

**EA02025**

**TEXAS INSTRUMENTS, INC.'S**

**09/10/03 LETTER TO ODI**

**REQUEST 13**

**BOX 13**

**PART A – E**

**PART C**

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

Document Number 503805  
 Revision Level G  
 Revision Date 30-Oct-85  
 Original (trial) Date 20-Dec-83

503805-REV C. 4/15  
 Page 1

System \_\_\_\_\_  
 Subsystem \_\_\_\_\_  
 X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1983

Prepared By G. Wagner

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	O c c u r e n c e	R e p. a r t	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S e r	O c c	D a t e	R e p. a r t		
EXPORT (30000)																		
Provides a hydraulic sealing surface per SAE J312.	Fails to seal.	Leakage of brake fluid.	9	FF	Incorrect surface finish specification. Incorrect material specification. Improperly specified geometry. Excessive pressure.	1	Cross-check of print dimensions vs. SAE standard. Comprehensive evaluation of design at tolerance limits. Burst testing to customer-specified limits.	1	9									
Provides external thread for installation into mating part.	Fails to properly install in mating part.	Damage threads in mating part during installation. Does not allow installation.	7	FF	Threads specified improperly. Threads not gauged per ANSI spec's. Flaring buildup.	3	Cross-check of applicable SAE and ANSI standards.	2	20									
	Apparently installs, but fails to properly seal and seal.	Brake fluid leakage.	8	FF	Threads specified improperly. Threads not gauged per ANSI spec's. Flaring buildup.	1	Cross-check of applicable SAE and ANSI standards.	3	27									
Provides hex feature for B/PF wrench.	Incorrect hex size.	Damage to hex flats during wrenching. B/PF wrench does not fit.	5		Hex features improperly specified per applicable SAE/ANSI spec's.	1	Cross-check of applicable SAE and ANSI standards.	1	5									
Provides fluid passage to pressure-sensing elements.	Fluid passage is too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low temp. Subject to blockage by foreign matter.	7	FF	Inadequate size of fluid passage specified. Inadequate review of Ford standard practices.	1	Review of Ford standard practices. Review of industry practices.	1	7									
	Fluid passage is too large.	Resulting thin wall section causes breakage during installation during underhood service operations.	7	FF	Fluid passage specified excessively large.	1	Torque testing.	1	7									

TI-NHTSA 019244

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

Document Number 503005

Page 2

Revision Level C

Revision Date 30-Oct-98

System \_\_\_\_\_  
Subsystems \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Inlet) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D a t e	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results								
												Actions Taken	S e v	C l a s s	D e t	R. P. N.				
EXPORT (20200)																				
Provides gasket for internal gasket.	Flange fails to seal internal gasket properly.	Leakage of brake fluid.	8		Gasket dimensions improperly specified. Surface finishes improperly specified. Gasket geometry improperly designed.	1	Cross-check with recommendations of gasket supplier. Comprehensive testing.	1	9											
Provides flange which interfaces with other components to form pressure- sensitive structure.	Flange fails to mate properly with other components of pressure sensor.  Dia. too large results in assembly difficulty. Diameter too small results in bad component alignment. Flange too thick results in poor crimp.  Flange too thin results in reduced burst capacity. Improper edge chamfer results in stress concentration which weakens crimp.		8		Improper or incomplete specification of dimensions and tolerances.	1	Experiments and analysis to determine proper thickness for required strength. Tolerance stack-up analysis. Pilot review.	1	9											
	Material too soft or weak.	Inadequate burst capacity. Damage/breakage during installation or subsequent service. Threads prone to damage, leads to assembly difficulties.	8		Improper material selection.	1	Comprehensive evaluation of physical properties.	1	9											
	Material cracks.	Loosening of crimp leads to leakage.	8		Improper material selection.	1	Review of material properties.	1	8											
	Material degrades in presence of working fluid(s).	Leakage	8		Improper material selection.	1	Cross-check with similar products.	1	8											
	Insufficient environmental protection.	Long-term attack causes weakening of key areas which leads to leakage or breakage.	8		Improper or insufficient plating specification.	1	Comprehensive environmental testing.	3	27											

TI-NHTSA 019246

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

Document Number 503805

Page 3

Revision Level C

Revision Date 30-Oct-85

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (In/Out) Date 20-Dec-83

Model Year(s)/Vehicle(s) Year(s) \_\_\_\_\_

Key Date 1985

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C i t i c a l	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. M.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r e	C i t i c a l	D e t e r m i n e d	R. P. M.
REPORT (38800)		Corrosive problems.					Review of plating specifications.									

TL-NHTSA 019248

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

Document Number 503500  
Revision Level D  
Revision Date 20-Oct-86  
Original (Initial) Date 20-Dec-82

Page 1  
503400-REV D

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1983

Prepared By C. Wagner

Core Test Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C i r c u i t	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	F l o o p N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results					
												Action Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d	F l o o p N.	
DISC (Switch)																	
Controls activation and release set-points of switch relative to applied force.	Fails to activate and/or release at the proper points at assembly.	Miss. yield loss.	5		Disc material improperly specified.  Dimensions and tolerances improperly specified.	1	Characterization experiments.  Comparison of design with similar product.	1	5								
Key component in defining usable service life of device.	Disc activation and/or release set-points change excessively over life.	Shift in device setpoints over life.	7		Disc material improperly specified.  Disc heat-treat improperly specified. Material thickness improperly specified. Excessive force applied by spring.	1	Impulse testing.  Pre- and post-characterizations.	1	7								
Service life shorter than customer requirements.	Dramatic shift in setpoints over life.  Device inoperative - open circuit.	Dramatic shift in setpoints over life.  Device inoperative - open circuit.	7		Disc material improperly specified.  Disc heat-treat improperly specified. Material thickness improperly specified. Excessive force applied by spring.	1	Impulse testing.  Pre- and post-characterizations.	1	7								

TI-NHTSA 019247

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

Document Number 503796  
 Revision Level E  
 Revision Date 30-Oct-88  
 Original (Initial) Date 20-Dec-83

503796 rev 6  
 Page 1

System \_\_\_\_\_  
 Subsystem \_\_\_\_\_  
 X Component Pressure Switch

Design Responsibility Pressure Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1989

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C l a s s i f i c a t i o n	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r i t y	C l a s s i f i c a t i o n	D e t e r m i n e d	R. P. N.
DIAPHRAGM (OR SEAL) (74178) Forms flexible element of fluid containment cavity.  Transfers pressure from fluid to pressure-sensing elements.	Fails to contain fluid	Fluid leakage.	8		Gradual rupture over life due to improper design of supporting elements. Gradual rupture over life due to excessive fatigue/elongation. Gradual rupture over life due to stress concentrations caused by asymmetric strain distributions. Chemical attack due to incorrect material specified. Incorrect thickness (or # of layers) of diaphragm material. Insufficient location/clamping of diaphragm.	1	Burst, impulse, and thermal cycle tests.  Material mg. recommendation.  Comparison of design with similar products.	1	8							
	Change in area of pressure transfer over life.	Shift in response over life.	5		Excessively tight diaphragm clamping.  Diaphragm too stiff. Incorrect material specified.	1	Life testing w/ characteristics at intermediate points.	1	5							
	Excessive change of pressure transfer area versus pressure.	Excessively high pressure needed to adequately form pressure transfer area; wide spread on setpoints due to unpredictability at lower pressures.		6		Diaphragm too stiff.  Incorrect material specified.	1	Force and pressure versus deflection testing to calculate effective areas.	1	6						

