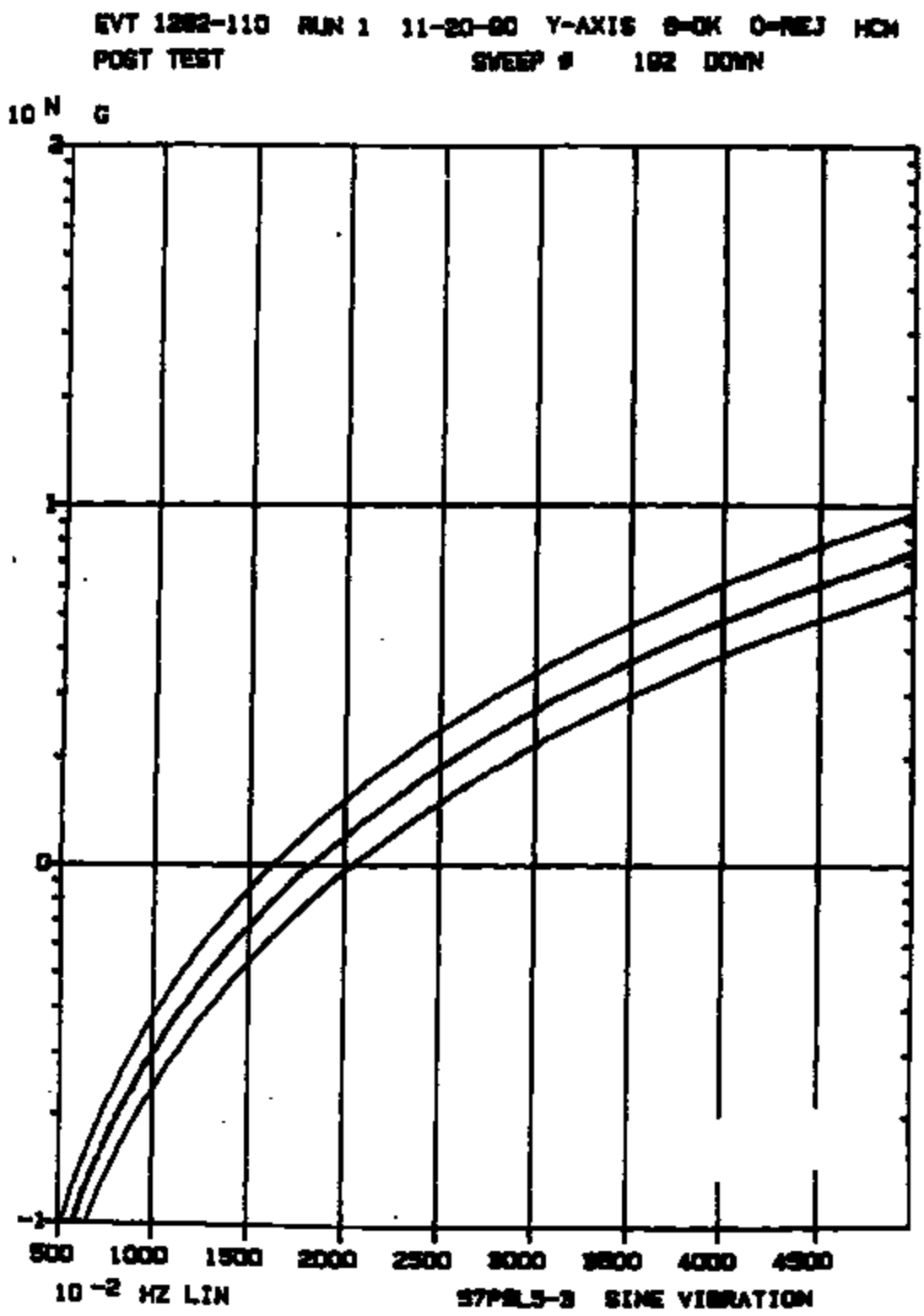
d. Vibrate the switch at 1.5 mm displacement (peak-to-peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period.

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).

