SPEC-O-SNAP SETS W38440
PRINTING ASSOCIATES, SAN JOSE

W42603

DATE 12-13 1963
EQUIP. USED Boonton 75A 58
TAKEN BY KH
REQUESTED BY CG

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

( ) T. CLASS
REMARKS Run # 5
CUSTOMER
GROUP

LOT No.	DE.	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP.	

Signal Level 20 mA.

LOT No.	UNIT No.	Conf	RMR		Conf.	RMR		Conf.	RMR		
	01	1.08	>100		.99	100		1.21	12		
	02	1.00	100		.91	100		1.38	80		
	03	1.18	100		.88	100		1.30	20		
	04	1.11	100		99	100		1.18	50		
	05	1.12	100		94	100		1.13	100		
	06	.88	50		1.10	100		.25	100		
	07	.88	6		1.41	50		1.02	100		
	08	.92	60		1.12	100		.25	100		
	09	.85	8		1.45	100		1.34	100		
	10	.941	80		1.27	41		1.28	100		
	11	1.00	50		1.20	100		1.41	100		
	12	.79	15		29	100		.27	100		
	13	.93	50		1.15	3		1.34	16		
	14	.81	40		.23	100		1.37	1		
	15	.84	50		1.30	50		1.28	100		
	16	1.06	50		1.27	100		1.09	100		
	17	.91	30		1.20	1		1.31	80		
	18	.96	14		1.57	80		1.18	100		
	19	.87	35		1.03	100		.31	3		
	20	.94	50		1.28	100		1.21	100		
	21	1.06	50		1.26	100		1.04	100		
	22	.95	10		1.41	18		1.22	5		
	23	.64	100		.25	100		1.25	80		
	24	.92	9		1.01	100		1.33	20		
	25	1.22	100		1.03	100		1.16	5		
	26	.93	50		1.30	50		1.41	100		
	27	1.10	70		.28	1.5		.96	100		
	28	.78	30		1.24	100		1.32	50		
	29	.85	50		.31	0		1.33	50		
	30	1.06	100		1.31	100		1.50	80		
	31	.25	100		1.40	100		1.36	1		
	32	1.28	30		1.25	100		1.35	100		
	33	1.37	100		.27	100		1.32	100		
	34	1.27	1		1.20	2		1.45	100		
	35	1.30	50		.32	100		1.23	100		
	36	.17	>100		1.40	2		1.25	13		
	37	1.11	20		1.48	100		1.29	100		
	38	1.12	50		1.23	100		1.27	25		
	39	1.38	100		.26	15		1.41	100		
	40	.24	100		1.24	100		1.28	100		
	41	1.41	100		1.41	20		1.11	100		
	42	1.38	50		1.28	6		1.05	1		
	43	1.21	100		1.34	3		1.24	100		
	44	.28	100		1.15	18		1.29	100		
	45	1.28	40		1.27	100		1.12	90		
	46	1.34	60		1.23	100		1.05	20		
	47	1.09	80		1.34	100		1.41	100		
	48	1.26	100		1.21	100		1.06	50		
	49	.26	3		1.18	100		1.22	50		
	50	1.21	100		1.41	5		1.25	100		

#115 Solomon

~~EVERETT E. GUTHRIE~~

#115

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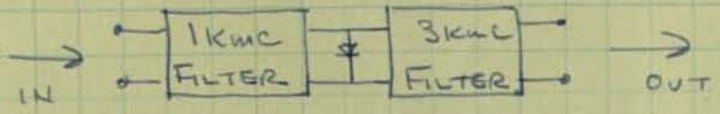
Job # 141

Will eventually use Fairchild Varactors, when available. For the time being will purchase some Microwave Associates diodes and any others that seem ~~ade~~ useful.

To get started will construct a tripler from 1000 mc to 3000 mc. Will assume a 1.0 watt source at 1000 mc since this should soon be possible from solid state source.

Diode Selection :-

1. Diode will be resonated in shunt.



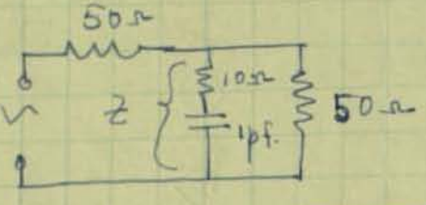
Reasons:

a. Filters can easily be made to look like open circuits at the unwanted harmonics.

b. Input and Output Impedances should be on the order of 50Ω and more easily worked with (T.E.M. Transmission Lines)

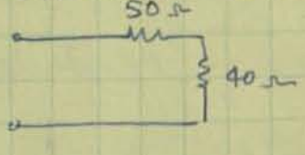
2. Break down Voltage Required

For Power Handling considerations circuit should look something like:



$|Z| \cong 150\Omega$.

Circuit becomes



$V_{RMS} = \sqrt{P_{ave} \cdot R}$, $P_{ave} = 1$ watt.

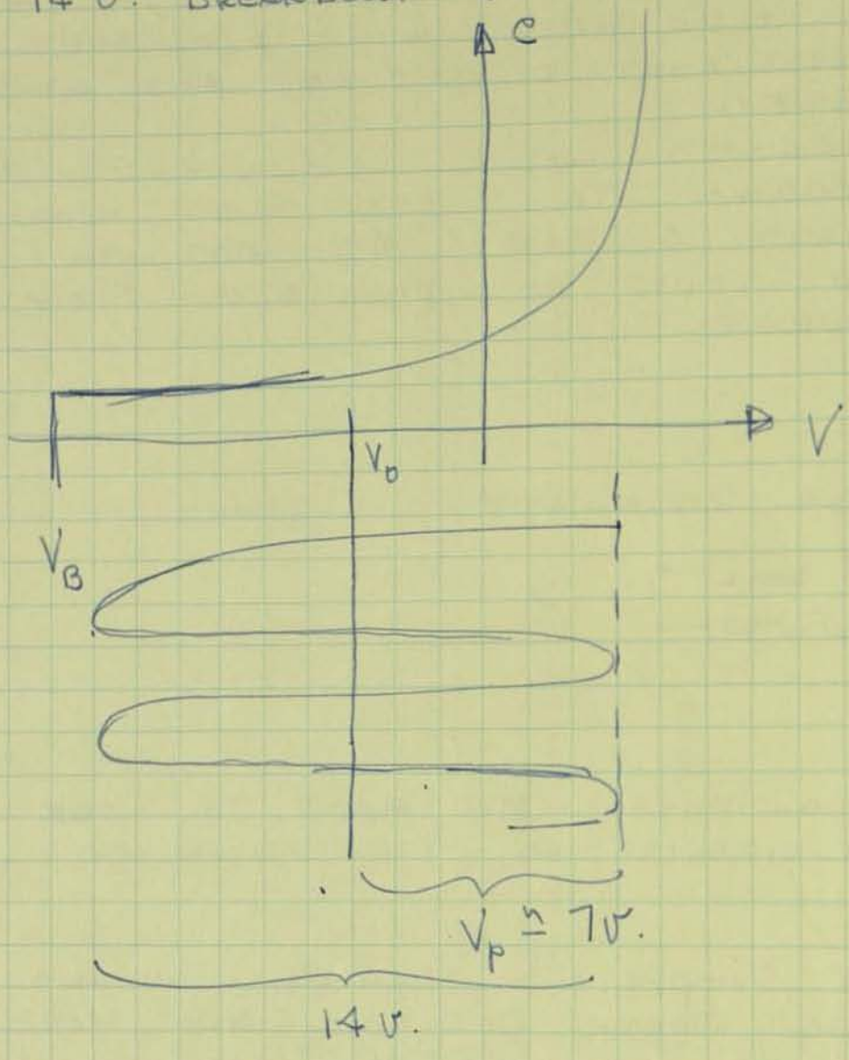
$V_{RMS} = \sqrt{90} \cong 10V$

$\frac{V_{peak}}{\sqrt{2}} = V_{RMS}$

$V_{peak} \cong 14v$, $\therefore$ V_{peak} across diode $\cong 7v$

CONTINUED FROM P. 1.

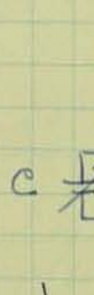
THEREFORE, A DIODE WITH BETTER THAN 14 V. BREAKDOWN IS NEEDED. CONSIDER C VS. V PLOT:



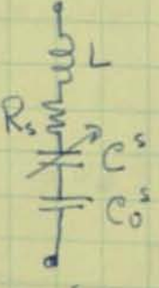
WILL TRY THE 24V. M.A. DIODE.

3. BARRIER CAPACITY REQUIRED FOR PROPER RESONANT FREQUENCY (OUTPUT)

EQUIVALENT CIRCUIT OF DIODE TO BE USED



CONSIDER



WOULD LIKE TO TUNE C_0^s WITH L.

LET US ASSUME $C_0 \simeq C_0^s$ WILL CHECK RESONANCE EXPERIMENTALLY ANYWAY.

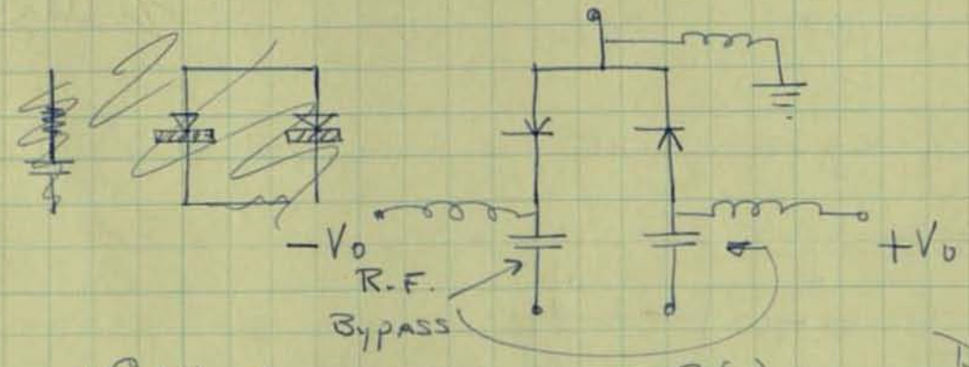
CONTINUED FROM p. 2

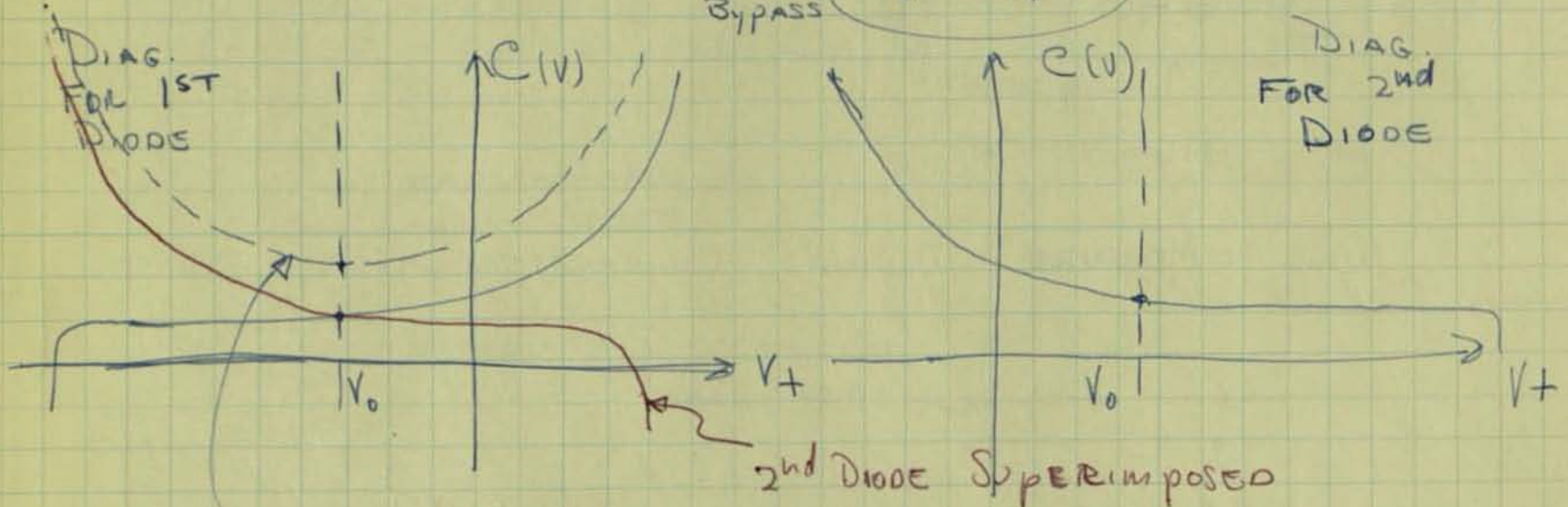
SET RESONANT FREQUENCY = 3 KMC.

$$C_0 = \frac{1}{\omega^2 L}, \quad L = .8 \times 10^{-9} \text{ h} \quad \text{FROM M.A. CATALOG}$$

$$C_0 = \frac{1}{(4\pi^2)(.8\times10^{-9})(9\times10^{18})} \cong 3.6 \text{ pf.}$$

ALSO, CONSIDER OPERATING A BALANCED PAIR OF DIODES.





ADDING TOGETHER GET ONLY EVEN HARMONICS

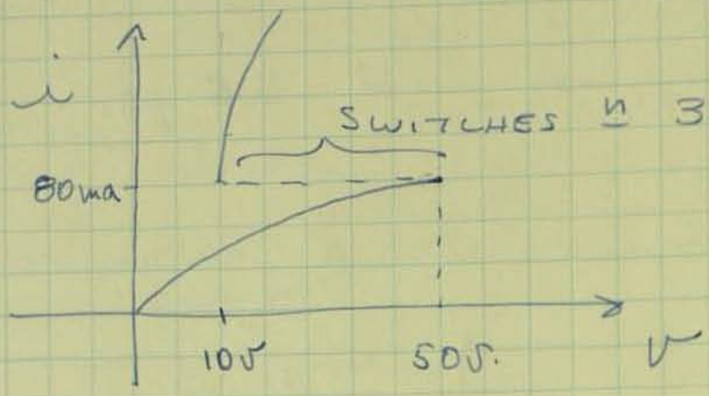
∴ ~~THIS~~ CIRCUIT WOULD PROVIDE A DOUBLER OR QUADRUPLER, ETC. ~~NEVERTHELESS, THE C'S ARE IN PARALLEL~~ $C_0 \cong 1.8$ pf ~~PER DIODE.~~

∴ THE MA ~~4334B~~ 4334C WITH AXIAL PRONG OR MA-4334-~~B~~C (PILL) ~~E~~ ARE TO BE PURCHASED.

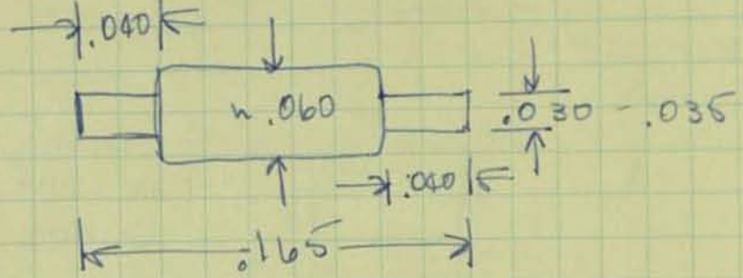
C_{min} in pf. - ~~XXXXX~~ .8 - 1.6, $R_{s_{max}}$ = ~~XXX~~ 3.5 Ω

NEGATIVE RESISTANCE DEVICE DEVISED BY A. SAXENA.

THE J.V. CURVE TAKEN ON BREADBOAD UNIT:



PACKAGE SIZE

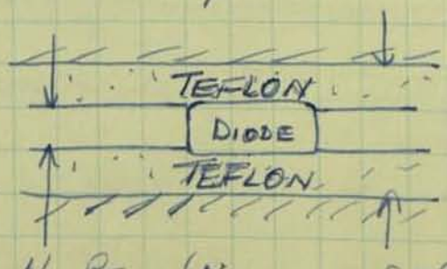


WILL MEASURE DIODE CHARACTERISTICS FIRST:



BIAS WILL PUT ON LINE PRECEDING SLOTTED BY WAY OF A BIASER. (μ/AD)

GEOMETRY SHOULD BE SOMETHING LIKE:



CONTINUED FROM p. 3 2/1/62

SUBJECT: EFFICIENCY AND OPTIMUM MATCHING CONDITIONS.

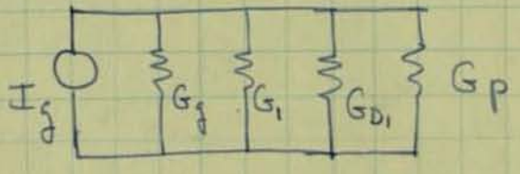
REFERENCE: JOHNSON: LARGE SIGNAL ANALYSIS OF A PARAMETRIC HARM. GENERATOR. PGMTT - SEPT. 60

$$\eta = 2\frac{G_L G_g}{G_{T_1} G_{T_2}} \frac{100}{\left[1 + \frac{(n w_1 C_o b_n)^2}{2 G_{T_1} G_{T_2}} + \frac{G_{T_1} G_{T_2}}{2 (n w_1 C_o b_n)^2}\right]}$$

η - EFFICIENCY IN %

$G_{T_1} = G_1 + G_{D_1} + G_g$

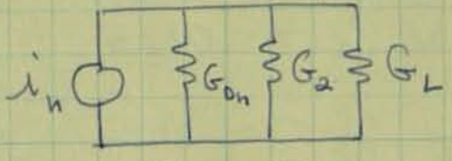
$G_{T_2} = G_2 + G_{Dn} + G_L$



INPUT CIRCUIT

G_1 & G_2 ARE CIRCUIT LOSSES LET $G_1 = G_2 = 0$ FOR THE TIME BEING.

w_1 - RADIAN MEASURE INPUT FREQ.



OUTPUT CIRCUIT FOR n^{th} HARM.

G_{D_1} - DIODE CONDUCTANCE AT w_1.

G_{Dn} - " " " w_n.

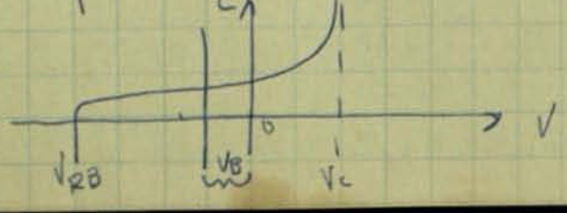
G_g - INPUT CONDUCTANCE.

G_L - OUTPUT "

C_o - OPERATING POINT CAPACITY.

$\therefore$ $b_n = \frac{q_n}{C_o V_1}$, WHERE $q = \frac{q_0}{2} + \sum_{n=1}^{\infty} q_n \cos(n w_1 t - \psi_n)$

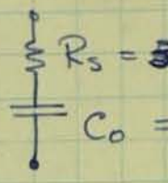
& $V = V_B + V_1 \cos w_1 t + V_n \cos(n w_1 t + \phi_n)$ - VOLT. ACROSS DIODE. (TOTAL)



CONT. FROM P.5 2/2/62

LET US SELECT $G_g = G_L = G$
AND ALSO CONSIDER VALUES OF G_{D_1} & G_{D_2}

AT OPERATING POINT (D.C. BIAS POINT) DIODE LOOKS LIKE:



$$Z = 3.5 - j\frac{1}{\omega C} = R_s - jX_{C_o}$$

$$Y = \frac{1}{Z} = \frac{1}{R_s - jX_{C_o}} \times \frac{R_s + jX_{C_o}}{R_s + jX_{C_o}} = \frac{R_s}{R_s^2 + X_{C_o}^2} + j\frac{X_{C_o}}{R_s^2 + X_{C_o}^2}$$

$$\therefore G_D = \frac{R_s}{R_s^2 + X_{C_o}^2} = \frac{3.5}{12.2 + \left(\frac{1}{\omega\, 2\times10^{-12}}\right)^2}$$

IF $\omega_1 = 2\pi\, 10^9$, $f_1 = 1000$ mc,

$$\omega_1 C_o = .0125, \quad \frac{1}{\omega_1 C_o} = 80, \quad \left(\frac{1}{\omega_1 C_o}\right)^2 = 6400$$

$$\& \; G_{D_{1kmc}} = \frac{3.5}{6412} = \underline{5.47 \times 10^{-4}}$$

$$\approx \underline{.55 \times 10^{-3}}$$

IF $\omega_2 = 2\pi(2\times10^9)$

$$\frac{1}{\omega_2 C_o} = 40, \quad \left(\frac{1}{\omega_2 C_o}\right)^2 = 1600$$

$$G_{D_{2kmc}} = \frac{3.5}{12.2 + 1600} = \frac{3.5}{1612} = \underline{2.18 \times 10^{-3}}$$

LET US ASSUME $G_{D_{1kmc}} = G_{2kmc} = \underline{1.5 \times 10^{-3}}$ ℧

$\therefore G_{T_1} = G_{T_2} = G_T$

NOW $$\eta = \frac{2G^2}{G_T^2} \frac{100}{\left[1 + \frac{K}{2G_T^2} + \frac{G_T^2}{2K}\right]}$$

WHERE $K = (n\omega_1 C_o b_n)^2$

CONT. FROM P. 6 2/2/62

$$\eta = 400\,K\,\frac{G^2}{(G_T^2+K)^2}\,, \quad G_T = G_D + G$$

NOW TO MAXIMIZE η TO GET G.

$$\frac{d\eta}{dG} = 400K\left\{\frac{(G_T^2+K)^2 2G - G^2 2(G_T^2+K)\,2G_T\,\frac{dG_T}{dG}}{(G_T^2+K)^4}\right\}$$

SINCE $\frac{dG_T}{dG} = 1$ & SETTING $= 0$

$$(G_T^2+K)^2 2G - 4G^2G_T(G_T^2+K) = 0$$

TRIVIAL SOLUTIONS ARE:

$$G=0\,, \quad G_T^2+K=0 \text{ OR } G_T^2 = -K\,, \quad K \geq 0$$

LEAVING:

$$2(G_T^2+K) - 4G_TG = 0$$

$$G_D^2 + 2GG_D + G^2 + K - 2GG_D + 2G^2 = 0$$

$$G_D^2 - G^2 + K = 0$$

$$\text{OR} \quad G = \sqrt{G_D^2 + (n w_1 C_0 b_n)^2}$$

FROM JOHNSON $b_2 \cong .2$ FOR MAX. SWING OF INPUT VOLTAGE

$\therefore$ $n w_1 C_0 b_n = (2)(.0125)(.2) = 5.0 \times 10^{-3}$

$(n w_1 C_0 b_n)^2 = 25.0 \times 10^{-6}$

& $G_D^2 = 2.3 \times 10^{-6}$

$\therefore$ $G = 10^{-3}\sqrt{27.3} = 5.22 \times 10^{-3}$ U

$(R = \frac{1}{G} \cong 191\,\Omega)$

5.22
1.50
6.72

$G_T = 6.72 \times 10^{-3}$
$G_T^2 = 45 \times 10^{-6}$

2/2/62

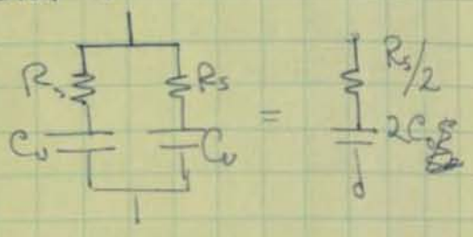
CONT. FROM Φ.7

CALCULATING η

$$\eta = 400 \frac{(25.0\times10^{-6})(27.3\times10^{-6})}{(45\times10^{-6}+25\times10^{-6})^2}$$

$$= 400 \frac{(25.0)(27.3)}{(70)^2} \cong 55\%$$

CONSIDER BALANCED SYSTEM:



THEN $K = 100\times10^{-6}$

G_D WOULD STAY ABOUT THE SAME

$$G = \sqrt{100\times10^{-6}}$$

$$G \cong .010$$

$$R = \frac{1}{G} \cong 100\ \Omega$$

$$G_T = G + G_D \cong 10\times10^{-3} + 1.5\times10^{-3}$$

$$G_T = 11.5\times10^{-3}$$

$$G_T^2 = 132\times10^{-6}$$

$$\eta = 400 \frac{(102\times10^{-6})(100\times10^{-6})}{(132\times10^{-6}+100\times10^{-6})^2}$$

$$\eta = 400 \frac{(102)(100)}{(132+100)^2} = \frac{(400)(10200)}{(232)^2} \cong 75\%$$

~~IT APPEARS BALANCED SYSTEM MORE EFFICIENT~~

ERROR! $G_D \cong 3\times10^{-3}$, $G_D^2 = 9\times10^{-6}$

$$G = \sqrt{9\times10^{-6}+100\times10^{-6}} = 10.4\times10^{-3}$$

$$G_T = G + G_D = 13.4\times10^{-3}$$

$$G_T^2 \cong 180\times10^{-6}$$

$$\eta = 400\,\frac{K\,G^2}{(G_T^2+K)^2} = \frac{(400)(100\times10^{-6})(109\times10^{-6})}{(180\times10^{-6}+100\times10^{-6})^2}$$

$\eta \doteq 55\%$

∴ EFFICIENCY SHOULD BE SAME.

$R_{in} = \frac{1}{109} \doteq 9\Omega$

CHECKING AGAINST JOHNSON'S CURVES - FIG. 7. SHOWING Q_{01} VS. INSERTION LOSS

$$Q_{01} = \frac{\omega_1 C_0}{G_{01}} = \frac{2\pi\,10^9\;\; 2\times10^{-12}}{.55\times10^{-3}}$$

$Q_{01} \doteq 25$

WHICH GIVES A LOSS OF ABOUT 3db. - 4db.

NOW CONSIDER REACTIVE PORTION OF G_T Y, NAMELY

$jB = j\,\frac{X_{c0}}{R_s^2 + X_{c0}^2}$. THIS HAS NOT BEEN CONSIDERED IN THE CIRCUIT ∴ MUST BE TUNED OUT.

CALCULATION OF REACTANCE IN THE .5 - 2.0 KMC RANGE.