TI-NHTSA 019248

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

Document Number 503785

Revision Level 0

Revision Date 30-Oct-98

Original (Initial) Date 20-Dec-98

System  
Subsystem  
 Component Powers Switch

Design Responsibility Powers Switch Group

Model Year(s)/Vehicle(s) Various

Key Date 1998

Prepared By C. Wagner

Coe Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

503785 REV 0  
PAGE 1

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C i r c u i t r y	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t i o n	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Action Taken	S e v e r i t y	O c c u r r e n c e	D e t e c t i o n	FL P. N.
BASE (48515) Provides a system of slots which guide, locate, and physically support terminals.	Fails to properly locate terminals.	Terminals out of position.	3		Incorrect dimensions and/or tolerances specified between slots and terminals.  Inadequate staking design concept.	1	Comparison with dimensions of similar 57PS product.	1	3							
	Fails to properly guide the terminals difficult insertion.	Device will not assemble properly; yield loss in mfg.	5		Incorrect dimensions and/or tolerances specified between slots and terminals.  Insufficient lead-in.	1	Review with assembly equipment designers to determine correct clearances and lead in.	1	5							
	Fails to properly support the terminals.	Terminals move relative to each other or the base (such as under physical or thermal loading).	5		Incorrect material specified.  Excessively large dimensions specified on terminal slots.	1	Comparison with design of similar 57PS product.	1	5							
Provides features to enhance the effectiveness of terminal staking.	Terminal staking is insufficient.	Loose terminals.  Short-circuiting in high amp points	5		Incomplete understanding of design of staking features.	1	Comparison with design of similar 67PS product.  Staking evaluation.	1	5							
Provides a dielectric medium for the electrical elements.	Current leakage between terminals or terminal-to-housing.	Improper switching action.	5		Low insulation resistance.  Incorrect material specified.	1	Comparison with design of similar 57PS product.  Material evaluation.	1	5							

TI-NHTSA 019249

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

Document Number 503788  
Revision Level D  
Revision Date 30-Oct-98

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-93

Model Year(s)/Vehicle(s) Various

Key Date 1993

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	B e v	O c c	D e t	R. P. N.
BASE (MS15) Provides physical location of the switch components.	Fails to physically locate: ignores of matter from external environment.	High current leakage.  High voltage drop.  Erratic or inoperative switch action.	5		Incorrect material specified.  Poor molded part design i.e. seal sections too thin, etc.	1	Comparison with design of similar 67PS product.  Design review with moldor.  Mold flow analysis.	1	5							
Provides a reference surface which locates the physical elements relative to the passage sensor.	Fails to properly locate the switch elements relative to the pressure sensor.	Shift in setpoints.  Erratic or inoperative switch.	5		Warpage of the reference surface.  Inclusion of other design elements into the plane of the reference surface.  Excessive clearance specified between mating features.	1	Specification of flatness on print.  Raise this surface to prevent intrusion of other elements.  Tolerances: stackup analysis.	1	5							
Provides a ledge to compress the internal environmental seal.	Improper compression of internal environmental seal.	Inadequate compression may lead to ingress of matter.  Excessive compression may prevent switch from seating correctly to sensor assembly.	7		Incorrect seal gland design.  Warpage.	1	Review of standard gland design practice.  Comparison to similar products.  Flatness specified on print.	1	7							

TI-NHTSA 019260



POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DEMON PFMEA)

Document Number 503786

Page 2

Revision Level II

Revision Date 30-Oct-89

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Original (Initial) Date 20-Dec-83

Model Year(s)/Vehicle(s) Various

Key Date 1989

Prepared By C. Wagner

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	F. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r i t y	C o n s e q u e n c e	D e t e r m i n e d	F. P. N.
BASE (40815) Provides interference tabs to locate and temporarily hold the base in relation to the clamp ring prior to clamp.	Fails to properly locate/hold prior to clamp.	Too large may cause difficulty in assembly, base cracking, or prevent seals from seating to occur.  Too small provides no effect, possibly affecting subsequent assembly operations.	5		Design of interference tabs is insufficient.	1	Calculation and experimentation to determine limits of size.  Tolerances stacking analysis	1	5							
Provides a flange surface for the clamp ring.	Fails to provide adequate geometry for clamp ring.	Base loose or insufficient torque withstand.  Base cracked.	7		Incorrect design of flange for clamp ring.	1	Comparison with design of similar STPS product.	1	7							
Provides lock tabs, tags, and features which mate to electrical connector.	Mating electrical connector doesn't fit properly.	Connector difficult to install.  Connector falls off.	6	FF	Connector geometry improperly specified.	1	Review of dimensions relative to mating connector prints.	1	6							
Provides compression to environmental seal in connector.	Mating connector seal is not properly compressed.	Ingress of water into switch cavity.  Connector difficult to install and/or falls off.	7		Connector geometry and/or surface condition/finish is improperly specified.  Incorrect material specified.	1	Review of dimensions relative to mating connector prints.  Material evaluation.	1	7							

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Base 4697-113  
Page 1

\_\_\_\_ System  
\_\_\_\_ Subsystem  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s)/Version \_\_\_\_\_

Key Date 1983

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 30-Oct-86

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	C o n t r o l s	C u r r e n t D e s i g n C o n t r o l s	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results							
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R. P. N.			
BASE (4697)																			
Provides a system of slots which guide, locate, and physically support terminals.	Fails to properly locate terminals.	Terminals out of position.	3		Incorrect dimensions and/or tolerances specified between slots and terminals.  Inadequate staking design concept.	5	Comparison with dimensions of similar 57PS product.	5	75										
	Fails to properly guide the terminals difficult insertion.	Device will not assemble properly; yield loss in mfg.	5		Incorrect dimensions and/or tolerances specified between slots and terminals.  (see Foreign log-in.)	1	Review with assembly equipment designers to determine correct clearance and lead in.	1	5										
	Fails to properly support the terminals.	Terminals move relative to each other or the base (such as under physical or thermal loading).	5		Incorrect material specified.  Excessively large dimensions specified on terminal slots.	1	Comparison with design of similar 57PS product.	1	5										
Provides features to enhance the effectiveness of terminal seating.	Terminal staking is insufficient.	Loose terminals.  Disturbance in switch setpoints.	5		Incomplete understanding of design of staking features.	3	Comparison with design of similar 57PS product.  Staking evaluations.	5	75										
Provides a dielectric medium for the electrical elements.	Current leakage between terminals or terminal-to-housing.	Improper switching action.	5		Low insulation resistance.  Incorrect material specified.	1	Comparison with design of similar 57PS product.  Material evaluation.	1	5										

TI-NHTSA 019262

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 30-Oct-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C i r c u l a r i t y	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
												Actions Taken	S e v e r i t y	C i r c u l a r i t y	D e t e r m i n e d
BASE (48315) Provides physical isolation of the switch components.	Failure to physically isolate ingress of matter from external environment.	High current leakage.  High voltage drop.  Erratic or inoperative switch action.	5		Increased material specified.  Poor molded part design (i.e. wall sections too thin, etc.)	1	Comparison with design of similar 57PS product.  Design review with moldier.  Mold flow analysis.	1	5						
Provides a reference surface which locates the electrical elements relative to the pressure sensor.	Failure to properly locate the switch elements relative to the pressure sensor.	Shift in setpoints.  Erratic or inoperative switch.	5		Warpage of the reference surface.  Intrusion of other design elements into the plane of the reference surface.  Excessive clearance specified between mating features.	3	Specification of flatness on print.  False this surface to prevent intrusion of other elements.  Tolerances stackup analysis.	1	15						
Provides a flange to compress the internal environmental seal.	Improper compression of internal environmental seal.	Inadequate compression may lead to ingress of matter.  Excessive compression may prevent switch from seating correctly to sensor assembly.	7		Incorrect seal gland design.  Warpage.	1	Review of standard gland design practice.  Comparison to similar products.  Flatness specified on print.	1	7						

TL-NHTSA 019263

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 3

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Propane Switch

Design Responsibility Propane Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1999

