

UTMB 2005 06

Jun Work Book PIM
~~Feb~~ 05 - Jan '06

Roaring Spring.

Compositions

Name W. Thornton, M.D.

School

Grade

QUAD. RULED 5 to 1"

9¾ in. x 7½ in. 100 Leaves



0 70972 77255 7

Roaring Spring, PA 16673

INDEX

I

1

Pulse Generation

10

Audio and V.O,
Bose Phones

25

Electric

Charge - Coulomb, Quantity, $\frac{+1 \text{ sec}}{\Sigma}$ One Ampere 1

Ampere - rate of flow of charge, current
(Charge/Time) defined by E.M. Force on wire in M field
and M field (per length of wire)

Electric Potential - Volt (Joule/Coulomb)
(for work)

(Joule = Force $\times$ Distance)

Note: removal, ionization

29 June Pulse, Impulse

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Overview: Revise AM tone system -

Search for digital sys. show them to complex, hard to find

Will continue to use ① ch. of stereo for sound
and ② ch. for tone commands -

In process of trying 2 freqs. $1.5 \pm 1 \text{ KHz}$ 'A'
and $7.5 \pm 1 \text{ KHz}$ 'B'.

LM2917 chips can produce $\sim 1 \text{ V/KHz}$ to $\sim 8.5 \text{ V}$
($\sim \#2$ -)

Also need improved pulse transducer -

Enspire feel they can synthesize pulses and sent
trial waveforms today -

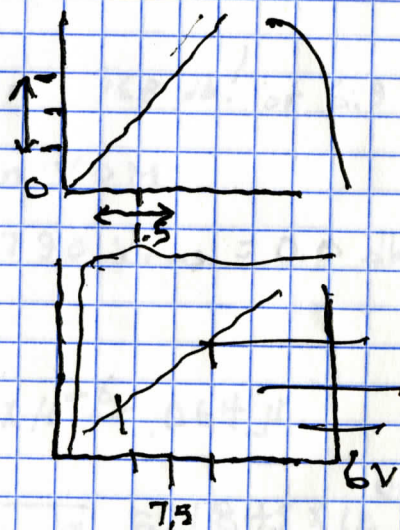
Schema; demod

① Audio 15-15 KHz



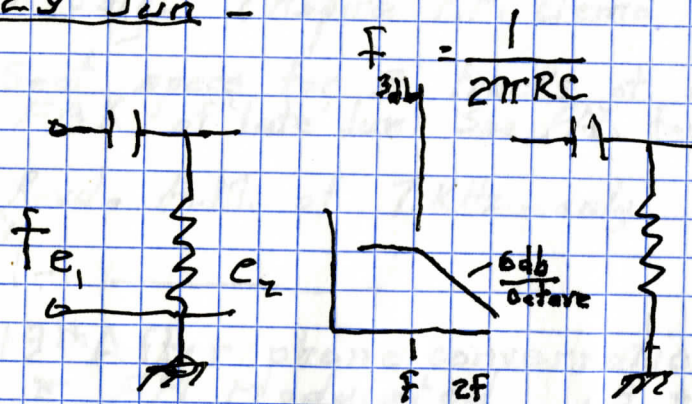
② Command A $1.5 \pm 1 \text{ KHz}$

B $7.5 \pm 1 \text{ KHz}$



29 Jun -

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$$A = 1.5 \pm 1 \text{ KHz}$$

$$f_i = 2.5 \text{ KHz}$$

$$\uparrow \text{1 oct.} = 5 - 2 \text{ sect } \frac{1}{4}$$

$$B = 7.5 \pm 1$$

$$10 = 6.5$$

$$db = 20 \log \frac{e_1}{e_2} - 3$$

$$-3 = 20 \log \frac{e_1}{e_2}$$

$$\frac{3}{20} = .15$$

As widely separated as A + B are, two ^{or 3} sect. RC Filt. should give adequate separation.

$$30 \text{ dB} \cdot 1.5 = 1.4$$

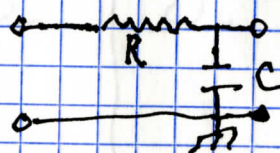
$$6 \text{ dB} \cdot 2.0 = \frac{16.8}{20} = 8.4$$

Plan: Calc. Components - Order parts.

$$f = 1.5 \text{ KHz} \rightarrow 2.5 \text{ KHz} \quad 2.5 \mid \frac{2.8}{200} \quad \text{or } 2.8 \times = 16.8 \text{ dB! or } 6.9$$

$$f_2 = 7.0 \text{ K}$$

$$f_{3db} = \frac{1}{2\pi RC}$$



on VOM:

$$0.790 \text{ Vrms} = 0.0 \text{ dBm}$$

$$C \text{ for } R = 10^3 = \frac{1}{2\pi \cdot 2.5 \times 10^3 \times 10^3} = \frac{1}{15.70} \times 10^{-6} = .064 \mu$$

$$\text{Meas: } R = 98 \Omega$$

$$f = \frac{1}{2\pi \cdot 98 \times 10^3 \times .88 \times 10^{-7}} = .1845 \times 10^4 = 1845 \text{ KHz}$$

$$C = .88 \times 10^{-7}$$

$$3 \text{ dB} \approx f_{gc} \text{ (VOM)} \rightarrow 1.677 \text{ "}$$

$$\text{Cont'd. P} \approx 10\%$$

5 July. Enspire FM. Demo Effort

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Sent specs for 5 tracks of demo of FM. Sys. See FAX of 'late' Jun. See FAX for details P-4

Rcvd. A.M. of 7. KHz - only

Tr

1-

19th After phone conversations, etc., rcvd. email re FM Modulated 1.5 + 7 KHz - 2 FM Mod.

Found NASA FM Demod.

Will take cursory look at CD just rcd. - 5 July specs.

F₁ - A 1.5 KHz + 0 - 1.0 KHz
F₂ - B 7.0 " " "

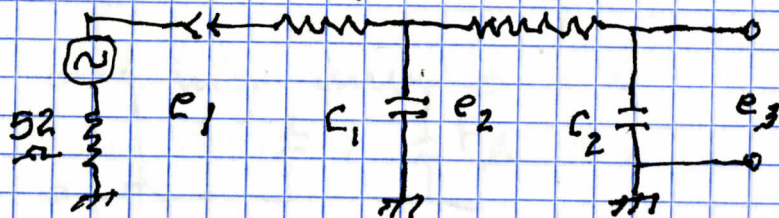
Left Channel	1	2	3	4	5 - Trk.
A. CAR Ch 1	50	Car 25 Δ 100ms	Car 50 *	BIF 50	Car 50 %
B. CAR Ch 2	100	Car 50 *	Rad 50 * Δ 50ms	Car 50	Rad 50 Δ 50ms
Right Channel (Stereo)	0	0	0	0	Normal Heart Sounds, Synched to Car

2, 3 A+B distorted

R.C. Filter

R_1 R_2 L.Pass 1.5-2.5 KHz.

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R-1	983 Ω
2	988 Ω
C-1	98.6 nF
2	91.7 nF

NB - -3db pt for e_2 = 0.765 KHz

F KHz	e_1 mV	e_1 dbm	e_2 mV	e_2 dbm	e_3 mV	e_3 dbm
1.50	778	0	388	-6.0	292.9	-8.6
2.50	388	-7.0	252	-9.0	152.1	-14.3
7.00	775	0	122	-16.2	28.9	-20.8
8.0750	777	0	106	-17.5	21.1	-31.2

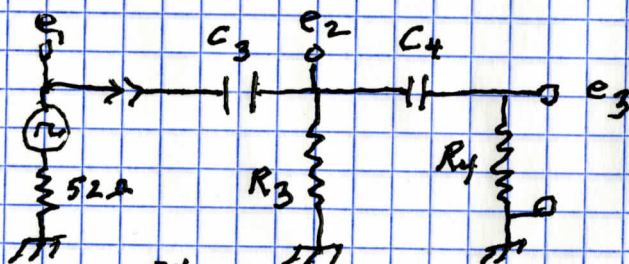
Two sects. worked well & wide band demod. effectively removing effects of F_B - 7.8 KHz - First section was also adeq.

H.P. Filter 7.8 KHz -

$$C = 7 \times 10^3 \frac{1}{2\pi f R} = \frac{1}{6.24 \times 7 \times 10^3 \times 10^3} = 0.022 \mu F \text{ Parts Chase!}$$

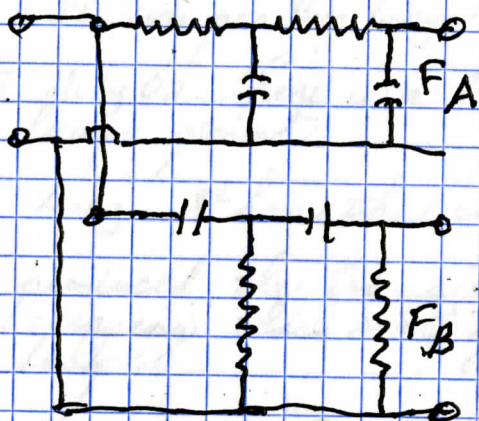
$$R = \frac{1}{2\pi \times 7 \times 10^3 \times 4.7 \times 10^{-8}} = 4.837 \times 10^3 \times 10^5 = 483 \Omega$$

C_3 48 x 10 FR₃ 469 Ω
 C_4 " R₄



10.0	734	0.0	618	-2.0
8.0	744	0.0	575	-2.8
7.0	779	0.0	536	-3.4
5.0	781	0.0	381	-6.3
2.5	785	0.0	251	-10.0
1.0	785	0.0	107	-17.1

Next P₂ -



Modulator Prob. - FM Demod. 06

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23 July - Depending on Demod. Ckt., carrier drop outs can produce large neg. transients - see below.

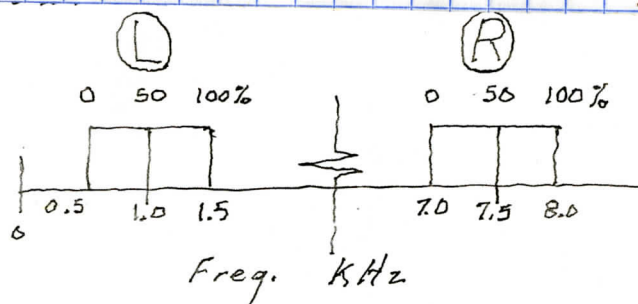
27 July '05 - There is a large audible transient at the loop point

? Aug - When the carriers are first added this produced the transient which was eliminated by clipping this starting transient & then making the loop's

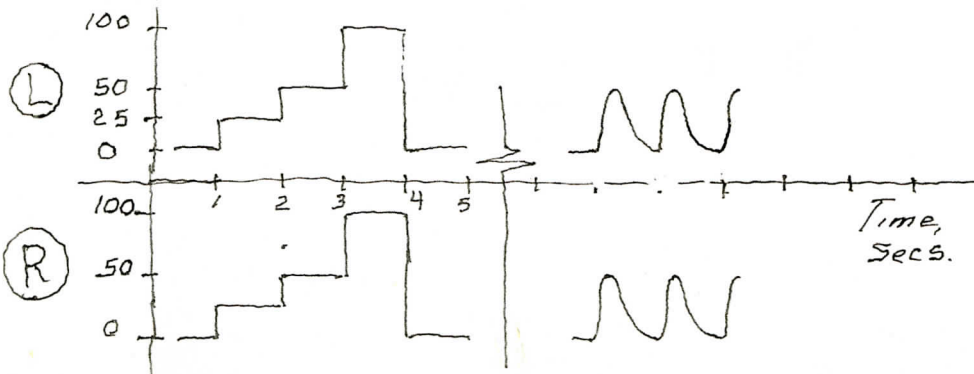
9 Jan 06 Records of FM Demod & Bread Board work to date disappeared in Christmas Chaos - Will search again tomorrow.

