

Fermilab

TM-1390
2563.800

A NEW PREAMPLIFIER FOR DRIFT CHAMBERS

T. Zimmerman

March 1986

Table of Contents

	<u>Page</u>
Abstract	1
I. Circuit Description	1
II. Gain and Linearity.....	1
III. Rise and Fall Times.....	3
IV. Crosstalk	3
V. Noise	3
VI. Frequency Response	4
VII. Response vs. Supply Voltage	4
Figures	6

A NEW PREAMPLIFIER FOR DRIFT CHAMBERS

Abstract

A new preamplifier has been developed by T. Kondo and a monolithic version built by Fujitsu of Japan. The monolithic device, MB43468, is in a 14 pin small outline IC package and contains four amplifiers. The package is similar to the MB43458, which was built by Fujitsu for the Fermilab YTPC and covered in TM-1284. However, unlike the MB43458, the device is an inverting negative feedback amplifier, intended for positive outputs. This report documents the results of the tests performed on this device.

I. CIRCUIT DESCRIPTION

The MB43468 is a four channel preamplifier in a 14 pin SOIC package. The chip pin out and the schematic of one channel are shown in Figures 1 and 2. Only the input and output of each amplifier are available. The supply voltage is specified as +8V. The circuit is an inverting common emitter amplifier in the cascode configuration, with a bootstrapped load for high impedance. This is followed by two emitter followers, providing a low impedance output. A 20K negative feedback resistor is inside the chip and determines the DC gain. A reverse biased transistor is used as a feedback capacitance, determining impulse gain. One input diode provides some protection against negative transients. It is probably desirable to back terminate the output with an external resistance equal to cable impedance.

II. GAIN AND LINEARITY

The gain test circuit is shown in Figure 3, along with a picture of the impulse response for a 1,000,000 electron input. Note that the output is back terminated for all tests, so that all

measurements are half the value that would be measured directly at the amplifier output. Table 1 and Figure 4 show the gain in mv/pc for different amounts of input charge. The output amplitude is not limited by the standing current in the output transistor since the transistor is being turned on for positive output pulses. For larger amplitude output pulses, a negative overshoot begins to appear.

Table 1 - MB43468 Impulse Gain

<u>Qin (pc)</u>	<u>Yout+ (mv)</u>	<u>Gain (mv/pc)</u>
.0208	7.0	337
.0416	14	337
.052	18	346
.104	38	365
.156	58	372
.208	80	385
.26	104	400
.52	225	433
.78	350	449
1.04	470	452
1.3	600	462
1.56	710	455
2.08	920	442

The gain of the amplifier changes with temperature. An amplifier output was seen to change from 209 mv at ambient to 200 mv at stabilized operating temperature.

The MB43468 will produce negative output pulses from positive inputs, however, the pulses saturate at 50 mv because of the 2 ma standing current in the output. At levels well below saturation, the gain is comparable to the positive output gain, although slightly lower. An external output pull down resistor will increase the negative output range if desired.

III. RISE AND FALL TIMES

The MB43468 set at +100 mv output amplitude exhibits a clean pulse and is quite similar in shape to the MB43458 output. The rise and fall times of the Fujitsu chips and the well known Redeka amplifier are compared in Table 2.

Table 2 - Rise and Fall Times (10%-90%, 100 mv output)

<u>Amplifier</u>	<u>Rise Time</u>	<u>Fall Time</u>
MB43468	5.5 ns	26 ns
MB43458	6 ns	30 ns
Redeka	4 ns	80 ns

IV. CROSSTALK

Since crosstalk is very layout sensitive, the MB43468 was mounted on a small board above a ground plane, with short input runs, and a .1 ufd bypass as close as possible to the power leads. The worst case crosstalk was about +/- 1%. Crosstalk waveforms for all four channels are shown in Figure 5. The top waveform is the output of the channel receiving the input signal, and the bottom waveform is the output of another channel, showing the crosstalk to that channel. All waveforms are labelled by channel number, channel 1 being the amplifier whose input is pin 1 on the chip. Crosstalk for this chip is a little larger than for the MB43458. This may be due to the harder to implement layout geometry of the MB43468 chip (all inputs on one side, all outputs on the other).

V. NOISE

The noise of the MB43468 was measured by observing the distribution of output pulse areas at 100 ns gate time. The setup used is shown in Figure 6. Results are shown and compared with the MB43458 in Table 3. The noise of the MB43468 seems considerably lower than the

MB43458 at high input capacitance.

Table 3 - Equivalent Input Noise vs. Input Capacitance for 100 ns gate (e RMS)

<u>Device</u>	<u>Cin=10 pf</u>	<u>25 pf</u>	<u>43 pf</u>	<u>78 pf</u>
MB43468	2740	3120	3600	4770
MB43458	3250	4050	5190	8030

VI. FREQUENCY RESPONSE

The magnitude and phase response of the MB43468 as measured on a network analyzer is shown in Figure 7. Nominal low frequency voltage gain is 30 db. The 3 db frequency is approximately 21 MHz. By comparison, the MB43458 3 db frequency is 10 MHz.