AT 1KMC. $\omega_1 C_0 = .0125$, $\frac{1}{\omega_1 C_0} = 80$

$$jB = j\,\frac{80}{3.5^2+6400} = \frac{80}{12+6400}$$ → FOR SINGLE ENDED SYSTEM

FOR DOUBLE ENDED SYSTEM

$$jB = j\,\frac{40}{(1.75)^2+(160)^2}$$

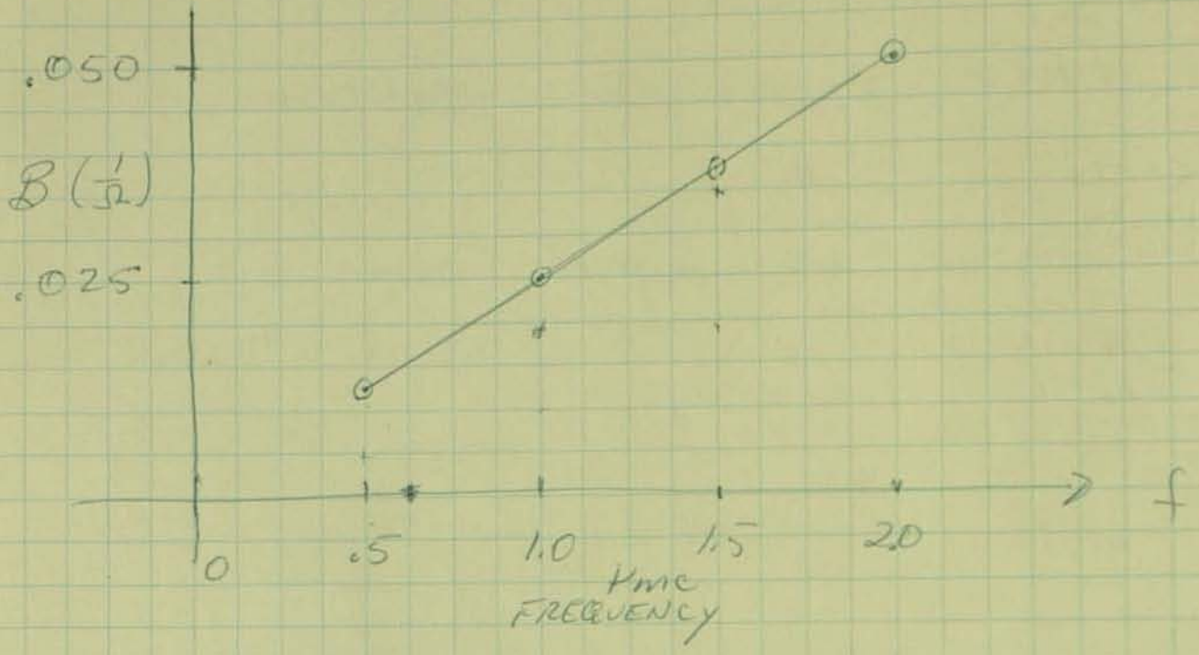
∴ WILL NEGLECT R_s^2 ∴ $jB = j\omega 2C_0$ FOR BALANCED SYSTEM

CONT. FROM p. 9 2/5/62

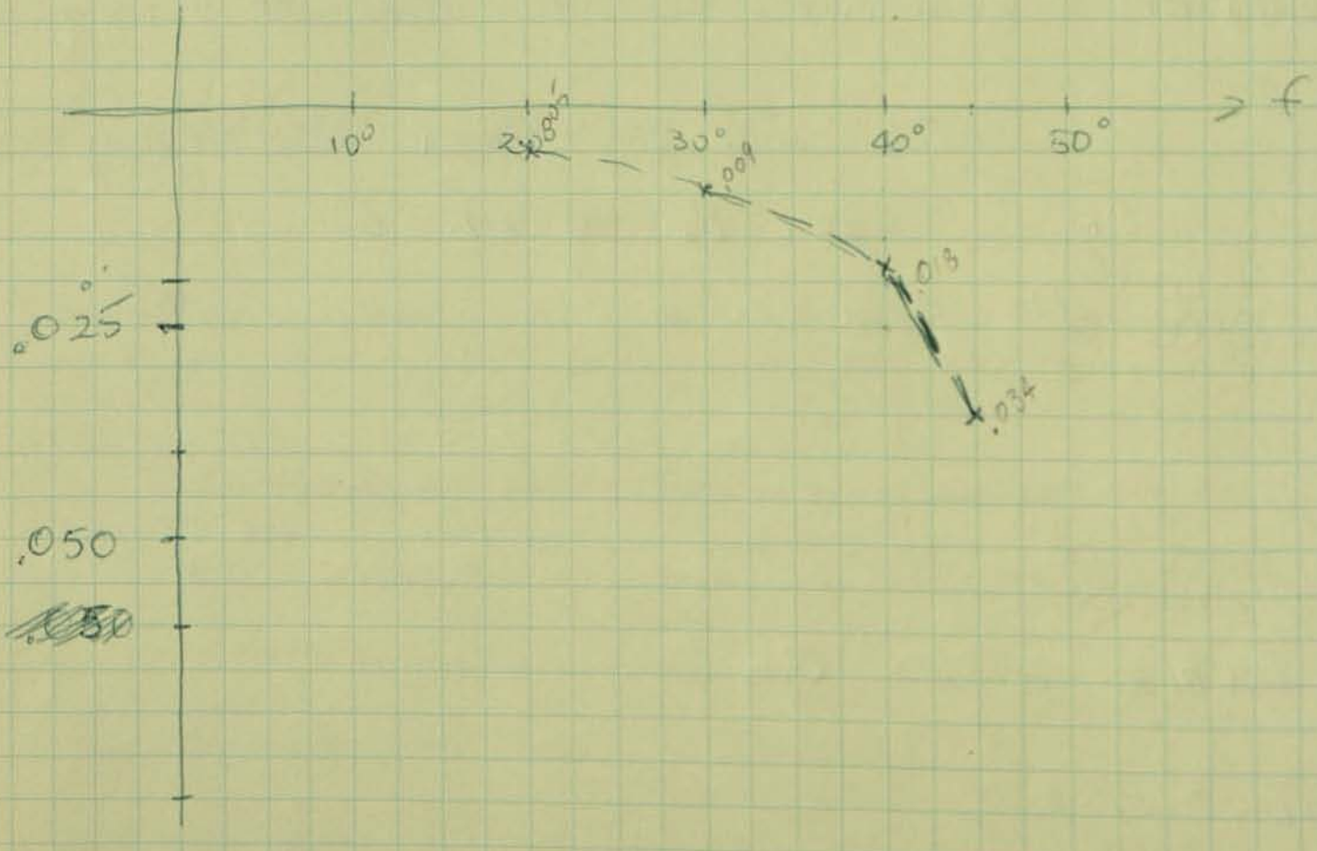
$B = 4\pi f C_0$, TAKING $C_0 = 2 \times 10^{-12}$ fd.
& f IN KMC.

$B = 8\pi f_{kmc} \times 10^{-3}$ ~~UE~~.

$B = .025 f_{kmc}$.



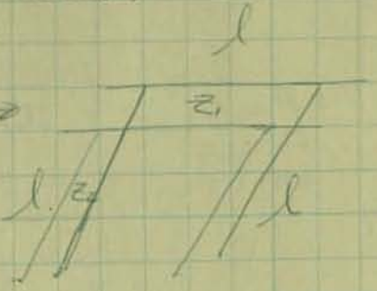
FROM COMPENSATED FILTER PLOTS
UN NORMALIZED ~~ATTENUATION IMAGE IMPEDANCE~~



CONT. FROM p. 10

WILL GO AHEAD AND CONSTRUCT 50Ω IMAGE FILTER. WANT STOPBAND CENTER AT 3.0 Kmc. AND CUTOFF AT 2 1.6 Kmc.

LET $\rho = 1 = \frac{Z_1}{Z_2}$



$Z_{I_0} = 50 = \frac{Z_1}{\sqrt{3}}$

$Z_1 = 86.5\ \Omega = Z_2$

USING REXOLITE # 1422 $\sqrt{\varepsilon_r} = 1.60$

$\therefore \sqrt{\varepsilon_r}\, Z_1 \doteq 138\ \Omega$, $\lambda/_b = \frac{.003}{.25} = .012$

$\therefore \frac{w}{b} = .25$, $b = \frac{1}{4}$

$w = \frac{.250}{4} .063$

$\ell = \frac{\lambda}{4}$ @ 3Kmc. $= \frac{3 \times 10^{10}}{(4)(1.6)(3 \times 10^9)(.454)} = .615$

THIS GIVES A $f_c = 2$ Kmc. ~~WHICH WILL BE~~ O.K. TO START WITH.

FOR 50Ω LINE $50\sqrt{\varepsilon_r} = 80\Omega$, $\frac{w}{b} = .72$

$w = .180$

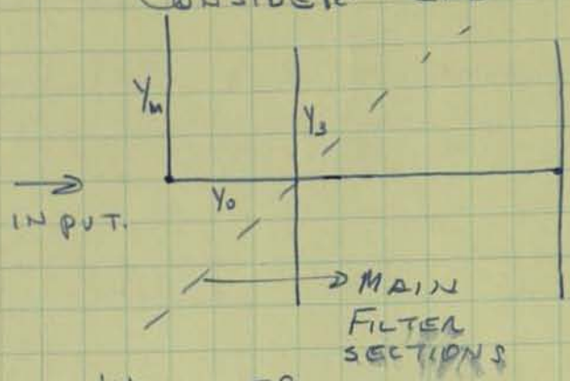
CORRECTION

DESIRE TO STOP 4 Kmc.

FROM VALUES SHOWN ON p. 10 IT LOOKS MORE ADVANTAGEOUS TO START WITH 500mc AND MULTIPLY TO 1000mc

CONTINUED FROM p. 11 2/20/62

CONSIDER END MATCHING FOR FILTER



$Y_3 = \frac{1}{56\Omega}$, $Y_0 = \frac{1}{102\Omega}$.

$Z_3 = 56\Omega$, $Z_0 = 102\Omega$.

$\sqrt{\epsilon_r}\,56 = 89.5\Omega$. $\sqrt{\epsilon_r}\,102 = 163\Omega$

$\frac{w_3}{b} = .59$ $\frac{w_0}{b} = .155$

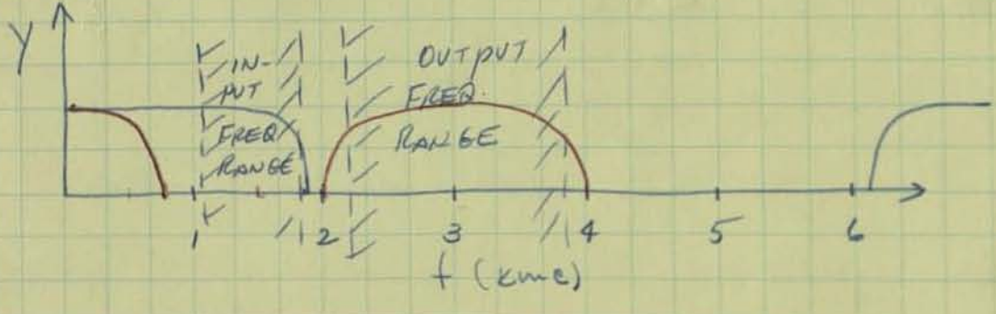
$w_3 = .147$ $w_0 = .039$

Y_m FROM PREVIOUS DESIGN $w_m \doteq .045$

LENGTH $\ell = .600$ FOR $f_c = 4.0$ KMC.

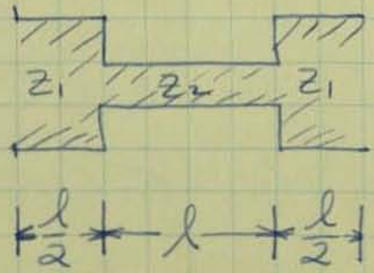
$\frac{4.0}{1.6} = \frac{N}{.460}$, $N = 1.15"$

OUTPUT FILTER DESIGN (IN RED)



WILL CENTER AT 3 KMC - SHOULD BE SELF RESONANT FREQ. OF DIODE

TYPE OF FILTER SECTION:



$A = -K + (1+K)\cos^2\phi$

$-1 = -K + (1+K)\cos^2 120°$

$\cos 120° = -\cos 60° = -\frac{1}{2}$

$\therefore -1 = -K + \frac{1+K}{4}$

ϕ = π @ 3 KMC

$\frac{180}{\phi_c} = \frac{3}{2}$

$\phi_c = 120°$

WHERE $K = \frac{1}{2}\left(\frac{Z_1}{Z_2} + \frac{Z_2}{Z_1}\right)$

$-4 = -4K + 1 + K$

$3K = 5 \quad , \quad K = 5/3$

$\frac{10}{3} = \frac{Z_1}{Z_2} + \frac{Z_2}{Z_1}$ ALSO $50 = \sqrt{Z_1 Z_2}$

$\frac{10}{3} = X + \frac{1}{X}$ OR $2500 = Z_1 Z_2$

$X^2 - \frac{10}{3} X + 1 = 0$

$X = \frac{10/3 \pm \sqrt{\frac{100}{9} - 4}}{2} = \frac{5}{3} \pm \frac{4}{3}$

$X = 3 \text{ or } \frac{1}{3}$, SINCE $Z_2 > Z_1$

$Y = \frac{Z_1}{Z_2} = \frac{1}{3} \quad , \quad Z_2 = 3 Z_1$

$2500 = 3 Z_1^2 \quad , \quad Z_1 = \frac{50}{\sqrt{3}}$

$Z_1 = 28.9 \Omega$

$Z_2 = 86.7 \Omega$

WITH $\sqrt{\varepsilon_r} = 1.6$ $\quad \lambda/6 = .012$

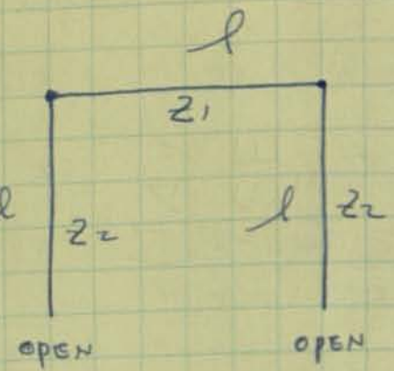
$\sqrt{\varepsilon_r} Z_1 = 46.2 \qquad W_1/b = 1.55 \qquad W_1 = .388$

$\sqrt{\varepsilon} Z_2 = 139.0 \qquad W_2/b = .23 \qquad W_2 = .058$

$$\ell = \frac{1}{4} \frac{3 \times 10^{10}}{(1.6)(1.5 \times 10^9)\, 2.54} = 1.23''$$

CONT. FROM p. 13

CONSIDER ANOTHER FILTER:



$$C = j\frac{\rho \sin\phi}{Z_1}\left[1+\rho(2-\rho\tan^2\phi)\right]$$

$$B = j Z_1 \rho \sin\phi$$

$$Y_I = \pm\sqrt{\frac{C}{B}} = \pm\sqrt{\frac{1+\rho(2-\rho\tan^2\phi)}{Z_1^2}}$$

or $$\frac{Y_I}{Y_1} = \pm\sqrt{1+\rho(2-\rho\tan^2\phi)}\quad,\quad \rho = \frac{Z_1}{Z_2} = \frac{Y_2}{Y_1}$$

$$A = (1+\rho)\cos\phi - \frac{\rho}{\cos 2\phi}$$

at cutoff $A = +1$ i.e. USING 1ST HARMONIC

PASS BAND :- ALSO ϕ_{c_1} ↔ 2 KMC. & ϕ_{180° ↔ 3 KMC.

$$\frac{180^\circ}{\phi_{c_1}} = \frac{3}{2}\quad,\quad \phi_{c_1} = 120^\circ$$

$$\cos 120^\circ = -\cos 60^\circ = -\frac{1}{2}$$

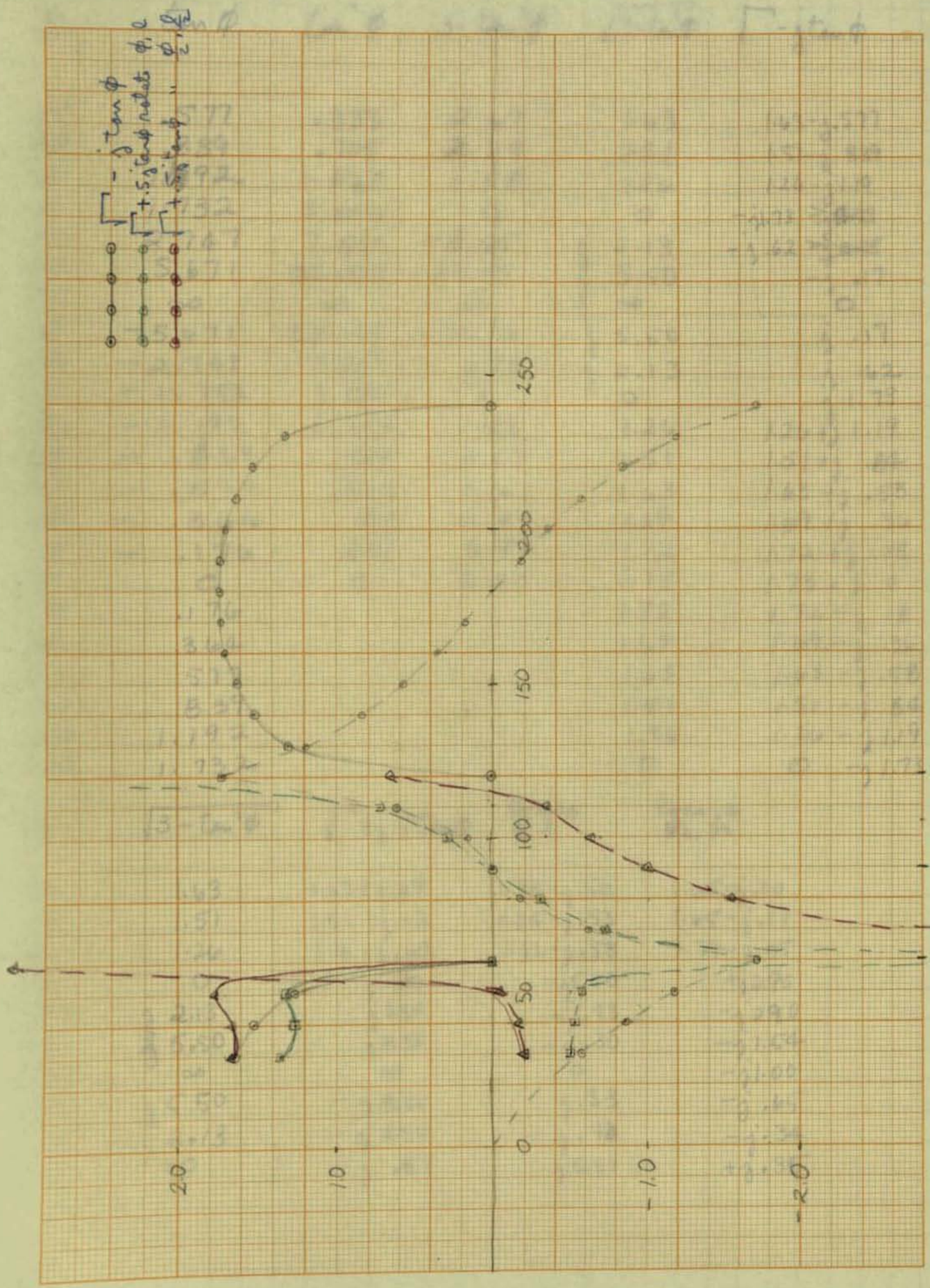
$$1 = (1+\rho)\left(-\frac{1}{2}\right) + 2\rho$$

$$2 = -1 - \rho + 4\rho\quad,\quad 3\rho = 3\quad,\quad \rho = 1\quad,\quad Z_1 = Z_2 = Z$$

$$\therefore\quad \frac{Y_I}{Y_1} = \pm\sqrt{3-\tan^2\phi}$$

ON FOLLOWING PAGE WILL PLOT $\frac{Y_I}{Y_1}$ VS. ϕ

WHERE
180° ↔ 3 KMC.
120° ↔ 2 KMC.
80° ↔ 1.5 KMC.
60° ↔ 1.0 KMC.
30° ↔ .5 KMC.


- ρ tan φ
+ 1.5 tan φ
+ tan φ
250
200
150
100
50
0
20
10
-10
-20
2.0
1.5
1.0
kg/sq. - kwen

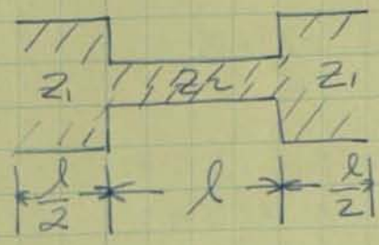
CONT. FROM p. 14

f. Sec.	ϕ (°)	$\tan\phi$	$\tan^2\phi$	$3-\tan^2\phi$	$\sqrt{3-\tan^2\phi}$	$\sqrt{-j\tan\phi}$
.5	30°	.577	.333	2.67	1.63	1.63 - j.577
	40°	.839	.705	2.29	1.51	1.51 - j.839
	50	1.192	1.420	1.58	1.26	1.26 - j 1.19
1.0	60	1.732	3.000	0	0	-j1.73 ~~= j1.73~~
	70	2.747	7.550	-4.55	2.13	- j .62 ~~= j.275~~
	80	5.671	32.100	-29.10	5.50	- j .17
1.5	90	∞	∞	$-\infty$	∞	0
	100	-5.671	32.100	-29.10	5.50	j .17
	110	-2.747	7.550	- 4.55	2.13	j .62
2.0	120	- 1.732	3.000	0	0	j 1.73
	130	- 1.192	1.420	1.58	1.26	1.26 + j 1.19
	140	- .839	.705	2.29	1.51	1.51 + j .84
2.5	150	- .577	.333	2.67	1.63	1.63 + j .58
	160	- .364	.133	2.87	1.69	1.69 + j .36
	170	- .176	.031	2.97	1.72	1.72 + j .18
3.0	180	0	0	3.00	1.73	1.73 + j 0
	190	.176			1.72	1.72 - j .18
	200	.364			1.69	1.69 - j .36
3.5	210	577			1.63	1.63 - j .58
	220	839			1.51	1.51 - j .84
	230	1.192			1.26	1.26 - j 1.19
4.0	240	1.732			0	0 - j 1.73

ϕ	$\sqrt{3-\tan^2\phi}$	$\sqrt{+j.5\tan\phi}$	Rotate ϕ, ℓ	Rotate $\phi/2, \ell/2$
30	1.63	1.63 + j.29	1.35 - j.50	1.65 - j.20
40	1.51	1.51 + j.42	1.25 - j.53	1.65 - j.17
50	1.26	1.26 + j.60	1.32 - j.58	1.77 - j.05
60	0	j .86	-j5.50	+j2.90
70	j 2.13	j 3.50	- j .73	- j 2.90
80	j 5.50	j 8.33	- j .30	- j 1.54
90	∞	∞	0	- j 1.00
100	- j 5.50	- j 8.33	j .33	- j .65
110	- j 2.13	- j 3.50	j .78	- j .34
120	0	- j .87	j 5.50	+ j .35

MORE FILTERS – SEE p. 12

3/2/62



$$B = j Z_1 \sin\phi \cos\phi + \frac{j}{2Z_2}\left[Z_2^2 - Z_1^2 + (Z_2^2 + Z_1^2)\cos\phi\right]\sin\phi$$

$$C = \frac{j}{Z_1}\sin\phi\cos\phi + \frac{j}{2Z_1^2 Z_2}\left[Z_1^2 - Z_2^2 + (Z_1^2 + Z_2^2)\cos\phi\right]\sin\phi$$

$$Y_I^2 = \frac{\frac{\cos\phi}{Z_1} + \frac{Z_1^2 - Z_2^2 + (Z_1^2 + Z_2^2)\cos\phi}{2Z_1^2 Z_2}}{Z_1\cos\phi + \frac{Z_2^2 - Z_1^2 + (Z_2^2 + Z_1^2)\cos\phi}{2Z_2}} = \frac{C}{B}$$

$$= Y_1^2 \frac{\frac{\cos\phi}{Y_1} + \frac{Y_2}{2}\left[Z_1^2 - Z_2^2 + (Z_1^2 + Z_2^2)\cos\phi\right]}{\frac{\cos\phi}{Y_1} + \frac{Y_2}{2}\left[Z_2^2 - Z_1^2 + (Z_2^2 + Z_1^2)\cos\phi\right]}$$

$$= Y_1^2 \frac{\cos\phi\left(\frac{1}{Y_1} + \frac{Y_1^2 + Y_2^2}{2Y_1^2 Y_2}\right) + \frac{Y_2^2 - Y_1^2}{2Y_1^2 Y_2}}{\cos\phi\left(\frac{1}{Y_1} + \frac{Y_1^2 + Y_2^2}{2Y_1^2 Y_2}\right) + \frac{Y_1^2 - Y_2^2}{2Y_1^2 Y_2}}$$

$$= Y_1^2 \frac{\cos\phi\,(Y_1 + Y_2)^2 + (Y_2 + Y_1)(Y_2 - Y_1)}{\cos\phi\,(Y_1 + Y_2)^2 + (Y_1 + Y_2)(Y_1 - Y_2)}$$

DIVIDING OUT $Y_2 + Y_1$

$$Y_I^2 = Y_1^2 \frac{(Y_1 + Y_2)\cos\phi + Y_2 - Y_1}{(Y_1 + Y_2)\cos\phi + Y_1 - Y_2} = Y_1^2 \frac{\left(\frac{Y_1}{Y_2} + 1\right)\cos\phi + \left(1 - \frac{Y_1}{Y_2}\right)}{\left(\frac{Y_1}{Y_2} + 1\right)\cos\phi - \left(1 - \frac{Y_1}{Y_2}\right)}$$

LETTING $\frac{Y_1}{Y_2} = \rho$

$$\boxed{\frac{Y_I}{Y_1} = \pm\sqrt{\frac{(1+\rho)\cos\phi + (1-\rho)}{(1+\rho)\cos\phi - (1-\rho)}}}$$

LET $\rho = 3 = \frac{Y_1}{Y_2} = \frac{Z_2}{Z_1}$ — SPECIAL CASE.

$$\frac{Y_I}{Y_1} = \sqrt{\frac{2\cos\phi - 1}{2\cos\phi + 1}}$$

AT ZERO FREQ. OR $\phi = 0$

$$Y_{I_0} = \pm Y_1 \sqrt{\frac{(1+\rho)+(1-\rho)}{(1+\rho)-(1-\rho)}} = \pm Y_1 \sqrt{\frac{2}{2\rho}}$$

$$Y_{I_0} = Y_1 \sqrt{\frac{1}{\rho}}$$

at FIRST PASS BAND $\phi = 180°$

$$Y_I\Big|_{\phi=180°} = Y_1 \sqrt{\frac{-(1+\rho)+1-\rho}{-(1+\rho)-1+\rho}} = Y_1 \sqrt{\frac{-2\rho}{-2}}$$

$$Y_I\Big|_{\phi=180°} = Y_1 \sqrt{\rho}$$

FOR THE CASE OF $\rho = 3$

PLOT Y_I/Y_1 ~~ALSO DESIRE~~ Y NORMALIZED WITH RESPECT TO Y_1

ROTATE $\phi/2$

ϕ (°)	$\cos\phi$	$2\cos\phi$	$(2\cos\phi - 1)$	$(2\cos\phi + 1)$	$\frac{2\cos\phi-1}{2\cos\phi+1}$	$\sqrt{\frac{2\cos\phi-1}{2\cos\phi+1}}$	$.044\sqrt{\quad}$	$\phi/2$ A
50	.642	1.284	.284	2.284	.124	.352	.0155	.42 - j.40
60	.500	1.000	0	2.000	0	0	0	- j.58
70	.342	.684	- .316	1.684	- .187	j.432	j.0190	- j.20
80	.174	.348	- .616	1.384	- .445	j.667	j.0294	- j.11
90	0	0	- 1.000	1.000	- 1.000	j1.000	j.044	0
100	- .174	- .348	- 1.384	.616	- 2.25	j 1.50	j.066	j.11
110	- .342	- .684	- 1.684	.316	- 5.33	j 2.31	j.102	j.20
120	- .500	- 1.000	- 2.000	0	∞	∞	∞	j.57
125	- .574	- 1.148	- 2.148	- .148	14.52	3.91	.172	.32 + j.48
130	- .642	- 1.284	- 2.284	- .284	8.05	2.84	.125	.41 + j.47
140	- .766	- 1.532	- 2.532	- .532	4.75	2.18	.096	.50 + j.37
150	- .866	- 1.732	- 2.732	- .732	3.73	1.93	.085	.54 + j.20
160	- .940	- 1.880	- 2.880	- .880	3.27	1.81	.080	.56 + j.12
170	- .985	- 1.970	- 2.970	- .970	3.06	1.75	.077	.57 + j.06
180	- 1.00	- 2.000	- 3.000	- 1.000	3.00	1.73	.075	.57 + j 0

$$Z_I\Big|_{\phi=180°} = \frac{Z_1}{\sqrt{\rho}}, \quad \text{LET } Z_I\Big|_{180°} = 10\,\Omega$$

$\rho = 5$, $\sqrt{\rho} = 2.24$, $\therefore Z_1 = 22.4\,\Omega$, $Z_2 = 112\,\Omega$.

$$\therefore Y_1 = \frac{1}{22.4} = .044$$

CONT. FROM p. 17

3/7/62

$Z_1 = 22.4\,\Omega$, $Z_2 = 112\,\Omega$

$\sqrt{\varepsilon_r}\, Z_1 = 36\,\Omega$. , $\sqrt{\varepsilon_r}\, Z_2 = 179\,\Omega$.

USING REX # 1422

$\frac{w_1}{b} = 2.1$ $\frac{w_2}{b} = .11$, $b = \frac{1}{4}$

$w_1 = .525$ $w_2 = .028$

$w_2 \simeq .025$

FROM p. 13 MAKE $\ell = 1.25''$

NOW CONSIDER TRANSFORMER FROM $10\,\Omega$ TO $50\,\Omega$.