FMEA Date (Orig.) 20-Dec-99  
(Rev.) 20-Oct-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C o n s e q u e n c e	Potential Cause(s) / Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Action Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d	R. P. N.
BASE (48518) Provides interference tabs to locate and temporarily hold the base in relation to the crimp ring prior to crimp.	Fails to properly cooperate prior to crimp.	Too large may cause difficulty in assembly, beam cracking, or prevent switch from seating to connect.  Too small provide no effect, possibly affecting subsequent assembly operations.	6		Design of interference tabs is inefficient.	3	Calculation and experimentation to determine limits of size.  Tolerance stackup analysis.	1	15							
Provides a flange surface for the crimp ring.	Fails to provide adequate geometry for crimp ring.	Beam loose or insufficient torque retained.  Beam cracked.	7		Incorrect design of flange for crimp ring.	1	Comparison with design of similar 57 PS product.	1	7							
Provides lock tabs, keys, and features which mate to electrical connector.	Mating electrical connector doesn't fit properly.	Connector difficult to install.  Connector falls off.	6	FF	Connector geometry improperly specified.	1	Review of dimensions relative to mating connector prints.	1	8							
Provides compressions to environmental seal in connector.	Mating connector seal is not properly compressed.	Ingress of matter into switch cavity.  Connector difficult to install and/or falls off.	7		Connector geometry and/or surface condition/finish is improperly specified.  Incorrect material specified.	1	Review of dimensions relative to mating connector prints.  Material evaluation.	1	7							

TI-NHTSA 019264

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s)/Version \_\_\_\_\_

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 30-Oct-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

*Disc 36876-D-2 x 15*

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R e l i a n c e	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R e l i a n c e		
DISC (9899)																		
Controls actuation and release end-points of switch relative to applied force.	Fails to actuate and/or release at the proper points at assembly.	Mfg. yield loss.	5		Disc material improperly specified.  Dimensions and tolerances improperly specified.	1	Characterization experiments.  Comparison of design with similar styled.	1	5									
Key component in defining usable service life of device.	Disc actuation spring releases end-points change excessively over life.	Shift in device end-points over life.	7		Disc material improperly specified.  Disc heat-treat improperly specified. Material thickness improperly specified. Excessive force applied to spring.	6	Impulse testing.  Pre- and post-characterizations.	1	35									
	Service life shorter than customer requirements.	Drastic shift in end-points over life.  Device inoperative - open circuit.	7		Disc material improperly specified.  Disc heat-treat improperly specified. Material thickness improperly specified. Excessive force applied to spring.	5	Impulse testing.  Pre- and post-characterizations.	1	35									

TI-NHTSA 019205

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s)/Variant \_\_\_\_\_

Key Date 1998

FMEA Date (Orig.) 29-Dec-88  
(Rev.) 30-Oct-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

*Seal 74176*  
*1/5*

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r i n i n g	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
												Action Taken	S e v e r i t y	O c c u r r e n c e	D e t e r i n i n g
DIAPHRAGM (OR SEAL) (74176) Forms flexible element of fluid containment cavity.	Fail to contain fluid.	Fluid leakage.	8		Gradual rupture over life due to improper design of supporting elements. Gradual rupture over life due to excessive flexure/deflection. Gradual rupture over life due to stress concentrations caused by asymmetric strain distribution. Chemical attack due to incorrect material specified. Incorrect thickness (or # of layers) of diaphragm material. Insufficient location/damping of diaphragm.		Stress, impact, and thermal cycle tests.  Material mg. recommendation.  Comparison of design with similar products.	1	27						
Transfer pressure from fluid to pressure-sensing elements.	Change in area of pressure transfer over life.	Shift in setpoint over life.	7		Excessively light diaphragm clamping.  Diaphragm too stiff, incorrect material specified.		Life testing w/ characteristics of intermediate points.	1	2						
	Excessive change of pressure transfer over service pressure.	Excessively high pressure needed to adequately form pressure transfer area; sets signal off setpoint due to incompressibility of layer pressure.	8		Diaphragm too stiff.  Incorrect material specified.		Force and pressure versus deflection testing to calculate effective areas.	1	8						

TI-NHTSA 019268

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pump Seal

Design Responsibility Pump Seal Group

Prepared By C. Wegner

Model Year(s)/Vehicle(s)/Variant \_\_\_\_\_

Key Date 5-May-98

FMEA Date (Orig.) 5-May-98  
(Rev.) \_\_\_\_\_

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

O-Ring 744951-X15

Item Function	Potential Failure Mode	Potential Effects of Failure	S e v e r e	I n t e r n a l	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	C u r r e n t D e s i g n C o n t r o l s	D e t e c t i o n	R e p a r a b l e	F l o o r o v e r s e e d A c t i o n (s)	Responsibility & Target Completion Date	Action Results			
												S e v e r e	O c c u r r e n c e	D e t e c t i o n	R e p a r a b l e
O-RING (744951) Provides fluid seal between shaft and housing and corresponding sealing part.	Failure to provide adequate seal.	Shaft fluid leakage.	3		Incorrect O-ring size specified.  Incorrect material specified.	1	Validation testing including impulse, burst, thermal cycled, and proof tests per customer specification.  Comparison with design of similar products Review of material specifications and manufacturer information. O ring dimensions designed per SAE recommendations.	1	0						

TI-NHTSA 019267

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-98

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

2-17-98 30812.2(5)

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C i a s e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	C u r r e n t D e s i g n C o n t r o l s	D e t e r m i n e d	P. e n. c e	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Action Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d	P. e n. c e
HEXPONT (26217) Provides a hydraulic testing surface per SAE J514.	Fails to seal.	Leakage.	8		Incorrect surface finish specification.  Incorrect material specification.  Incorrectly specified geometry.  Excessive pressure.	1	Cross-check of print dimensions vs. SAE standard.  Impulse testing at customer specified limits.  Burst testing to customer-specified limits.	1	8							
Provides external thread for installation into mating part.	Fails to properly install in mating part.	Damages threads in mating part during installation.  Does not allow installation.	7		Threads not gauged per ANSI spec's.  Threads specified improperly. Pitting buildup.	7	Cross-check of applicable SAE and ANSI standards.	5	244							
	Apparently installs, but fails to properly seal and seal.	Fluid leakage.	8		Threads specified improperly.  Pitting buildup. Threads not gauged per ANSI spec's.	7	Cross-check of applicable SAE and ANSI standards.	5	216							
Provides hex feature for 9/16" wrench.	Incorrect hex size.	Damage to hex flats during wrenching.  9/16" wrench does not fit.	5		Hex feature improperly specified per established SAE/ANSI spec's.	1	Cross-check of applicable SAE and ANSI standards.	1	5							
Provides fluid passage to pressure-sensing elements.	Fluid passage is too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low temp.  Subject to blockage by foreign matter.	7		Inadequate size of fluid passage specified.  Inadequate review of customer standard practices.	1	Review of customer standard practices.  Review of industry practices.	1	7							

71-NHTSA 019268



**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 2

\_\_\_\_ System  
\_\_\_\_ Subsystem  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1989

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-86

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S o l v e d	O c c u r r e n c e	D e t e r m i n e d	R. P. N.		
HEXPORT (38517)	Fluid passage is too large.	Resulting thin wall section causes breakage: during installation during use/hood service operations	7		Fluid passage specified excessively large.	1	Torque loading.	1	7									
Provides gasket for internal gasket.	Fails to seal internal gasket properly.	Leakage.	9		Gasket dimensions improperly specified. Surface finishes improperly specified. Gasket geometry improperly designed.	1	Cross-check with recommendations of gasket supplier. Comprehensive loading. Experiments and analysis to determine proper thickness for required strength. Tolerance stack-up analysis. Print review.	1	9									
Provides flange which interfaces with other components to form pressure-receiver structure.	Flange fails to mate properly with other components of pressure receiver.	Dis. too large results in assembly difficulty. Diameter too small results in bad component alignment. Flange too thick results in poor clamp. Flange too thin results in reduced burst capacity. Improper edge chamfer results in stress concentration which weakens clamp.	5		Improper or incomplete specification of dimensions and tolerances.	1		1	5									
	Material too soft or weak.	Inadequate burst capacity. Damage/breakage during installation or subsequent service. Threads prone to damage, leads to assembly difficulties.	9		Improper material selection.	1	Comprehensive evaluation of physical properties.	1	9									
	Material cracks.	Loosening of clamp leads to leakage.	9		Improper material selection.	1	Review of material properties.	1	9									