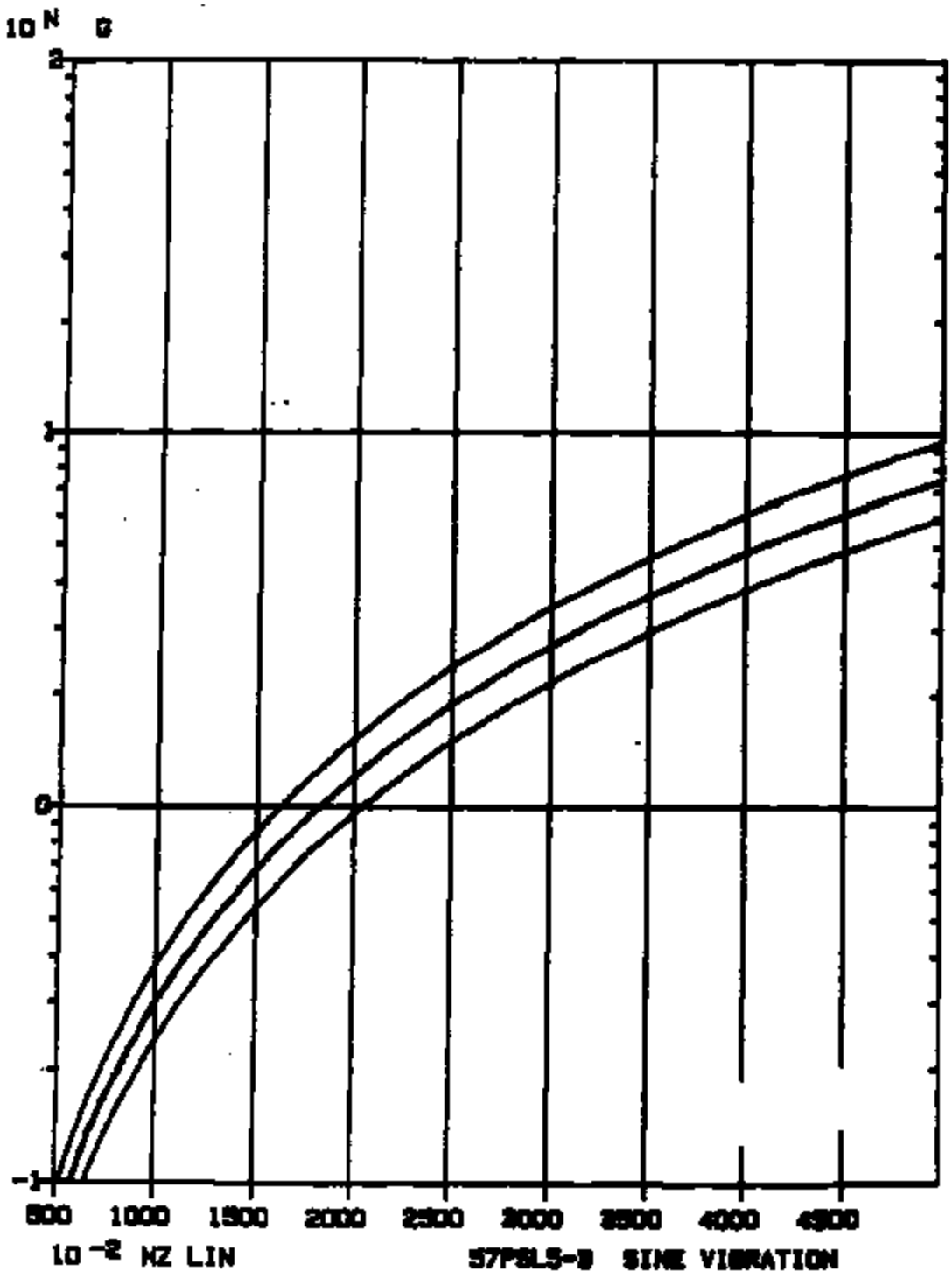
2. Acceptance Requirements

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

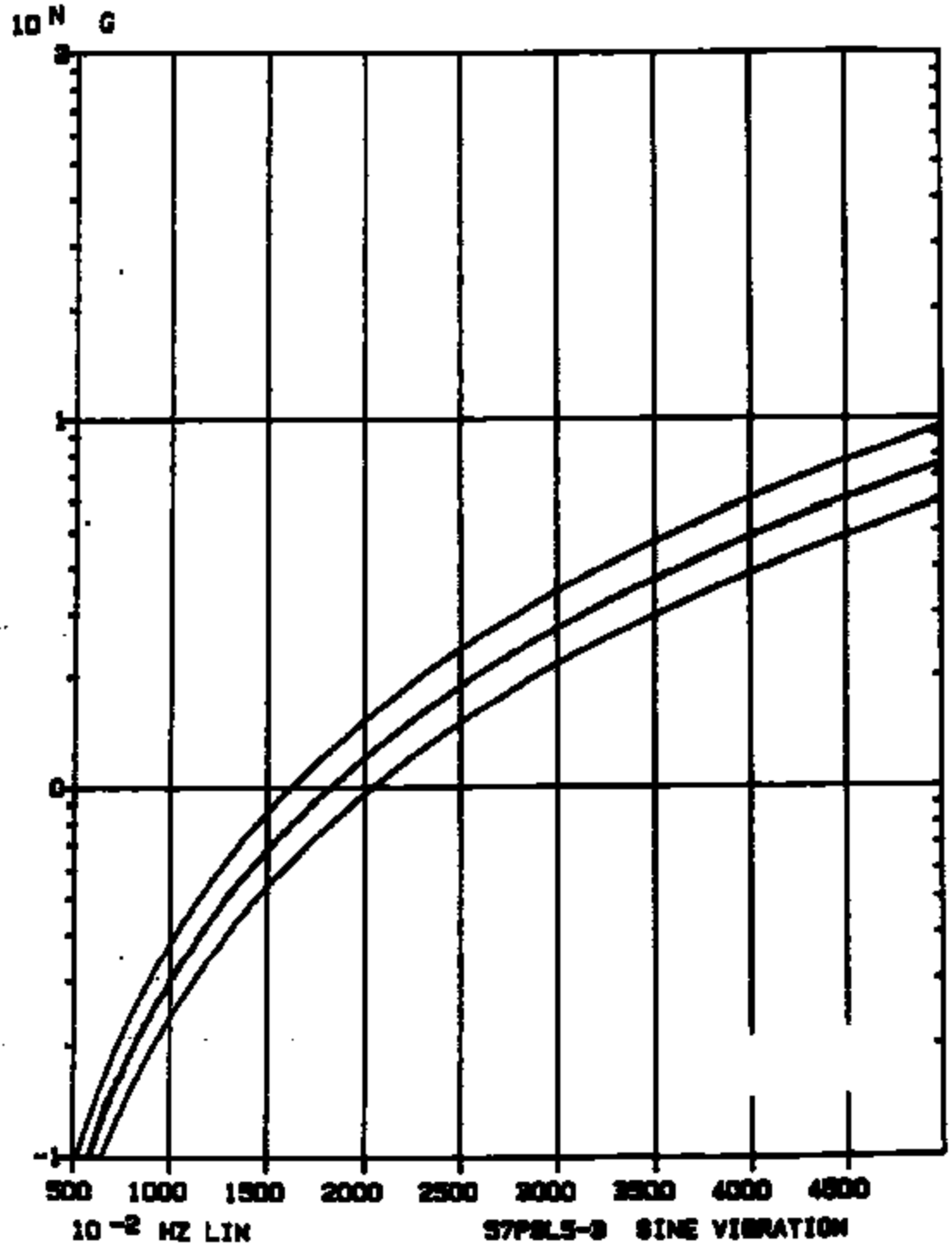
b. Nonconformance is defined as any evidence of leakage or any change in electrical continuity/discontinuity during the vibration cycles, or any switch not meeting the criteria in sections A, B, C, or D. Samples used for this test must be destroyed after all testing is completed.


EVT 1282-110 RUN 1 11-20-00 Y-AXIS 0=OK 0=REJ HCH
POST TEST SWEEP # 102 DOWN
10 N G
2
1
0
-1
500 1000 1500 2000 2500 3000 3500 4000 4500
10 -2 HZ LIN
97PSL3-2 SINE VIBRATION

EVT 1262-110 RUN 2 11-20-00 2-AXIS 0=OK 0=REJ 000
POST TEST SWEEP # 102 DOWN



EVT 1282-110 RUN 3 11-28-00 X-AXIS 0=OK D=REJ HCH
POST TEST SWEEP # 182 DOWN



TI-NHTSA 001614

Appendix 4.2.4
Thermal Cycle Day/Time/Temp

TEST LOT NO.	TEST	ISSUE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-03-11		PAGE 52

