EA02-025

TEXAS INSTRUMENTS, INC.'S

9/10/03

REQUEST NO. 7

BOX 9

PART A – R

PART K

Brake Pressure Switch Test Log, Updated 7/22/99

Category	Test	Location	Test Parameters	Results Update
Lab Simulation	1	TI	Vary water concentrations in "new" Brake Fluid	200+ hours, Current draw in the 0.5mA to 5mA range
of Potential Ignition			14Vdc to one terminal, hexport grounded	Fluid has discolored.
in Switch			Water Conc: 4%, 5%, 10%, 70%	No Significant Temperature Rise. Test Suspended.
				Internal Analysis suspended.
	2	TI	New Brake Fluid	200+ hours. Constant temperature.
			1 Amp through switch terminals	No significant temperature rise with time
			14Vdc to one terminal, hexport grounded	Test Suspended.
	3	AVT	new/ Brake Fluid in Switch, 24 VDC to one	> 300 hours into test, max current 7mA
			terminal. Hexport Grounded	No significant change with time. Test ongoing
	4	AVT	new/ Brake Fluid in Switch, 24 VDC to one	10 hours into test max current 5mA
			terminal. Hexport Grounded, Ambient at 100 C	No significant temperature rise with time. Test suspended.
	5	AVT	new/ Brake Fluid in Switch, 10 Amps	Temperature rise of 20 C above room temp
			Through switch terminals	Delta T reached steady state at 20 C. Test suspended.
	5a	AVT	new/ Brake Fluid in Switch approx. 30 Amps	Temperature rose to approx. 270 F. No smoke. No ignition
			through Switch Terminals	Test suspended.
	6	TI	Build heater elements into Switch.	3 tested. Smoke observed, ignition observed on part w/heater
			Heat til failure, include sparking.	See attachment
			(1) w/ solution of Brake Fluid and 5 wt. % H_2O	Test complete
				Brake fluid in cavity slows down heat build-up.
				Smoke observed at 675 F, Glass melts and falls off at 800 F
	6a	TI	Create heater by corroding spring wire	One out of 15 devices increased resistance to 5 ohms.
			Salt water solution, 14V between spring	Others either very low resistance or degraded.
			and hexport	It took about 100 hours to reach the 5 ohm stage.
				The 5 ohm device ignited under conditions similar to test 6.
	6b	TI	Re-run ignition test to understand	Switch ignition with repeated 5% water solution into switch
			repeatability and current path.	Current path is through hexport.
				See pics and video.
				Additional test include tap water, old BF, new BF and other.

Brake Pressure Switch Test Log, Updated 7/22/99

	6c	TI	Pure 'new' brake fluid with metal shavings	Metal shavings do not contribute significantly to brake fluid conductivity
Life Cycle Reliability of Pressure Switch	7	TI	0-1450 psig pressure pulses at 130C per ES	First leak observed at 728,800 cycles. Test Completed. See attached Weibull Chart.
Diaphragm Wear	8	TI	0-1450 psig pressure pulses at 130C	Parts withdrawn every 200k cycles, characterized for wear
Field vs Lab Correlation	9	Central Labs	Field returns, from dealer lots, junkyards	Parts in Central Labs, see Ford spreadsheet
Design Of Experiments (1) Evaluating Factors Effecting Diaphragm Wear Impulse test	10	TI	Vary water concentrations in 'new' Brake Fluid 12 snap + 12 quiet switches w/ 0 % water in BF 12 snap + 12 quiet switches w/ 3 % water in BF	Test Report being written investigation continues. Suspended at 1.3 million cycles with no leaks observed. Snap samples suspended at 1.3 million cycles with 2 leaks observed at 1.2M. Quiet samples suspended at 580k cycles to assess filtering anomalies.
On-Vehicle Characterization of Pressure & Temperature Profile in Town Car	11	AVT	Monitor Pressure and Temperature at Switch Location for ABS and non-ABS braking events.	Test at AVT.....see Ford charts...>600k in car?
Brake fluid analysis Used fluid at master cylinder.	11a	TI	Analyze used brake fluid at the master cylinder (UMC), used brake fluid at the caliper (UCA) and new brake fluid (NEW) for metal and water content.	Test complete. UMC: Cu = 415 (ug/ml), Fe = 3.8 (ug/ml), Cr = 0.08 (ug/ml), 1.1 %H2O. UCA: Cu = 532 (ug/ml), Fe = 6.5 (ug/ml), Cr = 1.0 (ug/ml), 1.1 %H2O. NEW: Cu = <0.01 (ug/ml), Fe = 0.02 (ug/ml), Cr = <.01 (ug/ml), 0.3 %H2O.
Spark Arc Study	12	Central Labs	Determine if arc/spark forms in switch using clutch loads and high speed video. Use dry switches as well as switches with various brake fluid water mixes.	Equipment set-up in progress at Central Labs. TI Experimented with no 'significant' sparks observed
Characterization of switches retrieved from field junkyards & other sources	13	Central Labs	Characterize electrical, mechanical and chemical aspects of returned switches	Data log and analysis procedure set up complete. Analysis of switches in progress.
Fluid Ignition Tests	13a	TI	Repeat ignition simulation with different fluids. (3) hour tests: 5% NaCl in tap water rain water	Test complete. 5% NaCl sample resulted in an ignition. All brake fluid samples drew less than 3 mAmps. No corrosion visible on brake fluid samples.

Brake Pressure Switch Test Log, Updated 7/22/[illegible]

			(24) hour tests:	Rain water and tap water samples drew <10 mAmps and showed
			tap water	some signs of corrosion.
			used brake fluid	Chemical anlysis in process.
			used brake fluid w/ 5% H_2O	
			new brake fluid	
			new brake fluid w/ 5% H_2O	
Design Of Experiments (2)	13b	TI	Vary water concentrations in 'new' Brake Fluid	Test suspended. Analysis in process to assess test fixturing.
Repeat of test 10			10 amp + 20 quiet switches w/ 0 % water in BF	
			10 amp + 20 quiet switches w/ 5 % water in BF	
Compatibility of Kapton	14	Dupont	Characterize change in properties of Kapton	Test in progress ([illegible]) hours completed. - Oxalic acid shows
with Oxalic Acid			with various % oxalic acid in brake fluid.	similar effects that water has on Kapton properties.
Evaluation of Plastic	15	TI	Assess properties and moldability of different	Test suspended.
Materials with Improved			grades of plastic resin with additives	Celanese and Noryl ignited 3/5 and 2/5 trials
Parameters			to improve plastic part performance	ZYTEL samples tested 1/5 ignitions
Long duration brake fluid	16a	TI	(4) samples with new brake fluid	Test suspended ([illegible]) hours completed.
ingress test.			(2) samples with used brake fluid	Used brake fluid current dropped off to <1/10 mAmp.
				New BF ingress current can increase w/ time under cont. power.
Evaluation of Switch	16b	TI	Assess ignition sensitivity to switch orientation.	Test complete. Ignition is independent of switch orientation.
Orientation			Test vertical versus 45 degree.	Simulated switch ignition can occur in vertical or 45 degree angle.
			Test rotational sensitivity in 45 deg. orientation.	Ignition appears not sensitive to switch rotational alignment.
Relay Circuit	16	TI	Repeat test 13a in Ford relay circuit for (48) hrs.	Test complete. No ignition. Corrosion rate drastically reduced.
Test			Bring switch to impending ignition in (10) Amp	Insufficient power in circuit to create or move toward ignition in lab
			circuit then place in relay circuit for (10) hrs.	Heater element was warm to the touch.
			Input max. circuit power into heater on switch.	
Long duration brake fluid	17	TI	(10) samples filled with new brake fluid	Test suspended. ([illegible]) hours completed.
ingress test number 2.			(1) hour of vibration per day	Average ingress current is 1.[illegible] mAmp (stdeviation = 1.[illegible] mAmps)
			(1) hour soak at 100 deg C per day	

TI-NHTSA 014286

Date Code	Device	Sensor	Base	Pin	Offset	Incoming	Vacuum	P.T.
9120	77-2					No Continuity	N/A	Pass
9102	77-3	0.048	0.0908	0.143	-0.0028	No Continuity	N/A	Pass
9096	77-4	0.0465	0.0901	0.143	-0.0026	Good	N/A	Pass
9098	77-5	0.04545	0.0914	0.144	-0.00285	No Continuity	N/A	Pass
9076	77-6	0.04825	0.0929	0.1446	-0.00355	Good	No Continuity	Pass
9098	77-7	0.0469	0.0912	0.144	-0.0031	No Continuity	No Continuity	Pass
9096	77-8	0.0457	0.0909	0.1435	-0.0031	Good	Intermittent	Pass
9095	77-9	0.0465	0.0895	0.1434	-0.0016	Good	Good	Pass
9096	77-10	0.04625	0.0904	0.1428	-0.00285	No Continuity	No Continuity	Pass
9096	77-11	0.0469	0.0914	0.1427	-0.0046	Good	No Continuity	Pass
9096	77-12	0.0525	0.0899	0.1422	-0.0072	No Continuity	Intermittent	Pass
9096	77-13	0.0492		0.1441		No Continuity	No Continuity	Pass
9095	77-14	0.0494	0.092	0.1436	-0.0048	No Continuity	Good	Pass
9042	77-15	0.0512	0.0926	0.1437	-0.0073	Good	Good	Pass
9095A	77-16	0.0493	0.0912	0.1437	-0.0068	No Continuity	No Continuity	Pass
9140	77-17	0.0471	0.0916	0.1417	-0.004	Good	Good	Pass
9095A	77-18	0.0516	0.0916	0.1417	-0.0095	No Continuity	No Continuity	Pass
9095A	77-19	0.0516	0.0956	0.1436	-0.0096	No Continuity	No Continuity	Pass

Pin - (Sen + Base + A)

Device	Sensor	Base	Pin	Offset	
1	0.0452	0.0902	0.14	-0.0024	
2	0.0463	0.0919	0.1413	-0.0039	
3	0.0463	0.0902	0.1407	-0.0028	
4	0.0458	0.0917	0.1411	-0.0034	
5	0.0463	0.091	0.1411	-0.0032	
6	0.0455	0.0923	0.1417	-0.0031	
7	0.0464	0.0915	0.141	-0.0039	
8	0.0508	0.0865	0.141	-0.0063	Kapton snap/rattler
9	0.0465	0.0912	0.1409	-0.0038	
10	0.0464	0.091	0.1411	-0.0033	
11	0.0498	0.0913	0.141	-0.0071	Kapton snap/rattler
12	0.0464	0.0911	0.1408	-0.0037	
13	0.0458	0.0918	0.1416	-0.003	
14	0.0475	0.0915	0.1424	-0.0036	
15	0.0458	0.0918	0.1417	-0.0029	
16	0.0457	0.0915	0.142	-0.0022	

LF

Device	Sensor	Pressure	Base	Pin	Offset		
1	0.0452	0.0455	0.0902	0.14	-0.0024	-0.0027	
2	0.0463	0.0464	0.0919	0.1413	-0.0039	-0.004	
3	0.0463	0.0466	0.0902	0.1407	-0.0028	-0.0031	
4	0.0456	0.0462	0.0917	0.1411	-0.0034	-0.0036	
5	0.0463	0.0466	0.091	0.1411	-0.0032	-0.0035	
6	0.0455	0.0458	0.0923	0.1417	-0.0031	-0.0034	
7	0.0464	0.0467	0.0915	0.141	-0.0039	-0.0042	
8	0.0508	0.0467	0.0885	0.141	-0.0053	-0.0012	Kapton snap/rattler
9	0.0465	0.0466	0.0912	0.1409	-0.0038	-0.0041	
10	0.0464	0.0467	0.091	0.1411	-0.0033	-0.0036	
11	0.0498	0.0464	0.0913	0.141	-0.0071	-0.0037	Kapton snap/rattler
12	0.0464	0.0466	0.0911	0.1408	-0.0037	-0.0039	
13	0.0458	0.0462	0.0918	0.1416	-0.003	-0.0034	
14	0.0475	0.0454	0.0916	0.1424	-0.0036	-0.0025	
15	0.0458	0.046	0.0918	0.1417	-0.0029	-0.0031	
16	0.0457	0.046	0.0915	0.142	-0.0022	-0.0025	

Customer Returns

Switch ID	Atmosphere	Vacuum open (in of water)	Atmosphere
11	closed	12.00	11.50
12	closed	closed *	closed
13	closed	11.00	9.50
14	closed	8.00	7.50
15	closed	closed *	closed
16	closed	7.50	6.50
Average:		9.63	8.75
STD		2.21	2.22
MAX		12.00	11.50

Procedure:
1) Subject switch to 60psig.
2) Check cont at atmos pressure
3) Subject to vacuum.
4) Record vacuum pressure at cont loss.
5) Decrease vacuum and record pressure at cont.
6) Measure cont at atmos pressure.

* max vacuum of 29.9 inches achieved.

Line Fallout

Switch ID	Atmosphere	Vacuum open (in of water)	Atmosphere
LF1	closed	16.00	15.00
LF2	closed	13.00	10.50
LF3	closed	12.50	11.50
LF4	closed	14.50	13.50
LF5	closed	12.00	8.50
LF6	closed	13.00	11.50
LF7	closed	22.00	20.00
LF8	closed	closed*	closed
LF9	closed	11.00	9.00
LF10	closed	9.00	6.00
LF11	closed	14.00	OPEN
LF12	closed	23.00	21.00
LF13	closed	14.00	10.00
LF14	closed	28.00	14.00
LF15	closed	27.00	25.00
LF16	closed	20.00	18.00
Average:		16.67	14.04
STD		6.15	5.86
MAX:		28.00	25.00

2:30 PM7/22/99

"STORY" OF THE PROCESS

- WHAT COULD CAUSE A FIRE
- CAN LEAKAGE SURFACE FLUID
- HIGH TEMP → SOLV E-SYSTEM
  - INJECTING
- O_2
- SPARK

→ HOW → CORROSION → HEATING → MELT PLASTIC

→ SOURCE OF POWER

- H_2O
- CHEMICAL
-

POWER —

—

—

CY 91 | CY 92 | CY93

Disc Δ's

Plastic Δ's — Genotype / Learner

GTX 830

Equipment??

46445 Base History

TI-NHT8A 014291

QUIET → L3-1

SNAP → L2-1

PLASTIC

(3)

- ANOTHER) TEVES → GROUND W/ LEAK

-

DOCUMENTATION DOW STATE PAPER

OLD BRAKE FLUID - INHIBITORS -

WILL CORRODE METALS -

- USE OLD FLUID?

---

93 TOWN CAR ---- SAMPLE

PRETTY TOUGH TO LIVE w/ BF

PLASTIC PROBABLY 2 U

EASIER

MEMPHIS VEHICLE

EXPLAIN ISSUES

?? GOOD

→ TURN CURB PROBLEMS

TI-NHTSA 014295

OXALIC ACID

(2)

LA [illegible] — M/C [illegible]

CAN WASH [illegible] [illegible]

OXILIC ACID — [illegible]

PHOSPHATES [illegible] [illegible] M/C

MAYBE CAN WASH STUFF

MAYBE [illegible] OXILAN [illegible]

PROCESS

~~SCI [illegible] — [illegible] [illegible] [illegible] —~~

FOIL GREEN STUFF — [illegible] HOPKINS —
& SLUDGE JENSEN [illegible] N. LAPORT [illegible]?
REN [illegible] [illegible]

JOBS WORKED → STA ELECTRICAL

FMEA

– JUSTAN

– FIELD

– LAB imports

– FORM imports

FFF – M&CRN

C/A – TRACKWISE

CONC MGT

IPDs

PLANS

REPAIRS

COACHING

TEAM COMMUNICATION

(5)

WERE SEEN @ cycles (1/fan
@ events 1/rex)

QUANTITATIVE WAY TO
CHARACTERIZE ~~WATER~~

VEHICLE ~~HISTORY~~

~~LIST OF DEFS~~

~~FE~~

What happens to the contacts with
without contacts
[illegible] in speed

DRAWINGS AVAILABLE UPON REQUEST

McGuirk, Andy

From: ~~Rahman, Aziz~~
Sent: ~~Thursday, February 11, 1999 11:56 AM~~
To: TO McGuirk, Andy; Beringhause, Steven; Baumann, Russ; Dague, Bryan; Douglas, Charles; Sharpe, Robert; Sullivan, Martha; Rowland, Thomas; Baker, Gary RAHMAN, AZIZ
Subject: 77PS Day 2, 2/10/99 Summary

Day 2, 2/10/99 Highlights

Main event of the day was a team meeting to prep for the Executive Technical Review on 2/11. Joe Nemi of Large Vehicle Safety Group led the meeting. There were a lot of participants, including Fred Porter, Tom Masters from Engineering, Norm LaPointe AVT Design Analysis, Steve LaRouche from CRL, Ford legal folks, wiring, connector etc. TI was the only supplier represented.