FROM COHN'S PAPER

$$\phi_1 = \frac{180^\circ}{1+p} \quad , \quad p = \frac{f_2}{f_1} = 2$$

$$\phi_1 = 60^\circ \quad , \quad \cos\phi_1 = .5 \quad , \quad \frac{1}{\cos\phi_1} = 2$$

TAKE $S_{max} = 1.10$ (MAX. VSWR)

SOLVING FOR n

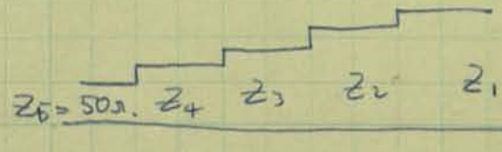
$$T_{n-1}\left[\frac{1}{\cos\phi_1}\right] = \left[\frac{S_{max}-1}{\ln\left[\frac{Z_{n+1}}{Z_1}\right]}\right]^{-1} = \frac{\ln\left[\frac{Z_{n+1}}{Z_1}\right]}{S_{max}-1}$$

$\therefore T_{n-1}[2] = \frac{\ln 5}{.10} = \frac{1.61}{.10} = 16.1$

$T_3[2] = 4\cdot 2^3 - 3\cdot 2 = 32 - 6 = 26$

$T_2[2] = 2\cdot 2^2 - 1 = 7$

LET $n-1 = 3$ OR $n = 4$



FROM COHNS TABLES: -

$$g_1 : g_2 : g_3 : g_4 = 1 : 2\tfrac{1}{4} : 2\tfrac{1}{4} : 1$$

$$g_1 + g_2 + g_3 + g_4 = 6.5$$

$k=1$ $\ln \frac{Z_2}{Z_1} = \frac{(1)(1.61)}{6.5} = .248$, $\frac{Z_2}{Z_1} = 1.282$

$k=2$ $\ln \frac{Z_3}{Z_2} = \frac{(2.25)(1.61)}{6.5} = .558$, $\frac{Z_3}{Z_2} = 1.745$

$k=3$ $\ln \frac{Z_4}{Z_3} = \ln \frac{Z_3}{Z_2} = .558$, $\frac{Z_4}{Z_3} = 1.745$

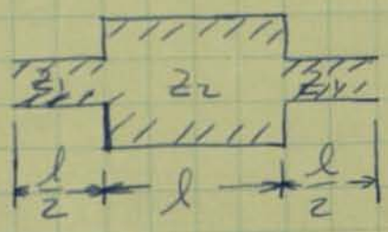
$k=4$ $\ln \frac{Z_5}{Z_4} = \ln \frac{Z_2}{Z_1} = .248$, $\frac{Z_5}{Z_4} = 1.282$

$b = \frac{1}{4}$

$Z_1 = 10\,\Omega$	$\sqrt{\varepsilon_r} Z_1 = 16\,\Omega$.	$\omega_1/b =$		
$Z_2 = 12.82\,\Omega$	$\sqrt{\varepsilon_r} Z_2 = 20.5\,\Omega$.	$\omega_2/b = 4.0$	$\omega_2 = 1.0$	
$Z_3 = 22.40\,\Omega$	$\sqrt{\varepsilon_r} Z_3 = 35.8\,\Omega$	$\omega_3/b = 2.1$	$\omega_3 = .525$	
$Z_4 = 39.10$	$\sqrt{\varepsilon_r} Z_4 = 62.5\,\Omega$.	$\omega_4/b = 1.05$	$\omega_4 = .262$	
$Z_5 = 50.20$ ck.	$\sqrt{\varepsilon_r} Z_5 = 80.0\,\Omega$.	$\omega_5/b = .7$	$\omega_5 = .179$	

ℓ SHOULD BE $\frac{\lambda}{4}$ @ 3000 mc, $\ell = \frac{3\times10^{10}}{(1.6)(3\times10^9)(2.54)(4)} = .615$

CONSIDER FOLLOWING FILTER: (TRY .60)



LET $\rho = \frac{1}{3} = \frac{Y_1}{Y_2} = \frac{Z_2}{Z_1}$

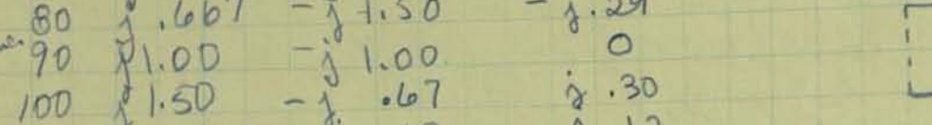
$$\frac{Y_I}{Y_1} = \pm\sqrt{\frac{\frac{4}{3}\cos\phi + \frac{2}{3}}{\frac{4}{3}\cos\phi - \frac{2}{3}}} = \pm\sqrt{\frac{2\cos\phi + 1}{2\cos\phi - 1}}$$

∴ THIS VALUE OF $\frac{Y_I}{Y_1}$ WOULD BE RECIPROCAL TO THAT TABULATED ON p. 17. ~~WHICH~~ SEE FOLLOWING PAGE.

8/12/62

CONT. FROM p. 19

	Ⓐ $\frac{2\cos\phi-1}{2\cos\phi+1}$	Ⓑ $\sqrt{\frac{2\cos\phi+1}{2\cos\phi-1}}$	Ⓑ ROTATE $\ell/2$ @ Y_1
ϕ			
0		1.73	1.73
50	.352	2.84	~~1.25~~ $-j1.2$
60	0	∞	$-j1.75$
70	$j.432$	$-j2.31$	$-j.62$
80	$j.667$	$-j1.50$	$-j.29$
90 (1.5 kmc)	$j1.00$	$-j1.00$	0
100	$j1.50$	$-j.67$	$j.30$
110	$j2.31$	$-j.43$	$j.62$
120	∞	0	$j1.75$
125	3.91	.26	$.97+j1.43$
130	2.84	.35	$1.25+j1.20$
140	2.18	.46	$1.52+j.83$
150	1.93	.52	$1.62+j.56$
160	1.81	.55	$1.68+j.38$
170	1.75	.57	$1.72+j.2$
180 (3 kmc)	1.73	.58	1.73

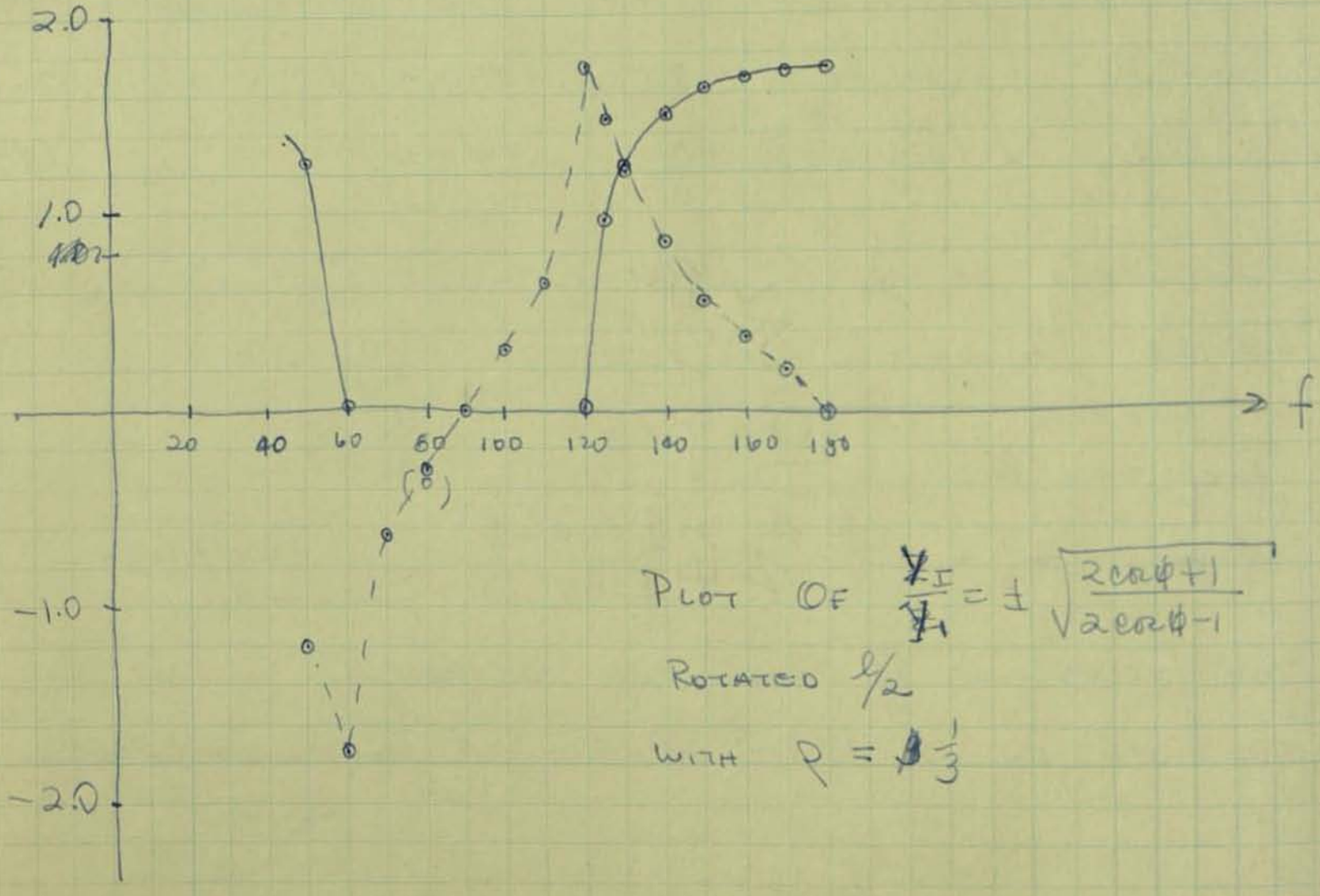


@ 3 kmc $\frac{Y_I}{Y_1} = 1.73$, $Y_I = 1.73\,Y_1$

$Z_I = \frac{Z_1}{1.73}$

SINCE $Z_1 = 112\,\Omega$, $Z_I = 69.5\,\Omega$

OR $Z_I = \frac{Z_1}{.58} = 193\,\Omega$



PLOT OF $\frac{Y_I}{Y_1} = \pm\sqrt{\frac{2\cos\phi+1}{2\cos\phi-1}}$

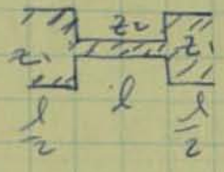
ROTATED $\ell/2$

WITH $\rho = 1/3$

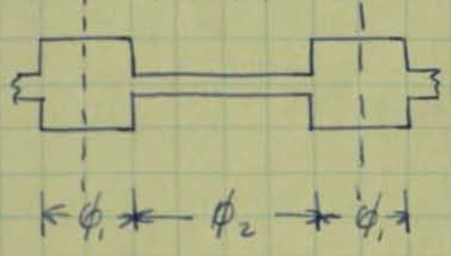
FROM p. 16 AT BOTTOM OF PAGE

$$\left(\frac{Y_I}{Y_1}\right)^{-1} = \frac{Y_1}{Y_I} = \frac{Z_I}{Z_1} = \pm\sqrt{\frac{2\cos\phi+1}{2\cos\phi-1}}$$

$\therefore \frac{Z_I}{Z_1}$ IS SAME PLOT $\frac{Y_I}{Y_1}$ ON p. 20 OPPOSITE.

I.E. FOR  $\rho = 3$

FOR BROADER STOP BANDS CONSIDER:



LET $\phi_2 = 2\phi_1$

FROM GEPPERT'S REPORT

$$C = \frac{j}{Z_1}\sin\phi_1\cos\phi_2 + \frac{j}{2Z_1^2Z_2}\left[Z_1^2 - Z_2^2 + (Z_1^2+Z_2^2)\cos\phi_1\right]\sin\phi_2$$

$$B = jZ_1\sin\phi_1\cos\phi_2 + \frac{j}{2Z_2}\left[Z_2^2 - Z_1^2 + (Z_2^2+Z_1^2)\cos\phi_1\right]\sin\phi_2$$

$$\text{ALSO } Z_1^2 - Z_2^2 + (Z_1^2+Z_2^2)\cos\phi_1 = \frac{1}{Y_1^2} - \frac{1}{Y_2^2} + \left(\frac{1}{Y_1^2}+\frac{1}{Y_2^2}\right)\cos\phi_1$$

$$= \frac{Y_2^2 - Y_1^2 + (Y_1^2+Y_1^2)\cos\phi_1}{Y_1^2Y_2^2}$$

$$\therefore C = jY_1\sin\phi_1\cos\phi_2 + \frac{j}{2Y_2}\left[Y_2^2 - Y_1^2 + (Y_2^2+Y_1^2)\cos\phi_1\right]\sin\phi_2$$

$$B = \frac{j}{Y_1}\sin\phi_1\cos\phi_2 + \frac{j}{2Y_2Y_1^2}\left[Y_1^2 - Y_2^2 + (Y_1^2+Y_2^2)\cos\phi_1\right]\sin\phi_2$$

$$\frac{C}{B} = Y_1^2\,\frac{\sin\phi_1\cos\phi_2 + \frac{1}{2}\left[\frac{Y_2}{Y_1} - \frac{Y_1}{Y_2} + \left(\frac{Y_2}{Y_1}+\frac{Y_1}{Y_2}\right)\cos\phi_1\right]\sin\phi_2}{\sin\phi_1\cos\phi_2 + \frac{1}{2}\left[\frac{Y_1}{Y_2} - \frac{Y_2}{Y_1} + \left(\frac{Y_1}{Y_2}+\frac{Y_2}{Y_1}\right)\cos\phi_1\right]\sin\phi_2}$$

IF AGAIN $\rho = \frac{Y_1}{Y_2}$ & $\sin\phi_2 = \sin 2\phi_1 = 2\sin\phi_1\cos\phi_1$

CONT. FROM p. 21 4/5/62

$$\frac{C}{B} = Y_1^2 \frac{\cos 2\phi_2 + [\frac{1}{\rho} - \rho + (\frac{1}{\rho} + \rho) \cos 2\phi_1] \cos \phi_1}{\cos 2\phi_2 + [\rho - \frac{1}{\rho} + (\rho + \frac{1}{\rho}) \cos 2\phi_1] \cos \phi_1}$$

$$\cos \phi_2 = \cos 2\phi_1 = 2\cos^2 \phi_1 - 1$$

$$\therefore \frac{C}{B} = Y_1^2 \frac{2\cos^2 \phi_1 - 1 + [\frac{1}{\rho} - \rho + (\frac{1}{\rho} + \rho) \cos \phi_1] \cos \phi_1}{2\cos^2 \phi_1 - 1 + [\rho - \frac{1}{\rho} + (\frac{1}{\rho} + \rho) \cos \phi_1] \cos \phi_1}$$

$$\frac{C}{B} = Y_1^2 \frac{(2 + \rho + \frac{1}{\rho}) \cos^2 \phi_1 + (\frac{1}{\rho} - \rho) \cos \phi_1 - 1}{(2 + \rho + \frac{1}{\rho}) \cos^2 \phi_1 + (\rho - \frac{1}{\rho}) \cos \phi_1 - 1}$$

$$\therefore \frac{Y_I}{Y_1} = \pm \sqrt{\frac{(2 + \rho + \frac{1}{\rho}) \cos^2 \phi_1 + (\frac{1}{\rho} - \rho) \cos \phi_1 - 1}{(2 + \rho + \frac{1}{\rho}) \cos^2 \phi_1 + (\rho - \frac{1}{\rho}) \cos \phi_1 - 1}}$$

if $\phi_1 = 0$

$$\frac{Y_I}{Y_1} = \pm \sqrt{\frac{2 + \rho + \frac{1}{\rho} + \frac{1}{\rho} - \rho - 1}{2 + \rho + \frac{1}{\rho} + \rho - \frac{1}{\rho} - 1}} = \sqrt{\frac{1 + \frac{2}{\rho}}{1 + 2\rho}} = \sqrt{\frac{\rho + 2}{\rho(1 + 2\rho)}}$$

if $\phi_1 = \pi$

$$\frac{Y_I}{Y_1} = \pm \sqrt{\frac{2 + \rho + \frac{1}{\rho} - \frac{1}{\rho} + \rho - 1}{2 + \rho + \frac{1}{\rho} - \rho + \frac{1}{\rho} - 1}} = \sqrt{\frac{1 + 2\rho}{1 + \frac{2}{\rho}}}$$

$$\left\{ \frac{Z_I}{Z_1} = \pm \sqrt{\frac{(2 + \rho + \frac{1}{\rho}) \cos^2 \phi_1 + (\rho - \frac{1}{\rho}) \cos \phi_1 - 1}{(2 + \rho + \frac{1}{\rho}) \cos^2 \phi_1 + (\frac{1}{\rho} - \rho) \cos \phi_1 - 1}} \right.$$

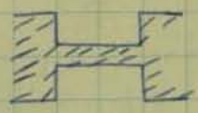
TRY FOR 3 TO 1 STOP BAND

ϕ_0 ↳ 4 KNC. $\phi_0 = 45°$

$$\frac{4}{45°} = \frac{2}{22.5} \quad \therefore \phi_{c_1} = 22.5°$$

CONT. FROM p. 16 REF. p. 16

$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{(1+\rho)\cos\phi + (1-\rho)}{(1+\rho)\cos\phi - (1-\rho)}}$$



ALSO FROM GEPPERT $A = \cos^2\phi - \frac{1}{2}\left(\frac{1}{\rho}+\rho\right)\sin^2\phi$

LET BAND CENTER @ $f = 5$ KMC. @ $\phi_0 = \frac{\pi}{2}$

AND $f_1 = 2$ KMC - CUTOFF FREQUENCY FOR LOW PASS
I.E. STOPBAND FROM 2 KMC TO 8 KMC.

$$\frac{\phi_c}{\phi_0} = \frac{2}{5}, \quad \phi_c = \frac{2}{5}\overset{18}{90^\circ} = 36^\circ$$

$$-1 = \cos^2 36^\circ - \frac{1}{2}\left(\frac{1}{\rho}+\rho\right)\sin^2 36^\circ$$

$\sin 36^\circ = .588$ $\cos 36^\circ = .809$

$\sin^2 36^\circ = .346$ $\cos^2 36^\circ = .655$

$$\frac{1}{\rho} + \rho = \frac{(1.655)(2)}{.346} = 9.56$$

$$\rho^2 - 9.56\rho + 1 = 0, \quad \rho = \frac{9.56 \pm \sqrt{91.5 - 4}}{2} = \frac{9.56 \pm 9.35}{2}$$

$\therefore \rho = 9.46$ OR $\rho = .11$, SELECT $\frac{Z_2}{Z_1} = 9.46$

$$\therefore \frac{Z_I}{Z_1} = \pm\sqrt{\frac{10.46\cos\phi + 8.46}{10.46\cos\phi - 8.46}}$$

$$= \pm\sqrt{\frac{1.235\cos\phi + 1}{1.235\cos\phi - 1}}$$

$$\begin{array}{r} 91.5 \\ 4 \\ \hline 87.5 \end{array}$$

$$\begin{array}{r} 9.56 \\ 9.35 \\ \hline 2\,|\,18.91 \\ 9.455 \end{array}$$

$$2\,|\,.21 \quad .105$$

TO MATCH FILTER TO 50 Ω.

$Z_1 Z_2 = 2500$ AND SINCE $\frac{Z_2}{Z_1} = 9.46$

$Z_1^2\, 9.46 = 2500$

$$Z_1 = \frac{50}{\sqrt{9.46}} = \frac{50}{3.08}, \quad \boxed{\begin{array}{l} Z_1 = 16.2\ \Omega \\ Z_2 = 155\ \Omega. \end{array}}$$

CONTINUED FROM p. 23. 4/6/62

TO PLOT $\frac{Z_I}{Z_1}$ ROTATED $\ell/2$

$$\frac{Z_I}{Z_1} = \sqrt{\frac{1.235\cos\phi + 1}{1.235\cos\phi - 1}}$$

SLOPE MUST BE (−) DUE TO FOSTER'S REACTANCE THM.

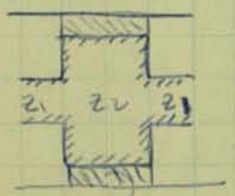
			A	A+1	A−1	A+1 / A−1	$\frac{Z_I}{Z_1}$	B: $\frac{Z_I}{Z_1}$ ROTATED $\frac{\ell}{2}$
Inc. f	ϕ	$\cos\phi$	1.235 cos ϕ					
	0	1					3.12	
	10	.985	1.215	2.215	.215	10.30	3.21	3.0 + j .75
	20	.940	1.160	2.160	.160	13.50	3.68	2.7 + j 1.55
	30	.866	1.070	2.070	.070	29.60	5.44	1.65 + j 2.90
2.0	36	.809	1.000	2.000	0	∞	∞	+ j 3.10
	40	.766	.916	1.916	−.084	− 22.80 j	4.78	+ j 7.00
	50	.642	.783	1.783	−.217	− 8.22 j	2.87	+ j 9.50
	60	.500	.617	1.617	−.383	− 4.22 j	2.06	+ j 14.00
	70	.342	.412	1.412	−.588	− 2.40 j	1.55	+ j 30.00
	80	.174	.215	1.215	−.785	− 1.55 j	1.25	+ j 50.00
5.0	90	0	0	1.000	−1.000	− 1.000 j	1.00	∞
	100	−.174	−.215	.785	−1.215	− .65 j	.81	− j 60.00
	110	−.342	−.412	.588	−1.412	− .42 j	.65	− j 30.00
	120	−.500	−.617	.383	−1.617	− .24 j	.49	− j 14.00
	130	−.642	−.783	.217	−1.783	− .12 j	.35	− j 9.50
	140	−.766	−.916	.084	−1.916	− .04 j	.20	− j 7.00
8.0	144	−.809	−1.000	0	−2.000	0	0	− j 3.10
	150	−.866	−1.070	−.070	−2.070	.030	.17	1.85 − j 2.75
	160	−.940	−1.160	−.160	−2.160	.075	.27	2.70 − j 1.50
	170	−.985	−1.215	−.215	−2.215	.097	.31	2.95 − j .70
10.0	180	−1.000	−1.235	−.235	−2.235	1.05	1.03	

CONSIDER FOLLOWING DESIGN: (FROM C ABOVE)

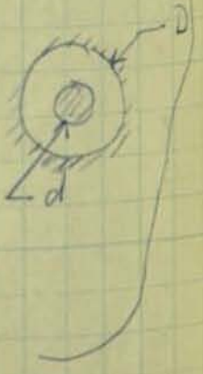
LET $\frac{Z_I}{Z_1} = .30$, IF $Z_I = 50\,\Omega$ } $\rho = .11$

$$Z_1 = \frac{50}{.30} = 167\,\Omega$$

$$Z_2 = (.11)(167) \approx 18.5\,\Omega$$



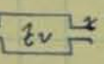
TRY TEFLON SUPPORTS IN COAX LINE $Z_0 = \frac{138}{\sqrt{\varepsilon_r}} \log \frac{D_1}{d_1}$



FOR Z_{21} $\sqrt{\varepsilon} = \sqrt{2.1} = 1.45$ LET $D_1 = .375$

$$Z_{21} = \frac{138}{1.45} \log \frac{D_1}{d_1} = 18.5 \qquad \log \frac{.375}{d_1} = .194$$

$\frac{Z_1}{Z_2} = .105$



B $\frac{Z_1}{Z_2}$	B $\frac{Z_1}{Z_2}$ ROTATED $\frac{l}{\lambda/2}$	C INVERT $\frac{Z_I}{Z_1}$ FOR $\rho = \frac{1}{2.46}$		D ROTATE C $\frac{l}{\lambda}$ to load.
		.32		.32
.314 + j.078	.31 − j.001	.312		.315 − j.08
.282 + j.016	.28 − j.001	.272		.280 − j.16
.017 + j.030	.16 + j.035	.184		.195 − j.26
j.033	+ j.000	0		− j.32
j.073	+ j.300	j .209	84.9	− j.145
j .99	+ j.360	j .348	63.0	− j.10
j 1.46	+ j.480	j .486	81.0	− j.075
j3.14	+ j.920	j .645	108.0	− j.035
j5.23	+ j.970	j .800	134	− j.020
∞	j 1.00	j 1.000	167	0
− j5.23	j 1.24	j 1.230	205	j .020
− j3.14		j 1.54	257	j .035
− j 1.46		j 2.04	340	j .070
− j .99		j 2.86	477	+ j.10
− j .13		j 5.00	835	+ j.16
− j .32	∞	∞	∞	+ j.33
0.9 + j .29	3.45 − j.6	5.88		.18 + j.18 j.26
280 + j .16	3.65	3.70		.27 + j.08 j.16
310 − j.073	3.20	3.22		.31 + j.08
		.97		1.03

$\frac{.375}{d_1} = 1.56$

$\therefore d_1 = .240 = .276$ IN AIR.

FOR Z_2 WILL USE AIR AS DIELECTRIC.

$167 = 138 \log \frac{D_1}{d_2}$

$\log \frac{D_1}{d_2} = 1.21$

$\therefore d_2 = .023$

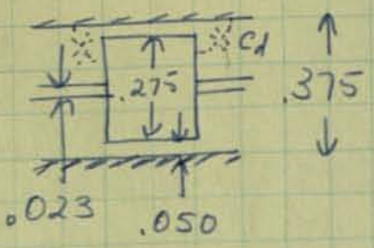
SEE NEXT PAGE.

$\frac{D}{d_2} = 16.2$

$d_2 = \frac{.375}{16.2} = .0232$

 Cont. From p. 25. 4/17/62

Consider Filter Section in Air Dielectric.



To Calculate Cd From p. 61 in Microwave Handbook

$$\alpha = \frac{b-c}{b-a} = \frac{.050}{.176}$$

$$\gamma = \frac{b}{a} = .284$$

From Graph $C_d' = .058$ pf./cm.

$= .147$ pf/in.

$C_d = \pi D C_d'$, Let $D = .325$

$C_d = (3.14)(.325)(.147)$

$C_d = .15$ pf.

$b = \frac{.375}{2}$

$a = \frac{.023}{2}$

$c = \frac{.275}{2}$

$$\begin{array}{r} .375 \\ .023 \\ \hline 2\overline{).352} \end{array}$$

$b - a = .176$

To Calculate the Length of Low Impedance Line in Air To Be Remove To Compensate For This.

$C_d = \pi D \ell$

$\ell = \frac{C_d}{\pi D} = .15$

$C_d = \frac{.225\ \varepsilon_r A}{t}$ pf., $A = \frac{C_d t}{(.225)\varepsilon_r} = \frac{(.15)(.050)}{(.225)(\varepsilon_r)(1.0)}$ ↓ Air.

$A = .033$ in^2

Then $\pi D \ell = .033$, $\ell = \frac{.033}{(3.14)(.325)} \cong .033$" in Air.

In Teflon

$\ell = \frac{.033}{\sqrt{\varepsilon_r}} = \frac{.033}{1.45} \cong .023$

∴ .023" should be removed from the length of the Low Impedance lines in the filter.

Co

C

To Cal
IN Micr

	ϕ	A $\cot\phi \tan\phi/2$	B $\cot\phi \tan\phi/2$	3.76A	3.76B	1+A	1−B
	~~40~~	~~.43~~	~~3.27~~	~~1.62~~			
α =	50	.40	1.80	1.50	6.80	1.40	−.80
	60	.33	1.00	1.24	3.76	1.33	0
	70	.25	.52	.94	1.95	1.25	.48
γ =	80	.15	.21	.56	.79	1.15	.79
	90	0	0	0	0	1.00	1.00
From G	100	−.21	−.15	−.79	−.56	.79	1.15
	110	−.52	−.25	−1.95	−.94	.48	1.25
	120	−1.00	−.33	−3.76	−1.24	0	1.33
C	130	−1.60	−.40	−6.80	−1.50	−.80	1.40

	$\frac{1+A}{1-B}$	$\sqrt{\quad}$	to load $l/2$	$z_I = 50$ z_I
C	50	−1.75	j 1.32	.j.52 .j26.0
C	60	∞	∞	j1.75 j 86.5
To	70	2.6	1.61	1.05+j.5 52.5 + j25
To K	80	1.46	1.21	1.01 +j.2 50.5 + j10
	90	1.00	1.00	1.00 50
	100	.69	.84	~~.98 − j.16~~ 1.01 − j.2 50.5 − j10
	110	.38	.62	1.05 − j.5 52.5 − j25
	120	0	0	− j 1.75 − j 86.5
C,	130	− .57	j .76	

~~E~~

F

Then

In

900 50 (900)

A^3

650 250 50

.023 should be removed from the length of the

Low Impedance lines in the filter.

CENTER THE STOP BAND AT 6 Kmc.

THEN $\ell = \frac{\lambda}{4}$ @ 6 Kmc.

Z_2: $\ell_2 = \frac{1}{4} \frac{3\times10^{10}}{(1.45)(6\times10^9)(2.54)} = .340$

CORRECTING FOR C_d $\ell_2 = .340 - (.023)2$

.340
.023
.317
.340
.046
.294

Try ~~$\ell_2 = .3\cancel{1}7 \pm .003$~~

$\boxed{\ell_2 = .294 \pm .003}$

$\boxed{\ell_1 = .493 \pm .003}$

$\frac{90°}{36°} = \frac{6}{f_{c_1}}$, $f_{c_1} = 2.4$ Kmc.

∴ LOW PASS CUTOFF WILL BE

$f_{c_1} = 2.4$ Kmc.

$f_{c_2} = 4 f_{c_1} = 9.6$ Kmc.