FORM 3265

11/14/00

99/15-80

TEMP CYCLE

* NO WORK 11/19 - 11/27

	← HOT →					← COLD →			
	DATE	TIME	VEHID	AMBIENT	*	DATE	TIME	VEHID	AMBIENT
1	11/14/00	1:48	40°C	40°C		11/14/00	3:10	-40°C	-41°C
2	"	3:35	40	41		11/15/00	7:50	-43	-43
3	11/15/00	9:40	40	41	42	"	9:55	-40	-43
4	11/16/00	10:25	41	44	43	"	11:45	-41	-42
5	11/17/00	12:35	1:45	42	30	"	2:06	-41	-42
6	"	2:40	42	41		"	4:06	-42	-43
7	"	4:25	40	41		11/16/00	7:55	-41	-42
8	11/16/00	8:25	42	44		"	9:45	-40	-43
9	"	10:15	42	41		"	11:30	-40	-43
10	"	12:35	41	41		"	2:00	-41	-42
11	"	2:30	40	42		"	3:45	-41	-43
12	"	4:15	42	41		11/17/00	9:10	-41	-43
13	11/24/00	10:00	40	43		"	11:15	-40	-43
14	"	11:50	41	42		"	1:05	-40	-43
15	"	1:40	42	41		"	3:00	-42	-43
16	"	3:35	43	41		11/27/00	7:35	-42	-43
17	11/27/00	8:45	42	41		"	10:00	-40	-43
18	"	10:35	41	41		"	12:30	-43	-43
19	"	2:00	40	41		"	3:20	-40	-43
20	"	3:55	42	41		11/28/00	8:00	-43	-43
21	11/28/00	8:30	40	41		"	9:30	-41	-43
22	"	10:20	43	40		"	11:40	-40	-42
23	"	12:20	40	40		"	1:35	-40	-43
24	"	2:05	43	40		"	3:25	-40	-42
25	"	3:55	43	41		11/29/00	7:55	-43	-43
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									

EFFICIENCY LINE = 23.3%

Appendix 4.2.5
Humidity

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	REV.
DATE 91-01-11		PAGE 31

FORM 8393

m25-3 a

Form 8515

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90 REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90 EXTENSION 12-29

DEVICE STPSLS-3

CHARGE DEPT. NO. 127 I.O. NO. 101093

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

SOURCE OF TEST SAMPLES DESIGN LAB

QUANTITY OF TEST SAMPLES 6

REPORT NO. 1344-110

TESTED BY Lab

COMPLETION DATE 12-3-90

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN HUMIDITY TEST PER ATTACHED.

TEST PERFORMED:

START : 11:30 AM 11-29-90 (THURS.)

STOP : 8:00 PM 12-2-90 (SUN.)

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE.

111. [illegible] (cont'd)

C. 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.

D. 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.

Appendix 4.2.6
Salt Spray

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SEC.
DATE 91-01-11		PAGE 1*

FORM 5298

Form 5819

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90

REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90

EXTENSION 9109 MS 12-29

DEVICE 57PSLS-3

CHARGE DEPT. NO. 127 LO. NO. 101093

REPORT NO. 1345-116

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

TESTED BY Lab

SOURCE OF TEST SAMPLES DESIGN LAB

COMPLETION DATE 12-3-90

QUANTITY OF TEST SAMPLES 6

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN SALT SPRAY TEST PER ATTACHED.

TEST PERFORMED:

In: 0900 11-30-90

Out: 0900 12-3-90

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE

III. [illegible]

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.

Appendix 4.2.7
Fluid Resistance

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-03-11		PAGE 44

FORM 2286

FORM NO. [illegible]

TEST NO. T10077 — TECHNICAL SERVICE LABS — TEST NO. T10077

[redacted]

REPORT OF RESULTS:

complete

DATE RECEIVED 10/13/90 DATE OUT 11-29

EMPLOYEE NO.									
JOB NO.									
NO. ANALYZED									
HOURS WORKED									

TI-NHTSA 001624

Appendix 4.3
TI QAS-296

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 11-01-11		PAGE 42

FORM 8268

TEXAS INSTRUMENTS INCORPORATED

QAS 296

FORD MOTOR COMPANY

TI P/N	CUSTOMER P/N	CUSTOMER
57PSL2-1	ES-E53C-3NB24-AA	FORD-AUTO
57PSL2-2	ES-E57A-3NB24-AA	FORD-TRUCK/MELSEY HAYES
57PSF3-3	ES-E75C-3NB24-AA	FORD-SURFACES/PITTS
57PSL3-1	ES-E73C-3NB24-AA	ANCHOR-SHAN
57PSF3-5	ES-E80C-2C283-CA	FORD-PITTS

		QUALITY ASSURANCE SPECIFICATIONS TEXAS INSTRUMENTS (INCORPORATED)	Q.A.C. NO. 296	REVISIONS # / DATE
			DATE ISSUED 5/1/84	A 8/15/87 B 8/13/88
			Sh 1 of 12	
SUBJECT: Doc 1, Disc 5, QAS 296, Rev. B, Ford-57 Pressure Switch				

LTR	DESCRIPTION	DATE	APPROVAL
	first issue	5/1/84	N.Gerfin
A	Typed to disc 5, and reviewed by QC engineer deleted SEC 5(in-process) added SEC 6(auditing) reliability becomes SEC 5	8/15/87	N. Gerfin
B	Cover Sheet - Add name, change part number	9/12/89	J. Haynes

2.10 Delete
2.11 Change to 2.10
3.0 Delete inspection log sentence
3.2 Add sentence
4.1.1 Change sample sizes: delete (a) (b)
4.1.1.C Revise sentence
4.1.4 Change to 4.1.5, reword sentence
4.1.5 Change to 4.1.4, reword sentence: delete upon comp. - etc. to 4.1.1
5.2.5.4 Change P/N: Act.: cycle counts: delete (A)
8.- Delete section entirely

1.0 SCOPE

This specification establishes the inspection criteria, methods, standards and reaction plans for the inspection of the 5795 pressure switch. It is the intent of this document to meet or exceed requirements set forth by Ford Motor Company purchase orders and engineering standards.

2.0 DEFINITIONS

2.1 This specification is applicable to all production units.

2.2 Unless otherwise noted all sampling plans allow zero defects (reject on one defect).

2.3 Every effort shall be made to employ statistical methods ($\bar{X}$ & R chart, precontrol, etc.) to assure on going process control after capability has been demonstrated.

2.4* A route card shall accompany each sublot of material, after it obtains identity.

2.5 A lot is defined as that quantity of devices which is homogenous. A lot shall not exceed 8 hours of production or 4000 devices. If one day's production exceeds 4000 devices sub-lot numbers may be used. A sub-lot of the same shift's production will be noted with a letter and will not exceed 4000 devices.

2.6 Unless otherwise specified, all tests will be conducted at room ambient conditions.

2.7 Final inspection will be accomplished in accordance with section 3 of this QAS. A Reject Notice (form no. 5341) shall be initiated and the applicable reaction plan will be initiated.

