FCI-19-94(2-62)

YOUR NOTEBOOK

1) This notebook is a record of your thought and activity as an engineer and employee of Fairchild. Its contents must be safeguarded as "Company Private Material", and shall not be disclosed to anyone outside of the Fairchild Organization without proper authorization. All notebooks are the property of Fairchild and shall be turned in to the Notebook Registrar upon termination of employment.
2) Material selected for invention disclosure must be submitted to the Parent Company Patent Department in accordance with SPI-19-405.3. If you do not have a copy of this instruction see your supervisor.
3) The procedure below specifies how notebooks must be maintained to make them acceptable in patent proceedings as legal proof of what was done and when it was done. The early date of record may be the deciding factor in obtaining an important patent for Fairchild in your name.
4) Proper maintenance of your notebook is a meaningful contribution to your individual progress at Fairchild.

NOTEBOOK ENTRY PROCEDURE

1) Make regular entries in this notebook of all notes, calculations, sketches, circuit diagrams, formulas, equations, graphs, developmental and test observations, and all test results and conclusions regardless of whether successful or not. (DO NOT USE SCRAP OR OTHER LOOSE PAPER FOR THIS WORK.)
2) All entries shall be kept chronologically using a separate page for each idea and all entries on any one page shall be made only as of a single date indicated on the page. Draw lines through unused portions of a page so there are no empty spaces between entries. (DO NOT SKIP PAGES AND NEVER TEAR OUT PAGES.)
3) Do not make entries in the notebook of another and do not permit anyone to make entries in your notebook.
4) When blueprints, photostats, or other material will clarify or explain entries, affix such material securely to the appropriate pages.
5) New ideas which may be original regardless of whether they are conceived under company sponsored program or a commercial or government contract should be entered in sufficient detail to enable any engineer or any person skilled in the art to fully understand the idea involved. Such entries should be dated and attested by two individuals who have read and fully understood the entry. (DO THIS PROMPTLY.) Subsequent additions or changes should be made on other pages likewise dated and attested and reference previous pages and earlier notebooks.
6) If the new idea has been operated in a piece of apparatus your notes should include a description of the conditions under which the apparatus operated, the operations performed, the persons present, the data taken and any other facts which will substantiate the steps taken by you. Two engineers, one preferably your supervisor, should witness such apparatus operation, check the detail sufficiently that they know the idea embodied therein and sign the notebook pages as having witnessed the operation. At this point check with your supervisor if the apparatus is to be tagged and stored as a patent exhibit.
7) Take your notebook to conferences or technical discussions and enter any ideas or suggestions you make, refer to the discussion, those present and its date. Shortly thereafter, amplify the notes so they will be understandable at a future date. Obtain signatures of two witnesses who were present when the disclosure was made.
8) By following the above instructions you should always be able to testify that any one of your notebook pages is in its original condition and that no changes were made thereto after the original entry and signatures.
9) When inventive work is performed under a Government Prime or Subcontract which is classified for security purposes, a separate notebook shall be kept for each such contract and the notebook shall be safeguarded in accordance with requirements applicable to the security classification of the contract.

NOTEBOOK CONTROL PROCEDURE

1) Each notebook issued shall have a copy of this instruction affixed to the front inside cover.
2) Each notebook page shall be numbered and the book itself shall be numbered and recorded by employee name in a register maintained by each Engineering Department.
3) Each notebook shall be periodically reviewed by the employees supervisor.
4) Each filled notebook that has served its reference use shall be returned to the notebook registrar for filing.

E. Guthrie / #1110
I D Salt
1-31-68

12/15/65 HALLICRAFTER C-BAND UP-CONVERTER

LOW FREQUENCY INPUT RANGE 200 mc - 310 mc.

THE TWO PUMP FREQUENCIES { 4720 mc. / 4790 mc.

THE TWO OUTPUT SIDE-BANDS WILL BE:

4920 - 5030 mc. 4990 - 5100 mc.

CONSIDER USING THE FOURTH HARMONIC FOR THE PUMP.

THEN INPUT OSC. FREQUENCIES WILL BE:

$$\frac{4720}{4} = 1180\text{ mc}, \quad \frac{4790}{4} = 1197.5\text{ mc.}$$

CONSIDER PUMP COMBLINE FILTER

$f_1 = 4700$ mc. { $f_2 = 4810$ mc

FIRST, CONSIDER DESIGN PARAMETERS REQUIRED FOR C-BAND UNIT.

FROM p. 110 NOTEBOOK # 1068

$$\sqrt{\frac{\omega_1}{\omega_2}} = \sqrt{\frac{f_1}{f_2}} = \sqrt{\frac{250}{4750}} = \sqrt{.0515} = .227$$

AGAIN LET $R_1 = R_2$

2/9/66 WILL HAVE RON SHIPOW DESIGN THE X4 MULTIPLIER FOR THIS JOB.

Statement of Operation ____________________

____

Witnessed operation (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

Signature ____________ Date ________

Read and Understood (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

2/9/66 C-BAND UPCONVERTER

OUTPUT BAND IS 4990 – 5100 mc.
& 4920 – 5030 mc.

SINCE FM MOD. IS ±6 mc. AT PUMP, MAX. BANDWIDTH FOR BOTH BANDS ~~4984~~ 4914 mc TO ~~5036~~ 5106 mc.

LET f_1 = ~~4950~~ 4890 mc. & f_2 = ~~5070~~ 5130 mc.
f_0 = ~~5010 mc.~~ 5010 mc.

5130	5070	5070
4890	4950	−4950
2 / 10020	2 / 10020	120
5010	5010	

5130
−4890
240

$$w = \frac{240}{5010} = .048$$

CONSIDER 5^{th} HARMONIC OF 1180 mc PUMP. (FUND OSC.)
5 × 1180 = 5900 mc.

$$\frac{\omega'}{\omega_1} = \frac{2}{w}\left(\frac{\omega-\omega_0}{\omega_0}\right) = \frac{2}{.048}\left(\frac{5900-5010}{5010}\right) = \frac{1}{.024}\left(\frac{890}{5010}\right)$$

$$= 7.4, \quad \left|\frac{\omega'}{\omega_1}\right| - 1 = 6.4$$

n = 3 SHOULD BE ADEQUATE.

DESIRE TO USE A 5Ω IMPEDANCE LEVEL AT UP-CONVERTER DIODE END OF PACKAGE. WILL TRY TO WORK BACKWARDS AND FIND IF 5Ω IS REASONABLE STARTING WITH A SQUARE COUPLING FINGER.

CONSIDER: $$\frac{W_0}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C_f'}{\epsilon} - \frac{(C_{fe})_{01}}{\epsilon}\right]$$

LET $\frac{t}{b} = .8$, $\frac{C_f'}{\epsilon} = 1.7$, $\frac{(C_{fe})_{01}}{\epsilon}$ = ~~.6~~ .4

2/21/66 CONT. FROM p. 2

THE .8 VALUE WAS SELECTED AS A REASONABLE MEAN VALUE. ALSO IF LINE IS SQUARE $\frac{w_0}{b} = \frac{t}{b} = .8$

$\therefore \quad \frac{1}{2}\left(1 - \frac{t}{b}\right) = .1$

$\{ \quad .8 = .1\left[\frac{1}{2}\frac{C_0}{\epsilon} - 1.7 - .8\right] = .1\left[\frac{1}{2}\frac{C_0}{\epsilon} - 2.5\right]$ (corrections written above: .4 over .8; 2.1 over 2.5)

$8 = \frac{1}{2}\frac{C_0}{\epsilon} - 2.5 \,(2.1), \quad 16 = \frac{C_0}{\epsilon} - 5 \,(4.2)$

$$\boxed{\frac{C_0}{\epsilon} = \begin{matrix}21.0\\20.2\end{matrix}}$$

USING $\theta_0 = \frac{\pi}{4}$, $\left(\frac{\cot\theta_0 + \theta_0 \csc^2\theta_0}{2}\right) = 1.285$

ALSO FOR .1 db RIPPLE.

1.000 :	1.032 :	1.147 :	1.032 :	1.000
g_0	g_1	g_2	g_3	g_4

~~CONSIDER EQUA. $\frac{C_0}{\epsilon} = \frac{376.7\,Y_A}{\sqrt{\epsilon_r}}\left(1 - \sqrt{\frac{G_{T1}}{Y_A}}\right)$~~

~~TO CALCULATE REASONABLE VALUE FOR $\frac{G_{T1}}{Y_A}$ } THEN SOLVE FOR Y_A~~

~~LET $Y_{A1} = \frac{1}{25\Omega}$.~~

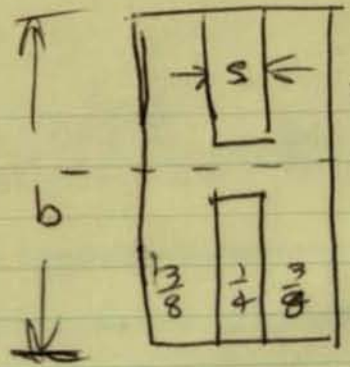
FOR $\frac{t}{b} = .8$ $\quad \frac{s}{b} \cong .09$ FOR A REASONABLE SPACING (FOR INSTANCE IF $b = \frac{1}{4}$ $s = .022$)

THIS GIVES $\frac{C_{01}}{\epsilon} = 9.0$

USING $\frac{C_{01}}{\epsilon} = 376.7\,Y_A - \frac{C_0}{\epsilon}$ $\Rightarrow$ $Y_A = \frac{1}{376.7}\left(\frac{C_{01}}{\epsilon} + \frac{C_0}{\epsilon}\right)$

$Y_A = \frac{30}{376.7} = \frac{1}{12.5\Omega}$

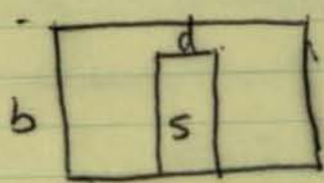
(a)



$S = .25 \quad b = 1.0, \; a = 1.0$

$\frac{s}{b} = .25 \qquad \frac{s}{a} = .25$

$Z_T = 2Z_0$, try



$b = .5$

$a = 1.0$

$S = .25$

$\frac{d}{b} = \frac{.030}{.5} = \frac{3}{50} = .06$

$\frac{s}{a} = \frac{.25}{1} = .25$

Try $d = .030$

$Y_{0_{f=\infty}} \cong .03$

$Z_{0_{f=\infty}} \cong 33\,\Omega$

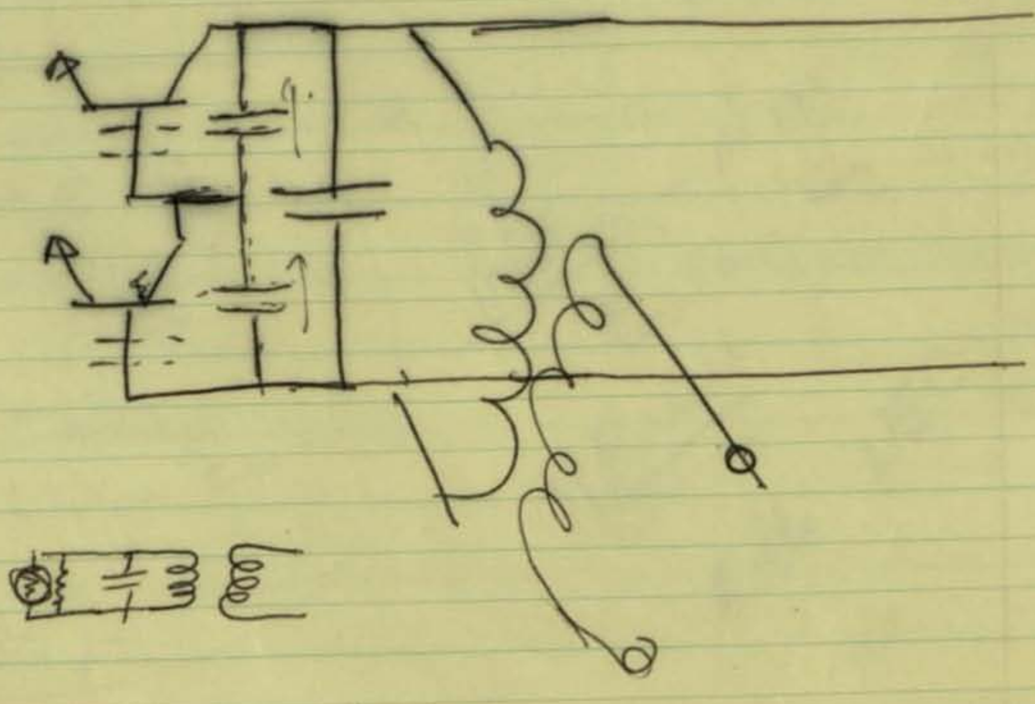
$2Z_0 \cong 66\,\Omega$

$C = \frac{\sqrt{\epsilon}}{v_p 2Z_0} = \frac{1}{3\times10^{10}\,50} = \frac{10^{-10}}{150} = \frac{10^{-12}}{1.5}$

$f = \frac{3\times10^{10}}{6\cdot 2.54} = \frac{30\times10^{9}}{15} = 2$

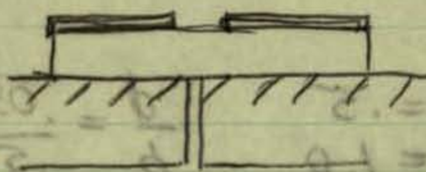
$\frac{\lambda_c}{2} \cong 6, \; a = 1$

$\lambda_c = 6''$



$\frac{S}{b} = .25 \qquad \frac{S}{a} = .25$

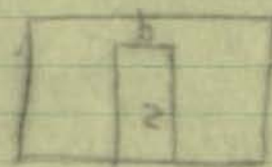
$Z_T = 2Z_0$



$b = .5 \quad \frac{d}{b} = \frac{.030}{.5}$

$a = 1.0$

$S = .25$



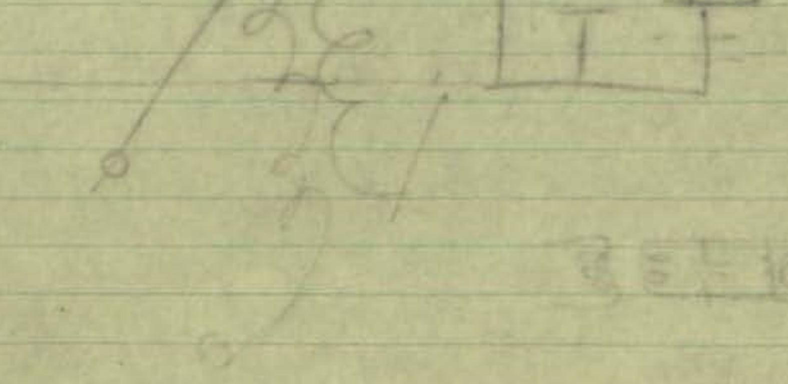
$\frac{S}{a} = \frac{.25}{1} = .25$

$d = .030$

$Y_0 \cong .03$

$Z_0 \cong 33\Omega$

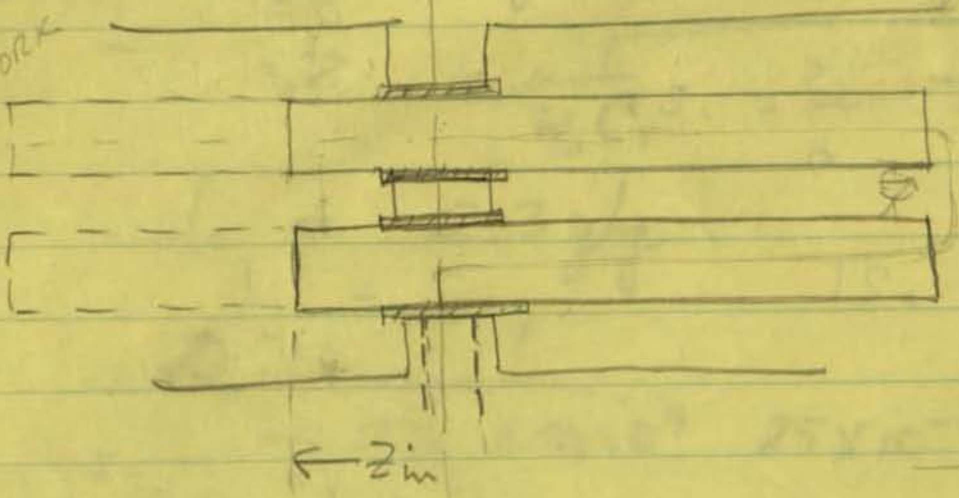
$2Z_0 \cong 66\Omega$

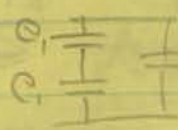


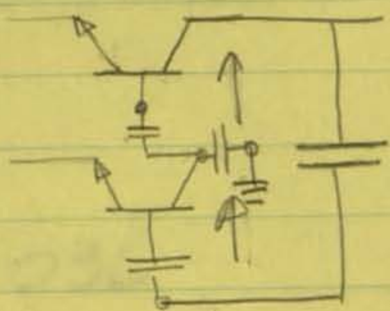
Carruthers
212
PL 26000

$C_{cB} \simeq 4.5$ pf.

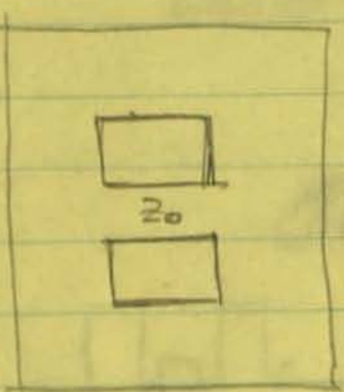
NEW YORK







CHARACTERISTIC Z_0



Tom Flynn. Gilfillan

IF $Z_0 = 77\Omega$.

$$Z_{in} = -j Z_0 \cot \theta$$

LET $C_0 = 10 \frac{C_1}{2}$

$= 10 \cdot \frac{4.5}{2}$

$C_0 = 22.5$ pf.

$C_T = 22.5 + \frac{4.5}{2}$

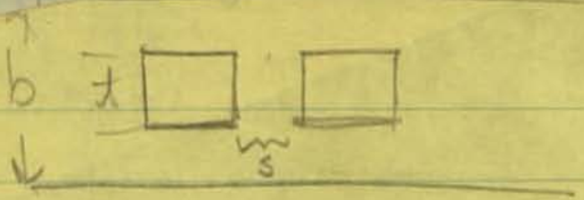
$C_T \simeq 25$ pf.

Muller — M.A.
Burlington

Korbell

NEC

6 db



$\frac{t}{b} = .5 \quad \frac{s}{b} = .25$

let $t = .25$

$b = .5$

$s = .125$

$\frac{\Delta C}{\epsilon} = .21$

$Z_0 = \frac{1}{v_p C}$

$C = \frac{\sqrt{\epsilon}}{3Z_0} \times 10^{-4}\ \mu f/cm$

$= \frac{\sqrt{\epsilon}}{3Z_0} \times 10^{-2}\ \mu f/m$

$$Z_{in} = -j\, Z_0 \cot\theta$$

$$Z_{in} = \frac{1}{\omega_0 C_T}$$

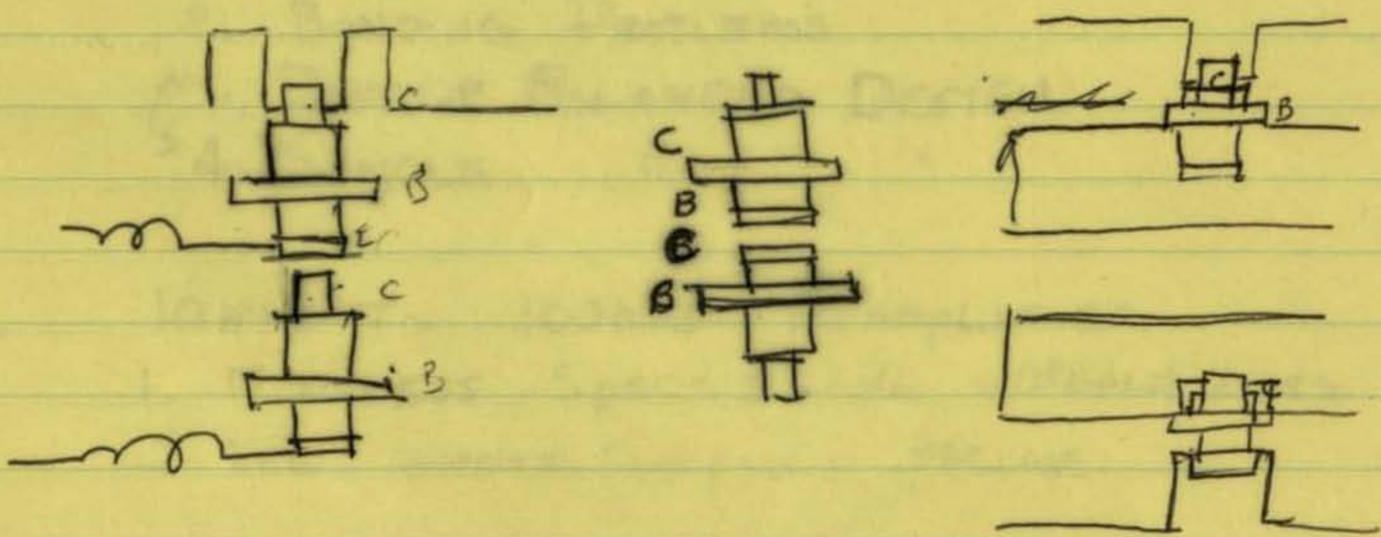
$$f_0 = 2.3\ \text{ghz}$$

$$Z_{in} = \frac{1}{2\pi \cdot 2.3\times10^{9}\ \ 25\times10^{-12}} = \frac{20}{\pi\, 2.3}$$

$$= 2.77\,\Omega.$$

$$\cot\theta = \frac{2.77}{77} = .036$$

88°



$$Z_{in} = -j Z_0 \cot\theta$$

$$Z_i = \frac{1}{\omega_0 C_T}$$

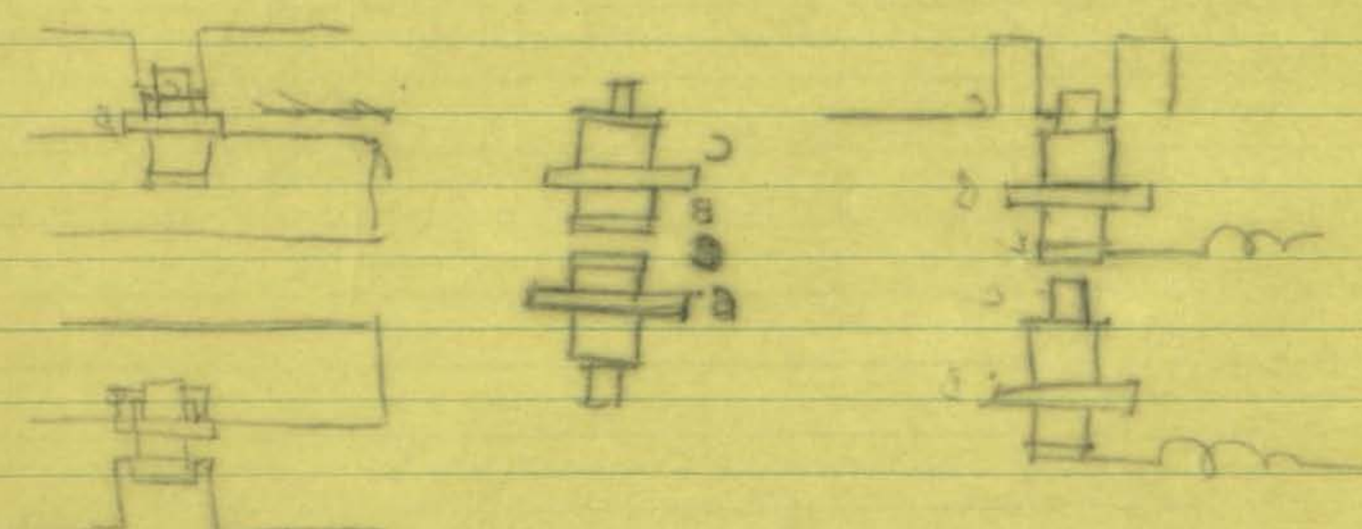
$$f_0 = 2.3\ ghz$$

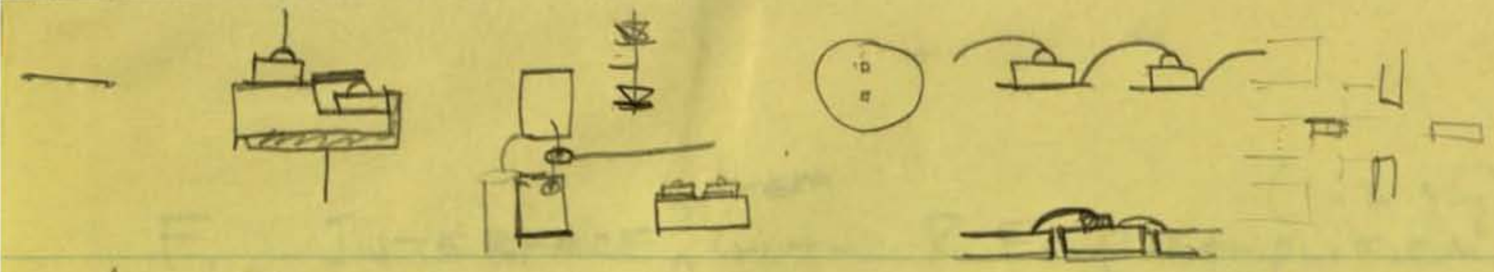
$$Z_i = \frac{1}{2\pi\, 2.3\times10^{9}\ 25\times10^{-12}} = \frac{\cancel{1000}\ 20}{\cancel{50}\pi\, 2.3} =$$

$$= 2.77\ \Omega.$$

$$\cot\theta = \frac{2.77}{77} = .036$$

88°





A. DIODE TEST JIG

1. EVALUATE SINGLE ^OR PAIR DIODE IN COAX PKG.
R_s, N.F., C_o, BURNOUT.

COME UP WITH STANDARD DEVICE TESTING

B. HYBRID CIRCUITS

1. STUDY SLOT LINE POSSIBILITY.
2. " MICROSTRIP AS " .
3. CONSTRUCT STRIPLINE CIRCUITS FOR TEM FEASIBILITY (OR COAXITUBE)

3db HYBRIDS

~~4~~ 5 CONSTRUCT 180° DIFF. Ø SHIFT NETWORKS

C. CONSTRUCT MIXER ON HYBRID

1. DIE ATTACH PROBLEMS
2. BONDING PROBLEMS
3. DOUBLE BALANCED DESIGN.
4. SINGLE " "

D. 10 MHZ TO 100 MHZ PREAMPLIFIER

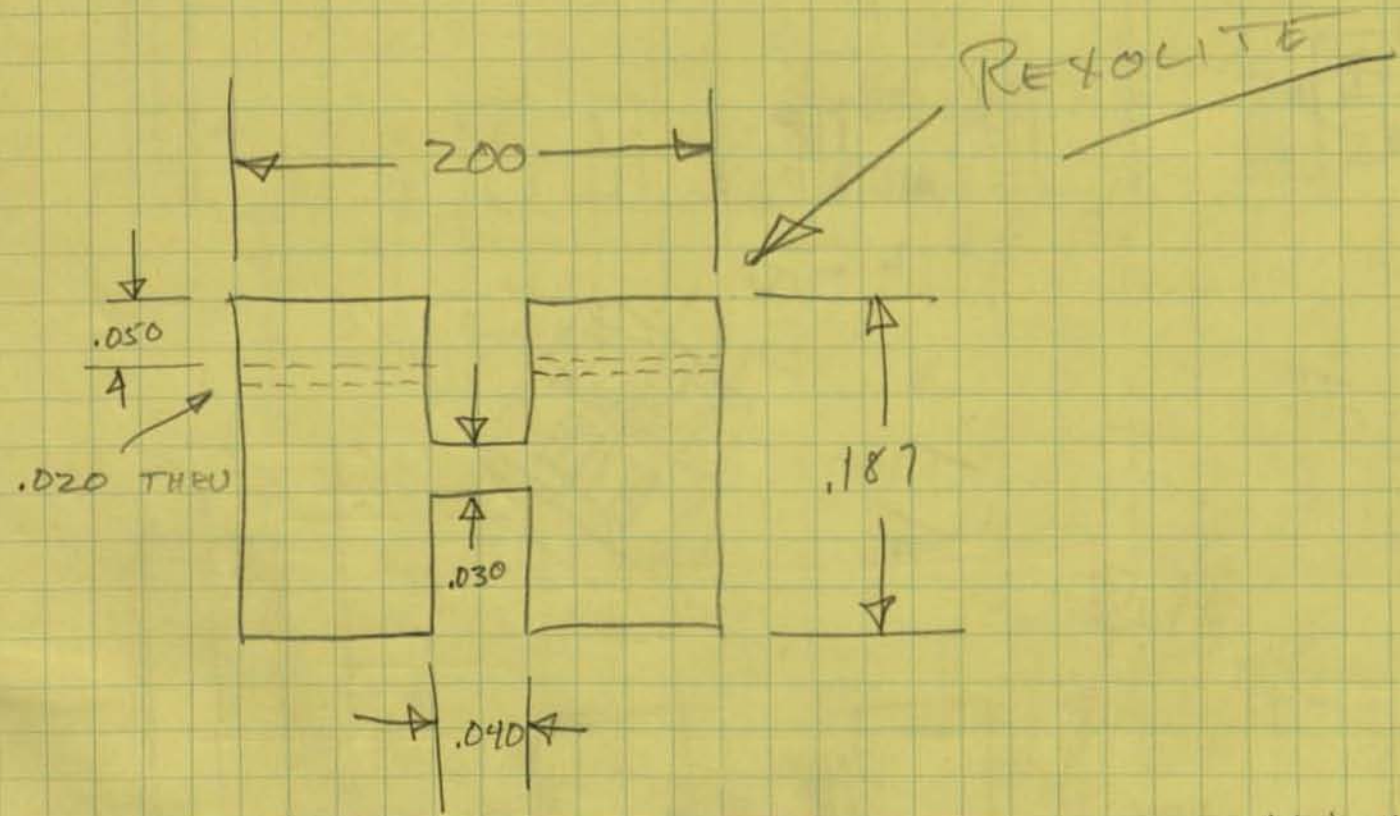
1. FLATNESS SPEC:- ±.1 db + standard specs.
2. USE ~~STAND~~ FLATPACK PACKAGE

E. MIXER-PRE-AMPLIFIER INTERFACE.

1. IMPEDANCE MATCH V.S.
   a. SPURIOUS FREE DYNAMIC RANGE
   b. OVERALL N.F.

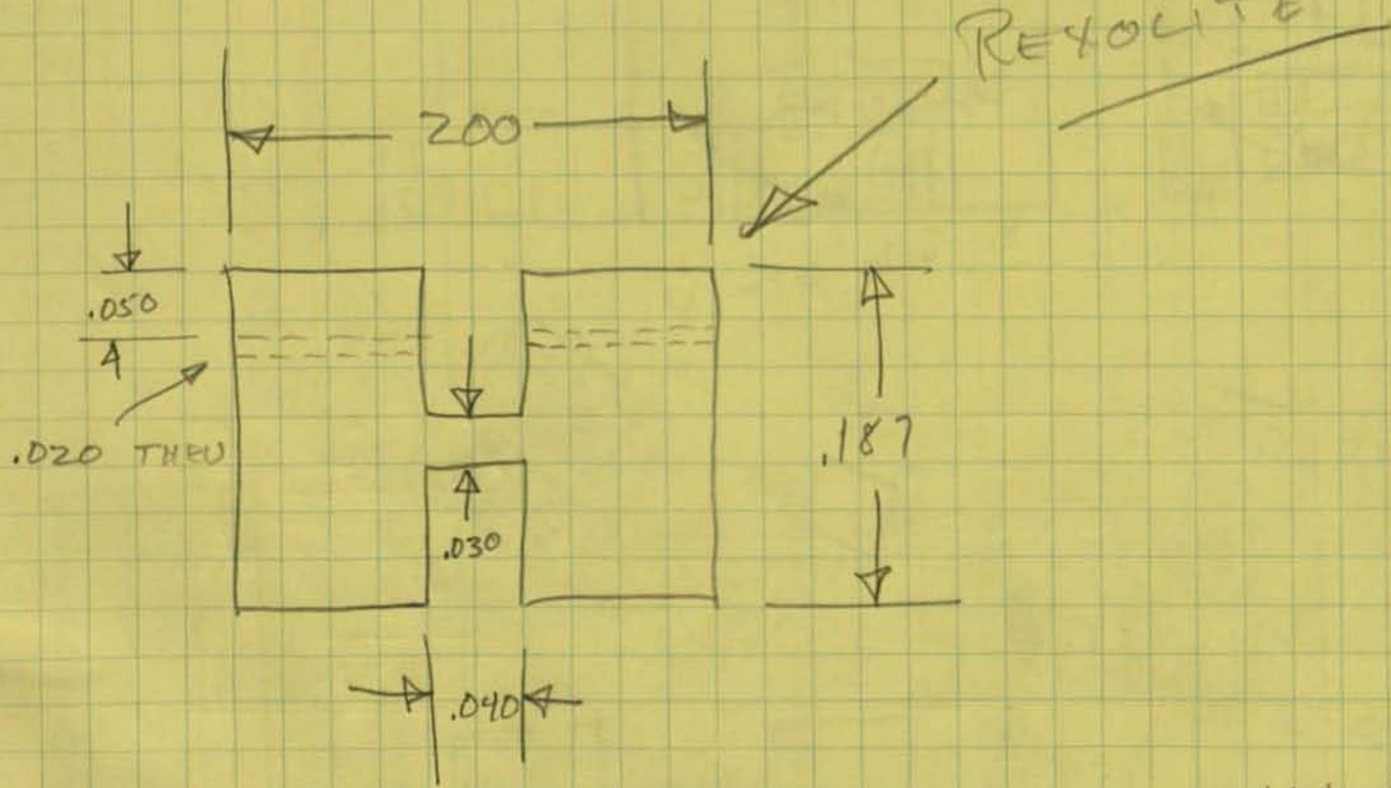
F. INTERFACE SYSTEM WITH R.F. PREAMPLIFIER (1-2 ghz)
1. IMPEDANCE MATCHING VS.
N.F., dynamic RANGE - SPURIOUS FREE

G. CONSIDER FET AS MIXER.



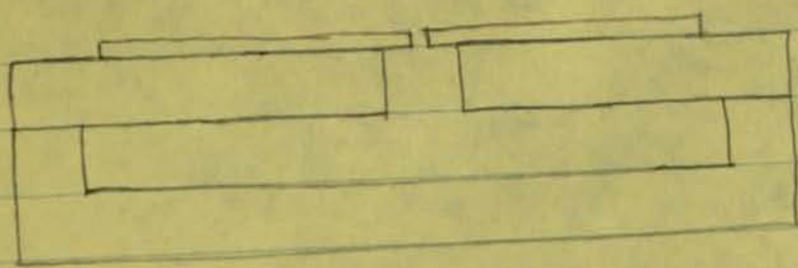
7 TURNS #40 ENAM.
CLOSEWOUND

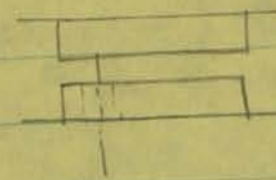
HELICAL COIL

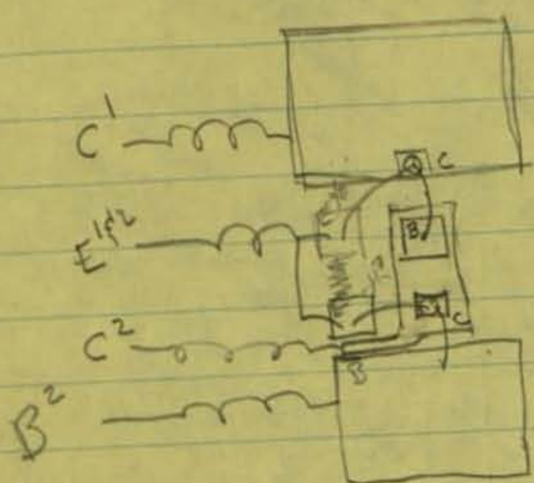


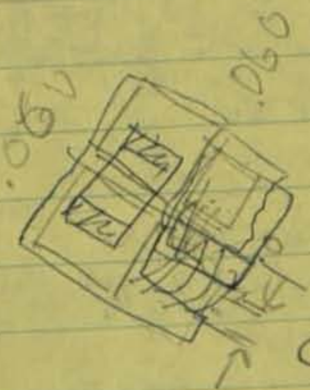
7 TURNS #40 ENAM.
CLOSEWOUND

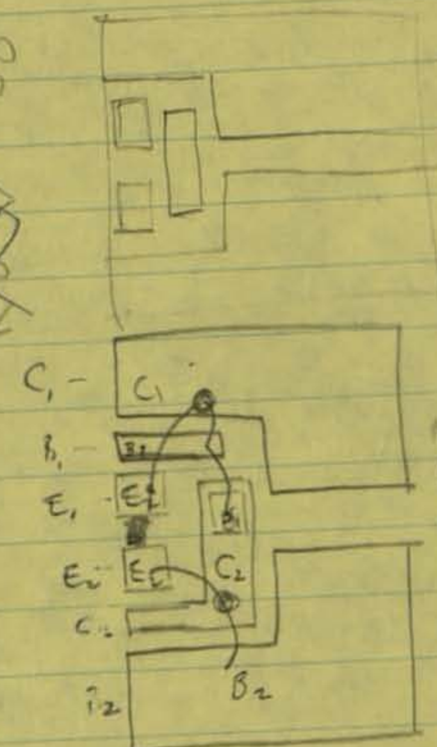
HELICAL COIL

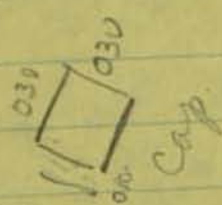


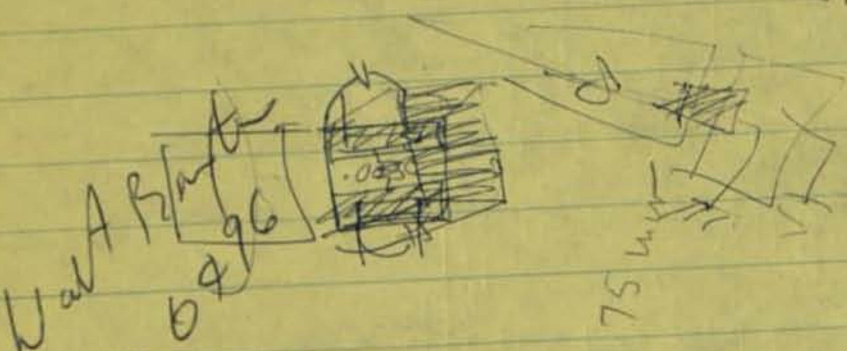


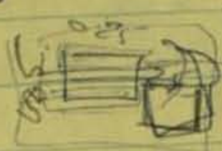

C1
E1&2
C2
B2
B1
C

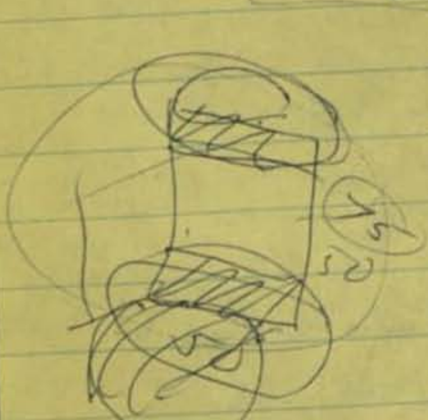

.060
.060

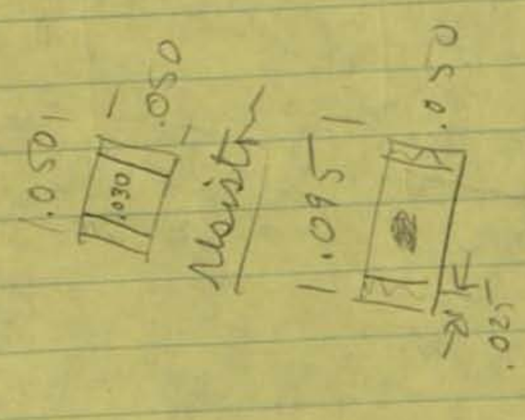

C1
B1
E1
E2
C2
B2

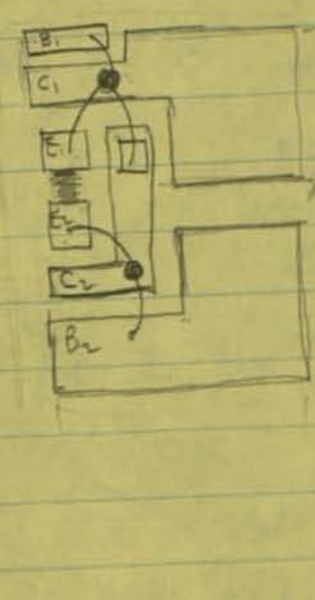

.030
.030
.010
Cap


96
75




75
50


.050
.050
.030
.050
.095
.025
Cap


B1
C1
E1
E2
C2
B2

 2/21/66 CONT. FROM p. 3

IF ONE USED TEFLON LOADING FOR C_o

THEN $\frac{C_o}{\epsilon} = (2.1)(21) = 44.0$

NOW $Y_A = \frac{44.0 + 9.0}{376.7} = \frac{53.0}{376.7} = \frac{1}{7.1\Omega}$

SOLVING FOR Y_{a1} FROM: $\frac{C_o}{\epsilon} = 376.7 Y_A \left(1 - \sqrt{\frac{G_{T1}}{Y_A}}\right)$
(by $\frac{G_{T1}}{Y_A}$)

$\frac{C_o/\epsilon}{376.7 Y_A} - 1 = -\sqrt{\frac{G_{T1}}{Y_A}}$, $\sqrt{\frac{G_{T1}}{Y_A}} = 1 - \frac{44.0}{376.7/7.1} = 1 - \frac{44.0}{53} = 1 - .83$

$1.00 - .83 = .17$

$\boxed{\frac{G_{T1}}{Y_A} = .41}$

ALSO $\frac{b_1}{Y_A} = \frac{G_{T1}/Y_A \quad g_0 g_1}{W} = \frac{(.41)(1.032)}{.048} = 8.82$

USING $\frac{\cot\theta_o + \theta_o \csc^2\theta_o}{2} = 1.285$

$8.82 = \frac{Y_{a1}}{Y_A} 1.285$, $\frac{Y_{a1}}{Y_A} = 6.87$

IF $Y_A = \frac{1}{7.1}$, $Y_{a1} = \frac{6.87}{7.1} = \frac{1}{1.03\Omega}$

FROM SHIPOWS TECH. MEMO:

$\frac{C_o}{\epsilon} = \frac{376.7}{Z_a} - 8.8$, FOR $\frac{t}{b} = .8$ & SQUARE TRANS. TOOTH

SINCE WE DESIRE TO LOAD THIS FINGER WITH TEFLON $\epsilon_r = 2.1$ EQUATION BECOMES

$\frac{C_o}{\epsilon} \epsilon_r = \frac{376.7}{Z_a} - 8.8$, $\frac{C_o}{\epsilon} = \frac{376.7}{2.1 Z_a} - \frac{8.8}{2.1} = \frac{180}{Z_a} - 4.2$

THEN $\frac{W_o}{b} = .1\left(\frac{90}{Z_a} - 2.1 - 2.07\right)$, LET $\frac{W_o}{b} \cdot \frac{t}{b} = .8$

$.8 = \frac{9}{Z_a} - .42$, $\frac{9}{Z_a} = 1.22$, $\boxed{Z_a \cong 7.4\Omega}$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

2/26/66 CONT. FROM p. 4

SHIPOW IS USING $\ell = \frac{\lambda}{8}\Big|_{f_0 = 4.755\,gc} = .310''$

FOR PUMP - COMBLINE.

ALSO $b = .350$, ∴ $t = (.8)(.350) = .280$

TO CALCULATE θ_0 AT $f_0 = 5010$ ~~5070~~ mc

$$\frac{4.755}{5.010} = \frac{45°}{\theta_0}, \quad \theta_0 = 47.5°, \quad \cot\theta_0 = .916$$

$\sin\theta_0 = .737$
$\csc\theta_0 = 1.36$
$\csc^2\theta_0 = 1.84$
$\theta_0 = 47.5\,\frac{\pi}{180} = .83$

$\pi\,rad/180°$, $1° = \frac{\pi}{180}\,rad.$

$$\frac{\cot\theta_0 + \theta_0\csc^2\theta_0}{2} = \frac{.916 + (.83)(1.84)}{2}$$

$$= \frac{.92 + 1.53}{2} = 1.225 \approx 1.23$$

1.53
.92
2.45

ASSUMING TEFLON LOADED Wall

ALSO CALCULATING $\frac{C_0}{\epsilon} = \frac{376.7}{Z_A} - 8.8$

$$\frac{C_0}{\epsilon} = \frac{376.7}{7.4} - 8.8 = 51.0 - 8.8$$

51.0
8.8
42.2

$$\boxed{\frac{C_0}{\epsilon} = 42.2}$$

CALCULATION OF Z_{a1}

FROM $\frac{C_0}{\epsilon} = \frac{376.7}{Z_A}\left(1 - \sqrt{G_{T1} Z_A}\right) = 51\left(1 - \sqrt{}\right)$

$$\frac{42.2}{51} = .83 = 1 - \sqrt{}, \quad \sqrt{G_{T1} Z_A} = .17$$

$$\boxed{\frac{G_{T1}}{Y_A} = .029}$$

$\frac{.03}{.05} = .6$

ALSO $\frac{G_{T1}}{Y_A} = \frac{w}{g_0 g_1}\,\frac{b_1}{Y_A} = \frac{.048}{1.032}\,\frac{b_1}{Y_A}$

$$\frac{b_1}{Y_A} = \frac{(.029)(1.032)}{.048} = 0.62$$

$$\frac{b_1}{Y_A} = \frac{Y_{a1}}{Y_A}\,1.23, \quad \frac{Y_{a1}}{Y_A} = \frac{.62}{1.23} = .505 = \frac{Z_A}{Z_{a1}}$$

$$\boxed{Z_{a1} = \frac{7.4}{.505} = 14.7}$$

 2/26/66 CONT. FROM p. 5

LET $Z_{a2} = 50\Omega$.

$$\frac{b_2}{Y_A} = \frac{Y_{a2}}{Y_A} 1.23 = \frac{\frac{1}{50}}{\frac{1}{7.4}} 1.23 = \frac{(7.4)(1.23)}{50}$$

$$\frac{b_2}{Y_A} = .182$$

$$\frac{J_{12}}{Y_A} = .048 \sqrt{\frac{(.62)(.18)}{(1.032)(1.147)}} = .048\sqrt{.0942} = (.048)(.307)$$

$$\boxed{\frac{J_{12}}{Y_A} = .0147}$$

$$\frac{376.7}{Y_A} Y_A = \frac{376.7}{7.4} = 51.0$$

$$\frac{Y_{a1}}{Y_A} = \frac{1/14.7}{\frac{1}{7.4}} = \frac{7.4}{14.7}$$

$$\frac{C_1}{\epsilon} = 376.7\, Y_A\left(\frac{Y_{a1}}{Y_A} - 1 + \frac{G_{T1}}{Y_A} - \frac{J_{12}}{Y_A}\tan\theta_0\right) + \frac{C_0}{\epsilon}.$$

$$\frac{Y_{a1}}{Y_A} = \frac{\frac{1}{14.7}}{\frac{1}{7.4}} = .505, \quad \tan\theta_0 = \tan 47.5' = 1.09$$

$$\frac{C_1}{\epsilon} = 51.0\left[.505 - 1 + .029 - (.015)(1.09)\right] + 42.2.$$

(.016)

$$\frac{C_1}{\epsilon} = (51.0)(-.482) + 42.2.$$

$$= -24.6 + 42.2$$

$$\boxed{\frac{C_1}{\epsilon} = 17.6}$$

−1.016	.505
.534	.029
−.482	.534

42.2
−24.6
17.6

TO CALCULATE C_2/ϵ USING $Z_{a2} = 50\Omega$

$$\therefore \frac{Y_{a2}}{Y_A} = \frac{\frac{1}{50}}{\frac{1}{7.4}} = \frac{7.4}{50} = .148$$

$$\therefore \frac{b_2}{Y_A} = (.148)(1.23) = .182$$

Statement of Operation

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

2/28/66 CONT. FROM p. 6

TRY $\frac{b_3}{Y_A} = .182$, $b_3 = .182 \frac{1}{7.4} = .0246$

$\therefore \frac{Y_{B3}}{Y_B} = .148$

THEN $G_{T3} = \frac{(.048)(\text{~~.182~~})(.0246)}{1.032}$

LET $Y_B = \frac{1}{50}$, $\frac{G_{T3}}{Y_B} = \frac{(.048)(.0246)(50)}{1.032} = .0572$

$\sqrt{\frac{G_{T3}}{Y_B}} = .24$, $1 - \sqrt{\frac{G_{T3}}{Y_B}} = .76$

$(.5)(.75)(.5)$

$\frac{.25}{4}$

$$\boxed{\frac{C_4}{\epsilon} = (7.54)(.76) = 5.73}$$

$$\frac{C_3}{\epsilon} = 51.0\left[.148 - \frac{Y_B}{Y_A} + \frac{G_{T3}}{Y_A} - \frac{J_{23}}{Y_A}\tan\Theta_0\right]$$

$\frac{Y_B}{Y_A} = \frac{\frac{1}{50}}{\frac{1}{7.4}} = \frac{7.4}{50} = .148$, $\frac{G_{T3}}{Y_A} = \frac{G_{T1}}{Y_A} = .029$, $\tan\Theta_0 = 1.09$

$\frac{J_{23}}{Y_A} = .048\sqrt{\frac{b_3/Y_A \; b_3/Y_A}{g_2 g_3}} = .048\sqrt{\frac{(.182)^2}{(1.147)(1.032)}} = \frac{(.048)(.182)}{\sqrt{1.19}}$

$= \frac{(.048)(.182)}{1.09}$

$= .008$

$\therefore \frac{C_3}{\epsilon} = 51.0\left[.148 - .148 + .029 - (.008)(1.09)\right] + 5.73$

$.00872 \cong .009$

$\frac{C_3}{\epsilon} = 51.0\,(.020) + 5.73$

1.02

$$\boxed{\frac{C_3}{\epsilon} = 6.75}$$

$.016$ $\quad$ $.009$

$\frac{C_2}{\epsilon} = 51.0\left[.148 - (.015)(1.09) - (.008)(1.09)\right]$,

$.148 - .025 = .123$

~~$\boxed{\frac{C_2}{\epsilon} = 6.27}$~~

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

3/1/66 CONT. FROM p. 7

$\frac{C_{01}}{\epsilon} = 51.0 - \frac{C_0}{\epsilon} = 51.0 - 42.2$

$\boxed{\frac{C_{01}}{\epsilon} = 8.8}$ $\frac{s_{01}}{b} = .09, \left(\frac{C'_{fe}}{\epsilon}\right)_{01} = .40$

7.54
5.73
1.81

$\frac{C_{34}}{\epsilon} = 7.54 - \frac{C_4}{\epsilon} = 7.54 - 5.73$

$\boxed{\frac{C_{34}}{\epsilon} = 1.81}$ $\frac{s_{34}}{b} = .35, \left(\frac{C'_{fe}}{\epsilon}\right)_{34} = 1.00$

$\frac{C_{12}}{\epsilon} = 51.0(.015)(1.09)$

$\boxed{\frac{C_{12}}{\epsilon} = .834}$ $\frac{s_{12}}{b} = .57, \left(\frac{C'_{fe}}{\epsilon}\right)_{12} = 1.30$

.35
.6
.210

$\frac{C_{23}}{\epsilon} = 51.0(.008)(1.09)$

$\boxed{\frac{C_{23}}{\epsilon} = .445}$ $\frac{s_{23}}{b} = .76, \left(\frac{C'_{fe}}{\epsilon}\right)_{23} = 1.45$

.35
.09
.0315

IF $b = .350$

$s_{01} = .031, \; s_{12} = .200, \; s_{23} = .265, \; s_{34} = .120,$

$\frac{1}{2}\left(1 - \frac{t}{b}\right) = .1$

21.1
− 2.1
19.0

~~$\frac{W_0}{b} = .1[21.1 - 1.7 - .40] = 1.9$~~

FROM p. 4 WE HAVE A SQUARE FINGER

.350
.8
.2800

$\boxed{\therefore W_0 = .280}$

8.8
− 1.7
.71

$\frac{W_1}{b} = .1[8.8 - .40 - 1.30] = .71$

.35
.04
.0140

.35
.71
.2485

$\boxed{W_1 = .250}$

3.14
2.75
.39

$\frac{W_2}{b} = .1[3.14 - 1.30 - 1.45] = .039$

$\boxed{W_2 = .014}$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

3/2/66 Cont. From p. 8

~~W_2/b~~ Let us consider $t/b = .4$ for S_{12}/b, W_2/b

$\frac{1}{2}(1 - \frac{t}{b}) = .3$

$S_{12} = .161$ $\frac{S_{12}}{b} = .46$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{12} = .58$

$\frac{W_2}{b} = .3[3.14 - .58 - .70] = (.3)(1.86) = .558$

$S_{23} = .230$ $\frac{S_{23}}{b} = .65$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{23} = .70$

$W_2 = .196$

$3.14 - 1.28 = 1.86$

$S_{34} = .090$ $\frac{S_{34}}{b} = .26$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{34} = .37$

$3.37 - 1.07 = 2.30$

$\frac{W_3}{b} = .3\left[\frac{6.75}{2} - .70 - .37\right] = (.3)(2.30) = .69$ ($\frac{6.75}{2} = 3.37$)

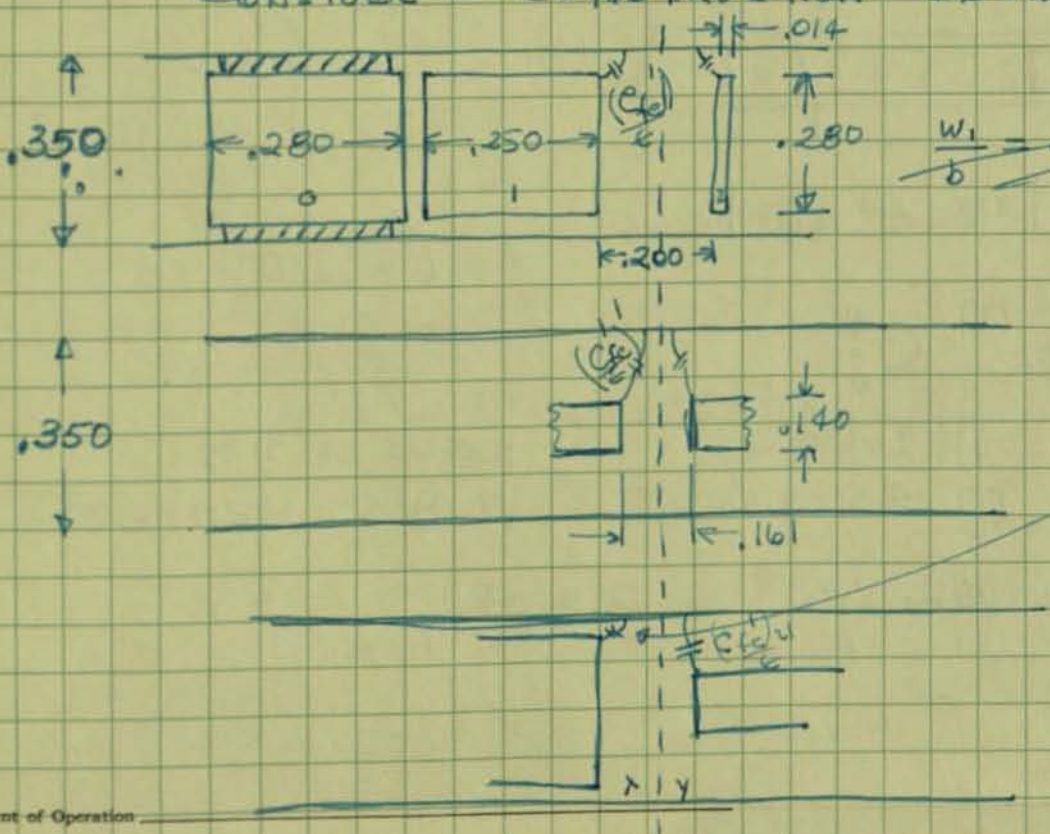
$W_3 = .242$

$\frac{W_4}{b} = .3\left[\frac{5.73}{2} - .37 - .93\right] = (.3)(1.57) = .471$ ($\frac{5.73}{2} = 2.87$)

$2.87 - 1.30 = 1.57$

$W_4 = .165$

Consider Construction Between W_2 & W_1



~~$\frac{W_1}{b} = .1\left(8.8 - \left(\frac{C'_{fe}}{\epsilon}\right)_{01}\right)$~~

Consider something closer to $\frac{C'_f}{\epsilon}$ for $\left(\frac{C'_{fe}}{\epsilon}\right)_{12}$ is 1.5

Also $\left(\frac{C'_{fe}}{\epsilon}\right)_{21}$ will be less

3/6/46 CONT. FROM p. 9.