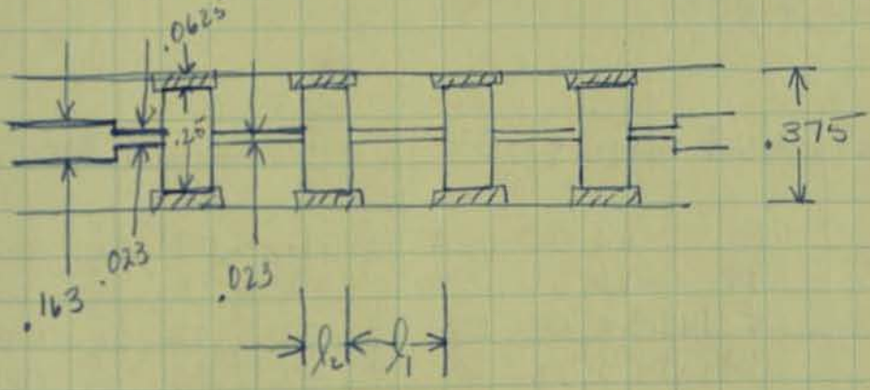
FOR 50 Ω LINE

$\frac{D}{d} = 2.3$

$d = \frac{D}{2.3} = \frac{.375}{2.3}$

$d = .163$

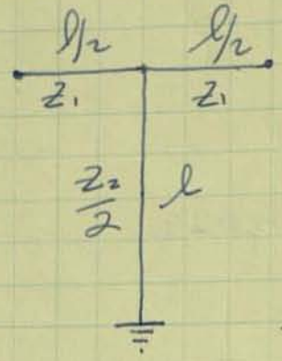
FILTER WILL LOOK LIKE:



.375
.125
.250

2 28 BAND PASS FILTER FOR OUTPUT DOUBLER OR TRIPLER 4/18/62

CONSIDER FOLLOWING FILTER: $\rho = \frac{Z_1}{Z_2}$



$$B = j Z_1 [\sin\phi + \rho \cos\phi \tan\tfrac{\phi}{2}]$$

$$C = j\frac{\sin\phi}{Z_1} - j\frac{\cos\phi}{Z_2 \tan\frac{\phi}{2}}$$

$$\frac{B}{C} = Z_1^2 \left[\frac{\sin\phi + \rho\cos\phi\tan\phi/2}{\sin\phi - \rho\cos\phi\cot\phi/2}\right], \text{ WHERE } \rho = \frac{Z_1}{Z_2}$$

$$\frac{B}{C} = Z_1^2 \left[\frac{1 + \rho\cot\phi\tan\phi/2}{1 - \rho\cot\phi\cot\phi/2}\right]$$

$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{1 + \rho\cot\phi\tan\phi/2}{1 - \rho\cot\phi\cot\phi/2}}$$

LET $\rho = 1$

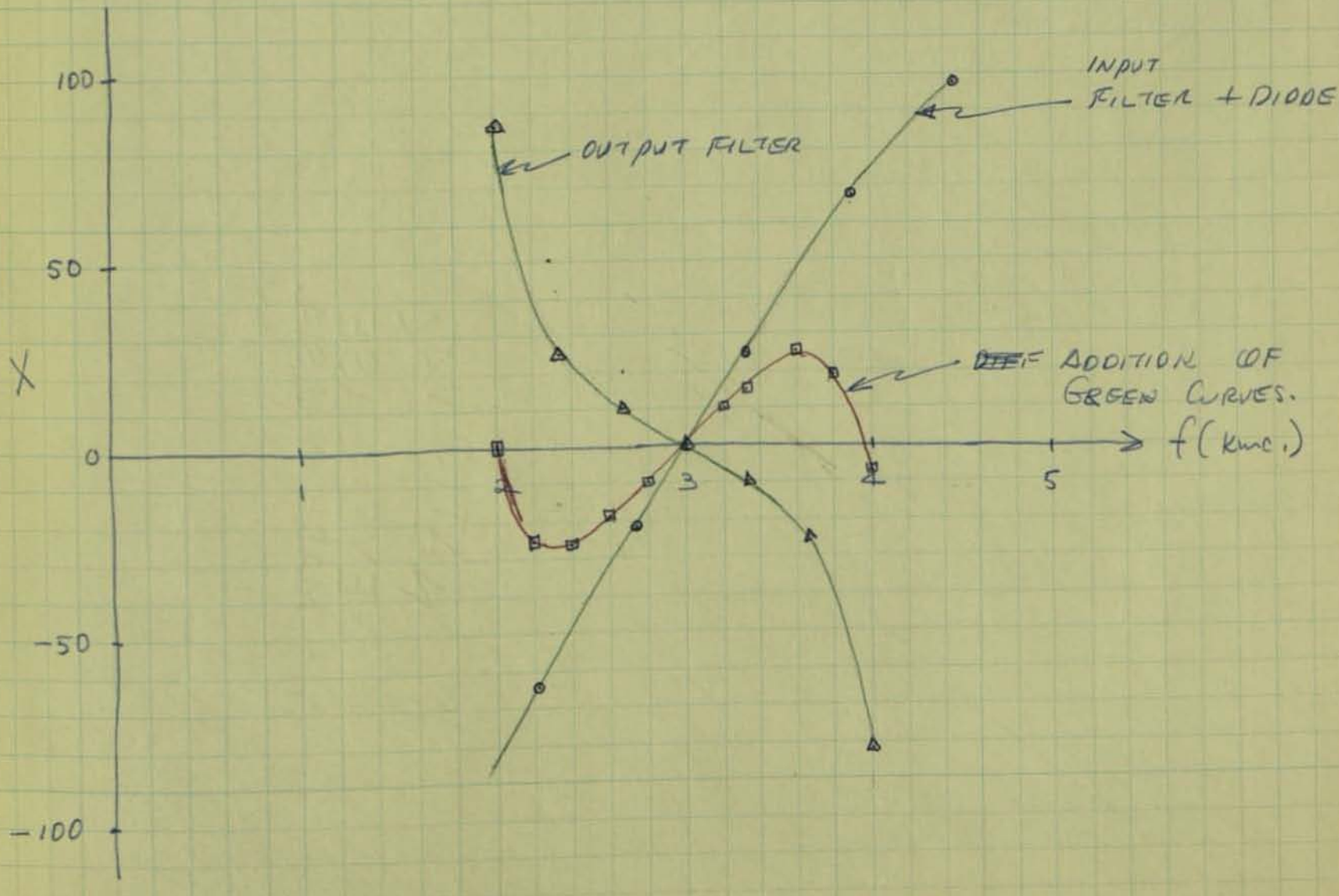
$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{1 + \cot\phi\tan\phi/2}{1 - \cot\phi\cot\phi/2}}$$

ϕ	$\cot\phi$	$\cot\frac{\phi}{2}$	$\cot\phi\cot\frac{\phi}{2}$	$\tan\frac{\phi}{2}$	$\cot\phi\tan\frac{\phi}{2}$	$1+\cot\phi\tan\frac{\phi}{2}$	$1-\cot\phi\cot\frac{\phi}{2}$	$\frac{1+}{1-}$	A $\frac{Z_I}{Z_1}$	B $Z_0 \tan\frac{\phi}{2}$	A B $Z_0 \tan\frac{\phi}{2}$	
0												
10	5.67	11.43	65.0	.09	.51	1.51	−64.0	−.024	j .16	j.07	j 35	
20	2.75	5.67	15.6	.18	.49	1.49	−14.6	−.102	j .32	j.13	j 6.5	
30	1.73	3.73	6.45	.27	.47	1.47	− 5.45	−.27	j .52	j.22	j 11.0	
40	1.19	2.75	3.27	.36	.43	1.43	− 2.27	−.63	j .80	j.34	j 17.0	
50	.84	2.14	1.80	.47	.40	1.40	− .80	−1.75	j 1.32	j.53	j 26.5	
60	.58	1.73	1.00	.58	.33	1.33	0	∞	∞	j1.73	j 86.5	2.0
70	.36	1.43	.52	.70	.25	1.25	.48	2.60	1.61	1.05+j.5	52.5 + j 25	2.33
80	.18	1.19	.21	.84	.15	1.15	.79	1.46	1.21	1.02+j.2	51.0 + j 10	2.47
90	0	1.00	0	1.00	0	1.00	1.00	1.00	1.00	1.00	50.0	3.0
100	−.18	.84	−.15	1.19	−.21	.79	1.15	.69	.83	1.02−j.2	51.0 − j 10	3.33
110	−.36	.70	−.25	1.43	−.52	.48	1.25	.38	.62	1.05−j.5	52.5 − j 25	3.67
120	−.58	.58	−.33	1.73	−1.00	0	1.33	0	0	−j1.73	− j 86.5	4.0
130	−.84	.47	−.40	2.15	−1.80	−.80	1.40	−.57	j .75	−j.53	− j 26.5	

COMPARISON OF OUTPUT. FILTER & DIODE REACTANCES VS. FREQUENCY. (AT OUTPUT DOUBLED FREQUENCY)

f (kmc)	INPUT FILTER	DIODE	FILTER +DIODE
2.22	34.9	− 100	− 65.0
2.78	53.0	− 75	− 22.0
3.33	81.0	− 55	26.0
3.90	108.0	− 40	68.0
4.45	134.0	− 30	94.0
5.00	167.0	− 22	145.0
5.55	206.0	− 17	188.0
6.10	257.0		
6.70	340.0		
7.20	477.		
7.80	835.		

TAKEN FROM EXPERIMENTAL CURVES.



4/19/62

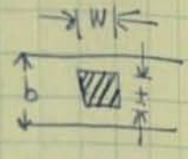
CONT. FROM P. 29.

CUTOFF OF L. P. FILTER IS ACTUALLY AT 2.4 KMC. THEREFORE WILL TRY TO HAVE H. P. FILTER BEGIN AT SAY 2.3 KMC AND END AT 4.6 KMC.

$$\therefore f_0 = \frac{2.3}{2\overline{)6.9}}^{4.6} = 3.45 \text{ ≒ } 3.4 \text{ KMC.}$$

AND ℓ THE LENGTH OF LINE WILL BE:

$$\ell = \frac{1}{4} \frac{3 \times 10^{10}}{(3.4 \times 10^9)(2.54)} = .870''$$

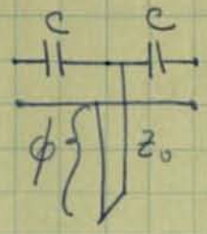


SINCE $Z_I = Z_1 = Z_2 = 50\ \Omega$. $\begin{cases} b = .25 \\ \text{LET } t = .125 \end{cases}$ $t/b = .5$

$$\frac{w}{b} = .48$$

$w = .12$, $\therefore$ 1/8 X 1/8 STOCK SHOULD BE O.K.

ANOTHER POSSIBLE OUTPUT FILTER



$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 1 & \frac{1}{j\omega C} \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ \frac{1}{jZ_0 \tan\phi} & 1 \end{pmatrix} \begin{pmatrix} 1 & \frac{1}{j\omega C} \\ 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 - \frac{1}{\omega C Z_0 \tan\phi} & \frac{1}{j\omega C} \\ \frac{1}{jZ_0 \tan\phi} & 1 \end{pmatrix} \begin{pmatrix} 1 & \frac{1}{j\omega C} \\ 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 - \frac{1}{\omega C Z_0 \tan\phi} & \frac{1}{j\omega C}\left(1 - \frac{1}{\omega C Z_0 \tan\phi}\right) + \frac{1}{j\omega C} \\ \frac{1}{jZ_0 \tan\phi} & -\frac{1}{\omega C Z_0 \tan\phi} + 1 \end{pmatrix}$$

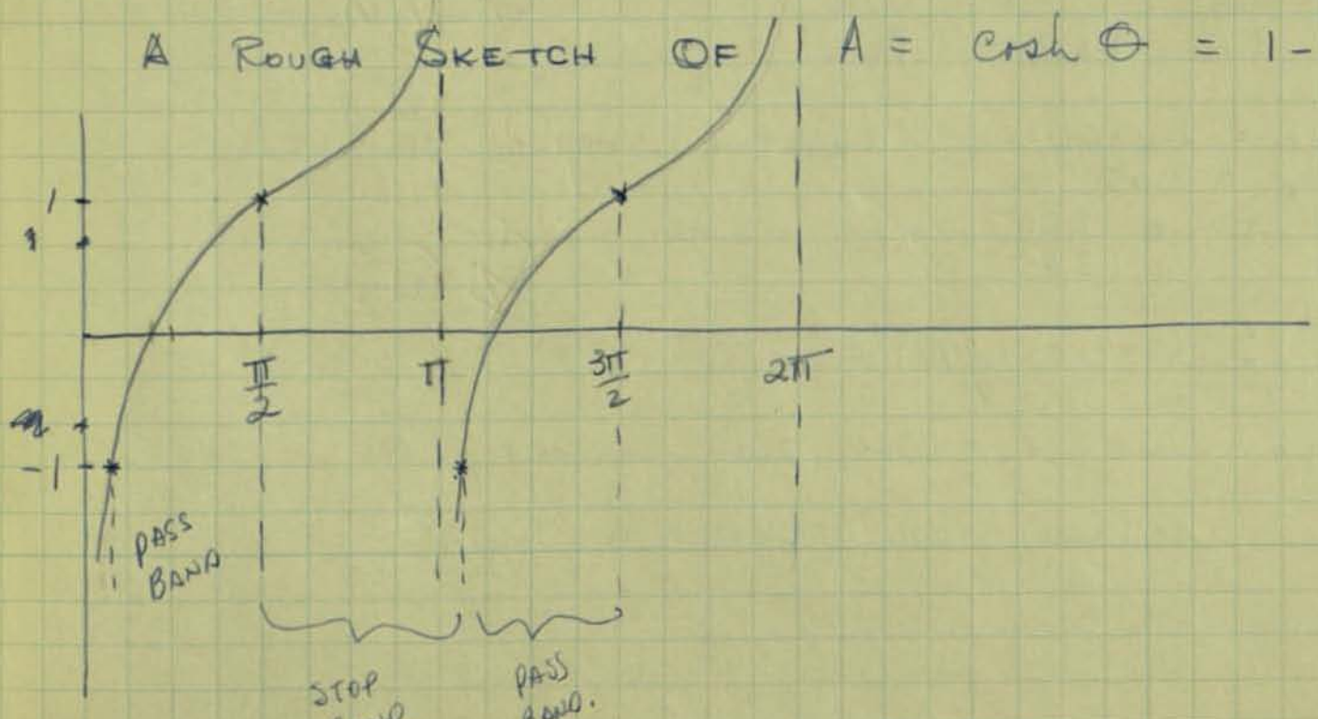
$$\therefore \quad A = D = 1 - \frac{1}{\omega C Z_0 \tan\phi}$$

$$B = \frac{1}{j\omega C}\left(2 - \frac{1}{\omega C Z_0 \tan\phi}\right) \qquad C = \frac{1}{jZ_0 \tan\phi}$$

$$Z_I = \pm\sqrt{\frac{B}{C}} = \pm\sqrt{Z_0 \tan\phi\left(2 - \frac{1}{\omega C Z_0 \tan\phi}\right)}$$

$$= \pm\sqrt{\frac{1}{\omega C}\left(2Z_0 \tan\phi - \frac{1}{\omega C}\right)} = \pm\frac{1}{\omega C}\sqrt{2\omega C Z_0 \tan\phi - 1}$$

A ROUGH SKETCH OF $A = \cosh\Theta = 1 - \frac{1}{\omega C Z_0}\cot\phi$

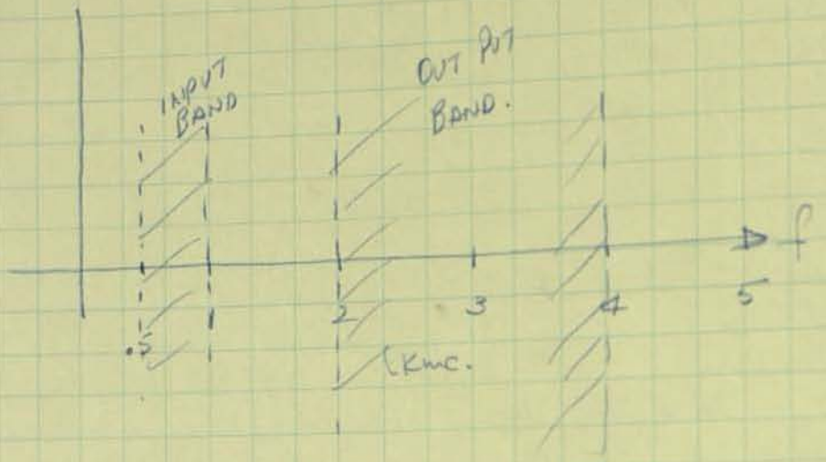


5/3/62

More Harmonic Generation

Desire $\frac{1}{2}$ watt at 2250 mc

Try for Quadrupling from 562.5 mc



Will scale design Pg. 27 (for low pass)

f_{c_1} actually turned out to be 2.2 Kmc.

∴ Lengths should be scaled by ratio $\frac{2.2}{.9} = \cancel{4.4}\ 2.44$

$$\therefore \boxed{\begin{aligned} l_2 &= (2.44)(.294) = .720 \\ l_1 &= (2.44)(.493) = 1.205 \end{aligned}}$$

For the Band Pass (pg. 30)

$\left.\begin{matrix} f_{c_1} = 2.6 \text{ Kmc.} \\ f_0 = 3.55 \end{matrix}\right\}$ ∴ Lengths should be scaled by ratio $\frac{3.55}{3.45} = 1.03$

$$\therefore \boxed{l = (1.03)(.870) = .895}$$

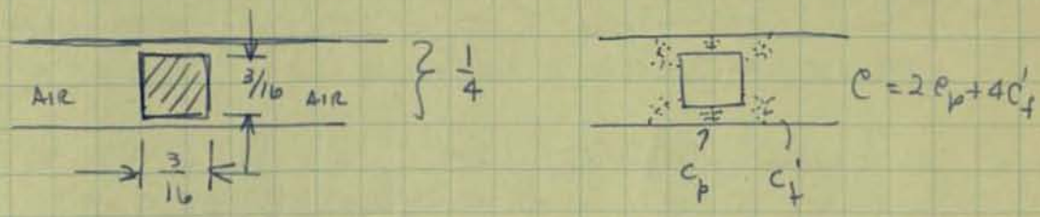
Should scale $l_2 = .340$ then subtract .046 see p. 27

$(2.44)(.340) - .046 = .830 - .046 = .784$

830
046
784

5/4/62 LOWER IMPEDANCE OUTPUT FILTER FOR HARMONIC GEN. (REFERENCE p. 30)

CONSIDER:



$$Z_0\sqrt{\epsilon_r} = \frac{\eta}{C/\epsilon}, \quad \eta = 376.7$$

$$\sqrt{\epsilon_r} = 1$$

$$\frac{w}{b} = \frac{\frac{3}{16}}{\frac{1}{4}} = .75$$

$$\frac{t}{b} = .75$$

$$C = 2C_p + 4C'_f$$

$$\frac{C_p}{\epsilon} = 2\,\frac{w/b}{1 - t/b} = 2 \cdot \frac{\frac{3}{4}}{\frac{1}{4}}$$

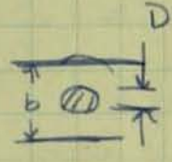
$$\frac{C_p}{\epsilon} = 6, \quad \frac{C'_f}{\epsilon} = 1.5$$

$$\frac{C}{\epsilon} = 2 \cdot 6 + 4 \cdot 1.5 = 12 + 6 = 18$$

$$Z_0 = \frac{376.7}{18} = 21\,\Omega.$$

FOR QUARTER WAVE TRANSFORMER (MATCHING TO 50 Ω) $Z_m = \sqrt{50 \cdot 20}$

$$Z_m = 31.6\,\Omega.$$



TRY CONSTRUCTION.

$$\frac{D}{b} = .76, \quad D = .76 \cdot \frac{1}{4} = .190$$

TRY TO CENTER AT 3 KMC.

$$\ell = \frac{3 \times 10^{10}}{4(3 \times 10^{9})}\,2.5 = .984.$$

5/15/62

QUADRUPLER
FROM p. 32.

CONSIDERATION OF SELF RESONANT FREQ. OF DIODE PLUS FILTER WITH L.P. CUTOFF AT 1 Kmc.

FROM p. 29. & 28 $f_{c_1} = 2.4$ Kmc. ∴ FREQUENCY VALUES MUST BE SCALED BY $\frac{1.0}{2.4} \cong .42$

f (Kmc) P. 29	f (Kmc) SCALED	INPUT FILTER Ω	DIODE Ω	FILTER + DIODE Ω
2.22	.92	34.9	~~100~~	~~-65~~
2.78	1.16	53.0	~~75~~	~~-22~~
3.33	1.39	81.0	~~55~~ -180	-79
3.90	1.63	108.0	40 -140	-32
4.45	1.90	134.0	30 -115	19
5.00	2.08	167.0	22 -100	67
5.55	2.31	205.0	17 -85	120
6.10	2.54	257.0	-70	
6.70	2.80	340.0	-60	
7.20	3.00	477.0	-50	
7.80	3.25	835.0	-45	

CONSIDER OUTPUT FILTER DESIGN AGAIN:

IF USE 21 Ω SHUNT STUBS AND CENTER BAND AT $f_1 = 2.4$ Kmc

$\rho = \frac{Z_1}{Z_2} = \frac{50}{21} = 2.4$, $l = (1+\rho) \sin\theta_c$

$\sin\theta_c = \frac{1}{3.4} \cong .29$

$\theta_c \cong 73°$ $\qquad \frac{90}{73} = \frac{2.4}{f_c}$, $f_c = 1.95$ Kmc

$l = \frac{\lambda}{4}\Big]_{\text{at } 2.4 \text{ Kmc}} = \frac{1}{4} \frac{3\times10^{10}}{2.4\times10^{9}} 2.54 = 1.23''$

DEGENERATE PARAMETRIC AMPLIFIER USING FD-6 6/14/62

SELF RESONANT DIODE FREQ. $f_{res.} = 10$ Kmc.
$R_s = 1.0\,\Omega$ ∴ INPUT FREQ IS 5 Kmc.
$C_{-1} \cong 1.2$ pf.

ASSUME $\frac{C_0}{C(V_0)} = 1.2$ FROM KOTZEBUE'S TEXT $\left(\frac{V}{V_0} = \frac{\text{pump volt}}{\text{total static volt}} = .9\right)$

$$\therefore C(-1) = \frac{C_{-1}}{1.2} = 1\ pf$$

HERE WE WILL ASSUME TO OPERATE AT −1 VOLTS. BIAS

LET PUMPING PARAMETER $a = .25$, $1-a^2 \cong .94$

TO CALCULATE R_{bo}, THE REAL PART OF OPTIMUM DIODE IMPED. FOR A SPECIFIED DIODE Q AND AMPLIFIER GAIN.

$$Q_d = \frac{1}{2\pi f_0 R_s C_{\underset{\alpha C(-1)}{0}} (1-a^2)} = \frac{1}{2\pi (5\times10^9)(1.0)(1\times10^{-12})(.94)}$$

$$\boxed{Q_d = 32.2}$$ ← Q OF SERIES RESONATED DIODE AT 5 Kmc.

USING CURVES OF MATTHAEI "OPTIMUM DESIGN OF WIDEBAND PARAMP'S." $\frac{R_b}{a(X_{11})_0}$ IS PLOTTED AS A FUNCTION OF GAIN WITH aQ_d AS A PARAMETER.

$$\{ (X_{11})_0 = \frac{1}{2\pi f_0 C(-1)(1-a^2)} = 32.2 \text{ ALSO}$$

$$\{ aQ_d = 8.05$$

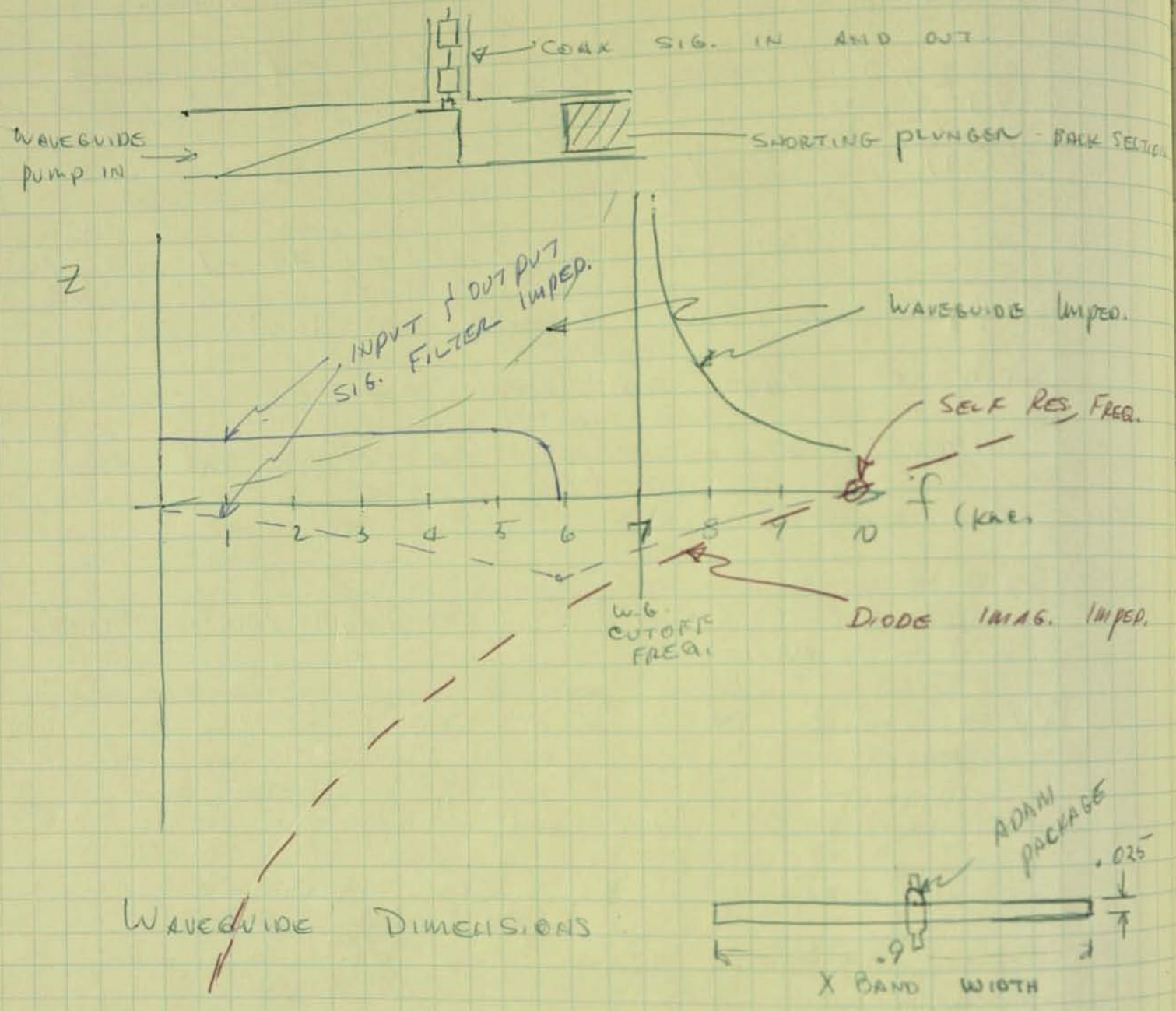
ALSO SELECTING GAIN AT 15 db, $\{aQ_d = 8$

$$\frac{R_{bo}}{a(X_{11})_0} \cong 1, \quad \boxed{R_{bo} = \frac{1}{4}\,32.2 \cong 8\,\Omega}$$

Cont. From p. 35

6/15/62

Consider Impedance Values of Following Sketch



Waveguide Dimensions

$$Z_0 = 60\pi^2 \frac{b}{a} \frac{1}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}} \quad , \quad \frac{b}{a} = \frac{.025}{.9} = .028$$

$$Z_0 = \frac{16.5}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$$

$f_c = 6.56$ KMC.

TABLE OF WAVEGUIDE Z_0 VALUES.

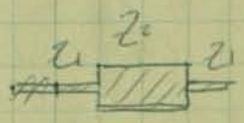
f freq. (KMC)	$\frac{6.56}{f}$	$\left(\frac{6.56}{f}\right)^2$	$1-(\ )^2$	$\sqrt{1-(\ )^2}$	Z_0 (Ω)	$2Z_0$ (Ω)
4.0	1.62	2.62	$-1.62 \pm j$	1.27	$j\,13.0$	$j\,26.0$
4.5	1.44	2.08	$-1.08 \pm j$	1.04	$j\,15.9$	$j\,31.8$
5.0	1.30	1.69	$-.69 \pm j$	.83	$j\,19.9$	$j\,39.8$
5.5	1.18	1.39	$-.39 \pm j$	.63	$j\,26.2$	$j\,52.4$
6.0	1.08	1.17	$-.17 \pm j$	.41	$j\,40.2$	$j\,80.4$

$2Z_0$ WAS PLOTTED BECAUSE THE COAX SIG LINE SEES 2 WAVEGUIDES IN SERIES

PLOT OF SUM OF $Im\{Diode Z\}$ AND $2Z_0$

f.	$2Z_0$	Diode	$2Z_0$ + Diode
4.0	$j\,26$	$-j\,45$	$-j\,19.0$
4.5	$j\,31.8$	$-j\,37$	$-j\,5.2$
5.0	$j\,39.8$	$-j\,31$	$+j\,8.8$
5.5	$j\,52.4$	$-j\,26$	$+j\,26.4$
6.0	$j\,80.4$	$-j\,21$	$+j\,59.4$

CONSIDER FOLLOWING FILTER DESIGN



From p. 24 (p. 23)

$$\frac{Z_I}{Z_1} = j\sqrt{\frac{(1+\rho)\cos^2\phi - (1-\rho)}{(1+\rho)\cos^2\phi + (1-\rho)}} \qquad \rho = \frac{Z_2}{Z_1}$$

ALSO LET $f_c = 6$ KMC. AND $f_0 = 10$ KMC.

f_0 IS OPEN CIRCUIT FREQ. OF FILTER

$$\frac{\phi_c}{\phi_0} = \frac{6}{10}, \quad \phi_c = .6\,\phi_0 \;\&\; \phi_0 = \pi/2, \quad \therefore \phi_c = 54^\circ$$

ALSO $-1 = \cos^2 54^\circ - \frac{1}{2}\left(\frac{1}{\rho}+\rho\right)\sin^2 54^\circ$

$\cos^2 54^\circ = .346$, $\sin^2 54^\circ = .655$

6/15/62

CONT. FROM p. 37

$-1 = .346 - \frac{1}{2}(\quad).655$

$\frac{(1.346)^2}{.655} = \frac{1}{\rho} + \rho = 4.1$, $\rho^2 - 4.1\rho + 1 = 0$

$\rho = \frac{4.1 \pm \sqrt{16.8 - 4}}{2} = 2.05 \pm 1.79$

$\rho = .26$ or 3.84

WITH THIS CASE $\frac{Z_2}{Z_1} = .26$

THEN $\frac{Z_I}{Z_1} = \sqrt{\frac{1.26\cos\phi - .74}{1.26\cos\phi + .74}}$ at $\phi = 0$

$\frac{Z_I}{Z_1} = \sqrt{\frac{.52}{2.00}} = \sqrt{.26} = .51$

$Z_1 = \frac{Z_I}{.51}$, if $Z_I = 8\ \Omega$. $Z_1 \doteq 16\ \Omega$

$Z_2 \doteq 4\ \Omega$.