2.8 Special inspections and requirements will be accomplished in accordance with section 4.0 of this QAS.

*The route card shall indicate the link no., description, date, operator number and inspection status. (Where applicable.)

2.9 Reliability testing will be accomplished per section 5.0 of this QAS.

3.0 FINAL INSPECTION TEST

The following inspections will be accomplished on completed devices. When a discrepancy is encountered, Quality Engineering will be notified by a reject notice (Form 5341). Tear down analysis or other means will be employed to ascertain the cause of the discrepancy and to define what corrective actions will be initiated.

3.1 Post Pressure Tester Inspection

Five (5) devices per box selected at random, will be visually checked for:

A. Code - Legibility and correctness of code

B. Crimp Ring and Neuport-free of dents, nicks, scratches, surface contamination and other deformaties.

C. Check base for cracks, bent or deformed terminals and large surface dents.

D. Record results on "Inspection Log Sheet."

3.2 Packing

Check all shipping labels for current Engineering Revision No. and ensure correct customer part number is on label and device. Ensure labels on box are in correct position and legible.

4.0 SPECIAL INSPECTIONS AND REQUIREMENTS

4.1 The following chart is to be used as a guide for special testing of pilots prior to build. Results will be used as the final inspection for these attributes.

RANDOM SAMPLE - 18 PER PILOT LOT

CALIBRATION (4.1.1) - 18 DEVICES

10 DEVICES	4 DEVICES	4 DEVICES
CURRENT LEAKAGE 4.1.2	PROOF 4.1.5	DIMENSIONAL 4.1.6
IMPULSE 4.1.3	CALIBRATION 4.1.1	TERM'L STRENGTH 4.1.7
CALIBRATION 4.1.1	SCRAP	CALIBRATION 4.1.1
CURRENT LEAKAGE 4.1.2		CURRENT LEAKAGE 4.1.2
PROOF 4.1.4		PROOF 4.1.4
BURST 4.1.5		PUSH OUT 4.1.8
SCRAP		VACUUM 4.1.9
		CALIBRATION 4.1.1
		CURRENT LEAKAGE 4.1.2
		PROOF 4.1.5

4.1.1 Calibration/Creep/Voltage Drop (Automatic)

A. Eighteen (18) devices will be 100% tested for calibration, creep, and voltage drop using TI automatic test equipment.

B. All tests will be accomplished after the third cycle with the switch conducting 5 to 10mA at 14.0VDC.

C. The actuation release pressure will meet the customer requirements as indicated on Envelope Drawing.

D. The rate of pressure change (ramp-up,ramp-down) will be 10 PSI/Sec.

E. The disc snap function must occur within 30 milliseconds of the contact continuity to pass the creep function.

F. The voltage drop across the contact area is automatically checked by the test equipment.

G. The voltage drop will not exceed 200 MV with a 5.0 to 10.0mA current flow through the switch.

H. Devices which fail must be segregated from acceptable units and appropriately identified by category.

I. Results of the calibration creep voltage drop test shall be maintained by inspection for 2 years.

NOTE: The Automatic pressure tester provides screen indications for Actuation, Release, Differential, Voltage drop, and Creep Test so discrepancies can be categorized.

4.1.2 Current Leakage Test

Ten (10) devices per sample of eighteen (18) will be measured for current leakage. The current leakage is to be measured with 500VDC, 60 Hz alternating current applied. The current leakage is to be checked as follows:

A. Between the terminals with contacts open

B. Between each terminal and switch housing with contact open

C. Between either terminal and switch housing with contact closed

For lot acceptance the measured leakage current shall not exceed one milliampere. Record results on inspection characteristic data sheet.

4.1.3 Impulse Test

The same ten (10) devices from test 4.1.2 will be used. The switches shall have an impulse test with 14.0 VDC applied and the switch conducting 5.0 to 10.0 ma. The pressure medium used shall be currently released power steering fluid or equivalent. The switches will be cycled as per the table in section 5.0.

NOTE: Upon completion of impulse testing the switches are to be tested per Para. 4.1.1, 4.1.2, 4.1.4. Record results on Inspection Characteristic data sheet.

4.1.4 Proof Test

The same ten (10) devices used in 4.1.3 will be used. The test is to be conducted using power steering fluid or equivalent as pressure medium. Test pressure shall be 2000 PSIG. Test pressure is to be isolated from pressure source and held for not less than 30 seconds. For lot acceptance the switches shall not show any evidence of oil leakage, seepage or drop in pressure greater than 25.0 PSIG. Record results on inspection log. Upon completion of proof testing, the switches shall be tested for Calibration.

NOTE: The test samples must be scrapped after testing.

4.1.5 Burst Test

Four (4) devices per sample of eighteen (18) will be burst tested. The burst pressure medium shall be power steering fluid or equivalent. The switch is to be pressurized to 4000 PSIG and held for 30 seconds minimum. For acceptance all switches will not show evidence of oil leakage or seepage from the switch or threads. Record data on inspection characteristics data sheet.

NOTE: Samples used for this test must be scrapped after testing is completed.

4.1.6 Dimensional Checks

Four (4) devices per pilot will be checked for dimensions as follows:

A. Gland Dimensions Dia. .312 ± .004"

B. Width .060-.080

C. Length 2.450 Max. (Go-gage)

D. Crimp Ring dia. 1.255 Max (no-go gage)

E. Hex 0.562 ± 0.005"

F. Thread (Go/no-go-gage) 3/8 -24-UNF-2A

G. Connector end dimensions (per print)

H. Terminal Location and Dimensions (Go gages)

I. Record results on Inspection Log.

4.1.7 Terminal Strength Test

A. The same four devices used in 4.1.6 will be measured for terminal strength.

B. The switch shall be mounted in a special force test gage.

C. A pendulum shall apply a 10.0 Lb. (.415 lb at 1.0 ft) impact force to the switch housing at the connector end, perpendicular to the center line axis of the switch.

D. Upon completion of the test, the switches shall be tested for Calibration, Current Leakage, and Proof Test.

E. For lot acceptance all switches shall not have any terminal or housing fracture, and must pass test defined above. Record results on "Inspection Log".

4.1.8 Push Out Test

The same Four (4) devices used in 4.1.7 will be tested for push out force. The switches will be mounted in test stand with a force gage. For acceptance, the terminals will withstand a 20.0 lb. axial push force.

4.1.9 Vacuum Test

A. The same four (4) devices used in 4.1.8 will be tested for vacuum.

B. The switches will be mounted in a test port at room temperature using ambient air as a pressure medium.

C. The switches will be subjected to 5.0 cycles of vacuum from atmospheric pressure (760 mm Hg.) to an absolute pressure of 18-22 mm Hg.