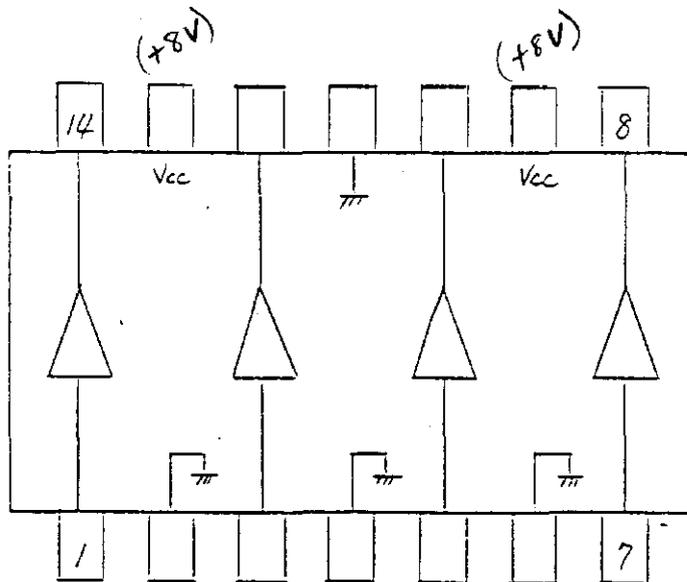
VII. RESPONSE VS. SUPPLY VOLTAGE

With $V_{cc} = +8V$, the chip draws 14.2 ma, dissipating 114 mW. It was noticed that as the supply voltage was decreased, the low frequency gain increased, and for $V_{cc} = +5.8V$, the response curve was identical to that for $V_{cc} = +8V$. However, this was for a small input amplitude on the network analyzer. Using the gain test circuit of Figure 3, output pulses on a scope were observed while changing V_{cc} and it was found that +8V is not necessarily the optimum V_{cc} for highest impulse gain. The gain was a little higher for a V_{cc} of about +7V, and then dropped off for V_{cc} lower than 7V. A 100 mv pulse only lost about 10% of its amplitude when V_{cc} was changed from +8V to +5.8V. This is shown in Figure 9. However, this behavior was observed with the test circuit, not with a chamber. It is suspected, but not known, that the same characteristics would be observed if the amplifier was driven by an actual chamber.

