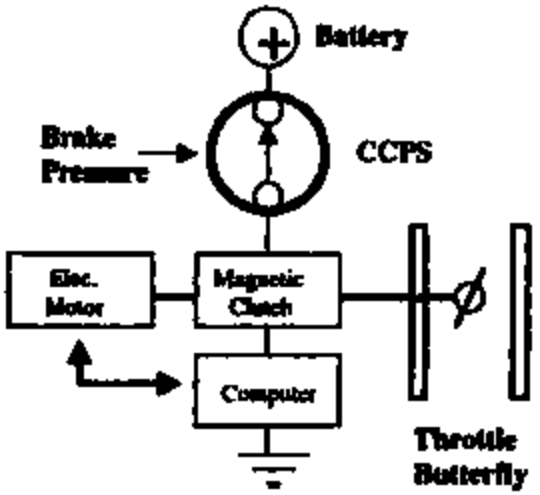
Overview

- The CCPS is a redundant safety device designed for use in a vacuum-less electronic cruise control system.
- Functionally, it replaces the present vacuum dump valve by de-energizing a clutch which connects the throttle to an electronic actuator.
- It is plumbed into the brake line. When the driver applies pressure to the brake pedal, the normally-closed switch opens, disconnecting the actuator from the throttle butterfly.



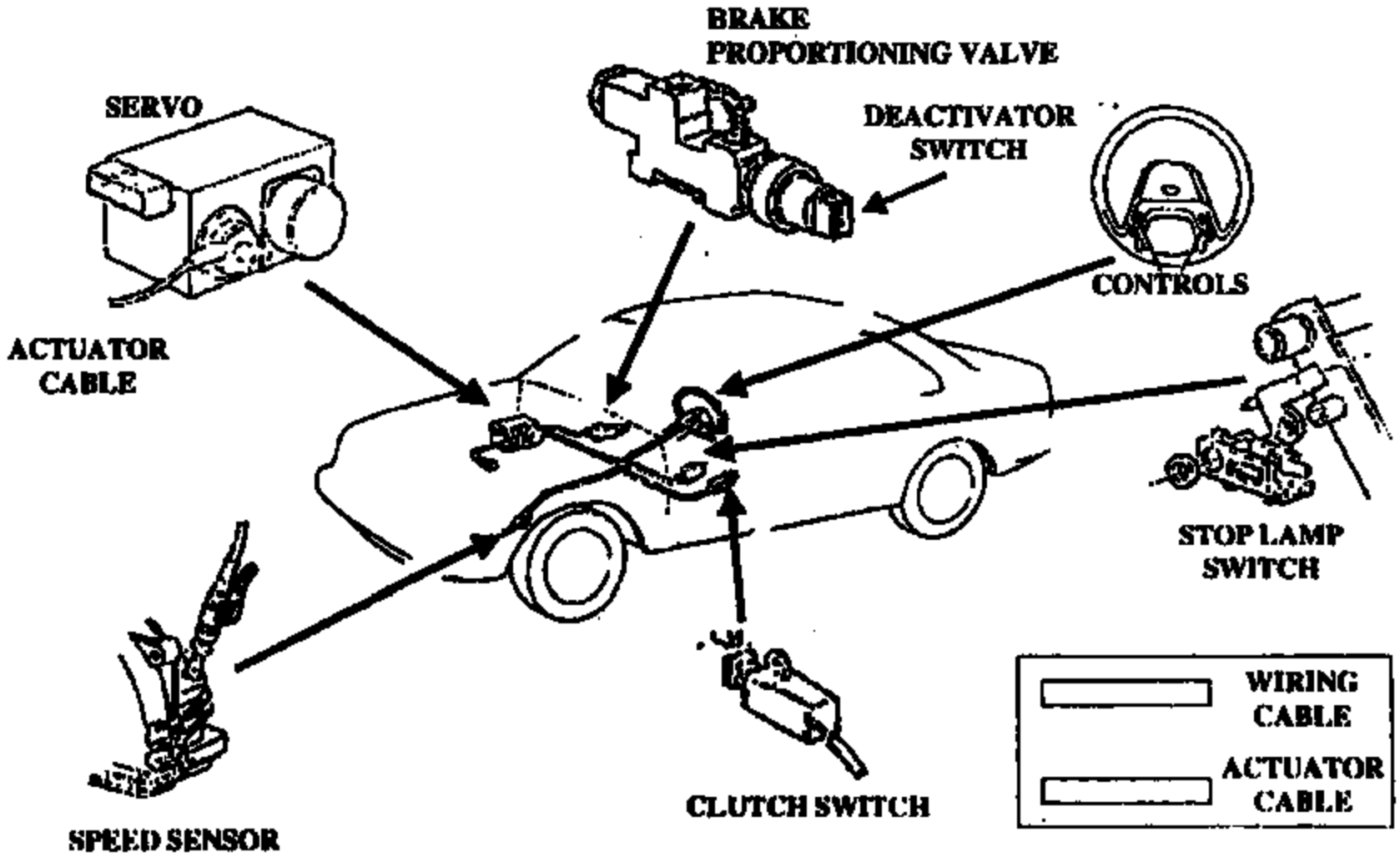
Specifications:

Actuation:	125 PSI +/- 35
	250 PSI +/- 50
Release:	20 PSI min
	40 PSI min
Burst:	7000 PSI
Proof:	3000 PSI
	4000PSI
Cycles:	500K, 0 - 1450 PSI, 2 H_z
Voltage:	Battery
Current:	0.75 AMP Inductive

TEXAS INSTRUMENTS

Automotive Sensors & Controls
Cruise Control Pressure Switch

1991 Next Generation Speed Control System



TI-NHTSA 001284

-150 [illegible]

R#=OET STMC DIV=0050 CORP0A<1 BY=CZAR ATMC, CCTR, [illegible]

TO: [illegible]
ED [illegible]
CC: [illegible]
KATY SELLERS FOME
CHARLIE DOUGLAS CDPC
JOE SCHUCK WHLZ
BILL SWEET FOME
FM: DAVE CZARN ZARN

RE: ELCO TELECON - 12/21/90 - 7TPS HEXPORT

THE FOLLOWING SUMMARIZES OUR 12/21 CONVERSATION WITH WAYNE AXE, MICHAEL MICHAUD AND JIM SHAW OF ELCO.

. A CNC LATHE WILL BE PURCHASED BY ELCO TO SUPPORT 500K PCS/YR, UPON RELEASE OF A P.O. FOR THE "TRUE J512" HEXPORT. LEADTIME TO ORDER/INSTALL THE LATHE IS 6 MONTHS. TO MEET THE MID-SEPTEMBER START-UP, WE WILL REQUEST A DESIGN DECISION FROM FORD BY JAN 31.

CHARLIE WILL SEND A LETTER TO FORD BY JAN 10, OUTLINING THE COST AND TIMING ISSUES ASSOCIATED WITH THE DIFFERENT HEXPORT OPTIONS. WINAL, WE NEED THE PRICING BREAKDOWN FOR THE L/T AND P/C SPLIT VOLUMES BY JAN 04 TO MAKE THIS HAPPEN.

. THERE IS A 3 MONTH TOOLING LEADTIME FOR THE "RELAXED TOLERANCE" J512 HEXPORT FOR P/C. WE WILL CONFIRM P/C'S DESIGN DECISION BY JAN 31 AND RELEASE TOOLING IN EARLY FEBRUARY. START-UP FOR P/C IS MID-MAY.

. ELCO HAS MADE NO PROGRESS IN DEFINING THE J512 GAGING TECHNIQUE. THEY AGREED TO WORK ON A CONCEPT "THROUGH THE HOLIDAYS". WINAL, PLEASE UPDATE THEIR PROGRESS AT THURSDAY'S MEETING. WE THINK THAT STEVE'S TECHNIQUE (DESCRIBED LAST MEETING) IS THE WAY TO GO. BUT WOULD LIKE TO SEE IF ELCO HAS A BETTER APPROACH.

. ELCO WILL BE PRODUCING 2000 HEXPORTS BY THE END OF JANUARY. THEY HAVE AGREED TO PROVIDE A CAPABILITY STUDY ON THE CHAMFER DIAMETER, BOTH PRE- AND POST-PLATE. THEY WILL MEASURE THE DIAMETER ON AN OPTICAL COMPARATOR.

. WE DISCUSSED THE QUALITY PROBLEMS OBSERVED WITH THE FIRST CNC LATHE PARTS. JIM SHAW STATED THAT HE HAD SOME IDEAS TO IMPROVE THE TOOLING WHICH HE WILL TRY DURING THE NEXT RUN OF 2000 PIECES.

REGARDS,
DAVE

/2-CCPS

HIGHLIGHTS
Stephen B. Offiler
Week Ending 01/04/91

FORD MY'92 NEXT-GENERATION SPEED CONTROL DEACTIVATE PS

HEXPORT: The tolerance relaxation experiment has progressed successfully through 4 of 25 thermal cycles and 80K of 500K impulse cycles. At this rate, we are on track to finish up by the stated date of 91/01/17. After review of notes taken during the Ford visit last September, the final procedures have been changed from sectioning all 16 to sectioning 8 and disassembling 8.

I received a call from two Elco gentlemen, Russ Peterson and Tom Vervais, who are working on the J512 chamfer gaging issue. After discussion of the difficulties of using optical techniques, they proposed use of a ball-type gage. I described my idea of using two different size gages (cylindrical, spherical) which allows calculation of both diameter and angle. They liked the idea, and are laying this out in order to determine appropriate ball sizes, etc. I expect a fax from them detailing the outcome of our discussion.

An informative meeting was held with Dick Shaw and Gamal Fattah from AFCC Screw Machine. We discussed the possibility of using a Hydromat machine to produce housports. They are not concerned about the .233-.237 versus the .220-.230 chamfer dimensions, and claim the Hydromat is capable of doing either for the same unit cost. There are at least a couple of very good reasons why we cannot use some capacity off the "one-piece-fanspay" Hydromat which is to be delivered soon: we need about 14-15 stations and that one has 12; and we need 1-1/16" stock and that one is 1" max. AFCC has already quoted this business, and their price for either the tight- or loose-tolerance part is very similar to Elco's loose-tolerance part. They are going to take a hard look at the quote, as well as experiment with their CMM to determine if they can measure the chamfer. Design related concerns include the strength of a cut (Hydromat/screw-machine) part versus a forged (Elco) part, which relates directly to burst pressure capability.

77PS BASE: Matt Sellers and I had a brief meeting with Steve Wallace yesterday. We went over several minor issues that Steve raised with the 46515 print, involving slight drafting errors, location of cavity ID's, etc. An outside house is presently working on the design of the 4-station production mold, and these issues need to be cleaned up right away to avoid delays.

77PS TERMINALS/SPRING: Parts were expected from the Model Shop today. I was informed that the EDM stamping tools have not yet been completed, and I'm trying to find out where we stand in that queue. The Model Shop has the bending tools ready to go.

PRESSURE SWITCH DATA Form 21605 **TEST NO.** 1J1-01-06

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMPL DATE
579565-3	1-8-91		

PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
[illegible]	1-17-91	1-22-91	

PROJECT TITLE: Cruise Control Pressure Switch

CUSTOMER: [redacted]

PURPOSE OF TEST: Samples CD 91-9

PROCEDURE:

ELCO INDUSTRIES, INC.
PRECISION FORMING DIVISION
[illegible]

CC: Mike Demottka
John Haynes
David Czarnecki
Hoff Sellers

January 9, 1991

TEXAS INSTRUMENTS, INC.
34 Forest Street
MS 12-2
Attleboro, MA 02703

Attention: Vinney Barros

Subject: Corrective Actions on J-512 Hexports

Dear Vinney,

On December 26th, I received from you some samples of the J-512 hexport requesting corrective actions on five issues. The following is our response:

Chatter on inverted flare - We were aware of this problem before we shipped the parts and started developing new Miyano tools. This tooling is now complete and will be used to run the next 2M pieces.

No threads - The first 2M pieces were hand-fed through the Miyano because the auto-feed fixture was not available at that time. The operator accidently dropped an unfinished part into the finished product pan. The next 2M pieces will be auto-fed.

No chucker machining - The machine/operator accidently dropped an unfinished part into the finished parts during the first machining operation after heading. This can happen on occasion and is hard to control for. The way Elco will control for this is to put a safety rail on the feed tray for the second machining operation, whether it is a chucker or a Miyano, so that an unmachined blank will not enter the second machining operation.

Burrs in through-hole - The new tooling mentioned under the chatter issue will correct the incidence of burrs in the through-hole.

Damaged hex - This issue is still under investigation. It is very difficult to determine where low-level handling damage occurs. When we run the next 2M pieces, we will watch for machine jams, part drop distances off machines, use of self-stacking pans and cleaning/plating loads and drop distances.

Vinney, a copy of this letter will be forwarded to the person who will be updating the FMEA and control plan for this part so that these defects will be controlled for in the future.

Continued.....

Sincerely,

Precision Forming Division
ELCO INDUSTRIES, INC.

Michael R. Michaud

Michael R. Michaud
Sales Department

MM:sb
cc:Les Whyte, Sales Rep. (Phone 203/272-5076)
Bob Hendershot

TEXAS INSTRUMENTS

09 January 1991

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

Stan:

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

****

DRAWING 1

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

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

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

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

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

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

The proposed dimension changes for "E" as shown, are: .233" - .237" (old) becomes .220" (5.59mm) - .230" (5.85mm) (new). The proposed dimension changes for "K" as shown, are: .040" - .050" (old) becomes .043" (1.10mm) - .055" (1.40mm) (new). Note on metric conversions: slight rounding errors may be apparent. This is due to the fact that both decimal inch and metric dimensions are in use simultaneously i.e. TI's customer prefers metric while the suppliers prefer decimal inch.

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

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

****

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

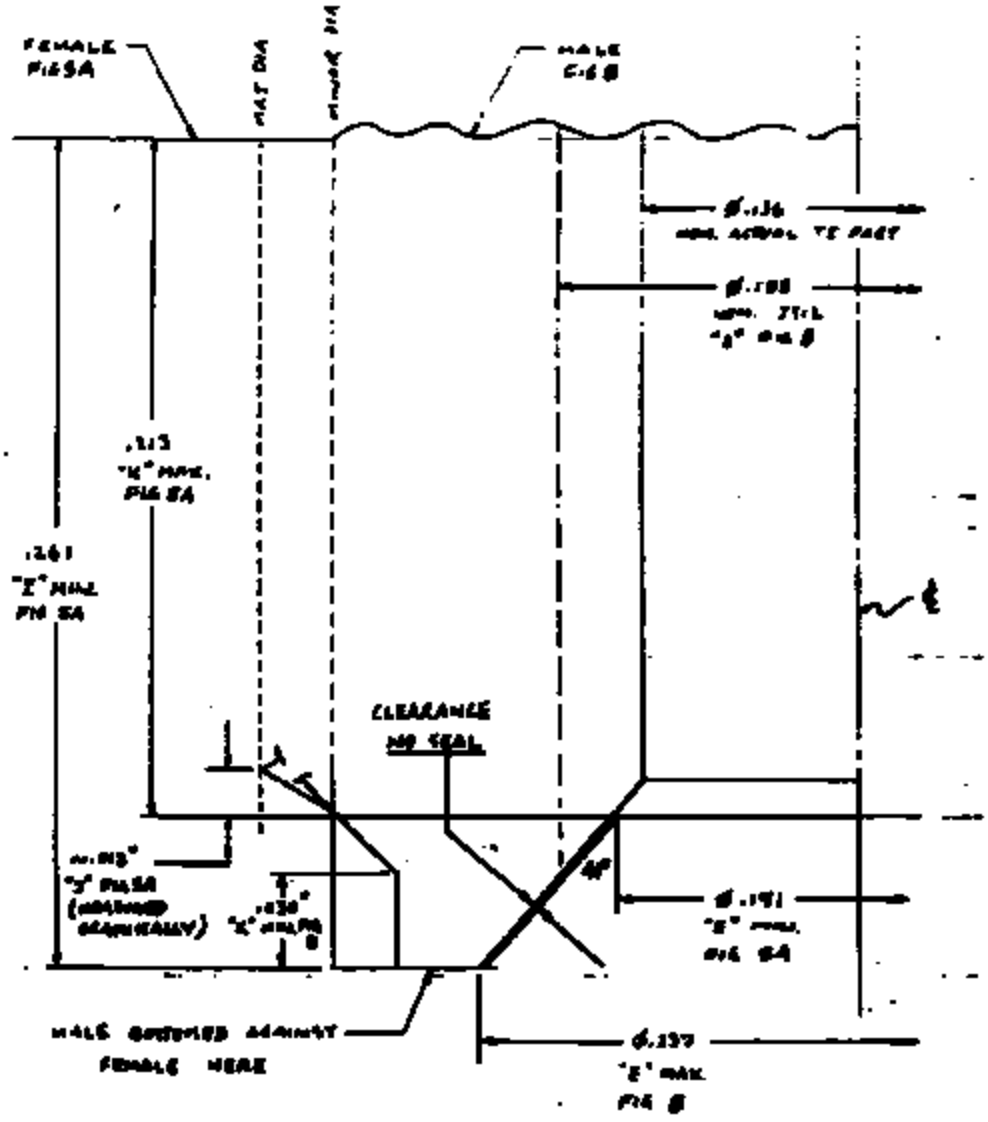
In closing, Stan, it would be greatly appreciated if the SAE J512 committee would consider the above information and recommendations as part of your existing ballot to increase the tolerance on dimension "E" from .004(total) to +/- .005.

Thanks and regards,

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

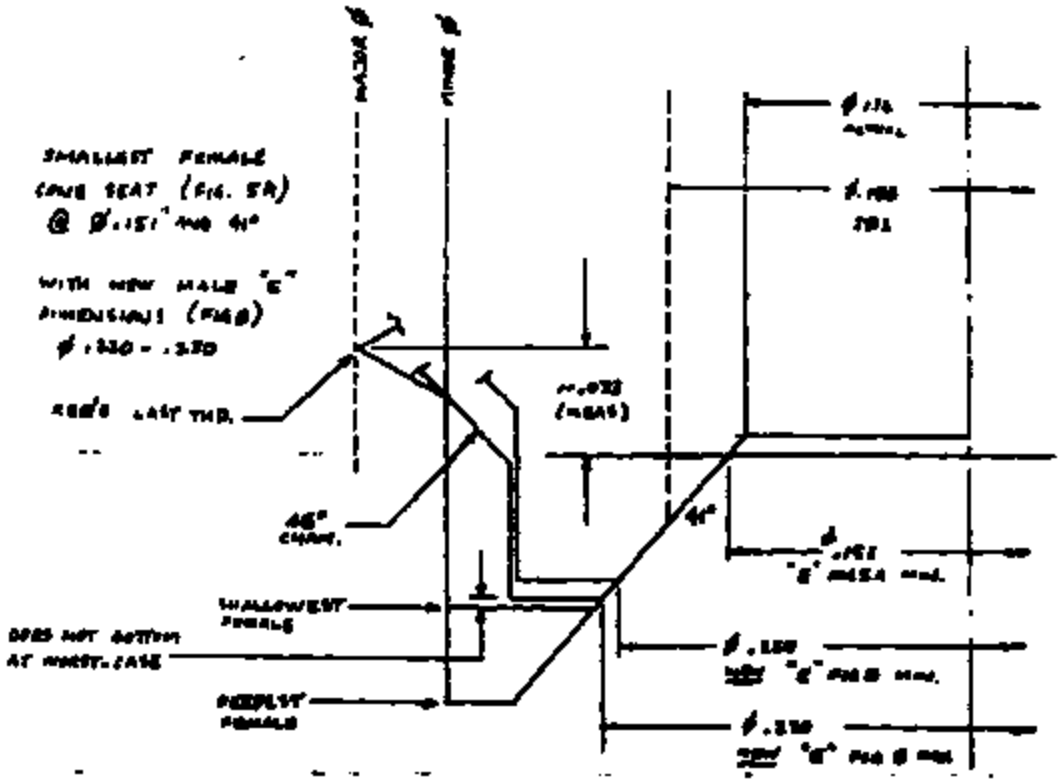
Enclosures

DRAWING 1



BY: STEVE SPIELER
DT: 100917
SCALE: 20X

DRAWING 2



BY: STEVE OFFNER
DT: 900917
SCALE: 20X

[illegible]

	DAVE CZARN	DAR
	[illegible]	PCCA
	[illegible]	PCCA
	[illegible]	BHL
	[illegible]	CES
	[illegible]	PCCS
	[illegible]	PCCC
	STEVE OFFILER	SBC.
	BILL SWEET	PCME
PI	MATT SELLERS	PCME

[illegible] 57/FSPS TERMINAL POSITION MEETING MINUTES

HIS MEETING WAS HELD TO DISCUSS POSSIBLE CORRECTIVE ACTIONS THAT HEN INITIATED WOULD IMPROVE OUR ABILITY TO PREDICT THE END OSITION OF THE 57PS TERMINALS AFTER STAPING. THE NEW FORD SPE EQUIREMENT ON THE TRUE POSITION OF THE 57PSLS-2 & 5-3 TERMINALS S (+/- .1 MM OF TRUE BASE CENTER & MMC, .5 MM OFFSET.).

URING THE MEETING WE DISCUSSED THE FACT THAT THE 57PS PRODUCT WAS ESIGNED TO A RATHER LIBERALLY DIMENSIONED PRINT, AND A LESS ENANDING FORD. THIS IS IN CONTRAST THIS GEOMETRICALLY DIMENSIONED RINT FOR THESE NEW FORD PRODUCTS, 57PSLS-2 & 57PSLS-3).

, I WAS PRESENTED THAT DEMONSTRATED OUR CURRENT CAPABILITY. WE EEM TO HAVE NO DIFFICULTY WITH THE 'X' DIRECTION OF MEASUREMENT. REFERENCE) THE BASE ASSEMBLY BEING HELD WITH THE POLARITY (S) WARD YOU). HOWEVER, WE HAVE A DIFFICULT TIME MEETING THESE EQUIREMENTS IN THE 'Y' DIRECTION. WHETHER THIS IS A RESULT OF THE ESIGN OR THE PROCESS REMAINS TO BE LEARNED. CURRENT OPINIONS ARE MIXTURE. WITH THE DESIGN CONTRIBUTION BEING THE LARGER ERCENTAGE, THIS IS NOT A STAB AT OUR DESIGN; IT QUESTIONS THE HETHER IT IS REASONABLE TO EXPECT THE DESIGN TO MEET THESE PECIFICATIONS.

O THE BEST OF THE TEAM ATTENDEES KNOWLEDGE NO INSERTION PROBLEMS AVE EVER BEEN NOTED WITH OUR CUSTOMER. THE MALE CONNECTOR PLUG IS ERY FORGIVING WITH RESPECT TO TERMINAL POSITION.

EEPING IN MIND THE WE NEED A FORMAL RESPONSE READY FOR FORD BY /14/91, THESE ACTIONS NEED TO BE COMPLETED ASAP:

. CONFIRM THAT NO RMR'S HAVE EVER BEEN LOGGED CONCERNING TERMINAL POSITION ISSUES.

  MIKE & DONNA

. SECURE INFO ON THE NUMBER OF PRODUCTS SUPPLIED TO FORD SINCE LINE START-UP.

  MIKE & DONNA

. EVALUATE CHANNELING TOOLS, STRIPPER TOOLS, E/C. THAT CAN POSSIBLY BE INSTITUTED THAT WILL IMPROVE OUR CAPABILITY WITH THE 57PS PRODUCTS.

EVALUATE 76PS TERMINAL STA ING PROCESS. DETERMINE IF THERE
IS ANYTHING TO LEARN FOR BOTH ITEMS AND TWO MODELS.

MATT

SUPPLY MATT WITH CAPABILITY OF [illegible]

JOHN

IS INFORMATION SHOULD BE COMPILED TO THE FULLEST [illegible]
D DIRECTED TO MIKE BY [illegible].

CARDS...MATT
245

[illegible]

Dave Czarn

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

FR: Steve Effler 8811

Re: SAE J512 Update - Contact with SAE Committee members

My purpose in contacting the SAE committee which wrote J512 was to discuss the issues we've run into specifically, the difficulty in producing and measuring the tight tolerance on the gage, i.e. the tolerance stackup which, at one extreme, allows a theoretically unusable seal to J512 is presently written.

I spoke with the chairman, Hans Fiedl (Parker-Hannifin, 614-279-7711) who informed me that a ballot was filed on 9/11/90 to open the tolerances in the spec. from +/- .002" to +/- .005". Upon then referred me to the committee member who is most a part of automotive fittings and is the same man who wrote the ballot, Stan Bragdon (Parker-Hannifin Brass Products Div., 216-943-7111).