Basic Plan is to have 2 FM channel $\bar{c}$ $F_{01} = 1.5 \text{ KHz}$ and 2nd, $F_{02} = 7.5 \text{ KHz}$ - No See Below -

A.M. System will swing from 0 to 1 KHz Δf - giving output of say 0-1.0 V.



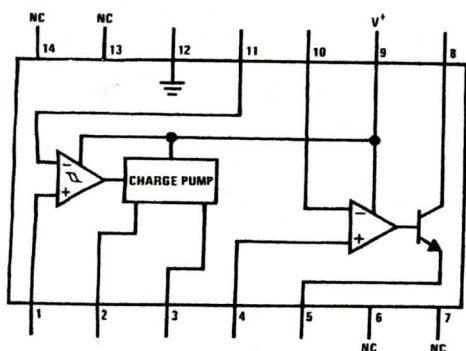
% Modulation



10 Jan 06

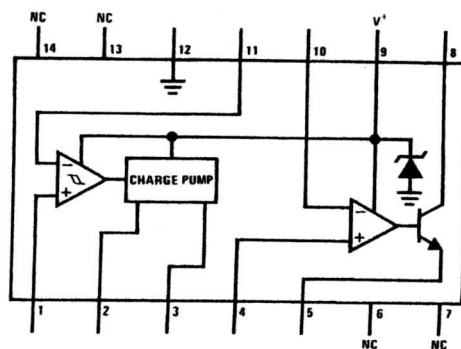
CV. MKII Demod.

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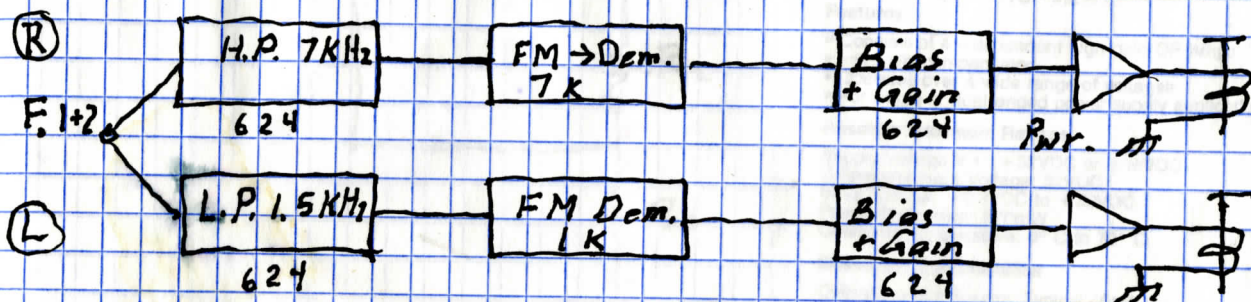
00794203

Order Number LM2907M or LM2907N
See NS Package Number M14A or N14A



00794204

Order Number LM2917M or LM2917N
See NS Package Number M14A or N14A



Freq. Split. Act vs Passive:

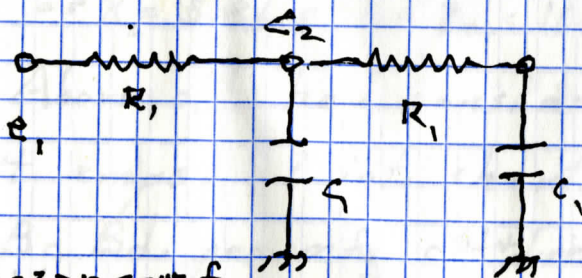
Passive. $LP - F_c = 1.5 \times 10^3 \text{ Hz}$ & $F_{c, \text{alt}} = \frac{1}{2\pi RC}$ & $C = 4.7 \times 10^{-8}$

$$R = \frac{1}{2\pi f C} =$$

$$\frac{1}{2\pi \cdot 1.5 \cdot 10^3 \cdot 4.7 \cdot 10^{-8}}$$

$$\times 44.3 \times 10^{-3}$$

$$= 2.25 \times 10^3$$



$$R_{1,2} = 2.2 \text{ K} \quad C = 47 \text{ nF}$$

$$e_1 = 1 \text{ V}$$

$$R_2 = 4 \text{ K}$$

KHz	e1	e2
1.5	0.7	.37
7.	.17	.03

$$.28$$

$$.017$$

10 Jan '06 - FM Demod.

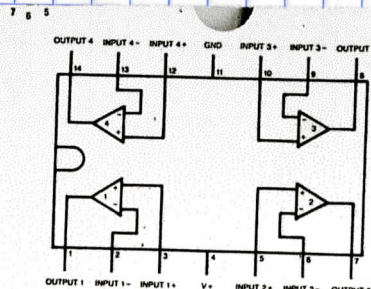
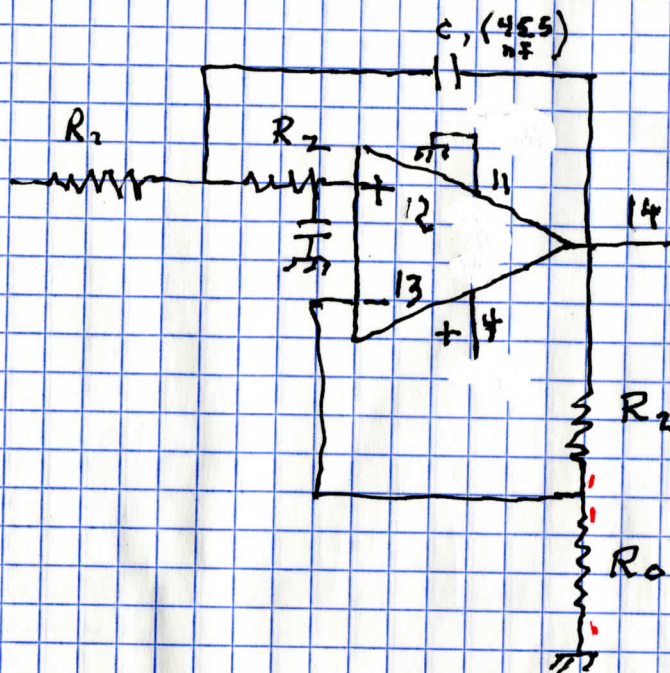
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Input - 10-40 mV ? RMS or PP.

RC 1 pole will give 4:1 reduct. $\therefore F = 1.5 + 7. K$ resp

Butterworth " " 17:1 " "

✓ Skt - Try Quad Amp - LM 324 N



Features

- Consists of 4 independent high-gain OP Amps
- Internally compensated
- Operates over a wide range of voltages
- For single or dual-ended power supply applications

Absolute Maximum Ratings

Supply Voltage V_{+} : +32VDC or ± 16 VDC
 Differential Input Voltage: 32VDC
 Input Voltage: -0.3VDC to +32VDC
 Power Dissipation: 570mW
 Operating Temperature: 0° C to 70° C

Electrical Characteristics

Output Current Source: Typical 40mA
 Output Current Sink: Typical 20mA
 Input Offset Voltage: Typical 2.0mVDC

Using 5.06 P. 275 etc Art of Electronics

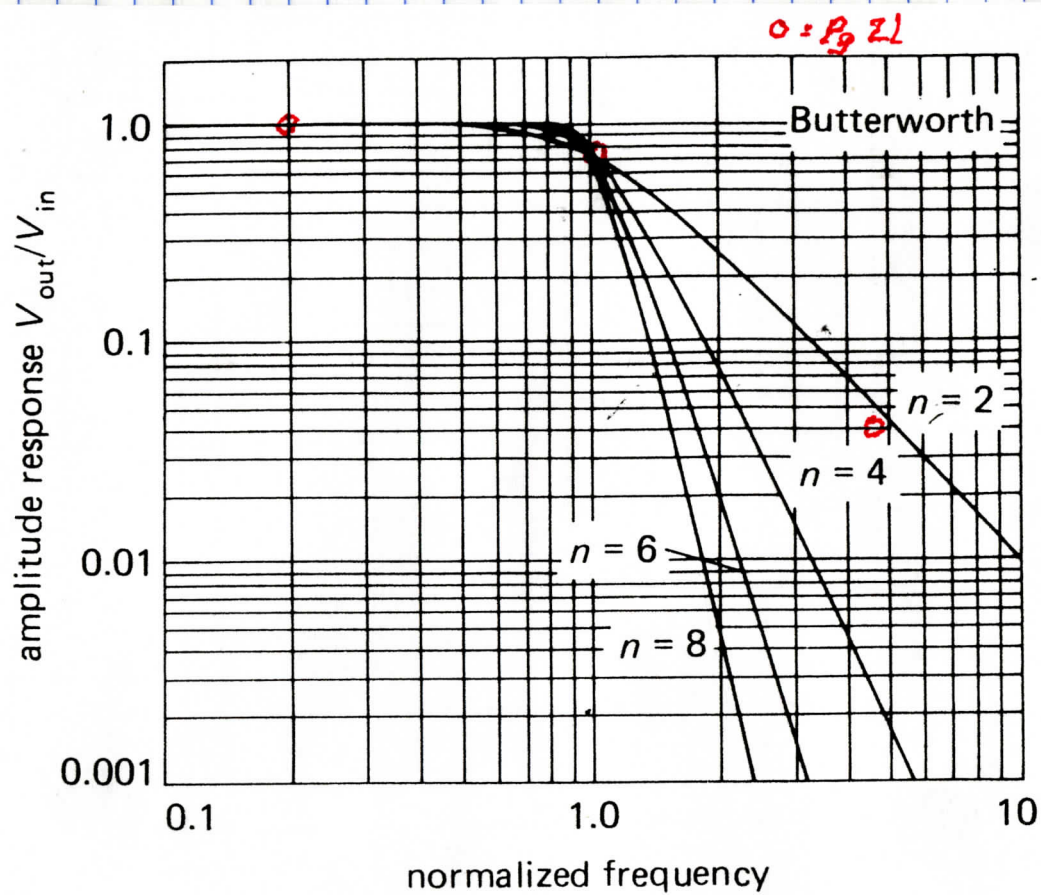
$$R_2 = (K-1)R_0 + K = 1.586 \text{ For } B_{with} \quad \left. \begin{array}{l} R_1, C_1 \approx \frac{1}{2\pi RF} \\ \text{see calc P 18} \end{array} \right\}$$

$$\text{or } R_2 = 5.86 K \text{ For } R_0 = 10 K (2.82 m)$$

Above ckt. had constant Gain - ? - tried two of 4 amps. ? into short. - Will use LM324N -

