

Department _____

Subject Lab Techniques I

Name SEGAL

Address _____



43-648

Computation Notebook

Dennison Stationery Products Co., Framingham, MA 01701



75 Sheets
11 1/4" x 9 1/4"
4x4 Quad

0 73333 43648 8

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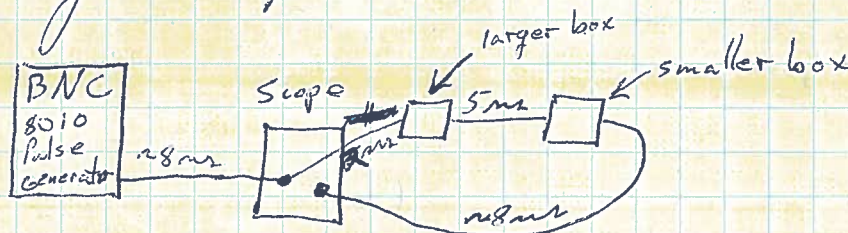
140

145

Risetime and Amplitude Response of N277L & 2735 DC

150

Attenuator boxes are setup as 4-way
 splitters (4 ports) (3-way splitters, 1 ground)
 for larger box input pulse is -940 mV
 looking at scope with BNC "T" into 1M Ω .



looking at output of larger box into 50Ω on
 scope -290 mV .

looking at output of smaller box into 50Ω on
 scope -94.5

$$\frac{940}{290} = 3.24$$

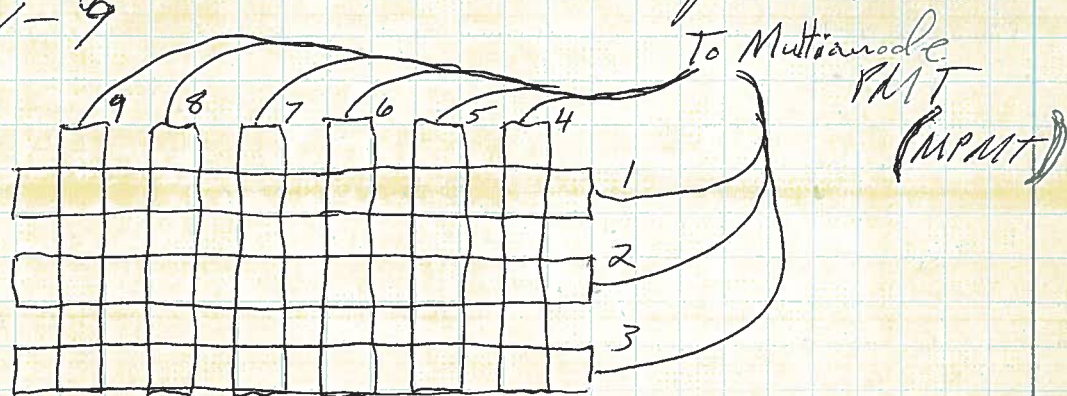
$$\frac{290}{94.5} = 3.07$$

$$\frac{940}{94.5} = 9.95$$

$$3.24 \times 3.07 = 9.95$$

2/19
1/8

Paddle arrangement in PB test stand.
Looking down on the whole setup we
refer to the scintillator paddles as
1-9



for both upper & lower sets.

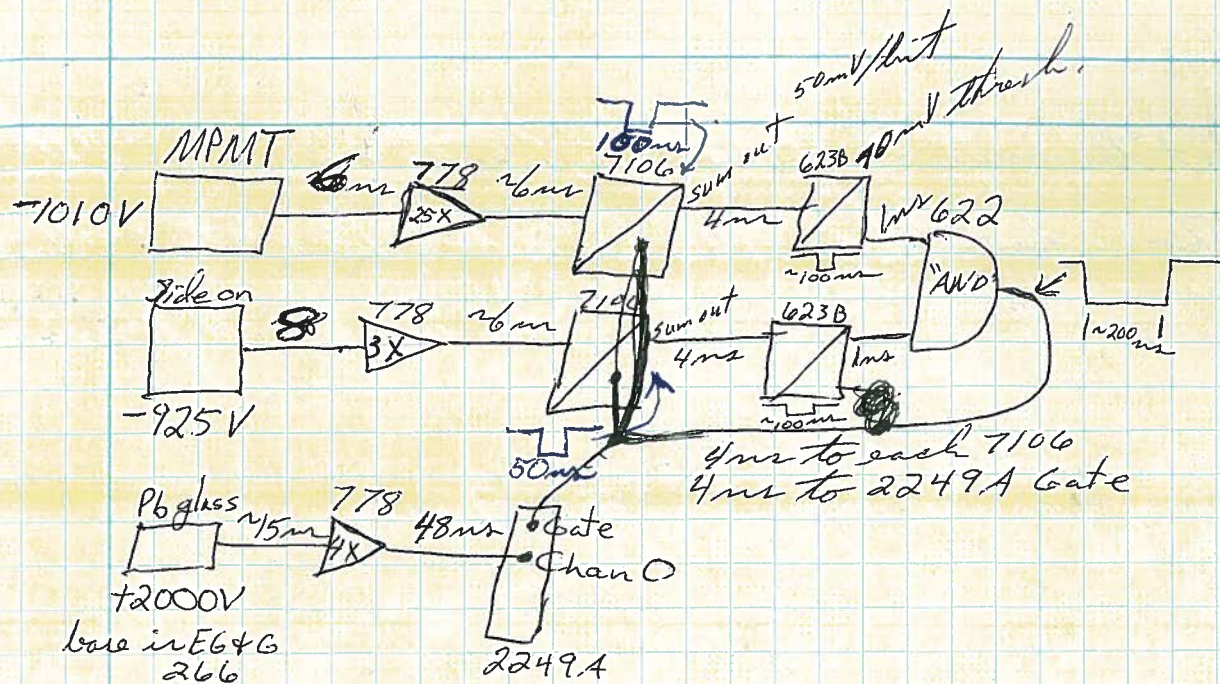
Using a Na^{22} source I verified the cabling so paddle 1-9 of the upper set is read into the corresponding input channel 1-9 of a Phillips 7106 in slot 12 of the Comac crate. Paddles 1-9 of the lower set are read into channels 11-9 of a 7106 in slot 14.

from the MPMT I have 6 ns to Phillips 778 gain set to $\times 25$
from lower side on PMT's I have 8 ns to Phillips 778
from Pb Glass (XP2050) I have ~ 15 ns to Phillips 778

All the gains of ~~MPMT~~ MPMT 778's set to $25 \times$ using the attenuators on p. 5 and the BNC model 8010 pulse generator using the -8V output.

Similarly the Pb glass set to $4 \times$ (gain of 4)

Gains of 778 for the side on tubes used in the bottom (Hammamatsu 931B) set to $3 \times$ (gain of ~ 3)



I am looking at an or of paddles 1x2x3

$$[(1 \times 2 \times 3) \cdot (4 \times 5 \times 6 \times 7 \times 8 \times 9)] \cdot [(1 \times 2 \times 3) \cdot (4 \times 5 \times 6 \times 7 \times 8 \times 9)]$$

and requiring one & only one paddle of the set 4, 5, 6, 7, 8, 9 is hit and that if ~~4~~ 4 on the top is hit it must also be 4 on the bottom which is hit and so forth for 5, 6, 7, 8 and 9

This thus creates 6 "regions." SEC ONE for paddle 4, SEC TWO for paddle 5, SEC THREE for paddle 6, SEC FOUR for paddle 7, SEC FIVE for paddle 8, and ~~SEC SIX for paddle 9~~ SEC SIX for paddle 9.

Right now the Kmax instrument is called INTERMEDIATE.

Stopped run on 2/21 with TRIGS 23927

9632	10705	9096	5829	5166	5054	5496	5029	4734
8719	10751	10531	5227	4864	5284	5219	5168	4843

Thresholds for 7106 in slot 12 (bottom) set to 15 $\Rightarrow$ 25mV
Thresholds for 7106 in slot 14 (top) set to 1 $\Rightarrow$ 11mV

2/22/74

Set the outputs of both 7106's to 400ms width
thresholds of 7106 in slot 12 set to 1.711mV
results of overnight run similar to previous.

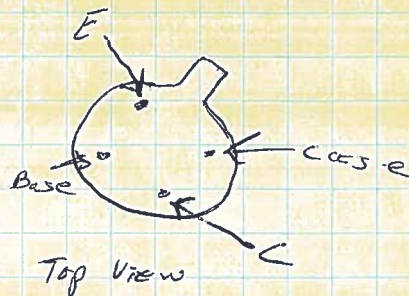
Upper tube is R4760

Lower tubes are Hamamatsu 931B

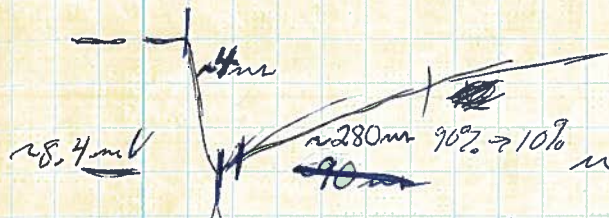
PB glass is an XP2050

3/11/8

2N5179



3/12



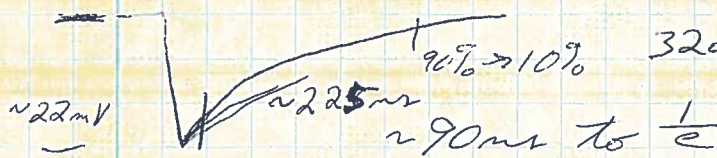
input is 300mV step with 4.7pF of 51Ω on input and 38dB.

$$1mV \Rightarrow 4.7fC$$

$$\frac{300}{79.4} = 3.78mV$$

$$= 17.8fC$$

$$\Rightarrow .47mV/fC$$

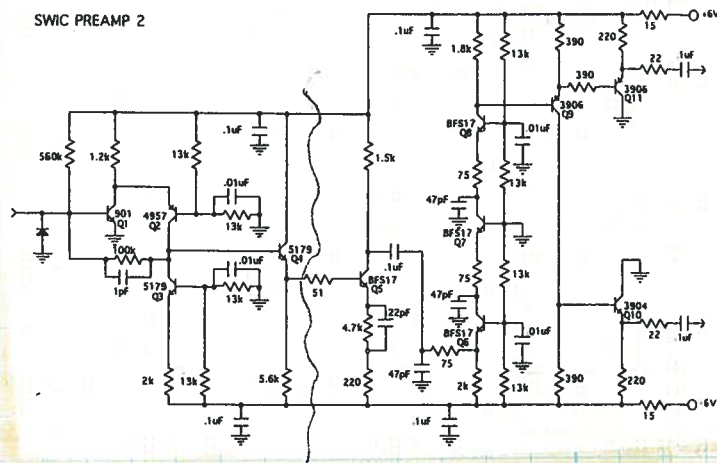


$$32dB \Rightarrow \frac{300}{39.8} = 7.54mV$$

$$\Rightarrow 35.4fC$$

$$\Rightarrow .62mV/fC$$

185ms? .35mV/fC
140ms? .39mV/fC



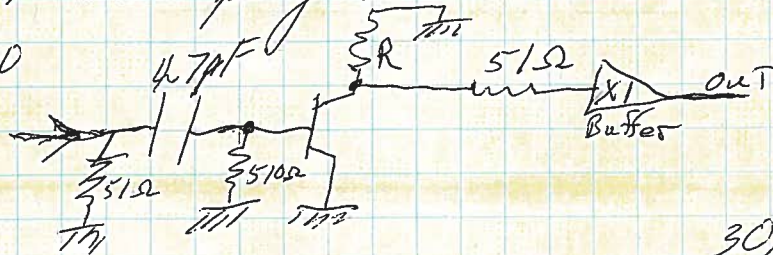
10
3/18

OTA

Yesterday I took a look at the Burr-Brown OPA660 AP. \$5.85 ea for 200.

On the plug board

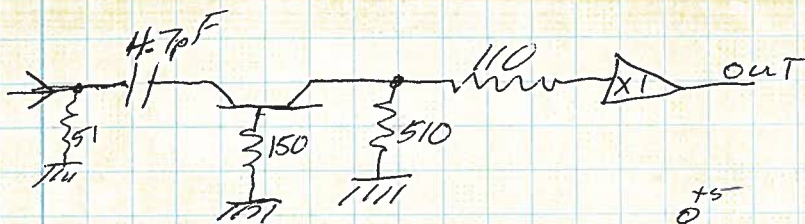
input pulse
is from BNC8010
through 220Ω
-300mV step



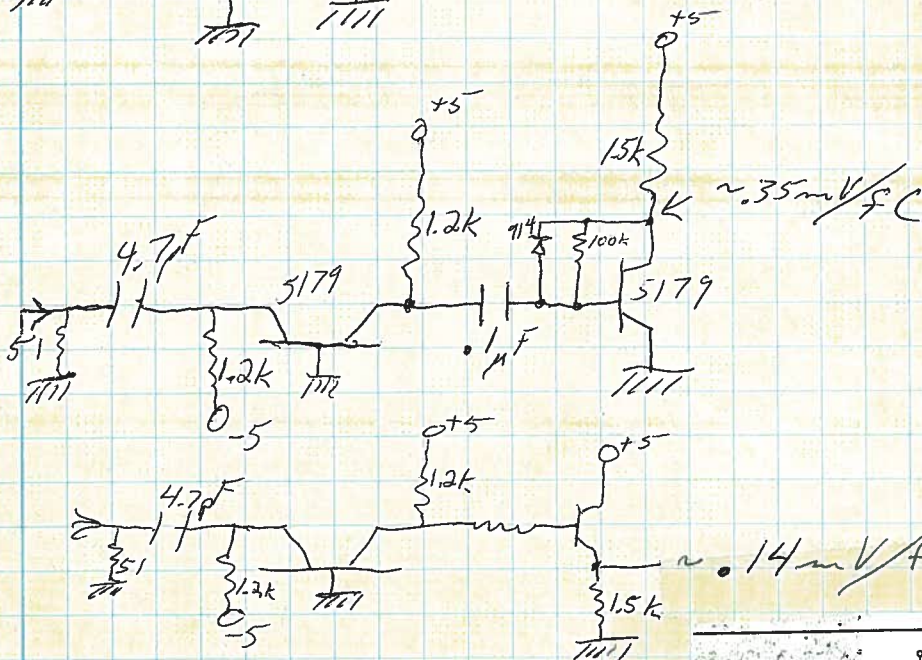
30mV on 4.7pF $\Rightarrow$ 141 fC

$R=220$ $\sim 225mV$ $T_{rise} \sim 7\mu s$ $\Rightarrow \sim 1.6mV/fC$

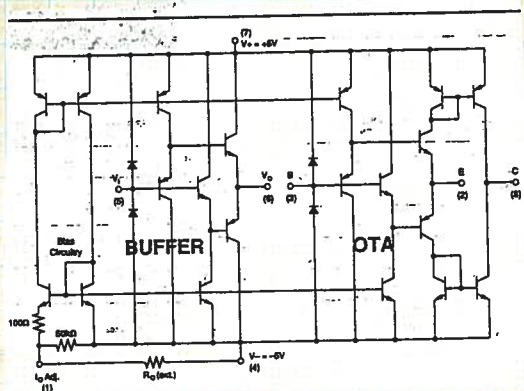
$R=220//130$ $\sim 100mV$ $T_{rise} \sim 5\mu s$ $\Rightarrow \sim .7mV/fC$



$\sim .06mV/fC$



OPA660 $\rightarrow$



Gain and Noise of Hall B preamp 3/19
 "Swic" amp and QPA03

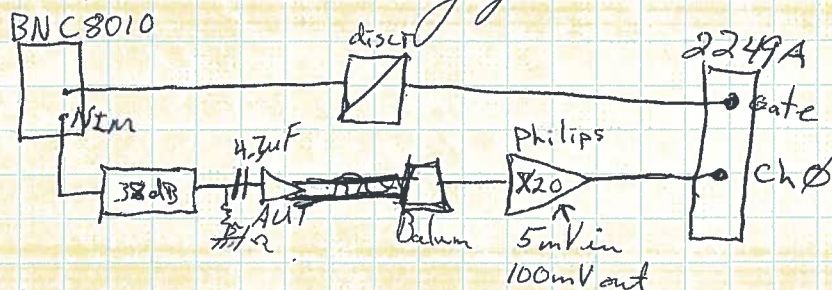
Hall B amp — $V_{\text{supply}} = +4.98V$

BNC pulser $\sim 1\text{ kHz}$ 300mV into $\sim 38\text{ dB}$ $10^{\frac{38}{20}} = 79.43$
 trigger/gate on NI Mout of pulser

$$\text{on } 4.7\text{ pF } \frac{300}{79.43} \times 4.7 = 17.75\text{ fC}$$

preamp output is through balun

$\sim 5\text{ mV}$ pulse is up & down in $\leq 15\text{ ns}$
 $\Rightarrow .28\text{ mV/fC}$ ($\sim 47\text{ mV/fC}$ for diff gain using 21.15 fC, ~ 1.14 see p. 14)
 gate width to ADC is $\sim 55\text{ ns}$ whole preamp pulse is enclosed by gate.



histograms stored as B-Pulsed, B-Notpulsed, B-Noampinput
 and B-Noadcinput
 for BNC output at 600mV histograms stored as
 B2-Pulsed, etc...

Looking at "Swic" preamp

$V_{\text{supply}} = +5.98V, -5.98V$

No Balun

BNC pulser output at 300mV

preamp output 11.5 mV $\Rightarrow \frac{17.75}{11.5} = .65\text{ mV/fC}$ ($\sim 54\text{ mV/fC}$ see p. 14)
 250mV after Philips 778

gate width is the same $\sim$ first 35 ns of pulse is enclosed.

Histograms stored as S1-Pulsed, etc...

for BNC output at 600mV histograms stored as
 S2-Pulsed, etc...

From QPA03 $V_{supply} = 4.25V$ Outputs coupled to balun through μF capacitors.

BNC output at 300mV preamp output is 115mV after the balun.

Philips amp set to an output of 420mV. Preamp output is up and down in $\approx 15ms$. Slightly faster than hall B preamp.

Gate is same as before. whole pulse is enclosed.

Histograms stored as Q1-Pulsed, etc... and Q2-Pulsed, etc... for 600mV input

$$\frac{115mV}{17.75} \Rightarrow 6.5mV/\mu C$$

Looking back at previous check of QPA03 gain $\approx 4mV/\mu C$ at $V_{supply} = 4.5V$ (assuming also through the balun. i.e. output of balun is not doubled to compensate for loss through balun)

if 115mV is true $\frac{115mV}{3.78mV} = 30.67$

$$300 \div (10^{\frac{38}{20}}) = \uparrow$$

$$\frac{30.67}{3.78} = 8.11\mu F$$

~~3.4pF extra??~~

$$\frac{115mV}{4\mu C} = 4mV/\mu C$$

$$x = 28.75\mu C$$

$$3.78mV \times y\mu F = 28.75\mu C$$

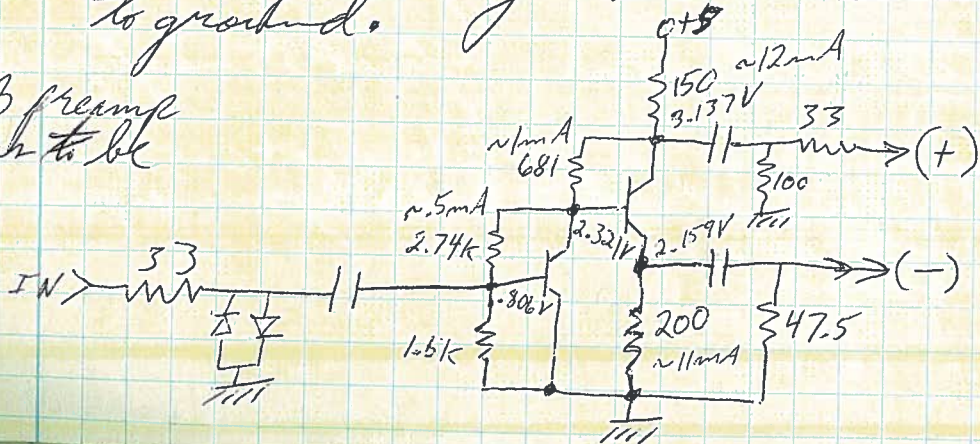
$$y = 7.6\mu F \Rightarrow \underline{\underline{2.9\mu F \text{ extra}}}$$

Hall B preamp was set on a plug board.

Some signals may also have been bled off to ground.

3/20/88

Hall B preamp seems to be



3/20

Borrowed an HP 8013B pulser from Hall C.
 Output pulse is set to ~~amplitude~~ width and width
 of $\sim 1/2$ μ s base to base.
 Set amplitude to ~ 300 mV width to ~ 800 ns

Looking at output of QPAC3 (38dB on input)
 I see ~ 85 mV output $\Rightarrow \frac{85 \text{ mV}}{17.75 \text{ fC}} = 4.8 \text{ mV/fC}$

input step is ~ 312 mV

output of attenuator is 4.5 mV $\Rightarrow \div 69.3$

$\Rightarrow 21.15 \text{ fC injected}$

$\Rightarrow 4.0 \text{ mV/fC}$

Still higher than before but much more reasonable. So, the driving pulse was poorly shaped and the attenuation was wrong.

Looking at Hall B preamp. Input looked
 up as per ^(p. 14) Fernando's recommendation. Pulse
 height is left at ~ 300 mV (lowest setting). Pulse
 width is $\sim 1/2$ μ s base to base (lowest setting)

$1.6 \times 2 \text{ mV} \Rightarrow 3.2 \text{ mV}$

if 4.5 mV/in & $G = 2.2 \text{ mV}/\mu\text{A}$

$\Rightarrow 9.9 \text{ mV}$

balun output is $5.2 \text{ mV} \Rightarrow 6.4 \text{ mV}$ differential ^{differential}

Increasing the pulse width the output pulse reaches
 $2.1 \times 2 \text{ mV} = 4.2 \text{ mV}$

$\Rightarrow 8.4 \text{ mV}$ differential $\Rightarrow 1.9 \text{ mV}/\mu\text{A}$

Output of pulser is ~ 20 ns base to base at this point.

At shortest pulse width pulse height is 280 mV

$\Rightarrow 4.04 \text{ mV into amp.}$

$4.04 \times 2.2 \Rightarrow 8.88 \text{ mV differential}$. I see $6.4 \text{ mV} \Rightarrow 1.6 \text{ mV}/\mu\text{A}$

Balun is not calibrated.

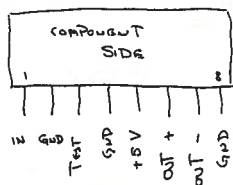
With pulser @ 600 mV and ~ 30 ns base to base

balun output is $4.1 \times 2 \text{ mV} = 8.2 \text{ mV} \Rightarrow 16.4 \text{ mV differential}$

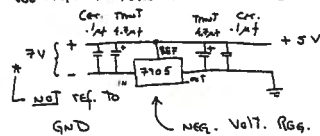
$\frac{600}{69.3} \times 2.2 = 19.0 \text{ mV diff.}$

F.B. - 3/12/91

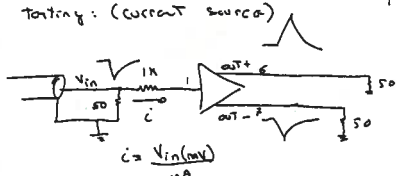
CP1 Ramp



- Voltage Regulator is recommended:



- Testing: (Current Source)



for 10 mV $\rightarrow$ 10 μ A
 CP1 Gain = 2.2 mV/ μ A (diff)

3/2/91 Hooked up the OPA660 with grounded E as on p. 10. R_{ext} is 330 Ω . $V_{supply} = +5.0V \& -5.0V$

Output of buffer is $\rightarrow$ 51k (probe)

Using HP 8013B pulser with amplitude set to minimum and width set to ~ 400 ns.

Output pulse is ~ 10 mV $\Rightarrow \frac{10 \text{ mV}}{21.15 \text{ ns}} = .47 \text{ mV/ns}$ (p. 13)

~ 10 ns from base to pulse peak (on rise) ~ 25 ns on fall.

$\sim 10\% \rightarrow 90\%$

note: $R = 220 // 150$

I cannot find any 130 Ω . I find a few of 120 & 150. Perhaps the 130 Ω on p. 10 was not 130 Ω ?

$R = 220 // 120$ ~ 8 mV output pulse shape is almost identical to that with 220 // 150.

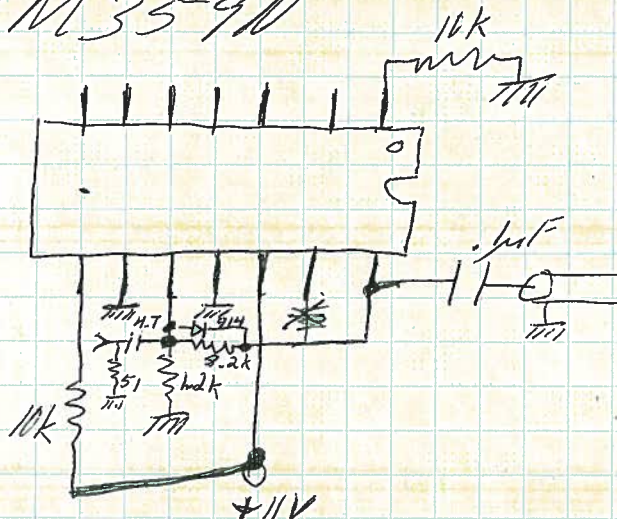
$R = 220$ pulse is $\sim (4.75 \times 5 \text{ mV}) = 23 \text{ mV} \Rightarrow 1.1 \text{ V/ns}$
 ~ 14 ns from base to peak on rise
 ~ 20 ns to ground on fall then overshoot of ~ 4 mV

Set R to $51.1\Omega = \sim 5\text{mV}$ output on scope
output of Phillips 778 amp is $\sim 50\text{mV} \Rightarrow \times 10$

Replaced R with $220//150$ now $\sim 100\text{mV}$

Ran ADC & saved histograms. ADC gate $\sim 55\text{ms}$ & set
so pulse entirely within gate.
Saved as OPA-PULSED, etc...

Hooked up LM359N



With scope (50Ω) I see $\sim 8.8\text{mV} \Rightarrow 43\text{mV}/5\text{C}$
 $\sim 15\text{ms}$ base to peak on rise
 $\sim 30\text{ms}$ peak to base on fall plus a
little overshoot.

Switch to (+) output on pulser. At minimum setting the
amplitude is 300mV .
ADC gate is left as above ($\sim 55\text{ms}$). This clip off just
into the overshoot.
Saved histograms as LM-PULSED, etc...

$$\frac{300}{69.3} \times 4.7\text{pF} = 20.3\text{fC}$$

↑
(p.13)

3/22/93 Looking at Hall B preamp again
 JA Pulser (HP8013B) output is $\sim 312 \text{ mV}$ steps.
 5.4 mV into 50Ω after 40 ns .

output of balun is $\sim 3.6 \text{ mV}$ 5 mV by 10 ns

DC offset of Phillips 778 amp is $\sim 45 \text{ mV}$.
 $3.6 \times 2 \div 21.15 \Rightarrow .34 \text{ mV}/\text{fC}$ diff'l
 amp output is $\sim 33 \text{ mV}$

LeCroy 623B discriminator output set to $\sim 40 \text{ ns}$ width.
 Pulse rate is $\sim 3.2 \text{ kHz}$

gain of Phillips 778 set to $\frac{7.2 \times 10 \text{ mV}}{3.6 \text{ mV}} = 40$
 Histogram saved as B-Plug-Noise

Looking at the "Swic" amp I see $6.2 \times 2 \text{ mV}$. This is
 using the "+" output since the amp is inverting.
 Rise time is $\sim 6 \text{ ns}$. (1st pulse is negative this way)

After Phillips amp pulse is $4.9 \times 100 \text{ mV} = 490 \text{ mV}$
 All readings taken at odd thresholds. The one at an
 even threshold is an unrecorded data point. Boops.

Vsupply is $\pm 5.83 \text{ V}$

Histogram saved as S-Noise

Looking at LM359 same as on p. 15 Vsupply = 11.0 V
 rise time $10\% \rightarrow 90\% \sim 7.5 \text{ ns}$ $4.6 \text{ div} \times 2 \text{ mV}$ peak height

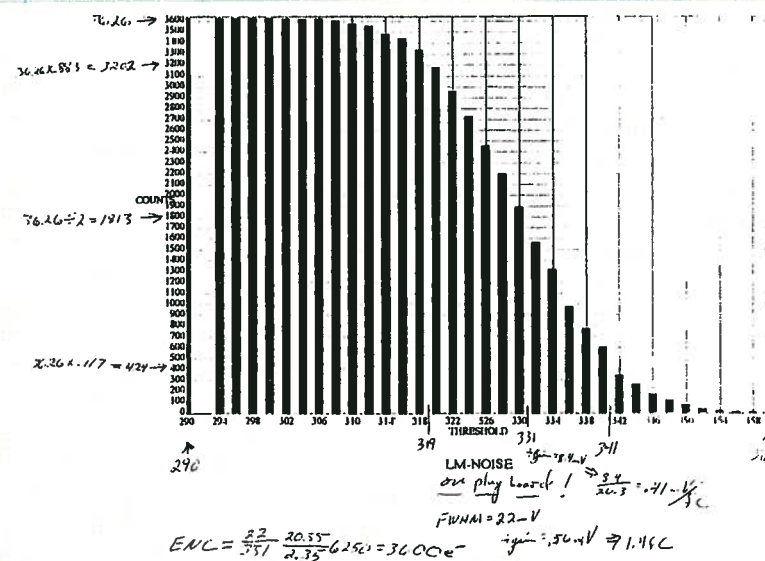
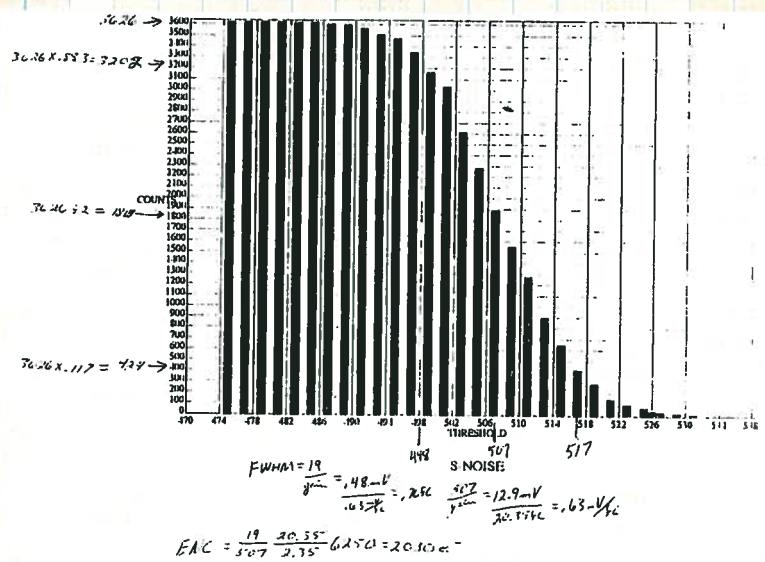
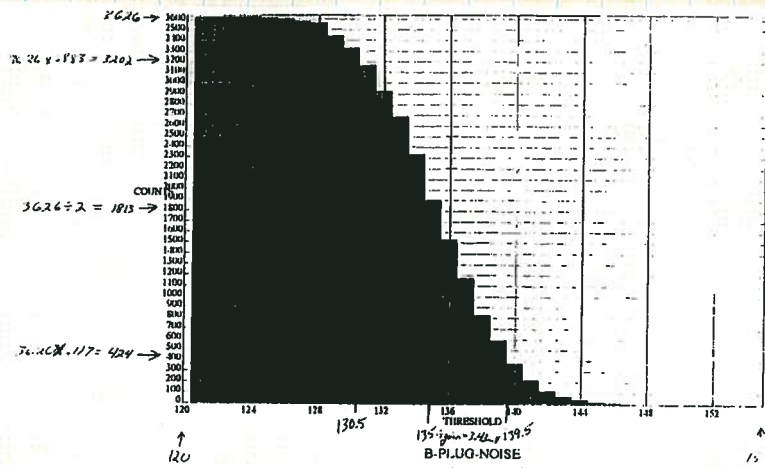
Put back biased diode from compensation to input
 rise $10 \rightarrow 90\% \sim 7.5 \text{ ns}$ 4.2 div peak less overshoot
 2.9 div with 51Ω in series with output

Remove diode entirely rise $10 \rightarrow 90\% \sim 8.5 \text{ ns}$ 5.8 div peak overshoot of some ring

Leave diode from compensation to input. No 51Ω on output.
 After Phillips amp there is
 Time $10\% \rightarrow 90\% = 8 \text{ ns}$ 32.5 mV peak

Maximum count is ~ 3626 for all three.

• Put need to couple Phillips 778 with
 the LeCroy 623B!!
 DC offset can be such a pain in the ass sometimes.



On LM359

Varying feed back resistor + resistor from "-" input to gnd. Set both to same value

Using "+" output of pulse to get a negative pulse out as the first pulse

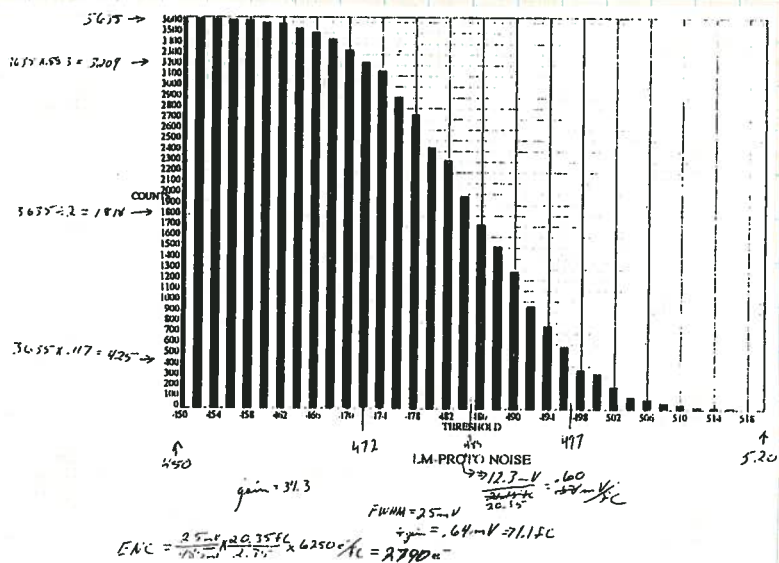
8.2k $\rightarrow$ $\tau_{rise 10\% \rightarrow 90\%} \sim 8ms$ 9.4 mV peak
 25ms peak to baseline + some overshoot.
 10k $\rightarrow$ $\tau_{rise 10\% \rightarrow 90\%} \sim 9ms$ 10.4 mV peak
 35ms peak to baseline less overshoot
 27k $\rightarrow$ $\tau_{rise 10\% \rightarrow 90\%} \sim 12ms$ 12.4 mV peak
 100ms peak to baseline no overshoot

Put the LM359 on prototyping board in a socket.

8.2k used for feedback $\uparrow$ to gnd from "-".
 $\sim 12.2 mV$ peak $\tau_{rise 10\% \rightarrow 90\%} 7ms$
 (60mV/5C) base to peak on rise $\sim 13ms$
 Peak to baseline on fall $\sim 22ms$
 $\sim 2 mV$ overshoot

Out of Phillips amp $\sim 480 mV$ $\sim 80 mV$ overshoot
 $V_{supply} = 7.05 V$

Maximum count was 3635
 Histogram stored as LM-Proto-Noise



LM359 again.

3/23

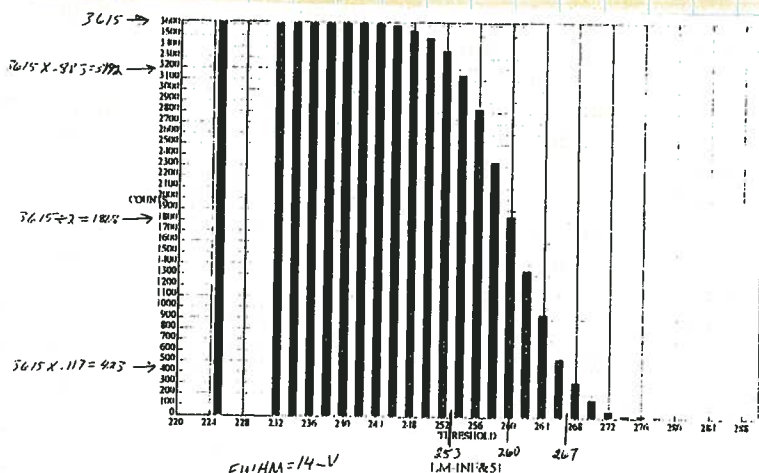
Remove 8.2k from "-" to gnd.
 6.2 div. $\times$ 2mV/div. = 12.4mV peak output
 $\sim 14\mu$ s from base to peak. $\sim 21\mu$ s from peak to base (fall)
 $\sim 7\frac{1}{2} \rightarrow 8\mu$ s 10% $\rightarrow$ 90% on rise
 Overshoot ~ 2.4 mV

Put 51 Ω in series with output. (1/8W carbon comp.)
 3.3 div $\times$ 2mV/div. = 6.6mV peak. ~ 1.45 mV overshoot.
 $T_{10\% \rightarrow 90\%}$ still $\sim 8\mu$ s
 $\sim 13\mu$ s from base to peak. $\sim 19\mu$ s from peak to base.

Leaving 51 Ω on the output. $6.6\text{mV} / 20.35\text{FC} = .32\text{mV/FC}$

Output of Phillips 778 with .1 μ F on output ~ 260 mV peak
 $\sim 14\mu$ s base to peak on rise. $\sim 19\mu$ s peak to base on fall + $\sim 6\text{mV}$ overshoot
 $T_{\text{rise } 10\% \rightarrow 90\%} \sim 7\frac{1}{2} \rightarrow 8\mu$ s

Histogram gave as LM-INF#51
 Max count was 3615



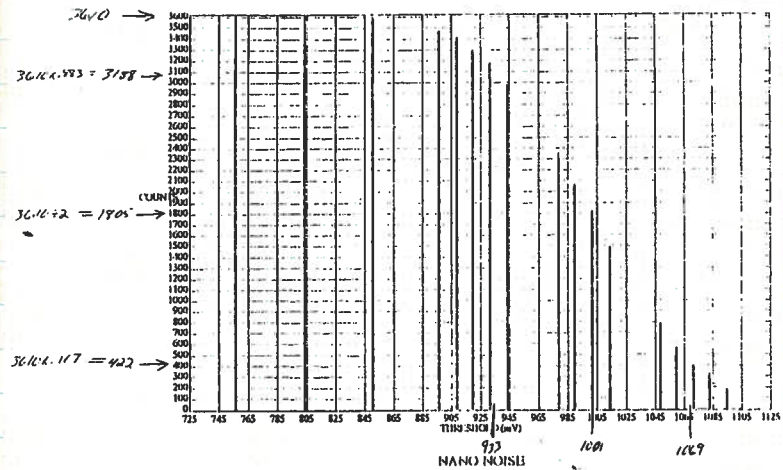
$$\text{ENC} = \frac{14\text{-V}}{260\text{-V}} \times \frac{20.35\text{FC}}{2.35} \times 6250 = 2914e^-$$

3/24/JS

Noise check of Parometric 277 L
Borrowed amp from Hall C

Card seated
on edge
for convective
cooling.

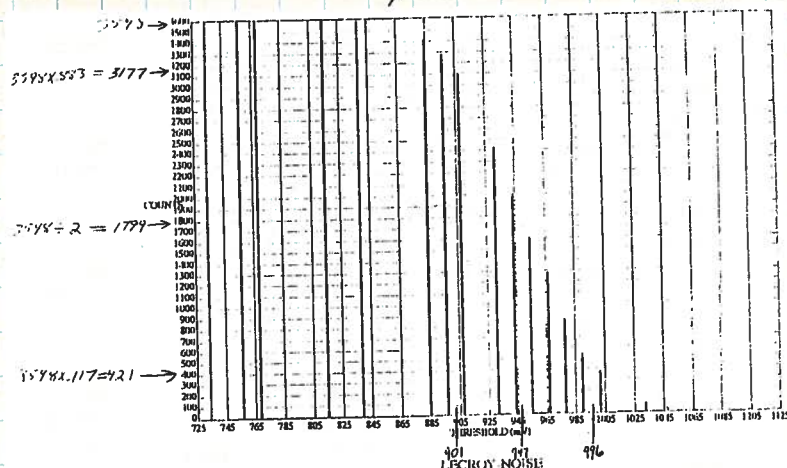
Voltages at +5.0V & -5.2V
Threshold measured with Fluke 79 multimeter.
Pulse taken from (-) output of HP pulser.
Input pulse applied to a card edge connector into
which the amp was socketed.



$$ENC = \frac{116}{1001} \times \frac{21.15}{2.35} \times 16250 = 7642e^-$$

3/25/JS

Noise check of Lecroy 2735 DC borrowed from Hall C
Supply voltages at +5.03 & -5.17
As above except 4.7pF soldered to input.



$$ENC = \frac{95}{947} \times \frac{21.15}{2.35} \times 16250 = 5643e^-$$

Using 4.7 pF for charge injection + Capacitor for loading.
 Going back to "Swic" amp

$$V_{\text{supply}} = \pm 6.02 \text{ V}$$

Pulse output is from (+) output
 Risettime is $\sim 5 \frac{1}{2} \text{ ns}$ (10% to 90%), peak is $\sim 11 \text{ mV}$

Fall time is $\sim 10 \text{ ns}$ to $\frac{1}{e}$

Phillips amp output is $\sim 415 \text{ mV}$ peak

Looking at Hall B preamp. Pulse out from (-) output.

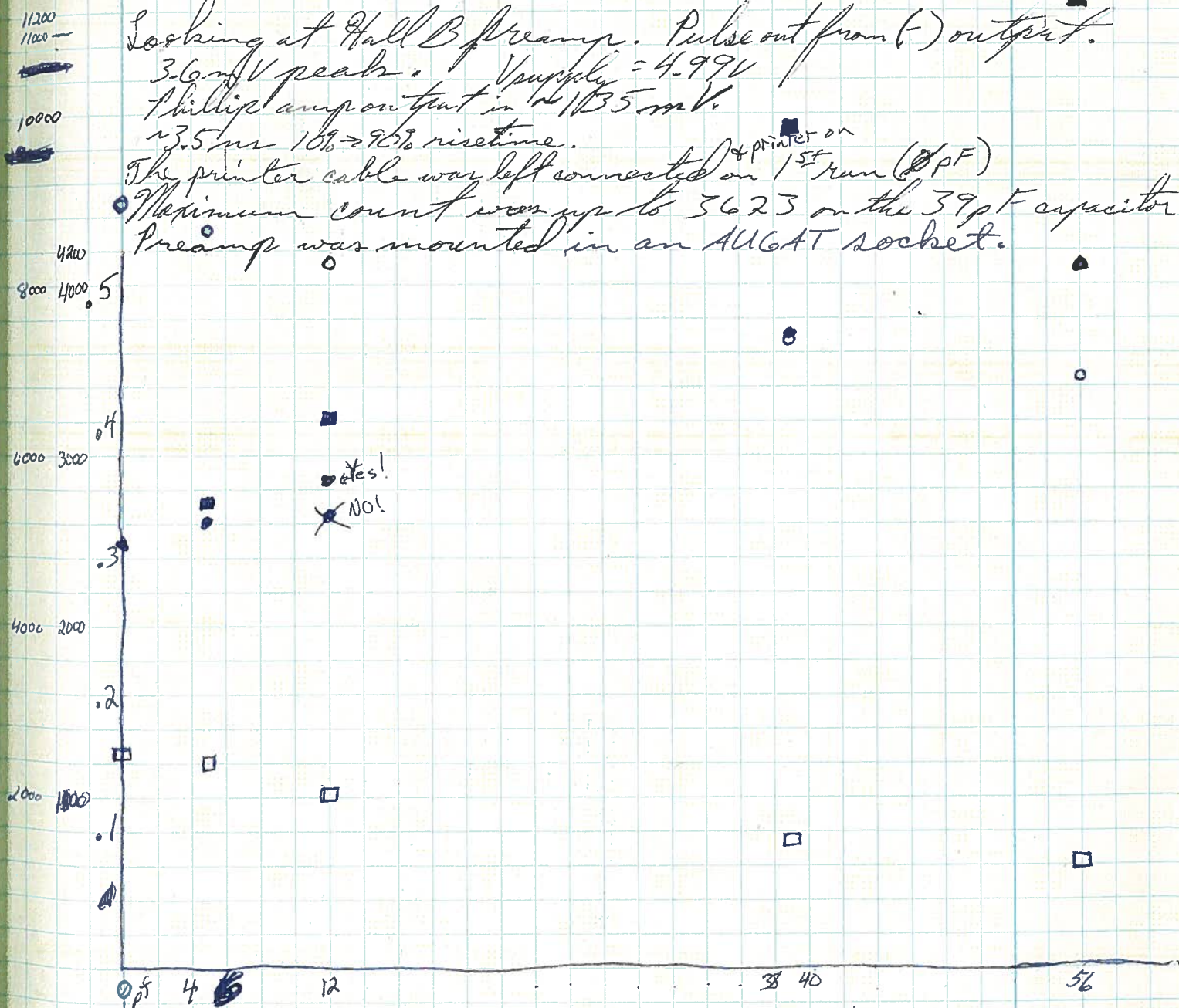
3.6 mV peak. $V_{\text{supply}} = 4.99 \text{ V}$

Phillips amp output is $\sim 1135 \text{ mV}$.

$\sim 3.5 \text{ ns}$ 10% to 90% risetime.

The printer cable was left connected on 1st run (0 pF)

Maximum count was up to 3623 on the 39 pF capacitor
 Preamp was mounted in an AUGAT socket.

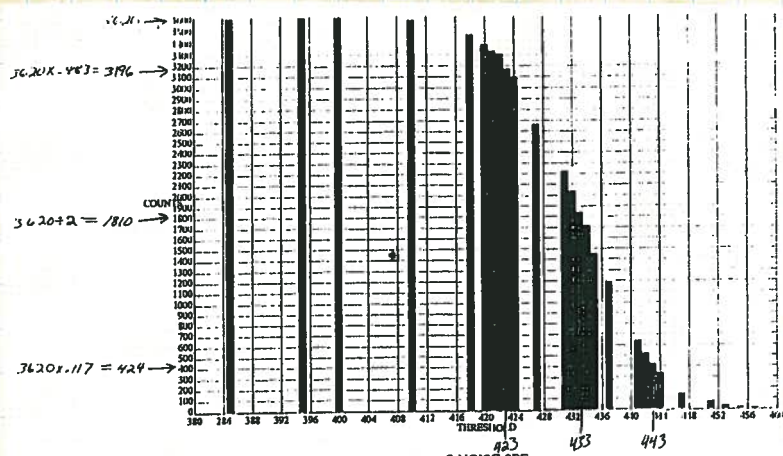


$\sim 125 \text{ e}^-/\text{pF}$ for Hall B preamp

$\sim 30 \text{ e}^-/\text{pF}$ for "Swic" amp

Histograms from p. 21 - 2

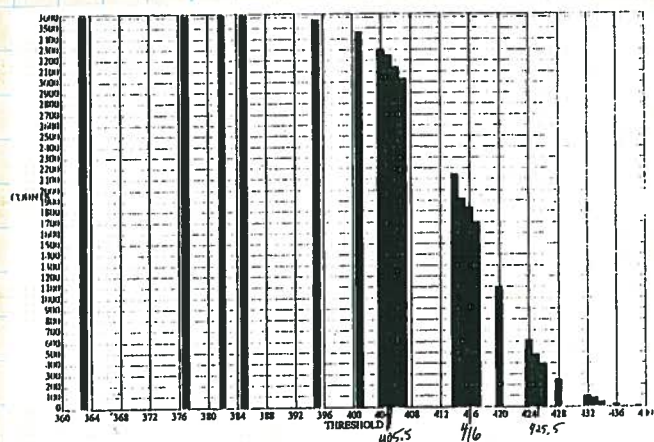
Histograms acquired from low pF to high pF values. "S" run first then "B."



$$ENC = \frac{20}{433} \frac{20.35}{2.75} 6250 = 2500 e^-$$

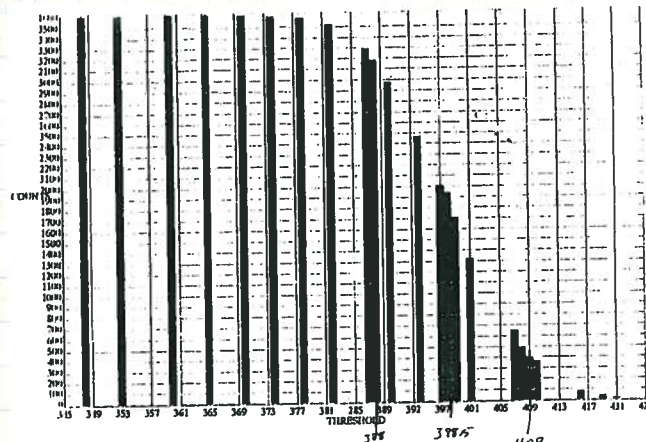
.56 $\frac{mV}{\sqrt{Hz}}$

Thresholds
are in
mV on the 623B
discriminator
(X.01V on the monitor)
pin was measured
pF is value of loading
capacitor



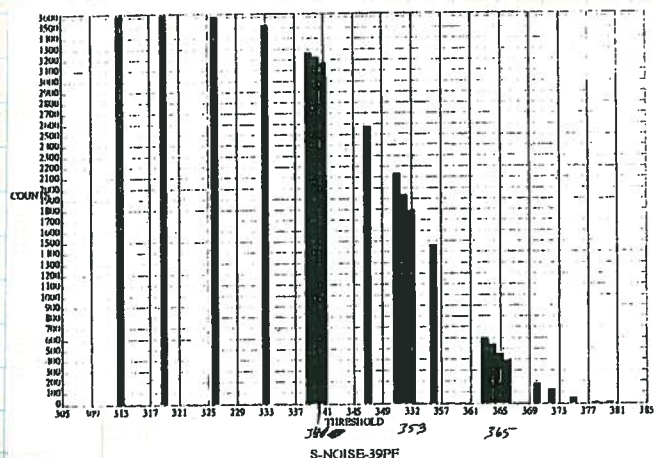
$$ENC = \frac{20}{416} \frac{20.35}{2.75} 6250 = 2602 e^-$$

.54 $\frac{mV}{\sqrt{Hz}}$



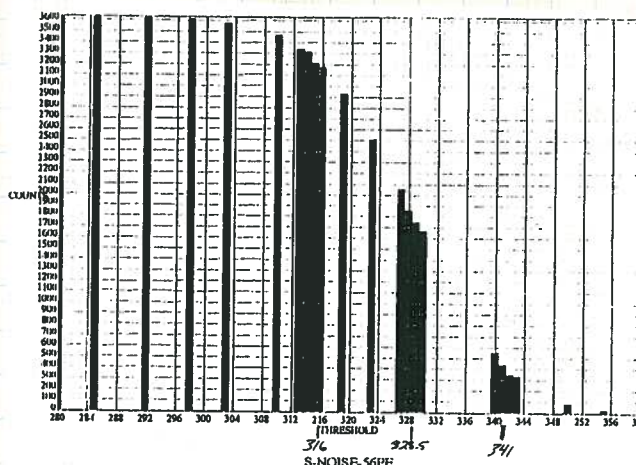
$$ENC = \frac{21}{378.5} \frac{20.35}{2.75} 6250 = 2852 e^-$$

.52 $\frac{mV}{\sqrt{Hz}}$



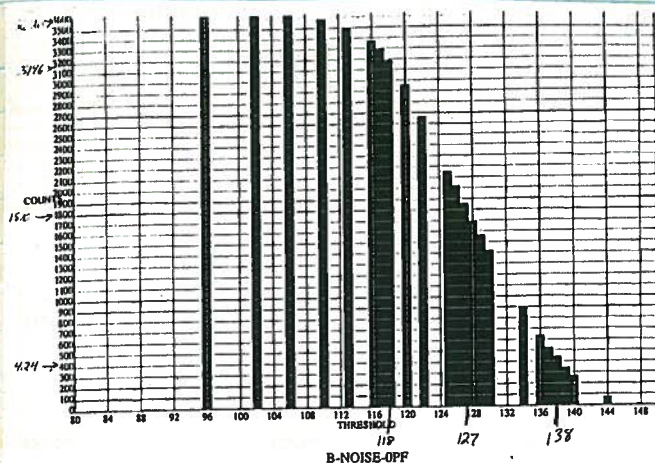
$$ENC = \frac{24}{353} \frac{20.35}{2.75} 6250 = 3680 e^-$$

.46 $\frac{mV}{\sqrt{Hz}}$



$$ENC = \frac{25}{329.5} \frac{20.35}{2.75} 6250 = 4119 e^-$$

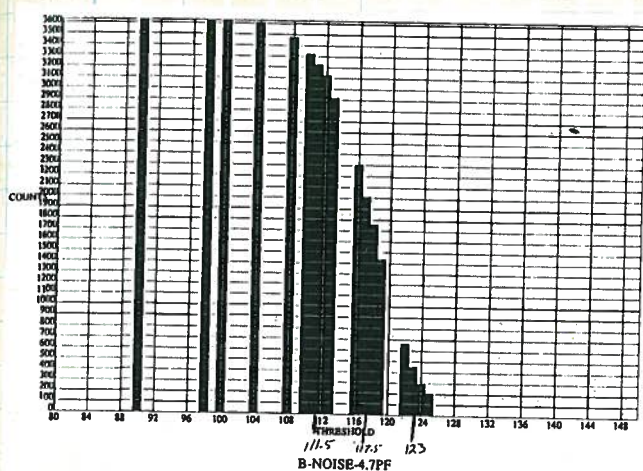
.43 $\frac{mV}{\sqrt{Hz}}$



$ENC = \frac{20}{127} \frac{2.15}{2.35} 6250 = 8858e^-$

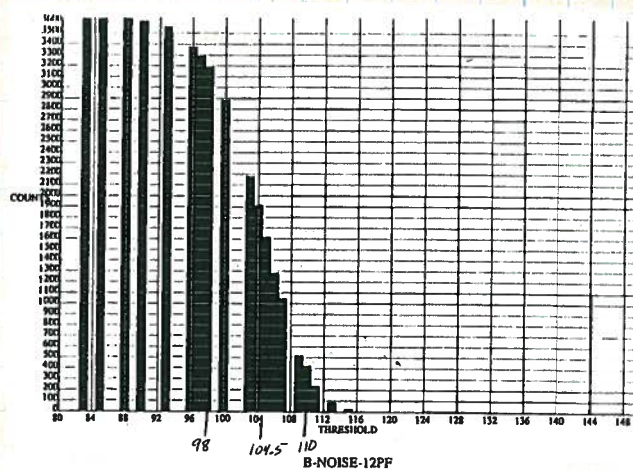
$.16\% \quad \text{Printer was on 4 connected!}$

Thresholds are $\sim 623B$
 $(X.018 \text{ on the monitor})$
 pin was measured



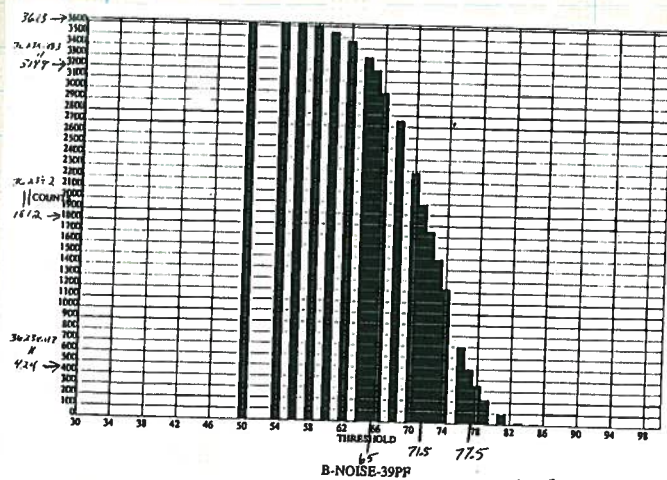
$ENC = \frac{11.5}{117.5} \frac{2.15}{2.35} 6250 = 5505e^-$

$.15\%$



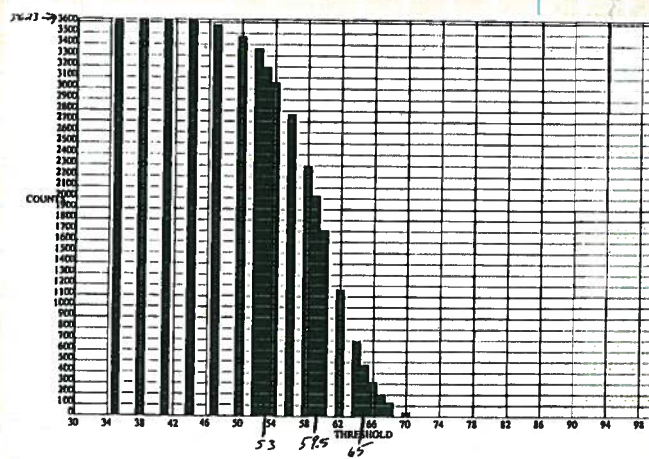
$ENC = \frac{12}{104.5} \frac{2.15}{2.35} 6250 = 6459e^-$

$.13\%$



$ENC = \frac{12.8}{71.5} \frac{2.15}{2.35} 6250 = 9834e^-$

$.09\%$



$ENC = \frac{12}{57.5} \frac{2.15}{2.35} 6250 = 11345e^-$

$.08\%$

DIFFERENTIAL INPUT

INSTRUMENTATION AMPLIFIER

THRESHOLD

500 nano amp. + 150 nano amps.
Input impedance 330 ohms each input.

 THRESHOLD ADJUSTMENT |

Set by an external voltage.
1 volt = 1 micro amp.
Range is 0 to 20 micro amps.

SIGNAL POLARITY

Handles both positive and negative inputs.
No jumpers required!

NOISE

1000 hz total for all 16 channels.
400 hz maximum for an individual channel.
Test conditions.
Threshold voltage 0.5 volts.
Pos. input grounded
Neg. input shunted by 50 ohms or ie

TIME WALK

3.5 nano sec. maximum.
5.5 nano sec. typical average.
Test conditions
Threshold set at 0.5 volts.
Test pulses.
1.3 to 6.5 micro amps.

CROSSTALK

Adjacent channels, greater than 30 db.
Non adjacent channels, greater than 40 db.

FAST OR OUTPUT

Delivers -0.6 ma from a current source.
-e. -30 mv into 50 ohms.

SIGNAL OUTPUTS

Drives 16 differential ECL lines.

POWER

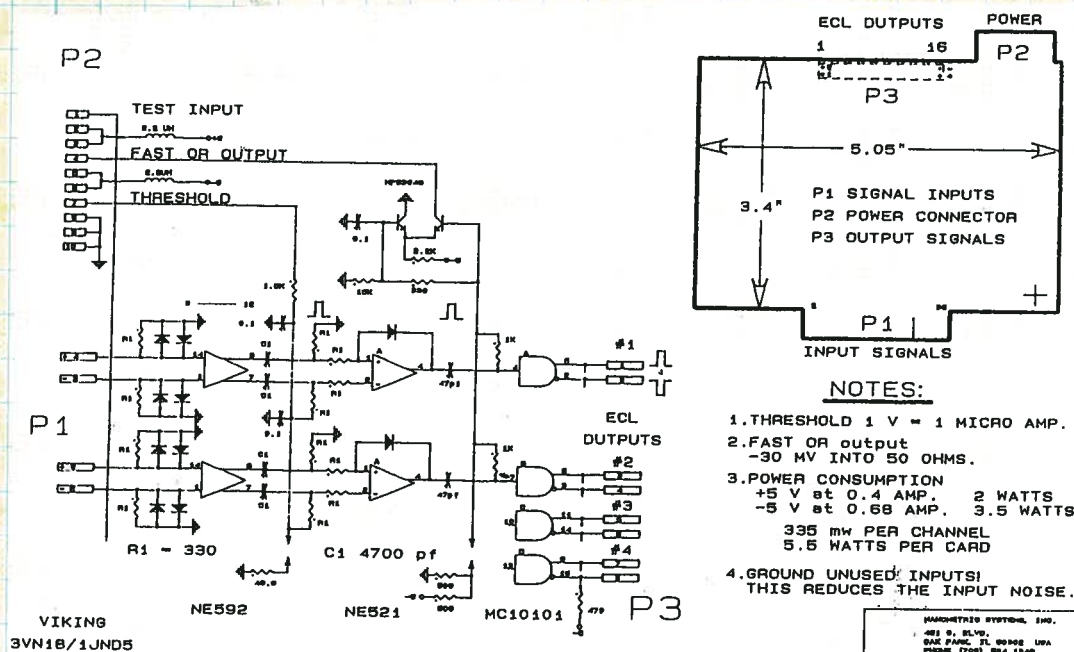
50 mw per channel.
Total power for a 16 channel card.
+5 volts at 0.4 amps.
-5 volts at 0.68 amps.

