

2. Describe all assessments, analyses, tests, test results, studies, surveys, simulations, investigations, inquiries and/or evaluations (collectively, "actions"), including any Failure Mode and Effect Analyses (FMEAs), that relate to, or may relate to, the subject component or the alleged defect in the subject vehicle that have been conducted, are being conducted, are planned, or are being planned by, or for, Honeywell. For each such action, provide the following information:
 - a. Vehicle make, model, and model year for which the subject component is used;
 - b. Action title or identifier;
 - c. The actual or planned start date;
 - d. The actual or expected end date;
 - e. Brief summary of the subject and objective of the action;
 - f. Engineering group(s)/supplier(s) responsible for designing and for conducting the action;
 - g. A brief description of the procedure used to complete the action, including testing or survey sample sizes, where applicable; and,
 - h. A brief summary of the findings and/or conclusions resulting from the action.

For each action identified, provide copies of all documents related to the action, regardless of whether the documents are in interim, draft, or final form. Organize the documents chronologically by action.

Attachment
2A
(Gear Train Analysis)

FASCO Controls Corporation

Electric Column Lock

October 19, 1994

JTS
Software

Set #1
Design Data
(Original Design)

20:1 0.0625" Thread Lead

***** VARIABLE SHEET *****

Input	Name	Output	Unit	Comment
48.0000	pn		1/in	#1 Nominal
14.5000	npa		deg	60-125 (Ver 4.2)
	n_mod	.5292	mm	CROSSED AXIS INVOLUTE HELICAL GEARS
	ncp	.0654	in	(Non-Enveloping Worm Gears)
	pnb	.06337	in	Press "Alt A" for Solution List
				*NORMAL PLANE:
				*Diametral_Pitch
				*Nominal Pressure Angle
				*Module
				*Circular_Pitch
				*Base Pitch
				COMMON:
90.0000	E		deg	*Shaft Angle (+ or -)
.37500	cd		in	*Operating_center distance
	std_cd	.37541	in	*Standard_center distance
	Lc	.1395	in	*Length_of_contact
	mp	2.2009		*Contact_ratio (SAP > TIF)
	mpc	No		*Contact_below finished involute?
	tug	20		*Gear_ratio
				*DRIVER:
1	ndr			Number of teeth
'frm	meth_dr			*Hobbed ('hob), Shaped ('shp)
				Formed ('frm)
.3747	oddr		in	*Outside Diameter
	modd_dr	NA	in	*Start_Tip_Modification
	Emod_dr	NA	deg	*Roll_at_start_of_tip_modification
	xndr	NA	in	*Normal_OD_tip_relief
	xncdr	NA	in	*Normal_circular_OD_tip_relief
	xdr	NA	in	*Transverse_circular_OD_tip_relief
	eoddr	.3747	in	*Effective_outside_diameter
	nttodr	.0213	in	*Normal_tooth_thickness_at_EOD
	xn_eoddr	NA	in	*Normal_EOD_tip_relief
	ptd_dx	.4540	in	*Pointed tooth diameter (No tip mod)
	pddr	.3333	in	*Reference PD
.0320	nttdr		in	*Finished_normal_tooth_thickness
0	SSn_dr		in	*Total_normal_circular_finish
				stock_on_tooth_thickness
86.4167	hadr		deg	*Helix_angle (+ Right, - Left)
	ladr	3.5833	deg	*Lead_angle (+ Right, - Left)
	Pdr_min	.1664	in	*Minimum_face_width (bi-rotation)
	ptdr	3.0000	1/in	*Transverse_diametral_pitch
	cpdr	1.04719	in	*Transverse_circular_pitch
	tmoddr	8.4666	mm	*Transverse_module
	tpaddr	76.4138	deg	*Transverse_pressure_angle
	tttdr	.5120	in	*Transverse_tooth_thickness
	tbpdr	.24599	in	*Transverse_base_pitch
	bhadr	75.07301	deg	*Base_helix_angle
	ap_dr	.06558	in	*Axial_pitch
	lead_dr	.0656	in	*Lead
	Dhi_dr	.2983	in	*Inv/fillet_intersection_dia (TIF)
	EDhi_dr	210.6171	deg	*Roll_at_inv/fil_intersection_dia
	rddr	.2848	in	*Root_diameter
	dbdr	.0783	in	*Base_diameter

20
 'frm ndm
 meth_dn
 .4580 oddn in
 modd_dn NA in
 Emod_dn NA deg
 xmdn NA in
 xncdn NA in
 xdn NA in
 eoddn .4580 in
 nttodn .0178 in
 xm_ecdd NA in
 ptd_dn .4883 in
 pddn .4175 in
 .0320 nttdn in
 0 SSn_dn in
 3.5833 hadn deg
 ladn 86.4167 deg
 Fdn_min .0141 in
 ptdn 47.9062 1/in
 cpdn .06558 in
 tmoddr .5302 mm
 tpadr .14.5272 deg
 ttdn .0321 in
 tbpdn .06348 in
 bhadr 3.46905 deg
 ap_dn 1.04719 in
 lead_dn 20.9439 in
 Dhi_dn .4044 in
 EDhi_dn 2.0501 deg
 rddn .3688 in
 dbdn .4041 in
 delta -.00041 in
 cpc -.0001 in
 work .0414 in
 abbl .0012 in
 pn 48.0000 1/in
 ncp .06545 in
 npa 14.5000 deg
 pddr .3333 in
 nttdr .0320 in
 hadr 86.4167 deg
 ladr 3.5833 deg
 ptdr 3.0000 1/in
 cpdr 1.04719 in
 tmoddr 8.4666 mm
 tpadr 76.4138 deg
 ttdr .5120 in
 abldr 6.815 deg
 sap_dr .3048 in
 ntsapr .0393 in

***DRIVEN:**
 Number of teeth
 *Hobbed ('hob), Shaped ('shp)
 Formed ('frm)
***Outside Diameter**
 *Start_Tip_Modification
 *Roll_at_start_of_tip_modification
 *Normal_OD_tip_relief
 *Normal_circular_OD_tip_relief
 *Transverse_circular_OD_tip_relief
 *Effective_outside_diameter
 *Normal_tooth_thickness_at_EOD
 *Normal_EOD_tip_relief
 *Pointed_tooth_diameter_(No_tip_mod)
 *Reference_PD
 *Finished_normal_tooth_thickness
 *Total_normal_circular_finish
 stock_on_tooth_thickness
 *Helix_angle(+_Right,-_Left)
 *Lead_angle(+_Right,-_Left)
 *Minimum_face_width(bi-rotation)
 *Transverse_diametral_pitch
 *Transverse_circular_pitch
 *Transverse_module
 *Transverse_pressure_angle
 *Transverse_tooth_thickness
 *Transverse_base_pitch
 *Base_helix_angle
 *Axial_pitch
 *Lead
 *Inv/fillet_intersection_dia(TIF)
 *Roll_at_inv/fil_intersection_dia
 *Root_diameter
 *Base_diameter

OPERATING DATA:
 *Separation_of_pitch_planes
 *Contact_path_to_line_of_centers
 *Working_depth
Normal Plane:
 *Base_backlash
 *Diametral_pitch
 *Circular_pitch
 *Pressure_angle
***DRIVER:**
 *Pitch_diameter
 *Normal_Tooth_Thickness
 *Helix_Angle(+_Right,-_Left)
 *Lead_Angle(+_Right,-_Left)
 *Transverse_Diametral_Pitch
 *Transverse_Circular_Pitch
 *Transverse_Module
 *Transverse_Pressure_Angle
 *Transverse_Tooth_Thickness
 *Angular_backlash
 *Start_of_active_profile(SAP)
 *Normal_tooth_thickness_at_SAP

nswladdr .0261	in	*Normal_space width at SAP
rtcl_dr .0036	in	*Root_clearance
pddn` .4175	in	*Pitch_diameter
nttdn` .0320	in	*Normal_Tooth_Thickness
hadn` 3.5833	deg	*Helix_Angle (+ Right, - Left)
ladn` 86.4167	deg	*Lead_Angle (+ Right, - Left)
ptdn` 47.9062	1/in	*Transverse_Diametral_Pitch
cpdn` .06558	in	*Transverse_Circular_Pitch
tmoddn` .5302	mm	*Transverse_Module
tpadn` 14.5272	deg	*Transverse_Pressure_Angle
tttdn` .0321	in	*Transverse_Tooth_Thickness
abldn` .341	deg	*Angular_backlash
sap_dn .4044	in	*Start_of_active_profile (SAP)
nttsapn .0332	in	*Normal_tooth thickness at SAP
nswladdr .0302	in	*Normal_space width at SAP
rtcl_dn .0033	in	*Root_clearance
PLOT CONFIGURATION:		
mark 'y		*Mark_inv/fil intersections?
markm 'y		*Mark_mod/inv intersections?
teeth 1		*Number_of_teeth on plot (Def=1)
roll	deg	*Driver_contact roll angle of
t# 1		*Driver tooth number (Def=1)
DRIVER ROLL ANGLES:		
Esap_dr 215.5512	deg	*Start_of_active profile
Eod_dr 268.1238	deg	*Effective outside diameter
DRIVEN ROLL ANGLES:		
Esap_dn 2.0501	deg	*Start_of_active profile
Eod_dn 30.5517	deg	*Effective outside diameter
DRIVER HOB:		
tpdr `	-	*Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
hfa_dr	deg	*Flank angle
h`dr	in	*Tip to Reference Line
t`dr	in	*Tooth thickness at Reference Line
hs`dr	in	*Reference Line to Start Mod Ramp
hfa2_dr	deg	*Pressure Angle of Mod Ramp
rt_dr	in	*Tip_radius
u_dr	in	*Protuberance
ua_dr	deg	*Protuberance_angle from flank
uap_dr	deg	*Protuberance_pressure_angle
hu`dr	in	*Tip_to_flank/prot intersection
hobAPdr	in	*Ref_Line to Hob SAP
nswAPdr	in	*Normal_Space Width at Hob SAP
DRIVEN HOB:		
tpdn `	-	*Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
hfa_dn	deg	*Flank angle
h`dn	in	*Tip to Reference Line
t`dn	in	*Tooth thickness at Reference Line
hs`dn	in	*Reference Line to Start Mod Ramp
hfa2_dn	deg	*Pressure Angle of Mod Ramp
rt_dn	in	*Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space_Width at Hob SAP

nc_dr	-	in	*Number_of_Teeth
odc_dr	-	in	*Outside_Diameter
nttc_dr	-	in	*Normal_Tooth_Thickness
rts_dr	-	in	*Tip_Radius - Normal Plane
us_dr	-	in	*Protuberance - Normal Plane
cds_dr	NA	in	*Center_distance with gear
sapc_dr	-	in	*Start_of_active_profile_diameter

nc_dn	-	in	*Number_of_Teeth
odc_dn	-	in	*Outside_Diameter
nttc_dn	-	in	*Normal_Tooth_Thickness
rts_dn	-	in	*Tip_Radius - Normal Plane
us_dn	-	in	*Protuberance - Normal Plane
cds_dn	NA	in	*Center_distance with gear
sapc_dn	-	in	*Start_of_active_profile_diameter

14.5000	rfa``dr	deg	*Basic_Rack_Form:
.0228	h``dr	in	*Flank_Angle
.0327	t``dr	in	*Tip_to_Reference_Line
.0089	rt``dr	in	*Tooth_Thickness_at_Reference_Line
	tc_dr 0	in	*Tip_radius
	tr_dr 0	in	*Radial_tip_chamfer_Def=0
	xp_dr -	-	*Normal_tip_radius_Def=0
			*Normal_tip_relief_exponent_Def=3/2

14.5000	rfa``dn	deg	*Basic_Rack_Form:
.0229	h``dn	in	*Flank_Angle
.0327	t``dn	in	*Tip_to_Reference_Line
.0089	rt``dn	in	*Tooth_Thickness_at_Reference_Line
	tc_dn 0	in	*Tip_radius
	tr_dn 0	in	*Radial_tip_chamfer_Def=0
	xp_dn -	-	*Normal_tip_radius_Def=0
			*Normal_tip_relief_exponent_Def=3/2

DRIVER SHAPER:

- *Number_of_Teeth
- *Outside_Diameter
- *Normal_Tooth_Thickness
- *Tip_Radius - Normal Plane
- *Protuberance - Normal Plane
- *Center_distance with gear
- *Start_of_active_profile_diameter

DRIVEN SHAPER:

- *Number_of_Teeth
- *Outside_Diameter
- *Normal_Tooth_Thickness
- *Tip_Radius - Normal Plane
- *Protuberance - Normal Plane
- *Center_distance with gear
- *Start_of_active_profile_diameter

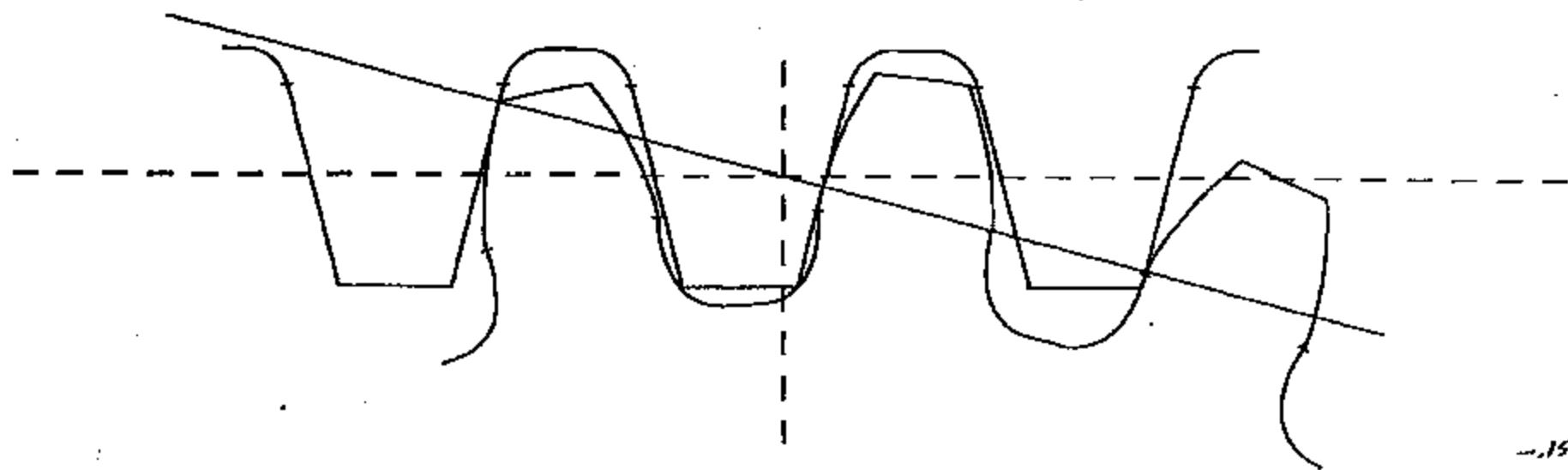
FORMED DRIVER:

- *Basic_Rack_Form:
- *Flank_Angle
- *Tip_to_Reference_Line
- *Tooth_Thickness_at_Reference_Line
- *Tip_radius
- *Radial_tip_chamfer_Def=0
- *Normal_tip_radius_Def=0
- *Normal_tip_relief_exponent_Def=3/2

FORMED DRIVEN:

- *Basic_Rack_Form:
- *Flank_Angle
- *Tip_to_Reference_Line
- *Tooth_Thickness_at_Reference_Line
- *Tip_radius
- *Radial_tip_chamfer_Def=0
- *Normal_tip_radius_Def=0
- *Normal_tip_relief_exponent_Def=3/2

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



-15-15

14-5-61

***** VARIABLE SHEET *****

Input	Name	Output	Unit	Comment
LOADING:				
.06	Vs f	0	ft/min	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze drive..)
	eff	+51	%	*Approx_efficiency
	effback	+4	%	*Approx_efficiency backdriving
	sfb			*Anti-backdrive safety factor
	nload	18.592	lbf	*Imposed normal tooth load
	Fo	1		*Overload factor Def=1
	tnload	9.296	lbf	*Total_normal tooth load.
	cli	76.878	deg	*At_center of contact interval:
	s	64605	psi	*Angle between contact curvatures
	Cc	4486.2	psi	*Specific compressive stress, s *Load/compressive stress factor, Cc
Driver:				
0	power	0	HP	*Power
3	rev_dr		rpm	*Rotational speed
	tork_dr		ozf-in	*Torque
	E_dr	30E6	psi	*Young's modulus (Default = Steel)
	clidr	76.223	deg	*Contact curvature inclination angle
	tan_dr	1.125	lbf	*Tangential force
	sep_dr	4.655	lbf	*Separating force
	ax_dr	17.965	lbf	*Axial_force
	Mo_dr	3.051	lbf-in	*Overturning moment
Driven:				
	rev_dn	0	rpm	*Rotational speed
	tork_dn	30.527	ozf-in	*Torque
	E_dn		psi	*Young's modulus (Default = Bronze)
	clidn	.654	deg	*Contact curvature inclination ang.
	tan_dn	17.965	lbf	*Tangential force
	sep_dn	4.655	lbf	*Separating force
	ax_dn	1.125	lbf	*Axial_force
	Mo_dn	.231	lbf-in	*Overturning moment
Screw Connected to Driven and Nut				
	T	30.526504	ozf-in	Screw Driving
	Fa	88.18283	lbf	Torque
.335	Dm		in	Total axial resisting load
1	Ns			Thread pitch diameter
.0625	Tlead		in	Number of starts
	p	.0625	in	Thread lead
.06	f			Thread axial pitch
30	phi		deg	Coefficient of friction: threads
	alpha	3.3985855	deg	One half included thread angle
0	fc			Thread mean lead angle
.375	Dc		in	Coefficient of friction: thrust collar
	theta	30.130728	deg	Mean diameter of thrust collar
	e	46.355286	%	Axis to thread normal surface
	LgS		in	Thread efficiency
.766	OD		in	Threaded length
.375	RD		in	Screw OD
.298	ID		in	Screw Root Diameter
.307	At	.0786751	in^2	Nut ID
	An	.43932591	in^2	Tensile stress area
				Total thread surface area

.03125	ScT	200.72303 psi	Compressive stress (Full contact)
	att	in	Screw axial tooth thickness
	attR	.04741581 in	Screw axial tooth thickness at Nut ID
	attN	.05434401 in	Nut axial tooth thickness at Screw OD
	SnS	.56048004 in^2	Total screw shear area
	SnN	.78466012 in^2	Total nut shear area
	SsS	157.33447 psi	Screw shear stress (Full contact)
	SsN	112.38347 psi	Nut shear stress (Full contact)
	StS	367.17948 psi	Torsional stress at screw root dia
	StA	1120.848 psi	Axial stress at screw root dia
	StR	1230.4209 psi	Max tensile stress at screw root dia
	SsR	669.99689 psi	Max shear stress at screw root dia

***** VARIABLE SHEET *****

Input --- Name --- Output --- Unit --- Comment ---

				LOADING:
.06	Vs f	0	ft/min	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze drive..)
	eff	+51	%	*Approx_efficiency
	effback	+4	%	*Approx_efficiency backdriving *Anti-backdrive safety factor
	sfb			*Imposed normal tooth load
	nlload	37.184	lbf	*Overload factor Def=1
	Fo	1		*Total_normal tooth load
	tnload	18.592	lbf	*At_center of contact interval:
	cli	76.878	deg	*Angle between contact curvatures
	s	81397	psi	*Specific compressive stress, s
	Cc	8972.4	psi	*Load/compressive stress factor, Cc
0	power	0	HP	Driver:
6	rev_dr		rpm	*Power
	tork_dr		ozf-in	*Rotational speed
	E_dr	30E6	psi	*Torque
	clidr	76.223	deg	*Young's modulus (Default = Steel)
	tan_dr	2.25	lbf	*Contact curvature inclination angle
	sep_dr	9.31	lbf	*Tangential force
	ax_dr	35.93	lbf	*Separating force
	Mo_dr	6.102	lbf-in	*Axial_force
	rev_dn	0	rpm	*Overturning moment
1.4E6	tork_dn	61.053	ozf-in	Driven:
	E_dn		psi	*Rotational speed
	clidn	.654	deg	*Torque
	tan_dn	35.93	lbf	*Young's modulus (Default = Bronze)
	sep_dn	9.31	lbf	*Contact curvature inclination angle
	ax_dn	2.25	lbf	*Tangential force
	Mo_dn	.463	lbf-in	*Separating force
				*Axial_force
				*Overturning moment
				Screw Connected to Driven and Nut
				Screw Driving
	T	61.053007	ozf-in	Torque
	Fa	176.36566	lbf	Total axial resisting load
335	Dm		in	Thread pitch diameter
	Ns			Number of starts
.0625	Tlead		in	Thread lead
	p	.0625	in	Thread axial pitch
.06	f			Coefficient of friction: threads
30	phi		deg	One half included thread angle
	alpha	3.3985855	deg	Thread mean lead angle
0	fc			Coefficient of friction: thrust collar
.375	Dc		in	Mean diameter of thrust collar
	theta	30.130728	deg	Axis to thread normal surface
	e	46.355286	%	Thread efficiency
.766	LgS		in	Threaded length
.375	OD		in	Screw OD
.298	RD		in	Screw Root Diameter
.307	ID		in	Nut ID
	At	.0786751	in^2	Tensile stress area
	An	.43932591	in^2	Total thread surface area

.03125	ScT	401.44607	psi	Compressive stress (Full contact)
	att		in	Screw axial tooth thickness
	attR	.04741581	in	Screw axial tooth thickness at Nut ID
	attN	.05434401	in	Nut axial tooth thickness at Screw OD
	SnS	.56048004	in ²	Total screw shear area
	SnN	.78466012	in ²	Total nut shear area
	SsS	314.66894	psi	Screw shear stress (Full contact)
	SsN	224.76695	psi	Nut shear stress (Full contact)
	StS	734.35895	psi	Torsional stress at screw root dia
	StA	2241.696	psi	Axial stress at screw root dia
	StR	2460.8418	psi	Max tensile stress at screw root dia
	SsR	1339.9938	psi	Max shear stress at screw root dia

***** VARIABLE SHEET *****

at Input---	Name---	Output---	Unit-----	Comment-----
				#1 Nominal Hoechst 90 deg Worm Gears Steel, Hostaform Worm/Hostaform Gear Non-Enveloping (Crossed Axis Helic (See 60-125 for Input Data) Press "Alt U" for Units Change
1	z1			GENERAL:
20	z2			Number of Worm Teeth
	i	20		Number of Gear Teeth
	mn	.52916667	mm	Ratio
48	DPn			Normal Module
	m	.53020322	mm	Normal Diametral Pitch
	DP	47.906159		Gear Trans Module
14.5000	npa		deg	Gear Trans Pitch
	tpa	14.5272	deg	Normal Pressure Angle
3.5833	gamma_n		deg	Gear Trans Pressure Angle @ Ref PD
				Worm Lead Angle
.3750	a		in	Center Distance
.3747	da1		in	Worm OD
.4580	da2		in	Gear OD
	dml	.3334	in	Worm Mean Working Depth Dia
	dm2	.4167	in	Gear Mean Working Depth Dia
	wkd	.0414	in	Working Depth
				LOAD CHARACTERISTIC:
26.9475	F2		lbf	Gear Tangential Load
0	w		ft/min	Flank Sliding Velocity
	b	.1711	in	Effective Face Width
	fz	.66		Tooth Number Coefficient
	c	3654.9031	lbf/in ²	Load Characteristic, c
	c_al	1160.3019	lbf/in ²	Allowable Load Characteristic, c
	Sc	.32		Load Characteristic Safety Factor
				TOOTH BREAKAGE:
35.93	F2max		lbf.	Maximum Gear Tangential Load
185	T		F	Operating Temperature
	ra1	.1874	in	Worm Outside Radius
	rml	.1667	in	Worm Mean Working Depth Radius
	ra2	.2290	in	Gear Outside Radius
.0321	ttt		in	Gear Trans Tooth Thickness @ Ref PD (If Hostaform Worm, Gear TTT Should Be Approx Equal to Worm TTT)
	tttm	.0322	in	Gear Trans Tooth Thickness @ Mean Dia
	dbg	.4041	in	Gear Base Dia
	chi	70.2200	deg	
	phi	18.0000	deg	Pitch Angle
	t	3		Number of Engaged Teeth
	sm	.0274	in	Ave Width of Shear-Stressed Surface
	A	.0188	in ²	Total Shear-Stressed Area
	tauB	5545.6	lbf/in ²	Allowable Shear Stress
	Fb	104.0944	lbf	Tooth Breakage Force
	S	2.90		Tooth Breakage Safety Factor

Set #2
Design Data

18:1:0.1875" Thread Lead

VARIABLE SHEET						
Input		Name	Output	Unit	Comment	
'e	type				#2 Min Eff CD - Cold 60-146 (Ver 4.2) Eff Center Distance Due to Tolerance, Operating Temperature & Moisture Absorption Press 'Alt A' for Model Solutions External or Internal Set ('e or 'i)	
35	pn			1/in		
	mn	.72571429	mm	mm		
7	ha			deg		
25	tpa			deg		
+68	TR			F		
19	Hmatl				ASSEMBLY CONDITIONS:	
	HN	Zinc			Normal Diametral Pitch	
	KM	15.20E-6	1/degF		Normal Module	
	KM'	0	in/in		Helix Angle	
.3794	Cd			in	Operating Transverse Pressure Angle	
- .0082	Ct			in	Temperature (Default =68F =20C)	
+ .0082	Ct''			in	Housing:	
	TCTP	.00110	in		Material Number (See Material Table)	
	TCTG	.00410	in		Material Code	
0	bROp			in	Thermal Coefficient of expansion	
0	bROg			in	Moisture Coefficient of expansion	
0	BRPp			in	Basic or nominal center distance	
0	BRPg			in	Minimum center distance tolerance	
	Cmin	.3712	in		Maximum center distance tolerance	
	Cmax	.3928	in		Pinion total composite tolerance	
7	Pmatl				Gear total composite tolerance	
	PN	Brass			Pinion bearing runout (TIR)	
1	np				Gear bearing runout (TIR)	
10	Qp				Pinion bearing total radial play	
	KP	10.50E-6	1/degF		Gear bearing total radial play	
	KP'	0	in/in		Minimum assembled center distance	
.2344	d			in	Maximum assembled center distance	
22	Gmatl				Pinion:	
	GN	For1140			Material Number (See Material Table)	
18	ng				Material Code	
6	Qg				Number of teeth	
	KG	11.67E-6	1/degF		AGMA Quality Class	
	KG'	37.50E-6	in/in		Thermal Coefficient of expansion	
.5181	D			in	Moisture Coefficient of expansion	
	dCT	-.0002	in		Nominal operating pitch diameter	
	dtbl	-.0002	in		(Enter Ref PD for X-Axis Gears)	
	→ Cmin_op	.3710	in		Gear:	
					Material Number (See Material Table)	
					Material Code	
					Number of teeth	
					AGMA Quality Class	
					Thermal Coefficient of expansion	
					Moisture Coefficient of expansion	
					Nominal operating pitch diameter	
					(Enter Ref PD for X-Axis Gears)	
					OPERATING CONDITIONS:	
-40	TM			F	Housing temperature	
-40	TP			F	Pinion temperature	
-40	TG			F	Gear temperature	
	dCT	-.0002	in		Effective center distance:	
	dtbl	-.0002	in		Change in CD (Thermal, Moisture)	
	→ Cmin_op	.3710	in		Approximate change in trans backlat	
					Minimum center distance	

Cmax_op .3926 in
dCd .02160 in

Maximum center distance
CD Range

***** VARIABLE SHEET *****

Input		Name	Output	Unit	Comment
					#2 Min CD, TRs Max TTs, ODs -40C
					60-125 (Ver 4.2)
					CROSSED AXIS INVOLUTE HELICAL GEARS
					(Non-Enveloping Worm Gears)
					Press "Alt A" for Solution List
35.0000	pn			1/in	*NORMAL PLANE:
25.0000	npa			deg	*Diametral_Pitch
	n_mod	.7257		mm	*Nominal Pressure Angle
	ncp	.0898		in	*Module
	pnb	.08135		in	*Circular_Pitch
					*Base Pitch
90.0000	E		deg		COMMON:
.37100	cd		in		*Shaft_Angle (+ or -)
	std_cd	.37630		in	*Operating_center distance
	Lc	.1456		in	*Standard_center distance
	mp	1.7904			*Length_of_contact
	mpc	No			*Contact_ratio (SAP > TIF)
	mg	18			*Contact_below finished involute?
					*Gear_ratio
1	ndr				*DRIVER:
'frm	meth_dr				Number of teeth
.3050	oddr		in		*Hobbed ('hob), Shaped ('shp)
	modd_dr	NA	in		Formed ('frm)
	Emod_dr	NA	deg		*Outside Diameter
	xndr	NA	in		*Start_Tip_Modification
	xncdr	NA	in		*Roll_at_start of tip modification
	xdr	NA	in		*Normal_OD tip relief
	eoddr	.3016	in		*Normal_circular_OD tip relief
	nttdr	.0100	in		*Transverse_circular_OD tip relief
	xn_eodr	NA	in		*Effective_outside_diameter
	ptd_dr	.3198	in		*Normal_tooth_thickness_at_EOD
	pddr	.2344	in		*Normal_EOD tip relief
.0415	nttdr		in		*Pointed tooth diameter (No tip mod)
0	SSn_dr		in		*Reference PD
					*Finished_normal_tooth_thickness
					*Total_normal_circular_finish
					stock_on_tooth_thickness
33.0000	baddr		deg		*Helix angle (+ Right, - Left)
	ladr	7.0000	deg		*Lead_angle (+ Right, - Left)
	Fdr_min	.1701	in		*Minimum face width (bi-rotation)
	ptdr	4.2654	1/in		*Transverse_diametral_pitch
	cpdr	.73652	in		*Transverse_circular_pitch
	tmoddr	5.9549	mm		*Transverse_module
	tpaddr	75.3534	deg		*Transverse_pressure_angle
	tttdr	.3405	in		*Transverse_tooth_thickness
	tbpdr	.18624	in		*Transverse_base_pitch
	bhadr	64.09928	deg		*Base_helix_angle
	ap_dr	.09043	in		*Axial_pitch
	lead_dr	.0904	in		*Lead
	Dhi_dr	.1715	in		*Inv/fillet intersection dia (TIF)
	EDhi_dr	155.5760	deg		*Roll_at_inv/fil intersection dia
	rddr	.1589	in		*Root_diameter
	dbdr	.0593	in		*Base_diameter

18	ndn	
'frm	meth_dn	
.5750	oddn	in
	modd_dn	in
	Emod_dn	deg
	xndn	in
	xncdn	in
	xdn	in
	eoddn	.5724
	nttddn	.0136
	xn_ecdd	NA
	ptd_dn	.5911
	pddn	.5181
.0425	nttdn	in
0	SSn_dn	in
7.0000	hadn	deg
	ladn	83.0000
	Fdn_min	.0231
	ptdn	34.7391
	cpdn	.09043
	tmoddn	.7312
	tpadn	25.1646
	tttdn	.0428
	tbpdn	.08185
	bhadrn	6.34132
	ap_dn	.73652
	lead_dn	13.2574
	Dhi_dn	.4695
	EDhi_dn	2.6310
	rddn	.4287
	dbdn	.4690
	delta	-.00530
	cpc	-.0014
	work	.0660
	nbb1	.0007
	pn	35.0000
	ncp	.08976
	npa	25.0000
	pddr	.2344
	nttdr	.0415
	hadr	83.0000
	ladr	7.0000
	ptdr	4.2654
	cpdr	.73652
	tmoddr	5.9549
	tpadr	75.3534
	tttdr	.3405
	abldr	3.293
	sap_dr	.1786
	nttsapr	.0669

*DRIVEN:

- Number of teeth
- *Hobbed ('hob), Shaped ('shp)
- Formed ('frm)
- *Outside Diameter
- *Start_Tip Modification
 - *Roll_at_start of tip modification
 - *Normal_OD tip relief
 - *Normal_circular OD tip relief
 - *Transverse_circular_OD tip relief
- *Effective_outside diameter
- *Normal_tooth_thickness_at_EOD
- *Normal_EOD tip relief
- *Pointed tooth diameter (No tip mod)
- *Reference PD
- *Finished normal tooth thickness
- *Total normal circular finish
- stock on tooth thickness
- *Helix_angle (+ Right, - Left)
- *Lead_angle (+ Right, - Left)
- *Minimum face width (bi-rotation)
- *Transverse_diametral pitch
- *Transverse_circular pitch
- *Transverse_module
- *Transverse_pressure angle
- *Transverse_tooth thickness
- *Transverse_base pitch
- *Base_helix_angle
- *Axial_pitch
- *Lead
- *Inv/fillet intersection dia (TIF)
 - *Roll_at_inv/fil intersection dia
- *Root_diameter
- *Base_diameter

OPERATING DATA:

- *Separation_of pitch planes
- *Contact_path to line of centers
- *Working_depth

Normal Plane:

- *Base_backlash
- *Diametral_pitch
- *Circular_pitch
- *Pressure_angle

*DRIVER:

- *Pitch_diameter
- *Normal_Tooth_Thickness
- *Helix_Angle (+ Right, - Left)
- *Lead_Angle (+ Right, - Left)
- *Transverse_Diametral_Pitch
- *Transverse_Circular_Pitch
- *Transverse_Module
- *Transverse_Pressure_Angle
- *Transverse_Tooth_Thickness
- *Angular_backlash
- *Start_of_active_profile (SAP)
- *Normal_tooth_thickness at SAP

nswlddr	.0224	in	*Normal_space width at SAP
rtcl_dr	.0040	in	*Root_clearance
pddn	.5181	in	*Pitch_diameter
nttdn	.0425	in	*Normal_Tooth_Thickness
hadn	7.0000	deg	*Helix_Angle (+ Right, - Left)
ladn	83.0000	deg	*Lead_Angle (+ Right, - Left)
ptdn	34.7391	1/in	*Transverse_Diametral_Pitch
cpdn	.09043	in	*Transverse_Circular_Pitch
tmoddn	.7312	mm	*Transverse_Module
tpadn	25.1646	deg	*Transverse_Pressure_Angle
tttdn	.0428	in	*Transverse_Tooth_Thickness
abldn	.183	deg	*Angular_backlash
sap_dn	.4706	in	*Start_of_active_profile (SAP)
nttsapn	.0529	in	*Normal_tooth_thicknes at SAP
nswlddn	.0288	in	*Normal_space_width at SAP
rtcl_dn	.0042	in	*Root_clearance

PLOT CONFIGURATION:

- *Mark inv/fil intersections?
- *Mark mod/inv intersections?
- *Number of teeth on plot (Def=1)
- *Driver_contact roll angle of
- *Driver tooth number (Def=1)

DRIVER ROLL ANGLES:

- *Start_of_active profile
- *Effective outside diameter

DRIVEN ROLL ANGLES:

- *Start_of_active profile
- *Effective outside diameter

DRIVER HOB:

- *Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
- *Flank_angle
- *Tip_to_Reference Line
- *Tooth_thickness at Reference Line
- *Reference_Line to Start Mod Ramp
- *Pressure_Angle of Mod Ramp
- *Tip_radius
- *Protuberance
- *Protuberance_angle from flank
- *Protuberance_pressure angle
- *Tip_to_flank/prot intersection
- *Ref_Line to Hob SAP
- *Normal_Space Width at Hob SAP

DRIVEN HOB:

- *Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
- *Flank_angle
- *Tip_to_Reference Line
- *Tooth_thickness at Reference Line
- *Reference_Line to Start Mod Ramp
- *Pressure_Angle of Mod Ramp
- *Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space Width at Hob SAP

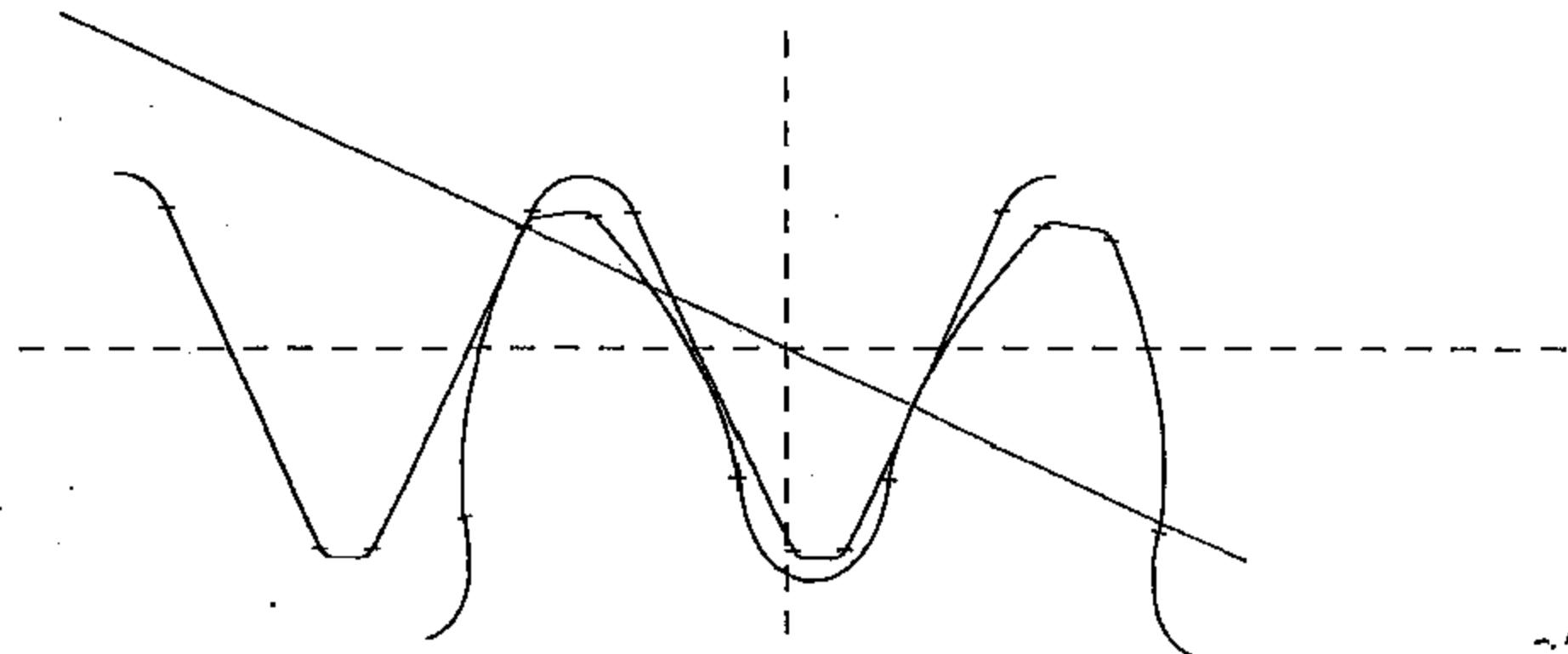
nc_dr	-	in	DRIVER SHAPER:
odc_dr	-	in	*Number_of_Teeth
nttc_dr	-	in	*Outside_Diameter
rts_dr	-	in	*Normal_Tooth_Thickness
us_dr	-	in	*Tip_Radius - Normal Plane
cds_dr	NA	in	*Protuberance - Normal Plane
sapc_dr	-	in	*Center distance with gear
			*Start_of_active_profile diameter

nc_dn	-	in	DRIVEN SHAPER:
cdc_dn	-	in	*Number_of_Teeth
nttc_dn	-	in	*Outside_Diameter
rts_dn	-	in	*Normal_Tooth_Thickness
us_dn	-	in	*Tip_Radius - Normal Plane
cds_dn	NA	in	*Protuberance - Normal Plane
sapc_dn	-	in	*Center distance with gear
			*Start_of_active_profile diameter

25.0000	rfa``dr	deg	FORMED DRIVER:
.0216	h``dr	in	*Basic Rack Form:
.0332	t``dr	in	*Flank Angle
.0102	rt``dr	in	*Tip to Reference Line
.0030	tc_dr	0	*Tooth Thickness at Reference Line
	tr_dr	-	*Tip_radius
	xp_dr	-	*Radial_tip chamfer Def=0
			*Normal_tip radius Def=0
			*Normal_tip_relief exponent Def=3/2

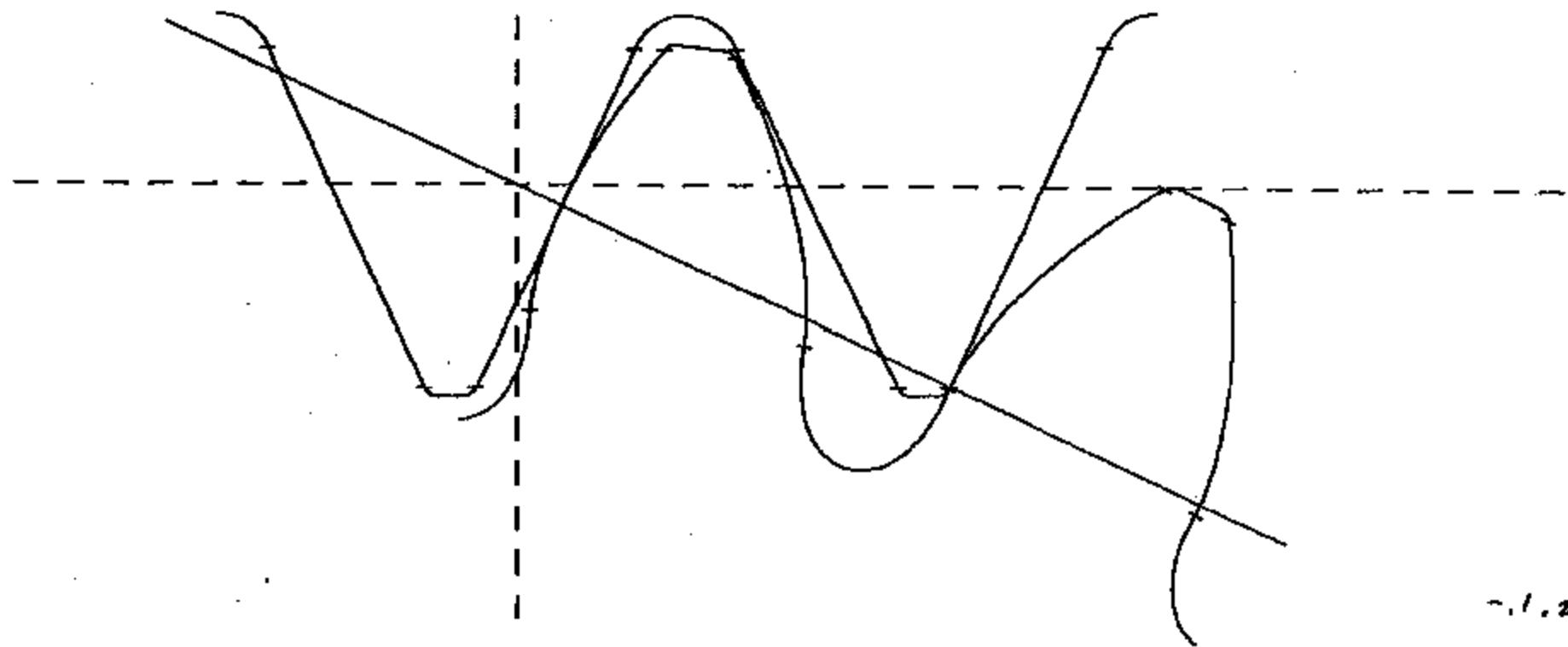
25.0000	rfa``dn	deg	FORMED DRIVEN:
.0286	h``dn	in	*Basic Rack Form:
.0322	t``dn	in	*Flank Angle
.0043	rt``dn	in	*Tip to Reference Line
.0030	tc_dn	0	*Tooth Thickness at Reference Line
	tr_dn	-	*Tip_radius
	xp_dn	-	*Radial_tip chamfer Def=0
			*Normal_tip radius Def=0
			*Normal_tip_relief exponent Def=3/2

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



100 100 100 100 100 100 100 100 100 100 100 100

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



VARIABLE SHEET					
t Input	Name	Output	Unit	Comment	
.06	Vs f	0	ft/min	LOADING:	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze drive
	eff	+67	%		*Approx_efficiency
	effback	+51	%		*Approx_efficiency backdriving
	sf3				*Anti-backdrive safety factor
	nload	14.482	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	14.482	lbf		*Total_normal tooth load
	cli	76.622	deg		*At_center of contact interval:
	s	74901	psi		*Angle between contact curvatures
	Cc	4398.2	psi		*Specific compressive stress, s
					*Load/compressive stress factor, Cc
0	power	0	HP	Driver:	*Power
3	rev_dr		rpm		*Rotational speed
15E6	tork_dr		ozf-in		*Torque
	E_dr		psi		*Young's modulus (Default = Steel)
	clindr	74.148	deg		*Contact curvature inclination angle
	tan_dr	1.6	lbf		*Tangential force
	sep_dr	6.12	lbf		*Separating force
	ax_dr	13.027	lbf		*Axial_force
	Mo_dr	1.56	lbf-in		*Overturning moment
1.9E6	rev_dn	0	rpm	Driven:	*Rotational speed
	tork_dn	36.007	ozf-in		*Torque
	E_dn		psi		*Young's modulus (Default = Bronze)
	clidn	2.474	deg		*Contact curvature inclination ang.
	tan_dn	13.027	lbf		*Tangential force
	sep_dn	6.12	lbf		*Separating force
	ax_dn	1.6	lbf		*Axial_force
	Mo_dn	.403	lbf-in		*Overturning moment
	Screw Connected to Driven and Nut				
	Screw Driving				
	T	36.006979	ozf-in	Torque	
	Fa	55.428525	lbf		Total axial resisting load
	Dm		in		Thread pitch diameter
	Ns				Number of starts
	Tlead	.1875	in		Thread lead
	p		in		Thread axial pitch
	f				Coefficient of friction: threads
	phi		deg		One half included thread angle
	alpha	10.161154	deg		Thread mean lead angle
	fc				Coefficient of friction: thrust collar
	Dc		in		Mean diameter of thrust collar
	theta	17.46629	deg		Axis to thread normal surface
	e	75.149633	%		Thread efficiency
	LgS		in		Threaded length
	OD		in		Screw OD
	RD		in		Screw Root Diameter
	ID		in		Nut ID
	At	.07282231	in^2		Tensile stress area
	An	.51452402	in^2		Total thread surface area

.03125	ScT	107.72777 psi	Compressive stress (Full contact)
	att	in	Screw axial tooth thickness
	attR	.04081885 in	Screw axial tooth thickness at Nut ID
	attN	.04211194 in	Nut axial tooth thickness at Screw OD
	SnS	.46521221 in ²	Total screw shear area
	SnN	.60804417 in ²	Total nut shear area
	SsS	119.14675 psi	Screw shear stress (Full contact)
	SsN	91.158715 psi	Nut shear stress (Full contact)
	StS	545.14191 psi	Torsional stress at screw root dia
	StA	761.14754 psi	Axial stress at screw root dia
	StR	1045.4167 psi	Max tensile stress at screw root dia
	SsR	664.84291 psi	Max shear stress at screw root dia

***** VARIABLE SHEET *****

Input		Name	Output	Unit	Comment
.06	Vs f	0		ft/min	LOADING:
	eff	+67	%		*Maximum sliding velocity
	effback	+51	%		*Approx_coefficient of friction
	sfB				(Default value is for hardened
	nload	28.964	lbf		steel driver and bronze driv.
	Fo	1			*Approx_efficiency
	tnload	28.964	lbf		*Approx_efficiency backdriving
					*Anti-backdrive safety factor
	cli	76.622	deg		*Imposed normal tooth load
	s	94370	psi		*Overload factor Def-1
	Cc	8796.3	psi		*Total_normal tooth load
					*At_center of contact interval:
					*Angle between contact curvatures
					*Specific compressive stress, s
					*Load/compressive stress factor, Cc
0	power	0	HP		Driver:
6	rev_dr		rpm		*Power
15E6	tork_dr		ozf-in		*Rotational speed
	E_dr		psi		*Torque
	clidr	74.148	deg		*Young's modulus (Default = Steel)
	tan_dr	3.199	lbf		*Contact curvature inclination angle
	sep_dr	12.241	lbf		*Tangential force
	ax_dr	26.054	lbf		*Separating force
	Mo_dr	3.12	lbf-in		*Axial_force
					*Overturning moment
1.9E6	rev_dn	0	rpm		Driven:
	tork_dn	72.014	ozf-in		*Rotational speed
	E_dn		psi		*Torque
	clidn	2.474	deg		*Young's modulus (Default = Bronze)
	tan_dn	26.054	lbf		*Contact curvature inclination ang
	sep_dn	12.241	lbf		*Tangential force
	ax_dn	3.199	lbf		*Separating force
	Mo_dn	.805	lbf-in		*Axial_force
					*Overturning moment
					Screw Connected to Driven and Nut
					Screw Driving
	T	72.013959	ozf-in		Torque
	Fa	110.85705	lbf		Total axial resisting load
	Dm		in		Thread pitch diameter
	Ns				Number of starts
	Tlead	.1875	in		Thread lead
	P		in		Thread axial pitch
	f`				Coefficient of friction: threads
	phi		deg		One half included thread angle
	alpha	10.161154	deg		Thread mean lead angle
	fc				Coefficient of friction: thrust collar
	Dc		in		Mean diameter of thrust collar
	theta	17.46629	deg		Axis to thread normal surface
	e	75.149633	%		Thread efficiency
	Lgs		in		Threaded length
	OD		in		Screw OD
	RD		in		Screw Root Diameter
	ID		in		Nut ID
	At	.07282231	in^2		Tensile stress area
	An	.51452402	in^2		Total thread surface area

.03125	ScT	215.45554	psi	Compressive stress (Full contact)
	att		in	Screw axial tooth thickness
	attR	.04081885	in	Screw axial tooth thickness at Nut ID
	attN	.04211194	in	Nut axial tooth thickness at Screw OD
	SnS	.46521221	in ²	Total screw shear area
	SnN	.60804417	in ²	Total nut shear area
	SsS	238.29351	psi	Screw shear stress (Full contact)
	SsN	182.31743	psi	Nut shear stress (Full contact)
	StS	1090.2838	psi	Torsional stress at screw root dia
	StA	1522.2951	psi	Axial stress at screw root dia
	StR	2090.8334	psi	Max tensile stress at screw root dia
	SsR	1329.6858	psi	Max shear stress at screw root dia

***** VARIABLE SHEET *****

Input--- Name--- Output--- Unit---- Comment-----

#2 Max Eff CD - Hot

60-146 (Ver 4.2) Eff Center Distance
Due to Tolerance, Operating
Temperature & Moisture Absorption
Press "Alt A" for Model Solutions
External or Internal Set ('e or 'i)

ASSEMBLY CONDITIONS:

Normal Diametral Pitch

Normal Module

Helix Angle

Operating Transverse Pressure Angle
Temperature (Default =68F -20C)

Housing:

Material Number (See Material Table)

Material Code

Thermal Coefficient of expansion

Moisture Coefficient of expansion

Basic or nominal center distance

Minimum center distance tolerance

Maximum center distance tolerance

Pinion total composite tolerance

Gear total composite tolerance

Pinion bearing runout (TIR)

Gear bearing runout (TIR)

Pinion bearing total radial play

Gear bearing total radial play

Minimum assembled center distance

Maximum assembled center distance

Pinion:

Material Number (See Material Table)

Material Code

Number of teeth

AGMA Quality Class

Thermal Coefficient of expansion

Moisture Coefficient of expansion

Nominal operating pitch diameter

(Enter Ref PD for X-Axis Gears)

Gear:

Material Number (See Material Table)

Material Code

Number of teeth

AGMA Quality Class

Thermal Coefficient of expansion

Moisture Coefficient of expansion

Nominal operating pitch diameter

(Enter Ref PD for X-Axis Gears)

OPERATING CONDITIONS:

Housing temperature

Pinion temperature

Gear temperature

Effective center distance:

Change in CD (Thermal, Moisture)

Approximate change in trans backla

Minimum center distance

35	pn		1/in
	mn	.72571429	mm
7	ha		deg
25	tpa		deg
+68	TR		F

Operating Transverse Pressure Angle
Temperature (Default =68F -20C)
Housing:

19	Hmatl		
	HN	Zinc	
	KM	15.20E-6	1/degF
	KM	0	in/in
.3794	Cd		in
- .0082	Ct		in
+ .0082	Ct		in
	TCTP	.00110	in
	TCTG	.00410	in
0	bROp		in
0	bROg		in
0	bRPP		in
0	bRPg		in
	Cmin	.3712	in
	Cmax	.3928	in

Material Number (See Material Table)
Material Code
Number of teeth
AGMA Quality Class
Thermal Coefficient of expansion
Moisture Coefficient of expansion
Nominal operating pitch diameter
(Enter Ref PD for X-Axis Gears)

22	Gmatl		
	GN	For1140	
18	ng		
6	Qg		
	KG	11.67E-6	1/degF
	KG	37.50E-6	in/in
.5181	D		in

Material Number (See Material Table)
Material Code
Number of teeth
AGMA Quality Class
Thermal Coefficient of expansion
Moisture Coefficient of expansion
Nominal operating pitch diameter
(Enter Ref PD for X-Axis Gears)

+185	TM		F
+185	TP		F
+185	TG		F
	dCT	+.0002	in
	dtbl	+.0002	in
	Cmin_op	.3714	in

→ Cmax_op .3930 in Maximum center distance
 dCd .02160 in CD Range

***** VARIABLE SHEET *****

t Input --- Name --- Output --- Unit --- Comment ---

#2 Max CD, TRs Min TTs, QDs +185F

60-125 (Ver 4.2)

CROSSED AXIS INVOLUTE HELICAL GEARS

(Non-Enveloping Worm Gears)

Press "Alt A" for Solution List

35.0000	pn	1/in
25.0000	npa	deg
	n_mod	mm
	ncp	in
	pnb	in

*NORMAL PLANE:

- *Diametral_Pitch
- *Nominal Pressure Angle
- *Module
- *Circular_Pitch
- *Base Pitch

90.0000	E	deg
.39300	cd	in
	std_cd	in
	Lc	in
	mp	1.0135
	mpc	No
	mg	18

COMMON:

- *Shaft_Angle (+ or -)
- *Operating_center_distance
- *Standard_center_distance
- *Length_of_contact
- *Contact_ratio (SAP > TIF)
 - *Contact_below finished involute?
- *Gear_ratio

1	ndr	
'frm	meth_dr	
.3030	oddr	in
	modd_dr	NA
	Emod_dr	NA
	xndr	NA
	xncdr	NA
	xdr	NA
	eoddr	.2973
	nttodr	.0105
	xn_eoddr	NA
	ptd_dr	.3166
	pddr	.2344
.0400	nttdr	in
)	SSn_dr	in

*DRIVER:

- Number of teeth
- *Hobbed ('hob), Shaped ('shp)
- Formed ('frm)
- *Outside Diameter
- *Start_Tip_Modification
 - *Roll_at_start_of_tip_modification
 - *Normal_OD_tip_relief
 - *Normal_circular_OD_tip_relief
 - *Transverse_circular_OD_tip_relief
- *Effective_outside_diameter
- *Normal_tooth_thickness_at_EOD
- *Normal_EOD_tip_relief
- *Pointed_tooth_diameter (No tip mod)
- *Reference PD
- *Finished_normal_tooth_thickness
- *Total_normal_circular_finish
 - stock on tooth thickness

33.0000	hadr	deg
	ladr	deg
	Fdr_min	0.0000
	ptdr	0.0923
	cpdr	4.2654
	tmoddr	.73652
	tpaddr	5.9549
	tttdr	75.3534
	tbydr	.3282
	bhadr	.18624
	ap_dr	64.09928
	lead_dr	.09043
	Dhi_dr	.0904
	BDhi_dr	.1684
	rddr	152.3645
	dbdr	.1557
		.0593

- *Helix_angle (+ Right, - Left)
- *Lead_angle (+ Right, - Left)
- *Minimum_face_width (bi-rotation)
- *Transverse_diametral_pitch
- *Transverse_circular_pitch
- *Transverse_module
- *Transverse_pressure_angle
- *Transverse_tooth_thickness
- *Transverse_base_pitch
- *Base_helix_angle
- *Axial_pitch
- *Lead
- *Inv/fillet_intersection_dia (TIF)
 - *Roll_at_inv/fil_intersection_dia
- *Root_diameter
- *Base_diameter

18	ndn		
'frm	meth_dn		
.5700	oddn	in	
	modd_dn	in	
	Emod_dn	deg	
	xndn	in	
	xncdn	in	
	xdn	in	
	eoddn	.5655	in
	nttdn	.0160	in
	xn_eodd	NA	in
	ptd_dn	.5881	in
	pddn	.5181	in
.0405	nttdn	in	
0	SSn_dn	in	
7.0000	hadn	deg	
	ladn	83.0000	deg
	Fdn_min	.0220	in
	ptdn	34.7391	1/in
	cpdn	.09043	in
	tmoddn	.7312	mm
	tpadn	25.1646	deg
	tttdn	.0408	in
	tbpdn	.08185	in
	bhadrn	6.34132	deg
	ap_dn	.73652	in
	lead_dn	13.2574	in
	Dhi_dn	.4691	in
	EDhi_dn	1.3987	deg
	rddn	.4244	in
	dbdn	.4690	in
	delta	.01670	in
	cpc	.0043	in
	work	.0384	in
	nbbl	.0225	in
	pn	35.0000	1/in
	ncp	.08976	in
	npa	25.0000	deg
	pddr	.2344	in
	nttdr	.0400	in
	hadr	83.0000	deg
	ladr	7.0000	deg
	ptdr	4.2654	1/in
	cpdr	.73652	in
	tmoddr	5.9549	mm
	tpadr	75.3534	deg
	tttdr	.3282	in
	abldr	99.62	deg
	sap_dr	.2272	in
	nttsapr	.0434	in

*DRIVEN:

- Number of teeth
- *Hobbed ('hob), Shaped ('shp)
- Formed ('frm)
- *Outside Diameter
- *Start_Tip Modification
 - *Roll_at_start of tip modification
 - *Normal_OD tip relief
 - *Normal_circular_OD tip relief
 - *Transverse_circular_OD tip relief
- *Effective_outside diameter
- *Normal_tooth_thickness_at_EOD
- *Normal_EOD tip relief
- *Pointed tooth diameter (No tip mod)
- *Reference PD
- *Finished normal tooth thickness
- *Total normal circular finish
 - stock on tooth thickness
- *Helix angle (+ Right, - Left)
- *Lead_angle (+ Right, - Left)
- *Minimum face width (bi-rotation)
- *Transverse_diametral pitch
- *Transverse_circular pitch
- *Transverse_module
- *Transverse_pressure_angle
- *Transverse_tooth thickness
- *Transverse_base_pitch
- *Base_helix_angle
- *Axial_pitch
- *Lead
- *Inv/fillet intersection dia (TIF)
 - *Roll_at_inv/fil intersection dia
- *Root_diameter
- *Base_diameter

OPERATING DATA:

- *Separation of pitch planes
- *Contact_path to line of centers
- *Working_depth

Normal Plane:

- *Base_backlash
- *Diametral_pitch
- *Circular_pitch
- *Pressure_angle

*DRIVER:

- *Pitch_diameter
- *Normal_Tooth_Thickness
- *Helix_Angle (+ Right, - Left)
- *Lead_Angle (+ Right, - Left)
- *Transverse_Diametral_Pitch
- *Transverse_Circular_Pitch
- *Transverse_Module
- *Transverse_Pressure_Angle
- *Transverse_Tooth_Thickness
- *Angular_backlash
- *Start_of_active_profile (SAP)
- *Normal_tooth_thickness_at_SAP

nswlddr	.0464	in	*Normal_space width at SAP
rtcl_dr	.0301	in	*Root_clearance
pddn`	.5181	in	*Pitch_diameter
nttdn`	.0405	in	*Normal_Tooth_Thickness
hadn`	7.0000	deg	*Helix_Angle (+ Right, - Left)
ladn`	83.0000	deg	*Lead_Angle (+ Right, - Left)
ptdn`	34.7391	1/in	*Transverse_Diametral_Pitch
cpdn`	.09043	in	*Transverse_Circular_Pitch
tmoddn`	.7312	mm	*Transverse_Module
tpadn`	25.1646	deg	*Transverse_Pressure_Angle
tttdn`	.0408	in	*Transverse_Tooth_Thickness
abldn	5.534	deg	*Angular_backlash
sap_dn	.4930	in	*Start_of_active_profile (SAP)
nttsagn	.0483	in	*Normal_tooth_thicknes at SAP
nswlddn	.0372	in	*Normal_space width at SAP
rtcl_dn	.0293	in	*Root_clearance

mark	'y		
markm	'y		
teeth	1		
roll		deg	
t#	1		

Esap_dr	211.9626	deg	
Eod_dr	281.5779	deg	

Esap_dn	18.5853	deg	
Eod_dn	38.6074	deg	

tpdr	'_		
hfa_dr	-	deg	*Flank_angle
h`dr	-	in	*Tip_to_Reference_Line
t`dr	-	in	*Tooth_thickness_at_Reference_Line
hs`dr	-	in	*Reference_Line_to_Start_Mod_Ramp
hfa2_dr	-	deg	*Pressure_Angle_of_Mod_Ramp
rt_dr	-	in	*Tip_radius
u_dr	-	in	*Protuberance
ua_dr	-	deg	*Protuberance_angle_from_flank
uap_dr	-	deg	*Protuberance_pressure_angle
hu`dr	-	in	*Tip_to_flank/prot_intersection
hobAPdr	-	in	*Ref_Line_to_Hob_SAP
nswAPdr	-	in	*Normal_Space_Width_at_Hob_SAP

tpdn	'_		
hfa_dn	-	deg	*Flank_angle
h`dn	-	in	*Tip_to_Reference_Line
t`dn	-	in	*Tooth_thickness_at_Reference_Line
hs`dn	-	in	*Reference_Line_to_Start_Mod_Ramp
hfa2_dn	-	deg	*Pressure_Angle_of_Mod_Ramp
rt_dn	-	in	*Tip_radius

PLOT CONFIGURATION:

- *Mark inv/fil intersections?
- *Mark mod/inv intersections?
- *Number of teeth on plot (Def=1)
- *Driver_contact roll angle of
- *Driver tooth number (Def=1)

DRIVER ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

DRIVEN ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

DRIVER HOB:

- *Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius
- *Protuberance
- *Protuberance_angle_from_flank
- *Protuberance_pressure_angle
- *Tip_to_flank/prot_intersection
- *Ref_Line_to_Hob_SAP
- *Normal_Space_Width_at_Hob_SAP

DRIVEN HOB:

- *Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space Width at Hob SAP

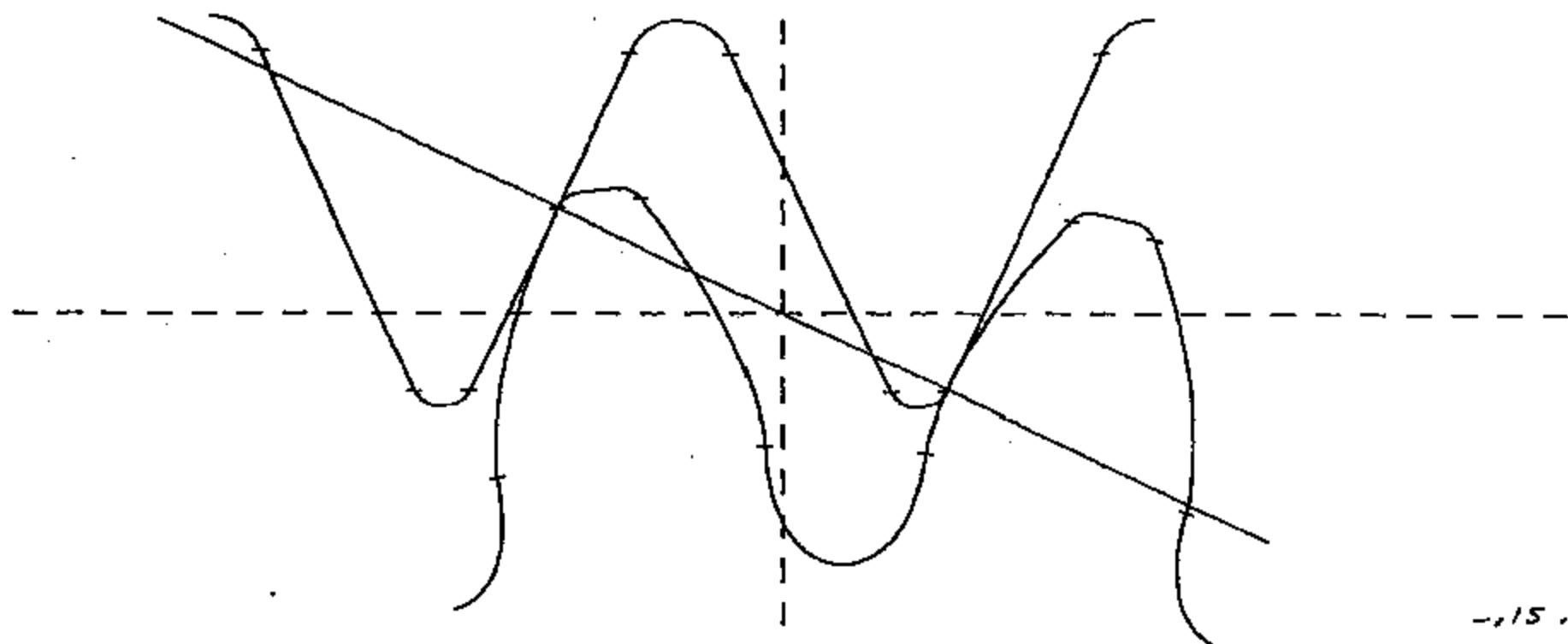
nc_dr	-	in	DRIVER SHAPER:
odc_dr	-	in	*Number_of_Teeth
nttc_dr	-	in	*Outside_Diameter
rts_dr	-	in	*Normal_Tooth_Thickness
us_dr	NA	in	*Tip_Radius - Normal Plane
cds_dr	NA	in	*Protuberance - Normal Plane
sapc_dr	-	in	*Center distance with gear
			*Start_of_active_profile diameter

nc_dn	-	in	DRIVEN SHAPER:
odc_dn	-	in	*Number_of_Teeth
nttc_dn	-	in	*Outside_Diameter
rts_dn	-	in	*Normal_Tooth_Thickness
us_dn	-	in	*Tip_Radius - Normal Plane
cds_dn	NA	in	*Protuberance - Normal Plane
sapc_dn	-	in	*Center distance with gear
			*Start_of_active_profile diameter

25.0000	rfa``dr	deg	FORMED DRIVER:
.0216	h``dr	in	*Basic Rack Form:
.0332	t``dr	in	*Flank Angle
.0102	rt``dr	in	*Tip to Reference Line
.0050	tc_dr	0	*Tooth Thickness at Reference Line
	tr_dr	in	*Tip_radius
	xp_dr	-	*Radial_tip_chamfer Def=0

25.0000	rfa``dn	deg	*Normal_tip_radius Def=0
.0286	h``dn	in	*Normal_tip_relief_exponent Def=3/2
.0322	t``dn	in	FORMED DRIVEN:
.0043	rt``dn	in	*Basic Rack Form:
.0050	tc_dn	0	*Flank Angle
	tr_dn	in	*Tip to Reference Line
	xp_dn	-	*Tooth Thickness at Reference Line

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



-15 .15

12.5 X 2

VARIABLE SHEET					
Input		Name	Output	Unit	Comment
.06	Vs f	0		ft/min	LOADING: *Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	eff	+67	%		*Approx_efficiency
	effback	+51	%		*Approx_efficiency backdriving
	sfb				*Anti-backdrive safety factor
	nload	14.482	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	14.482	lbf		*Total_normal tooth load
	cli	78.683	deg		*Angle between contact curvatures
	s	57832	psi		*Specific compressive stress, s
	Cc	3096.1	psi		*Load/compressive stress factor, Cc
0	power	0	HP		Driver: *Power
3	rev_dr		rpm		*Rotational speed
15E6	tork_dr		ozf-in		*Torque
	E_dr		psi		*Young's modulus (Default = Steel)
	clidr	75.527	deg		*Contact_curvature inclination angle
	tan_dr	1.6	lbf		*Tangential force
	sep_dr	6.12	lbf		*Separating force
	ax_dr	13.027	lbf		*Axial_force
	Mo_dr	1.707	lbf-in		*Overturning moment
1.5E6	rev_dn	0	rpm		Driven: *Rotational speed
	tork_dn	36.007	ozf-in		*Torque
	E_dn		psi		*Young's modulus (Default = Bronze)
	clidn	3.155	deg		*Contact_curvature inclination angle
	tan_dn	13.027	lbf		*Tangential force
	sep_dn	6.12	lbf		*Separating force
	ax_dn	1.6	lbf		*Axial_force
	Mo_dn	.419	lbf-in		*Overturning moment
	Screw Connected to Driven and Nut				
	Screw Driving				
	T	36.006979	ozf-in		Torque
	Fa	55.428525	lbf		Total axial resisting load
	Dm		in		Thread pitch diameter
	Ns				Number of starts
	Tlead	.1875	in		Thread lead
	P		in		Thread axial pitch
	f				Coefficient of friction: threads
	phi		deg		One half included thread angle
	alpha	10.161154	deg		Thread mean lead angle
	fc				Coefficient of friction: thrust collar
	Dc		in		Mean diameter of thrust collar
	theta	17.46629	deg		Axis to thread normal surface
	e	75.149633	%		Thread efficiency
	Lgs		in		Threaded length
	OD		in		Screw OD
	RD		in		Screw Root Diameter
	ID		in		Nut ID
	At	.07282231	in^2		Tensile stress area
	An	.51452402	in^2		Total thread surface area

.03125 ScT 107.72777 psi Compressive stress (Full contact)
 att in Screw axial tooth thickness
 attR .04081885 in Screw axial tooth thickness at Nut ID
 attN .04211194 in Nut axial tooth thickness at Screw OD
 SnS .46521221 in² Total screw shear area
 SnN .60804417 in² Total nut shear area
 SsS 119.14675 psi Screw shear stress (Full contact)
 SsN 91.158715 psi Nut shear stress (Full contact)
 StS 545.14191 psi Torsional stress at screw root dia
 StA 761.14754 psi Axial stress at screw root dia

 StR 1045.4167 psi Max tensile stress at screw root dia
 SsR 664.84291 psi Max shear stress at screw root dia

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
.06	Vs f	0	ft/min	LOADING:	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	eff	+67	%		*Approx_efficiency
	effback	+51	%		*Approx_efficiency backdriving
	sfb				*Anti-backdrive safety factor
	nload	28.964	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	28.964	lbf		*Total_normal tooth load
	cli	78.683	deg		*At_center of contact interval:
	s	72863	psi		*Angle between contact curvatures
	Cc	6192.3	psi		*Specific compressive stress, s
	power	0	HP		*Load/compressive stress factor, Cc
0	rev_dr		rpm	Driver:	*Power
6	tork_dr		ozf-in		*Rotational speed
15E6	E_dr		psi		*Torque
	clidr	75.527	deg		*Young's modulus (Default = Steel)
	tan_dr	3.199	lbf		*Contact_curvature inclination angle
	sep_dr	12.241	lbf		*Tangential force
	ax_dr	26.054	lbf		*Separating force
	Mo_dr	3.415	lbf-in		*Axial_force
	rev_dn	0	rpm		*Overturning moment
	tork_dn	72.014	ozf-in	Driven:	*Rotational speed
1.5E6	E_dn		psi		*Torque
	clidn	3.155	deg		*Young's modulus (Default = Bronze)
	tan_dn	26.054	lbf		*Contact curvature inclination angle
	sep_dn	12.241	lbf		*Tangential force
	ax_dn	3.199	lbf		*Separating force
	Mo_dn	.838	lbf-in		*Axial_force
					*Overturning moment
				Screw Connected to Driven and Nut	
				Screw Driving	
	T	72.013959	ozf-in		Torque
	Fa	110.85705	lbf		Total axial resisting load
.333	Dm		in		Thread pitch diameter
3	Ns				Number of starts
	Tlead	.1975	in		Thread lead
.0625	p		in		Thread axial pitch
.06	f				Coefficient of friction: threads
14.5	phi		deg		One half included thread angle
0	alpha	10.161154	deg		Thread mean lead angle
.375	fc				Coefficient of friction: thrust collar
	Dc		in		Mean diameter of thrust collar
	theta	17.46629	deg		Axis to thread normal surface
	e	75.149633	%		Thread efficiency
.766	Lgs		in		Threaded length
.375	OD		in		Screw OD
.276	RD		in		Screw Root Diameter
.296	ID		in		Nut ID
	At	.07282231	in^2		Tensile stress area
	An	.51452402	in^2		Total thread surface area

.03125	ScT	215.45554	psi	Compressive stress (Full contact)
	att		in	Screw axial tooth thickness
	attR	.04081885	in	Screw axial tooth thickness at Nut ID
	attN	.04211194	in	Nut axial tooth thickness at Screw OD
	SnS	.46521221	in ²	Total screw shear area
	SnN	.60804417	in ²	Total nut shear area
	SsS	238.29351	psi	Screw shear stress (Full contact)
	SsN	182.31743	psi	Nut shear stress (Full contact)
	StS	1090.2838	psi	Torsional stress at screw root dia
	StA	1522.2951	psi	Axial stress at screw root dia
	StR	2090.8334	psi	Max tensile stress at screw root dia
	SsR	1329.6858	psi	Max shear stress at screw root dia

***** VARIABLE SHEET *****

Input	Name	Output	Unit	Comment
35.0000	pn		1/in	#2 Nominal
25.0000	npa		deg	60-125 (Ver 4.2)
	n_mod	.7257	mm	CROSSED AXIS INVOLUTE HELICAL GEARS
	ncp	.0898	in	(Non-Enveloping Worm Gears)
	pnb	.08135	in	Press "Alt A" for Solution List
				*NORMAL PLANE:
				*Diametral_Pitch
				*Nominal Pressure Angle
				*Module
				*Circular_Pitch
				*Base Pitch
				COMMON:
90.0000	E		deg	*Shaft Angle (+ or -)
.37940	cd		in	*Operating_center distance
	std_cd	.37630	in	*Standard_center distance
	Lc	.1202	in	*Length of contact
	mp	1.4777		*Contact ratio (SAP > TIF)
	mpc	No		*Contact_below finished involute?
	mg	18		*Gear_ratio
				*DRIVER:
1	ndr			Number of teeth
'frm	math_dr			*Hobbed ('hob), Shaped ('shp)
				Formed ('frm)
.3040	oddr		in	*Outside Diameter
	modd_dr	NA	in	*Start_Tip_Modification
	Bmod_dr	NA	deg	*Roll_at_start of tip modification
	xndr	NA	in	*Normal_OD tip relief
	xncdr	NA	in	*Normal_circular OD tip relief
	xdr	NA	in	*Transverse_circular_OD tip relief
	eoddr	.2994	in	*Effective_outside_diameter
	nttdr	.0102	in	*Normal_tooth_thickness_at_EOD
	xn_eodd	NA	in	*Normal_EOD tip relief
	ptd_dr	.3182	in	*Pointed tooth diameter (No tip mod)
	pddr	.2344	in	*Reference PD
.0408	nttdr		in	*Finished normal tooth thickness
0	SSn_dr		in	*Total normal circular finish
				stock on tooth thickness
83.0000	hadr		deg	*Helix angle (+ Right, - Left)
	ladr	7.0000	deg	*Lead_angle (+ Right, - Left)
	Fdr_min	.1298	in	*Minimum face width (bi-rotation)
	ptdr	4.2654	1/in	*Transverse_diametral pitch
	cpdr	.73652	in	*Transverse_circular pitch
	tmoddr	5.9549	mm	*Transverse_module
	tpadr	75.3534	deg	*Transverse_pressure_angle
	tttdr	.3344	in	*Transverse_tooth thickness
	tbpdr	.18624	in	*Transverse_base_pitch
	bhadr	64.09928	deg	*Base_helix_angle
	ap_dr	.09043	in	*Axial_pitch
	lead_dr	.0904	in	*Lead
	Dhi_dr	.1700	in	*Inv/fillet intersection dia (TIF)
	EDhi_dr	153.9712	deg	*Roll_at_inv/fil intersection dia
	rddr	.1573	in	*Root_diameter
	dbdr	.0593	in	*Base_diameter

18 ndn
 'frm meth_dn
 .5725 oddn in
 modd_dn NA in
 Emod_dn NA deg
 xndn NA in
 xncdn NA in
 xdn NA in
 eoddn .5689 in
 nttdn .0148 in
 xn_eodd NA in
 ptd_dn .5896 in
 pddn .5181 in
 .0415 nttdn in
 0 SSn_dn in
 7.0000 hadn deg
 ladn 83.0000 deg
 Fdn_min .0226 in
 ptdn 34.7391 1/in
 cpdn .09043 in
 tmoddn .7312 mm
 tpadn 25.1646 deg
 ttdn .0418 in
 tbpdn .08185 in
 bhadn 6.34132 deg
 ap_dn .73652 in
 lead_dn 13.2574 in
 Dhi_dn .4693 in
 EDhi_dn 2.0148 deg
 rddn .4265 in
 dbdn .4690 in

***DRIVEN:**
 Number of teeth
 *Hobbed ('hob), Shaped ('shp)
 Formed ('frm)
***Outside Diameter**
 *Start Tip Modification
 *Roll_at_start of tip modification
 *Normal_OD tip relief
 *Normal_circular OD tip relief
 *Transverse_circular_OD tip relief
***Effective_outside diameter**
 *Normal_tooth_thickness_at_EOD
 *Normal_EOD tip relief
***Pointed tooth diameter (No tip mod)**
***Reference PD**
 *Finished normal tooth thickness
 *Total normal circular finish
 stock on tooth thickness
 *Helix angle (+ Right, - Left)
 *Lead_angle (+ Right, - Left)
 *Minimum face width (bi-rotation)
 *Transverse_diametral pitch
 *Transverse_circular pitch
 *Transverse_module
 *Transverse_pressure angle
 *Transverse_tooth thickness
 *Transverse_base pitch
 *Base_helix angle
 *Axial pitch
 *Lead
 *Inv/fillet intersection dia (TIF)
 *Roll_at_inv/fil intersection dia
 *Root_diameter
 *Base_diameter

OPERATING DATA:
 delta .00310 in
 cpc .0008 in
 work .0548 in
 nbbl .0094 in
 pn 35.0000 1/in
 ncp .08976 in
 npa 25.0000 deg

pddr .2344 in
 nttdr .0407 in
 hadr 83.0000 deg
 ladr 7.0000 deg
 ptdr 4.2654 1/in
 cpdr .73652 in
 tmoddr 5.9549 mm
 tpaddr 75.3534 deg
 ttdr .3344 in
 abldr 41.732 deg
 sap_dr .1976 in
 nttsapr .0576 in

***SEPARATION OF PITCH PLANES**
***CONTACT PATH TO LINE OF CENTERS**
***WORKING DEPTH**
Normal Plane:
 *Base_backlash
 *Diametral_pitch
 *Circular_pitch
 *Pressure_angle
***DRIVER:**
 *Pitch_diameter
 *Normal_Tooth_Thickness
 *Helix_Angle (+ Right, - Left)
 *Lead_Angle (+ Right, - Left)
 *Transverse_Diametral_Pitch
 *Transverse_Circular_Pitch
 *Transverse_Module
 *Transverse_Pressure_Angle
 *Transverse_Tooth_Thickness
 *Angular_backlash
 *Start_of_active_profile (SAP)
 *Normal_tooth_thickness_at_SAP

nswladdr	.0318	in
rtcl_dr	.0145	in
pddn`	.5181	in
nttdn`	.0415	in
hadn`	7.0000	deg
ladn`	83.0000	deg
ptdn`	34.7391	1/in
cpdn`	.09043	in
tmoddn`	.7312	mm
cpadn`	25.1646	deg
tttdn`	.0418	in
abldn	2.318	deg
sap_dn	.4763	in
nttsapn	.0518	in
nswladdr	.0308	in
rtcl_dn	.0141	in

- *Normal_space width at SAP
- *Root_clearance
- *DRIVEN:
- *Pitch_diameter
- *Normal_Tooth_Thickness
- *Helix_Angle (+ Right, - Left)
- *Lead_Angle (+ Right, - Left)
- *Transverse_Diametral_Pitch
- *Transverse_Circular_Pitch
- *Transverse_Module
- *Transverse_Pressure_Angle
- *Transverse_Tooth_Thickness
- *Angular_backlash
- *Start_of_active_profile (SAP)
- *Normal_tooth_thicknes at SAP
- *Normal_space_width at SAP
- *Root_clearance

mark	'y	
markm	'y	
teeth	1	
roll		deg
t#	1	

PLOT CONFIGURATION:

- *Mark_inv/fil intersections?
- *Mark_mod/inv intersections?
- *Number_of_teeth on plot (Def=1)
- *Driver_contact roll angle of
- *Driver tooth number (Def=1)

Esap_dr	182.1884	deg
Eod_dr	283.6891	deg

DRIVER ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

Esap_dn	10.1630	deg
Eod_dn	39.3557	deg

DRIVEN ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

tpdr	'	
hfa_dr	-	deg
h`dr	-	in
t`dr	-	in
hs`dr	-	in
hfa2_dr	-	deg
rt_dr	-	in
u_dr	-	in
ua_dr	-	deg
uap_dr	-	deg
hu`dr	-	in
hobAPdr	-	in
nswAPdr	-	in

DRIVER HOB:

- *Hob_type (Semi-Top-'s, Tip-Rel-'r
Non-Top-'n)
- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius
- *Protuberance
- *Protuberance_angle_from_flank
- *Protuberance_pressure_angle
- *Tip_to_flank/prot_intersection
- *Ref_Line_to_Hob_SAP
- *Normal_Space_Width_at_Hob_SAP

cpdn	'	
hfa_dn	-	deg
h`dn	-	in
t`dn	-	in
hs`dn	-	in
hfa2_dn	-	deg
rt_dn	-	in

DRIVEN HOB:

- *Hob_type (Semi-Top-'s, Tip-Rel-'r
Non-Top-'n)
- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space Width at Hob SAP

DRIVER SHAPER:

nc_dr	-	in	*Number_of_Teeth
odc_dr	-	in	*Outside_Diameter
nttc_dr	-	in	*Normal_Tooth_Thickness
rts_dr	-	in	*Tip_Radius - Normal Plane
us_dr	-	in	*Protuberance - Normal Plane
cds_dr	NA	in	*Center_distance with gear
sapc_dr	-	in	*Start_of_active_profile_diameter

DRIVEN SHAPER:

nc_dn	-	in	*Number_of_Teeth
odc_dn	-	in	*Outside_Diameter
nttc_dn	-	in	*Normal_Tooth_Thickness
rts_dn	-	in	*Tip_Radius - Normal Plane
us_dn	-	in	*Protuberance - Normal Plane
cds_dn	NA	in	*Center_distance with gear
sapc_dn	-	in	*Start_of_active_profile_diameter

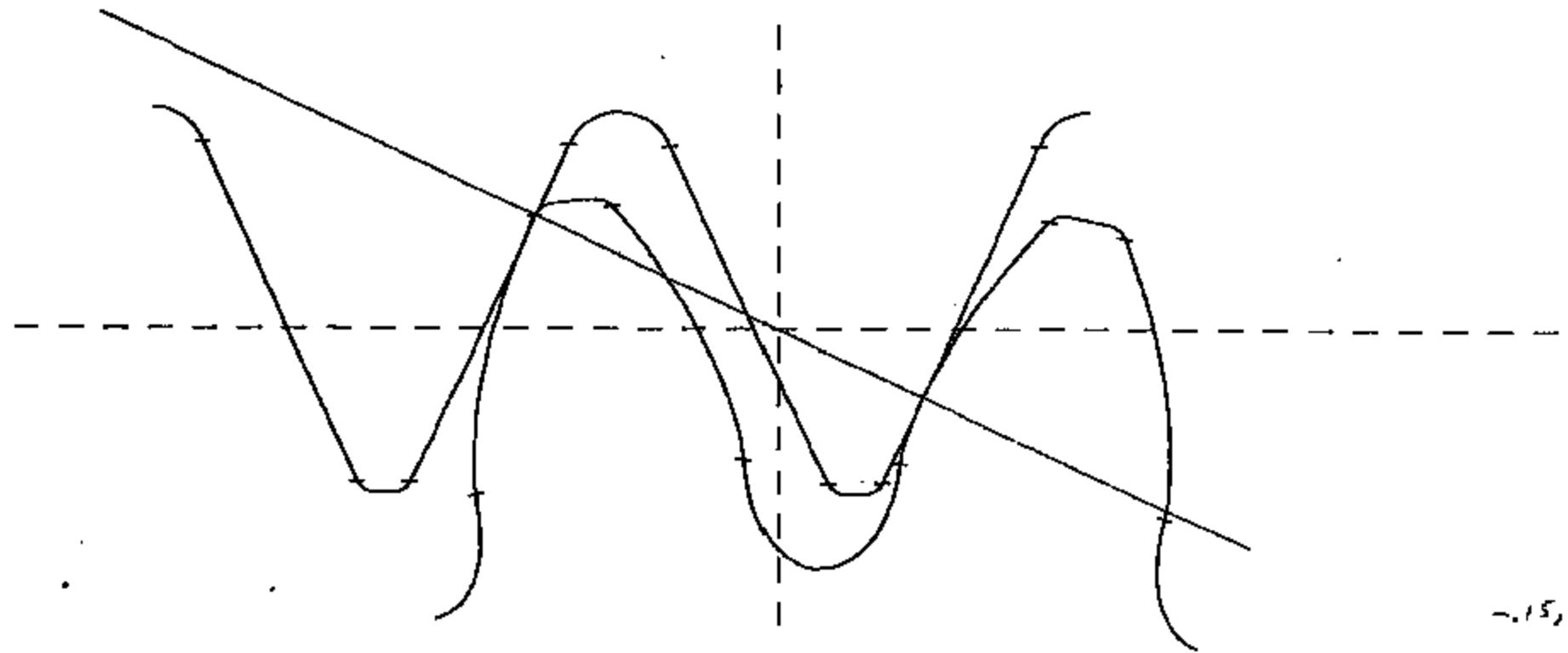
FORMED DRIVER:

			*Basic_Rack_Form:
			*Flank_Angle
			*Tip_to_Reference_Line
			*Tooth_Thickness_at_Reference_Line
			*Tip_radius
			*Radial_tip_chamfer_Def=0
			*Normal_tip_radius_Def=0
			*Normal_tip_relief_exponent_Def=3/2

FORMED DRIVEN:

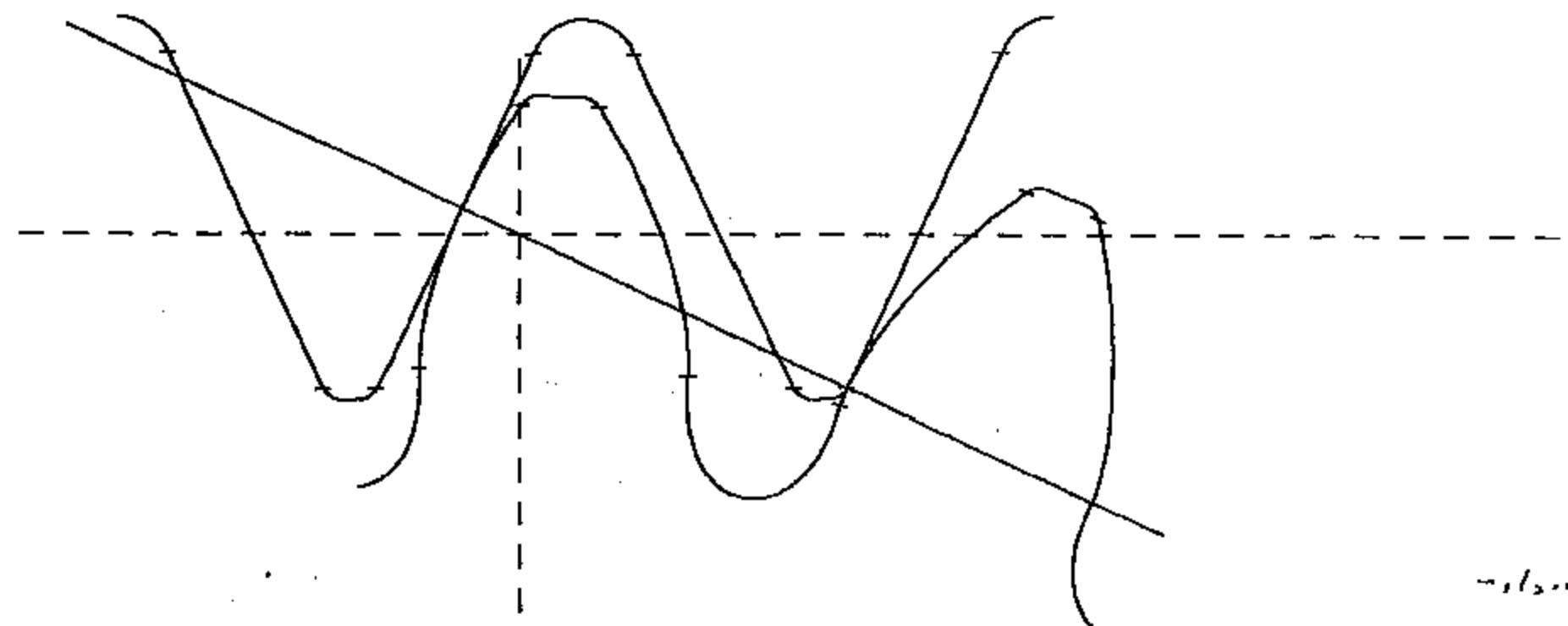
			*Basic_Rack_Form:
			*Flank_Angle
			*Tip_to_Reference_Line
			*Tooth_Thickness_at_Reference_Line
			*Tip_radius
			*Radial_tip_chamfer_Def=0
			*Normal_tip_radius_Def=0
			*Normal_tip_relief_exponent_Def=3/2

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



-154.0

Gear Mesh (Path of Contact Section = Virtual) Driver/Driven



-12.2

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
.06	Vs	0	ft/min	LOADING:	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	f				
	eff	+67	%		*Approx_efficiency
	affback	+51	%		*Approx_efficiency backdriving
	sfB				*Anti-backdrive safety factor
	nload	21.723	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	21.723	lbf		*Total_normal tooth load
	cli	77.44	deg		*At_center of contact interval:
	s	81969	psi		*Angle between contact curvatures
	Cc	5764.3	psi		*Specific compressive stress, s
					*Load/compressive stress factor, Cc
	power	0	HP	Driver:	*Power
0	rev_dr		rpm		*Rotational speed
4.5	tork_dr		ozf-in		*Torque
15E6	E_dr		psi		*Young's modulus (Default = Steel)
	clidr	74.707	deg		*Contact curvature inclination angle
	tan_dr	2.399	lbf		*Tangential force
	sep_dr	9.18	lbf		*Separating force
	ax_dr	19.541	lbf		*Axial_force
	Mo_dr	2.425	lbf-in		*Overturning moment
	rev_dn	0	rpm	Driven:	*Rotational speed
	tork_dn	54.01	ozf-in		*Torque
1.9E6	E_dn		psi		*Young's modulus (Default = Bronze)
	clidn	2.733	deg		*Contact curvature inclination angle
	tan_dn	19.541	lbf		*Tangential force
	sep_dn	9.18	lbf		*Separating force
	ax_dn	2.399	lbf		*Axial_force
	Mo_dn	.613	lbf-in		*Overturning moment
	T	54.010469	ozf-in	Screw Connected to Driven and Nut	
	Fa	83.142788	lbf	Screw Driving	
.333	Dm		in	Torque	
3	Ns			Total axial resisting load	
	Tlead	.1875	in	Thread pitch diameter	
.0625	P		in	Number of starts	
.06	f			Thread lead	
14.5	phi		deg	Thread axial pitch	
	alpha	10.161154	deg	Coefficient of friction: threads	
0	fc			One half included thread angle	
.375	Dc		in	Thread mean lead angle	
	theta	17.46629	deg	Coefficient of friction: thrust collar	
	e	75.149633	t	Mean diameter of thrust collar	
.766	Lgs		in	Axis to thread normal surface	
.375	OD		in	Thread efficiency	
.276	RD		in	Threaded length	
.296	ID		in	Screw OD	
	At	.07282231	in^2	Screw Root Diameter	
	An	.51452402	in^2	Nut ID	
				Tensile stress area	
				Total thread surface area	

.03125	ScT	161.59165 psi	Compressive stress (Full contact)
	att	in	Screw axial tooth thickness
	attR	.04081885 in	Screw axial tooth thickness at Nut ID
	attN	.04211194 in	Nut axial tooth thickness at Screw OD
	SnS	.46521221 in ²	Total screw shear area
	SnN	.60804417 in ²	Total nut shear area
	SsS	178.72013 psi	Screw shear stress (Full contact)
	SsN	136.73807 psi	Nut shear stress (Full contact)
	StS	817.71286 psi	Torsional stress at screw root dia
	StA	1141.7213 psi	Axial stress at screw root dia
	StR	1568.125 psi	Max tensile stress at screw root dia
	SsR	997.26436 psi	Max shear stress at screw root dia

***** VARIABLE SHEET *****

Input	Name	Output	Unit	Comment
				#2 Nominal Hoechst 90 deg Worm Gears Steel, Hostaform Worm/Hostaform Gear Non-Enveloping (Crossed Axis Helical) (See 60-125 for Input Data) Press "Alt U" for Units Change

	1	z_1		GENERAL:
	18	z_2		Number of Worm Teeth
		i	18	Number of Gear Teeth
		m_n	.72571429 mm	Ratio
	35	DP_n		Normal Module
		m	.73116427 mm	Normal Diametral Pitch
		DP	34.739115	Gear Trans Module
	25.0000	$n_p a$	deg	Gear Trans Pitch
		$t_p a$	25.1646 deg	Normal Pressure Angle
	7.0000	γ_n	deg	Gear Trans Pressure Angle @ Ref PD
				Worm Lead Angle
	.3794	a	in	Center Distance
	.3040	d_{a1}	in	Worm OD
	.5725	d_{a2}	in	Gear OD
		d_{m1}	.2452 in	Worm Mean Working Depth Dia
		d_{m2}	.5137 in	Gear Mean Working Depth Dia
		wkd	.0588 in	Working Depth
				LOAD CHARACTERISTIC:
	19.541	F2	lbf	Gear Tangential Load
0		w	ft/min	Flank Sliding Velocity
		b	.1798 in	Effective Face Width
		fz	.59	Tooth Number Coefficient
		c	2031.684 lbf/in^2	Load Characteristic, c
		c _{al}	1160.3019 lbf/in^2	Allowable Load Characteristic, c
		Sc	.57	Load Characteristic Safety Factor
				TOOTH BREAKAGE:
	26.054667	F2max	lbf	Maximum Gear Tangential Load
185		T	F	Operating Temperature
		r _{a1}	.1520 in	Worm Outside Radius
		r _{m1}	.1226 in	Worm Mean Working Depth Radius
		r _{a2}	.2863 in	Gear Outside Radius
	.0418	ttt	in	Gear Trans Tooth Thickness @ Ref PD (If Hostaform Worm, Gear TTT Should Be Approx Equal to Worm TTT)
		tttm	.0435 in	Gear Trans Tooth Thickness @ Mean Dia
		dbg	.4690 in	Gear Base Dia
		chi	73.6683 deg	
		phi	20.0000 deg	Pitch Angle
		t	3	Number of Engaged Teeth
		sm	.0370 in	Ave Width of Shear-Stressed Surface
		A	.0273 in^2	Total Shear-Stressed Area
		τ_{aB}	5545.6 lbf/in^2	Allowable Shear Stress
		F _b	151.2278 lbf	Tooth Breakage Force
		S	5.80	Tooth Breakage Safety Factor

Set #3
Design Data

15:1 0.156" Thread Lead

***** VARIABLE SHEET *****

t Input--- Name--- Output--- Unit---- Comment-----
 #3 Min Eff CD - Cold
 60-146 (Ver 4.2) Eff Center Distance
 Due to Tolerance, Operating
 Temperature & Moisture Absorption
 Press "Alt A" for Model Solutions
 External or Internal Set ('e or 'i)

'e type

30.1 pn 1/in
 mm .84385382 mm
 8 ha deg
 25 tpa deg
 +68 TR F

ASSEMBLY CONDITIONS:

Normal Diametral Pitch
 Normal Module
 Helix Angle
 Operating Transverse Pressure Angle
 Temperature (Default =68F =20C)
 Housing:

19 Hmatl
 HN Zinc
 XM 15.20E-6 1/degF
 XM' 0 in/in
 .3794 Cd in
 -.0082 Ct in
 +.0082 Ct'' in
 TCTP .00120 in
 TCTG .00440 in
 0 bROP in
 0 bROG in
 0 bRPP in
 0 bRPg in
 Cmin .3712 in
 Cmax .3932 in

Material Number (See Material Table)
 Material Code
 Thermal Coefficient of expansion
 Moisture Coefficient of expansion
 Basic or nominal center distance
 Minimum center distance tolerance
 Maximum center distance tolerance
 Pinion total composite tolerance
 Gear total composite tolerance
 Pinion bearing runout (TIR)
 Gear bearing runout (TIR)
 Pinion bearing total radial play
 Gear bearing total radial play
 Minimum assembled center distance
 Maximum assembled center distance

Pinion:

Material Number (See Material Table)
 Material Code
 Number of teeth
 AGMA Quality Class
 Thermal Coefficient of expansion
 Moisture Coefficient of expansion
 Nominal operating pitch diameter
 (Enter Ref PD for X-Axis Gears)

Gear:

Material Number (See Material Table)
 Material Code
 Number of teeth
 AGMA Quality Class
 Thermal Coefficient of expansion
 Moisture Coefficient of expansion
 Nominal operating pitch diameter
 (Enter Ref PD for X-Axis Gears)

22 Gmatl
 GN For1140
 15 ng
 6 Qg
 KG 11.67E-6 1/degF
 KG' 37.50E-6 in/in
 .5032 D in
 -40 TM F
 -40 TP F
 -40 TG F
 dCT' -.0002 in
 dtbl' -.0002 in
 Cmin_op .3710 in

OPERATING CONDITIONS:

Housing temperature
 Pinion temperature
 Gear temperature
 Effective center distance:
 Change in CD (Thermal, Moisture)
 Approximate change in trans backlash
 Minimum center distance

Cmax_op .3930 in
dCd .02200 in

Maximum center distance
CD Range

===== VARIABLE SHEET =====

Input	Name	Output	Unit	Comment
				#3 Min CD,TRs Max TTs,ODs -40C
				60-125 (Ver 4.2)
				CROSSED AXIS INVOLUTE HELICAL GEARS
				(Non-Enveloping Worm Gears)
				Press "Alt A" for Solution List
30.1000	pn		1/in	*NORMAL PLANE:
25.0000	npa		deg	*Diametral_Pitch
	n_mod	.8439	mm	*Nominal Pressure Angle
	ncp	.1044	in	*Module
	pnb	.09459	in	*Circular_Pitch
				*Base Pitch
90.0000	E		deg	COMMON:
.37100	cd		in	*Shaft Angle (+ or -)
	std_cd	.37098	in	*Operating_center distance
	Lc	.1592	in	*Standard_center distance
	mp	1.6834		*Length_of_contact
	mpc	No		*Contact_ratio (SAP > TIF)
	mg	15		*Contact_below finished involute?
				*Gear_ratio
1	ndr			*DRIVER:
'frm	meth_dr			Number of teeth
				*Hobbed ('hab), Shaped ('shp)
				Formed ('frm)
.3210	oddr		in	*Outside Diameter
	modd_dr	NA	in	*Start_Tip_Modification
	Bmod_dr	NA	deg	*Roll_at_start of tip modification
	xndr	NA	in	*Normal_OD tip relief
	xncdr	NA	in	*Normal_circular_OD tip relief
	xdr	NA	in	*Transverse_circular_OD tip relief
	eoddr	.3176	in	*Effective_outside_diameter
	nttodr	.0101	in	*Normal_tooth_thickness_at_EOD
	xn_eodd	NA	in	*Normal_EOD tip relief
	ptd_dr	.3353	in	*Pointed tooth diameter (No tip mod)
	pddr	.2387	in	*Reference PD
.0472	nttdr		in	*Finished_normal_tooth_thickness
0	SSn_dr		in	*Total_normal_circular_finish
				stock on tooth thickness
82.0000	hadr		deg	*Helix angle (+ Right, - Left)
	ladr	8.0000	deg	*Lead_angle (+ Right, - Left)
	Fdr_min	.1723	in	*Minimum face width (bi-rotation)
	ptdr	4.1891	1/in	*Transverse_diametral_pitch
	cpdr	.74994	in	*Transverse_circular_pitch
	tmoddr	6.0633	mm	*Transverse_module
	tpaddr	73.3819	deg	*Transverse_pressure_angle
	tttdr	.3391	in	*Transverse_tooth_thickness
	tbpdr	.21448	in	*Transverse_base_pitch
	bhadr	63.82977	deg	*Base_helix_angle
	ap_dr	.10540	in	*Axial_pitch
	lead_dr	.1054	in	*Lead
	Dhi_dr	.1780	in	*Inv/fillet intersection dia (TIF)
	EDhi_dr	137.9165	deg	*Roll_at_inv/fil intersection dia
	rddr	.1590	in	*Root_diameter
	dbdr	.0683	in	*Base_diameter

15 ndn
 'frm meth_dn
 .5750 oddn in
 modd_dn NA in
 Emod_dn NA deg
 xndn NA in
 xncdn NA in
 xdn NA in
 eoddn .5726 in
 nttdn .0186 in
 xn_eodd NA in
 ptd_dn .5960 in
 pddn .5032 in
 .0564 nttdn in
 0 SSn_dn in
 8.0000 hadn deg
 ladn 82.0000 deg
 Fdn_min .0299 in
 ptdn 29.8071 1/in
 cpdn .10540 in
 tmoddn .8521 mm
 tpadn 25.2153 deg
 tttdn .0570 in
 tbpdn .09535 in
 bhadn 7.24623 deg
 ap_dn .74994 in
 lead_dn 11.2491 in
 Dhi_dn .4555 in
 EDhi_dn 1.8863 deg
 rddn .4130 in
 dbdn .4553 in

*DRIVEN:
 Number of teeth
 *Hobbed ('hob), Shaped ('shp)
 Formed ('frm)
 *Outside Diameter
 *Start_Tip_Modification
 *Roll_at_start_of_tip_modification
 *Normal_OD_tip_relief
 *Normal_circular_OD_tip_relief
 *Transverse_circular_OD_tip_relief
 *Effective_outside_diameter
 *Normal_tooth_thickness_at_EOD
 *Normal_EOD_tip_relief
 *Pointed tooth diameter (No tip mod)
 *Reference PD
 *Finished_normal_tooth_thickness
 *Total_normal_circular_finish
 stock on tooth thickness
 *Helix_angle (+ Right, - Left)
 *Lead_angle (+ Right, - Left)
 *Minimum_face_width (bi-rotation)
 *Transverse_diametral_pitch
 *Transverse_circular_pitch
 *Transverse_module
 *Transverse_pressure_angle
 *Transverse_tooth_thickness
 *Transverse_base_pitch
 *Base_helix_angle
 *Axial_pitch
 *Lead
 *Inv/fillet_intersection_dia (TIF)
 *Roll_at_inv/fil_intersection_dia
 *Root_diameter
 *Base_diameter

delta .00002 in
 cpc 0 in
 work .0741 in
 nbbl .0007 in
 pn 30.1000 1/in
 ncp .10437 in
 npa 25.0000 deg

*OPERATING DATA:
 *Separation_of_pitch_planes
 *Contact_path_to_line_of_centers
 *Working_depth
 Normal Plane:
 *Base_backlash
 *Diametral_pitch
 *Circular_pitch
 *Pressure_angle

pdbr .2387 in
 nttdr .0472 in
 hadr 82.0000 deg
 ladr 8.0000 deg
 ptdr 4.1891 1/in
 cpdr .74994 in
 tmoddr 6.0633 mm
 tpaddr 73.3819 deg
 tttdr .3391 in
 abldr 2.742 deg
 sap_dr .1829 in
 nttsapr .0724 in

*DRIVER:
 *Pitch_diameter
 *Normal_Tooth_Thickness
 *Helix_Angle (+ Right, - Left)
 *Lead_Angle (+ Right, - Left)
 *Transverse_Diametral_Pitch
 *Transverse_Circular_Pitch
 *Transverse_Module
 *Transverse_Pressure_Angle
 *Transverse_Tooth_Thickness
 *Angular_backlash
 *Start_of_active_profile (SAP)
 *Normal_tooth_thickness_at_SAP

nswlddr	.0313	in	*Normal_space width at SAP
rtcl_dr	.0040	in	*Root_clearance
pddn`	.5032	in	*DRIVEN:
nttdn`	.0564	in	*Pitch_diameter
hadn`	8.0000	deg	*Normal_Tooth_Thickness
ladn`	82.0000	deg	*Helix_Angle (+ Right, - Left)
ptdn`	29.8071	1/in	*Lead_Angle (+ Right, - Left)
cpdn`	.10540	in	*Transverse_Diametral_Pitch
tmoddn`	.8521	mm	*Transverse_Circular_Pitch
tpadn`	25.2153	deg	*Transverse_Module
tttdn`	.0570	in	*Transverse_Pressure_Angle
abldn	.183	deg	*Transverse_Tooth_Thickness
sap_dn	.4564	in	*Angular_backlash
nttsapn	.0651	in	*Start_of_active_profile (SAP)
nswlddn	.0297	in	*Normal_tooth_thicknes at SAP
rtcl_dn	.0040	in	*Normal_space_width at SAP
			*Root_clearance

mark	'y		
markm	'y		
teeth	1		
roll		deg	
t#	1		

Esap_dr	142.4372	deg	
Eod_dr	260.3195	deg	

Esap_dn	3.9428	deg	
Eod_dn	43.7020	deg	

tpdr	'-		
hfa_dr	-	deg	
h`dr	-	in	*Flank_angle
t`dr	-	in	*Tip_to_Reference_Line
hs`dr	-	in	*Tooth_thickness_at_Reference_Line
hfa2_dr	-	deg	*Reference_Line_to_Start_Mod_Ramp
rt_dr	-	in	*Pressure_Angle_of_Mod_Ramp
u_dr	-	in	*Tip_radius
ua_dr	-	deg	*Protuberance
uap_dr	-	deg	*Protuberance_angle_from_flank
hu`dr	-	in	*Protuberance_pressure_angle
hobAPdr	-	in	*Tip_to_flank/prot_intersection
nswAPdr	-	in	*Ref_Line_to_Hob_SAP
			*Normal_Space_Width_at_Hob_SAP

tpdn	'-		
hfa_dn	-	deg	
h`dn	-	in	*Flank_angle
t`dn	-	in	*Tip_to_Reference_Line
hs`dn	-	in	*Tooth_thickness_at_Reference_Line
hfa2_dn	-	deg	*Reference_Line_to_Start_Mod_Ramp
rt_dn	-	in	*Pressure_Angle_of_Mod_Ramp

*Tip_radius

*Transverse_Diametral_Pitch

*Transverse_Circular_Pitch

*Transverse_Module

*Transverse_Pressure_Angle

*Transverse_Tooth_Thickness

*Angular_backlash

*Start_of_active_profile (SAP)

*Normal_tooth_thicknes at SAP

*Normal_space_width at SAP

*Root_clearance

PLOT CONFIGURATION:

- *Mark_inv/fill intersections?
- *Mark_mod/inv intersections?
- *Number of teeth on plot (Def=1)
- *Driver_contact roll angle of
- *Driver tooth number (Def=1)

DRIVER ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

DRIVEN ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

DRIVER HOB:

- *Hob_type (Semi-Top='s, Tip-Rel='r
Non-Top='n)
- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius
- *Protuberance
- *Protuberance_angle_from_flank
- *Protuberance_pressure_angle
- *Tip_to_flank/prot_intersection
- *Ref_Line_to_Hob_SAP
- *Normal_Space_Width_at_Hob_SAP

DRIVEN HOB:

- *Hob_type (Semi-Top='s, Tip-Rel='r
Non-Top='n)

- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space Width at Hob SAP

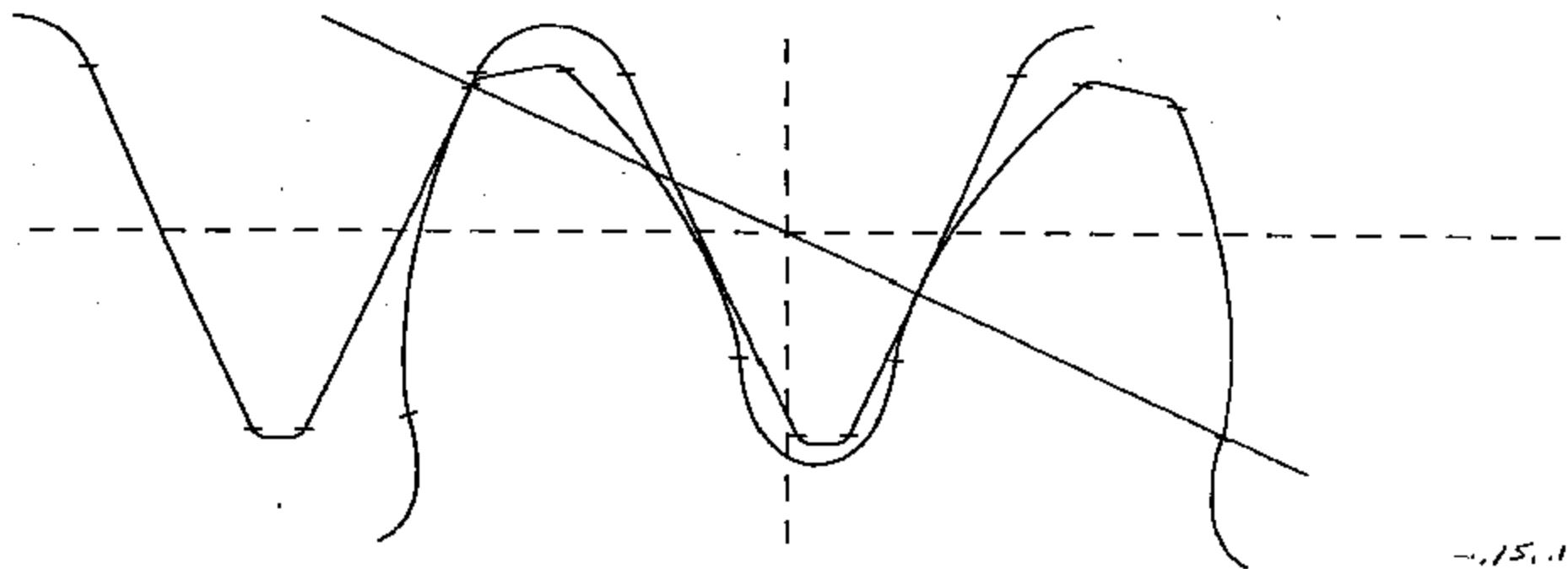
nc_dr	-	in	DRIVER SHAPER:
odc_dr	-	in	*Number_of_Teeth
nttc_dr	-	in	*Outside_Diameter
rts_dr	-	in	*Normal_Tooth_Thickness
us_dr	-	in	*Tip_Radius - Normal Plane
cds_dr	NA	in	*Protuberance - Normal Plane
sapc_dr	-	in	*Center distance with gear
			*Start_of_active_profile diameter

nc_dn	-	in	DRIVEN SHAPER:
odc_dn	-	in	*Number_of_Teeth
nttc_dn	-	in	*Outside_Diameter
rts_dn	-	in	*Normal_Tooth_Thickness
us_dn	-	in	*Tip_Radius - Normal Plane
cds_dn	NA	in	*Protuberance - Normal Plane
sapc_dn	-	in	*Center distance with gear
			*Start_of_active_profile diameter

25.0000	rfa``dr	deg	FORMED DRIVER:
.0340	h``dr	in	*Basic Rack Form:
.0517	t``dr	in	*Flank Angle
.0156	rt``dr	in	*Tip to Reference Line
.0030	tc_dr	0	*Tooth Thickness at Reference Line
	tr_dr	in	*Tip_radius
	xp_dr	-	*Radial_tip chamfer Def=0
			*Normal_tip radius Def=0
			*Normal_tip_relief exponent Def=3/2

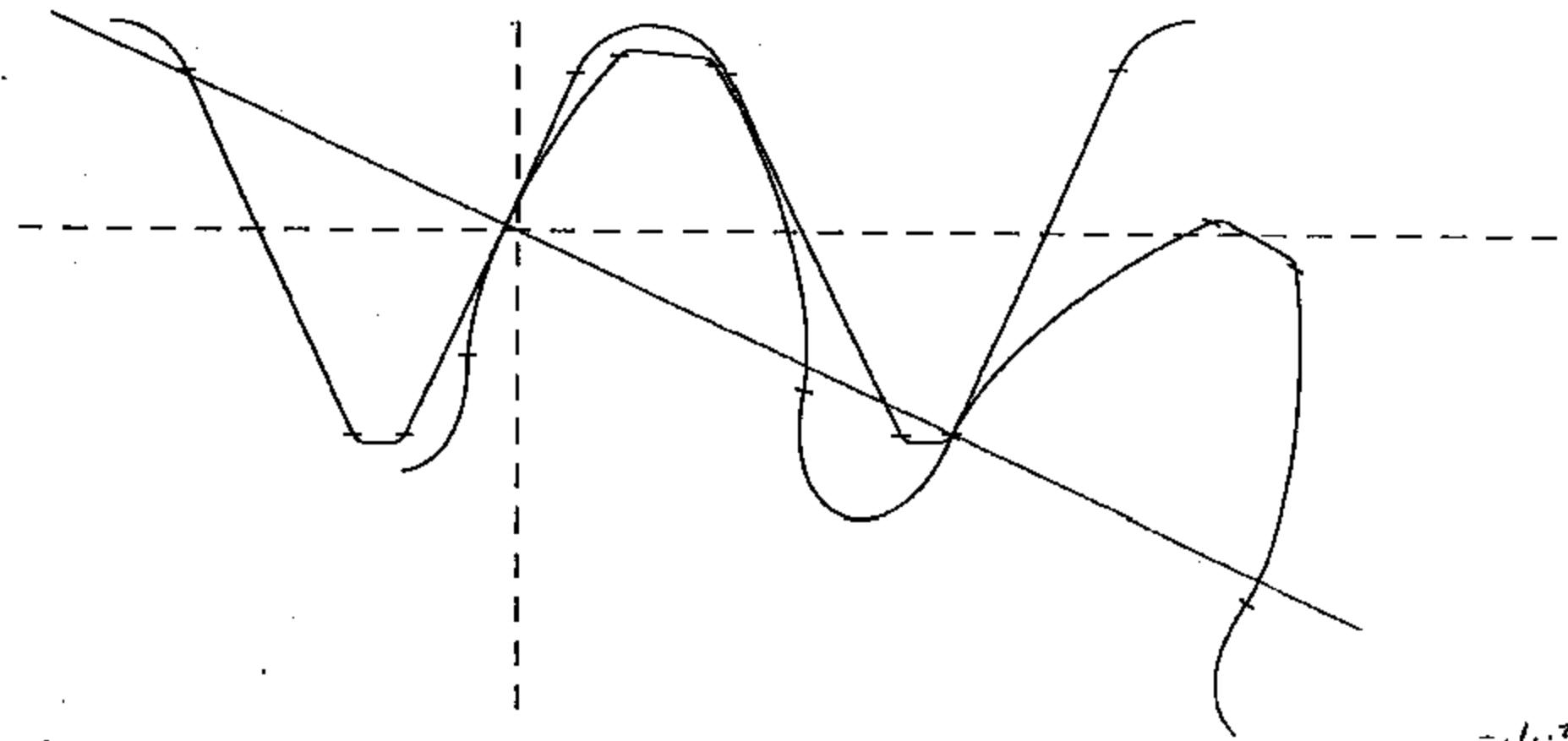
25.0000	rfa``dn	deg	FORMED DRIVEN:
.0502	h``dn	in	*Basic Rack Form:
.0527	t``dn	in	*Flank Angle
.0046	rt``dn	in	*Tip to Reference Line
.0030	tc_dn	0	*Tooth Thickness at Reference Line
	tr_dn	in	*Tip_radius
	xp_dn	-	*Radial_tip chamfer Def=0
			*Normal_tip radius Def=0
			*Normal_tip_relief exponent Def=3/2

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



-15-15

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



-1, 1, 2

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
.06	Vs f	0	ft/min	LOADING:	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	eff	+69	%		*Approx_efficiency
	effback	+57	%		*Approx_efficiency backdriving
	sfB				*Anti-backdrive safety factor
	nload	12.454	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	12.454	lbf		*Total_normal tooth load
	cli	75.413	deg		*At_center of contact interval:
	s	69674	psi		*Angle between contact curvatures
	Cc	3540.1	psi		*Specific compressive stress, s
					*Load/compressive stress factor, Cc
0	power	0	HP	Driver:	*Power
3	rev_dr		rpm		*Rotational speed
15E6	tork_dr		ozf-in		*Torque
	E_dr		psi		*Young's modulus (Default = Steel)
	clidr	72.411	deg		*Contact_curvature inclination angle
	tan_dr	1.571	lbf		*Tangential force
	sep_dr	5.263	lbf		*Separating force
	ax_dr	11.178	lbf		*Axial_force
	Mo_dr	1.394	lbf-in		*Overturning moment
1.9E6	rev_dn	0	rpm	Driven:	*Rotational speed
	tork_dn	31.27	ozf-in		*Torque
	E_dn		psi		*Young's modulus (Default = Bronze)
	clidn	3.002	deg		*Contact_curvature inclination angle
	tan_dn	11.178	lbf		*Tangential force
	sep_dn	5.263	lbf		*Separating force
	ax_dn	1.571	lbf		*Axial_force
	Mo_dn	.387	lbf-in		*Overturning moment
	Screw Connected to Driven and Nut				
	Screw Driving				
.333	T	31.270479	ozf-in	Torque	
2	Fa	~55.104335	lbf	Total axial resisting load	
	Dm		in	Thread pitch diameter	
	Ns			Number of starts	
.156	Tlead		in	Thread lead	
	P	.078	in	Thread axial pitch	
.06	f			Coefficient of friction: threads	
14.5	phi		deg	One half included thread angle	
	alpha	8.4813445	deg	Thread mean lead angle	
0	fc			Coefficient of friction: thrust collar	
.375	Dc		in	Mean diameter of thrust collar	
	theta	16.621865	deg	Axis to thread normal surface	
	e	71.307912	%	Thread efficiency	
.766	LgS		in	Threaded length	
.375	OD		in	Screw OD	
.276	RD		in	Screw Root Diameter	
.296	ID		in	Nut ID	
	At	.07282231	in^2	Tensile stress area	
	An	.41029951	in^2	Total thread surface area	

.039	ScT	134.30271 psi	Compressive stress (Full contact)
	att	in	Screw axial tooth thickness
	attR	.04856885 in	Screw axial tooth thickness at Nut ID
	attN	.04986194 in	Nut axial tooth thickness at Screw OD
	SnS	.4435408 in ²	Total screw shear area
	SnN	.57687865 in ²	Total nut shear area
	SsS	124.23735 psi	Screw shear stress (Full contact)
	SsN	95.521536 psi	Nut shear stress (Full contact)
	StS	473.43178 psi	Torsional stress at screw root dia
	StA	756.69574 psi	Axial stress at screw root dia
	StR	984.3881 psi	Max tensile stress at screw root dia
	SsR	606.04023 psi	Max shear stress at screw root dia

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
.06	Vs	0	ft/min	LOADING:	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	f				
	eff	+69	†		*Approx_efficiency
	effback	+57	†		*Approx_efficiency backdriving
	sFB				*Anti-backdrive safety factor
	nload	24.909-	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	24.909	lbf		*Total_normal tooth load
	cli	75.413	deg		*At_center of contact interval:
	s	87784	psi		*Angle between contact curvatures
	Cc	7080.3	psi		*Specific compressive stress, s
					*Load/compressive stress factor, Cc
0	power	0	HP	Driver:	*Power
6	rev_dr		rpm		*Rotational speed
15E6	tork_dr		ozf-in		*Torque
	E_dr		psi		*Young's modulus (Default = Steel)
	clidr	72.411	deg		*Contact curvature inclination angle
	tan_dr	3.142	lbf		*Tangential force
	sep_dr	10.527	lbf		*Separating force
	ax_dr	22.355	lbf		*Axial_force
	Mo_dr	2.789	lbf-in		*Overturning moment
1.9E6	rev_dn	0	rpm	Driven:	*Rotational speed
	tork_dn	62.541	ozf-in		*Torque
	E_dn		psi		*Young's modulus (Default = Bronze)
	clidn	3.002	deg		*Contact curvature inclination angle
	tan_dn	22.355	lbf		*Tangential force
	sep_dn	10.527	lbf		*Separating force
	ax_dn	3.142	lbf		*Axial_force
	Mo_dn	.775	lbf-in		*Overturning moment
	T	62.540957	ozf-in	Screw Connected to Driven and Nut	
	Pa	110.20867	lbf	Screw Driving	
.333	Dm		in	Torque	
2	Ns			Total axial resisting load	
.156	Tlead		in	Thread pitch diameter	
	p	.078	in	Number of starts	
.06	f			Thread lead	
14.5	phi		deg	Thread axial pitch	
	alpha	8.4813445	deg	Coefficient of friction: threads	
0	fc			One half included thread angle	
.375	Dc		in	Thread mean lead angle	
	theta	16.621865	deg	Coefficient of friction: thrust collar	
	e	71.307912	†	Mean diameter of thrust collar	
	Lgs		in	Axis Pa, thread normal surface	
.766	OD		in	Thread efficiency	
.375	RD		in	Threaded length	
.276	ID		in	Screw OD	
.296	At	.07282231	in^2	Screw Root Diameter	
	An	.41029951	in^2	Nut ID	
				Tensile stress area	
				Total thread surface area	

.039 ScT 268.60541 psi Compressive stress (Full contact)
 att in Screw axial tooth thickness
 attR .04856885 in Screw axial tooth thickness at Nut ID
 attN .04986194 in Nut axial tooth thickness at Screw OD
 SnS .4435408 in² Total screw shear area
 SnN .57687865 in² Total nut shear area
 SsS 248.4747 psi Screw shear stress (Full contact)
 SsN 191.04307 psi Nut shear stress (Full contact)
 StS 946.86357 psi Torsional stress at screw root dia
 StA 1513.3915 psi Axial stress at screw root dia

 StR 1968.7762 psi Max tensile stress at screw root dia
 SsR 1212.0805 psi Max shear stress at screw root dia

VARIABLE SHEET					
St Input	Name	Output	Unit	Comment	
				#3 Max Eff CD - Hot 60-146 (Ver 4.2) Eff Center Distance Due to Tolerance, Operating Temperature & Moisture Absorption Press "Alt A" for Model Solutions External or Internal Set ('e or 'i)	
'e	type				
30.1	pn		1/in		
	mm	.84385382	mm		
8	ha		deg		
25	tpa		deg		
+68	TR		F		
				ASSEMBLY CONDITIONS:	
				Normal Diametral Pitch	
				Normal Module	
				Helix Angle	
				Operating Transverse Pressure Angle	
				Temperature (Default =68F =20C)	
				Housing:	
				Material Number (See Material Table)	
				Material Code	
				Thermal Coefficient of expansion	
				Moisture Coefficient of expansion	
				Basic or nominal center distance	
				Minimum center distance tolerance	
				Maximum center distance tolerance	
				TCTP .00120 in	
				TCTG .00440 in	
				bROP in	
				bROg in	
				bRPp in	
				bRPg in	
				Cmin .3712 in	
				Cmax .3932 in	
				Pinion:	
				Material Number (See Material Table)	
				Material Code	
				Number of teeth	
				AGMA Quality Class	
				KP 10.50E-6 1/degF	
				KP' 0 in/in	
				d in	
				Gear:	
				Material Number (See Material Table)	
				Material Code	
				Number of teeth	
				AGMA Quality Class	
				KG 11.67E-6 1/degF	
				KG' 37.50E-6 in/in	
				D in	
				OPERATING CONDITIONS:	
				Housing temperature	
				Pinion temperature	
				Gear temperature	
				Effective center distance:	
				Change in CD (Thermal, Moisture)	
				Approximate change in trans backlash	
				Mmin_center distance	
+185	TM		F		
+185	TP		F		
+185	TG		F		
				dCT' +.0002 in	
				dtbl' +.0001 in	
				Cmin_op .3713 in	

Cmax_op .3933 in
dCd .02200 in

Maximum center distance
CD Range

***** VARIABLE SHEET *****

Input---	Name---	Output---	Unit----	Comment-----
				#3 Max CD,TRs Min TTs,ODs +185C
				60-125 (Ver 4.2)
				CROSSED AXIS INVOLUTE HELICAL GEARS
				(Non-Enveloping Worm Gears)
				Press "Alt A" for Solution List
				*NORMAL PLANE:
30.1000	pn		1/in	*Diametral_Pitch
25.0000	npa		deg	*Nominal Pressure Angle
	n_mod	.8439	mm	*Module
	ncp	.1044	in	*Circular_Pitch
	pnb	.09459	in	*Base Pitch
90.0000	E		deg	COMMON:
.39330	cd		in	*Shaft Angle (+ or -)
	std_cd	.37098	in	*Operating_center distance
	Lc	.0958	in	*Standard_center distance
	mp	1.0129		*Length_of_contact
	mpc	No		*Contact_ratio (SAP > TIF)
	mg	15		*Contact_below finished involute?
				*Gear_ratio
1	ndr			*DRIVER:
'frm	meth_dr			Number of teeth
				*Hobbed ('hob), Shaped ('shp)
				Formed ('frm)
.3190	oddr		in	*Outside_Diameter
	modd_dr	NA	in	*Start_Tip_Modification
	Emod_dr	NA	deg	*Roll_at_start of tip modification
	xndr	NA	in	*Normal_OD_tip_relief
	xncdr	NA	in	*Normal_circular_OD_tip_relief
	xdr	NA	in	*Transverse_circular_OD_tip_relief
	eoddr	.3133	in	*Effective_outside_diameter
	nttdcr	.0106	in	*Normal_tooth_thickness_at_EOD
	xn_eodd	NA	in	*Normal_EOD_tip_relief
	ptd_dr	.3322	in	*Pointed_tooth_diameter (No tip mod)
	pddr	.2387	in	*Reference_PD
.0457	nttdr		in	*Finished_normal_tooth_thickness
0	SSn_dr		in	*Total_normal_circular_finish
				stock on tooth thickness
82.0000	hadr		deg	*Helix_angle (+ Right, - Left)
	ladr	.8.0000	deg	*Lead_angle (+ Right, - Left)
	Fdr_min	.1166	in	*Minimum_face_width (bi-rotation)
	ptdr	4.1891	1/in	*Transverse_diametral_pitch
	cpdr	.74994	in	*Transverse_circular_pitch
	tmoddr	6.0633	mm	*Transverse_module
	tpaddr	73.3819	deg	*Transverse_pressure_angle
	tttdr	.3284	in	*Transverse_tooth_thickness
	tbgdr	.21448	in	*Transverse_base_pitch
	bhadr	63.82977	deg	*Base_helix_angle
	ap_dr	.10540	in	*Axial_pitch
	lead_dr	.1054	in	*Lead
	Dhi_dr	.1749	in	*Inv/fillet_intersection_dia (TIF)
	EDhiI_dr	135.0992	deg	*Roll_at_inv/fil_intersection_dia
	rddr	.1558	in	*Root_diameter
	dbdr	.0683	in	*Base_diameter

.15 ndn
 'frm meth_dn
 .5700 oddn in
 modd_dn NA in
 Emod_dn NA deg
 xndn NA in
 xncdn NA in
 xdn NA in
 eoddn .5658 in
 nttodn .0211 in
 xn_eodd NA in
 ptd_dn .5932 in
 pddn .5032 in
 .0544 nttdn in
 0 SSn_dn in
 8.0000 hadn deg
 ladn 82.0000 deg
 Pdn_min .0287 in
 ptdn 29.8071 1/in
 cpdn .10540 in
 tmoddn .8521 mm
 tpadn 25.2153 deg
 tttdn .0549 in
 tbpdn .09535 in
 bhadn 7.24623 deg
 ap_dn .74994 in
 lead_dn 11.2491 in
 Dhi_dn .4553 in
 EDhi_dn .6194 deg
 rddn .4087 in
 dbdn .4553 in

*DRIVEN:
 Number of teeth
 *Hobbed ('hob), Shaped ('shp)
 Formed ('frm)
 *Outside Diameter
 *Start_Tip Modification
 *Roll_at_start of tip modification
 *Normal_OD tip relief
 *Normal_circular OD tip relief
 *Transverse_circular_OD tip relief
 *Effective_outside diameter
 *Normal_tooth_thickness_at_EOD
 *Normal_EOD tip relief
 *Pointed tooth diameter (No tip mod)
 *Reference PD
 *Finished normal tooth thickness
 *Total normal circular finish
 stock on tooth thickness
 *Helix angle (+ Right, - Left)
 *Lead_angle (+ Right, - Left)
 *Minimum face width (bi-rotation)
 *Transverse_diametral pitch
 *Transverse_circular pitch
 *Transverse_module
 *Transverse_pressure angle
 *Transverse_tooth thickness
 *Transverse_base pitch
 *Base_helix angle
 *Axial pitch
 *Lead
 *Inv/fillet intersection dia (TIF)
 *Roll_at_inv/fil intersection dia
 *Root_diameter
 *Base_diameter

OPERATING DATA:
 delta .02232 in
 cpc .0066 in
 work .0463 in
 nbbl .0227 in
 pn 30.1000 1/in
 ncp .10437 in
 npa 25.0000 deg

*Separation of pitch planes
 *Contact_path to line of centers
 *Working depth
 Normal Plane:
 *Base_backlash
 *Diametral_pitch
 *Circular_pitch
 *Pressure_angle

*DRIVER:
 pddr .2387 in
 nttdr .0457 in
 hadr 82.0000 deg
 ladr 8.0000 deg
 ptdr 4.1891 1/in
 cpdr .74994 in
 tmoddr 6.0633 mm
 tpaddr 73.3819 deg
 tttdr .3284 in
 abldr 86.548 deg
 sap_dr .2316 in
 nttsapr .0490 in

*Pitch_diameter
 *Normal_Tooth_Thickness
 *Helix_Angle (+ Right, - Left)
 *Lead_Angle (+ Right, - Left)
 *Transverse_Diametral_Pitch
 *Transverse_Circular_Pitch
 *Transverse_Module
 *Transverse_Pressure_Angle
 *Transverse_Tooth_Thickness
 *Angular_backlash
 *Start_of_active_profile (SAP)
 *Normal_tooth_thickness at SAP

nswlddr	.0553	in	*Normal_space width at SAP
rtcl_dr	.0304	in	*Root_clearance
pddn`	.5032	in	*DRIVEN:
nttdn`	.0544	in	*Pitch_diameter
hadn`	8.0000	deg	*Normal_Tooth_Thickness
ladn`	82.0000	deg	*Helix_Angle (+ Right, - Left)
ptdn`	29.8071	1/in	*Lead_Angle (+ Right, - Left)
cpdn`	.10540	in	*Transverse_Diametral Pitch
tmoddn`	.8521	mm	*Transverse_Circular Pitch
tpadn`	25.2153	deg	*Transverse_Module
tttdn`	.0549	in	*Transverse_Pressure Angle
abldn	5.77	deg	*Transverse_Tooth_Thickness
sap_dn	.4781	in	*Angular_backlash
nttsapn	.0614	in	*Start_of_active_profile (SAP)
nswlddn	.0378	in	*Normal_tooth_thicknes at SAP
rtcl_dn	.0295	in	*Normal_space_width at SAP
mark	'y		*Root_clearance
markm	'y		
teeth	1		
roll		deg	PLOT CONFIGURATION:
t#	1		*Mark_inv/fil intersections?
Esap_dr	185.7222	deg	*Mark_mod/inv intersections?
Eod_dr	256.6520	deg	*Number_of_teeth_on_plot (Def-1)
Esap_dn	18.3546	deg	*Driver_contact_roll_angle_of
Eod_dn	42.2777	deg	*Driver_tooth_number (Def-1)
tpdr	'_		DRIVER ROLL ANGLES:
hfa_dr	-	deg	*Start_of_active_profile
h`dr	-	in	*Effective_outside_diameter
t`dr	-	in	
hs`dr	-	in	
hfa2_dr	-	deg	
rt_dr	-	in	
u_dr	-	in	
ua_dr	-	deg	
uap_dr	-	deg	
hu_dr	-	in	
hobAPdr	-	in	
nswAPdr	-	in	
tpdn	'_		DRIVEN ROLL ANGLES:
hfa_dn	-	deg	*Start_of_active_profile
h`dn	-	in	*Effective_outside_diameter
t`dn	-	in	
hs`dn	-	in	
hfa2_dn	-	deg	
rt_dn	-	in	
tpdr	'_		DRIVER HOB:
hfa_dr	-	deg	*Hob_type (Semi-Top='s, Tip-Rel='r Non-Top='n)
h`dr	-	in	*Flank_angle
t`dr	-	in	*Tip_to_Reference_Line
hs`dr	-	in	*Tooth_thickness_at_Reference_Line
hfa2_dr	-	deg	*Reference_Line_to_Start_Mod_Ramp
rt_dr	-	in	*Pressure_Angle_of_Mod_Ramp
u_dr	-	in	*Tip_radius
ua_dr	-	deg	*Protuberance
uap_dr	-	deg	*Protuberance_angle_from_flank
hu_dr	-	in	*Protuberance_pressure_angle
hobAPdr	-	in	*Tip_to_flank/prot_intersection
nswAPdr	-	in	*Ref_Line_to_Hob_SAP
tpdn	'_		*Normal_Space_Width_at_Hob_SAP
hfa_dn	-	deg	
h`dn	-	in	
t`dn	-	in	
hs`dn	-	in	
hfa2_dn	-	deg	
rt_dn	-	in	
tpdr	'_		DRIVEN HOB:
hfa_dr	-	deg	*Hob_type (Semi-Top='s, Tip-Rel='r Non-Top='n)
h`dr	-	in	*Flank_angle
t`dr	-	in	*Tip_to_Reference_Line
hs`dr	-	in	*Tooth_thickness_at_Reference_Line
hfa2_dr	-	deg	*Reference_Line_to_Start_Mod_Ramp
rt_dr	-	in	*Pressure_Angle_of_Mod_Ramp
u_dr	-	in	*Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space Width at Hob SAP

DRIVER SHAPER:

nc_dr	-	in	*Number_of_Teeth
odc_dr	-	in	*Outside_Diameter
nttc_dr	-	in	*Normal_Tooth_Thickness
rts_dr	-	in	*Tip_Radius - Normal Plane
us_dr	-	in	*Protuberance - Normal Plane
cds_dr	NA	in	*Center distance with gear
sapc_dr	-	in	*Start_of_active_profile diameter

DRIVEN SHAPER:

nc_dn	-	in	*Number_of_Teeth
odc_dn	-	in	*Outside_Diameter
nttc_dn	-	in	*Normal_Tooth_Thickness
rts_dn	-	in	*Tip_Radius - Normal Plane
us_dn	-	in	*Protuberance - Normal Plane
cds_dn	NA	in	*Center distance with gear
sapc_dn	-	in	*Start_of_active_profile diameter

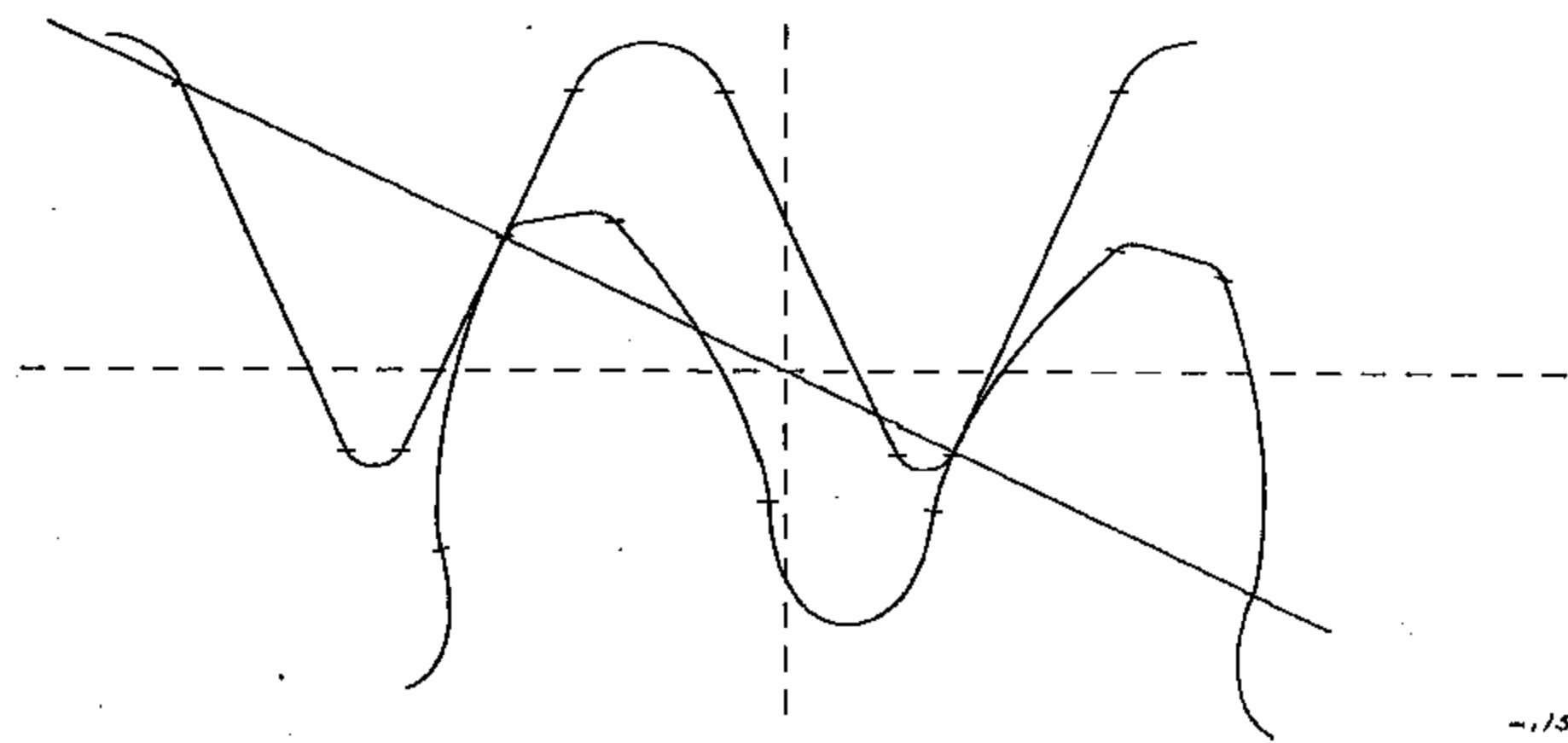
FORMED DRIVER:

25.0000	rfa``dr	deg	*Basic Rack Form:
.0340	h``dr	in	*Flank Angle
.0517	t``dr	in	*Tip to Reference Line
.0156	rt``dr	in	*Tooth Thickness at Reference Line
.0050	tc_dr	0	*Tip_radius
	tr_dr	in	*Radial_tip chamfer Def=0
	xp_dr	-	*Normal_tip radius Def=0
			*Normal_tip_relief exponent Def=3/2

FORMED DRIVEN:

25.0000	rfa``dn	deg	*Basic Rack Form:
.0502	h``dn	in	*Flank Angle
.0527	t``dn	in	*Tip to Reference Line
.0046	rt``dn	in	*Tooth Thickness at Reference Line
.0050	tc_dn	0	*Tip_radius
	tr_dn	in	*Radial_tip chamfer Def=0
	xp_dn	-	*Normal_tip radius Def=0
			*Normal_tip_relief exponent Def=3/2

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



VARIABLE SHEET

Input		Name	Output	Unit	Comment
.06		Vs f	0	ft/min	LOADING: *Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze drive)
		eff	+69	%	*Approx_efficiency
		effback	+57	%	*Approx_efficiency backdriving
		sfB			*Anti-backdrive safety factor
		nload	12.454	lbf	*Imposed normal tooth load
		Fo	1		*Overload factor Def=1
		tnload	12.454	lbf	*Total_normal tooth load
		cli	77.719	deg	*At_center of contact interval:
		s	53935	psi	*Angle between contact curvatures
		Cc	2511.5	psi	*Specific compressive stress, s
					*Load/compressive stress factor, Cc
0		power	0	HP	Driver: *Power
3		rev_dr		rpm	*Rotational speed
15E6		tork_dr		ozf-in	*Torque
		E_dr		psi	*Young's modulus (Default = Steel)
		clidr	73.901	deg	*Contact curvature inclination angle
		tan_dr	1.571	lbf	*Tangential force
		sep_dr	5.263	lbf	*Separating force
		ax_dr	11.178	lbf	*Axial_force
		Mo_dr	1.522	lbf-in	*Overturning moment
1.5E6		rev_dn	0	rpm	Driven: *Rotational speed
		tork_dn	31.27	ozf-in	*Torque
		E_dn		psi	*Young's modulus (Default = Bronze)
		clidn	3.818	deg	*Contact curvature inclination ang.
		tan_dn	11.178	lbf	*Tangential force
		sep_dn	5.263	lbf	*Separating force
		ax_dn	1.571	lbf	*Axial_force
		Mo_dn	.405	lbf-in	*Overturning moment
		T	31.270479	ozf-in	Screw Connected to Driven and Nut
		Fa	55.104335	lbf	Screw Driving
333		Dm		in	Torque
		Ns			Total axial resisting load
156		Tlead		in	Thread pitch diameter
		P	.078	in	Number of starts
.06		f			Thread lead
14.5		phi		deg	Thread axial pitch
		alpha	8.4813445	deg	Coefficient of friction: threads
0		fc			One half included thread angle
.375		Dc		in	Thread mean lead angle
		theta	16.621865	deg	Coefficient of friction: thrust collar
		e	71.307912	%	Mean diameter of thrust collar
.766		Lgs		in	Axis to thread normal surface
.375		OD		in	Thread efficiency
.276		RD		in	Threaded length
.296		ID		in	Screw OD
		At	.07282231	in^2	Screw Root Diameter
		An	.41029951	in^2	Nut ID
					Tensile stress area
					Total thread surface area

.039	ScT	134.30271 psi	Compressive stress (Full contact)
	att	in	Screw axial tooth thickness
	attR	.04856885 in	Screw axial tooth thickness at Nut ID
	attN	.04986194 in	Nut axial tooth thickness at Screw OD
	SnS	.4435408 in ²	Total screw shear area
	SnN	.57687865 in ²	Total nut shear area
	SsS	124.23735 psi	Screw shear stress (Full contact)
	SsN	95.521536 psi	Nut shear stress (Full contact)
	StS	473.43178 psi	Torsional stress at screw root dia
	StA	756.69574 psi	Axial stress at screw root dia
	StR	984.3881 psi	Max tensile stress at screw root dia
	SsR	606.04023 psi	Max shear stress at screw root dia

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
.06	Vs f	0	ft/min	LOADING:	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	eff	+69	%		*Approx_efficiency
	effback	+57	%		*Approx_efficiency backdriving
	sfb				*Anti-backdrive safety factor
	nload	24.909	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	24.909	lbf		*Total_normal tooth load
	cli	77.719	deg		*At_center of contact interval:
	s	67954	psi		*Angle between contact curvatures
	Cc	5023.1	psi		*Specific compressive stress, s
					*Load/compressive stress factor, Cc
0	power	0	HP	Driver:	*Power
6	rev_dr		rpm		*Rotational speed
45E6	tork_dr		ozf-in		*Torque
	E_dr		psi		*Young's modulus (Default = Steel)
	clindr	73.901	deg		*Contact curvature inclination angle
	tan_dr	3.142	lbf		*Tangential force
	sep_dr	10.527	lbf		*Separating force
	ax_dr	22.355	lbf		*Axial_force
	Mo_dr	3.043	lbf-in		*Overturning moment
1.5E6	rev_dn	0	rpm	Driven:	*Rotational speed
	tork_dn	62.541	ozf-in		*Torque
	E_dn		psi		*Young's modulus (Default = Bronze)
	clidn	3.818	deg		*Contact curvature inclination angle
	tan_dn	22.355	lbf		*Tangential force
	sep_dn	10.527	lbf		*Separating force
	ax_dn	3.142	lbf		*Axial_force
	Mo_dn	.809	lbf-in		*Overturning moment
	T	62.540957	ozf-in	Screw Connected to Driven and Nut	
	Fa	110.20867	lbf	Screw Driving	
.333	Dn		in	Torque	
2	Ns			Total axial resisting load	
	Tlead		in	Thread pitch diameter	
.156	P	.078	in	Number of starts	
	f`			Thread lead	
.06	phi		deg	Thread axial pitch	
14.5	alpha	8.4813445	deg	Coefficient of friction: threads	
0	fc			One half included thread angle	
.375	Dc		in	Thread mean lead angle	
	theta	16.621865	deg	Coefficient of friction: thrust collar	
	e	71.307912	%	Mean diameter of thrust collar	
.766	Lgs		in	Axis to thread normal surface	
.375	OD		in	Thread efficiency	
.276	RD		in	Threaded length	
.296	ID		in	Screw OD	
	At	.07282231	in^2	Screw Root Diameter	
	An	.41029951	in^2	Nut ID	
				Tensile stress area	
				Total thread surface area	

.039	ScT	268.60541 psi	Compressive stress (Full contact)
	att	in	Screw axial tooth thickness
	attR	.04856885 in	Screw axial tooth thickness at Nut ID
	attN	.04986194 in	Nut axial tooth thickness at Screw OD
	SnS	.4435408 in ²	Total screw shear area
	SnN	.57687865 in ²	Total nut shear area
	SsS	248.4747 psi	Screw shear stress (Full contact)
	SsN	191.04307 psi	Nut shear stress (Full contact)
	StS	946.86357 psi	Torsional stress at screw root dia
	StA	1513.3915 psi	Axial stress at screw root dia
	StR	1968.7762 psi	Max tensile stress at screw root dia
	SsR	1212.0805 psi	Max shear stress at screw root dia

===== VARIABLE SHEET =====

Input	Name	Output	Unit	Comments
30.1000	pn		1/in	#3 Nominal
25.0000	npa		deg	60-125 (Ver 4.2)
	n_mod	.8439	mm	CROSSED AXIS INVOLUTE HELICAL GEARS
	ncp	.1044	in	(Non-Enveloping Worm Gears)
	pnb	.09459	in	Press "Alt A" for Solution List
90.0000	E		deg	*NORMAL PLANE:
.37940	cd		in	*Diametral_Pitch
	std_cd	.37098	in	*Nominal Pressure Angle
	Lc	.1341	in	*Module
	mp	1.4176		*Circular_Pitch
	mpc	No		*Base Pitch
	mg	15		
1	ndr			COMMON:
'frm	meth_dr			*Shaft Angle (+ or -)
.3200	oddr		in	*Operating_center distance
	modd_dr	NA	in	*Standard_center distance
	Emod_dr	NA	deg	*Length_of_contact
	xndr	NA	in	*Contact_ratio (SAP > TIF)
	xncdr	NA	in	*Contact_below finished involute?
	xdr	NA	in	*Gear_ratio
	eoddr	.3155	in	
	nttodr	.0103	in	
	xn_eoddr	NA	in	
	ptd_dr	.3338	in	
	pddr	.2387	in	
.0465	nttdr		in	
0	SSn_dr		in	
82.0000	badr		deg	*DRIVER:
	ladr	0.0000	deg	Number of teeth
	Fdr_min	.1321	in	*Hobbed ('hob), Shaped ('shp)
	ptdr	4.1891	1/in	Formed ('frm)
	cpdr	.74994	in	*Outside Diameter
	tmoddr	6.0633	mm	*Start_Tip_Modification
	tpadr	73.3819	deg	*Roll_at_start_of_tip_modification
	tttdr	.3338	in	*Normal_OD_tip_relief
	tbpdr	.21448	in	*Normal_circular_OD_tip_relief
	bhadr	63.82977	deg	*Transverse_circular_OD_tip_relief
	ap_dr	.10540	in	*Effective_outside_diameter
	lead_dr	.1054	in	*Normal_tooth_thickness_at_EOD
	Dhi_dr	.1764	in	*Normal_EOD_tip_relief
	EDhi_dr	136.5078	deg	*Pointed_tooth_diameter (No tip mod)
	rddr	.1574	in	*Reference_PD
	dbdr	.0683	in	*Finished_normal_tooth_thickness
				*Total_normal_circular_finish
				stock_on_tooth_thickness
				*Helix_angle (+ Right, - Left)
				*Lead_angle (+ Right, - Left)
				*Minimum_face_width (bi-rotation)
				*Transverse_diametral_pitch
				*Transverse_circular_pitch
				*Transverse_module
				*Transverse_pressure_angle
				*Transverse_tooth_thickness
				*Transverse_base_pitch
				*Base_helix_angle
				*Axial_pitch
				*Lead
				*Inv/fillet_intersection_dia (TIF)
				*Roll_at_inv/fil_intersection_dia
				*Root_diameter
				*Base_diameter

15
 'frm ndn
 .5725 oddn in
 modd_dn NA in
 Emod_dn deg
 xndn in
 xcndn in
 xdn in
 eoddn .5693 in
 nttodn .0198 in
 xn_eoddn NA in
 ptd_dn .5946 in
 pddn .5032 in
 .0554 ntdn in
 0 SSn_dn in
 8.0000 hadn deg
 ladn 82.0000 deg
 Fdn_min .0293 in
 ptdn 29.8071 1/in
 cpdn .10540 in
 tmoddn .8521 mm
 tpadn 25.2153 deg
 ttdn .0559 in
 tbpdn .09535 in
 bhadn 7.24623 deg
 ap_dn .74994 in
 lead_dn 11.2491 in
 Dhi_dn .4554 in
 EDhi_dn 1.2528 deg
 rddn .4108 in
 dbdn .4553 in