TI is not invited to the Tech Rev. (whew?!)
Tech Rev will be a high level, broad overview of Town Car Underhood Fires
Numbers Joe has thus far:
  149 Underhood Fires, Thermal Anomalies, Thermal Events
  39 with engine off, 9 with engine on, no information on the rest
  5 possible related to the Brake Pressure Switch (BPS), 17 potential other root causes, no information on the rest
  Other root causes from above line : 42 way connector, EEC wire harness, Relay pack.
At this point NHTSA response required on BPS, F2VC part only. Others may follow
Lengthy discussion on approach for the review. General consensus that presentation from technical side should be broad based, since sufficient info is not available for any deep dive.
General consensus that we need a lot more parts back from the field that were involved in these events.Oasis message discussed.
Someone inquired about TI answers to questions from last meeting. I responded that I had provided the information to Fred and Steve Reimers, and they acknowledged. Two other questions for TI:
  Does TI sell the switch directly to aftermarket, like auto part stores. I replied that most probably not. We would go through Ford Service Parts for service parts. **Is that accurate Charlie?**
  Does TI have fire experts on site who can determine origin of fires, as in experts who work on structural fires. I replied in the negative, but said I would follow up. Any inputs? Intent was to answer repeatedly asked question: Do we know where the fire originated. Outside - in, inside - out, what burned first, brake fluid, or plastic base??

Joe's meeting was followed by a vigorous brainstorming session with Fred, Tom, Norm, Steve & Len. This was all technical and I actively participated.
  I reviewed TI report PS/98/14 on weibull life of quiet switch showing first leaker at 900k+ cycles. Gave copy to Norm. Bryan, need weibull data quickly on pass-car snap switch.
  I reviewed our finding that the 92 through 97 Town Car, Grand Marquis, Crown Vic platforms had prop valve mounted switches and that in vehicles with ABS option, the prop valve is located downstream of the ABS module.
  There was considerable discussion on pressure profile at such a location with Len saying that the switch probably sees full pressure reversals. We agreed that I would contact Teves for more info.
  We discussed formation of electrolytic cell with Brake Fluid in the base cavity, and how a low resistance path to ground could be formed. Discussed the wattage available with a 15A fuse and 14Vdc system. Is that sufficient to generate enough heat through the ground path.
  Discussed CRL analysis of Memphis part, and gave copy of Al's report to Norm. Bryan, per Norm, Al retained "spoonfuls" of the corrosion residue. Do you know if Al has done any compositional analysis (IR) as opposed to elemental only?
  Kept getting back to source of fire. Ford has not yet been able to create a fire in a switch. Team decided that pulling in Dow Chemical was key to understand if we can create a fire with given constraints.
  I will start exposing the resistivity test here to temperature 2/11.

To Sam

TEVES - PRESSURE WAVE @ PUMP VALVE

WE CAN DELIVER AN IMPROVED SWITCH

---

without ff testing process

TI-NHTSA 014307

TEVES - PRESSURE WAVE @
PUMP VALVE

WE CAN DELIVER AN IMPROVED
SWITCH

intent of testing process

TI-NHTSA 014308

currently process controls

first tests data —

W95

— C&E diagram

— try to ignite the brake fluid

— plastic

— letter #1 — e-mail

— letter #2 overview e-mail

— C&E ? ←

focus on 2 ways 100°C 0.1 m@

fporter@ford.com...

MY 99 — No Brake System

—

3 SWITCHES FROM JUNXGANOS (TEXAS?) WHICH DO NOT SHOW SIGNS OF ELECTRICAL OPERATION

---

* IS THIS SOMETHING NEW?

* CONTAMINATION THRU CON SEAL

CORROSION

---

* RUBBER BOOT AROUND CONNECTOR BODY.....

— WISH WE COULD HAVE EXTRA INSULATION IN SWITCHES

* FUSE / LIMIT ELECTRICALLY ✓

* FIRE RETARD / HI TEMP ✓

TI-NHTSA 014310

8/2/99

DELIVERABLES

DUPONT KAPTON INFO ✓] — STEVE/ANDY — IP TUE/ WEDS

HIGHER MELT TEMP]
HIGHER IGNITION TEMP] ← BRYAN — NORM —] WOL

☆ INSULATE CUP] ← MEMO TO FORD W/ ANDY DEFINITIVE CAUSE/SOLUTION

TEST OXALIC ACID] — STEVE/BRYAN/AL
10 AM —

☆ CONNECTOR BODY] — ?? WHAT DID FORD DO?

ODD P/S .... JUNKYARD?]
25-35 M Ω] H2O INTO CONNECTOR BODY ...

— OBTAIN BARREL W/O INHIBITORS — ANDY

QUIET /STD SWITCH —] WHO WAS SUPPLY CHAIN? — ANDY
92 93

IMPROVED LIFE SWITCH DEVICE] — STEVE

☆ ELIMINATE GROUND] — ANDY
HOSE IDEA ← HEAT ELECTROLYSIS

☆ CURRENT LIMIT TO 3/4 A] — ANDY
& OFF POWER SOLENOID

TI-NHTSA 014311

STACK ABOVE
STRESS BALLOTIC &
CAUSE STRUT - SPRING
FAILURE ?

TI LOOKING HERE
GOOD ON THIS -

TI CAUSES
OR SOMETHING ?
- NO - NOT THAT
THINKING THAT
- NO 10 B $
CLOUD
BEING
- BUILT TO
8 AC - 12C
50% -
PARBOND

- PULL SWITCH
- EXTENSION -
- NEW SWITCH INSTRUCTION
- BRAKE PEDAL

OTHER THINGS
CAUSING UNDERSTOOD
FIRES @ FORD

TI-NHTSA 014312

Correction — ?

— Not only consideration

.3 G deceleration on firm stop

Foot Pressure — Fluid Pressure

— Stop switch [illegible]

— Pressure [illegible] [illegible]

---

300 PSI normal stop

MEMPHIS - MAY CONTACT BARLEW

PRICE CAR - SPARK BROKEN

BRAKE FLUID - CORRODE & [illegible] OFF

CAUSES LOW RESISTANCE TO GROUND
(NOT CONFIRM)

BNC OFF B/F – HEAT.

MELT – IGNITE

C/A
– ISOLATE FROM GROUND
– NO KNOWN POTENTIAL – STATIC?
– 10 MEG CONNECTION DRAIN
– CURRENT LIMITING ?

Dec

DOW — USES OLD FLUID.......

— W/O RUST INHIBITORS

└ BARRIER

USE FIRE RETARDENT PLASTIC FOR SWITCH HEAD....

IMPROVED LIFE —

INSULATED CUP

- RETAINERS / LAMINATE

- CAVE / WORDS

INFREQUENTLY LOT

TI-NHTSA 014317

OXALIC ACID (WE?)

MELT TEMP
GE FIRE RETARDENT

INSULATE CUP

CHLORIDE TO B/F
EROSION INHIBITORS

TI-NHTSA 014318

- SWITCH CAN CONFORM
- O2O, NO RUST INHIBITORS

- PATH N GROUNDS...

F "BB"

1280A

91 280A

BROWN
NATURAL

313 8453722

TI-NHTSA 014319

Snap

Quiet

Device: 77PS	Test Type: Impulse	Test #: - -	
Start Date: 5-6-99	Start Time: ~0930 HRS		
Start Temp: 135 deg. C	Min. Pressure: 0-500 psi	Max. Pressure: 1400 psi	
Frequency: 2 Hz	sec. Per cycle: 7 sec	Length of Test: HRS - T.1 Failure	
# of cycles:	End Date:	End Time: HRS	

Date	Time	T1 Temp	T2 in C	Pressure psi	Counter AVG master	Counter AVG @[illegible]	Counter AVG 100% sol	Frequency Hz	Actions
5 6 99	1030	135.5	135.1	0-1405	10.5K		10.5K	2.0	Test was started pressures were
									set, plots were Taken
5-6	1600	135.5	135.5	0-1407	52k		52k	2	check [illegible]
5-9	0645			STOP	570K		1386K	STOP	leaker, defective piston
									Replace piston, remove +
									replace 1-G1 part
5-9	0930								fire up chamber
	1010	135.2	135.1	0-1410	Reset		1486K	2.0	cycle, plot
5-9-99	1:00 PM	135.2	135.1	0 1410	Reset		1490.4K	2.0	Remove failed G2 part @
									1 of each Group Below Failure
5-9-99	2:35 PM	134.6	135.4	0-1410	6000		1596K	2.0	Remove failed G3 [illegible]
5-10	0900	135.5	135.5		6K		1594K	2.0	Re-start
5-10	0901	135.5	135.5		6K		1597K	STOP	leak -- stop test
									Remove + open
									parts -- compare
									parts w/ connector to
									parts w/o connector
									G1

T1 - Ambient
T2 - manifold surface mounted T.C.

TI-NHTSA 014322

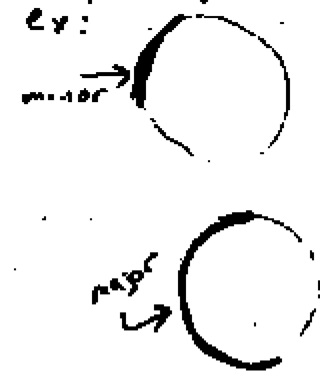
Group	1 F	1 K	1 C	2 F	2 K	2 C	3 F	3 K	3 C	w/converter F	w/converter K	w/converter C	w/o converter F	w/o converter K	w/o converter C	Total F	Total K	Total C
group 1	1 *	2 L	2	2	2	2	2	3	3	5	7	7	—			5	7	7
	1	0	0	0	0	0	0	0	0	—			1	0	0	1	0	0
	1 *	3 L	2	3	3	3	3	3	3*	7	9	8	—			7	9	8
	1	2	2	0	0	0	0	0	0	—			1	2	2	1	2	2
	2	2	2	0	0	0	0	0	0	—			2	2	2	2	2	2
	1	0	0	0	0	0	0	0	0	—			1	0	0	1	0	0
	1	2	2	0	0	0	0	0	0	—			1	2	2	1	2	2
	1	0	0	0	0	0	0	0	0	—			1	0	0	1	0	0
	1	2	2	0	0	0	0	0	0	—			1	2	2	1	2	2
	3 *	3 L	3	3	3	3	3	3	3	9	9	9	—			9	9	9
TRS	13	4	15	8	8	8	8	9	9	21	25	24	8	8	8	29	33	32
group 2	1	0	0	0	0	0	0	0	0	—			1	0	0	1	0	0
	1	2	2	0	0	0	0	0	0	—			1	2	2	1	2	2
	1	0	0	0	0	0	0	0	0	—			1	0	0	1	0	0
	1	2	1	0	0	0	0	0	0	—			1	2	1	1	2	1
	1	2	2	0	0	0	0	0	0	—			1	2	2	1	2	2
	1	2	2	0	0	0	0	0	0	—			1	2	2	1	2	2
	1	0	1	0	0	0	0	0	0	—			1	0	1	1	0	1
	1 *	0	1	0	0	0	0	0	0	1	0	1	—			1	0	1
	2 *	2	2	0	0	0	0	0	0	2	2	2	—			2	2	2
	1 *	2	1	0	0	0	0	0	0	1	2	1	—			1	2	1
TRS	11	12	12	0	0	0	0	0	0	4	4	4	7	8	5	11	12	12
group 3	1	0	0	0	0	0	0	0	2	—			1	0	2	1	0	2
	2	2	2	0	0	0	0	0	0	—			2	2	2	2	2	2
	1	2	2	0	0	0	0	0	0	—			1	2	2	1	2	2
	1	2	1	0	0	0	0	0	0	—			1	2	2	1	2	2
	1	2	1	0	0	0	0	0	0	—			1	2	1	1	2	1
	1	0	0	0	0	0	0	0	0	—			1	0	0	1	0	0
	1 *	2 L	2	1	1	1	2	2	3	4	5	6	—			4	5	6
	1 *	0	0	0	0	0	0	0	0	1	0	0	—			1	0	0
	1 *	0	1	0	0	0	0	0	1	0	0	2	—			0	0	2
	1 *	2 L	2	2	2	2	2	2	2	5	6	6	—			5	6	6
TRS	11	12	11	3	3	3	4	4	8	10	11	14	7	8	8	17	19	22

F: fluid side
K: Kapton
C: converter side
Kapton 1: fluid
Kapton 2: middle
Kapton 3: converter

group 1: virgin parts
group 2: line vacuum
group 3: Rapid vacuum

Scores:
1 = delam w/ hole(s)
*2: Cracks/Leaks (minor)
3: Cracks/Leaks (major)

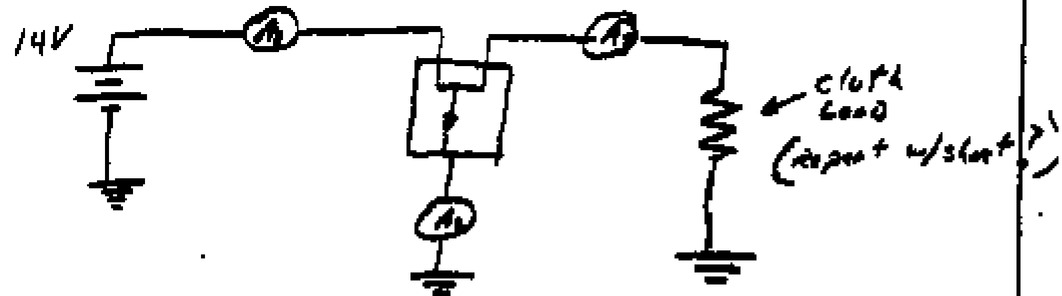
*A minor crack/leak covers less than ~30% of perimeter
ex:



* = w/ connector   L = leaked

THHT8A 014323

Burn Test:



Procedure:

1. Measure Ω w/Power Disconnected.
   - Terminal to Terminal
2. Fill w/ 5% solution
3. Record all (A)
3b. Record Temperature
4. Run till Dry (2 - 5 hours ?)
5. Go to 1 until Loss of Contact or Thermal Event

Objective:

1. Determine where the current goes.
1b. Start a Thermal Event.

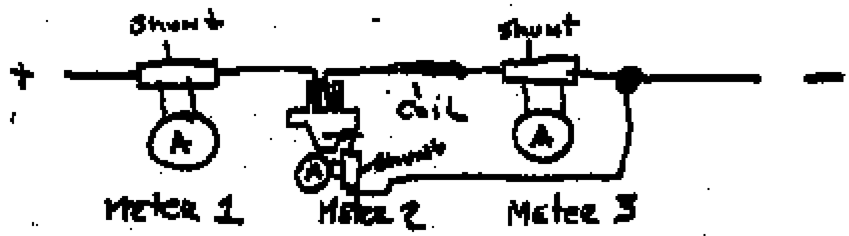
Repeat w/ old Dirty Brake Fluid.

1st attmp

8/8/79

Test # 8

Device filled with 5% salt/water solution and connector cavity dried
Temp. cycle method used to fill device



14.5 VDC

100 AMP = 100 MV shunts used for tests

Readings every 2 min.