N-277-C

has positive signal inputs grounded. FERMILAB standard

I-277-CD

Differential input impedance is 112 ohms.
Input impedance 56 ohms each input.



RESISTANCE IN OHMS
CAPACITANCE IN MICRO FARADS
INDUCTANCE IN MILLIHY

MAGNETRIC SYSTEMS, INC.	
481 S. 5LVD.	
OAK PARK, IL 60462 UPA	
PHONE (708) 884 1840	
FAX (708) 884 8774	
Title	
IS CHANNEL AMPLIFIER CARD	
File Document Number	
N	N-277
Date	APR 14 1998

N-277

NANOMETRIC SYSTEMS INC.

N-277

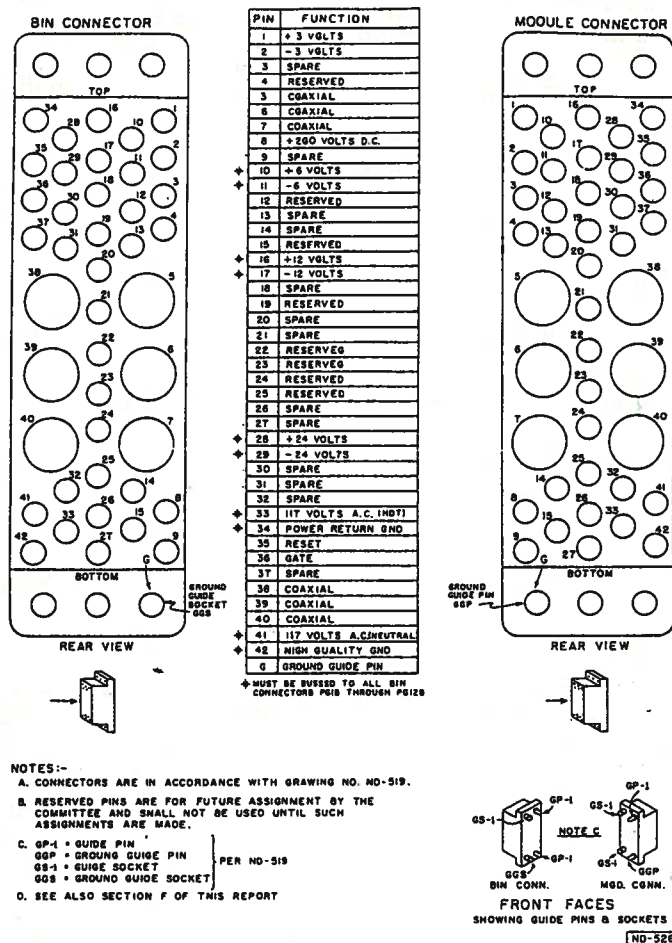
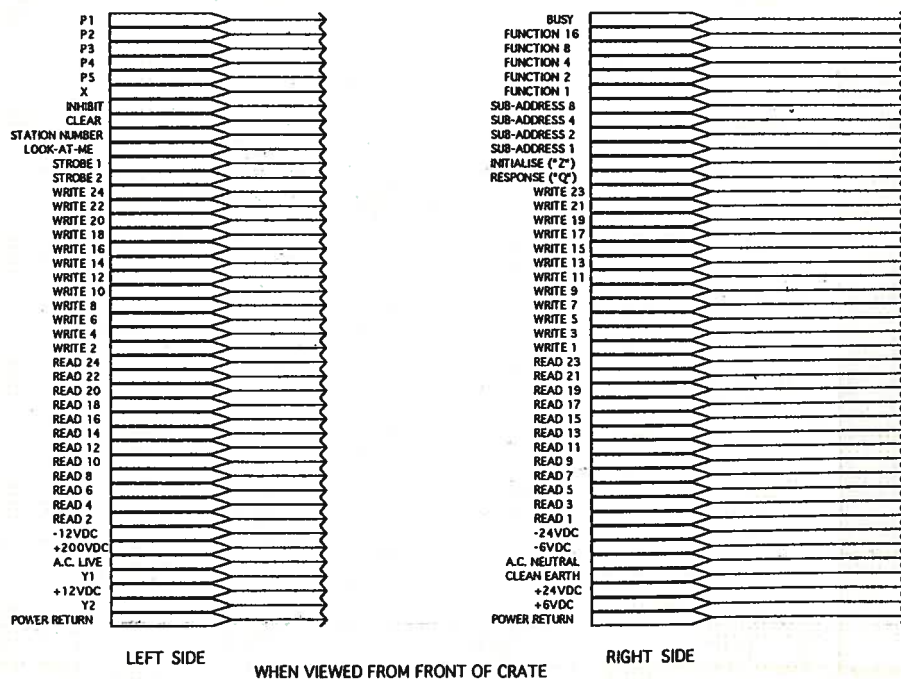
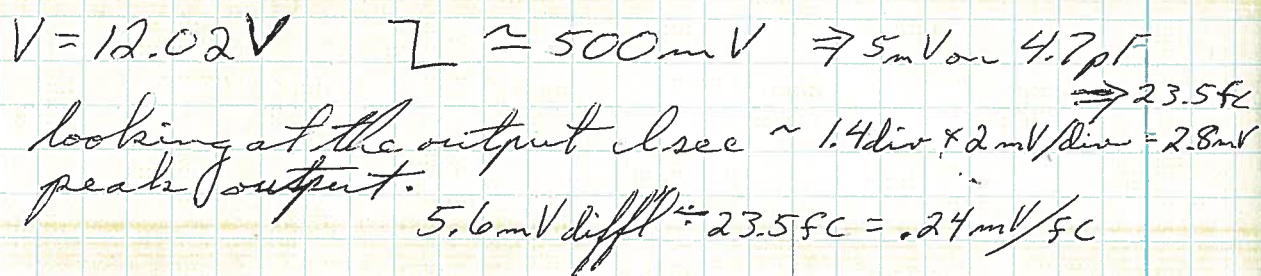


Fig. 5. Power Connector—Pin Assignments; and Other Details

NIM

for regular slot →





$$\tau_{\text{fall}} = 88 \text{ ns} \quad \text{with } 13 \text{ K}\Omega \Rightarrow 6.8 \text{ pF on collector of qnd base transistor}$$

$$\sim 17 \text{ mV output peak} \Rightarrow 0.12 \text{ mV/}^\circ\text{C}$$

Replacing the collector & emitter resistors with 8.2K and 10K I get very close to the same gain. If it's different I can't tell.

for $I \approx 3V$ $t_{rise} \approx 3ns$
 $t_{fall} \approx 50ns$ with $8.2k\Omega \Rightarrow 6.1pF$ on collector

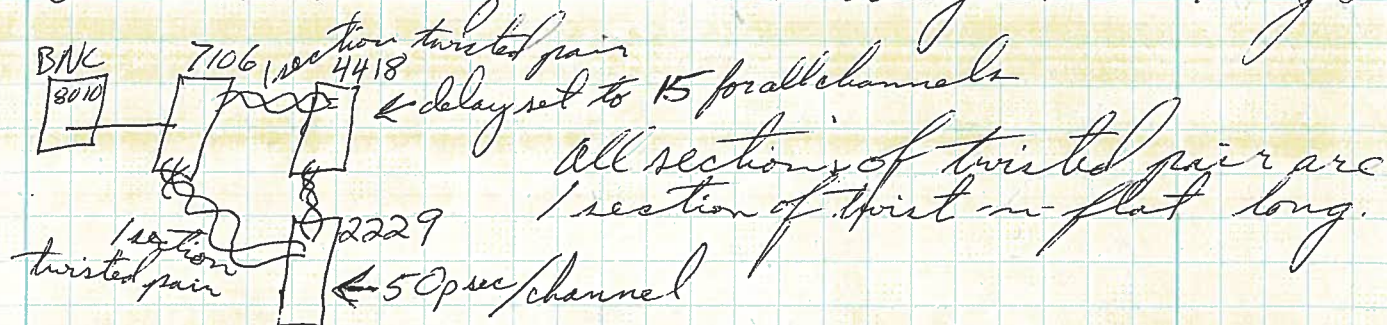
<u>Z</u>	<u>Peak</u>
500mV	2.75mV
700mV	3.95mV
1V	5.5mV
1.6V	8.6mV
2V	10.7mV
3V	16.2mV
4V	21.7mV
5V	27.3mV

$$6.25 \times 10^{18} \text{ e}^-/\text{C}$$

$$6250 e^- / \text{FC}$$

$$.24 \text{ mV/fC} \Rightarrow .038 \text{ } \cancel{\mu\text{V/e}} \quad .038 \mu\text{V/e}^-$$

Quick look at jitter on 4418 delay unit 5/21/88



First use blue wire to input 1 of 4418

green wire from 1 out to TDC channel

TDC channel 456 filled

Then use blue to 1 in, green from 1 out to 2 in, yellow 2 out to TDC

TDC channel 1107 filled

Then use blue to 1 in, green 1 out to 2 in, yellow 2 out to 3 in, purple 3 out to TDC

TDC channel 1771 filled

Second use blue wire to 1 in and yellow from 1 out to TDC

TDC channel 452 filled

Then use blue to 1 in, yellow 1 out to 2 in, purple 2 out to TDC in

TDC channel 1107 filled

Then use blue to 1 in, yellow 1 out to 2 in, purple 2 out to 3 in, green 3 out to TDC

TDC channel 1771 filled

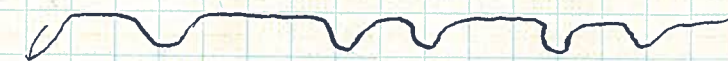
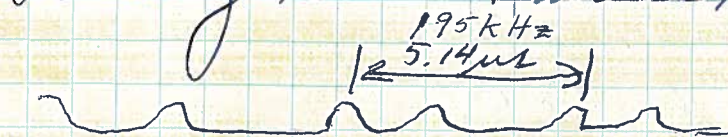
Leaving the wires in this last configuration, vary the delay value.

delay	filled channel	
0	766	$\Rightarrow 38.3 \text{ ns} \div 3 \Rightarrow 12.8 \text{ ns/channel}$
4	1022	$\Rightarrow \Delta t = 12.8 \text{ ns} \Rightarrow \Delta t = 3.2 \text{ ns/step}$
8	1300	$\Rightarrow \Delta t = 13.9 \text{ ns} \Rightarrow \Delta t = 3.5 \text{ ns/step}$
12	1573	$\Rightarrow \Delta t = 13.7 \text{ ns} \Rightarrow \Delta t = 3.4 \text{ ns/step}$
15	1771	$\Rightarrow \Delta t = 9.9 \text{ ns} \Rightarrow \Delta t = 3.3 \text{ ns/step}$

Maximum spread for 2000 pulses was 5 bins (250 ps)

6/1/88

Secroy 7200A with / of 7242B

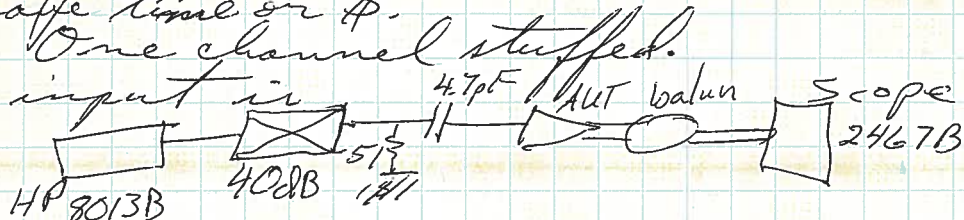


↑
~10.3 MHz
inside

Grounded Base, Again

6/8/8

Got parts and board for preamp from Ken @ LLVA. Preamp was the one we were going to put on PC 1, 2 & 3 but didn't have time or \$.



With a $\square$ $\$500\text{mV}$ I see on the scope $\sim 2.3\text{div} \times 2\text{mV/div}$
 $4.6\text{mV} \times 2 \Rightarrow 9.2\text{mV} / 23.5\text{SC} = .4\text{mV/SC}$

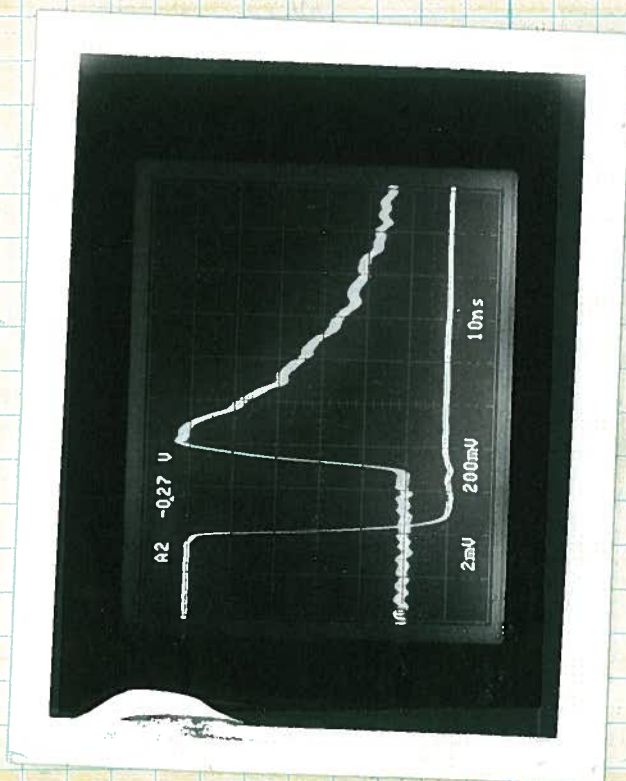
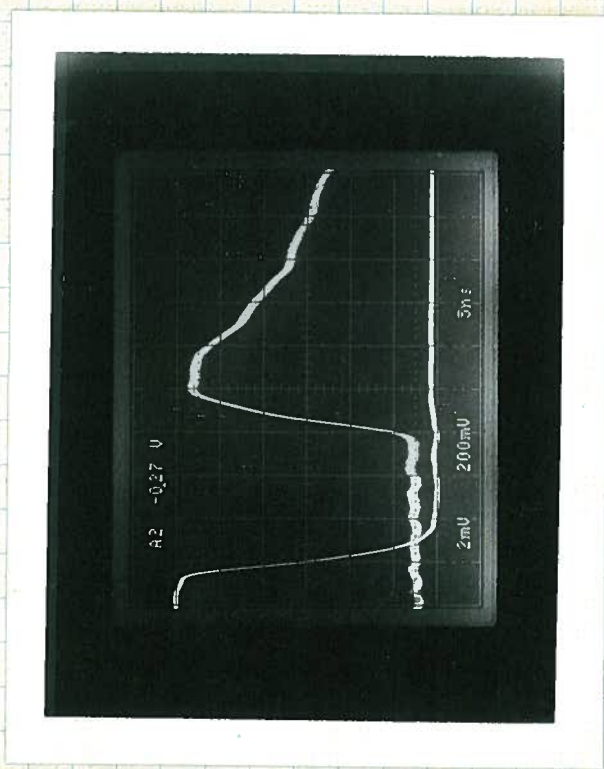
with $\square$ $\$1.2\text{V}$ I see $5.5\text{div} \times 2\text{mV/div} \Rightarrow 7.5\text{mV/SC}$
 $\approx 2\text{pC on collector}$

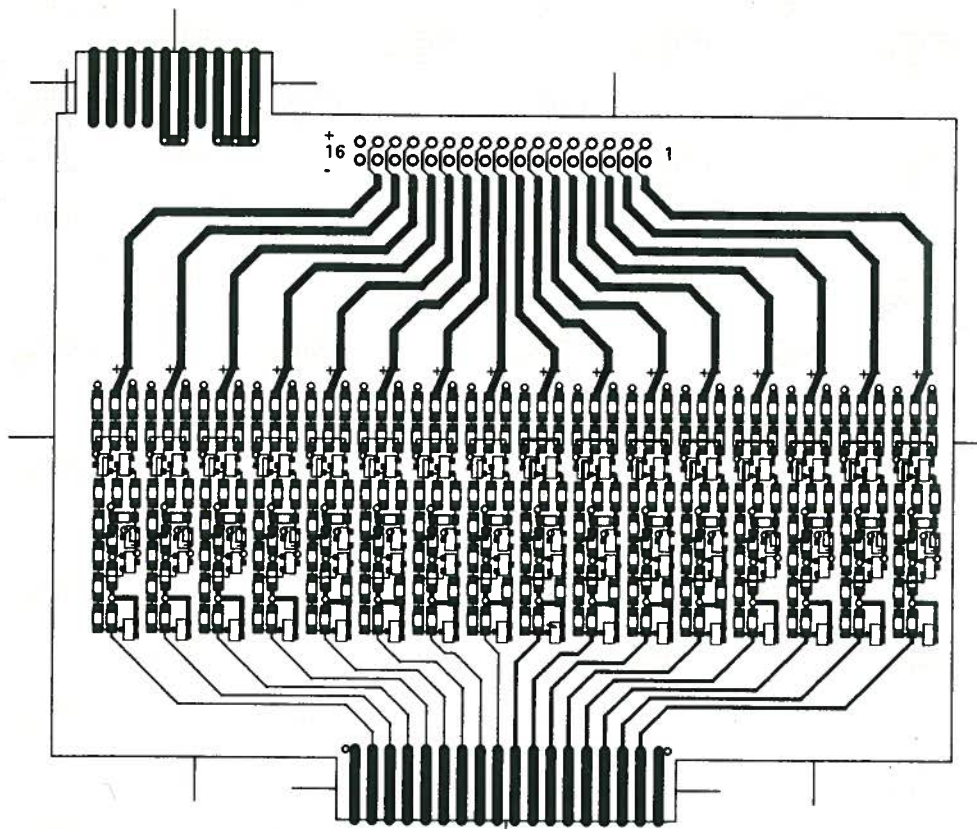
$$\frac{1}{e} = .368 \quad \times 5 = 1.84\text{ divisions} \quad \tau_{\text{fall}} \approx 26\text{ns}$$

$$\tau_{\text{rise}} \approx 3.5\text{ns}$$

for $\square$ $\$500\text{mV}$ I see $\sim 2.5\text{ns}$ or so.

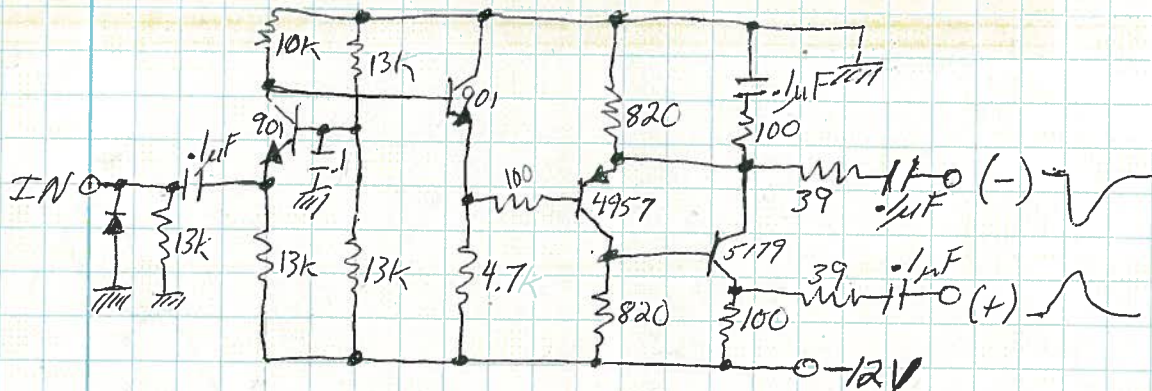
Using the Tektronix 9211 with 1m rise & fall I see similar results but τ_{rise} @ $\$1.2\text{V}$ is $\sim 2\text{ns}$





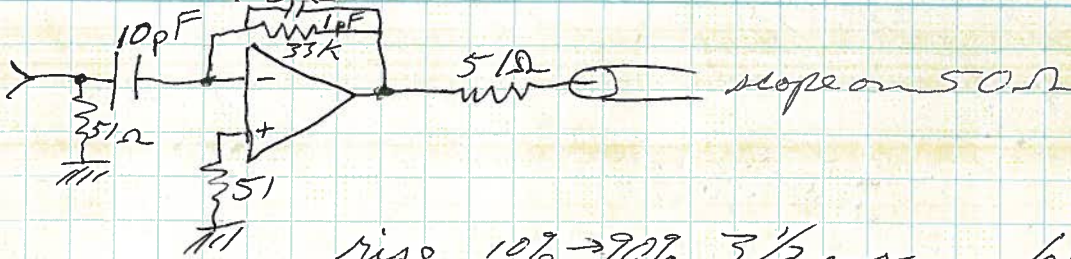
TOP SIDE

7H $\Rightarrow$ 5179
 7A $\Rightarrow$ 901
 7F $\Rightarrow$ 4957



CLC 425

6/15
JH



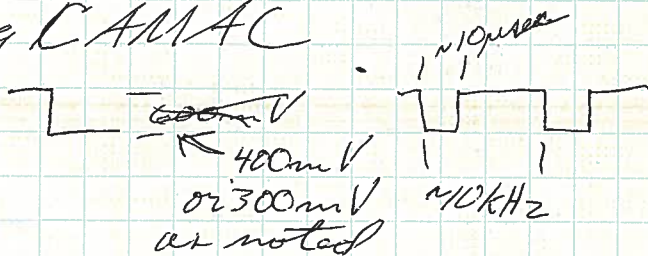
rise 10% → 90% 3 1/2 ms
~ 7ms base to peak
fall 40ms to 1/2

600mV step
input

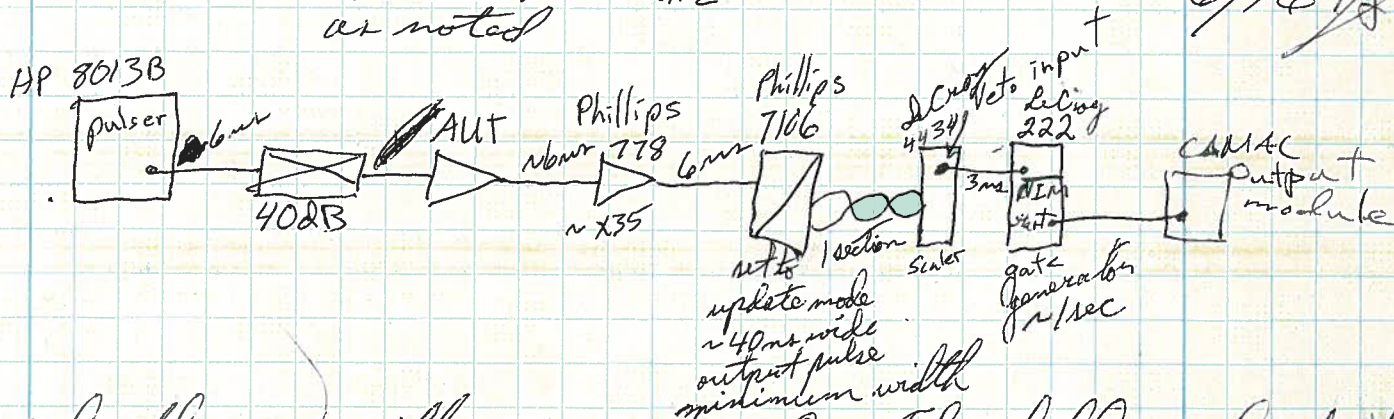
$$\frac{25\text{mV}}{60\text{FC}} = .42 \text{ mV/FC}$$

~ doubles with scope at 1MΩ

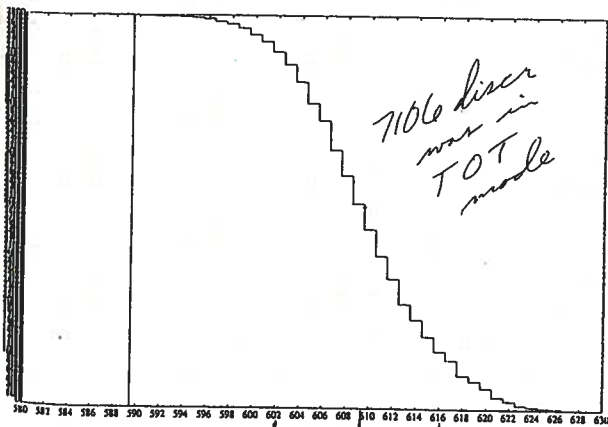
Using CAMAC



6/16
JH



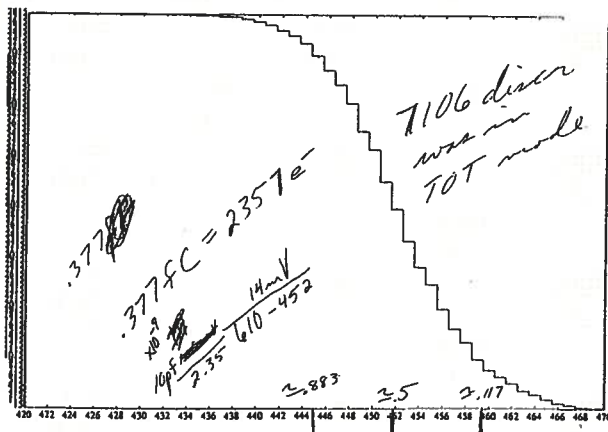
Accidentally, ran with 7106 in Time Over Threshold mode. I got 2



CLC425 400mV PLUS AMP

14mV/div
150
610-40
35.9

400mV
40FC
2.5 25 1



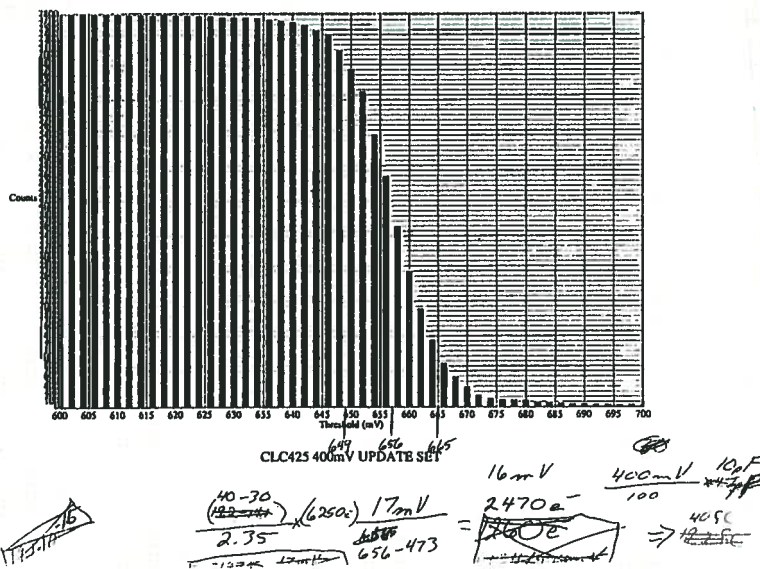
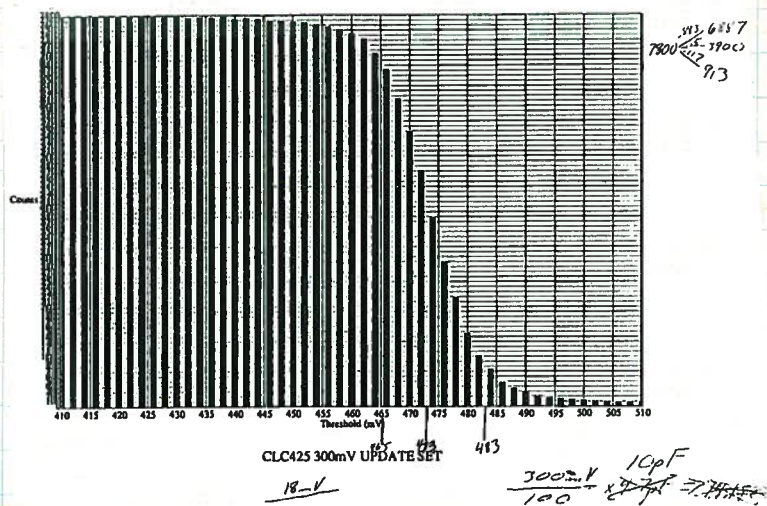
CLC425 300mV PLUS AMP

452
12.7
35.6
12.7mV
10pF
2.35
610-452
2.883
2.5
2.117

445 457

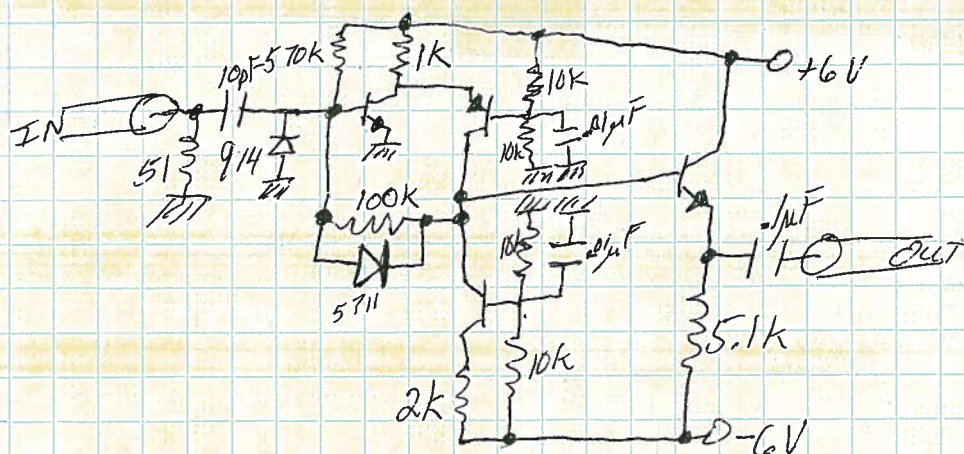
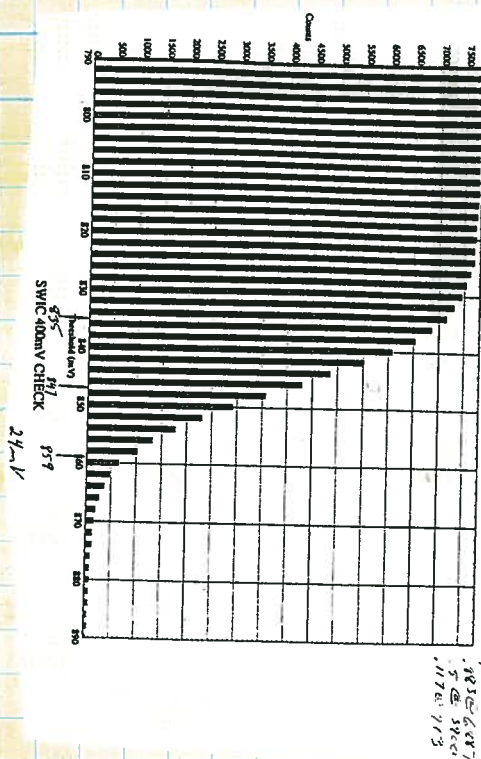
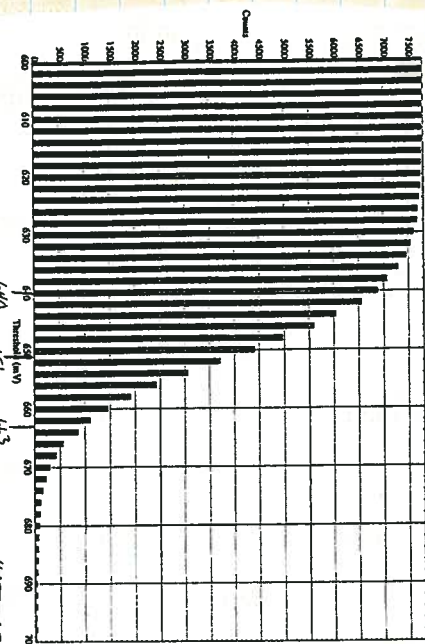
11mV/div

Setting the 7106 to Update with a minimum output width of ≈ 40 ns gives $\approx$



This is comparable to SWIC amp from p. 9 whose data is on p. 22.

Re-run SWIC amp.



Checking at ~ 9 PM at night I get the same
gains and $ENC = 2940 e^-$

Change to the PC amp prototype. 4.7pF on the input.
Input fed through Balun to discriminator amp.

$$\frac{1}{V} \quad \frac{1}{V} \quad \frac{1}{V}$$

$\frac{.883}{93}$	$\frac{.5}{76.5}$	$\frac{.117}{79.5}$	for 300 mV	$\Delta = 6.5$
97.5	101	104	for 400 mV	$\Delta = 6.5$

$$\frac{(19.2 - 14.1 \text{ fC}) (6250 \text{ e}^-/\text{fC})}{2.35} \left(\frac{6.5 \text{ mV}}{101 - 76.5 \text{ mV}} \right) = 3599 \text{ e}^-$$

$$\text{ENC} = 3600 \text{ e}^-$$

158	164.5	169.5	for 400mV	$\Delta = 11.5 \text{mV}$
118	122.5	127.5	for 300mV	$\Delta = 9.5$
158	163	168	for 402mV	$\Delta = 10$

So, for the surface mount version of the
 PF preamp circuit

$$\frac{(5.1 \text{ fC})(6250 \text{ e}^-/\text{fC})}{2.35} \left(\frac{10 \text{ mV}}{163 - 122.5} \right) = 3349 \text{ e}^-$$

$$\text{ENC} = 3350 \text{ e}^-$$

Looking at Gall B preamp. 10 pF on input.
 Preamp output is through balun

$\frac{.883}{306}$	$\frac{.5}{310.5}$	$\frac{.117}{315.5}$	for 400 mV $\Delta = 9.5 \text{ mV}$
225	230	235	for 300 mV $\Delta = 10 \text{ mV}$

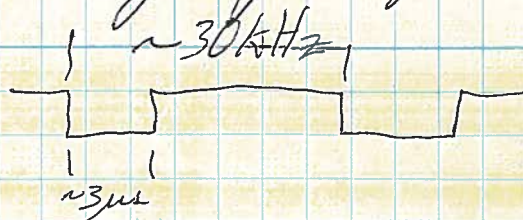
$$\frac{(10 \text{ fC})(6250 \text{ e}^-/\text{fC})}{2.35} \left(\frac{10 \text{ mV}}{310.5 - 230} \right) = 3304 \text{ e}^-$$

$$\text{ENC} = 3300 \text{ e}^-$$

Amp Gains Varying Injection Cap.

35

Pulser set to



6/17
JA

~23500 counts for full scale

input step height selected. Then input capacitors varied using 4.7pF, 10pF + 18pF.

~23800 for PC 10PF 400mV

~23600 for B 4.7PF 400mV

~23700 for B 10PF 400mV

For QPA03 first did one ref at 400mV input and no additional amplification. Amplifier (additional) set to ~x5. Power supply set to 4.0 Volts.

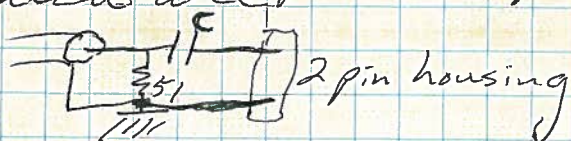
Using 23700 as the nominal count rate

$$\begin{aligned} 23700 \times \frac{.883}{.5} &= 20927 \approx 21,000 \\ 23700 \times \frac{.117}{.5} &= 11850 \approx 12,000 \\ 23700 \times \frac{.117}{.5} &= 2773 \approx 3,000 \end{aligned}$$

AMP	C (pF)	Gain (mV)	Δ mV	mV (step input)	Amp	C	Gain	Δ	step
Same capacitors used on all amps.	B	4.7	97	9	200	PC	4.7	82	8
			149	9	300			123	8
			195	10	400			164	8
		10	161	10	200		10	155	8
			246	10	300			234	9
			328	10	400			311	9
	18		230	10	200	18		275	12
			352	10	300			412	13
			468	10	400			544	11
		4.7	202	13	200		4.7	216	11
			299	13	300			313	11
			398	13	400			402	10
CLC425	10		359	16	200	10		368	12
			542	16	300			511	9
			726	16	400			621	8
		18	623	19	200		18	527	11
			931	20	300			684	8
								761	5
QPA03	4.7		202	13	200	4.7		216	11
			299	13	300			313	11
			398	13	400			402	10
		10	359	16	200		10	368	12
			542	16	300			511	9
			726	16	400			621	8

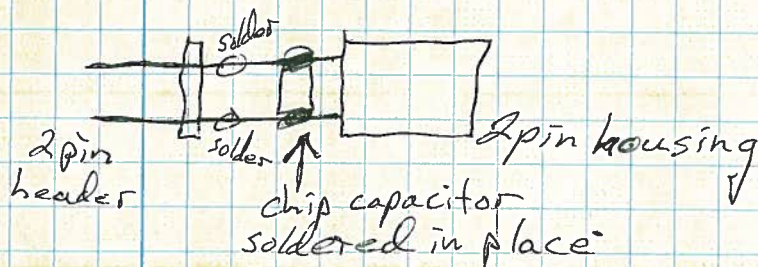
6/18/88 Looking at capacitive loading.

I made 3 capacitors for the charge injection which are



with $C = 4.7\text{pF}$
 10pF
 18pF

This allows ~~also~~ also adding



I made several using 0pF , 10pF , 15pF ,
 22pF , 39pF , 56pF & 120pF

So, 0pF gives ~~some~~ accounting for stray capacitances (more or less).

I tried wrapping the PC in aluminum foil. This did not reduce the noise as determined by this method. Although, it had a noticeable effect on pickup. After much playing around I'm satisfied this is the best I can do. I will leave the foil off!

4.7pF will be used for the charge injection.

4.7pF	4.7pF	4.7pF
3mV	5mV	7mV
14.1fC	23.5fC	32.9fC

(mV)	(pF)	21 st Count	12 th Count	3 rd Count	(mV)	23800 ≤ 11950 → 12000 2796 → 3000
Input step	Parallel Cap	(mV)	(mV)	(mV)	(mV)	37
		.883	.5	.117	Δ	<u>PC amp</u>
500	0	146	149	152	6	
	10	136	139.5	142.5	6.5	
	15	131	134	138	7	
	22	126.5	129.5	133	6.5	
	39	117	120.5	124	7	
	56	111.5	115.5	119	7.5	
	120	97.5	102	116.5	9	
700	120	135.5	140.5	145	9.5	
	56	158	161.5	165.5	7.5	
	39	166	169.5	173.5	7.5	
	22	179	182	185.5	6.5	
	15	185	188.5	192	7	
	10	189.5	192.5	196	6.5	
	0	199	202.5	205.5	6.5	← output of amp was not checked
300	0	85.5	88	91	5.5	← output of PC amp checked & is 3.00mV
	10	81.5	84.5	87.5	6	
	15	79	82	85.5	6.5	
	22	77	80	83.5	6.5	
	0					← output of PC amp checked & is same as above
500	0					← 5.00mV out of PC amp
700	0					← 6.70mV out of PC amp
Hall B						preamp connected. Pulser is unchanged.
cl see						
700	0					← 7.00mV out of CPD1 preamp

38) Input step	(pF) Parallel Cap	(mV)	(mV)	(mV)	(mV)
		.883	.5	.117	Δ

CPØ1 amp

700	0				
500	0				
300	0	99	102	105	6
	10	73.5	77	80.5	7
	15	64	67.5	71	7
	22	55.5	59	62.5	7
	39	42	45	49	7
500	39	72	76	79.5	7.5
	22	96.5	100	104	7.5
	15	112	115.5	119	7
	10	128	131.5	135	7
	0	173	176	179.5	6.5
	56	60	63.5	67	7
	120	36.5	40	44	7.5
700	120	50.5	54	58	7.5
	56	83	86.5	91	8
	39	100	104	108	8
	22	132	136	140	8
	15	153.5	157	160.5	7
	10	174.5	178	182	7.5
	0	234.5	238	241.5	7

← 7.00 mV out of amp (from p. 38)
 ← 4.9 mV out of amp
 ← 3.00 mV out of amp

(mV)	(pF)	(mV)	(mV)	(mV)	(mV)
Input step	Parallel Cap				

CLC 425

700	0	453	458.5	463	10
	10	438	443.5	449	11
	22	424	432	441	17
	56	357	371	384	27
500	56	250	264	278	28
	22	298	306	315	17
	10	308.5	315	320.5	12
	0	317	321.5	326.5	9.5

CLC output checked and found to be oscillating @ ~650MHz

Damn! I'm tired and I'm going home.

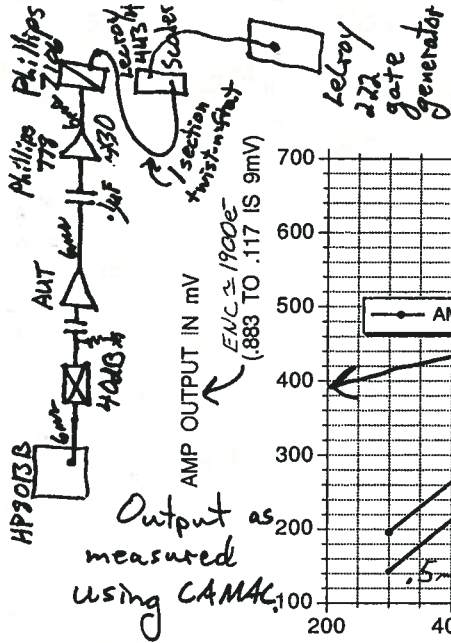
0 323.5 327.5 332 8.5 ← got oscillations to stop by sticking a piece of copper tape from the ground plane to the 4.7pF injection capacitor. It's play mode tomorrow. This was the result.

Copper strip is attached to suppress oscillations. 6/19 JS

500	0	328.5	333	337.5	9.5
300	0	192	196	200.5	8.5 ← 6.30 mV out of amp
500	0	327	331.5	336	9 ← 10.45 mV out of amp
700	0	444.5	448.5	453	8.5 ← 14.10 mV out of amp
1000	0	639.5	643.5	648	8.5 ← 20.4 mV out of amp

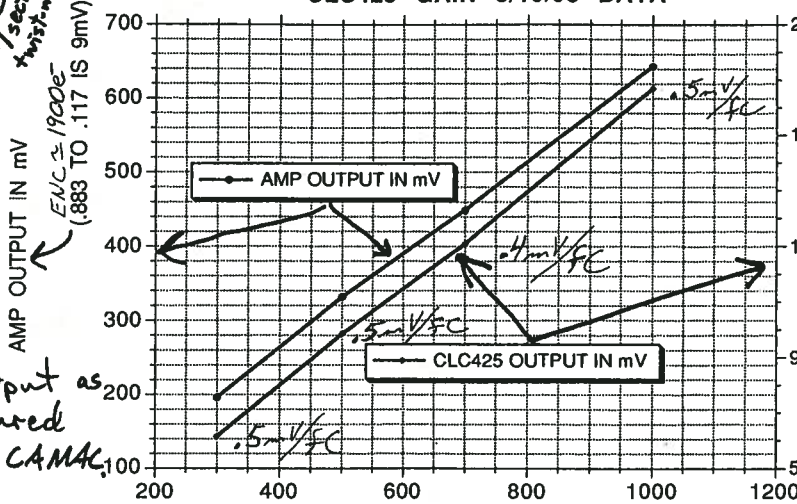
rise ~2ms
fall ~35ms
~4ms base to peak

Group not stable with added capacitor. difference in osc. amplitude is ~10mV going from 1pF to 156pF (from ~40mV p-p to ~50mV p-p). Osc. frequency varies only slightly with capacitance. approx 650MHz.



Amp likes to oscillate @ $\approx 650 \text{ MHz}$.

CLC425 GAIN 6/19/93 DATA

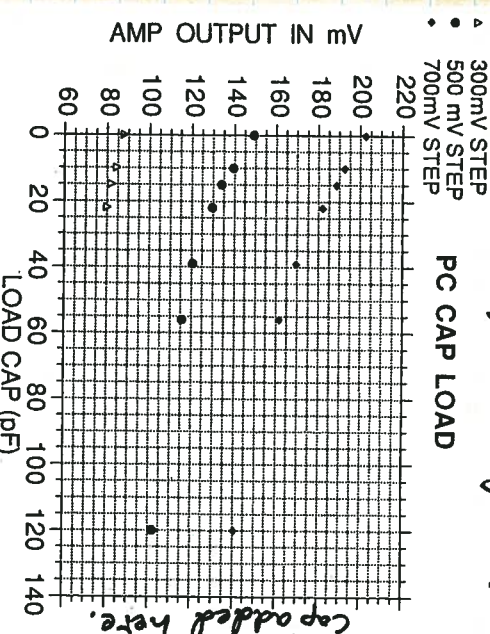
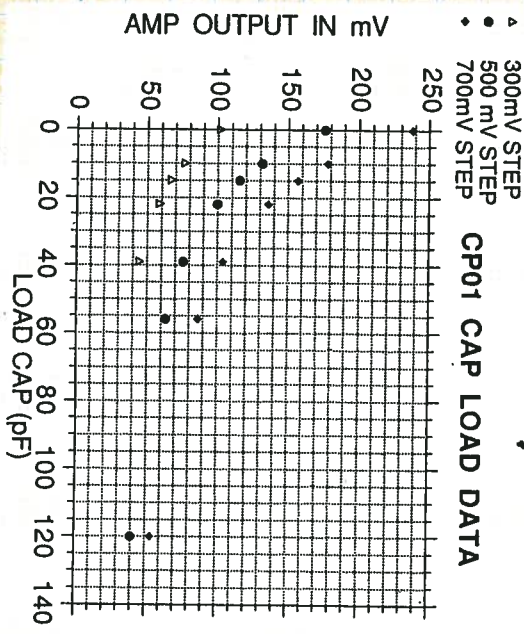
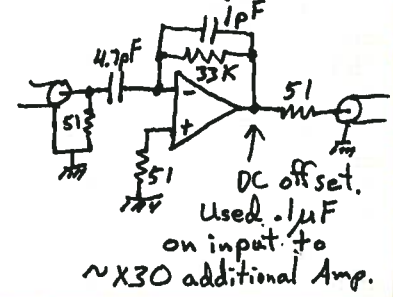


Output of Preamp into Scope. @ 50Ω

$\tau_{\text{rise } 10\% \rightarrow 90\%} \approx 2 \text{ ns}$
 $\tau_{\text{fall to } 1/2} \approx 35 \text{ ns}$

$\text{mV} \div 100 \times 4.7 \text{ pF} = \text{fc}$
 (40dB)
 value of capacitor for charge injection.

300mV $\Rightarrow 14.1$
 500mV $\Rightarrow 23.5$
 700mV $\Rightarrow 32.9$
 1000mV $\Rightarrow 47 \text{ fc}$



4.7pF used for charge injection.

no blocking cap on ~X30 amp.



Gain linearity check of CLC 425 6/28

CLC 425 is the same as on p. 31 except charge injection is the one used on p. 36 with 4.7 pF. 10 pF!! see below!

Gaining of pulses same as on p. 35

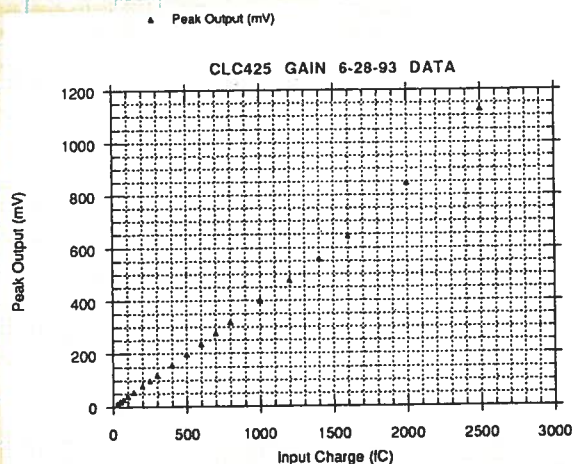
Attenuation (dB)	input step (mV)	output peak (mV)	input charge (fC)
40	300	12.55	14 30
	500	20.0	24 50
	700	28.0	33 70
	1000	40.0	47 100
	1400	55.5	66 140
	2000	79	94 200
	2500	98.5	118 250
	3000	118	141 300
	4000	157	188 400

removed ~~charge~~ 20dB attenuator.

Attenuation (dB)	input step (mV)	output peak (mV)	input charge (fC)
20	400	158	188 400
	500	197	235 500
	600	237	282 600
	700	277	329 700
	800	317	376 800
	1000	400	470 1000
	1200	476	564 1200
	1400	558	658 1400
	1600	644	752 1600
	2000	845	940 2000
	2500	1125	1175 2500

slow rate limited?
 $\frac{1.24 \text{ V}}{7.6 \text{ ns}} = 163 \text{ V}/\mu\text{s}$

Output measured on 2467B oscilloscope.



On 6/30 I found the charge injection capacitor was actually 10 pF. I verified the above measurements by checking the gain of the CLC 425 one more time. With the 10 pF and a 400 mV step using 20 dB of attenuation I got 152 mV peak output. With 40 dB I got 15.15 mV.

6/30 JS

6/29

Noise check of CLC425, CPD1 & PC. amps in aluminum box.

I assembled an aluminum bud box to shield the amplifiers during the noise testing. Input step set to 300mV through 40dB.

CLC425

17700 pulses .883 → 15629 357mV
 .5 → 8850 362.5mV
 .117 → 2071 368mV

$$\frac{(30\text{fC})(6250\text{e}^-/\text{fC})}{2.35} \left(\frac{11\text{mV}}{362.5\text{mV}} \right) = 2420\text{e}^-$$

CPD1

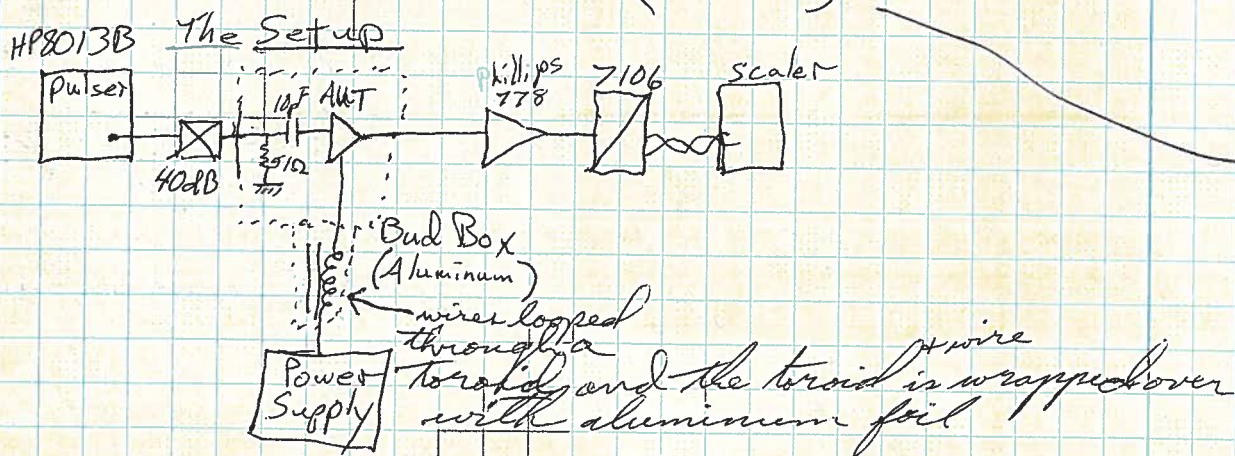
"OUT-" is connected to ~3ms of R6174 bemo cable

"OUT+" has 51Ω to ground.

Trying to remove the balun from the setup. In case most of the noise is pickup from the balun.

.883 → 15700 166.5mV
 .5 → 8900 170.5mV
 .117 → 2000 175mV

$$\frac{(30\text{fC})(6250\text{e}^-/\text{fC})}{2.35} \left(\frac{8.5\text{mV}}{170.5\text{mV}} \right) = 3980\text{e}^-$$



While playing ground I notice that when I wrap my hand around the toroid I can reduce the noise.

17900 pulses now .883 → 15800 167.5mV
 .5 → 9000 171mV
 .117 → 2100 175mV

$$\text{ENC} = 3500\text{e}^-$$

There are no bypass capacitors on the CDD1.
This may be part of the reason wrapping my hand around the core has an effect.

PC Amp

$$\begin{aligned} .883 &\xrightarrow{15800} 160 \text{ mV} \\ .5 &\xrightarrow{9000} 162.5 \text{ mV} \\ .117 &\xrightarrow{2100} 165 \text{ mV} \end{aligned}$$

input step verified to be $\sim 300 \text{ mV}$. Set step to 600 mV .

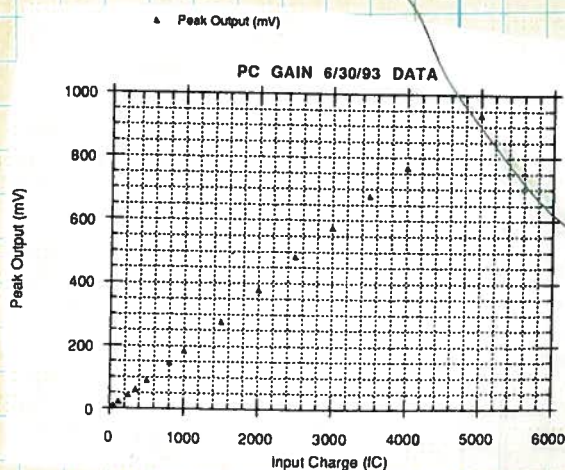
$$\begin{aligned} .883 &\rightarrow 15800 & 316 \text{ mV} \\ .5 &\rightarrow 9000 & 318.5 \text{ mV} \\ .117 &\rightarrow 2100 & 321 \text{ mV} \end{aligned}$$

$$\frac{(60 \text{ fC} - 30 \text{ fC}) (6250 \text{ e}^-/\text{fC})}{2.35} \left(\frac{5 \text{ mV}}{318.5 - 162.5 \text{ mV}} \right) = 2560 \text{ e}^-$$

Wrapping my hand around the toroid for the PC amp had no visibly noticeable effect.

Checking Gain Linearity of PC amp. 6/30/93
10 pF injection capacitor. Output measured on 2467B scope.

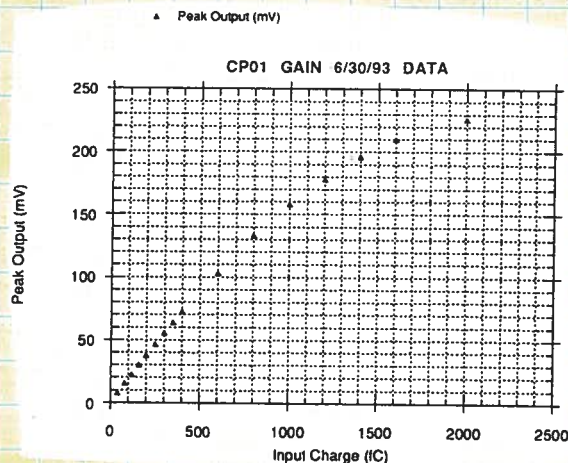
Atten	input step	inj. charge	peak output
40dB	600mV	60	10.65mV
	300	30	5.50
	1200	120	21.2
	2500	250	44.4
	3500	350	62.2
20dB	500mV	500	90.5
	800	800	146
	1000		184
	1500		277
	2000		377
	2500		484
	3000		576
	3500		678
	4000		768
	5000		935



Had forgotten to check the power supply setting.
Checking it & find it at -11.07 V

Checking the gain linearity of CP01 amp.
 10pF step charge injection. Output measured on 2 1/2 scope.
 Power supply set to 5.03V

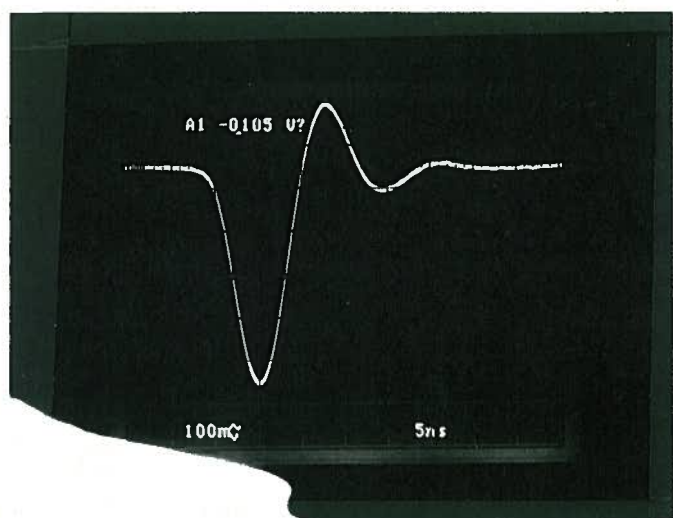
Atten.	input step (mV)	charge (fC)	peak output (mV)
40dB	400	40	7.8
	800	80	15.25
	1200	120	22.3
	1600	160	30.1
	2000	200	37.5
	2500	250	46.4
	3000	300	55.2
	3500	350	64.0
20dB	4000	400	72.4
	400	400	70.2
	600	600	103
	800		133
	1000		158
	1200		178
	1400		196
	1600		210
	2000		226



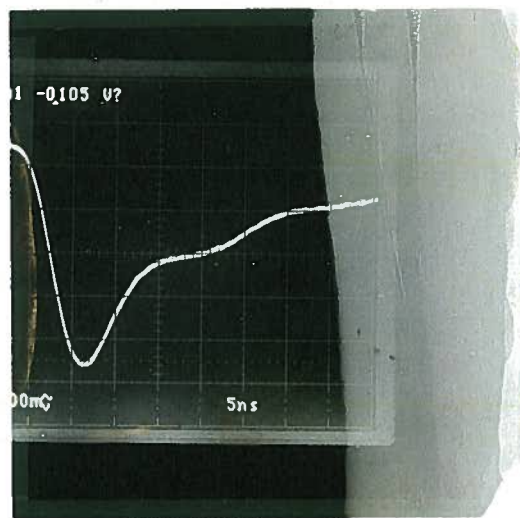
Looking at Overshoot of CPD1 & PC 7/30

I have been trying to use a 733 and 687 as a differential discriminator. One problem seems to be overshoot on the preamp.

With just the 733 (capacitors to input of 687 are removed) I look at the output pins with the 6205 FET probe. With one section of T in F I see the pictures below. These were taken quite a while ago.