Br. Bd. per mfg. ckt directions - Behaves as Amp. did -

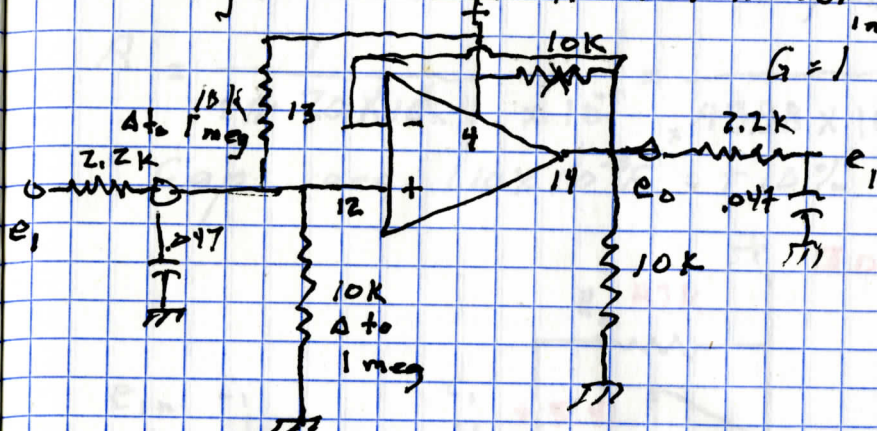
With meas. & back calc. component values & Did. Freq. ckt OK - then try 324 in follower ckt -



10 Jan

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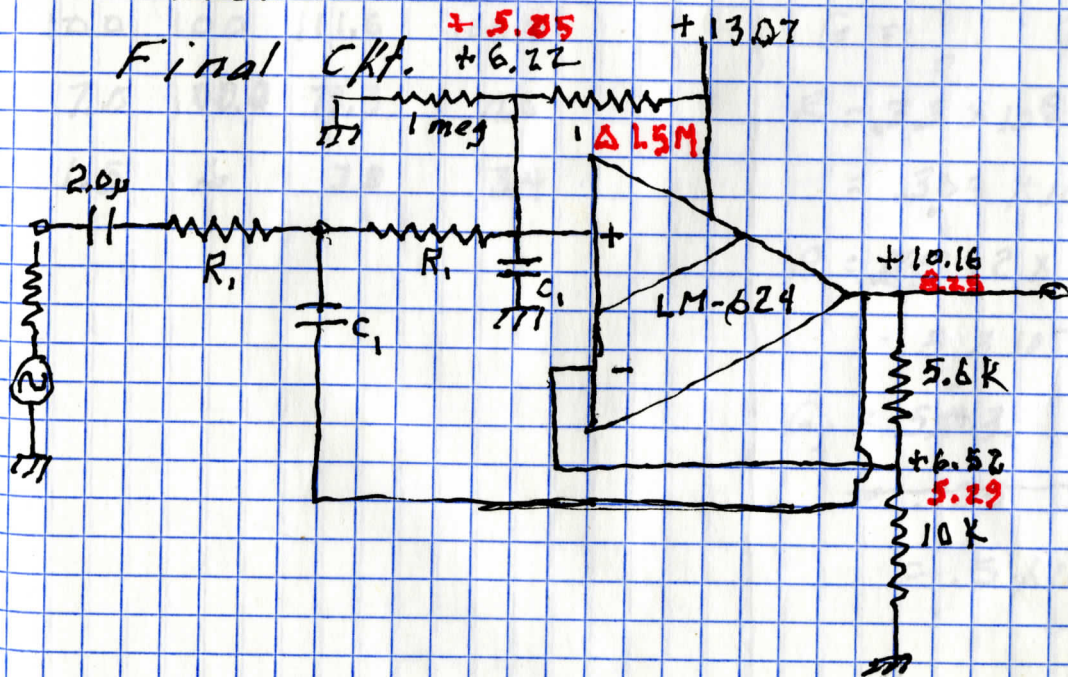
Try same 624 as a follower $\bar{z}$ bias



input in
 $G=1$
 $100 \text{ mV} - 200$
 70.4
 $15.$
 F/H_z
 1.574
 $7,000$

f_{Hz}	e_1	e_0	e_i						
K	mVPP	mVPP	mVPP						
0.20	100	98.4	97.5	max $\frac{1}{2}$	146.	154	158.2	1.00	154
1.5	"	73.8	52.5		113.2	119	125.1	0.77	119
7.0	"	28.0	3.1		34.9	6.3	6.3	0.4	0.4

? Why didn't MIT Bwt filter work?
 Mis biased probably * ckt on pg-19 ** normalized
 Butter worth is Flatter - & at 7 K is within
 meas. error



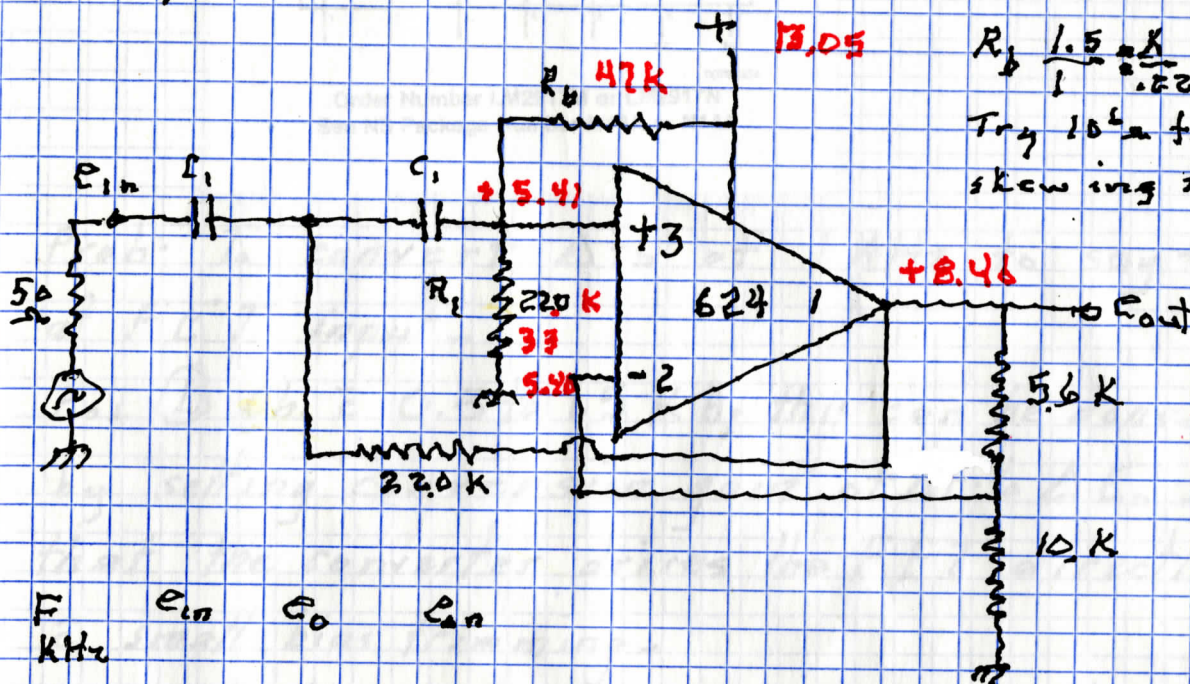
11 MK II Demod

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Calc. R + C For 7 KHz 3db pole - Hi Pass

$$R = \frac{1}{2\pi \cdot 7.0 \times 10^3 \cdot 1 \times 10^{-9}} = \frac{1}{43.98 \times 10^{-6}} = 2.27 \times 10^4 = 22 \text{ K}$$

Caps are $1.10 \times 10^{-9} \text{ F} = +10\%$ - Use 280 K



$$R_f = \frac{1.5 \text{ mV}}{1 \times 10^{-6} \text{ A}} = 1.5 \text{ mV} \times 10^6 = 1.5 \text{ V}$$

Try 10^6 to avoid skewing freq.