	Meter 1 line in		Meter 2 current to ground		Meter 3 clutch coil		Temp. °F
1	.8		.2		.6		83.9 °F
2	1.2		.7		.5		113.3 °F
3	1.4		1.0		.5		130.7° F
4	1.2		.7		.5		127.6° F
5	1.3		.8		.5		123.4° F
6	.9		.9		.5		117.8° F
7	.9	Cavity (Dry)	.9	Refilled	.5		113.6 °F
8	.7		.3		.5		99.6° F
9	1.6		1.0		.4		109.2° F
10	1.4		.9		.4		118.7° F
11	1.0	Cavity	.6	Refilled	.4		123.4 °F
12	1.3		.9		.5		100.8° F
13	1.4		1.3	Contact Arm	.0	Failure	136.0 °F
14							
15							

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Start of Terminal event shown, smoke started coil Pulled in smoke stopped coil DROPPED out smoke Puffed amps DROPPED off to .4 to ground @ coil Temp 146° F

Kept test going, Refilled Device

①		②	③	Temp	
.7		.4	.0	coolant to intake H2O	
1.1		.6	.5	coil in	113.5° F
.7	Device Filled	.9	.9	" "	120.1° F
.9		0	.4	"	133.1° F

Device Removed from test for contact arm inspection

Summary:

Found tracings leading from Terminal to Terminal This could be a possible current leak path

Post test disassembly showed that contact arm was non-existent

4

Test #8

Abstract

The purpose of this experiment was to corrode contact terminals of 77PS switches in an attempt to cause ignition when power is applied to the switch

Procedure

The contact cavity of a switch was filled with a 5% salt/ water solution.
A power source was connected to terminal 1 of the switch

Meter 1 measured the current supplied to terminal 1 of the switch.
Meter 2 measured the current traveling to ground through the hexport body
Meter 3 measured the current from terminal 2 of the switch through the Ford clutch assembly (inductive load)

Time (minutes)	Meter 1	Meter 2	Meter 3	Temperature (°F)
0	.8	.2	.6	83.9
2	1.2	.7	.5	113.3
4	1.4	1.0	.5	130.7
6	1.2	0.7	.5	127.6
8	1.3	0.8	.5	123.4
10	0.9	0.4	.5	119.8
12	0.9	0.4	.5	113.6
14	0.7	0.3	.5	84.6
16	1.6	10.	.4	109.2
18	1.4	0.9	.4	118.7
20	1.0	0.6	.4	123.4
22	1.3	0.9	.5	100.8
24	1.4	1.3	0	136

Brake Pressure Switch Test Log, Updated 08/10/1999

Category	Test	Location	Test Parameters	Results Update
Lab Simulation of Potential Ignition in Switch	1	TI	Vary water concentrations in 'new' Brake Fluid 14Vdc to one terminal, hexport grounded Water Conc: 4%, 6%, 10%, 75%	250+ hours, Current draw in the 0.5mA to 5mA range Fluid has discolored. No Significant Temperature Rise. Test Suspended. Internal Analysis suspended.
	2	TI	New Brake Fluid 1 Amp through switch terminals 14Vdc to one terminal, hexport grounded	250+ hours. Constant temperature. No significant temperature rise with time Test Suspended.
	3	AVT	'new' Brake Fluid in Switch, 24 VDC to one terminal. Hexport Grounded	> 300 hours into test, max current 7mA No significant change with time. Test suspended
	4	AVT	'new' Brake Fluid in Switch, 24 VDC to one terminal. Hexport Grounded, Ambient at 100 C	16 hours into test max current 5mA No significant temperature rise with time. Test suspended.
	5	AVT	'new' Brake Fluid in Switch, 16 Amps Through switch terminals	Temperature rise of 20 C above room temp Delta T reached steady state at 20 C. Test suspended.
	5a	AVT	'new' Brake Fluid in Switch approx. 50 Amps through Switch Terminals	Temperature rose to approx. 279 F. No smoke. No ignition Test suspended.
	6	TI	Build heater elements into Switch. Heat till failure, include sparking. (1) w/ solution of Brake Fluid and 6 wt. % H_2O	3 tested. Smoke observed, ignition observed on part w/heater See attachment Test complete Brake fluid in cavity slows down heat build-up Smoke observed at 675 F, Base melts and falls off at 839 F
	6a	TI	Create heater by corroding spring arm Salt water solution, 14V between spring and hexport	One out of 15 devices increased resistance to 5 ohms. Others either very low resistance or megaohms. It took about 100 hours to reach the 5 ohm stage. The 5 ohm device ignited under conditions similar to test 6.
	6b	TI	Re-run ignition test to understand repeatability and current path.	Switch ignition with repeated 5% water solution into switch Current path is through hexport. See plots and video. Additional test include tap water, old BF, new BF and other.
	6c	TI	Pure 'new' brake fluid with metal shavings	Metal shavings do not contribute significantly to brake fluid

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				coductivity
Life Cycle Reliability	7	TI	0-1400 psig pressure pulses at 135C	First leak observed at 720,000 cycles.
of Pressure Switch			per ES	Test Completed. See attached Weibull Chart.
Diaphragm Wear	8	TI	0-1400 psig pressure pulses at 135C.	Parts withdrawn every 200k cycles, characterized for wear
Field vs Lab Correlation	9	Central Labs	*Field returns, from dealer lots, junkyards*	Parts in Central Labs, see Ford spreadsheet
Design Of Experiments (1)	10	TI	Vary water concentrations in 'new' Brake Fluid	Test Report being written investigation continues.
Evaluating Factors			12 snap + 12 quiet switches w/ 0 % water in BF	Suspended at 1.3 million cycles with no leaks observed.
Effecting Diaphragm Wear			12 snap + 12 quiet switches w/ 5 % water in BF	Snap samples suspended at 1.3 million cycles with 2 leaks
Impulse test				observed at 1.3M. Quiet samples suspended at 500k cycles to
				assess fixturing anomalies.
On-Vehicle Characterization	11	AVT	Monitor Pressure and Temperature	Test at AVT,....see Ford charts,..>500k in car?
of Pressure & Temperature			at Switch Location for ABS and non-ABS	
Profile in Town Car			braking events.	
Brake fluid analysis	11a	TI	Analyze used brake fluid at the master cylinder	Test complete.
Used fluid at master cylinder.			(UMC), used brake fluid at the caliper (UCA)	UMC: Cu = 415 (ug/ml), Fe = 5.8 (ug/ml), Cr = 0.09 (ug/ml), 1.1 %H20.
			and new brake fluid (NEW) for metal and water	UCA: Cu = 592 (ug/ml), Fe = 5.5 (ug/ml), Cr = 1.9 (ug/ml), 1.1 %H20.
			content.	NEW: Cu = <0.01 (ug/ml), Fe = 0.92 (ug/ml), Cr = <.01 (ug/ml), 0.3 %H20.
Spark /Arc Study	12	Central Labs	Determine if arc/spark forms in switch	Equipment set-up in progress at Central Labs.
			using clutch loads and high speed video.	TI Experimented with no 'significant' sparks observed
			Use dry switches as well as switches with	
			various brake fluid water mixes.	
Characterization of	13	Central Labs	Characterize electrical, mechanical	Data log and analysis procedure set up complete.
switches retrieved from field			and chemical aspects of returned switches	Analysis of switches in progress.
junkyards & other sources				
Fluid Ingress Tests	13a	TI	Repeat ignition simulation with different fluids.	Test complete.
			<u>(3) hour tests:</u>	5% NaCl sample resulted in an ignition.
			5% NaCl in tap water	All brake fluid samples draw less than 3 mAmps. No corrosion
			rain water	visible on brake fluid samples.
			<u>(24) hour tests:</u>	Rain water and tap water samples draw <10 mAmps and showed
			tap water	some signes of corrosion.
			used brake fluid	Chemical anlysis in process.

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			used brake fluid w/ 5% H_2O	
			new brake fluid	
			new brake fluid w/ 5% H_2O	
Design Of Experiments (2)	13b	TI	Vary water concentrations in 'new' Brake Fluid	
Repeat of test 10			10 snap + 20 quiet switches w/ 5 % water in BF	Test suspended. Analysis in process to assess test filtering.
			10 snap + 20 quiet switches w/ 5 % water in BF	
Compatibility of Kapton	14	Dupont	Characterize change in properties of Kapton	
with Oxalic Acid			with various % oxalic acid in brake fluid.	Test in progress (100) hours completed. Oxalic acid shows
				similar effects that water has on Kapton properties.
Evaluation of Plastic	15	TI	Assess properties and moldability of different	
Materials with Improved			grades of plastic resin with additives	Test suspended.
Parameters			to improve plastic part performance	Celanese and Noryl ignited 3/5 and 2/5 trials
				ZYTEL samples tested 1/5 ignitions
Long duration brake fluid	15a	TI	(4) samples with new brake fluid	
ingress test.			(2) samples with used brake fluid	Test suspended (550) hours completed.
				Used brake fluid current dropped off to <1/10 mAmp.
				New BF hexport current can increase w/ time under cont. power.
Evaluation of Switch	15b	TI	Assess ignition sensitivity to switch orientation.	
Orientation			Test vertical versus 45 degree.	Test complete. Ignition is independent of switch orientation.
				Simulated switch ignition can occur in vertical or 45 degree angle.
			Test rotational sensitivity in 45 deg. orientation.	Ignition appears not sensitive to switch rotational alignment.
Relay Circuit	16	TI	Repeat test 13a in Ford relay circuit for (48) hrs.	
Test			Bring switch to impending ignition in (15) Amp	Test complete. No ignition. Corrosion rate drastically reduced.
			circuit then place in relay circuit for (16) hrs.	Insufficient power in circuit to create or move toward ignition in lab
			Input max. circuit power into heater on switch.	Heater element was warm to the touch.
Long duration brake fluid	17	TI	(50) samples filled with new brake fluid	
ingress test number 2.			(1) hour of vibration per day	Test suspended. (312) hours completed.
			(1) hour soak at 100 deg C per day	Average hexport current is 1.9 mAmp (stdeviation = 1.8 mAmps)

TI 77PS Test Synopsis

This document is a synopsis of tests conducted by Texas Instruments during the 77PS investigation. The intent of this document is to highlight test findings which drove the investigation to its current state. Throughout the investigation, several tests were conducted with the same objective. When each objective was met, efforts were refocused to obtain a new level of understanding and to establish a new set of objectives. As such, tests have been categorized into (5) levels, representing the level of knowledge obtained from the group of tests conducted. Each level is listed below with a short description of the objective:

Level 1: Create a laboratory switch ignition without any restrictions on methods.
Level 2: Create a laboratory switch ignition using only conditions found in the switch operating environment.
Level 3: Understand the laboratory ignition mechanism.
Level 4: Compare factors contributing to laboratory ignition.
Level 5: Evaluate recommendations.

Refer to Brake Pressure Switch Test Log.

Level 1 Objective: Determine if a switch ignition can be created in the laboratory.

- Test 1

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact cavity flooded with brake fluid mixed with varying amounts of % H_20.
14 volts applied to one terminal, second terminal electrically floating. (No electrical load across switch terminals).
Switch hexport electrically grounded.

Results: (8) samples were tested total:
(2) with 4% H_20 in brake fluid.
(2) with 6% H_20 in brake fluid.
(2) with 10% H_20 in brake fluid.
(2) with 75% H_20 in brake fluid.

No ignition occurred. No significant temperature rise observed in all samples. Current draw ranged from 0.5 mAmps to 5 mAmps over a period greater than (250) hours.

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- Test 2

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Switch contact flooded with brake fluid.
14 volts applied to one terminal, second terminal connected to a 14 Ω resistor which is tied to ground. (1 Amp load across switch terminals).
Switch hexport electrically grounded.

Results: (2) samples were tested. No ignition occurred. No significant temperature rise observed for a period over (250) hours.

Conclusion: A (1) Amp load through switch terminals cannot ignite brake fluid in the contact cavity of switches.

- Test 6

Objective: Determine if switch ignition can occur under the following laboratory conditions:

Heater element installed in contact cavity of the switch.
Power applied to the heater element until plastic base melts.
Spark generated in contact cavity of switch.
Brake fluid present in the contact cavity (wet device) and absent in the contact cavity (dry device).

Results: (2) dry devices were tested and (1) wet device was tested. Ignition occurred in all devices.
Wet device: The internal temperature of a wet device reached 660°F. A hole burned through the base of the switch (close to the heating element). The applied spark ignited the fumes in the contact cavity of the switch and engulfed the base material of the switch.
Dry device: The internal temperature of a dry switch reached over 1000°F. The switch base flopped over. The applied spark ignited the fumes in the contact cavity of the switch and engulfed the base material of the switch.

Conclusion: A switch Ignition can occur under the following laboratory conditions:

Heater element installed in the switch contact cavity.
5 watts of power dissipated in heating element.
Spark generated in the contact cavity of the switch.

Brake fluid did not contribute to the ignition process.

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Level 2: **Objective:** Determine if a laboratory ignition can occur using only switch components and elements found in the switch environment.

- Test 6a

Objective: Determine if corrosive degradation of switch electrical components can cause an increase in electrical resistance (and thus a source of heat) in the switch, which may lead to an ignition.

Results: (1) out of (15) samples tested increased resistance to 5 Ωs. A solution of 5 wt. % NaCl in H_20 can corrode the electrical components of the switch and cause an increase in electrical resistance. Repeated injections of the solution of 5 wt. % NaCl in H_20 into the contact cavity of a switch, with the switch continuously powered at 14 Volts, can cause an ignition.

Conclusion: A switch ignition can occur under the following laboratory conditions:

A solution of 5% NaCl in H_20 is injected into contact cavity of a switch.
Continuous 14 Volt power applied to the switch.
Hexport is grounded.
Current is limited at 15 Amps.

- Test 6c

Objective: Determine if brake fluid with metal shavings is conductive enough to create an ignition.

Results: (3) devices with various size metal particles were tested. No significant current increase detected.

Conclusion: Metal shavings did not significantly increase conductivity brake fluid. Current levels measured were well below levels necessary to create an ignition.

- Test 7

Objective: Determine if switch meets cycle life specification.

Results: Tests conducted during the first quarter of 1999 show that switches exceed cycle life specification.
In the first quarter of 1999, a total of (42) 77PSL2-1 snap switches were impulse tested to over 1,000,000 cycles with only (1) leak below 1,000,000 cycles, which

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occurred at 728,000 cycles. A Weibull analysis showed 99.9% reliability at 500,000 cycles at 95% confidence level.

Conclusions: Switches meet cycle life specification. First quarter, 1999 tests confirm impulse test findings made during the period between 1991 and 1992. During that period, (6) impulse tests on 144 devices of 57PS and 77PS construction, had no leaks when tested to 500,000 cycles. A Weibull analysis of first quarter, 1999 tests, showed 99.9% reliability at 500,000 cycles at 95% confidence level.

- Test 15a

Objective: Determine the long term corrosive effects of brake fluid on the electrical components of switches which are continuously powered at 14 Volts.

Results: Test was suspended after 550 hours of testing. (6) samples were tested with continuous 14 Volts power. The contact cavity of (4) switches contained new brake fluid and (2) switches contained old brake fluid. Switches with old brake fluid drew very little hexport current and showed a decrease in hexport current over time to less than 1/10 mAmp. Samples with new brake fluid showed an increase in hexport current to over 20 mAmps toward the end of the 550 hours of testing. Analyses of (1) sample with new brake fluid and (1) sample with old brake fluid revealed electrolytic corrosion of the contact arm of both switches. There was a much lower level of corrosion in the sample with used brake fluid than the sample with new brake fluid.

Conclusion: Brake fluid in the contact cavity of switches, which are at 14 Volts continuous power for over 500 hours, can cause electrolytic corrosion of the switch contact arm. It is unknown if this corrosion, under continuous power conditions, can eventually lead to sufficient current draw to drive an ignition.

- Test 17

Objective: Quantify the long term corrosive effects of new brake fluid on the electrical components of switches under the following laboratory conditions:

Contact cavity of switch flooded with new brake fluid.
Switches at continuous 14 Volts power.
Switches subjected to vibration for (1) hour per day.
Switches subjected to 100°C for (1) hour per day.

Results: Test suspended after (312) hours. (50) samples tested. The average hexport current draw after (312) hours is 1.9 mAmps with a standard deviation of 1.8 mAmps. There has been no increase in hexport current. These results are consistent with results previously found in Test 15a.

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Conclusion: New brake fluid in the contact cavity of switches, has not caused an increase in hexport current after (312) hours at continuous 14 Volts power.

Level 3: Objective: Understand the laboratory ignition process, determine the current path and establish a repeatable ignition method.

- **Test 6b**

Objective: Understand the ignition process, determine the current path and establish a repeatable ignition method.

Results: Multiple attempts at laboratory ignition, via injection of a solution of 5 wt. % NaCl in H_2O into the contact cavity of switches, has resulted in a repeatability rate of approximately 50%. Plots of hexport current verses time show an increase in current until the point of ignition.

Conclusion: A repeatable laboratory method for switch ignition was established. Based on hexport current measurements, the current path is from switch terminals to hexport body.
When a solution of 5 wt. % NaCl in H_2O is repeatedly injected into the contact cavity of powered switches, electrolytic corrosion of the switch terminal results in an increase in terminal resistance. When sufficient power is drawn through the corrosive resistance, switch elements heat up and begin to glow red hot. A hole burns through the switch base and ignition occurs. There is arcing visible throughout the corrosion process which may provide the spark necessary for ignition.

Level 4: Objective: Compare and contrast variables influencing ignition using the established laboratory ignition method.

- **Test 13a**

Objective: Compare various fluids in the established ignition method.