RECALCULATING W_1

$$\frac{W_1}{b} = .1\,[8.8 - .40 - 1.50] = .69$$

8.8
1.9
6.9

$W_1 = .240$

$$\frac{C'_{12}}{\epsilon} = \frac{C'_{fo}}{\epsilon} - \frac{C'_{fe}}{\epsilon}$$

$$\frac{C'_{fo}}{\epsilon} = \frac{C'_{12}}{\epsilon} + \frac{C'_{fe}}{\epsilon}$$

FOR $\frac{t}{b} = .4$

$$\frac{C'_{fo}}{\epsilon} = .83 + 58$$

$$\frac{C'_{fo}}{\epsilon} = 1.41$$

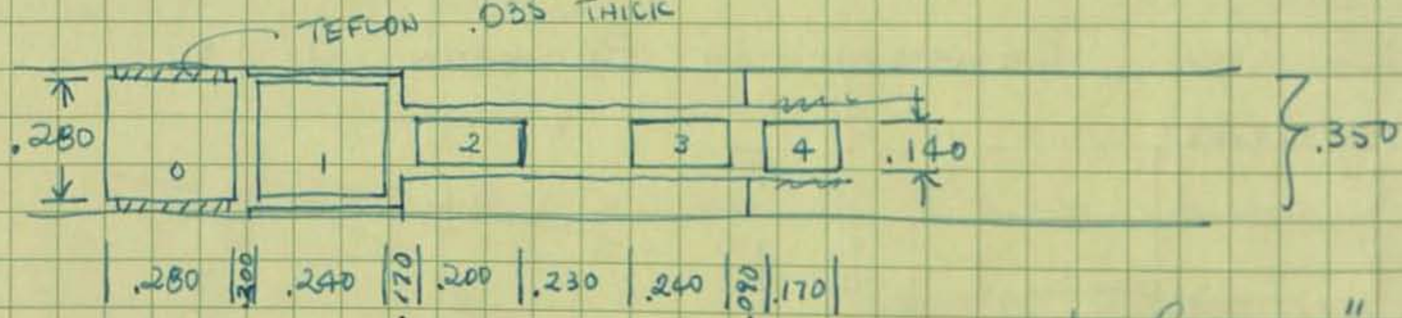
FOR $\frac{t}{b} = .8$ $\quad \frac{C'_{fo}}{\epsilon} = .83 + 1.30$

$$\frac{C'_{fo}}{\epsilon} = 2.13$$

$x = .100$, $y = .075$, $x + y = .175$ TRY .120

FINAL SPACINGS AND THICKNESSES

.350
-.280
2) .070
.035



$\{ \ l = .310''$

CALCULATION OF C_j^S

$$C_1^S = \frac{1}{7.4}(.505)\frac{\cot\theta_0\ (47.5^\circ)}{5.010 \times 10^9\ 2\pi} = \frac{(.505)(.916)}{(7.4)(5.01)(2\pi)\times 10^9}$$

$$= .00199 \times 10^{-9} \simeq .002 \times 10^{-9} = 2.0 \text{ pf.}$$

Statement of Operation ____________________

Witnessed operation (obtain two signatures):

Signature ____________ Date ______

Signature ____________ Date ______

Signature ____________ Date ______

Read and Understood (obtain two signatures):

Signature ____________ Date ______

Signature ____________ Date ______

3/7/66 Cont. From p. 10

$$\frac{Y_{AC}}{Y_A} = .148 = \frac{Y_{AB}}{Y_A}$$

$$C_2^s = C_3^s = \frac{1}{7.4}\,\frac{(.148)(.916)}{(2\pi)(5.01)\times 10^9}$$

$$C_2^s = C_3^s = .59 \text{ pf}$$

Calculation of Dimensions of End Capacities.

$$C = \frac{.225\,\varepsilon_r A}{t}$$, using Teflon $\varepsilon_r = 2.1$

For $C_1^s = 2.0$ pf Try $t = .010$

$$A = \frac{Ct}{(.225)(2.1)} = \frac{(2.0)(.010)}{(.225)(2.1)} = .0423$$

$$A/2 = .021$$

$$(x_1)(.240) = .021, \quad x_1 = \frac{.021}{.240} = .088$$

Consider No Teflon & $t = .035$

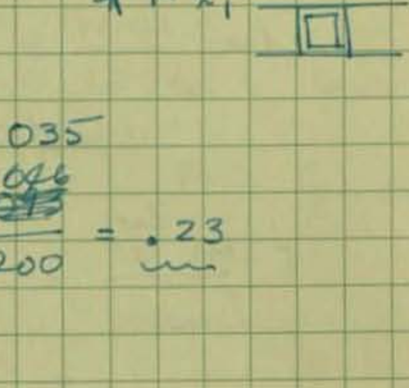
$$A = \frac{(2.0)(.035)}{(.225)(1)} = .31$$ ~~Too Long~~!

$$A/2 = .155$$

$$x_1 = \frac{.155}{.240} = .6$$ — Too Long

Try $A/4 = \frac{.31}{4} = .077$

$$x_1 = \frac{.077}{.260} = .296$$ With Teflon $\frac{.296}{2.1} = .141$



For $C_2^s = C_3^s = .59$ Try $\varepsilon_r = 1$ & $t = .035$

$$A = \frac{(.6)(.035)}{(.225)(1)} = .093, \quad x_2 = \frac{.046}{.200} = .23$$

$$A/2 = .046$$

CONT. FROM p. 11 3/8

Try .020 ~~TEFLON~~ AIR

$$A = \frac{(2.0)(.020)}{(.225)(1)} = .178$$

$$\frac{A}{4} = .045$$

$$x_1 = \frac{.045}{.260} = \boxed{.173} \quad \text{WITH TEFLON} \quad \frac{.173}{2.1} \doteq .082$$

For x_2

$$A = \frac{(.60)(.020)}{(.225)(1)} = .053$$

$$A/2 = .027$$

$$x_2 = \frac{.027}{.200} = \boxed{.130}$$

TRANSFORMER FROM 7.4 Ω TO 50 Ω SHOULD COVER pump AS WELL AS SIDE BAND

TRY $p = 1.4 = \frac{f_2}{f_1}$, $f_0 = 5010$ mc

$$\frac{f_2 + f_1}{2} = 5010, \quad 1.4 f_1 + f_1 = 10\,010$$

$$f_1 = \frac{10010}{2.4} \doteq 4.2\,gc, \quad f_2 = 5.85\,gc$$

$$S_{max} - 1 = \frac{\ln \frac{Z_{n+1}}{Z_1}}{T_{n-1}\left[\frac{1}{C_R \phi_1}\right]}, \quad T_{n-1}\left[\frac{1}{C_R \phi_1}\right] = \frac{\ln \frac{Z_{n+1}}{Z_1}}{S_{max} - 1}$$

$$\ln \frac{Z_{n+1}}{Z_1} = \ln \frac{50}{7.4} = \ln 6.75 = 1.91, \quad \text{LET } S_{max} = 1.10$$

$$\phi_1 = \frac{180}{1 + 1.4} = 75^\circ, \quad C_R\, 75^\circ = .259, \quad \frac{1}{C_R \phi_1} = 3.86$$

$$\left\{ \frac{\ln \frac{Z_{n+1}}{Z_1}}{S_{max} - 1} = \frac{1.91}{.1} = 19.1 \right.$$

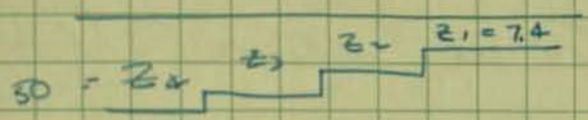
Cont. From p 12 3/9

Try $T_3(x) = 4x^3 - 3x$

$\therefore T_3(3.86) = 230 - 3(3.86)$ Too Large

~~$T_2(3.$~~ $T_2(x) = 2x^2 - 1 = 29.8 - 1 = 28.8$

$\therefore$ $n-1 = 2$ or $n = 3$ sections.



$a_1 : a_2 : a_3 \longrightarrow 1 : 1.87 : 1$, $a_1 + a_2 + a_3 = 3.87$

$\ln \frac{Z_2}{Z_1} = \frac{1.91}{3.87} = .495$, $\frac{Z_2}{Z_1} = 1.64$

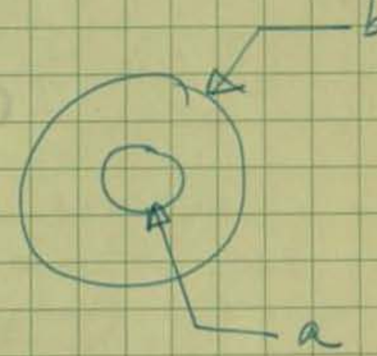
$\ln \frac{Z_3}{Z_2} = \frac{(1.87)(1.91)}{3.87} = .925$, $\frac{Z_3}{Z_2} = 2.52$

$\frac{Z_4}{Z_3} = .495$, $\frac{Z_4}{Z_3} = 1.64$

$Z_1 = 7.40$
$Z_2 = 12.13$
$Z_3 = 30.60$
$Z_4 = 50.00$

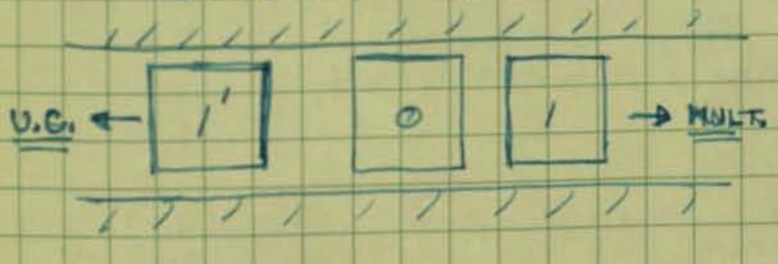
b/a LET b = .25

$Z_1 = 7.4$,	~~2~~	
$Z_2 = 12.13$,	1.22	.205
$Z_3 = 30.60$,	1.65	.151
$Z_4 = 50.00$,	2.30	.110



$$l_0 = \frac{\lambda_0}{4} = \frac{1}{4} \frac{3 \times 10^{10}}{5.010 \times 10^9 \; 2.54} = .59$$

Consider Following Construction:



$\frac{C_0}{\epsilon}$ For MULT. $= 66.6$, $\frac{C_{01}}{\epsilon} = 8.8$

$\frac{C_0}{\epsilon}$ For U.C. $= 42.2$, $\frac{C_{01}'}{\epsilon} = 8.8$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

 8/11/66

GROUNDED BASE JIG FOR PURPOSE OF EVALUATING TRANSISTORS AS AMPLIFIERS

THE FOLLOWING IS INFORMATION GOTTEN FROM K. LYON IN THE DEVICE DEPT.

FOR 0060 TRANS. – 10V at 20ma } f=500mc

grounded emitter

$$Y_{11} = 42.5 + j11 \text{ mmhos}$$

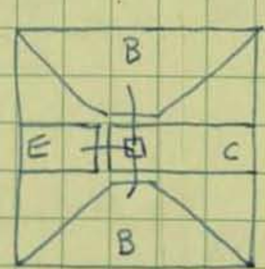
$$Y_{22} = 1.6 + j7.5 \text{ mmhos}$$

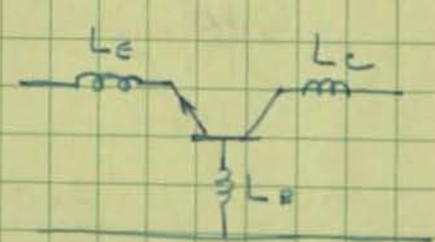
$$\omega C_{bc} = 7.5 \times 10^{-3} \text{ mhos}$$

$$C_{bc} = \frac{7.5 \times 10^{-3}}{2\pi\, 500 \times 10^{6}} = \frac{7.5 \times 10^{-12}}{\pi}$$

$$C_{bc} = 2.4 \text{ pf.}$$

CONSIDER USING STRIPLINE PACKAGE





ACCORDING TO PREVIOUS MEMO BY M. PURNAIYA

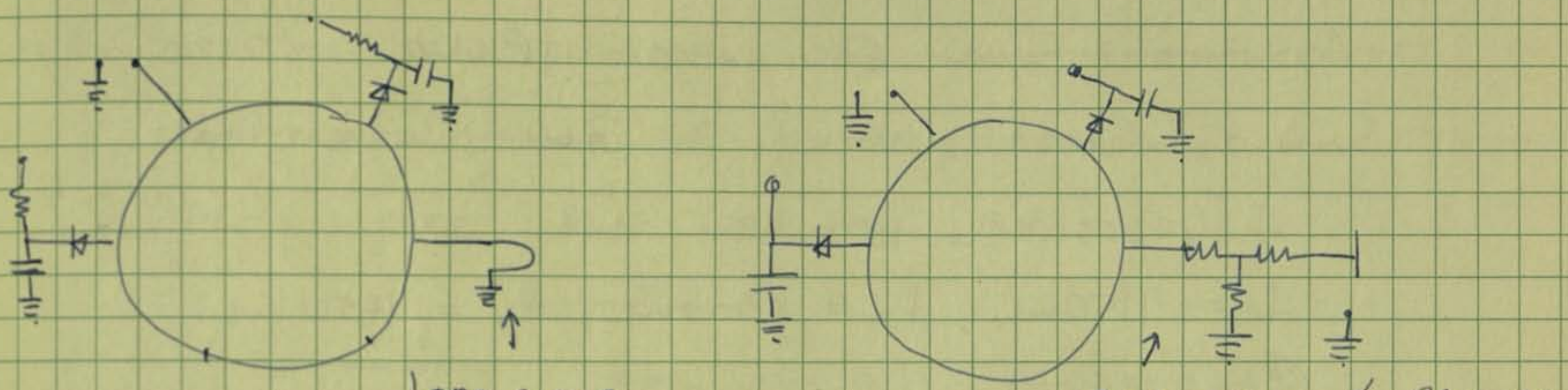
$L_E = 2.32$ nh, $L_B = .5$ nh., $L_C = 1.7$ nh

CONTINUED ON p. 17

8/17/66

DESIGN OF NEW PHASE DETECTOR USING A RAT-RACE CIRCUIT.

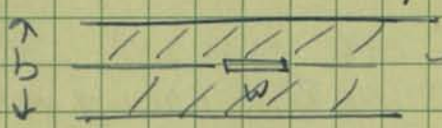
CONSIDER TWO POSSIBLE CIRCUITS:



LOOP COUPLE FOR D.C. RETURN

PADS INPUT & PROVIDES D.C. RETURN

CONSIDER STRIPLINE GEOMETRY.



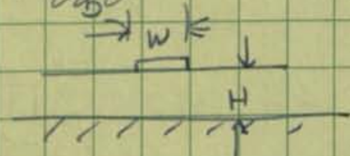
FOR $\frac{t}{b} = 0$

$Z_0 = 50\,\Omega$, $Z_1 = 71\,\Omega$.

$\sqrt{\epsilon_r}\, Z_0 = 150\,\Omega$, $\frac{w}{b} = .210$, $b = \frac{1}{4}$, $w = \frac{.21}{4} = .052$

$\sqrt{\epsilon_r}\, Z_1 = 213$, $w \approx .020$

CONSIDER :- (MICROSTRIP)

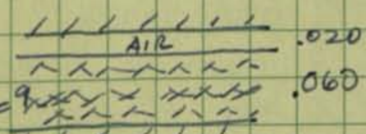


FROM T.I. REPORT FOR $Z_1 = 71\,\Omega$.

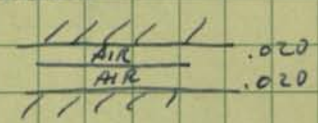
$\frac{W}{H} = .4$, IF $H = .125 = \frac{1}{8}$, $W = .050$

IF $H = \frac{1}{16}$ $W = .025$

CONSIDER FOLLOWING



=



$b = .040$

FOR $Z_1 = 71\,\Omega$.

$\frac{W}{b} = .9$, $W = .036$

SINCE $Z_0 = \frac{1}{V_p C} = \frac{\sqrt{\epsilon_r}}{c\, C}$

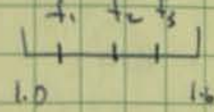
8/18/66 CONT. FROM p. 15

CONSIDER RAT RACE LENGTH USING ϵ_r'S FOR VARIOUS FILLING FACTORS

FROM T.I. REPORT EFFECTIVE $\sqrt{\epsilon_r} \cong 2.5$

ASSUME FUND. OSCILLATOR BAND 1.0 TO 1.6 gc

SHOULD COVER WITH 3 RAT RACE DIA.



$\frac{1}{4} \times 600\text{mc} = 150\text{mc}$

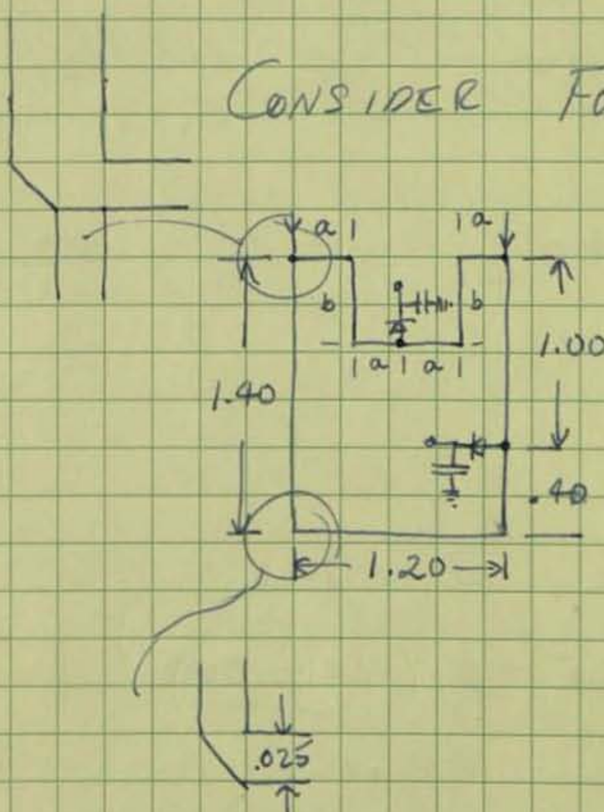
$f_1 = 1150\text{mc}, \; f_2 = 1300\text{mc}, \; f_3 = 1450\text{mc}$

$$C_1 = \frac{3 \times 10^{10}}{2.5 \;\; 1.15 \times 10^9 \;\; 2.54} \;\; \frac{3}{2} = \underline{\underline{6.16 \text{ in}}}$$

$\pi D_1 = 6.16 \text{ in}, \;\; \underline{\underline{D_1 = 1.96 \text{ in}}} \qquad \frac{\lambda}{4} = \frac{6.16}{6} = 1.026$

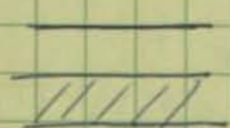
TRY $\frac{\lambda}{4} = 1.00$

CONSIDER FOLLOWING CONSTRUCTION



$a = .30, \;\; b = .40$

USING .060 AIR AND .060 Al_2O_3



FOR $Z_0 = 50\Omega, \; W_0 = .060$

$Z_1 = 71\Omega \;\; W_1 = .025$

Statement of Operation ______

Witnessed operation (obtain two signatures).

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

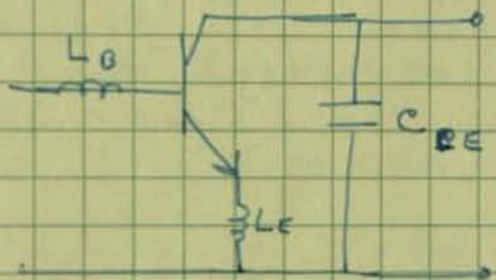
Signature ______ Date ______

Signature ______ Date ______

CONTINUED FROM p. 14

9/9/66

ADMITTANCE INFORMATION ON p. 14 WAS TAKEN USING A TO46 HEADER. ACCORDING TO K. LYON THE RESIDUAL $C_{bc} \cong .5$ pf. RESIDUAL $C_{bc} \cong .7$ pf ON STRIPLINE PACKAGE. ~~WE WILL THEREFORE TRY TO MATCH OUT OF A 2.6pf CAPACITY.~~ ALSO THESE TESTS WERE RUN GROUNDED EMITTER:



$L_E \cong 2.8$ nh.

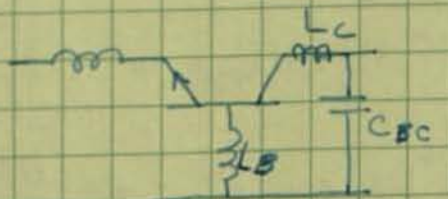
~~REAL~~ SUSCEPTANCE OF L_E AT 500mc

$$B_{L_E} = \frac{1}{\omega L_E} = \frac{1}{2\pi\, 500 \times 10^6 \;\; 2.8 \times 10^{-9}}$$

$$B = \frac{10^{3}}{(\pi)(2.8)} = ~~0.114 \times 10^{-3}~~ = .114 \times 10^{-3}\ ℧$$

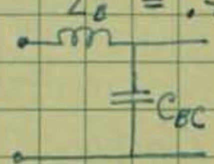
THIS IS NEGLIGIBLE IN VIEW OF THE IMAGINARY PART OF Y_{22}, $Im(Y_{22}) = 7.5 \times 10^{-3}$ ℧

WE WILL TRY TO MATCH OUTPUT CAPACITY OF 2.5pf

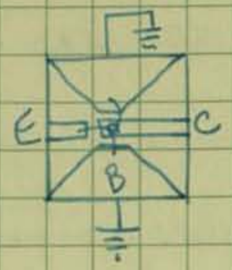


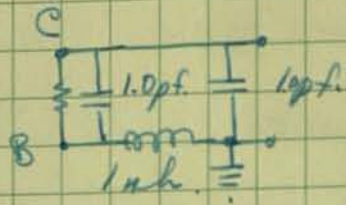
CONSIDER OUTPUT TO BE

$L_B = .5$ nh $+ 1.7$ nh. $= 2.2$ nh



CONSIDER FOLLOWING IDEA 9/21/66





$$f_c = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(10^{-9})(10^{-12})}}$$

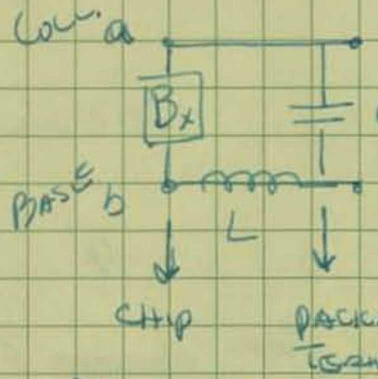
$$f_c = \frac{1}{2\pi\ 3.2 \times \sqrt{10^{-22}}} = \frac{10^{+11}}{20}$$

$$f_c = .05 \times 10^{+11} = 5 \times 10^{+9} = 5\ gc$$

$$Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{10^{-9}}{10^{-12}}} = \sqrt{1000} = 32\ \Omega$$

REFERRING TO A T.I. ARTICLE IN MICROWAVE JOURNAL "JULY 1966" DATA IS AVAILABLE ON AN L-49 TRANSISTOR THAT HAS ABOUT THE SAME ACTIVE AREA AS THE 0060. FROM THIS DATA AT 2.3 gc THE OUTPUT SUSCEPTANCE IS .020 ℧ (6mil² FAN, 7mil² T.I.)

AT 2.3 gc



$\leftarrow jB_L = .022\ ℧$

$C = .1\ pf.$, $L = .16\ NHY$ } FROM ARTICLE

$$jB_L = \frac{(jB_x)(-j/\omega L)}{(jB_x) - j/\omega L} + j\omega C$$

$jB_L = j.022$, $j\omega C = j.001$, $-j/\omega L = -j.43$

$$\therefore\ j.022 = \frac{(jB_x)(-j.43)}{jB_x - j.43} + j.001$$

$$\frac{(j.021)}{(-j.43)}(jB_x - j.43) = jB_x$$

$$(-.049)(jB_x) + j.021 = jB_x$$

$$j.021 = j1.049\ B_x$$

$$\boxed{j.020 = B_x} \qquad \omega C_x = .02$$

EQUIV. OUTPUT CAPACITY AT CHIP $C_x = \frac{.02}{2\pi\ 2.3 \times 10^9} = \boxed{1.4\ pf}$

Statement of Operation ____

Witnessed operation (obtain two signatures).

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

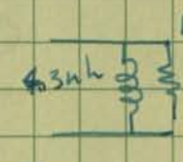
CONT. FROM p. 18 9/23/66

CAN APPROXIMATELY GET 50Ω OUTPUT IF INCREASE L_c. WILL OPERATE DIRECTLY INTO 50Ω.

ON THE INPUT SIDE $-jB_s = -j.016$

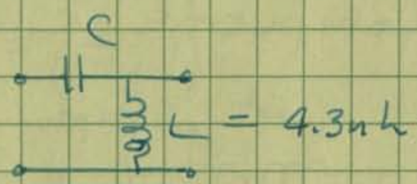
∴ @ $f = 2.3$ gc. $\frac{1}{\omega L_{in}} = .016$

$$L_{in} = \frac{1}{2\pi(2.3 \times 10^9)(.016)} = 4.3 \text{ nh}$$



TRY A SIMPLE HIGH PASS TUNING CIRCUIT.

ASSUME A 5Ω MATCH.



$$5 = \sqrt{\frac{L}{C}}$$

$$\frac{L}{C} = 25, \quad C = \frac{4.3 \times 10^{-9}}{25} = .0172 \times 10^{-9} = 172 \text{ pf.}$$

$$f_{cutoff} = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{4.3 \times 10^{-9} \; 172 \times 10^{-12}}} = \frac{1}{2\pi\sqrt{740 \times 10^{-21}}}$$

$$f_c = \frac{1}{2\pi \times 10^{-10}\sqrt{74.}} = \frac{10^{10}}{54} = .185 \times 10^9$$

$f_c = 185$ mc.

CONSIDER LOW PASS IMPEDANCE MATCHING TRANSFORMER
– MATTHAEI'S ARTICLE IN AUG 64

~~5~~ 33.3 Ω TO 50 Ω. $g_0 = 1$

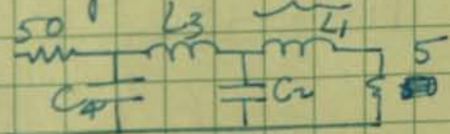
$r = $ ~~10~~ 1.5 & WITH $w = .8$ $L_{ar} \leq 1$db

$\frac{R}{R'} = 5$ 33.3

$\omega_m = 2\pi \, 2.3 \times 10^9 = 14.5 \times 10^9$

$n = 4$, $g_1 = 1.971$, $g_2 = .475$

$g_3 = g_2 r = 4.75$ (.71), $g_4 = \frac{g_1}{r} = .0197 \approx .020$ (1.31)



Statement of Operation

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

CONT FROM p.19

9/26/66

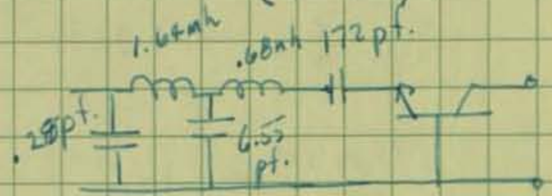
$L_1 = 1.97 \frac{1}{14.5 \times 10^9} \frac{(33.3)}{5} = 0.68\ nh$ 45 nh.

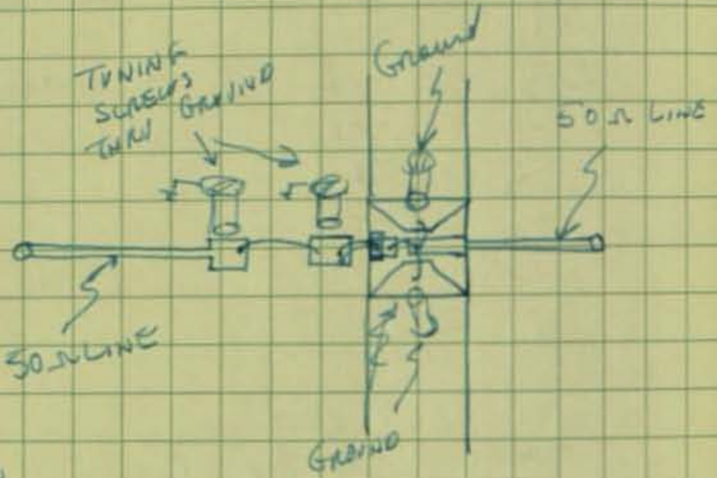
$C_2 = .475 \frac{1}{14.5 \times 10^9} \frac{1}{5} = 6.55\ pf.$ .98 pf.

$L_3 = 4.75\ (.71) \frac{1}{14.5 \times 10^9} \cdot 5\ (33.3) = 1.64\ nh$ 1.63 nh

$C_4 = .020\ (1.31) \frac{1}{14.5 \times 10^9} \frac{1}{5}\ (33.3) = .276\ pf.$ .271 pf.

COMPLETE CIRCUIT :- (R.F.)





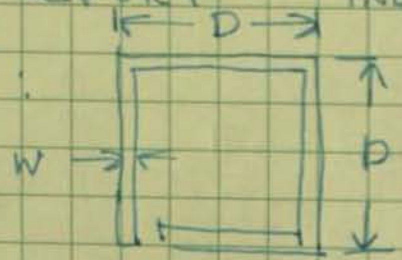
~~BIAS CIRCUIT CONSTRUCTION~~

INDUCTANCE GEOMETRIES

ACCORDING TO M. DURNIYIA'S REPORT SMALL INDUCTIVE JUMPER WIRES ARE ABOUT 1nh ∴ 2 IN PARALLEL SHOULD GIVE ≅ .5 nh.

FOR THE 1.64 nh INDUCTANCE CONSIDER DATA FROM T.J. ~~AIR FORCE~~ NASA REPORT - INDUCTANCE OF SP

FOR 1 LOOP IN MICROSTRIP:



D ≅ .080

W ≅ .016

 9/26/66

+ T_0

$W = \frac{\Delta f}{f_0} = .8$

$f_0 = 2.3$

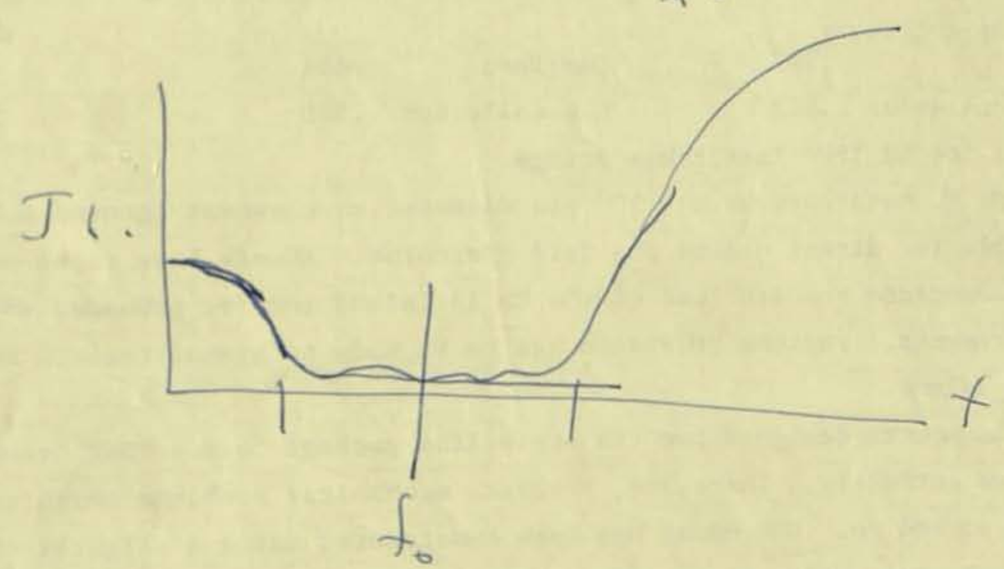
$\Delta f = \frac{2.3^2 \cdot .8}{1.8 \quad 4}$

$f_1 = 1400$

$f_2 = 3100$

$\sqrt{\epsilon_r} = 1.67$

$\frac{2.5''}{1.67} = 3.0''$



.050 LONG

NE

35 Ω

= .180

Signature______ Date______

Signature______ Date______

Signature______ Date______

Signature______ Date______

L1

C2

L3

C4

Package Characterization

The To18 Microbloc, To18 Island, and Stripline packages have been characterized in terms of a wye-delta of inductances and capacitances. The direct capacitances between all terminals of the island leader have been obtained. Values are listed below.

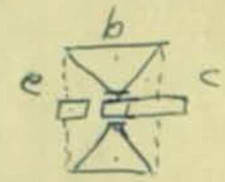
To 46

Package	Le(nh)	Lb	Lc	Cbe(pf)	Cce	Cbc
To 18 Island (1)	2.8	2.8	2.25	0.515	0.044	.54 0.634
To 18 Island (2)				0.470	0.582	0.074
To 18 Microbloc	2.24	2.24	1.64	.001	0.318	0.317
Stripline (3)	2.32	0.5	1.7	0.445	0.062	0.700

(1) Can tied to emitter externally.

(2) Can tied to base externally.

(3) Inductance of 1 mil gold lead used to attach dice to strip-line approximately 1 nh.



To 18 Island Package Direct Capacitance.

Emitter-base.	.042 pf	Can-Emitter	.467
Emitter-collector	.047	Can-Base	.401
Base-collector	.073	Can-collector	.546

IN

Mounts for GR 1607 Immittance Bridge.

(1) G. R. manufactures a 0.100 pin diameter circle mount (grounded base) suitable for direct use on the To18 Microbloc. Mounts have to be modified to accommodate the 4th lead on the To 18 Island and for grounded emitter measurements. Further provision has to be made to ground the can on the To 18 Island. (new mount 4. lead)

(2) The mounts designed for the strip-line package have a VSWR below 1.1 if used correctly. There are, however, mechanical problems which are being worked on. One mount has been constructed using a slightly different approach, and while not as easy to use, shows promise as to precision of measurement.

Mike Purnaiya
4/4/63

Statement

Witnessed

Signature ________ Date ________

Signature ________ Date ________

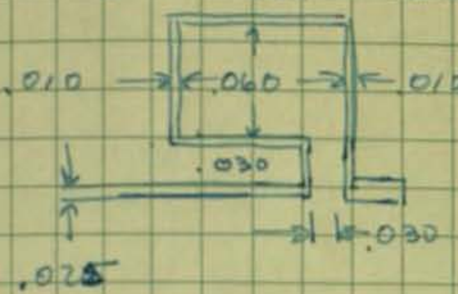
Read and Understood (obtain two signatures):

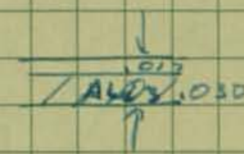
Signature ________ Date ________

Signature ________ Date ________

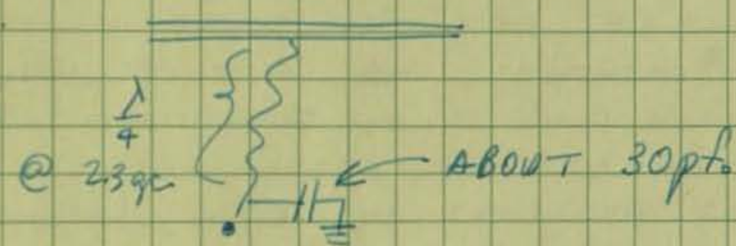
Con't From p. 20 9/26/66

SINCE WE WILL USE STRIPLINE - REDUCE WIDTH TO ABOUT .010 AND EXTEND FROM MAIN LINE:





BIAS CIRCUITS.



ON CERAMIC $\sqrt{\epsilon_r}$ eff. ≈ 2.5

$$\frac{\lambda}{4} = \frac{3 \times 10^{10}}{(2.5)(2.3)(2.54)\times 10^{9}} \quad 2.06 \text{ in.}$$

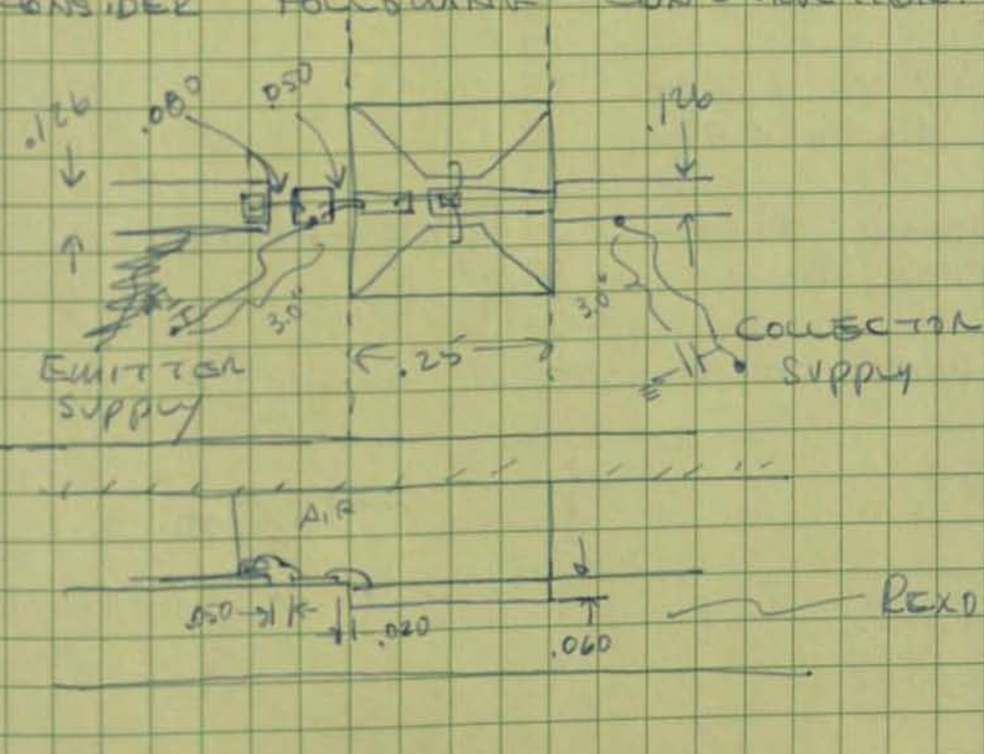
For Rex 2200 $\sqrt{\epsilon_r} = 1.67$

$\frac{\lambda}{4} = 2.06 \quad \frac{2.54}{1.67} \approx 3.0$ in

CONSIDER FOLLOWING CONSTRUCTION:

WIRE JUMPER ≈ .050 LONG
≈ 1 λ/4 ?

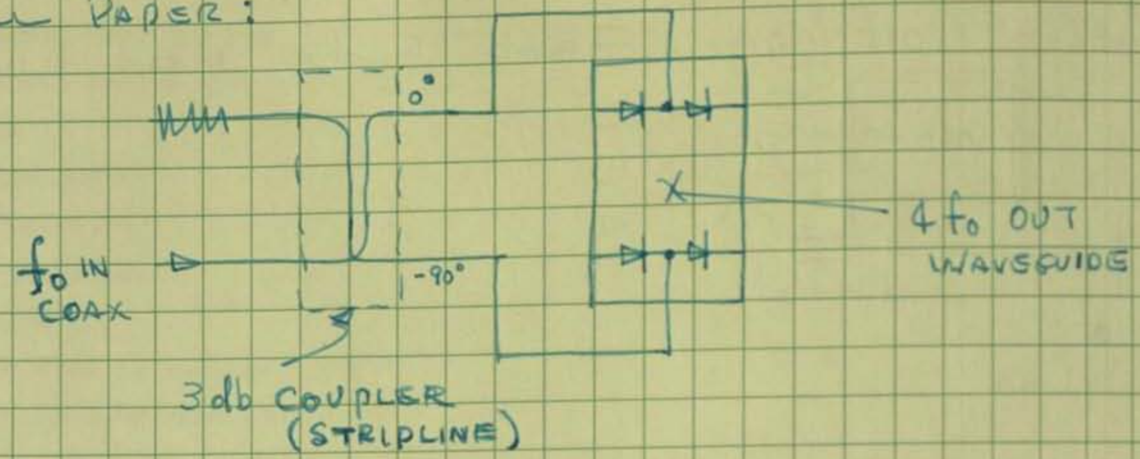
FOR 50Ω LINE
50 · 1.67 = 83.5 Ω
W/b = 1
b = .180
W = .126



12/14/66

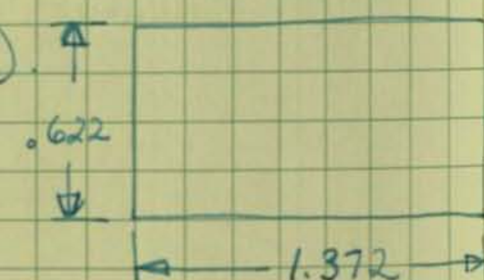
BALANCED QUADRUPLER

FROM BELL PAPER:



PHASE DIFFERENCE BETWEEN DIODE INPUTS IS 90°. THEREFORE, ON THE 4TH HARMONIC THE OUTPUTS WILL BE 360° APART AND IN PHASE. EACH PAIR IS AN EVEN HARMONIC GENERATOR AND THE 3RD IS ALSO REJECTED BY WAVEGUIDE CUTOFF. AT THE 2ND THE WAVEGUIDE PRESENTS AN OPEN CIRCUIT - THEREFORE ~~THE~~ EACH PAIR IS MADE SELF RESONANT ($2 f_0$).

TYPE OF WAVEGUIDE TO BE USED (OUTPUT).
(hp J-BAND)



$f_{co} = 4.285$ gc.

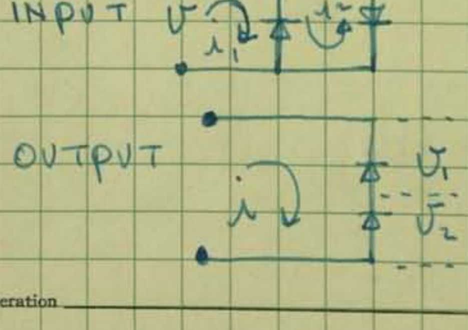
OUTPUT BANDWIDTH = 5.9 - 6.4 gc

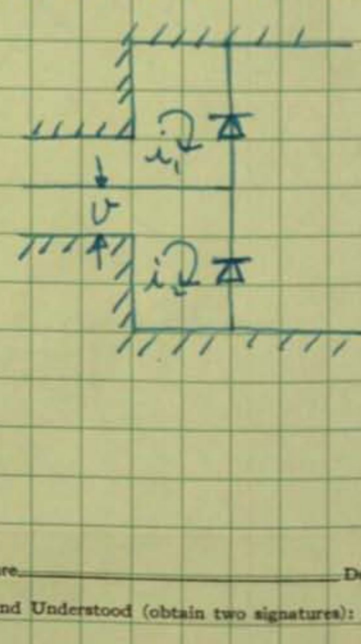
$\therefore \Delta f_0 = 1.47$ TO 1.6 gc

FOR 3RD HARM. 4.4 TO 4.8 gc.

WILL NEED SOME ADDITIONAL FILTERING TO SHUTOFF 3RD HARMONIC OVER BAND.

CONSIDER ONE PAIR OF DIODES:





Statement of Operation

Witnessed operation (obtain two signatures).

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

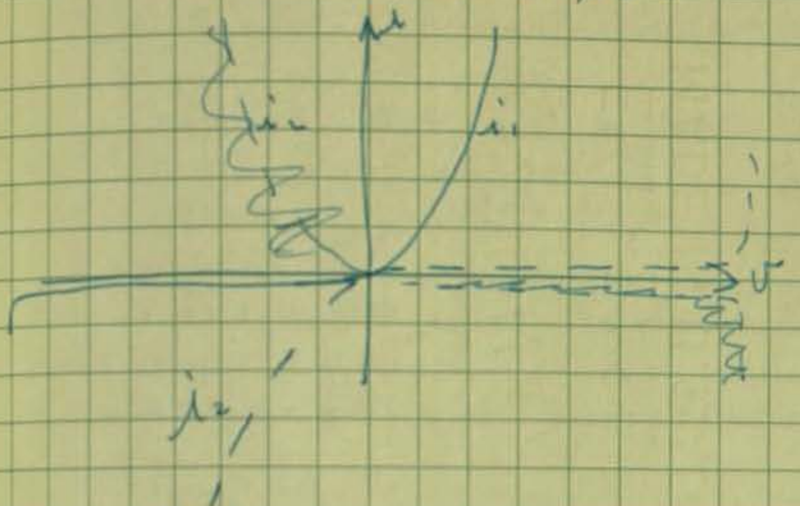
Read and Understood (obtain two signatures):

Signature ______ Date ______

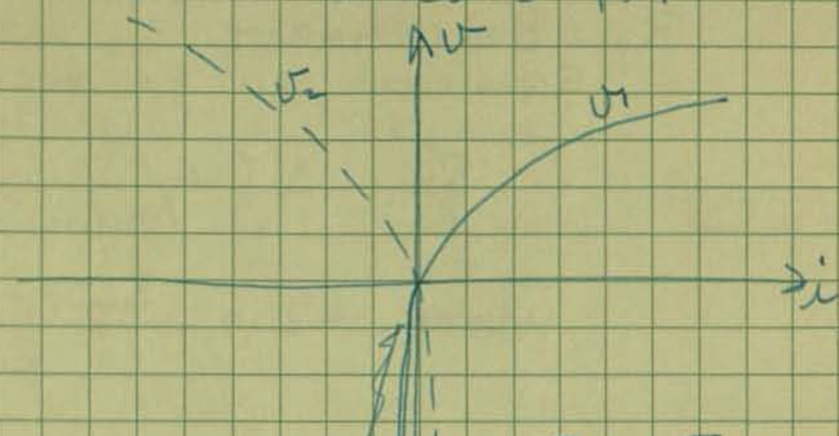
Signature ______ Date ______

12/15/66 CONT. FROM p. 22

BALANCED INPUT



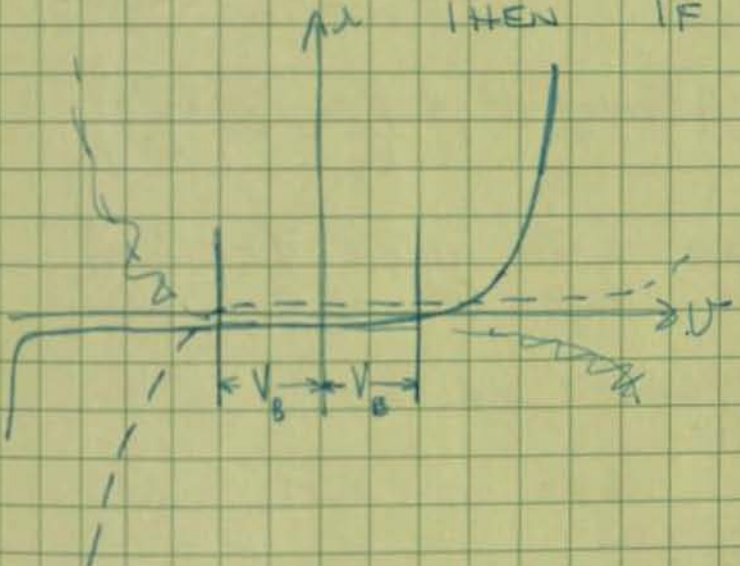
BALANCED OUTPUT

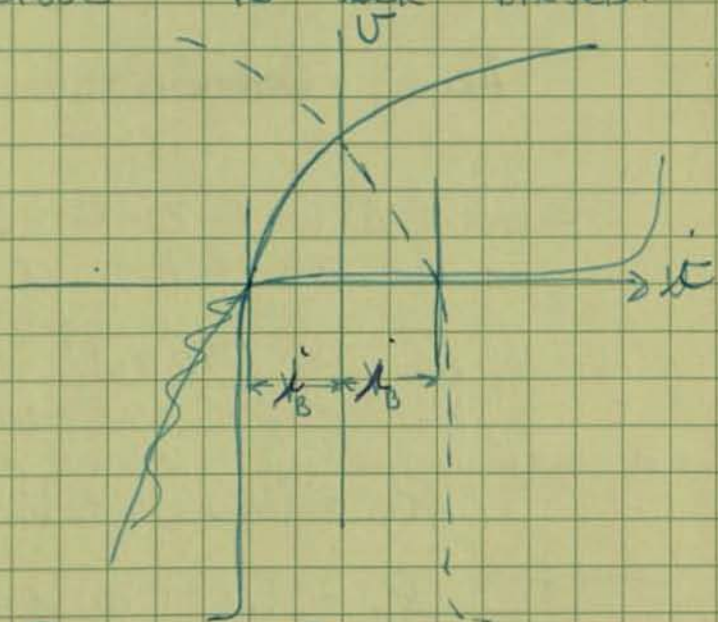


EVEN FUNCTION
EVEN HARM.

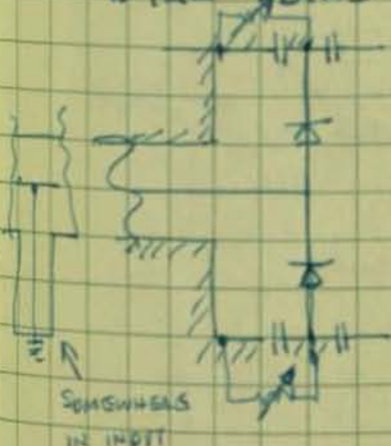
~~EVEN~~ ODD FUNCTION
∴ ODD HARMONICS

THEN IF EACH DIODE IS BACK BIASED.

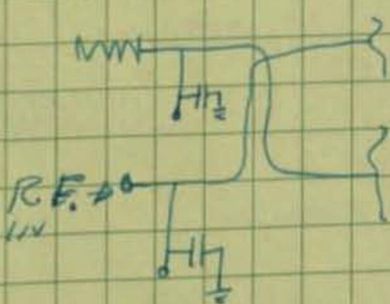


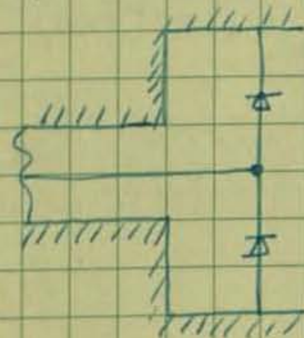


WILL BIAS EACH DIODE TO HELP BALANCING SITUATION.



IF WELL BALANCED DIODES CAN BE FOUND CAN BIAS FROM INPUT:





 12/16/66 CONTINUED FROM p. 23.

CALCULATION OF MULTIPLIER PARAMETERS FROM B.S.T.J. APRIL '65 BY BURCKHARDT.

EQUATIONS TO BE USED:

$$\frac{R_{in}}{R_s} = A\left(\omega_c/\omega_o\right), \quad \frac{R_\ell}{R_s} = B\left(\omega_c/\omega_o\right)$$

WHERE $\omega_c = \dfrac{S_{max} - S_{min}}{R_s}$

S – ELASTANCE
ω_c – CUTOFF FREQ.
ω_o = INPUT FREQ.
R_s = SPREADING RESIS.