F kHz	E_{in}	E_o	E_n
10.0	100	111.6	100.0
7.0	100.0	79.3	70.0
1.5	↓	3.8	3.4

$$G = \frac{1}{R} \quad G_x = G_1 + G_2$$

$$R = 3.3 \times 10^5 \quad G = 10^{-5}$$

$$= 3.03 \times 10^{-6}$$

$$R = 1.2 \times 10^6$$

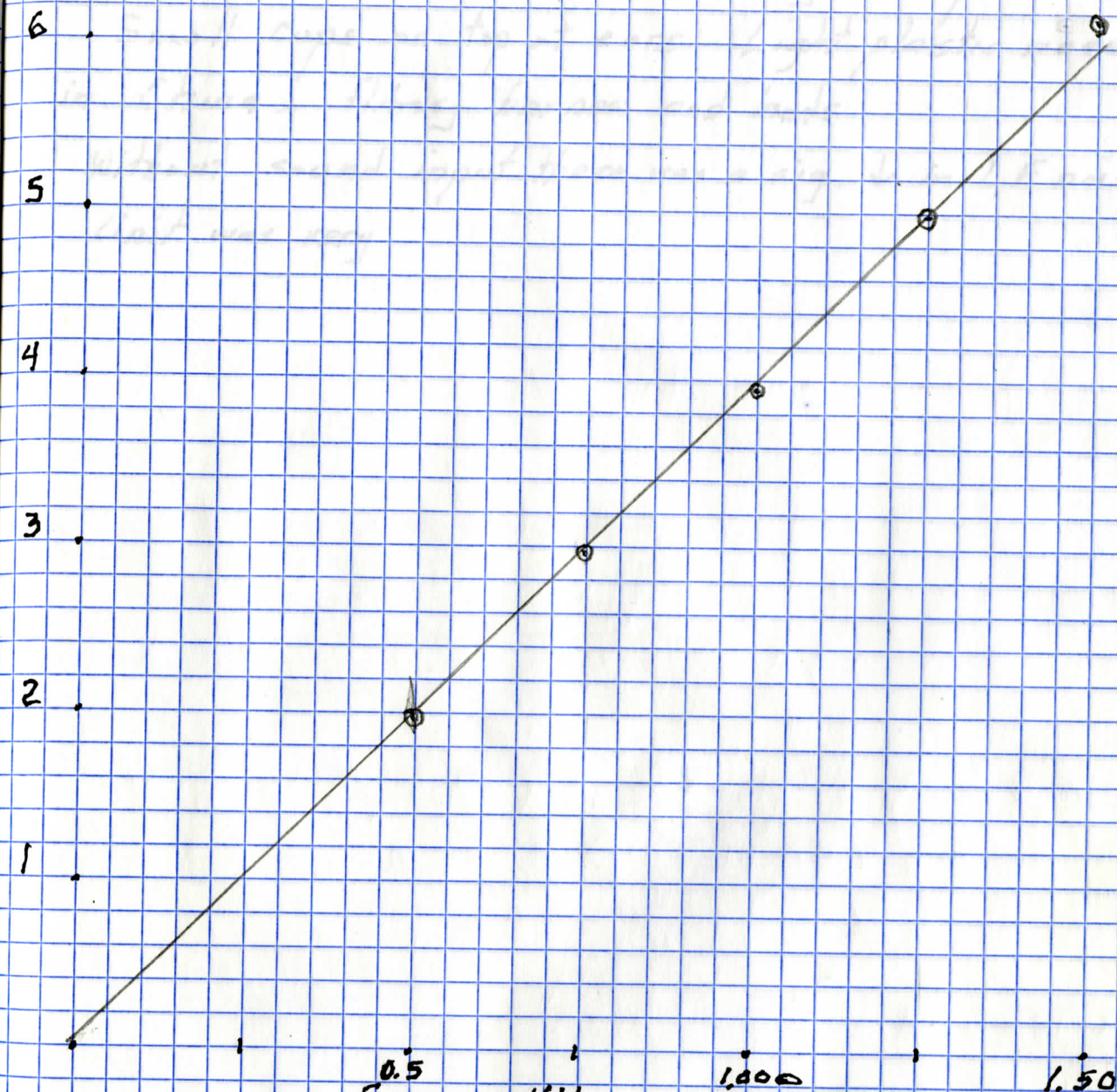
$$= 5 \times 10^{-6}$$

$$G_x = 5.03 \times 10^{-6} = 2 \times 10^{-6}$$

$$= 1.25 \times 10^{-6}$$

$$= .5 \times 10^{-6}$$

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	C_0	C_1	Freq. KHz	
500	5.00	1.979	1.996	} .985
750		2.958	2.981	
1000		3.975	3.945	} .964
1250		4	4.98	
1500		5.96	5.94	} .96

Audio incl, V.O.

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Trial of Bose Noise Reducing Headphones

Small cups on top of ears - light plastic made in China - flimsy harness and leads

Without sound input there was a sig. $\downarrow$ in L.F. noise
Unit was very

12 Jan 06 MK 11 Contd

E

V.C.

D.C. Res $7.9 - 1.1 = 6.8 \Omega$

25

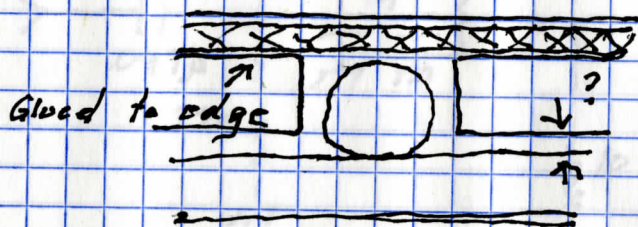
$$6.3 / 6.8 = .926 A$$

$$\& 5.83 W$$

$$12.6 V / 6.8 \Omega = 1.85 A$$

$$\& 23.3 W$$

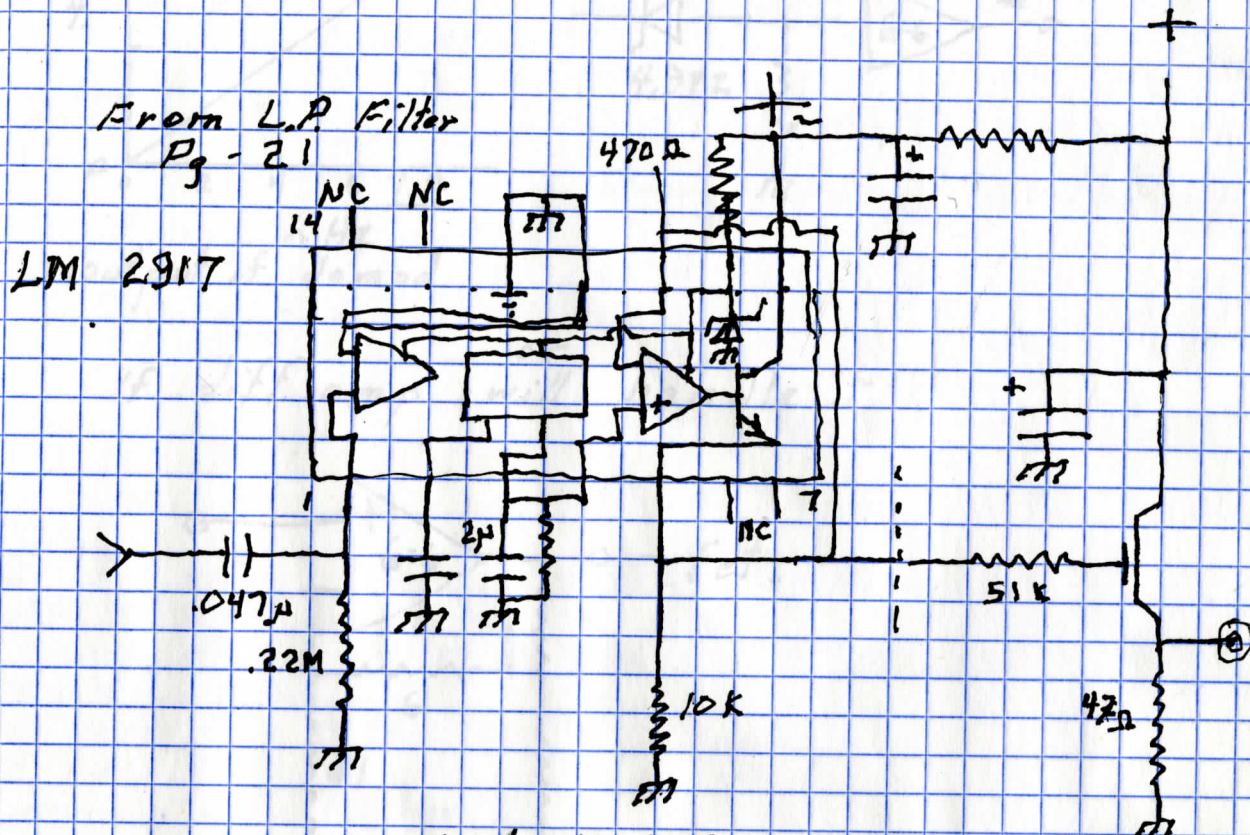
Had planned to use Cardionics X'ducers. but unit failed after $\sim 6-8$ pulses. C. removed dust cap & repl. $\bar{e}$ poorly fitting cap which had been relieved around V.C. connection. A solid ? xplastic foam tube had been glued on top but the slot it operated in was narrowed & covered $\bar{e}$ thick foam $\bar{e}$ thick cover.



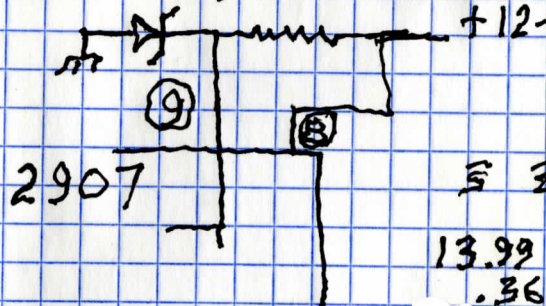
Now will try to get H.W. to lash up two V.C. prototypes

11 Jan 06

① Channel (1.K) - Data on Pp. 2, 3, 4 used ²⁶
ckt below -



to 10V Zener



$$\frac{2V}{2 \times 10^{-2}} = 1 \times 10^{-2}$$

$$= 10 \text{ mA}$$

$$\text{Max } I_2 = \frac{1.0W}{1 \times 10^{-4}}$$

$$= 100 \text{ mA}$$

$$250 \text{ mA for } 2V$$

$$= \frac{2}{2.5 \times 10^{-2}} \approx 10^2$$

Use

$$13.99 - 13.63 =$$

$$.36 \times 10^{-2} \text{ A}$$

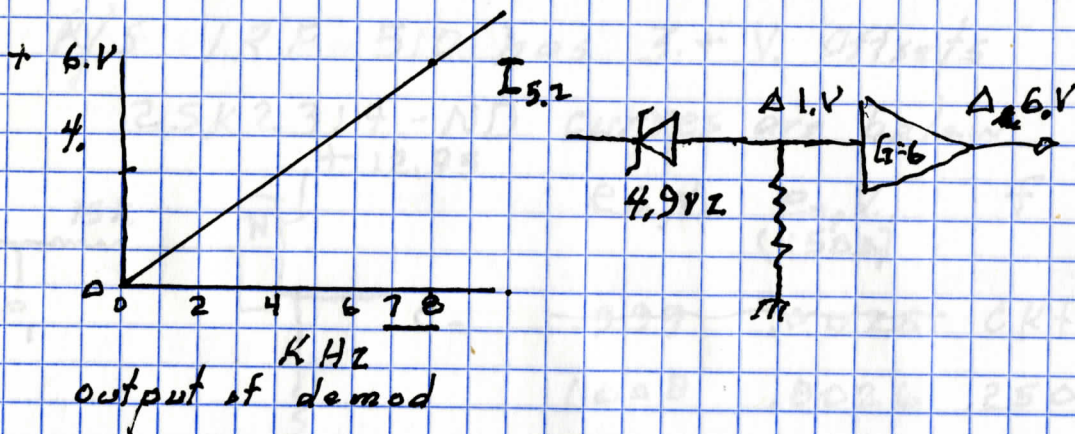
$$= 3.6 \text{ mA}$$

$$Z_w = 14 - 10V = 4V$$

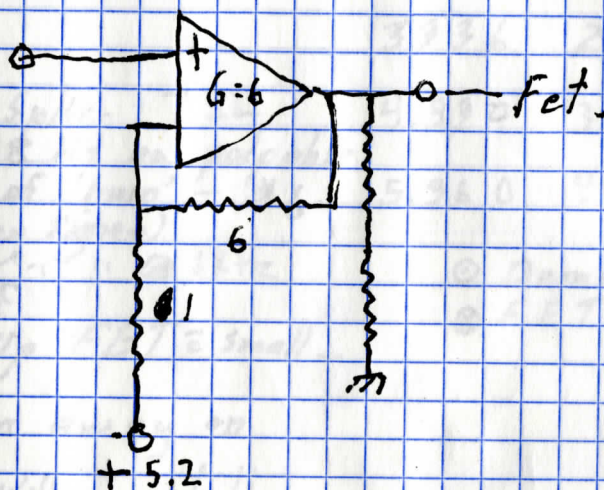
$$W = 4 \times 10^{-2} \times 10V = 4 \times 10^{-1} \text{ W}$$

11 Jan 06 - 7 KHz (R) Ch-

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if diff amp ^{or} will handle it