*DRIVEN:
 Number of teeth
 *Hobbed ('hob), Shaped ('shp)
 Formed ('frm)
 *Outside Diameter
 *Start Tip Modification
 *Roll_at_start of tip modification
 *Normal_OD tip relief
 *Normal_circular OD tip relief
 *Transverse_circular_OD tip relief
 *Effective_outside diameter
 *Normal_tooth_thickness_at_EOD
 *Normal_EOD tip relief
 *Pointed tooth diameter (No tip mod)
 *Reference PD
 *Finished normal tooth thickness
 *Total normal circular finish
 stock on tooth thickness
 *Helix angle (+ Right, - Left)
 *Lead_angle (+ Right, - Left)
 *Minimum face width (bi-rotation)
 *Transverse_diametral pitch
 *Transverse_circular pitch
 *Transverse_module
 *Transverse_pressure angle
 *Transverse_tooth thickness
 *Transverse_base pitch
 *Base_helix angle
 *Axial pitch
 *Lead
 *Inv/fillet intersection dia (TIF)
 *Roll_at_inv/fil intersection dia
 *Root_diameter
 *Base_diameter

delta .00842 in
 cpc .0025 in
 work .0630 in
 nbbl .0094 in
 pn 30.1000 1/in
 ncp .10437 in
 npa 25.0000 deg

*OPERATING DATA:
 *Separation of pitch planes
 *Contact_path to line of centers
 *Working_depth
 Normal Plane:
 *Base_backlash
 *Diametral_pitch
 *Circular_pitch
 *Pressure_angle

pddr .2387 in
 ntdr .0464 in
 hadr 82.0000 deg
 ladr 8.0000 deg
 ptdr 4.1891 1/in
 cpdr .74994 in
 tmoddr 6.0633 mm
 tpaddr 73.3819 deg
 ttdr .3338 in
 abldr 35.799 deg
 sap_dr .2016 in
 nttsapr .0634 in

*DRIVER:
 *Pitch_diameter
 *Normal_Tooth_Thickness
 *Helix_Angle (+ Right, - Left)
 *Lead_Angle (+ Right, - Left)
 *Transverse_Diametral_Pitch
 *Transverse_Circular_Pitch
 *Transverse_Module
 *Transverse_Pressure_Angle
 *Transverse_Tooth_Thickness
 *Angular_backlash
 *Start_of_active_profile (SAP)
 *Normal_tooth thickness at SAP

nswlddr	.0406	in	*Normal_space width at SAP
rtcl_dr	.0145	in	*Root_clearance
pddn`	.5032	in	*Pitch_diameter
nttdn`	.0554	in	*Normal_Tooth_Thickness
hadn`	8.0000	deg	*Helix_Angle (+ Right, - Left)
ladn`	62.0000	deg	*Lead_Angle (+ Right, - Left)
ptdn`	29.8071	1/in	*Transverse_Diametral_Pitch
cpdn`	.10540	in	*Transverse_Circular_Pitch
tmoddn`	.8521	mm	*Transverse_Module
tpadn`	25.2153	deg	*Transverse_Pressure_Angle
tttdn`	.0559	in	*Transverse_Tooth_Thickness
abldn	2.387	deg	*Angular_backlash
sap_dn	.4615	in	*Start_of_active_profile (SAP)
nttsapn	.0643	in	*Normal_tooth thickness at SAP
nswlddn	.0316	in	*Normal_space width at SAP
rtcl_dn	.0140	in	*Root_clearance
mark	'y		PILOT CONFIGURATION:
markm	'y		*Mark inv/fil intersections?
teeth	1		*Mark mod/inv intersections?
roll		deg	*Number of teeth on plot (Def=1)
t#	1		*Driver_contact roll angle of
			*Driver tooth number (Def=1)
Esap_dr	159.2147	deg	DRIVER ROLL ANGLES:
Eod_dr	258.4864	deg	*Start_of_active profile
 			*Effective outside diameter
Esap_dn	9.5238	deg	DRIVEN ROLL ANGLES:
Eod_dn	43.0060	deg	*Start_of_active profile
			*Effective outside diameter
tpdr	'-		DRIVER HOB:
hfa_dr	-	deg	*Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
h`dr	-	in	*Flank_angle
t`dr	-	in	*Tip_to_Reference Line
hs`dr	-	in	*Tooth_thickness_at Reference Line
hfa2_dr	-	deg	*Reference_Line_to_Start_Mod_Ramp
rt_dr	-	in	*Pressure_Angle_of_Mod_Ramp
u_dr	-	in	*Tip_radius
ua_dr	-	deg	*Protuberance
uap_dr	-	deg	*Protuberance_angle_from_flank
hu`dr	-	in	*Protuberance_pressure_angle
hobAPdr	-	in	*Tip_to_flank/prot intersection
nswAPdr	-	in	*Ref_Line_to_Hob_SAP
			*Normal_Space_Width_at_Hob_SAP
tpdn	'-		DRIVEN HOB:
hfa_dn	-	deg	*Hob type (Semi-Top='s, Tip-Rel='r Non-Top='n)
h`dn	-	in	*Flank_angle
t`dn	-	in	*Tip_to_Reference Line
hs`dn	-	in	*Tooth_thickness_at Reference Line
hfa2_dn	-	deg	*Reference_Line_to_Start_Mod_Ramp
rt_dn	-	in	*Pressure_Angle_of_Mod_Ramp
			*Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space_Width at Hob SAP

nc_dr	-	in	*Number_of_Teeth
odc_dr	-	in	*Outside_Diameter
nttc_dr	-	in	*Normal_Tooth_Thickness
rts_dr	-	in	*Tip_Radius - Normal Plane
us_dr	-	in	*Protuberance - Normal Plane
cds_dr	NA	in	*Center_distance with gear
sapc_dr	-	in	*Start_of_active_profile_diameter

nc_dn	-	in	*Number_of_Teeth
odc_dn	-	in	*Outside_Diameter
nttc_dn	-	in	*Normal_Tooth_Thickness
rts_dn	-	in	*Tip_Radius - Normal Plane
us_dn	-	in	*Protuberance - Normal Plane
cds_dn	NA	in	*Center_distance with gear
sapc_dn	-	in	*Start_of_active_profile_diameter

DRIVEN SHAPER:

- *Number_of_Teeth
- *Outside_Diameter
- *Normal_Tooth_Thickness
- *Tip_Radius - Normal Plane
- *Protuberance - Normal Plane
- *Center_distance with gear
- *Start_of_active_profile_diameter

FORMED DRIVER:

- *Basic_Rack_Form:
- *Flank_Angle
- *Tip_to_Reference_Line
- *Tooth_Thickness_at_Reference_Line
- *Tip_radius
- *Radial_tip_chamfer_Def=0
- *Normal_tip_radius_Def=0
- *Normal_tip_relief_exponent_Def=3/2

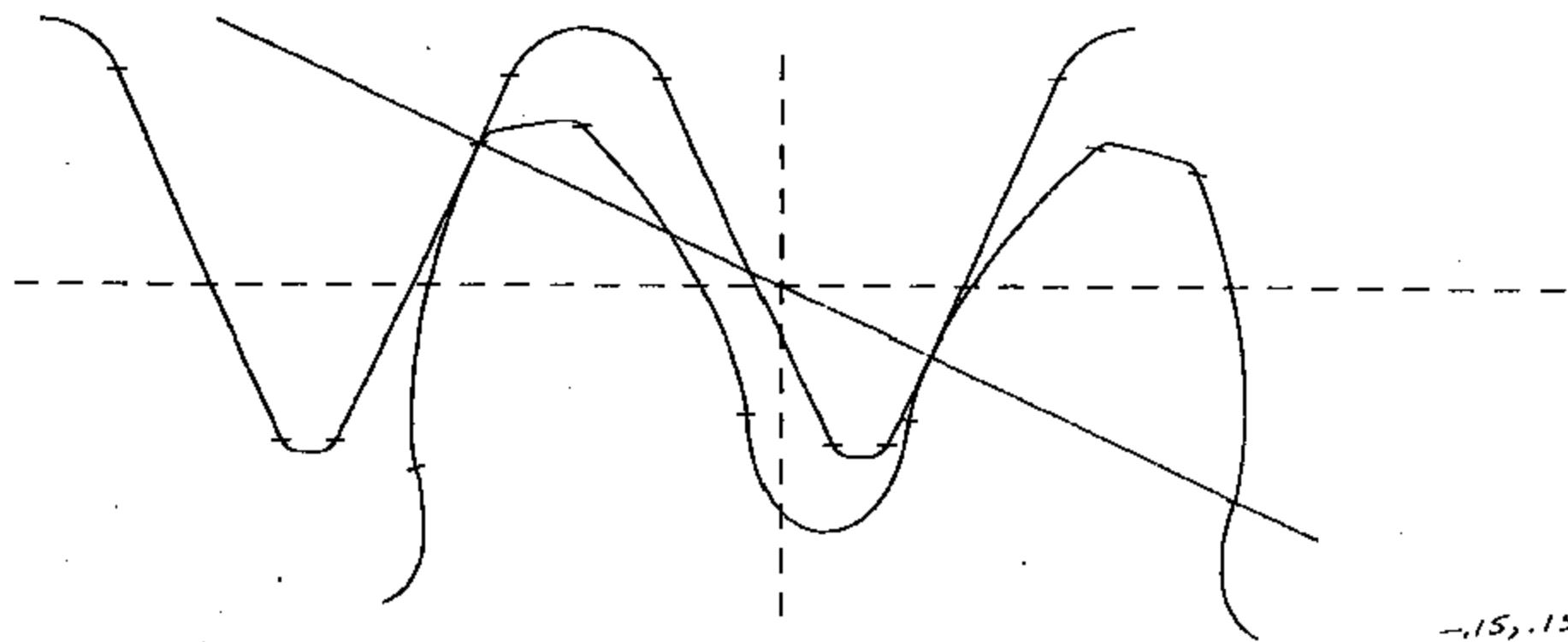
FORMED DRIVEN:

- *Basic_Rack_Form:
- *Flank_Angle
- *Tip_to_Reference_Line
- *Tooth_Thickness_at_Reference_Line
- *Tip_radius
- *Radial_tip_chamfer_Def=0
- *Normal_tip_radius_Def=0
- *Normal_tip_relief_exponent_Def=3/2

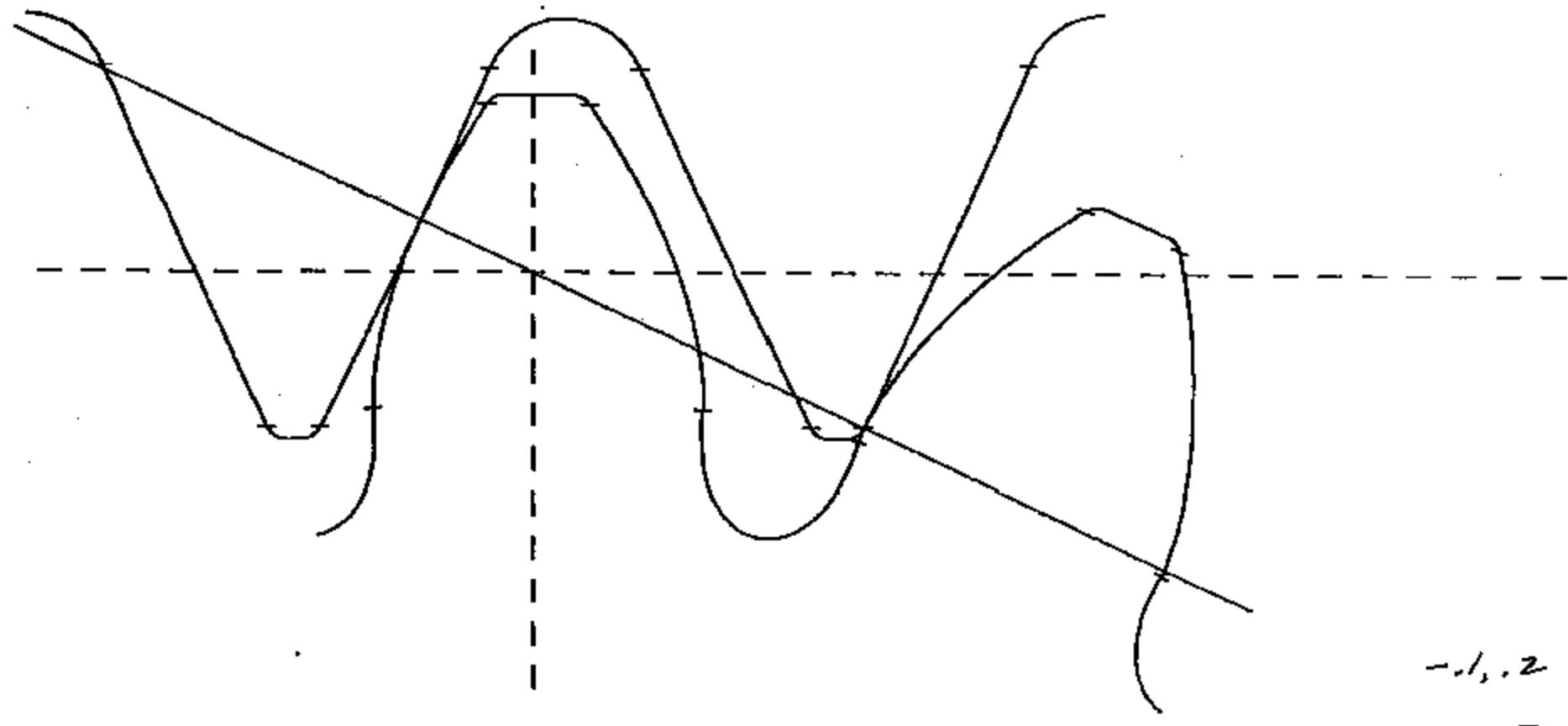
25.0000	rfa``dr	deg
.0340	h``dr	in
.0517	t``dr	in
.0156	rt``dr	in
.0040	tc_dr	0
	tr_dr	in
	xp_dr	-

25.0000	rfa``dn	deg
.0502	h``dn	in
.0527	t``dn	in
.0046	rt``dn	in
.0040	tc_dn	0
	tr_dn	in
	xp_dn	-

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



Gear Mesh (Path of Contact Section ~ Virtual) Driver/Driven



-1, 2

1, 5 N3

***** VARIABLE SHEET *****

	Input	Name	Output	Unit	Comment
.06	Vs f	0		ft/min	LOADING: *Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	eff	+69	%		*Approx_efficiency
	effback	+57	%		*Approx_efficiency backdriving
	sfb				*Anti-backdrive safety factor
	nload	18.682	g	lbf	*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	18.682		lbf	*Total_normal tooth load
	cli	76.312	deg		*At_center of contact interval: *Angle between contact curvatures
	s	76352	psi		*Specific compressive stress, s
	Cc	4658.7	psi		*Load/compressive stress factor, Cc
0	power	0		HP	Driver: *Power
4.5	rev_dr			rpm	*Rotational speed
15E6	tork_dr			ozf-in	*Torque
	E_dr			psi	*Young's modulus (Default = Steel)
	clidr	73.003		deg	*Contact_curvature inclination angle
	tan_dr	2.356		lbf	*Tangential force
	sep_dr	7.895		lbf	*Separating force
	ax_dr	16.766		lbf	*Axial_force
	Mo_dr	2.163		lbf-in	*Overturning moment
1.9E6	rev_dn	0		rpm	Driven: *Rotational speed
	tork_dn	46.906		ozf-in	*Torque
	E_dn			psi	*Young's modulus (Default = Bronze)
	clidn	3.309		deg	*Contact_curvature inclination angle
	tan_dn	16.766		lbf	*Tangential force
	sep_dn	7.895		lbf	*Separating force
	ax_dn	2.356		lbf	*Axial_force
	Mo_dn	.59		lbf-in	*Overturning moment
	T	46.905718	ozf-in		Screw Connected to Driven and Nut Screw Driving
	Fa	82.656502	lbf		Torque
.333	Dm			in	Total axial resisting load
2	Ns				Thread pitch diameter
.156	Tlead			in	Number of starts
	P.	.078		in	Thread lead
.06	f				Thread axial pitch
14.5	phi			deg	Coefficient of friction: threads
	alpha	8.4813445		deg	One half included thread angle
0	fc				Thread mean lead angle
.375	Dc			in	Coefficient of friction: thrust collar
	theta	16.621865		deg	Mean diameter of thrust collar
	e	71.307912	%		Axis to thread normal surface
.766	Lgs			in	Thread efficiency
.375	OD				Threaded length
.276	RD			in	Screw OD
.296	ID			in	Screw Root Diameter
	At	.07282231		in^2	Nut_ID
	An	.41029951		in^2	Tensile stress area
					Total thread surface area

.039 ScT 201.45406 psi Compressive stress (Full contact)
att in Screw axial tooth thickness
attR .04856885 in Screw axial tooth thickness at Nut ID
attN .04986194 in Nut axial tooth thickness at Screw OD
SnS .4435408 in² Total screw shear area
SnN .57687865 in² Total nut shear area
SsS 186.35603 psi Screw shear stress (Full contact)
SsN 143.2823 psi Nut shear stress (Full contact)
StS 710.14768 psi Torsional stress at screw root dia
StA 1135.0436 psi Axial stress at screw root dia

StR 1476.5822 psi Max tensile stress at screw root dia
SsR 909.06035 psi Max shear stress at screw root dia

===== VARIABLE SHEET =====

Input	Name	Output	Unit	Comment
				#3 Nominal Hoechst 90 deg Worm Gears Steel, Hostaform Worm/Hostaform Gear Non-Enveloping (Crossed Axis Helical) (See 60-125 for Input Data) Press "Alt U" for Units Change
1	z1			GENERAL:
15	z2			Number of Worm Teeth
	i	15		Number of Gear Teeth
	mm	.84385382	mm	Ratio
30.1	DPn			Normal Module
	m	.85214686	mm	Normal Diametral Pitch
	DP	29.807069		Gear Trans Module
25.0000	npa		deg	Gear Trans Pitch
	tpa	25.2153	deg	Normal Pressure Angle
8.0000	gamma_n		deg	Gear Trans Pressure Angle @ Ref PD
				Worm Lead Angle
.3794	a		in	Center Distance
.3200	da1		in	Worm OD
.5725	da2		in	Gear OD
	dml	.2532	in	Worm Mean Working Depth Dia
	dm2	.5057	in	Gear Mean Working Depth Dia
	wkd	.0668	in	Working Depth
				LOAD CHARACTERISTIC:
16.766	F2		lbf	Gear Tangential Load
0	w		ft/min	Flank Sliding Velocity
	b	.1957	in	Effective Face Width
	fz	.49		Tooth Number Coefficient
	c	1668.8103	lbf/in^2	Load Characteristic, c
	c_al	1160.3019	lbf/in^2	Allowable Load Characteristic, c
	Sc	.70		Load Characteristic Safety Factor
				TOOTH BREAKAGE:
22.354667	F2max		lbf	Maximum Gear Tangential Load
185	T		F	Operating Temperature
	ra1	.1600	in	Worm Outside Radius
	rml	.1266	in	Worm Mean Working Depth Radius
	ra2	.2863	in	Gear Outside Radius
.0559	ttt		in	Gear Trans Tooth Thickness @ Ref PD (If Hostaform Worm, Gear TTT Should Be Approx Equal to Worm TTT)
	tttm	.0550	in	Gear Trans Tooth Thickness @ Mean Dia
	dbg	.4553	in	Gear Base Dia
	chi	79.6727	deg	
	phi	24.0000	deg	Pitch Angle
	t	3		Number of Engaged Teeth
	sw	.0468	in	Ave Width of Shear-Stressed Surface
	A	.0364	in^2	Total Shear-Stressed Area
	tauB	5545.6	lbf/in^2	Allowable Shear Stress
	Fb	201.9940	lbf	Tooth Breakage Force
	S	9.04		Tooth Breakage Safety Factor

Set #4
Design Data

10:1 0.125" Thread Lead

VARIABLE SHEET					
Input		Name	Output	Unit	Comment
'e		type			#4 Min Eff CD - Cold 60-146 (Ver 4.2) Eff Center Distance Due to Tolerance, Operating Temperature & Moisture Absorption Press "Alt A" for Model Solutions External or Internal Set ('e or 'i)
22	pn		1/in		
	mn	1.1545455	mm		
10	na		deg		
25	tpa		deg		
+68	TR		F		
					ASSEMBLY CONDITIONS:
					Normal Diametral Pitch
					Normal Module
					Helix Angle
					Operating Transverse Pressure Angle
					Temperature (Default =68F -20C)
					Housing:
					Material Number (See Material Table)
19	Mmatl				Material Code
	HN	Zinc			Thermal Coefficient of expansion
	XM	15.20E-6	1/degF		Moisture Coefficient of expansion
	KM	0	in/in		Basic or nominal center distance
.3801	Cd		in		Minimum center distance tolerance
-.0089	Ct		in		Maximum center distance tolerance
+.0089	Ct''		in		Pinion total composite tolerance
	TCTP	.00140	in		Gear total composite tolerance
	TCTG	.00510	in		Pinion bearing runout (TIR)
0	bROP		in		Gear bearing runout (TIR)
0	bROG		in		Pinion bearing total radial play
0	bRPP		in		Gear bearing total radial play
0	bRPg		in		Minimum assembled center distance
	Cmin	.3712	in		Maximum assembled center distance
	Cmax	.3955	in		Pinion:
	Pmatl				Material Number (See Material Table)
	PN	Brass			Material Code
1	sp				Number of teeth
10	QP				AGMA Quality Class
	XP	10.50E-6	1/degF		Thermal Coefficient of expansion
	XP'	0	in/in		Moisture Coefficient of expansion
.2618	d		in		Nominal operating pitch diameter (Enter Ref PD for X-Axis Gears)
					Gear:
22	Gmatl				Material Number (See Material Table)
	GN	Far1140			Material Code
10	ng				Number of teeth
6	QG				AGMA Quality Class
	KG	11.67E-6	1/degF		Thermal Coefficient of expansion
	KG'	37.50E-6	in/in		Moisture Coefficient of expansion
.4616	D		in		Nominal operating pitch diameter (Enter Ref PD for X-Axis Gears)
					OPERATING CONDITIONS:
-40	TM		F		Housing temperature
-40	TP		F		Pinion temperature
-40	TG		F		Gear temperature
					Effective center distance:
	dCT	-.0002	in		Change in CD (Thermal, Moisture)
	dthb1	-.0002	in		Approximate change in trans backlash
	Cmin_op	.3710	in		Minimum center distance

Cmax_op .3953 in
dCd .02430 in

Maximum center distance
CD Range

----- VARIABLE SHEET -----

Input	Name	Output	Unit	Comment
				#4 Min CD,TRs Max TTs,ODs -40C 60-125 (Ver 4.2)
				CROSSED AXIS INVOLUTE HELICAL GEARS (Non-Enveloping Worm Gears)
				Press "Alt A" for Solution List
22.0000	pn		1/in	*NORMAL PLANE:
25.0000	npa		deg	*Diametral_Pitch
	n_mod	1.1545	mm	*Nominal Pressure Angle
	ncp	.1428	in	*Module
	pnb	.12942	in	*Circular_Pitch
				*Base Pitch
90.0000	s		deg	COMMON:
.37100	cd		in	*Shaft Angle (+ or -)
	std_cd	.36166	in	*Operating_center distance
	lc	.1986	in	*Standard_center distance
	mp	1.5342		*Length_of_contact
	mpc	No		*Contact_ratio (SAP > TIF)
	mg	10		*Contact_below finished involute?
1	ndr			*Gear_ratio
'frm	meth_dr			
.3700	oddr		in	*DRIVER:
	modd_dr	NA	in	Number of teeth
	Emod_dr	NA	deg	*Hobbed ('hob), Shaped ('shp)
	modr	NA	in	Formed ('frm)
	xmodr	NA	in	*Outside Diameter
	xncdr	NA	in	*Start_Tip_Modification
	xdr	NA	in	*Roll_at_start of tip modification
	eoddr	.3667	in	*Normal_OD_tip_relief
	nttodr	.0121	in	*Normal_circular_OD_tip_relief
	xn_eoddr	NA	in	*Transverse_circular_OD_tip_relief
	ptd_dr	.3871	in	*Effective_outside_diameter
	pddr	.2618	in	*Normal_tooth_thickness_at_EOD
.0619	nttdr		in	*Normal_EOD_tip_relief
0	SSn_dr		in	*Pointed_tooth_diameter (No tip mod)
				*Reference PD
				*Finished_normal_tooth_thickness
				*Total_normal_circular_finish
				stock on tooth thickness
80.0000	hadr		deg	*Helix_angle (+ Right, - Left)
	ladr	10.0000	deg	*Lead_angle (+ Right, - Left)
	Fdr_min	.1870	in	*Minimum_face_width (bi-rotation)
	ptdr	3.8203	1/in	*Transverse_diametral_pitch
	cpdr	.82235	in	*Transverse_circular_pitch
	tmoddr	6.6488	mm	*Transverse_module
	tpaddr	69.5752	deg	*Transverse_pressure_angle
	ttcdr	.3565	in	*Transverse_tooth_thickness
	tbpdr	.28698	in	*Transverse_base_pitch
	bhadr	63.19404	deg	*Base_helix_angle
	ap_dr	.14500	in	*Axial_pitch
	lead_dr	.1450	in	*Lead
	Dhi_dr	.1907	in	*Inv/fillet_intersection_dia (TIF)
	EDhi_dr	105.0151	deg	*Roll_at_inv/fil_intersection_dia
	rddr	.1590	in	*Root_diameter
	dbdr	.0913	in	*Base_diameter

10	ndn	
'frm	meth_dn	
.5750	oddn	in
	modd_dn	NA
	Emod_dn	NA
	xndn	NA
	xncdn	NA
	xdn	NA
	eoddn	.5731
	nttoddn	.0225
	kn_eodd	NA
	ptd_dn	.5962
	pddn	.4616
.0888	nttdn	in
0	ssn_dn	in
10.0000	badrn	deg
	ladn	80.0000
	Fdn_min	.0474
	ptdn	21.6658
	cpdn	.14500
	tmoddn	1.1724
	tpadn	25.3376
	tttdn	.0902
	thpdn	.13105
	bhadrn	9.05478
	ap_dn	.82235
	lead_dn	8.2235
	Dhi_dn	.4172
	EDhi_dn	0
	rddn	.3599
	dbdn	.4172
	delta	.00934
	cpc	.0034
	work	.0989
	nbb1	.0007
	pn`	22.0000
	ncp`	.14280
	npa`	25.0000
	pddr`	.2618
	nttdr`	.0619
	hadr`	80.0000
	ladr`	10.0000
	ptdr`	3.8203
	cpdr`	.82235
	tmoddr`	6.6488
	tpadr`	69.5752
	tttdr`	.3565
	abldr	2.043
	sap_dr	.1983
	nttsapr	.0898

*DRIVEN:
Number of teeth
*Hobbed ('hob), Shaped ('shp)
 Formed ('frm)
*Outside Diameter
*Start Tip Modification
 *Roll_at_start of tip modification
*Normal_OD tip relief
*Normal_circular OD tip relief
*Transverse_circular_OD tip relief
*Effective_outside diameter
 *Normal_tooth_thickness_at_EOD
 *Normal_EOD tip relief
*Pointed tooth diameter (No tip mod)
*Reference PD
 *Finished normal tooth thickness
 >Total normal circular finish
 stock on tooth thickness
 *Helix angle (+ Right, - Left)
 *Lead_angle (+ Right, - Left)
*Minimum face width (bi-rotation)
*Transverse_diametral pitch
*Transverse_circular pitch
*Transverse_module
*Transverse_pressure angle
*Transverse_tooth thickness
*Transverse_base pitch
*Base_helix angle
*Axial pitch
*Lead
*Inv/fillet intersection dia (TIF)
 *Roll_at_inv/fil intersection dia
*Root diameter
*Base_diameter

OPERATING DATA:

- *Separation of pitch planes
- *Contact_path to line of centers
- *Working depth
- Normal Plane:
 - *Base_backlash
 - *Diametral_pitch
 - *Circular_pitch
 - *Pressure_angle
- *DRIVER:
 - *Pitch_diameter
 - *Normal_Tooth_Thickness
 - *Helix_Angle (+ Right, - Left)
 - *Lead_Angle (+ Right, - Left)
 - *Transverse_Diametral_Pitch
 - *Transverse_Circular_Pitch
 - *Transverse_Module
 - *Transverse_Pressure_Angle
 - *Transverse_Tooth_Thickness
 - *Angular_backlash
 - *Start of active profile (SAP)
 - *Normal_tooth_thicknes at SAP

nswlddr	.0514	in
rtcl_dr	.0040	in
pddn	.4616	in
nttdn	.0888	in
hadn	10.0000	deg
ladn	80.0000	deg
ptdn	21.6658	1/in
cpdn	.14500	in
tmoddn	1.1724	mm
tpadn	25.3376	deg
cttdn	.0902	in
abldn	.204	deg
sap_dn	.4172	in
nttsapn	.0934	in
nswlddn	.0361	in
rtcl_dn	.0061	in

- *Normal_space width at SAP
- *Root_clearance
- *DRIVEN:
- *Pitch_diameter
- *Normal_Tooth_Thickness
- *Helix_Angle (+ Right, - Left)
- *Lead_Angle (+ Right, - Left)
- *Transverse_Diametral_Pitch
- *Transverse_Circular_Pitch
- *Transverse_Module
- *Transverse_Pressure_Angle
- *Transverse_Tooth_Thickness
- *Angular_backlash
- *Start_of_active_profile (SAP)
- *Normal_tooth_thicknes at SAP
- *Normal_space_width at SAP
- *Root_clearance

mark	'y	
markm	'y	
teeth	1	
roll		deg
t#	1	

PLOT CONFIGURATION:

- *Mark_inv/fil intersections?
- *Mark_mod/inv intersections?
- *Number_of_teeth on plot (Def=1)
- *Driver_contact_roll_angle of
- *Driver_tooth_number (Def=1)

Esap_dr	110.4024	deg
Eod_dr	222.7304	deg

DRIVER ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

Esap_dn	.0996	deg
Eod_dn	53.9638	deg

DRIVEN ROLL ANGLES:

- *Start_of_active_profile
- *Effective_outside_diameter

tpdr	'-	
hfa_dr	-	deg
h_dr	-	in
t_dr	-	in
hs_dr	-	in
hfa2_dr	-	deg
rt_dr	-	in
u_dr	-	in
ua_dr	-	deg
uap_dr	-	deg
hu_dr	-	in
hobAPdr	-	in
nawAPdr	-	in

DRIVER HOB:

- *Hob_type (Semi-Top='s, Tip-Rel='r Non-Top='n)
- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius
- *Protuberance
- *Protuberance_angle_from_flank
- *Protuberance_pressure_angle
- *Tip_to_flank/prot_intersection
- *Ref_Line_to_Hob_SAP
- *Normal_Space_Width_at_Hob_SAP

tpdn	'-	
hfa_dn	-	deg
h_dn	-	in
t_dn	-	in
hs_dn	-	in
hfa2_dn	-	deg
rt_dn	-	in

DRIVEN HOB:

- *Hob_type (Semi-Top='s, Tip-Rel='r Non-Top='n)
- *Flank_angle
- *Tip_to_Reference_Line
- *Tooth_thickness_at_Reference_Line
- *Reference_Line_to_Start_Mod_Ramp
- *Pressure_Angle_of_Mod_Ramp
- *Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space_Width at Hob SAP

DRIVER SHAPER:

nc_dr	-	in	*Number_of_Teeth
odc_dr	-	in	*Outside_Diameter
nttc_dr	-	in	*Normal_Tooth_Thickness
rts_dr	-	in	*Tip_Radius - Normal Plane
us_dr	-	in	*Protuberance - Normal Plane
cds_dr	NA	in	*Center_distance with gear
sapc_dr	-	in	*Start_of_active_profile diameter

DRIVEN SHAPER:

nc_dn	-	in	*Number_of_Teeth
odc_dn	-	in	*Outside_Diameter
nttc_dn	-	in	*Normal_Tooth_Thickness
rts_dn	-	in	*Tip_Radius - Normal Plane
us_dn	-	in	*Protuberance - Normal Plane
cds_dn	NA	in	*Center_distance with gear
sapc_dn	-	in	*Start_of_active_profile diameter

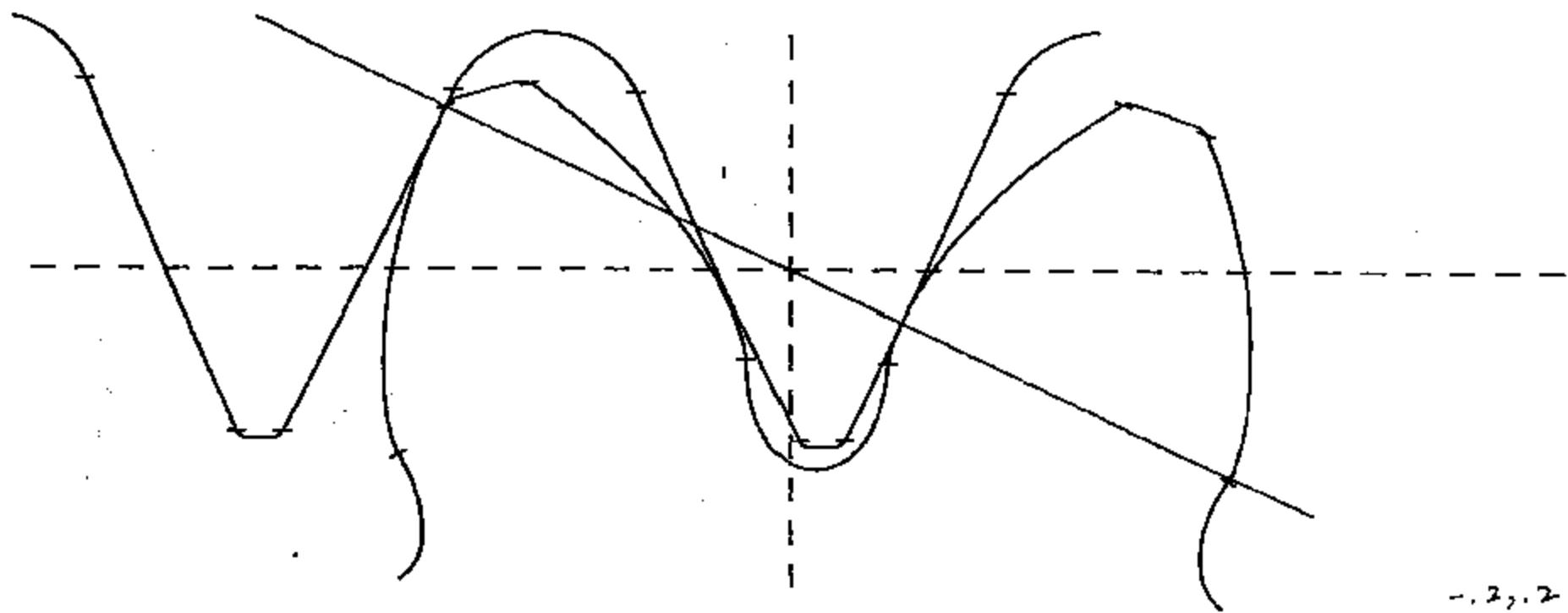
FORMED DRIVER:

25.0000	rfa``dr	deg	*Basic_Rack_Form:
.0412	h``dr	in	*Flank_Angle
.0714	t``dr	in	*Tip_to_Reference_Line
.0258	rt``dr	in	*Tooth_Thickness_at_Reference_Line
	tc_dr	0	*Tip_radius
.0030	tr_dr	in	*Radial_tip_chamfer_Def=0
	xp_dr	-	*Normal_tip_radius_Def=0
			*Normal_tip_relief_exponent_Def=3/2

FORMED DRIVEN:

25.0000	rfa``dn	deg	*Basic_Rack_Form:
.0695	h``dn	in	*Flank_Angle
.0714	t``dn	in	*Tip_to_Reference_Line
.0051	rt``dn	in	*Tooth_Thickness_at_Reference_Line
	tc_dn	0	*Tip_radius
.0030	tr_dn	in	*Radial_tip_chamfer_Def=0
	xp_dn	-	*Normal_tip_radius_Def=0
			*Normal_tip_relief_exponent_Def=3/2

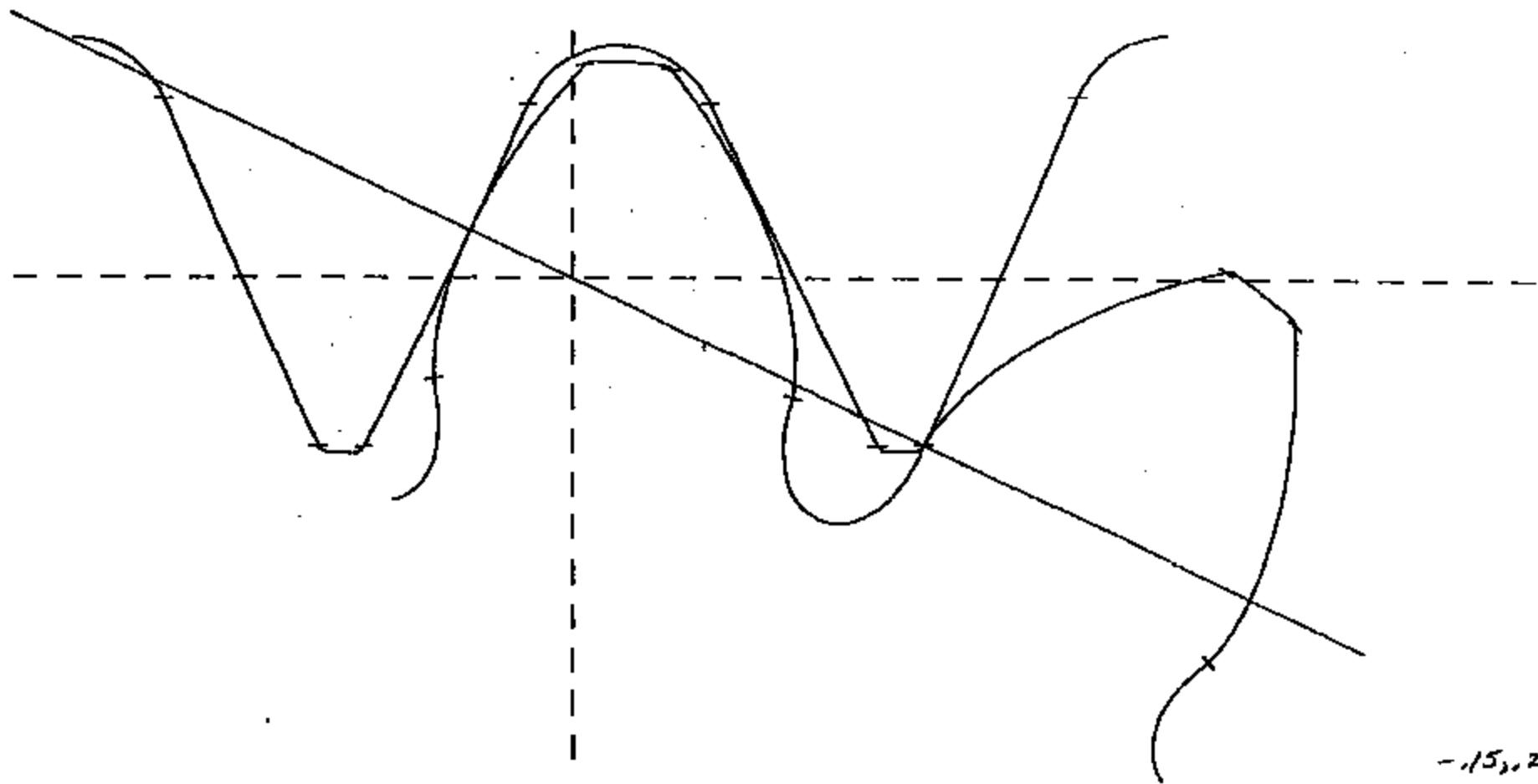
Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



-22-

12574

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



-15, 25

17574

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
.06	Vs f	0	ft/min	LOADING:	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)
	eff	+74	%		*Approx_efficiency
	effback	+65	%		*Approx_efficiency backdriving
	sfb				*Anti-backdrive safety factor
	nload	9.103	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	9.103	lbf		*Total_normal tooth load
	cli	73.17	deg		*At_center of contact interval:
	s	60041	psi		*Angle between contact curvatures
	Cc	2265.4	psi		*Specific compressive stress, s
	power	0	HP		*Load/compressive stress factor, Cc
0	rev_dr		rpm	Driver:	*Power
3	tork_dr		ozf-in		*Rotational speed
15E6	E_dr		psi		*Torque
	clidr	68.924	deg		*Young's modulus (Default = Steel)
	tan_dr	1.433	lbf		*Contact curvature inclination angle
	sep_dr	3.847	lbf		*Tangential force
	ax_dr	8.125	lbf		*Separating force
	Mo_dr	1.141	lbf-in		*Axial_force
	rev_dn	0	rpm		*Overturning moment
	tork_dn	22.147	ozf-in	Driven:	
	E_dn		psi		*Rotational speed
	clidn	4.246	deg		*Torque
	tan_dn	8.125	lbf		*Young's modulus (Default = Bronze)
	sep_dn	3.847	lbf		*Contact curvature inclination angle
	ax_dn	1.433	lbf		*Tangential force
1.9E6	Mo_dn	.33	lbf-in		*Separating force
					*Axial_force
					*Overturning moment
	T	22.146626	ozf-in	Screw Connected to Driven and Nut	
	Fa	45.48122	lbf	Screw Driving	
.333	Dm		in	Torque	
2	Ns			Total axial resisting load	
.125	Tlead		in	Thread pitch diameter	
.06	p	.0625	in	Number of starts	
14.5	f			Thread lead	
	phi		deg	Thread axial pitch	
	alpha	6.8137223	deg	Coefficient of friction: threads	
0	fc			One half included thread angle	
.375	Dc		in	Thread mean lead angle	
	theta	15.901497	deg	Coefficient of friction: thrust collar	
	e	66.344336	%	Mean diameter of thrust collar	
.766	Lgs		in	Axis to thread normal surface	
.375	OD		in	Thread efficiency	
.276	RD		in	Threaded length	
.296	ID		in	Screw OD	
	At	.07282231	in^2	Screw Root Diameter	
	An	.51005641	in^2	Nut ID	
				Tensile stress area	
				Total thread surface area	

.03125	ScT	89.169	psi	Compressive stress (Full contact)
	att		in	Screw axial tooth thickness
	attR	.04081885	in	Screw axial tooth thickness at Nut ID
	attN	.04211194	in	Nut axial tooth thickness at Screw OD
	SnS	.46521221	in^2	Total screw shear area
	SnN	.60804417	in^2	Total nut shear area
	SsS	97.764458	psi	Screw shear stress (Full contact)
	SsN	74.799204	psi	Nut shear stress (Full contact)
	StS	335.29761	psi	Torsional stress at screw root dia
	StA	624.5506	psi	Axial stress at screw root dia
	StR	770.46778	psi	Max tensile stress at screw root dia
	SsR	458.19248	psi	Max shear stress at screw root dia

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
.06	Vs f	0	ft/min	LOADING: *Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze driven)	
	eff	+74	%	*Approx_efficiency	
	effback	+65	%	*Approx_efficiency backdriving	
	sfb			*Anti-backdrive safety factor	
	nload	18.206	lbf	*Imposed normal tooth load	
	Fo	1		*Overload factor Def=1	
	tnload	18.206	lbf	*Total_normal tooth load	
	cli	73.17	deg	*At_center of contact interval:	
	s	75647	psi	*Angle between contact curvatures	
	Cc	4530.9	psi	*Specific compressive stress, s	
				*Load/compressive stress factor, Cc	
0	power	0	HP	Driver:	
6	rev_dr		rpm	*Power	
15E6	tork_dr		ozf-in	*Rotational speed	
	E_dr		psi	*Torque	
	clidr	68.924	deg	*Young's modulus (Default = Steel)	
	tan_dr	2.865	lbf	*Contact curvature inclination angle	
	sep_dr	7.694	lbf	*Tangential force	
	ax_dr	16.249	lbf	*Separating force	
	Mo_dr	2.282	lbf-in	*Axial_force	
				*Overturning moment	
1.9E6	rev_dn	0	rpm	Driven:	
	tork_dn	44.293	ozf-in	*Rotational speed	
	E_dn		psi	*Torque	
	clidn	4.246	deg	*Young's modulus (Default = Bronze)	
	tan_dn	16.249	lbf	*Contact curvature inclination angle	
	sep_dn	7.694	lbf	*Tangential force	
	ax_dn	2.865	lbf	*Separating force	
	Mo_dn	.661	lbf-in	*Axial_force	
				*Overturning moment	
				Screw Connected to Driven and Nut	
				Screw Driving	
	T	44.293252	ozf-in	Torque	
	Fa	90.96244	lbf	Total axial resisting load	
	Dm		in	Thread pitch diameter	
	Ns			Number of starts	
	Tlead		in	Thread lead	
	p	.0625	in	Thread axial pitch	
	f			Coefficient of friction: threads	
	phi		deg	One half included thread angle	
	alpha	6.8137223	deg	Thread mean lead angle	
	fc			Coefficient of friction: thrust collar	
	Dc		in	Mean diameter of thrust collar	
	theta	15.901497	deg	Axis to thread normal surface	
	e	66.344336	%	Thread efficiency	
	Lgs		in	Threaded length	
	OD		in	Screw OD	
	RD		in	Screw Root Diameter	
	ID		in	Nut ID	
	At	.07282231	in^2	Tensile stress area	
	An	.51005641	in^2	Total thread surface area	

.03125	ScT	176.338	psi	Compressive stress (Full contact)
	att		in	Screw axial tooth thickness
	attR	.04081885	in	Screw axial tooth thickness at Nut ID
	attN	.04211194	in	Nut axial tooth thickness at Screw OD
	SnS	.46521221	in ⁻²	Total screw shear area
	SnN	.60804417	in ⁻²	Total nut shear area
	SsS	195.52892	psi	Screw shear stress (Full contact)
	SsN	149.59841	psi	Nut shear stress (Full contact)
	StS	670.59521	psi	Torsional stress at screw root dia
	StA	1249.1012	psi	Axial stress at screw root dia
	StR	1540.9356	psi	Max tensile stress at screw root dia
	SsR	916.38496	psi	Max shear stress at screw root dia

VARIABLE SHEET					
Input	Name	Output	Unit	Comment	
'e	type			#4 Max Eff CD - Hot 60-146 (Ver 4.2) Eff Center Distance Due to Tolerance, Operating Temperature & Moisture Absorption Press "Alt A" for Model Solutions External or Internal Set ('e or 'i)	
22	pn		1/in		
	mn	1.1545455	mm		
10	ha		deg		
25	tpa		deg		
+68	TR		F		
				ASSEMBLY CONDITIONS:	
				Normal Diametral Pitch	
				Normal Module	
				Helix Angle	
				Operating Transverse Pressure Angle	
				Temperature (Default =68F =20C)	
				Housing:	
				Material Number (See Material Table)	
19	Hmatl			Material Code	
	HN	Zinc		Thermal Coefficient of expansion	
	KM	15.20E-6	1/degF	Moisture Coefficient of expansion	
	KM'	0	in/in	Basic or nominal center distance	
.3801	Cd		in	Minimum center distance tolerance	
-.0089	Ct		in	Maximum center distance tolerance	
+.0089	Ct'		in		
	TCTP	.00140	in	Pinion total composite tolerance	
	TCTG	.00510	in	Gear total composite tolerance	
0	bROP		in	Pinion bearing runout (TIR)	
0	bROG		in	Gear bearing runout (TIR)	
0	bRPP		in	Pinion bearing total radial play	
0	bRPg		in	Gear bearing total radial play	
	Cmin	.3712	in	Minimum assembled center distance	
	Cmax	.3955	in	Maximum assembled center distance	
				Pinion:	
7	Pmatl			Material Number (See Material Table)	
	PN	Brass		Material Code	
1	np			Number of teeth	
10	Qp			AGMA Quality Class	
	KP	10.50E-6	1/degF	Thermal Coefficient of expansion	
	KP'	0	in/in	Moisture Coefficient of expansion	
.2618	d		in	Nominal operating pitch diameter (Enter Ref PD for X-Axis Gears)	
				Gear:	
22	Gmatl			Material Number (See Material Table)	
	GN	For1140		Material Code	
10	ng			Number of teeth	
6	Qg			AGMA Quality Class	
	KG	11.67E-6	1/degF	Thermal Coefficient of expansion	
	KG'	37.50E-6	in/in	Moisture Coefficient of expansion	
.4616	D		in	Nominal operating pitch diameter (Enter Ref PD for X-Axis Gears)	
				OPERATING CONDITIONS:	
+185	TM		F	Housing temperature	
+185	TP		F	Pinion temperature	
+185	TG		F	Gear temperature	
				Effective center distance:	
	dCT'	+.0002	in	Change in CD (Thermal, Moisture)	
	dtbl'	+.0001	in	Approximate change in trans backlash	
	Cmin_op	.3713	in	Minimum center distance	

Cmax_op .3956 in
dCd .02430 in

Maximum center distance
CD Range

===== VARIABLE SHEET =====

Input	Name	Output	Unit	Comment
				#4 Max OD,TRs Min TTS,ODs +185C 60-125 (Ver 4.2) CROSSED AXIS INVOLUTE HELICAL GEARS (Non-Enveloping Worm Gears) Press "Alt A" for Solution List
22.0000	pn		1/in	*NORMAL PLANE: *Diametral_Pitch
25.0000	npa		deg	*Nominal Pressure Angle
	n_mod	1.1545	mm	*Module
	ncp	.1428	in	*Circular_Pitch
	pnb	.12942	in	*Base Pitch
90.0000	E		deg	COMMON:
.39560	cd		in	*Shaft Angle (+ or -)
	std_cd	.36166	in	*Operating_center distance
	Lc	.1308	in	*Standard_center distance
	mp	1.0104		*Length of contact
	mpc	No		*Contact ratio (SAP > TIF)
	mg	10		*Contact_below finished involute?
1	ndr			*Gear_ratio
'frm	meth_dr			
.3680	oddr		in	*DRIVER:
	modd_dr	NA	in	Number of teeth
	Emod_dr	NA	deg	*Hobbed ('hob), Shaped ('shp)
	xndr	NA	in	Formed ('frm)
	xncdr	NA	in	*Outside Diameter
	xdr	NA	in	*Start_Tip Modification
	eoddr	.3624	in	*Roll_at_start of tip modification
	nttodr	.0127	in	*Normal_OD tip relief
	xn_eoddr	NA	in	*Normal_circular_OD tip relief
	ptd_dr	.3840	in	*Transverse_circular_OD tip relief
	pddr	.2618	in	*Effective_outside_diameter
.0604	nttdr		in	*Normal_tooth_thickness_at_EOD
0	SSn_dr		in	*Pointed_tooth_diameter (No tip mod)
80.0000	hadr		deg	*Reference PD
	ladr	10.0000	deg	*Finished_normal_tooth_thickness
	Fdr_min	.1772	in	*Total_normal_circular_finish
	ptdr	3.6203	1/in	stock_on_tooth_thickn
	cpdr	.82235	in	*Helix_angle (+ Right, - Left)
	tmoddr	6.6488	mm	*Lead_angle (+ Right, - Left)
	tpadr	69.5752	deg	*Minimum_face_width (bi-rotation)
	tttdr	.3478	in	*Transverse_diametral_pitch
	tbpdr	.28698	in	*Transverse_circular_pitch
	bhadr	63.19404	deg	*Transverse_module
	ap_dr	.14500	in	*Transverse_pressure_angle
	lead_dr	.1450	in	*Transverse_tooth_thickness
	Dhi_dr	.1877	in	*Transverse_base_pitch
	EDhi_dr	102.8622	deg	*Base_helix_angle
	rddr	.1558	in	*Axial_pitch
	dbdr	.0913	in	*Lead
				*Inv/fillet_intersection_dia (TIF)
				*Roll_at_inv/fil_intersection_dia
				*Root_diameter
				*Base_diameter

10	ndn	
'frm	meth_dn	
.5700	oddn	in
	modd_dn	NA
	Bmod_dn	NA
	xndn	NA
	xncdn	NA
	xdn	NA
	eoddn	.5667
	nttddn	.0256
	xn_eodd	NA
	ptd_dn	.5936
	pddn	.4616
.0868	nttdn	in
0	SSn_dn	in
10.0000	hadn	deg
	ladn	80.0000
	Fdn_min	.0459
	ptdn	21.6658
	cpdn	.14500
	tmoddn	1.1724
	tpadn	25.3376
	ttcdn	.0881
	tbpdn	.13105
	bhadr	9.05478
	ap_dn	.82235
	lead_dn	.82235
	Dhi_dn	.4174
	EDhi_dn	1.8245
	rddn	.3556
	dbdn	.4172
	delta	.03394
	cpc	.0124
	work	.0690
	nbb1	.0247
	pn	22.0000
	nep	.14280
	npa	25.0000
	pddr	.2618
	nttdr	.0604
	hadr	80.0000
	ladr	10.0000
	ptdr	3.8203
	cpdr	.82235
	tmoddr	6.6488
	tpadrr	69.5752
	tttdr	.3478
	abldr	68.704
	sap_dr	.2501
	nttsapr	.0657

*DRIVEN:

- Number of teeth
- *Hobbed ('hob'), Shaped ('shp')
- Formed ('frm')
- *Outside Diameter
- *Start Tip Modification
 - *Roll at start of tip modification
 - *Normal OD tip relief
 - *Normal_circular OD tip relief
 - *Transverse_circular_OD tip relief
- *Effective_outside diameter
 - *Normal_tooth thickness_at_SOD
 - *Normal_EOD tip relief
- *Pointed tooth diameter (No tip mod)
- *Reference PD
- *Finished normal tooth thickness
- *Total normal circular finish
 - stock on tooth thickness
- *Helix angle (+ Right, - Left)
- *Lead_angle (+ Right, - Left)
- *Minimum face width (bi-rotation)
- *Transverse_diametral pitch
- *Transverse_circular pitch
- *Transverse_module
- *Transverse_pressure angle
- *Transverse_tooth thickness
- *Transverse_base pitch
- *Base_helix angle
- *Axial pitch
- *Lead
- *Inv/fillet intersection dia (TIF)
 - *Roll_at_inv/fil intersection dia
- *Root_diameter
- *Base_diameter

OPERATING DATA:

- *Separation of pitch planes
- *Contact_path to line of centers
- *Working_depth
- Normal Plane:
 - *Base_backlash
 - *Diametral_pitch
 - *Circular_pitch
 - *Pressure_angle
- *DRIVER:
 - *Pitch_diameter
 - *Normal_Tooth_Thickness
 - *Helix_Angle (+ Right, - Left)
 - *Lead_Angle (+ Right, - Left)
 - *Transverse_Diametral_Pitch
 - *Transverse_Circular_Pitch
 - *Transverse_Module
 - *Transverse_Pressure_Angle
 - *Transverse_Tooth_Thickness
 - *Angular_backlash
 - *Start_of_active_profile (SAP)
 - *Normal_tooth_thicknes at SAP

nswlddr	.0769	in
rtcl_dr	.0327	in
pddn`	.4616	in
ntcdn`	.0868	in
hadn`	10.0000	deg
ladn`	80.0000	deg
ptdn`	21.6658	1/in
cpdn`	.14500	in
tmoddn`	1.1724	mm
tpadn`	25.3376	deg
tttdn`	.0881	in
abldn	6.87	deg
sap_dn	.4356	in
nttsapn	.0918	in
nswlddn	.0432	in
rtcl_dn	.0338	in

*Normal_space width at SAP
 *Root_clearance
***DRIVEN:**
 *Pitch_diameter
 *Normal_Tooth_Thickness
 *Helix_Angle (+ Right, - Left)
 *Lead_Angle (+ Right, - Left)
 *Transverse_Diametral_Pitch
 *Transverse_Circular_Pitch
 *Transverse_Module
 *Transverse_Pressure_Angle
 *Transverse_Tooth_Thickness
 *Angular_backlash
 *Start_of_active_profile (SAP)
 *Normal_tooth thickness at SAP
 *Normal_space width at SAP
 *Root_clearance

mark	'y	
markm	'y	
teeth	1	
roll		deg
t#	1	

PLOT CONFIGURATION:

*Mark_inv/fill intersections?
 *Mark_mod/inv intersections?
 *Number_of_teeth_on_plot (Def=1)
 *Driver_contact_roll_angle_of
 *Driver_tooth_number (Def=1)

Esap_dr	146.0108	deg
Eod_dr	219.9859	deg

DRIVER ROLL ANGLES:

*Start_of_active_profile
 *Effective_outside_diameter

Esap_dn	17.2061	deg
Eod_dn	52.6791	deg

DRIVEN ROLL ANGLES:

*Start_of_active_profile
 *Effective_outside_diameter

tpdr	'-	
hfa_dr	-	deg
h`dr	-	in
t`dr	-	in
hs`dr	-	in
hfa2_dr	-	deg
rt_dr	-	in
u_dr	-	in
ua_dr	-	deg
uap_dr	-	deg
hu_dr	-	in
hobAPdr	-	in
nswAPdr	-	in

DRIVER HOB:

*Hob_type (Semi-Top-'s, Tip-Rel='r
 Non-Top-'n)
 *Flank_angle
 *Tip_to_Reference_Line
 *Tooth_thickness_at_Reference_Line
 *Reference_Line_to_Start_Mod_Ramp
 *Pressure_Angle_of_Mod_Ramp
 *Tip_radius
 *Protuberance
 *Protuberance_angle_from_flank
 *Protuberance_pressure_angle
 *Tip_to_flank/prot_intersection
 *Ref_Lines_to_Hob_SAP
 *Normal_Space_Width_at_Hob_SAP

tpdn	'-	
hfa_dn	-	deg
h`dn	-	in
t`dn	-	in
hs`dn	-	in
hfa2_dn	-	deg
rt_dn	-	in

DRIVEN HOB:

*Hob_type (Semi-Top-'s, Tip-Rel='r
 Non-Top-'n)
 *Flank_angle
 *Tip_to_Reference_Line
 *Tooth_thickness_at_Reference_Line
 *Reference_Line_to_Start_Mod_Ramp
 *Pressure_Angle_of_Mod_Ramp
 *Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
hobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space_Width at Hob SAP

nc_dr	-	in	*Number_of_Teeth
odc_dr	-	in	*Outside_Diameter
nttc_dr	-	in	*Normal_Tooth_Thickness
rts_dr	-	in	*Tip_Radius - Normal Plane
us_dr	-	in	*Protuberance - Normal Plane
cds_dr	NA	in	*Center_distance with gear
sapc_dr	-	in	*Start_of_active_profile diameter

nc_dn	-	in	*Number_of_Teeth
odc_dn	-	in	*Outside_Diameter
nttc_dn	-	in	*Normal_Tooth_Thickness
rts_dn	-	in	*Tip_Radius - Normal Plane
us_dn	-	in	*Protuberance - Normal Plane
cds_dn	NA	in	*Center_distance with gear
sapc_dn	-	in	*Start_of_active_profile diameter

DRIVEN SHAPER:

- *Number_of_Teeth
- *Outside_Diameter
- *Normal_Tooth_Thickness
- *Tip_Radius - Normal Plane
- *Protuberance - Normal Plane
- *Center_distance with gear
- *Start_of_active_profile diameter

FORMED DRIVER:

- *Basic_Rack_Form:
 - *Flank_Angle
 - *Tip_to_Reference Line
 - *Tooth_Thickness_at_Reference Line
 - *Tip_radius
- *Radial_tip_chamfer Def=0
- *Normal_tip_radius Def=0
- *Normal_tip_relief_exponent Def=3/2

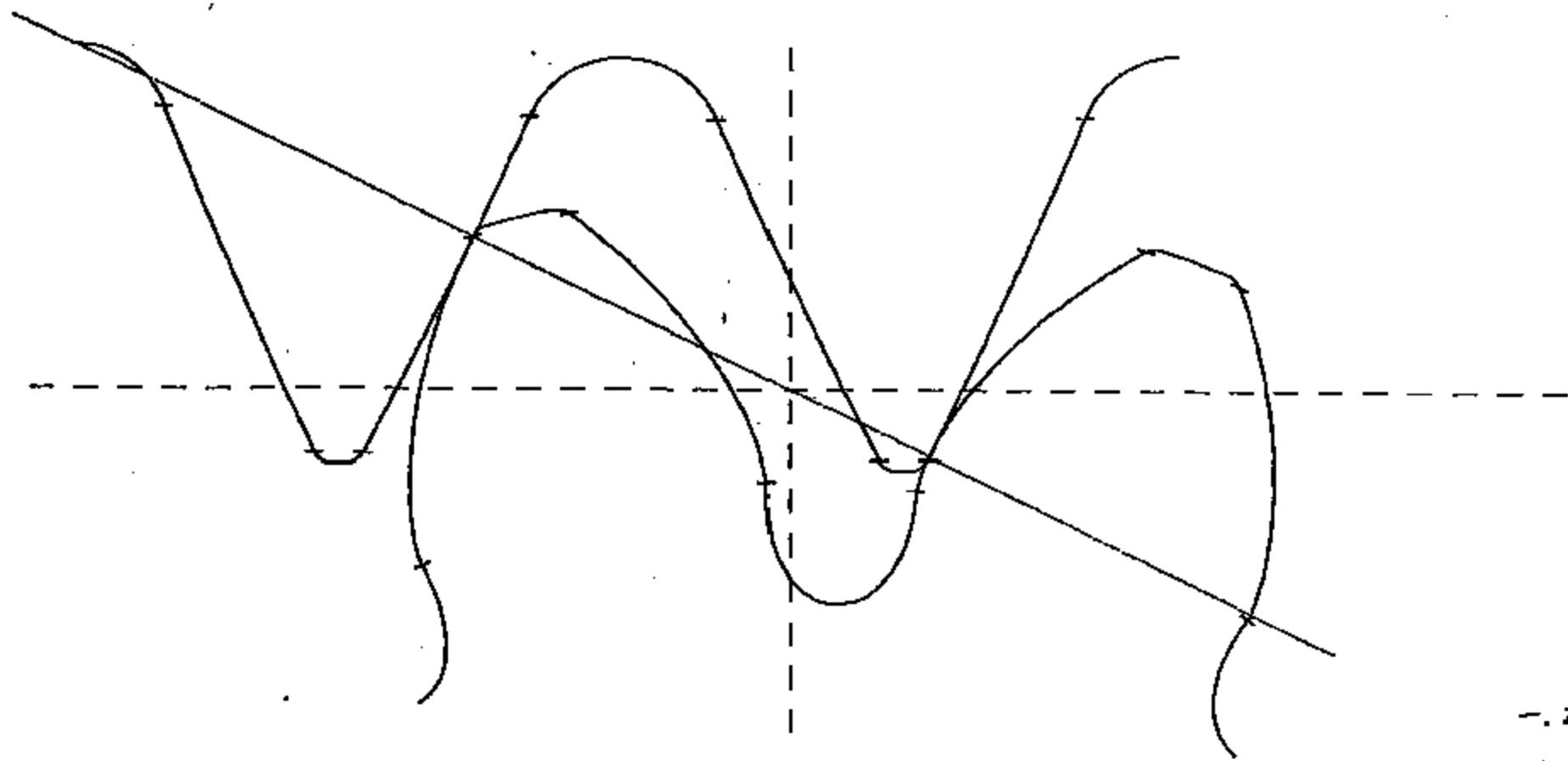
FORMED DRIVEN:

- *Basic_Rack_Form:
 - *Flank_Angle
 - *Tip_to_Reference Line
 - *Tooth_Thickness_at_Reference Line
 - *Tip_radius
- *Radial_tip_chamfer Def=0
- *Normal_tip_radius Def=0
- *Normal_tip_relief_exponent Def=3/2

25.0000	rfa``dr	deg
.0412	h``dr	in
.0714	t``dr	in
.0258	rt``dr	in
.0050	tc_dr	0
	tr_dr	in
	xp_dr	-

25.0000	rfa``dn	deg
.0695	h``dn	in
.0714	t``dn	in
.0051	rt``dn	in
.0050	tc_dn	0
	tr_dn	in
	xp_dn	-

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



VARIABLE SHEET

Input	Name	Output	Unit	Comment
LOADING:				
.06	Vs f	0	ft/min	*Maximum sliding velocity *Approx_coefficient of friction (Default value is for hardened steel driver and bronze drive...)
	eff	+74	%	*Approx_efficiency
	effback	+65	%	*Approx_efficiency backdriving
	sfb			*Anti-backdrive safety factor
	nload	9.103	lbf	*Imposed normal tooth load
	Fo	1		*Overload factor Def-1
	tnload	9.103	lbf	*Total_normal tooth load
	cli	76.152	deg	*At_center of contact interval:
	s	46347	psi	*Angle between contact curvatures
	Cc	1593.6	psi	*Specific compressive stress, s *Load/compressive stress factor, Cc
Driver:				
0	power	0	HP	*Power
3	rev_dr		rpm	*Rotational speed
1.5E6	tork_dr		ozf-in	*Torque
	E_dr		psi	*Young's modulus (Default = Steel)
	cldr	70.67	deg	*Contact curvature inclination angle
	tan_dr	1.433	lbf	*Tangential force
	sep_dr	3.847	lbf	*Separating force
	ax_dr	8.125	lbf	*Axial_force
	Mo_dr	1.242	lbf-in	*Overturning moment
Driven:				
1.5E6	rev_dn	0	rpm	*Rotational speed
	tork_dn	22.147	ozf-in	*Torque
	E_dn		psi	*Young's modulus (Default = Bronze)
	cldn	5.482	deg	*Contact curvature inclination ang...
	tan_dn	8.125	lbf	*Tangential force
	sep_dn	3.847	lbf	*Separating force
	ax_dn	1.433	lbf	*Axial_force
	Mo_dn	.35	lbf-in	*Overturning moment
Screw Connected to Driven and Nut				
				Screw Driving
	T	22.146626	ozf-in	Torque
	Fa	45.48122	lbf	Total axial resisting load
	Dm		in	Thread pitch diameter
	Ns			Number of starts
	Tlead		in	Thread lead
	P	.0625	in	Thread axial pitch
	f			Coefficient of friction: threads
	phi		deg	One half included thread angle
	alpha	6.8137223	deg	Thread mean lead angle
	fc			Coefficient of friction: thrust collar
	Dc		in	Mean diameter of thrust collar
	theta	15.901497	deg	Axis to thread normal surface
	e	66.344336	%	Thread efficiency
	LgS		in	Threaded length
	OD		in	Screw OD
	RD		in	Screw Root Diameter
	ID		in	Nut ID
	At	.07282231	in^2	Tensile stress area
	An	.51005641	in^2	Total thread surface area

.03125	ScT	89.169	psi	Compressive stress (Full contact)
	att		in	Screw axial tooth thickness
	attR	.04081885	in	Screw axial tooth thickness at Nut ID
	attN	.04211194	in	Nut axial tooth thickness at Screw OD
	SnS	.46521221	in ²	Total screw shear area
	SnN	.60804417	in ²	Total nut shear area
	SsS	97.764458	psi	Screw shear stress (Full contact)
	SsN	74.799204	psi	Nut shear stress (Full contact)
	StS	335.29761	psi	Torsional stress at screw root dia
	StA	624.5506	psi	Axial stress at screw root dia
	StR	770.46778	psi	Max tensile stress at screw root dia
	SsR	458.19248	psi	Max shear stress at screw root dia

.03125	ScT	179.338	psi	Compressive stress (Full contact)
	att	in		Screw axial tooth thickness
	attR	.04081885	in	Screw axial tooth thickness at Nut ID
	attN	.04211194	in	Nut axial tooth thickness at Screw OD
	SnS	.46521221	in ²	Total screw shear area
	SnN	.60804417	in ²	Total nut shear area
	SsS	195.52892	psi	Screw shear stress (Full contact)
	SsN	149.59841	psi	Nut shear stress (Full contact)
	StS	670.59521	psi	Torsional stress at screw root dia
	StA	1249.1012	psi	Axial stress at screw root dia
	StR	1540.9356	psi	Max tensile stress at screw root dia
	SsR	916.38496	psi	Max shear stress at screw root dia

----- VARIABLE SHEET -----

t Input--- Name--- Output--- Unit---- Comment-----

#4 Nominal

60-125 (Ver 4.2)

CROSSED AXIS INVOLUTE HELICAL GEARS

(Non-Enveloping Worm Gears)

Press "Alt A" for Solution List

22.0000	pn	1/in
25.0000	npa	deg
	n_mod	mm
	ncp	in
	pnb	in

*NORMAL PLANE:

- *Diametral_Pitch
- *Nominal Pressure Angle
- *Module
- *Circular_Pitch
- *Base Pitch

90.0000	E	deg
.38010	cd	in
	std_cd	in
	Lc	in
	mp	1.3310
	mpc	No
	mg	10

COMMON:

- *Shaft Angle (+ or -)
- *Operating_center distance
- *Scandard_center distance
- *Length_of_contact
- *Contact_ratio (SAP > TIF)
 - *Contact_below finished involute?
- *Gear_ratio

1	ndr	
'frm	meth_dr	
.3690	oddr	in
	modd_dr	NA
	Emod_dr	NA
	xndr	NA
	xncdr	NA
	xdr	NA
	eoddr	.3646
	nttodr	.0124
	xn_eoddr	NA
	ptd_dr	.3855
	pcdr	.2618
.0612	nttdr	in
0	SSn_dr	in

*DRIVER:

- Number_of_teeth
- *Hobbed ('hob), Shaped ('shp)
- Formed ('frm)
- *Outside_Diameter
- *Start_Tip_Modification
 - *Roll_at_start_of_tip_modificati
- *Normal_OD_tip_relief
- *Normal_circular_OD_tip_relief
- *Transverse_circular_OD_tip_relief
- *Effective_outside_diameter
- *Normal_tooth_thickness_at_EOD
- *Normal_EOD_tip_relief
- *Pointed_tooth_diameter (No tip mod)
- *Reference_PD
- *Finished_normal_tooth_thickness
- *Total_normal_circular_finish
- stock_on_tooth_thickness

80.0000	hadr	deg
	ladr	10.0000
	Fdr_min	.1815
	ptdr	3.8203
	cpdr	.82235
	tmoddr	6.6488
	tpadr	69.5752
	tttdr	.3521
	tbpdr	.28698
	bhadr	63.19404
	ap_dr	.14500
	lead_dr	.1450
	Dhi_dr	.1892
	EDhi_dr	103.9387
	rddr	.1574
	dbdr	.0913

- *Helix_angle (+ Right, - Left)
- *Lead_angle (+ Right, - Left)
- *Minimum_face_width (bi-rotation)
- *Transverse_diametral_pitch
- *Transverse_circular_pitch
- *Transverse_module
- *Transverse_pressure_angle
- *Transverse_tooth_thickness
- *Transverse_base_pitch
- *Base_helix_angle
- *Axial_pitch
- *Lead
- *Inv/fillet_intersection_dia (TIF)
 - *Roll_at_inv/fil_intersection_dia
- *Root_diameter
- *Base_diameter

10	ndn	
'frm	meth_dn	
.5725	oddn	in
	modd_dn	NA
	Emod_dn	NA
	xndn	NA
	xncdn	NA
	xdn	NA
	eoddn	.5699
	nttoddn	.0241
	xn_eodd	NA
	ptd_dn	.5949
	pddn	.4616
.0878	nttdn	
0	SSn_dn	
10.0000	hadn	deg
	ladn	80.0000
	Fdn_min	.0466
	ptdn	21.6658
	cpdn	.14500
	tmoddn	1.1724
	tpadn	25.3376
	tttdn	.0892
	tbpdn	.13105
	bhadr	9.05478
	ap_dn	.82235
	lead_dn	8.2235
	Dhi_dn	.4172
	EDhi_dn	0
	rddn	.3577
	dbdn	.4172
	delta	.01844
	cpc	.0068
	work	.0871
	nbb1	.0100
	pn	22.0000
	ncp	.14280
	npa	25.0000
	pddr	.2618
	nttdr	.0612
	hadr	80.0000
	ladr	10.0000
	ptdr	3.8203
	cpdr	.82235
	tmoddr	6.6488
	tpadr	69.5752
	tttdr	.3521
	abldr	27.85
	sap_dr	.2177
	nttsapr	.0809

*DRIVEN:

- Number of teeth
- *Hobbed ('hob), Shaped ('shp)
- Formed ('frm')
- *Outside Diameter
- *Start_Tip Modification
 - *Roll_at_start of tip modification
 - *Normal_OD tip relief
 - *Normal_circular OD tip relief
 - *Transverse_circular_OD tip relief
- *Effective_outside diameter
- *Normal_tooth_thickness_at_EOD
- *Normal_EOD_tip_relief
- *Pointed tooth diameter (No tip mod)
- *Reference PD
- *Finished normal tooth thickness
- *Total normal circular finish stock on tooth thickness
- *Helix angle (+ Right, - Left)
- *Lead_angle (+ Right, - Left)
- *Minimum face width (bi-rotation)
- *Transverse_diametral pitch
- *Transverse_circular pitch
- *Transverse_module
- *Transverse_pressure_angle
- *Transverse_tooth_thicknes
- *Transverse_base_pitch
- *Base_helix_angle
- *Axial_pitch
- *Lead
- *Inv/fillet intersection dia (TIF)
- *Roll_at_inv/fil intersection dia
- *Root_diameter
- *Base_diameter

OPERATING DATA:

- *Separation of pitch planes
- *Contact_path to line of centers
- *Working_depth

Normal Plane:

- *Base_backlash
- *Diametral_pitch
- *Circular_pitch
- *Pressure_angle

*DRIVER:

- *Pitch_diameter
- *Normal_Tooth_Thickness
- *Helix_Angle (+ Right, - Left)
- *Lead_Angle (+ Right, - Left)
- *Transverse_Diametral_Pitch
- *Transverse_Circular_Pitch
- *Transverse_Module
- *Transverse_Pressure_Angle
- *Transverse_Tooth_Thickness
- *Angular_backlash
- *Start_of_active_profile (SAP)
- *Normal_tooth_thickness_at_SAP

newladdr	.0610	in	*Normal_space width at SAP
rtcl_dr	.0152	in	*Root_clearance
pddn`	.4616	in	*DRIVEN:
nttdn`	.0878	in	*Pitch_diameter
hadn`	10.0000	deg	*Normal_Tooth_Thickness
ladn`	80.0000	deg	*Helix_Angle (+ Right, - Left)
ptdn`	21.6658	1/in	*Lead_Angle (+ Right, - Left)
cpdn`	.14500	in	*Transverse_Diametral_Pitch
tmoddn`	1.1724	mm	*Transverse_Circular_Pitch
tpadn`	25.3376	deg	*Transverse_Module
tttdn`	.0892	in	*Transverse_Pressure_Angle
abldn	2.785	deg	*Transverse_Tooth_Thickness
sap_dn	.4199	in	*Angular_backlash
nttsapn	.0928	in	*Start_of_active_profile (SAP)
newlddn	.0374	in	*Normal_tooth_thickness_at_SAP
rtcl_dn	.0167	in	*Normal_space_width_at_SAP
			*Root_clearance

PLOT CONFIGURATION:

mark	'y		*Mark_inv/fil intersections?
markm	'y		*Mark_mod/inv intersections?
teeth	1		*Number_of_teeth_on_plot (Def=1)
roll		deg	*Driver_contact_roll_angle_of
t#	1		*Driver_tooth_number (Def=1)

DRIVER ROLL ANGLES:

Esap_dr	123.9156	deg	*Start_of_active_profile
Eod_dr	221.3625	deg	*Effective_outside_diameter

DRIVEN ROLL ANGLES:

Esap_dn	6.5968	deg	*Start_of_active_profile
Eod_dn	53.3251	deg	*Effective_outside_diameter

DRIVER HOB:

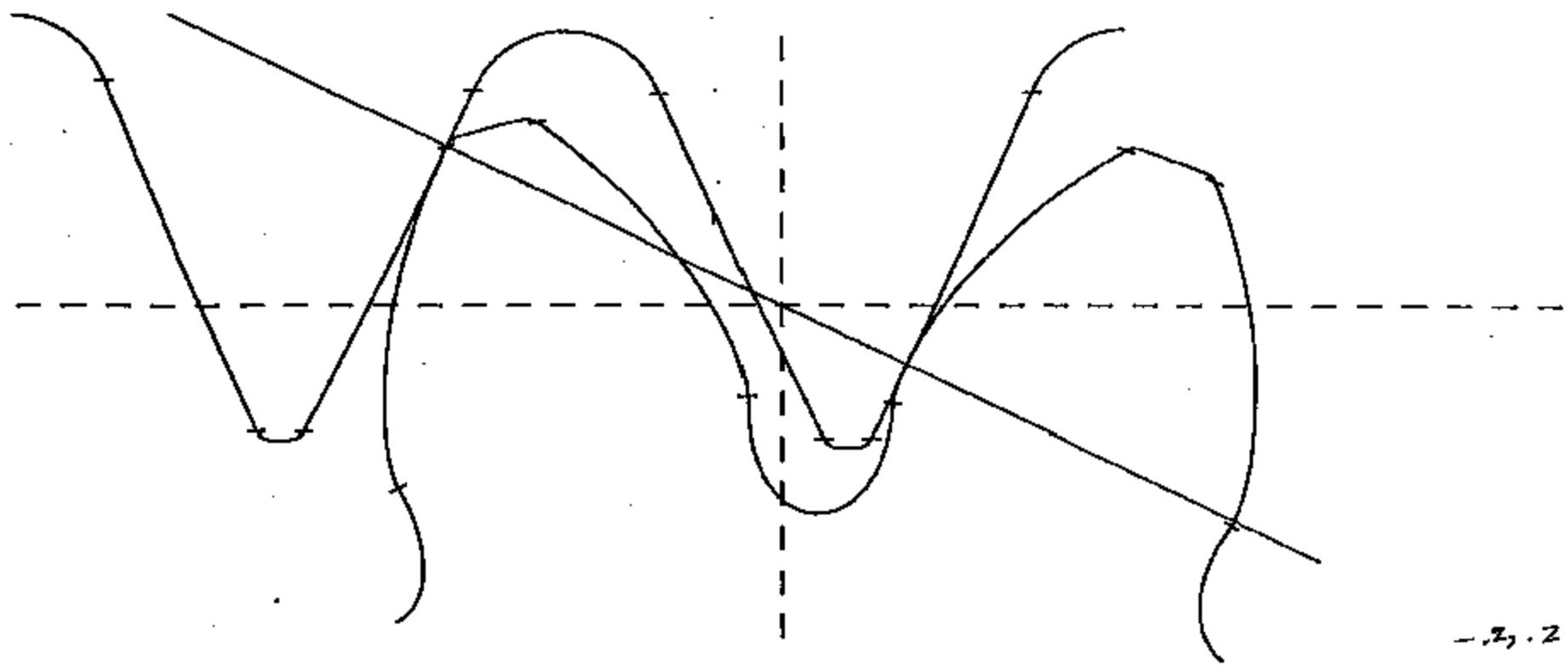
tpdr	'-		*Hob_type (Semi-Top='s, Tip-Rel='r Non-Top='n)
hfa_dr	-	deg	*Flank_angle
h`dr	-	in	*Tip_to_Reference_Line
t`dr	-	in	*Tooth_thickness_at_Reference_Line
hs`dr	-	in	*Reference_Line_to_Start_Mod_Ramp
hfaz2_dr	-	deg	*Pressure_Angle_of_Mod_Ramp
rt_dr	-	in	*Tip_radius
u_dr	-	in	*Protuberance
ua_dr	-	deg	*Protuberance_angle_from_flank
uap_dr	-	deg	*Protuberance_pressure_angle
hu_dr	-	in	*Tip_to_flank/prot_intersection
hobAPdr	-	in	*Ref_Line_to_Hob_SAP
newAPdr	-	in	*Normal_Space_Width_at_Hob_SAP

DRIVEN HOB:

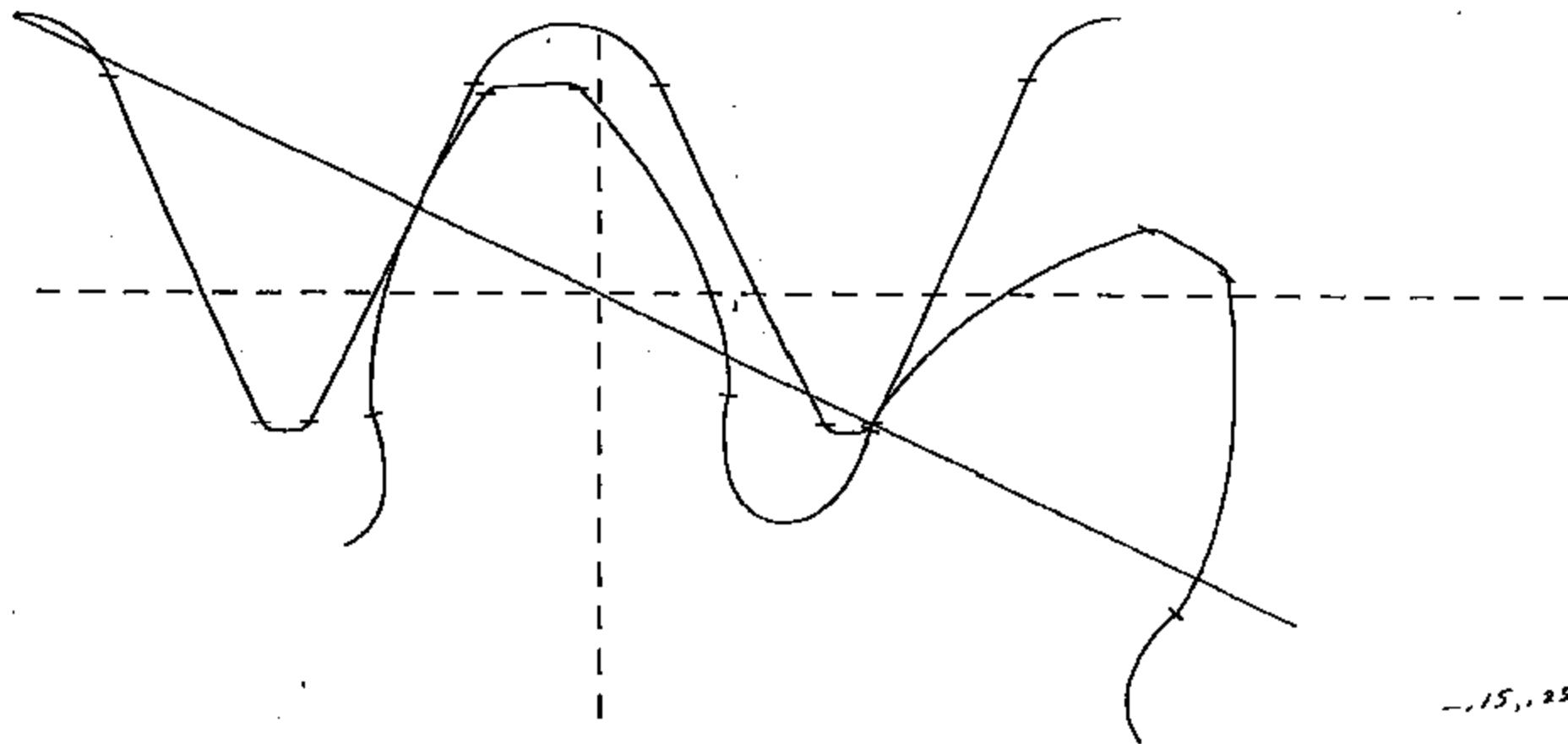
tpdn	'-		*Hob_type (Semi-Top='s, Tip-Rel='r Non-Top='n)
hfa_dn	-	deg	*Flank_angle
h`dn	-	in	*Tip_to_Reference_Line
t`dn	-	in	*Tooth_thickness_at_Reference_Line
hs`dn	-	in	*Reference_Line_to_Start_Mod_Ramp
hfaz2_dn	-	deg	*Pressure_Angle_of_Mod_Ramp
rt_dn	-	in	*Tip_radius

u_dn	-	in	*Protuberance
ua_dn	-	deg	*Protuberance_angle from flank
uap_dn	-	deg	*Protuberance_pressure angle
hu_dn	-	in	*Tip_to_flank/prot intersection
bobAPdn	-	in	*Ref_Line to Hob SAP
nswAPdn	-	in	*Normal_Space Width at Hob SAP
nc_dr	-	in	DRIVER SHAPER:
odc_dr	-	in	*Number_of_Teeth
nttc_dr	-	in	*Outside_Diameter
rts_dr	-	in	*Normal_Tooth_Thickness
us_dr	-	in	*Tip_Radius - Normal Plane
cds_dr	NA	in	*Protuberance - Normal Plane
sapc_dr	-	in	*Center distance with gear
nc_dn	-	in	*Start_of_active_profile_diameter
odc_dn	-	in	DRIVEN SHAPER:
nttc_dn	-	in	*Number_of_Teeth
rts_dn	-	in	*Outside_Diameter
us_dn	-	in	*Normal_Tooth_Thickness
cds_dn	NA	in	*Tip_Radius - Normal Plane
sapc_dn	-	in	*Protuberance - Normal Plane
25.0000	rfa``dr	deg	*Center distance with gear
.0412	h``dr	in	*Start_of_active_profile_diameter
.0714	t``dr	in	FORMED DRIVER:
.0258	rt``dr	in	*Basic Rack Form:
.0040	tc_dr	0	*Flank Angle
	tr_dr	in	*Tip to Reference Line
	xp_dr	-	*Tooth Thickness at Reference Line
25.0000	rfa``dn	deg	*Tip_radius
.0695	h``dn	in	*Radial_tip_chamfer_Def=0
.0714	t``dn	in	*Normal_tip_radius_Def=0
.0051	rt``dn	in	*Normal_tip_relief_exponent_Def=3/2
.0040	tc_dn	0	FORMED DRIVEN:
	tr_dn	in	*Basic Rack Form:
	xp_dn	-	*Flank Angle

Gear Mesh (Path of Contact Section - Virtual) Driver/Driven



Gear Mesh (Path of Contact Section = Virtual) Driver/Driven



..,15.,25

125N4

----- VARIABLE SHEET -----

	t Input	Name	Output	Unit	Comment
LOADING:					
.06	Vs f	0	ft/min		*Maximum sliding velocity *Approx coefficient of friction (Default value is for hardened steel driver and bronze driven,
	eff	+74	%		*Approx_efficiency
	effback	+65	%		*Approx_efficiency backdriving
	sfB				*Anti-backdrive safety factor
	nload	13.654	lbf		*Imposed normal tooth load
	Fo	1			*Overload factor Def=1
	tnload	13.654	lbf		*Total_normal tooth load
	cli	74.307	deg		*At_center of contact interval:
	s	65602	psi		*Angle between contact curvatures
	Cc	2955	psi		*Specific compressive stress, s
					*Load/compressive stress factor, Cc
Driver:					
0	power	0	HP		*Power
4.5	rev_dr		rpm		*Rotational speed
15E6	tork_dr		ozf-in		*Torque
	E_dr		psi		*Young's modulus (Default = Steel)
	clindr	69.603	deg		*Contact curvature inclination angle
	tan_dr	2.149	lbf		*Tangential force
	sep_dr	5.771	lbf		*Separating force
	ax_dr	12.187	lbf		*Axial_force
	Mo_dr	1.767	lbf-in		*Overturning moment
Driven:					
1.9E6	rev_dn	0	rpm		*Rotational speed
	tork_dn	33.22	ozf-in		*Torque
	E_dn		psi		*Young's modulus (Default = Bronze)
	clidn	4.705	deg		*Contact curvature inclination ang...
	tan_dn	12.187	lbf		*Tangential force
	sep_dn	5.771	lbf		*Separating force
	ax_dn	2.149	lbf		*Axial_force
	Mo_dn	.506	lbf-in		*Overturning moment
Screw Connected to Driven and Nut					
					Screw Driving
.333	T	33.219939	ozf-in		Torque
2	Fa	68.22183	lbf		Total axial resisting load
	Dm		in		Thread pitch diameter
	Ns				Number of starts
.125	Tlead		in		Thread lead
	P	.0625	in		Thread axial pitch
.06	f				Coefficient of friction: threads
14.5	phi		deg		One half included thread angle
0	alpha	6.8137223	deg		Thread mean lead angle
.375	fc				Coefficient of friction: thrust collar
	Dc		in		Mean diameter of thrust collar
	theta	15.901497	deg		Axis to thread normal surface
	e	66.344336	%		Thread efficiency
.766	LgS		in		Threaded length
.375	OD		in		Screw OD
.276	RD		in		Screw Root Diameter
.296	ID		in		Nut ID
	At	.07282231	in^2		Tensile stress area
	An	.51005641	in^2		Total thread surface area

.03125	ScT	133.7535	psi	Compressive stress (Full contact)
	att		in	Screw axial tooth thickness
	attR	.04081885	in	Screw axial tooth thickness at Nut ID
	attN	.04211194	in	Nut axial tooth thickness at Screw OD
	SnS	.46521221	in ²	Total screw shear area
	SnN	.60804417	in ²	Total nut shear area
	SsS	146.64669	psi	Screw shear stress (Full contact)
	SsN	112.19881	psi	Nut shear stress (Full contact)
	StS	502.94641	psi	Torsional stress at screw root dia
	StA	936.8259	psi	Axial stress at screw root dia
	StR	1155.7017	psi	Max tensile stress at screw root dia
	SsR	687.28872	psi	Max shear stress at screw root dia

===== VARIABLE SHEET =====

t. Input --- Name --- Output --- Unit ----- Comment-----
 #4 Nominal
 Hoechst 90 deg Worm Gears
 Steel, Hostaform Worm/Hostaform Gear
 Non-Enveloping (Crossed Axis Helic)
 (See 60-125 for Input Data)
 Press "Alt U" for Units Change

			GENERAL:
1	z1		Number of Worm Teeth
10	z2		Number of Gear Teeth
	i	10	Ratio
	mn	1.1545455 mm	Normal Module
22	DPn		Normal Diametral Pitch
	m	1.1723562 mm	Gear Trans Module
	DP	21.665771	Gear Trans Pitch
25.0000	npa	deg	Normal Pressure Angle
	tpa	25.3376 deg	Gear Trans Pressure Angle @ Ref PD
10.0000	gamma_n	deg	Worm Lead Angle
.3801	a	in	Center Distance
.3690	da1	in	Worm OD
.5725	da2	in	Gear OD
	dml	.2784 in	Worm Mean Working Depth Dia
	dm2	.4819 in	Gear Mean Working Depth Dia
	wkd	.0905 in	Working Depth
			LOAD CHARACTERISTIC:
12.187	F2	lbf	Gear Tangential Load
0	w	ft/min	Flank Sliding Velocity
	b	.2422 in	Effective Face Width
	fz	.29	Tooth Number Coefficient
	c	1178.1894 lbf/in^2	Load Characteristic, c
	c_al	1160.3019 lbf/in^2	Allowable Load Characteristic, c
	Sc	.98	Load Characteristic Safety Factor
			TOOTH BREAKAGE:
16.2493	F2max	lbf	Maximum Gear Tangential Load
185	T	F	Operating Temperature
	ral	.1845 in	Worm Outside Radius
	rml	.1392 in	Worm Mean Working Depth Radius
	ra2	.2863 in	Gear Outside Radius
.0892	ttt	in	Gear Trans Tooth Thickness @ Ref PD (If Hostaform Worm, Gear TTT Should Be Approx Equal to Worm TTT)
	tttm	.0822 in	Gear Trans Tooth Thickness @ Mean Dia
	dbg	.4172 in	Gear Base Dia
	chi	93.9349 deg	
	phi	36.0000 deg	Pitch Angle
	t	2	Number of Engaged Teeth
	sm	.0699 in	Ave Width of Shear-Stressed Surface
	A	.0267 in^2	Total Shear-Stressed Area
	tauB	5545.6 lbf/in^2	Allowable Shear Stress
	Fb	148.2902 lbf	Tooth Breakage Force
	S	9.13	Tooth Breakage Safety Factor

Attachment 2B

(Concept & Design
Testing with empirical
development matrix)

DESCRIPTION		DESIGNATION
LEADScrew -	PLASTIC (ACETAL) - SOLID, 1/4-20 "V" THD.	A
9300-7413	PLASTIC W/126 STEEL PIN	B
	PLASTIC W/0037 STEEL PIN	
	PLASTIC (ACETAL) - SOLID, 3/8-16 "V" THD.	F
	PLASTIC (ACETAL) - SOLID, 3/8-16 "SQ." THD.	
	BRASS (CDA-3600) 1/4-20 "V" THD.	C
	BRASS (CDA-3600) 1/4-16 "SQ." THD.	D
	STEEL (416 SS) 1/4-20 "V" THD.	E
	STEEL (416 SS) 1/4-16 "SQ." THD.	
	PLASTIC (MACHINED ACETAL) 3/8-11 THD.	G
	PLASTIC (MACHINED ACETAL) 3/8-04 THD.	H
	PLASTIC (MACHINED ACETAL) 3/8-8 DBL. LEAD	I
	PLASTIC (MACHINED ACETAL) 3/8-16 DBL. LEAD	J
	PLASTIC (MACHINED ACETAL) 3/8-16 TRPL. LEAD	K
CARRIER -	PLASTIC (ACETAL) PTPE FILLED 1/4-20 "V" THD.	A
9300-7403	1/4-16 "SQ." THD.	B
	3/8-16 "V" THD.	C
	3/8-16 "SQ." THD.	D
	3/8-11 "V" THD.	F
	3/8-04 THD.	G
	3/8-08 DBL. LEAD	H
	3/8-16 DBL. LEAD	I
	3/8-16 TRPL. LEAD	J
	PLASTIC (NYLON) PTPE FILLED	
	PLASTIC (NYLON) 19% GF	
	PLASTIC (NYLON) 33% GF	
	DIECAST (ZAMAC #3)	E
SPUR GEAR -	PLASTIC (ACETAL) - MOLDED W/LEADScrew (20 TH.)	A
9300-7402	PLASTIC (ACETAL) - HEX I.D. (20 TH.)	B
	BRASS (PURCHASED) (20 TH.)	
	PLASTIC (ACETAL) - HEX I.D. (22 TH.)	C
WORM GEAR -	BRASS (1 LD.)	
9300-7400	STEEL (UNHARDENED) (1 LD.)	
	STEEL (HARDENED-GROUND) (1 LD.)	A
	PLASTIC (1 LD.)	B
	BRASS (2 LD.)	C
MOTOR -	WITH P.T.C.	A
9300-7414	WITHOUT P.T.C.	B
	WITH END CAP	C
	WITHOUT END CAP	D
	WITH EXTERNAL LINEAR THRUST LIMITER	E
	WITHOUT EXTERNAL LINEAR THRUST LIMITER	F
COVER -	WITH ATTACHED METAL STOP	A
9300-7408	WITHOUT ATTACHED METAL STOP	B
LUBRICANT -	SYNTHETIC (WHITE)	A
	GRAPHITE	B
	NYE 8568	C
	NYE 718M	D
	NYE 774L	E

COMPONENT	#CYCLES	TEST #1	TEST #2	TEST #3	TEST #4	TEST #5	TEST #6	TEST #7
LEADScrew		15,660	10,172 40,763	33,470 54,644	24,278	21,074 30,987	104,347	COMB.#7
CARRIER	'A'	B	C	D	E	F	G	
SPUR GEAR	A	A	B	B	B	B	C	
WORM GEAR	A	A	A	A	A	A	C	
MOTOR	ACF	ADE	ADF	ADE	"BDE"	"BOE"	ADE	
COVER	'B'	A	A	A	A	A	A	
LUBRICANT	A	A	A	B	B	A	A	

NOTE: 1) * INDICATES FAILED COMPONENT
2) ** INDICATES COMPONENT REPLACED

- TEST #1 - LE a) LEADScrew flexed away from mating gear causing binding & distortion.
b) COVER CRACKED DUE TO STRESS.
- TEST #2 - a) MOLDED CARRIER BROKE AT 10,172 CYCLES, (BETWEEN THREAD & CAM).
b) SWITCH ACTUATOR CAM REFORMED AFTER 37,278 CYCLES.
c) REMOVED FROM TEST AT 40,763 CYCLES TO FACILITATE TESTING OF NEXT ITERATION
- TEST #3 - a) CARRIER "V" THREADS (MOLDED) WERE STRIPPED AT 33,470 CYCLES.
b) CARRIER "V" THREADS (MOLDED) WERE STRIPPED AT 51,174 CYCLES.
c) 64,644 TOTAL CYCLES ON OTHER COMPONENTS
- TEST #4 - CARRIER "SQUARE" THREADS (MACHINED) WERE STRIPPED AT 24,278 CYCLES.
- TEST #5 - a) MOTOR BRUSHES FAILED, THIS MOTOR WAS DISASSEMBLED TO REMOVE THE P.T.C., IT WAS DAMAGED DURING REASSEMBLY.
b) THE MOTOR WAS REPLACED AND TESTING CONTINUED.
- TEST #6 - a) TEST FAILED AT 104,347 CYCLES.
b) UNIT HAS A MACHINED PLASTIC LEADScrew WITH AN IMPROVED MOLDED CARRIER.
- TEST #7 - a) TESTING STARTED ON 10/11/94.
b) CARRIER FRACTURED

8V (FT.LB.s)	THREAD (FT.LB.s)	12V (FT.LB.s)	RATIO	HRDSTOP (LOCK)	HRDSTOP (UNLOCK)	COATING
COMB. #1	40	(1/4-20)	45	1:1	167.5V	167.5V
COMB. #2	40	(1/4-20)	45	1:1	167.5V	167.5V
COMB. #3	27	(3/8-16)	38	1:1	167.5V	167.5V
COMB. #4	65	(3/8-16)	100	1:1	166.5V	166.5V (TEFLON)
COMB. #5	100	(3/8-11)	100	1:1	166.5V	166.5V (TEFLON)
COMB. #6	100	(3/8-11)	100	1:1	166.0V	166.0V (TEFLON)
COMB. #7	70**	(3/8-04)	80**	1:1	204.0V	204.0V (TEFLON)
COMB. #8	70	(3/8-16 x2)	70	1:1	222.5V	222.5V (TEFLON)

NOTE: 1) ** INDICATES LOCK BOLT WAS USED FOR MULTIPLE TESTS.

S. SAWLOCK ACTUATOR RC-018758
ENGINEER: G.GAETH

DAILY TESTING REPORT

FASCO CONTROLS INC.
PREPARED BY: W.LANDIS

04/04/03

	DESCRIPTION	DESIGNATION
LEADScrew - 9300-7413	PLASTIC (MACHINED ACETAL) 38-16 DBL LEAD	J
	PLASTIC (MACHINED ACETAL) 38-18 TRPL LEAD	K
	PLASTIC (1140L4 MOLDED) 38-18 DBL LEAD	L
	PLASTIC (PPS-TEFLON) 38-078-156 (1PC)	M
	PLASTIC (ACETAL) 38-078-158 (2 PC)	N
	PLASTIC (ACETAL) 38-078-158 (1 PC)	O
CARRIER - 9300-7403	PLASTIC (ACETAL) PTFE FILLED 38-16 DBL LEAD	I
	38-18 TRPL LEAD	J
	PLASTIC (GC25A MOLDED) 38-18 DBL LEAD	K
	PLASTIC (GC25A MOLDED) 38-068-156	L
	PLASTIC (PPS-TEFLON) 38-078-158	M
	PLASTIC (ACETAL) 38-078-158	N
SPUR GEAR - 9300-7401	PLASTIC (ACETAL) MOLDED W/ LEADScrew (20 TH.)	A
	PLASTIC (ACETAL) HEX I.D. (20 TH.) (14.5 PA.)	B
	BRASS (PURCHASED) (26 TH.)	
	PLASTIC (ACETAL) HEX I.D. (22 TH.)	C
	PLASTIC (ACETAL) HEX I.D. (20 TH.) (20 PA.)	D
	PLASTIC (PPS-TEFLON) 38-078-158 (15:1) (1 PC)	E
WORM GEAR - 9300-7406	PLASTIC (ACETAL) 38-078-158 (15:1) (2 PC)	F
	PLASTIC (PPS-30%GF) 38-078-158 (16:1) (2 PC)	G
	PLASTIC (ACETAL) 38-078-158 (15:1) (1 PC)	H
	STEEL (UNHARDENED) (1 LD.)	
	STEEL (HARDENED-GROUND) (1 LD.)	A
	PLASTIC (1 LD.)	B
MOTOR - 9300-7414	BRASS (2 LD.)	C
	STEEL (UNHARDENED) (2 LD.)	D
	BRASS (1LD.) U.T.S. PROFILE (15:1)	E
	WITH P.T.C.	A
	WITHOUT P.T.C.	B
	WITHOUT END CAP	D
COVER - 9300-7408	WITH EXTERNAL LINEAR THRUST LIMITER	E
	WITH END CAP	F
	WITH ATTACHED METAL STOP	A
	WITH ATTACHED METAL STOP WITH GUSSETS	B
	SILICONE (WHITE)	A
	GRAPHITE	B
LUBRICANT -	NYE 055B	C
	NYE 719M	D
	NYE 774L	E

COMPONENT	TEST #9 [CYCLES]	TEST #10 22,099	TEST #11 16,773	TEST #12 22,813/30K	TEST #12A 60,322	TEST #12B 251,734	TEST #13 71,895
LEADScrew	J	I	I	M	M*	M*	M*
CARRIER	I	K	K	'L	'M"	'M"	M
SPUR GEAR	D	D	D	F	F"	F"	H
WORM GEAR	D	D	D	E	E	E	E
MOTOR	BDE	"ADE	BFE	ADE	ADE	ADE	ADE
COVER	A	A	A	A	A	A	B'
LUBRICANT	A	B	D	A	A	A	A

NOTE: (*) INDICATES FAILED COMPONENT.

(**) INDICATES REPLACED COMPONENT

- TEST #9-
a) TEST STARTED ON 10/17/94.
b) REMOVED FROM TEST ON 10/18/94.
c) MOLDED LEADScrew BINDING DUE TO WARPAGE, MOLD BEING MODIFIED.
d) TEST STARTED ON 10/18/94.
e) UNIT FAILED - 22,098 CYCLES COMPLETE IN THERMOTRON.
f) P.T.C. LOCATED OUTSIDE CHAMBER.
g) PRELIMINARY CAUSE - GEAR FAILURE, DETAILED ANALYSIS TO FOLLOW.
- TEST #10-
a) TEST STARTED 10/27/94.
b) ACTUATOR STOPPED AFTER B32 CYCLES.
c) INTERFERENCE BETWEEN WORM GEAR AND MOTOR END BELL, MACHINED AND RETURNED TO TEST.
d) UNABLE TO KEEP UNIT RUNNING.
- TEST#11-
a) TEST STARTED 10/29/94
b) 16,773 CYCLES COMPLETE.
c) UNIT HAS MOTOR SHAFT AXIAL THRUST SUPPORT IN REAR OF HOUSING.
d) CARRIER MACHINED THREADS STRIPPED AFTER 16,773 CYCLES.
- TEST#12-
a) CARRIER THREADS STRIPPED AFTER 22,813 CYCLES, CARRIER REPLACED.
b) TEST STOPPED AFTER 30,000 CYCLES FOR IMPROVED CARRIER PARTS.
- TEST#12A
a) CARRIER & LEADScrew REPLACED (PPS TEFLON CARRIER, ACETAL LEADScrew)
b) HANDFORMED ACTUATORS REPLACED DUE TO FRACTURE.
c) CARRIER FRACTURED AFTER 60,322 TOTAL CYCLES (60,322 ON THIS CARRIER)
d) MOTOR, WORM, SWITCH, COVER, HOUSING, UPSTOP & BEARINGS COMPD 60,322 CYCLES
- TEST#12B
a) CARRIER & LEADScrew REPLACED (PPS TEFLON CARRIER WRADII, ACETAL LEAD)
b) HANDFORMED ACTUATORS REPLACED DUE TO FRACTURE.
c) UNIT STARTED EXPERIENCING HARDSTOPS AFTER 157,978 CYCLES.
d) RESTARTED FROM HARDSTOPS AT (158,031), (161,335) & 171,066 CYCLES.
e) TEST STOPPED AFTER 171,412 CYCLES COMP. ON CARRIER (FRACTURED) & LEADSCRE
- TEST#13-
f) MOTOR, WORM, SWITCH, COVER, HOUSING, UPSTOP & BEARINGS COMPD 251,734 CYCLE;
a) TEST STARTED 01/31/95, THRU THERMAL CYCLING (+85 TO -40 C)
b) 71,895 CYCLES COMPLETE, STOPPED TEST ON 02/08/95.
c) UPPER STOP BROKE AFTER APPROXIMATELY 12,000 CYCLES.
d) UNIT EXHIBITED "HARDSTOP" AFTER 71,895 CYCLES.
e) UNIT HAD STRIPPED LEADScrew AND BROKEN UPPER STOP.

TEST #1 - 18,450 CYCLES-

FAILURE #1- GEAR LOCKUP

CAUSE- LEADScrew FLEXED AT GEAR INTERFACE PERMITTING GEAR TEETH TO "CLIMB".

CORRECTIVE ACTION- INSTALLED STEEL PIN IN LEADScrew

FAILURE #2- CRACKED COVERS

CAUSE- MOLDED COVER UNABLE TO WITHSTAND LOADS APPLIED BY THE CARRIER AT THE UNLOCK POSITION.

CORRECTIVE ACTION- A) MEASUREMENTS TAKEN TO DETERMINE "REAL" LOADS BEING APPLIED.

B) METAL UPPER STOP INCORPORATED IN DESIGN.

TEST #2 - 10,172 CYCLES-

FAILURE #1- MOLDED CARRIER BROKE AT WEB.

CAUSE- ANALYSIS REVEALED POORLY PROCESSED PART.

CORRECTIVE ACTION- A) PROCESSING PROCEDURES WERE REVIEWED AND CORRECTED.

B) PARTS WERE REMOLDED AND THE CARRIER WAS REPLACED IN THE UNIT.

TEST #3 - 37,276 CYCLES-

FAILURE #2- TRAVEL SENSING SWITCH FAILED TO OPERATE.

CAUSE- ACTUATOR CAM DEFORMED NOT ALLOWING SWITCH TO BE DEPRESSED.

CORRECTIVE ACTION- A) ACTUATOR CAM WAS REFORMED AND THE UNIT RETURNED TO TEST.

B) TOLERANCE STACKS WERE PERFORMED ON THE RELATED COMPONENTS.

C) DETAIL DRAWINGS WERE CORRECTED.

TEST #4 - 40,753 CYCLES- UNIT WAS REMOVED FROM TEST TO ALLOW FOR NEXT ITERATION.

TEST #5 - 31,474 CYCLES-

FAILURE #1- LOCK BOLT FAILED TO EXTEND.

CAUSE- CARRIER THREADS WERE STRIPPED.

CORRECTIVE ACTION- A) CARRIER REPLACED AND UNIT RETURNED TO TEST.

B) THREAD PROFILE DESIGN REVIEWED.

C) TOOLING INITIATED TO MAKE A LEADScrew WITH A SQUARE THREAD FOR IMPROVED THRUST LOAD CAPABILITY.

TEST #6 - 64,644 CYCLES-

FAILURE #2- LOCK BOLT FAILED TO EXTEND.

CAUSE- CARRIER THREADS WERE STRIPPED.

CORRECTIVE ACTION- SEE ABOVE

TEST #4 - 24,278 CYCLES-

FAILURE- LOCK BOLT FAILED TO EXTEND.

CAUSE- MACHINED SQUARE THREADS ON CARRIER WERE STRIPPED.

CORRECTIVE ACTION- REVIEWED MACHINED THREADS. MOLDED THREADS EXHIBIT GREATER STRENGTH AND LIFE DUE TO CONTINUED MOLECULAR CHAINS

TEST #6 - 21,574 CYCLES-

FAILURE- MOTOR WOULD NOT OPERATE.

CAUSE- BRUSHES WERE DAMAGED DURING REASSEMBLY AFTER REMOVING THE P.T.C.

CORRECTIVE ACTION- A) MOTORS WOULD BE PURCHASED WITHOUT THE P.T.C. TO ELIMINATE THE NEED FOR DISASSEMBLY.

B) MOTOR WAS REPLACED AND UNIT RETURNED TO TEST.

TEST #5 - 34,847 CYCLES- UNIT REMOVED FROM TEST TO ALLOW FOR NEXT ITERATION.

TEST #5 - 184,347 CYCLES-

FAILURE- LOCK BOLT FAILED TO EXTEND.

CAUSE- A) MOTOR HAD "DEAD SPOT"- COMMUTATOR FAILED.

B) GEAR LOCKUP DUE TO DEGRADATION OF COMPONENTS.

CORRECTIVE ACTION- A) GEAR TOOTH PROFILE AND PRESSURE ANGLE REVIEWED.

B) TOLERANCE STACKS REVIEWED ON RELATED COMPONENTS.

TEST #7 - MIN. # OF CYCLES-

FAILURE- LOCK BOLT FAILED TO RETRACT

CAUSE- A) CARRIER BROKEN ON WALL OF "HUT" SECTION.

B) CROSS SECTIONAL AREA COMPROMISED AFTER MACHINING FOR A 3/8-04 THREAD.

CORRECTIVE ACTION- CARRIER WALL SECTION WAS INCREASED.

TEST #8 - UNABLE TO KEEP RUNNING AT UPPER TEMP.

FAILURE- UNIT WOULD NOT OPERATE AT TEMP. EXTREMES.

CAUSE- A) P.T.C. GOES "OPEN" NOT ALLOWING CURRENT TO MOTOR.

B) CURRENT DRAW EXCESSIVE DUE TO LEADScrew BINDING AT TEMP. EXTREMES.

C) LEADScrew WARPED DURING MOLDING PROCESS.

CORRECTIVE ACTION- ADDITIONAL GAPS ADDED TO LEADScrew MOLD TO MINIMIZE RUNOUT.

TEST #9 - 23,889 CYCLES-

FAILURE- LOCK BOLT FAILED TO EXTEND.

CAUSE- A) WORM GEAR (DRIVEN) TEETH STRIPPED.

B) DRIVEN GEAR TOOTH PROFILE NOT ADEQUATE FOR LOADS (PURCHASED GEAR)

C) UTS CALCULATIONS CONFIRM TEST RESULTS.

CORRECTIVE ACTION- CONTINUE TO TEST AVAILABLE GEARS FOR OTHER FAILURE MODES.

TEST #10 - 142 CYCLES-

FAILURE- UNIT BINDING

CAUSE- BRASS INSERT ON WORM (DRIVEN) INTERFERING WITH END BELL ON MOTOR.

CORRECTIVE ACTION- A) COMPONENT DRAWINGS CORRECTED TO ELIMINATE INTERFERENCE

B) INSERT WAS MACHINED AND ATTEMPTED TO RETURN UNIT TO TEST. (DAMAGE TO MOTOR DID NOT ALLOW)

TEST #11 - 16,773 CYCLES-

FAILURE- LOCK BOLT WOULD NOT RETRACT.

CAUSE- MACHINED THREADS IN CARRIER STRIPPED.

CORRECTIVE ACTION- A) MATERIAL SELECTION AND STRESSES BEING REVIEWED.

B) INSERT FOR CARRIER MOLD BEING FABRICATED.

CONCERN: ACTUATOR DURABILITY

1) IMPROVEMENTS HAVE SHOWN DURABILITY LIFE CYCLES OF:
 a) 15,850 TO 104,347 AT AMBIENT TEMP.
 b) 16,773 TO 22,054 AT -40 TO 65 DEG. C.

2) FAILURE MODES:
 a) FRICTION/TEMP. LOCK-UP OF LEADScrew.
 b) GEAR TOOTH FAILURE
 c) GEARTRAIN ALIGNMENT

SOLUTION: REF. COMPONENT ANALYSIS BELOW

COMPONENT DESCRIPTION	CURRENT DESIGN		UTS/NEW DESIGN		IMPROVEMENT
	DESCRIPT.	MATERIAL	DESCRIPT.	MATERIAL	
A LEADSCREW					
A1 THREAD TYPE	3/8-.062 x 2	1140L4	3/8-.078 x 2	1140L4	
A2 FABRICATION PROCESS	MOLDED "V"	PPS	MOLD. ACME	PPS	"V" THD. EFF. - 68%, ACME THD. EFF. - 71%
A3 NO. OF STARTS	2		2		
A4 THREAD PITCH	.062"		.078"		STeeper lead angle increased operating eff.
A5 LEAD PITCH	.125"		.156"		Increased back driving capability (rebounded at 10 deg.)
A6 TENSILE STRESS AT ROOT DIA./MAX.	1640.9 PSI	24,000PSI	1981.4 PSI	24,000PSI	
A7 SHEAR STRESS AT RT. DIA./MAX.	978.4 PSI		1212.1 PSI		
A8 SCREW SHEAR STRESS	186.5 PSI		246.5 PSI		
A9 TOTAL SCREW SHEAR AREA	.466 SQ.IN.		.466 SQ.IN.		
B CARRIER					
B1 THREAD TYPE	3/8-.062 x 2	GC25A	3/8-.078 x 2	GC25A	SEE "LEADSCREW" ABOVE
B2 FABRICATION PROCESS	MACHINED "V"	ACETAL	MOLD. ACME	ACETAL	MOLDED THREADS EXHIBIT GREATER STRENGTH & LONGER LIFE
B3 NO. OF STARTS	2		2		
B4 THREAD PITCH	.062"		.078"		STeeper lead angle increased operating eff. stronger
B5 LEAD PITCH	.125"		.156"		
B6 NUT SHEAR STRESS	149.8 PSI	16,000PSI	191.04 PSI	18,000PSI	
C DRIVER (WORM)		STEEL		BRASS	IMPROVED COEFFICIENT OF FRICTION (.6 VERSUS .35 UNLUBED)
C1 PITCH DIAMETER	.333"		.2387"		Maintains driver/driven centerline
C2 PRESSURE ANGLE	20 DEG.		25 DEG.		Decreases gear train lockup probability
C3 NO. OF LEADS	TWO		ONE		Allows increased tooth cross section on driven
C4 LEAD ANGLE	3.5833 DEG.		8.00 DEG.		Increased back driving capability (rebounded at 10 deg.)
C5 DIAMETRICAL PITCH	48		30		Less teeth per inch (stronger tooth profile on driven)
D DRIVEN (WORM GEAR)		ACETAL		1140L4	1140L4 PPS MATERIAL HAS HIGHER LOAD & STRESS CAPABILITY
D1 NO. OF TEETH	20		15		73% INCREASE X-SECTION, MORE TOLERANT OF CL. EXTREMES
D2 PITCH DIAMETER	.417"		.303"		73% INCREASE X-SECTION, MORE TOLERANT OF CL. EXTREMES
D3 PRESSURE ANGLE	20 DEG.		26 DEG.		Decreases gear train lockup probability
D4 LEAD ANGLE	14.4444 DEG.		8.00 DEG.		Increased back driving capability (rebounded at 10 deg.)
D5 DIAMETRICAL PITCH	48		30		Less teeth per inch (stronger tooth profile on driven)
D6 GEAR TOOTH CROSS SECTION	.032"		.0634"		73% INCREASE X-SECTION, MORE TOLERANT OF CL. EXTREMES
E HOUSING/STOP					
E1 HOUSING/STOP (ATTACHMENT)	3 BOLT ATTCH ZAMACR3	2 BOLT ATTCH ZAMACR3			Increased rigidity of upper stop
E2 HOUSING/STOP (ALIGNMENT)	BOLT ALIGN.	PORT ALIGN.			Decreased cl. tolerances
E3 HOUSING (RADIAL SUPPORT)	1" SUPPORT ZAMACR3	1" SUPPORT ZAMACR3			Controls radial motor shaft movement
E4 HOUSING (THRUST SUPPORT)	1 SUPPORT	2 SUPPORTS			Controls axial motor thrust in both directions
E5 TOLERANCE ZONE	+/-0.14"		+/-0.008		Decreased cl. tolerances
F ASSEMBLY					
F1 ACTUATION TIME	0.48 SEC		10.60 SEC APP.		SPEC REQUIREMENT IS 1.4 SECONDS
F2 NOISE	48 db		46 db APP.		Improved noise quality due to optimized gear profiles
F3 LOAD CAPABILITY AT 3 OZ-IN.	48.5 lb		55.1 lb		21% improvement in load capability

NOTE: 1) * INDICATES SIGNIFICANT CHANGES TO CURRENT DESIGN.

2) UTS GEAR TEETH PROFILES ARE OPTIMIZED FOR MAXIMUM STRENGTH, NOISE REDUCTION, AND CL VARIATIONS

3) STRESSES ARE CALCULATED BASED ON 6 OZ-IN. INPUT TORQUE (THE MOTOR IS RATED AT 6 OZ-IN.)

TESTING SCHEDULE:

1) 1X LIFE DURABILITY TESTING REQUIRES TEN DAYS (5760 CYCLES/DAY). START 12/08/94 COMPLETE 12/20/94
 2) COMPLETE DURABILITY TESTING REQUIRES APP 45 DAYS (5760 CYCLES/DAY). START 12/09/94 COMPLETE 02/10/95

TIMING:

1) CURRENT TOOLING LEAD TIMES ACCOMMODATE A 12/09/94 TEST START DATE.
 2) CURRENT FASCO TIME LINES INDICATE A 04/16/95 "DROP DEAD" DATE FOR PRODUCTION TOOLING RELEASE.
 TOOLING START ON 04/16/95 WILL MEET THE 12/04/95 PPAP SUBMISSION DATE.

4GINAW LOCK ACTUATOR #26050960
ENGINEER: G.GAETH

TEST SUMMARY

FASCO CONTROLS INC.
PREPARED BY: W.LANDIS

04/

DESIGN VALIDATION TEST STARTED ON 03/24/95
NO. OF UNITS TESTED (24)
TYPE OF TEST- DURABILITY

ACTUATOR#	FAILURE MODE	NO.# OF CYCLES	GREASE	COMMENTS	
133	STRIPPED LEADScrew	38,600 FAILED	NYE 362F	FAILURE AT 38,600	
134	STRIPPED LEADScrew	39,806 REMOVED	NYE 362F	INTERMITTENT STARTING AT 39,316	
135	MOTOR FAILURE	INTJ REMOVED	NYE 362F	TBD	
136	STRIPPED LEADScrew	39,805 REMOVED	NYE 362F	TBD	
137	STRIPPED LEADScrew	38,984 FAILED	NYE 362F	FAILURE AT 38,984	
138	STRIPPED LEADScrew	39,805 REMOVED	NYE 362F	INTERMITTENT STARTING AT 39,315	
139	STRIPPED LEADScrew	39,805 REMOVED	NYE 362F	FAILURE AT 38,544	
140	STRIPPED LEADScrew	39,805 REMOVED	NYE 362F	INTERMITTENT STARTING AT 38,165	
141	STRIPPED LEADScrew	39,806 REMOVED	NYE 362F	INTERMITTENT STARTING AT 38,185	
142	STRIPPED LEADScrew	39,499 FAILED	NYE 362F	FAILURE AT 39,499	
143	STRIPPED LEADScrew	39,296 FAILED	NYE 362F	FAILURE AT 39,296	
144	STRIPPED LEADScrew	39,805 REMOVED	NYE 362F	TBD	
145	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
146	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
147	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
148	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
149	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
150	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
151	NO FAILURE /STRIPPED LDSCR.	50,000 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
152	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
153	NO FAILURE /STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	RETURNED TO TEST AFTER PULL -OUT CHECKS	ANALYZED AFTER 50,000 CYCLES
154	STRIPPED LEADScrew	39,806 REMOVED	NYE 362HB	FAILURE AT 38,821	
155	STRIPPED LEADScrew	39,805 REMOVED	NYE 362HB	TBD	
156	SWITCH INOP/STRIPPED LDSCR.	40,241 FUNCT.	NYE 362HB	TBD	ANALYZED AFTER 50,000 CYCLES

SNAW LOCK ACTUATOR #C-018758
ENGINEER: G.GAETH

DURABILITY TEST RESULTS

FASCO CONTROLS INC.
PREPARED BY: W.LANDIS

04/04/03

	DESCRIPTION	DESIGNATION
LEADScrew -	PLASTIC (PPS-TEFLON)- 38-.078-.156 (1PC)	L
9300-7413	PLASTIC (ACETAL)- 38-.078-.156 (1 PC)	N
CARRIER -	PLASTIC (PPS-TEFLON)- 38-.078-.156	M
9300-7403	PLASTIC (PPS-30%GF)- 38-.078-.156	O
SPUR GEAR -	PLASTIC (PPS-TEFLON)- 38-.078-.156 (15:1) (1 PC)	E
	PLASTIC (ACETAL)- 38-.078-.156 (15:1) (1 PC)	H
WORM GEAR -	BRASS (1LD.) U.T.S. PROFILE (15:1)	E
9300-7405		
MOTOR -	WITH P.T.C.	A
9300-7414	WITHOUT P.T.C.	B
	WITHOUT END CAP	D
	WITH EXTERNAL LINEAR THRUST LIMITER	E
		F
COVER -	WITH ATTACHED METAL STOP WITH GUSSETS	B
9300-7408		
LUBRICANT -	SILICONE (WHITE)	A

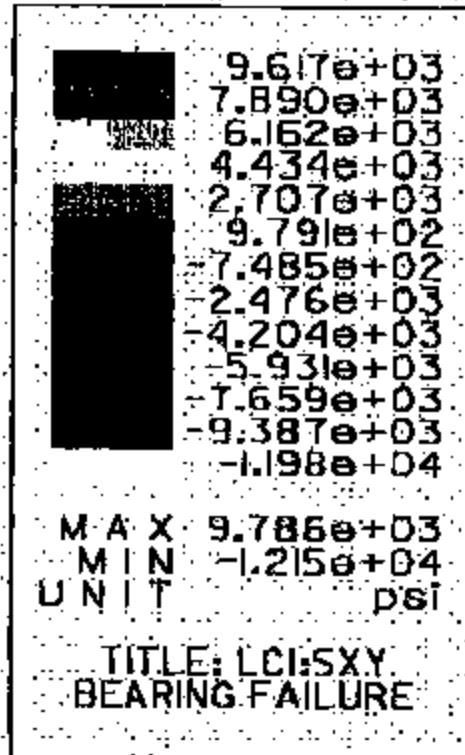
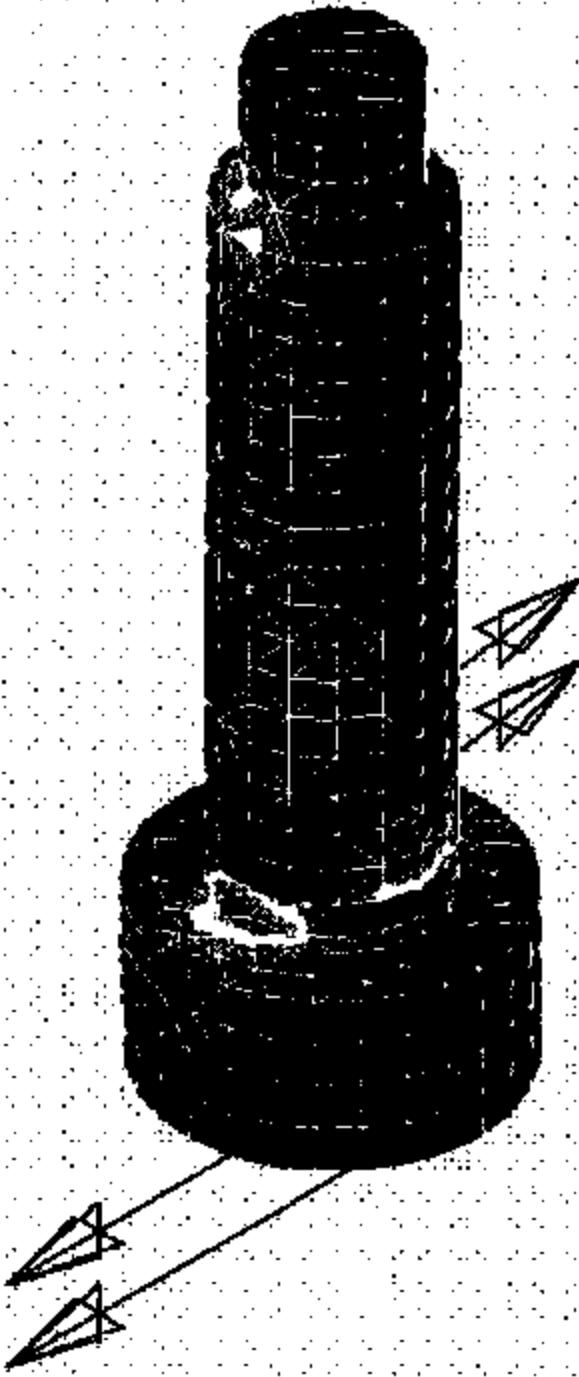
UNIT #>	PPS 118 (NO P.T.C.)	PPS 119,120	ACETAL 121,122, 123,124,	ACETAL 125,126, 127,128	ACETAL 129 (NO P.T.C.)		SINGLE STATION TEST # 13 71,885
V LEADScrew	L	L	N	N	N		N*
CARRIER	O	O	M	M	M		M
SPUR GEAR	E	E	H	H	H		H
WORM GEAR	E	E	E	E	E		E
MOTOR	BDE	ADE	ADE	ADE	BDE		ADE
COVER	B	B	B	B	B		B*
LUBRICANT	A	A	A	A	A		A

UNIT #	# CYCLES	COMMENTS	TEMP.(C)
118	297	HARD STOP	75
119	433	HARD STOP	79
120	383	HARD STOP	77
121	49,985	U'STOP, COVER, LEADScrew BROKEN	60
122	17,800	CARRIER BROKEN	60
123	28,800	U'STOP, COVER BROKEN; DRIVEN GEAR STRIPPED	75
124	29,440	U'STOP BROKEN; STRIPPED LEADScrew	25
125	23,300	CARRIER BROKEN	25
126	24,900	U'STOP, CARRIER BROKEN	10
127	37,120	U'STOP, CARRIER BROKEN	82
128	25,280	U'STOP, CARRIER BROKEN	35
129	38,800	U'STOP, CARRIER BROKEN	85

NOTE: 1) PPS LEADScrew AVG. # OF CYCLES: 374
2) ACETAL LEADScrew AVG. # OF CYCLES: 30,372

Attachment 2C

(FEAs -- Finite element
analysis on Leadscrew &
Up'stop)



PART CONSTRAINED AT
UPPER BEARING AREA.
6.25 IN/LB TORQUE APPLIED
TO PITCH DIAMETER.

(STRESS IN XY DIRECTIONS)



FAC-1163F

**Finite Element Analysis (FEA)
of Up-stop
for
Fasco Controls Corporation, Inc.**

**By:
AccentOnDESIGN, Inc.
Jerry T. Branner**

2/16/95

Objective:

The objective of the analysis of the Upstop was to predict deflections and stress levels of the loaded cast part. The geometry was provided by Faaco on print. The analysis included a (3) different Boundary Conditions (see attached) at Loads of 750, 1000, and 1500 lbs.

Assumptions:

- 1) Theoretical Model - Linear Analysis
- 2) Static Load of 150 Lbs applied
Stress numbers then compared to Fatigue Data
- 3) Thermal Loads not included.
- 4) Material: Zinc Alloy ($E=10,300,000$ psi)
ZA-27: UTS = 60 ksi, Fatigue (Rotary Bend) = 25 ksi
5 E8 cycles

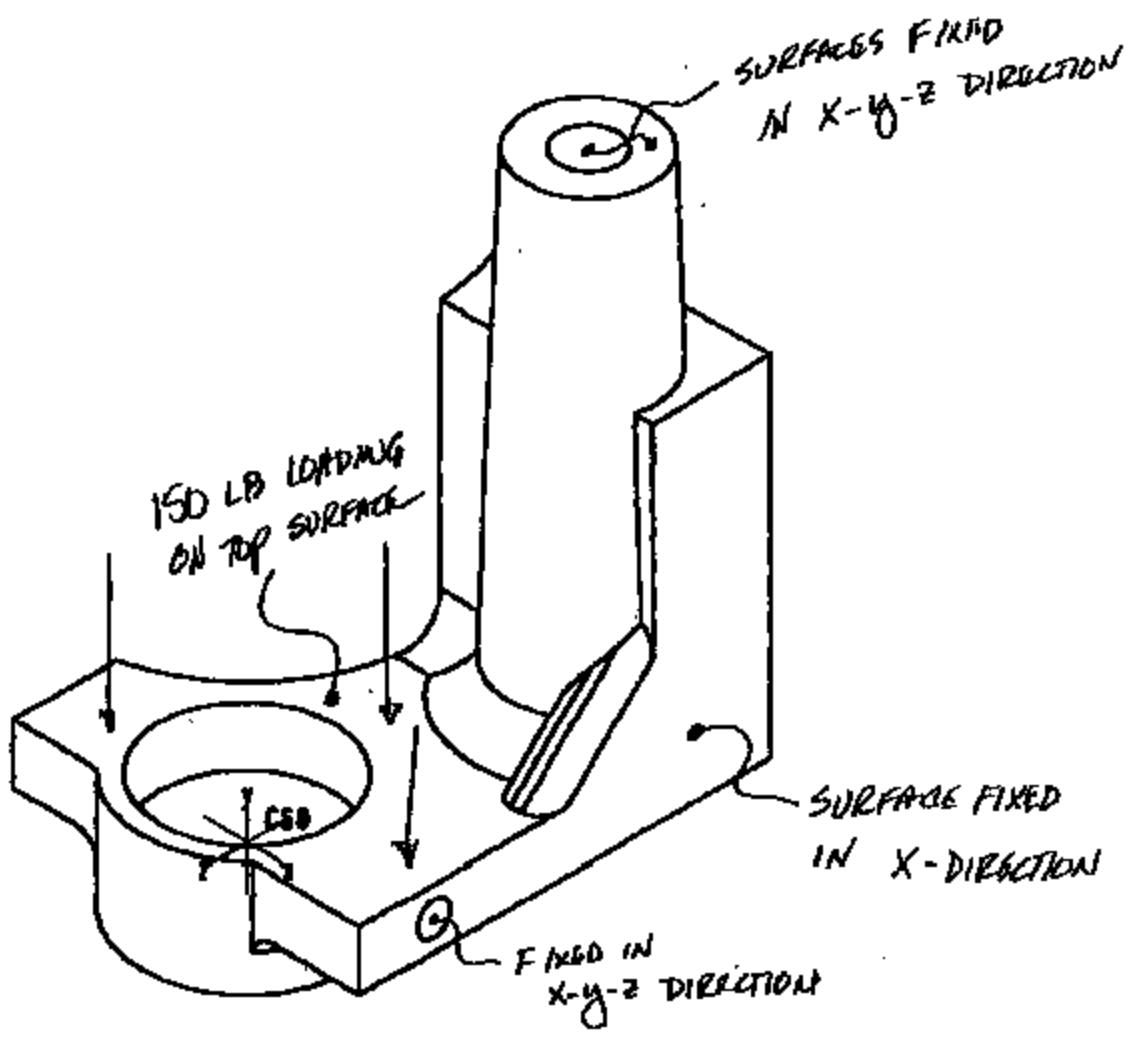
Results:

The results were a Max Von Mises Stress of 32 ksi in the areas shown. These results are shown on the attached sheet.

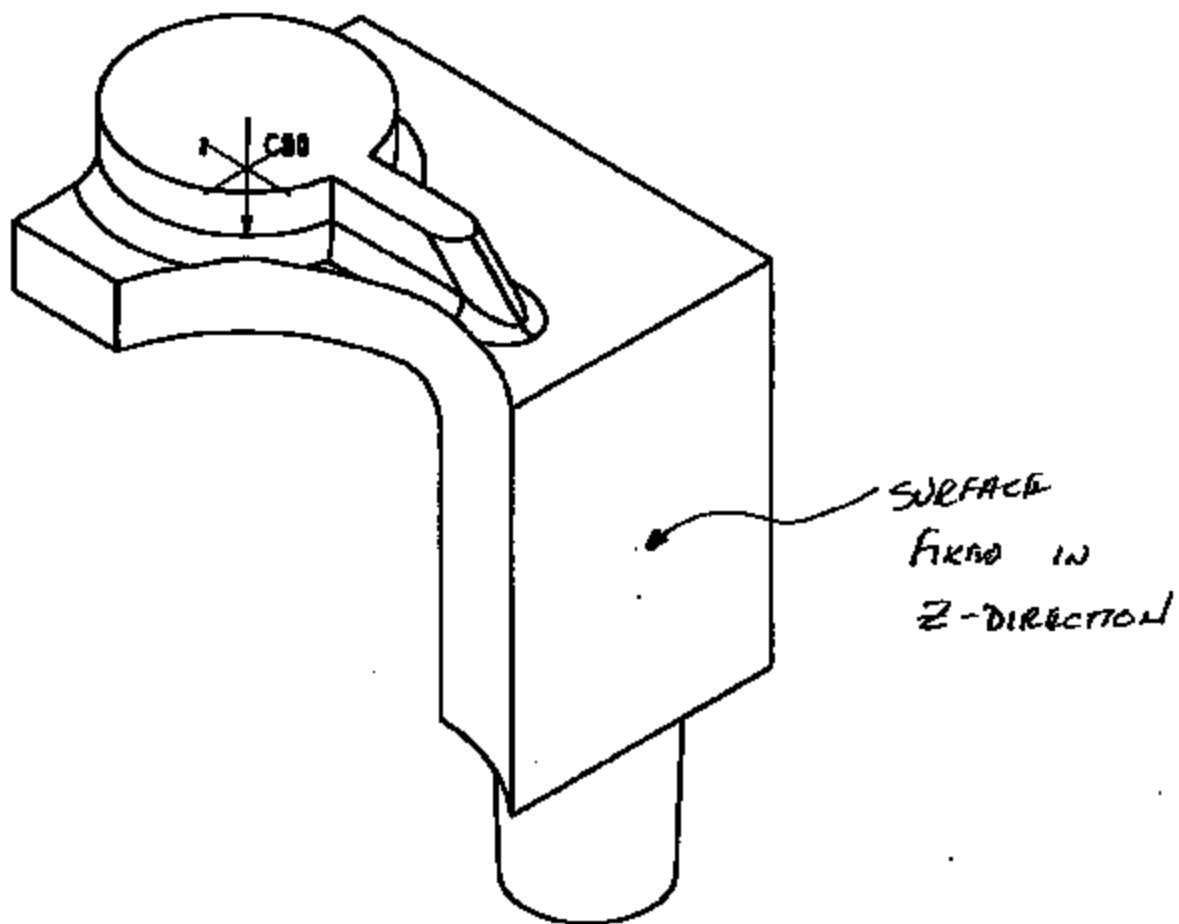
Recommendations:

This theoretical analysis typically will be on the conservative side. However, I recommend that without thermal loading included in this analysis and the unknown porosity values in cast parts, increases in fillets and a material with a higher Fatigue Strength should be researched and proven through further analysis and testing.

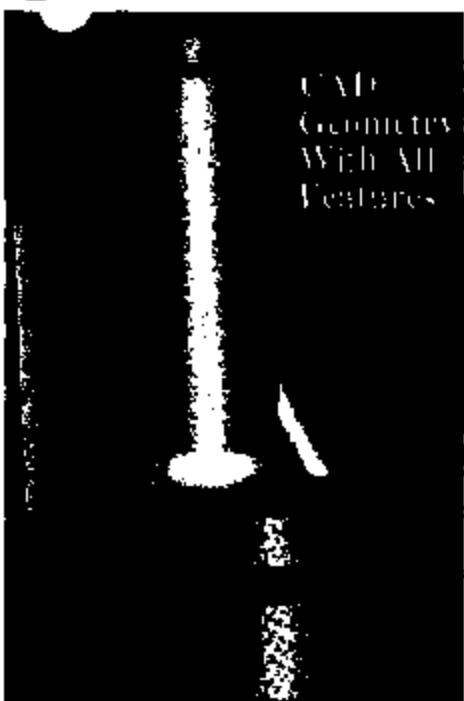
LOADS & CONSTRAINTS



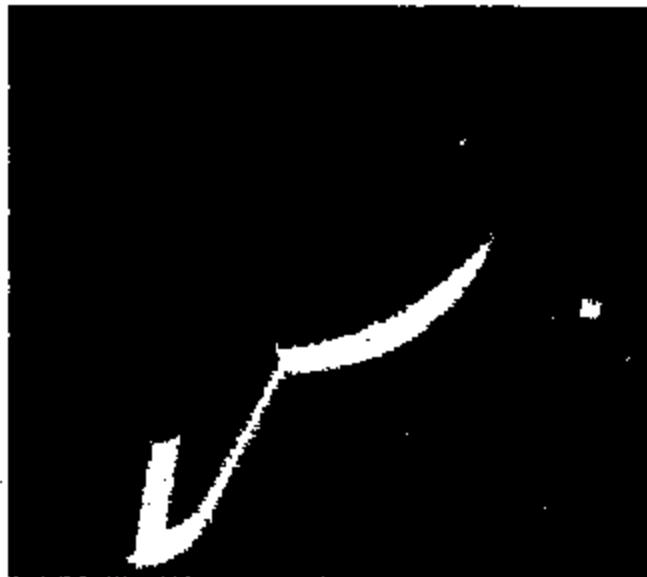
TOP ISO



BACK ISO

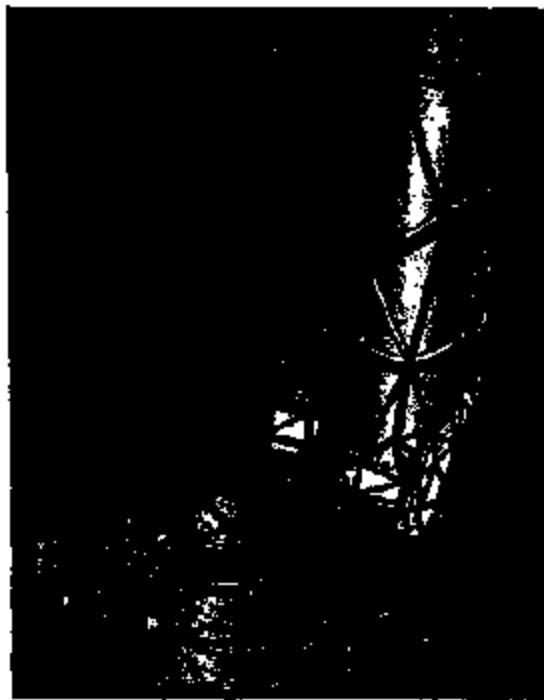


CAD
Geometry
With All
Features



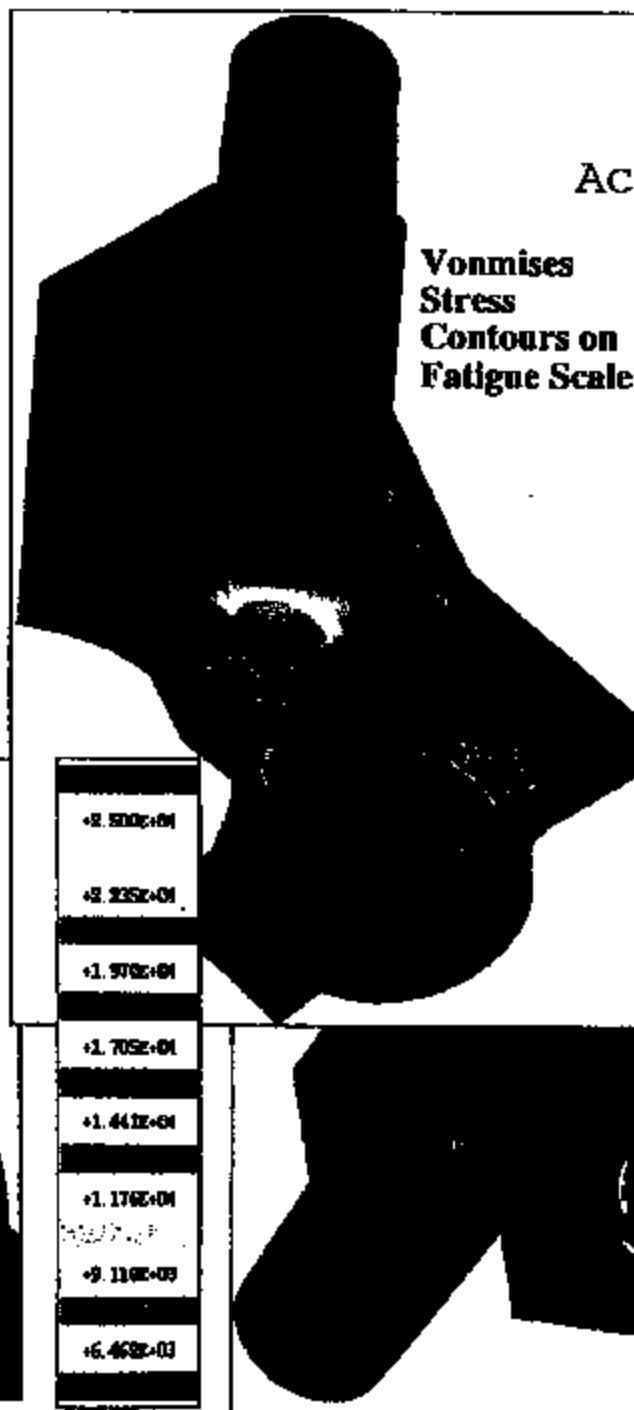
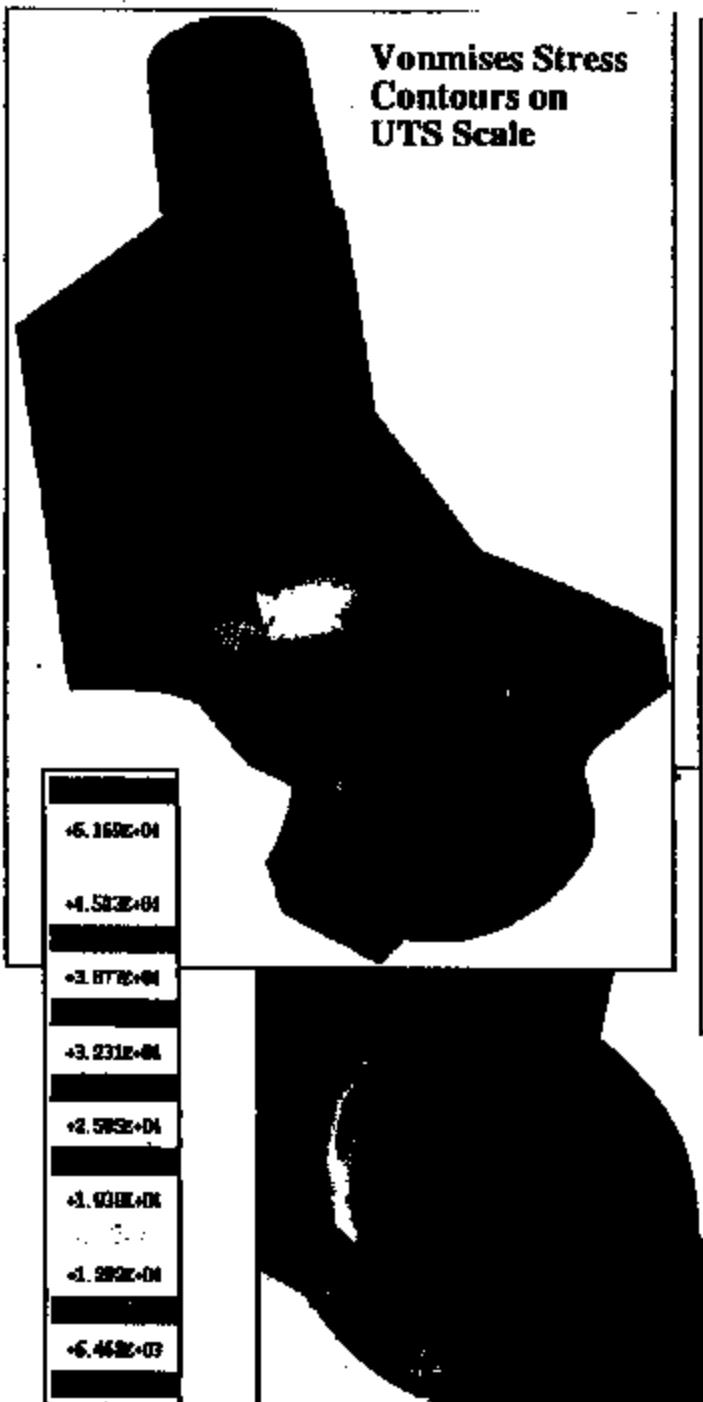
Accent On DESIGNinc.

**Engineering Design Using
Exact CAD Models - No
Defeaturing Necessary**



**Geometric Elements Capture
All Features Precisely for an
Exact Understanding of True
Part Behavior**





Accent On DESIGNinc.

**Component Design with
Built in Convergence
Checking – Quality in
Results.**



Attachment 2D

(Thermal Strain analysis
on Housing)

99TR1020PHL
April 23, 1999

Thermal Strain Analysis of a Cast Housing

By

Mallett Technology, Inc.
9801 Germantown Avenue, Suite 315
Lafayette Hill, PA 19444

For

FASCO Controls Corporation
1100 Airport Road
Shelby, NC 28150

TERMS AND CONDITIONS: Consulting services are offered on a best effort basis. Results, opinions and recommendations are drawn based upon information and analyses believed to be correct and applicable. Nevertheless, no warranty or guarantee is expressed or implied.

Mallett Technology, Inc.

Report No. 99TR1020PHL

Project No. FAS-99-001

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3.0	Model Information	1
4.0	Analysis Information	3
5.0	Results Information	4
6.0	Discussion and Conclusions.....	8

Mallett Technology, Inc.

Report No. 99TR1020PHL

Project No. FAS-99-001

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List of Tables

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Mallett Technology, Inc.

Report No. 99TR1020PHL

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1.0 Summary

This report documents a linear static analysis of the FASCO Controls Corporation's "cast housing" based on the geometry found in the IGES file supplied to Mallett Technology. The housing was subjected to a uniform temperature increase of 65 °C. The housing was assigned material properties of the Zamak Die Cast Alloy No. 5. Total displacement of the housing, as well as displacement in the x, y, and z global directions has been reported. The analysis was performed using ANSYS 5.5 finite element analysis software.

For details about the analysis, see Background and Purpose, Model Information, Analysis Information, Results Information, and the Discussions and Conclusions.

2.0 Background and Purpose

The subject casting houses a mechanism that is used to actuate locking and unlocking of an automobile steering column. This locking mechanism jams occasionally, and the FASCO Controls Corporation is exploring possible causes of this problem. Deformation of the surrounding housing due to thermal strain is one of several possible causes that have been identified. It is, therefore the subject of this work to predict the thermal strain (expansion) of the cast housing under the action of typical thermal loads. The analysis was performed with ANSYS 5.5, a general purpose finite element modeling package.

3.0 Model Information

The ANSYS finite element analysis program was used to create and solve the structural analysis problem. Figure 1 shows the finite element mesh. Table 1 lists the number of nodes and elements that comprise the model and Table 2 lists the properties of the material (Zamack Die Cast Alloy No. 5) used in the model.

Mallett Technology, Inc.

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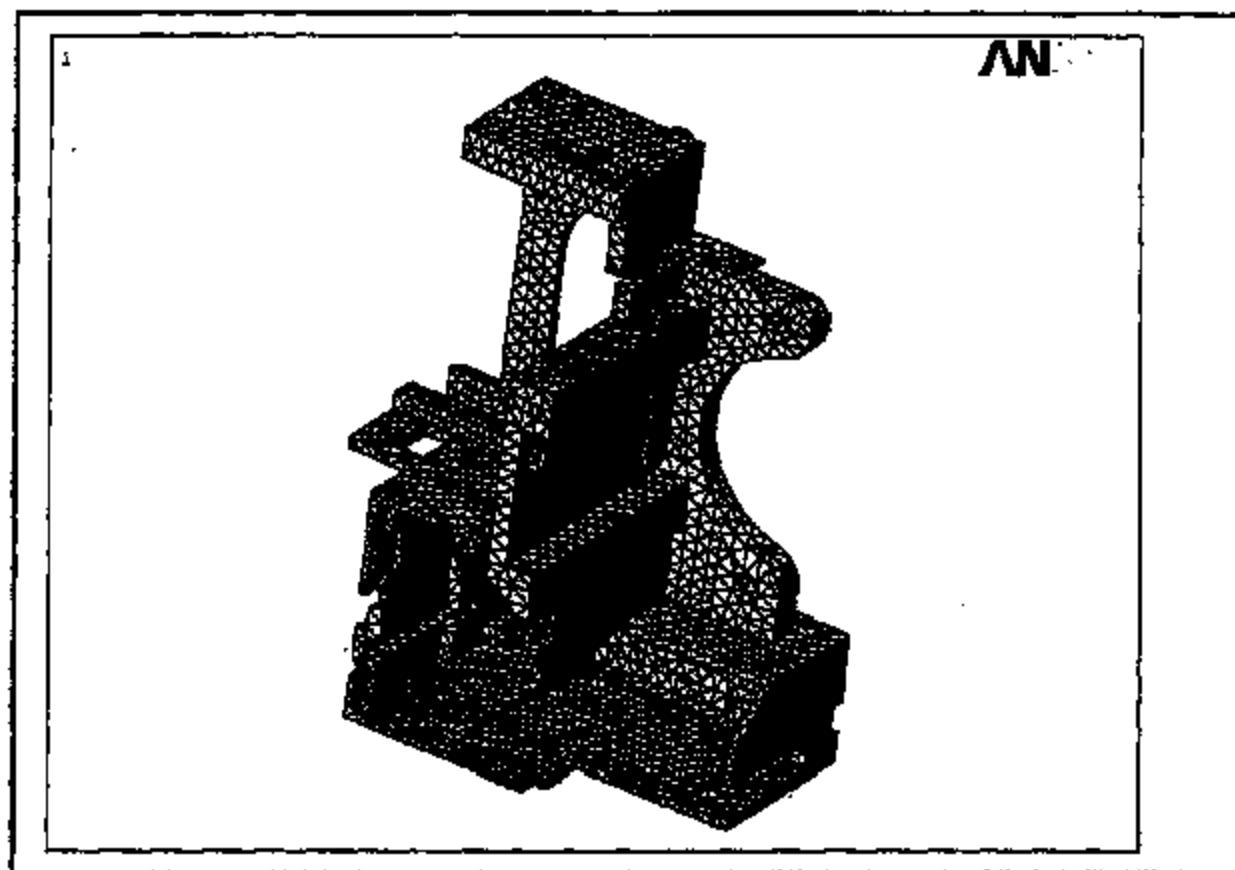


Figure 1. Meshed Model

Table 1. Details of the Finite Element Model

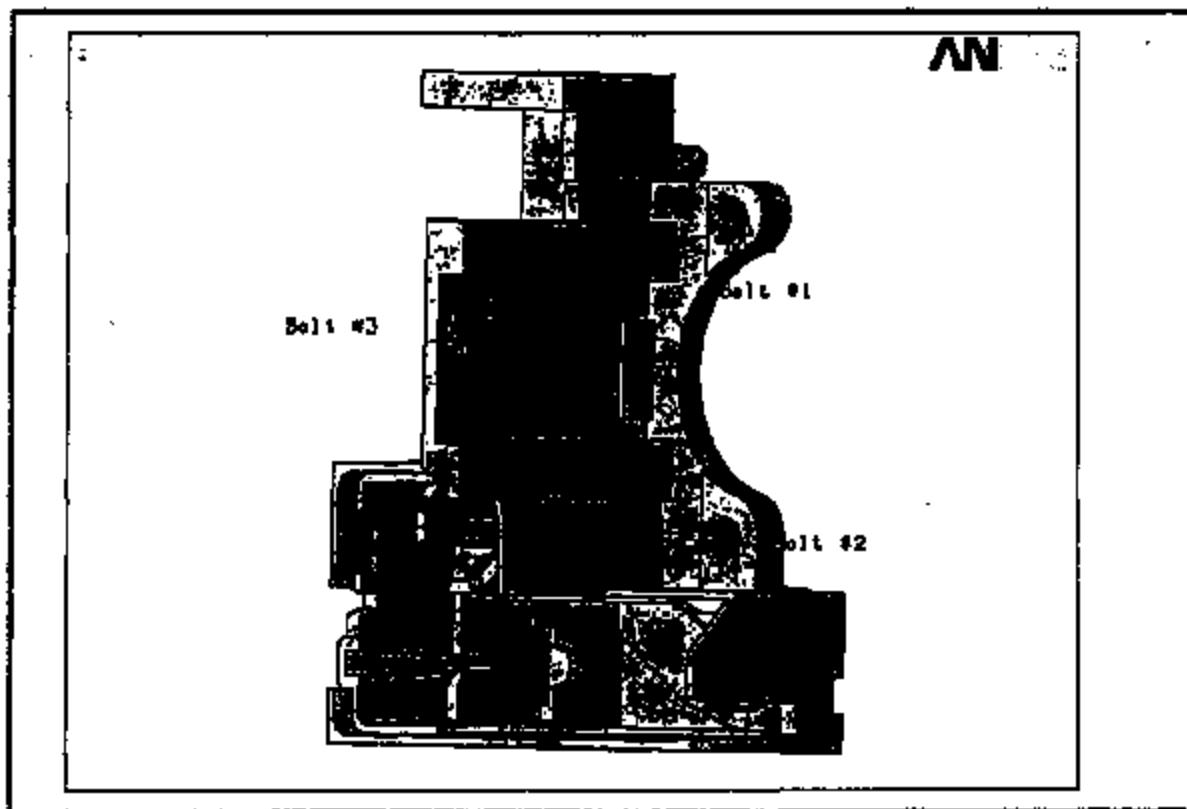
Entity	Number Defined	Type	Description
Elements	21146	Solid45	3-D Structural Solid
Nodes	6875	-	-

Table 2. Material Properties

Material Properties for Zamack Die Cast Alloy No. 5	
Modulus of Elasticity [Pa]	85×10^9
Density [g/cm ³]	6.7
Poisson's Ratio	0.3
Thermal Expansion Coefficient [1/ ^o C]	2.74×10^{-5}

4.0 Analysis Information

The housing was fully constrained at the three bolt hole locations (see Figure 2) as specified by FASCO Controls. A uniform temperature increase of 65 °C was applied to the model (see Table 3). The model was then evaluated with a linear static analysis.