CPD1

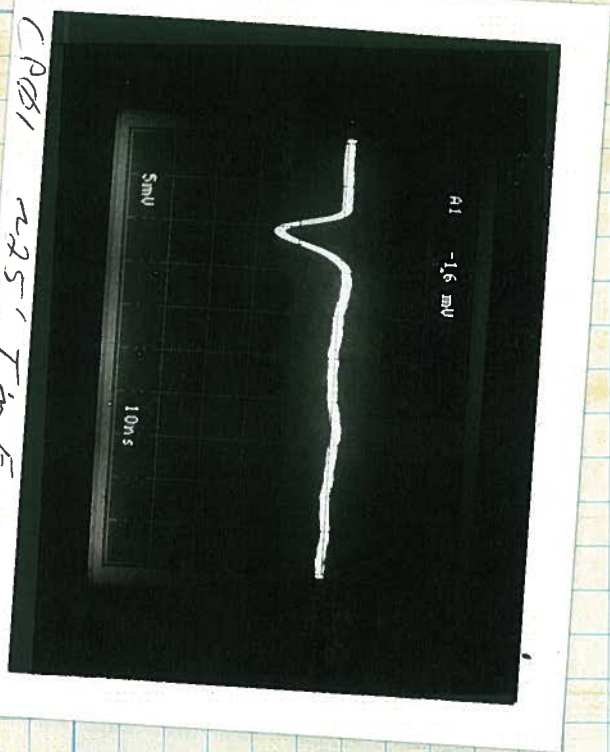


PC

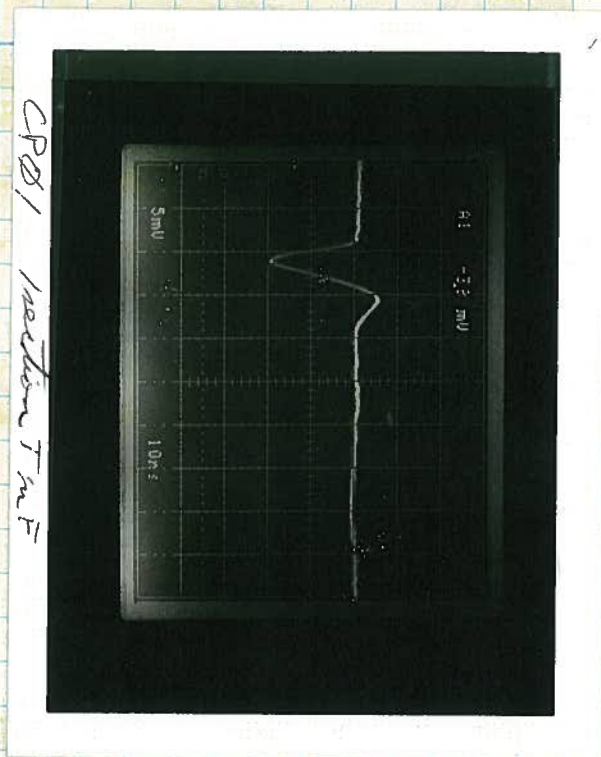
Looking at both preamps today I ran the preamp output into the input of a nanometric N-277-L for termination. No power to nanometric. Input step was ~ 5.75 V with 40dB into 4.7pF. GND is center line of display. CPD1 was triggering on + slope PC on -." That was a boo-boo.

I looked with the FET probe at one ^{side} of the input of the nanometric. ~~At~~ The preamp output was through either 1 section of T in F or $\sim 25'$ of T in F. See photos next page.

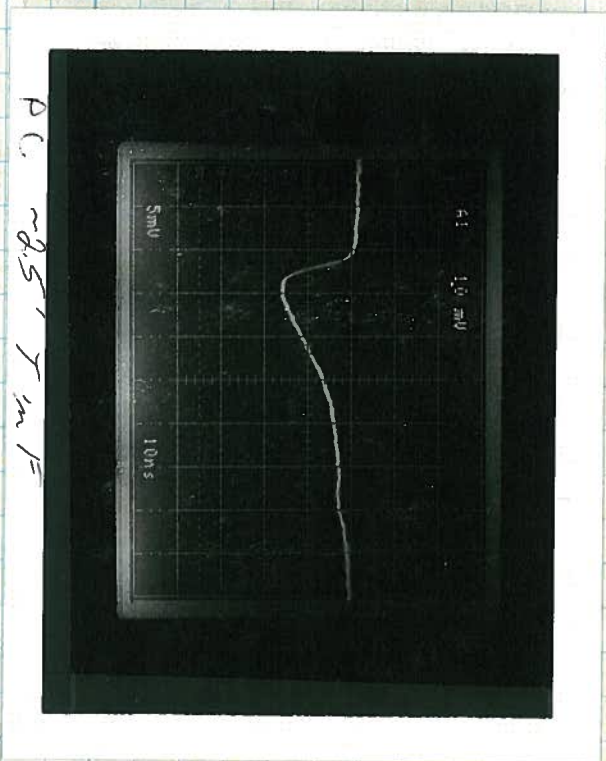
CP01 2.5' T in F



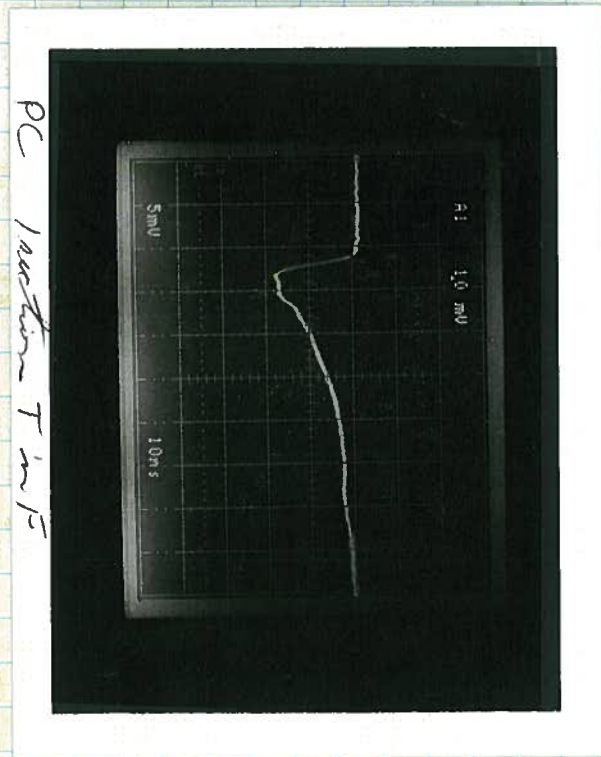
CP01 1000' T in F



PC 2.5' T in F

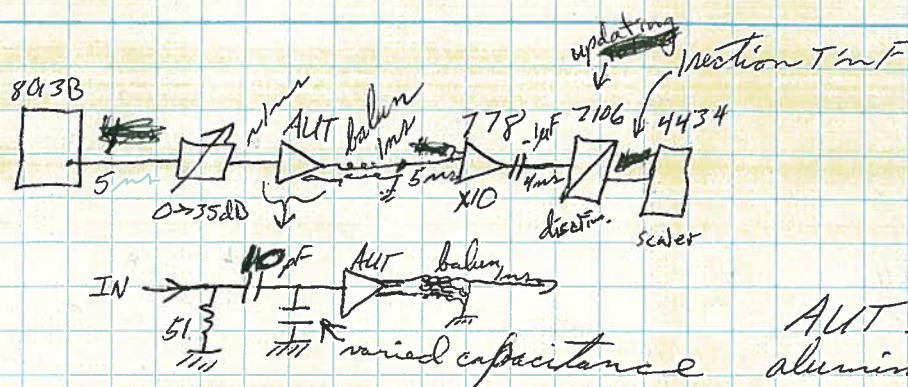


PC 1000' T in F



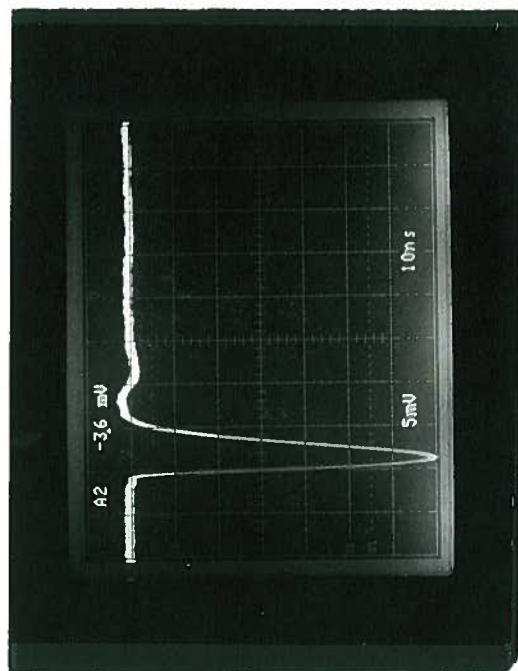
$T \text{ in } F \Rightarrow \text{twist in flat cable}$

7/31 JS

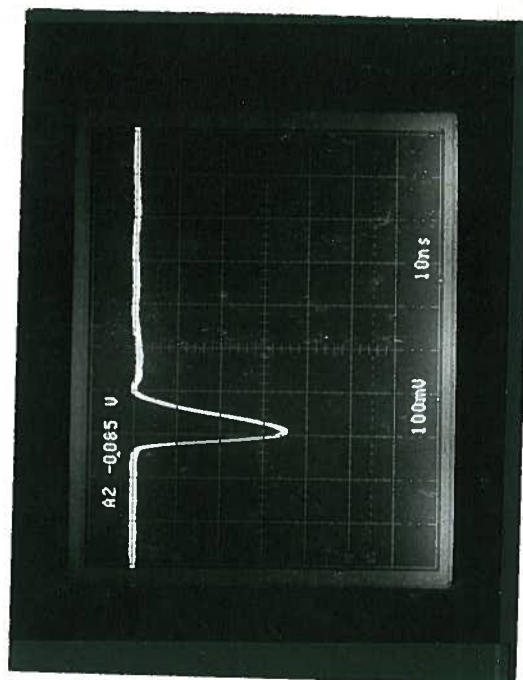


Preamp peak output is checked on oscilloscope. (2467B)

8013B output is 1V into 50Ω on scope.
CPD1 output is shown below with 0.1pF added capacitance and 35dB. Also shown is 778 output adjusted to ~X10 gain.

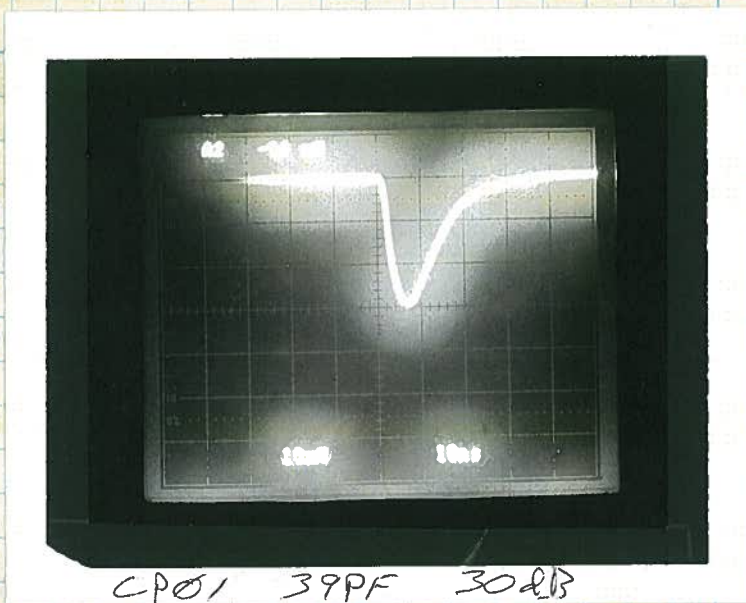


at input to 778



at input to 7706

μF	dB	$\frac{CP1}{out}$ $\frac{in}{mV}$
0	35	35 _{mV}
	30	60
10	35	27
	30	46
15	35	24.5
	30	41.5
22	35	21.5
	30	37
39	35	17
	30	29



Changed from 10pF charge injection at input of CPO1 to $\rightarrow$ un^{ALT} $\rightarrow$ 1k $\rightarrow$ 51Ω

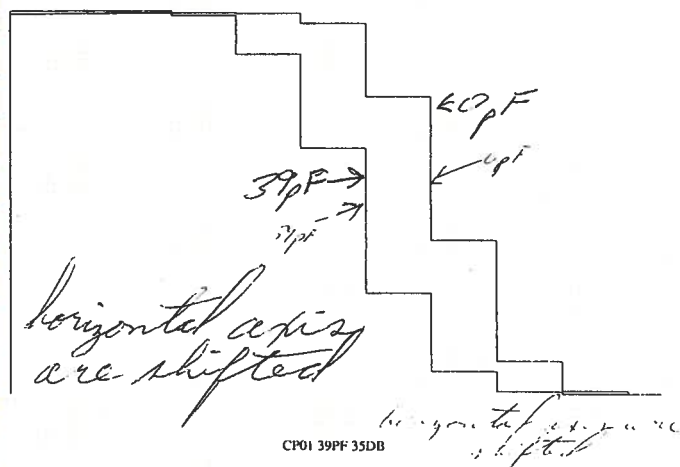
dB	input (mV)	Factor	input on 1k (mV)
35	17.8	56.2	17.8
30	30.1	31.6	31.6
25	54	17.8	56.2
20	94	10	100
15	162	5.6	179
10	234	3.2	33
5	241	1.8	556
0	241	0	1000

for PC amp $\rightarrow$	output (mV)
84	62.2
143	106
259	193
458	338
820	608
1340	1055

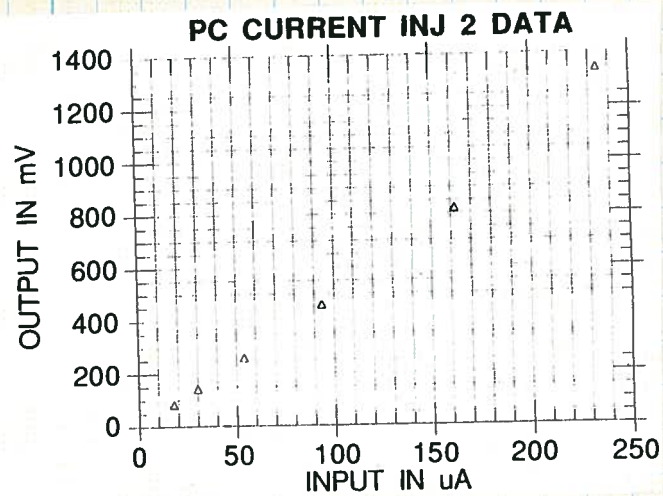
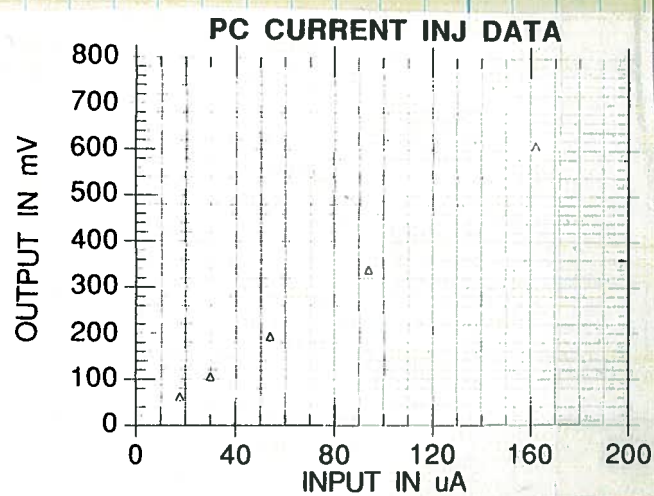
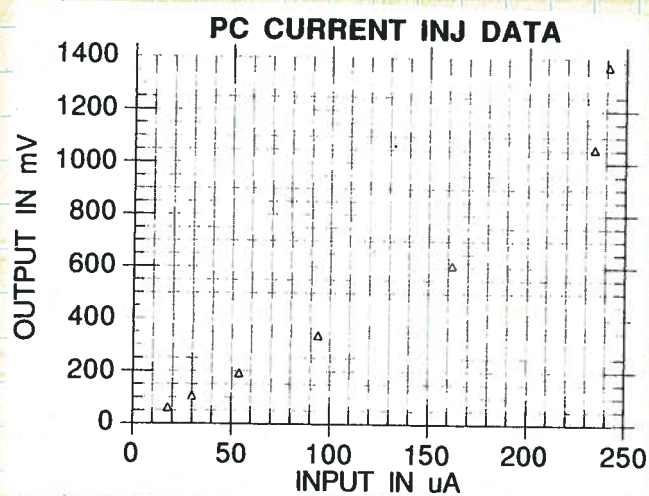
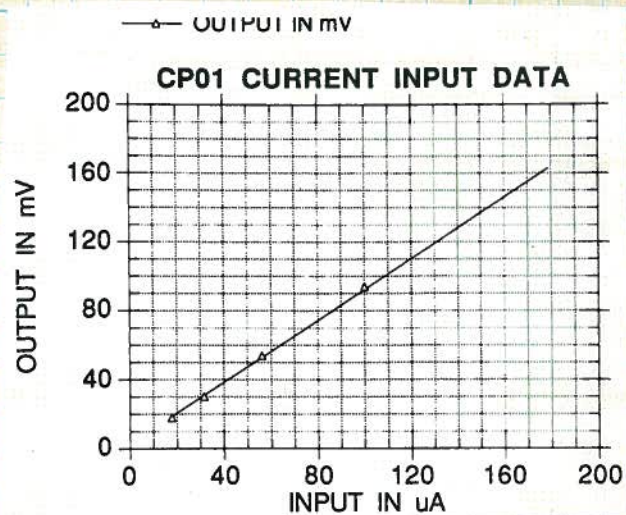
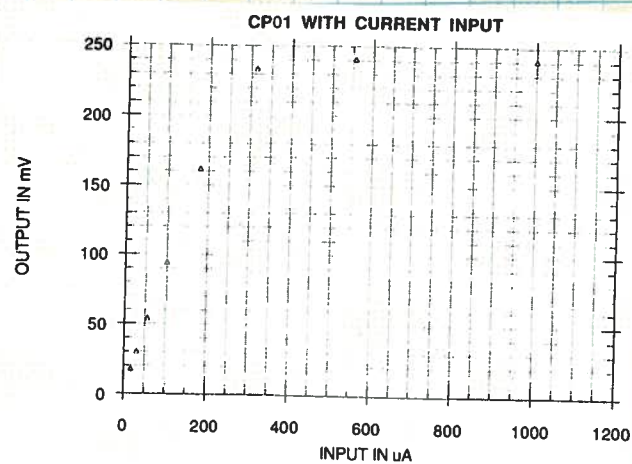
1370 ~~resistive~~

capacitive injection.
vs. resistive injection?

9/27/93



CP01 39PF 35DE



9/23 Pictures of Misc. Amps.

Looking at the op amps in the 8-pin socket setup for standard quick check of amps.

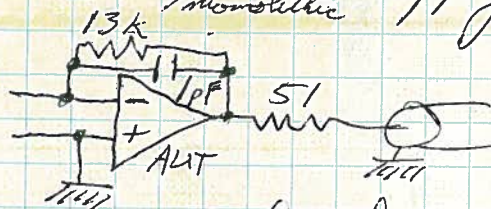
$\sim 1\frac{1}{2}$ of wire for V_{supply} loops

10 Ω 1/8W resistors in series with power supply wires. Resistors soldered to $\pm V$ pins.

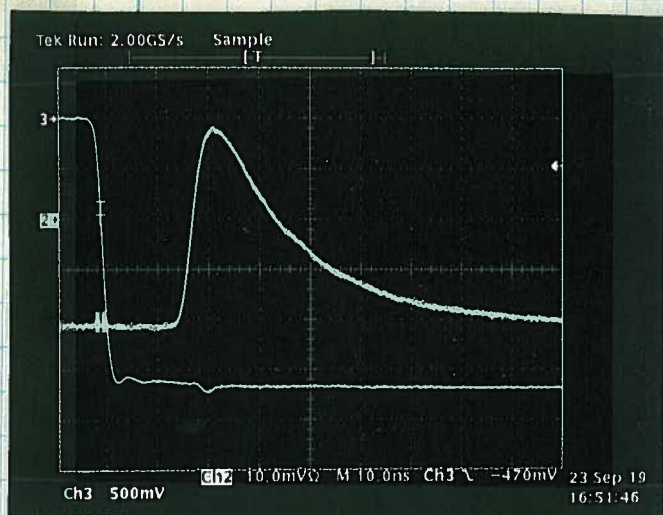
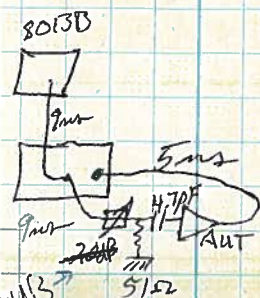
10 μF and .1 μF on supply pins.

Test.

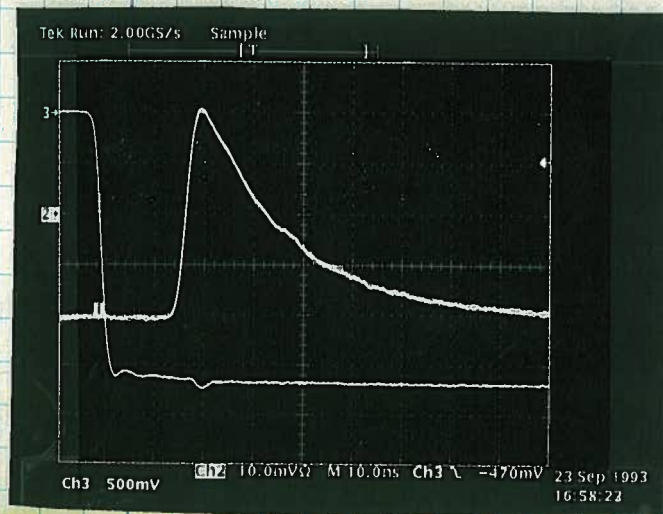
resistors are 1/8W carbon comp.



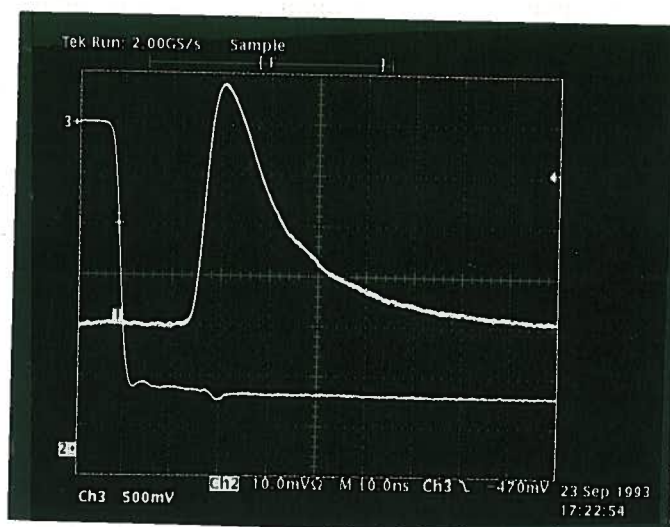
feedback resistor is 14.6K measured.
output resistor is 53.1 Ω measured
feedback cap is 1pF nominally



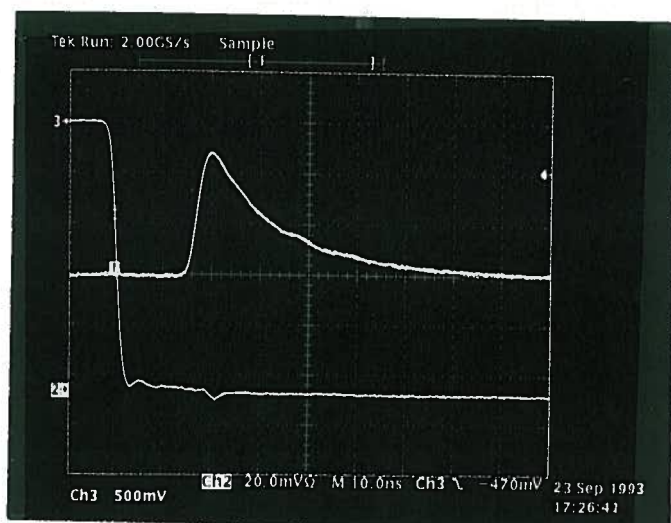
AD9624 $V_{supply} \pm 4.98V$
(.6mV/FC)



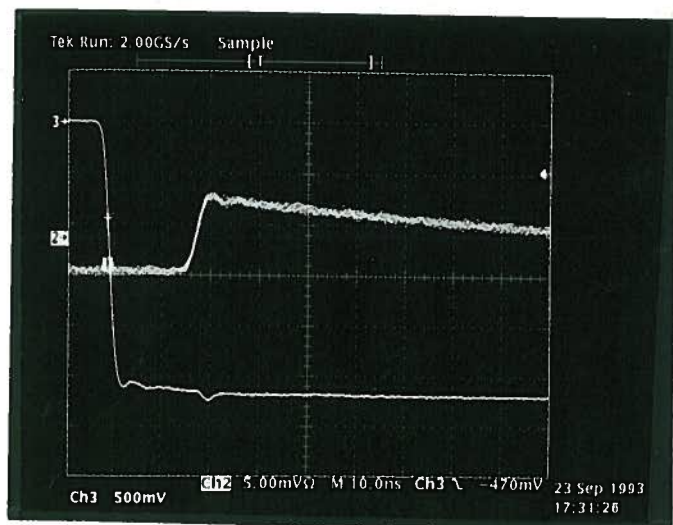
AD9624 $V_{supply} \pm 2.98V$



CLC 425
 $V_{supply} = \pm 2.98V$



CLC 425
 $V_{supply} = \pm 4.50V$

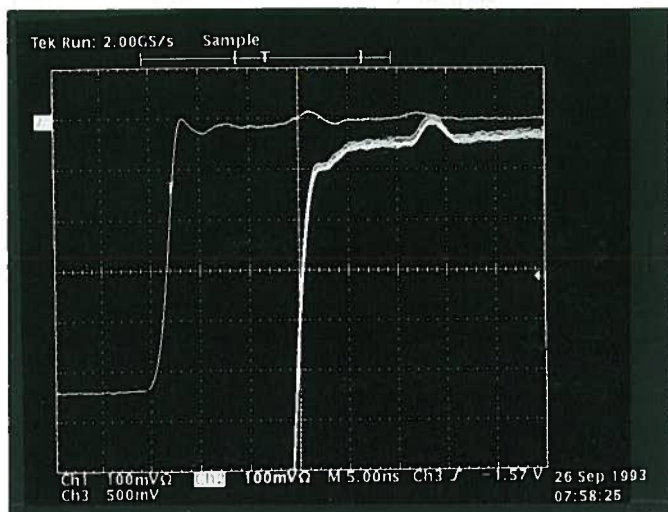


AD811
 $V_{supply} = \pm 4.98V$

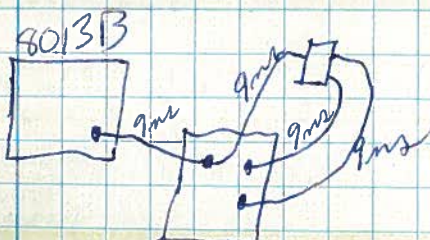
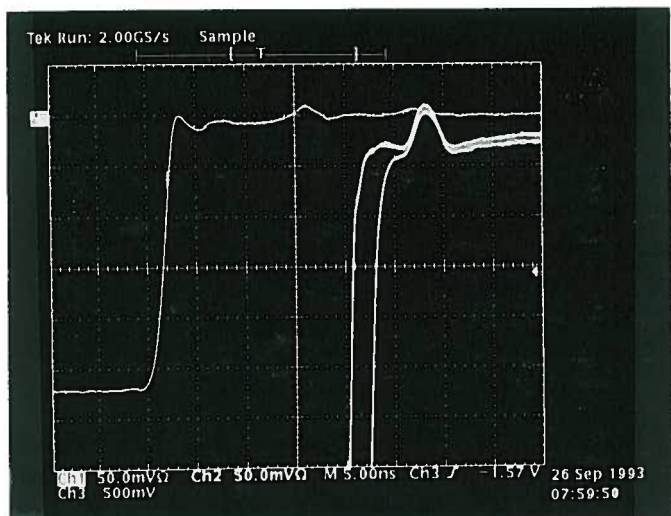
9/26

644A Anomalous

While checking out a pulse splitter I noticed something about the 644A scope. When changing voltage scales there appeared to be a triggering shift.



Ch 3 is the input to the splitter.
Ch 1 & 2 are the splitter outputs.

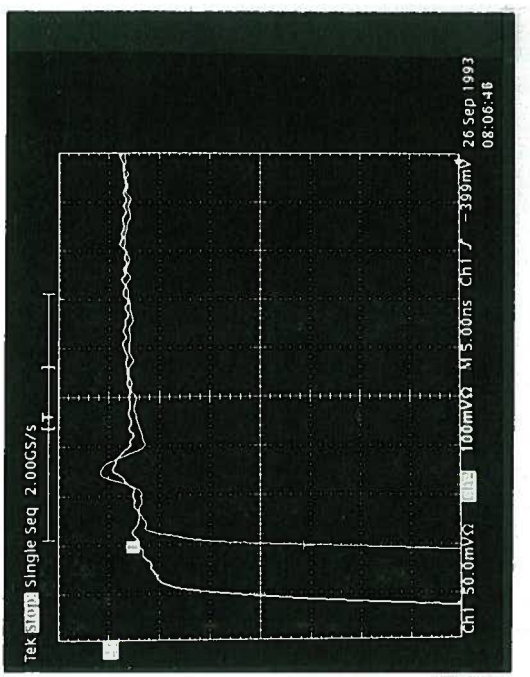
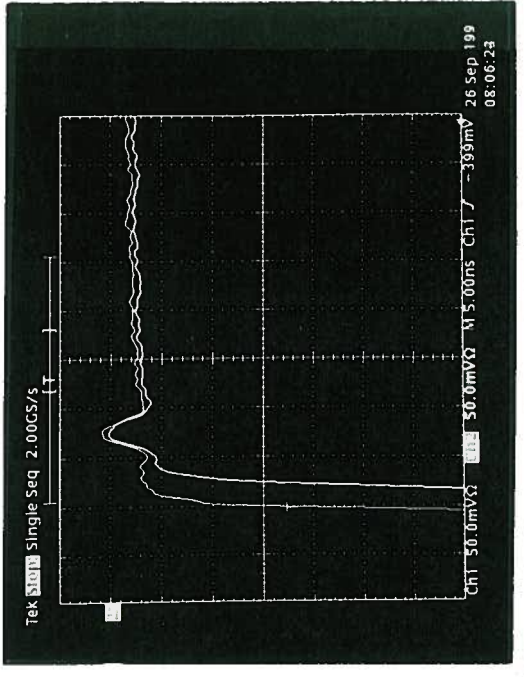
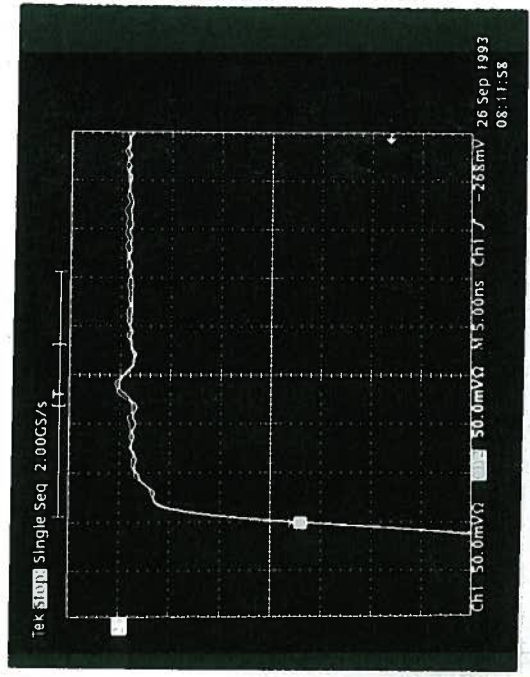
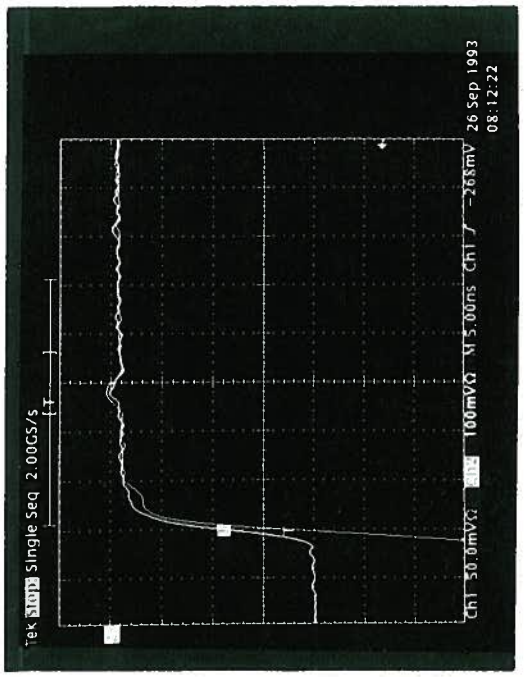


Same stuff as previous page. Trig on Ch1

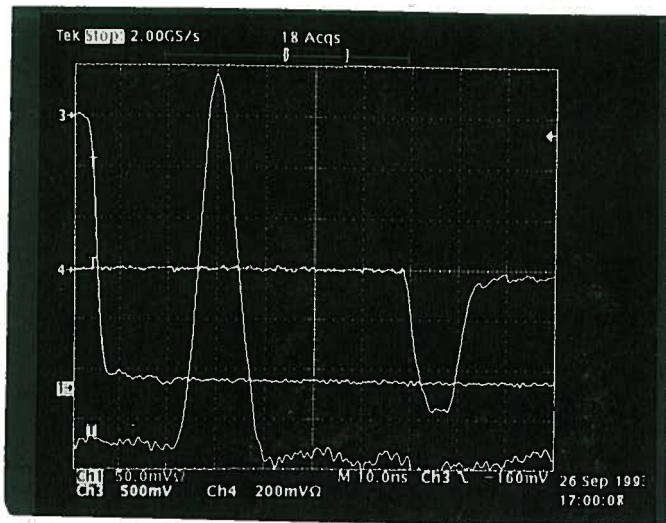
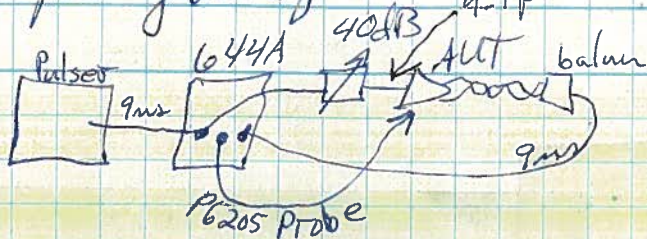
Playing with input pulse amplitude seems to be an "overdrive" or something. Reducing input amplitude eliminates the problem. There is a point where you can see the problem develop.

0.5V input step
0.5V input is just above this transition point.

well behaved region



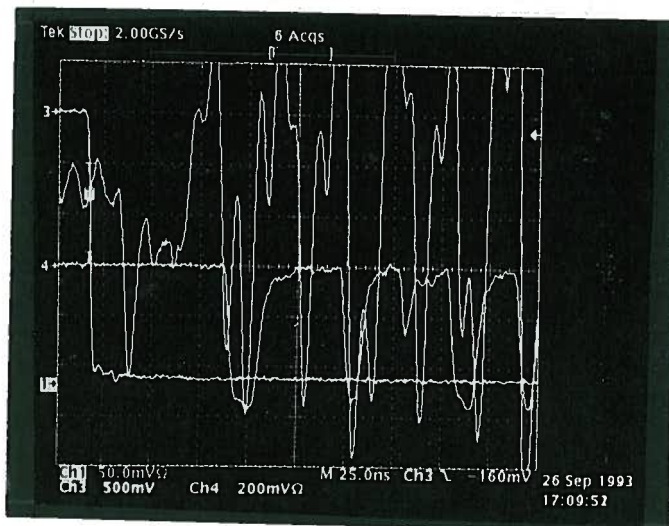
Comparing Delroy & Nanometric 4.7pF charge injector used



Looking at input step
input to MVL407
and balun output

$V_{supplies} = \pm 6V$
 $.68A$ on $-6V$
 $.34A$ on $+6V$
 $V_{thresh} = 3.8V$

Delroy 2735 DC
 ←

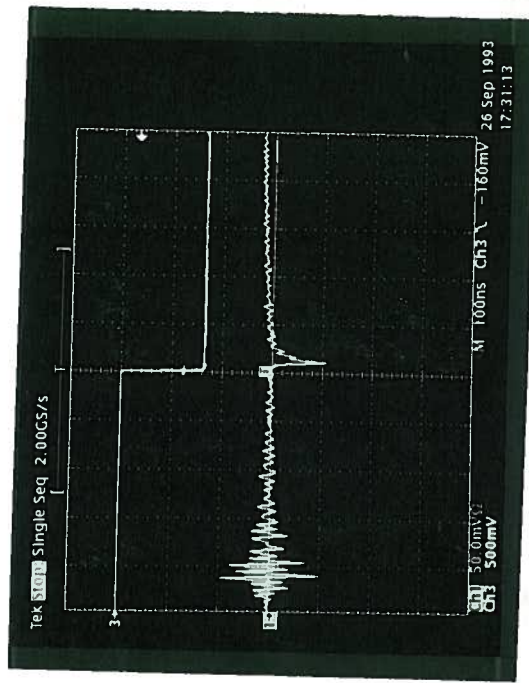
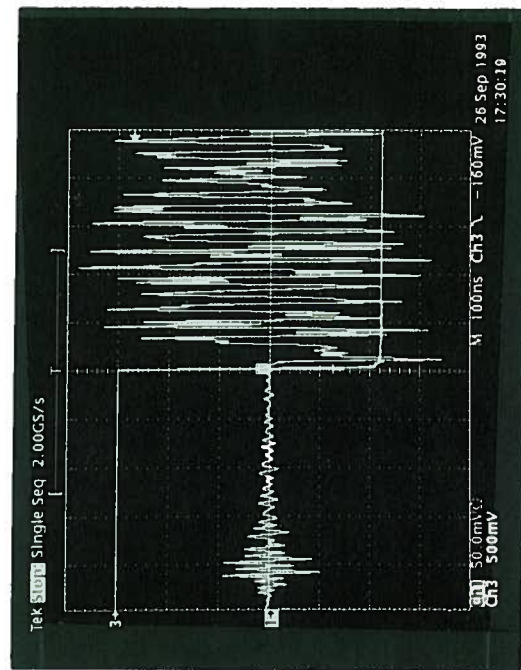


N-277-L
 as above (at comparator input)
 $.80A$ on $-6V$
 $.49A$ on $+6V$
 $V_{thresh} = 6.4V$

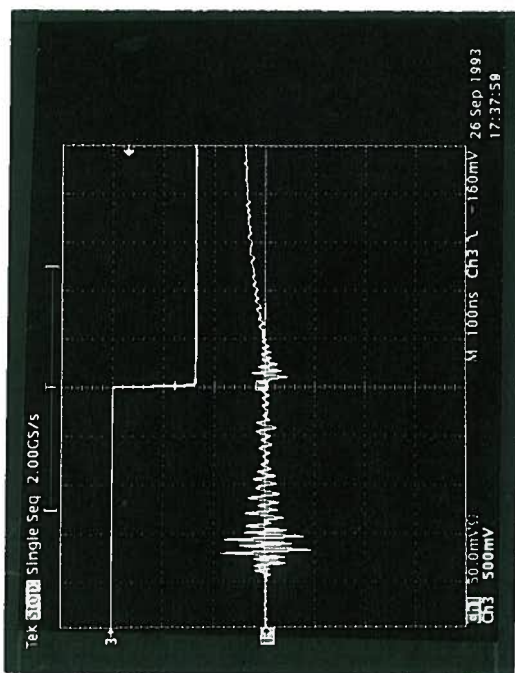
Looking at Noise of 8013B Pulser

55

There is some noise generated by the HP pulser when it triggers. Pulse delay should be set long enough so that the noise/ringing has died away by the time the output pulse comes from the pulser.

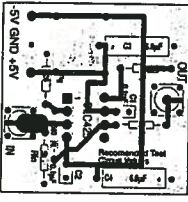
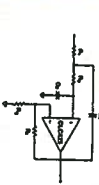
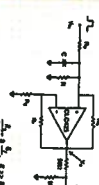
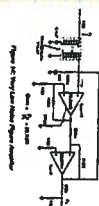


Delay adjusted to show ringing output pulse. Looking at N-277-L of previous setup.



This photo has input charge capacitor rotated so only the ground pin is connected. Delay has been re-adjusted (clear playing around.) and input charge cap. circuit completely removed from the input there is no ringing visible.

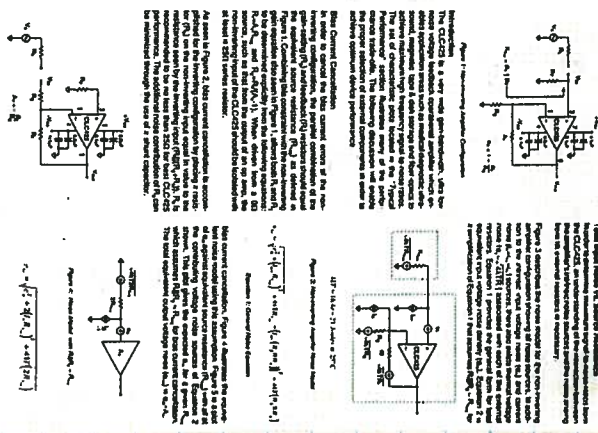
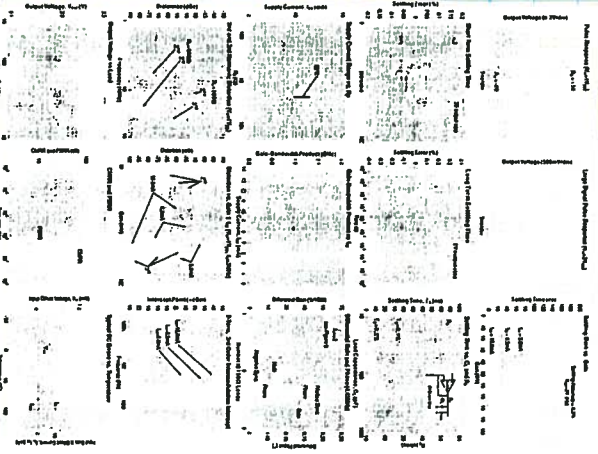
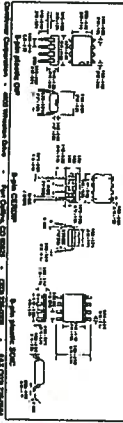
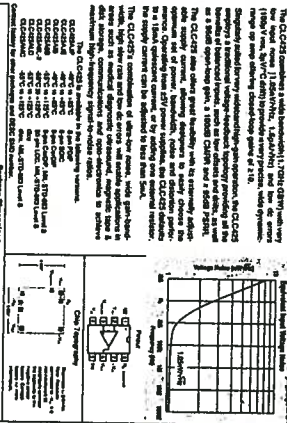
Same effect as if use external trigger & a pocket pulser as the trigger.
Note baseline rise after pulse



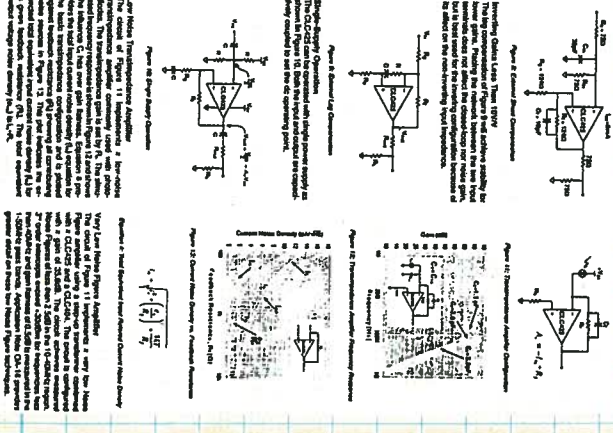
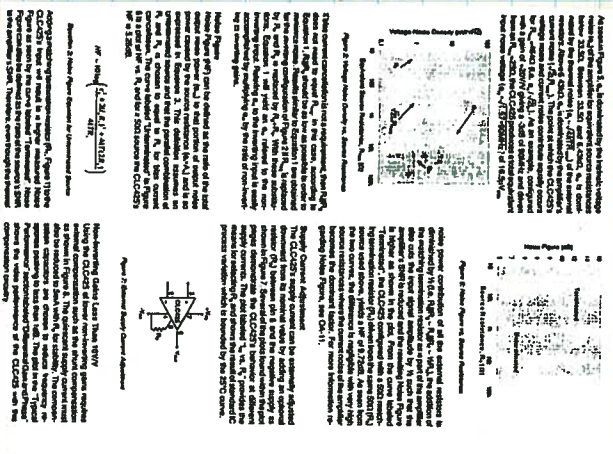
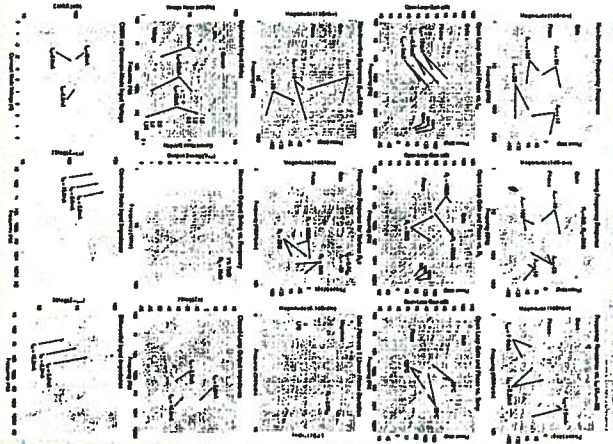
APPLICATIONS

The CLC425 is a wideband, low-noise, high-precision, single-supply, CMOS op amp. It is designed for use in a wide variety of applications, including:

- 100% gain bandwidth product
- 100% input common-mode range
- 100% output swing
- 100% rail-to-rail operation
- 100% rail-to-rail input range
- 100% rail-to-rail output range
- 100% rail-to-rail input range
- 100% rail-to-rail output range



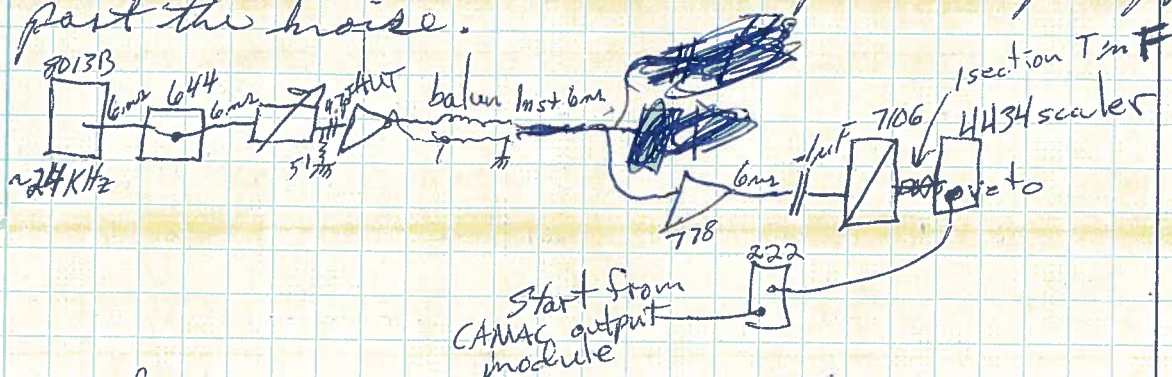
Parameter	CLC425	CLC425A	CLC425B	CLC425C	CLC425D	CLC425E	CLC425F	CLC425G	CLC425H	CLC425I	CLC425J	CLC425K	CLC425L	CLC425M	CLC425N	CLC425O	CLC425P	CLC425Q	CLC425R	CLC425S	CLC425T	CLC425U	CLC425V	CLC425W	CLC425X	CLC425Y	CLC425Z
Supply Voltage	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Input Bias Current	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Input Offset Voltage	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Common-Mode Input Range	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Output Voltage Swing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gain Bandwidth Product	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Phase Margin	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Power Consumption	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10



10/2
JL

PC and 3227 Noise Check

In light of p.55 (noise of 8013B) set delay to maximum of lowest scale to push output pulse past the noise.



Checking scaler max count will be assumed 22800.
 $.883 \neq 20,100$ $.5 = 11,400$ $.117 = 2,700$

Looking at PC amp $V_{supply} = -12.02V$ Supply wire wrapped around toroid no shielding
 attenuation is 20dB
 with step input = 324mV $.883 = 356.5$ 703.5
 $.5 = 357.5$ 704.5
 $.117 = 359$ 706mV
 324mV 648mV

$$\frac{(305 - 152 fC)(6250 e^- / fC)(2.5 mV)}{2.35} = 2932 e^- ENC$$

Looking at 3227 amp $V_{supply} = -6.06V, +6.04V$ supply wires shielded but not wrapped around a toroid
 attenuation is 40dB
 step input 408mV 820
 $.883 = 244.5$ 504
 $.5 = 250$ 509.5
 $.117 = 256$ 515.5

$$\frac{(38.5 - 19 fC)(6250 e^- / fC)(11.5 mV)}{2.35} = 2300 e^- ENC$$

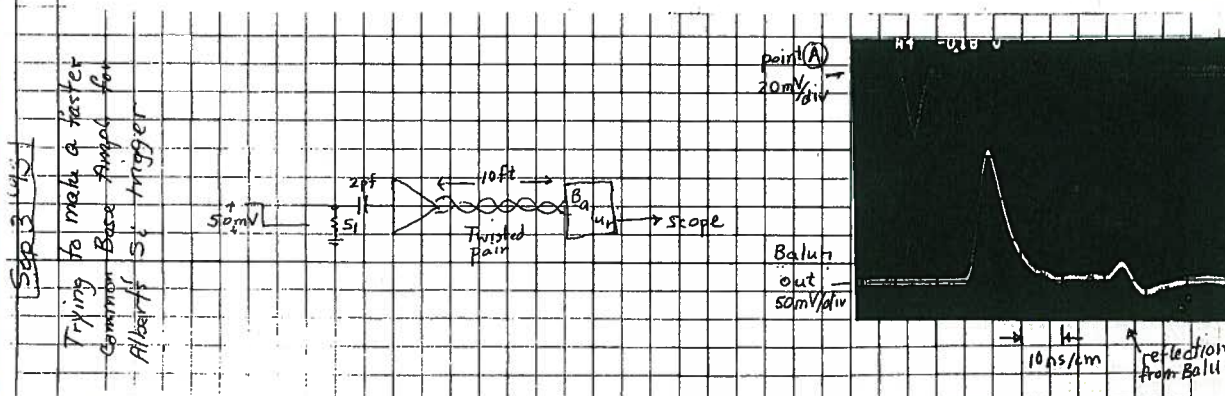
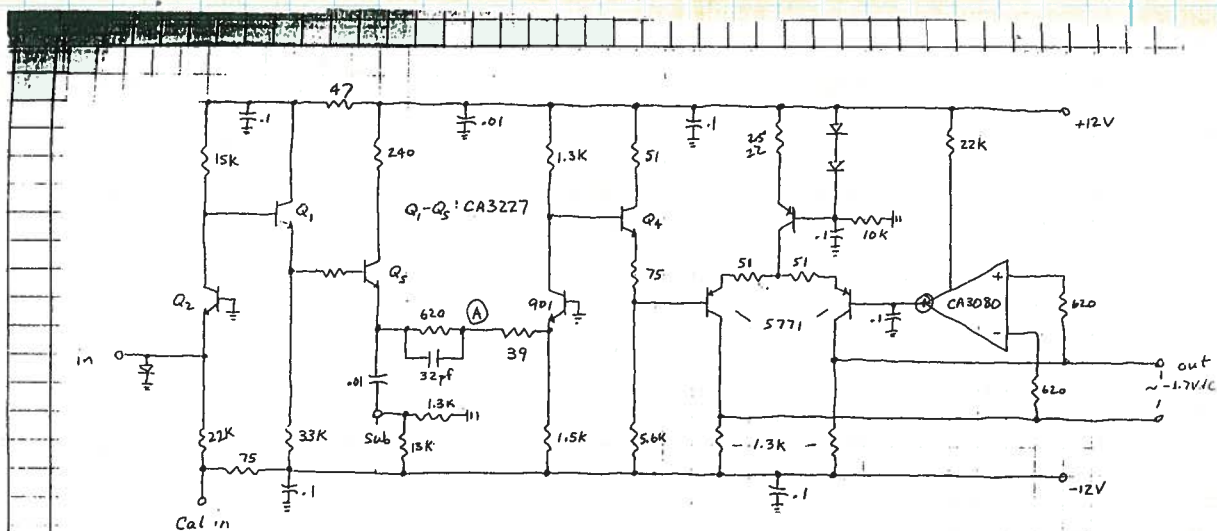
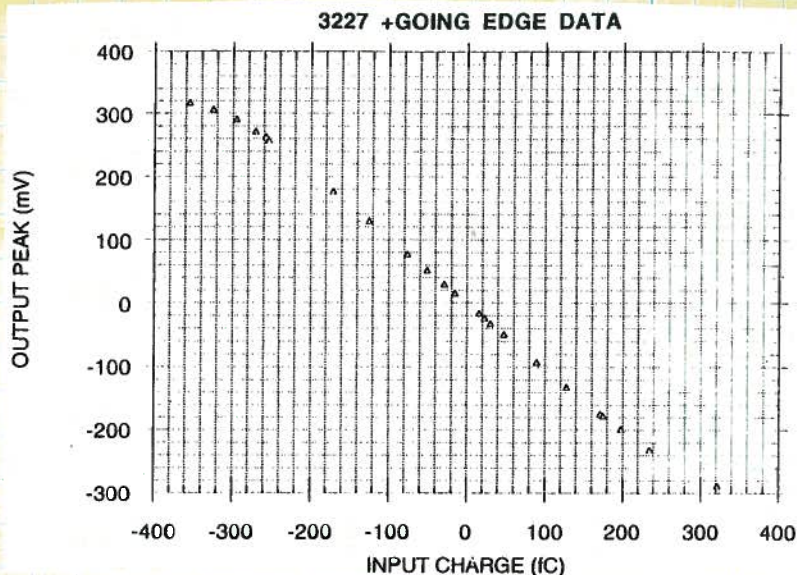
I want to see if bypass capacitors on the power supply pins improve the noise for the CPO1. 20dB attenuation of the input step was used.

$$\frac{(361 - 175 fC)(6250 e^- / fC)(2.5 mV)}{2.35} = 2800 e^- ENC$$

3370e- if $\Delta = 3.0mV$ not 2.5

build most fit
mips inside
aluminum box
Box used as a
common
grounding
point!

Checking the linearity of the 3227 amp.
Same setup except the amp output goes to the scope,
not 778 amp.



CA3237, CA3246

CA3237, CA3246

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
For Each Transistor					
Collector-Base Breakdown Voltage	V_{CBR}	$I_C = 10 \mu A$	12	20	V
Collector-Emitter Breakdown Voltage	V_{CEB}	$I_E = 10 \mu A$	10	—	V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = 10 \mu A$	—	0.2	V
Base-Emitter Breakdown Voltage	V_{EBR}	$I_E = 10 \mu A$	—	10	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$	$I_E = 10 \mu A$	—	0.2	V
Collector-Base Current	I_{CB}	$V_{CB} = 10 V$	—	100	nA
Collector-Emitter Current	I_{CE}	$V_{CE} = 10 V$	—	100	nA
Base Current	I_B	$V_{BE} = 10 V$	—	100	nA
Base-Emitter Voltage	V_{BE}	$I_E = 10 \mu A$	—	0.2	V
Collector-Emitter Voltage	V_{CE}	$I_C = 10 \mu A$	—	0.2	V
Collector Current	I_C	$V_{CE} = 10 V$	—	0.2	V
Base Current	I_B	$V_{BE} = 10 V$	—	0.2	V

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	TYPICAL VALUE	UNIT
For Each Transistor				
Input Resistance	R_{in}	$V_{in} = 10 V$	4	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	MΩ
Input Resistance	R_{in}	$V_{in} = 10 V$	4	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	MΩ
Input Resistance	R_{in}	$V_{in} = 10 V$	4	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	MΩ

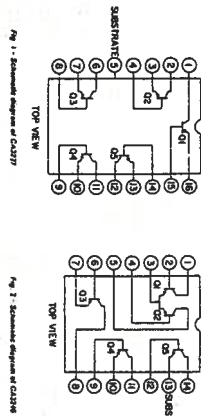


Fig. 1 - Schematic diagram of CA3237

Fig. 2 - Schematic diagram of CA3246

Operational Transconductance Amplifiers (OTAs)

Cascaded Gain Stages

Features:

- Short-circuit safety gain compensation, 20 V/V
- Package supply voltage range, 2.7 V to 18 V
- Input bias current, 10 nA
- Input resistance, 10 MΩ
- Output resistance, 100 Ω
- Frequency response, 100 kHz
- Temperature stability, 0.1%/°C

The CA3237 and CA3246 are operational transconductance amplifiers (OTAs) that provide a high gain, high input resistance, and low output resistance. They are designed for use in a wide range of applications, including signal processing, filtering, and control systems. The CA3237 is a single-supply device, while the CA3246 is a dual-supply device. Both devices are available in a variety of package types, including DIP, SOIC, and TSSOP.

The CA3237 and CA3246 are designed to provide a high gain, high input resistance, and low output resistance. They are designed for use in a wide range of applications, including signal processing, filtering, and control systems. The CA3237 is a single-supply device, while the CA3246 is a dual-supply device. Both devices are available in a variety of package types, including DIP, SOIC, and TSSOP.

CA3080, CA3080A

ELECTRICAL CHARACTERISTICS

For Temperature Range

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
For Each Transistor					
Input Resistance	R_{in}	$V_{in} = 10 V$	4	—	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	—	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	—	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	—	MΩ
Input Resistance	R_{in}	$V_{in} = 10 V$	4	—	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	—	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	—	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	—	MΩ

CA3080, CA3080A

ELECTRICAL CHARACTERISTICS

For Temperature Range

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
For Each Transistor					
Input Resistance	R_{in}	$V_{in} = 10 V$	4	—	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	—	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	—	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	—	MΩ
Input Resistance	R_{in}	$V_{in} = 10 V$	4	—	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	—	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	—	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	—	MΩ

ELECTRICAL CHARACTERISTICS

Typical Values Intended Only for Design Guidance

CHARACTERISTIC	SYMBOL	TEST CONDITIONS	MIN.	MAX.	UNIT
For Each Transistor					
Input Resistance	R_{in}	$V_{in} = 10 V$	4	—	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	—	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	—	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	—	MΩ
Input Resistance	R_{in}	$V_{in} = 10 V$	4	—	MΩ
Output Resistance	R_{out}	$V_{out} = 10 V$	2.7	—	MΩ
Forward Transfer Resistance	R_{f1}	$V_{in} = 10 V$	0.3	—	MΩ
Reverse Transfer Resistance	R_{r1}	$V_{in} = 10 V$	0.3	—	MΩ

CA3080, CA3080A

MAXIMUM RATINGS - Absolute-Maximum Values

DC SUPPLY VOLTAGE (Between V^+ and V^-)

DC INPUT VOLTAGE

DC OUTPUT VOLTAGE

TEMPERATURE RANGE

Storage Temperature

Lead Temperature (Solder Reflow)

All dimensions in inches or millimeters.

Short-circuit should be avoided as much as possible.