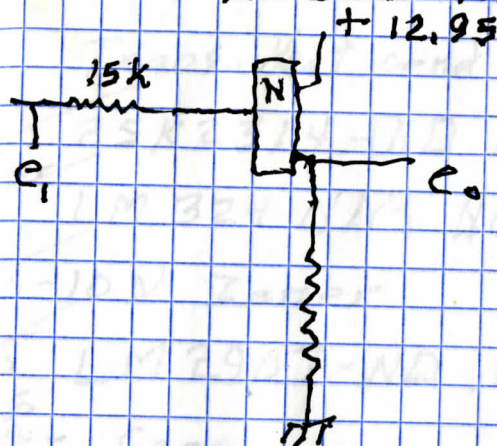


12 Jan 06 PIM FET Bias Probs

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R/S IRF 510 has 3. + V. Offsets

25K2314 - ND curves are below



E_{in}, V	E_{out}, V (150Ω)	F	$E_{out}, 7\Omega$ load
0.000	0.0026	CK error	
1.008	0.0026	250	0.003
1.998	.610	499	.403
2.994	1.543	751	1.294
3.936	2.458	992	2.186
4.990	3.479	1258	3.170
5.960	4.440	1505	4.13

$\bar{E}$ 3" Spkr. 7Ω

At 498 Hz no palpable trace of 'hum' - X6

10 mV on signal

also 10 mV... @ 1KHz

$\bar{E}$ 1.0 μF

Burned Up FET & small radiator

Temp ran away on

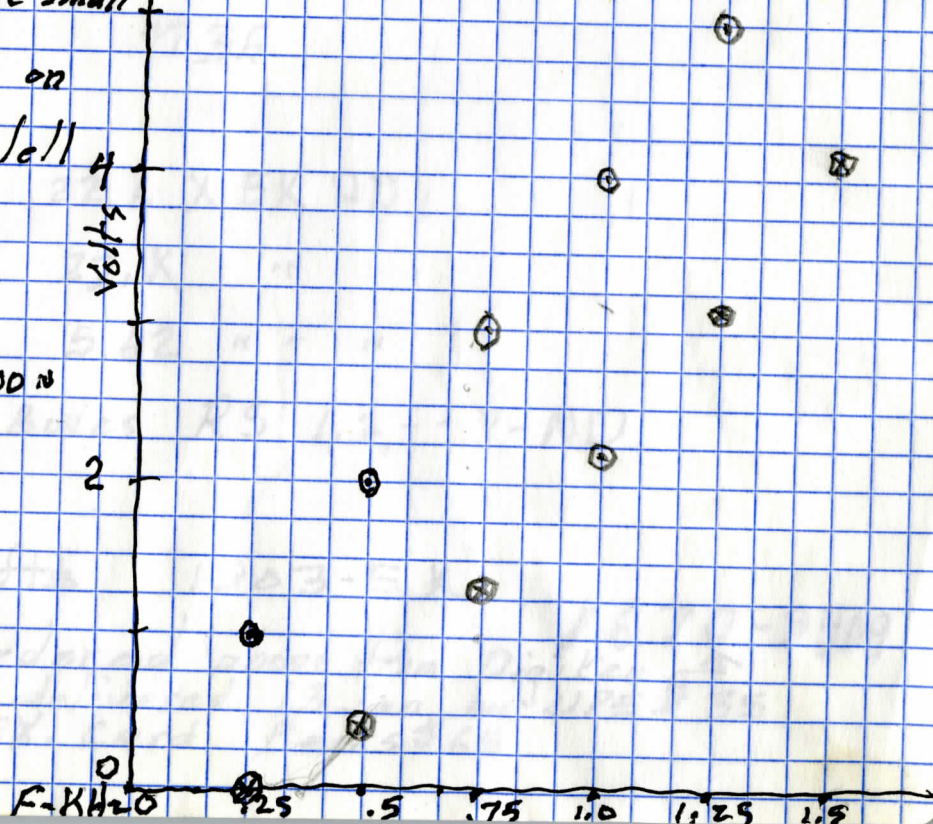
FET - Will parallel

them -

Call Digi Key

* I could hear 500 Hz & 1 KHz tone

○ Demod
⊗ FET



12 Jan 06 Parts -

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2X4X6 Bud Box - 2

Ckt Boards - 3

Trans. Heat cond mtg. ? TD-220

~~12~~ 2SK2314 - ND N Ch. MOSFET

800 344 4539

~~12~~ LM 324 N.Y.S. ND

ZXM64NO35L3 (P-55)

~~10~~ 10 V Zener

1N4740 ADICT-ND

~~6~~ LM 2907 - ND 14 DIP

~~6~~ Caps -

.047 EF 1473 ND

.1 1104

.47 1474

1.0 1105

~~16~~ .001 2% PS 1H102G - ND

~~6~~ .047 4735

~~22~~ 220 K 1%

22K X BK ND

1

~~22~~ 22 K 1%

22K "

~~5.6~~ 5.6 K 1%

5.62 " " "

Boxes RS 1,2,-- X-ND

~~Al~~ Box

~~1~~ Stand offs 1903-EK

✓ = ordered above from Digkey
to be delivered 13 Jan by UPS #35
Am. EX. Card Parts #65 - 1670-9409

12 Jan 06 T B D

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Finish (L) channel

Filter for demod

Calc
Br. Bd.

✓ Response time

Test (build) FET array

Design (R) Driver Channel

? Filter

Test Amplify - 7 to 8 V to 0 to 6 V - A=6
above

Design Pwr. Arrangement

Get 2 transducers

Build -

Circuit Bds.

Box & Cables

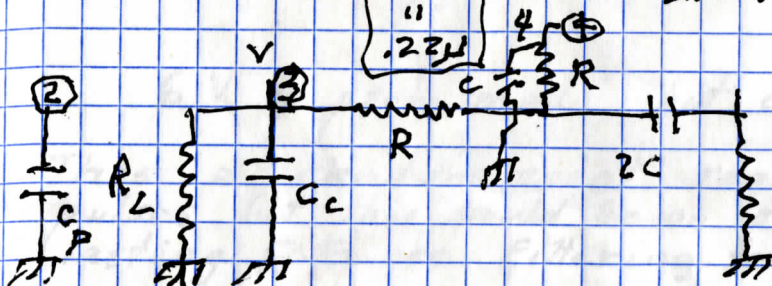
Filter for Ripple - 13 Jan 06

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From Appl Notes:

$$f = \frac{.707}{2\pi RC} \quad \& \quad RC = \frac{.707}{2\pi f} = \frac{7.07 \times 10^{-1}}{10^2 \pi} = 2.25 \times 10^{-3}$$

$$R = \frac{2.25}{C} \approx \frac{2.2 \times 10^{-3}}{2.2 \times 10^{-7}} = 1 \times 10^4 \text{ or } .022 \mu$$



$$\tau = \frac{1}{f} = \frac{1}{50} = .02 \times 10^{-1}$$

$$\tau = RC = 10^5 \times 10^{-6} = .1$$

$$\text{For } 2 \times 10^{-7} \approx 10^5 C$$

$$R = 2 \times 10^{-7} = .2 \mu$$



During C/O of above E_o vs Freq. suddenly chgd
Repl of $E_p \in .01$ for .001 restored spurs -

Will A DT chip before recalc. $\Delta f = \Delta E_o$

NB $\in 10V$ inn $\sim 9V$ is max - No diff. must have made error in

Δ components - Recalc. Slope - No time-Trim R_L
✓ max first. $2.01 \text{ cap } (.0106 \mu)$

1012 Hz, 7.78 Use 7.5V for 1.5 kHz -

1104 8.47

9.6 .62

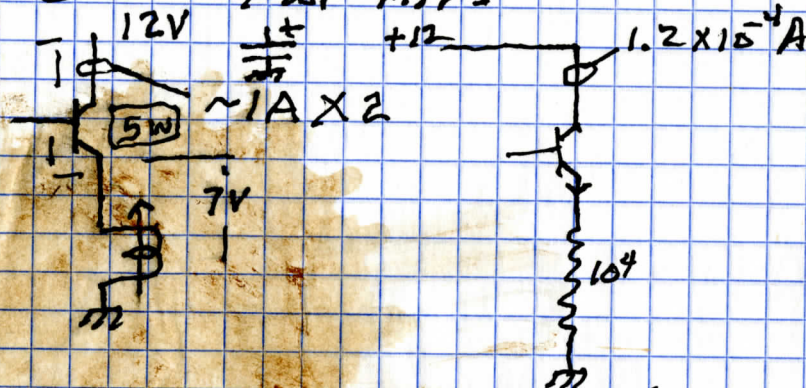
1301 .62

14 62

13 Jan 06

Power Arr.

32



$$r_{equiv} = \frac{12V}{2A} = 6\Omega$$

6V is prob. max - but even at 1A:

This a random event requiring two max. ampl. pulses but this would be an event $\approx$ 50% duty $\sim$ lasting 0.5 sec. Filtering for 2 sec, $T = RC$

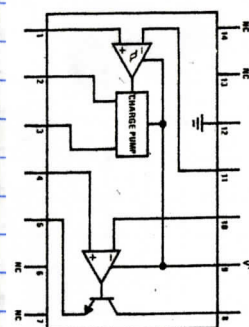
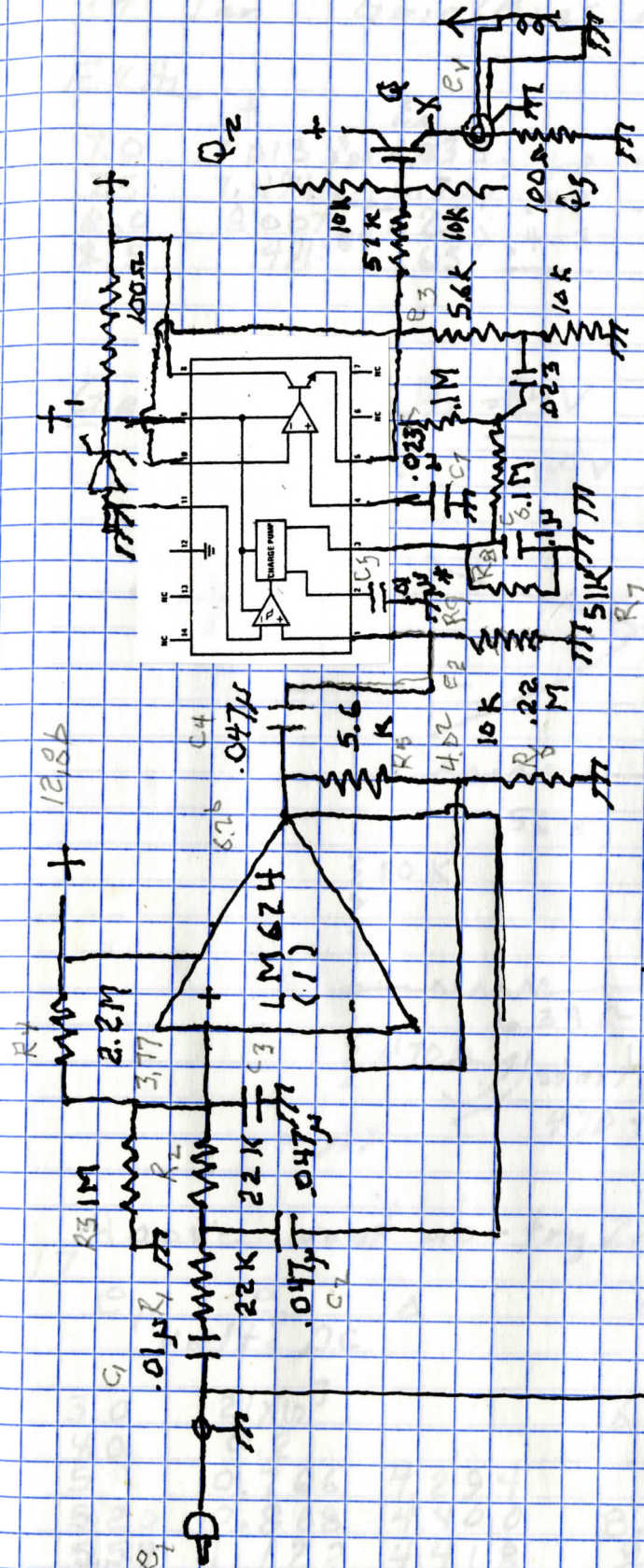
$$\frac{2}{6} = C = \frac{1}{3} F. = 3300 \mu F \quad 3.3 \times 10^5 \mu F \quad (P736)$$

Panasonic has .12 F 40 x 80 mm $\sim$ 12.