Results: The following fluids were tested.
(1) NaCl in H_2O.
(1) tap water
(1) rain water
(1) used brake fluid
(1) used brake fluid with 5 wt. % H_2O
(1) new brake fluid
(1) new brake fluid with 5 wt. % H_2O
The switch filled with 5 wt. % NaCl in H_2O resulted in an ignition when average hexport current exceeded 2.5 Amps. Switches that were filled with tap water and rain water drew less than 10 mAmps over a (3) hour test and showed little signs of

corrosion: Switches filled with a matrix of new and used brake fluids, with water and without water, all drew less than 3 mAmps hexport current draw and showed no signs of corrosion over the (24) hour test.

Conclusion: Brake fluid is not conductive enough to cause the electrolytic corrosion and necessary current draw to create an ignition. Because of its' significantly higher conductivity, an ionic rich fluid such as NaCl in H_20 is necessary to cause an ignition.

- Test 15

Objective: Compare the ignition characteristics of various plastics as switch base material.

Results: When 5 wt. % NaCl in H_20 was injected into switches with different base materials, the following results were obtained: Cellanex 4300 ignited 3 out of 5 attempts. Noryl ignited 2 out of 5 attempts. Zytel ignited 1out of 5 attempts.

Conclusions: All plastics tested can ignite using the established laboratory ignition method.

- Test 15b

Objective: Determine if switch ignition can occur in the vertical position and 45° orientation. Determine if switch ignition can occur and at different rotational angles in the 45° orientation.

Results: Switch ignitions can occur in both the vertical and 45° orientation using the established laboratory ignition method.

Conclusion: Switch ignition does not appear to be sensitive to vertical orientation verses 45° orientation nor to rotational angle in the 45° orientation.

Level 5 Objective:

Test 16

- **Objective: Test proposed relay circuit.**

Results: (1) switch was injected with a solution of 5 wt. % Nacl in H_20 and placed in the proposed current limiting circuit for (48) hours. The current draw remained constant at 180 mAmps throughout the test. There was no activity observed and the contact arm remained mostly intact.
(1) switch was brought to an impending burn condition using the established burn method. An impending burn is a condition where a corrosive resistance has built

up in the switch and an ignition is imminent. The switch was then placed in the proposed relay circuit for(18) hours where it drew 160 mAmps, showed no visible activity and did not result in an ignition.
Because the proposed relay circuit acts as a resistor which limits current to the switch, the maximum power to the switch is limited to .75 Watts. A resistive wire was wrapped around the base of (1) switch and 0.75 Watts of power was dissipated in the wire. The wire became warm to the touch but had no effect on the switch.

Conclusion: 0.75 Watts, the maximum power in the proposed circuit design, is insufficient to cause substantial electrolytic corrosion or significant switch terminal heating, which is necessary to create an ignition. In previous tests, using a resistor as the heating element (see Test 6), approximately 5 Watts of power was necessary to create an ignition. There is not enough power in the proposed circuit to create ignition.

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FORM

TEST NO. 152744

TECHNICAL SERVICE LABS

LOG NO. ______

TEST NO. 152744

PCC I.D.	127	[illegible]	INFORMATION [redacted]
[illegible]	[illegible]	Rush	
[illegible]	[illegible]	See attached	
[illegible]	[illegible]	sheet	
[illegible]	[illegible]		
[illegible]	[illegible]		
[illegible]	[illegible]		
[illegible]	[illegible]		
[illegible]	[illegible]		
[illegible]	[illegible]		

REPORT OF RESULTS:

DATE RECEIVED ______ DATE OUT ______

TECHNICIAN			
HOURS WORKED			
PROCEDURE USED			

*PCC I.D.

MC-325	TM-431	CLKE-122	FACIL-514
PC-127	WIRE-432	CAN-954	FACIL-521
VERS-168	EPD-621	AD DEV-256	FACIL-531
AFCC-463	PEP-622	EMCD-677	STAFF-556
IMD-430	CSD-635		

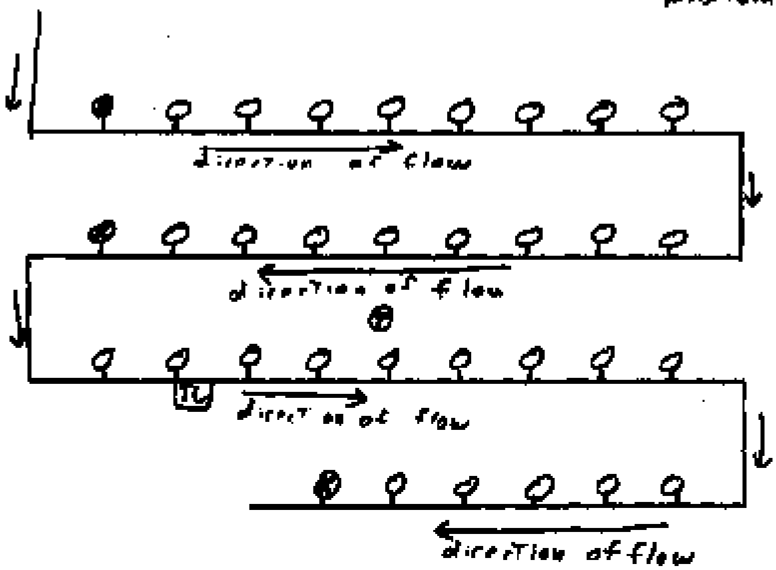
TI-NHTSA 014339

DISTRIBUTION: White and Yellow - Lab Pink - Requestor

77PS Impulse Test

-30 devices 77PS
-3 APT 3CP2-1 devices

T: 135°C 5:2Hz
Pmin: 0-50psi Pmax: 1450±50psi
medium: New brake fluid.



O: 77PS devices
⊕: APT 3CP2-1 device
⊞: Surface mounted thermocouple
⊕: Suspended (Ambient) Thermocouple

~10 connecters w/ counters randomely placed on devices.

- APT's were used to verify pressure profiles along the circuit. Pressures adjusted/set using a 5000psig matched sensotec set up so that 1 mV output = 1psi of pressure. The APT's were placed as follows:
    - APT #1 = start of circuit
    - APT #2 = middle of circuit
    - APT #3 = End of circuit

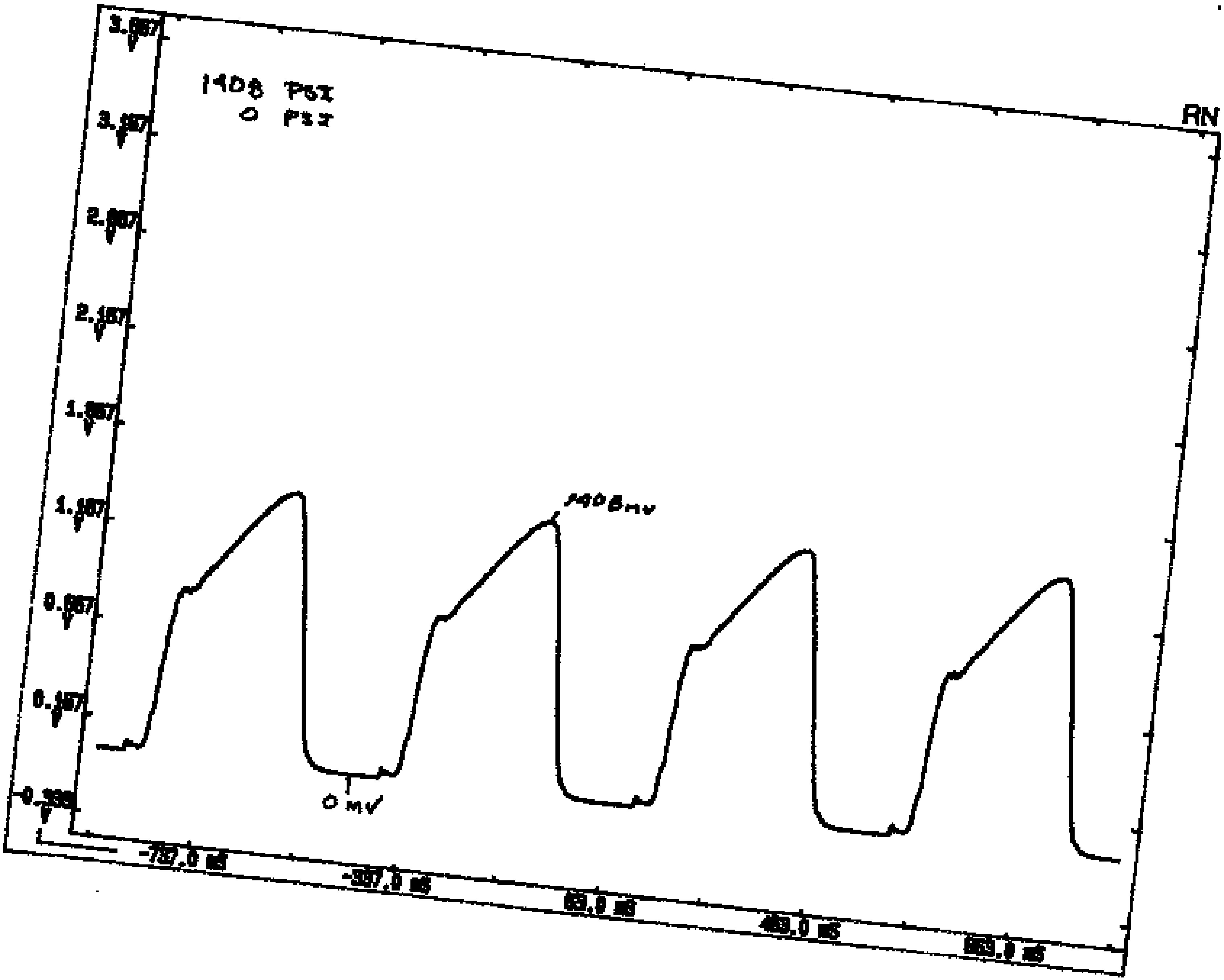
APT's were used for reference only. Only accurate to 3.4%.

Formula for Pressure reading using an APT.

$$\text{Actual Pressure} = \frac{\text{APT voltage} - 0.3}{0.00188}$$

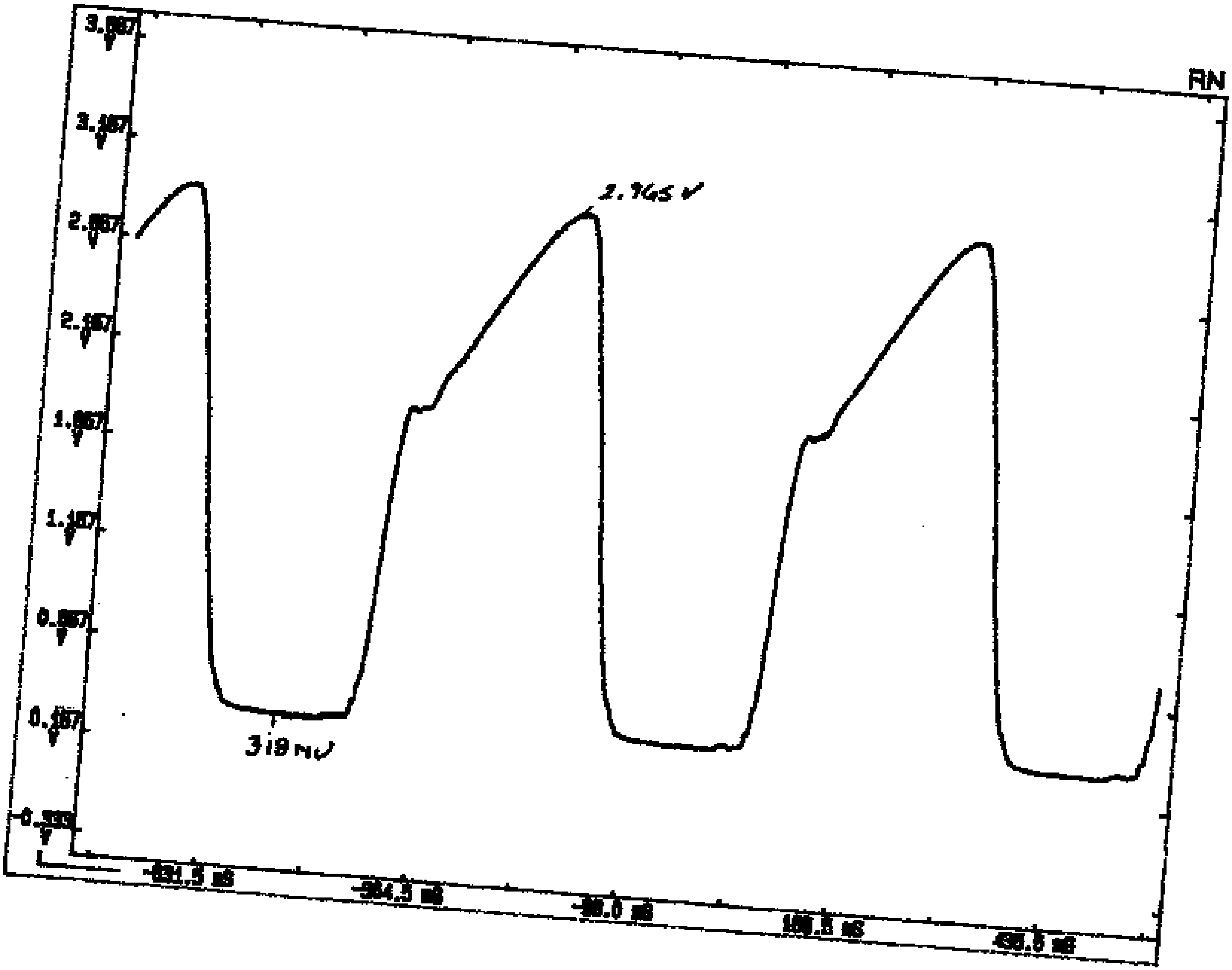
Sensor Vcc Reading

8.9.99



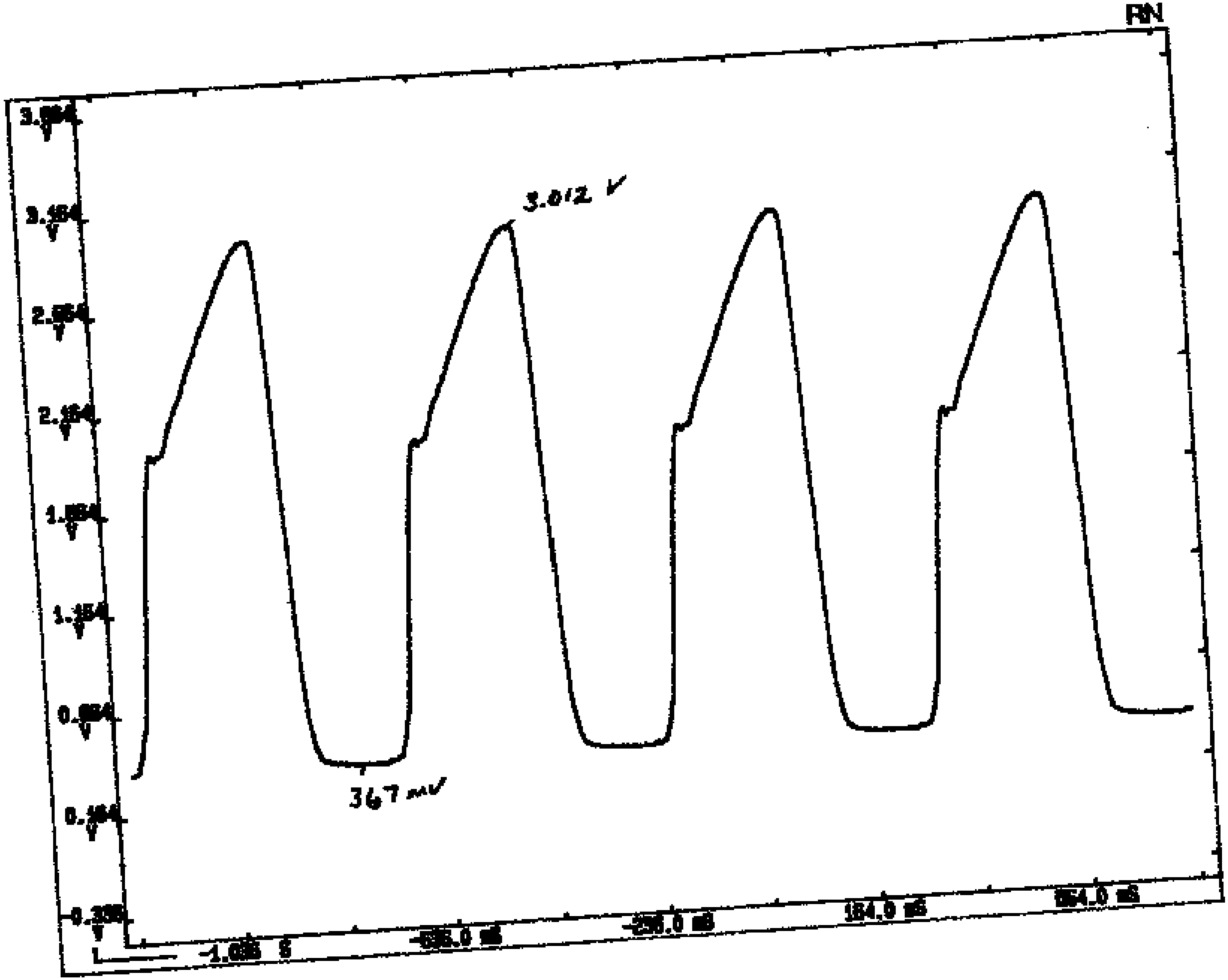
APT 1 (Bottom)