**Figure 2. Boundary Conditions**

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Table 3. Boundary Conditions

Constraints			
Type	Location	Direction	Coordinate System
Constrained Translation	Bolt hole 1	XYZ	Global Cartesian
Constrained Translation	Bolt hole 2	XYZ	Global Cartesian
Constrained Translation	Bolt hole 3	XYZ	Global Cartesian

Loads				
Type	Reference Temp.	Uniform Temp.		
Uniform Temperature (°C)	20	85		Applied to all elements

5.0 Results Information

The following figures and tables show the response of the housing to the applied temperature loading and constraints. Please also see the Windows animation file 'housingresponse.avi', for an animation of the thermal response of the cast housing. All results are expressed in the global Cartesian coordinate system.

Mallett Technology, Inc.

Report No. 99TR1020PHL

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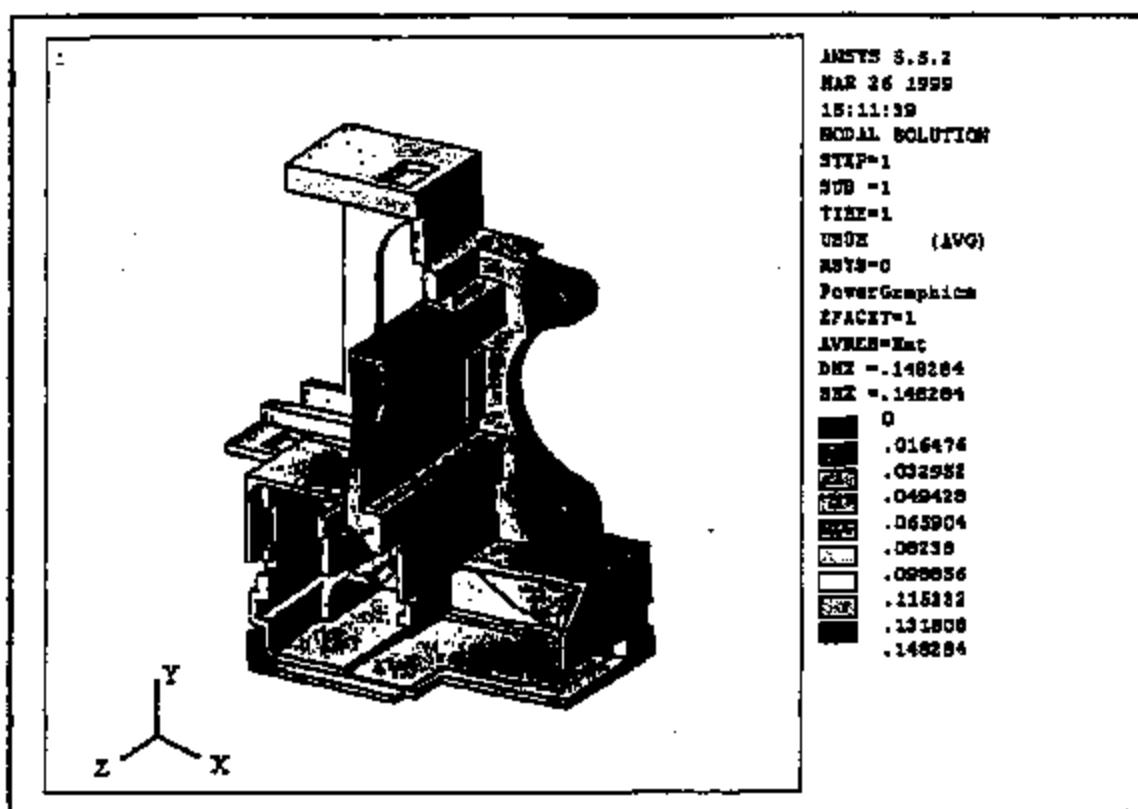


Figure 3. Contour Plot of Total Displacement

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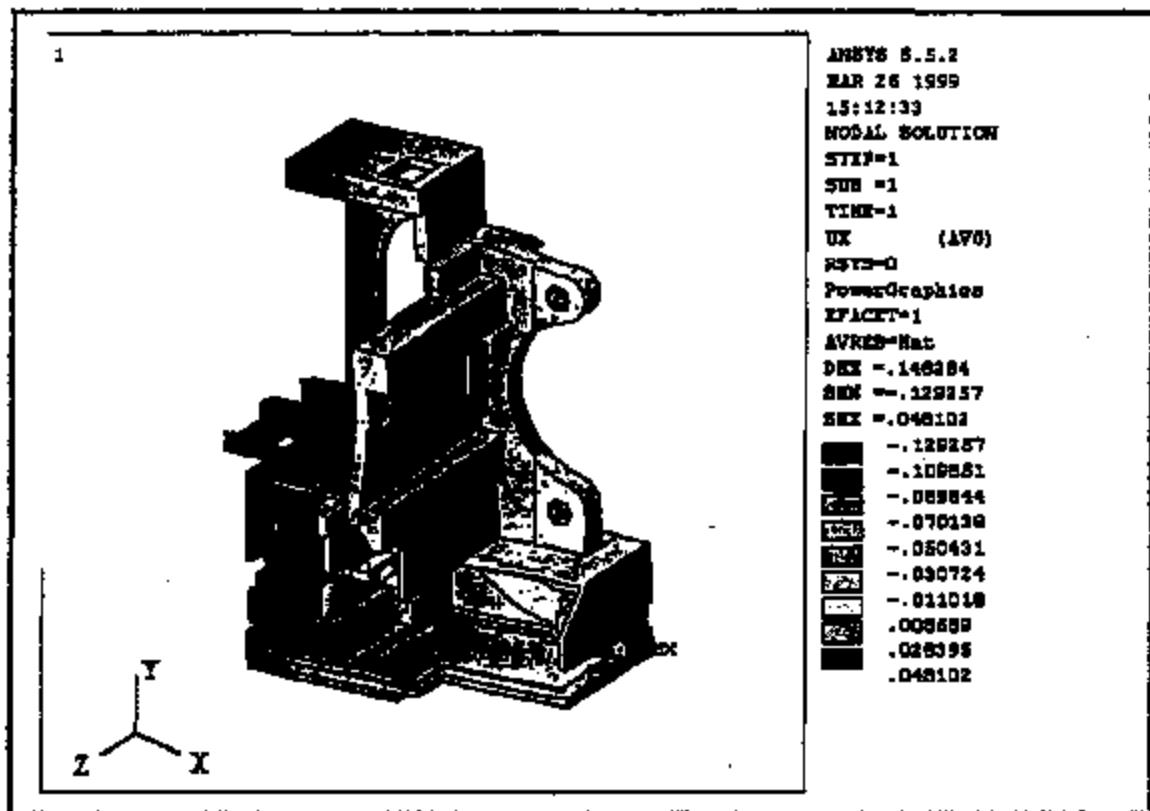


Figure 4. Contour Plot of X Direction Displacement

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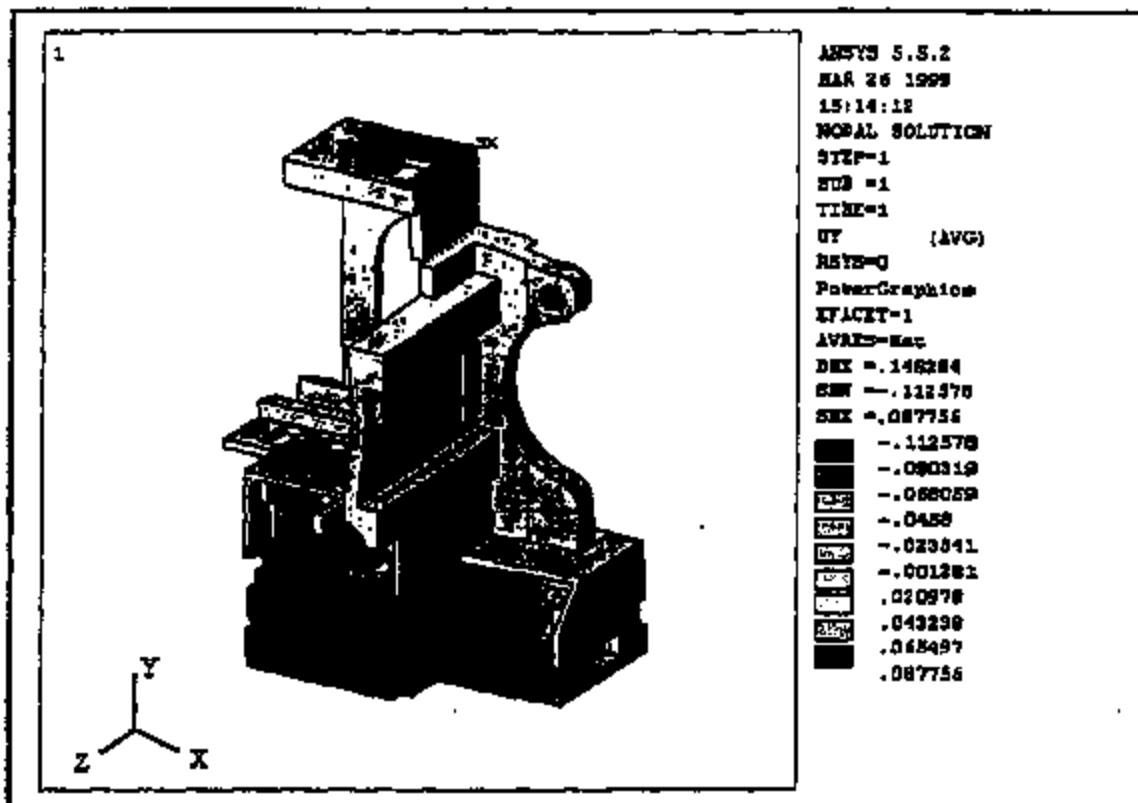
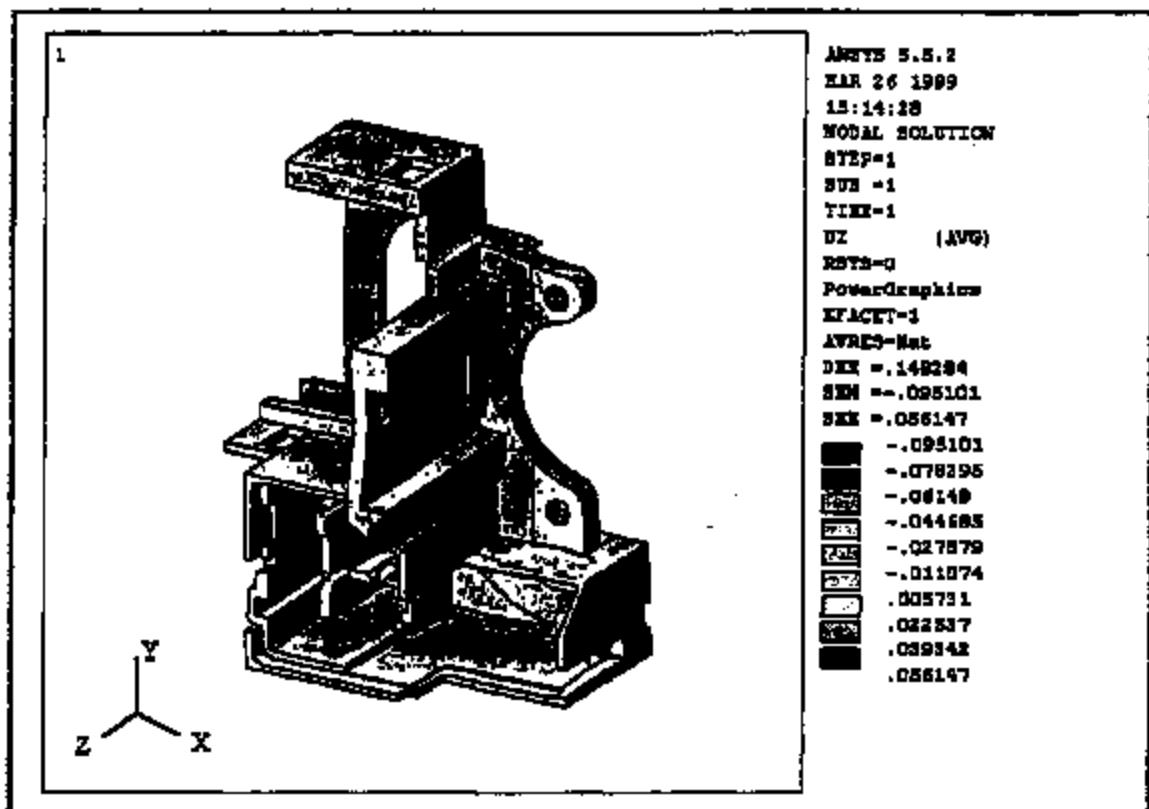


Figure 5. Contour Plot of Y Direction Displacement

Figure 6. Contour Plot of Z Direction Displacement**Table 6. Displacements**

Displacements [mm]				
	X	Y	Z	Sum
Maximum	-0.129257	-0.112378	-0.095101	0.148284

6.0 Discussions and Conclusions

The subject casting undergoes deformation due to thermal loads which may cause binding of the enclosed locking mechanism due to either undesirable contact between the mechanism and the housing and/or the subsequent misalignment of mechanism components. The figures of the previous section provide an overview of this deformation. Details of the deformation field in specific regions of the housing will be provided by Mallett Technology, Inc. at the request of FASCO Controls Corporation.

Attachment 2E

(Lubricant & Material
Selection Wear testing)

WEAR TEST GROUPS
SAGINAW STEERING LOCK ACTUATOR
SAGINAW # 29060960
FASCO # 1740-0002 (9300-7401)

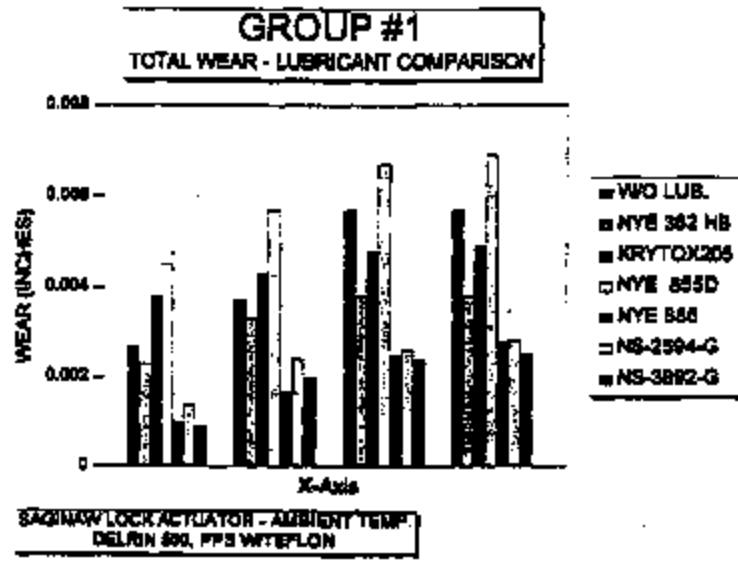
- GROUP #1** LEADSCREW- ACETAL- DELRIN II 500
CARRIER - PPS WTEFLON - G.E. SUPEC W331
- GROUP #2** LEADSCREW - ACETAL - 7% TEFLON (COPOLYMER)
CARRIER - PPS WTEFLON - G.E. SUPEC W331
- GROUP #3** LEADSCREW- ACETAL- DELRIN II 500
CARRIER - NYLON 6/6 - ZYTEL 103 HS1L (UNFILLED)
- GROUP #4** LEADSCREW - ACETAL - 7% TEFLON (COPOLYMER)
CARRIER - NYLON 6/6 - ZYTEL 103 HS1L (UNFILLED)

REVISED
07/25/96

GROUP #1
TOTAL WEAR - LUBRICANT COMPARISON
ambient temp.

05/16/96

W/O LUB.	0.0027	0.0037	0.0057	0.0057	66 HR.S
NYE 362 HB	0.0023	0.0033	0.0038	0.0038	82.5 HR.S
KRYTOX205	0.0038	0.0043	0.0048	0.0049	45 HR.S
NYE 855D	0.0045	0.0057	0.0067	0.0069	66 HR.S
NYE 885	0.0010	0.0017	0.0025	0.0028	80HR.S
NS-2594-G	0.0014	0.0024	0.0028	0.0028	66.75HR.S
NS-3892-G	0.0008	0.0020	0.0024	0.0025	66.75HR.S

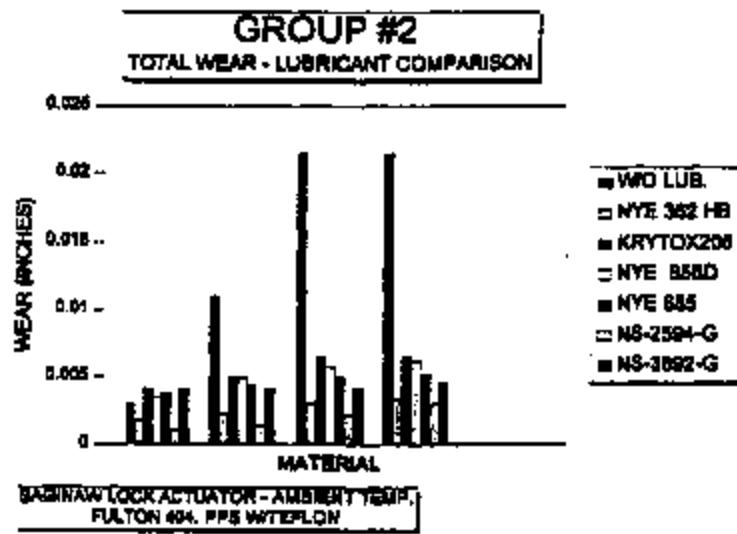


REVISED
07/25/96

GROUP #2
TOTAL WEAR - LUBRICANT COMPARISON
ambient temp.

05/16/96

W/O LUB.	0.0030	0.0110	0.0215	0.0215	66 HR.S
NYE 362 HB	0.0018	0.0023	0.0030	0.0034	82.5 HR.S
KRYTOX205	0.0042	0.0050	0.0065	0.0065	45 HR.S
NYE 855D	0.0035	0.0049	0.0068	0.0062	66 HR.S
NYE 885	0.0038	0.0045	0.0060	0.0052	80 HR.S
NS-2594-G	0.0011	0.0014	0.0022	0.0030	66.75HR.S
NS-3892-G	0.0041	0.0042	0.0043	0.0048	66.75HR.S

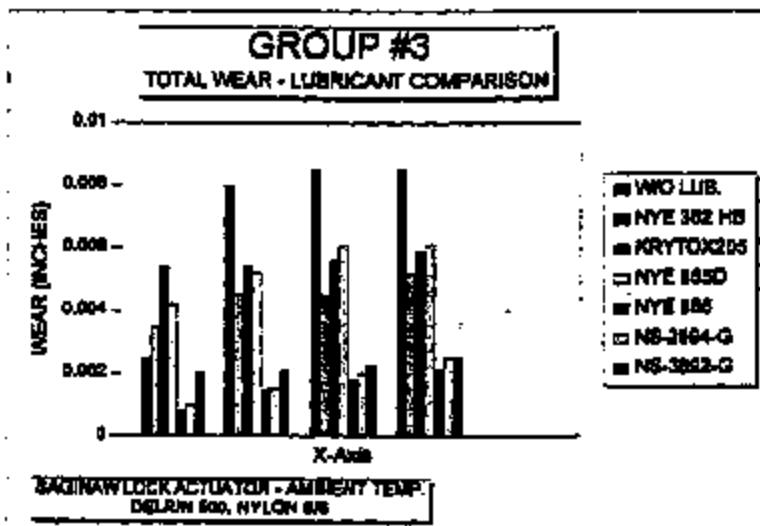


REVISED
07/25/98

GROUP #3
TOTAL WEAR - LUBRICANT COMPARISON
ambient temp.

05/15/95

WO LUB.	0.0025	0.0080	0.0085	0.0085 60 HR.S
NYE 362 HB	0.0035	0.0045	0.0045	0.0052 82.5 HR.S
KRYTOX205	0.0054	0.0054	0.0058	0.0059 45 HR.S
NYE 855D	0.0042	0.0052	0.0061	0.0061 60 HR.S
NYE 885	0.0008	0.0016	0.0018	0.0021 60 HR.S
NS-2594-G	0.0010	0.0015	0.0020	0.0025 60.75HR.S
NS-3892-G	0.0020	0.0021	0.0023	0.0025 60.75HR.S

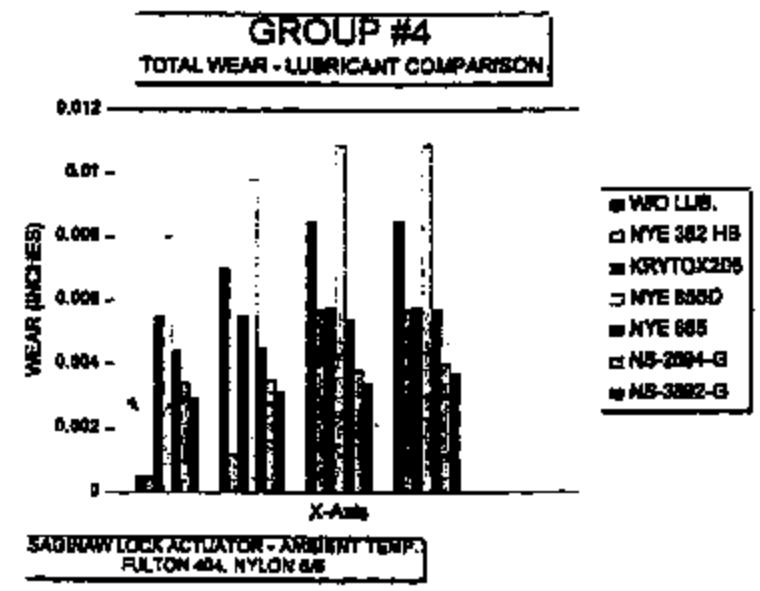


REVISED
07/25/98

GROUP #4
TOTAL WEAR - LUBRICANT COMPARISON
ambient temp.

05/15/95

WO LUB.	0.0005	0.0070	0.0085	0.0085 60 HR.S
NYE 362 HB	0.0005	0.0012	0.0057	0.0057 82.5 HR.S
KRYTOX205	0.0065	0.0055	0.0088	0.0068 45 HR.S
NYE 855D	0.0080	0.0088	0.0109	0.0109 60 HR.S
NYE 885	0.0044	0.0045	0.0054	0.0057 60 HR.S
NS-2594-G	0.0034	0.0035	0.0038	0.0040 60.75HR.S
NS-3892-G	0.0029	0.0032	0.0034	0.0037 60.75HR.S

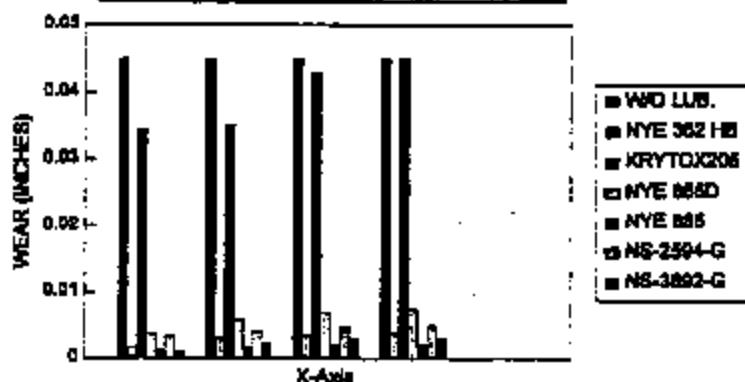


REVISED
07/26/96

DELRUN 500, PPS W/TEFLON 06/05/95
TOTAL WEAR - LUBRICANT COMPARISON
150 DEG F

W/O LUB.	0.0450	0.0450	0.0450	0.0450	23 HR.S (P)
NYE 362 HB	0.0017	0.0030	0.0034	0.0038	88 HR.S
KRYTOX205	0.0344	0.0352	0.0428	0.0451	91.5 HR.S
NYE 855D	0.0037	0.0069	0.0070	0.0074	91 HR.S
NYE 885	0.0012	0.0016	0.0020	0.0022	91 HR.S (P)
NS-2594-G	0.0034	0.0041	0.0047	0.0050	91 HR.S
NS-3882-G	0.0011	0.0024	0.0030	0.0030	90.5 HR.S

GROUP #1 AT 150 DEG.(F)
TOTAL WEAR - LUBRICANT COMPARISON



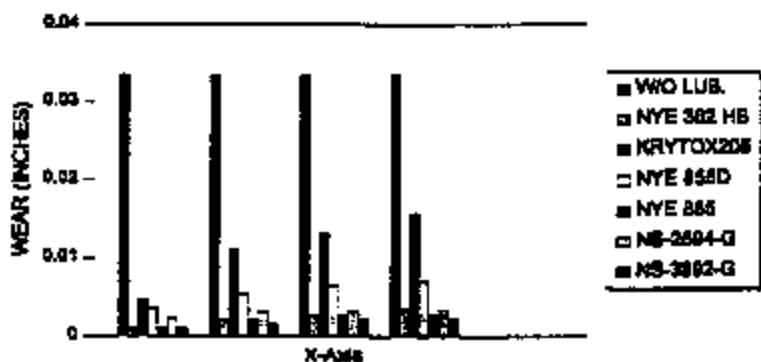
SAGINAW LOCK ACTUATOR
DELRUN 500, PPS W/TEFLON

REVISED
07/26/96

FULTON 404, PPS W/TEFLON 06/05/95
TOTAL WEAR - LUBRICANT COMPARISON
150 DEG F

W/O LUB.	0.0335	0.0335	0.0335	0.0335	23 HR.S
NYE 362 HB	0.0011	0.0022	0.0028	0.0038	88 HR.S
KRYTOX205	0.0049	0.0113	0.0133	0.0158	91.5 HR.S
NYE 855D	0.0038	0.0058	0.0087	0.0071	91 HR.S
NYE 885	0.0012	0.0023	0.0029	0.0030	91 HR.S
NS-2594-G	0.0028	0.0033	0.0034	0.0035	91 HR.S
NS-3882-G	0.0012	0.0017	0.0023	0.0024	91 HR.S

GROUP #2 AT 150 DEG.(F)
TOTAL WEAR - LUBRICANT COMPARISON



SAGINAW DOOR ACTUATOR
FULTON 404, PPS W/TEFLON

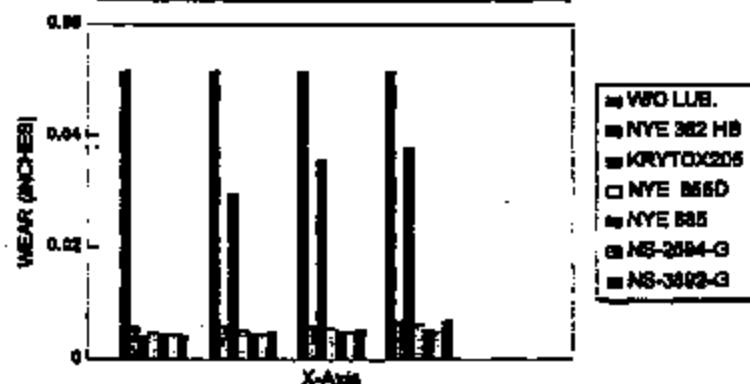
REVISED
07/25/96

DELRIN 500, NYLON 6/6
TOTAL WEAR - LUBRICANT COMPARISON
150 DEG. F

06/02/95

W/O LUB.	0.0517	0.0517	0.0517	0.0517	28 HR.S (
NYE 362 HB	0.0059	0.0059	0.0059	0.0069	110.5 HR.S
KRYTOX205	0.0040	0.0297	0.0358	0.0380	65 HR.S
NYE 855D	0.0049	0.0063	0.0055	0.0063	66.75 HR.S
NYE 885	0.0045	0.0048	0.0052	0.0055	66.75 HR.S
NS-2594-G	0.0045	0.0047	0.0049	0.0051	68 HR.S
NS-3882-G	0.0044	0.0050	0.0054	0.0070	99 HR.S (P)

GROUP #3 AT 150 DEG. (F)
TOTAL WEAR - LUBRICANT COMPARISON



DRAWBAR LOCK ACTUATOR
DELRIN 500, NYLON 6/6

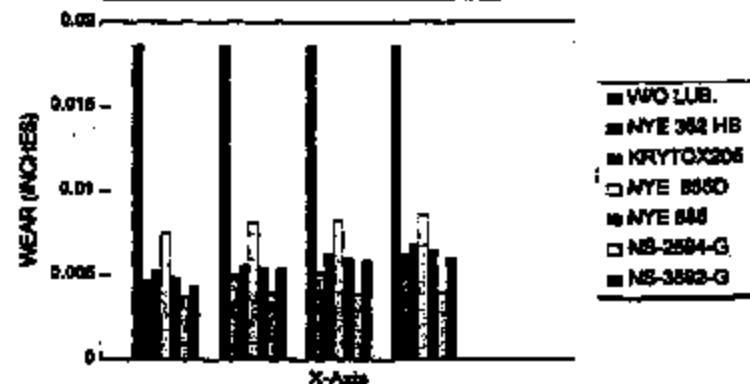
REVISED
07/25/96

FULTON 404- NYLON 6/6
TOTAL WEAR - LUBRICANT COMPARISON
150 DEG. F

06/02/95

W/O LUB.	0.0188	0.0188	0.0188	0.0188	23 HR.S
NYE 362 HB	0.0047	0.0050	0.0062	0.0082	110.5 HR.S
KRYTOX205	0.0053	0.0056	0.0062	0.0068	65 HR.S
NYE 855D	0.0075	0.0081	0.0083	0.0086	66.75 HR.S
NYE 885	0.0049	0.0055	0.0060	0.0065	66.75 HR.S
NS-2594-G	0.0037	0.0038	0.0039	0.0040	68 HR.S
NS-3882-G	0.0044	0.0054	0.0059	0.0080	91.5 HR.S

GROUP #4 AT 150 DEG. (F)
TOTAL WEAR - LUBRICANT COMPARISON



DRAWBAR LOCK ACTUATOR
FULTON 404, NYLON 6/6

Attachment 2F

(Design and Product
Validation Testing -- with
"Hardstop" graphs.)

ITEM DATE TESTING PERFORMED

- 1) 11/01/96 THERMAL GROUP #1 - 12 UNITS PLACED ON TEST (-40/85 C)
REF. 2.65 BeCu ACTUATOR - 0.01.8 SWITCH PT.
REMOVED FROM TEST ON 11/02/96 - 4 OF 12 FAILED (INTERMITTANT AT -20 C)
- 2) 11/01/96 DURABILITY GROUP #A - 24 UNITS PLACED ON TEST THRU THERMAL (-40/85 C)
REF. 2.65 BeCu ACTUATOR - 0.01.8 SWITCH PT.
REMOVED FROM TEST ON 11/06/96 - 11 OF 24 INTERMITTANT AT AMB. - 31,536 CYCLES CO
- 3) 11/06/96 127 UNITS TESTED ON PRODUCTION TESTER AT 1.01.8 SET POINT. (AMBIENT TEMP.) 3 FAILED
98 UNITS TESTED ON O'SCOPE AT 16.0 VDC (AMBIENT TEMP.) - NO FAILURES
- 4) 11/04/96 5 RETURNED UNITS RETESTED ON PRODUCTION TESTER & O'SCOPE
(ALL FIVE UNITS REJECTED 3 OF 3 TIMES AT FINAL TESTER)
11/06/96 THERMAL GROUP #2 - 12 UNITS PLACED ON TEST (4 LOCKED, 6 UNLOCKED) GROUP #2
REF. 2.62 BeCu ACTUATOR - 1.01.8 SWITCH PT.
ALL PARTS STILL FUNCTIONAL AS OF 11/7/96
- 11/06/96 PPAP #1 DURABILITY PARTS RETESTED USING O'SCOPE AT AMBIENT
1 OF 6 FAILED (INTERMITTANT)
- 11/06/96 PPAP #2 DURABILITY PARTS RETESTED USING O'SCOPE AT AMBIENT
6 OF 8 PASSED
PPAP #2 DURABILITY PARTS RETESTED ON 11/12/96 USING O'SCOPE AT 30 C
12 OF 18 FAILED (INTERMITTANT)
- 5) 11/07/96 18 OF 42 RETURN TESTED AND MEASURED (O'SCOPE/SWITCH PT.)
ALL FAILED FINAL TESTER (REF. 1.01.8 SW/PT.) & O'SCOPE TEST (16.0 VDC)
- 6) 11/08/96 THERMAL GROUP #3 - 12 UNITS TESTED FOR SW. PT. DEGRADATION AT AMB. & THERMAL
REF. 2.62 BeCu ACTUATOR - 1.01.8 SWITCH PT.
ALL PARTS STILL FUNCTIONAL AS OF 11/12/96
- 11/08/96 DURABILITY GROUP #B - 24 UNITS PLACED ON DURABILITY TEST
REF. 2.62 BeCu ACTUATOR - 1.01.8 SWITCH PT.
REMOVED FROM TEST ON 11/13/96 - 22 OF 24 INTERMITTANT AT 71 C - 22,924 CYCLES
RETESTED AT AMBIENT ON 11/14/96 - NO FAILURES (24 OF 24)
TEMP. RAMP-UP TEST PERFORMED 11/14/96 - 13 OF 24 FAILED AT 45 C
5 OF 24 FAILED AT 30 C
- 7) 11/13/96 THERMAL TEST - SPECIAL - 12 ACTUATORS (REF#S-3173)
REF. 2.62 - (6) BeCu & (6) STAINLESS STEEL COMPRESSED TO 1.0 MM
- 8) 11/14/96 SWITCHES (86107-2001) TESTED AT 30 DEG C (ALL PASSED)
DURABILITY PARTS RETESTED AT AMBIENT - REF. GROUP #5
- 9) 11/15/96 DURABILITY GROUP #C - 24 UNITS PLACED ON DURABILITY TEST
REF. 2.62 STAINLESS STEEL ACTUATOR - 1.01.8 SWITCH PT.
12 UNITS INTERMITTANT AFTER 28,874 CYCLES AT 77 DEG C
TESTING STOPPED ON 11/20/96 AT 24,540 CYCLES
- 10) 11/21/96 DURABILITY GROUP #D - 24 UNITS PLACED ON DURABILITY TEST
REF. 2.62 STAINLESS STEEL ACTUATOR - 1.01.8 SWITCH PT.
CONCERN ABOUT TRENDING
- 11) 12/09/96 DURABILITY GROUP #E - 24 UNITS PLACED ON DURABILITY TEST
REF. 2.62 STAINLESS STEEL ACTUATOR - 1.01.8 SWITCH PT.
MODIFIED TESTER WITH THERMOCOUPLE - TO SIMULATE APPLICATION - COMP. 12/07/96
HIGH RESISTANCE DETECTED ACROSS MULTIPLE SWITCHES
- 12) 12/20/96 DURABILITY GROUP #F - 24 UNITS PLACED ON DURABILITY TEST
REF. 2.62 STAINLESS STEEL ACTUATOR - 1.01.8 SWITCH PT.
LUBRICANT REMOVED FROM SWITCH AREA
3 UNITS FAILED FINAL TESTER
1) DOUBLE SWITCH 2) STICKING AT 5.0V 3) LOW SW. PT. 4) MULTIPLE UNITS - P.T.C.
50K CYCLES COMPLETED
- 13) 01/13/97 DURABILITY GROUP #G - 24 UNITS PLACED ON DURABILITY TEST
REF. 2.62 STAINLESS STEEL ACTUATOR - 1.01.8 SWITCH PT.
REF. PTFE ON LOCK BOLTS, NYLON BUSHING
LUBRICANT REMOVED FROM SWITCH AREA

GRAPHS
ATTACHED

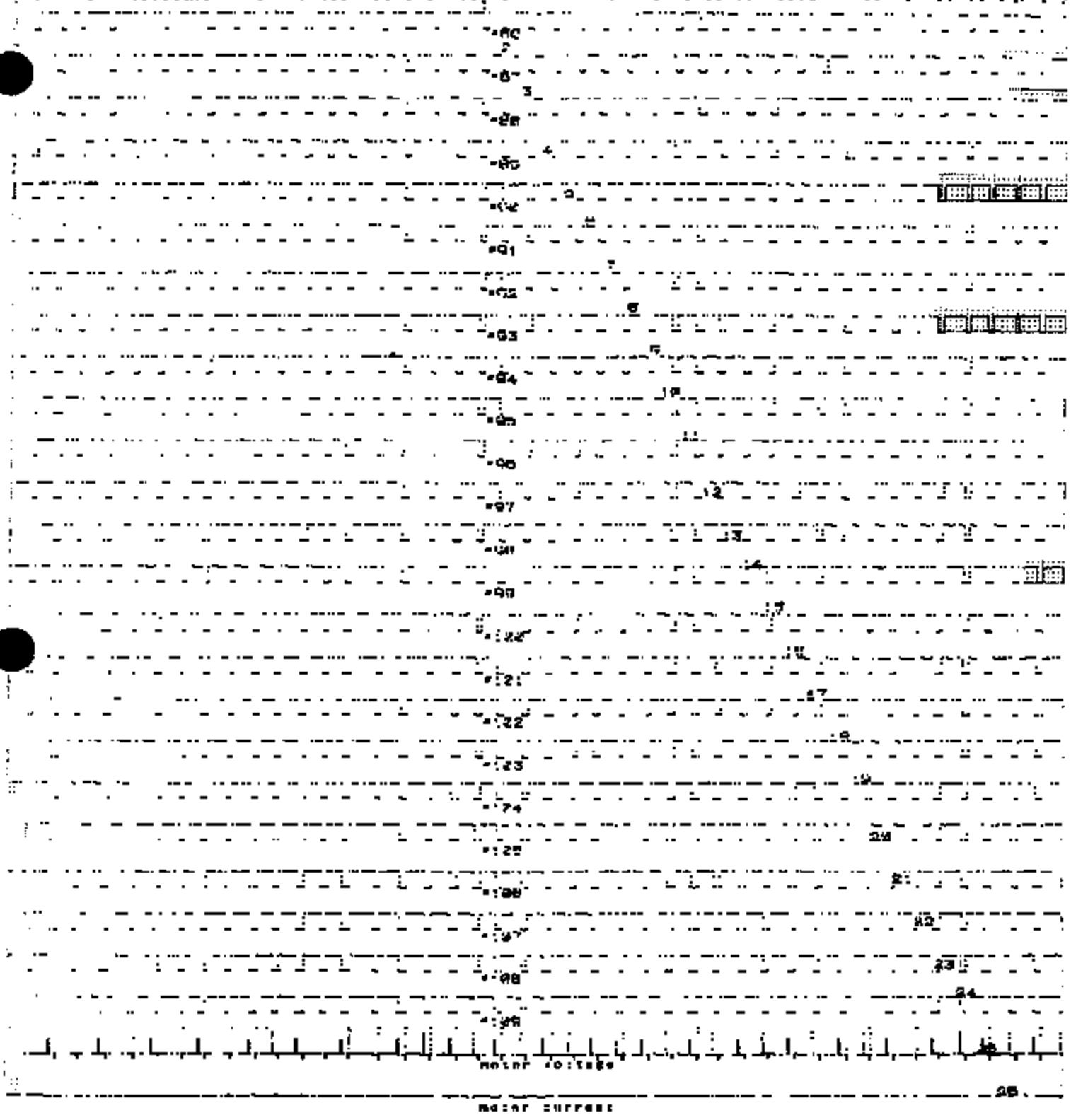
SAGINAW COLUMN LOCK ACTUATOR 11/18/96
SAG120050960 FASCOM 1740-0002 Revised 01/13/97
TEST SUMMARY (REF.PPR 01 10/26/96)

STUDIES PERFORMED

- 11/04/96 CAPABILITY STUDIES PERFORMED ON OMRON SWITCH # 5107-2007
- 11/05/96 CAPABILITY STUDIES PERFORMED ON ACTUATOR # 8100-2173
CAPABILITY STUDIES PERFORMED ON ECLIP AFTER TESTING
- 11/06/96 CAPABILITY STUDIES PERFORMED ON SWITCH/TERMINAL DISC ASSY.
- 11/07/96 CAPABILITY STUDIES PERFORMED ON ACTUATOR - (FORCE vs DEFLECTION)
- 11/08/96 CAPABILITY STUDIES PERFORMED ON ACTUATOR/DISC COVER ASSY. - (FORCE vs DEFLECTION)
CAPABILITY STUDY PERFORMED ON SWITCH FORCE REQ'D TO ACTUATE
- 11/14/96 FORCE MEASUREMENTS TAKEN ON REV#48, REV#50, PPAP #2, & SB ACTUATORS
MEASUREMENTS TAKEN ON KEY COMPONENTS AND KEY DIM'S
REF. - REV#48, REV#50, PPAP#2 - CARRIERS, UPSTOP, HOUSINGS, ACTUATORS
- 01/08/97 NEW SONY SWITCH POINT TESTER IN PLACE
- 01/10/97 CORRELATION STUDY PERFORMED BETWEEN FINAL TESTER AND SONY TESTER
- 01/11/97 SWITCH POINT STUDIES COMPLETED - REF. TEMP. SOAK AT 88 C.

border

Pg.s 1-8 SEQUENTIAL REF. DURABILITY
13:00:13 31 Dec 90 ASPD: 12 mm/m TIME SCALE



temperature in degrees-

App 4320 CYCLES/24 HR. MIN.

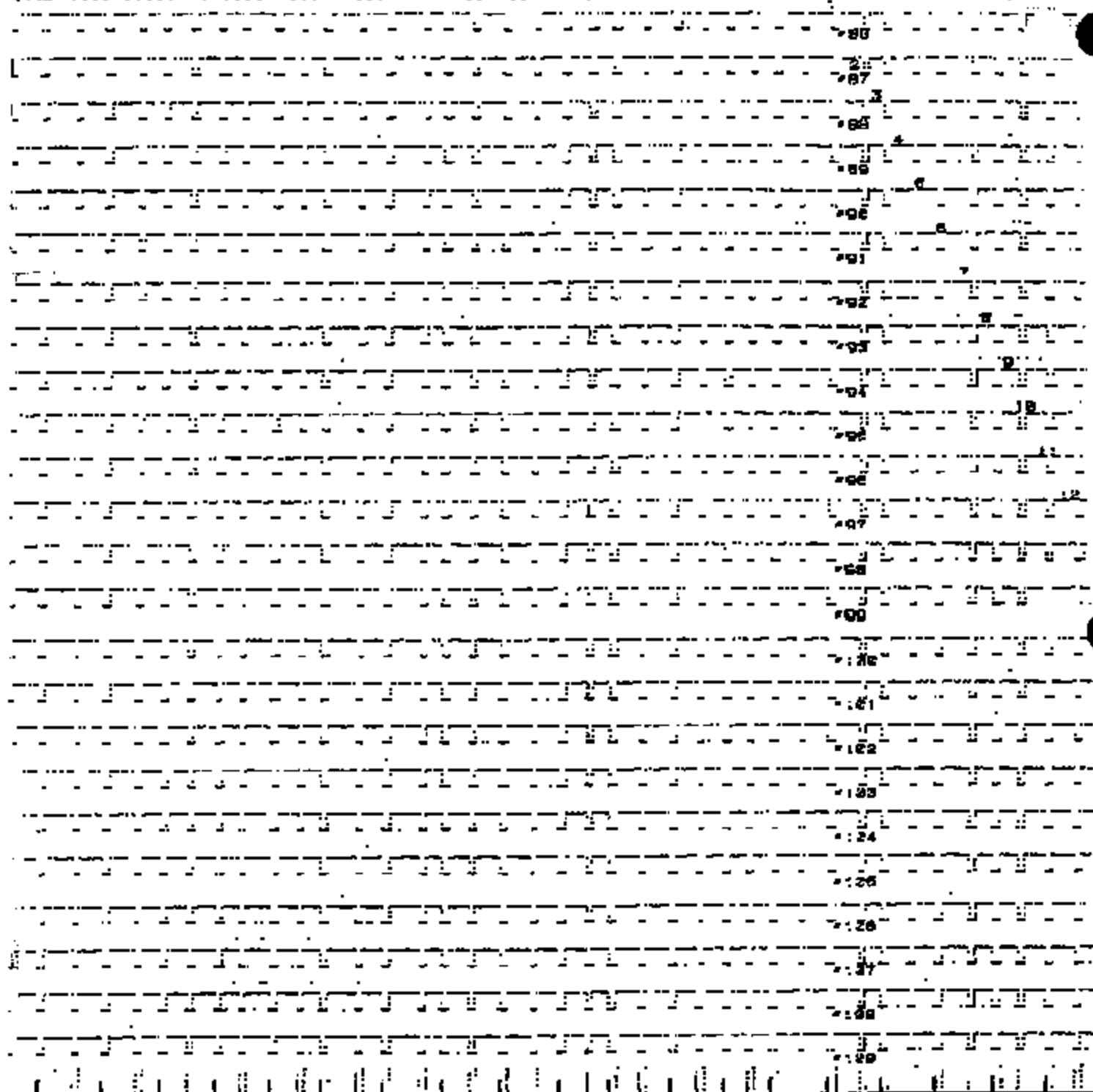
B.O. 8/68

REALTIME RECORDER

13:26:53

31 Dec

App 41 K CYCLES COMP.



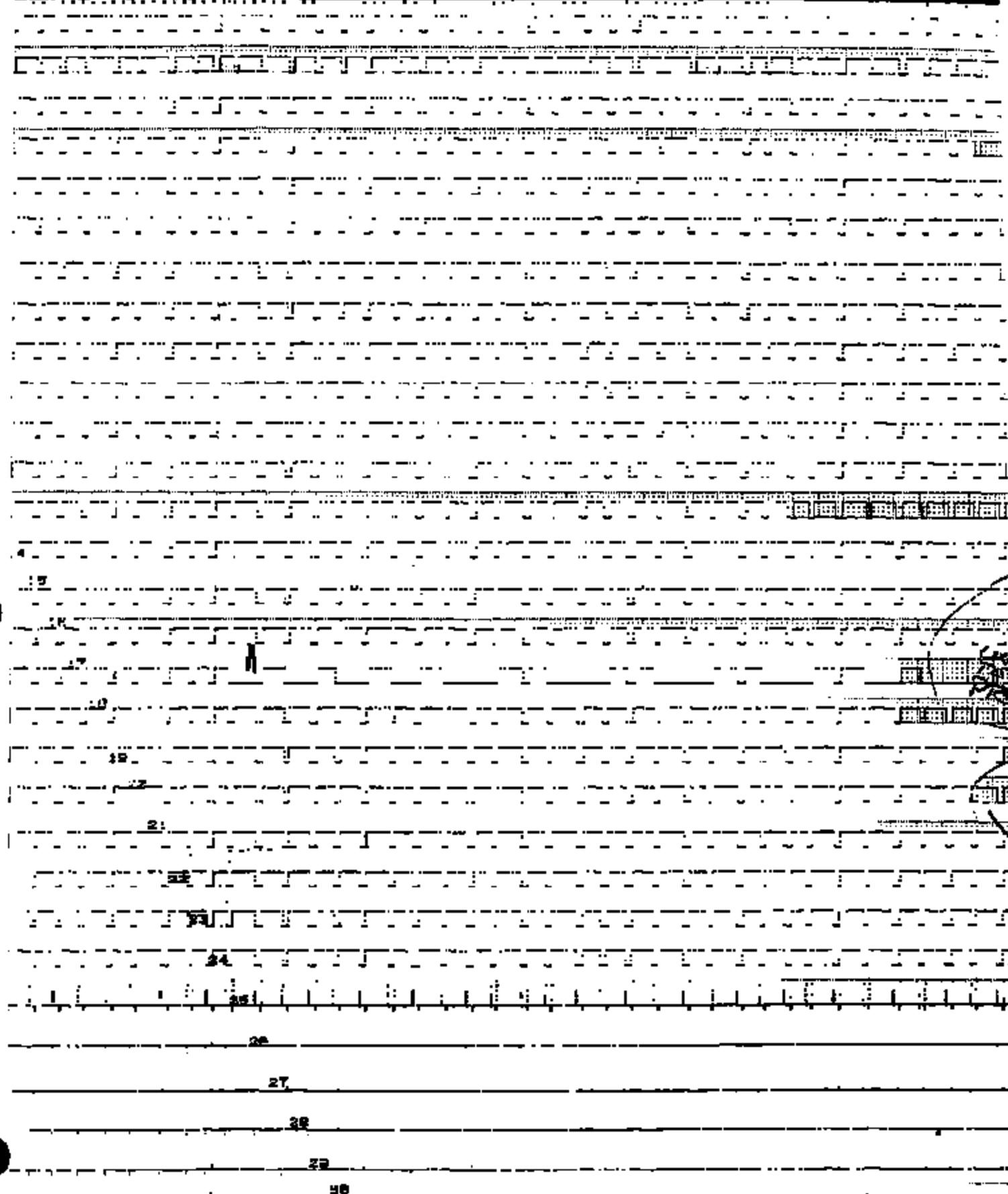
motor current

29

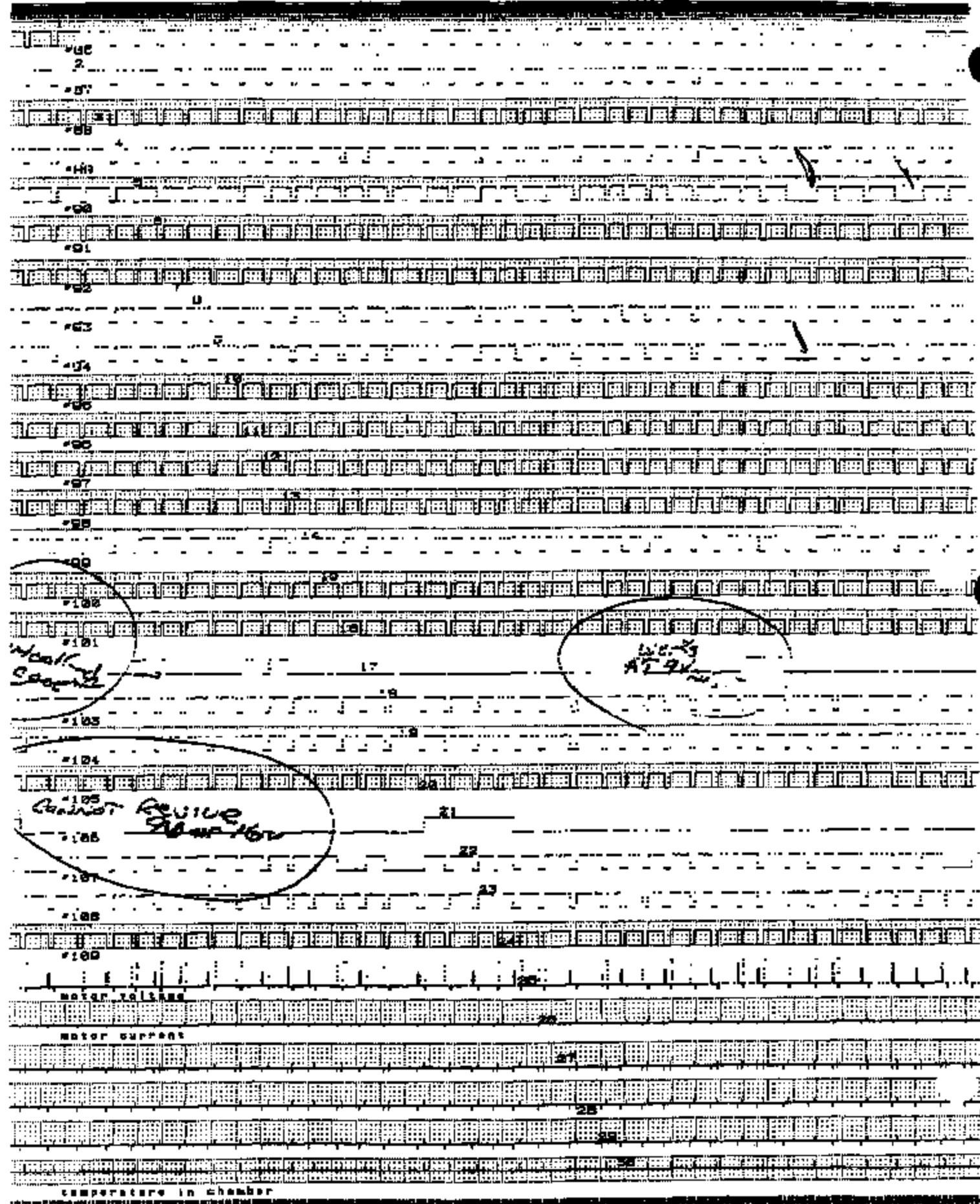
30

temperature in chamber

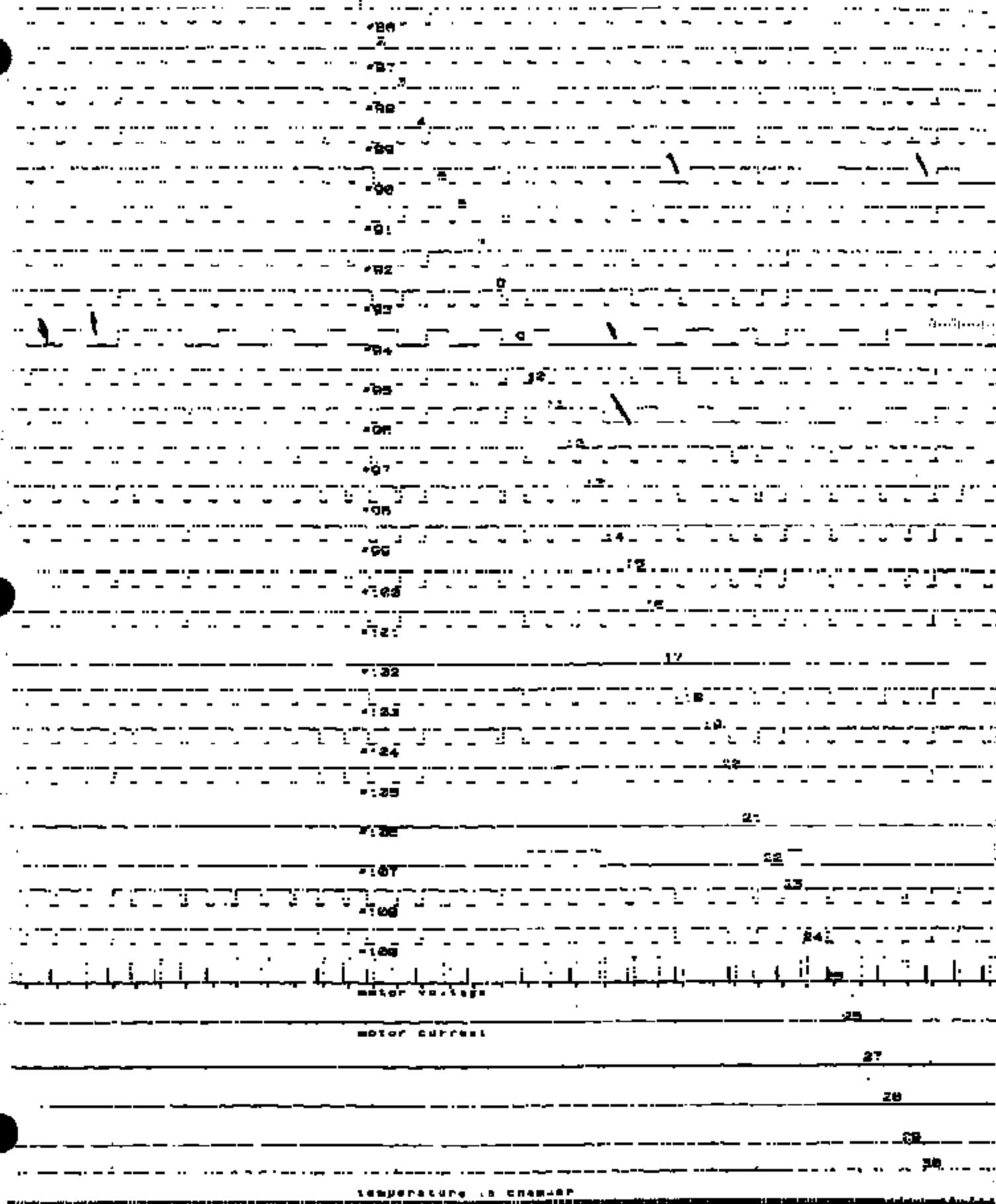
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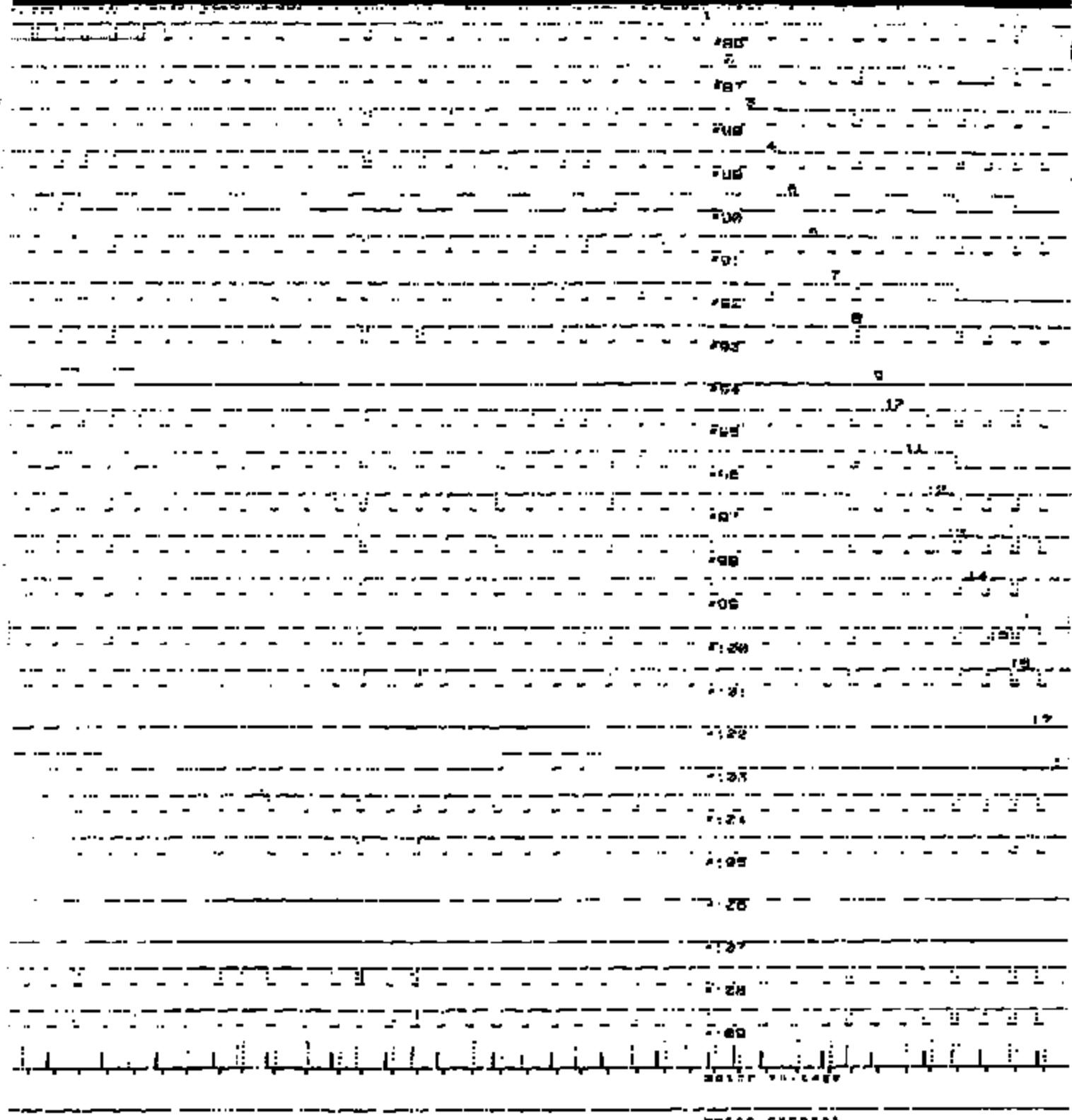


* 13:48:33 31 Dec 98 *SPD: 12 mm/s *TIME SCALE: 5.0 s/mm *REALTIME RECORDER

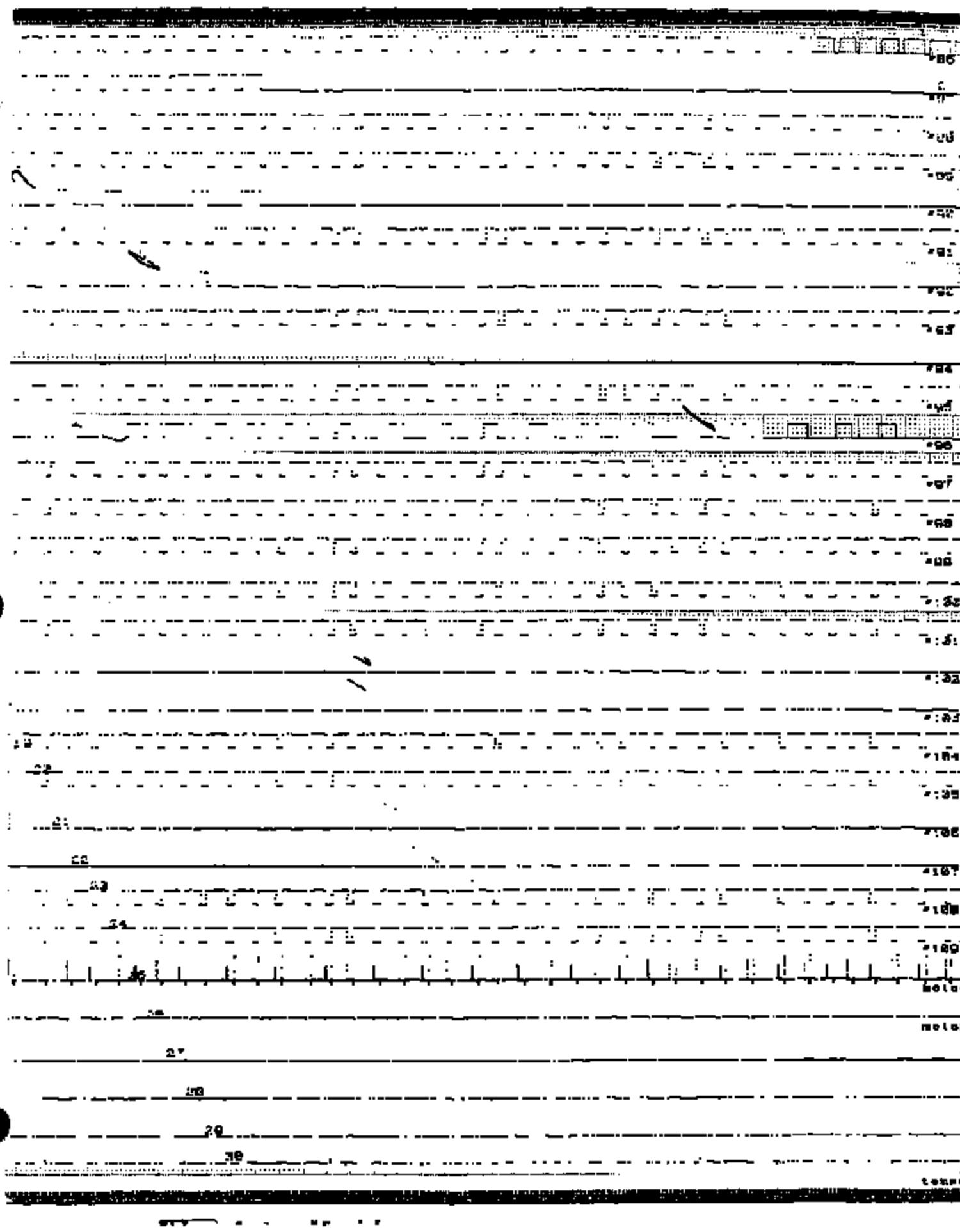


* 14:10:13 31 Dec 96 *SPD: 12 mm/s *TIME SCALE: 5.0

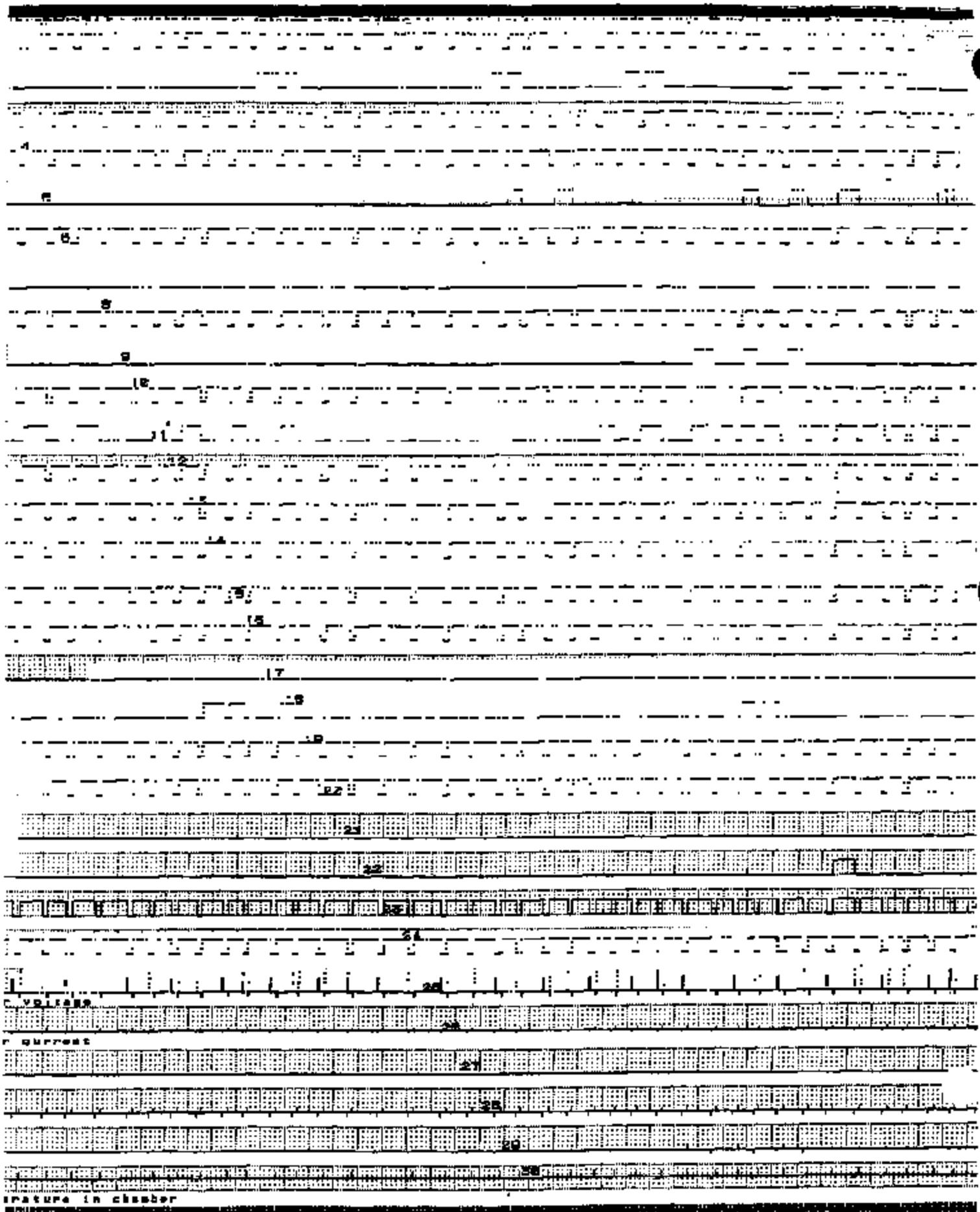




12 sec/s *TIME SCALE: 5.0 sec *REALTIME RECORDER



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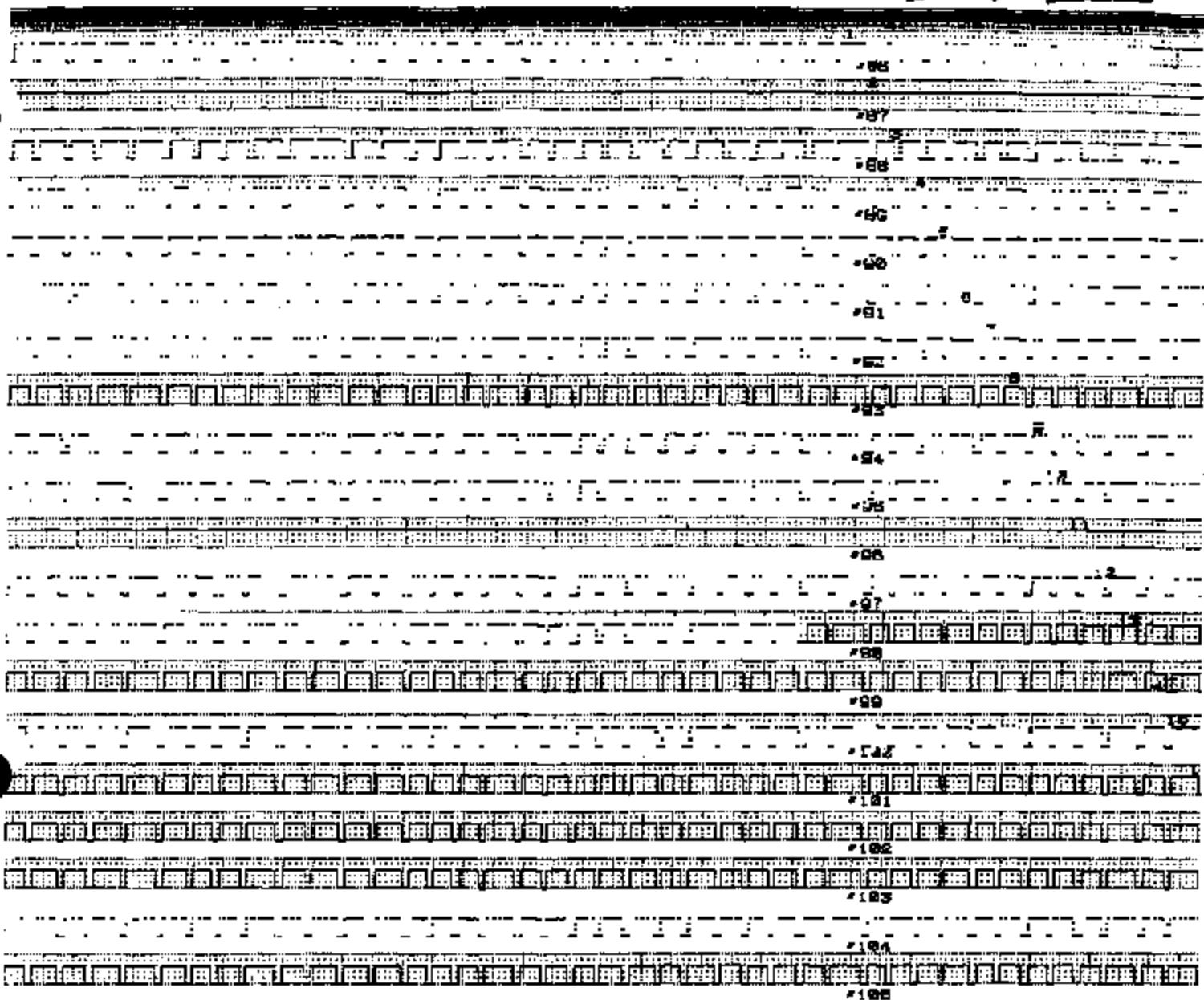


42 - 43 K CYCLES

5.0 8/88 •REALTIME RECORDER

21-43-11

31 Dec 86



every day

longer

UNIT

20

Doubtful

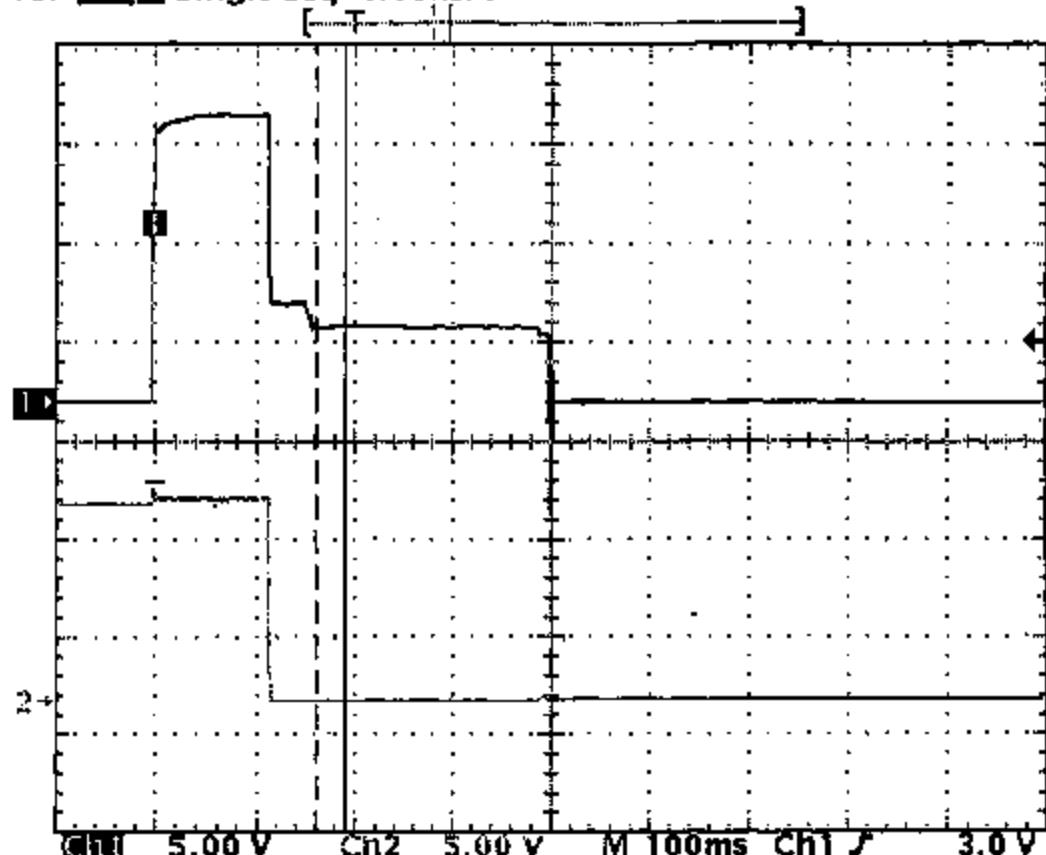
Safe

METER SUPPORT

temperature in chamber

SPD: 12 mm/s TIME SCALE: 5.0 s/mm REALTIME RECORDER

Tek Stop! Single Seq 1.00kS/s

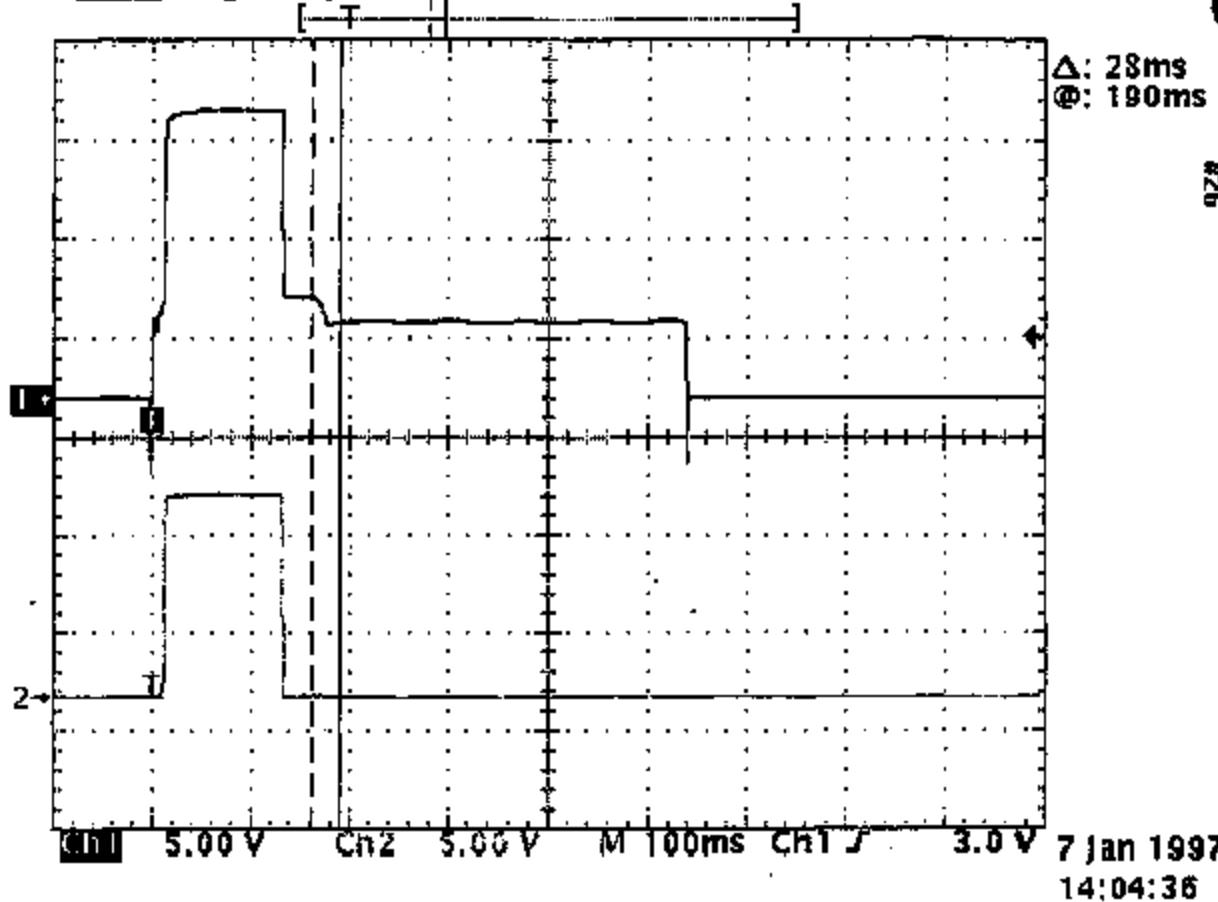


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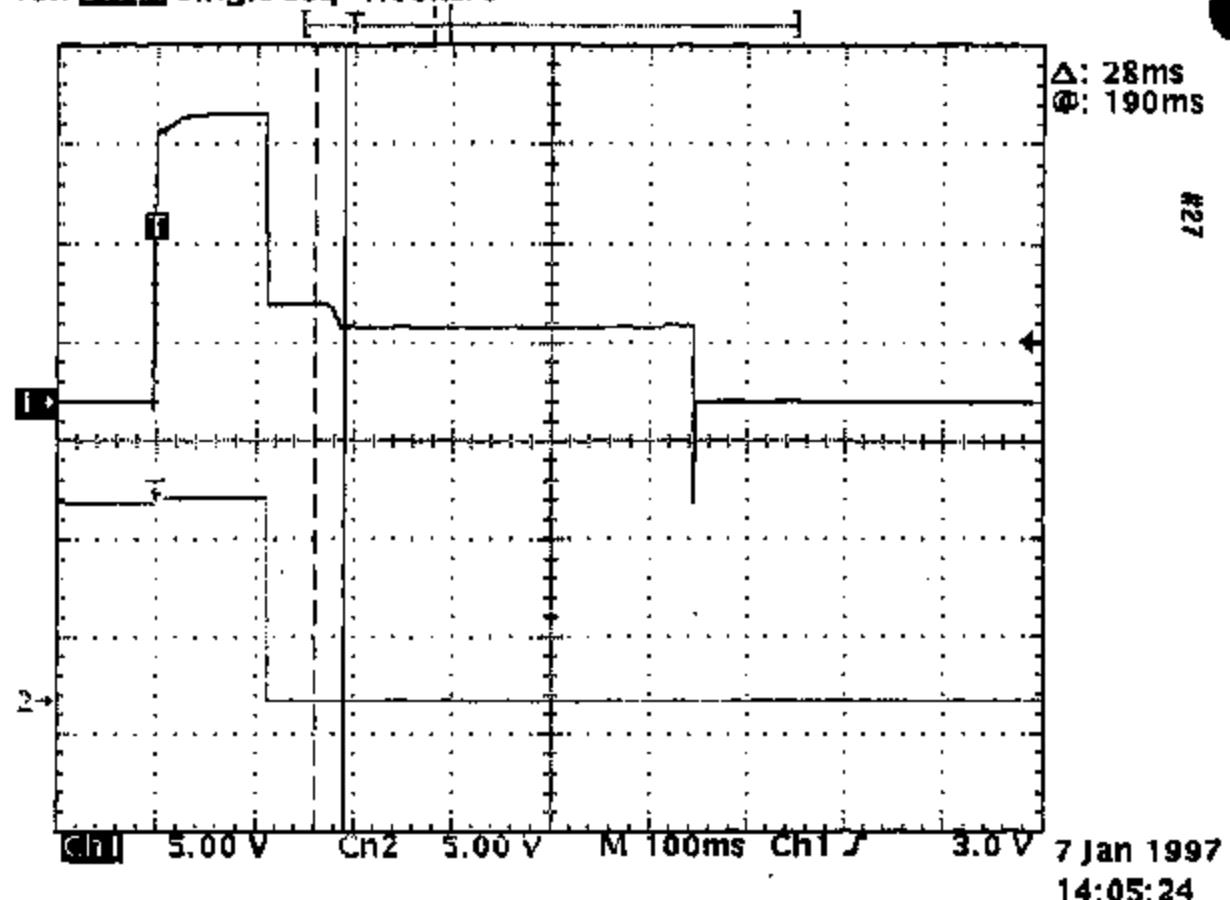
Part # 25

7 Jan 1997
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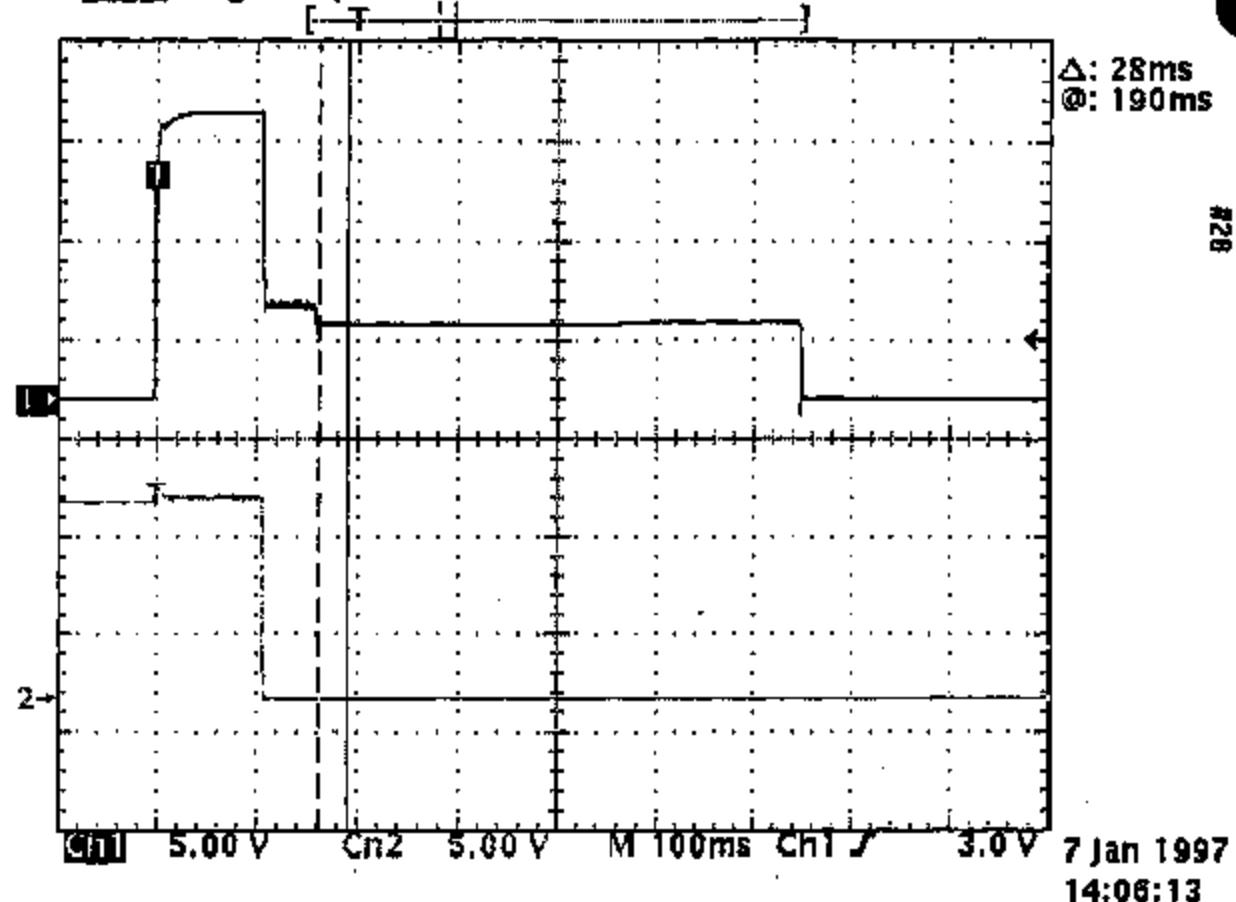
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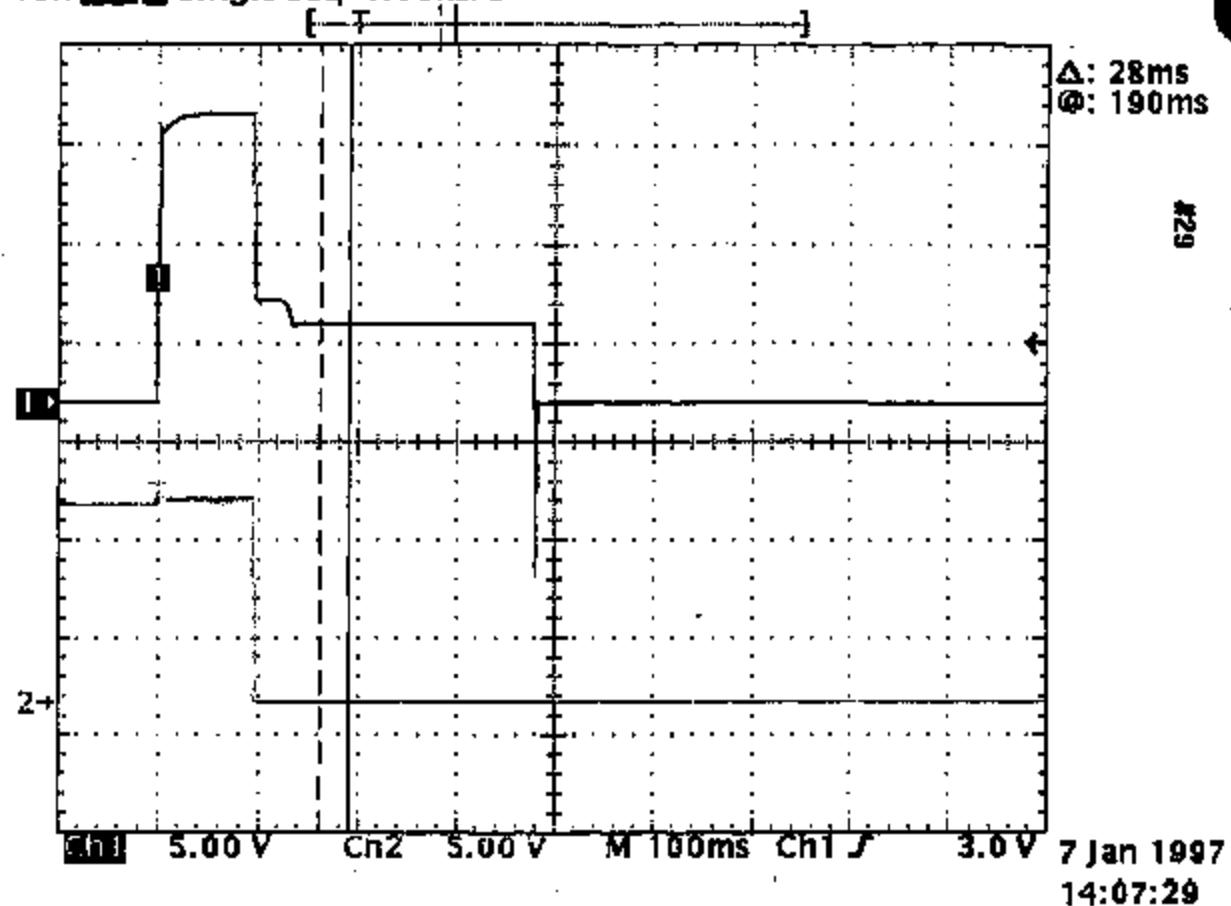
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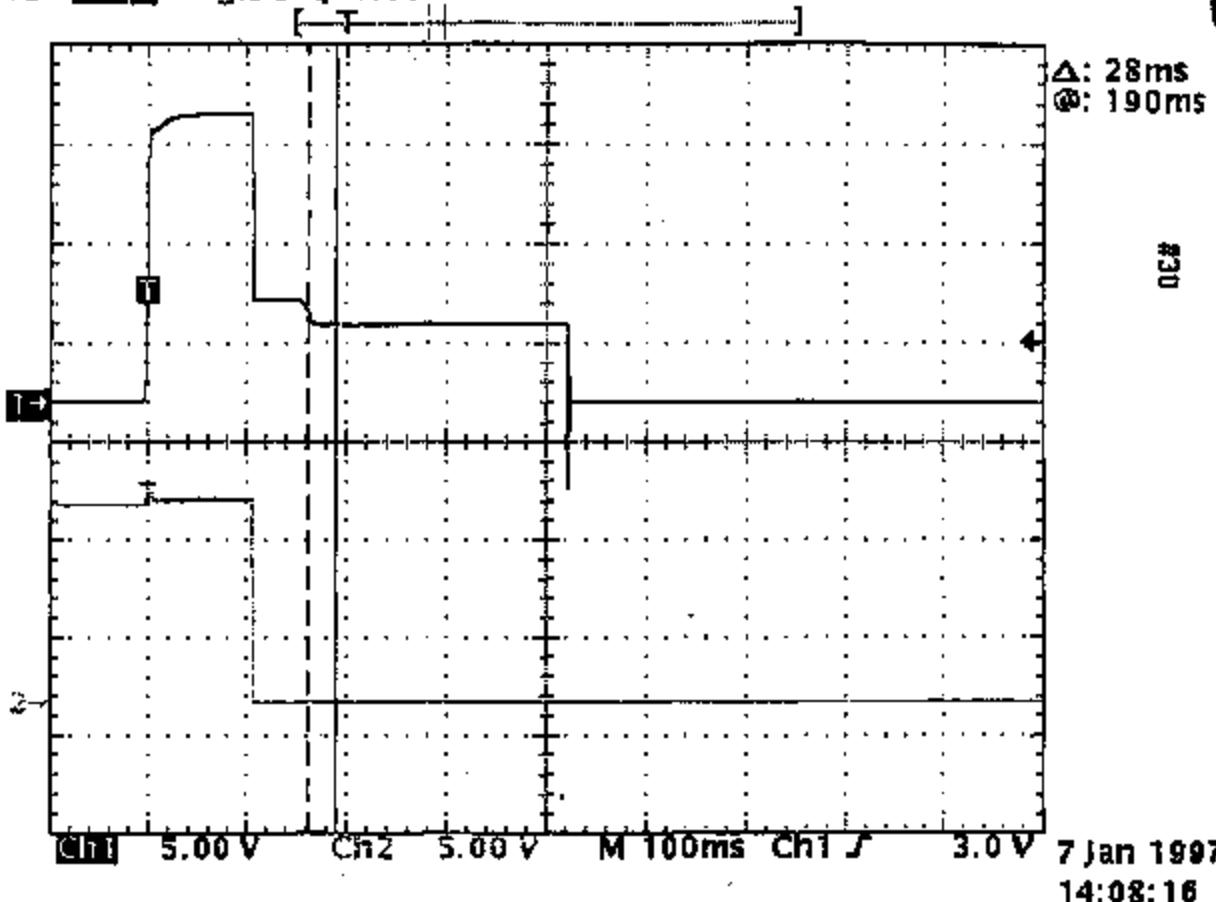
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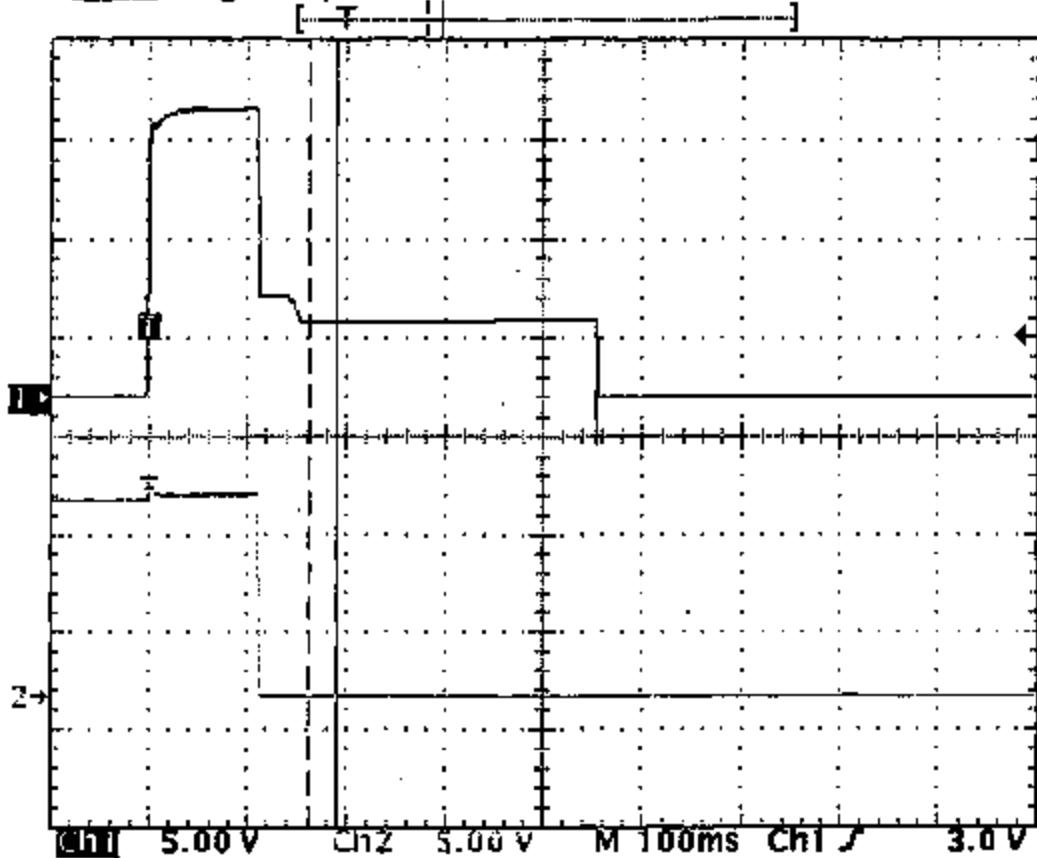
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Tek Stop Single Seq 1.00kS/s



Tek Stop! Single Seq 1.00kS/s

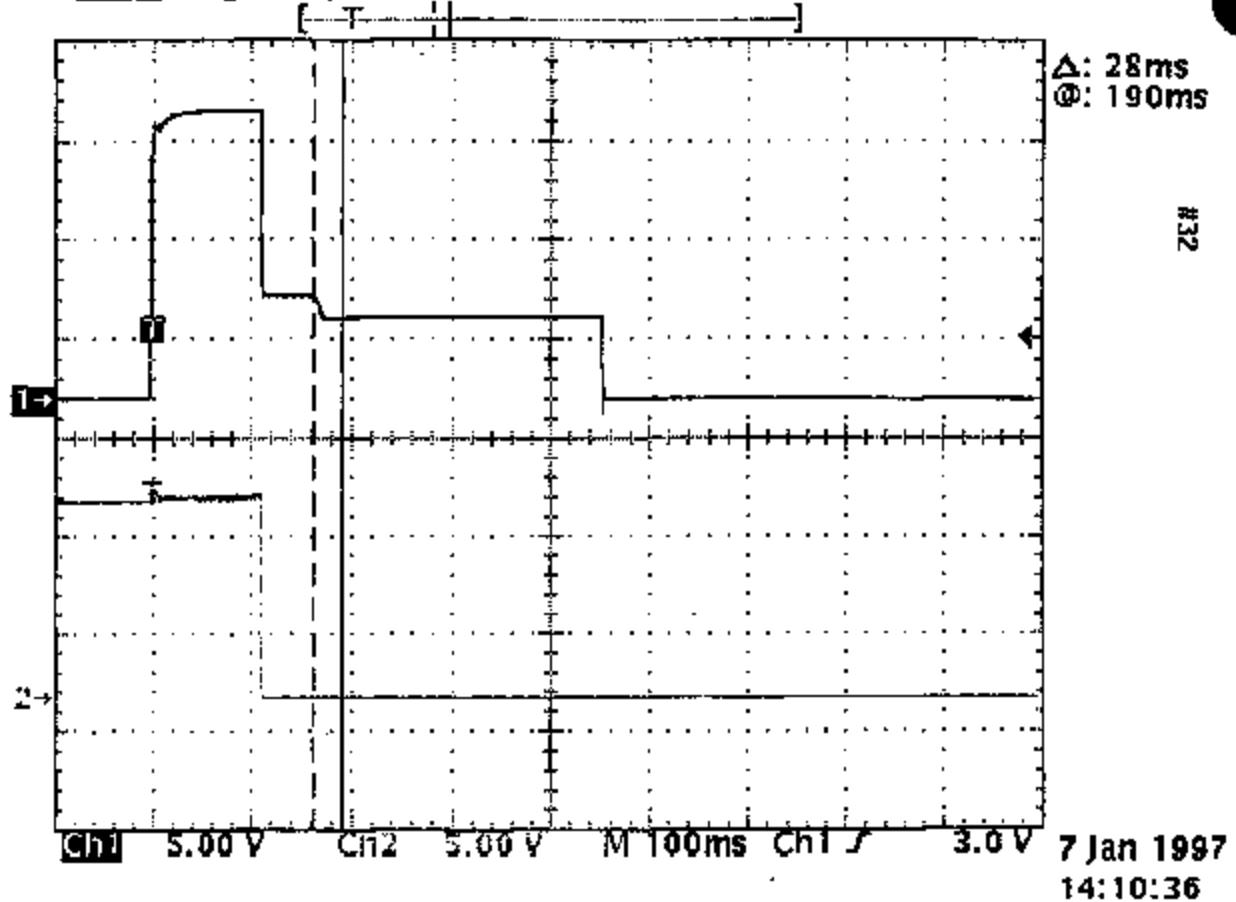


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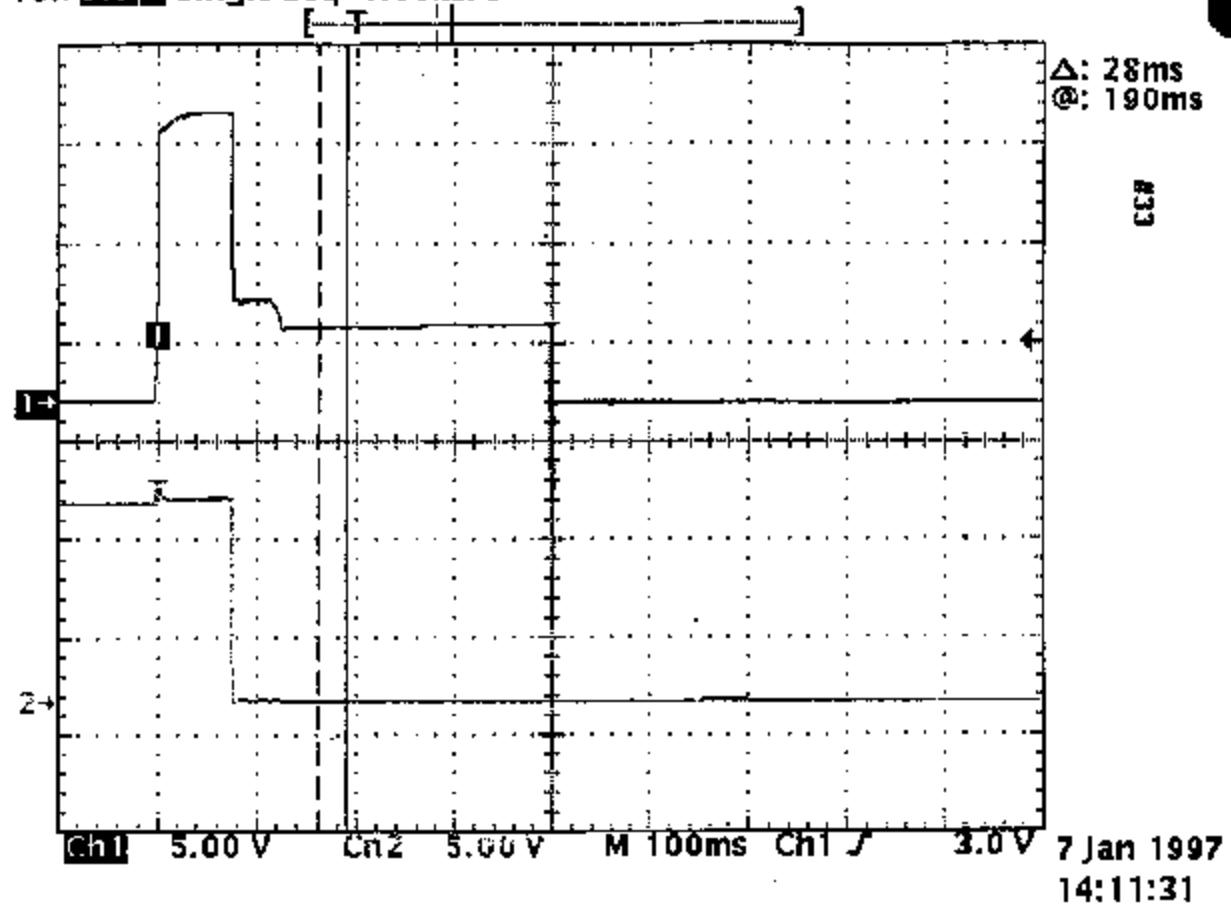
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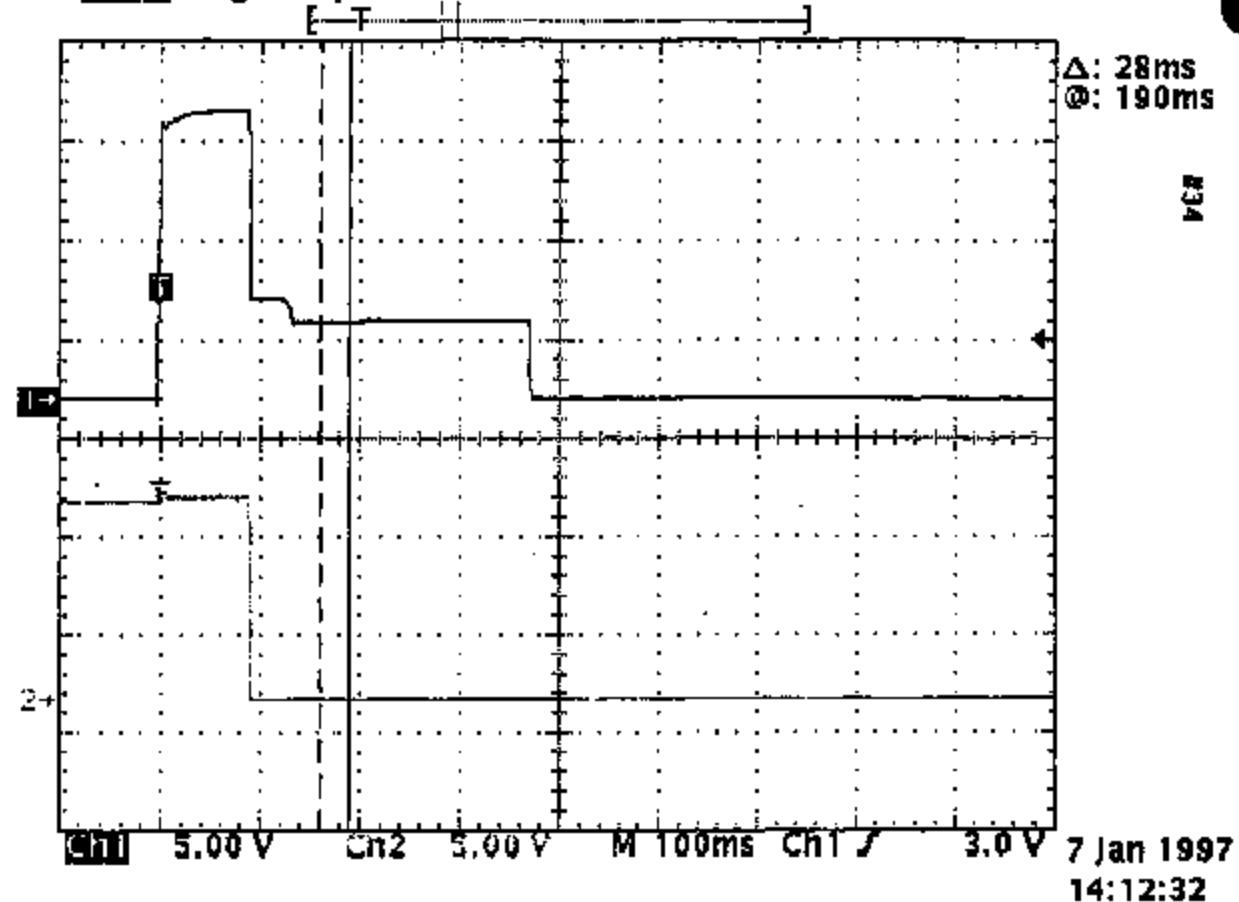
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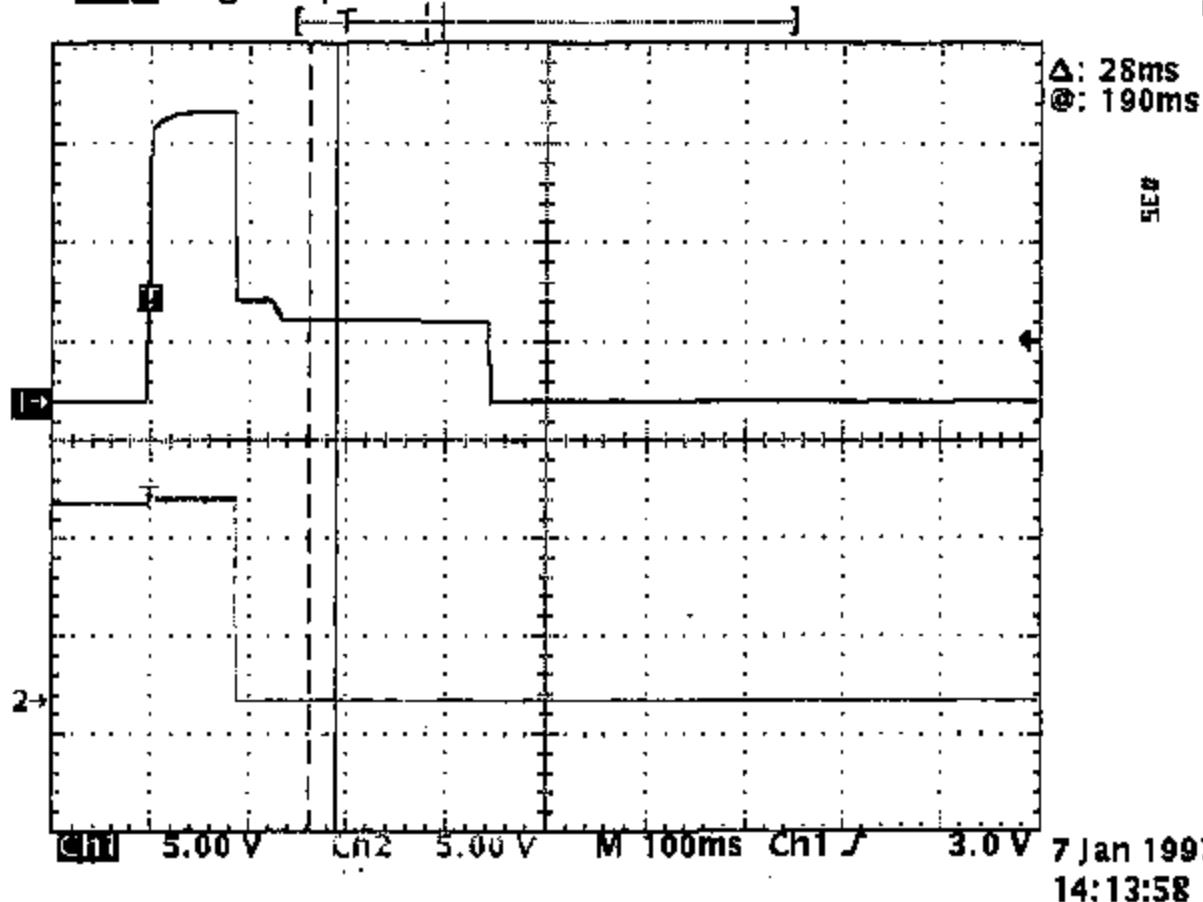
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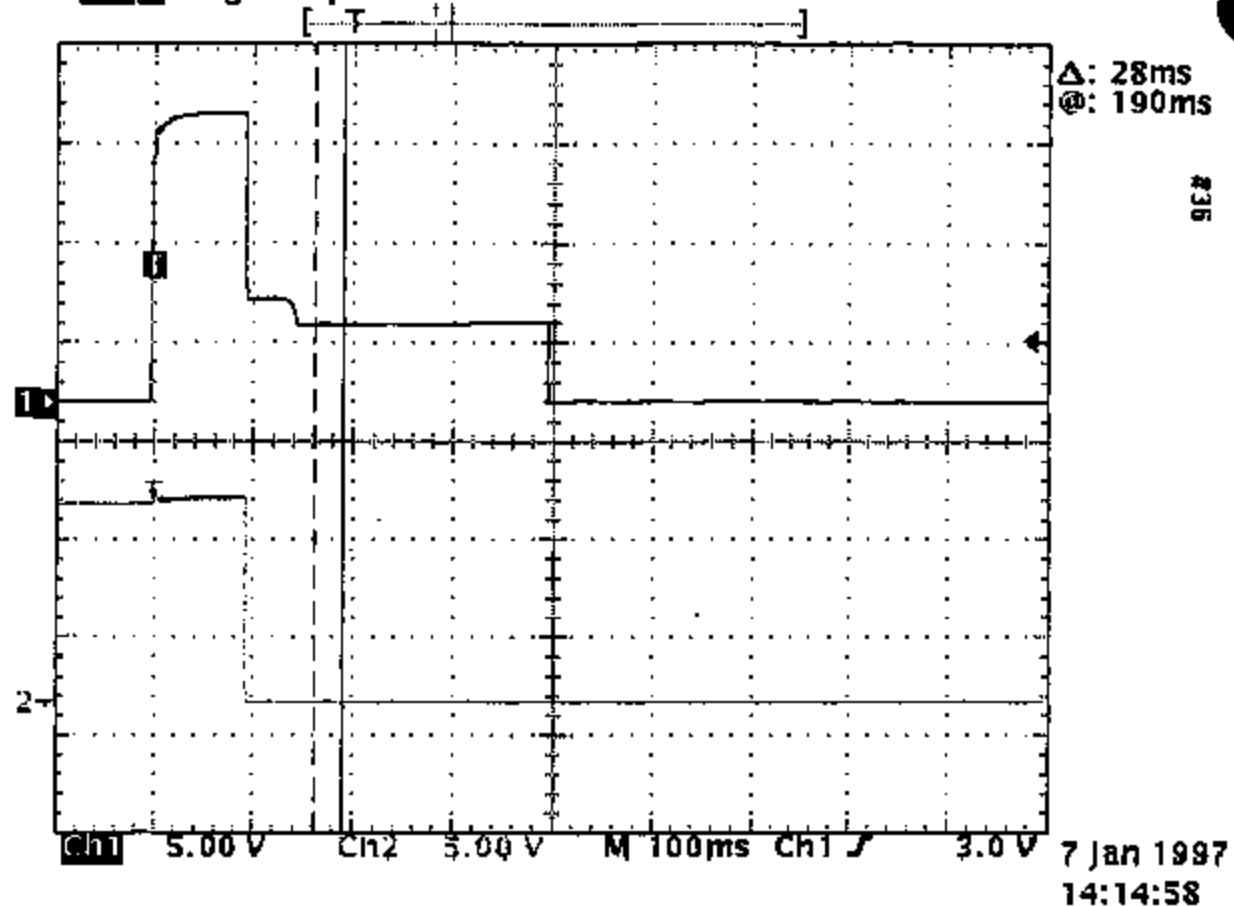
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Tek STOP: Single Seq 1.00kS/s



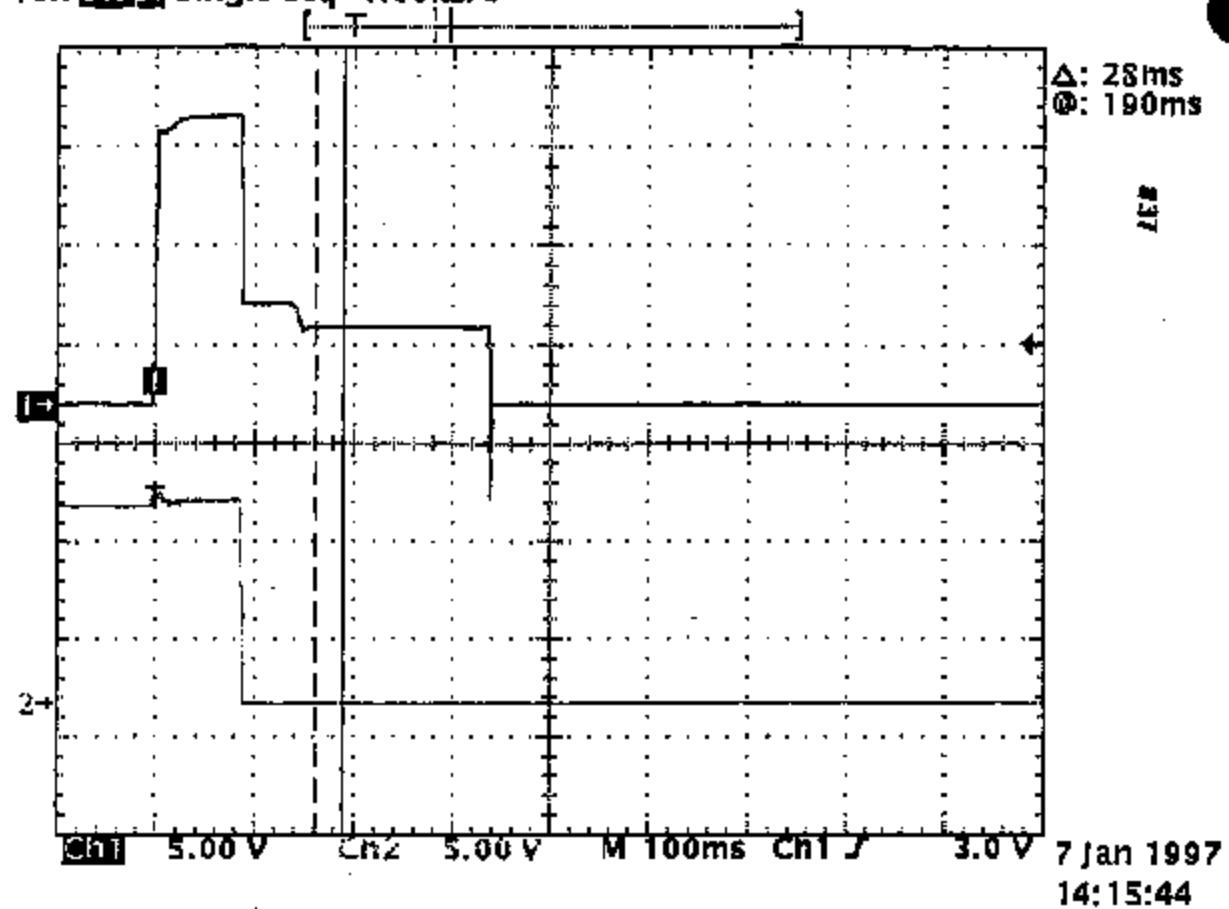
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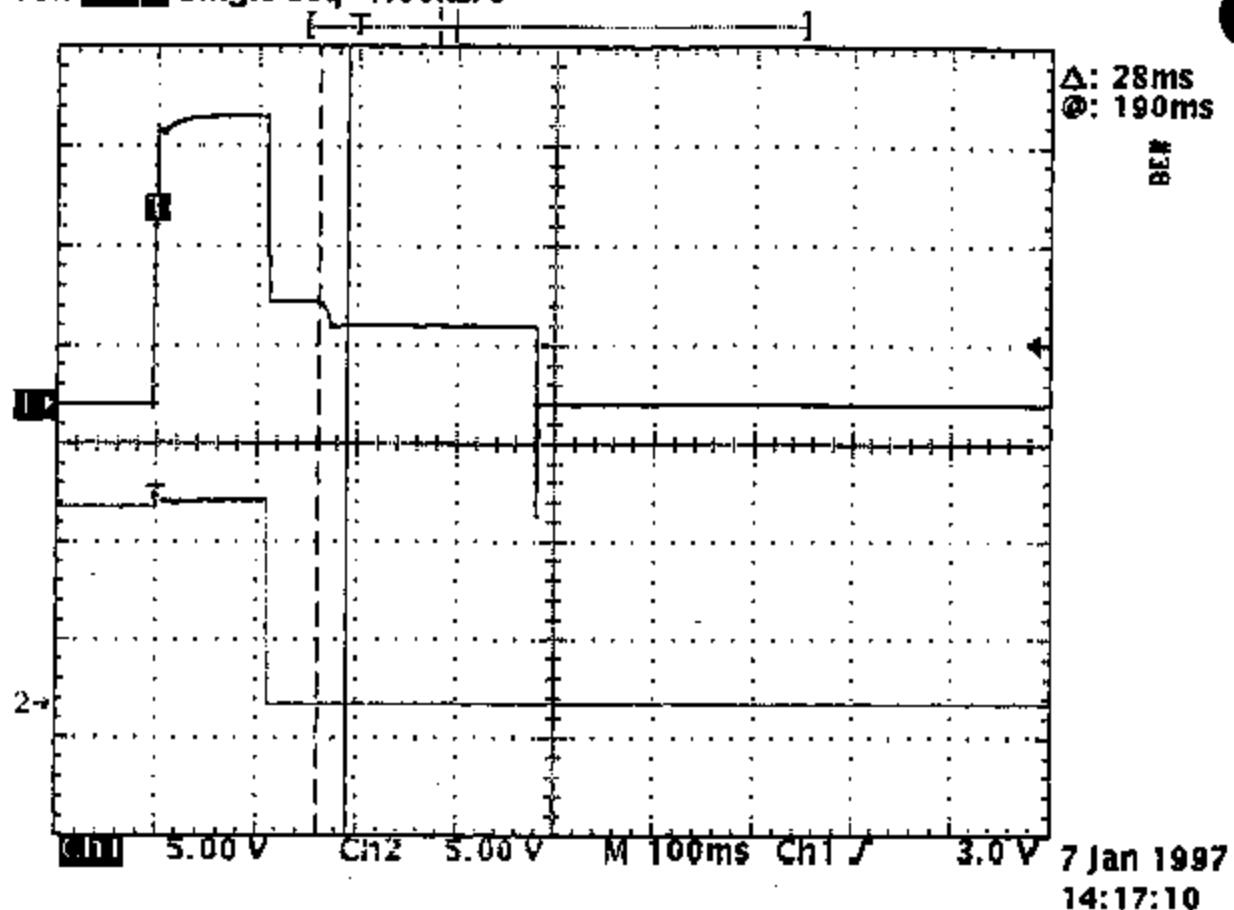
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936

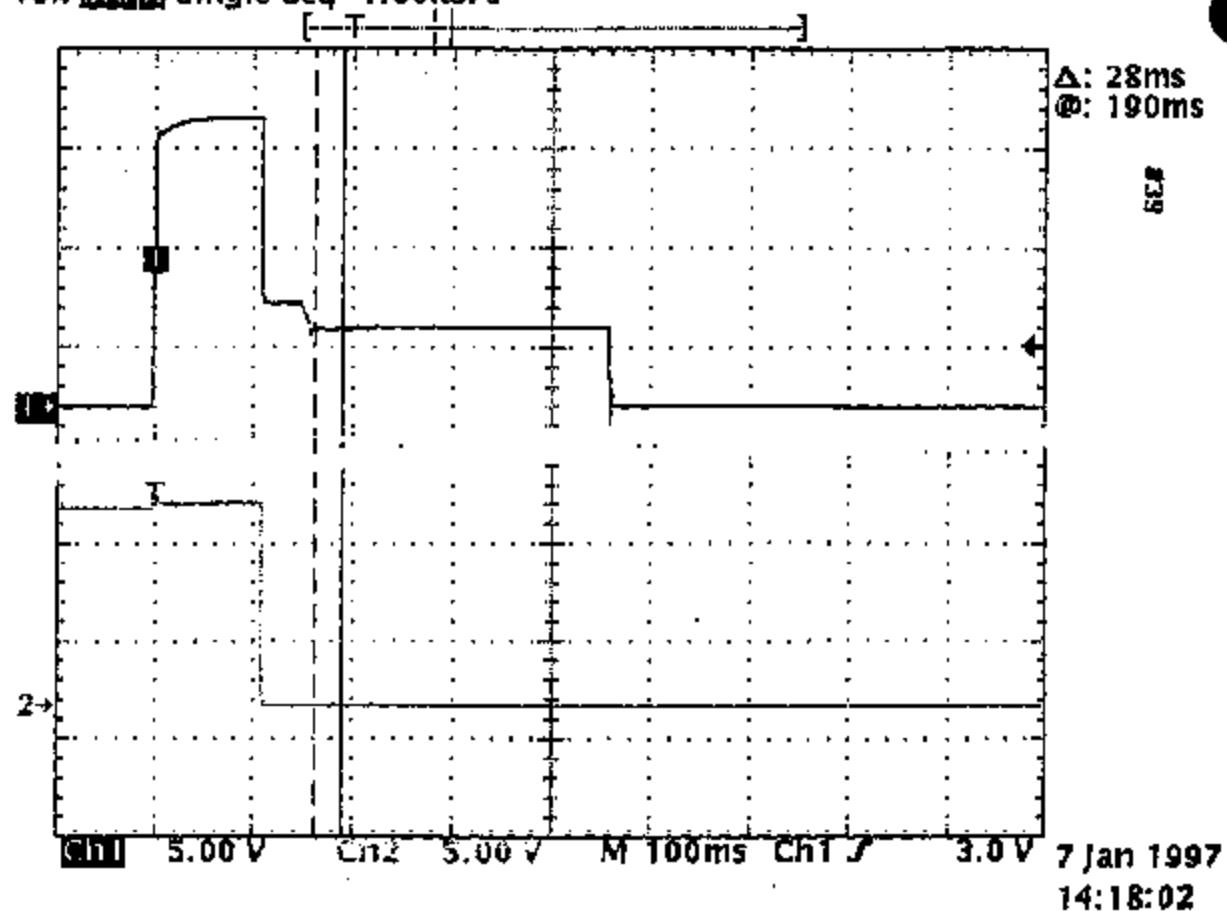
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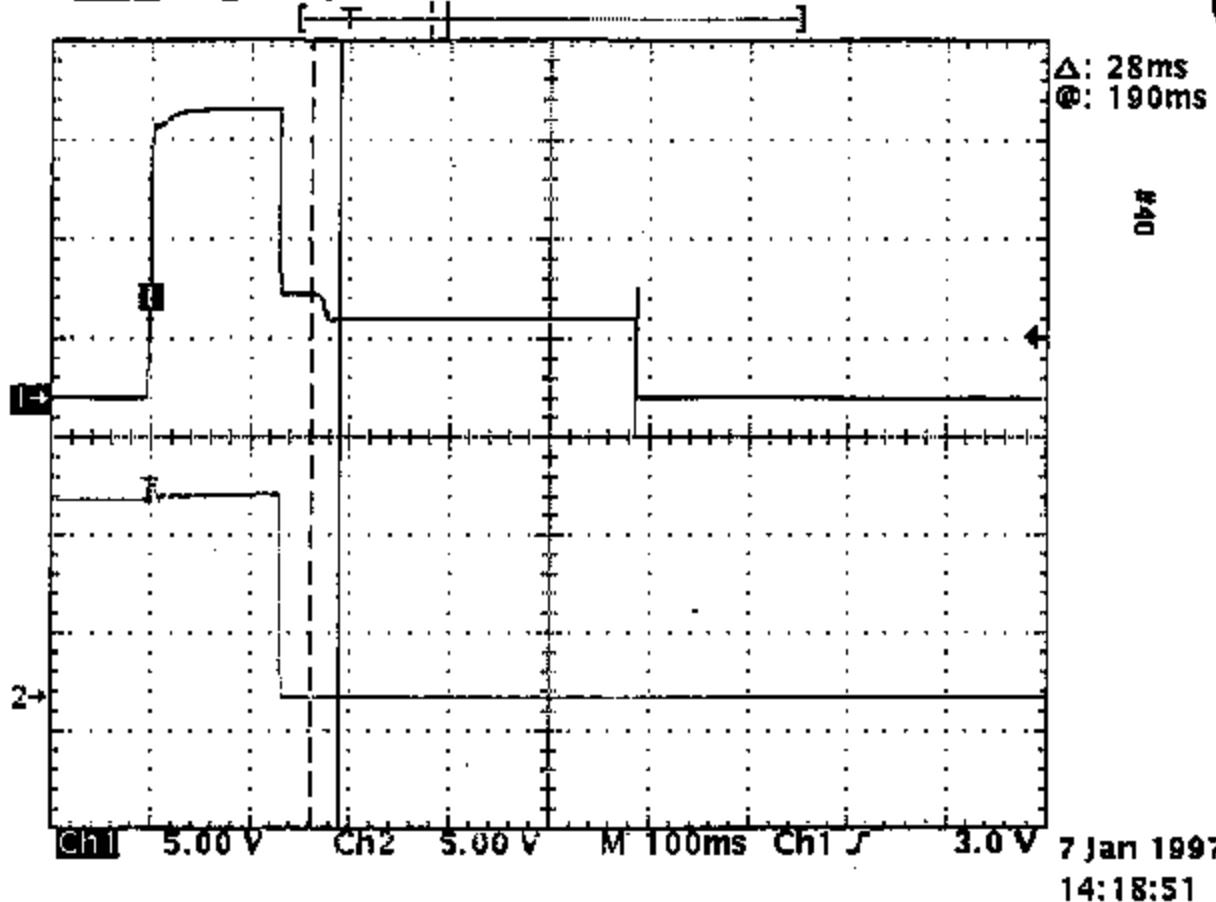
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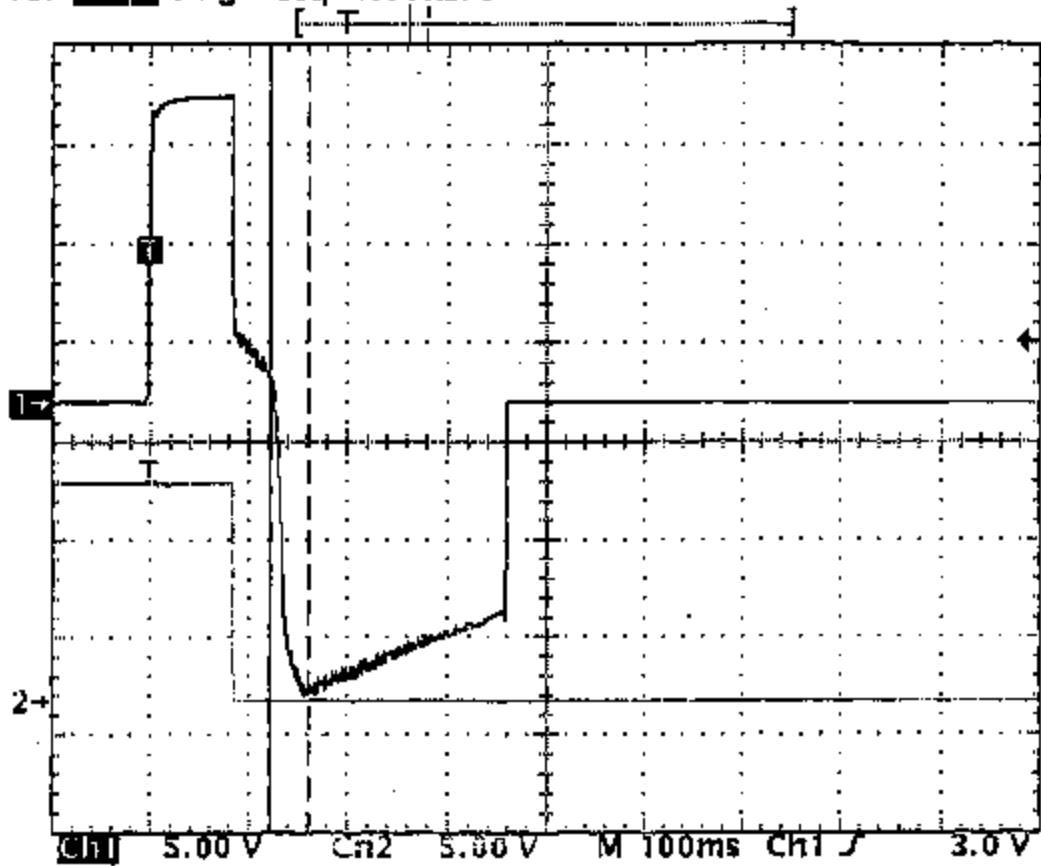
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Tek Stop! Single Seq 1.00kS/s



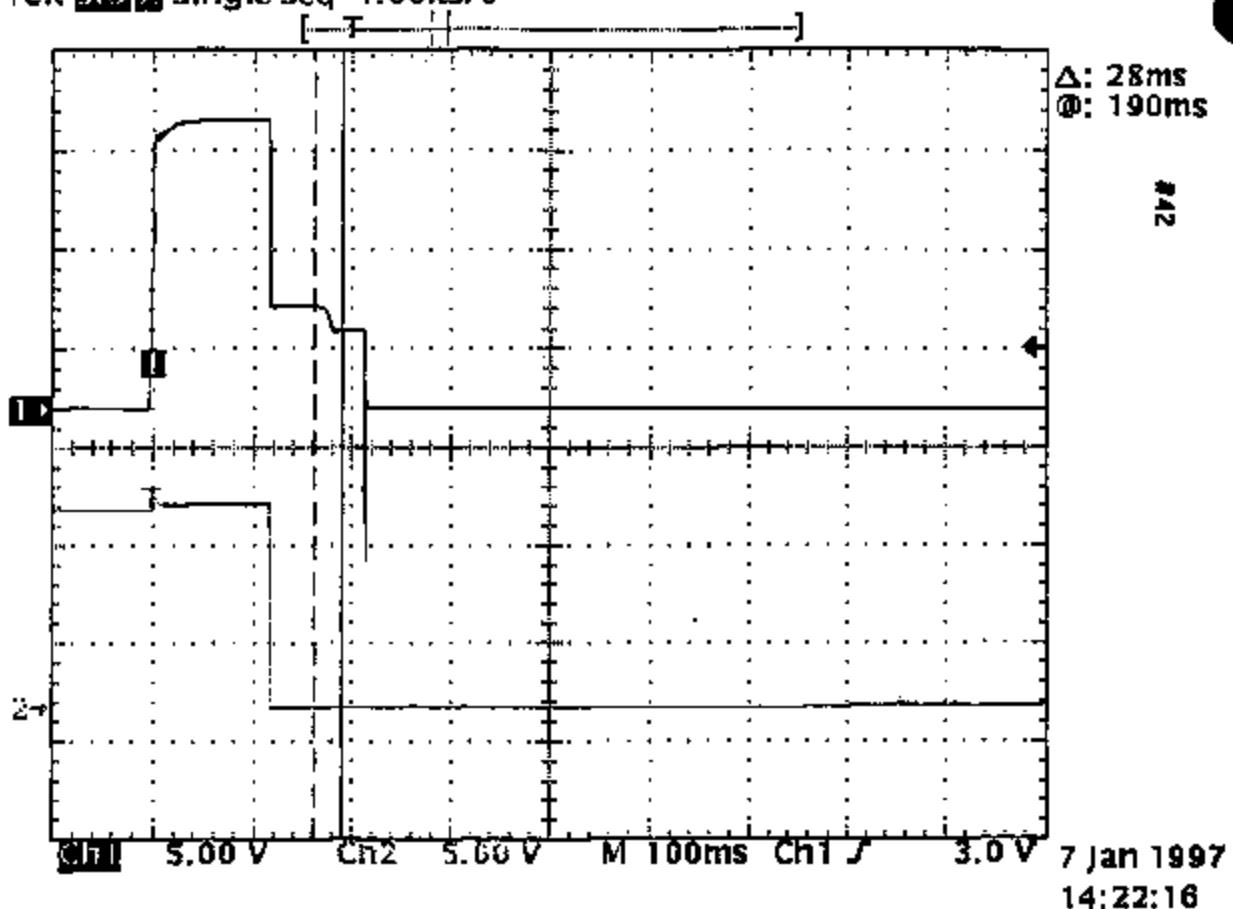
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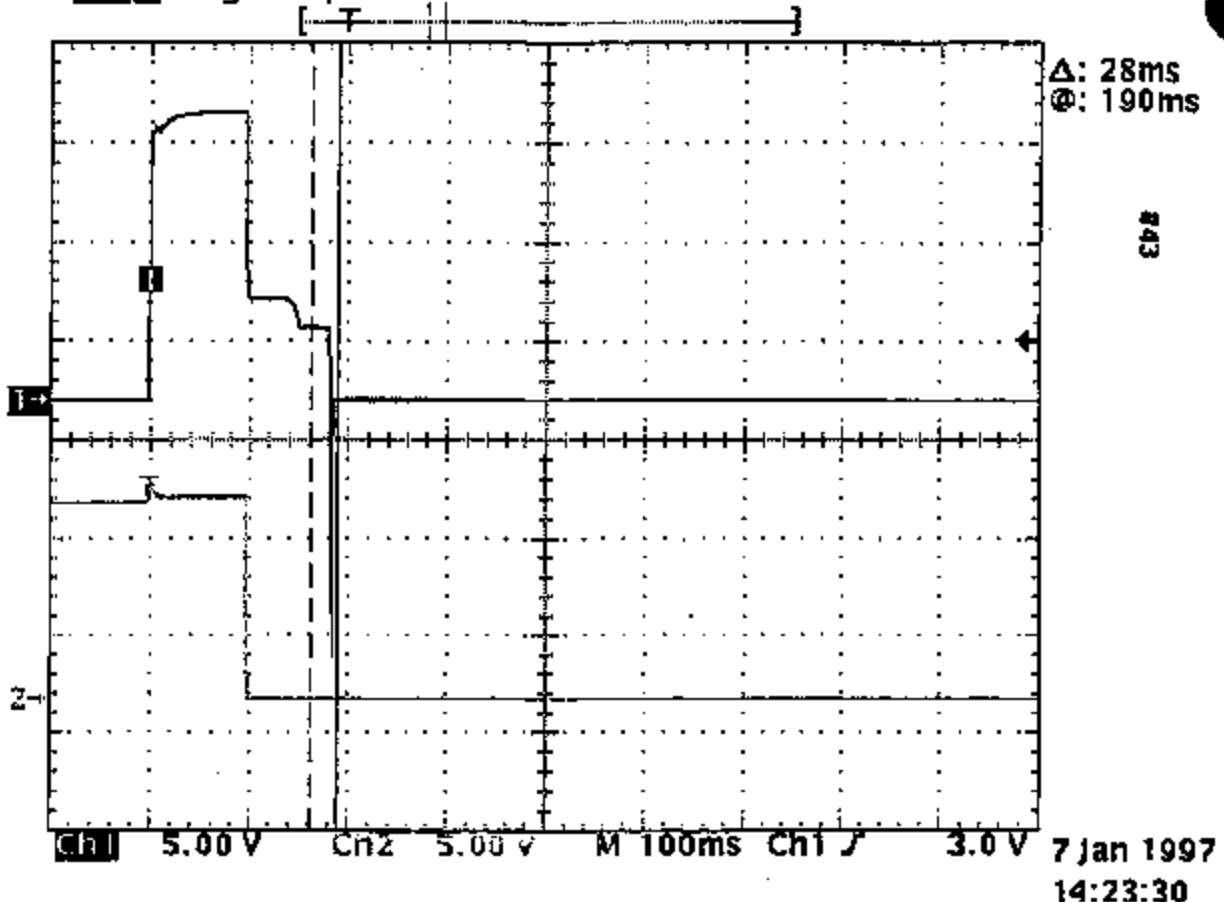
7 Jan 1997
16:24:14

41 ok using Beta
to stop ground

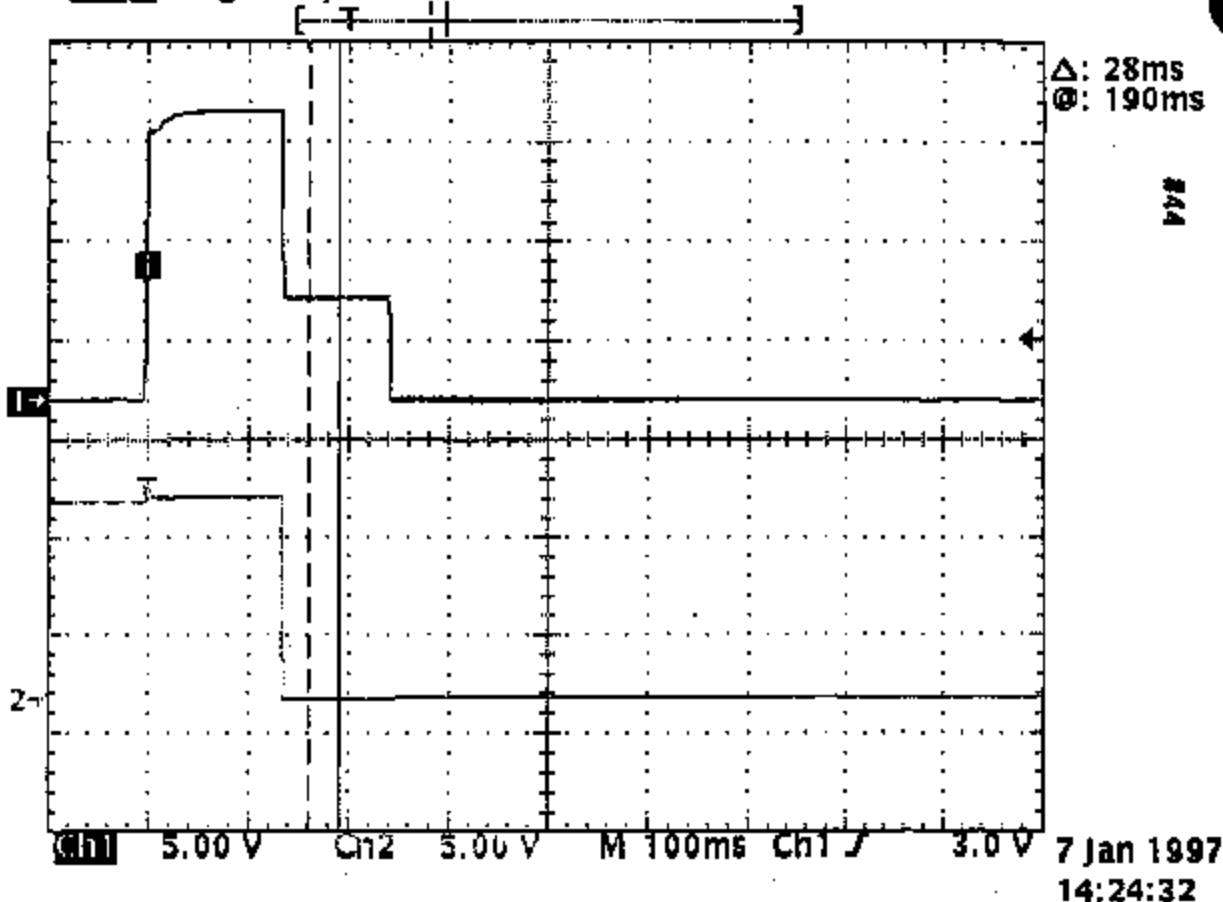
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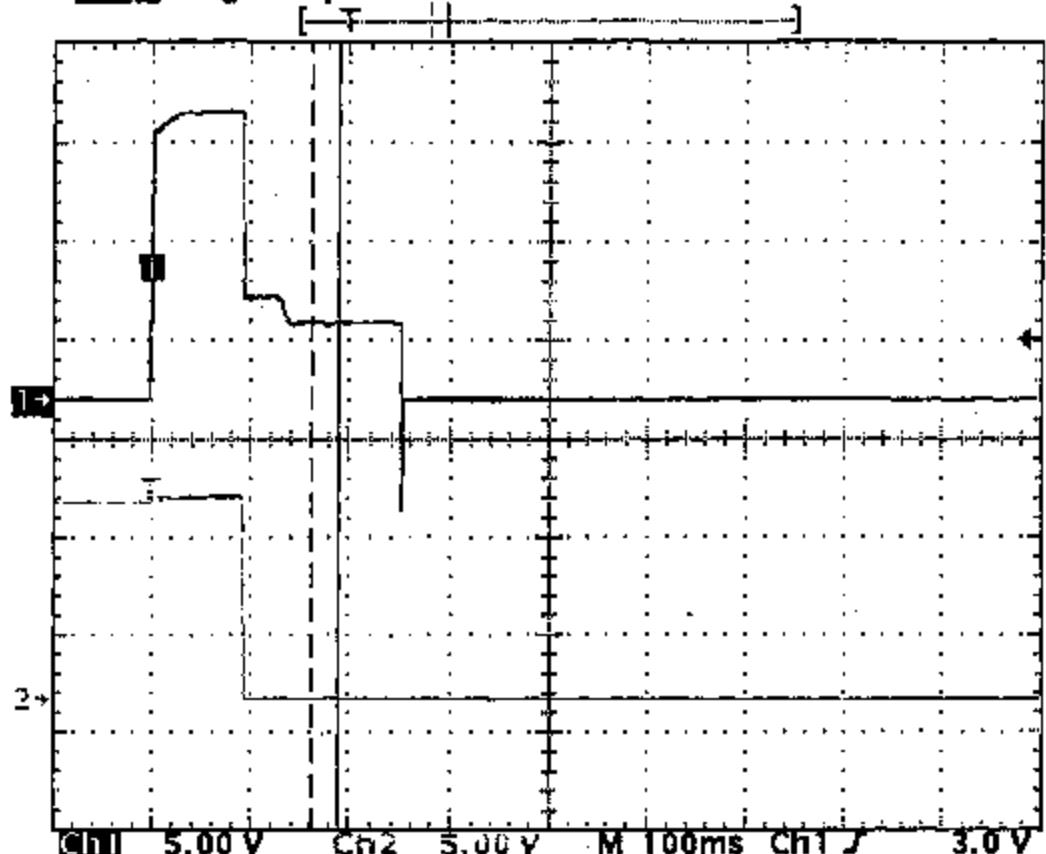
Tek Stop! Single Seq 1.00kS/s



Tek Stop: Single Seq 1.00kS/s

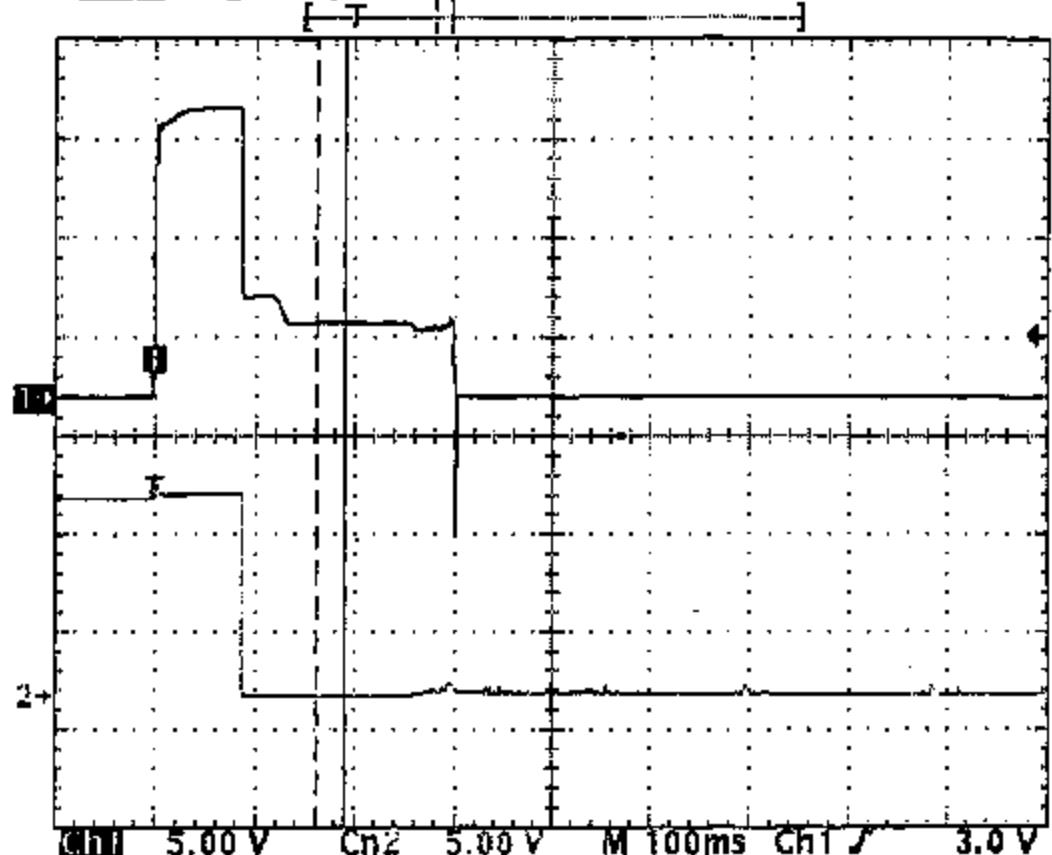


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7 Jan 1997
14:25:28

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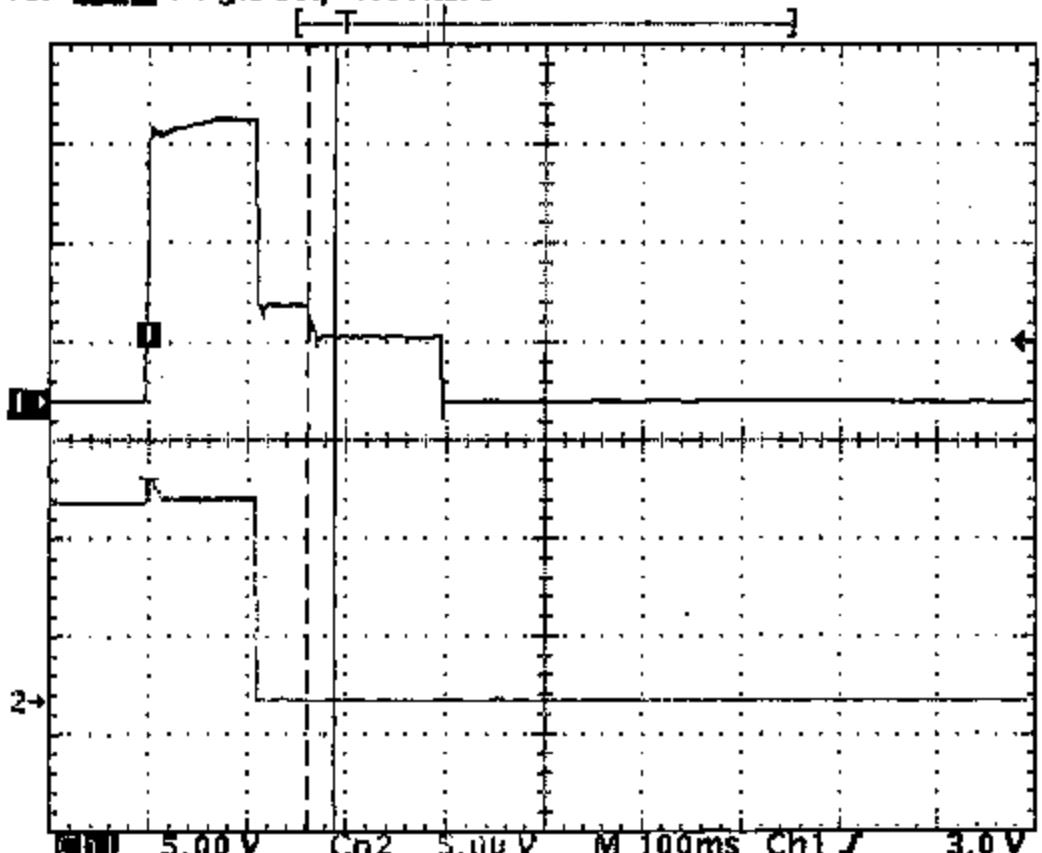


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#46

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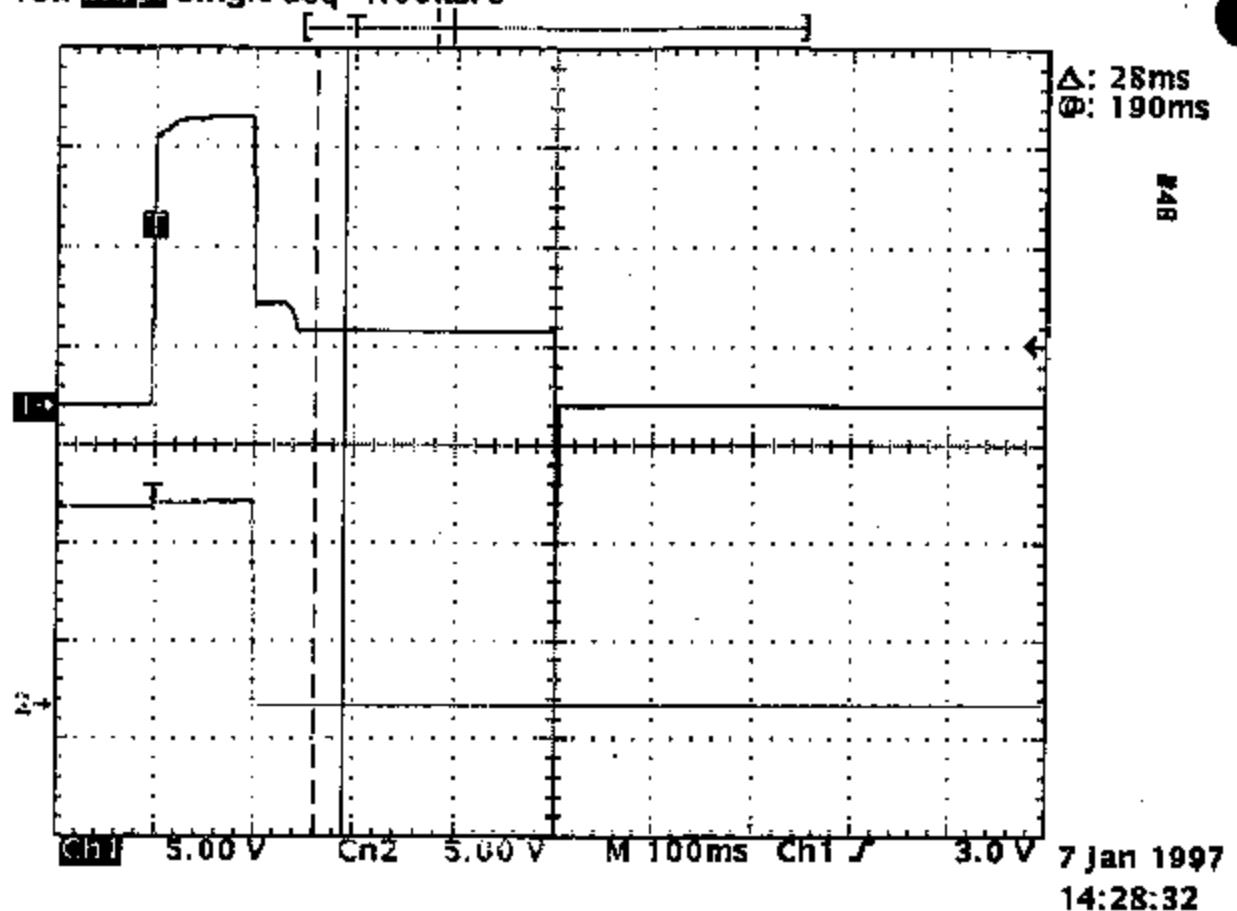


Δ: 28ms
@: 190ms

#7

7 Jan 1997
14:27:43

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Attachment 2G

(Design and Product
Validation Testing -- Ref.
Durability Testing
Attempts.)

