EA02025

TEXAS INSTRUMENTS, INC.'S

9/10/03 ATTACHMENT TO ODI

BOX 4, PARTS A - N

PART M

REPORT OF ISR TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH
P8/92/80

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 92-08-12		PAGE

FORM 5288

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1.0 GENERAL

1.1 Customer: Ford Motor Company P.I.A. from ITT Teves

1.2 Part Numbers:

1.2.1 Ford P/N: F3DC-9F924-AA

1.2.2 ITT Teves P/N: 10.0522 - 9907.1

1.2.3 Texas Instruments P/N: 77PSL5-2

1.3 Engineering Specification: (inv delta) ES-F2VC-9F924-AA

1.4 Date of Completion: 920811

1.5 Quantity of Units Tested: 30

1.6 Disposition of Tested Units: All devices are presently retained under quarantine, completely separate from any production devices, to be destroyed per the ES at a later date after full ISR approval is obtained.

1.7 TI test series number: 245-15-80

1.8 TI Pressure Switch test report number: PS/92/80

2.0 OBJECTIVE

This testing was performed to demonstrate the ability of 77PSL5-2 to conform to customer specifications given in (inv delta) ES-F2VC-9F924-AA, in fulfillment of the requirements of the Initial Sample Report. Units tested were built using fully qualified production components and production assembly equipment.

3.0 TEST PROCEDURES AND RESULTS

All switches were tested per Ford Engineering Specification (inv 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 requires elaboration, a complete explanation of the procedure is presented. For all tests, raw data is included in Appendix 4.2.1.

Please note that validation of the SHO Taurus switch (F3DC-9F924-AA) was combined with the Crown Vic/Grand Marquis switch (F2AC-9F924-AA), as previously concurred by Bruce Maeroff, Supervisor, Passenger Car Brake Systems Engineering Dept, Ford Motor Co. See Appendix 4.3 for the memorandum dated 14 April 1992 which stated the rationale for combining these tests.

The differences between F2AC and F3DC are as follows: F3DC contains an orifice within its fluid passage which is nominal 0.5mm in diameter, and located at a minimum depth of 2.5mm. The port fitting of F2AC is zinc plated with yellow chromate, while F3DC substitutes clear chromate for the purpose of visual identification. Otherwise, these two parts are absolutely identical.

3.0 TEST PROCEDURES AND RESULTS, CONTINUED

The entire battery of ES tests was performed on F2AC, while only those tests which could possibly be affected by the presence of the orifice were performed on F3DC. These tests are Impulse and Thermal Cycle. The purpose of the orifice (also known as a "snubber") is to restrict the fluid flow velocity, which tends to reduce the audible noise and tactile feel during switching action. These two tests are the only ES tests where fluid flow is present and therefore a potential factor. Environmental resistance of the yellow versus clear chromate is not included as a possible differentiating factor for the following reasons: TI has been supplying hydraulic pressure switches to Ford for power steering and brake applications since 1984, and variants of these devices have used both yellow and clear chromates. At no time has any testing of these devices shown any difference to exist. This is further supported by verbal inputs from experts within TI's in-house plating operation.

3.1 CALIBRATION

3.1.1 Devices tested: 245-15-01 thru 72 and -81 thru 110

3.1.2 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The change in continuity is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

3.1.3 Equipment: Custom TI designed and built pressure check station, using Haise 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.

3.1.4 Initial Results: Prior to proof testing, the average actuation was found to be 125 psi with a sigma of 6.0; after proof the average actuation was 129 psi with a sigma of 5.3. The average shift is 3.2%. Prior to proof testing, the average release was found to be 111 psi with a sigma of 6.8; after proof the average release was 115 psi with a sigma of 8.0. The average shift is 3.6%.

3.1.5 Final Results: Prior to proof testing, the average actuation was found to be 130 psi with a sigma of 5.4; after proof the average actuation was 129 psi with a sigma of 5.4. The average shift is -0.8%. Prior to proof testing, the average release was found to be 107 psi with a sigma of 7.3; after proof the average release was 107 psi with a sigma of 6.8. The average shift is 0.

3.2 VOLTAGE DROP

3.2.1 Devices tested: 245-15-01 thru 72 and -81 thru 110

3.2.2 Procedure: Voltage drop is checked simultaneously with Calibration (see 3.1.2). The measurement is taken at room temperature using ambient air as the pressure medium. For the purpose of stabilization, data is 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The voltage drop is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

3.2.3 Equipment: Fluke Model 8020B Digital Multimeter, calibrated quarterly, used in conjunction with the continuity equipment in 3.1.3.

3.2.4 Initial results: Values for all devices fell below the specification of 200 millivolts maximum by close to two orders of magnitude; no specific statistics calculated for this reason.

3.2.5 Final results: With the exception of parts undergoing Impulse testing (devices 245-15-81 thru 104), all final results were comparable with initial results. The Impulse parts experience an increase in the voltage drop reading due to the specified 25,000 cycles run at full electrical load, which causes a certain amount of normal erosion of the contact surfaces. All 24 Impulse devices still fell significantly below 200 mV maximum, and statistics show a Cpk of 3.47.

3.3 CURRENT LEAKAGE

3.3.1 Devices tested: 245-15-01 thru 72 and -81 thru 110

3.3.2 Procedure: Per the ES section III. C. This test is conducted as a pass/fail.

3.3.3 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%).

3.3.4 Initial results: All devices passed.

3.3.5 Final results: All devices passed.

3.4 PROOF

3.4.1 Devices tested: 245-15-01 thru 72 and -81 thru 110

3.4.2 Procedure: Per the ES section III. D. This test is conducted as a pass/fail. The test pressure specified on the part drawing is 3000 psi.

3.4.3 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.

3.4.4 Initial Results: All devices passed.

3.4.5 Final Results: All devices passed.

3.5 IMPULSE

3.5.1 Devices tested: 245-15-81 thru -104.

3.5.2 Procedure: Per the ES section III. E.

3.5.3 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 (figure 4) used in the last 25K cycles.

3.5.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.6 BURST

3.6.1 Devices tested: 245-15-67 thru 72.

3.6.2 Procedure: Per the ES section III. F. After holding 7000 psi for 30 seconds as specified, the devices were inadvertently pressurized to approx. 7600 psi.

3.6.3. Equipment: Same as 3.4.3, with the addition of Enerpak gauge reading to 10,000 psig with 100 psi increments, resolvable to 50 psi., calibrated quarterly.

3.6.4. Results: All six devices passed 30 seconds at 7000 psig without evidence of fluid leakage or seepage from the switch or threads.

At 7600 psi, one device (-70) displayed evidence of fluid seepage.

3.7 HUMIDITY

3.7.1 Devices tested: 245-15-25 thru -30.

3.7.2 Procedure: Per the ES section III. G. Please note that performing a full characterization per the ES consists of measurement of actuation, release, voltage 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 (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.

3.7.3 Equipment: Humidity chamber RK model 55.

3.7.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.8 SALT SPRAY

3.8.1 Devices tested: 245-15-31 thru -36.

3.8.2 Procedure: Per the ES section III. H.

3.8.3 Equipment: Harshaw salt spray chamber.

3.8.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.9 VIBRATION

3.9.1 Devices tested: 156-15-61 thru 66.

3.9.2 Procedure: Per the ES section III. I.

3.9.3 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; 160 psig * 1.1 = 176 psi minimum.

3.9.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.10 TERMINAL STRENGTH

3.10.1 Devices tested: 245-15-13 thru -24.

3.10.2 Procedure: Per the ES section III. J.

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

3.10.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.11 VACUUM

3.11.1 Devices tested: 245-15- 55 thru 60.

3.11.2 Procedure: Per the ES section III. K.

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

3.11.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.12 TEMPERATURE CYCLE

3.12.1 Devices tested: 245-15-105 thru 110.

3.12.2 Procedure: Per the ES section III. L.

3.12.3 Equipment: Same as 3.5.3.

3.12.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.13 FLUID RESISTANCE

3.13.1 Devices tested: 245-15-01 thru -36.

3.13.2 Procedure: Per the ES section III. M.

3.13.3 Equipment: Fluids as called out in ES table in III. M. 1. c. plus appropriate beakers and storage apparatus; vented hood.

3.13.4 Results: The 36 devices were divided into groups as follows for subsequent testing. Results of these tests are reported in the section indicated.

3.13.4.1 Impulse (3.5), -01 thru -12

3.13.4.2 Terminal Strength (3.10), -13 thru -24.

3.13.4.3 Humidity (3.7), -25 thru -30.

3.13.4.4 Salt Spray (3.8), -31 thru -36.

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 93-09-13		PAGE 11

FORM 8298

Engineering Specification

PART NAME	PART NUMBER
SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE	▽ E5-9270-9F924-AA

LET																			
PR																			
LET																			
PR																			

DATE	LET	PR	REVISIONS	DR	CK
			ADDED DATA TO COMPLETE SPEC. & RETYPED		
4/11/90			NCD06E10079779602		

REFERENCE

PREPARED/APPROVED BY
B.S. Peo-ca 9.09.10

ORDERED BY | DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR

DESIGN ENGINEERING MGT.

MANUFACTURING ENGRG.

QUALITY CONTROL

PURCHASING

SUPPLIER QUALITY ASSISTANCE

ELECTRONICS DIVISION

▽ CONTROL ITEM - THE ▽ SYMBOL ALSO DENOTES PRODUCT ENGINEERING DESIGNATED CRITICAL CHARACTERISTICS AND ADDITIONAL CRITICAL CHARACTERISTICS IDENTIFIED BY PROCESS CONTROL PLANS WHICH APPEAR ON THE Q-101 CONTROL PLANS WHICH REQUIRE PRODUCT ENGINEERING APPROVAL

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 Sect. 3.3, "Engineering Specification (ES) Test Performance Requirements" shall be invoked.

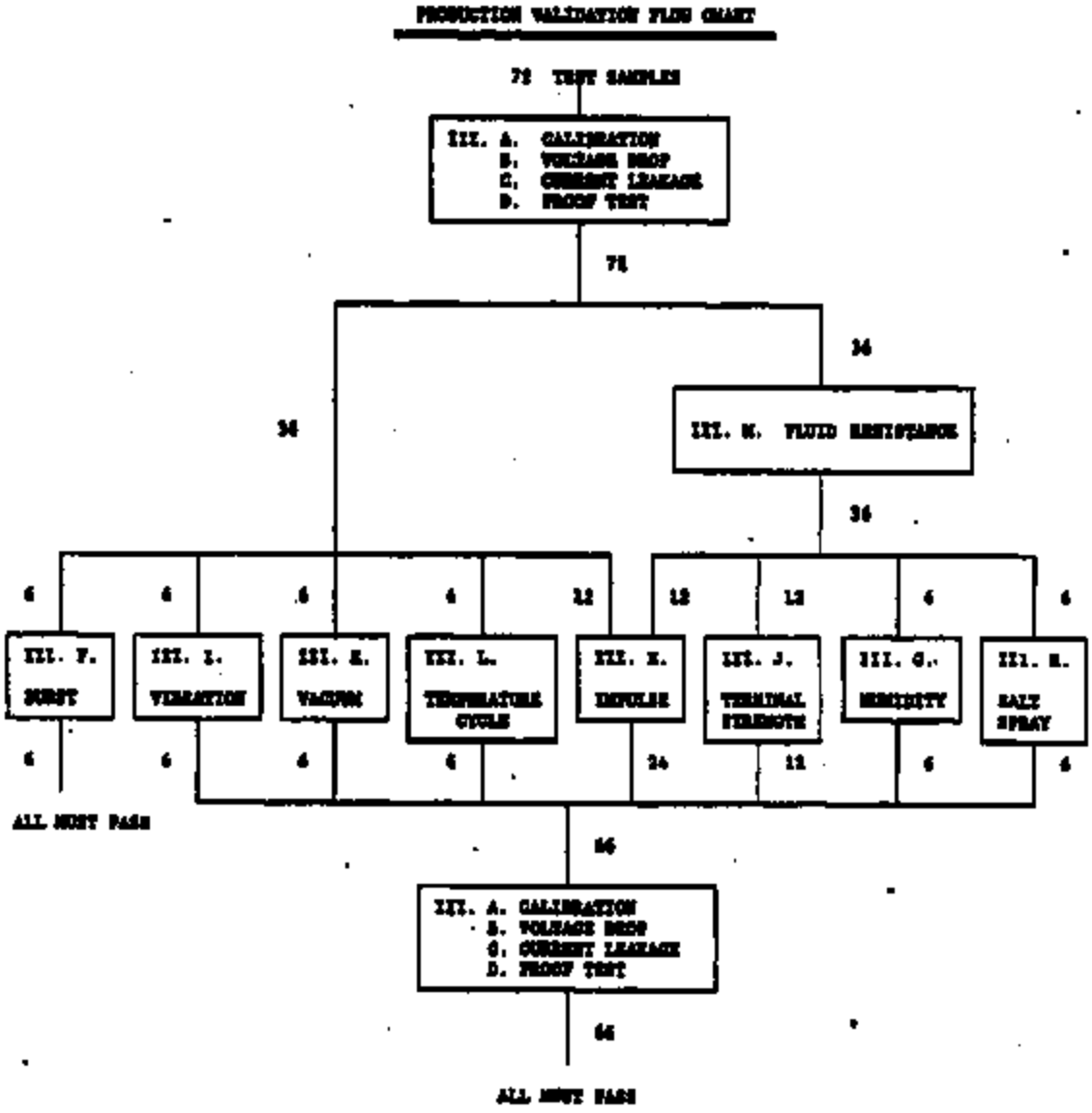
T1-NHTSA 006750

SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
▽ A	Calibration	72	F90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	F90-.96	12/Mo.	F90-.84	4/Lot	" " "
C	Current Leakage	72	F90-.96	3/Mo.	F90-.56	4/Lot	" " "
D	Proof Test	72	F90-.96	12/Mo.	F90-.84	4/Lot	" " "
F	Burst	6	F90-.72	3/Mo.	F90-.56	4/Lot	" " "
I	Vibration	6	F90-.72	3/Mo.	F90-.56	6/6 Mo.	F90-.72
J	Terminal Strength	12	F90-.84	6/Mo.	F90-.72	4/Lot	All Must Pass
K	Vacuum	6	F90-.72	3/Mo.	F90-.56	6/6 Mo.	F90-.72
L	Temperature Cycle	6	F90-.72	3/Mo.	F90-.56	6/6 Mo.	F90-.72
M	Fluid Resistance	36	F90-.94	36/12Mo	F90-.94	36/12Mo.	F90-.94

Durability Tests

Item	Test Name	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
E	Impulse	24	F90-.90	12/Mo.	F90-.84	3/6 Mo.	F90-.56
G	Humidity	6	F90-.72	3/Mo.	F90-.56	[illegible]	F90-.72
H	Salt Spray	6	F90-.72	3/Mo.	F90-.56	6/6 Mo.	F90-.72



TI-NHTSA 006752

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.

TI-NHTSA 006753

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.

TI-NHTSA 006754

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

E. Impulse

1. Test Requirements

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

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

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

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

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

d. Switch must open and close each cycle.

2. Acceptance Requirements

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

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

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

F. Burst

1. Test Requirement

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

b. Pressurize the switch to 48.3 MPa (7000 PSI) minimum and hold for 10 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.

TI-NHTSA 006755

III. TEST REQUIREMENTS AND CONDITIONS (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.

TI-NHTSA 006756

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. Nonconformance 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.

TI-NHTSA 008757

III. TEST PROCEDURES AND REQUIREMENTS (CONT'D)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

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

(2) With a pendulum apply a 45 ± 5 N impact force to the switch housing at the connector end, 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 3-4 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.

TI-NHTSA 006758

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.

TI-NHTSA 006758

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) ESF-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.

TI-NHTSA 006760

IV. STATISTICAL ANALYSIS METHODS

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

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

V. REVALIDATION REQUIREMENTS

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

SUBSYSTEM CHANGE REVALIDATION

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

5. Annual revalidation is not required on carryover switches.

VI. LOT DEFINITION

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

VII. RECORD RETENTION

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

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

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

VIII. INSTRUCTIONS AND NOTES

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

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

Test port configuration is shown in Figure 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.

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IX. CORRELATION OF REFERENCE DOCUMENTS

ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard - 1990 Edition

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

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

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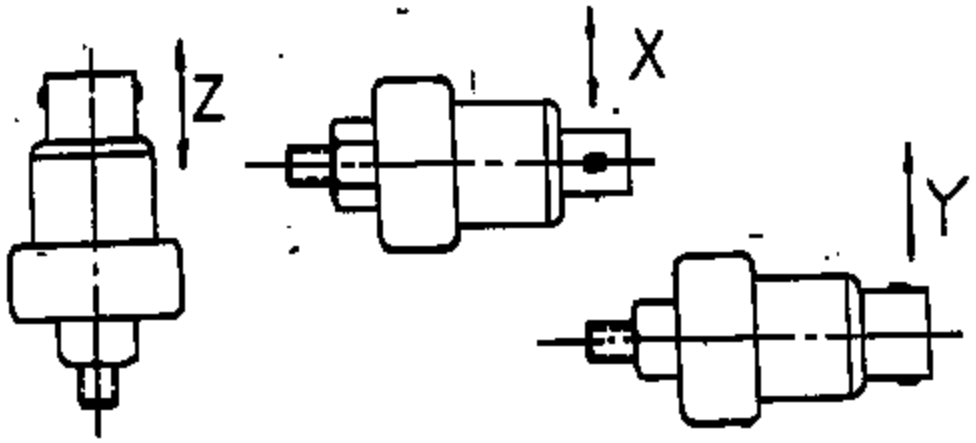
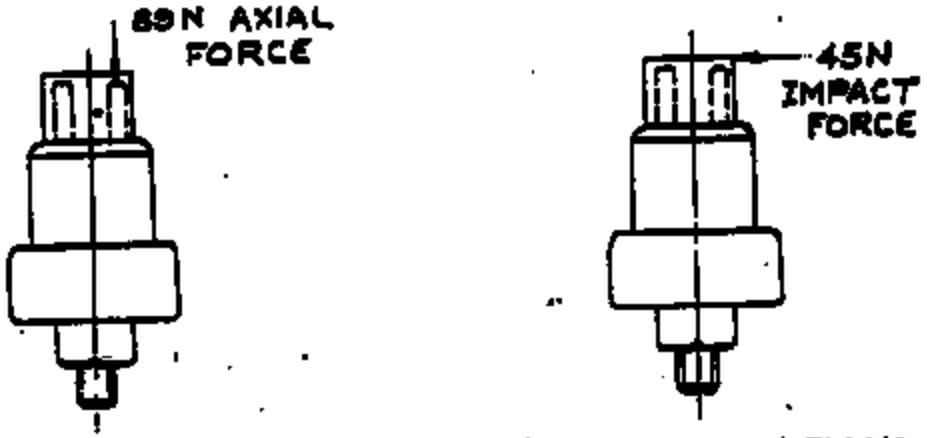


VIBRATION TEST - SWITCH ORIENTATION

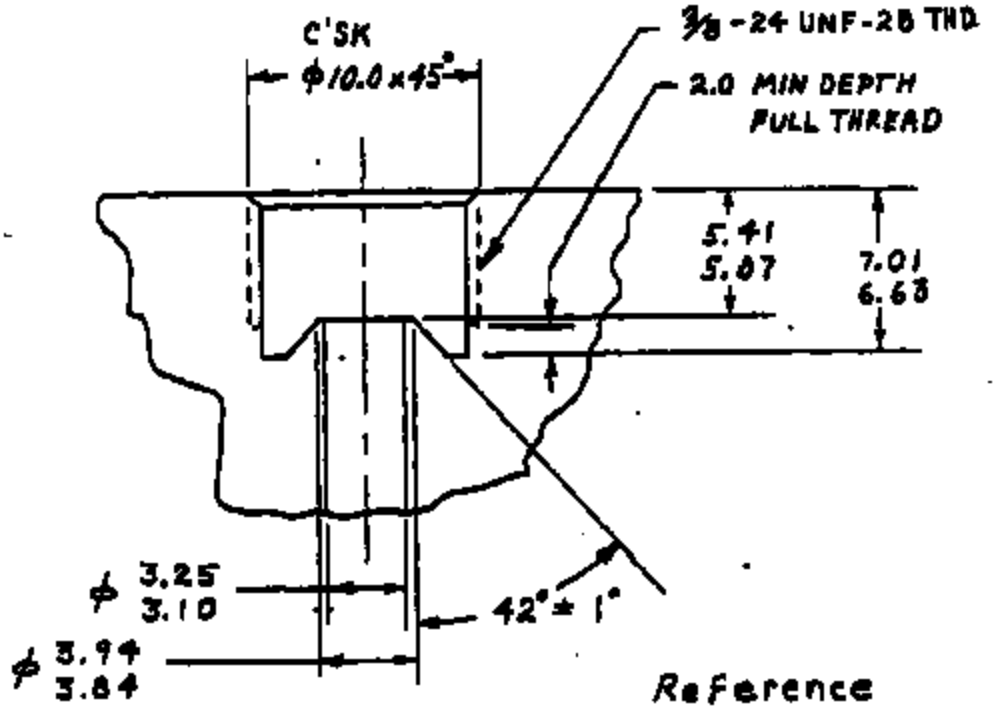
FIGURE 1.



TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2.

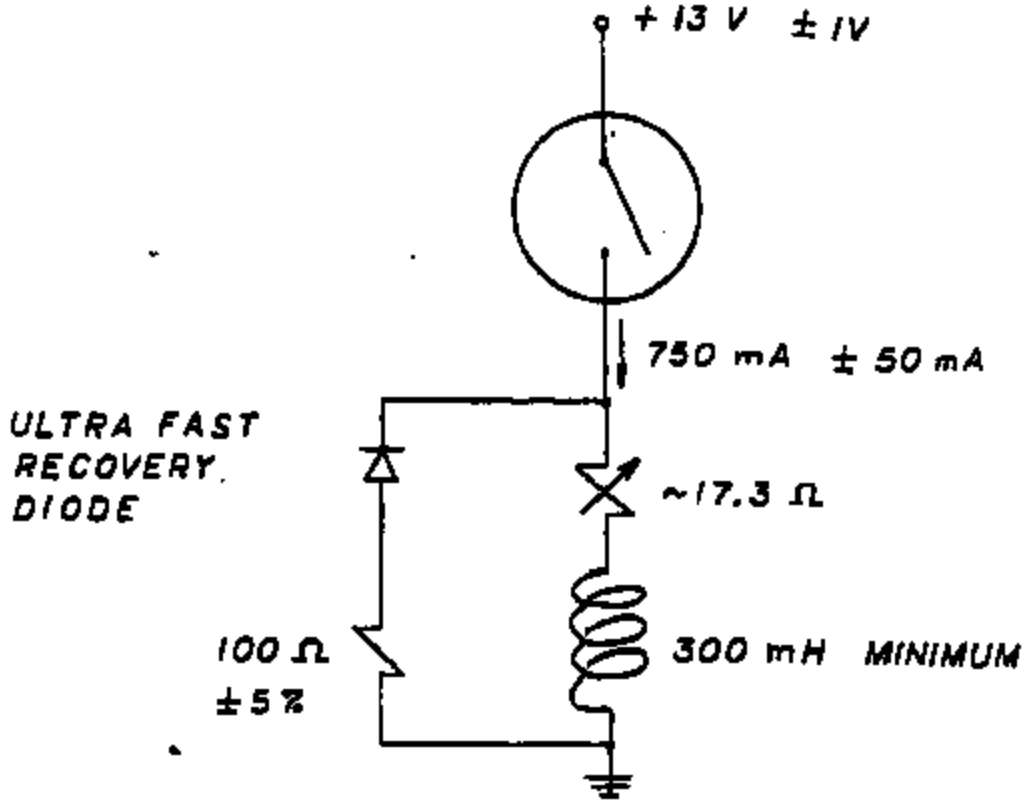
Engineering Specification



TEST FIXTURE PORT CONFIGURATION

FIGURE 3

FRAME 17 OF 18	REVISED		▽ 88-B2V0-93924-AA NUMBER



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

TI-NHTSA 006766

Appendix. 4.2
Data

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 93-08-12		PAGE 32

FORM 8295

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 245-15-127

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PSL 3-1, 77PSL 5-2	920413	Steve Offiler	

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
Jeffie DiDomenico	920415		

PROJECT TITLE: Speed Control

CUSTOMER:

PURPOSE OF TEST: Production Validation

PROCEDURE: ▽ ES-F2VC-9F924-AA : Full ISR

Natural Noryl Bases
ultra-low diff discs.
Act 90-110
Rel. 20 Min.