FOR 16 Ω AIR LINE

$.116 = \frac{16}{138} = \log \frac{D}{d}$, LET $D = .25$

$\frac{D}{d} = 1.3$, $d = \frac{D}{1.3} = \frac{.25}{1.3} = .192$

USING TEFLON DIELECTRIC FOR SUPPORT - $Z = 4\ \Omega$.

$\frac{(4)(2.1)}{138} = \log \frac{D}{d}$

$.061 = \log \frac{D}{d}$ $\frac{D}{d} = 1.15$, $d = \frac{.25}{1.15} = .218$

For length in air $\ell = \frac{1}{4}\frac{3\times10^{10}}{(10\times10^7)(254)} = \frac{3}{(4)(254)} = .295$

in Teflon $\ell' = \frac{.295}{1.45} = .204$ remove .030 for fringing cap.

Cont from p. 38 6/15/62

$Z_1 = 16\ \Omega$ $\ell_1 = .295$

$Z_2 = 4\ \Omega$ $\ell_2 = .174.$

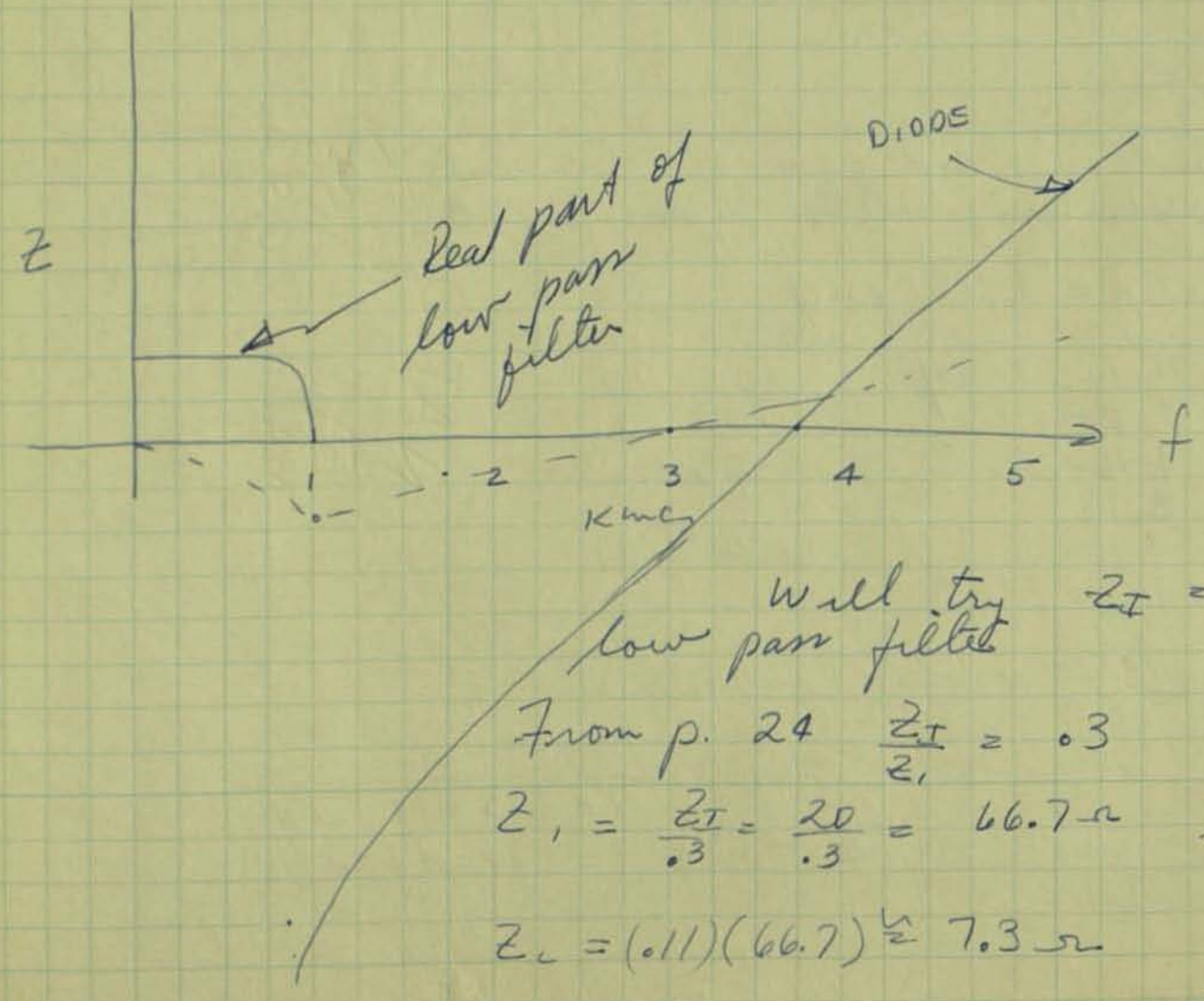
.204
.030
.174

More harmonic generation 6/27/62

(Quadrupling)

Results of design on p. 34 for quadruplr were at best only about 12% eff. at our freq. It is felt that the self resonant freq. is too high to work with in the "SOAM" package diode. ∴ a non-SOAM package diode was checked out and found to have a self resonant freq. of about 3.7 kmc. It is felt that this can be more easily controlled. Also, it was found that a real input impd. of about 20Ω was necessary to get optimum efficiency.

CONSIDER THE FOLLOWING IMPED. SKETCH:-



Will try $Z_I = 20\ \Omega$ for low pass filter

From p. 24 $\frac{Z_I}{Z_1} = .3$

$Z_1 = \frac{Z_I}{.3} = \frac{20}{.3} = 66.7\ \Omega$, $\rho = \frac{Z_2}{Z_1}$

$\rho = .11$

$Z_2 = (.11)(66.7)^{\frac{1}{2}} = 7.3\ \Omega$

Cont. from p. 39 6/27/62

Consider filter impedance plot from p. 24 (compensated) (column labeled D)

f. Kc.	ϕ	D.	A Z_I $z_1 = 66.7\,\Omega$	B Z_1 Divide	A+B	Z_{I_0} OF OUTPUT FILTER BELOW
	0	.32				
	10	.315 − j.08				
	20	.280 − j.16				
	30	.195 − j.26				
1.65	40		~~j.33~~ j145	−j9.70		
2.06	50		~~j.145~~ −j.10	−j6.67		
2.47	60		~~j.110~~ −j.075	−j5.00	−j51.0	−j56.0 +j86.5
2.89	70		~~j.0775~~ −j.035	−j2.30	−j29.0	−j31.3 52.5 + j25.0
3.29	80		−j.020	−j1.33	−j14.0	−j15.3 50.5 + j10.0
3.7	90		~~j.0200~~ 0	0	0	0 50
4.11	100		~~0~~ +j.020	+j1.33	+j9.	+j10.3 50.5 − j10.0
4.53	110		+j.035	+j2.30	+j21.0	+j23.3 52.5 − j25.0
4.94	120		+j.075	+j5.00	+j32.0	+j37.0 − j86.0
5.35	130		+j.10	+j6.67		
	140		+j.145	+j9.70		
	150	.195 + j.26				
	160	.280 + j.16				
	170	.315				
	180	.320				

Consider band pass of 3.2 Kc to 4.2 Kc centered at 3.7 Kc, using filter type p. 28.

$$A = (1+\rho)\cos\phi \qquad \rho = \frac{Z_1}{Z_2}$$

$$1 = (1+\rho)\cos\phi$$

$$1 = (1+\rho)\,.21$$

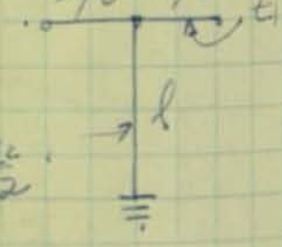
$$1+\rho = 4.76$$

$$\rho = 3.76$$

$$\frac{3.7}{3.2} = \frac{90^\circ}{\chi}$$

$$\chi = 78^\circ$$

$\cos 78^\circ = .21$



$$\left\{ Z_1 = Z_I = 50\,\Omega, \right.$$

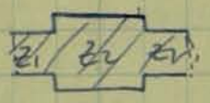
$$\therefore\ Z_2 = \frac{Z_1}{\rho} = \frac{50}{3.76} = 13.3\,\Omega$$

$$\frac{Z_I}{Z_1} = \pm\sqrt{\frac{1+3.76\cot\phi\tan l/2}{1-3.76\cot\phi\cot l/2}}$$

CONT. FROM p. 40

LOW PASS FILTER CONSTRUCTION:-

$Z_1 = 66.7\,\Omega$, $Z_2 = 7.3\,\Omega$.



COAX DIMENSIONS FOR Z_1 (AIR DIELECTRIC)

$$Z_1 = 138 \log \frac{D}{d}, \quad \text{let } D = .375$$

$$\log \frac{D}{d} = \frac{66.7}{138} = .483, \quad \frac{D}{d} = 3.04$$

$$d_1 = \frac{.375}{3.04} = .123 \approx .125$$

COAX DIMENSIONS FOR Z_2 (TEFLON DIELECTRIC)

$$Z_2 = \frac{138}{1.45} \log \frac{D}{d}$$

$$\log \frac{D}{d} = \frac{(1.45)(7.3)}{138} = .0767$$

$$\frac{D}{d_2} = 1.19, \quad d_2 = \frac{.375}{1.19} = .315$$

$$\begin{array}{r} .375 \\ .315 \\ \hline 2)\,.060 \\ .030 \end{array}$$

~~Center of strip pass band will be 3.7 Kmc~~

$$\frac{5\ \text{Kmc.}}{2\ \text{Kmc.}} = \frac{3.7\ \text{Kmc.}}{\Phi_c}, \quad \Phi_c = 1.48\ \text{Kmc.}$$

$\therefore \ell = \frac{\lambda}{4}$ @ 3.7 Kmc. in air

$$\ell_1 = \frac{1}{4} \frac{3 \times 10^{10}}{(3.7 \times 10^9)(2.54)} = .798"$$

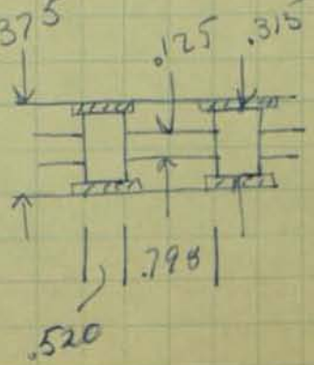
7.5 / 4 = 1.87

in teflon

$$\ell_2' = \frac{.798}{1.45} = .550"$$

Correction about .030

$\therefore \ell_2 = .550 - .030 = .520.$



CONT. FROM p. 41.

CONSIDER MATCHING TRANSFORMER FROM 20Ω TO 50Ω OVER FREQUENCY RANGE 3.2 KMC TO 4.2 KMC.

if $n=2$ { USING $S_{min} = 1 + \frac{\ln\left[\frac{Z_{n+1}}{Z_1}\right]}{T_{n-1}\left[\frac{1}{\cos\phi_1}\right]}$

$$P = \frac{f_2}{f_1} = \frac{4.2}{3.2} = 1.31$$

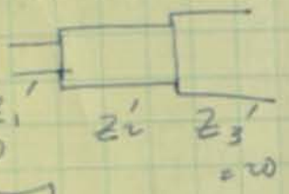
$$\phi_1 = \frac{180^\circ}{1+P} = \frac{180^\circ}{2.31} = 78^\circ, \quad \cos 78^\circ = .208$$

$$\frac{1}{\cos\phi} \stackrel{n}{=} 5, \quad \ln\frac{Z_{n+1}}{Z_1} = \ln\frac{50}{20} = \ln 2.5 = .92$$

{ $T_1(x) = x$ $\therefore T_1(5) = 5$

$$S_{min} = 1 + \frac{.92}{5} = 1 + .18$$

$S_{min} \triangleq 1.18$



$$Z_2' = \sqrt{50 \cdot 20} = 5.2\sqrt{2.5} = 10\sqrt{10}$$

$$Z_2' = 31.6\ \Omega$$

i.e. $Z_2' = 138 \log\frac{.375}{d_2'}$, $\log\frac{.375}{d_2'} = \frac{31.6}{138} = .229$

$\frac{.375}{d_2'} = 1.69$, $d_2' = \frac{.375}{1.69} = .222$

$l_2' = .798''$

i teflon $\log\frac{.375}{d_2} = .338$

$\frac{.375}{d_2} = 2.4$

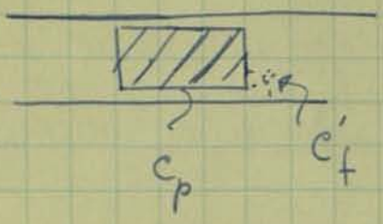
$d_2 = .175$

CALCULATING THE ~~IMPED~~ GEOMETRY OF A 13.3 Ω IMPEDANCE.

From p. 33

$$C = 2C_p + 4C_f'$$

$$\frac{C_p}{\epsilon} = 2\,\frac{w/b}{1 - t/b}$$



$$Z_0 = \frac{\eta}{C/\epsilon}$$

Pick $\frac{t}{b} = .9$

& $\frac{C_f'}{\epsilon} = 2.1$

$$\frac{C}{\epsilon} = \frac{\eta}{Z_0} = \frac{376.7}{13.3}$$

$$\frac{C}{\epsilon} = 28.3$$

Then $28.3 = 2\frac{C_p}{\epsilon} + 8.4$

$\frac{C_p}{\epsilon} \leq 10 = 2\,\frac{w/b}{1-.9}$, $w/b = (5)(.1)$

OR $\frac{w}{b} = .5$, $w = \frac{.50}{4} = .13$ w/ $b = \frac{1}{4}$

Try $\frac{t}{b} = .8$, $\frac{C_f'}{\epsilon} = 1.65$, $4\frac{C_f'}{\epsilon} = 6.60$

$$\frac{C_p}{\epsilon} = 10.85 = 2\,\frac{w/b}{1-.8}$$

$$2\overline{)21.7}\quad 28.3 - 6.6 = 21.7 \quad 10.85$$

$$\frac{w}{b} = \frac{10.85}{2}(.2)\cdot 1 = 1.085$$

$$w = \frac{1.085}{4} = .271 \qquad t = \frac{.8}{4} = .20$$

Consider $f_0 = 3.5$ Kc., $l = \frac{1}{4}\,\frac{3\times10^{10}}{3.5\times10^{9}}\,2.54 = .843$

7/31/62

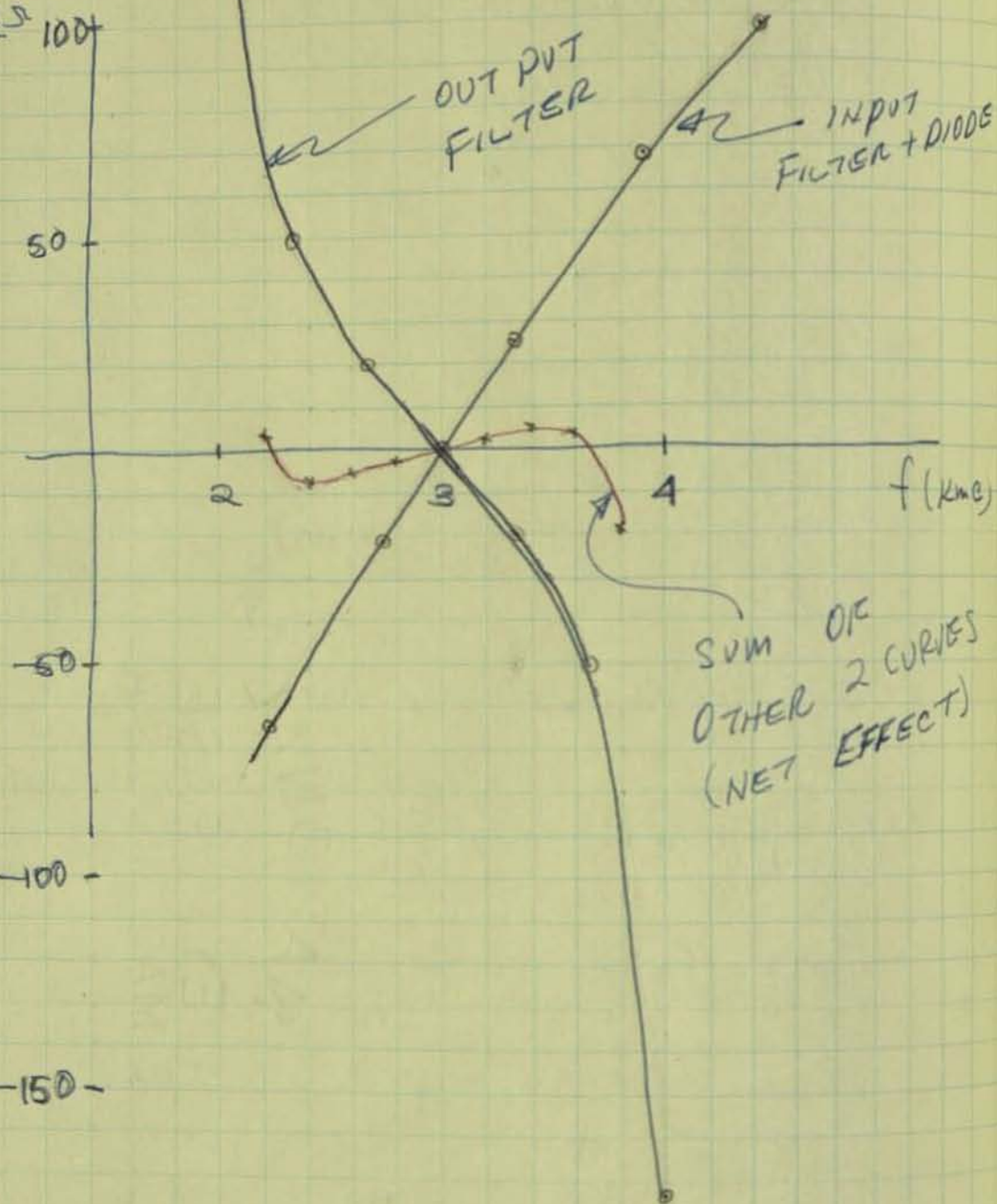
HARMONIC GENERATION

CONSIDER A 100Ω OUTPUT FILTER FOR DOUBLER.

SEE p. 29, 28

COLUMN B X 100Ω

f (kmc.	
2.0	+j173
2.33	105 +j50
2.67	102 +j20
3.00	100
3.33	102 −j20
3.67	105 −j50
400	−j173



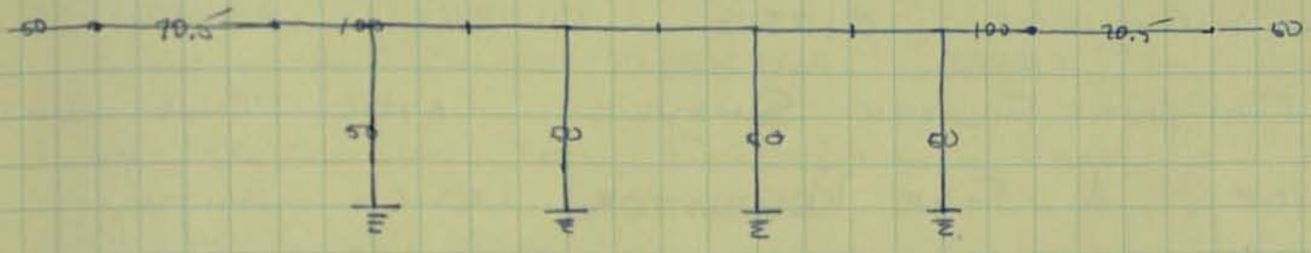
PLOT OF IMAGINARY PARTS OF OUTPUT CIRCUIT.

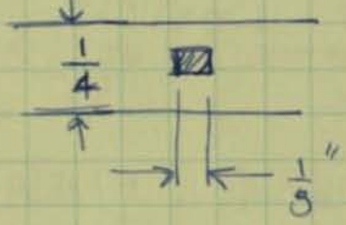
OUTPUT SHOULD WORK PRETTY WELL FROM 2.2 kmc TO 3.8 kmc.

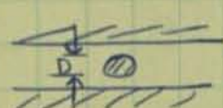
$$\ell = \frac{\lambda}{4} = \frac{1}{4}\,\frac{3\times10^{10}}{(2.5k)(3\times10^{9})} = .984 \text{ in}$$

WILL TRY SINGLE GEOMETRIC MEAN MATCHING IMPED.

$$Z_m = \sqrt{50\cdot100} = 50\sqrt{2} = 70.5$$



FOR 50 Ω.  FOR

FOR 70.5 Ω LINE  1/4 = b

$$\frac{D}{b} = .39 \qquad D = \frac{.39}{4} = .0975$$

FOR 100Ω LINE $\frac{D}{b} = .235$, $D = \frac{.235}{4} = .060 \approx \frac{1}{16}$

April 10, 1963

Fifth Order Harmonic Generator For Solid State Source.

Output Filter

Since the first effort will be a 10% Bandwidth Source Centered about 5.5 kmc the Output Filter Should Cover this Band. Consider A Four Resonator Design With .1 DB Ripple For Tcheb. Design.

From Getsinger:

1.0880 : 1.3061 : 1.7703 : 0.8189 { g values }

For $r = 0.7378$

Before the above Design is considered will scale the 50 Ω Design Done At S.R.I.

Will cut Ground plane spacing By $\frac{1}{3}$

$b = \frac{1}{3} \times .625 = .208$

$t = \frac{1}{3} \times .187 = .062$ ≈ $\frac{1}{16}$ Stock

Then if $\frac{1}{4}$ stock is used For Cover plates the Spacers Between S Lines And Ground Planes will be $\frac{1}{2}(.208 - .062) = .073$

RECOPYING TABLE FROM MATTHAEI - PGMTT NOV. 62 & DIVIDING BY 3

k	$S_{k,k+1}$
0 ↕ 6	.042
1 ↕ 5	.140
2 ↕ 4	.171
3	.173

k	W_k
0 ↕ 7	.146
1 ↕ 6	.051
2 ↕ 5	.061
3 ↕ 4	.061

1.63
1.49
3.12

EXISTING BAND CENTER SEEMS TO BE $\frac{1.63+1.49}{2}$

TRY SCALING TO 5.4 - 5.9 Kmc BAND = 1.56 Kmc

$f_0 = 5.65$ Kmc

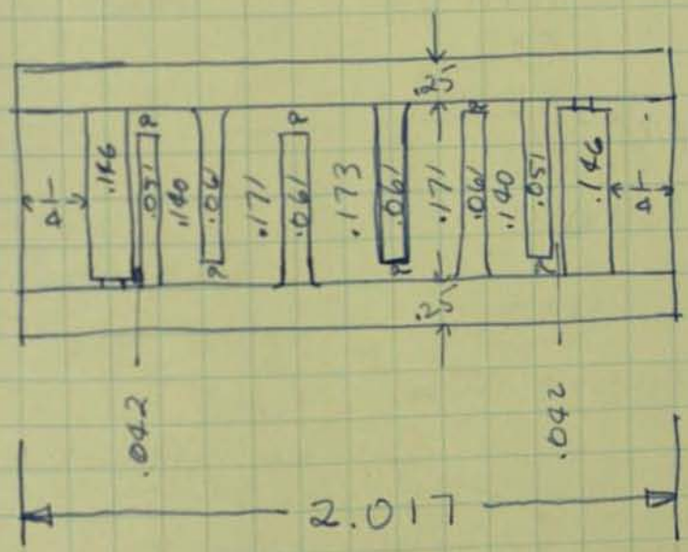
5.4
5.9
2 | 11.3
5.65

$\frac{\ell}{1.75} = \frac{1.56}{5.65}$ ~~$\ell = .633$~~

$\ell = .483$, ALSO, SCALING END SPACINGS:

$\frac{.216}{3} = .072$

DIMENSIONS BECOME:-



~~a = .072~~ Try

.060

~~1.055~~ 1.043

.146
.146
.25
.25
~~.084~~
.102
.28
.122
.342
.122
.173
~~2.113~~
2.017

.483
.072
.500
1.055
-.012
1.043

APRIL 18, 63 INPUT FILTER FOR HARM. GEN.

WILL TRY STYCAST #9 AS DIELECTRIC SUPPORT.

CONSIDER ALSO $\frac{1}{4}$" GROUND PANE SPACING.

50 Ω LINE FOR .003 COPPER FOIL

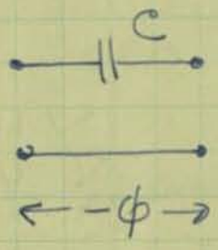
$$\frac{t}{b} = \frac{.003}{.250} = .012$$

$$50\sqrt{\varepsilon_r} = 150\,\Omega, \quad \frac{W}{b} \doteq .2, \quad W = \frac{.2}{4} = .050$$

CONSIDER CENTER FREQ. OF $f_0 = 1100$ MC.

$$\lambda = \frac{3\times10^{10}}{(3)(1.1\times10^{9})(2.54)} = 3.58\text{"} \text{ IN } K-9$$

CONSIDER IMPEDANCE INVERTER AT 1100 MC.



IF $C \doteq 1$ pf.

$$B = \omega C$$

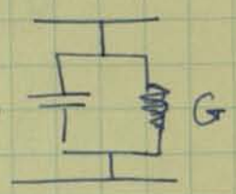
$$= 2\pi \times 1.1\times10^{9} \times 1\times10^{-12}$$

$$B = 2.2\pi\times10^{-3} = 6.9\times10^{-3}$$

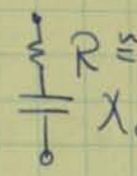
$$X = \frac{1000}{6.9} = 145$$

4|24|63 CONTINUED FROM p. 48

CONSIDER A SHUNT DIODE HOOK-UP.



STARTING FROM HENSCHKE'S MEASURED VALUES AT 1.5 Kmc. :



$$Y = \frac{1}{Z} = \frac{1}{R - jX_c} \cdot \frac{R + jX_c}{R + jX_c} = \frac{R}{R^2 + X_c^2} + j\frac{X_c}{R^2 + X_c^2}$$

$$\therefore\ G = \frac{R}{R^2 + X_c^2}, \quad B = \frac{X_c}{R^2 + X_c^2}$$

$$R^2 + X_c^2 = 225 + 2500 = 2{,}725$$

at 1 Kmc $\quad G = \frac{15}{2725}$ $\quad B = \frac{50}{2725}$

$$\frac{1}{G} = 182\ \Omega: \qquad \frac{1}{B} = 55.5\ \Omega$$

CONSIDER 10% BANDWIDTH VALUES AROUND 1.5 Kmc. $\quad f_1 = 1.35$ Kmc. $\quad f_2 = 1.65$ Kmc.

$$\frac{1}{G} = \frac{R^2 + \left(\frac{1}{\omega C}\right)^2}{R} = R + \frac{1}{R}\left(\frac{1}{\omega C}\right)^2$$

TO FIND C: $\quad \omega C = \frac{1}{55.5} = .018$ at 1.5 Kmc

$$C = \frac{.018}{2\pi\ 1.5 \times 10^9} = \frac{1.8 \times 10^{-11}}{3.01\pi}$$

$$C = 1.91\ \text{pf.}$$

AT $f_1 = 1.35$ Kmc. ($X_c|_{f_1} = 62.2$)

$$\left.\frac{1}{G}\right|_{f_1} = 15 + \frac{1}{15}\left(\frac{1}{2\pi\ 1.35 \times 10^9\ 1.9 \times 10^{-12}}\right)^2 = 15 + \frac{1}{15}\left(\frac{10^{+3}}{16.1}\right)^2$$

$$= 15\Omega + 257\Omega = 272\Omega$$

$\frac{257}{15}$
$\frac{}{272}$

4/24/63 Cont. From p. 49

$$\frac{1}{B} = \frac{R^2 + X_c^2}{X_c} = \frac{R^2}{X_c} + X_c = \frac{(15)^2}{62.2} + 62.2$$

$$\left.\frac{1}{B}\right|_{f_1} = 3.62 + 62.2 = \underline{65.8\ \Omega}$$

At $f_2 = 1.65$ Kmc.