D. The vacuum pressure will be maintained for 60 seconds.

E. Upon completion of the test switches will be tested for Calibration, Current Leakage, and Proof Test.

F. For acceptance, all switches must pass all tests.

4.2 Inspection of Salvaged/Reworked Material

All salvaged material will be inspected prior to use. Ten percent (10%) of the salvaged parts or sub-assemblies will be inspected to determine that they conform to print specification or engineering standards. A defect requires notification of the supervisor or group leader by a reject notice (Form #5341) and a resample after corrective action.

4.3 Records Retention

Route cards, control charts, inspection characteristic data sheets, test forms, laboratory test results, gage repeatability studies, and engineering specification test methods must be retained through the current model year and for one year thereafter. All records will be available for review by Ford Motor Co. representatives and copies of individual records will be furnished upon request.

5.0 RELIABILITY

Reliability testing will be accomplished per the following schedule.

5.1

TYPE TEST	SAMPLE SIZE	FREQUENCY	MIN REQ
Humidity	6	2/yr	P60=.85
Salt Spray	6	2/yr	P60=.85
Vibration	10	2/yr	P60=.90
Vacuum	6	2/yr	P60=.85
Temperature Cycle	6	2/yr	P60=.85

NOTE: Additional reliability testing may be accomplished to assure product conformance.

5.2 Test Procedures:

5.2.1 Humidity

5.2.1.1 Mount the switch (45 degrees from vertical) in the test port in a humidity chamber; currently released mating electrical connector must be installed before start of test.

5.2.1.2 Subject the switch to ten (10) humidity cycles as follows:

A. 8 hours at 38°C minimum at 90 to 100% relative humidity

B. Lower temperature to 24°C maximum over a 2 hour period.

C. Raise temperature to 38°C minimum at 90 to 100% relative humidity over a two hour period.

5.2.1.3 Within 15 minutes after completion of the tenth humidity cycle check the switch to sections 4.0. para 4.1.1., 4.1.2 and 4.1.4.

5.2.1.4 Nonconformance is defined as any switch not meeting the criteria in sections 4 para 4.1.1, 4.1.2 and 4.1.4.

*57PSF3-3 to be mounted horizontal

5.2.2 Salt Spray

5.2.2.1 Mount the switch horizontal 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.

5.2.2.2 Expose the switch assembly to 98 hours of salt spray per ASTM-B 117.

5.2.2.3 After exposure, check the switch to sections 4.0 para 4.1.1, 4.1.2 and 4.1.4 using the procedure established in each section.

5.2.2.4 Nonconformance is defined as any switch not meeting the criteria in section 3. Samples used for this test must be destroyed after all testing is completed.

5.2.3 Vibration

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

5.2.3.2 Switches are to be vibrated in all 3 planes with electrical continuity being monitored during the entire test. Vibration tests are to be conducted at room temperature; using brake Fluid, ambient air, or equivalent as the pressure medium.

5.2.3.3 Internal pressure shall be maintained at 50 + 25 PSIG when the switch is in the opened position and 1450± 25PSIG when the switch is in the closed position.

5.2.3.4 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.

5.2.3.4 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)

5.2.3.6 After the entire vibration sequence check the switches to section 4.0, para 4.1.1, 4.1.2, and 4.1.4 using the procedures established in each section.

5.2.3.7 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 4.0, para 4.1.1, 4.1.2 and 4.1.4. Samples used for this test must be destroyed after all testing is completed.

5.2.3.8 As an alternate procedure the vibration test specified in the currently released Light Truck Engineering Power Steering Pressure Switch.Specification may be used.

5.2.4 <u>Vacuum</u>

5.2.4.1 Mount the switch in the test port. Test to be conducted at room temperature using ambient air as the pressure medium.

5.2.4.2 Subject the switch to 5 cycles of vacuum from atmospheric pressure (760 mm Hg) to an absolute pressure of 18-22 mm Hg. Maintain the vacuum for a minimum of 60 seconds.

5.2.4.3 Check the switch to sections 4.0, para. 4.1.1., 4.1.2 and 4.1.4 using the procedure established in each section.

5.2.4.4 Nonconformance is defined as any switch not meeting the criteria in section 4.0, para. 4.1.1., 4.1.2, and 4.1.4.

5.2.5 <u>Temperature Cycle</u>

5.2.5.1 Mount switch in the test port. Temperature test to be run using currently released power steering fluid.

5.2.5.2 Soak switches for a minimum of 8 hours at -40°C. maximum. After soak, while the switch/fluid are still at this temperature, check the switch per sections 4.0, para 4.1.1, 4.1.2, and 4.1.4.

5.2.5.3 Gradually increase the fluid temperature to 275°F and the ambient temperature to 225°F over 2 hours time (5°F/minute maximum). Soak switches for a minimum of 8 hours at 275°F minimum fluid temperature and 229°F minimum ambient temperature. After soak, while the switch/fluid are still at this temperature, check the switch per section 4.0, para 4.1.1, 4.1.2, and 4.1.4.

5.2.5.4 Nonconformance is defined as any switch not meeting the criteria in sections 4.0, para 4.1.1, 4.1.2, 4.1.4 after either soak period. Calibration settings after soak period are to be as follows:

Actuation Pressure 450 PSI + or - 100 PSI
Release Pressure 200 PSI Min.
Minimum Differential Pressure 150 PSI

PN	Actuation	Release	Differential	Cycles
57PSF 3-3	400 + or - 50			500,000
57PSF 3-5	375 + or - 25			500,000
57PSL 2-1	450 + or - 50	200 Min	150 Min	225,000
57PSL 2-2	350 + or - 50	120 Min	50 Min	225,000
57PSL 3-1	450 + or - 50	200 Min	150 Min	225,000

NOTE: For calibration Test Voltage 13.0 + or - 1VDC

Test Current 5-10 Milliamps
Test Temp 16 to 35 Deg C

6.0 AUDITING

6.1 To provide uniform and systematic procedures for conducting an audit for a single operation or an entire product line. Audits will be conducted to insure all operations are in control and being performed to the latest manufacturing standards and procedures and comply to both internal and customer drawings and specifications.