TI-NHTSA 006768

77PSL 3-1
INITIAL Characterizations

Device #	Act	Rel	Hu Drop	Current Leak	Vacuum Proof	Act	Rel	Test	Complete	Test	Complete
245-15-01	130	107	4.1	✓	✓	140	107	Fluid Res	✓	Impulse	✓
-02	127	105	3.1	✓	✓	130	113		✓		✓
-03	132	111	2.8	✓	✓	130	115		✓		✓
-04	131	115	5.7	✓	✓	131	117		✓		✓
-05	133	117	6.1	✓	✓	126	115		✓		✓
-06	124	108	4.7	✓	✓	132	115		✓		✓
-07	125	117	4.5	✓	✓	131	112		✓		✓
-08	123	107	4.8	✓	✓	119	103		✓		✓
-09	130	108	4.5	✓	✓	132	119		✓		✓
-10	131	115	3.3	✓	✓	137	116		✓		✓
-11	125	114	4.9	✓	✓	135	118		✓		✓
-12	136	117	4.2	✓	✓	137	124		✓		✓
-13	136	116	3.3	✓	✓	133	123		✓	Temp. Transit	✓
-14	107	92	4.0	✓	✓	128	114		✓		✓
-15	129	116	3.4	✓	✓	135	125		✓		✓
-16	129	111	4.1	✓	✓	124	111		✓		✓
-17	125	108	3.9	✓	✓	125	107		✓		✓
-18	126	116	3.7	✓	✓	132	116		✓		✓
-19	138	116	5.3	✓	✓	[illegible]	118		✓		✓
-20	122	111	3.1	✓	✓	127	119		✓		✓
-21	134	121	3.9	✓	✓	141	128		✓		✓
-22	121	105	3.2	✓	✓	132	115		✓		✓
-23	126	114	2.7	✓	✓	132	120		✓		✓
-24	119	98	3.6	✓	✓	123	117		✓		✓
-25	124	110	3.1	✓	✓	127	112		✓	Humidity	✓
-26	119	108	3	✓	✓	125	117		✓		✓
-27	131	117	3	✓	✓	132	125		✓		✓
28	131	120	3.2	✓	✓	130	119		✓		✓

(OVER)

Device #	Act	Rel	Hg Drop	Current Leak	Integral Proof	Act	Rel	Test	Complete	Test	Complete
2HE-15-29	124	114	3.3	✓	✓	120	110	Fluid Res	✓	Humidity	✓
-30	114	106	2.8	✓	✓	126	116	↓	✓	↓	✓
-31	129	114	2.9	✓	✓	127	118	↓	✓	Salt Spray	✓
-32	[illegible]	115	2.6	✓	✓	133	120	↓	✓	↓	✓
-33	[illegible]	104	2.5	✓	✓	115	105	↓	✓	↓	✓
-34	126	119	2.3	✓	✓	138	122	↓	✓	↓	✓
-35	119	109	2.9	✓	✓	125	115	↓	✓	↓	✓
-36	122	117	2.9	✓	✓	127	115	↓	✓	↓	✓
-37	131	119	3.1	✓	✓	132	118	Impulse	✓	Noise	✓
-38	132	118	2.6	✓	✓	136	125	↓	✓	↓	✓
-39	134	125	2.6	✓	✓	135	126	↓	✓	↓	✓
-40	124	112	2.7	✓	✓	129	120	↓	✓		
-41	125	112	2.8	✓	✓	127	118	↓	✓		
-42	116	106	2.7	✓	✓	130	118	↓	✓		
-43	117	106	2.7	✓	✓	127	117	↓	✓		
-44	120	101	2.7	✓	✓	121	145	↓	✓		
-45	124	126	3.7	✓	✓	140	131	↓	✓		
-46	122	114	3.4	✓	✓	130	120	↓	✓		
-47	123	117	2.7	✓	✓	133	118	↓	✓		
-48	116	107	2.7	✓	✓	127	120	↓	✓		
-49	124	112	3.7	✓	✓	137	115	T-Cycle	✓	Noise	✓
-50	132	121	2.9	✓	✓	135	124	↓	✓	↓	✓
-51	112	101	3.0	✓	✓	130	99	↓	✓	↓	✓
-52	137	121	3.4	✓	✓	136	125	↓	✓		
-53	127	121	3.0	✓		124	122	↓	✓		
-54	121	102	3.8	✓	✓	125	114	↓	✓		
-55	128	115	3.0	✓	✓	127	119	Vacuum	✓		
-56	126	114	2.8	✓	✓	128	118	↓	✓		
-57	127	118	2.7	✓		130	119	↓	✓		
-58	122	111	3.2	✓	✓	130	126	↓	✓		
-59	123	112	3.1	✓		125	105	↓	✓		
-60	131	117	3.4	✓		133	121	↓	✓		
-61	127	119	3.2	✓		134	130	Vibration	✓		
-62	127	117	2.7	✓		131	124	↓	✓		
-63	129	118	2.6	✓	✓	132	125	↓	✓		
-64	128	117	3.5	✓	✓	136	125	↓	✓		
-65	121	112	2.8	✓	✓	136	118	↓	✓		
-66	118	107	2.7	✓	✓	127	115	↓	✓		
-67	132	103	2.9	✓	✓	134	122	Burst	Pass		
-68	126	117	2.9	✓	✓	132	122	↓	Pass		
-69	128	128	2.7	✓	✓	130	124	↓	Pass		
-70	119	109	2.9	✓	✓	129	121	↓	Burst 7600		
-71	129	120	2.9	✓	✓	132	121	↓	Pass		
-72	125	119	2.8	✓	✓	136	126	↓	Pass		
-73	135	120	2.8	✓	✓	139	124	Not used			
-74	124	118	2.4	✓		138	130	↓			
-75	119	112	3.4	✓		126	117	↓			
-76	107	103	2.4	✓		121	114	↓			
-77	120	108	3.1	✓		126	118	↓			
-78	111	101	2.4	✓		125	113	↓			
-79	112	103	2.4	✓		129	117	↓			
-80	131	124	2.7	✓	✓	136	120	↓			

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PRESSURE SWITCH DATA Form 21605 **TEST NO.** ________

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**	

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST: Production Validation

PROCEDURE: Snubber Devices

77PSL5-2

Typical Characteristics

Device #	Act	Rel	Ma Prf	Coaxial Leak	300 PSI Proof	Act	Rel	Test	complete	TEST	COMPL.
345-15-81	126	100	1.2	OK	OK	127	118	Impulse	✓	NOISE	✓
-82	130	100	2.2			117	130		✓	↓	✓
[illegible]	132	112	[illegible]			134	[illegible]		✓	↓	✓
[illegible]	131	102	[illegible]			[illegible]	[illegible]		✓		
[illegible]	132	[illegible]	[illegible]			[illegible]	[illegible]		✓		
[illegible]	[illegible]	[illegible]	3.5			127	[illegible]		✓		
[illegible]	131	105	2.0			130	105		✓		
88	130	115	2.9			[illegible]	110		✓		
89	[illegible]	108	5.1			[illegible]	108		✓		
90	111	109	4.2			115	[illegible]		✓		
91	125	111	2.9			127	[illegible]		✓		
92	114	99	3.0			113	106		✓		
93	117	[illegible]	2.3			125	104		✓		
94	120	109	2.1			129	108		✓		
95	132	109	2.4			131	[illegible]		✓		
96	119	101	2.2			118	97		✓		
97	124	[illegible]	1.9			125	106		✓		
98	131	113	1.5			130	118		✓		
99	126	110	2.2			127	[illegible]		✓		
100	123	100	2.2			131	101		✓		
101	132	115	1.6			134	118		✓		
102	132	109	1.5			126	99		✓		
103	121	[illegible]	[illegible]			130	116		✓		
104	132	[illegible]	1.7			131	105	↓	✓		
105	[illegible]	[illegible]	2.8			130	104	T-cycle	✓	NOISE	✓
106	132	118	2.4			127	[illegible]		✓	↓	✓
107	130	[illegible]	3.0			[illegible]	117		✓	↓	✓
108	132	[illegible]	2.7	↓	↓	[illegible]	114	↓	✓		

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(OVER)

Device #	Act Rel	Mc Resp	Current leak	Leakage test	Act Rel	Test	complete		
245-15-107	124 115	2.7	OK	OK	128 [illegible]	T-Cycle			
-110	115 [illegible]	4.2			129 [illegible]				
-111	120 [illegible]	2.6			120 109	NOT used			
-112	120 114	2.2			125 116				
-113	124 109	2.1			130 107				
-119	121 [illegible]	2.7			134 [illegible]				
-115	127 105	2.3			125 111				
-116	125 107	2.5			127 [illegible]				
-117	120 105	2.3			123 114				
-118	127 104	2.0			120 103				
-119	121 115	2.4			125 115				
-120	125 109	2.0			125 102				
-121	127 99	2.6			132 98				
-122	124 106	2.0			125 108				
-123	[illegible]	[illegible]			126 101				
-124	120 [illegible]	2.2			131 105				
-125	120 98	2.2			[illegible]				
-126	127 111	2.2			121 119				
-127	[illegible]	2.5			127 119				
-128	121 [illegible]	3.2			124 101				
-129	121 97	1.9			122 [illegible]				

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PRESSURE SWITCH DATA Form 21605 **TEST NO.** ______

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:

771SL3-1

Final Characterizations

Device #	act	deact	Mv Drop	[illegible]	300 [illegible]	act deact
[illegible]	131	104	38.6	✓	✓	128-110
[illegible]	122	97	29.4	✓	✓	122-105
[illegible]	130	102	20.6	✓	✓	129-108
[illegible]	128	102	27.0	✓	-	127-104
[illegible]	135	108	25.2	✓	-	132-110
[illegible]	117	95	72.1	✓	✓	117-97
[illegible]	130	103	45.6	✓	✓	128-105
[illegible]	124	99	17.2	✓	✓	122-103
[illegible]	124	96	24.3	✓	✓	123-105
[illegible]	122	100	85.5	✓	✓	120-101
[illegible]	127	99	25.9	✓	✓	126-105
[illegible]	125	102	46.8	✓	✓	125-105
[illegible]	138	109	4.3	✓	✓	138-115
[illegible]	124	92	2.7	-	-	119-95
[illegible]	135	109	2.8	✓	✓	136-115
[illegible]	136	111	2.9	-	✓	136-120
[illegible]	134	112	2.6	✓	✓	132-116
[illegible]	131	99	2.2	✓	✓	132-105
[illegible]	133	99	2.7	-	✓	132-115
[illegible]	132	97	5.5	✓	✓	130-111
[illegible]	142	80	4.7	✓	✓	140-122
[illegible]	132	104	5.1	✓	✓	132-112
[illegible]	133	108	3.0	✓	✓	135-112
[illegible]	135	103	2.5	✓	✓	136-114
[illegible]	131	105	2.1	✓	✓	131 [illegible]
[illegible]	124	112	5.0	✓	✓	125 108
[illegible]	138	117	3.1	✓	✓	137 114
[illegible]	133	113	2.4	✓	✓	133 107

(OVER)

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[illegible] #	act rel	M. Avg	[illegible]	[illegible]	act rel				
[illegible]	[illegible]	2.7	✓	✓	[illegible]				
30	129 97	2.9	✓	✓	[illegible] 110				
[illegible]	122 [illegible]	2.9	✓	✓	130 112				
[illegible]	121 103	2.3	✓	✓	[illegible]				
[illegible]	11? 97	6.6	✓	✓	130 97				
[illegible]	127 115	2.8		✓	132 118				
[illegible]	120 106	2.9	✓	✓	12? 95				
[illegible]	130 101	3.1	✓	✓	128 [illegible]				
[illegible]	125-112	8.6	✓	✓	123-103				
[illegible]	130-114	6.8	✓	✓	127-105				
[illegible]	126-112	8.7	✓	✓	126-108				
-40	131-113	8.0	✓	✓	128-110				
-41	125-111	7.2	✓	✓	122-106				
-42	126-112	5.6	✓	✓	126-107				
-43	127-113	5.7	✓	✓	124-103				
-44	125-111	5.5	✓	✓	122-99				
-45	138-123	7.7	✓	✓	135-115				
-46	133-116	7.0	✓	✓	132-105				
[illegible]	121-117	8.0	✓	✓	127-105				
48	126-112	4.5	✓	✓	122-105				
49	127-98	2	✓	·	116 78				
[illegible]	129-100	5.6	✓	·	129 100				
[illegible]	126-109	2.6	✓	✓	127 98				
[illegible]	130-105	1.7	✓	✓	130 101				
[illegible]	130-102	2.9	·	·	128 102				
[illegible]	125-103	1.1	·	·	125 77				
[illegible]	138-117	1.3	✓	✓	135-100				
[illegible]	132-120	1.2	✓	✓	130-115				
[illegible]	136-123	1.2	✓	✓	134-108				
[illegible]	135-121	1.7	✓	✓	131-113				
[illegible]	130-118	2.7	✓	✓	127-114				
[illegible]	140-128	1.7	✓	✓	136-120				
[illegible]	134-117	1.5	✓	✓	134-120				
[illegible]	131-104	2.8	✓	✓	130-114				
·	137-115	2.6	✓	✓	135-100				
[illegible]	135-109	2.6	✓	✓	138-113				
[illegible]	127-107	2.8	✓	✓	130-104				
-66	129-105	3.1	✓	✓	128-110				

PRESSURE SWITCH DATA Form 21605 **TEST NO.** ____

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY	

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:

770565-2

Final Characterizations

Device #	act rel	MuDup	[illegible] leak	[illegible] Proof	act rel
245-15. 91	131 106	13.3	✓	✓	130 102
-52	115 98	77.7	✓	✓	121 95
-47	130 102	22.4	✓	✓	129 102
-44	130 102	69.5	✓	✓	127 100
-45	139 104	36.5	✓	✓	131 104
-51	132 105	16.8	✓	✓	131 102
[illegible]	119 102	24.0	✓	✓	116 91
92	132 105	31.4	✓	✓	132 102
29	138 106	53.7	✓	✓	136 108
96	131 103	17.8	✓	✓	125 99
-91	135 104	67.3	✓	✓	131 - 111
-92	114 96	36.1	✓	✓	110 - 101
-77	126 99	21.6	✓	✓	123 - 106
-94	136 106	10.9	✓	✓	131 - 118
-95	138 108	16.7	✓	✓	133 - 116
91	120 94	22.5	✓	✓	117 - 104
-97	131 104	13.8	✓	✓	131 - 112
-98	138 106	5.6	✓	✓	131 - 115
89	135 103	17.2	✓	✓	132 - 112
-100	131 103	25.7	✓	✓	128 - 113
-101	140 112	17.5	✓	✓	136 - 121
-102	131 104	10.7	✓	✓	126 - 112
-103	135 109	35.0	✓	✓	133 - 116
-104	137 103	8.2	✓	✓	133 - 114
-105	128 - 104	1.0	✓	✓	127 102
-106	124 - 100	.2	✓	✓	123 98
-107	132 - 105	.2	✓	✓	132 99
-108	132 - 119	.8	✓	✓	135 107

TI-NHTSA 006774

(OVER)

Device #	act col	Volt Drop	current test	power proof	scr col				
741-11-102	126-102	.8	✓	✓	127 102				
111	127-110	.5	✓	✓	116 101				

TI-NHTSA 006775

Appendix 4.3
Memorandum

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 92-08-12		PAGE 41

FORM 5295

M E M O R A N D U M
14 April 1992

TO: Bruce Maeroff - Ford Motor Co.

CC: Dave Czarn
Jeff DiDomenico
Norm Freda
Elaine Rose
Jim Watt

FR: Steve Offiler

RE: ES Testing for Full ISR Submission for: F2AC-9F924-AA
F3DC-9F924-AA

The proposed methodology to complete the full ISR submissions for the above referenced part numbers is as follows. A complete battery of ES tests per Ford Engineering Specification (delta) F2VC-9F924-AA will be performed on F2AC. The only difference between this device and F3DC is the fact that F3DC includes a "snubber" which is an .020" nominal diameter orifice in the fluid passage. Therefore, the only tests to be run on F3DC are those which may be somehow impacted by this orifice, specifically the Impulse test and the Thermal Cycle test. Furthermore, as can be seen in the attached Flow Chart (marked-up) the F3DC parts will not be required until 920605, giving sufficient time to obtain production quanities from the supplier.

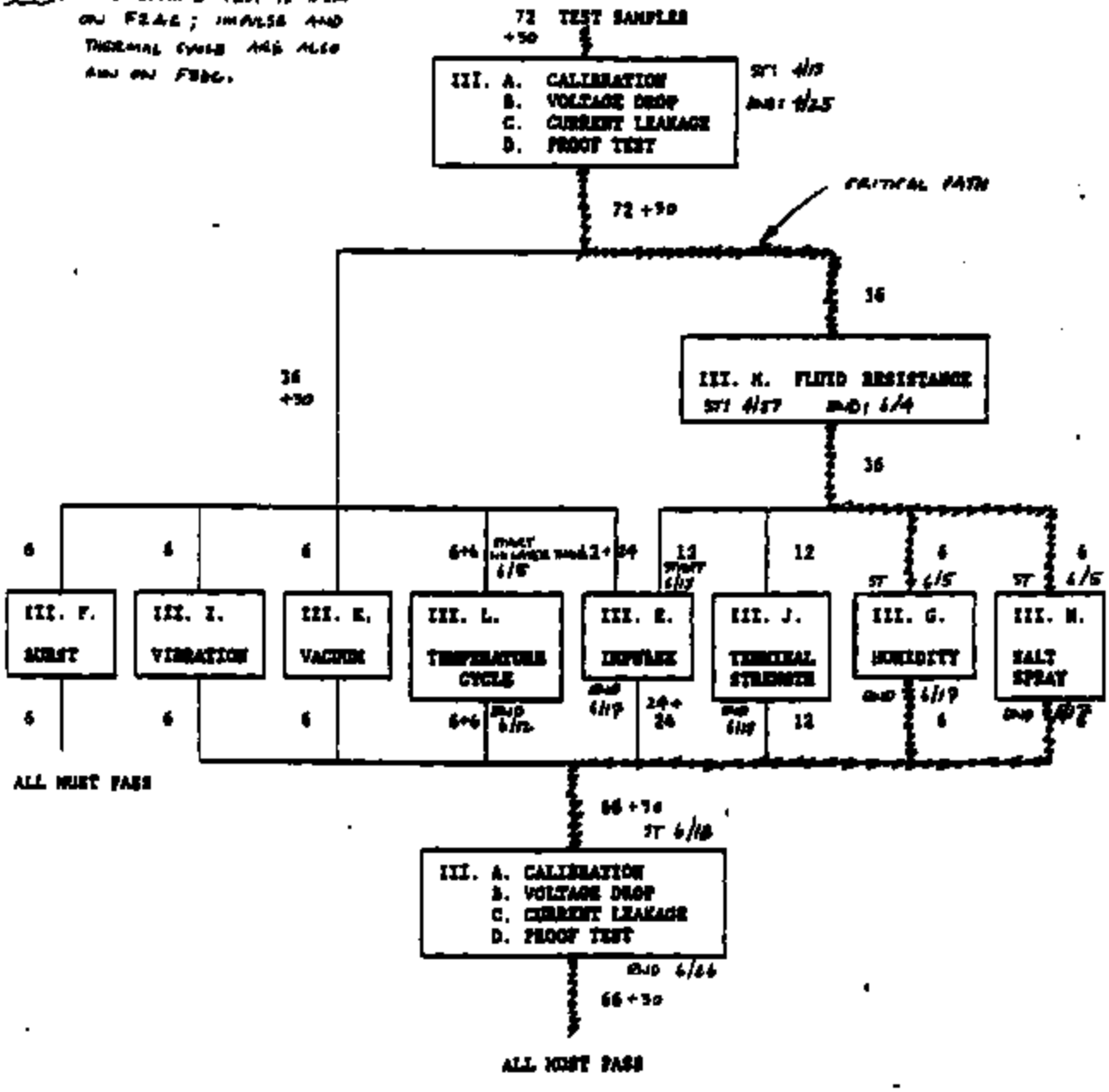
SO 920413

MARKED-UP BY STEVE APPLEGATE 12-19-93

COMBINED F1AC-9F924-AA & F3DC-9F924-AA

PRODUCTION VALIDATION FLOW CHART

NOTE: THE ENTIRE TEST IS RUN ON F1AC; IMPULSE AND THERMAL CYCLE ARE ALSO RUN ON F3DC.



FRAME 4 OF 18	REVISED		NUMBER F2ZC-9270-9F924-AA

TO: Dave Czarn .
Matt Sellers

drs92-47

FR: Dale Sogge

SJ: Target Preload

Attached is a report describing how the target preload was determined for quiet car and truck.

In reviewing my information I found that I had made a mistake and used +/-2.0mils for the manufacturing pinning capability rather than +/-2.5mils. Corrected analysis is shown on the attached curves.

QUIET CAR: Calculated Target preload = 7.0
Preload tolerance = less than zero

Discussion: Pinning at 7.00 will produce devices that fall slightly below 90psi at 150C. This does not account for the spread in the high temp base shift either. It assumes all bases shift exactly three mils. Since the actual operating temp is 125C, and pressure shift vs pin length at temp studies shown no pressure drop until less than 2 mils preload at 125C. Therefore, pinning at 7.0 should be ok.

QUIET TRUCK: Calculated Target preload = 10.6
Preload tolerance = less than zero

Discussion: Pinning at 10.6 will produce devices that fall slightly below 90psi at 180C and exceed 300psi at -40C. This does not account for the spread in the base temp shift.

Pressure shift vs pin length at various temps shows that the pressure starts to drop at pin lengths somewhere between 4 and 6 mils. Six mils is less than the low spec limit of 8.1 so no pressure shift should occur.

To be on the safe side we need to see if the spec limits can be increased to 190-310psi. Or at least see if the customer can tolerate this range.

For rework purposes we can use the following tolerances:

CAR	7.0	-0.0	+0.5
Truck	10.6	-0.0	+0.5

This is based on the engineering judgement that very few parts will fallout at 300psi and these few can be tolerated.

The fine needs to be informed of these new limits, assuming Czarn concurs.

Note: This analysis assumes that the static measurments indicate where the priload really is. Crimping can increase or decrease the preload depending on how tight it is. The LVDT work should be continued to find where the preload is really at on an assembled device.

Regards
Dale

ESTABLISHMENT OF QUIET SWITCH
AND QUIET TRUCK PARAMETERS
BASED ON NOMINAL DIMENSIONS

The quiet passenger car parameters for manufacturing were established as follows:

1. Measure disc diff in test fixture using 2° disc seat. (Dale's special version.)

2. Assemble a range of discs into sensor assemblies.

3. Test sound pulse to find a maximum disc differential that will have a pulse of less than -1.5 psi.

4. Build six sensor assemblies with discs from lots meeting requirement #2.

5. Plot sensor curve using an LVDT tracking the top of the disc. Plot all six curves on top of each other to get a visual indication of dispersion.

6. Draw a line horizontally across the page at 90 psi and 200 psi.

   90 psi is the lowest the act can go and still be acceptable to the customer.

   200 psi is the highest the act can go and still be acceptable to the customer.

   Prior to development the Ford spec was:
   Act 125± 35 psig
   Rel 20 psig min

   The customer felt it was okay to increase the upper limit on act. it was opened at 200 psi based on our combined experiences.

7. Draw a vertical line at the point 90 psi intersects the lowest act value curve.

8. Measure from this point over 5.5 miles and mark the spot
   (3.0 mils for 25°-150°C terminal movement)
   (2.5 mils for manufacturing capability consisting of
   ± 0.5 on pin and sensor, ± 2.0 on base calibration

9. From where the highest act value curve crosses 200 psi measure left 4.5 mils, 2 mils for cold temp shift and 2.5 mils for pin/base manufacturing capability. Mark this point.

10. Draw a line halfway between step 7 & 8. This is the target preload with Step 7 & 8 defining the tolerance on the target.

11. If the tolerance range is negative (overlap) pick the mid point and then calculate the actual worst case act pressures.

12. Decide if the tolerance is okay or if the target valve should be shifted one way or another to avoid failures. For example, shift the preload 0.5 mils higher (to the right) to reduce the risk of high temperature open circuits.

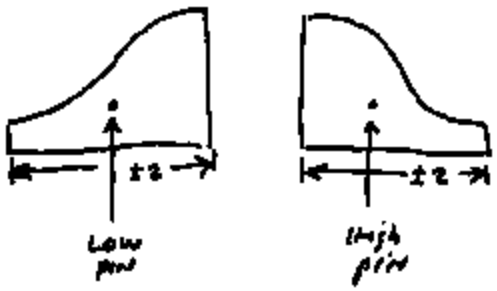
Shifting to slightly higher preloads +0.5/+1.0 seems desirable at this time because a device that opens at high temperature is immediately recognizable by the customer as a failure.

For quiet truck the same steps except this device is know to operate at 182°C.
The customer has melted connectors.

Use 200 psi min act
300 psi max act
40 psi min release

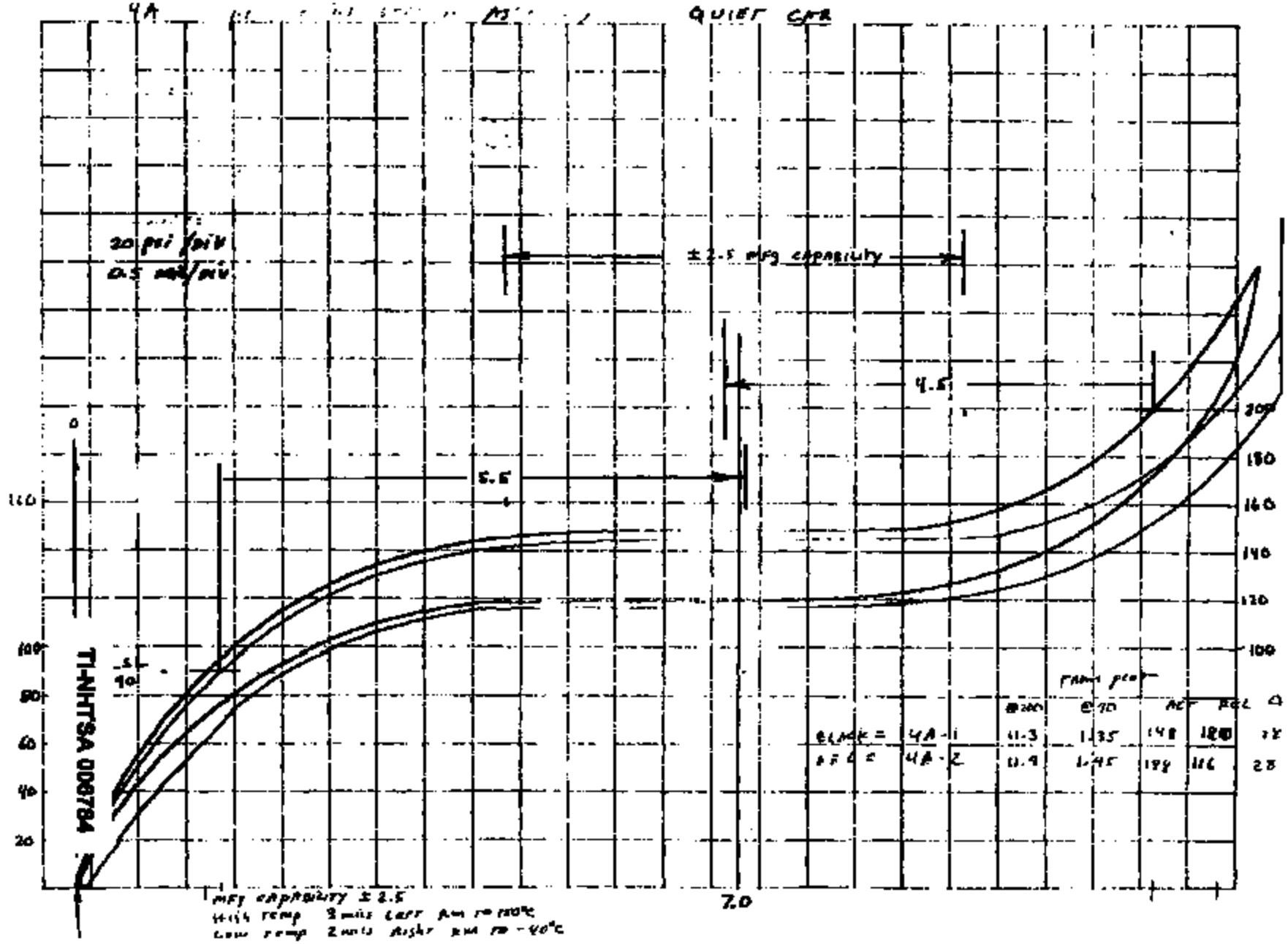
5 mil high temp movement 25°-182°C
plus 2.5 mil manufacturing cap (test 302-15)

NOTES: 1. Bases are calibrated, resulting in a truncated spread of ± 4 mils, normally distributed. The lot is split in half at the mean. The low half of the lot is used with a pin 1 mil less than calculated based on the mean of the entire base population. The upper half of the lot is pinned with a pin 1.0 mil longer than nominal. Pin and sensor capability is ± 0.5 mils.



NOTES: 2. The temperature shift is taken at 150°C even though the max temp required is 125°C. This gives an extra cushion. Temp shift taken from test 302-15-24.