8-9-99



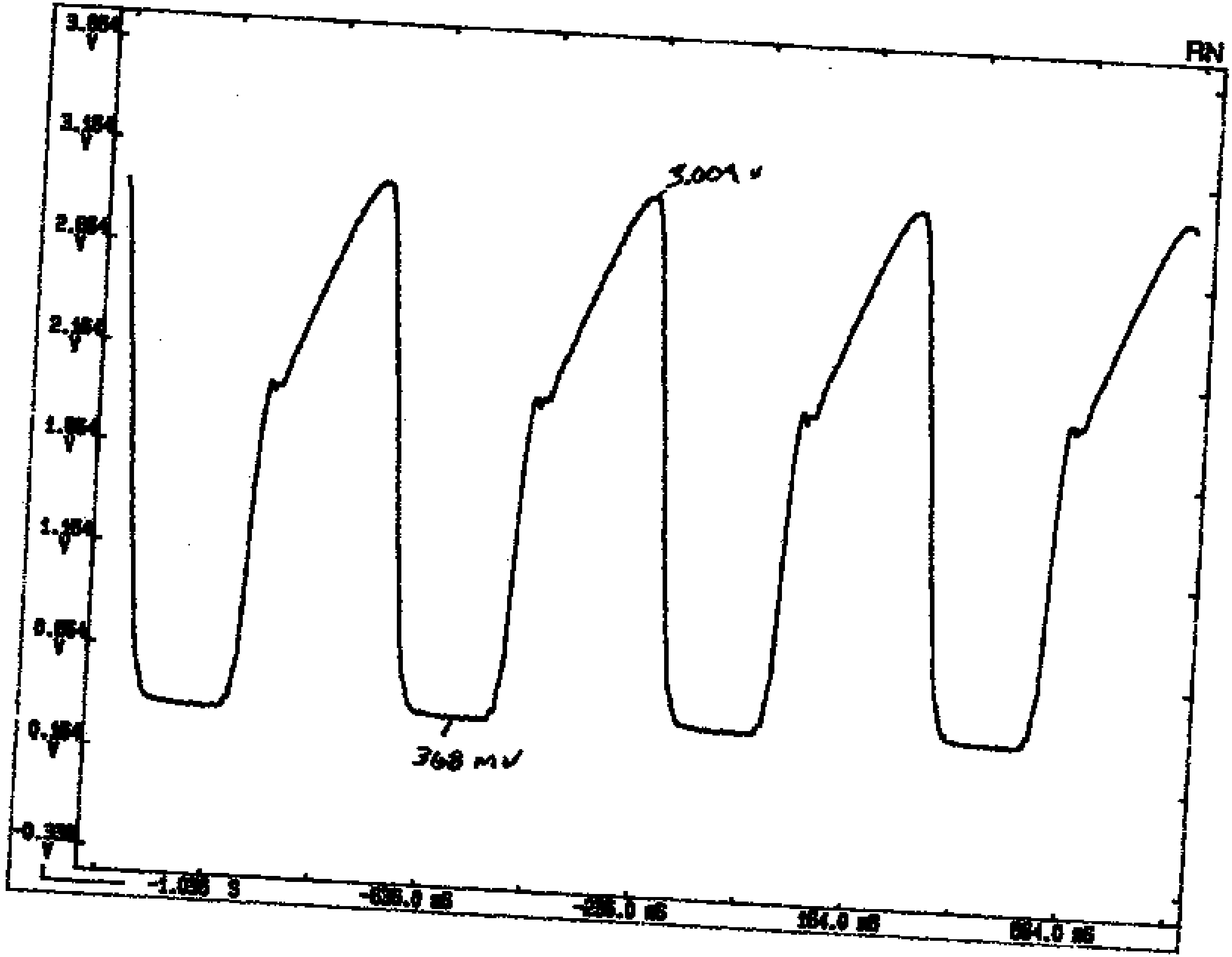
2 (auto)

8-9-99



APT. 3 (Top)