TI-NHTSA 019259

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 3

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wehr

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	O c c u r r e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t i v e	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e c t i v e
EXPORT (39917)  Provides dog point for thread protection.	Material degrades in presence of working fluid.	Leakage	9	1	Improper material selection.	1	Cross-check with similar products.	1	9						
	Insufficient environmental protection.	Long-term attack causes weakening of key areas which leads to leakage or breakage.  Cosmetic problems.	9	1	Improper or insufficient plating specification.	1	Comprehensive environmental testing.  Review of plating practices.	3	27						
	Thread damaged during processing.	Part will be difficult to install or will not install.	4	1	Dog point geometry incorrect.	1	Study of thread protection needs during plating.	1	4						
Provides resistance to corrosion.	Part not assemble to female part.	Leakage.	9	1	Dog point too short.  Dog point too long.	1	Manufacturer recommendations.  Examination of tolerance stackups and customer evaluation.	1	9						
	Insufficient environmental protection.	Long term attack causes weakening of key areas which leads to leakage or breakage.  Cosmetic leakage.	9	1	Improper or insufficient plating specification.	1	Comprehensive environmental testing.  Review of plating practices.	3	27						

TI-NHTSA 019280

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 4

\_\_\_\_ System  
\_\_\_\_ Subsystem  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-95

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results					
												Actions Taken	S o l v e	O c c u r	D e t e r m i n e	R. P. N.	
HEXPORT (38917)																	

TI-NHTSA 019281

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1989

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-88

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

*Handwritten:* 11/20/89 3:00 PM JCS

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	D e t e r m i n e d	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
												Actions Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d
HEXPORT (28007)  Provides a hydraulic sealing surface per SAE J512.	Fails to seal.	Leakage of brake fluid.	9		Incorrect surface finish specifications. Incorrect material specification. Incorrectly specified geometry. Excessive pressure.	1	Cross-check of print dimensions vs. SAE standard. Comprehensive evaluation of design at tolerance limits. Burst testing to customer-specified limits.	1	8						
Provides external thread for installation into mating part.	Fails to properly install in mating part.	Damages threads in mating part during installation. Does not allow installation.	7		Threads specified improperly. Threads not gauged per ANSI spec's. Flaring buildup.	7	Cross-check of applicable SAE and ANSI standards.	5	245						
	Apparently installs, but fails to properly seal and seat.	Brake fluid leakage.	9		Threads specified improperly. Threads not gauge per ANSI spec's. Flaring buildup.	7	Cross-check of applicable SAE and ANSI standards.	5	315						
Provides hex feature for 3/16" wrench.	Incorrect hex size.	Damage to hex flats during wrenching. 3/16" wrench does not fit.	5		Hex features improperly specified per established SAE/ANSI spec's.	1	Cross-check of applicable SAE and ANSI standards.	1	5						
Provides fluid passage to pressure-sensing elements.	Fluid passage is too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low temp.  Subject to blockage by foreign matter.	7		Inadequate size of fluid passage specified.  Inadequate review of Ford standard practices.	1	Review of Ford standard practices.  Review of industry practices.	1	7						
	Fluid passage is too large.	Resulting thin wall section causes breakage during installation during underhood service operations.	7		Fluid passage specified excessively large.	1	Torque testing.	1	7						

TI-NHTSA 018282

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DEMON FMEA)

FMEA Number \_\_\_\_\_

Page 2

\_\_\_\_ System  
\_\_\_\_ Subsystem  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-95

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C l a s s i f i c a t i o n	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t i o n	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Plan(s)				
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e c t i o n	R. P. N.
EXPORT (38087) Provides snubber feature to snub pump and reduce pedal feel during activation.	Snubber too large.	End user bumps or tests switch controls.	7		Snubber diameter specified excessively large.	1	TI and Customer evaluation.	1	7							
	Snubber too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low (RIP).	7		Snubber diameter specified excessively small.	1	TI and Customer evaluation.	1	7							
Provides gland for internal gasket.  Provides flange which interfaces with other components to form pressure-tight seal.	Gland fails to seal internal gasket properly.	Leakage of brake fluid.	9		Gland dimensions improperly specified. Surface finishes improperly specified. Gland geometry improperly designed.	1	Case-check with recommendations of gasket supplier. Comprehensive testing.	1	6							
	Flange fails to mate properly with other components of pressure sensor.	Dis. too large results in assembly difficulty. Diameter too small results in bad component alignment. Flange too thick results in poor clamp. Flange too thin results in reduced burst capacity. Improper edge chamfer results in stress concentrations which weaken clamp.	5		Improper or incomplete specification of dimensions and tolerances.	1	Experiment to determine proper thickness for required strength. Tolerance stack-up analysis. Print review.	1	5							
	Material too soft or weak.	Inadequate burst capacity. Damage/breakage during installation or subsequent service. Threads prone to damage, leads to assembly difficulties.	9		Improper material selection.	1	Comprehensive evaluation of physical properties.	1	9							

TI-NHTSA 019263

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 3

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Version(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R. P. N.
EXPORT (32207)  Provide dog point for thread protection.	Material creeps.	Loosening of orimp leads to leakage.	3		Improper material selection.	1	Review of material properties.	1	9							
	Material degrades in process of working (Subs).	Leakage	3		Improper material selection.	1	Cross-check with similar products.	1	9							
	Insufficient environmental protection.	Long-term effect causes weakening of key areas which leads to leakage or breakage.  Cosmetic problems.	3		Improper or insufficient plating specification.	1	Comprehensive environmental testing.  Review of plating practices.	3	27							
	Thread damaged during processing.	Part will be difficult to install or will not hold.	4		Dog point geometry incorrect.  Dog point too short.	1	Study of thread protection needs during plating. Manufacturer recommendations.	1	4							
	Part not assemblable to female part.	Brake fluid leakage.	3		Dog point too long.	1	Examination of tolerance stackups and customer evaluation.	1	3							

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 4

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Weyer

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-96

Core Team: Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	C u r r e n t D e s i g n C o n t r o l s	D e t e r m i n e d R. P. N.	R e c o m m e n d e d A c t i o n (s)	R e s p o n s i b i l i t y & T a r g e t C o m p l e t i o n D a t e	Action Results				
											Action Taken	S e v	O c c u r e n c e	D e t e r m i n e d R. P. N.	
EXPORT (20007)															