8-12-92


QUIET CAR
20 psi/div
0.5 mph/div
±2.5 mfg capability
4.5
5.6
7.0
TI-NHTSA 006784
mfg capability ± 2.5
High temp 2 mils richer RVM @ T = 110°C
Low temp 2 mils richer RVM @ T = -40°C
100
80
60
40
20
120
140
160
180
200

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 317-15-4

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77P5C3-1	8-13-92	DAVE SABOE	8-21
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**

PROJECT TITLE: ACTUAL PRELOAD DETERMINATION

CUSTOMER: FORD

PURPOSE OF TEST: TO DETERMINE WHERE ON THE P-D CURVE THE DEVICE ACTUALLY MAKES CONTACT. DOES ASSEMBLY CHANGE THE PRELOAD TO INCREASE

4 DEVICES

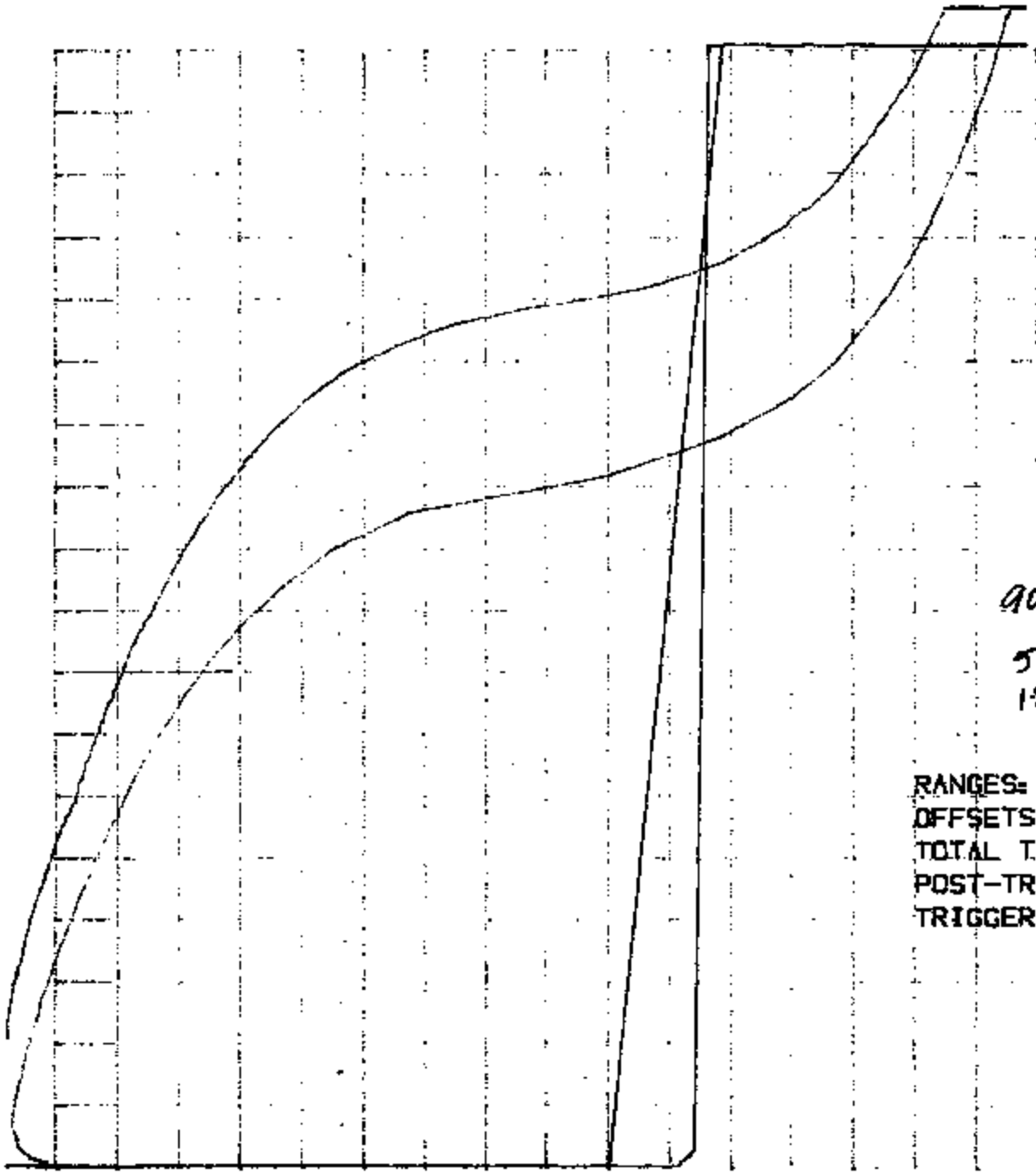
PROCEDURE: PUT LVDT PROBE IN CONNECTOR & ON TO THE BUMP IN THE CONTACT ARM. MEASURE PRESSURE DEFLECTION, USE A HIGH SPEED FOUR CHANNEL SCOPE TO PROPERLY EXAMINE THE ELECTRICAL SIGNAL VS DISPLACEMENT.

(OVER)

TI-NHTSA 006785

TI-NHTSA 006786

317-15-4



900 mV = 10 PSI/div

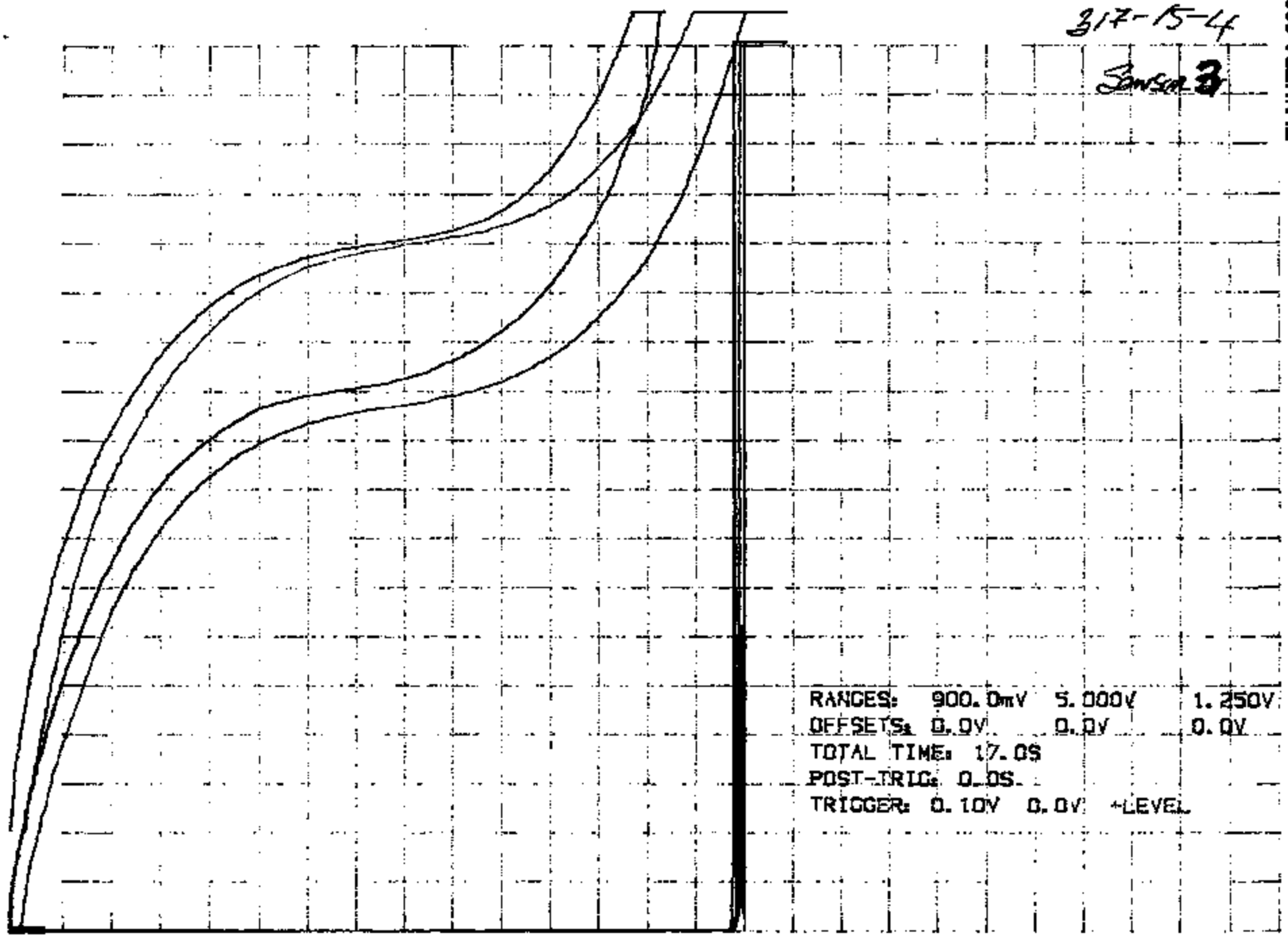
5V Blue switch
1.25V = 5 PSI/DIV

RANGES: 900.0mV 5.000V 1.250V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 17.0S
POST-TRIG: 0.0S
TRIGGER: 0.10V 0.0V ←LEVEL

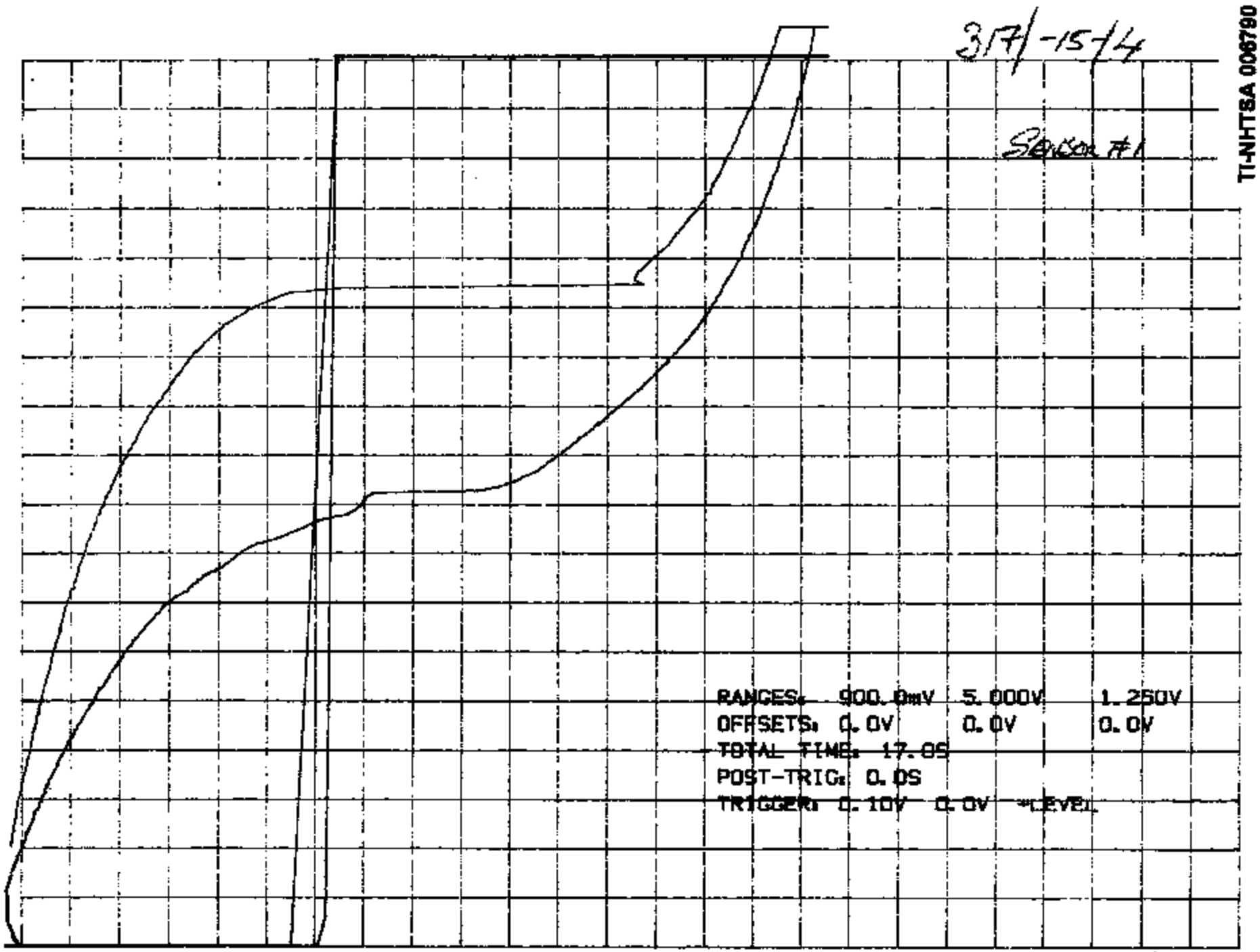
TI-NHTSA 006788

317-15-4

Sensor 3



TI-NHTSA 006789



TI-NHTSA 006790

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 306 -15-12

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
FPS	7/29/92	Jeff DiGiacomo	7/29/92
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
David Toole	7/29/92	7/29/92	Dave 2.

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST: To find out if Devices are Noisy

PROCEDURE: Tested Devices in Hydr. Test Station, Measured Susp? of Disc's with Scope.

Device #	HV.
245-37	0
38	0
39	0
245-49	0
50	0
51	0
245-81	0
82	0
83	0
245-105	0
106	0
107	0

(OVER)

PRESSURE SWITCH DATA Form 21605 TEST NO. 307 -13 -02

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
775	7/21/92	Dale Scaife / Matt Silbey	7/29/92
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
David Tootle	7/24/92	7/29/92	Dale Scaife

PROJECT TITLE:

CUSTOMER: Production

PURPOSE OF TEST: To See if Devices are Noisy. Test Production Equipment Picked up Disc Noise.

PROCEDURE:

Tested on Board Pulse Test Station (and one) & Measured with Scope.

Results: Both Devices Met Limits Spec & No Volts.

Device #	Volts
01	
02	

(OVER)

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 316-15-6

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PS63-1	8-17-92	DALE SOGGE	8-21
PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY

PROJECT TITLE: CRIMP TIGHTNESS

CUSTOMER: FORD

PURPOSE OF TEST: TO DETERMINE IF THE BASE FULLY SEATS AGAINST THE SENSOR ASSEMBLY WHEN ALUMINUM CRIMP RING IS CRIMPED. IF IT DOES NOT THEN IT EFFECTS THE CONTACT PRELOAD & COULD CAUSE LOW PRELOADS LEADING TO LOW ACT VALUES

PROCEDURE: 6 FULLY ASSEMBLED SENSORS FROM PRODUCTION. MEASURE TORQUE VALUE TO TWIST BASE. HAVE 2 MADE WITH CRIMP PURPOSEFULLY LOOSE. AND 4 THAT REPRESENT RANGE OF TORQUE. APPLY A FORCE TO TOP OF CONNECTOR AND RECORD FORCE DEFLECTION. DO THIS ON THE FOUR PIECES PLUS 2. IF BASE IS LOOSE THERE SHOULD BE A SLOPE CHANGE IN THE CURVE WHEN THE BASE BOTTOMS OUT.

THE DIFFERENCE BETWEEN A GOOD AND BAD (TIGHT VS LOOSE) WAS NOT DETECTABLE WITH THIS SYSTEM. IT SUGGESTS IT HAS NO AFFECT ON PIN LENGTH OR CONTACT PRELOAD.

(OVER)

TI-NHTSA 006793

TI-NHTSA 006784

77PSL3- ST NO 250-12-56
NOISE EV. JATION ON MATRIX OF DEVICES WITH VARYING DIFFEREN. S

DEVICE #	CAR/TRUCK	DISC TYPE		LAB/ACT	LAB/REL	Device Differential	Disc differential	PULSE LEVEL IN PSI 1ST READING	nd reading	ance 1-2nd
250-12-01	CAR	Quiet car prod		141	114	27		2	0.5	1.5
2				134	111	23		2	0.5	1.5
3				132	110	22		1	0.25	0.75
4				144	112	32		1.15	0.5	0.65
5				138	115	23		0.85	0	0.85
AVERAGE			5.75	137.8	112.4	25.4	#DIV/0!	1.4		1.4
STN DEVIATION				4.91935	2.073644	4.159326869	#DIV/0!	0.55769784		0.557696
									0	0
6	TRUCK	Noisy truck prod		262	86	176		87.2	-81	168.2
7				230	114	116		19.225	-53	72.225
8				237	83	154		27.625	-75	102.625
9				245	103	142		63	-74.5	137.5
10				252	104	148		67.5	-26.2	93.7
AVERAGE			13	245.2	98	147.2	#DIV/0!	52.91		52.91
STN DEVIATION				12.51799	13.0956	21.66102491	#DIV/0!	28.56786109		28.56786
									0.5	-0.5
11	TRUCK	Truck Lot "AA"		260	215	45		0	0	0
12				266	222	44		0	0	0
13				262	196	66		0.4125	0.5	-0.0875
14				270	219	51		0.59375	0	0.59375
15				265	229	36		0	0	0
AVERAGE			4.5	264.6	216.2	48.4	#DIV/0!	0.20125		0.20125
STN DEVIATION				3.847077	12.39758	11.19374826	#DIV/0!	0.282925564		0.282926
										0
16	CAR	Car Lot "N"		183	165	18		0	0	0
17				140	118	22		0	0	0
18				193	167	26		0	0	0
19				192	170	22		0	0	0
20				154	133	21		0	0	0
AVERAGE			8	172.4	150.6	21.8	#DIV/0!	0		0
STN DEVIATION				24.02707	23.58601	2.863564213	#DIV/0!	0		0
										0
21	CAR	Car Lot "L"		197	164	33		0	1	-1
22				198	159	39		0.0625	0	0.0625
23				211	181	30		0.14375	0	0.14375
24				153	128	25		6.39	0	6.39
25				156	123	33		6.2655	-4.25	10.5155
AVERAGE			11	183	151	32	#DIV/0!	2.57235		2.57235
STNDRV PULSE.XLS, 6/23/92, 1				26.61766	24.72853	5.099018514	#DIV/0!	3.428856878		3.428857

TI-NHTSA 006795

DRAWINGS AVAILABLE UPON REQUEST

PRESSURE SWITCH DATA Form 21605 TEST NO. 298-13-04

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77/87 PS. Honda plate type.	7/14/92	Steve Butler	7/15/92
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
DAVID O Toole.	7/15/92	7/15/92	

PROJECT TITLE: Pressure impulse Test.

CUSTOMER: Honda

PURPOSE OF TEST: To measure impulse spike.

PROCEDURE: Conducted Tests into brake fluid test station & measured impulse voltage spike with Scope.

Part #	Volts
02-15-08	1.7425
02-15-11	1.5466
#1	2.19
#2	2.465

(OVER)

TI-NHTSA 006800

PRESSURE SWITCH DATA Form 21605 TEST NO. 315-15-10

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PSC3-1	3-13-92	DALE SCOGGIE	8-17-92
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**

PROJECT TITLE: KAPTON RELAXATION EFFECT ON PRELOAD

CUSTOMER: FORD

PURPOSE OF TEST: BECAUSE OF A LACK OF PRELOAD ON THE QUIET DISC THE KAPTON IS HOLDING THE DISC AGAINST THE CAP SCREW. IF THE KAPTON RELAXES AT HIGH TEMPS AWAY FROM THE CONVERTOR THEN THE CONTACT PRELOAD WILL DECREASE & THE SWITCH COULD OPEN WITH NO PRESSURE APPLIED. QUESTION: DOES THE KAPTON RELAX

PROCEDURE: SELECT 10 SENSOR ASSEMBLIES FROM THE LINE AT RANDOM. MEASURE THE DEPTH TO THE DISC FROM THE CAP REFERENCE SURFACE USING AN PORTABLE INDICATOR CONFIGURED FOR THIS. MOUNT THE SENSORS TO OIL CAN TO WHICH PORT TO DIAPHRAGM. INCREASE SENSOR IN HOT OIL WITH TOP OF SENSOR JUST SLIGHTLY EXPOSED. MEASURE SENSOR DEPTH IN HOT OIL AFTER 4 HOUR EXPOSURE. DISC SHAFT MUST APPLY 120-150gf FORCE

SENSOR #	23°C DEPTH	125°C DEPTH	150° DEPTH	23°C DEPTH					
1	160	215	305	160	PASS				
2	160	225	315	164					
3	155	225	320	186					
4	155	235	340	183					
5	150	245	345	190					
6	150	250	345	195					
7	145	240	345	190					
8	165	250	305	200					
9	155	250	345	195					
10	150	245	345	182					
AVG	.1535	.23375	.334	.184					
σ_{n-1}	.0047	.0135	.016	.012					

TI-NHTSA 006801

PRESSURE SWITCH DATA Form 21605 TEST NO. 316-15-6

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PSL3-1	8-17-92	ORCE 30006	8-21
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**

ROJECT TITLE: CRIMP HARNESS

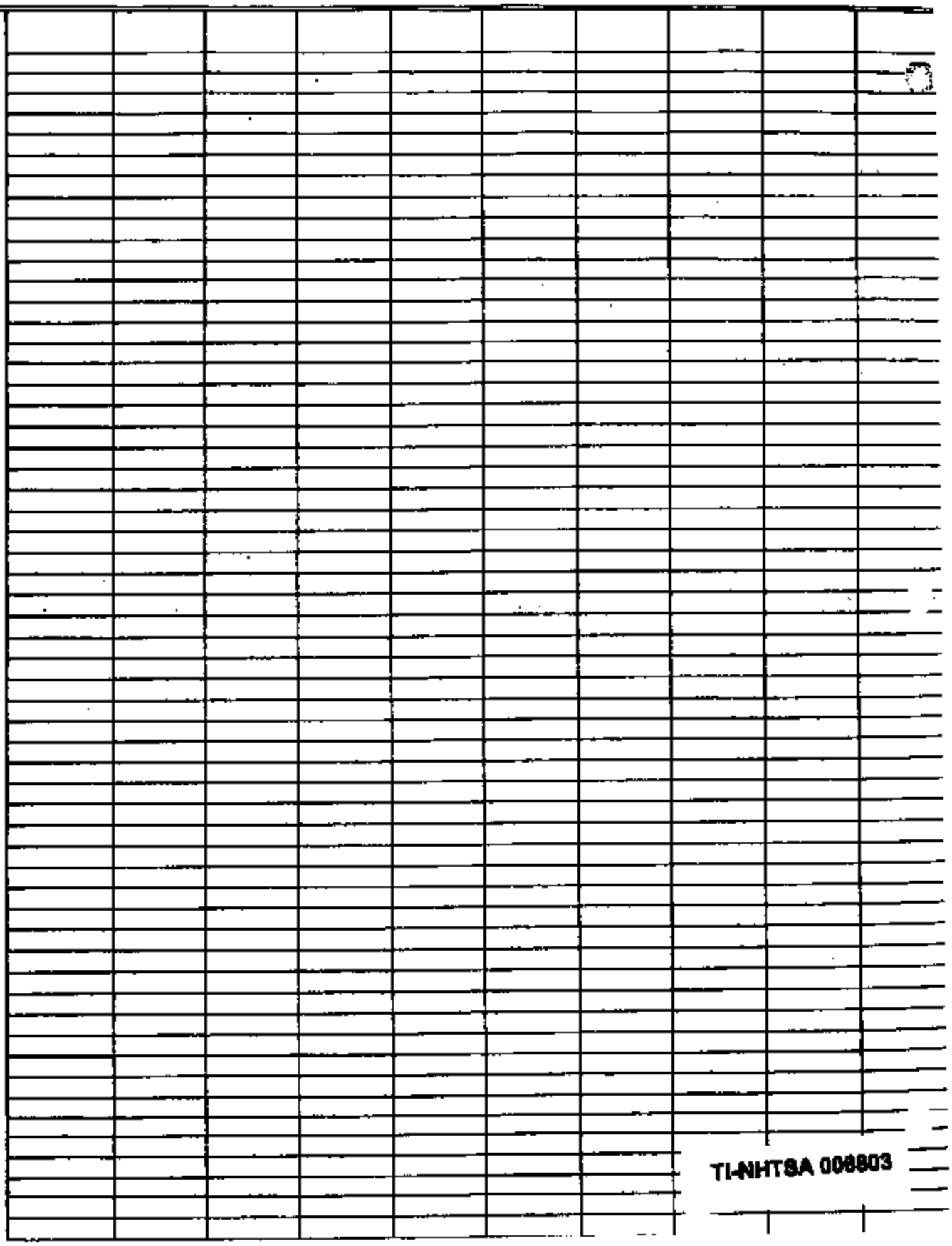
CUSTOMER: FORD

PURPOSE OF TEST: TO DETERMINE IF THE BASE FULLY SEATS AGAINST THE SEAL ASSEMBLY WHEN MINIMUM CRIMP DIM IS CRIMPED. IF IT DOES NOT THEN IT EFFECTS THE CONTACT RETENTION & COULD CAUSE LOW PRESSURE LEADING TO LOW SET VALUES

PROCEDURE: 6 fully assembled sensors from production. Measure torque value to twist base. Have 2 more with crimp purposefully loose. And 4 that represent range of torque. Apply a force to top of connector and record force deflection, do this on the four pieces plus 2. If base is loose there should be a slope change in the curve when the base bottoms out.

THE DIFFERENCE BETWEEN A GOOD AND BAD (tight vs loose) WAS NOT DISCERNABLE WITH THIS SYSTEM. IT SUGGESTS IT HAS NO EFFECT ON grip strength OR CONTACT FORCE.