CA3080, CA3080A, CA3080B, CA3080C, CA3080D, CA3080E, CA3080F, CA3080G, CA3080H, CA3080I, CA3080J, CA3080K, CA3080L, CA3080M, CA3080N, CA3080O, CA3080P, CA3080Q, CA3080R, CA3080S, CA3080T, CA3080U, CA3080V, CA3080W, CA3080X, CA3080Y, CA3080Z

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CA3080, CA3080A, CA3080B, CA3080C, CA3080D, CA3080E, CA3080F, CA3080G, CA3080H, CA3080I, CA3080J, CA3080K, CA3080L, CA3080M, CA3080N, CA3080O, CA3080P, CA3080Q, CA3080R, CA3080S, CA3080T, CA3080U, CA3080V, CA3080W, CA3080X, CA3080Y, CA3080Z

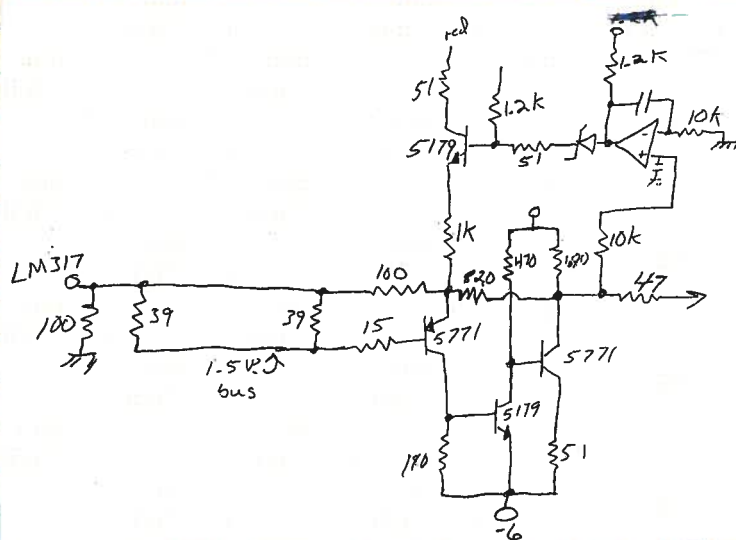
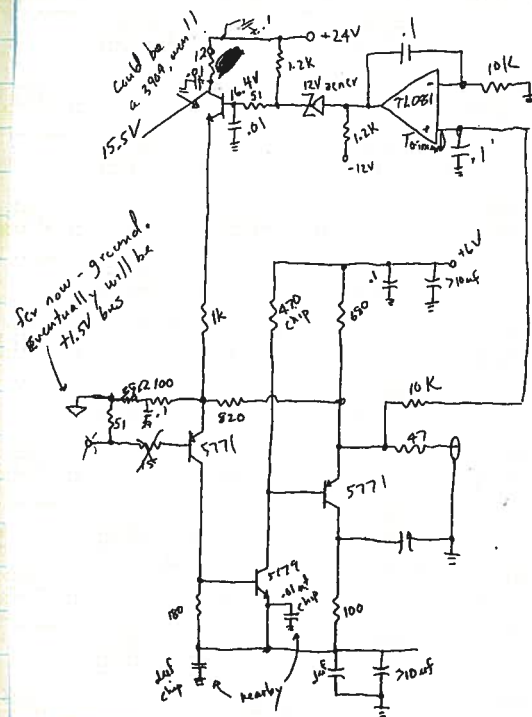
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AMUX TTL Schematics

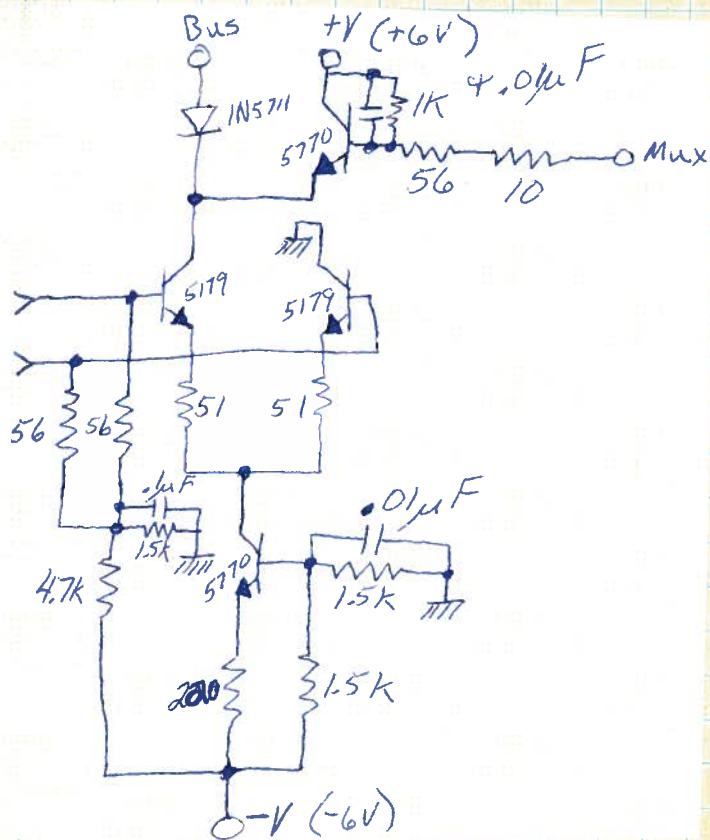
61

10/10/93
JS



from original prototype

from original prototype

 $+V (+6V)$

4.000 F

56 10

10

220

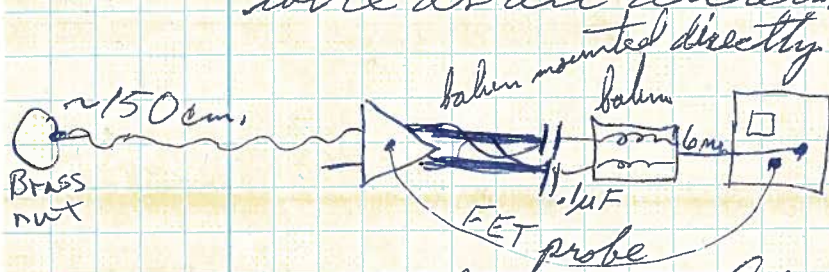
$-V (-6V)$

-K

10/26 Pickup noise in Hall

BY
BV

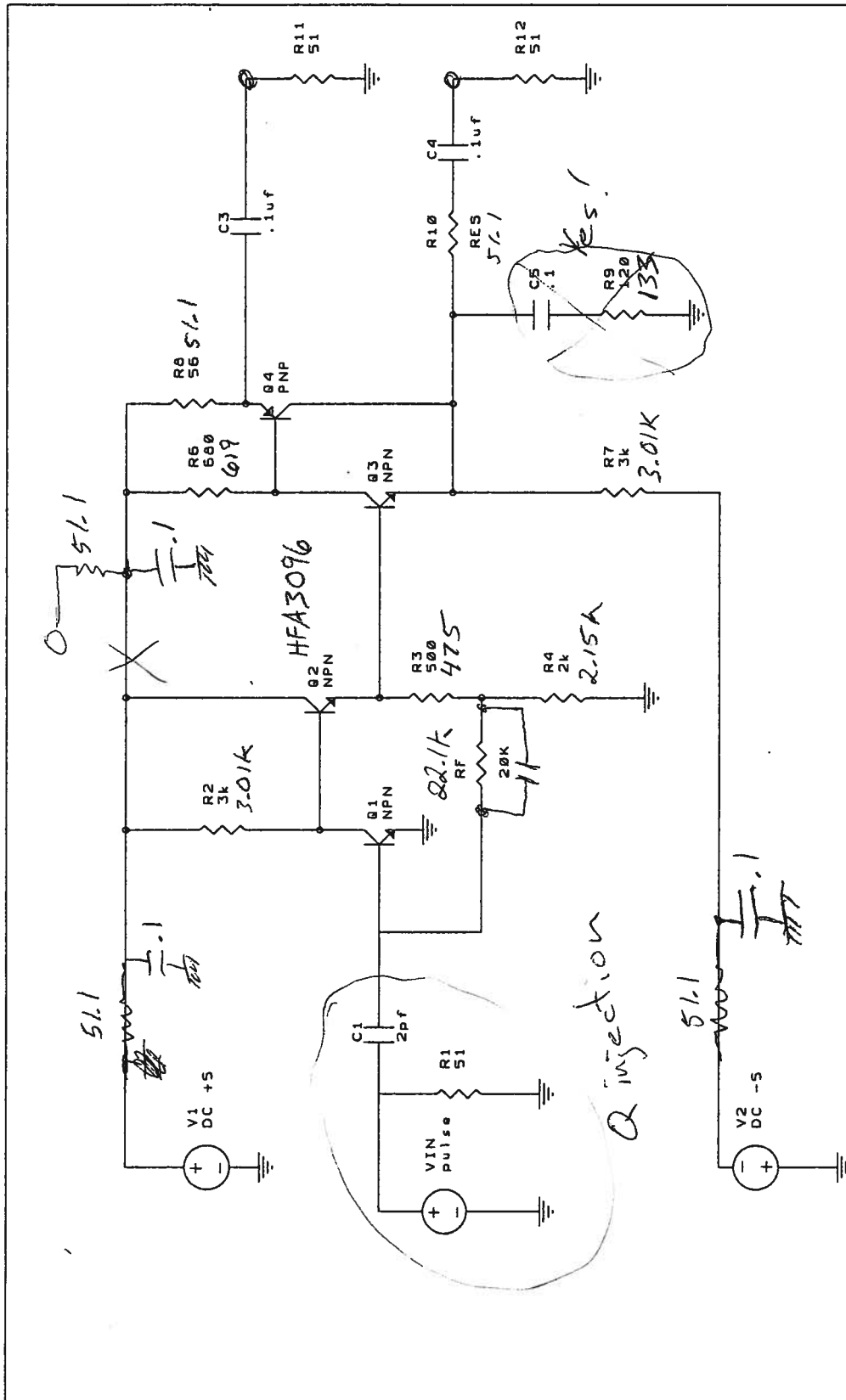
Looking at pickup in the hall using a nanovoltmeter and 150 cm of thin magnet wire as an antenna.



FET probe is clipped to the anode of the feedback diode on the comparator

Hall C 002. WFM
HALL C 003. WFM

using HFA3096



SSCLab M. Wright	
Title	
Trans Amp Cable Driver	
Size	Document Number
A	REV
1	1
Date:	March 10, 1993 Sheet of

HFA3046, HFA3096, HFA3127, HFA3128

PRELIMINARY

March 1992

Ultra High Frequency Transistor Array

Features

- NPN Transistor (f_T)..... 8GHz
- NPN Current Gain (h_{FE})..... 150
- NPN Early Voltage (V_A) 60V
- PNP Transistor (f_T)..... 4GHz
- PNP Current Gain (h_{FE})..... 60
- PNP Early Voltage (V_A)..... 40V
- Noise Figure @ 1kHz..... 2dB
- Complete Isolation Between Transistors
- Pin Compatible with Industry Standard 3XXX Series Arrays

Applications

- VHF Amplifiers
- VHF Mixers
- IF Converters
- Synchronous Detectors

Description

The HFA3046, HFA3096, HFA3127 and the HFA3128 are Ultra High Frequency Transistor Arrays that are fabricated from Harris Semiconductor's complementary bipolar UHF process. Each array consists of five dielectrically isolated transistors on a common monolithic substrate. The NPN transistors exhibit a f_T of 8GHz while the PNP transistors provide a f_T of 4GHz. Both types exhibit low noise (2dB), making them ideal for high frequency amplifier and mixer applications.

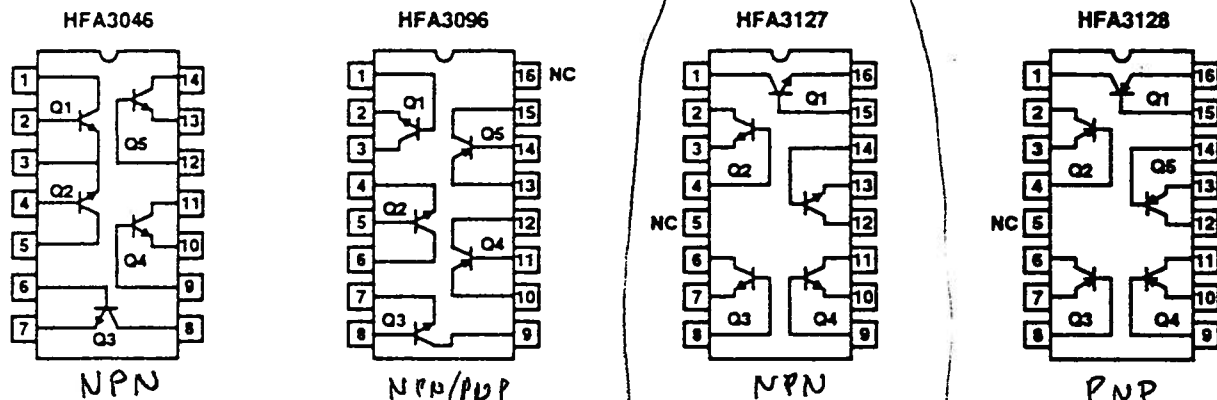
The HFA3046 and HFA3127 are all-NPN arrays while the HFA3128 has all PNP transistors. The HFA3096 is a NPN-PNP combination. Access is provided to each of the terminals for the individual transistors for maximum application flexibility. Monolithic construction of these transistor arrays provides close electrical and thermal matching of the five transistors.

For your future transistor array requirements contact your local sales office for more information.

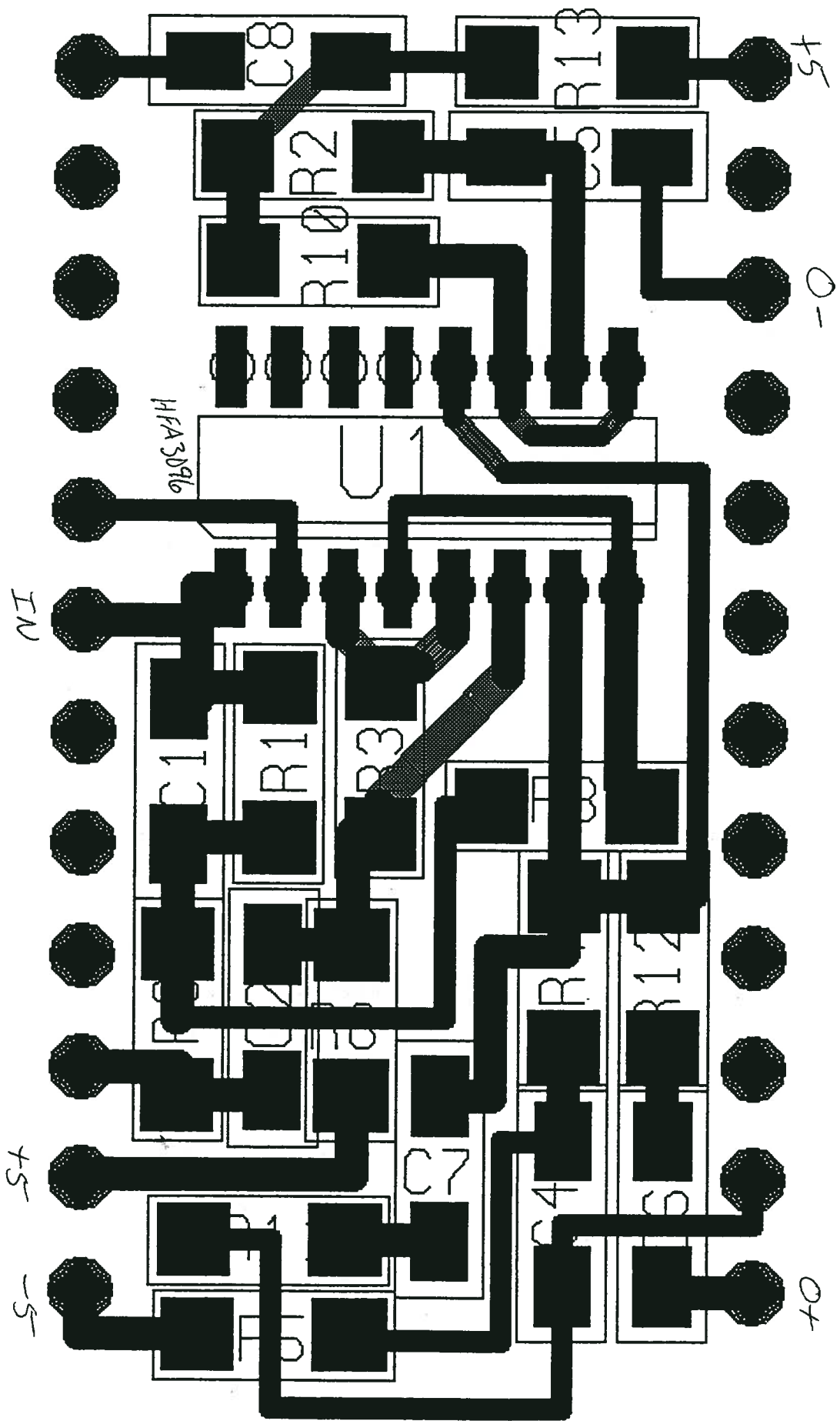
Ordering Information

MODEL NUMBER	PRODUCT DESCRIPTION
HFA3046B	14 LD SOIC
HFA3096B, HFA3127B, HFA3128B	16 LD SOIC
HFA3046Y, HFA3096Y	DIE
HFA3127Y, HFA3128Y	DIE

Pinouts

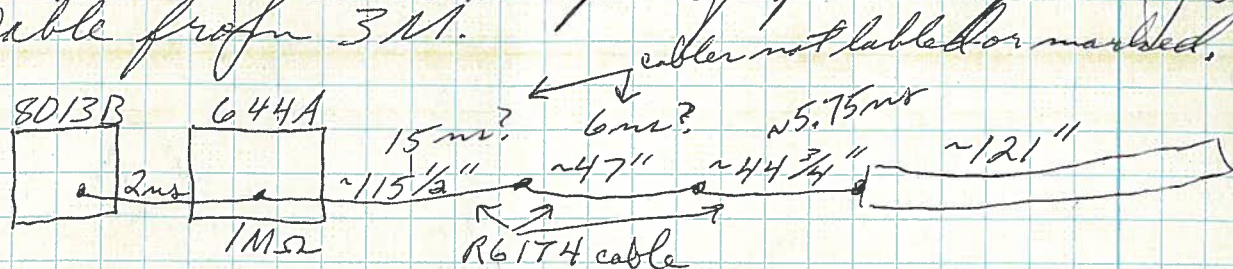


14 and 16 lead SOIC packages are available in narrow body width (150mils). Refer to package outline information.



Pleated Foil Cable (.050" center) 11/1/93

Looking at a sample of pleated foil cable from 3M.



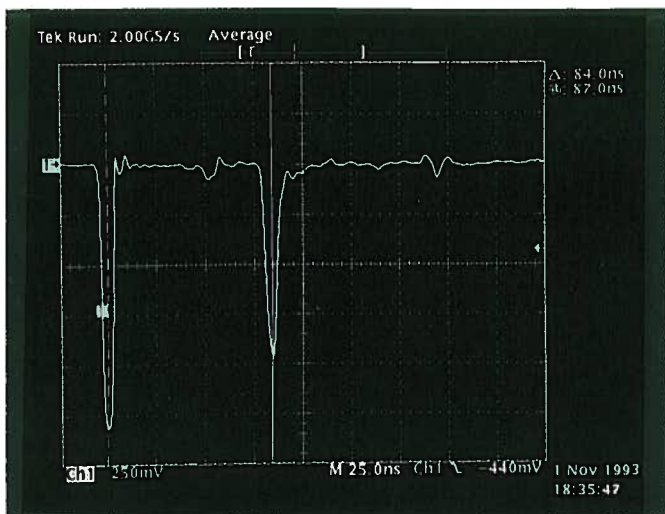
For the first setup I will use the foil grounded and Gnd-signal-Gnd for the wires. A double row header is inserted in the connector with one row of pins connected by a wire soldered on them. The ends of the wire are looped back to the foil and soldered on the edges of the cable to the foil. This way the heat from soldering should only deform the dielectrics on the last two wires, at worst. This gives the odd wires at Gnd, even for signals.

Signal input is on a cable (44 3/4") with a BNC connector on one end, braid peeled back on the other end to form a pigtail ~3" long and the center conductor trimmed back so it extends no more than 8" beyond shield.

Pigtail is soldered to row of pins for Gnd. Center conductor is soldered to wire 8 (fourth pin in the row).

Scope is set to average 15 traces.

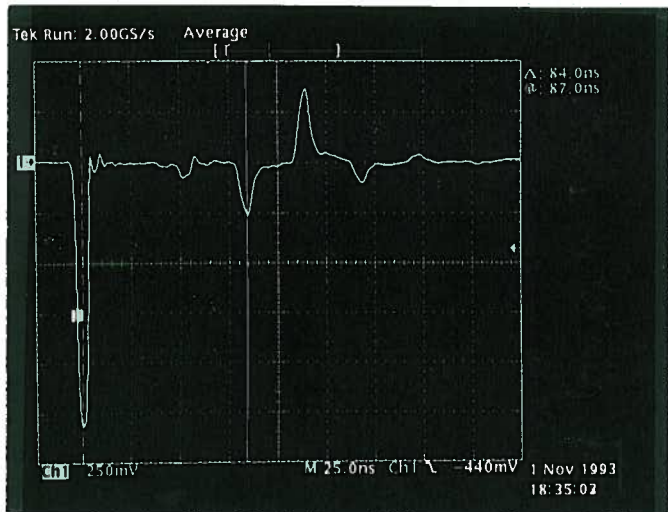
All unused signal lines are open at both ends for the Gnd-Signal-Gnd setups.



Far end of Pleatsville (PFC)
 is open.

All wires were open at
 the far end of PFC.

Trace is an average of 15.



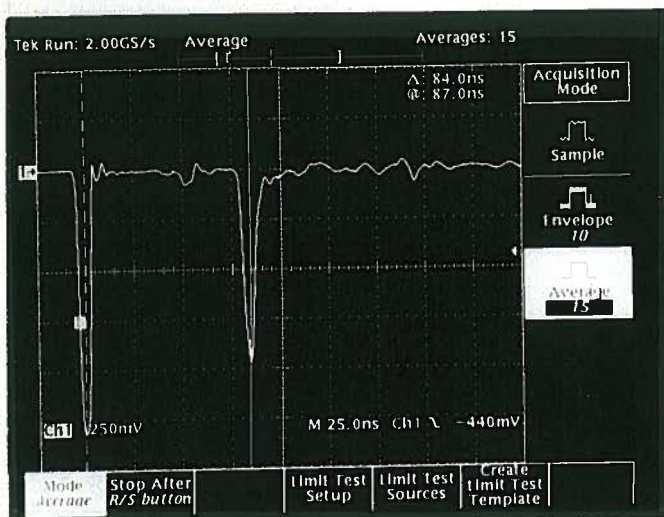
51Ω
~~50Ω~~ 1/4W carbon comp resistor
 from wire 7 to 8 on far end
 of PFC

All wires were open at
 the far end of PFC.

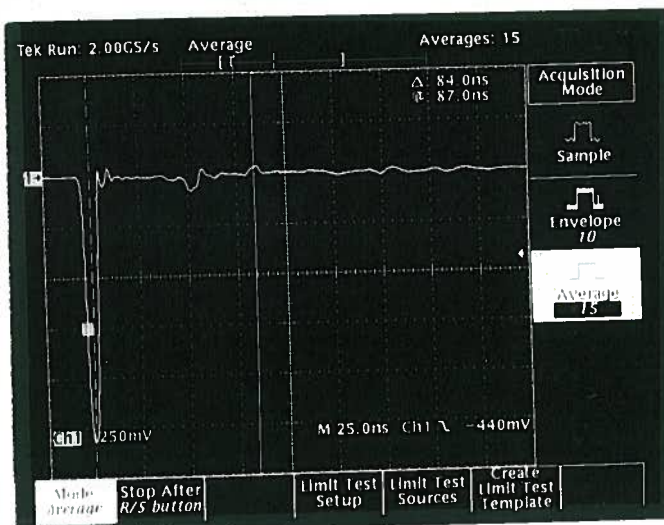
Trace is an average of 15.

A double row of pins is inserted into the far
 end of the PFC with the same row of pins connected
 together and connected to the foil as was done
 for the near end.

From this point on all resistors will be
 1/8W carbon composition. 5% tol.

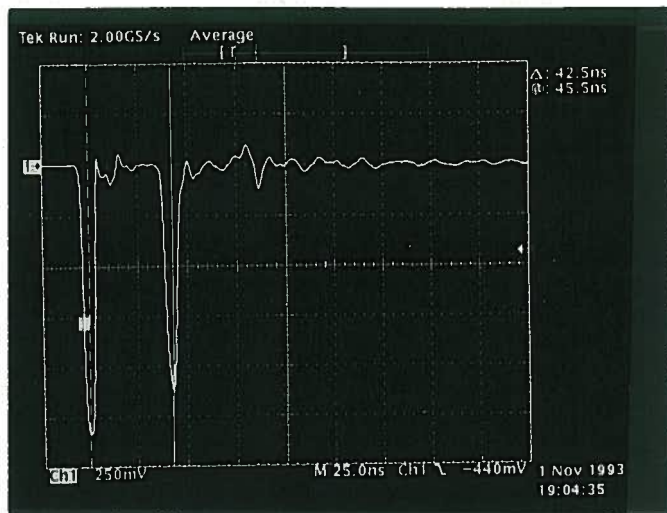


Far end of line 8 open



Far end has 18W 51-12
carbon comp.

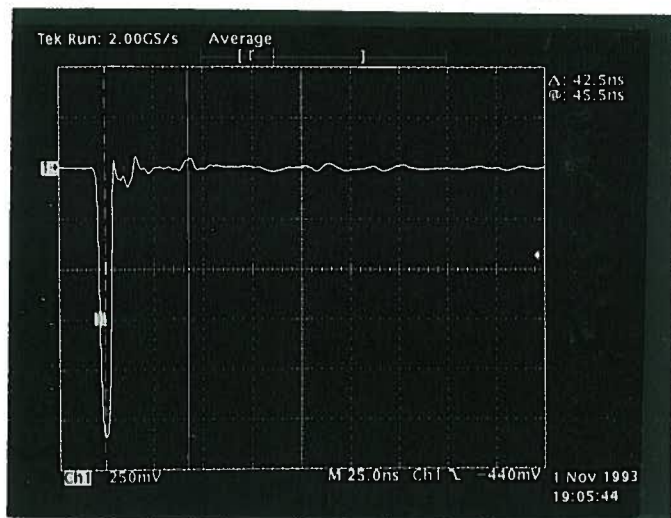
The two sections of RG174 (115 1/2" & 47") are removed. Now there is only ~44 3/4" from scope to R/F C



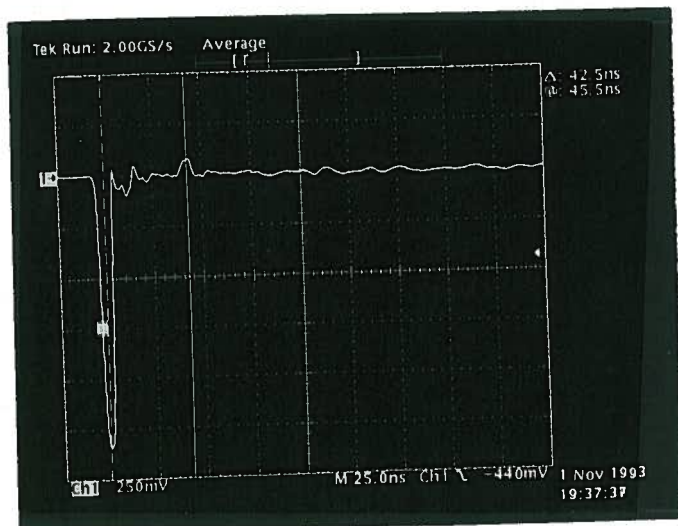
Far end is open.

$$(42.5\text{ns} - 11.5\text{ns}) \div 20 = 1.55\text{ns/ft}$$

$$.65\text{ft/ns} \Rightarrow .66\text{c}$$

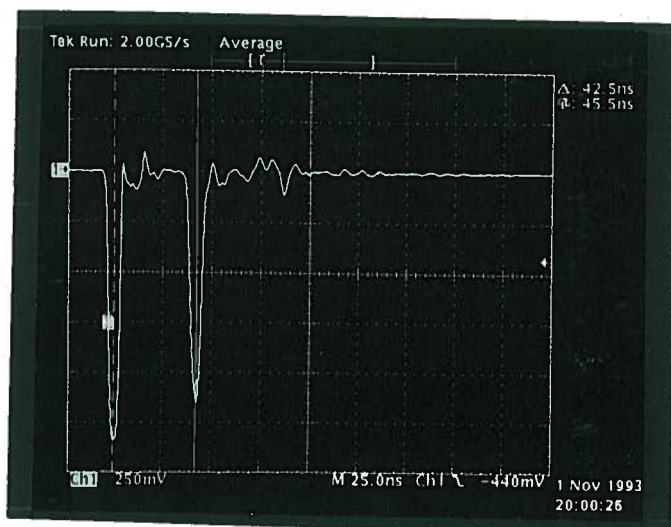


Far end terminated
with 51Ω

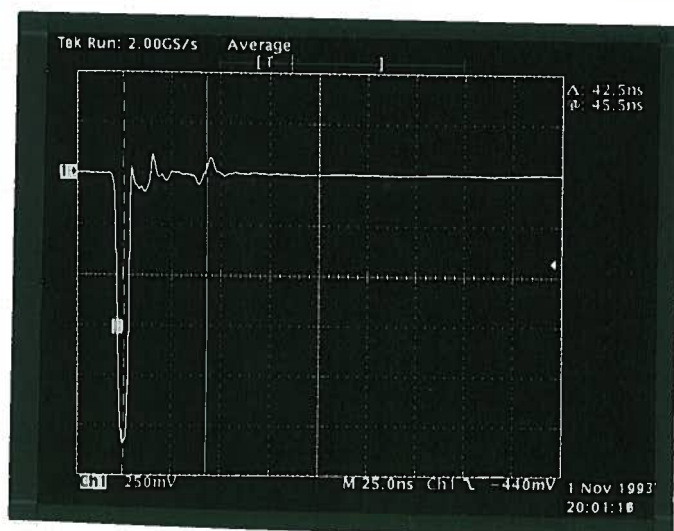


Far end terminated
with 47Ω

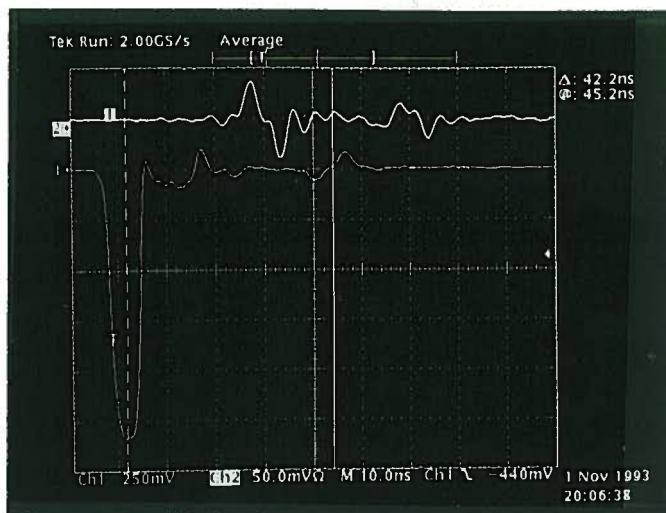
The double rows of pins are pulled out of both ends of the PTH. 51Ω resistors soldered to two pins inserted in lines 7 + 9. Soldered from pin to wire soldered to cable foil. This is done on both ends of the cable. The signal R6174 cable still has the pigtail soldered to wire connected to the cable foil. The center conductor is soldered to a single pin and inserted into line 8 socket hole. So I have 51Ω -signal- 51Ω . All other lines open at both ends.



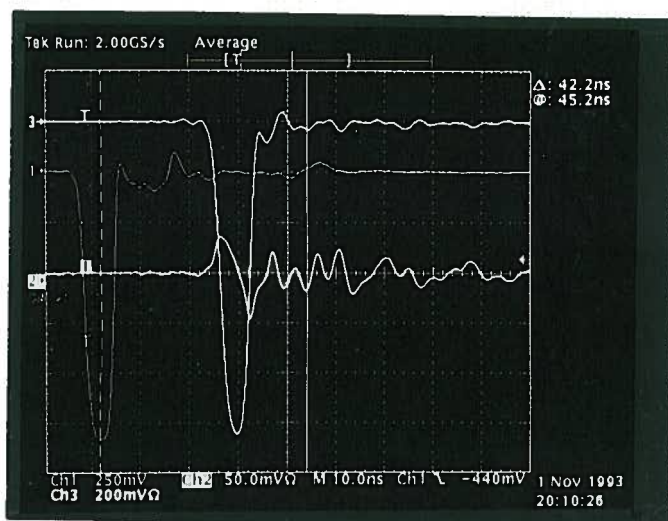
Far end of line 8 is open



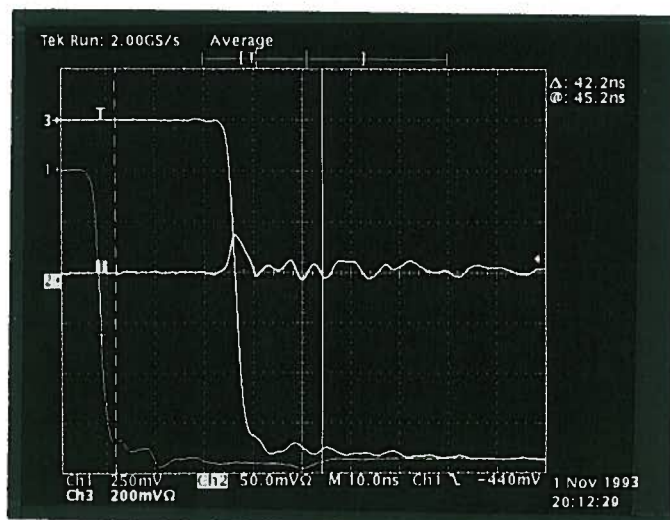
Far end of line 8 is terminated in 51Ω



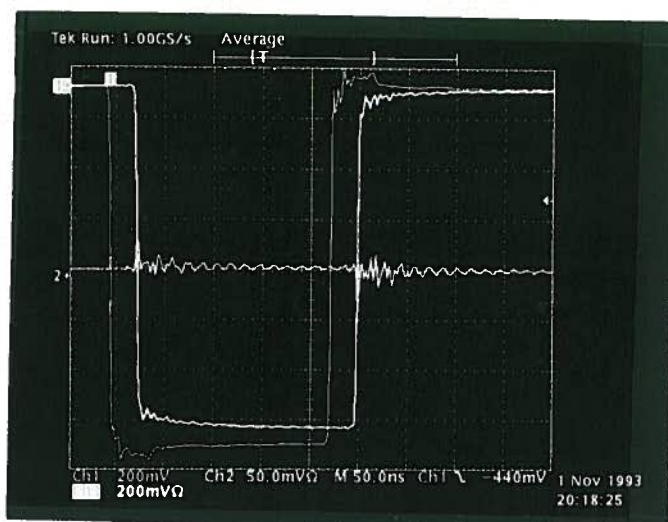
Same as previous photo.
Probes (FET) on far end
of line 9.
Note scale change.



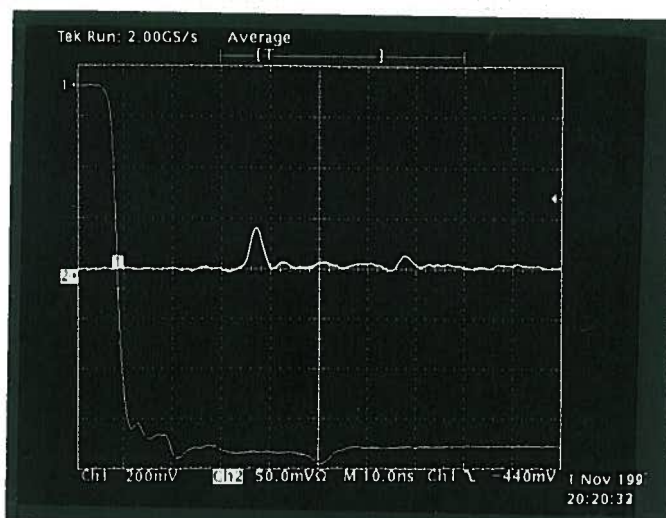
Same as above. FET probes
on far ends of lines 8 & 9



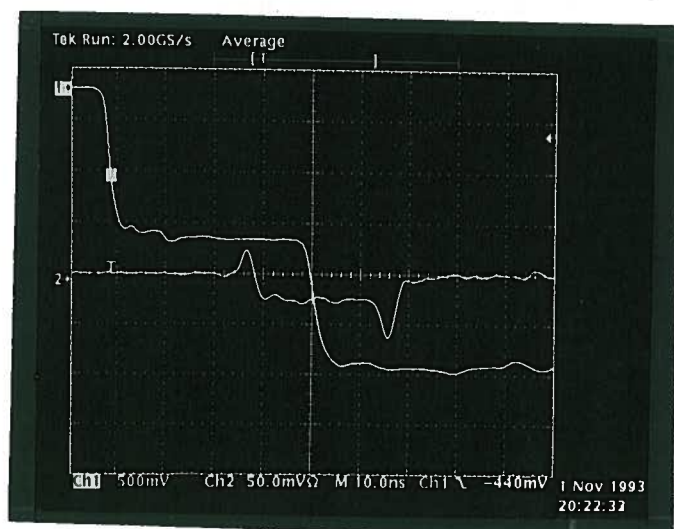
Same as photo immediately above.
Pulse stretched out longer.



Same as photo on bottom of last page. Note scale changes.



Same as above. Probe removed from end of line 8.



Same as photo immediately above except far end of line 8 is open. Note scale change.

.050" Pitch High Performance "Pleated Foil Covered" Transmission Line Cable

Innovative IDC cable offers a cost-effective option to coax and Teflon® cable for high speed applications

3M introduces an innovative, mass terminable, Pleated Foil Covered (PFC) ribbon cable with electrical performance near that of individual coaxial cable. System designers can now use 3M's patented PFC cable in a multitude of high speed applications which previously required expensive coaxial cable, Teflon, or twisted pair cables.

Controlled Impedance Cable, perfect for your 50 ohm unbalanced or 100 ohm balanced (differential) applications. For differential applications, normal twisted pair cable performs up to about 15 MHz; PFC cable can be used at data rates exceeding 350 MHz.

New proprietary Thermoplastic Elastomer (TPE) insulation allows PFC cable to approach the performance of Teflon cable at a significantly lower cost. 3M's new TPE, with an effective dielectric constant of 2.2, reduces the rise time degradation of PFC cable to below 0.1 nanoseconds per 10 foot length. Typical polyvinyl chloride (PVC) ground plane, twisted pair or flat cables have rise time degradation in the 1 to 2 nanoseconds range, which severely distorts digital data. PFC cable provides near perfect signal fidelity.

Crosstalk problems are virtually eliminated when using PFC cable. Even when using an incredibly fast signal rise time of 0.6 nanoseconds on a 10 foot length of PFC cable, the forward crosstalk is an incredibly low 20 millivolts (3 volt signal input in GSG configuration).

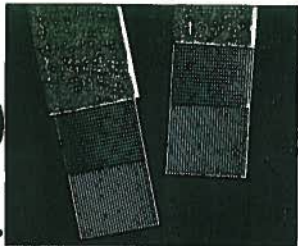
Easy, cost-effective insulation displacement termination to a variety of standard .100" X .100" IDC connectors. Mass termination of PFC cable eliminates the costly, labor intensive process of terminating individual coax cable or discrete twisted pair cable.

Transmit Multiple High Frequency Video/Analog signals and digital data all on the same cable. Previously, the only way to transmit these high speed signals was with individual coax cable and BNC connectors. With PFC's low digital crosstalk and analog isolation of 65 dB at 10 MHz and 50 dB at 100 MHz, all these signals can be transmitted down the same cable with negligible interference.

Space requirements are dramatically reduced using PFC cable in the all signal mode. Similar to ground plane cable, a .25 conductor (.050" pitch) PFC cable can be used to transmit the same data as a 50 conductor flat ribbon cable and occupies one-half the space. Increased signal density reduces your space problems.

Near perfect shielding results from pleated copper foil wrapped completely around the new TPE ribbon cable. PFC cable has a shielding effectiveness that exceeds 95 dB from 30 MHz to 1 GHz, outperforming even double shielded coax. Unsurpassed shielding makes PFC cable ideal for applications with strict FCC requirements.

For Interior or Exterior Needs, PFC comes with a .011" thick interior covering, or a .035" thick exterior jacket. The flexible interior covering is perfect for your board-to-board applications and provides protection against accidental shorting. The exterior jacket meets your I/O device needs with the ability to withstand hard abuse and meets the CL2 rating for applications over 10 feet.



Comparison of Electrical Properties of Various Cable Types versus PFC Cable

Electrical Properties (Typical test values)	1260 Series PFC Cable (.050" Pitch)	Ground plane cable 3469 Series	Flat ribbon, copper mesh shielded cable 3517 Series	Round jacketed, shielded discrete twisted pair cable 3750 Series
Velocity of propagation (%)	62	62	67	59
Time delay (ns/ft)	1.64	1.64	1.51	1.71
Attenuation: dB/100 ft @ 100MHz	10.0 37.0	10.0 37.0	6.5 21.0	5.0 20.0
Rise time degradation (ns/10 ft)	1.2	1.2	0.5	1.1
Crosstalk for 10 foot test length ¹ 5 volt, 2.5 ns rise time				
Unbalanced (single ended GSG) F2 B2	470mv/ 9.4% 150mv/ 3.0%	470mv/ 9.4% 150mv/ 3.0%	60mv/1.2% 40mv/0.8%	480mv/ 9.6% 220mv/ 4.4%
Unbalanced (single ended SSS) F2 B2	810mv/16.2% 300mv/ 6.0%	810mv/16.2% 300mv/ 6.0%	250mv/5.0% 250mv/5.0%	835mv/16.7% 350mv/ 7.0%
Balanced (differential SS SS) F2 B2	130mv/ 2.6% 125mv/ 2.5%	130mv/ 2.6% 125mv/ 2.5%	125mv/2.5% 75mv/1.5%	80mv/ 1.6% 50mv/ 1.0%
Crosstalk for 10 foot test length ¹ 5 volt, .6 ns rise time				
Unbalanced (single ended GSG) F2 B2	680mv/13.6% 150mv/ 3.0%	680mv/13.6% 150mv/ 3.0%	110mv/2.2% 40mv/0.8%	890mv/17.8% 220mv/ 4.4%
Unbalanced (single ended SSS) F2 B2	1100mv/22.0% 300mv/ 6.0%	1100mv/22.0% 300mv/ 6.0%	450mv/9.0% 250mv/5.0%	1420mv/28.4% 350mv/ 7.0%

Note 1: Crosstalk results are for cable only. Connectors, ground paths, circuit board traces, etc., will affect final circuit crosstalk values.

Note 2: F=Forward (far end), B=backward (near end), crosstalk. Amplitude of B (backward crosstalk) is generally independent of input signal rise time or cable length. Amplitude of F (forward crosstalk) is directly dependent on input signal rise time and cable length.

Note 3: Tests were performed using standard test procedures. For more information, see 3M TECHNICAL PAPER 80-6104-3562-2

80-335-3373
-800-3374-7372

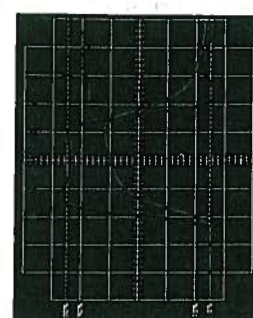
Ground-Signal-Ground (GSG) Mode Oscilloscope Input versus Output Waveforms 50 Foot Cable Test Length



.050" Plated Foil Cable



.050" Ground Plane Cable



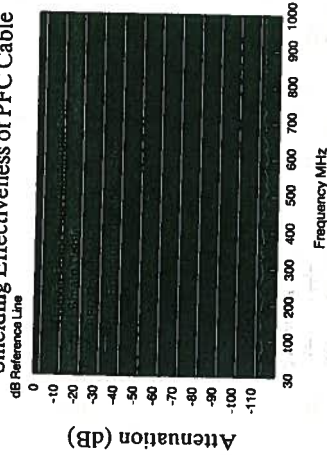
.050" Flat Ribbon, Copper Mesh Shielded Cable



Round Jacketed, Shielded Double Twisted Pair Cable with Aluminum Shield

As shown by the oscilloscope wave forms above, .050" pitch PFC cable has the lowest signal attenuation and rise time degradation of any of the flat or twisted cables. Because of the dramatically lower signal attenuation and rise time degradation, PFC cables are the preferred choice for longer length cable assemblies without impairing the signal fidelity. A 15 foot length of ground plane cable (2469 Series) has approximately the same attenuation and rise time degradation as a 31 foot length of PFC cable.

Shielding Effectiveness of PFC Cable



The chart above shows the shielding effectiveness of .050" PFC cable from 30 MHz to 1 GHz. A Hewlett Packard Model 8733A network analyzer and close field probe were used to measure the field intensity before and after application of the plated copper foil shield. The 0 dB reference line represents the unshielded cable. The radiated emissions were measured to a straight line by the network analyzer computer. The noise floor represents the maximum sensitivity or measuring capability of the instruments. The shielding effectiveness of the PFC cable exceeds 95 dB. This compares to the 45 to 60 dB shielding effectiveness typical of most aluminum foil, copper mesh, or braided shields.

Teflon is a registered trademark of E.I. DuPont de Nemours.

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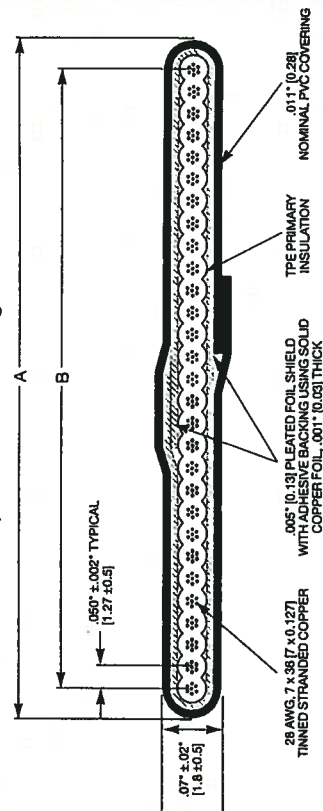
10-6194-2665-2 2005.09.2 01990 3M

USA

3M Electronic Products Division
PO Box 2963
Austin, Texas 78769-2963



90204 Series
.050" Plead Foil Shielded Cable
28 AWG Stranded, TPE Primary, 11 Mil PVC Covering



Specifications:

PHYSICAL:	Electrical:
Covering Material: Polyvinyl Chloride (PVC)	Insulation Resistance: (Inner Cable) > 1 X 10 ¹⁰ Ω/10ft [3m]
Color: Gray	* Characteristic Impedance: 53 Ω unbalanced, 110 Ω balanced
Inner Cable: Thermoplastic Elastomer Insulation (TPE), 28 AWG, 7 x 35 [7 x 0.127] Tinned Stranded Copper	* Capacitance: 28.1 pF/ft [92.2 pF/m] unbalanced 13.4 pF/ft [44.0 pF/m] balanced
ENVIRONMENTAL:	* Inductance: .08 μH/ft [0.26 μH/m] unbalanced .16 μH/ft [0.52 μH/m] balanced
Temperature Rating: -4°F to +221°F [-20°C to +105°C]	* Propagation Delay: 1.49 ns/ft [4.89 ns/m] unbalanced 1.48 ns/ft [4.86 ns/m] balanced
Flammability Rating: UL: VW-1	

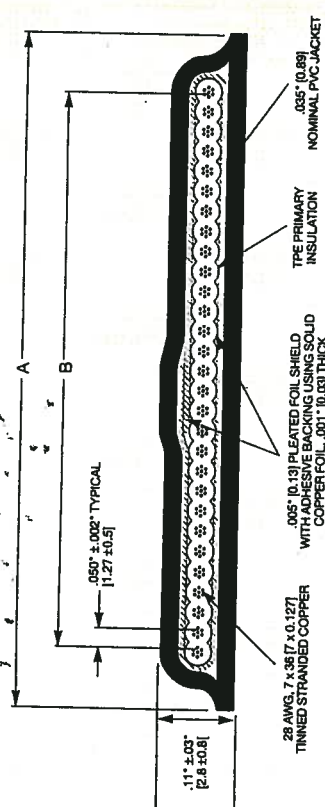
*Note: Unbalanced is measured between ground-signal-ground conductors with shield grounded. Balanced is measured between signal conductors within a pair, with the shield floating.

Ordering Information:

No. of Conductors	3M Part Number	Dimension A	Dimension B
15	90204/151	.742 ± .03 [18.8 ± 0.8]	.700 ± .007 [17.78 ± 0.18]
20	90204/201	.992 ± .04 [25.1 ± 1.0]	.950 ± .011 [24.13 ± 0.28]
25	90204/251	1.242 ± .04 [31.5 ± 1.0]	1.200 ± .011 [30.48 ± 0.28]
26	90204/261	1.292 ± .04 [32.8 ± 1.0]	1.250 ± .011 [31.75 ± 0.28]
34	90204/341	1.692 ± .04 [42.9 ± 1.0]	1.650 ± .015 [41.91 ± 0.38]
37	90204/371	1.842 ± .04 [46.7 ± 1.0]	1.800 ± .015 [45.72 ± 0.38]
40	90204/401	1.992 ± .04 [50.5 ± 1.0]	1.950 ± .015 [49.53 ± 0.38]
50	90204/501	2.492 ± .04 [62.8 ± 1.0]	2.450 ± .015 [62.23 ± 0.38]
60	90204/601	2.992 ± .04 [75.9 ± 1.0]	2.950 ± .015 [74.93 ± 0.38]
64	90204/641	3.192 ± .04 [81.0 ± 1.0]	3.150 ± .015 [80.01 ± 0.38]

Note: Available in standard lengths of 100 feet per roll.
 Note: 1. Manufactured in limited quantities; call for availability.

90104 Series
.050" Plead Foil Shielded Cable
28 AWG Stranded, TPE Primary, 35 Mil PVC Jacket



Specifications:

PHYSICAL:	Electrical:
Jacketing Material: Polyvinyl Chloride (PVC)	Insulation Resistance: (Inner Cable) > 1 X 10 ¹⁰ Ω/10ft [3m]
Color: Gray	* Characteristic Impedance: 53 Ω unbalanced, 110 Ω balanced
Inner Cable: Thermoplastic Elastomer Insulation (TPE), 28 AWG, 7 x 35 [7 x 0.127] Tinned Stranded Copper	* Capacitance: 28.1 pF/ft [92.2 pF/m] unbalanced 13.4 pF/ft [44.0 pF/m] balanced
ENVIRONMENTAL:	* Inductance: .08 μH/ft [0.26 μH/m] unbalanced .16 μH/ft [0.52 μH/m] balanced
Temperature Rating: CL2; 167°F [75°C] MAX	* Propagation Delay: 1.49 ns/ft [4.89 ns/m] unbalanced 1.48 ns/ft [4.86 ns/m] balanced
Flammability Rating: N.E.C. 725, CL2	

*Note: Unbalanced is measured between ground-signal-ground conductors with shield grounded. Balanced is measured between signal conductors within a pair, with the shield floating.

Ordering Information:

No. of Conductors	3M Part Number	Dimension A	Dimension B
15	90104/15	1.072 ± .03 [27.2 ± 0.8]	.700 ± .007 [17.78 ± 0.18]
20	90104/20	1.272 ± .03 [32.3 ± 0.8]	.950 ± .011 [24.13 ± 0.28]
25	90104/25	1.622 ± .03 [41.1 ± 0.8]	1.200 ± .011 [30.48 ± 0.28]
26	90104/26	1.672 ± .03 [42.4 ± 0.8]	1.250 ± .011 [31.75 ± 0.28]
34	90104/34	1.972 ± .03 [49.9 ± 0.8]	1.650 ± .015 [41.91 ± 0.38]
37	90104/37	2.082 ± .03 [52.8 ± 0.8]	1.800 ± .015 [45.72 ± 0.38]
40	90104/40	2.232 ± .03 [56.6 ± 0.8]	1.950 ± .015 [49.53 ± 0.38]
50	90104/50	2.732 ± .03 [69.3 ± 0.8]	2.450 ± .015 [62.23 ± 0.38]
60	90104/60	3.232 ± .03 [82.1 ± 0.8]	2.950 ± .015 [74.93 ± 0.38]
64	90104/64	3.532 ± .03 [90.2 ± 0.8]	3.150 ± .015 [80.01 ± 0.38]

Note: 1. Available in standard lengths of 100 feet per roll.

Nominal characteristics of Belden RG-174/41
from the Belden catalog are 50Ω , $.66c$, $30.8pF/ft$,
 $8.4dB/100ft @ 100MHz$

$$10^{\frac{8.4}{20}} = 2.63 \text{ or } .38/100'$$

$$\alpha^n A_i = A_f \quad \alpha = \text{fractional reduction per unit length}$$

$n = \text{number of unit lengths}$

$A_i = \text{initial amplitude}$

$A_f = \text{final amplitude}$

$$\frac{1200''}{4434''} = 26.82 \quad 26.82 \sqrt{.38} = .965 \text{ for short piece of RG174 used}$$

Let x be reduction through 10' of PFC. From p. 46 top photo
input is 5.3 divisions and final is 4.4 divisions.

$$\frac{4.4}{5.3} = .83$$

$$x^2 \cdot (.965^2) = .83$$

$x = .94$ per 10' of PFC
Degraded due to 2 passes through cable.

$$\text{for 10' of RG174} \quad \frac{10}{\sqrt{.38}} = .91$$

Speed of light is 11.8 inches/ns = 29.979 cm/ns

$$11.8 \cdot .66 = 7.79 \text{ inches/ns for RG174}$$

From p. 74, using $\kappa_0 = 196.9'$ $\frac{V}{V_0} = e^{-\left(\frac{44.75}{12 \kappa_0}\right)}$
 $\frac{V}{V_0} = .98$

$$\text{from above } x = \sqrt{\frac{.83}{.98^2}}$$

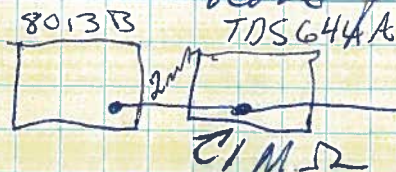
$$= .928 \text{ per 10' of PFC}$$

$$\text{for PFC } \kappa_0 = 134.7'$$

$$6.45 dB/100'$$

11/4
js

Attenuation of RG174



open end

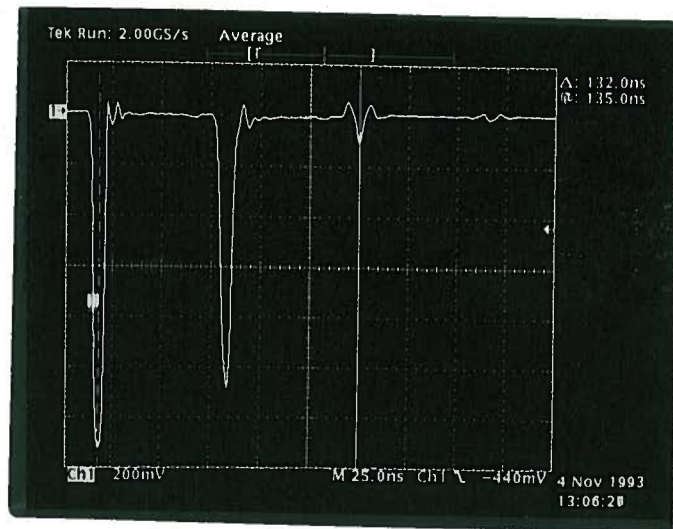
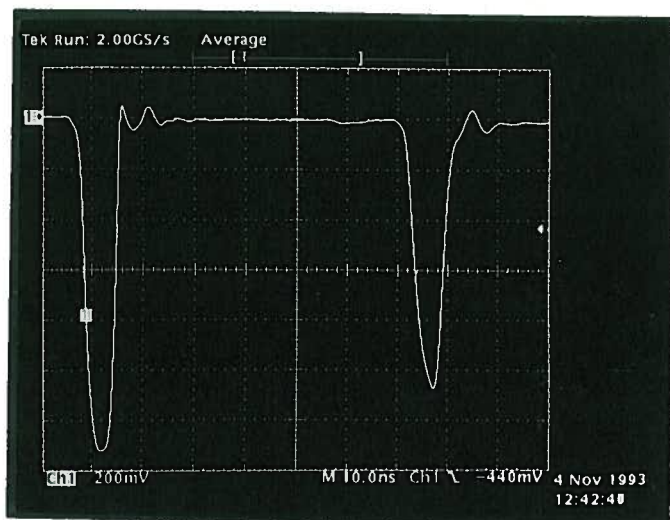
$$\text{assume } V = V_0 e^{-\frac{x}{x_0}}$$

$$N_0 = \ln\left(\frac{V_0}{V}\right)$$

32 ms of cable

20.19"

249" x 2 = 498" round trip

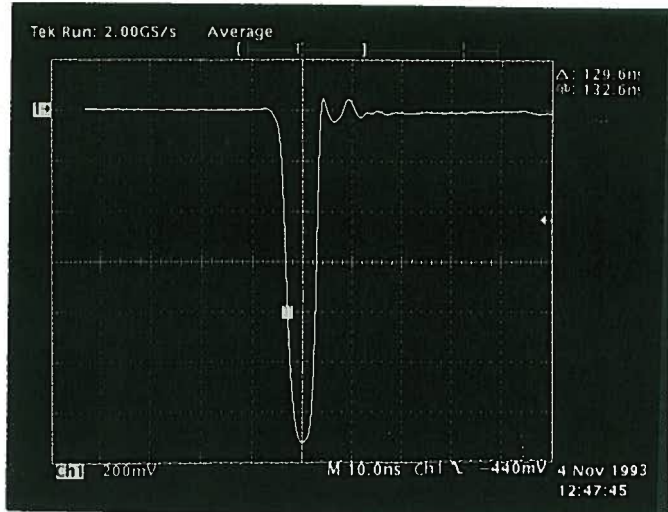
65 ms $\Rightarrow$ ~~64 ft/ms~~
638 ft/ms

$$\frac{5.35 \text{ dB}}{6.6 \text{ dB}} = .81$$

$$N_0 = 196.9'$$

$$4.41 \text{ dB/100'}$$

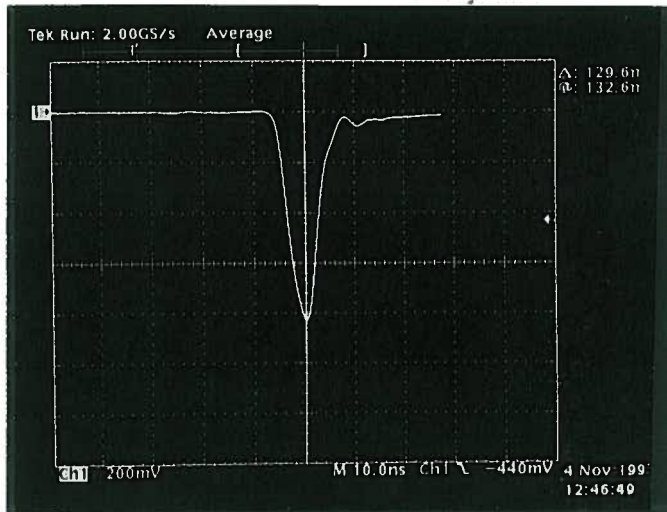
$$\text{dB/100'} = 20 \log(e^{\frac{x}{x_0}})$$



Nominally 64ns
20'9" + 20'10"

499" x 2 = 998" round trip
129.6ns $\Rightarrow$.642 $\frac{\text{ns}}{\text{ft}}$

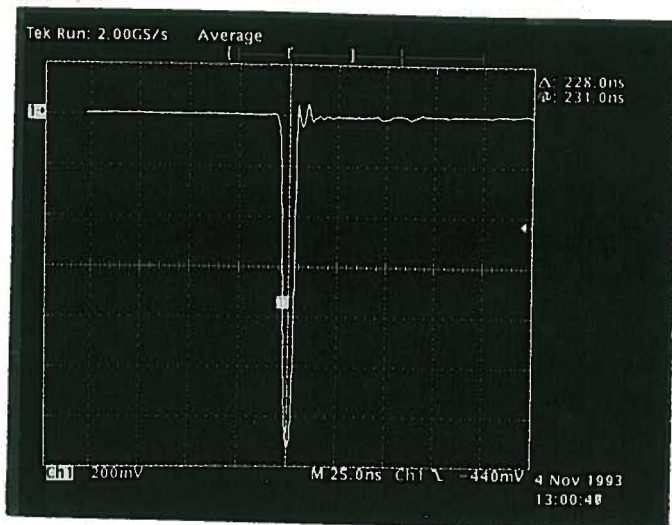
← initial pulse
↙ reflected pulse



$$\frac{4.15 \text{ div}}{6.6 \text{ div}} = .63$$

$$x_0 = 180.0'$$

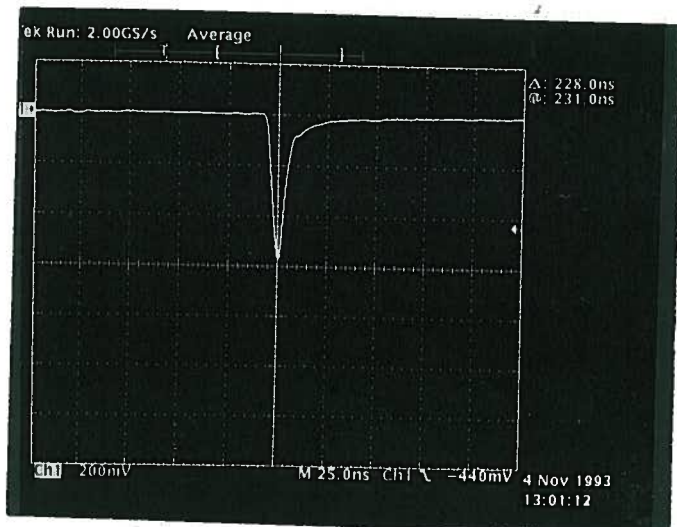
$$4.83 \text{ dB}/100'$$



$$20'9'' + 20'10'' + 32'3\frac{1}{2}''$$

$$886.5'' \times 2 = 1773'' \text{ round trip}$$

← incident pulse
 ↙ reflected pulse

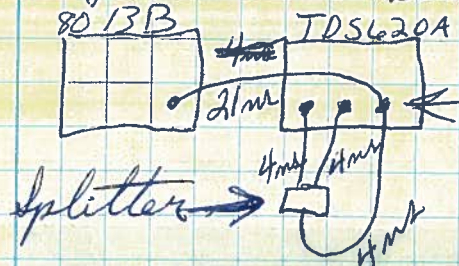


$$\frac{2.8 \text{ div}}{6.6 \text{ div}} = .42$$

$$x_0 = 170.3'$$

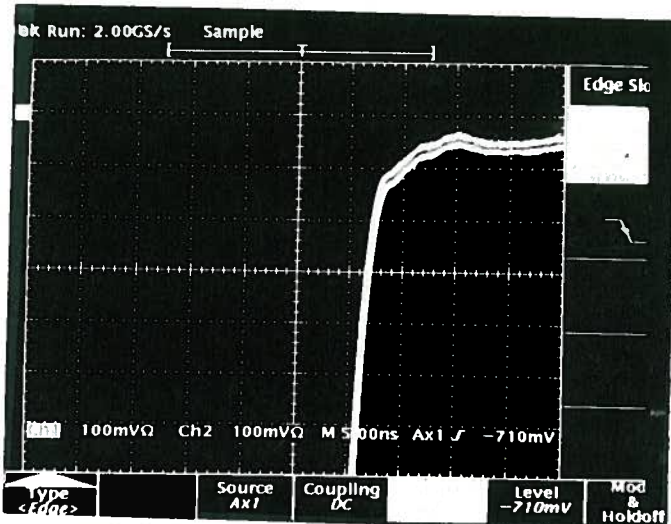
$$5.10 \text{ dB}/100'$$

TDS620A "overdrive?" Problem
 The same setup as on p. 52 is used.
 Except as noted

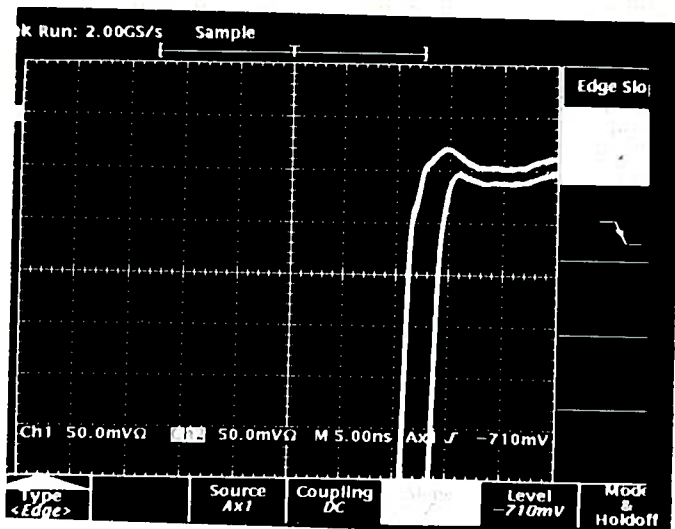


AUX1 on 1M Ω
 Ch1 & Ch2 on 50 Ω

Input is



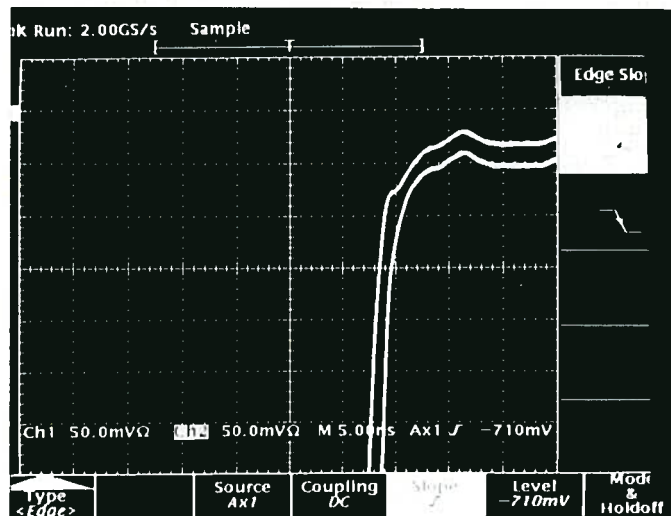
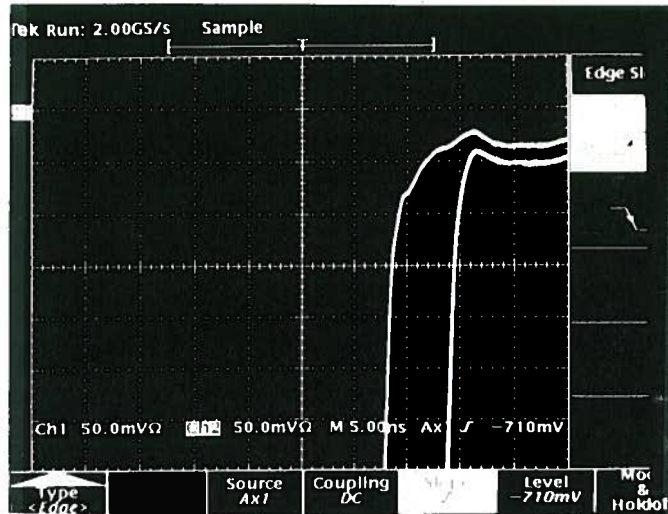
Lower input step.
 (absolute amplitude)



Higher (more negative)
 input step.