USING $\gamma = 0$, $S_{min} = 0$

& $R_s \simeq 1.5\,\Omega$ BY MEASUREMENT & $S_{max} = \dfrac{1}{.85 \times 10^{-12}}$

$$\omega_c = \frac{S_{max}}{R_s} = \frac{1}{(1.5)(.85 \times 10^{-12})} = .79 \times 10^{+12} = 790 \times 10^{+9}$$

FROM BURCKHARDT $\dfrac{R_{in}}{R_s} = A\left(\omega_c/\omega_o\right)$, & $\dfrac{R_\ell}{R_s} = B\left(\omega_c/\omega_o\right)$

ALSO A 1-2-4 QUADRUPLER (NO IDLER AT $3\omega_o$)
$A = .28$ & $B = .10$ FOR A DRIVE OF 2.0 TO 1.0

$$\frac{\omega_c}{\omega_o} = \frac{790 \times 10^9}{(2\pi)(1.5 \times 10^9)} = \frac{790}{3\pi} = 84$$

$$R_{in} = (1.5)(.28)(84) = 35.3\,\Omega$$

$$R_\ell = (1.5)(.10)(84) = 12.5\,\Omega$$

FOR EFFICIENCY FROM BURCKHARDT $\epsilon = e^{-\left(\alpha \frac{\omega_{out}}{\omega_c}\right)}$

$\alpha = 10.3$, $\omega_{out} = 2\pi \times 6 \times 10^9$, $\dfrac{\omega_{out}}{\omega_c} = \dfrac{37.6 \times 10^9}{790 \times 10^9} = .048$

$$\epsilon = e^{-(10.3 \cdot .048)} = e^{-.495} = \frac{1}{e^{.495}} = \frac{1}{1.64} = .61$$

$\epsilon \simeq 60\%$

Statement of Operation ______

Witnessed operation (obtain two signatures).

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

12/20/66 CONTINUED FROM p. 24.

IMPEDANCE CONSIDERATIONS FOR OUTPUT FILTER:

DIODE PAIR IN SERIES AT OUTPUT. $\therefore 2R_L = 25\Omega$.

OTHER DIODE PAIR IS ~~IN~~ SHUNT $\therefore$ THE OUTPUT RESIST. ~~IMPED.~~

AT PLANE OF DIODES IS 12.5Ω.

AN ADDITIONAL FACTOR IS THAT THE SELF-RESONANT

OF THE DIODE PAIR WILL BE SET AT THE 2nd

HARMONIC. - FROM BURCKHARDT'S TABLES $\frac{S_{02}}{S_{max}} = .5$

OR $C_{02} = 2C_{min}$, $C_{02} = 1.7\ pf$.

L OF DIODE IN WAVEGUIDE SHOULD BE ABOUT 1 nh

$$\therefore \quad f_{res} = \frac{1}{2\pi}\sqrt{\frac{1}{(1.7\times10^{-12})(1.0\times10^{-9})}} = \frac{1}{2\pi}\sqrt{\frac{1}{1.7\times10^{-21}}}$$

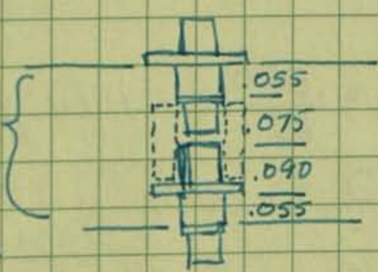
$$= \frac{1}{2\pi\times10^{-11}}\ \frac{1}{4.1} = 3.9\ gc$$

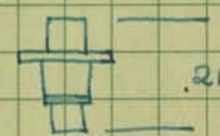
WILL HAVE TO ADD SOME INDUCTANCE TO BRING f_{RES} DOWN

TO 3.0 gc.

PACKAGE SIZE FOR OUTPUT:

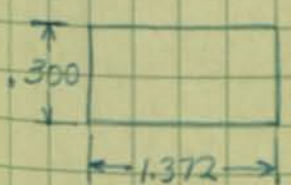
TRY .300 →





.055
.055
.075
.090
.275

CONSIDER WAVEGUIDE SIZE AS:



CONSIDER $Z_{V,I} = \frac{\pi b}{2a} Z_0$

WHERE $Z_0 = 377\left(1 - \frac{\lambda^2}{4a^2}\right)^{-\frac{1}{2}}$

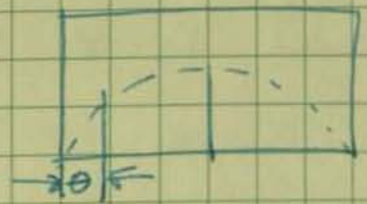
$$\lambda_{at\ 6gc} = \frac{3\times10^{10}}{6\times10^{9}\ 2.54} = \frac{5}{2.54} = 1.97''$$

 12/21/66 CONTINUED FROM p 25

$$\frac{\lambda^2}{4a^2} = \frac{1.97^2}{(4)(1.372)^2} = .514$$

$$\begin{array}{r} 1.000 \\ .514 \\ \hline .486 \end{array}$$

$\sqrt{.486} \doteq .70$



$$Z_0 = \frac{377}{.70} = 540\ \Omega$$

$540 \sin\theta = 25$

$\sin\theta = \frac{25}{540} = .046$

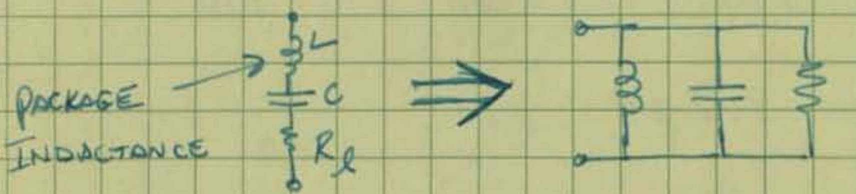
$\theta = 2.7°$

$$Z = \frac{\pi}{2}\ \frac{.3}{1.372}\ Z_0 = 185\ \Omega.$$

$\sin\theta = \frac{25}{185} = .135$, $\theta = 7.8°$, $\frac{7.8}{180} = \frac{x}{1.372}$

$x = .0595"$

CONSIDER SHUNT MODEL OF DIODE:

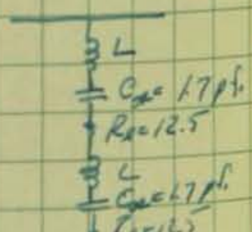


$R_\ell = 25\ \Omega$. FROM BURCKHARDT $\frac{S_{0f}}{S_{max}} = .5$ FOR 

$\therefore \frac{C_{min}}{C_{0f}} = .5$, & SINCE $C_{min} = .850$ pf.

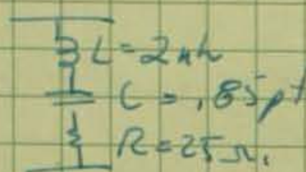
$C_{0f} = \frac{.850}{.5} = 1.70$ pf.

WITH 2 DIODES IN SERIES AT OUTPUT:



ASSUME $L \cong 1$ nh.

FINAL SERIES CIRCUIT BECOMES



$$Z = 25 + j\left(\omega L - \frac{1}{\omega C}\right)$$

A 6 gc

Statement of Operation ______

Witnessed operation (obtain two signatures).

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

$\omega L = 2\pi\, 6\times10^9\; 2\times10^{-9} = 24\pi = \underline{75.4\ \Omega}$.

$\frac{1}{\omega C} = \frac{1}{2\pi\, 6\times10^9\; .85\times10^{-12}} = \frac{1000}{(1.7)\,6\pi} = \frac{1000}{32} = \underline{31.2}$

$Z_{eqv} = 25 + j\,44.2$ (75.4 − 31.2 = 44.2)

$Y_{eqv} = \frac{1}{Z} = \frac{1}{25 + j\,44.2}\cdot\frac{25 - j\,44.2}{25 - j\,44.2} = \frac{25 - j\,44.2}{625 + 1950}$ (1950 + 625 = 2575)

$= \frac{25}{2575} - j\,\frac{44.2}{2575}$

$\therefore \frac{1}{G} = 100\ \Omega,\ \frac{1}{B} = 58\ \Omega.$

CONSIDER DIODE STRUCTURE SELF (series) RES. AT 3.0 gc. (SOLVE FOR L)

$\omega = \frac{1}{\sqrt{LC}},\quad L = \frac{1}{\omega^2 C} = \frac{1}{(2\pi\, \cancel{6}\,3\times10^9)^2\; .85\times10^{-12}}$

$= \frac{1\times4}{1420\times10^{18}\,(.85\times10^{-12})} = \frac{4}{1210\times10^6}$

$= \frac{4}{1.21\times10^9}$

$\underline{L = .83\ \cancel{nh}\times4 = 3.3\ nh.}$

THEN ωL ABOVE WOULD BE $75.4\times\frac{3}{2} = 113\ \Omega$.

$Z = 25 + j\,81.8$ (113 − 31.2 = 81.8)

$\frac{1}{G} = 290\ \Omega,\ \frac{1}{B} = 90\ \Omega.$ ($(81.8)^2 = 6700$; 6700 + 625 = 7325)

FOR FULL HEIGHT GUIDE

$185\times\frac{.622}{.300} = \underline{384\ \Omega}.$

$\sin\theta = \frac{290}{384} = .755,\ \theta = 50^\circ$ $\quad \frac{50}{180} = \frac{x}{1.372}$

$x = .38$ ABOUT $\frac{1}{4}$ OF GUIDE WIDTH FROM SIDE WALL.

 CONTINUED FROM p. 27 12/22/66

26 /

CONSIDER WAVEGUIDE FILTER DESIGN. USING INDUCTIVE POSTS - THE FIRST POST BEING THE INDUCTANCE OF THE DIODE SYSTEM.

X_L = 81.8 Ω FOR ONE SIDE

CONSIDER 2 SECTION (2 ELEMENT FILTER)

$$X_{k,k+1} = \frac{\frac{\Omega}{\sqrt{g_k g_{k+1}}}}{1 - \frac{\Omega^2}{g_k g_{k+1}}} , \quad \Omega = \pi \frac{\lambda_{g_1} - \lambda_{g_2}}{\lambda_{g_1} + \lambda_{g_2}}$$

$$f_1 = 5.85\ gc., \ \lambda g_1 = 2.977'', \quad \Omega = \pi \frac{.521}{5.433} = .30$$
$$f_2 = 6.45\ gc., \ \lambda g_2 = 2.456''$$

$$g_0 = \Omega = g_3 = .3$$

FOR MAX. FLAT $g_1 = g_2 = 1.414$

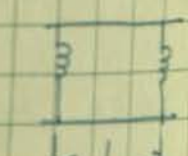
$$\therefore X_{01} = X_{12} = \frac{.3/1.414}{1 - \frac{(.3)^2}{2}} = \frac{.3}{1.414\left(1 - \frac{.09}{2}\right)}$$

1.000
.045
.955

$$X_{01} = X_{12} = .22$$

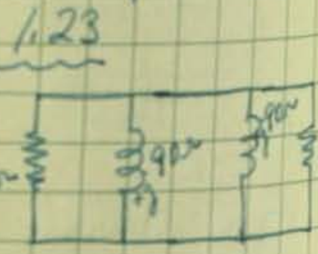
PAR
IN

FROM NOMOGRAPH - p. 138 $\frac{L_k}{\lambda_g} = .434$



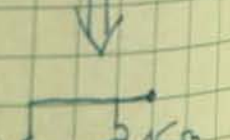
USE λ_g AT 6gc.
$\lambda_g \approx 2.82''$ $L = (.434)(2.82) = 1.23$

DIODE MODEL TO BE MATCHED



FOR FULL HEIGHT GUIDE - Z_0 = 384 Ω.
$\frac{X_{01}}{Z_0}$ = .22 OR X_{01} = 84.5 Ω

WHICH MEANS 2 × j84.5 Ω = j169 Ω IN PARALLEL
CUTTING HEIGHT IN HALF WOULD GIVE 2
j84.5 Ω INDUCTORS IN PARALLEL REQUIRED
FOR DESIGN.



CONT. FROM p. 28 12/28/66

CALCULATION ON PREVIOUS PAGE INCORRECT
USING S.R.I. HANDBOOK

$$\frac{\pi}{2} w_\lambda = \frac{\pi}{2} \frac{\lambda_{g_1} - \lambda_{g_2}}{\lambda_{g_0}} = \frac{\pi}{2} \frac{\frac{\lambda_{g_1} - \lambda_{g_2}}{}}{\frac{\lambda_{g_1} + \lambda_{g_2}}{2}} = .3$$

$$\frac{K_{01}}{Z_0} = \sqrt{\frac{\frac{\pi}{2} w_\lambda}{g_0 g_1}} = \sqrt{\frac{.3}{(1)(1.414)}} = \sqrt{.212} = 0.46$$

$$\therefore \left(\frac{K_{01}}{Z_0}\right)^2 = .212$$

1.000
.212
.788

$$\therefore \frac{X_{01}}{Z_0} = \frac{.46}{.788} = .59$$

IF $g_1 = .4$, $\frac{K_{01}}{Z_0} = \sqrt{\frac{.3}{.4}} = \sqrt{.75} = .87$ — TOO LARGE!

FOR $n = 1$ $g_0 = 1,\ g_1 = 2,\ g_3 = 1$

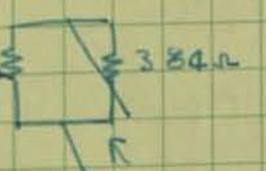
$$\frac{K_{01}}{Z_0} = \sqrt{\frac{.3}{2}} = \sqrt{.150} = .39$$

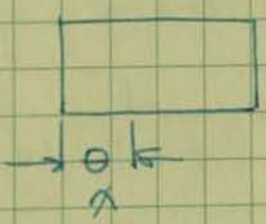
1.00
.15
.85

$$\frac{X_{01}}{Z_0} = \frac{X_{12}}{Z_0} = \frac{.39}{.88} = .46$$

CONSIDER HALF HEIGHT GUIDE $\frac{Z_0}{2} = 192\,\Omega$.

MATCH TO 384Ω





$\sin\theta = \frac{290}{384} = .755$

$\theta = 49°$

$$\frac{49}{180°} = \frac{x}{1.37''},\quad x = .372''$$

~~NOW CONSIDER INPUT MATCHING CIRCUIT.~~
WILL USE HALF HEIGHT GUIDE WITH DIODE PAIRS LOCATED
1/4 GUIDE WIDTH FROM SIDES.
CALCULATION OF REMAINING POST TO COMPLETE FILTER SECTION.

$$\frac{X_{12}}{Z_0} = .46,\quad \frac{X_{12}}{Z_0}\frac{\lambda_{g0}}{Z_a} = \frac{(.46)(2.82)}{(2)(1.37)} = .474$$

$$\lambda_0 = \frac{3\times10^{10}}{6\times10^{9}\ 2.54} = 1.97'' \quad \frac{\lambda_0}{a} = \frac{1.97}{1.37} = 1.44$$

FROM S.R.I. REPORT
$\frac{d}{a} \doteq .030$
$d = (.030)(1.37)$
$d = .041$

Statement of Operation ____________

Witnessed operation (obtain two signatures):

Signature ____________ Date ____

Signature ____________ Date ____

Signature ____________ Date ____

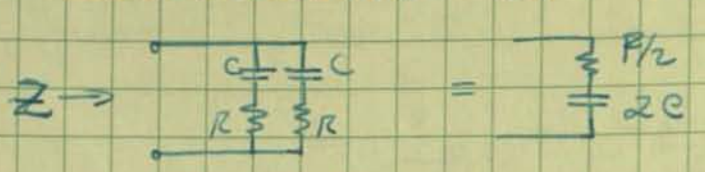
Read and Understood (obtain two signatures):

Signature ____________ Date ____

Signature ____________ Date ____

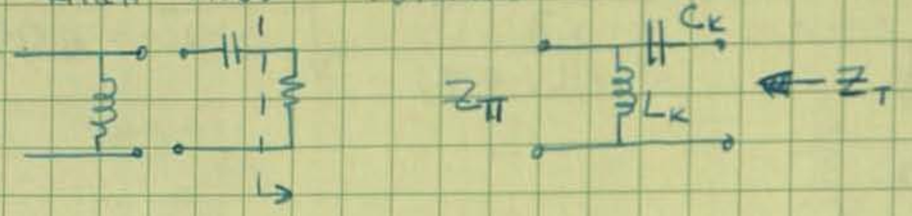
12/30/66 CONTINUED FROM p. 29

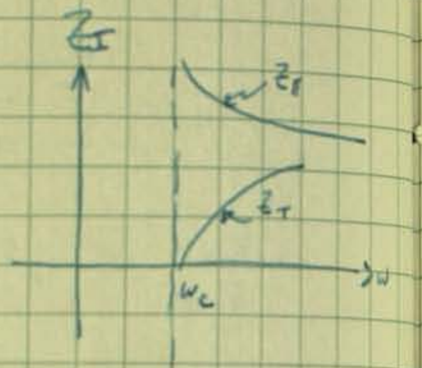
CONSIDERATION OF INPUT CIRCUIT:



$R/2 = 17.6\ \Omega.$
$2C = 2 \times 1.7\ pf. = 3.4\ pf.$

CONSIDER HIGH PASS TUNING L SECTION:





FROM I.T.T. HANDBOOK

$$Z_T = R\sqrt{1-\left(\frac{w_c}{w}\right)^2}\ ,\quad Z_\pi = \frac{R}{\sqrt{1-\left(\frac{w_c}{w}\right)^2}}$$

OR $Z_T = Z_\pi\left[1-\left(\frac{w_c}{w}\right)^2\right]$

$$\frac{w_c}{w} = \sqrt{1-\frac{Z_T}{Z_\pi}}\ ,\quad \text{LET } Z_T = 17.6\ \Omega\ ,\ Z_\pi = 50\ \Omega$$

$$\frac{17.6}{50} = .35$$

$\frac{w_c}{w} \cong .8$, IF $f = 1.5$ gc

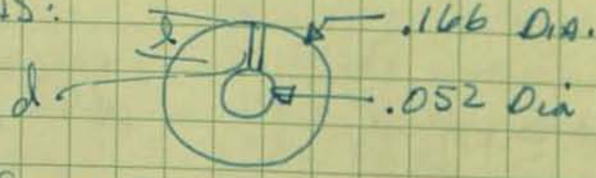
$f_c = 1.20$ gc.

$$w_c = \frac{1}{\sqrt{L_K C_K}}\ ,\quad L_K = \frac{1}{w_0^2 C_K} = \frac{1}{(2\pi)^2(1.2\times10^9)^2\, 3.4\times10^{-12}}$$

$$L_K = \frac{10^{-6}}{4\pi^2(1.44)(3.4)} = .0052\times10^{-6} = 5.2\ nh.$$

@ 1.5 gc. $jwL_K = j2\pi\ 1.5\times10^9\ 5\times10^{-9} = j15\pi = j47\Omega.$

CONSIDER ACHIEVING L_K BY A THIN WIRE ACROSS 50Ω COAXITUBE LINE WITH FOLLOWING DIMENSIONS:



$l = .057$

FROM CURVES IN MICROWAVE HANDBOOK $\frac{d}{l} = .22$

$d = (.22)(.057)$

$d = .013$

∴ WILL TRY .018 BE CU WIRE.

Statement of Operation ____

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

1/4/67 CONTINUED FROM P. 30

IMPEDANCE TRANSFORMER BETWEEN .300 HEIGHT GUIDE AND .622 HEIGHT (FULL HEIGHT) GUIDE.

$$Z_2 = \sqrt{Z_1 Z_3} = \sqrt{(384)(185)} = \sqrt{71000} = 266 \Omega.$$

$$\frac{.622}{x} = \frac{384}{266}, \quad x = .443$$

CALCULATION OF MAX. ~~BANDWIDTH~~ VSWR FOR 10% B.W.

LET γ = FRACTIONAL BANDWIDTH

$$\gamma = \frac{f_2 - f_1}{f_0}, \quad f_0 = \frac{f_1 + f_2}{2}$$

$$\gamma = \frac{f_2 - f_1}{\frac{f_1 + f_2}{2}} = \frac{2f_2 - 2f_1}{f_1 + f_2} = \frac{2\frac{f_2}{f_1} - 2}{1 + \frac{f_2}{f_1}}$$

$$\gamma + \gamma \frac{f_2}{f_1} = 2\frac{f_2}{f_1} - 2$$

$$\frac{f_2}{f_1}(\gamma - 2) = -2 - \gamma$$

$$\frac{f_2}{f_1} = \frac{2+\gamma}{2-\gamma}, \quad \text{IF } \gamma = .1 \quad \frac{f_2}{f_1} = \frac{2.1}{1.9} = 1.105$$

$$\phi_1 = \frac{180}{1+1.105} = \frac{180}{2.105} = 89.5^\circ, \quad \cos 89.5^\circ = .0087$$

$$\frac{1}{\cos\phi_1} = 115, \quad \frac{Z_3}{Z_1} = \frac{384}{185} = 2.08, \quad \ln \frac{Z_3}{Z_1} = .73$$

$$T_1(X) = X$$

$$S_{max} = 1 + \frac{.73}{115} = 1 + .007$$

FOR LENGTH USE $\lambda/4$ AT 6.45 gc. – $\lambda_g = 2.456$

LET l = 0.60

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

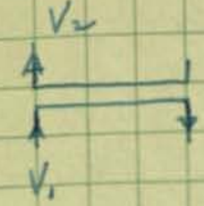
Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

1/9/67   30B. COUPLER WITH VARYING IMPEDANCE. IN COUPLED SECTION.



FOR 3 db COUPLER $\frac{P_2}{P_1} = \frac{V_2^2}{V_1^2} = .5$

$$\frac{V_1}{V_2} = .707 = k$$

$$\frac{Z_{oe} - Z_{oo}}{Z_{oe} + Z_{oo}} = k \quad , \quad Z_0 = \sqrt{Z_{oe} Z_{oo}} \quad , \quad Z_0^2 = Z_{oe} Z_{oo}$$

$$Z_{oe} = \frac{Z_0^2}{Z_{oo}}$$

$$\therefore \frac{\frac{Z_0^2}{Z_{oo}} - Z_{oo}}{\frac{Z_0^2}{Z_{oo}} + Z_{oo}} = \frac{Z_0^2 - Z_{oo}^2}{Z_0^2 + Z_{oo}^2} = k$$

$$Z_0^2 - Z_{oo}^2 = k Z_0^2 + k Z_{oo}^2$$

$$Z_0^2(1-k) = \cancel{Z_{oo}^2} + k Z_{oo}^2 = Z_{oo}^2(1+k)$$

$$\therefore Z_{oo}^2 = Z_0^2 \left(\frac{1-k}{1+k}\right) \quad , \quad \boxed{Z_{oo} = Z_0 \sqrt{\frac{1-k}{1+k}}}$$

$$Z_{oe} = \frac{Z_0^2}{Z_{oo}} = \frac{Z_0^{\cancel{2}}}{\cancel{Z_0}\sqrt{\frac{1-k}{1+k}}} = \boxed{\frac{Z_0}{\sqrt{\frac{1-k}{1+k}}} = Z_{oe}}$$

$$\begin{array}{r} 1.000 \\ .707 \\ \hline .293 \end{array}$$

$$\frac{1-k}{1+k} = \frac{.293}{1.707} = \cancel{.415}\ .172 \ , \quad \sqrt{\frac{1-k}{1+k}} = \cancel{.645}\ 0.415$$

$$\text{THEN} \quad Z_{oe} = \frac{Z_0}{\cancel{.645}\ .415} \ , \quad Z_{oo} = Z_0\, \cancel{.645}\ .415$$

TRY $Z_0 = 50\,\Omega$, $Z_{oe} = 120\,\Omega$. , $Z_{oo} = 20.8\,\Omega$.

IF $\varepsilon_r = 9$

$\sqrt{\varepsilon_r}\, Z_{oe} = 360\,\Omega$. $\sqrt{\varepsilon_r}\, Z_{oo} = 62.5\,\Omega$

$s/b < .005$ IF $b = .060$

$s < .0003$ TOO SMALL!

1/9/67 Cont. from p. 32

Try $Z_0 = 20\Omega$, $Z_{oe} = 48.2\Omega$, $Z_{oo} = 8.3\Omega$.

$\sqrt{\epsilon_r}\, Z_{oe} = 145\Omega$, $\sqrt{\epsilon_r}\, Z_{oo} = 24.9\Omega$.

s/b OFF SCALE — TOO SMALL!

Try $Z_0 = 100\Omega$, $Z_{oe} = 241\Omega$, $Z_{oo} = 41.5$

$3 \times Z_{oe} = 723$, $3 \times Z_{oo} = 124.5$

1/12/67 WIDE BAND STRIPLINE BALUN.

FROM ARTICLE BY JONES AND SHIMIZU - S.R.I. PGMTT p. 128 JAN. '59.

Try Z = ~~[illegible]~~ 100Ω

CONSIDER DESIGN OF FOLLOWING FILTERS #

FOR I. $$Z_s = \frac{2 Z_{oe} Z_{oo} \sin\theta}{\left[(Z_{oe} - Z_{oo})^2 - (Z_{oe} + Z_{oo})^2 \cos^2\theta\right]^{1/2}}$$

AT BAND CENTER $$Z_s = \frac{2 Z_{oe} Z_{oo}}{Z_{oe} - Z_{oo}}$$

FROM PAPER WILL SELECT BALUN II.

$\frac{Z_{oe}}{Z_{oo}} = 6.5$, $\frac{Z_{oe}}{Z} = 2.250$, $\frac{Z_{oo}}{Z} = 0.393$, $b = .180$

$\frac{Z_s}{Z}$ (MIDBAND) = 0.925, Z_0/Z (MIDBAND) = 1.081

IF $Z = 100\Omega$ $Z_{oe} = 225\Omega$ & $Z_{oo} = 39.3\Omega$.

FOR REX ® 2200, $\epsilon_r = 2.77$, $\sqrt{\epsilon_r} \cong 1.66$

$\sqrt{\epsilon_r}\, Z_{oe} = 374\Omega$ $\sqrt{\epsilon_r}\, Z_{oo} = 65.3\Omega$.

$\frac{s}{b} = .005$ $s = .0009$ TOO THIN.

1/12/67 CONT. FROM p. 33.

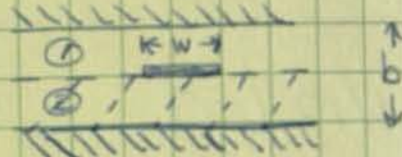
TRY $Z = 50\Omega$ & $\frac{Z}{2} = 25\Omega$

$Z_{oe} = (50)(2.25) = 112.5\,\Omega.$, $Z_{oo} = (50)(.393) = 19.6\,\Omega.$

$\sqrt{\epsilon_r}\, Z_{oe} = 187\,\Omega$, $\sqrt{\epsilon_r}\, Z_{oo} = 32.6\,\Omega$

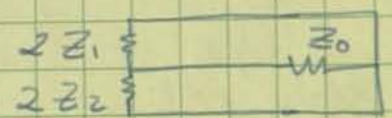
1/19/67

CONSIDER Z CALCULATION OF FOLLOWING STRIPLINE



MEDIUM ① - AIR
" ② - ALUMINA $\epsilon_r = 9$

ASSUME STRIPLINE LOADED BY 2 IMPEDANCES



THEN $\frac{2Z_1 \times 2Z_2}{2(Z_1+Z_2)} = Z_0$

$\frac{2Z_1 Z_2}{Z_1+Z_2} = Z_0$

IF STRIPLINE CONSTRUCTION SYMMETRICAL EXCEPT FOR ϵ_r

$\frac{Z_1}{Z_2} = \sqrt{\frac{\epsilon_{r2}}{\epsilon_{r1}}}$, SINCE $Z_0 = \frac{\eta}{\sqrt{\epsilon_r}\,(C/\epsilon)}$

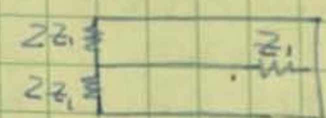
SINCE $\epsilon_r = 9.0$ FOR ALUMINA

$\frac{Z_1}{Z_2} = 3$, $Z_1 = 3Z_2$

SUBSTITUTING $\frac{2(3Z_2)Z_2}{3Z_2+Z_2} = Z_0$

$\frac{6Z_2}{4} = Z_0$, $\boxed{Z_2 = \frac{2}{3}Z_0, \quad Z_1 = 2Z_0}$

FOR Z_1 IN AIR



CALCULATION OF $\frac{W}{b}$ FOR $Z_0 = 50\Omega$ $Z_1 = 2Z_0 = 100\,\Omega.$, $b = 2 \times .060 = .120$

$\frac{W}{b} = .35$, $W = (.35)(.120)$, $\boxed{W = .042}$

IF $b = .060$, $\boxed{W = .021}$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

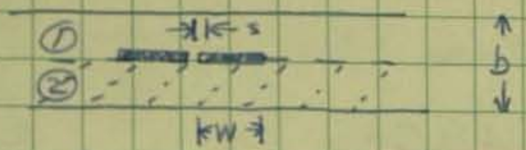
Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

1/23/67 CONT. FROM p. 34

CONSIDER SAME ARGUMENT FOR COUPLED STRIPS.



FOR $Z_0 = 50\Omega$, $\begin{cases} Z_{oe} = 120\ \Omega \\ Z_{oo} = 20.8\ \Omega \end{cases}$ SEE p. 32

ANALOGOUS TO p. 34 $Z_{oe_2} = \frac{2}{3} Z_{oe}$, $Z_{oo_2} = \frac{2}{3} Z_{oo}$

$Z_{oe_1} = 2 Z_{oe}$, $Z_{oo1} = 2 Z_{oo}$

$Z_{oe_1} = 240\ \Omega$

$Z_{oo_1} \cong 42\ \Omega$ $\frac{s}{b} = .0013$, $s = .000156$ FOR $b = .120$

TRY $s = .0002$

$\frac{W}{b} = .18$, $W = .022$

5/5/67 AMPLIFIER CIRCUIT

REALIZATION OF SERIES INDUCTANCE

MEASURED :- .020 → .2nh

.080 → .8nh

.160 → 2.5nh

8/2/67

INTERDIGITAL FILTER FOR OUTPUT IN 13.7 Gc TO 14.2 Gc. RANGE

5% MARGIN IS ABOUT 700 mc.

LET f_1 = 13.00 Gc. & f_2 = 14.9 Gc. ,

$$w = \frac{1.9}{13.95} = .136$$

14.90
− 13.00
1.90

2 | 27.90
13.95

TRY MARGIN OF 200 mc.

f_1 = 13.50 Gc, f_2 = 14.40

$$w = \frac{~~1.20~~\ .090}{~~14.10~~\ 13.95} = ~~.085~~\ .065$$

f_0 = ~~14.10 gc.~~ 13.95 gc.

14.40
13.50
0.90

2 | 27.90
13.95

CONSIDER USING 6^{th} HARMONIC

$$\frac{13.7}{6} = 2.28\ Gc \quad , \quad \frac{14.2}{6} = 2.37\ Gc.$$

16.00
− 13.95
2.05

7^{th} HARM. 7 X 2.28 = 16.0 Gc.

$$\frac{\omega'}{\omega_1'} = \frac{2}{w}\left(\frac{\omega - \omega_0}{\omega_0}\right) \quad , \quad \frac{\omega - \omega_0}{\omega_0} = \frac{f - f_0}{f_0} = \frac{1.9}{16}$$

$$= \frac{2}{.085}\ \frac{2.05}{13.95} = 3.46 \quad , \quad \left|\frac{\omega'}{\omega_1'}\right| - 1 = 2.46$$

n = 6 SHOULD GIVE BETTER THAN 60 db REJECTION

$g_0 = 1$, $g_1 = 1.168$, $g_2 = 1.404$, $g_3 = 2.056$, $g_4 = 1.517$

$g_5 = 1.903$, $g_6 = .862$, $g_7 = 1.355$

n = 5 JUST 60 db

$g_0 = 1$, $g_1 = 1.147$, $g_2 = 1.371$, $g_3 = 1.975$, $g_4 = 1.371$, $g_5 = 1.147$, $g_6 = 1.$

$\theta_1 = \frac{\pi}{2}\left(1 - \frac{w}{2}\right)$,

$$\begin{array}{r} 1.000 \\ -\ .032 \\ \hline .968 \end{array}$$

$\theta_1 = \left(\frac{\pi}{2}\right)(.968) = 1.52$ RAD.

$= 1.52 \frac{180}{\pi} = 87.2°$

LET $Y_A = \frac{1}{20\Omega}$, $Y_B = \frac{1}{50\Omega}$

$\frac{J_{01}}{Y_A} = \frac{1}{\sqrt{g_0 g_1 \omega_1'}} = \frac{1}{\sqrt{1.147}} = \frac{1}{1.07} = .935$, $\left(\frac{J_{01}}{Y_A}\right)^2 = .875$

$\frac{J_{12}}{Y_A} = \frac{1}{\sqrt{(1.147)(1.371)}} = \frac{1}{\sqrt{1.57}} = \frac{1}{1.25} = .800$, $\left(\frac{J_{12}}{Y_A}\right)^2 = .640$

$\frac{J_{23}}{Y_A} = \frac{1}{\sqrt{(1.371)(1.975)}} = \frac{1}{\sqrt{2.71}} = \frac{1}{1.65} = .605$, $\left(\frac{J_{23}}{Y_A}\right)^2 = .365$

$\tan\theta_1 = \tan 87.2° = 20.45$

$\tan^2\theta = 418$, $\frac{\tan^2\theta}{4} = 10.22$

$$\begin{array}{r} 10.22 \\ .64 \\ \hline 10.86 \end{array}$$

$N_{1,2} = \sqrt{\left(\frac{J_{1,2}}{Y_A}\right)^2 + \frac{\tan^2\theta_1}{4}} = \sqrt{.640 + 10.22} = 3.30$

$$\begin{array}{r} 10.22 \\ .37 \\ \hline 10.59 \end{array}$$

$N_{23} = \sqrt{.365 + 10.22} = 3.26$

$\frac{C_K}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} \, h \, Y_A' \left(N_{K-1,K} + N_{K,K+1} - \frac{J_{K-1,K}}{Y_A} - \frac{J_{K,K+1}}{Y_A}\right)$

~~$\frac{C_3}{\epsilon}$~~ MA TRY $Y_A' = \left(\sqrt{50 \cdot 20}\right)^{-1} = \left(10\sqrt{10}\right)^{-1} = \frac{1}{32\Omega}$.

$\frac{376.7}{32} = 11.8$

8/9/67 CONT. FROM p. 37

$$\frac{C_3}{\epsilon} = 11.8\,h\left(N_{23} + N_{34} - \frac{J_{23}}{Y_A} - \frac{J_{34}}{Y_A}\right)$$
$$= 11.8\,h\,(3.26 + 3.26 - .365 - .365),$$
$$= (11.8)(5.79)\,h = \underline{68.2\,h}$$

$$\begin{array}{r} 6.52 \\ -\ .73 \\ \hline 5.79 \end{array}$$

$$\frac{C_{23}}{\epsilon} = 11.8\,h\left(\frac{J_{23}}{Y_A}\right) = 11.8\,h\,(.365)$$

$$\frac{C_{23}}{\epsilon} = \underline{4.30\,h} = \frac{C_{34}}{\epsilon}, \quad \frac{2C_{23}}{\epsilon} = 8.60$$

$$17.2\,h + 68.2\,h = 5.4$$

$$\begin{array}{r} 68.2 \\ 17.2 \\ \hline 85.4 \end{array}$$

$$\boxed{h = \frac{5.4}{85.4} = .063} \qquad \sqrt{h} = .25$$

$$\frac{(376.7)(.063)}{20} = 11.90, \quad \frac{(376.7)(.063)}{50} = 4.75$$

$$M_1 = Y_A\left(\frac{J_{01}}{Y_A}\sqrt{h} + 1\right), \quad M_5 = Y_B\left(\frac{J_{56}}{Y_B}\sqrt{h} + 1\right)$$

$$= \frac{1}{20}\left[(.935)(.25) + 1\right], \quad = J_{56}\sqrt{h} + Y_B$$

$$J_{56} = Y_A\,.935 = \frac{.935}{20} = .047$$

$$= \frac{1.234}{20} = \underline{.062}$$

$$M_5 = (.047)(.25) + \frac{1}{50} =$$
$$= .012 + .020 = \underline{.032}$$

$$\begin{array}{r} .020 \\ .012 \\ \hline .032 \end{array}$$

$$\frac{C_0}{\epsilon} = 376.7\left[2Y_A - M_1\right]$$

$$= 376.7\left(\frac{2}{20} - .062\right) = (376.7)(.038)$$

$$\begin{array}{r} .100 \\ -\ .062 \\ \hline .038 \end{array}$$

$$\boxed{\frac{C_0}{\epsilon} = 1430}$$

Statement of Operation ____________________

____

Witnessed operation (obtain two signatures):

Signature ____________ Date ______

Signature ____________ Date ______

Signature ____________ Date ______

Read and Understood (obtain two signatures):

Signature ____________ Date ______

Signature ____________ Date ______

$$\frac{C_6}{\epsilon} = 376.7\left[2Y_B - M_5\right] = 376.7\left(\frac{2}{50} - .032\right),$$

$$= (376.7)(.008)$$

$$\boxed{\frac{C_6}{\epsilon} = 3.02}$$

.040
032
.008

$$\frac{C_1}{\epsilon} = 376.7\left\{Y_A - M_1 + hY_A\left[\frac{\tan\theta_1}{2} + \left(\frac{J_{01}}{Y_A}\right)^2 + N_{12} - \frac{J_{12}}{Y_A}\right]\right\}.$$

$$= 376.7\left\{\frac{1}{20} - .062 + \frac{(.25)}{20}\left[\frac{20.45}{2} + .875 + 3.30 - .80\right]\right\},$$

.05 10.22

$$= 376.7\left[-.012 + \frac{13.60}{80}\right] = 376.7\,(-.012 + 0.17) = (376.7)(.158)$$

$$\boxed{\frac{C_1}{\epsilon} = 59.5}$$

10.22
.88
3.30
14.40
-.80
13.60
.170
-.012
.158

$$\frac{C_5}{\epsilon} = 376.7\left\{Y_B\right.$$

Statement of Operation

Witnessed operation (obtain two signatures):

Signature Date

Signature Date

Signature Date

Read and Understood (obtain two signatures):

Signature Date

Signature Date

 3/6/69

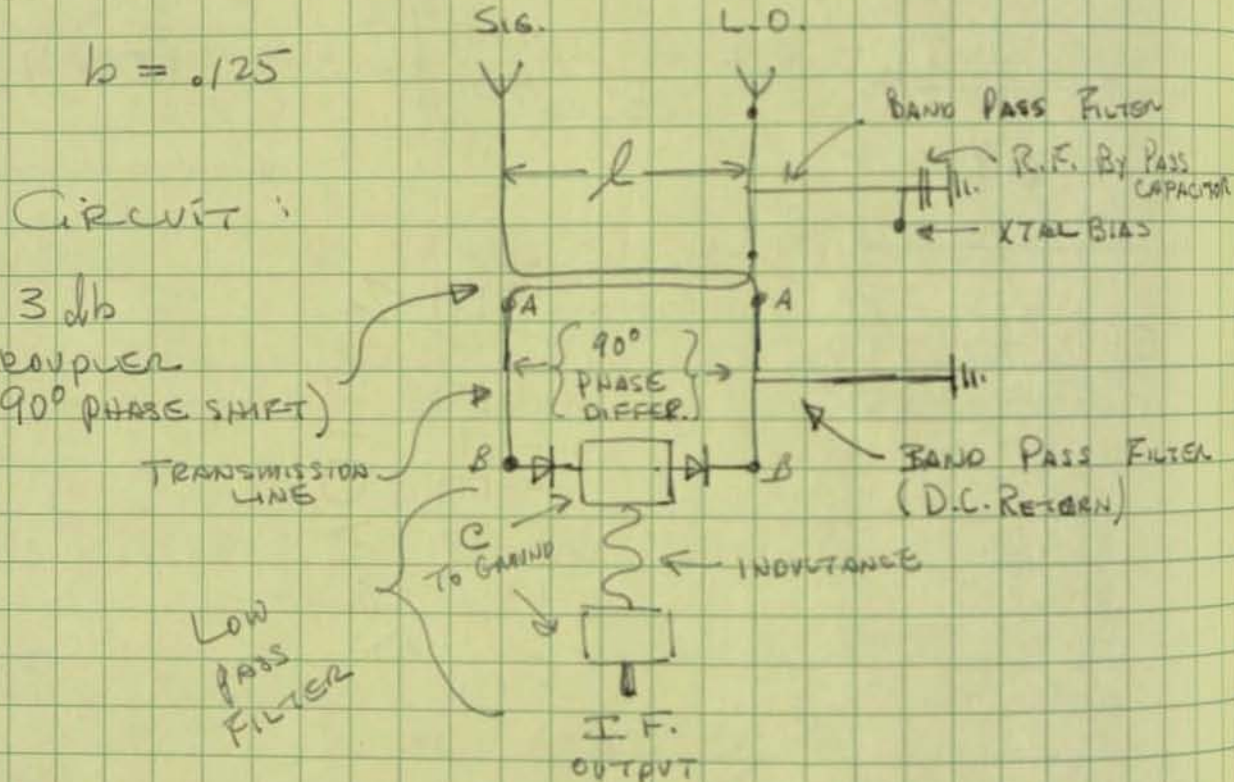
A SCHOTTKY BARRIER MIXER TO BE PUT ON CERAMIC MICROSTRIP CONSTRUCTION

CONSIDER:
1. 4-8 GHZ. DESIGN
2. R.F. IMPEDANCE OF 50 Ω.

START WITH STRIPLINE IN REXOLITE 2200

$\varepsilon_r = 2.77$, $b = .125$

GENERAL CIRCUIT:



AT POINTS A THERE WILL BE A 90° PHASE DIFFERENTIAL FROM 4.0 TO 8.0 GHZ. AT POINTS B THERE WILL BE 180° PHASE DIFFERENTIAL DUE TO THE 90° DIFFERENTIAL BETWEEN "T" FILTER SECTION AND TRANSMISSION LINE.

IN THE LOW PASS FILTER BEING FED BY THE TWO DIODES IN PARALLEL THE INPUT IMPEDANCE WILL BE SET AT 25 Ω. THE CUTOFF OF THE LOW PASS WILL BE SET AT 1200 MHZ ALLOWING IF FREQUENCIES UP TO 1.0 GHZ.

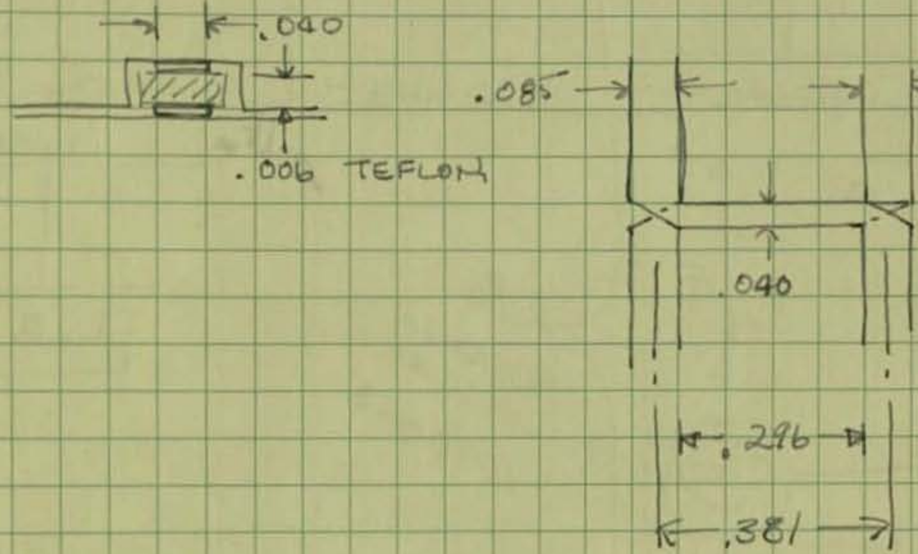
3/7/69

CONTINUED FROM p. 40

CONSIDER 3db COUPLER DESIGN.

$$\ell = \frac{1}{4}\,\frac{3\times10^{10}}{6.0\times10^{9}\,(2.54)\,1.66} = .296''$$

FROM PREVIOUS DESIGN WILL USE FOLLOWING COUPLING CONSTRUCTION:



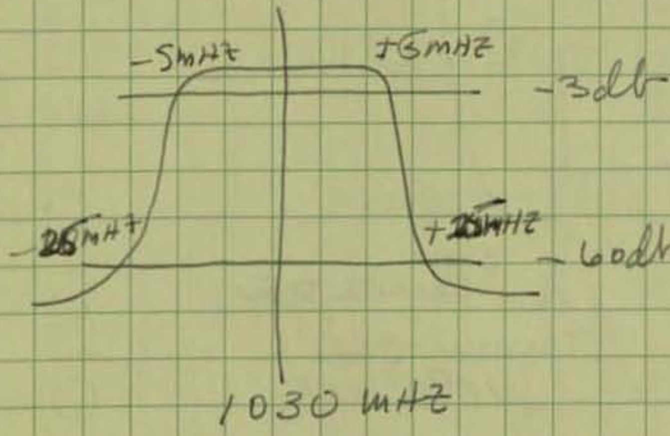
$$\begin{array}{r} .296 \\ .085 \\ \hline .381 \end{array}$$

CONSIDER FILTER WITH FOLLOWING REQUIREMENTS 3/26/69

$$w = \frac{\omega_2-\omega_1}{\omega_0} = \frac{f_2-f_1}{f_0}$$

$$w = \frac{10}{1030} = .0097$$

$f_0 = 1030$ MHZ



$$\left|\frac{\omega'}{\omega_1'}\right| = \frac{2}{w}\left(\frac{f-f_0}{f_0}\right)$$

$$= \frac{2}{.0097}\left(\frac{25}{1030}\right) = \frac{5}{(.0097)(103)} = 5.0$$

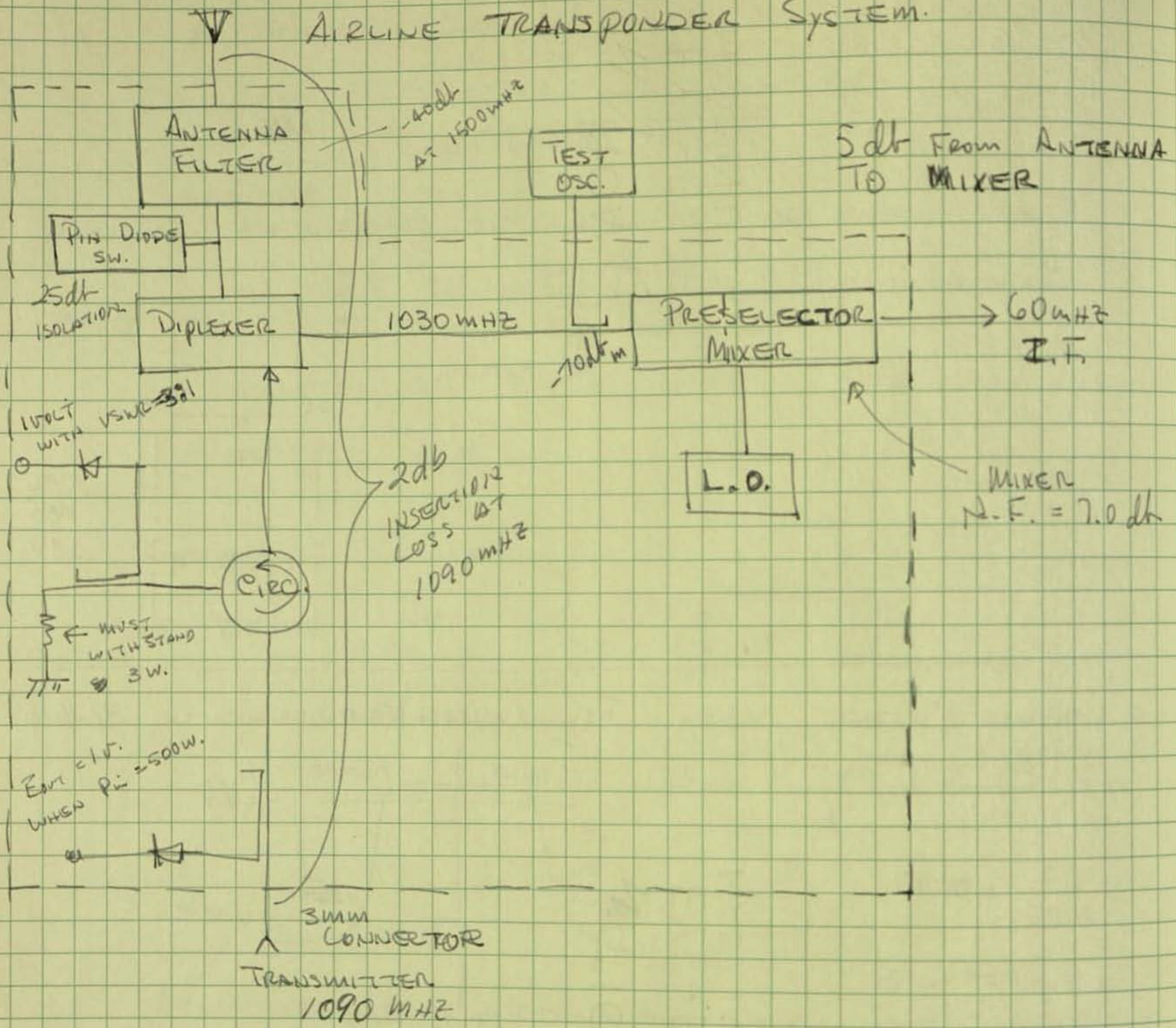
$$\left|\frac{\omega'}{\omega_1'}\right| - 1 = 4.0$$

, max flat n=5 RESONATORS

For 70 db. AT ±25 MHZ

 3/26/69 CONT. FROM p. 41

AIRLINE TRANSPONDER SYSTEM.



PEAK POWER MAX. 1000 W.
AVE. POWER MAX. 3W.

Statement of Operation ____

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

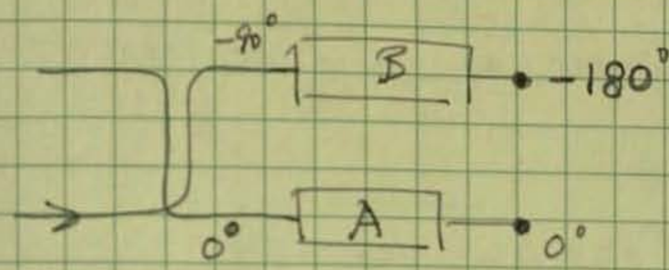
Signature ____ Date ____

Signature ____ Date ____

4/3/69 CONT. FROM p. 41 PHASE SHIFTER

CONT. FROM p. 41

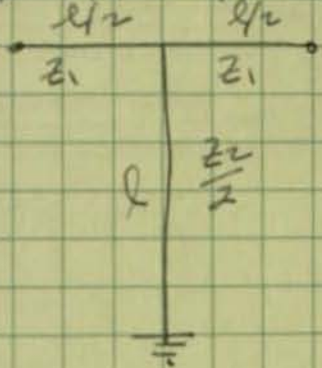
CONSIDER FOLLOWING COMBINATION



COUPLER GIVES 90° PHASE DIFFERENTIAL.

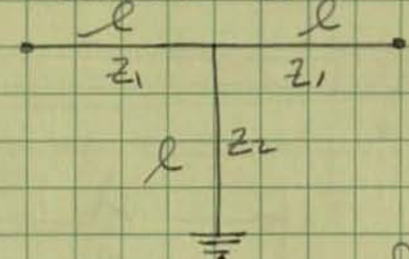
ADD CIRCUITS A & B TO GIVE 180° PHASE DIFFERENTIAL.

CIRCUIT A



$\rho_A = \frac{Z_1}{Z_2}$

CIRCUIT B



$\rho_B = \frac{Z_1}{Z_2}$

$\cosh \theta_A = (1+\rho_A)\cos\phi$

IN PASS BAND

$\cos \beta_A = (1+\rho_A)\cos\phi$

$\cos \beta_A \Big|_{\phi=\frac{\pi}{2}} = 0$

$\therefore \beta_A \Big|_{\phi=\pi/2} = \pm 90°, \pm 270°, \ldots$

CONSIDER $f_{c_1} \sim 45° = \phi$, $\cosh\theta_A = 1$

$\cos\beta_A = 1$

$1 = (1+\rho_A)\,.707$

$1+\rho_A = 1.41$

$\rho_A = .41 = \frac{Z_1}{Z_2}$, LET $Z_1 = 50$

$\therefore Z_2 = \frac{50}{.41} = 121\,\Omega$.

$\cosh\theta_B = \frac{\rho_B}{2} + \left(1+\frac{\rho_B}{2}\right)\cos 2\phi$

$\cos\beta_B = \frac{\rho_B}{2} + \left(1+\frac{\rho_B}{2}\right)\cos 2\phi$

$\cos\beta_B \Big|_{\phi=\frac{\pi}{2}} = -1$

$\therefore \beta_B \Big|_{\phi=\pi/2} = \pm\pi, \ldots$

SELECT ~~Cosh~~ $\cosh_B\theta = 0 \sim \phi = 45°$

$\cos\beta = 0$

$0 = \frac{\rho_B}{2} + \left(1+\frac{\rho_B}{2}\right)(0)$

OR $\rho_B = 0$

WON'T WORK!