TL-NHTSA 019285

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 3

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 5-May-88

FMEA Date (Orig.) 5-May-88  
(Rev.) \_\_\_\_\_

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e r v i c e	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	C u r r e n t D e s i g n C o n t r o l s	D e t e r m i n e d	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results					
												Actions Taken	S e v	O c c	D e t	R P N	
HEXPORT (37067) Provides a hydraulic sealing surface per modified SAE J514.	Fails to seal.	Leakage of brake fluid.	6		Incorrect surface finish specification.  Incorrect material specification.  Incorrectly specified geometry.  Excessive pressure.	1	Cross-check of part dimensions vs. SAE standard.  Impulse testing at customer specified limits. Burst testing to customer-specified limits.	1	8								
Provides external thread for installation into mating port.	Fails to properly install in mating port.	Damage threads in mating port during installation.  Does not allow installation.	7		Threads not gauged per ANSI spec's.  Threads specified improperly. Plating buildup.	7	Cross-check of applicable SAE and ANSI standards.	6	246								
	Apparently installs, but fails to properly seal and seal.	Brake fluid leakage.	8		Threads specified improperly.  Plating buildup.	7	Cross-check of applicable SAE and ANSI standards.	5	216								
Provides hex feature for 14 mm wrench.	Incorrect hex size.	Damage to hex flats during wrenching.  14 mm wrench does not fit.	5		Threads not gauged per ANSI spec's.  Hex feature improperly specified per established SAE/ANSI spec's.	1	Cross-check of applicable SAE and ANSI standards.	1	5								
Provides fluid passage to pressure-sensing elements.	Fluid passage is too small.	Electrical signal from switch is delayed vs. pressure signal especially at very low temp.  Subject to blockage by foreign matter.	7		Inadequate size of fluid passage specified.  Inadequate review of Ford standard practices.	1	Review of Ford standard practices.  Review of industry practices.	1	7								

TL-NHTSA 019286

37067  
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POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 5-May-98

FMEA Date (Orig.) 5-May-98  
(Rev.) \_\_\_\_\_

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t i o n	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e c t i o n	R. P. N.		
HEXPORT (37047)	Fluid passage is too large.	Resulting thin wall section causes leakage: during installation during underhood service operations	7		Fluid passage specified excessively large.	1	Torque testing.	1	7									
Provides gland for internal gasket.	Fails to seal internal gasket properly.	Leakage of brake fluid.	8		Gland dimensions improperly specified. Surface finishes improperly specified. Gland geometry improperly designed.	1	Cross-check with recommendations of gasket supplier. Comprehensive testing.	1	8									
Provides flange which interfaces with other components to form pressure-sensor structure.	Flange fails to mate properly with other components of pressure sensor.	Dist. too large results in assembly difficulty. Diameter too small results in bad component alignment. Flange too thick results in poor crimp. Flange too thin results in reduced burst capacity. Improper edge chamfer results in stress concentration which weakens crimp.	5		Improper or incomplete specification of dimensions and tolerances.	1	Experiments and analysis to determine proper thickness for required strength. Tolerance stack-up analysis. Print review.	1	5									
	Material too soft or weak.	Inadequate burst capacity. Damage/breakage during installation or subsequent service. Threads prone to damage, leads to assembly difficulties.	8		Improper material selection.	1	Comprehensive evaluation of physical properties.	1	8									
	Material creeps.	Loosening of crimp leads to leakage.	9		Improper material selection.	1	Review of material properties.	1	9									

TI-NHTSA 019287

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 3

\_\_\_\_ System  
\_\_\_\_ Subsystem  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 5-May-98

FMEA Date (Orig.) 5-May-98  
(Rev.) \_\_\_\_\_

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R. P. N.
REPORT (97087)	Material degrades in presence of working fluid(s)	Leakage	8		Improper material selection.	1	Cross-check with similar products.	1	B							
	Insufficient environmental protection.	Long term attack causes weakening of key areas which leads to leakage or breakage.  Cosmetic problems.	9		Improper or insufficient plating specification.	1	Comprehensive environmental testing.  Review of plating practices.	3	27							
	Provides dog point for thread protection.	Thread damaged during processing.	Part will be difficult to install or will not install.	4		Dog point geometry incorrect.	1	Study of thread protection needs during plating.	1	4						
Provides resistance to corrosion.					Dog point too short.		Manufacturer recommendations.									
	Part not accessible to female part.	Broken fluid leakage.	8		Dog point too long.	1	Examination of tolerance stackups and customer evaluation.	1	9							
		Long term attack causes weakening of key areas which leads to leakage or breakage.  Cosmetic issues.	9		Improper or insufficient plating specification.	1	Comprehensive environmental testing.  Review of plating practices.	3	27							

TI-NHTSA 019268

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 4

\_\_\_\_ System  
\_\_\_\_ Subsystem  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 5-May-86

FMEA Date (Orig.) 5-May-86  
(Rev.) \_\_\_\_\_

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C a u s e s	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	C u r r e n t D e s i g n C o n t r o l s	D e t e r m i n e d	R. P. N.	R e c o m m e n d e d A c t i o n (s)	R e s p o n s i b i l i t y & T a r g e t C o m p l e t i o n D a t e	Action Results						
												A c t i o n T a k e n	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R. P. N.		
HEXPOR1 (37087)																		

TI-NHTSA 019289

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By G. Wagner

Model Year(s)/Vehicle(s)/Version \_\_\_\_\_

Key Date 1998

FMEA Date (Orig) 20-Dec-95  
(Rev) 5-May-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

WAGNER 2/14/98  
5738Y 113

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e c t e d	R. P. N.
CONVERTER (27406 or 27389)  Transfers pressure from fluid (via diaphragm) to a force on pressure- sensing disc.	Fails to correctly transfer fluid pressure to force on disc.	Shift in setpoints	5		Bulge O.D. incorrectly specified relative to washer I.D.  Converter major O.D. incorrectly specified relative to cup I.D.  Converter thickness incorrectly specified.  Incorrect material specified.	1	Tolerance stacking analysis.  Force/deflection analysis to determine strength and resistance to plastic deformation.  Burst, impulse, and Thermal cycle tests.	1	5							
Provides alignment and support to disc.	Fails to properly align and support disc.	Loose tolerances allow misalignment which may cause shift in setpoints or erratic operation.	5		Bulge O.D. incorrectly specified relative to washer I.D.	2	Tolerance stacking analysis.	1	15							
		Disc out-of-place relative to converter may cause erratic operation or inoperative device, stuck open- circuit.			Converter major O.D. incorrectly specified relative to cup I.D.  Disc support bump incorrectly specified. Disc retaining wall incorrectly specified.		Comparison of design with similar product.									
Provides a portion of the support surface for diaphragm.	Fails to properly support diaphragm.	Reduced diaphragm life results in leakage.	2		Contours of surface in contact with diaphragm are specified incorrectly.	1	Burst, impulse, and Thermal cycle tests.	1	5							

TI-NHTSA 019270

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r r	Current Design Controls	D e t e r m i n e	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S e v e r e	C l a s s	D e t e r m i n e	R. P. N.		
CONVERTER (27406 or 27366)					Condition of edges in contact with diaphragm are specified incorrectly. Clearance between converter bump and washer I.D. are specified too wide.		Comparison of design with similar product.											
Provides disc support during over pressure (proofburst).	Fails to properly support disc during over pressure.	Disc deformation results in shift in setpoints. Reduced disc travel if disc motion is restricted prematurely. Reduced disc life.	6		Features which control disc motion during over pressure are incorrectly specified.	3	Pre and post-proof characterization Pressure-deflection measurements of disc motion.	1	18									
Vent in converter prevents pressure buildup from affecting setpoints.	Does not vent properly.	Shift in setpoints over temp. Reduced disc snap.	7		Vent hole incorrectly specified.	1	Comparison of design with similar product. Temperature characterizations.	1	7									

TI-NHTSA 019271

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystems \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1985