$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi (1.65 \times 10^9)(1.91 \times 10^{-12})}$$

$$X_c = 50.5, \quad X_c^2 = 2550$$

$$\frac{1000}{(2\pi)(1.65)(1.91)} = \frac{1000}{19.8} = 50$$

$$\left.\frac{1}{G}\right|_{f_2} = 15 + \frac{1}{15}(2550) = 15 + 170 = \underline{185\ \Omega}.$$

$$\left.\frac{1}{B}\right|_{f_2} = \frac{225}{50.5} + 50.5 \doteq 4.5 + 50.5 = \underline{55\ \Omega}.$$

	$\frac{1}{G}$	$\frac{1}{B}$
f_1	272	65.8
~~f_1~~ $f = 1.4$ Kmc	251	63.3
f_0	182	59.5
$f = 1.6$ Kmc	195	56.0
f_2	185	55.0

For $f = 1.60$ kmc. $X_c = 52.0$ $X_c^2 = 2710$

$$\frac{1}{G} = 15 + \frac{1}{15}\,2710 = 15 + 180 = 195\ \Omega.$$

$$\frac{1}{B} = \frac{225}{52} + 52 = 4.33 + 52 = 56\ \Omega.$$

For $f = 1.40$ kmc. $X_c = 59.5$, $X_c^2 = 3540$

$$\frac{1}{G} = 15 + \frac{1}{15}\,3540 = 15 + 236 = \underline{251\ \Omega}$$

$$\frac{1}{B} = \frac{225}{59.5} + 59.5 = 3.8 + 59.5 = \underline{63.3\ \Omega}.$$

CONSIDER SITUATION AT 1.0 Kmc – 1.2 Kmc.

@ 1.0 Kmc. $\frac{1}{\omega C} = \frac{1}{2\pi\ 10^9\ 1.91\times10^{-12}} = 83.4$

$\left(\frac{1}{\omega C}\right)^2 = 6950$ $\frac{1000}{12}$

$\frac{1}{G} = 15 + \frac{1}{15}\ 6950 = 15 + 463 = \underline{478}\ \Omega$

$\frac{1}{B} = \frac{225}{83.4} + 83.4 = 2.7 + 83.4 = \underline{86.1}\ \Omega.$

@ 1.1 Kmc

$\frac{1}{\omega C} = 75.8,\ \left(\frac{1}{\omega C}\right)^2 = 5750$

$\frac{1}{G} = 15 + \frac{1}{15}(5750) = 15 + 383 = \underline{398}\ \Omega.$

$\frac{1}{B} = \frac{225}{75.8} + 75.8 = 3.0 + 75.8 = \underline{78.8}\ \Omega$

@ 1.2 Kmc.

$\frac{1}{\omega C} = \frac{1}{2\pi\ 1.2\times10^9\ 1.91\times10^{-12}} = 69.5$

$\left(\frac{1}{\omega C}\right)^2 = 4830$

$\frac{1}{G} = 15 + \frac{1}{15}(4830) = 15 + 322 = \underline{337}\ \Omega$

$\frac{1}{B} = \frac{225}{69.5} + 69.5 = 3.25 + 69.5 \cong \underline{72.8}\ \Omega$

5/7/63 INPUT FILTER DESIGN

START WITH $f_1 = 1000$ cps. $f_2 = 1.2$ Kcs
1.0 Kcs

FOR $n=5$ $nf_1 = 5.00$ Kcs, $nf_2 = 6.0$ Kcs.

NEAREST SIDE BAND OCCUR AT

$$\frac{2}{2n+1} = \frac{2}{11} = 18\%$$

$$w_0 = 2\,\frac{w_a w_b}{w_b + w_a}$$

$$f_0 = 2 \cdot \frac{f_a f_b}{(f_a + f_b)}, \quad f_0 = \frac{2 f_a f_b}{f_a + f_b}$$

$$f_0 = \frac{(1.0)(1.2)}{2.2} = 1.09 \text{ Kcs.}$$

USING 5.4 Kcs TO 5.9 Kcs ON OUTPUT.

$$\frac{5.4}{5} = 1.08 \text{ Kcs.} \qquad \frac{5.9}{5} = 1.18 \text{ Kcs}$$

$$f_0 = 2\,\frac{(1.08)(1.18)}{2.126} = 1.13 \text{ Kcs.}$$

FOR .2 db RIPPLE, $g_0 = 1$, $g_5 = \frac{1}{.6499} = 1.54$

$g_1 = 1.3028$, $g_2 = 1.2844$, $g_3 = 1.9761$, $g_4 = .8468$

$$\delta = w_1' \left(\frac{w_b + w_a}{w_b - w_a} \right) = 1 \left(\frac{2.2}{.2} \right) = 11.0$$

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi}{2\delta g_0 g_1}} = \sqrt{\frac{\pi}{(2)(11)(1.30)}} = \sqrt{.11}$$

$$\frac{J_{01}}{Y_0} = .332$$

$$\frac{B_{01}}{Y_0} = \frac{J/Y_0}{1-(J/Y_0)^2} = \frac{.332}{.890} = .373$$

1.000
.110
.890

$$B_{01} = \frac{.373}{15} = .0249$$

$$C_{01} = \frac{.0249}{(2\pi)(1.13\times10^9)} = 3.5\ pf.$$

ALSO $$\frac{J_{45}}{Y_0} = \sqrt{\frac{\pi}{2\delta 1.3}} = \frac{J_{01}}{Y_0}$$

$\therefore$ $C_{45} = 3.5\ pf.$

$$\frac{K_{12}}{Z_0} = \frac{\pi}{2\delta\sqrt{g_1 g_2}} = \frac{\pi}{22\sqrt{(1.30)(1.28)}} = \frac{\pi}{(22)(1.29)}$$

$$\frac{K_{12}}{Z_0} = .111, \quad \left(\frac{K_{12}}{Z_0}\right)^2 = .0122$$

1.000
.012
.988

$$\frac{X_{12}}{Z_0} = \frac{K_{12}/Z_0}{1-(K_{12}/Z_0)^2} = \frac{.111}{.988} = .112$$

WITH $Z_0 = 15\ \Omega$ $X_{12} = 1.68$

$$L_{12} = \frac{1.68}{(2\pi)1.13\times10^9} = \frac{1680}{2.26\pi}\times10^{-12}$$

$L_{12} = .237$ nh.

$$\frac{J_{23}}{Y_0} = \frac{\pi}{2\delta\sqrt{g_2 g_3}} = \frac{\pi}{22\sqrt{(1.28)(1.97)}} = \frac{.143}{\sqrt{2.52}} = \frac{.143}{1.59}$$

$$\frac{J_{23}}{Y_0} = .089, \quad \frac{B_{23}}{Y_0} = \frac{.089}{.992} = .091$$

1.000
.009
.992

$$B_{23} = \frac{.091}{15} = .006, \quad C_{23} = \frac{.006}{(2\pi)1.13\times10^9} = \frac{6.\times10^{-12}}{2.26\pi}$$

$C_{23} = .85\ pf.$

CONT. FROM p. 53 5/8/63

FOR 15Ω LINE IN K-9

$\sqrt{\epsilon_r}\ 15 = 45\Omega$

$\frac{w}{b} = 1.6$ WITH $b = \frac{1}{4}$

$w = .4$

WITH $b = \frac{1}{8}$ $w = .2$

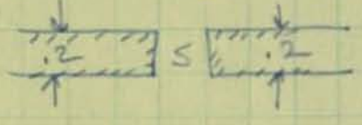
FOR 1 STEP TRANSFORMER BETWEEN 50Ω & 15Ω

$Z_m = \sqrt{50 \cdot 15} = 5\sqrt{30} = 27.4\Omega$

$\sqrt{\epsilon}\ 27.4 = 82.5$

$w/b = .67$ $w = \frac{.670}{8} = .084$

TO CALCULATE DIMENSIONS OF $C_{23} = .085$ pf.



$\epsilon = .0885\ \epsilon_r$ pf/cm.

$\epsilon_r = 9$, $\epsilon = .7965$

$C_{fo} = \frac{.085}{(.2)(2.54)} = 1.67$ pf/cm

$\therefore \frac{C_{fo}}{\epsilon} = \frac{1.67}{.80} = 2.1$

FROM COHN'S ODD MODE GRAPH

$\frac{S}{b} = .025$

$S = \frac{.025}{8} \approx .003$

TO CALCULATE DIMENSIONS OF 3.5 pf (USING $t = .005$ TEFLON)

$C = .225\ \frac{A}{t}\ k$ pf $A = \frac{Ct}{.225\,k} = \frac{3.5 \times .005}{(.225)(2.1)}$

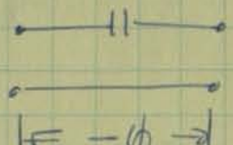
$A = \frac{17.5 \times 10^{-3}}{(.225)(2.1)} = .037$ in^2

FOR A .002 THICKNESS

$A = 37 \times 10^{-3} \times \frac{2}{5} = .015 \text{ m}^2$

TO CALCULATE LINE LENGTHS.

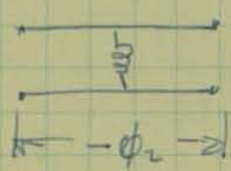
$\frac{J_{01}}{Y_0} = \tan^{-1} \frac{\phi_1}{2} = .332$



$\frac{\phi_1}{2} = 18.35^\circ \quad \phi_1 = 36.7^\circ$

$\frac{360^\circ}{36.7} = \frac{3.58}{\lambda}$, $\lambda = .365''$ $\frac{\lambda}{2} = .182''$

FOR K INVERTER



$\tan \frac{\phi_2}{2} = .111$

$\frac{\phi}{2} = 6.4^\circ$, $\phi = 12.8^\circ$

$\frac{360}{12.8} = \frac{3.58}{\lambda_2}$, $\lambda_2 = .127$, $\frac{\lambda_2}{2} = .063$

$\frac{\lambda}{2} = \frac{3.58}{2} \quad \frac{1.10}{1.13} = 1.75$, $\frac{\lambda}{4} = .88$

$l = \frac{\lambda}{2} - \frac{\lambda_1}{2} - \frac{\lambda_2}{2} = 1.75 - \frac{.365}{2} - .127$

$l = 1.44$

.182
.127
.492

1.750
.492
1.258

.182
.127
.309

1.75
.31
1.44

TO CALCULATE INDUCTANCE DIMENSIONS.

$L = .237$ nh

USING STUB OF $Z = 15\Omega$

$\frac{X_{12}}{Z_0} = .112 = \tan\theta$

$\theta = 6.4^\circ$, $\therefore l = 1/16$

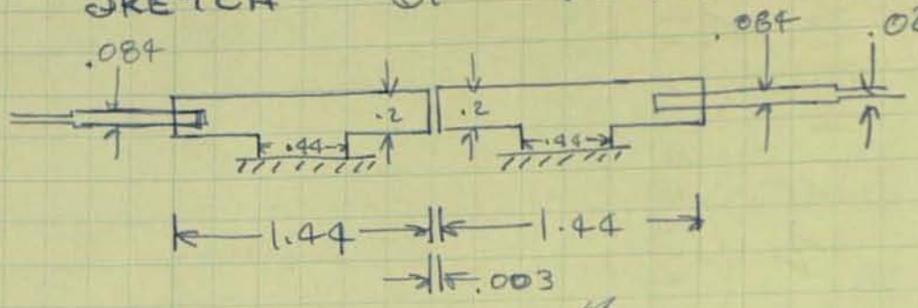
IF $l = 1/8$, $\theta = 12.6^\circ$, $\tan\theta = .223 = \frac{X}{Z_0}$

$Z_0 = \frac{X}{.223} = \frac{1.68}{.223} = 7.54\Omega$, $\sqrt{\varepsilon_r}\ 7.54 = 22.6\ \Omega$.

$\frac{W}{b} = 3.55 \quad W = \frac{3.55}{8} = .444$

5 56 5/8/63 CONT. FROM p. 55.

SKETCH OF DESIGN FOR 50Ω LINE IN K-9



CONSIDER A 2 RESONATOR DESIGN WITH FOLLOWING

PROPERTIES:- $f_1 = 900$ mc $f_2 = 1000$ mc

HARMONIC $n=6$

$nf_1 = 5400$ mc $nf_2 = 6000$ mc

$$f_0 = \frac{2 f_1 f_2}{f_1 + f_2} = \frac{2(.9)(1.0)}{1.9} = \frac{1.8}{1.9} = .95 \text{ kmc.}$$

$$\delta = \omega_1' \left(\frac{\omega_2 + \omega_1}{\omega_2 - \omega_1} \right) = \frac{1.0 + .9}{.1} = 19$$

FOR 2 SECTIONS · WITH .2 db RIPPLE

$g_0 = 1$, $g_1 = 1.038$, $g_2 = .675$, $g_3 = \frac{1}{.650} = 1.54$

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi}{2 \delta g_0 g_1}} = \sqrt{\frac{\pi}{2 \cdot 19 \cdot 1.04}} = \sqrt{.0795}$$

$$\frac{J_{01}}{Y_0} = .282$$

$$\frac{B_{01}}{Y_{01}} = \frac{J_{01}/Y_0}{1 - \left(\frac{J_{01}}{Y_0}\right)^2} = \frac{.282}{.920} = .306$$

1.000
.080
.920

FOR $Z_{01} = 15\ \Omega$

$$B_{01} = \frac{.306}{15} = .0204$$

20/6

$$C_{01} = \frac{.0204}{2\pi \cdot .95 \times 10^9} = 3.42 \text{ pf.}$$

$$\frac{K_{12}}{Z_0} = \frac{\pi}{\frac{Z_0}{Z_0} 2\delta\sqrt{g_1 g_2}} = \frac{\pi}{38\sqrt{(1.04)(.615)}} = \frac{\pi}{38\sqrt{.702}} = \frac{\pi}{(38)(.84)}$$

$$\frac{K_{12}}{Z_0} = .0985 \quad , \quad \left(\frac{K_{12}}{Z_0}\right)^2 = .0097$$

$\frac{3}{36} = \frac{1}{12}$

$$\begin{array}{r} 1.0000 \\ .0097 \\ \hline .9903 \end{array}$$

$$\frac{X_{12}}{Z_0} = \frac{K_{12}/Z_0}{1 - \left(\frac{K_{12}}{Z_0}\right)^2} = \frac{.0985}{.9903}$$

$$\frac{X_{12}}{Z_0} = .099$$

FOR $Z_0 = 15\,\Omega$.

$$X_{12} = 1.49\,\Omega \quad , \quad L = \frac{1.49}{2\pi(.95)\times 10^9} = \underline{.25\ \text{nh}}$$

FOR $Z_0 = 50\,\Omega$.

$$\frac{B_{01}}{Y_0} = .306 \quad , \quad B_{01} = \frac{.306}{50} = .00612 \quad , \quad \frac{1}{B_{01}} = 163\,\Omega.$$

$$C_{01} = \frac{.006}{2\pi(.95)\times 10^9} = \underline{1.03\ \text{pf.}}$$

$$\frac{X_{12}}{Z_0} = .099 \quad , \quad X_{12} = 4.95\,\Omega$$

$$\underline{L = .83\ \text{nh}}$$

FOR 100 Ω
$C_{01} = .151$ pf. $L = 1.66$ nh

TO REALIZE C_{01}

$$C = \frac{.225\, k\, A}{t} \quad , \quad \frac{A}{t} = \frac{C}{.225\, k} = \frac{1.03}{(.225)(2.1)} = 2.18$$

↑ TEFLON

FOR $t = .005$

$A \doteq .011$

$\sqrt{A} = .105$

→ OR $\pi R^2 = .011$

$R^2 = .0035$

$R = .059$

FOR MYLAR $k = 3.0$
$\frac{A}{t}$ FOR $t = .005$
$A = .00763$
$\sqrt{A} = .087$

5/17/63 CONT. FROM p. 57

FOR $L = .83$ nh
TRY SHORTED LINE WITH $Z_0 = 30\Omega$.

$$\omega L = Z_0 \tan\phi$$

$$\tan\theta = \frac{\omega L}{Z_0} = \frac{2\pi (.95\times10^{9})(.83\times10^{-9})}{30} = \frac{\pi(.95)(.83)}{15}$$

$$\tan\theta = .165 \quad , \quad \theta = 9.4^\circ$$

$$\lambda_{@.95\text{ kmc}} \text{ IN K-9} = \frac{3\times10^{10}}{(.95\times10^{9})(3)(2.54)} = \frac{10}{(.95)(2.54)} = 4.15$$

$$\frac{360}{4.15} = \frac{9.4}{\chi} \quad , \quad \chi = .108$$

$\sqrt{\varepsilon_r}\ 30 = 90\Omega$. , $\frac{w}{b} = .58$

FOR $b = \frac{1}{4}$, $w = .145$

TRY $Z = 15\Omega$ THEN $w = .4$

$\tan\theta = .165$ $\quad \frac{30}{15} = .330$

$\theta = 18.3^\circ$ $\quad \frac{360^\circ}{4.15} = \frac{18.3}{\chi}$

$\chi = .211$

TO GET NEGATIVE LINE LENGTHS

$$\tan\phi_1 = \frac{2B}{Y_0} = (2)(.306) = .612$$

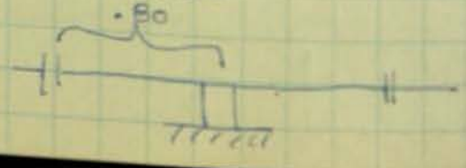
$$\phi_1 = 31.5^\circ \quad , \quad \frac{360}{4.15} = \frac{31.5}{\chi_1} \quad , \quad \chi_1 = .363$$

$$\tan\phi_2 = \frac{2X}{Z_0} = (2)(.099) = .198$$

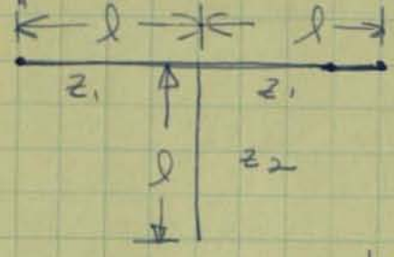
$$\phi_2 = 11.2^\circ \quad , \quad \frac{360}{4.15} = \frac{11.2^\circ}{\chi_2} \quad , \quad \chi_2 = .129$$

$$\ell = \frac{\lambda}{4} - \frac{\chi_1}{2} - \frac{\chi_2}{2} = 1.04 - .181 - .06$$

$\ell = .80$



CONSIDER FILTER TYPES TO STOP SPURIOUS RESPONSES at 3rd AND 5th HARM.



$$R_i = \frac{Z_1}{\sqrt{1+\rho}}, \quad \rho = \frac{Z_1}{Z_2}$$

IF $Z_1 = R_i = 50\ \Omega$.

$\sqrt{1+\rho} = 1$, NO GOOD!

TRY $R_i = 50\ \Omega$. & $\rho = 1$

$Z_1 = (1.414)(50) = \underline{70.7\ \Omega}$.

ALSO, CONSIDER DESIGN WITH STOPBAND CENTERED AT 6.0 KMC. OR BETTER $f_1 = 2.5$ KMC.

AND $f_2 = 4 f_1 = 10$ KMC. $\therefore f_0 = \frac{12.5}{2} = 6.25$ KMC.

$$A = 1 - (2+\rho)\,\mathrm{sn}^2\phi$$

$$-1 = 1 - (2+\rho)\,\mathrm{sn}^2\phi_1$$

$$2+\rho = \frac{2}{.346} = 5.78$$

$$\rho = \underline{3.78}$$

$$\frac{6.25}{90^\circ} = \frac{2.5}{\phi_1}$$

$\phi_1 = 36^\circ$

$\mathrm{sn}\,36^\circ = .588$

$\mathrm{sn}^2 36^\circ = .346$

$\therefore$ $Z_1 = R_i\sqrt{1+\rho} = 50\sqrt{4.78} = (50)(2.18)$

$\underline{Z_1 = 109\ \Omega}$, $Z_2 = \frac{Z_1}{\rho} = \frac{327}{3.78} = 86.5$

IN K-9 $\sqrt{\varepsilon_r}\, Z_1 = 327\ \Omega$. → TOO LARGE

5/21/63 CONT. FROM p. 59

TRY $f_0 = 5.0$ KMC WITH $f_1 = 2.5$ KMC, $f_2 = 7.5$ KMC

$A = 1 - (2+\rho)\,\mathrm{sn}^2\phi$

$-1 = 1 - (2+\rho)\frac{1}{2}$

$-2 = 2 - (2+\rho)$

$\rho = 2$

$\therefore Z_1 = 50\sqrt{1+\rho} = 50\sqrt{3}$

$Z_1 = 86.5\,\Omega$ $\quad Z_2 = \frac{Z_1}{\rho} = \frac{86.5}{2} = 43.25$

$\sqrt{\varepsilon_r}\,Z_1 = 259\,\Omega$ $\quad \sqrt{\varepsilon_r}\,Z_2 = 130\,\Omega$

$\frac{W_1}{b} \cong .04$ $\quad \frac{W_2}{b} = .28$

$W_1 \cong .010$ $\quad W_2 = .070$

$\frac{5.0}{90^\circ} = \frac{2.5}{x}$

$x = 45^\circ$

$\mathrm{sn}\,x = \frac{1}{\sqrt{2}}$

$\mathrm{sn}^2 x = \frac{1}{2}$

TO CALCULATE PHASE SHIFT AT .95 KMC PER SECTION. (β)

IN THE PASS BAND $\quad \cos\beta = 1 - 4\,\mathrm{sn}^2\phi$

$\cos\beta = 1 - .346$

$\cos\beta = .654$

$\beta = 49.1^\circ$ PER SECTION

CORRESPONDS TO $2\chi = 34.2^\circ$ OF STRAIGHT TRANS. LINE.

1.000
.346
.654

$\frac{5.0}{90^\circ} = \frac{.95}{\chi}$

$\chi = 17.1^\circ$

$\mathrm{sn}\,17.1^\circ = .294$

$\mathrm{sn}^2 17.1^\circ = .086$

$\lambda = 4.15''$ IN K-9 AT .95 KMC CORRESPONDS TO 360°

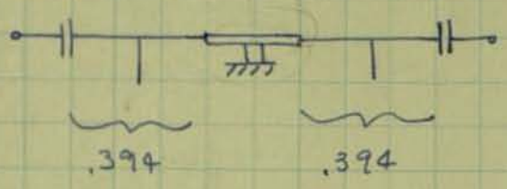
$\frac{360^\circ}{4.15''} = \frac{49.1^\circ}{\chi}$, $\chi = .566''$

BUT $l = \frac{\lambda}{4}$ @ 5.0 KMC. IN K-9 $= \frac{1}{4}\,\frac{3\times10^{10}}{(3)(5\times10^9)\,2.54} = .197$

$2l = .394''$

$\frac{.566}{.394} = \frac{.8}{x}$, $x = .557$

POSSIBLE .468 HOOKUP:

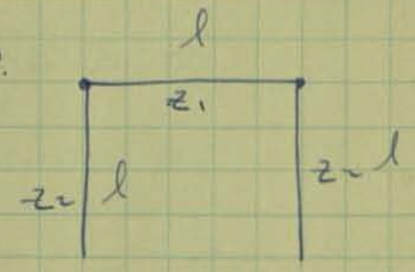


.800 − .394 = .406

.800 − .566 = .234

.234 × 2 = .468

CONSIDER ANOTHER FILTER TYPE:



$A = \cos\phi - \rho \sin\phi \tan\phi$

AGAIN, IF $f_0 = 5$ kmc.
& $f_1 = 2.5$ kmc, $f_2 = 7.5$ kmc

$\phi_1 = 45°$

$\therefore -1 = \frac{1}{\sqrt{2}} - \rho \frac{1}{\sqrt{2}} \cdot 1$, $-\sqrt{2} = 1 - \rho$, $\rho = 1 + \sqrt{2}$

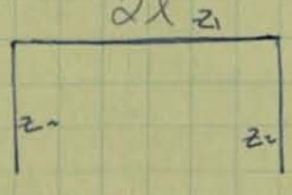
$\rho = 2.414$

$R_{i_1} = \frac{Z_1}{\sqrt{1+2\rho}}$, $Z_1 = R_i \sqrt{1+2\rho}$

$Z_1 = 50\sqrt{5.83} = 121\ \Omega$. ← TOO LARGE

4.828
1

CONSIDER ALSO



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

$A = -\rho + (1+\rho)\cos 2\beta l$

$-1 = -\rho + (1+\rho)(0)$

$\rho = 1$

FOR $f_0 = 5.0$ kmc., $(\beta l)_0 = 90°$; $f_1 = 2.5$ kmc., $(\beta l)_1 = 45°$

$Z_{i_0} = \frac{Z_1}{\sqrt{1+\rho}}$

$Z_1 = 50\sqrt{2} \cong 71.\ \Omega$

$\sqrt{\varepsilon_r} Z_1 = 213\ \Omega$

$\frac{w}{b} \cong .07$

$w = .\frac{07}{4} = .017$

Cont. From p. 61 5/21/63

To Calculate Phase Shift Thru One Section. At 950 mc

$$A = -\rho + (1+\rho)\cos 2\beta l$$

Since $\rho = 1$

$$\cos\theta = -1 + 2\cos 2\beta l$$

$$\cos\theta = -1 + 1.654$$

$$\cos\theta = .654$$

$$\theta = 49.1^\circ$$

5.0 kc in $\beta l = 90^\circ$

$$\frac{5.0}{.95} = \frac{90^\circ}{(\beta l)_{.95}}$$

$$(\beta l)_{.95} = 17.1^\circ$$

$$2\beta l = 34.2$$

$$\cos 34.2^\circ = .827$$

$$\frac{.827^2}{1.654}$$

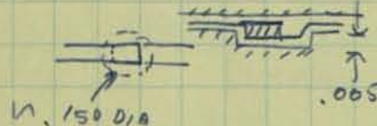
Consider Design Of Bandpass Filter Using Rexolite. 1422.

For 50 Ω line: $\varepsilon_r = 2.54$, $\sqrt{\varepsilon_r} \doteq 1.6$, $\frac{t}{b} = \frac{.002}{25} = .008$

$\sqrt{\varepsilon_r}\, 50 = 80$, $\frac{w}{b} = .72$, $w = \frac{.72}{4} = .180$

Or $b = \frac{1}{8}$, $w = .090$

Consider Capacity Of .090 Square With Spacing Of .003 Mylar



$$C = \frac{(.225)(2.9)(.090)^2}{.003} = \frac{(.225)(2.9)\,81}{30} = 1.176$$

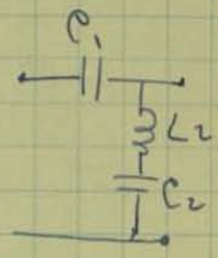
As To Line Lengths

$$\frac{l_1}{l_2} = \frac{\sqrt{\varepsilon_{r_2}}}{\sqrt{\varepsilon_{r_1}}}, \quad \frac{.85}{l_2} = \frac{1.6}{3}, \quad l_2 = 1.59$$

CONSIDER HIGH PASS FILTER DESIGN.
(AT LEAST ADDING M DERIVED SECTION TO AN EXISTING CONSTANT K DESIGN.)

$f_c = 700$ mc $\quad \{ \quad R = 50\Omega$

$$R = \sqrt{\frac{L_K}{C_K}}, \qquad 2\pi f_c = \frac{1}{\sqrt{L_K C_K}}$$



$$L_K = R^2 C_K, \qquad L_K C_K = \frac{1}{4\pi^2 f_c^2}$$

THEN $\quad R^2 C_K^2 = \frac{1}{4\pi^2 f_c^2}$

$$C_K = \frac{1}{2\pi R f_c} = \frac{1}{2\pi (50)(.7\times 10^9)} = \frac{10^{-11}}{.7\pi}$$

$C_K = \underline{4.55}$ pf.

$L_K = (2500)(4.55)\times 10^{-12}$

$L_K = \underline{11.4}$ nh.

DESIRE $\quad \omega_{\infty} = 2\pi f_{\infty} = 2\pi \ .475$ Kmc

$\omega_{\infty} = 2.98$

$$m = \sqrt{1 - \omega_{\infty}^2/\omega_c^2} = \sqrt{1 - \left(\frac{.475}{.700}\right)^2} = \sqrt{1 - .46}$$

$$m = \sqrt{.54} = \underline{.735}$$

$$\frac{m}{1-m^2} = \frac{.735}{1-.54} = \frac{.735}{.46} = \underline{1.6}$$

$$C_1 = \frac{C_K}{m} = \frac{4.55}{.735} = \underline{6.2}\ \text{pf}$$

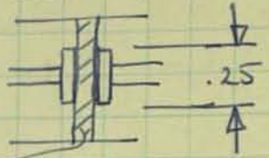
$$L_2 = \frac{L_K}{m} = \frac{11.4}{.735} = \underline{15.5}\ \text{nh}$$

$$C_2 = \frac{m}{1-m^2} C_K = 1.6\, C_K = \underline{7.3}\ \text{pf}$$

6/10/63

CONT. FROM p. 63

CONSIDER PHYSICAL SIZE. FOR $C_K = 4.55$ pf.

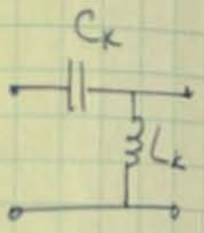


TEFLON

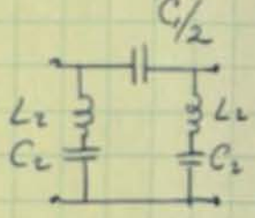
$$C = \frac{.225\, k\, A}{t}, \quad A = \pi\left(\frac{.25}{2}\right)^2 = \pi .0156 = .049$$

$$t = \frac{.225\, k\, A}{C}$$

$$t = \frac{(.225)(2.1)(.049)}{4.55} = .0051$$



WILL TRY A FILTER OF THIS TYPE:



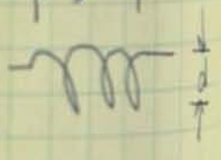
$\frac{C_1}{2} = 3.1$ pf

$L_2 = 15.5$ mh

$C_2 = 7.3$ pf.