SAGINAW COLUMN LOCK ACTUATOR

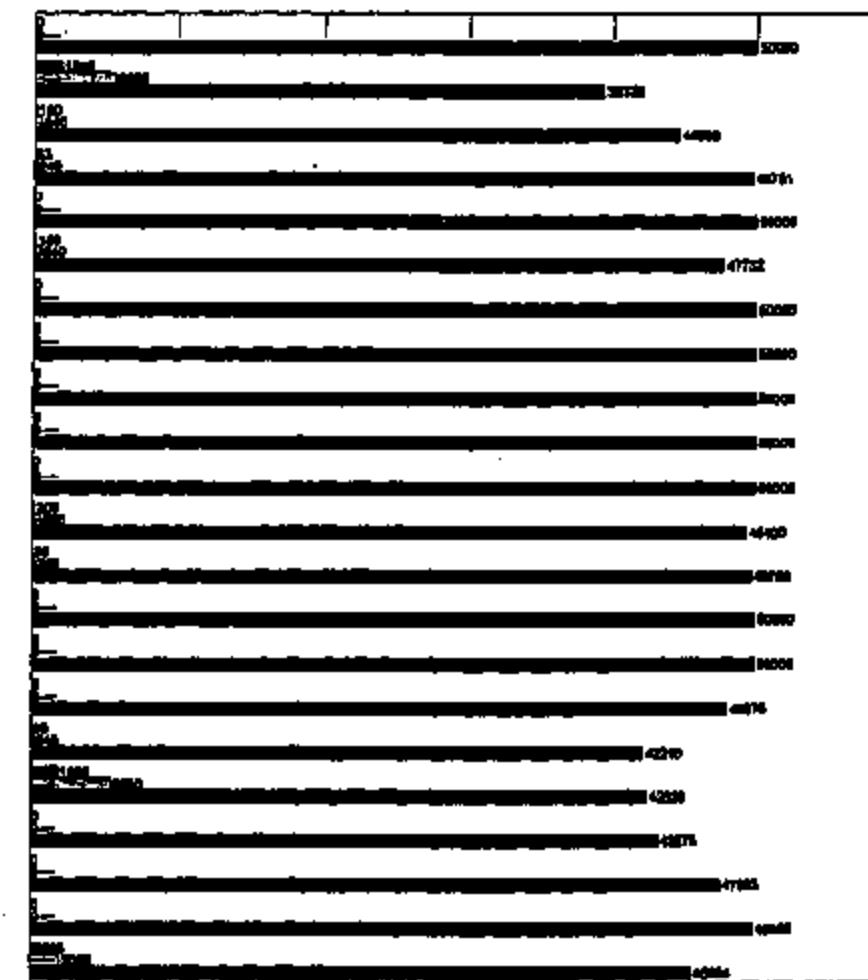
06/02/97

SAGINAW #26050960
FASCO # 1740-0002

DATE	RECENT TESTING UPDATE
06-3/18-97	24 UNITS ON DURABILITY TEST WITH THERMAL A) UNITS WERE CURRENT PRODUCTION EXCEPT FOR: 1) NYLON CARRIERS (MODIFIED) 2) OILLITE BUSHINGS B) 50K CYCLES COMPLETED C) FAILURES RECORDED DUE TO : 1) UNITS "STICKING" IN THE LOCKED DIRECTION AT COLD TEMP. a) FAILURES DUE TO INTERFERENCE BETWEEN HOUSING AND GEAR b) CAUSE - NYLON SHRINKAGE APP .015", PPS APP. .004" 2) UNITS WERE INTERMITTENT a) CAUSE - NYLON SHRINKAGE APP .015", PPS APP. .004" b) INSUFFICIENT MATERIAL TO ACTUATE SWITCH MECHANISM D) ELIMINATED LEADScrew WEAR FAILURES-NO INCIDENCES E) ELIMINATED BEARING FAILURES- NO INCIDENCES
04-9/24-97	24 UNITS ON DURABILITY TEST WITH THERMAL A) UNITS WERE CURRENT PRODUCTION EXCEPT FOR: 1) NYLON CARRIERS (MODIFIED) 2) OILLITE BUSHINGS B) 50K CYCLES COMPLETED C) FAILURES RECORDED DUE TO : UNITS "STICKING" IN THE LOCKED DIRECTION AT COLD TEMP. 2) UNITS WERE INTERMITTENT a) CAUSE - NYLON SHRINKAGE APP .015", PPS APP. .004" b) INSUFFICIENT MATERIAL TO ACTUATE SWITCH MECHANISM D) ELIMINATED LEADScrew WEAR FAILURES-NO INCIDENCES E) ELIMINATED BEARING FAILURES- NO INCIDENCES
03-21-97	6 UNITS ON DURABILITY TEST WITH THERMAL A) UNITS WERE CURRENT PRODUCTION EXCEPT FOR: OILLITE BUSHINGS (PPS CARRIERS) B) 50K CYCLES COMPLETED C) FAILURES RECORDED DUE TO : WORN LEADScrews
01-13/2-6/97	24 UNITS ON DURABILITY TEST WITH THERMAL A) UNITS WERE CURRENT PRODUCTION EXCEPT FOR: 1) NYLON BUSHINGS 2) PTFE TEFLON ON LOCKBOLTS 3) NO LUBRICANT ON THE SWITCH B) 50K CYCLES COMPLETED C) FAILURES RECORDED DUE TO : 1) WORN LEADScrews 2) UNITS "STICKING" AT VARIOUS TEMPERATURES CAUSE - INCREASED AXIAL MOVEMENT IN THE LEADScrew DUE TO NYLON BUSHING DEFORMATION. (PROTOTYPE BUSHINGS IN CURRENT PRODUCTION HOUSING)

COLUMN LOCK ACTUATOR
DURABILITY TEST 1022087

Thousands

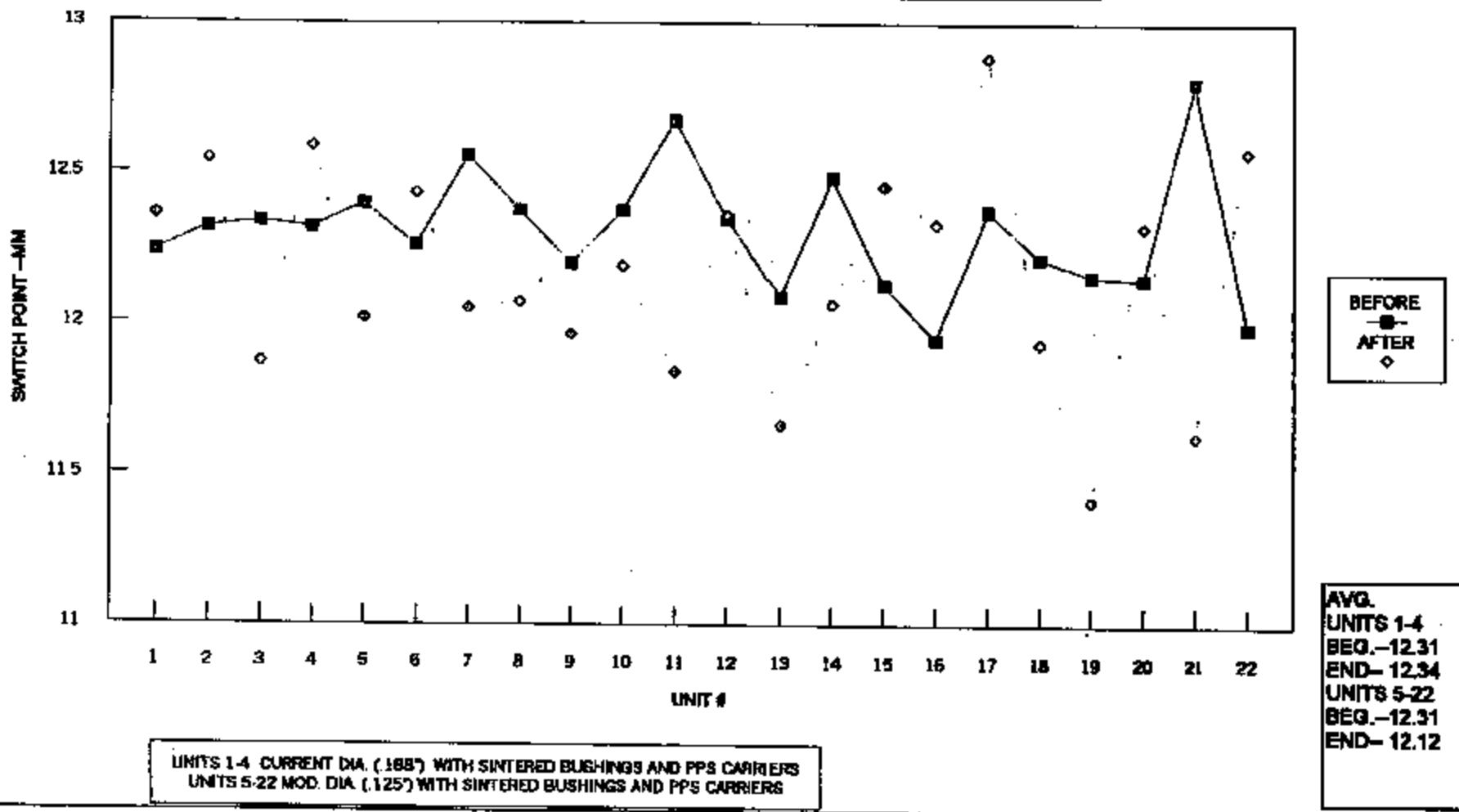


- MIN/1000 HOURS
- CYCLES HOURS
- ACTUAL CYCLES COMP.

UNITS 1-4 WITH .700" O.D. WITH CENTERED SLEEVE
UNITS 5-22 WITH .125" O.D. WITH CENTERED SLEEVE

SAGINAW COLUMN LOCK ACTUATOR #26050960

DURABILITY TEST COMP. 10/27/87—SWITCH POINT



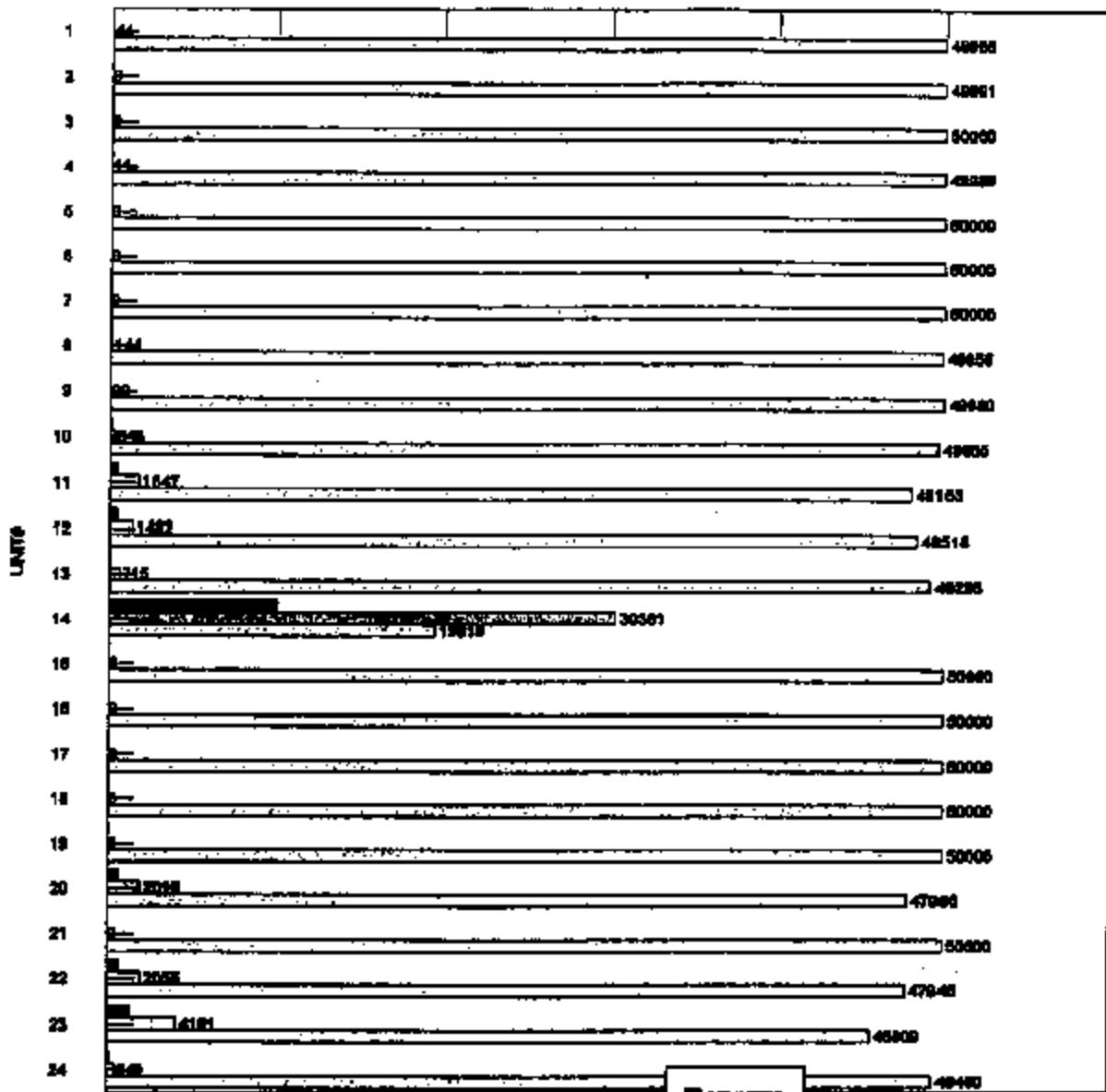
COLUMN LOCK ACTUATOR

DURABILITY TEST 11/20/97

OF CYCLES

Thousands

0 10 20 30 40 50 60

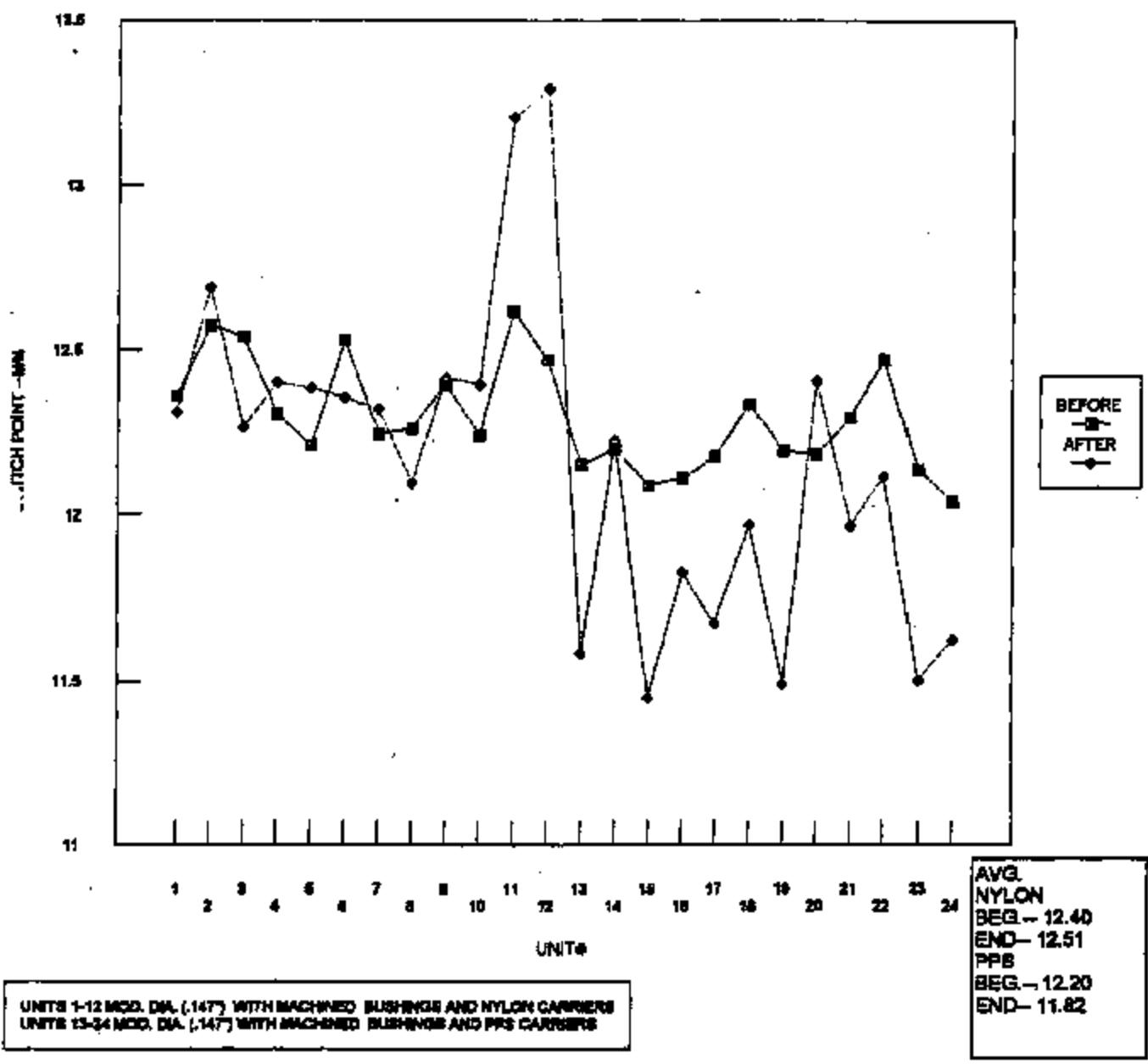


UNITS 1-12 WITH NYLON CARRIERS (147° DIA)
UNITS 13-24 WITH PPS CARRIERS (147° DIA)

- MINUTES
- CYCLES NEEDED
- ACT. CYC.

SAGINAW COLUMN LOCK ACTUATOR #26050960

DURABILITY TEST COMPLETED 12/03/97 - SWITCH POINT CHANGE



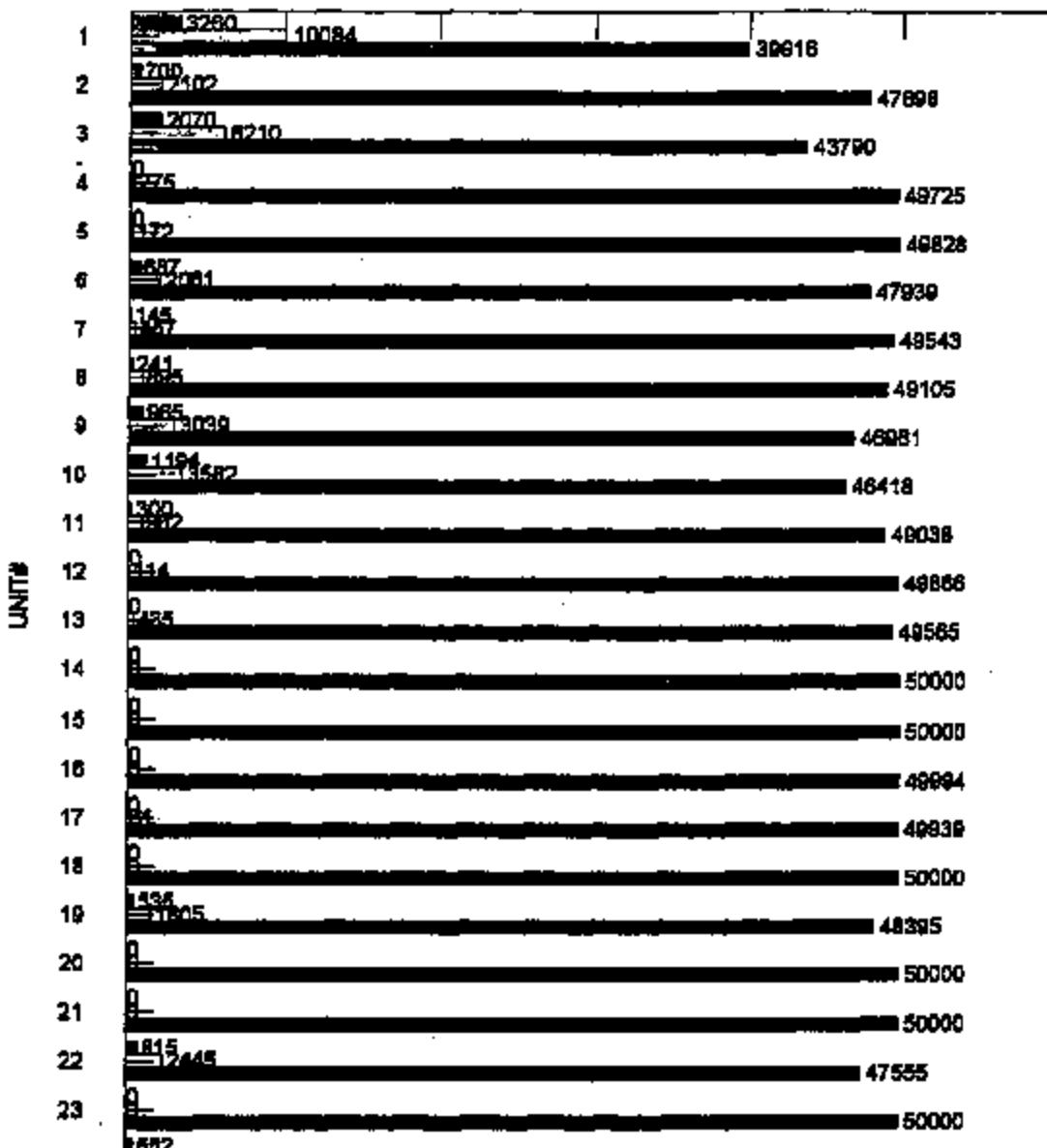
SAGINAW COLUMN LOCK ACTUATOR #26050960

DURABILITY TESTING COMPLETED ON 12/25/97

* OF CYCLES

Thousands

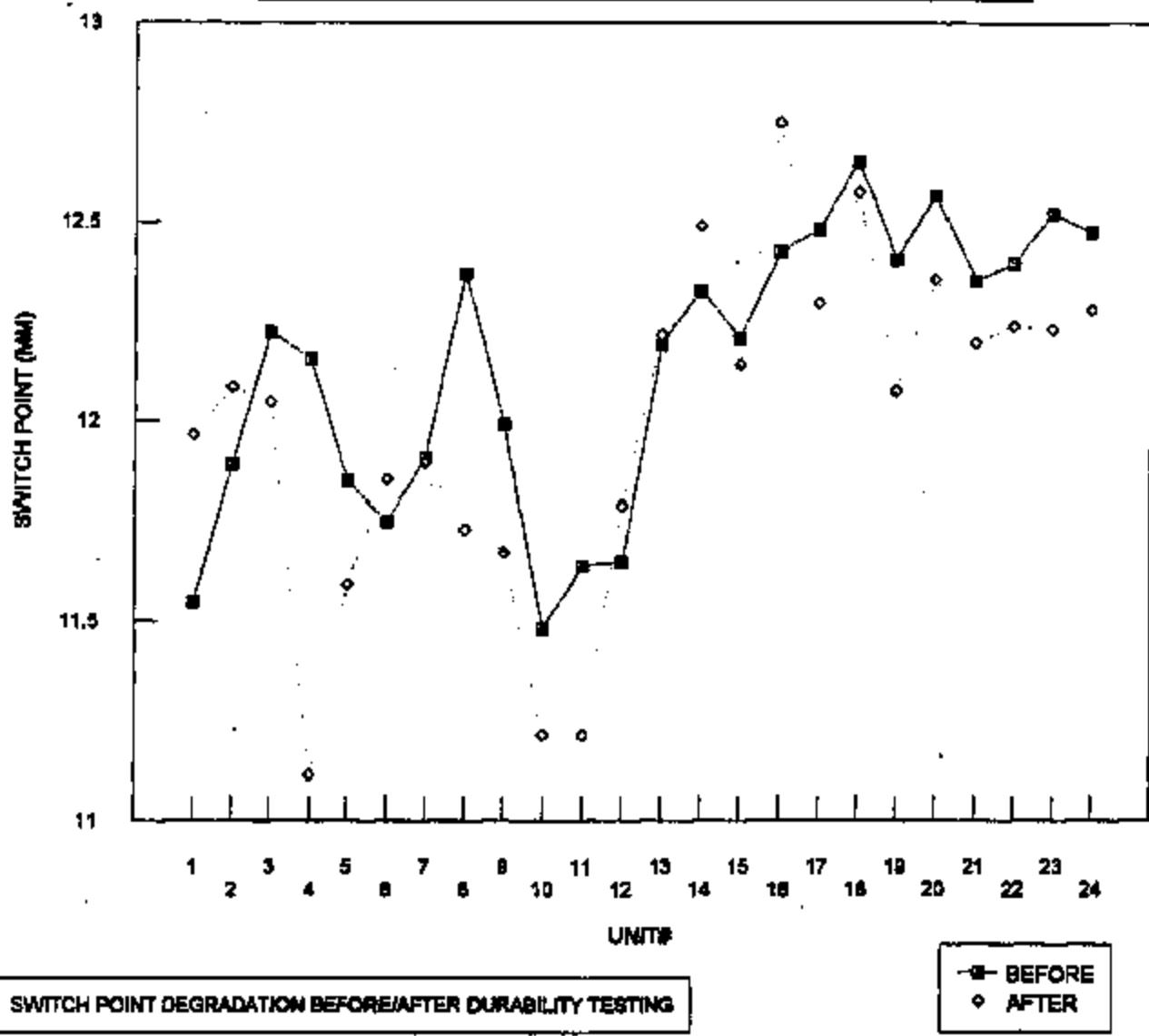
0 10 20 30 40 50 60



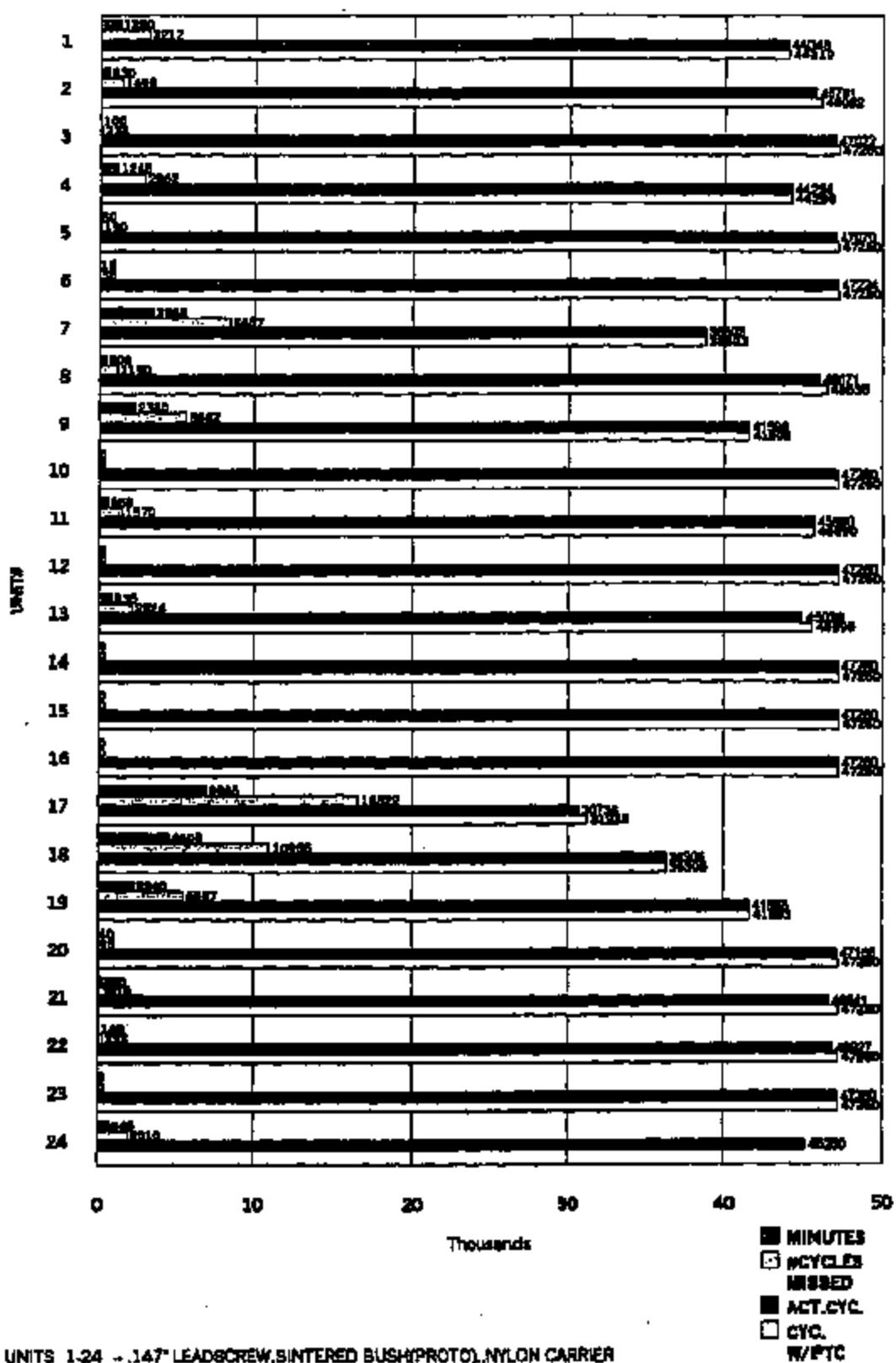
- MINUTES
- #CYCLES
- MISSED
- ACT.CYC.

UNITS 1-12 MOD. DIA. (.147") WITH MACHINED BUSHINGS AND 15%GF PPS CARRIERS
UNITS 13-24 MOD. DIA. (.147") WITH MACHINED BUSHINGS AND NYLON CARRIERS

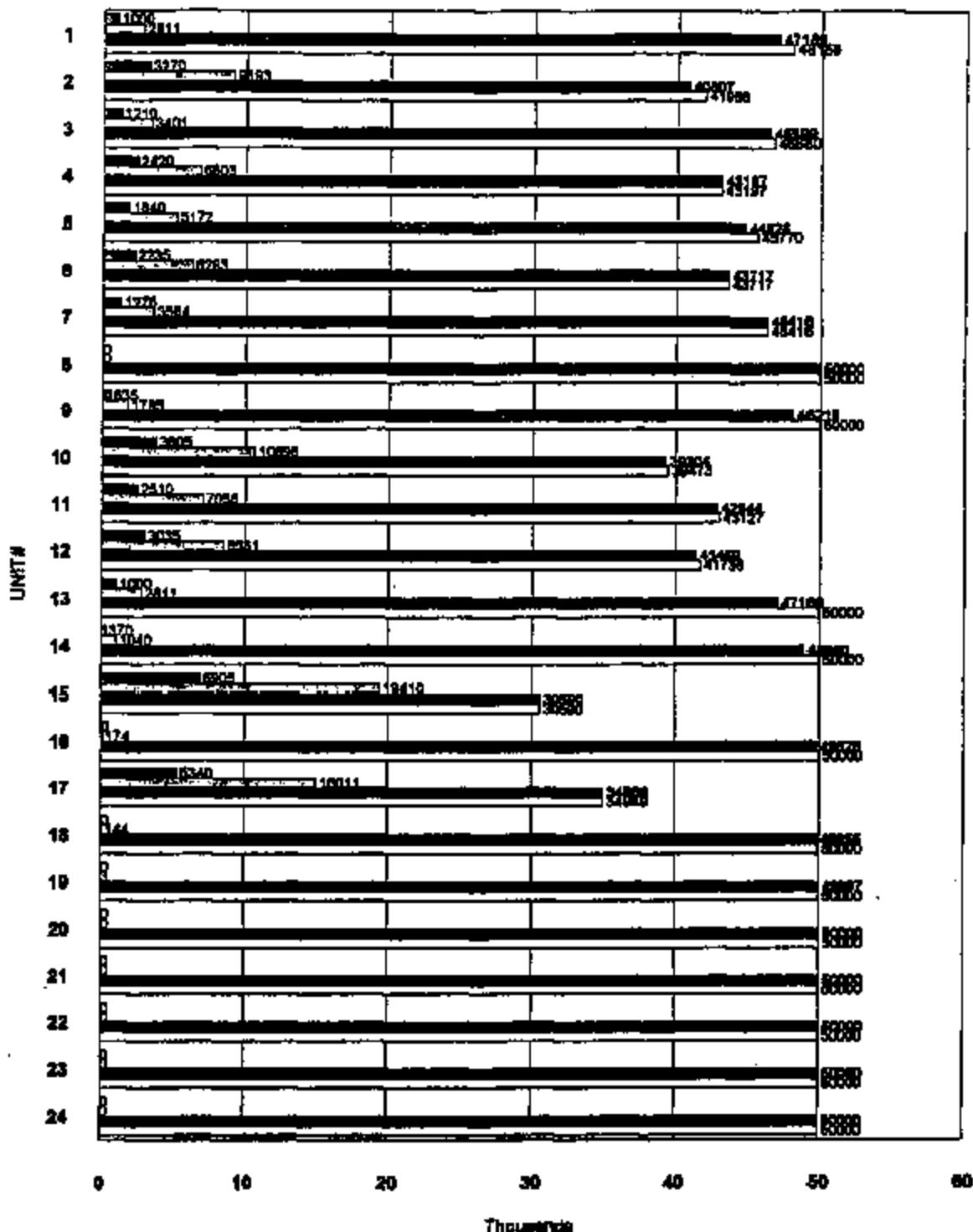
SAGINAW COLUMN LOCK ACTUATOR
DURABILITY TEST 12/12/97 E.O.T. 12/25/97 8:05 A.M.



BAGINAW COLUMN LOCK ACTUATOR #26050960
DURABILITY TESTING COMPLETED ON 03/04/96



SAGINAW COLUMN LOCK ACTUATOR #26050960
DURABILITY TESTING COMPLETED ON 04/02/98

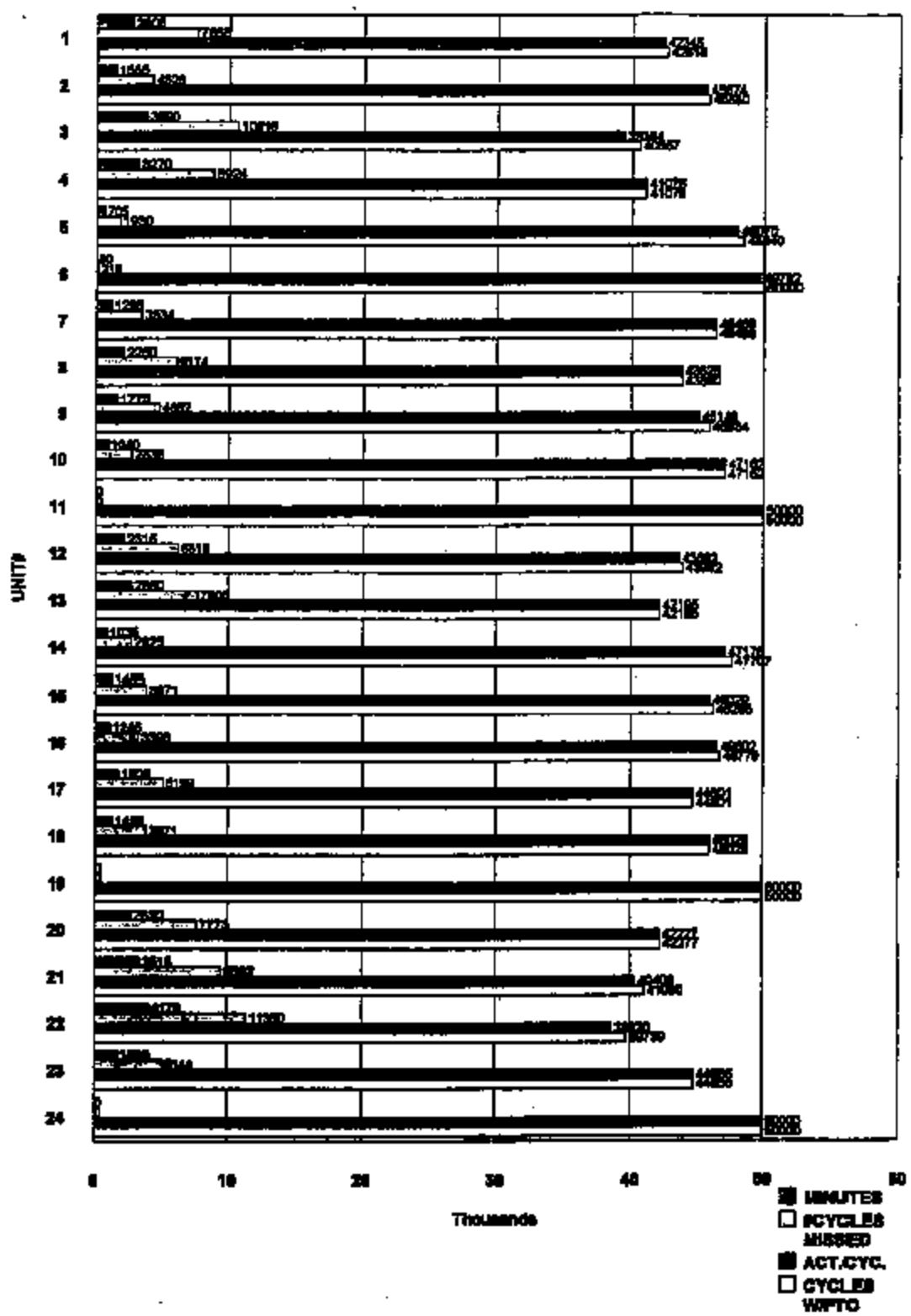


UNITS 1-12 CURRENT PRODUCTION

UNITS 13-18 MACHINED H'SNGS(.825"), MACH. NYLON BUSHINGS AND NYLON CARRIERS

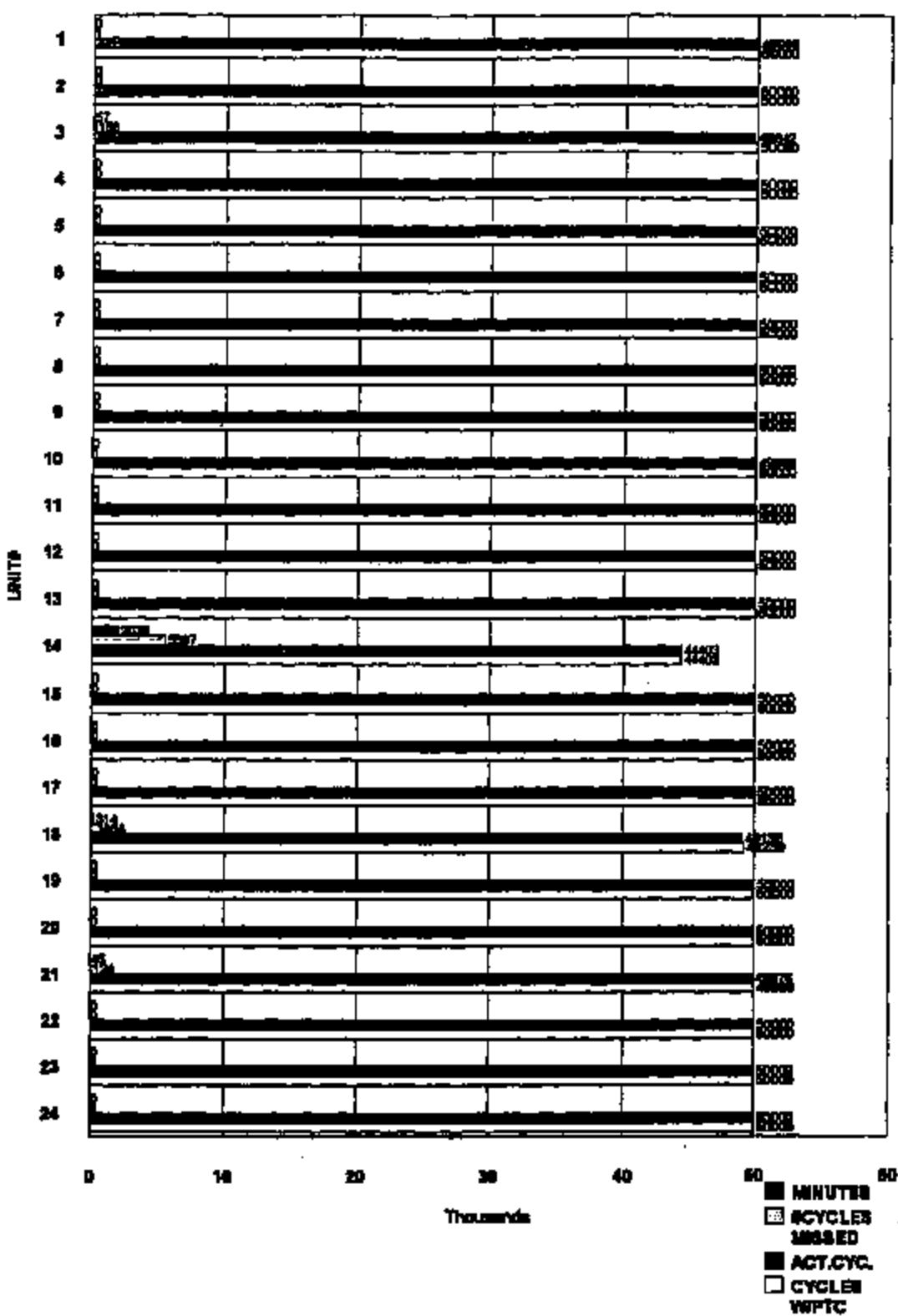
UNITS 19-24 INTEGRAL UPSTOP ,MACH. H'SNGS(.825"), MACHINED NYLON BUSHINGS AND NYLON CARRIERS

SAGINAW COLUMN LOCK ACTUATOR #28050950
DURABILITY TESTING COMPLETED ON 04/17/98



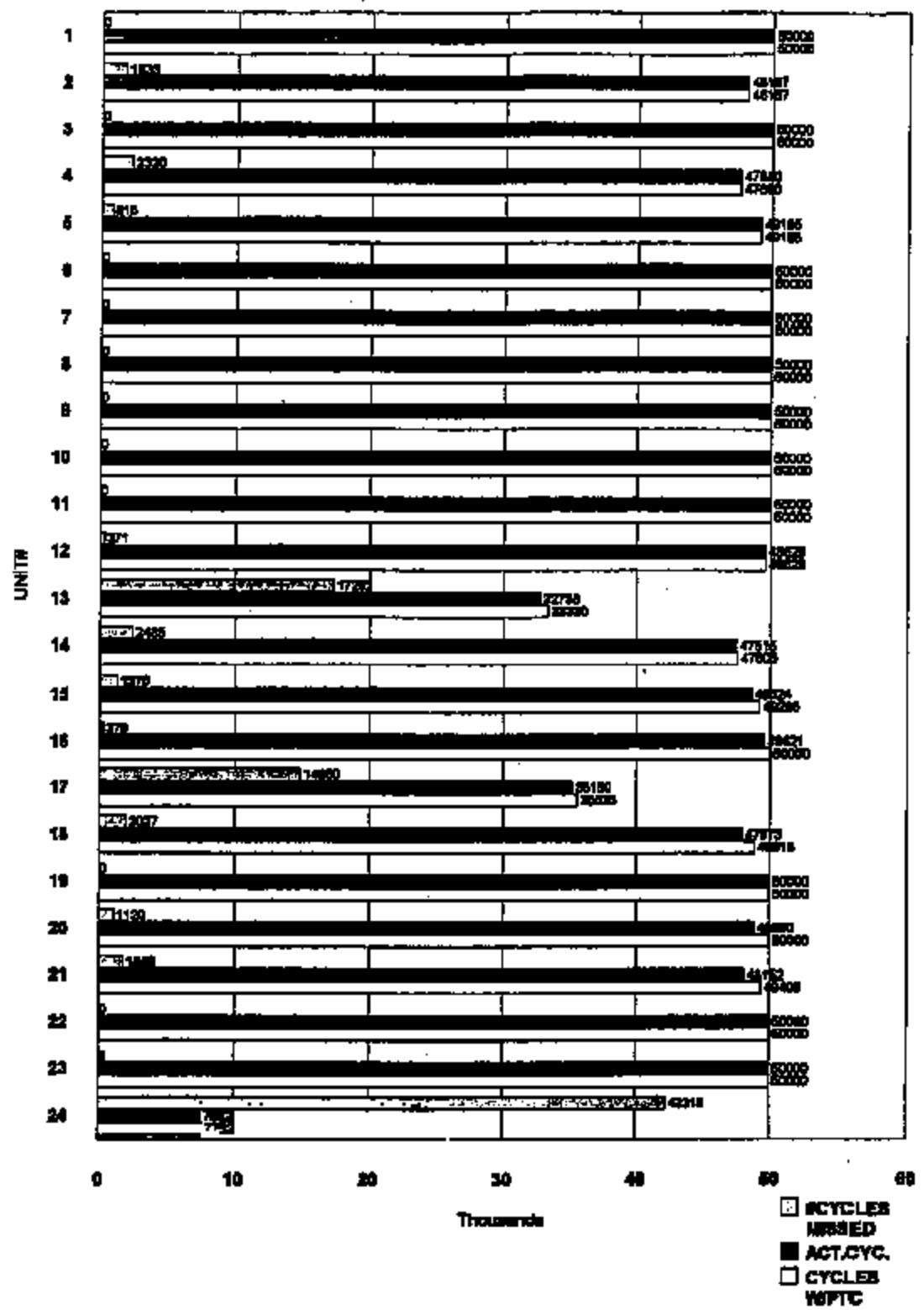
UNITS 1-24 - .147" LEADSCREW, SINTERED BUSH, MACH. HTSNG(810), NYLON CARRIER, TIP RELIEF ON WORM(MA)

SAGINAW COLUMN LOCK ACTUATOR #26050900
 DURABILITY TESTING COMPLETED ON 05/21/98 (1X LIFE)



UNITS 1-12 - 8.55 SHIMS, .147" LEADSCREW/MOLDED BUSH, MACH. NYLNG(110), NYLON CARRIER, INTEGRAL UPSTOP, THRU BOLT & NUT
 UNITS 13-24 - .005" MAX. MOTOR CLEARANCE, .147" LEADSCREW/MOLDED BUSH, MACH. NYLNG(110), NYLON CARRIER, INTEGRAL UPSTOP, THRU BOLT & NUT
 TESTED AT RAV PROBT

SAGINAW COLUMN LOCK ACTUATOR #26050960
 DURABILITY TESTING COMPLETED ON 06/17/88 (1X LIFE)



UNITS 1-12 - .147" LEADScrew, MOLDED TPE BUSH, 30-DUP, MACH. NYLON, #10-32" MAULCLEAR, NYLON CARRIER, INTEGRAL UP/STOP, THRU BOLT & NUT (M)

**[CONFIDENTIAL MATERIAL
REDACTED]**

Attachment
2 I
(Concept Review)

ECL Concept Review Meeting

Invensys, March 24, 2000

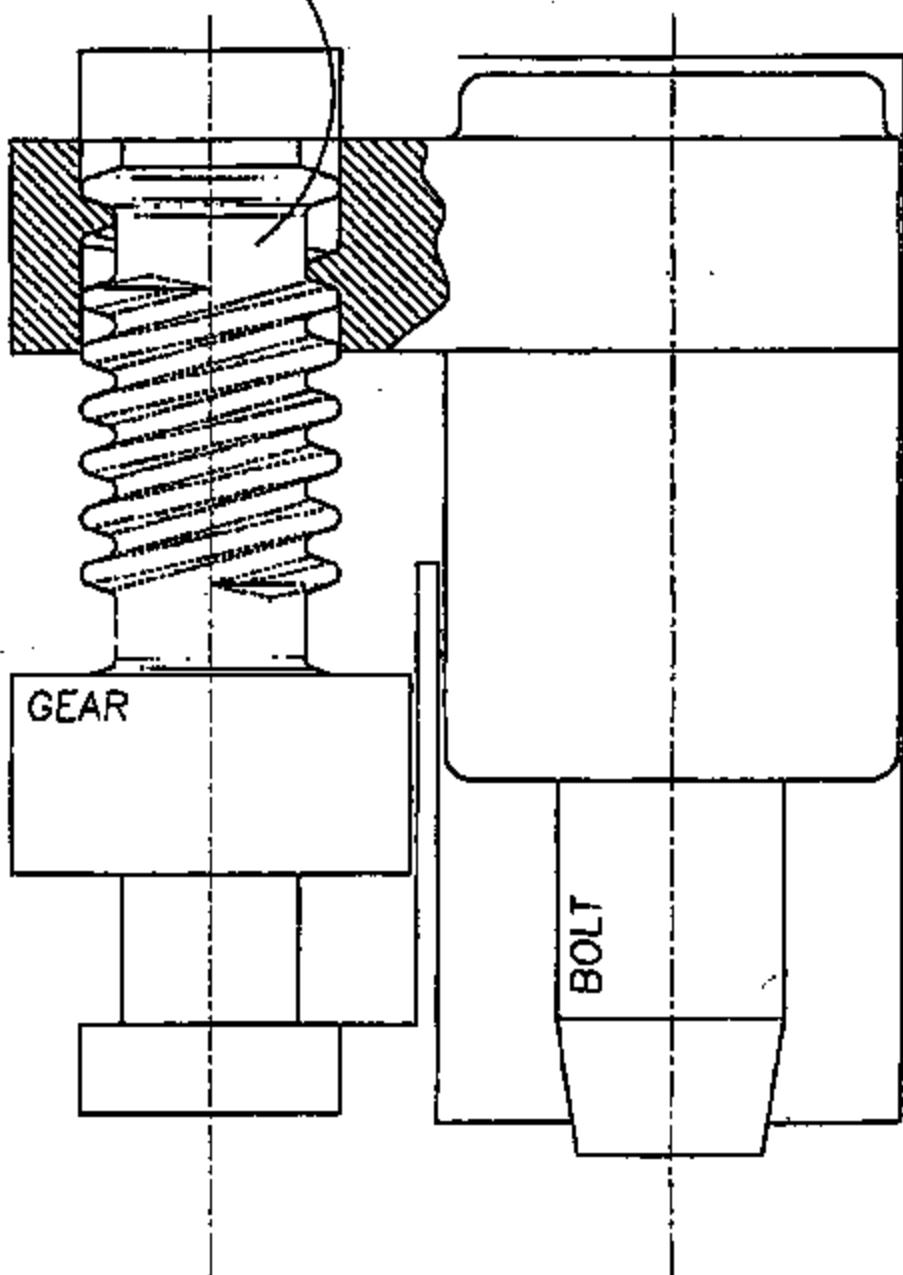
- 8:00-8:15 Introductions and Sign in All
- 8:15-8:30 Goals and Evaluation Criteria Invensys
- 8:30- 10:20 Concept Presentation Invensys
- 10:20-10:30 Break All
- 10:30-11:30 Additional Concepts All
- 11:30- 12:00 Lunch All
- 12:00-1:00 Concept Evaluation All
- 1:00- 2:00 Program Issue Invensys/
Saginaw

OPTION #1

SCREW RELIEF

16MR00

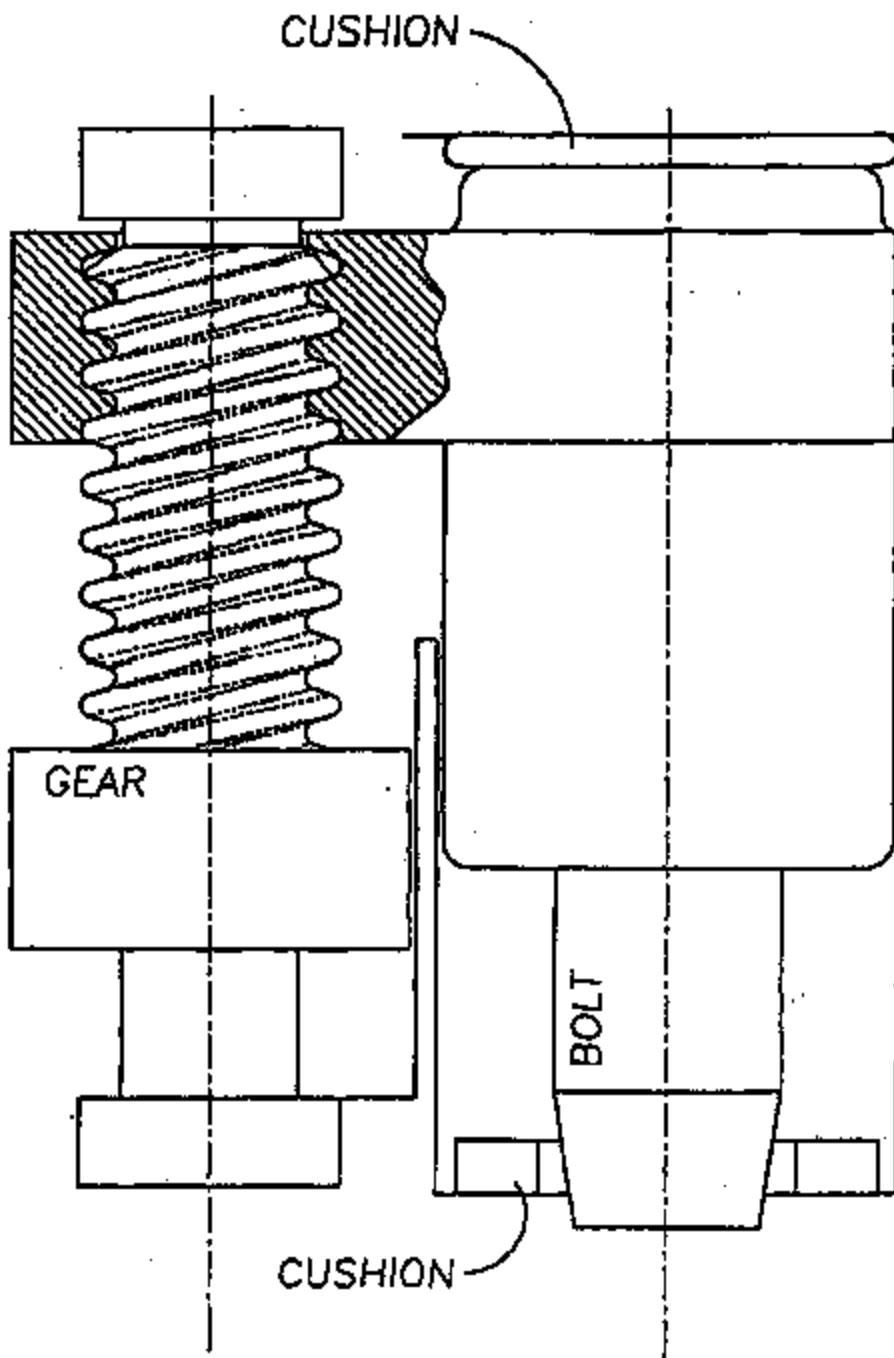
NO TEETH AT ENDS OF TRAVEL



NOTE: MAY STRIP TEETH IF BOLT HAS BEEN TORQUED

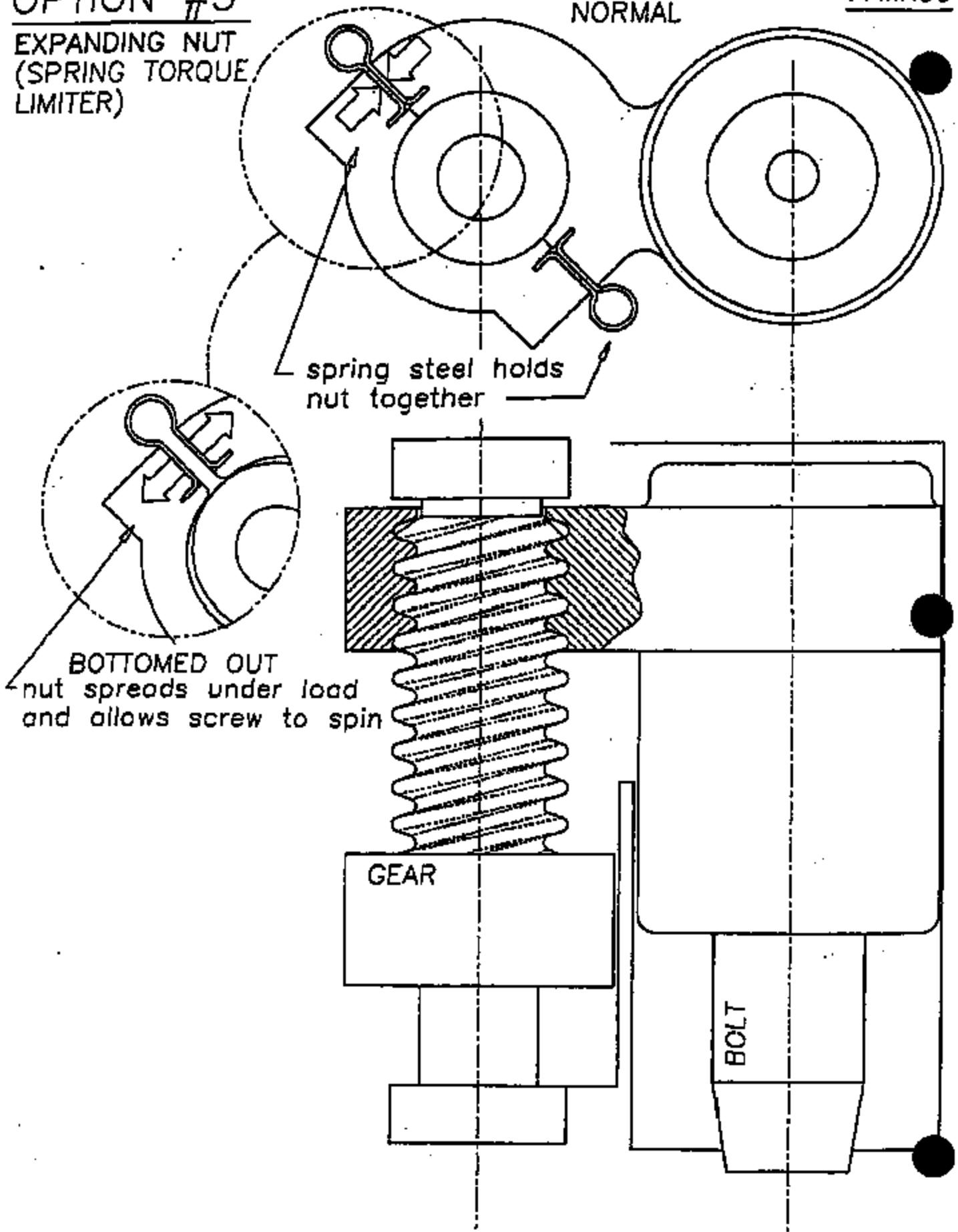
OPTION #2
CUSHIONED STOPS

CUSHION THE END STOPS



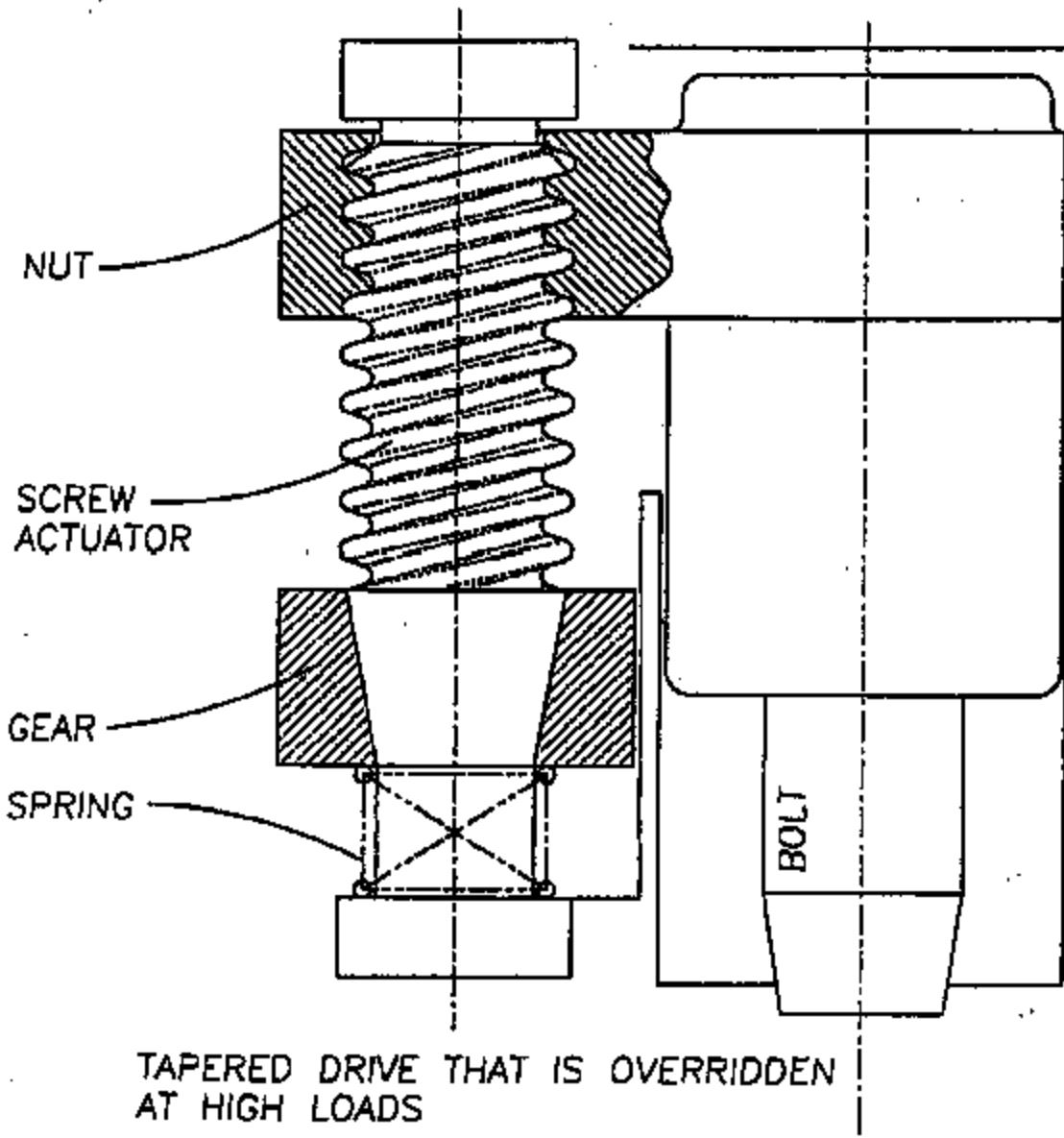
OPTION #3

17MR00

**EXPANDING NUT
(SPRING TORQUE
LIMITER)**

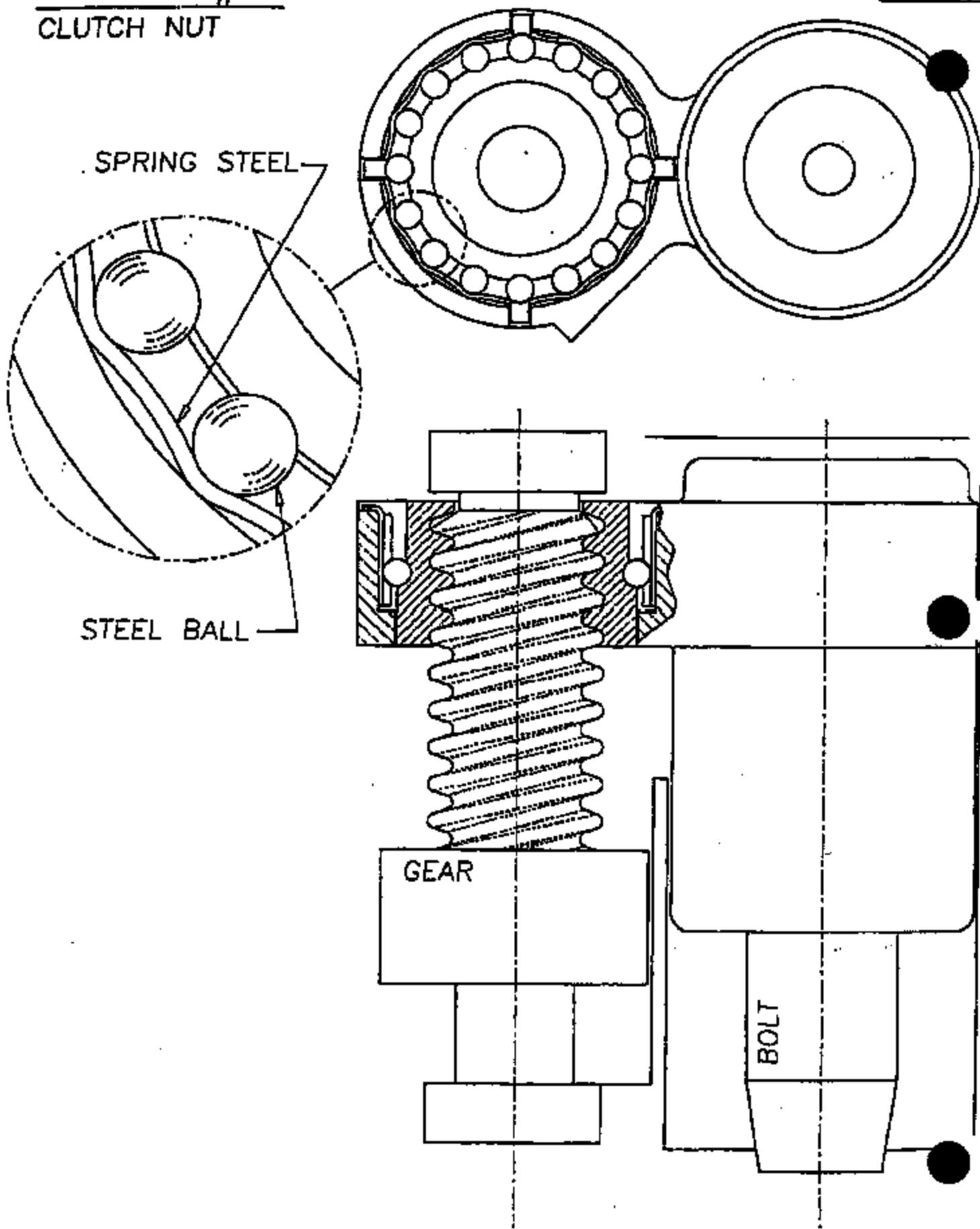
OPTION #4
CONE CLUTCH

17MR00



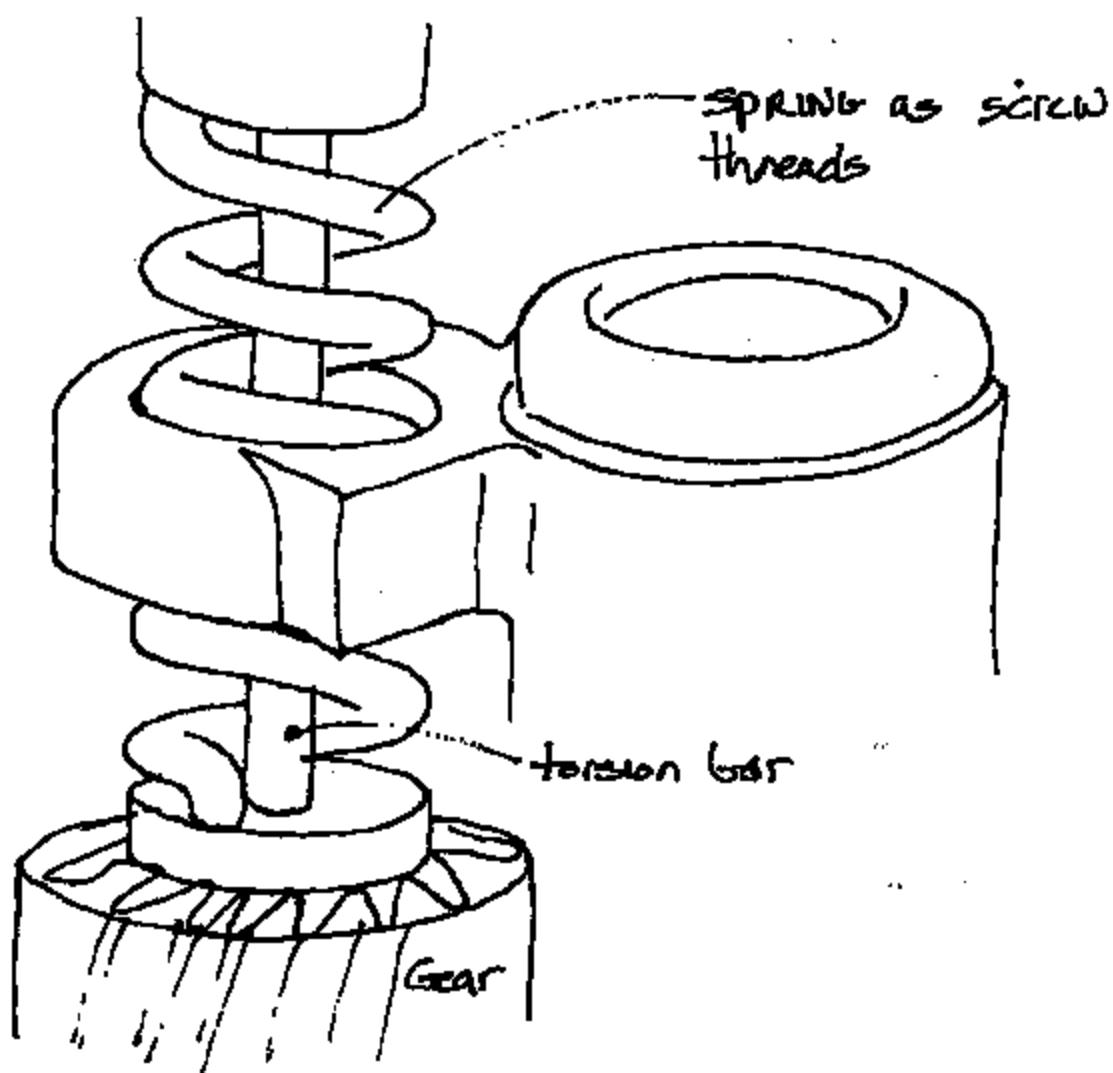
OPTION #5
CLUTCH NUT

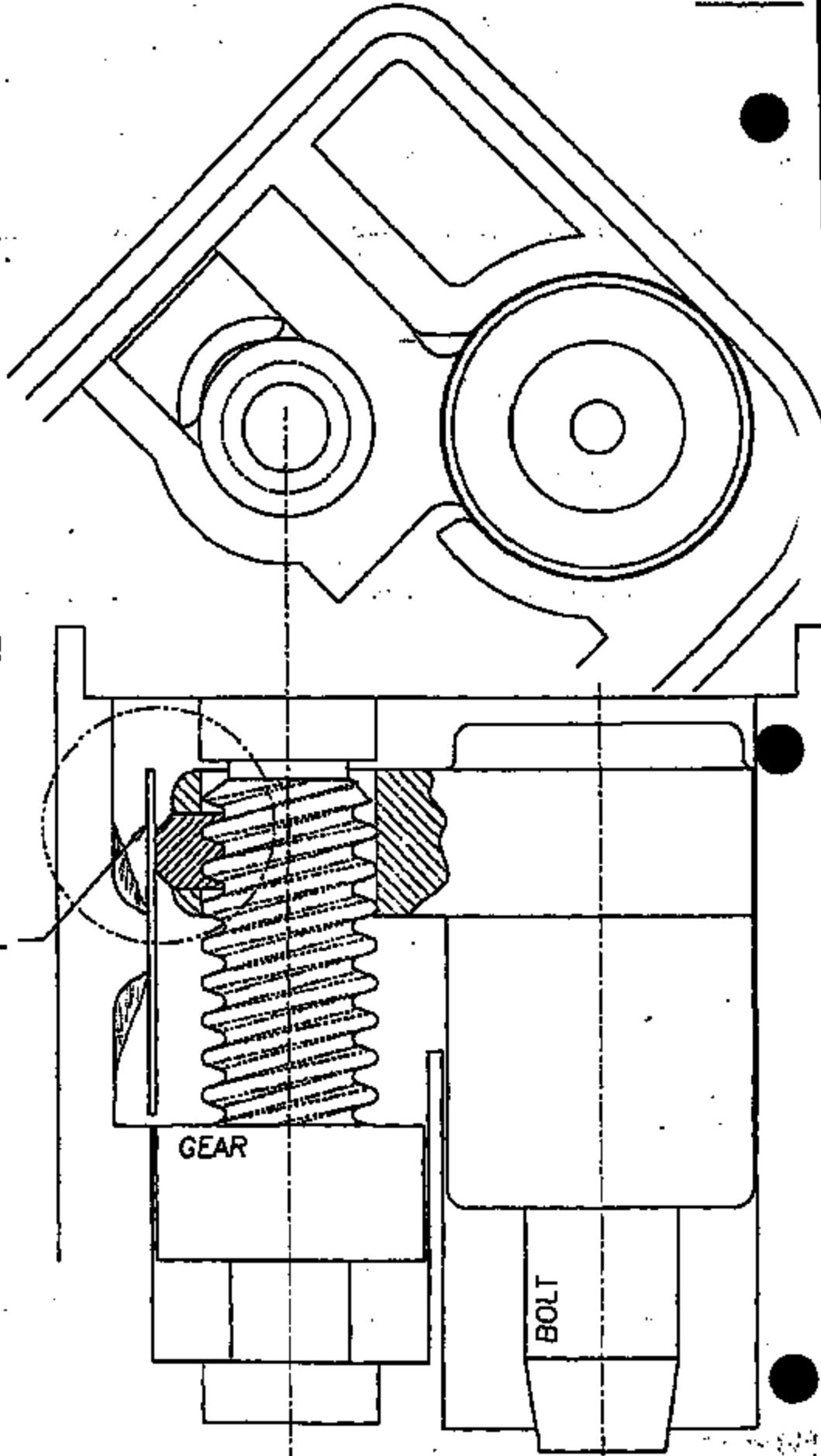
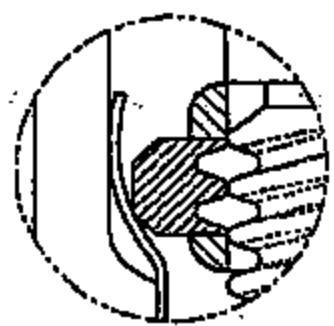
17MR00

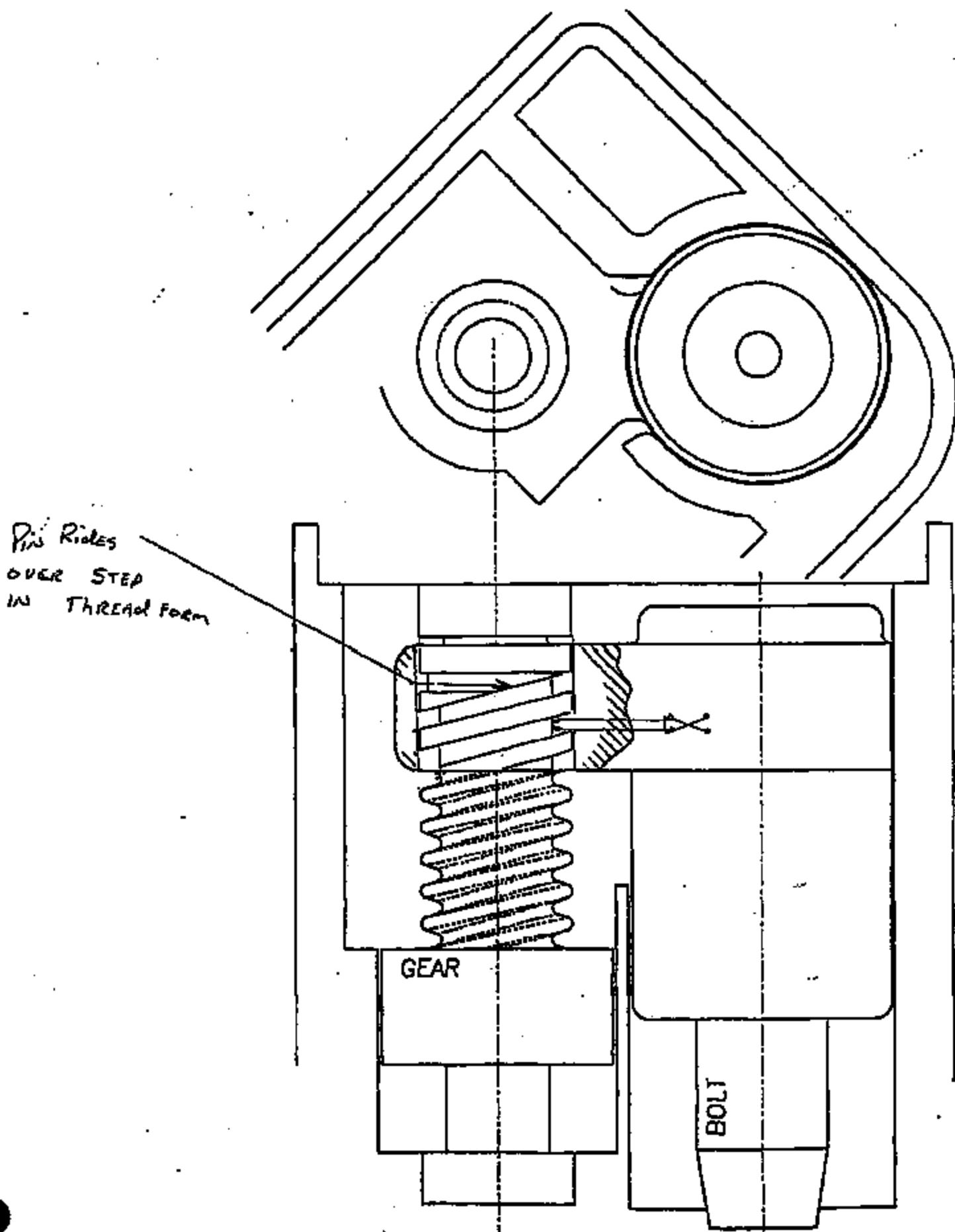


OPTION #6
SPRING SCREW

17MR00

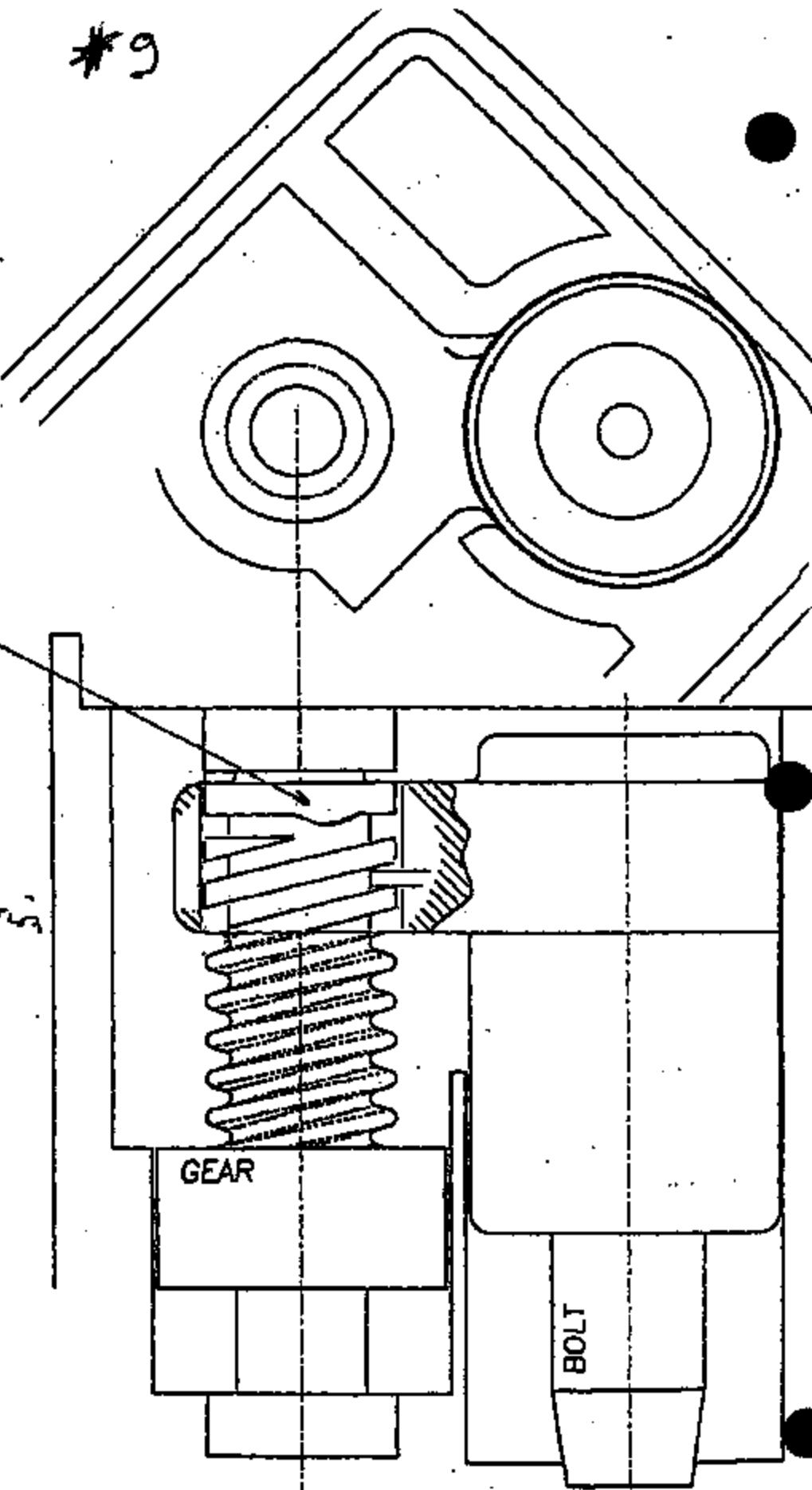






#9

Lobe forces
Pin to Decent
Threads
Rotated in
Appropriate
Direction - Oscillation
At Diameter of
Follower



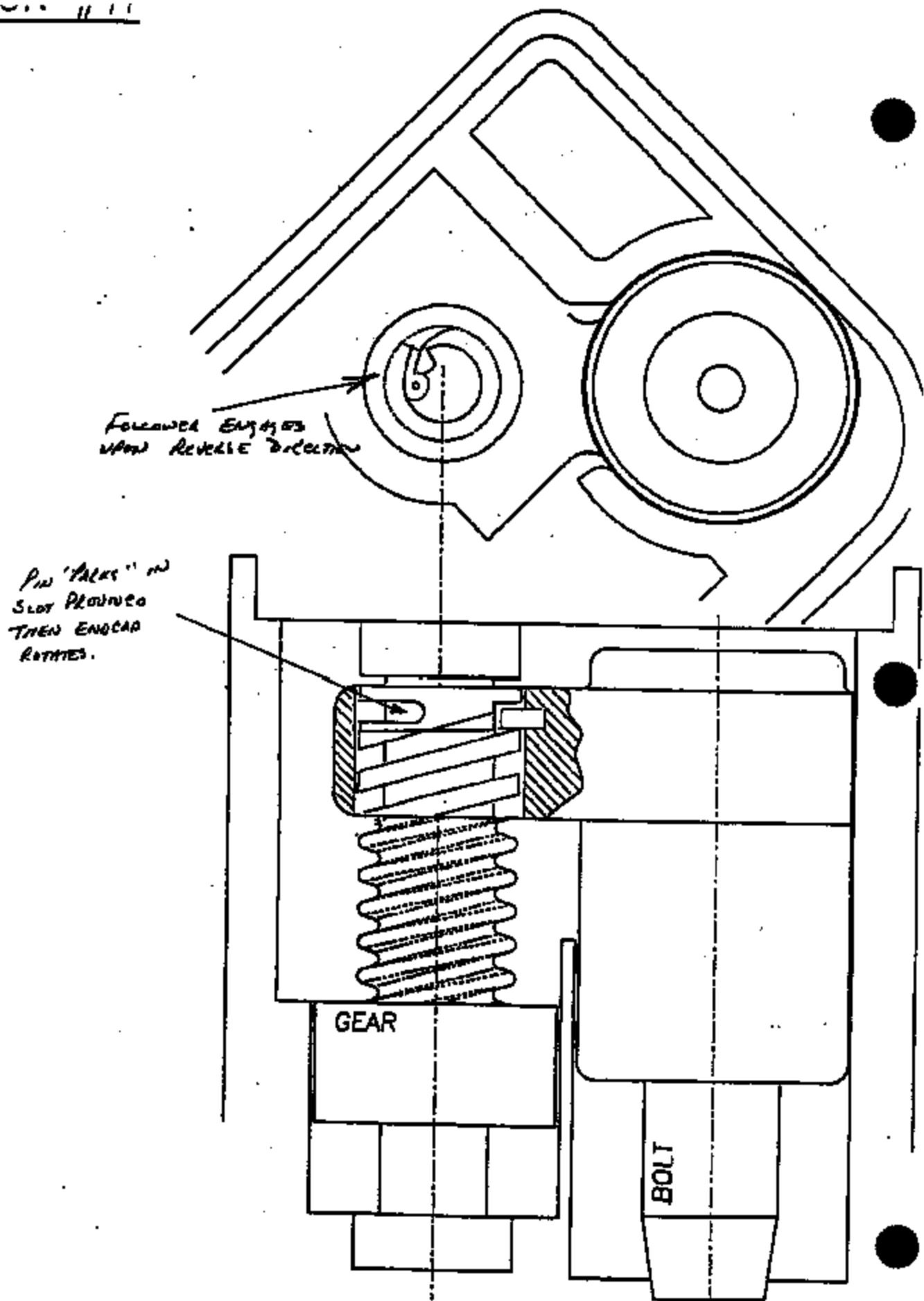
End Cap
is separate
part

Belleville
Spring

Follower
Dog (MAY be 180°
from Ramp) aligns
parts.

GEAR

BOLT



LEAF Spring

- Depressed for idle
- Deflects following To decelerate Thread.

GEAR

BOLT

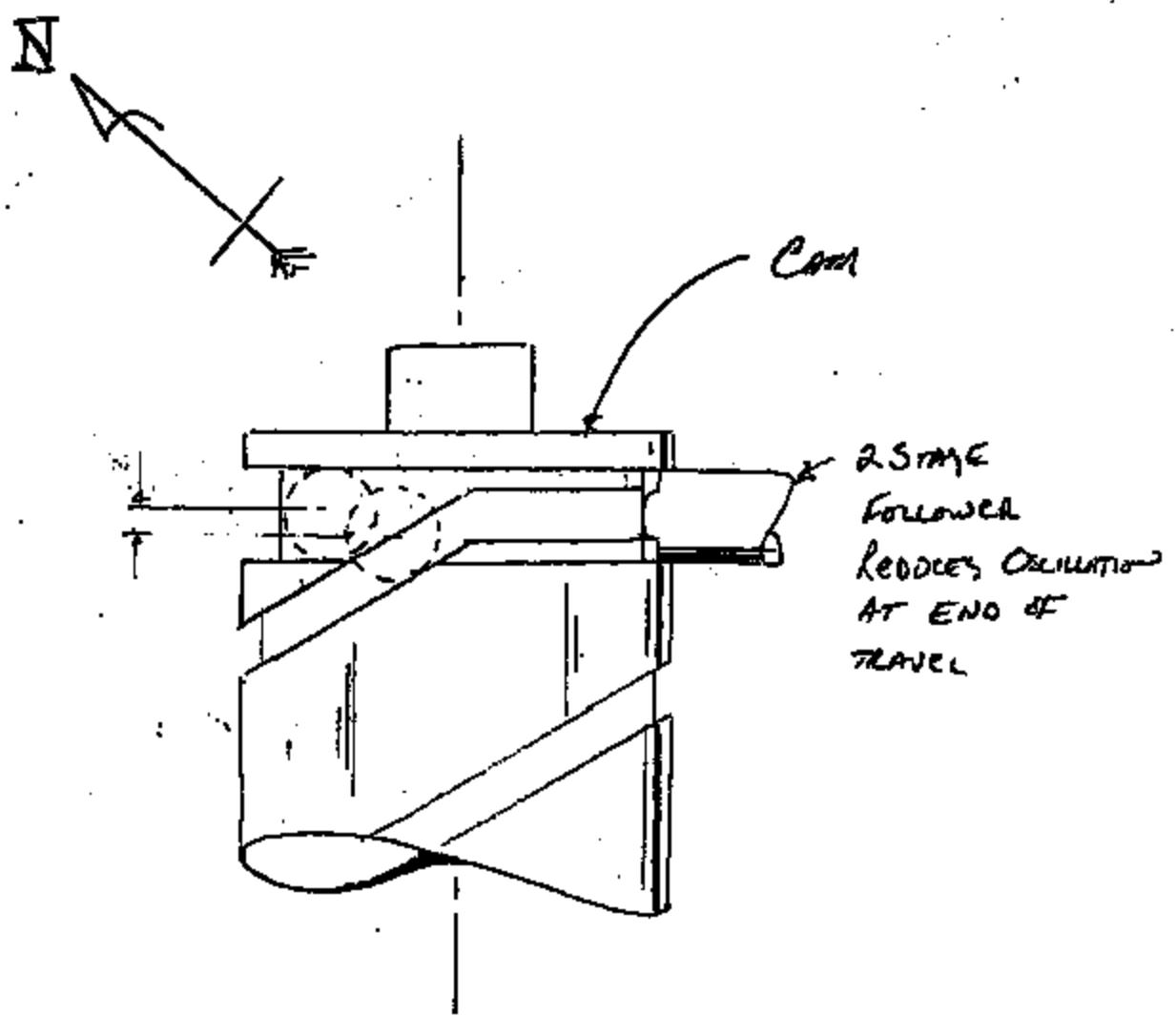
GATE PIVOTS
TO MELLUN

This technical drawing shows a cross-section of a mechanical assembly. At the top, two large circular components are shown, one with concentric circles and another with a central hole. A vertical line extends downwards from the center of these components. Below this line, there is a rectangular housing or frame. Inside this frame, a stack of several rectangular components is visible, with diagonal hatching applied to some of them. To the right of this stack, a cylindrical bolt is partially inserted into a hole. The word "GEAR" is printed below the stack of components. To the right of the bolt, the word "BOLT" is printed vertically. A horizontal line extends from the left side of the assembly, pointing to the text "GATE PIVOTS TO MELLUN".

GEAR

BOLT

Option #14



**[CONFIDENTIAL MATERIAL
REDACTED]**

Saginaw Electric Column Lock Testing Milestones

- Mid 1998- Began looking at methods to dissipate kinetic energy created when device is not loaded
- 5/1998- Shainin enters, focused initially on motor stall current as measurement
- 4/1999- Still using chart recorder for data acquisition
- 11/1999- Performed rebound test for Saginaw
- 01/2000- Rebound and vehicle schematic mentioned in test documents
- 02/2000- Labview data acquisition replaces strip recorder
- 06/2000- Test for new relay config.
- 01/2001- Relay comparison test
- 01/2001- Taguchi enters
- 03/2001- Test for SCRR 0170 (insulator change)
- 03/2001- Another relay comparison
- 04/2001- Test for crush rib addition to terminal disc overmold (Delphi Rev. 078)
- 04/2001- Test for bearing grease change

Test Log

Test Log Number
01-0057

Date of Request
04/04/2001

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
PPAP

Test Start Date
04/06/2001

Date Actual Completed
04/25/2001

Est. Completion Date

Engineer
Dan Thurber

Technician
Larry Kane

Comments:

Report# 01-0057a Bearing grease (BG-1 -> 5)
Report # 01-0057b Crush rib Change (CR-1 ->6)

Help Attachments or Links Here:

Created by Larry Kane/ShelbyNC/US/Fasco/Sensors on 04/10/2001

Test Log

Test Log Number
01-0053

Date of Request
03/26/2001

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Taguchi Study

Test Start Date
03/28/2001

Date Actual Completed
04/05/2001

Est. Completion Date

Engineer
Tim Willette

Technician
Larry Kane

Comments:

121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140

help Attachments or Links Here:

Created by Larry Kane/ShelbyNC/US/Fasco/Sensors on 03/29/2001

Test Log

Test Log Number
01-0050

Date of Request
03/21/2001

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Taguchi Study

Test Start Date
03/21/2001

Date Actual Completed
03/26/2001

Est. Completion Date

Engineer
Tim Willette

Technician
Larry Kane

Comments:

101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120

help Attachments or Links Here:

Created by Larry Kane/Shelby NC/US/Fasco/Sensors on 03/21/2001

Test Log

Test Log Number
01-0043

Date of Request
03/07/2001

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Taguchi Study

Test Start Date
03/09/2001

Date Actual Completed
03/22/2001

Est. Completion Date

Engineer
Tim Willette

Technician
Larry Kane

Comments:

81,82,83,84,85,86,87,88,89,90,92,93,94,95,96,97,98,99,100

Help Attachments or Links Here:

Created by Larry Kane/ShelbyNC/US/Faseco/Sensors on 03/12/2001

Test Log

Test Log Number Date of Request Part Number
01-0037 02/26/2001 17400002

Customer Type of Request
Delphi Saginaw PPAP

Test Start Date Date Actual Completed Est. Completion Date
03/01/2001 03/23/2001

Engineer Technician
Dan Thurber Larry Kane

Comments:

Insulator Validation Testing

Started durability on 3/8/01 Completed: 3/12/01

help Attachments or Links None



SCRR 00-0170_01-0037.doc

Created by Larry Kane/ShelbyNC/US/Fasco/Sensors on 03/01/2001

Test Log

Test Log Number
01-0030

Date of Request
02/08/2001

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Taguchi Study

Test Start Date
02/08/2001

Date Actual Completed
02/22/2001

Est. Completion Date

Engineer
Tim Willette

Technician
Larry Kane

Comments:

Part #'s: 53,55,56,60,61,62,64,65,66,67,68,69,70,71,74,75,76,77,78,79,80

help Attachments or Links Here:

Created by Larry Kane/ShelbyNC/US/Fasco/Sensors on 02/08/2001

Test Log

Test Log Number
01-0025

Date of Request
01/30/2001

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Taguchi Study

Test Start Date
01/30/2001

Date Actual Completed
02/05/2001

Est. Completion Date

Engineer
Tim Williette

Technician
Larry Kane

Comments:

Part #'s 42,45,46,47,49,50,52,54,57, & 58

Help Attachments or Links Here:

Created by Larry Kane/ShelbyNC/US/Fasco/Sensors on 01/30/2001

Test Log

Test Log Number **01-0024** Date of Request **01/05/2001** Part Number **17400002**

Customer **Delphi Saginaw** Type of Request **Taguchi Study**

Test Start Date **01/05/2001** Date Actual Completed **01/06/2001** Est. Completion Date

Engineer **Tim Willette** Technician **Larry Kane**

Comments:

Part # 1,2,3,4,5,6,7,8,10,13,14,15,16,17,18,19,20,21

help Attachments or Links Here:

Created by Larry Kane/ShelbyNC/US/Fasco/Sensors on 01/29/2001

Test Log

Test Log Number
01-0022

Date of Request
01/19/2001

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Taguchi Study

Test Start Date
01/19/2001

Date Actual Completed
01/23/2001

Est. Completion Date

Engineer
Tim Willette

Technician
Larry Kane

Comments:

Modified Taguchi Study. Part #'s: 24,25,28,29,30,32,33,37,38, & 40

help Attachments or Links Here:

Created by Larry Kane/ShelbyNC/US/Fasco/Sensors on 01/24/2001

Test Log

Test Log Number Date of Request Part Number
00-0195 12/04/2000 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
12/22/2000 01/08/2001

Engineer Technician
Dan Thurber Dennis Byrd

Comments:

Perform PV testing on 6 samples of thermo deburred and 6 control samples.

Help Attachments or Links Here:

Created by Larry Kane/Shelby NC/US/Fasco/Sensors on 12/22/2000

Test Log

Test Log Number
00-0148

Date of Request
08/17/2000

Part Number
17400012

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
08/17/2000

Date Actual Completed
08/17/2000

Est. Completion Date

Engineer
Steve Davis

Technician
Larry Kane

Comments:

Thread Compression Test

help Attachments or Links Here:

Created by Larry Kane/QUALITY/SHELBY/FASCO on 08/17/2000

Test Log

Test Log Number Date of Request Part Number
00-0146 08/14/2000 17400012

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
08/14/2000 08/14/2000

Engineer Technician
Steve Davis Larry Kane

Comments:

Load Testing of various Lead Screw materials

help Attachments or Links Here:

Created by Larry Kane/QUALITY/SHELBY/FASCO on 08/14/2000

Test Log

Test Log Number
00-0134

Date of Request
07/12/2000

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
07/13/2000

Date Actual Completed
07/24/2000

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

NEW DESIGN

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 07/24/2000

Test Log

Test Log Number
00-0106

Date of Request
05/23/2000

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
05/25/2000

Date Actual Completed
05/24/2000

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Place 4 parts on durability test. Run only tests with side loads. Do NOT thermal cycle. Run after tester loads have been verified.

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 05/24/2000

Test Log

Test Log Number
00-0103

Date of Request
05/19/2000

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
DV

Test Start Date
05/19/2000

Date Actual Completed
05/30/2000

Est. Completion Date

Engineer
Dan Thurber

Technician
Larry Kane

Comments:

Cover assembly thermal cycling (-40°C to 85°C) Parts returned to D. Thurber on 5/30/2000

Help Attachments or Links Here:

Created by Larry Kane/QUALITY/SHELBY/FASCO on 05/19/2000

Test Log

Test Log Number
00-0098

Date of Request
05/01/2000

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
05/02/2000

Date Actual Completed
05/16/2000

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hayle

Comments:

12 parts on 1 group of relays and 12 parts on the other.

Help Attachments or Links Here:

Created by Lori Hayle/QUALITY/SHELBY/FASCO on 05/01/2000

Test Log

Test Log Number
00-0056

Date of Request
02/25/2000

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
03/01/2000

Date Actual Completed
03/15/2000

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

24 parts placed on durability test. All tests are at 9 Volts. New lock bolt plates to be placed on fixtures. Relays will not be implemented at this time.

Help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 03/01/2000

Test Log

Test Log Number
00-0044

Date of Request
02/11/2000

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
PV

Test Start Date
02/14/2000

Date Actual Completed
02/25/2000

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Test 24 production parts on the new tester to establish a baseline.

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 02/14/2000

Test Log

Test Log Number
00-0039

Date of Request
02/03/2000

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
02/07/2000

Date Actual Completed
04/07/2000

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Cycle parts to 50,000 cycles. Remove and check rebound and switch point every 500 cycles.

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 02/07/2000

Test Log

Test Log Number Date of Request Part Number
00-0006 01/06/2000 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
01/11/00 01/17/2000

Engineer Technician
Steve Davis Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 01/10/2000

Test Log

Test Log Number Date of Request Part Number
00-0006 01/08/2000 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
01/11/00 01/17/2000

Engineer Technician
Steve Davis Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 01/10/2000

Test Log

Test Log Number
99-0279

Date of Request
10/26/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
10/29/99

Date Actual Completed
12/02/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Durability Measure switch points locking and unlocking and fully retracted every 5000 cycles.
Measure the housing at the pin before test.
Test completed. Report to follow 12/2/99

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 10/29/99

Test Log

Test Log Number
99-0232

Date of Request
09/16/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
DV

Test Start Date
09/17/99

Date Actual Completed
10/16/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Change Voltage back to Spec.

Help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 09/16/99

Test Log

Test Log Number
99-0210

Date of Request
08/17/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Returned Goods

Test Start Date
08/23/99

Date Actual Completed
09/14/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Check actuation time and current draw at 85C & -40C. Place 23 other parts on durability. PARTS RETURNED TO STEVE DAVIS

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 08/23/99

Test Log

Test Log Number
99-0167

Date of Request
07/16/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
PV

Test Start Date
07/21/99

Date Actual Completed
08/29/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

PASSED

Help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 07/21/99

Test Log

Test Log Number
99-0164

Date of Request
06/28/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
07/08/99

Date Actual Completed
07/08/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Determine current draw of 2 of the best and 2 of the worst from test 99-0140

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 07/08/99

Test Log

Test Log Number
99-0152

Date of Request
06/23/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
DV

Test Start Date
06/24/99

Date Actual Completed
07/06/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

help:Attachments or Links Hint:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 06/24/99

Test Log

Test Log Number
99-0140

Date of Request
06/11/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
DV

Test Start Date
06/14/99

Date Actual Completed
06/24/99

Est. Completion Date

Engineer
Steve Davis

Technician
Dennis Byrd

Comments:

help Attachments or Links Here:

Created by Dennis Byrd/QUALITY/SHELBY/FASCO on 06/11/99

Test Log

Test Log Number
99-0115

Date of Request
06/01/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
06/01/99

Date Actual Completed
06/11/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyte

Comments:

Help Attachments or Links Here:

Created by Lori Hoyte/QUALITY/SHELBY/FASCO on 06/01/99

Test Log

Test Log Number
99-0110

Date of Request
05/13/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
05/14/99

Date Actual Completed
05/26/99

Est. Completion Date

Engineer:
Steve Davis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Marge Jones/QUALITY/SHELBY/FASCO on 05/20/99

Test Log

Test Log Number
98-0094

Date of Request
04/29/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
04/29/98

Date Actual Completed
05/03/98

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/PASCO on 05/03/98

Test Log

Test Log Number
98-0080

Date of Request
04/12/99

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date
04/15/99

Date Actual Completed
05/19/99

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 04/15/99

Test Log

Test Log Number 99-0080 Date of Request 04/12/99 Part Number 17400002

Customer Delphi Saginaw Type of Request Engineering

Test Start Date 04/15/99 Date Actual Completed 05/19/99 Est. Completion Date

Engineer Steve Davis Technician Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Lori Hoyle/QUALITY/SHELBY/FASCO on 04/18/99

Test Log

Test Log Number
98-0219

Date of Request
11/16/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
12/03/98

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

DURABILITY

Help Attachments or Links Here:

Created by Margie Jones/QUALITY/SHELBY/FASCO on 01/22/99

Test Log

Test Log Number
98-0218

Date of Request
11/10/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Returned Goods

Test Start Date

Date Actual Completed
11/11/98

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Margie Jones/QUALITY/SHELBY/FASCO on 01/22/99

Test Log

Test Log Number Date of Request Part Number
98-0207 10/19/98 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date

Engineer Technician
Steve Davis Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 10/26/98

Test Log

Test Log Number Date of Request Part Number
98-0196 10/14/98 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date

Engineer
Steve Davis Technician
 Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrif/QUALITY/SHELBY/FASCO on 10/26/98

Test Log

Test Log Number
98-0185

Date of Request
09/30/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
09/30/98

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 10/05/98

Test Log

Test Log Number
98-0182

Date of Request
09/28/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
PV

Test Start Date

Date Actual Completed
10/01/98

Est. Completion Date

Engineer
Steve Davis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 10/08/98

Test Log

Test Log Number Date of Request Part Number
98-0160 08/28/98 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date

Engineer Technician
Wade Landis Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift\QUALITY\SHELBY\FASCO on 08/16/98

Test Log

Test Log Number
98-0159

Date of Request
08/28/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 09/16/98

Test Log

Test Log Number
98-0150

Date of Request
08/21/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Wade Thirlby/QUALITY/SHELBY/FASCO on 08/16/98

Test Log

Test Log Number
98-0136

Date of Request
08/10/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request:
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 08/14/98

Test Log

Test Log Number
98-0108

Date of Request
07/17/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date Date Actual Completed Est. Completion Date

Engineer

Wade Landis

Technician

Lori Mayle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 07/25/98

Test Log

Test Log Number
98-0108

Date of Request
07/17/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 07/28/98

Test Log

Test Log Number Date of Request Part Number
98-0081 06/05/98 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
06/23/98

Engineer
Wade Landis Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 07/02/98

Test Log

Test Log Number
98-0082

Date of Request
05/18/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

FORCE

help, Attachments or Links Here:

Created by Margie Jones/QUALITY/SHELBY/FASCO on 05/03/98

Test Log

Test Log Number Date of Request Part Number
98-0075 05/11/98 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
05/11/98 05/12/98

Engineer Technician
Wade Landis Lori Hoyle

Comments:

FORCE MAKE

help Attachments or Links Here:

Created by Marge Jones/QUALITY/SHELBY/FASCO on 06/03/98

Test Log

Test Log Number
98-0074

Date of Request
05/08/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Margie Jones/QUALITY/SHELBY/FASCO on 06/03/98

Test Log

Test Log Number
98-0061

Date of Request
04/21/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
DV

Test Start Date Date Actual Completed Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/PASCO on 05/04/98

Test Log

Test Log Number
98-0052

Date of Request
04/04/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
PV

Test Start Date

Date Actual Completed
04/17/98

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 05/04/98

Test Log

Test Log Number **98-0040** Date of Request **03/19/98** Part Number **17400002**

Customer **Delphi Saginaw** Type of Request **Engineering**

Test Start Date **04/02/98** Date Actual Completed **04/02/98** Est. Completion Date

Engineer **Wade Landis** Technician **Lori Hoyle**

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 04/02/98

Test Log

Test Log Number
98-0018

Date of Request
02/17/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
PPAP

Test Start Date

Date Actual Completed
03/04/98

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 04/02/98

Test Log

Test Log Number Date of Request Part Number
98-0009 01/30/98 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date

Engineer
Wade Landis Technician
Lori Hoyle

Comments:

Durability

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 02/12/98

Test Log

Test Log Number
98-0003

Date of Request
01/16/98

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
01/29/98

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thirlby/QUALITY/SHELBY/FASCO on 02/12/98

Test Log

Test Log Number Date of Request Part Number
98-0001 01/05/98 17400002

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
01/16/98

Engineer Technician
Wade Landis Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 02/12/98

Test Log

Test Log Number
97-0470

Date of Request
12/11/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help, Attachments or Links Here:

Created by Margie Jones/QUALITY/SHELBY/FASCO on 12/12/97

Test Log

Test Log Number 97-0461	Date of Request 11/20/97	Part Number 17400002
Customer Delphi Saginaw	Type of Request Engineering	
Test Start Date	Date Actual Completed 12/04/97	Est. Completion Date
Engineer Wade Landis	Technician Lori Hoyle	

Comments:

help Attachments or Links Here:

Created by Marge Jones/QUALITY/SHELBY/FASCO on 12/12/97

Test Log

Test Log Number
97-0458

Date of Request
11/06/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
11/11/97

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Humidity

help Attachments or Links Here:

Created by Margie Jones/QUALITY/SHELBY/FASCO on 11/13/97

Test Log

Test Log Number
97-0444

Date of Request
10/14/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Durability

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 10/14/97

Test Log

Test Log Number
97-0414

Date of Request
09/10/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Margie Jones/QUALITY/SHELBY/FASCO on 09/16/97

Test Log

Test Log Number
97-0358

Date of Request
06/17/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
06/30/97

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Durability

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 07/10/97

Test Log

Test Log Number
97-0358

Date of Request
06/12/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
06/16/97

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

. (Inductance)

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 07/10/97

Test Log

Test Log Number
97-0348

Date of Request
06/03/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date Date Actual Completed Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 06/06/97

Test Log

Test Log Number
97-0326

Date of Request
05/19/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
05/20/97

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 06/09/97

Test Log

Test Log Number
97-0251

Date of Request
04/09/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date Date Actual Completed Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 04/22/97

Test Log

Test Log Number
97-0247

Date of Request
04/04/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
04/08/97

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

Help Attachments or Links Here:

Created by Vickie Thrift/QUALITY/SHELBY/FASCO on 04/22/97

Test Log

Test Log Number
97-0221

Date of Request
03/21/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
04/04/97

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Jane Francis/QUALITY/SHELBY/FASCO on 03/27/97

Test Log

Test Log Number 97-0153	Date of Request 02/16/97	Part Number 17400002
Customer Delphi Saginaw	Type of Request Returned Goods	
Test Start Date	Date Actual Completed 02/20/97	Est. Completion Date
Engineer Brandon Goforth	Technician Lori Hoyle	

Comments:

Help Attachments or Links Here:

Created by Jane Francis/QUALITY/SHELBY/FASCO on 02/24/97

Test Log

Test Log Number Date of Request Part Number
97-0078 01/23/97 17598038

Customer Type of Request
Delphi Saginaw Engineering

Test Start Date Date Actual Completed Est. Completion Date
01/24/97

Engineer Technician
Greg Spangler Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Jane Franck/QUALITY/SHELBY/FASCO on 02/08/97

Test Log

Test Log Number
97-0042

Date of Request
01/13/97

Part Number
17400002

Customer
Delphi Saginaw

Type of Request
Engineering

Test Start Date

Date Actual Completed
02/06/97

Est. Completion Date

Engineer
Wade Landis

Technician
Lori Hoyle

Comments:

help Attachments or Links Here:

Created by Jane Francia/QUALITY/SHELBY/FASCO on 01/16/97

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0024

Modified Taguchi Study

Delphi Saginaw Electronic Column Lock Assembly

Invensys Part #: 1740-0002

Specification #: See Test Set-up Page

Sample Size: 18

Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3	Test Results	Failures

Tested By: Lamphere Date: 1/25/01
(Technician)

Product Test Lab Supervisor: Sabri Shujat Date: 1/29/01

Test Facilities Manager: DJ Date: 1/25/01

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Page 1 of 3
8669-2113
9/13/2000

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0022
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 10
Build Date: N/A
Technician: Larry Kane
Start Date: 01/19/2001
Finish Date: 01/22/2001

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
1	14	14	5000	85°C
2	16	9	1641	85°C
3	16	9	539	85°C
4	9	16	2500	85°C
5	18	9	2500	85°C
6	9	18	2500	85°C

Total # of Cycles = 15000

Total Test Time = 27.5 Hrs.

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Page 2 of 3
8869-2113
9/13/2000



Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0022
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 10
Build Date: N/A
Technician: Larry Kane
Start Date: 01/19/2001
Finish Date: 01/22/2001

Part #	Condition	Test #	Cycle	Temperature	Comments
1	Passed	All	All	All	
2	Passed	All	All	All	
3	Passed	All	All	All	
4	Passed	All	All	All	
5	Passed	All	All	All	
6	Passed	All	All	All	
7	Passed	All	All	All	
8	Passed	All	All	All	
10	Stuck Lock	6	1141	21.80°C	No recovery
13	Rebound	3	343	81.16°	Recovered at cycle 441 (82.09°C)
14	Stuck Lock	5	139	77.26°C	Recovered at cycle 1638 of Test # 6 (21.89°C)
15	Rebound	2	1147	77.69°C	Recovered at cycle 3 of Test #4 (82.47°C)
	Stuck Unlock	4	484	23.80°C	No recovery
16	Rebound	2	1112	74.66°C	No recovery
17	Rebound	2	1063	71.22°C	No recovery
18	Rebound	2	1456	82.39°C	No recovery
19	Rebound	2	1134	76.63°C	No recovery
20	Rebound	2	1186	79.82°C	Recovered at cycle 3 of Test #4 (82.47°C)
	Stuck Lock	5	25	81.95°C	No recovery
21	Rebound	2	1191	80°C	No recovery

Synopsis: 1-8 -> passed all tests
13,15,16,17,18,19,20, & 21 -> Rebound very prevalent
14 -> Passed tests 1,2,3, & 4

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0025
Modified Taguchi Study
Delphi Saginaw Electronic Column Lock Assembly
Invensys Part #: 1740-0002
Specification #: See Test Set-up Page
Sample Size: 10
Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3	Test Results	

Tested By: Larry Karr Date: 2/5/01
(Technician)

Product Test Lab Supervisor: Seiby Shultz Date: 2/5/01

Test Facilities Manager: [Signature] Date: 2/5/01

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Page 1 of 3
5669-2113
8/13/2000

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0025
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 10
Build Date: N/A
Technician: Larry Kane
Start Date: 01/30/2001
Finish Date: 02/05/2001

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
9	14	14	5000	85°C
10	9	16	2500	85°C
11	16	9	2500	85°C
12	9	19	2500	85°C
13	18	9	2500	85°C

Total # of Cycles = 15000

Total Test Time = 60 Hrs.

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Page 2 of 3
8669-2113
9/13/2000



Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0025
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 10
Build Date: N/A
Technician: Lamy Kane
Start Date: 01/30/2001
Finish Date: 02/05/2001

Part #	Condition	Test #	Cycle	Temperature	Comments
42	Stuck Lock	13	953	81.99	Remained @ SL for 1547 cycles
46	Passed	All	All	All	
48	Passed	All	All	All	
47	Passed	All	All	All	
49	Passed	All	All	All	
50	Passed	All	All	All	
52	Rebound	13	119	82.08	Rebounded 17 times until cycle 1723
54	Passed	All	All	All	
57	Stuck Lock	13	872	82.08	Remained @ SL for 1628 cycles
58	Passed	All	All	All	

Synopsis:

- Part #42 - Passed Test # 9,10,11, & 12.
Failed after cycle # 953 of test #13. Remained Stuck Lock for 1547 cycles.
- Part #52 - Passed Test # 9,10,11, & 12.
Failed after cycle 119 of test #13 for Rebound. Recorded 17 rebounds until cycle #1723.
- Part #57 - Passed Test # 9,10,11, & 12.
Failed after cycle 872 of test #13. Remained Stuck Lock for 1628 cycles.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 0J-0030
Modified Taguchi Study
Delphi Saginaw Electronic Column Lock Assembly
Invensys Part #: 1740-0002
Specification #: See Test Set-up Page
Sample Size: 21
Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3	Test Results	

Tested By: Larry Kau Date: 2/22/01
(Technician)

Product Test Lab Supervisor: Vipul Thakur Date: 2/22/01

Test Facilities Manager: D. J. G. Date: 2/22/01

Note: This report shall not be reproduced in full without the written permission from Invensys Sensor Systems and the Product Test Laboratory. Test results relate to items tested only.



Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0030
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 21
Build Date: N/A
Technician: Larry Kane
Start Date: 02/06/2001
Finish Date:

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
9	14	14	5000	85°C
10	9	16	2500	85°C
11	16	9	2500	85°C
12	9	16	2500	85°C
13	16	9	2500	85°C

Total # of Cycles = 15000

Total Test Time = 58.3 Hrs.

Pin #	Pad Location	Relay Type
53	1	SPDT
55	2	SPDT
56	3	SPDT
60	4	SPDT
61	5	SPDT
62	6	SPDT
64	7	SPDT
65	8	SPDT
66	9	SPDT
67	10	SPDT
68	11	SPDT
69	12	SPDT
70	13	SPST
71	14	SPST
74	15	SPST
75	16	SPST
76	17	SPST
77	18	SPST
78	19	SPST
79	20	SPST
80	21	SPST

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Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0030
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 21
Build Date: N/A
Technician: Larry Kane
Start Date: 02/08/2001
Finish Date:

Part #	Condition	Test #	Cycle	Comments
03	Stuck Lock	13	403	Never Recovered
05	Stuck Lock	11	2087	Recovered in Test 12 Cycle 184
06	Stuck Lock	13	2070	Never Recovered
08	Stuck Lock	11	1291	Recovered in Test 12 Cycle 1
09				Conformed
01				Conformed
02	Stuck Lock	11	795	Recovered at Test 12 Cycle 130
03	Stuck Lock	13	1170	Never Recovered
04	Stuck Lock	13	2014	Never Recovered
05	Stuck Lock	11	1218	Recovered at Test 12 Cycle 1
06	Stuck Lock	13	821	Never Recovered
07				Conformed
07	Stuck Lock	13	1489	Never Recovered
08	Stuck Lock	11	2	Recovered at Test 12 Cycle 4
09	Stuck Lock	13	2022	Never Recovered
06	Stuck Lock	11	888	Recovered at Test 12 Cycle 1
07	Rebound	9	3774	Rebounded 526x to Test 10 cycle 851
08	Rebound	12	92	Rebound directly to Stuck Lock; Recover T13 C1
09	Stuck Lock	13	1044	Never Recovered
07	Rebound	12	38	Rebounded 2x to cycle 38
08	Rebound	8	381	Rebounded 2x to cycle 483
09	Rebound	10	1485	Rebounded 5x to Test 12 Cycle 1
07	Rebound	8	1643	Rebounded 481x to cycle 4410
08	Rebound	9	2389	Rebounded 622x in test 9
09	Rebound	10	1	Rebounded 8x to cycle 921
07	Rebound	12	70	Rebounded 1x
08	Rebound	8	1041	Rebounded 230x to cycle 300-4
09	Rebound	8	3781	Rebounded 50x to cycle 4432
07	Rebound	10	1	Rebounded 7x to cycle 1800
08	Rebound	10	6	Rebounded 7x to cycle 2800
09	Rebound	12	2	Rebounded 6x to cycle 2800
07	Rebound	8	1081	Rebounded 483x to cycle 5000
08	Rebound	10	28	Rebounded 12x to cycle 2500
09	Rebound	12	68	Rebounded 1x
08	Rebound	8	5008	Rebounded 249x to cycle 6000
09	Rebound	10	1	Rebounded 2x to cycle 537
07	Rebound	12	46	Rebounded 2x to cycle 46
08	Stuck Lock	13	1854	Never Recovered

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0037
Modified Product Validation Test
Delphi Saginaw Electronic Column Lock Assembly
Invenys Part #: 1740-0002
Specification #: Delphi #26050960 Chg. Level 078
Sample Size: 6
Build Date: N/A

Saginaw Tracking #: SCRR # 00-0170
Insulator Change Validation

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3	Initial Switch Point Data	All Conformed
4	Durability Test Results	All Conformed
5	Final Switch Point Data	All Conformed

Tested By:  Date: 3/23/01
(Technician)

Product Test Lab Supervisor:  Date: 3/26/01

Test Facilities Manager:  Date: 3/26/01

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Product Validation Test
Test Log #: 01-0037
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 6
Build Date: N/A
Technician: Larry Kane
Start Date: 03/01/2001
Finish Date: 03/

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
1	16	16	7000	85°C

Total # of Cycles = 7000

Total Test Time = 14 Hrs.

These units were tested on the Floor Production Tester.

Note: This report shall not be reproduced in full without the written permission from Invensys Sensor Systems and the Product Test Laboratory. Test results relate to items tested only.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Product Validation
Test Log #: 01-0037
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Initial Switch Point Data
Sample Size: 24
Build Date: N/A
Technician: Larry Kane
Start Date: 03/01/2001
Finish Date: 03/01/2001

Part #	Full Lock Dim. (mm) >17.55mm	Switch Point Unlock (mm) \leq 12.84mm	Switch Point Lock (mm) \leq 12.84mm
INS-1	18.000	11.705	11.580
INS-2	19.940	11.790	11.840
INS-3	17.980	12.005	11.890
INS-4	18.010	11.845	11.750
INS-5	18.020	12.030	11.925
INS-6	17.985	12.080	11.940

Synopsis: All conformed to specifications

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Product Validation
Test Log #: 01-0037
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Durability
Sample Size: 24
Build Date: N/A
Technician: Larry Kane
Start Date: 03/08/2001
Finish Date: 03/12/2001

Durability: Cycle ECL units at 85°C for 7000 cycles at 7 seconds per cycle. No side loading is to be applied during this test. Voltage level is 18Vdc for both lock and unlock cycle. Record any fault conditions.

Part #	Fault Conditions
INS-1	No fault conditions – Units passed
INS-2	No fault conditions – Units passed
INS-3	No fault conditions – Units passed
INS-4	No fault conditions – Units passed
INS-5	No fault conditions – Units passed
INS-6	No fault conditions – Units passed

Summary: Data from the continuous monitoring system revealed that the above unit operated in conformance with specification.

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9/13/2000

Invensys

Sensor Systems

Type of Test: Modified Product Validation
Test Log #: 01-0037
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Final Switch Point Data
Sample Size: 24
Build Date: N/A
Technician: Larry Kane
Start Date: 03/21/2001
Finish Date: 03/21/2001

Part #	Full Lock Dim. (mm) ≥17.55mm	Switch Point Unlock (mm) <12.84mm	Switch Point Lock (mm) ≤12.84mm
INS-1	18.090	11.480	11.355
INS-2	18.045	11.850	11.645
INS-3	18.090	11.580	11.505
INS-4	18.070	11.690	11.595
INS-5	18.130	11.860	11.730
INS-6	18.095	11.845	11.850

Synopsis: All conformed to specification.

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Insulator PPAP Durability Test Data
Saginaw ECL 1740-0002

	INS-1	INS-2	INS-3	INS-4	INS-5	INS-6	INS-7	INS-8	INS-9	INS-10	INS-11	INS-12	INS-13	INS-14	INS-15	INS-16	INS-17	INS-18	INS-19	INS-20	INS-21	INS-22	INS-23	INS-24
U-0 Unlock Pass	6900	6900	6900	6900	6900	6900	1462	6900	6900	6900	6900	6900	6900	6900	6900	1720	6900	6900	6900	6900	6900	6900	6900	6900
U-1 Unl-Overshoot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-2 Unl-Rebound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-3 Unl-Wrong Start	0	0	0	0	0	0	0	3518	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
U-4 Unl-HardStop	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0	5200	0	0	0	0	0	0	0
U-5 Unl-PTCA	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	1	0	1	1
U-6 Unl-PTCB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1
U-7 Unl-Elect. Fall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-8 Unl-Sys. Err	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-9 Unl-Timing Error	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-0 Lock Pass A	7000	7000	7000	7000	7000	7000	1462	7000	6900	6900	6900	6900	6900	7000	7000	1719	6978	6900	7000	7000	7000	7000	6970	6904
L-1 Lock Pass B	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0
L-2 Lock Wrong Start	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-3 Lock Bounce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	2	0	0	0	0	0	0
L-4 Lock HardStop	0	0	0	0	0	0	0	301	0	0	0	0	17	0	0	254	0	0	0	0	0	0	30	105
L-5 Lock PTCA	0	0	0	0	0	0	0	57	0	0	0	0	45	0	0	3458	0	0	0	0	0	0	0	0
L-6 Lock PTCB	0	0	0	0	0	0	0	5070	0	0	0	0	79	0	0	1570	0	0	0	0	0	0	0	0
L-7 Lock Elect. Switch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-8 Lock Sys. Err	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L-9 Lock Timing Err.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

DELPHI

Automotive Systems

SUPPLIER CHANGE REQUEST / REVIEW

Tracking # 00-0170

DELPHI Part No./Chg. Level 28050001 / 072

Shown on Dwg. # 28050001

Product Application

Steering Column Lock

Detailed Description of Change Proposal:

1 DELPHI Part Name

Lock, Electric Column

Supplier Name

Inverysys Sensor Systems

2 DELPHI Reviewing Division/Location

Supern Steering Systems, Plant 5

Supplier Manufacturing Location/DUNS

Shelby, NC 807884457

SECTION 1: CHANGE DESCRIPTION

Change the insulator for the motor assembly. The change is to remove the insulator by the side of the motor.

*Testing = 24 pcs durability with thermal**Testing = 6 pcs on continuous Testing**Fixture / Sub-plate PER CONT. Cat II
27 FEB 01 W7 R. Nash, D. Priebe, J. Bunting JER*Reason For Change: *A part was found at Bunting Green Bay had the terminal shorted to the housing.*

Reference PRR # (Replaceable): 20000801-080505

- Affected
Y/N
- Appearance
 - Audit Capacity
 - Drawing/ Dims.
 - Function
 - Key Prod. Char.
 - Maps
 - Material
 - Packaging
 - Process
 - Quality
 - Safety
 - Timing

SECTION 2: CHANGE IMPACT

THIS SECTION MUST BE COMPLETED FOR ALL ITEMS MARKED "YES" IN ITEM #1. ATTACH DETAIL AS NECESSARY (See Instructions)

Reasons change not being

This will help correct the short whenever that occurs during assembly.

This will then reduce warranty issues in the field.

"ATTACH IMPLEMENTATION TIMELINE, CONTINGENCY PLAN, SKETCHES, DRAWINGS, ENG. PERMITS, etc."

Signature:

(Supplier)

Per Supplier Details:

Supplier Contact: Dan Thunber

Date: 6-19-01

(At DELPHI)

Submitted As:

N/A

Last Banks: 517-767-7070

PPAP

Submission Date:

N/A

Functional Areas Affected (check one):

Signature & Date of Decision

FUNCTION	PRINTED NAME & PHONE #	APPROVED <input checked="" type="checkbox"/> <i>(Printed Name/Initials)</i>	REJECTED <input type="checkbox"/> <i>(Do Not Proceed with Change)</i>
Supplier Quality Eng.	Jim Barnes	J. Barnes (J.B.)	
Procurement Eng. & Log.	Jim Barnes	J. Barnes	
Buyer:			
Product / Systems Eng.	Bill Baker 914-570-1	B. Baker 6/12/01	
Plant-Quality Eng. 2nd Func.	F344-570-1		
Eng. / Indus. / Process Eng.	Bob Lutz 914-570-1		
PPAP Submission/Planning:	Tim O'Leary	N/A	

If Approved: (one box must be checked)

 Proceed with preparation of PPAP Submission as defined below (Include copy of this form with PPAP submission)

NOTE - This does not authorize production shipment incorporating changes; authorization will be contingent on PPAP approval or engineering permit.

 Subsequent ship requirements will be communicated through Delphi PC&L PPAP Submission Not Required - Proceed with Change as defined below

NOTE - Supplier must still update and maintain appropriate documents at their location

Information to be Submitted / Actions Required: PPAP LEVEL - 1 2 3 4 5 (circle one)

PPAP Requirements: CPG-1991 Edm. Ver. 2000 New Part Number: _____ Print and Inspection Results Appearance Approval Report Sample Part Qty: _____ DFMEA PFMEA Process Flow Diagram Engineering Permits

- Process Control Plan
- Early Production Containment
- Process Capability Studies
- Gaging Audit
- Gage Studies
- Laboratory/Test Results/Specs
- Material Certification(s)
- Tier I Approval (Documentation Req'd)
- Other

- Implementation Requirements:
- Pending Delphi Design/Process Validation
- Pending Delphi Customer Approval
- Pending Delphi Production Trial Run
- On Site Audit
- Early Production Containment Qty: _____
- Appropriate Packaging Forms
- Run of Rate Qty: _____ Date: _____
- Cust. Monitored / Suppl. Monitored
- Breakpoint Tag Required for Shipment

COMMENTS / CONDITIONS:

by _____ date _____

CHANGE AUTHORIZATION SENT TO: *Dan Thunber* (Supplier contact) and all above "X" function Date: *6/19/01*

Insulator PPAP Read

Saginaw ECL Before

Initial Data

Operational Data 5 pcs@ start, mid and end of shift

5 Vdc power for all lock pin and sw. point measurements

12.0n Vdc for lock time measurements

Part	Date	Time	Full Lock	Switch Point	Full Unlock	Switch Point	Lock
			Dim. (mm)	Unlock (mm)	Dim. (mm)	Lock (mm)	Time (ms)
1			18.000	11.705	10.380	11.570	
2	2		17.940	11.970	10.300	11.840	
3	3		17.960	12.005	10.320	11.870	
4	4		18.010	11.845	10.325	11.750	
5	5		18.020	12.030	10.340	11.925	
6	1		17.965	12.090	10.315	11.940	
7	2		17.945	11.865	10.305	11.760	
8	3		17.975	12.085	10.290	11.830	
9	4		17.940	11.855	10.315	11.800	
10	5		18.010	12.080	10.365	11.915	
11	1		17.980	12.465	10.360	12.285	
12	2		18.035	12.155	10.335	12.030	
13	3		17.930	12.000	10.325	11.900	
14	4		17.980	12.185	10.365	12.175	
15	5		17.990	11.915	10.380	11.675	
16	1		17.975	11.985	10.360	11.780	
17	2		17.920	12.110	10.325	11.635	
18	3		17.910	11.915	10.310	11.685	
19	4		17.955	11.840	10.340	11.685	
20	5		18.040	11.780	10.430	11.740	
21	1		17.925	11.780	10.260	11.705	
22	2		17.935	12.130	10.325	11.925	
23	3		17.965	12.070	10.285	11.870	
24	4		17.895	12.475	10.280	12.020	
	5						
1							
2							
3							
4							
5							
1							
2							
3							
4							
5							

Saginaw ECL

Operational Data 5 pcs @ start, mid and end of shift
 5 Vdc power for all lock pin and sw. point measurements
 12.0n Vdc for lock time measurements

Part	Date	Time	Full Lock	Switch Point	Full Unlock	Switch Point	Lock
			Dlm. (mm)	Unlock (mm)	Dlm. (mm)	Lock (mm)	Time (ms)
1	1	3/7/01	18.090	11.480	10.240	11.355	
2	2		18.045	11.850	10.230	11.645	
3	3		18.090	11.590	10.235	11.505	
4	4		18.070	11.690	10.255	11.595	
5	5		18.130	11.860	10.260	11.730	
6	1		18.095	11.845	10.250	11.850	
7	2		18.070	11.480	10.250	11.390	
8	3						Upstop stuck
9	4		18.105	11.520	10.260	11.465	
10	5		18.105	11.720	10.300	11.740	
11	1		18.060	12.270	10.220	12.110	
12	2		18.050	11.520	10.165	11.525	
13	3		18.085	11.770	10.165	11.645	
14	4		18.085	12.005	10.295	11.760	
15	5		18.095	11.555	10.310	11.505	
16	1						Upstop stuck
17	2		18.030	11.850	10.170	11.545	
18	3		18.045	11.690	10.265	11.610	
19	4		18.095	11.570	10.185	11.510	
20	5		18.120	11.565	10.310	11.610	
21	1		18.130	11.780	10.285	11.725	
22	2		18.050	11.920	10.175	11.745	
23	3		18.050	11.945	10.255	11.685	
24	4		12.985	12.145	10.185	11.795	
25	5	✓					No 25
1							
2							
3							
4							
5							
1							
2							
3							
4							
5							

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

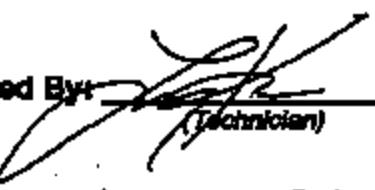


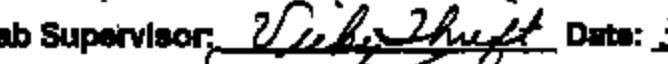
Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0037
Modified Product Validation Test
Delphi Saginaw Electronic Column Lock Assembly
Invenys Part #: 1740-0002
Specification #: Delphi #26050960 Chg. Level 078
Sample Size: 6
Build Date: N/A

Saginaw Tracking #: SCRR # 00-0170
Insulator Change Validation

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3	Initial Switch Point Data	All Conformed
4	Durability Test Results	All Conformed
5	Final Switch Point Data	All Conformed

Tested By:  Date: 3/23/01
(Technician)

Product Test Lab Supervisor:  Date: 3/26/01

Test Facilities Manager:  Date: 3/26/01

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Product Validation Test
Test Log #: 01-0037
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 8
Build Date: N/A
Technician: Larry Kane
Start Date: 03/01/2001
Finish Date: 03/

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
1	16	16	7000	85°C

Total # of Cycles = 7000

Total Test Time = 14 Hrs.

These units were tested on the Floor Production Tester.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Product Validation
Test Log #: 01-0037
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Initial Switch Point Data
Sample Size: 24
Build Date: N/A
Technician: Larry Kane
Start Date: 03/01/2001
Finish Date: 03/01/2001

Part #	Full Lock Dim. (mm) >17.55mm	Switch Point Unlock (mm) ≤12.84mm	Switch Point Lock (mm) ≤12.84mm
INS-1	18.000	11.705	11.580
INS-2	19.940	11.790	11.840
INS-3	17.980	12.005	11.890
INS-4	18.010	11.845	11.750
INS-5	18.020	12.030	11.925
INS-6	17.985	12.090	11.940

Synopsis: All conformed to specifications

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9/13/2000

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Product Validation
Test Log #: 01-0037
Customer/Part Description: Delphi Seginew ECL
Invensys Part #: 1740-0002
Test Description: Durability
Sample Size: 24
Build Date: N/A
Technician: Larry Kane
Start Date: 03/08/2001
Finish Date: 03/12/2001

Durability: Cycle ECL units at 85°C for 7000 cycles at 7 seconds per cycle. No side loading is to be applied during this test. Voltage level is 16Vdc for both lock and unlock cycle. Record any fault conditions.

Part #	Fault Conditions
INS-1	No fault conditions – Units passed
INS-2	No fault conditions – Units passed
INS-3	No fault conditions – Units passed
INS-4	No fault conditions – Units passed
INS-5	No fault conditions – Units passed
INS-6	No fault conditions – Units passed

Summary: Data from the continuous monitoring system revealed that the above unit operated in conformance with specification.

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9/13/2000

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Product Validation
Test Log #: 01-0037
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Final Switch Point Data
Sample Size: 24
Build Date: N/A
Technician: Larry Kane
Start Date: 03/21/2001
Finish Date: 03/21/2001

Part #	Full Lock Dim. (mm) <i>>17.56mm</i>	Switch Point Unlock (mm) <i><12.84mm</i>	Switch Point Lock (mm) <i><12.84mm</i>
INS-1	18.090	11.480	11.355
INS-2	18.045	11.650	11.645
INS-3	18.090	11.590	11.505
INS-4	18.070	11.690	11.585
INS-5	18.130	11.880	11.730
INS-6	18.095	11.845	11.850

Synopsis: All conformed to specification.

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Product Test Laboratory
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Shelby, NC 28150

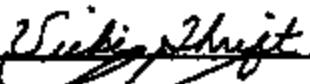
Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0043
Modified Taguchi Study
Delphi Saginaw Electronic Column Lock Assembly
Invensys Part #: 1740-0002
Specification #: See Test Set-up Page
Sample Size: 19
Build Date: N/A

Page #	Table of Contents
1	Cover Page
2	Test Set-up Page
3-6	Test Results
7	Result Codes

Tested By:  Date: 3/22/01
(Technician)

Product Test Lab Supervisor:  Date: 3/20/01

Test Facilities Manager:  Date: 3/28/01

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Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0043
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 10
Build Date: N/A
Technician: Larry Kane
Start Date: 03/08/2001
Finish Date: 03/22/2001

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
9	14	14	5000	85°C
10	9	16	2500	85°C
11	16	9	2500	85°C
12	9	16	2500	85°C
13	18	9	2500	85°C

Total # of Cycles = 15000

Total Test Time = 30 Hrs.

Part #	Station #	Relay Type
81	1	SPDT
82	2	SPDT
83	3	SPDT
84	4	SPDT
85	5	SPDT
86	6	SPDT
87	7	SPDT
88	8	SPDT
89	9	SPDT
90	10	SPDT
92	11	SPDT
93	12	SPDT
94	13	SPST
95	14	SPST
96	15	SPST
97	16	SPST
98	17	SPST
99	18	SPST
100	19	SPST

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1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0043
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 19
Build Date: N/A
Technician: Larry Kane
Start Date: 03/09/2001
Finish Date: 03/22/2001

ID#	U-0 Unlock Pass	U-1 Unlock- Overshoot	U-2 Unlock- Rebound	U-3 Unlock-Wrong Start	U-4 Unlock- Hardstop
81	14999	0	1	0	0
82	14999	0	1	0	0
83	15000	0	0	0	0
84	14999	0	1	0	0
85	14998	0	2	0	0
86	14999	0	1	0	0
87	15000	0	0	0	0
88	9994	0	0	0	0
89	15000	0	0	0	0
90	15000	0	0	0	0
92	14695	0	0	0	0
93	15000	0	0	0	0
94	13812	0	1155	0	0
95	10317	0	4883	0	0
96	15000	0	0	0	0
97	10184	0	2316	0	0
98	9742	0	1981	3277	0
99	10300	0	4700	0	0
100	10217	0	4783	0	0

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8/13/2000

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0043
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 19
Build Date: N/A
Technician: Larry Kane
Start Date: 03/08/2001
Finish Date: 03/22/2001

ID#	U-5 Unlock PTCA	U-6 Unlock PTCB	U-7 Unlock Elect. Fail	U-8 Unlock Sys. Err	U-9 Unlock Timing Error
81	0	0	0	0	0
82	0	0	0	0	0
83	0	0	0	0	0
84	0	0	0	0	0
85	0	0	0	0	0
86	0	0	0	0	0
87	0	0	0	0	0
88	2511	2495	0	0	0
89	0	0	0	0	0
90	0	0	0	0	0
92	304	1	0	0	0
93	0	0	0	0	0
94	16	17	0	0	0
95	0	0	0	0	0
96	0	0	0	0	0
97	56	2444	0	0	0
98	0	0	0	0	0
99	0	0	0	0	0
100	0	0	0	0	0

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Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0043
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 10
Build Date: N/A
Technician: Larry Kane
Start Date: 03/09/2001
Finish Date: 03/22/2001

ID#	L-0 Lock Pass A	L-1 Lock Pass B	L-2 Lock Wrong Start	L-3 Lock Bounce	L-4 Lock Hardstop
81	15000	0	0	0	0
82	15000	0	0	0	0
83	15000	0	0	0	0
84	15000	0	0	0	0
85	15000	0	0	0	0
86	14973	0	0	27	0
87	15000	0	0	0	0
88	8772	0	5005	223	0
89	14999	0	0	1	0
90	15000	0	0	0	0
92	14898	0	304	0	0
93	15000	0	0	0	0
94	13747	0	1252	1	0
95	10322	0	4678	0	0
96	15000	0	0	0	0
97	10178	0	4822	0	0
98	9735	3	1985	0	1240
99	10294	0	4706	0	0
100	10223	0	4777	0	0

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1100 Airport Rd.
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Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0043
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 18
Build Date: N/A
Technician: Larry Kane
Start Date: 03/09/2001
Finish Date: 03/22/2001

ID#	L-6 Lock PTCA	L-6 Lock PTCB	L-7 Lock Elect Switch	L-8 Lock Sys. Err	L-8 Lock Timing Err.
81	0	0	0	0	0
82	0	0	0	0	0
83	0	0	0	0	0
84	0	0	0	0	0
85	0	0	0	0	0
86	0	0	0	0	0
87	0	0	0	0	0
88	0	0	0	0	0
89	0	0	0	0	0
90	0	0	0	0	0
92	0	0	0	0	0
93	0	0	0	0	0
94	0	0	0	0	0
95	0	0	0	0	0
96	0	0	0	0	0
97	0	0	0	0	0
98	0	2037	0	0	0
99	0	0	0	0	0
100	0	0	0	0	0

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Sensor Systems

Result Codes:

Code #	Classification	Criteria
U-0	Pass-Unlock	Switch Starts High - Switch Ends Low Single Transition between 50 and 810msec from Power ON
U-1	Unlock-Overshoot	Switch Starts High - Switch Ends High OR Low (may end Low when power is released at 650msec) Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is ON (Current >0.5Amps)
U-2	Unlock-Rebound	Switch Starts High - Switch Ends High - Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is OFF (Current <0.5Amps)
U-3	Unlock-wrong start	Switch Starts Low.
U-4	Unlock-Hardstop	Switch Starts High - Switch Ends High - No Transitions Current Remains High For entire test (>0.5 Amps)
U-5	Unlock-PTCA	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 100milliseconds
U-6	Unlock-PTCB	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 300milliseconds
U-7	Unlock-Elect failure	Switch Starts High - Switch Ends High - No Transitions - Current appears normal, but remains high in the end (may not be able to do this one....)
U-8	Unlock-System Error	Switch Starts High - Switch Ends High - No Transitions - No Current Or More than 2 transitions.
U-9	Unlock-timing	Switch Starts High - Switch Ends Low - Single Transition outside of range: 50 and 810msec from Power ON
L-0	Lock-Pass A	Switch Starts Low - Switch Ends High - Single Transition before 300 msec
L-1	Lock-Pass B	Switch Starts Low - Switch Ends High - Single Transition before 810 msec
L-2	Lock-wrong start	Switch Starts High
L-3	Lock-bounce	Switch Starts Low - Switch Ends High - Multiple transitions - at any point in the cycle
L-4	Lock-Hardstop	Switch Starts and Ends Low - No transition - Current remains high for duration of test (>0.5Amps)
L-5	Lock-PTC A	Switch Starts and Ends Low - No transition - Current starts high and drops off after 100 msec.
L-6	Lock-PTC B	Switch Starts and Ends Low - No transition - Current starts high and drops off after 300 msec.
L-7	Lock-Elect	Switch Starts and Ends Low - No transition - Current appears "normal" (this class may not be able to be classified)
L-8	Lock-System Error	Switch Starts and Ends Low - No transition - No Power - No current
L-9	Unlock-timing	Switch Starts Low - Switch Ends High - Single Transition after 810msec

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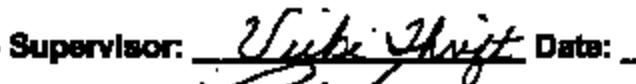
Invensys

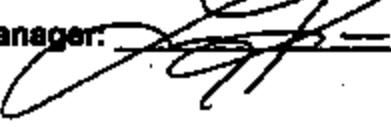
Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0050
Modified Taguchi Study
Delphi Saginaw Electronic Column Lock Assembly
Invensys Part #: 1740-0002
Specification #: See Test Set-up Page
Sample Size: 20
Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3-6	Test Results	
7	Result Codes	

Tested By:  Date: 3/28/01
(Technician)

Product Test Lab Supervisor:  Date: 3/28/01

Test Facilities Manager:  Date: 3/28/01

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Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0050
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 03/22/2001
Finish Date: 03/26/2001

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
9	14	14	5000	25°C
10	8	16	2500	85°C
11	16	9	2500	85°C
12	9	18	2500	85°C
13	18	9	2500	85°C

Total # of Cycles = 15000

Total Test Time = 30 Hrs.