TI-NHTSA 006802

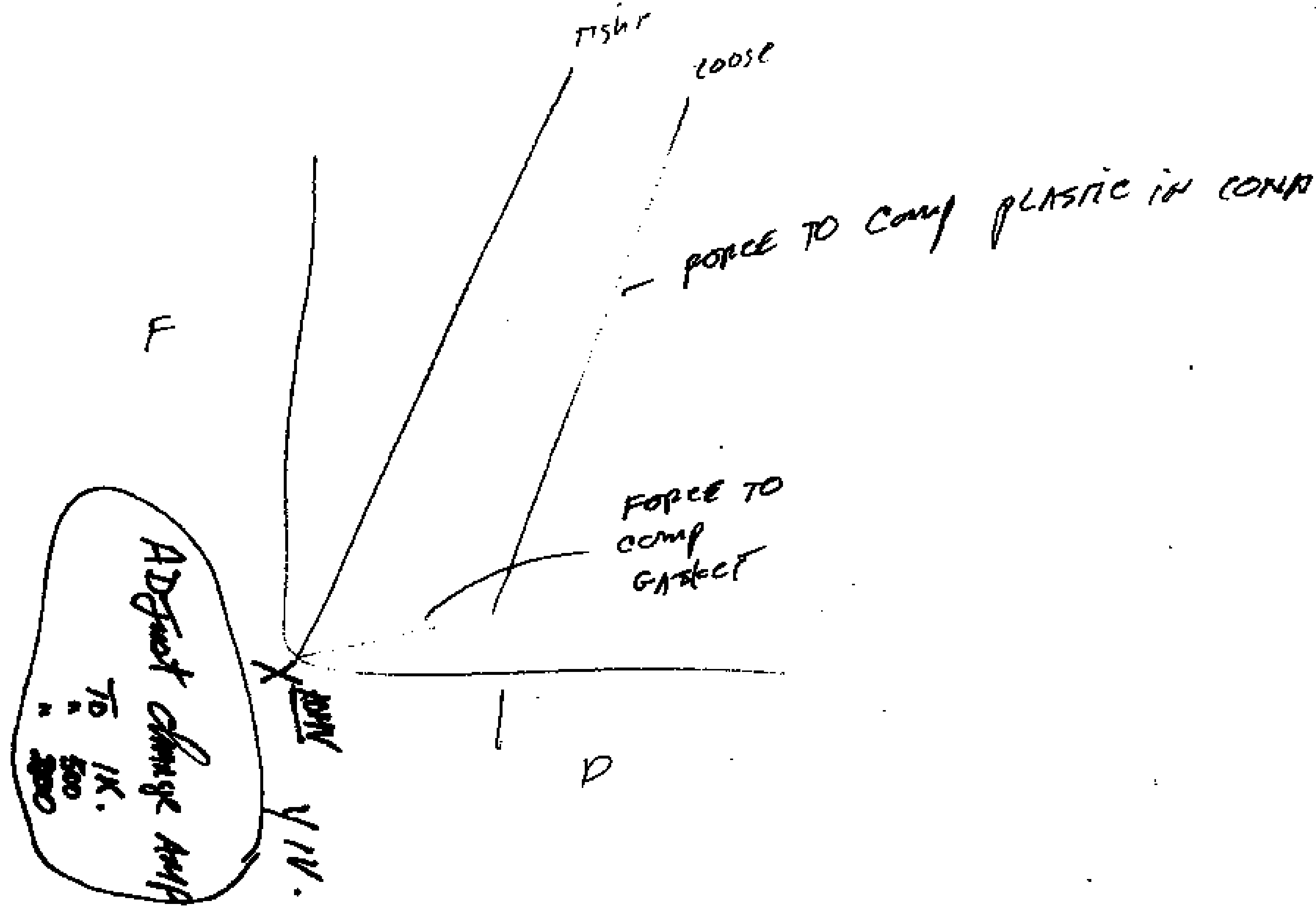

TI-NHTSA 006803

77PSL3-[illegible]ST NO 250-12-56

NOISE EV[illegible]JATION ON MATRIX OF DEVICES WITH VARYING DIFFEREN[illegible]S

DEVICE #	CAR/TRUCK	DISC TYPE		LAB/ACT	LAB/REL	Device Differential	Disc differential	PULSE LEVEL IN PSI 1ST READING	2nd reading	ance 1-2nd
250-12-01	CAR	Quiet car prod		141	114	27		2	0.5	1.5
-2				134	111	23		2	0.5	1.5
-3				132	110	22		1	0.25	0.75
-4				144	112	32		1.15	0.5	0.65
-5				138	115	23		0.85	0	0.85
AVERAGE			5.75	137.8	112.4	25.4	#DIV/0!	1.4		1.4
STN DEVIATION				4.91935	2.073644	4.159326969	#DIV/0!	0.55789784		0.557898
6	TRUCK	Noisy truck prod		282	86	176			0	0
7				230	114	116		87.2	-81	168.2
8				231	88	154		19.225	-53	72.225
9				245	103	142		27.625	-75	102.625
10				252	104	148		63	-74.5	137.5
AVERAGE			13	245.2	98	147.2	#DIV/0!	67.5	-262	93.7
STN DEVIATION				12.51799	13.0958	21.66102491	#DIV/0!	52.91		52.91
								28.56786109		28.56786
11	TRUCK	Truck Lot "AA"		260	215	45			0.5	-0.5
12				266	222	44		0	0	0
13				262	196	66		0	0	0
14				270	219	51		0.4125	0.5	-0.0875
15				265	229	36		0.59375	0	0.59375
AVERAGE			4.5	264.6	216.2	48.4	#DIV/0!	0	0	0
STN DEVIATION				3.847077	12.39758	11.19374828	#DIV/0!	0.20125		0.20125
								0.282925584		0.282926
16	CAR	Car Lot "N"		183	165	18				0
17				140	118	22		0	0	0
18				193	167	26		0	0	0
19				192	170	22		0	0	0
20				154	133	21		0	0	0
AVERAGE			8	172.4	150.6	21.8	#DIV/0!	0	0	0
STN DEVIATION				24.02707	23.58601	2.863564213	#DIV/0!	0		0
										0
21	CAR	Car Lot "L"		197	164	33				0
22				198	159	39		0	1	-1
23				211	181	30		0.0625	0	0.0625
24				163	128	25		0.14375	0	0.14375
25				156	123	33		6.39	0	6.39
AVERAGE			11	183	151	32	#DIV/0!	6.2656	-4.25	10.5156
STN[illegible].XLS, 6/29/92, 1				26.61766	24.72853	5.099019514	#DIV/0!	2.57235		2.57235
								3.428856878		3.428857

TI-NHTSA 000604



TI-NHTSA 006805

DRAWINGS AVAILABLE UPON REQUEST

PRESSURE SWITCH DATA Form 21605 TEST NO. 317-16-4

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77P363-1	8-13-92	DAVE SCHULZ	8-21
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**

PROJECT TITLE: ACTUAL PRELOAD DETERMINATION

CUSTOMER: FORD

PURPOSE OF TEST: TO DETERMINE WHERE ON THE P-D CURVE THE DEVICE ACTUALLY MAKES CONTACT. DOES ASSEMBLY CAUSE THE PRELOAD TO INCREASE

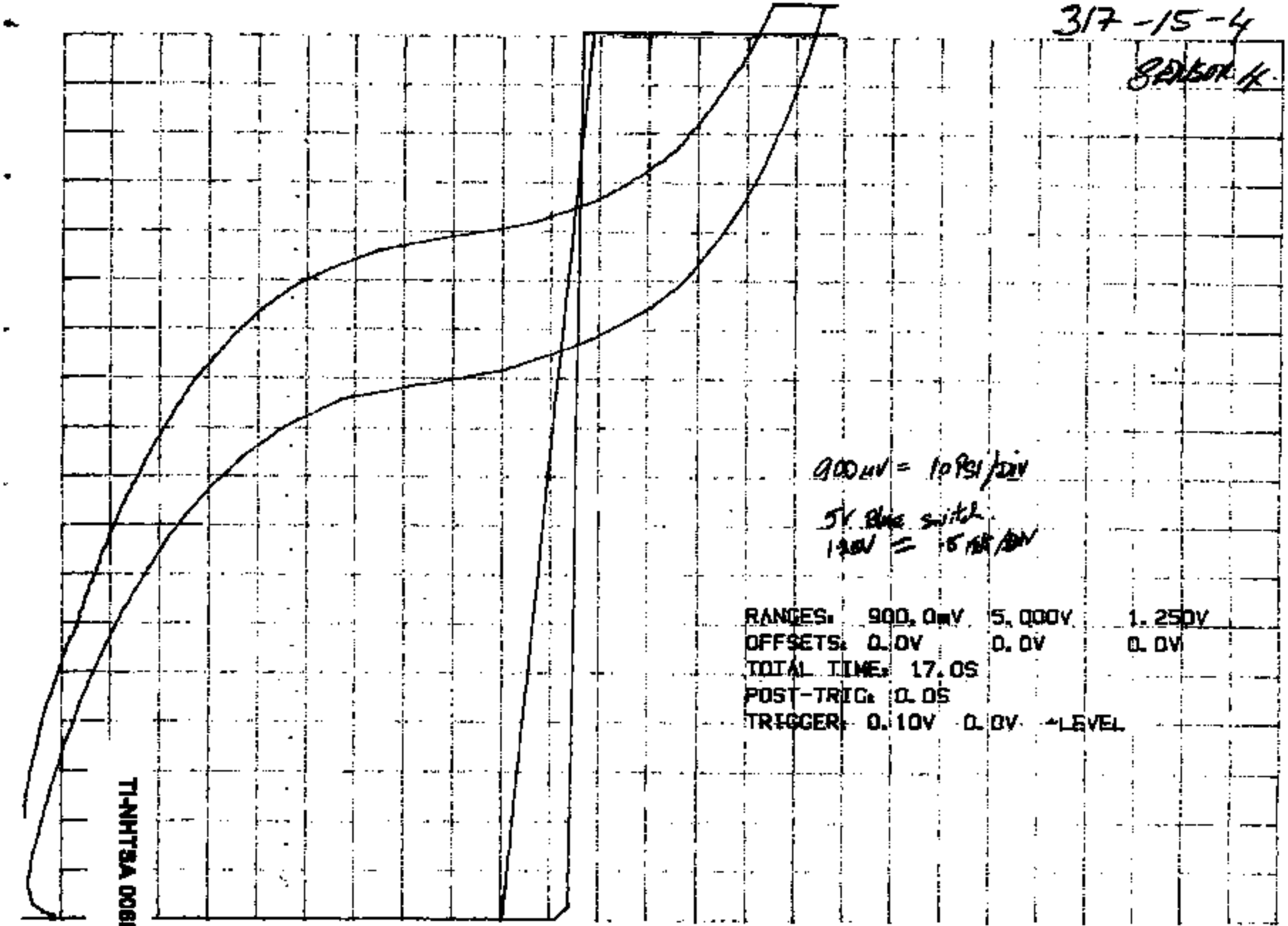
4 DEVICES

PROCEDURE: PUT LVDT PROBE IN CONNECTOR & ON TO THE BUMP IN THE CONTACT ARM. MEASURE PRESSURE DEFLECTION. USE A HIGH SPEED DAK CHANNEL SCOPE TO PROPERLY CAPTURE THE ELECTRICAL SIGNAL VS DISPLACEMENT.

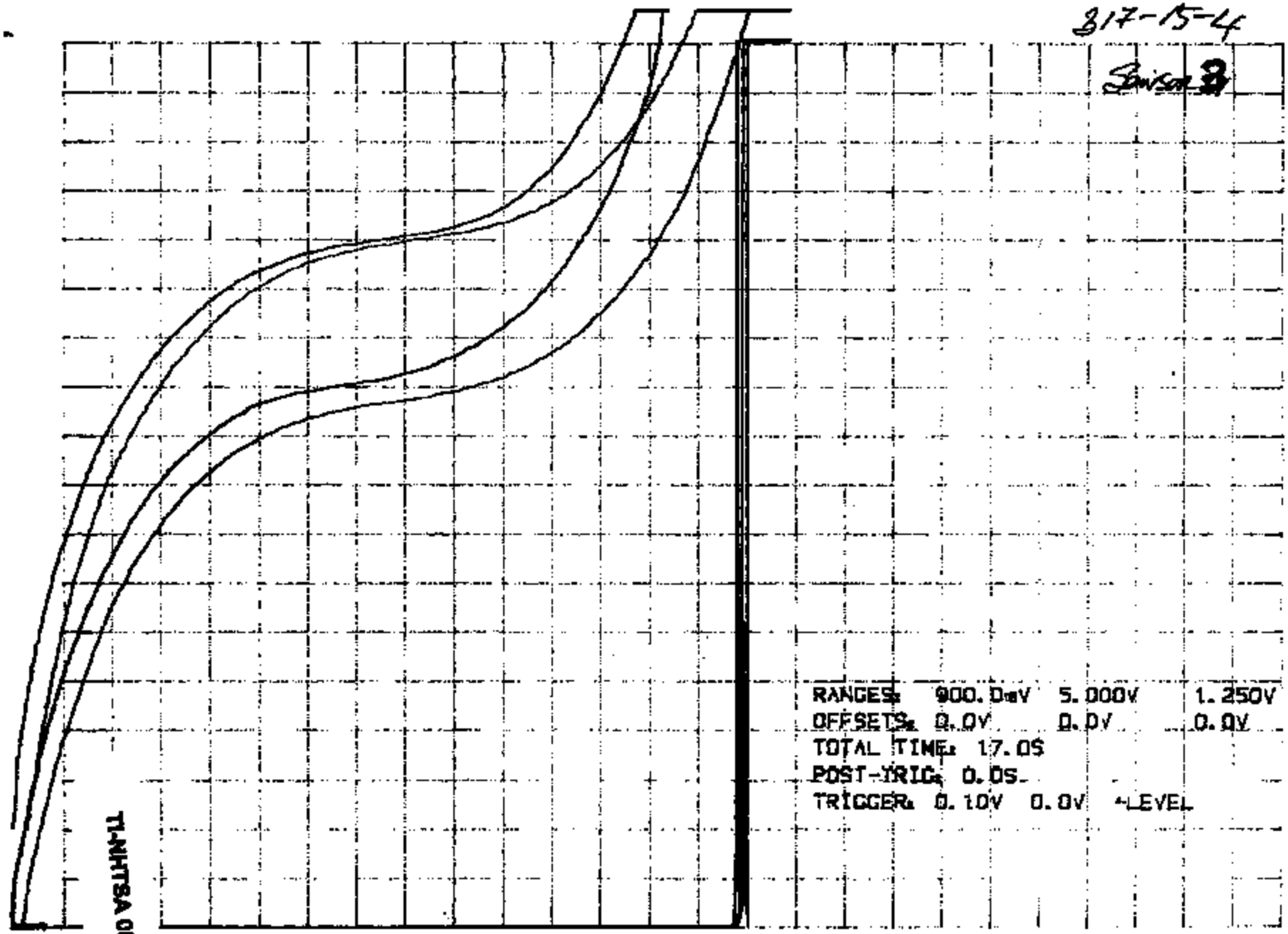
TI-NHTSA 006810

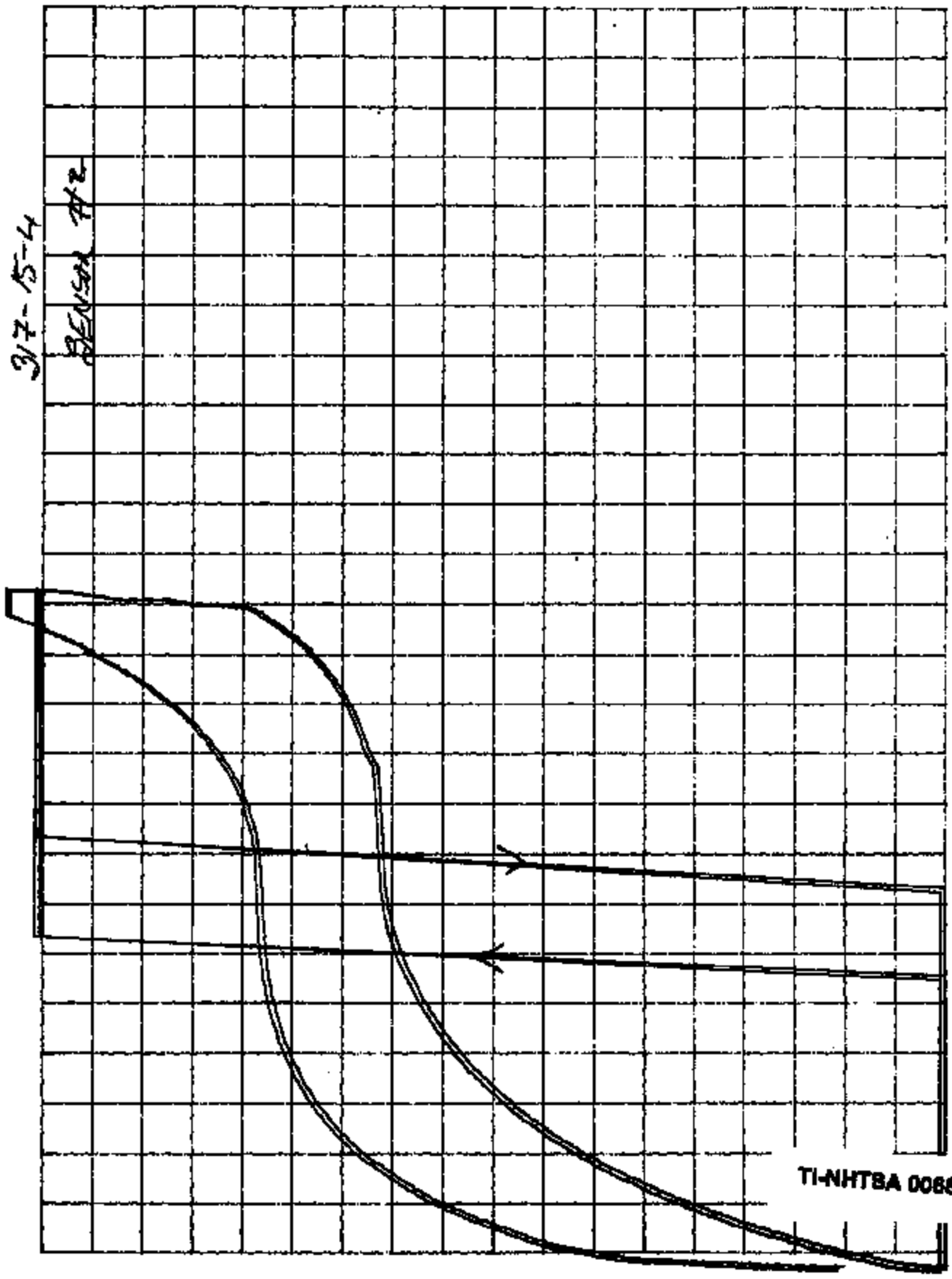
317-15-4

SENSOR #

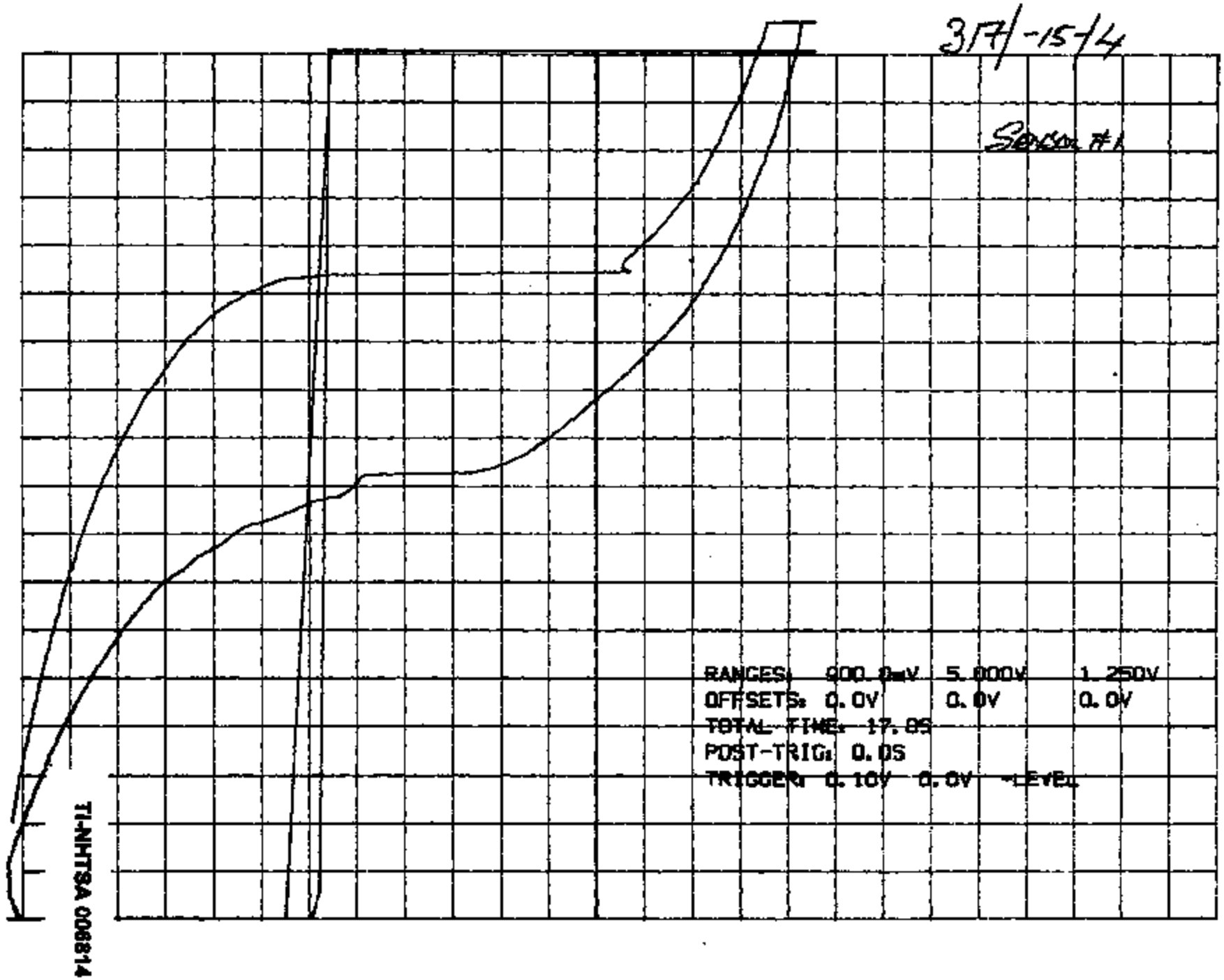


TI-NHTSA 006811


817-15-4
Sensor 3
RANGES: 900.0mV 5.000V 1.250V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 17.0S
POST-TRIG: 0.0S
TRIGGER: 0.10V 0.0V *LEVEL
TI-NHTSA 006812



TI-NHTSA 006813


357-15-14
Sensor #1
RANGES: 900.0mV 5.000V 1.250V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 17.0S
POST-TRIG: 0.0S
TRIGGER: 0.10V 0.0V <LEVEL
TI-NHTSA 008814

-MSG M#= 108926 FR=6801 TO=PCME SENT=08/14/92 09:46 AM
R#=038 ST=C DIV=0050 CC=00101 BY=6801 AT=08/14/92 09:46 AM

TO:	Ted Ballard	ETB	Paul Kotch	PRK1
	Tom Burke	MFPC	Steve Major	SMFH
	Rick Conlin	RAC1	Danny O'Driscoll	DOD
	Jeff DiDomenico	DIDO	Dale Sogge	FFUN
	Charlie Douglas	CMP1	[redacted]	PCME
	Norm Freda	WHLZ	Rusty Struble	RCS2
	Dick Gariepy	MFPC	Jim Watt	PCQA
CC:	Tom Charboneau	(delivered separately)		
	Dave Czarn			
FR:	Steve Offiler	6801		

TI-NHTSA 006815

SJ: BiWeekly Highlights

The ES testing for 77PSL3-1 and 77PSL5-2 has been completed on a somewhat compressed timetable. This was due to a miscommunication with Teves, where we thought we had successfully obtained approval to move our submission date out to 14 Aug, when in fact this was unacceptable as Teves' submission date to Ford is also 14 Aug and could not be moved. We expedited completion of the final tests, Impulse and Thermal Cycle, as well as the battery of final characterizations, in order to provide Teves with verbal results 12 Aug and written results 13 Aug. Fortunately, we experienced no problems whatsoever during the testing. The L5-2 report, completed and fax'ed to Teves, carefully describes our similarity claim with L3-1 and the approval we obtained from Bruce Masroff for this. The L3-1 report (Dana-Weatherhead device for EN53) is forthcoming.

As we prepare to include noise testing in the ES, we checked a total of 12 of the above devices for noise pre- and post-test. Three each of L3-1 and L5-2 Impulse and Thermal Cycle parts were checked. All devices produced the characteristic flat line (no pressure dip at actuation which is associated with noise) before and after testing.

Base dimension shifts due to temperature have been recharacterized for Noryl at 150 C and 182 C. The measurements are taken using empty bases (no terminals) crimped to dummy sensors cut to facilitate measurement. At 150 C, the average shift is 3 mils, with a max of 4 mils. At 182 C, the average is 5 mils, with a max of 6 mils.

We've learned that the high vacuum issue with Ford Australia is a true requirement. Based on actual measurements of their evac & fill equipment, they need switches that withstand 0.4 mBar vacuum (0.3 mm Hg) versus the US spec of 3.0 - 6.0 mm g. Initial tests show the Kapton is sucked out of place at higher vacuum, resulting in wrinkles that are likely to cause diaphragm life problems. They want production-intent proto's for a vehicle build on Nov 1. We are beginning a controlled experiment soon which will compare diaphragm life for several different diaphragm configurations after application of high vacuum.

We have prepared Ford Australia for the possibility of a design change to handle high vacuum, and used this as rationale to reschedule the Capri validation. This buys some time and frees up the cycler for the required testing. Also, colored O-rings will be needed for this validation, and Stan is presently working on a couple of different ideas for 57PSF3-6 whose need is more immediate. We plan to use whatever Stan is able to come up with.

Jeff is presently working on obtaining equipment for the new hydraulic cycler. An issue that needs to be addressed is space. It looks like we should move the burst test equipment to a new location T-8-D to free up space beside the Despatch oven. Also, Jeff has completed modifications to the CCPS

cycler to tie in the chamber to the programmable controller. We now have the ability to automatically return to room temperature whenever the cycler shuts down (at the end of a preset count; brake fluid leak; improper switch action per the monitor circuit; and low hydraulic fluid reservoir). This is because we strongly suspect temperature effects on diaphragm life, and we wish to avoid prolonged exposure to high temperature during those unattended periods where a leaker has caused the cycler to shut down.

Regards,
Steve O.

HIGHLIGHTS

Stephen B. Offiler
Week Ending 92-08-14

The ES testing for 77PSL3-1 and 77PSL5-2 has been completed on a somewhat compressed timetable. This was due to a miscommunication with Teves, where we thought we had successfully obtained approval to move our submission date out to 14 Aug, when in fact this was unacceptable as Teves' submission date to Ford is also 14 Aug and could not be moved. We expedited completion of the final tests, Impulse and Thermal Cycle, as well as the battery of final characterizations, in order to provide Teves with verbal results 12 Aug and written results 13 Aug. Fortunately, we experienced no problems whatsoever during the testing. The L5-2 report, completed and fax'ed to Teves, carefully describes our similarity claim with L3-1 and the approval we obtained from Bruce Maeroff for this. The L3-1 report (Dana-Weatherhead device for EN53) is forthcoming.

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Jeff is presently working on obtaining equipment for the new hydraulic cycler. An issue that needs to be addressed is space. It looks like we should move the burst test equipment to a new location T-B-D to free up space beside the Despatch oven. Also, Jeff has completed modifications to the CCPS cycler to tie in the chamber to the programmable controller. We now have the ability to automatically return to room temperature whenever the cycler shuts down (at the end of a preset count; brake fluid leak; improper switch action per the monitor circuit; and low hydraulic fluid reservoir). This is because we strongly suspect temperature effects on diaphragm life, and we wish to avoid prolonged exposure to high temperature during those unattended periods where a leaker has caused the cycler to shut down.

REPORT OF ISR TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH
PS/92/82

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

TI-NHTSA 006818

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 82-08-17		PAGE 1

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TI-NHTSA 006819

1.0 **GENERAL**

1.1 Customer: Ford Motor Company P.I.A. from Dana-Weatherhead

1.2 Part Numbers:

1.2.1	Ford P/N:	F2AC-9F924-AA
1.2.2	Dana P/N:	120-55046
1.2.3	TI P/N:	77PSL3-1

1.3 Engineering Specification: (inv delta) ES-F2VC-9F924-AA

1.4 Date of Completion: 920811

1.5 Quantity of Units Tested: 72

1.6 Disposition of Tested Units: All devices are presently retained under quarantine, completely separate from any production devices, to be destroyed per the ES at a later date after full ISR approval is obtained.

1.7 TI test series number: 245-15-129

1.8 TI Pressure Switch test report number: PS/92/82

TI-NHTSA 006820

2.0 OBJECTIVE

This testing was performed to demonstrate the ability of 77PSL3-1 to conform to customer specifications given in (inv delta) ES-F2VC-9F924-AA, in fulfillment of the requirements of the Initial Sample Report. Units tested were built using fully qualified production components and production assembly equipment.

3.0 TEST PROCEDURES AND RESULTS

All switches were tested per Ford Engineering Specification (inv 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 requires elaboration, a complete explanation of the procedure is presented. For all tests, raw data is included in Appendix 4.2.

3.1 CALIBRATION

3.1.1 Devices tested: 245-15-01 thru 72

3.1.2 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The change in continuity is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

TI-NHTSA 006821

3.1.3 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.

3.1.4 Initial Results: Prior to proof testing, the average actuation was found to be 126 psi with a sigma of 6.2; after proof the average actuation was 131 psi with a sigma of 4.9. The average shift is 4%. Prior to proof testing, the average release was found to be 113 psi with a sigma of 6.5; after proof the average release was 119 psi with a sigma of 5.7. The average shift is 5%.