I spoke with Stan, who seems to be very reasonable and helpful. He explained that he received inputs (from where? is this consensus or is Ford or one of the "Big 3" involved?) indicating that the +/- .002" tolerance was unrealistically tight, and suggesting a change to +/-.005". His role (until I so-called "sell" him on my analysis) was to simply write the ballot, not necessarily to perform any analysis. The ballot must be approved by the rest of the committee which is made up of both "producers" and "users".

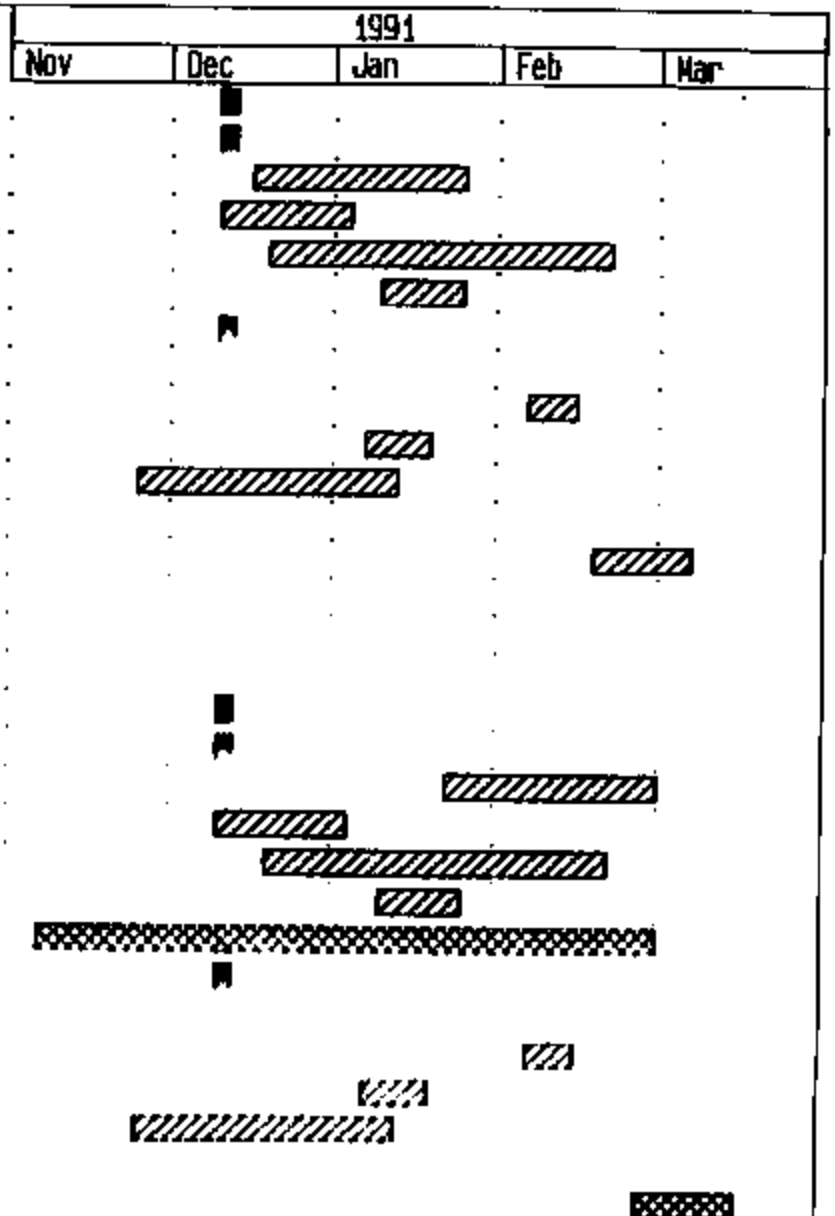
Apparently whoever suggested the tolerance change was unspecific as to how to apply it, because Stan chose to maintain the minimum (in our size this is .333"), so the new tolerance spec'd .338" +/- .005". This shifts the nominal UP by .003 which is the wrong direction by my analysis. I explained this to Stan, who is now VERY interested in seeing my tolerance stack-up analysis. I plan to immediately pull together a clear, concise report based on the many pages of calculations I've amassed and send it to Stan. He will then analyze the situation to determine if he agrees with me, and possibly modify the ballot.

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

Regards,
Steve E.

"cleaned up" version; included in Ford letter of 01/10/91

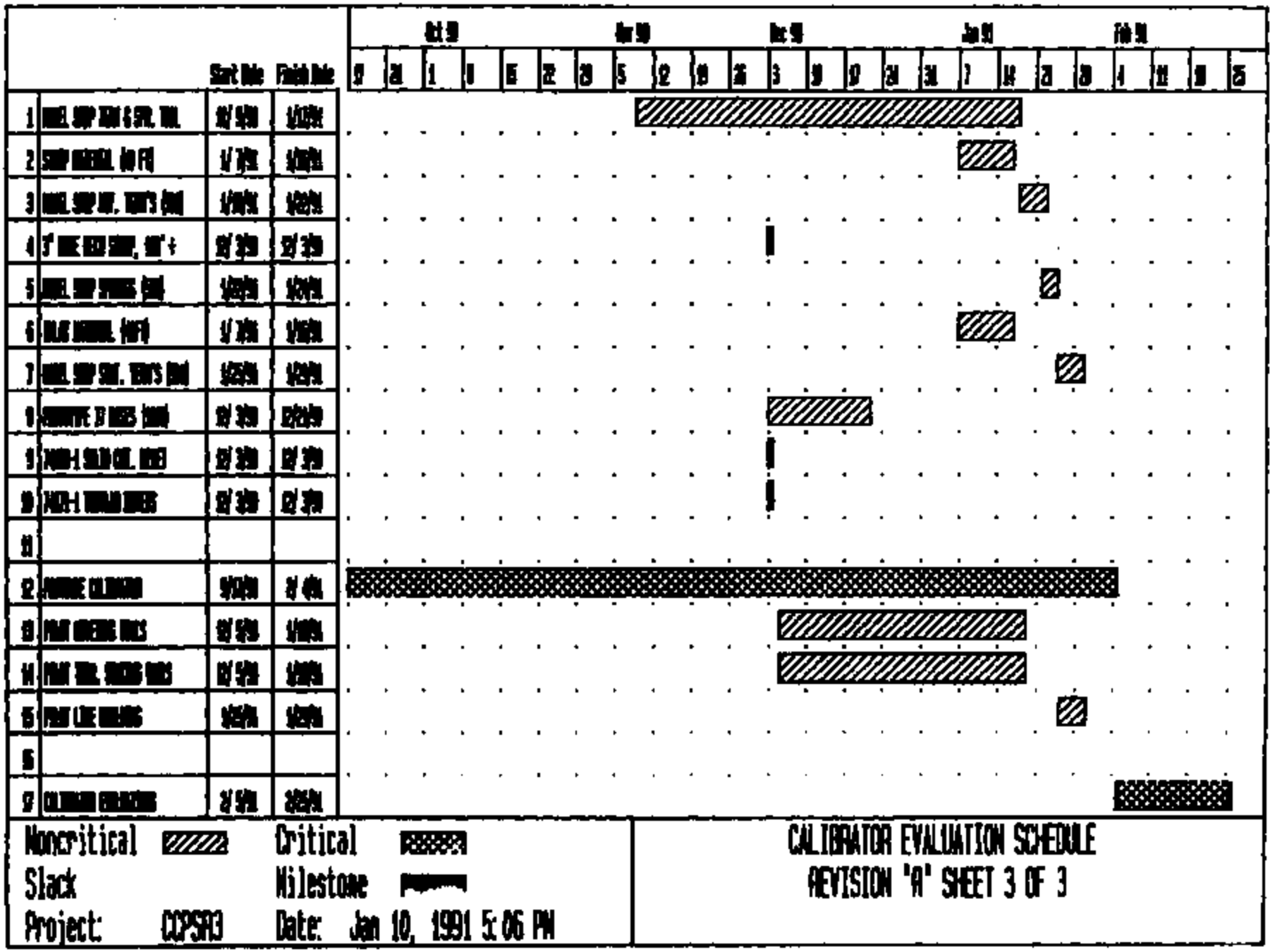
		Start Date	Finish Date
1	LIGHT TRUCK SCHEDULE	12/11/90	12/11/90
2	==========	12/11/90	12/11/90
3	J512 HEXPORTS (2K)	12/17/90	1/25/91
4	28/12-15 DISCS	12/11/90	1/ 3/91
5	ALUMINUM RINGS (15K)	12/21/90	2/18/91
6	46412 LT BLACK BASES	1/11/91	1/24/91
7	ALL OTHER STD 57PS COMP	12/11/90	12/11/90
8			
9	TEMP RING CODER MOD	2/ 8/91	2/14/91
10	DEVICE CRIMP NEST MOD	1/ 7/91	1/18/91
11	PRESSURE TESTER SOFTWARE	11/27/90	1/11/91
12			
13	57PS LIGHT TRUCK PILOT	2/19/91	3/ 4/91
14			
15			
16			
17	PASS CAR SCHEDULE	12/11/90	12/11/90
18	==========	12/11/90	12/11/90
19	J512 HEXPORTS (2K MORE)	1/25/91	2/26/91
20	22/10-13 DISCS	12/11/90	1/ 3/91
21	ALUMINUM RINGS 2 (15K)	12/21/90	2/18/91
22	46412 OFFSET PC BASES	1/11/91	1/24/91
23	PC CUP SAMPLES	11/ 8/90	2/27/91
24	ALL OTHER STD 57PS COMP	12/11/90	12/11/90
25			
26	TEMP RING CODER MOD 2	2/ 8/91	2/14/91
27	DEVICE CRIMP NEST MOD 2	1/ 7/91	1/18/91
28	PRESSURE TESTER SOFTWARE	11/27/90	1/11/91
29			
30	57PS PASS CAR PILOT	2/20/91	3/13/91

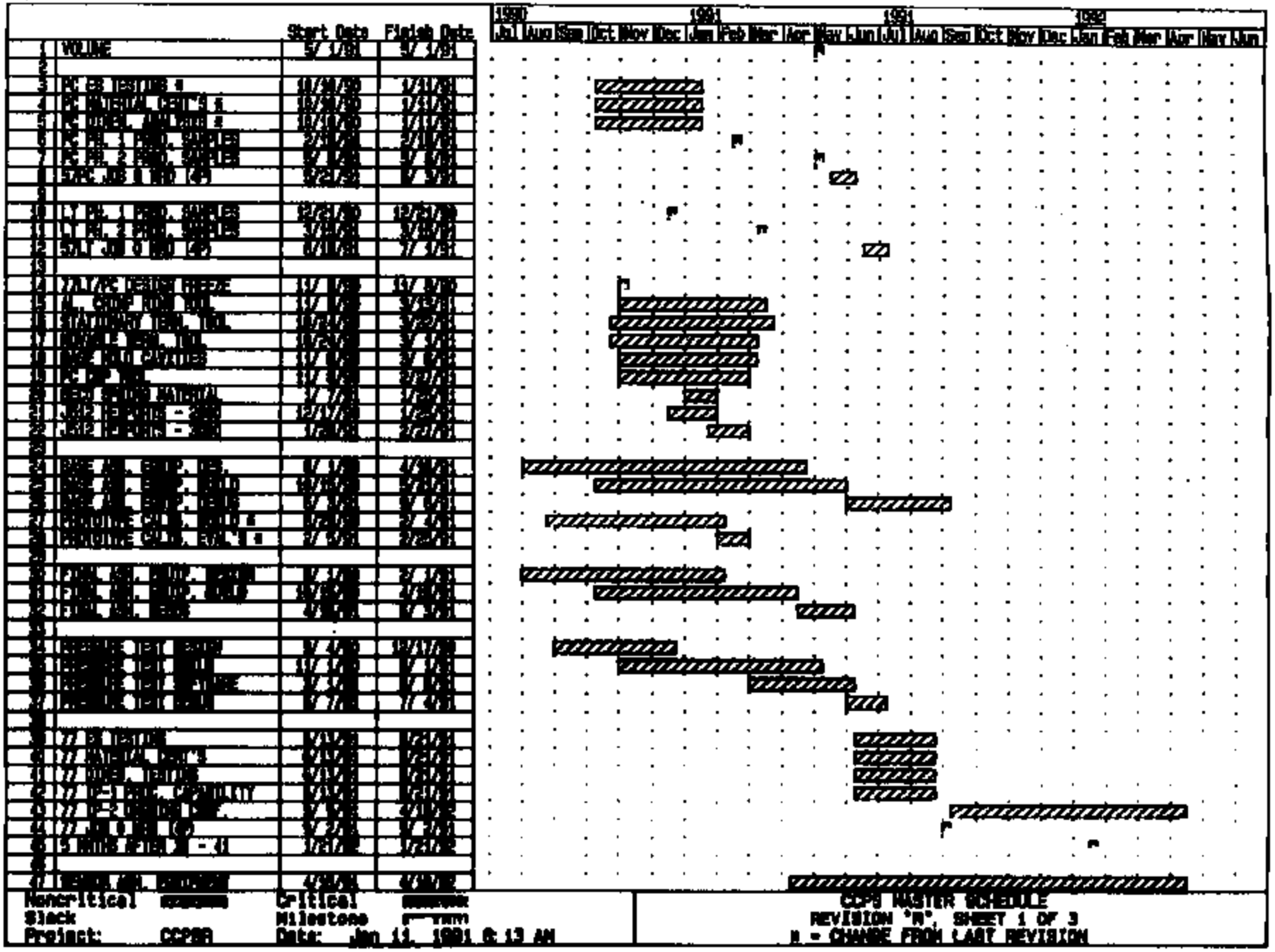


Noncritical Slack
Critical
Milestone
Project: CCPSR2 Date: Jan 10, 1991 5:21 PM

LT/PC PILOT SCHEDULES
REVISION "A" SHEET 2 OF 3

TI-NHTSA 001287


Start Date
Finish Date
Noncritical
Slack
Critical
Milestone
Project: CCPSR3
Date: Jan 10, 1991 5:06 PM
CALIBRATOR EVALUATION SCHEDULE
REVISION "A" SHEET 3 OF 3



TL-NHTSA 001269

HIGHLIGHTS
Stephen B. Offiler
Week Ending 01/11/91

FORD MY'92 ELECTRONIC SPEED CONTROL DEACTIVATE PS

HEXPORT: The SAE committee which writes J512 was contacted. The chairman referred me to the expert in automotive fittings, Stan Bragdon of Parker-Hannifin Brass Products Div. We learned that just before Christmas someone filed a ballot to increase the tolerances on J512 Figure 8, Table 5 (the male plug, which is the geometry we use) from +.004"/-0 to +/-.005". See MSG# 50387 (91-01-08) for more detail. I have forwarded to Stan a report summarizing the dimensional studies conducted by myself, Bruce Pease at Ford, and Jim Cousins at Kelsey-Hayes. I expect a reply late next week or so. Ideally, Stan will accept our conclusions and change the ballot to include our new dimensions, and the committee will approve this ballot. No reading on the likelihood of this or the timing.

We have received inputs from Elco's gaging experts regarding the use of spherical-shaped gaging for the J512 chamfer. After discussing this matter with me last week, they have outlined a method using two different size balls, allowing calculation of chamfer diameter and angle, while being insensitive to runout errors and resistant to changes due to wear of the gage surfaces (unlike my cylindrical gaging idea). Matt Sellers and I plan to look at this in detail early next week.

The experiment to test the new, relaxed J512 tolerances is within 100K impulse cycles and one thermal cycle of completion. At this time, all parts look good, with absolutely no evidence of leakage. Next, one-half of the parts will be sectioned and one-half will be disassembled for examination of the metal-to-metal seal.

77PS: The model shop is working on the prototype terminal and spring stamping tools. The schedule for these tools is slipping; the holdup was in Bld 20 at the EDM. The model shop now has the EDM components, and is working on finishing the tools. They report that bending tools are complete. Matt has been working to ensure we have sufficient quantities of materials on hand to produce several hundred of each part.

Revisions to the 77PS production base mold (46515) to correct various minor errors/discrepancies on the print have been completed. Due to the urgency conveyed by Steve Walters, a mock-up was completed first and delivered to him early this week to be overnited to the mold builder in Chicago. Drafting has completed the official version as well.

Matt Sellers and Dave Peripoli are presently working on tools to stake 77PS prototype terminals into the base, and to rivet both the contact and springimovable terminal rivet. We have provided prints and a few parts for this purpose. These tools will be used to construct test parts to exercise the calibrator when it becomes available and for any other engineering test samples or customer samples.

TI-004369

CUSTOMER ISSUES: Bruce Pease has sent a letter to everyone (TI, Tier-1's, Ford Purchasing, Engineering, SQA, etc.) outlining details of the Pass-Car program. This includes dates for incorporation of office-key connectors, the changeover from 57PS to 77PS, our J512 dimension revisions, and a requirement that the Tier-1's and TI eventually

conduct certain tests at dimensional extremes to validate these new dimensions. The Tier-1's will need us to supply custom-machined hexports; no contact from them requesting parts as yet.

Bruce is re-releasing our switches with the new J512 chamfer dimensions. Ford part numbers will go to rev level "B", i.e. the 57PS is now F2VC-9F924-BB and 77PS is F2VC-9F924-AB. Because of the sensitive nature of the new dimensions (in terms of politics and cost), he has required that we document on the envelope print in the revisions column exactly what has changed between his A-level and B-level switches.

Work progresses well on the Pass-Car ES test report, due today. It follows the same format as the Light Truck report, including most of the same appendices, etc.

SAMPLES, TESTING, MISC: We have obtained production-representative discs to be built and life-tested on production equipment. The matrix includes a range of discs for the Pass Car calibration, using .0122" non-passivated material; a range of discs for the Light Truck calibration also using .0122" NP material; and single lots of .013" passivated material, one each for PC and LT.

We have learned from Mike McQueen that the metric hexports for the Ford of Australia application do not carry priority at this time, and will not be delivered for SEVERAL WEEKS unless we obtain a higher priority. They are scheduled to be produced on CNC lathe equipment.

57PSL5-3 RIGHT TERM .68/.58 STUDY 1 11 91

SPECIFICATION = .68/.58 MM
.2 @ MMC OR +/-.1

.68/.58 ACTUAL	+/- TOL. W/BONUS	ACTUAL MEAS -MM-	COMMENTS
0.647	0.117	-0.198	BAD
0.697	0.122	-0.001	GOOD
0.643	0.119	-0.124	BAD
0.634	0.123	-0.139	BAD
0.641	0.120	-0.030	GOOD
0.635	0.123	0.011	GOOD
0.643	0.119	-0.137	BAD
0.638	0.121	-0.111	GOOD
0.631	0.125	-0.176	BAD
0.637	0.122	0.238	BAD
0.630	0.125	-0.014	GOOD
0.630	0.125	-0.058	GOOD
0.629	0.126	0.172	BAD
0.626	0.127	0.212	BAD
0.637	0.122	0.085	GOOD
0.638	0.121	0.101	GOOD
0.620	0.130	0.130	MARGINAL
0.640	0.120	0.130	BAD
0.660	0.110	0.070	GOOD
0.660	0.110	0.220	BAD
0.650	0.115	0.120	BAD
0.640	0.120	0.080	GOOD
0.660	0.110	0.140	BAD
0.640	0.120	0.130	BAD
0.670	0.105	0.000	GOOD
0.630	0.125	0.020	GOOD
0.680	0.100	0.090	GOOD
0.670	0.105	0.040	GOOD
0.670	0.105	0.060	GOOD
0.680	0.100	0.040	GOOD
0.630	0.125	0.140	BAD
0.680	0.100	0.140	BAD

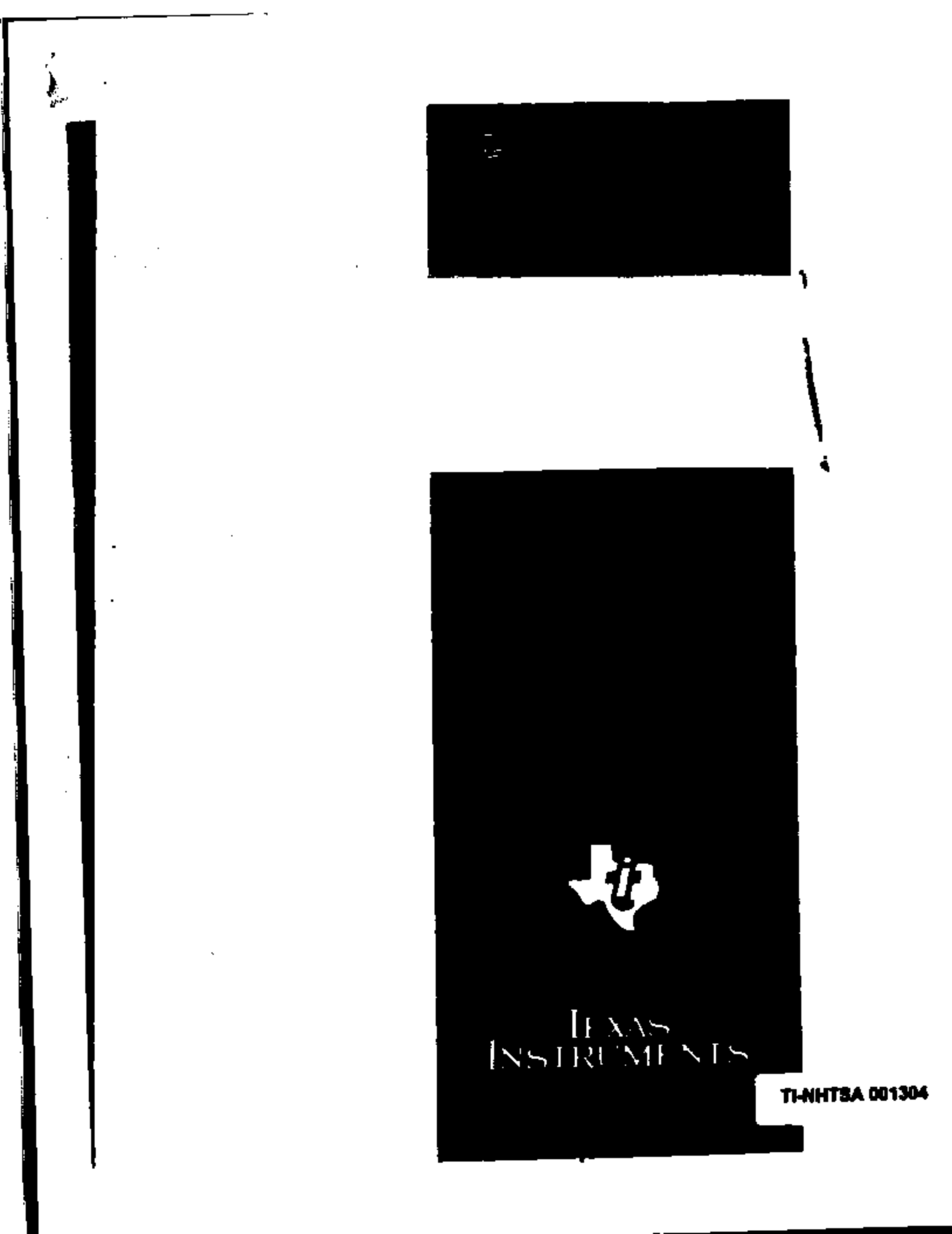
AVERAGE OUT 0.105 (0.0041)
SIGMA OUT 0.065 (0.0026)
0.300 = + 3SIGMA
0.366 = + 4SIGMA

.010

57PSL5-1 LEFT TERM .68/.58 STUDY 1 11:31

SPECIFICATION = .68/.58 MM
.2 @ MMC OR +/-.1

.68/.58 ACTUAL	+/- TOL. W/BONUS	ACTUAL MEAS (MM)	COMMENTS
0.639	0.121	-0.121	MARGINAL
0.632	0.124	0.318	OUT
0.636	0.122	-0.306	OUT
0.639	0.121	0.132	OUT
0.635	0.123	0.243	OUT
0.645	0.119	0.216	OUT
0.635	0.123	0.189	OUT
0.632	0.124	0.270	OUT
0.632	0.124	0.319	OUT
0.624	0.128	0.175	OUT
0.635	0.123	0.128	OUT
0.626	0.127	0.311	OUT
0.629	0.126	0.222	OUT
0.624	0.128	0.290	OUT
0.636	0.122	0.248	OUT
0.649	0.116	0.153	OUT
0.630	0.125	-0.170	OUT
0.640	0.120	-0.300	OUT
0.630	0.125	-0.350	OUT
0.630	0.125	-0.210	OUT
0.640	0.120	-0.250	OUT
0.670	0.105	-0.300	OUT
0.540	0.170	-0.390	OUT
0.630	0.125	-0.390	OUT
0.650	0.115	-0.100	GOOD
0.500	0.180	-0.210	OUT
0.660	0.110	-0.320	OUT
0.670	0.105	-0.150	OUT
0.650	0.115	-0.350	OUT
0.820	0.130	-0.200	OUT
0.640	0.120	-0.290	OUT
0.640	0.120	-0.340	OUT
	AVERAGE OUT	0.252 (.0099)	
	SIGMA OUT	0.083 (.0033)	
		0.502 = + 3SIGMA	
		0.585 = + 4SIGMA	



PS/91/25

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

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

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

TABLE OF CONTENTS

1.0 GENERAL

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

1.2 TI Part Number: S7PSL5-3

1.3 Customer Part Number: F2VC-9F924-BA

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

1.5 Applicable SREA(s): # 147660

1.6 Date of Completion: 90-12-13

1.7 Quantity of Units Tested: 72

1.8 Disposition of Tested Units:
- 1.8.1 One device, 99-15-31, was autopsied
- 1.8.2 Six devices were destroyed during Burst (test 3.5)
- 1.8.3 The remainder (qty. 65) are held in quarantine at TI

1.9 TI test series number: 99-15-80

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

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

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

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

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

3.0 TEST PROCEDURES AND RESULTS

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

A flow chart is included in the ES (frame 4 of 18), as follows: All test devices were subject to an initial characterization consisting of Calibration, Voltage Drop, Current Leakage, and Proof. Devices were then divided into groups per the flow chart and subject to the indicated tests in the indicated order. Finally, all tested devices were subject to a final characterization which was identical to the initial characterization.