Part #	Station Location	Relay Type
101	1	SPDT
102	2	SPDT
103	3	SPDT
104	4	SPDT
105	5	SPDT
106	6	SPDT
107	7	SPDT
108	8	SPDT
109	9	SPDT
110	10	SPDT
111	11	SPDT
112	12	SPDT
113	13	SPST
114	14	SPST
115	15	SPST
116	16	SPST
117	17	SPST
118	18	SPST
119	19	SPST
120	20	SPST

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Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0050
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 03/22/2001
Finish Date: 03/28/2001

ID #	U-0 Unlock-Pass	U-1 Unlock-Overshoot	U-2 Unlock-Rebound	U-3 Unlock-Wrong Start	U-4 Unlock-Hardstop
101	15000	0	0	0	0
102	15000	0	0	0	0
103	13842	0	0	0	0
104	10349	0	0	0	0
105	14995	1	4	0	0
106	14999	0	1	0	0
107	15000	0	0	0	0
108	13718	0	1	0	0
109	15000	0	0	0	0
110	14853	0	2	0	0
111	15000	0	0	0	0
112	14999	0	1	0	0
113	7767	0	4733	0	0
114	10373	0	4827	0	0
115	10311	0	4889	0	0
116	10226	0	4772	0	0
117	6847	0	4794	0	0
118	10186	0	4804	0	0
119	10296	0	4702	0	0
120	9979	0	5021	0	0

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0050
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 03/22/2001
Finish Date: 03/26/2001

ID #	U-5 Unlock PTCA	U-6 Unlock PTCB	U-7 Unlock Elect. Fail	U-8 Unlock Sys. Err	U-9 Unlock Timing Error
101	0	0	0	0	0
102	0	0	0	0	0
103	41	1117	0	0	0
104	39	4612	0	0	0
105	0	0	0	0	0
106	0	0	0	0	0
107	0	0	0	0	0
108	0	1261	0	0	0
109	0	0	0	0	0
110	161	174	0	0	0
111	0	0	0	0	0
112	0	0	0	0	0
113	2423	77	0	0	0
114	0	0	0	0	0
115	0	0	0	0	0
116	0	0	0	0	0
117	1733	1626	0	0	0
118	0	0	0	0	0
119	0	0	0	0	0
120	0	0	0	0	0

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9/13/2000

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0050
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 03/22/2001
Finish Date: 03/26/2001

ID #	L-0 Lock Pass A	L-1 Lock Pass B	L-2 Lock Wrong Start	L-3 Lock Bounce	L-4 Lock Hardstop
101	15000	0	0	0	0
102	14999	0	0	1	0
103	13843	0	1157	0	0
104	10272	0	4651	77	0
105	14898	0	0	104	0
106	14998	0	0	1	0
107	15000	0	0	0	0
108	13720	0	1280	0	0
109	14874	0	0	328	0
110	14885	0	334	0	0
111	15000	0	0	0	0
112	15000	0	0	0	0
113	7758	0	7230	12	0
114	10373	0	4627	0	0
115	9389	0	4685	946	0
116	8975	0	4770	255	0
117	6850	0	8150	0	0
118	9129	0	4803	1068	0
119	10302	0	4698	0	0
120	9987	0	5013	0	0

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0050
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 03/22/2001
Finish Date: 03/26/2001

ID #	L-6 Lock PTCA	L-6 Lock PTCB	L-7 Lock Elect Switch	L-8 Lock Sys. Err	L-9 Lock Timing Err.
101	0	0	0	0	0
102	0	0	0	0	0
103	0	0	0	0	0
104	0	0	0	0	0
105	0	0	0	0	0
106	0	0	0	0	0
107	0	0	0	0	0
108	0	0	0	0	0
109	0	0	0	0	0
110	0	0	0	0	0
111	0	0	0	0	0
112	0	0	0	0	0
113	0	0	0	0	0
114	0	0	0	0	0
115	0	0	0	0	0
116	0	0	0	0	0
117	0	0	0	0	0
118	0	0	0	0	0
119	0	0	0	0	0
120	0	0	0	0	0

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9/13/2000



Sensor Systems

Result Codes:

Code #	Classification	Criteria
U-0	Pass-Unlock	Switch Starts High - Switch Ends Low Single Transition between 50 and 510msec from Power ON
U-1	Unlock-Overshoot	Switch Starts High - Switch Ends High OR Low (may end Low when power is released at 650msec) Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is ON (Current >0.6Amps)
U-2	Unlock-Rebound	Switch Starts High - Switch Ends High - Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is OFF (Current <0.5Amps)
U-3	Unlock-wrong start	Switch Starts Low.
U-4	Unlock-Hardstop	Switch Starts High - Switch Ends High - No Transitions Current Remains High For entire test (>0.5 Amps)
U-5	Unlock-PTCA	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 100milliseconds
U-6	Unlock-PTCB	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 300milliseconds
U-7	Unlock-Elect failure	Switch Starts High - Switch Ends High - No Transitions - Current appears normal, but remains high in the end (may not be able to do this one....)
U-8	Unlock-System Error	Switch Starts High - Switch Ends High - No Transitions - No Current Or More than 2 transitions.
U-9	Unlock-timing	Switch Starts High - Switch Ends Low - Single Transition outside of range: 50 and 510msec from Power ON
L-0	Lock-Pass A	Switch Starts Low - Switch Ends High - Single Transition before 300 msec
L-1	Lock-Pass B	Switch Starts Low - Switch Ends High - Single Transition before 510 msec
L-2	Lock-wrong start	Switch Starts High
L-3	Lock-bounce	Switch Starts Low - Switch Ends High - Multiple transitions - at any point in the cycle
L-4	Lock-Hardstop	Switch Starts and Ends Low - No transition - Current remains high for duration of test (>0.6Amps)
L-5	Lock-PTC A	Switch Starts and Ends Low - No transition - Current starts high and drops off after 100 msec,
L-6	Lock-PTC B	Switch Starts and Ends Low - No transition - Current starts high and drops off after 300 msec.
L-7	Lock-Elect	Switch Starts and Ends Low - No transition - Current appear 'normal' (this class may not be able to be classified)
L-8	Lock-System Error	Switch Starts and Ends Low - No transition - No Power - No current
L-9	Unlock-timing	Switch Starts Low - Switch Ends High - Single Transition after 510msec

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Shelby, NC 28160

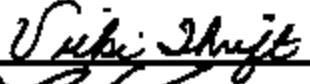
Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0053
Modified Taguchi Study
Delphi Saginaw Electronic Column Lock Assembly
Invenys Part #: 1740-0002
Specification #: See Test Set-up Page
Sample Size: 20
Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3-6	Test Results	
7	Result Codes	

Tested By:  Date: 4/9/01
(Technician)

Product Test Lab Supervisor:  Date: 4/9/01

Test Facilities Manager:  Date: 4/9/01

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0053
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 20
Build Date: N/A
Technician: Lanny Kana
Start Date: 3/28/2001
Finish Date: 4/02/2001

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Temperature
9	14	14	5000	25°C
10	9	16	2500	85°C
11	16	9	2500	85°C
12	9	18	2500	85°C
13	18	9	2500	85°C

Total # of Cycles = 15000

Total Test Time = 30 Hrs.

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9/13/2000

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0053
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 3/26/2001
Finish Date: 4/02/2001

Part #	U-0 Unlock Pass	U-1 Unlock-Overshoot	U-2 Unlock-Rebound	U-3 Unlock-Wrong Start	U-4 Unlock-HardStop
121	15000	0	0	0	0
122	15000	0	0	0	0
123	12326	0	0	0	0
124	14991	0	9	0	0
125	13704	0	0	1266	0
126	14999	0	1	0	0
127	14986	0	15	0	0
128	15000	0	0	0	0
129	12636	0	0	2164	0
130	12478	0	0	0	0
131	15000	0	0	0	0
132	14988	0	4	0	0
133	9928	0	5072	0	0
134	9840	0	5160	0	0
135	10000	0	5000	0	0
136	10000	0	5000	0	0
137	9990	0	5010	0	0
138	7414	0	2508	2323	0
139	8487	0	4013	0	0
140	7834	0	7166	0	0

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Product Test Laboratory
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Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0053
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 3/28/2001
Finish Date: 4/02/2001

Part #	U-5 Unlock PTCA	U-6 Unlock PTCB	U-7 Unlock Elect. Fall	U-8 Unlock Sys. Err	U-9 Unlock Timing Error
121	0	0	0	0	0
122	0	0	0	0	0
123	295	2379	0	0	0
124	0	0	0	0	0
125	0	8	0	0	0
126	0	0	0	0	0
127	0	0	0	0	0
128	0	0	0	0	0
129	0	0	0	0	0
130	22	2500	0	0	0
131	0	0	0	0	0
132	0	0	0	0	0
133	0	0	0	0	0
134	0	0	0	0	0
135	0	0	0	0	0
136	0	0	0	0	0
137	0	0	0	0	0
138	826	2127	0	0	0
139	19	2481	0	0	0
140	0	0	0	0	0

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0053
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 3/28/2001
Finish Date: 4/02/2001

Part #	L-0 Lock Pass A	L-1 Lock Pass B	L-2 Lock Wrong Start	L-3 Lock Bounce	L-4 Lock Hardstop
121	14997	0	0	3	0
122	14998	0	0	2	0
123	12327	0	2873	0	0
124	14999	0	0	1	0
125	13704	0	8	0	1
126	14579	0	0	421	0
127	15000	0	0	0	0
128	15000	0	0	0	0
129	12835	1	0	0	38
130	12478	0	2522	0	0
131	15000	0	0	0	0
132	14997	0	0	3	0
133	9905	0	5095	0	0
134	9779	0	5227	0	0
135	10000	0	5000	0	0
136	9999	0	5000	1	0
137	9973	0	5027	0	0
138	7414	0	5283	0	1
139	5315	0	8884	1	0
140	7836	0	7184	0	0

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Modified Taguchi Study
Test Log #: 01-0053
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 20
Build Date: N/A
Technician: Larry Kane
Start Date: 3/28/2001
Finish Date: 4/02/2001

Part #	L-5 Lock PTCA	L-6 Lock PTCB	L-7 Lock Elect Switch	L-8 Lock Sys. Err	L-9 Lock Timing Err.
121	0	0	0	0	0
122	0	0	0	0	0
123	0	0	0	0	0
124	0	0	0	0	0
125	0	1287	0	0	0
126	0	0	0	0	0
127	0	0	0	0	0
128	0	0	0	0	0
129	0	2126	0	0	0
130	0	0	0	0	0
131	0	0	0	0	0
132	0	0	0	0	0
133	0	0	0	0	0
134	0	0	0	0	0
135	0	0	0	0	0
136	0	0	0	0	0
137	0	0	0	0	0
138	0	2322	0	0	0
139	0	0	0	0	0
140	0	0	0	0	0

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Sensor Systems

Result Codes:

Code #	Classification	Criteria
L-0	Pass-Lock	Switch Starts High - Switch Ends Low Single Transition between 50 and 610msec from Power ON
L-1	Unlock-Overshoot	Switch Starts High - Switch Ends High OR Low (may end Low when power is released at 650msec) Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is ON (Current >0.5Amps)
L-2	Unlock-Rebound	Switch Starts High - Switch Ends High - Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is OFF (Current <0.5Amps)
L-3	Unlock-wrong start	Switch Starts Low.
L-4	Unlock-Hardstop	Switch Starts High - Switch Ends High - No Transitions Current Remains High For entire test (>0.5 Amps)
L-5	Unlock-PTCA	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 100milliseconds
L-6	Unlock-PTCB	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 300milliseconds
L-7	Unlock-Elect. failure	Switch Starts High - Switch Ends High - No Transitions - Current appears normal, but remains High in the end (may not be able to do this one....)
L-8	Unlock-System Error	Switch Starts High - Switch Ends High - No Transitions - No Current Or More than 2 transitions.
L-9	Unlock-timing	Switch Starts High - Switch Ends Low - Single Transition outside of range: 50 and 610msec from Power ON
L-0	Lock-Pass A	Switch Starts Low - Switch Ends High -Single Transition before 300 msec
L-1	Lock-Pass B	Switch Starts Low - switch Ends High - Single Transition before 610 msec
L-2	Lock-wrong start	Switch Starts High
L-3	Lock-bounce	Switch Starts Low - Switch Ends High - Multiple transitions - at any point in the cycle
L-4	Lock-Hardstop	Switch Starts and Ends Low - No transition -Current remains high for duration of test (>0.5Amps)
L-5	Lock-PTC A	Switch Starts and Ends Low - No transition - Current starts High and drops off after 100 msec.
L-6	Lock-PTC B	Switch Starts and Ends Low - No transition - Current starts High and drops off after 300 msec.
L-7	Lock-Elect.	Switch Starts and Ends Low - No transition -Current appear "normal" (this class may not be able to be classified)
L-8	Lock-System Error	Switch Starts and Ends Low - No transition - No Power - No current
L-9	Unlock-timing	Switch Starts Low - Switch Ends High - Single Transition after 610msec

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0057b
PPAP

Delphi Saginaw Electronic Column Lock Assembly
Invensys Part #: 1740-0002
Specification #: Delphi #26050960 Chg. Level 078
Sample Size: 6
Build Date: 4041

Crush Rib Change

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3	Durability Test Results	See Details
4	Result Codes	

Tested By: Lynn James Date: 4/25/01
(Technician)

Product Test Lab Supervisor: Vicki Shultz Date: 4/25/01

Test Facilities Manager: [Signature] Date: 4/25/01

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Invensys

Sensor Systems

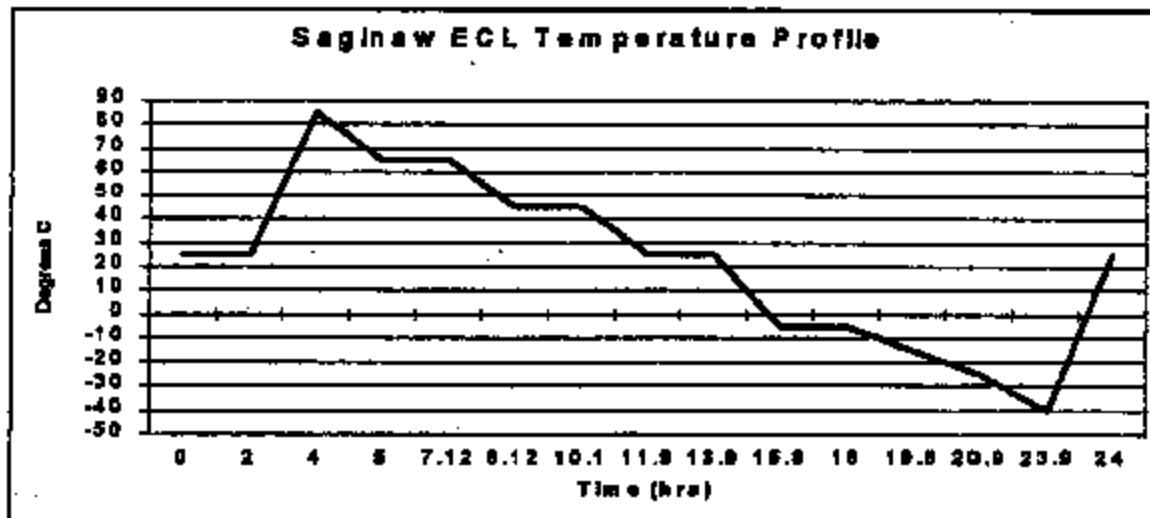
Type of Test: PPAP
Test Log #: 01-0057b
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 6
Build Date: 4041
Technician: Wade Landis
Start Date: 4/6/2001
Finish Date: 4/16/2001

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Side Load
1	9	9	15	22 ft/lb.
2	12	12	1000	11 ft/lb.
3	12	12	10,000	5 ft/lb.
4	9	12.8	9747	0 ft/lb.
5	12.8	9	9738	0 ft/lb.
6	9	14.2	9747	0 ft/lb.
7	14.2	9	9748	0 ft/lb.
8	9	9	15	22 ft/lb.

Total # of Cycles = 15000

Total Test Time = 58.3 Hrs.



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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0057b
 Customer/Part Description: Delphi Saginaw ECL
 Invensys Part #: 1740-0002
 Test Description: Durability
 Sample Size: 6
 Build Date: 4041
 Technician: Larry Kane
 Start Date: 4/8/2001
 Finish Date: 4/16/2001

Part #	First Failure				Test Station Relay Type	U-0 Unlock Pass	U-1 Unlock- Overshoot	U-2 Unlock- Rebound
	T#	C#	o	Fall Code				
CR-1	2	501	78.6	U-2	SPST	37733	1	8828
CR-2	2	851	62	L-2	SPST	31270	0	11191
CR-3	3	48	61.5	U-2	SPST	38351	0	11854
CR-4	2	670	67.4	L-2	SPST	37804	0	12203
CR-5	2	522	76.1	U-2	SPST	37281	2	12721
CR-6	2	807	71.7	U-2	SPST	32284	0	12046

Part #	U-3 Unlock- Wrong Start	U-4 Unlock- Hardstop	U-5 Unlock PTCA	U-6 Unlock PTCB	U-7 Unlock Elect. Fall	U-8 Unlock Sys. Err	U-9 Unlock Timing Error	L-0 Lock Pass A
CR-1	0	0	0	3648	0	0	0	37619
CR-2	0	0	0	7548	0	0	1	31248
CR-3	0	0	0	6	0	0	0	38283
CR-4	0	0	0	1	0	0	0	37819
CR-5	0	0	0	6	0	0	0	37196
CR-6	0	0	0	5879	0	0	1	32201

Part #	L-1 Lock Pass B	L-2 Lock Wrong Start	L-3 Lock Bounce	L-4 Lock Hardstop	L-5 Lock PTCA	L-6 Lock PTCB	L-7 Lock Elect Switch	L-8 Lock Bye. Err	L-9 Lock Timing Err.
CR-1	0	12385	8	0	0	0	0	0	0
CR-2	0	18758	3	0	0	0	0	0	0
CR-3	0	11718	8	0	0	0	0	0	0
CR-4	0	12185	8	0	0	0	0	0	0
CR-5	0	12808	8	0	0	0	0	0	0
CR-6	0	17807	2	0	0	0	0	0	0

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Sensor Systems

Result Codes:

Code #	Classification	Criteria
U-0	Pass-Unlock	Switch Starts High - Switch Ends Low Single Transition between 60 and 810msec from Power ON
U-1	Unlock-Overshoot	Switch Starts High - Switch Ends High OR Low (may end Low when power is released at 650msec) Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is ON (Current >0.5Amps)
U-2	Unlock-Rebound	Switch Starts High - Switch Ends High - Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is OFF (Current <0.5Amps)
U-3	Unlock-wrong start	Switch Starts Low.
U-4	Unlock-Hardstop	Switch Starts High - Switch Ends High - No Transitions Current Remains High For entire test (>0.5 Amps)
U-5	Unlock-PTCA	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 100milliseconds
U-6	Unlock-PTCB	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 300milliseconds
U-7	Unlock-Elect failure	Switch Starts High - Switch Ends High - No Transitions - Current appears normal, but remains high in the end (may not be able to do this one....)
U-8	Unlock-System Error	Switch Starts High - Switch Ends High - No Transitions - No Current Or More than 2 transitions.
U-9	Unlock-timing	Switch Starts High - Switch Ends Low - Single Transition outside of range: 60 and 810msec from Power ON
L-0	Lock-Pass A	Switch Starts Low - Switch Ends High - Single Transition before 300 msec
L-1	Lock-Pass B	Switch Starts Low - Switch Ends High - Single Transition before 810 msec
L-2	Lock-wrong start	Switch Starts High
L-3	Lock-bounce	Switch Starts Low - Switch Ends High - Multiple transitions - at any point in the cycle
L-4	Lock-Hardstop	Switch Starts and Ends Low - No transition - Current remains high for duration of test (>0.5Amps)
L-5	Lock-PTC A	Switch Starts and Ends Low - No transition - Current starts high and drops off after 100 msec.
L-6	Lock-PTC B	Switch Starts and Ends Low - No transition - Current starts High and drops off after 300 msec.
L-7	Lock-Elect	Switch Starts and Ends Low - No transition - Current appear "normal" (this class may not be able to be classified)
L-8	Lock-System Error	Switch Starts and Ends Low - No transition - No Power - No current
L-9	Unlock-timing	Switch Starts Low - Switch Ends High - Single Transition after 810msec

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0057a

PPAP

Delphi Saginaw Electronic Column Lock Assembly

Invensys Part #: 1740-0002

Specification #: Delphi #26050960 Chg. Level 078

Sample Size: 5

Build Date: 3281

Bearing Grease Change

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Set-up Page	
3	Durability Test Results	See Details
4	Result Codes	

Tested By: Larry Kanz Date: 4/25/01
(Technician)

Product Test Lab Supervisor: Richie Shultz Date: 4/25/01

Test Facilities Manager: John Date: 4/25/01

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Invensys

Sensor Systems

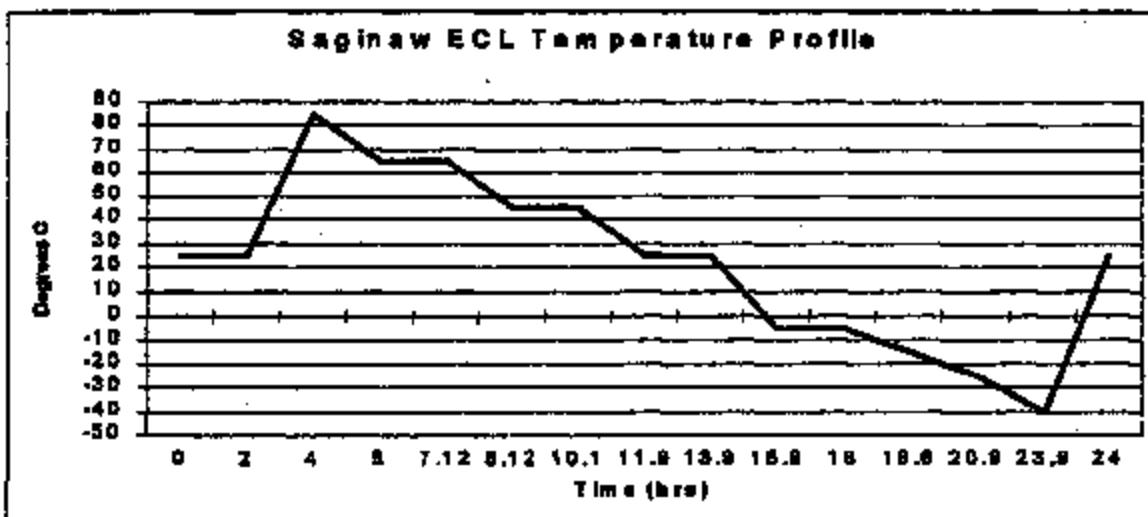
Type of Test: PPAP
Test Log #: 01-0057a
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 5
Build Date: 3281
Technician: Wade Landis
Start Date: 4/6/2001
Finish Date: 4/16/2001

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Side Load
1	9	9	15	22 ft/lb.
2	12	12	1000	11 ft/lb.
3	12	12	10,000	5 ft/lb.
4	9	12.8	9747	0 ft/lb.
5	12.8	9	9738	0 ft/lb.
6	9	14.2	9747	0 ft/lb.
7	14.2	9	9748	0 ft/lb.
8	9	9	15	22 ft/lb.

Total # of Cycles = 15000

Total Test Time = 58.3 Hrs.



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Invensys

Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0057a
 Customer/Part Description: Delphi Saginaw ECL
 Invensys Part #: 1740-0002
 Test Description: Durability
 Sample Size: 5
 Build Date: 3/28/01
 Technician: Larry Kane
 Start Date: 4/6/2001
 Finish Date: 4/18/2001

Part #	First Failure				Test Station Relay Type	U-0 Unlock Pass	U-1 Unlock- Overhook	U-2 Unlock- Rebound
	T#	C#		Fall Code				
BG-1	2	814	62.9	U-2	SPST	33514	0	9675
BG-2	3	145	61.5	U-2	SPST	35634	0	10284
BG-3	3	5880	82	U-2	SPST	37458	0	8881
BG-4	1	5	21.4	U-4	SPST	42035	0	7871
BG-5	2	638	76	U-2	SPST	38368	0	11638

Part #	U-3 Unlock- Wrong Start	U-4 Unlock- Handstop	U-5 Unlock PTCA	U-6 Unlock PTCB	U-7 Unlock Elect. Fall	U-8 Unlock Sys. Err	U-9 Unlock Timing Error	L-0 Lock Pass A
BG-1	0	0	0	8621	0	0	0	33538
BG-2	0	0	0	4092	0	0	0	35580
BG-3	0	0	0	3693	0	0	0	37443
BG-4	0	0	0	3	0	0	1	42036
BG-5	0	0	0	8	0	0	0	38368

Part #	L-1 Lock Pass B	L-2 Lock Wrong Start	L-3 Lock Bounce	L-4 Lock Handstop	L-5 Lock PTCA	L-6 Lock PTCB	L-7 Lock Elect. Switch	L-8 Lock Syst. Err	L-9 Lock Timing Err.
BG-1	0	18474	0	0	0	0	0	0	0
BG-2	0	14391	24	0	0	0	0	0	0
BG-3	0	12562	5	0	0	0	0	0	0
BG-4	0	7871	3	0	0	0	0	0	0
BG-5	0	11641	1	0	0	0	0	0	0

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Sensor Systems

Result Codes:

Code #	Classification	Criteria
U-0	Pass-Unlock	Switch Starts High - Switch Ends Low Single Transition between 50 and 610msec from Power ON
U-1	Unlock-Overshoot	Switch Starts High - Switch Ends High OR Low (may end Low when power is released at 650msec) Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is ON (Current >0.5Amps)
U-2	Unlock-Rebound	Switch Starts High - Switch Ends High - Two Transitions (H->L and L->H) Transition from Low back to High occurs when Power is OFF (Current <0.5Amps)
U-3	Unlock-wrong start	Switch Starts Low.
U-4	Unlock-Hardstop	Switch Starts High - Switch Ends High - No Transitions Current Remains High For entire test (>0.6 Amps)
U-5	Unlock-PTCA	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 100milliseconds
U-6	Unlock-PTCB	Switch Starts High - Switch Ends High - No Transitions Current Starts High and then drops off after 300milliseconds
U-7	Unlock-Elect failure	Switch Starts High - Switch Ends High - No Transitions - Current appears normal, but remains high in the end (may not be able to do this one....)
U-8	Unlock-System Error	Switch Starts High - Switch Ends High - No Transitions - No Current Or More than 2 transitions.
U-9	Unlock-timing	Switch Starts High - Switch Ends Low - Single Transition outside of range: 50 and 610msec from Power ON
L-0	Lock-Pass A	Switch Starts Low - Switch Ends High - Single Transition before 300 msec
L-1	Lock-Pass B	Switch Starts Low - Switch Ends High - Single Transition before 610 msec
L-2	Lock-wrong start	Switch Starts High
L-3	Lock-bounce	Switch Starts Low - Switch Ends High - Multiple transitions - at any point in the cycle
L-4	Lock-Hardstop	Switch Starts and Ends Low - No transition - Current remains high for duration of test (>0.5amps)
L-5	Lock-PTC A	Switch Starts and Ends Low - No transition - Current starts high and drops off after 100 msec.
L-6	Lock-PTC B	Switch Starts and Ends Low - No transition - Current starts high and drops off after 300 msec.
L-7	Lock-Elect	Switch Starts and Ends Low - No transition - Current appear 'normal' (this class may not be able to be classified)
L-8	Lock-System Error	Switch Starts and Ends Low - No transition - No Power - No current
L-9	Unlock-timing	Switch Starts Low - Switch Ends High - Single Transition after 610msec

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Product Test Laboratory

Product Validation Report #: 01-0115

Product Validation

Delphi Saginaw Electronic Column Lock P/N 26053015

Invensys Part #: 1740-0002

Specification #: 26053015 Dated 4/17/95

Sample Size: 22

Build Date: 9111

Page #	Table of Contents	Test Results
1	Cover Page	
2	Contact Resistance	As detailed
3	Initial Characteristics	All Conform
4	Durability Setup and Evaluation	No Anomalies
5	Durability (20% of test profile)	All Conform
6	Wire Pull Test	All Conform
7	Calibrated Equipment List	

Tested By: Larry Kime Date: 9/27/01
(Technician)

Product Test Lab Supervisor: Wesley Shroyer Date: 9/27/01

Test Facilities Manager: Wesley Shroyer Date: 9/27/01

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9/13/2000

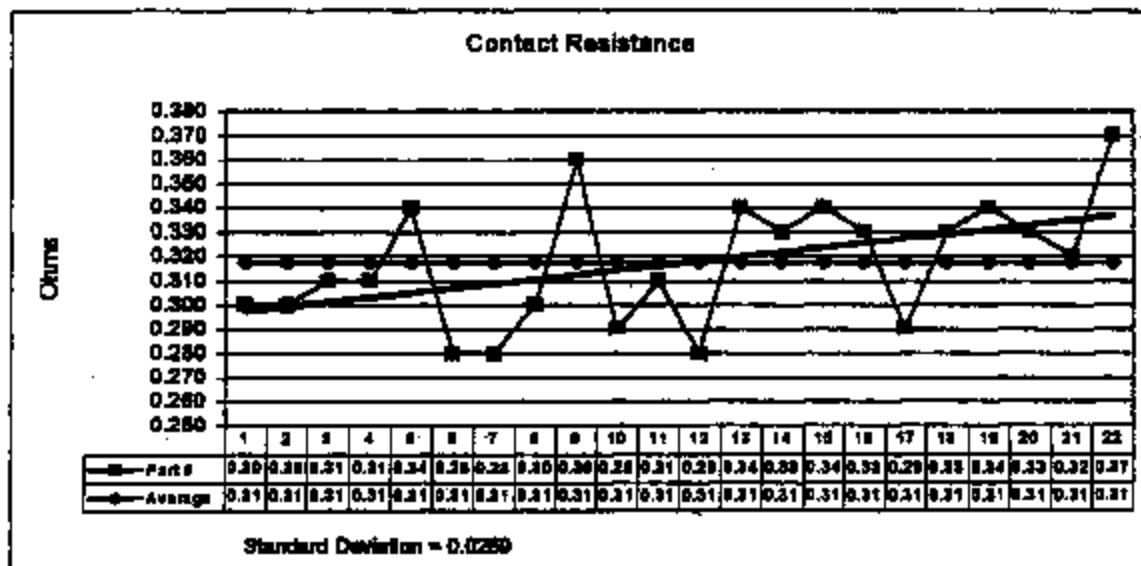
Invensys

Sensor Systems

Type of Test: Product Validation
Test Log #: 01-0115
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Contact Resistance
Sample Size: 22
Build Date: 9111
Technician: Larry Kane
Start Date: 9/17/2001
Finish Date: 9/17/2001

Measure the resistance of the switch contacts.

Part #	Resistance	Part #	Resistance
1	0.30	12	0.28
2	0.30	13	0.34
3	0.31	14	0.33
4	0.31	15	0.34
5	0.34	16	0.33
6	0.28	17	0.29
7	0.28	18	0.33
8	0.30	19	0.34
9	0.36	20	0.33
10	0.29	21	0.32
11	0.31	22	0.37



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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Product Validation
Test Log #: 01-0115
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Initial Characteristics
Sample Size: 22
Build Date: 9/11/01
Technician: Larry Kane
Start Date: 9/18/01
Finish Date: 9/20/01

Part #	Switch Point 5Vdc		Side Load 22 ft/lbs. 9Vdc	Current Draw NTE 7A @ 25°C & 18.0Vdc		Lock bolt Activation Time	
	Extend > 17.58mm	Retract < 12.84mm		P/F	Extend		
1	17.985	11.930		Pass	5.411	4.085	223.5ms
2	17.940	12.030		Pass	6.560	6.895	223.5ms
3	17.895	12.280		Pass	6.037	6.168	231.0ms
4	17.985	12.385		Pass	6.582	5.927	223.0ms
5	17.885	12.175		Pass	4.421	4.502	211.0ms
6	17.960	12.380		Pass	6.597	5.440	213.5ms
7	17.935	12.130		Pass	5.797	5.480	211.0ms
8	17.940	11.755		Pass	4.970	5.225	207.0ms
9	17.960	12.175		Pass	6.217	6.958	211.0ms
10	17.890	12.120		Pass	5.162	6.445	235.0ms
11	17.935	11.980		Pass	6.503	4.287	346.0ms
12	17.925	12.190		Pass	6.882	6.989	208.0ms
13	17.940	12.040		Pass	5.914	6.910	249.5ms
14	17.930	11.925		Pass	6.087	5.097	224.5ms
15	17.985	12.380		Pass	4.900	5.433	204.5ms
16	17.930	12.125		Pass	5.773	5.983	241.0ms
17	17.960	12.205		Pass	6.331	6.548	188.0ms
18	17.935	12.385		Pass	6.899	3.451	219.5ms
19	17.985	12.065		Pass	5.011	5.107	219.5ms
20	17.905	12.380		Pass	6.878	6.854	221.5ms
21	18.195	12.240		Pass	3.997	4.619	219.0ms
22	17.940	12.020		Pass	7.043	6.854	235.0ms

Results: All conformed to specifications

Note: This report shall not be reproduced in full without the written permission from Invensys Sensor Systems and the Product Test Laboratory. Test results relate to items tested only.

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Product Validation
Test Log #: 01-0115
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Durability Set-up & Data Evaluations
Sample Size: 22
Build Date: 9111
Technician: Larry Kane
Start Date: 9/24/2001
Finish Date: 9/26/2001

Test #	Unlock Voltage	Lock Voltage	# Cycles	Load (N-lbs.)
1	9	9	3	22
2	12	12	200	11
3	12	12	2000	7
4	9	12.8	1949	None
5	12.8	9	1948	None
6	9	14.2	1947	None
7	14.2	9	1950	None
8	9	9	3	22

Data Evaluation of durability cycling test:

All units have completed 10,000 cycles per the above setup.

No electrical failures detected during this phase of the testing.

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Sensor Systems

Type of Test: Product Validation
Test Log #: 01-0115
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: Durability Performance Characteristics
Sample Size: 22
Build Date: 9/11/01
Technician: Larry Kane
Start Date: 9/26/2001
Finish Date: 9/26/2001

Perform 20% of the durability life test cycles (total of 10,000 cycles)

Part #	Switch Point		Side Load (EOL Tester)	Current Draw		Lock bolt Actuation Time
	Extend > 17.55mm	Retract < 12.84mm		P/F	Extend	
1	18.40	12.21	Pass	5.871	4.085	252.0ms
2	18.41	12.38	Pass	6.420	6.854	229.5ms
3	18.23	12.40	Pass	5.587	6.242	218.0ms
4	18.14	12.33	Pass	6.215	6.244	226.0ms
5	18.14	12.32	Pass	5.451	4.715	224.0ms
6	18.06	12.30	Pass	5.546	5.357	199.5ms
7	18.23	12.23	Pass	5.189	5.480	201.0ms
8	18.33	11.87	Pass	5.037	5.225	221.0ms
9	18.26	12.26	Pass	6.217	6.175	216.0ms
10	18.11	12.41	Pass	5.162	6.561	205.0ms
11	18.08	11.93	Pass	6.426	4.867	239.0ms
12	18.23	12.45	Pass	6.128	6.264	215.0ms
13	18.20	12.12	Pass	5.451	6.517	239.5ms
14	18.12	11.84	Pass	6.878	6.176	218.5ms
15	18.31	12.30	Pass	5.184	5.433	199.5ms
16	18.28	12.24	Pass	5.846	5.750	234.0ms
17	18.24	12.30	Pass	6.684	6.548	192.0ms
18	18.06	12.35	Pass	5.132	5.798	215.5ms
19	18.13	11.90	Pass	5.453	5.194	231.5ms
20	18.06	12.32	Pass	6.457	6.371	241.5ms
21	18.06	11.77	Pass	4.516	4.519	214.0ms
22	18.15	11.77	Pass	6.157	6.581	241.0ms

Results: All conformed to specification.

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Sensor Systems

Type of Test:	Product Validation
Test Log #:	01-0115
Customer/Part Description:	Delphi Saginaw ECL
Invensys Part #:	1740-0002
Test Description:	2.1.7.1 Strain Relief
Sample Size:	22
Build Date:	9111
Technician:	Larry Kane
Start Date:	9/26/2001
Finish Date:	9/27/2001

The actuator assembly must meet electrical specification after subjecting the wire harness to a 70N minimum pull force at a rate of 50mm/minute any of the + axis of wire ext.

Part #	2.1.10 Nominal Voltage Actuator will operate at a 12.0 Vdc nominal operating condition	2.1.11 Operating Voltage Actuator must operate throughout the 9-16Vdc operating range at -40°C to 80°C	2.1.11.d Min. voltage to operate with no 8TRG Shaft Torque applied The actuator assembly, after running into a hardstop in either direction @ 14.2Vdc, must operate at a minimum of 8.5Vdc under all temperature conditions with no side load applied to the lock bolt	2.1.12 Over Voltage -Jump Start Actuator must withstand 18Vdc applied to the motor for 30 seconds.	2.1.13 Motor Stall Current draw shall not exceed 7 amps at 25°C and 18Vdc	2.1.14 Actuator Speed Time shall be no longer than 0.5 sec at 9Vdc at -40°C
1	Pass	Pass	Pass	Pass	6.214	195.5 ms
2	Pass	Pass	Pass	Pass	6.118	187 ms
3	Pass	Pass	Pass	Pass	6.841	195.5 ms
4	Pass	Pass	Pass	Pass	5.328	225.5 ms
5	Pass	Pass	Pass	Pass	5.841	197.5 ms
6	Pass	Pass	Pass	Pass	6.287	244 ms
7	Pass	Pass	Pass	Pass	6.271	196.0 ms
8	Pass	Pass	Pass	Pass	6.184	197.5 ms
9	Pass	Pass	Pass	Pass	5.961	197.0 ms
10	Pass	Pass	Pass	Pass	5.729	299 ms
11	Pass	Pass	Pass	Pass	6.105	215.0 ms
12	Pass	Pass	Pass	Pass	6.507	438.0 ms
13	Pass	Pass	Pass	Pass	6.189	19.5 ms
14	Pass	Pass	Pass	Pass	6.328	205.0 ms
15	Pass	Pass	Pass	Pass	5.782	202 ms
16	Pass	Pass	Pass	Pass	5.841	197.0 ms
17	Pass	Pass	Pass	Pass	5.934	213.5 ms
18	Pass	Pass	Pass	Pass	6.059	195.0 ms
19	Pass	Pass	Pass	Pass	5.014	202.0 ms
20	Pass	Pass	Pass	Pass	6.941	189.0 ms
21	Pass	Pass	Pass	Pass	6.278	195.5 ms
22	Pass	Pass	Pass	Pass	6.187	234.5 ms

Results: All conformed to specifications.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Calibrated Equipment

Name	Description	ID #	Calibration Date	Calibration Due
Lambda Power Supply	LLS8040 40Vdc/10A	VAB310T38973	5/17/01	5/17/02
Sony LVDT	Measurement Station	I-100908	5/17/01	5/17/02
Snap Elektrotork II	Torque Wrench	TW-12950008	11/9/00	11/9/01
Tektronix 2230	Oscilloscope	B021117	8/1/01	8/1/02

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9/13/2000



Production Part Approval Performance Test Results

SUPPLIER		PART NAME					
Invensys Sensor Systems		Delphi Saginaw Column Lock Actuator					
NAME OF LABORATORY		PART NUMBER					
Ref. No.	Requirements	Test Freq.	Cty. Tested	Supplier Test Results and Test Conditions			OK
2.5	Functional Testing						Not OK
	Plunger Length						
	Locked	Y	176	Conformed			X
	Switch Point	Y	176	Non Conformance - 1 unit exceeded specification			X
	Lockbolt side force pullout	Y	176	Conformed			X
	Current at 14.2Vdc	Y	176	Conformed			X
	Hardstop Test						
	Unlock	Y	176	Conformed			X
	Lock	Y	176	Conformed			X
	Time Pull In @ 9Vdc & -40°C	Y	176	Conformed			X
	Notes						
	Unlock	Y	176	Non Conformance - 97 units exceeded specification			X
	Lock	Y	176	Non Conformance - 116 units exceeded specification			X
2.5.1	Humidity Test						
	Plunger Length						
	Locked	Y	44	Conformed			X
	Switch Point	Y	44	Non Conformance - 1 unit exceeded specification			X
	Lockbolt side force pullout	Y	44	Conformed			X
	Current at 14.2Vdc	Y	44	Conformed			X
	Hardstop Test						
	Unlock	Y	44	Conformed			X
	Lock	Y	44	Conformed			X
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed			X
	Notes						
	Unlock	Y	44	Non Conformance - 24 units exceeded specification			X
	Lock	Y	44	Non Conformance - 36 units exceeded specification			X
2.5.2	Over Test						
	Plunger Length						
	Locked	Y	44	Conformed			X
	Switch Point	Y	44	Non Conformance - 1 unit exceeded specification			X
	Lockbolt side force pullout	Y	44	Conformed			X
	Current at 14.2Vdc	Y	44	Conformed			X
	Hardstop Test						
	Unlock	Y	44	Conformed			X
	Lock	Y	44	Conformed			X
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed			X
	Notes						
	Unlock	Y	44	Non Conformance - 19 units exceeded specification			X
	Lock	Y	44	Non Conformance - 38 units exceeded specification			X
2.5.1	Pullout Force Test	Y	44	Conformed			X
2.5	Functional Test						
	Plunger Length						
	Locked	Y	44	Conformed			X
	Switch Point	Y	44	Non Conformance - 1 unit exceeded specification			X
	Lockbolt side force pullout	Y	44	Conformed			X
	Current at 14.2Vdc	Y	44	Conformed			X
	Hardstop Test						
	Unlock	Y	44	Conformed			X
	Lock	Y	44	Conformed			X
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed			X
	Notes						
	Unlock	Y	44	Non Conformance - 19 units exceeded specification			X
	Lock	Y	44	Non Conformance - 37 units exceeded specification			X

8669-3314

4/6/2000

Page 1 of 3



Production Part Approval -

Performance Test Results

SUPPLIER			PART NAME			
NAME OF LABORATORY			PART NUMBER			
Product Test Lab			Delphi Saginaw Column Lock Actuator			
Ref. No.	Requirements	Test Freq.	Qty. Tested	Supplier Test Results and Test Conditions		OK
2.5.4	Set Pos.					Not OK
	Plunger Length					
	Locked	Y	44	Conformed	X	
	Switch Point	Y	44	Conformed	X	
	Lockbolt side force pullout	Y	44	Conformed	X	
	Current at 14.2Vdc	Y	44	Conformed	X	
	Hardstop Test					
	Unlock	Y	44	Conformed	X	
	Lock	Y	44	Conformed	X	
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed	X	
	Notes					
	Unlock	Y	44	Non Conformance - 38 units exceeded specification	X	
	Lock	Y	44	Non Conformance - 27 units exceeded specification	X	
2.5.7	Thermal Shock					
	Plunger Length					
	Locked	Y	44	Conformed	X	
	Switch Point	Y	44	Conformed	X	
	Lockbolt side force pullout	Y	44	Conformed	X	
	Current at 14.2Vdc	Y	44	Conformed	X	
	Hardstop Test					
	Unlock	Y	44	Conformed	X	
	Lock	Y	44	Conformed	X	
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed	X	
	Notes					
	Unlock	Y	44	Non Conformance - 8 units exceeded specification	X	
	Lock	Y	44	Non Conformance - 8 units exceeded specification	X	
2.5.9	Pullout Force Test	Y	44	Conformed	X	
2.5	Functional Testing					
	Plunger Length					
	Locked	Y	44	Conformed	X	
	Switch Point	Y	44	Conformed	X	
	Lockbolt side force pullout	Y	44	Conformed	X	
	Current at 14.2Vdc	Y	44	Conformed	X	
	Hardstop Test					
	Unlock	Y	44	Conformed	X	
	Lock	Y	44	Conformed	X	
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed	X	
	Notes					
	Unlock	Y	44	Non Conformance - 8 units exceeded specification	X	
	Lock	Y	44	Non Conformance - 8 units exceeded specification	X	
2.5.2	Vibration Test	Y	44			
	Plunger Length					
	Locked	Y	44	Conformed	X	
	Switch Point	Y	44	Non Conformance - 1 unit exceeded specification	X	
	Lockbolt side force pullout	Y	44	Conformed	X	
	Current at 14.2Vdc	Y	44	Conformed	X	
	Hardstop Test					
	Unlock	Y	44	Conformed	X	
	Lock	Y	44	Conformed	X	
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed	X	
	Notes					
	Unlock	Y	44	Non Conformance - 8 units exceeded specification	X	
	Lock	Y	44	Non Conformance - 8 units exceeded specification	X	



Production Part Approval -

Performance Test Results

SUPPLIER			PART NAME			
NAME OF LABORATORY			PART NUMBER			
Ref. No.	Requirements	Test Freq.	Qty. Tested	Supplier Test Results and Test Conditions	OK	Not OK
2.5.1	Pullout Force Test	Y	44	Conformed	X	
2.5	Functional Testing					
	Plunger Length					
	Locked	Y	44	Conformed	X	
	Switch Point	Y	44	Conformed	X	
	Lockbolt side force pullout	Y	44	Conformed	X	
	Current at 14.2Vdc	Y	44	Non Conformance - 3 units exceeded specification	X	
	Hardstop Test					
	Unlock	Y	44	Conformed	X	
	Lock	Y	44	Conformed	X	
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed	X	
	Notes					
	Unlock	Y	44	Non Conformance - 7 units exceeded specification	X	
	Lock	Y	44	Non Conformance - 7 units exceeded specification	X	
2.5.8	Thermal Storage Test					
	Plunger Length					
	Locked	Y	44	Conformed	X	
	Switch Point	Y	44	Non Conformance - 2 units exceeded specification	X	
	Lockbolt side force pullout	Y	44	Conformed	X	
	Current at 14.2Vdc	Y	44	Conformed	X	
	Hardstop Test					
	Unlock	Y	44	Conformed	X	
	Lock	Y	44	Conformed	X	
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed	X	
	Notes					
	Unlock	Y	44	Non Conformance - 18 units exceeded specification	X	
	Lock	Y	44	Non Conformance - 14 units exceeded specification	X	
2.5.9	Durability Test					
	Plunger Length					
	Locked	Y	44	Conformed	X	
	Switch Point	Y	44	Non Conformance - 1 unit exceeded specification	X	
	Lockbolt side force pullout	Y	44	Conformed	X	
	Current at 14.2Vdc	Y	44	Non Conformance - 3 units exceeded specification	X	
	Hardstop Test					
	Unlock	Y	44	Conformed	X	
	Lock	Y	44	Conformed	X	
	Time Pull In @ 9Vdc & -40°C	Y	44	Conformed	X	
	Notes					
	Unlock	Y	44	Non Conformance - 1 units exceeded specification	X	
	Lock	Y	44	Non Conformance - 4 units exceeded specification	X	
Note	Damaged unit			Part #170 exhibited excessive beyond the point of function. Engineer removed this unit for analysis. See CAR #1342		

May 1998 CFG 1005

Signature

Title

Date

Test Facility 7/9/02



Sensor Systems

Product Test Laboratory
1100 Airport Road
Shelby, NC 28150

Test Failure Notification Form

February 14, 2002

From: Alan Smith
To: Michael Goodson
Wayne Ledbetter

Mark Spurling
Sarah Flata

Den Thurber

Report Number: 01-0139
Type of Test: PPAP DV PPAP In-process Reliability
Endurance Other
Part # and Name: 1740-0014 Delphi Saginaw Electronic Control Lock
Failure Mode: See details in report
Test Specifications: See details in report
Actual Measured Value: See details in report
Remarks: Most of the failures were due to the noise specification and the inability of the product to conform to this. Other failures were evident but need to be reviewed through the results of the testing

Lot/sample size: 161 & 181 176pc sample
Person Contacted: Michael Goodson
To Report Failure:

Defects in Sample: 118
Date of Contact: 12/07/01

Signed By: Vickie Shiff
Product Test Lab Supervisor

 14 Feb 02
Test Facilities Manager

Reply from Engineer on Failure:

Cause of Failure: _____
_____Corrective Action: _____
_____Corrective Action Responsibility: _____
Due Date for Corrective Action: _____
Follow-up on Corrective Action: _____

8809-2400
Rev.3 10/4/2000

Corrective Action Response to be supplied to Product Test Laboratory Supervisor within:

three working days of receipt of failure

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Product Test Laboratory

Product Validation Report #: 01-0139

Product Validation

Delphi Saginaw Column Lock Actuator 17400014

Invensys Part #: 1740-0014

Specification #: Specification #26053015 Rev.25 (28JA96), Print 17400014 Rev.0
(06/01/01)

Sample Size: 176

Build Date: 161 & 191

Page #	Table of Contents	Test Results
1	Failure Notification Form	
2	Cover Page	
3-7	Initial Performance	Failed
8-9	2.5.5 Humidity Test	Failed
10-11	2.5.9 Dust Test	Failed
12	2.5.1 Pull-Out Force Test	Conformed
13-14	2.5 Functional Test	Failed
15-16	2.5.4 Salt Fog Test	Failed
17-18	2.5.7 Thermal Shock Test	Failed
19	2.5.1 Pull-Out Force Test	Conformed
20-21	2.5 Functional Test	Failed
22-23	2.5.2 Vibration Test	Failed
24	2.5.1 Pull-Out Force Test	Conformed
25-26	2.5 Functional Test	Failed
27-28	2.5.8 Thermal Storage Test	Failed
29-30	2.5.9 Durability Test	Failed
31	Technician Notes For Test To Date	
32	Calibrated Equipment List	

Tested By: C. Allen Smith Date: 2-14-02
(Technician)

Product Test Lab Supervisor: Vicki Knott Date: 2-14-02

Test Facilities Manager: J. J. Karr Date: 1/16/02

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: Initial Performance
 Sample Size: 176
 Build Date: 161& 191
 Technician: Alan Smith
 Start Date: 11/26/01
 Finish Date: 12/08/01

2.5 Functional Testing: The parts shall conform to the specs. As required and denoted below.

Plunger length: locked min length of 17.55mm

Switch point max length of 12.64mm

Lockbolt side force pullout 30Nm @ 9Vdc

Current @ 14.2Vdc

Hardstop: Drive voltage of 18Vdc and return voltage of 9Vdc

Lockbolt actuation time: < 600 msec @ 9Vdc @ -40°C

Noise: 12Vdc @ ambient temp @ distance of 375 mm with a background noise < 41 dba with actuator suspended at no load applied Max noise of 53dba.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9Vdc @ -40°C	Noise (dBA)	
	Locked	Switch Point			unlocked	locked		unlocked	locked
1	18.035	12.020	Pass	5.648	Pass	Pass	262.0 msec	53.3	53.0
2	18.085	12.070	Pass	5.725	Pass	Pass	366.5 msec	55.2	55.2
3	18.000	12.680	Pass	6.088	Pass	Pass	230.5 msec	54.3	55.3
4	18.025	12.160	Pass	6.808	Pass	Pass	258.5 msec	55.3	55.2
5	18.105	12.300	Pass	6.057	Pass	Pass	233.5 msec	55.7	55.0
6	17.990	12.075	Pass	6.134	Pass	Pass	273.5 msec	54.5	55.2
7	18.025	11.960	Pass	5.819	Pass	Pass	241.5 msec	55.2	54.3
8	18.046	12.005	Pass	6.181	Pass	Pass	231.5 msec	54.8	51.6
9	18.048	12.160	Pass	6.076	Pass	Pass	252.5 msec	56.3	56.0
10	18.003	12.135	Pass	6.088	Pass	Pass	234.0 msec	54.6	56.0
11	18.035	12.000	Pass	6.943	Pass	Pass	253.0 msec	57.1	56.0
12	18.080	12.220	Pass	5.737	Pass	Pass	267.5 msec	55.8	53.7
13	18.030	12.130	Pass	6.913	Pass	Pass	250.0 msec	56.3	54.8
14	18.045	11.888	Pass	6.810	Pass	Pass	235.0 msec	56.7	57.5
15	17.990	12.370	Pass	6.043	Pass	Pass	245.5 msec	52.6	51.9
16	18.080	12.160	Pass	5.928	Pass	Pass	253.5 msec	56.3	56.0
17	17.990	12.300	Pass	5.801	Pass	Pass	271.5 msec	55.8	50.0
18	17.990	12.210	Pass	6.123	Pass	Pass	249.0 msec	53.3	52.3
19	18.025	12.130	Pass	6.587	Pass	Pass	274.5 msec	60.5	57.5
20	18.130	13.005	Pass	6.508	Pass	Pass	243.5 msec	57.5	57.1
21	18.000	12.260	Pass	5.898	Pass	Pass	268.5 msec	56.3	53.7
22	18.040	12.670	Pass	5.897	Pass	Pass	227.5 msec	56.8	51.3
23	18.010	11.945	Pass	6.390	Pass	Pass	213.5 msec	57.8	56.7
24	18.035	12.115	Pass	6.929	Pass	Pass	226.0 msec	57.6	63.0
25	18.035	12.450	Pass	6.880	Pass	Pass	267.0 msec	57.1	56.7
26	18.010	12.440	Pass	5.792	Pass	Pass	236.5 msec	53.7	48.8
27	18.035	12.585	Pass	6.010	Pass	Pass	237.5 msec	56.3	52.2

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: Initial Performance (cont.)
 Sample Size: 176
 Build Date: 161& 191
 Technician: Alan Smith
 Start Date: 11/26/01
 Finish Date: 12/08/01

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
28	17.970	12.455	Pass	6.067	Pass*	Pass	238.0 msec	53.3	52.8
29	18.025	12.015	Pass	5.682	Pass	Pass	263.0 msec	53.7	52.6
30	17.970	12.145	Pass	6.067	Pass	Pass	238.5 msec	53.3	46.5
31	18.035	12.430	Pass	5.788	Pass*	Pass*	226.0 msec	58.7	54.5
32	17.995	11.935	Pass	6.048	Pass	Pass	244.0 msec	58.7	51.5
33	18.040	11.945	Pass	6.038	Pass	Pass	220.5 msec	54.1	56.0
34	18.005	12.445	Pass	5.984	Pass	Pass	227.0 msec	53.0	54.1
35	18.025	12.110	Pass	5.914	Pass	Pass	223.5 msec	56.7	58.2
36	18.005	12.155	Pass	5.801	Pass	Pass	287.0 msec	52.5	51.2
37	17.970	11.980	Pass	6.034	Pass	Pass	283.0 msec	58.3	58.0
38	18.060	12.235	Pass	6.022	Pass	Pass	228.0 msec	55.2	53.3
39	17.960	12.365	Pass	5.807	Pass*	Pass	286.0 msec	55.2	51.1
40	17.960	12.185	Pass	5.990	Pass	Pass	264.5 msec	53.7	51.0
41	18.020	11.985	Pass	6.129	Pass*	Pass	259.0 msec	53.0	51.5
42	18.045	12.155	Pass	6.123	Pass	Pass	239.0 msec	57.5	57.5
43	17.995	12.085	Pass	5.632	Pass	Pass	225.5 msec	57.3	53.7
44	18.000	12.235	Pass	5.942	Pass	Pass	229.5 msec	57.1	56.5
45	18.005	12.245	Pass	7.444	Pass	Pass	210.5 msec	54.3	54.1
46	18.035	12.185	Pass	5.929	Pass	Pass	234.5 msec	58.2	55.8
47	18.005	12.530	Pass	5.982	Pass	Pass	234.0 msec	58.6	58.0
48	18.005	12.305	Pass	6.027	Pass	Pass	270.5 msec	53.7	57.6
49	18.015	12.280	Pass	7.085	Pass	Pass	233.5 msec	58.2	53.0
50	17.980	12.390	Pass	5.847	Pass	Pass	210.5 msec	54.5	54.5
51	18.020	12.280	Pass	6.127	Pass	Pass	240.0 msec	58.2	59.0
52	18.000	12.245	Pass	7.110	Pass	Pass	234.0 msec	53.0	55.6
53	18.030	12.360	Pass	6.120	Pass	Pass	238.0 msec	55.2	56.0
54	18.035	12.145	Pass	6.131	Pass	Pass	232.0 msec	54.1	58.0
55	18.025	11.940	Pass	6.064	Pass	Pass	280.0 msec	53.0	58.2
56	18.000	12.080	Pass	5.985	Pass	Pass	250.0 msec	57.5	58.3
57	18.000	11.960	Pass	5.925	Pass	Pass	230.0 msec	52.2	57.6
58	17.930	12.200	Pass	5.787	Pass	Pass	233.5 msec	52.8	53.3
59	18.075	12.070	Pass	6.028	Pass	Pass	230.5 msec	57.5	58.2
60	18.040	12.680	Pass	5.928	Pass	Pass	228.5 msec	58.2	58.6
61	18.055	12.230	Pass	5.018	Pass	Pass	242.0 msec	58.0	58.3
62	18.035	12.360	Pass	6.070	Pass	Pass	231.0 msec	54.0	58.7
63	18.025	12.275	Pass	5.138	Pass	Pass	300.0 msec	52.2	58.8
64	18.035	12.085	Pass	5.980	Pass	Pass	239.5 msec	53.7	55.2
65	18.035	12.435	Pass	6.039	Pass	Pass*	263.0 msec	55.2	55.6

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test:

PPAP

Test Log #:

01-0139

Customer/Part Description:

Delphi Saginaw Column Lock Actuator

Invensys Part #:

17400014

Test Description:

Initial Performance (cont.)

Sample Size:

176

Build Date:

161& 191

Technician:

Alan Smith

Start Date:

11/26/01

Finish Date:

12/06/01

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Notes	
	Locked	Switch Point			unlocked	locked		unlocked	locked
65	18.010	11.920	Pass	5.130	Pass	Pass	248.0 msec	54.5	57.1
67	18.008	12.335	Pass	8.063	Pass	Pass	277.0 msec	53.0	51.5
68	18.025	12.280	Pass	8.228	Pass	Pass	290.5 msec	50.3	56.0
59	18.028	12.240	Pass	8.168	Pass*	Pass*	243.5 msec	53.3	55.2
70	18.000	12.075	Pass	6.191	Pass	Pass	220.5 msec	55.8	60.5
71	18.005	12.010	Pass	6.739	Pass	Pass	272.5 msec	48.5	57.1
72	18.015	12.195	Pass	6.185	Pass	Pass	223.0 msec	56.3	56.3
73	18.104	11.865	Pass	6.625	Pass	Pass	245.0 msec	53.7	56.6
74	18.050	12.280	Pass	6.114	Pass	Pass	255.5 msec	55.8	58.2
75	18.030	12.225	Pass	8.122	Pass	Pass	240.5 msec	56.3	58.3
76	18.006	12.085	Pass	6.121	Pass	Pass	234.0 msec	56.6	58.7
77	18.005	12.160	Pass	7.293	Pass	Pass*	238.0 msec	56.0	57.5
78	18.010	12.420	Pass	6.168	Pass	Pass	236.5 msec	54.8	58.2
79	18.045	12.280	Pass	6.218	Pass	Pass	258.5 msec	54.5	58.6
80	18.025	12.050	Pass	6.180	Pass	Pass	261.5 msec	54.1	57.5
81	18.010	12.015	Pass	5.839	Pass	Pass	234.0 msec	59.0	58.2
82	18.015	11.880	Pass	5.582	Pass	Pass	239.5 msec	55.8	57.1
83	18.030	12.135	Pass	6.141	Pass	Pass	226.0 msec	56.6	59.0
84	18.010	12.145	Pass	6.018	Pass	Pass	222.0 msec	55.8	58.6
85	17.965	12.205	Pass	5.923	Pass	Pass	232.0 msec	51.5	55.6
86	18.040	12.070	Pass	5.930	Pass	Pass	221.0 msec	54.1	57.3
87	17.955	12.210	Pass	6.005	Pass	Pass	244.5 msec	53.3	58.0
88	17.965	11.975	Pass	7.320	Pass*	Pass	260.5 msec	54.8	57.5
89	17.955	12.100	Pass	5.704	Pass	Pass	222.0 msec	56.3	56.6
90	18.006	12.080	Pass	7.193	Pass	Pass	242.5 msec	56.7	57.8
91	18.045	12.400	Pass	6.011	Pass	Pass	211.5 msec	55.6	57.1
92	18.040	12.220	Pass	6.231	Pass	Pass	261.5 msec	56.7	58.0
93	18.038	12.315	Pass	7.750	Pass	Pass	257.5 msec	53.0	58.2
94	18.035	12.040	Pass	7.282	Pass	Pass	227.5 msec	54.5	58.3
95	18.040	12.285	Pass	5.985	Pass	Pass	234.0 msec	53.7	54.5
96	18.020	12.360	Pass	6.973	Pass	Pass	232.5 msec	54.1	57.1
97	18.068	12.160	Pass	6.608	Pass	Pass	229.5 msec	62.2	57.1
98	18.000	12.215	Pass	7.051	Pass	Pass	235.5 msec	54.3	58.0
99	18.005	12.135	Pass	6.168	Pass	Pass	221.0 msec	54.1	58.0
100	18.030	12.100	Pass	6.168	Pass	Pass	226.0 msec	56.3	51.3
101	18.015	12.320	Pass	6.128	Pass	Pass	229.5 msec	57.8	57.5
102	17.965	12.070	Pass	5.984	Pass*	Pass	241.5 msec	57.1	58.0
103	18.080	11.975	Pass	7.247	Pass	Pass	243.0 msec	57.1	54.1

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: Initial Performance (cont.)
 Sample Size: 176
 Build Date: 1618 191
 Technician: Alan Smith
 Start Date: 11/26/01
 Finish Date: 12/08/01

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 5.0Vdc @ -40°C	Notes	
	Locked	Switch Point			unlocked	locked		unlocked	locked
104	18.050	12.255	Pass	5.987	Pass	Pass	223.5 msec	56.0	56.0
105	18.000	12.170	Pass	6.238	Pass	Pass	235.5 msec	56.7	59.7
106	18.035	12.175	Pass	6.089	Pass*	Pass	224.5 msec	56.8	59.1
107	18.065	12.160	Pass	6.741	Pass	Pass	281.5 msec	55.6	57.1
108	18.026	11.925	Pass	6.008	Pass*	Pass	244.5 msec	56.3	58.2
109	18.040	12.215	Pass	6.188	Pass	Pass	221.5 msec	56.0	59.3
110	18.050	12.025	Pass	7.150	Pass*	Pass	312.5 msec	54.1	56.0
111	18.050	12.275	Pass	6.028	Pass	Pass	213.5 msec	56.8	56.7
112	18.026	12.265	Pass	6.030	Pass	Pass	245.5 msec	57.1	56.3
113	18.030	12.180	Pass	6.231	Pass	Pass	236.0 msec	56.2	56.7
114	18.060	12.765	Pass	6.248	Pass	Pass	247.5 msec	56.3	57.5
116	18.035	12.016	Pass	5.904	Pass	Pass	287.5 msec	56.3	56.7
118	18.020	12.090	Pass	5.911	Pass	Pass	248.0 msec	56.3	57.8
117	18.020	12.220	Pass	6.879	Pass	Pass*	256.0 msec	57.1	54.1
118	17.985	12.285	Pass	6.020	Pass	Pass	211.0 msec	54.8	56.7
119	18.030	12.265	Pass	6.933	Pass	Pass	224.5 msec	57.8	56.3
120	18.010	12.510	Pass	6.068	Pass	Pass	208.0 msec	52.7	56.0
121	17.980	12.125	Pass	6.189	Pass	Pass	227.5 msec	48.2	56.7
122	18.040	12.280	Pass	6.571	Pass	Pass	254.5 msec	54.1	56.0
123	18.010	12.065	Pass	6.009	Pass	Pass	246.0 msec	55.2	53.7
124	18.020	12.185	Pass	5.725	Pass	Pass	211.5 msec	59.0	59.3
125	18.010	12.910	Pass	6.181	Pass	Pass	218.5 msec	52.6	55.2
126	17.980	12.340	Pass	6.006	Pass	Pass	239.0 msec	61.2	62.7
127	18.070	12.500	Pass	6.058	Pass*	Pass	273.0 msec	52.6	52.2
128	18.010	12.620	Pass	7.383	Pass	Pass	195.5 msec	57.1	56.3
129	18.080	12.480	Pass	6.213	Pass	Pass	212.0 msec	56.3	55.6
130	17.990	12.290	Pass	6.082	Pass	Pass	235.5 msec	54.8	50.7
131	18.000	11.970	Pass	6.076	Pass	Pass	280.5 msec	56.2	56.7
132	18.035	12.275	Pass	6.930	Pass	Pass	215.5 msec	56.7	56.7
133	18.100	12.290	Pass	5.018	Pass	Pass	247.0 msec	61.1	48.6
134	18.060	12.480	Pass	5.753	Pass	Pass*	208.0 msec	56.7	57.8
135	18.015	12.030	Pass	5.425	Pass*	Pass	233.5 msec	53.3	54.5
136	17.985	12.330	Pass	5.498	Pass	Pass	220.5 msec	57.9	58.2
137	17.975	11.985	Pass	5.210	Pass*	Pass	228.5 msec	54.1	54.1
138	18.030	12.250	Pass	5.775	Pass	Pass	214.0 msec	54.1	56.2
139	18.030	12.335	Pass	5.811	Pass	Pass	213.5 msec	56.3	52.8
140	17.985	12.485	Pass	5.823	Pass	Pass*	213.0 msec	54.1	56.3
141	17.985	12.315	Pass	5.820	Pass	Pass*	213.5 msec	51.8	54.8

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invenys Part #: 17400014
Test Description: Initial Performance (cont.)
Sample Size: 176
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 11/26/01
Finish Date: 12/08/01

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.6Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
142	18.046	12.350	Pass	5.700	Pass	Pass	213.0 msec	53.3	55.2
143	17.930	12.380	Pass	5.700	Pass	Pass	212.0 msec	51.8	54.8
144	18.025	12.710	Pass	5.814	Pass	Pass	204.0 msec	57.2	57.5
145	18.030	12.818	Pass	5.742	Pass	Pass	220.0 msec	58.8	50.0
146	17.988	11.830	Pass	5.550	Pass*	Pass	210.0 msec	54.1	53.0
147	18.030	12.210	Pass	5.904	Pass	Pass	241.0 msec	58.7	54.8
148	18.028	11.970	Pass	5.942	Pass	Pass	238.0 msec	53.0	56.0
149	18.010	12.305	Pass	5.049	Pass	Pass	222.0 msec	53.7	51.8
150	18.038	12.285	Pass	5.894	Pass	Pass	231.0 msec	53.7	52.8
151	17.990	12.230	Pass	5.938	Pass	Pass	208.0 msec	52.6	53.0
152	18.010	12.120	Pass	6.457	Pass	Pass	225.5 msec	58.3	55.8
153	18.010	11.985	Pass	5.531	Pass*	Pass	221.0 msec	54.5	48.5
154	18.038	12.305	Pass	5.744	Pass	Pass	216.0 msec	50.7	54.5
155	18.008	12.105	Pass	6.027	Pass	Pass	236.0 msec	54.1	57.1
156	18.015	12.095	Pass	5.980	Pass	Pass	228.0 msec	52.6	52.2
157	17.980	11.950	Pass	5.778	Pass	Pass	210.5 msec	52.8	53.7
158	18.010	12.180	Pass	5.813	Pass	Pass	208.0 msec	53.0	55.2
159	18.005	12.280	Pass	5.816	Pass	Pass	218.0 msec	52.2	59.0
160	18.026	12.060	Pass	6.726	Pass	Pass*	231.0 msec	58.7	56.0
161	17.995	12.105	Pass	5.903	Pass	Pass	244.5 msec	50.0	51.1
162	18.026	12.265	Pass	5.900	Pass	Pass	206.0 msec	53.7	54.8
163	17.985	12.225	Pass	6.012	Pass	Pass	202.0 msec	55.8	54.8
164	18.005	12.275	Pass	6.367	Pass	Pass	204.0 msec	56.7	56.7
165	18.008	12.410	Pass	5.733	Pass	Pass	208.0 msec	58.3	57.5
166	18.026	12.320	Pass	5.897	Pass	Pass	200.0 msec	58.7	54.5
167	18.048	12.235	Pass	6.630	Pass	Pass*	230.0 msec	54.8	56.8
168	18.045	12.350	Pass	6.088	Pass	Pass	195.0 msec	57.5	55.6
169	18.040	12.620	Pass	5.851	Pass	Pass	215.5 msec	54.1	54.1
170	17.930	12.380	Pass	6.122	Pass	Pass*	242.0 msec	52.2	54.8
171	17.985	11.980	Pass	5.910	Pass	Pass	218.5 msec	54.8	57.8
172	18.060	12.415	Pass	5.901	Pass*	Pass	220.0 msec	58.2	55.6
173	18.020	12.250	Pass	5.863	Pass	Pass	209.0 msec	58.2	58.3
174	17.970	12.315	Pass	6.042	Pass	Pass	223.0 msec	58.7	58.2
175	17.970	12.375	Pass	6.017	Pass	Pass	213.0 msec	58.0	58.0
176	18.025	12.205	Pass	6.088	Pass	Pass	220.0 msec	58.3	58.3

Results: There were multiple failures for noise. Part # 3 had a high switch point.

High current reading noted during hard stop test.

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.5 Humidity Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 11/29/01
 Finish Date: 12/22/01

2.5.5 Humidity Test: The actuator must withstand 120 hrs. of exposure time to a relative humidity of 95% or greater. The temperature must be varied from 24° C to 38° C and the back to 24° C every 24hrs. Duty cycle shall be 1 hr. "on" and 3 hrs. "off". The samples must be mounted in vehicle position with no side load applied to lock bolt. Exposure time should be equally divided ½ time actuated in and ½ time actuated out. At completion of exposure time, samples must be completely functional within 15 minutes of removal from chamber.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
1	18.060	12.168	Pass	6.107	Pass	Pass	210.8 msec	51.5	58.0
2	18.085	12.083	Pass	5.984	Pass	Pass	222.5 msec	58.0	67.8
3	17.985	12.985	Pass	6.488	Pass	Pass	183.0 msec	48.8	51.1
4	18.075	12.155	Pass	6.234	Pass	Pass	201.5 msec	48.6	50.7
5	18.125	12.380	Pass	7.586	Pass	Pass	205.5 msec	53.7	58.6
6	17.980	12.405	Pass	6.387	Pass	Pass	211.0 msec	54.1	58.3
7	18.040	12.085	Pass	5.988	Pass	Pass	221.5 msec	58.7	59.3
8	18.040	12.120	Pass	6.289	Pass	Pass	207.5 msec	57.5	58.0
9	18.056	12.475	Pass	6.071	Pass	Pass*	202.5 msec	50.3	51.8
10	18.006	12.340	Pass	6.295	Pass	Pass	202.0 msec	57.5	61.6
11	18.085	12.285	Pass	6.324	Pass	Pass	210.0 msec	48.5	49.2
12	18.045	12.495	Pass	5.959	Pass	Pass	199.5 msec	58.6	58.2
13	18.005	12.225	Pass	6.064	Pass	Pass*	204.0 msec	47.7	50.7
14	18.070	12.230	Pass	6.283	Pass	Pass	199.0 msec	58.7	57.9
15	17.980	12.415	Pass	5.903	Pass	Pass	203.5 msec	58.7	57.8
16	18.045	12.345	Pass	6.292	Pass	Pass*	207.5 msec	55.2	60.1
17	18.015	12.525	Pass	6.128	Pass	Pass*	192.0 msec	58.8	60.1
18	17.995	12.285	Pass	7.457	Pass	Pass	205.5 msec	57.8	60.5
19	17.995	12.285	Pass	7.181	Pass	Pass	203.5 msec	58.0	60.5
20	18.120	12.725	Pass	8.252	Pass*	Pass	190.5 msec	53.0	54.8
21	18.005	12.320	Pass	6.141	Pass	Pass	187.5 msec	54.5	58.9
22	18.030	12.650	Pass	7.133	Pass*	Pass*	186.5 msec	57.5	59.0

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.5 Humidity Test
Sample Size: 44
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 11/29/01
Finish Date: 12/22/01

2.5.5 Humidity Test: The actuator must withstand 120 hrs. of exposure time to a relative humidity of 95% or greater. The temperature must be varied from 24° C to 38° C and the back to 24° C every 24hrs. Duty cycle shall be 1 hr. "on" and 3 hrs. "off". The samples must be mounted in vehicle position with no side load applied to lock bolt. Exposure time should be equally divided ½ time actuuated in and ½ time actuuated out. At completion of exposure time, samples must be completely functional within 15 minutes of removal from chamber.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 8.9Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
23	18.020	12.176	Pass	7.096	Pass	Pass	210.0 msec	55.2	59.3
24	18.025	12.100	Pass	6.393	Pass	Pass	212.5 msec	56.0	58.2
25	18.040	12.595	Pass	6.590	Pass*	Pass*	189.5 msec	55.8	58.6
26	18.015	12.590	Pass	7.330	Pass	Pass*	180.5 msec	56.7	58.6
27	18.046	13.190	Pass	5.860	Pass	Pass	181.0 msec	55.2	57.6
28	17.985	12.760	Pass	6.063	Pass	Pass	191.5 msec	54.1	57.1
29	17.995	12.195	Pass	7.023	Pass	Pass*	200.0 msec	54.8	58.3
30	18.020	12.470	Pass	6.775	Pass	Pass	189.5 msec	48.1	57.1
31	18.065	12.645	Pass	6.193	Pass	Pass	192.5 msec	58.6	58.6
32	18.040	12.460	Pass	6.960	Pass	Pass	185.5 msec	56.0	58.3
33	18.030	12.275	Pass	6.423	Pass*	Pass	195.5 msec	54.8	57.5
34	18.015	12.445	Pass	5.982	Pass	Pass	190.0 msec	54.1	60.1
35	18.070	12.280	Pass	6.762	Pass	Pass	194.5 msec	57.1	60.1
36	18.075	12.370	Pass	7.294	Pass	Pass*	198.5 msec	58.3	59.7
37	18.005	12.190	Pass	6.031	Pass	Pass	203.5 msec	58.3	59.5
38	18.135	12.600	Pass	5.910	Pass	Pass	202.0 msec	48.8	48.2
39	18.085	12.435	Pass	6.745	Pass	Pass	189.5 msec	48.8	53.0
40	17.985	12.370	Pass	6.096	Pass	Pass	184.0 msec	60.3	58.6
41	18.040	12.280	Pass	6.233	Pass*	Pass	196.0 msec	53.3	56.6
42	18.046	12.445	Pass	6.009	Pass	Pass	196.0 msec	52.2	58.7
43	18.020	12.280	Pass	6.087	Pass	Pass	182.0 msec	55.2	58.2
44	18.035	12.505	Pass	6.304	Pass	Pass	188.0 msec	58.6	57.8

Results: Parts # 3 and # 27 had high switch points.

Multiple failures for noise.

Several parts with high current noticed during hardstop test.

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.9 Dust Test
 Sample Size: 44
 Build Date: 181 & 191
 Technician: Alan Smith
 Start Date: 12/27/01
 Finish Date: 01/02/02

2.5.9 Dust Test: Parts must withstand 8 hrs. of exposure to coarse dust conforming to SAE J726 spec. The dust must be agitated 5 seconds of every 20min. period for the duration of the test. Dust density must be maintained at 0.003 – 0.014 g/cubic in. Samples are to be mounted in vehicle position, and test time divided equally between the actuated out and the actuated in position. After testing, accumulated dust may be removed by brushing, wiping, or shaking. Samples must be completely functional at end of test.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
1	18.080	12.203	Pass	6.130	Pass	Pass*	197.5 msec	54.1	54.8
2	18.080	11.925	Pass	5.800	Pass	Pass*	211.5 msec	54.5	56.7
3	17.995	12.755	Pass	6.238	Pass*	Pass	157.5 msec	49.8	54.8
4	18.035	12.010	Pass	6.041	Pass	Pass	199.0 msec	52.6	56.0
5	18.125	12.320	Pass	6.468	Pass*	Pass	208.0 msec	53.0	57.1
6	17.980	12.355	Pass	6.218	Pass	Pass	201.0 msec	55.2	58.2
7	18.045	11.840	Pass	6.104	Pass	Pass	207.0 msec	54.1	57.5
8	18.038	12.080	Pass	6.375	Pass*	Pass	209.0 msec	53.3	55.6
9	18.038	12.238	Pass	6.068	Pass	Pass*	203.0 msec	51.1	57.1
10	18.010	12.330	Pass	5.988	Pass	Pass	198.5 msec	58.2	60.5
11	18.045	11.925	Pass	6.160	Pass*	Pass	205.5 msec	51.5	53.3
12	18.010	12.155	Pass	6.701	Pass	Pass	195.5 msec	58.2	59.0
13	18.015	12.085	Pass	6.003	Pass	Pass	199.0 msec	52.2	60.8
14	18.070	12.080	Pass	7.842	Pass	Pass	198.5 msec	54.8	58.8
15	17.995	12.285	Pass	6.231	Pass	Pass	181.0 msec	50.7	51.1
16	18.080	12.180	Pass	5.988	Pass	Pass	198.5 msec	55.8	61.8
17	18.030	12.280	Pass	6.225	Pass	Pass	194.0 msec	52.8	55.3
18	17.970	12.040	Pass	6.364	Pass	Pass	199.5 msec	55.8	57.8
19	17.980	12.188	Pass	6.007	Pass	Pass	210.8 msec	59.7	62.0
20	17.980	12.580	Pass	5.103	Pass	Pass	195.0 msec	57.5	61.2
21	17.995	12.330	Pass	6.278	Pass	Pass*	195.0 msec	56.0	60.8
22	18.040	12.580	Pass	7.037	Pass	Pass	186.5 msec	56.7	57.5

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test:

PPAP

Test Log #:

01-0139

Customer/Part Description:

Delphi Saginaw Column Lock Actuator

Invensys Part #:

17400014

Test Description:

2.5.9 Dust Test

Sample Size:

44

Build Date:

161 & 191

Technician:

Alan Smith

Start Date:

12/27/01

Finish Date:

01/02/01

2.5.9 Dust Test: Parts must withstand 8 hrs. of exposure to coarse dust conforming to SAE J726 specs. The dust must be agitated 5 seconds of every 20min. period for the duration of the test. Dust density must be maintained at 0.003 - 0.014 g/cubic ft. Samples are to be mounted in vehicle position, and test time divided equally between the actuated out and the actuated in position. After testing, accumulated dust may be removed by brushing, wiping, or shaking. Samples must be completely functional at end of test.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
23	18.010	11.998	Pass	6.025	Pass*	Pass	208.5	54.8	50.1
24	18.020	11.980	Pass	6.026	Pass*	Pass	198.0	54.8	57.8
25	18.015	12.543	Pass	6.173	Pass	Pass	186.5	55.0	62.3
26	17.980	12.660	Pass	7.066	Pass	Pass	181.5	57.1	61.2
27	18.120	13.105	Pass	6.336	Pass	Pass	187.5	54.1	57.1
28	17.960	12.620	Pass	6.568	Pass	Pass	186.0	54.1	56.0
29	17.988	12.000	Pass	6.048	Pass	Pass	202.5	56.7	58.2
30	18.015	12.395	Pass	7.849	Pass*	Pass	200.5	50.7	58.2
31	18.035	12.600	Pass	6.260	Pass	Pass	200.5	56.3	59.0
32	17.998	12.325	Pass	6.101	Pass	Pass	204.5	56.0	60.8
33	18.005	12.150	Pass	7.249	Pass*	Pass	204.5	53.0	56.3
34	18.005	12.520	Pass	5.844	Pass	Pass	188.5	53.3	59.2
35	17.985	12.120	Pass	6.368	Pass	Pass	187.0	56.2	60.5
36	18.008	12.240	Pass	7.076	Pass	Pass	186.5	57.8	59.3
37	17.995	12.080	Pass	6.042	Pass	Pass	202.5	49.6	53.3
38	18.068	12.335	Pass	6.304	Pass	Pass	203.5	56.2	62.0
39	18.035	12.385	Pass	6.163	Pass	Pass	186.5	47.3	50.3
40	17.945	12.540	Pass	6.197	Pass	Pass*	176.0	53.3	58.0
41	18.020	12.195	Pass	6.316	Pass	Pass	206.0	54.8	59.8
42	18.045	12.185	Pass	6.276	Pass	Pass	206.5	50.7	58.2
43	17.980	12.045	Pass	6.108	Pass	Pass	204.5	57.1	60.1
44	18.018	12.380	Pass	6.316	Pass	Pass	183.5	56.0	57.5

Results: Part # 27 had high switch point.

Multiple failures noticed for noise.

High current reading noticed during hardstop test.

Part # 3 had long time before pull in time test showed switching

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.1 Pullout Force Test
Sample Size: 44
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 01/04/02
Finish Date: 01/10/02

2.5.1 High Pullout Force Test: Test the actuator for 5 cycles in both directions while having a 45 NM (33 ft-lbs.) applied to the shaft lock. The plunger shall pull out with a voltage of 9 Vdc applied at room temperature.

Part #	33 ft-lbs. CW	33 ft-lbs. CCW	Part #	33 ft-lbs. CW	33 ft-lbs. CCW
1	Pass	Pass	23	Pass	Pass
2	Pass	Pass	24	Pass	Pass
3	Pass	Pass	25	Pass	Pass
4	Pass	Pass	26	Pass	Pass
5	Pass	Pass	27	Pass	Pass
6	Pass	Pass	28	Pass	Pass
7	Pass	Pass	29	Pass	Pass
8	Pass	Pass	30	Pass	Pass
9	Pass	Pass	31	Pass	Pass
10	Pass	Pass	32	Pass	Pass
11	Pass	Pass	33	Pass	Pass
12	Pass	Pass	34	Pass	Pass
13	Pass	Pass	35	Pass	Pass
14	Pass	Pass	36	Pass	Pass
15	Pass	Pass	37	Pass	Pass
16	Pass	Pass	38	Pass	Pass
17	Pass	Pass	39	Pass	Pass
18	Pass	Pass	40	Pass	Pass
19	Pass	Pass	41	Pass	Pass
20	Pass	Pass	42	Pass	Pass
21	Pass	Pass	43	Pass	Pass
22	Pass	Pass	44	Pass	Pass

Results: All parts conform to test specs.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5 Function Test
Sample Size: 44
Build Date: 181 & 191
Technician: Alan Smith
Start Date: 01/15/02
Finish Date: 01/17/02

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull in @ 9.6Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
1	18.045	12.085	Pass	6.358	Pass	Pass	222.5 msec	54.5	54.8
2	18.080	11.940	Pass	6.141	Pass*	Pass	201.5 msec	54.8	56.7
3	17.985	12.045	Pass	6.190	Pass	Pass	203.5 msec	50.1	54.8
4	18.015	12.090	Pass	6.177	Pass	Pass	211.0 msec	53.0	56.0
5	18.080	12.155	Pass	6.377	Pass	Pass	221.5 msec	52.8	57.5
6	17.980	12.265	Pass	6.903	Pass	Pass*	207.5 msec	55.6	57.8
7	18.035	11.855	Pass	6.843	Pass	Pass	202.5 msec	55.0	57.0
8	18.040	11.980	Pass	6.303	Pass	Pass*	202.0 msec	54.3	56.2
9	18.010	12.130	Pass	6.232	Pass	Pass	210.0 msec	51.1	56.1
10	17.980	12.100	Pass	6.177	Pass	Pass	199.5 msec	59.0	59.9
11	18.010	11.885	Pass	6.318	Pass	Pass	204.0 msec	52.0	53.3
12	18.035	12.110	Pass	7.404	Pass	Pass	198.0 msec	58.4	59.2
13	17.985	12.015	Pass	6.017	Pass	Pass	203.5 msec	53.2	61.0
14	18.025	11.815	Pass	7.325	Pass	Pass	207.5 msec	54.0	56.0
15	17.970	12.110	Pass	6.681	Pass*	Pass*	182.0 msec	50.5	52.0
16	18.030	12.105	Pass	7.786	Pass*	Pass	208.5 msec	55.8	61.0
17	18.080	12.285	Pass	6.838	Pass	Pass	203.5 msec	52.6	58.0
18	17.950	12.110	Pass	6.158	Pass*	Pass	180.5 msec	55.5	58.7
19	17.990	12.030	Pass	6.181	Pass	Pass	197.5 msec	59.0	61.0
20	18.060	12.585	Pass	6.065	Pass	Pass	188.5 msec	58.0	62.0
21	17.985	12.185	Pass	6.451	Pass	Pass	210.5 msec	55.8	61.0
22	17.988	12.410	Pass	6.126	Pass*	Pass	212.5 msec	57.8	55.7

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5 Function Test
Sample Size: 44
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 01/15/02
Finish Date: 01/17/02

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.8Vdc @ -40°C	Notes	
	Locked	Switch Point			unlocked	locked		unlocked	locked
23	17.975	11.895	Pass	5.555	Pass	Pass	200.0 msec	54.5	60.4
24	18.025	12.020	Pass	6.203	Pass*	Pass	191.5 msec	54.8	57.8
25	17.985	12.510	Pass	7.115	Pass	Pass	188.5 msec	56.5	62.1
26	17.980	12.370	Pass	7.385	Pass*	Pass	185.5 msec	57.1	61.2
27	18.055	13.015	Pass	6.475	Pass	Pass	210.5 msec	54.8	58.7
28	17.945	12.575	Pass	6.732	Pass	Pass	201.5 msec	58.0	58.0
29	17.980	11.880	Pass	5.991	Pass	Pass	182.5 msec	55.8	57.5
30	17.985	12.135	Pass	7.306	Pass	Pass*	185.5 msec	50.0	52.6
31	18.000	12.380	Pass	6.208	Pass*	Pass*	186.5 msec	55.8	58.2
32	17.985	12.280	Pass	6.250	Pass	Pass	187.5 msec	54.5	57.5
33	17.980	11.820	Pass	5.183	Pass	Pass	205.5 msec	56.0	57.5
34	17.940	12.330	Pass	6.288	Pass*	Pass	194.5 msec	50.7	58.2
35	18.000	12.010	Pass	7.381	Pass	Pass*	186.5 msec	53.0	58.3
36	17.970	12.168	Pass	5.982	Pass	Pass	202.0 msec	58.2	62.0
37	17.985	11.830	Pass	6.236	Pass*	Pass	184.5 msec	47.3	50.3
38	18.035	12.300	Pass	8.070	Pass	Pass	188.0 msec	56.2	60.5
39	18.010	12.060	Pass	7.338	Pass	Pass	182.0 msec	49.8	50.3
40	17.935	12.585	Pass	5.967	Pass	Pass*	188.0 msec	53.3	56.0
41	17.980	12.005	Pass	6.243	Pass*	Pass	180.0 msec	53.0	58.3
42	18.020	12.080	Pass	6.075	Pass	Pass	194.5 msec	49.8	58.2
43	17.980	12.000	Pass	5.959	Pass	Pass	188.5 msec	58.2	60.5
44	18.010	12.225	Pass	6.280	Pass	Pass	202.0 msec	58.7	58.2

Results: Part # 27 had high switch point.

Several failures for high current and high noise.

High current readings noted during hardstop test.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.4 Salt Fog
Sample Size: 44
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 12/05/01
Finish Date: 12/08/01

2.5.4 salt Fog: Parts shall withstand 24 hours of exposure time to a 5% neutral salt fog at 35° C. Parts to be mounted in vehicle position. Exposure time should be equally divided between the lockbolt in and the lockbolt out. At completion of exposure time, samples must be completely functional, and remain functional after drying.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull in @ 9.0Vdc @ -40°C	Notes	
	Locked	Switch Point			unlocked	locked		unlocked	locked
45	18.075	12.370	Pass	6.443	Pass	Pass	194.0 msec	58.7	58.7
46	18.125	12.250	Pass	6.081	Pass	Pass	208.5 msec	57.1	54.1
47	18.130	12.655	Pass	5.977	Pass	Pass	210.0 msec	61.2	60.5
48	18.150	12.480	Pass	6.137	Pass	Pass	232.5 msec	54.8	54.5
49	18.115	12.390	Pass	5.943	Pass	Pass	218.5 msec	56.8	48.1
50	18.155	12.720	Pass	5.738	Pass	Pass	201.5 msec	58.7	57.5
51	18.210	12.600	Pass	6.251	Pass	Pass	241.0 msec	60.1	62.0
52	18.175	12.480	Pass	6.229	Pass	Pass	205.0 msec	58.0	58.3
53	18.240	12.740	Pass	7.038	Pass	Pass	213.0 msec	54.5	63.7
54	18.100	12.280	Pass	6.284	Pass	Pass*	208.5 msec	57.5	57.8
55	18.105	12.065	Pass	6.048	Pass	Pass	225.5 msec	55.8	65.5
56	18.080	12.260	Pass	6.059	Pass	Pass	239.0 msec	50.5	60.1
57	18.215	12.380	Pass	5.910	Pass	Pass	218.5 msec	56.3	56.3
58	18.100	12.310	Pass	6.173	Pass	Pass	228.0 msec	51.1	63.3
59	18.185	12.300	Pass	6.137	Pass*	Pass	212.5 msec	57.1	57.5
60	18.185	12.760	Pass	6.729	Pass	Pass	203.5 msec	53.3	50.7
61	18.185	12.405	Pass	6.181	Pass	Pass	223.5 msec	52.8	64.1
62	18.240	12.610	Pass	6.781	Pass	Pass	215.5 msec	55.6	57.1
63	18.120	12.185	Pass	6.206	Pass	Pass	225.5 msec	54.1	54.6
64	18.220	12.345	Pass	6.009	Pass	Pass	228.0 msec	54.5	54.5
65	18.235	12.650	Pass	5.991	Pass	Pass	218.5 msec	55.6	55.2
66	18.185	12.200	Pass	7.304	Pass	Pass	217.0 msec	56.2	63.0

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.4 Salt Fog
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 12/05/01
 Finish Date: 12/06/01

2.5.4 Salt Fog: Parts shall withstand 24 hours of exposure time to a 5% neutral salt fog at 35° C. Parts to be mounted in vehicle position. Exposure time should be equally divided between the lockbolt in and the lockbolt out. At completion of exposure time, samples must be completely functional, and remain functional after drying.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
67	18.135	12.440	Pass	6.207	Pass	Pass	232.5 msec	52.2	52.6
88	18.120	12.525	Pass	6.115	Pass	Pass	235.0 msec	58.3	58.6
89	18.230	12.570	Pass	5.988	Pass	Pass	235.0 msec	57.1	53.0
70	18.185	12.225	Pass	7.068	Pass	Pass	228.0 msec	54.3	58.7
71	18.305	12.495	Pass	5.965	Pass	Pass	237.5 msec	55.2	58.0
72	18.175	12.345	Pass	7.138	Pass	Pass	218.0 msec	58.3	57.8
73	18.225	11.985	Pass	6.093	Pass	Pass	218.5 msec	54.8	54.1
74	18.115	12.395	Pass	6.057	Pass	Pass	233.0 msec	54.3	59.0
75	18.200	12.385	Pass	5.883	Pass	Pass	227.0 msec	56.2	57.1
76	18.115	12.220	Pass	5.307	Pass	Pass	232.0 msec	56.3	60.8
77	18.145	12.425	Pass	6.161	Pass	Pass	228.0 msec	56.0	58.7
78	18.110	12.580	Pass	6.068	Pass	Pass	224.0 msec	53.7	57.8
79	18.150	12.530	Pass	5.848	Pass	Pass	240.5 msec	55.2	56.7
80	18.220	12.665	Pass	6.788	Pass	Pass	241.5 msec	58.6	53.3
81	18.185	12.235	Pass	6.078	Pass	Pass	209.0 msec	54.8	55.5
82	18.125	12.030	Pass	6.032	Pass	Pass	219.0 msec	57.1	58.7
83	18.140	12.315	Pass	6.163	Pass	Pass	230.8 msec	58.2	58.2
84	18.170	12.425	Pass	6.252	Pass	Pass	220.5 msec	57.1	58.7
85	18.110	12.420	Pass	6.067	Pass	Pass	237.5 msec	54.1	58.7
86	18.285	12.420	Pass	6.138	Pass	Pass	216.0 msec	53.3	58.5
87	18.150	12.395	Pass	6.188	Pass	Pass	208.5 msec	58.6	57.1
88	18.085	12.105	Pass	5.925	Pass	Pass	232.5 msec	57.5	59.7

Results: Multiple failures for noise.

Several parts noted with high current during hardstop test.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.7 Thermal Shock
Sample Size: 44
Build Date: 181 & 191
Technician: Alan Smith
Start Date: 12/10/01
Finish Date: 12/26/01

2.5.7 Thermal Shock: Parts must withstand 10 cycles through the following thermal schedule. Soak parts @ -40°C for 1 hour. Remove parts from chamber and allow to warm at room temperature for 4 minutes, parts should be cycled lock – unlock with no load @ 9Vdc during warm-up. Soak parts @ 85°C for 1 hour. Cycle parts lock – unlock @ 12.8Vdc during this period. Remove parts from chamber and allow to cool at room temperature for 2 minutes before returning to soak @ -40°C.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Handstop Test		Time Pull In @ 9.4Vdc @ -40°C	Notes	
	Locked	Switch Point			unlocked	locked		unlocked	locked
45	18.060	12.085	Pass	6.691	Pass	Pass	207.0 msec	57.8	56.3
46	18.130	12.005	Pass	6.121	Pass	Pass	212.5 msec	50.3	51.8
47	18.135	12.415	Pass	6.249	Pass	Pass	218.0 msec	57.8	59.0
48	18.120	12.250	Pass	6.273	Pass	Pass	211.5 msec	50.7	54.1
49	18.060	11.925	Pass	6.070	Pass	Pass	117.5 msec	52.2	51.8
50	18.140	12.410	Pass	6.152	Pass	Pass	192.5 msec	52.8	54.8
51	18.225	12.680	Pass	6.342	Pass	Pass	215.5 msec	50.8	58.3
52	18.145	12.160	Pass	6.711	Pass	Pass	209.0 msec	52.6	53.8
53	18.150	12.075	Pass	6.894	Pass	Pass	216.0 msec	47.0	50.0
54	18.125	12.200	Pass	6.269	Pass	Pass	207.0 msec	53.3	56.3
55	18.140	11.950	Pass	6.113	Pass	Pass	221.5 msec	49.2	52.6
56	18.115	12.045	Pass	7.043	Pass	Pass*	221.5 msec	55.2	58.2
57	18.190	11.935	Pass	5.962	Pass	Pass	220.0 msec	57.1	54.2
58	18.085	12.310	Pass	6.279	Pass	Pass	224.5 msec	52.2	53.7
59	18.160	12.185	Pass	6.907	Pass	Pass	211.5 msec	50.7	53.3
60	18.130	12.485	Pass	7.280	Pass	Pass	188.5 msec	45.8	51.8
61	18.165	12.245	Pass	6.017	Pass	Pass	208.0 msec	48.5	51.5
62	18.140	12.385	Pass	6.739	Pass	Pass	202.5 msec	50.3	50.7
63	18.105	12.240	Pass	6.587	Pass	Pass	231.0 msec	51.5	54.4
64	18.170	12.195	Pass	5.935	Pass	Pass	226.0 msec	48.8	51.1
65	18.205	12.280	Pass	6.863	Pass	Pass	215.5 msec	55.2	56.0
66	18.195	11.880	Pass	6.281	Pass	Pass	224.0 msec	53.3	54.8
67	18.120	12.045	Pass	5.822	Pass*	Pass	230.0 msec	51.1	50.3

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.7 Thermal Shock
 Sample Size: 44
 Build Date: 181 & 191
 Technician: Alan Smith
 Start Date: 12/10/01
 Finish Date: 12/26/01

2.5.7 Thermal Shock: Parts must withstand 10 cycles through the following thermal schedule. Soak parts @ -40°C for 1 hour. Remove parts from chamber and allow to warm at room temperature for 4 minutes, parts should be cycled lock – unlock with no load @ 9Vdc during warm-up. Soak parts @ 85°C for 1 hour. Cycle parts lock – unlock @ 12.8Vdc during this period. Remove parts from chamber and allow to cool at room temperature for 2 minutes before returning to soak @ -40°C.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Notes	
	Locked	Switch Point			unlocked	locked		Unlocked	locked
68	18.175	11.985	Pass	6.332	Pass	Pass	220.5 msec	52.6	53.3
69	18.145	12.095	Pass	6.280	Pass	Pass	218.5 msec	48.5	50.3
70	18.110	11.955	Pass	6.296	Pass	Pass	213.0 msec	48.2	53.3
71	18.295	11.980	Pass	5.708	Pass	Pass	222.5 msec	47.7	53.0
72	18.185	12.185	Pass	6.180	Pass	Pass	222.5 msec	51.6	53.3
73	18.265	11.790	Pass	6.212	Pass	Pass	228.0 msec	48.1	50.7
74	18.080	11.805	Pass	6.767	Pass	Pass	225.0 msec	46.8	53.3
75	18.235	12.175	Pass	6.120	Pass	Pass	214.5 msec	47.3	51.8
76	18.145	11.910	Pass	6.452	Pass	Pass*	226.5 msec	50.3	52.2
77	18.115	12.045	Pass	6.263	Pass	Pass	230.5 msec	51.5	52.6
78	18.130	12.185	Pass	5.935	Pass	Pass	231.0 msec	48.1	53.7
79	18.135	12.080	Pass	6.297	Pass	Pass	234.0 msec	48.5	51.1
80	18.240	11.925	Pass	6.866	Pass	Pass*	230.5 msec	51.8	52.2
81	18.175	12.105	Pass	6.249	Pass	Pass	211.0 msec	50.3	53.0
82	18.155	11.900	Pass	5.986	Pass	Pass	219.0 msec	46.5	48.5
83	18.150	11.880	Pass	6.145	Pass	Pass	232.5 msec	51.5	55.8
84	18.155	11.895	Pass	5.976	Pass	Pass	216.5 msec	50.7	52.2
85	18.110	11.940	Pass	6.155	Pass	Pass	229.0 msec	50.7	51.8
86	18.325	12.005	Pass	6.172	Pass	Pass	207.5 msec	46.5	52.2
87	18.135	12.050	Pass	6.226	Pass	Pass	212.5 msec	52.5	54.8
88	18.140	11.955	Pass	7.178	Pass	Pass*	230.5 msec	49.2	51.1

Results: Multiple parts failed for high noise.

Several parts noted for high current during hardstop test. Parts # 51 and # 56 had long lag time before switch was seen in the pull in test.

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.1 Pullout Force Test
Sample Size: 44
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 01/04/02
Finish Date: 01/10/02

2.5.1 High Pullout Force Test: Test the actuator for 5 cycles in both directions while having a 45 NM (33 ft-lbs.) applied to the shaft lock. The plunger shall pull out with a voltage of 9 Vdc applied at room temperature.

Part #	33 ft-lbs. CW	33 ft-lbs. CCW	Part #	33 ft-lbs. CW	33 ft-lbs. CCW
45	Pass	Pass	67	Pass	Pass
46	Pass	Pass	68	Pass	Pass
47	Pass	Pass	69	Pass	Pass
48	Pass	Pass	70	Pass	Pass
49	Pass	Pass	71	Pass	Pass
50	Pass	Pass	72	Pass	Pass
51	Pass	Pass	73	Pass	Pass
52	Pass	Pass	74	Pass	Pass
53	Pass	Pass	75	Pass	Pass
54	Pass	Pass	76	Pass	Pass
55	Pass	Pass	77	Pass	Pass
56	Pass	Pass	78	Pass	Pass
57	Pass	Pass	79	Pass	Pass
58	Pass	Pass	80	Pass	Pass
59	Pass	Pass	81	Pass	Pass
60	Pass	Pass	82	Pass	Pass
61	Pass	Pass	83	Pass	Pass
62	Pass	Pass	84	Pass	Pass
63	Pass	Pass	85	Pass	Pass
64	Pass	Pass	86	Pass	Pass
65	Pass	Pass	87	Pass	Pass
66	Pass	Pass	88	Pass	Pass

Results: All parts conform to test specs.

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invenys Part #: 17400014
 Test Description: 2.5 Function Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 01/16/02
 Finish Date: 01/17/02

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Handstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
45	18.075	12.240	Pass	6.088	Pass	Pass	211.5 msec	57.2	58.7
46	18.115	12.085	Pass	7.083	Pass	Pass	218.0 msec	51.2	50.8
47	18.120	12.455	Pass	7.086	Pass	Pass	212.5 msec	58.0	58.6
48	18.140	12.165	Pass	6.248	Pass*	Pass	207.5 msec	50.1	54.1
49	18.100	12.035	Pass	5.887	Pass	Pass	182.5 msec	52.4	52.0
50	18.140	12.460	Pass	6.143	Pass	Pass	213.5 msec	52.4	55.2
51	18.195	12.565	Pass	6.415	Pass	Pass	209.0 msec	50.4	60.6
52	18.140	12.240	Pass	6.239	Pass	Pass	215.0 msec	53.0	53.0
53	18.130	12.115	Pass	6.139	Pass*	Pass*	230.5 msec	48.8	51.0
54	18.080	12.085	Pass	5.905	Pass	Pass	228.5 msec	53.0	57.3
55	18.100	12.040	Pass	7.223	Pass	Pass	214.5 msec	50.0	52.6
56	18.070	11.975	Pass	6.188	Pass*	Pass	225.0 msec	58.2	58.4
57	18.155	12.105	Pass	5.983	Pass	Pass	228.0 msec	58.7	55.2
58	18.050	12.290	Pass	6.320	Pass	Pass	222.5 msec	52.4	54.2
59	18.090	12.130	Pass	6.277	Pass	Pass	222.5 msec	50.2	52.8
60	18.135	12.455	Pass	6.209	Pass	Pass	213.0 msec	48.0	52.0
61	18.075	12.070	Pass	6.836	Pass	Pass	218.5 msec	49.0	51.0
62	18.130	12.550	Pass	5.803	Pass	Pass	220.5 msec	50.0	50.2
63	18.060	12.085	Pass	6.945	Pass	Pass	202.5 msec	51.5	54.4
64	18.135	12.260	Pass	6.789	Pass	Pass	206.0 msec	49.6	52.1
65	18.105	12.270	Pass	6.083	Pass	Pass	198.5 msec	55.0	55.7
66	18.155	11.860	Pass	6.341	Pass	Pass	211.5 msec	53.3	54.4
67	18.055	12.035	Pass	6.303	Pass	Pass	224.5 msec	52.1	51.3

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5 Function Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 1/15/02
 Finish Date: 1/17/02

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlock	locked		unlocked	locked
88	18.150	11.945	Pass	5.947	Pass	Pass	220.0 msec	52.8	53.0
89	18.116	12.035	Pass	6.939	Pass	Pass	221.5 msec	49.0	50.0
70	18.080	12.065	Pass	6.931	Pass	Pass	207.0 msec	47.3	52.3
71	18.280	11.910	Pass	6.053	Pass	Pass	222.5 msec	48.0	52.0
72	18.155	12.135	Pass	5.836	Pass	Pass	213.0 msec	52.0	53.0
73	18.205	11.785	Pass	6.068	Pass	Pass	218.5 msec	49.0	50.0
74	18.085	12.005	Pass	6.290	Pass	Pass	220.3 msec	46.3	52.3
75	18.185	11.940	Pass	7.408	Pass	Pass	230.0 msec	48.3	52.8
76	18.100	12.015	Pass	6.388	Pass	Pass	224.0 msec	51.3	52.4
77	18.080	11.955	Pass	6.883	Pass	Pass	215.0 msec	51.8	52.5
78	18.130	12.200	Pass	5.870	Pass	Pass	228.0 msec	46.1	52.7
79	18.070	11.885	Pass	7.383	Pass	Pass	209.0 msec	48.3	52.1
80	18.180	11.885	Pass	6.291	Pass	Pass	212.5 msec	52.0	52.0
81	18.040	11.960	Pass	6.279	Pass	Pass	207.5 msec	50.3	52.3
82	18.140	11.910	Pass	5.980	Pass	Pass	223.0 msec	47.5	48.2
83	18.155	11.865	Pass	6.282	Pass	Pass	216.5 msec	52.1	54.6
84	18.140	12.030	Pass	6.218	Pass	Pass	232.5 msec	51.0	51.2
85	18.080	12.010	Pass	5.849	Pass	Pass	219.0 msec	50.7	52.0
86	18.205	12.075	Pass	6.139	Pass	Pass	211.0 msec	49.5	51.2
87	18.105	11.970	Pass	6.105	Pass	Pass	230.5 msec	53.8	54.8
88	18.145	11.785	Pass	6.801	Pass	Pass	234.0 msec	50.2	51.1

Results: Several parts had high current readings.

Several noted with high current during hardstop test.

Several also noted with failures for high noise.

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.2 Vibration Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 12/15/01
 Finish Date: 01/04/02

2.5.2 Vibration Test: Test per ETS -1141 - IV, the electrical actuator assembly, component vibration test. Parts to perform to functional testing specifications after vibration is done.

- A. For SAE sine vibration, the frequency range is to be from 10 to 55 to 10 Hz with a linear sweep period of 2 minutes per cycle. Excursion shall be 1.0-mm peak to peak over the entire frequency range.
- B. For resonant search, the frequency range is to be varied from 10 to 1000 Hz at a linear sweep rate of 1.0 octaves/min. Feedback accelerometers are to be mounted directly to the part.
- C. Each sample is to be vibrated in each of 3 mutually perpendicular planes for 4 hours each plane.

Part #	Plunger Length		Lockbolt slide force pullout	Current @ 14.2Vdc	Handstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
89	17.975	12.115	Pass	5.826	Pass	Pass	211.0 msec	53.0	53.3
90	17.975	12.005	Pass	6.315	Pass	Pass	205.0 msec	57.1	54.8
91	17.995	12.440	Pass	6.013	Pass	Pass	217.0 msec	48.1	54.3
92	18.035	12.160	Pass	6.092	Pass	Pass	223.5 msec	53.7	54.1
93	18.125	12.380	Pass	6.134	Pass	Pass	222.0 msec	63.3	63.7
94	18.035	12.130	Pass	6.146	Pass	Pass	205.0 msec	53.1	51.8
95	18.075	12.340	Pass	6.036	Pass	Pass	221.0 msec	51.8	53.0
96	17.915	12.335	Pass	6.276	Pass	Pass	230.0 msec	48.8	52.6
97	18.065	12.215	Pass	6.095	Pass	Pass	234.0 msec	54.8	56.7
98	18.025	12.225	Pass	5.983	Pass	Pass	214.0 msec	53.0	54.1
99	18.120	12.290	Pass	5.790	Pass	Pass	241.0 msec	51.8	55.2
100	18.015	12.010	Pass	6.065	Pass	Pass	223.0 msec	54.5	53.7
101	18.015	12.185	Pass	6.158	Pass	Pass	231.5 msec	51.5	54.8
102	17.990	11.970	Pass	7.030	Pass	Pass	226.0 msec	54.8	50.7
103	18.075	11.905	Pass	6.140	Pass	Pass	226.0 msec	54.5	53.7
104	17.990	12.185	Pass	5.772	Pass	Pass	207.0 msec	57.1	51.8
105	17.995	12.115	Pass	6.207	Pass	Pass	226.5 msec	55.8	53.3
106	18.015	12.240	Pass	6.889	Pass	Pass	216.0 msec	60.1	58.2
107	18.035	12.145	Pass	5.998	Pass	Pass	228.0 msec	53.7	51.1
108	17.995	11.970	Pass	6.074	Pass	Pass	246.0 msec	55.2	57.5
109	18.025	12.185	Pass	6.101	Pass	Pass	212.0 msec	50.3	50.7
110	18.035	11.935	Pass	6.047	Pass	Pass	212.0 msec	51.1	52.2
111	17.983	12.235	Pass	6.801	Pass	Pass	211.0 msec	63.8	53.0

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.2 Vibration Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 12/15/01
 Finish Date: 01/04/02

2.5.2 Vibration Test: Test per ETS -1141 - IV the electrical actuator assembly, component vibration test. Parts to perform to functional testing specifications after vibration is done.

- A. For SAE sine vibration, the frequency range is to be from 10 to 35 to 10 Hz with a linear sweep period of 2 minutes per cycle. Excursion shall be 1.0-mm peak to peak over the entire frequency range.
- B. For resonant search, the frequency range is to be varied from 10 to 1000 Hz at a linear sweep rate of 1.0 octaves/min. Feedback accelerometers are to be mounted directly to the part.
- C. Each sample is to be vibrated in each of 3 mutually perpendicular planes for 4 hours each plane.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 8.0Vdc @ -44°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
112	17.880	12.040	Pass	5.69	Pass	Pass	225.0 msec	56.3	51.5
113	18.010	12.125	Pass	6.198	Pass	Pass	224.0 msec	51.5	53.3
114	18.160	12.960	Pass	6.245	Pass	Pass	217.0 msec	54.5	50.0
115	18.045	12.080	Pass	5.858	Pass	Pass	246.0 msec	54.1	52.6
116	18.008	12.060	Pass	6.038	Pass	Pass	217.0 msec	52.6	52.2
117	18.015	11.930	Pass	6.143	Pass	Pass	235.0 msec	53.3	50.0
118	18.025	12.235	Pass	6.079	Pass	Pass	221.5 msec	54.8	57.5
119	17.985	12.215	Pass	5.950	Pass	Pass	216.5 msec	54.1	54.8
120	18.070	12.585	Pass	5.996	Pass	Pass	208.5 msec	50.7	54.1
121	17.925	12.180	Pass	6.428	Pass	Pass	221.5 msec	47.3	53.0
122	18.005	12.280	Pass	5.844	Pass	Pass	226.0 msec	56.0	55.6
123	18.025	12.005	Pass	6.916	Pass	Pass	230.5 msec	52.2	52.6
124	18.046	12.380	Pass	6.180	Pass	Pass	214.5 msec	57.5	57.1
125	17.965	12.505	Pass	6.170	Pass	Pass	213.0 msec	53.0	51.6
126	17.985	12.315	Pass	6.117	Pass	Pass	245.0 msec	54.3	59.7
127	18.060	12.380	Pass	6.971	Pass*	Pass	212.0 msec	53.7	57.1
128	17.965	12.360	Pass	6.031	Pass	Pass	198.0 msec	52.7	54.1
129	18.080	12.660	Pass	6.975	Pass	Pass	211.5 msec	54.8	52.2
130	18.125	12.460	Pass	6.027	Pass	Pass	210.0 msec	52.2	47.0
131	17.985	11.950	Pass	6.080	Pass	Pass	225.5 msec	47.3	50.7
132	18.030	12.050	Pass	6.118	Pass*	Pass	203.5 msec	54.5	54.1

Results: Part # 114 had a high switch point.

Several parts failed for high noise.

Several parts noted for high current during hardstop test.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.1 Pullout Force Test
Sample Size: 44
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 01/04/02
Finish Date: 01/10/02

2.5.1 High Pullout Force Test: Test the actuator for 5 cycles in both directions while having a 45 NM (33 ft-lbs.) applied to the shaft lock. The plunger shall pull out with a voltage of 9 Vdc applied at room temperature.

Part #	33 ft-lbs. CW	33 ft-lbs. CCW	Part #	33 ft-lbs. CW	33 ft-lbs. CCW
89	Pass	Pass	111	Pass	Pass
90	Pass	Pass	112	Pass	Pass
91	Pass	Pass	113	Pass	Pass
92	Pass	Pass	114	Pass	Pass
93	Pass	Pass	115	Pass	Pass
94	Pass	Pass	116	Pass	Pass
95	Pass	Pass	117	Pass	Pass
96	Pass	Pass	118	Pass	Pass
97	Pass	Pass	119	Pass	Pass
98	Pass	Pass	120	Pass	Pass
99	Pass	Pass	121	Pass	Pass
100	Pass	Pass	122	Pass	Pass
101	Pass	Pass	123	Pass	Pass
102	Pass	Pass	124	Pass	Pass
103	Pass	Pass	125	Pass	Pass
104	Pass	Pass	126	Pass	Pass
105	Pass	Pass	127	Pass	Pass
106	Pass	Pass	128	Pass	Pass
107	Pass	Pass	129	Pass	Pass
108	Pass	Pass	130	Pass	Pass
109	Pass	Pass	131	Pass	Pass
110	Pass	Pass	132	Pass	Pass

Results: All parts conform to test spec.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5 Function Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 01/15/02
 Finish Date: 01/17/02

Part #	Plunger Length		Lockball side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 8.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
89	17.875	12.070	Pass	6.851	Pass	Pass	212.0 msec	53.3	53.0
90	17.985	11.920	Pass	6.438	Pass	Pass	207.5 msec	56.7	54.8
91	18.003	12.430	Pass	6.128	Pass	Pass	216.5 msec	48.1	54.1
92	18.020	12.160	Pass	6.208	Pass	Pass	219.0 msec	53.2	54.5
93	18.110	12.280	Pass	6.244	Pass	Pass	211.0 msec	53.1	51.8
94	18.040	12.065	Pass	6.368	Pass	Pass	215.5 msec	53.3	53.7
95	18.080	12.288	Pass	6.920	Pass	Pass	221.5 msec	51.8	52.8
96	17.925	12.145	Pass	6.838	Pass	Pass	236.0 msec	48.6	53.0
97	18.070	12.040	Pass	6.258	Pass	Pass	217.0 msec	53.8	57.0
98	18.020	12.165	Pass	6.262	Pass	Pass	246.0 msec	53.2	54.1
99	18.150	12.215	Pass	6.124	Pass	Pass	217.0 msec	51.2	54.9
100	18.020	12.020	Pass	6.228	Pass	Pass	224.0 msec	54.7	54.3
101	18.025	12.180	Pass	6.182	Pass	Pass	225.0 msec	52.0	54.7
102	17.990	12.010	Pass	6.153	Pass	Pass	211.0 msec	54.2	51.0
103	18.065	11.860	Pass	6.262	Pass	Pass	212.0 msec	58.0	52.2
104	17.985	12.225	Pass	5.814	Pass	Pass	245.0 msec	58.7	52.0
105	18.005	12.030	Pass	6.285	Pass	Pass	228.0 msec	55.9	54.0
106	18.028	12.200	Pass	6.154	Pass	Pass	218.0 msec	59.9	59.0
107	18.035	12.105	Pass	5.937	Pass	Pass	226.5 msec	54.0	52.1
108	18.005	11.780	Pass	5.900	Pass	Pass	207.0 msec	54.9	58.5
109	18.035	12.160	Pass	6.208	Pass	Pass	228.0 msec	50.5	50.5
110	18.030	11.950	Pass	6.124	Pass	Pass	226.0 msec	52.1	52.4
111	18.005	12.335	Pass	6.188	Pass	Pass	231.5 msec	53.1	53.3

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5 Function Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 01/15/02
 Finish Date: 01/17/02

Part #	Plunger Length		Lockbolt slide force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
112	17.995	12.085	Pass	6.201	Pass	Pass	223.0 msec	56.0	52.6
113	18.020	12.125	Pass	6.240	Pass	Pass	214.0 msec	51.7	53.5
114	18.060	12.780	Pass	7.185	Pass*	Pass	234.0 msec	54.7	50.1
115	18.035	11.955	Pass	6.180	Pass	Pass	230.0 msec	54.4	53.6
116	17.990	12.145	Pass	6.328	Pass	Pass	221.0 msec	52.4	52.2
117	18.018	11.875	Pass	7.827	Pass	Pass	205.0 msec	53.3	50.1
118	18.035	12.285	Pass	6.045	Pass	Pass	222.0 msec	54.8	50.5
119	17.995	12.210	Pass	6.220	Pass	Pass*	223.5 msec	54.0	54.5
120	18.030	12.495	Pass	6.231	Pass	Pass	217.0 msec	51.7	54.1
121	17.945	12.175	Pass	7.358	Pass*	Pass*	209.0 msec	48.3	52.1
122	18.010	12.125	Pass	6.231	Pass	Pass*	211.0 msec	56.0	56.1
123	18.035	11.855	Pass	6.088	Pass	Pass	219.0 msec	53.2	53.6
124	18.045	12.285	Pass	6.163	Pass	Pass	221.5 msec	56.5	56.9
125	18.025	12.420	Pass	6.399	Pass	Pass	217.0 msec	53.0	52.8
126	17.975	12.375	Pass	6.336	Pass	Pass	224.0 msec	53.4	57.9
127	18.040	12.380	Pass	6.276	Pass	Pass	207.0 msec	53.7	56.1
128	18.010	12.480	Pass	6.230	Pass	Pass	228.0 msec	52.7	54.3
129	18.070	12.435	Pass	6.355	Pass	Pass	226.0 msec	54.4	53.2
130	18.110	12.285	Pass	6.094	Pass	Pass	203.5 msec	52.2	48.1
131	17.980	11.975	Pass	6.183	Pass	Pass	225.5 msec	48.3	51.2
132	18.020	12.105	Pass	6.146	Pass	Pass	210.0 msec	54.7	54.3

Results: Parts # 114, # 117, and # 121 noted with high current.

Several parts noted with high current during hardstop test.

Several parts failed with high noise.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.6 Thermal Storage Test
Sample Size: 44
Build Date: 161 & 191
Technician: Alan Smith
Start Date: 11/27/01
Finish Date: 12/03/01

2.5.6 Thermal Storage Test: Parts to be stored for 48 hrs. @ 80° C and then 48 hrs. @ -40° C. Parts to conform to initial functional tests after thermal storage test.

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 8.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
133	18.080	12.035	Pass	5.886	Pass	Pass	303.0 msec	56.0	48.5
134	18.050	12.185	Pass	6.168	Pass	Pass	222.5 msec	59.0	54.8
135	18.080	11.770	Pass	6.093	Pass	Pass	261.5 msec	54.8	53.5
136	18.015	12.305	Pass	6.257	Pass	Pass	264.0 msec	55.2	56.0
137	18.030	11.940	Pass	6.237	Pass	Pass	312.5 msec	50.7	53.3
138	18.075	12.105	Pass	6.492	Pass	Pass	264.0 msec	54.8	51.8
139	18.025	12.390	Pass	5.839	Pass	Pass	260.5 msec	51.1	55.2
140	18.075	12.355	Pass	6.984	Pass	Pass	252.5 msec	50.3	54.5
141	18.095	12.340	Pass	6.007	Pass	Pass	296.0 msec	58.0	58.0
142	18.095	12.380	Pass	6.163	Pass*	Pass*	235.5 msec	54.1	62.2
143	17.895	12.055	Pass	6.095	Pass	Pass	288.0 msec	56.3	53.7
144	18.070	13.025	Pass	5.995	Pass	Pass	272.5 msec	57.5	53.7
145	18.050	12.560	Pass	6.207	Pass	Pass	247.5 msec	54.8	54.5
146	18.035	11.560	Pass	5.912	Pass	Pass	261.5 msec	54.8	53.3
147	18.065	12.140	Pass	6.269	Pass	Pass	272.5 msec	55.8	53.3
148	18.105	11.950	Pass	5.992	Pass	Pass	261.0 msec	51.8	49.6
149	18.020	12.300	Pass	5.785	Pass	Pass	275.0 msec	50.0	55.2
150	18.075	12.240	Pass	6.430	Pass	Pass	242.0 msec	54.5	53.3
151	18.015	12.260	Pass	6.138	Pass	Pass*	216.0 msec	51.8	51.1
152	18.050	12.170	Pass	5.920	Pass	Pass	291.5 msec	54.5	57.5
153	18.035	11.825	Pass	6.272	Pass	Pass*	253.0 msec	54.8	53.0
154	18.070	12.420	Pass	6.022	Pass	Pass	247.0 msec	54.1	50.3
155	18.100	11.920	Pass	6.042	Pass	Pass	278.0 msec	57.1	51.5

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Product Test Laboratory

1100 Airport Rd.

Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.6 Thermal Storage Test
 Sample Size: 44
 Build Date: 181 & 191
 Technician: Alan Smith
 Start Date: 11/27/01
 Finish Date: 12/03/01

2.5.6 Thermal Storage Test: Parts to be stored for 48 hrs. @ 90° C and then 48 hrs. @ -40° C. Parts to conform to initial functional tests after thermal storage test.

Part #	Plunger Length		Lockball side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
156	18.025	12.100	Pass	8.447	Pass	Pass	232.0 msec	54.1	58.7
157	17.985	11.780	Pass	8.036	Pass	Pass	255.5 msec	56.0	53.3
158	18.075	12.000	Pass	8.143	Pass	Pass	340.5 msec	51.8	56.7
159	18.050	12.395	Pass	8.189	Pass	Pass	268.0 msec	53.0	53.0
160	18.075	12.220	Pass	8.162	Pass	Pass	260.0 msec	53.7	53.7
181	17.995	12.000	Pass	8.123	Pass	Pass	254.0 msec	49.2	57.8
182	18.040	12.105	Pass	5.980	Pass	Pass	245.5 msec	52.2	52.2
163	18.025	12.170	Pass	5.842	Pass	Pass	244.5 msec	51.1	54.5
164	18.115	11.905	Pass	8.753	Pass	Pass	288.5 msec	53.0	61.8
165	18.025	12.225	Pass	5.836	Pass	Pass	259.0 msec	54.5	56.0
168	18.000	12.020	Pass	8.148	Pass	Pass	269.5 msec	56.0	54.6
187	18.025	12.080	Pass	5.846	Pass	Pass	261.0 msec	58.2	57.4
165	18.060	12.180	Pass	5.953	Pass	Pass	253.0 msec	51.8	54.5
169	18.035	12.240	Pass	6.122	Pass	Pass	266.0 msec	50.0	50.0
170	17.985	12.470	Pass	6.022	Pass	Pass	237.5 msec	55.5	52.6
171	18.010	11.840	Pass	5.989	Pass	Pass	269.5 msec	56.7	56.3
172	18.080	11.900	Pass	5.783	Pass	Pass	250.5 msec	52.8	52.6
173	18.010	12.065	Pass	6.125	Pass	Pass	251.5 msec	57.1	56.3
174	17.915	12.200	Pass	8.134	Pass	Pass	270.5 msec	48.5	50.7
175	17.985	12.370	Pass	8.240	Pass	Pass	248.0 msec	52.2	54.6
176	18.015	12.130	Pass	8.084	Pass	Pass	256.0 msec	58.7	57.1

Results: Parts # 136 and # 144 had high switch points.

Several parts noted with high current during hardstop test.

Multiple failures for high noise noted.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Seginew Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5.8 Durability Test
Sample Size: 44
Build Date: 181 & 191
Technician: Alan Smith
Start Date: 12/05/01
Finish Date: 01/02/02

2.5.8 Durability Test: Parts to undergo 50,000 cycles of testing combined with ETS-1141-A thermal durability test. After test parts shall conform to functional test. The durability shall consist of the following:

Test #	# cycles	Voltage Unlock	Voltage Lock	Side Load Force
1	15	9Vdc	9Vdc	30Nm
2	1000	12Vdc	12Vdc	15Nm
3	10000	12Vdc	12Vdc	7Nm
4	9747	9Vdc	12.8Vdc	0Nm
5	9738	12.8Vdc	9Vdc	0Nm
6	9737	9Vdc	14.2Vdc	0Nm
7	9748	14.2Vdc	9Vdc	0Nm
8	15	9Vdc	9Vdc	30Nm

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Pull In @ 9.8Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
133	18.340	12.318	Pass	7.146	Pass	Pass*	206.5 msec	50.7	51.1
134	18.035	12.085	Pass	7.241	Pass	Pass	203.0 msec	52.6	54.1
135	18.075	11.565	Pass	6.868	Pass*	Pass	223.5 msec	52.2	54.5
136	18.015	12.380	Pass	6.180	Pass	Pass	190.5 msec	49.2	53.7
137	18.050	11.845	Pass	7.128	Pass	Pass	217.0 msec	48.3	52.2
138	18.010	11.765	Pass	7.042	Pass	Pass	217.5 msec	51.8	52.6
139	18.125	12.185	Pass	6.817	Pass	Pass	220.0 msec	48.1	51.1
140	18.100	12.295	Pass	7.157	Pass	Pass	212.5 msec	52.6	54.6
141	18.080	12.480	Pass	7.284	Pass	Pass	202.0 msec	51.5	54.5
142	18.175	12.075	Pass	6.754	Pass	Pass	219.0 msec	53.7	57.5
143	18.100	12.105	Pass	6.787	Pass	Pass*	223.0 msec	51.5	54.5
144	18.255	12.925	Pass	5.904	Pass	Pass	194.0 msec	49.8	52.6
145	18.140	12.880	Pass	5.998	Pass	Pass	205.0 msec	50.7	51.6
146	17.985	11.590	Pass	6.165	Pass	Pass*	220.0 msec	48.8	51.8
147	18.175	11.830	Pass	6.065	Pass*	Pass*	211.5 msec	49.8	51.8
148	18.245	12.050	Pass	7.405	Pass	Pass	225.5 msec	47.0	50.0
149	18.110	12.035	Pass	7.537	Pass	Pass*	214.0 msec	53.0	53.7
150	18.085	11.945	Pass	6.278	Pass	Pass*	212.5 msec	50.0	51.6
151	18.160	12.160	Pass	6.737	Pass	Pass*	162.0 msec	48.8	52.2
152	18.085	11.975	Pass	6.087	Pass	Pass	218.5 msec	48.3	51.1
153	18.185	12.430	Pass	6.868	Pass	Pass	211.5 msec	48.5	52.2
154	18.250	12.440	Pass	6.099	Pass	Pass	213.5 msec	49.8	50.7
155	18.205	11.785	Pass	7.220	Pass	Pass*	234.0 msec	48.5	49.2
156	18.125	11.870	Pass	6.389	Pass*	Pass	221.0 msec	47.7	48.8

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Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.5.8 Durability Test
 Sample Size: 44
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 12/05/01
 Finish Date: 01/02/02

2.5.8 Durability Test: Parts to undergo 50,000 cycles of testing combined with ETS-1141-A thermal durability test. After test parts shall conform to functional test. The durability shall consist of the following:

Test #	# cycles	Voltage Unlock	Voltage Lock	Side Load Force
1	15	9Vdc	9Vdc	30Nm
2	1000	12Vdc	12Vdc	15Nm
3	10000	12Vdc	12Vdc	7Nm
4	9747	9Vdc	12.8Vdc	0Nm
5	9738	12.8Vdc	9Vdc	0Nm
6	9737	9Vdc	14.2Vdc	0Nm
7	9748	14.2Vdc	9Vdc	0Nm
8	15	9Vdc	9Vdc	30Nm

Part #	Plunger Length		Lock/bolt side force pullout	Current @ 14.2Vdc	Hardstop Test		Time Puff In @ 9.0Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
157	18.170	11.795	Pass	6.856	Pass	Pass	225.0 msec	47.7	50.7
158	18.205	11.795	Pass	7.518	Pass	Pass*	233.0 msec	51.8	51.5
159	18.125	12.235	Pass	6.947	Pass	Pass	223.0 msec	51.9	53.0
160	18.170	11.975	Pass	6.730	Pass*	Pass	225.0 msec	50.3	51.1
161	17.990	11.830	Pass	7.167	Pass*	Pass	230.0 msec	51.8	54.1
162	18.110	11.740	Pass	7.263	Pass	Pass*	219.5 msec	52.9	55.6
163	18.090	11.880	Pass	6.713	Pass	Pass	222.0 msec	52.2	57.8
164	18.185	11.795	Pass	6.103	Pass	Pass*	231.0 msec	51.1	54.1
165	18.210	12.130	Pass	6.067	Pass	Pass*	261.5 msec	53.7	54.6
166	18.125	11.935	Pass	5.987	Pass*	Pass	234.0 msec	52.2	55.6
167	18.240	11.915	Pass	5.957	Pass*	Pass*	213.0 msec	53.2	53.0
168	18.350	12.235	Pass	7.382	Pass*	Pass*	229.5 msec	50.7	52.2
169	18.340	12.205	Pass	6.834	Pass*	Pass*	214.0 msec	51.8	54.1
170	NA								
171	18.155	11.880	Pass	6.985	Pass	Pass	233.0 msec	51.6	51.8
172	18.150	11.810	Pass	6.002	Pass*	Pass*	227.0 msec	53.3	52.6
173	18.220	11.825	Pass	6.703	Pass	Pass*	230.0 msec	53.0	55.2
174	18.155	12.140	Pass	6.628	Pass	Pass	229.0 msec	53.7	53.7
175	18.100	12.045	Pass	7.212	Pass	Pass*	226.0 msec	51.1	51.1
176	18.145	12.030	Pass	6.964	Pass	Pass	217.5 msec	51.8	52.2

Results: Part # 144 had high switch point.

Part # 170 had a blow out in the housing.

Several parts noted with high current during the hardstop test.

Several parts failed with high noise.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: Technician Notes
Sample Size: 172
Build Date: 161 and 191
Technician: Alan Smith
Start Date: 11/26/01
Finish Date: 1/17/02

Technician Notes For Testing To Date

1. Have found some parts during current testing that have been above 7.0 amps at 14.2Vdc but have no specifications for this voltage. Specification for current draw is, shall not exceed 7 amps at 25°C and 18.0Vdc applied. (2.1.13). Have also found several parts during hard stop testing to have exceeded this 7 amp rating these have been denoted with a *** under the hard stop testing sections of all test.
2. During the lock bolt actuation time test (2.1.14) of the function test I had four parts that did not show up switching on the o-scope until after several minutes. The following is a list of parts and their times before a trace was seen for the switching of contacts. The motors ran but contact was not seen. Part # 144 after durability took 8 minutes to see switch on scope. Part #51 after thermal shock took 9 minutes to see switch on scope. Part # 60 after thermal shock took 5 minutes to see switch on scope. Part #3 after dust test took 14 minutes to see switch on scope.
3. I had a few parts that had switch points out of specs.
4. I had a lot of parts that were out of specifications on the sound levels noted in the test specs.
5. Part # 170 was removed from testing after durability test. This part was found to have been assembled improperly.
6. Several parts had high current readings during final functional checks.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Calibrated Equipment List

Name	Description	ID# / Model	S/N	Cal. Date	Due Date
Lambda	LLS8040	VA-9510T38973	9510T38973	5/17/01	5/17/02
Sony	DT12P	T-100908	100908	5/17/01	5/17/02
Omega	HH12	TT-633134	633134	1/10/02	4/10/02
Quest	Model 2800	HS-2100012	HS-2100012	2/18/01	2/18/02
Fluke 45	Dual Display Meter	MM - 7323018	7323018	3/22/01	3/22/02
Lambda	LLS8040	S/N - 91T051485	91T051485	1/25/01	1/25/02
Tektronix	2230 O-Scope	Tex 2230 B021117	2230 B021117	8/2/01	8/2/02
Fluke 79 III	Multimeter	MM - 71891070	71891070	7/23/01	1/23/02

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0139

PPAP - Supplement

Delphi Saginaw Electronic Column Lock Assembly P/N 26050960

Invensys Part #: 1740-0014

Specification #: Specification #26053015 Rev.25 (28JA96), Print 17400014 Rev.0
(06/01/01)

Sample Size: 162

Build Date: 161 & 191

Supplement to Report: 01-139
Current Draw Comparison

Page #	Table of Contents	Test Results
1	Cover Page	
2-4	2.1.13 Motor Stall Current	Conformed
5	Equipment List	

Tested By: C. Allen Smith Date: 10-8-02
(Technician)

Test Facilities Manager: J. H. Haas Date: 10/7/02

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139 - Supplement
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.1.13 Motor Stall Current
Sample Size: 162
Build Date: 161& 181
Technician: Alan Smith
Start Date: 11/26/01
Finish Date: 10/7/02

This test is performed at the request of the customer - Delphi Saginaw

This test was originally performed at 14.2Vdc. Section 2.6 Functional requirement for specification specifies that Run/Stall Current is to be performed at 14.2 Vdc. The following testing is a comparison of Section 2.5 and 2.1.13. Voltage levels are different for each section.

Part #	Current @ 14.2Vdc	Current @ 14.2Vdc	Current @ 18.0Vdc	Part #	Current @ 14.2Vdc	Current @ 14.2Vdc	Current @ 18.0Vdc
	01-0139	01-0129	01-0139		01-0139	01-0139	01-0139
	Test date 01/17/02	Test date 10/02/02	Test date 10/02/02		Test date 01/17/02	Test date 10/02/02	Test date 10/02/02
1	6.386	5.054	6.281	35	6.281	5.46	6.258
2	6.141	5.642	6.122	36	5.982	5.973	6.308
3	6.180	5.492	6.228	37	6.238	5.533	6.186
4	6.177	5.034	6.444	38	6.070	5.34	6.684
5	6.377	5.398	6.751	39	6.433	5.578	6.373
6	6.903	5.58	6.827	40	5.967	5.247	6.185
7	6.843	5.048	6.788	41	6.243	5.043	6.015
8	6.303	5.298	6.191	42	6.075	5.138	6.296
9	6.232	5.282	6.188	43	5.989	5.333	6.662
10	6.177	5.879	6.41	44	6.280	6.087	6.387
11	6.318	5.921	6.824	45	6.086	5.303	6.719
12	6.292	5.719	6.387	46	6.289	5.008	6.38
13	6.017	5.162	6.16	47	6.243	5.983	6.267
14	6.029	5.166	6.303	48	6.246	5.224	6.463
15	6.881	5.082	6.87	49	5.987	5.186	6.018
16	6.292	5.051	6.372	50	6.143	5.41	6.547
17	6.836	5.068	6.262	51	6.415	5.344	6.446
18	6.166	6.12	6.104	52	6.298	5.748	6.847
19	6.181	5.002	6.943	53	6.138	5.686	6.873
20	6.088	6.48	6.888	54	5.808	5.338	6.802
21	6.451	5.012	6.498	55	6.289	5.024	6.823
22	6.128	4.921	6.076	56	6.168	5.608	6.772
23	6.888	5.292	6.289	57	5.983	5.875	6.799
24	6.203	5.205	6.988	58	6.320	5.386	6.844
25	6.292	5.725	6.738	59	6.277	5.362	6.829
26	6.292	5.888	6.791	60	6.208	5.353	6.845
27	6.475	5.381	6.386	61	6.938	4.71	6.184
28	6.762	4.981	6.846	62	5.803	5.810	6.829
29	6.031	5.21	6.213	63	6.345	5.878	6.408
30	6.292	5.725	6.89	64	5.789	5.227	6.868
31	6.208	5.288	6.168	65	6.083	5.264	6.685
32	6.250	5.248	6.802	66	6.341	4.969	6.693
33	6.183	5.348	5.98	67	6.303	5.918	6.498
34	6.286	4.858	6.483	68	5.947	5.279	6.409

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0139 - Supplement
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.1.13 Motor Stall Current
 Sample Size: 162
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 11/26/01
 Finish Date: 10/7/02

This test is performed at the request of the customer - Delphi Saginaw

This test was originally performed at 14.2Vdc. Section 2.5 Functional requirement for specification specifies that Run/Stall Current is to be performed at 14.2 Vdc. The following testing is a comparison of Section 2.5 and 2.1.13. Voltage levels are different for each section.

Part #	Current @ 14.2Vdc	Current @ 14.2Vdc	Current @ 16.0Vdc	Part #	Current @ 14.2Vdc	Current @ 14.2Vdc	Current @ 16.0Vdc
	01-0139 Test date 01/17/02	01-0139 Test date 10/02/02	01-0139 Test date 10/02/02		01-0139 Test date 01/17/02	01-0139 Test date 10/02/02	01-0139 Test date 10/02/02
69	6.939	5.347	6.772	103	6.140	Eng.	Eng.
70	6.331	5.211	6.882	104	5.772	6.208	6.524
71	6.063	5.648	6.441	105	6.207	6.129	6.127
72	5.836	5.458	6.621	106	6.889	5.122	6.328
73	6.069	5.515	6.411	107	5.995	5.027	6.039
74	6.290	5.135	6.803	108	6.074	5.239	6.775
75	5.024	5.371	6.371	109	6.101	5.249	6.904
76	6.388	5.351	6.161	110	6.047	5.065	6.228
77	6.863	6.818	6.371	111	6.801	5.741	6.26
78	5.670	5.771	6.676	112	6.09	5.127	6.181
79	5.20	6.760	6.760	113	6.159	5.472	6.176
80	6.251	5.298	6.802	114	6.245	5.259	6.13
81	6.279	5.818	6.335	115	5.858	5.882	6.486
82	5.960	5.804	6.361	116	6.036	5.537	6.329
83	6.242	5.178	6.296	117	6.143	5.166	6.882
84	6.218	5.628	6.824	118	6.079	5.231	6.997
85	5.849	5.188	6.272	119	5.950	5.128	6.874
86	6.138	6.907	6.925	120	5.898	5.246	6.139
87	6.108	6.957	6.69	121	6.426	6.073	6.888
88	6.901	5.038	6.038	122	5.844	5.158	6.741
89	5.826	5.571	6.798	123	6.916	5.75	6.238
90	6.316	5.039	6.158	124	6.180	6.008	6.318
91	6.013	5.468	6.363	125	6.170	5.768	6.882
92	6.082	5.228	6.839	126	6.117	5.383	6.572
93	6.134	5.239	6.691	127	5.871	5.210	6.764
94	6.148	5.498	6.42	128	6.031	5.807	6.832
95	6.038	5.428	6.189	129	5.975	5.038	6.129
96	6.278	6.711	6.93	130	6.027	5.542	6.826
97	6.085	5.328	6.811	131	6.080	5.213	6.488
98	5.963	5.885	6.114	132	6.118	5.54	6.386
99	5.769	5.308	6.28	133	5.885	6.308	6.845
100	6.085	5.11	6.739	134	6.168	5.79	6.764
101	6.158	5.191	6.141	135	6.085	5.108	6.182
102	5.181	5.571	6.257	136	6.257	Eng.	Eng.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: PPAP
 Test Log #: 01-0138 - Supplement
 Customer/Part Description: Delphi Saginaw Column Lock Actuator
 Invensys Part #: 17400014
 Test Description: 2.1.13 Motor Stall Current
 Sample Size: 162
 Build Date: 161 & 191
 Technician: Alan Smith
 Start Date: 11/26/01
 Finish Date: 10/7/02

This test is performed at the request of the customer - Delphi Saginaw

This test was originally performed at 14.2Vdc. Section 2.5 Functional requirement for specification specifies that Run/Stall Current is to be performed at 14.2 Vdc. The following testing is a comparison of Section 2.5 and 2.1.13. Voltage levels are different for each section.

Part #	Current @ 14.2Vdc	Current @ 14.2Vdc	Current @ 18.0Vdc	Part #	Current @ 14.2Vdc	Current @ 14.2Vdc	Current @ 18.0Vdc
	01-0138	01-0138	01-0138		01-0138	01-0138	01-0138
	Test date 01/17/02	Test date 10/02/02	Test date 10/02/02		Test date 01/17/02	Test date 10/02/02	Test date 10/02/02
137	6.237	5.31	6.888	171	6.909	Eng.	Eng.
138	6.452	Eng.	Eng.	172	5.763	5.29	6.563
139	5.839	Eng.	Eng.	173	6.125	6.353	6.877
140	6.984	6.706	6.784	174	6.134	6.760	6.877
141	6.007	5.123	6.665	175	6.240	6.557	6.889
142	6.163	5.131	6.925	176	6.064	Eng.	Eng.
143	6.068	4.629	6.036				
144	5.986	Eng.	Eng.				
145	6.207	4.998	6.348				
146	5.912	5.823	6.888				
147	6.268	5.37	6.887				
148	5.962	5.584	6.436				
149	5.783	Eng.	Eng.				
150	6.430	5.494	6.386				
151	6.135	Eng.	Eng.				
152	5.820	5.254	6.811				
153	6.272	5.356	6.666				
154	6.022	5.432	6.377				
155	6.082	5.787	6.219				
156	6.447	Eng.	Eng.				
157	6.036	5.374	6.425				
158	6.143	Eng.	Eng.				
159	6.189	4.926	6.476				
160	6.162	5.242	6.848				
161	6.120	5.683	6.968				
162	5.880	Eng.	Eng.				
163	5.842	5.103	6.308				
164	6.753	6.832	6.139				
165	5.936	5.251	6.492				
166	6.148	5.478	6.765				
167	5.849	Eng.	Eng.				
168	5.963	5.251	6.563				
169	6.122	5.879	6.911				
170	6.022	Eng.	Eng.				

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Calibrated Equipment List

Name	Description	ID# / Model	S / N	Cal. Date	Due Date
Lambda	LL98040	VA-9610T38973	9510T38973	1/25/02	1/25/02
Fluke 45	Dual Display Meter	MM-7323018	732301B	2/7/02	2/7/03

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8/28/2002

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Product Test Laboratory
Product Validation Report #: 01-0139A

Product Validation
Delphi Saginaw Column Lock Actuator 17400014
Invensys Part #: 1740-0014

Specification #: Specification #26053015 Rev.25 (28JA96), Print 17400014 Rev.0
(06/01/01)

Sample Size: 3
Build Date: 161 & 191

Re-Measure Time Pull-In Test

Temperature: -40°C
Voltage: 9Vdc

Page #	Table of Contents	Test Results
1	Cover Page	
2	Test Data	
3	Graphical Analysis	

Tested By: C. Ahn Smith Date: 01-18-02
(Technician)

Product Test Lab Supervisor: Vicky Wright Date: 1/18/02

Test Facilities Manager: J. G. Jones Date: 1/21/02

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

Invensys

Sensor Systems

Type of Test: PPAP
Test Log #: 01-0139
Customer/Part Description: Delphi Saginaw Column Lock Actuator
Invensys Part #: 17400014
Test Description: 2.5 Functional Test
Sample Size: 3
Build Date: 161& 191
Technician: Alan Smith
Start Date: 1/17/2002
Finish Date: 1/18/2002

2.5 Functional Testing: The parts shall conform to the specs. As required and denoted below.

Plunger length: Extend min length of 17.85mm

Switch point max length of 12.84mm

Lockbolt side force pullout: 30Nm @ 9Vdc

Current @ 14Vdc

Holdstop: Drive voltage of 18Vdc and return voltage of 9Vdc

Lockbolt actuation time: < 600 msec @ 9Vdc @ -40°C

Note: 12Vdc @ ambient temp @ distance of 375 mm with a background noise < 41 dba with actuator suspended in no load applied Max noise of 55dba

Part #	Plunger Length		Lockbolt side force pullout	Current @ 14Vdc	Holdstop Test		Time Pull In @ 9Vdc @ -40°C	Noise	
	Locked	Switch Point			unlocked	locked		unlocked	locked
Switching at Low Temperature readings taken at 11:00am on 1/17/2002									
3	17.870	12.805	Pass	6.840	Pass	Pass	185.5	NA	NA
51	18.180	12.810	Pass	6.740	Pass	Pass	203.0	NA	NA
60	18.150	12.275	Pass	5.790	Pass	Pass	224.5	NA	NA
Switching at Low Temperature readings taken at 3:30pm on 1/17/2002									
3	NA	NA	NA	NA	NA	NA	176.0	NA	NA
51	NA	NA	NA	NA	NA	NA	242.0	NA	NA
60	NA	NA	NA	NA	NA	NA	202.0	NA	NA
Switching at Low Temperature readings taken at 9:00am on 1/18/2002									
3	NA	NA	NA	NA	NA	NA	173.0	NA	NA
51	NA	NA	NA	NA	NA	NA	218.0	NA	NA
60	NA	NA	NA	NA	NA	NA	198.0	NA	NA

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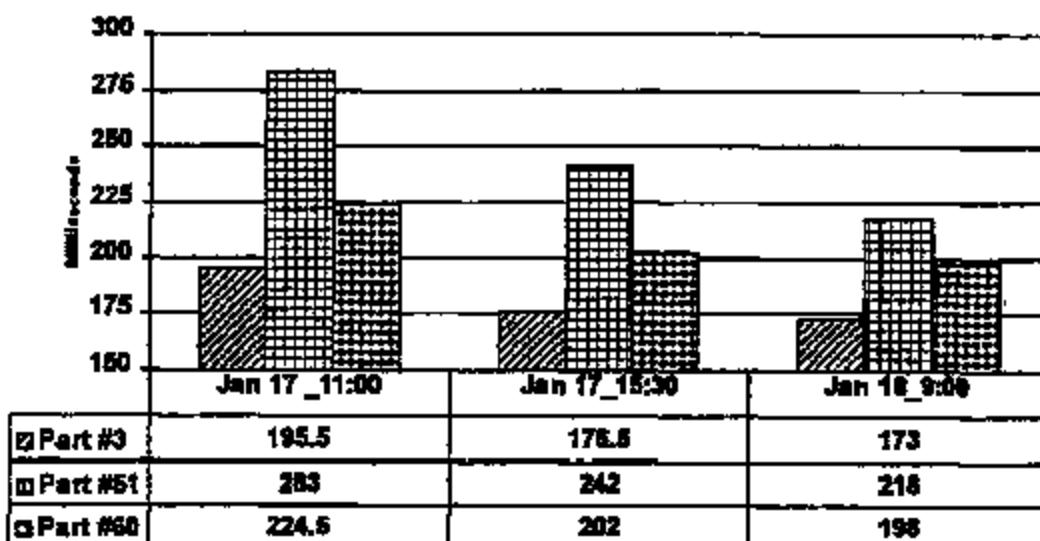
Page 2 of 3
8009-2113
9/13/2000

Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150

invensys

Sensor Systems

Time Pull In @ 14Vdc & -40°C



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8689-2113
9/13/2000

memorandum



Sensor Systems

To Michael Goodson
From Larry Kane
Date 12/17/01
Subject Delphi Saginaw ECL Noise Comparison
cc Steve Davis, Mark Spurling, Sarah Flala

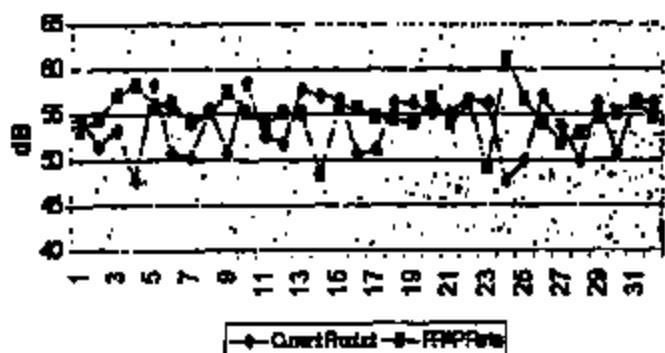
Mike,

Below are the comparison results of the current product being built today in a comparison of the PPAP product that were assembled for the bearing change. Alan Smith measured all the samples in the same manner as represented by the Delphi Product Specification #26053015 rev 025 (28JA96). The PPAP samples were selected at random from the initial functional set. Thirty-two samples were delivered to us on Friday, December 14th for the comparison.

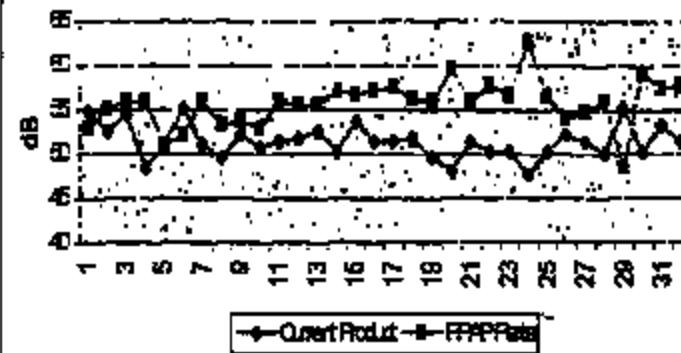
Sample	Current Product					PPAP Parts				
	Retract	Extend	Average	Std Dev.	Max Limit	Retract	Extend	Average	Std Dev.	
1	54.5	54.8	54.66	0.21	55	53.3	53	53.15	0.21	
2	51.5	62.5	62.06	0.78	55	54.6	56.2	54.86	0.49	
3	52.3	54.5	53.8	0.86	55	57.1	56	56.55	0.78	
4	47.7	48.5	48.1	0.57	55	58.2	58	57.1	1.56	
5	58.2	51.1	54.85	5.02	55	58	51.1	53.55	3.48	
6	50.7	66.2	62.95	3.18	55	56.3	52.2	54.25	2.90	
7	50.3	51.1	50.7	0.57	55	54.1	56	56.05	1.34	
8	55.8	49.8	52.8	4.24	55	56.2	53.3	54.25	1.84	
9	60.7	62.2	51.45	1.06	65	57.6	53.7	56.8	2.60	
10	58.0	50.7	54.85	6.59	55	55.2	53	54.1	1.56	
11	52.8	51.5	52.05	0.78	55	54.1	58	56.05	1.34	
12	51.8	51.8	51.8	0.00	55	55.2	55.6	55.4	0.28	
13	57.8	52.8	55.2	3.68	55	55.2	55.6	55.4	0.28	
14	57.1	60.3	69.7	4.81	55	48.6	57.1	52.6	6.06	
15	58.7	53.7	55.2	2.12	65	58	56.7	56.35	0.49	
16	60.7	61.5	61.1	0.67	55	55.6	57.1	58.35	1.06	
17	51.1	51.8	51.3	0.28	65	54.9	57.5	56.15	1.01	
18	56.3	51.8	54.05	3.18	55	54.5	56.3	55.4	1.27	
19	56.3	49.8	52.95	4.74	55	54.1	58	55.05	1.34	
20	55.2	48.1	51.85	5.02	55	56.7	69.7	68.2	2.12	
21	55.2	51.5	53.35	2.62	55	54.1	58	55.05	1.34	
22	58.7	50.8	53.5	4.53	65	58.3	67.8	67.05	1.06	
23	58.3	60.3	59.3	4.24	55	49.2	58.7	52.95	5.30	
24	47.7	47.7	47.7	0.00	55	61.2	62.7	61.85	1.06	
25	60	50.3	50.15	0.21	55	58.7	56.7	56.7	0.00	
26	57.1	52.2	54.85	3.48	55	54.1	54.1	54.1	0.00	
27	63.7	51.5	52.6	1.56	55	51.8	54.8	53.3	2.12	
28	50	50	50	0.00	65	63	58	54.8	2.12	
29	56.3	66.2	66.75	0.78	55	54.5	48.5	51.6	4.24	
30	50.7	50.3	50.5	0.28	65	58.2	59	57.1	2.60	
31	56.8	53.3	54.95	2.33	55	58.3	67.5	56.9	0.86	
32	56.3	51.5	53.9	3.39	55	54.6	57.8	56.3	2.12	
Average	53.85	51.45	52.66	2.21		54.98	55.77	55.38	1.73	

Here is a graphical analysis of the data from the previous page.

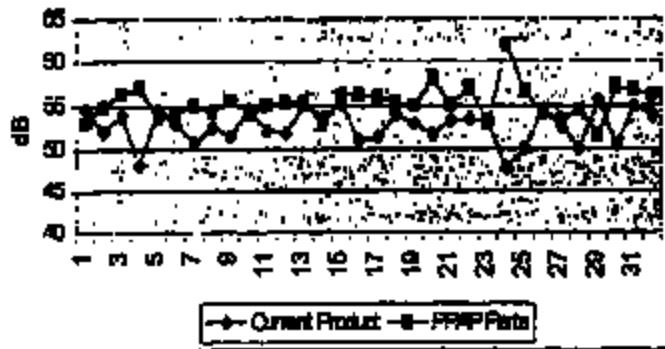
Sound Test Comparison
Lock/Bolt Retract



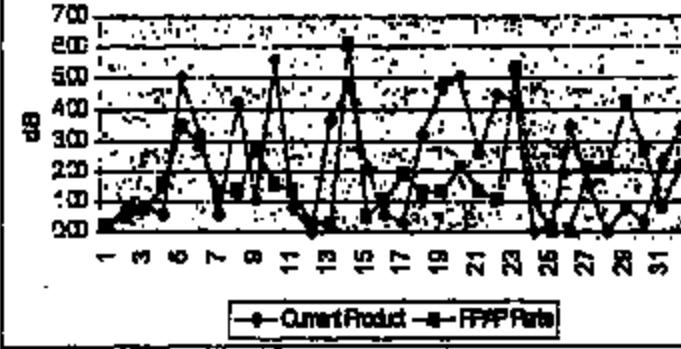
Sound Test Comparison
Lock/Bolt Extend



Sound Test Comparison
Lock/Bolt Average



Sound Test Comparison
Lock/Bolt Standard Deviation



Random Samples of Initial Data PPTF PART

	<u>IN</u>	<u>Out</u>		<u>IN</u>	<u>Out</u>
(1)	1. 53.3	53.0	(89)	17. 54.8	52.5
(4)	2. 54.5	55.2	(94)	18. 54.5	56.3
(11)	3. 57.1	56.0	(99)	19. 54.1	56.0
(16)	4. 59.2	56.0	(105)	20. 56.7	59.7
(22)	5. 56.0	51.1	(110)	21. 54.1	52.0
(27)	6. 56.3	52.2	(116)	22. 56.3	52.8
(33)	7. 54.1	56.0	(121)	23. 49.2	56.7
(38)	8. 55.2	52.3	(126)	24. 61.2	62.7
(43)	9. 57.5	53.7	(131)	25. 56.7	56.7
(49)	10. 55.2	53.0	(137)	26. 54.1	50.1
(54)	11. 54.1	56.0	(143)	27. 51.8	54.6
(60)	12. 55.2	55.6	(149)	28. 52.0	56.0
(65)	13. 55.2	55.6	(155)	29. 54.5	48.5
(71)	14. 44.5	57.1	(159)	30. 55.2	59.0
(76)	15. 56.0	56.7	(165)	31. 56.3	52.5
(77)	16. 55.6	57.1	(171)	32. 54.8	52.8

Current Product Sample Test

	In	Out	In	Out
1.	54.5	54.8	17.	58.1
2.	51.5	52.6	18.	56.3
3.	53.3	54.5	19.	56.3
4.	47.7	48.5	20.	55.2
5.	58.2	51.1	21.	55.2
6.	50.7	55.2	22.	56.7
7.	50.3	51.1	23.	56.3
8.	55.6	48.6	24.	47.7
9.	50.7	52.2	25.	50.0
10.	58.6	50.7	26.	57.1
11.	52.6	51.5	27.	53.7
12.	51.8	51.8	28.	50.0
13.	57.8	52.6	29.	56.3
14.	57.1	50.3	30.	50.7
15.	56.8	53.7	31.	56.6
16.	50.7	51.5	32.	56.3

**FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT**

Type of Test:	Engineering
Log #:	00-0005
Customer/Product Description:	Saginaw Column Lock
Fasco Part #:	1740-0002
Test Description:	Durability Before Test
Sample Size:	12
Build Date:	N189
Technician:	Lori Hoyle
Start Date:	01/01/2000
Finish Date:	01/19/2000

Power on motor for 300 msec

Results: Part # 13's motor is shorted to the housing. # 13 will not be put on test.