3.1.5 Final Results: Prior to proof testing, the average actuation was found to be 130 psi with a sigma of 5.4; after proof the average actuation was 129 psi with a sigma of 5.3. The average shift is -0.8%. Prior to proof testing, the average release was found to be 108 psi with a sigma of 7.7; after proof the average release was 108 psi with a sigma of 6.6. The average shift is 0.

3.2 VOLTAGE DROP

3.2.1 Devices tested: 245-15-01 thru 72

3.2.2 Procedure: Voltage drop is checked simultaneously with Calibration (see 3.1.2). The measurement is taken at room temperature using ambient air as the pressure medium. For the purpose of stabilization, data is 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The voltage drop is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

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TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 92-04-17		PAGE

3.2.3 Equipment: Fluke Model 8020B Digital Multimeter, calibrated quarterly, used in conjunction with the continuity equipment in 3.1.3.

3.2.4 Initial results: Values for all devices fell below the specification of 200 millivolts maximum by close to two orders of magnitude; no specific statistics calculated for this reason.

3.2.5 Final results: With the exception of parts undergoing Impulse testing (devices 245-15-01 thru 12 and -37 thru 48), all final results were comparable with initial results. The Impulse parts experience an increase in the voltage drop reading due to the specified 25,000 cycles run at full electrical load, which causes a certain amount of normal erosion of the contact surfaces. All 24 Impulse devices still fell significantly below 200 mV maximum, and statistics show a Cpk of 2.53.

3.3 CURRENT LEAKAGE

3.3.1 Devices tested: 245-15-01 thru 72

3.3.2 Procedure: Per the ES section III. C. This test is conducted as a pass/fail.

3.3.3 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%).

3.3.4 Initial results: All devices passed.

3.3.5 Final results: All devices passed.

TI-NHTSA 008823

3.4 PROOF

3.4.1 Devices tested: 245-15-01 thru 72

3.4.2 Procedure: Per the ES section III. D. This test is conducted as a pass/fail. The test pressure specified on the part drawing is 3000 psi.

3.4.3 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.

3.4.4 Initial Results: All devices passed.

3.4.5 Final Results: All devices passed.

3.5 IMPULSE

3.5.1 Devices tested: 245-15-01 thru 12 and -37 thru 48

3.5.2 Procedure: Per the ES section III. E.

3.5.3 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

TI-NHTSA 006824

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 (figure 4) used in the last 25K cycles.

3.5.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.6 BURST

3.6.1 Devices tested: 245-15-67 thru 72.

3.6.2 Procedure: Per the ES section III. F. After holding 7000 psi for 30 seconds as specified, the devices were inadvertently pressurized to approx. 7600 psi.

3.6.3. Equipment: Same as 3.4.3, with the addition of Enerpak gauge reading to 10,000 psig with 100 psi increments, resolvable to 50 psi., calibrated quarterly.

3.6.4. Results: All six devices passed 30 seconds at 7000 psig without evidence of fluid leakage or seepage from the switch or threads.

At 7600 psi, one device (-70) displayed evidence of fluid seepage.

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3.7 **HUMIDITY**

3.7.1 Devices tested: 245-15-25 thru -30.

3.7.2 Procedure: Per the ES section III. G. Please note that performing a full characterization per the ES consists of measurement of actuation, release, voltage 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 (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.

3.7.3 Equipment: Humidity chamber RK model 5S.

3.7.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.8 **SALT SPRAY**

3.8.1 Devices tested: 245-15-31 thru -36.

3.8.2 Procedure: Per the ES section III. H.

3.8.3 Equipment: Harshaw salt spray chamber.

3.8.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.9 **VIBRATION**

3.9.1 Devices tested: 156-15-61 thru 66.

3.9.2 Procedure: Per the ES section III. I.

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3.9.3 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; 160 psig * 1.1 = 176 psi minimum.

3.9.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.10 TERMINAL STRENGTH

3.10.1 Devices tested: 245-15-13 thru -24.

3.10.2 Procedure: Per the ES section III. J.

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

3.10.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.11 VACUUM

3.11.1 Devices tested: 245-15- 55 thru 60.

3.11.2 Procedure: Per the ES section III. K.

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

3.11.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

TI-NHTSA 006827

3.12 TEMPERATURE CYCLE

3.12.1 Devices tested: 245-15-49 thru 54

3.12.2 Procedure: Per the ES section III. L.

3.12.3 Equipment: Same as 3.5.3.

3.12.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.13 FLUID RESISTANCE

3.13.1 Devices tested: 245-15-01 thru -36.

3.13.2 Procedure: Per the ES section III. M.

3.13.3 Equipment: Fluids as called out in ES table in III. M. 1. c. plus appropriate beakers and storage apparatus; vented hood.

3.13.4 Results: The 36 devices were divided into groups as follows for subsequent testing. Results of these tests are reported in the section indicated.

3.13.4.1 Impulse (3.5), -01 thru -12

3.13.4.2 Terminal Strength (3.10), -13 thru -24.

3.13.4.3 Humidity (3.7), -25 thru -30.

3.13.4.4 Salt Spray (3.8), -31 thru -36.

TI-NHTSA 006828

3.14 NOISE

In certain vehicle applications, the brake pressure switch action has been shown to be transmitted to the passenger compartment as audible noise and corresponding tactile feel in the brake pedal. A "silent" device has been developed by Texas Instruments in order to address this concern. At the same time, a means of quantifying the noise/feel was explored. The hypothesis was that a sudden motion of pressure-sensing components within the switch caused a pressure wave to propagate from the switch. Characterization of this effect using high-speed pressure transducers showed that "noisy" devices produce a large negative pressure spike at the point of switch activation, and supported the hypothesis. The "silent" devices produce little or no spike. See Appendix 4.3 for a pressure trace of a typical silent device.

Ultimately (inv delta) ES-F2VC-9F924-AA will be updated to include a section on noise testing, to be applicable only to devices designated as silent. For this validation, in lieu of an officially finalized noise specification, a total of 12 devices (6 from this test and 6 similar devices) were initially characterized for noise, then run through Impulse or Thermal Cycle testing, then recharacterized for noise at the end.

3.14.1 Devices tested:

77PSL3-1 Impulse:	245-15-37, 38, 39
77PSL3-1 Thermal Cycle:	245-15-49, 50, 51
77PSL5-2 Impulse:	245-15-81, 82, 83
77PSL5-2 Thermal Cycle	245-15-105, 106, 107

3.14.2 Procedure: The device under test is installed on the test manifold. Air is evacuated via a vacuum pump. The manifold is filled with the test fluid. Pressure to 300 psi is applied and the signal from the high-speed transducer is captured on a digital oscilloscope.

TI-NHTSA 008829

3.14.3 Equipment: Custom TI designed and built equipment, utilizing a single-port test manifold within a protective enclosure. The manifold is evacuated by a Piab H-125 pneumatic vacuum pump. DOT 3 Brake Fluid is introduced via a fluid reservoir. Pressure is applied via pressurized air which is introduced to an air-over-oil chamber which connects to the test manifold. The dynamic pressure signal during switch actuation is measured with a Kistler High-Frequency Dynamic Pressure Transducer model 606A (SN C46154) with a Kistler 5004 Charge Amplifier whose output connects to channel A of a dual-channel Nicolet 4094A Digital Oscilloscope. The electrical switching action of the device under test is recorded simultaneously on channel B using a 5-volt source and a 1K ohm load resistor.

3.14.4 Initial results: All twelve test devices produced zero pressure spike.

3.15.5 Final results: All twelve test devices produced zero pressure spike.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
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Appendix 4.1
Ford Engineering Specification
(inv delta) ES-F2VC-9F924-AA

TI-NHTSA 006831

Engineering Specification

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

LET																			
PR																			
LET																			
PR																			

DATE	LET	PR	REVISIONS	DR	CK
			ADDED DATA TO COMPLETE		
			SPEC. & RETYPED		
901130			NCOOE10079779002		[illegible]

REFERENCE

PREPARED/APPROVED BY
B.S. Pease 90.09.10

CHECKED BY | DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR
K. [illegible] 900910

DESIGN ENGINEERING MGT.

MANUFACTURING ENGRG.

QUALITY CONTROL
[illegible signature] 10/1/90

PURCHASING

SUPPLIER QUALITY ASSISTANCE
[illegible signature]

ELECTRONICS DIVISION
[illegible signature] 900911

▽ CONTROL ITEM — THE ▽ SYMBOL ALSO IDENTIFIES PRODUCT ENGINEERING DESIGNATED CRITICAL CHARACTERISTICS. THESE AND ADDITIONAL CRITICAL CHARACTERISTICS IDENTIFIED BY PROCESS REVIEW, MUST APPEAR ON THE Q-101 CONTROL PLANS WHICH REQUIRE PRODUCT ENGINEERING APPROVAL.

TI-NHTSA 006832

Engineering Specification

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 Sect. 3.5, "Engineering Specification (ES) Test Performance Requirements" shall be invoked.

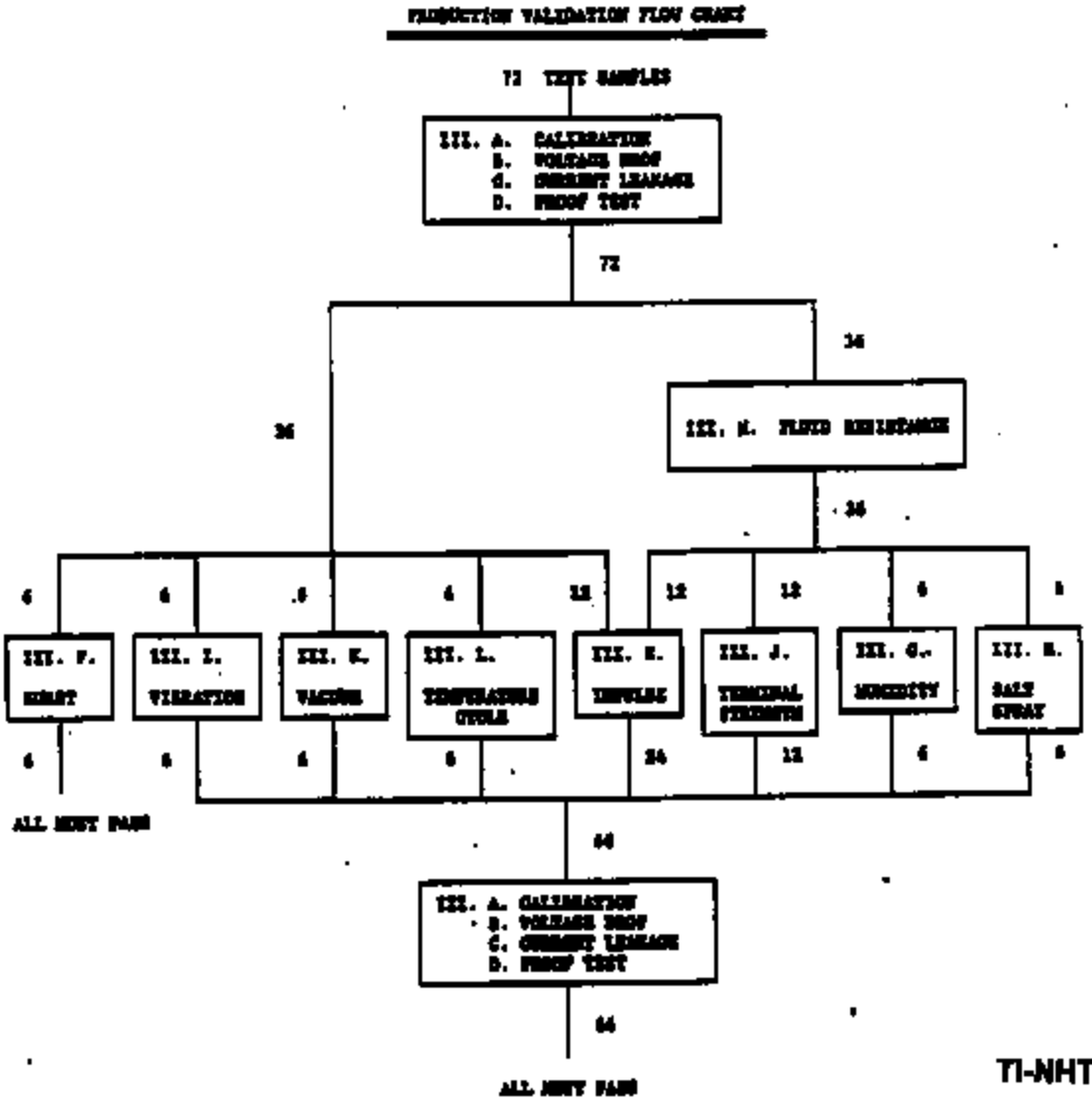
TI-NHTSA 006833

SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
A	Calibration	72	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.96	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
I	Vibration	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
J	Terminal Strength	12	P90-.84	6/Mo.	P90-.72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
L	Temperature Cycle	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
M	Fluid Resistance	36	P90-.94	36/12Mo	P90-.94	36/12Mo.	P90-.94
	Durability Tests						
III.							
B	Impulse	24	P90-.90	12/Mo.	P90-.84	3/3 Mo.	P90-.56
G	Humidity	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
H	Salt Spray	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72

TI-NHTSA 006834

Engineering Specification



PRODUCTION VALIDATION FLOW CHART

TI-NHTSA 006835

III. TEST PROCEDURES AND REQUIREMENTS

▽ A. Calibration

1. Test Requirements

a. Switch calibration is to be checked at room temperature (18°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.

TI-NHTSA 006836

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) microamperes.

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.

TI-NHTSA 006837

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

E. Impulse

1. Test Requirements

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

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

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

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

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

d. Switch must open and close each cycle.

2. Acceptance Requirements

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

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

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

F. Burst

1. Test Requirement

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

b. Pressurize the switch to 48.3 MPa (7000 PSI) minimum and hold for 10 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.

TI-NHTSA 006838

III. Test Procedures and Requirements (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 80-94% 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.

TI-NHTSA 006839

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.

TI-NHTSA 008840

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

(1) Apply a 89 ± 5 N axial force to each terminal.

(2) With a pendulum apply a 45 ± 5 N impact force to the switch housing at the connector end, 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.

TI-NHTSA 006841

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. Sequencially, 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.

TI-NHTSA 006842

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 (name) 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. For 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.

TI-NHTSA 006843

IV. STATISTICAL ANALYSIS METHOD

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

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

V. REVALIDATION REQUIREMENTS

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

MINIMUM CHANGE REVALIDATION

Component	Process or Material Change or New Supplier
1. Terminals, Contacts, or Connector	III, B, C, E, G, H,I, J, L, M.
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, K, I, M.

B. Annual revalidation is not required on carryover switches.

VI. LOT DEFINITION

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

TI-NHTSA 006844

VII. RECORD RETENTION

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

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

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

VIII. INSTRUCTIONS AND NOTES

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

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

Test port configuration is shown in Figure 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 interpretation.

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 problem 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.

TI-NHTSA 006845

IX. COMPILATION OF REFERENCE DOCUMENTS

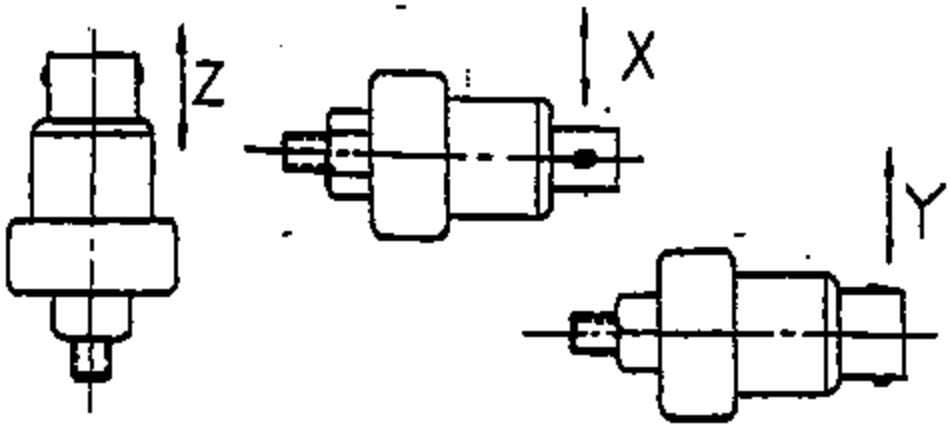
ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard - 1990 Edition

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

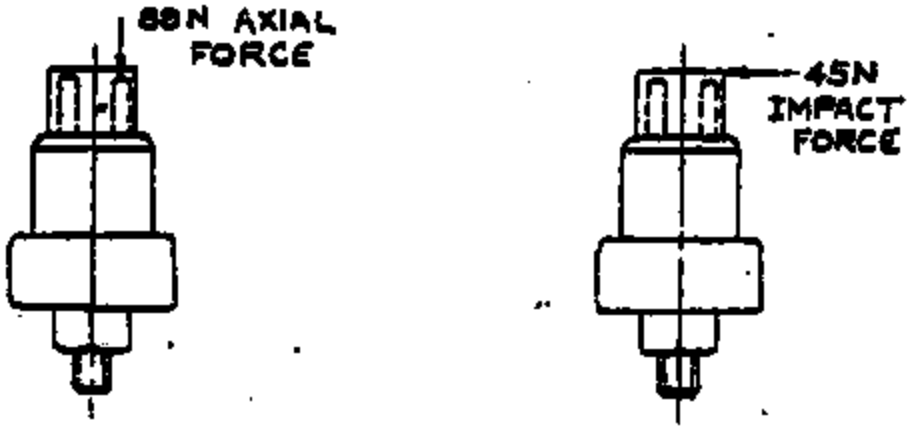
ES-F2VF-9C735-AA, Specification - Servo Assembly Speed Control

TI-NHTSA 006846



VIBRATION TEST - SWITCH ORIENTATION

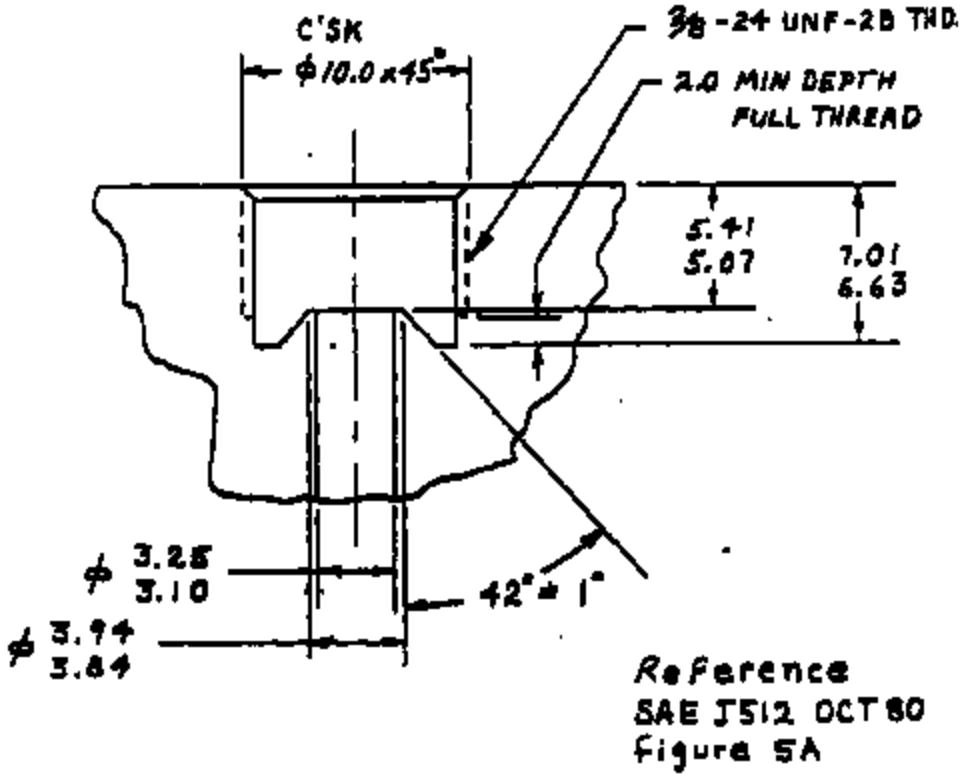
FIGURE 1.



TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2.

Engineering Specification

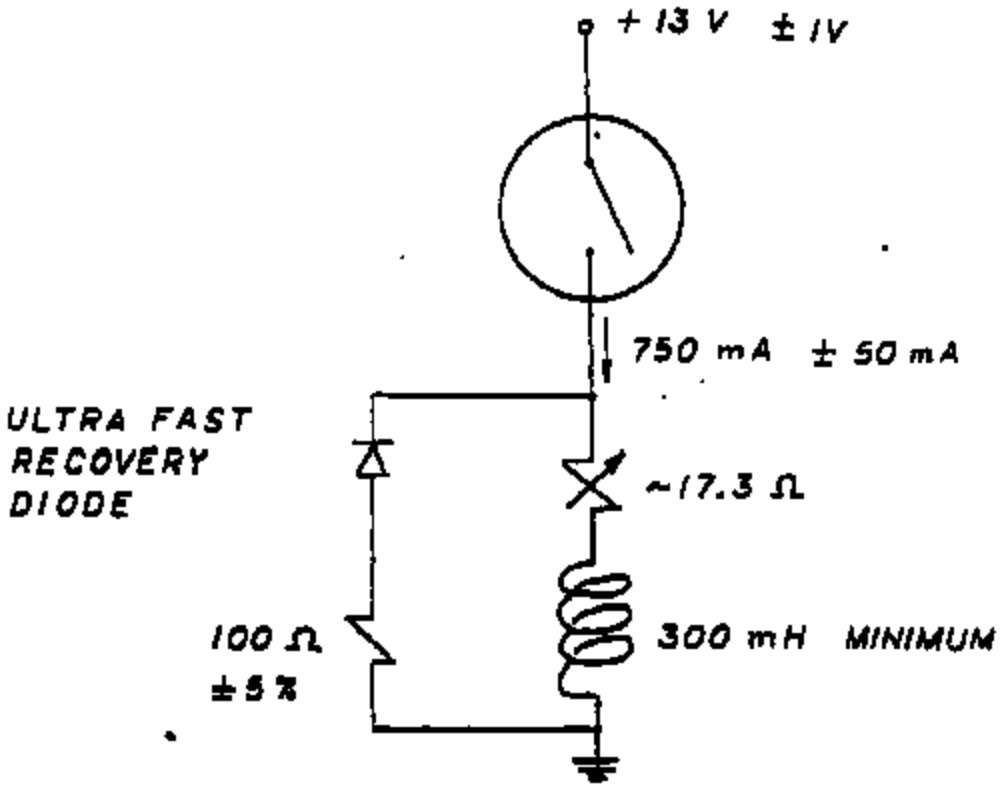


TEST FIXTURE PORT CONFIGURATION

FIGURE 3

FRAME 17 OF 18	REVISED		▽ [illegible] NUMBER

TI-NHTSA 006848



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

TI-NHTSA 006849

Appendix. 4.2
Data

TI-NHTSA 006850

PRESSURE SWITCH DATA Form 21605 **TEST NO.**

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:

771563-1

Final Characterization

Device #	[illegible]	[illegible]	Hy Drop	[illegible]	[illegible]	[illegible]				
[illegible]	131	104	18.6	✓	✓	128-110				
[illegible]	128	97	29.4	✓	✓	122-105				
[illegible]	130	102	20.6	✓	✓	129-108				
[illegible]	128	102	19.0	✓	✓	127-104				
[illegible]	135	108	25.2	✓	✓	132-110				
[illegible]	117	95	24.1	✓	✓	117-97				
[illegible]	130	103	45.6	✓	✓	128-105				
[illegible]	124	99	17.2	✓	✓	123-103				
[illegible]	124	96	54.3	✓	✓	123-105				
[illegible]	122	100	88.5	✓	✓	120-101				
[illegible]	127	99	25.9	✓	✓	126-105				
[illegible]	125	104	36.8	✓	✓	128-105				
[illegible]	138	109	4.3	✓	✓	138-115				
[illegible]	124	92	2.7	✓	✓	119-95				
[illegible]	135	109	2.8	✓	✓	134-115				
[illegible]	136	111	2.1	✓	✓	136-120				
[illegible]	134	107	3.6	✓	✓	132-116				
[illegible]	131	99	2.2	✓	✓	132-105				
[illegible]	133	99	2.7	✓	✓	132-115				
[illegible]	132	97	3.5	✓	✓	130-111				
[illegible]	142	110	4.7	✓	✓	140-122				
[illegible]	132	104	5.1	✓	✓	132-112				
[illegible]	137	108	3.0	✓	✓	145-112				
[illegible]	135	103	2.5	✓	✓	136-114				
[illegible]	[illegible]	[illegible]	[illegible]	✓	✓	[illegible]				
[illegible]	124	112	5.0	✓	✓	125-109				
	[illegible]	[illegible]	[illegible]							

TI-NHTSA 006851

[illegible] #	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1[illegible]	2.7	✓	✓	[illegible]
[illegible]	129 97	[illegible]	✓	✓	[illegible]
[illegible]	12[illegible]	2.9	✓	✓	130 [illegible]
[illegible]	[illegible]	[illegible]	✓	✓	[illegible]
[illegible]	11[illegible] 99	1.6	✓	✓	12[illegible]
[illegible]	121 118	[illegible]		✓	127 118
[illegible]	121 116	2.7	✓	✓	[illegible]
[illegible]	13[illegible] 101	2.1	✓	✓	128 [illegible]
[illegible]	125-112	9.6	✓	✓	123-103
[illegible]	130-114	6.8	✓	✓	127-105
[illegible]	126-112	9.7	✓	✓	126-108
[illegible]	131-113	8.0	✓	✓	128-110
[illegible]	125-111	7.2	✓	✓	122-106
[illegible]	126-112	5.6	✓	✓	126-107
[illegible]	127-113	5.7	✓	✓	124-108
-49	126-111	5.5	✓	✓	122-99
[illegible]	138-123	7.7	✓	✓	135-115
[illegible]	133-116	7.0	✓	✓	132-105
[illegible]	131-117	2.0	✓	✓	127-105
[illegible]	126-112	4.5	✓	✓	122-105
[illegible]	127-98	.8	-	-	126 99
[illegible]	129-100	5.6	-	-	129 100
[illegible]	126-108	2.6	✓	✓	127 98
[illegible]	130-105	1.7	-	-	130 101
[illegible]	130-102	2.9	-	-	128 102
[illegible]	125-108	1.1	-	-	125 97
[illegible]	138-117	1.3	✓	✓	135-110
[illegible]	132-120	1.2	✓	✓	130-115
[illegible]	136-123	1.2	✓	✓	134-108
[illegible]	136-121	1.7	✓	✓	131-113
[illegible]	130-118	2.7	✓	✓	127-114
[illegible]	140-128	1.7	✓	✓	136-120
[illegible]	134-117	1.5	✓	✓	134-120
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[illegible]	137-115	2.6	✓	✓	135-110
[illegible]	135-109	2.6	✓	✓	138-113
[illegible]	127-107	2.8	✓	✓	130-104
-66	127-105	3.1	✓	✓	128-110

TI-NHTSA 006852

Appendix 4.3
Noise Pressure Trace

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA 02703	DOC.
DATE 82-08-17		PAGE 38

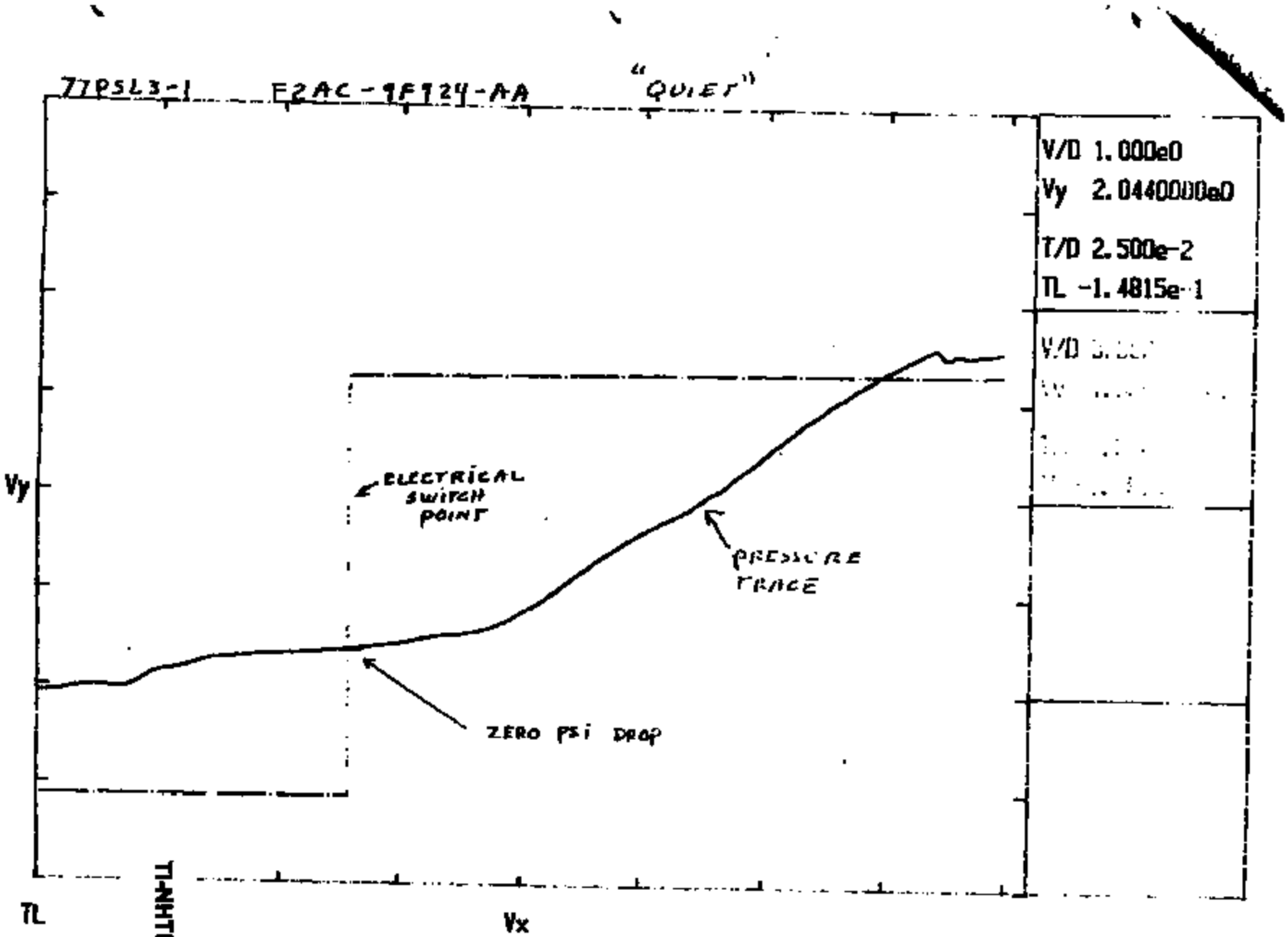

FIGURE 3

TI-NHTSA 000954

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 245-15-179

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PSL 3-1, 77PSL 5-2	920413	Steve Offiler	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeffrey D'Ocampo	920415		

PROJECT TITLE: Speed Control

CUSTOMER:

PURPOSE OF TEST: Production Validation

PROCEDURE: DES-F2VC-9F924-AA ; Full ISR

Natural Noryl Bases

ultra-low diff discs.