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-86

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	O c c u r r e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d	R. P. N.
CUP (27713 OR 27288) Provides crimpable area which holds pressure sensor together.	Fails to provide a suitable geometry for crimp.  Leakage  Reduced diaphragm life.		8		Crimp well thickness incorrectly specified.  Crimp well height incorrectly specified.  Incorrect material specified.	1	Burst and impulse testing.  Comparison of design with similar product.	1	9							
Locates hoopst, diaphragms, and washer.	Fails to correctly locate hoopst, diaphragm, or washer.  Difficult assembly.  Leakage Reduced diaphragm life.		9		I.D. specified incorrectly.	1	Tolerance stackup analysis.	1	9							
Provides support and location for disc.	Fails to support and locate the disc/computer correctly.  Shift in endpoints.  Erratic operation. Stuck open at assembly.		7		Incorrect disc envelope specified.  Bump true-position incorrectly specified.	5	Tolerance stackup analysis.  Impulse testing.	1	36							
		Reduced disc life.			Poor surface condition of bump, no control specified.											
Provides guide for transfer pin.	Fails to guide transfer pin correctly.  Erratic operation. Device stuck short-circuit.		5		Pin guide geometry is incorrectly specified.	1	Tolerance stackup analysis.	1	5							
Provides portion of environmental seal gland.	Fails to allow a proper environmental seal.  Ingress of matter.  Switch does not seat correctly to cup.		7		Surface condition required for good seal not understood or not correctly specified.	1	Environmental testing.  Switch cavity pressurization testing.	1	7							

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CUP 27713 OR 27288

POTENTIAL  
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(DESIGN FMEA)

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\_\_\_\_ System  
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 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C i r c u l a r	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d	R. P. N.		
CUP (27713 OR 27286)					Geometry incorrectly specified.		Review of standard and design rules.											
Provides surface to interface with base/switch assembly.	Fails to properly locate relative to switch.	Shift in setpoints.	7		Incorrect geometry of mating surface specified.	1	Tolerance stackup analysis.	1	7									
		Erratic or inoperative switch.					Cross-section actual devices for inspection of interface.											
(Post-assembly crimp) provides geometry for final assembly with crimp ring.	Fails to allow proper final assembly with crimp ring.	Erratic operation.  Ingress of matter. Cracked base.	7		Post-assembly geometry is not controlled per design intent.  Cup diameter incorrectly specified.	1	Tolerance stackup analysis.  Base torque testing.	1	7									

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**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
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System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
K. Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s)/Various \_\_\_\_\_

Key Date 1988

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-88

Cons Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

*CRIMP RING 74747*

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R. P. N.
CRIMP RING (74787) Hold together base assembly and sensor assembly.	Fail to hold base to sensor correctly.	Erratic switch operation.  Cracked base.  Shift in response.  Low base torque withstand.	7		Incorrect geometry of crimpable area specified.  Incorrect geometry at formed rail. Incorrect material specified.	3	Impulse, thermal cycle, base torque, and base/terminal impact tests.	1	21							
Provide a surface for part identification/trace code.	ID characters legible.	Improperly identified parts at assembly plant.	5		Geometry/finish not properly specified.  Wrong material specified.	3	Coding tests.  Environmental tests.	1	15							
Impart environmental protection and sealant to device.	Inability to withstand environment.	Corrosion causes material consumption, loss of mechanical properties, switch eventually fails off sensor. Moisture coating.	7		Wrong material specified.	1	Environmental tests.	1	7							
Provide lubrication to crimp die via imp coating.	Insufficient lubrication.	Metal flakes/particles on external device surfaces.	5		Incorrect or insufficient oil specified.	3	Clamping tests.	1	15							



POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

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System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-95

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d	R. P. N.
GASKET (74353) Provides fluid seal between housing and diaphragm.	Fails to provide adequate fluid seal.	Brake fluid leakage.	8		Insufficient compression specified.  Very excessive compression specified, leading to displacement from gland. Incorrect ID and/or OD leading to displacement from gland. Incorrect cross-section shape specified. Incorrect material specified, fluid incompatibility. Incorrect design of sealing mechanism.	1	Review of general seal design principles.  Manufacturer's recommendations.  Burst, impulse, and thermal cycle tests.  Comparison with design of similar products.	1	9							

SHEET 1 43533

TL-NHTSA 019276

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

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System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S	C	Potential Cause(s) Mechanism(s) of Failure	O	Current Design Controls	D	R	Recommended Action(s)	Responsibility & Target Completion Date	Action Results							
												1	P	1	5	1	5	1	5
MOVABLE CONTACT (74408)																			
Provides electrical switching interface with stationary terminal.	Fails to provide adequate electrical contact.	Device appears non-circuited.  Intermittent continuity.  High millivolt drop.	5		Contact material specified too thin.  Incorrect contact material specified.  Contamination.  Incorrect contact attachment method specified.	1	Review of Ti proprietary and general contact design info.  Eliminate points for logness of construction.	1	5										
Provides electrical path from interface to spring.	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified.	1	Review with contact rivet manufacturer.  Testing.	1	5										
Provides means of mechanical attachment to spring.	Inadequate attachment to spring.	Shift in setpoints over life.	7		Incorrect geometry specified.	2	Manufacturer recommendation.	2	28										
		Essaj: operation.			Incorrect material specified.		Comparison with design of similar products.												
Provides rigidity to maintain dimensions and flexure device calibrations over time.	Calibration shift	Shift in setpoints	7		Incorrect geometry specified.  Incorrect material specified.	1	Manufacturer recommendation.  Comparison with design of similar products.	1	7										

TI-NHTSA 019276

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1988

FMEA Date (Orig.) 20-Dec-88  
(Rev.) 5-May-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results					
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R. P. N.	
MOVABLE CONTACT (74406) Provides a feature to concentrate force in a particular area.	Inadequate force concentration.	Htg millvolt drop.	5		Incorrect geometry specified.	3	Manufacturer recommendation.	1	15								
	Excessive force concentration.	Shift in setpoints over life.	7		Incorrect geometry specified.	3	Manufacturer recommendation.	1	21								
					Incorrect material specified.		Compare with design of similar products.										

TI-NHTSA 019277

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-95

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

MILWAUKEE TERMINAL  
56847 TCS

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	D i c t u r	Current Design Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v	O c c r	D e t	R. P. N.
MOVABLE TERMINAL (36887)  Provides a brass blade for interconnection.  Provides a mounting point for the spring via rivet.	Poor interconnection.	Device appears open-circuit existing connector installed.	5		Contamination of brass blade.  Material specified too thin.	3	Review design and dimensions of mating connector to ensure proper interference and wiping action.	1	15							
	Blade geometry improper.	Difficult to install mating connector.	5		Lead-in chamfers on terminal are insufficiently specified.  Material specified too thick.	1	Review design and dimensions of mating connector. Compare with design of similar 57FS product.	1	5							
	Fails to allow proper spring/rivet installation.	Shrinkage in switch endpoints (base rivet).  Inoperative device (rivet falls out completely)	7		Rivet hole size is specified incorrectly.  Rivet hole position is specified incorrectly.	9	Compare with design of similar products.  Check with recommendations of rivet manufacturer.	5	315							
Provides features to ensure adequate staking into base.		High yield loss.			Support surface for spring is incorrectly specified.  Choice of fastener style incorrect.		Testing.									
	Terminal is inadequately staked into base.	Loose terminals.  Shrinkage in switch endpoints.	7		Incomplete understanding of design of staking features.	5	Comparison of design with similar 57FS product.  Staking evaluation.	5	178							

TI-NHTSA 019278

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1999

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C i a s e	Potential Cause(s) / Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results					
												Action Taken	S e v	O c c u r r e n c e	D e t e r m i n e d	R P N	
MOVABLE TERMINAL (30007) Provides features which mate with slots in base for location of terminal.	Fails to properly locate terminal.	Terminal out of position.	3		Incorrect dimensions and/or tolerances specified between slots and terminals.  Inadequate sliding design concept.	5	Comparison of design with similar 57PS product.	5	75								
Provides electrical path from movable contact via spring to mating connector.	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified.  Inadequate cross-section area.	1	Calculations of resistance using $R = (\rho)(L) / A$  Testing	1	5								

TI-NHTSA 019279

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 1

\_\_\_\_ System  
\_\_\_\_ Subsystem  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1983