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
Test Log #: 00-0005
Item/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Test Description: Durability Before Test
Sample Size: 12
Build Date: N189
Technician: Lori Hoyle
Start Date: 01/01/2000
Finish Date: 01/19/2000

Power on motor for 300 mSec

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Ampa) 14.2 @ Ambient Unlock < 7 Amps	
13	13.840	Not Measured	5.900	6.100	
14	13.515	Not Measured	5.800	6.200	
15	15.605	Not Measured	5.800	6.200	
16	15.780	Not Measured	5.600	6.000	
17	Made	Not Measured	5.500	5.800	
18	13.080	Not Measured	5.300	6.000	
19	12.255	Not Measured	5.900	6.300	
20	12.175	Not Measured	6.500	6.000	
21	12.300	Not Measured	5.800	6.100	
22	12.275	Not Measured	5.800	6.200	
23	12.470	Not Measured	5.400	6.100	
24	12.335	Not Measured	5.800	6.000	

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0005
 Item/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability After Test
 Sample Size: 12
 Build Date: N189
 Technician: Lori Hoyle
 Start Date: 01/01/2000
 Finish Date: 01/19/2000

Power on motor for 300 mSec

Part #	Pull Force@ 22 ft-lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 5 Volts 11.6mm - 12.8mm
13	SHORTED	SHORTED	SHORTED	SHORTED	SHORTED
14	Passed	Not Measured	Passed	Passed	13.065
15	Passed	Not Measured	Passed	Passed	13.910
16	Passed	Not Measured	Passed	Passed	13.190
17	Passed	Not Measured	Passed	Passed	12.890
18	Passed	Not Measured	Passed	Passed	13.155
19	Passed	Not Measured	Passed	Passed	12.080
20	Passed	Not Measured	Passed	Passed	11.865
21	Passed	Not Measured	Passed	Passed	12.120
22	Passed	Not Measured	Passed	Passed	12.355
23	Passed	Not Measured	Passed	Passed	12.090
24	Passed	Not Measured	Passed	Passed	12.520

Results:

**FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT**

Type of Test:	Engineering
Log #:	00-0005
Customer/Product Description:	Saginaw Column Lock
Fasco Part #:	1740-0002
Test Description:	Durability After Test
Sample Size:	12
Build Date:	N189
Technician:	Lori Hoyle
Start Date:	01/01/2000
Finish Date:	01/18/2000

Power on motor for 300 mSec

As: Part # 13 was shorted from the beginning. I found part # 19 to be shorted at the end of the test.

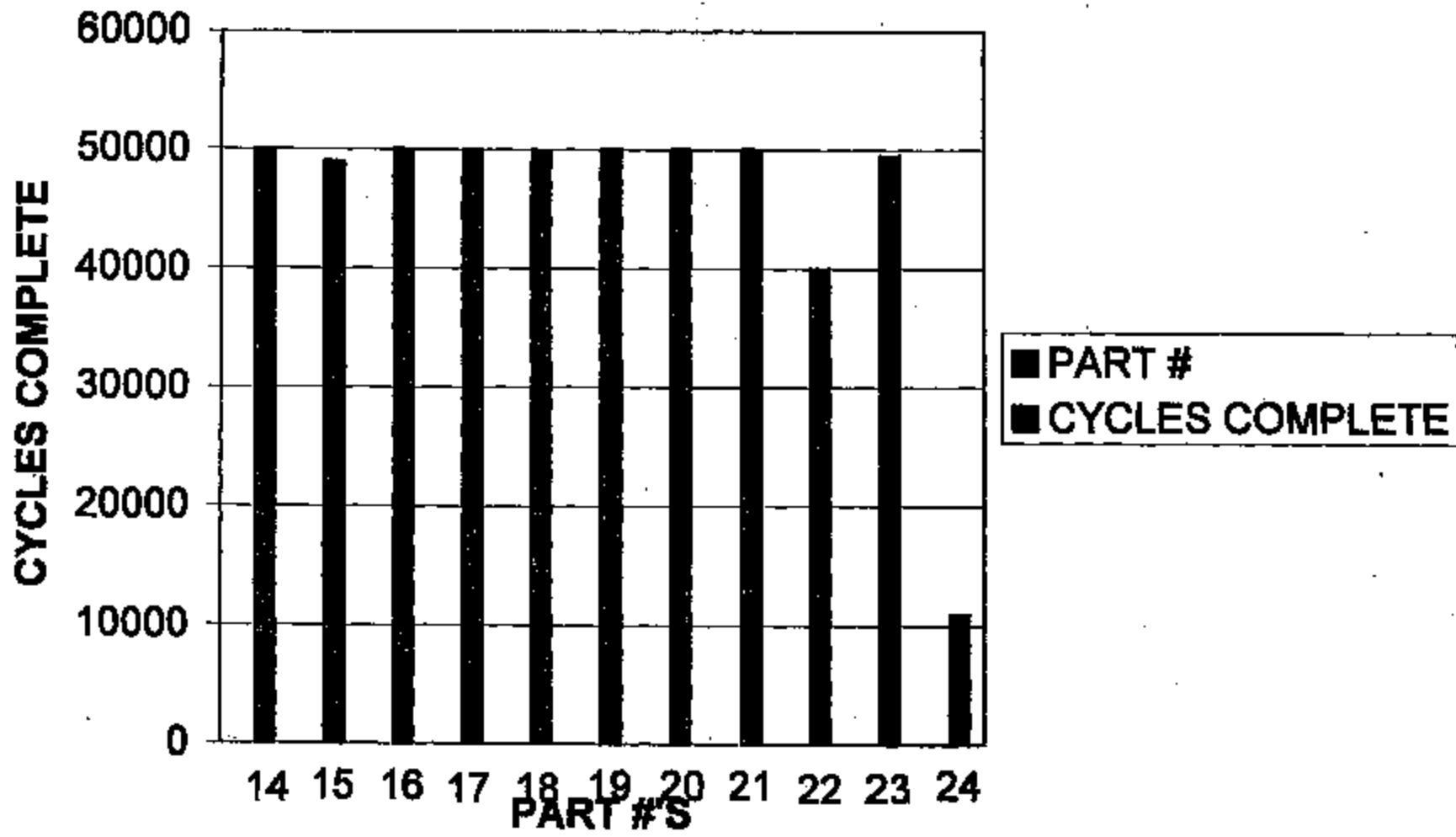
SAGINAW COLUMN LOCK

TEST LOG #: 00-0005
DATE: 02/08/2000
ENGINEER: STEVE DAVIS
TECHNICIAN: LORI HOYLE

These parts were cycled 50,000 times at 85C. The motor on time was 300 milliseconds.
Parts numbered 13-17 had ear bumpers in them. Parts 18-24 were current production.

Part 24 failed around 11,000 cycles and never worked again. Pin up.
Part 23 failed around 36,000 for about 2 hours. Pin up.
Part 22 failed around 40,000 cycles and never worked again. Pin up.
Part 18 failed around 45,000 for about 1 hour.
Part 17 failed around 36,200 for about 25 cycles. Pin up.
Part 16 missed 1 cycle around 20,00 cycles.
Part 15 failed around 49,000 cycles and never returned. Pin up.
Part 13's motor was shorted to the housing and was never tested.

SAGINAW 00-0005



SAGINAW COLUMN LOCK

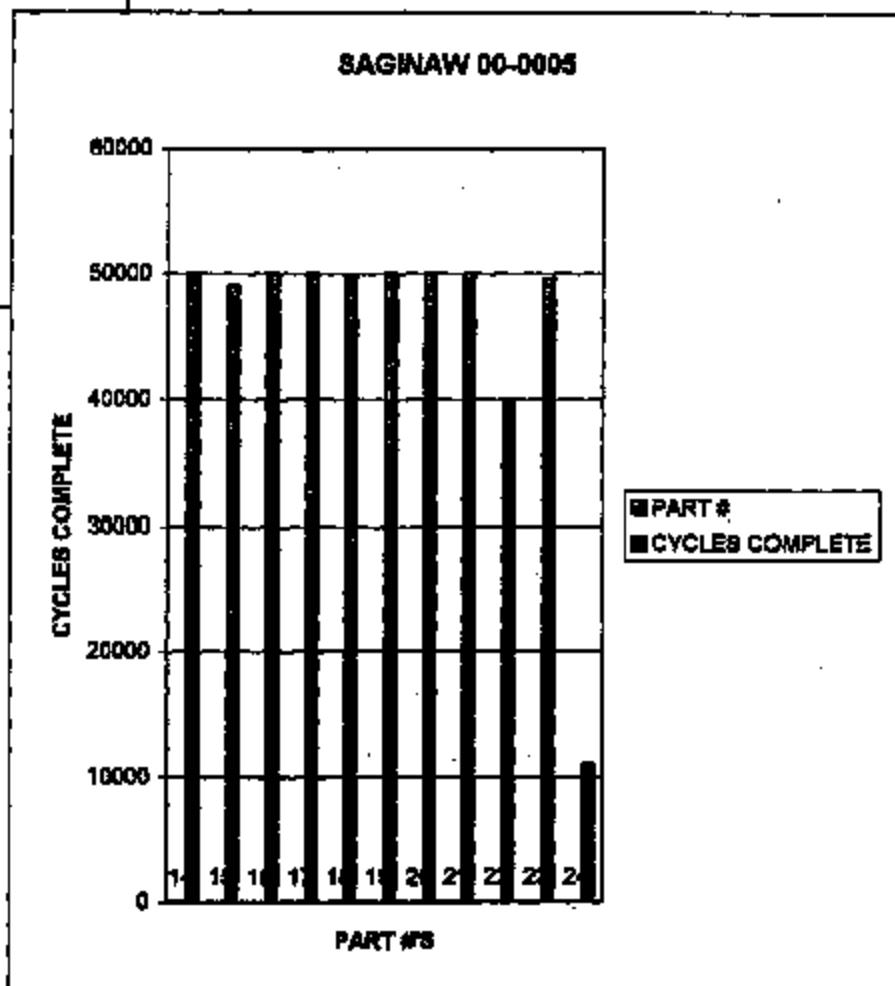
TEST LOG # 00-0005

Date 02/08/200

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

PART #	CYCLES COMPLETE
14	50,000
15	49,000
16	49,999
17	49,975
18	49,780
19	50,000
20	50,000
21	50,000
22	40,000
23	49,520
24	11,000



Lab Work Request

SS-0006

06-0056

Date: 01/06/2000

Request By: Steve Davis

Date needed: 01/08/2000

Part Name: SCL

Part Number: 1740-0002

Customer: SAGINAW

Type of Test or Work: ENG EVAL

Special Requirements:

EVALUATE EFFECTS OF VARYING POWER "ON" TIME WITH RESPECT TO REBOUND
SCHEMATIC AND DISCUSSION OF TEST SPECIFIC PROVIDED 1/6/00 AM

All Areas that are Effectected:
ENG TEST

NOTE: You must include all pertinent drawings, prints and specifications along with this document. Failure to do so will cause this request to be returned to sender and delay the project.
help Attachments or Links Here:

Document History Section:

Document Created on 01/06/2000 by Steve Davis

0609-2240 12/2/98

6006
TEST LOG # 00-0001

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

DATE: 01/17/00

TIME VOLTAGE APPLIED: 50mSEC

514 NO TROUBLE FOUND (NTF)

505 NTF

519 NTF

CP = CURRENT PRODUCTION

PART #	REBOUND (mm)	SWITCH (mSec)	CURRENT (Amps)
514 NTF	10.35	178	4.7
	10.37	178	4.7
	10.35	178	4.7
505 NTF	10.16	188	4.1
	10.15	188	4.1
	10.15	188	4.1
519 NTF	10.39	154	4.3
	10.28	154	4.3
	10.27	154	4.3
508 RETURN	10.36	144	5.1
	10.4	144	5.1
	10.36	144	5.1
523 RETURN	10.37	159	4.9
	10.37	159	4.9
	10.36	159	4.9
539 RETURN	10.45	162	4.3
	10.47	162	4.3
	10.45	162	4.3
1-CP	13.48	150	4.5
	13.48	150	4.5
	13.45	150	4.5
2-CP	14.53	102	4.5
	14.53	102	4.5
	14.27	102	4.5
3-CP	14.12	102	4.7
	14.29	102	4.7
	14.24	102	4.7
4-CP	13.41	122	4.5
	13.52	122	4.5
	13.27	122	4.5
5-CP	14.4	102	4.3
	14.35	102	4.3
	14.54	102	4.3
6-CP	12.97	130	4.7
	13.87	130	4.7
	13.52	130	4.7

TEST LOG # 00-0001

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

DATE: 01/17/00

TIME VOLTAGE APPLIED: 100milliseconds

PART #	REBOUND (mm)	SWITCH (mSec)	CURRENT (Amps)
514	10.38	128	4.5
	10.38	128	4.5
	10.38	128	4.5
505	10.17	137	4.3
	10.16	137	4.3
	10.17	137	4.3
519	10.3	122	4.1
	10.25	122	4.1
	10.24	122	4.1
508	10.35	118	4.9
	10.36	118	4.9
	10.36	118	4.9
523	10.32	122	4.1
	10.33	122	4.1
	10.32	122	4.1
539	10.43	140	4.1
	10.44	140	4.1
	10.44	140	4.1
1-CP	10.08	142	4.3
	10.08	142	4.3
	10.09	142	4.3
2-CP	10.29	140	4.3
	10.3	140	4.3
	10.32	140	4.3
3-CP	10.12	136	4.3
	10.11	136	4.3
	10.11	136	4.3
4-CP	10.1	140	4.5
	10.09	140	4.5
	10.1	140	4.5
5-CP	11.12	132	4.3
	10.21	132	4.3
	10.22	132	4.3
6-CP	10.21	132	3.9
	10.21	132	3.9
	10.23	132	3.9

TEST LOG # 00-0001

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

DATE: 01/17/00

TIME VOLTAGE APPLIED: 200mSec

PART #	REBOUND (mm)	SWITCH (mSec)	CURRENT (Amps)
514	10.88	114	4.9
	10.88	114	4.9
	10.89	114	4.9
605	10.33	122	4.3
	10.37	122	4.3
	10.38	122	4.3
519	10.34	118	4.3
	10.33	118	4.3
	10.32	118	4.3
508	11.11	110	4.9
	11.19	110	4.9
	10.93	110	4.9
623	10.82	110	4.9
	10.85	110	4.9
	10.9	110	4.9
639	11.21	110	4.9
	11.22	110	4.9
	11.23	110	4.9
1-CP	10.13	140	4.5
	10.13	140	4.5
	10.13	140	4.5
2-CP	10.27	136	4.5
	10.28	136	4.5
	10.27	136	4.5
3-CP	10.02	134	4.7
	10.03	134	4.7
	10.07	134	4.7
4-CP	10.1	134	4.9
	10.1	134	4.9
	10.1	134	4.9
5-CP	10.21	134	4.7
	10.21	134	4.7
	10.22	134	4.7
6-CP	10.25	134	4.5
	10.25	134	4.5
	10.25	134	4.5

TEST LOG # 00-0001

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

DATE: 01/17/00

TIME VOLTAGE APPLIED: 300 mSec

PART #	REBOUND (mm)	SWITCH (mSec)	CURRENT (Amps)
514	10.87	110	5.5
	10.82	110	5.5
	10.82	110	5.5
608	10.32	112	5.3
	10.34	112	5.3
	10.34	112	5.3
519	10.35	108	5.3
	10.34	108	5.3
	10.34	108	5.3
508	10.64	104	5.5
	10.98	104	5.5
	11.41	104	5.5
623	10.78	104	6.1
	10.89	104	6.1
	10.83	104	6.1
639	11.01	104	5.3
	11.09	104	5.3
	11.12	104	5.3
1-CP	10.1	128	4.9
	10.1	128	4.9
	10.11	128	4.9
2-CP	10.23	128	5.5
	10.24	128	5.5
	10.27	128	5.5
3-CP	10.03	128	6.1
	10.03	128	6.1
	10.03	128	6.1
4-CP	10.12	128	5.3
	10.12	128	5.3
	10.12	128	5.3
5-CP	10.19	128	5.3
	10.12	128	5.3
	10.29	128	5.3
6-CP	10.22	128	5.1
	10.23	128	5.1
	10.24	128	5.1

TEST LOG # 00-0001

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

DATE: 01/17/00

TIME VOLTAGE APPLIED: 400mSEC

PART #	REBOUND (mm)	SWITCH (mSec)	CURRENT (Amps)
514	10.78	114	5.3
	10.75	114	5.3
	10.76	114	5.3
505	10.23	120	4.9
	10.25	120	4.9
	10.26	120	4.9
519	10.38	118	4.7
	10.35	118	4.7
	10.35	118	4.7
508	11.11	110	5.3
	11.08	110	5.3
	11.11	110	5.3
523	10.81	112	6.1
	10.87	112	6.1
	10.88	112	6.1
539	11.11	110	4.9
	11.13	110	4.9
	11.13	110	4.9
1-CP	10.11	134	5.3
	10.11	134	5.3
	10.11	134	5.3
2-CP	10.21	134	5.9
	10.23	134	5.9
	10.24	134	5.9
3-CP	10.02	132	5.3
	10.02	132	5.3
	10.02	132	5.3
4-CP	10.11	134	5.3
	10.11	134	5.3
	10.11	134	5.3
5-CP	10.17	132	5.9
	10.18	132	5.9
	10.19	132	5.9
6-CP	10.21	132	5.1
	10.21	132	5.1
	10.21	132	5.1

TEST LOG # 00-0001

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

DATE: 01/17/00

TIME VOLTAGE APPLIED: 500mSEC

PART #	REBOUND (mm)	SWITCH (mSec)	CURRENT (Amps)
514	10.72	112	5.7
	10.76	112	5.7
	10.77	112	5.7
505	10.25	118	5.3
	10.31	118	5.3
	10.31	118	5.3
519	10.33	110	5.3
	10.33	110	5.3
	10.33	110	5.3
508	11.07	110	5.5
	11.08	110	5.5
	11.12	110	5.5
523	10.82	110	6.1
	10.95	110	6.1
	10.97	110	6.1
539	11.08	110	5.3
	11.14	110	5.3
	11.13	110	5.3
1-CP	10.11	128	5.3
	10.13	128	5.3
	10.12	128	5.3
2-CP	10.27	128	5.1
	10.3	128	5.1
	10.32	128	5.1
3-CP	10.02	128	6.1
	10.02	128	6.1
	10.02	128	6.1
4-CP	10.15	128	5.1
	10.15	128	5.1
	10.13	128	5.1
5-CP	10.22	128	5.3
	10.21	128	5.3
	10.21	128	5.3
6-CP	10.23	128	6.1
	10.23	128	5.1
	10.23	128	5.1

TEST LOG # 00-0001

ENGINEER: STEVE DAVIS

TECHNICIAN: LORI HOYLE

DATE: 01/17/00

TIME VOLTAGE APPLIED: 600mSEC

PART #	REBOUND (mm)	SWITCH (mSec)	CURRENT (Amps)
514	10.72	110	6.3
	10.78	110	6.3
	10.89	110	5.3
505	10.24	118	5.1
	10.27	118	5.1
	10.31	118	5.1
519	10.35	114	5.1
	10.33	114	5.1
	10.33	114	5.1
508	11.08	106	5.5
	11.09	106	5.5
	11.1	106	5.5
523	11.05	106	5.9
	10.9	106	5.9
	10.94	106	5.9
539	11.07	106	5.1
	11.07	106	5.1
	11.09	106	5.1
1-CP	10.11	132	5.1
	10.11	132	5.1
	10.12	132	5.1
2-CP	10.22	132	5.1
	10.24	132	5.1
	10.27	132	5.1
3-CP	10.02	128	5.1
	10.02	128	5.1
	10.02	128	5.1
4-CP	10.11	128	5.1
	10.12	128	5.1
	10.14	128	5.1
5-CP	10.16	128	4.9
	10.21	128	4.9
	10.21	128	4.9
6-CP	10.23	128	5.1
	10.22	128	5.1
	10.24	128	5.1

TEST LOG # 00-0001

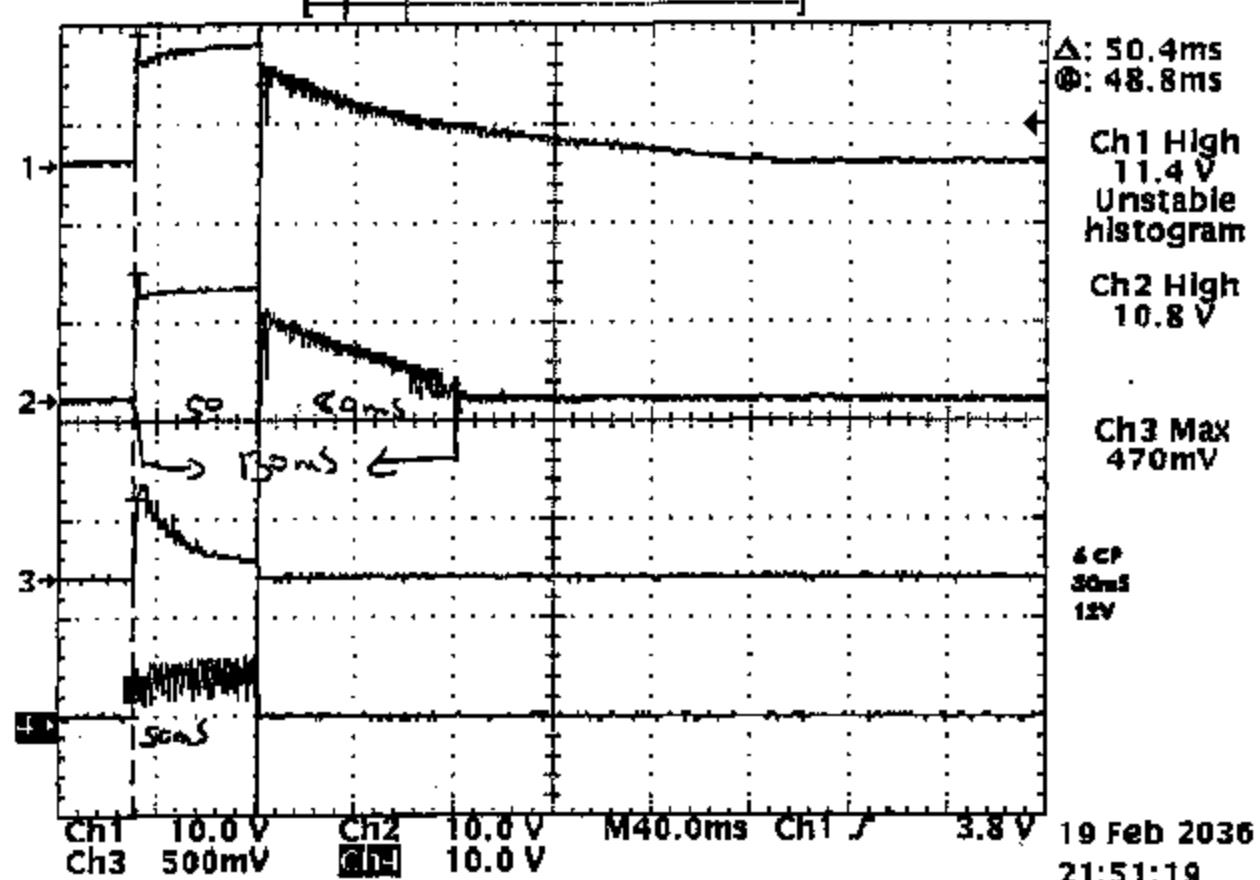
ENGINEER: STEVE DAVIS

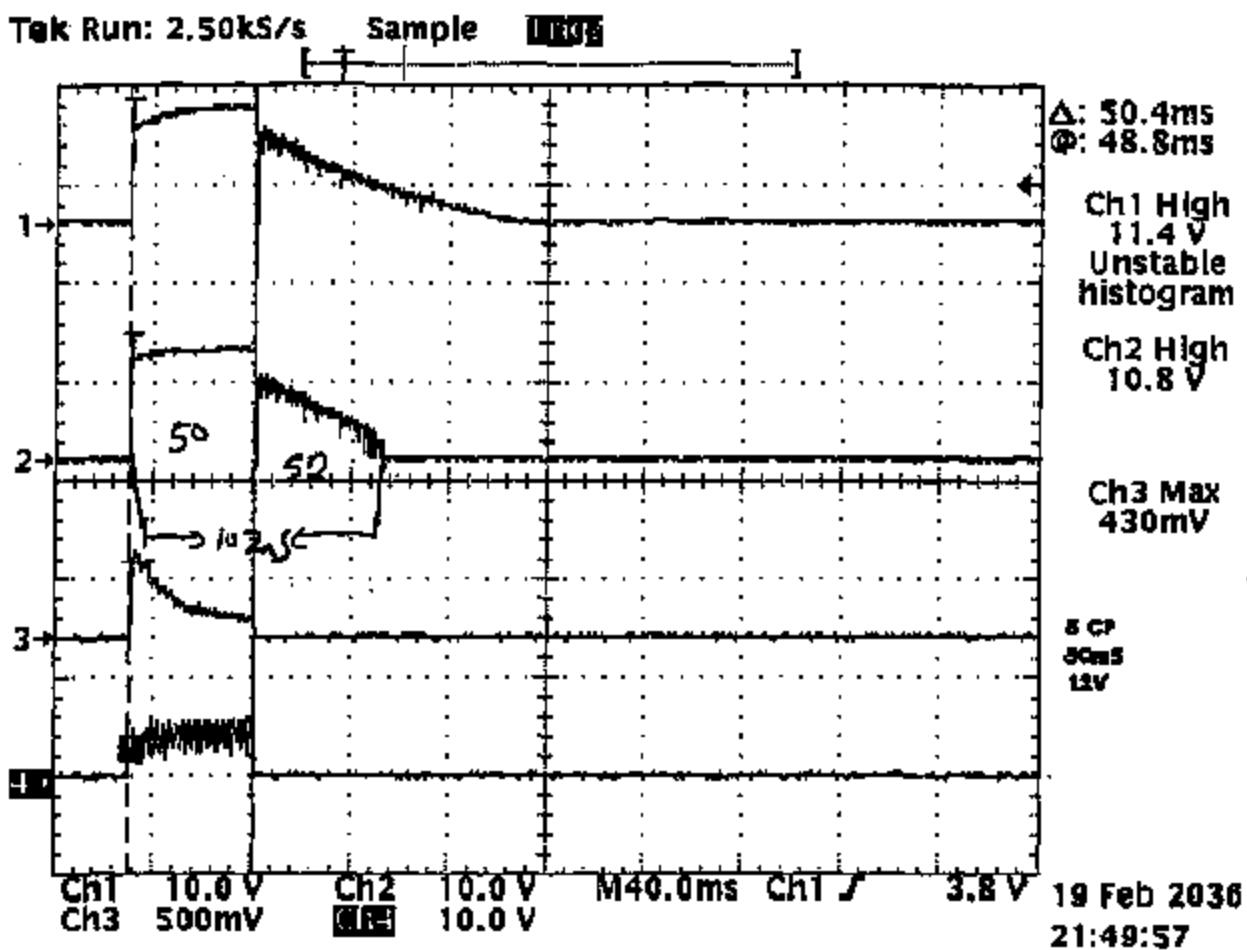
TECHNICIAN: LORI HOYLE

DATE: 01/17/00

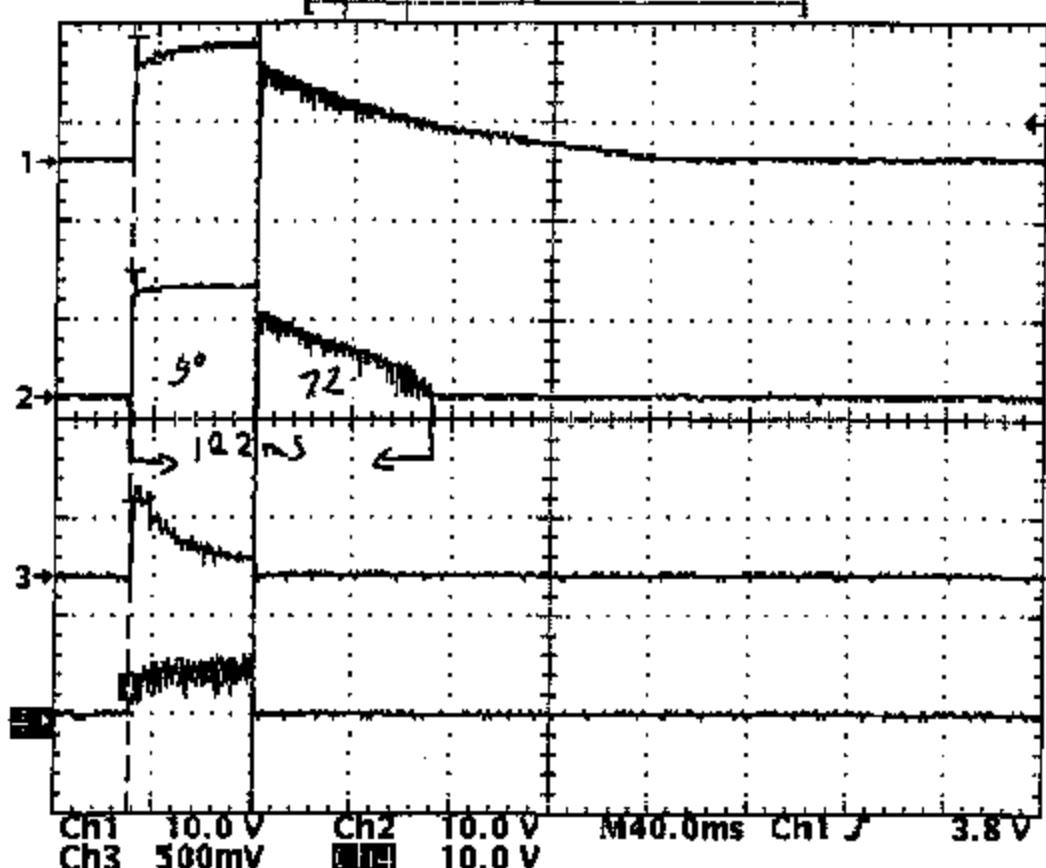
PART #	SWITCH POINT RETRACTED	FULL RETRACT	SWITCH POINT EXTENDING
514	11.770	10.380	11.830
	12.025	10.375	11.740
	12.050	10.370	11.520
505	12.115	10.110	11.585
	12.175	10.110	11.545
	12.190	10.105	11.585
519	12.105	10.300	11.980
	12.320	10.330	11.935
	12.415	10.335	11.780
508	12.390	10.390	11.970
	12.190	10.365	12.030
	12.375	10.420	12.025
523	12.110	10.365	11.735
	12.135	10.370	11.650
	12.270	10.370	11.895
539	11.920	10.410	11.305
	11.910	10.410	11.310
	11.960	10.415	11.845
1-CP	12.225	10.065	11.735
	12.135	10.060	11.735
	11.995	10.065	11.835
2-CP	12.305	10.225	12.015
	12.600	10.220	12.110
	12.580	10.190	11.895
3-CP	12.290	10.065	12.000
	12.280	10.045	11.985
	12.590	10.063	11.890
4-CP	12.550	10.110	12.135
	12.580	10.065	11.970
	12.485	10.100	11.975
5-CP	12.255	10.185	12.130
	12.410	10.165	12.115
	12.240	10.180	12.035
6-CP	12.420	10.200	11.725
	12.445	10.200	11.935
	12.300	10.200	12.075

Tek Run: 2.50kS/s Sample: 1000



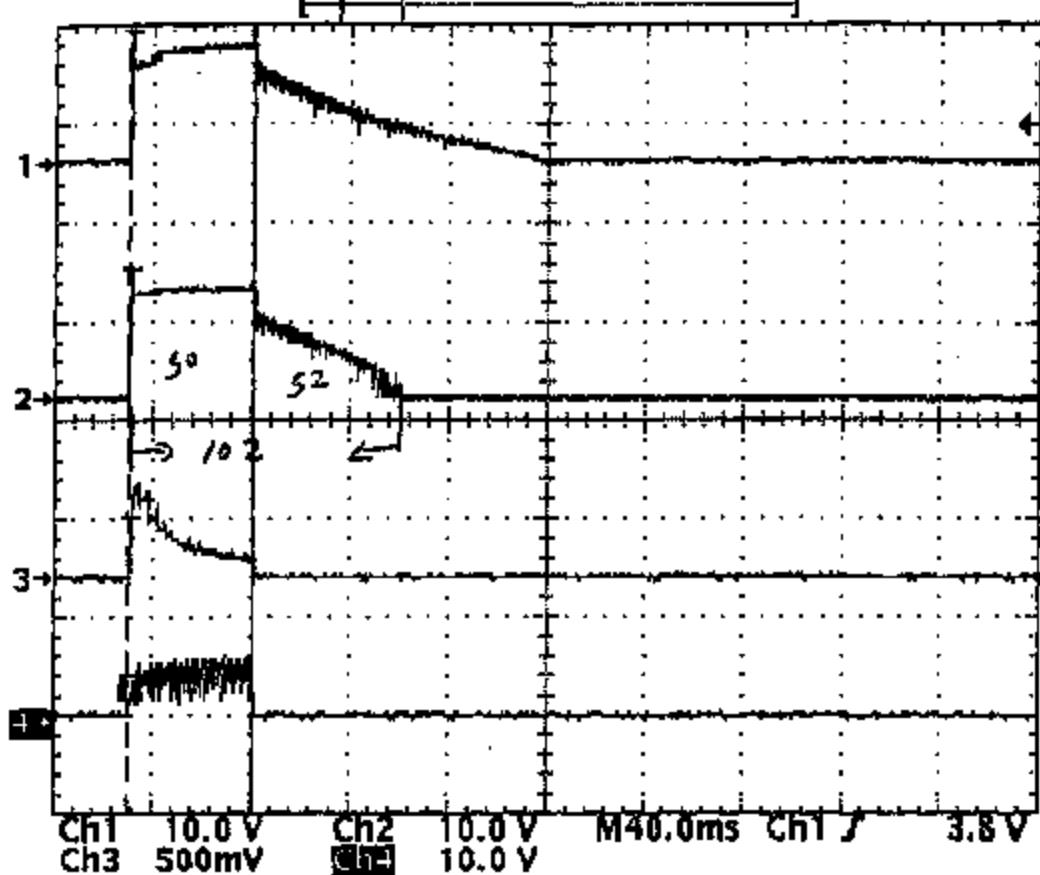


Tek Run: 2.50kS/s Sample 1000



19 Feb 2036
21:49:03

Tek Run: 2.50ks/s Sample 100%



Δ: 50.4ms
@: 48.8ms

Ch1 High
11.4 V
Unstable
histogram

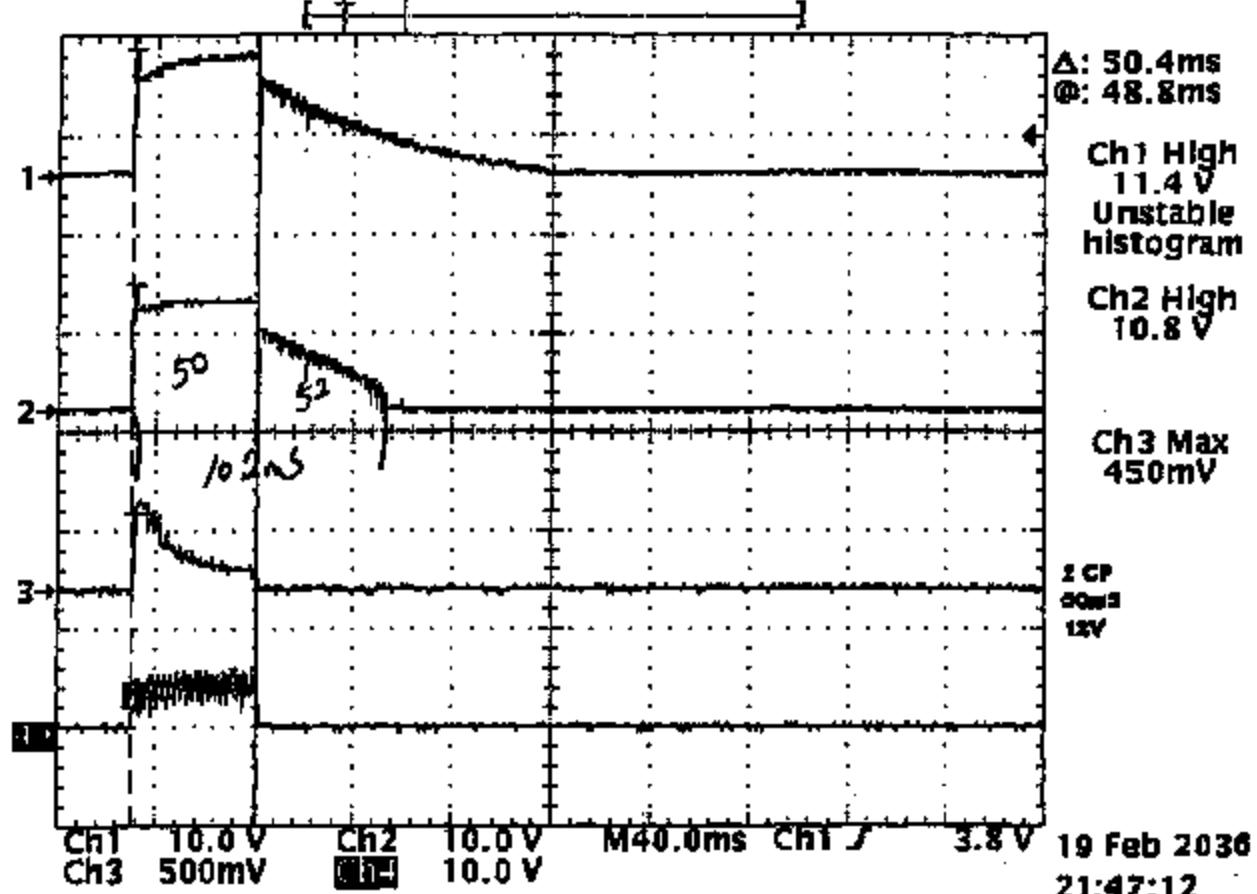
Ch2 High
10.8 V

Ch3 Max
470mV

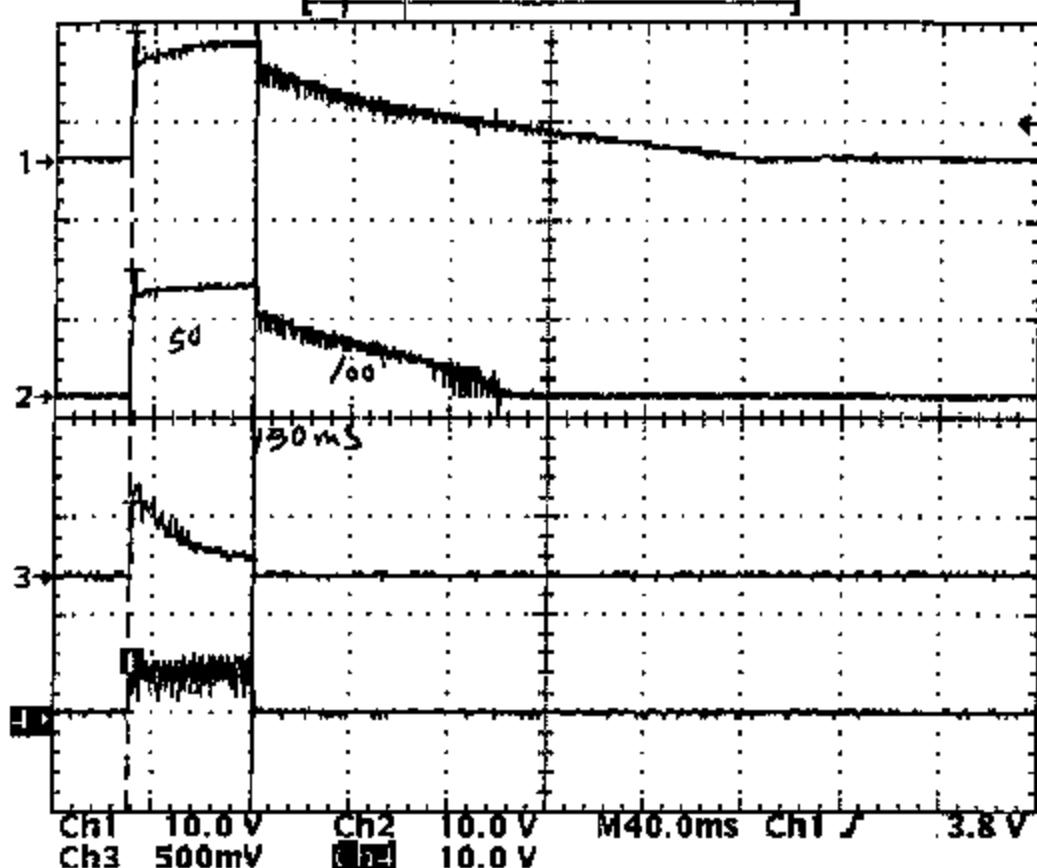
3 CF
80ms
12Y

19 Feb 2036
21:48:23

Tek Run: 2.50kS/s Sample 1908



Tek Run: 2.50kS/s Sample 1028



Δ: 50.4ms
Φ: 48.8ms

Ch1 High
11.4 V
Unstable
histogram

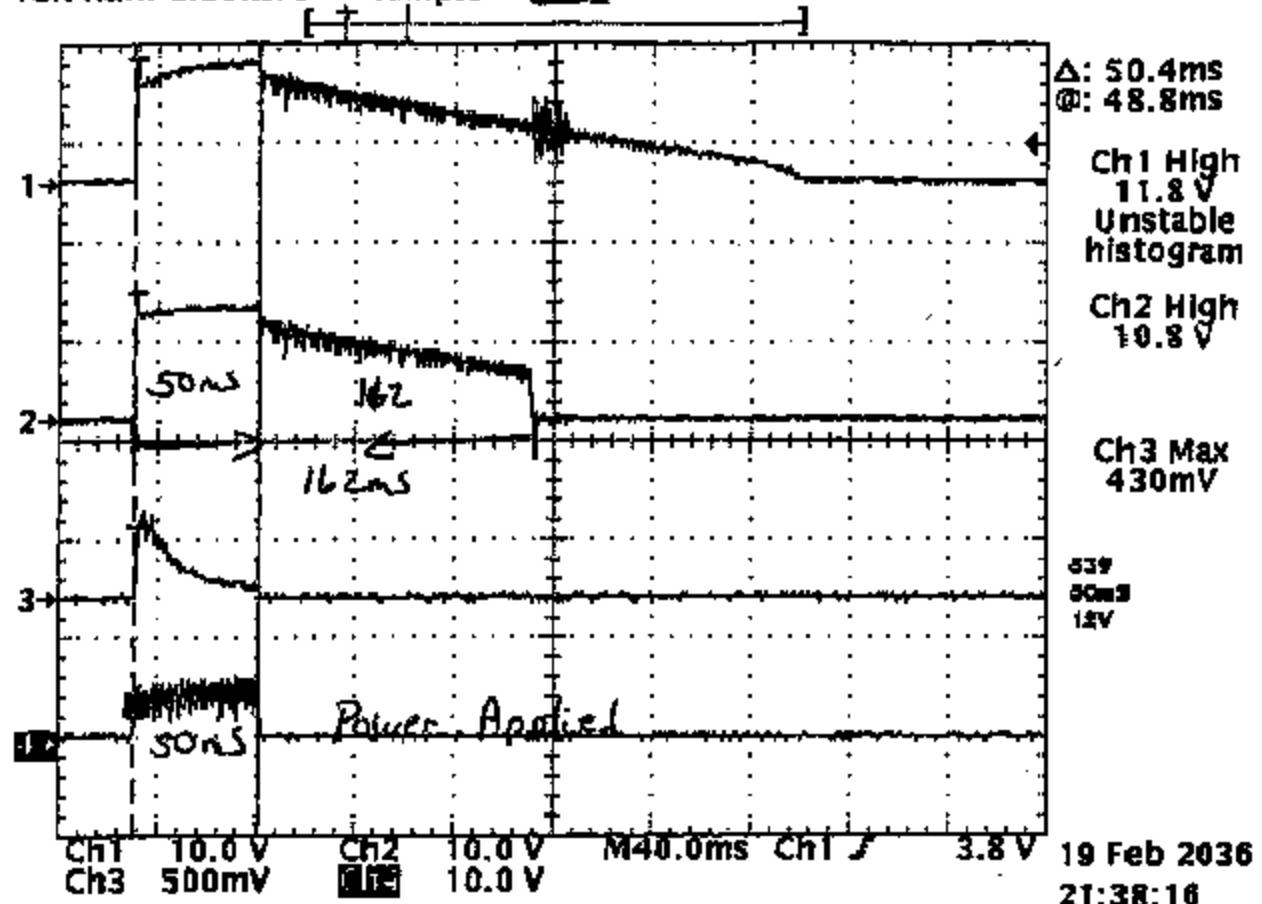
Ch2 High
10.8 V
Unstable
histogram

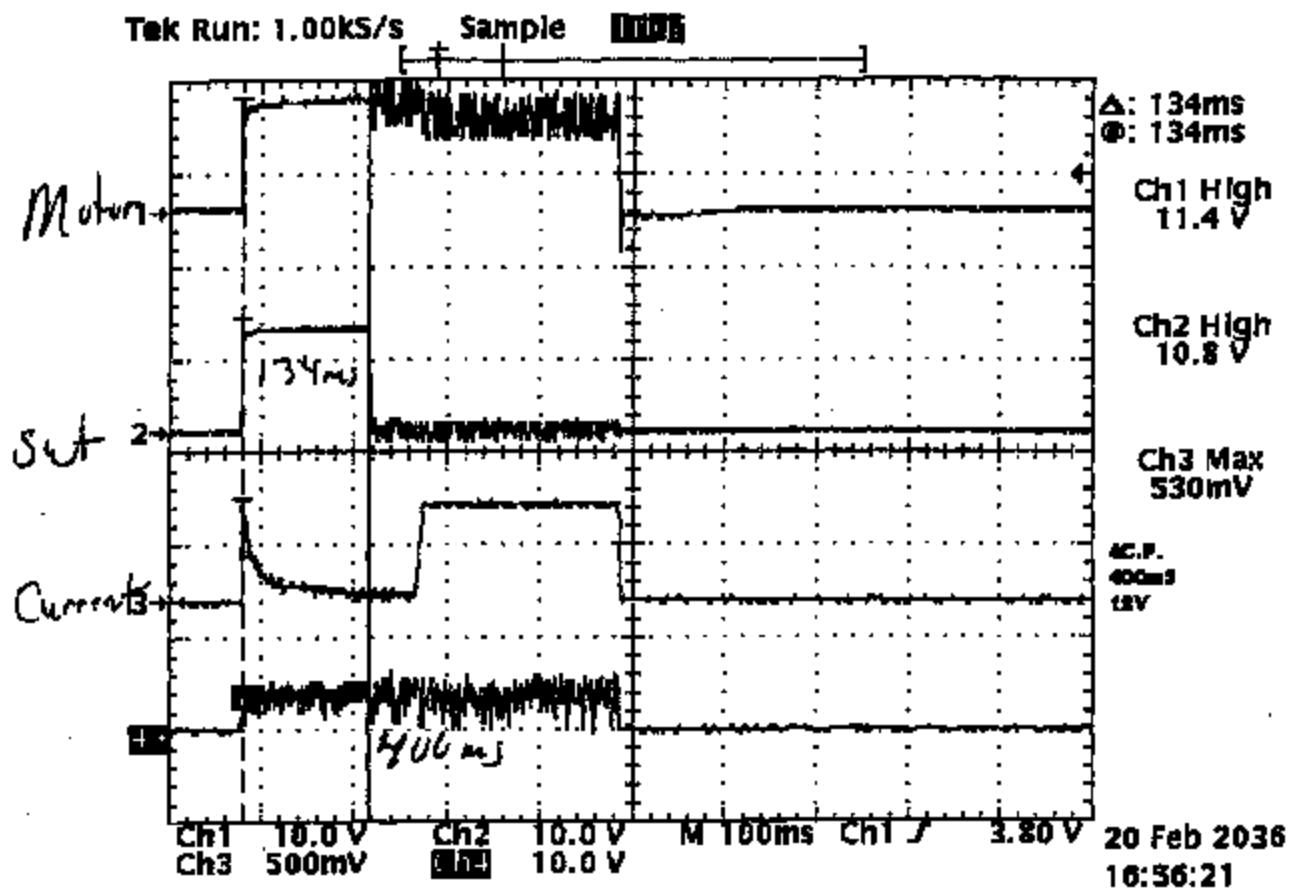
Ch3 Max
450mV

1 CP
50ms
12V

19 Feb 2036
21:41:31

Tek Run: 2.50kS/s Sample 100%





Tek Run: 1.00kS/s Sample 100%

Motor

Surf

Current

U

Δ: 132ms
Φ: 132ms

Ch1 High
11.8 V

Ch2 High
10.8 V

Ch3 Max
530mV

3 G.P.
400ms
12V

20 Feb 2036
16:54:14

Ch1 10.0 V
Ch3 500mV

Ch2 10.0 V
M 100ms

Ch1 3.80 V

172μs

400μs

Tek Run: 1.00kS/s Sample 1000

Motor 1+

134ms

Switch 2

Current 3-

40ms

Ch1 10.0 V
Ch3 500mV

Ch2 10.0 V

M 100ms

Ch1 3.80 V

20 Feb 2036
16:52:14

Δ: 134ms
@: 134ms

Ch1 High
11.8 V

Ch2 High
10.8 V

Ch3 Max
590mV

2 G.P.
400ms
12V

Tek Run: 1.00kS/s Sample 1000

Motor

1

134ms

Switch

2

Current

3

400ns

Δ: 134ms
@: 134ms

Ch1 High
11.8 V

Ch2 High
10.8 V

Ch3 Max
530mV

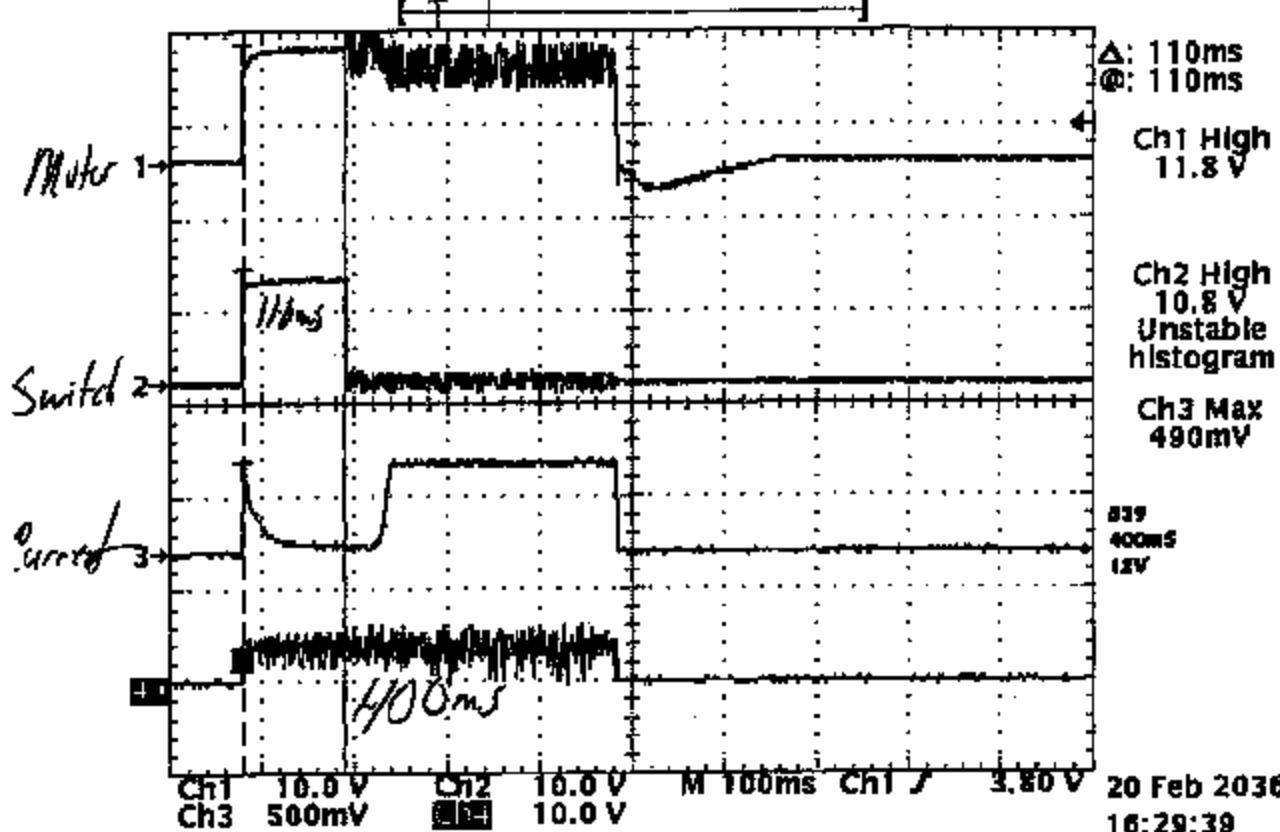
1 Current Prod.
400ms
12V

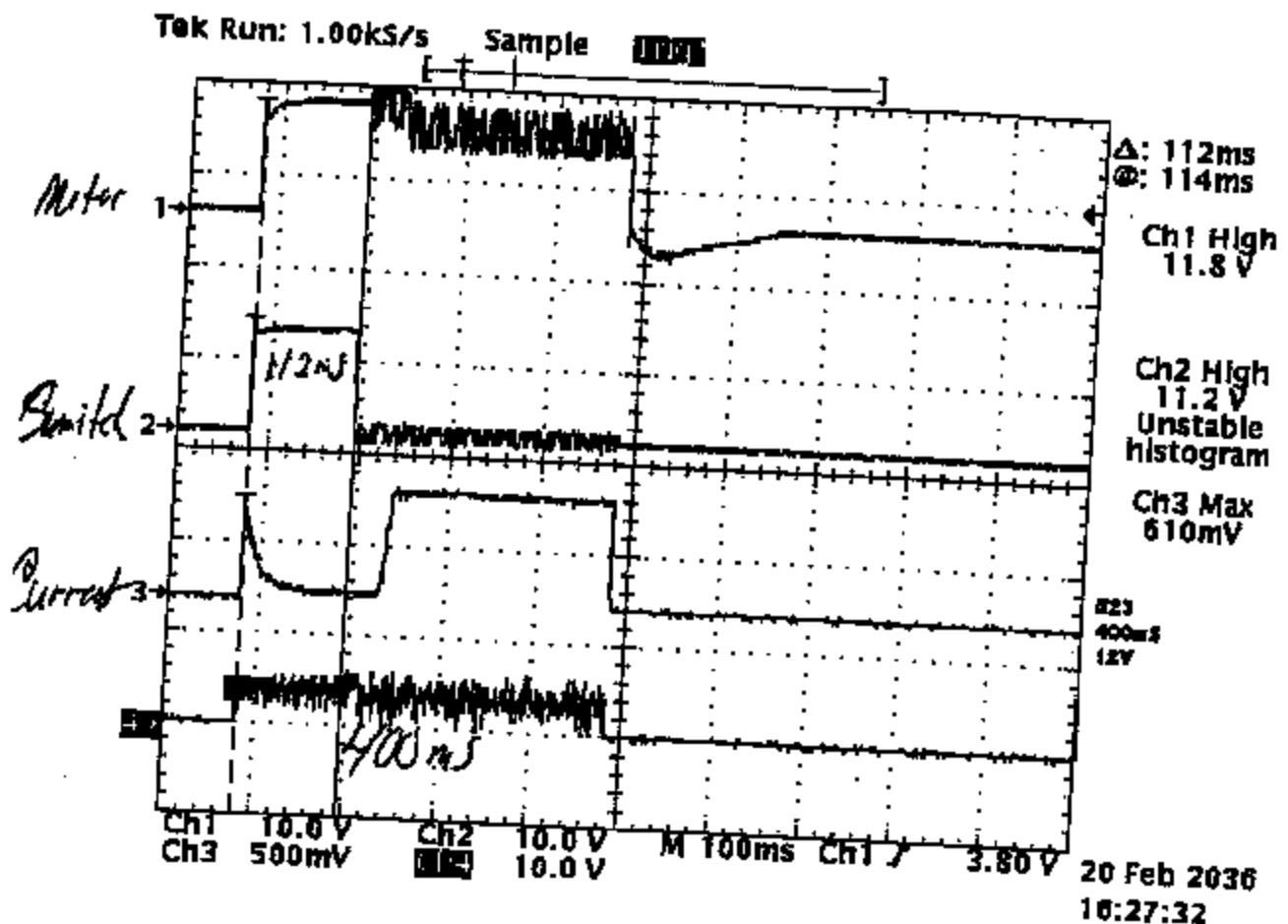
Ch1 10.0 V
Ch3 500mV

Ch2 10.0 V
M 100ms Ch1 3.80 V

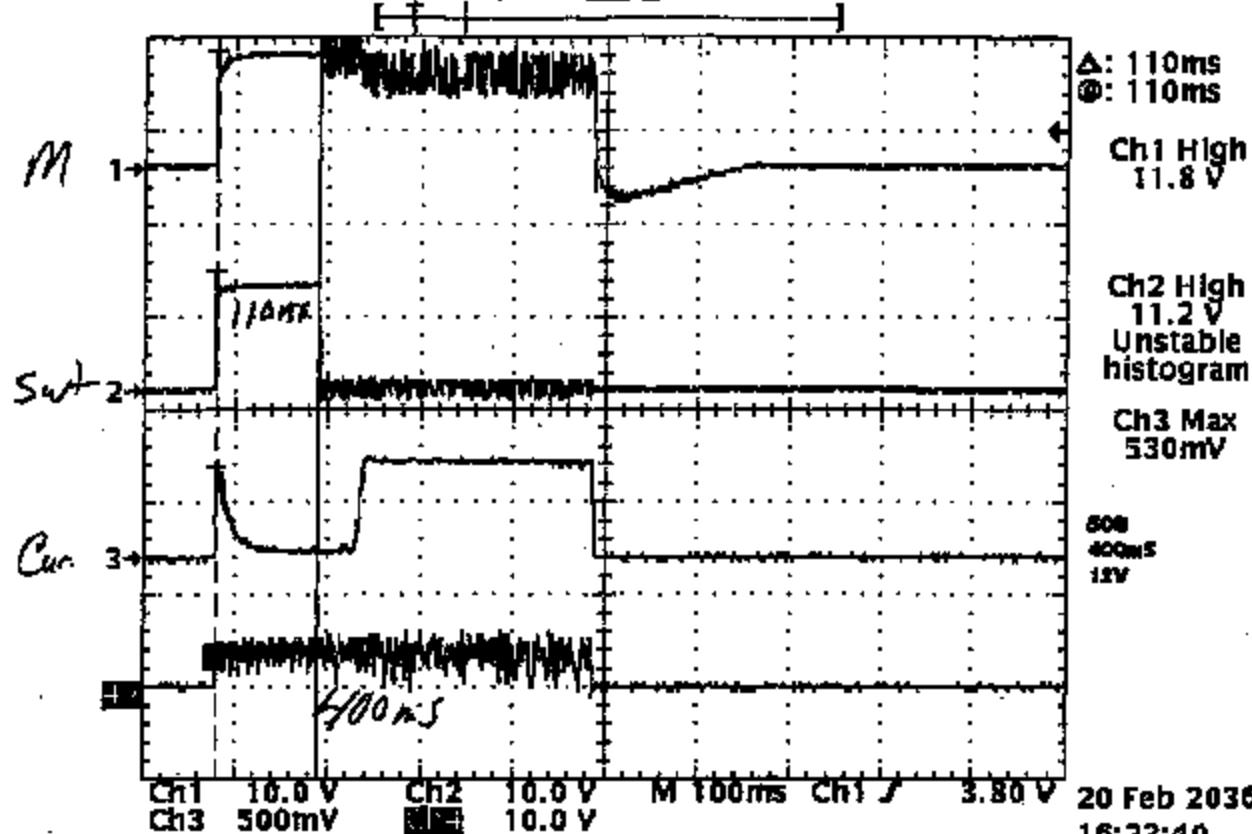
20 Feb 2036
16:50:34

Tek Run: 1.00kS/s Sample 1109





Tek Run: 1.00kS/s Sample 1000



Tek Run: 1.00kS/s Sample 1000

M

1

2

S

2

C

3

H

4

118

500ns

Ch1 10.0 V
Ch3 500mV

Ch2 10.0 V
Ch3 500mV

M 100ms Ch1 J

3.80 V

20 Feb 2006
16:22:03

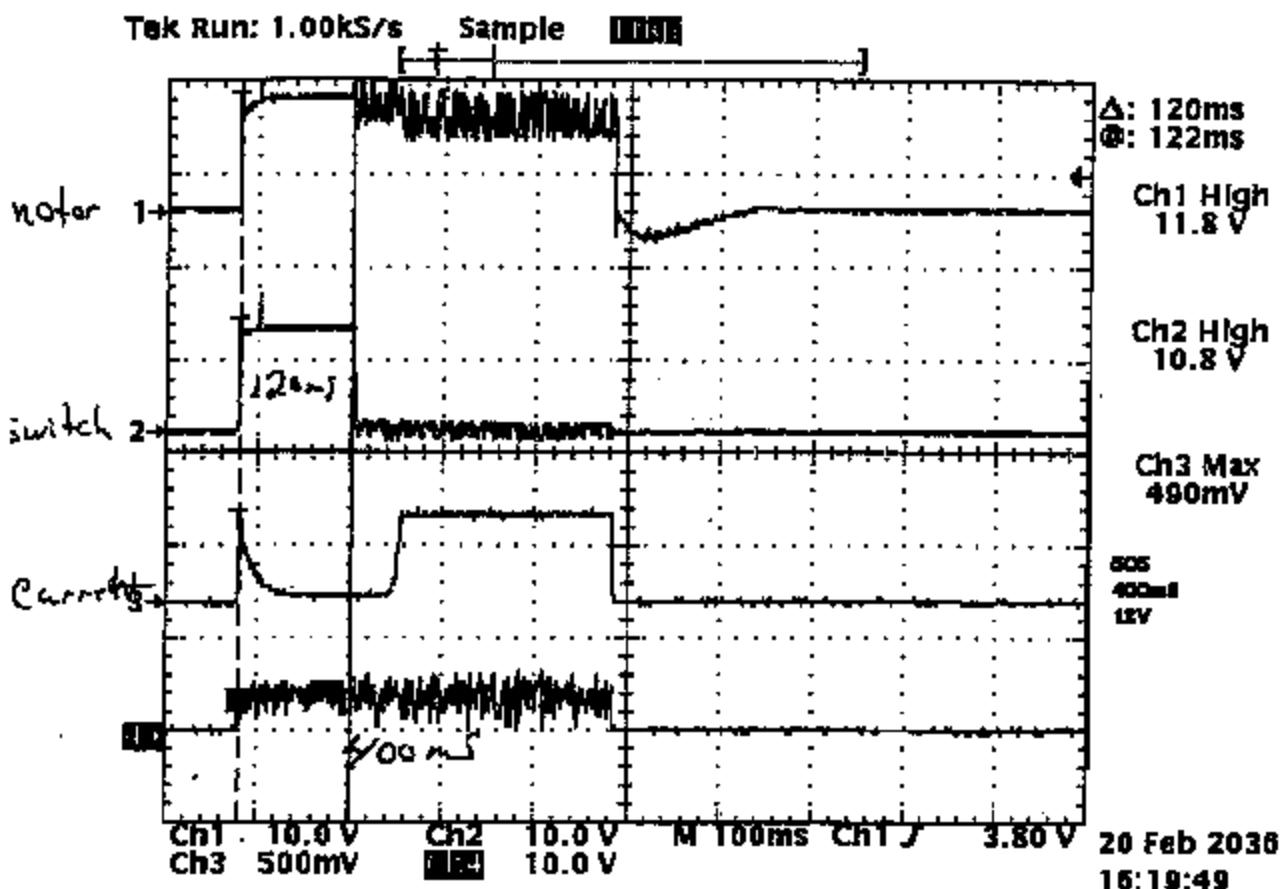
Δ: 118ms
◎: 118ms

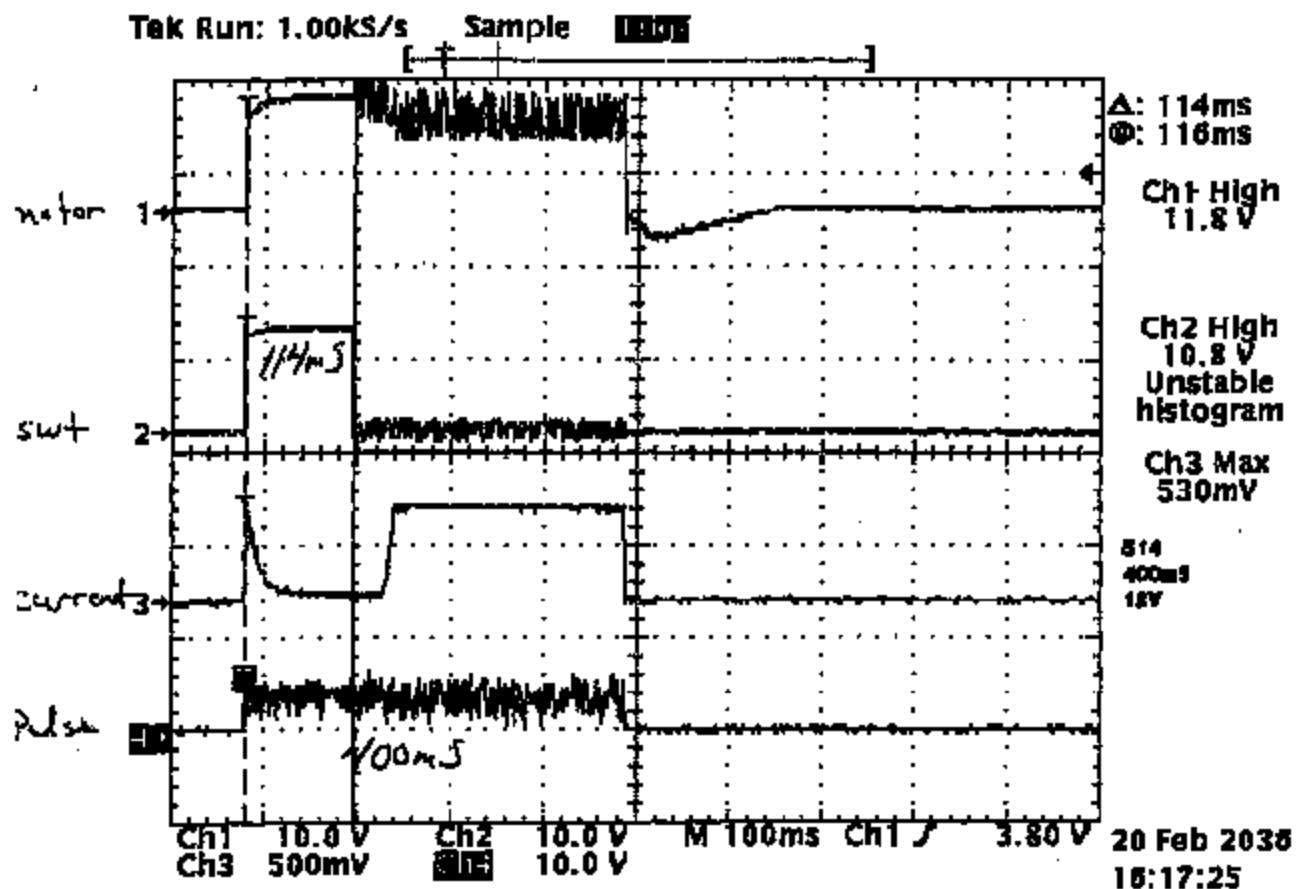
Ch1 High
11.8 V

Ch2 High
11.2 V
Unstable
histogram

Ch3 Max
470mV

518
400ms
12V





400 m/s

514 10.78
 112 5.3
 10.75 114 5.3
 10.78 114 5.3

③ 1 10.11 134 5.3
 10.11 134 5.1
 10.11 134 5.1

④ 505 10.23 120 4.9
 10.25 120 4.9
 10.26 120 5.1

⑤ 2 10.21 134 5.9
 10.23 " 5.1
 10.24 6.1

⑥ 519 10.36 118 4.7
 10.35 114 4.9
 10.35 110 4.7

⑦ ③ 10.02 132 5.3
 10.02 " "
 10.02 " "

⑧ 508 11.11 110 5.3
 11.08 110 5.5
 11.11 110 5.1

⑨ 4 10.11 134 5.3
 10.16 " "
 10.11 " 5.1

10 523 10.81 112 6.1
 10.87 " 6
 10.88 " 5.9

⑩ ⑤ 10.17 132 5.9
 10.18 " "
 10.19 " 4.5

11 539 11.11 110 5.1
 11.13 110 4.9
 11.13 " "

⑪ 6 10.21 132 5.1
 10.21 " "
 10.21 5.1

R. repeat
at
400m/s

TEK Run: 2.50ks/s Sample 8116

Motol1

Switch2

1ms

Current

3+

4-

Ch1 10.0 V
Ch3 500mV

Ch2 10.0 V
GND

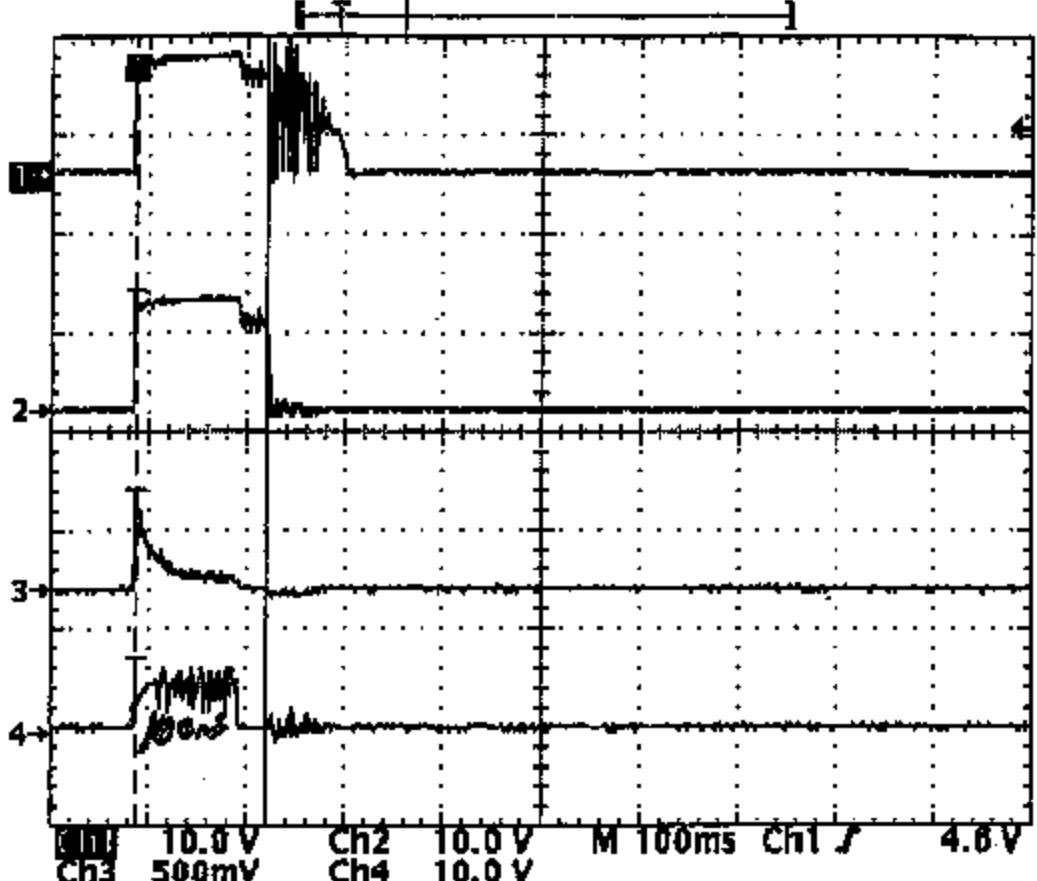
M40.0ms Ch1

3.8 V

19 Feb 2036
21:29:56

△: 50.4ms
◎: 48.8ms
Ch1 High 11.8 V Unstable histogram
Ch2 High 10.8 V Unstable histogram
Ch3 Max 470mV
814 50ms 12V

Tek Run: 1.00kS/s Sample 100%



△: 132ms
∅: 132ms

Ch1 High
11.8 V

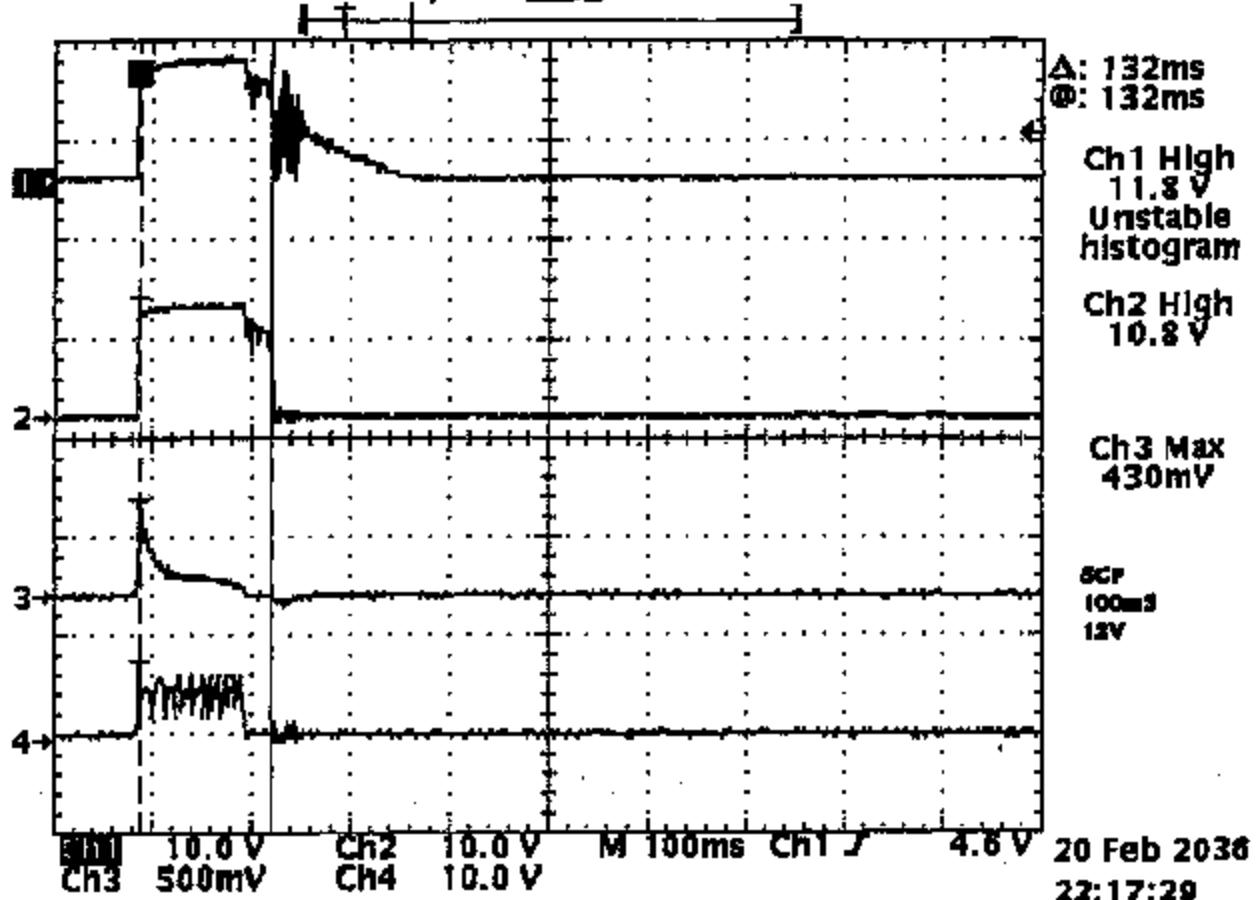
Ch2 High
10.8 V

Ch3 Max
380mV

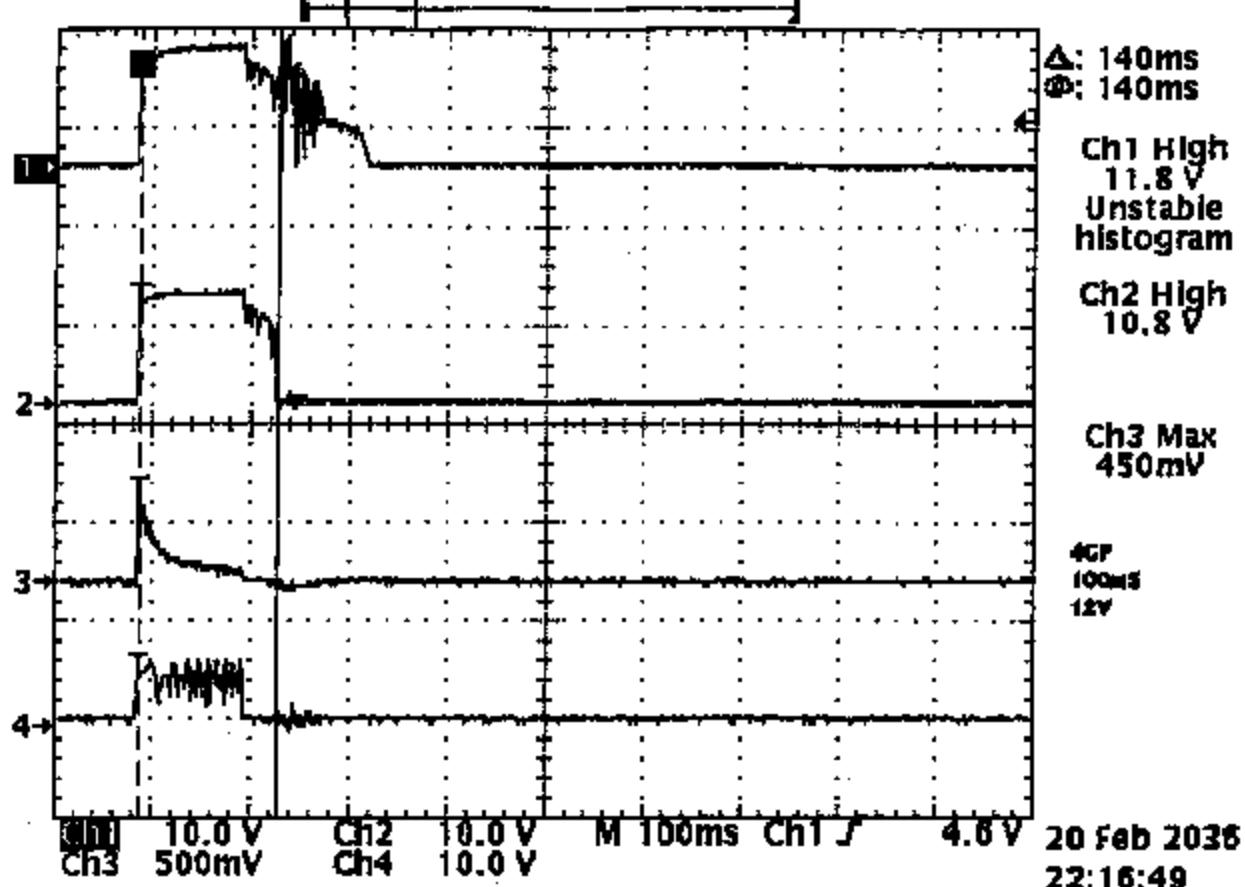
SCP
100ms
12V

20 Feb 2036
22:18:07

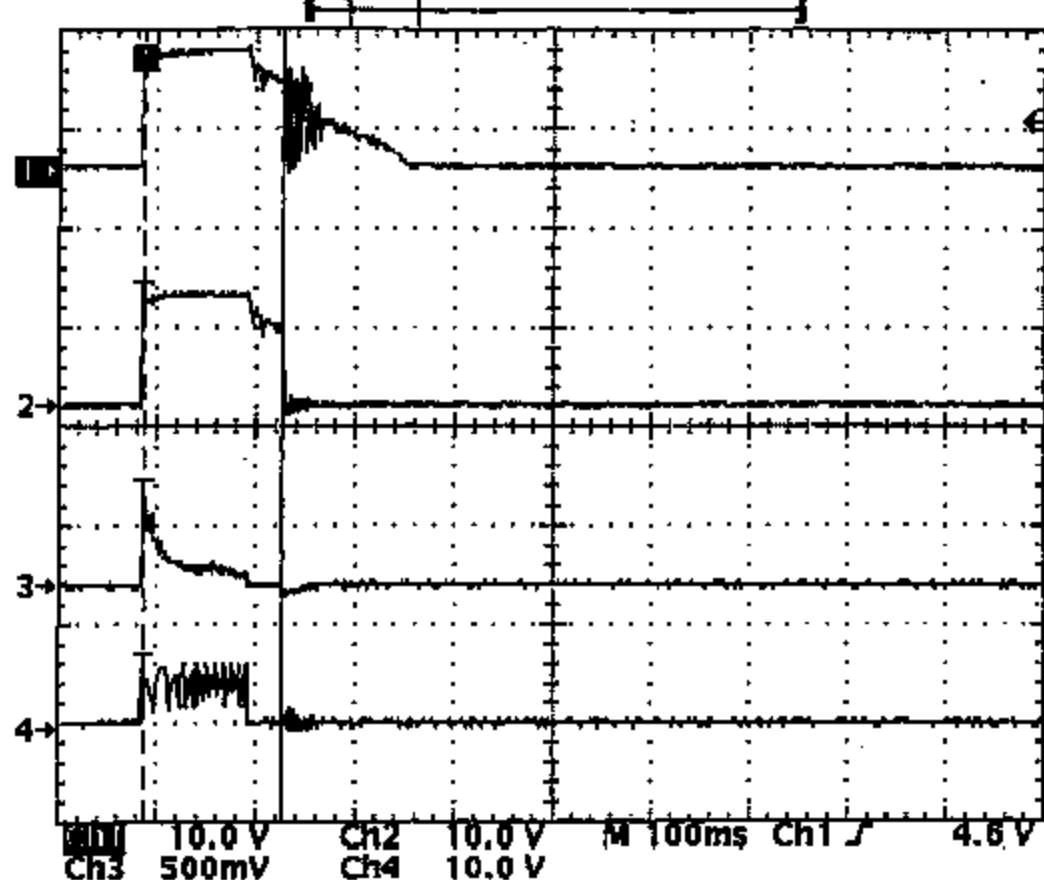
Tek Run: 1.00kS/s Sample 1000



Tek Run: 1.00kS/s Sample 100%



Tek Run: 1.00kS/s Sample 1404



△: 136ms
◎: 138ms

Ch1 High
11.8 V

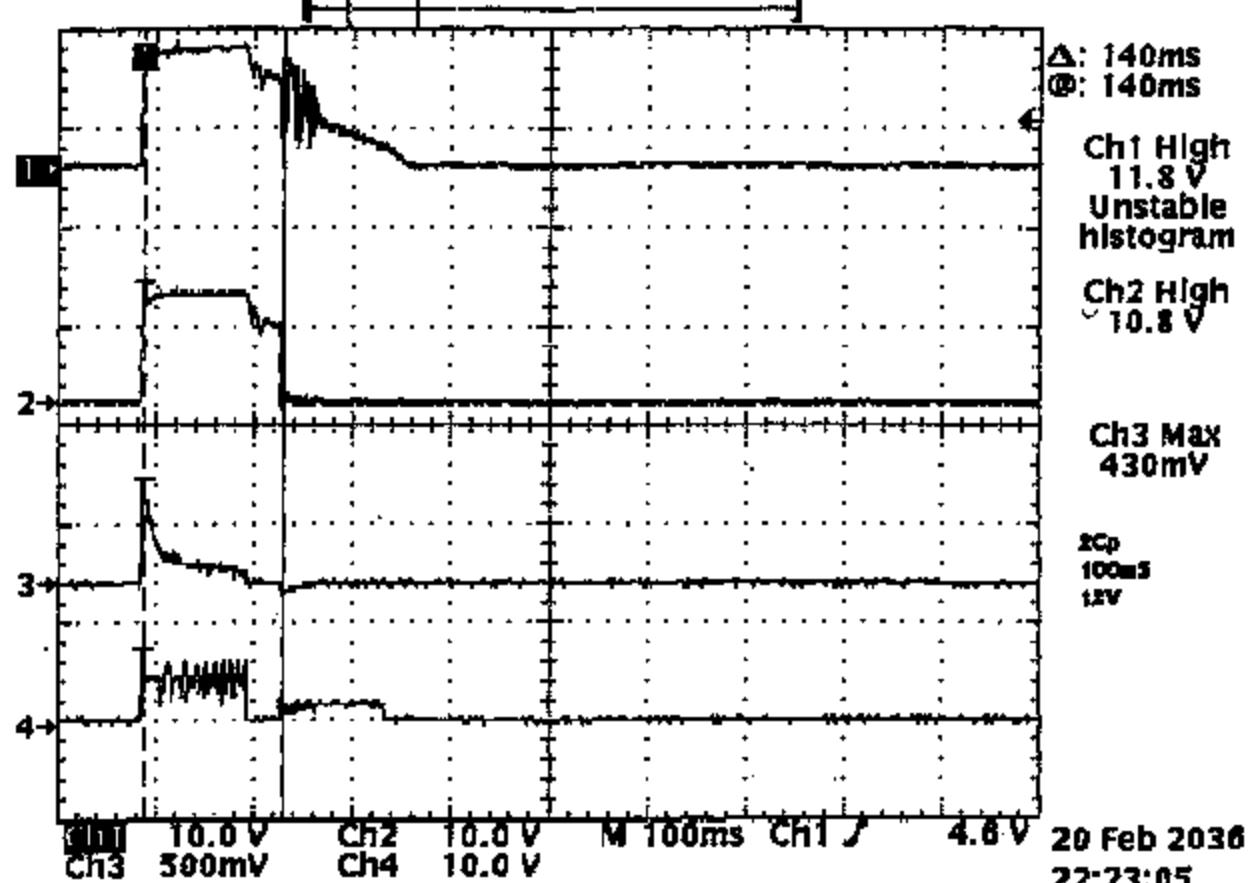
Ch2 High
10.8 V
Unstable
histogram

Ch3 Max
430mV

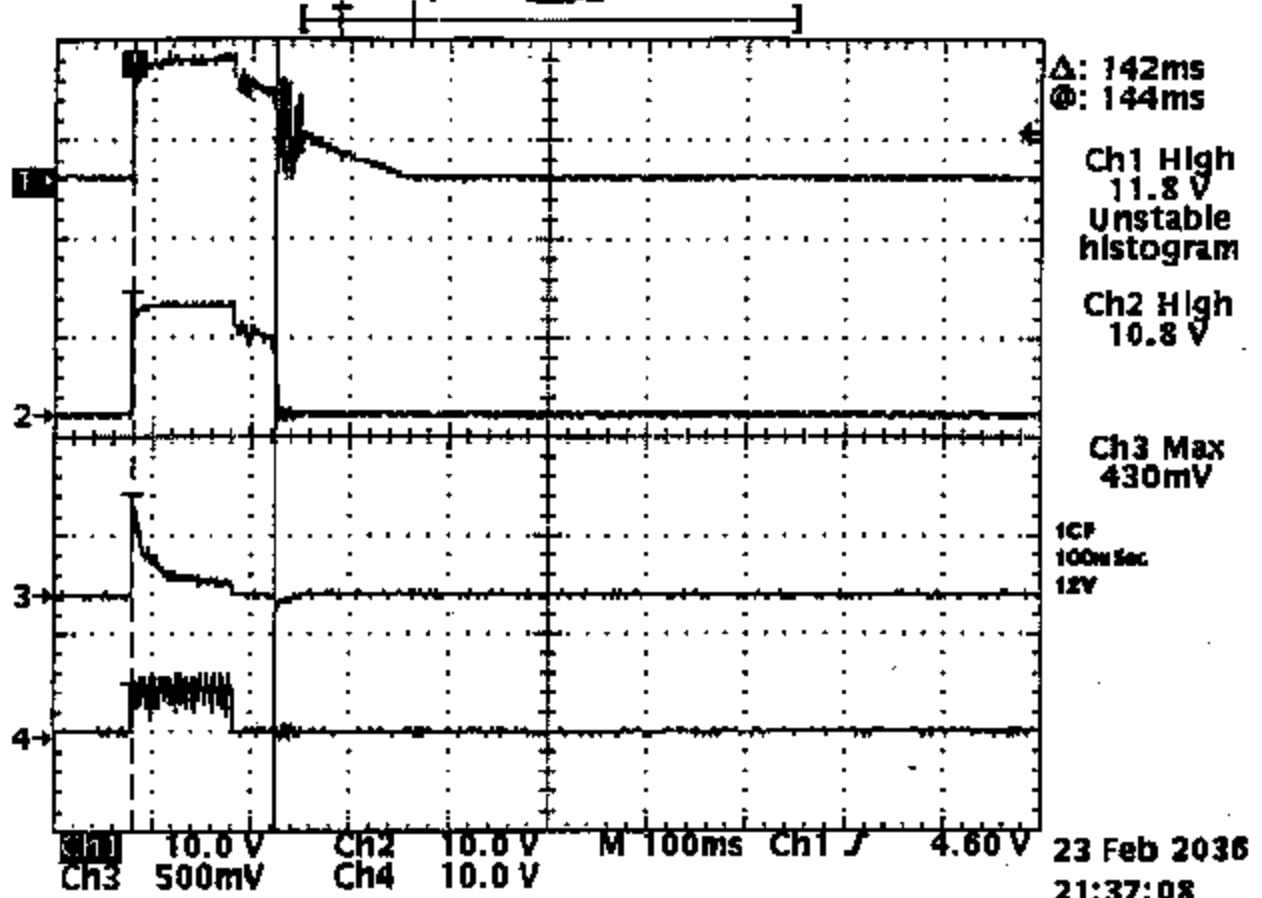
3CP
100MS
12V

20 Feb 2036
22:15:31

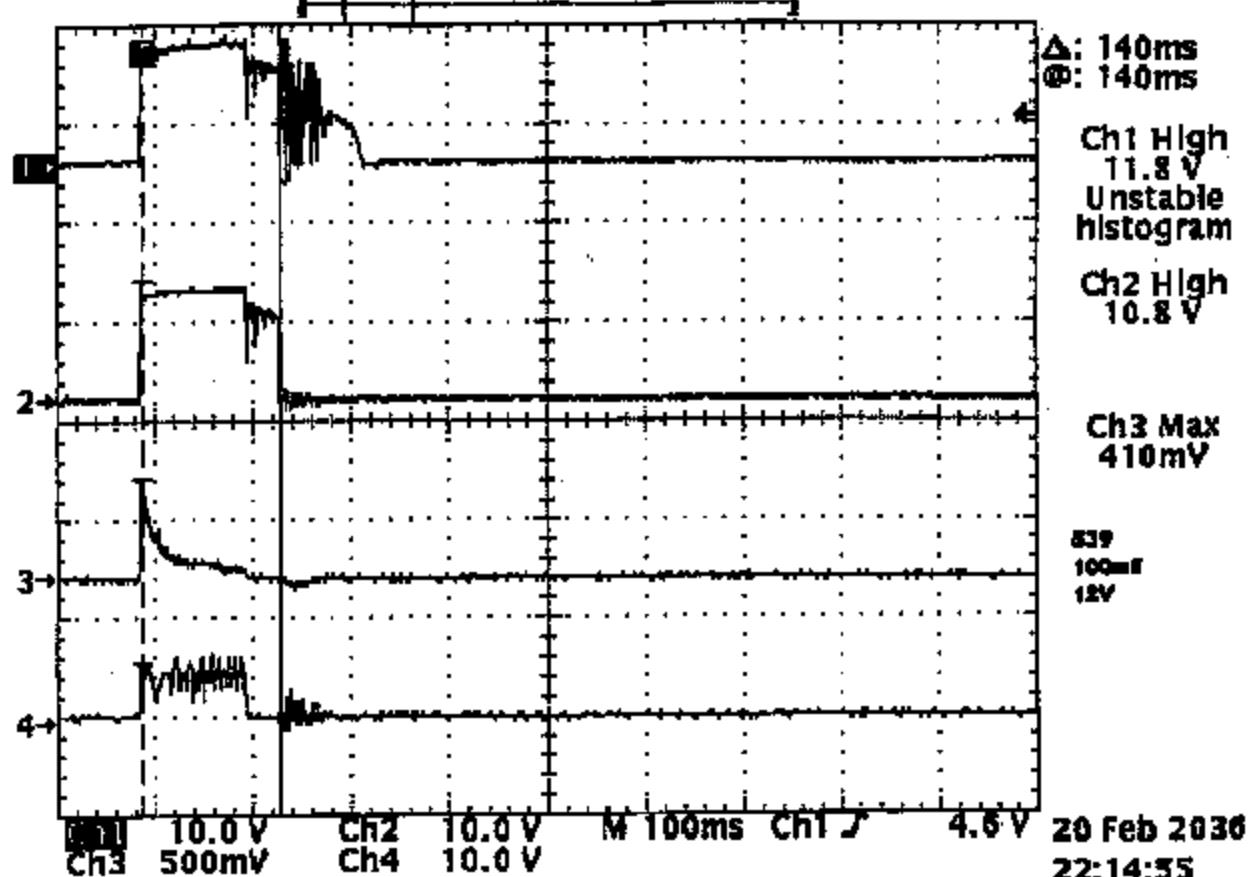
Tek Run: 1.00kS/s Sample 1000



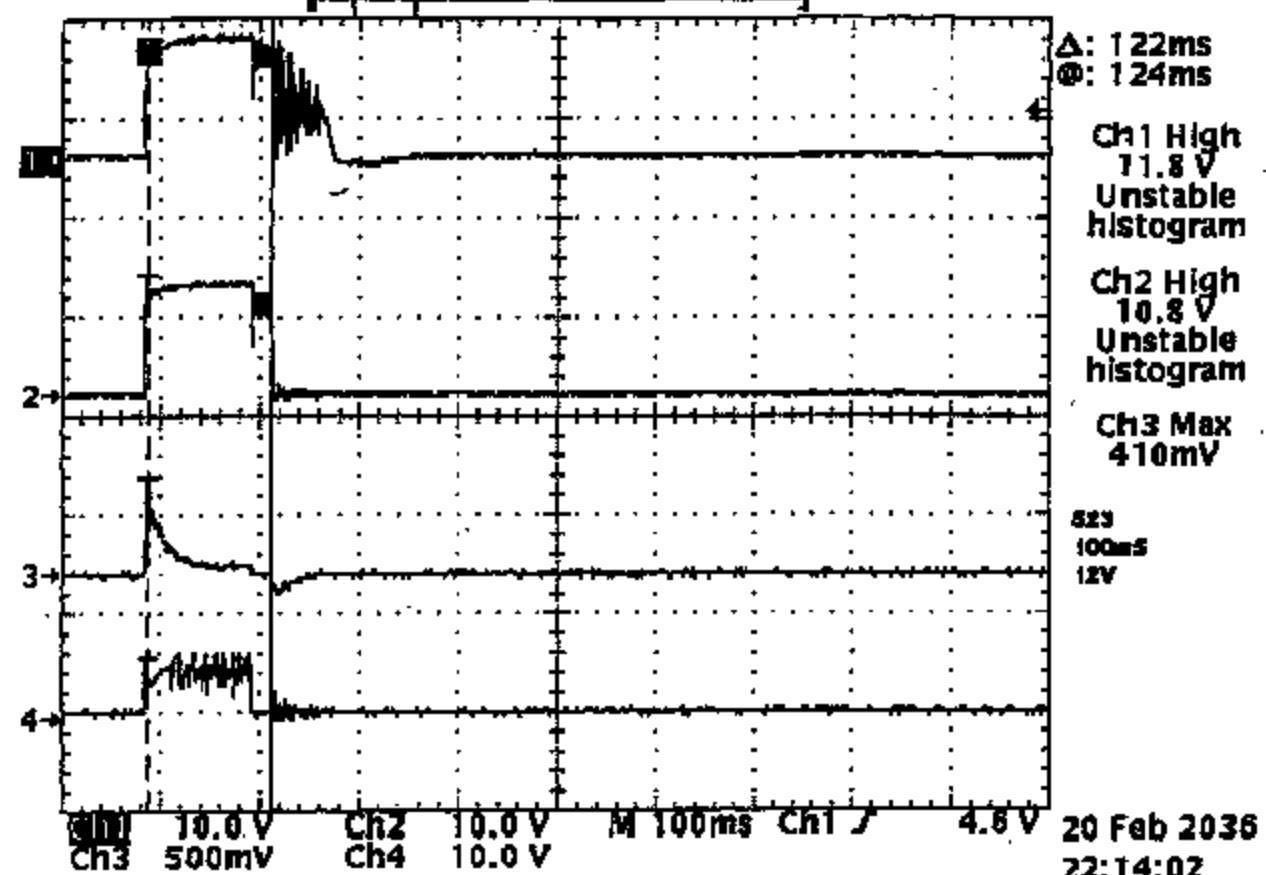
Tek Run: 1.00kS/s Sample 11196



Tek Run: 1.00kS/s Sample 1000

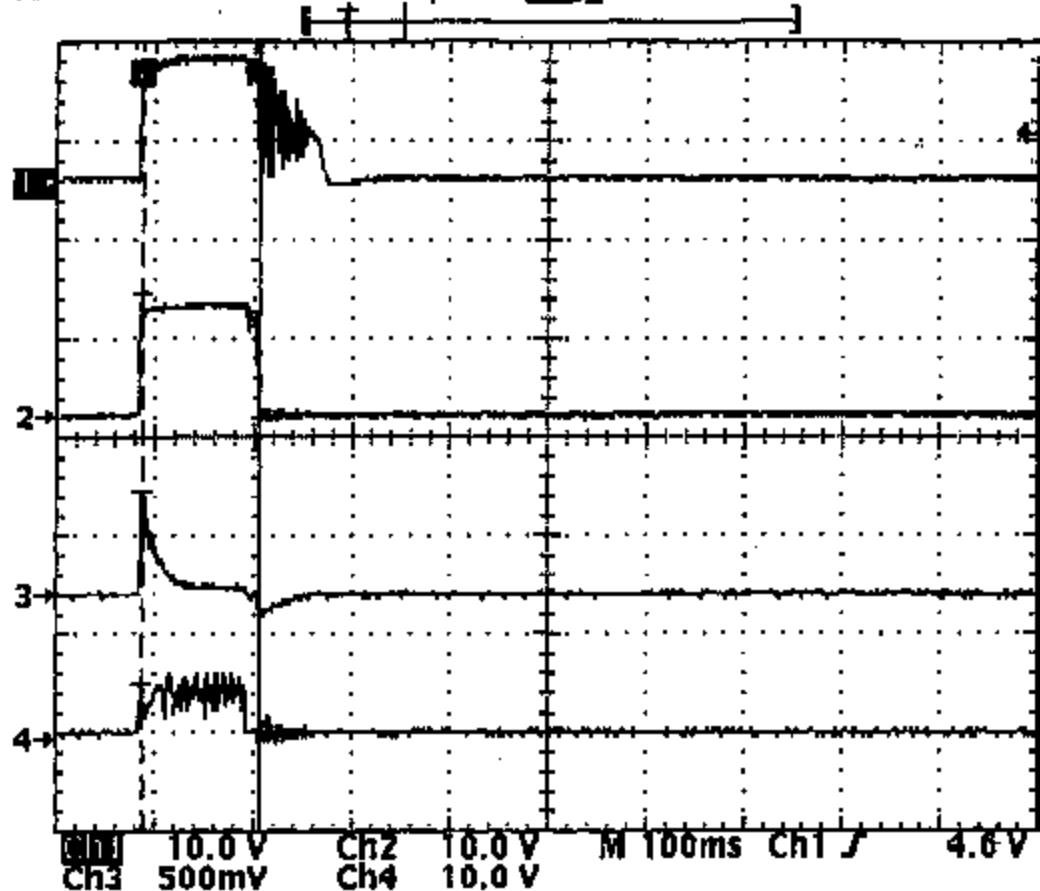


Tek Run: 1.00kS/s Sample 100%



20 Feb 2036
22:14:02

Tek Run: 1.00kS/s Sample 10098



Δ: 118ms
Φ: 118ms

Ch1 High
11.8 V
Unstable
histogram

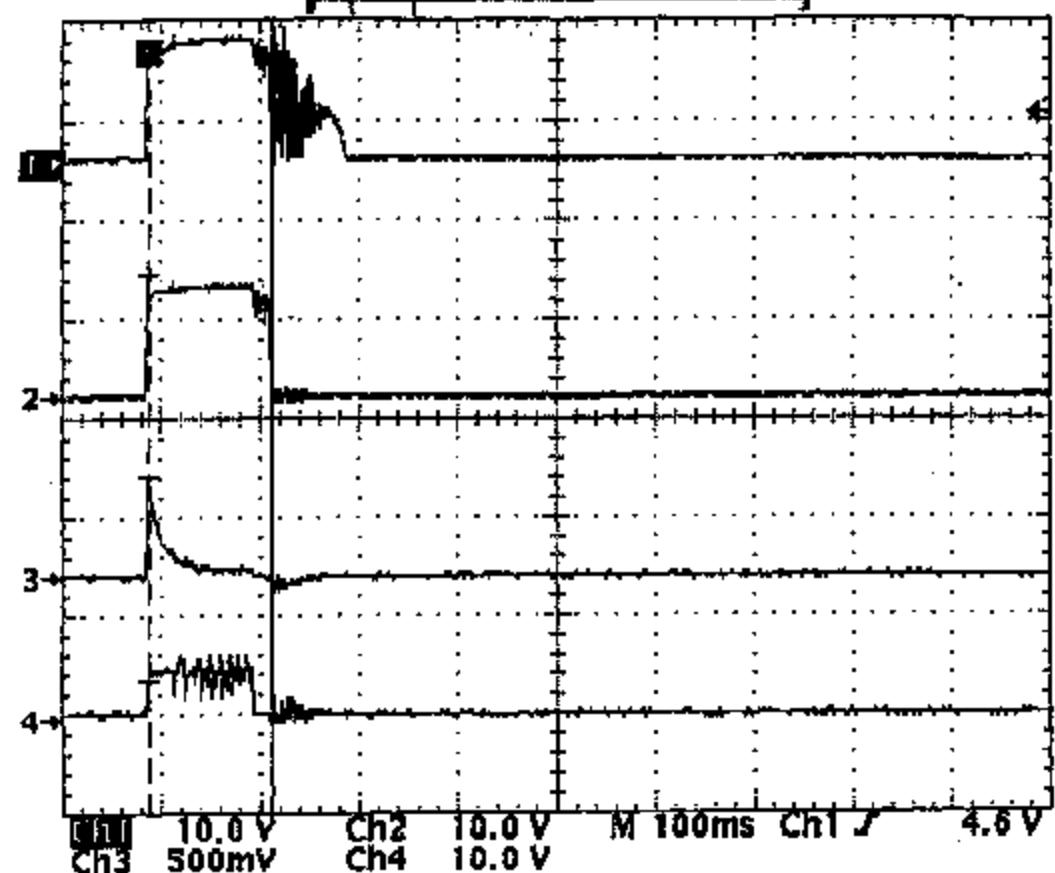
Ch2 High
10.8 V
Unstable
histogram

Ch3 Max
490mV

500
100ms
12V

20 Feb 2036
22:12:33

Tek Run: 1.00kS/s Sample 100%



Δ: 122ms
@: 124ms

Ch1 High
11.8 V
Unstable
histogram

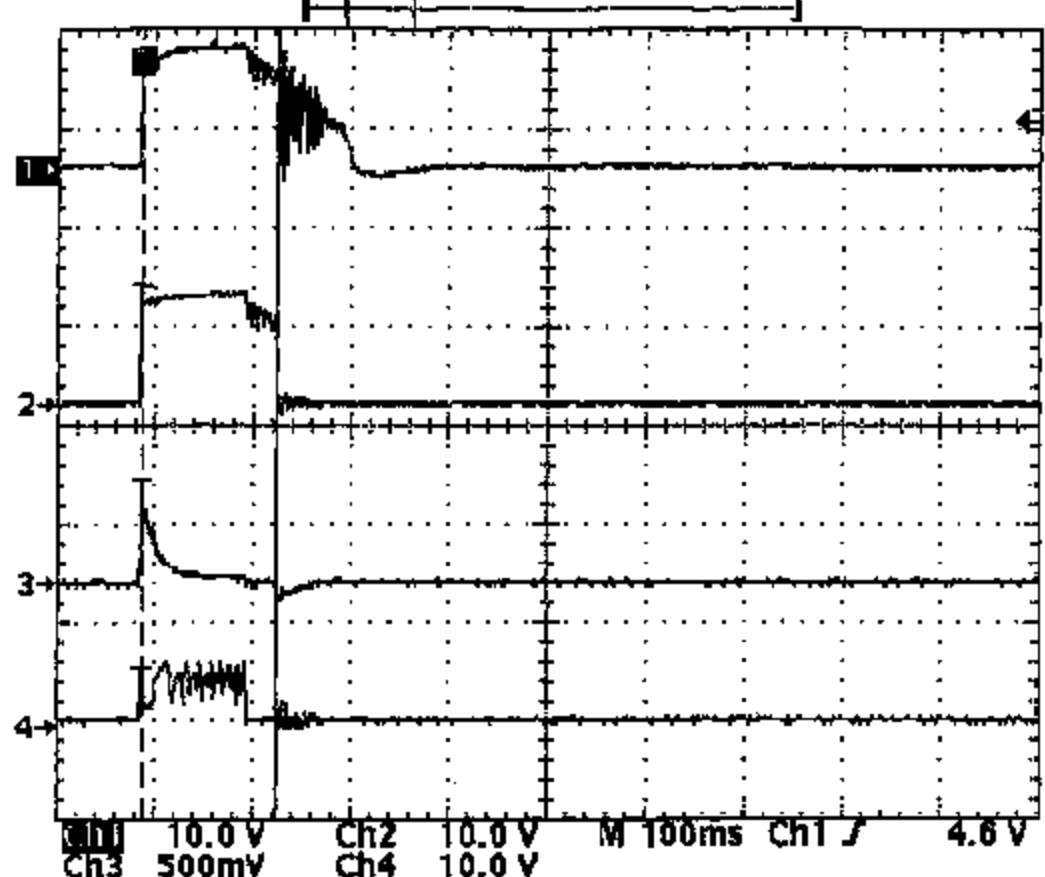
Ch2 High
10.8 V
Unstable
histogram

Ch3 Max
410mV

519
100ms
12V

20 Feb 2036
22:10:56

Tek Run: 1.00kS/s Sample [000]