Perhaps it is possible and advantageous to run the MB43468 at a lower supply voltage,

depending on gain and amplitude desired. The current draw at +5.8V is 12.3 mA, resulting in a dissipation of only 71 mW. Also, the output noise in a 10 MHz bandwidth is about 30% less at $V_{cc} = +5.8V$. The output noise voltage peaks at about $V_{cc} = +6.5V$ and drops off for V_{cc} higher or lower than this value.

ブロック図, 端子名称



TOP VIEW

Pin No.	記号	機能
1	INA	Ach 入力
2	GND	GND
3	INB	Bch 入力
4	GND	GND
5	INc	Cch 入力
6	GND	GND
7	IND	Dch 入力
8	OUTB	Dch 出力
9	Vcc	Vcc電源
10	OUTc	Cch 出力
11	GND	GND
12	OUTB	Bch 出力
13	Vcc	Vcc電源
14	OUTA	Ach 出力

FIGURE 1 - PIN OUT

ドリフトチェンバ用プリアンプ 等価回路図

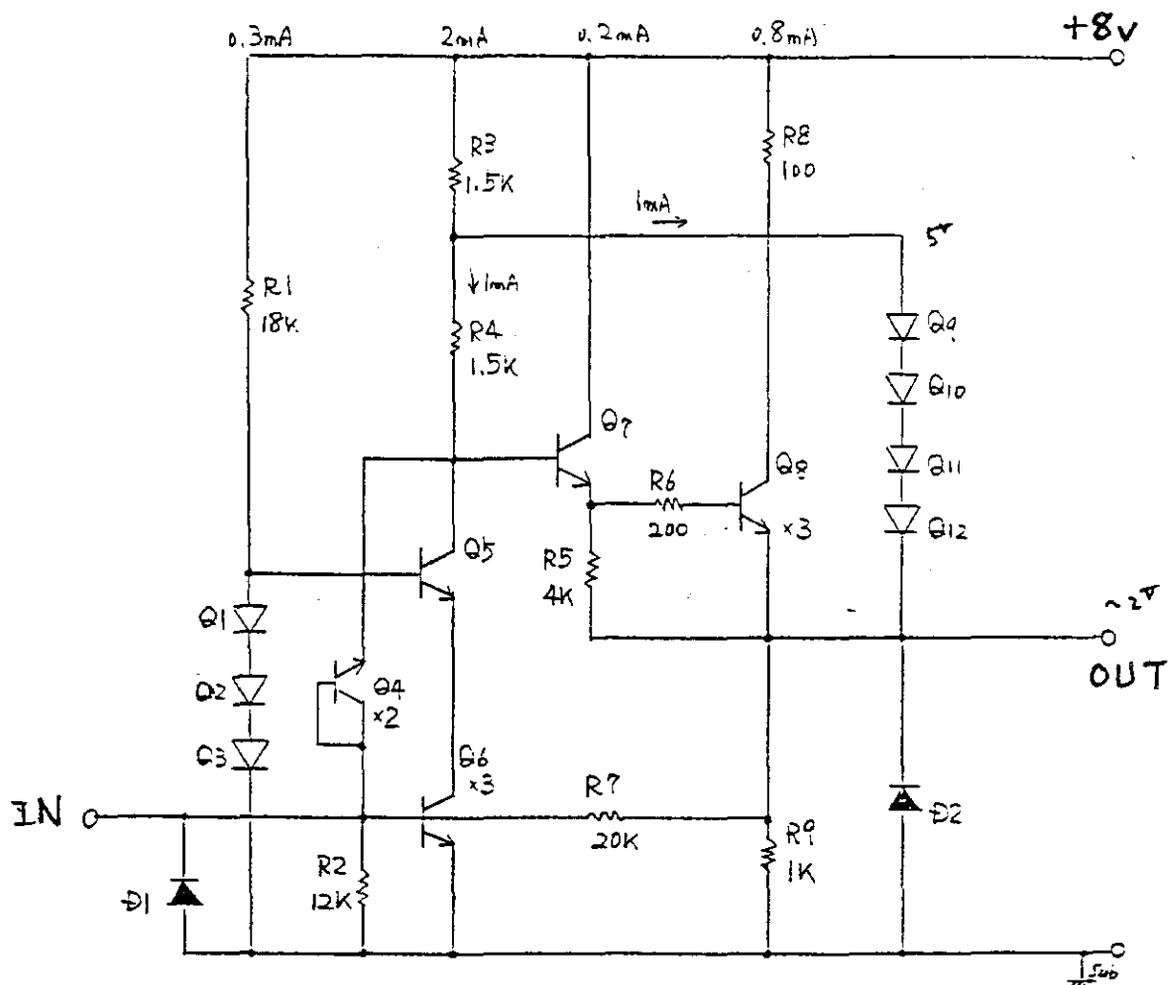
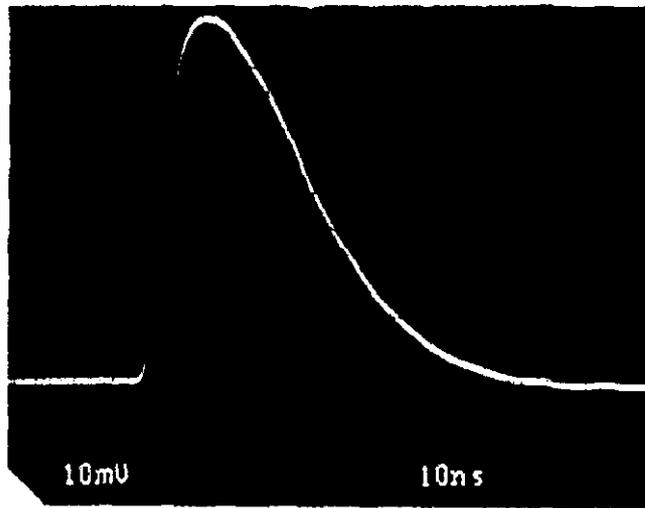
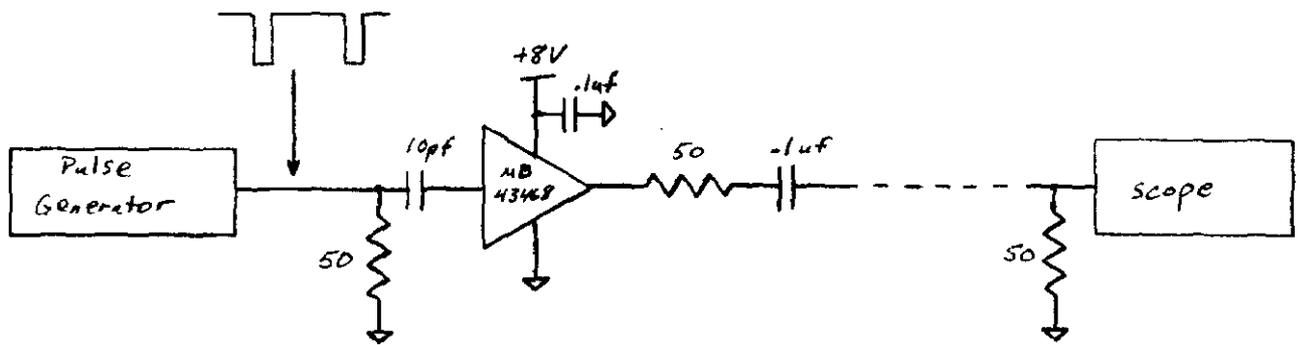