Statement of Operation ______________________

Witnessed operation (obtain two signatures):

Signature ______________ Date ______

Signature ______________ Date ______

Signature ______________ Date ______

Read and Understood (obtain two signatures):

Signature ______________ Date ______

Signature ______________ Date ______

4/5/69

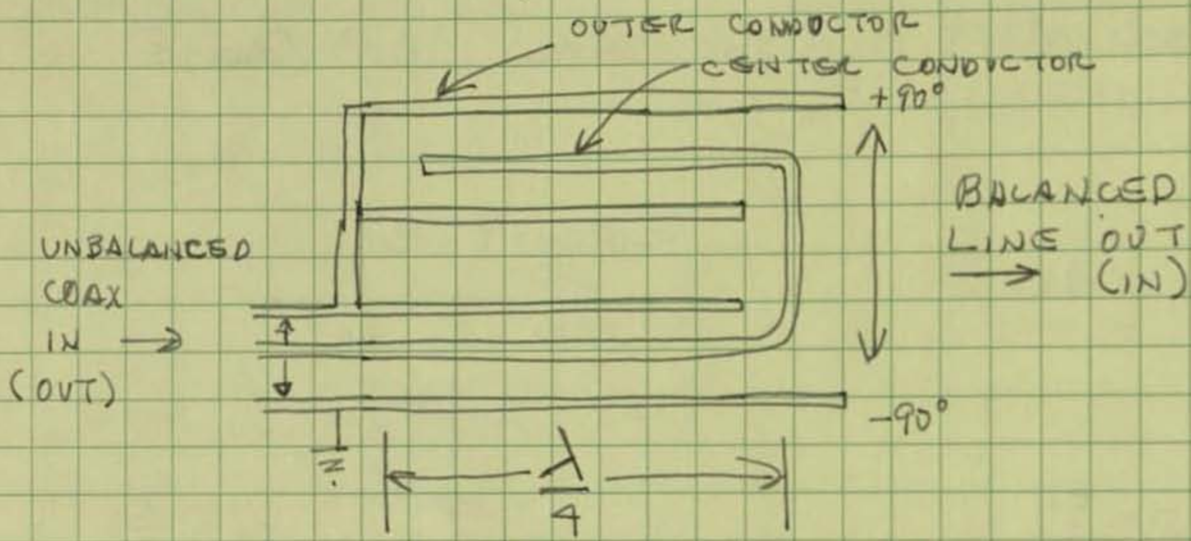
DESIGN FOR A DOUBLY BALANCED MIXER

CONSIDER THE FOLLOWING BALUN.

FROM ~~DE~~ THE OLTMAN ARTICLE IN THE MTT.

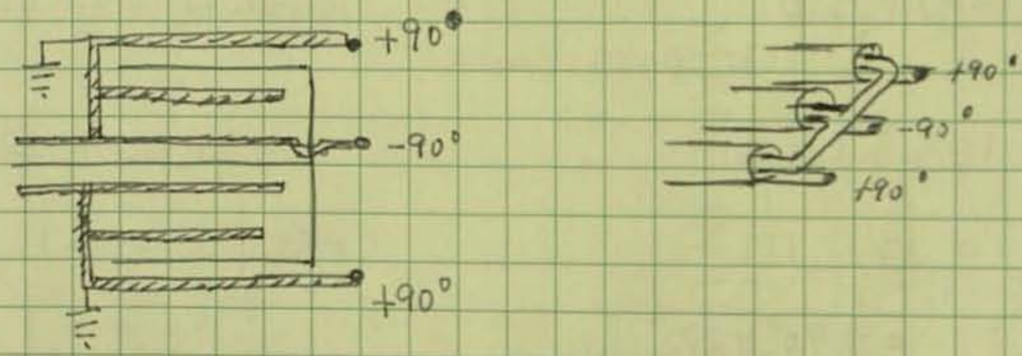
MAR. 1966 p. 112

CUTAWAY VIEW OF COAXIAL VERSION:

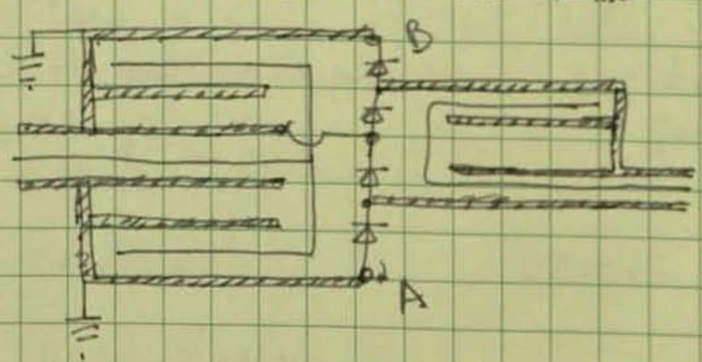


AT BAND CENTER

CONSIDER PARALLEL OUTPUT ON THE BALANCED SIDE:



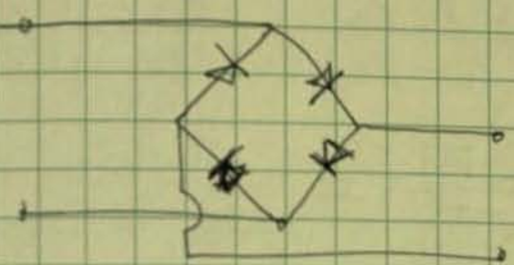
ADD 4 MIXER DIODES AND ANOTHER BALUN.



POINTS A AND B ARE AT SAME POTENTIAL

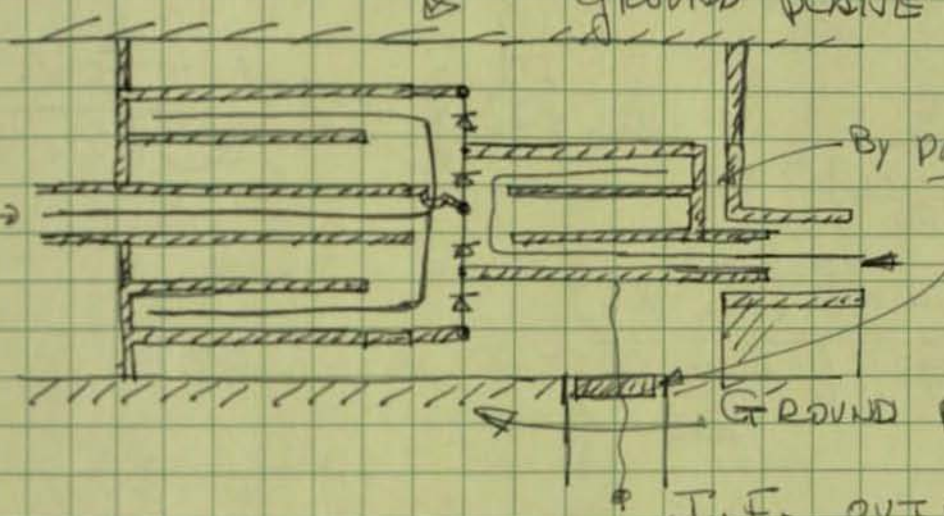
4/11/69 CONTINUED FROM p. 44

THIS GIVES THE SAME EFFECT AS:

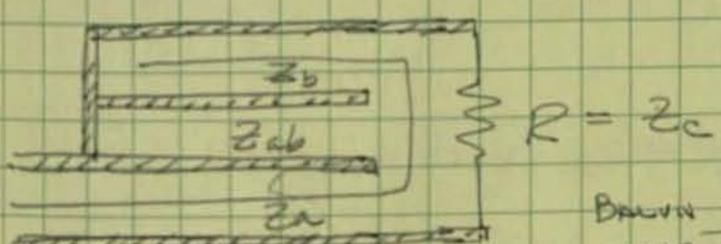


CONVENTIONAL CIRCUIT FOR A ~~BAL~~ DOUBLEY BALANCED MIXER.

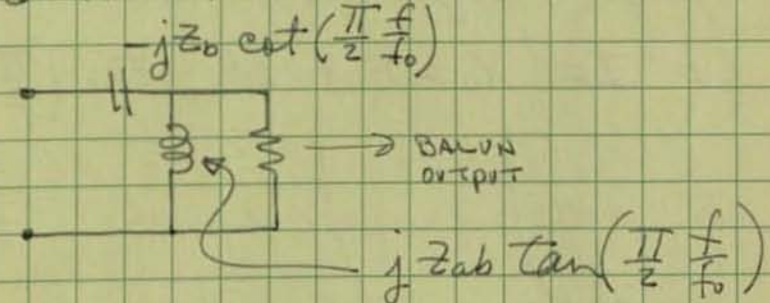
CONSIDER FOLLOWING I.F. OUTPUT CIRCUIT.



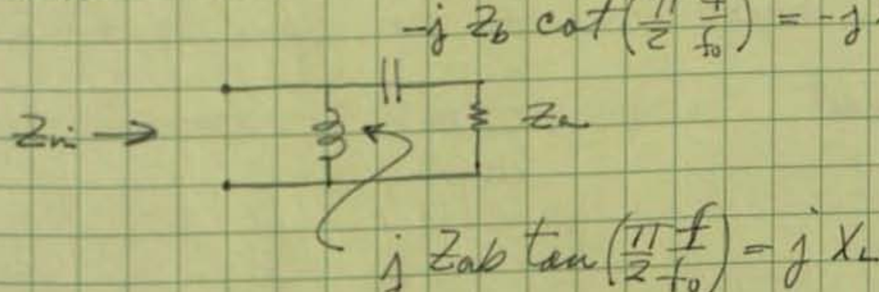
CONSIDER ANALYSIS OF BASIC BALUN.



EQUIVALENT CIRCUIT.



LOOKING FROM BALANCED LINE:



 4/12/69 CONTINUED FROM p. 45

$$Z_{in} = \frac{(Z_a - jX_c)(jX_L)}{(Z_a - jX_c) + jX_L} = \frac{X_L X_c + j X_L Z_a}{Z_a + j(X_L - X_c)} \times \frac{Z_a - j(\quad)}{Z_a - j(\quad)}$$

$$Re\{Z_{in}\} = \frac{Z_a X_L X_c + X_L Z_a (X_L - X_c)}{Z_a^2 + (X_L - X_c)^2} = \frac{X_L^2 Z_a}{Z_a^2 + (X_L - X_c)^2}$$

$$Im\{Z_{in}\} = \frac{Z_a^2 X_L - X_c X_L (X_L - X_c)}{Z_a^2 + (X_L - X_c)^2}$$

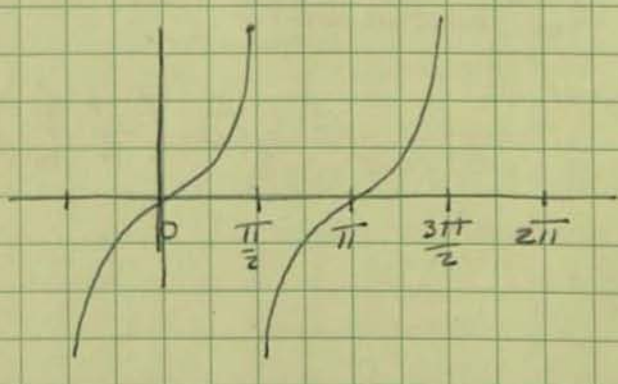
$$Re\{Z_{in}\} = \frac{X_L^2 / Z_a}{1 + \left(\frac{X_L - X_c}{Z_a}\right)^2}, \quad Im\{Z_{in}\} = X_L \frac{1 - \frac{X_c}{Z_a^2}(X_L - X_c)}{Z_a^2 + (X_L - X_c)^2}$$

$$Im\{Z_{in}\} = X_L \frac{1 - \frac{X_c}{Z_a^2}(X_L - X_c)}{1 + \left(\frac{X_L - X_c}{Z_a}\right)^2}$$

TO FIND ZEROS OF $Im\{Z_{in}\}$

$$[X_L]\left[1 - \frac{X_c}{Z_a^2}(X_L - X_c)\right] = 0$$

1. IF $X_L = 0$, $Z_{ab} \tan\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 0$, SINCE $Z_{ab} \neq 0$ $\tan\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 0$



$$\frac{\pi}{2}\frac{f}{f_0} = n\pi, \quad n = 0, 1, 2, \ldots$$

$$f = 2n f_0$$

ZEROS OCCUR AT $f = 0$, $f = 2f_0$, $f = 4f_0$, ETC.

Statement of Operation ____________________

____

Witnessed operation (obtain two signatures).

Signature __________ Date __________

Signature __________ Date __________

Signature __________ Date __________

Read and Understood (obtain two signatures):

Signature __________ Date __________

Signature __________ Date __________

2. IF $1 - \frac{X_c}{Z_a^2}(X_L - X_c) = 0$

$$\frac{Z_b}{Z_a^2}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\left[Z_{ab}\tan\left(\frac{\pi}{2}\frac{f}{f_1}\right) - Z_b\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right] = 1$$

OR $$\frac{Z_b Z_{ab}}{Z_a^2} - \frac{Z_b^2}{Z_a^2}\cot^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 1$$

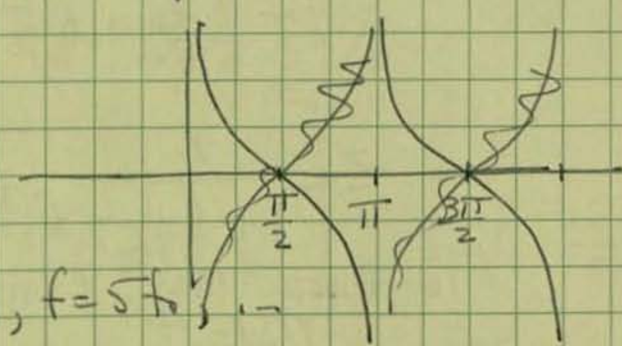
$$\cot^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = \frac{\frac{Z_b Z_{ab}}{Z_a^2} - 1}{\frac{Z_b^2}{Z_a^2}} = \frac{Z_b Z_{ab} - Z_a^2}{Z_b^2}$$

$$\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right) = \pm\frac{1}{Z_b}\sqrt{Z_b Z_{ab} - Z_a^2}$$

TO MAKE PHYSICAL SENSE $Z_b Z_{ab} \geq Z_a^2$

IF $Z_b Z_{ab} = Z_a^2$ THEN Z_a IS GEOMETRIC MEAN OF Z_b AND Z_{ab}, $Z_a = \sqrt{Z_b Z_{ab}}$

AND $\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 0$



$\left\{\frac{\pi}{2}\frac{f}{f_0} = \frac{n\pi}{2}\right.$, $n = 1, 3, 5, \ldots$

OR $f = n f_0$ $\Big\}$ $f = f_0,\ f = 3f_0,\ f = 5f_0, \ldots$

IF $Z_b Z_{ab} > Z_a^2$ THEN ZEROS WILL OCCUR ON EITHER SIDE OF $f = n f_0$, $n = 1, 3, 5, \ldots$ HENCE, A POLE WILL THEN OCCUR AT $f = n f_0$, $n = 1, 3, 5, \ldots$ BY FOSTERS REACTANCE THM.

4/13/69 CONTINUED FROM p. 47

$$\operatorname{Im}\{Z_{in}\} = Z_{ab}\tan\left(\frac{\pi}{2}\frac{f}{f_0}\right)\frac{1-\frac{Z_b}{Z_a^2}\left[Z_{ab}-Z_b\cot^2\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right]}{1+\frac{1}{Z_a^2}\left[Z_{ab}\tan\left(\frac{\pi}{2}\frac{f}{f_0}\right)-Z_b\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right]^2}$$

APPLYING CONSTRAINT $Z_a^2 = Z_{ab}Z_b$, $\frac{Z_b Z_{ab}}{Z_a^2}=1$, $\frac{Z_{ab}}{Z_a}=\frac{Z_a}{Z_b}$

$$\operatorname{Im}\{Z_{in}\} = Z_{ab}\tan\left(\frac{\pi}{2}\frac{f}{f_0}\right)\frac{1-\left[1-\frac{Z_b^2}{Z_a^2}\cot^2\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right]}{1+\left[\frac{Z_a}{Z_b}\tan\left(\frac{\pi}{2}\frac{f}{f_0}\right)-\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right]^2}$$

$$= Z_{ab}\tan\left(\frac{\pi}{2}\frac{f}{f_0}\right)\frac{\frac{Z_b^2}{Z_a^2}\cot^2\left(\frac{\pi}{2}\frac{f}{f_0}\right)}{1+\left[\frac{1}{\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)}-\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right]^2}$$

$$= \frac{\frac{Z_{ab}Z_b^2}{Z_a^2}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)}{1+\left[\frac{1}{\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)}-\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right]^2} = \frac{\frac{Z_a}{Z_a}\times Z_b\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)}{1+\left[\frac{1}{\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)}-\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right]^2}$$

$$= Z_a\frac{X}{1+\left(\frac{1}{X}-X\right)^2} \quad \text{WHERE } X = \frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)$$

TO FIND MAX. & MIN TAKE DERIV AND SET = 0

let $\frac{f}{f_0} = y$

$$\frac{d\operatorname{Im}\{Z_{in}\}}{dy} = \frac{d\operatorname{Im}\{Z_{in}\}}{dx}\cdot\frac{dx}{dy} \qquad \frac{X}{1+\frac{1}{X^2}-2+X^2} = \frac{X}{X^2-1+\frac{1}{X^2}}$$

$$\frac{d\operatorname{Im}\{Z_{in}\}}{dx} = \frac{d}{dx}\left[Z_a\frac{X}{1+\left(\frac{1}{X}-X\right)^2}\right] = Z_a\frac{\left(X^2-1+\frac{1}{X^2}\right)-X\left(2X-\frac{2}{X^3}\right)}{\left(X^2-1+\frac{1}{X^2}\right)^2}$$

$$= Z_a\frac{X^2-1+\frac{1}{X^2}-2X^2+\frac{2}{X^2}}{\left(X^2-1+\frac{1}{X^2}\right)^2} = Z_a\frac{-X^2-1+\frac{3}{X^2}}{\left(X^2-1+\frac{1}{X^2}\right)^2}$$

Statement of Operation ______

Witnessed operation (obtain two signatures).

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

4/13/69 CONTINUED FROM p. 48

$$\frac{dx}{dy} = \frac{d}{dy}\left[\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)\right] = ~~\frac{Z_b}{Z_a}\frac{\pi}{2}\left[-\csc^2 \frac{\pi}{2} y\right]~~$$

$$\frac{Z_b}{Z_a}\frac{\pi}{2}\csc^2\left(\frac{\pi}{2}y\right) = \frac{Z_b}{Z_a}\frac{\pi}{2}\csc^2\left(\frac{\pi}{2}\frac{f}{f_0}\right)$$

$$\frac{d}{dy}\text{Im}\{Z_{in}\} = Z_a \frac{-x^2-1+\frac{3}{x^2}}{\left(x^2-1+\frac{1}{x^2}\right)^2}\; \frac{Z_b}{Z_a}\frac{\pi}{2}\csc^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 0$$

$$\text{OR} \left(-x^2-1+\frac{3}{x^2}\right)\csc^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 0$$

1. ~~IF $-x^2-1+\frac{3}{x^2} = 0$~~

~~$x^4 + x^2 + 3 = 0$~~

~~$x^2 = \frac{-1 \pm \sqrt{1+12}}{2}$~~

~~$x^2 = -\frac{1}{2} \pm \frac{3.6}{2}$~~

2. ~~IF $\csc^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 0$~~

$$\frac{Z_a}{Z_b}X = \cot\left(\frac{\pi}{2}\frac{f}{f_0}\right)$$

$$\csc^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 1 + \cot^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = ~~1+\frac{Z_a^2}{Z_b^2}X^2~~$$

$$\left(-x^2-1+\frac{3}{x^2}\right)\left(1+\frac{Z_a^2}{Z_b^2}X^2\right) = 0$$

$$\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right) = \pm\sqrt{-1} = \pm j$$

IS NOT A USEFUL SOLUTION

$1 + kx^2$

$-x^2 - 1 + \frac{3}{x^2}$

$-kx^2 + 3k \quad - kx^4$

$$-(1+k)x^2 + 3k - 1 + \frac{3}{x^2} - kx^4 = 0$$

$$x^2 + 1 - \frac{3}{x^2} = 0$$

$$x^4 + x^2 - 3 = 0$$

$$x^2 = \frac{-1 \pm \sqrt{1+12}}{2}$$

$$x^2 = -\frac{1}{2} \pm \frac{3.6}{2}$$

→ USING ONLY POSITIVE ROOT

$$x^2 = \frac{2.6}{2} = 1.3$$

$$x = \pm\sqrt{1.3} = \pm 1.14$$

$$\frac{Z_b}{Z_a}\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right) = \pm 1.14$$

$$\cot\left(\frac{\pi}{2}\frac{f}{f_0}\right) = \pm 1.14\frac{Z_a}{Z_b}$$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

 4/14/69 CONT. FROM p. 49

TO FIND SLOPE AT $f = f_0$

$$\frac{d}{dy} \text{Im}\{Z_{in}\} = \frac{\pi}{2} Z_b \left(\csc^2 \frac{\pi}{2}\right) \frac{-x^2 - 1 + \frac{3}{x^2}}{\left(x^2 - 1 + \frac{1}{x^2}\right)^2} \Big] x^4 \Big] x^4 = \frac{-x^6 - x^4 + 3x^2}{\left(x^4 + x^2 + 1\right)^2} \cdot \frac{\pi}{2} Z_b \left(\csc^2 \frac{\pi}{2}\right)$$

$$X \Big|_{f=f_0} = \frac{Z_b}{Z_a} \cot\left(\frac{\pi}{2}\right) = 0, \ \csc^4\left(\frac{\pi}{2}\right) = 1$$

$$\therefore \frac{d}{dy} \text{Im}\{Z_{in}\} \Big|_{f=f_0} = 0 \quad \therefore \text{SLOPE IS ZERO}$$

$$\text{Im}\{Z_{in}\} = Z_a \frac{X}{1 + \left(\frac{1}{X} - X\right)^2}, \ \text{AT } f = f_0, \ X = 0$$

$$\frac{X}{1 + \left(\frac{1}{X} - X\right)^2} \Big] X^2 \Big] X^2 = \frac{X^3}{X^2 + (1 - X^2)^2} = \frac{X^3}{X^2 + 1 - 2X^2 + X^4}$$

$$\lim_{X \to 0} \text{Im}\{Z_{in}\} = \frac{0}{1} = 0$$

SUBSTITUTING BACK IN TO GET VALUE OF $\text{Im}\{Z_{in}\}$ AT MAX & MIN POINTS,

$$X = \frac{Z_b}{Z_a} \cot\left(\frac{\pi}{2} \frac{f}{f_0}\right) = \pm 1.14$$

$$\text{Im}\{Z_{in}\} \Big|_{\text{slope}=0} = Z_a \frac{1.14}{1 + \left(\frac{1}{1.14} - 1.3\right)^2}, \ \text{OR } Z_a \frac{-1.14}{1 + \left(1.3 - \frac{1}{1.14}\right)^2}$$

$$1.30 \quad .88 \quad .42 \quad (.42)^2 = .18$$

$$= Z_a \frac{1.14}{1 + (.88 - 1.3)^2} \ \text{OR} \ - \frac{Z_a \ 1.14}{1 + (1.3 - .88)^2}$$

Statement of Operation ______________________

____

Witnessed operation (obtain two signatures).

Signature ______________ Date ________

Signature ______________ Date ________

Signature ______________ Date ________

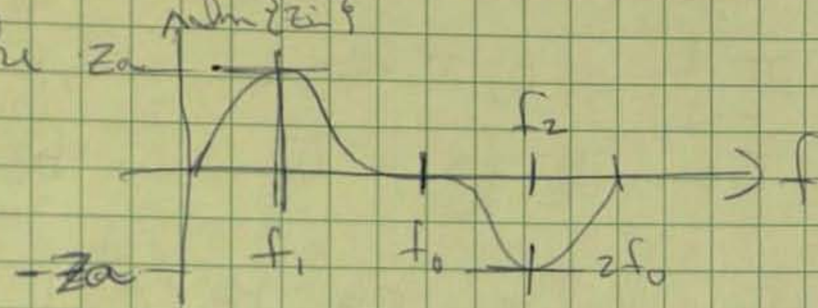
Read and Understood (obtain two signatures):

Signature ______________ Date ________

Signature ______________ Date ________

$$\text{Im}\{Z_{in}\} = \pm \frac{Z_a\, 1.14}{1 + .18} = \pm\ .96\, Z_a$$

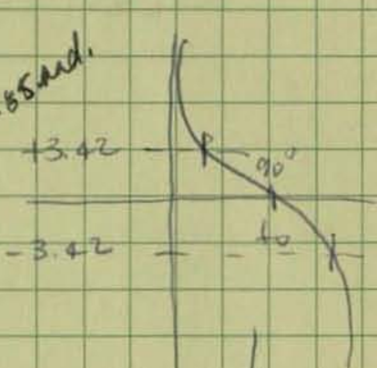
Function looks like



To find f_1 and f_2

Let $\frac{Z_a}{Z_b} = 3$, $\pm \frac{Z_a}{Z_b} 1.14 = 3.42$

$$\cot\left(\frac{\pi}{2}\frac{f_{1,2}}{f_0}\right) = \pm 3.42$$

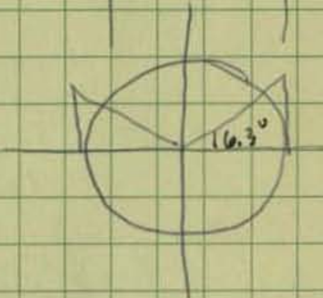


$\frac{\pi}{2}\frac{f_1}{f_0} = \theta_1 \Rightarrow 16.3° = .284$ radians, ~~$\theta_2 = 163.7$~~ or $\frac{\pi}{2}\frac{f_2}{f_0} = \theta_2 = 163.7 = 2.85$ rad.

$180.0 - 16.3 = 163.7$

$\frac{f_2}{f_1} = \frac{\theta_2}{\theta_1} \approx 10$ $\qquad \frac{f_1}{f_0} = .18 \qquad \frac{f_2}{f_0} = 1.81$

$\boxed{\frac{f_2}{f_1} \approx 10}$



Consider Real Part

$$\text{Re}\{Z_{in}\} = \frac{X_L^2/Z_a}{1 + \left(\frac{X_L - X_C}{Z_a}\right)^2}$$

$$= \frac{\frac{1}{Z_a} Z_{ab}^2 \tan^2(\ )}{1 + \left[\frac{Z_{ab}}{Z_a}\tan(\ ) - \frac{Z_b}{Z_a}\cot(\ )\right]^2}$$

Using restriction $Z_b Z_{ab} = Z_a^2$, $\frac{Z_{ab}}{Z_a} = \frac{Z_a}{Z_b}$

$$\frac{\frac{Z_b}{Z_a} Z_{ab}\left(\frac{Z_a}{Z_b}\right)^2 \tan^2(\ )}{1 + \left[\frac{Z_a}{Z_b}\tan(\ ) - \frac{1}{\frac{Z_a}{Z_b}\tan(\ )}\right]^2} = \frac{Z_a\left(\frac{Z_a}{Z_b}\right)^2 \tan(\ )}{1 + \left[\frac{Z_a}{Z_b}\tan(\ ) - \frac{1}{\frac{Z_a}{Z_b}\tan(\ )}\right]^2}$$

5/27/69 CONT. FROM p. 51

TO FIND ZEROS:

$$\tan^2\left(\frac{\pi}{2}\frac{f}{f_0}\right) = 0 \quad \text{or} \quad \tan\left(\frac{\pi}{2}\frac{f}{f_1}\right) = 0$$

$$\frac{\pi}{2}\frac{f}{f_1} = 0, \pi, 2\pi, \ldots, n\pi,$$

For $\frac{\pi}{2}\frac{f_2}{f_1} = \pi$, $f_2 = 2f_0$, $f_1 = f_0$

TO FIND VALUE OF $Re\{Z_i\}$ AT $f = f_0$

$$Re\{Z_{in}\} = \frac{Z_a \left(\frac{Z_a}{Z_b}\right)^2 \tan^2(\ )}{\left(\frac{Z_a}{Z_b}\right)^2 \tan^2(\ ) + \frac{1}{\left(\frac{Z_a}{Z_b}\right)^2 \tan^2(\ )} - 1} \begin{matrix} \times \frac{1}{\tan^2(\ )\frac{Z_a^2}{Z_b^2}} \\ \times \frac{1}{\tan^2(\ )\frac{Z_a^2}{Z_b^2}} \end{matrix}$$

$$= Z_a \frac{1}{1 + \frac{1}{\left(\frac{Z_a}{Z_b}\right)^4 \tan^4(\ )} - \frac{1}{\left(\frac{Z_a}{Z_b}\right)^2 \tan^2(\ )}}$$

IN LIMIT $\tan\left(\frac{\pi}{2}\frac{f}{f_0}\right) \to \infty$ AS $f \to f_0$

$$\therefore Re\{Z_i\}\Big|_{f=f_0} = Z_a$$

CONSIDER VALUE OF $Re\{Z_i\}$ at $\frac{Z_b}{Z_a}\cot(\ ) = \pm 1.14$

or $\frac{Z_a}{Z_b}\tan(\ ) = \pm .88$

$\left(\frac{Z_a}{Z_b}\right)^2 \tan^2(\ ) = .77$

$$Re\{Z_i\} = \frac{Z_a(.77)}{.77 + \frac{1}{.77} - 1}$$

$$= \frac{Z_a(.77)}{1.07} = .72\,Z_a$$

$\frac{1}{.77} = 1.3$

$$\begin{array}{r} 1.3 \\ +.77 \\ \hline 2.07 \end{array}$$

Statement of Operation ____________________

____

Witnessed operation (obtain two signatures).

Signature ____________ Date ________

Signature ____________ Date ________

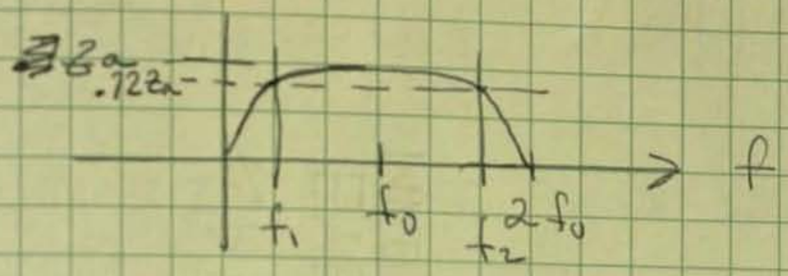
Signature ____________ Date ________

Read and Understood (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

$\therefore Re\{Z_{in}\}$ LOOKS LIKE :–



IF $\frac{Z_a}{Z_b} = 4$, $\cot\left(\frac{\pi}{2}\frac{f_{1,2}}{f_0}\right) = \left(\pm 1.14\right)(4) = \pm 4.56$

$\cot\left(\frac{\pi}{2}\frac{f_{1,2}}{f_0}\right) = \pm 4.56$, $\frac{\pi}{2}\frac{f_1}{f_0} = 12.4^\circ = .216$ rad.

$\frac{f_1}{f_0} = .137$, $\frac{\pi}{2}\frac{f_2}{f_0} = 2.92$ rad.

$180.0 - 12.4 = 167.6$ or 2.92 rad.

$\frac{f_2}{f_0} = 1.86$

$\therefore \frac{f_2}{f_1} = \frac{1.86}{.137} \cong 13.5$

$\therefore$ CAN GET A 13.5 TO 1 BAND WIDTH IF $Z_a = 4Z_b$

ALSO SINCE $Z_a^2 = Z_{ab} Z_b$, $Z_{ab} = \frac{Z_a^2}{Z_b}$ AND IF

$Z_a = 50\Omega$ $Z_{ab} = (50)(4) = 200\Omega$ ← PRETTY HIGH

ALSO, FROM p. 51 CAN GET A 10 TO 1 BANDWIDTH IF

$Z_a = 3Z_b$. & $Z_{ab} = (50)(3) = 150\Omega$ IF $Z_a = 50\Omega$

CONSIDER PARALLEL CONNECTION AS SHOWN p. 44

NOW INPUT BALANCED LINE WILL HAVE TO BE $\frac{Z_a}{2}$

TO MATCH A Z_a ACROSS EACH OF THE BALANCED

LINES.

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

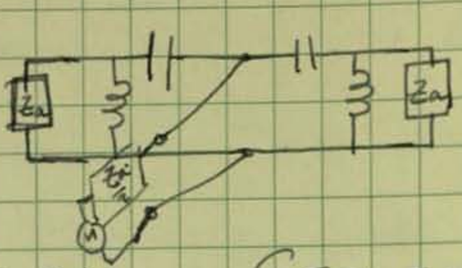
Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

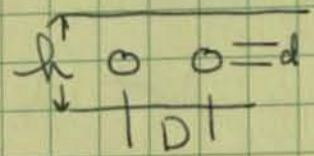
 5/28/69 CONT. FROM p. 53



THEN IF $\frac{Z_a}{2} = 50\,\Omega$, $Z_a = 100$

$Z_b = 33.3\,\Omega$ & $Z_{ab} = \frac{Z_a^2}{Z_b} = 300\,\Omega$ ← HIGH!

CONSIDER GEOMETRY FROM ITT HANDBOOK p. 592



$$Z_0 = \frac{276}{\sqrt{\varepsilon}} \log_{10}\left(\frac{4h \tanh \frac{\pi D}{2h}}{\pi d}\right), \quad \text{LET } h = .25 \ \left(\tfrac{1}{4}\right), \quad d = .0625 \ \left(\tfrac{1}{16}\right)$$

$$\frac{300}{276} = 1.09 = \log_{10}\frac{(4 \cdot \frac{1}{4}) \tanh 2\pi D}{\pi/16} = \log_{10} \frac{16}{\pi} \tanh 2\pi D$$

APPROXIMATELY $10 = \frac{16}{\pi} \tanh 2\pi D$ OR $\tanh 2\pi D = 1.96$

IN LIMIT $\tanh x \to 1.0$
AS $x \to \infty$

$\therefore$ IF $Z_0 \simeq 276$ THEN $\frac{\pi d}{4h} \times 10 < 1$, OR $\frac{d}{h} < \frac{4}{10\pi} \doteq .13$

TRY $\frac{d}{h} = .1$ IF $h = \frac{1}{4}$ $d = .025$

THEN ______________________

Statement of Operation ______________________

____

Witnessed operation (obtain two signatures).

Signature ______________ Date ________

Signature ______________ Date ________

Signature ______________ Date ________

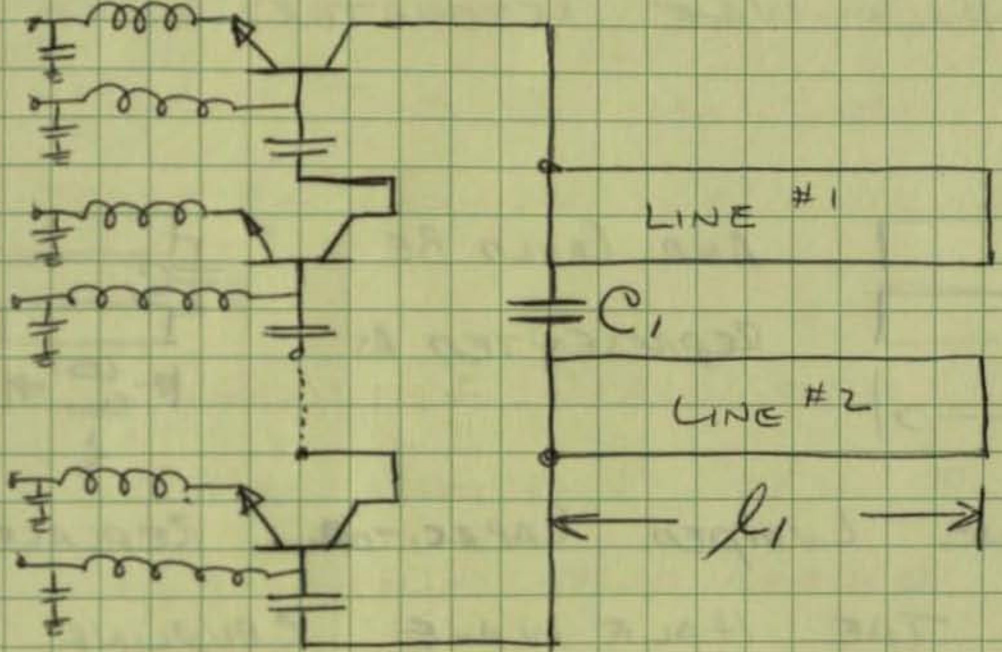
Read and Understood (obtain two signatures):

Signature ______________ Date ________

Signature ______________ Date ________

9/26/69 SERIES CONNECTED TRANSISTORS FOR PUSH-PUSH OR PUSH-PULL OPERATION.

CONSIDER USING BALUN AS DISCUSSED ON p. 44 TO ACHIEVE THE 180° PHASE DIFFERENCE.



CAPACITOR C1 ALONG WITH LINE #1 AND LINE #2 PLUS THE TOTAL SERIES BASE TO COLLECTOR CAPACITIES FORM AN EQUIVALENT HALF WAVE RESONATOR. THE BASE TO COLLECTOR CAPACITIES INCLUDE ANY RESIDUAL ~~CAPACIT~~ REACTANCES THAT THAT ARE INCURRED IN PACKAGING. THE IMPORTANT RESONANCE MODE OF TRANSMISSION LINES #1 AND #2 IS A BALANCED MODE.

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature Everett E. Gustin Date 9/26/69

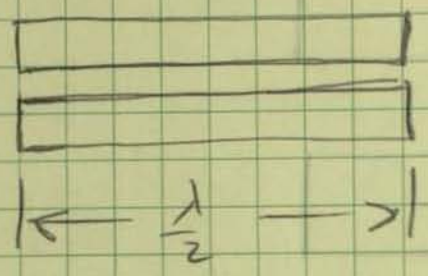
Read and Understood (obtain two signatures):

Signature ______ Date ______

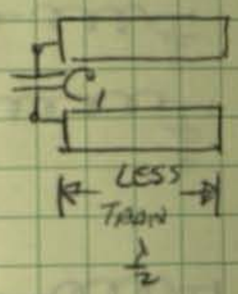
Signature ______ Date ______

11/13/69 CONTINUED FROM p. 55

THE BALANCED MODE HAS R.F. VOLTAGES BETWEEN LINES #1 AND #2 RATHER THAN TO GROUND. CONCEPTUALLY TWO BALANCED COUPLED HALF WAVE RESONATORS WOULD LOOK LIKE:



AND COULD BE REPRESENTED AS:



WHERE THE LUMPED CAPACITOR REPLACES PART OF THE HALF WAVE COUPLING DISTRIBUTED CAPACITY. EACH WOULD RESONATE AT THE SAME FREQUENCY. IN PRACTICE THE OUTPUT CONNECTION OF THE TRANSISTOR OR SERIES CONNECTION OF TWO OR MORE TRANSISTORS IS PUT IN PARALLEL WITH C_1. IF C_1 IS LARGE ENOUGH IT WILL MAKE CAPACITY CHANGES (OUTPUT) IN THE TRANSISTOR WITH TEMPERATURE NEGLIGIBLE. THIS ASSUMES THAT C_1 IS STABLE IN VALUE WITH TEMPERATURE

Statement of Operation ____________________

Witnessed operation (obtain two signatures).

Signature ____________ Date ____________

Signature ____________ Date ____________

Signature [signature] Date 11/13/69

Read and Understood (obtain two signatures):

Signature ____________ Date ____________

Signature ____________ Date ____________

11/13/69 CONTINUED FROM p. 56

THE SERIES CONNECTION OF TRANSISTOR OUTPUTS GIVES SEVERAL ADVANTAGES.

1. IF THE TRANSISTORS CAN BE LOCATED PHYSICALLY CLOSE TOGETHER TO NEGLECT PHASE BETWEEN THEM THE TOTAL CAPACITY IS REDUCED ~~THAT~~ BY ADDING THE INDIVIDUAL CAPACITIES IN SERIES.
2. AGAIN, IF PHASE SHIFT CAN BE NEGLECTED EVEN HARMONICS WILL ELECTRICALLY CANCEL OUT WHICH HELP REDUCE INTERMODULATION PROBLEMS IN THE SYSTEM FOLLOWING.
3. PUSH-PULL TYPE CIRCUITS TEND TO HAVE BETTER EFFICIENCIES.

THE DESCRIPTION ON PAGE 55 IS AN OSCILLATOR WITH THE CAPACITIES BETWEEN ANY NUMBER OF TRANSISTORS BEING FOR BY PASS OF THE R.F. THE COILS REPRESENT BIAS CIRCUITRY.

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature Everett E. Guthrie Date 11/13/69

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

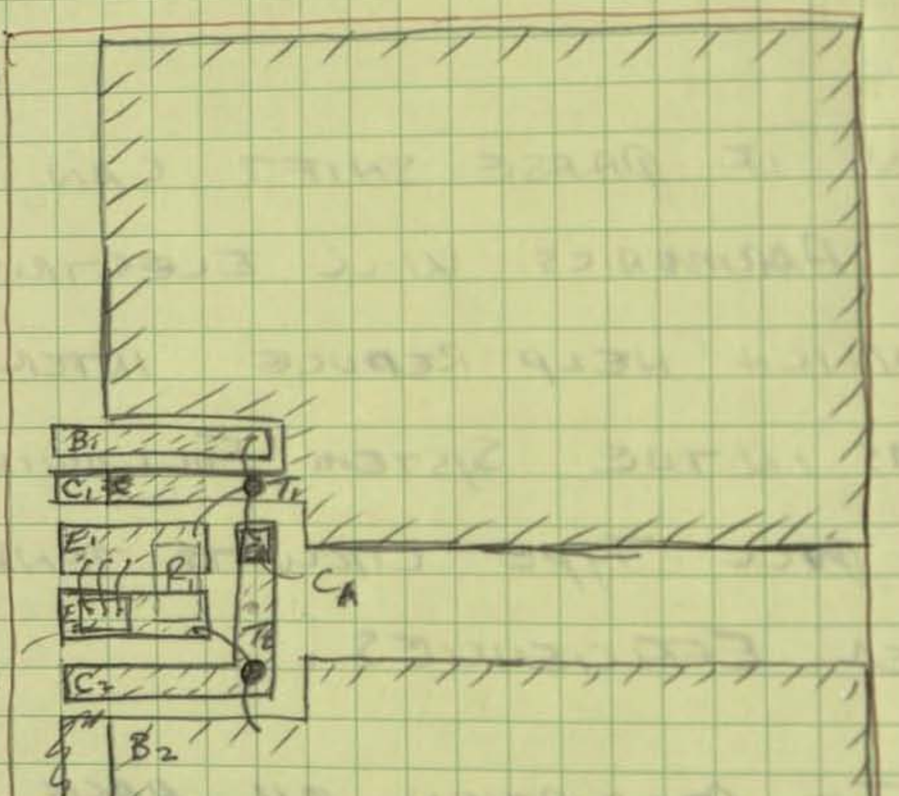
 CONT. FROM p. 57 11/13/69

COUPLING OUT OF THE RESONANT CIRCUIT CAN BE DONE MAGNETICALLY CLOSE TO CAPACITOR C_1 OR ELECTRICALLY NEAR THE END OF THE RESONATOR.

PACKAGING OF TWO TRANSISTORS ON BeO.

THICKNESS = .025

METALLIZATION PATTERN ON BeO SUBSTRATE (RED OUTLINE)



T_1 = TRANSISTOR #1

T_2 = TRANSISTOR #2

B_1 = BASE OF TRANSISTOR #1

B_2 = " " " #2

C_1 = COLLECTOR " " #1

C_2 = " " " #2

E_1 = EMITTER " " #1

E_2 = " " " #2

C_A = BYPASS CAPAC. BETWEEN T_1 & T_2

C_B = R.F. BYPASS CAPACITOR BETWEEN E_1 AND E_2

R_1 = RESISTOR BETWEEN E_1 & E_2 FOR CURRENT SHARING

Statement of Operation ______

Witnessed operation (obtain two signatures)

Signature ______ Date ______

Signature ______ Date ______

Signature Everett E. Guthrie 11/13/69

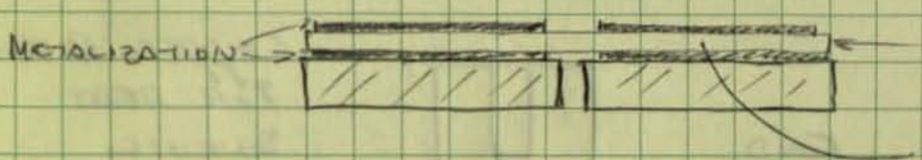
Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

CONT. FROM p. 58 11/13/69

THIS SUBSTRATE WILL SET BETWEEN RESONATORS SUCH THAT THE LARGE METALIZED AREAS WILL PROVIDE R.F. BYPASS TO GROUND. LOOKING END-ON AT RESONATORS IT WILL APPEAR:



TRY FOR $C_c = 50\,pf.$, $\varepsilon_r = 6$, $t = .025''$

$$C_c = \frac{.225\,\varepsilon_r A}{t}, \quad A = \frac{C_c t}{.225\,\varepsilon_r} = \frac{(50)(.025)}{(.225)6} \simeq \frac{50}{60}\ in^2$$

$$A \simeq .835\ in^2 = l \times l, \quad l = .91''$$

TRY $C_c = 25\,pf.$, $A \cong .44$, $l = .67''$

AT $f = 3.0\,ghz$, $\frac{\lambda}{2} = 2$ in. in air, $\frac{2}{\sqrt{6}} = \frac{2}{2.45} = .8''$ in BeO

∴ NO DIMENSIONS (LINEAR) SHOULD be .8" OR GREATER

AT $f = 2.3\,ghz$, $\frac{\lambda}{2} = \frac{30 \times 10^{10}}{2 \cdot 2.54 \cdot 2.45 \cdot 2.3 \times 10^{9}} = 1.05''$

∴ WILL TRY TO USE NEAR .7 X .7 ON THE TWO CAPACITIES. AS SHOWN ABOVE THE

Statement of Operation

Witnessed operation (obtain two signatures):

Signature Date

Signature Date

Signature Everett P. Guthrie Date 11/13/69

Read and Understood (obtain two signatures):

Signature Date

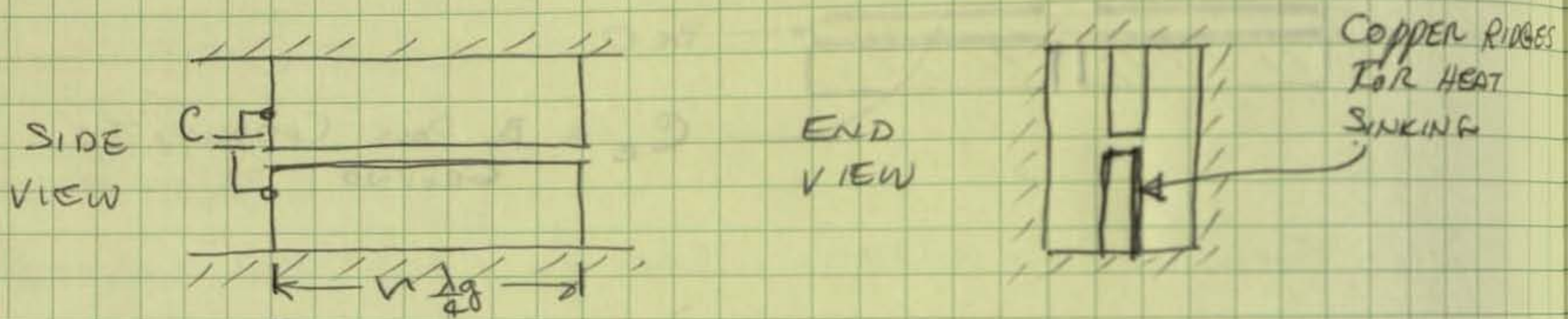
Signature Date

11/13/69 CONT. FROM p. 59

BACKSIDE IS METALIZED IN PART FOR SOLDERING DOWN TO METAL RESONATORS.

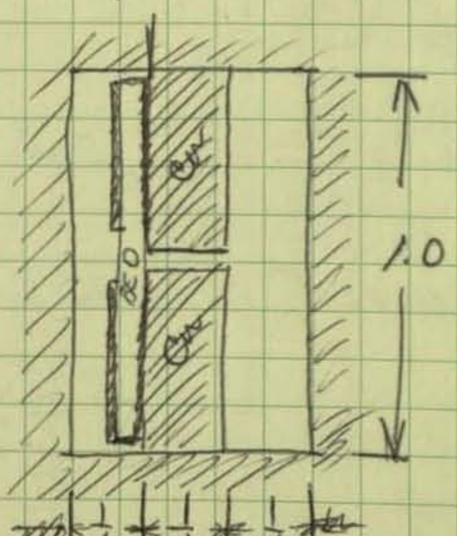
12/11/69 CONTINUED.

CONSIDER USING A TYPE OF RIDGED WAVE-GUIDE:



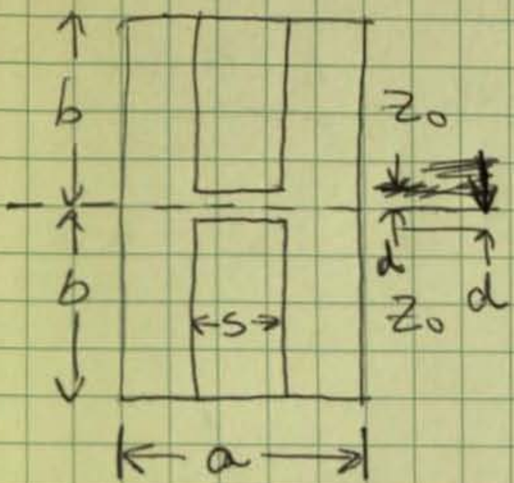
C WILL PROVIDE THE FORESHORTENING TO GIVE A HALF WAVELENGTH RESONATOR.

CONSIDER THE FOLLOWING DIMENSIONS TO HOLD THE BEO PACKAGE DESCRIBED ON p. 58.



DIVIDE STRUCTURE INTO TWO RIDGED WAVEGUIDES IN SERIES FOR PURPOSE OF CALCULATING IMPEDANCES, GUIDE WAVELENGTH CUTOFF FREQUENCY, ETC

12/12/69 CONTINUED FROM p. 60



$a = .75''$, $b = .5''$, $S = .25$

$\frac{S}{a} = \frac{.25}{.75} = \frac{1}{3} = .33$, $\frac{d}{b} = .031$

TRY $d = .031$, $\frac{d}{b} = \frac{.031}{.5} = .062$

FROM GRAPHS IN ENGRING HDBK.

(~~EXTRAPOLATING~~ EXTRAPOLATING)

$\frac{\lambda_c}{a} \simeq 6.5$, $\lambda_c \cong 4.9''$

$$f_c = \frac{3 \times 10^{10}}{(4.9)(2.54)} = \frac{30}{(4.9)(2.54)} \times 10^9 = 2.4 \text{ ghz}$$

TOO HIGH!

TRY $d = .016$ $\qquad \frac{d}{b} = \frac{.016}{.5} = .032$

OFF OF CURVES IN HANDBOOK

IF $a = 1.0''$ $\quad b = 1.0''$ $\quad S = .25$

$\frac{S}{a} = .25$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

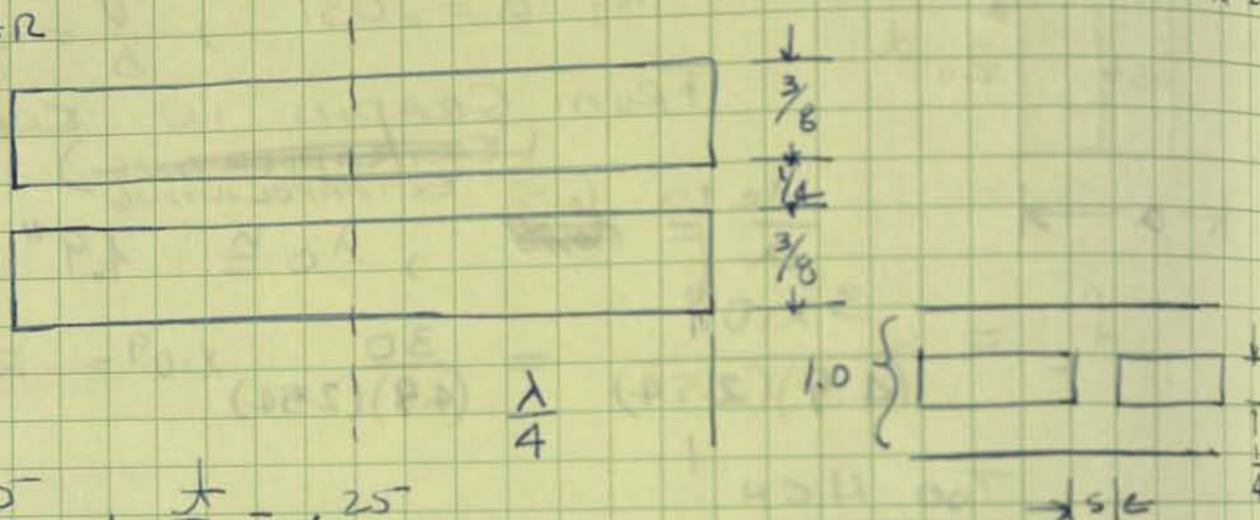
CONT. FROM P. 61

1/16/70

CONSIDER A TEM STRUCTURE

$\frac{\lambda}{4}$ AT 2.3 ghz = $\frac{3 \times 10^{10}}{4 \cdot 2.54 \cdot 2.3 \times 10^{9}}$ = 1.28 in

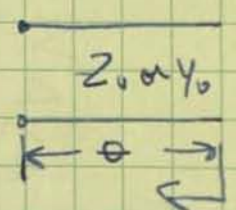
CONSIDER



$\frac{S}{b} = \frac{.125}{1}$, $\frac{t}{b} = .25$

$\frac{\Delta C}{\epsilon} \cong 1.4$, $Z_0 = \frac{\eta}{C/\epsilon} \cong \frac{377}{1.4} = 270\Omega$

TRY $S = .125$, $\frac{\Delta C}{\epsilon} = 3.5$, $Z_0 \cong 108\Omega$



$Y = Y_0 \tan\theta$

TRY EQUIVALENCE TO C = 30pf. @ 2.3ghz

$\omega C = 2\pi \cdot 2.3 \times 10^{9} \cdot 30 \times 10^{-12}$

$= 6 \cdot 2.3 \cdot \pi \times 10^{-2}$ ℧ $= 43. \times 10^{-2}$

$= .43$ ℧

THEN $\tan\theta = \frac{Y}{Y_0} = \frac{.43}{1/108} \sim 46$

Statement of Operation

Witnessed operation (obtain two signatures)

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures)

Signature ______ Date ______

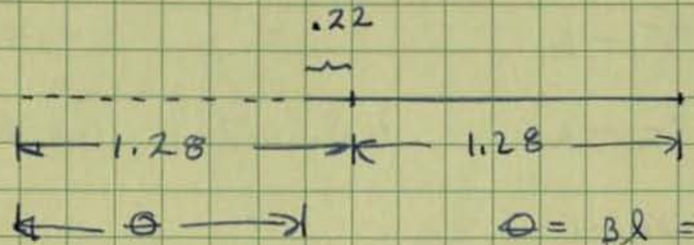
Signature ______ Date ______

CONT. FROM p. 62

TRY $\frac{S}{b} = \frac{.062}{1}$ $\frac{\Delta C}{\epsilon} \cong 6.0$

$$Z_0 = \frac{377}{6} \cong 63\,\Omega.$$

CONSIDER



$\theta = \beta l = \frac{2\pi}{\lambda} l$

$Z_0 = 63\,\Omega.$

$$2\pi \frac{1.06}{2 \cdot 2.56} = 2\pi \frac{.415}{2} =$$

$$= 2\pi\, .207 \cong 75^\circ, \quad \tan 75^\circ = 3.73$$

$$y = Y_0 \tan\theta = \left(\frac{1}{63}\right)(3.73) = .059 = B$$

$$B = \omega C, \quad C = \frac{B}{\omega} = \frac{.059}{2\pi\, 2.3\times10^9} = \frac{59\times10^{-12}}{4.6\pi}$$

$$\underline{C = 4.1\ \text{pf.}}$$

if $\theta = 2\pi \frac{1.2}{5.12} = 84^\circ$ $\tan 84^\circ = 9.6$

$$y = \frac{9.6}{63} = .15, \quad C = \frac{.15}{2\pi \cdot 2.3\times10^9} = \frac{150}{4.6\pi} \cong 10.4\ \text{pf.}$$

10.4 pf. IS REASONABLE TO START WITH IF $2 C_{OB}$ IN SERIES ARE $\cong$ 2.0 pf.