Δ: 134ms
◎: 134ms

Ch1 High
11.8 V

Ch2 High
10.8 V
Unstable
histogram

Ch3 Max
430mV

504
100ms
12V

20 Feb 2036
22:10:06

Tek Run: 1.00kS/s Sample 1000

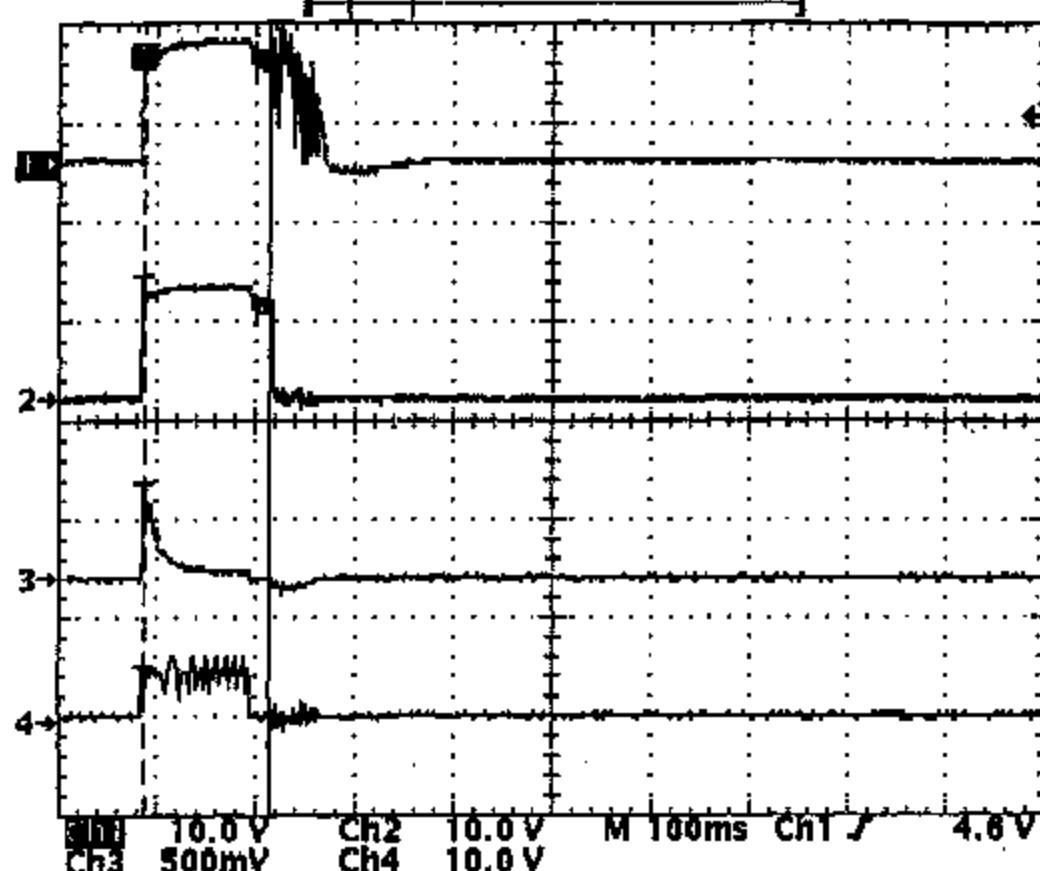
Δ: 126ms
◎: 126ms

Ch1 High
11.8 V

Ch2 High
10.8 V
Unstable
histogram

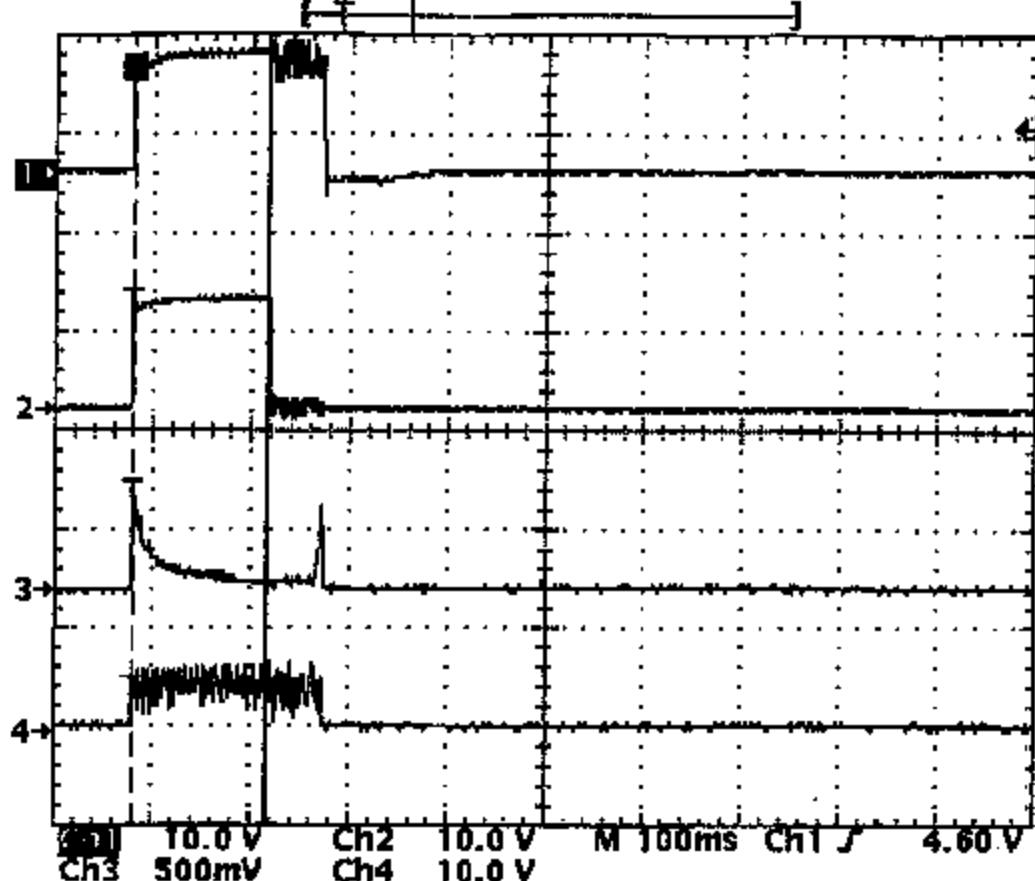
Ch3 Max
450mV

E14
100ms
12V



20 Feb 2036
22:09:15

Tek Run: 1.00kS/s Sample 00006



△: 134ms
◎: 134ms

Ch1 High
11.8 V

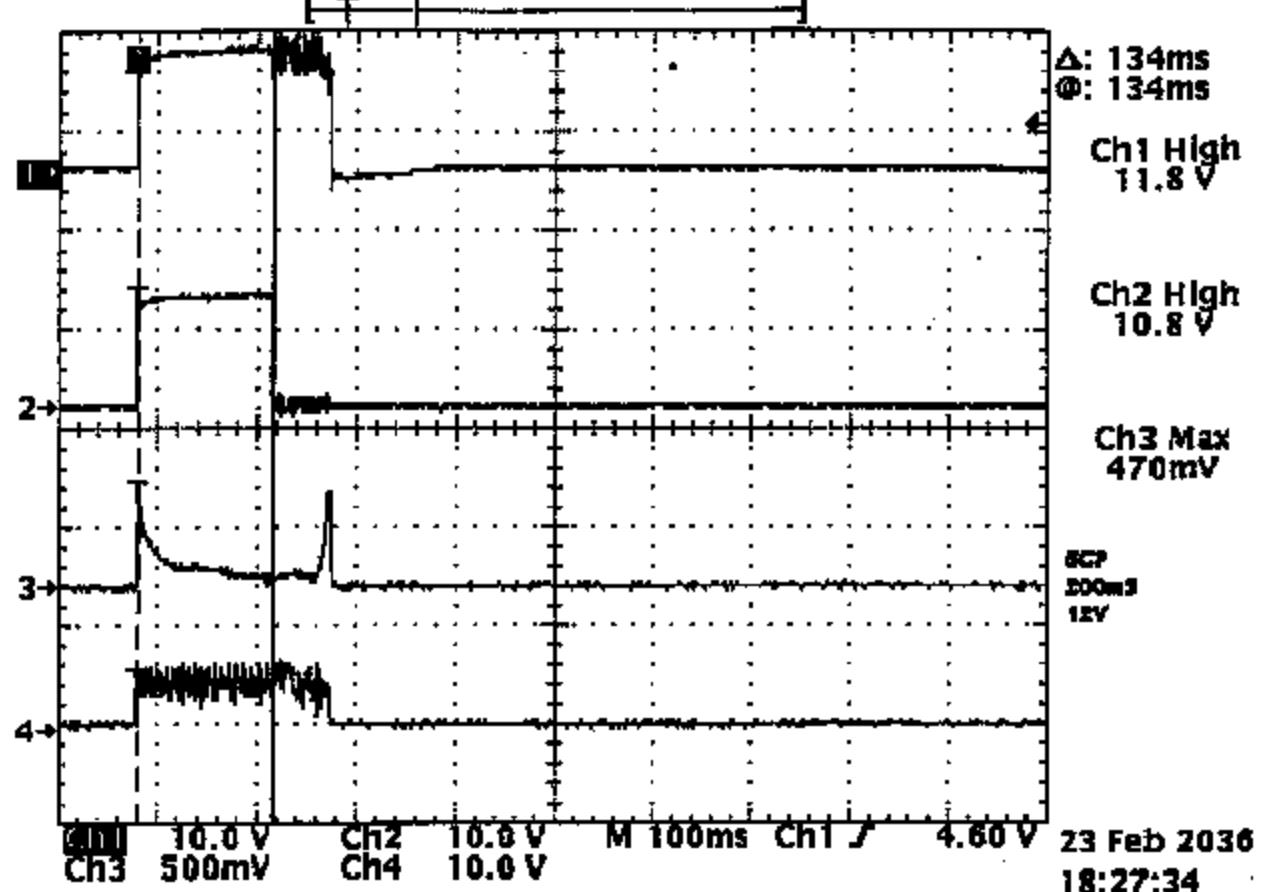
Ch2 High
10.8 V

Ch3 Max
450mV

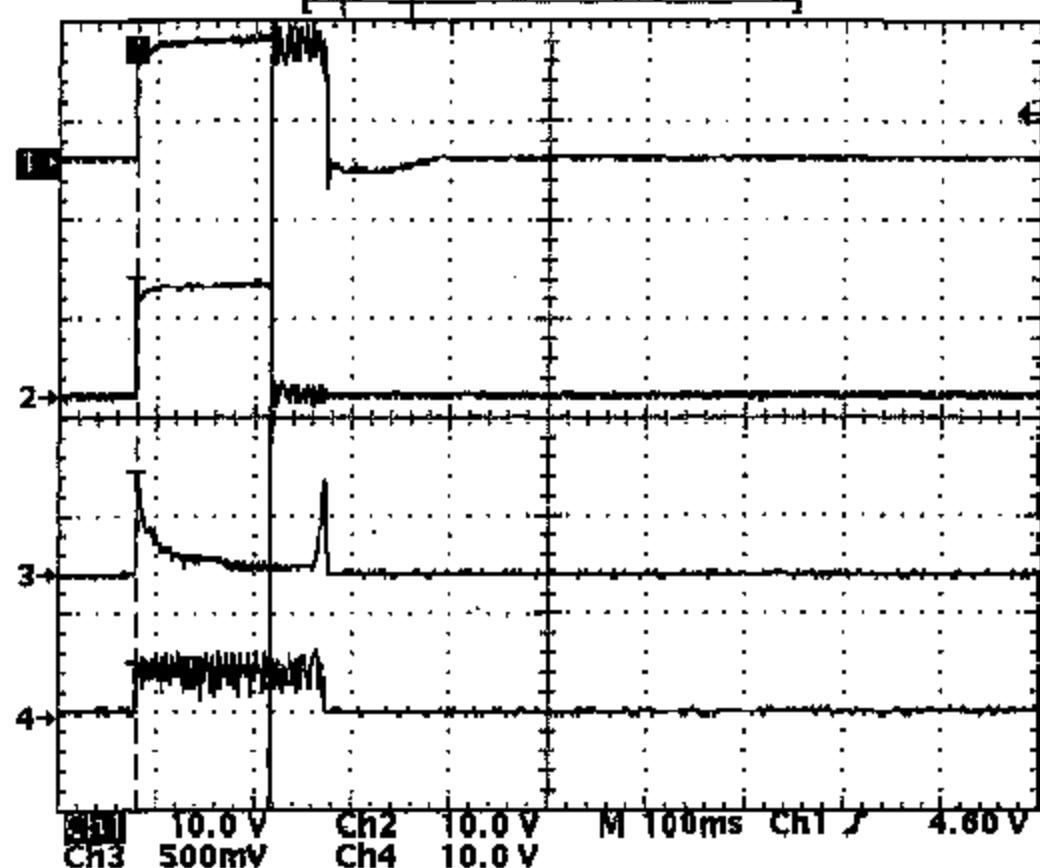
6CP
200ms
12V

23 Feb 2036
18:30:05

Tek Run: 1.00kS/s Sample



Tek Run: 1.00kS/s Sample 1005



Δ: 134ms
@: 134ms

Ch1 High
11.8 V

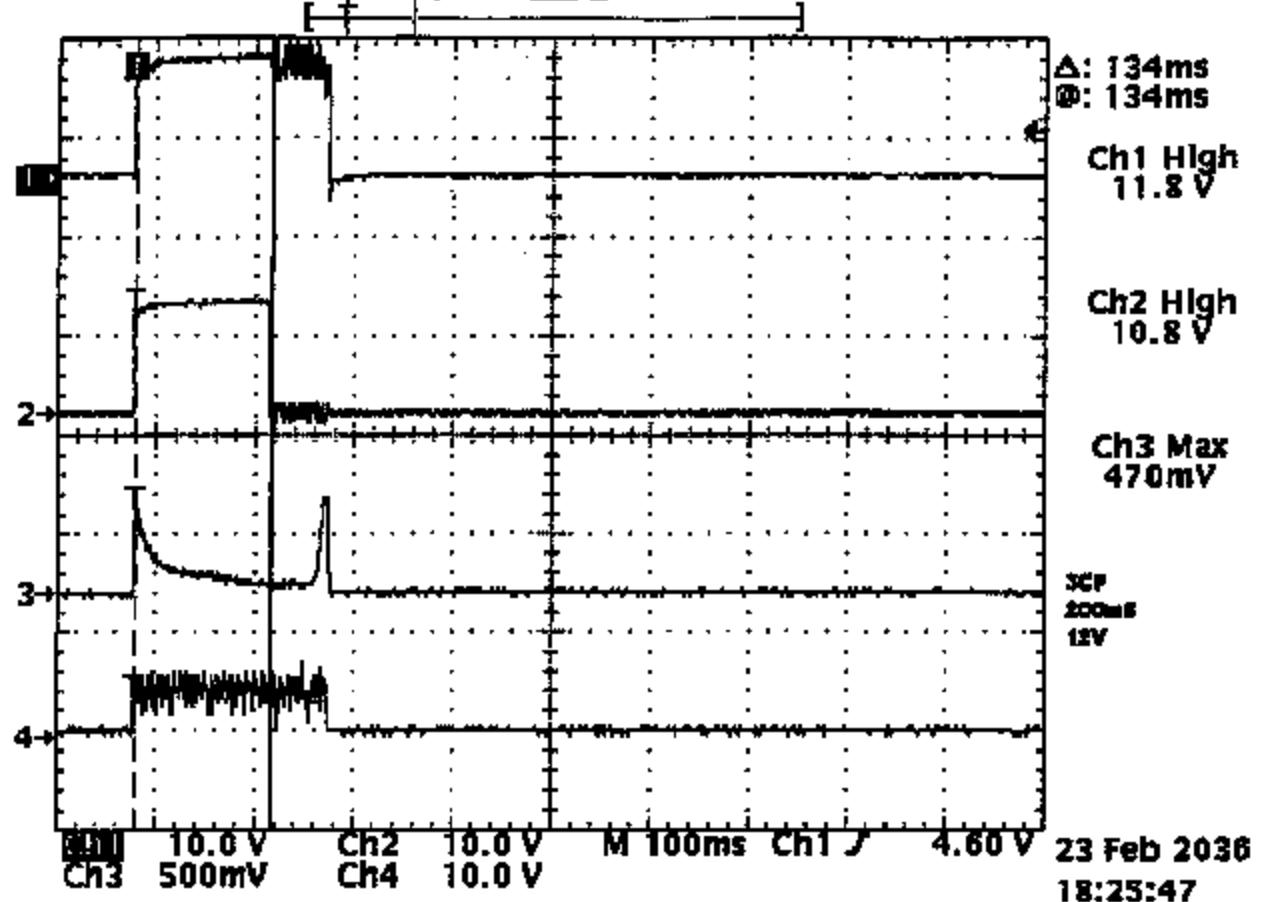
Ch2 High
10.8 V

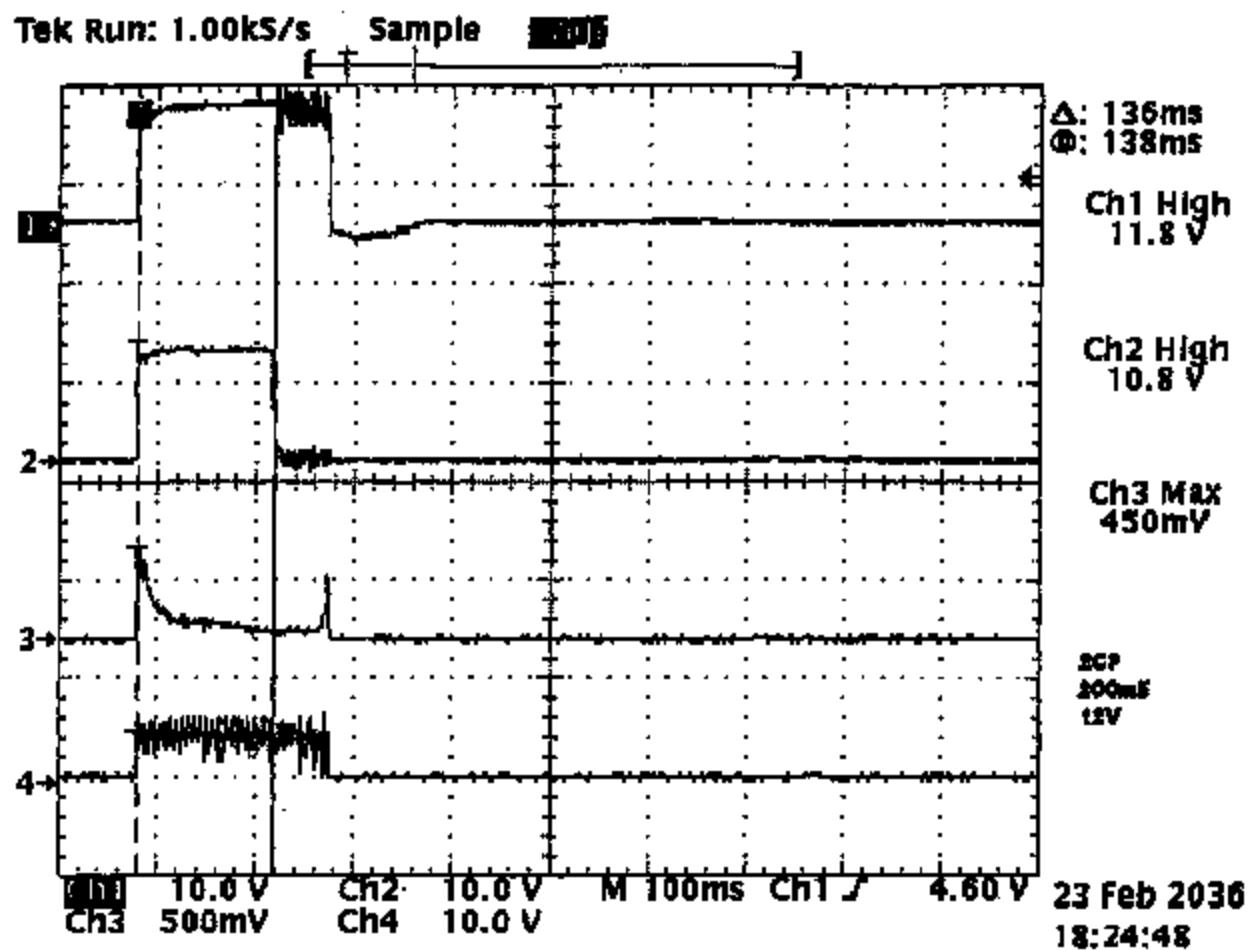
Ch3 Max
490mV

4CP
200ms
12V

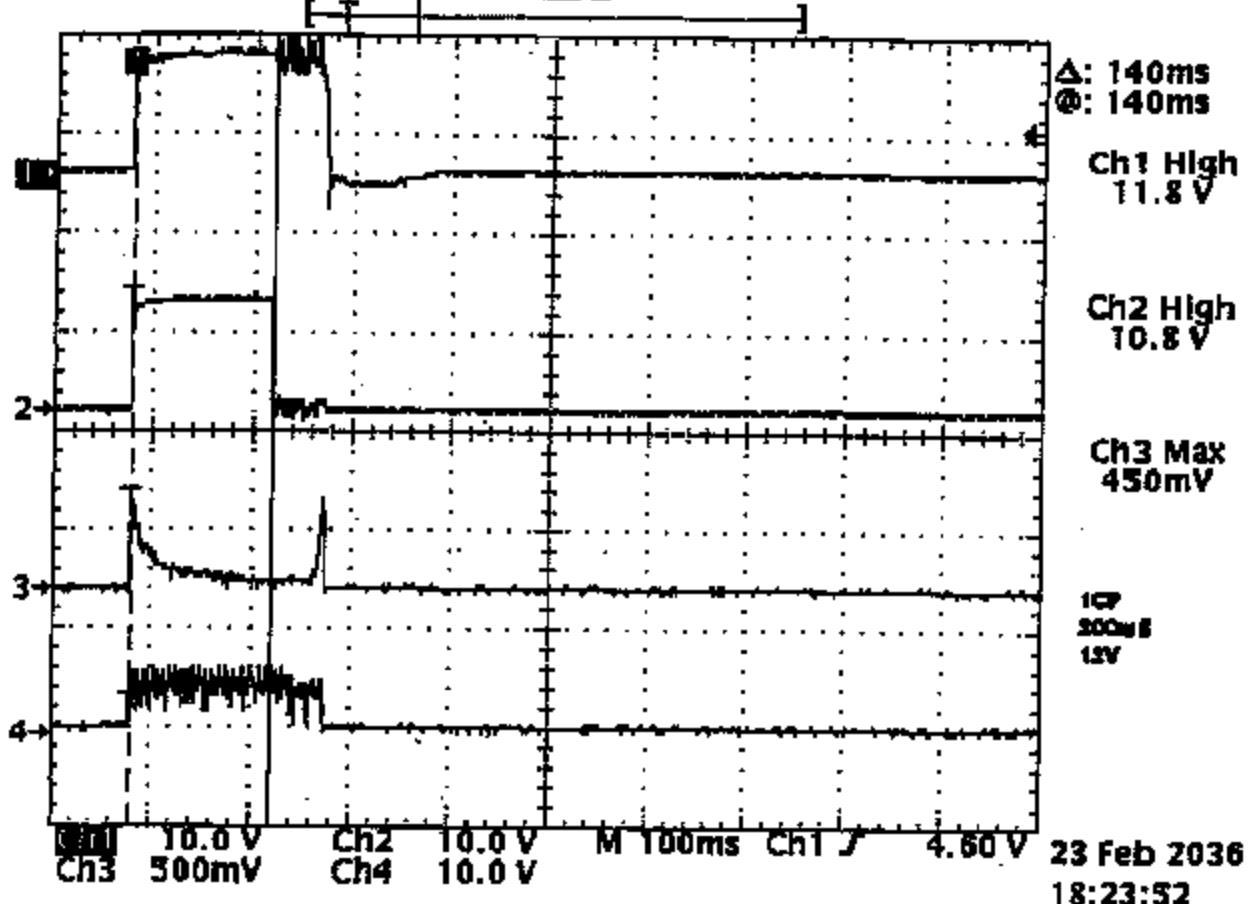
23 Feb 2036
18:26:41

Tek Run: 1.00kS/s Sample 11095

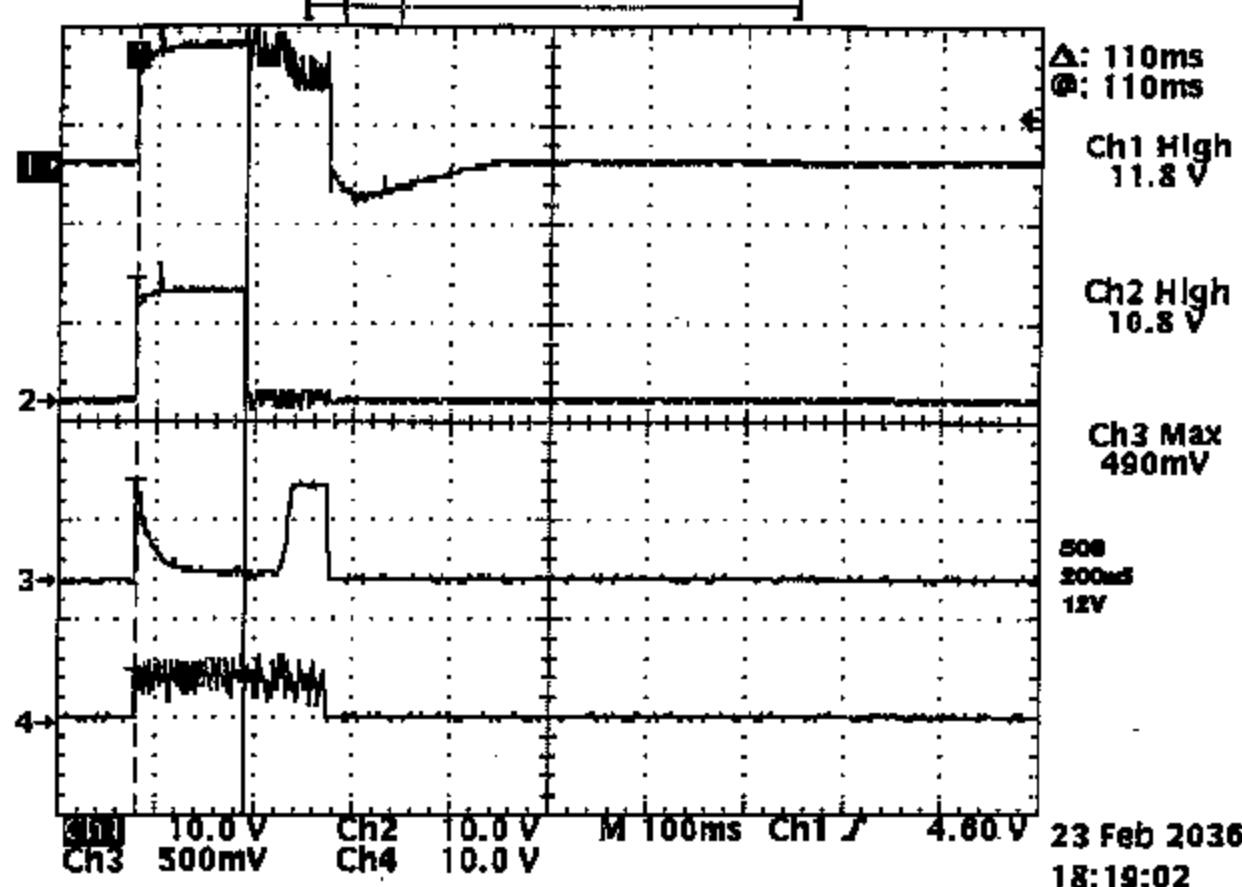




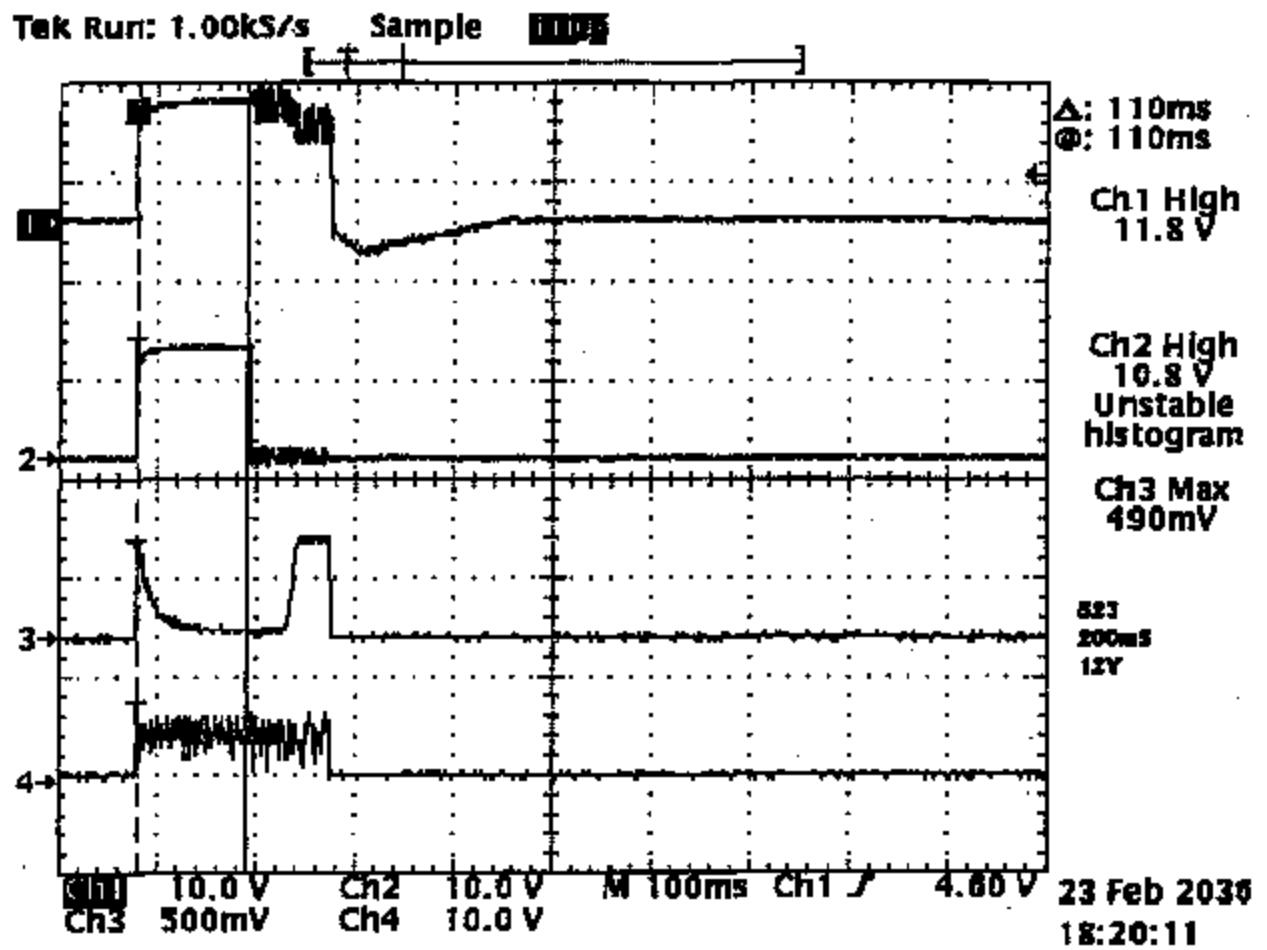
Tek Run: 1.00kS/s Sample 1000



Tek Run: 1.00kS/s Sample 110ms



23 Feb 2036
18:19:02



△: 110ms
◎: 110ms

Ch1 High
11.8 V

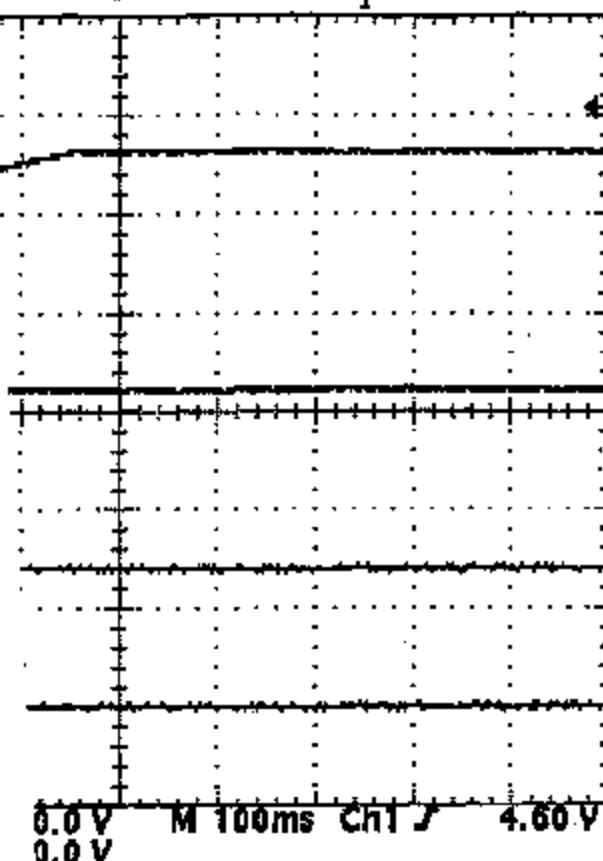
Ch2 High
10.8 V
Unstable
histogram

Ch3 Max
490mV

823
200ms
12V

3V
23 Feb 2036
18:20:11

Sample 100ms



△: 110ms
◎: 110ms

Ch1 High
11.8 V

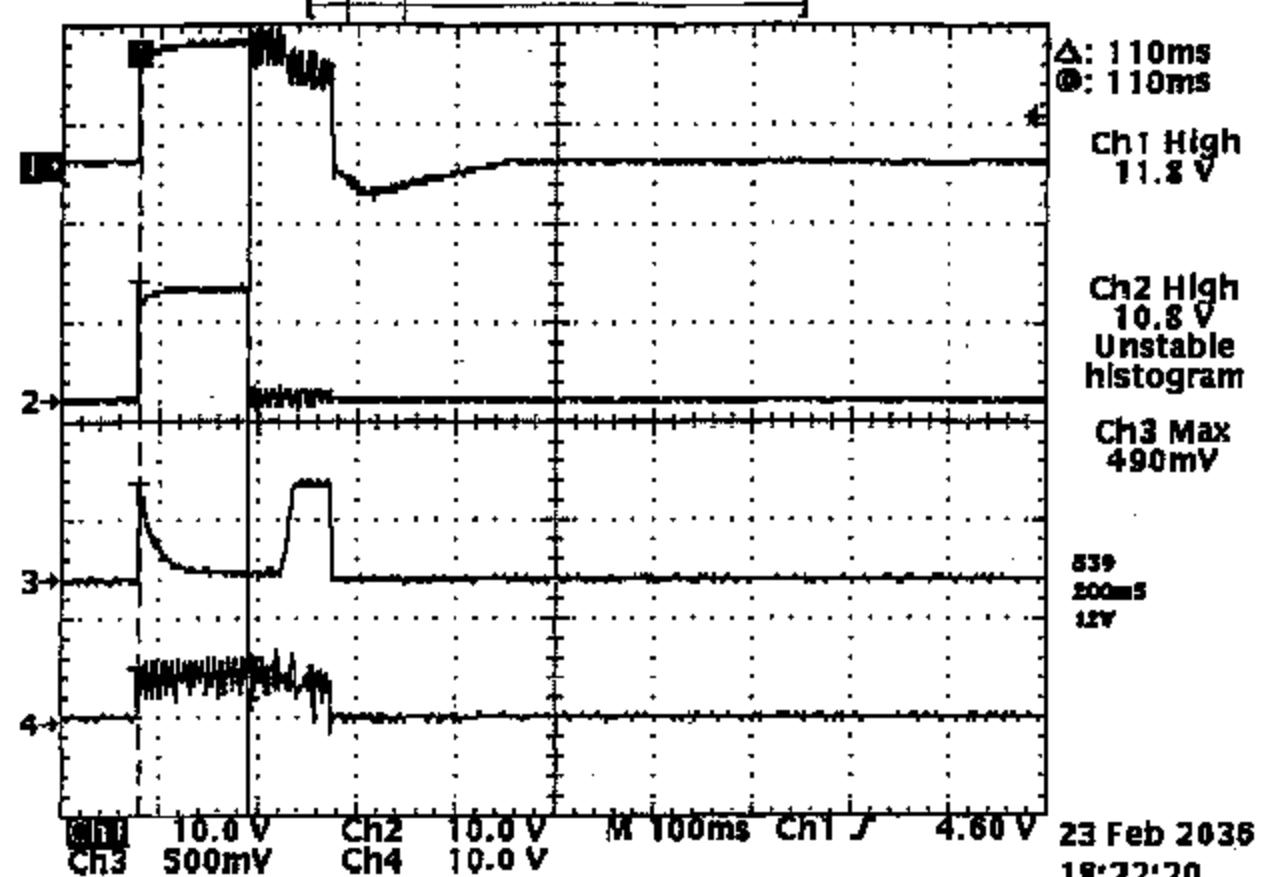
Ch2 High
10.8 V
Unstable
histogram

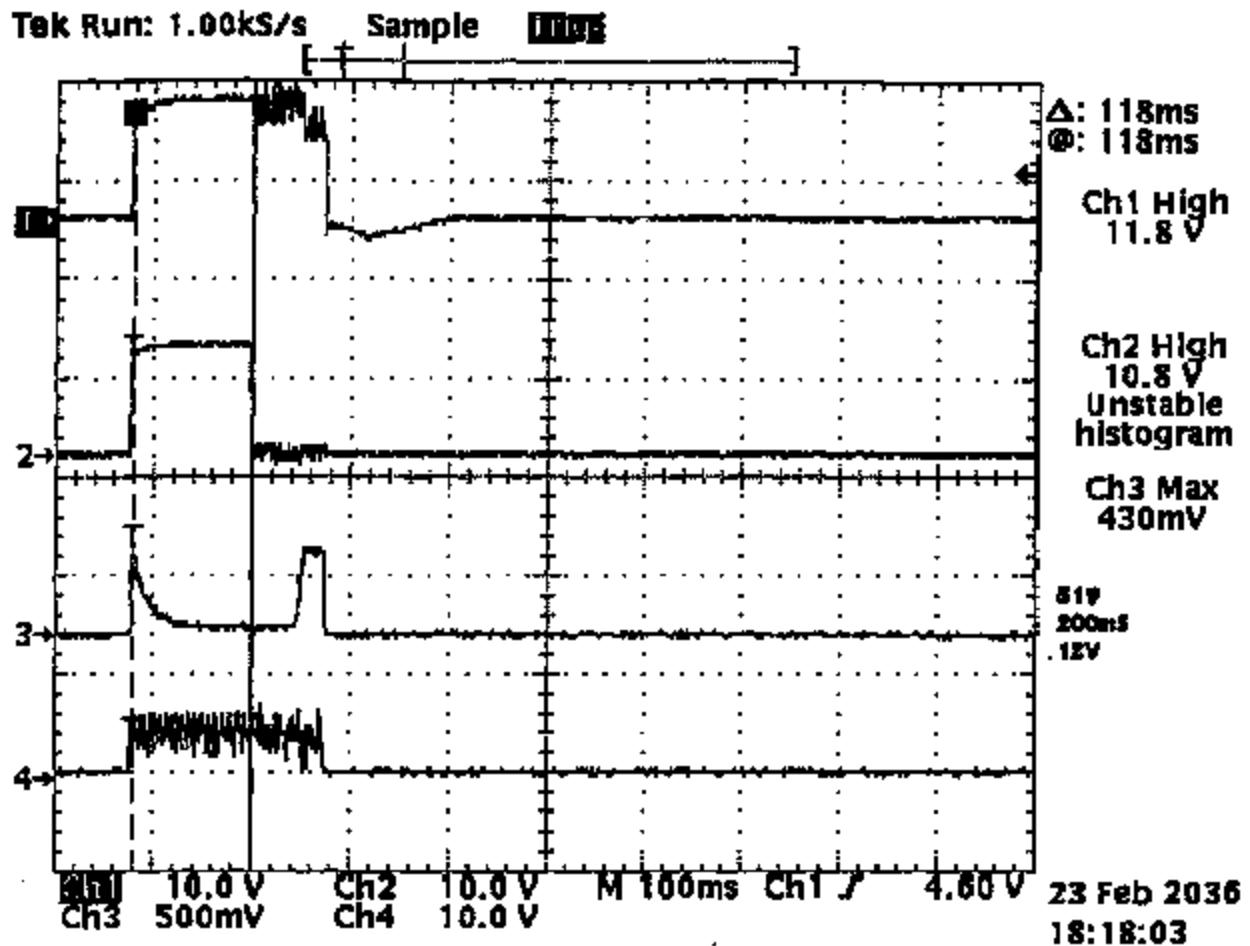
Ch3 Max
490mV

839
200ms
12V

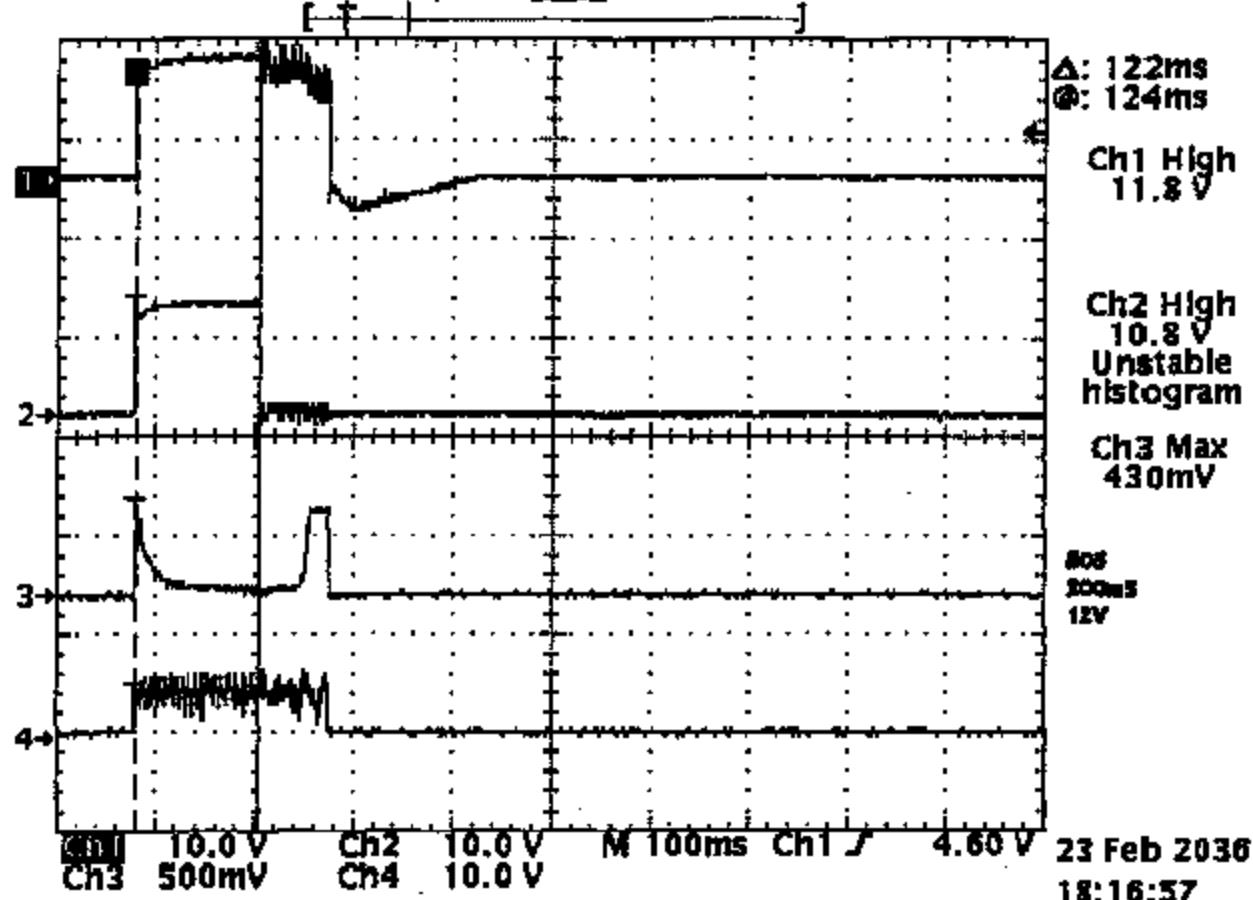
23 Feb 2036
18:22:20

Tek Run: 1.00kS/s Sample 1000





Tek Run: 1.00kS/s Sample 8006



Tek Run: 1.00kS/s Sample 1005

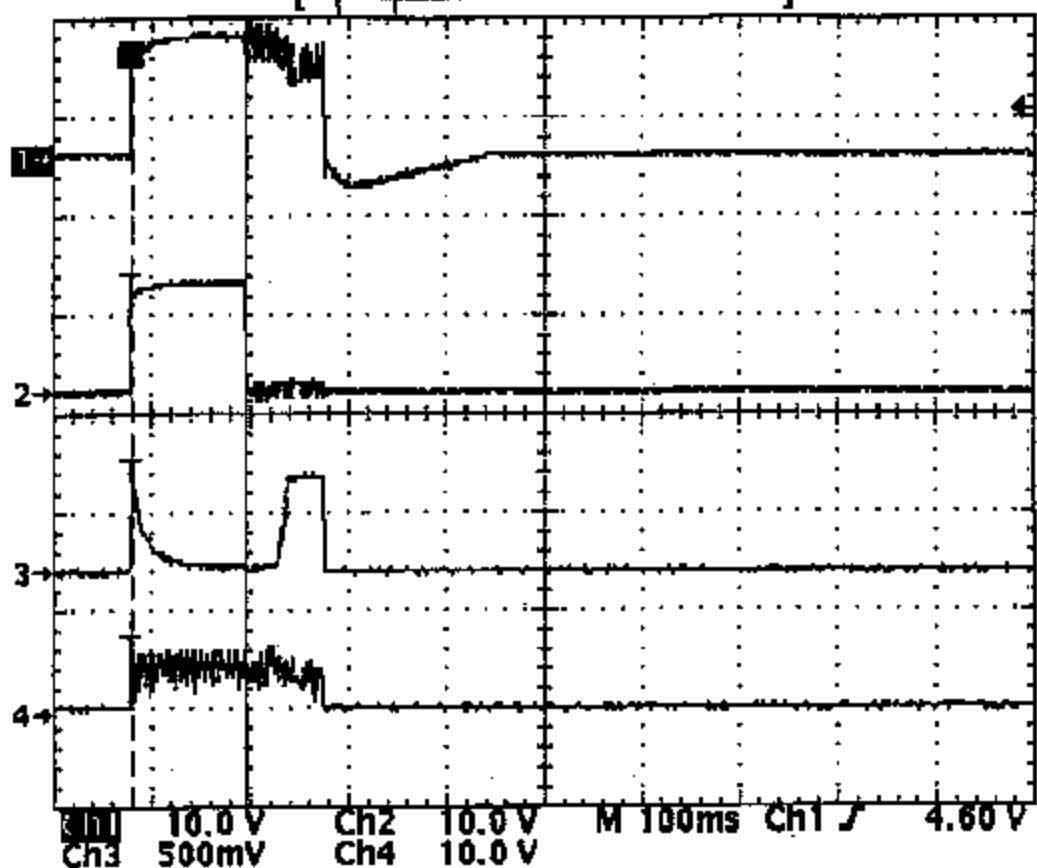
△: 114ms
◎: 116ms

Ch1 High
11.8 V

Ch2 High
10.8 V

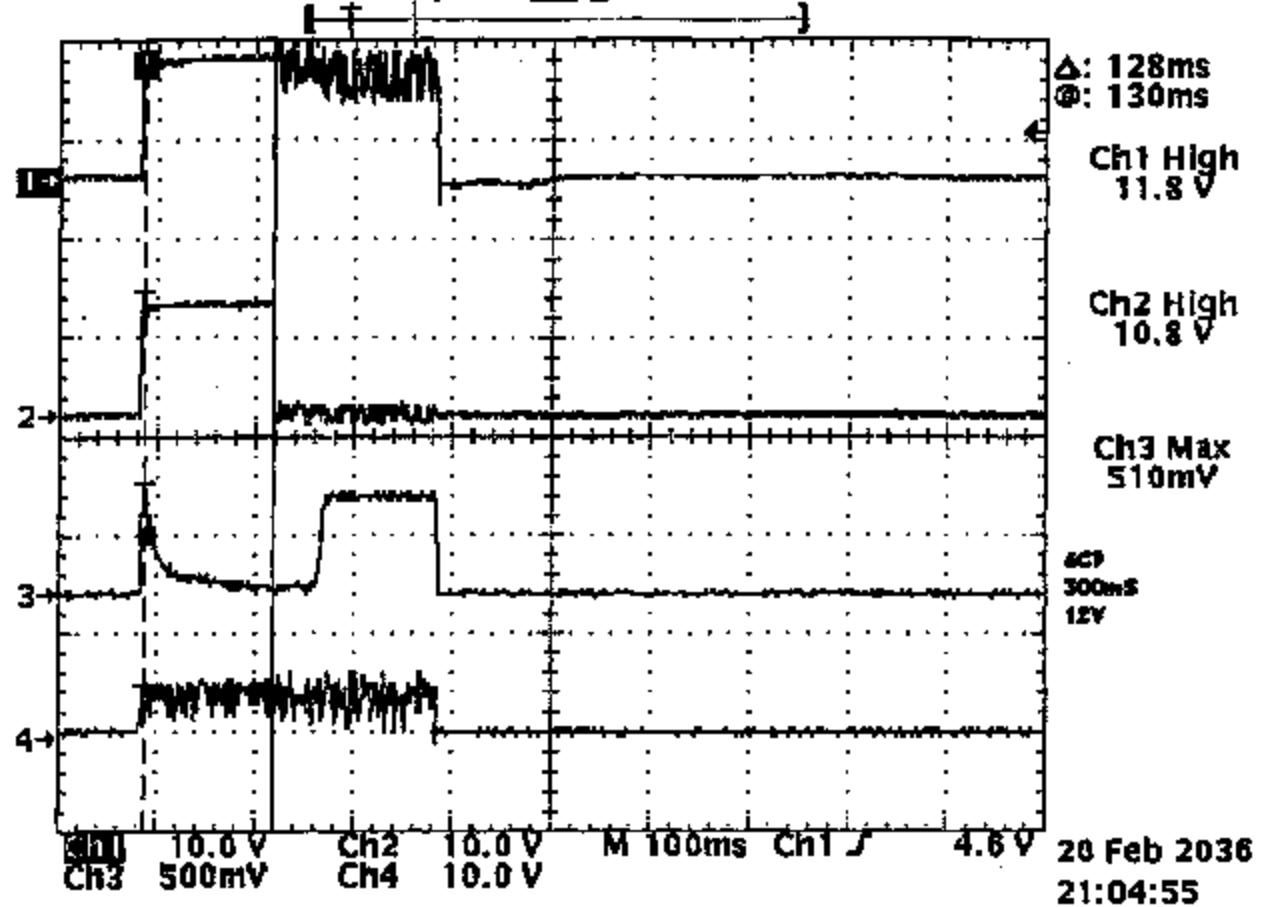
Ch3 Max
490mV

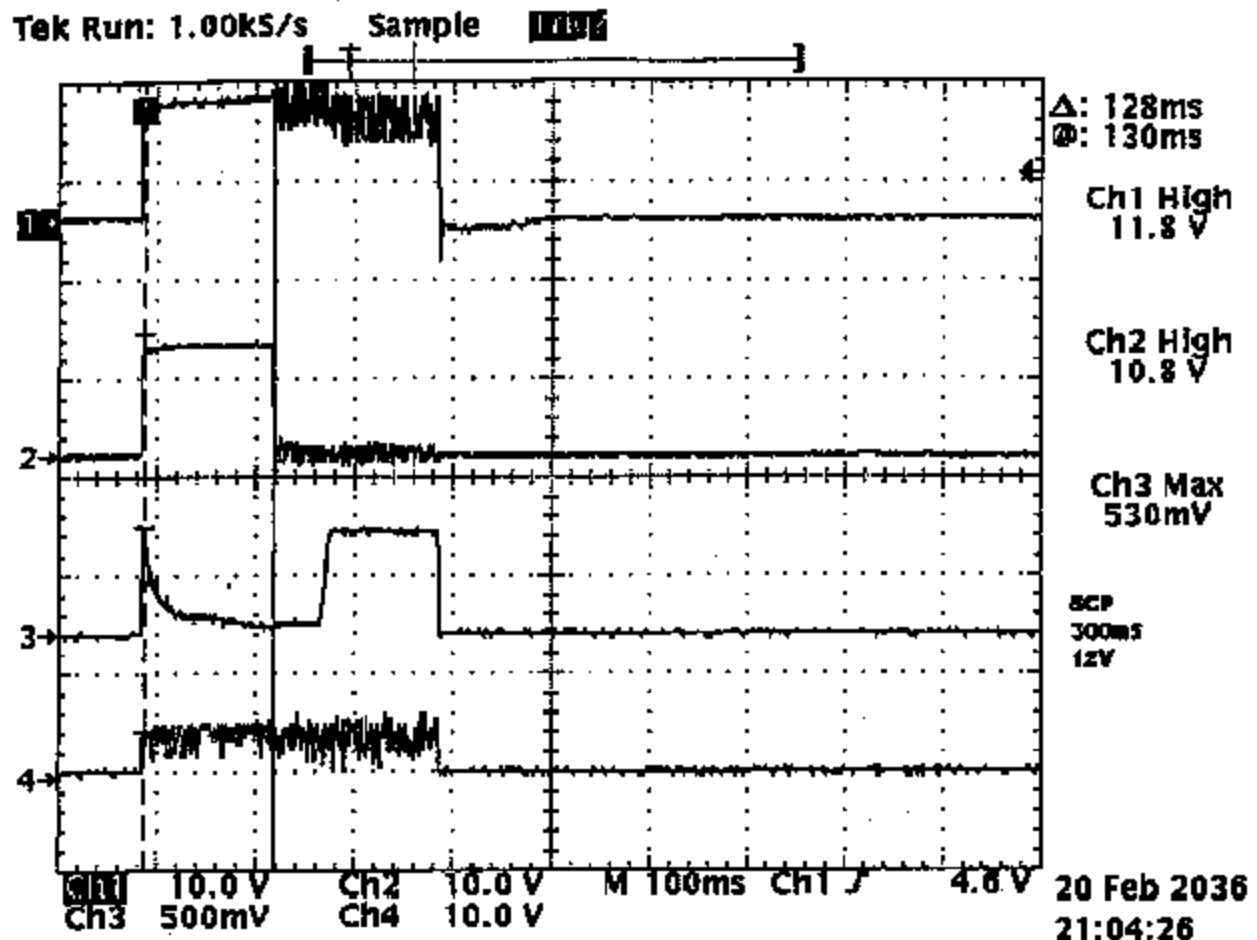
514
200ms
12V



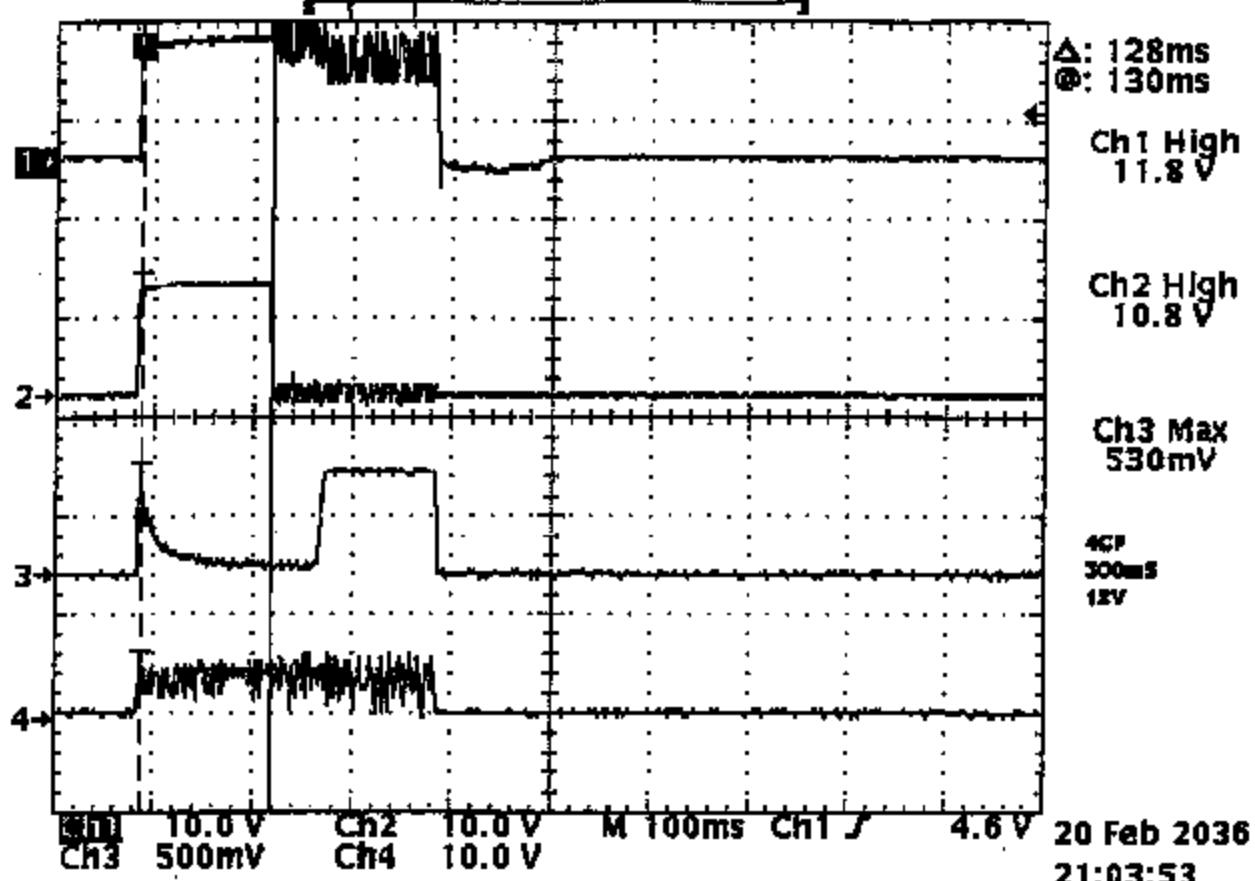
23 Feb 2036
18:16:22

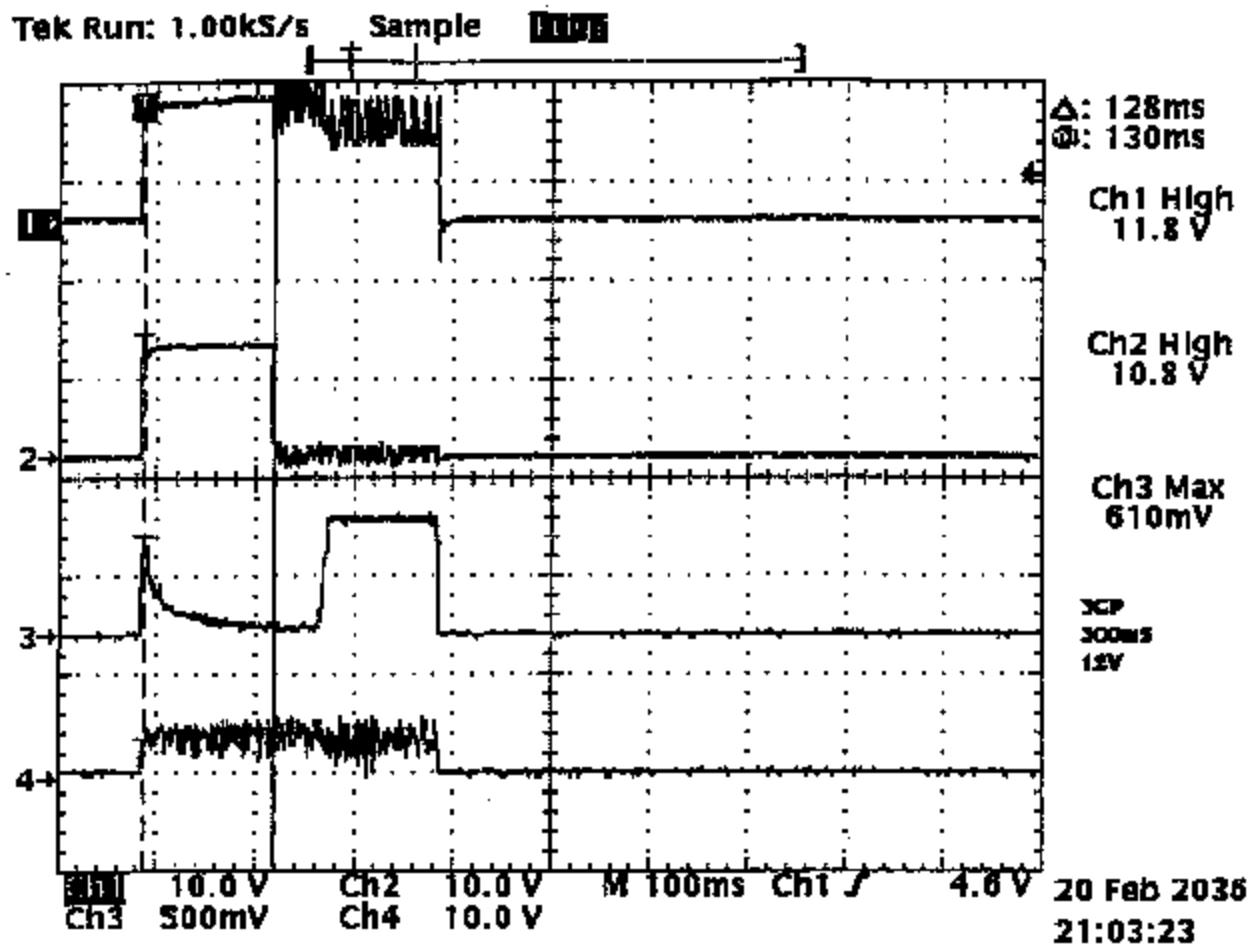
Tek Run: 1.00kS/s Sample 1000



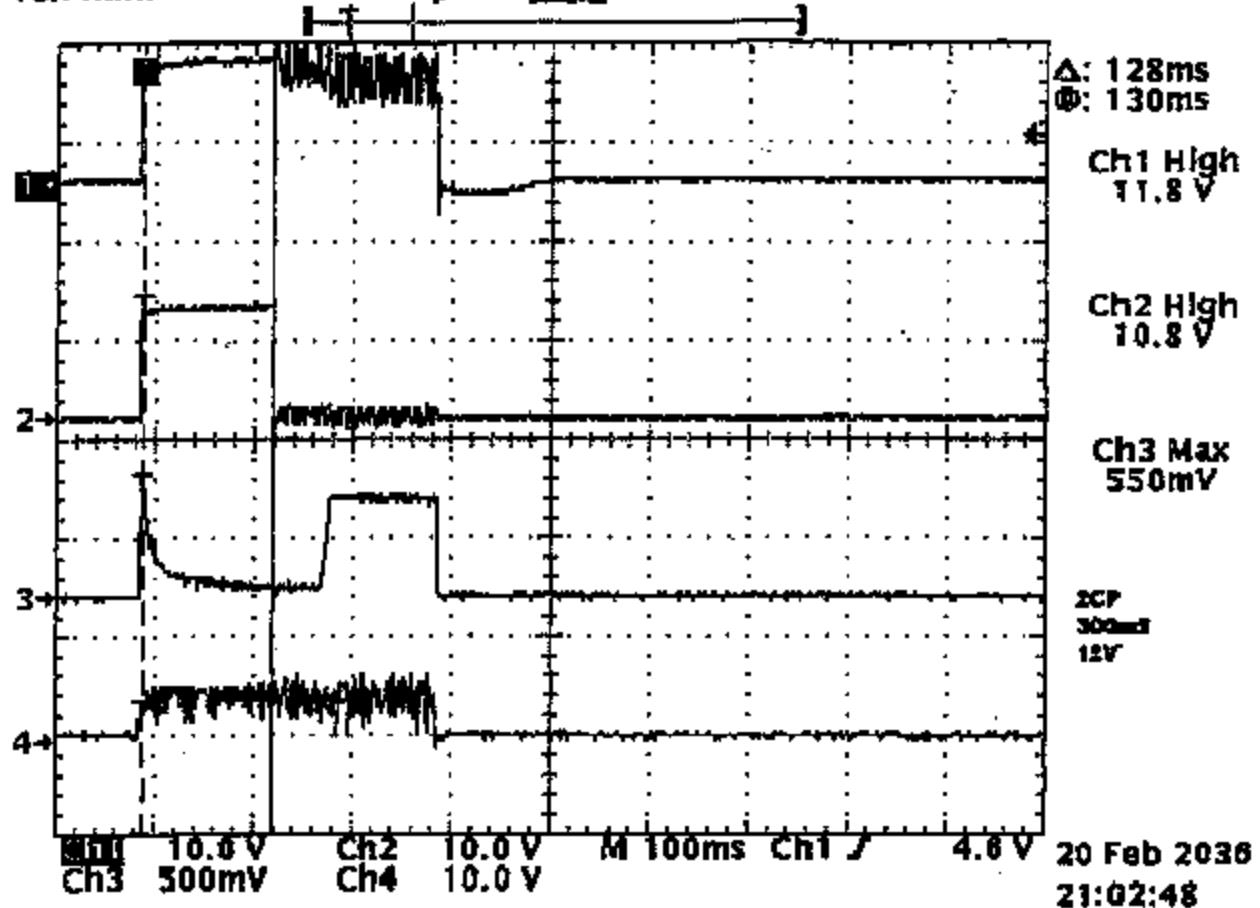


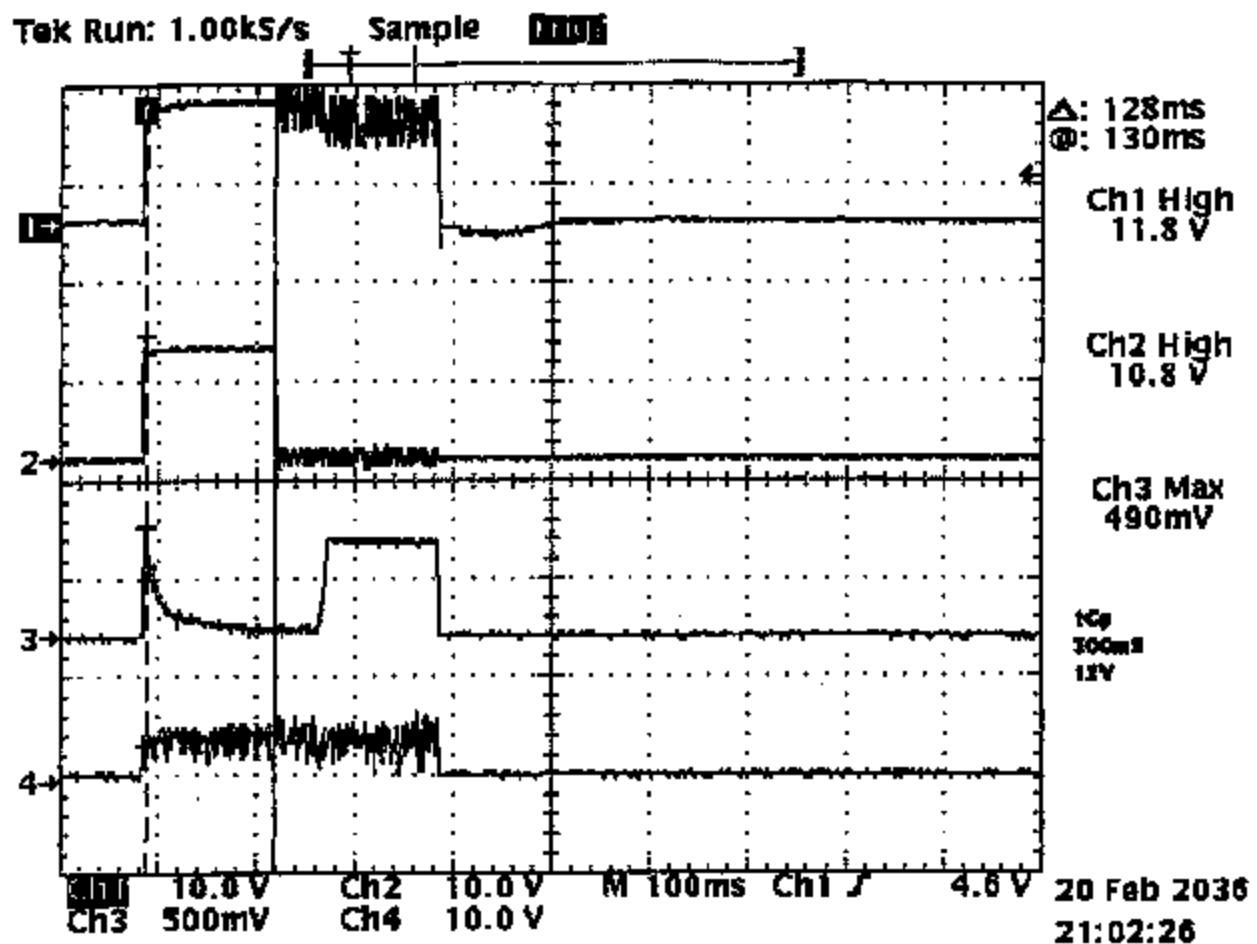
Tek Run: 1.00kS/s Sample 1000



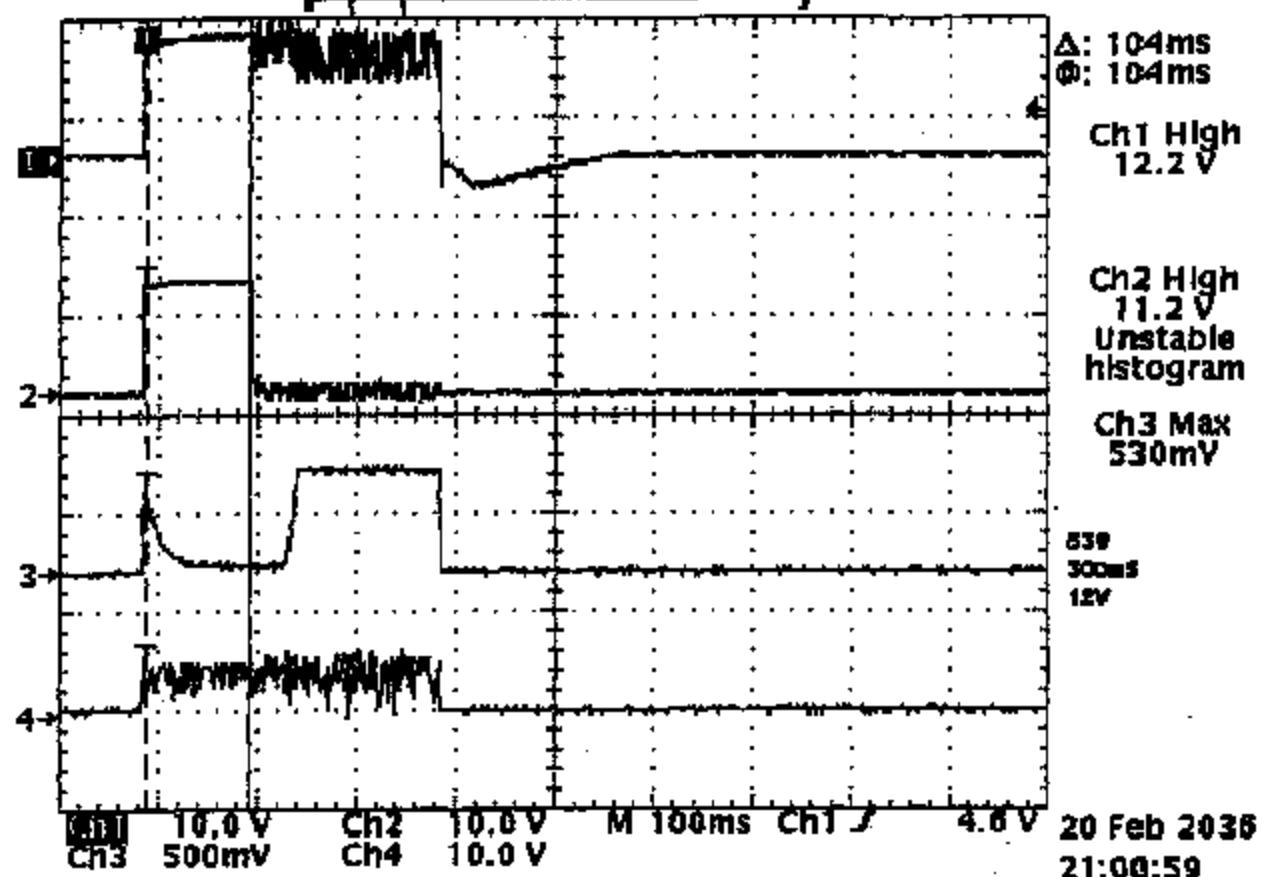


Tek Run: 1.00kS/s Sample 0005

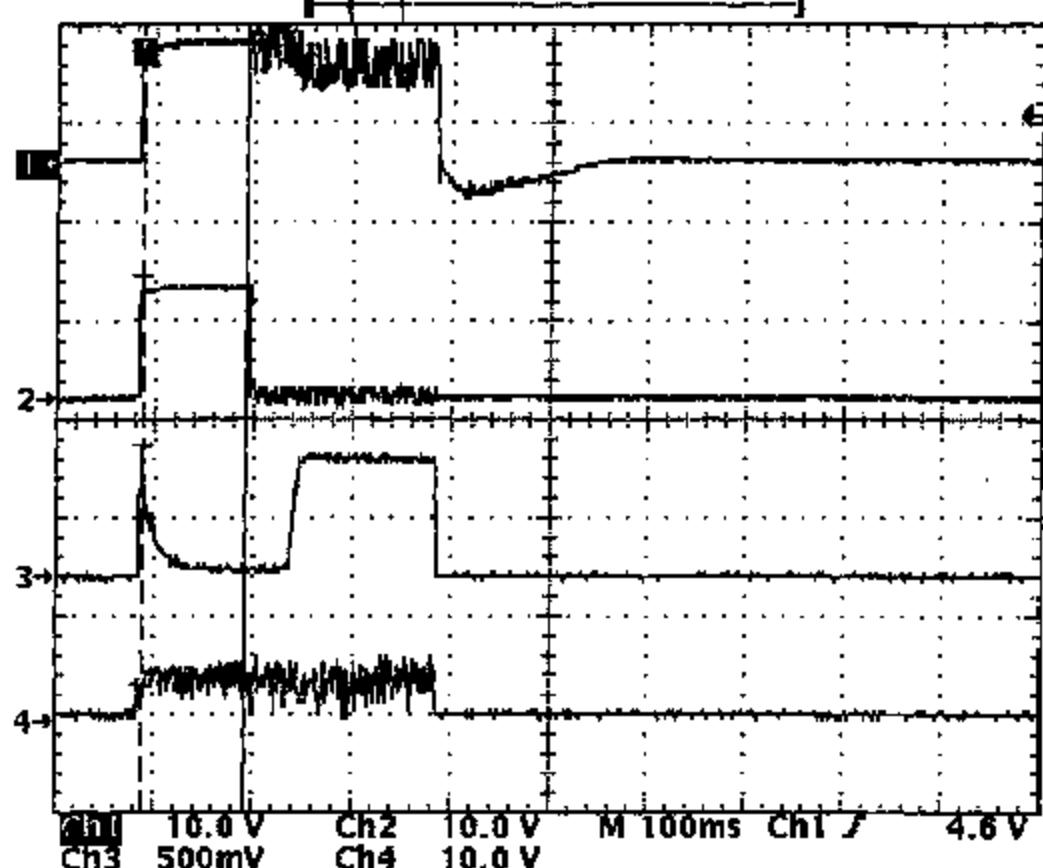




Tek Run: 1.00kS/s Sample 104ms



Tek Run: 1.00kS/s Sample 100%



Δ: 104ms
@: 104ms

Ch1 High
11.8 V

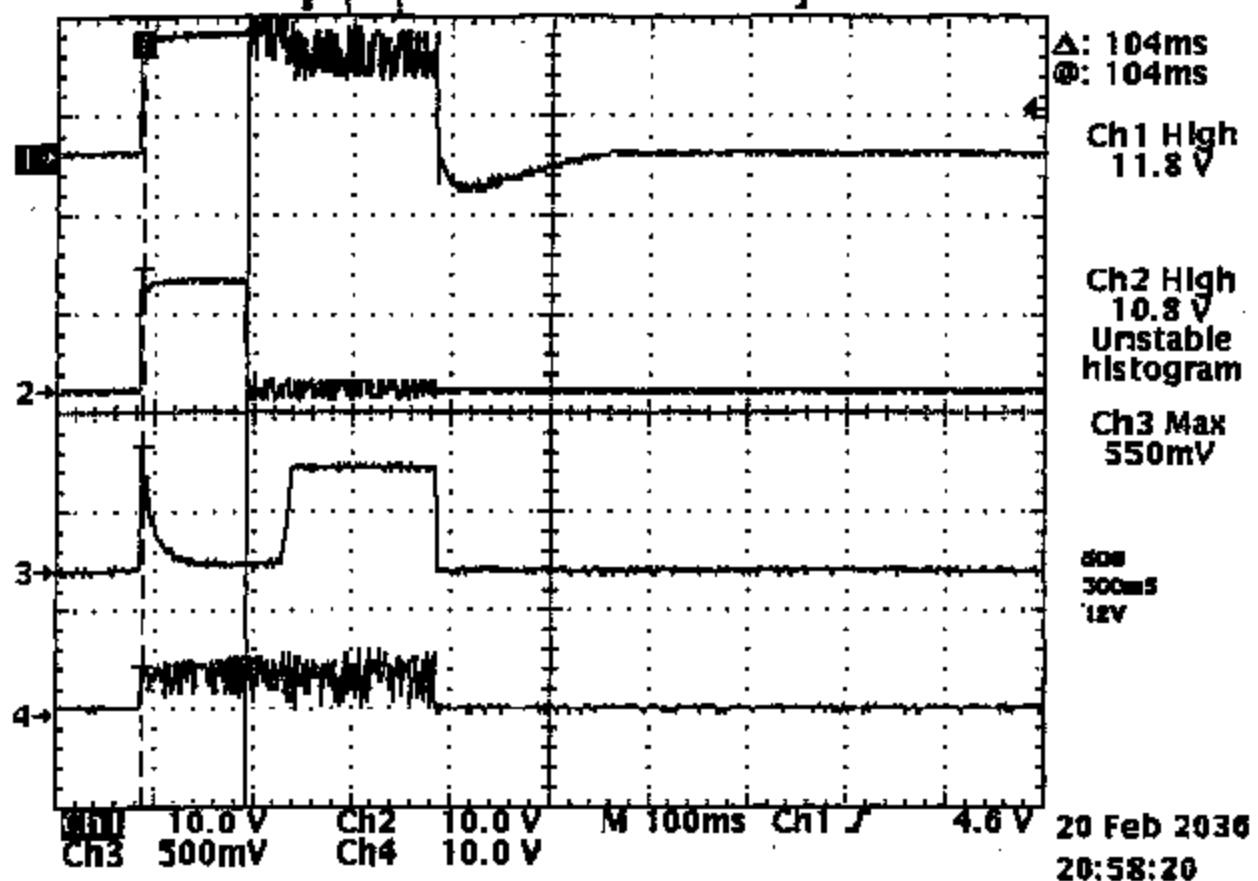
Ch2 High
11.2 V
Unstable
histogram

Ch3 Max
610mV

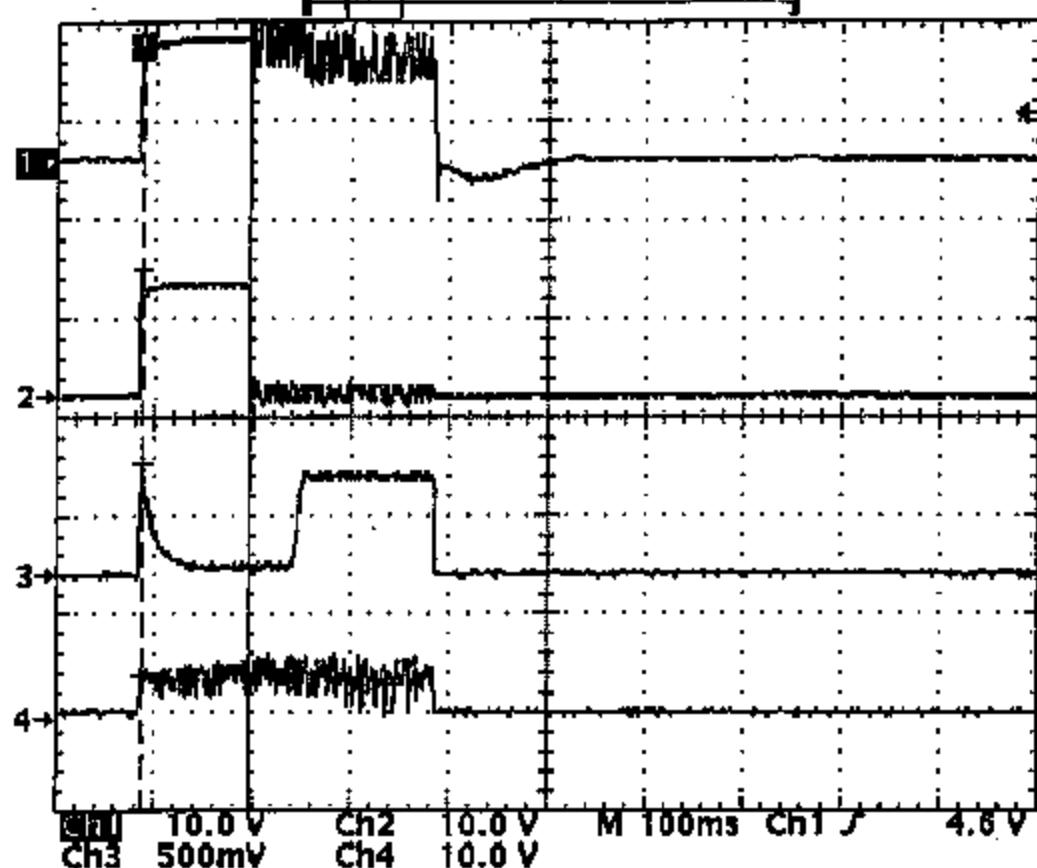
623
300ms
12V

20 Feb 2036
20:59:43

Tek Run: 1.00kS/s Sample 00005



Tek Run: 1.00kS/s Sample 2036



Δ: 106ms
Φ: 108ms

Ch1 High
11.8 V

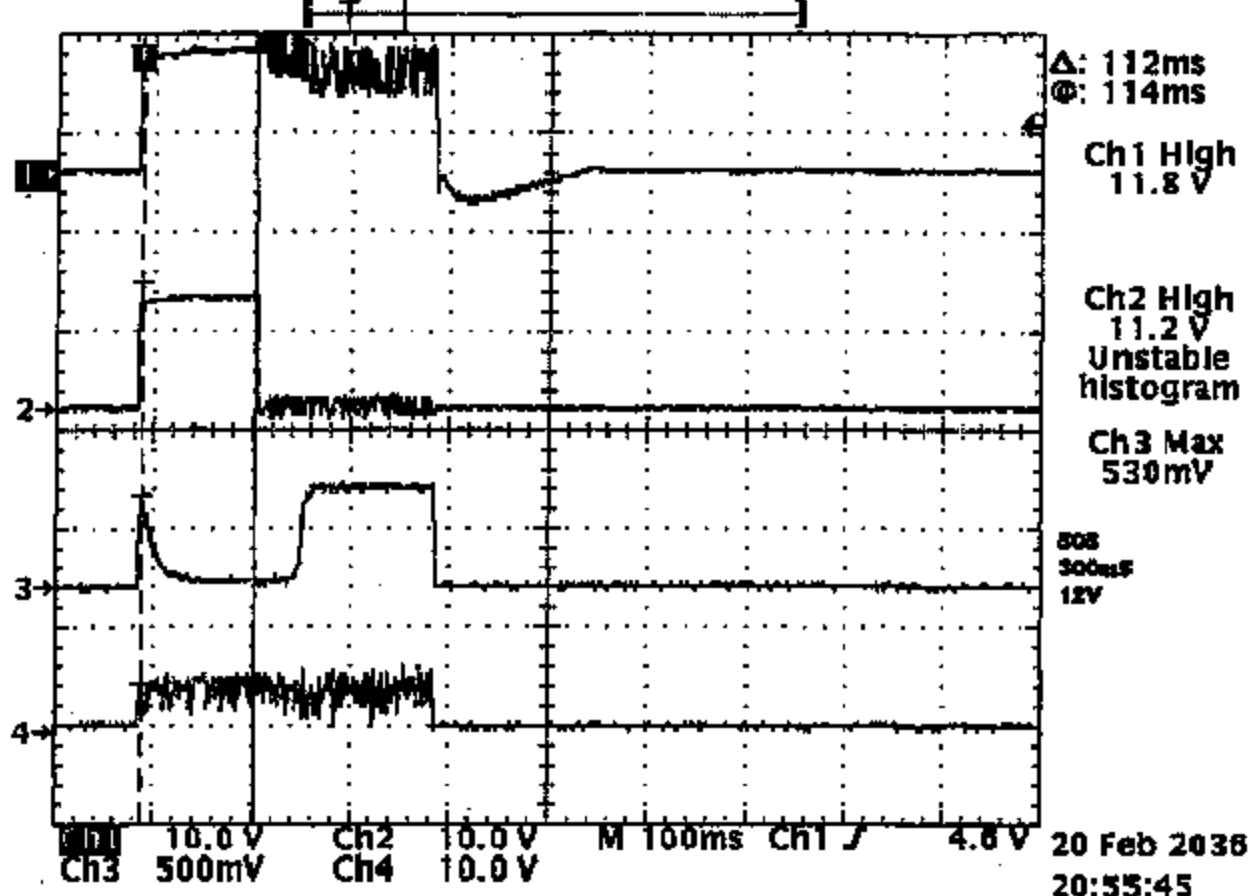
Ch2 High
10.8 V
Unstable
histogram

Ch3 Max
530mV

519
300ms
12V

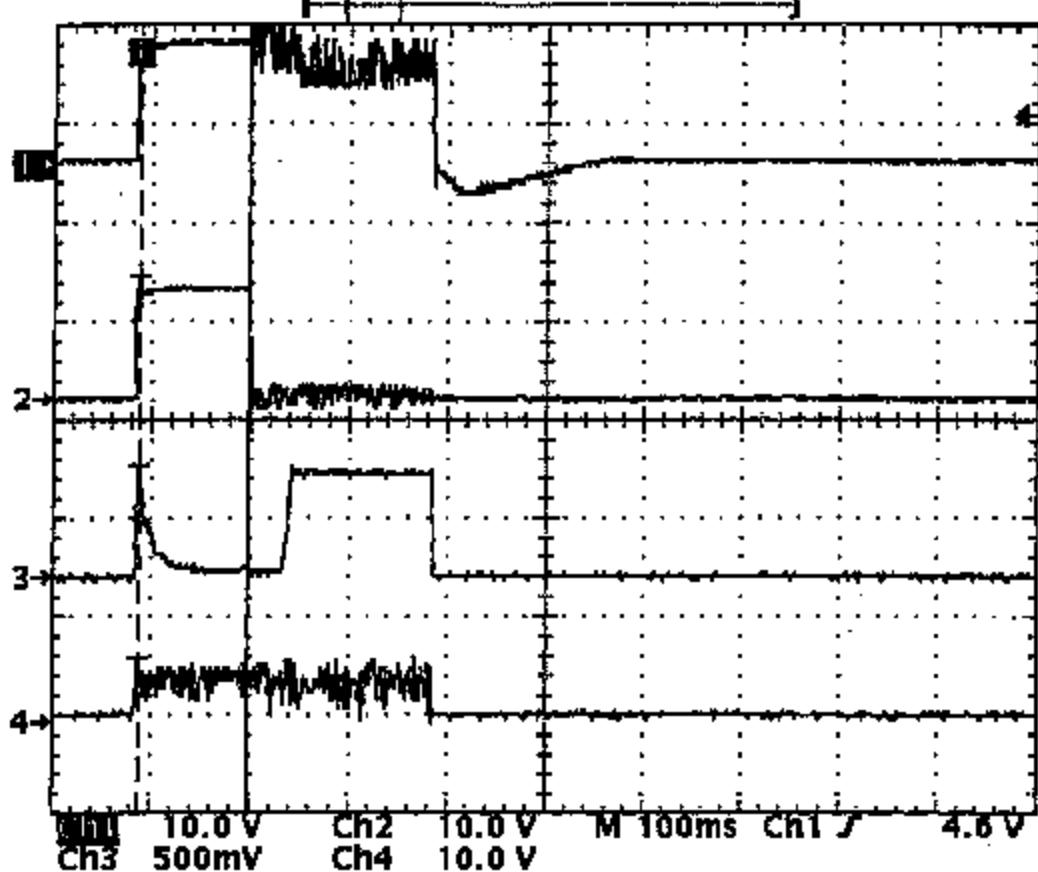
20 Feb 2036
20:56:54

Tek Run: 1.00kS/s Sample 0000



20 Feb 2038
20:55:45

Tek Run: 1.00kS/s Sample 100%



Δ: 110ms
@: 110ms

Ch1 High
11.8 V

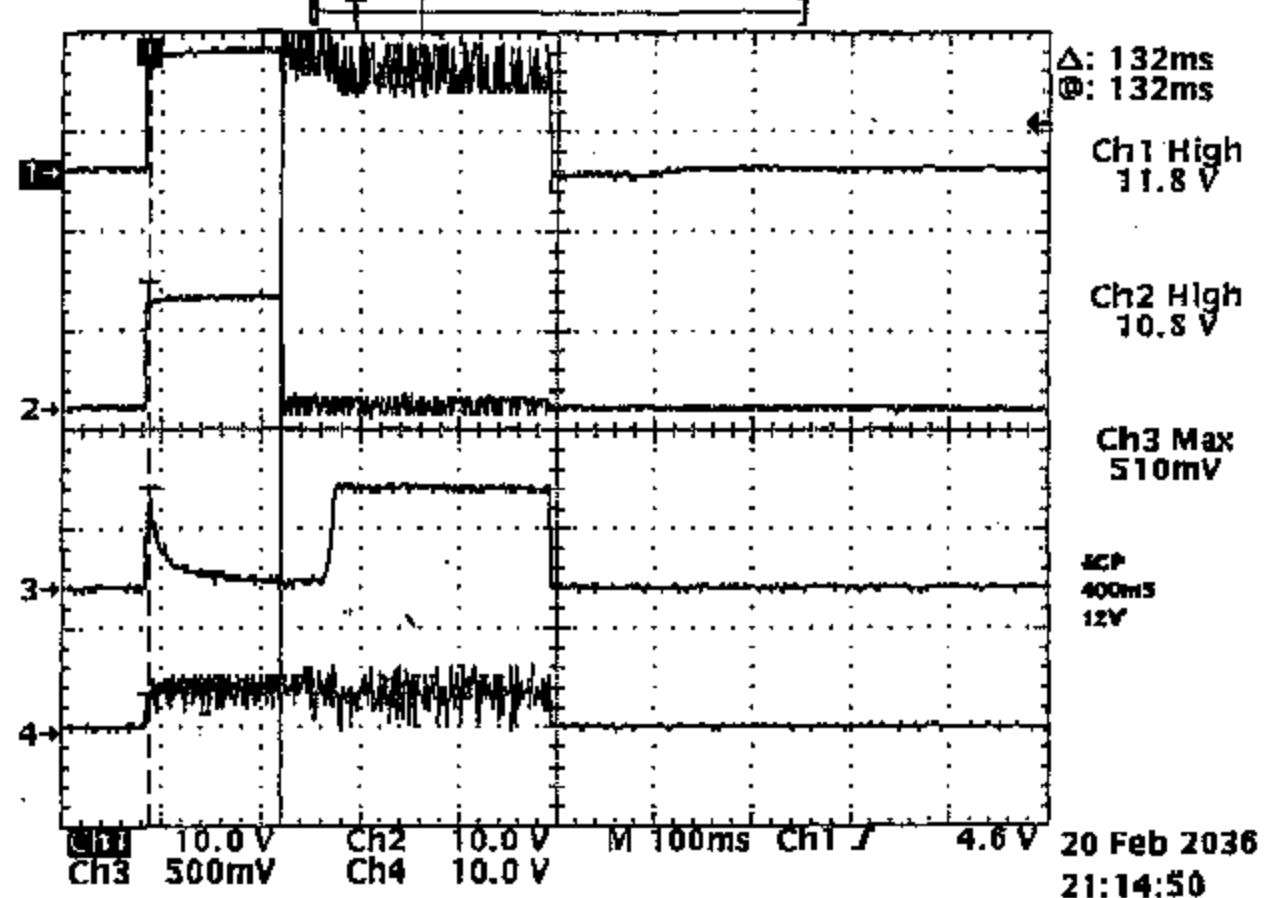
Ch2 High
11.2 V
Unstable
histogram

Ch3 Max
550mV

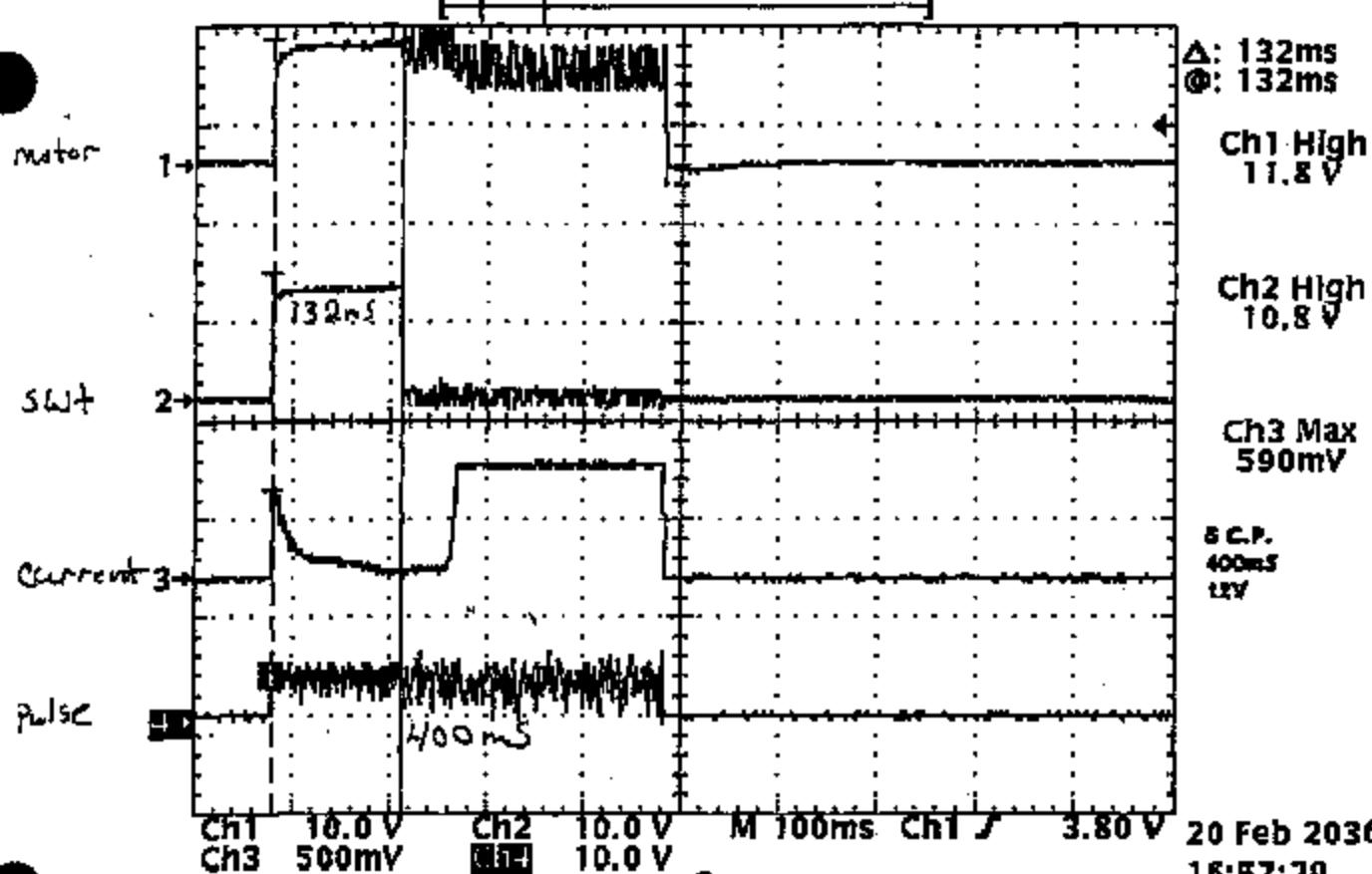
514
300ms
12V

20 Feb 2036
20:54:53

Tek Run: 1.00ks/s Sample 1000

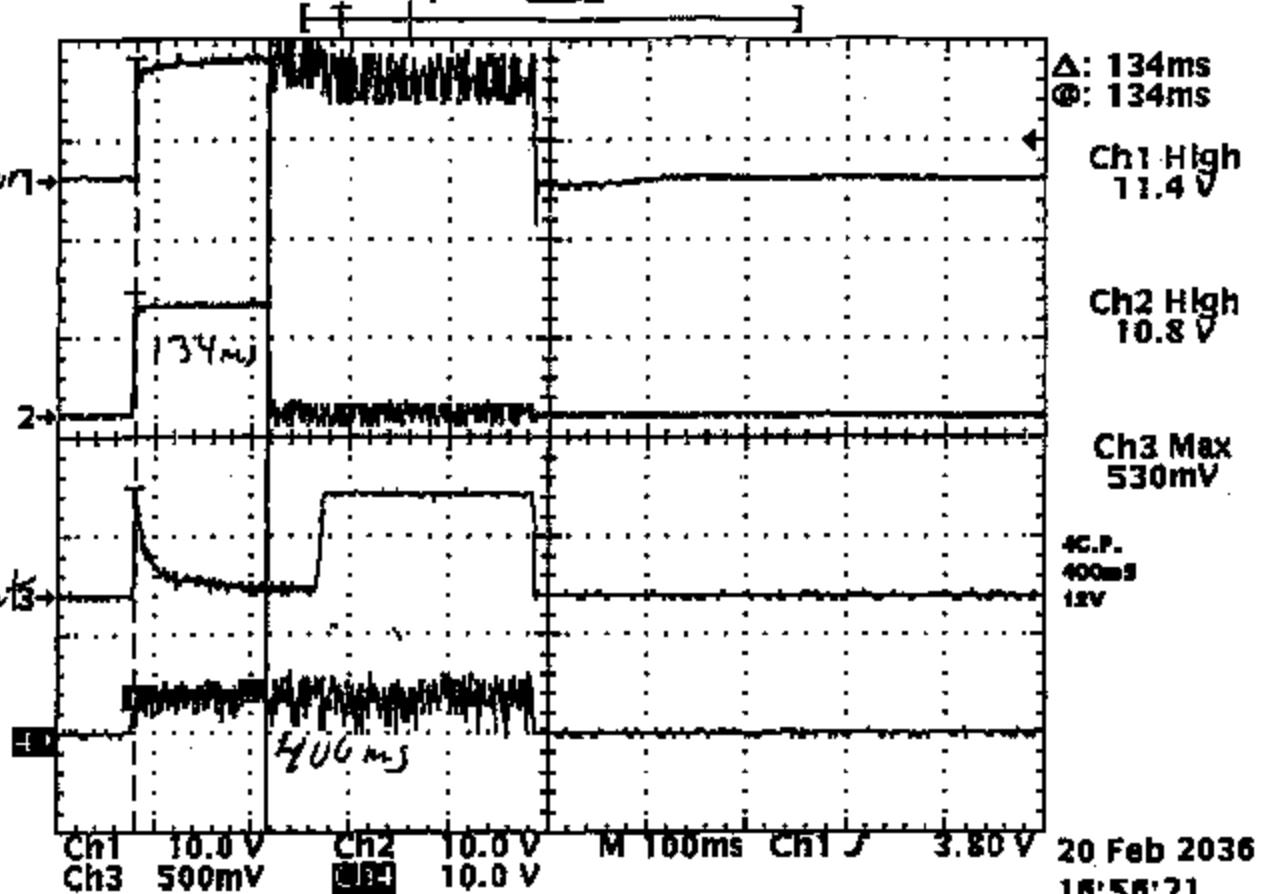


Tek Run: 1.00KS/s Sample 1018



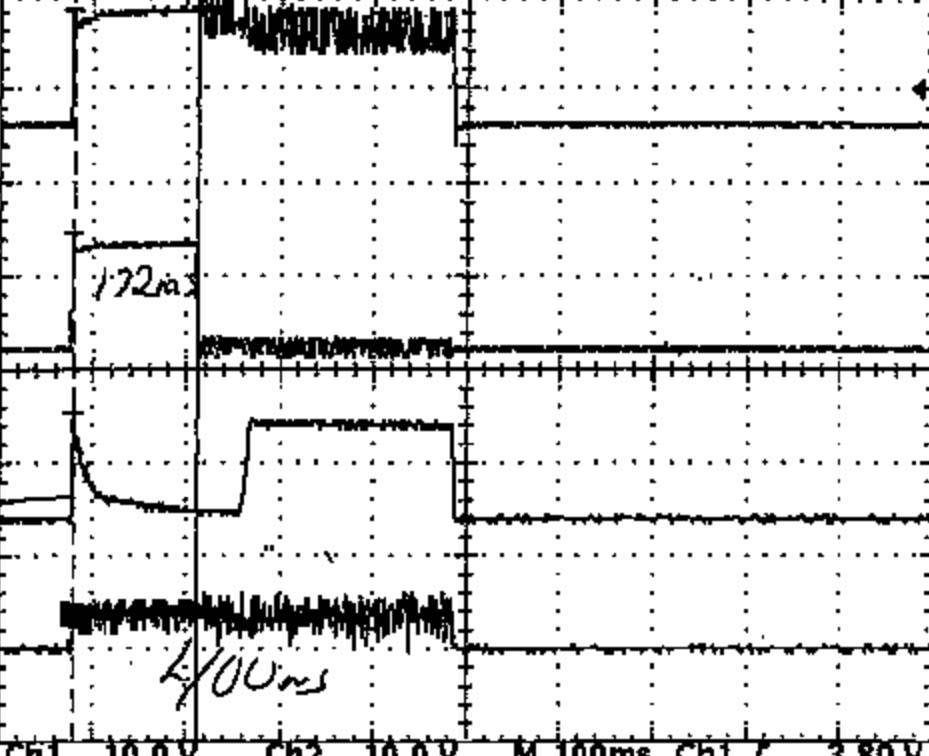
Rechannel	sut	<u>Current</u>
10.17	132 ms	5.9
10.18	132 ms	5.9
10.19	132 ms	4.9

Tek Run: 1.00ks/s Sample 100%



Tek Run: 1.00ks/s Sample 0096

Motor 1+



Δ: 132ms
@: 132ms

Ch1 High
11.8 V

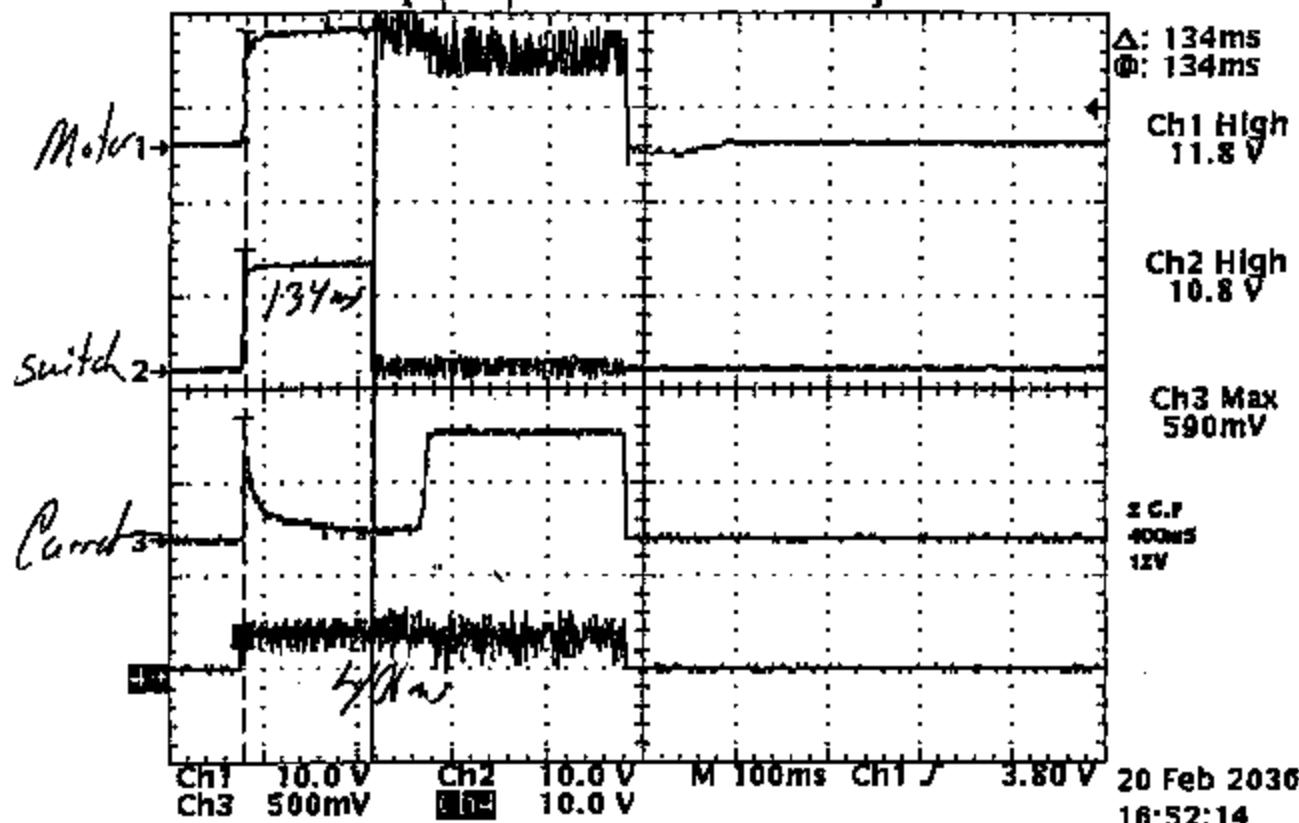
Ch2 High
10.8 V

Ch3 Max
530mV

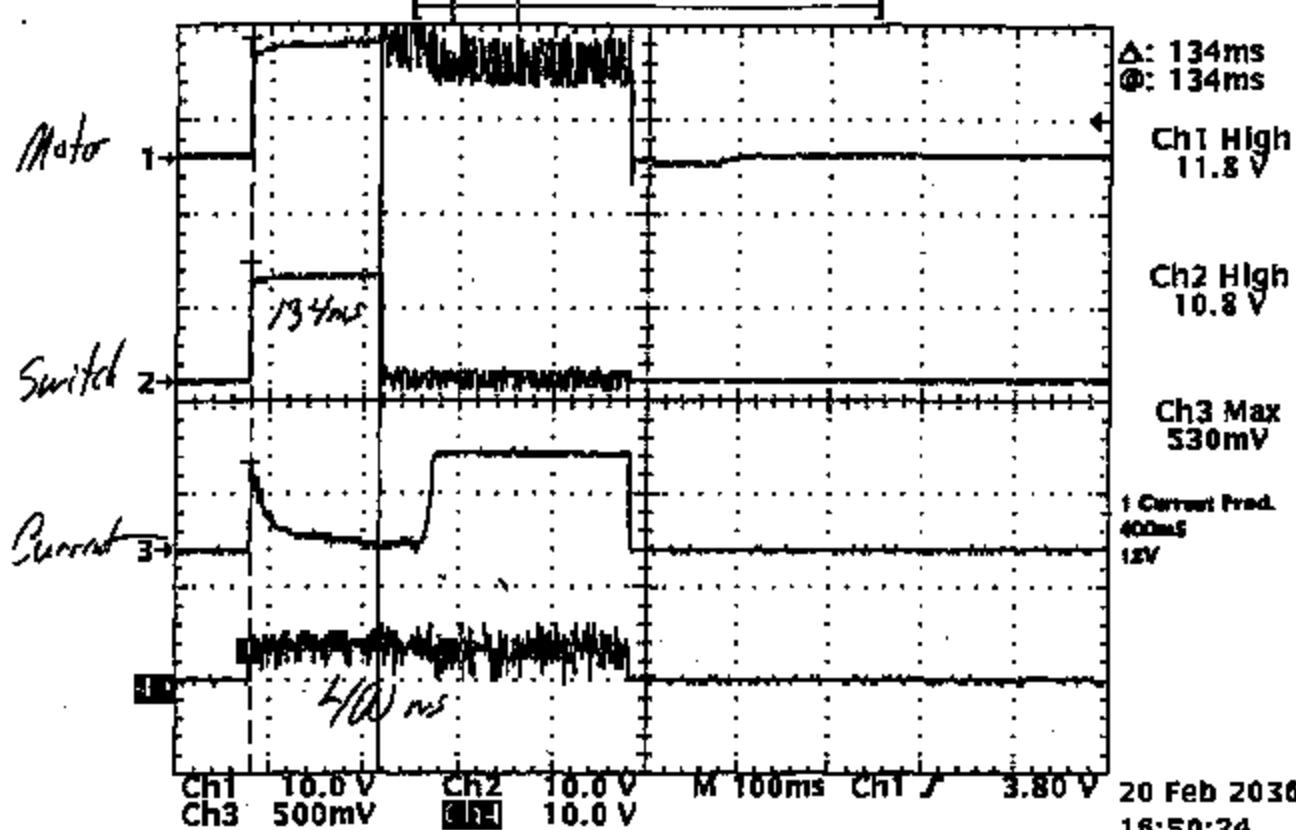
3 G.P.
400ms
12V

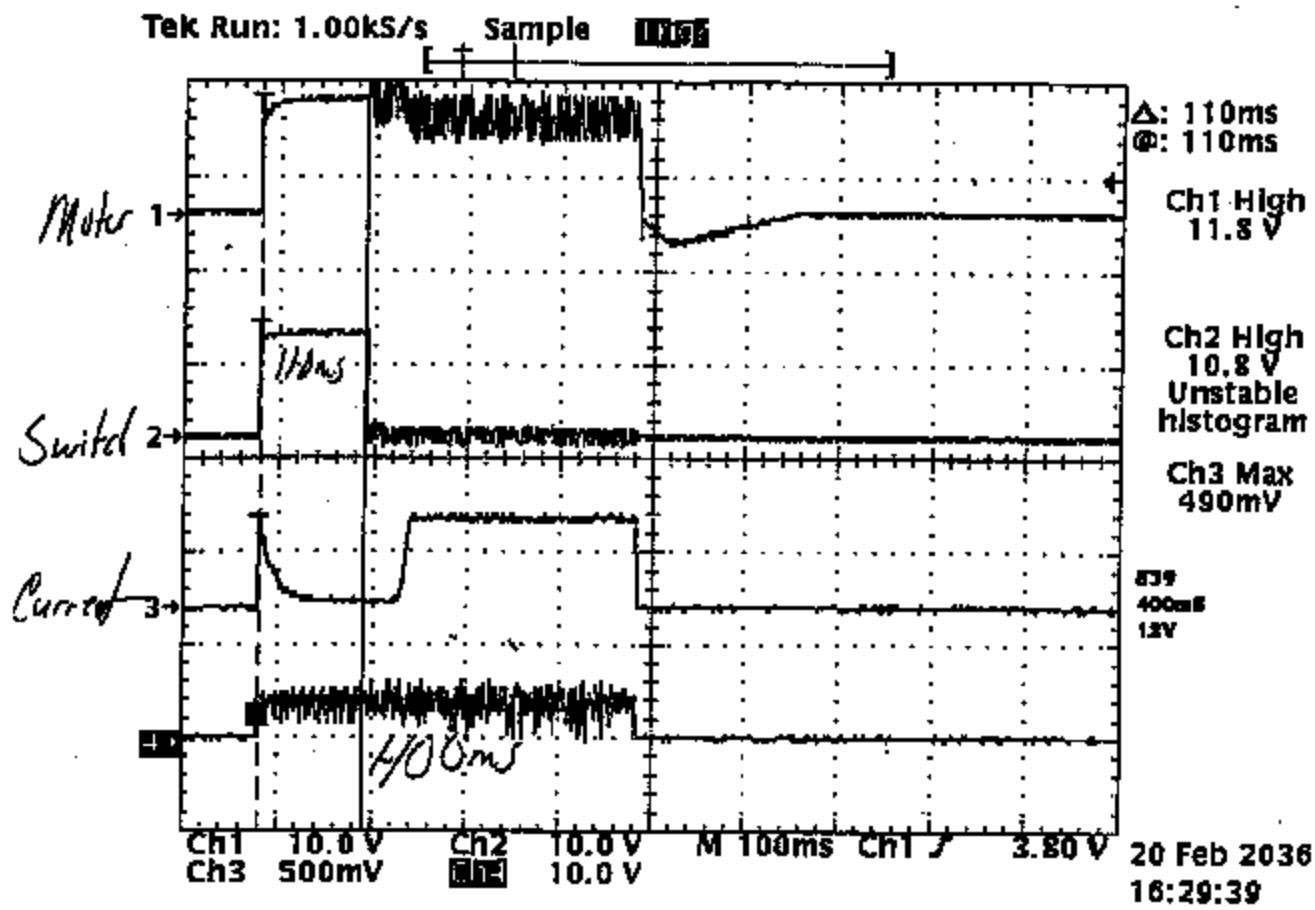
20 Feb 2036
16:54:14

Tek Run: 1.00KS/s Sample 0006



Tek Run: 1.00kS/s Sample 1006





Tek Run: 1.00kS/s Sample 1198

Motor 1

Gaitor 2

Current 3

CH1 10.0 V
CH3 500mV

CH2 10.0 V
CH4 10.0 V

M 100ms

CH1 3.80 V

20 Feb 2036
16:27:32

Δ: 112ms
@: 114ms

Ch1 High
11.8 V

Ch2 High
11.2 V
Unstable
histogram

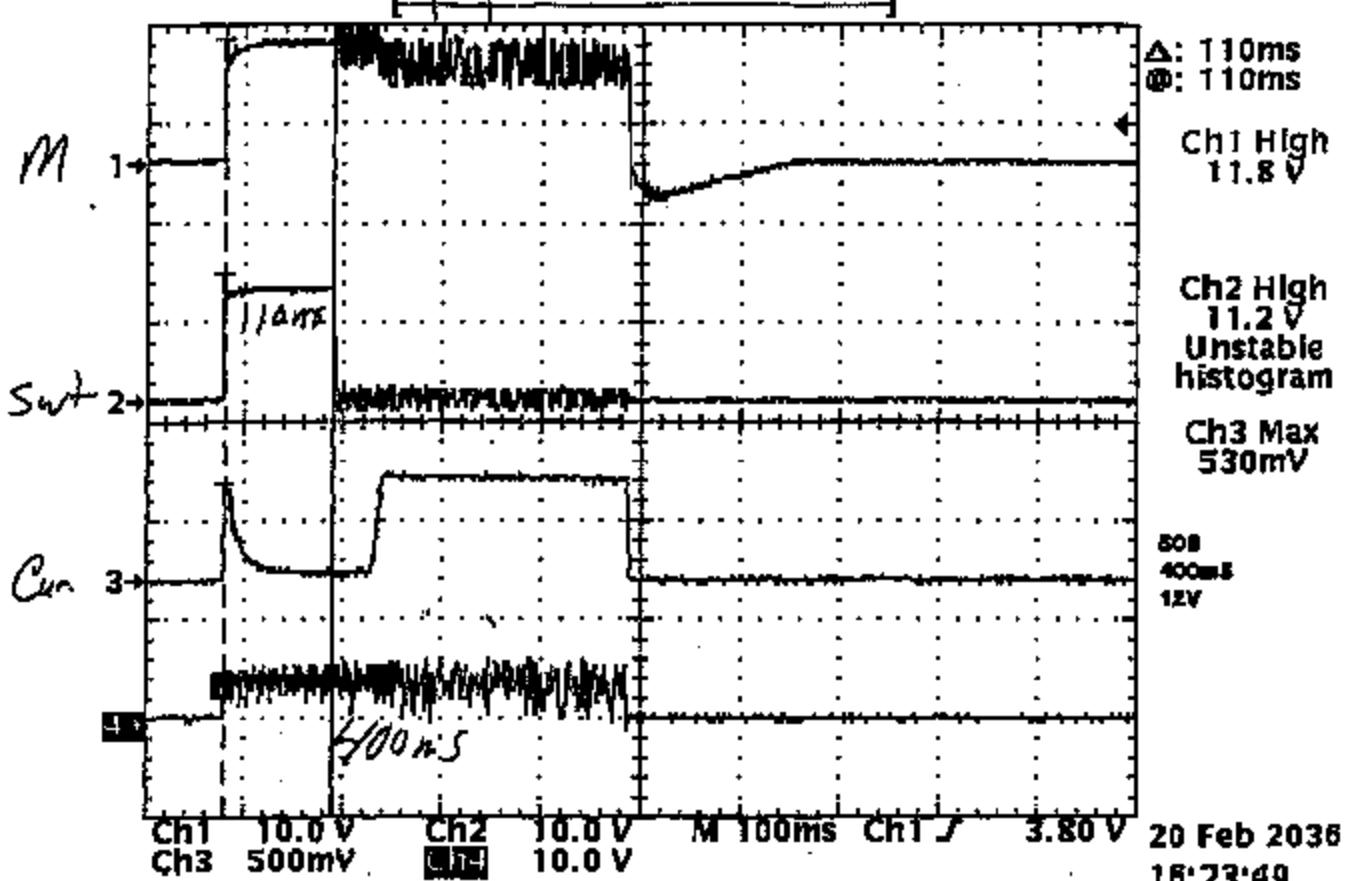
Ch3 Max
610mV

823
400ms
12V

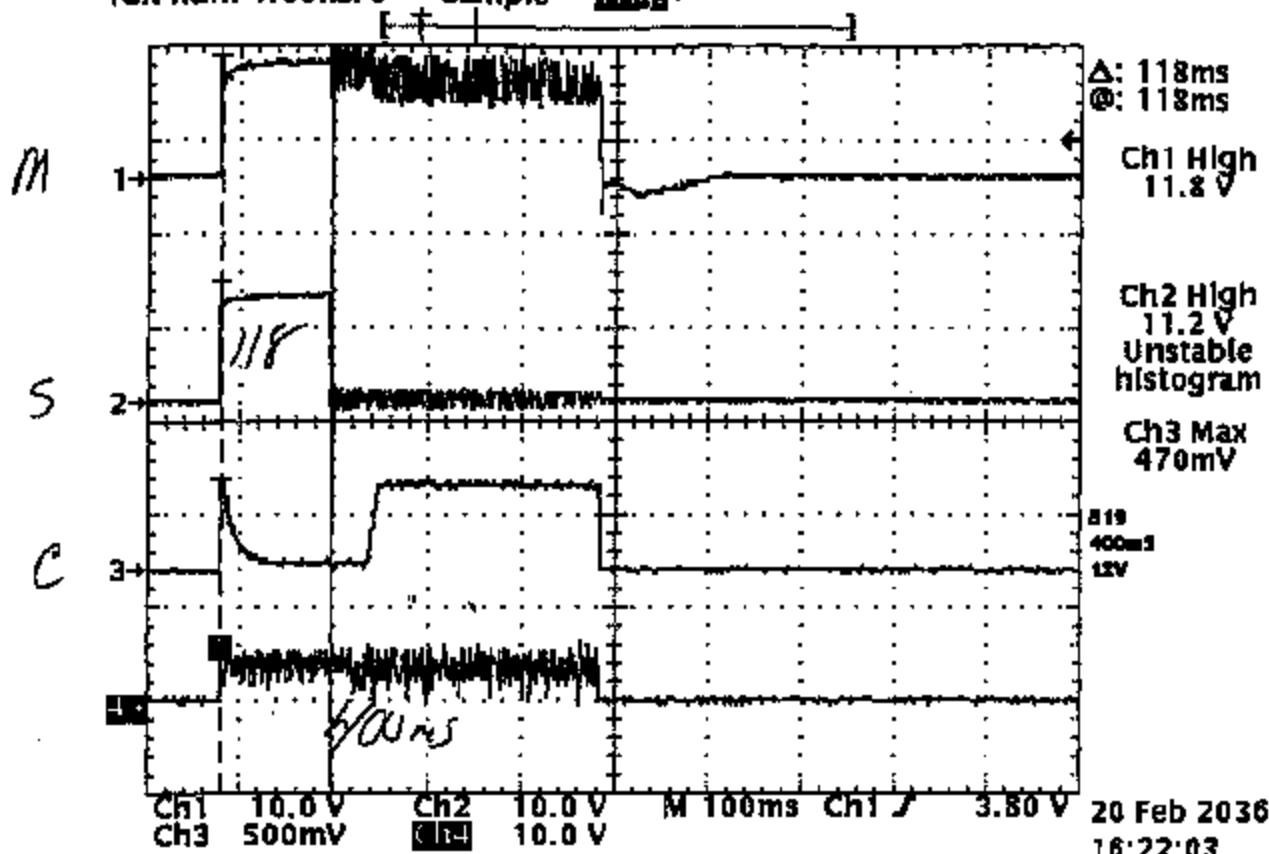
1f2ns

400ns

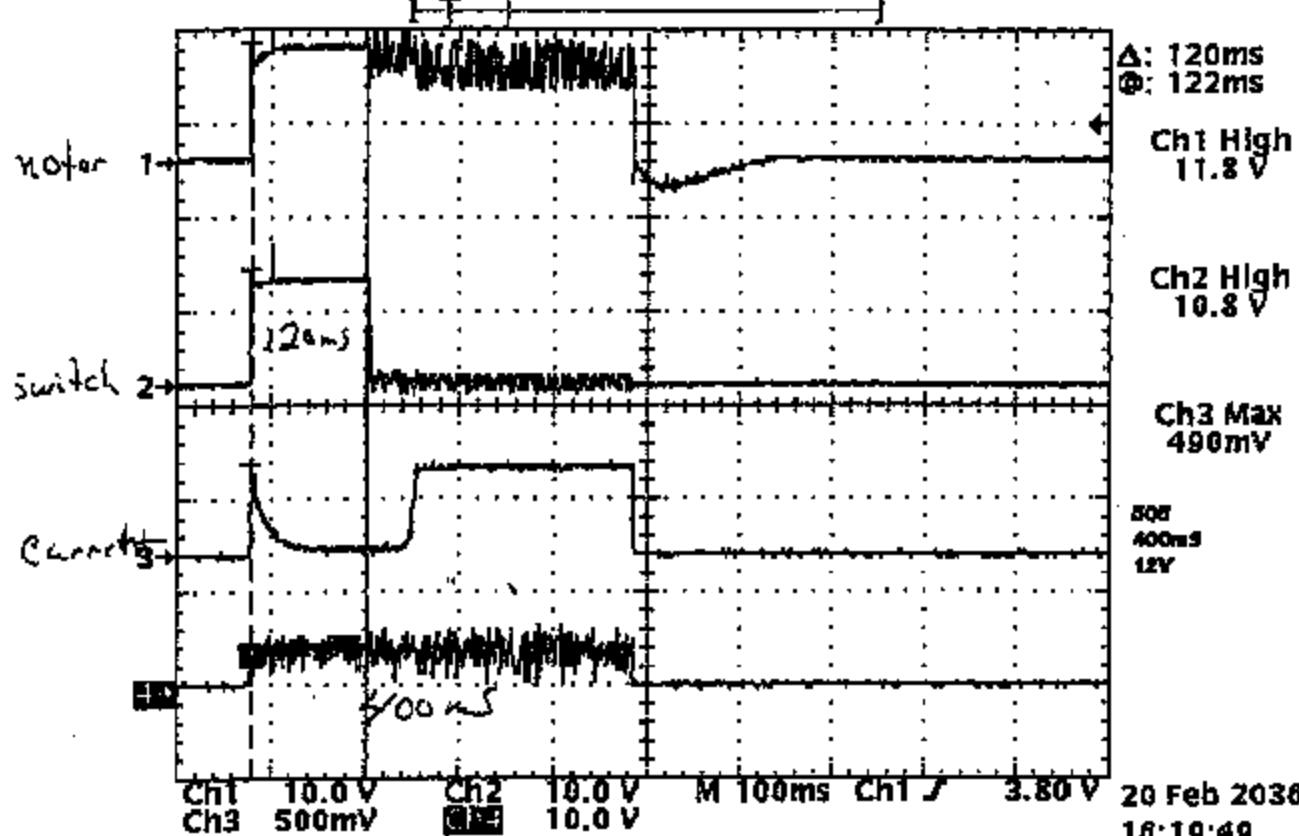
Tek Run: 1.00kS/s Sample 100%



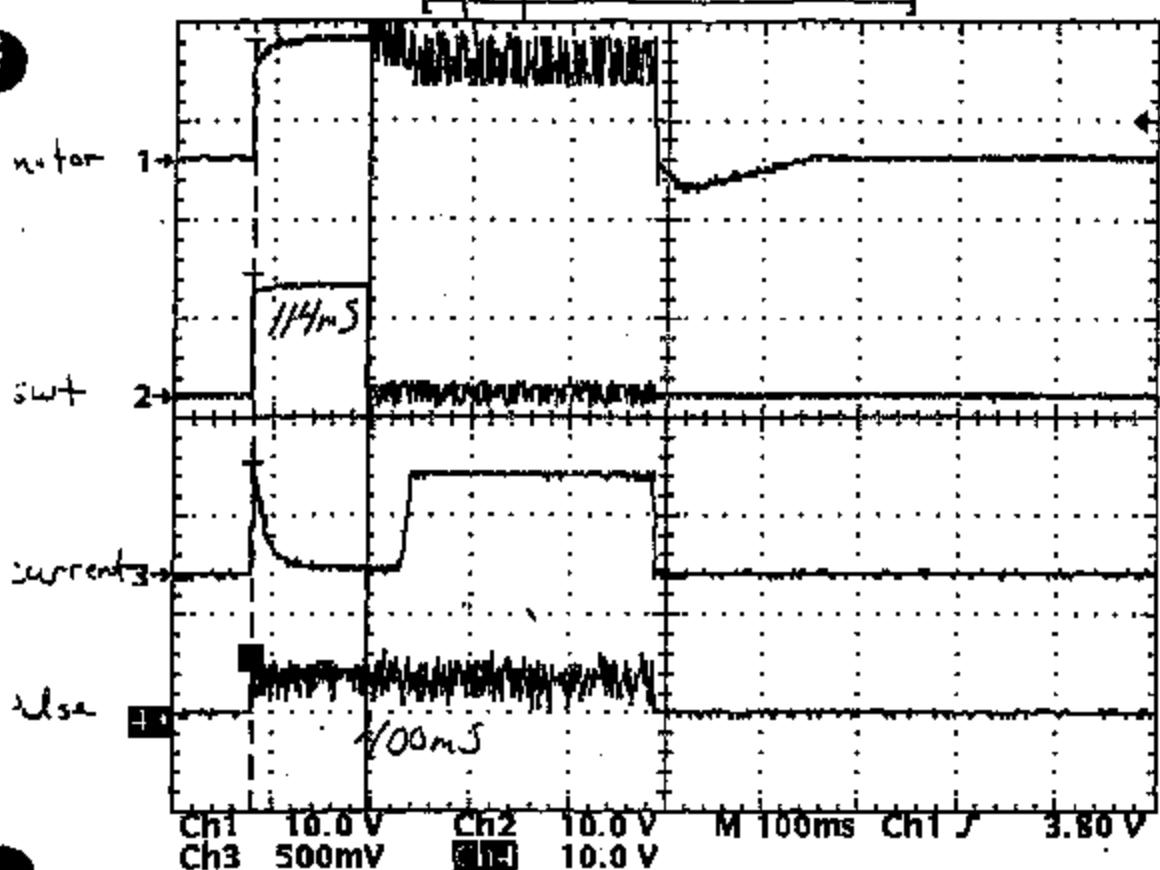
Tek Run: 1.00kS/s Sample 11098



Tek Run: 1.00kS/s Sample 1000



Tek Run: 1.00kS/s Sample 1000



Δ: 114ms
@: 116ms

Ch1 High
11.8 V

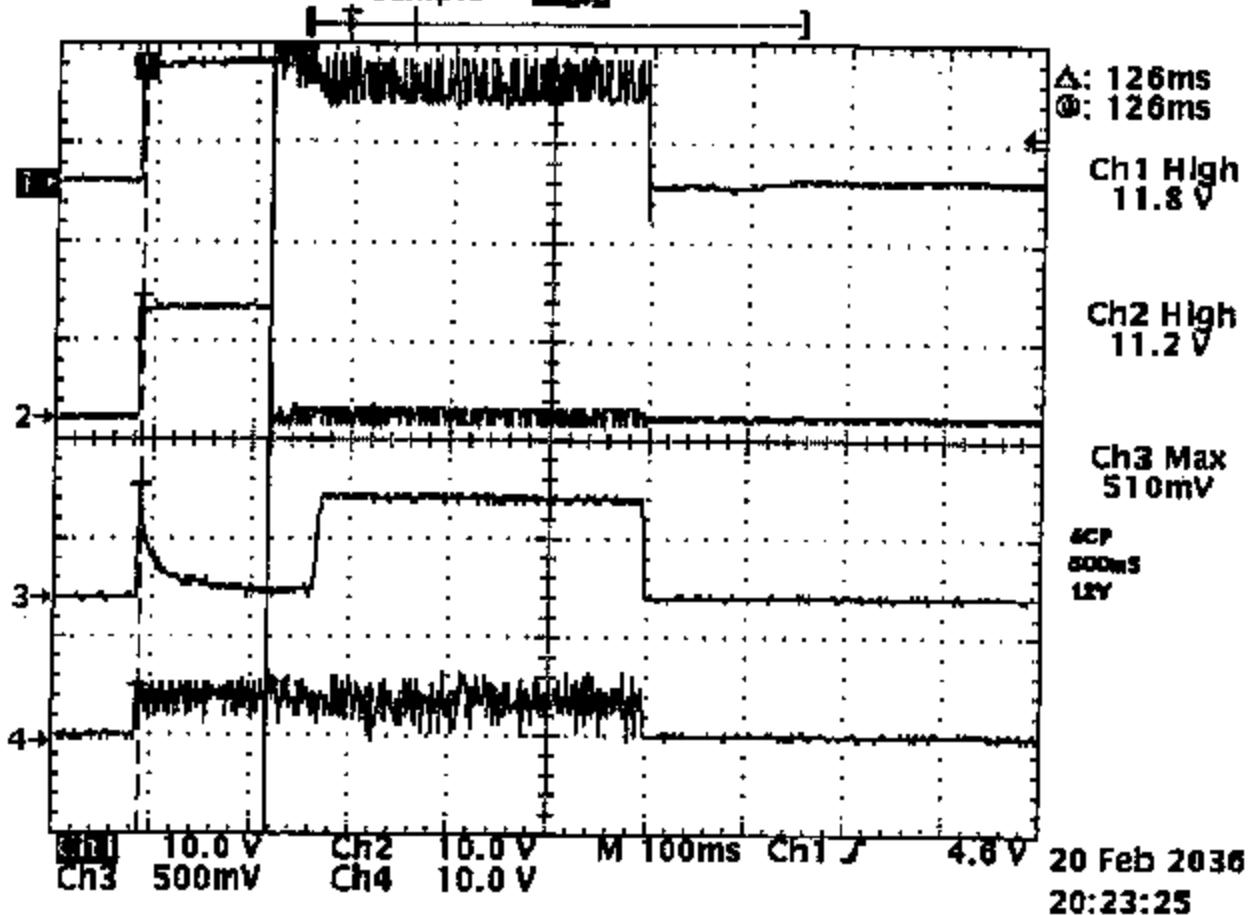
Ch2 High
10.8 V
Unstable
Histogram

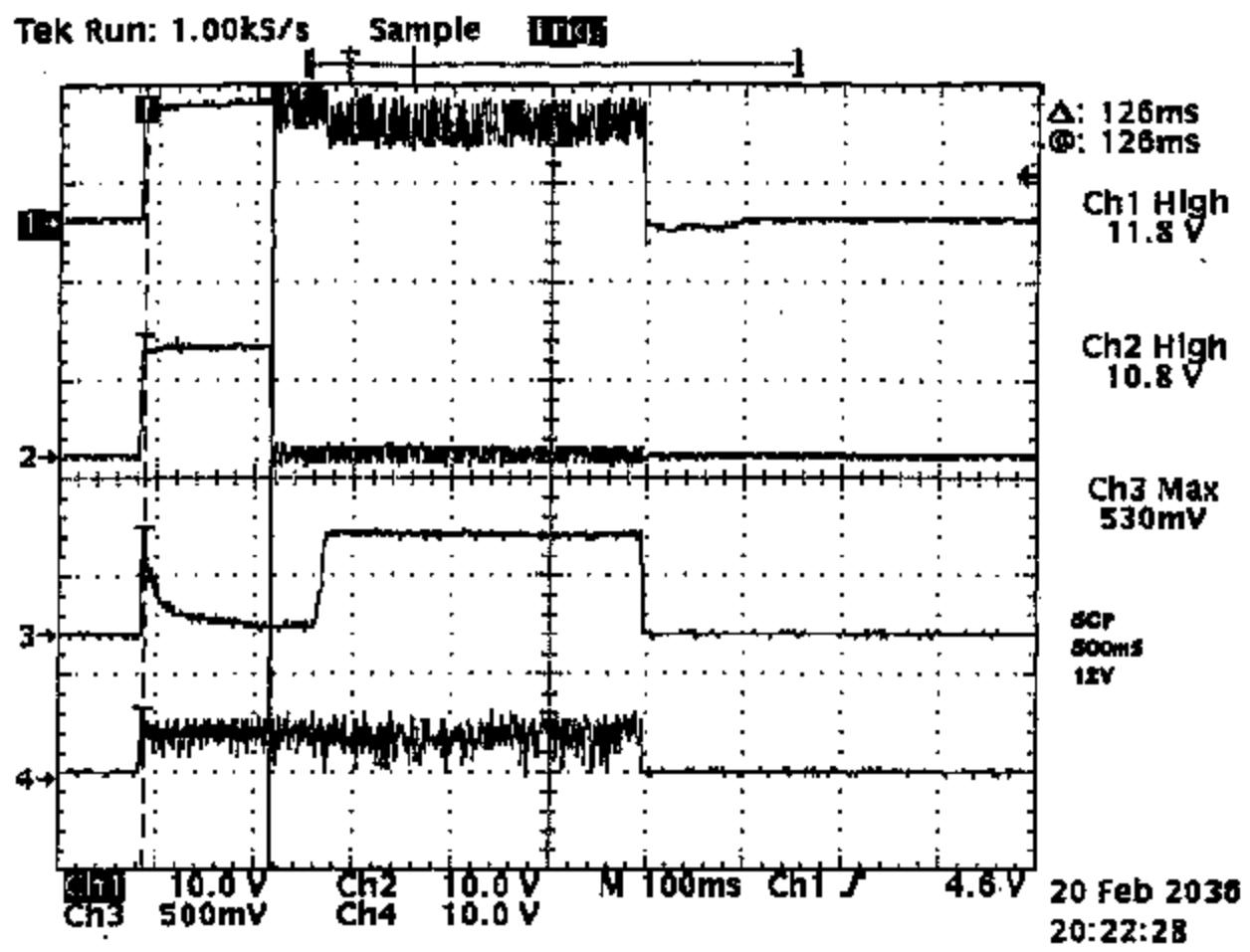
Ch3 Max
530mV

514
400ms
12V

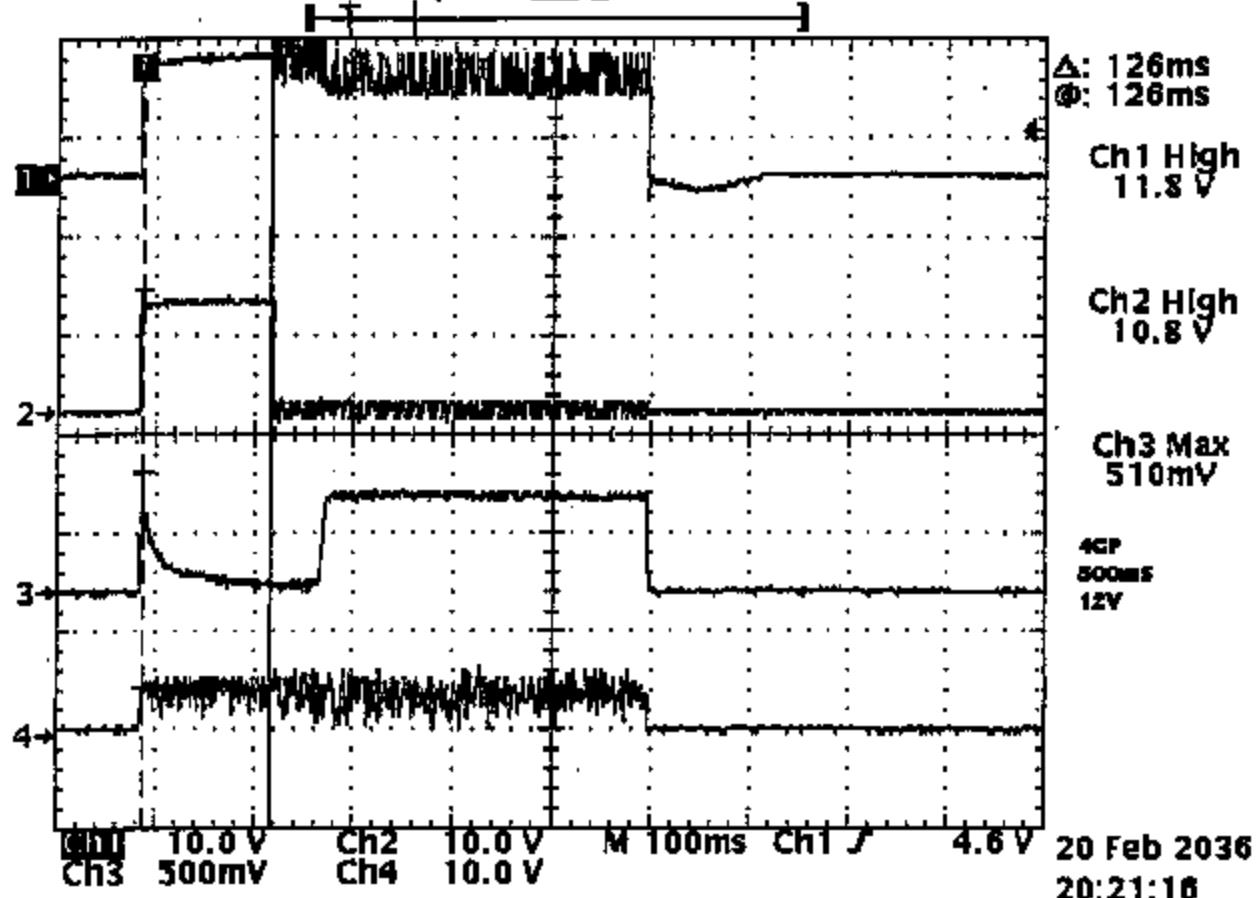
20 Feb 2036
16:17:25

Tek Run: 1.00kS/s Sample 1000s

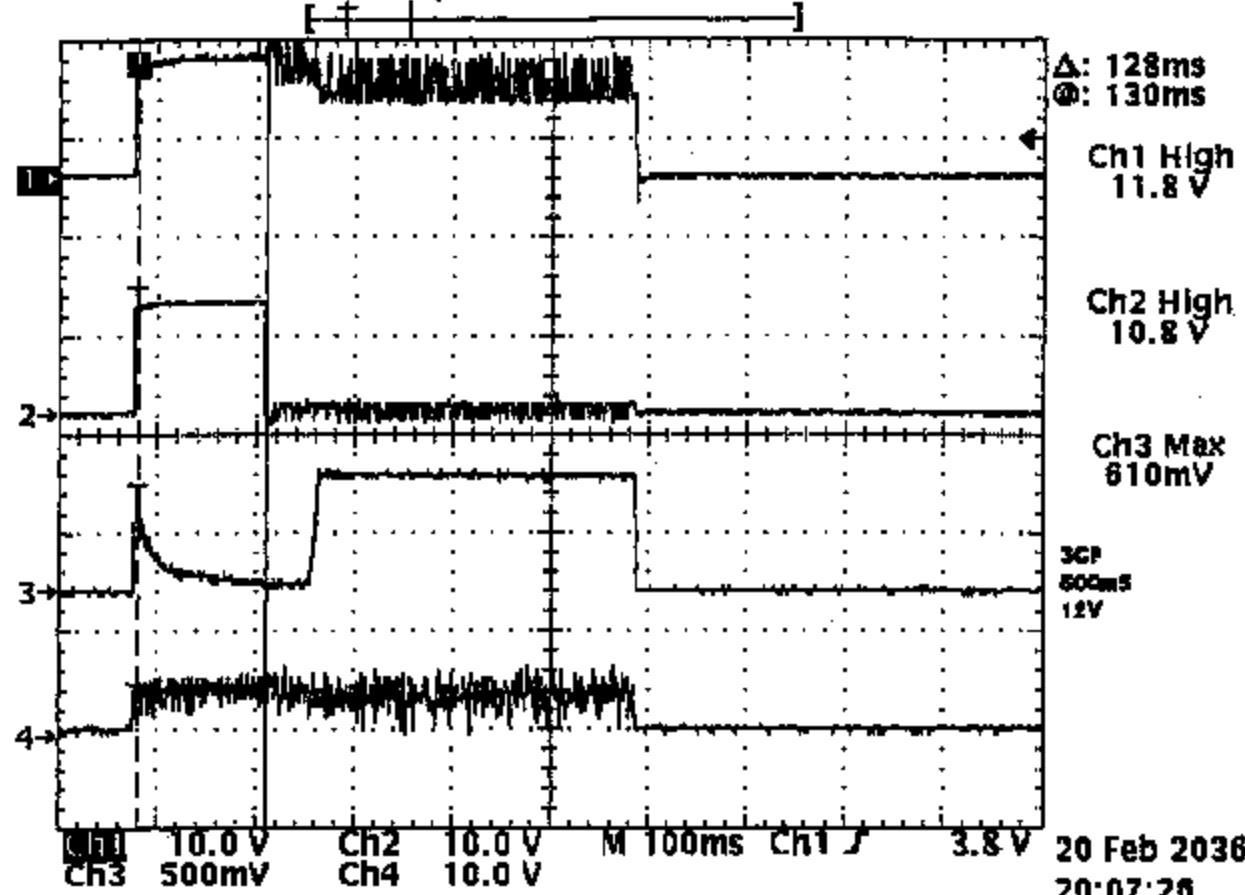




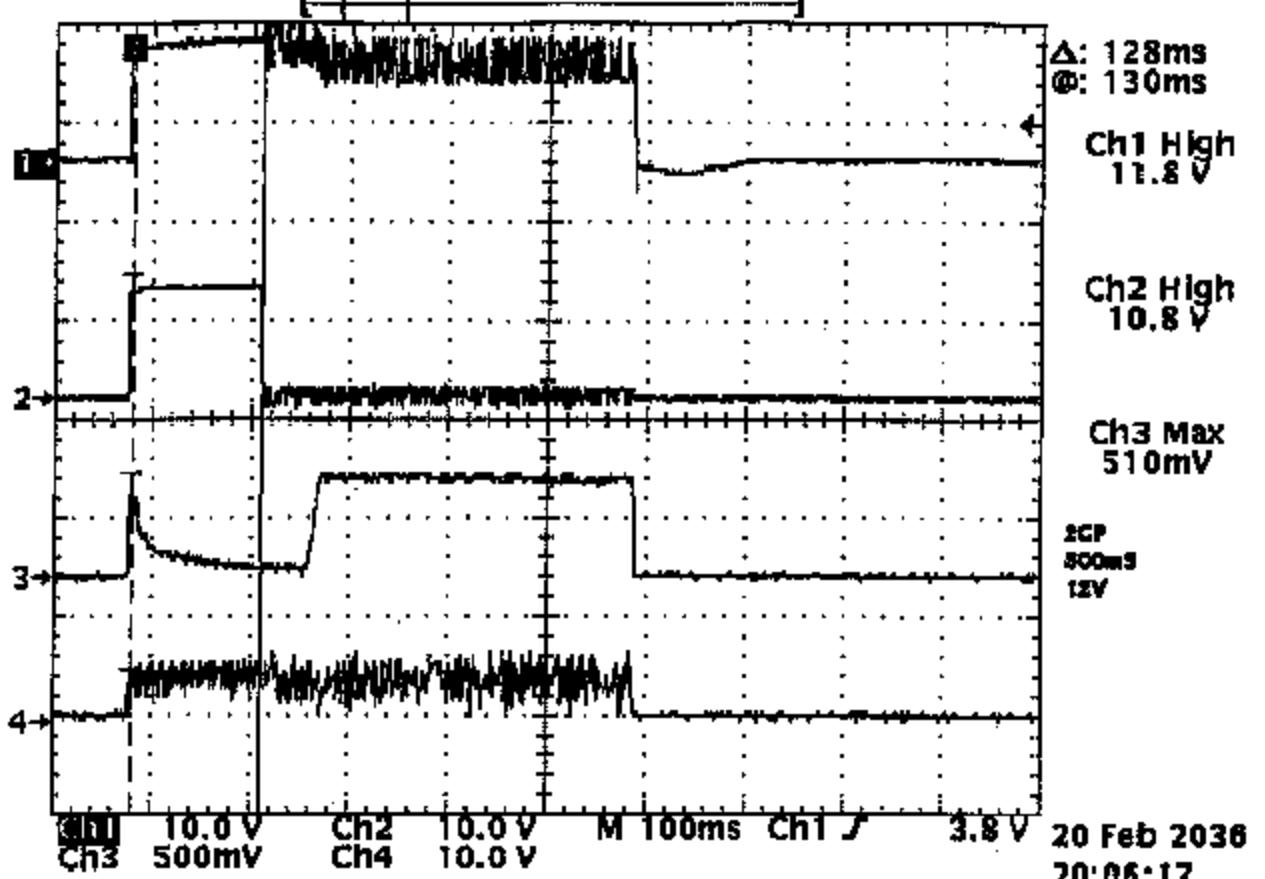
Tek Run: 1.00kS/s Sample 1000



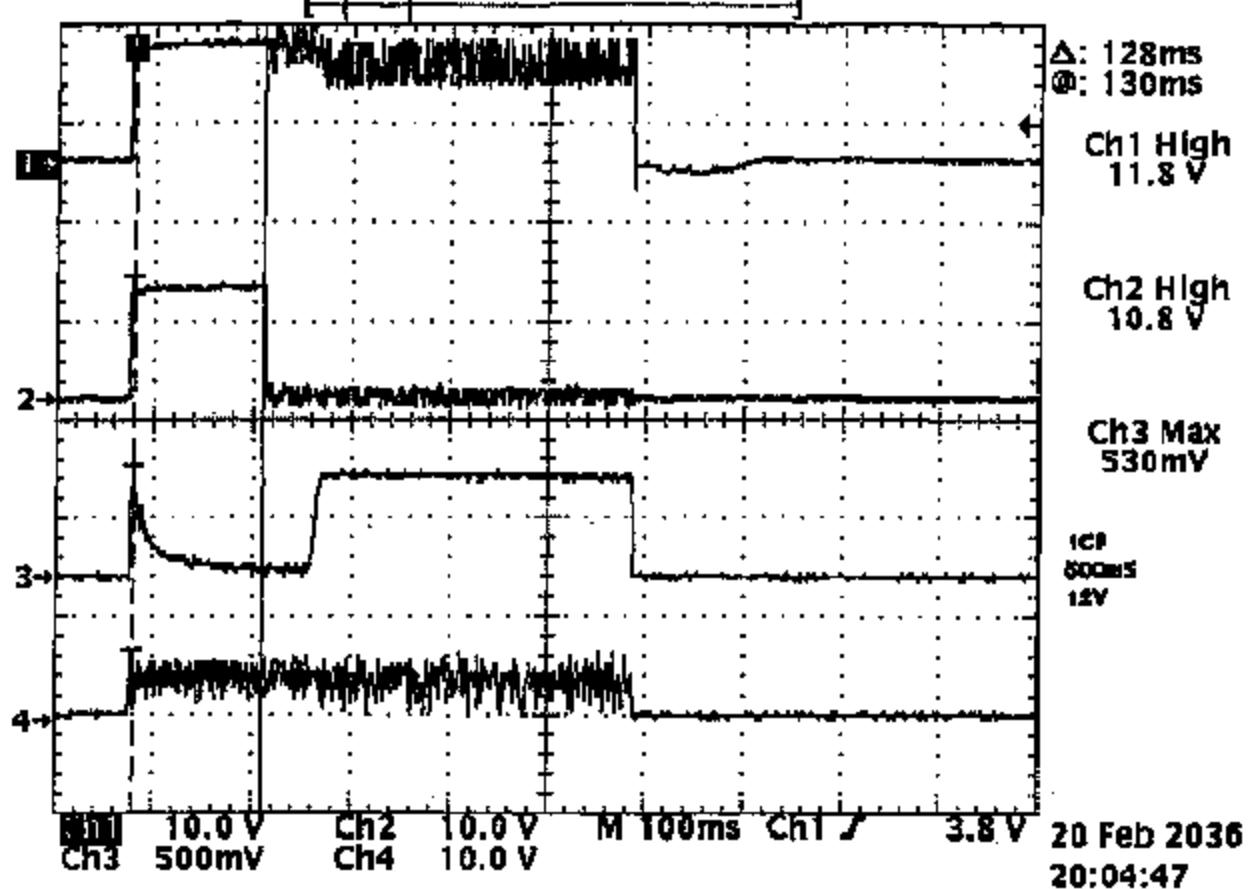
Tek Run: 1.00kS/s Sample



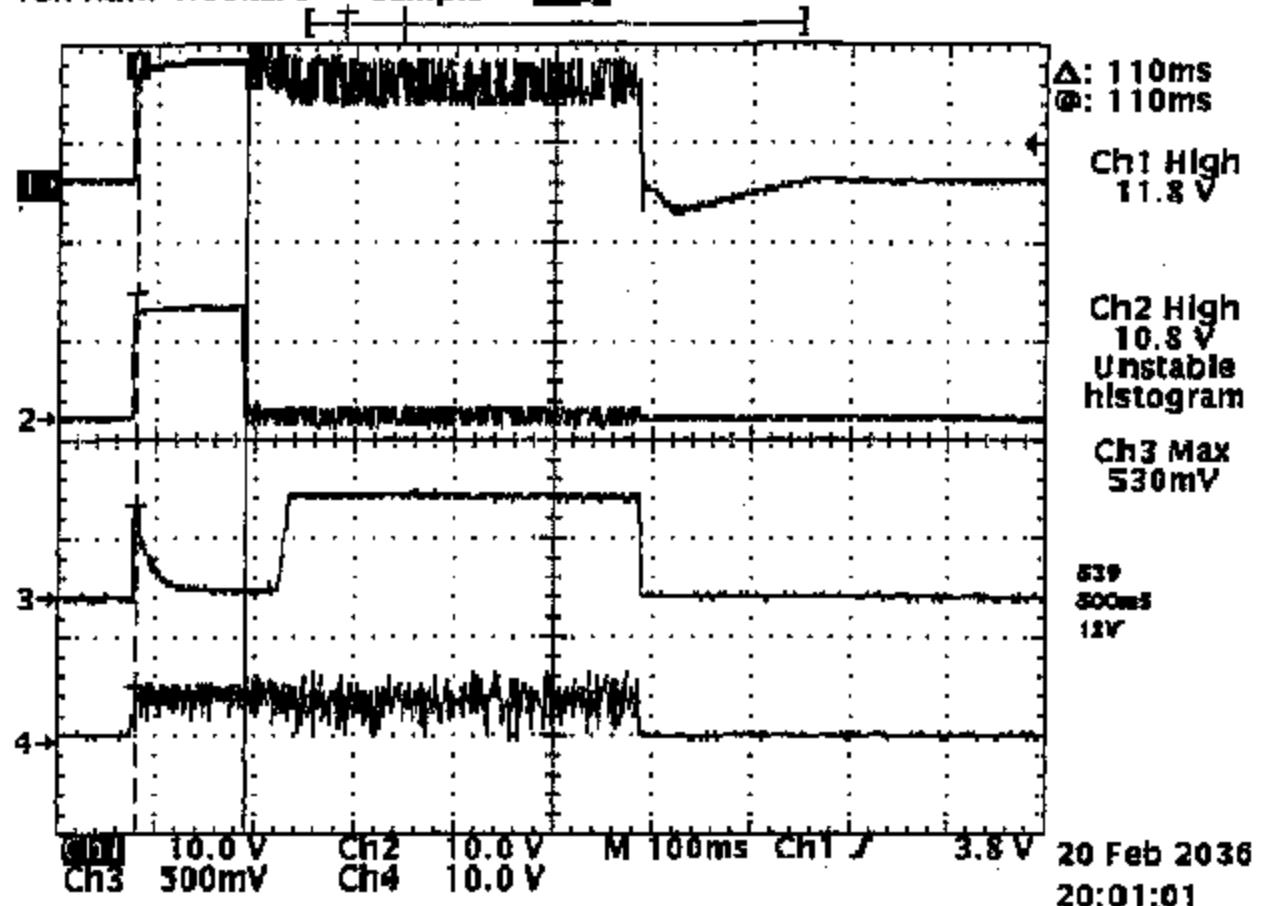
Tek Run: 1.00kS/s Sample 1600

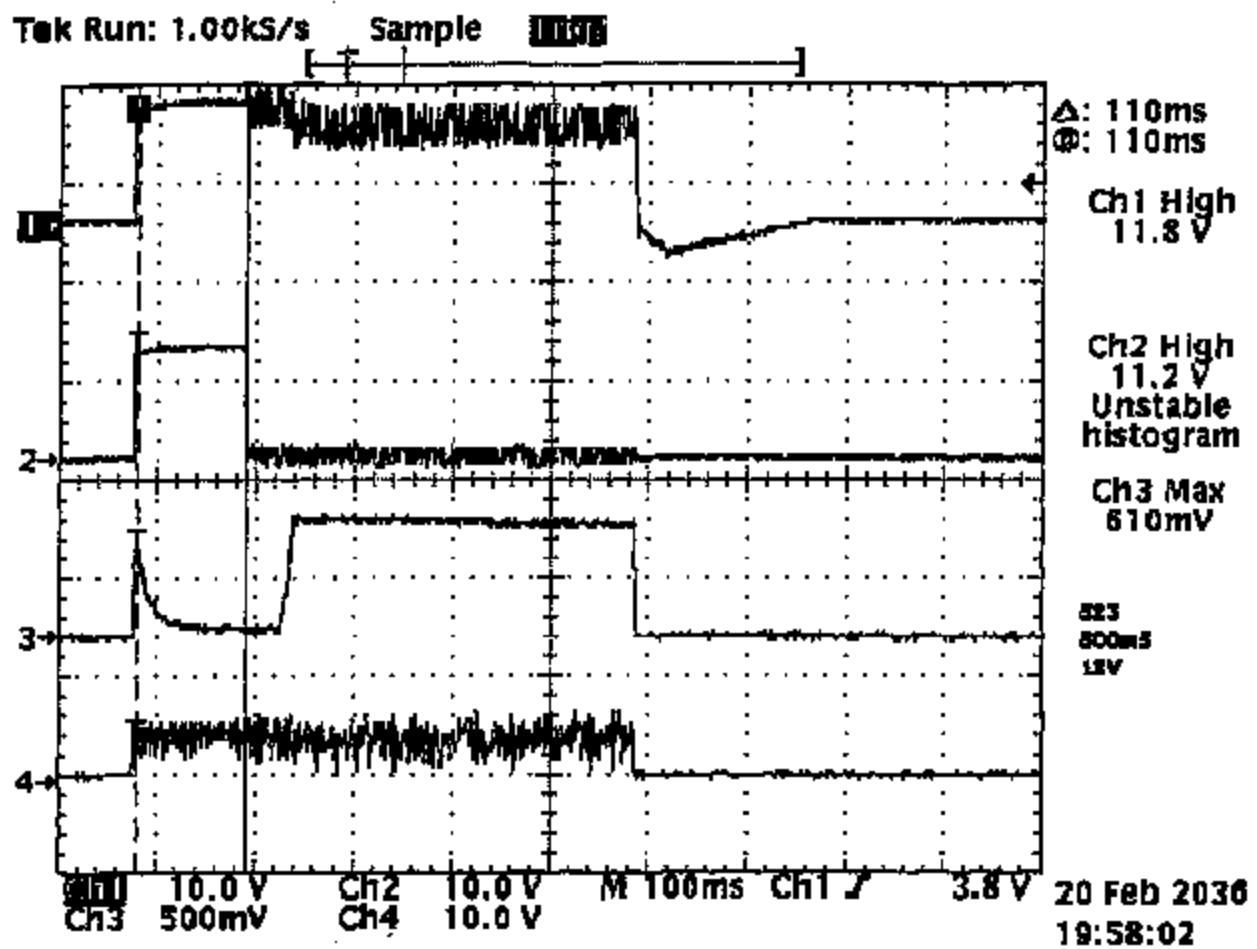


Tek Run: 1.00kS/s Sample 1005

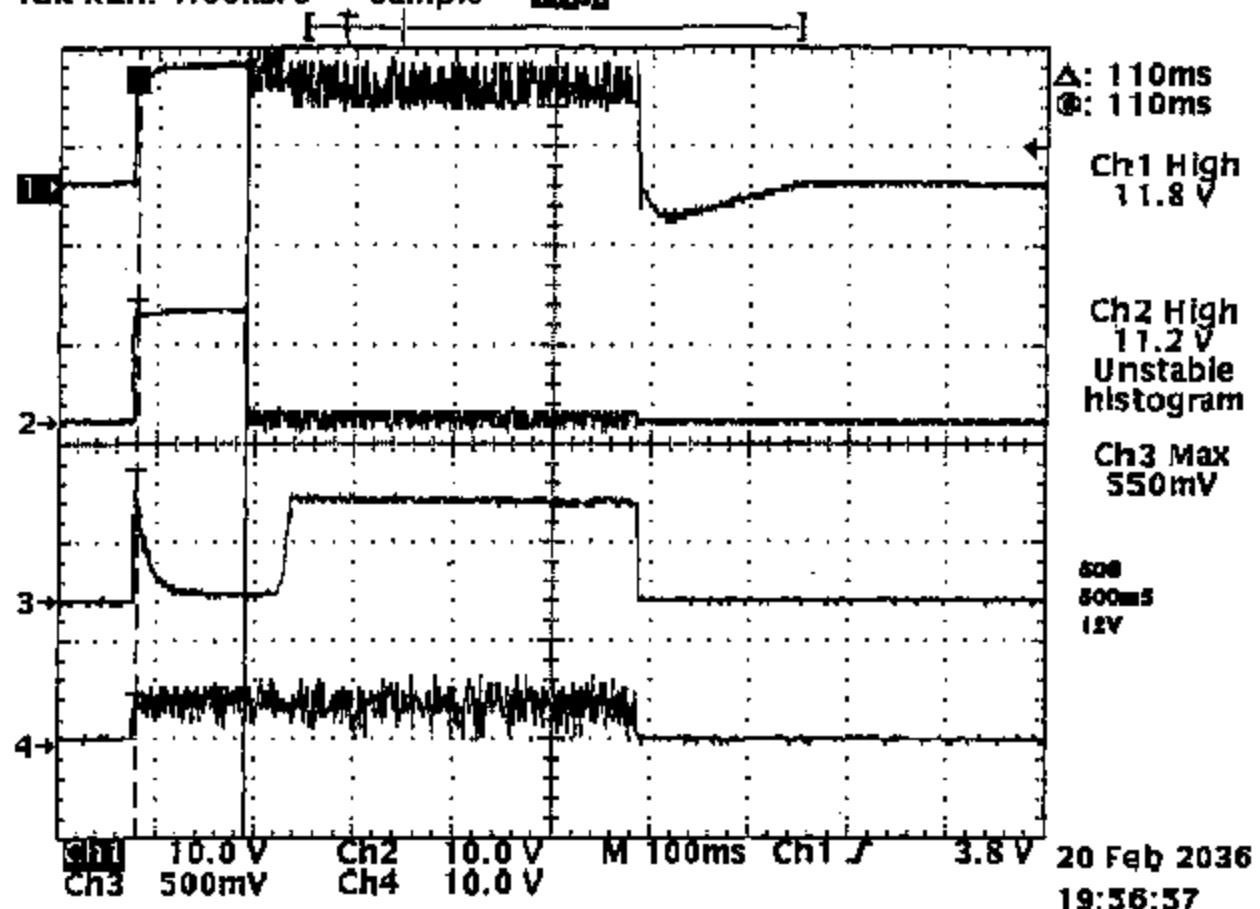


Tek Run: 1.00kS/s Sample 1000

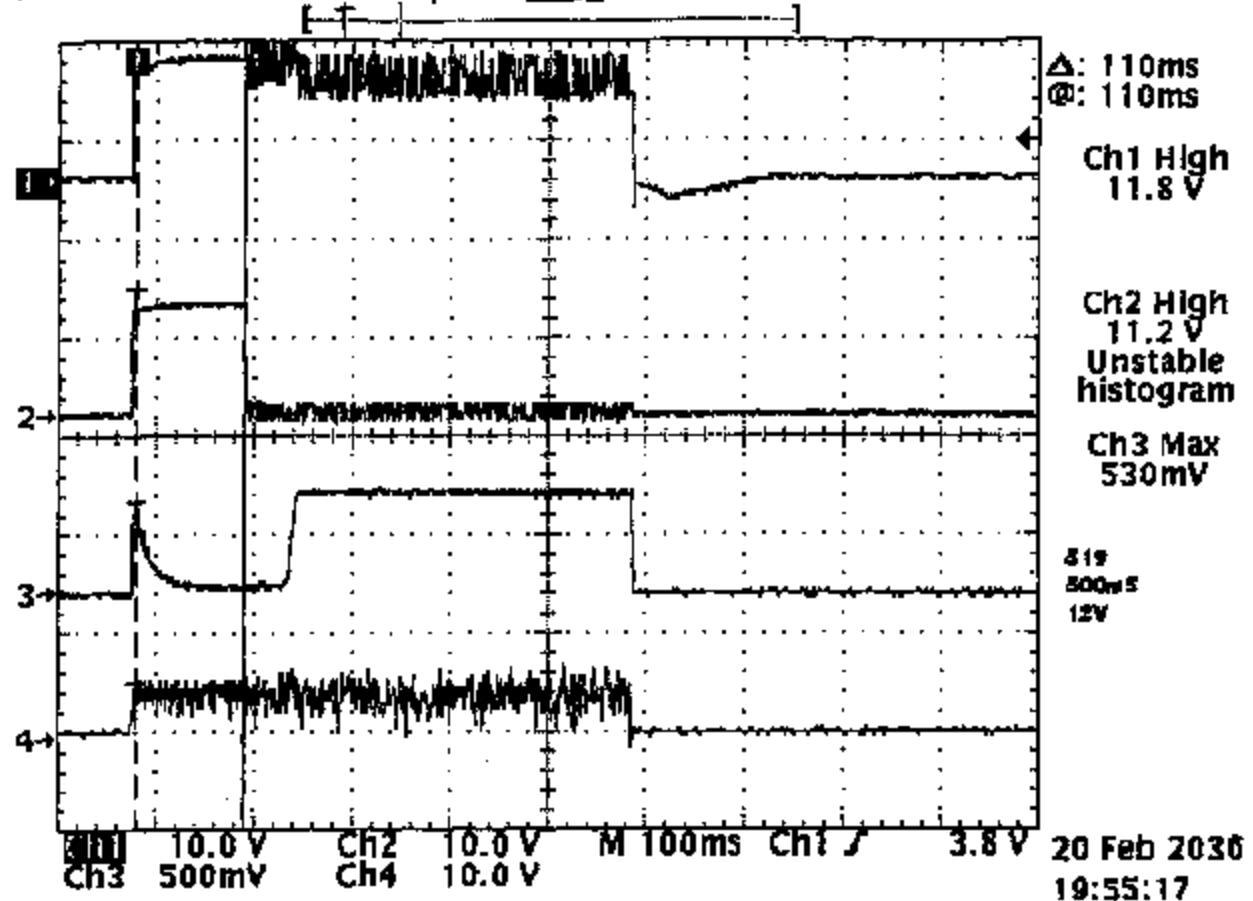




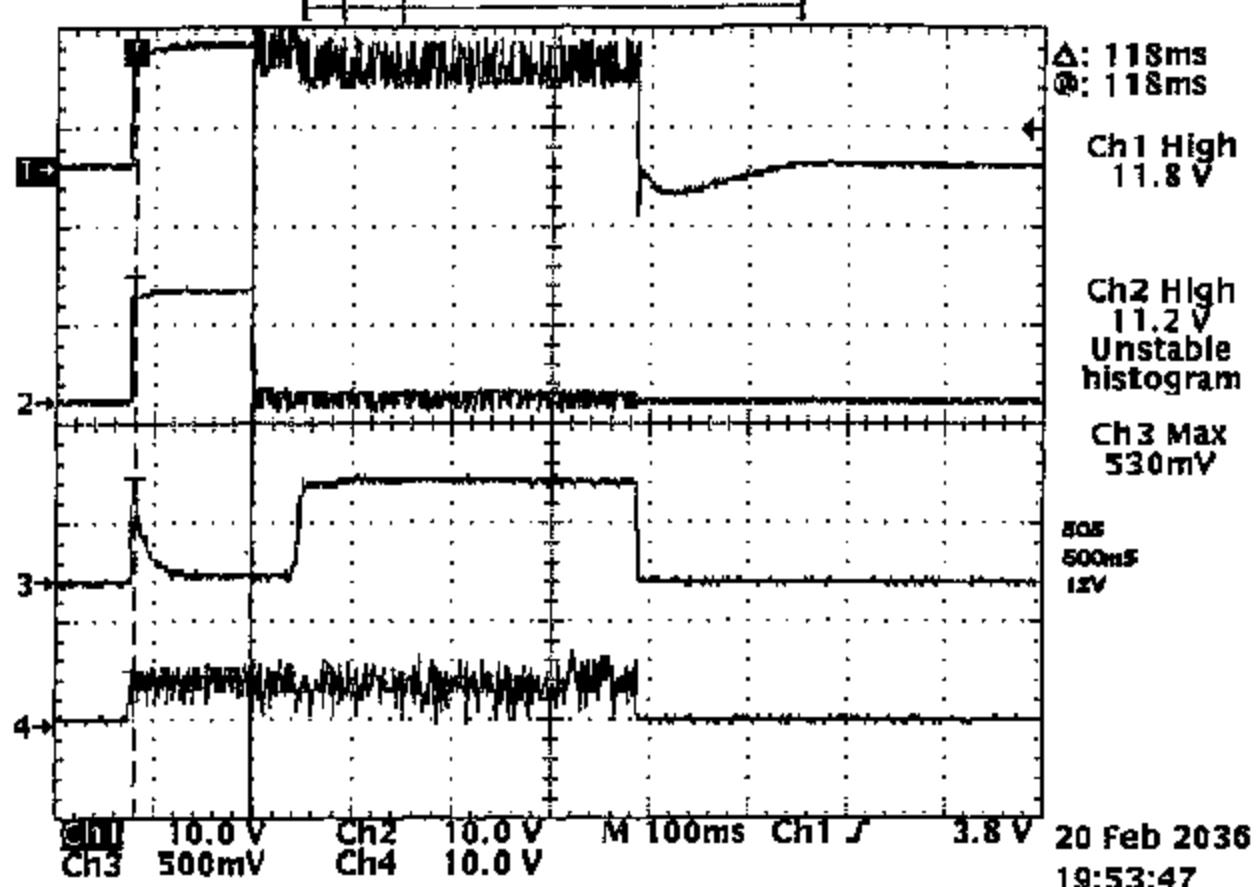
Tek Run: 1.00kS/s Sample 1000

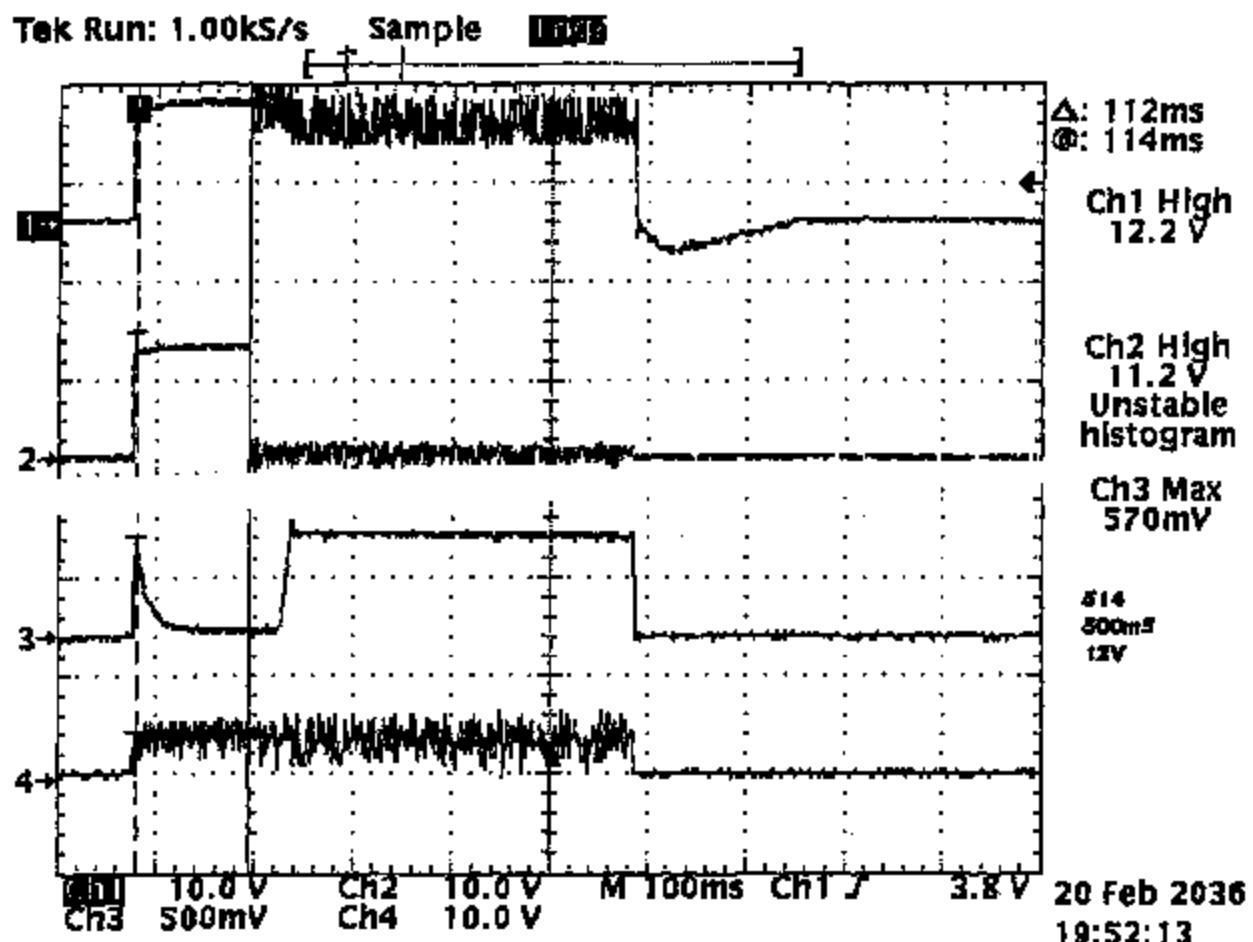


Tek Run: 1.00kS/s Sample 1000

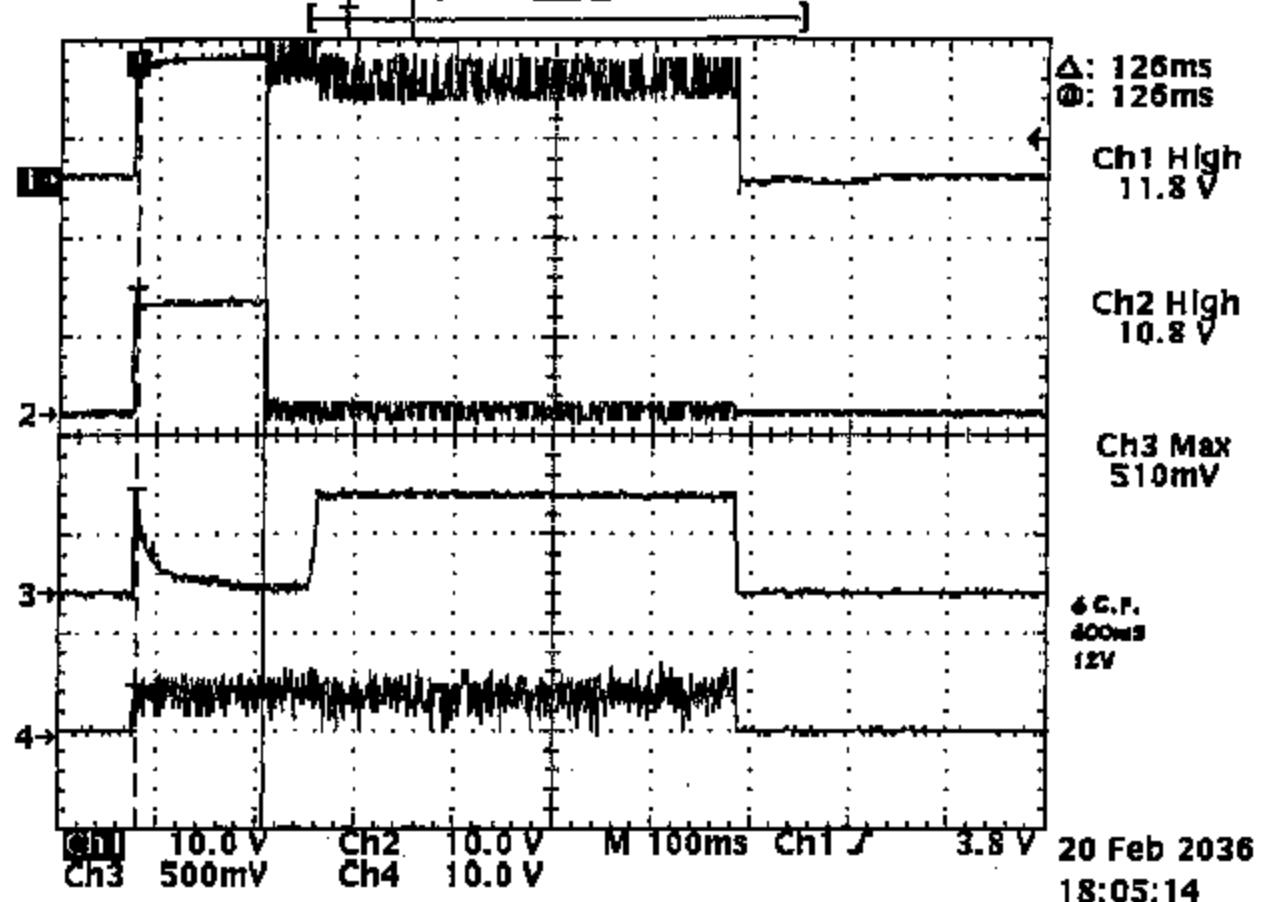


Tek Run: 1.00kS/s Sample 1098

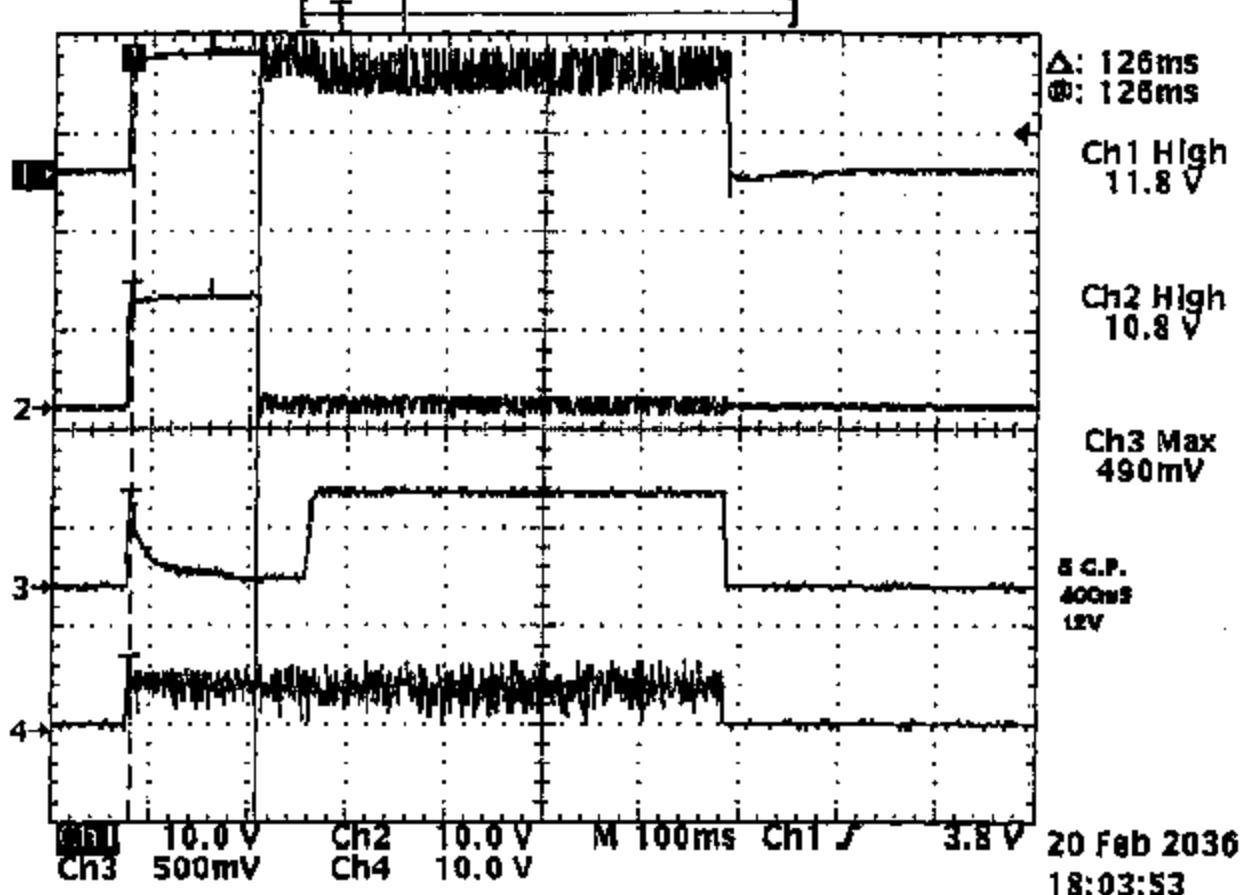




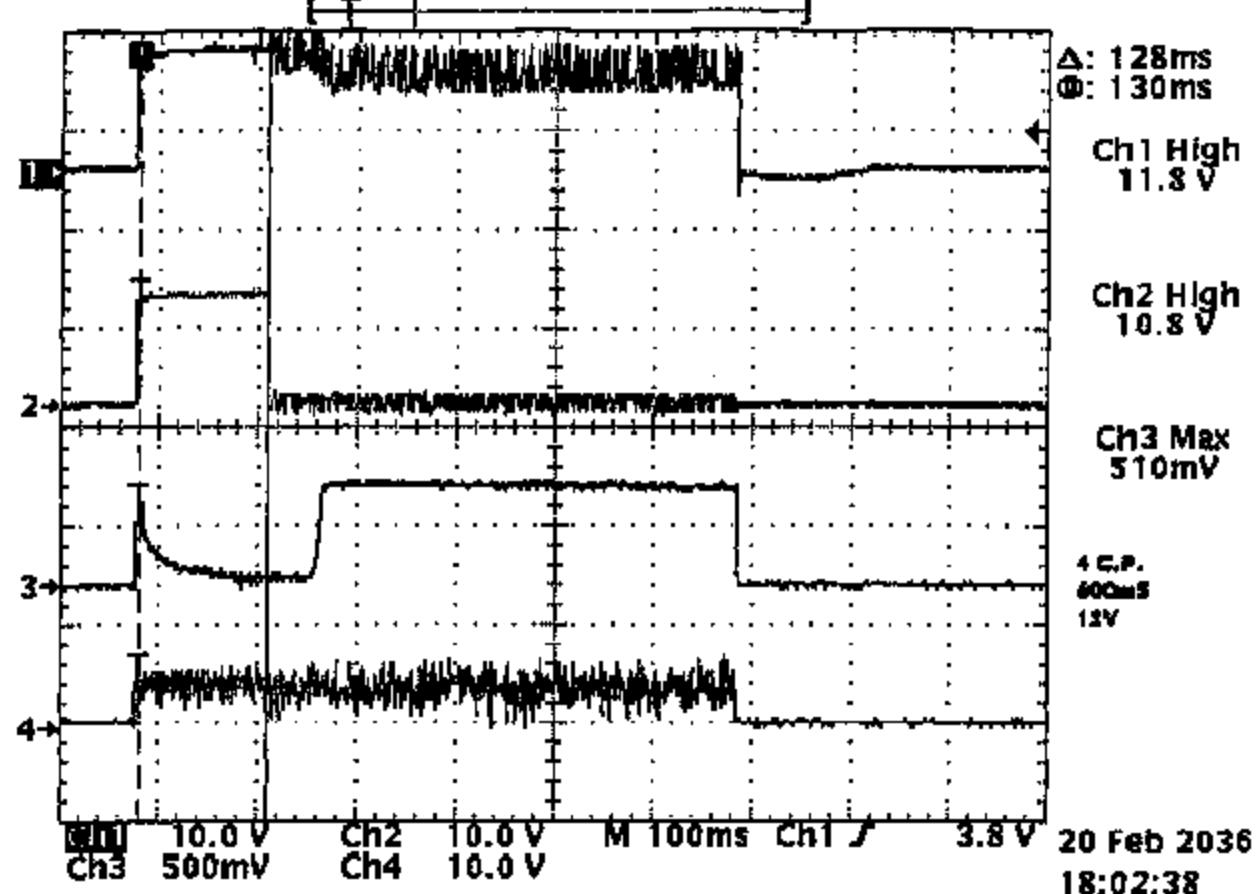
Tek Run: 1.00kS/s Sample 11956



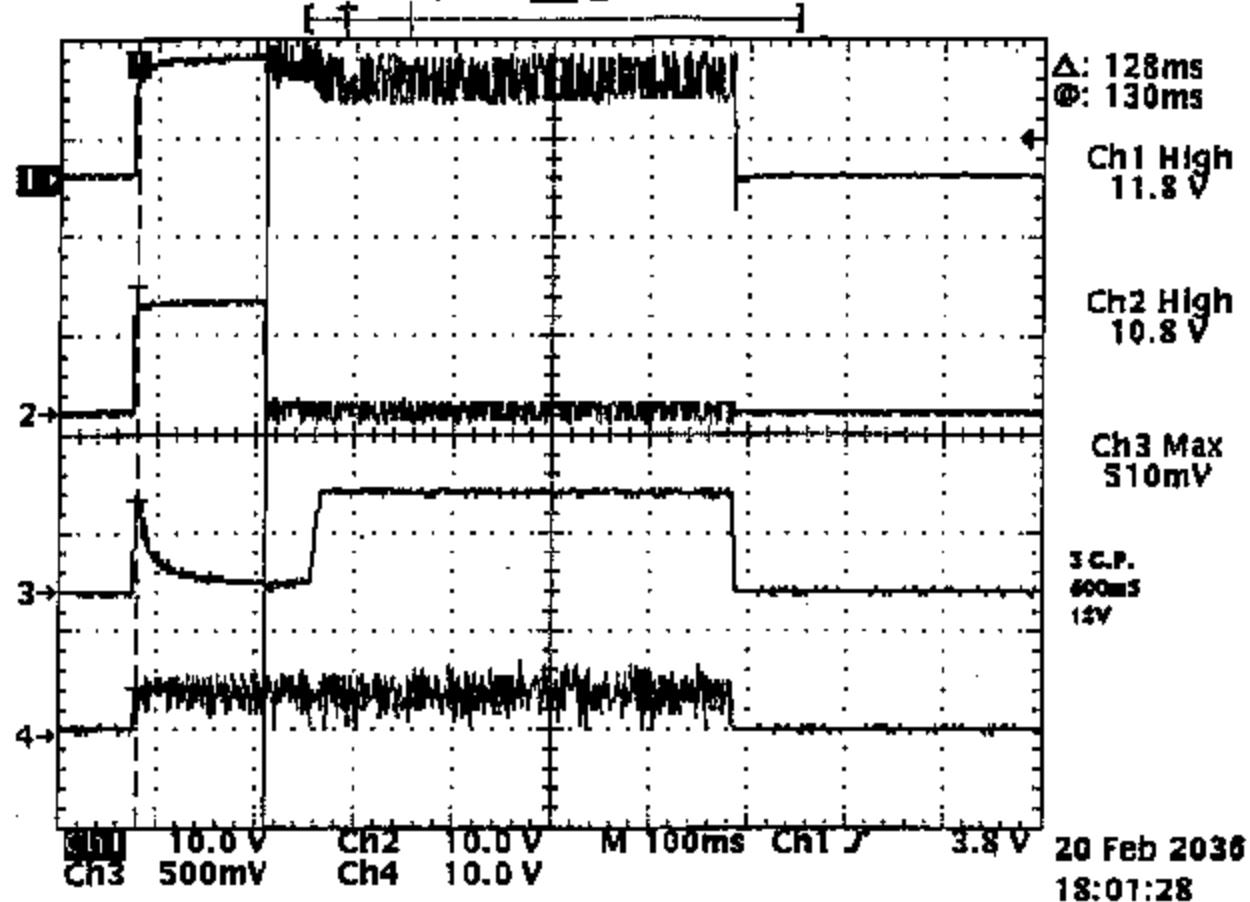
Tek Run: 1.00kS/s Sample 1000



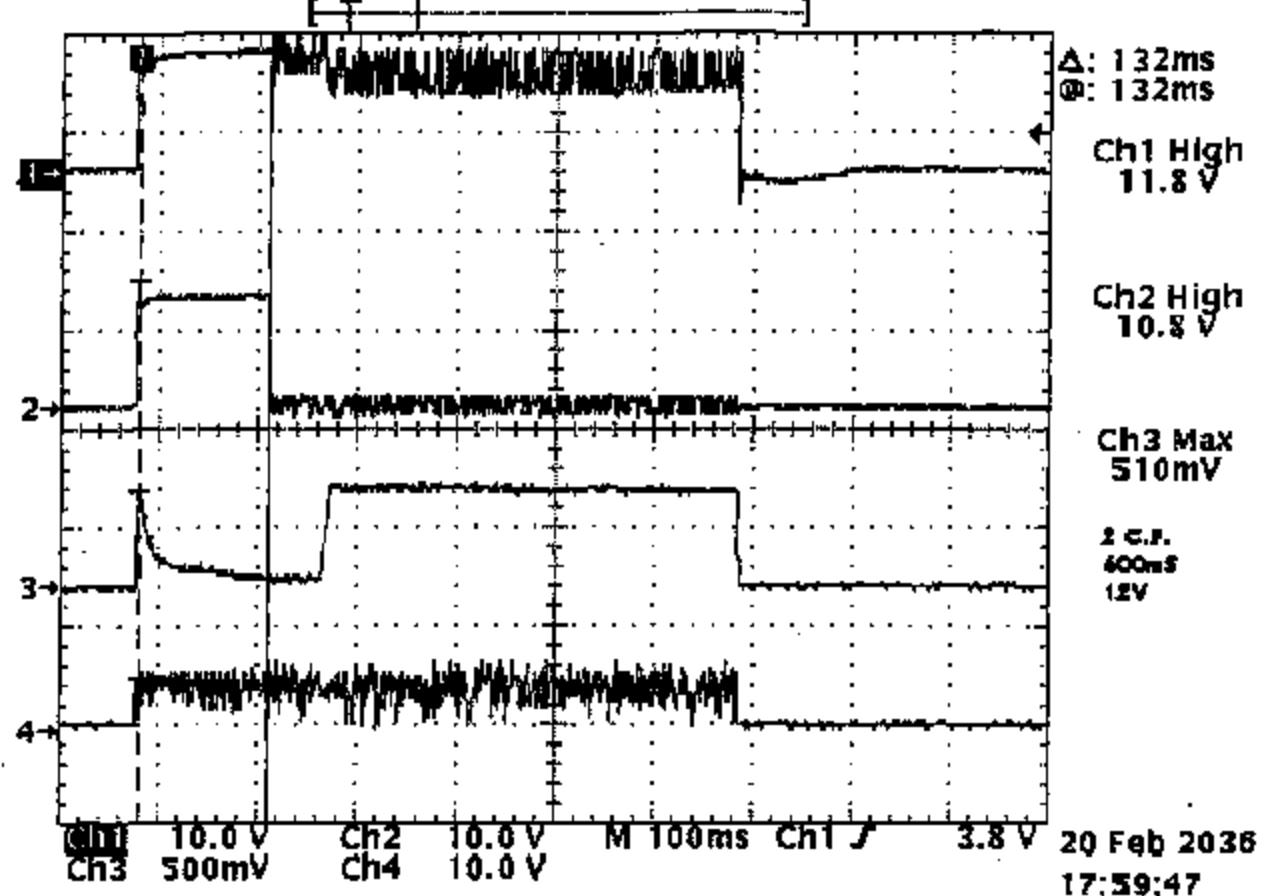
Tek Run: 1.00kS/s Sample 100%

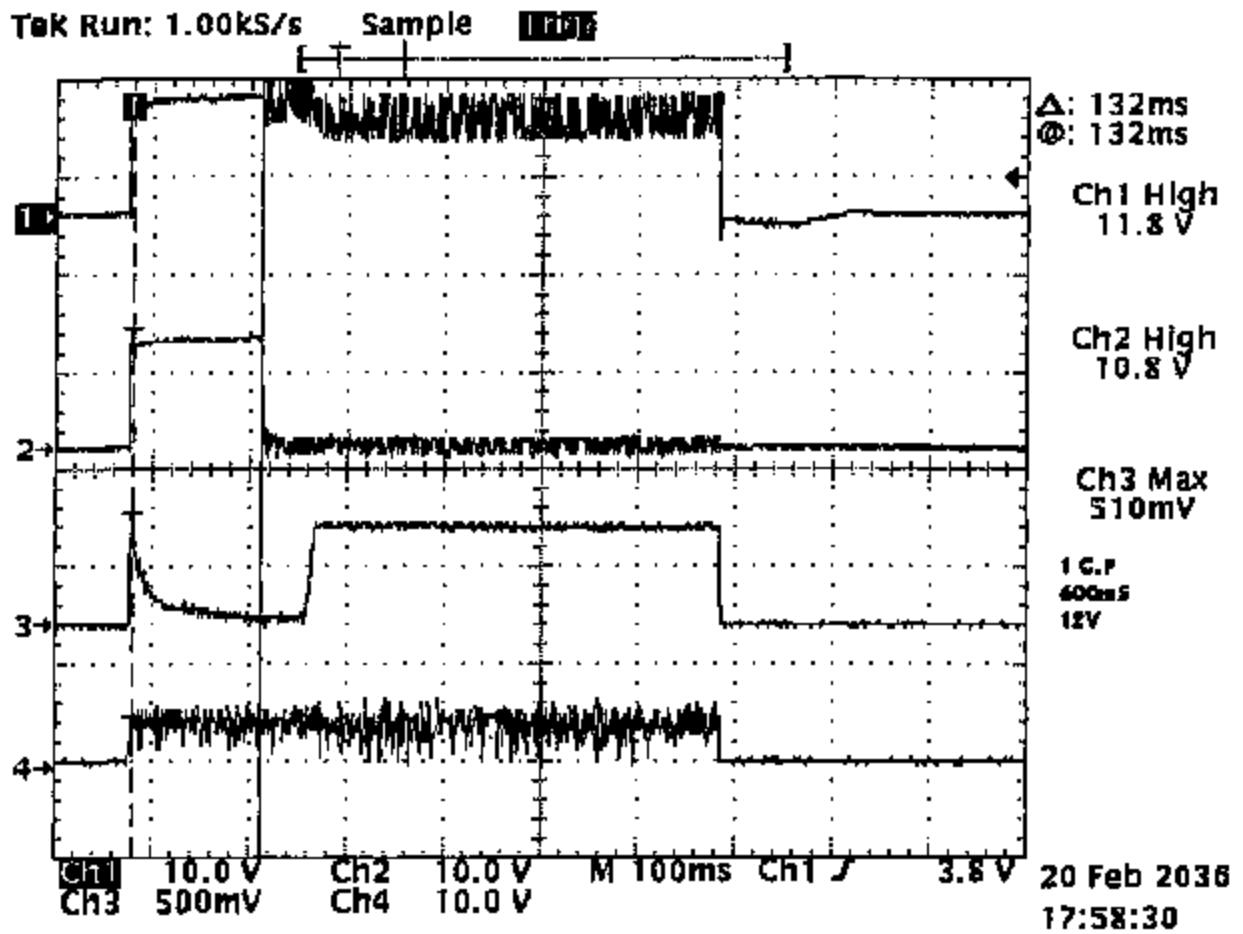


Tek Run: 1.00kS/s Sample 1103

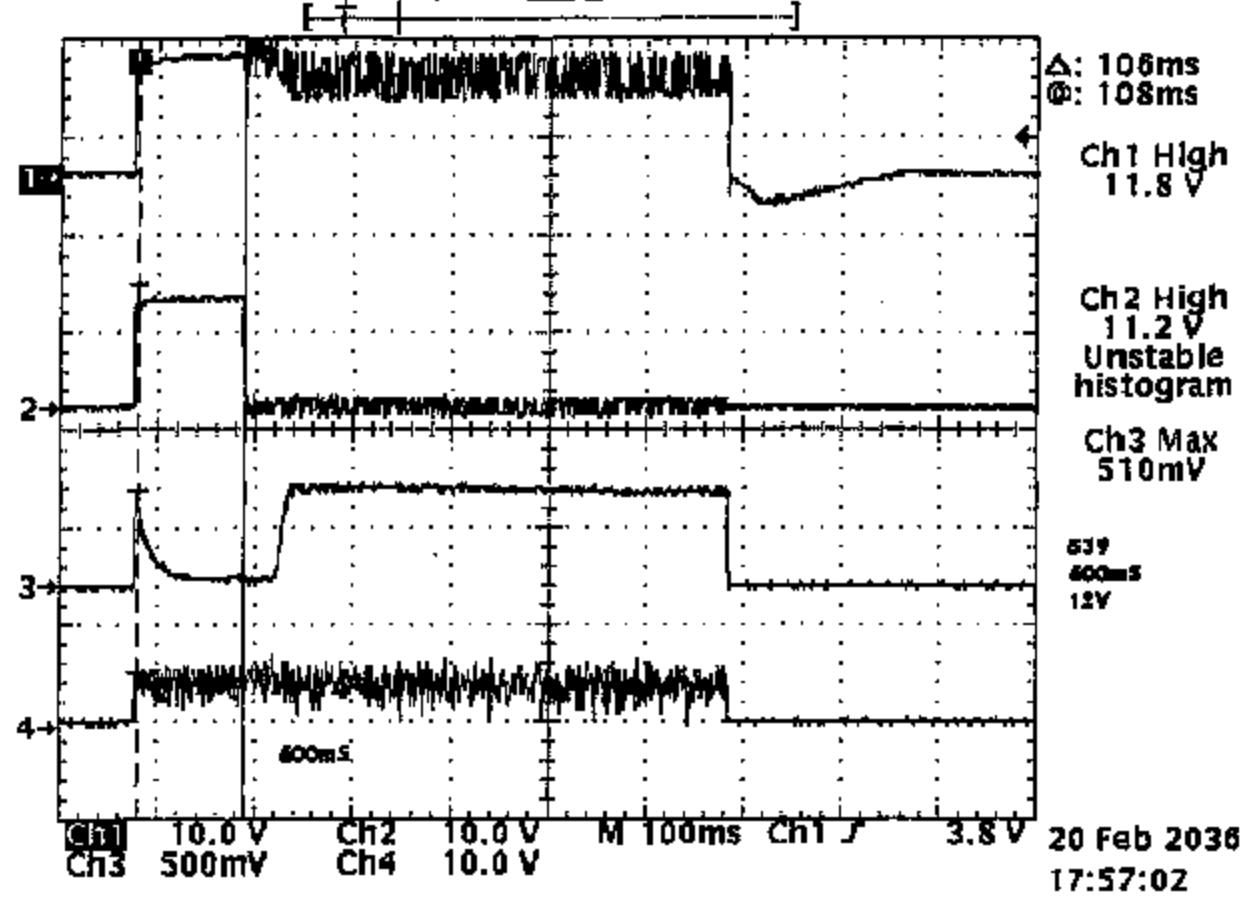


Tek Run: 1.00kS/s Sample 1109

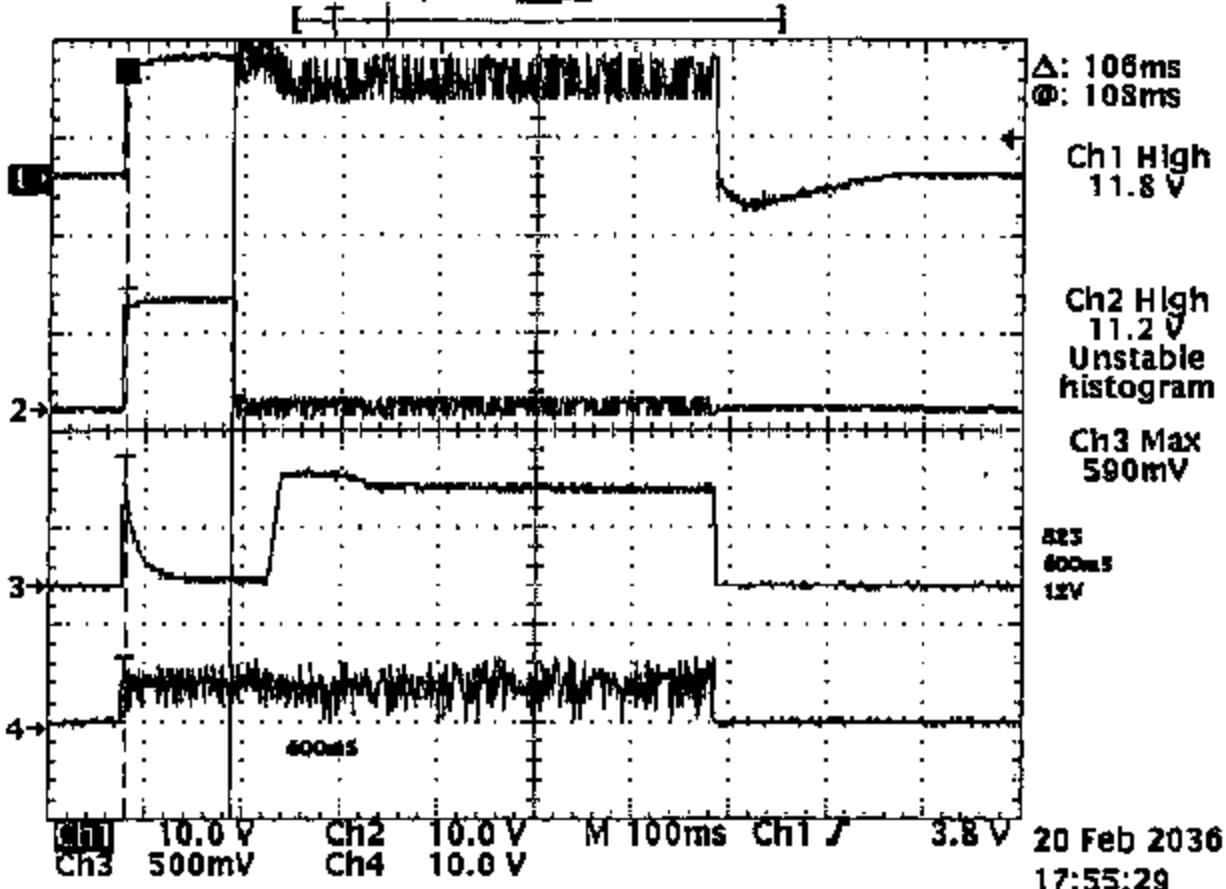




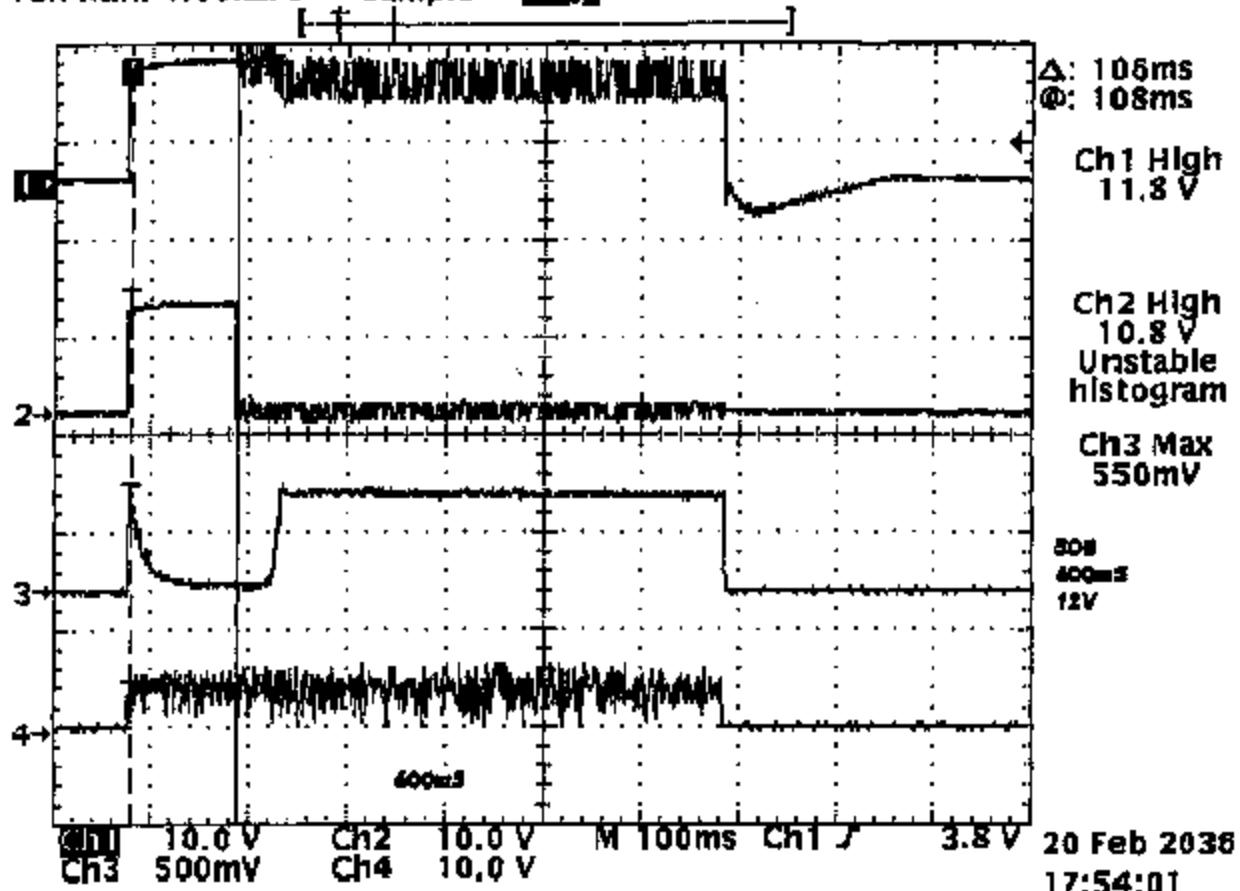
Tek Run: 1.00kS/s Sample 1196



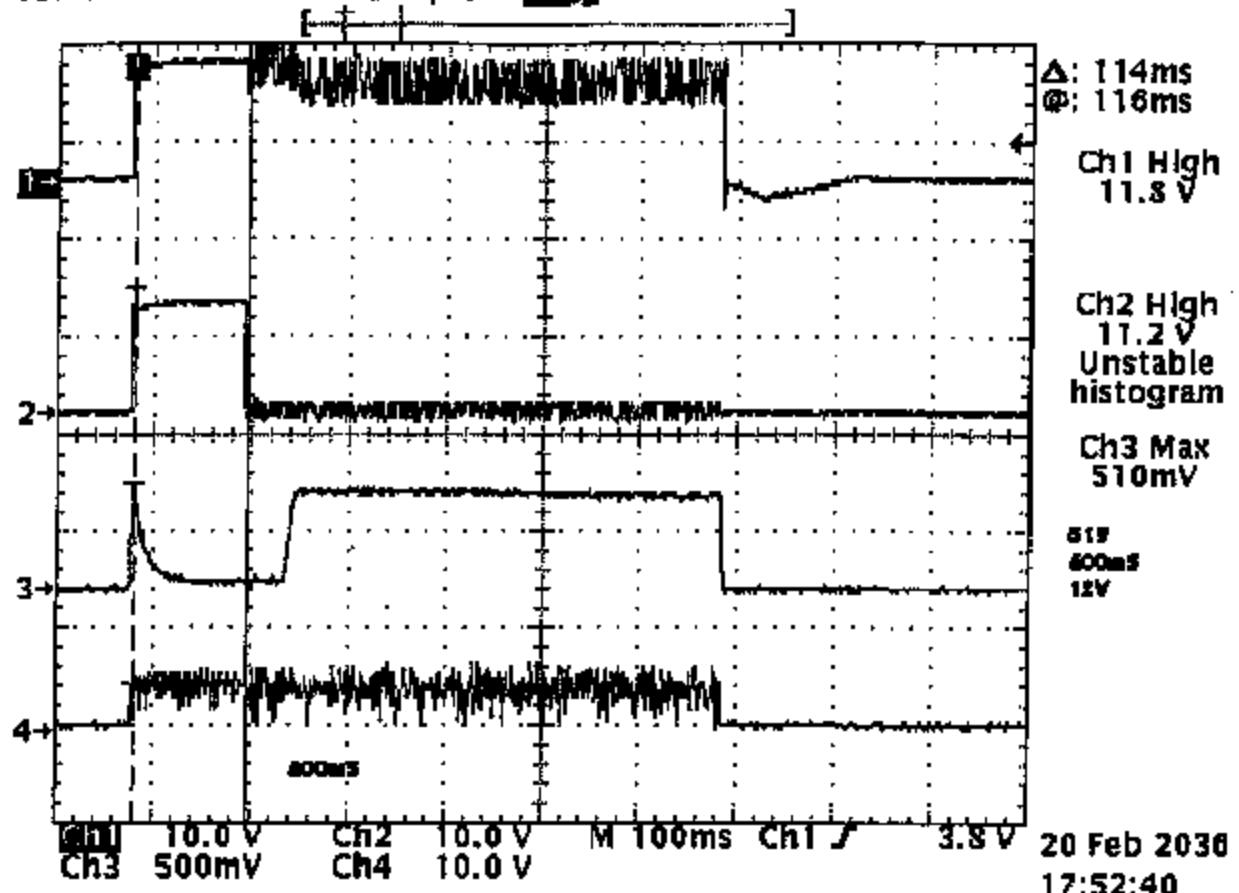
Tek Run: 1.00kS/s Sample 1000



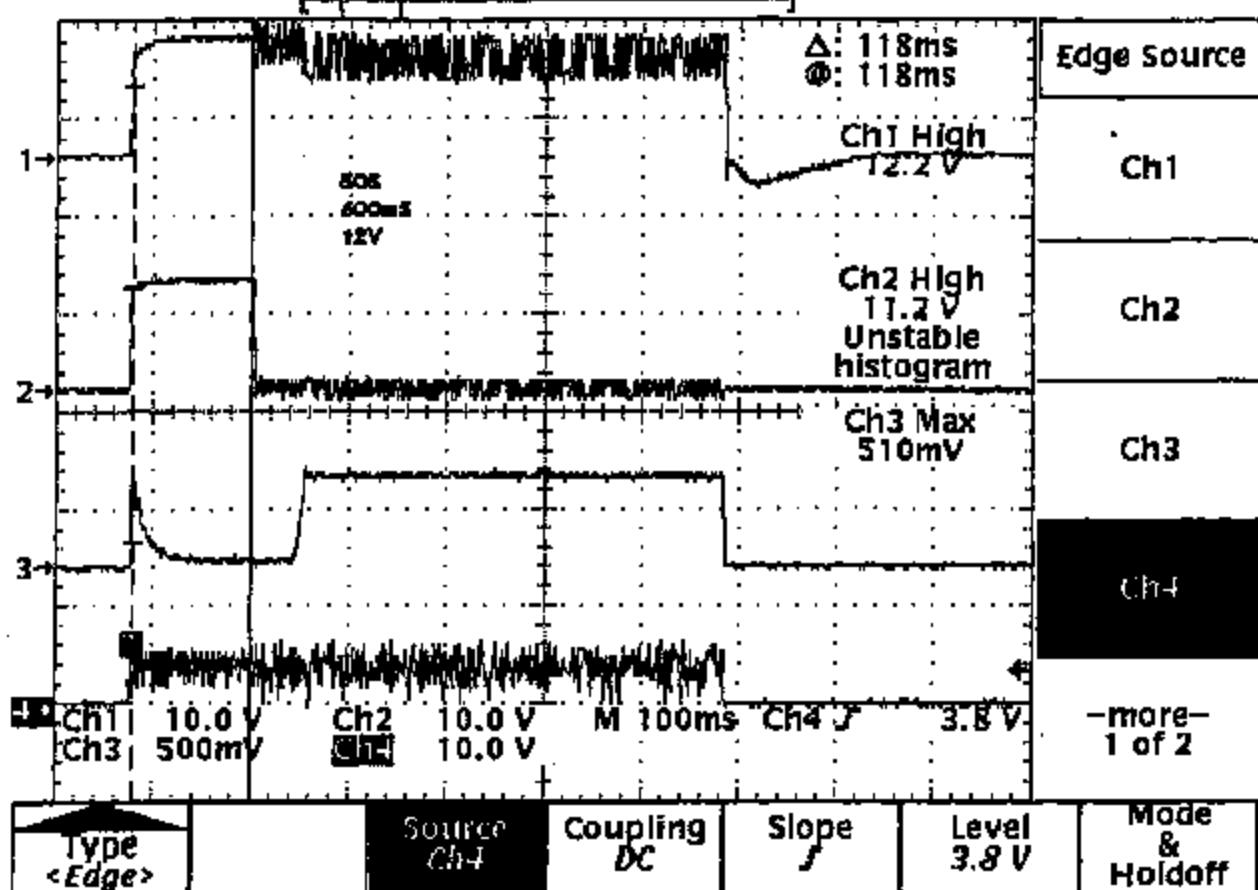
Tek Run: 1.00kS/s Sample 1000



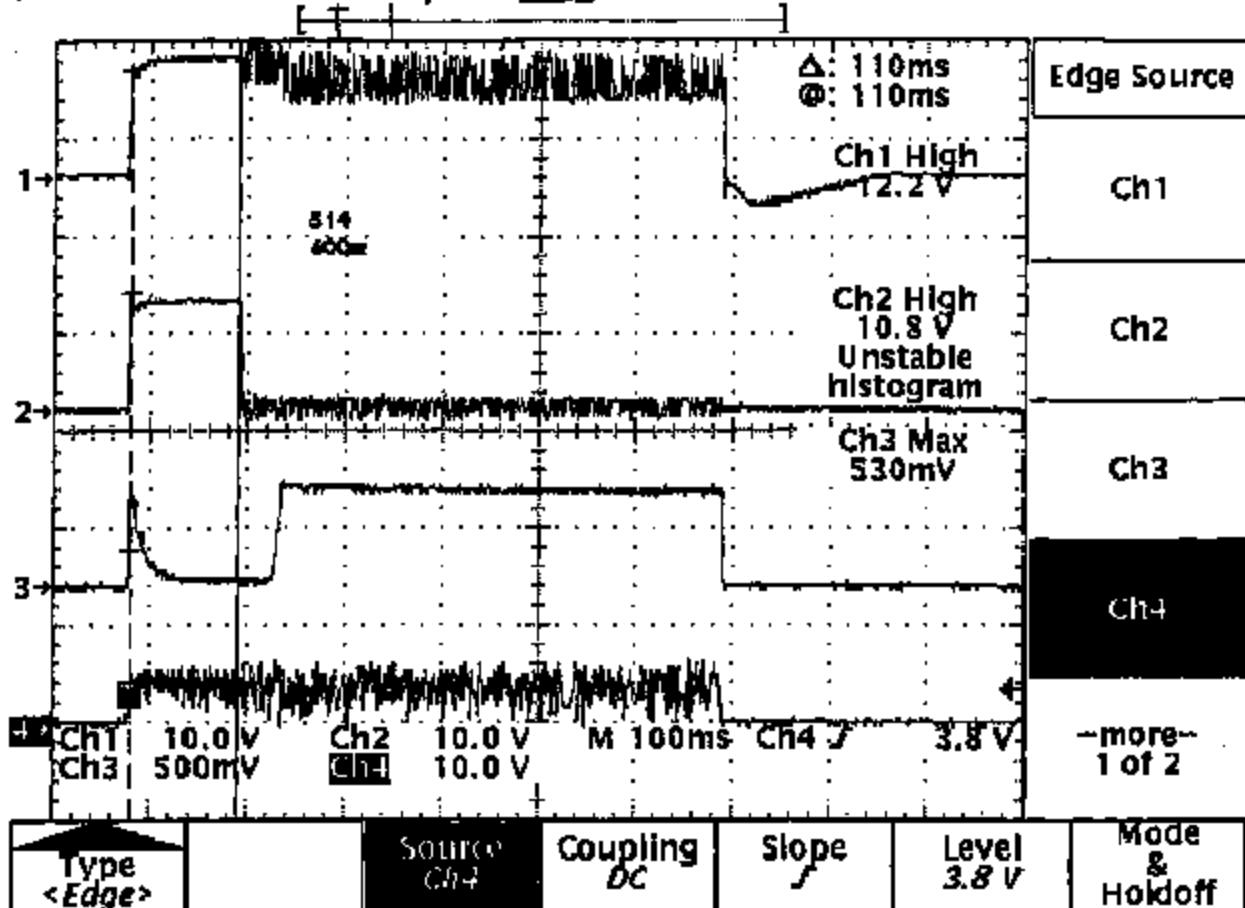
Tek Run: 1.00kS/s Sample 1100



Tek Run: 1.00kS/s Sample 1000



Tek Run: 1.00kS/s Sample 1100



Lab Work Request

00-0044

Date: 02/11/2000

Request By: Steve Davis

Date needed: 02/11/2000

Part Name: ECL

Part Number: 174D-0002

Customer: Delphi

Type of Test or Work: PV

Special Requirements:

Baseline test of current product with new data acquisition to establish baseline performance.