FIGURE 2 - SCHEMATIC OF ONE CHANNEL



Impulse response for 10^6 electron input

FIGURE 3 - GAIN TEST CIRCUIT

46 0780

10 X 10 TO THE INCHES
KODAK SAFETY FILM
KODAK SAFETY FILM

Peak Positive Output Voltage (mv)

900
800
700
600
500
400
300
200
100

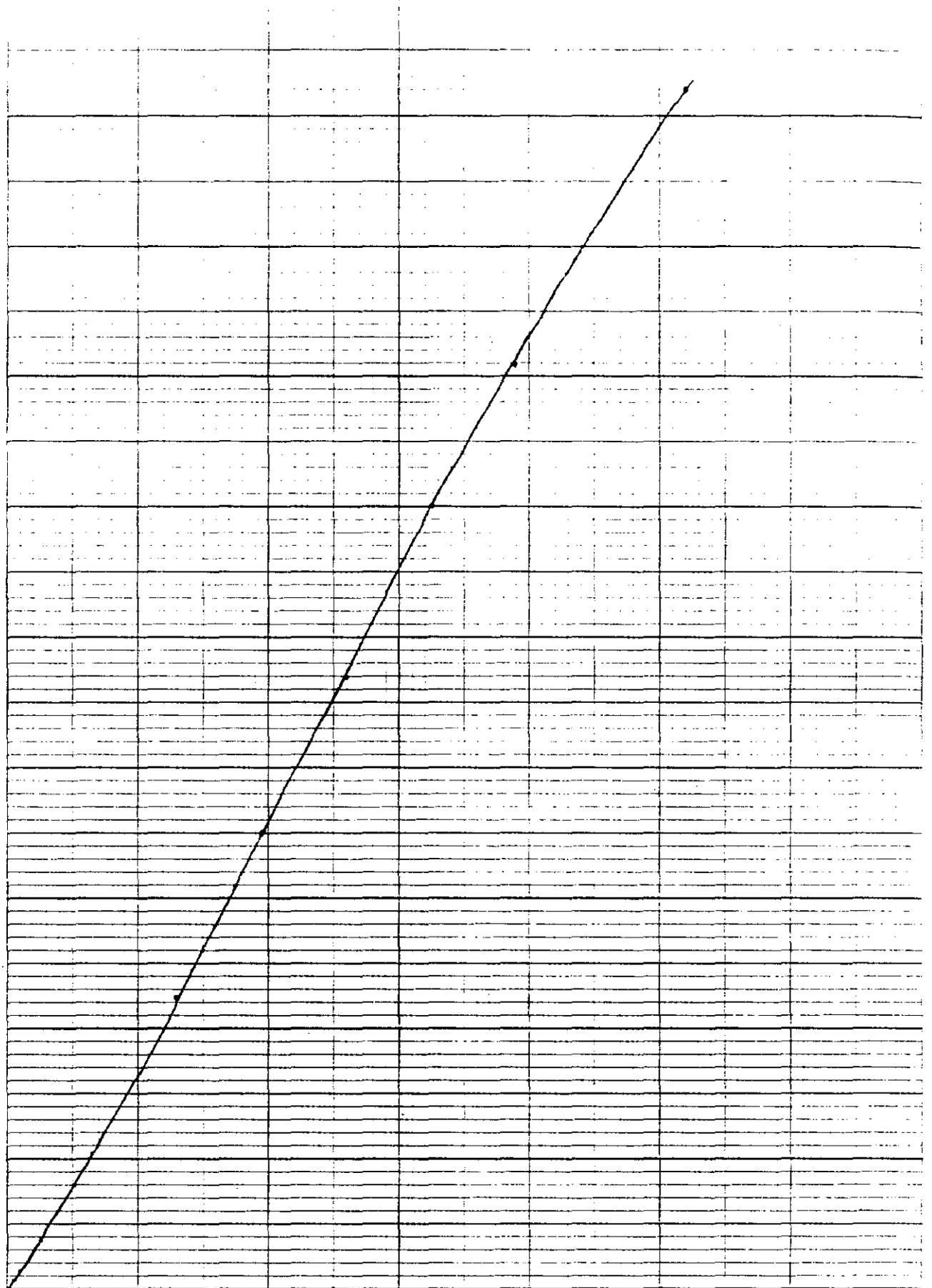
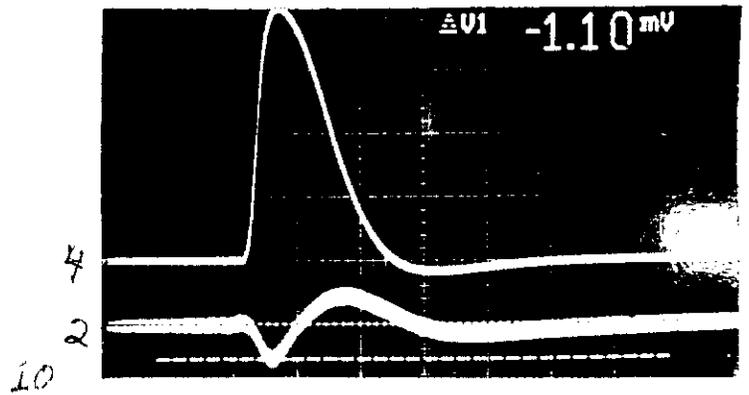
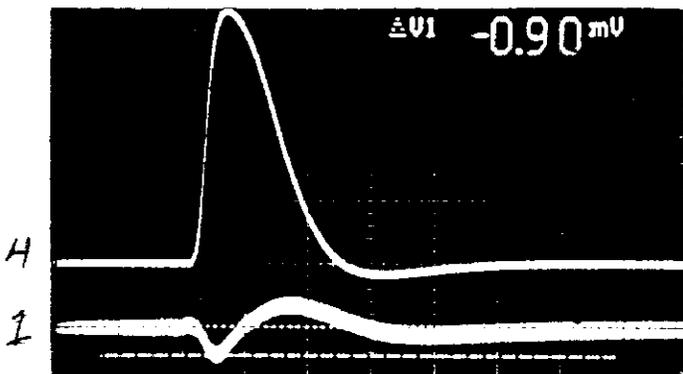
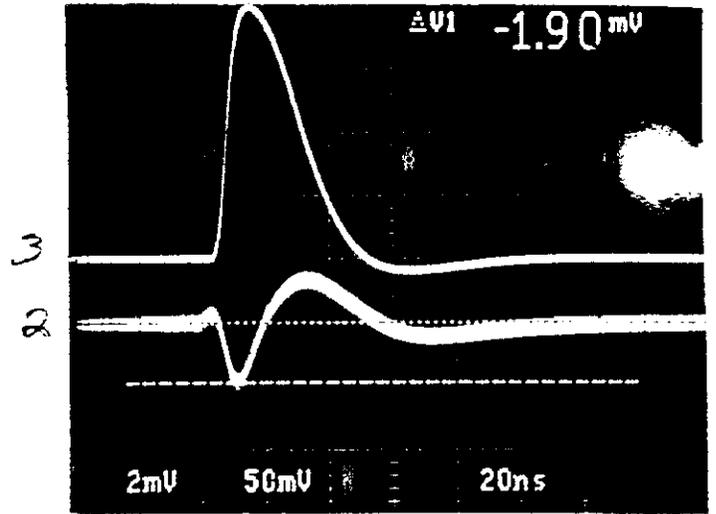
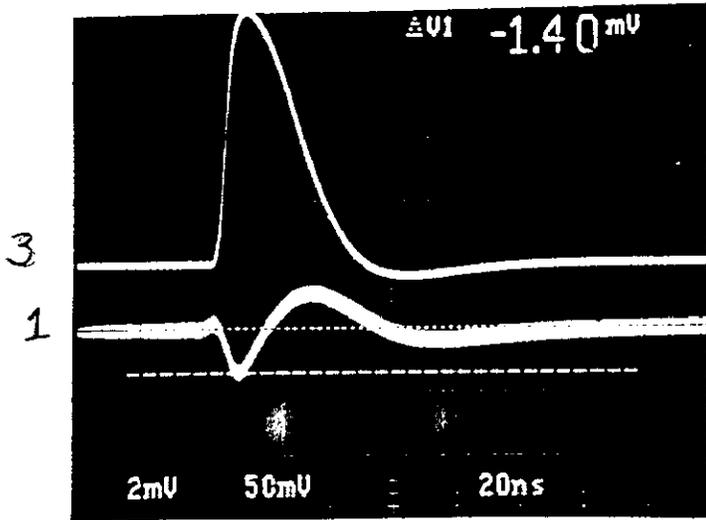
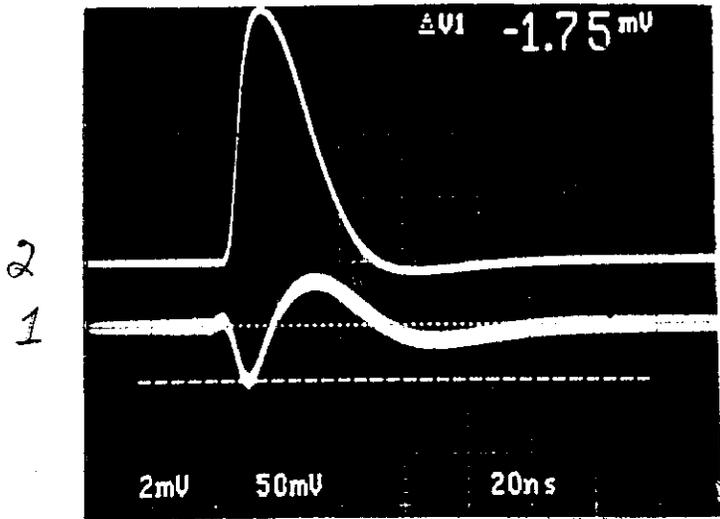
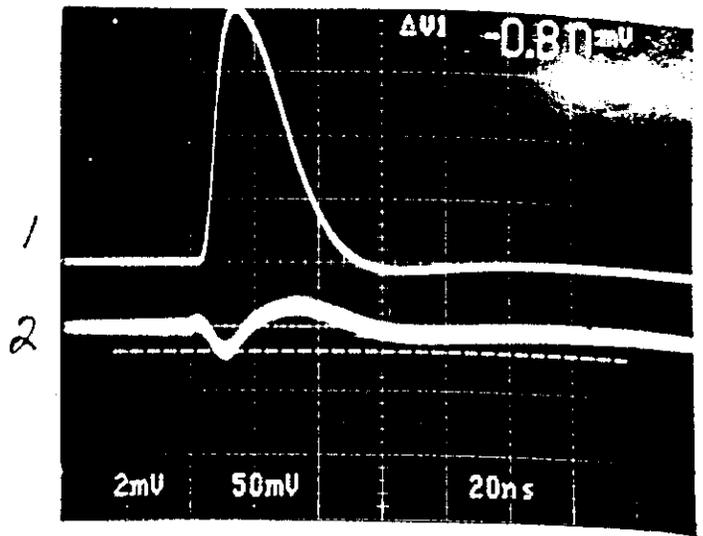