Act 90-110

Rel 30 Min

TI-NHTSA 006855

77PSL 3-1

INITIAL Characterizations

Device #	Act	Rel	Hy Drop	Current Leak	Dielectric Proof	Act	Rel	Test	Complete	Test	Complete
245-15-01	119	97	4.1	✓	✓	140	123	Fluid Ax	✓	Impulse	✓
-02	117	95	3.1	✓	✓	130	113	↓	✓	↓	✓
-03	132	111	5.5	✓	✓	130	113		✓		✓
-04	131	115	5.7	✓	✓	131	117		✓		✓
-05	133	117	4.1	✓	✓	126	115		✓		✓
-06	124	108	4.7	✓	✓	127	115		✓		✓
-07	125	117	4.5	✓	✓	131	113		✓		✓
-08	123	107	4.3	✓	✓	112	113		✓		✓
-09	124	108	4.5	✓	✓	122	119		✓		✓
-10	131	115	3.7	✓	✓	127	116		✓		✓
-11	125	114	4.9	✓	✓	125	118		✓		✓
-12	136	117	4.2	✓	✓	[illegible]	121		✓		✓
-13	136	116	3.5	✓	✓	133	123		✓	Tem. Strength	✓
-14	107	92	6.0	✓	✓	132	117		✓	↓	✓
-15	127	116	3.4	✓	✓	135	125		✓		✓
-16	129	111	4.1	✓	✓	134	111		✓		✓
-17	125	108	3.9	✓	✓	[illegible]	107		✓		✓
-18	126	116	3.7	✓	✓	132	116		✓		✓
-19	128	116	5.3	✓	✓	[illegible]	118		✓		✓
-20	122	111	3.1	✓	✓	127	109		✓		✓
-21	124	121	3.9	✓	✓	141	128		✓		✓
-22	121	105	3.2	✓	✓	132	115		✓		✓
-23	126	114	2.9	✓	✓	128	120		✓		✓
-24	119	93	3.6	✓	✓	123	117		✓	↓	✓
-25	124	110	3.1	✓	✓	122	112		✓	Humidity	✓
-26	119	108	3	✓	✓	125	117		✓		✓
-27	121	[illegible]	3	✓	✓	[illegible]	[illegible]				

Device #	Act	Rel	Mx Drop	Current leak	Isolation Proof	Act	Rel	Test	Complete	Test	Complete
JAE-IC-29	124	114	3.3	✓	✓	120	10	Flood Test	✓	Humidity	✓
- 30	114	106	3.3	✓	✓	126	116		✓	↓	✓
- 31	129	114	2.9	✓	✓	121	118		✓	Salt Spray	✓
- 32	125	115	3.0	✓	✓	132	120		✓	↓	✓
- 33	114	104	3.0	✓	✓	115	105		✓		✓
- 34	136	126	3.0	✓	✓	138	128		✓		✓
- 35	118	109	2.9	✓	✓	125	115		✓		
- 36	122	112	2.9	✓	✓	127	115	↓	✓	↓	✓
- 37	131	119	3.1	✓	✓	128	118	Impulse	✓	NONE	✓
- 38	132	118	3.0	✓	✓	136	125		✓	↓	✓
- 39	134	124	3.0	✓	✓	135	126		✓		✓
- 90	123	113	3.0	✓	✓	129	120		✓		
- 91	125	115	3.0	✓	✓	127	117		✓		
- 92	116	106	3.0	✓	✓	130	118		✓		
- 93	117	106	3.0	✓	✓	127	117		✓		
- 94	130	120	3.0	✓	✓	131	120		✓		
- 95	134	124	3.0	✓	✓	140	131		✓		
- 96	109	114	3.0	✓	✓	130	120		✓		
- 97	127	117	3.0	✓	✓	133	118		✓		
- 98	116	107	3.0	✓	✓	127	120	↓	✓		
- 99	134	112	3.0	✓		127	115	T-Cycle	✓	water	✓
- 100	132	121	2.9	✓	✓	135	121		✓	↓	✓
- 101	113	101	3.0	✓	✓	130	119		✓		
- 102	127	121	3.0	✓	✓	136	125		✓		
- 103	133	121	3.0	✓		129	120		✓		
- 104	121	102	3.0	✓	✓	125	114	↓	✓		
- 105	128	115	3.0	✓	✓	121	119	Vacuum	✓		
- 106	126	114	2.9	✓	✓	128	118		✓		
- 107	127	117	3.0	✓		130	119		✓		
- 108	133	111	3.0	✓		130	116		✓		
- 109	123	112	3.0	✓		125	114		✓		
- 110	131	117	3.0	✓		123	121	↓	✓		
- 111	127	117	3.0	✓		129	120	Vibration	✓		
- 112	127	117	3.0	✓		121	111		✓		
- 113	129	118	3.0	✓		123	113		✓		
- 114	128	117	3.0	✓		130	120		✓		
- 115	121	112	3.0	✓	✓	126	116		✓		
- 116	119	109	3.0	✓	✓	127	115	↓	✓		
- 117	132	123	3.0	✓	✓	134	123	Burst	Pass		
- 118	126	117	3.0	✓	✓	130	120		Pass		
- 119	128	118	3.0	✓	✓	130	120		Pass		
- 120	119	109	3.0	✓	✓	129	120		Burst 700		
- 121	128	120	3.0	✓	✓	132	121		Pass		
- 122	125	114	3.0	✓	✓	126	116		Pass		
- 123	125	120	3.0	✓	✓	130	120	↓			
- 124	124	114	3.0	✓		128	118	Not used			
- 125	119	110	3.0	✓		126	117				
- 126	119	109	3.0	✓		121	111				
- 127	120	109	3.0	✓		126	116				
- 128	111	101	3.0	✓		125	115				
- 129	119	109	3.0	✓	✓	127	117				
- 130	131	121	3.0	✓	✓	136	126	↓			

TI-NHTSA 006856


ES Test

REPORT OF ISR TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH
PS/92/82

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 92-08-17		PAGE 1

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1.0 GENERAL

1.1 Customer: Ford Motor Company P.I.A. from Dana-Weatherhead

1.2 Part Numbers:

1.2.1 Ford P/N: F2AC-9F924-AA

1.2.2 Dana P/N: 120-55046

1.2.3 TI P/N: 77PSL3-1

1.3 Engineering Specification: (inv delta) ES-F2VC-9F924-AA

1.4 Date of Completion: 920811

1.5 Quantity of Units Tested: 72

1.6 Disposition of Tested Units: All devices are presently retained under quarantine, completely separate from any production devices, to be destroyed per the ES at a later date after full IQR approval is obtained.

1.7 TI test series number: 245-15-129

1.8 TI Pressure Switch test report number: PS/92/82

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TESTED BY		
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2.0 OBJECTIVE

This testing was performed to demonstrate the ability of 77PSL3-1 to conform to customer specifications given in (inv delta) ES-F2VC-9F924-AA, in fulfillment of the requirements of the Initial Sample Report. Units tested were built using fully qualified production components and production assembly equipment.

3.0 TEST PROCEDURES AND RESULTS

All switches were tested per Ford Engineering Specification (inv 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 requires elaboration, a complete explanation of the procedure is presented. For all tests, raw data is included in Appendix 4.2.

3.1 CALIBRATION

3.1.1 Devices tested: 245-15-01 thru 72

3.1.2 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The change in continuity is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

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3.1.3 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.

3.1.4 Initial Results: Prior to proof testing, the average actuation was found to be 126 psi with a sigma of 6.2; after proof the average actuation was 131 psi with a sigma of 4.9. The average shift is 4%. Prior to proof testing, the average release was found to be 113 psi with a sigma of 8.5; after proof the average release was 119 psi with a sigma of 5.7. The average shift is 5%.

3.1.5 Final Results: Prior to proof testing, the average actuation was found to be 130 psi with a sigma of 5.4; after proof the average actuation was 129 psi with a sigma of 5.3. The average shift is -0.8%. Prior to proof testing, the average release was found to be 106 psi with a sigma of 7.7; after proof the average release was 108 psi with a sigma of 6.6. The average shift is 0.

3.2 VOLTAGE DROP

3.2.1 Devices tested: 245-15-01 thru 72

3.2.2 Procedure: Voltage drop is checked simultaneously with Calibration (see 3.1.2). The measurement is taken at room temperature using ambient air as the pressure medium. For the purpose of stabilization, data is 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The voltage drop is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

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3.2.3 Equipment: Fluke Model 8020B Digital Multimeter, calibrated quarterly, used in conjunction with the continuity equipment in 3.1.3.

3.2.4 Initial results: Values for all devices fell below the specification of 200 millivolts maximum by close to two orders of magnitude; no specific statistics calculated for this reason.

3.2.5 Final results: With the exception of parts undergoing Impulse testing (devices 245-15-01 thru 12 and 37 thru 48), all final results were compatible with initial results. The Impulse parts experience an increase in the voltage drop reading due to the specified 25,000 cycles run at full electrical load, which causes a certain amount of normal erosion of the contact surfaces. All 24 Impulse devices still fell significantly below 200 mV maximum, and statistics show a Cpk of 2.53.

3.3 CURRENT LEAKAGE

3.3.1 Devices tested: All 245-15-01 thru 72.

3.3.2 Procedure: Per the ES section III. C. This test is conducted as a pass/fail.

3.3.3 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%).

3.3.4 Initial results: All devices passed.

3.3.5 Final results: All devices passed.

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APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP, ATTLEBORO, MA OFFICE	DOC.
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3.4 PROOF

3.4.1 Devices tested: 245-15-01 thru 72

3.4.2 Procedure: Per the ES section III. D. This test is conducted as a pass/fail. The test pressure specified on the part drawing is 3000 psi.

3.4.3 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.

3.4.4 Initial Results: All devices passed.

3.4.5 Final Results: All devices passed.

3.5 [illegible]

3.5.1 Devices tested: 245-15-01 thru 12 and -37 thru 48

3.5.2 Procedure: Per the ES section III. E.

3.5.3 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, Sippson 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

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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 (figure 4) used in the last 25K cycles.

3.5.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.6 BURST

3.6.1 Devices tested: 245-15-67 thru 72.

3.6.2 Procedure: Per the ES section III. F. After holding 7000 psi for 30 seconds as specified, the devices were inadvertently pressurized to approx. 7600 psi.

3.6.3. Equipment: Same as 3.4.3, with the addition of Enerpak gauge reading to 10,000 psig with 100 psi increments, resolvable to 50 psi, calibrated quarterly.

3.6.4. Results: All six devices passed 30 seconds at 7000 psig without evidence of fluid leakage or seepage from the switch or threads.

At 7600 psi, one device (-70) displayed evidence of fluid seepage.

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3.7 HUMIDITY

3.7.1 Devices tested: 245-15-25 thru -30.

3.7.2 Procedure: Per the ES section III. G. Please note that performing a full characterization per the ES consists of measurement of actuation, release, voltage 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 (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.

3.7.3 Equipment: Humidity chamber RK model 5S.

3.7.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.8 SALT SPRAY

3.8.1 Devices tested: 245-15-31 thru -36.

3.8.2 Procedure: Per the ES section III. H.

3.8.3 Equipment: Harshaw salt spray chamber.

3.8.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.9 VIBRATION

3.9.1 Devices tested: 156-15-61 thru 66.

3.9.2 Procedure: Per the ES section III. I.

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3.9.3 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; 160 psig * 1.1 = 176 psi minimum.

3.9.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.10 TERMINAL STRENGTH

3.10.1 Devices tested: 245-15-13 thru -24.

3.10.2 Procedure: Per the ES section III. J.

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

3.10.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.11 VACUUM

3.11.1 Devices tested: 245-15- 55 thru 60.

3.11.2 Procedure: Per the ES section III. K.

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

3.11.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

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3.12 TEMPERATURE CYCLE

3.12.1 Devices tested: 245-15-49 thru 54

3.12.2 Procedure: Per the ES section III. L.

3.12.3 Equipment: Same as 3.5.3.

3.12.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.13 FLUID RESISTANCE

3.13.1 Devices tested: 245-15-01 thru -36.

3.13.2 Procedure: Per the ES section III. M.

3.13.3 Equipment: Fluids as called out in ES table in III. M. 1. c. plus appropriate beakers and storage apparatus/ vented hood.

3.13.4 Results: The 36 devices were divided into groups as follows for subsequent testing. Results of these tests are reported in the section indicated.

3.13.4.1 Impulse (3.5), -01 thru -12

3.13.4.2 Terminal Strength (3.10), -13 thru -24.

3.13.4.3 Humidity (3.7), -25 thru -30.

3.13.4.4 Salt Spray (3.8), -31 thru -36.

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3.14 NOISE

In certain vehicle applications, the brake pressure switch action has been shown to be transmitted to the passenger compartment as audible noise and corresponding tactile feel in the brake pedal. A "silent" device has been developed by Texas Instruments in order to address this concern. At the same time, a means of quantifying the noise/feel was explored. The hypothesis was that a sudden motion of pressure-sensing components within the switch caused a pressure wave to propagate from the switch. Characterization of this effect using high-speed pressure transducers showed that "noisy" devices produce a large negative pressure spike at the point of switch activation, and supported the hypothesis. The "silent" devices produce little or no spike. See Appendix 4.3 for a pressure trace of a typical silent device.

Ultimately (inv delta) ES-F2VC-9F924-AA will be updated to include a section on noise testing, to be applicable only to devices designated as silent. For this validation, in lieu of an officially finalized noise specification, a total of 12 devices (6 from this test and 6 similar devices) were initially characterized for noise, then run through Impulse or Thermal Cycle testing, then recharacterized for noise at the end.

3.14.1 Devices tested:

77PSL3-1 Impulse:	245-15-37, 38, 39
77PSL3-1 Thermal Cycle:	245-15-49, 50, 51
77PSL5-2 Impulse:	245-15-81, 82, 83
77PSL5-2 Thermal Cycle	245-15-105, 106, 107

3.14.2 Procedure: The device under test is installed on the test manifold. Air is evacuated via a vacuum pump. The manifold is filled with the test fluid. Pressure to 300 psi is applied and the signal from the high-speed transducer is captured on a digital oscilloscope.

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3.14.3 Equipment: Custom TI designed and built equipment, utilising a single-port test manifold within a protective enclosure. The manifold is evacuated by a Piab H-125 pneumatic vacuum pump. DOT 3 Brake Fluid is introduced via a fluid reservoir. Pressure is applied via pressurised air which is introduced to an air-over-oil chamber which connects to the test manifold. The dynamic pressure signal during switch actuation is measured with a Kistler High-Frequency Dynamic Pressure Transducer model 606A (SN C46154) with a Kistler 5004 Charge Amplifier whose output connects to channel A of a dual-channel Nicolet 4094A Digital Oscilloscope. The electrical switching action of the device under test is recorded simultaneously on channel B using a 5-volt source and a 1K ohm load resistor.

3.14.4 Initial results: All twelve test devices produced zero pressure spike.

3.15.5 Final results: All twelve test devices produced zero pressure spike.

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 23-Oct-17		PAGE 14

Engineering Specification

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

DATE	LTR	FR	REVISIONS	DR	CK	REFERENCE
	2		ADDED DATA TO COMPLETE SPEC. & RETYPED			PREPARED/APPROVED BY
9/11/90			NC00510079779002			

CHECKED BY | DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR

DESIGN ENGINEERING MGT.

MANUFACTURING ENGRG.

QUALITY CONTROL

PURCHASING

SUPPLIER QUALITY ASSISTANCE

ELECTRONICS DIVISION

∇ CONTROL ITEM — THE ∇ SYMBOL ALSO ...

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 established 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.

QS 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 ITIS 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 Sec. 1.3, "Engineering Specification (ES) Test Performance Requirements" shall be invoked.

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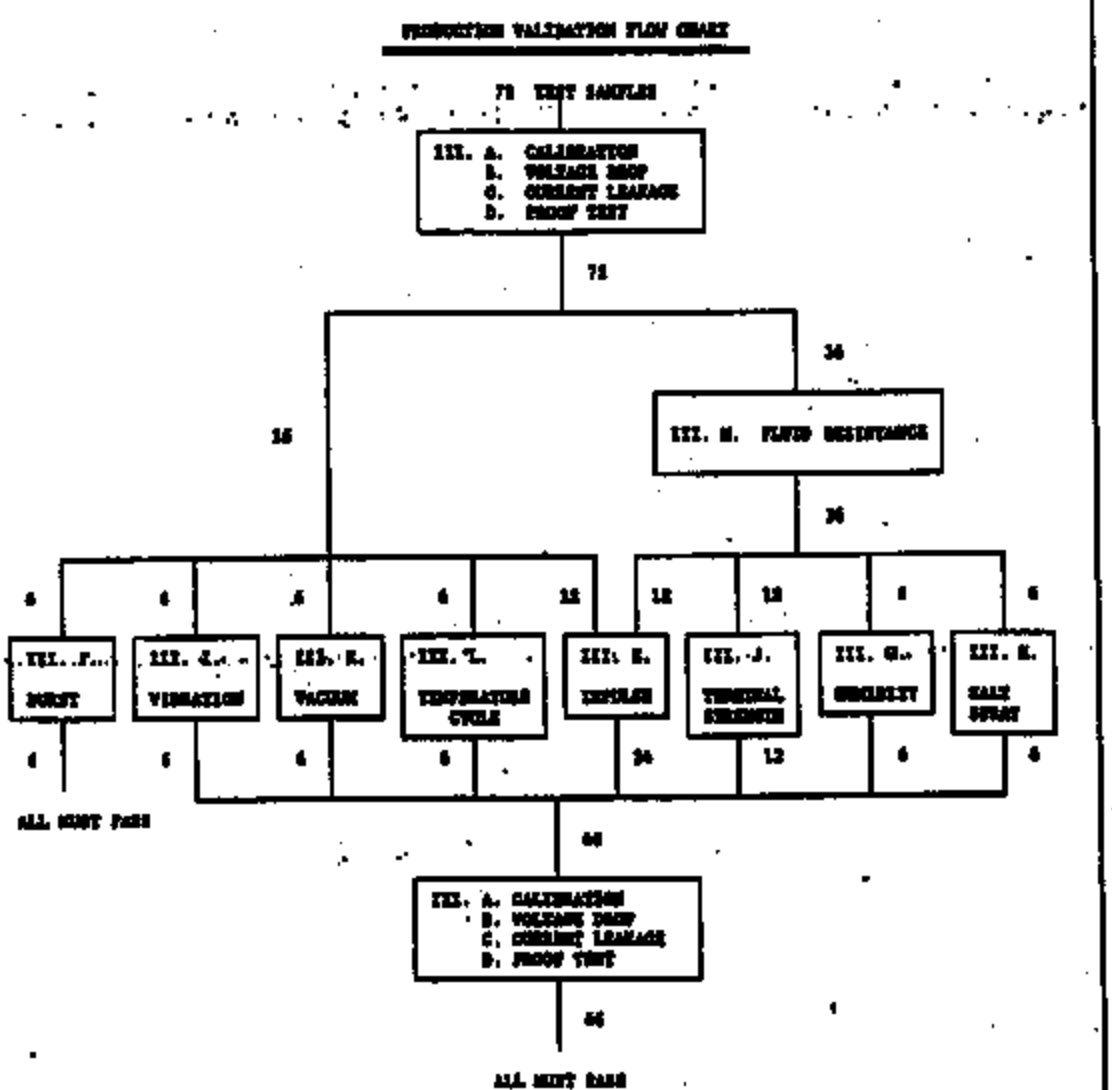
Engineering Specification

SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
▽ A	Calibration	72	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.96	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
I	Vibration	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
J	Terminal Strength	12	P90-.84	6/Mo.	P90-.72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
L	Temperature Cycle	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
M	Fluid Resistance	36	P90-.94	36/12Mo	P90-.94	36/12Mo.	P90-.94
	Durability Tests						
III.							
B	Impulse	24	P90-.90	12/Mo.	P90-.84	3/3 Mo.	P90-.56
G	Humidity	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
H	Salt Spray	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72

Engineering Specification



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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.

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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) microamperes.

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 450 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.

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III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

E. Impulse

1. Test Requirements

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

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

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

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

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

d. Switch must open and close each cycle.

2. Acceptance Requirements

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

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

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

F. BURST

1. Test Requirement

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

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

2. Acceptance Requirements

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

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III. Test 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.

1. 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.

TI-NHTSA 006879

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.

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III. TEST SEQUENCE AND REQUIREMENTS (Cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

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

(2) With a pendulum apply a 45 ± 9 N impact force to the switch housing at 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 3 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.

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III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

L. Temperature Cycle

1. Test Requirements

a. Mount switches in cast parts: test to be run using currently released brake fluid.

b. Repeat the following procedure 25 times.

(1) Lower the switch and fluid temperature so 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, despagt, or not meeting the criteria of sections A, B, C, and D.

M. Fluid Resistance

1. Test Requirements

a. Mount the switch in the cast part 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.

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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.

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IV. **STATISTICAL ANALYSIS METHOD**

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 Rc-R is interpreted as minimum reliability equal to R, at a confidence C; thus R90-.80 means a minimum reliability of 80% at 90% confidence.

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

V. **REVALIDATION REQUIREMENTS**

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

RUNNING CHANGE REVALIDATION

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

5. Annual revalidation is not required on carryover switches.

VI. **LOT DEFINITION**

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

VII. RECORD RETENTION

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

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

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

VIII. INSTRUCTIONS AND NOTES

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

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

Test port configuration is shown in Figure 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.