All Areas that are Effectected:

PV

NOTE: You must include all pertinent drawings, prints and specifications along with this document. Failure to do so will cause this request to be returned to sender and delay the project.
Help Attachments or Links Here:

Document History Section:

Document Created on 02/11/2000 by Steve Davis

0000-ZZ46 12/2000

INITIAL AND DAILY SET UP SHEET

Test Log #: 00-0044
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Specification #: 26053015

Equipment Used:
 Type of Test:
 Engineer:
 Technician:

Environmental Chamber, Labview Data Acquisition
 Engineering
 Steve Davis
 Lori Hoyte

Test Specifications: 50,000 Cycles -40C to 85C

Date	Time	Cycles Complete Test #	Temp. -40C to 85C Spec. Tol.	Voltage 9V to 12V Spec. Tol.	Amperage N/A Spec. Tol.	Pressure N/A Spec. Tol.	Comments	Initials
2-17	11:30	1-15	15°C	9V			Test 1 is in separate Data File	LH
2-17	11:45	2-0	15°C	12V			Restart after changing cycle time	LH
2-17	1:30	2-224	75°C				None time exceeded test stopped	LH
2-17	2:15	2-335	65°C					LH
2-18	4:30	2-408	58°C				OK	LH
2-18	11:30	3-3758	81.2°C				OK	LH
2-18	2:00	3-4376	70.8°C				OK	LH
2-21	8:30	5-460	-31°C	Parts 13-24 did not cycle Spec. at 3 = 7580 - 0.5W			Part 13-24 did not cycle Spec. at 3 = 7580 - 0.5W	LH
2-22	7:30	5-2708	24°C	Error				LH
2-22	7:56	5-384	-26°C				#23 Failed Retest	LH
2-23	7:35	5-4015	24°C				Bad Rotary ... check w/ power supply	LH
2-24	8:45	5-31	-28°C				Restart All OK	LH
2-25	7:35	6-781	-18°C				#16 195 failures Pin out (stuck)	LH
2-29	7:37	6-2560	85°C	11.420	116;195			LH

**PRODUCT TEST LABORATORY
INITIAL AND DAILY SET UP SHEET**

Test Log #: 00-0044
Customer/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Specification #: 28053015

Equipment Used: Environmental Chamber, Labview Data Acquisition
Type of Test: Engineering
Engineer: Steve Davis
Technician: Lori Hoyle

Test Specifications: 50,000 Cycles -40°C to 85°C

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
Log #: 00-0044
Customer/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Test Description: Durability
Sample Size: 24
Build Date: N189
Technician: Lori Hoyte
Start Date: 02/14/2000
Finish Date: 02/28/2000

Part #	Pull Force@ 22 ft.lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 6 Volts 11.6mm - 12.8mm
1	Passed	201.000	Passed	Passed	12.195
2	Passed	217.000	Passed	Passed	12.415
3	Passed	197.000	Passed	Passed	12.540
4	Passed	197.000	Passed	Passed	12.455
5	Passed	197.000	Passed	Passed	12.445
6	Passed	201.000	Passed	Passed	12.540
7	Passed	201.000	Passed	Passed	12.510
8	Passed	229.000	Passed	Passed	12.410
9	Passed	201.000	Passed	Passed	12.275
10	Passed	225.000	Passed	Passed	12.230
11	Passed	217.000	Passed	Passed	12.425
12	Passed	208.000	Passed	Passed	12.540

Results

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0044
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability (Before)
 Sample Size: 24
 Build Date: N189
 Technician: Lori Hoyle
 Start Date: 02/14/2000
 Finish Date: 02/28/2000

Part #	Pull Force @ 22 ft.lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 800 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 6 Volts 11.8mm - 12.8mm
13	Passed	205.000	Passed	Passed	12.625
14	Passed	213.000	Passed	Passed	12.375
15	Passed	205.000	Passed	Passed	12.605
16	Passed	217.000	Passed	Passed	12.280
17	Passed	209.000	Passed	Passed	12.550
18	Passed	217.000	Passed	Passed	12.445
19	Passed	205.000	Passed	Passed	12.335
20	Passed	229.000	Passed	Passed	12.370
21	Passed	213.000	Passed	Passed	12.135
22	Passed	217.000	Passed	Passed	12.605
23	Passed	209.000	Passed	Passed	12.525
24	Passed	209.000	Passed	Passed	11.955

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
Test Log #: 00-0044
Customer/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Test Description: Durability (Before)
Sample Size: 24
Build Date: N189
Technician: Lori Hoyle
Start Date: 02/14/2000
Finish Date: 02/28/2000

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps)	Current Measurement (Amps)	
			14.2V @ Ambient Lock < 7 Amps	14.2V @ Ambient Unlock < 7 Amps	
1	11.905	N/A	5.000	5.700	
2	12.175	N/A	5.200	5.500	
3	12.120	N/A	5.200	5.800	
4	12.140	N/A	6.600	5.500	
5	12.045	N/A	5.500	5.100	
6	12.170	N/A	5.100	5.400	
7	11.885	N/A	5.400	5.700	
8	12.075	N/A	6.200	5.800	
9	11.825	N/A	5.100	5.800	
10	12.050	N/A	5.000	5.400	
11	11.940	N/A	5.100	5.500	
12	12.025	N/A	5.100	5.700	

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0044
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability (Before)
 Sample Size: 24
 Build Date: N189
 Technician: Lori Hoyle
 Start Date: 02/14/2000
 Finish Date: 02/28/2000

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Amps) 14.2 @ Ambient Unlock < 7 Amps	
13	12.275	N/A	5.500	5.900	
14	12.195	N/A	5.300	5.700	
15	12.170	N/A	5.300	5.800	
16	12.070	N/A	5.200	5.800	
17	12.275	N/A	5.200	5.500	
18	12.145	N/A	6.300	5.800	
19	11.905	N/A	5.300	5.800	
20	11.950	N/A	6.000	5.800	
21	11.815	N/A	5.800	5.800	
22	12.300	N/A	5.200	5.800	
23	12.225	N/A	5.200	5.400	
24	11.800	N/A	5.500	5.800	

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0044
 Item/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability (After)
 Sample Size: 24
 Build Date: N189
 Technician: Lori Hoyle
 Start Date: 02/14/2000
 Finish Date: 02/28/2000

Part #	Pull Force @ 22 ft.lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 5 Volts 11.6mm - 12.8mm
1	Passed	181.000	Passed	Passed	12.640
2	Passed	181.000	Passed	Passed	12.175
3	Passed	189.000	Passed	Passed	12.145
4	Passed	193.000	Passed	Passed	12.230
5	Passed	209.000	Passed	Passed	12.415
6	Passed	185.000	Passed	Passed	12.305
7	Passed	253.000	Passed	Passed	12.050
8	Passed	173.000	Passed	Passed	12.250
9	Passed	177.000	Passed	Passed	12.095
10	Passed	193.000	Passed	Passed	12.300
11	Passed	197.000	Passed	Passed	12.235
12	Passed	181.000	Passed	Passed	12.425

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
Test Log #: 00-0044
Customer/Product Description: Sashlock Column Lock
Fasco Part #: 1740-0002
Test Description: Durability (After)
Sample Size: 24
Build Date: N189
Technician: Lori Hoyle
Start Date: 02/14/2000
Finish Date: 02/28/2000

Part #	Pull Force @ 22 ft.lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 5 Volts 11.6mm - 12.8mm
13	Passed	201.000	Passed	Passed	12.445
14	Passed	201.000	Passed	Passed	12.380
15	Passed	209.000	Passed	Passed	12.270
16	Passed	225.000	Passed	Passed	12.475
17	Passed	173.000	Passed	Passed	12.630
18	Passed	189.000	Passed	Passed	12.245
19	Passed	169.000	Passed	Passed	12.200
20	Passed	193.000	Passed	Passed	12.085
21	Passed	185.000	Passed	Passed	11.785
22	Passed	193.000	Passed	Passed	12.480
23	Passed	213.000	Passed	Passed	12.235
24	Passed	229.000	Passed	Passed	12.025

Results:

RESULTS OF TEST 00-00444

BASELINE TEST FOR NEW DURABILITY TESTER

TEST 1

9 volts lock 9 volts unlock 22 ft-lbs.

Part # 2 misses 3 unlock cycles.

Part # 3 missed 1 unlock cycle.

Part # 4 missed 1 unlock cycle.

All misses were at 20C.

TEST 2

12 volts lock 12 volts unlock 11 ft-lbs.

NO failures

TEST 3

12 volts lock 12 volts unlock 7 ft-lbs.

Parts #1, 1st miss at 8777 cycles. Temp at -27.7C.

Missed about 383 cycles in test 3.

Failure: Stuck in the lock position.

At 9581 cycles the part missed 1 time for rebound in the unlock position. Temp was 68.7C.

TEST 4

12.8 volts lock 9 volts unlock.

NO failures

TEST 5

9 volts lock 12.8 volts unlock.

Part # 1 24 failures were for rebound.

1st failure was at 977 cycles in the unlock position. Missed 24 times.

2nd failure occurred after the tester was repaired, this time there was about 500 cycles missed.

The temp range was from 80C to -6.3C.

Total failures: 24

Failure Position: Unlock

Failure Mode: Rebound

Total failures for being stuck locked were 500

All failures were in the unlock position.

Part # 7: First failure was at 623.

Total cycles misses: 700

Temp: 79C was the temp when the part failed the first time. The part continued to miss cycles all through test 5 at various temps.

Failure Mode: All ways stuck in the unlock position.

Part # 8: & 10

All failures were for the switch bouncing when trying to lock. This is a failure the car would not see.

Temp Range: -40C to -15C.

Part 8 missed around 600 cycles. Part # 10 around 400 misses.

Part # 11: Failed about 3 cycles for bouncing when locked, temp -20C.

Failed stuck unlocked at 79C for about 600 cycles, did not start working again until test 6 at -6C.

Part # 16

Failure Mode: Stuck unlocked
Temp Failure: 64C to 48C
Failed off and on for about 200 cycles.

Part # 20

Failure Mode: Stuck unlocked
Temp failures occur: -34.7C
Failed about 50 cycles.

Part # 23

Failure mode: Stuck unlocked
Temp failures occur: 79C
Failed about 125 times.

Test 5 Summary

Parts 7, 11, 16, 20, 23, 24 Stick in the unlock position at temps of 64C to 79C.
Part # 1 and 20 stick in the unlock position at -34C. Most of the misses are more intermittent, they are not off for long periods of time.
The car would not see part 8 and 10's failure. Part # 11 also exhibited some failures that would not be seen by the car.

TEST 6

14.2 volts lock 9 volts unlock

Part # 1

Failure Mode: Stuck locked
Failure temp: Can fail at any temp.
Cycles missed: 3683

Part # 7

Failure Mode: Stuck locked
Temp: Failed 1st time at 78C and was off 24 hours, therefore part can fail at any temp.
Cycles missed: About 6882

Part # 9

Failure mode: Stuck locked
Part failed at 2332 cycles at 79C. Part did not work again until test 7-529 and 34C.
Cycles missed: 7714

Part # 15

Failure Mode: Stuck locked
Failed from 2552 (79C) - 5933(-6C)
Cycles missed: 3446

Part # 16

Failed at cycle 1 and was off 11 hours.
Failure Mode: Stuck locked
Temp Failed: -6C and restarted at 62C
Failed again at 3212 and was off for 24 hours.
Temp Failed: 62C and restarted at 64C.

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0044
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability (After)
 Sample Size: 24
 Build Date: N189
 Technician: Lori Hoyle
 Start Date: 02/14/2000
 Finish Date: 02/28/2000

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Amps) 14.2 @ Ambient Unlock < 7 Amps
1	12.375	N/A	7.100	5.400
2	11.745	N/A	5.800	5.300
3	11.620	N/A	6.900	6.700
4	11.705	N/A	7.300	5.300
5	11.905	N/A	7.100	6.300
6	11.845	N/A	7.100	5.300
7	11.365	N/A	6.800	6.200
8	11.785	N/A	5.900	6.700
9	11.655	N/A	6.700	5.300
10	11.975	N/A	7.000	6.500
11	11.645	N/A	7.000	5.500
12	11.900	N/A	5.700	6.800

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0044
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability(After)
 Sample Size: 24
 Build Date: N189
 Technician: Lori Hoyle
 Start Date: 02/14/2000
 Finish Date: 02/26/2000

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Amps) 14.2 @ Ambient Unlock < 7 Amps	
13	11.860	N/A	7.200	5.400	
14	12.095	N/A	7.100	5.400	
15	11.860	N/A	5.900	5.500	
16	11.980	N/A	5.800	5.400	
17	12.175	N/A	7.200	5.300	
18	11.775	N/A	6.000	5.800	
19	11.750	N/A	5.900	5.500	
20	11.835	N/A	6.900	5.300	
21	11.435	N/A	5.800	6.800	
22	12.185	N/A	5.700	6.800	
23	11.830	N/A	7.100	6.400	
24	11.860	N/A	5.500	6.500	

Results:

Total cycles missed: 8843

Part # 19

Failure Mode: Stuck locked

Failed at 80C and was off from 2637 - 7771.

Temp at which failure occurred was 80.6C

Cycles missed: 5134

Test 6 Summary

Most of the initial misses were at 80C once the part fails it is off for long periods of time. The temp at which the part starts working varies. All the failures were sticking in the lock direction.

TEST 7

9 volts lock 14.2 volts unlock

Part # 1

First failure occurred at 4106 cycles.

It missed around 1000 cycles. The temp ranged from 60C to 85C during the misses.

Part # 5

Failed at 855 cycles, it failed about 5000 cycles.

The temp was at 23C when the part failed the first time. It continued to fail through the cold cycle and back up to 75C. At 75C I had my longest failure (4770 cycles).

Failure Mode: Stuck unlocked

Part # 7

Failure Mode: Stuck unlocked

Cycles missed: 6300

Temp: Can fail at any temp and for long periods of time.

Part never worked after 7-5790.

Part # 11

Failure Mode: Stuck unlocked

First failure was at cycle 1 for 24 hours (43.3C).

Total failures were 5800 cycles.

Part # 13

Failed first time at 4273 cycles.

Failure Mode: Stuck unlocked

Total cycles failed: 100

Part # 15

Failure Mode: Stuck unlocked

Failed first at cycle 410 and 38C (3699 cycles).

Temps that it fails at are: 38, 60, & 79C.

Part # 16

Failed at 4411.

Failure Mode: Stuck unlocked.

Failed about 100 cycles at temps from 79C to 2.06C.

Part # 19

Failed at 335 cycles.

Temp: -34C

Failure Mode: Rebounding when trying to lock, this would not be seen by the car.

Part # 20

Failure Mode: Stuck unlocked

Temp: 43C

Part # 21

Failure Mode: Stuck unlocked

Temp: 80C

Cycles missed: 287

Part # 23

Failure Mode: Stuck unlocked

Temp: 42C

Cycles missed: 800

Part # 24

Failure Mode: Stuck unlocked

Temp: 42C

Lot's of short failures.

Test 7 Summary

Most failures occurred in the temp range of 42C – 75C. Test 7 was more like test 5 in that the misses were more intermittent. The part would miss for a while and then run for a while. The first failure was always in the temp range of 23C – 75C, however, the next failures could be any temp. All the parts failed in the unlocked position (stuck).

TEST 8

Repeat of test 1

Part # 4 failed 1 cycle.

Part # 5 failed 1 cycle.

Part # 7 failed 15 cycles.

Part # 15 failed 2 cycles.

Part # 23 failed 1 cycle.

All failures were in the unlock position.

Temps for all were 20C.

Parts that saw no failures:

2

6

12

14

17

18

21

Part 4 missed only 1 cycle in test 1 and test 8.

Parts 8 and 10 had rebound problems in the lock direction that the car would never see.



FASCO
CONTROLS CORPORATION

Sensor Systems

Product Test Laboratory

Product Validation Report #: 00-0044

Product Validation - Baseline Analysis of Current Design

Delphi Saginaw Electronic Column Lock

Fasco Part #: 1740-0002

Specification #: 26053015

Sample Size: 24

Build Date: NJ89

Page #	Table of Contents	Test Results
1	Cover page	
2-3	Initial Readings	All conformed to specification
4	Analysis of Durability	See details
5-6	Post Durability Performance	All conformed to specification
7-12	Analysis of Baseline Testing of Current Design	See details

Tested By: Joe Kelly Date: 4-7-00
Technician

Product Test Lab Supervisor: Vicki Threlkeld Date: 4/7/2000

Test Facilities Manager: JG Date: 4/7/2000

Note: This report shall not be reproduced in full without the written permission from Invensys Sensor Systems and the Product Test Laboratory. Test results relate to items tested on.



Sensor Systems

Type of Test: Product Validation – Baseline Analysis of Current Product
Test Log #: 00-0044
Customer/Part Description: Delphi Saginaw Electronic Column Lock
Fasco Part #: 1740-0002
Test Description: Initial Readings
Sample Size: 24
Build Date: N189
Technician: Lori Hoyle
Start Date: 02/14/2000
Finish Date: 02/14/2000

Part #	Pull Force @ 22 ft/lbs. 9 Vdc	Time to Actuate (ms) @ -40°C NTE 600 ms	Hardstop (Unlock) 14.2V/8.5V	Hardstop (Lock) 14.2V/8.5V	Switch Point @ 5Vdc 11.6mm min. 12.8mm max.
1	Passed	201	Passed	Passed	12.195
2	Passed	217	Passed	Passed	12.415
3	Passed	197	Passed	Passed	12.540
4	Passed	197	Passed	Passed	12.455
5	Passed	197	Passed	Passed	12.445
6	Passed	201	Passed	Passed	12.540
7	Passed	201	Passed	Passed	12.510
8	Passed	229	Passed	Passed	12.410
9	Passed	201	Passed	Passed	12.275
10	Passed	225	Passed	Passed	12.230
11	Passed	217	Passed	Passed	12.425
12	Passed	209	Passed	Passed	12.540
13	Passed	206	Passed	Passed	12.625
14	Passed	213	Passed	Passed	12.375
15	Passed	205	Passed	Passed	12.605
16	Passed	217	Passed	Passed	12.280
17	Passed	209	Passed	Passed	12.560
18	Passed	217	Passed	Passed	12.445
19	Passed	206	Passed	Passed	12.335
20	Passed	229	Passed	Passed	12.370
21	Passed	213	Passed	Passed	12.635
22	Passed	217	Passed	Passed	12.605
23	Passed	209	Passed	Passed	12.525
24	Passed	209	Passed	Passed	11.955

Results: All parts conformed to specification.

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Sensor Systems

Type of Test: Product Validation - Baseline Analysis of Current Product
Test Log #: 00-0044
Customer/Part Description: Delphi Saginaw Electronic Column Lock
Fasco Part #: 1740-0002
Test Description: Initial Readings
Sample Size: 24
Build Date: N189
Technician: Lori Hoyle
Start Date: 02/14/2000
Finish Date: 02/14/2000

Part #	Switch Point (Extending) mm	Rebound	Current Measurement (amps) 14.2Vdc @ Ambient Lock Cycle NTE 7 amps	Current Measurement (amps) 14.2Vdc @ Ambient Unlock Cycle NTE 7 amps
1	11.905		5.0	5.7
2	12.175		5.2	5.5
3	12.120		5.2	5.8
4	12.140		5.8	5.5
5	12.045		5.5	5.1
6	12.170		5.1	5.4
7	11.885		5.4	5.7
8	12.075		5.2	5.6
9	11.825		5.1	5.8
10	12.050		5.0	5.4
11	11.940		5.1	5.5
12	12.025		5.1	5.7
13	12.275		5.5	5.9
14	12.195		5.3	5.7
15	12.170		5.3	5.6
16	12.070		5.2	5.6
17	12.275		5.2	5.6
18	12.145		5.3	5.8
19	11.905		5.3	5.6
20	11.950		5.0	5.6
21	11.815		5.6	5.8
22	12.300		5.2	5.8
23	12.225		5.2	5.4
24	11.800		5.5	5.8

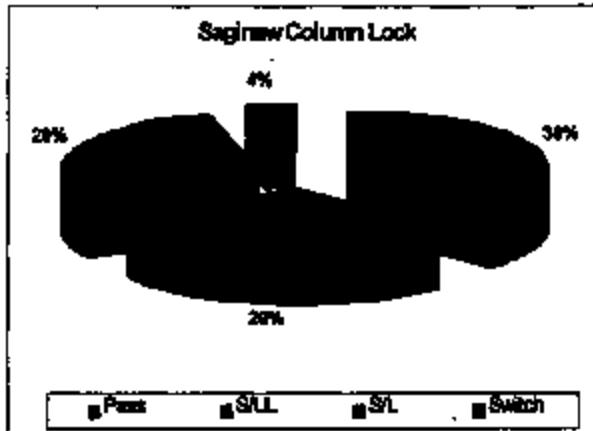
Results: All parts conformed to specification.

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Sensor Systems

Testing Failure Mode Analysis

	%
Pass	37.50
Stuck/Unlock	29.17
Stuck/Lock	29.17
Switch Event	4.17



Temperature was a significant factor on the parts that failed due to a "stuck" condition. Whether in the Lock or Unlock position, parts failed "stuck" at temperatures that averaged 77°C. Engineering analysis has shown that the materials of the gearing become malleable at temperatures above -60°C.

Only a small percentage of parts failed due to a severe rebound problem that would show as a switch event failure.

Sensor Systems

Type of Test: Product Validation - Baseline Analysis of Current Product
Test Log #: 00-0044
Customer/Part Description: Delphi Saginaw Electronic Column Lock
Fasco Part #: 1740-0002
Test Description: Post Durability Performance Verification
Sample Size: 24
Build Date: N169
Technician: Lori Hoyle
Start Date: 02/14/2000
Finish Date: 02/14/2000

Part #	Pull Force @ 22 ft/lbs. 9 Vdc	Time to Actuate (ms) @ -40°C NTE 600 ms	Hardstop (Unlock) 14.2V/8.5V	Hardstop (Lock) 14.2V/8.5V	Switch Point @ 5Vdc 11.6mm min. 12.8mm max.
1	Passed	181	Passed	Passed	12.64
2	Passed	181	Passed	Passed	12.175
3	Passed	169	Passed	Passed	12.145
4	Passed	183	Passed	Passed	12.230
5	Passed	209	Passed	Passed	12.415
6	Passed	185	Passed	Passed	12.305
7	Passed	253	Passed	Passed	12.050
8	Passed	173	Passed	Passed	12.260
9	Passed	177	Passed	Passed	12.095
10	Passed	193	Passed	Passed	12.300
11	Passed	197	Passed	Passed	12.235
12	Passed	181	Passed	Passed	12.425
13	Passed	201	Passed	Passed	12.445
14	Passed	201	Passed	Passed	12.380
15	Passed	209	Passed	Passed	12.270
16	Passed	225	Passed	Passed	12.475
17	Passed	173	Passed	Passed	12.630
18	Passed	189	Passed	Passed	12.246
19	Passed	169	Passed	Passed	12.200
20	Passed	183	Passed	Passed	12.065
21	Passed	185	Passed	Passed	11.785
22	Passed	193	Passed	Passed	12.480
23	Passed	213	Passed	Passed	12.235
24	Passed	229	Passed	Passed	12.025

Results: All parts conformed to specification.

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Sensor Systems

Type of Test: Product Validation - Baseline Analysis of Current Product
Test Log #: 00-0044
Customer/Part Description: Delphi Saginaw Electronic Column Lock
Fasco Part #: 1740-0002
Test Description: Post Durability Performance Verification
Sample Size: 24
Build Date: N189
Technician: Lori Hoyle
Start Date: 02/14/2000
Finish Date: 02/14/2000

Part #	Switch Point (Extending) mm	Current Measurement (amps) 14.2Vdc @ Ambient Lock Cycle NTE 7 amps	Current Measurement (amps) 14.2Vdc @ Ambient Unlock Cycle NTE 7 amps
1	12.375	7.1	5.4
2	11.746	6.8	6.3
3	11.620	6.9	6.7
4	11.706	7.3	6.3
5	11.805	7.1	6.3
6	11.845	7.1	6.3
7	11.385	6.8	6.2
8	11.785	5.9	6.7
9	11.855	6.7	5.3
10	11.875	7.0	6.5
11	11.845	7.0	5.5
12	11.900	5.7	6.6
13	11.980	7.2	5.4
14	12.095	7.1	5.4
15	11.880	5.9	6.6
16	11.980	5.8	5.4
17	12.175	7.2	6.3
18	11.775	6.0	6.6
19	11.760	5.9	5.5
20	11.635	6.9	5.3
21	11.435	5.8	6.6
22	12.185	5.7	6.6
23	11.830	7.1	6.4
24	11.860	5.5	6.3

Results: All parts conformed to specification.

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Sensor Systems

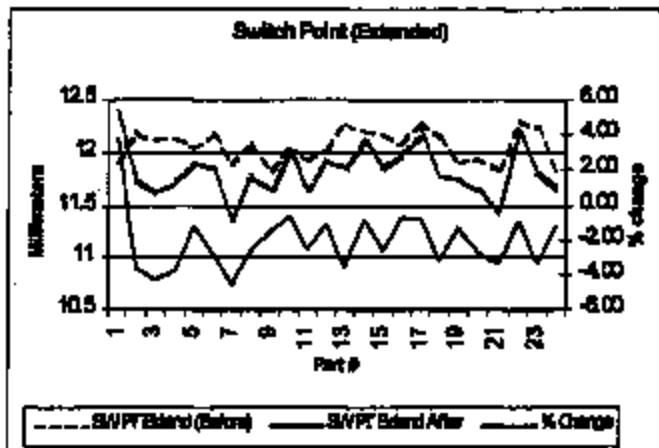
Analysis of Baseline Testing of Current Design

The current design was tested to show what changes occur to the parts during the durability testing. Performance testing alone does not show a true representation of what actually occurs to the product through a specified durability cycle. This type of testing only shows that the product with the current design stays within the limits set forth by Delphi Saginaw Specification # 26063015.

The following tables and graphs detail the testing completed February 28, 2000. The durability tester uses National Instruments LabView software to control the functionality of the testing and the data acquisition of each component under test. The data is then analyzed to determine anomalies and determine failure modes.

Performance data is gathered prior to and after the durability testing. An analysis of the data is provided below to show any significant changes that occur to the product.

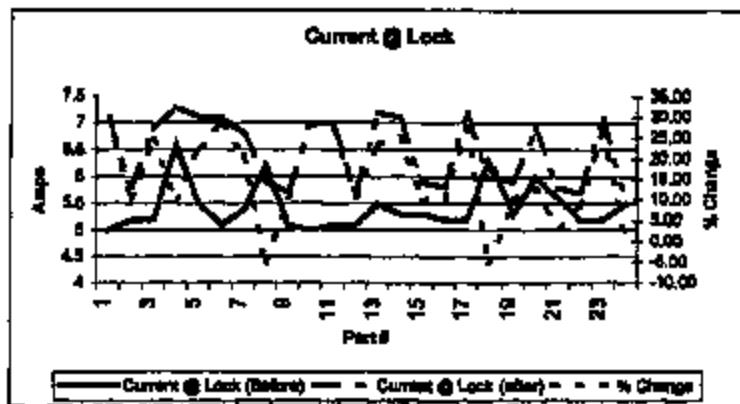
Part #	SW PT Extend (Before)	SW PT Extend After	Actual Change (mm)	% Change
1	11.905	12.375	0.47	3.80
2	12.175	11.745	-0.43	-3.55
3	12.12	11.82	-0.5	-4.30
4	12.14	11.705	-0.435	-3.72
5	12.045	11.905	-0.14	-1.18
6	12.17	11.845	-0.325	-2.74
7	11.885	11.385	-0.52	-4.58
8	12.075	11.785	-0.31	-2.63
9	11.825	11.655	-0.17	-1.46
10	12.05	11.975	-0.075	-0.63
11	11.94	11.645	-0.295	-2.59
12	12.025	11.9	-0.125	-1.05
13	12.275	11.88	-0.415	-3.50
14	12.195	12.095	-0.1	-0.83
15	12.17	11.86	-0.31	-2.61
16	12.07	11.88	-0.09	-0.76
17	12.275	12.175	-0.1	-0.62
18	12.145	11.775	-0.37	-3.14
19	11.905	11.75	-0.155	-1.32
20	11.95	11.835	-0.315	-2.71
21	11.815	11.435	-0.38	-3.32
22	12.3	12.185	-0.115	-0.84
23	12.225	11.83	-0.395	-3.34
24	11.8	11.66	-0.14	-1.20



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Sensor Systems

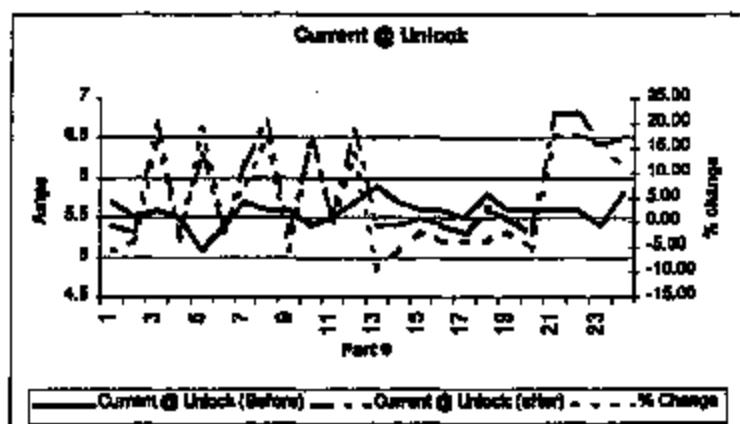
Part #	Current @ Lock (Before)	Current @ Lock (after)	% Change
1	6	7.1	29.58
2	5.2	5.8	10.34
3	5.2	6.9	24.64
4	6.8	7.3	9.59
5	5.5	7.1	22.54
6	5.1	7.1	28.17
7	5.4	6.8	20.59
8	6.2	5.9	-5.08
9	5.1	5.7	10.53
10	5	7	28.57
11	5.1	7	27.14
12	5.1	5.7	10.53
13	5.5	7.2	23.81
14	5.3	7.1	25.35
15	5.3	5.9	10.17
16	6.2	5.8	10.34
17	5.2	7.2	27.78
18	6.3	6	-5.00
19	5.3	5.9	10.17
20	6	6.9	13.04
21	5.8	5.8	3.45
22	5.2	5.7	8.77
23	5.2	7.1	26.76
24	5.5	5.5	0.00



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Sensor Systems

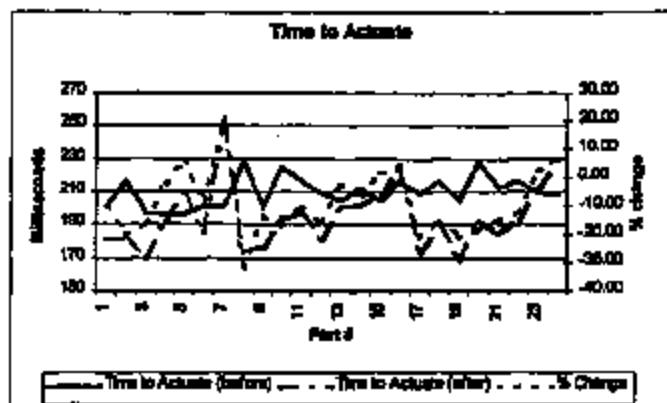
Part #	Current @ Unlock (Before)	Current @ Unlock (After)	% Change
1	5.7	5.4	-5.56
2	5.5	5.3	-3.77
3	5.6	6.7	16.42
4	5.6	5.3	-3.77
5	6.1	6.3	19.06
6	5.4	5.3	-1.89
7	5.7	6.2	8.06
8	5.6	6.7	16.42
9	5.6	5.3	-5.66
10	5.4	6.6	18.92
11	6.6	5.5	0.00
12	5.7	6.6	13.64
13	5.8	5.4	-9.26
14	5.7	5.4	-5.56
15	5.6	5.5	-1.82
16	5.6	5.4	-3.70
17	5.5	5.3	-3.77
18	5.8	5.6	-3.67
19	5.6	5.5	-1.82
20	5.6	5.3	-5.66
21	5.6	6.8	17.65
22	5.5	6.8	17.65
23	5.4	6.4	15.63
24	5.8	6.5	10.77



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Sensor Systems

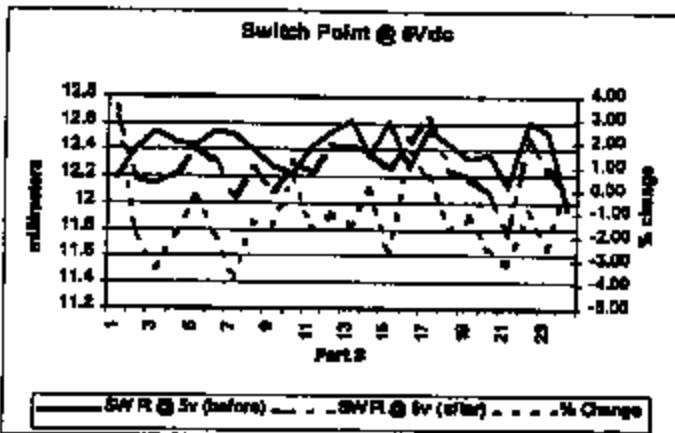
Part #	Time to Actuate ms (before)	Time to Actuate ms (after)	Actual Change ms	% Change
1	201	181	-20	-11.05
2	217	181	-36	-18.89
3	197	169	-28	-16.57
4	197	193	-4	-2.07
5	197	209	12	5.74
6	201	185	-16	-8.86
7	201	253	52	20.55
8	229	173	-56	-32.37
9	201	177	-24	-13.56
10	225	193	-32	-16.58
11	217	197	-20	-10.15
12	209	181	-28	-15.47
13	205	201	-4	-1.99
14	213	201	-12	-5.97
15	205	209	4	1.91
16	217	225	8	3.56
17	209	173	-26	-20.81
18	217	189	-28	-14.81
19	206	169	-36	-21.30
20	229	193	-36	-16.85
21	213	185	-28	-15.14
22	217	193	-24	-12.44
23	209	213	4	1.89
24	209	229	20	8.73



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Sensor Systems

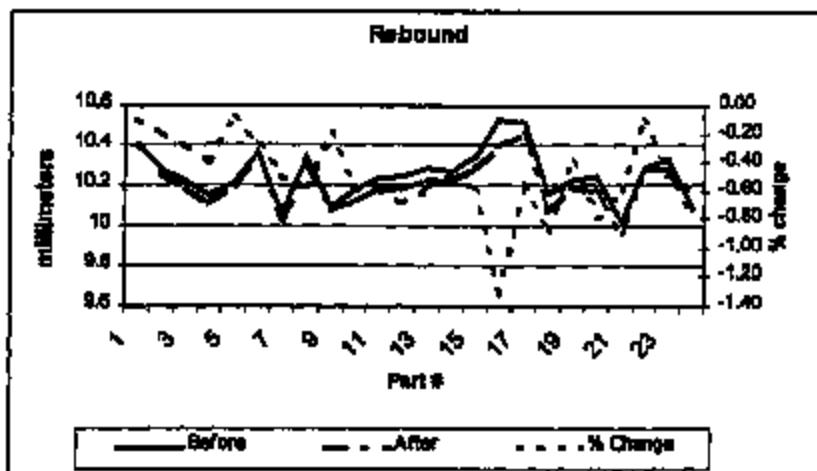
Part #	SW Pt @ 5Vdc mm (before)	SW Pt @ 5Vdc mm (after)	Actual Change	% Change
1	12.195	12.84	0.445	3.52
2	12.415	12.175	-0.24	-1.97
3	12.54	12.145	-0.395	-3.25
4	12.455	12.23	-0.225	-1.84
5	12.445	12.415	-0.03	-0.24
6	12.54	12.305	-0.235	-1.91
7	12.51	12.05	-0.46	-3.82
8	12.41	12.25	-0.16	-1.31
9	12.275	12.095	-0.18	-1.49
10	12.23	12.3	0.07	0.57
11	12.425	12.235	-0.19	-1.55
12	12.54	12.425	-0.115	-0.93
13	12.625	12.445	-0.18	-1.45
14	12.375	12.38	0.005	0.04
15	12.805	12.27	-0.335	-2.73
16	12.28	12.475	0.195	1.56
17	12.55	12.83	0.08	0.63
18	12.445	12.245	-0.2	-1.63
19	12.335	12.2	-0.135	-1.11
20	12.37	12.085	-0.285	-2.35
21	12.135	11.765	-0.37	-3.14
22	12.805	12.48	-0.125	-1.00
23	12.525	12.235	-0.29	-2.37
24	11.955	12.025	0.07	0.58



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Sensor Systems

Part #	Rebound mm (Initial)	Rebound mm (Post)	% Change
1	10.4	10.39	-0.096
2	10.28	10.28	-0.195
3	10.22	10.19	-0.294
4	10.15	10.11	-0.384
5	10.21	10.2	-0.090
6	10.37	10.34	-0.289
7	10.06	10.01	-0.497
8	10.34	10.28	-0.580
9	10.09	10.07	-0.198
10	10.18	10.12	-0.589
11	10.24	10.18	-0.586
12	10.25	10.18	-0.683
13	10.29	10.23	-0.683
14	10.27	10.22	-0.487
15	10.35	10.28	-0.580
16	10.53	10.39	-1.330
17	10.51	10.45	-0.571
18	10.16	10.07	-0.886
19	10.23	10.19	-0.391
20	10.25	10.17	-0.780
21	10.01	9.95	-0.599
22	10.29	10.28	-0.097
23	10.33	10.28	-0.484
24	10.08	10.02	-0.595



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Lab Work Request

00-0056

Date: 02/24/2000

Request By: Steve Davis

Date needed: 02/24/2000

Part Name: eAGINAW ed

Part Number: 1740-0002

Customer: eAGINAW

Type of Test or Work: ENVIRONMENTAL AND DURABILITY

Special Requirements:

VOLTAGE LIMITED TO 9 VDC MAX. FOR ALL TEST LEGS

All Areas that are effected:

TO DETERMINE IS HARDESTOP IS VOLTAGE DRIVEN

NOTE: You must include all pertinent drawings, prints and specifications along with this document. Failure to do so will cause this request to be returned to sender and delay the project.
[Help Attachments or Links Here](#)

Document History Section:

Document Created on 02/24/2000 by Steve Davis

6669-2248 12/2006

**PRODUCT TEST LABORATORY
INITIAL AND DAILY SET UP SHEET**

Test Log #: 00-0058
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Specification #: 26053015

Equipment Used:
 Type of Test:
 Engineer:
 Technician:
 Environmental Chamber, Labview Data Acquisition
 Engineering
 Steve Davis
 Lori Hoyle

Test Specifications: 50,000 Cycles -40C to 85C 4H Tests 9V New lock built plate installed

Date	Time	Cycles Complete Test #	Temp. -40C to 85C Spec. Tol.	Voltage 9V to 12V Spec. Tol.	Amperage N/A Spec. Tol.	Pressure N/A Spec. Tol.	Comments	Initials
2-0-0								
3-2	7:45	2-15	25	9V	AN Parts had quite a few misses at 2204. No Part 2.8 in had misses in test 2/11/11 going to the right			X/H
3-2	10:00	2-36	34.34		Time limit exceeded	(OK)		X/H
3-3	4:57pm	3-3886	378	9V			OK	LK
3-6	7:40	3-4039	32.5°C	9V	Time allotted for heating exceeded			X/H
3-6	9:40	3-5282	47°C	9V	49 NW stuck unlock			
Failures to this point: 1-14; 2-50; 3-26; 4-14; 5-16; 6-12; 7-18; 8-72; 9-71; 10-206; 11-60; 12-32; 13-6; 14-12; 15-8; 16-4; 17-4; 18-2; 19-2; 20-6; 21-10; 22-6; 23-6								
3-7	7:50	3-6912			1-14; 2-22; 3-60; 4-14; 5-28; 6-12; 7-38; 8-72; 9-30; 10-36;			
3-7	11:05	3-8637	42°C		11-60; 12-32; 13-6; 14-12; 15-8; 16-4; 17-4; 18-3; 19-2; 20-6			
					21-10; 22-4; 23-6; 24-8			
3-8	7:50	4-2M4	45°C					
3-8	3:55	4-4087	41.5°C			23 NW		X/H
						45 NW		X/H

**PRODUCT TEST LABORATORY
INITIAL AND DAILY SET UP SHEET**

Test Log #: 00-0056
Customer/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Specification #: 26053015

Equipment Used: Environmental Chamber, Labview Data Aquisition
Type of Test: Engineering
Engineer: Steve Davis
Technician: Lori Hoyle

Test Specifications: 50,000 Cycles -40°C to 85°C

Date	Time	Cycles Complete Test #	Temp. -40C to 85C Spec. Tol.	Voltage 9V to 12V Spec. Tol.	Amperage N/A Spec. Tol.	Pressure N/A Spec. Tol.	Comments	InMels
3-9	6:05	5-487	24°C					✓P
3-16	4:25	5-5754	41°C				18 #23 NW	✓H
3-13	7:51	7-1818	56°C					OK
3-13	7:10Pm	7-4587	223°C	#13NW → 1-24 2-74 3-158 4-16 5-30 6-138 7-40 8-74				✓H
9-180	10-380	11-62	12-34	13-9	14-14 15-10	16-12	17-6 18-12	✓H
19-4	20-8	21-12	22-8	23-14	24-116			✓H
3-14	28°C	7-7533			#13NW			✓H
3-15	End							
		(1-41) (2-47) (3-211) (4-25) (5-43) (6-51) 7-52 (8-87) (9-153)						
		(10-393) → 11-74 12-46 (13-11) (14-29) 15-16 (16-30) 17-10						
		(18-27) 19-16 20-14 21-16 22-22 23-54 (24-127)						
		○ = NW AT END OF TEST						

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Time of Test:
Log #:
Customer/Product Description:
Fasco Part #:
Test Description:
Sample Size:
Build Date:
Technician:
Start Date:
Finish Date:

Engineering
00-0058
Saginaw Column Lock
1740-0002
Durability (Initial)
24
2290
Lori Hoyle
03/02/2000
03/15/00

Part #	Pull Force @ 22 ft.lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 5 Volts 11.6mm - 12.8mm
1	Passed	6.700	Passed	Passed	12.240
2	Passed	5.800	Passed	Passed	12.215
3	Passed	5.500	Passed	Passed	12.230
4	Passed	5.400	Passed	Passed	12.100
5	Passed	5.700	Passed	Passed	12.310
6	Passed	5.400	Passed	Passed	12.225
7	Passed	5.500	Passed	Passed	12.425
8	Passed	6.100	Passed	Passed	12.395
9	Passed	6.600	Passed	Passed	12.270
10	Passed	5.600	Passed	Passed	12.410
11	Passed	5.400	Passed	Passed	12.250
12	Passed	5.600	Passed	Passed	12.225

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0058
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability(Initial)
 Sample Size: 24
 Build Date: 2290
 Technician: Lori Hoyle
 Start Date: 03/02/2000
 Finish Date: 03/15/00

Part #	Pull Force@ 22 ft-lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 5 Volts 11.6mm - 12.8mm
13	Passed	205.000	Passed	Passed	12.215
14	Passed	193.000	Passed	Passed	12.335
15	Passed	177.000	Passed	Passed	12.350
16	Passed	177.000	Passed	Passed	12.425
17	Passed	173.000	Passed	Passed	12.225
18	Passed	185.000	Passed	Passed	12.350
19	Passed	177.000	Passed	Passed	12.410
20	Passed	185.000	Passed	Passed	12.235
21	Passed	173.000	Passed	Passed	12.320
22	Passed	185.000	Passed	Passed	12.110
23	Passed	189.000	Passed	Passed	12.385
24	Passed	181.000	Passed	Passed	12.650

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
Test Log #: 00-0056
Customer/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Test Description: Durability(Initial)
Sample Size: 24
Build Date: 2290
Technician: Lori Hoyle
Start Date: 03/02/2000
Finish Date: 03/15/00

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Amps) 14.2 @ Ambient Unlock < 7 Amps	
1	11.956	N/A	5.800	8.700	
2	12.095	N/A	5.700	5.800	
3	11.725	N/A	5.700	5.500	
4	11.730	N/A	7.100	5.400	
5	12.030	N/A	6.100	5.700	
6	11.715	N/A	5.800	5.400	
7	12.150	N/A	5.900	5.500	
8	12.185	N/A	5.700	6.100	
9	11.730	N/A	5.800	6.600	
10	12.130	N/A	6.000	5.500	
11	11.985	N/A	5.900	5.400	
12	12.025	N/A	5.800	5.600	

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0058
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability(initial)
 Sample Size: 24
 Build Date: 2290
 Technician: Lori Hoyle
 Start Date: 03/02/2000
 Finish Date: 03/15/00

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Amps) 14.2 @ Ambient Unlock < 7 Amps
13	11.880	N/A	6.100	6.700
14	11.890	N/A	7.100	5.400
15	11.950	N/A	5.900	5.400
16	11.950	N/A	5.900	5.400
17	11.815	N/A	6.900	5.500
18	12.080	N/A	5.900	5.800
19	12.095	N/A	5.900	5.500
20	11.955	N/A	5.900	5.800
21	11.995	N/A	5.900	6.800
22	11.790	N/A	5.500	5.400
23	11.805	N/A	5.800	5.300
24	11.825	N/A	6.000	5.300

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test:
Test Log #: Engineering
Customer/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Test Description: Durability(Post)
Sample Size: 24
Build Date: 2290
Technician: Lori Hoyte
Start Date: 03/02/2000
Finish Date: 03/15/00

Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Amps) 14.2 @ Ambient Unlock < 7 Amps	
1	12.035	N/A	7.000	5.300	
2	11.720	N/A	5.700	5.500	
3	11.340	N/A	6.800	6.300	
4	11.300	N/A	7.100	5.300	
5	11.710	N/A	5.900	5.400	
6	11.280	N/A	5.800	6.700	
7	11.620	N/A	7.300	6.900	
8	11.815	N/A	5.700	6.900	
9	11.495	N/A	7.200	6.800	
10	11.980	N/A	7.100	6.900	
11	11.680	N/A	5.700	6.800	
12	11.680	N/A	5.900	5.800	

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0058
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability(Post)
 Sample Size: 24
 Build Date: 2290
 Technician: Lori Hoyle
 Start Date: 03/02/2000
 Finish Date: 03/15/00

Part #	Pull Force @ 22 ft.lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 5 Volts 11.0mm - 12.5mm
13	Passed	201.000	Passed	Passed	12.395
14	Passed	201.000	Passed	Passed	11.790
15	Passed	193.000	Passed	Passed	12.270
16	Passed	209.000	Passed	Passed	12.060
17	Passed	209.000	Passed	Passed	11.885
18	Passed	197.000	Passed	Passed	12.160
19	Passed	185.000	Passed	Passed	12.265
20	Passed	207.000	Passed	Passed	11.800
21	Passed	185.000	Passed	Passed	12.105
22	Passed	189.000	Passed	Passed	12.035
23	Passed	217.000	Passed	Passed	12.135
24	Passed	209.000	Passed	Passed	11.995

Results:

FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT

Type of Test: Engineering
 Test Log #: 00-0058
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability (Post)
 Sample Size: 24
 Build Date: 2290
 Technician: Lori Hoyle
 Start Date: 03/02/2000
 Finish Date: 03/15/00

Part #	Pull Force @ 22 ft.lbs 9 Volts Ambient	Time To Actuate (milliseconds) -40C < 600 milliseconds	Hardstop (Unlock) Ambient 14.2V/8.5V	Hardstop (Lock) Ambient 14.2V/8.5V	Switch Point 5 Volts 11.6mm - 12.8mm
1	Passed	189.000	Passed	Passed	12.585
2	Passed	187.000	Passed	Passed	12.140
3	Passed	189.000	Passed	Passed	11.735
4	Passed	189.000	Passed	Passed	11.695
5	Passed	189.000	Passed	Passed	12.145
6	Passed	185.000	Passed	Passed	11.935
7	Passed	185.000	Passed	Passed	11.940
8	Passed	189.000	Passed	Passed	11.080
9	Passed	189.000	Passed	Passed	11.920
10	Passed	185.000	Passed	Passed	12.205
11	Passed	189.000	Passed	Passed	12.025
12	Passed	177.000	Passed	Passed	12.165

Results:

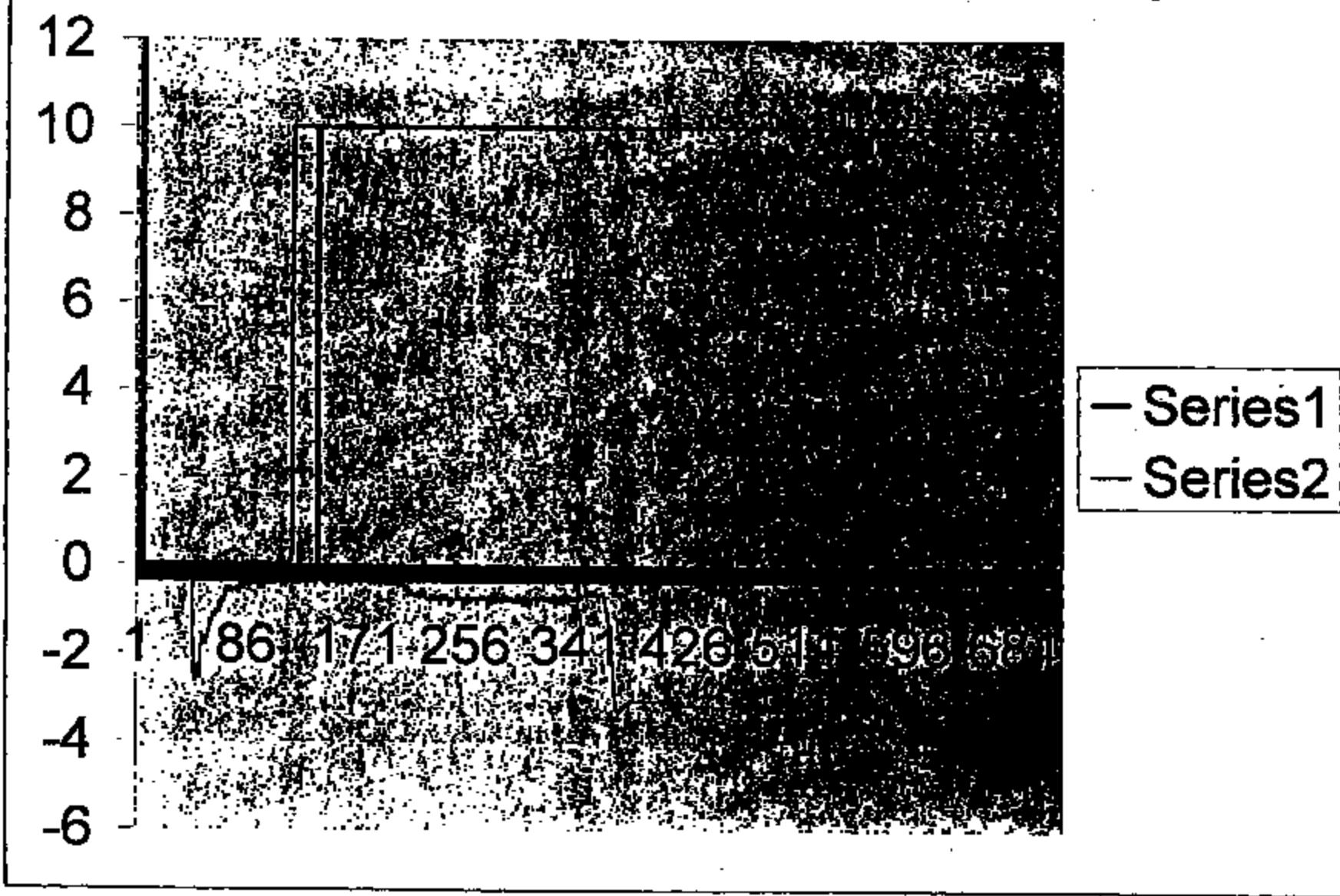
**FASCO CONTROLS CORPORATION
PRODUCT TEST LABORATORY
TEST REPORT**

Type of Test: Engineering
 Test Log #: 00-0056
 Customer/Product Description: Saginaw Column Lock
 Fasco Part #: 1740-0002
 Test Description: Durability(Post)
 Sample Size: 24
 Build Date: 2280
 Technician: Lori Hoyle
 Start Date: 03/02/2000
 Finish Date: 03/15/00

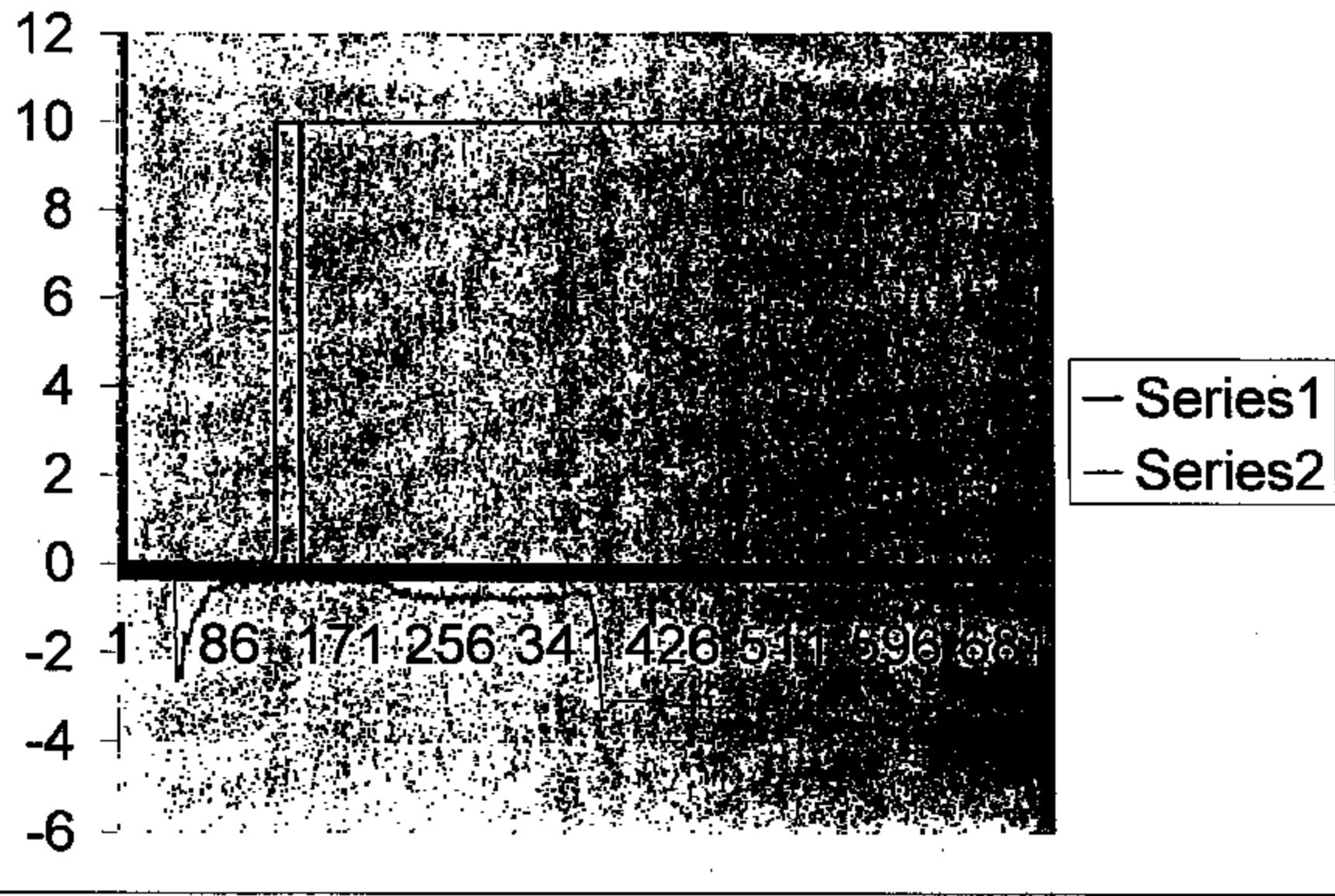
Part #	Switch Point (Extending) (millimeters)	Rebound (millimeters) Optional	Current Measurement (Amps) 14.2V @ Ambient Lock < 7 Amps	Current Measurement (Amps) 14.2 @ Ambient Unlock < 7 Amps	
13	11.735	N/A	7.100	5.800	
14	11.480	N/A	5.800	5.800	
15	11.855	N/A	5.800	6.800	
16	11.650	N/A	6.700	6.700	
17	11.475	N/A	5.800	6.700	
18	11.850	N/A	5.900	5.800	
19	11.955	N/A	7.000	5.300	
20	11.445	N/A	5.800	5.800	
21	11.945	N/A	7.300	6.900	
22	11.890	N/A	5.700	5.400	
23	11.675	N/A	5.500	5.300	
24	11.500	N/A	6.000	5.900	

Results:

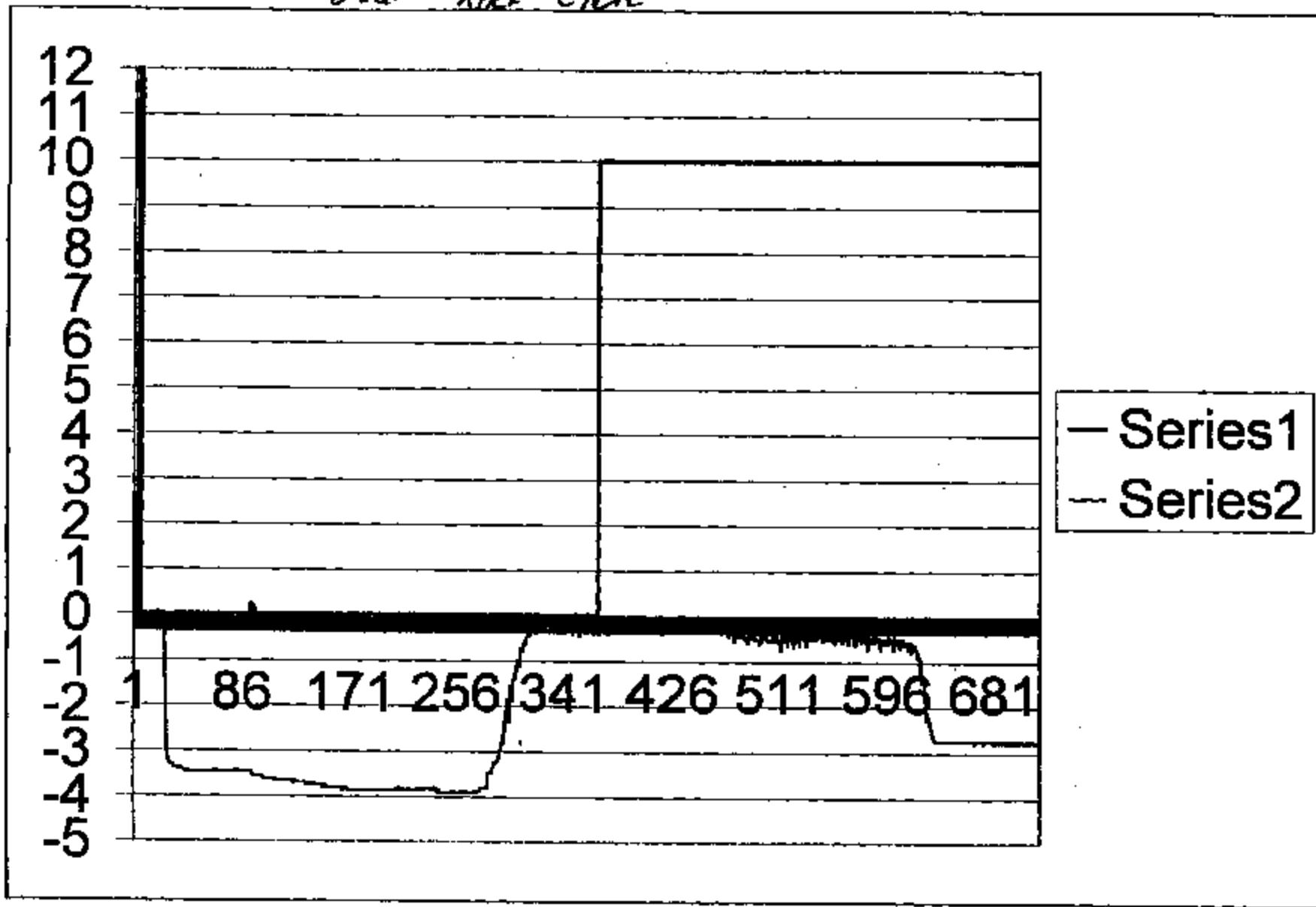
Richard when looking



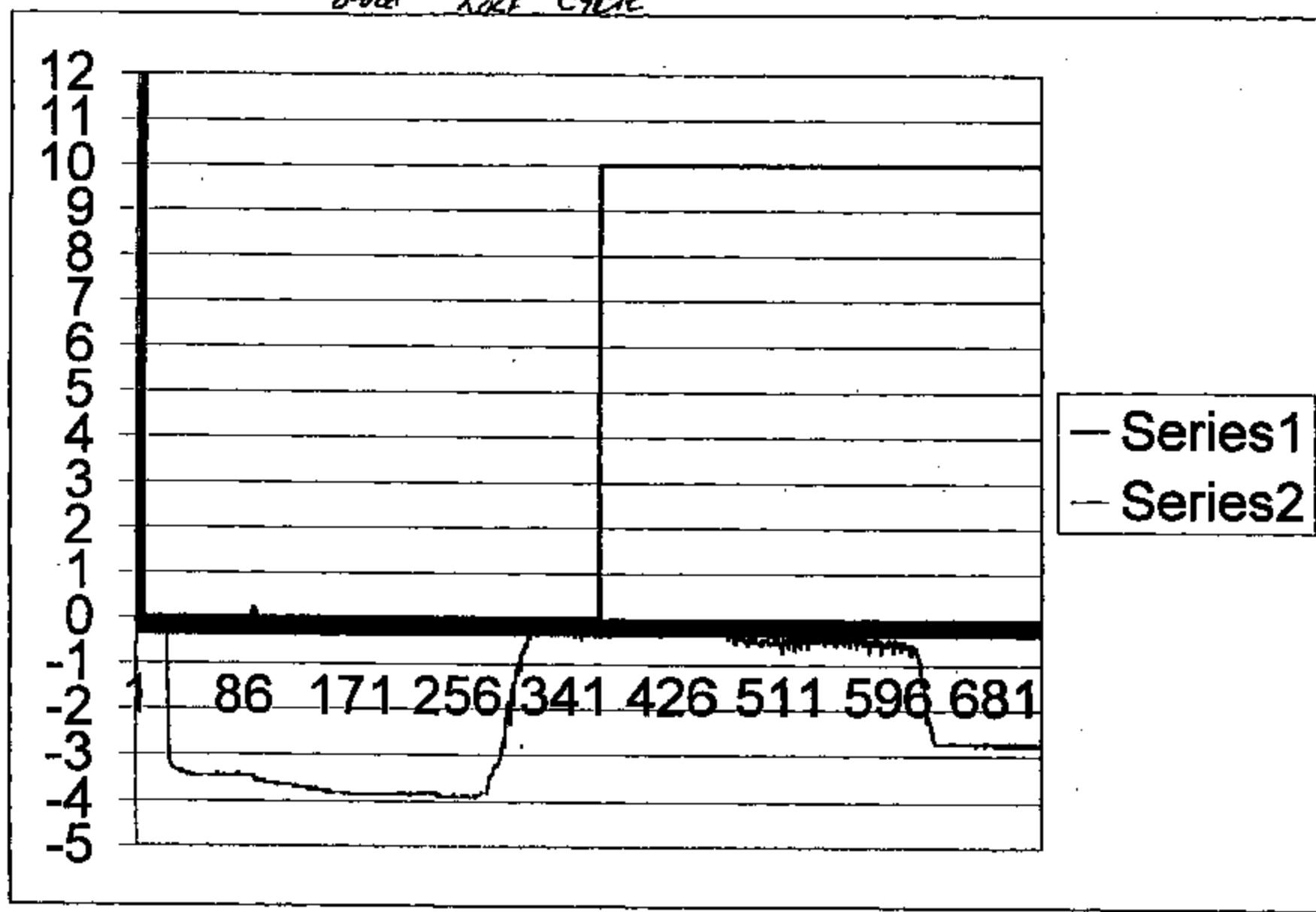
Richard John Lockett



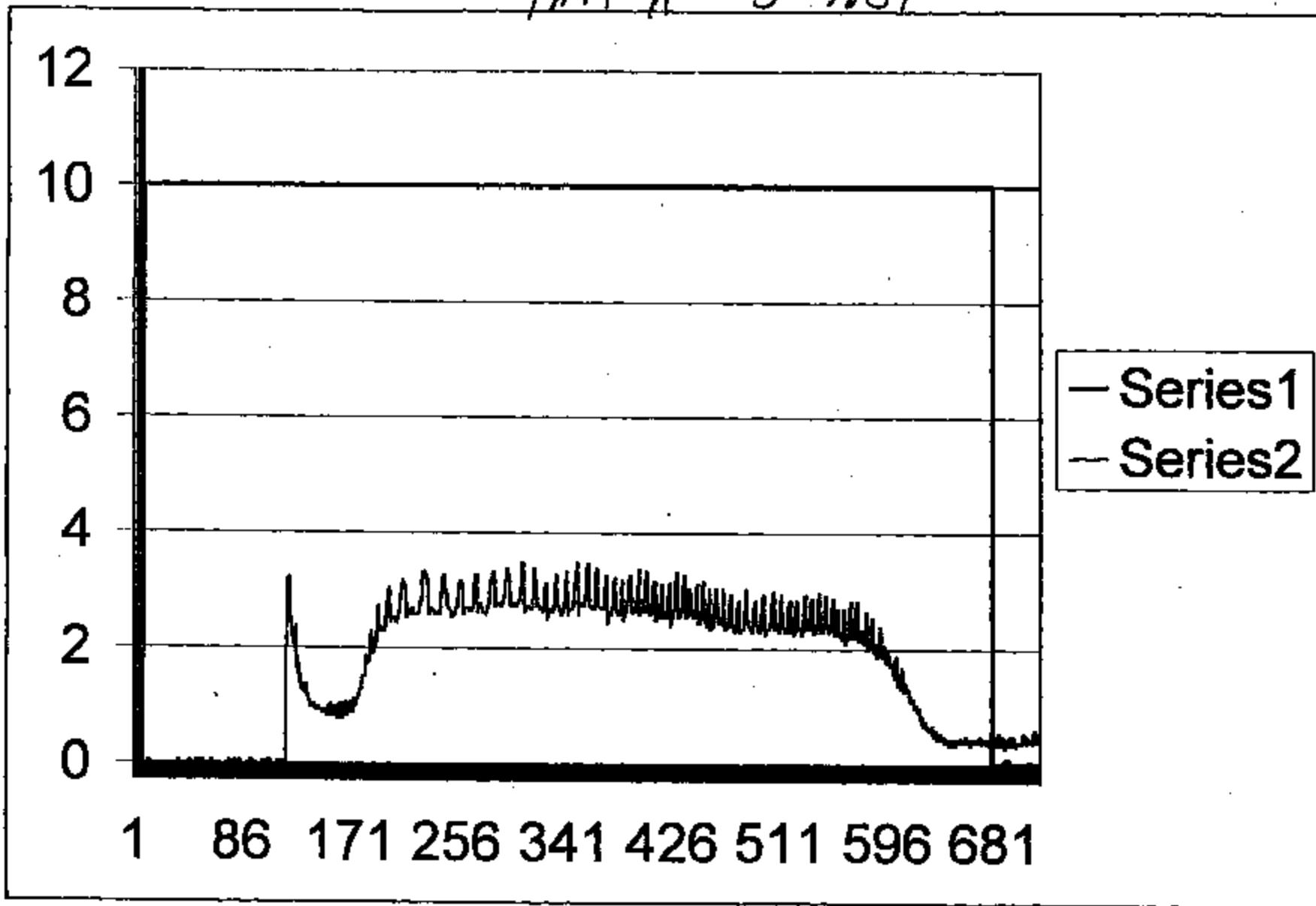
bad last cycle



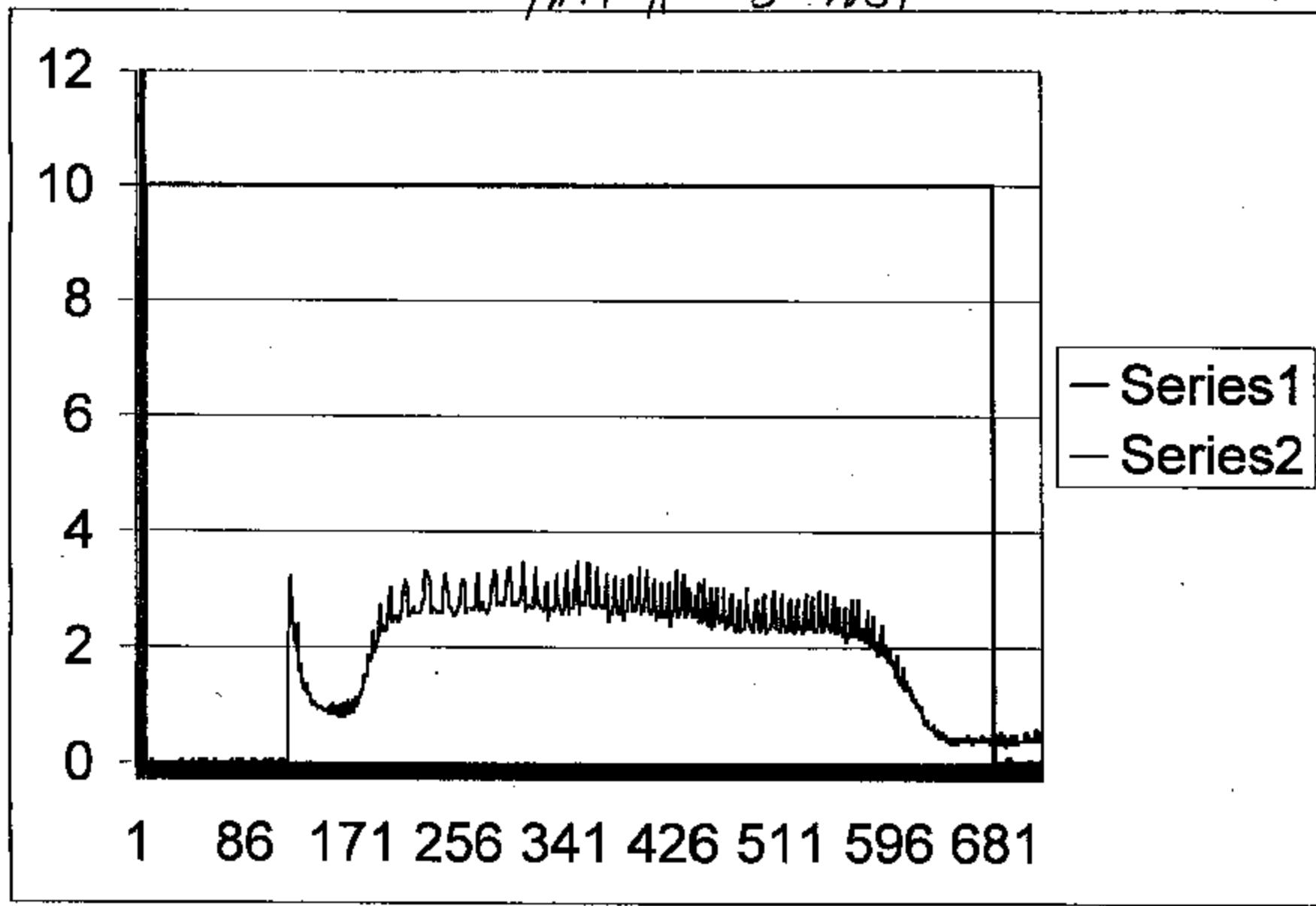
good last cycle



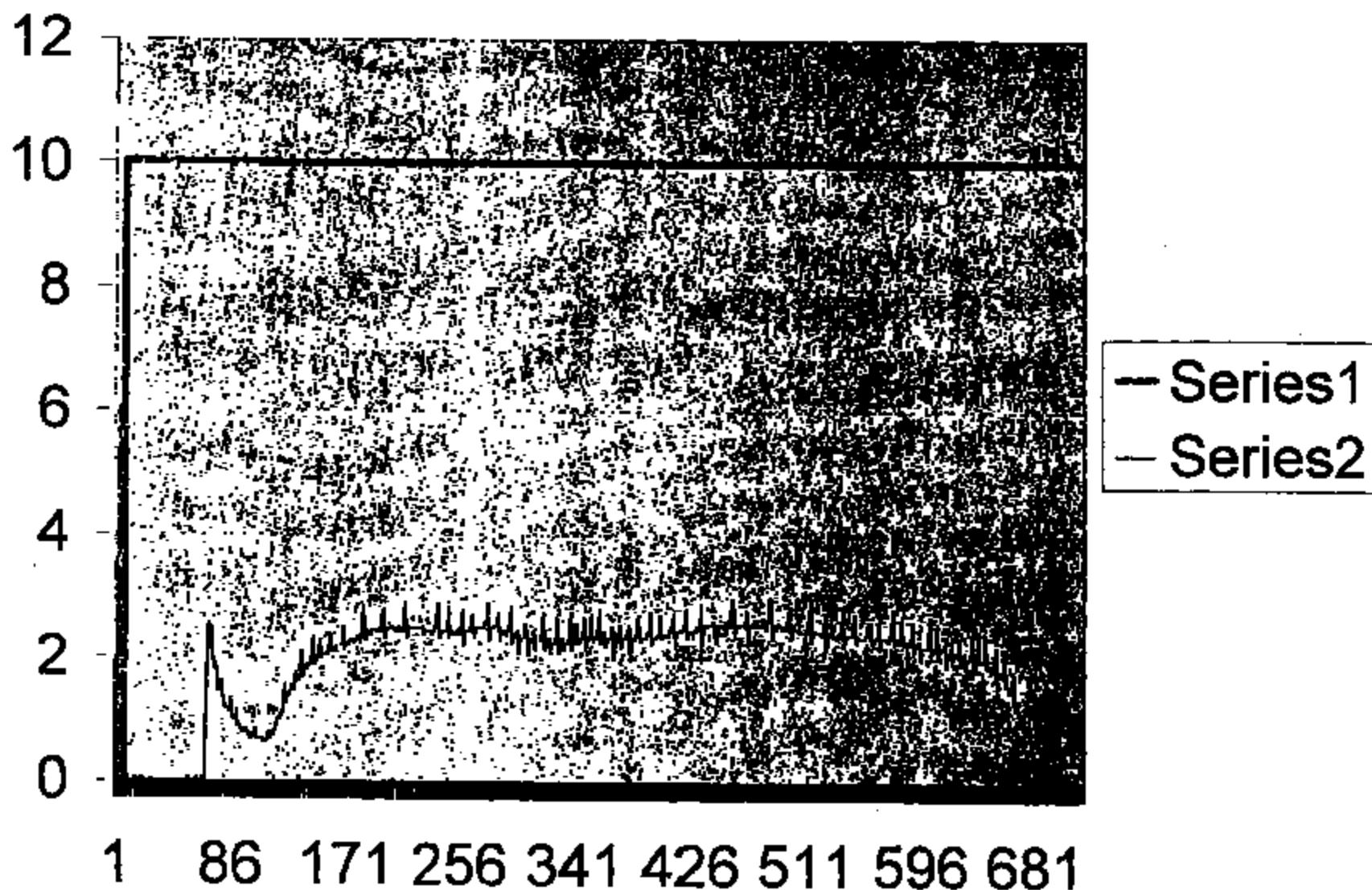
Part II 3-1854



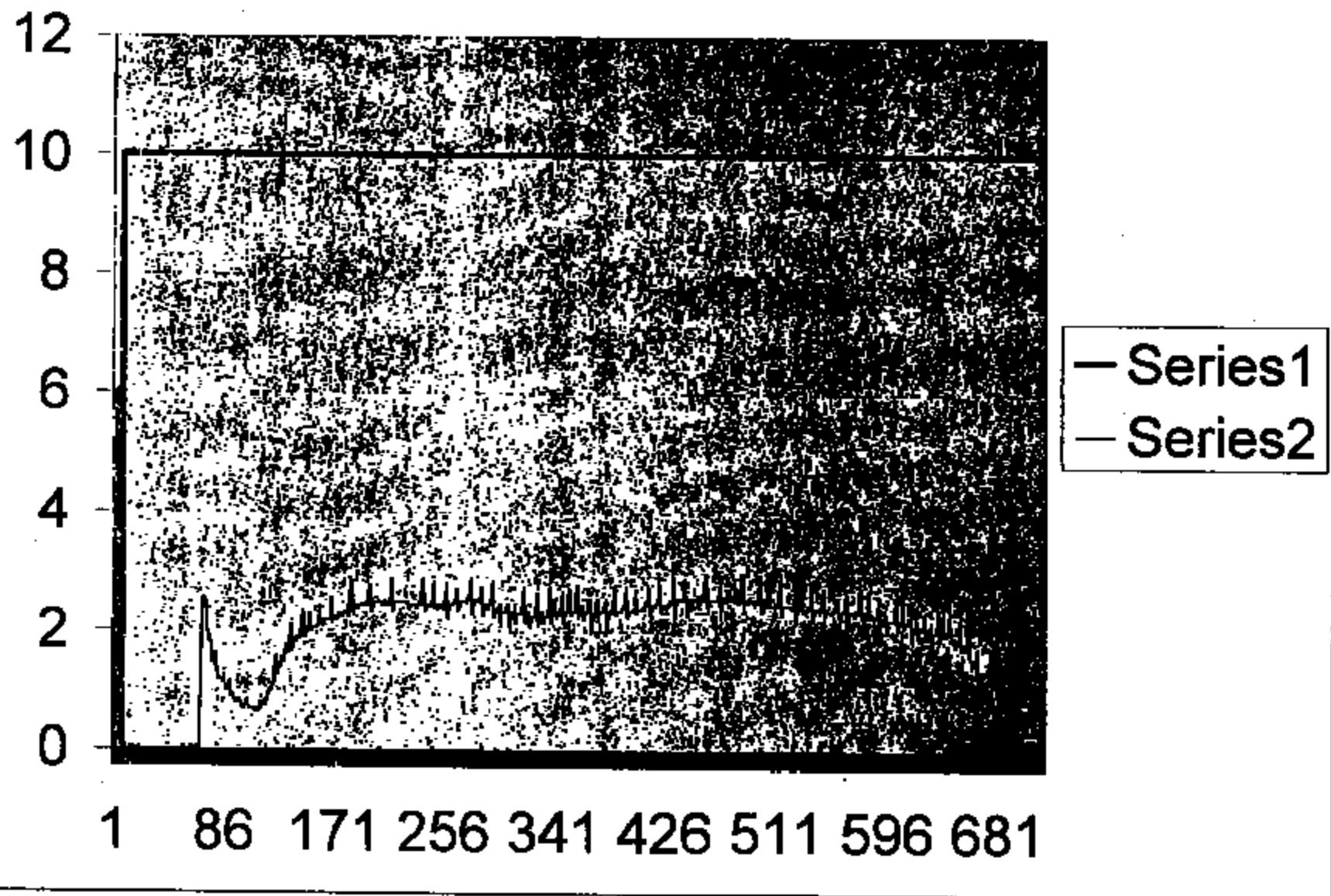
Part II 3-1854



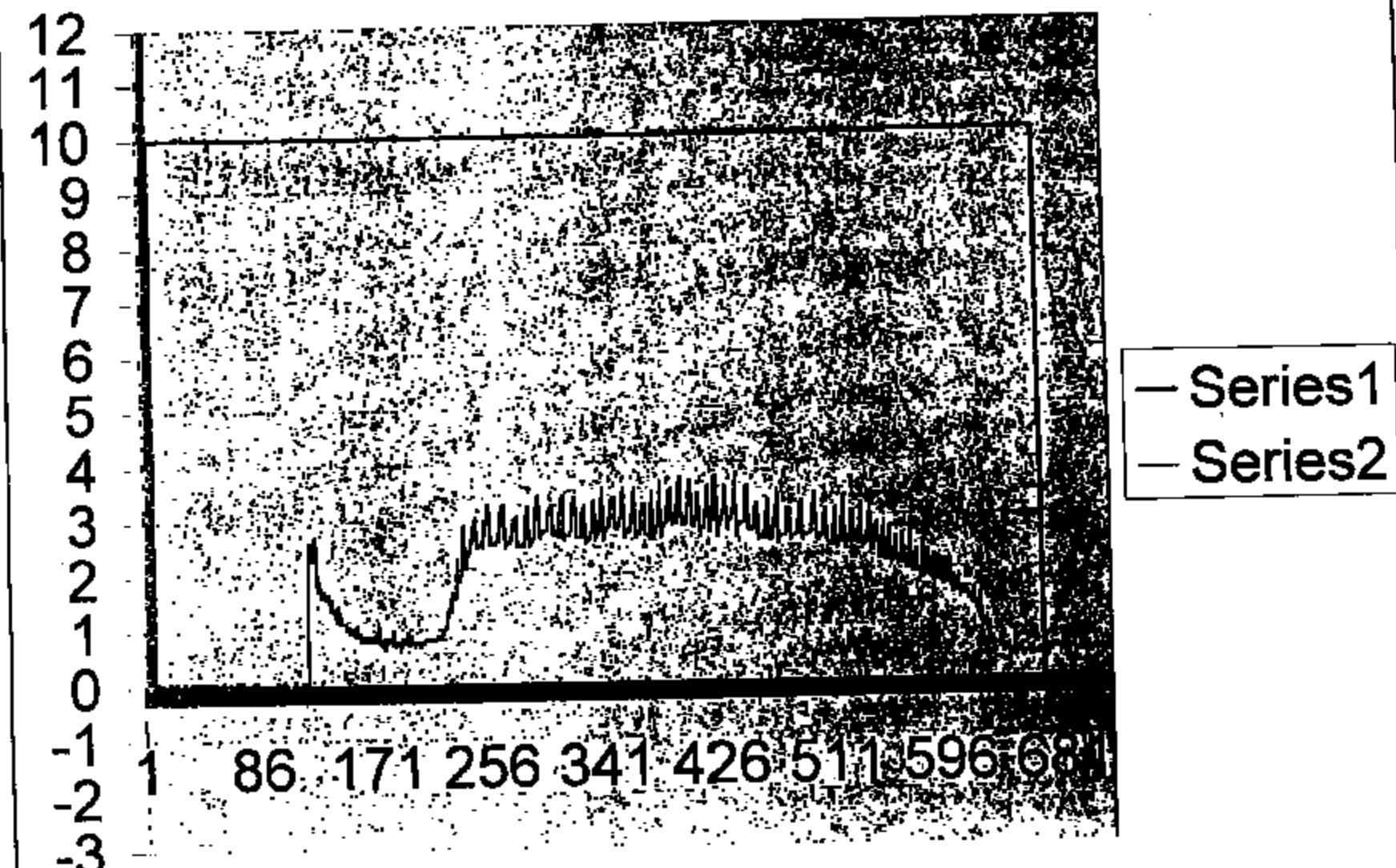
Part #11 2-6 20.57%



Part #11 2-6 20.97%

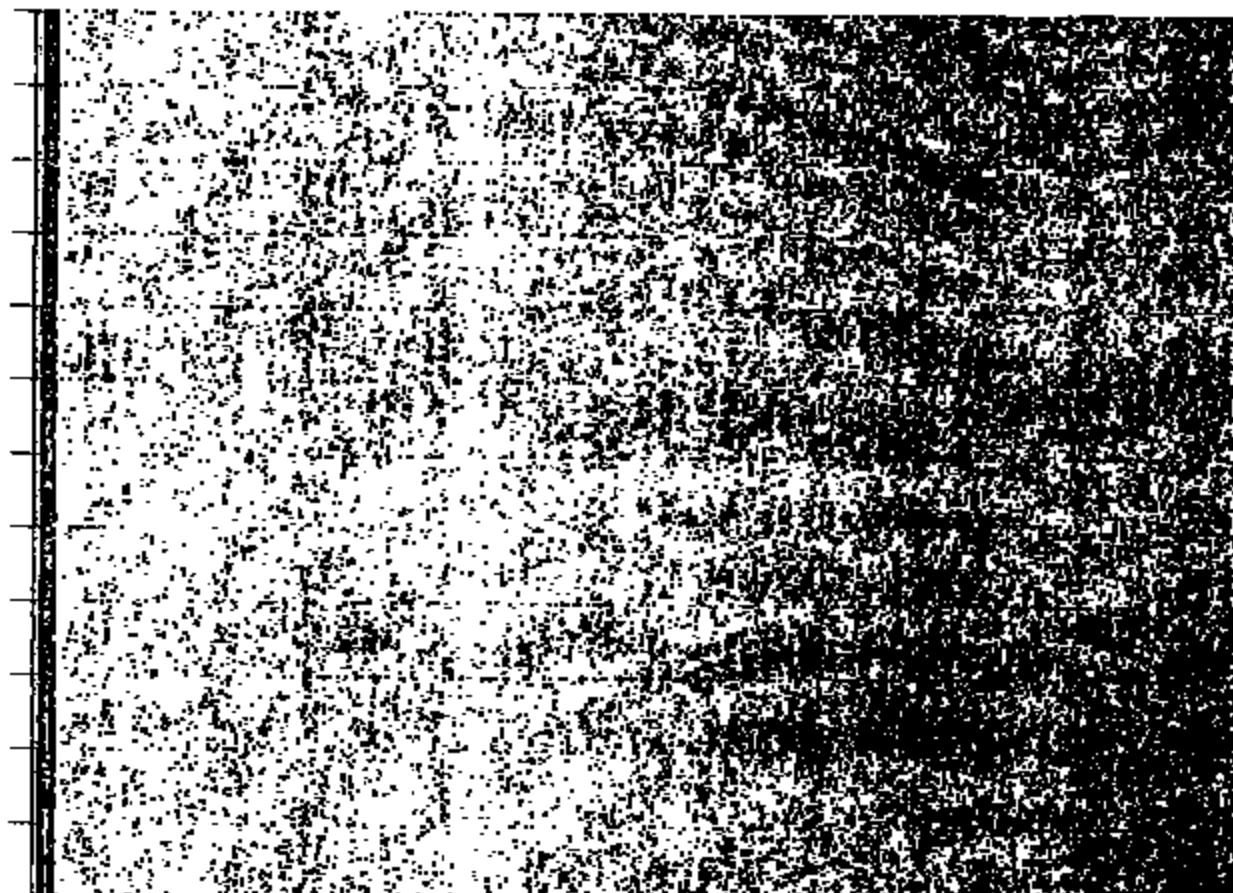


3-6537 unlock -29.61°C



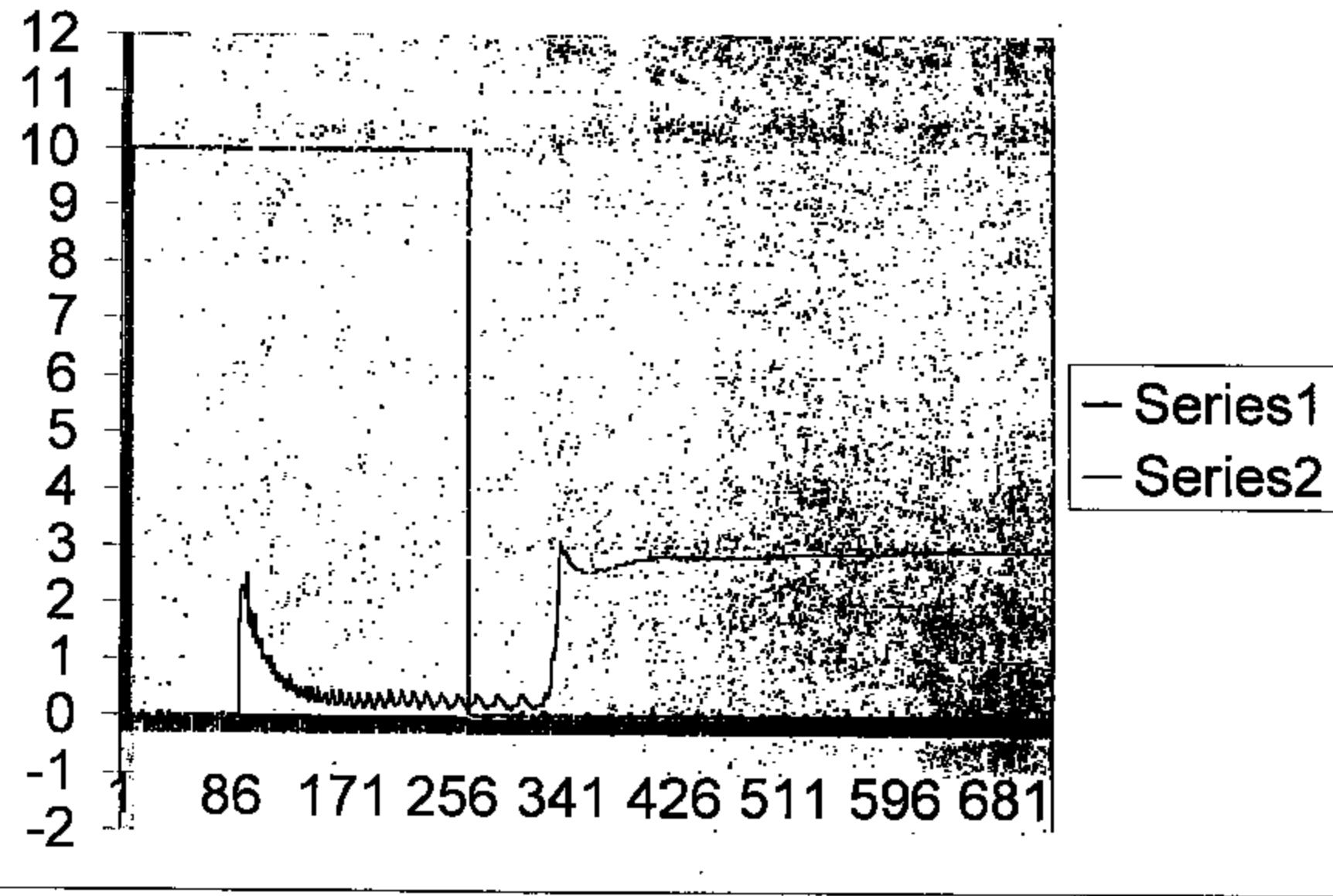
Part #1 5-5754 unlock 4/13/92

12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

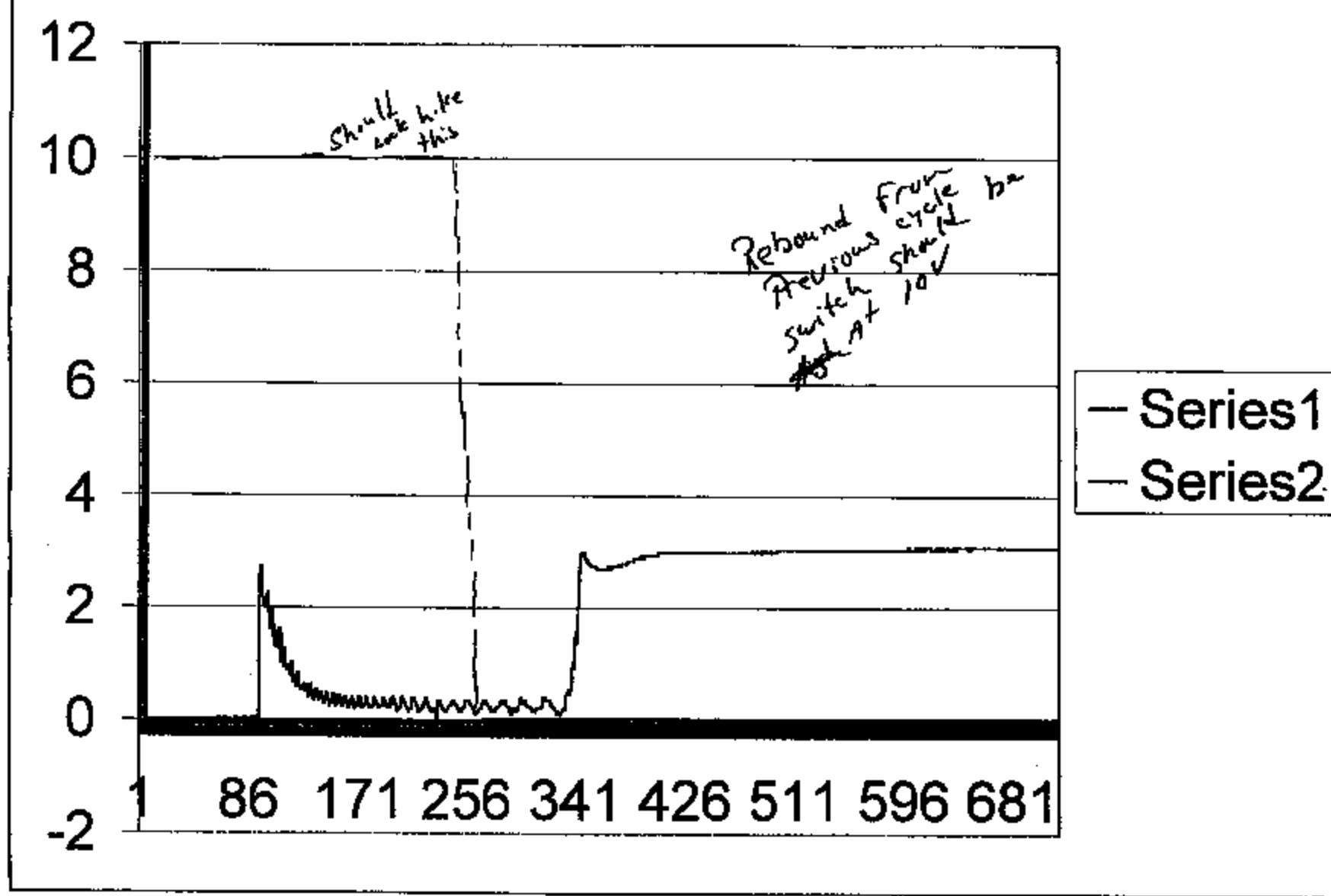


- Series1
- Series2

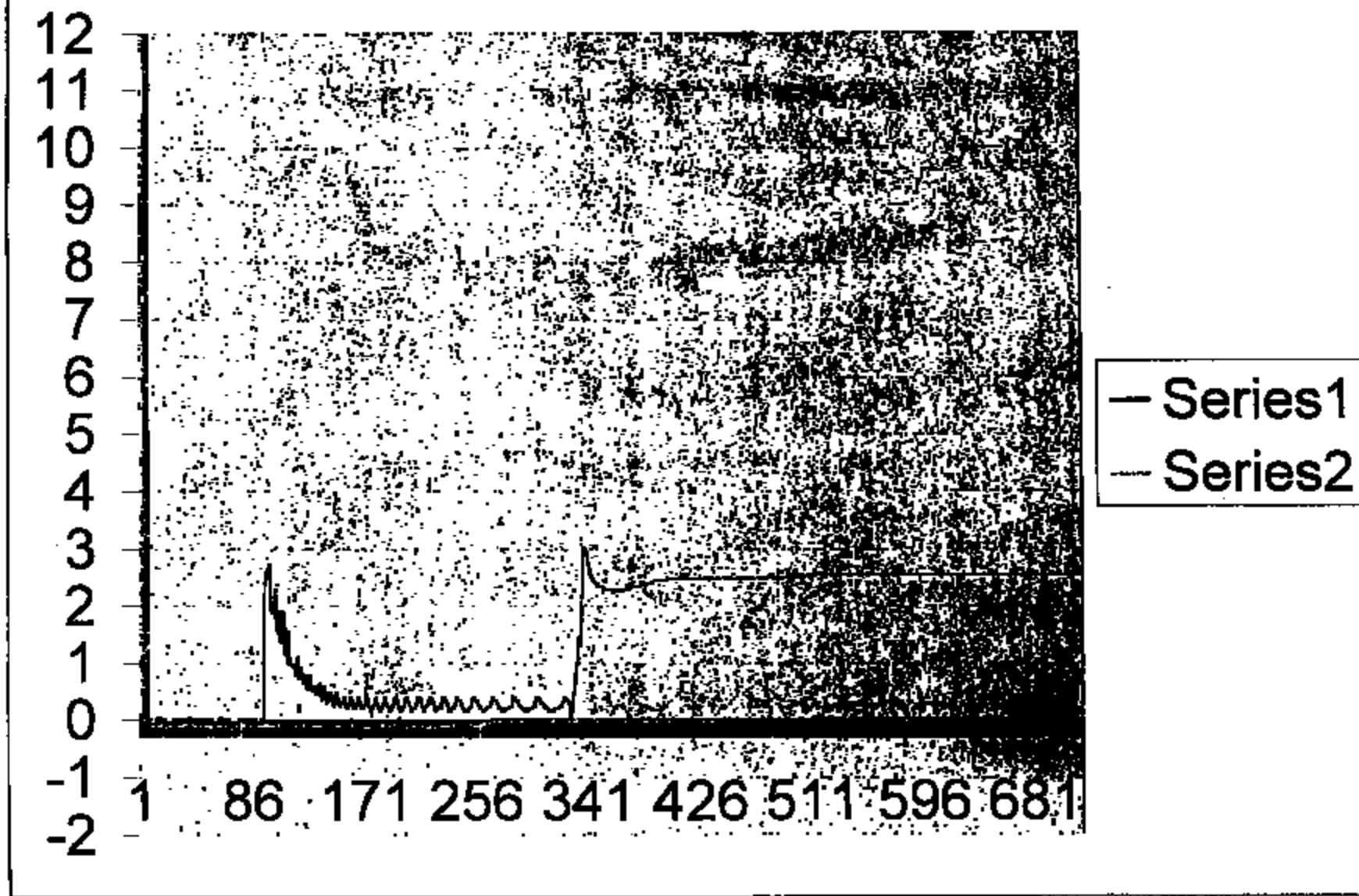
Part 2 Good Trace

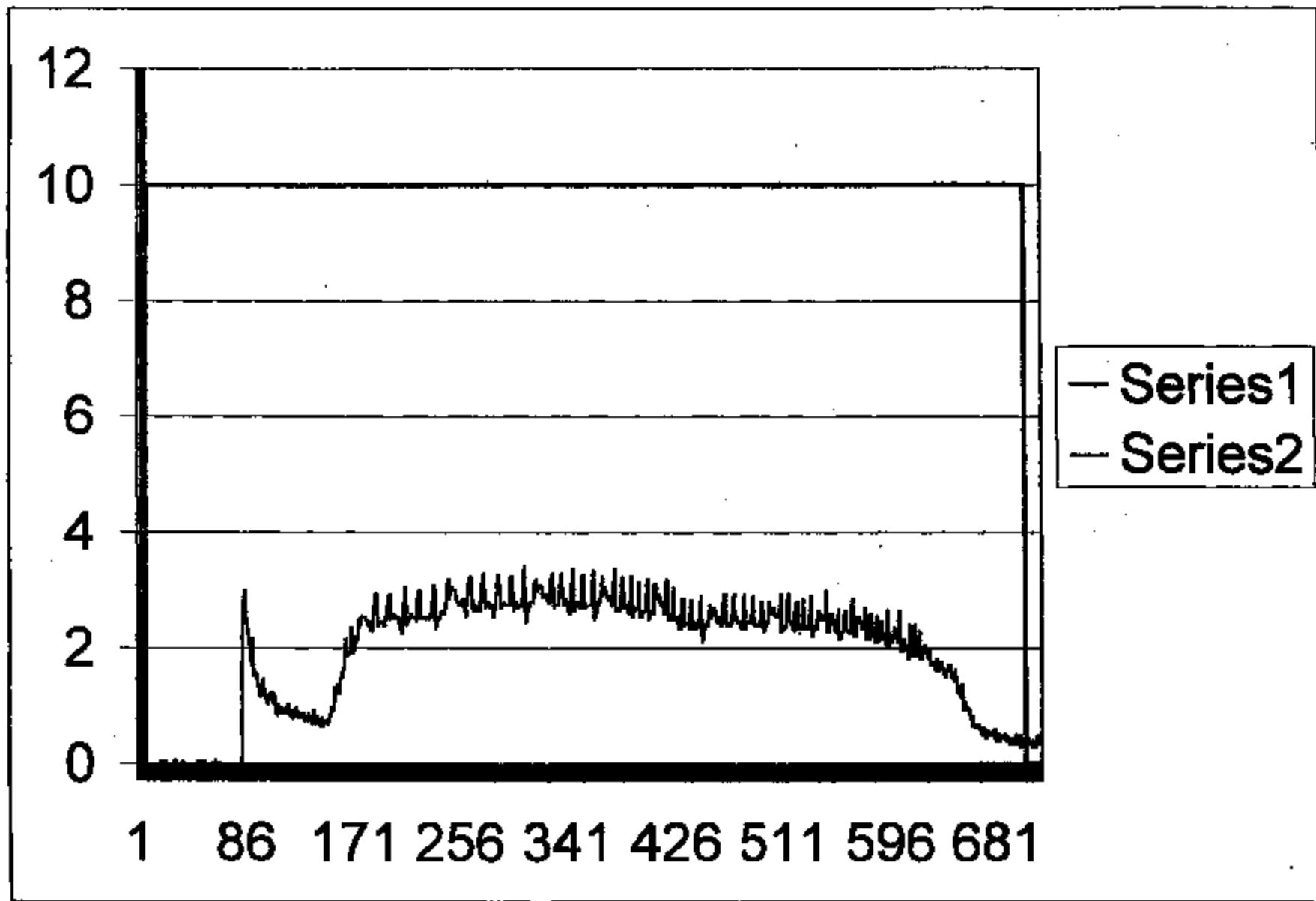


Part H 4 5-5754 unlock 41°C

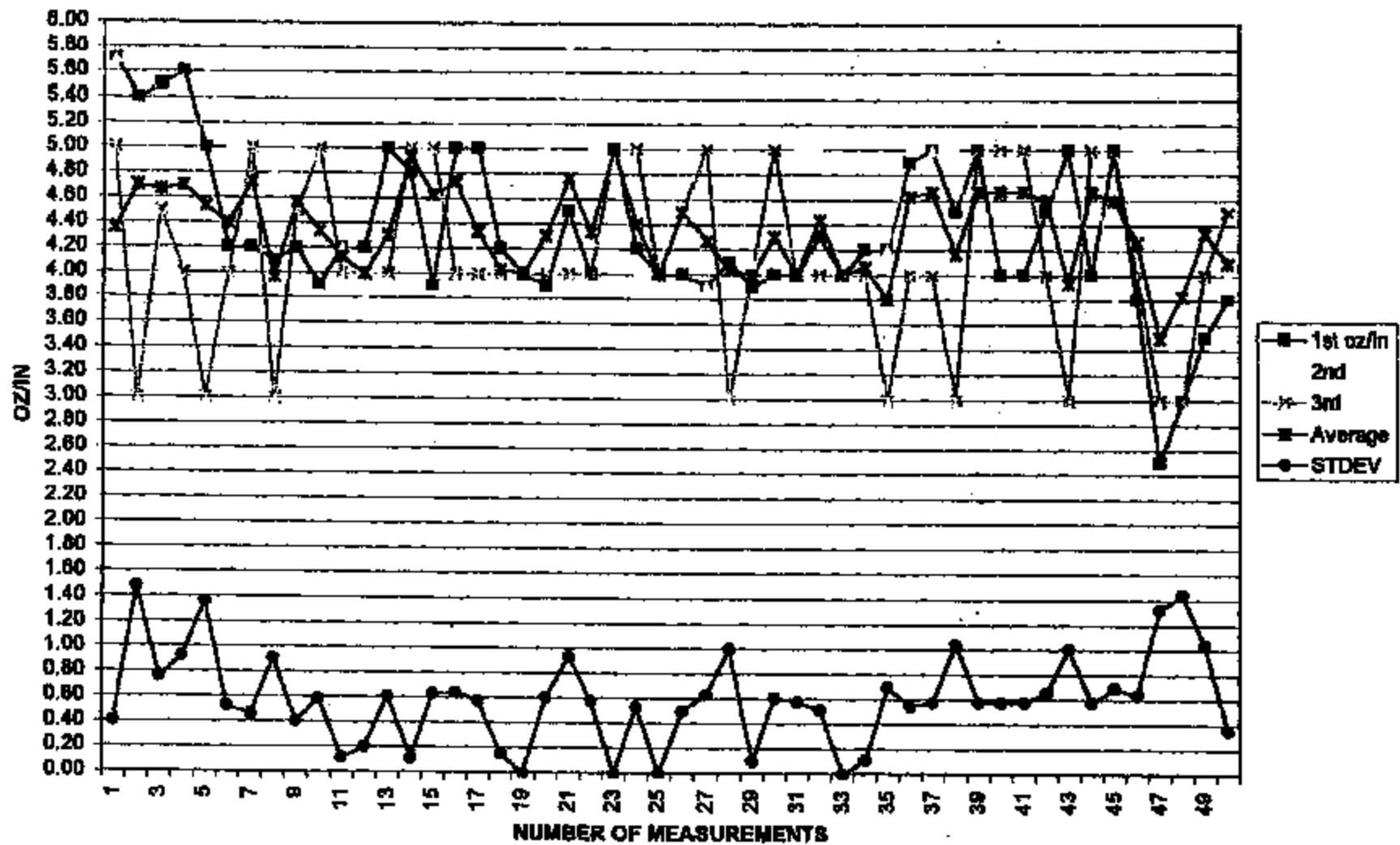


5-5794 unlock 41358





TORQUE



TORQUE OF SAGINAW MOTORS

PART #	1st oz/in	2nd	3rd	Average	STDEV
1	5.70	5.70	5.00	4.36	0.404145
2	5.40	5.70	3.00	4.70	1.479865
3	5.50	4.00	4.50	4.67	0.763763
4	5.80	4.00	4.00	4.70 ²	0.92376
5	6.00	5.60	3.00	4.63	1.381372
6	4.20	5.00	4.00	4.40	0.52915
7	4.20	5.00	5.00	4.73 ²	0.46188
8	4.10	4.60	3.00	3.97 ²	0.907377
9	4.20	5.00	4.50	4.57	0.404145
10	3.90	4.10	5.00	4.33	0.585847
11	4.20	4.20	4.00	4.13	0.11847
12	4.20	3.80	4.00	4.08	0.2
13	5.00	3.90	4.00	4.38	0.608275
14	4.80	5.00	5.00	4.93 ²	0.11847
15	3.90	5.00	5.00	4.63	0.636066
16	5.00	5.20	4.00	4.73 ²	0.64291
17	5.00	4.00	4.00	4.33	0.57735
18	4.20	3.90	4.00	4.03	0.162753
19	4.00	4.00	4.00	4.00	0
20	3.90	6.00	4.00	4.30	0.808275
21	4.50	5.80	4.00	4.77 ²	0.929167
22	4.00	5.00	4.00	4.33	0.57735
23	5.00	5.00	5.00	5.00	0
24	4.20	4.00	5.00	4.40	0.52915
25	4.00	4.00	4.00	4.00	0
26	4.00	5.00	4.50	4.50	0.5
27	3.90	3.90	5.00	4.27	0.636066
28	4.10	5.00	3.00	4.03	1.001665
29	3.80	4.10	4.00	4.00	0.1
30	4.00	3.90	5.00	4.30	0.808275
31	4.00	5.00	4.00	4.00	0.57735
32	4.30	5.00	4.00	4.43	0.51318
33	4.00	4.00	4.00	4.00	0
34	4.20	4.00	4.00	4.07	0.11847
35	4.20	4.20	3.00	3.80 ²	0.69282
36	4.80	5.00	4.00	4.83	0.550757
37	5.00	5.00	4.00	4.67	0.57735
38	4.50	5.00	3.00	4.17	1.040823
39	5.00	4.00	5.00	4.67	0.57735
40	4.00	5.00	5.00	4.67	0.57735
41	4.00	5.00	5.00	4.67	0.57735
42	4.50	5.30	4.00	4.60	0.655744
43	5.00	3.80	3.00	3.83 ²	1.006848
44	4.00	5.00	5.00	4.67	0.57735
45	5.00	3.80	5.00	4.60	0.69282
46	3.80	5.00	4.00	4.27	0.64291
47	2.50	5.00	3.00	3.60 ²	1.322875
48	3.00	5.50	3.00	3.83 ²	1.443375
49	3.50	5.50	4.00	4.33	1.040833

Pink BOB
Purple Wuu

3
50 3.80 4.00 4.50 4.10- 0.3606555
215.50 232.70 207.00 215.83 12.97009
4.34 4.65 4.14 4.38 0.261494

Sensor Systems

Product Test Laboratory
Product Validation Report #: 00-0096
Relay Comparison Test – Rebound Analysis
Delphi Saginaw Electronic Column Lock
Fasco Part #: 1740-0002
Specification #: 26053015
Sample Size: 18
Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Rebound-Relay Comparison	See Details

Tested By: Lori Doyle Date: Aug 8, 00
Technician

Product Test Lab Supervisor: Vickie Thruft Date: 8/8/00

Test Facilities Manager: J. J. Date: 8/8/00

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Sensor Systems

Type of Test:	Engineering Evaluation – Rebound Analysis
Test Log #:	00-0098
Customer/Part Description:	Delphi Saginaw Electronic Column Lock
Fasco Part #:	1740-0002
Test Description:	Verification of Rebound Failures per Test
Sample Size:	18
Build Date:	N/A
Technician:	Lori Hoyle
Start Date:	06/08/2000
Finish Date:	06/18/2000

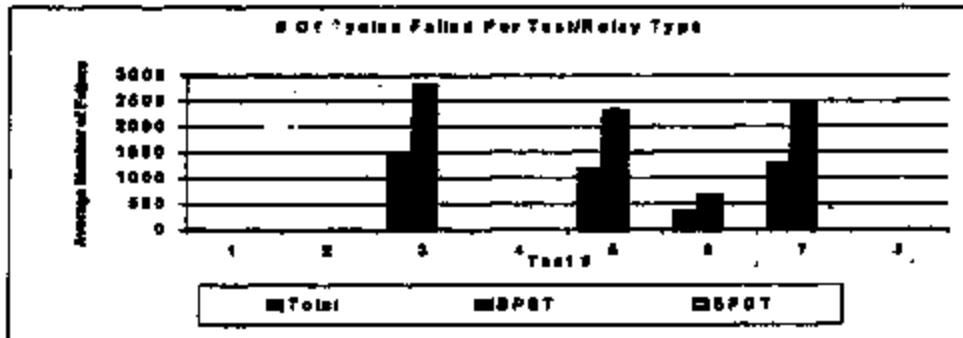
Test Description:

The Delphi Saginaw Electronic Column Lock Assembly was tested under the normal conditions of durability according to Specification #26053015. There are seven individual tests that apply a different amount of stress on the devices. The total amount of cycling applied to these units equates to 50000 powered cycles. One cycle includes an extend and retract of the bolt assembly. This is specified in the specification. For further details on the durability testing, refer to the specification.

Changes were made to the durability tester, which include a relay across the motor of the ECL. Two different relays were used in the test. One relay, a SPST, was used on half of the devices. Another relay, a SPDT, was used on the other half. The SPST's were used to simulate a current model application while the SPDT's were used to simulate a possible change. The purpose was to evaluate the effect rebound and relay play upon the ECL.

Test Analysis

Based upon the data that was gathered during the durability test, it was determined that the SPDT type relay provides better protection against rebound. The graph below shows the average number of cycles per test that the units under test failed due to rebound. The relay type also segregates these.



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Lab Work Request

Date: 05/19/2000

3 hrs

Request By: Dan Thurber

Date needed: 05/19/2000

Part Name: Column Lock cover assembly

Part Number: 17400002

Customer: Delphi Saginaw

Type of Test or Work: Temperature cycle cover assemblies for 1 week between -40 degrees C and 85 degrees C.

Special Requirements:

None

All Areas that are Effectected:

Design Validation

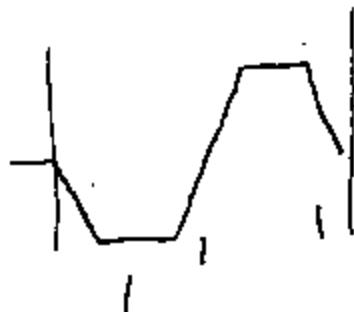
NOTE: You must include all pertinent drawings, prints and specifications along with this document. Failure to do so will cause this request to be returned to sender and delay the project.
[Help](#) [Attachments](#) or [Links](#) Here:

Document History Section:
Document Created on 05/19/2000 by Dan Thurber

8669-2248

12/2/96

Report Log # 00-0103



56 cycles

**PRODUCT TEST LABORATORY
INITIAL AND DAILY SET UP SHEET**

Test Log #: 00-0103
Customer/Product Description: Saginaw Column Lock
Fasco Part #: 1740-0002
Specification #: 26053015

Equipment Used: Environmental Chamber, Labview Data Aquisition
Type of Test: Engineering
Engineer: Steve Davis
Technician: Lori Hoyle

Test Specifications: Soak caps for 1 hour -40°C and 1 hour 85°C. Repeat for 1 week.

Invensys

FASCO

CONTROLS CORPORATION

Sensor Systems

Product Test Laboratory
Product Validation Report #: 00-0096
Relay Comparison Test – Rebound Analysis
Delphi Saginaw Electronic Column Lock
Fasco Part #: 1740-0002
Specification #: 26053015
Sample Size: 18
Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Rebound-Relay Comparison	See Details

Tested By: Lori Key Date: 8/9/2000
Technician

Product Test Lab Supervisor: Vicky Shultz Date: 8/9/2000

Test Facilities Manager: Jeff Date: 8/9/2000

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Sensor Systems

Type of Test:	Engineering Evaluation – Rebound Analysis
Test Log #:	00-0098
Customer/Part Description:	Delphi Saginaw Electronic Column Lock
Fasco Part #:	1740-0002
Test Description:	Verification of Rebound Failures per Test
Sample Size:	18
Build Date:	N/A
Technician:	Lori Hoyle
Start Date:	06/06/2000
Finish Date:	06/16/2000

Test Description:

The Delphi Saginaw Electronic Column Lock Assembly was tested under the normal conditions of durability according to Specification #28053015. There are seven individual tests that apply a different amount of stress on the devices. The total amount of cycling applied to these units equates to 60000 powered cycles. One cycle includes an extend and retract of the bolt assembly. This is specified in the specification. For further details on the durability testing, refer to the specification.

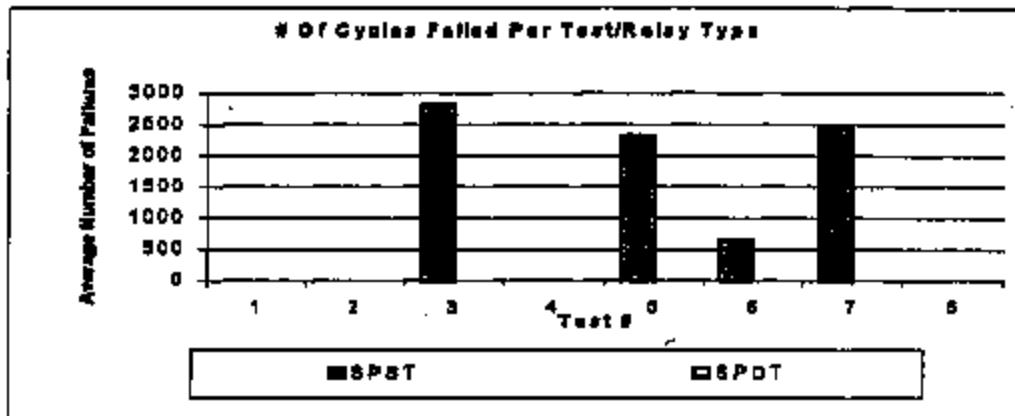
Changes were made to the durability tester, which include a relay across the motor of the ECL in the configuration specified by Saginaw Engineering. Two different relays were used in the test. One relay, a SPST, was used on half of the devices. Another relay, a SPDT, was used on the other half. The SPST's were used to simulate a current model application while the SPDT's were used to simulate a possible change. The purpose was to evaluate the effect rebound and relay play upon the ECL.

Sensor Systems

Test Analysis

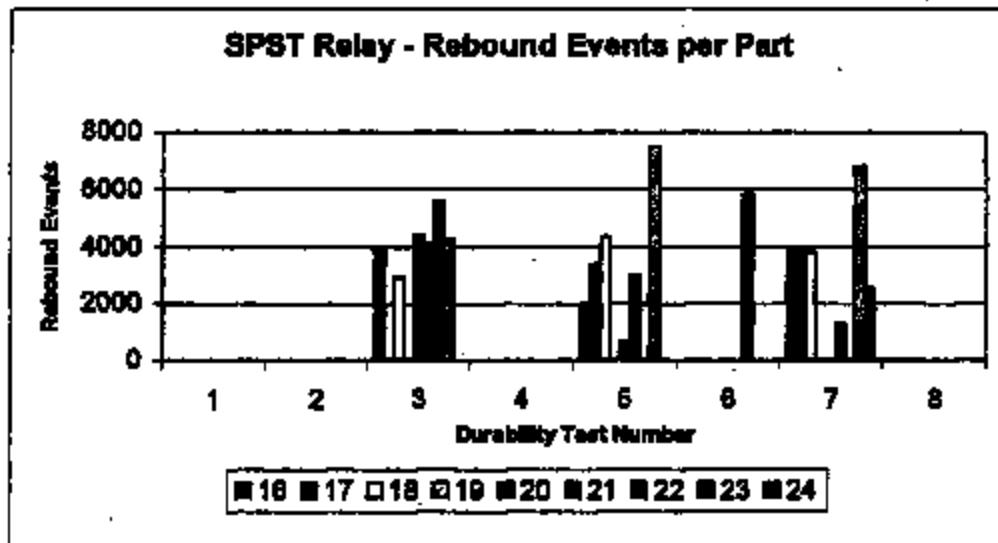
Based upon the data that was gathered during the durability test, it was determined that the SPDT type relay reduces the occurrence of rebound. The Graph A illustrates the number of rebound events averaged over their respective relay type per test.

Graph A



Graph B details the actual number of rebound occurrences per DUT. This is only applicable to the SPST relay type that was used for half of the devices during the durability test. No events for rebound were detected with the SPDT in use for the other half of devices.

Graph B



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invensys

FASCO
CONTROLS CORPORATION

Sensor Systems

Product Test Laboratory
Product Validation Report #: 00-0146
Engineering – Material Evaluation
Delphi Saginaw Electronic Column Lock Lead Screw Assembly
Fasco Part #: 1740-0002
Specification #: N/A
Sample Size: 10
Build Date: N/A

Page #	Table of Contents	Test Results
1	Cover Page	
2	Results of Test	See Details

Tested By: Layton Date: 8/14/00
Technician

Product Test Lab Supervisor: Vicki Tuff Date: 8/14/00

Test Facilities Manager: Layton Date: 8/14/00

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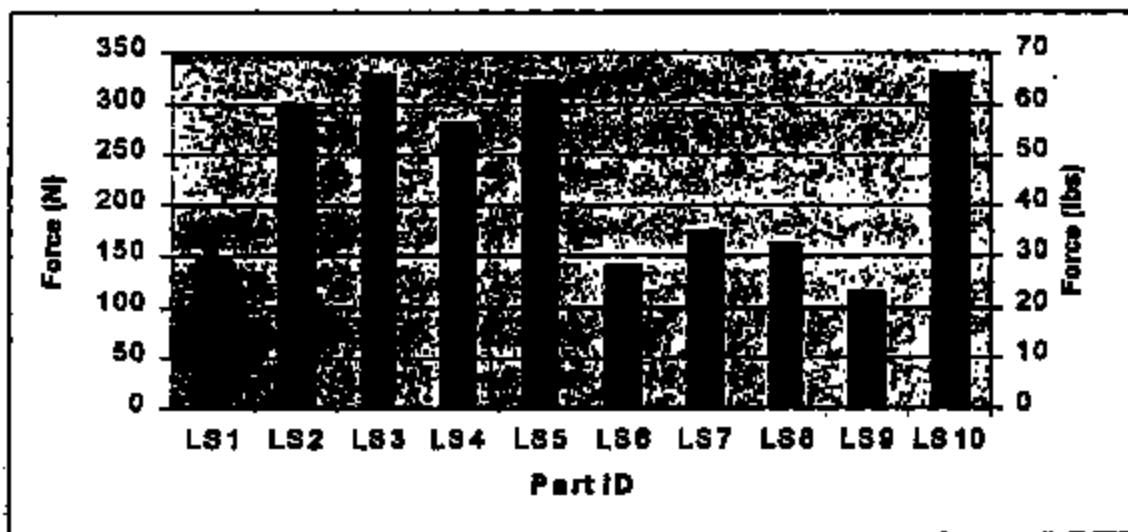
Page 1 of 2
6000-2113
1/10/2000

Sensor Systems

Type of Test: Engineering - Materials Evaluation
Test Log #: 00-0146
Customer/Part Description: Delphi Saginaw ECL Lead Screw Assembly
Fasco Part #: 1740-0002
Test Description: Load Test to Failure
Sample Size: 10
Build Date: N/A
Technician: Larry Kane
Start Date: 08/14/2000
Finish Date: 08/14/2000

Determine ultimate load capacity of various thread materials. Compression test samples in an axial orientation at a rate of 50 mm/sec until failure.

Part #	Force Required for Failure (N)
LS1	127.8
LS2	267
LS3	292
LS4	249.7
LS5	265
LS6	125.3
LS7	155.7
LS8	144.5
LS9	103
LS10	295



Results: Engineer will evaluate results.

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Product Test Laboratory
Product Validation Report #: 00-0195
Engineering Test
Delphi Saginaw Electronic Column Lock Assembly
Invensys Part #: 1740-0002
Specification #: See Test Set-up Page
Sample Size: 12
Build Date: N/A

6 samples of thermo-deburred and 6 control samples.

Page #	Table of Contents
1	Cover Page
2	Test Set-up Page
3 - 5	Analysis of Data

Tested By: Harold Lane Date: 1/26/01
(Technician)

Product Test Lab Supervisor: Vincent Knight Date: 1/26/01

Test Facilities Manager: D. J. F. J. Date: 1/26/01

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Engineering Test
Test Log #: 00-0195
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See Below
Sample Size: 12
Build Date: N/A
Technician: Dennis Byrd / Larry Kane
Start Date: 12/22/2000
Finish Date: 01/09/2000

Set up conditions and parameters:

Test #	Unlock Voltage	Lock Voltage	# Cycles	Load (ft-lbs.)
1	9	9	15	22
2	12	12	1000	11
3	12	12	10000	7
4	9	12.8	9747	None
5	12.8	9	9738	None
6	9	14.2	9737	None
7	14.2	9	9748	None
8	9	9	15	22

Total # of Cycles = 50000

Total Test Time = ~11.5 Days

DUT	Station	Relay Type	DUT	Station	Relay Type
CP1	24	SPST	T1	23	SPST
CP2	22	SPST	T2	21	SPST
CP3	20	SPST	T3	19	SPST
CP4	8	SPDT	T4	7	SPDT
CP6	10	SPDT	T5	9	SPDT
CP8	12	SPDT	T6	11	SPDT

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Product Test Laboratory
1100 Airport Rd.
Shelby, NC 28150



Sensor Systems

Type of Test: Engineering
Test Log #: 00-0185
Customer/Part Description: Delphi Saginaw ECL
Invensys Part #: 1740-0002
Test Description: See page 2
Sample Size: 12
Build Date: N/A
Technician: Dennis Byrd / Larry Kane
Start Date: 12/22/2000
Finish Date: 01/09/2001

Part #	Condition	Test #	Cycle	Temperature	Comments
CP-1	Rebound	All Tests	N/A	> 63°C	Recovered at ~ 13.8°C
	Passed	2,7,8	N/A	N/A	N/A
CP-2	Stuck Lock	1	2	14.91	Recovered cycle 3
	Rebound	3,4,5, & 6	Inconsistent	> 55.5°C	Recovered at ~ 11.4°C
	Passed	2,7,8	N/A	N/A	N/A
CP-3	Stuck Lock	1	3	14.91	Immediate Recovery
	Rebound	3,4,5,6	Inconsistent	> 43.4°C	Recovered at ~ 13.3°C
	Passed	2,7,8	N/A	N/A	N/A
CP-4	Passed	All Tests	N/A	N/A	N/A
CP-5	Stuck Unlock	6	6737	28.33°C	Recovered at Cycle 7388 (81.18°C)
	Passed	1,2,3,4,5,7,8	N/A	N/A	N/A
CP-6	Stuck Lock	5	7291	60.84°C	Immediate Recovery
	Passed	1,2,3,4,6,7,8	N/A	N/A	N/A
77	Rebound	3	4418	73.24°C	Recovered at cycle 8810
	Stuck lock	3	9005	82.54°C	Recover at Test 4 Cycle 2
	Rebound	4	2	44.26°C	Recover at cycle 93
	Rebound	4	718	23.82°C	Immediate SL
	Stuck Lock	4	955	22.94°C	Recovered at cycle 7985
	Rebound	4	7975	82.87°C	Recovered at cycle 8739
	Stuck Lock	5	1049	23.36°C	Recovered at 1201

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Sensor Systems

Cont.

Part #	Condition	Test #	Cycle	Temperature	Comments
T1	Rebound	5	1203	79.6°C	Recovered at cycle 2048
	Rebound	5	4168	60.59°C	Recovered at cycle 6051
	Rebound	5	7290	59.2°C	Recovered at cycle 6317
	Rebound	8	803	53.83	Recovered at cycle 1358
	Rebound	8	3756	58.42	Recovered at cycle 4228
	Rebound	8	7364	81.58	Never recovered
	Stuck Lock	7,8	All	All	
T2	Passed	1 & 2	All	All	
	Rebound	3	4595	82.8°C	Recovered at cycle 6558 (8.05°C)
	Rebound	3	8810	53.56°C	Recovered at cycle 90 of Test 4 (42.92°C)
	Rebound	4	717	23.87°C	Recovered at cycle 1243 (7.01°C)
	Rebound	4	4939	36.26°C	Recovered at cycle 5769 (-4.43°C)
	Rebound	4	7836	68.55°C	Recovered at cycle 9475 (-7.13°C)
	Rebound	5	1127	55.73°C	Recovered at cycle 2208 (1.75°C)
	Rebound	5	4135	47.53°C	Recovered at cycle 5210 (3.70°C)
	Rebound	5	7272	50.00°C	Recovered at cycle 8347 (11.8°C)
	Rebound	5	8414	6.45°C	Immediate Recovery
	Rebound	6	803	53.83°C	Recovered at cycle 1497 (20.68°C)
	Rebound	6	3735	48.13°C	Recovered at cycle 4807 (11.21°C)
	Rebound	6	6781	42.26°C	Recovered at cycle 8927 (12.2°C)
	Passed	7 & 8	All	All	

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Invensys

Sensor Systems

Part #	Condition	Test #	Cycle	Temperature	Comments
T3	Passed	1 & 2	All	All	
	Rebound	3	4807	82.7°C	Recovered at cycle 5883 (32.29°C)
	Rebound	3	9000	82.36°C	Recovered at test 4 cycle 89 (42.26°C)
	Rebound	4	5087	42.15°C	Recovered at cycle 5099 (40.75°C)
	Rebound	4	7913	81.88°C	Recovered at cycle 8284 (43.02°C)
	Rebound	5	1209	80.29°C	Recovered at cycle 1657 (44.82°C)
	Rebound	5	1636	43.24°C	Recovered at cycle 1826 (35.57°C)
	Rebound	5	4218	81.37°C	Recovered at cycle 4374 (83.84°C)
	Rebound	5	7418	82.03°C	Recovered at cycle 7884 (43.14°C)
	Rebound	5	7947	42.98°C	Recovered at cycle 8295 (16.82°C)
	Rebound	6	829	78.91°C	Recovered at cycle 1342 (24.43°C)
	Rebound	6	3268	78.09°C	Recovered at cycle 4933 (-4.80°C)
	Rebound	6	7385	81.44°C	Recovered at cycle 8765 (12.87°C)
	Rebound	7 & 8	All	> 78.7°C	Always recovered when temp dropped below 12°C
T4	Passed	1,2,3,4,5,6 ,7, & *	All	All	
T5	Passed	1,2,3,4,5,6 ,7, & *	All	All	
T6	Passed	1,2,3,4,5,6 ,7, & *	All	All	

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