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.1 CALIBRATION

3.1.1 Procedure: Calibration is checked at room temperature using ambient air as the pressure medium. Calibration settings, as specified on the part drawing, are actuation (electrical contacts opening) at 90 - 160 psig, and release (contacts reclosing) at 20 psig minimum. Actuation values are recorded on the sixth cycle, after subjecting the switch to two (2) pressure cycles to 300 psig minimum and back to zero, followed by three (3) cycles to 1.1 times actuation pressure minimum and back to zero. The change in continuity is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.5 volts DC.

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

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

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.2 VOLTAGE DROP

3.2.1 Equipment: Fluke Model 8023B Digital Multimeter, calibrated quarterly, used in conjunction with the continuity equipment in 3.1.2.

3.2.2. Initial results: The average voltage drop was 11.8 millivolts, and the standard deviation was 2.6. All values are significantly below the specification of 200 millivolts maximum.

3.2.3 Final results: The average voltage drop was 11.4 millivolts, and the standard deviation was 2.9.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.3 CURRENT LEAKAGE

3.3.1 Equipment: Associated Research HyPot test unit used as power source for 500 VAC, 60 Hz test circuit. Fluke Model 8021B Digital Multimeter, calibrated quarterly, used to measure voltage drop across a series resistance of one megohm + - 5%).

3.3.2 Initial results: Information could be obtained directly from inspection of the data without a need to calculate statistics. Measuring terminals to case with switch closed; measuring terminals to case with switch open; and measuring between the terminals: in no case did the leakage current exceed 1.39 microamps. All values are significantly below the specification of 100 microamps.

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

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

3.4 PROOF

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

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

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

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.5 BURST

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

3.5.2 Procedure: A pressure of 7000 psig was applied and held for 30 seconds minimum. Pressure was then increased slowly until failure. Failure is typically signalled by a sudden drop in test pressure of several hundred psi. The peak pressure attained as this occurs is defined as the bursting point.

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

3.5.4. Results: All six devices passed 30 seconds at 7000 psig without evidence of fluid leakage or drop in test pressure. Pressure was then increased until the failure point defined in 3.5.2, and a Weibull plot generated. See data section 4.2.2. Using the statistical acceptance criteria from the ES (frame 3 of 18), a minimum Weibull slope (beta) of 33.97 and a minimum Characteristic Life (theta) of 8829.6 psig was calculated at 90% confidence. The 0.72 reliability at 90% confidence is 8544.9 psi. Thus, the parts exceed the burst specification of 7000 psig by 1544.9 psi.

3.6 VIBRATION

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

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

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.7 VACUUM

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

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

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

3.8 TEMPERATURE CYCLE

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

3.8.2 Equipment: Thermotron model S-4 Mini-Max environmental chamber capable of -55 C to +200 C, humidity uncontrolled. Custom TI designed and built cycler, utilizing Enerpak integrated hydraulic pressure source, TI315 Programmable Logic Controller, Moog servovalve and controller, Simpson signal generator, and opposing-piston fluid isolators, to produce a hydraulic-fluid flow-type primary with a brake-fluid dead-end-type secondary terminated with a 24-station manifold equipped with internal heaters. Capability to 5 Hz at 0-1500 psig cycle. Custom TI designed and built 24 station Switch Monitor Circuit which automatically stops the cycler in the event of abnormal switch action, defined as continuity change which does not track the signal from the signal generator. Thermocouple readouts calibrated quarterly.

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
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3.9 FLUID RESISTANCE

3.9.1 Devices tested: 99-15-01 thru 99-15-36.

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

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

- 3.9.3.1 Impulse, -01 thru -12
- 3.9.3.2 Terminal Strength, -13 thru -24.
- 3.9.3.3 Humidity, -25 thru -30.
- 3.9.3.4 Salt Spray, -31 thru -36.

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.10 IMPULSE

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

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

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

3.10.4 Results/Discussion: All twenty-four devices passed the acceptance criteria found in the ES (frame 7 of 18; section III. E. 2.).

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.11 TERMINAL STRENGTH

3.11.1 Devices tested: 99-15-13 thru 99-15-24.

3.11.2 Equipment: Custom TI designed and built fixtures for gaging terminal movement after force application and for application of impact via a pendulum. This equipment is regularly used on the 57PS assembly line in testing to TI Quality Assurance Specification 296 (see Appendix 4.3).

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.12 HUMIDITY

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

3.12.2 Equipment: Humidity chamber RK model 5S.

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

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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3.13 SALT SPRAY

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

3.13.2 Equipment: Harshaw salt spray chamber.

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

TEST LOT NO.	TEST	DEVICE
TESTED BY		
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Appendix 4.1
Ford Engineering Specification
(delta) ES-F2VC-9F924-AA

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DSO.
DATE 93-01-11		PAGE 19

Engineering Specification

PART NAME	PART NUMBER
SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE	▽ ES-F2TC-[illegible]-AA

LET												
FR												
LET												
FR												

DATE	LET	FR	REVISIONS	DR	CK

REFERENCE

PREPARED/APPROVED BY

CHECKED BY DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVIS

DESIGN ENGINEERING MGT

MANUFACTURING ENGRG

QUALITY CONTROL

PURCHASING

SUPPLIER QUALITY ASSISTANCE

ELECTRONICS DIVISION

SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE

I. General

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

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

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

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

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

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

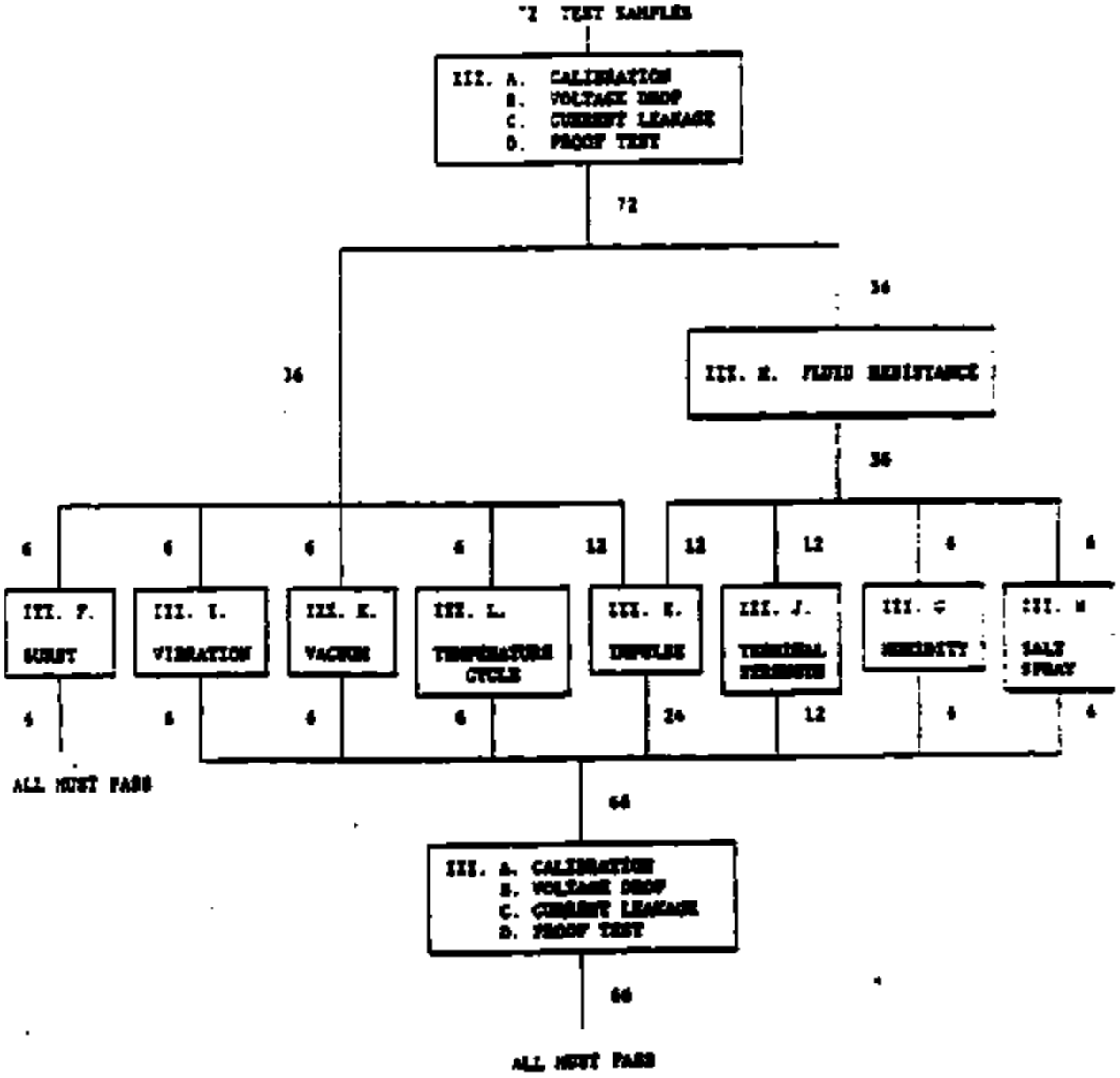
- In-Process Test Phase 1 (IP-1) - IP-1 tests are used to demonstrate process capability and must be completed using initial production parts from production tooling and processes prior to first production shipment approval. IP-1 tests are to continue in effect until process capability is demonstrated.

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

SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
▽ A	Calibration	72	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
C	Current Leakage	72	P90-.96	3/Mo.	P90-.56	4/Lot	" " "
D	Proof Test	72	P90-.96	12/Mo.	P90-.84	4/Lot	" " "
F	Burst	6	P90-.72	3/Mo.	P90-.56	4/Lot	" " "
I	Vibration	6	P90-.72	3/Mo.	P90-.56	6/6 Mo	P90 72
J	Terminal Strength	12	P90-.84	6/Mo.	P90-.72	4/Lot	All Must Pass
K	Vacuum	6	P90-.72	3/Mo.	P90-.56	6/6 Mo	P90-.72
L	Temperature Cycle	6	P90-.72	3/Mo.	P90-.56	6/6 Mo.	P90 72
M	Fluid Resistance	16	P90-.94	16/12Mo	P90-.94	16/12Mo	P90-.94
	Durability Tests						
III.							
G	Impulse	24	P90-.90	12/Mo	P90 84	1/1 Mo	P90 56
H	Humidity	6	P90-.72	3/Mo	P90 56	6/6 Mo	P90 72
N	Salt Spray	6	P90 72	1/Mo	P90 56	6/6 Mo	P90 72

PRODUCTION VALIDATION FLOW CHART



III. TEST PROCEDURES AND REQUIREMENTS

▽ A. Calibration

1. Test Requirements

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

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

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

2. Acceptance Requirements

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

B. Voltage Drop

1. Test Requirements

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

2. Acceptance Requirements

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

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

C. Current Leakage

1. Test Requirements

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

b. Current leakage is to be checked:

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

2. Acceptance Requirements

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

D. Proof Test

1. Test Requirements

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

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

c. Recheck the switches to Section A.

2. Acceptance Requirements

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

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

c. The test samples must be destroyed after testing.

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

E. Impulse

1. Test Requirements

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

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

2) 475,001 - 500,000 cycles: 13 ± 1 volts 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.

G. Humidity

1. Test Requirements

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

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

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

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

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

2. Acceptance Requirements

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

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

H. Salt Spray

1. Test Requirements

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

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

2. Acceptance Requirements

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

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

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

I. Vibration

1. Test Requirements

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

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

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

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

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

2. Acceptance Requirements

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

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

III. Test Procedures and Requirements (cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

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

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

2. Acceptance Requirements

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

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

K. Vacuum

1. Test Requirements

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

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

2. Acceptance Requirements

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

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

3 mm Hg = 0.058 psi = 0.400 K Pa

6 mm Hg = 0.116 psi = 0.800 K Pa

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

L. Temperature Cycle

1. Test Requirements

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

b. Repeat the following procedure 25 times.

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

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

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

(4) Repeat Step 2.

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

2. Acceptance Requirements

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

M. Fluid Resistance

1. Test Requirements

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

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

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

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

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

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

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

Acceptance Requirements

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

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

IV. STATISTICAL ANALYSIS METHODS

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

B. All samples must pass 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.

[illegible] 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.

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.

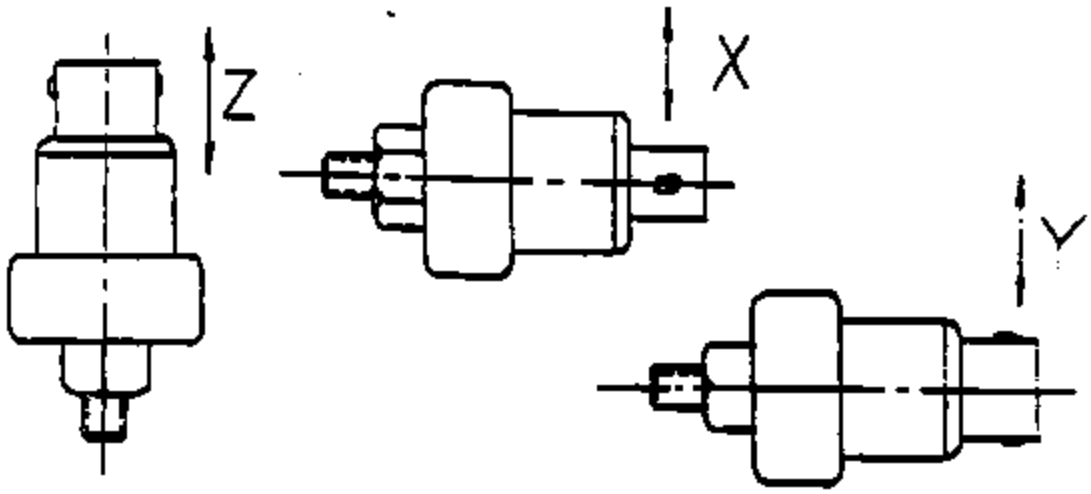
IX. COMPILATION OF REFERENCE DOCUMENTS

ASTM B-117. Salt Spray Testing

Ford Q-101. Quality System Standard 1993 Edition

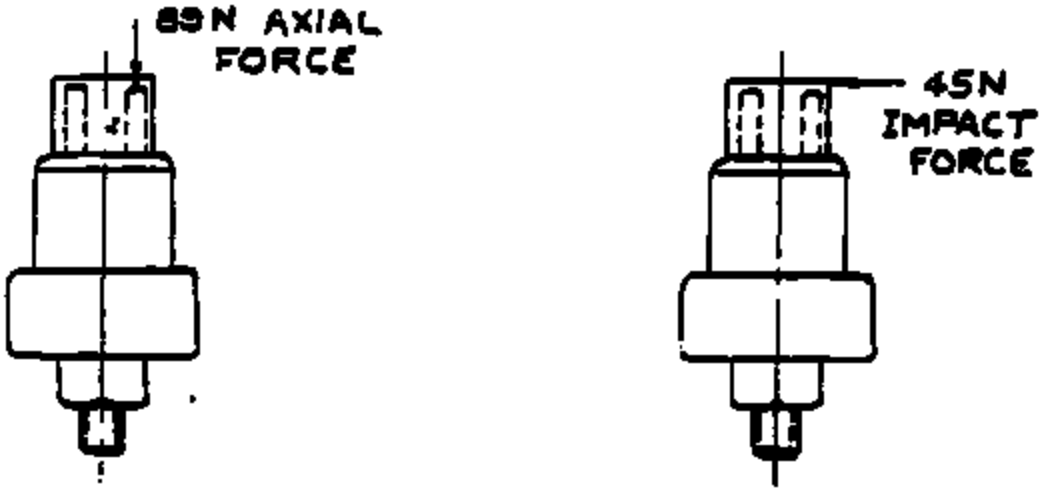
ES-F0EB-14A464-AA. Specification - SLV Assy - Wire Connector

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



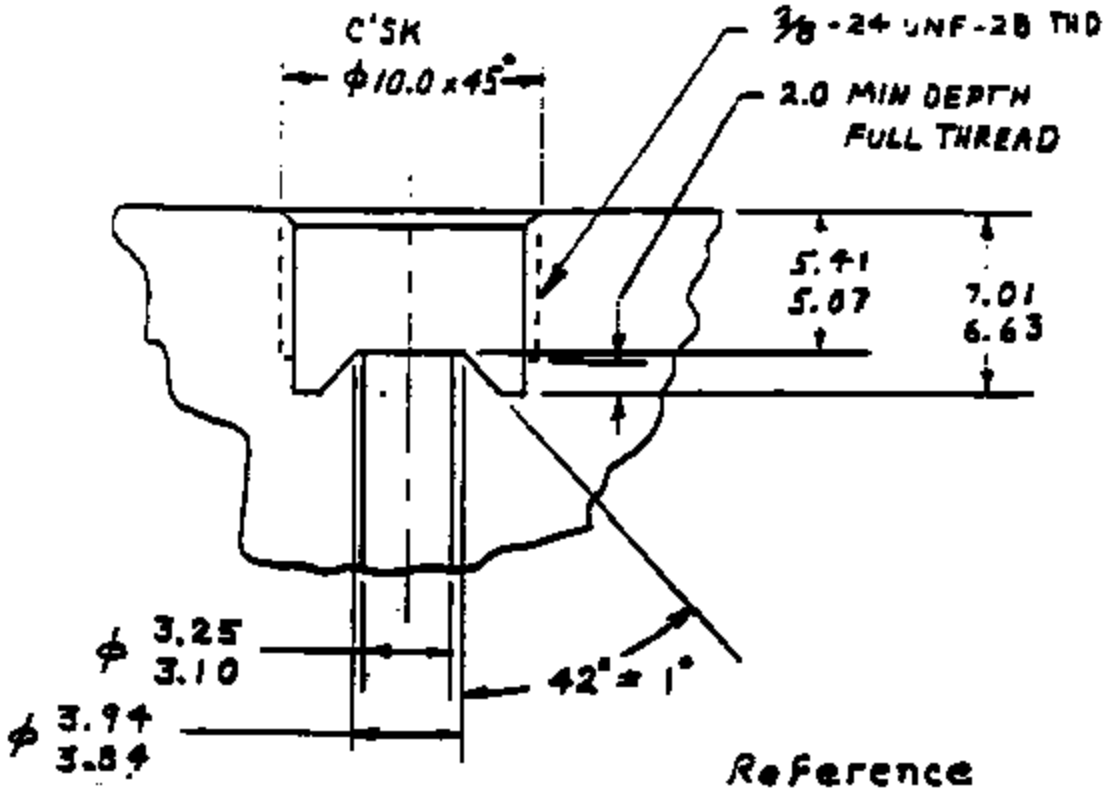
VIBRATION TEST - SWITCH ORIENTATION

FIGURE 1.



TERMINAL STRENGTH - LOAD ORIENTATION

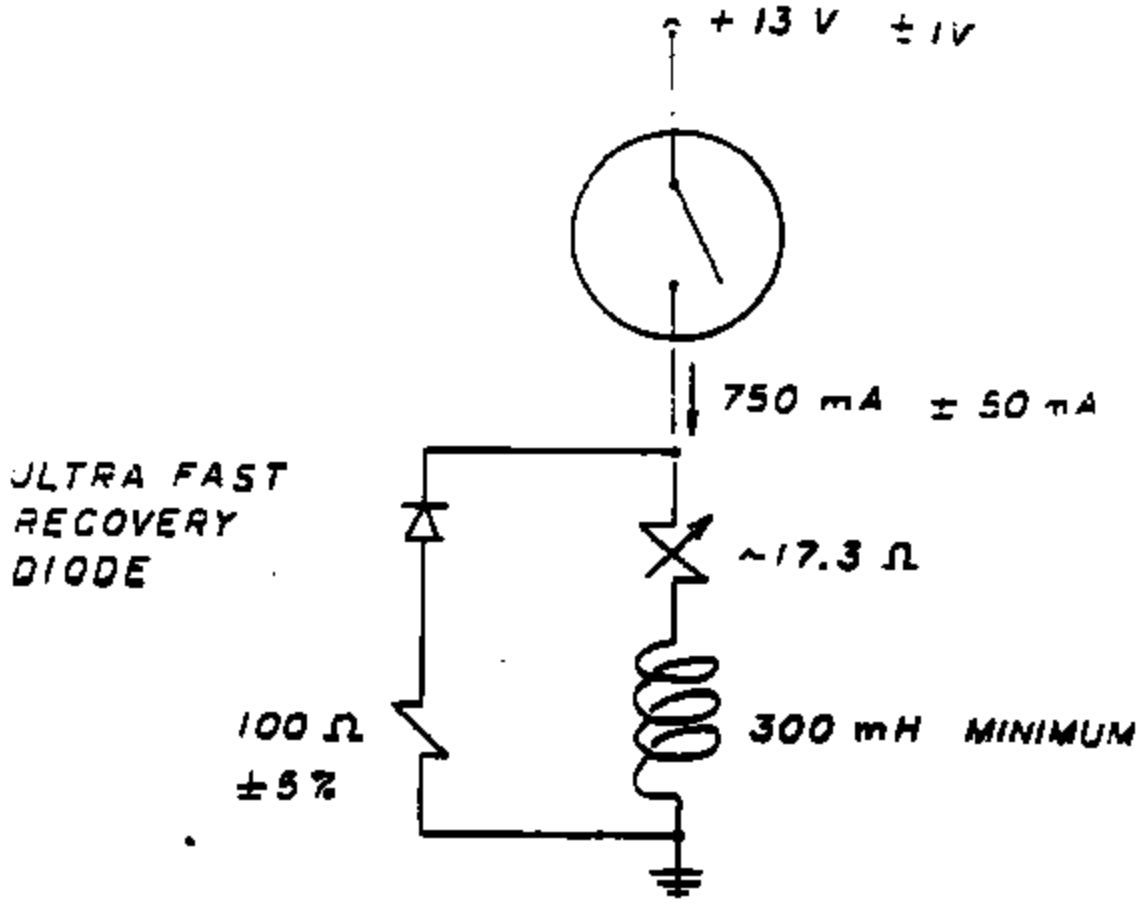
FIGURE 2.