FIGURE 4 Input charge (pc)

FIGURE 5 - CROSSTALK WAVEFORMS



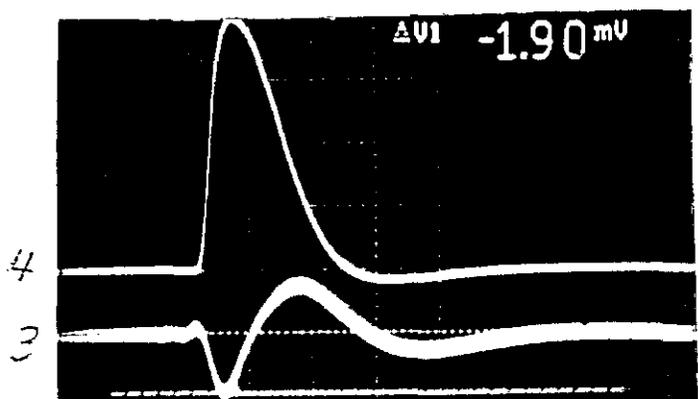
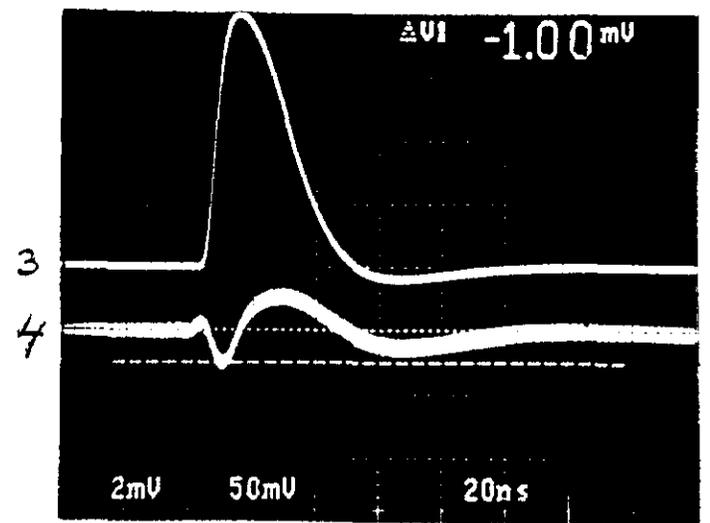
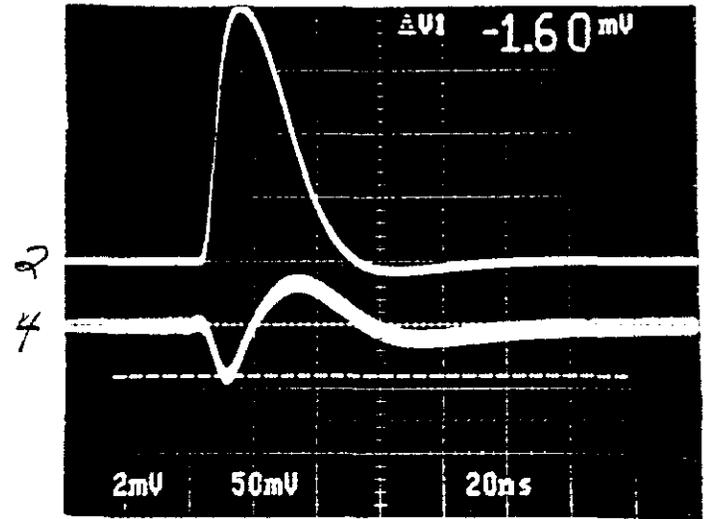
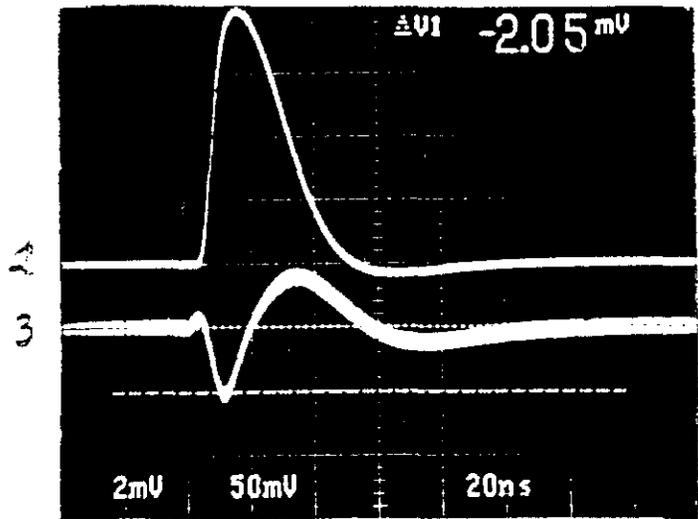
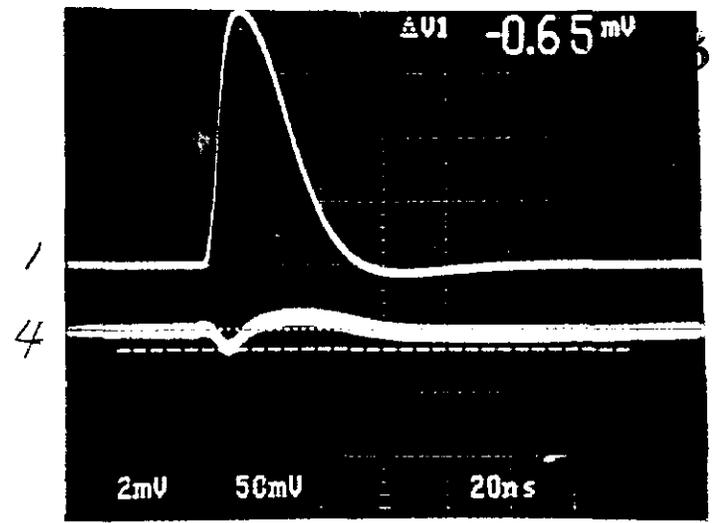
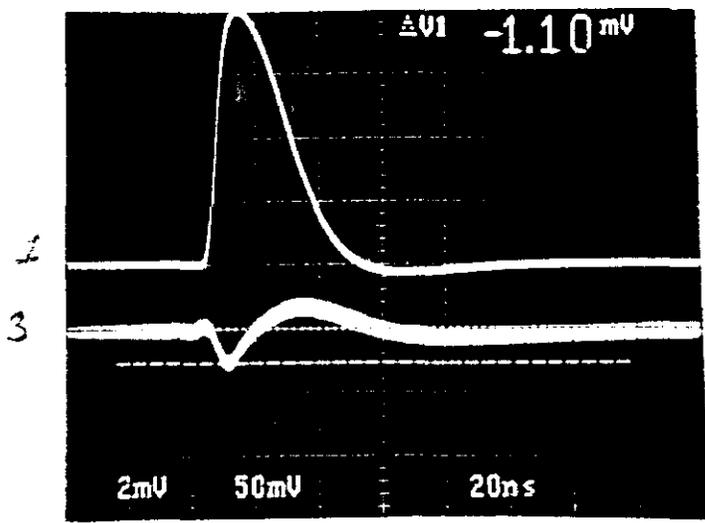


FIGURE 8 (CONT.)