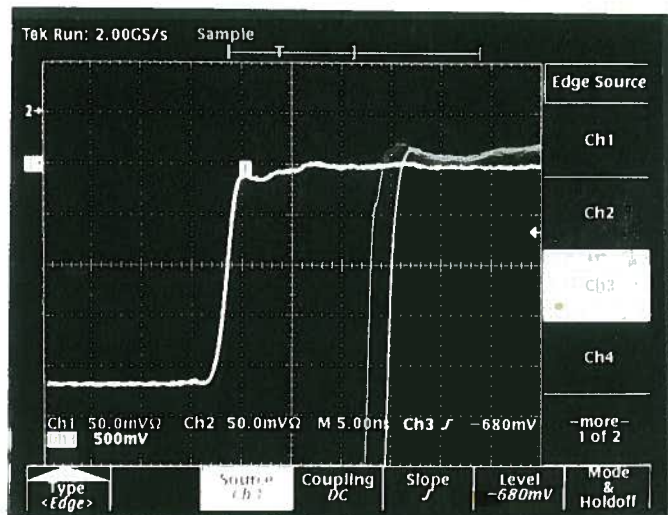
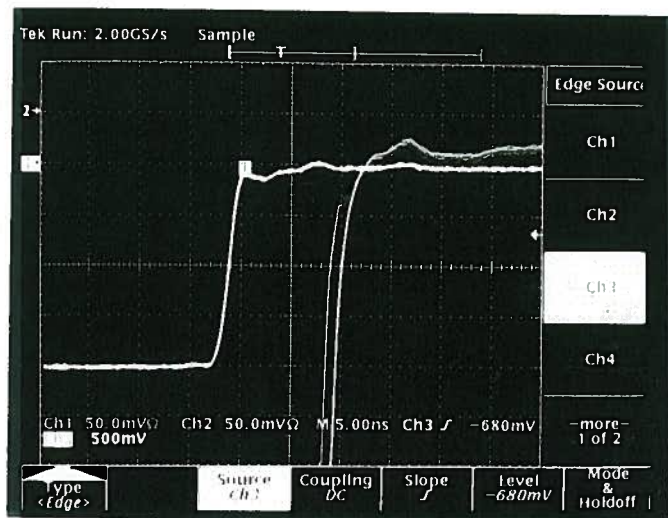
The transition occurs at $\sim -2V$ input step which corresponds to $\sim -9V$ into Ch1 and Ch2.

As the steps amplitude is lowered (less negative voltage, closer to GND) the channels do not change states at the same input value.



Although, the difference in the responses could be due to an asymmetry in the pulse splitter.

Looking back at p. 53 I see a note about 1.5V input step. Putting the TDS644A in in place of the TDS620A I see the identical behavior as for the TDS620A.



11/7
JA

Using the same setup as on p. 74 ^{to do input}
 with 20'9" cable 1 sec; ~~912 mV~~ ^{120 mV} ~~1080 mV~~ ^{320 mV}
 $249 \times 2 \div 12 = 41.5'$ $-1080 \text{ mV} @ 65 \text{ ms}$

$$\frac{1080}{1320} = .818$$

$$K_0 = 206.8'$$

with 20'9" + 20'10" cable 1 sec; $-840 \text{ mV} @ 129.6 \text{ ms}$
 $499 \times 2 \div 12 = 83.17'$ ^{499"}

$$\frac{840}{1320} = .636$$

$$K_0 = 184.0'$$

with 20'9" + 20'10" + 32'3 1/2" cable 1 sec; $-572 \text{ mV} @ 228 \text{ ms}$
 $886.5 \times 2 = 1773" = 147.75'$

$$\frac{572}{1320} = .433$$

$$K_0 = 176.7'$$

with 20'9" + 20'10" + 32'3 1/2" + 32'2" cable 1 sec; $-392 \text{ mV} @ 327 \text{ ms}$
 $2545" \div 12 = 212.08'$ ~~221.08"~~

$$\frac{392}{1320} = .297$$

$$K_0 = 174.7'$$

with 20'9" + 9'8 1/4" cable 1 sec; $-964 \text{ mV} @ 95 \text{ ms}$
 $365.25 \times 2 \div 12 = 60.88'$

$$\frac{964}{1320} = .730$$

$$K_0 = 193.7$$

with 20'9" + 20'10" + 9'8 1/4" cable 1 sec; $-740 \text{ mV} @ 159 \text{ ms}$
 $615.25 \times 2 \div 12 = 102.54'$

$$\frac{740}{1320} = .561$$

$$K_0 = 177.2'$$

expanding scale 1 sec; $-744 \text{ mV} @ 159.4 \text{ ms}$
 $+60 \text{ ms}$

$$\frac{744}{1320} = .564$$

$$K_0 = 178.8'$$

using exponential fit $y = a e^{-bx}$ on Kaledigraph
 on the Macintosh gives $a = 1.048$
 $b = .00599$ $n = .9999$
 $\Rightarrow x_0 = 166.9'$

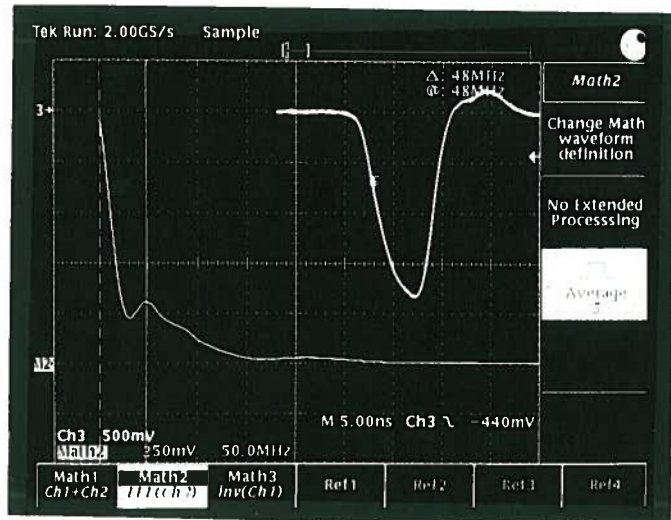
using my calculator & $\frac{1}{y} = \frac{1}{a} e^{bx}$ I get
 $a = \frac{1}{.9603} = 1.041$
 $b = .00592 \Rightarrow x_0 = 168.9'$
 $n = .9998$

From Macintosh results $\Rightarrow 4.80 \text{ dB}/100'$
 $4.79 \text{ dB}/100'$ from calculator results

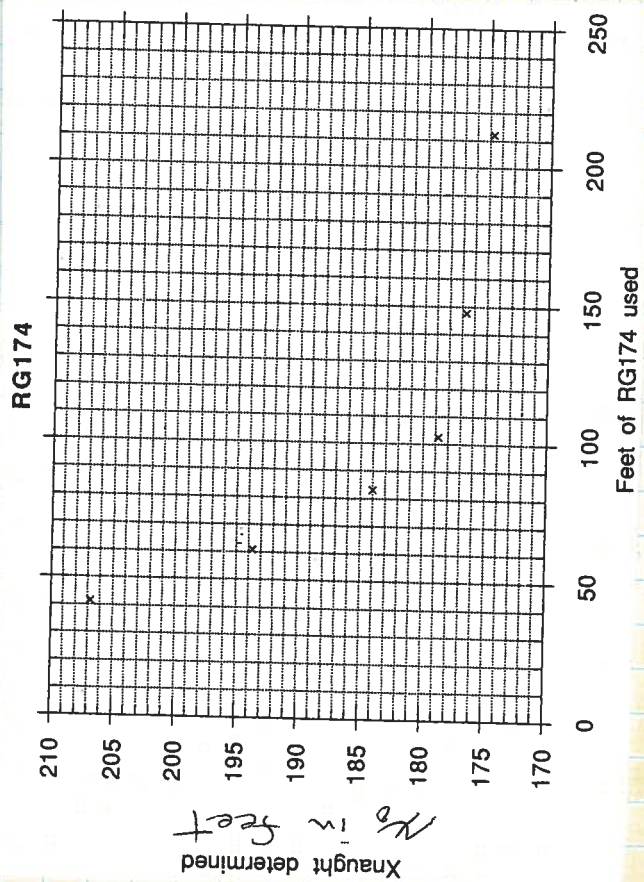
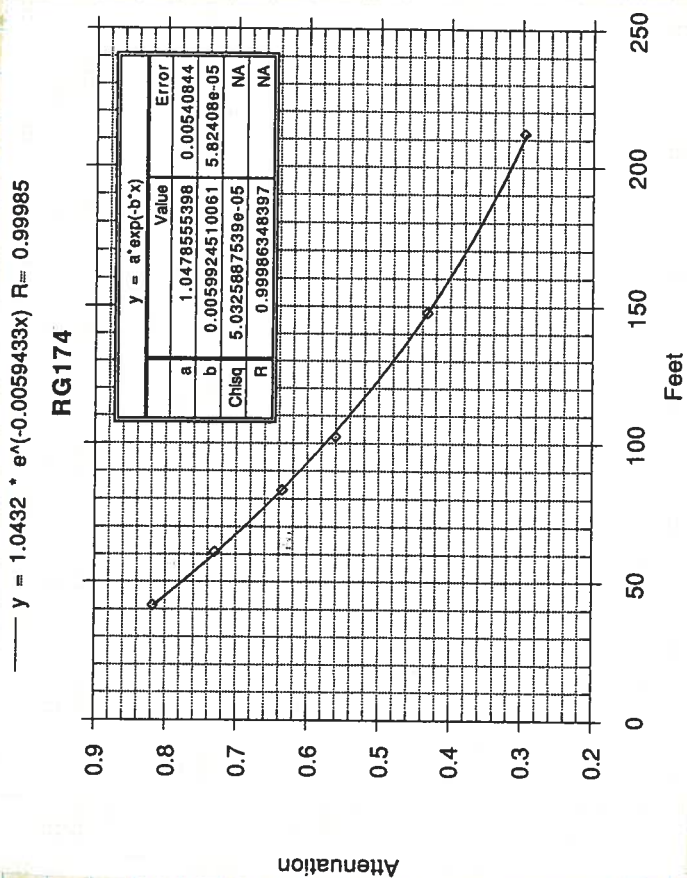
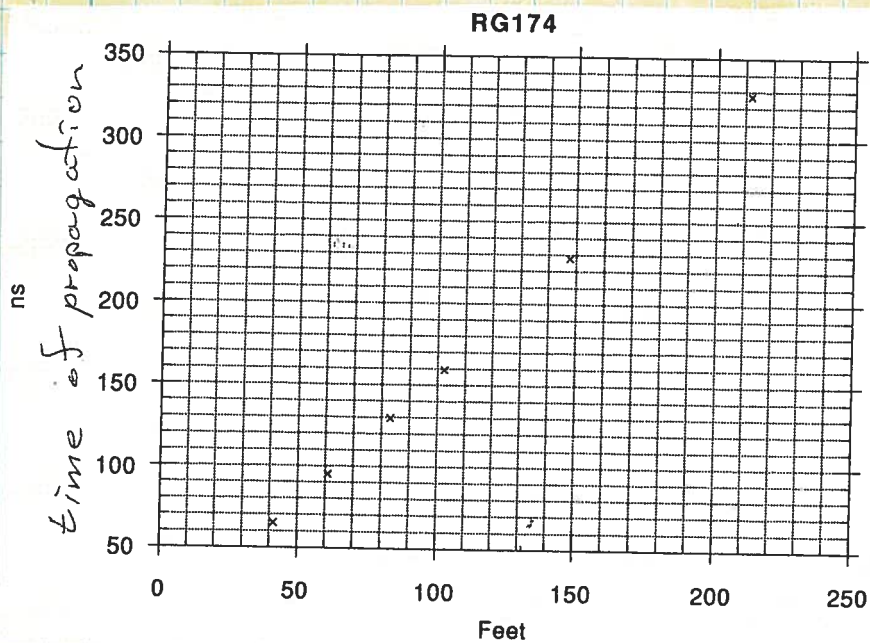
For the 44.75" piece of RG174 on p. 73 (for attenuation calculation)

Using Kaledigraph values for 10' of PFC I get $x_0 = 145.7'$
 $5.96 \text{ dB}/100'$
 $6.52 \text{ dB}/100'$

Using the calculator values $x_0 = 133.2'$
 $6.52 \text{ dB}/100'$



The scope gives this
 FFT when using a
 rectangular window
 and 500 points in 10div.



Same setup as p. 63 except only 44 3/4" cable from scope to pleated foil cable.

All odd lines at gnd (connected to foil).

Lines ~~6 & 10~~ 6 & 10 terminated at both ends in 51 Ω 1/8 W carbon comp

Line 8 is pulsed line with far end open or 51 Ω

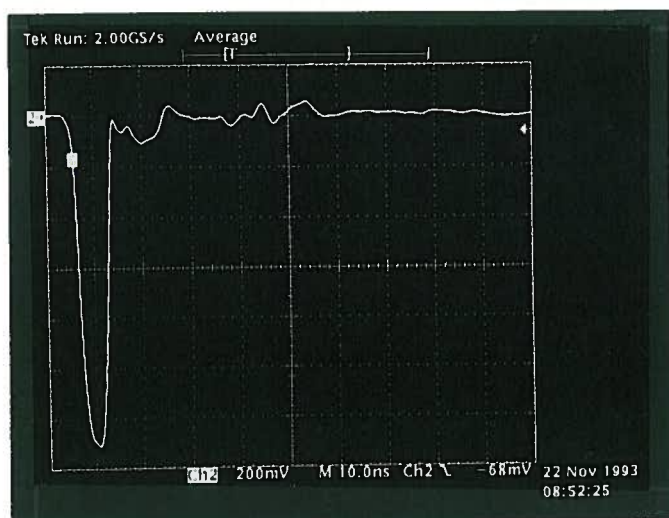
Ch 2 is "tee" on the TDS644A scope

R1 is far end of line 10

R3 is far end of line 6

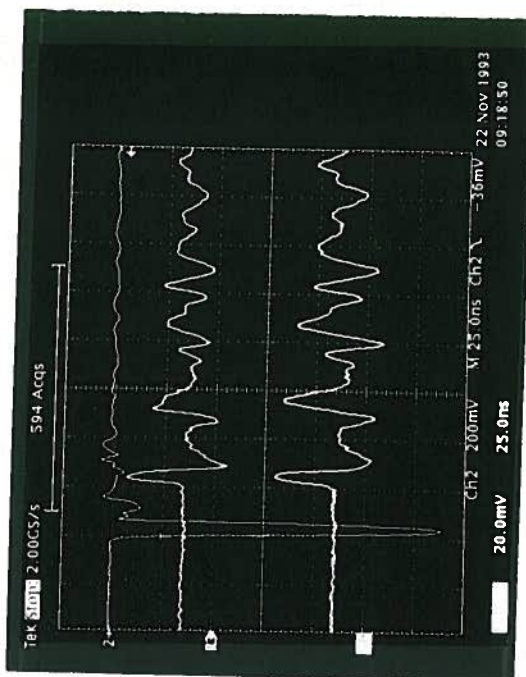
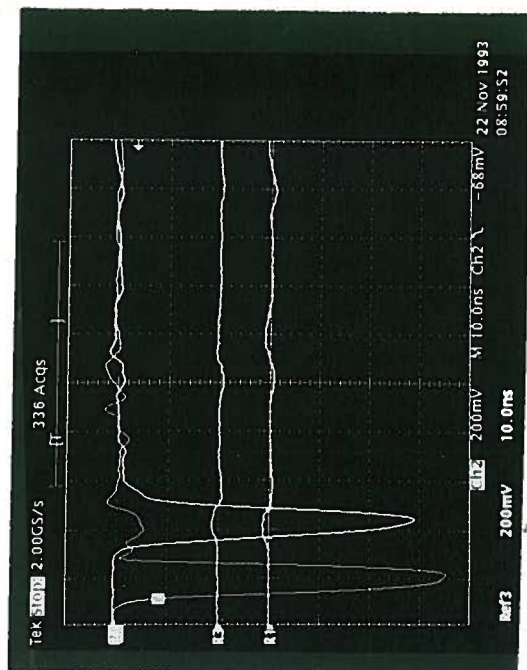
R2 is far end of line 8

} Scope set to average 15 waveforms

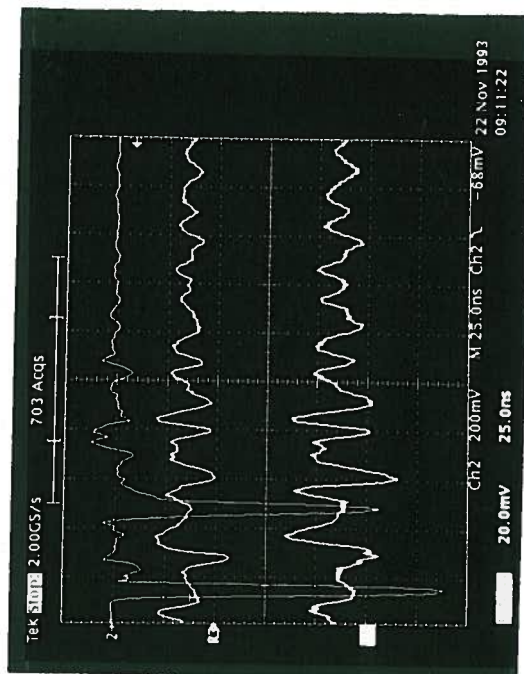
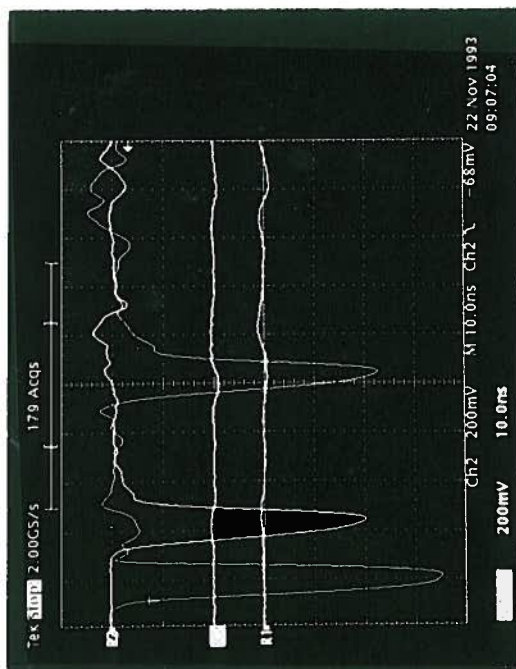


Line 8 term with 51 Ω

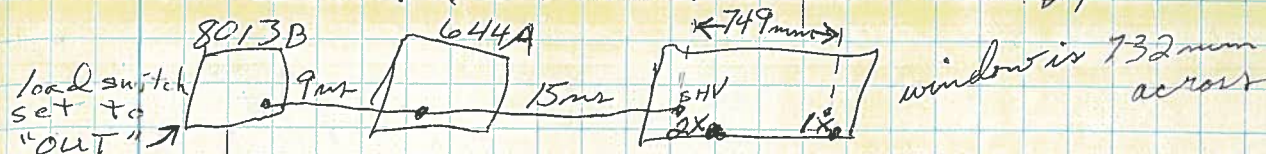
Line 8 term in 512.



Line 8 ~~term~~ open at far end.



Looking at the "LAMPF" Chambers 12/9
 if all sense wires bussed on a delay line for
 connected to the SHV connector;



The end of the RG174 15ms cable has been
 pulled off. The connection to the SHV is done by
 holding the cable to it.

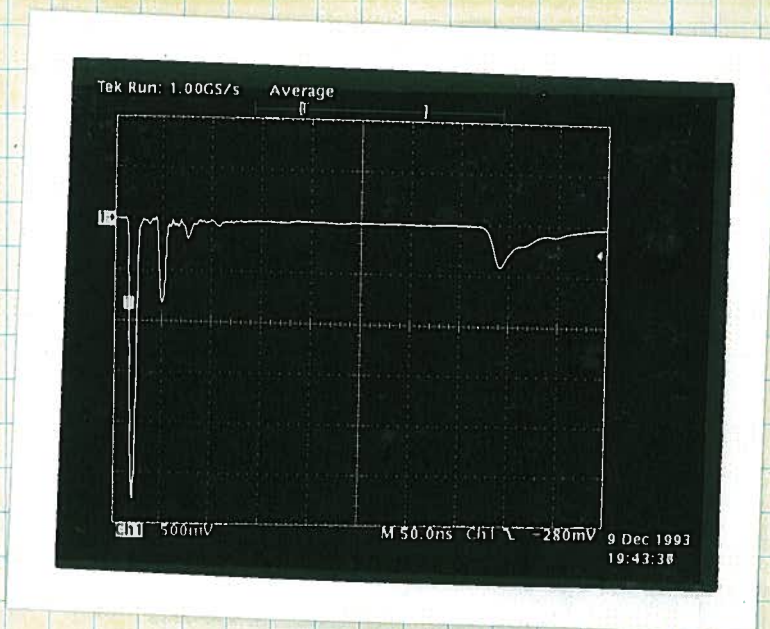
The pulser output is 40ms across the base
 and -2.75 V peak.

With 15ms of RG174 & ∞ impedance at the end
 of the cable I see -2.00V on the scope for the
 reflection and 30ms time.

Connecting the 15ms cable to the SHV I see there
 is still some reflection from the SHV. Negative pulse,
 same as input $\Rightarrow$ impedance is $> 51\Omega$. -810V is
 the amplitude coming back to the scope. What is
 apparently the reflection from the far end of the
 line, comes 341ms after the reflection from the SHV
 and is -400V in amplitude at the scope.

Average of 15

Tail of
 fast reflection
 is smoother
 if load
 switch
 set to
 "INT"
 All else is
 similar.



Looking at 1V I see 129ms for reflection from end of
 "delay line." -940V for SHV reflection and -660V for
 far end of "delay line."

$$\frac{A_r}{A_i} = \frac{Z-50}{Z+50}$$

since the attenuation through the 15 m piece of cable affects both A_i & A_r we can use

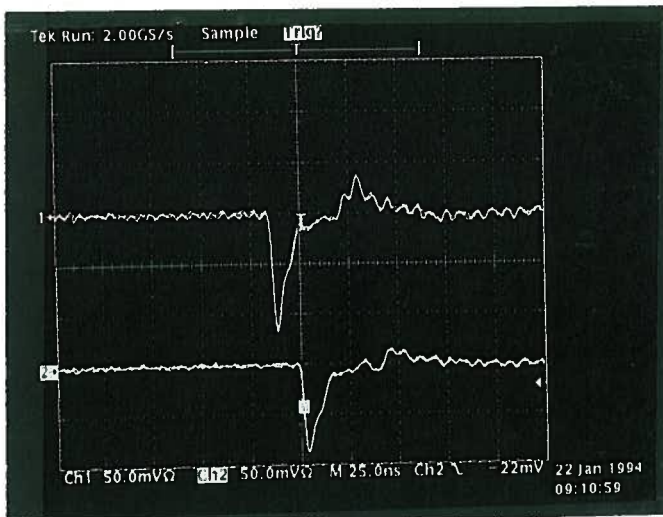
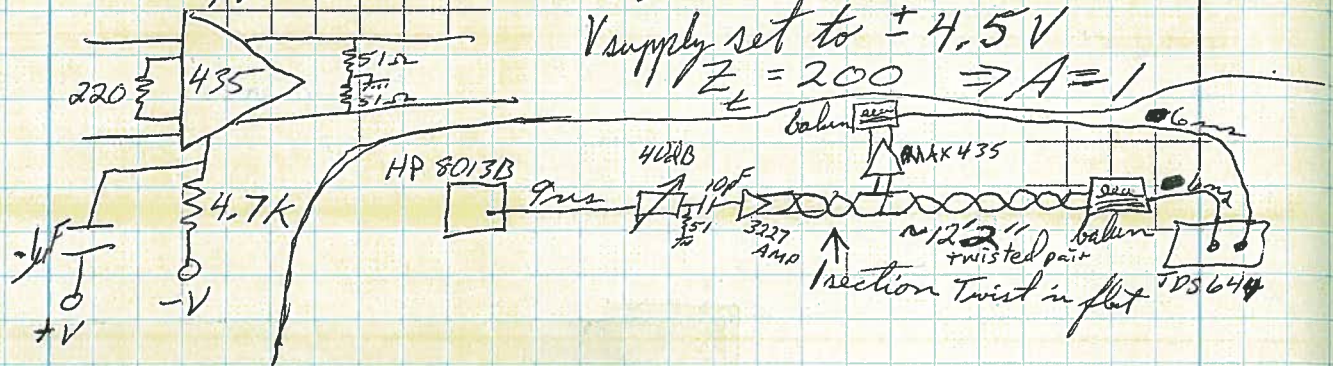
$$\frac{.81V}{2.5V} (Z+50) = Z-50$$

$$66.2 = .676Z$$

$$99.2\Omega = Z$$

1/22 JS MAX435 Differential Pickoff

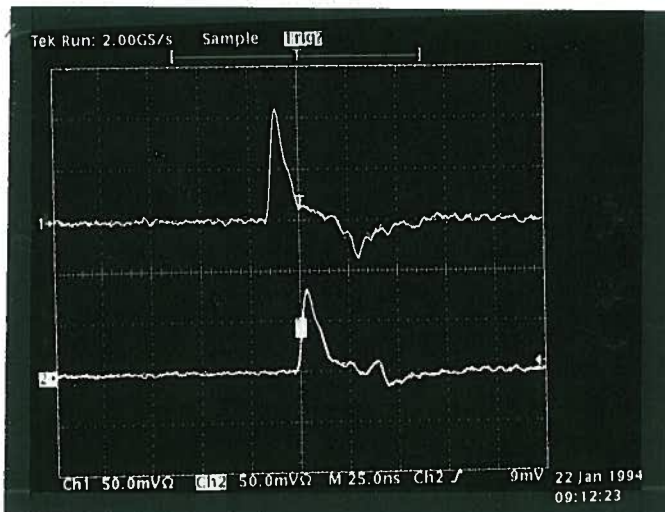
Looking into the possibility of using the MAX435 as a differential pickoff.



Ch 2 3227 Amp output
 Ch 1 MAX435 output

Ch 1 shows reflection off the balun.

Ch 2 shows reflection off pickoff point.

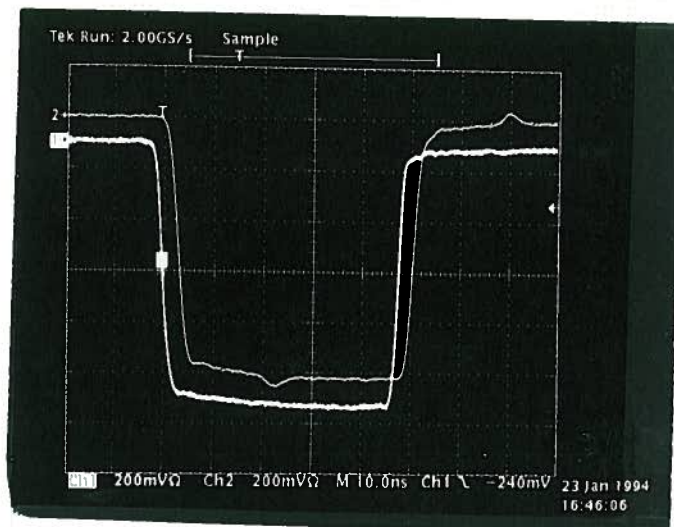
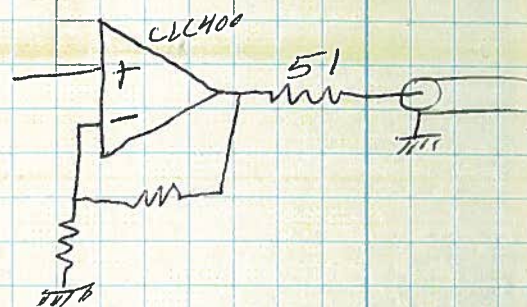
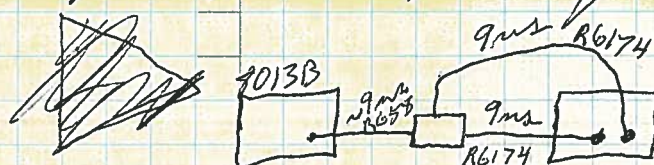


CLC400 R658 Pickoff

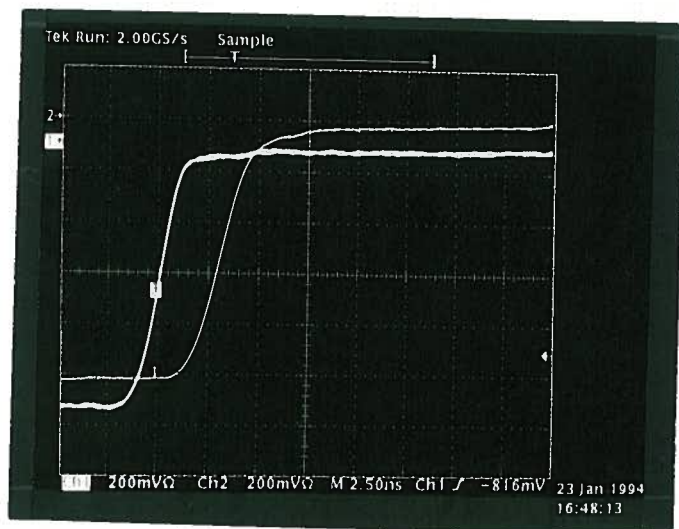
1/23

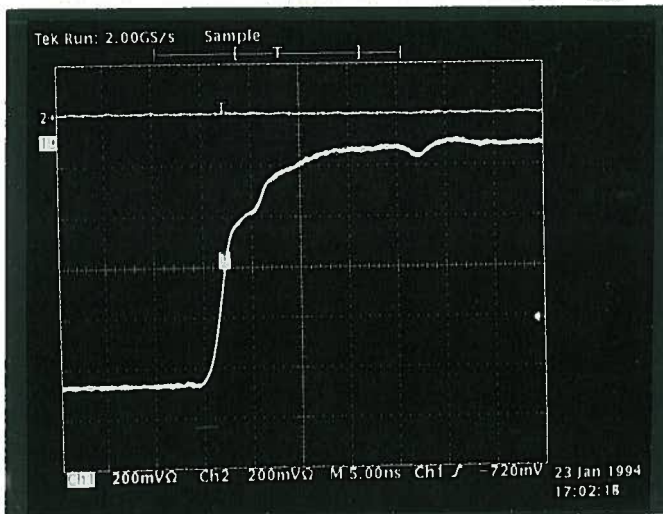
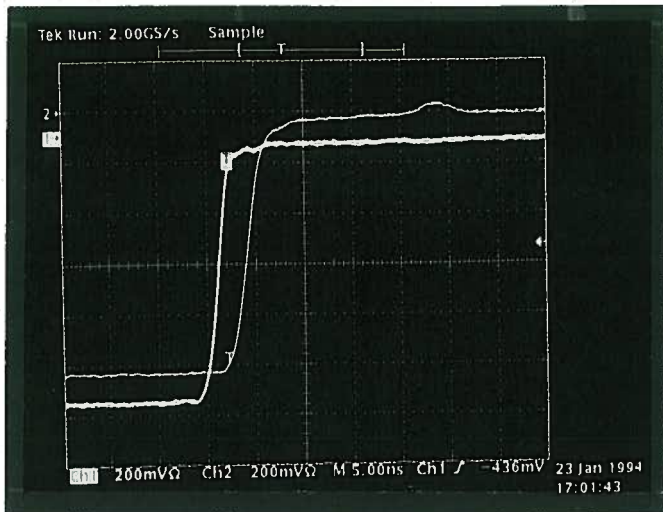
A quick look at using a CLC400 as a pickoff for R658.

The circuit was etched in house. $\frac{1}{8}W$ resistors were used instead of 1206's. $\frac{1}{4}W$ 51 Ω used on output. Chips had to be re-soldered twice. The film was flipped, ~~and~~ soldered the CLC400 on the trace side of the board finally.

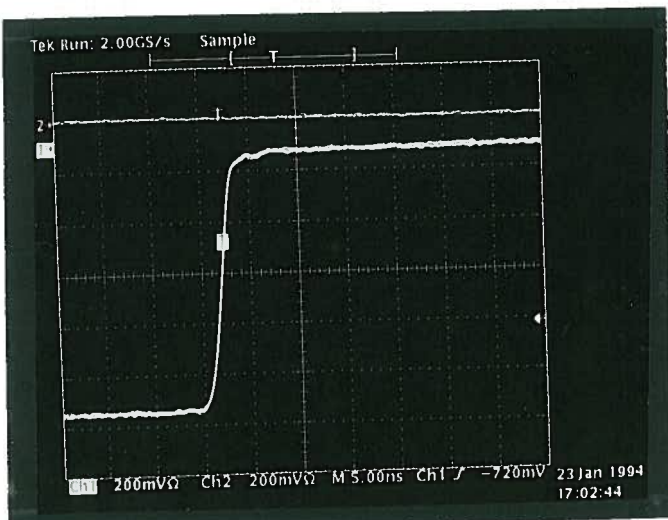


Ch 2 is output of CLC400
Note reflection, apparently off the scope input. Verified by inserting 9ms of R6174 on Ch 1 and 2, alternately, one at a time and of this.



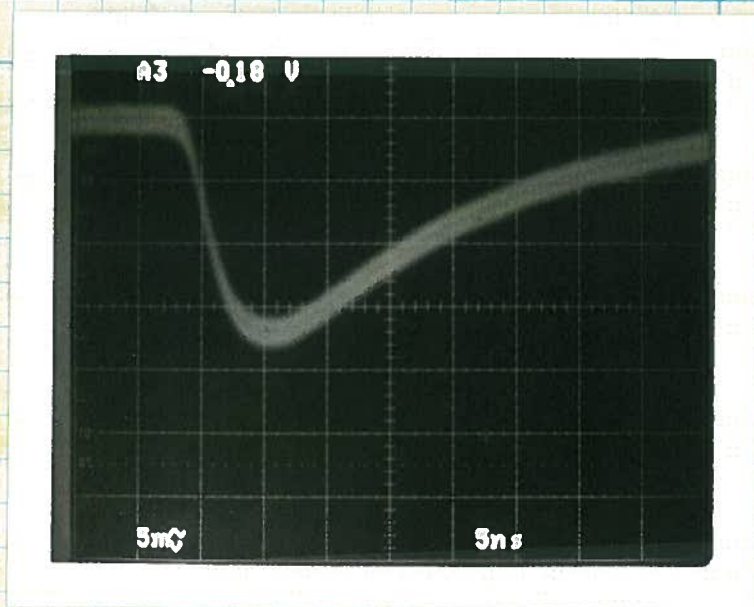


power off on amp

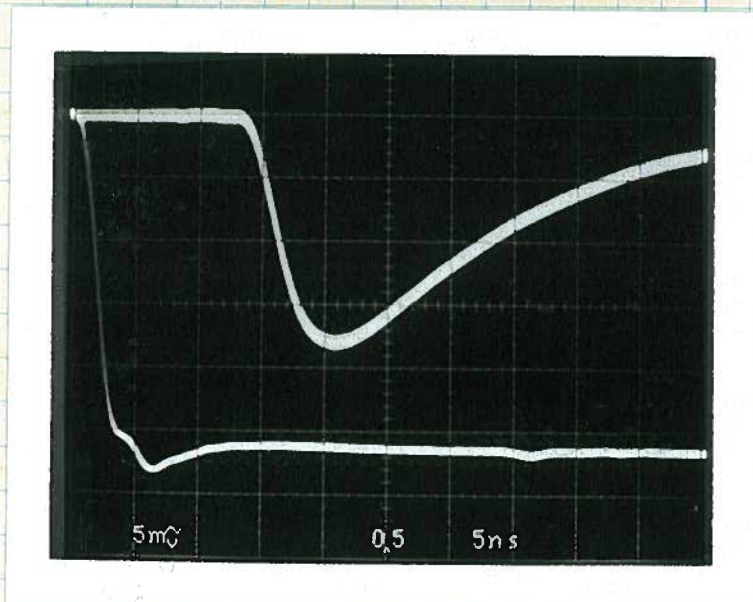


Response of HFA 3127
sample after emitter of
 Q_5 on the ^{first} schematic

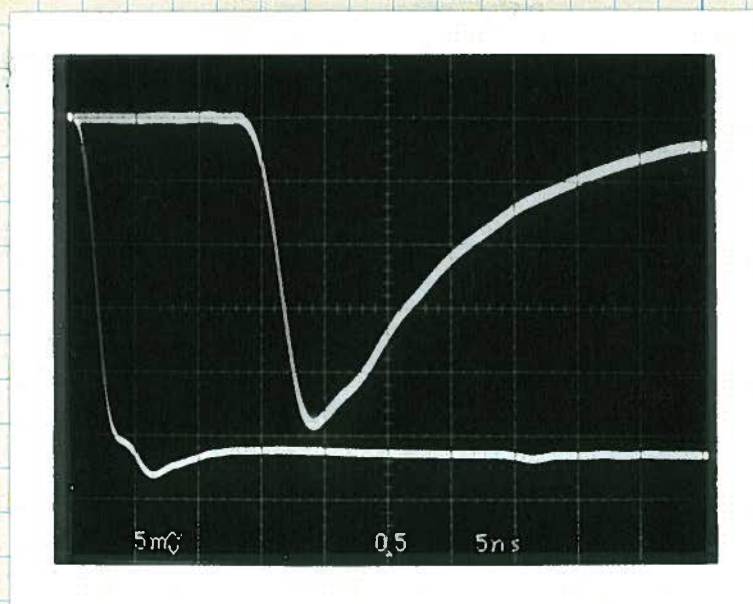
The $100\ \Omega$ resistor is
removed from the base
of Q_5 on the second
(input section) schematic.
The base is tied to gnd
with a short wire.



First sample chips of HFA 3127
removed & second sample
soldered into place.



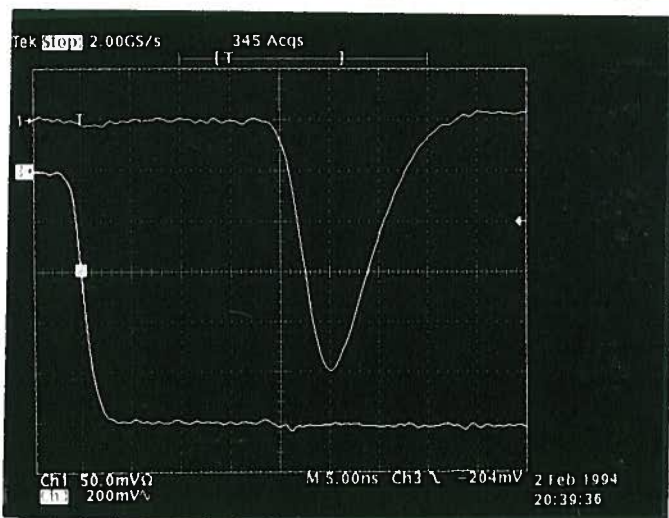
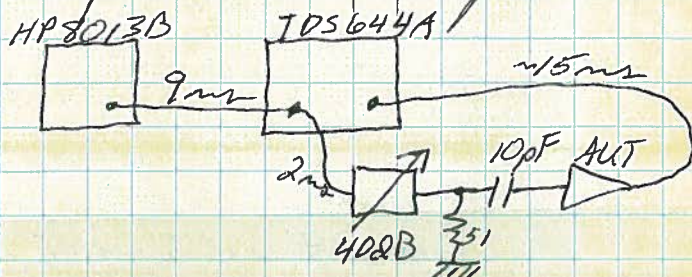
I got some 3227s in a SOIC
package. 3127 chip removed
and a 3227 soldered into
place.



Gain of 3227 SOIC amp.

2/3

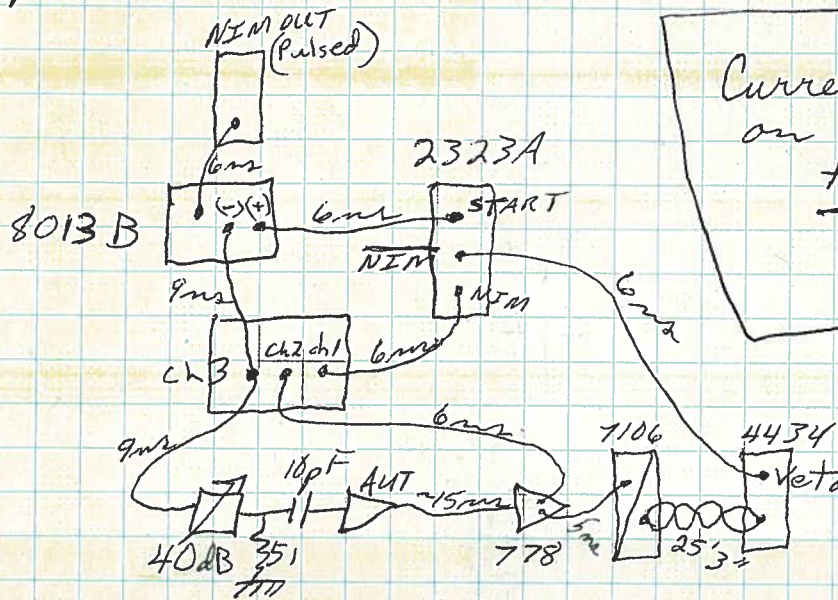
Looking at amp from p.91. The 100Ω resistor is replaced on the base of Q_5 on the second (output section) schematic. 22pF capacitor is put in on the pole cancellation.



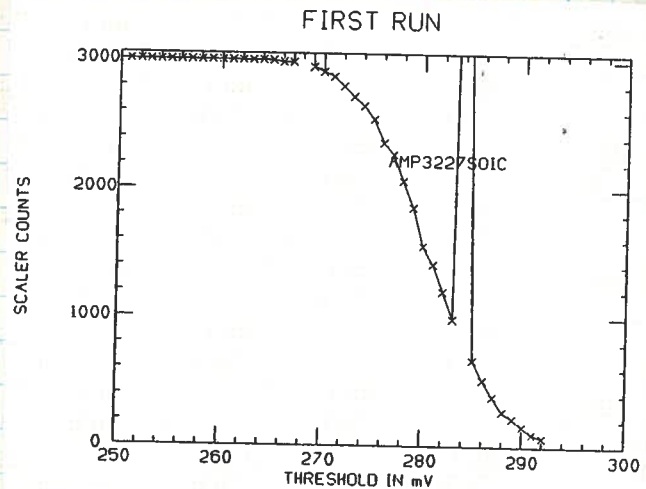
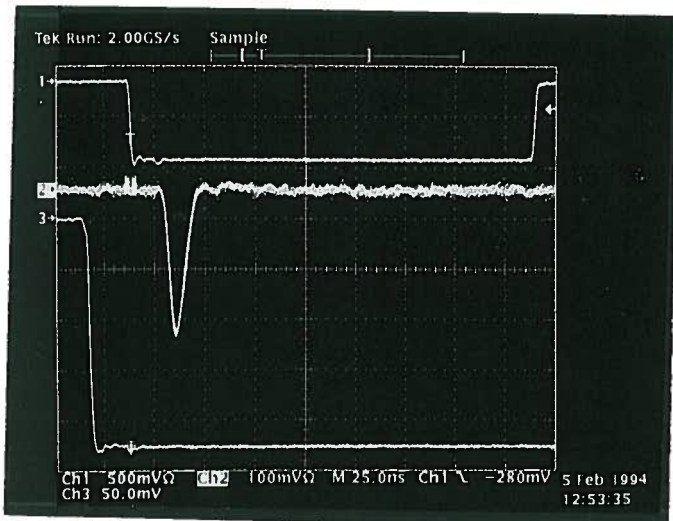
2/15
JS

Noise of 3227 SOIC Amp

Looking at the amp from p.93. It looks like quite a bit of noise. The pramp is covered in a fold of paper and wrapped in aluminium foil. Copper tape from amp ground plane out to aluminium foil.



Current drawn measured
on 2/24 JA
+12.0V supply 16.45mA
-12.0V supply 16.78mA

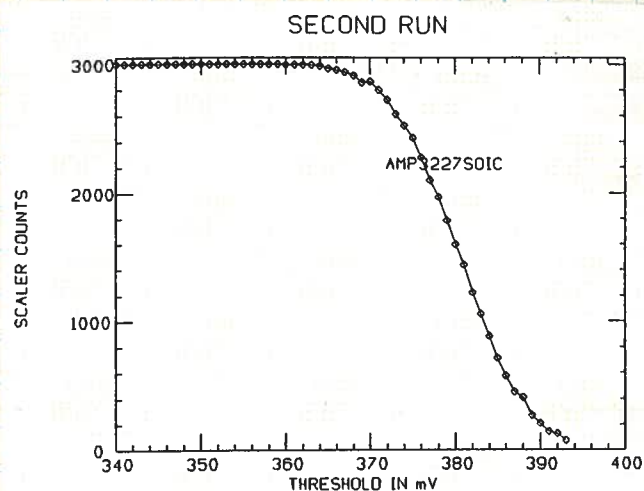
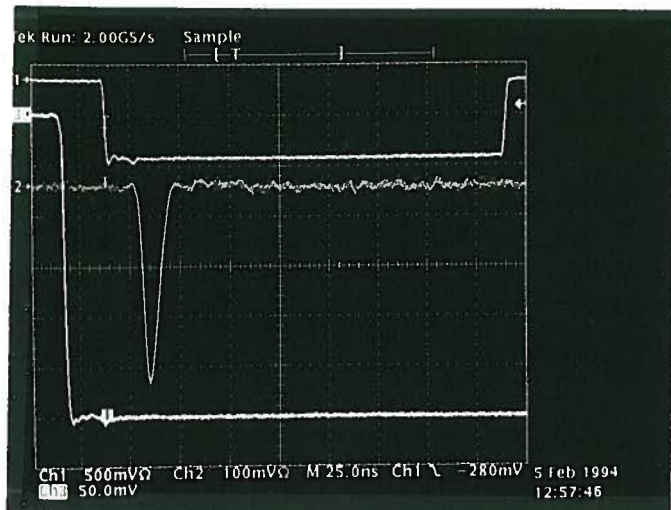


$$.883 \times 3000 = 2649$$

$$.117 \times 3000 = 351$$

$$\begin{aligned} &\uparrow \uparrow \uparrow \\ &.883 \quad 280^+ \quad .117 @ \sim 287 \\ &@ \sim 274 \quad 280^+ \text{ mV} \\ &\Delta \approx 13 \text{ mV} \end{aligned}$$

$$225 \text{ mV} \div 100 \times 10 \text{ pF} = 22.5 \text{ fC}$$



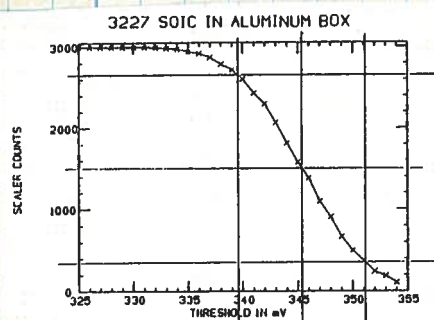
$300 \text{ mV} \div 100 \times 10^6 = 30 \text{ fC}$ midpoint @ 380^+

$7.5 \text{ fC} / 100 \text{ mV} = .075 \text{ fC/mV}$

$\frac{7.5 \text{ fC} \times 16250 \text{ e}^-/\text{fC} \times 13 \text{ mV}}{100 \text{ mV} \times 2.35} = 2593 \text{ e}^-/\text{ENC}$

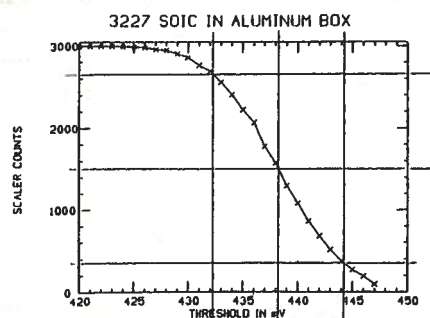
$\Delta = 16 \text{ mV} \Rightarrow \sim 3100 \text{ e}^- \text{ ENC}$

2/7/94



$235 \text{ mV} \div 100 = 23.5 \text{ fC}$

$\Delta = 11.5 \text{ mV}$



$300 \text{ mV} \div 100 = 30 \text{ fC}$

$30 \text{ fC} \rightarrow 75 \text{ mV} \div 5 \text{ fC} \rightarrow 14.3 \text{ fC}$

$\Delta = 12 \text{ mV}$

$\Delta = 12 \text{ mV} \Rightarrow \sim 2200 \text{ e}^- \text{ ENC}$

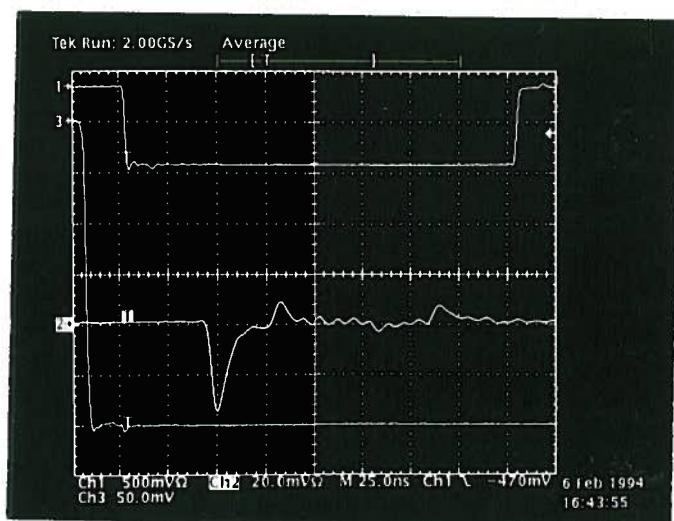
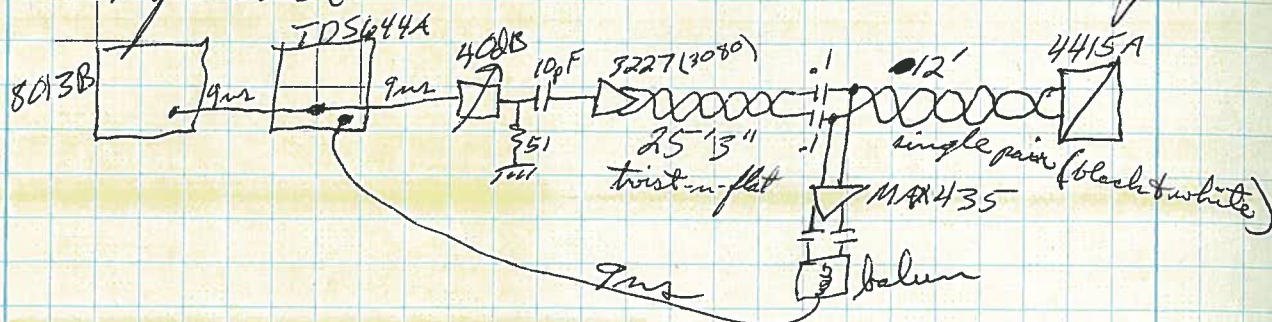
The oscilloscope was removed from the input. Amp from pulser to the attenuator. The amp was put inside an aluminum Bud box.

$\text{ENC} = 2200 \text{ e}^-$

2/6
JA

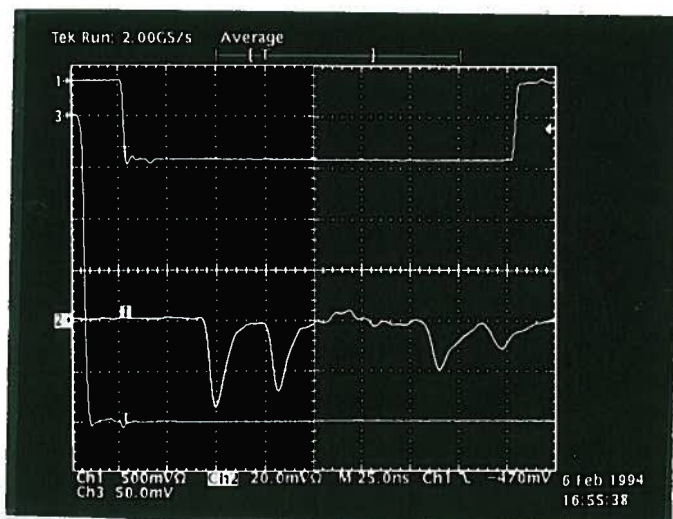
MAX435 Further Investigations

When looking at the MAX435 on p. 98 it appeared to have some overshoot. Looking into this further.

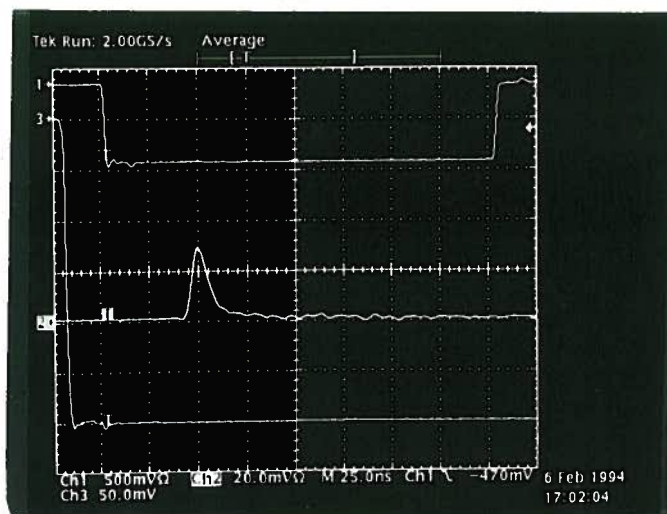


Ch 1 - output of gate generator
ignore this. Still setup from
p. 94

Ch 2 MAX435 output
Ch 3 8013B output pulse
Setup as above.