Reference
SAE J512 OCT 80
Figure 5A

TEST FIXTURE PORT CONFIGURATION

FIGURE 3



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

Appendix. 4.2.1
Initial and Final Characterization

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

PRESSURE SWITCH DATA Form 21605 TEST NO. 99-15-80

DEVICE	DATE REQUESTED	REQUESTED BY	RECEIVED CHECK DATE
EX3423	10-19-90	J OFFICER	
PERFORMED BY	**DATE STARTED**	**DATE COMPLETED**	**APPROVED BY**
RAUGHELI	10-19-90	11-13-90	

PROJECT TITLE: FORD PASS-CAR REVALIDATION

CUSTOMER: FORD

PURPOSE OF TEST: PASS-CAR QUALIFICATION

PROCEDURE: SEE FORD ENGINEERING SPEC

	CHARACTERISTICS				HYPOT				
DEVICE NO	PRESS	Ac-	REL	mV)	TO CASE (mA)	TO CASE (mA)	RESIDUAL TRACE	TESTS	
99-A-01	PASS	123 mg	30 mg	13.36	1.772	1.935	1.917	FAILED	CHANGE
02		112	58	13.05	1.667	1.913	1.910	-	
03		116	49	13.90	1.689	1.938	1.898		
04		123	55	13.88	1.708	1.916	1.895	-	
05		119	53	13.12	1.698	1.916	1.900		
06		118	51	13.67	1.761	1.960	1.909	-	-
07		122	53	13.31	1.666	1.907	1.853	-	-
08		120	56	13.51	1.760	1.966	1.899		
09		120	52	13.38	1.685	1.928	1.899	-	
10		119	58	13.28	1.723	1.963	1.865	-	
11		117	48	12.98	1.697	1.932	1.893	-	
12		118	58	13.42	1.704	1.937	1.867	-	
13		106	45	13.60	1.685	1.908	1.916		CHANGE TO
20		119	58	14.03	1.683	1.922	1.910		
15		123	51	13.52	1.707	1.935	1.896		
16		115	50	14.63	1.695	1.949	1.902		
17		123	52	12.95	1.660	1.910	1.861		
18		118	53	11.91	1.662	1.929	1.893		
19		125	55	13.30	1.660	1.936	1.894		
20		123	51	13.61	1.689	1.942	1.900		
21		120	51	13.40	1.675	1.926	1.890		
22		115	53	13.56	1.708	1.978	1.897		
23		113	49	14.07	1.725	1.990	1.926		
24		119	55	13.16	1.684	1.946	1.907		
25		126	52	13.50	1.723	1.985	1.930	-	HIGH SET
26		116	53	13.29	1.698	1.900	1.906	-	
27		119	53	13.30	1.705	1.896	1.912		

(OVER)

DEVICE NO	PASS	A.-	Rel	mVS	TO CASE SW CASE	TO CASE SW CASE	BETWEEN TERMINALS	TCS - S
99-15-28	PASS	125 pcs	52 pcs	12.30	1.618	1.300	1.378	SWEPT
29	"	125	50	12.50	1.626	1.303	1.364	
30	"	140	56	12.11	1.622	1.291	1.386	
31	"	118	52	12.57	1.646	1.300	1.382	SALT SPR
32	"	135	54	12.32	1.773	1.355	1.447	
33	"	127	50	11.86	1.706	1.328	1.500	
34	"	124	53	11.68	1.615	1.332	1.428	
35	"	121	52	12.55	1.617	1.317	1.427	
36	"	123	54	11.27	1.696	1.328	1.407	"
37	"	102	49	8.26	1.532	1.225	1.302	BURST 3000
38	"	107	55	8.24	1.603	1.270	1.320	2900
39	"	145	56	8.47	1.718	1.306	1.434	6900
40	"	103	57	8.16	1.716	1.298	1.328	6700
41	"	143	60	8.78	1.804	1.214	1.404	" 3000
42	"	142	64	8.80	1.772	1.298	1.369	" 1600
43	"	119	51	9.61	1.698	1.324	1.389	V. MOTION
44	"	117	48	9.57	1.693	1.304	1.419	
45	"	116	50	8.78	1.706	1.331	1.409	
46	"	106	48	9.01	1.681	1.299	1.382	
47	"	110	51	8.79	1.693	1.300	1.387	
48	"	110	45	10.78	1.693	1.297	1.386	
49	"	102	40	9.29	1.606	1.277	1.350	VACUUM
50	"	142	58	8.76	1.774	1.308	1.387	"
51	"	140	57	8.03	1.767	1.278	1.377	"
52	"	139	60	8.02	1.776	1.328	1.390	"
53	"	132	53	8.01	1.715	1.301	1.396	"
54	"	102	41	8.31	1.713	1.296	1.350	"
55	"	128	53	8.08	1.680	1.270	1.379	TEST CYCLE
56	"	127	51	8.25	1.698	1.276	1.398	
57	"	131	50	8.46	1.687	1.278	1.393	
58	"	135	53	8.18	1.696	1.276	1.375	"
59	"	139	57	8.17	1.711	1.294	1.378	"
60	"	111	57	8.03	1.684	1.272	1.378	"
61	"	135	53	8.32	1.720	1.289	1.375	SWEPT
62	"	132	61	8.37	1.693	1.293	1.410	"
63	"	136	58	8.29	1.717	1.298	1.378	
64	"	136	52	8.36	1.691	1.313	1.409	
65	"	139	55	7.70	1.814	1.311	1.402	
66	"	140	55	8.18	1.703	1.298	1.403	"
67	"	131	55	8.31	1.[illegible]	1.[illegible]	1.[illegible]	"
68	"	135	60	7.43	1.[illegible]	1.[illegible]	1.[illegible]	
69	"	136	56	8.10	1.801	1.303	1.382	
70	"	135	61	8.25	1.790	1.[illegible]	1.[illegible]	
71	"	131	49	8.29	1.767	1.311	1.393	
72	"	132	52	9.41	1.735	1.325	1.416	
73	"							TSB OUT PLATE
74	"							
75	"							
76	"							
77	"							
78	"							
EXTRA 79	"	133	43	8.46	1.[illegible]	1.709	1.391	

FINAL CHARACTERIZATION - HYPOT

DEVICE NO	POST PROOF	ACT	REL	MVD	TO CASE SW CLSD	TO CASE SW OPEN	BETWEEN TERMS	TESTS	
99-15-01	PASS	113 ACT	62 REL	9.56 MV	1.926	1.798	1.862	FAILURES:	TESTS
02	"	107	56	9.25	1.891	1.752	1.907		
03	"	113	52	10.01	1.965	1.747	1.903		
04	"	119	61	8.66	1.939	1.790	1.854		
05	"	112	60	9.19	1.924	1.776	3.360		
06	"	107	55	10.31	1.942	1.786	1.949		
07	"	116	55	10.11	1.903	1.748	1.966		
08	"	121	62	8.97	1.942	1.793	1.959		
09	"	120	56	12.41	1.942	1.793	1.941		
10	"	119	57	9.29	1.948	1.797	3.396		
11	"	110	54	9.37	1.898	1.746	1.923		
12	"	110	60	9.07	1.913	1.772	4.986		
13	PASS	112	47	8.56	1.903	1.837	1.951		TESTS
14	"	122	52	7.41	1.992	1.891	2.037		
15	"	126	53	8.89	1.926	1.825	1.930		
16	"	125	51	9.05	1.905	1.777	1.938		
17	"	129	51	8.50	1.906	1.786	1.934		
18	"	124	52	9.04	1.904	1.783	1.940		
19	"	134	49	8.77	1.928	1.806	1.931		
20	"	129	49	9.06	1.909	1.830	1.977		
21	"	127	51	8.93	1.908	1.784	1.946		
22	"	114	57	9.62	1.929	1.825	1.931		
23	"	121	46	8.93	1.939	1.796	1.935		
24	"	128	55	8.79	1.954	1.831	2.030		
25	PASS	135	53	9.16	1.939	1.817	1.929		HI-POT
26	"	127	50	8.77	2.030	1.877	1.921		
27	"	133	56	10.97	1.976	1.822	1.925		
28	"	135	57	9.59	1.947	1.817	1.918		
29	"	124	54	9.30	1.957	1.826	1.940		
30	"	131	59	9.14	1.960	1.819	1.942		
31	PASS	126	53	9.07	63.100	63.100	63.100		SALT SPRAY
32	"	127	53	8.65	1.949	1.845	1.932		
33	"	135	51	9.92	4.210	4.356	4.340		
34	"	131	52	9.02	1.898	1.765	1.925		
35	"	126	52	9.83	1.926	1.815	1.939		
36	"	128	53	8.89	8.350	7.460	8.380		
37	—	—	—	—	—	—	—	BURST	
38	—	—	—	—	—	—	—	"	
39	—	—	—	—	—	—	—	"	
40	—	—	—	—	—	—	—		
41	—	—	—	—	—	—	—		
42	—	—	—	—	—	—	—		
43	PASS	114	61	9.26	1.963	1.796	1.925	VIBRATION	
44	"	113	49	8.35	1.948	1.797	1.926	"	
45	"	103	46	8.93	1.926	1.814	1.907	"	
46	"	102	46	9.27	1.942	1.804	1.944	"	
47	"	110	49	8.61	1.916	1.793	1.924	"	
48	"	117	47	9.45	1.935	1.798	1.937	"	
49	PASS	145	61	8.46	1.881	1.772	1.851	VIBRATION	
50	"	142	52	9.34	1.956	1.807	1.945	"	
51	"	143	57	8.83	1.882	1.806	1.926	"	
52	"	139	63	8.86	1.948	1.820	1.896	"	
53	"	143	54	8.79	1.879	1.798	1.878	"	
54	"	147	47	9.82	1.962	1.787	1.865	"	

FINAL CHARACTERIZATION - HYPOT (CONT).

DEVICE NO	POST PROOF	ACT	REL	mVD	TO CASE 2M OHM	TO CASE 5M OHM	BETWEEN TERMS	TESTS	
99-15-55	PASS	119 ACT	36 REL	9.23 mV	1.957	1.889	1.912	FINAL	CYCLE
56	"	125	52	8.93	1.941	1.869	1.904	"	
57	"	124	55	8.70	1.872	1.793	1.910	"	
58	"	130	63	7.31	1.885	1.806	1.896	"	
59	"	123	58	8.74	1.955	1.875	1.913	"	
60	"	118	57	9.79	1.893	1.802	1.900	"	
61	PASS	130	61	14.11	1.933	1.790	1.939	3 MIN SOAK	
62	"	133	66	11.62	1.950	1.793	1.944	"	
63	"	133	64	12.93	1.896	1.756	1.925	"	
64	"	126	64	10.25	1.932	1.802	1.897	"	
65	"	134	70	20.79	1.949	1.793	1.909	"	
66	"	120	61	15.10	1.970	1.721	1.937	"	
67	"	132	61	10.26	1.865	1.717	1.857	"	
68	"	133	67	11.97	1.900	1.751	1.908	"	
69	"	131	63	14.50	1.903	1.746	1.911	"	
70	"	137	64	19.01	1.931	1.778	1.935	"	
71	"	121	56	12.76	1.942	1.787	1.946	"	
72	"	128	63	17.01	1.893	1.735	1.857	"	

Appendix 4.2.2
Burst test Weibull

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

TI-NHTSA 001348

ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS

SHAPE(BETA) PARAMETER	:	68.720 (illegible)
LOWER LIMIT	:	33.970 (illegible)
UPPER LIMIT	:	%139.01820373535(illegible)
SCALE(THETA) PARAMETER	:	8923.360 (illegible)
LOWER LIMIT	:	8829.575 (illegible)
UPPER LIMIT	:	9018.143

illegible LOW EXTREMES OF β AND θ @ 90% CONFIDENCE

[redacted] VALUES FOR SPECIFIED LEVELS OF RELIABILITY

* WEIBULL SLOPE :33.97
* CHARACTERISTIC LIFE : 8829.58

NO.	RELIABILITY(%)	TIME
1	72	8544.9170

Appendix 4.2.3
Vibration

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REV.
DATE 91-01-11		PAGE 46

Form 5515

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/02/90

REQUESTED BY RON RIGGIERI

REQUIRED COMPLETION DATE 11/09/90

EXTENSION 3109 MS 12-29

DEVICE 57PSL5-3

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

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

SOURCE OF TEST SAMPLES DESIGN LAB

QUANTITY OF TEST SAMPLES 6

REPORT NO. 1282-110

TESTED BY Lab

COMPLETION DATE 11-26-90

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

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

TEST PERFORMED:

Per above.

TEST RESULTS:

See attached

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE:

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

I. Vibration

1. Test Requirements

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

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

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

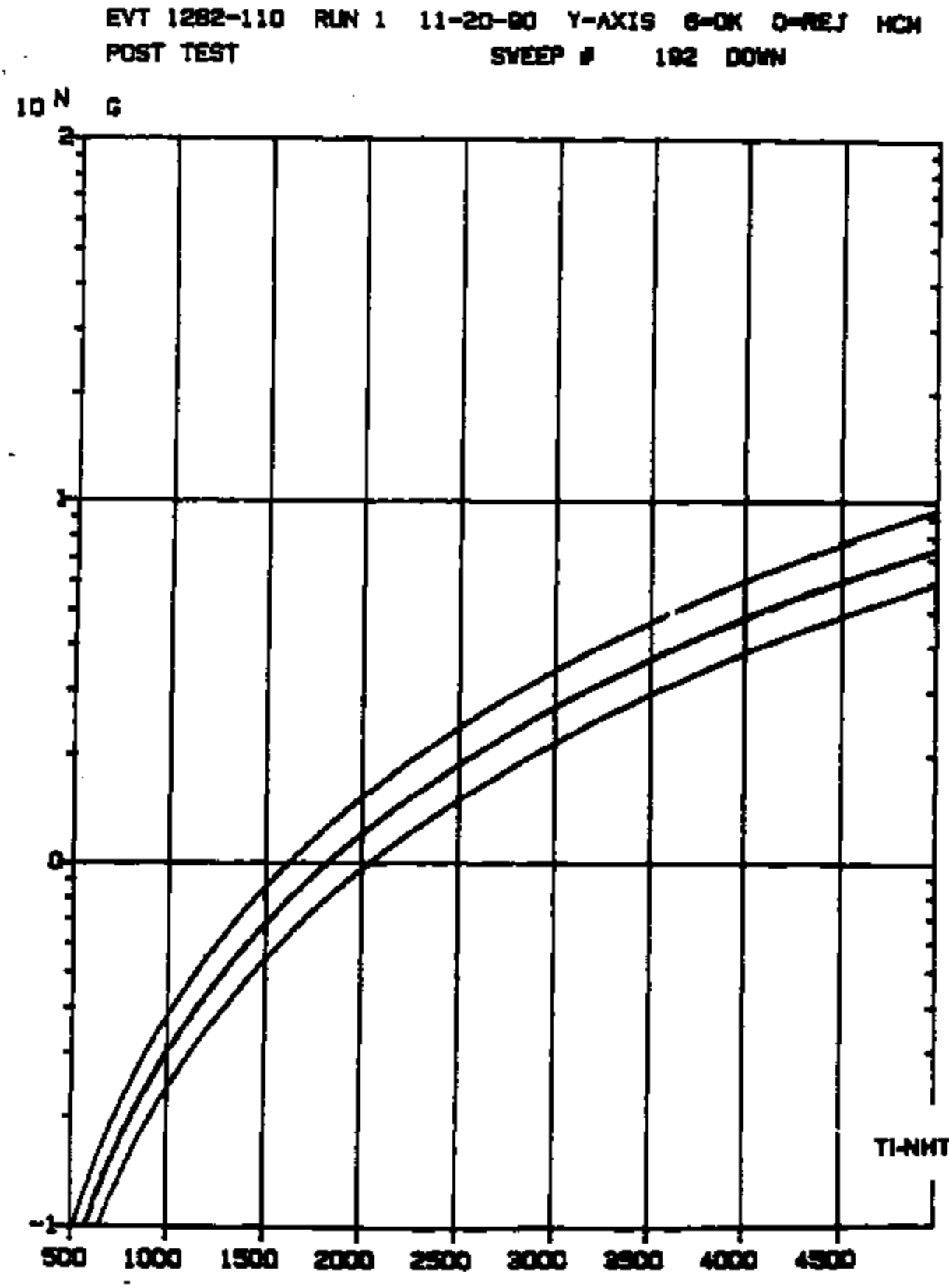
d. Vibrate the switch at 1.5 mm displacement (peak-to-peak) while varying the frequency uniformly from 5 to 30 to 5 Hz over a 5 minute period.

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

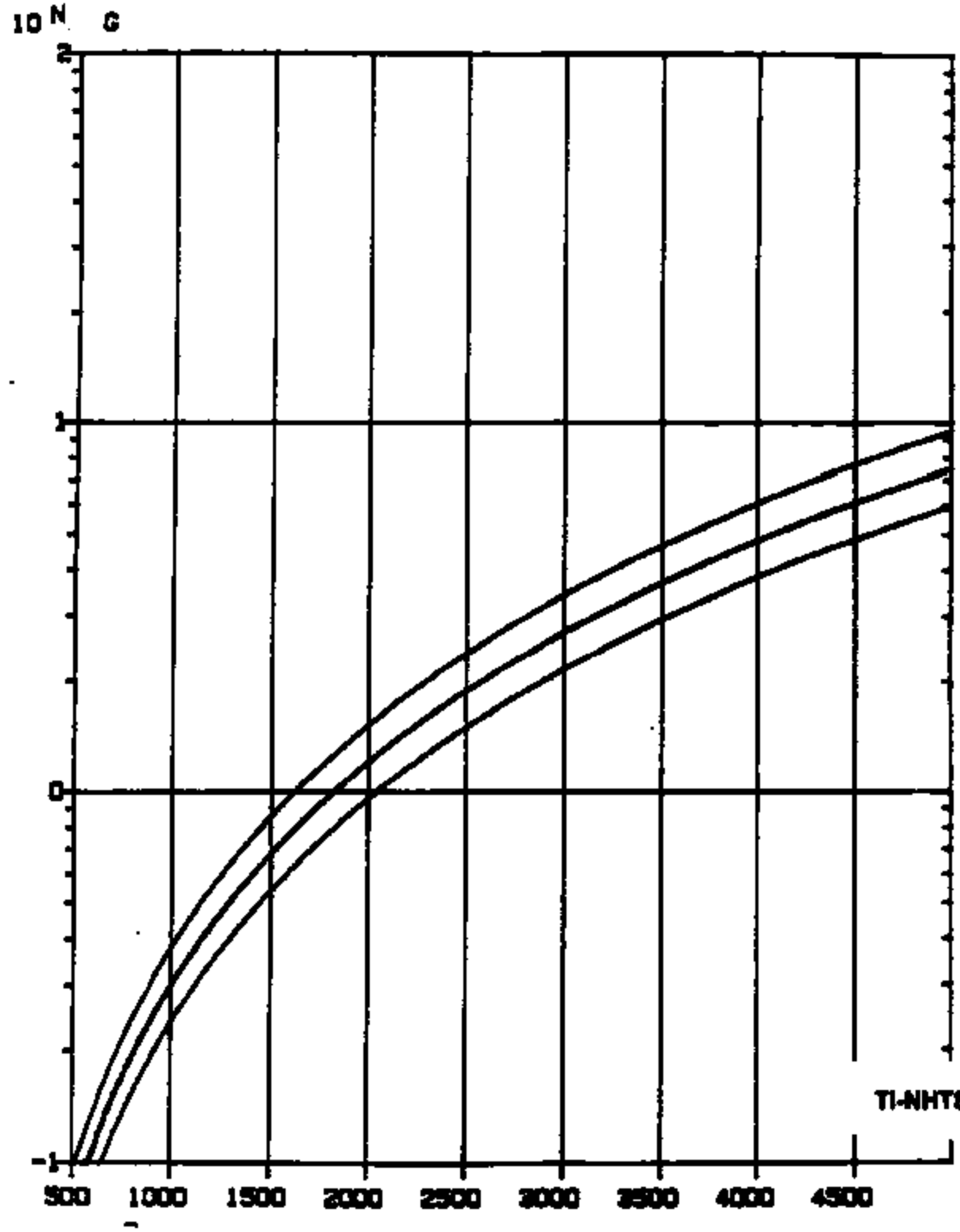
a. After the entire vibration sequence check the switches to sections A, B, C, or D using the procedure established in each section.

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.



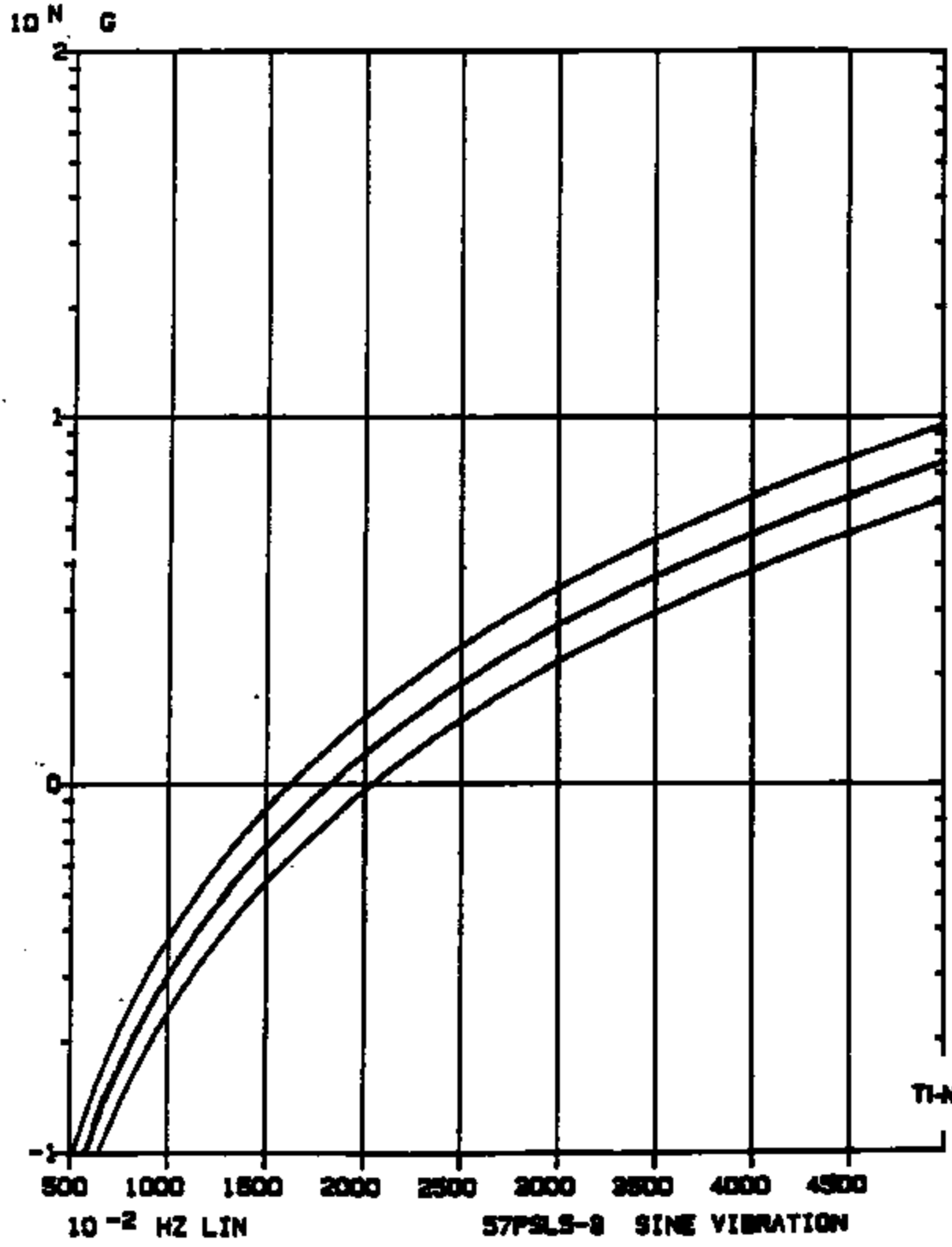
TI-NHTSA 001353

EVT 1282-110 RUN 2 11-20-80 Z-AXIS 8=OK 0=REJ GGO
POST TEST SWEEP # 192 DOWN



TI-NHTSA 001354

EVT 1282-110 RUN 9 11-26-80 X-AXIS 8-OK 0-REJ HCH
POST TEST SWEEP # 192 DOWN



TI-NHTSA 001356

Appendix 4.2.4
Thermal Cycle Day/Time/Temp

TI-NHTSA 001356

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

11/14/90

99/15-80

TEMP CYCLE

← HOT →

	DATE	TIME	FLUID	AMBIENT
1	11/14/90	1:45	40°C	45°C
2	"	3:35	40	41
3	11/15/90	9 40	40	41
4	11/15/90	10 25	41	44
5	11/15/90	12 35	1 40	42
6	"	2 40	+42	41
7	"	4:25	40	41
8	11/16/90	8:25	42	44
9	"	10:15	42	41
10	"	12:35	41	41
11	"	2:30	40	42
12	"	4:15	42	41
13	11/26/90	10:00	40	43
14	"	11:50	41	42
15	"	1:40	42	41
16	"	3:35	43	41
17	11/27/90	8:05	42	41
18	"	10:35	41	41
19	"	2:00	40	41
20	"	3:55	42	41
21	11/28/90	8:30	40	41
22	"	10:20	43	40
23	"	12:20	40	40
24	"	2:05	43	40
25	"	3:55	43	41

← COLD →

DATE	TIME	FLUID	AMBIENT
11/14/90	3:10	-40°C	-41°C
11/15/90	7:50	-43	-43
"	9 55	-40	-43
"	1 05	-42	-42
"	2 05	-41	-42
"	4:00	-40	-40
11/16	7:55	-41	-42
"	9:45	-40	-43
"	11:30	-42	-43
"	2 00	-41	-42
"	3:45	-41	-40
11/26/90	7:10	-41	-42
"	11:15	-40	-43
"	1:05	-40	-43
"	3:40	-42	-43
11/27/90	8:55	-42	-42
"	10 00	-40	-43
"	2:30	-43	-43
"	3:20	-40	-43
11/28/90	8:00	-43	-43
"	9 50	-41	-43
"	11:40	-40	-42
"	1:35	-40	-43
"	3:25	-40	-42
11/29/90	7:55	-43	-43

EFFICIENCY LINE • 22-205

Appendix 4.2.5
Humidity

≈25-30

Form 5519

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90 REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90 EXTENSION 3154 Lab 12-29

DEVICE 57PSL5-3

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

REFERENCE SPEC. NO. ES-FZVC-96924-AA

SOURCE OF TEST SAMPLES DESIGN LAB

QUANTITY OF TEST SAMPLES 6

REPORT NO. 1344-110

TESTED BY Lab

COMPLETION DATE 12-2-90

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN HUMIDITY TEST PER ATTACHED.