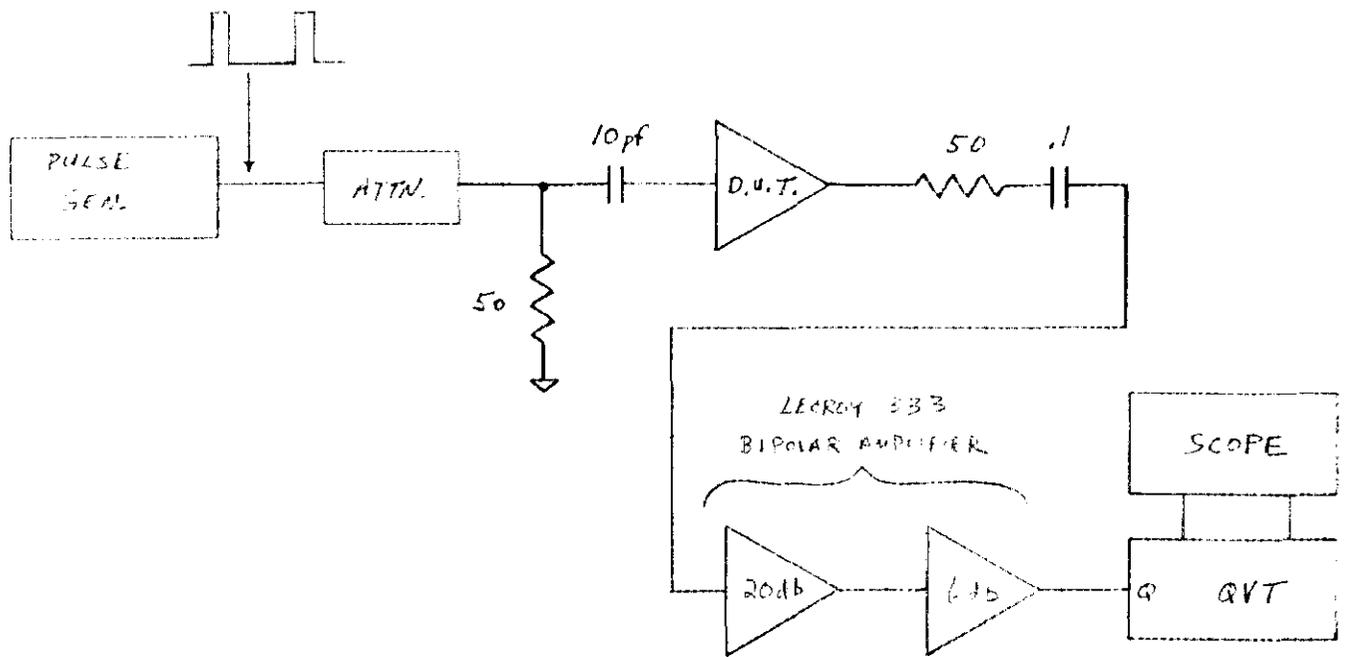


FIGURE 6 - NOISE MEASUREMENT CIRCUIT

MB43468 $V_{cc} = +8.0V$
 $I_{input} \text{ Amplitude} = -40dBm$

REF LEVEL	/DIV	MARKER 1 015	243.907Hz
40.000dB	5.000dB	MAG (UDF)	30.097dB
-90.000deg	45.000deg	MARKER 1 015	243.907Hz
		PHASE (UDF)	174.354deg

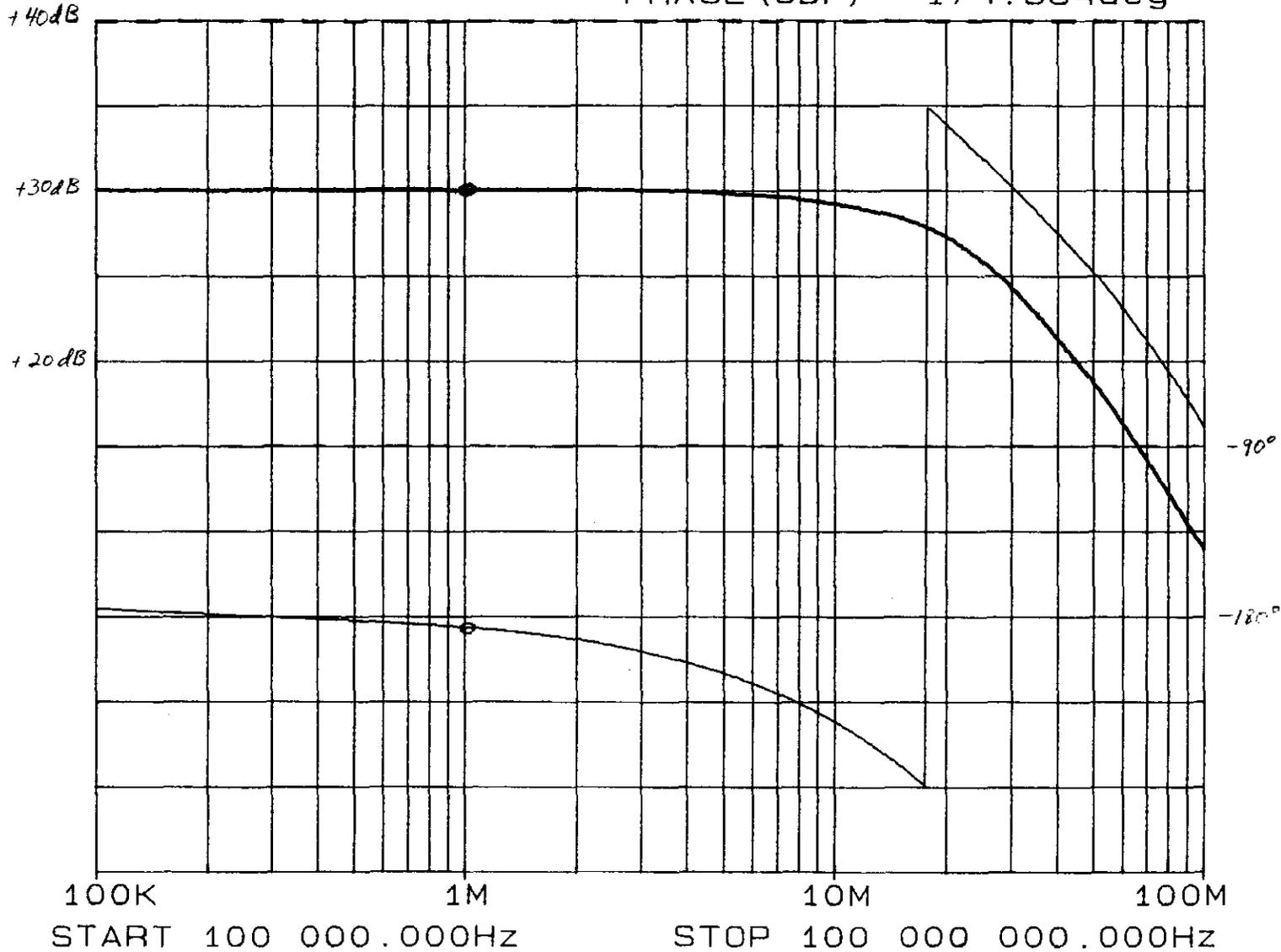


FIGURE 7 - FREQUENCY RESPONSE
13

MB43468 $V_{CC} = +5.8V$
Input Amplitude = -40dBm

REF LEVEL	/DIV	MARKER 1 015	243.907Hz
40.000dB	5.000dB	MAG (UDF)	30.013dB
-90.000deg	45.000deg	MARKER 1 015	243.907Hz
		PHASE (UDF)	176.295deg