2/9/70

Up CONVERTER
FOR CARS BAND TRANSMITTER

DIODES RECEIVED FROM GOPALA REDDI
MDN 57-1
ALSO SEVERAL GA-67 GaAs DIODES FROM
DOUG TREMERE.

2/19/70

CONSIDER DESIGN FOR SQUARE LAW JUNCTION
$\gamma = \frac{1}{2}$ FROM BELL BOOK "MICROWAVE SEMICONDUCTOR DEVICES AND THEIR CIRCUIT APPLICATIONS.
EDITED BY H. A. WATSON.
p. 262 - 269

f_1 = 54 mhz to ~~230~~ 108 mhz - INPUT TV. VHF LOW
f_2 = 12.646 ghz - pump FREQ.
f_3 = 12646 + (54 to 108) mhz
= 12700 mhz to 12754 mhz.

12646
54
12700 M
to
12754 M

SINCE THE OUTPUT BANDWIDTH IS NARROW
LET f_3 = 12727 mhz. & C_{min} = .5 pf = $\frac{1}{S_{max}}$
CONSIDER DIODE f_c = 250 ghz.
THEN $\frac{\omega_3}{\omega_c} = \frac{12.727}{250} \approx$ ~~.2~~.05 = 5×10^{-2}

Statement of Operation ______

Witnessed operation (obtain two signatures)
Signature ______ Date ______
Signature ______ Date ______

Signature ______ Date ______
Read and Understood (obtain two signatures)
Signature ______ Date ______
Signature ______ Date ______

CONTINUED FROM p. 64 2/19/70

FROM GRAPH p. 265

$m_1 = m_2 = .1$, $m_3 = .05$

$$R_{in,1} = \frac{S_{max}}{\omega_1} \frac{m_2 m_3}{m_1} + R_s$$

FOR $f_1 = 54$ mhz

$$R_{in,1} = \frac{1}{(2\pi\, 54 \times 10^6)(.5 \times 10^{-12})} \frac{(.1)(.05)}{(.1)} + R_s$$

$$= \frac{5 \times 10^{-2} \times 10^6}{54\pi} + R_s = \frac{50000}{170} + R_s$$

$$= 294 + R_s$$

147
294
2 | 441
220

FOR $f_1 = 108$ mhz

$$R_{in,1} = 294 \frac{54}{108} + R_s = 147\Omega + R_s$$

SINCE R_s IS NEGLIGLE COMPARED TO 147 to 294 Ω.

$R_{in,1} = 147$ to $294\,\Omega$, $R_{in,1\,avg} = 220\,\Omega$

$$R_{in,2} = \frac{S_{max}}{\omega_2} \frac{m_1 m_3}{m_2} + R_s$$

$$= \frac{1}{(2\pi\, 12.646 \times 10^9)(.5 \times 10^{-12})} \frac{(.1)(.05)}{(.1)} + R_s$$

$$= \frac{5 \times 10^{-2} \times 10^3}{12.646\,\pi} + R_s = \frac{50}{12.646\,\pi} + R_s = 1.26 + R_s$$

IF $R_s = 1.5\,\Omega$.

$R_{in,2} = 2.76\,\Omega$

Statement of Operation ____________________

____

Witnessed operation (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

Signature ____________ Date ________

Read and Understood (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

2/19/70 CONT. FROM p. 67

$$R_L = \frac{S_{max}}{\omega_3}\frac{m_1 m_2}{m_3} - R_s \quad , \quad \frac{m_1 m_2}{m_3} = \frac{(.1)(.1)}{.05} = \frac{.01}{.05}$$

$$= \frac{1}{(2\pi\, 12.727\times 10^9)(.5\times 10^{-12})} \qquad \frac{1}{5} - R_s = \frac{1000\ 200}{5\pi\ 12.727}$$

$R_L = 5 - R_s$ IF $R_s = 1.5\,\Omega$.

$$\boxed{R_L = 3.5\,\Omega}$$

FROM GRAYZEL "OVERDRIVEN VARACTOR UPPER SIDE BAND UP CONVERTER" MTT OCT. 67.

$\bar{R}_1 = .072$, $\bar{R}_2 = .107$, $\bar{R}_3 = .129$,
$\bar{X}_1 = .175$, $\bar{X}_2 = .176$, $\bar{X}_3 = .193$ } FOR $\frac{\omega_c}{\omega_3} = 25$

$\frac{250}{12.727} \div 20$

$$R_K = \frac{\bar{R}_K S_{max}}{\omega_K}$$

For $f_1 = 54$ mhz

$$R_1 = \frac{.072}{(.5\times 10^{-12})(2\pi\, 54\times 10^6)} = \frac{7.2\times 10^{-2}\times 10^6}{54\pi} = \frac{72000}{54\pi}$$

$\boxed{R_1 = 425\,\Omega \text{ @ } f_1 = 54\text{ mhz}}$

$\boxed{R_{1\,ave} = 318\,\Omega}$

FOR $\boxed{f_1 = 108\,\Omega,\ R_1 = 212\,\Omega}$

$$R_2 = \frac{.107}{(.5\times 10^{-12})(2\pi\, 12.646\times 10^9)} = \frac{1.07\times 10^{-1}\times 10^3}{12.646\pi} = \frac{107}{12.646\pi}$$

$\boxed{R_2 = 2.7\,\Omega}$

CONT. FROM p. 66 2/20/70

$$R_3 = \frac{.129}{(.5\times10^{-12})\,2\pi\,12.727\times10^9} = \frac{1.29\times10^{-1}\times10^3}{12.727\pi} = \frac{129}{12.727\pi}$$

$$\boxed{R_3 = 3.2\,\Omega.}$$

$$X_k = \frac{\overline{X_k}\,S_{max}}{w_k}$$

at 80 mhz

$$X_1 = \frac{.175}{(.5\times10^{-12})(2\pi\,80\times10^6)} = \frac{1.75\times10^{-1}\times10^5}{8\pi} = \frac{17500}{8\pi}$$

$$\boxed{X_1 = 700\,\Omega}$$

$$C_1 = \frac{1}{2\pi\,80\times10^6\;700} = \frac{1}{2\pi\,56\times10^9} = \frac{1}{.112\pi\times10^{12}}$$

$$C_1 = 2.8\text{ pf.}$$

at 12.646 ghz

$$X_2 = \frac{.176}{.5\times10^{-12}\,2\pi\,12.646\times10^9} = \frac{1.76\times10^{-1}\times10^3}{12.646\pi} = \frac{176}{12.646\pi}$$

$$\boxed{X_2 = 4.4\,\Omega}$$

$$C_2 = \frac{1}{2\pi\,12.646\times10^9\,(4.4)} = \frac{10^{-9}}{350\pi} = .9\text{ pf.}$$ (crossed out) 2.86pf.

not sure if very meaningful.

at 12.727 ghz

$$X_3 = \frac{.193}{.5\times10^{-12}\,2\pi\,12.727\times10^9} = 4.8\,\Omega$$

$$\boxed{X_3 = 4.8\,\Omega}$$

2/23/70 CONT. FROM p. 67

FROM BELL DESIGN CONSIDER GRAPH p. 266

SHOWING EFFICIENCY VS ω_3/ω_c

FOR $\frac{\omega_3}{\omega_c} = 5\times10^{-2}$ $\quad \eta = .35$

FROM OTHER GRAPH ON SAME PAGE:-

$$\frac{P_{out,3}\ S_{max}}{\omega_3\ (V_B-\phi)} = .003$$

$$P_{out,3} = \frac{.003\ \omega_3\ (V_B-\phi)}{S_{max}}$$

$$= (.003)\frac{(2\pi\ 12.727\times10^9)(6)\ .5\times10^{-12}}{1}$$

$$= 6\cdot3\times10^{-3}\ \pi\ 12.727\times10^{-3} = 720\times10^{-6}\text{ WATTS}$$

$$= 720\times10^{-3}\text{ mw} = .720\text{ mw}$$

$\therefore$ pump power REQUIRED AT DIODE $\frac{.720}{.35} = 2.0$ mw

FROM GRAYZEL PAPER

$$\eta \hat{=} e^{-\alpha(\omega_3/\omega_c)} \quad , \alpha = 20$$

$$= e^{-.051\cdot20} \hat{=} e^{-1} \qquad \text{WITH } \frac{\omega_3}{\omega_1} = \frac{12.727}{80} = 160$$

$$= \frac{1}{e} = \frac{1}{2.72} = .37 \qquad \frac{\omega_3}{\omega_c} = \frac{12.727}{250} = .051$$

$$P_3 = \frac{(V_B+\phi)^2}{S_{max}}\ \omega_3\ \beta \quad , \beta = 28$$

$$= (50)(.5\times10^{-12})\ 2\pi\ 12.7\times10^9\ (28) = .5\pi\ 28\cdot12.7\times10^{-1}$$

$$= \pi\ 14\cdot1.27$$

$P_3 = 57$ mw ← max power out.

Statement of Operation ______

Witnessed operation (obtain two signatures)

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

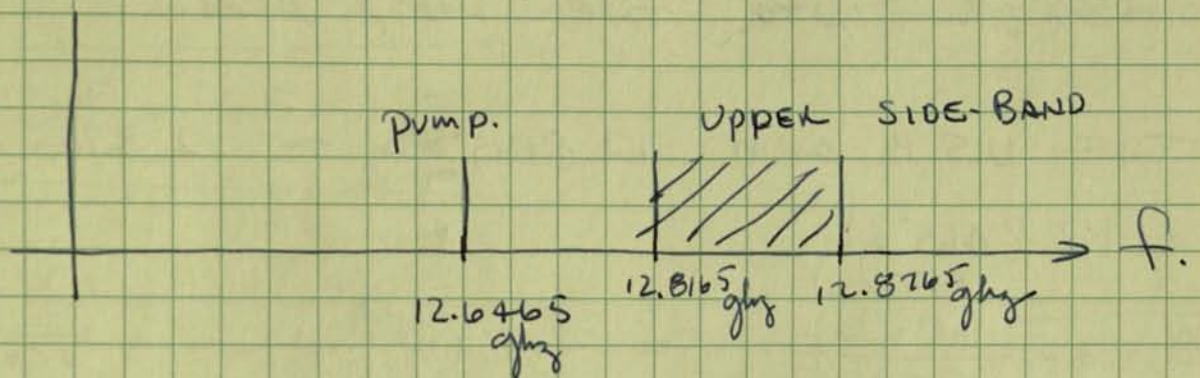
Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

2/24/70 CONT. FROM p. 68

CONSIDER A FILTER DESIGN FOR PUMP INPUT FREQ. AND UPPER SIDEBAND OUTPUT FREQ.



f_1 170 mhz To 230 mhz

$$\begin{array}{r} 12.6465 \\ .170 \\ \hline 12.8165 \end{array} \qquad \begin{array}{r} 12.6465 \\ .230 \\ \hline 12.8765 \end{array}$$

FOR PUMP BANDWIDTH ASSUME

STABILITY IS $\pm .05\%$ OR $.1\%$

$.1\%$ OF $12.6465\text{ ghz} = (.001)(12646.5\text{ mhz})$

$= 12.6\text{ mhz}$

TO ACCOUNT FOR FILTER STABILITY WITH TEMP.

TRY BANDWIDTH = 15 mhz

$$W = \frac{f_2 - f_1}{f_0} = \frac{15}{12.6465 \times 10^3} \cong 1.2 \times 10^{-3}$$

$$\frac{\omega'}{\omega_1'} = \frac{2}{W}\left(\frac{f - f_0}{f_0}\right) = \frac{2}{1.2\times10^{-3}}\left(\frac{12.8165 - 12.6465}{12.6465}\right)$$

$$= \frac{2}{1.2\times10^{-3}} \frac{.170}{12.6465} \cong \frac{340}{(1.2)(12.65)} = 22.$$

$$\left|\frac{\omega'}{\omega_1'}\right| - 1 = 21.$$, USING $L_{AR} = .01$ db RIPPLE

L_A IS AT LEAST 50 db. FOR $n=3$ RESONATORS.

~~IF PUMP IS +17 dbm, PUMP OUT OF SIGNAL ARM WOULD BE LESS THAN -33 dbm.~~

2/24/70 CONT. FROM p. 69

THERE SHOULD BE ABOUT 30db REJECTION TO THE UPPER-SIDE BAND SIGNAL at -4dbm i.e -34 dbm. INTO THE PUMP ARM.

FOR THE U.S.B. ARM 12.8165 ghz TO 12.8765 ghz

$f_0 = 12.8465$ ghz

$$W = \frac{60 \text{ mhz}}{12846.5 \text{ mhz}} = 4.7 \times 10^{-3}$$

$$\begin{array}{r} 12.8465 \\ 75 \\ \hline 12.6540 \end{array}$$

$$\frac{\omega'}{\omega_1'} = \frac{2}{W}\left(\frac{f - f_0}{f_0}\right) = \frac{2}{4.7\times10^{-3}}\left(\frac{12.8465 - 12.6540}{12.8465}\right)$$

$$= \frac{2}{4.7\times10^{-3}} \; \frac{.193}{12.847} = \frac{386}{(4.7)(12.847)} = 6.4$$

$$\begin{array}{r} 12.8465 \\ 12.6540 \\ \hline .1925 \end{array}$$

$$\left|\frac{\omega'}{\omega_1'}\right| - 1 = 5.4$$

USING .01 db RIPPLE SHOULD GIVE 50db REJECTION OF PUMP AT 12.646. PUMP AT +17dbm WOULD BE DOWN TO -33dbm.

CONSIDER DESIGN OF PUMP FILTER
FOR .01 db RIPPLE $n = 2$, $g_0 = 1$

$g_1 = .449$, $g_2 = .408$, $g_3 = 1.101$

~~RECONSIDER FILTER DESIGN USING λ_g at $f_0 = 12.6465$ ghz~~ IN DESIGN $W_\lambda \cong W$ FOR NARROW BANDWIDTHS.

Statement of Operation ____

Witnessed operation (obtain two signatures)

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

$$\frac{K_{01}}{Z_0} = \sqrt{\frac{\pi}{2}\frac{W}{g_0 g_1 \omega_1'}} = \sqrt{\frac{\pi}{2}\frac{1.2\times10^{-3}}{(1)(.449)}} = \sqrt{\frac{\pi}{2}\, 1.34\times10^{-3}}$$

$$= \sqrt{4.2\times10^{-3}} = \sqrt{42\times10^{-4}}$$

$$\boxed{\frac{K_{01}}{Z_0} = 6.5\times10^{-2}}$$

$$\frac{K_{12}}{Z_0} = \frac{\pi W}{2\omega_1'}\frac{1}{\sqrt{g_1 g_2}} = \frac{\pi}{2}\, 1.2\times10^{-3}\frac{1}{\sqrt{(.449)(.408)}} = \frac{.6\times10^{-3}\pi}{\sqrt{.183}}$$

$$= \frac{.6\times10^{-3}\pi}{.43} = 4.4\times10^{-3}$$

$$\boxed{\frac{K_{12}}{Z_0} = 4.4\times10^{-3}}$$

$$\boxed{\text{\&}\ \frac{K_{01}}{Z_0} = \frac{K_{23}}{Z_0} = 6.5\times10^{-2}}$$

$$\frac{X_{01}}{Z_0} = \frac{\frac{K_{01}}{Z_0}}{1-\left(\frac{K_{01}}{Z_0}\right)^2} = \frac{6.5\times10^{-2}}{1-(6.5\times10^{-2})^2} = \frac{6.5\times10^{-2}}{1-42\times10^{-4}}$$

$$\frac{X_{01}}{Z_0} \cong 6.5\times10^{-2}$$

$$\begin{array}{r} 1.0000 \\ -\ .0042 \\ \hline .9958 \end{array}$$

$$\frac{X_{12}}{Z_0} = \frac{4.4\times10^{-3}}{1-(4.4\times10^{-3})^2} \cong 4.4\times10^{-3}$$

$$\theta_1 = \pi - \frac{1}{2}\left[\tan^{-1}\left(\frac{2X_{01}}{Z_0}\right) + \tan^{-1}\left(\frac{2X_{12}}{Z_0}\right)\right]$$ RADIANS

$$= \pi - \frac{1}{2}\left(\tan^{-1} 13.\times10^{-2} + \tan^{-1} 8.8\times10^{-3}\right)$$

(.13, 7.5°; .0088, 0.5°)

$180° - \frac{8°}{2} = 176°$

$$\theta_1 = \pi - \frac{1}{2}(.13 + .009) \cong \pi - \frac{.14}{2} = \pi - .07$$

$= \theta_2$ ALSO

CONT. FROM p. 71 3/1/70

FROM pp. 66 & 67

$$R_3 = \frac{.129}{2\pi(.5\times10^{-12})(12.85\times10^{9})} = \frac{129}{\pi\, 12.85}$$

13.00

$$\boxed{R_3 = 3.2\ \Omega}$$

3.16

$$X_3 = \frac{.193}{2\pi(.5\times10^{-12})(12.85\times10^{9})} = \frac{193}{\pi\, 12.85}$$

13.00

$$\boxed{X_3 = 4.8\ \Omega}$$ CAPACITIVE REACTANCE OF DIODE (DYNAMIC) AT $f_3 = 12.85$ ghz.

4.73

LET $R_s = 1.8\ \Omega$. AND $L_o = .3$ nh SERIES INDUCTANCE OF DIODE

INDUCTIVE REACTANCE $X_{L_o} = \omega L_o = 2\pi(12.85\times10^{9})(.3\times10^{-9})$

13.00

$$\boxed{X_{L_o} = 24.2\ \Omega.}$$ $= .6\pi\, 12.85$

24.5

LET CARTRIDGE CAPACITY $C_p = .2$ pf.

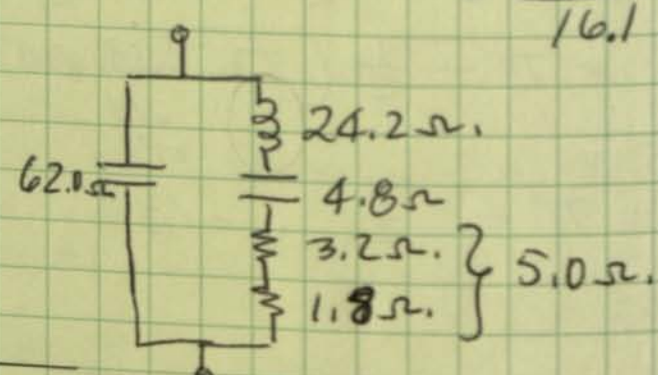
$$X_{C_p} = \frac{1}{\omega C_p} = \frac{1}{2\pi(12.85\times10^{9})(.2\times10^{-12})} = \frac{1000}{.4\pi\, 12.85}$$

13.00

$$\boxed{X_{C_p} = 62.\ \Omega}$$ $= \frac{1000}{16.1}$

61.3

∴ DYNAMIC EQUIVALENT CIRCUIT:



Statement of Operation ____

Witnessed operation (obtain two signatures)

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

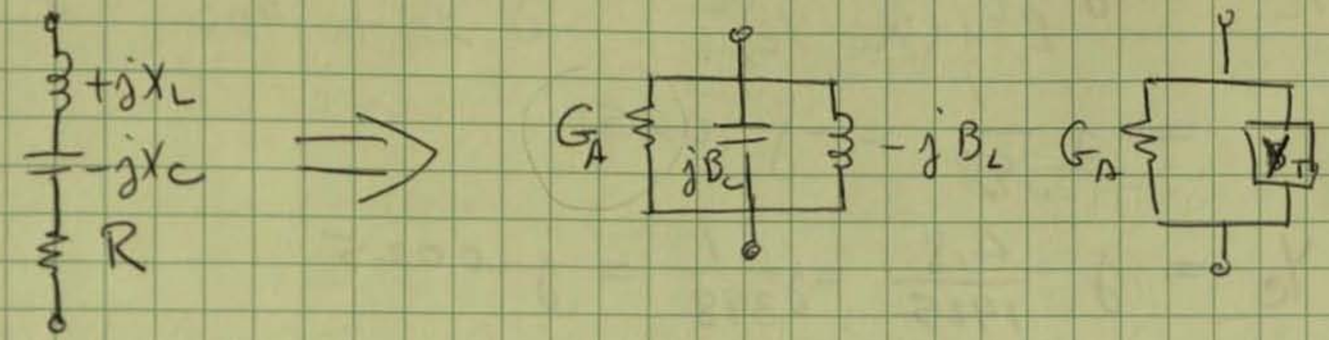
Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

CONT. FROM p. 72. 3/1/70

CONSIDER EQUIVALENT SHUNT CIRCUIT



$Z = R + j(X_L - X_C)$

$Y = \frac{1}{Z} = \frac{1}{R + j(X_L - X_C)} \cdot \frac{R - j(X_L - X_C)}{R - j(X_L - X_C)} = \frac{R}{R^2 + (X_L - X_C)^2} - j\frac{(X_L - X_C)}{R^2 + (X_L - X_C)^2}$

$G_A = \frac{R}{R^2 + (X_L - X_C)^2}$, $Y_T = \frac{-jX_L}{R^2 + (X_L - X_C)^2} + \frac{jX_C}{R^2 + (X_L - X_C)^2}$

$G_A = \frac{5}{25 + (24.2 - 4.8)^2}$ $= -j\frac{24.2}{401} + j\frac{4.8}{401}$

$= -j.0605 + j.0119$

24.2 − 4.8 = 19.4; $(19.4)^2 = 376$; 376 + 25 = 401

$= \frac{5}{25 + 376} = \frac{5}{401}$

CONSIDERING CARTRIDGE CAP.

$jB_{C_P} = \frac{1}{62.0} = .0161$

$G_A = .0125 = \frac{1}{80}$

THEN TOTAL SUSCEPTANCE (SHUNT)

48.4 − 4.8 = 43.6; $(43.6)^2 = 1900$

$Y_{TS} = -j.0605 + j.0119 + j.0161$

$= -j.0335$ (inductive)

IF L_0 IS DOUBLED TO .6 uh. $X_L = 48.4$

$G_A = \frac{5}{25 + (48.4 - 4.8)^2} = \frac{5}{25 + 1900} = \frac{1}{5 + 380}$

.0161 + .0119 = .0270; .0605 − .0270 = .0335

$G_A = \frac{1}{385}$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

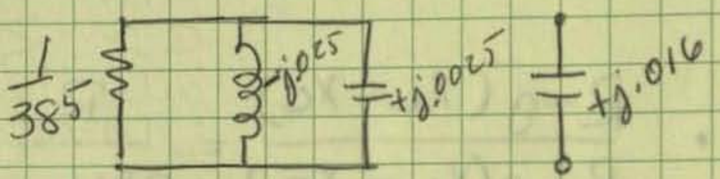
Signature ______ Date ______

CONT. FROM p. 73 3/1/70

$$Y_L = -j\frac{X_L}{R^2+(X_L-X_c)^2} = -j\frac{48.4}{25+1900} = -j\frac{48.4}{1925}$$

$$= -j\frac{1}{398} = -j\,.0251$$

$$Y_c = j\frac{4.8}{1925} = j\frac{1}{398} = j\,.0025$$



$$\begin{array}{r} +j.016 \\ +j.003 \\ \hline +j.019 \\ -j.025 \\ \hline -j.006 \end{array}$$

CONSIDER W.G. IMPED USING

$$Z_0 = 377\frac{\lambda_g}{\lambda_1}, \quad \lambda_g = \frac{\lambda_1}{\sqrt{1-\left(\frac{\lambda_1}{2a}\right)^2}}$$

λ_1 = FREE SPACE WAVELENGTH AT 12.85 ghz.

$$\lambda_1 = \frac{3\times10^{10}}{12.85\times10^9}\text{ cm} = \frac{30}{12.85} = 2.34\text{ cm.}$$

$$a = 1.5\times2.54 = 3.81\text{ cm.}$$

$$\begin{array}{r} 1.000 \\ .378 \\ \hline .622 \end{array}$$

$$\frac{\lambda_1}{2a} = \frac{2.34}{3.81} = .615, \left(\frac{\lambda_1}{2a}\right)^2 = .378, 1-(\ )^2 = .622$$

$$\sqrt{1-(\ )^2} = .79, \quad \frac{\lambda_1}{\lambda_g} = .79$$

$$\therefore Z_0 = \frac{(377)}{.79} = ~~297\Omega~~ \ 477\Omega.$$

Statement of Operation: ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

CONT. FROM p. 74 3/1/70

AN ALTERNATE FORM.

$$Z_{VI} = \frac{\pi b}{2a} Z_0 = \frac{\pi}{4} 477\Omega = 375\Omega.$$

∴ WILL USE $G_A = \frac{1}{375\Omega}$

AND ADD TO C_p TO RESONATE $L_D = .6uh$.

b = SUSCEPTANCE SLOPE PARAMETER

$$Q_A = \frac{b}{G_A}, \quad b = \frac{1}{\omega_0 L} = .025$$

$$Q_A = (.025)(375) = 9.4$$

TO CALCULATE MATCHING g VALUES.

FROM p. 70 $w = 4.7 \times 10^{-3}$

$$\delta = \frac{1}{w Q_A} = \frac{1}{(4.7\times10^{-3})\,9.4} = \frac{1000}{(4.7)(9.4)} = 22.6$$

TOO LARGE!

SET $\delta = 2$ & SOLVE FOR w

$$w = \frac{1}{\delta Q_A} = \frac{1}{2 \cdot 9.4} = \frac{1}{18.8} = .053$$

$$\frac{f_2 - f_1}{f_0} = .053, \quad f_1 = 12.8165 \text{ ghz}$$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

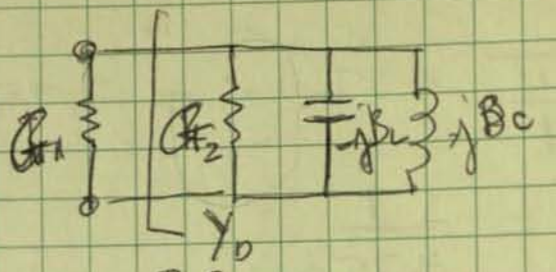
Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

CONT. FROM p. 75 3/1/70

RECONSIDER SHUNT CIRCUIT:



$$G_1 = \frac{3.2}{(3.2)^2 + (X_L - X_C)^2} \quad ,$$

LET $(X_L - X_C)^2 = 376$

$$G_1 = \frac{3.2}{10.2 + 376} = \frac{3.2}{386.2}$$

$$= \frac{1}{120}$$

TRY $X_L = 39.0$

$$G_1 = \frac{3.2}{(5.0)^2 + (39.0 - 4.8)^2}$$

39.0
4.8
34.2
$(34.2)^2$

$$= \frac{3.2}{25 + 1170} = \frac{3.2}{1205}$$

$$G_1 = \frac{1}{376.}$$

AGAIN SOLVING FOR W
IF $\delta = 2$

$$W = \frac{1}{\delta Q_2} = \frac{1}{2 \cdot 21}$$

$$W = .024$$

~~$G_2 = \frac{1.8}{(1.8)^2 + (X_L - X_C)^2}$~~

~~$G_2 = \frac{1.8}{379} = 1/$~~

$$G_2 = \frac{1.8}{1180} = \frac{1}{656}$$

$$Y_0 = G_2 - jB_L + jB_C$$

$$-jB_L = -j \frac{X_L}{R^2 + (X_L - X_C)^2}$$

$$= -j \frac{39.0}{25 + 1170} = .032$$

$$Q_2 = \frac{b}{G_2} = (.032)(656) = 21$$

Statement of Operation: ____________________

Witnessed operation (obtain two signatures):

Signature ____________ Date ______

Signature ____________ Date ______

Signature ____________ Date ______

Read and Understood (obtain two signatures):

Signature ____________ Date ______

Signature ____________ Date ______

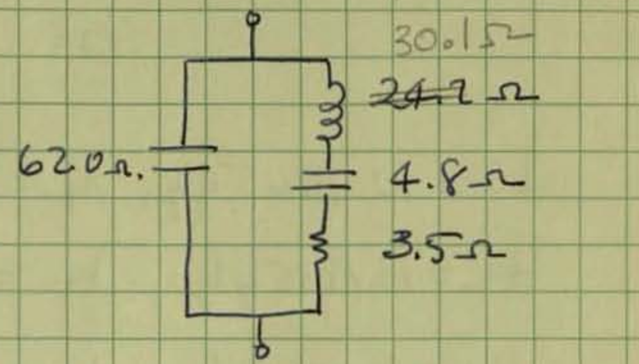
CONT. FROM p. 76 3/2/70

IF G_1 NOT COUNTED SUCH THAT

3.

$R_L = R_3 = 1.8\Omega + 1.7\Omega$

↓ R_3 $R_{TRANSFER}$



$$G_1 = \frac{1.7}{(1.7)^2 + (X_L - X_C)^2}$$

$$(X_L - X_C)^2 = \frac{1.7}{G_1} - (1.7)^2$$

LET $\frac{1}{G_1} = 375\Omega.$

$$(X_L - X_C)^2 = 640 - 2.9$$

$$X_L - X_C \cong 25.3$$

$$X_L = 25.3 + 4.8 = 30.1$$

THEN $-jB_L = -j\frac{30.1}{(3.5)^2 + (25.3)^2}$

$$= -j\frac{30.1}{12.2 + 640} = -j\frac{30.1}{652}$$

$$-jB_L = -j\,.048$$

$$Q_2 = \frac{b}{G_2} = (.048)(375) \cong 18$$

$$W = \frac{1}{\delta Q_2} = \frac{1}{2 \cdot 18} = .028$$

$f_1 = 12.8165$ ghz , $\frac{f_2 - f_1}{f_0} = .028$, $\frac{f_2 + f_1}{2} = f_0$

$f_0 = \frac{f_1}{.986} \cong 13.00$ ghz

$f_2 = 2f_0 - f_1$

$f_2 = 13.1835$

13.0000
12.8165
.1835

$$\frac{2f_0 - f_1 - f_1}{f_0} = .028$$

$$\frac{f_0 - f_1}{f_0} = .014$$

$$1 - \frac{f_1}{f_0} = .014$$

$$\frac{f_1}{f_0} = .986$$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Cont. From p. 77 3/2/70

$$W_\lambda = \frac{\lambda_{g1} - \lambda_{g2}}{\lambda_{g0}} \quad , \quad \lambda_g = \frac{\lambda_0}{\sqrt{1 - \left(\frac{\lambda_0}{2a}\right)^2}}$$

2a = 1.50 ~~2.54~~ = 3.81

$f_1 = 12.8165$ ghz, $\lambda_1 = 2.34$ cm, $\frac{\lambda_1}{2a} = .614$, $\left(\frac{\lambda_1}{2a}\right)^2 = .377$

$f_2 = 13.1835$ ghz, $\lambda_2 = 2.28$ cm (76), $\frac{\lambda_2}{2a} = .598$ (7), $\left(\frac{\lambda_2}{2a}\right)^2 = .356$

$f_0 = 13.0000$ ghz, $\lambda_0 = 2.308$ cm, $\frac{\lambda_0}{2a} = .606$, $\left(\frac{\lambda_0}{2a}\right)^2 = .368$ (7)

1.000	1.000	1.000
.377	.356	.3687
.6243	.644	.638

$\sqrt{(\ )} = .790$ $\sqrt{\ } = .802$ $\sqrt{\ } = .795$

$\lambda_{g1} = \frac{2.34}{.79} = 2.962$, $\lambda_{g2} = \frac{2.28}{.80} = 2.85$ (38), $\lambda_{g0} = \frac{2.31}{.795} = 2.903$

$$W_\lambda = \frac{2.962 - 2.838}{2.91} = \frac{.124}{2.91 \ 2.903}$$

$= .038$ ~~.038~~ $.043$

2.96
2.85
2/5.81
2.9

2.962
- 2.838
.124

2.962
2.838
5.800
2.900

$$\frac{\lambda_0}{\lambda_{g0}} = \frac{2.308}{2.903} = .795 \quad \sqrt{\frac{\lambda_0}{\lambda_{g0}}} = .897$$

$$\left(\frac{\lambda_0}{\lambda_{g0}}\right)^2 = .632 \ , \quad \delta_\lambda = \frac{1}{W_\lambda Q_A \left(\frac{\lambda_0}{\lambda_{g0}}\right)^2} = \frac{1}{(4.3\times10^{-2})18(6.32\times10^{-1})}$$

$$\delta_\lambda = .002 \times 10^3 = 2.0$$

From chart Filter Handbook - SRI
p. 129 ΔA = ~~1/4~~ n = 2

~~$g_1 = .151$~~ $g_1 = .500$, $g_2 = .400$, $\frac{g_3}{10} = .11$

$g_3 = 1.10$

Statement of Operation: ____

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

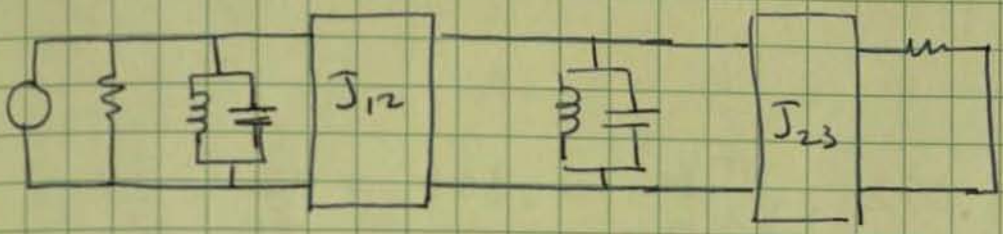
Read and Understood (obtain two signatures):

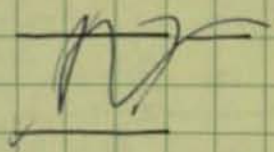
Signature ____ Date ____

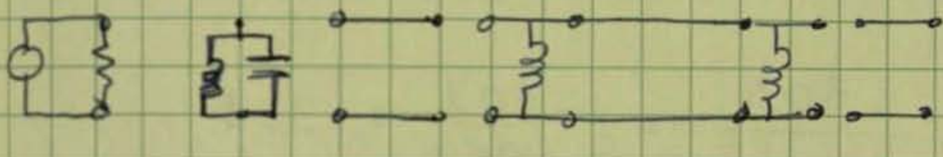
Signature ____ Date ____

CONT. FROM p. 78. 3/2/70

MATCHING CIRCUIT:-







TO GET TCHEBYCHEF RESPONSE n = ~~EVEN~~ ODD

LET n = 3, $g_0 = 1$ $g_1 = .50$, $g_2 = .79$, $g_3 = .44$, $g_4 = .98$

$$\frac{b_1}{Y_0} = \frac{\omega_1' g_1 g_0}{w} - \frac{\pi}{4} = \frac{(.5)(1)}{.028} - \frac{\pi}{4} = 17.9 - .785$$

$$\boxed{\frac{b_1}{Y_0} = 17.12}$$

17.90
.78
17.12

$$\frac{b_2}{Y_0} = \frac{g_2}{w} - \frac{\pi}{2} = \frac{.79}{.028} - \frac{\pi}{2} = 28.2 - 1.57$$

28.20
1.57
26.63

$$\boxed{\frac{b_2}{Y_0} = 26.63}$$

$$\frac{b_3}{Y_0} = \frac{g_3}{w} - \frac{\pi}{2}$$

$$\boxed{\frac{b_2}{Y_0} = \frac{g_2}{w} - \frac{\pi}{2} = 26.63}$$

$$\boxed{\frac{b_3}{Y_0} = \frac{b_1}{Y_0} = 17.12}$$

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Cont. From p. 79 3/2/70

$$\frac{K_j}{Z_0} = \sqrt{\frac{\pi}{2}\frac{Y_0}{b_j}}$$

$$\frac{Y_0}{b_3} = \frac{Y_0}{b_1} = .058,\quad \frac{\pi}{2}\frac{Y_0}{b_1} = .092,\quad \sqrt{\frac{\pi}{2}\frac{Y_0}{b_1}} = .303 = \frac{K_1}{Z_0} = \frac{K_3}{Z_0}$$

$$\frac{Y_0}{b_2} = .038,\quad \frac{\pi}{2}\frac{Y_0}{b_2} = .059,\quad \sqrt{\frac{\pi}{2}\frac{Y_0}{b_2}} = .243 = \frac{K_2}{Z_0}$$

$$\frac{X_3}{Z_0} = \frac{X_1}{Z_0} = \frac{K_1/Z_0}{1-\left(\frac{K_1}{Z_0}\right)^2} = \frac{.303}{1-.092} = \frac{.303}{.908} = .334$$

$$\frac{X_2}{Z_0} = \frac{K_2/Z_0}{1-\left(\frac{K_2}{Z_0}\right)^2} = \frac{.243}{1-.059} = \frac{.243}{.941} = .258$$

$$\phi = -\tan^{-1}\frac{2X}{Z_0}$$

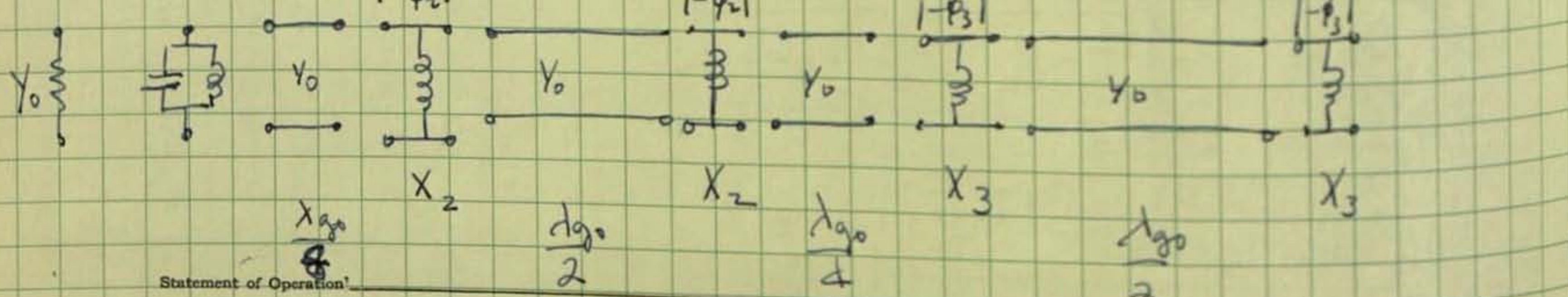
$$\phi_3 = \phi_1 = -\tan^{-1}\frac{2X_1}{Z_0} = -\tan^{-1} .668 = -33.8^\circ = .59 \text{ rad}$$

$$\phi_2 = -\tan^{-1}\frac{2X_2}{Z_0} = -\tan^{-1} .516 = -27.3^\circ = .48 \text{ rad.}$$

$\lambda_{g_0} = 2.90$ cm. $\frac{\lambda_{g_0}}{2} = 1.45$ cm $\frac{\lambda_{g_0}}{4} = .725$ cm, $\frac{\lambda_{g_0}}{8} = .36$ cm.

1.000
.092
.908

1.000
.059
.941



Statement of Operation: ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

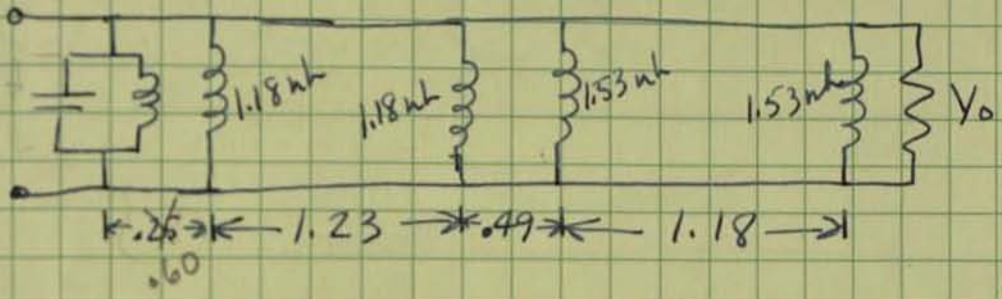
Signature ______ Date ______

Signature ______ Date ______

CONT. FROM p. 80 3/2/70

$\frac{1.45}{X_1} = \frac{180}{33.8}$ $X_1 = .27$ cm. $= X_3$, $\frac{1.45}{X_2} = \frac{180}{27.3}$, $X_2 = .22$ cm

$\frac{X_1}{2} = .13$ cm, $\frac{X_2}{2} = .011$ cm.



.11	1.45
.13	− .27
.24	1.18
.725	1.45
− .24	− .22
.485	1.23

$X_3 = .334\ Z_0$, $Z_0 = 375\ \Omega$.

$X_3 = 125\ \Omega$. $L_3 = \frac{125}{2\pi\ 13.0 \times 10^9} = 1.53 \times 10^{-9}$

.36
.11
.25

$X_2 = .258 \cdot 375$

$X_2 = 96.7\ \Omega$. $L_2 = \frac{96.7}{2\pi\ 13.0 \times 10^9} = 1.18 \times 10^{-9}$

.73
.13
.60

$\frac{1.45}{x} = \frac{180}{36.6}$ 375 $x = \frac{1.45}{5} = .29$

Statement of Operation ____

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

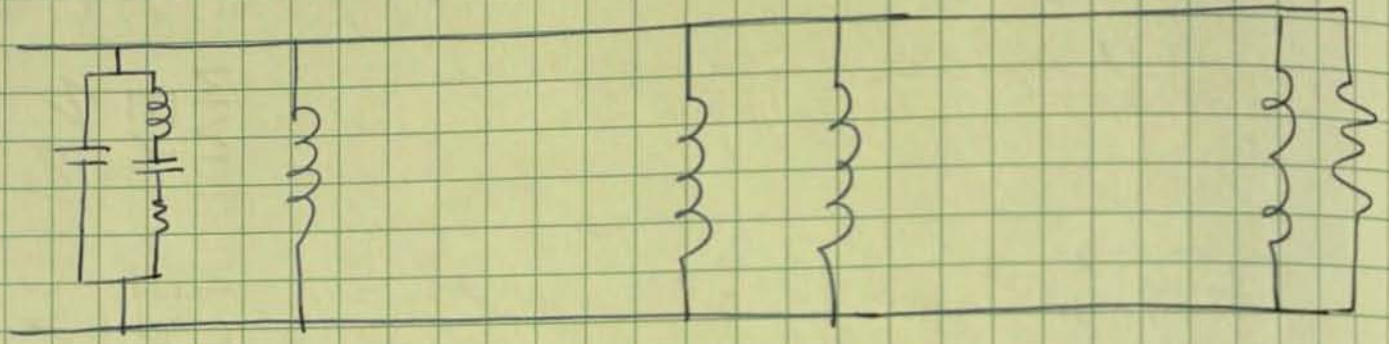
Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

CONT. FROM p. 81 3/4/70

CONSIDER FOLLOWING CIRCUIT



CONTINUATION 3/11/70
OF Up CONVERTER
USING NEW CONCEPT.

CONSIDER USING DIRECTIONAL FILTER

AS IN SRI. FILTER HANDBOOK p. 857

~~$(Q_E)_L =$ [illegible]~~

$D = 1.114''$. $h = .716'$, $\frac{D}{h}$ OR $\frac{D}{L} \cong 1.6$

FROM TABLES p. 251 FOR TE_{111} MODE FOR OPTIMUM Q.

$.28 = 6.95 \times 10^{-6} \sqrt{9.8}\ Q_u$

$Q_u = \frac{.28}{6.95 \times 10^{-6} (3.1)} = .013 \times 10^{6} = 13000$

FOR $f = 12.8$ ghz

$Q_u = \frac{.28}{6.95 \times 10^{-6} \sqrt{12.8}} = \frac{.28 \times 10^{6}}{(6.95)(3.57)} = 11000$

& AT 9.8 ghz ACTUAL $Q_u \cong 3000$

3/11/70 CONT. FROM p. 83

$$\frac{13000}{3800} = \frac{11000}{Q_{uk}}, \quad Q_{uk} = 2500$$

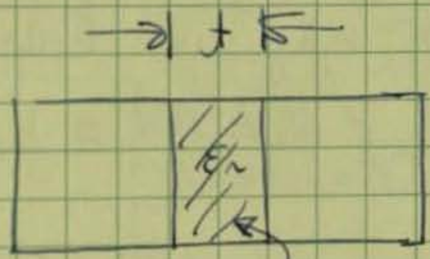
FOR CRITICAL COUPLING $g_0 = 1, g_1 = 2, g_2 = 1$

CHOOSE $\Delta f = 60$ mhz

$$W = \frac{60}{12800} = .0047$$

$$Q_E = \frac{2}{.0047} = 425$$

CONSIDER THE FOLLOWING:



PLACE DIELECTRIC IN GUIDE WITH A THICKNESS AND ϵ_r AND POSITION SUCH THAT THE POINT OF CIRCULAR POLARIZATION OF THE H FIELD IS SPECIFIED IN A BROAD BAND MANNER - SAY AT THE INTERFACE BETWEEN ONE SIDES OF THE DIELECTRIC AND THE AIR IN THE GUIDE.

Statement of Operation

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

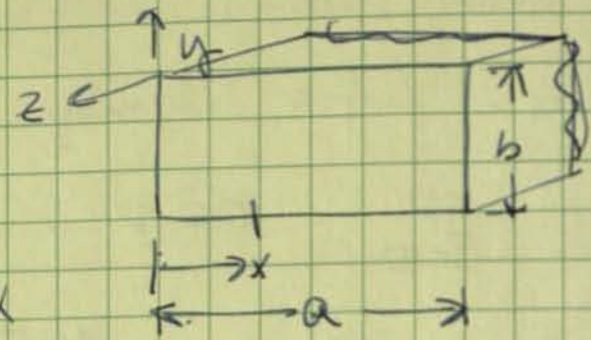
Signature ______ Date ______

Signature ______ Date ______

CONT. FROM P. 83 3/11/70

CALCULATION OF POINT OF CIRCULAR POLARIZATION IN RECTANGULAR WAVE GUIDE.

IT IS WHERE THE



$$|H_z| = |H_y|$$

OR $\cos \frac{\pi x}{a} = \frac{2a}{\lambda_g} \sin \frac{\pi x}{a}$

$\cot \frac{\pi}{a} x = \frac{2a}{\lambda_g}$, $\boxed{x = \frac{a}{\pi} \cot^{-1} \frac{2a}{\lambda_g}}$

FOR THE CASE OF CONVENTIONAL DIR. FILTER

$\lambda_g = 1.160$ AT 12.85 ghz IN WR-75 .75 X .375

$\frac{2a}{\lambda_g} = \frac{1.500}{1.160} = 1.29$ $\{$ $\cot \frac{\pi x}{a} = 1.29$

$\frac{\pi x}{a} = .66$ rad. $x = \frac{(.66)(.750)}{\pi}$

$\boxed{x_k = .158''}$

SCALING THE LENGTH OF THE RESONATORS.

FOR X BAND UNIT AT S.R.I.

$f_x = 9775$ mhz $\{$ $\lambda_{g_x} = 1.635''$ $\}$ $h_x = .770''$

$\frac{1.635}{1.160} = \frac{.770}{h_k}$, $\boxed{h_k = .545}$

Statement of Operation[1]

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

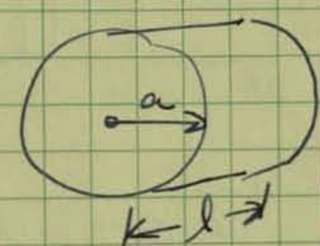
DIAMETER OF CENTER IRIS

FOR X BAND UNIT $d_x = .190$

$\frac{1.635}{1.100} = \frac{.190}{d_k}$, $d_k = .135$

START WITH ~~.130~~ .145

$$\lambda_1 = \frac{2l}{\sqrt{1+\left(\frac{2l}{3.41a}\right)^2}}$$



$l = .545"$; $a = \frac{.870}{2} = .435"$

$$\lambda_1 = \frac{(2)(.545)}{\sqrt{1+\left[\frac{(2)(.545)}{(3.41)(.435)}\right]^2}} = \frac{1.090}{\sqrt{1+\left(\frac{1.090}{1.485}\right)^2}} = \frac{1.09}{\sqrt{1+(.546)^2}}$$

$$\lambda_1 = \frac{1.09}{\sqrt{55.6}} = \frac{1.09}{7.45} = .146" = \frac{1.09}{\sqrt{1.546}} = \frac{1.09}{1.24} = .88$$

~~$\frac{\lambda_1}{2} = .44"$, ...~~

FROM SRI HANDBOOK $\lambda'_{g_0} = \frac{\lambda_0}{\sqrt{1+\left(\frac{\lambda_0}{1.706D}\right)^2}}$

FOR $f = 12.85$ ghz

$\lambda_0 = \frac{3\times10^{10}}{12.85\times10^9 (2.54)} = .92"$, $(1.706)(.870) = 1.48$, $\frac{.92}{1.48} = .62$

$(.62)^2 = .38$

$1.00 - .38 = .62$

$\lambda'_{g_0} = \frac{.92}{\sqrt{~~1.38~~\ .62}} = \frac{.92}{~~1.17~~\ .79} = ~~.78~~\ 1.17$, $\frac{\lambda'_{g_0}}{2} = ~~.39~~\ .585$

Statement of Operation ____

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

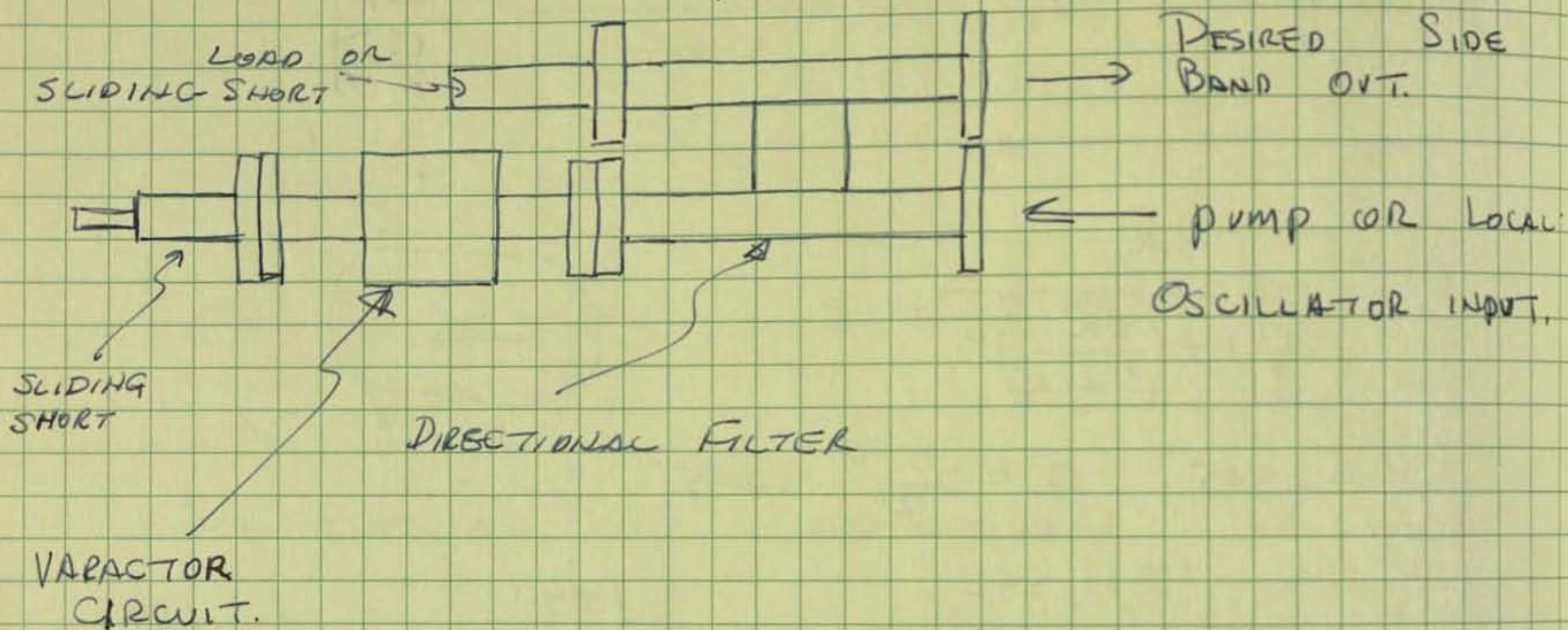
Read and Understood (obtain two signatures):

Signature ____ Date ____

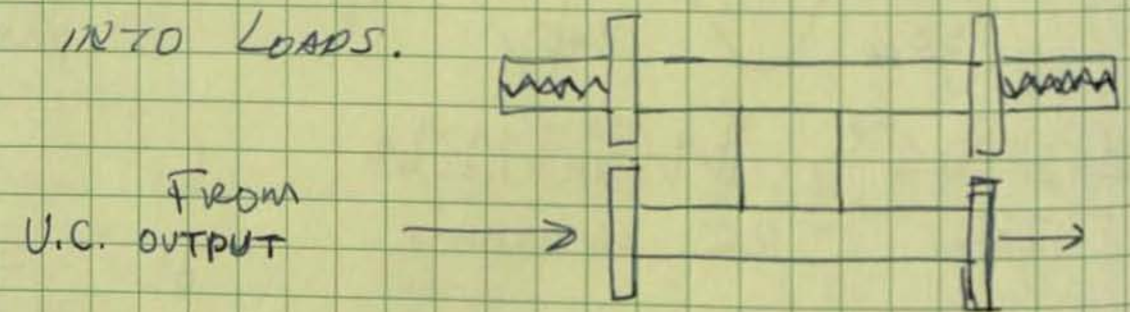
Signature ____ Date ____

 CONT. FROM p. 82 5/25/70

UP-CONVERTER MOUNT TO GO WITH THE DIRECTIONAL FILTER. CONSIDER FOLLOWING WAVEGUIDE ASSEMBLY.