Need Xfer curves:

For 3 FET in ||:

e_1	$e_2 = 6.232V$	e_3	e_2	e_3
0.00	0.00	0	5.84	12.31
.504	0.00	0	5.79	6.16
1.01	0.00	0	5.95	8.05
2.	0.00	0	13.02	11.02
2.	.337	.340	12.00	10.03
3.01	1.281	1.294		
4.00	2.253	2.264		
4.94	3.091	3.099		
6.08	4.21	4.23		
7.01	5.15	5.16		



* 01572

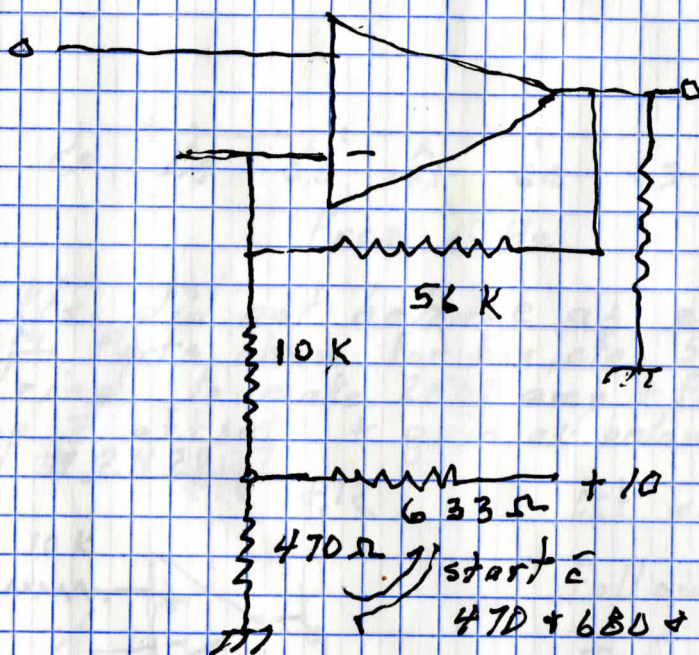
F KHz

F	E _e	ΔE/ΔF
7.0	7.013	6.33
7.5	7.494	6.75
8.0	8.007	7.22
8.5	8.491	6.5

$$F = 7.5 \text{ K}$$

$$\Delta E = .89 \text{ V}$$

$$\text{Gain} - \Delta 1 \text{ KHz} = \frac{15 \text{ V}}{.89 \text{ V}} = 5.61 \quad E_0 =$$



F KHz	E _e
5.680	.998
5.987	2.760
6.060	3.197
6.233	4.19
6.447	5.40
6.580	6.16
6.913	8.07-5.21
7.000	8.50
+	8.52

$$\frac{\Delta V}{\Delta F} = 5.2 \text{ KHz}$$

$$\text{or } G = \text{R. 5.1V Zener}$$

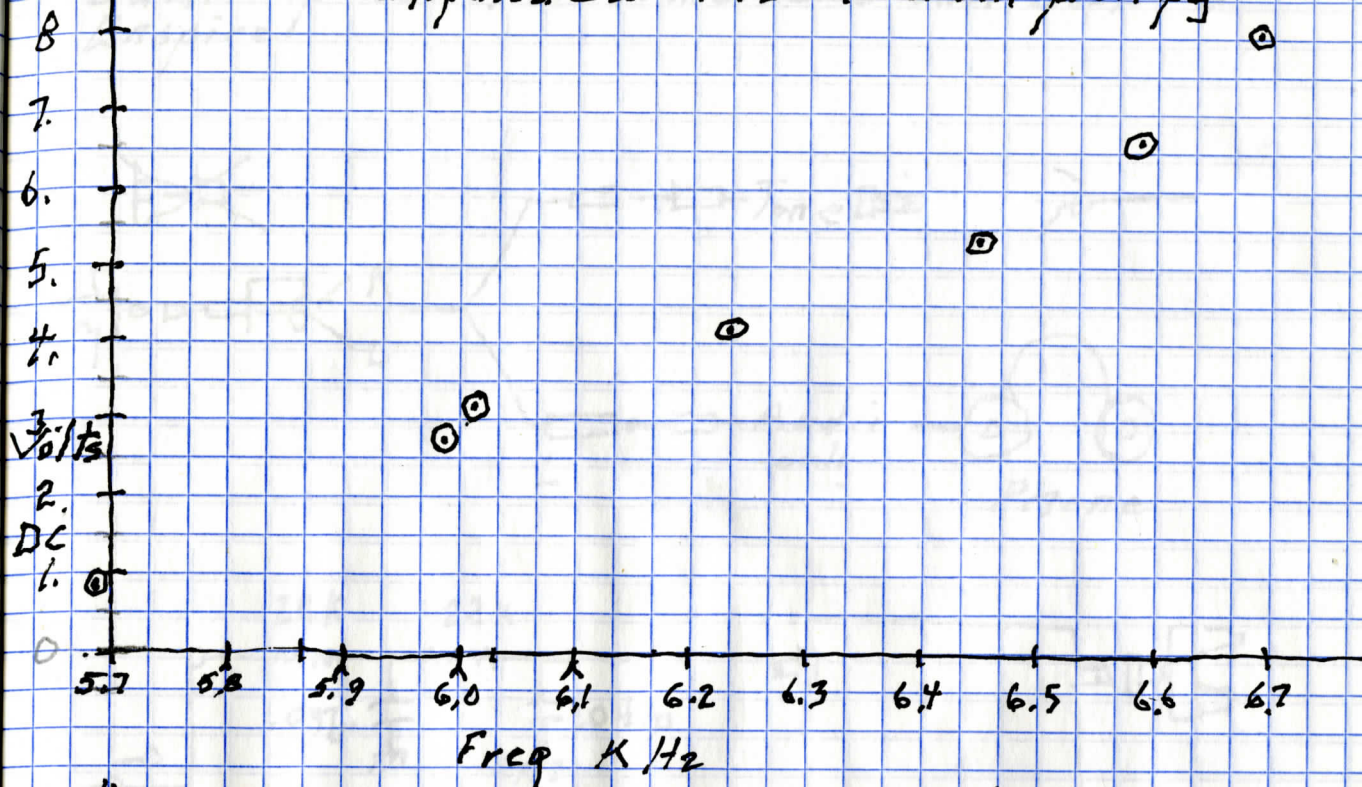
17 Above want do-try Zener for voltage shift

e ₁	e ₀	Δ	e ₁	e ₀	Δ
3.0	21X10 ⁻³		6.67	1.547	4.523
4.0	0.2		.49	1.904	.586
5.2	0.766	4.294	.99	2.344	.646
5.20	0.868	4.400	8.08	3.344	.766
5.54	1.122	4.418	9.00	4.240	.76?
			9.96	5.160	.800

666 3.126.65V 742PM Z is on low current at knee of curve possible but not good

14 + 18th

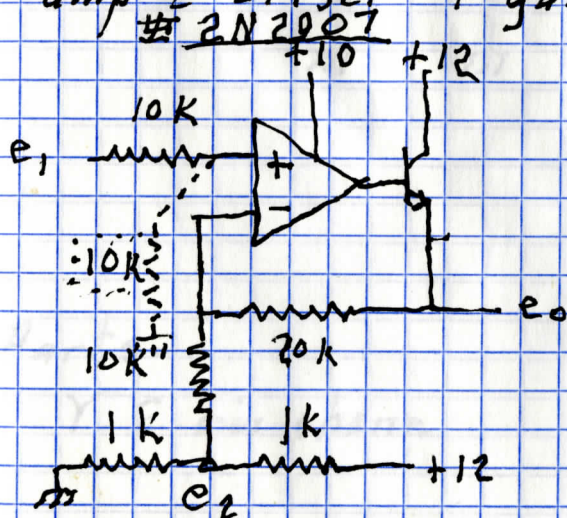
Expanded Xfer f from prev. pg. 36



18th E kts. did not behave as expected

14th Parts chase for box, etc. Started Ckt. bd.