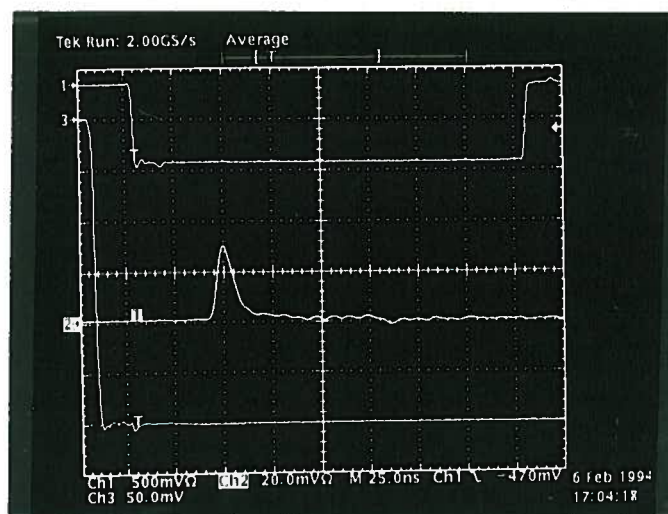


Setup as above except
12' single twisted pair is not
terminated in 4415A. Open
termination ($\infty \Omega$)



One of these pictures was of the balun at the end of the 25' 3" cable

← MAX435 + 12' single pair were removed



The other is of MAX435 pickoff as setup shows except 12' pair + 4415A were replaced by a 730' twist-n-flat cable which was open at the far end.

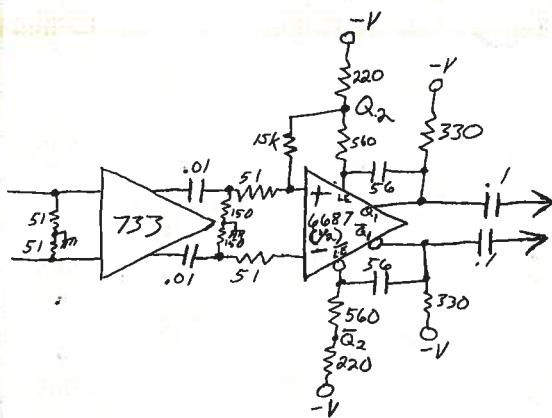
←

The apparent overshoot is evidently due to impedance mismatch between single twisted pair cable and 110 Ω (twist-n-flat).

JH
2/19/94

6687 Differential Discriminator

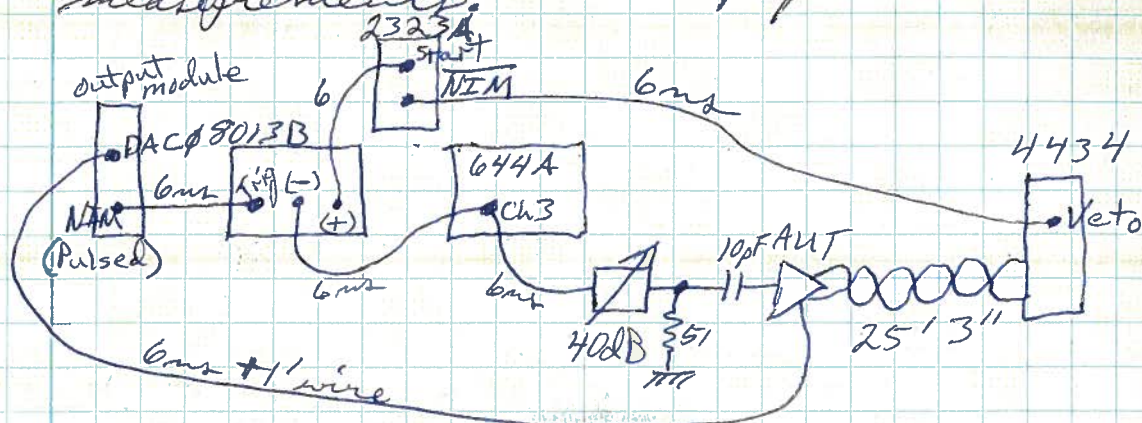
I've been looking at a 6687 + 733 as a possible discriminator. The circuit below is not very stable. Q_1 & $\bar{Q}_1$ are the outputs of 1/2 of 6687. Q_2 & $\bar{Q}_2$ are the outputs from the other half. The second half has its inputs hardwired one diode drop apart. So, $Q_1 = -0.8V$, $\bar{Q}_2 = -1.6V$.



$Q = -0.8V$ if $+ > -$

2735 DC & N-277-L Noise Measurements 2/20

Using the automated setup for noise measurements.



Copper tape ($\frac{1}{4}$ " wide) was soldered from N-277 board to ground of 51 Ω resistor and taped to the 40dB attenuators (2 x 20dB attenuators). A copper tape ($\frac{1}{4}$ " wide) was also taped to the attenuator and soldered to the ground of the amp card. This brought the noise under control. As viewed using the FET probe on far end of decoupling capacitor after the NF 592 (see p. 24 for N-277 schematic. This book.) The same setup used for the 2735 DC except the copper tapes were just taped to the gold grounded tabs on the input tabs.

For all photos;

$$+V_{\text{supply}} = +5.0V \quad -V_{\text{supply}} = -5.2V$$

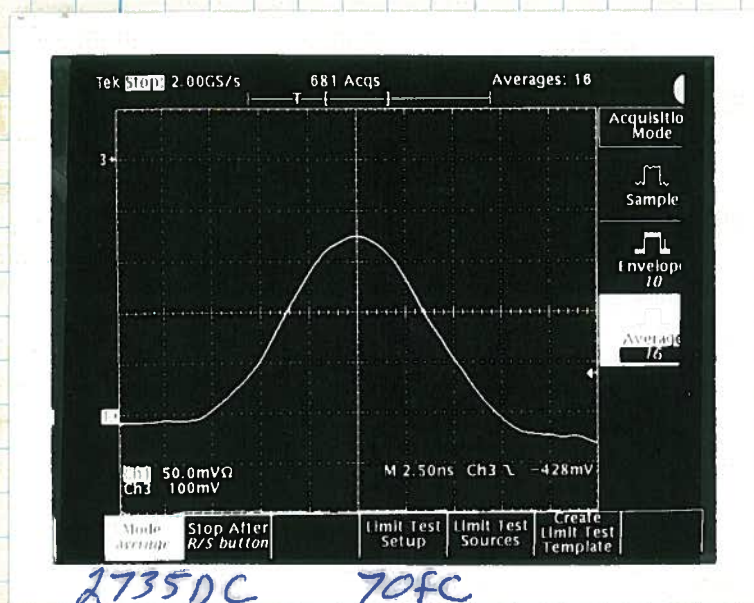
Scope set to average over 16 traces
Ch 1 is probe Ch 3 is input step

For the 2735 DC the copper tape was not soldered to the ground plane. Just taped to it. Securely



FET probe on far side of blocking cap. on A out of TRA 4025. (p. 23)
~~2-wire~~ single ended output used

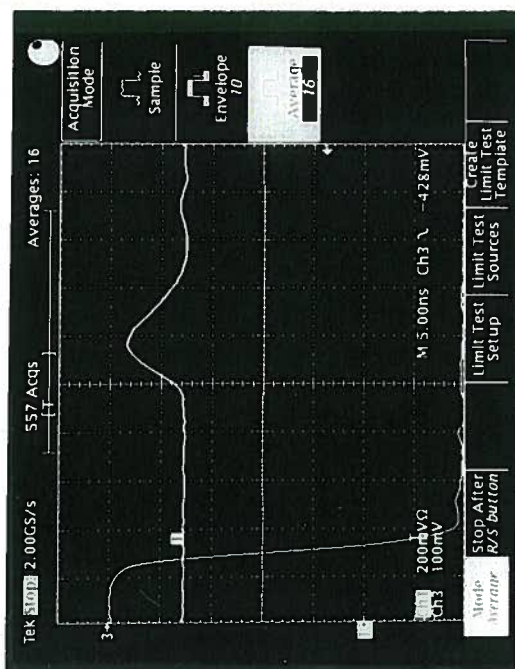




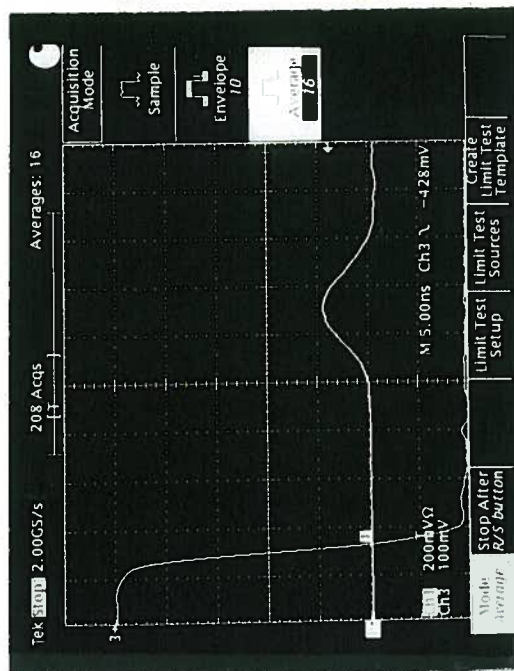
This is the same as the previous photo. Just on an expanded scale.

FET probe on Aout of chip

FET probe on far side of capacitor



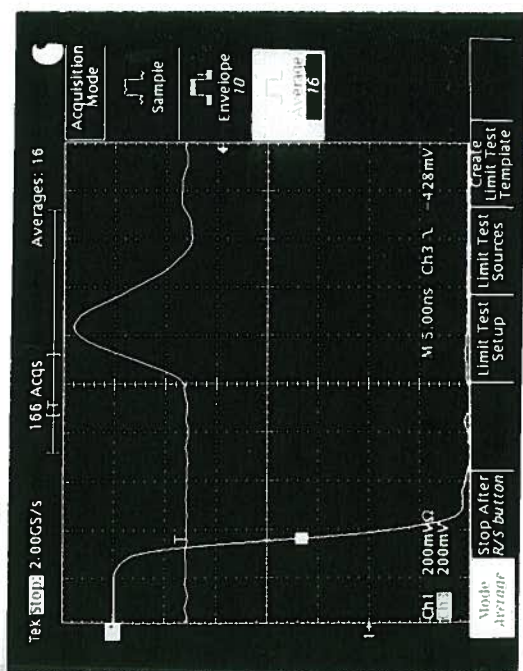
2735-DC 70FC A output



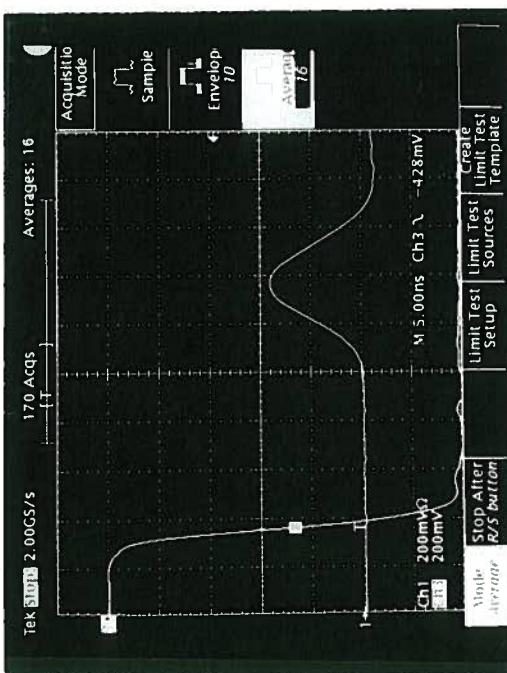
2735-DC 70FC after capac.

FET probe on Aout of chip

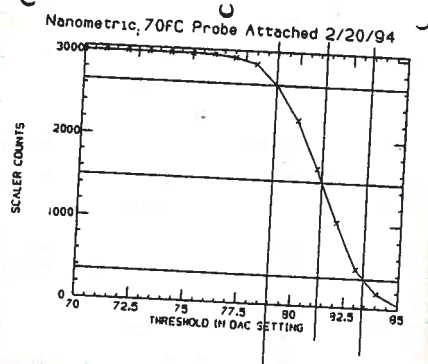
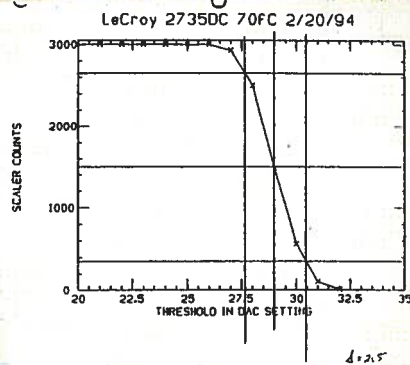
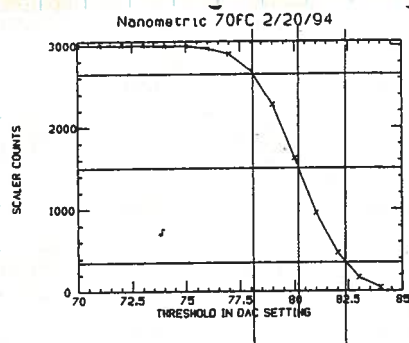
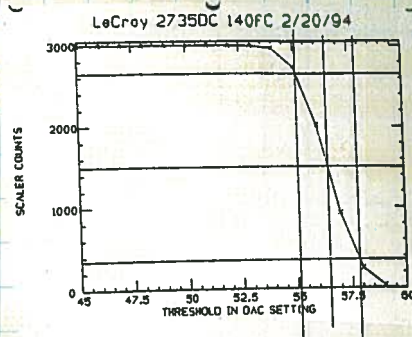
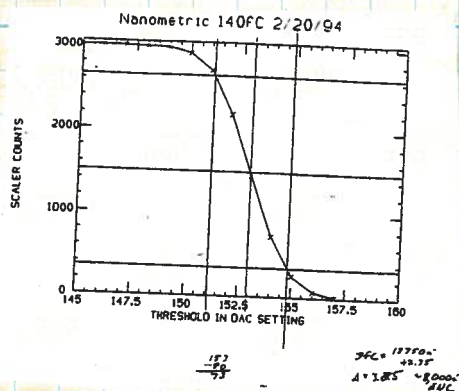
FET probe on far side of capacitor



2735DC 140FC Aout on chip



2735DC 140FC after capacitor



27.5 bits
dac setting (Bit)
70fc

$\Rightarrow \sim 17,000 e^- ??$

$ENC \approx 8,000 e^-$

2/21

2735 DC & N-277-L With Capacitive Loading

JS

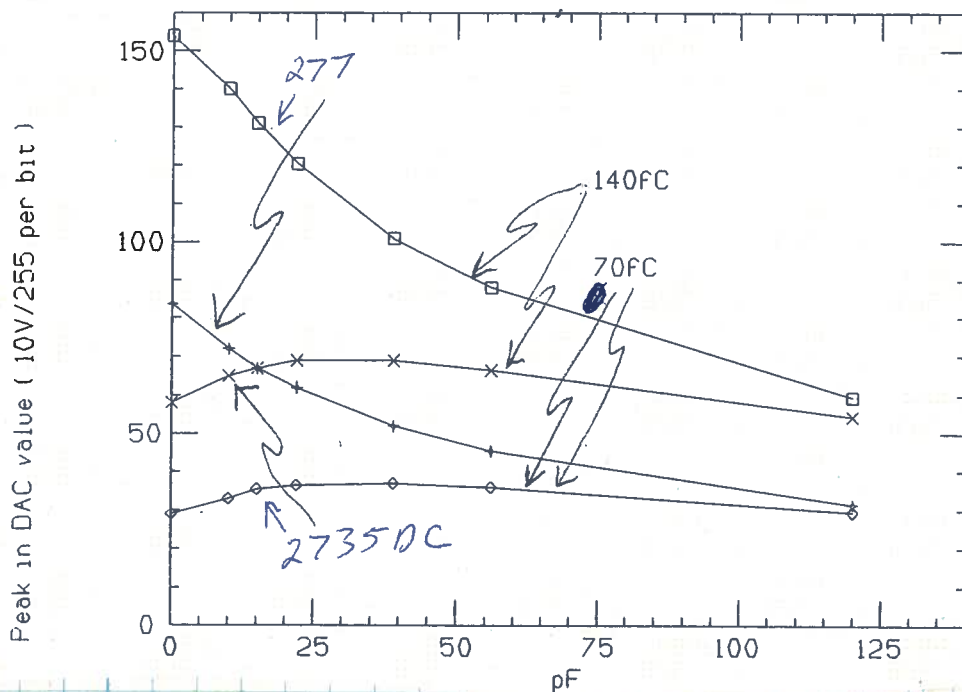
Looking at the two amplifiers with added capacitance to ground on the input.

The cable from the CAMAC output module DAC was run all the way up to the card connector. Demo all the way (RG174). The piece of ~20GA wire was removed. Otherwise the same setup as on p. 99.

The capacitors are chip capacitors inserted between the input and the 10pF charge injection capacitor.

The nanometric behaves as expected. The 2735DC does not. See below.

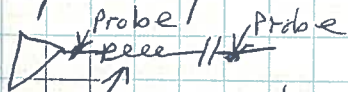
N-277-L and 2735DC Capacitively Loaded



Something must have been wrong with the setup. See p. 116 & 117 this volume for a more carefully checked setup.

This behavior is reproducible. I ran again from 0pF to 22pF and back to 0pF. The same results.

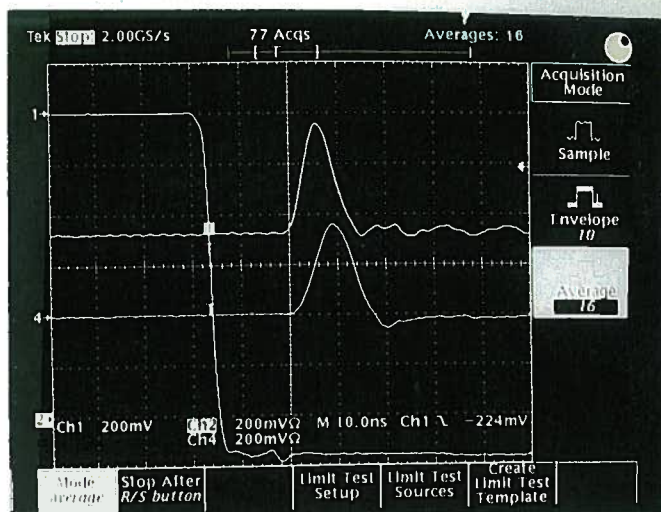
Looking with two FET probes. Ch 2 is the upper trace. Due to DC offset. Ch 2 is at the output pin of the TRA402S amp chip. Ch 4 is on the far side of the capacitor.



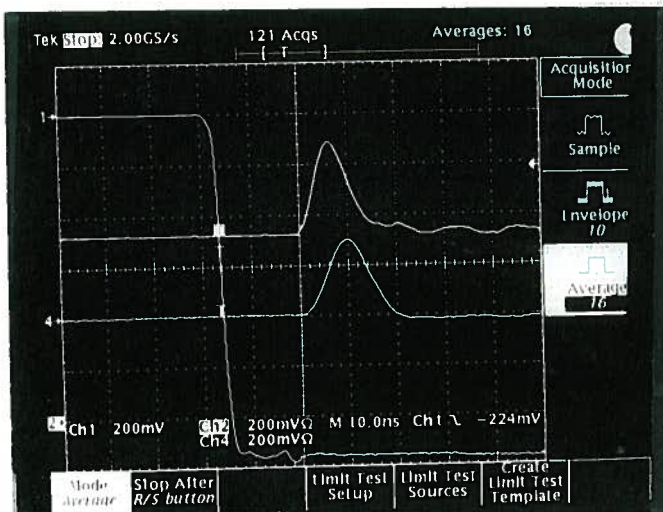
unknown element - suspected inductor
Ch 1 is the input step voltage.

The pulse out of the
TRANS is decreasing
with increasing capacitance.

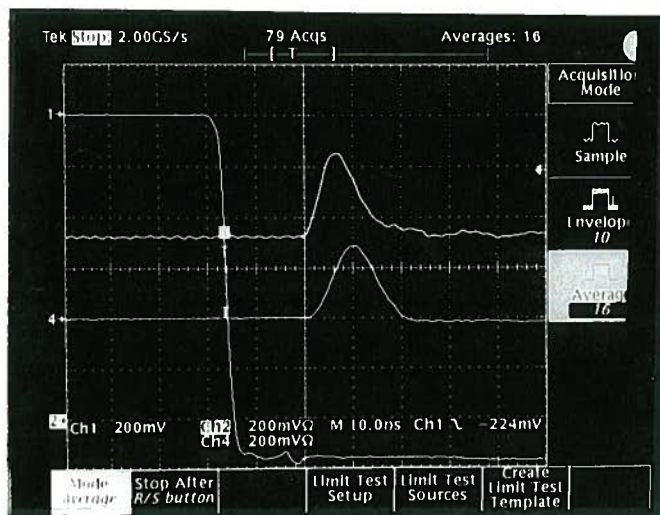
The pulse on the far side
of the capacitor is decreasing
with increasing capacitance.



0pF

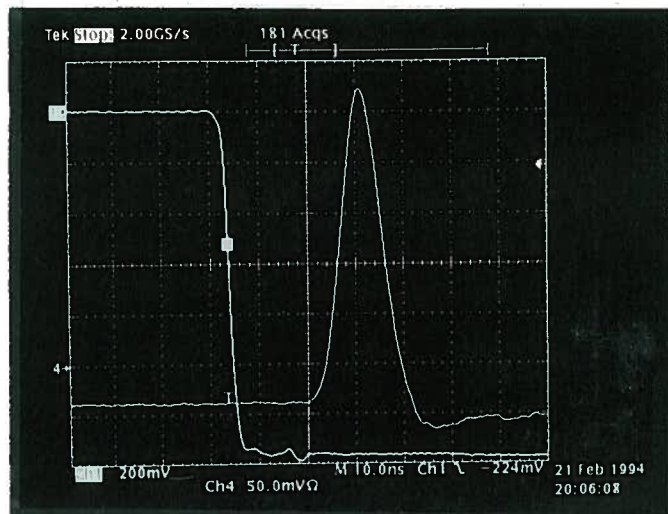


10pF

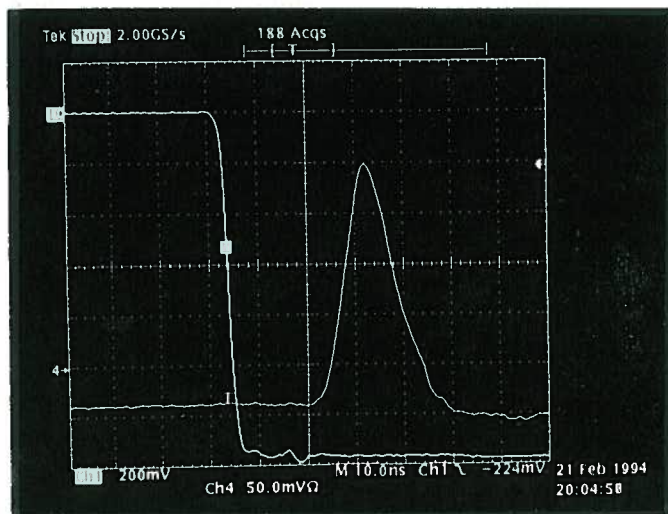


15pF

Looking at the input pin to the MVL407. Again the pulse decreases with increasing capacitance. Ch4 is the FET probe on the pin 4 of the MVL407.



0 pF



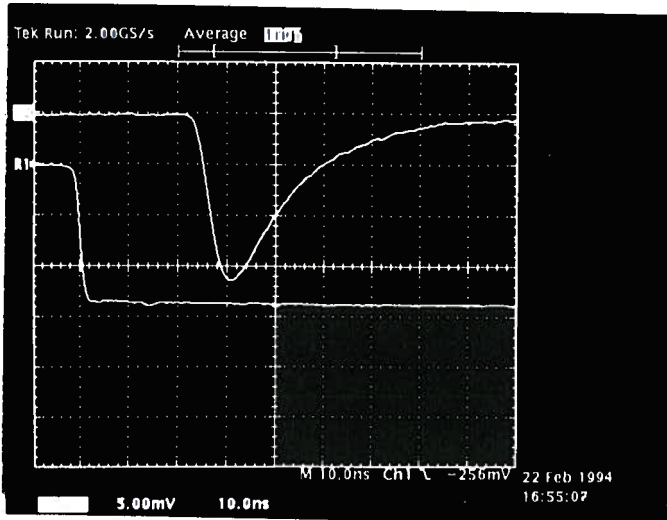
22 pF

Due to slower fall time for larger capacitance??

HFA3127 Revisited

2/22

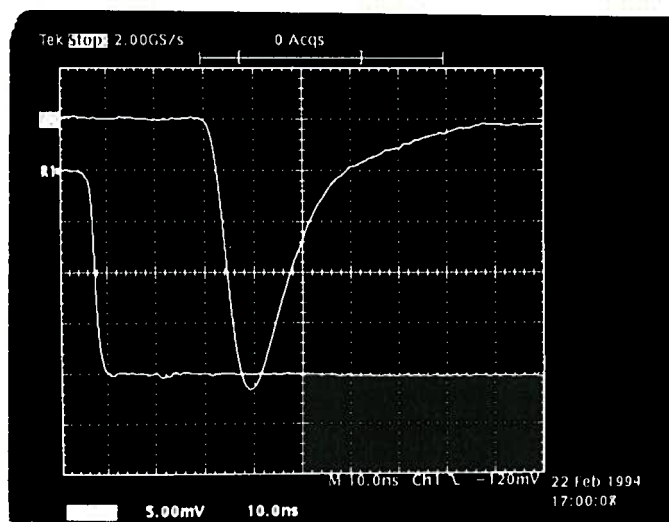
Shortly after the picture on p. 93 I also looked at another board with a 3127 on it. I had run out of film for the scope camera and saved the waveforms to a floppy disk. As I recall the setup was similar to the one on p. 93.



R1 is input step
R2 is amp output into scope @ 50 μ s.
R1 is 200mV/div.

4.7 pF on input for charge injection

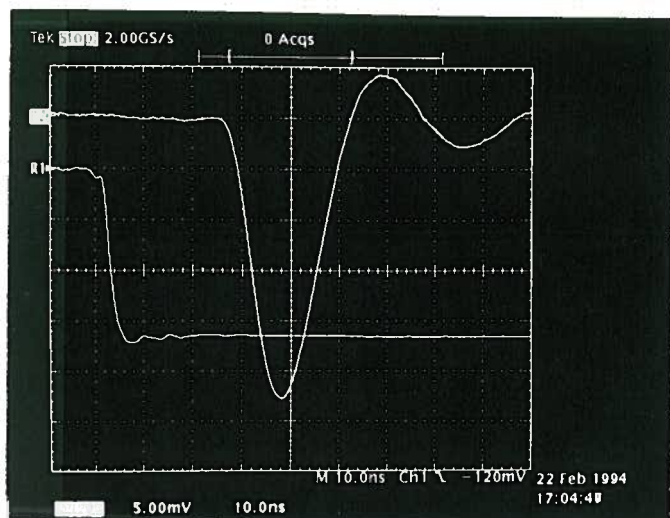
TDS644A scope used!



As above.

R1 is 100mV/div

10 pF on input for charge injection

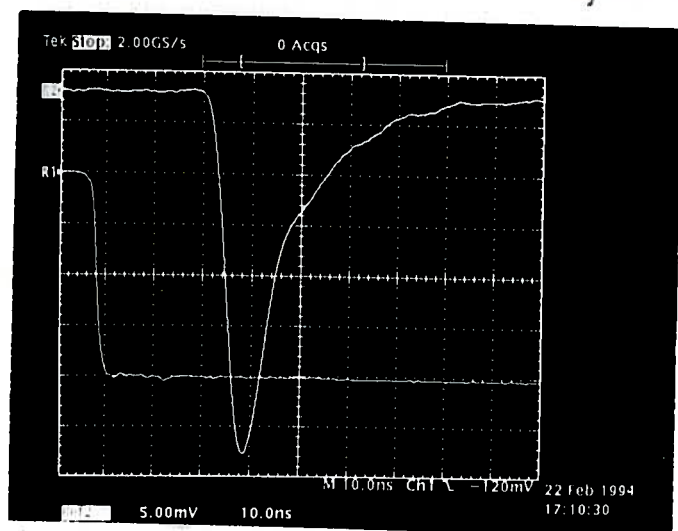


Same as from p. 107

R1 is 50 mV/div.

I believe ringing is due to stray capacitance. See data notes.

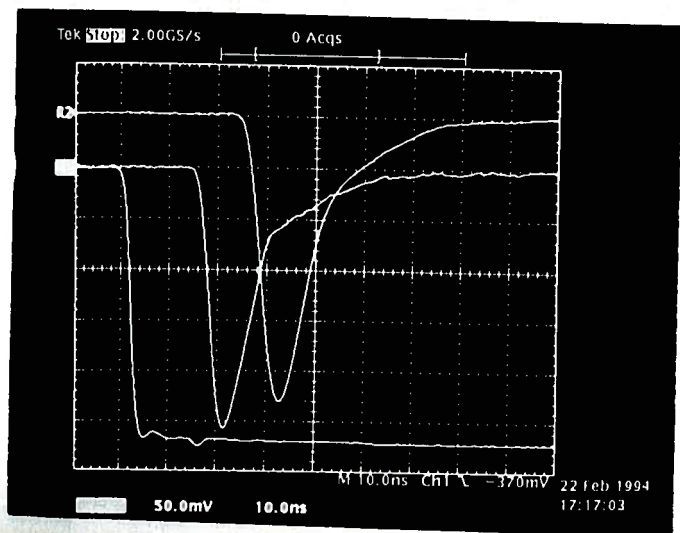
18 pF on input for charge injection



all that was noted was that the pole zero cancellation capacitor was removed.

R1 is 100 mV/div.

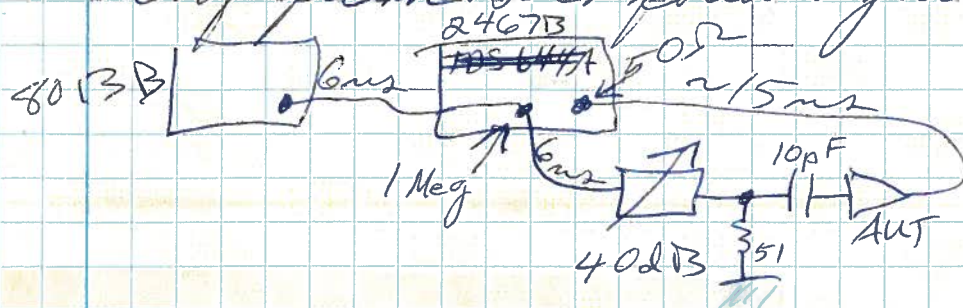
PF ?? unknown



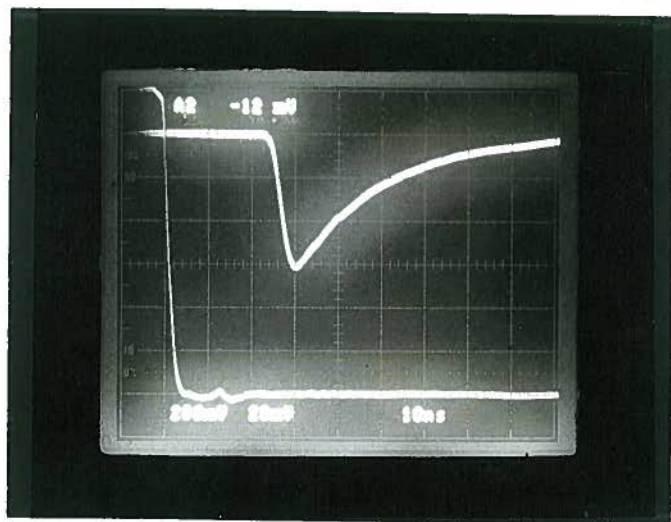
All that was noted was that this was the final arrangement. I believe R2 is input to scope. R4 is, I believe, FET probe at pole cancellation point. Point A of 1st schematic on p. 91. R1 is 500 mV/div.

PF is unknown

The previously ^{enough} information is vague and ^{deleted} ambiguous ^{to} warrant further inquiry. I had saved waveforms to floppy disk & taken out of film. The following was assembled;



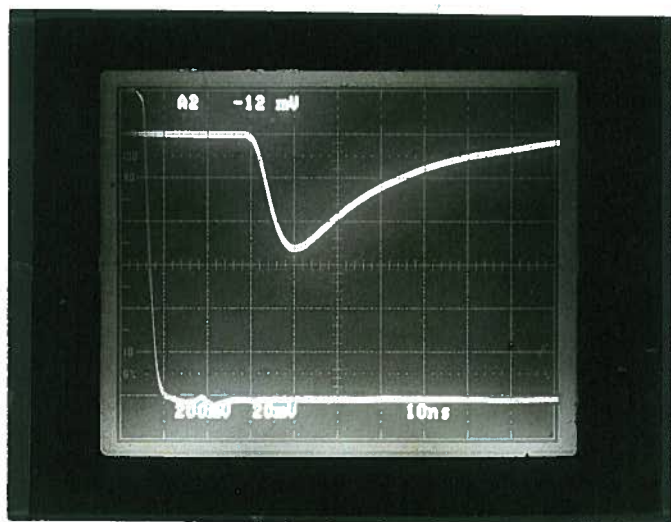
I took pictures this time!!



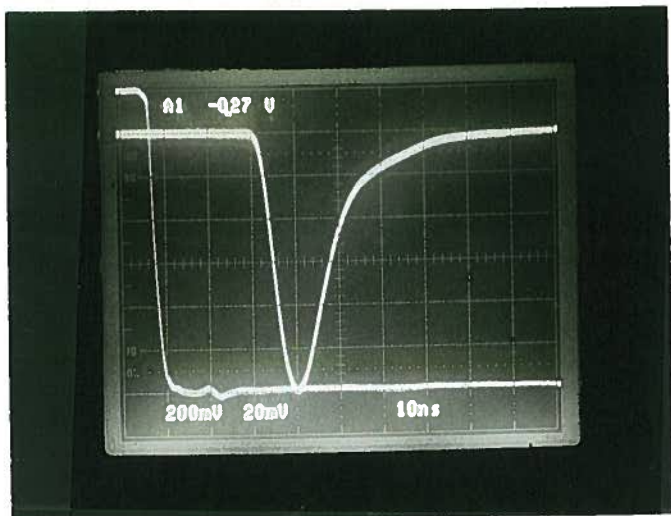
10pF input for charge injection.

20pF for pole cancellation capacitor. see p. 91 for schematics.

13k & 1.3K for substrate bias.

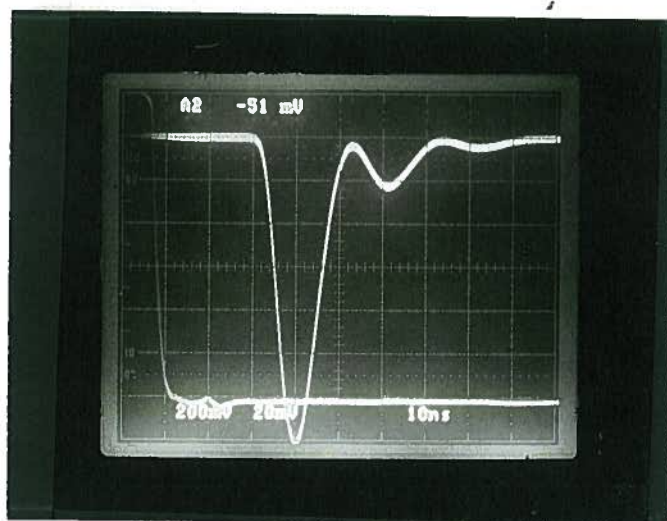


Same as above except 20pF is removed from pole cancellation network.

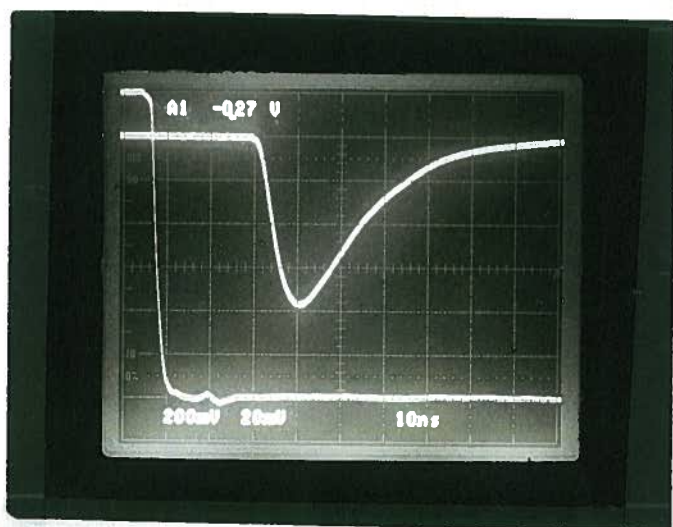


1st removed from substrate
bias network.

I notice something. If
I put my finger on the
+V supply line I can
alter the output to,



As I press my finger
more firmly the oscillation
amplitude increases
until some critical
point is exceeded and
it switches to



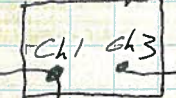
Removing my finger
returns to the upper
most trace.

Perhaps 18 pF on the top of p. 108 is a
similar situation.
20 pF on pole cancellation is a Mica
capacitor.

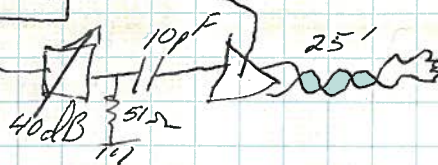
2/24 2735 DC Capacitive Loading Again

HP8013B

TDS644A

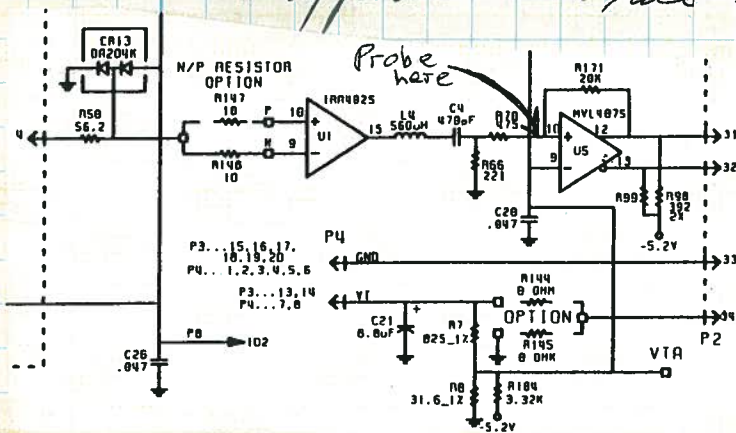


FET Probe



$V_{supply} @ +5.0V, -5.2V$

FET probe used with short grounding wire wrapped around the tip.



$$I_1 = I_2 - I_3$$

$$I_3 = \frac{-5.2 - V_D}{3.32k}$$

$$V_D = I_1 \cdot 31.6 \Omega$$

$$I_2 = \frac{V_T - V_D}{825}$$

$$V_D = 31.6 \left[\frac{V_T - V_D}{825} - \frac{(-5.2 - V_D)}{3.32k} \right]$$

Traces are, from top to bottom;

Ch 1 = input step

$R1 \equiv 0pF$

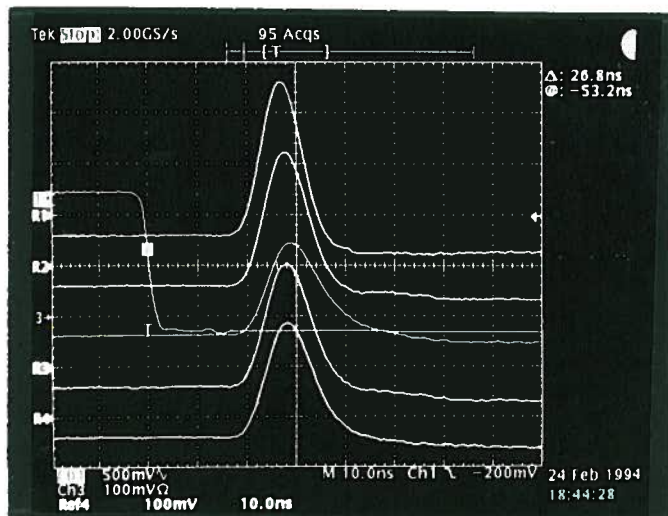
$R2 \equiv 10pF$

Ch 3 = 39pF

~~R3~~ $R3 \equiv 15pF$

$R4 \equiv 22pF$

Set to average 16 traces.



3mV/5C

step = 2.7div x 5V/div
= 1.35V

13.5mV x 10pF = 135fC

300mV @ 0pF $\Rightarrow$ 2.2mV/fC

240mV @ 15pF $\Rightarrow$ 1.8mV/fC

$$V_D = 31.6 \left[\frac{V_T - 5.2}{825} - \frac{V_D}{3320} + \frac{V_D}{3320} \right]$$

$$V_D = 31.6 \left[\frac{V_T}{825} - \frac{5.2}{3320} - V_D \left(\frac{1}{825} - \frac{1}{3320} \right) \right]$$

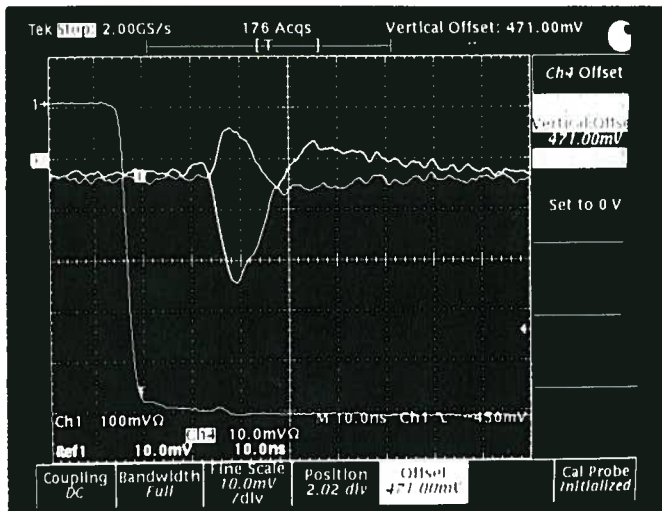
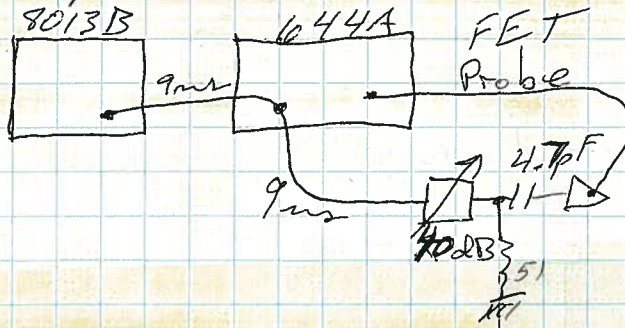
$$V_D \left[1 + 31.6 \left(\frac{1}{825} - \frac{1}{3320} \right) \right] = \frac{V_T}{825} - \frac{5.2}{3320}$$

$$0.033 V_D = \frac{V_T}{825} - 0.00157$$

$$V_D = 0.03723 V_T - 0.04822$$

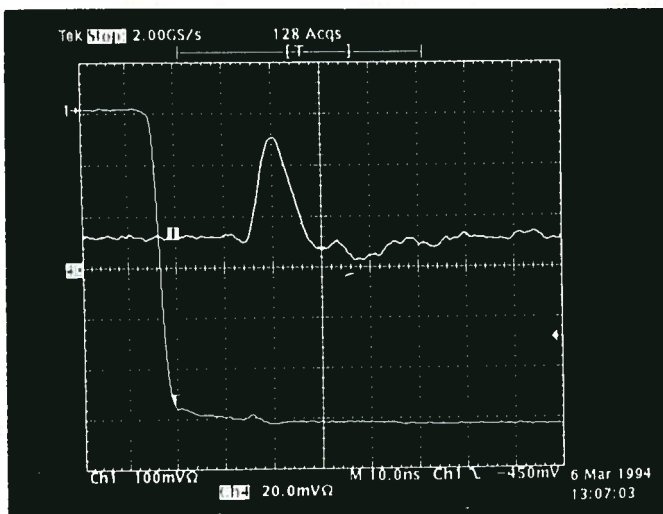
$$V_D \neq 0 @ V_T = 1.295V$$

Stanford E871 SCLPS Amp/Discrim 3/6/94



These are at the inputs to the transformer. Average of 16 traces.

$$6mV \times 4.7pF = 28fC$$

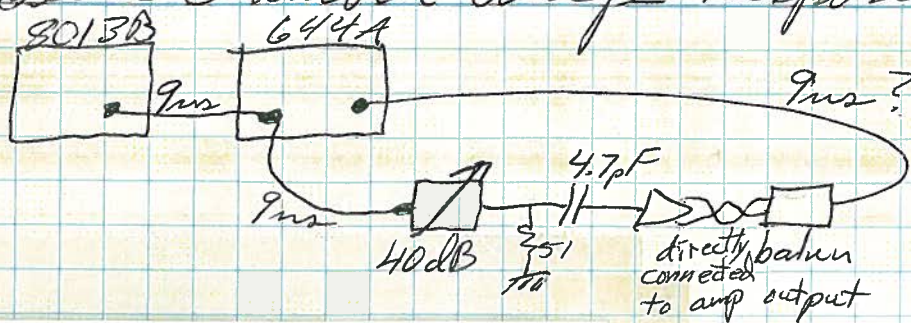


This is at the transformer output. Average of 16 traces.

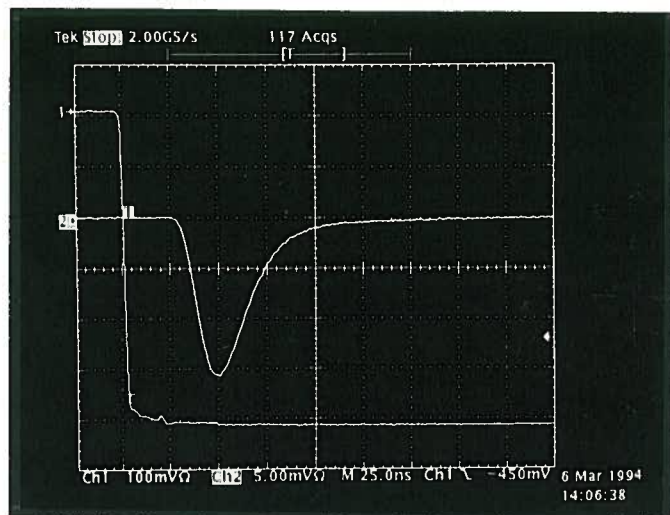
$$\sim 1.4mV/fC$$

3/60

Beam Chamber Amp Response



Average of 16 traces,



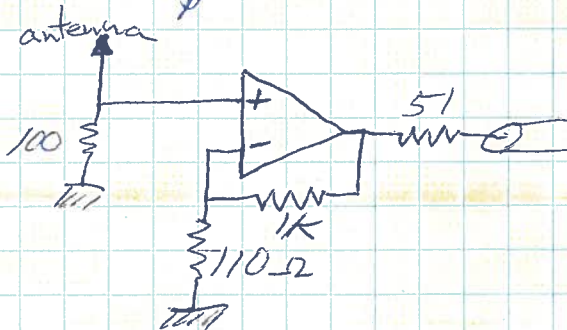
28fC injected ($600\text{mV} \div 100 \times 4.7\text{pF} \approx 28\text{fC}$)

$\approx 0.5\text{mV/fC}$ after balun

Snoopy Mark I

3/7

A CXC425 in an aluminum box with a battery (9V) and an isolated antenna on the input.

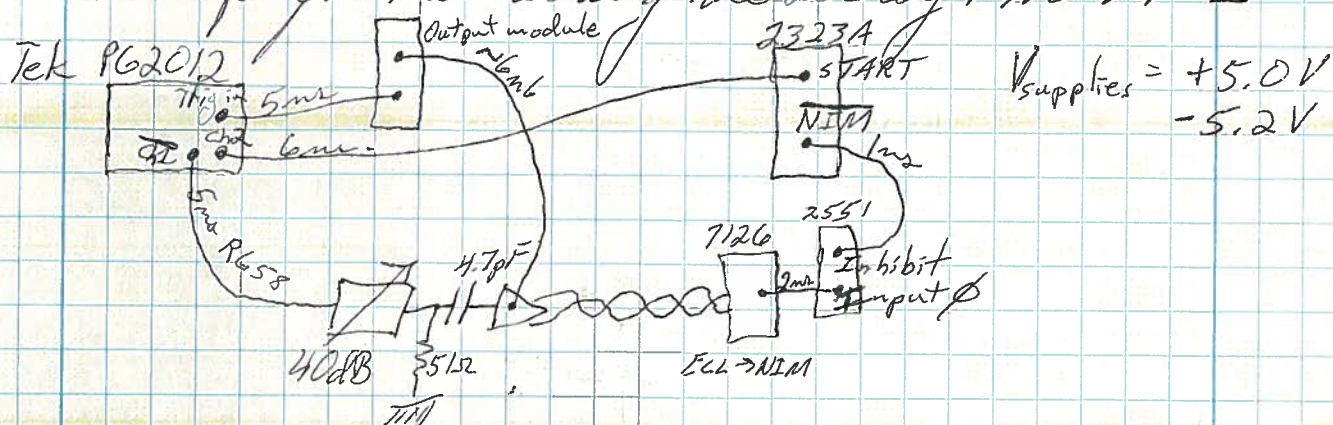


pretty basic

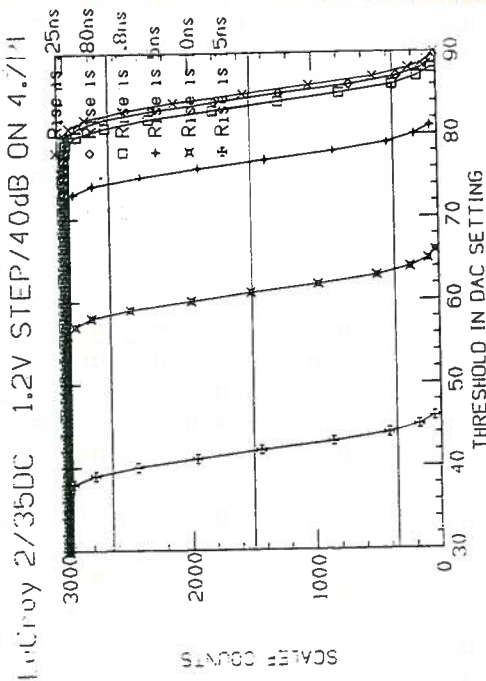
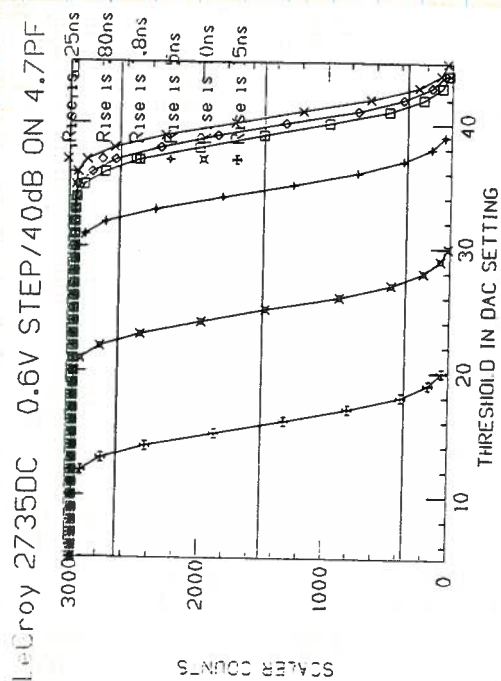
Looking over the results from p. 99-106.
On p. 99 I note ~~40~~ dB Attenuation

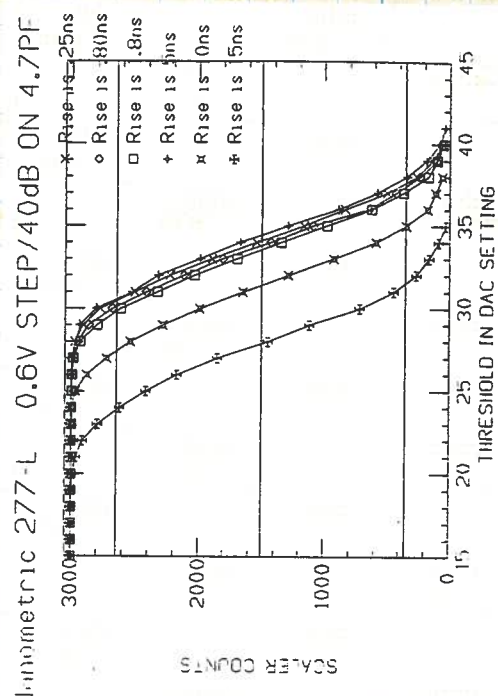
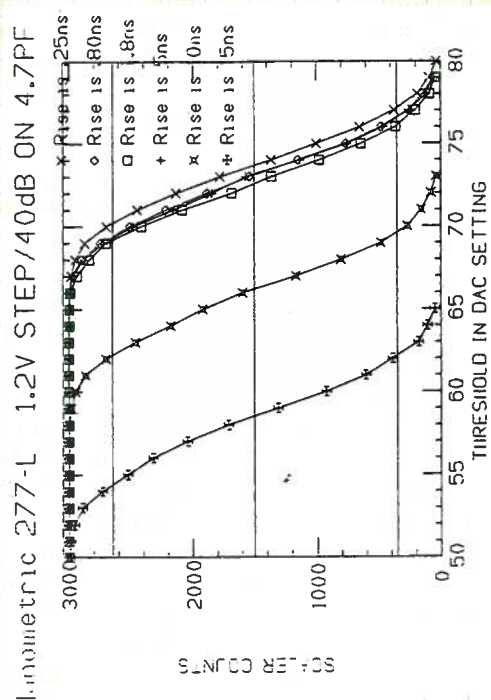
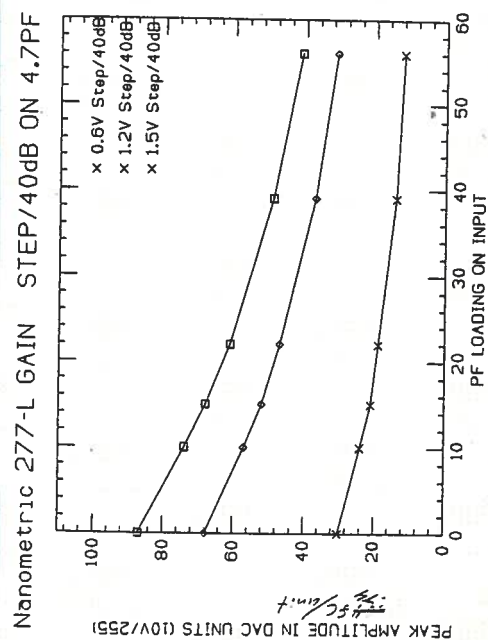
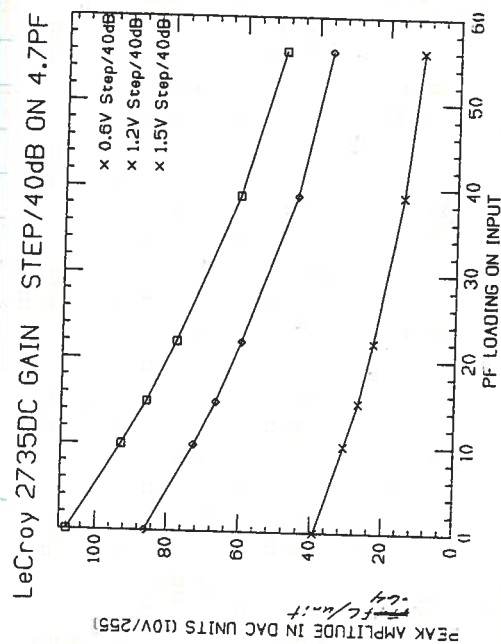
3/22

Setup for re-testing the LeCroy 4N277-2
☐ Output module 73334



23234 is set to trigger on (+) edge
Setray & Gammometric outputs checked. They do
have the same "sense."





LM359 Revisited

Trig in

CH1 CH2

5ms R658

40dB

4.7pF

351

AUT

5ms

output module

NIM

START

5ms

1706

7126

2551

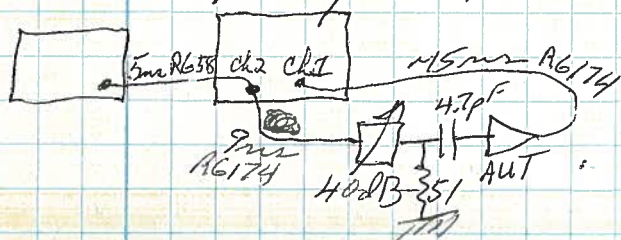
2ms

INHIBIT

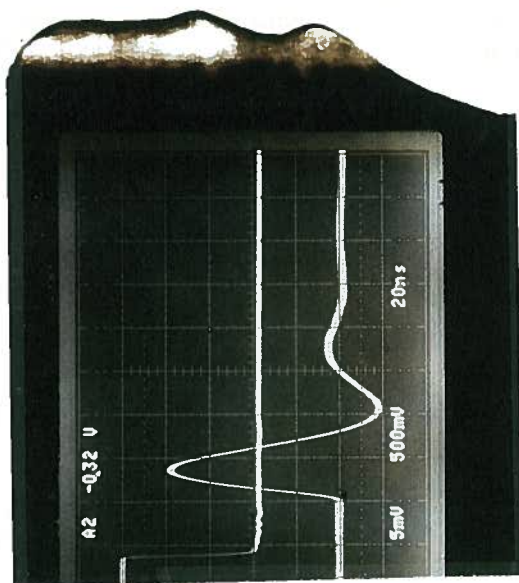
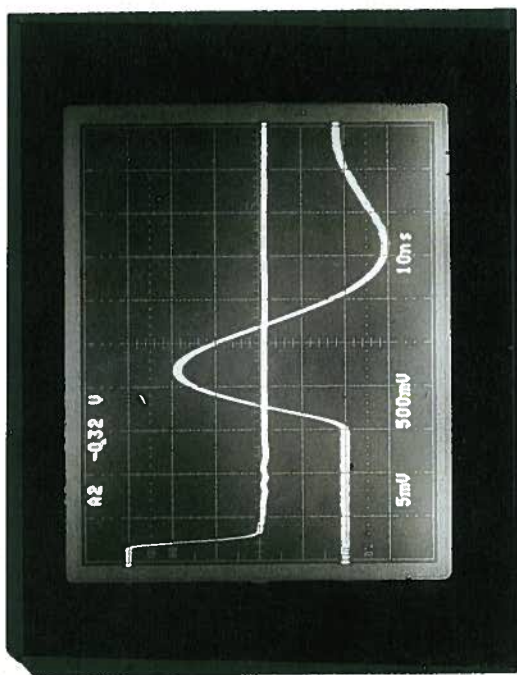
2ms

all cables R6174
except the one
5m R658

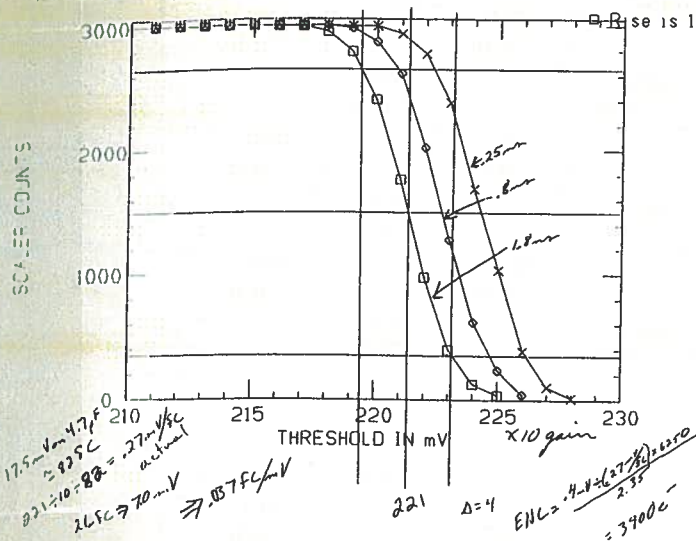
2323A is set to trigger on (-) edge
Output of amp is checked on scope.