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-86

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

*Mo. Approved Date 7/20/85*

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C l a s s i f i c a t i o n	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t a b l e	P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S a v e	O c c u r r e n c e	D e t e c t a b l e	R. P. N.
<b>MOVABLE CONTACT (74408)</b> Provides electrical switching interface with stationary terminal.	Fails to provide adequate electrical contact.	Device appears open- circuited.  Intermittent continuity.  High millivolt drop.	5		Contact material specified too thin.  Incorrect contact material specified.  Contamination.  Incorrect contact attachment method specified.	1	Review of TI proprietary and general contact design info.  Eliminate paths for ingress of contamination.	1	5							
Provides electrical path from interface to spring.	Fails to provide adequate conductivity.	High resistance shows as high millivolt drop.	5		Incorrect material specified.	1	Review with contact rivet manufacturer.  Testing.	1	6							
Provides means of mechanical attachment to spring.	Inadequate attachment to spring.	Shift in setpoints over life.	7		Incorrect geometry specified.	2	Manufacturer recommendation.	2	28							
		Earclic operation.			Incorrect material specified.		Comparison with design of similar products.									
Provides rigidity to maintain dimensions and thrust device collations over life.	Collation sets	Shift in setpoints	7		Incorrect geometry specified.  Incorrect material specified.	1	Manufacturer recommendation.  Comparison with design of similar products.	1	7							

TI-NHTSA 010280

**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Jan-93  
(Rev.) 5-May-95

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C i a s e	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results					
												Actions Taken	S a v e	O c c u r	D e t e c t	R. P. N.	
MOVABLE CONTACT (74400) Provides a feature to concentrate force in a particular area.	Inadequate face concentration.	Hig millivolt drop.	3		Incorrect geometry specified.	3	Manufacturer recommendation.	1	15								
					Incorrect material specified.		Comparison with design of similar products.										
	Excessive force concentration.	Shift in response over life.	7		Incorrect geometry specified.	3	Manufacturer recommendation.	1	21								
					Incorrect material specified.		Comparison with design of similar products.										

TI-NHTSA 019281

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 1

\_\_\_\_ System  
\_\_\_\_ Subsystem  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 25-Dec-83  
(Rev.) 5-May-88

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

ENVIRONMENTAL SEAL  
74267.15

Item Function	Potential Failure Mode	Potential Effects of Failure	S e v e r i t y	C l a s s i f i c a t i o n	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t i o n	R e p a r a b l e n e s s	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S e v e r i t y	C l a s s i f i c a t i o n	D e t e c t i o n	R e p a r a b l e n e s s		
ENVIRONMENTAL SEAL (74267) Prevents ingress of matter to switch cavity.	Contaminants enter switch cavity.	High current leakage  High millivolt drop.  Erratic or inoperative switch operation.	7		Gasket thickness is specified too small.  Liners on porous not specified.  Innovated material.	1	Review of attached practice for gland design.  Review with gasket manufacturer.  Comparison of design with similar product.	1	7									
Provides friction to aid in preventing base rotation.	Base rotates too easily.	Perceived as inadequate by assembly plant and/or service personnel.	5		Gasket thickness improperly specified.	1	Review of standard practice for gland design.  Torque-to-rotate testing.  Comparison of design with similar product.	1	5									

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POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
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System \_\_\_\_\_  
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X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-94

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

2245-462 22034 V15

Item / Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C i a s e	Potential Cause(s) Mechanism(s) of Failure	O c c u r	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Taken	S e v	O c c	D e t	R. P. N.
WASHER (27655) Provides a portion of the support surface for diaphragm.	Fails to correctly support the diaphragm.	Reduced diaphragm life results in leakage.	9		Contours of diaphragm support surface are specified incorrectly.  Condition of edges of support surface specified incorrectly. Clearance between washer I.D. and converter bump is specified too wide.	3		27	Burst, impulse, and Thermal Cycle tests.  Comparison of design with similar products.						
Provides support for compression of gasket.	Fails to allow proper gasket compression.	Leakage.	9		Washer thickness is incorrectly specified or unspecified.  Washer thickness is specified too small.  Washer material and/or heat-treat is incorrectly specified.	1		9	Burst, impulse, and Thermal Cycle tests.  Comparison of design with similar products.						
Locates and guides converter with respect to cap.	Converter is not properly located relative to cap.	Shift in setpoint.	7		Incorrectly specified button guide I.D.	1		7	Comparison of design with similar products.						
		Erratic behavior.			Incorrectly specified washer O.D.				Tolerance stackup analysis.						
	Converter travel is restricted by washer.	Disc cannot release; device is stuck open/closed.	5		Washer thickness is incorrectly specified or unspecified.  Washer thickness is specified too small.  Washer material and/or heat-treat is incorrectly specified. I.D. of button guide is too small.	1		5	Burst, impulse, and Thermal Cycle tests.  Comparison of design with similar products.  Tolerance stackup analysis.						

TI-NHTSA 019283

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
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FMEA Number \_\_\_\_\_

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System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1983

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-88

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

WIPER 77236-113

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	C u r r e n t D e s i g n C o n t r o l s	D e t e c t i o n	R e p a r a b l e	R e c o m m e n d e d A c t i o n (s)	R e s p o n s i b i l i t y & Target Completion Date	Action Results				
												Action Taken	S e v e r e	O c c u r r e n c e	D e t e c t i o n	R e p a r a b l e
WASHER (27830) Interfaces with cup feature and provides a portion of component stack for crimp.	Fails to interface correctly with cup.	Difficult assembly (washer O.D. too large).  Poor washer/coaxial location relative to cup (washer O.D. too small).	5		Washer O.D. specified incorrectly.	1	Comparison of design with similar products.  Tolerance stackup analysis.	1	5							
	Fails to allow proper crimp.	Reduced burst capability leads to leakage. Reduced fatigue resistance leads to leakage.	9		Thickness incorrectly specified.  O.D. incorrectly specified.  Edge condition incorrectly or unspecified.	1	Tolerance stackup analysis.  Burst, impulse, and Thermal Cycle tests.	1	9							

TL-NHTSA 019284

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

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System \_\_\_\_\_  
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X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-88  
(Rev.) 5-May-96

Core Team Design Engineers, Manufacturing Engineers, Manufacturing, Quality

REVISION NUMBER 1

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C i r c u l a r	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	C u r r e n t D e s i g n C o n t r o l s	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results								
												Actions Taken	S e v e r e	O c c u r r e n c e	D e t e r m i n e d	R. P. N.				
TRANSFER PIN (74078)  Transfers disc motion to movable electrical contact.	Fails to properly transfer disc motion.	Contacts stuck open.	5		Diameter incorrectly specified.	1	Tolerance stackup between pin and pin guide in cup.	1	5											
		Contacts stuck closed.			Chips/fragments cause pin to lodge.															Check with supplier for material properties regarding chips.
Enable operation.																				
Insulates electrical components from switch housing.	Fails to insulate.	Continuity between movable terminal and housing to ground.	5		Wrong material specified.	1	Check with supplier for material properties.	1	5											
							Check with customer for electrical logic of movable terminal.													