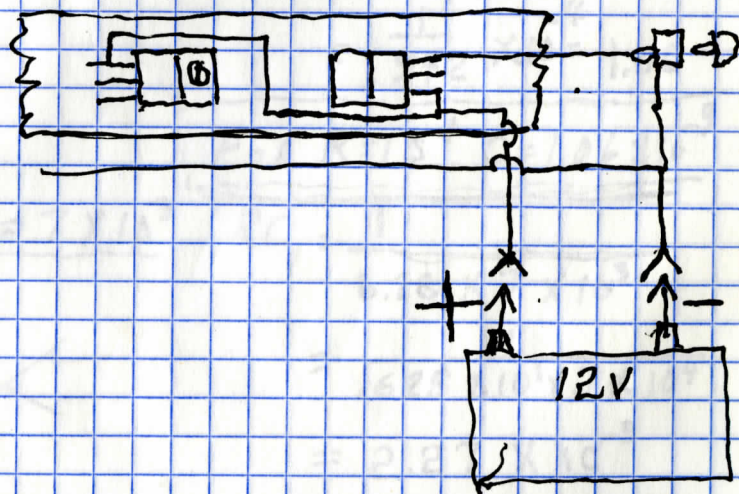
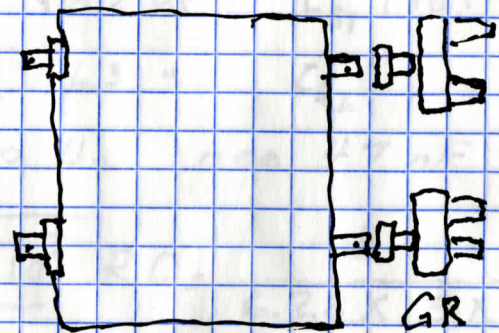
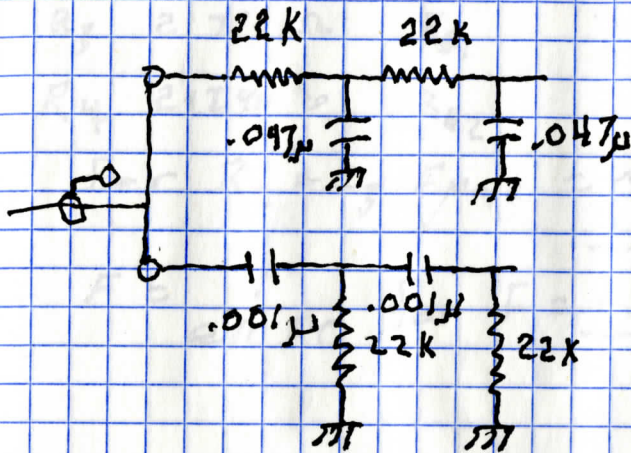
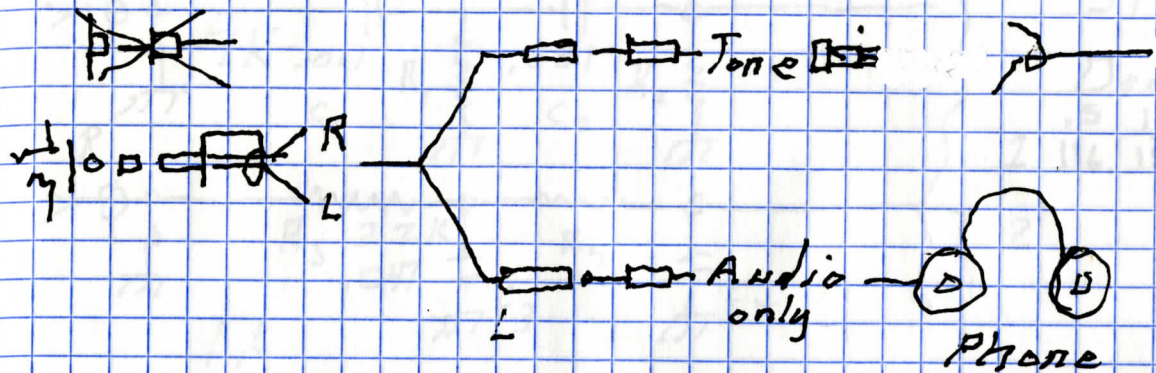
15-17 Tried to make 2N07 amp + follower into diff amp & offset + gain as below:



ckt would always act as follower & gain -

Tried 1/4 of LM 324 & somewhat better results but should have res. in dotted square - Ran out of time.

18 Lash up for for tomorrows 'First Look' at Enspire

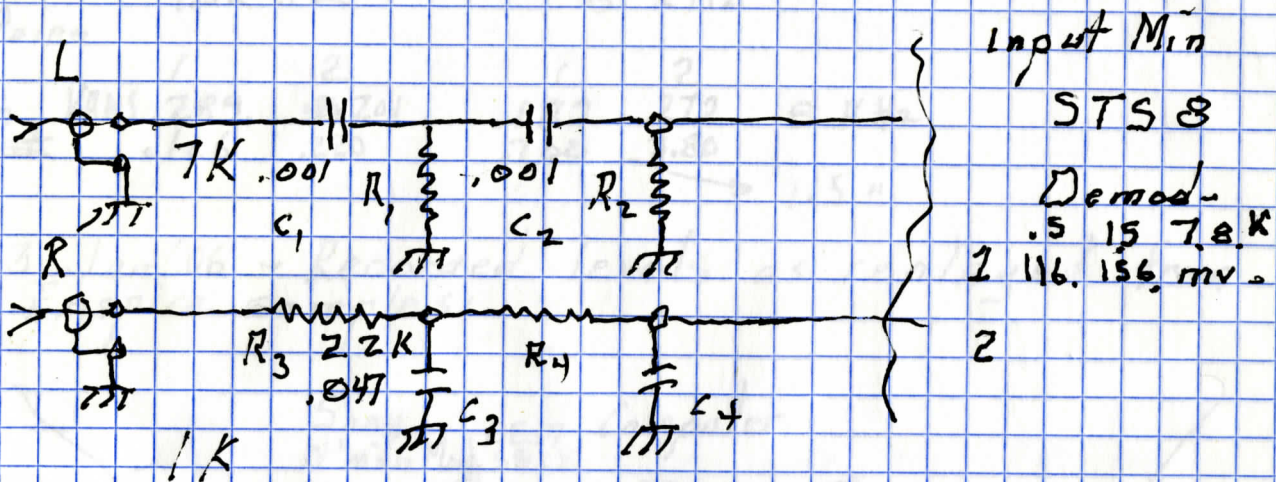


Parts -
Y C min phone

Scope
VOM

Battery
V.C.S

18th Jan - 1st Look PIM demo Filter ckt



R_3 21770 Ω R_{01} C_3 45.2 nF C_{01} 1.107 nF
 R_4 21240 " R_{02} C_4 46.3 " C_{02}

For R_3 & C_3 $F_{pole} \approx 1/50$ Hz use 4.7 nF

$$F = \frac{1}{2\pi RC} \text{ for } F = 1.5 \times 10^3 \text{ RC} = \frac{1}{6.28 \times 1.5 \times 10^3}$$

$$= \frac{1}{6.28 \times 10^3 \times 1.5 \times 10^3}$$

$$= \frac{1}{9.42 \times 10^6} = 1.06$$

For $R = 10^4$ $C = 1.06 \times 10^{-9}$

$F = 7 \times 10^3$ $RC = \frac{1}{6.28 \times 7 \times 10^3}$

$RC = 2.27 \times 10^{-5}$
 & For $C = 10^{-9}$
 $R = 2.27 \times 10^4$



$= \frac{1}{6.28 \times 10^3 \times 7 \times 10^3}$
 $= 2.27 \times 10^{-5}$

For $C \approx 2.27 \times 10^{-9}$
 $R = 1 \times 10^4$

18 Jan '06 RC values on Prev. pg S-B Demod.

Poles	1.5 KHz		8 KHz	
	1	2	1	2
In VRMS	.289	.701	.187	.272
Att	.166	.220	.700	3.80

8 KHz
→ 1.5"

23 Jan '06 - Recorded levels as replayed from
Empire samples;

Sony DECT Computer
W'men Mod. 58K
Mono Stereo Mon. Ster.

0.5 KHz -		680	620	840
		240	218	309
0.5 2500		680	620	840
		240	217	307
1.00		680	620	840
	168	239	216	307
1.50		680	620	840
	166	236	215	304
7.00		660		
		175		
7.25		660		
		173		
50		660		
		170		
8.00		660		
		166		

Spurious period $\approx 3.8 \mu\text{s}$

23 Jan '06 - Playback of recorded Tones

Ensp. Test.	Chr.	Freq KHz	Mono Computer	Stereo
			(614) mV pp/RMS*	
3/4		0.5	630/218	860/309
M/S		.75	" / 217	/ 307
		1.0	620/216	/ 306
		1.5	620/215	↓ / 305

Sony
Line Out

5/6	7.0	680 / 175	920 / 248
	.25	↓ / 173	940 / 245
	.50	675 / 171	↓ / 242
	8.0	↓ / 166	↓ / 236

UTMB Test Record 10% incr in ampl. for 1 KHz tone
Sony line out

1	0	1.0	0 /
2	100		29 /
3	10		58 /
4	20		/
5	30		116 /
6	40		/
7	50		/
8	60		200 /
9	78		/
10	80		/
11	90	↓	1120 /

* RMS meas. c VOM, PP c Scope

RMS, sin/cos * 1.414 = PK or 2.818 PP. (1) = 2416 -

Test record showed variety of odd distortions using Sony walkman phone output. Most of probs disappeared but we need it to establish recording levels.

30 Jan On scope Funct. gen is fth E Freq - VOM is not.

At 1600 mV PP
VRMS on VOM

10 Hz	.468
10 ²	56.5
10 ³	568
10 ⁴	356.
10 ⁵	372

S-B demod Sens

Ch		
KHz	1 - mVPP	2
8	5.5 x 50 = 275.	7 x 50 = 350
0.5	"	166.
		7 x 50
		170 (Rms)

30 Jan 06 Need Quick Look at Waveforms -

Prob. S-B demands need ≈ 300 mV PP

1 pole RC Filt. should do -

Measure what you have

LP = NO!

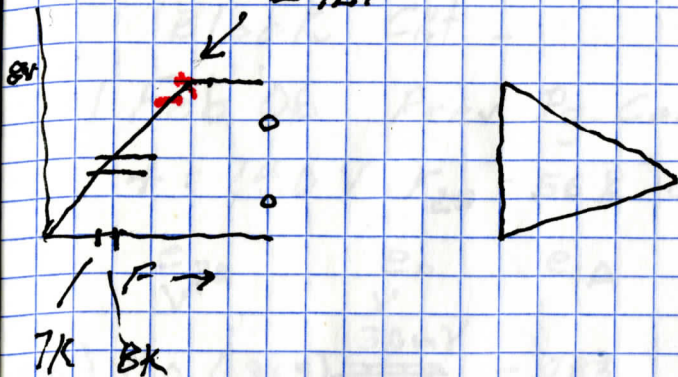
Finish MK II Demod

Breadboard Performance

Have to use scope - VOM's not flat

Freq In		Filt. out	B ⁺ - 13.7V		7K Ch -	
Hz	mV PP	mV PP	FET in	V dc	In	Out
					mV PP	mV PP
100	250	265				
500	250	250	2.46			
1K	250	210	4.89		250	15
1.5K	↓	165	7.31		250	15.
↓	↓	84% drop out 4000	out Δ			
7.0K	↓	20	.007			190
8.0K	↓	15	.007			210

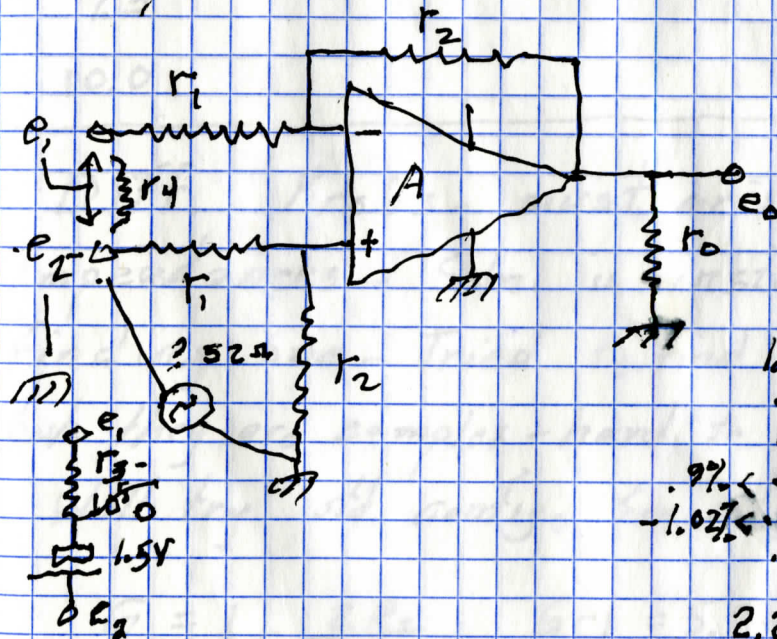
31 Jan '06
 $\Delta V / \Delta F$



If $\frac{\Delta V}{\Delta F} = \frac{7.5}{8} = .9375 \frac{V}{Kc} \times 7 KHz = 6.56V = \text{offset}$

For Gain $\Delta V = \frac{7.5V}{.9375} = 8 \times$ How much CMR will the
 For 2.5V offset $\Delta_i = \frac{5.0}{.9375} = 5.33 \text{ amp. handle}$
 Start @ 1 Amps - 1st is diff $\hat{G} = 2$
 2nd " " "

Eval. performance of LM324 as A amp.