TEST PERFORMED:

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

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

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE.

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. Assurance 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. Assurance Requirements

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

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

Appendix 4.2.6
Salt Spray

<31-36

Form 6013

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90

REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90

EXTENSION 3144 MS 12-29

DEVICE 57PSLS-3

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

REPORT NO. 1345-118

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

TESTED BY Lab

SOURCE OF TEST SAMPLES DESIGN LAB

COMPLETION DATE 12-3-90

QUANTITY OF TEST SAMPLES 6

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN SALT SPRAY TEST PER ATTACHED.

TEST PERFORMED:

In: 0900 11-30-90

Out: 0900 12-3-90

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT CUS DATE:

III. TEST REQUIREMENTS AND CONFORMANCE (cont'd)

G. Humidity

1. Test Requirements

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

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

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

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

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

2. Acceptance Requirements

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

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

H. Salt Spray

1. Test Requirements

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

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

2. Acceptance Requirements

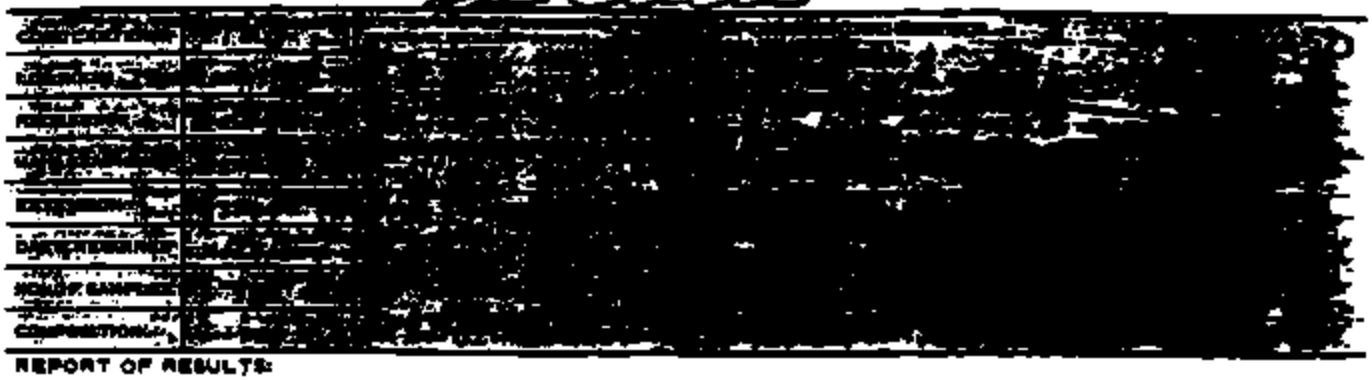
a. After exposure, check the switch to sections A, B, C, D, using the procedure established in each section.

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

Appendix 4.2.7
Fluid Resistance

FORM NO. 15000 1/90

TEST NO. 110077 TECHNICAL SERVICE LABS TEST NO. 110077



REPORT OF RESULTS:

complete

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

EMPLOYEE NO.									
JOB NO.									
NO. ANALYZED									
HOURS WORKED									

Appendix 4.3
TI QA5-296

TEST LOT NO.	TEST	REVIS...
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS — MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REC.
DATE 91-01-11		PAGE 42

TEXAS INSTRUMENTS INCORPORATED

QAS 296

FORD MOTOR COMPANY

TI P/N	CUSTOMER P/N	CUSTOMER
57PSL2-1	ES-E53C-3N824-AA	FORD-AUTO
57PSL2-2	ES-E57A-3N824-AA	FORD-TRUCK/KELSEY HAYES
57PSF3-3	ES-E79C-3N824-AA	FORD-SURFACES/PITTS
57PSL3-1	ES-E73C-3N824-AA	ANCHOR-SMAN
57PSF3-5	ES-E80C-2C283-CA	FORD-PITTS

TI-NHTSA 001367

DEPARTMENTS AFFECTED	PREPARED S. Ross	QUALITY ASSURANCE SPECIFICATIONS	Q.A.S. NO. 296	REVISIONS # DATE
	REV J. Snyder	TEXAS INSTRUMENTS INCORPORATED	DATE ISSUED 5/1/84	A 8/15/87
				B 9/12/89
			PG 1 OF 12	

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

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

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

1.0 SCOPE

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

2.0 DEFINITIONS

2.1 This specification is applicable to all production units.

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

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

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

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

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

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

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

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

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

3.0 FINAL INSPECTION TEST

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

3.1 Post Pressure Tester Inspection

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

A. Code - Legibility and correctness of code

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

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

D. Record results on "Inspection Log Sheet."

3.2 Packing

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

4.0 SPECIAL INSPECTIONS AND REQUIREMENTS

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

RANDOM SAMPLE - 18 PER PILOT LOT

CALIBRATION (4.1.1) - 18 DEVICES

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

4.1.1 Calibration/Creep/Voltage Drop (Automatic)

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

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

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

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

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

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

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

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

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

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

4.1.2 Current Leakage Test

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

A. Between the terminals with contacts open

B. Between each terminal and switch housing with contact open

C. Between either terminal and switch housing with contact closed

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

4.1.3 Impulse Test

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

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

4.1.4 Proof Test

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

NOTE: The test samples must be scrapped after testing.

4.1.5 Burst Test

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

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

4.1.6 Dimensional Checks

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

A. Gland Dimensions Dia. 312 ± .004"

B. Width .060-.080

C. Length 2.450 Max. (Go-gage)

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

E. Hex 0.562 ± 0.005"

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

G. Connector end dimensions (per print)

H. Terminal Location and Dimensions (Go gages)

I. Record results on Inspection Log.

4.1.7 Terminal Strength Test

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

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

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

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

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

4.1.8 Push Out Test

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

4.1.9 Vacuum Test

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

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

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

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

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

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

4.2 Inspection of Salvaged/Reworked Material

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

4.3 Records Retention

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

5.0 RELIABILITY

Reliability testing will be accomplished per the following schedule.

5.1

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

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

5.2 Test Procedures:

5.2.1 Humidity

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

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

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

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

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

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

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

*57PSF3-3 to be mounted horizontal

5.2.2 Salt Spray

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

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

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

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

5.2.3 Vibration

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

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

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

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

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

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

5.2.3.7 Nonconformance is defined as any evidence of leakage or any change in electrical continuity/discontinuity during the vibration cycles, or any switch not meeting the criteria in sections 4.0, para 4.1.1, 4.1.2 and 4.1.4. Samples used for this test must be destroyed after all testing is completed.

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

5.2.4 Vacuum

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

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

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

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

5.2.5 Temperature Cycle

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

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

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

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

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

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

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

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

6.0 AUDITING

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

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

6.3 Areas to be Audited

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

Appendix 4.4
SAE J512 OCT 80 Information

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

FORM 6296

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

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

FR: Steve Offiler SBO1

SJ: SAE J512 Update - Contact with SAE Committee members

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

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

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

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

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

Regards,
Steve O.

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

The proposed dimension changes for 'E' as shown, are: .233"-.237" (old) becomes .220" (5.59mm) - .230" (5.85mm) (new). The proposed dimension changes for 'K' as shown, are .040"-.050" (old) becomes .043" (1.10mm) - .055" (1.40mm) (new). Note on metric conversions, slight roundoff errors may be apparent. This is due to the fact that both decimal inch and metric dimensions are used simultaneously i.e. TI's customer prefers metric while the suppliers prefer decimal inch.

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

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

****

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

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

Thanks and regards.

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

Enclosures

TEXAS INSTRUMENTS

09 January 1991

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

Stan:

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

****

DRAWING 1

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

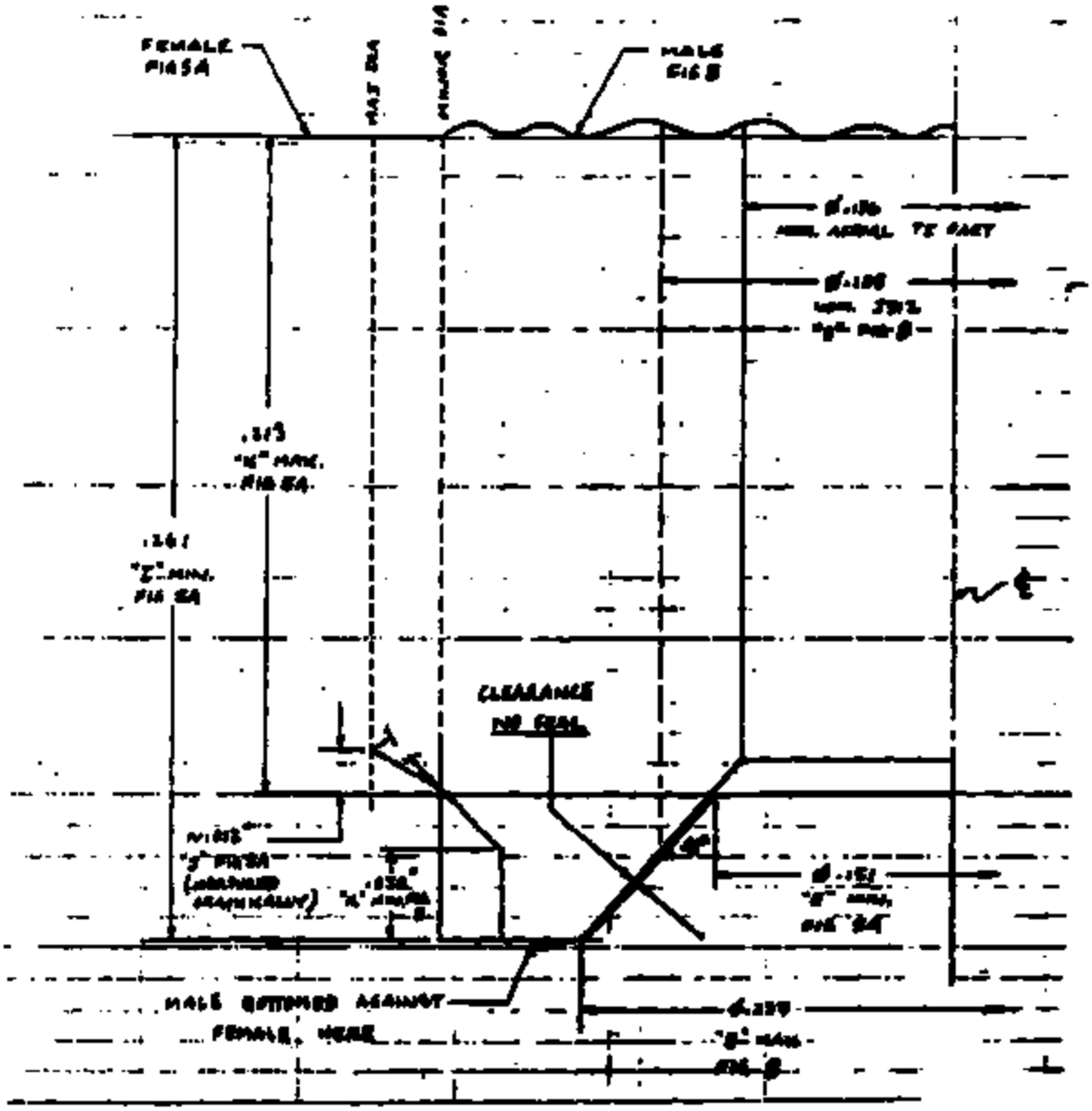
The female's cone seat is at its smallest, i.e. largest dimension "K", smallest dimension "I", smallest dimension "E" with most acute angle, 41°. The male plug's chamfer is at its largest, i.e. largest dimension "E" with most acute angle, 41°.

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

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

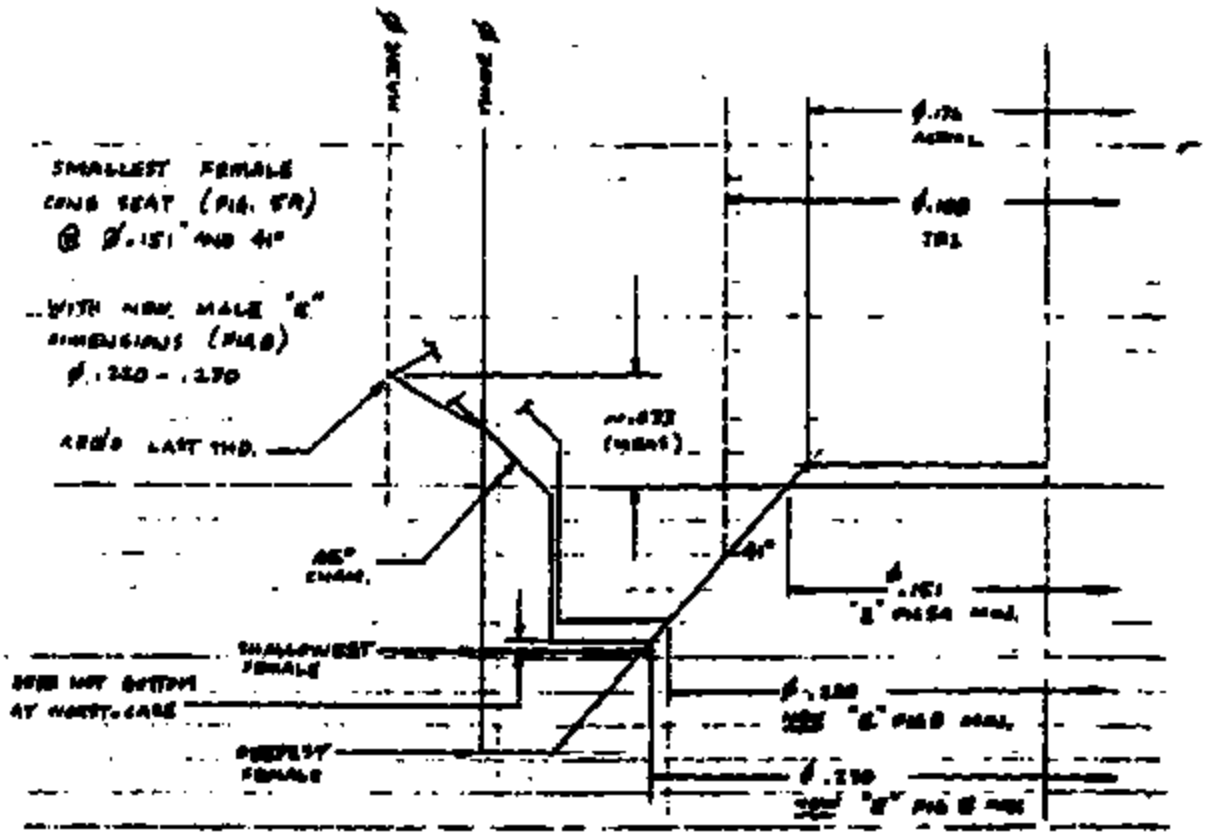
After requesting extensive quotes for producing the male part, from screw-machine houses, cold-headers, and major brake component manufacturers, TI has discovered that the J512 tolerance of .004"(total) on dimension "E" of Fig. 8 is unordinarily costly to produce. Thus, another factor to consider while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

DRAWING 1



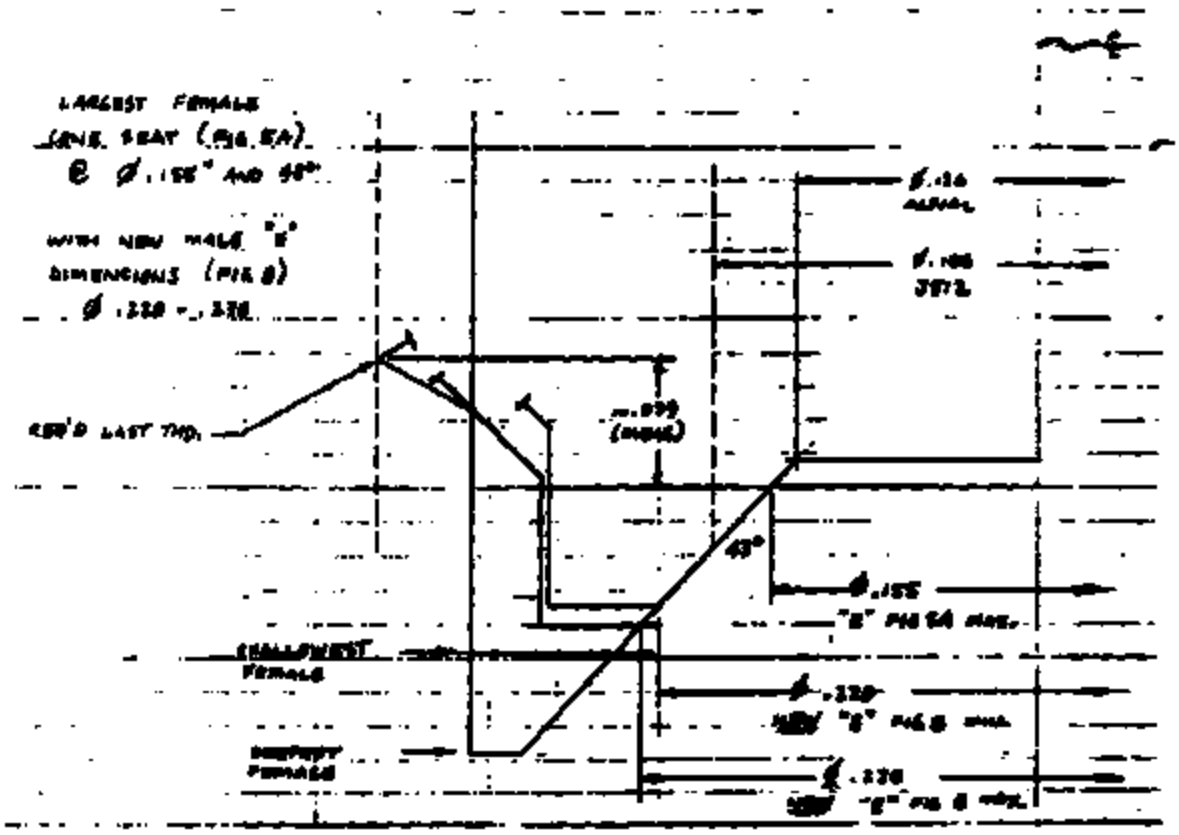
BY: STEVE OFFLOR
DT: 980827
SCALE: 20X

DRAWING 2



BY: STEVE OFFILER
DT: 900927
SCALE: 20X

DRAWING 3



BY: STEVE OPPILLIE

DT. 900927

SCALE: 20X

Appendix 4.5
Supplier Request for Engineering Approval

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 42

FORM 5206

Control Dept
M J Lack

Supplier Request for Engineering Approval

No. 14766

Date November 30, 19[illegible]

SUPPLIER TO COMPLETE

SUPPLIER NAME AND ADDRESS

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

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

SWITCH ASSY - SPEED CONTROL DEACTIVATE
(DELTA) F2VC - 9F924 - BA

CHANGE: ☒ DESIGN ☐ COMPOSITION ☐ PROCESSING DESCRIPTION

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

EFFECT OF CHANGE:

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

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

PRODUCT ENGINEERING TO COMPLETE

PCR IN PROCESS ☒ APPROVED ☐ REJECTED	BY R. F. Pease	DATE 9/13/11	DATE 9/13/11
BLANKET APPROVAL GRANTED FOR SUBSEQUENT CHANGES WHICH ARE SAME AS DESCRIBED ABOVE ☐ YES ☐ NO		SAMPLES OF CHANGED COMPONENT REQUIRED ☐ YES ☒ NO	

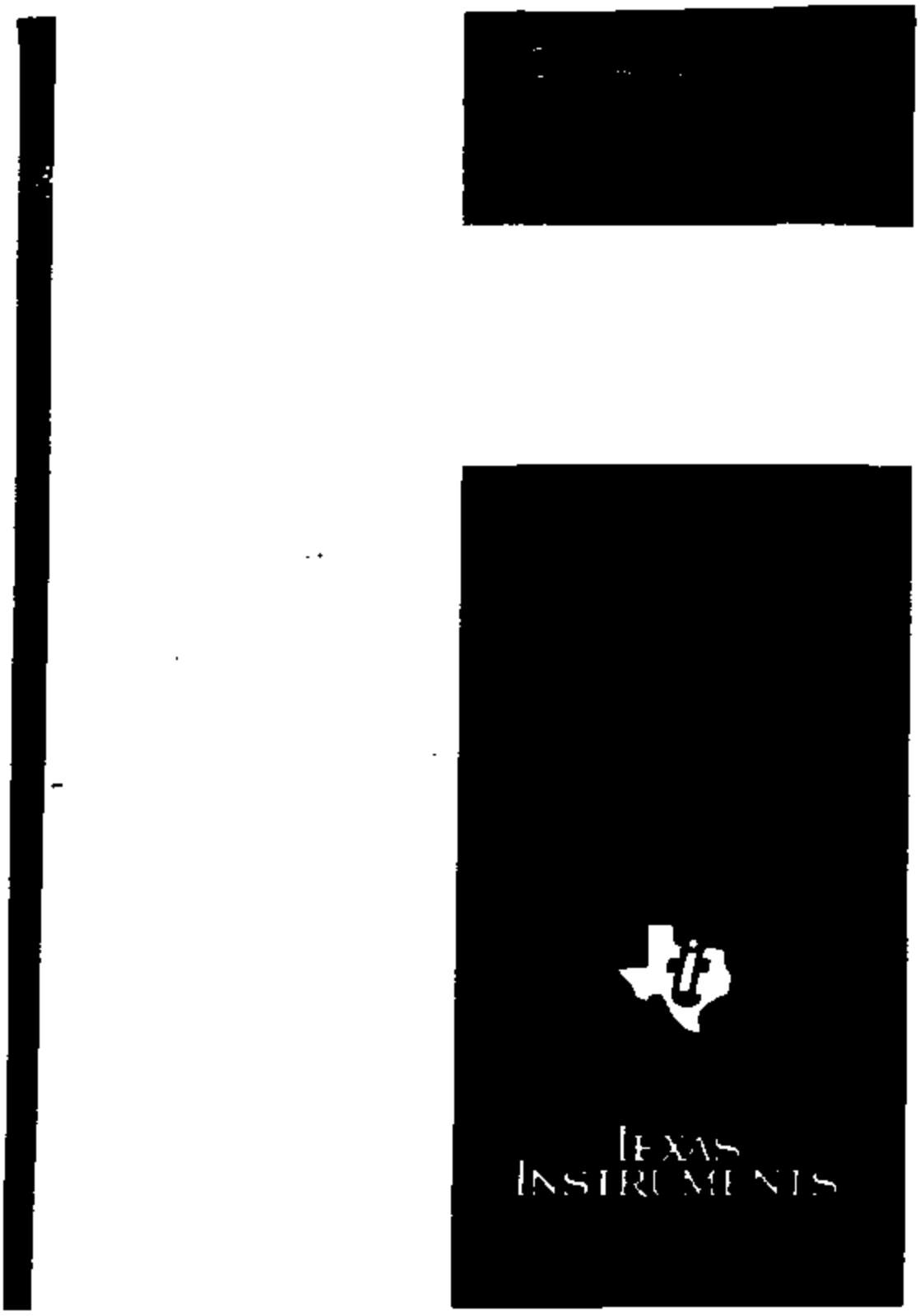
REASON FOR REJECTION OR QUALIFYING CONDITIONS OF ACCEPTANCE:

TI-NHTSA 001387

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

E-4 M 1638 (Previous editions may NOT be used)

SUPPLIER


TEXAS
INSTRUMENTS

FE/91/25

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

TEXAS INSTRUMENTS INCORPORATED
CONTROL PRODUCTS DIVISION
PRECISION CONTROLS DEPARTMENT
34 FOREST STREET MS12-25
ATTLEBORO, MA 02703

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TABLE OF CONTENTS

1.0 GENERAL

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

1.2 TI Part Number: 57PSL5-3

1.3 Customer Part Number: F2VC-9F924-BA

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

1.5 Applicable SREA(s): # 147660

1.6 Date of Completion: 90-12-13

1.7 Quantity of Units Tested: 72

1.8 Disposition of Tested Units:

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

1.8.2 Six devices were destroyed during Burst (test 3.5)

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

1.9 TI test series number: 99-15-80

2.0 TI Pressure Switch test report number: P5/91/25

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2.0 OBJECTIVE

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

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

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

3.0 TEST PROCEDURES AND RESULTS

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

A flow chart is included in the ES (frame 4 of 18), as follows: All test devices were subject to an initial characterization consisting of Calibration, Voltage Drop, Current Leakage, and Proof. Devices were then divided into groups per the flow chart and subject to the indicated tests in the indicated order. Finally, all tested devices were subject to a final characterization which was identical to the initial characterization.