PHYSICAL DIMENSIONS OF L_2

FROM TERMAN FOR SINGLE LAYER COIL



$$L = F n^2 d \ \mu h.$$

TRY $\frac{d}{d} = 1.0$ THEN $F = .017$

LET $d = .2$

$L = .0034\, n^2$, WITH $L = .0155\ \mu h$

$$n^2 = \frac{.0155}{.0034} = 4.55$$

$n \cong 2$ TURNS. ON .2 DIAM. ROD.

SINCE C_1 WILL OCCUR IN SERIES WITH STRAY LINE $\frac{D}{d} = 2.3$, $d = \frac{.375}{2.3} = .163$

PHYSICAL DIMENSIONS OF $C_{1/2}$ USING MYLAR $\epsilon_r = 2.9$

$$C = \frac{.225 k A}{t}$$

$$t = \frac{(.225)(2.9)}{3.1} \pi \left(\frac{.163}{2}\right)^2 = .0044$$

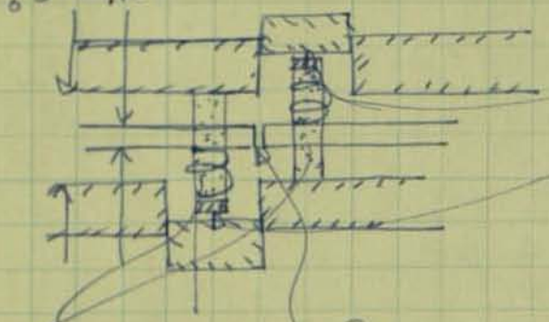
PHYSICAL DIMENSIONS OF C_2

TRY $\Omega = .2$

~~$t = .0044 \left(\frac{.200}{.163}\right)^2 = (.0044)$~~

$$t = \frac{(.225)(2.9)\pi (.1)^2}{7.3} = .0028$$

CONSTRUCTION



USE 2 TURNS OF #28 WIRE.

1 LAYER 2½ MILL MYLAR TAPE

2 LAYERS 2½ MILL MYLAR TAPE

.2 DIA. REX ROD.

6/19/63

CONT. FROM p. 65

SINCE SPURIOUS SIGNALS OCCUR AT BAND EDGES – 5.4 Kmc AND 5.9 Kmc – REQUIRES 2 STOP BANDS – ONE AT $\frac{.9}{2}$ = .450 Kmc AND $\frac{1.0}{2}$ = 5.0 Kmc. RATHER THAN CENTERED AT .475 Kmc

FROM p. 63 VALUE OF m MUST CHANGE

For $\omega_\infty = 2\pi .450$ Kc

$$m_1 = \sqrt{1 - \left(\frac{\omega_\infty}{\omega_c}\right)^2} = \sqrt{1 - \left(\frac{.450}{.700}\right)^2} = \sqrt{1 - .413}$$

1.000
.413
.587

$$m_1 = .766$$

C_K/m_1

L_K/m_1

$\frac{m}{1-m^2} C_K$

$C_K = 4.55$ pf.

$L_K = 11.4$ mh

$$\frac{C_K}{m_1} = \frac{4.55}{.766} = 5.93 \text{ pf.}$$

$$\frac{L_K}{m_1} = \frac{11.4}{.766} = 14.9 \text{ mh}$$

$$\frac{m}{1-m^2} C_K = (1.85)(4.55) = 8.4 \text{ pf.}$$

$$\frac{m}{1-m^2} = \frac{.766}{1-.587} = \frac{.766}{.413} = 1.85$$

1.000
.587
.413

For $\omega_\infty = 2\pi .500$

$$m_2 = \sqrt{1 - \left(\frac{.500}{.700}\right)^2} = \sqrt{.49} = .70$$

$$\frac{C_K}{m_2} = \frac{4.55}{.7} = 6.5 \text{ pf.}$$

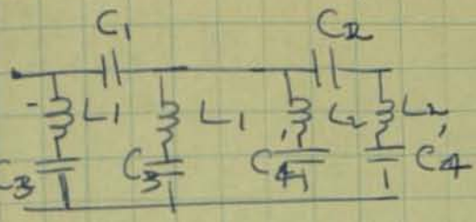
$$\frac{L_K}{m_2} = \frac{11.4}{.7} = 16.3 \text{ mh}$$

$$\frac{m_2}{1-m_2^2} C_K = (1.37)(4.55) = 6.25 \text{ pf.}$$

1.00
.51
.49

$$\frac{m_2}{1-m_2^2} = \frac{.7}{1-.49} = \frac{.7}{.51} = 1.37$$

CONT. FROM p. 66 6/19/63



$C_1 = \frac{5.93}{2} = 2.97$ pf.

$C_2 = \frac{6.5}{2} = 3.25$ pf

$C_3 = 8.4$ pf. $L_1 = 14.9$ nh

$C_4 = 6.125$ pf. $L_2 = 16.3$ nh

TO CALCULATE TURNS OF WIRE FOR L_1 & L_2

FOR L_1:

FOR $d = .25$ & $l = .25$

$L = .0034\ n^2$ FROM p. 64

$n_1^2 = \frac{.0149}{.0034} = 4.38$

$n_1 = 2.1$ TURNS. ≈ 2 TURNS

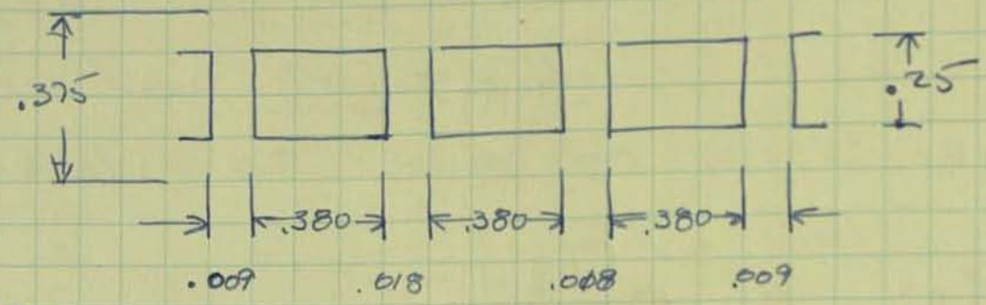
FOR L_2

$n_2^2 = \frac{.0163}{.0034} = 4.8$

$n_2 = 2.2$ ≈ $2\frac{1}{4}$ TURNS.

Cont. From p. 67 6/24/63

Consider using Constant K Design with End Matching Sections:



Dimensions used with Teflon Dielectric.

Consider X Band Source: Output Freq. (9335 – 9415 mc.)
60 mc IF.
Could start at C Band and Double:-

4667.5 – 4707.5 mc.

At best one might expect 25% conversion efficiency. If the C Band Source put out say 40 mw, then 10 mw out at X Band would be feasible.

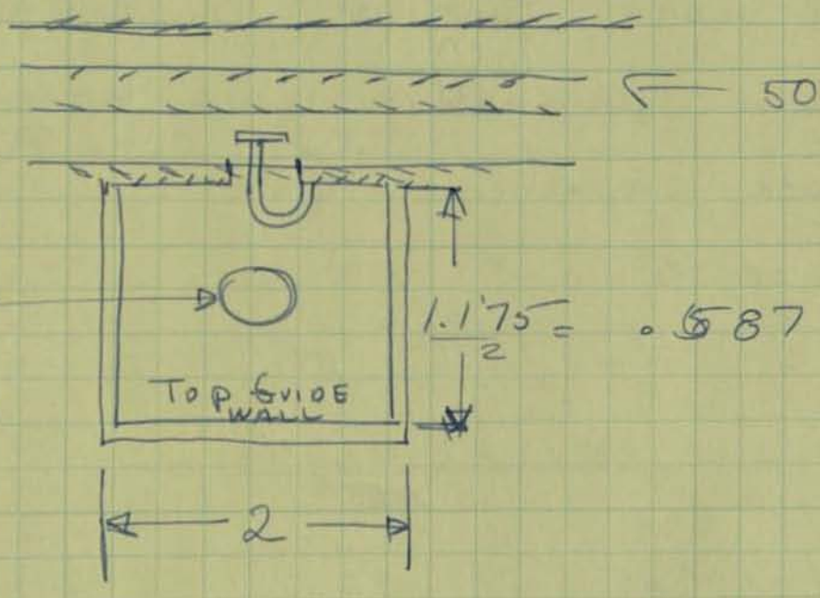
NARROW STOPBAND FILTER 6/27/63
TO BE USED WITH SPECTRUM ANALYSER

WILL USE COAX MAIN LINE TO PASS DOWN TO D.C. A TUNEABLE STUB IN WAVEGUIDE WHICH WILL BE COUPLED IN SHUNT TO COAX WILL PROVIDE SHORT A SINGLE FREQ.

~~SH~~ WAVELENGTH AT HIGHEST FREQ.:

$f = 6.0$ Kmc. $\lambda_g = 1.1753$

DIAG.



WOULD MAKE MORE SENSE TO USE 1.5 X .75 GUIDE IN WHICH CASE:

AT $f = 6.0$ Kmc. $\lambda = 2.82"$

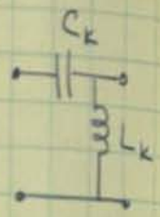
$\frac{\lambda}{2} = 1.42"$

HIGH PASS FILTER

6/27/63

FOR CONSTANT K SECTIONS SUCH AS p. 63

TRY $f_c = 850$ mc. , $R = 50\Omega$



$$C_K = \frac{1}{2\pi f_c R} = \frac{1}{2\pi \cdot .85 \times 10^9 \cdot 50}$$

$C_K = 3.75$ pf.

$L_K = R^2 C_K = 2500 \cdot 3.75 \times 10^{-12}$

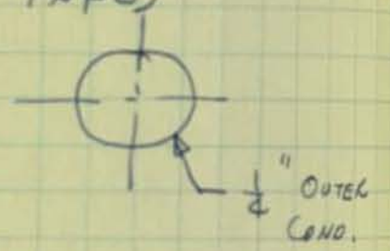
$L_K = 9.37$ nh

$\frac{10^{-4}}{5} = 3 \times 10^{-5}$

TO CALCULATE PHYSICAL DIMENSIONS OF C_K IN COAX PACKAGE. (USING MYLAR TAPE)

$\epsilon_r = 2.9$

CONSIDER CAPACITIVE DISK



• .156 OR $\frac{5}{32}$ DIA.

$$C = \frac{.225\ \epsilon_r\ \pi r^2}{t}\ \text{pf.}$$

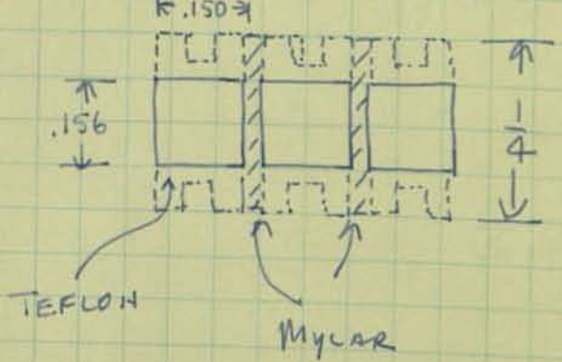
$$t = \frac{(.225)(2.9)\,\pi\,(.078)^2}{3.75}$$

$t = .00425$

$(.2)(3)(3)(.009)$

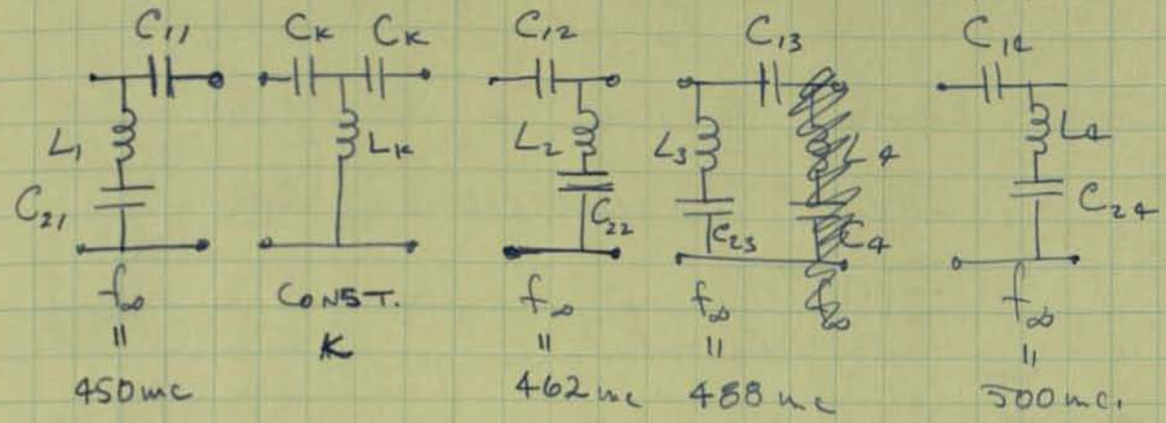
.06
.06
.0032

CONSIDER FOLLOWING CONSTRUCTION:



HIGH PASS FILTER 6/28/63

CONSIDER DESIGN WITH A FOUR RESONATOR CONSTRUCTION TO GO ALONG WITH 1 CONSTANT-K SECTION.



$L_K = 9.37$

$C_K = 3.75$ p

$$m = \sqrt{1 - \left(\frac{f_o}{f_c}\right)^2}$$

$$m_1 = \sqrt{1 - \left(\frac{450}{850}\right)^2} = \sqrt{.720} = .850$$

$$m_2 = \sqrt{1 - \left(\frac{462}{850}\right)^2} = \sqrt{.704} = .840$$

$$m_3 = \sqrt{1 - \left(\frac{488}{850}\right)^2} = \sqrt{.670} = .820$$

$$m_4 = \sqrt{1 - \left(\frac{500}{850}\right)^2} = \sqrt{.654} = .810$$

1.0
.2
.7

1.00
.29
.70

1.00
.330
.670

1.00
.346
.654

1.0
.6
.3

TRY $m = .83$, $\frac{m}{1-m^2} = \frac{.83}{.320} = 2.59$

$L_1 = L_2 = L_3 = L_4 = \frac{L_K}{m} = \frac{9.37}{.83} = 11.3$ nh

$C_{11} = C_{12} = C_{13} = C_{14} = \frac{C_K}{m} = \frac{3.75}{.83} = 4.52$ pf.

$C_{21} = C_{22} = C_{23} = C_{24} = \frac{m}{1-m^2} C_K = (2.59)(3.75) = 9.7$ pf.

$\frac{C_{11} \cdot C_K}{C_{11} + C_K} = \frac{(4.52)(3.75)}{8.27} = 2.05$ pf. $= \frac{C_{12} C_K}{C_{12} + C_K}$

$\frac{C_{13} C_{14}}{C_{13} + C_{14}} = \frac{4.52}{2} = 2.26$ pf.

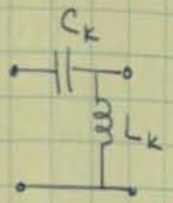


High Pass Filter

6/27/63

For constant k sections such as p. 63

Try $f_c = 850$ mc. , $R = 50\Omega$



$$C_k = \frac{1}{2\pi f_c R} = \frac{1}{2\pi \cdot .85 \times 10^9 \cdot 50}$$

$C_k = 3.75$ pf.

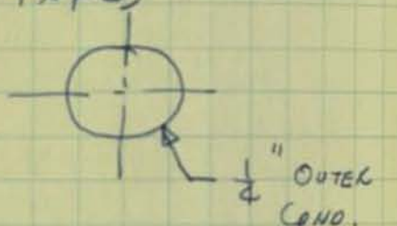
$L_k = R^2 C_k = 2500 \cdot 3.75 \times 10^{-12}$

$\frac{10^{-11}}{3} \approx 3 \times 10^{-12}$

$L_k = 9.37$ μh

To calculate physical dimensions of C_k in coax package. (using mylar tape) $\epsilon_r = 2.9$

Consider capacitive disk



.156 or $\frac{5}{32}$ Dia.

$$C = \frac{.225\, \epsilon_r \pi r^2}{t} \text{ pf.}$$

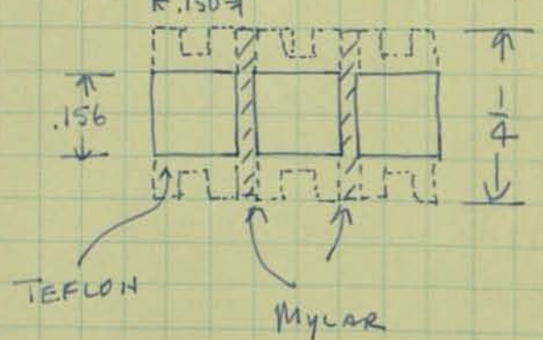
$$t = \frac{(.225)(2.9)\pi(.078)^2}{3.75}$$

$\frac{(.2)(3)(3)(.078)^2}{4}$

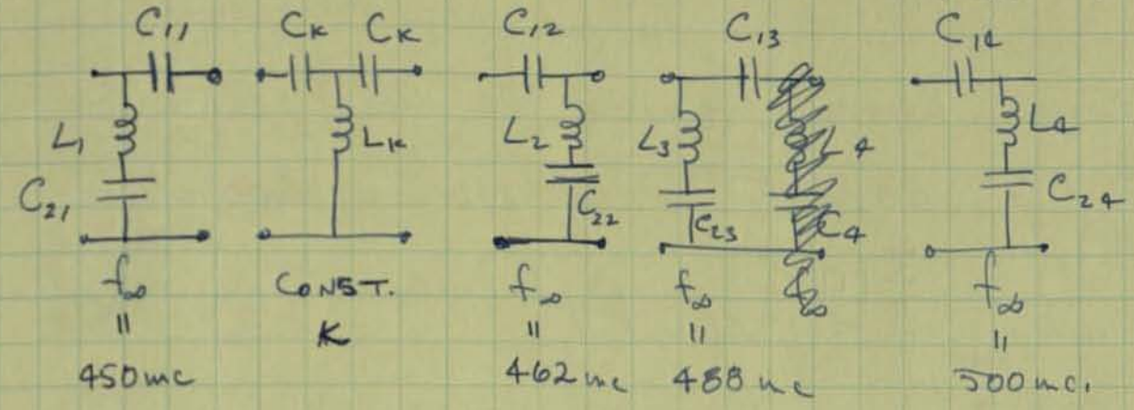
.06
.04
.0032

$t = .00425$

Consider following construction:



CONSIDER DESIGN WITH A FOUR RESONATOR CONSTRUCTION TO GO ALONG WITH 1 CONSTANT k SECTION.



$L_K = 9.37\ \mu h$

$C_K = 3.75\ pf.$

$$m = \sqrt{1 - \left(\frac{f_\infty}{f_c}\right)^2}$$

$$m_1 = \sqrt{1 - \left(\frac{450}{850}\right)^2} = \sqrt{.720} = .850 \qquad \begin{array}{r} 1.000 \\ .280 \\ \hline .720 \end{array}$$

$$m_2 = \sqrt{1 - \left(\frac{462}{850}\right)^2} = \sqrt{.704} = .840 \qquad \begin{array}{r} 1.000 \\ .296 \\ \hline .704 \end{array}$$

$$m_3 = \sqrt{1 - \left(\frac{488}{850}\right)^2} = \sqrt{.670} = .820 \qquad \begin{array}{r} 1.000 \\ .330 \\ \hline .670 \end{array}$$

$$m_4 = \sqrt{1 - \left(\frac{500}{850}\right)^2} = \sqrt{.654} = .810 \qquad \begin{array}{r} 1.000 \\ .346 \\ \hline .654 \end{array}$$

TRY $m = .83$, $\frac{m}{1-m^2} = \frac{.83}{.320} = 2.59$ $\qquad \begin{array}{r} 1.000 \\ .680 \\ \hline .320 \end{array}$

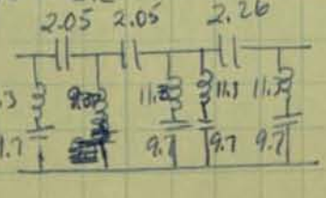
$$L_1 = L_2 = L_3 = L_4 = \frac{L_K}{m} = \frac{9.37}{.83} = 11.3\ \mu h$$

$$C_{11} = C_{12} = C_{13} = C_{14} = \frac{C_K}{m} = \frac{3.75}{.83} = 4.52\ pf.$$

$$C_{21} = C_{22} = C_{23} = C_{24} = \frac{m}{1-m^2} C_K = (2.59)(3.75) = 9.7\ pf.$$

$$\frac{C_{11} \cdot C_K}{C_{11} + C_K} = \frac{(4.52)(3.75)}{8.27} = 2.05\ pf. = \frac{C_{12}\, C_K}{C_{12} + C_K}$$

$$\frac{C_{13}\, C_{14}}{C_{13} + C_{14}} = \frac{4.52}{2} = 2.26\ pf.$$



CONT. FROM p. 71 7/1/63

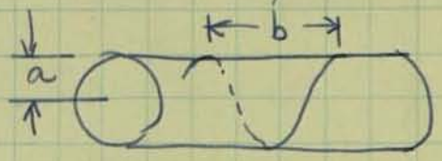
PHYSICAL DIMENSIONS OF $L = 11.3$ nh

USING EXPRESSION $L = \frac{Z_0}{v_p}$ HENRIES/m.

SINGLE LINE ABOVE GROUND $\therefore Z_0 = 180\,\Omega$.

$$L = \frac{180}{3\times10^8} = 60\times10^{-8} = 600\times10^{-9} = 600 \text{ nh/m.}$$

$$L = 6 \text{ nh/cm.} = 15.2 \text{ nh/inch}$$



$$s = \sqrt{(2\pi a)^2 + b^2}$$

LET $2a = .2$

$2\pi a = .628$, $(2\pi a)^2 = .395$

$b^2 = s^2 - .395$

IF $s = \frac{11.3}{15.2} = .744$, $s^2 = .553$

$b^2 = .158$, $b = .399 \approx .4$"

OR 2 TURNS IN .2"

NOW FOR $L = 9.37$ nh.

$s = \frac{9.37}{15.2} = .616$" TO GROUND.

FOR CAPACITIES: (USING MYLAR $\varepsilon_r = 2.9$)

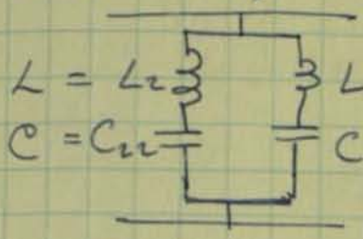
$C = 2.05$ pf.

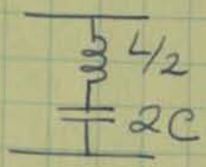
$$t = \frac{(.225)(2.9)\,\pi\left(\frac{.156}{2}\right)^2}{2.05} = .0061$$

$C = 2.26$

$t = .0061 \frac{2.05}{2.26} = .0055$

CONSIDER COMBINING THE SERIES TANKS $L_2 - C_{22}$ AND $L_3 - C_{23}$ ON P. 71.



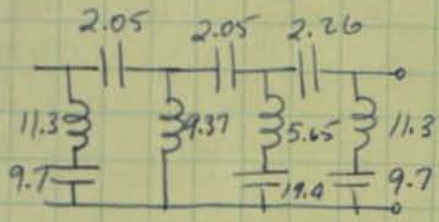


$$\frac{j(\omega L - \frac{1}{\omega C})\, j(\omega L - \frac{1}{\omega C})}{2j(\omega L - \frac{1}{\omega C})}$$

$$j\left(\omega \frac{L}{2} - \frac{1}{\omega 2C}\right)$$

$$\frac{L}{2} = \frac{11.3}{2} = 5.65 \text{ nh.}$$

$$2C = (2)(9.7) = 19.4 \text{ pf}$$



PHYSICAL DIMENSIONS OF $L = 5.65$ nh

SHOULD BE 1 TURN IN .2

PHYSICAL DIMENSIONS OF $C = 19.4$ pf $\quad \varepsilon_r = 2.9$
USING CYLINDRICAL SHAPE.

$$\pi D l = A \qquad A = \frac{C\,t}{\varepsilon_r \cdot .225} = \frac{(19.4)\ .005}{(2.9)\ (.225)}$$

LET $D = .375$ $\qquad A = .149$

$$l = \frac{.149}{(3.14)(.375)} = .126$$ ← 2 LAYERS OF 2½ MIL MYLAR.

IF $D = .125$

$$l = .126\ \frac{.375}{.125} = .378$$

12/3/63 CONT. FROM p 73

CONSIDER PHYSICAL DIMENSIONS OF COILS USING TERMAN.

FOR $L = 11.3$ mh. $F = .017$ $d = .2$

$$n^2 = \frac{L_0}{F d} = \frac{11.3 \times 10^{-3}}{(.017)(.2)} = 3.32$$

$n = 1.82$

IF $d = .125$, $l = .2$ } $\frac{d}{l} = .625$

$\therefore F = .012$

FOR $L = 11.3$ mh

$n^2 = \frac{.0113}{(.012)(.125)} = 7.54$

$n = 2\ 3/4$

FOR $L = 9.3$ mh.

$$n^2 = \frac{.0093}{(.017)(.2)} = 2.74$$

$n = 1.66$

FOR $L = 9.3$ mh

$n^2 = 6.2$

$n = 2\ 1/2$

FOR $L = 5.65$ mh

$n^2 = 1.76$

$n = 1.33$

FOR $L = 5.65$ mh

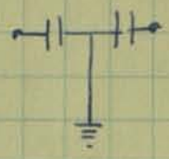
$n^2 = 3.77$

$n = 1.95 \approx 2$

EXPERIMENTAL DATA

f. (mc)	J.L. db	f. (mc)	I.L. db
1000	1.5		
950	1.6	600	21.0
900	2.4	550	33.5
850	5.8		
800	11.0		
750	16.4		
700	26.5		
670	29.0		
650	24.5		

CONSIDER HIGH PASS FILTER USING HELICAL LINE. 1080 - 1180



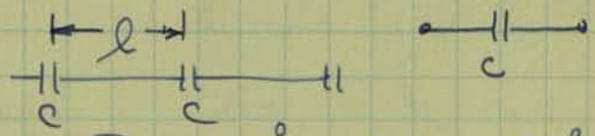
WITH $R = 50\,\Omega$

AND POSSIBLY $Z_1 = 200\,\Omega$.

$\tan \Theta_0 = \frac{Z_1}{R} = 4.25$, ~~$\Theta_0 = 4.011$~~ $76°$

$\frac{f_2}{f_1} \geq 1.4$ { IF $f_1 = 1000$ MC $f_2 = 1400$
OR $f_1 = 900$ MC $f_2 = 1260$

CONSIDER ANOTHER TYPE.



WITH $Z_1 = 200\,\Omega$, $R = 50$.

$\frac{Z_1}{R} = 4 = \tan \frac{\Theta_0}{2}$, $\frac{\Theta_0}{2} = 76°$, $\Theta_0 = 152°$

AGAIN $\frac{f_2}{f_1} \cong 1.4$

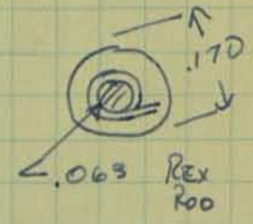
THIS MEANS RESONATOR ℓ IS $\lambda/2$ AT 1.4 KMC

OR $\frac{\lambda}{4}$ AT 2.8 KMC.

FROM CHART :-
MAC ALPINE - SCHILDKNECHT

SHIELD DIA. = .170
INCHES/TURN ≅ .040

CONSIDER .020 WIRE # ~~E~~ 24
ALSO GIVES 4 TURNS.



TO CALCULATE C:

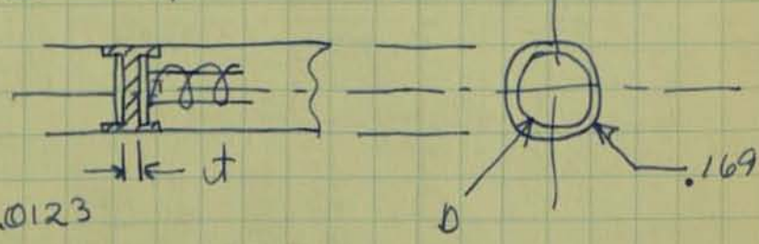
$$C = \frac{\cot 90° \frac{f_1}{f_2}}{2\pi f_1 Z_1} = \frac{\cot 64.3}{2\pi\, 10^9\, 200}$$

$$= \frac{.481 \times 10^{-9}}{400\,\pi} = .383 \text{ pf.}$$

.063
.020
.083

USING TEFLON

$$t = \frac{(.225)(2.1)}{C} A$$

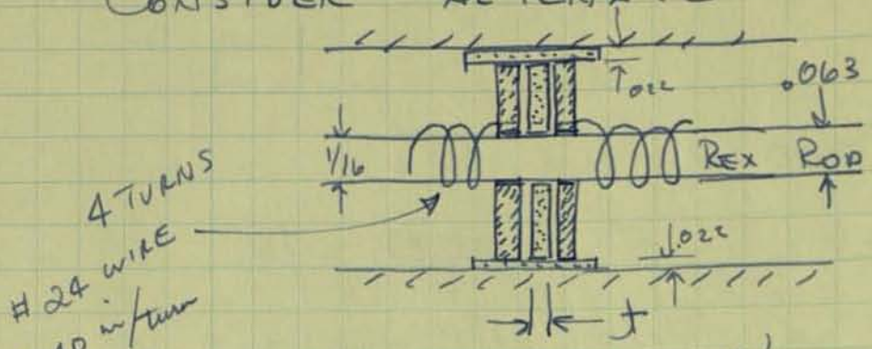


TRY $D = .125$, $A = \pi \left(\frac{1}{16}\right)^2 = .0123$

$$t = \frac{(.225)(2.1)(.0123)}{.383} \cong .015$$

CONT. FROM p. 75 7/8/63

CONSIDER ALTENATE CONSTRUCTION.