Case a - All $r_s = 10K$
 ex. as noted

+ 12.94V

	G	$e_1 - e_2$	e_o	e_2
	60	1.2mV		
	+ 99.0	+ 98.5	- 0.2mV	
	1.004	1.567	1.574	+ 1.00
	.000		1.568	+ 2.00
	.991		62	3.00
	.988		49	5.00
	.979		35	7.50
	.969	1.568	20	10.00

Case b - $r_{1,2} = 22K$

2.213	1.567	3.468	1.00
			2.50
			3.433
			5.00
			7.50
			10.00

- .6% - .013 < 2.190
 - .7% - .015 < 2.177
 - .7% - .015 < 2.162

68

Try $\hat{G} = 5.33$ (next pg.)

31 Jan 06

Block CKT -

1 Feb '06 Prev Pg. Cont'd.

$$+ = 14.0 \text{ V } R_{2S} = 56 \text{ K } e_{in} = 1.035 (r_3 = 15 \text{ K } r_4 = 1 \text{ K})$$

e_{2A} e_o e_{1A} G
V V

0.048) 1.0 (1.965) ~~1.13~~ -0.083
0.587) 2.5 (2.527) 66mV
5.09 5.0 (5.06) 175
7.5 (input polar. revers.)
10.0

+13.37 V

(1.100) ~~1.022~~
1.018 (917. 0.449

2.674) 2.8

5.0

7.5

10.0

Diff. Probs - must arise $\bar{c}$ diff. source
Impedances - Soln. is instr. amp. prob. is
finding one - Tried to find Instrumentation amp.
but they are complex - hard to find -
Will try std. config. See next pg -

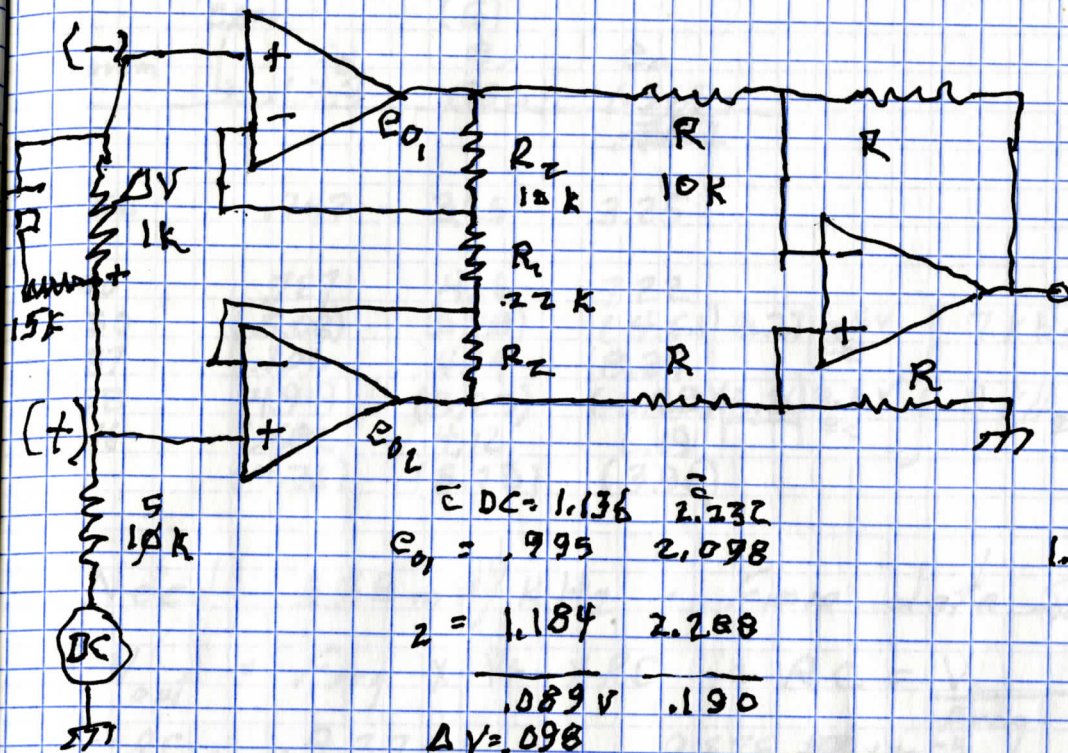
$$G = 1 + \frac{2R_2}{R} \quad G-1 = 5.3-1 = 4.3 = \frac{2R_2}{R_1}$$

$$\& R_1 = \frac{R_2}{4.3/2} = \frac{R_2}{2.15} \approx \frac{R_2}{2}$$

Confused $R_1 + 2R_2 = 10 \text{ K}$ $R_2 = 22 \text{ K}$

1 Jan '06

LM324



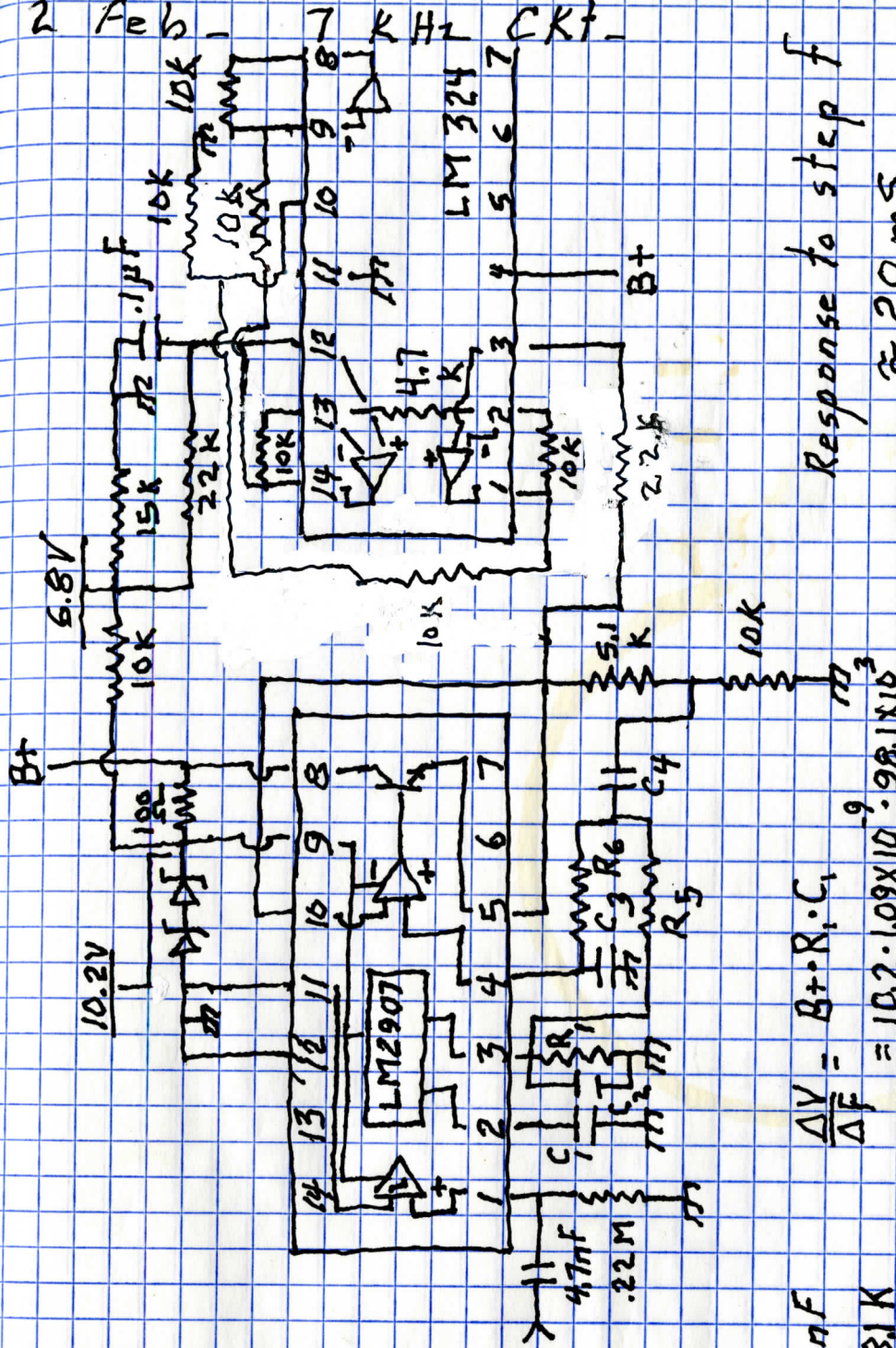
$$\begin{aligned} \bar{E}_{DC} &= 1.136 \quad 2.232 \\ E_0 &= .995 \quad 2.098 \\ Z &= 1.184 \quad 2.288 \\ \hline &.089V \quad .190 \\ \Delta V &= .098 \end{aligned}$$

$$1.5 \times (G = 6.5) = 9.75$$

epc	E in 98.0mV	1.565	+ = 1.356	0.787 e in
	E_0	G_{DC}	E_0	
1.020	.1817	1.85		
2.552	.580	5.91		
5.	.633	6.45		
6.15	.641	6.54	6.17	2.957
7.5?	.653	.66		$G = 1.89$
8.04	.556	.69	8.05	2.941
10.15	.669			1.88
				$G = 1.86$

Correctly Calc Gain = $1 + \frac{2R_2}{R} = 1 + \frac{2 \cdot 10k}{2.2 \cdot 10k} = 1.91$
 $R_2 \approx 5k(4.7)$

2 Feb 1971 7 KHz CKT.



$C_1 = 1.09 \text{ nF}$
 $R_1 = 0.981 \text{ K}$
 $C_2 = 47.4 \text{ nF}$
 $C_{3,4} = 22 \text{ nF}$
 $R_{5,6} = 100 \text{ K}$

$$\frac{\Delta V}{\Delta F} = B + R_i \cdot C_i$$

$$= 10.2 \cdot 1.09 \times 10^{-9} \cdot 98.1 \times 10^3$$

$$= 1.091 \text{ V/KHz}$$

Meas - 0.874 "

Response to step f
 $\approx 20 \text{ ms}$
 No detectable
 7 KHz ripple at 5mV/cm