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

3.1 CALIBRATION

3.1.1 Procedure: Calibration is checked at room temperature using ambient air as the pressure medium. Calibration settings, as specified on the part drawing, are actuation (electrical contacts opening) at 90 - 160 psig, and release (contacts reclosing) at 20 psig minimum. Actuation values are recorded on the sixth cycle, after subjecting the switch to two (2) pressure cycles to 850 psig minimum and back to zero, followed by three (3) cycles to 1.1 times actuation pressure minimum and back to zero. The change in continuity is measured while conducting 750 +/- 50 milliamps at 13.0 +/- 1.0 volts DC.

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

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

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

3.2 VOLTAGE DROP

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

3.2.2. Initial results: The average voltage drop was [illegible] millivolts, and the standard deviation was 2.6. All values are significantly below the specification of [illegible] millivolts maximum.

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

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3.3 CURRENT LEAKAGE

3.3.1 Equipment: Associated Research HyPot test unit used as power source for 500 VAC, 60 Hz test circuit. Fluke Model 8[illegible]B Digital Multimeter calibrated quarterly, used to measure voltage drop across a series resistance of one megohm (+ - 5%).

3.3.2 Initial results: Information could be obtained directly from inspection of the data without a need to calculate statistics. Measuring terminals to case with switch closed; measuring terminals to case with switch open; and measuring between the terminals; in no case did the leakage current exceed .99 microamps. All values are significantly below the specification of 100 microamps.

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

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

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3.4 PROOF

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

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

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

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

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3.5 BURST

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

3.5.2 Procedure: A pressure of 7000 psig was applied and held for 30 seconds minimum. Pressure was then increased slowly until failure. Failure is typically signalled by a sudden drop in test pressure of several hundred psi. The peak pressure attained as this occurs is defined as the bursting point.

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

3.5.4. Results: All six devices passed 30 seconds at 7000 psig without evidence of fluid leakage or drop in test pressure. Pressure was then increased until the failure point defined in 3.5.2, and a Weibull plot generated. See data section 4.2.2. Using the statistical acceptance criteria from the SS (frame 3 of 10), a minimum Weibull slope (beta) of 33.97 and a minimum Characteristic Life (theta) of 8829.6 psig was calculated at 90% confidence. The 0.72 reliability at 90% confidence is 8544.9 psi. Thus, the parts exceed the burst specification of 7000 psig by 1544.9 psi.

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3.6 VIBRATION

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

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

3.6.3 Results: All six switches met the acceptance criteria in the ES (frame 9 of 18; section III. 1. 2.).

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3.7 VACUUM

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

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

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

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3.8 TEMPERATURE CYCLE

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

3.8.2 Equipment: Thermotron model S-4 Mini-Max environmental chamber capable of -55 C to +200 C, humidity uncontrolled. Custom TI designed and built cycler, utilizing Enerpak integrated hydraulic pressure source, TI315 Programmable Logic Controller, Moog servovalve and controller, Simpson signal generator, and opposing-piston fluid isolators, to produce a hydraulic-fluid flow-type primary with a brake-fluid dead-end-type secondary terminated with a 24-station manifold equipped with internal heaters. Capability to 5 Hz at 0-1500 psig cycle. Custom TI designed and built 24 station Switch Monitor Circuit which automatically stops the cycler in the event of abnormal switch action, defined as continuity change which does not track the signal from the signal generator. Thermocouple readouts calibrated quarterly.

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

TEST LOT no.	TEST	DEVICE
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3.9 FLUID RESISTANCE

3.9.1 Devices tested: 99-15-01 thru 99-15-36.

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

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

3.9.3.1 Impulse, -01 thru -12

3.9.3.2 Terminal Strength, -13 thru -24.

3.9.3.3 Humidity, -25 thru -30.

3.9.3.4 Salt Spray, -31 thru -36.

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3.10 IMPULSE

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

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

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

3.10.4 Results/Discussion: All twenty-four devices passed the acceptance criteria found in the ES (frame 7 of 18; section III. E. 2.).

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

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3.11 TERMINAL STRENGTH

3.11.1 Devices tested: 99-15-13 thru 99-15-24.

3.11.2 Equipment: Custom TI designed and built fixtures for gaging terminal movement after force application and for application of impact via a pendulum. This equipment is regularly used on the 57PS assembly line in testing to TI Quality Assurance Specification 296 (see Appendix 4.3).

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

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TESTED BY		
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3.12 HUMIDITY

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

3.12.2 Equipment: Humidity chamber RK model 58.

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

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

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3.13 SALT SPRAY

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

3.13.2 Equipment: Harshaw salt spray chamber.

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

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

TEST LOT NO.	TEST	
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REQ.
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Ford **Engineering Specification**

PART NAME	PART NUMBER
SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE	▽ ES-F2FC-9F924-AA

LET																
FR																
LET																
FR																

DATE	LET	FR	REVISIONS	DR	CK

REFERENCE

PREPARED/APPROVED BY

CHECKED BY | DETAILED BY

CONCURRENCE/APPROVAL SIGNATURES

DESIGN ENGINEERING SUPERVIS

DESIGN ENGINEERING ASST

MANUFACTURING ENGRG

QUALITY CONTROL

PURCHASING

SUPPLIER QUALITY ASSURANCE

ELECTRONICS DIVISION

FRAME 1 OF 18 | REV | ▽ ES-F2FC-9F924-AA

SWITCH ASSEMBLY - SPEED CONTROL DEACTIVATE

I. General

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

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

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

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

II. PRODUCTION VALIDATION AND IN-PROCESS TESTS

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

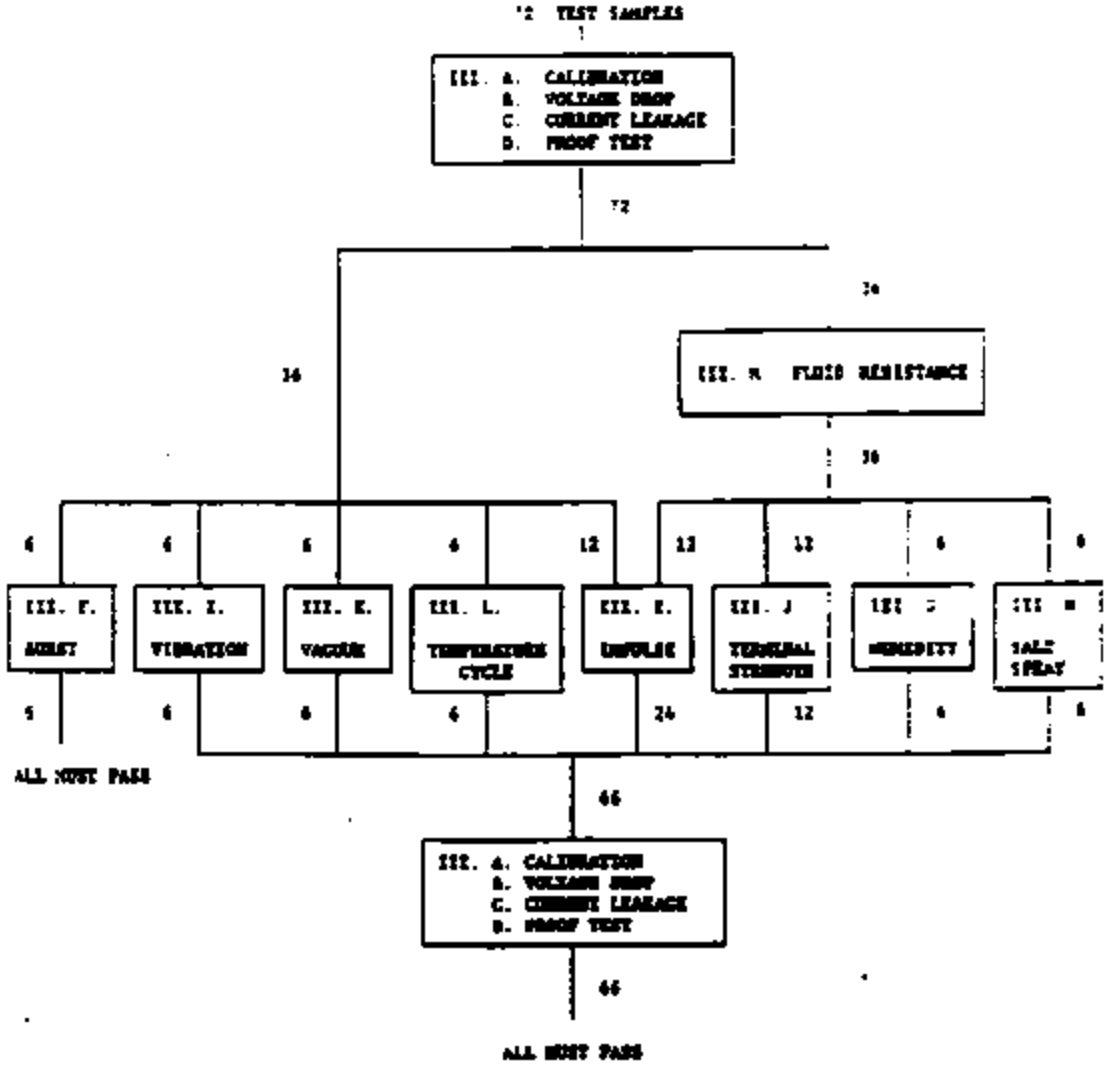
- In-Process Test Phase 1 (IP-1) - IP-1 tests are used to demonstrate process capability and must be completed using initial production parts from production tooling and processes prior to first production shipment approval. IP-1 tests are to continue in effect until process capability is demonstrated.

- In-Process Tests Phase 2 (IP-2) - IP-2 test program may be implemented only after process capability has been established. Tests must be completed with production parts on a continuing basis. Samples for these tests must be selected on a random basis to represent the entire production population as much as possible. In the event that any of the requirements in these tests is not met, the reaction plan specified in Ford Q101 Section III.E.3, "Q1 Test Performance Requirements" shall be invoked.

SECTION III. TABLE OF TESTS

Item	Test Name Functional Tests	PRODUCTION VALIDATION Minimum Sample Size	PRODUCTION VALIDATION Statistical Test Acceptance Criteria	IN-PROCESS IP-1 Minimum Sample Size	IN-PROCESS IP-1 Statistical Test Acceptance Criteria	IN-PROCESS IP-2 Minimum Sample Size	IN-PROCESS IP-2 Statistical Test Acceptance Criteria
III.							
▽ A	Calibration	22	P90-.96	100%	All Must Pass	100%	All Must Pass
B	Voltage Drop	22	P90-.96	12/Mo	P90-.84	4/Lot	" " "
C	Current Leakage	22	P90-.96	3/Mo	P90-.56	4/Lot	" " "
D	Proof Test	22	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							
I	Impulse	24	P90 .90	12/Mo	P90 .84	3/3 Mo	P90 .56
J	Humidity	6	P90 .72	3/Mo	P90 .56	6/6 Mo	P90 .72
M	Salt Spray	6	P90 .72	3/Mo	P90 .56	6/6 Mo	P90 .72

PRODUCTION VALIDATION FLOW CHART



4 18 FRAME OF	REVISED		[illegible] NUMBER

III. TEST PROCEDURES AND REQUIREMENTS

▽ A. Calibration

1. Test Requirements

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

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

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

2. Acceptance Requirements

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

B. Voltage Drop

1. Test Requirements

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

2. Acceptance Requirements

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

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

C. Current Leakage

1. Test Requirements

a. Current leakage is to be checked with 500 volts at 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.

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 . 50 ± 50 ma., per figure 4

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

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

d. Switch must open and close each cycle

2. Acceptance Requirements

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

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

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

F. Burst

1. Test Requirement

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

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

2. Acceptance Requirements

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

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

C. Humidity

1. Test Requirements

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

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

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

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

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

2. Acceptance Requirements

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

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

H. Salt Spray

1. Test Requirements

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

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

2. Acceptance Requirements

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

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

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

I. Vibration

1. Test Requirements

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

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

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

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

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

2. Acceptance Requirements

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

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

III. Test Sequences and Requirements (cont'd)

J. Terminal Strength

1. Test Requirements

a. Mount the switch in the test port.

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

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

2. Acceptance Requirements

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

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

K. Vacuum

1. Test Requirements

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

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

2. Acceptance Requirements

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

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

3 mm Hg = 0.058 psi = 0.400 kPa

6 mm Hg = 0.116 psi = 0.800 kPa

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

L. Temperature Cycle

1. Test Requirements

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

b. Repeat the following procedure 25 times

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

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

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

(4) Repeat Step 2.

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

2. Acceptance Requirements

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

M. Fluid Resistance

1. Test Requirements

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

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

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

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

Fluid	Drain Time	Storage Time
Reference Fuel C ASTM D471	60 ± 5 min	none
10W40 Engine Oil	24 ± 1 hour	14 days
Ethylene Glycol/ Water 50/50 by Volume	24 ± 1 hour	24 ± 1 hour
Brake Fluid DOT 3	24 ± 1 hour	48 ± 1 hour
Automatic Transmission/ Power Steering Fluid (same) 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. 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.

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.

PROPOSED 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,B,E,F,I,K,L
4. Fitting or Fluid Connection	III, D, E, F, H, I, K

B. Annual revalidation is not required on carryover switches.

VI. LOT DEFINITION

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

VII. RECORD RETENTION

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

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

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

VIII. INSTRUCTIONS AND NOTES

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

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

Test port configuration is shown in Figure 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 nonconformances of any shipped parts shall be reported immediately to the releasing Product Engineering Office.

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

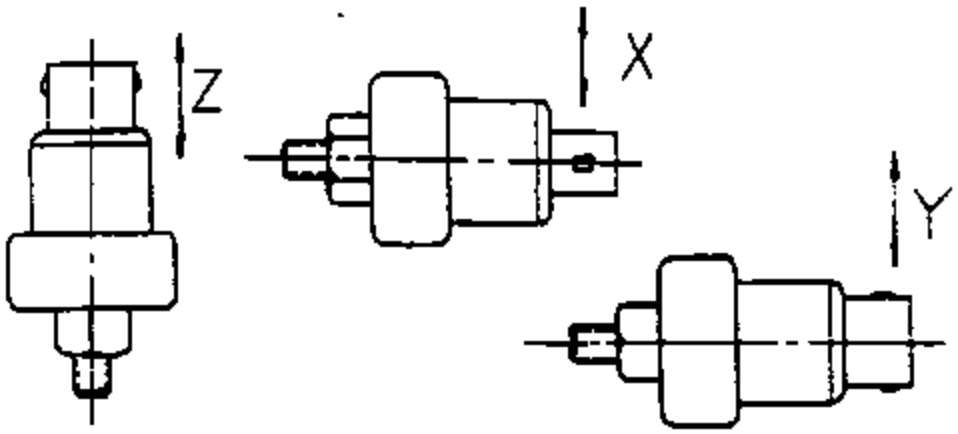
IX. COMPILATION OF REFERENCE DOCUMENTS

ASTM B-117, Salt Spray Testing

Ford Q-101, Quality System Standard 1991 Edition

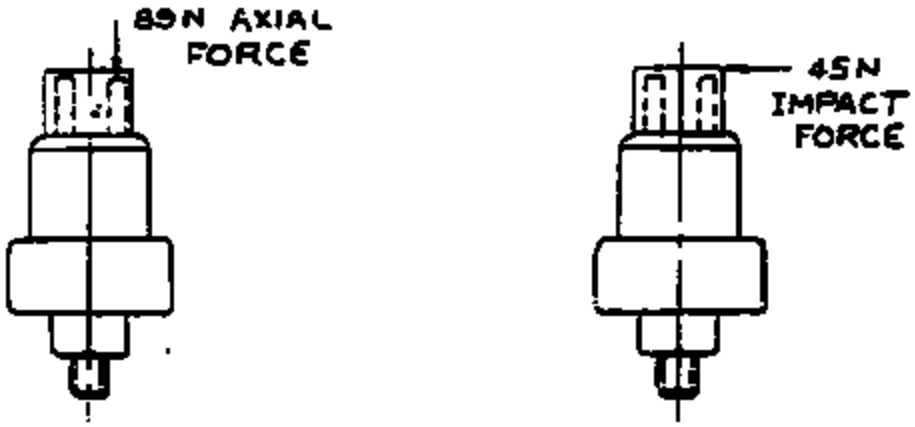
ES-F0EB-14A464-AA, Specification - SLV Assy - Wire Connector

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



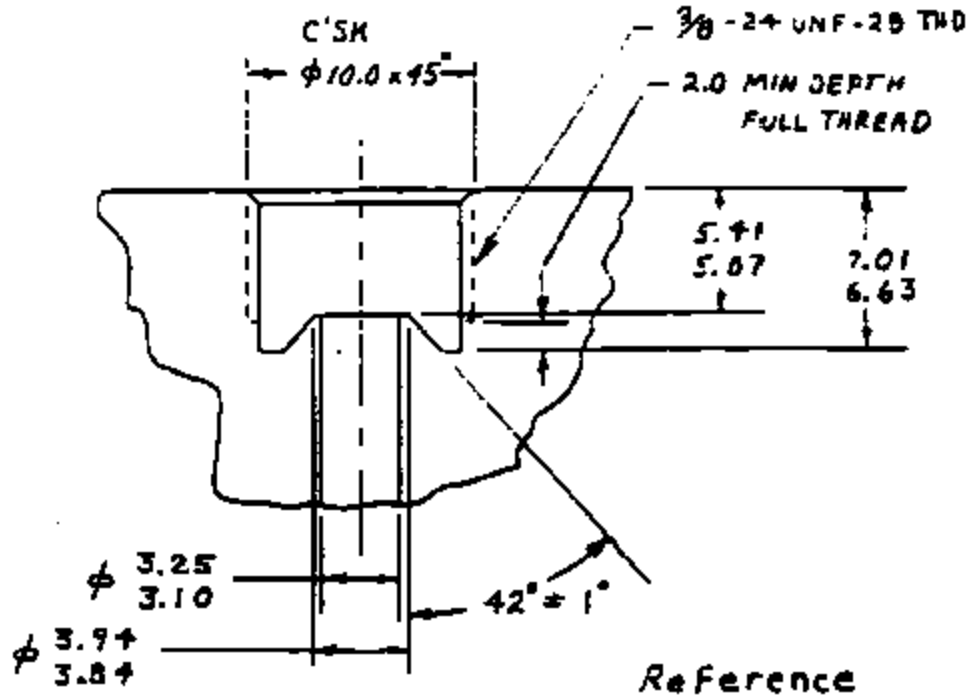
VIBRATION TEST - SWITCH ORIENTATION

FIGURE 1.



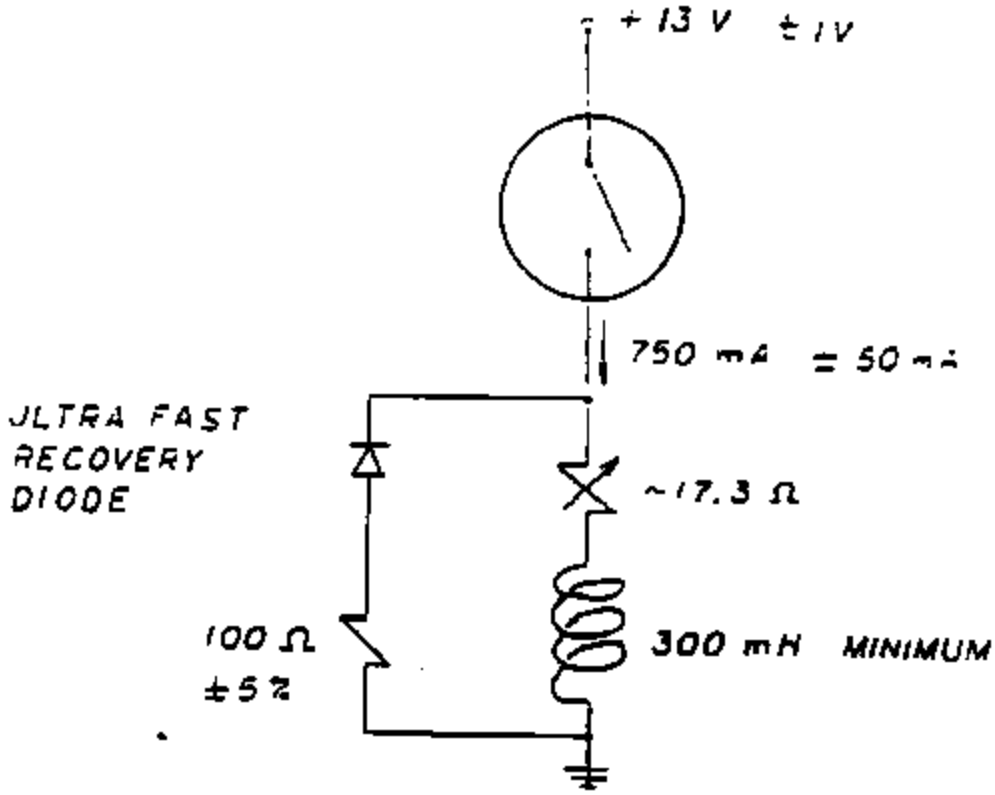
TERMINAL STRENGTH - LOAD ORIENTATION

FIGURE 2.