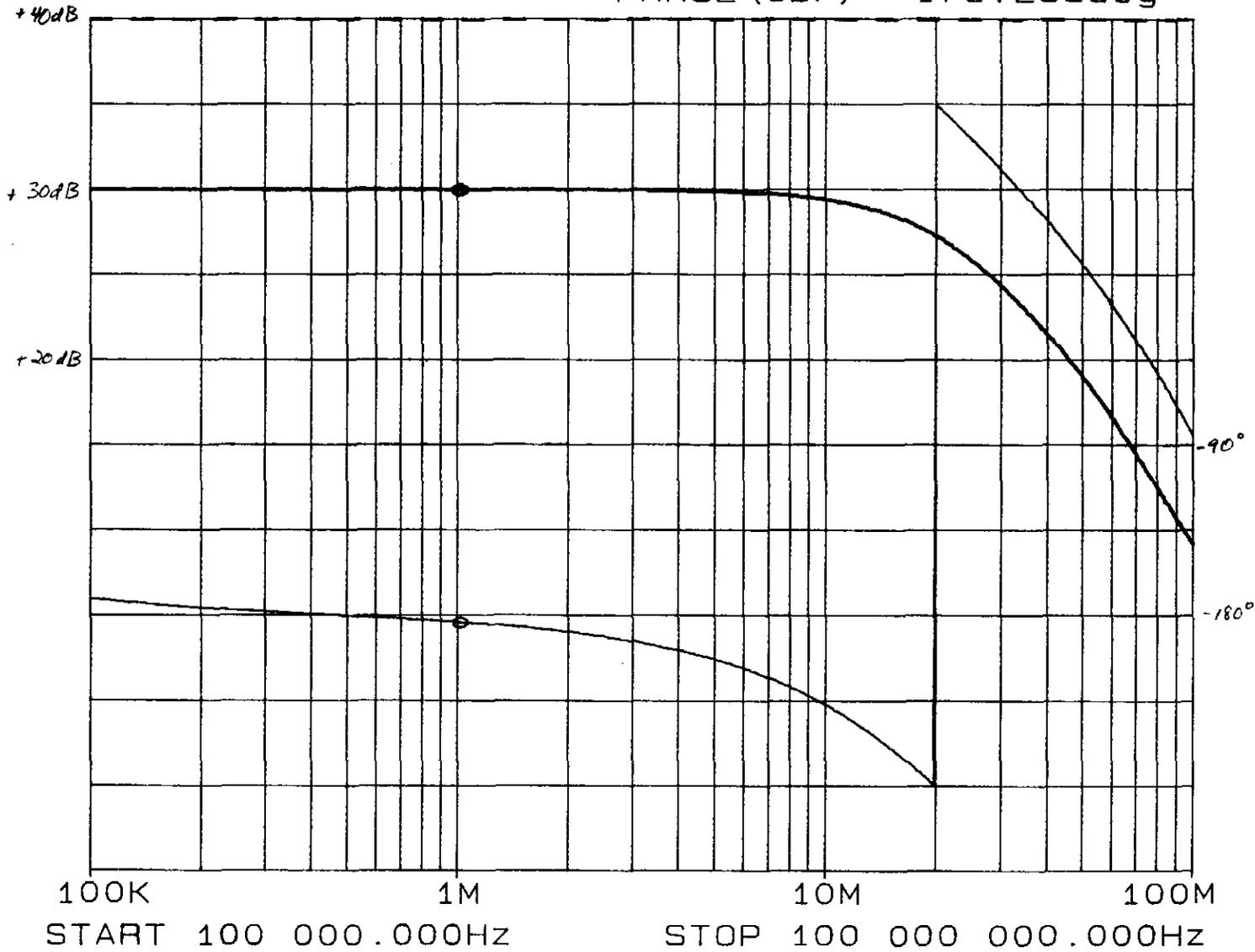
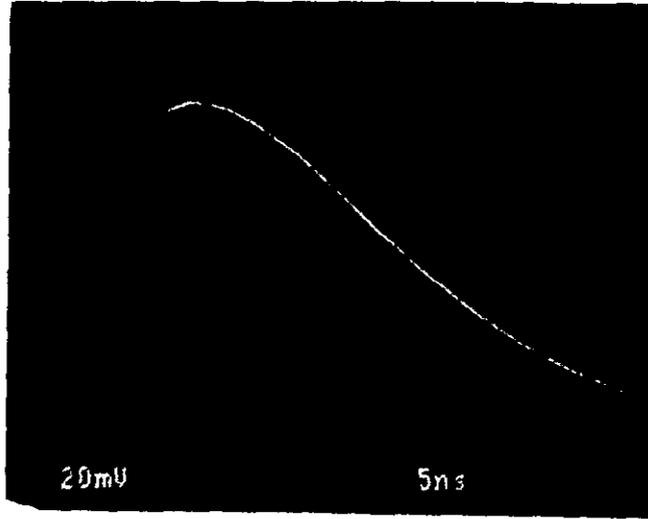


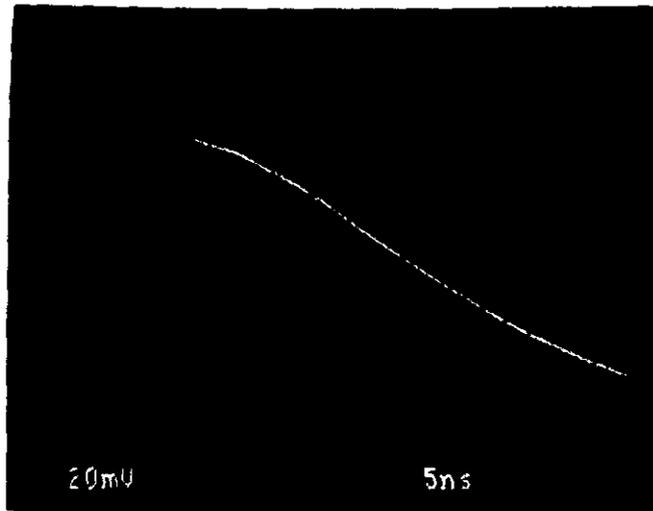
FIGURE 2 - FREQUENCY RESPONSE FOR $V_{CC} = +5.8V$

$V_{cc} = +8.0V$



$t_r = 5.5ns ; t_f = 26ns$

$V_{cc} = +5.8V$



$t_r = 5.2ns ; t_f = 31ns$

FIGURE 9 - RESPONSE AT DIFFERENT V_{cc}