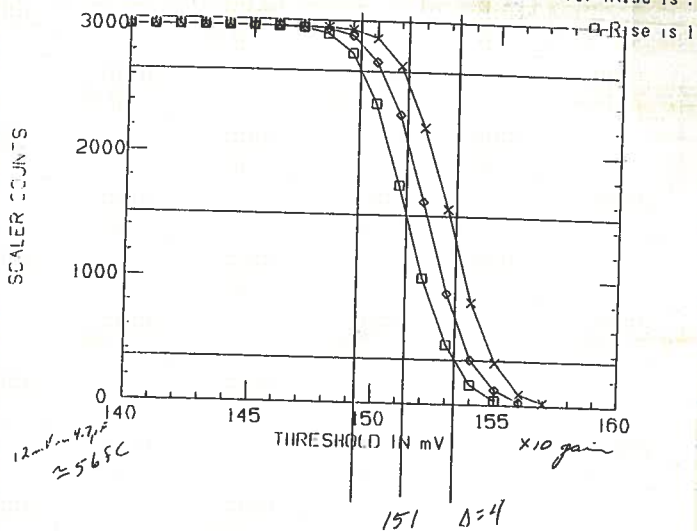
Amp layout is same as p. 15 of this book except no $1.2k\Omega$ to ground at the input



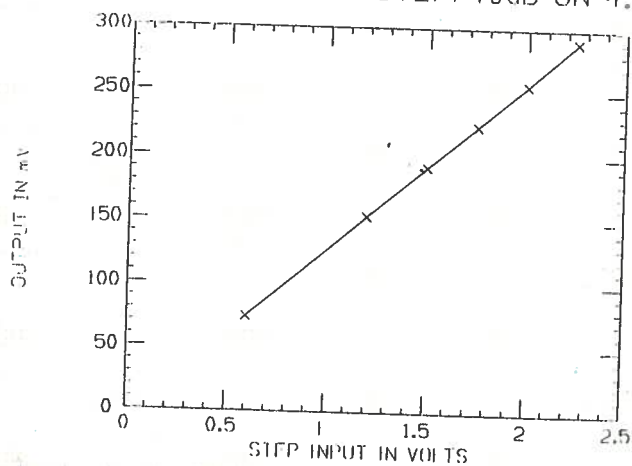
LM359 0pF 1.75V STEP/40dB ON 4.7PF



LM359 0pF 1.20V STEP/40dB ON 4.7PF

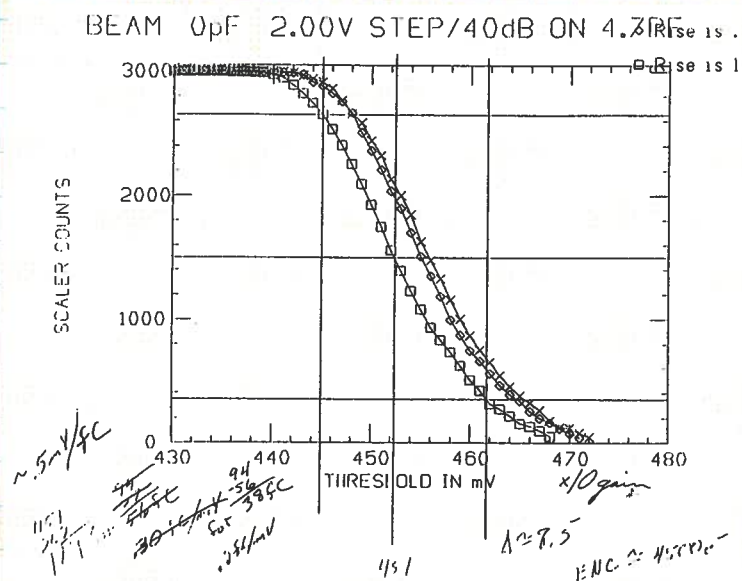


LM359 GAIN OF 10 FOR STEP/40dB ON 4.7PF

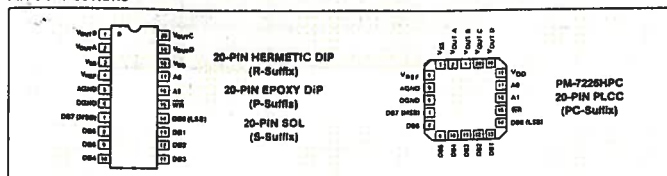


Beam Chamber Amp

Using the same setup used for p 119 data.



PIN CONNECTIONS



Specifications apply for DUAL or SINGLE SUPPLY, unless otherwise specified.

ELECTRICAL CHARACTERISTICS: DUAL SUPPLY: $V_{DD} = +11.4V$ to $+18.5V$; $V_{SS} = -5V \pm 10\%$; $AGND = DGND = 0V$; $V_{REF} = +2V$ to $(V_{DD} - 4V)$; SINGLE SUPPLY: $V_{DD} = +15V \pm 5\%$; $V_{SS} = AGND = DGND = 0V$; $V_{REF} = +10V$; unless otherwise specified. $T_A = -55^\circ C$ to $+125^\circ C$ apply for PM-7226AR/BR; $T_A = -25^\circ C$ to $+85^\circ C$ apply for PM-7226ER/FR; $T_A = 0^\circ C$ to $+70^\circ C$ apply for PM-7226GPH/PC/HS. All specifications apply for DACs A, B, C, and D. (Continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	PM-7226 TYP	MAX	UNITS
STATIC ACCURACY						
Resolution	N		8	—	—	Bits
Total Unadjusted Error (Note 1)	TUE	PM-7226A/E/G PM-7226B/F/H	—	$\pm 1/2$	± 1	LSB
Relative Accuracy	REL	PM-7226A/E/G PM-7226B/F/H	—	$\pm 1/2$	± 1	LSB
Differential Nonlinearity (Note 2)	DNL	PM-7226A/E/G PM-7226B/F/H	—	$\pm 1/2$	± 1	LSB
Full Scale Error	α_{FS}	PM-7226A/E/G PM-7226B/F/H	—	$\pm 1/2$	± 1	LSB
Full Scale Temperature Coefficient (Note 4)	TCO_{FS}		—	1	± 20	ppm/ $^\circ C$
Zero Code Error	V_{ZSE}	DUAL SUPPLY PM-7226A/E/G PM-7226B/F/H	—	—	± 5	mV
		SINGLE SUPPLY PM-7226A/E/G PM-7226B/F/H	—	—	± 10	mV
			—	—	± 20	mV
Zero Code Error Temperature Coefficient (Note 4)	TCV_{ZS}	DUAL SUPPLY ONLY	—	± 10	—	$\mu V/^\circ C$
REFERENCE INPUT						
Voltage Range (Note 3)			2	—	$(V_{DD} - 4V)$	V
Input Resistance	R_{IN}		2	—	—	M Ω
Input Capacitance (Note 4)	C_{IN}	Digital Inputs = all I's	65	—	—	pF

Specifications apply for DUAL or SINGLE SUPPLY, unless otherwise specified.

ELECTRICAL CHARACTERISTICS: DUAL SUPPLY: $V_{DD} = +11.4V$ to $+18.5V$; $V_{SS} = -5V \pm 10\%$; $AGND = DGND = 0V$; $V_{REF} = +2V$ to $(V_{DD} - 4V)$; SINGLE SUPPLY: $V_{DD} = +15V \pm 5\%$; $V_{SS} = AGND = DGND = 0V$; $V_{REF} = +10V$; unless otherwise specified. $T_A = -55^\circ C$ to $+125^\circ C$ apply for PM-7226AR/BR; $T_A = -25^\circ C$ to $+85^\circ C$ apply for PM-7226ER/FR; $T_A = 0^\circ C$ to $+70^\circ C$ apply for PM-7226GPH/PC/HS. All specifications apply for DACs A, B, C, and D. (Continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	PM-7226 TYP	MAX	UNITS
DIGITAL INPUTS						
Digital Inputs High	V_{IH}		2.4	—	—	V
Digital Inputs Low	V_{IL}		—	—	0.8	V
Input Current	I_{IN}	$V_{IN} = 0V$ or V_{DD}	—	—	± 1	μA
Input Capacitance (Note 4)	C_{IN}		—	—	4	pF
Input Coding			—	—	—	BINARY
POWER SUPPLIES						
Positive Supply Current (Note 6)	I_{DD}		—	—	12	mA
Negative Supply Current (Note 6)	I_{SS}	DUAL SUPPLY ONLY	—	—	10	mA
DYNAMIC PERFORMANCE						
V_{OUT} Slew Rate (Note 4)	SR		2.5	—	—	V/ μs
V_{OUT} Settling Time (Positive or Negative) (Notes 4, 5)	t_s		—	—	3	μs
Digital Crosshatch (Note 4)	C		—	10	—	nVs
Minimum Load Resistance	R_{Lmin}	$V_{OUT} = +10V$	2	—	—	k Ω
SWITCHING CHARACTERISTICS (Note 4)						
Address to Write Set-Up Time	t_{AS}		0	—	—	ns
Address to Write Hold Time	t_{AH}		0	—	—	ns
Data Valid to Write Set-Up Time	t_{DS}		90	—	—	ns
Data Valid to Write Hold Time	t_{DH}		10	—	—	ns
Write Pulse Width	t_{PW}		80	—	—	ns

NOTES:

- Includes Full Scale Error, Relative Accuracy, and Zero Code Error.
- All devices guaranteed monotonic over the full operating temperature range.
- $V_{DD} = 4$ volts is the maximum reference voltage for the above specifications.
- Guaranteed by design and not subject to production test.
- $V_{REF} = +10V$; to where output settles to $1/2$ LSB.
- $V_{DD} = V_{IN}$ or V_{SS} outputs unloaded.



Precision Monolithics Inc.

FEATURES

- Four Voltage Output DACs on a Single Chip
- Microprocessor Compatible
- Adjustment-Free $\pm 1/2$ LSB Total Error
- Guaranteed Monotonicity
- Single (+5V to +18V) or Dual Supply
- Space Saving 20-Pin 0.3 Inch DIP
- TTL/CMOS (5V) Compatible
- Single Specification Table for Both Dual and Single Power Supply Operation
- Fast Data Load, $t_{WH} = 90ns$, All Temperatures

APPLICATIONS

- Automatic Test Equipment
- Process/Industrial Controls
- Energy Controls
- Scientific Instrumentation
- Medical Equipment
- Multi-Channel Microprocessor-Controlled:
 - Variable Resistors
 - System Calibration
 - Op Amp Offset and Gain Adjust

GENERAL DESCRIPTION

The PM-7226 contains four 8-bit voltage output CMOS digital-to-analog converters on a single chip. Also incorporated into this chip are four input latches and interface control logic.

The four latches are under control of one write and two address signals and are fed from a common 8-bit data bus. It allows the PM-7226 to be packaged into a narrow space-saving 20-pin, 300-mil DIP. All digital inputs are TTL/CMOS (5V) compatible. Also, each DAC's input latch is addressable for easy microprocessor interface. The on-board output amplifiers can each drive up to 5mA from either a single or dual supply.

The PM-7226's compact size, low power, and economical cost-per-channel, make it attractive for applications requiring multi-

ple DAC converters without sacrificing circuit-board space. System reliability is also increased due to reduced parts count.

PMI's advanced oxide-isolated, silicon-gate, CMOS process allows the PM-7226's analog and digital circuitry to be manufactured on the same chip. This, coupled with PMI's highly-stable thin-film R-2R resistor ladder, aids in matching and temperature tracking between DACs.

The PM-7226 is an improved replacement for the AQ7226.

ORDERING INFORMATION

TOTAL UNADJUSTED ERROR	PACKAGE: 20-PIN		
	MILITARY* TEMPERATURE	INDUSTRIAL TEMPERATURE	COMMERCIAL TEMPERATURE
$\pm 1/2$ LSB	PM7226AR	PM7226BR	PM7226GP
± 1 LSB	PM7226BR	PM7226FR	PM7226HP
± 1 LSB	—	—	PM7226HPC(1)
± 1 LSB	—	—	PM7226HS(1)

* For devices processed in total compliance to MIL-STD-883, add /883 after part number. Consult factory for 883 data sheet.

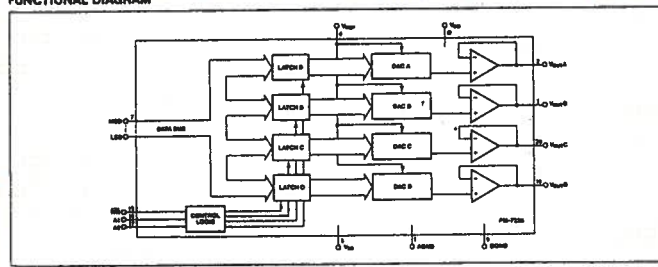
† Burn-in is available on commercial and industrial temperature range parts in cerdip, plastic dip, and TO-can packages. For ordering information, see 1988 Data Book, Section 2.

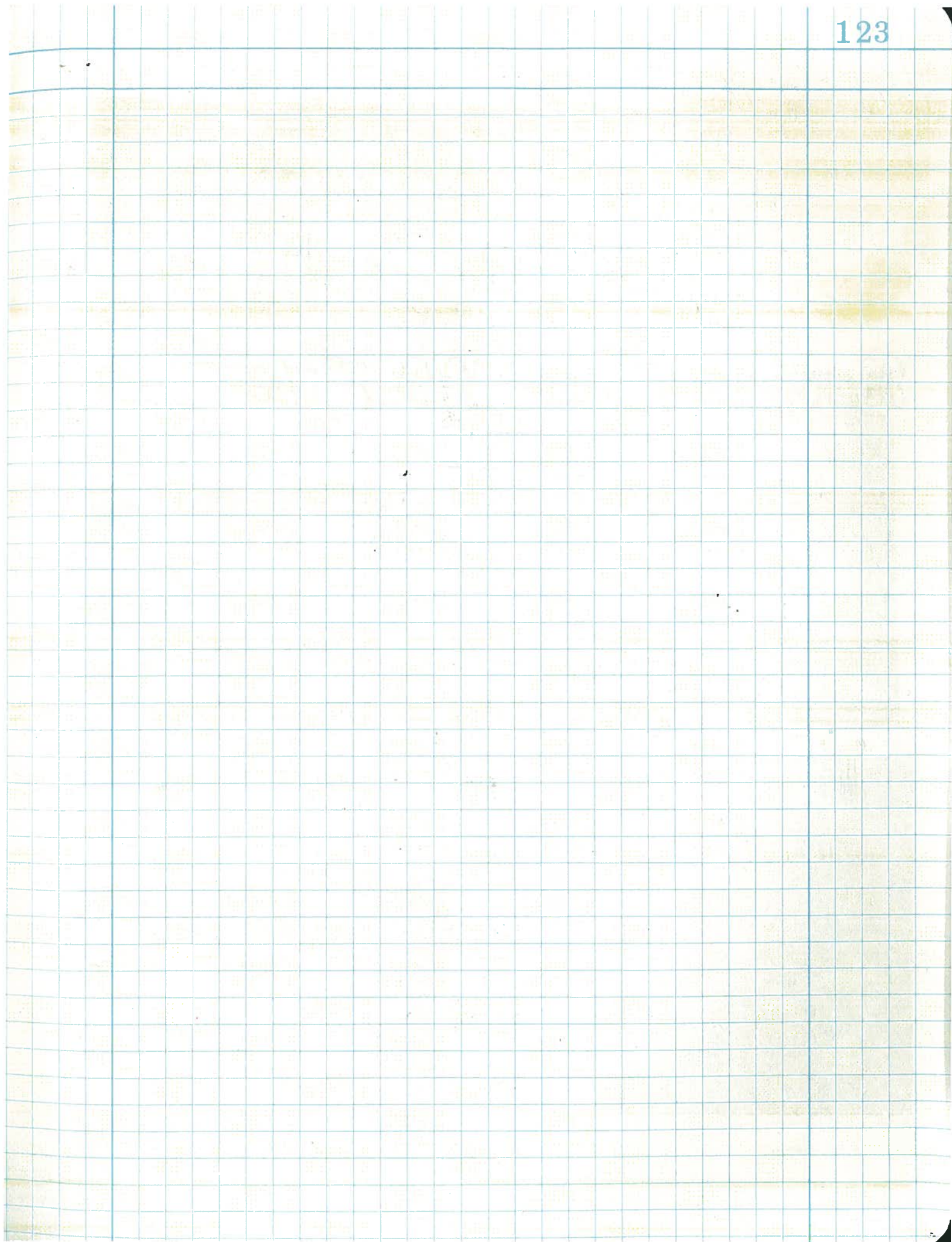
‡ For availability and burn-in information on SO and PLCC packages, contact your local sales office.

CROSS REFERENCE

PMI	ADI	TEMPERATURE RANGE
PM7226AR	—	MIL
PM7226BR	AD7226TQ	MIL
PM7226ER	—	IND
PM7226FR	AD7226BQ	IND
PM7226GP	—	COM
PM7226HP	AD7226KN	COM
PM7226HPC	AD7226KP	COM

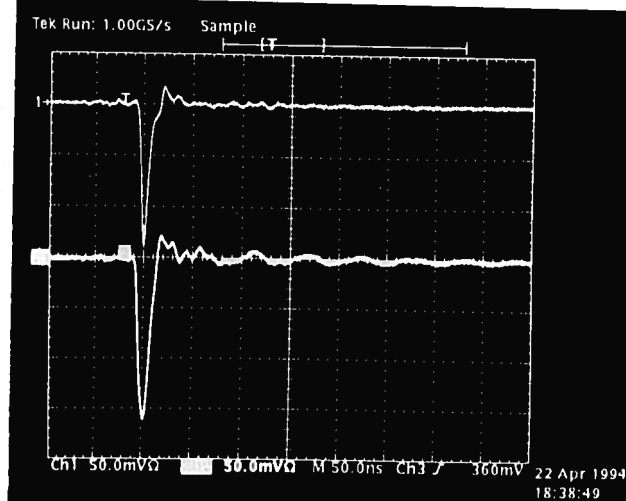
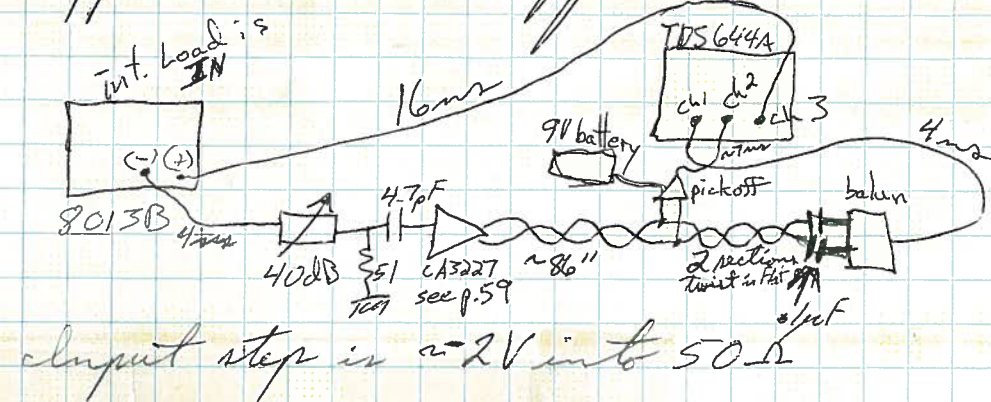
FUNCTIONAL DIAGRAM



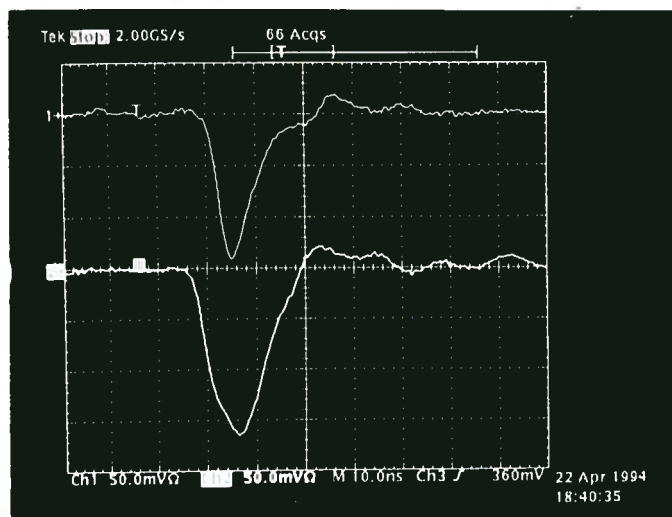


4/22
js

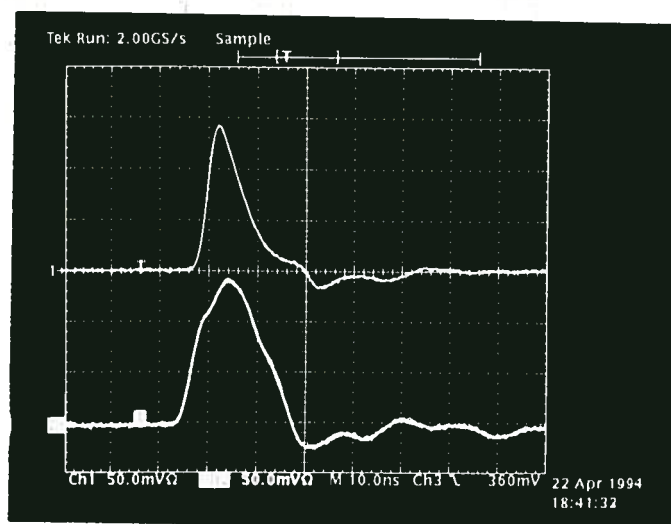
Differential Pickoff



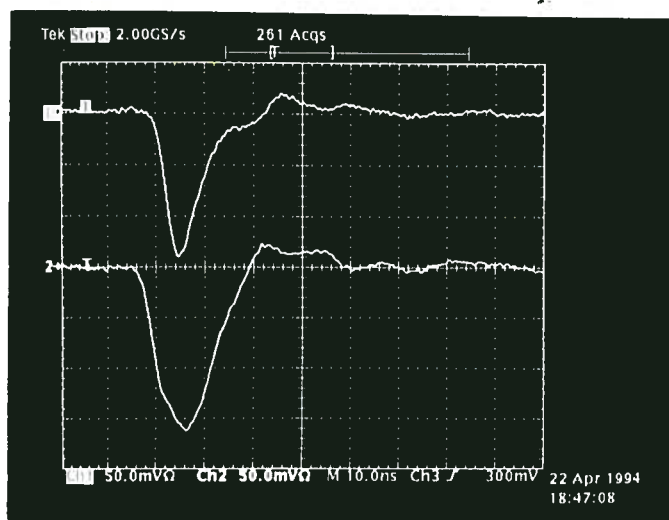
Response on negative edge of input step ($\approx 2V$)



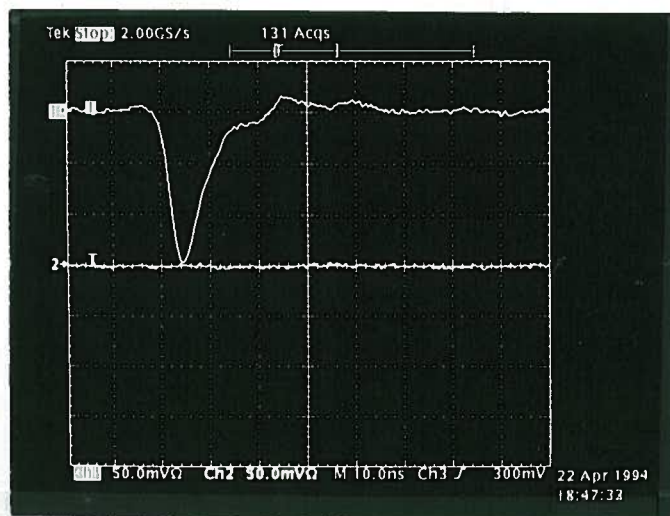
Same as above.



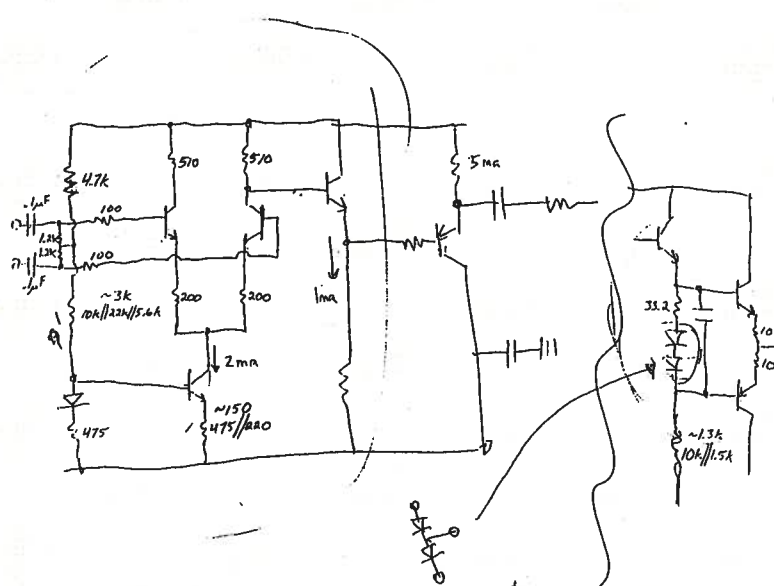
Response on positive
edge of input step ($\sqrt{-2V}$)



Same as bottom picture
p. 124.
(pickoff attached)



As above except pickoff
has been removed.



4/23

The output cable 0 gnd braid is connected to the ground side of the circuit board. Since the circuit is run off a 9V battery the gnd is determined by 330K from each power supply rail

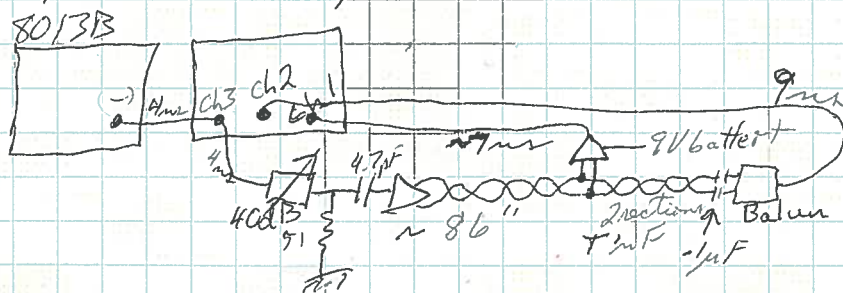
But, only the negative rail was bypassed!

OOPS! Bypass capacitor installed to +V rail from GND.

Things are very much improved.

Note ~ 4% reduction in pulse height when pickoff circuit is inserted. Perhaps can minimize with layout improvement.

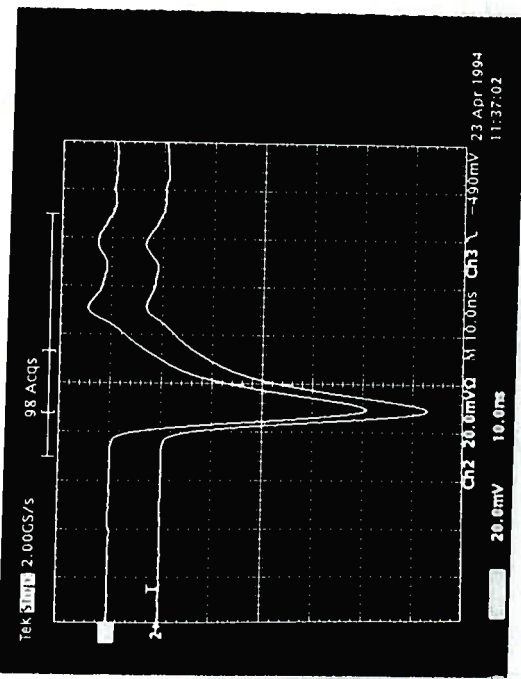
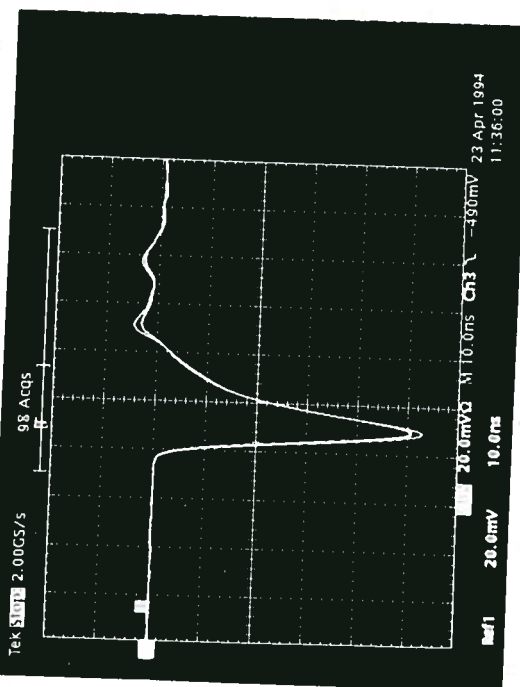
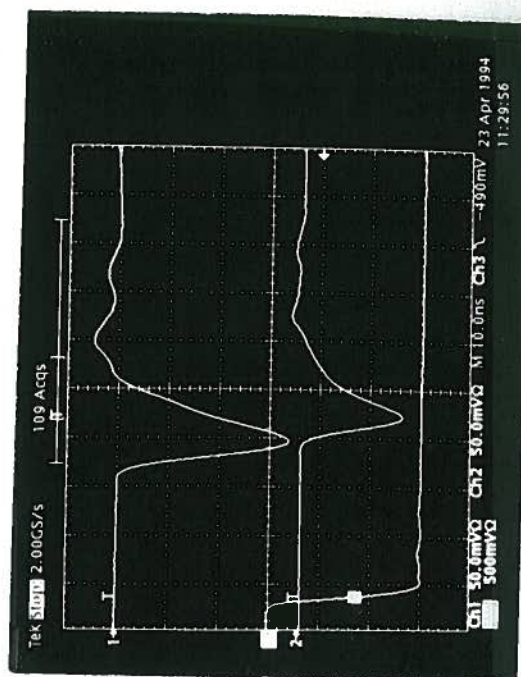
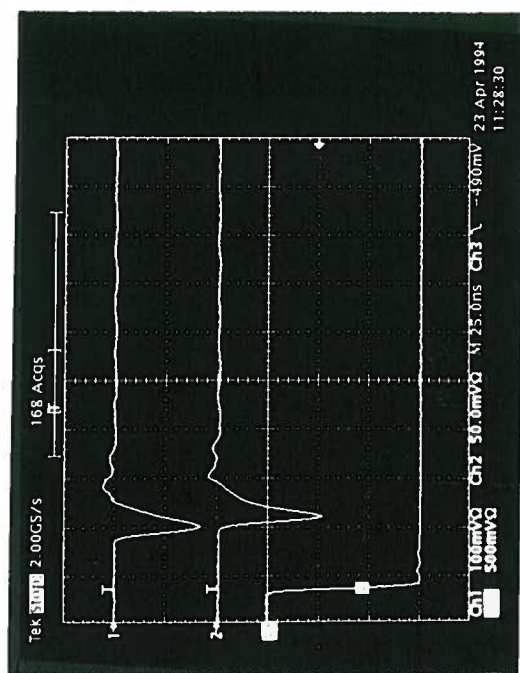
Steps similar to p. 124



After the photo on the next page I find Ch3 is on 50Ω ! Oh, well. It's still ok.

Top 2 photos are from setup bottom of previous page.

Average
of
16
acquisitions



The bottom 2 photos are of before output without pickoff (R1) and with pickoff (Ch2) both superimposed. Left photo is same but

4/24

Same setup as bottom of p. 126. Max 435
pickoff is used. Photos are the same/similar to those
on the bottom of p. 127. Output of pickoff is
through balun and then 6ms of RG174.
Ave. of 16 acquisitions

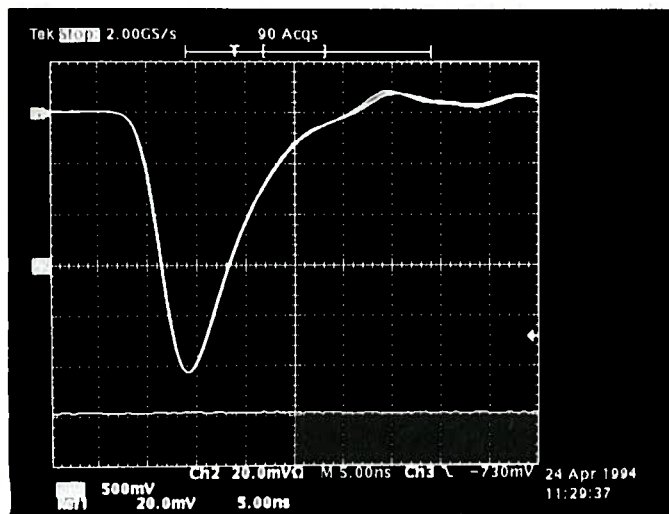
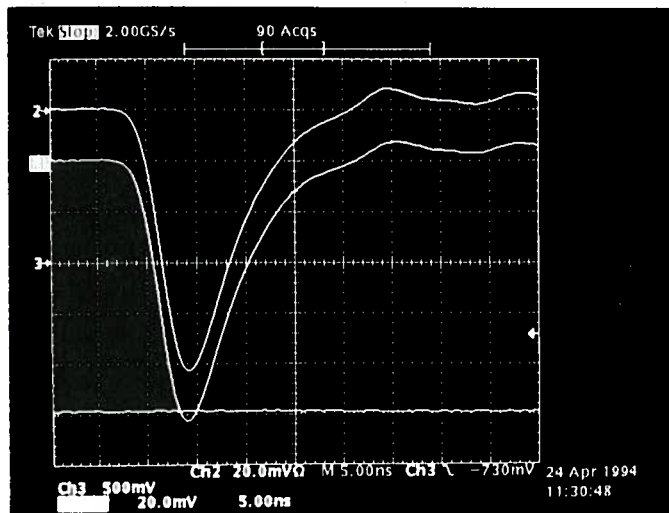


Photo is trace with
pickoff superimposed
on trace without
pickoff.

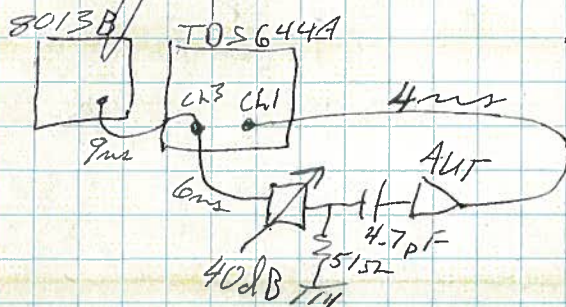


Ch2 is with pickoff
Ch3 is without pickoff

AD8001 Response

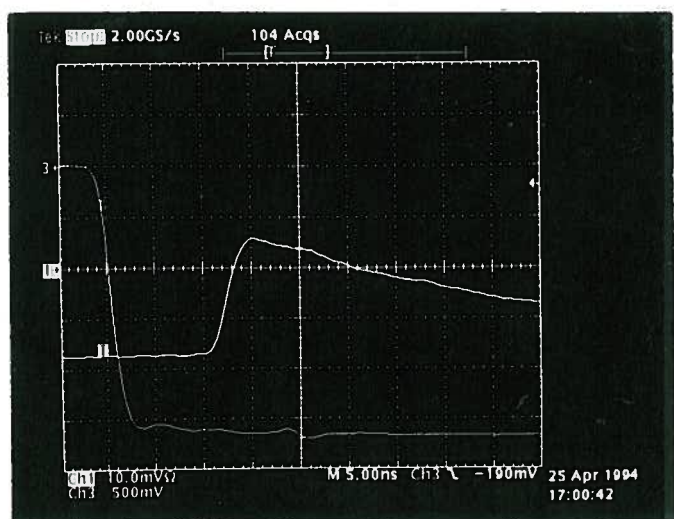
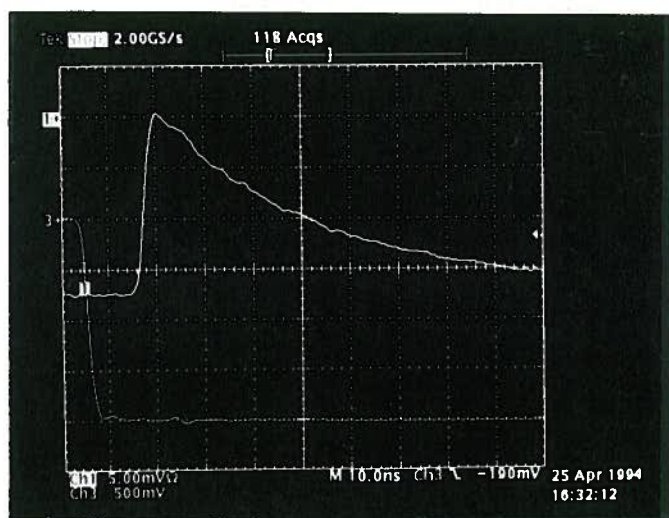
4/25
JA

Using the same setup as on p.50



same feedback networks
cause used the same socket
setup.

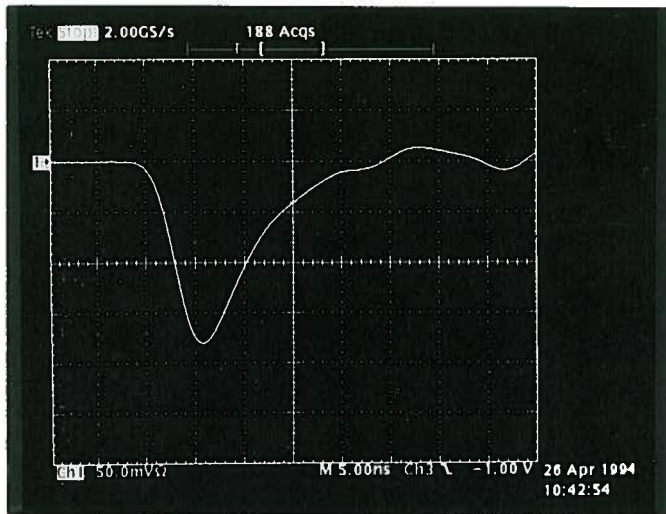
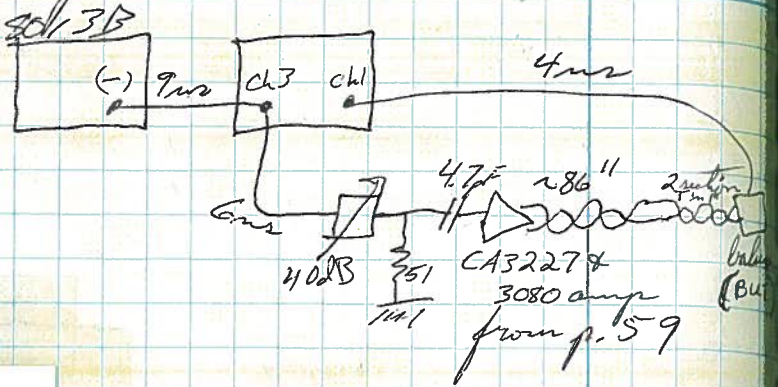
$$V_{\text{supplies}} = \pm 5.0V$$



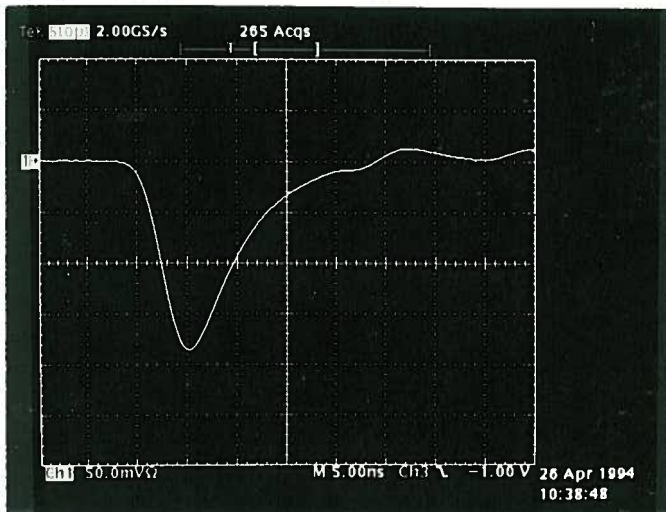
Same setup as upper
photo. Allows direct
comparison to photos
on p.50 etc.

4/26 Toho Balun Responses

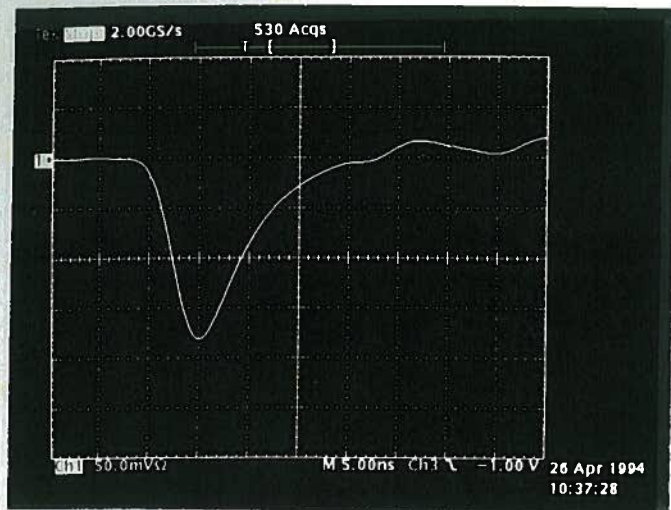
~~same setup as on~~
 same step pulse as used on
 bottom photo of p. 129



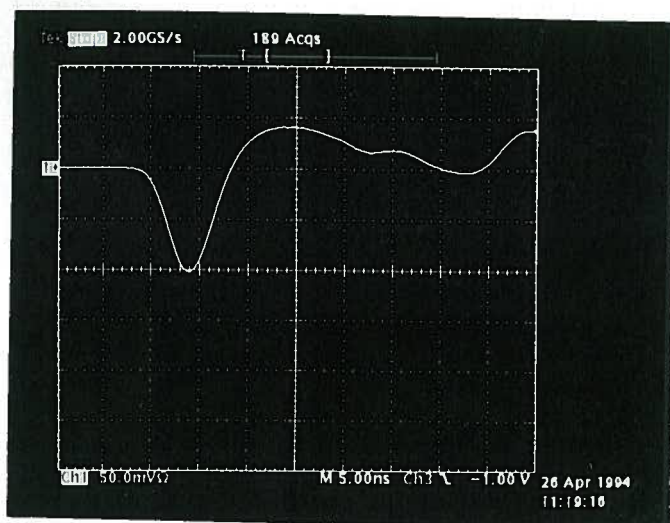
rt. x



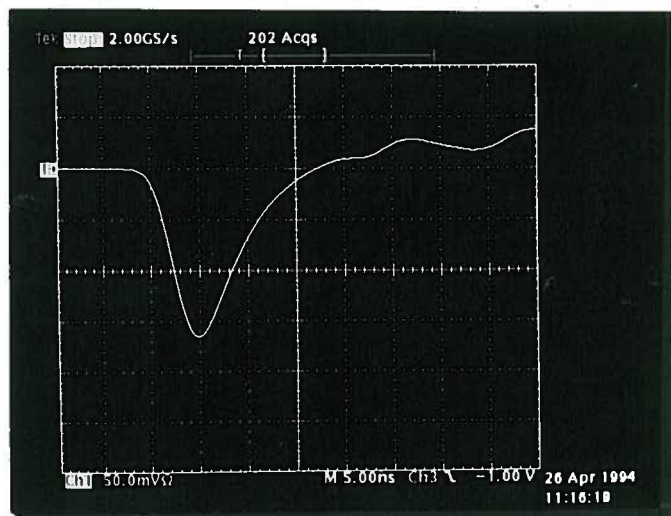
Copper tube



07

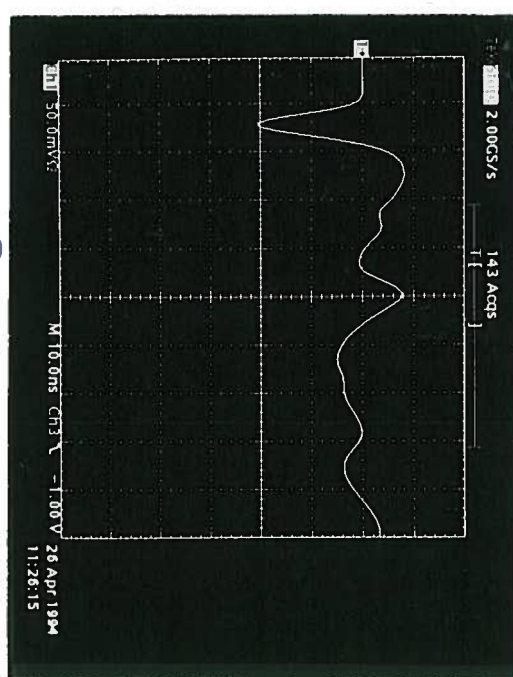
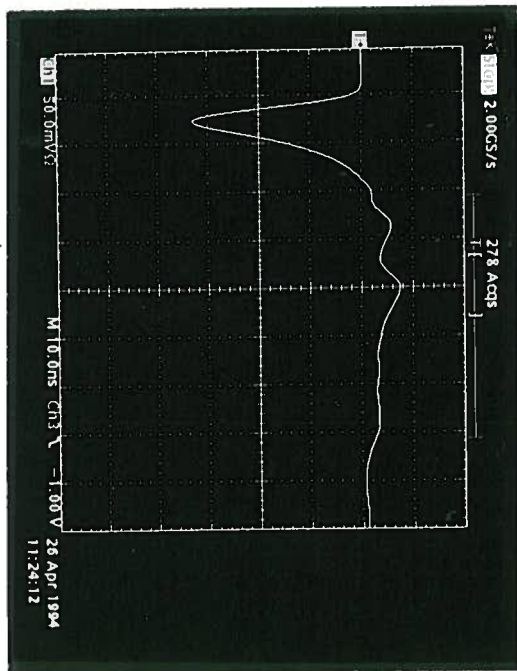
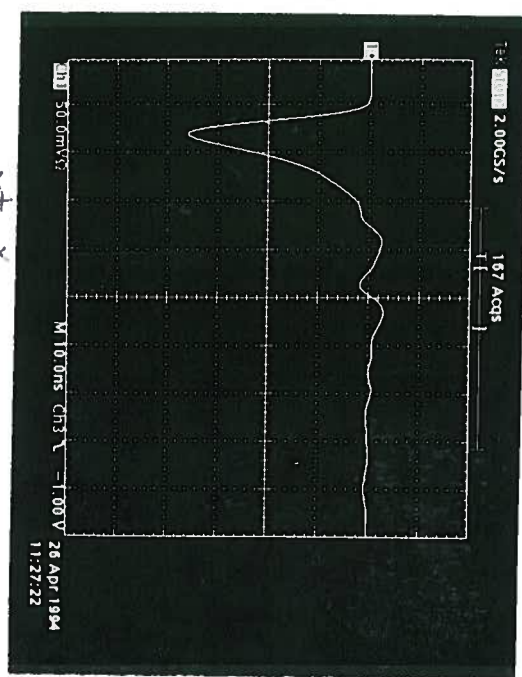
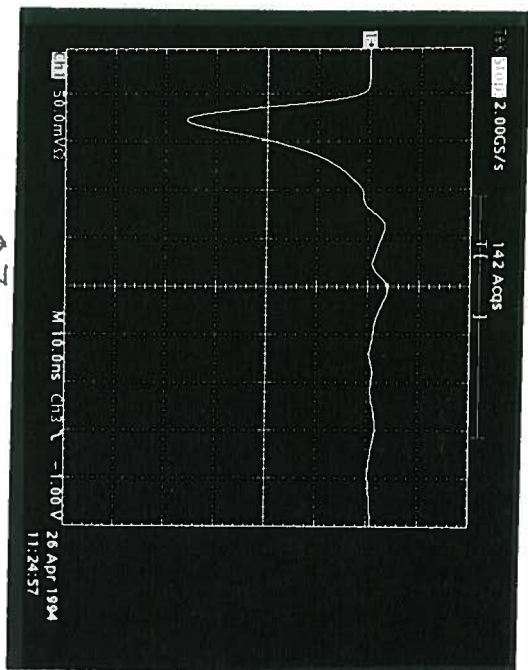


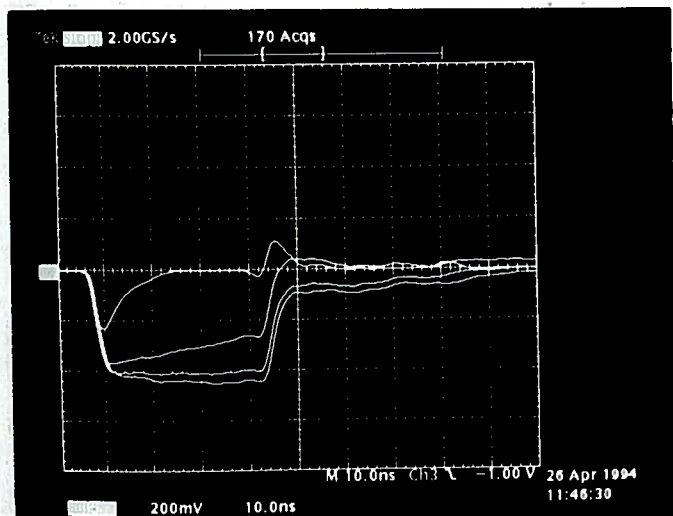
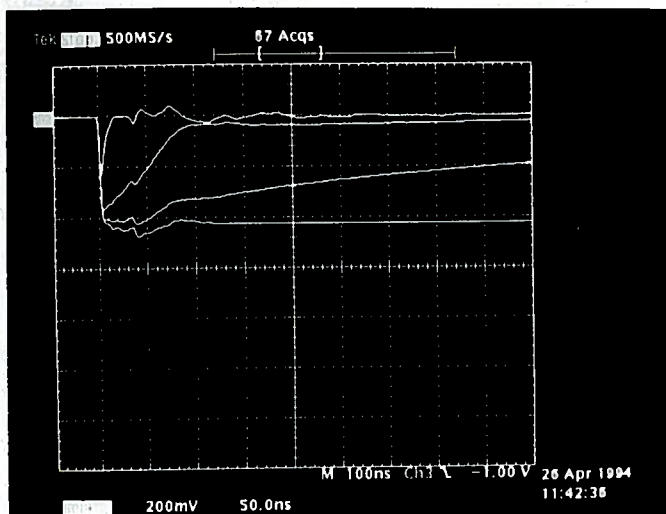
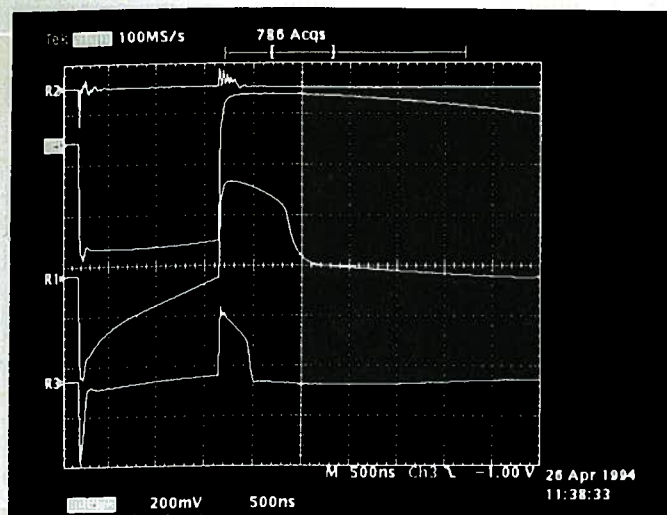
09



14

same setup as p. 130 & 131. Different time scale.



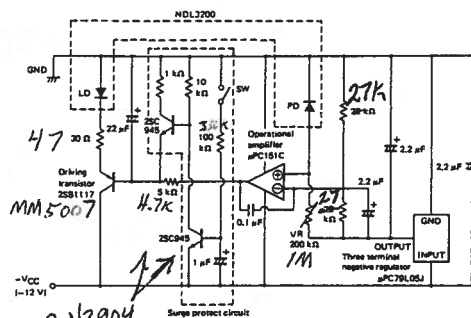


Laser Diode for Analog Transmission 1st attempt
Copied circuit from NEC data book.

3.1 Circuit Operation

Figure 3 shows an example of an APC circuit for NDL3200

Fig. 3 An example of an APC circuit (in continuous operation)



The LDR and the monitoring photo diode are represented respectively by 'LD' and 'PD' in the box. Maxium driving current of about 140 mA can be obtained.

The feedback loop of the APC circuit is composed of the LD, PD, op amp, and the base of the driving transistor. In that order,

The LD driving current is controlled by modifying the bias at the base of the driving transistor.

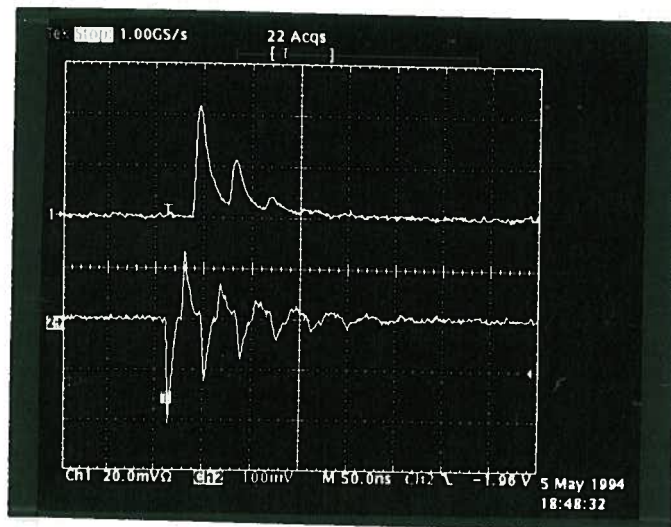
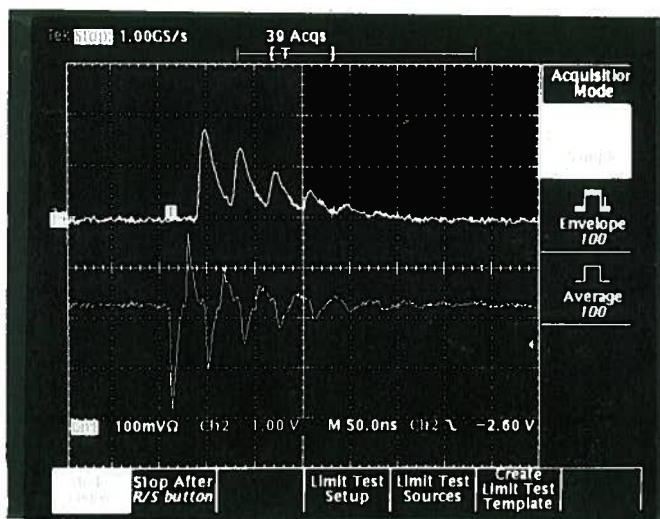
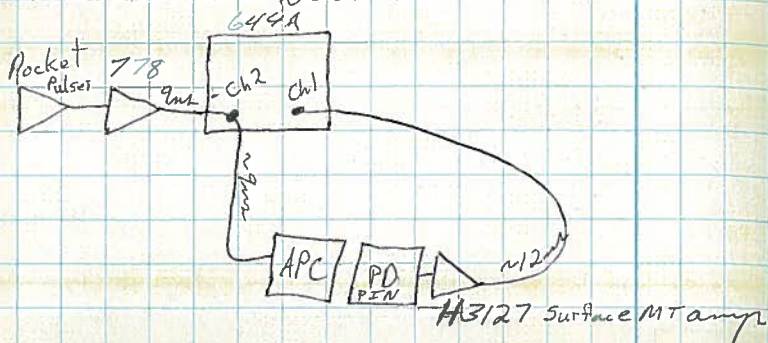
The surge protect circuit protects the LD from a current surge, with an approximately 0.1 fsec time constant for turning the LD on and off.

The following explains the setting of an APC circuit.

(Setting)

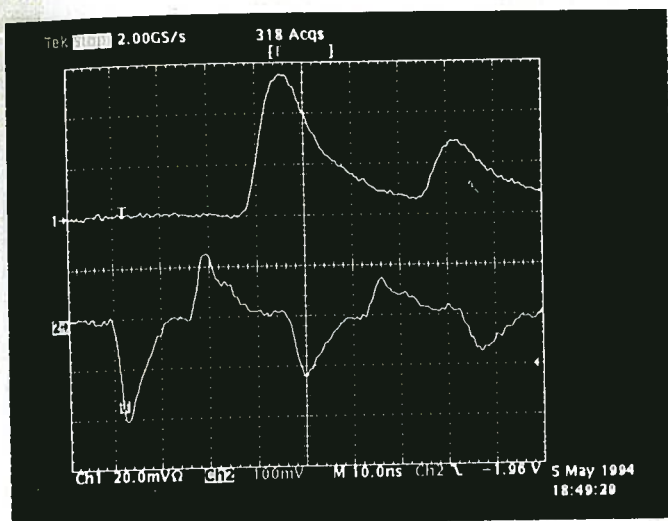
- 1 Set the variable resistor VR to the maximum ($VR = 200\text{ k}\Omega$)
- 2 Turn on the power V_{CC} (-12 V).
- 3 Turn on the switch and read out the optical output of the laser diode on the optical power meter.
(Approx. 0.5 mW)
- 4 Gradually lower the VR resistance to the desired optical output, referring to the optical power meter. The set optical output must not exceed the absolute maximum rating optical output. Using a potentiometer instead of a VR flattens the optical output change, making it easier to control the output.

Rough approximations of the optical in NDL3200 are: 1 mW, 2 mW, or 3 mW of P_O is obtained by setting VR to 50 k Ω , 16 k Ω , or 7 k Ω respectively.

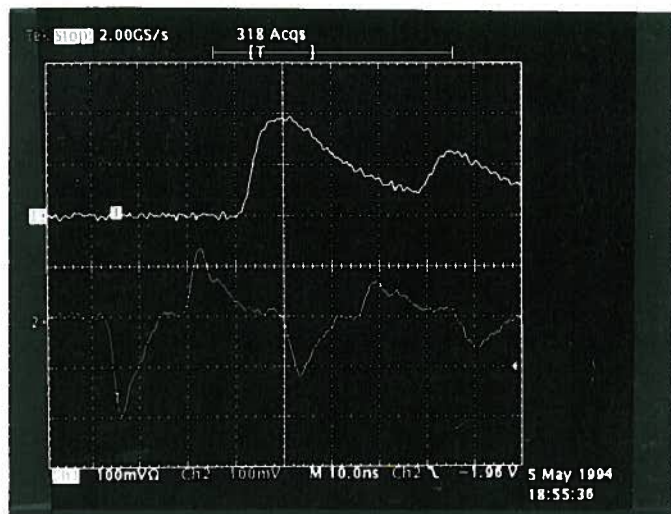


There two photos are
of the laser diode butted
up against the PIN diode
housing.

Threshold current is
35mA typ (55mA max)



Same as ~~top~~ bottom photo
 on previous page.
 Expanded time scale.

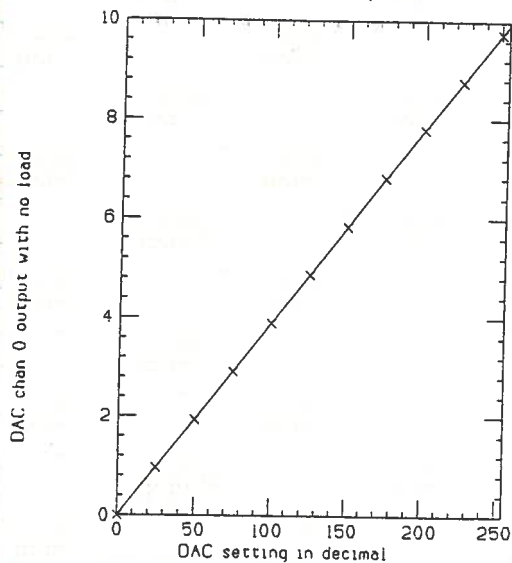


Short piece (~2") of 1mm
 fiber used to couple the
 LO + PIN.