TEST FIXTURE PORT CONFIGURATION

FIGURE 3



DEACTIVATE SWITCH
TEST SET UP

FIGURE 4

Appendix 4.2.1
Initial and Final Characterization

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 34

PRESSURE SWITCH DATA Form 21605 TEST NO. 99-15-80

DEVICE	DATE REQUESTED	REQUESTED BY	REQUESTED COMP. DATE
EX3423	10-18-90	J OFFILER	
PERFORMED BY	DATE STARTED	DATE COMPLETED	APPROVED BY
R RUGGIERI	10-19-90	12-13-90	

PROJECT TITLE: FORD PASS-CAR REVALIDATION

CUSTOMER: FORD

PURPOSE OF TEST: PASS-CAR QUALIFICATION

PROCEDURE: SEE FORD ENGINEERING SPEC

	CHARACTERIZATION				HIPOT				
DEVICE NO	PRESS	AC-	REL	Δ/D	TO CASE (milliamps)	TO CASE (in MΩ)	BREAKDOWN VOLTAGE	TESTS	
99-R-01	PASS	121avg	30avg	12.30	1.778	1.295	1.317	PASSED	SEE NOTE
02		112	58	15.05	1.667	1.311	1.370	"	"
03		116	49	11.80	1.697	1.318	1.619	"	
04		128	55	13.48	1.728	1.315	1.395	"	
05		119	53	15.13	1.692	1.316	1.370		
06		118	51	13.87	1.761	1.300	1.403		
07		132	53	13.31	1.661	1.287	1.452	"	"
08		120	52	13.71	1.760	1.298	1.389		
09		129	52	13.39	1.685	1.318	1.439		
10		119	56	12.85	1.724	1.301	1.365	"	
11		117	48	12.59	1.709	1.302	1.452	"	
12		118	58	13.44	1.704	1.307	1.437	"	
13		106	45	13.60	1.665	1.308	1.316		SEE NOTE
14		119	52	14.83	1.723	1.303	1.380		
15		123	51	13.45	1.687	1.295	1.372		
16		115	50	13.52	1.685	1.318	1.408		
17		123	52	12.58	1.668	1.310	1.361		
18		118	53	11.91	1.702	1.309	1.379		
19		125	55	12.30	1.660	1.302	1.352		
20		122	51	13.61	1.659	1.302	1.351		
21		120	51	12.40	1.675	1.304	1.370		
22		113	53	13.24	1.708	1.298	1.387	"	
23		113	49	14.07	1.683	1.290	1.352	"	
24		119	55	13.86	1.694	1.306	1.387		
25		126	52	13.50	1.683	1.305	1.350	"	NUMBER
26		116	53	13.29	1.668	1.300	1.396	"	
27		119	52	13.30	1.685	1.290	1.372	"	

COVER

DEVICE No	PLANE	A.-	Rel	mVD	TO FACE BY SIDE	TO CASE BY SIDE	ATTACHED TO	TCS	
99-15-36	PASS	136	52	12.30	1.618	1.300			
29	"	115	50	12.56	1.624	1.303			
30	"	140	56	12.31	1.622	1.297			
31	"	118	52	12.57	1.646	1.300			
32	"	125	54	12.27	1.773	1.355			
33	"	127	50	11.86	1.706	1.318			
34	"	124	53	11.92	1.695	1.309			
35	"	121	52	12.55	1.669	1.317			
36	"	123	55	11.27	1.696	1.336		"	
37	"	102	43	12.28	1.814	1.424			
38	"	107	45	12.28	1.801	1.420			
39	"	105	46	12.47	1.818	1.406			
40	"	103	47	12.16	1.796	1.436			
41	"	103	40	12.76	1.866	1.414		"	
42	"	102	44	12.80	1.895	1.490		"	
43	"	118	51	12.01	1.764	1.352			
44	"	117	48	12.37	1.803	1.364			
45	"	116	50	12.29	1.824	1.431			
46	"	106	47	12.01	1.807	1.399			
47	"	110	51	12.09	1.804	1.420			
48	"	110	45	12.06	1.802	1.399			
49	"	102	40	12.80	1.868	1.472			
50	"	142	56	12.76	1.776	1.408			
51	"	140	57	12.03	1.814	1.418			
52	"	139	60	12.02	1.830	1.438			
53	"	139	59	12.01	1.815	1.421			
54	"	142	61	12.31	1.824	1.436			
55	"	125	53	12.10	1.800	1.420			
56	"	129	61	12.25	1.796	1.426			
57	"	131	60	12.24	1.818	1.428			
58	"	136	63	12.12	1.859	1.426			
59	"	140	67	12.17	1.811	1.432			
60	"	119	57	12.09	1.806	1.418			
61	"	136	64	12.12	1.770	1.429			
62	"	132	67	12.37	1.827	1.437			
63	"	134	63	12.12	1.817	1.428			
64	"	136	64	12.12	1.818	1.433			
65	"	139	63	12.10	1.812	1.427			
66	"	A-	65	12.18	1.869	1.434			
67	"	138	66	12.31	1.870	1.434			
68	"	135	62	12.15	1.867	1.436			
69	"	136	56	12.10	1.801	1.423			
70	"	135	61	12.25	1.830	1.433			
71	"	131	65	12.19	1.811	1.431			
72	"	132	62	12.43	1.832	1.426			
73	"							TSB ON PLATE	
74	"								
75	"								
76	"								
77	"								
78	"								
NOMINAL	"	133	63	12.46	1.822	1.408	1.891		

FINAL CHARACTERIZATION - HYDOT

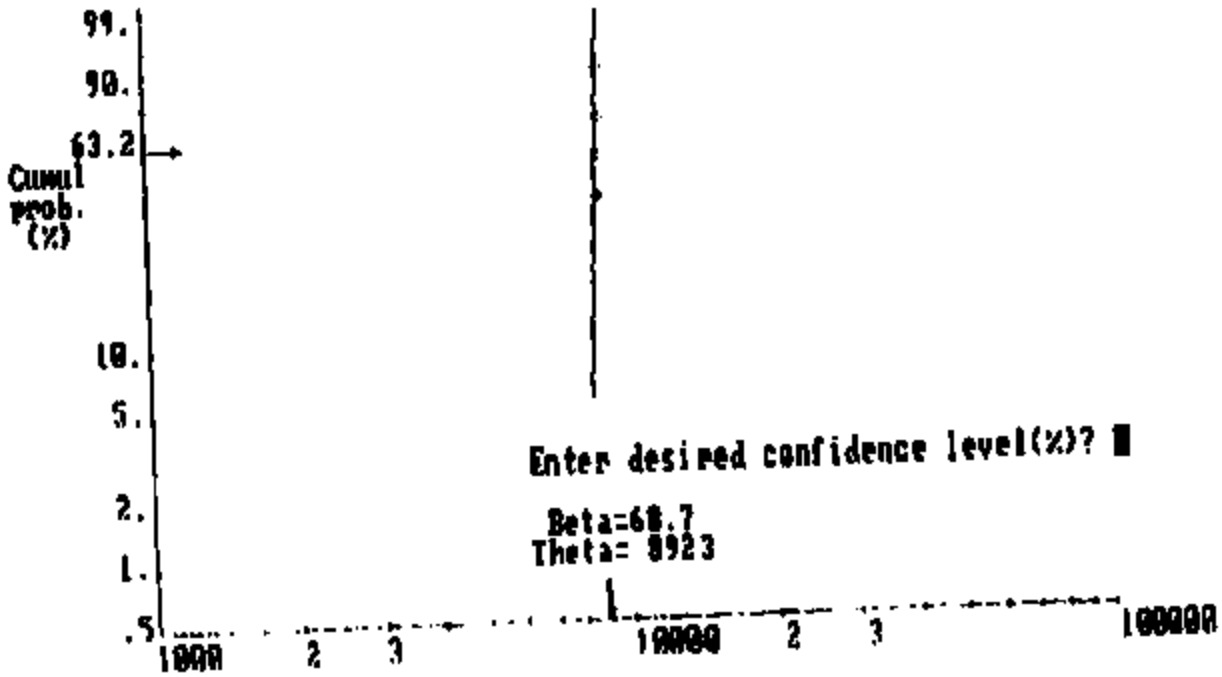
DEVICE NO	POST PROC	ACT	REL	MVD	TO CASE 3rd CLIP	TO CASE 3rd DUM	BETWEEN TEARS	T-S	S-T-S
99-15-01	PASS	113 ARM	62 ARM	9.36	1.926	1.798	4.180	RAILROAD	TOP OF SK
02	"	107	56	9.25	1.891	1.752	1.907	"	"
03	"	113	52	10.01	1.915	1.787	1.903	"	"
04	"	119	61	8.66	1.939	1.790	1.952	"	"
05	"	112	60	9.19	1.924	1.776	3.400	"	"
06	"	107	55	10.31	1.942	1.786	1.929	"	"
07	"	116	55	10.11	1.903	1.748	1.902	"	"
08	"	121	67	9.97	1.942	1.793	1.955	"	"
09	"	120	56	12.41	1.942	1.793	1.941	"	"
10	"	119	57	9.29	1.926	1.897	3.396	"	"
11	"	110	54	9.57	1.898	1.742	1.923	"	"
12	"	110	66	9.87	1.903	1.772	4.186	"	"
13	PASS	112	49	8.56	1.893	1.837	1.897	"	TOP OF SK
14	"	122	52	9.81	1.902	1.891	1.956	"	"
15	"	126	53	8.89	1.926	1.805	1.930	"	"
16	"	122	51	9.05	1.905	1.777	1.918	"	"
17	"	129	51	8.50	1.906	1.816	1.924	"	"
18	"	124	52	9.04	1.906	1.783	1.940	"	"
19	"	134	57	8.77	1.928	1.806	1.931	"	"
20	"	129	49	9.06	1.929	1.830	1.927	"	"
21	"	127	51	8.93	1.908	1.786	1.926	"	"
22	"	114	57	9.62	1.929	1.843	1.931	"	"
23	"	121	46	8.93	1.934	1.798	1.925	"	"
24	"	126	52	8.79	1.952	1.831	2.036	"	"
25	PASS	135	53	9.16	1.950	1.817	1.929	"	HEAD OF
26	"	127	54	8.77	2.030	1.877	1.931	"	"
27	"	133	58	10.27	1.976	1.824	1.915	"	"
28	"	135	57	9.55	1.957	1.809	1.918	"	"
29	"	134	48	9.30	1.937	1.806	1.909	"	"
30	"	131	59	9.14	1.960	1.809	1.943	"	"
31	PASS	126	53	9.07	4.300	4.160	4.280	"	SAT SPINE
32	"	127	55	8.84	1.949	1.815	1.932	"	"
33	"	135	51	9.14	4.210	4.156	4.340	"	"
34	"	131	52	9.09	1.854	1.765	1.918	"	"
35	"	126	52	9.63	1.926	1.835	1.940	"	"
36	"	128	55	9.89	4.350	4.260	4.300	"	"
37	—	—	—	—	—	—	—	BURST	
38	—	—	—	—	—	—	—	"	
39	—	—	—	—	—	—	—	"	
40	—	—	—	—	—	—	—	"	
41	—	—	—	—	—	—	—	"	
42	—	—	—	—	—	—	—	"	
43	PASS	114	47	9.76	1.953	1.796	1.915	VERTICAL	
44	"	113	43	8.55	1.924	1.795	1.926	"	
45	"	103	42	8.59	1.930	1.822	1.907	"	
46	"	102	46	9.27	1.892	1.808	1.908	"	
47	"	110	45	8.62	1.896	1.823	1.924	"	
48	"	117	49	9.48	1.935	1.821	1.937	"	
49	PASS	135	61	8.45	1.881	1.772	1.881	VERTICAL	
50	"	142	57	9.45	1.916	1.807	1.896	"	
51	"	143	57	8.43	1.918	1.816	1.902	"	
52	"	139	63	8.86	1.938	1.827	1.898	"	
53	"	134	54	8.77	1.929	1.823	1.898	"	
54	"	147	57	9.62	1.982	1.867	1.903	"	

FINAL CHARACTERIZATION - HYPOT (CONT).

DEVICE NO	POST PROOF	ACT	REL	mV	TO CASE SHORTED	TO CASE SHORTED	BETWEEN TERMS	TESTS	
55-55	PASS	119 AVG	54 AVG	9.13 AVG	1.957	1.919	1.972	TEMP	CYCLE
56	"	125	52	8.93	1.941	1.869	1.904	"	"
57	"	114	55	8.70	1.872	1.903	1.910	"	"
58	"	130	63	9.31	1.885	1.868	1.896	"	"
59	"	123	58	8.74	1.955	1.883	1.913	"	"
60	"	111	57	9.19	1.911	1.902	1.940	"	"
61	PASS	130	67	14.11	1.913	1.900	1.929	FAILURE	
62	"	133	66	11.42	1.958	1.903	1.924	"	"
63	"	133	69	12.93	1.878	1.936	1.925	"	"
64	"	126	64	10.25	1.933	1.912	1.947	"	"
65	"	134	70	20.79	1.939	1.903	1.909	"	"
66	"	120	61	15.10	1.870	1.921	1.937	"	"
67	"	132	61	10.26	1.885	1.917	1.939	"	"
68	"	133	67	11.91	1.900	1.911	1.909	"	"
69	"	131	63	14.50	1.903	1.906	1.911	"	"
70	"	137	64	19.01	1.951	1.878	1.935	"	"
71	"	121	56	12.76	1.942	1.917	1.946	"	"
72	"	128	63	19.01	1.893	1.915	1.937	"	"

Appendix 4.2.2
Burst test Weibull

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



ESTIMATE AND TWO SIDED 90 % CONFIDENCE
INTERVALS FOR DISTRIBUTION PARAMETERS

SHAPE(BETA) PARAMETER	:	68.720 (MEDIAN)
LOWER LIMIT	:	33.970 (LOW ESTIMATE @ 90%)
UPPER LIMIT	:	[illegible]
SCALE(THETA) PARAMETER:		8923.360 (MEDIAN)
LOWER LIMIT	:	8829.575 (LOW ESTIMATE @ 90%)
UPPER LIMIT	:	9018.143

ALTERNATE LOW EXTREMES OF β AND θ @ 90% CONFIDENCE

TIME VALUES FOR SPECIFIED LEVELS OF RELIABILITY

* WEIBULL SLOPE :33.97
* CHARACTERISTIC LIFE : 8829.58

NO.	RELIABILITY(%)	TIME
1	72	8544.9170

Appendix 4.2.3
Vibration

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 11-11-11		PAGE 41

Form 9214

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/02/90

REQUESTED BY RON RIGGERI

REQUIRED COMPLETION DATE 11/09/90

EXTENSION 3140 MS 12-29

DEVICE 572545-3

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

REPORT NO 1282-110

REFERENCE SPEC. NO. 85-F2VC-9F924-AA

TESTED BY Lab

SOURCE OF TEST SAMPLES DESIGN LAB

COMPLETION DATE 11-26-90

QUANTITY OF TEST SAMPLES 6

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

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

TEST PERFORMED:

Per above.

TEST RESULTS:

See attached

EQUIPMENT USED: **CALIBRATION DATE:** **NEXT DUE DATE**

III. TEST PROCEDURES AND REQUIREMENTS (cont'd)

1. Vibration

1. Test Requirements

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

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

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

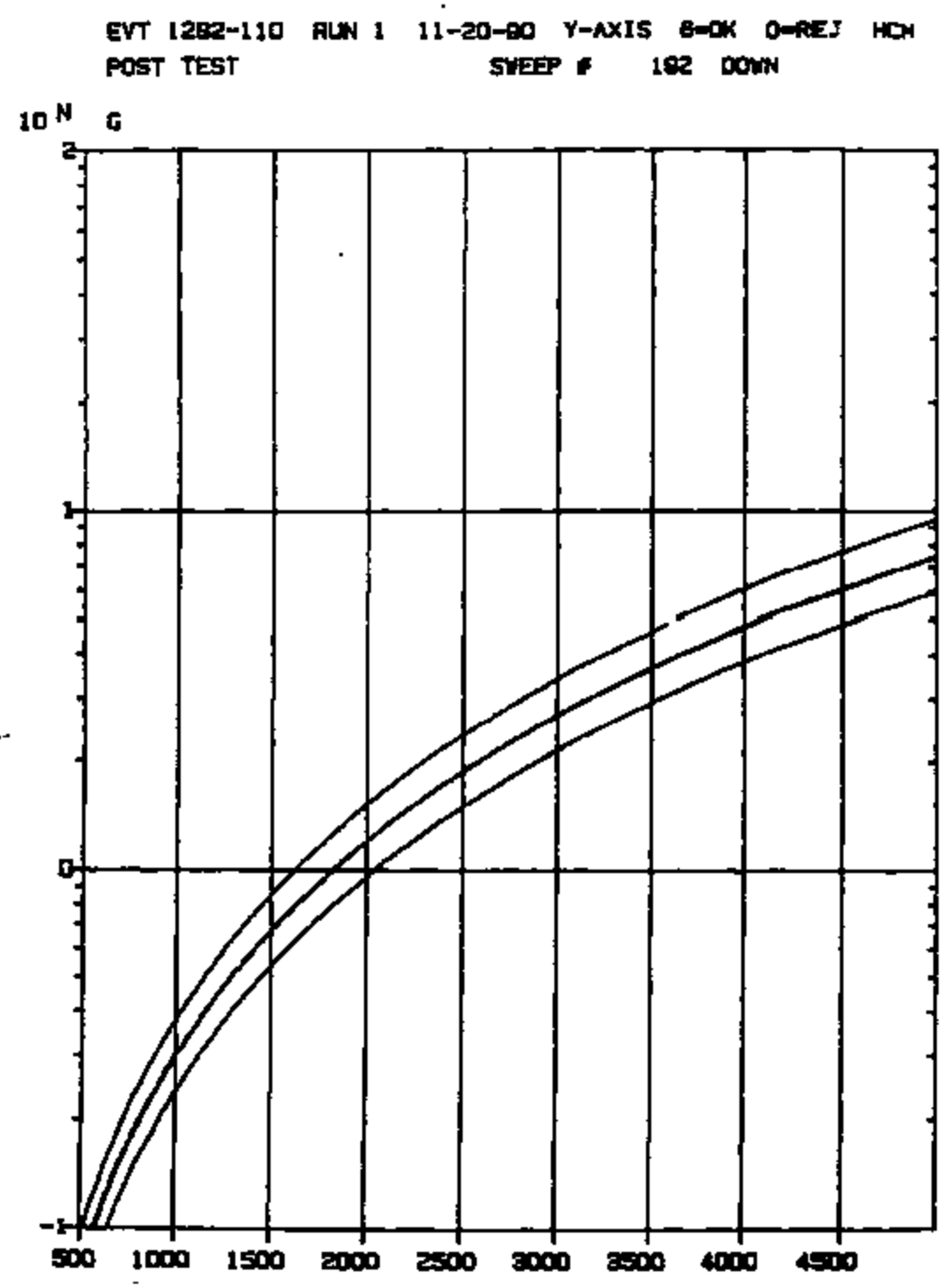
d. Vibrate the switch at 1.5 mm displacement (peak-to-peak) while varying the frequency uniformly from 5 to 50 to 5 Hz over a 5 minute period.

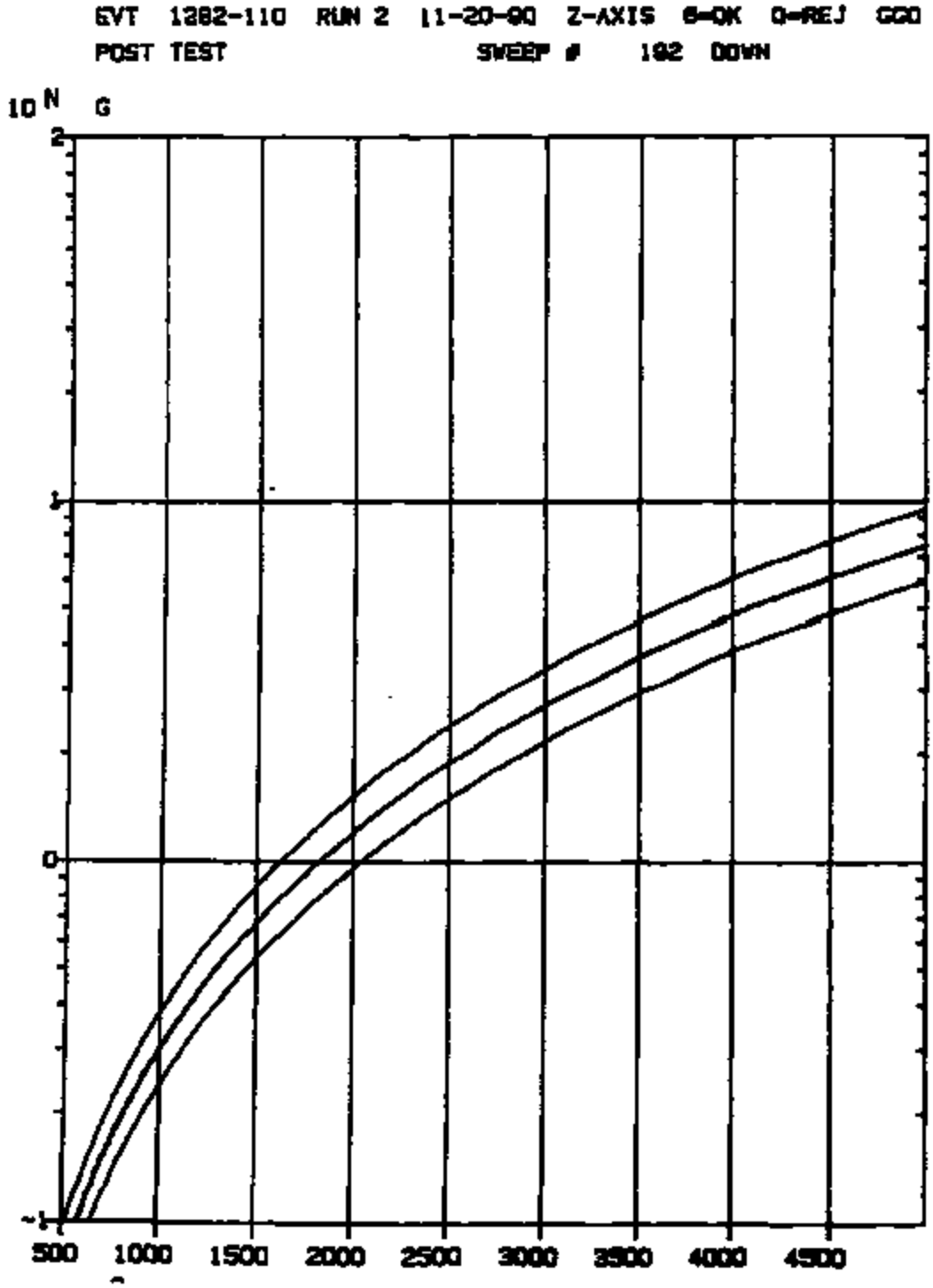
e. Vibrate the switch in alternate one-hour periods in the open and closed positions for a total of 8 hours in each plane. (Total test time is 24 hours).