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12. COMPILATION OF REFERENCE DOCUMENTS

ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard - 1990 Edition

ES-F0HB-14A464-AA, Specification - SLF Assy - Wire Connector

ES-F3VF-9C718-AA, Specification - Servo Assembly Speed Control

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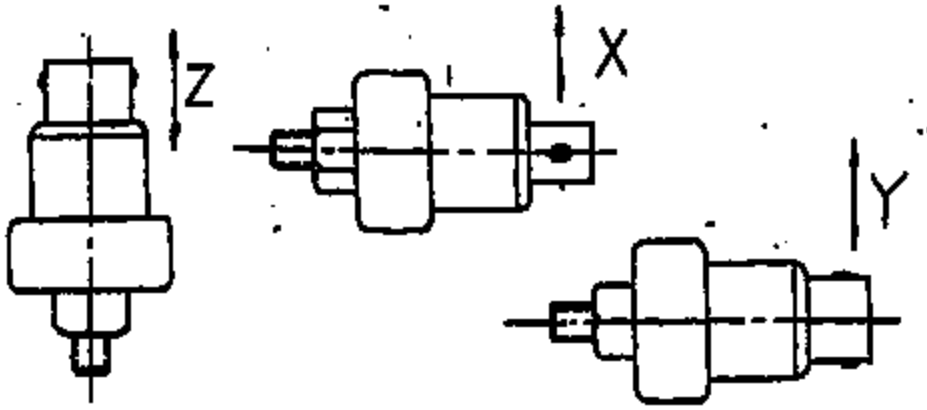
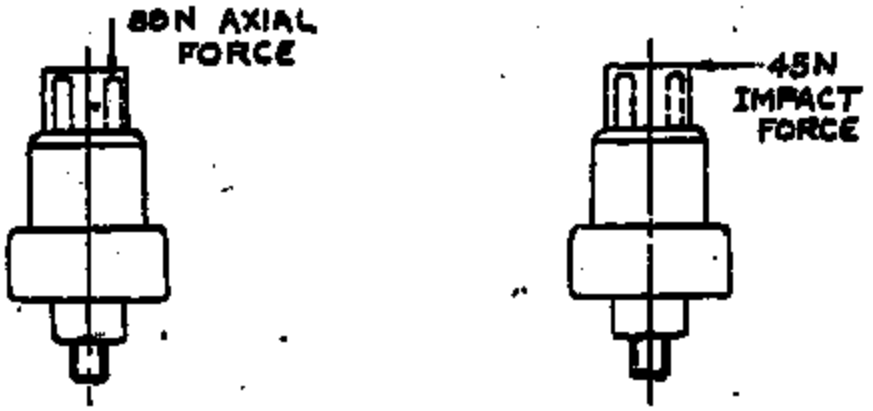


VIBRATION TEST - SWITCH ORIENTATION

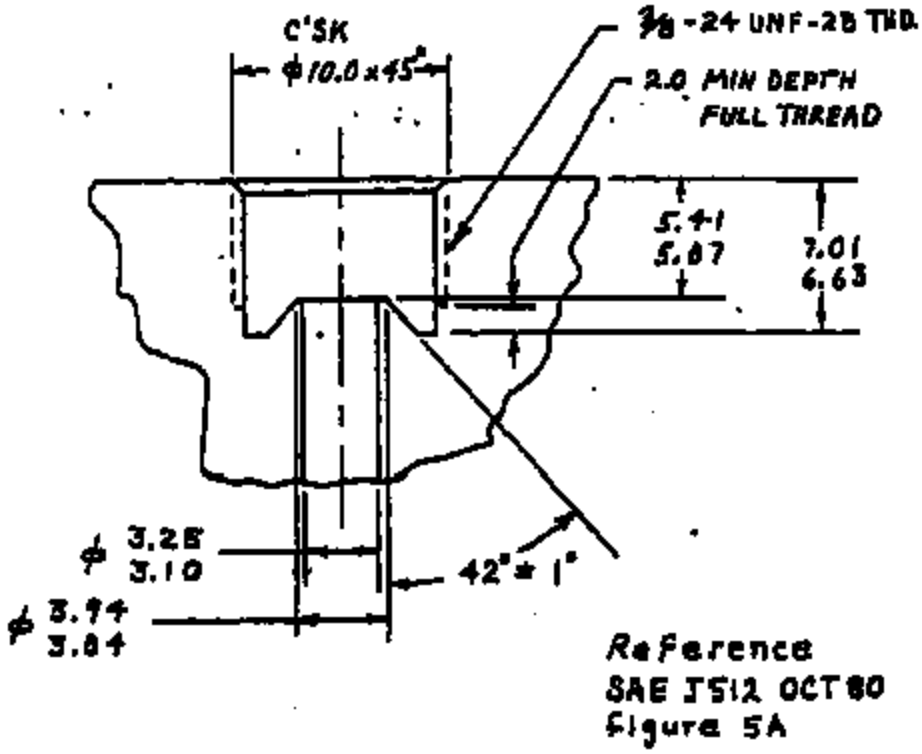
FIGURE 1.



TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2.

Engineering Specification

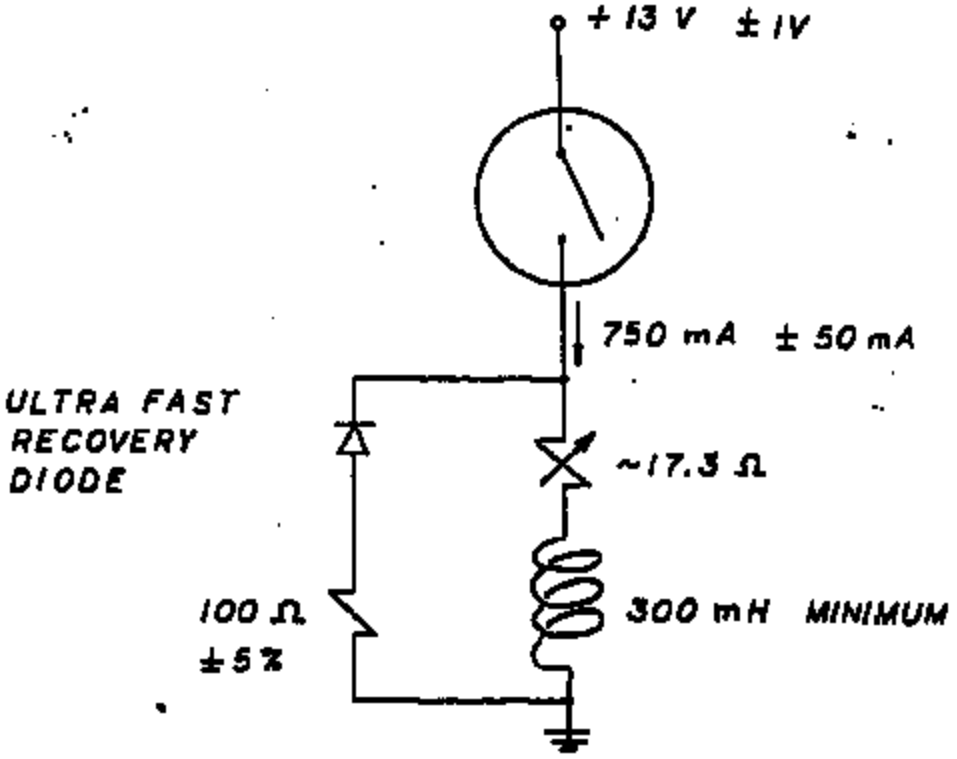


TEST FIXTURE PORT CONFIGURATION

FIGURE 3

FRAME 17 OF 18	REVISED		▽ [redacted] NUMBER

Engineering Specification



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

Appendix. 4.2
Data

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 88-08-17		PAGE 33

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 245-15-127

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE
77PSL 3-1, 77PSL 5-2	970413	Steve Offiler	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
Jeffrey DiOrazio	970413		

PROJECT TITLE: Speed Control

CUSTOMER:

PURPOSE OF TEST: Production Validation

PROCEDURE: DES-F2VC-9F924-AA : Full ISR

Natural Noryl Bases
ultra-low diff discs.
Act 90-160
Rel 30 Min

77PSL 3-1

INITIAL characterizations

Device #	Act	Rel	No Drip	Contact leak	Proof	Act	Rel	Test	Complete	Test	Complete
245-15-01	118	107	4.1	✓	✓	140	109	Fluid Im	✓	Impulse	✓
-02	117	85	4.1	✓	✓	130	113		✓		✓
-03	128	111	3.8	✓	✓	130	115		✓		✓
-04	131	115	5.7	✓	✓	131	117		✓		✓
-05	133	117	6.1	✓	✓	136	115		✓		✓
-06	124	103	4.7	✓	✓	122	113		✓		✓
-07	125	117	4.5	✓	✓	124	119		✓		✓
-08	125	107	4.3	✓	✓	119	102		✓		✓
-09	130	107	4.5	✓	✓	132	114		✓		✓
-10	131	115	3.3	✓	✓	127	116		✓		✓
-11	125	114	4.9	✓	✓	125	118		✓		✓
-12	136	117	4.2	✓	✓	[illegible]	124		✓		✓
-13	136	116	3.5	✓	✓	133	123		✓	Tem. Strength	✓
-14	107	92	4.0	✓	✓	128	119		✓		✓
-15	129	116	3.4	✓	✓	135	125		✓		✓
-16	129	111	4.1	✓	✓	124	111		✓		✓
-17	125	108	3.9	✓	✓	123	101		✓		✓
-18	126	116	3.7	✓	✓	122	116		✓		✓
-19	128	115	5.3	✓	✓	[illegible]	112		✓		✓
-20	122	101	3.1	✓	✓	127	109		✓		✓
-21	134	121	3.9	✓	✓	141	128		✓		✓
-22	121	105	3.2	✓	✓	132	115		✓		✓
-23	126	111	2.9	✓	✓	132	120		✓		✓
-24	119	98	3.6	✓	✓	123	117		✓		✓
-25	124	110	3.1	✓	✓	127	112		✓	Humidity	✓
-26	119	108	3	✓	✓	125	117		✓		✓
-27	[illegible]	[illegible]	[illegible]	✓	✓	[illegible]	[illegible]				

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Device #	Act	Rel	Mv Drop	Connect Leak	Weight Reset	Act	Rel	Test	Complete	Test	Complete
205-15-29	124	114	3.3	✓	✓	123	110	Fluid Res	✓	Humidity	✓
-30	114	106	2.3	✓	✓	126	116		✓		✓
-31	129	114	2.9	✓	✓	131	115		✓	Salt Spray	✓
-32	[illegible]	115	2.6	✓	✓	132	126		✓		✓
-33	[illegible]	104	2.5	✓	✓	115	126		✓		✓
-34	131	119	[illegible]	✓	✓	138	122		✓		✓
-35	118	109	2.9	✓	✓	125	115		✓		✓
-36	122	117	2.9	✓	✓	127	115		✓		✓
-37	131	119	3.1	✓	✓	132	118	Impulse	✓	None	✓
-38	132	117	2.6	✓	✓	136	125		✓		✓
-39	134	125	2.6	✓	✓	125	126		✓		✓
-40	124	112	2.7	✓	✓	125	125		✓		
-41	125	112	2.8	✓	✓	127	118		✓		
-42	116	106	2.7	✓	✓	130	118		✓		
-43	117	105	2.7	✓	✓	127	117		✓		
-44	120	101	2.7	✓	✓	131	125		✓		
-45	134	126	3.7	✓	✓	141	131		✓		
-46	[illegible]	114	[illegible]	✓	✓	130	120		✓		
-47	123	117	2.7	✓	✓	133	118		✓		
-48	116	107	2.7	✓	✓	127	120		✓		
-49	124	112	3.7	✓	✓	137	115	T-Cycle	✓	None	✓
-50	132	121	2.9	✓	✓	125	121		✓		✓
-51	112	101	3.0	✓	✓	130	127		✓		✓
-52	127	121	3.0	✓	✓	136	125		✓		
-53	127	121	3.0	✓		129	122		✓		
-54	121	112	3.8	✓	✓	125	114		✓		
-55	128	115	3.0	✓	✓	127	119	Vacuum	✓		
-56	126	114	2.8	✓	✓	132	117		✓		
-57	127	117	2.7	✓		130	129		✓		
-58	122	111	3.2	✓	✓	130	126		✓		
-59	123	112	3.1	✓		125	121		✓		
-60	131	117	3.4	✓		135	127		✓		
-61	123	119	3.2	✓		134	130	Vibration	✓		
-62	127	117	2.7	✓		131	124		✓		
-63	129	113	2.6	✓	✓	132	125		✓		
-64	128	117	3.5	✓	✓	136	125		✓		
-65	121	112	2.8	✓	✓	136	118		✓		
-66	119	107	2.7	✓	✓	127	115		✓		
-67	132	123	2.9	✓	✓	134	122	Burst	Pass		
-68	126	117	2.9	✓	✓	132	122		Pass		
-69	128	129	2.7	✓	✓	130	124		Pass		
-70	119	109	2.9	✓	✓	129	121		Burst [illegible]		
-71	128	110	2.7	✓	✓	132	129		Pass		
-72	125	119	2.8	✓	✓	136	126		Pass		
-73	135	120	2.8	✓	✓	137	124	Not used			
-74	124	118	2.4	✓		132	120				
-75	119	112	3.4	✓		126	117				
-76	117	107	2.4	✓		127	118				
-77	120	109	3.1	✓	✓	126	112				
-78	111	101	2.4	✓	✓	125	113				
-79	112	103	2.5	✓	✓	127	117				
-80	131	123	2.7	✓	✓	136	120				

PRESSURE SWITCH DATA Form 21605 TEST NO. ______

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL. DATE

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:

771563-1

Final Characterization

Device #	act rel	Mv Drop	Current Leak	[illegible] Proof	act rel				
[illegible]	131 104	38.6	✓	✓	129-100				
[illegible]	132 97	29.4	✓	[illegible]	122-105				
[illegible]	130 102	20.6	✓	✓	129-108				
[illegible]	129 102	33.0	✓	[illegible]	127-104				
[illegible]	135 109	25.2	✓	[illegible]	132-110				
[illegible]	117 95	24.1	✓	✓	117-97				
[illegible]	130 103	45.6	✓	✓	128-105				
[illegible]	124 99	17.2	✓	✓	122-102				
[illegible]	124 96	14.5	✓	✓	123-105				
[illegible]	122 100	22.5	✓	✓	120-101				
[illegible]	127 99	26.9	✓	✓	126-105				
[illegible]	125 102	46.2	✓	✓	125-105				
[illegible]	138 109	4.7	✓	✓	138-115				
[illegible]	124 93	2.7	[illegible]	✓	119-95				
[illegible]	135 109	2.8	✓	✓	136-115				
[illegible]	136 111	2.9	✓	✓	136-120				
[illegible]	134 112	2.6	✓	✓	133-116				
[illegible]	131 99	2.2	✓	✓	132-105				
[illegible]	133 99	2.7	✓	✓	133-115				
[illegible]	132 97	3.3	✓	✓	130-111				
[illegible]	142 110	4.2	✓	✓	140-122				
[illegible]	132 109	5.1	✓	✓	132-112				
[illegible]	133 109	3.8	✓	✓	135-112				
[illegible]	135 103	3.5	✓	✓	136-114				
[illegible]	131 105	3.1	✓	✓	129 1[illegible]				
[illegible]	124 113	5.0	✓	✓	125 109				
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				

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.10	129 99	[illegible]	✓	✓	[illegible]				
[illegible]	[illegible]	2.9	✓	✓	130 [illegible]				
[illegible]	[illegible]	[illegible]	✓	✓	[illegible]				
[illegible]	[illegible] 98	6.6	✓	✓	130 [illegible]				
[illegible]	121 118	[illegible]		✓	132 118				
[illegible]	127 106	2.9	✓	✓	[illegible]				
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[illegible]	130-114	6.8	✓	✓	127-105				
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[illegible]	134-124	2.8	✓	✓	130-114				
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[illegible]	127-117	2.8	✓	✓	130-104				
[illegible]	128-105	3.1	✓	✓	128-110				

Appendix 4.3
Noise Pressure Trace

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 92-08-17		PAGE 38

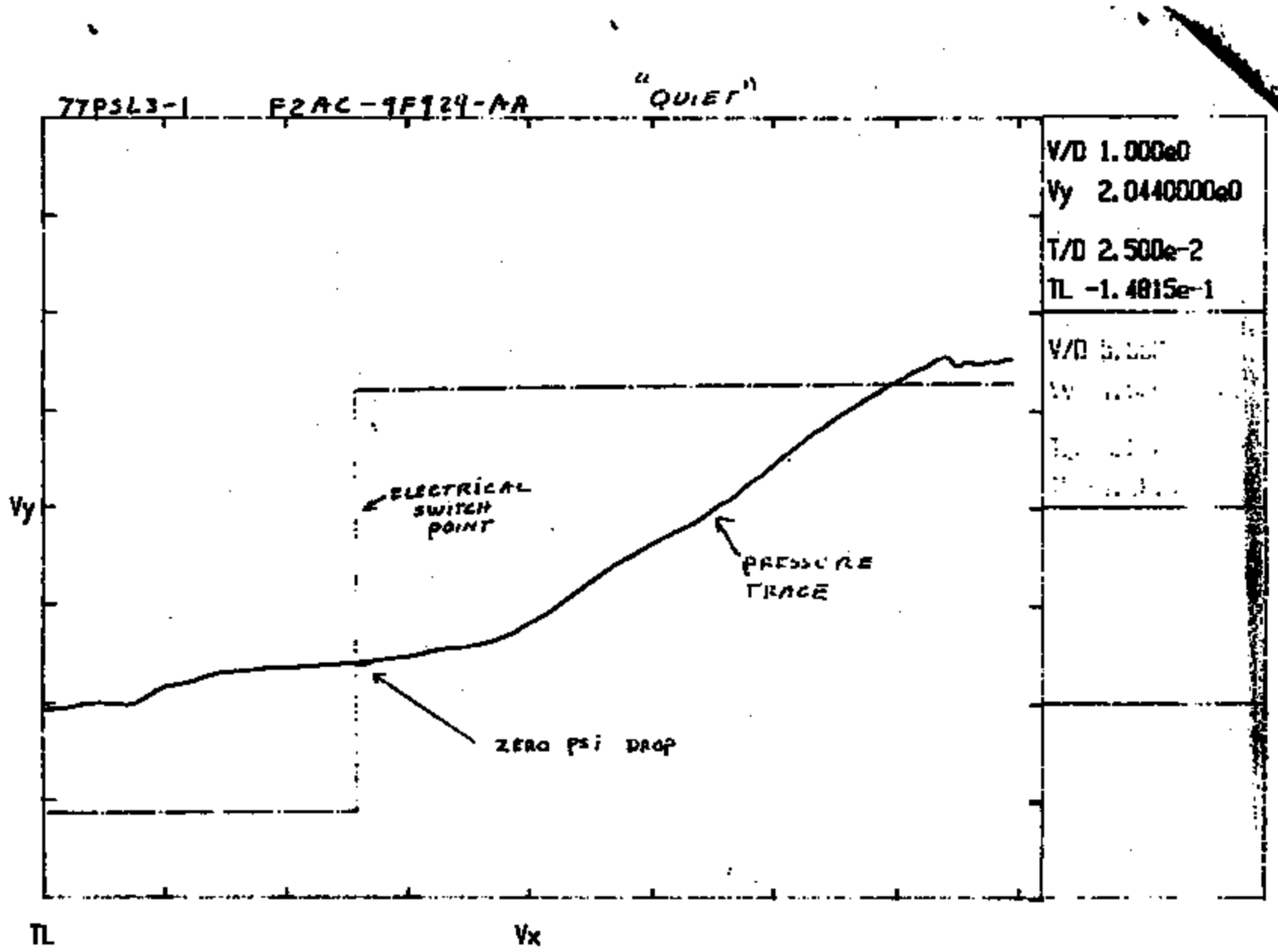

FIGURE 3

TI-NHTSA 006806

REPORT OF ISR TESTING
FORD PASSENGER CAR
ELECTRONIC SPEED CONTROL
DEACTIVATION PRESSURE SWITCH
PS/92/82

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 92-08-12		PAGE 1

TABLE OF CONTENTS

TI-NHTSA 006898

1.0 GENERAL

1.1 Customer: Ford Motor Company P.I.A. from Dana-Weatherhead

1.2 Part Numbers:

1.2.1 Ford P/N: F2AC-9F924-AA

1.2.2 Dana P/N: 120-55046

1.2.3 TI P/N: 77PSL3-1

1.3 Engineering Specification: (inv delta) ES-F2VC-9F924-AA

1.4 Date of Completion: 920811

1.5 Quantity of Units Tested: 72

1.6 Disposition of Tested Units: All devices are presently retained under quarantine, completely separate from any production devices, to be destroyed per the ES at a later date after full ISR approval is obtained.

1.7 TI test series number: 245-15-129

1.8 TI Pressure Switch test report number: PS/92/82

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 92-08-17		PAGE 3

2.0 OBJECTIVE

This testing was performed to demonstrate the ability of 77PSL3-1 to conform to customer specifications given in (inv delta) ES-F2VC-9F924-AA, in fulfillment of the requirements of the Initial Sample Report. Units tested were built using fully qualified production components and production assembly equipment.

3.0 TEST PROCEDURES AND RESULTS

All switches were tested per Ford Engineering Specification (inv 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 requires elaboration, a complete explanation of the procedure is presented. For all tests, raw data is included in Appendix 4.2.

3.1 CALIBRATION

3.1.1 Devices tested: 245-15-01 thru 72

3.1.2 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The change in continuity is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

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3.1.3 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.

3.1.4 Initial Results: Prior to proof testing, the average actuation was found to be 126 psi with a sigma of 6.2; after proof the average actuation was 131 psi with a sigma of 4.9. The average shift is 4%. Prior to proof testing, the average release was found to be 113 psi with a sigma of 6.5; after proof the average release was 119 psi with a sigma of 5.7. The average shift is 5%.

3.1.5 Final Results: Prior to proof testing, the average actuation was found to be 130 psi with a sigma of 8.4; after proof the average actuation was 129 psi with a sigma of 5.3. The average shift is -0.8%. Prior to proof testing, the average release was found to be 108 psi with a sigma of 7.7; after proof the average release was 108 psi with a sigma of 6.6. The average shift is 0.

3.2 VOLTAGE DROP

3.2.1 Devices tested: 245-15-01 thru 72

3.2.2 Procedure: Voltage drop is checked simultaneously with Calibration (see 3.1.2). The measurement is taken at room temperature using ambient air as the pressure medium. For the purpose of stabilization, data is 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 approx. 10% above actuation pressure and back to approx. 10% below release pressure. The voltage drop is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

3.2.3 Equipment: Fluke Model 8020B Digital Multimeter, calibrated quarterly, used in conjunction with the continuity equipment in 3.1.3.

3.2.4 Initial results: Values for all devices fell below the specification of 200 millivolts maximum by close to two orders of magnitude; no specific statistics calculated for this reason.

3.2.5 Final results: With the exception of parts undergoing Impulse testing (devices 245-15-01 thru 12 and -37 thru 48), all final results were comparable with initial results. The Impulse parts experience an increase in the voltage drop reading due to the specified 25,000 cycles run at full electrical load, which causes a certain amount of normal erosion of the contact surfaces. All 24 Impulse devices still fell significantly below 200 mV maximum, and statistics show a Cpk of 2.53.

3.3 CURRENT LEAKAGE

3.3.1 Devices tested: 245-15-01 thru 72

3.3.2 Procedure: Per the ES section III. C. This test is conducted as a pass/fail.

3.3.3 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%).

3.3.4 Initial results: All devices passed.

3.3.5 Final results: All devices passed.

3.4 PROOF

3.4.1 Devices tested: 245-15-01 thru 72

3.4.2 Procedure: Per the ES section III. D. This test is conducted as a pass/fail. The test pressure specified on the part drawing is 3000 psi.

3.4.3 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.

3.4.4 Initial Results: All devices passed.

3.4.5 Final Results: All devices passed.

3.5 IMPULSE

3.5.1 Devices tested: 245-15-01 thru 12 and -37 thru 48

3.5.2 Procedure: Per the ES section III. E.

3.5.3 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

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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 (figure 4) used in the last 25K cycles.

3.5.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.6 BURST

3.6.1 Devices tested: 245-15-67 thru 72.

3.6.2 Procedure: Per the ES section III. F. After holding 7000 psi for 30 seconds as specified, the devices were inadvertently pressurized to approx. 7600 psi.

3.6.3. Equipment: Same as 3.4.3, with the addition of Enerpak gauge reading to 10,000 psig with 100 psi increments, resolvable to 50 psi., calibrated quarterly.

3.6.4. Results: All six devices passed 30 seconds at 7000 psig without evidence of fluid leakage or seepage from the switch or threads.

At 7600 psi, one device (-70) displayed evidence of fluid seepage.

3.7 HUMIDITY

3.7.1 Devices tested: 245-15-25 thru -30.

3.7.2 Procedure: Per the ES section III. G. Please note that performing a full characterization per the ES consists of measurement of actuation, release, voltage 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 (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.

3.7.3 Equipment: Humidity chamber RK model 5S.

3.7.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.8 SALT SPRAY

3.8.1 Devices tested: 245-15-31 thru -36.

3.8.2 Procedure: Per the ES section III. H.

3.8.3 Equipment: Harshaw salt spray chamber.

3.8.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.9 VIBRATION

3.9.1 Devices tested: 156-15-61 thru 66.

3.9.2 Procedure: Per the ES section III. I.

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3.9.3 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; 160 psig * 1.1 = 176 psi minimum.

3.9.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.10 TERMINAL STRENGTH

3.10.1 Devices tested: 245-15-13 thru -24.

3.10.2 Procedure: Per the ES section III. J.

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

3.10.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.11 VACUUM

3.11.1 Devices tested: 245-15- 55 thru 60.

3.11.2 Procedure: Per the ES section III. K.

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

3.11.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

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3.12 TEMPERATURE CYCLE

3.12.1 Devices tested: 245-15-49 thru 54

3.12.2 Procedure: Per the ES section III. L.

3.12.3 Equipment: Same as 3.5.3.

3.12.4 Results: All devices passed the acceptance requirements of the ES (sections A, B, C, D).

3.13 FLUID RESISTANCE

3.13.1 Devices tested: 245-15-01 thru -36.

3.13.2 Procedure: Per the ES section III. M.

3.13.3 Equipment: Fluids as called out in ES table in III. M. 1. c. plus appropriate beakers and storage apparatus; vented hood.

3.13.4 Results: The 36 devices were divided into groups as follows for subsequent testing. Results of these tests are reported in the section indicated.

3.13.4.1 Impulse (3.5), -01 thru -12

3.13.4.2 Terminal Strength (3.10), -13 thru -24.

3.13.4.3 Humidity (3.7), -25 thru -30.

3.13.4.4 Salt Spray (3.8), -31 thru -36.

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3.14 NOISE

In certain vehicle applications, the brake pressure switch action has been shown to be transmitted to the passenger compartment as audible noise and corresponding tactile feel in the brake pedal. A "silent" device has been developed by Texas Instruments in order to address this concern. At the same time, a means of quantifying the noise/feel was explored. The hypothesis was that a sudden motion of pressure-sensing components within the switch caused a pressure wave to propagate from the switch. Characterization of this effect using high-speed pressure transducers showed that "noisy" devices produce a large negative pressure spike at the point of switch activation, and supported the hypothesis. The "silent" devices produce little or no spike. See Appendix 4.3 for a pressure trace of a typical silent device.

Ultimately (inv delta) ES-F2VC-9F924-AA will be updated to include a section on noise testing, to be applicable only to devices designated as silent. For this validation, in lieu of an officially finalized noise specification, a total of 12 devices (6 from this test and 6 similar devices) were initially characterized for noise, then run through Impulse or Thermal Cycle testing, then recharacterized for noise at the end.

3.14.1 Devices tested:

77PSL3-1 Impulse:	245-15-37, 38, 39
77PSL3-1 Thermal Cycle:	245-15-49, 50, 51
77PSL5-2 Impulse:	245-15-81, 82, 83
77PSL5-2 Thermal Cycle	245-15-105, 106, 107

3.14.2 Procedure: The device under test is installed on the test manifold. Air is evacuated via a vacuum pump. The manifold is filled with the test fluid. Pressure to 300 psi is applied and the signal from the high-speed transducer is captured on a digital oscilloscope.

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3.14.3 Equipment: Custom TI designed and built equipment, utilizing a single-port test manifold within a protective enclosure. The manifold is evacuated by a Piab R-125 pneumatic vacuum pump. DOT 3 Brake Fluid is introduced via a fluid reservoir. Pressure is applied via pressurized air which is introduced to an air-over-oil chamber which connects to the test manifold. The dynamic pressure signal during switch actuation is measured with a Kistler High-Frequency Dynamic Pressure Transducer model 606A (SN C46154) with a Kistler 5004 Charge Amplifier whose output connects to channel A of a dual-channel Nicolet 4094A Digital Oscilloscope. The electrical switching action of the device under test is recorded simultaneously on channel B using a 5-volt source and a 1K ohm load resistor.

3.14.4 Initial results: All twelve test devices produced zero pressure spike.

3.15.5 Final results: All twelve test devices produced zero pressure spike.

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 92-06-17		PAGE 14

Engineering Specification

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

LET																			
FR																			
LET																			
FR																			

DATE	LET	FR	REVISIONS	DR	CK
			ADDED DATA TO COMPLETE		
			SPEC. & RETYPED		
90/11/10			NC0081007977 9002		[illegible]

REFERENCE

PREPARED/APPROVED BY
R.S. [illegible] 90 09 10

CHECKED BY | DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVISOR
[illegible] 90 09 10
DESIGN ENGINEERING MGT.