8-9-99

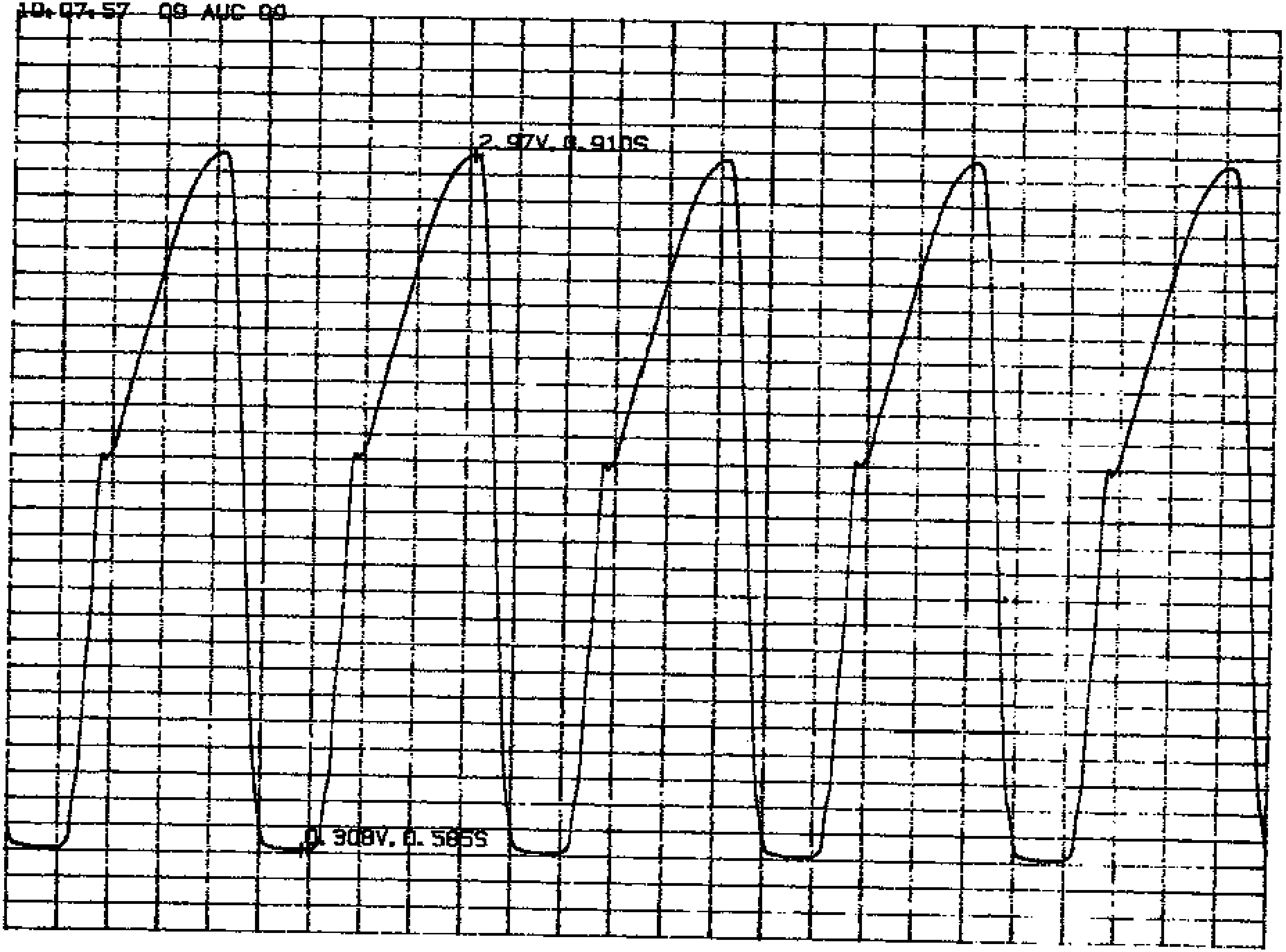


TI-NHTSA 014344

Senetec

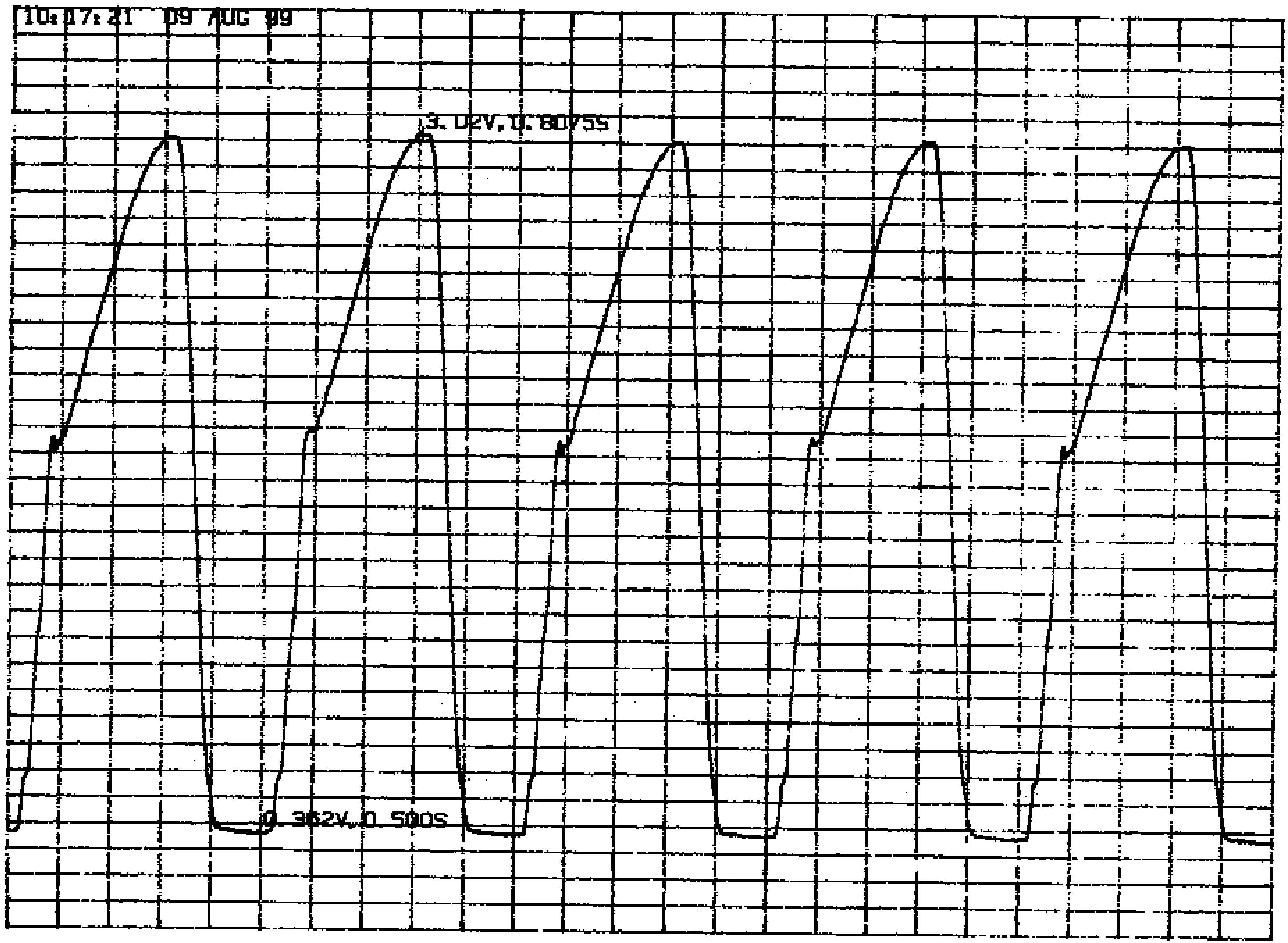
TI-NHT9A 014346

APT 1

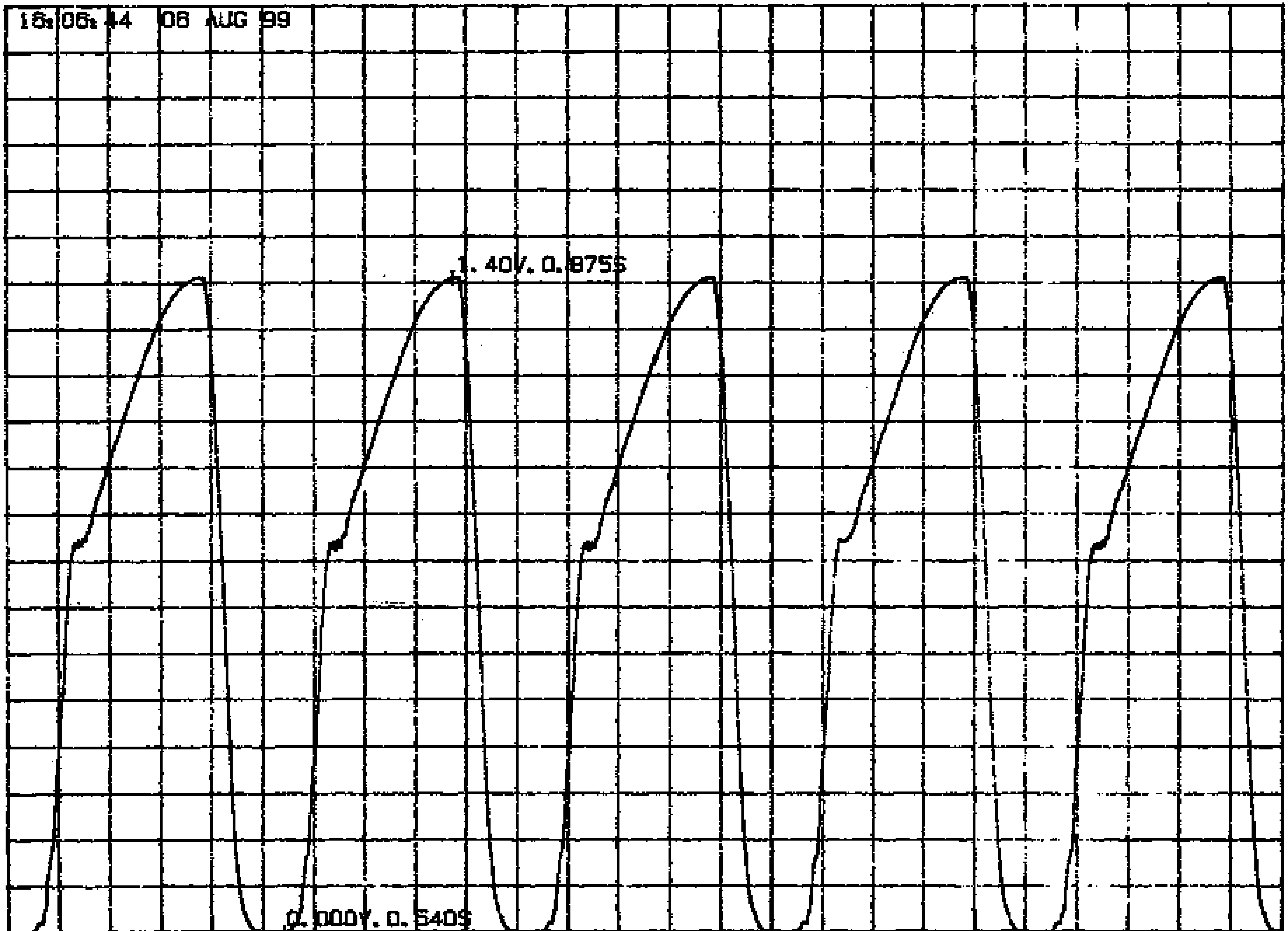


APT 2

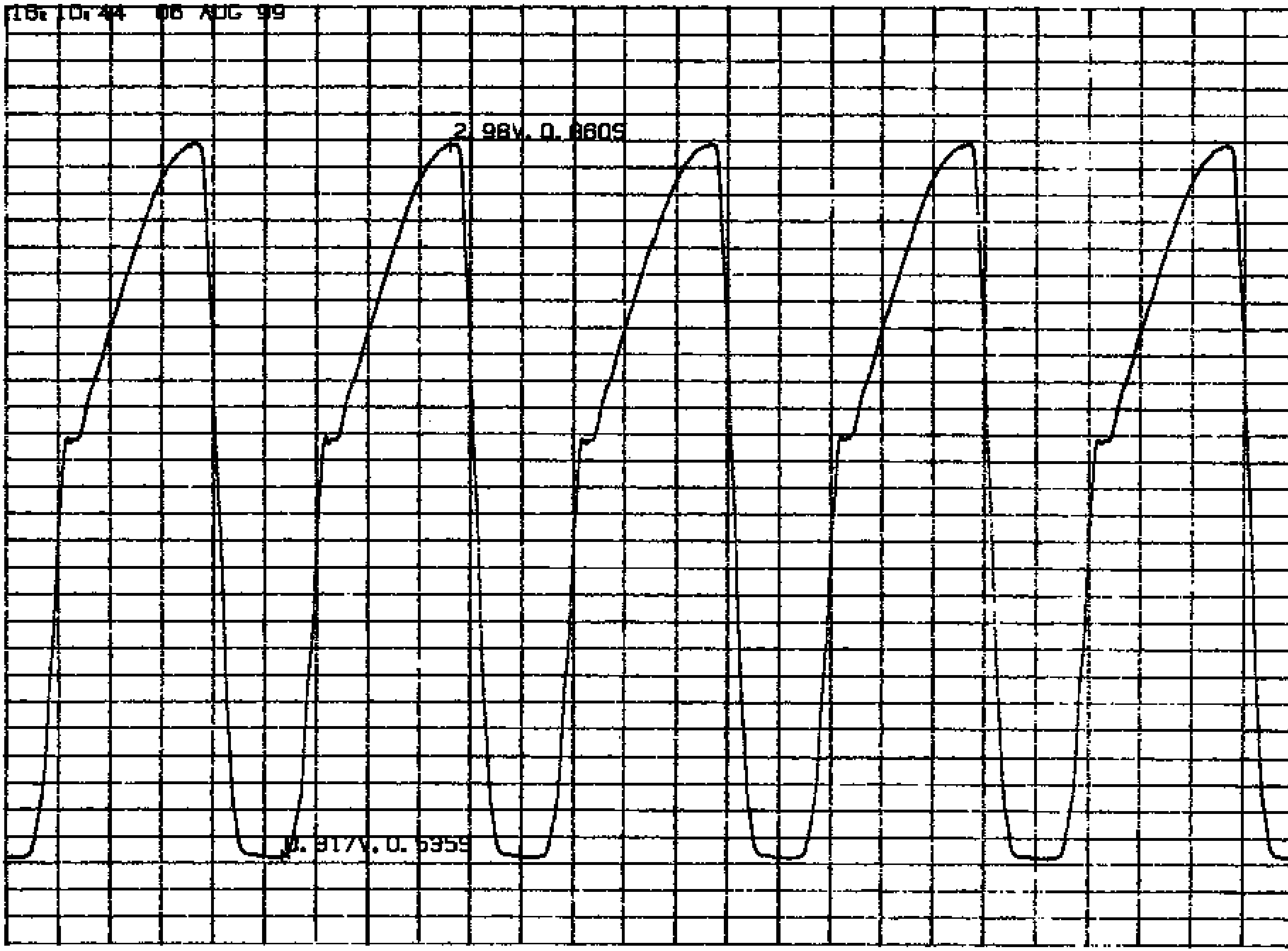
ADT #3



SensoTec

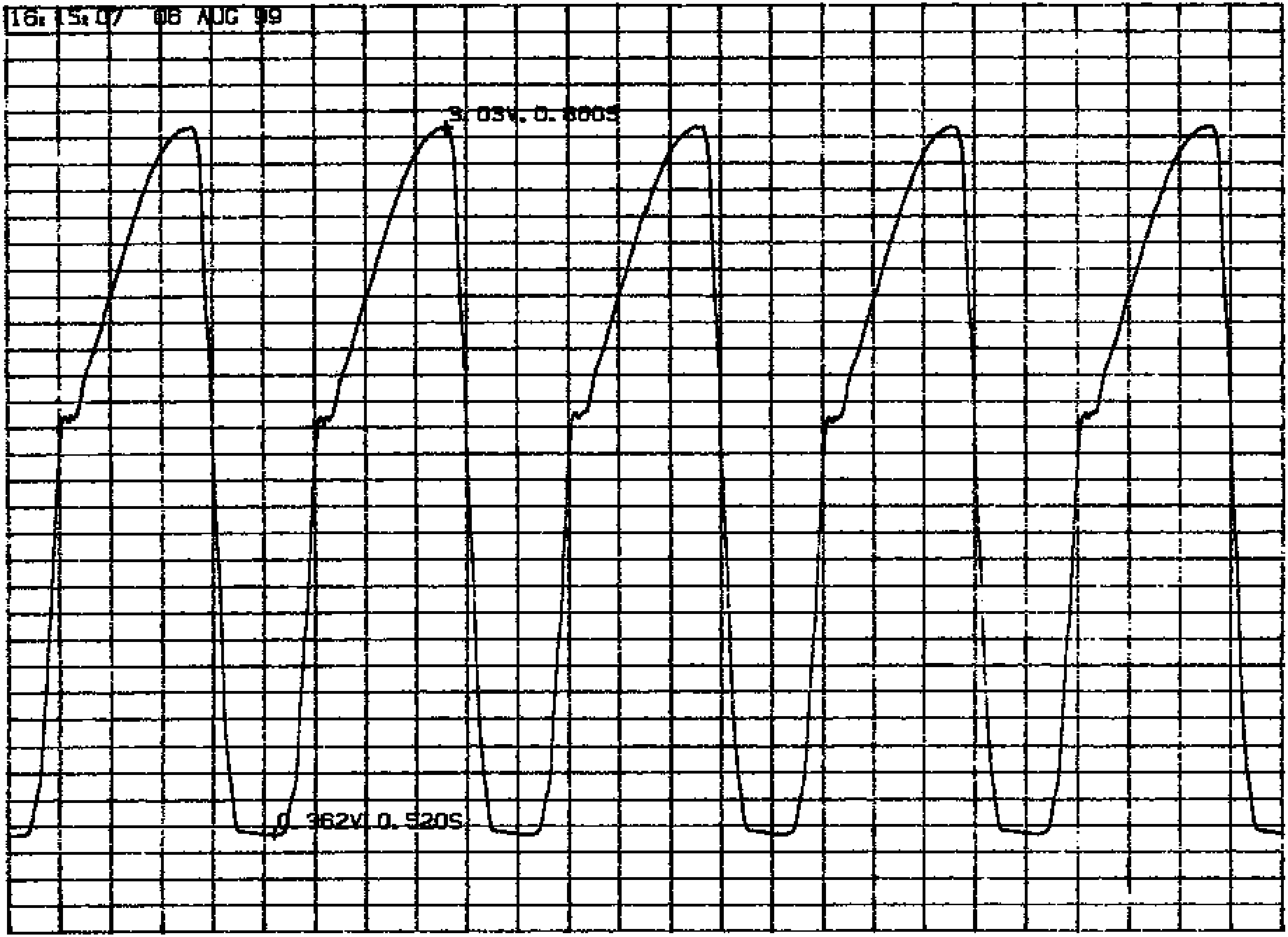


APT #1



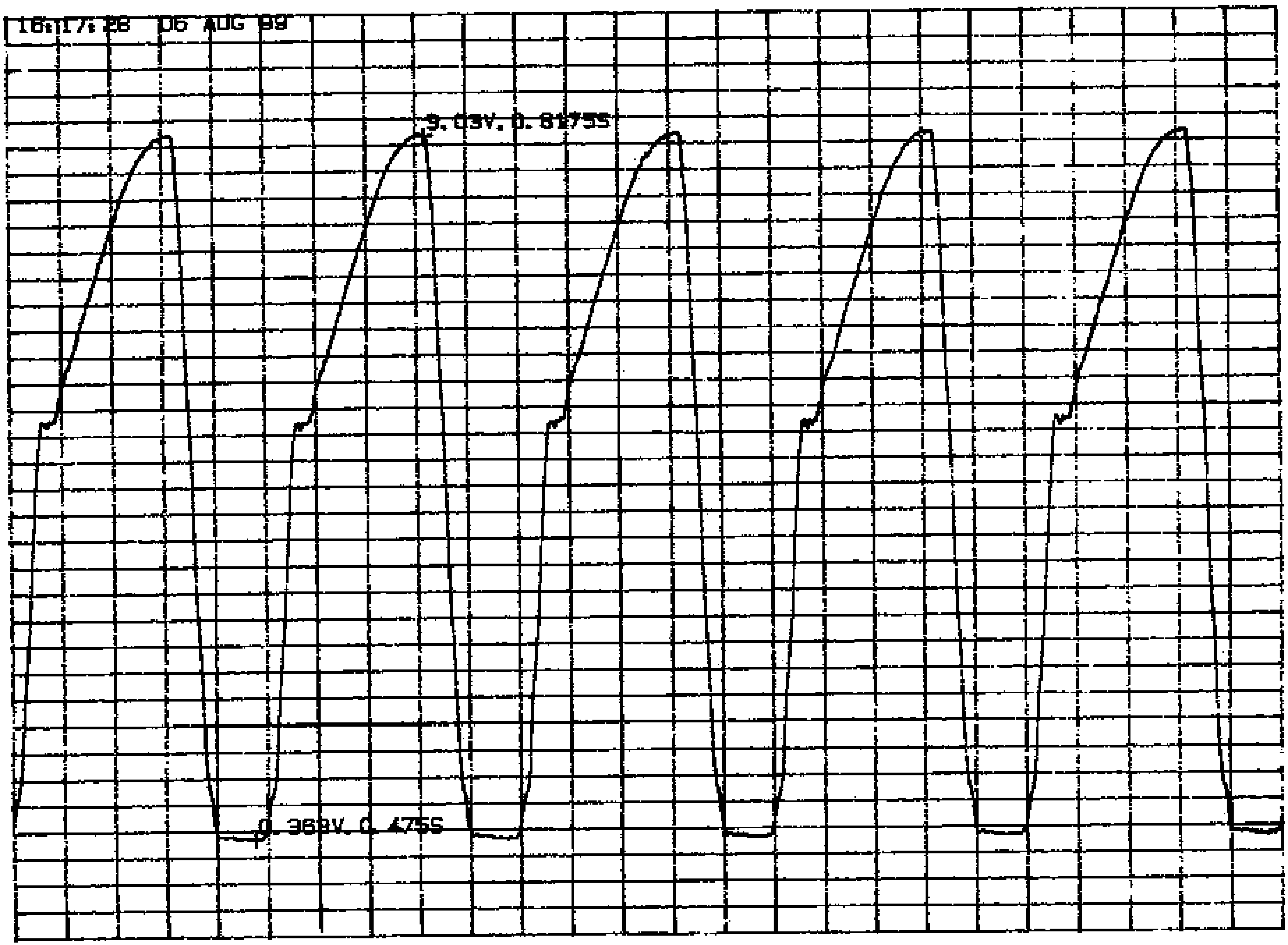
TI-NHTSA 014360

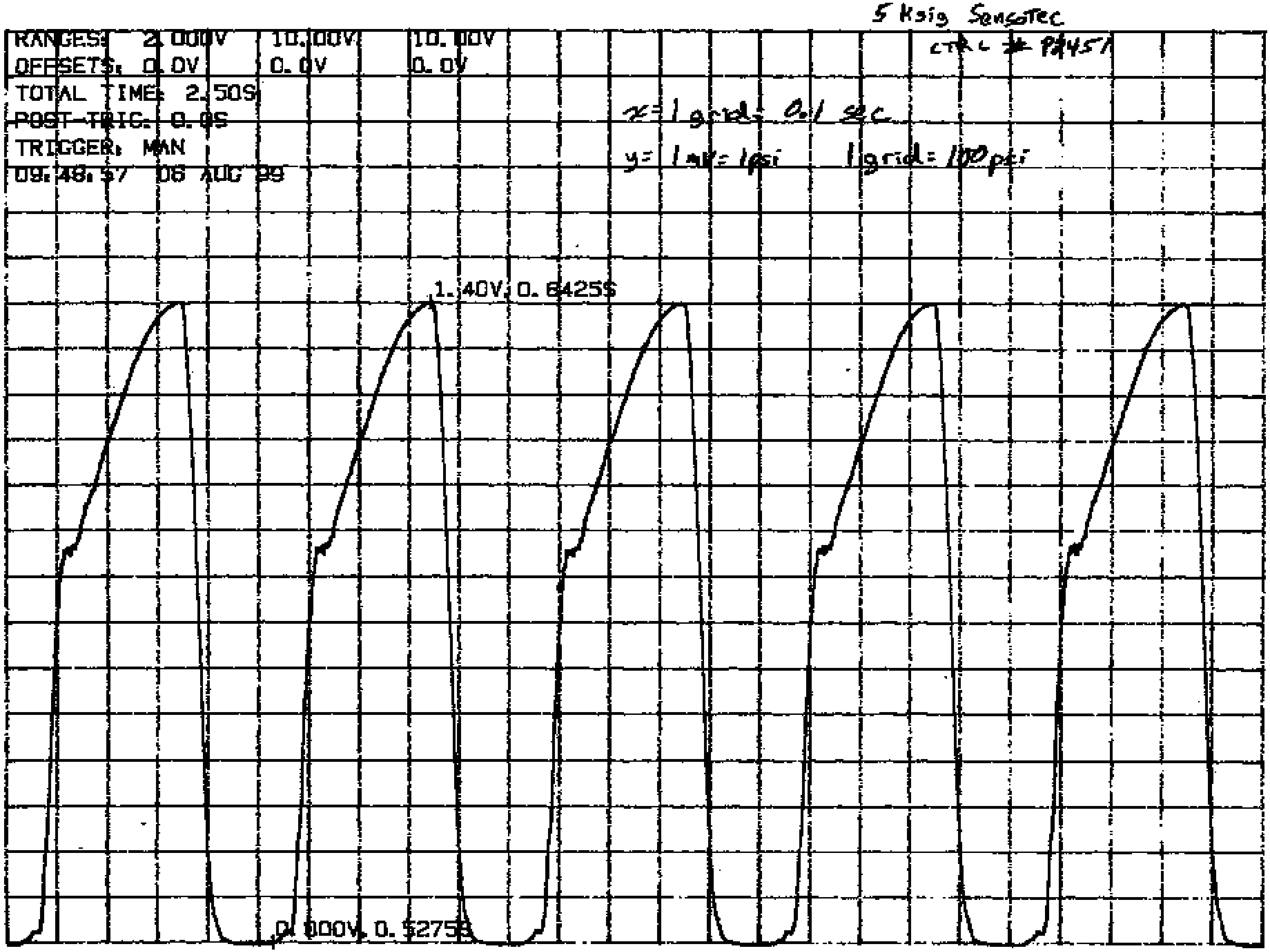
APT #2



TI-NHTSA 014361

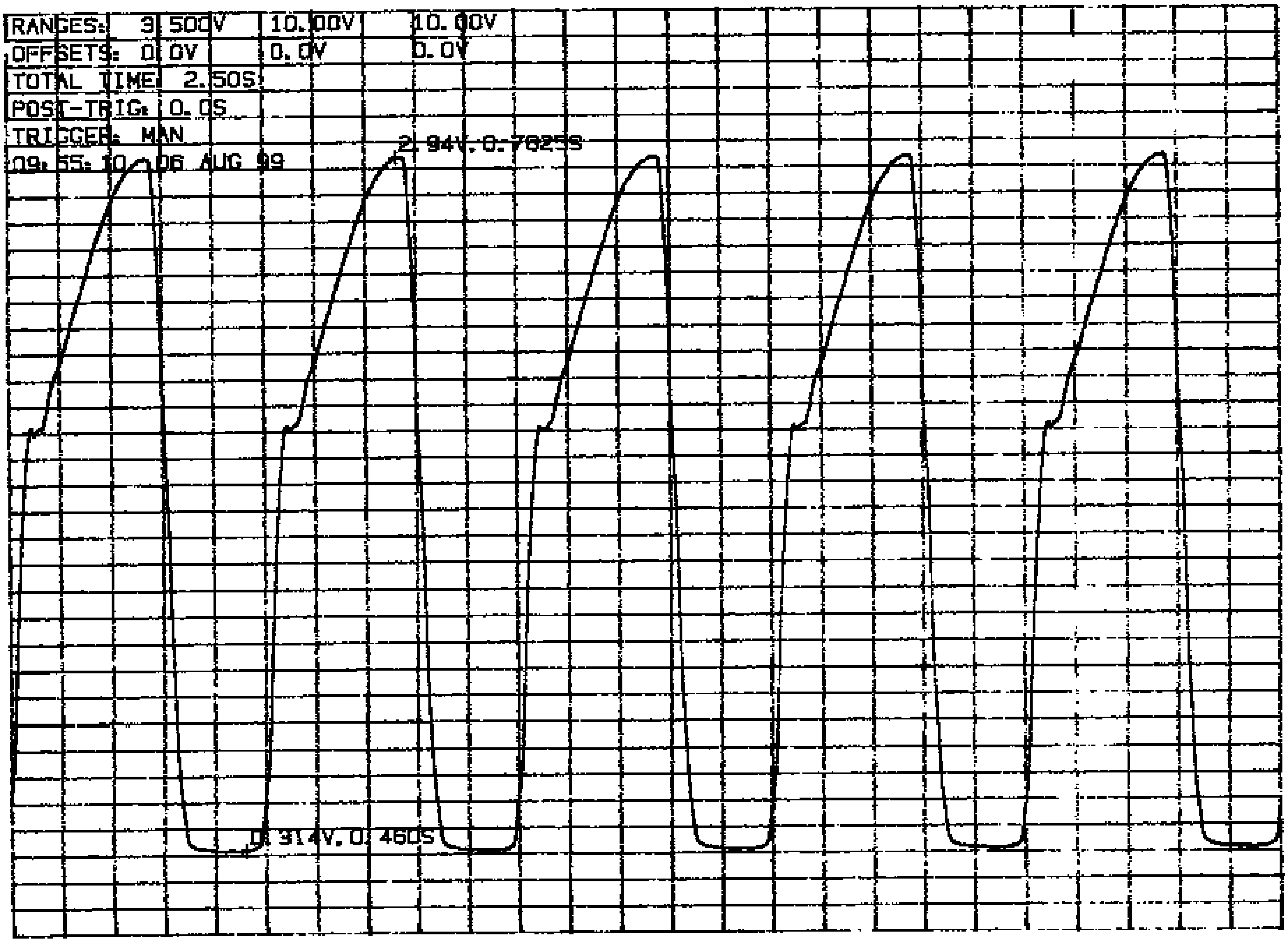
APT #3





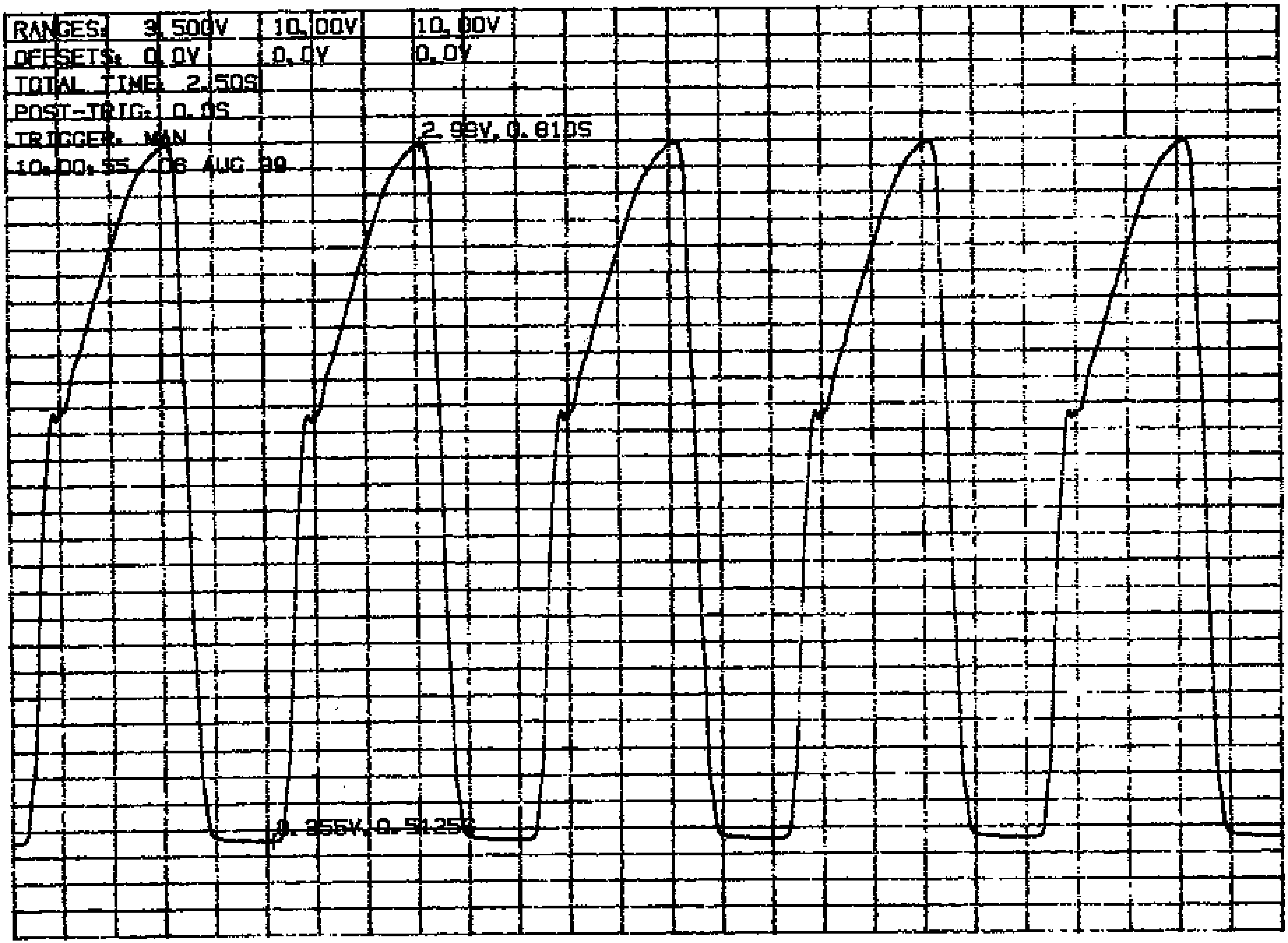
5 ksig Sensotec
RANGES: 2.000V 10.00V 10.00V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 2.50S
POST-TRIG: 0.0S
TRIGGER: MAN
09:48:57 06 AUG 99
x=1 grid= 0.1 sec
y= 1 mV= 1 psi
1 grid= 100 psi
1.40V, 0.6425S
0.000V, 0.5275S

APT #1



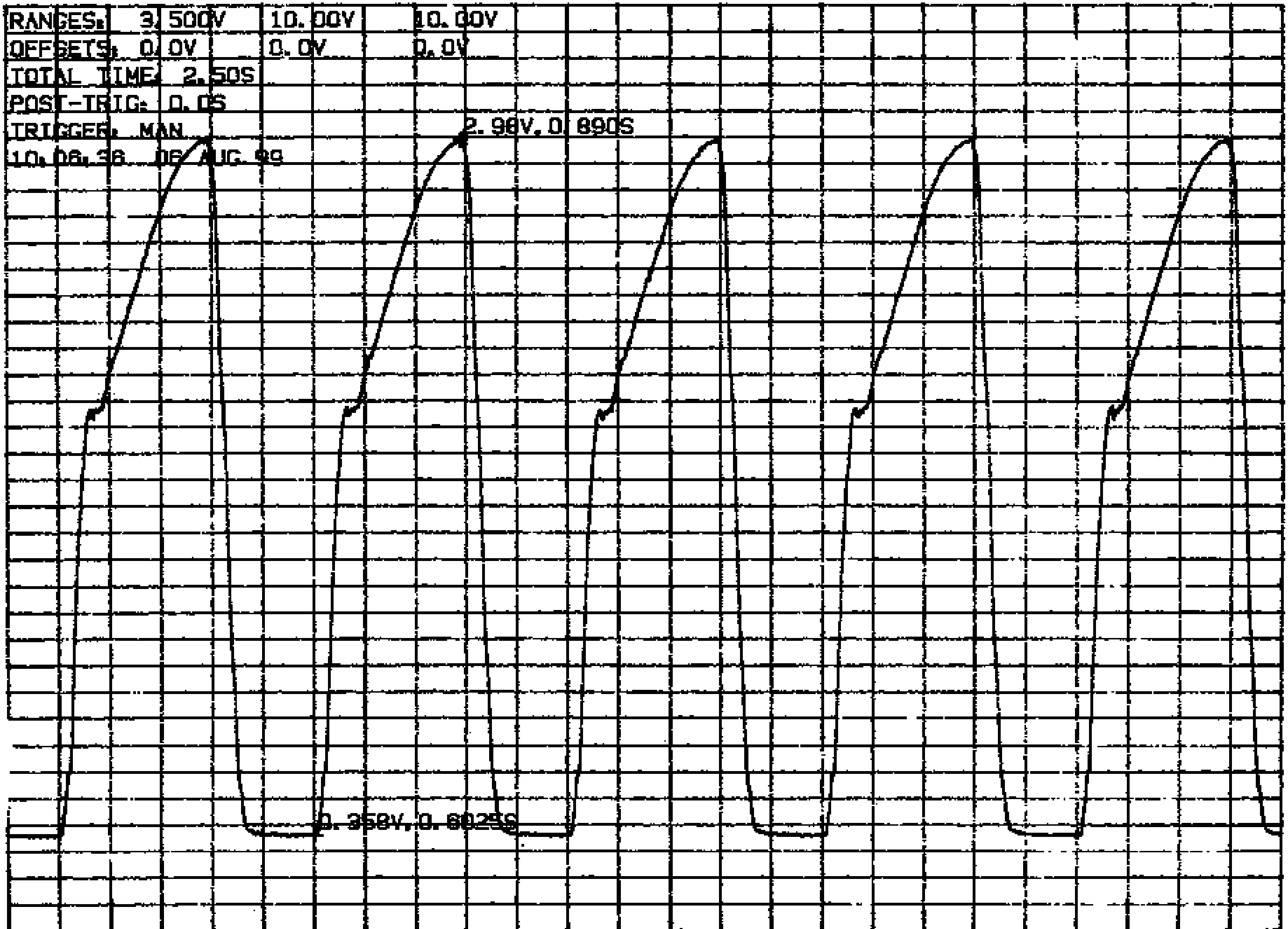
RANGES: 3.500V 10.00V 10.00V
OFFSETS: 0.0V 0.0V 0.0V
TOTAL TIME: 2.50S
POST-TRIG: 0.0S
TRIGGER: MAN
09:55:10 06 AUG 99
2.94V, 0.7825S
0.314V, 0.460S

AYT #2



TI-NM78A 014366

ATT #3



TI-NHTSA 014366