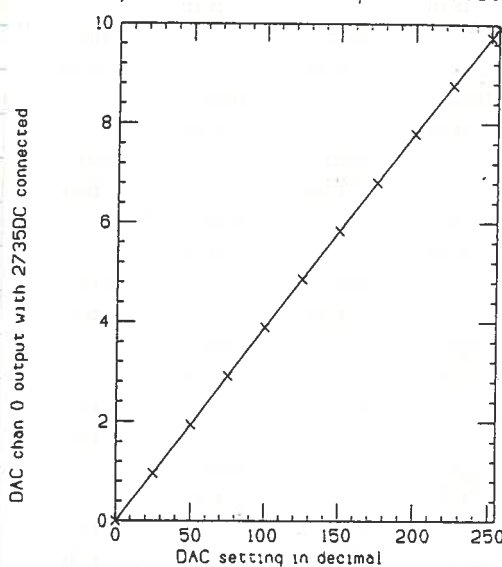
6/20 LeCroy 2735DC Threshold
 JS

DAC output as a function of setting for output module

LeCroy 2735DC and output module



LeCroy 2735DC and output module



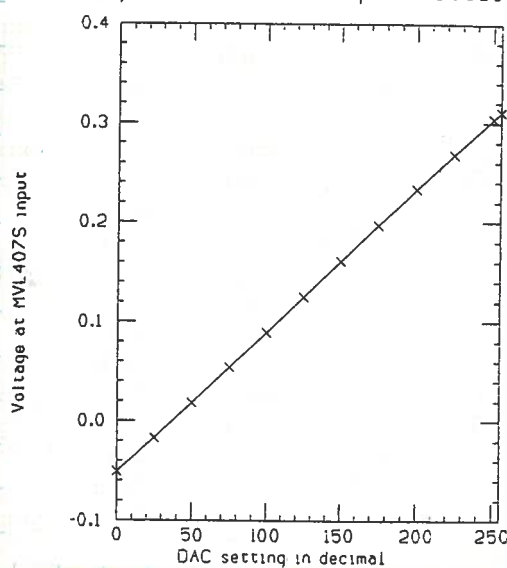
Voltages are measured
 using a Goldstar

DC bias at the other MVL4075
 input is measured for
 all 16 channels

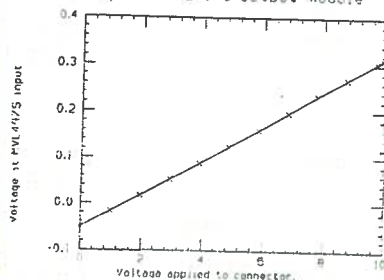
chip 1	chip 3
-59.1mV	-58.0
-58.6	-57.8
-58.6	-58.2
-58.8	-58.6

chip 2	chip 4
-58.9	-58.8
-58.4	-58.1
-58.9	-58.9
-59.2	-59.4

LeCroy 2735DC and output module



LeCroy 2735DC and output module



I would like to address the question of lifetime of the VDC's vs. Gain.

Let there exist an amplifier, LeCroy 2735DC, such that its gain with 15pF capacitance on the input is 1.8mV per fC of input charge. This is what I find for bench measurements of this amplifier. (My logbook p.112)

Furthermore, let the threshold to input charge have a relationship of

$$\text{fC input} = ((.036 * \text{Threshold voltage}) + .0075\text{V}) / (.0018 \text{ V per fC})$$
(My logbook p.136)

This is in agreement with bench measurements made by me, Jack Segal. Thus
 a Threshold of 5V $\Rightarrow$ 104fC of input charge and
 a Threshold of 8V $\Rightarrow$ 164fC of input charge

Given 6250 electrons = 1fC

$$104\text{fC} = 6.5 * 10^{**5} \text{ electrons}$$

$$\text{and } 164\text{fC} = 1.03 * 10^{**6} \text{ electrons}$$

If only 10% of the total charge is accumulated in the initial portion of the wire chamber signal the gain must be 10 times greater than that required to exceed threshold. So,

$$\text{for 5V threshold} \Rightarrow 6.5 * 10^{**6} \text{ electrons}$$

$$\text{for 8V threshold} \Rightarrow 1.03 * 10^{**7} \text{ electrons}$$

Assume the gas used is Argon/Isobutane at a ratio of 50/50.

Then, as given in the sacred text of Sauli(p.9),

the number of primary ion pairs per cm will be 37.7/cm and

the total number of ion pairs per cm will be 144.7/cm

Given a wire spacing of 4.23mm and a track angle of 45 degrees

$$\text{then } (4.23 * 2^{**0.5} * 2^{**0.5}) = 8.46\text{mm per track in a cell}$$

(This is not used in the calculation.)

Given a cathode to cathode spacing of 26mm and a track angle of 45 degrees

$$\text{then } (26 * 2^{**0.5}) = 36.8\text{mm per track in a plane}$$

(This is used in the calculation.)

Since 36.8mm per track and 144.7 ion pairs per cm

$$36.8 * 14.47 = 532 \text{ ion pairs per track per plane}$$

Assume the first electron is sufficient to cross threshold.

Assume the overall gain is 0.6*(Gain for the first electron) due to the

45 degree inclination of the track with respect to the sense wire and

the physical size of the avalanche. These two affect shielding of charge.

For 5V threshold this gives

$$(0.6 * (6.5 * 10^{**6} \text{ electrons})) * 532 \text{ ion pairs} = 2.1 * 10^{**9} \text{ electrons}$$

$$= 332\text{pC per track per plane}$$

For 8V threshold this gives

$$(0.6 * (1.03 * 10^{**7} \text{ electrons})) * 532 \text{ ion pairs} = 3.3 * 10^{**9} \text{ electrons}$$

$$= 526\text{pC per track per plane}$$

Assume a uniform flux of particles over the active area of VDC1

$$1666.9\text{mm}[\text{dispersive} * 2^{**0.5}] * 113.2\text{mm}[\text{transverse}] = 188697[\text{mm}^{**2}]$$

For one wire

$$113.2\text{mm} * 2^{**0.5} = 160.1\text{mm long and covers an area}$$

$$160.1\text{mm} * 4.23\text{mm} = 677.2(\text{mm}^{**2})$$

which is 0.36% of the active area of the VDC1.

Assume the particle flux is 1MHz over the VDC1 active area.

For 5V threshold there will be $1 * 10^{**6} * 332\text{pC} = 332\text{uC}$ per second per plane

For 8V threshold there will be $1 * 10^{**6} * 526\text{pC} = 526\text{uC}$ per second per plane

Given that 1 year = 31536000 seconds

For 5V threshold there will be 10470C per plane per year

$$= 10470\text{C} * .36\% = 38\text{C per wire per year}$$

$$= 38\text{C} / 16\text{cm} = 2.4\text{C per cm per year}$$

For 8V threshold there will be 16590C per plane per year

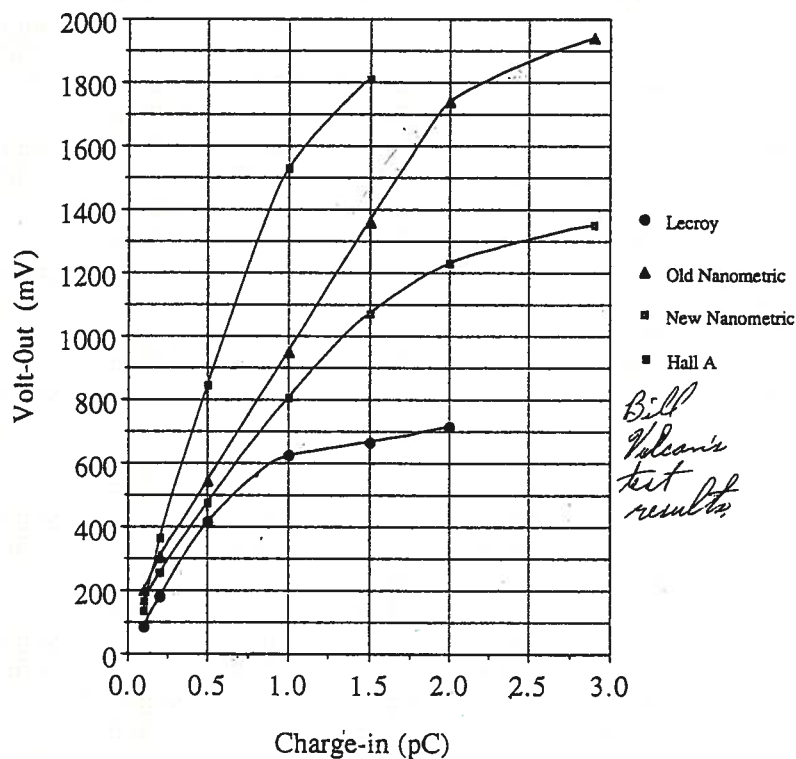
$$= 16590\text{C} * .36\% = 60\text{C per wire per year}$$

$$= 60\text{C} / 16\text{cm} = 3.7\text{C per cm per year}$$

Hall C 2735 DC vs. N-277-L

Test results from Hall C's investigation of amplifiers for their wire chambers.
 "New Nanometric" has diodes installed for input protection. "Old Nanometric" does not.

CHIP DATA



Probe measurements at amplifier chip outputs using FET probe and a TDS 540 scope

for 11904295600

From: DETAILED

4-20-14 09:34 3.2

Ref: Calculating conductor resistance change with a conductor temperature change:

T1 = Original Temperature
T2 = New Temperature
R1 = Resistance At Original Temperature
R2 = Resistance At New Temperature

Calculate:
 $(234.5 - T1) / R1 = (234.5 - T2) / R2$

Example: Conductor = 12 ohms at 20 degrees C. what is resistance at 75 degrees C?

$(234.5 - 20) / 12 = (234.5 - 75) / R2$

$254.5 / 12 = 389.5 / R2$

$21.21 = 389.5 / R2$

$R2 = 389.5 / 21.21$ or 14.592 Ohms at 75 degrees C

Tracy found out for us how to correct attenuation to ambient temperature:

Our published attenuation numbers assume 20 degrees C ambient. For any temperature other than 20C, use the following formula:

X=attenuation
T=New Temperature

$X(T) = X(20C) * \text{square root}[(1 - .00393 * (T - 20))]$

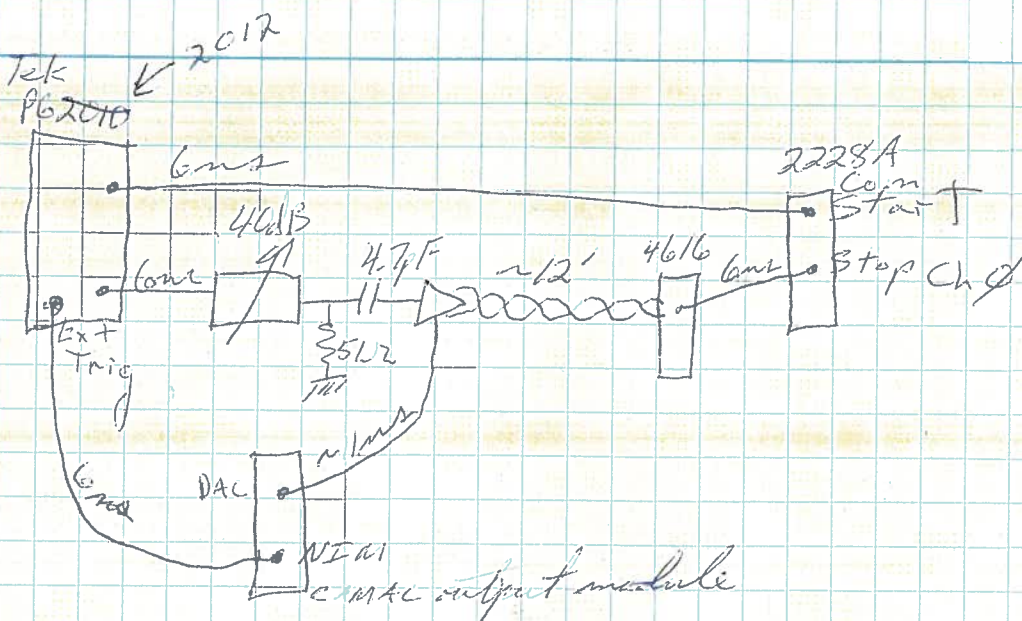
example: The attenuation of 8201 at 400 MHz assuming 20C is 5.3 dB/100'. We want to know attenuation at 60C:

$X(60C) = 5.3 * \text{square root}[(1 - .00393 * (60 - 20))]$

$X(60C) = 5.3 * \text{square root}[(1 - .1558)]$

$X(60C) = 5.89 \text{ dB/100'}$

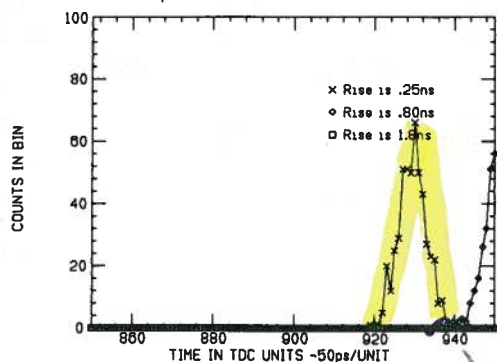
8/17



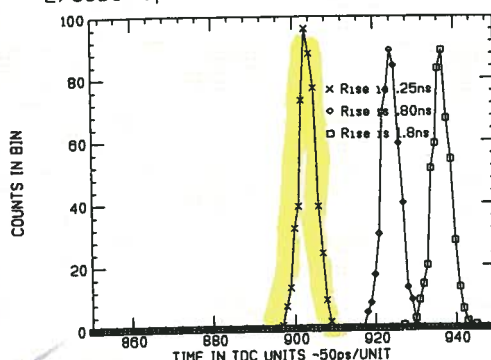
Step	20dB	40dB
0.60	28.2	282
1.20	56.4	564
1.50	70.5	705
1.75	82.3	823
2.00	94.0	940
2.25	106	1060

500 pulses done in a run.

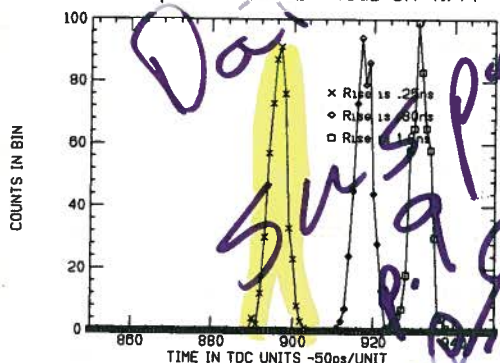
2735DC 0pF 0.60V STEP/40dB ON 4.7PF



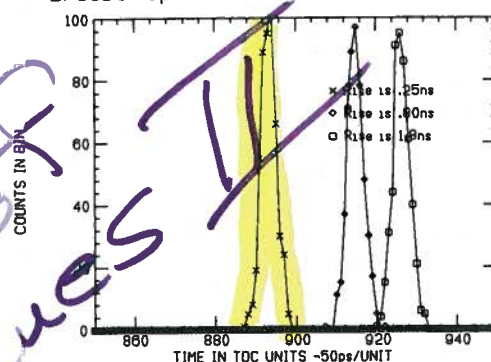
2735DC 0pF 1.20V STEP/40dB ON 4.7PF



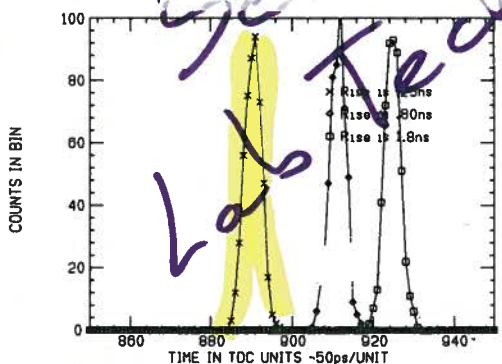
2735DC 0pF 1.50V STEP/40dB ON 4.7PF



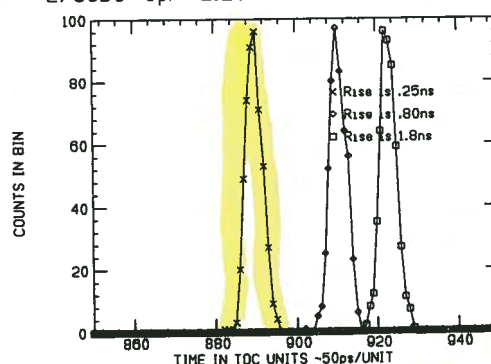
2735DC 0pF 1.75V STEP/40dB ON 4.7PF



2735DC 0pF 2.00V STEP/40dB ON 4.7PF



2735DC 0pF 2.25V STEP/40dB ON 4.7PF



Threshold for LeCroy was 20 DAC units

$$\frac{10V}{255} \times 20 = 0.78V$$

@ 1.8ns rise

from 56 to 105 FC

$$938 - 922 = 16 \text{ bins}$$

$$16 \times 50 = 800 \text{ ps}$$

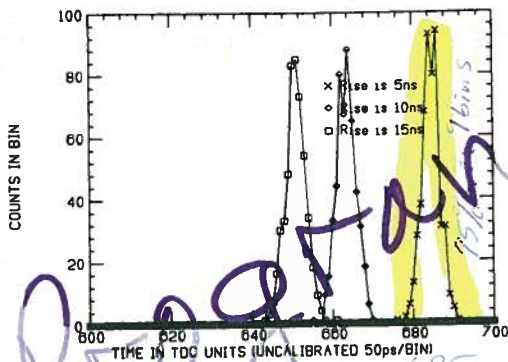
$\Rightarrow 0.8 \text{ ns timewalk}$

Order of short to long rise time is opposite of this on p. 142. Why??!!

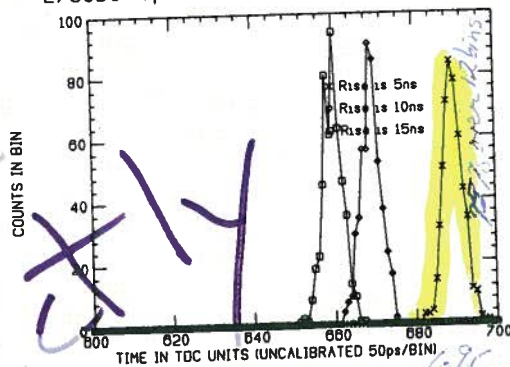
Time is later for a longer rise time.

Time is earlier for longer rise time!

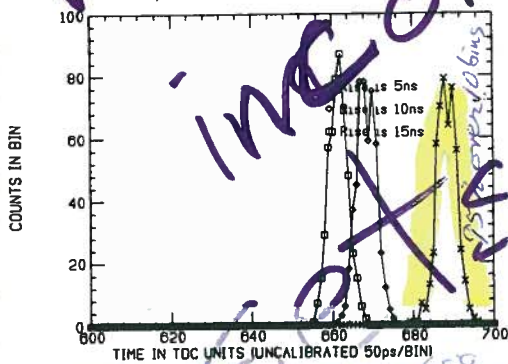
2735DC 0pF 0.60V STEP/40dB ON 4.7PF



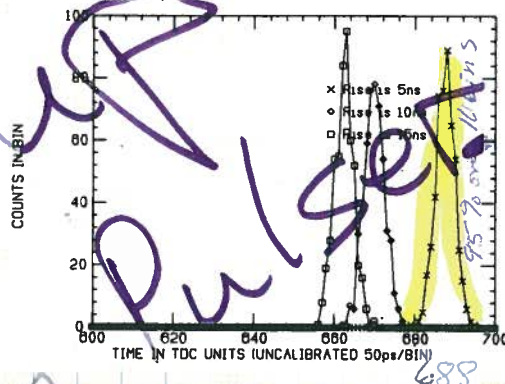
2735DC 0pF 1.20V STEP/40dB ON 4.7PF



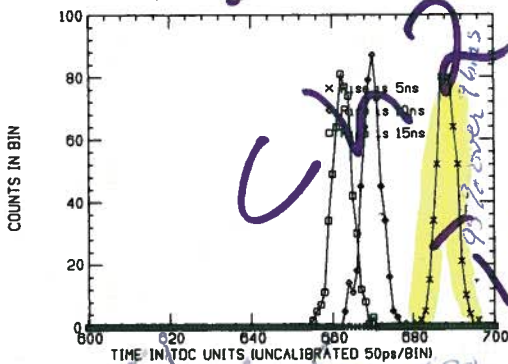
2735DC 0pF 1.50V STEP/40dB ON 4.7PF



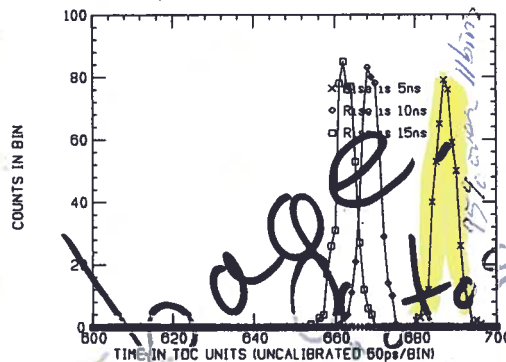
2735DC 0pF 1.75V STEP/40dB ON 4.7PF



2735DC 0pF 2.00V STEP/40dB ON 4.7PF



2735DC 0pF 2.25V STEP/40dB ON 4.7PF



@ 5ns rise from 56 to 105 fC

690-686 = 4 bins

4x50 = 200ps

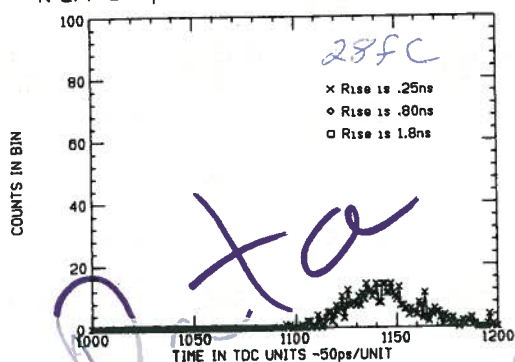
0.2ns time walk

10x50 = 500ps

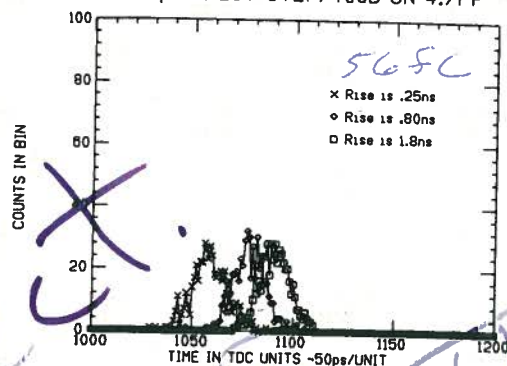
0.5ns jitter

Does not agree with p. 150!!! see p. 150 for Keesling's

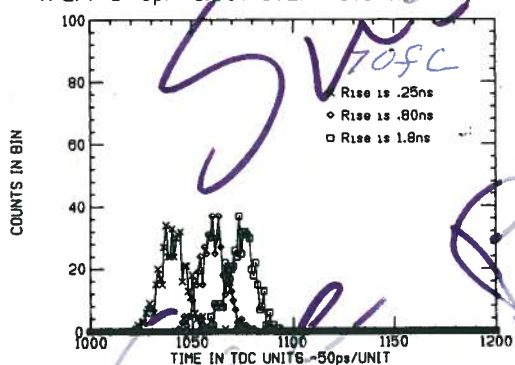
N-277-L 0pF 0.60V STEP/40dB ON 4.7PF



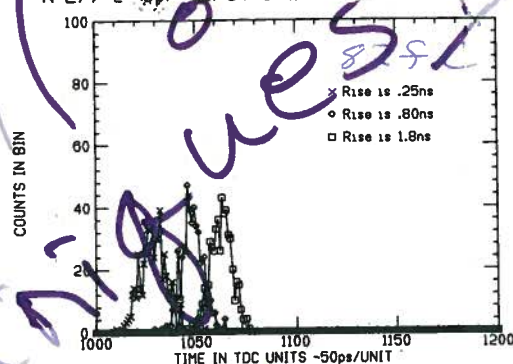
N-277-L 0pF 1.20V STEP/40dB ON 4.7PF



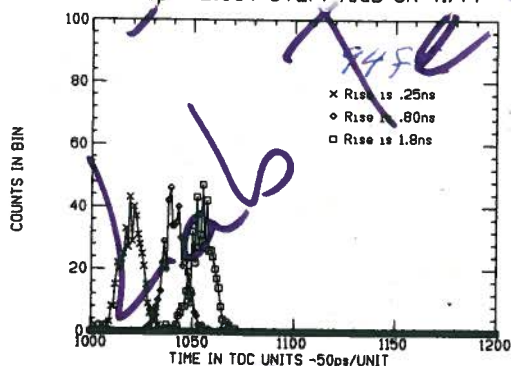
N-277-L 0pF 1.50V STEP/40dB ON 4.7PF



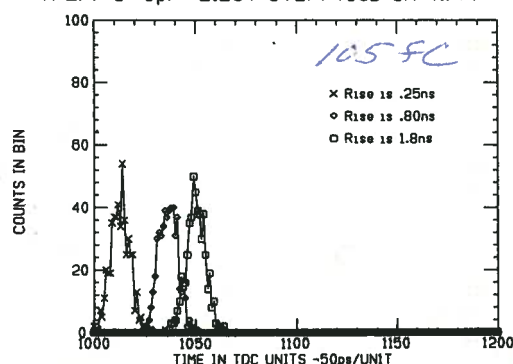
N-277-L 0pF 1.75V STEP/40dB ON 4.7PF



N-277-L 0pF 2.00V STEP/40dB ON 4.7PF



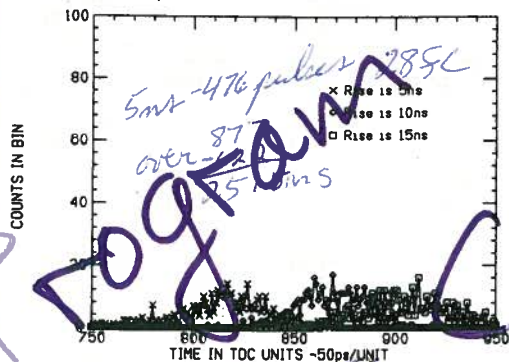
N-277-L 0pF 2.25V STEP/40dB ON 4.7PF



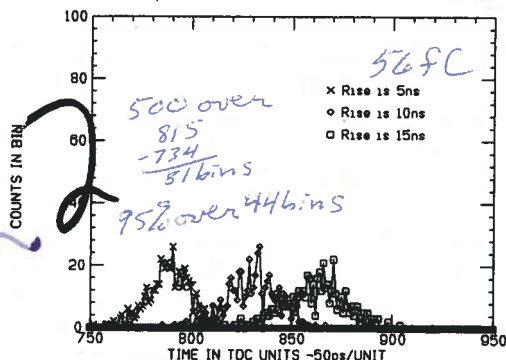
Threshold for Nanometric was 40 DAC units
 @ 1.8ns rise
 from 56 $\rightarrow$ 105 fc
 $1090 - 1050 = 40 \text{ bins}$
 $40 \times 50 = 2000 \text{ ps}$
 $\Rightarrow 2.0 \text{ ns time walk}$

$\frac{10V}{255} \times 40 = 1.57V$

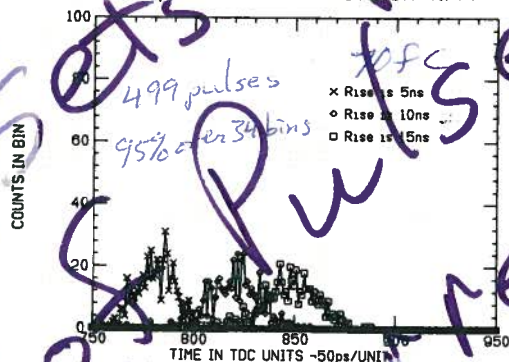
N-277-L 0pF 0.60V STEP/40dB ON 4.7PF



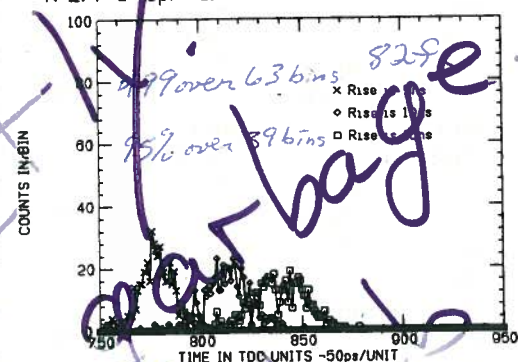
N-277-L 0pF 1.20V STEP/40dB ON 4.7PF



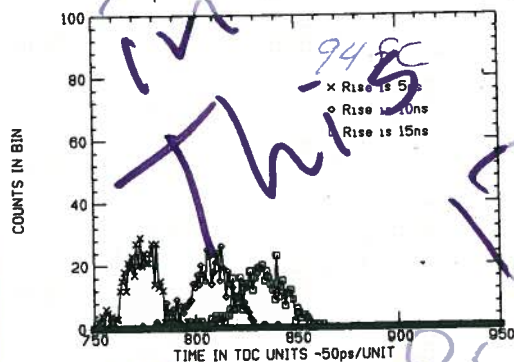
N-277-L 0pF 1.50V STEP/40dB ON 4.7PF



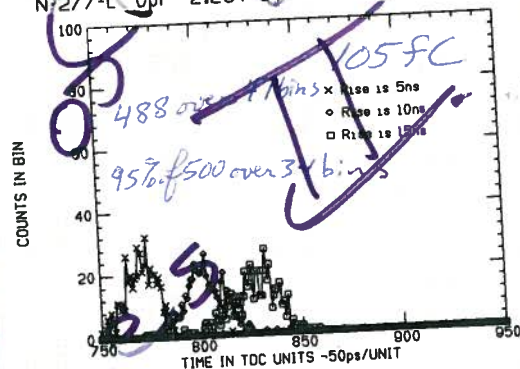
N-277-L 0pF 1.75V STEP/40dB ON 4.7PF



N-277-L 0pF 2.00V STEP/40dB ON 4.7PF



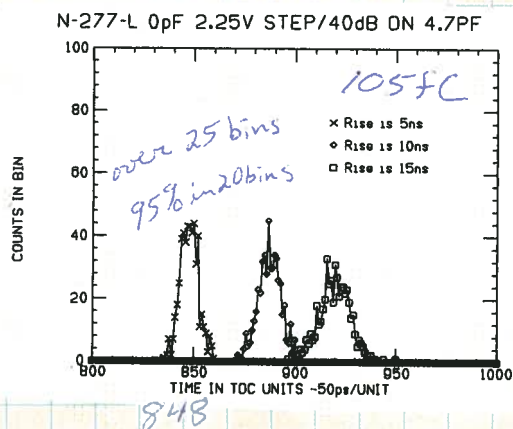
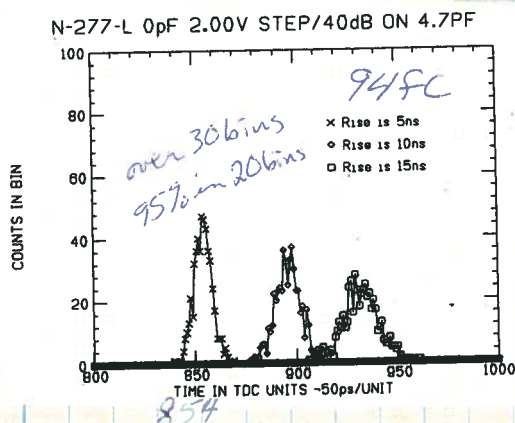
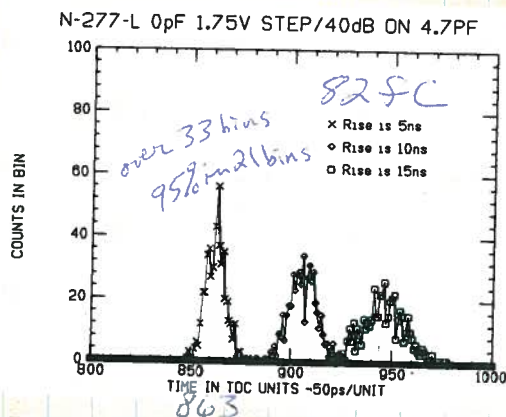
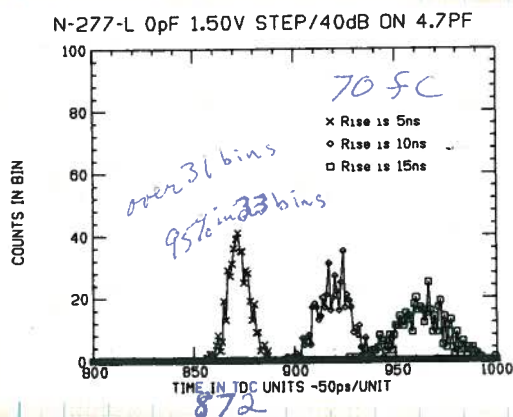
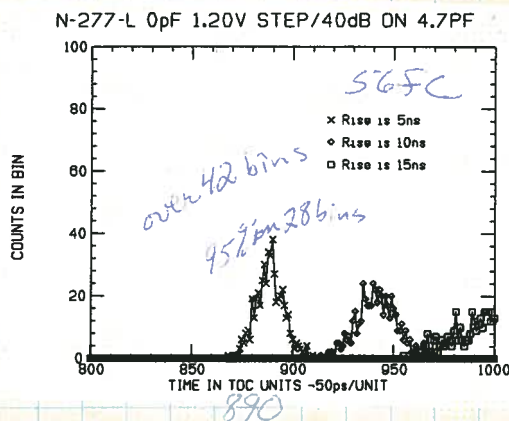
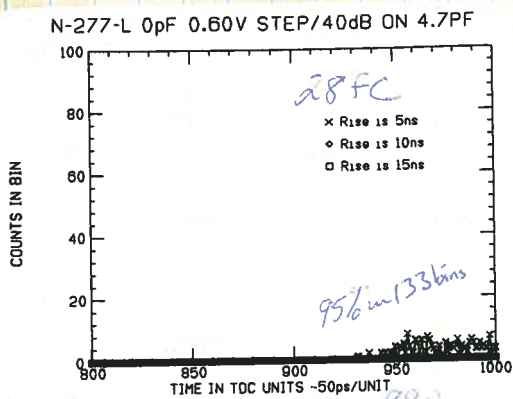
N-277-L 0pF 2.25V STEP/40dB ON 4.7PF



@ 5ms rise
 from 56 to 105 FC
 790 → 770 = 20 bins
 $20 \times 50 = 1000 \text{ ps}$
 $\Rightarrow 1.0 \text{ ms time walk}$
 34 × 50 = 1700 ps
 $\Rightarrow 1.7 \text{ ms jitter}$
 @ 5ms rise 4.6V on 40dB
 height is ~34 DAC units

The program used for the
fast risetime portion did
~~show~~ not correctly set Ch 2.
Consequently the scope went
into some strange mode. Not
clear what the whole trouble was.
Combined both slow & fast risetimes
in one program. Verified pulser
operating correctly. How runs
done on p. 8-112 of Lab
Technique V.

Same setup as p. 140 except 2.5' of TWT from 2735 to 2766.
 & 15 ns of cable on TDC start input, not less.



④ 5ns rise

from 56 → 105 FC

$$890 - 848 = 42 \text{ bins}$$

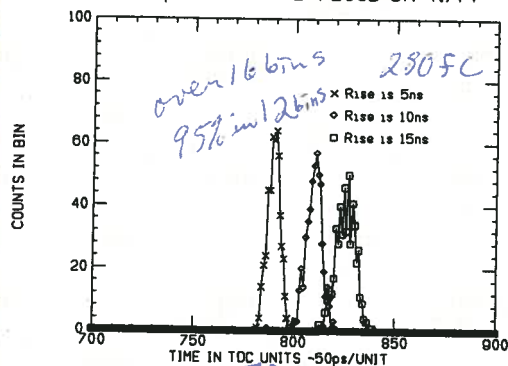
$$42 \times 50 = 2100 \text{ ps}$$

⇒ 2.1 ns time walk

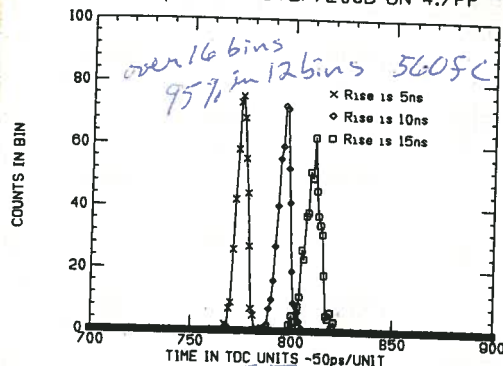
$$20 \times 50 = 1000 \text{ ps}$$

⇒ 1.0 ns jitter

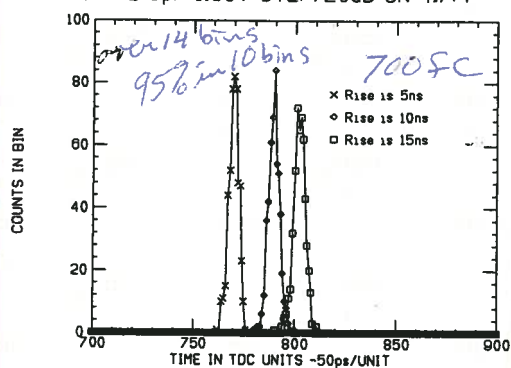
N-277-L 0pF 0.60V STEP/20dB ON 4.7PF



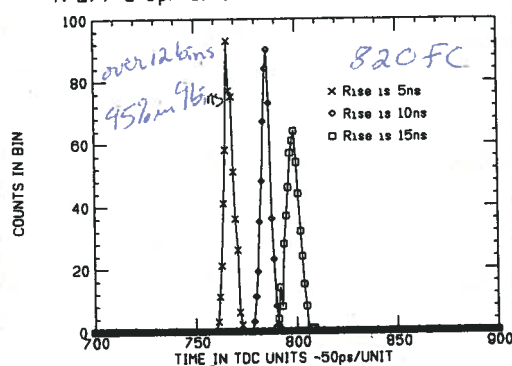
N-277-L 0pF 1.20V STEP/20dB ON 4.7PF



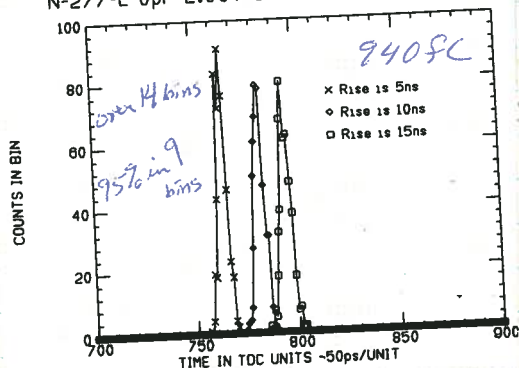
N-277-L 0pF 1.50V STEP/20dB ON 4.7PF



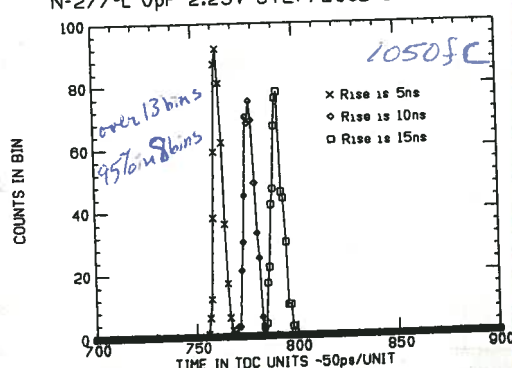
N-277-L 0pF 1.75V STEP/20dB ON 4.7PF



N-277-L 0pF 2.00V STEP/20dB ON 4.7PF



N-277-L 0pF 2.25V STEP/20dB ON 4.7PF



@ 5ns rise

from 700 → 700°C

$$872 - 770 = 98 \text{ bins}$$

$$98 \times 50 = 4900 \text{ ps}$$

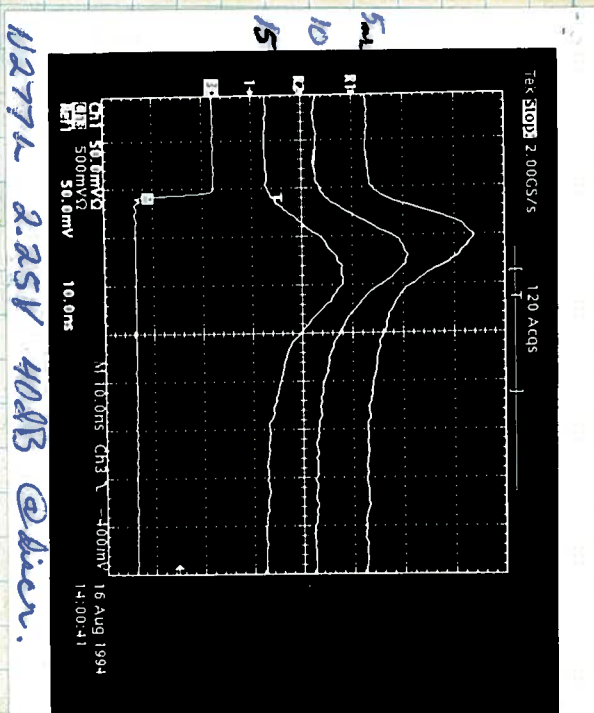
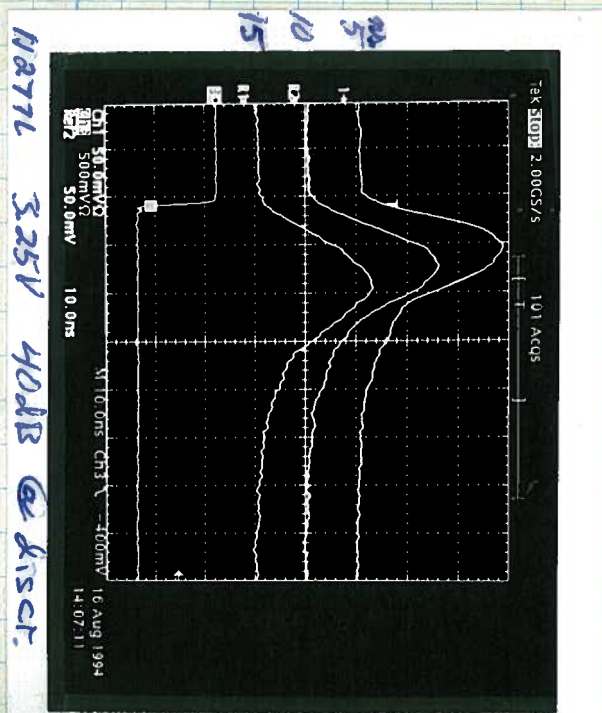
⇒ 4.9 ns time walk

$$10 \times 50 = 500 \text{ ps}$$

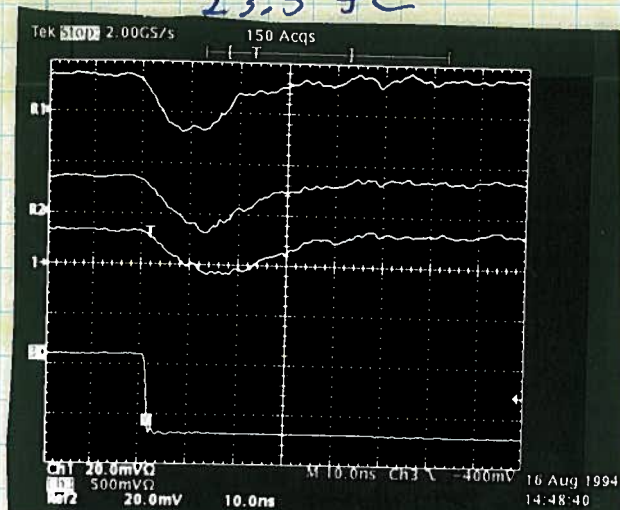
⇒ 0.5 ns jitter

Risetime and Amplitude Response of NA277L & 2735 DC

These pictures were taken yesterday.
 Rise time of step pulse is varied. Amplitude of
 step is also varied. Pictures @ $\text{discr} \equiv \text{FET}$
 probe at input pin of discriminating chip. @ amp
 $\equiv \text{FET}$ probe at output pin of the amplifier chip.
 Threshold set to 255 DAC units (10.0V).
 Step pulse in photo not used for Q injection!

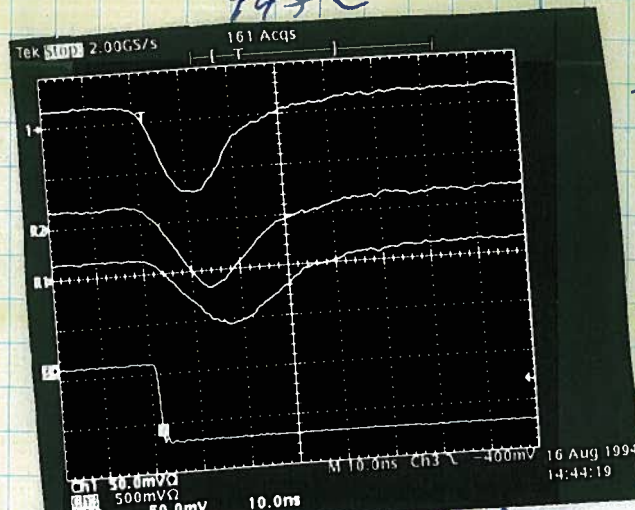


23.5 SC



277L 0.5V 40dB @discr.

94 SC



N277L 2.0V @discr.

5ns

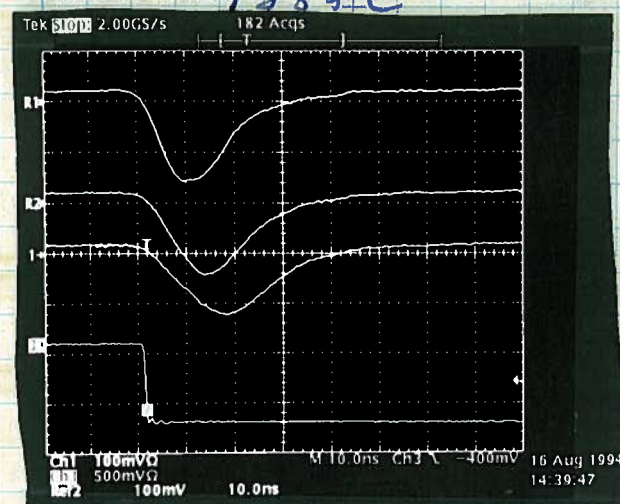
10ns

15ns
rise
time

Same

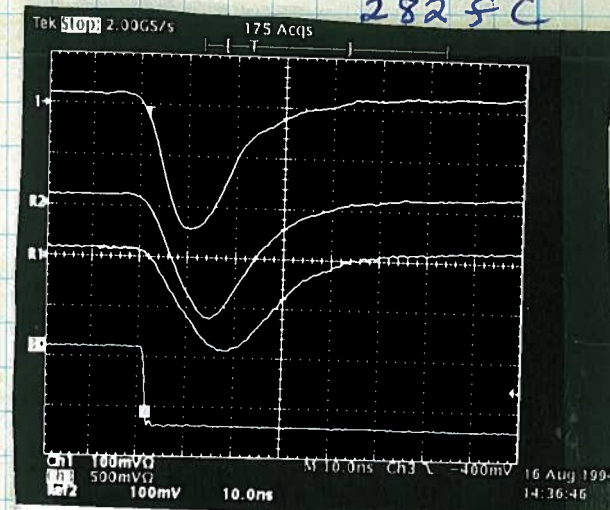
for
all
photosthis
page.

188 SC



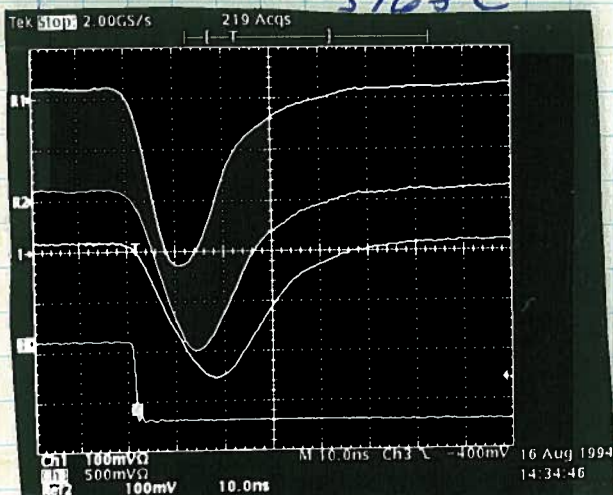
4.0V

282 SC



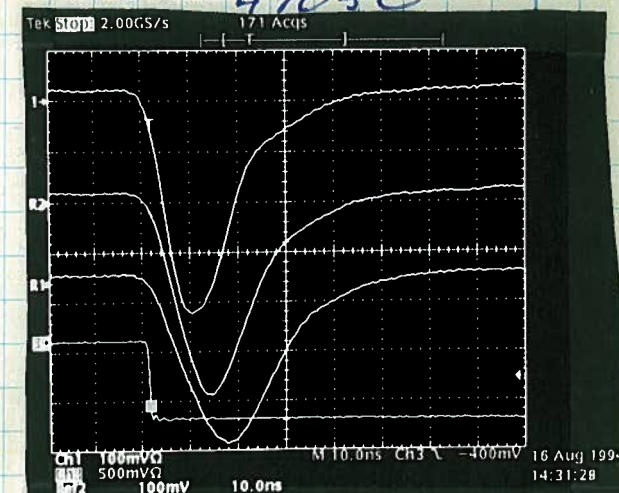
6.0V

376 SC

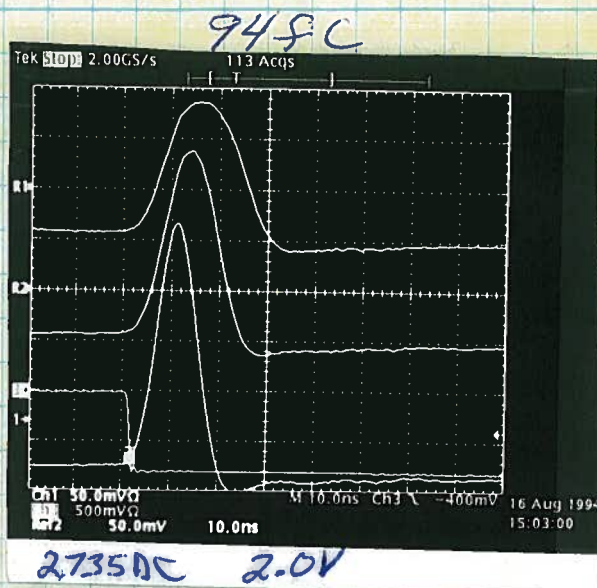
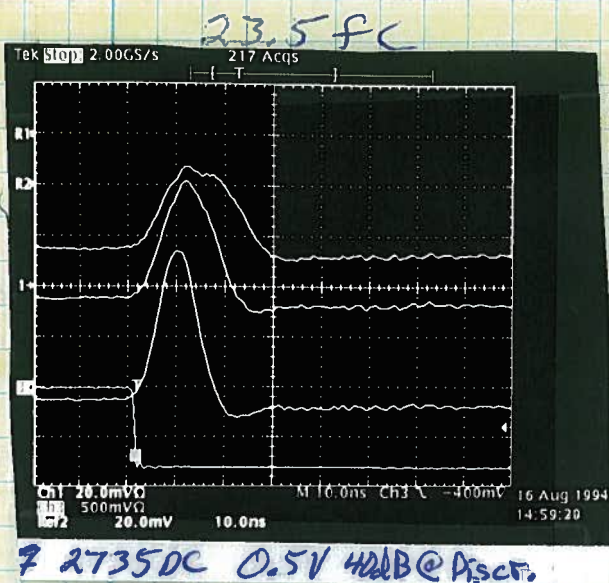


8.0V

470 SC



10.0V

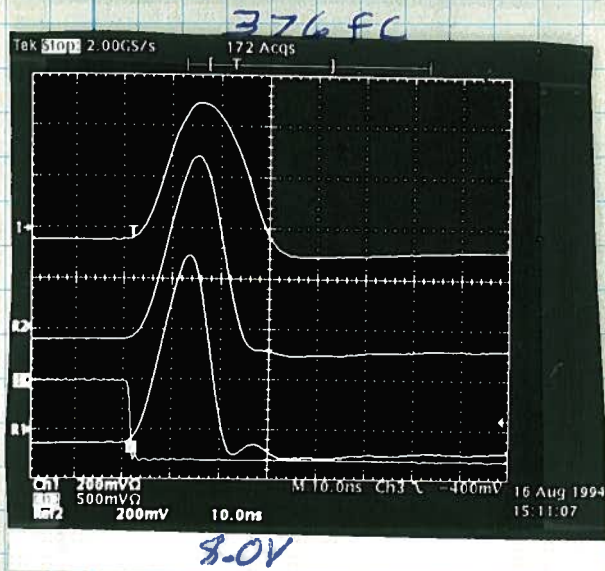
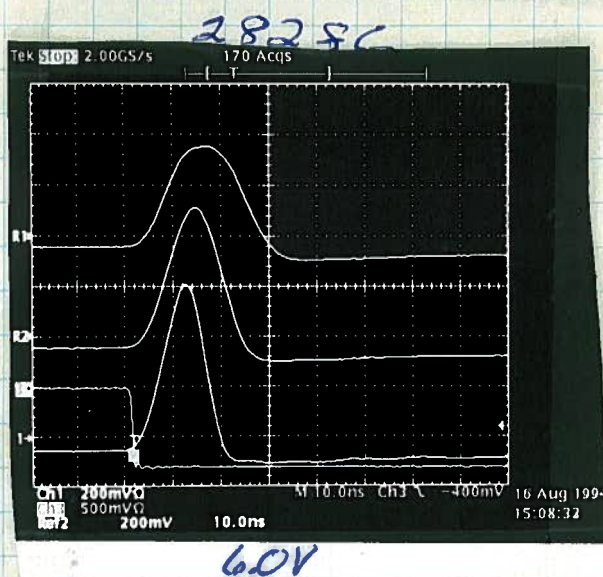
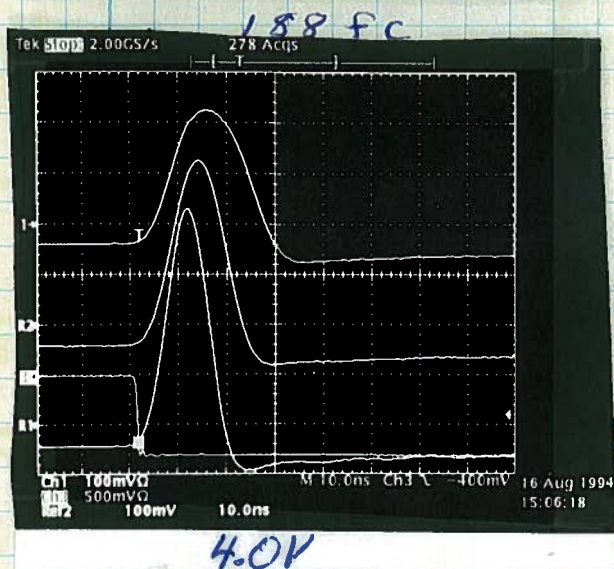


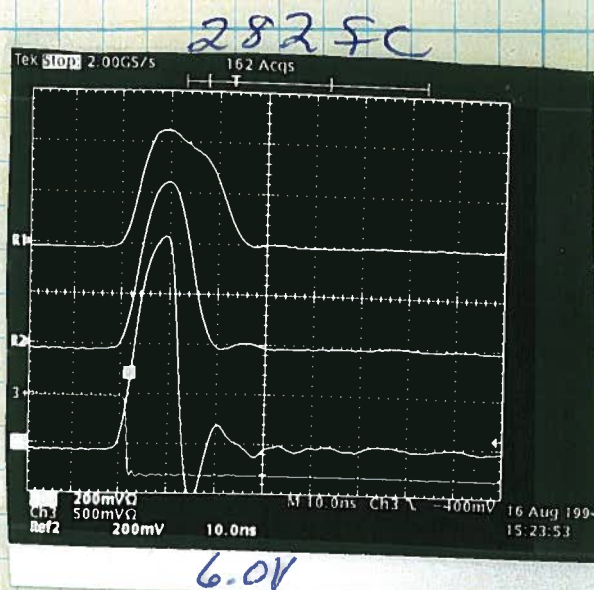
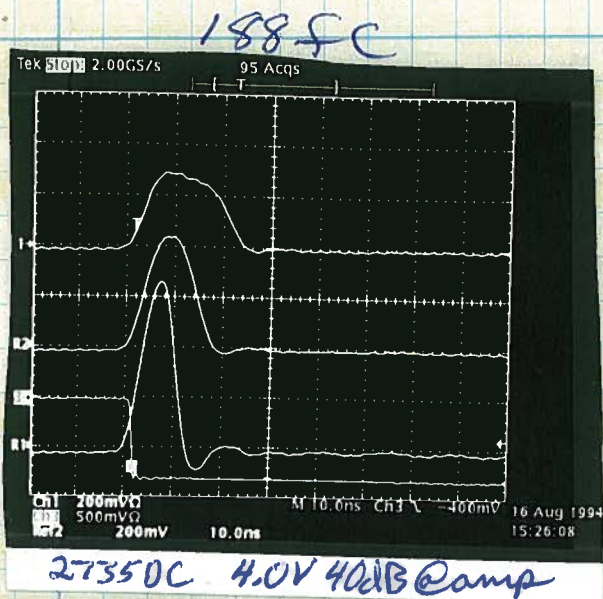
ALL
photos
this
page.

15ms

10ms

5ms
rise



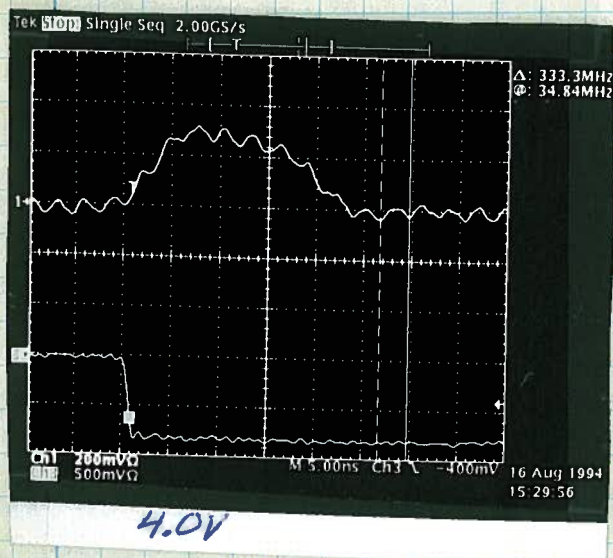


All photos
on this
page
are

15ms

10ms

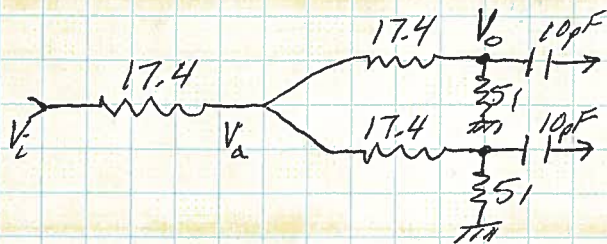
5ms
rise
time



This last photo on the page is
intended to demonstrate
the low-level oscillation
at the output of the amp
chip. 15ms rise time.

Photos continued in
Lab Techniques II

$$\frac{6.25 \times 10^{18} e^-/C}{6250 e^-/FC}$$



$$V_a = V_L \left(\frac{34.2}{34.2 + 17.4} \right)$$

$$V_o = V_a \left(\frac{51}{51 + 17.4} \right)$$

$$V_o = .494 V_L$$