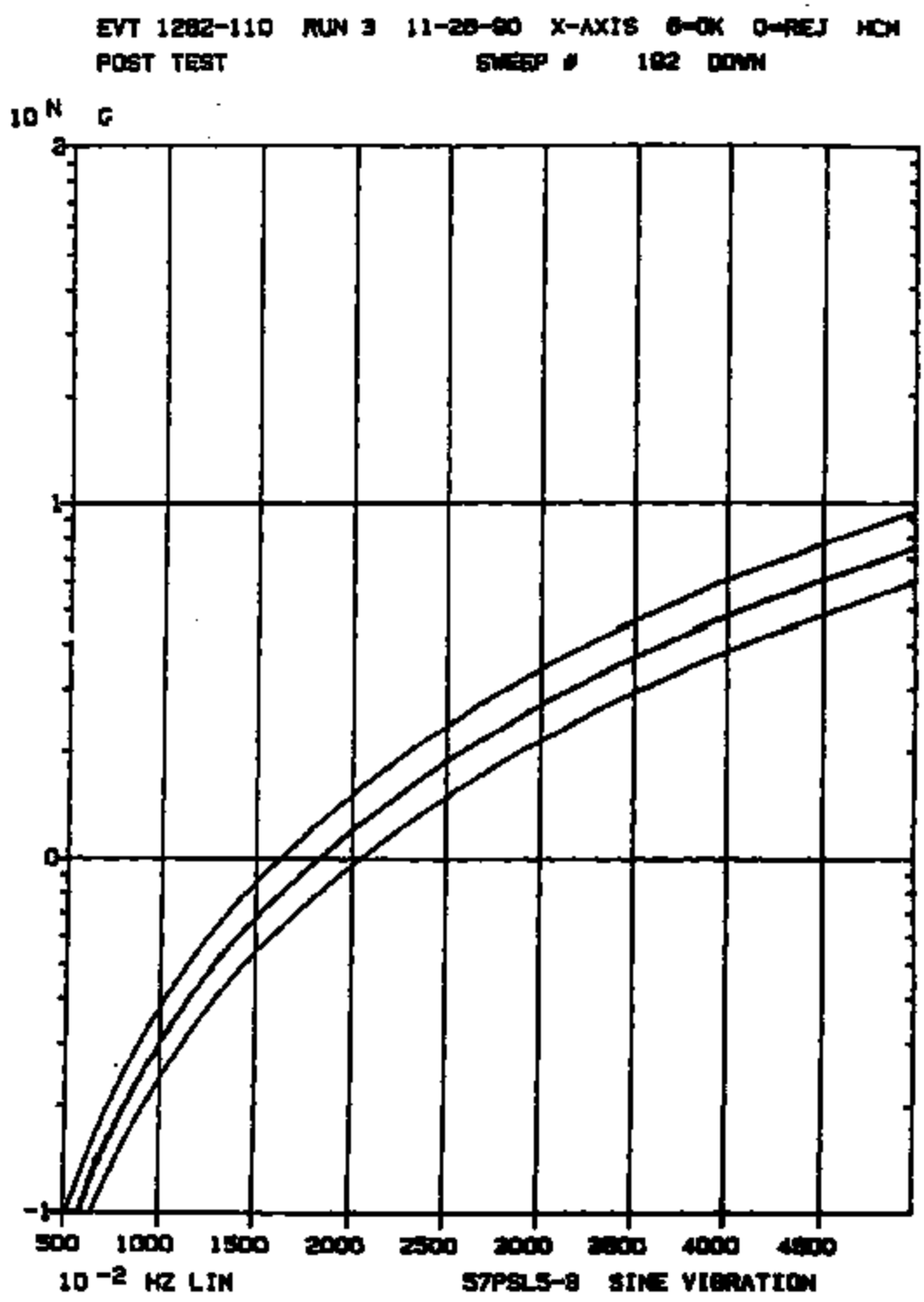
2. Acceptance Requirements

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

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


EVT 1282-110 RUN 1 11-20-80 Y-AXIS 6=OK 0=REJ HCN
POST TEST SWEEP # 192 DOWN
10 N G
2
1
0
-1
500
1000
1500
2000
2500
3000
3500
4000
4500


EVT 1282-110 RUN 2 11-20-90 Z-AXIS 6=OK 0=REJ GOO
POST TEST SWEEP # 192 DOWN
10 N G
2
1
0
-1
500
1000
1500
2000
2500
3000
3500
4000
4500


EVT 1282-110 RUN 3 11-28-90 X-AXIS 0=OK 0=REJ HCH
POST TEST SWEEP # 192 DOWN
10 N G
2
1
0
-1
500 1000 1500 2000 2500 3000 3500 4000 4500
10 -2 HZ LIN
S7PSLS-8 SINE VIBRATION

Appendix 4.2.4
Thermal Cycle Day/Time/Temp

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

11/14/00

99/15-80

TEMP CYCLE

← HOT →

	DATE	TIME	°FLUID	AMBIENT
1	11/14/00	1:45	40°C	45°C
2	"	3:35	40	41
3	11/15/00	9:40	40	41
4	11/15/00	10:25	41	44
5	11/15/00	11:35	1:45	42
6	"	2:40	42	41
7	"	4:25	40	41
8	11/16/00	8:25	42	44
9	"	10:15	42	41
10	"	11:35	41	41
11	"	2:20	40	42
12	"	4:15	40	41
13	11/24/00	10:00	40	43
14	"	11:50	41	42
15	"	1:40	42	41
16	"	3:35	43	41
17	11/27/00	8:45	42	41
18	"	10:35	41	41
19	"	2:00	40	41
20	"	3:55	42	41
21	11/28/00	8:30	40	41
22	"	10:20	43	40
23	"	12:20	40	40
24	"	2:05	43	40
25	"	3:55	43	41

← COLD →

	DATE	TIME	°FLUID	AMBIENT
1	11/14/00	3:10	-40°C	-41°C
2	11/15/00	7:50	-43	-43
3	"	9:55	-40	-43
4	"	11:45	-41	-42
5	"	2:06	-41	-42
6	"	4:00	-42	-42
7	11/16	7:55	-41	-42
8	"	9:45	-40	-43
9	"	11:30	-40	-43
10	"	2:00	-41	-42
11	"	3:45	-41	-42
12	11/16/00	7:10	-41	-42
13	"	11:15	-40	-43
14	"	1:05	-40	-43
15	"	3:00	-42	-43
16	11/17/00	7:55	-41	-42
17	"	10:40	-40	-43
18	"	2:30	-43	-43
19	"	3:30	-40	-43
20	11/20/00	8:00	-43	-43
21	"	9:50	-41	-43
22	"	11:40	-40	-42
23	"	1:35	-40	-43
24	"	3:25	-40	-42
25	11/20/00	7:55	-43	-43

EFFICIENCY LABS • 23-305

Appendix 4.2.5
Humidity

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	SPEC.
DATE 91-01-11		PAGE 34

Form 6416

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90 REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90 EXTENSION 3184 DATE 12-29

DEVICE 57P515-3

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

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

SOURCE OF TEST SAMPLES DESIGN LAB

QUANTITY OF TEST SAMPLES 6

REPORT NO. 1344-110 ✓

TESTED BY Lab

COMPLETION DATE 12-2-90

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN HUMIDITY TEST PER ATTACHED.

TEST PERFORMED:

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

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

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE

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 80-98% relative humidity.

2. Acceptance Requirements

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

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

~~D. Salt Spray~~

~~1. Test Requirements~~

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

~~b. Expose the switch assembly to 72 hours of salt spray per MTSK S-117.~~

~~2. Acceptance Requirements~~

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

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

Appendix 4.2.6
Salt Spray

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REC.
DATE 91-01-11		PAGE 17

<31-26

Form 9514

ENVIRONMENTAL TEST LAB REQUEST FORM

(ONE TEST PER REQUEST)

ENGINEERING

DATE 11/29/90

REQUESTED BY RON RUGGIERI

REQUIRED COMPLETION DATE 12/06/90

EXTENSION 484 DATE 12-29

DEVICE 57PSLS-3

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

REPORT NO. 1345-118

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

TESTED BY Lab

SOURCE OF TEST SAMPLES DESIGN LAB

COMPLETION DATE 12-3-90

QUANTITY OF TEST SAMPLES 6

TEST REQUIREMENTS: (TO BE FILLED IN BY REQUESTOR)

PLEASE RUN SALT SPRAY TEST PER ATTACHED.

TEST PERFORMED:

In: 0900 11-30-90

Out: 0900 12-3-90

TEST RESULTS:

EQUIPMENT USED: CALIBRATION DATE: NEXT DUE DATE:

III. TEST PROCEDURE AND REQUIREMENTS (cont'd)

G. Humidity

1. Test Requirements

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

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

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

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

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

2. Acceptance Requirements

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

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

H. Salt Spray

1. Test Requirements

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

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

2. Acceptance Requirements

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

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

Appendix 4.2.7
Fluid Resistance

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DOC.
DATE 91-01-11		PAGE 45

FORM NO. 4000B 1/80

TEST NO. 110077 TECHNICAL SERVICE LABS TEST NO. 110077

[redacted]

REPORT OF RESULTS:

complete

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

EMPLOYEE NO.									
JOB NO.									
NO. ANALYZED									
HOURS WORKED									

Appendix 4.3
TI QAS-296

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	DSO.
DATE 91-01-11		PAGE 42

TEXAS INSTRUMENTS INCORPORATED

QAS 296

FORD MOTOR COMPANY

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

		QUALITY ASSURANCE SPECIFICATIONS	Q.A.S. NO. 296	REVISIONS #	DATE
		TEXAS INSTRUMENTS INCORPORATED	5/1/84	A	8/15/8
			Sh 1 of 12	B	9/12/8
SUBJECT: Doc 1, Disc 5, QAS 296, Rev. B, Ford-57 Pressure Switch					

LTR	DESCRIPTION	DATE	APPROVAL
	First Issue	5/1/84	M.Gerfin
A	Typed to disc 5, and reviewed by QC engineer deleted SEC 5(in-process) added SEC 6(auditing) reliability becomes SEC 5	8/15/87	M. Gerfin
B	Cover Sheet - Add name, change part number 2.10 Delete 2.11 Change to 2.10 3.0 Delete inspection log sentence 3.2 Add sentence 4.1.1 Change sample sizes: delete (a) (b) 4.1.1.C Revise sentence 4.1.4 Change to 4.1.5. reword sentence 4.1.5 Change to 4.1.4. reword sentence: delete upon comp. - etc. to 4.1.1 5.2.5.4 Change P/N: Act.: cycle counts: delete (A) 8.- Delete section entirely	9/12/89	J. Haynes

1.0 SCOPE

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

2.0 DEFINITIONS

2.1 This specification is applicable to all production units.

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

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

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

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

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

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

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

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

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

3.0 FINAL INSPECTION TEST

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

3.1 Post Pressure Tester Inspection

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

A. Code - Legibility and correctness of code

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

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

D. Record results on "Inspection Log Sheet."

3.2 Packing

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

4.0 SPECIAL INSPECTIONS AND REQUIREMENTS

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

RANDOM SAMPLE - 18 PER PILOT LOT

CALIBRATION (4.1.1) - 18 DEVICES

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

4.1.1 Calibration/Creep/Voltage Drop (Automatic)

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

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

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

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

E. The disc snap function must occur within 10 milliseconds of the contact continuity to pass the creep function.

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

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

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

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

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

4.1.2 Current Leakage Test

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

A. Between the terminals with contacts open

B. Between each terminal and switch housing with contact open

C. Between either terminal and switch housing with contact closed

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

4.1.3 Impulse Test

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

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

4.1.4 Proof Test

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

NOTE: The test samples must be scrapped after testing.

4.1.5 Burst Test

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

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

4.1.6 Dimensional Checks

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

A. Gland Dimensions Dia. .312 ± .004"

B. Width .060~.080

C. Length 2.450 Max. (Go-gage)

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

E. Hex 0.562 ± 0.005"

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

G. Connector end dimensions (per print)

H. Terminal Location and Dimensions (Go gages)

I. Record results on Inspection Log.

4.1.7 Terminal Strength Test

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

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

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

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

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

4.1.8 Push Out Test

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

4.1.9 Vacuum Test

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

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

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

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

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

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

4.2 Inspection of Salvaged/Reworked Material

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

4.3 Records Retention

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

5.0 RELIABILITY

Reliability testing will be accomplished per the following schedule.

5.1

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

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

5.2 Test Procedures:

5.2.1 Humidity

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

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

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

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

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

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

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

*57PSF3-3 to be mounted horizontal

5.2.2 Salt Spray

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

5.2.2.2 Expose the switch assembly to 96 hours of salt spray per ASTM-B 117.

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

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

5.2.3 Vibration

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

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

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

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

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

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

5.2.3.7 Nonconformance is defined as any evidence of leakage or any change in electrical continuity/discontinuity during the vibration cycles, or any switch not meeting the criteria in sections 4.0, para 4.1.1, 4.1.2 and 4.1.4. Samples used for this test must be destroyed after all testing is completed.

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

5.2.4 Vacuum

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

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

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

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

5.2.5 Temperature Cycle

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

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

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

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

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

PN	Actuation	Release	Differential	Cycles
S7PSF 3-3	400 + or - 50			500,000
S7PSF 3-5	375 + or - 25			500,000
S7PSL 2-1	450 + or - 50	200 Min	150 Min	225,000
S7PSL 2-2	350 + or - 50	120 Min	50 Min	225,000
S7PSL 3-1	450 + or - 50	200 Min	150 Min	225,000

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

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

6.0 AUDITING

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

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

6.3 Areas to be Audited

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

Appendix 4.4
SAE J512 OCT 80 Information

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	REV.
DATE 91-01-11		PAGE 75

FORM 2206

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

TO: Vinnay Barros VIHN
Dave Czarn ZARN
Mike DeMattia PCQA
Charlie Douglas CPPC
Joe Schuck KHLZ
Matt Sellers PCME

FR: Steve Offiler SBO1

SJ: SAE J512 Update - Contact with SAE Committee members

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

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

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

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

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

Regards,
Steve O.

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

The proposed dimension changes for "E" as shown, are: .233" - .237" (old) becomes .220" (5.59mm) - .230" (5.85mm) (new). The proposed dimension changes for "K" as shown, are: 0.97 - 1.61 (old) becomes .043" (1.10mm) - .055" (1.40mm) (new). Note on metric conversions: slight rounded errors may be apparent. This is due to the fact that both decimal inch and metric dimensions are in use simultaneously i.e. TI's customer prefers metric while the suppliers prefer decimal inch.

Both problems explained above, bottoming and running out of thread, have been rectified. In the worst-case, no bottoming-out can occur as shown in Drawing 2, and the required position of the last full thread in the female is correctly located above the spec. requirement of .017" max.

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

I am presently conducting an experiment to test the integrity of the hydraulic seal using the new dimensions. Male parts have been created at each end of the new dimensions (.220"-.230") including the maximum runout, and a quantity of off-the-shelf female parts have been measured and sorted to obtain parts near each end of the Fig. 5A dimensions. A matrix (high/high, high/low, low/high, low/low) has been assembled, proof-tested to 4100 psi, and is presently undergoing a 500K cycle life test combined with a thermal cycle test. At the time of this writing roughly 300K cycles are complete with no evidence of leakage whatsoever from any of the size combinations.

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

Thanks and regards,

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

Enclosures

TEXAS INSTRUMENTS

09 January 1991

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

Stan:

I'd like to first express my appreciation for your consideration of this matter, regarding the changes to dimensions and tolerances of Figure 8 and Table 5 of SAE J512 OCT 90. Per our telephonic conversation of 08 January 1991, I have enclosed three scale drawings labelled Drawing 1, Drawing 2, and Drawing 3. Note that each of these drawings is per the 3/16" nominal tube dimensions. As I describe each of the drawings, I will simultaneously explain the reasoning behind the recommended changes to J512. This work is the result of mutual efforts between myself, and engineers at Ford Motor Co. and Kelsey-Hayes Co.

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DRAWING 1
This is a cross-section assembly drawing of the "female" J512 Inverted Flare per Fig. 5A and Table 4, so-called female because it is the female-threaded component and the "male" plug per Fig. 8 and Table 5. This drawing shows a potential problem in tolerance stack-up.

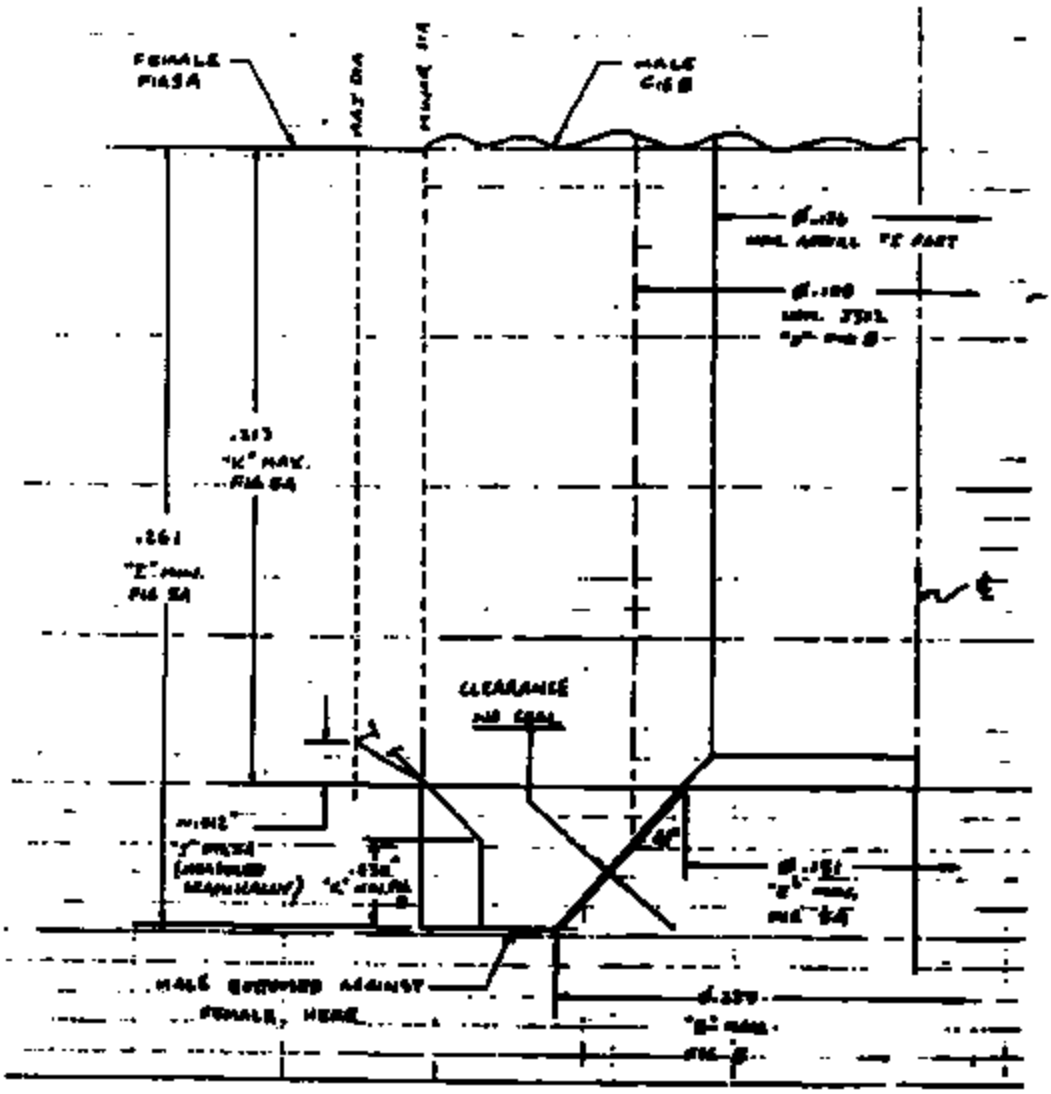
The female's cone seat is at its smallest, i.e. largest dimension "K", smallest dimension "I", smallest dimension "E" with most acute angle, 41°. The male plug's chamfer is at its largest, i.e. largest dimension "E" with most acute angle, 41°.

Two problems are shown in Drawing 1. One is that the male bottoms-out before the sealing surfaces can mate. The other is that when dimension "K" of Fig. 8 is at the maximum of .830" as shown, this puts the required location of the last female thread at .012" (dimension "J") which is below the J512 allowable size of .013". In other words, either the threads in the female are not deep enough, or conversely the male thread is too close to the end of the part.

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

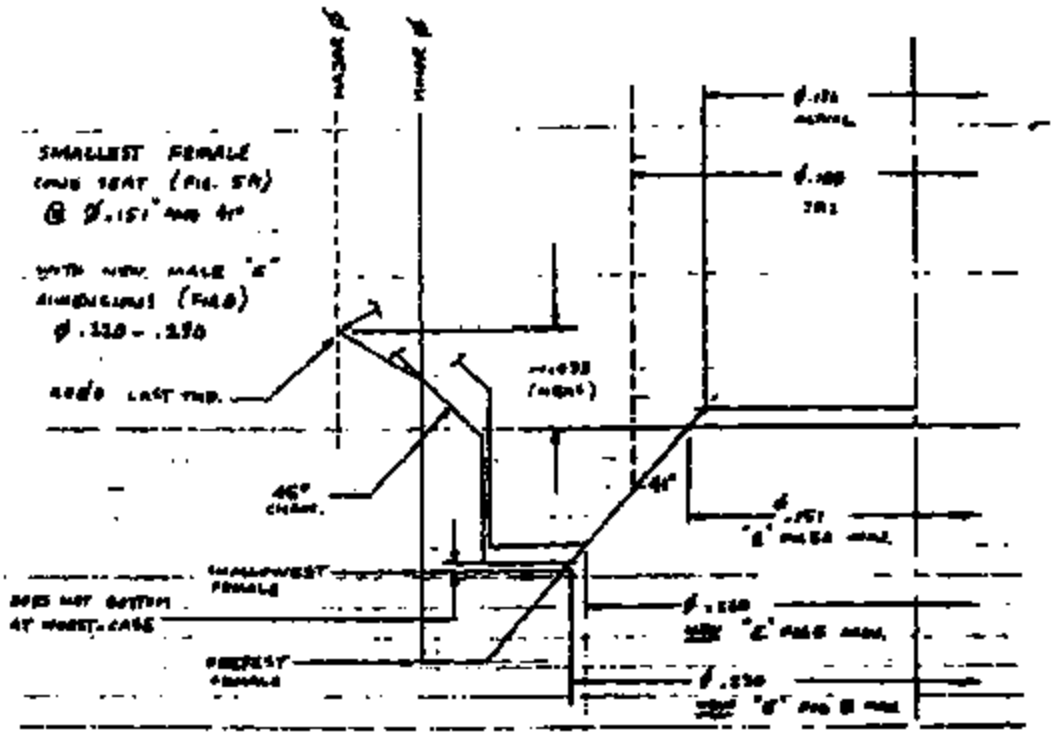
After requesting extensive quotes for producing the male part, from screw-machine houses, cold-headers, and major brake components manufacturers, TI has discovered that the J512 tolerance of .004"(total) on dimension "E" of Fig. 8 is inordinately costly to produce. Thus, another factor to consider while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

DRAWING 1



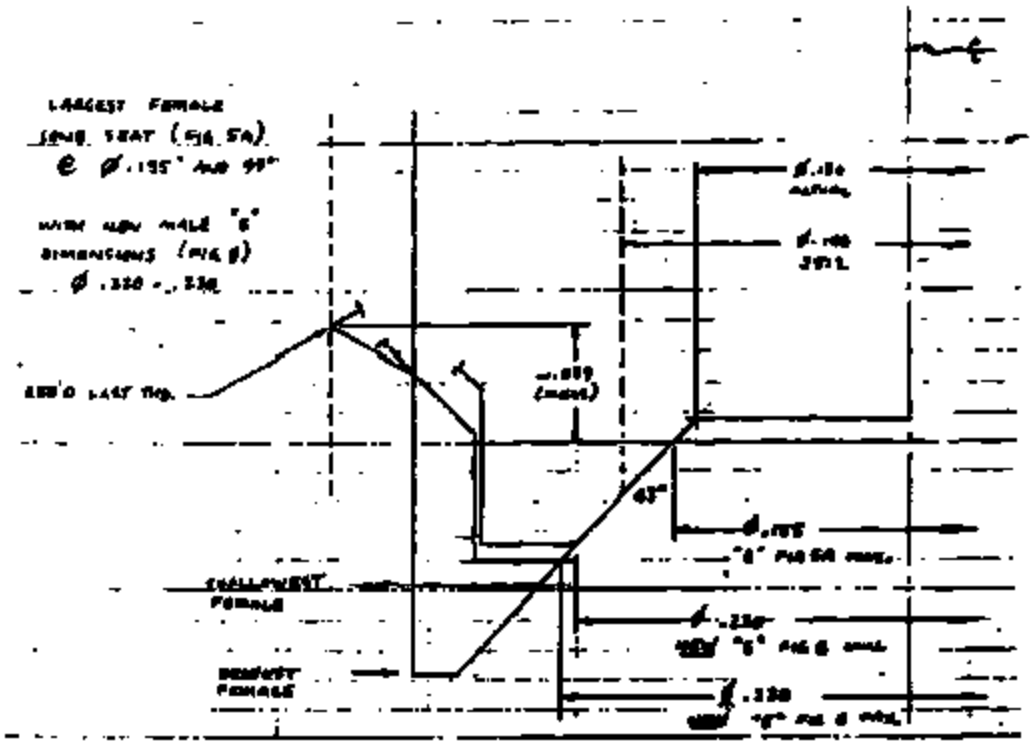
BY: Steve Affeldt
DF: 980827
SCALE: 20X

DRAWING 2



BY: STEVE OFFNER
OF: 4004LT
SCALE: 20X

DRAWING 3



BY: STEVE PEPPLE
AT: 9/29/93
SCALE: 2.0X

Appendix 4.5
Supplier Request for Engineering Approval

TEST LOT NO.	TEST	DEVICE
TESTED BY		
APPROVED BY	TEXAS INSTRUMENTS	DOC.
DATE 91-01-11	MATERIALS & CONTROLS GROUP ATTLEBORO, MA 02703	PAGE 41

FORM 3289

Supplier Request for Engineering Approval

No. 14766

Date November 30, 19 80

SUPPLIER TO COMPLETE

SUPPLIER NAME AND ADDRESS

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

FORD ASSIGN SUPPLIER PART NAME AND PART NUMBER OF ASSEMBLY AND ITS COMPONENTS

SWITCH ASSY - SPEED CONTROL DEACTIVATE

(DELTA) F2VC - 9F924 - BA

CHANGE: ☒ DESIGN ☐ CONSTRUCTION ☐ PROCESSING DESCRIPTION

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

EFFECT OF CHANGE

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

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

PRODUCT ENGINEERING TO COMPLETE

PART PROCESS ☒ APPROVED ☐ REJECTED BY R. E. Powers DATE 7/21/81	SUPERVISOR [signature] DATE 8/31/81
BLANKET APPROVAL GRANTED FOR SUBSEQUENT CHANGES WHICH ARE SAME AS DESCRIBED ABOVE ☐ YES ☐ NO	SUPPLIER QUALITY ASSURANCE APPROVED ☐ YES ☒ NO

REASON FOR REJECTION OR DEVELOPING CONDITIONS OF ACCEPTANCE

* This approval is granted upon the understanding that it is advisory in nature and in no manner changes the Seller's original responsibility for insuring that all characteristics, designated in the applicable engineering specifications either inherent or subject to control and approval, are maintained. Seller accepts full responsibility for the changes or lack of changes listed above and should no changes result in less satisfactory performance than experienced with the originally approved item, Seller will fully reimburse the User for all expenses incurred to correct the deficiency.

C-6-N 1638 (Previous editions may NOT be used) SUPPLIER