6.2 The detailed instructions for conducting an Audit will be found in QAS 299.

6.3 Areas to be Audited

A. PROCESS SPECIFICATIONS (OPERATIONS)
B. SPC PROCESS SPECIFICATIONS
C. ROUTE SLIPS
D. PREVENTIVE MAINTENANCE
E. BLUE PRINTS
F. TOOLS
G. QUALITY (PRODUCE/OPERATION)
H. STATISTICAL PROCESS CONTROL (SPC)
I. HOUSEKEEPING AND MATERIAL IDENTIFICATION
J. SAFETY

Appendix 4.4
SAE J512 OCT 80 Information

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SPEC.
DATE 91-01-31		PAGE 43

FORM 5298

-MSG M#= 00084680 FR=SBO1 TO=CPPC SENT=01/09/91 01:56 PM
R#=088 ST=C DIV=0050 CC=00175 BY=SBO1 AT=01/09/91 01:56 PM

TO: Vinney Barros VINN
Dave Czarn ZARN
Mike DeMattia PCQA
Charlie Douglas CPPC
Joe Schuck WELZ
Matt Sellers PCME

FR: Steve Offiler SBO1

SJ: SAE J512 Update - Contact with SAE Committee members

My purpose in contacting the SAE committee which writes J512 was to discuss the issues we've run into; specifically the difficulty in producing and measuring the tight tolerance on the chamfer, and the tolerance stack-up which, at one extreme, allows a questionable hydraulic seal as J512 is presently written.

I spoke with the chairman, Harry Patel (Parker-Hannifin, 614-279-7070) who informed me that a ballot was filed on 90-12-21 to change the tolerances in the spec. from +/- .002" to +/- .005". Harry then referred me to the committee member who is most expert in automotive fittings and is the same man who wrote the ballot, Stan Bragdon (Parker-Hannifin Brass Products Div., 616-694-9411).

I spoke with Stan, who seems to be very reasonable and helpful. He explained that he received inputs (from where? is this co-incidence? or is Ford or one of the Tier-1's involved?) indicating that the +/- .002" tolerance was unrealistically tight, and suggesting a change to +/-.005". His role (until I contacted him) was to simply write the ballot, not necessarily to perform any analysis. The ballot must be approved by the rest of the committee which is made up of both "producers" and "users".

Apparently whoever suggested the tolerance change was unspecific as to how to apply it, because Stan chose to maintain the old minimum (in our size this is .233"), so the new tolerance becomes .238" +/- .005". This shifts the nominal UP by .003" which is the wrong direction by my analysis. I explained this to Stan, who is now VERY interested in seeing my tolerance stack-up analysis. I plan to immediately pull together a clear, concise report based on the many pages of calculations I've amassed and send it to Stan. He will then analyze the situation to determine if he agrees with me, and possibly modify the ballot.

What this all means is that the relaxed spec's which Bruce Pease, Jim Cossins (Kelsey-Hayes) and I have agreed upon may in fact become the SAE standard if all goes well.

Regards,
Steve O.

TEXAS INSTRUMENTS

09 January 1991

Mr. Stan Kingdon
Parker-Hannifin Brass Products Div.
300 Parker Drive
Otsego, MI 49078

Stan:

I'd like to first express my appreciation for your consideration of this matter, regarding the changes to dimensions and tolerances of Figure 5 and Table 5 of SAE J512 OCT 80. Per our telephone conversation of 08 January 1991, I have enclosed three scale drawings labelled Drawing 1, Drawing 2, and Drawing 3. Note that each of these drawings is per the 3/16" nominal tube dimensions. As I describe each of the drawings, I will simultaneously explain the reasoning behind the recommended changes to J512. This work is the result of mutual efforts between myself, and engineers at Ford Motor Co. and Kelsey-Hayes Co.

****

DRAWING 1
This is a cross-section assembly drawing of the "female" J512 brazed Plate part per Fig. 5A and Table 4, so-called female because it is the female-threaded component and the "male" plug per Fig. 6 and Table 5. This drawing shows a potential problem in tolerance stack-up.

The female's cone seat is at its smallest, i.e. largest dimension "K", smallest dimension "I", smallest dimension "E" with most acute angle, 41°. The male plug's chamfer is at its largest, i.e. largest dimension "E" with most acute angle, 41°.

Two problems are shown in Drawing 1. One is that the male becomes too large the sealing surfaces can mate. The other is that when dimension "K" of Fig. 5 is at the minimum of .030" as shown, that puts the required location of the last female thread at .012" (dimension "J") which is below the J512 allowable min of .013". In other words, either the threads in the female are not deep enough, or conversely the male thread is too close to the end of the part.

In order to ensure that the sealing surfaces always meet first, i.e. to avoid either hammering or wearing out of thread, it is proposed that dimensions be changed in two areas. One, dimension "E" of Fig. 6 be reduced, and two, dimension "K" of Fig. 5 be enlarged. Note that your present ballot to change tolerances of J512 actually increases the nominal of dimension "E", which is contrary to this analysis.

After requesting extensive quotes for producing the male part, from screw-machine houses, cold-headers, and major brake component manufacturers, TI has discovered that the J512 tolerance of .004"(total) on dimension "E" of Fig. 6 is inordinately costly to produce. Thus, another factor to consider while recommending changes is to increase the tolerance to make the part economical to produce. Yet another issue is the measurement technique for dimension "E". Neither standard chamfer gaging practices, nor optical techniques, produce acceptable Gage Repeatability and Reproducibility (R&R). The gaging issue is positively influenced by the increase in tolerance as well.

DRAWING 2
This drawing is a cross-section similar to Drawing 1. Shown are the female at its smallest cone seat dimensions, with two overlaid views of the male, one at max. dimension "E" and min. dimension "K" the other at min. dimension "E" and max. dimension "K" using the new, proposed dimensions.

The proposed dimension changes for "E" as shown, are: .233"-.237" (old) becomes .230" (5.84mm) - .230" (5.85mm) (new). The proposed dimension changes for "K" as shown, are: .030"-.050" (old) becomes .043" (1.10mm) - .055" (1.40mm) (new). Note on metric conversions: slight roundoff errors may be apparent. This is due to the fact that both decimal inch and metric dimensions are in use simultaneously i.e. TI's customer prefers metric while the suppliers prefer decimal inch.

Both problems explained above, bottoming and running out of thread, have been excelled. In the worst-case, no bottoming-out can occur as shown in Drawing 2; and the required position of the last full thread in the female is correctly located above the spec. requirement of .013" max.

DRAWING 3
Included for information, this drawing is the compliment to Drawing 2 where the female is shown at its largest cone seat dimensions, again with two overlaid views of the male.

****

I am presently conducting an experiment to test the integrity of the hydraulic seal using the new dimensions. Male parts have been created at each end of the new dimensions (.230"-.230"), including the maximum runout, and a quantity of off-the-shelf female parts have been measured and sorted to obtain parts near each end of the Fig. 5A dimensions. A matrix (high/high, high/low, low/high, low/low) has been assembled, proof-tested to 4000 psi, and is presently undergoing a 500K cycle life test combined with a thermal cycle test. At the time of this writing roughly 300K cycles are complete with no evidence of leakage whatsoever from any of the test combinations.