TI-NHTSA 019285

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

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System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
K. Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-83  
(Rev.) 5-May-88

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

*Handwritten:* 74558-113

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e r m i n e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results					
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e r m i n e d	R. P. N.	
THREAD CAP (74888) Protects hexport threads from damage during shipping and travel. Prevents dust from entering the fluid cavity.	Incorrect length.	Does not protect threads sufficiently.	6		Length incorrectly specified.	1	Dimensional stackup study.	1	8								
	Loose Cap.	Allows dust to enter fluid cavity.	4		Incorrect diameter specified.	1	Dimensional analysis.	1	4								

TI-NHTSA 019286

POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

PAGE 1

\_\_\_ System  
\_\_\_ Subsystem  
 Computer Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

SMP/147-100 TERMINAL TO THE 415#

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r e	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Action Taken	S e v e r e	O c c u r r e n c e	D e t e c t	R. P. N.
STATIONARY TERMINAL (38888)  Provides a brass blade for interconnection.	Poor interconnection.	Device appears open-circuit resulting connector inoperative.	6		Contamination of brass blade.  Material specified too thin.	2	Review design and dimensions of mating connector to ensure proper interference and wiping action.	1	16							
	Blade geometry improper.	Difficult to install mating connector.	5		Lead-in chamfers on terminals are insufficiently specified.  Material specified too thick.	1	Review design and dimensions of mating connector. Compare with design of similar 57PG product.	1	5							
	Provides a silver alloy surface for electrical contact.	Fails to provide adequate electrical contact.  Intermittent continuity.  High millivolt drop.	Device appears open-circuited.	6		Incorrect contact material specified.  Contamination.  Silver layer specified too thin.	1	Review of TI proprietary and general contact design info. Eliminate paths for ingress of contamination.	1	8						
Provides feature for device calibration.	Excessive lips of contact height dimension (mechanical issue).	Shift in set points over life.	7		Silver layer specified too thick.	1	Review of TI proprietary and general contact design info. Life Testing.	1	7							
	Erosion of contacts due to electrical loads.	Shift in setpoints over life.  Intermittent or no continuity.	7		Incorrect material specified for particular electrical loading.	1	Review of TI proprietary and general contact design info. Review and testing with actual electrical loads.	1	7							
	Poor calibration	Mfg. yield loss	7		Design is excessively stiff.	5	Mechanical (and/or FEA) analysis	3	105							

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POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-96

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

How Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e	C a u s e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r	Current Design Controls	D e t e c t e d	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Required					
												Action Taken	S e v	O c c	D e t	R. P. N.	
STATIONARY TERMINAL (30000)		Shift in setpoints over life.			Design has excessive spring back.  Material hardness is incorrectly specified.  Initial position requires excess deformation to calibrate.		Force deflection springback testing Testing with actual production calibration equipment.										
					Design has inadequate strength to maintain calibration over life.												
Provides features to ensure adequate staking into base.	Terminal is inadequately staked into base.	Loose terminals.  Shift/fluctuation in switch setpoints.	7		incomplete understanding of design of staking features.	5	Comparison of design with similar 57PS product.  Staking evaluations.	5	175								
Provides features which mate with slots in base for location of terminal.	Fails to properly locate terminal.	Terminals out of position.	5		Incorrect dimensions and/or tolerances specified between slots and terminals.  Inadequate staking design concept.	5	Comparison of design with similar 57PS product.	5	75								
Provides electrical path from silver finny contact to wiring connector.	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified.	1	Calculations of resistance using R = (rho)L / A	1	5								
					inadequate cross-sectional area.		Testing										

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POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
X Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s)/Variant \_\_\_\_\_

Key Date 1999

FMEA Date (Orig.) 80-Dec-93  
(Rev.) 5-May-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing Quality

SPR 24  
3859 ALJ

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C i a s e	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D a t a b a s e	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
												Actions Taken	S e v	O c c	O e i	R. P. N.
SPRING (Stator) Provides contact force.	Low contact force.	High millivolt drop across contacts.	5		Incorrect geometry specified. Incorrect material specified.	3	Beam deflection equations. Force/deflection testing.	1	15							
	High contact force.	Shift in setpoints. Disc cracking over life.	7		Incorrect geometry specified. Incorrect material specified.	3	Beam deflection equations. Force/deflection testing.	1	21							
Provides electrical path from movable contact to movable terminal.	Fails to provide adequate conductivity.	High resistance shown as high millivolt drop.	5		Incorrect material specified.  Inadequate cross-section area.	1	Calculations of resistance using $R = (\rho)(L)/A$  Testing	1	5							
Provides feature to interface with transfer pin.	Fails to interface correctly with transfer pin.	Spring failure over life.  Shift in setpoints over life.  Sticking transfer pin causes intermittent operation.	7		Inadequate height of feature specified.  Inadequate slope of feature specified.  Improper position of feature specified.	1	Comparison of design with similar product. Dimension and tolerance stackup analysis.  Actual measurement.  Testing	1	7							
Provides feature for attachment to movable contact.	Fails to provide adequate mounting for movable contact.	Intermittent or erratic operation  Open circuit.	6		Hole size/position incorrectly specified.  Fit/ness inadequate.	1	Five/1 mfg. recommendations.  Comparison of design with similar product. Testing.	1	6							
Locates movable contact.	Fails to adequately locate movable contact relative to stationary contact.	High millivolt drop over life.  Excessive contact erosion over life.	7		Spring geometry incorrectly specified.	3	Dimension and tolerance stackup analysis.  Testing	1	21							

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**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 2

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s) Various

Key Date 1993

FMEA Date (Orig.) 20-Dec-93  
(Rev.) 5-May-98

Core Team Design Engineering, Manufacturing Engineering, Manufacturing, Quality

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v	C l a s s	Potential Cause(s) Mechanism(s) of Failure	O c c u r	Current Design Controls	D a t e	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
												Actions Taken	S e v	O c c	D e t	R. P. N.		
SPRING (30000)																		
Provides feature for attachment to movable terminal.	Fail to properly attach to movable terminal.	Erratic or intermittent operation.  Shift in setpoints.  Open or short circuit.	8		Rivet hole size or position incorrectly specified.  Flaws inadequate.  Choice of fastener style incorrect	9	Rivet only recommendations.  Comparison of design with similar product.  Testing.	5	27a									
Allows disc overtravel.	Fail to allow disc overtravel.	Shift in setpoints.  Disc cracking. Device inoperative at assembly. Poor calibration.	7		Incorrect geometry specified.  Incorrect material specified.	3	Beam deflection equations.  Force/deflection testing.	1	21									
Provides force to open contacts.	Inadequate force to open contacts	Insufficient resistance to mechanical vibration.  Short circuit.	5		Incorrect geometry specified.  Incorrect material specified.	1	Beam deflection equations.  Force/deflection testing.	1	5									
	Excessive force to open contacts.	Shift in setpoints.  Disc cracking. Device inoperative at assembly. Poor calibration.	7		Incorrect geometry specified.  Incorrect material specified.	3	Beam deflection equations.  Force/deflection testing.	1	21									

TI-NHTSA 019290



**POTENTIAL  
FAILURE MODE AND EFFECTS ANALYSIS  
(DESIGN FMEA)**

FMEA Number \_\_\_\_\_

Page 1

System \_\_\_\_\_  
Subsystem \_\_\_\_\_  
 Component Pressure Switch

Design Responsibility Pressure Switch Group

Prepared By C. Wagner

Model Year(s)/Vehicle(s)/Variants \_\_\_\_\_

Key Date 1993

FMEA Date (Orig.) 20-Dec-88  
(Rev.) 5-May-95

Core Teams Design Engineering, Manufacturing Engineering, Manufacturing, Quality

SPICER 37R 57.115

Item Function	Potential Failure Mode	Potential Effect(s) of Failure	S e v e r i t y	C o n s e q u e n c e	Potential Cause(s) Mechanism(s) of Failure	O c c u r r e n c e	Current Design Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
												Actions Taken	S e v e r i t y	O c c u r r e n c e	D e t e c t
SPACER (72058) Reduce friction between disc and converter	Fails to effectively reduce friction.	Shift in setpoints over life.  Reduced disc life.	7		Incorrect material specified.  Incorrect dimensions specified.	1	Impulse and Thermal Cycle tests. Pre- and Post-life characterizations. Tolerance stackup analysis.	1	7						
Allow venting of chamber formed by disc and converter.	Fails to allow venting.	Shift in setpoints over temp.  Reduced disc action.	7		Vent hole incorrectly specified.	1	Comparison of design with similar product.  Temperature characterization.	1	7						

TMHTSA 019291