DRAWINGS AVAILABLE UPON REQUEST

PART:__________

____

QUAN:__________

77PS Impulse Test

T: 135 °C P_{min}: 0-50psi P_{max}: 1450 ± 50 psi

f: 2.0 Hz   medium: New brake fluid

30 devices split into 3 groups:

group 1: Virgin parts

group 2: Production vacuum Tested

group 3: Rapid vacuum done in lab (1.5-2.0 sec f[rom] atmospheric To ~29.2 in/hg)

P monitored by: SensoTec 0-5ksig CTRL # PR451 and using 3 APT device# 3CPA-1 strategic[ally] placed along P circuit. Actual P: APT voltage - 0.

APT1 - placed @ start of circuit

APT2 - placed ~ middle of circuit

APT3 - placed @ end of circuit

- output read on Nicolet scope CTRL# 4125

Steps: 1- get parts (32 virgin parts, 16 line vacuum Test[ed])

2 prep chamber + cycler (purge out old fluid)

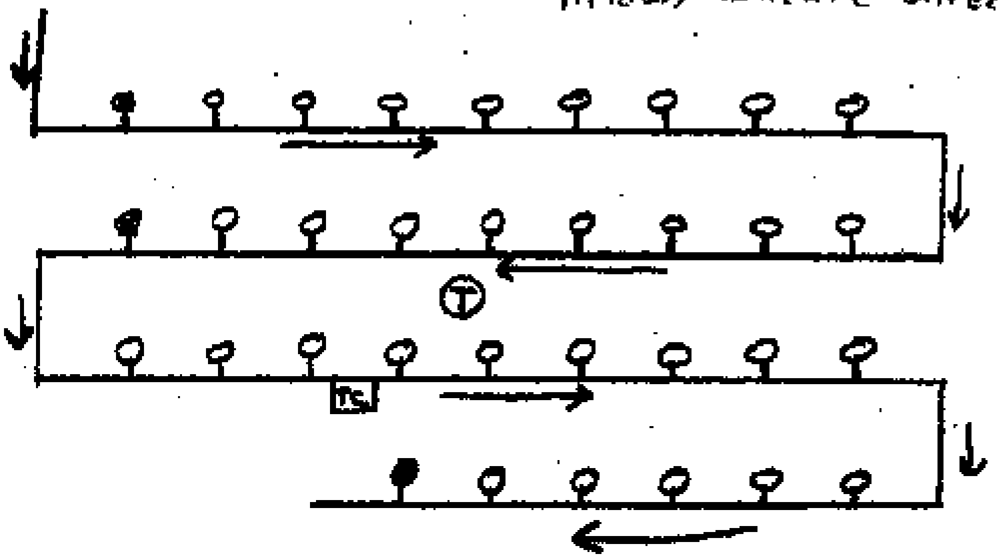
3- F/D curve 10pcs each group

4- Rapid vacuum group 3 parts

Temp monitored w/ OMEGA 672A digital Thermometer and usin[g] J-Type Thermocouples, 1-ambient (in chamber) suspended, 1-s[...] mounted To a manifold.