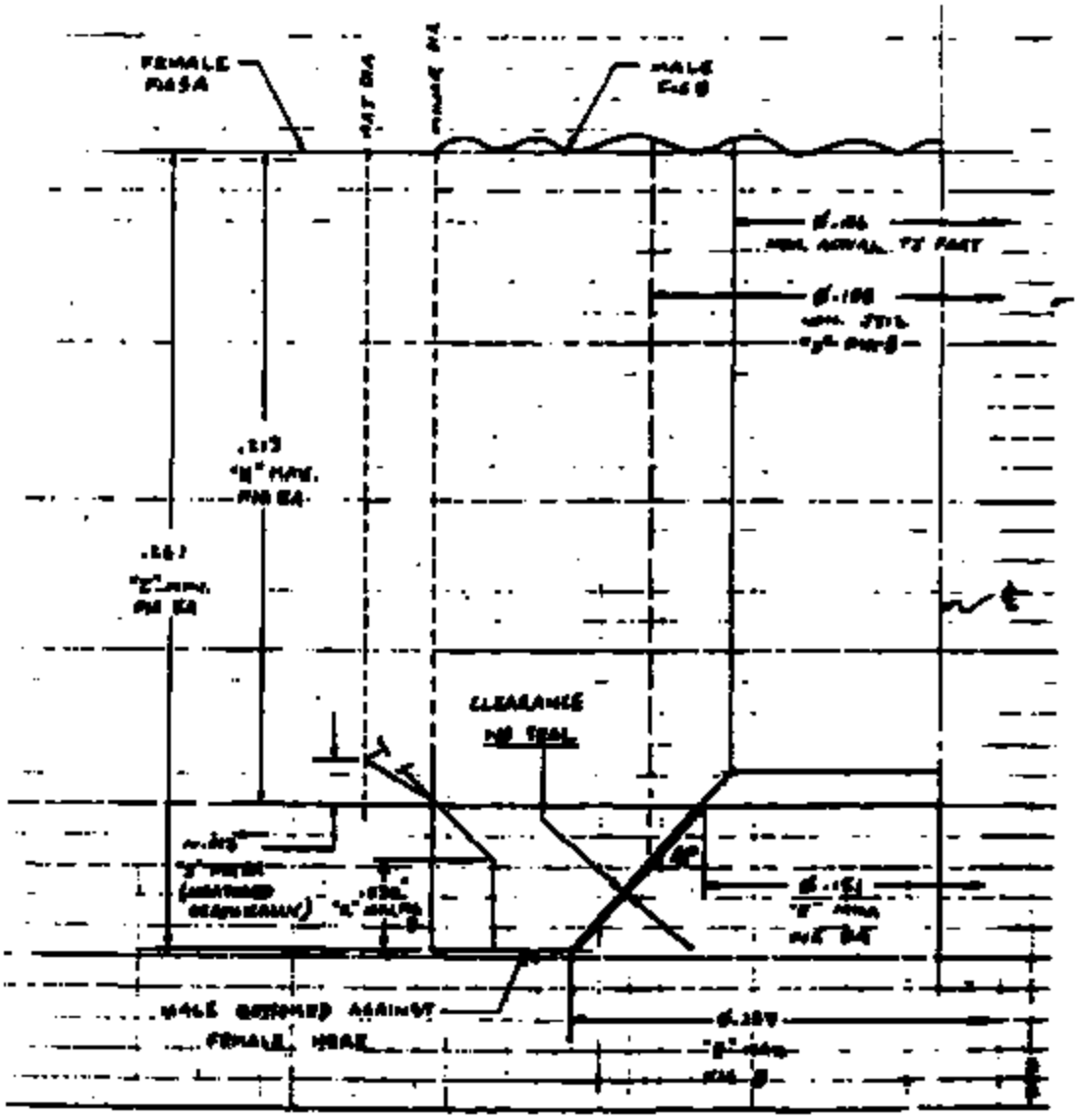
In closing, Stan, it would be greatly appreciated if the SAE J512 committee would consider the above information and recommendations as part of your ongoing ballot to increase the tolerance on dimension "E" from .004(total) to +/- .005.

Thanks and regards.

Stephen B. Offiler, Design Engineer
Texas Instruments Inc.
34 Forest St. MS 12-29
Attleboro, MA 02703
Phone: (508) 699-1382 Fax: (508) 699-3153