ADDITIONAL DIRECTIONAL FILTERS MAY BE ADDED IN CASCADE WITH THE OUTPUT PORT TO FURTHER REJECT PUMP OR ANY OUT OF BAND SPURIOUS RESISTIVELY INTO LOADS.



ALSO, SINCE DIRECTIONAL FILTERS ARE SOMEWHAT NARROW BAND - 60 MHZ AROUND 13.0 GHZ. SEVERAL CAN BE USED IN CASCADE TO HANDLE A BAND OF

Statement of Operation: ____

Witnessed operation (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

Signature ____ Date ____

Read and Understood (obtain two signatures):

Signature ____ Date ____

Signature ____ Date ____

CONT. FROM p. 86 5/25/70

FREQUENCIES IN SEGMENTS.

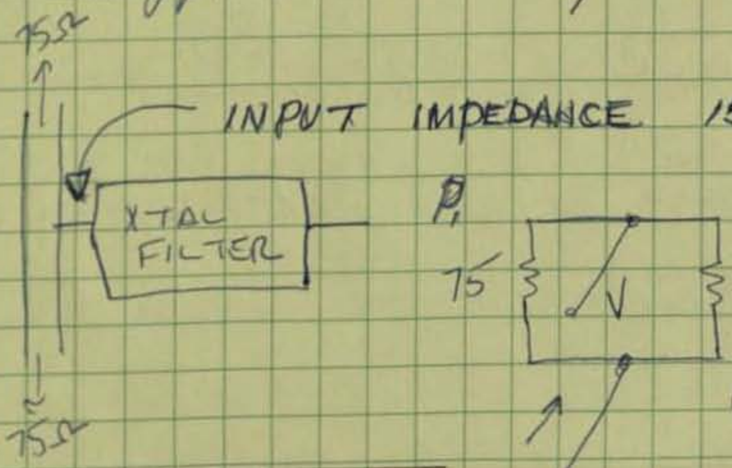
10/2/70

A.G.C. SYSTEM FOR GAIN AND TILT CONTROL FOR TRUNK AMPLIFIERS.

THE SYSTEM UNDER CONSIDERATION IS THE TWO PILOT TONE SYSTEM. ONE TONE IS NEAR 74.0 MHZ IN BETWEEN CHANNEL 4 AND 5. THE OTHER IS OR COULD BE ABOVE 270 MHZ SAY 275 OR 300 EVEN.

ONE OF THE DIFFICULT PROBLEMS IS TO SELECT OUT THE 74 MHZ SIGNAL WITHOUT EFFECTING THE 50-250 V.H.F. TELEVISION BAND. ONE CONSIDERATION IS USING A CRYSTAL FILTER TAPPING DIRECTLY OFF THE 75Ω OUTPUT LINE.

INPUT IMPEDANCE 1500 TO 2000 Ω.



$$\frac{P_1}{P_2} = \frac{V^2/75}{V^2/1500} = \frac{1500}{75} = 20$$

COUPLED POWER = ~~20~~ 13db DOWN

10/6/70 CONTINUED FROM p. 87

CALCULATION OF COUPLING VALUES OFF OF OUTPUT 75 Ω LINE TO DRIVE AGC CIRCUIT.

ASSUME 50 AMPLIFIERS

IF 20 db COUPLERS ARE USED, THE FRACTION OF POWER LEFT AT THE END OF THE 50[th] AMPLIFIER IS:

$$(.99)^{50}$$

$$\log (.99)^{50} = 50 \log .99 = -50 \log 1.01 = (-50)(.004)$$

$$= \frac{1}{10^{.2}} = \frac{1}{1.6} = \underline{.625}$$

USING A 17 db COUPLER:

$$(.98)^{50}$$

$$\log (.98)^{50} = (-50)(\log 1.02) = (-50)(.009)$$

$$= \frac{1}{10^{.45}} = \frac{1}{2.8} \cong \underline{.36}$$

$$\begin{array}{r} .009 \\ 50 \\ \hline .450 \end{array}$$

17 db APPEARS TO BE A REASONABLE CHOICE FOR SYSTEMS ANALYSIS.

Statement of Operation ________________________

Witnessed operation (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

Signature ____________ Date ________

Read and Understood (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

10/6/70 CONTINUED FROM p 88

ASSUME MINIMUM PILOT SIGNAL AVAILABLE IS 1mV INTO 75 Ω OR 0 db_{mv} = −49 dbm.

ALSO, FROM PAPER BY PAGE AT ENTRON A REASONABLE S/N = 43 db ON THE TRUNKLINE CABLE WILL BE USED. (THAT IS, IN A 4MHZ BANDWIDTH CHANNEL)

WE WILL ASSUME AT THIS POINT WE HAVE A NOISE BANDWIDTH OF 4MHZ.

TO DRIVE THE ATTENUATOR ABOUT 200mW WILL BE REQUIRED ADD 3db FOR SAFETY − 400mW OR +26dbm. THEREFORE, OVERALL POWER GAIN REQUIRED:

$$26\,dbm - (-17 - 49)\,dbm = \underline{92\,db}$$

26
49
17
92

IT WILL BE ASSUMED THE TILT CONTROL REQUIRES THE SAME AMOUNT.

AT THE RECTIFIER ASSUME MAX. OUTPUT 1ma. FOR ABOUT 300 mV INPUT.

USING 50 Ω INPUT $\frac{1}{2}\frac{E^2}{R} = \frac{(.3)^2}{2 \times 50} = \frac{.09}{100} = .0009 \cong .001$ OR 1mW.

∴ OUTPUT POWER (AVE.) OF R.F. AMPLIFIER 0dbm

∴ GAIN MUST BE $0 - (-17 - 49) = 66\,db$ POWER GAIN.

Statement of Operation ____________________

____

Witnessed operation (obtain two signatures):

Signature __________ Date __________

Signature __________ Date __________

Signature __________ Date __________

Read and Understood (obtain two signatures):

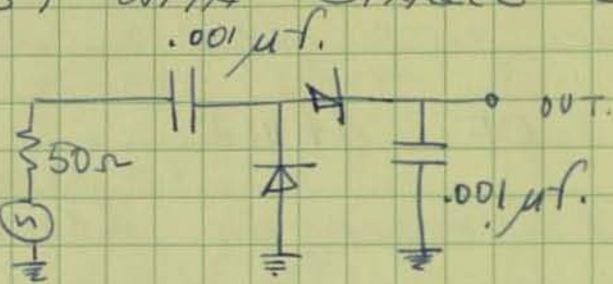
Signature __________ Date __________

Signature __________ Date __________

10/19/70 CONTINUED FROM p. 89

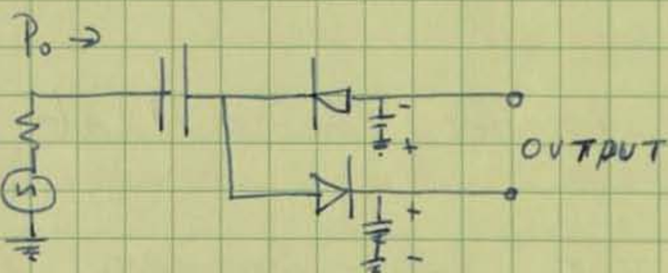
CONSIDER THE SYSTEM FROM THE STANDPOINT OF THE DETECTOR. THE FOLLOWING RESULTS WERE OBTAINED USING A VOLTAGE DOUBLER CIRCUIT: (USING FAIRCHILD FH 1100 SCHOTTKY BARRIER DIODES)

FIRST WITH SINGLE ENDED DESIGN:



P_{IN}	E_{IN}	E_{OUT}	R_L=20K
0 dbm	.316pk V.	1.0V	.667V.
+10dbm	1.0pk V.	3.94V.	

THEN WITH A BALANCED OUTPUT:



CALCULATED FOR 50Ω LOAD

P_o (dbm)	E_{rms}	E_{pk}	$2E_{pk}$
−10	.07	.10	.2
0	.224	.316	.632
+3	.316	.446	.892
+6	.448	.631	1.262
+10	.707	1.0	2.000
+13	1	1.41	2.82
−13	.05	.07	.14

PEOPLE TO CALL AT SAN RAPHAEL
MKTING – GOULDSBERRY – ALVAREZ.
OPERATIONAL – D. MARRIOTT

10/20/70 CONTINUED FROM p. 90

MEASURED RESULTS:

SCHOTTKY DIODES

Pin (dbm)	Ein (pk)	Eout pk (← MEASURED)	
-13	.07	.134	} DOUBLING
-10	.10	.222	
0	.316	.844	} TRIPLING OR BETTER
3	.446	1.246	
6	.631	1.90	
10	1.0	3.21	
13	1.41	4.27	

POINT CONTACT. SYLVANIA

Pin (dbm)	Ein pk	Eout pk
-20	.0316	.030
-13	.07	.096
-10	.10	.186
0	.316	.813
+3	.446	1.217
+6	.631	1.917
+10	1.0	3.20

DIFFICULTIES HERE DUE TO BEING R.F. HOT. –

Statement of Operation

Witnessed operation (obtain two signatures):

Signature Date

Signature Date

Signature Date

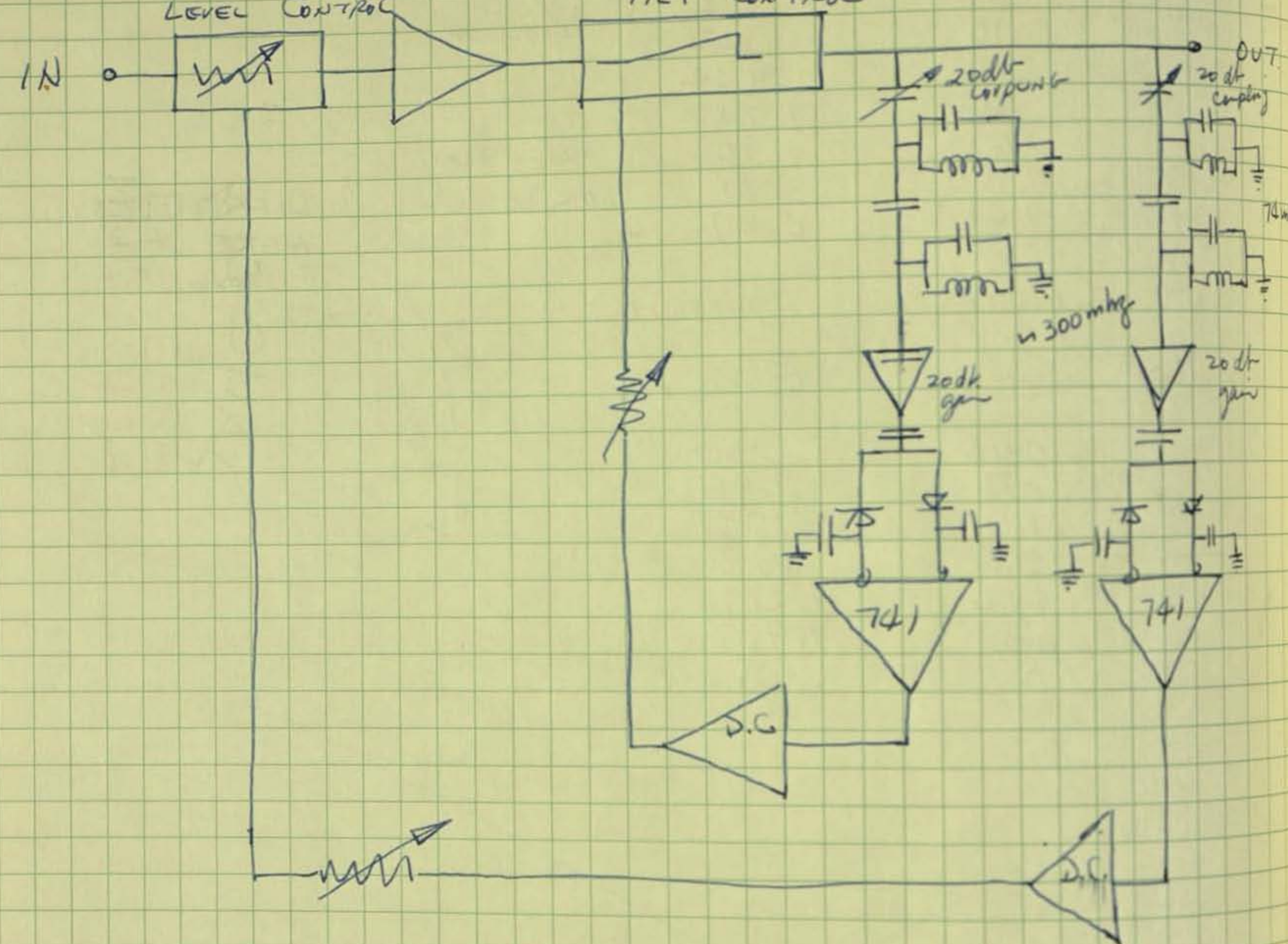
Read and Understood (obtain two signatures):

Signature Date

Signature Date

11/10/70 CONT. FROM p. 91

THE FOLLOWING SYSTEM HAS BEEN DECIDED UPON:



Statement of Operation ______

Witnessed operation (obtain two signatures)

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

	Gain S_{21}	Amp S_{12}		S_{11}		S_{22}	
#02	65 +25.2db	-30.8db	+53°	.34	-105°	.60	-35°
	70 +24.8db	-30.7db	+54°	.35	-109	.58	-36°
	75 +24.3db	-30.4db	+56°	.36	-112°	.55	-37°
	80 +24.0db	-30.0db	+56°	.36	-116°	.51	-38°
#2	65 25db	-32.5db	+54°	.35	-115°	.51	-25°
	70 24.6db	-32.1db	+55°	.35	-119°	.50	-26°
	75 24.2db	-32.0db	+56°	.36	-122°	.49	-27°
	80 23.8db	-31.6db	+58°	.36	-126°	.48	-28°
#01	65 25.6db	31.6db	+53	.36	-100°	.65	-31°
	70 25.2db	-31.3	+54	.36	-105°	.63	-32°
	75 24.7db	-31.0	+54	.36	-109°	.60	-33°
	80 +24.2db	-30.7	+55°	.36	-111°	.58	-34°

0

S_{22} θ

.7	-29°
.68	-30°
.66	-31°
.63	-32°
.69	-28°
.66	-29°
.64	-30°
.62	-30°

Witnessed operations (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

11/11/70 CONT. FROM p. 92

SCATTERING PARAMETERS OF 0060
CHIP IN TO-46 PACKAGE.
R&D UNITS $V_{cc} = 30V.$, $I_{cc} = 20ma.$

FREQ (MHz)	S_{21}	θ	S_{12}	θ	S_{11}	θ	S_{22}	θ
65								
70								
75								
80								

OUT OF 5 TRANSISTORS
3 - 17 db - 20 db AT 65 MHz
1 - OPEN
1 - 5 db " "

new set of transistors

#08

FREQ (MHz)	$\lvert V_1/V_2 \rvert$	S_{21}	θ	$\lvert V_4/V_1 \rvert$	S_{12}	θ	S_{11}	θ	S_{22}	θ
65	18.2	25.2 db	+130°	.0253	-32.1 db	+52°	.35	-100°	.7	-29°
70	17.4	24.8 db	+128°	.0258	-31.8 db	+54°	.35	-103°	.68	-30°
75	16.6	24.4 db	+125°	.0269	-31.5 db	+55°	.36	-106°	.66	-31°
80	15.8	24.0 db	+122°	.0274	-31.2 db	+55°	.36	-110°	.63	-32°

#60

FREQ (MHz)	S_{21}	θ	S_{12}	θ	S_{11}	θ	S_{22}	θ
65	25.2 db	+127°	32.2 db	+53°	.36	-104°	.69	-28°
70	24.9 db	+124°	-32.0 db	+54°	.36	-108°	.66	-29°
75	24.4 db	+122°	-31.6 db	+55°	.36	-112°	.64	-30°
80	24.0 db	+120°	-31.3 db	+56°	.36	-115°	.62	-30°

Statement of Operation ____________________

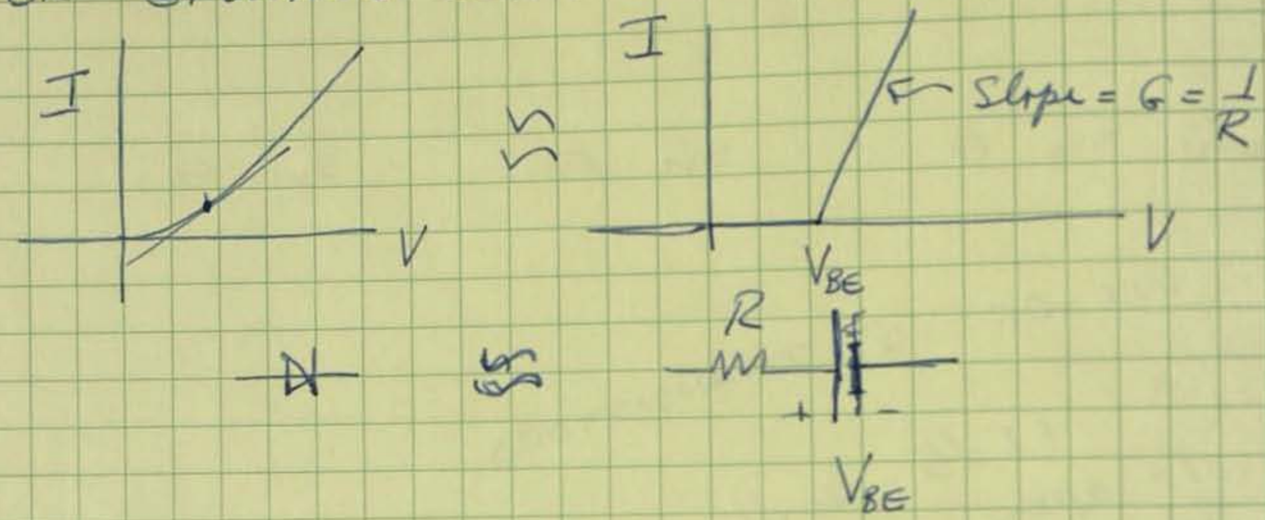
Witnessed operation (obtain two signatures):
Signature __________ Date __________
Signature __________ Date __________

Signature __________ Date __________
Read and Understood (obtain two signatures):
Signature __________ Date __________
Signature __________ Date __________

11/17/70 .. CONTINUED FROM p. 93

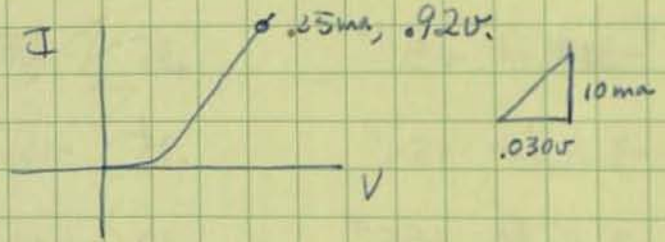
GETTING EQUIVALENT CIRCUIT - D.C. FOR ECAP ON COMPUTER

FOR GROUNDED EMITTER INPUT LOOK LIKE DIODE.

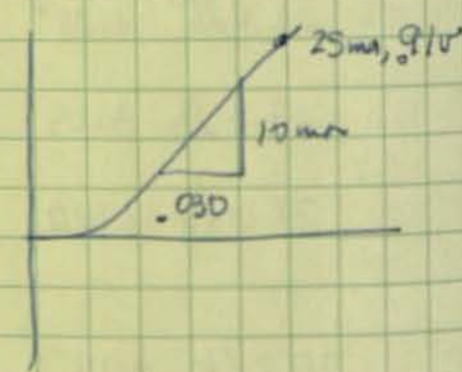


DATA OBTAINED ON CURVE TRACER

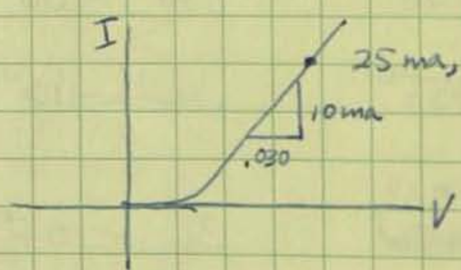
TEST TRANSISTOR



#02

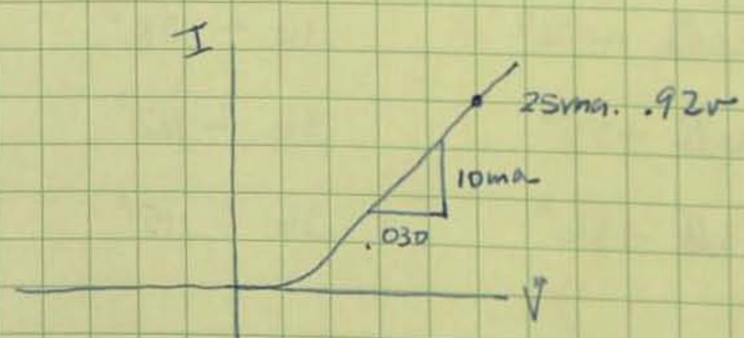


#08



$R = \frac{30\,mV}{10\,ma} = 3\Omega$

#2



.05
.6
.030

Statement of Operation ______

Witnessed operation (obtain two signatures)

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

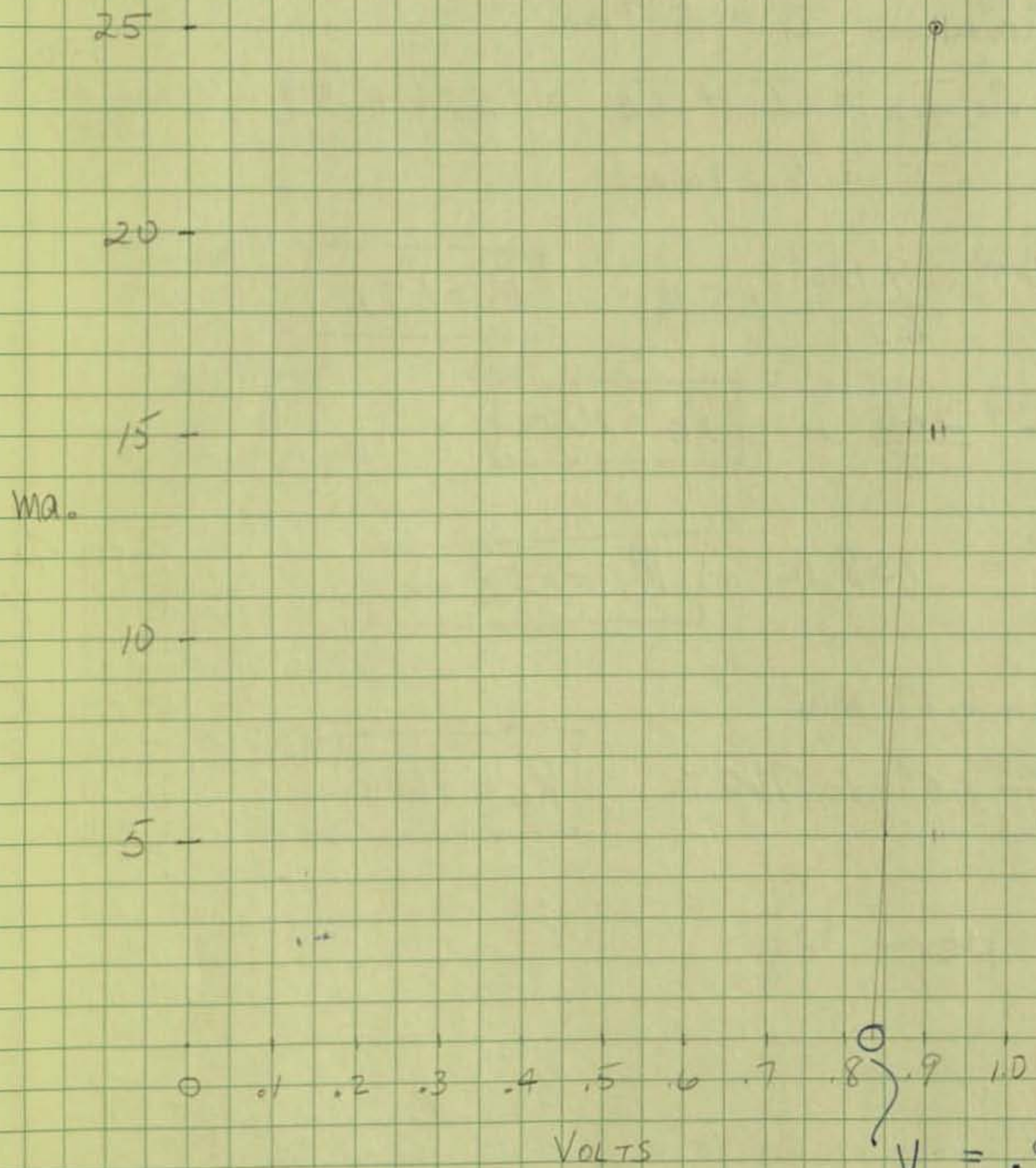
Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

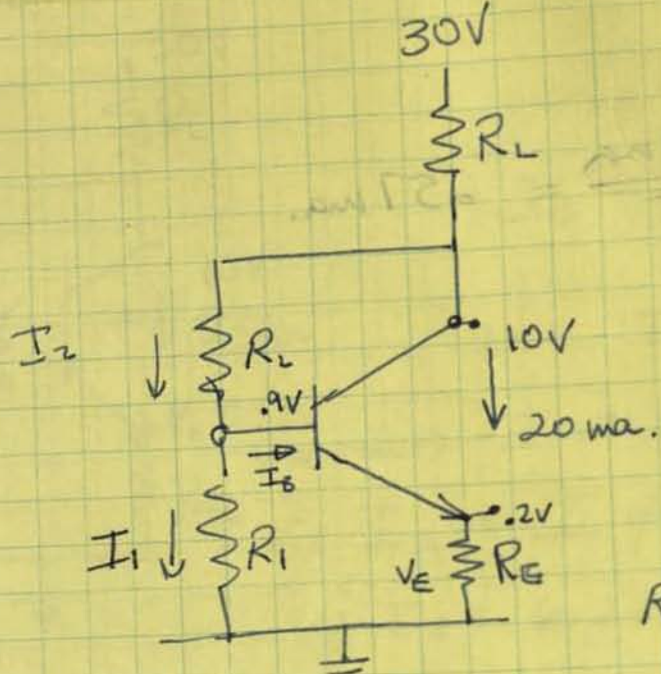
11/19/70 Cont. From p. 94

$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{(28-14)\ \text{ma}}{(.8-.4)\ \text{ma}} = 35$$



$V_B = .835$

11/19/70 CONT. FROM p. 95



ASSUME $\beta = 50$

$I_B = \frac{20\,ma}{50} = .4\,ma$

LET $I_1 = 10 I_B$

$I_1 = 4.\,ma$

$\therefore I_2 = 4.0 + .4 = 4.4\,ma$

$R_2 = \frac{10V}{4.4\,ma} = 2.2K$

~~$V_2 = I_2 R_2 = 4.4 \times 10^{-3}\ 2.2K =$~~ $R_2 = 2.2K$ (boxed)

~~$V_E = I_E$~~

$\frac{10}{20 \times 10^{-3}}$

500Ω

$V_E \cong .2V$ FROM EXPERIENCE

$R_E = \frac{.2V}{20\,ma.} = \frac{.2}{20 \times 10^{-3}} = \frac{.20}{.020} = 10\Omega$

$R_E = 10\Omega$ (boxed)

$V_{R_1} = .9V$

$R_1 = \frac{.9}{4\,ma} = \frac{.9}{4 \times 10^{-3}} = \frac{900}{4}$

$R_1 =$ ~~250~~ $225\,\Omega$ (boxed)

$I_{RL} \cong 20\,ma + 5\,ma$

$R_L = \frac{20}{25\,ma} = \frac{20}{25 \times 10^{-3}} = \frac{20\,000}{25}$

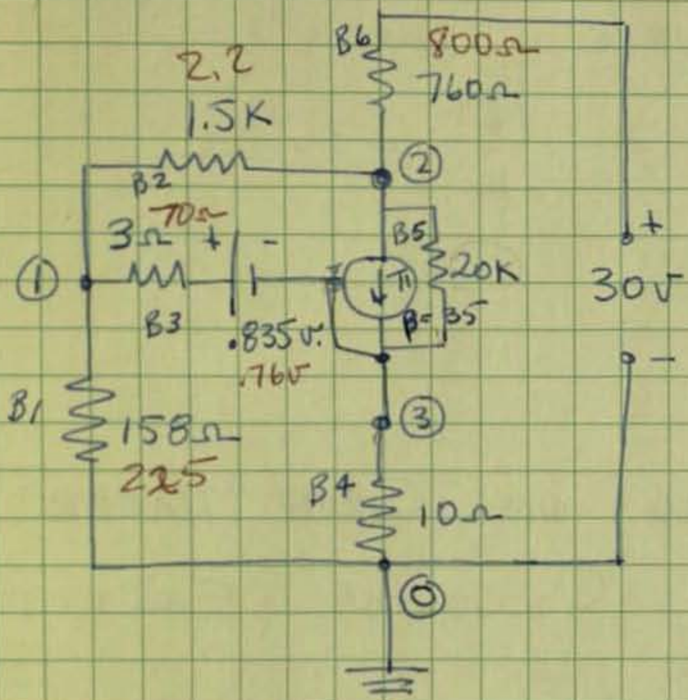
$R_L = 800\Omega$ (boxed)

Signature______ Date______

Signature______ Date______

 CONT. FROM p. 96

CONSIDER THE FOLLOW D.C. EQUIVALENT CIRCUIT.

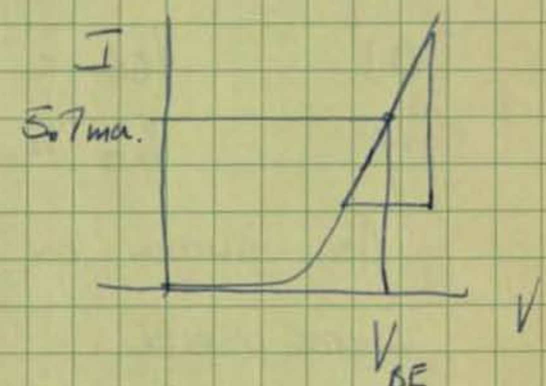


FOR ECAP D.C. ANALYSIS.

B1	N(1,0),	R=158 225 (.1)
B2	N(2,1),	R=1500 2200 (.1)
B3	N(3,1),	R=3 (70), E=+.835 (.2) (+.5)
B4	N(0,3);	R=10 (.05)
B5	N(3,2),	R=20 E3 (.1)
B6	N(0,2),	R=760 (800), E=+30
T1	B(3,5)	BETA=35 (50)

DATA ON p. 94 & 95 WAS RERUN

HERE IS RESULTS

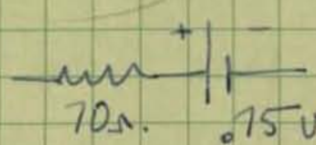


#2 $V_{BE} = .76$, $R = \frac{35}{.5} = 70\Omega$.

#01 $V_{BE} = .75$, $R = 70\Omega$

#09 $V_{BE} = .74$, $R = 70\Omega$

IN B3 ABOVE



NOW RERUN WITH

$2.5\,mV/^\circ C \times 100^\circ C = .25V$

$\frac{.25}{.75} = .33$, $\frac{.33}{2} = .165$

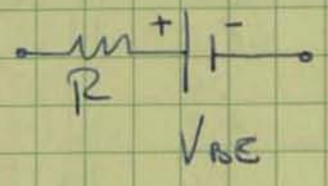
$\approx .17$

B1	N(1,0),	R=225 (.1)
B2	N(2,1),	R=2200 (.1)
B3	N(3,1),	R=70, E=.75 (.17)
B4	N(3,0),	R=10 (.05)
B5	N(3,2),	R=20000
B6	N(0,2),	R=800 (.1), E=30
T1	B(3,5),	BETA=35

 11/23/70 CONT. FROM p. 97.

THE β ON THE PREVIOUS PAGE WAS MEASURED ON THE CURVE TRACER

$$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{(28-14)\ ma}{(.8-.4)\ ma} = \frac{14}{.4} = 35$$

TO GET 

TRANSISTORS WERE MEASURED ON CURVE TRACER BASE & EMITTER IN COLLECTOR EMITTER TERMINALS.

#2 V_{BE} = .76 v. , R = 70 Ω.

#01 V_{BE} = .75 v , R = 70 Ω

#09 V_{BE} = .74 , R = 70 Ω

AS SHOWN ON PAGE 97 V_{BE} = .75 v & R = 70 Ω WERE USED.

AFTER ONE PASS ON COMPUTER R = 2500 Ω WAS CHANGED TO R = 2000 Ω. WITH 10% TOLERANCE PUTTING THIS INTO L. BESSERS "QUICK" PROGRAM

— THE CIRCUIT WAS ASSEMBLED AS FOLLOWS:

CONT. ON NEXT PAGE —

11/23/70 CONT. FROM p. 98

'PRNT'.0.0.0.0

(SAM)

/SAM/

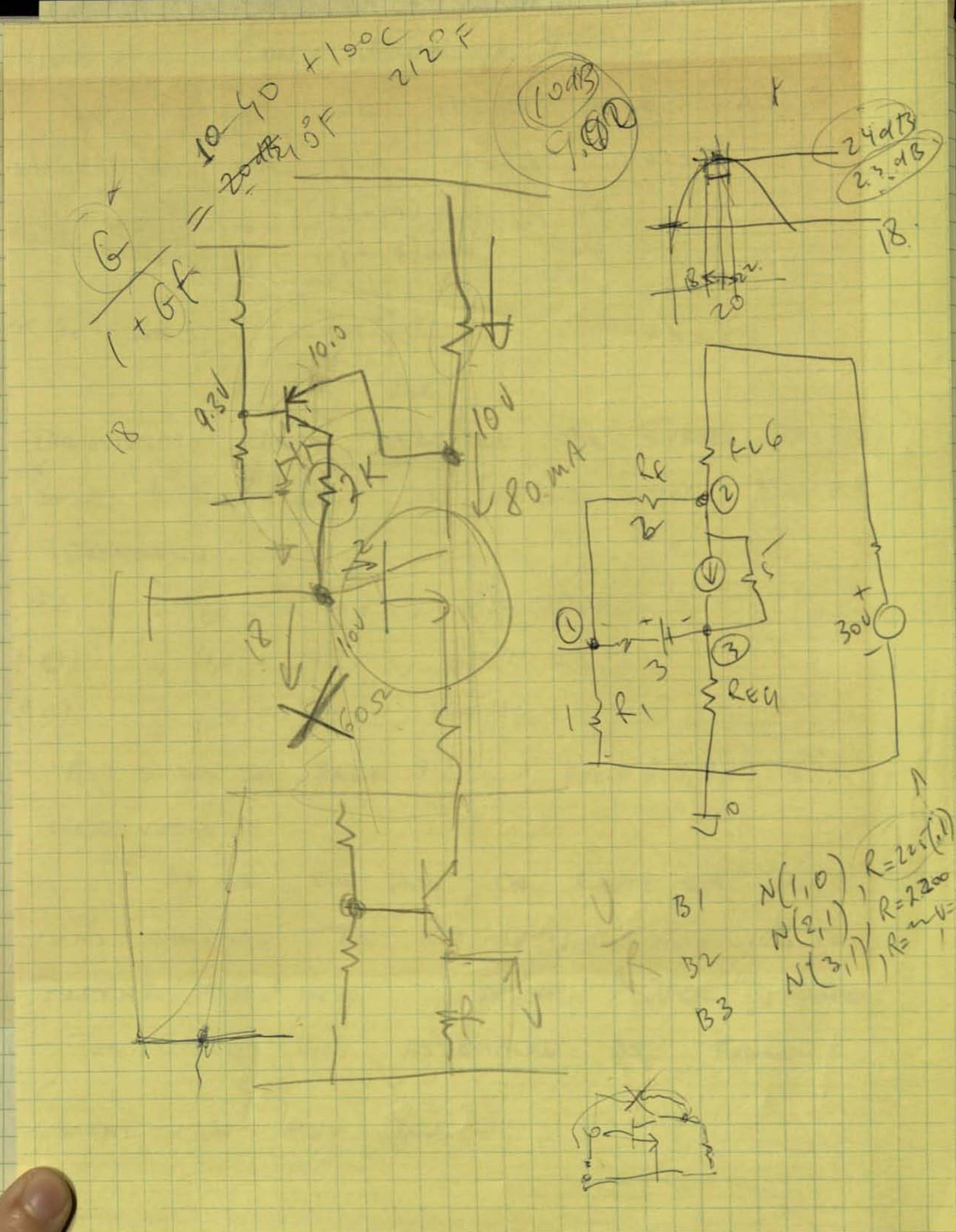
/SAM/

Signature_____ Date_____

Signature_____ Date_____

Signature_____ Date_____

Signature_____ Date_____



d operation (obtain two signatures)

ture________ Date________

nature________ Date________

Signature________ Date________

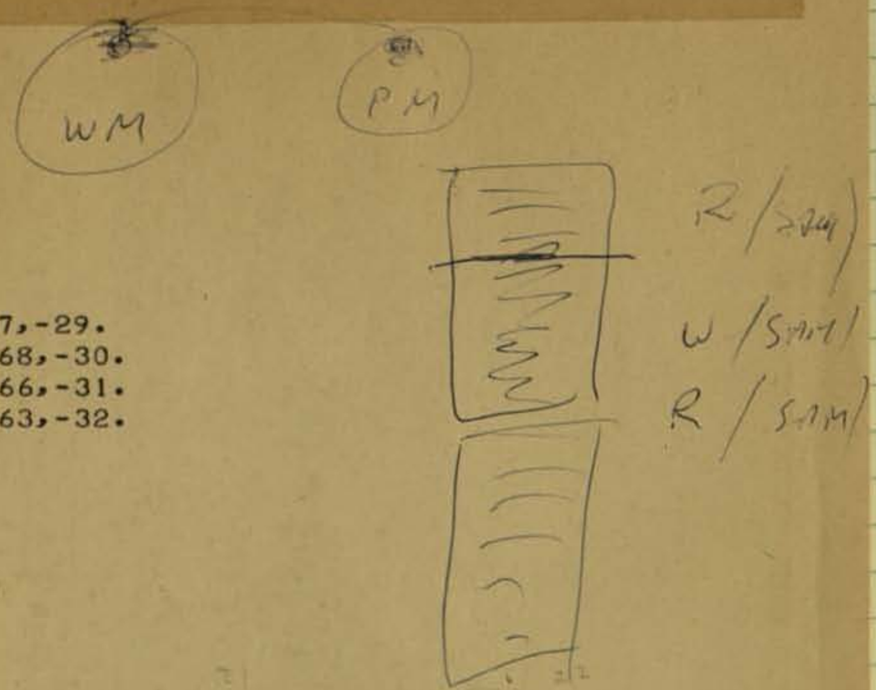
Read and Understood (obtain two signatures):

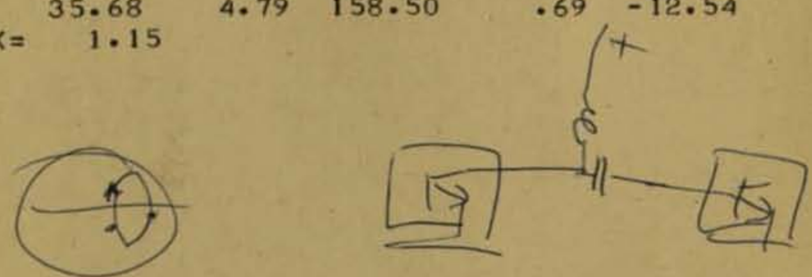
Signature________ Date________

Signature________ Date________

11/23/70 CONT. FROM p. 98

```
'PRNT',0,0,0,0
*/
9,65,80,5,1
'RP',1,225.,0,0
'SAV1',0,0,0,0
'RS',2,2000.,0,0
'SCE',5,0,0,0
'PPAD',5,0,0,0
'RP',2,10.,0,0
'SSAD',4,0,0,0
'RP',1,800.,0,0
'PRNT',0,0,0,0
.35,-100.,.025,52.,18.2,130.,.7,-29.
.35,-103.,.025,54.,17.4,128.,.68,-30.
.36,-106.,.027,55.,16.6,125.,.66,-31.
.36,-110.,.027,55.,15.8,122.,.63,-32.
*W AGC
 NEW FILE
301 CHARACTERS
*Q

-ASSIGN F:3,(FILE,AGC),(IN)

-GØ: QUICK
 F = 65.0000
      .39  -28.62      .047   30.44    4.86  163.06     .70  -9.87
  S21=  13.73 DB             K=   1.22

 F = 70.0000
      .39  -30.48      .048   32.21    4.83  161.85     .70  -10.65
  S21=  13.67 DB             K=   1.22

 F = 75.0000
      .40  -32.91      .049   34.48    4.81  160.23     .70  -11.51
  S21=  13.64 DB             K=   1.17

 F = 80.0000
      .40  -35.40      .050   35.68    4.79  158.50     .69  -12.54
  S21=  13.61 DB             K=   1.15

 *STØP* 0

-BYE
11/20/'70 16:42
RAD SPACE 3
CPU TIME 0.014
I/Ø WAIT TIME 0.016
MØN SERVICES 0.010
```





Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

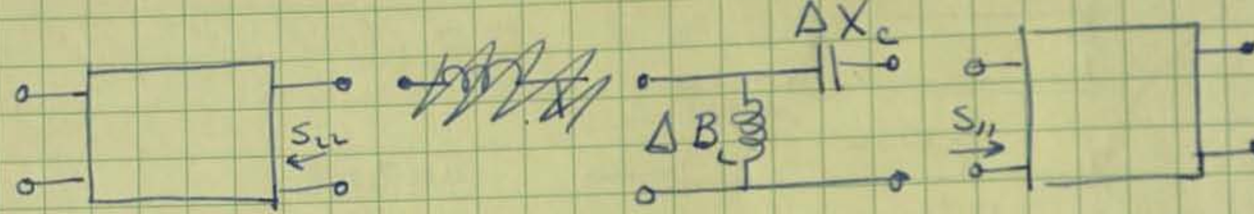
Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

11/23/70 CONT. FROM p. 99

IT APPEARS THAT INTERSTAGE MATCHING CAN BE ACHIEVED WITH A SHUNT L AND A SERIES C. (SEE ATTACHED SMITH CHART)



FROM THE CHART: (AT f = 75 MHz)

$\frac{\Delta B_L}{Y_0} = .38$

$\frac{1}{\omega L} = (.38)(.02)$

$= .0076$

$L = \frac{.0076}{2\pi\, 75 \times 10^6}$

$= \frac{7600}{150\pi} \times 10^{-9} = \frac{760}{15\pi} \times 10^{-12}$

$L = 16.1\ ph.$

$\frac{\Delta X_c}{Z_0} = 1.6$

$\frac{1}{\omega C} = (1.6)(50) = 80$

$C = \frac{1}{80 \cdot 2\pi\, 75 \times 10^6}$

$= \frac{10^{-7}}{8\pi\, 150} = \frac{10^{-8}}{120\pi}$

$= \frac{10^{-9}}{12\pi} = \frac{1000}{12\pi} \times 10^{-12}$

$C = 26.5\ pf$

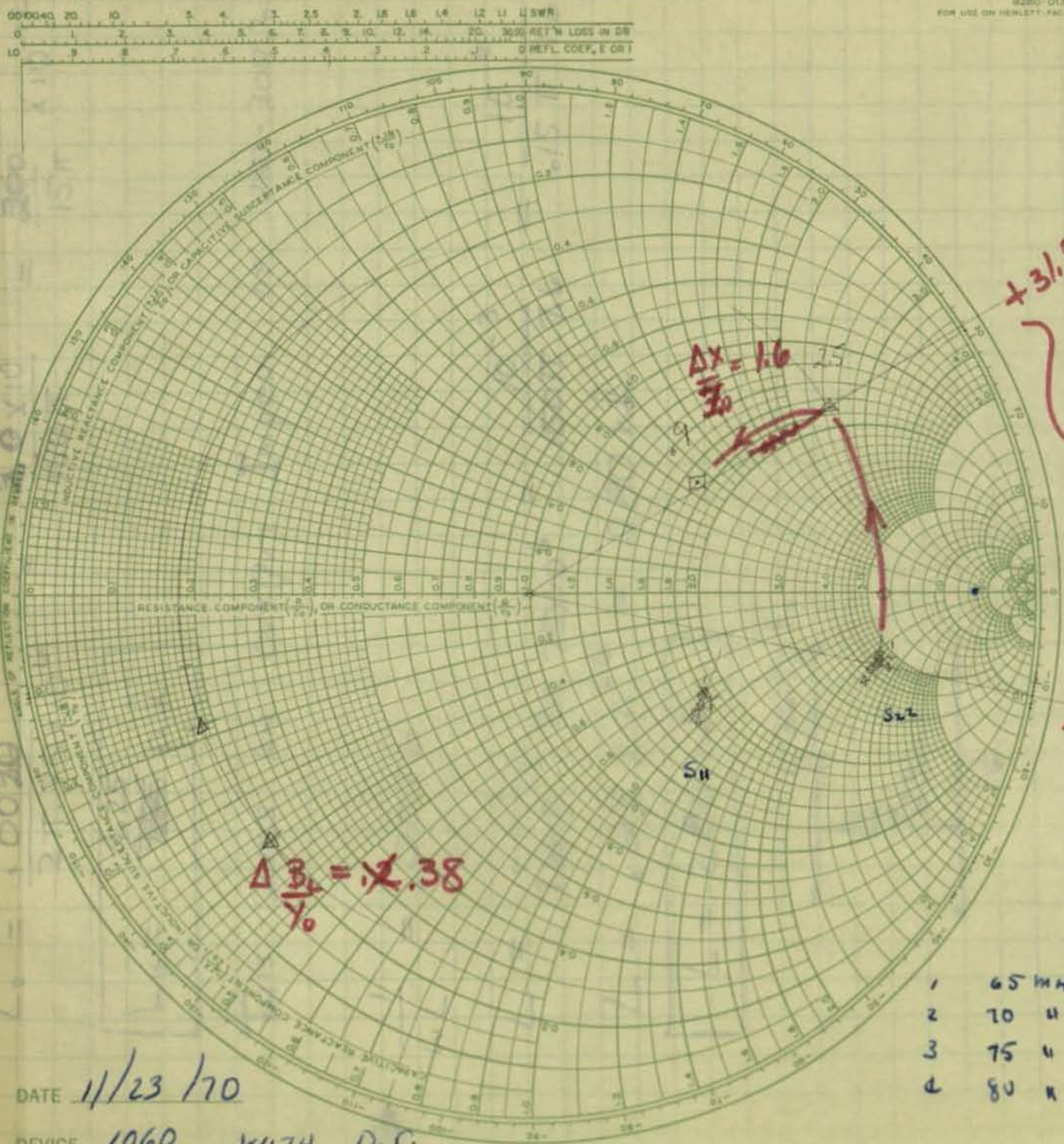
CAN MATCH OUTPUT S_{22} WITH A SHUNT INDUCTANCE.

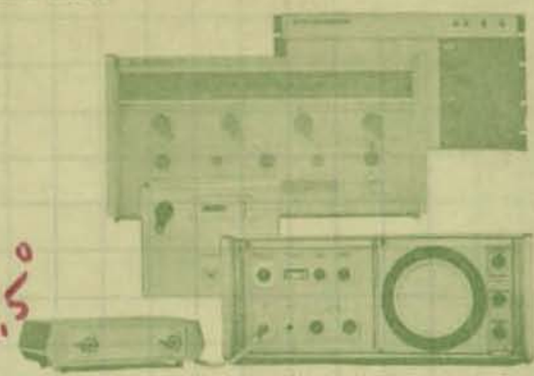
FROM CHART $\left(\frac{B_L}{Y_0}\right)_0 = .10 \quad (B_L)_0 = .0020$

$\omega L_0 = .0020$

11/23/70 CONT. FROM p. 100

HEWLETT-PACKARD
9280-0137
FOR USE ON HEWLETT-PACKARD RECORDERS





H-P MODEL 8410A NETWORK ANALYZER SYSTEM

DEVICE TEST PROCEDURE

1. Connect equipment: 8690A Sweep Oscillator, 8741A or 8742A Reflection Unit, 8410A/11A/14A Network Analyzer, Moseley X-Y Recorder to 8414A Polar Display rear panel outputs.
2. Set Sweeper to CW frequency, set 8410A frequency range, adjust RF level, push beam center, position beam at center of Polar Display.
3. Connect short to Reflection Unit, adjust amplitude and phase verniers and line stretcher for 1 /180° reading on 8414A.
4. Press beam center, adjust X-Y plotter zero controls to give a reference over 1.0 ±j0.0 on Smith Chart.
5. Adjust X channel gain for 0.0 ±j0.0 on Smith Chart, press beam center and adjust zero reference to 1.0 ±j0.0. Repeat until no correction need be made at either position.
6. Adjust Reflection Unit line stretcher for ±90° phase shift on 8414A display, repeat step 5 for points of 0.0 ±j1.0 making adjustment with Y channel gain and zero controls.
7. Move line stretcher to give 360° phase shift to check plotter settings.
8. Set start/stop frequencies for swept operation; disconnect X-Y recorder; with sweeper on auto, adjust line stretcher for minimum phase shift; position center of trace at 1 /180° with phase vernier; sweeper to manual sweep; connect X-Y recorder.
9. Connect test device and sweep.

HEWLETT hp PACKARD

DATE 11/23/70

DEVICE 1060 WITH D.C. BIAS CIRCUIT (INCLUDING FEEDBACK)

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

$L_0 = \frac{\ldots}{2\pi\, 75\times10^6}$ ... 150π ... 15π

$L_0 = 4.25\ \mu h.$ (boxed; ~~7.65~~ struck out)

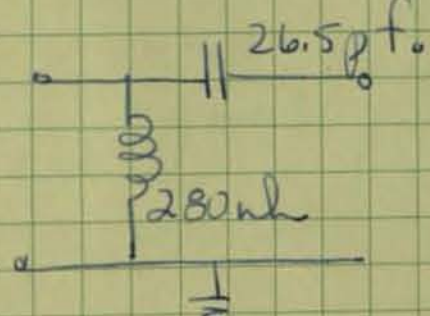
THIS GIVES AN OUTPUT IMPED. OF 250-300Ω. REAL.