TI-NHTSA 0

—Arrows indicate direction of

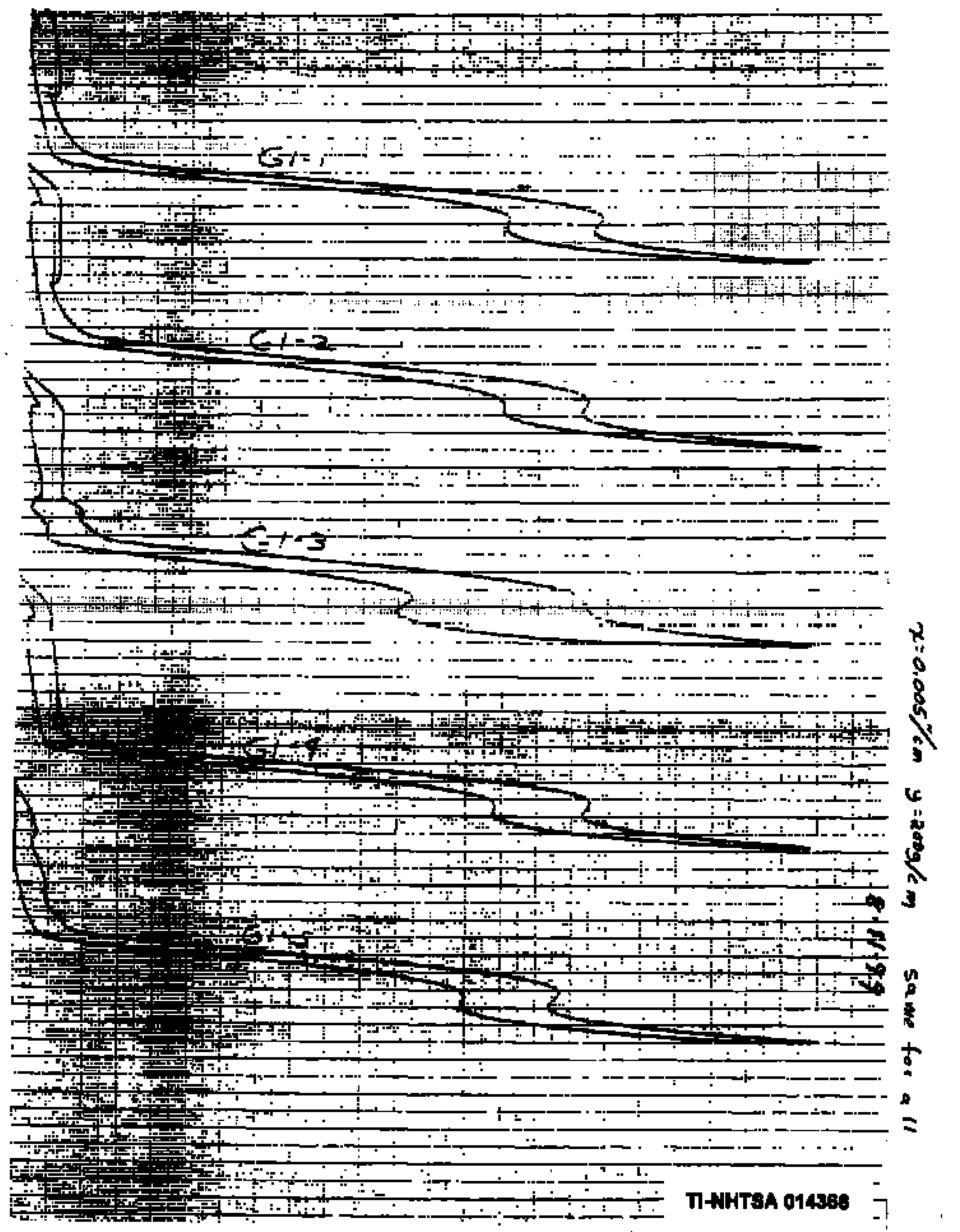


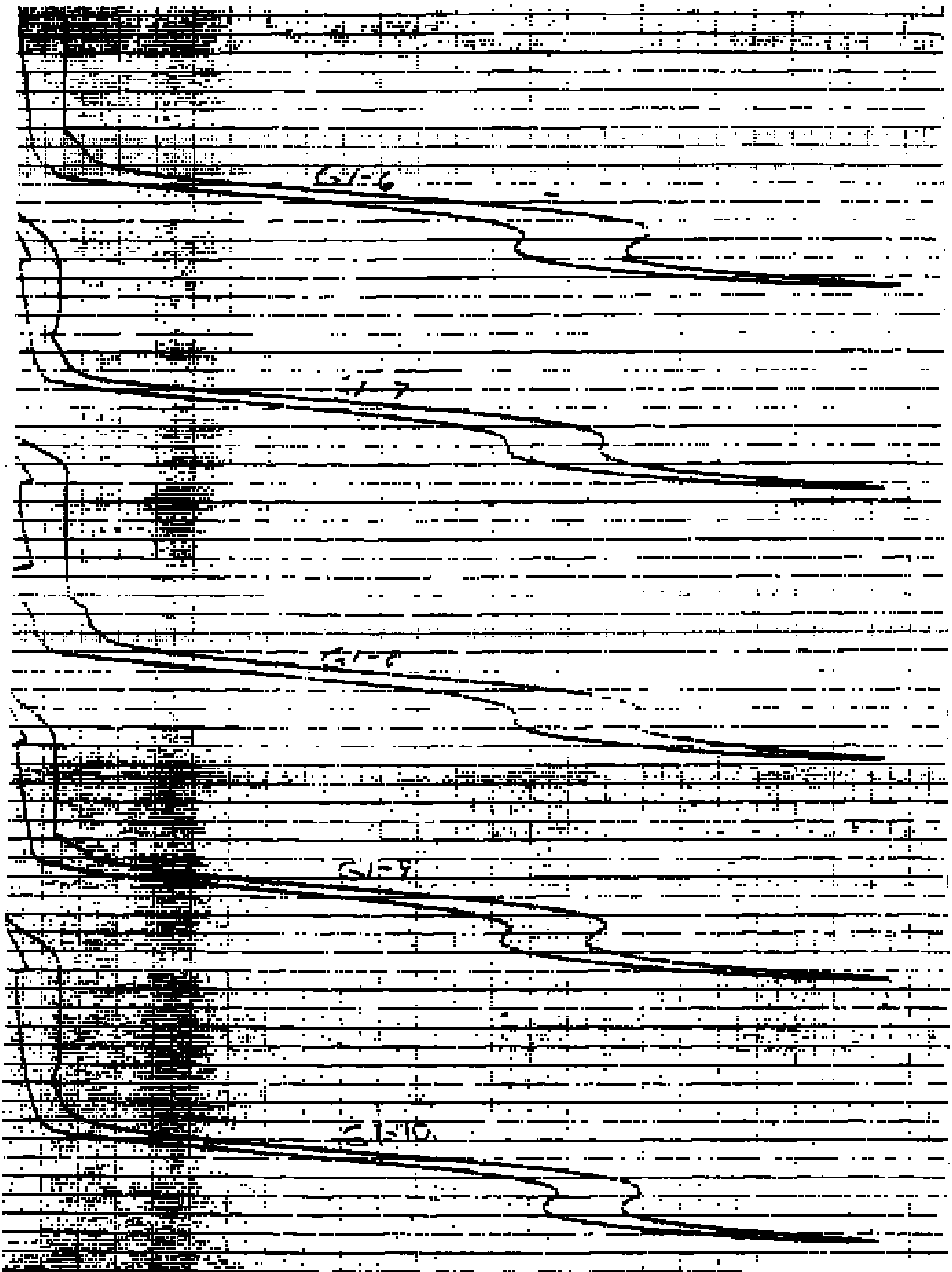
: TPPS devices

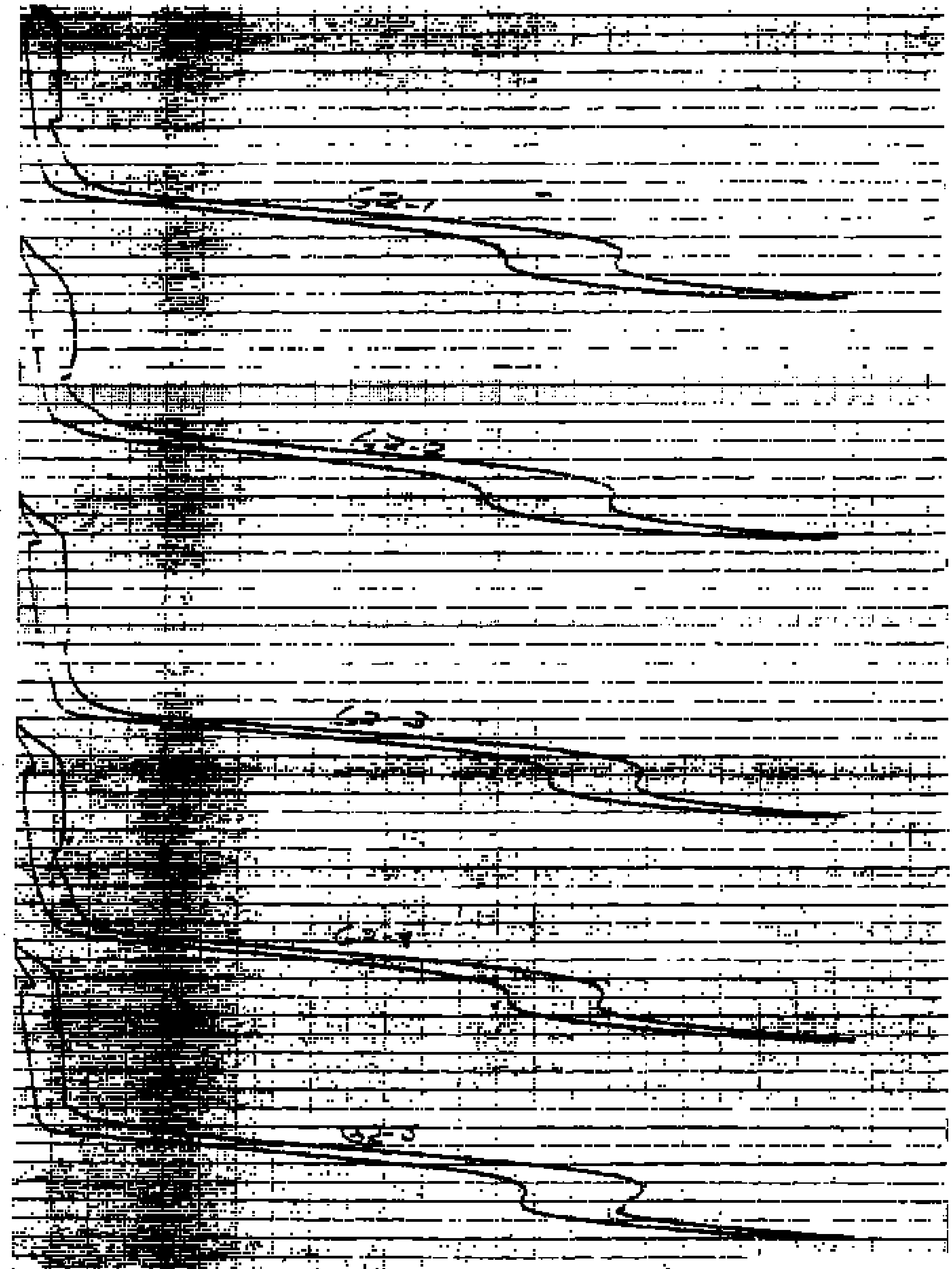
: APT 3CP2-1

(T): Suspended Thermocouple

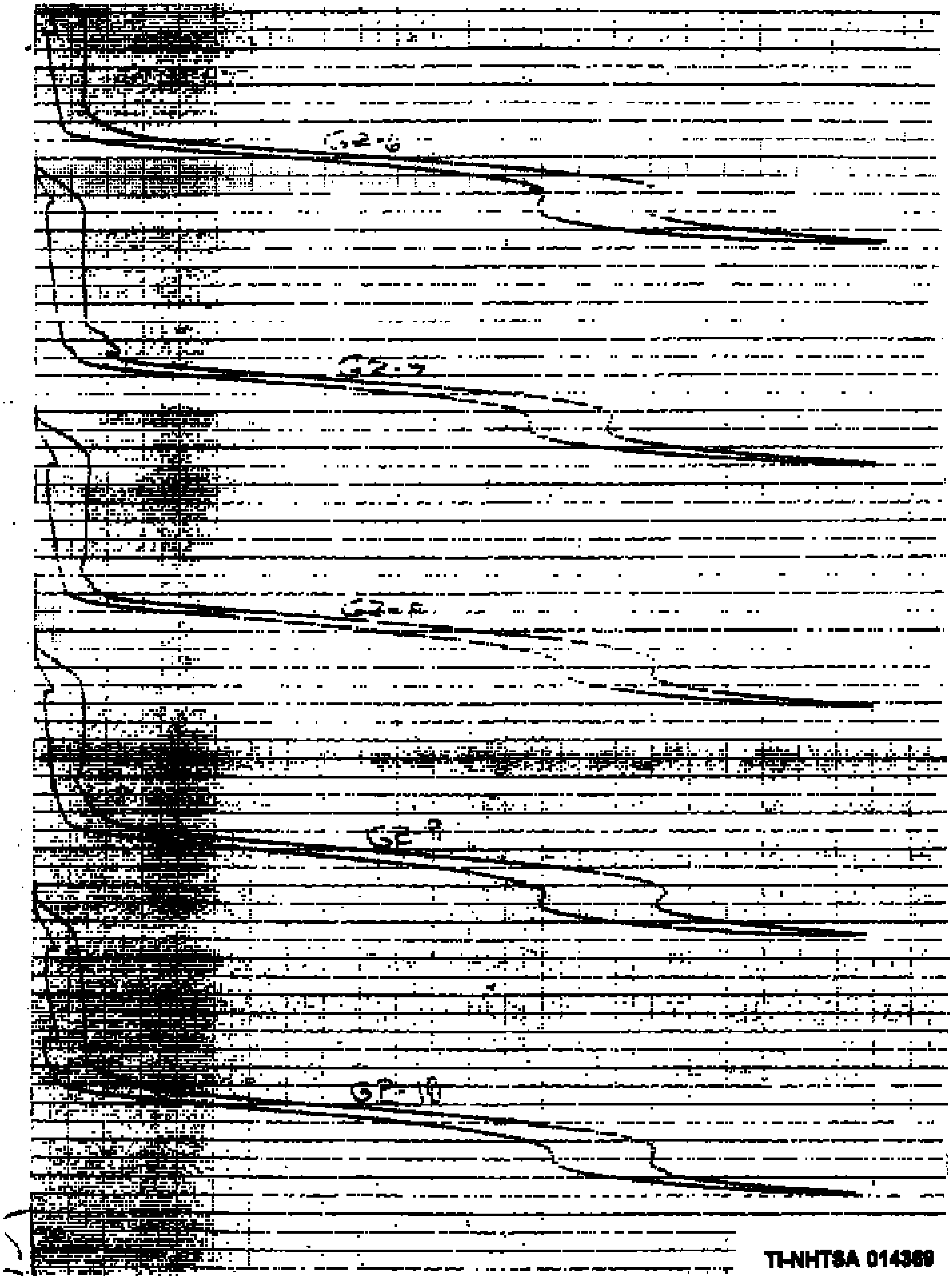
[TC]: Surface mounted thermo couple


G1-1
G1-2
G1-3
G1-4
G1-5
8/11/93
x: 0.005"/cm y: 200g/cm Same for all

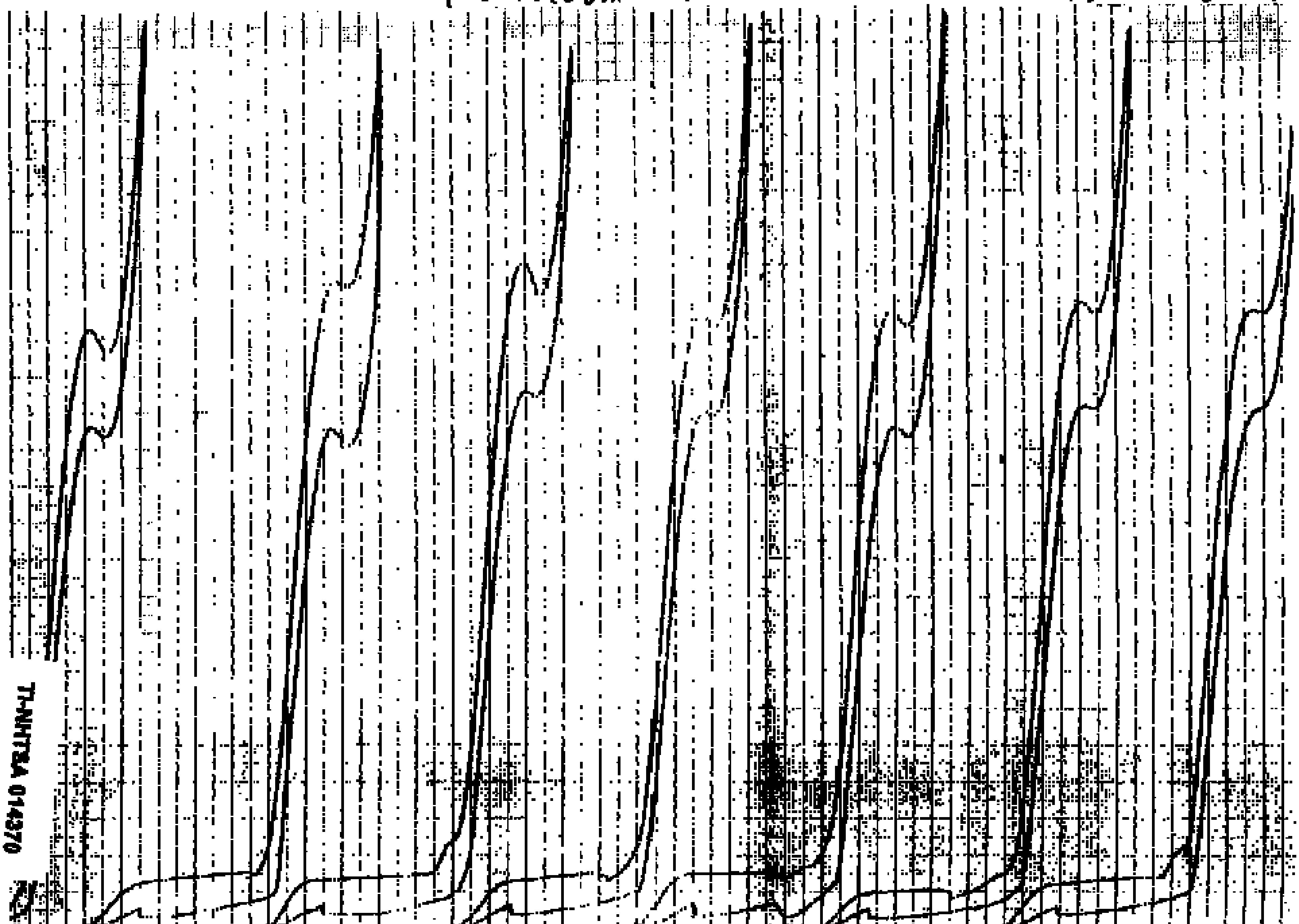

G1-6
-7
G1-8
G1-9
G1-10



TI-NHTSA 014368


G2-6
G2-7
G2-9

Pre-Vacuum Test



-1 -3-2 3-3 3-4 3-5 3-6a1 3-7

Pre-vacuum Test