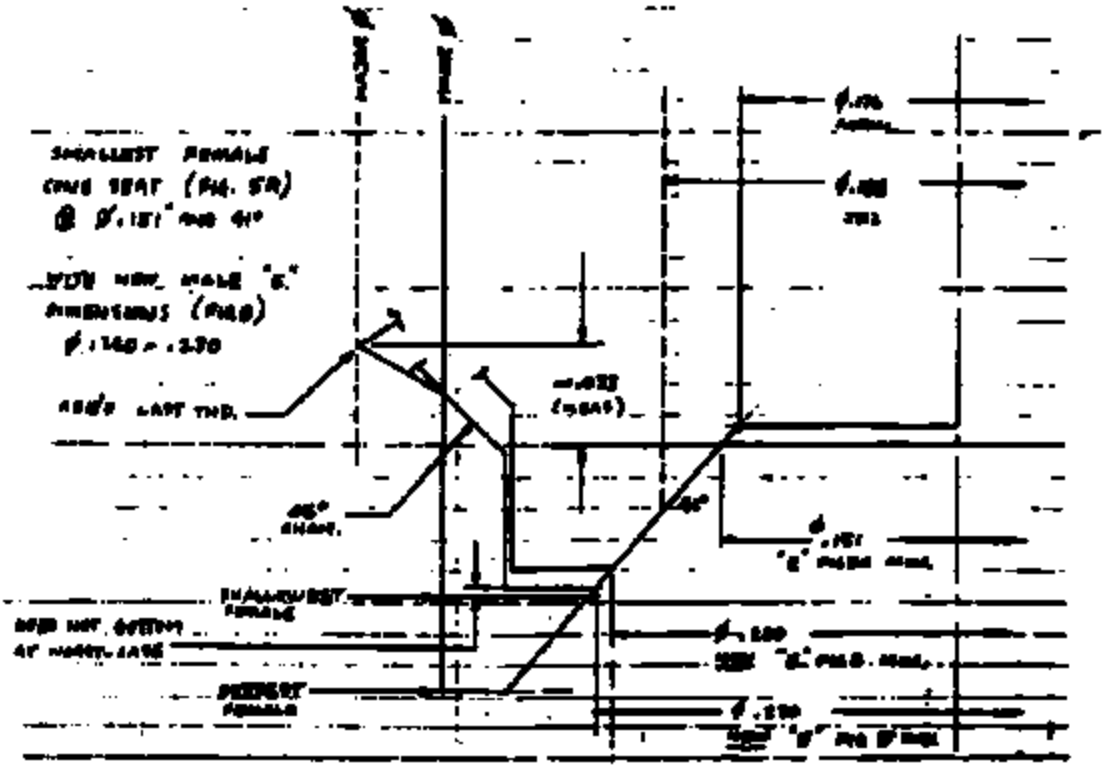
Enclosures

DRAWING 1



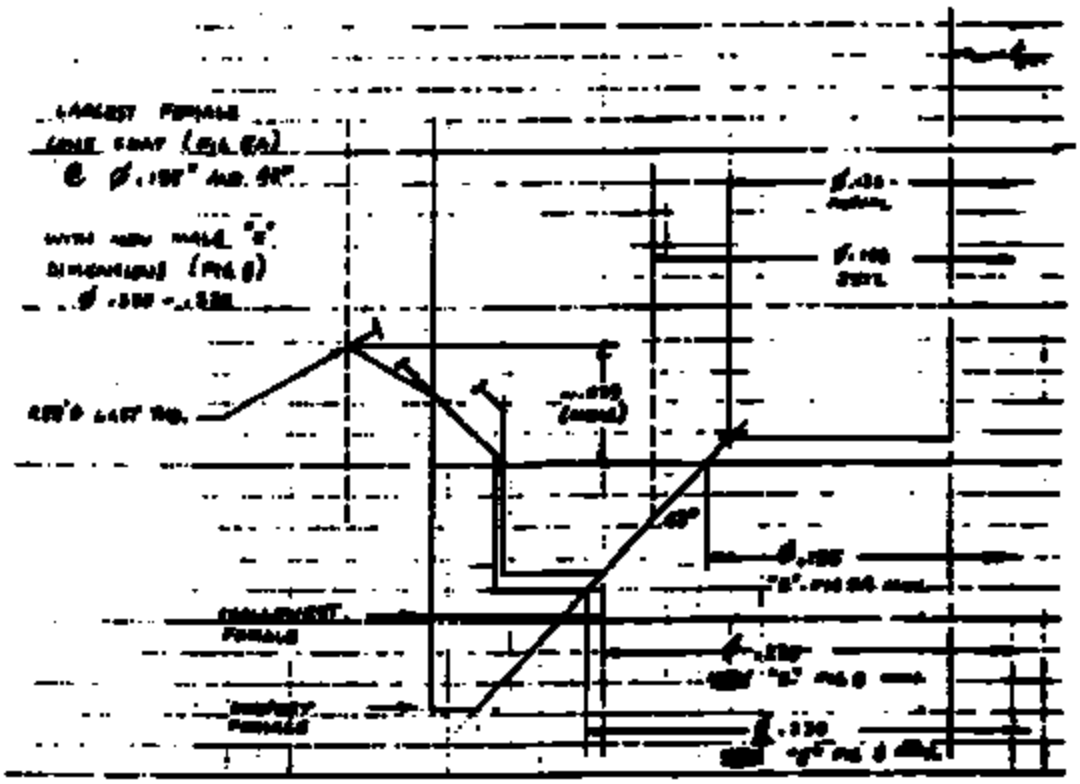
BY: STEVE SPRAGUE
DT: 9/09/87
SCALE: 20X

DRAWING 2



BY: STEVE OFFNER
DT: 900727
SCALE: 20X

DRAWING 3



BY: STEVE ERWILOK

DT: 990527

SCALE: 20X

Appendix 4.5
Supplier Request for Engineering Approval

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP	DEPT.
DATE 91-01-11		PAGE 91

FORM 5296

SEE TO SIDE OTHER CHANGE INFO 1-89
M J SCHER

No. 14766

Supplier Request for Engineering Approval

DATE November 3[illegible], 8[illegible]

SUPPLIER TO COMPLETE

SUPPLIER NAME AND ADDRESS

Texas Instruments Inc., 34 Forest Street, Attleboro, MA 02703

FORD AND/OR SUPPLIER PART NAME AND PART NUMBER OF ASSEMBLY AND ITS COMPONENTS

SWITCH ASSY - SPEED CONTROL DEACTIVATE

(DELTA) F2VC - 9F924 - BA

CHANGE: ☒ DESIGN ☐ COMPOSITION ☐ PROCESSING DESCRIPTION

The production part, as shown on released drawing, utilizes an offset polarity key. At the time of ISIR #3 testing, mating electrical connectors were not available. Thus, testing proceeded using a standard centered polarity key.

EFFECT OF CHANGE

The position of the polarity key has no effect on function or performance of the switch.

INTERCHANGEABILITY AFFECTED ASSEMBLY ☒ YES ☐ NO COMPONENTS ☒ YES ☐ NO	TOOLING OR FACILITY CHANGES REQUIRED ☐ YES ☒ NO IF YES, COST EFFECT $
TIME TO INCORPORATE CHANGE AFTER APPROVAL NONE	PIECE COST AFFECTED ☐ YES ☒ NO IF YES, COST EFFECT $
WILL INCORPORATION OF CHANGE AFFECT SHIPPING SCHEDULE? ☐ YES ☒ NO	SIGNATURE [signature]

PRODUCT ENGINEERING TO COMPLETE

FOR IN PROCESS ☒ APPROVED ☐ REJECTED BY R.T. Hooge DATE 10/3/11	APPROVED BY [signature] DATE 10/31/11
BLANKET APPROVAL GRANTED FOR PRODUCTION CHANGES WHICH ARE SAME AS DESCRIBED ABOVE ☐ YES ☒ NO	SUPPLIER CHANGE RESPONSIBILITY REVISED ☐ YES ☒ NO

REASON FOR REJECTION OR QUALIFYING CONDITIONS OF ACCEPTANCE

* This approval is granted upon the understanding that it is advisory in nature and in no manner changes the Seller's original responsibility for insuring that all characteristics, designated in the applicable engineering specifications and/or released or tentative or preliminary listed and approved, are maintained. Seller accepts full responsibility for the changes or type of changes noted above and that such changes result in less satisfactory performance than experienced with the originally approved item. Seller will fully reimburse the Buyer for all expenses incurred to correct the deficiency.

C.A.S. Part No. 1638 (Previous editions may NOT be used)

DRAWINGS AVAILABLE UPON REQUEST