$\frac{1}{\omega L} = .0076$

$L = \frac{1}{7.6\times10^{-3}\ 2\pi\ 75\times10^6} = \frac{10^{-3}}{150\pi\ 7.6} = \frac{10^{-6}}{.15\ \pi\ 7.6}$

$L = .28\times10^{-6} = 280\ nh$

$L = 280\ nh$ (boxed)

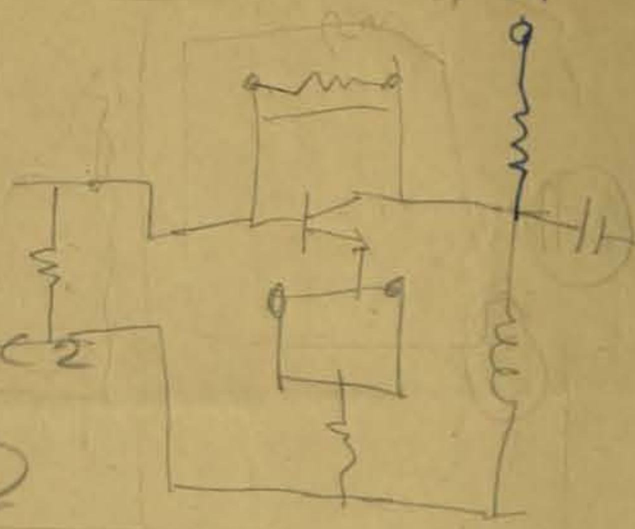


11/24/70 CONT FROM P. 101

FMOD, 9203LB, FAIR

```
7EDIT
*R AGC
301 CHARACTERS
*14/
.36,-110.,.027,55.,15.8,122.,.63,-32.
*14 CØPY 14
*13 CØPY 13
*12CØPY12
*11CØPY11
*9E
'RP',1,800.,0,0
L←'LP',1,.28←←←280.,0,0
*2CØPY2,9
*/
9,65,80,5,1
'RP',1,225.,0,0
'SAV1',0,0,0,0
'RS',2,2000.,0,0
'SCE',5,0,0,0
'PPAD',5,0,0,0
'RP',2,10.,0,0
'SSAD',4,0,0,0
'LP',1,280.,0,0
'RP',1,225.,0,0
'SAV1',0,0,0,0
'RS',2,2000.,0,0
'SCE',5,0,0,0
'PPAD',5,0,0,0
'RP',2,10.,0,0
'SSAD',4,0,0,0
'LP',1,280.,0,0
'PRNT',0,0,0,0
.35,-100.,.025,52.,18.2,130.,.7,-29.
.35,-100.,.025,52.,18.2,130.,.7,-29.
.35,-103.,.025,54.,17.4,128.,.68,-30.
.35,-103.,.025,54.,17.4,128.,.68,-30.
.36,-106.,.027,55.,16.6,125.,.66,-31.
.36,-106.,.027,55.,16.6,125.,.66,-31.
.36,-110.,.027,55.,15.8,122.,.63,-32.
.36,-110.,.027,55.,15.8,122.,.63,-32.
*10I
'CS',1,26.5,0,0
*19/
'PRNT',0,0,0,0
*18E
'LP',1,280.,0,0
'RP',1,800.,0,0
*1E
9,65,80,5,1
18,65,80,5,2
*W AGC2
 NEW FILE
592 CHARACTERS
*Q
```

Handwritten annotations: list; 72-257-6611; 'LS',1,69.,0,0; -7E; * R AGC2; *19I; 'CS'; 'LP'; D; *2I; 'LS'; D; Data for T and T at 65 MHz; 'CS',1,25.,0,0; 'LP',1,590.,0,0; no. of transistors; W AGC2

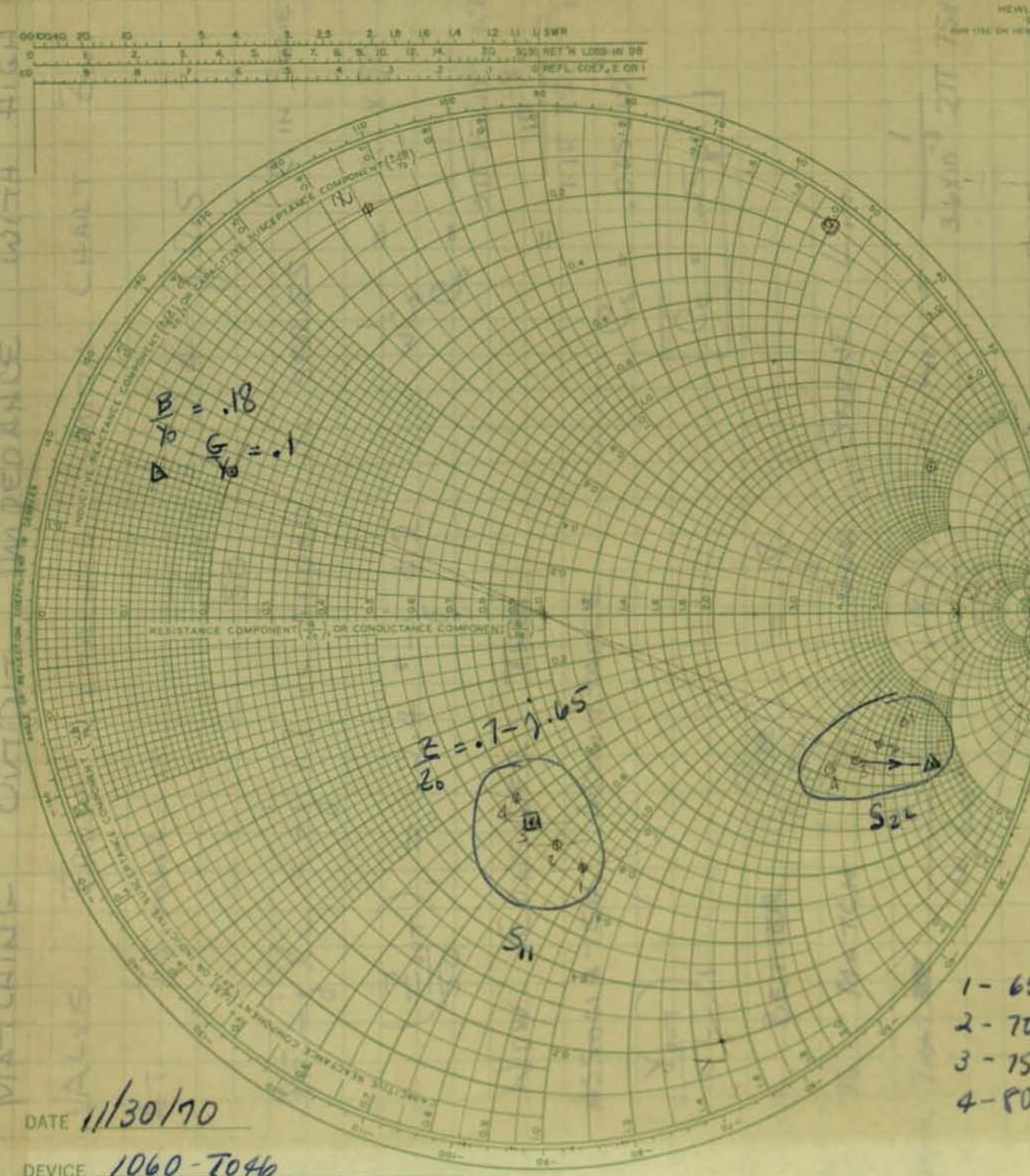


```
-ASSIGN F:3,(FILE,AGC2),(IN)

-GØ: QUICK
 F = 65.0000
        .49  -81.42     .004  123.03    41.41    28.25      .74  -16.48
 S21=  32.34 DB            K=    1.27

 F = 70.0000
        .44  -87.24     .004  116.91    42.06    16.18      .71  -20.86
 S21=  32.48 DB            K=    1.39

 F = 75.0000
        .40  -93.46     .004  112.68    42.26     4.20      .68  -24.92
 S21=  32.52 DB            K=    1.45

 F = 80.0000
        .36  -98.44     .005  107.11    41.34    -7.24      .64  -27.95
 S21=  32.33 DB            K=    1.62

 *STØP* 0

-BYE
11/23/'70 16:08
RAD SPACE 2
CPU TIME 0.025
I/Ø WAIT TIME 0.020
MØN SERVICES 0.015
```

CONT. FROM p. 102 11/29/70

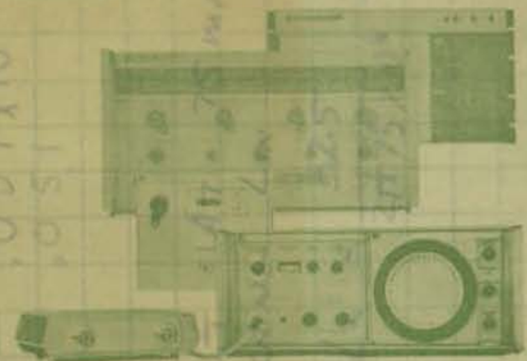
DATE 11/30/70

DEVICE 1060-T046
MWT 601A



1 - 65 MHz
2 - 70 "
3 - 75 "
4 - 80 "

HEWLETT-PACKARD
9280-0137
FOR USE ON HEWLETT-PACKARD RECORDERS



H-P MODEL 8410A NETWORK ANALYZER SYSTEM

DEVICE TEST PROCEDURE

1. Connect equipment: 8690A Sweep Oscillator, 8741A or 8742A Reflection Unit, 8410A/11A/14A Network Analyzer, Moseley X-Y Recorder to 8414A Polar Display rear panel outputs.
2. Set Sweeper to CW frequency, set 8410A frequency range, adjust RF level, push beam center, position beam at center of Polar Display.
3. Connect short to Reflection Unit, adjust amplitude and phase verniers and line stretcher for 1 /180° reading on 8414A.
4. Press beam center, adjust X-Y plotter zero controls to give a reference over 1.0 ±j0.0 on Smith Chart.
5. Adjust X channel gain for 0.0 ±j0.0 on Smith Chart, press beam center and adjust zero reference to 1.0 ±j0.0. Repeat until no correction need be made at either position.
6. Adjust Reflection Unit line stretcher for ±90° phase shift on 8414A display, repeat step 5 for points of 0.0 ±j1.0 making adjustment with Y channel gain and zero controls.
7. Move line stretcher to give 360° phase shift to check plotter settings.
8. Set start/stop frequencies for swept operation; disconnect X-Y recorder; with sweeper on auto, adjust line stretcher for minimum phase shift; position center of trace at 1 /180° with phase vernier; sweeper to manual sweep; connect X-Y recorder.
9. Connect test device and sweep.

HEWLETT hp PACKARD

Signature ______ Date ______
Signature ______ Date ______
Signature ______ Date ______
Signature ______ Date ______

MATCHING OUTPUT IMPEDANCE WITH HIGH VALVE. FROM ATTACHED SMITH CHART Z_{OUT} AT 75 MHZ IS:

$$\frac{Z_{OUT}}{50} = 2.4 - j2.5$$

IF $-jX_C = -j\,1.7$ IS ADDED IN SERIES (C_S IN SERIES)

$$\left(\frac{Z_{OUT}}{50}\right)_1 = 2.4 - j\,4.2$$

$$\frac{1}{wC_S} = 1.7 \times 50$$

$$C_S = \frac{1}{2\pi\, 75\times10^6 \cdot 1.7\times 50} = \frac{10^{-8}}{1.7\pi\, 75} = \frac{10^{-9}}{1.7\pi\, 7.5}$$

$$C_S = .025\times10^{-9}$$

$C_S = 25\,pf.$

NOW CONSIDER THE ASSOCIATED ADMITTANCE

$$\left(\frac{Y_{OUT}}{.02}\right)_1$$

OR BETTER $\left(\frac{B_{OUT}}{.02}\right)_1 = .18$ (.21)

TO MATCH MUST ADD SHUNT L_{OUT}

SUCH THAT $\frac{1}{w L_{OUT}} = (.18)(.02)$, $L_{OUT} = \frac{1}{3.6\times10^{-3}\, 2\pi\, 75\times10^6}$

.0036
.0042

$$L_{OUT} = \frac{10^{-3}}{3.6\,\pi\, 150} = \frac{10^{-5}}{3.6\pi\, 1.5} = .059\times10^{-5}$$

(4.2) (4.2) (.051)

$L_{OUT} = 590\,nh$

ALSO FROM CHART FOR ~~OUTPUT~~ INPUT AT 75 MHZ

$\frac{Z}{50} = .7 - j.65$ FOR INPUT MATCHING L_{IN}

$$\frac{1}{wL_{in}} = .65 \cdot 50 = 32.5, \quad L_{in} = \frac{32.5}{2\pi\, 75\times10^6} = \frac{325\times10^{-7}}{15\pi}$$

$L_{in} = 69\,nh$

Statement of Operation

Witnessed operation (obtain two signatures):

Signature _______ Date _______

Signature _______ Date _______

Signature _______ Date _______

Read and Understood (obtain two signatures):

Signature _______ Date _______

Signature _______ Date _______

 Cont. From p. 103 11/~~29~~ 30/70

THE

IN

```
TYMSHARE BTM E00.6 SUPPLEMENTAL SERVICE
12/04/'70 12:28
-WHØ IS CALLING, PLEASE?
 ?
-WHØ IS CALLING, PLEASE?
FAIR MICRØWV
 ?
-WHØ IS CALLING, PLEASE?  FMØD,9203LB,
ID= C
-7EDIT
*R AGC2
892 CHARACTERS
*4-
*$=27
*19I
'CS',1,25.,0,0
'LP',1,590.,0,0
*21
'LS',1,69.,0,0
*$=30
*1EDIT
18,65,80,5,2
21,65,80,5,2
*W AGC2
 ØLD FILE
638 CHARACTERS
*\
?
*/
21,65,80,5,2
'LS',1,69.,0,0
'RP',1,225.,0,0
'SAV1',0,0,0,0
'RS',2,2000.,0,0
'SCE',5,0,0,0
'PPAD',5,0,0,0
'RP',2,10.,0,0
'SSAD',4,0,0,0
'LP',1,280.,0,0
'CS',1,26.5,0,0
'RP',1,225.,0,0
'SAV1',0,0,0,0
'RS',2,2000.,0,0
'SCE',5,0,0,0
'PPAD',5,0,0,0
'RP',2,10.,0,0
'SSAD',4,0,0,0
'RP',1,800.,0,0
'CS',1,25.,0,0
'LP',1,590.,0,0
'PRNT',0,0,0,0
.35,-100.,.025,52.,18.2,130.,.7,-29.
.35,-100.,.025,52.,18.2,130.,.7,-29.
.35,-103.,.025,54.,17.4,128.,.68,-30.
.35,-103.,.025,54.,17.4,128.,.68,-30.
.36,-106.,.027,55.,16.6,125.,.66,-31.
.36,-106.,.027,55.,16.6,125.,.66,-31.
.36,-110.,.027,55.,15.8,122.,.63,-32.
.36,-110.,.027,55.,15.8,122.,.63,-32.
*QUIT

-ASSIGN F:3,(FILE,AGC2),(IN)

-GØ: ~~QUICK~~ SPEEDY
```

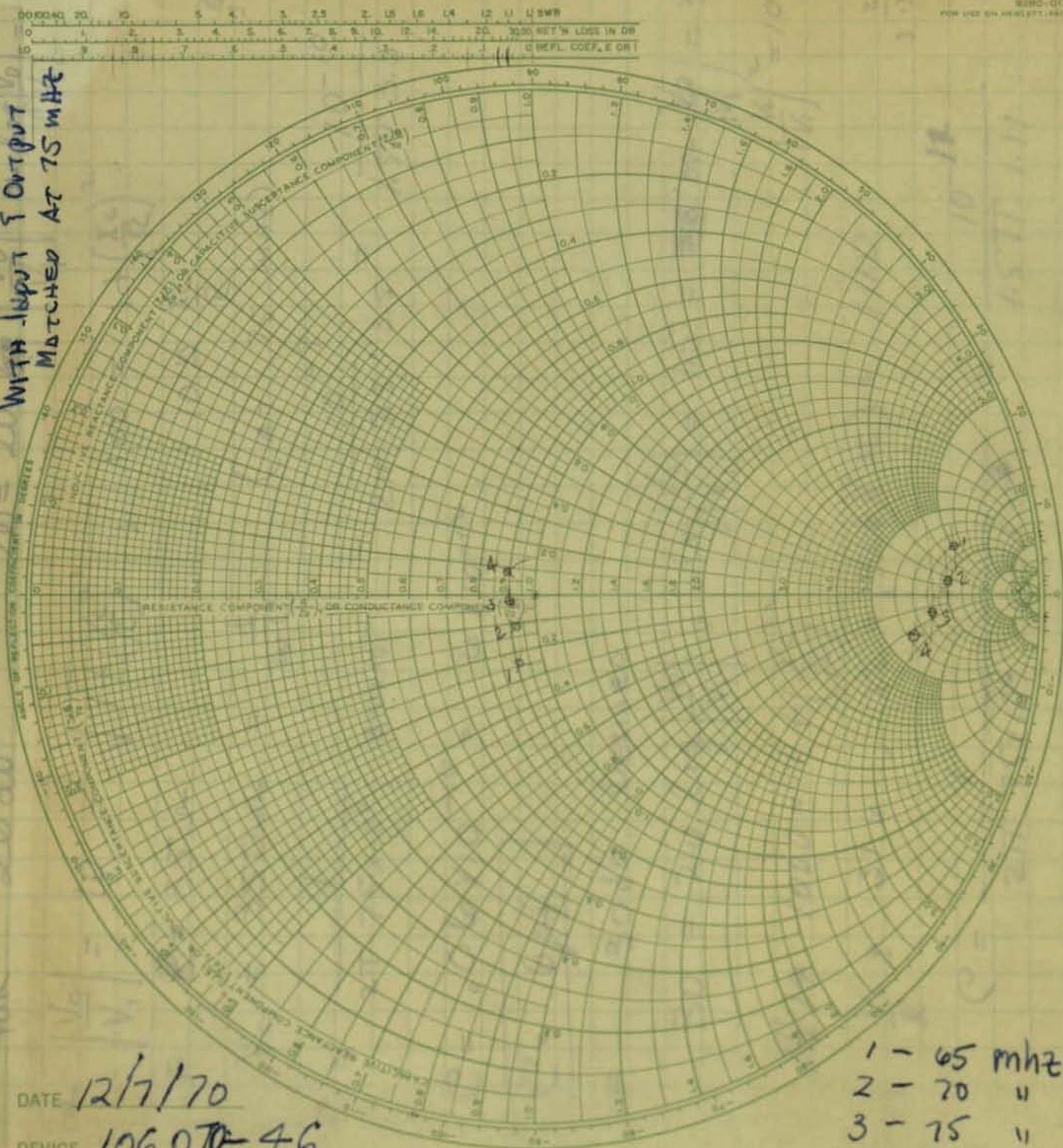
ØVERALL S PARAMETERS

FREQ. MHZ	S11 MAG.	S11 ANG.	S12 MAG.	S12 ANG.	S21 MAG.	S21 ANG.	S22 MAG.	S22 ANG.
65.	.13	-103.5	.003	131.5	36.09	36.7	.84	6.6
	S21= 31.15 DB		K= 1.27					
70.	.07	-122.0	.003	123.6	35.73	22.9	.82	1.8
	S21= 31.06 DB		K= 1.39					
75.	.05	-167.9	.004	117.8	35.34	9.3	.79	-2.6
	S21= 30.96 DB		K= 1.45					
80.	.07	139.9	.004	111.1	34.32	-3.3	.76	-6.2
	S21= 30.71 DB		K= 1.62					

```
*STØP* 0

-BYE
```

12/1/70 CONT. FROM p. 104

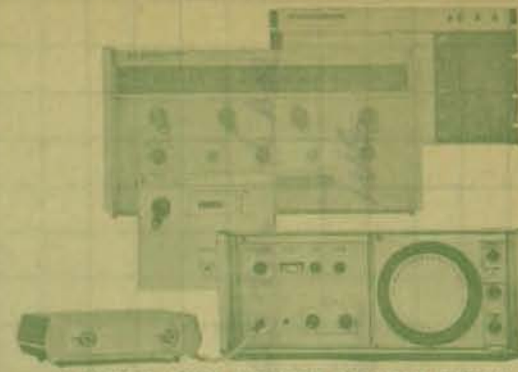
WITH INPUT & OUTPUT MATCHED AT 75 MHZ



DATE 12/7/70

DEVICE 106 OTD-46

HEWLETT-PACKARD
9280-0127
FOR USE ON HEWLETT-PACKARD RECORDERS



H-P MODEL 8410A NETWORK ANALYZER SYSTEM

DEVICE TEST PROCEDURE

1. Connect equipment: 8690A Sweep Oscillator, 8741A or 8742A Reflection Unit, 8410A/11A/14A Network Analyzer, Moseley X-Y Recorder to 8414A Polar Display rear panel outputs.
2. Set Sweeper to CW frequency, set 8410A frequency range, adjust RF level, push beam center, position beam at center of Polar Display.
3. Connect short to Reflection Unit, adjust amplitude and phase verniers and line stretcher for 1 /180° reading on 8414A.
4. Press beam center, adjust X-Y plotter zero controls to give a reference over 1.0 ±j0.0 on Smith Chart.
5. Adjust X channel gain for 0.0 ±j0.0 on Smith Chart, press beam center and adjust zero reference to 1.0 ±j0.0. Repeat until no correction need be made at either position.
6. Adjust Reflection Unit line stretcher for ±90° phase shift on 8414A display, repeat step 5 for points of 0.0 ±j1.0 making adjustment with Y channel gain and zero controls.
7. Move line stretcher to give 360° phase shift to check plotter settings.
8. Set start/stop frequencies for swept operation; disconnect X-Y recorder; with sweeper on auto, adjust line stretcher for minimum phase shift; position center of trace at 1 /180° with phase vernier; sweeper to manual sweep; connect X-Y recorder.
9. Connect test device and sweep.

HEWLETT hp PACKARD

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

12/2/70

CHARACTERIZATION OF 1060

NEAR 300 mHZ

I_{cc} = 20 mA
V_{cc} = 10 V.

02

FREQ. (MHZ)	S_{11}	θ	S_{22}	θ	S_{21}	θ	S_{12}	θ
270	.35	-170°	.43	-18°	14.8 14.8 db	88° +84	24.4 -24 db.	+70° +72°
280	.36	-171°	.42	-18°	14.3 14.5 db	88° +82°	24.2 -24 db	+71° +71°
290	.36	-173°	.42	-18°	14.2 14.4 db	+86° +80°	-24.0 -23.7 db	+71° +71°
300	.36	-174°	.41	-18°	13.8 14.0 db	+84° +79°	-23.8 -23.5 db	+71° +71°
310	.38	-175°	.41	-18°	13.5 13.6 db	+83° +78°	-23.5 -23.2 db	+71° +71°

08

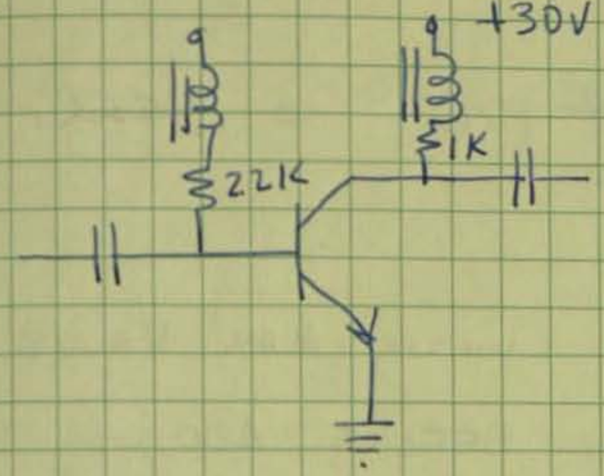
270	.28	-160°	.41	-20°	14.8 db	+90°	-23.0 db	+70°
280	.28	-163°	.40	-20°	14.5 db	+88°	-22.5 db	+70°
290	.28	-165°	.40	-20°	14.4 db	+86°	-22.5 db	+70°
300	.29	-168°	.40	-21°	14.0 db	+85°	-22.2 db	+70°
310	.29	-169°	.39	-21°	13.8 db	+83°	-22.0 db	+70°

# Trans	S_{11}	θ @ 270 mhz	S_{22}	θ @ 270 mhz
02	.35	-170	.35	-23°
09	.34	-168	.41	-19°
01	.33	-168	.38	-22°

12/3/70

CONT. FROM p. 106

BIAS CIRCUIT USED



$I_c = 20$ ma.

INDUCTORS :- 18 TURNS OF #30 WIRE
FERRITE - Q-3 TOROID
O.D. = .25"

12/8/70 FROM p. 103 CONSIDER MATCHING S_{22} TO 2500 Ω REAL AS ON ACCOMPANYING SMITH CHART. AROUND 75 MHZ 70 ~~pf~~ nh. IS A REASONABLE INDUCTANCE TO USE. FOR HYBRID INTEGRATED CIRCUITS.

FROM CHART $\frac{Y_L}{Y_0} = .2 + j.215$. IF $L = 70$ nh IS ADDED IN SHUNT.

$$-jB_L = -j\frac{1}{\omega L} = -j\frac{1}{2\pi\, 75\times10^6 \cdot 70\times10^{-9}} = -j\frac{1000}{150\pi\, 70}$$

$$-j\frac{B_L}{Y_0} = -j\frac{10}{105\pi}\cdot 50 = -j\frac{500}{105\pi},\ -j\frac{B_L}{Y_0} = -j1.515$$

$$\frac{Y_{11}}{Y_0} = .2 + j.215 - j1.515 = .2 - j1.30$$

THEN $\frac{Z_{11}}{Z_0} = .12 + j.75$. ADDING AN INDUCTANCE IN SERIES WILL ROTATE TO $Z_{12} = .12 + j2.30$

$\Delta X_L = 2.30 - .75 = 1.55$

Statement of Operation ____________

Witnessed operation (obtain two signatures):

Signature ____________ Date ____________

Signature ____________ Date ____________

Signature ____________ Date ____________

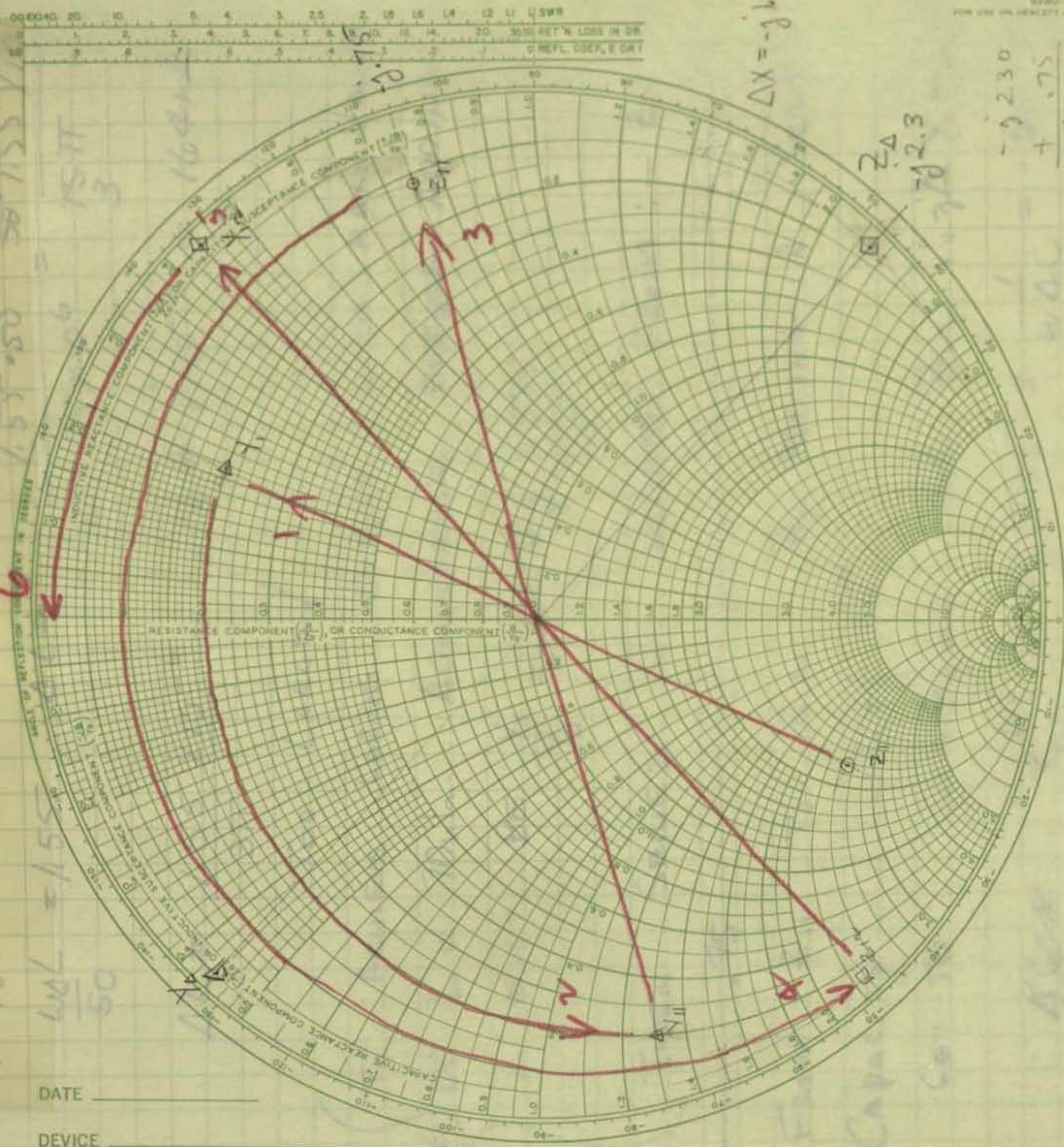
Read and Understood (obtain two signatures):

Signature ____________ Date ____________

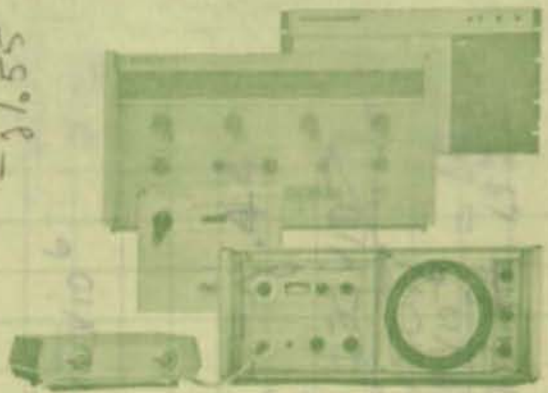
Signature ____________ Date ____________

12/8/70 Cont. from p. 107

HEWLETT-PACKARD
9280-0137
FOR USE ON HEWLETT-PACKARD RECORDERS



$-j2.30$
$+\ .75$
$-j1.55$



H-P MODEL 8410A NETWORK ANALYZER SYSTEM

DEVICE TEST PROCEDURE

1. Connect equipment: 8690A Sweep Oscillator, 8741A or 8742A Reflection Unit, 8410A/11A/14A Network Analyzer, Moseley X-Y Recorder to 8414A Polar Display rear panel outputs.
2. Set Sweeper to CW frequency, set 8410A frequency range, adjust RF level, push beam center, position beam at center of Polar Display.
3. Connect short to Reflection Unit, adjust amplitude and phase verniers and line stretcher for 1 /180° reading on 8414A.
4. Press beam center, adjust X-Y plotter zero controls to give a reference over 1.0 ±j0.0 on Smith Chart.
5. Adjust X channel gain for 0.0 ±j0.0 on Smith Chart, press beam center and adjust zero reference to 1.0 ±j0.0. Repeat until no correction need be made at either position.
6. Adjust Reflection Unit line stretcher for ±90° phase shift on 8414A display, repeat step 5 for points of 0.0 ±j1.0 making adjustment with Y channel gain and zero controls.
7. Move line stretcher to give 360° phase shift to check plotter settings.
8. Set start/stop frequencies for swept operation; disconnect X-Y recorder; with sweeper on auto, adjust line stretcher for minimum phase shift; position center of trace at 1 /180° with phase vernier; sweeper to manual sweep; connect X-Y recorder.
9. Connect test device and sweep.

HEWLETT hp PACKARD

DATE ____________

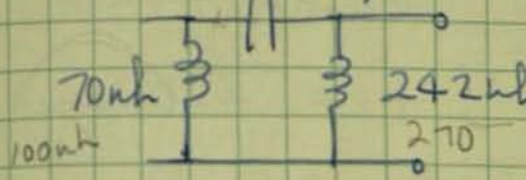
DEVICE ____________

Read and Understood (obtain two signatures):
Signature ____________ Date ________
Signature ____________ Date ________

Witnessed operation (obtain two signatures):
Signature ____________ Date ________
Signature ____________ Date ________

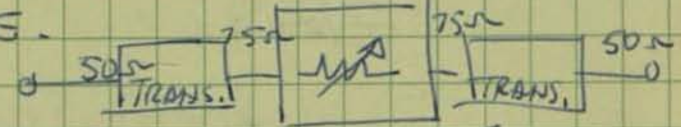
12/8/70 Cont. From p. 108

Matching Circuit to 2500 Ω LS



1/12/71 Considerations of Temperature Variations on Overall A.G.C. Circuitry.

Attenuator Performance.



About .6 db loss in transformers (total)

Inser. Loss (db)	Current (ma)	Voltage (volts)	V / I (kΩ)
1.35	10.1	30.	3.0
1.55	6.6	20.	3.0
1.75	4.8	15.	3.1
1.80	4.5	14	3.1
1.85	4.1	13	3.2
1.90	3.8	12	3.2
2.0	3.4	11	3.2
2.1	3.05	10	3.3
2.2	2.7	9	3.3
2.35	2.4	8	3.3
2.55	2.0	7	3.5
2.75	1.7	6	3.5
3.1	1.35	5	3.7
3.6	1.0	4	4.0
4.5	.7	3	~~4.1~~
6.2	.4	2	5.0
8.0	.2	1.5	7.5
11.8	.0	1.0	

1.55 – 3.6: ≈ 2 db change

4.5 – 8.0: ≈ 2 db change

V/I from 3.0 to 5.0: 6+ db Range (+3 … −3)

+3

4.1 → Mid Range 0

−3

Statement of Operation ______________________

____

Witnessed operation (obtain two signatures):

Signature ______________ Date ______

Signature ______________ Date ______

Signature ______________ Date ______

Read and Understood (obtain two signatures):

Signature ______________ Date ______

Signature ______________ Date ______

 2/19/71

BANDPASS FILTER DESIGN FOR INPUT TO UP CONVERTER FOR A.M. TRANSMITTER.

1. BANDPASS $f_1 = 170$ mhz, $f_2 = 220$ mhz
2. BAND STOP $\Delta f = 88$ mhz to 108 mhz
(FM TRANSMIT BAND)
3. $R_r = 75\,\Omega$ INPUT AND OUTPUT.

USING "FILTER SYNTHESIS HANDBOOK" By ZVEREV:

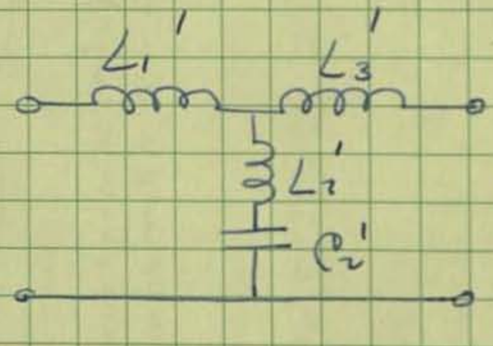
$n = 3$, $\rho = 4\% \sim .01$ db RIPPLE - PASS BAND

$\theta = 12° \sim 36$ db INSERTION LOSS (MIN. STOP BAND)

$f_m = \sqrt{f_1 f_2} = 193$ mhz

$a = \frac{f_m}{\Delta f} = \frac{193}{50} = 3.86$

PROTOTYPE:



FROM TABLES

$L_1' = L_3' = .56$

$L_2' = .04$

$C_2' = .88$

NORMALIZING FACTORS:

$\frac{R_r}{\omega_r} = 6.2 \times 10^{-8}$, $\frac{1}{R_r \omega_r} = 1.1 \times 10^{-11}$

CONT. FROM p. 110 2/19/71

FOR $\Theta = 12^\circ$ $\Omega_2 = 5.54$, $\Omega_1 = 1.72$

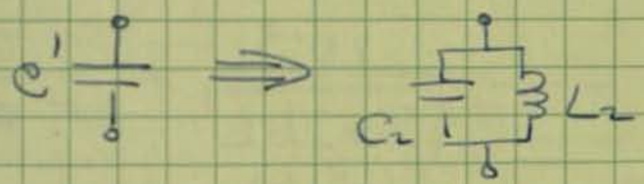
$$\frac{\Omega_\infty}{2a} = \frac{5.54}{7.72} = .72, \quad \left(\frac{\Omega_\infty}{2a}\right)^2 = .52$$

$$\Omega_\pm = \sqrt{1+.52} \pm .72 = 1.23 \pm .72$$

$$\Omega_+ = 1.95, \quad \Omega_- = .51, \quad f_{+\infty} = (193\,mhz)(.51) = 98.5\,mhz$$

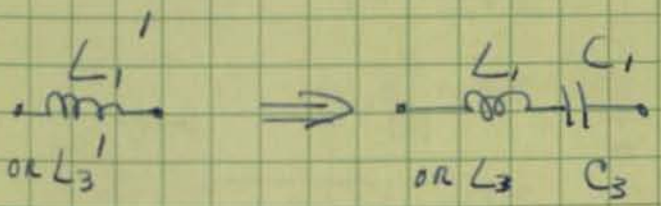
THIS SHOULD PUT MAX. ATTENUATION POINT IN MIDDLE OF Δf = 88 TO 108 MHZ BAND.

LOW PASS TO BAND PASS TRANSFORMATIONS.



$$L_2 = \frac{1}{a C_2'} \frac{R_r}{w_r} = \frac{6.2\times10^{-8}}{(3.86)(.88)}$$

$$\boxed{L_2 = 18.3\,nh}$$

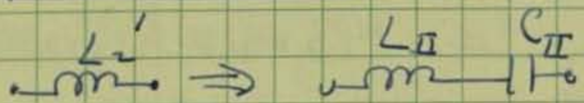


$$C_2 = (3.86)(.88)(1.1\times10^{-11})$$

$$\boxed{C_2 = 37.4\,pf.}$$

$$L_1 = a L_1' \frac{R_r}{w_r} = (3.86)(.56)(6.2\times10^{-8})$$

$$\boxed{L_1 = L_3 = 134\,nh}$$



$$L_{II} = a L_2' \frac{R_r}{w_r} = (3.86)(.04)(6.2\times10^{-8})$$

$$\boxed{L_{II} = 9.6\,nh}$$

$$C_1 = \frac{1}{a L_1'} \frac{1}{R_r w_r} = \frac{1.1\times10^{-11}}{(3.86)(.56)}$$

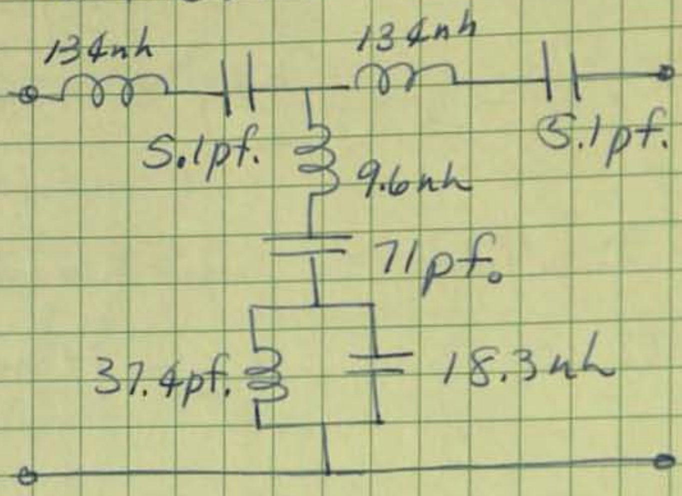
$$\boxed{C_1 = C_3 = 5.1\,pf}$$

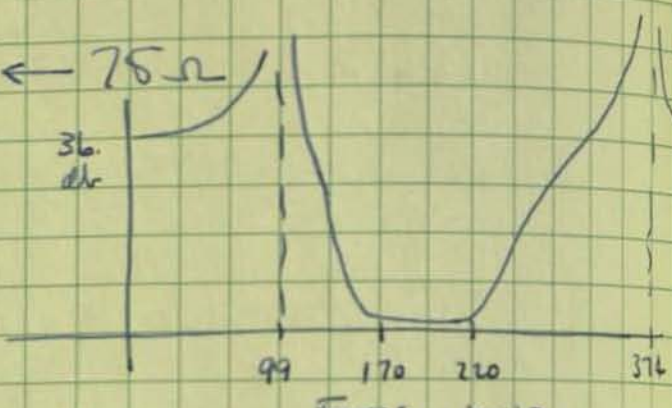
$$C_{II} = \frac{1.1\times10^{-11}}{(3.86)(.04)}$$

$$\boxed{C_{II} = 71\,pf}$$

2/19/71 Cont. From p. 111.

FINAL CIRCUIT BECOMES:





RESONANCE CHECK:-

$$f_{II\,Res} = \frac{1}{2\pi\sqrt{L_{II}C_{II}}} \doteq \frac{1}{2\pi\sqrt{(9.6\times10^{-9})(71\times10^{-12})}}$$

$$= \frac{10^{10}}{2\pi\sqrt{9.6\cdot7.1}} = \frac{10^{10}}{2\pi\ 8.25}$$

$$(\sqrt{68.2})$$

$$\boxed{f_{II\,Res} = \frac{10^{10}}{52} = 193\,mHZ}$$

$$f_{1\,or\,3\,Res} = \frac{1}{2\pi\sqrt{5.1\times10^{-12}\cdot134\times10^{-9}}} \doteq \frac{10^{10}}{2\pi\sqrt{68.2}}$$

$$\boxed{f_{1\,or\,3\,Res} = 193\,mHZ}$$

$$f_{2\,Res} = \frac{10^{10}}{2\pi\sqrt{37.4\cdot1.83}} = \frac{10^{10}}{2\pi\sqrt{68.5}}$$

$$\boxed{f_{2\,Res} = 193\,mhz}$$

COIL INFO.

134nh - #20 WIRE
$6\frac{1}{4}$ TURNS .25 I.D.

18nh St WIRE .019"
.8" LONG

28nh #18 $1\frac{1}{4}$ TURNS
.25 I.D.

Statement of Operation: ______________________

Witnessed operation (obtain two signatures):

Signature ______________ Date ______

Signature ______________ Date ______

Signature ______________ Date ______

Read and Understood (obtain two signatures):

Signature ______________ Date ______

Signature ______________ Date ______

4/12/71

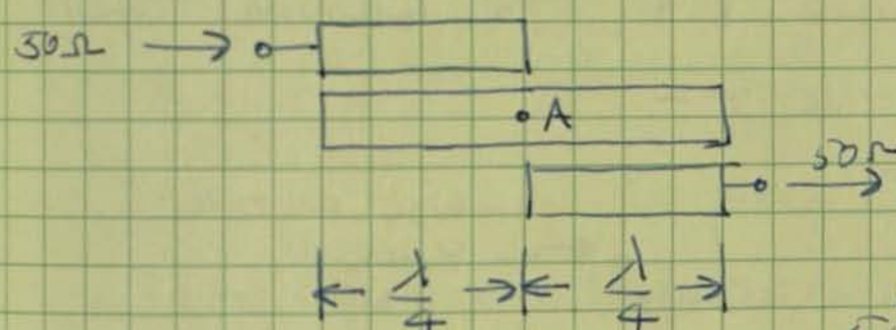
TRANSISTOR POWER AMPLIFIERS.

PULSED POWER AT 1090 MHZ.

TRANSISTORS ARE RUN COMMON BASE IN ORDER TO ACHIEVE HIGHER BREAKDOWN VOLTAGES.

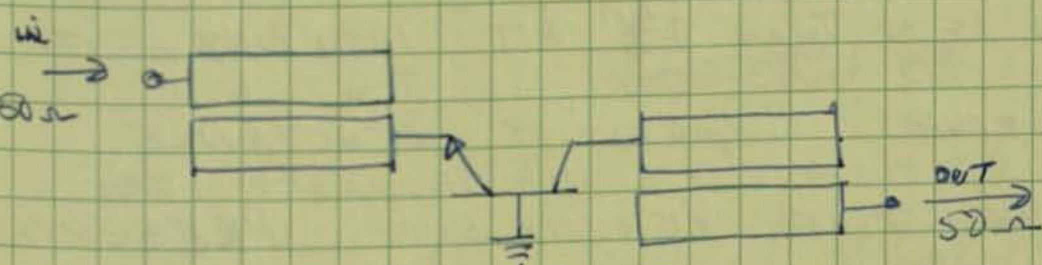
INPUT AND OUTPUT IMPEDANCES ARE QUITE LOW AND INDUCTIVE AS INDICATED BY SUCH COMPANIES AS MSC IN THERR LITERATURE.

CONSIDER THE FOLLOWING PASSIVE FILTER CIRCUIT (STRIPLINE)



AT POINT A THE IMPEDANCE TO GROUND WILL BE VERY LOW AT THE FREQUENCY WHERE EACH SECTION IS λ/4 AS SHOWN. IT CAN BE DESIGNED 50Ω IN AND 50Ω OUT.

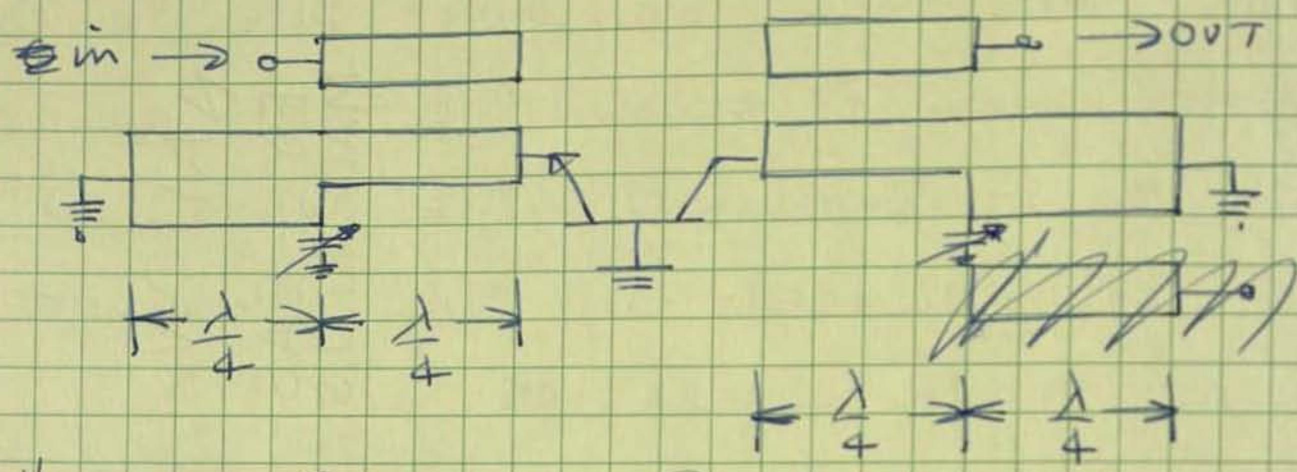
NEXT, CONSIDER BREAKING THE CIRCUIT AT A AND INSERTING GROUNDED BASE TRANSISTOR.



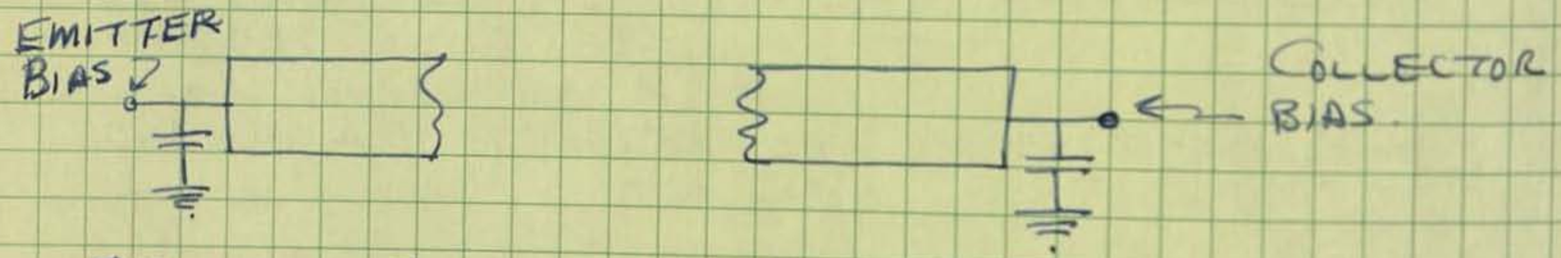
CONTINUED ON NEXT PAGE.

 CONTINUED FROM P. 113 4/12/71

CHANGE DESIGN BY ADDING SHORTED $\frac{\lambda}{4}$ LINE LENGTHS AS FOLLOWS!



VARIABLE CAPACITORS CAN TUNE OVER NARROW BAND OF FREQUENCIES. ALSO, BIAS CAN BE ACHIEVED BY BY-PASSING R.F. TO GROUND THRU A 500 pf. CAPACITOR: -

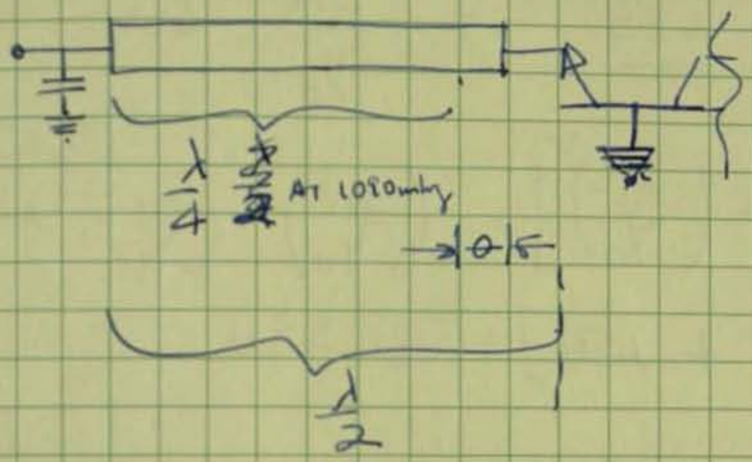


IF THE ELECTRICAL DISTANCE FROM THE SHORT TO THE EMITTER OR COLLECTOR IS GREATER THAN $\frac{\lambda}{4}$ AT 1090 MHz BUT LESS THAN $\frac{1}{2}$ AT 1090 MHz, IT WILL PRESENT A SERIES CAPACITIVE REACTANCE TO TUNE OUT ANY INDUCTIVE REACTANCE PRESENTED BY THE TRAASISTOR. FROM DATA SHEETS IT

CONT. FROM p 114 4/13/71

APPEARS TO BE ABOUT $jX_L = j10$

IF TRANSMISSION LINE IS 50Ω. i.e. $Z_0 = 50\Omega$



$\theta \simeq 84^\circ = 1.46$ RADIANS.

$\theta = \beta l = \frac{2\pi}{\lambda} l$

$\lambda = \frac{3 \times 10^{10}}{(1.09 \times 10^9)(2.54)(1.67)}$

$= \frac{30}{(1.09)(2.54)(1.67)} = 6.5''$

$l = \frac{\theta\lambda}{2\pi} = \frac{(1.46)(6.5'')}{2\pi} = 1.51''$

$\frac{\lambda}{4} = \frac{6.5}{4} = 1.62''$

∴ TOTAL LENGTH OF EACH LINE $\simeq 1.51 + 1.62 = 3.13''$

SINCE CAPACITORS (VARIABLE) MAKE EACH LINE LONGER WILL START WITH 3.00"

$\sqrt{\varepsilon_r} = 1.67$

$t = .003$ } $b = .25$

$\frac{t}{b} = \frac{.003}{.25} = .012$

FOR SINGLE 50 Ω LINE!