MANUFACTURING ENGRG.

QUALITY CONTROL
[illegible] 10/4/90
PURCHASING

SUPPLIER QUALITY ASSISTANCE
[illegible]

ELECTRONICS DIVISION
[illegible]

∇ CONTROL ITEM — THE ∇ SYMBOL AND IDENTIFIES PRODUCT ENGINEERING DESIGNATED CRITICAL CHARACTERISTICS. THESE AND ADDITIONAL CRITICAL CHARACTERISTICS MUST BE IDENTIFIED BY PROCESS ENGINEERING, APPEAR ON THE CONTROL PLAN AND REQUIRE PRODUCT ENGINEERING APPROVAL.

Engineering Specification

SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE

I. General

This specification covers the test requirements for the speed control deactivate switch -SPS24- 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 established 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 Sect. 3.5, "Engineering Specification (ES) Test Performance Requirements" shall be invoked.

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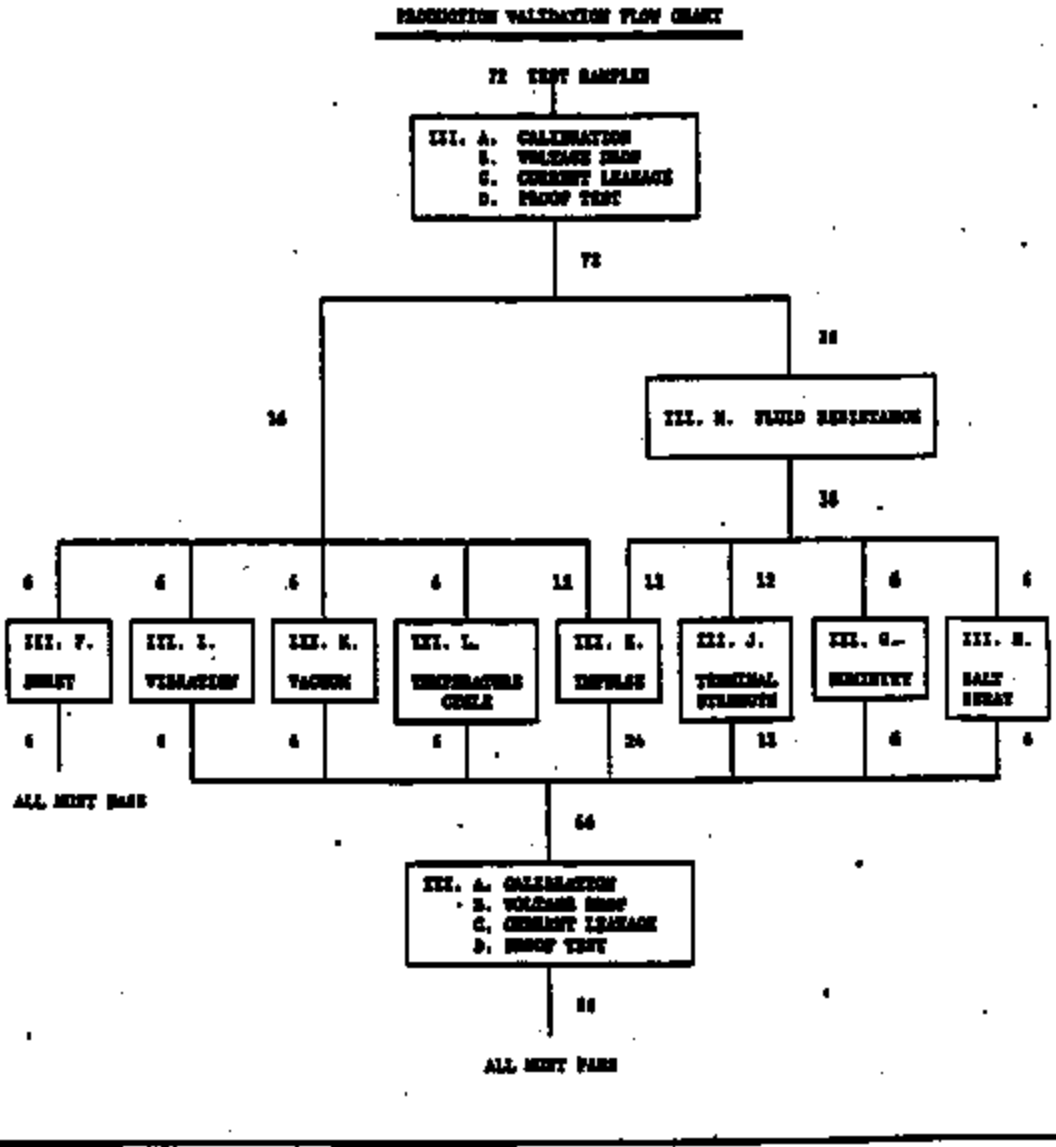
SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
A	Calibration	72	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.86	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/Mo.	P90-.86	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
I	Vibration	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
J	Terminal Strength	12	P90-.84	6/Mo.	P90-.72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
L	Temperature Cycle	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
M	Fluid Resistance	36	P90-.94	36/12Mo	P90-.94	36/12Mo.	P90-.94
	Reliability Tests						
III.							
E	Impulse	24	P90-.90	12/Mo.	P90-.84	3/3 Mo.	P90-.56
H	Humidity	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72
N	Salt Spray	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90-.72



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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 1 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 interfaces at terminals to be less than 10 millivolts.

2. Acceptance Requirements

a. Nonconformance is defined as a voltage drop in excess of 100 millivolts.

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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) microamperes.

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 ± 3% from the initial value is not permitted.

c. The test samples must be destroyed after testing.

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III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

E. Impulse

1. Test Requirements

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

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

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

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

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

d. Switch must open and close each cycle.

2. Acceptance Requirements

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

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

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

F. Burst

1. Test Requirement

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

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

2. Acceptance Requirements

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

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III. [illegible] (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.

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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.

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III. Test Procedures and Requirements (cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

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

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

2. Acceptance Requirements

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

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

K. Vacuum

1. Test Requirements

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

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

2. Acceptance Requirements

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

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

TI-NHTSA 006920

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.

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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 15/15 by Volume	24 ± 1 hour	none

d. For 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.

TI-NHTSA 006922

IV. STATISTICAL ANALYSIS METHODS

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

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

V. REVALIDATION REQUIREMENTS

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

EXISTING CHANGE REVALIDATION

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

B. Annual revalidation is not required on carryover switches.

VI. LOT DEFINITION

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

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VII. RECORD RETENTION

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

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

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

VIII. INSTRUCTIONS AND NOTES

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

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

Test part 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.

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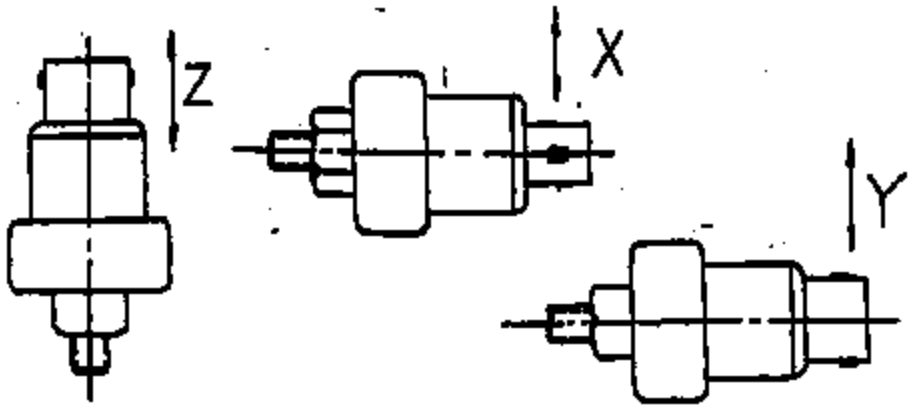
IX. CANCELLATION OF REFERENCE DOCUMENTS

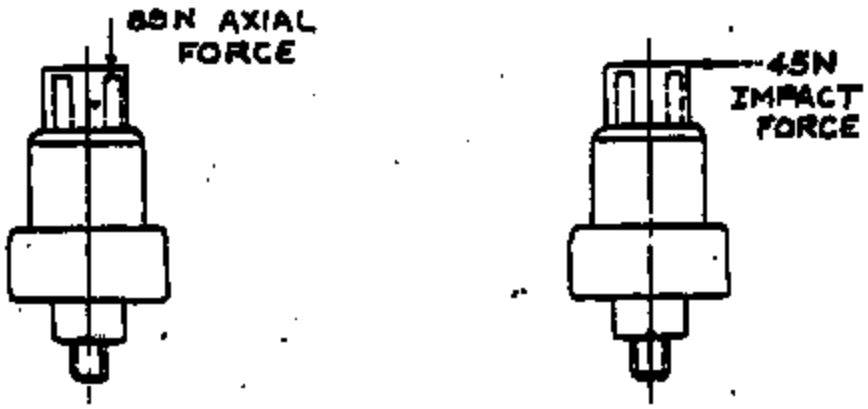
ASTM B-117, Salt Spray Testing
Ford Q-101, Quality System Standard - 1990 Edition
ES-F0HB-1AA464-AA, Specification - SLP Assy - Wire Connector
ES-F2VF-9C735-AA, Specification - Servo Assembly Speed Control

TI-NHTSA 006925



VIBRATION TEST - SWITCH ORIENTATION

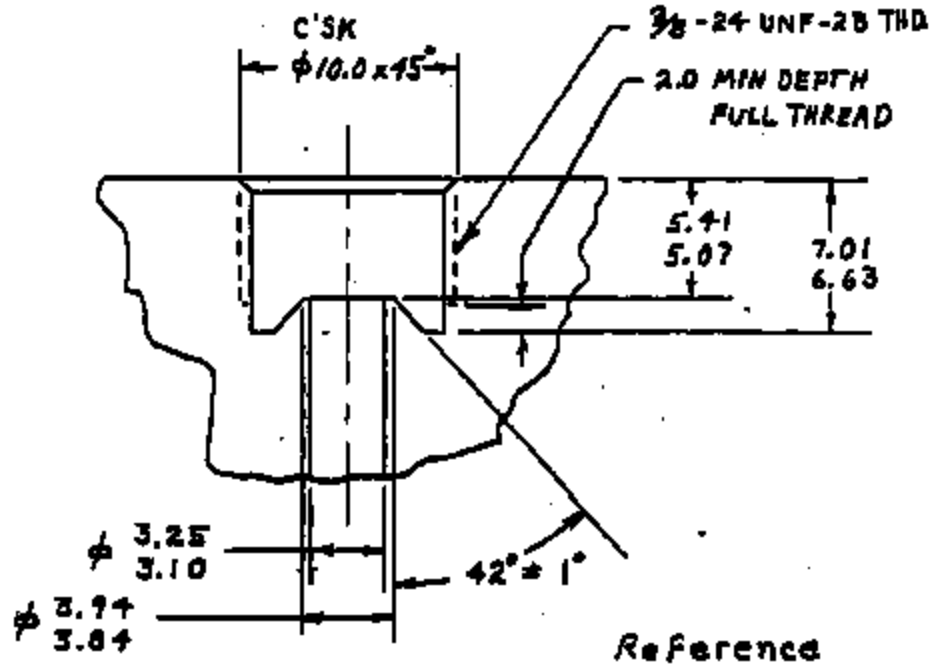
FIGURE 1.



TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2.

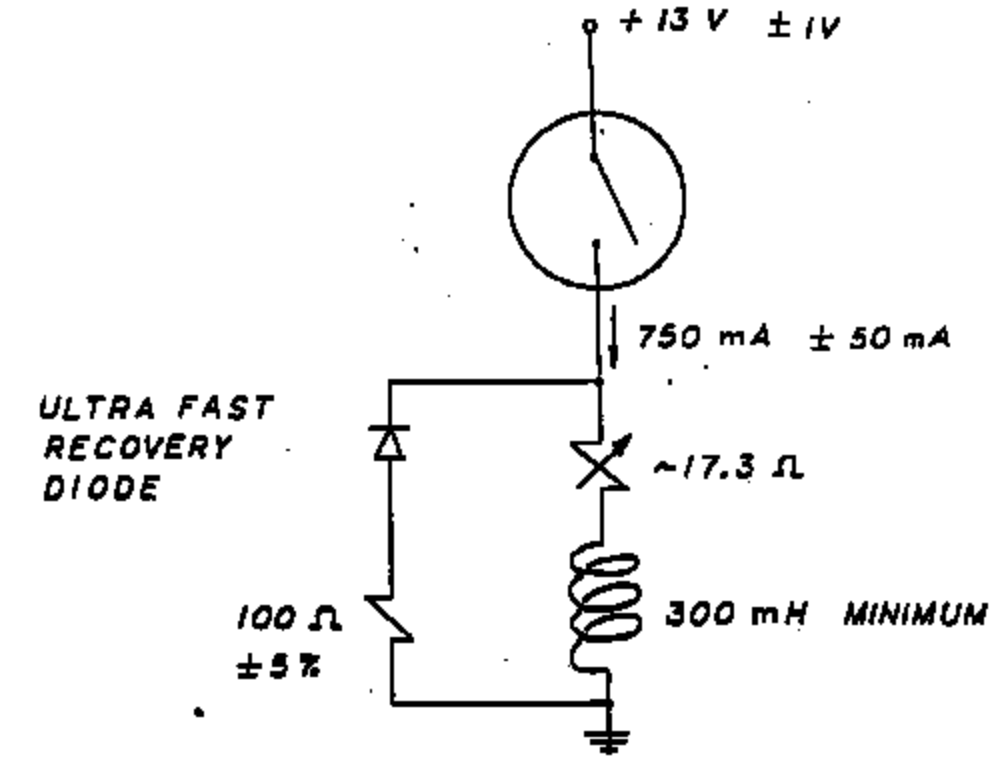
Engineering Specification



TEST FIXTURE PORT CONFIGURATION

FIGURE 3

FRAME 17 OF 18	REVISED		▽ 88-B270-BB324-AA NUMBER



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

TI-NHTSA 006928

Appendix. 4.2
Data

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 82-06-17		PAGE 13

PRESSURE SWITCH DATA Form 21605 **TEST NO.**

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**	

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:

77153-1

Final Characterization

Device #	Set	Rel	[illegible]	Contact [illegible]	[illegible]	Set – Rel
[illegible]	131	104	18.6	✓	✓	128-110
[illegible]	122	97	29.4	✓	✓	122-105
[illegible]	128	103	20.6	✓	✓	129-108
[illegible]	128	101	29.0	✓	—	127-104
[illegible]	135	109	25.2	✓	✓	132-110
[illegible]	117	95	24.1	✓	✓	117-97
[illegible]	130	103	45.6	✓	✓	128-105
[illegible]	124	99	17.2	✓	✓	122-103
[illegible]	124	96	74.3	✓	✓	123-105
[illegible]	122	110	85.5	✓	✓	120-101
[illegible]	127	97	20.9	✓	✓	126-106
[illegible]	125	102	46.2	✓	✓	125-105
[illegible]	138	109	4.3	✓	✓	138-115
[illegible]	124	92	2.7	—	—	119-95
[illegible]	135	109	2.8	✓	✓	136-115
[illegible]	136	111	2.1	✓	✓	136-120
[illegible]	134	107	3.6	✓	✓	133-116
[illegible]	131	99	2.2	✓	✓	132-105
[illegible]	133	99	2.7	✓	✓	132-115
[illegible]	132	97	3.5	—	✓	130-111
[illegible]	142	110	4.7	✓	✓	140-122
[illegible]	132	104	5.1	✓	✓	132-112
[illegible]	133	108	3.6	✓	✓	135-112
[illegible]	135	103	2.5	✓	✓	136-114
[illegible]	131	105	[illegible]	✓	✓	131-[illegible]
[illegible]	124	112	5.0	✓	✓	125-108

TI-NHTSA 006930

Device #	Act	Ref	Hg Drop	Current Leak	Tubeset Reset	Act	Ref	Test	Complete	Test	Complete
2XC-15-29	124	114	3.3	✓	✓	123	110	Fluid Aux	✓	Humidity	✓
-30	114	106	2.8	✓	✓	126	116		✓	↓	✓
-31	109	114	2.9	✓	✓	127	118		✓	Salt Spray	✓
-32	124	115	2.6	✓	✓	132	126		✓		✓
-33	[illegible]	104	2.5	✓	✓	115	115		✓		✓
-34	126	119	3.[illegible]	✓	✓	138	122		✓		✓
-35	118	109	2.9	✓	✓	125	115		✓		✓
-36	122	117	2.9	✓	✓	127	115	↓	✓	↓	✓
-37	121	119	3.1	✓	✓	132	117	Impulse	✓	None	✓
-38	132	118	2.6	✓	✓	130	125		✓		✓
-39	134	125	2.6	✓	✓	135	126		✓	↓	✓
-40	124	112	2.7	✓	✓	129	122		✓		
-41	125	112	2.8	✓	✓	127	118		✓		
-42	116	106	2.7	✓	✓	132	118		✓		
-43	117	106	2.7	✓	✓	127	117		✓		
-44	120	101	2.7	✓	✓	131	125		✓		
-45	134	126	2.7	✓	✓	143	131		✓		
-46	122	114	3.4	✓	✓	130	120		✓		
-47	123	117	2.7	✓	✓	133	118		✓		
-48	116	107	2.7	✓	✓	127	120	↓	✓		
-49	124	112	3.7	✓	✓	137	115	T-Cycle	✓	None	✓
-50	132	121	2.9	✓	✓	135	124		✓		✓
-51	112	101	3.0	✓	✓	130	123		✓	↓	✓
-52	134	121	2.6	✓	✓	136	129		✓		
-53	127	121	2.0	✓		129	122		✓		
-54	111	102	3.8	✓	✓	125	114	↓	✓		
-55	128	115	3.0	✓	✓	127	119	Vacuum	✓		
-56	126	114	2.8	✓	✓	132	118		✓		
-57	127	113	2.7	✓		130	119		✓		
-58	122	111	3.2	✓	✓	130	126		-		
-59	123	112	3.1	✓	✓	125	125		-		
-60	131	117	3.4	✓		133	121	↓	✓		
-61	127	119	3.6	✓		134	120	Vibration	✓		
-62	127	117	2.7	✓		131	124		✓		
-63	129	118	2.6	✓		133	125		✓		
-64	128	117	3.5	✓	✓	136	125		✓		
-65	121	112	2.8	✓	✓	136	118		✓		
-66	119	107	2.7	✓	✓	127	115	↓	✓		
-67	132	123	2.9	✓	✓	134	123	Burst	Pass		
-68	126	117	2.9	✓	✓	132	122		Pass		
-69	123	123	2.7	✓	✓	130	124		Pass		
-70	119	120	2.9	✓	✓	129	131		Burst 7600		
-71	121	120	3.7	✓	✓	132	124		Pass		
-72	125	119	3.8	✓	✓	136	126	↓	Pass		
-73	125	120	3.8	✓	✓	139	129	Not used			
-74	124	118	2.4	✓		138	120				
-75	119	112	3.4	✓		126	117				
-76	113	107	2.4	✓		127	114				
-77	120	109	3.1	✓		126	118				
-78	111	101	2.4	✓		125	113				
-79	115	105	2.9	✓	✓	127	117				
-80	131	124	2.7	✓	✓	136	120	↓			

TI-NHTSA 006931

PRESSURE SWITCH DATA Form 21605 **TEST NO.** ______

DEVICE	DATE REQUESTED	REQUESTED BY		REQUESTED COMPL. DATE
PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY	

PROJECT TITLE:

CUSTOMER:

PURPOSE OF TEST:

PROCEDURE:

771563-1

Final Characterization

Device #	on / off	Ar Dep	[illegible] leak	[illegible] proof	on - off				
[illegible]	131 104	18.6	✓	✓	128-110				
[illegible]	124 97	29.4	✓	✓	122-105				
[illegible]	118 102	20.6	✓	✓	129-108				
[illegible]	128 102	19.0	✓	-	129-104				
[illegible]	135 108	25.2	✓	✓	132-110				
[illegible]	117 95	24.1	✓	✓	117-97				
[illegible]	130 103	45.6	✓	✓	128-105				
[illegible]	124 99	19.2	✓	✓	123-103				
[illegible]	124 96	34.3	✓	✓	123-105				
[illegible]	122 100	85.5	✓	✓	120-101				
[illegible]	127 97	26.9	✓	✓	126-105				
[illegible]	125 102	96.8	✓	✓	125-105				
[illegible]	138 109	4.3	✓	✓	138-115				
[illegible]	124 92	2.7	.	✓	119-95				
[illegible]	125 107	2.8	✓	✓	136-115				
[illegible]	136 111	2.9	-	✓	136-120				
[illegible]	134 107	2.6	✓	✓	133-116				
[illegible]	131 99	2.2	✓	✓	133-105				
[illegible]	133 99	2.7	✓	✓	138-115				
[illegible]	132 97	5.5	.	✓	130-111				
[illegible]	142 100	4.7	✓	✓	140-122				
[illegible]	132 104	5.1	.	✓	132-112				
[illegible]	133 109	3.6	✓	✓	135-112				
[illegible]	135 103	3.3	✓	✓	136-114				
[illegible]	131 105	3.1	✓	✓	129 1[illegible]				
[illegible]	124 113	5.0	✓	✓	125 109				
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]				

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7	✓	✓	[illegible]
10	129 97	[illegible]	✓	✓	[illegible]
[illegible]	[illegible]	2.9	✓	✓	130 [illegible]
[illegible]	[illegible]	[illegible]	✓	✓	[illegible]
[illegible]	[illegible]	6.6	✓	✓	130 [illegible]
[illegible]	[illegible]	[illegible]		✓	[illegible]
[illegible]	[illegible]	[illegible]	✓	✓	[illegible]
[illegible]	[illegible] 101	3.1	✓	✓	[illegible]
[illegible]	128-112	8.6	✓	✓	123-[illegible]
[illegible]	130-114	6.8	✓	✓	127-105
[illegible]	126-112	9.7	✓	✓	126-108
[illegible]	131-113	8.0	✓	✓	128-110
[illegible]	125-111	7.2	✓	✓	123-106
[illegible]	124-112	5.6	✓	✓	126-107
[illegible]	127-115	5.7	✓	✓	124-108
[illegible]	125-111	5.5	✓	✓	123-99
[illegible]	138-125	7.7	✓	✓	135-115
[illegible]	133-116	7.0	✓	✓	132-105
[illegible]	131-117	8.0	[illegible]	✓	127-105
[illegible]	126-112	4.5	[illegible]	✓	122-105
[illegible]	127-98	[illegible]	[illegible]	[illegible]	[illegible] 98
[illegible]	129-100	5.6	[illegible]	[illegible]	129 100
[illegible]	126-109	2.6	✓	[illegible]	127 98
[illegible]	130-105	1.7	[illegible]	[illegible]	130 101
[illegible]	130-102	2.9	[illegible]	[illegible]	128 104
[illegible]	125-103	1.1	[illegible]	[illegible]	125 97
[illegible]	138-117	1.3	✓	✓	135-110
[illegible]	132-120	1.2	✓	✓	130-115
[illegible]	136-123	1.2	✓	✓	134-108
[illegible]	135-121	1.7	✓	✓	131-113
[illegible]	130-118	2.7	✓	✓	127-114
[illegible]	140-128	1.7	✓	✓	136-120
[illegible]	134-117	1.5	✓	✓	134-120
[illegible]	131-107	2.8	✓	✓	130-114
[illegible]	137-115	2.6	✓	✓	135-100
[illegible]	135-109	2.6	✓	✓	139-113
[illegible]	127-107	2.8	✓	✓	130-104
[illegible]	127-105	3.1	✓	✓	128-110

Appendix 4.3
Noise Pressure Trace

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 92-08-17		PAGE 38

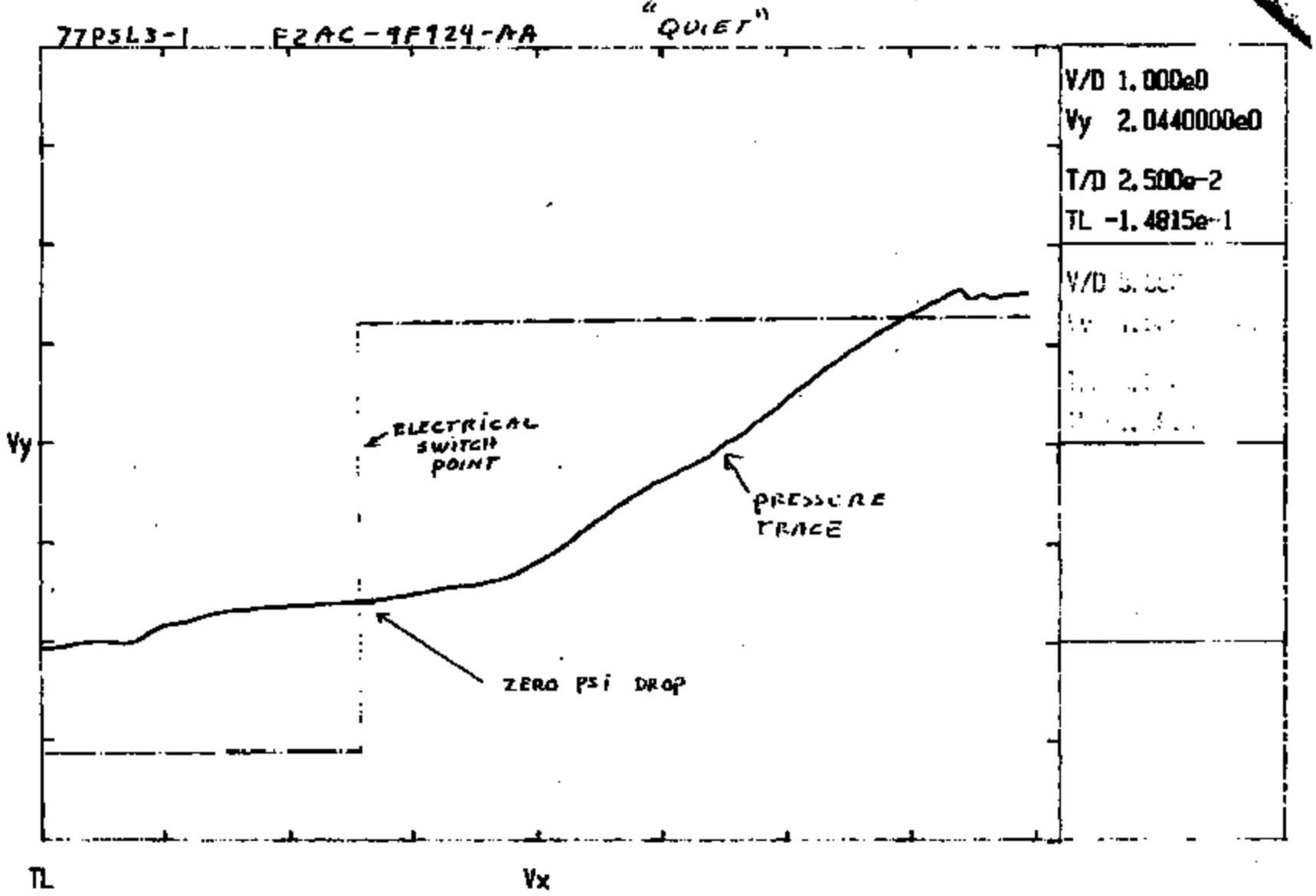

FIGURE 3

TI-NHTSA 000935