$Z_0 \sqrt{\varepsilon_r} = (50)(1.67) = 83.5$

$w/b = .67$ $w = .167 \simeq .170$

FOR PARALLEL COUPLED FILTER:

$w = .10$, FOR $n = 1$ { .01 db RIPPLE, $g_0 = 1$, $g_1 = .10$, $g_2 = 1.0$

 CONT. FROM p. 115 4/13/71

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi w}{2g_0 g_1}} = \sqrt{\frac{(3.14)(.1)}{2(.1)}} = \underline{1.25} = \frac{J_{12}}{Y_0} \text{ ALSO}$$

$$(Z_{oe})_{01} = \frac{1}{Y_0}\left[1 + \frac{J_{01}}{Y_0} + \left(\frac{J_{12}}{Y_0}\right)^2\right], \quad \left(\frac{J_{01}}{Y_0}\right)^2 = \left(\frac{J_{12}}{Y_0}\right)^2 = 1.56$$

$$= 50\left[1 + 1.25 + 1.56\right] = (50)(3.81)$$

$$\boxed{(Z_{oe})_{01} = 190\,\Omega}$$

$$(Z_{oo})_{01} = \frac{1}{Y_0}\left[1 - \frac{J_{01}}{Y_0} + \left(\frac{J_{12}}{Y_0}\right)^2\right] = (50)(1.31)$$

$$\boxed{(Z_{oo})_{01} = 65\,\Omega}$$

1
1.56
1.25
3.81

2.56
−1.25
1.31

GET IMPOSSIBLE DIMENSIONS TO WORK WITH — TRY MAXIMALLY FLAT. $g_0 = 1,\ g_1 = 2,\ g_2 = 1$

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi w}{2g_0 g_1}} = \sqrt{\frac{\pi \cdot .1}{2 \cdot 2}} = \frac{1}{2}\sqrt{.314} = \frac{.56}{2}$$

$$\frac{J_{01}}{Y_0} = \frac{J_{12}}{Y_0} = .28, \quad \left(\frac{J_{01}}{Y_0}\right)^2 \doteq .08$$

$$(Z_{oe})_{01} = 50\left[1 + .28 + .08\right] = (50)(1.36) = 68$$

$$\boxed{(Z_{oe})_{01}\sqrt{\epsilon_r} = 114\,\Omega}$$

$$(Z_{oo})_{01} = 50(1 - .28 + .08) = (50)(.8) = 40\,\Omega$$

$$\boxed{(Z_{oo})_{01}\sqrt{\epsilon_r} = 67\,\Omega}$$

1.08
−.28
.80

Statement of Operation: ____________

Witnessed operation (obtain two signatures):

Signature ____________ Date ____________

Signature ____________ Date ____________

Signature ____________ Date ____________

Read and Understood (obtain two signatures):

Signature ____________ Date ____________

Signature ____________ Date ____________

CONT. FROM p. 116

4/13/21

FROM NOMOGRAPHS

$\frac{W}{b} = .6$

$\boxed{W = .15}$

$\frac{S}{b} = .12$

$\boxed{S = .03}$

Statement of Operation

Witnessed operation (obtain two signatures):

Signature Date

Signature Date

Signature Date

Read and Understood (obtain two signatures):

Signature Date

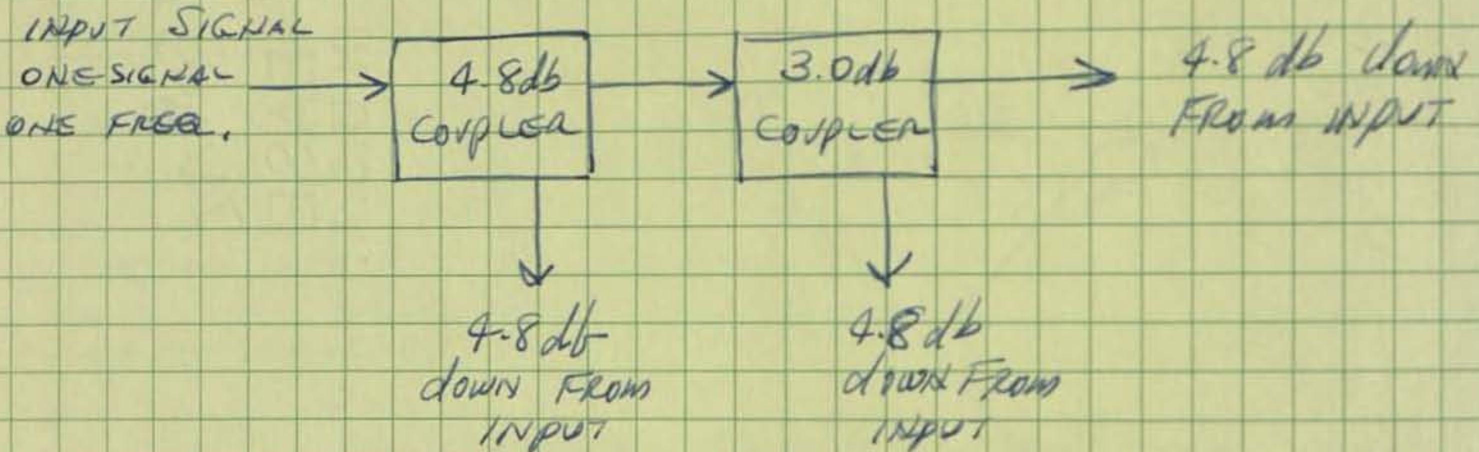
Signature Date

8/16/71

3 CHANNELS COMBINING INTO 3 ANTENNAS OR ANY 3 OUTPUTS

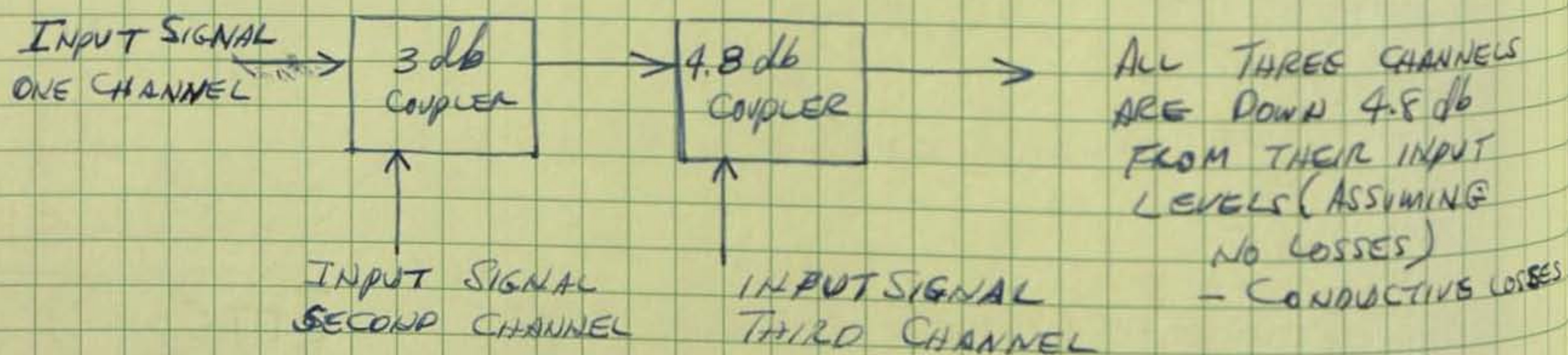
A COMMON WAY OF DIVIDING OR COMBING 3 SIGNALS OF ANY FREQUENCIES IS TO USE A 3.0db COUPLER AND A 4.8 db COUPLER. FOR EXAMPLE:

1. A DIVIDER



ASSUMING NO LOSSES THE INPUT SIGNAL POWER IS DIVIDED UP INTO THIRDS. (CONDUCTIVE LOSSES)

2. A COMBINER



Statement of Operation' ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature Everett E. Gerhart Date 8/16/71

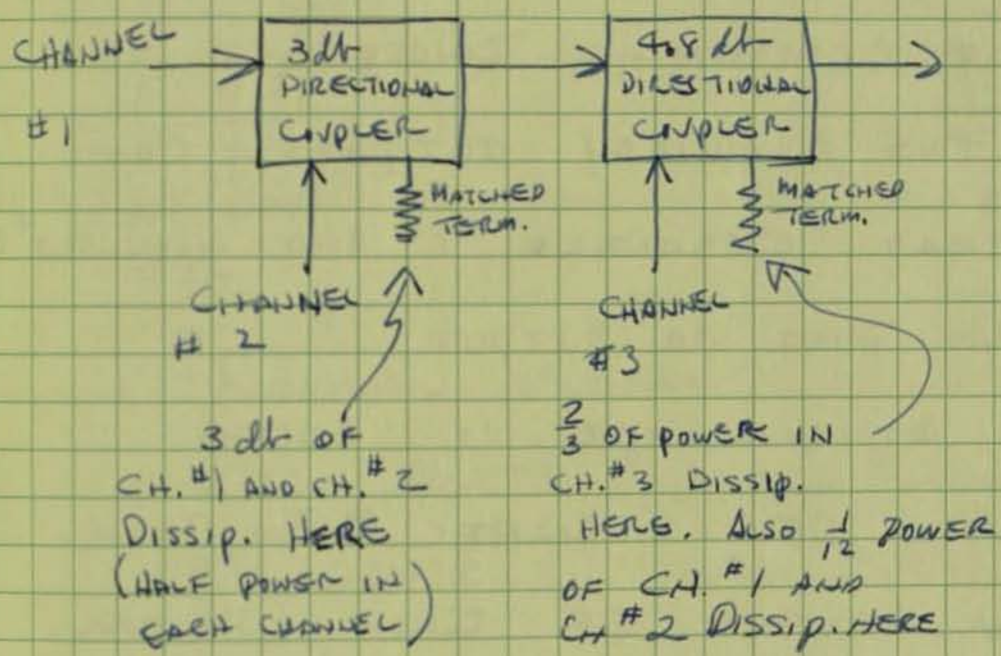
Read and Understood (obtain two signatures):

Signature [signature] Date 9/15/71

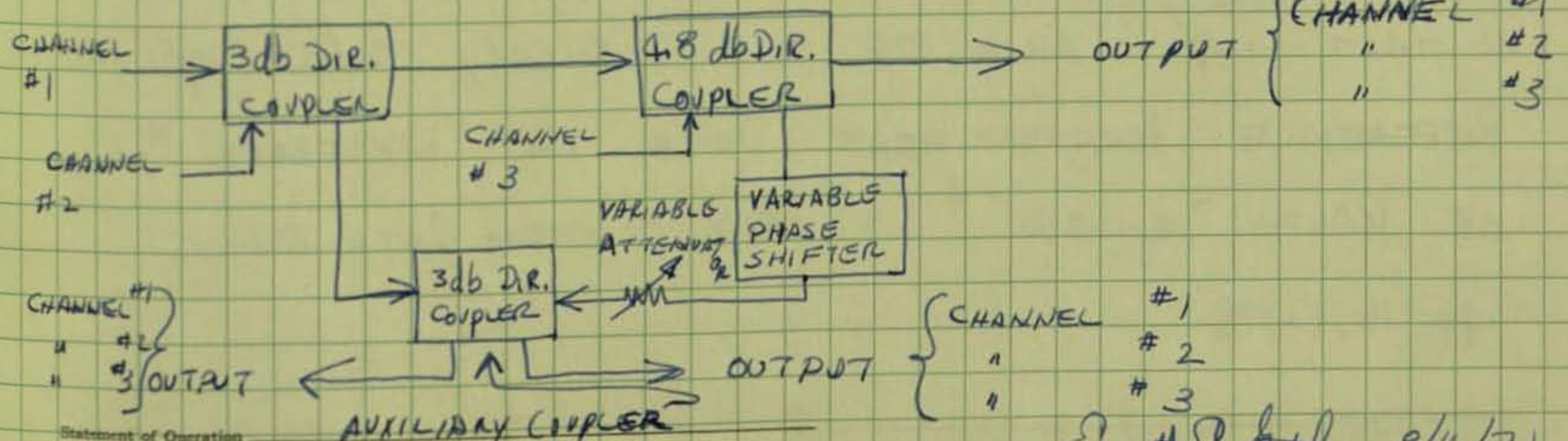
Signature [signature] Date 9/15/71

CONTINUED FROM p. 118 8/16/71

THE COMBINING SCHEME HAS A DISADVANTAGE IN THAT A DIRECTIONAL COUPLER AS USED IN THIS COMBINING SCHEME IS A FOUR PORT DEVICE WITH ONE PORT NORMALLY TERMINATED IN A MATCHED LOAD. THE DISADVANTAGE SHOWS UP IN COMBINING BY SIGNALS BEING DISSIPATED INTO THESE TERMINATIONS.



THIS DISADVANTAGE CAN BE GREATLY OVERCOME BY THE FOLLOWING HOOK-UP.



Statement of Operation AUXILIARY COUPLER

Signature Everett E. Guthrie Date 8/16/71

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

~~Read and~~ Understood (obtain two signatures):

Signature [signature] Date 9/15/71

Signature Philip J. Barton Date 9/15/71

 8/16/71 CONTINUED FROM p. 119

AS CAN BE SEEN THE POWER THAT WOULD NORMALLY BE LOST IN THE MATCHED TERMINATIONS IS COMBINED TO FEED TWO ADDITIONAL OUTPUTS OR ANTENNAS. THE VARIABLE PHASE SHIFTER IS REQUIRED SO THAT CHANNELS #1 AND #2 COMING OUT OF THE 4.8 db COUPLER WILL BE IN THE PROPER COMBINING PHASE WITH RESPECT TO CHANNELS #1 AND #2. BY PROPER COMBINING PHASE IT IS MEANT THAT THE TWO AUXILIARY OUTPUTS CAN BE ADJUSTED SO THAT CHANNEL #1 AND CHANNEL #2 ARE EQUAL AT EACH PORT OR OUTPUT.

THE VARIABLE ATTENUATOR IS ADDED TO BRING THE LEVEL OF CHANNEL #3 DOWN SUCH THAT POWER LEVELS OF EACH CHANNEL IN ONE OUTPUT ARE THE SAME. IT ALSO REDUCES THE CONTRIBUTION OF CHANNELS #1 AND #2 IN THAT INPUT ARM OF THE AUXILIARY 3db COUPLER. REFERENCE MEASUREMENT DATA IN NOTEBOOK #1 OF RALPH JENSEN "SSB-AM SYSTEM DATA ONLY" pp 16, 17, 18.

Statement of Operation: ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature Everett E. Guthrie Date 9/15/71

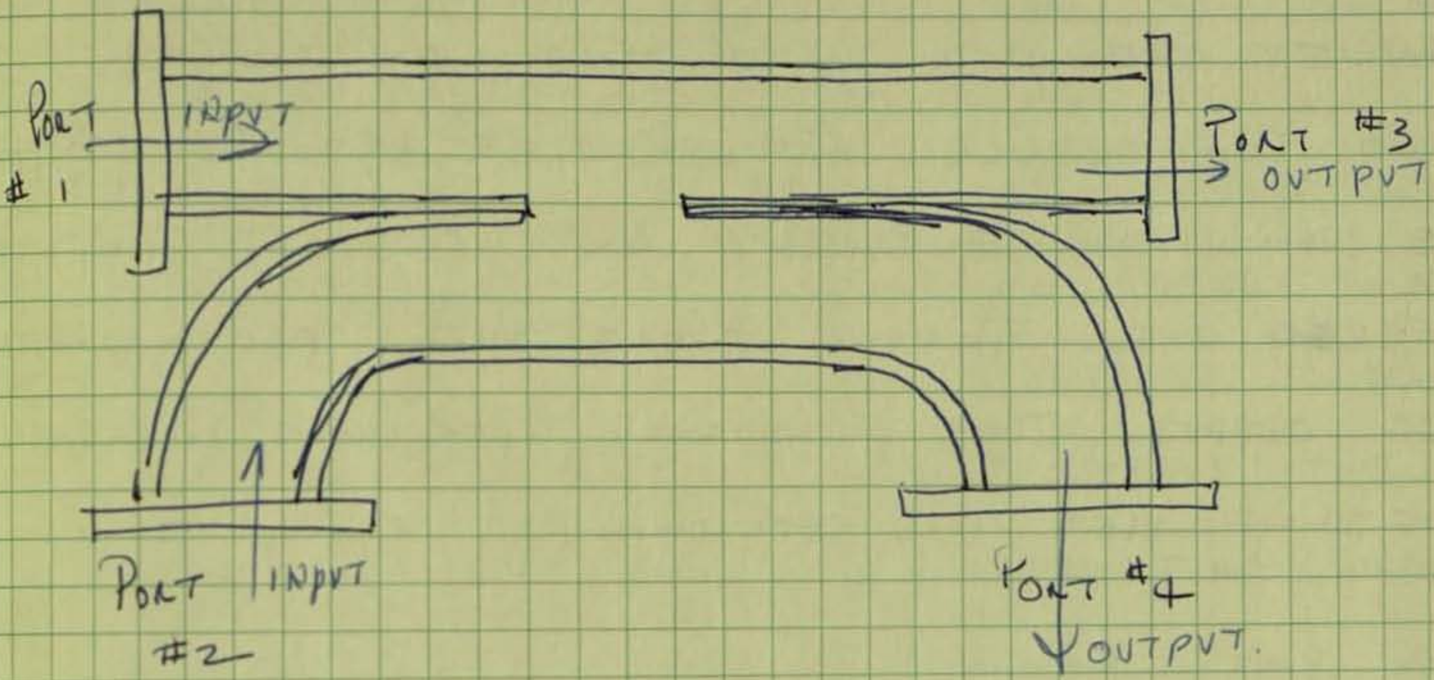
Read and Understood (obtain two signatures):

Signature Ralph Jensen Date 9/15/71

Signature Philip [illegible] Date 9/15/71

NOTE USEAGE OF AUXILIARY COUPLER:

SKETCH LOOK INTO TOP WALL OF COUPLER



NORMAL USEAGE WOULD BE TO COMBINE INTO PORTS #1 AND #2. OUTPUTS (EACH CONTAINING 3 CHANNELS) WOULD THEN BE PORTS #3 AND #4.

Statement of Operation

Witnessed operation (obtain two signatures):

Signature Date

Signature Date

Signature Everett S. Gruber Date 9/15/71

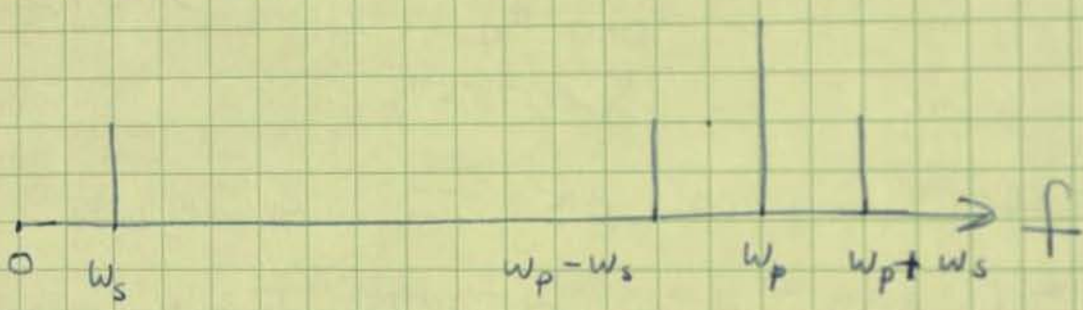
Read and Understood (obtain two signatures):

Signature [signature] Date 9/15/71

Signature [signature] Date 9/15/71

9/27/71 UP CONVERTER IMPEDANCE MATCHING CIRCUITS

AN UP CONVERTER IS A CIRCUIT CONTAINING A NON-LINEAR ELEMENT SUCH THAT WHEN TWO FREQUENCIES ARE PUT INTO THE CIRCUIT, THE SUM AND DIFFERENCE FREQUENCIES ARE GENERATED BY THE NONLINEAR ELEMENT AND ONE OF THESE IS FILTERED OUT. THAT IS, THERE ARE TWO INPUTS AND ONE OUTPUT. THE FREQUENCY SPECTRUM MIGHT BE SOMETHING LIKE THE FOLLOWING:



W_s = INPUT SIGNAL

W_p = INPUT PUMP OR CARRIER

$W_p + W_s$ = UPPER SIDE BAND

$W_p - W_s$ = LOWER SIDE BAND

THE PARTICULAR TYPE OF UP CONVERTER WE ARE CONCERNED WITH HERE IS SOME TIMES CALLED A PARAMETRIC TYPE UP CONVERTER BECAUSE

Statement of Operation

Witnessed operation (obtain two signatures)

Signature ________ Date ________

Signature ________ Date ________

Signature [signature] Date 9/27/71

Read and Understood (obtain two signatures)

Signature [signature] Date 10-6-71

Signature [signature] Date 10-6-71

9/27/71 CONTINUED FROM p. 122

THE NONLINEAR ELEMENT IS A VARACTOR DIODE. THAT IS, THE NONLINEARITY IS IN A VARIABLE CAPACITANCE. TO BE EVEN MORE DEFINITIVE WE ARE INTERESTED IN WHAT IS COMMONLY CALLED A POWER UP CONVERTER. THIS MEANS AN UP CONVERTER DESIGN SUCH THAT MAXIMIZES THE OUTPUT SIDEBAND POWER (WHICHEVER IS CHOSEN - UPPER OR LOWER) VERSUS THE PUMP OR CARRIER POWER PUT INTO THE CIRCUIT. A FIGURE OF MERIT IS CALLED PUMP EFFICIENCY AND IS EXPRESSED IN PERCENT AND EQUALS

$$100 \times \frac{\text{OUTPUT SIDEBAND POWER}}{\text{INPUT PUMP POWER}}.$$

CONSIDERATIONS FOR SUCH DESIGN IS ON p. 64 OF THIS NOTEBOOK. THAT IS, THE BEGINNING OF DESIGN. ON PAGE 66 IS SHOWN A CALCULATION FOR A 54 MHZ INPUT IMPEDANCE OF 425 OHMS. WHAT THIS SHOWS IS THAT IN ORDER TO DESIGN A POWER UP-CONVERTER ONE MUST BE ABLE TO PRESENT A HIGH IMPEDANCE TO THE VARACTOR AT THE SIGNAL INPUT PORT.

Statement of Operation

Witnessed operation (obtain two signatures):

Signature Date

Signature Date

Signature E. Sutton Date 9/29/71

Read and Understood (obtain two signatures):

Signature [signature] Date 10-6-71

Signature [signature] Date 10-6-71

9/27/71 CONTINUED FROM p. 123

425 OHMS IS HIGH IN IMPEDANCE AS COMPARED TO COMMON TRANSMISSION LINE IMPEDANCES AS 50 OHMS OR 75 OHMS. IN FACT, THERE IS A PAPER ENTITLED "UP CONVERTER TYPE TRANSMITTER FOR RADIO LINK" BY W. KWIATKOWSKI GIVEN IN THE PROCEEDINGS OF THE JOINT SYMPOSIUM ON MICROWAVE APPLICATIONS OF SEMICONDUCTORS - UNIVERSITY COLLEGE, LONDON - JUNE 30 - JULY 2, 1965. PAPER NO. 23., WHICH SHOWS THE IMPORTANCE OF MATCHING TO HIGH INPUT IMPEDANCE. FIGURE 7 SHOWS THAT HIGH IMPEDANCE MATCHING PROVIDES BEST LINEARITY OF OUTPUT VERSUS INPUT OF THE UP CONVERTER.

SINCE OUR APPLICATION IS FOR AN A.M. SYSTEM & LINEARITY OF THE UP CONVERTER IS THE MOST CRITICAL PARAMETER REGARDING DISTORTION ESPECIALLY IN A MULTICHANNEL SYSTEM. THE MORE LINEAR THE UP CONVERTER THE LESS THE DISTORTION. THEREFORE, THE FOLLOWING IS A CIRCUIT BY WHICH THE REQUIRED HIGH IMPEDANCE

Statement of Operation ______

Witnessed operation (obtain two signatures)

Signature ______ Date ______

Signature ______ Date ______

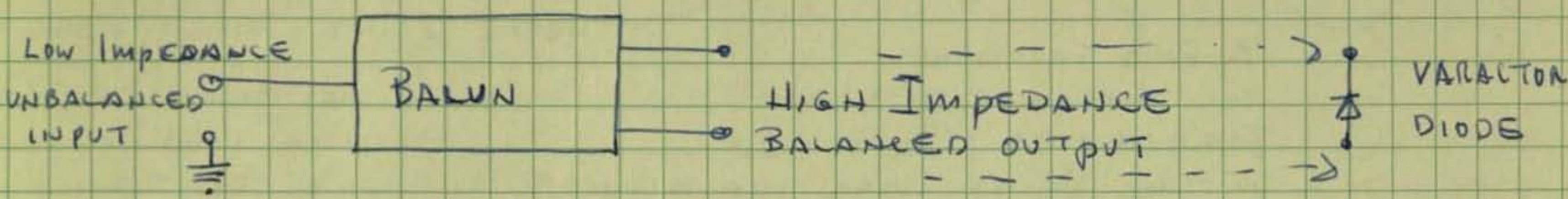
Signature Everett P. Gilbert Date 9/29/71

Read and Understood (obtain two signatures):

Signature [signature] Date 10-6-71

Signature [signature] Date 10-6-71

IS ACHIEVED AT THE OUTPUT WHILE THE INPUT TO THE CIRCUIT CAN BE IN THE COMMON RANGE OF 50Ω TO 75Ω:



THE LOW IMPEDANCE SIDE CAN BE FED BY A 50Ω - 75Ω COAXIAL LINE WHILE THE HIGH IMPEDANCE SIDE WOULD BE TERMINATED ~~TH~~ BY THE VARACTOR.

ALSO, THE BALUN CAN BE DESIGNED AND CONSTRUCTED SUCH THAT IT CAN HAVE A SIZEABLE SERIES INDUCTIVE REACTANCE THAT WILL MATCH THE SERIES CAPACITIVE REACTANCE OF THE VARACTOR DIODE.

THE NEXT CONSIDERATION IS HOW TO COUPLE THE PUMP FREQUENCY SIGNAL TO THE VARACTOR AND ALSO TAKE OUT A SIDEBAND SIGNAL.

A SUCCESSFUL TECHNIQUE IS THE FOLLOWING:

(NEXT PAGE)

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

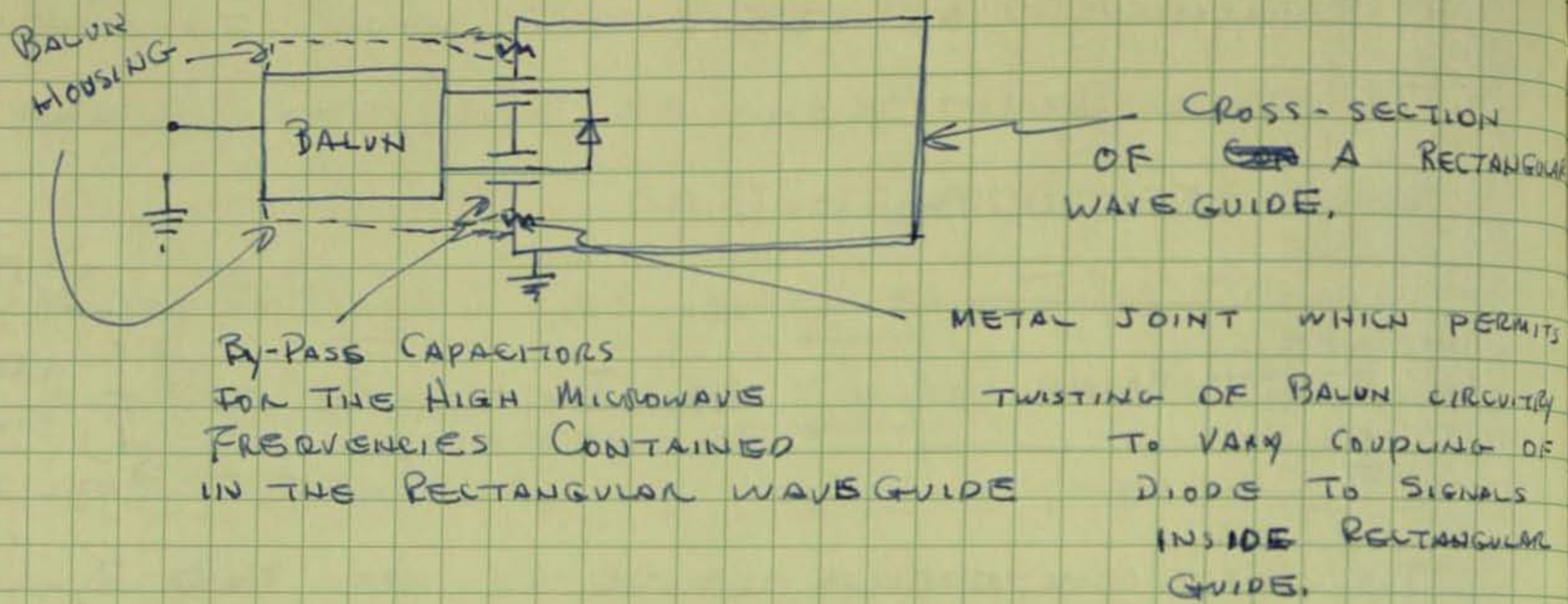
Signature Everett P. Guthrie Date 10/1/71

Read and Understood (obtain two signatures):

Signature [signature] Date 10-6-71

Signature [signature] Date 10-6-71

 CONTINUED FROM p. 125 10/1/71



AS SHOWN, TWISTING THE BALUN HOUSING VARIES THE COUPLING OF THE VARACTOR TO THE WAVEGUIDE. ALSO, THE HOUSING CAN BE MOVED WITH SLIDING CONTACTS IN AND OUT OF THE WAVEGUIDE. THIS IS ANOTHER TECHNIQUE TO VARY THE COUPLING. THE BY-PASS CAPACITANCE IS MAINTAINED BY DIELECTRIC COATED RODS THAT MAINTAIN A SLIDING SURFACE. THE BALUN HOUSING PROVIDES A CONTINUITY OF GROUND FROM THE UNBALANCED INPUT TO THE WAVEGUIDE CIRCUIT.

OTHER POSSIBLE CONFIGURATIONS FOR THE DIODE MOUNT WOULD INCLUDE BALANCED DIODES OR UNBALANCED DIODES.

Statement of Operation

Witnessed operation (obtain two signatures)

Signature Date

Signature Date

Signature Everett E. Gunther Date 10/1/71

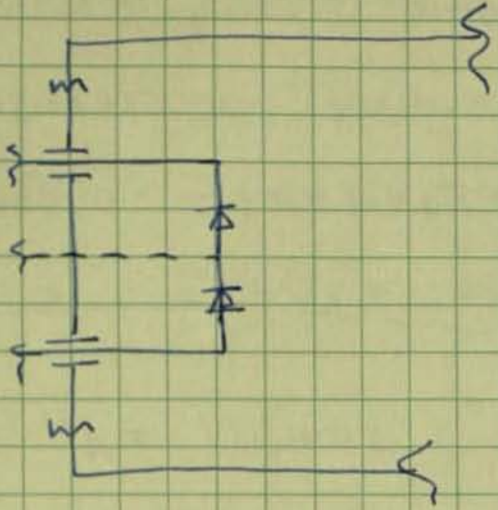
Read and Understood (obtain two signatures):

Signature [signature] Date 10-6-71

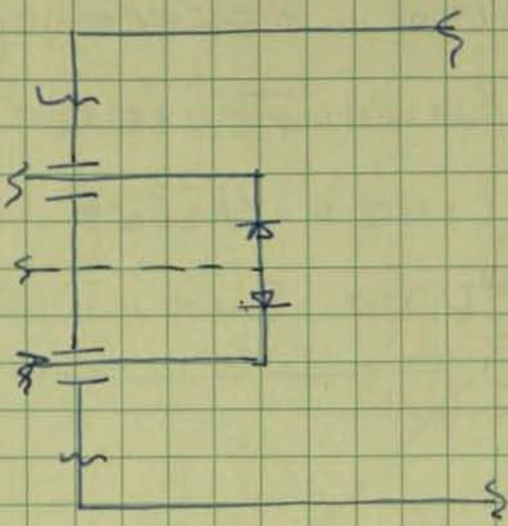
Signature [signature] Date 10-6-71

CONTINUED FROM p. 126 10/1/71

SUCH AS:



OR



A SLIDING GROUND CONNECTION CAN BE ADDED FOR HEAT SINKING AND SEPARATE GROUND RETURN.

THIS BALUN MATCHING APPROACH CAN ALSO BE USED AT HIGHER FREQUENCY INPUTS BY USING DIFFERENT TYPES OF HIGH FREQUENCY BALUNS.

ANY BALUN TYPE MAY BE USED; HOWEVER, BALUNS WITH HIGH IMPEDANCE RATIOS MUST BE USED, SUCH AS DESCRIBED IN "SOME BROAD BAND TRANSFORMERS" BY C.L. RUTHROFF, PROCEEDINGS OF IRE. AUG. 1959 pp. 1337-1342. BALUNS WITH 4:1 CHANGE IN IMPEDANCE HAVE BEEN USED IN THE LAB. REFERENCE LAB. NOTEBOOK #1 RALPH JENSEN - SSBAM SYSTEM DATA pp. 18, 20, 21, 22.

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature [illegible] Date 10/6/71

Read and Understood (obtain two signatures):

Signature [illegible] Date 10/6/71

Signature [illegible] Date 10/7/71

CONTINUED FROM p 127 10/6/71

ALSO REFERENCE NOTEBOOK # 2, 4/26/71
RALPH JENSEN. OTHER COAX OR TRANSMISSION
LINE: BALUNS OR TRANSFORMERS COULD BE
USED.

Statement of Operation

Witnessed operation (obtain two signatures)

Signature Date

Signature Date

Signature Everett A. C. Guthrie Date 10/6/71

Read and Understood (obtain two signatures):

Signature Ralph Jensen Date 10/6/71

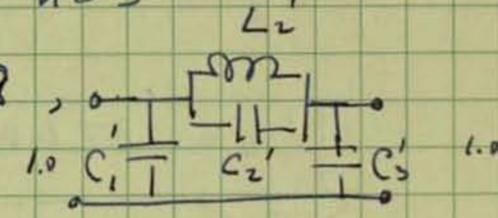
Signature Date

LOW PASS FILTER FOR CRYSTAL OSC. OUTPUT.

USING "HANDBOOK OF FILTER SYNTHESIS"

BY ZVEREV. P. 17~~2~~3 $\rho = 5\%$, $n = 3$

$\theta = 31^\circ$, $C_1' = C_3' = .48$, $C_2' = .30$, $L_2' = .69$,

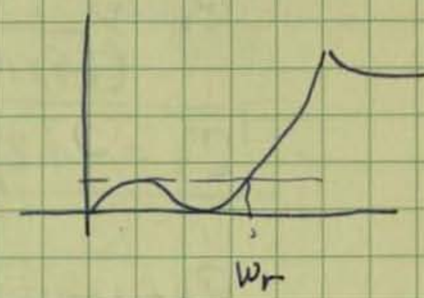


LET $f_r = 110$ MHZ

$W_r = 2\pi \; 110 \times 10^6 = 69 \times 10^7$

$W_r = 6.9 \times 10^8$

$R_r = 50\,\Omega$.



$$L_2 = L_2' \frac{R_r}{W_r} = (.69)\frac{50}{6.9 \times 10^8} = 50 \times 10^{-9}$$

$L_2 = 50$ nh

$$C_1 = C_3 = \frac{C_1'}{W_r R_r} = \frac{.48}{(6.9 \times 10^8)(50)} = \frac{4800 \times 10^{-12}}{(6.9)(50)}$$

$C_1 = C_3 = 13.9$ pf.

$$C_2 = \frac{C_2'}{W_r R_r} = \frac{.30}{(6.9 \times 10^8)(50)} = \frac{\overset{60}{\cancel{3000}} \times 10^{-12}}{(6.9)(\cancel{50})}$$

$C_2 = 8.7$ pf.

RESONANCE CHECK

$$f_s = \frac{1}{2\pi\sqrt{L_2 C_2}} = \frac{1}{2\pi\sqrt{(5.0 \times 10^{-8})(8.7 \times 10^{-12})}} = \frac{10^{10}}{2\pi\sqrt{43.5}} = \frac{10{,}000 \times 10^6}{2\pi \; 6.6}$$

$= 240$ mhz

TOO HIGH, WANT TO REJECT 200MHZ

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

CONT. FROM p. 129 2/17/72

TRY $\rho = 4\%$ $n = 3$

$\theta = 40°$, $C_1' = C_3' = .33$, $C_2' = .73$, $L_2' = .45$

$$L_2 = \frac{(.45)\,50}{6.9\times10^8} = 3.26\times10^{-8} = 32.6\times10^{-9}$$

$L_2 = 32.6\,nh$

$$C_2 = \frac{.73}{(6.9\times10^8)\,50} = \frac{7300}{(50)\,6.9}\times10^{-12} = 21.2\,pf.$$

$C_2 = 21.2\,pf.$

RESONANCE: $$f_s = \frac{1}{2\pi\sqrt{(32.6\times10^{-9})(21.2\times10^{-12})}} = \frac{10^{+10}}{2\pi\sqrt{(3.26)(21.2)}}$$ 69

$$f_s = \frac{10^{+10}}{2\pi\ 8.3} = \frac{10{,}000}{16.6\pi}\times10^6$$

$f_0 = 192\ mhz$

$$\frac{\overset{66}{\cancel{3300}}}{(6.9)\ \cancel{50}}\times10^{-12}$$

$$C_1 = C_3 = \frac{.33}{(6.9\times10^8)(50)} = 9.6\,pf.$$

$C_1 = C_3 = 9.6\,pf.$

$$\cancel{2\pi\sqrt{\frac{9.6\times10^{-12}}{2}\ 32.6\times10^{-9}}} = \cancel{\frac{10^{10}}{2\pi\sqrt{(3.26)(9.6)}}} = \cancel{\frac{10^{10}}{2\pi\ 5.6}}$$

31.2

Statement of Operation ______

Witnessed operation (obtain two signatures)

Signature ______ Date ______

Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

Signature ______ Date ______

Signature ______ Date ______

TEMPERATURE COMPENSATION OF A GUNN OSC.

2/23/72

Statement of Operation ____________________

Witnessed operation (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

Signature ____________ Date ________

Read and Understood (obtain two signatures):

Signature ____________ Date ________

Signature ____________ Date ________

Statement of Operation ________________

Witnessed operation (obtain two signatures)

Signature__________ Date______

Signature__________ Date______

Signature__________ Date______

Read and Understood (obtain two signatures):

Signature__________ Date______

Signature__________ Date______

Statement of Operation ______

Witnessed operation (obtain two signatures):

Signature ______ Date ______

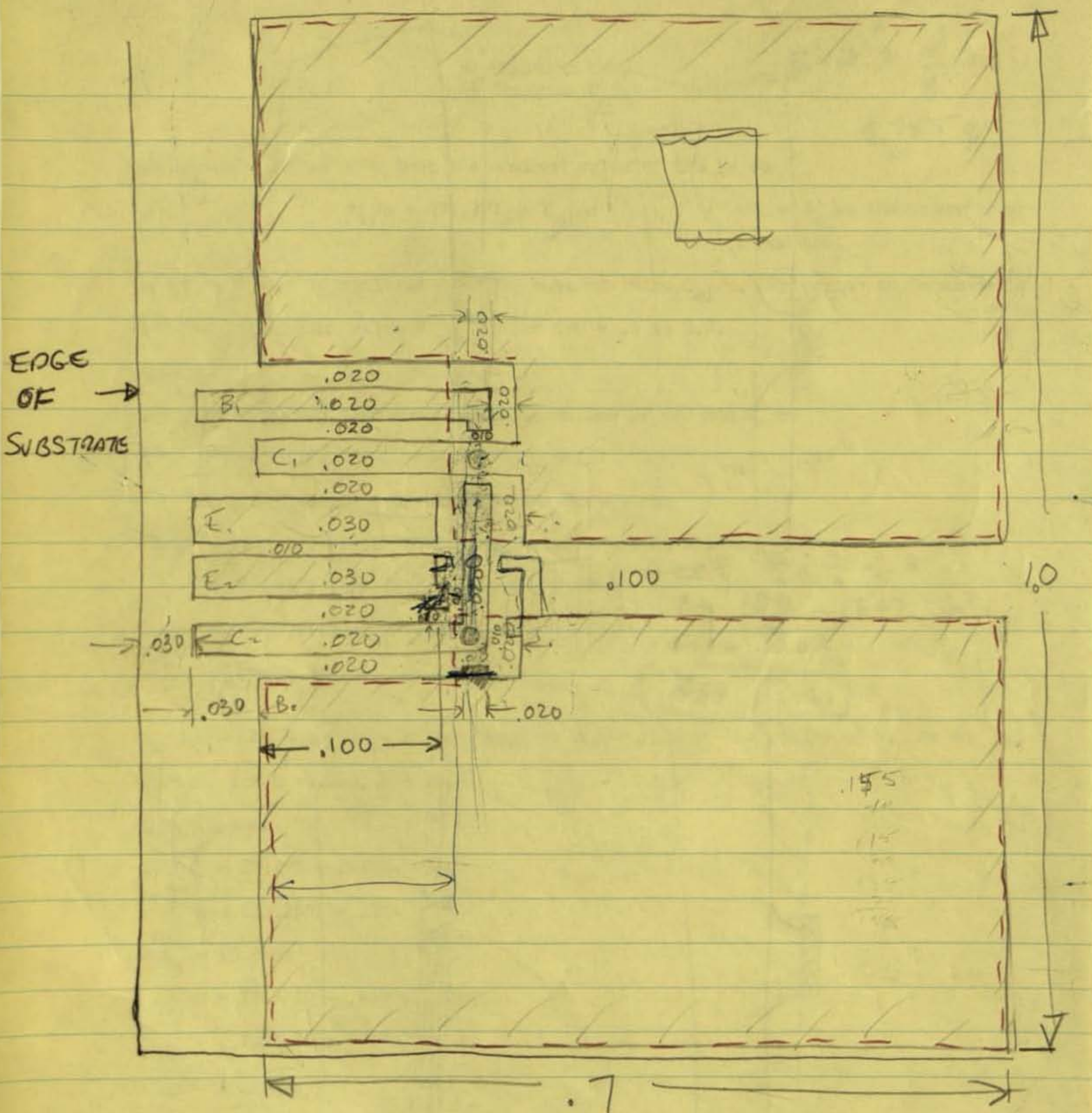
Signature ______ Date ______

Signature ______ Date ______

Read and Understood (obtain two signatures):

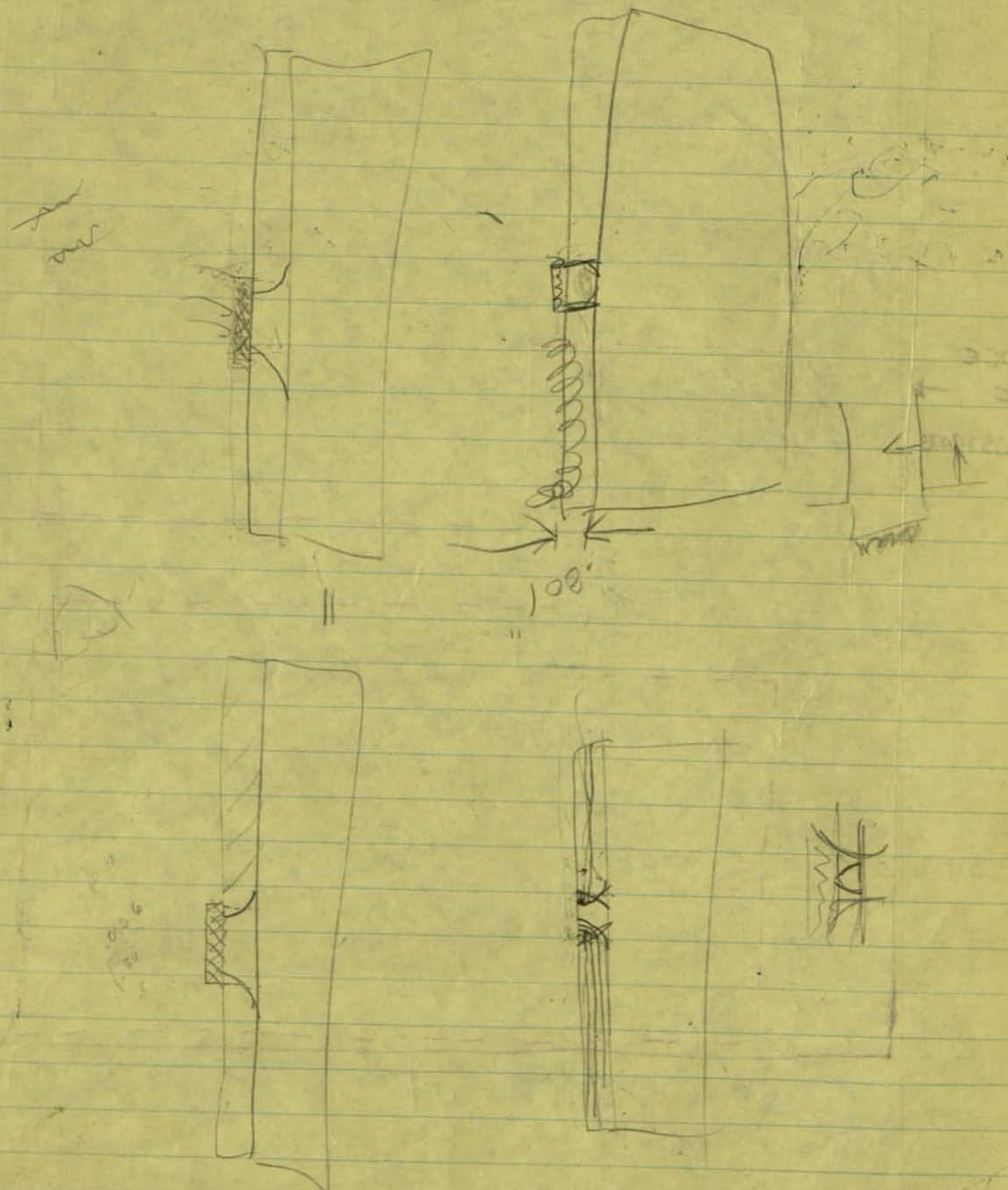
Signature ______ Date ______

Signature ______ Date ______



DIELECTRIC : BeO .025" THICK

RED :- BACKSIDE METALLIZATION



company private

INTERNAL CORRESPONDENCE

FAIRCHILD SEMICONDUCTOR

MICROWAVE PRODUCTS

TO: List

DATE: February 18, 1966

FROM: R. Shipow

CC: I. H. Solt, Jr.

SUBJECT: Technical Memorandum No. 2
"Transformer Tooth Cross Section as a Function of Transformer Tooth Impedance for Low Impedance Values in Combline Filters."

Combline filter theory does not account for any capacitance that may appear between the input end of a transformer tooth and ground. The way to avoid such capacities is to make the transformer tooth as square as possible, since than the hole in which the connector sits will cover the maximum amount of tooth.

Theoretical criteria as well as practice has shown that it is necessary for comb line filters to have very low impedances when used in devices such as harmonic generators and upconverters. Given a certain fixed tooth height, the width of the finger increases as its impedance decreases. It therefore becomes of interest to determine what the minimum theoretical value of transformer tooth impedance may be and still have a square finger.

The normalized width of a transformer tooth is given by;

$$W_o/b = 1/2(1-t/b)(C_o/2e - C'fe/e_{o1} - C'f/e)$$

Inspection of this equation shows that if W_o/b is to be minimized as it must be, the following should be done;

a) Maximize t/b.
b) Minimize $\frac{C_o}{e}$

$.310'' = \frac{\lambda}{8}$
4.755 gc

Getsinger's curves show that the maximum value of t/b is .8

Also: $C_o/e = 376.7/Z_a - C_{o1}/e$ where Z_a is the transformer impedance.

It appears that to minimize C_o/e, we must maximize C_{o1}/e. Referring to Getsinger's curves, the maximum value of C_{o1}/e for t/b = .8 is 8.8.

Therefore: $C_o/e = 376.7/Z_a - 8.8$

Getsinger's curves also show for these values of t/b and C_o/e:

$C'f/e = 1.68$ $C'fe/e_{o1} = .39$ $S_{o1}/b = .09$

Plugging these values into the equation for width:

$W_o/b = 1/2\ (1-.8)\ (376.7/2Z_a - 8.8/2 - 1.68 - .39)$

$W_o/b = 1/2\ (.2)\ (188/Z_a - 4.4 - 2.07)$

$W_o/b = .1(188/Z_a - 6.47)$

$W_o/b = 18.8/Z_a - .647$

LET $\frac{W_o}{b} = \frac{t}{b} = .8$

$.8 = \frac{18.8}{Z_A} - .647$

$1.447 = 18.8/Z_A$

$Z_A = 13\Omega.$

The degree of squareness of the tooth is unaffected by the choice of b. As an example, let b = .250, t = .200.

1) $Z_a = 5$ ohms.

$W_o/b = 18.8/5 - .647 = 3.11$

$W_o = 3.11(.250) = .779$

2) $Z_a = 10$ ohms

$W_o/b = 18.8/10 - .647 = 1.233$

$W_o = 1.233(.250) = .309$

3) $Z_a = 13$ ohms.

$W_o/b = 18.8/13 - .647 = .803$

$W_o = .803(.250) = .201$

Therefore, the lowest impedance that can be used and still realize a square tooth is 13 ohms. If lower impedances than this are required, the transformer tooth must be dielectrically loaded to square it.

data
to Gene Guthrie,

10-4-66
KE Lyon

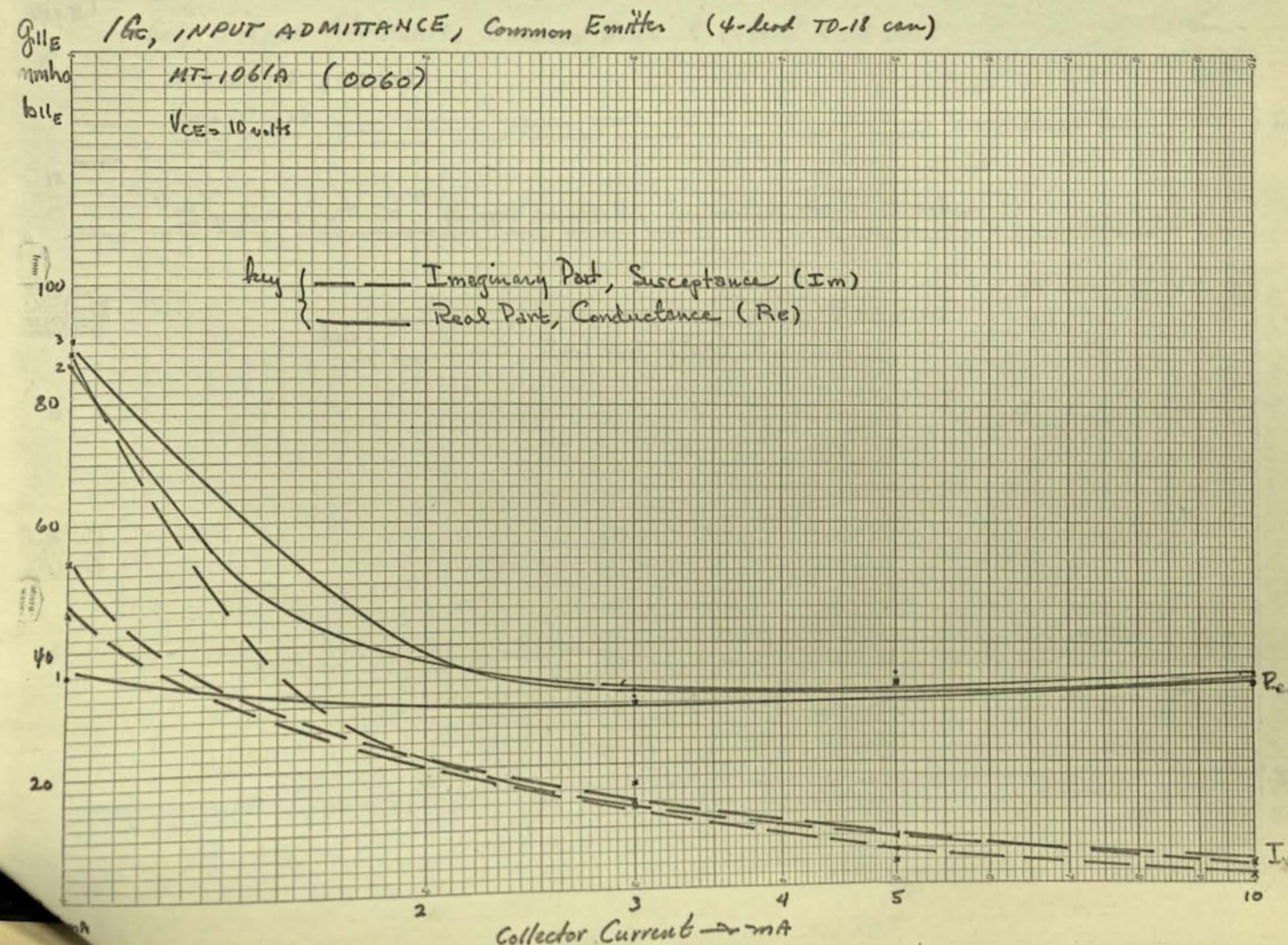
MT-1061A. 4-lead TO-18 package, 4th lead the "can" gnd

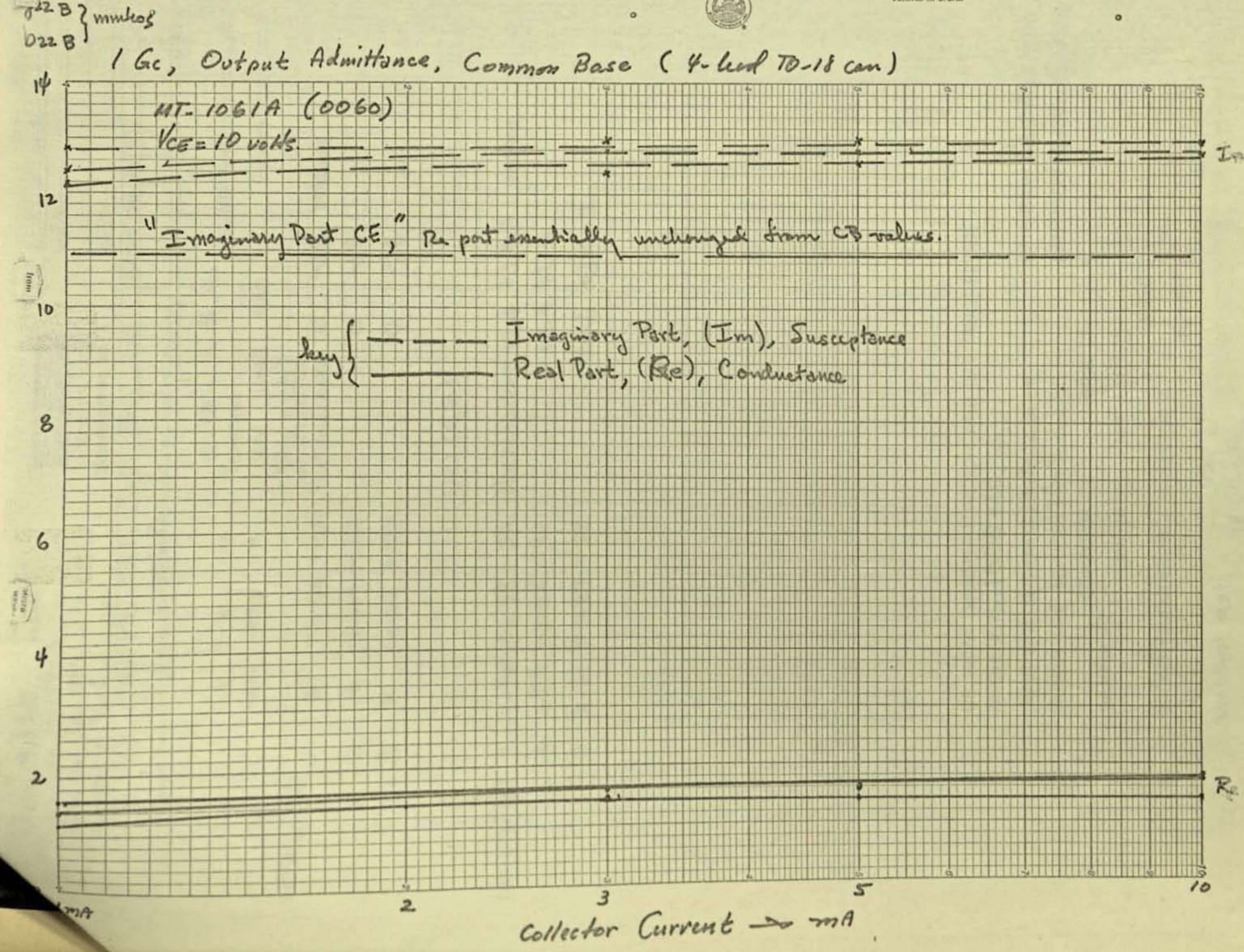
Input Admittance - CE, Curve vs I_c, $V_{CE}=10V$

Output Admittance - CB, Curve vs I_c, $V_{CE}=10V$, (CE value also shown)

Fwd Xfr Admittance, CB data sheet at $V_{CE}=10V$, $I_c = 5mA$

Rev Xfr Admittance, CB " " " "


1Gc, INPUT ADMITTANCE, Common Emitter (4-lead TO-18 can)
g11E
mmho
b11E
MT-1061A (0060)
VCE = 10 volts
key
Imaginary Part, Susceptance (Im)
Real Part, Conductance (Re)
100
80
60
40
20
2
3
4
5
10
Re
Im
Collector Current → mA



g22 B } mmhos
b22 B
1 Gc, Output Admittance, Common Base (4-lead TO-18 can)
MT-1061A (0060)
VCE = 10 volts
"Imaginary Part CE," Re part essentially unchanged from CB values.
key { — — — Imaginary Part, (Im), Susceptance
——— Real Part, (Re), Conductance
Im
Re
14
12
10
8
6
4
2
1 mA
2
3
5
10
Collector Current → mA

DATE 9/28 19__
EQUIP. USED 1607-A
TAKEN BY K.W.
REQUESTED BY K.L.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

FT. ______ CLASS ______
REMARKS ______
GROUP ______

LOT No.	DE.	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP
				0060							

VC = 10 v Ic = 5 MA Parameter ______ Transfer Fcn ______ Immitance ______

LOT No.	UNIT No.	A REAL	B IMAG	M M	REAL	IMAG	MAG
					Y12 (CB)		
MT 1061 Lt # 128	1	0	-0.04	-10X	NORMALIZED 0	-J8	mmhos
	2	0	-0.04	-10X	0	-J8	
	3	0	-0.04	-10X	0	-J8	
					Y21 (CB)		
MT 1061 128	1	0.40	+0.33	-3X	NORMALIZED +24	+J19.8	mmhos
	2	0.39	+0.25	-3X	+23.4	+J15	
	3	0.41	+0.27	-3X	24.6	+J16.2	

GR 1607A TRANSFER FUNCTION AND IMMITANCE BRIDGE

FREQUENCY 1000 Mc

INPUT LINE SETTING 174.2 cm   EXTENSION NONE △ UNITS

OUTPUT LINE SETTING 174.5 cm   EXTENSION NONE △ UNITS

DAMPER AT COLLECTOR ☐ BASE ☐ EMITTER ☐ NOT USED ☐

SOCKET ORIENTATION – COLLECTOR AT INPUT ☐ OUTPUT ☐

MULTIPLIER PLATE USED ☐ NOT USED ☐