.169
.125
.044
.011

$\frac{1}{30 \cdot 30} = \frac{1}{900}$

AREA ACROSS ROD $A' = \pi\left(\frac{1}{32}\right)^2 = .00306$

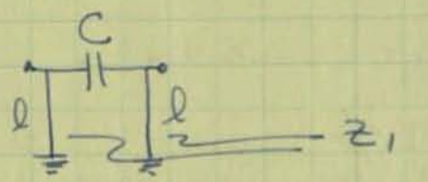
.0123
.0031
.0092

$\therefore$ NET AREA = .0123 − .0031 = .0092

$\therefore t = .0152 \quad \frac{.0092}{.0123} = .0114$

ABOVE DESIGN NOT CORRECT — WOULD REQUIRE 4 TIMES THE TURNS —

GOING BACK TO —



AGAIN $R = 50\,\Omega$. THIS TIME $Z_1 = 100\,\Omega$.

$\tan\theta_0 = \frac{R}{Z_1} = .5, \quad \theta_0 = 26.5°$

$\therefore \frac{f_2}{f_1} \approx 5$

IF $Z_1 = 150\,\Omega$.

$\tan\theta_0 = .33, \quad \theta_0 = 18.4°$

IF $Z_1 = 130\,\Omega, \quad \tan\theta_0 = \frac{50}{130} = .385$

$\frac{f_1}{f_1} \approx 6.0$

$\theta_0 = 21° = .366$ rad.

$C = \frac{l}{R c \theta_0} = \frac{1.25}{(50)(3\times10^{10})(.366)}$

$l = \frac{\lambda}{4} @ 6\text{ kmc} = \frac{3\times10^{10}}{(4)\ 6\times10^{9}} = \frac{30}{24} = 1.25$ cm

$C \approx 2.3$ pf.

CONT. FROM p. 76 7/9/63

FROM SCHILDKNECHT & MACALPINE

$2\frac{1}{2}$ TURNS & ABOUT .040"/TURN. WITH $\frac{1}{16}$ DIA.

TRY $Z_1 =$ 120 Ω $\tan\theta_0 = \frac{50}{120} = .416$, $\theta_0 = 22.6$

$\frac{f_2}{f_1} = 5.5$, $f_2 = 5.5$ kmc $= .394$ rad.

$2\frac{1}{4}$ TURNS & ABOUT .055"/TURN ON $\frac{1}{16}$ DIA. ROD

SHIELD DIA. BECOMES .150 - TRY .156 W/ $\frac{5}{32}$ BALL END MILL

$$\ell = \frac{\lambda_2}{4} \doteq \frac{3\times10^{10}}{(4)\ 5.5\times10^{9}} = 1.36 \text{ cm.}$$

$$C = \frac{1.36}{(50)(3\times10^{10})(.394)} = \underline{2.3 \text{ pf.}}$$

TO OBTAIN PHYSICAL DIMENSIONS OF C USING MYLAR $\varepsilon_r = 2.9$

AND THICKNESS OF 2.5×10^{-3} INCHES

$$A = \frac{C\,t}{(.225)(\varepsilon_r)} = \frac{(2.3)(2.5\times10^{-3})}{(.225)(2.9)} = .0088$$

$A = \pi r^2 = .0088$, $r^2 = .0028$

$r = .053$ or $d = .106$

CONSIDER 3/16 DIA FOR STRAIGHT THRU CONDUCTOR

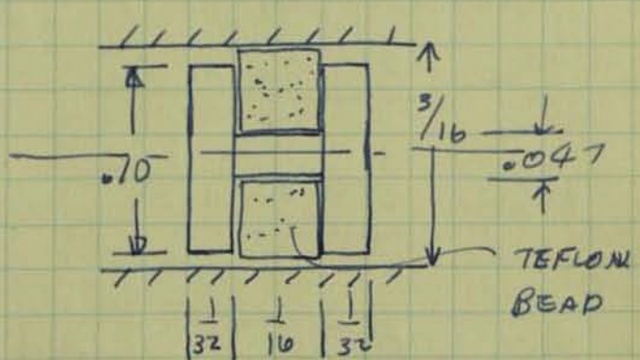
50Ω LINE IN TEFLON

$$Z_0 = \frac{138}{\sqrt{\varepsilon_r}} \log \frac{D}{d}$$

$$\log \frac{.156}{d} = .525$$

$$\frac{.156}{d} = 3.34$$

$$d = .047$$



78 7/15/63 HIGH PASS FILTER

$f_c = 0.9$ Kmc. $R = 30\Omega$.



TRY $f_2 = 5.0$ Kmc

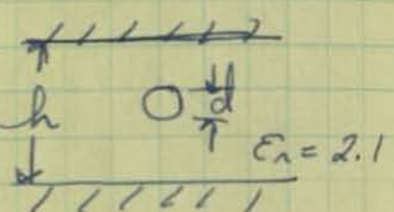
$f_2/f_1 = 5.5$, $\theta_0 \cong 23° = .4$ rad.

$\tan\theta_0 = .425$, $Z_1 = \frac{R}{\tan\theta_0} = \frac{30}{.425} \cong 71\Omega$

IF. $R = 40\Omega$. $Z_1 = \frac{40}{.425} = 94\Omega$.

SMALLEST WIRE - #32 - $\cong$ .008" IN DIA.

FOR



$\log \frac{4h}{\pi d} = \frac{Z_1\sqrt{\varepsilon_r}}{138} = \frac{(94)(1.45)}{138}$

$\log \frac{4h}{\pi d} = .99$, $\frac{4h}{\pi d} = 9.75$

$h = \frac{9.75\,\pi\,.008}{4} = .061$

PUT ON CYLINDRICAL FORM



$C = \frac{h}{RC\theta_0}$

$C = \frac{1.03}{(30)\,3\times10^{10}(.4)}$ 2.86 1.15 pf.

$C = \frac{.225\,\varepsilon_r\,\pi\,r^2}{t}$

$t = \frac{.225\,\varepsilon_r\,\pi\,r^2}{C} = \frac{(.225)(2.1)\,\pi\,(.062)^2}{1.15}$ $\frac{1.15}{2.86} \cong .002$

$t = .005$, $\pi d = (3.14)(.125) = .392$

or $(3.14)(.187) = .590$

$\lambda = \frac{1}{4}\frac{3\times10^{10}}{1.45\,5\times10^9} = \frac{1.5\text{ cm}}{1.45}$

$h = 1.03$ cm $= .41$ in.

7/16/63 HIGH PASS FILTER (CONT.)

START WITH $t = .005$ OF TEFLON

$$A = \frac{Ct}{.225\,\varepsilon_r} = \frac{(2.86)(.005)}{.225\ \ 2.01} = .0302 = \pi r^2$$

$r^2 = .00963$, $r = .098$ $\quad d = .196$

.250
.196
.054
.027

USING MYLAR WITH $\frac{1}{8}$ DIA. ROD.

$t = .002$ $\quad \frac{2.9}{2.1} = \cancel{2076}\ .00276$

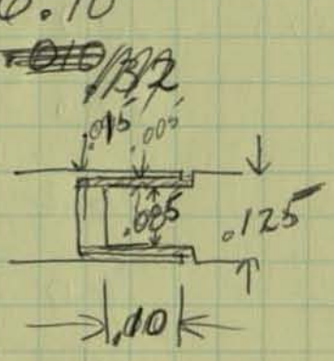
CONSIDER CYLINDRICAL CAPACITOR
.095 ~~.080~~ DIA.

.125
.030
.095

USING $t = .005$

$$A = \pi d \ell = .0302$$

$$\ell = \frac{.0302}{(3.14)(.095)} \cong \cancel{.010}\ .102$$



.125
.040
.085

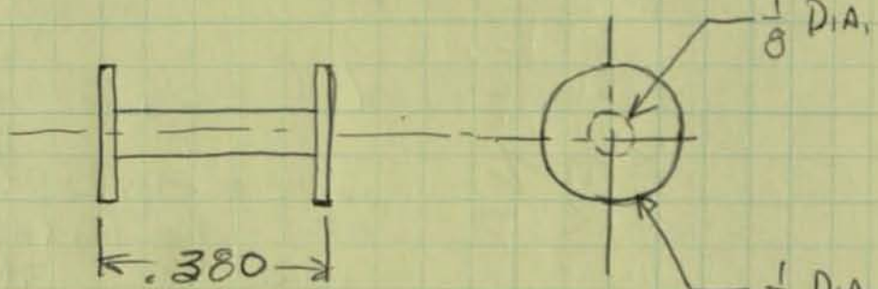
INSERTION LOSS VS. FREQ.

FREQ. (mc)	I.L. (db)	FREQ (Kmc)	I.L. (db)
800 mc.	43	2.0	12.0
900 mc.	23		
~~850~~ 950	6.6		
1000	2.5		
1100	1.4		
1200	1.4		
1300	.65		
1500	2.30		

80 7/18/63 H.P. FILTER

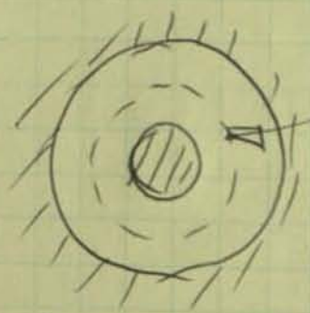
Freq (kmc)	I.L. (db)	.085 spacing on elec's FREQ (kmc)		I.L. (Db)
	.10 overlap on ends			
.800	.005 ~~4.0~~	18.5	22.0	6.0	6.7
.850	DISCS IN CENTER 4.3		6.1		
.900	SECTIONS 2.3		3.1	6.0	.3
1.000	1.3		1.0	2.0	
1.100	1.2		1.35	1.75	
1.150	.8		1.05	1.80	
1.200	.6		.65	1.25	
1.300	2.2		1.60		
1.400	1.8		2.00		
1.600	1.0				
1.800	6.2				
2.000	10.0				
2.2	17.0				
2.4	15.2				
2.6	16.0				
2.8	18.3				
3.0					
3.2	18.2				
3.4					
3.6	17.3				
3.8					
4.0	15.0				
4.4	11.8				
4.8	7.7				

HIGH PASS CONSTRUCTION





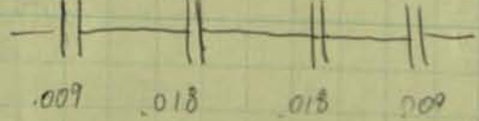
WIRE DIA. ≈ .020 ABOUT #24 WIRE



$d = \frac{1}{4}$

$\pi d = \frac{3.14}{4} = .785$

SPACING ~~DE~~ FOR CAPACITORS IN TEFLON



C FOR A .009 SPACER

$$C = \frac{(.225)(2.1)\pi(.125)^2}{.009} = 2.58\,pf.$$

$\ell \doteq .8" = \frac{\lambda_2}{4}$ IN TEFLON

$\lambda_2 = 3.2" = \frac{3}{3}$

$$\therefore f_2 = \frac{3\times10^{10}}{3.2\times2.54\times1.45} = 2.54\ Kmc.,$$

$\frac{f_2}{f_1} = \frac{2.54}{.7} = 3.63$

$\Theta_0 = 35°$

$\tan\Theta_0 = .7$

Z_0 OF LINE TO GROUND

$\frac{.020}{.125} = .16$ $\therefore \sqrt{\varepsilon_r}\, Z_0 = 125\Omega$

$\varnothing \frac{1}{+} .020$ } .125

$$Z_0 = \frac{125}{1.45} = 86.2$$

$$\therefore R = Z_1 \tan\Theta_0 = (86.2)(.7) \doteq 60\Omega.$$

125. 87.5

USING 60Ω ON DESIGN p. 78

$$C = \frac{1.03}{(60)(3\times10^{10})(.4)} = 1.43\,pf.$$

$t = .004$

$\frac{t}{b} = .05$, w/ $D = .006$

$b = \frac{.008}{.05} = .160$

~~$\frac{t}{b} = \tan\Theta_0 = 60°$~~

$$Z_1 = \frac{R}{\tan\Theta_0} = \frac{60}{.425} = 141\Omega.$$

$Z_1\sqrt{\varepsilon_r} = 205\Omega$

CONSIDER USING $\Theta_0 = 35°$ $f_2 = 3.6$ Kmc, $\ell = \frac{1}{4}\frac{3\times10^{10}}{3.6\times10^9} = 2.08$ cm

$= .61$ radians $= .82"$ air

$$C = \frac{2.08}{(60)\,3\times10^{10}\,.61} = 1.9\,pf.$$

87.5

1.3 pf.

$\frac{C}{2} = .95\,pf.$

.65

or $\frac{.82}{1.45} = .565"$ in teflon

$\ell = .565"$

CONT. FROM p. 81

PHYSICAL DIMENSIONS OF CAPACITORS

USING .25 DISC. & TEFLON

$$t = \frac{(.225)(2.1)\pi(.125)^2}{1.9} = .0122$$

START WITH $t = .005$

$$n^2 t = \frac{(.005)(1.9)}{(.225)(2.1)\pi} = .0064, \quad n = .080$$

$d = .160$

USING $D = .375$

GIVES GROUND PLANE.

SPACING OF $b = .108$ $\rightarrow t = \frac{(.225)(2.1)\pi(.0064)}{1.3} = .0073$

TO MAINTAIN $\sqrt{L/C}$ OF 125 Ω.

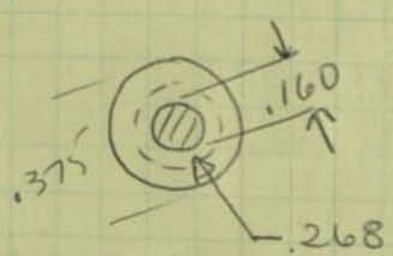
WITH $\frac{D}{b} = .16$ { DIAM

$D = (.108)(.16) = .0173$

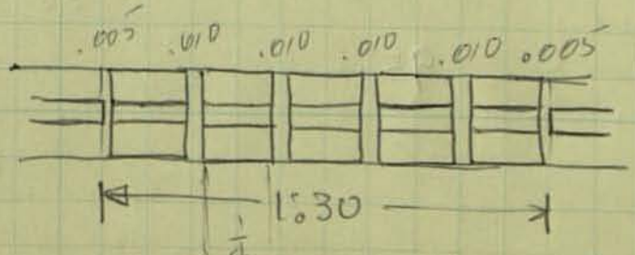
#26 WIRE

WIRE & LOOP DIA.

$\pi .268 = .840$



DIAG. OF FILTER



.160
.108
.268

3
.375
.160
2|.215
.1075

.375
2.3 =

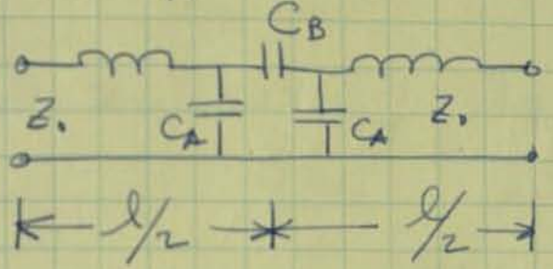
.080
.25

INPUT BANDPASS FILTER FOR ~~BW~~ 2.1 - 2.4 Kmc

OUTPUT FREQ. DOUBLER - OSCILLATOR

FREQUENCY - 1.05 - 1.2 Kmc

FILTER TYPE:



$f_1 = 1.00$ Kmc $\quad f_2 = 1.25$ Kmc

$\frac{f_1}{f_2} = .8$, $\left(\frac{f_1}{f_2}\right)^2 = .64$

$1 - \left(\frac{f_1}{f_2}\right)^2 = .36$

SELECT $\Theta_2 = .5$ RADIAN $\quad \Theta_1 = .4$ RADIAN

ALSO $Z_0 = 188\,\Omega$

$$C_A = \frac{1}{\omega_1 \Theta_2 Z_0} \frac{f_1}{f_2} = \frac{1}{(2\pi \times 10^9)(.5)\,188\;\;1.25}$$

$\frac{1}{3 \cdot .2 \cdot 1} = \frac{1}{.6}$

$C_A = 1.36$ pf.

$$C_B = \frac{1}{2\omega_1 \Theta_1 Z_0}\left[1 - \left(\frac{f_1}{f_2}\right)^2\right] = \frac{.36}{2(2\pi \times 10^9)(.4)\,188}$$

$C_B = .381$ pf., $2C_B = .76$ pf.

$\frac{1}{4 \cdot 3 \cdot .2} \cdot \frac{1}{2.4}$

$$Z_{IO} = \frac{Z_0\left[\frac{f_2}{f_1} - 1\right]}{\sqrt{\left(\frac{f_2}{f_1}\right)^2 + 1 + \Theta_2^2 + \frac{1}{\Theta_1^2}}} = \frac{(188)(.25)}{\sqrt{(1.25)^2 + 1 + .25 + \frac{1}{.16}}}$$

$$= \frac{47}{3.01} = 15.6\,\Omega$$

$\begin{array}{r} 1.56 \\ 1.25 \\ \hline 6.25 \\ \hline 9.06 \end{array}$

$\beta_1 \ell/2 = .4$, $\ell/2 = \frac{.4}{\beta_1} = \frac{.4}{2\pi}\lambda_1$

$\ell/2 = \frac{.4}{2\pi}\,30 = 1.91$ cm. $\qquad \lambda_1 = 30$ cm.

10/1/63 CONT. FROM p. 83

$\Theta_1 = .4$ RAD. $\approx$ $f_1 = 1.0$ Kmc.
$\Theta_1 = 23°$

$\Theta_2 = .5$ RAD $\approx$ $f_2 = 1.25$ Kmc
$\Theta_2 = 28.6°$

$\Theta_0 = .45$ RAD $\approx$ $f_0 = 1.125$ Kmc.
$\Theta_0 = 25.8°$

CONSIDER $2C_B = 1.0$ pf. KEEPING EVERYTHING THE SAME — SOLVE FOR Z_0.

$$Z_0 = \frac{1}{.381} \quad .381 \times \frac{188}{.5} = 143\ \Omega$$

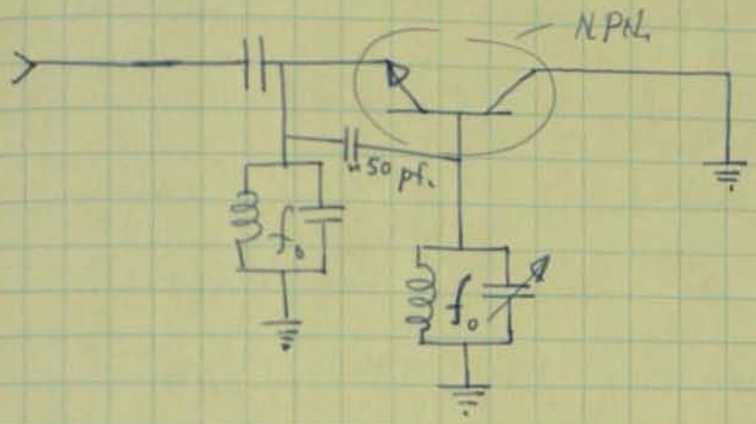
$$Z_{I0} = \frac{(.25)(143)}{3.01} \approx 12\ \Omega$$

TOO LOW!

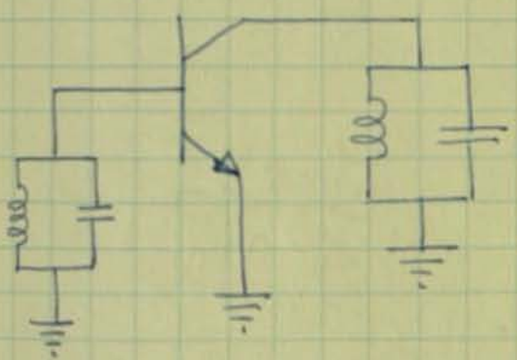
10/3/63

TRANSISTOR OSCILLATOR CIRCUIT.

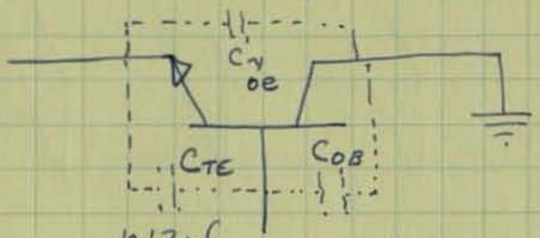
START WITH GROUNDED COLLECTOR COLLPITTS OSCILLATOR:



FROM R. F. STANDPOINT IT IS THE SAME AS: (GROUNDED EMITTER)

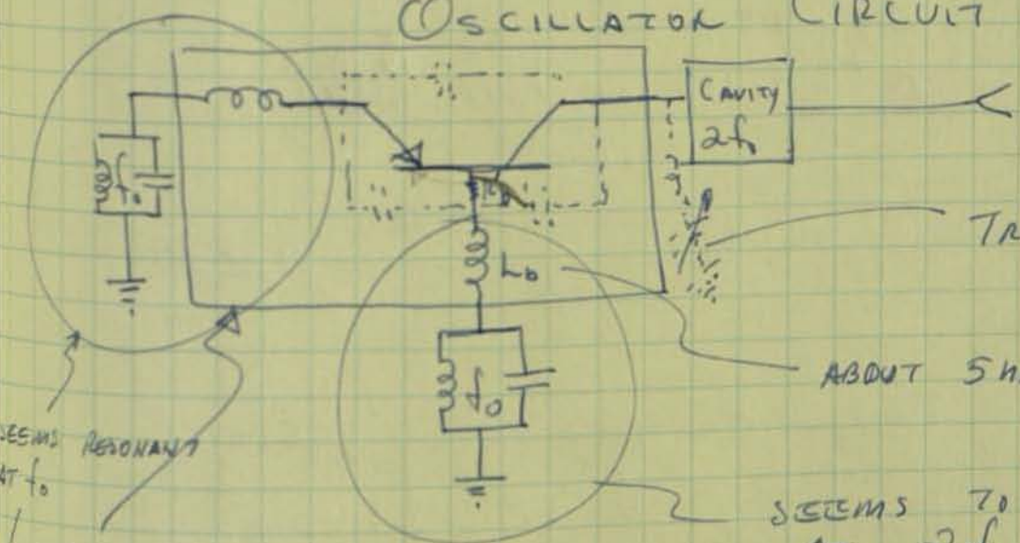


RESIDUAL CAPACITIES:



C_{TE} - TRANSITION CAPACITY

OSCILLATOR CIRCUIT BEING USED



TRAP - IMPROVED EFFICIENCY BUT NARROW BANDED.

ABOUT 5nh.

SEEMS TO BE SERIES RESONANT AT $2f_0$

EFFECTS FREQ. MORE THAN BASE CIRCUIT.

10/17/63 BANDPASS FILTER, INPUT

A VARIATION OF PROBLEM ON P. 83

OUTPUT BANDWIDTH 8.5 Kmc. - 9.6 Kmc.

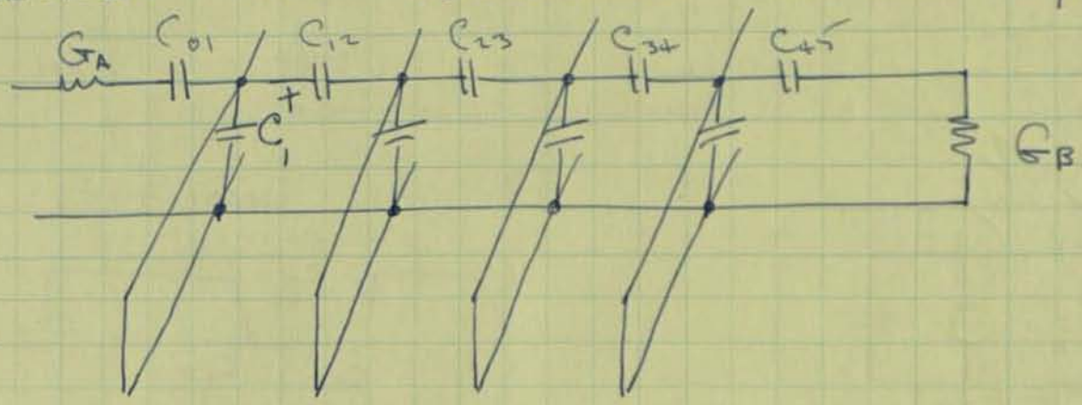
IF WE TRIPLE TWICE

$f_1' = .945$ Kmc., $f_2' = 1.07$ Kmc.

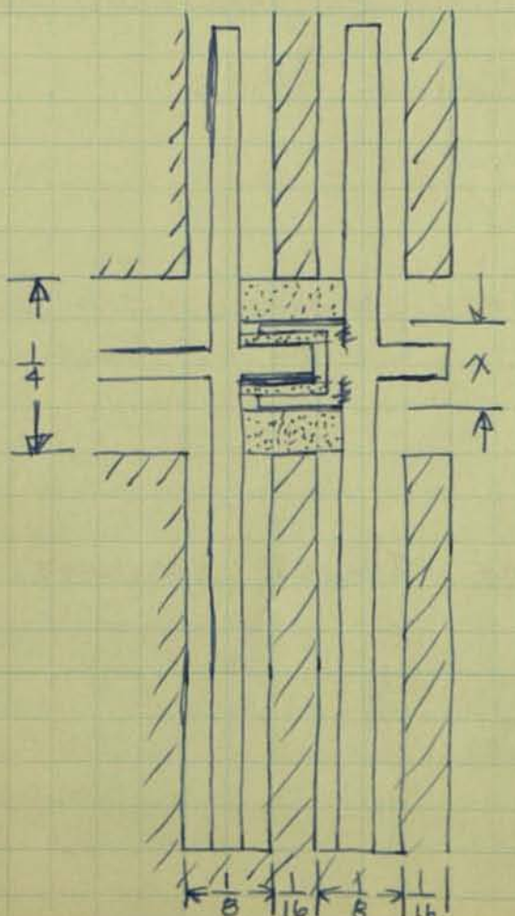
CONSIDER $f_1 = .9$ Kmc. & $f_2 = 1.1$ Kmc.

THIS WOULD GIVE A 20% BANDWIDTH.

CONSIDER THE FOLLOWING FILTER TYPE:-



ALSO CONSIDER THE FOLLOWING CONSTRUCTION:-



TRY $x = .125$

$$C_1' \cong \frac{(.225)(2.1)(\pi)\ 3/16}{.062}$$

$$C_1' = \frac{(.225)(2.1)\,\pi\ 9}{16} = 0.835 \text{ pf.}$$

FOR ESTIMATING PURPOSES

TRY $C_1' \cong .8$ pf.

10/18/63 CONT. FROM p. 86

SELECT $n = 4$, .1 db RIPPLE, $\omega_1' = 1$

$g_0 = 1$
$g_1 = 1.1088$
$g_2 = 1.3061$
$g_3 = 1.7703$
$g_4 = .818$
$g_5 = 1.3554$

$$W = 2\,\frac{\omega_2 - \omega_1}{\omega_2 + \omega_1} = 2\,\frac{200}{2000}$$

$W = .20$ — 20% BANDWIDTH

$$\omega_0 = \frac{2\omega_2\omega_1}{\omega_2 + \omega_1} = \frac{2 \cdot 2\pi \cdot .9 \cdot 1.1}{2.0} \times 10^9$$

$$\omega_0 = 1.98\pi \times 10^9 = 6.21 \times 10^9$$

ALSO $G_A = \frac{1}{25\Omega} = .04\ \mho$, $G_B = \frac{1}{50\Omega} = .02\ \mho$

THEY $Y_0 = \frac{1}{50\Omega} = .02\ \mho$

SINCE DIODE ZERO BIAS CAPACITY IS ABOUT 1.0pf.

LET $C_{01} = 1.0$ pf.

$$B_1^J = \left[\frac{\omega_0 C_{01}}{1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2} + \omega_0 C_1^* + \omega_0 C_{12}\right)$$

$$\frac{\omega_0 C_{01}}{G_A} = \frac{1.98\pi \times 10^{-3}}{4 \times 10^{-2}} = 1.555 \times 10^{-1}$$

$$= .1555$$

$$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = .0242, \quad \frac{\omega_0 C_{01}}{1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{1.98\pi \times 10^{-3}}{1.0242} = 6.07 \times 10^{-3}$$

6.07
4.97
4.66
15.70

$\omega_0 C_1^* = (6.21 \times 10^9)(.8 \times 10^{-12}) = 4.968 \times 10^{-3}$

TRY $C_{12} = .75$ pf., $\omega_0 C_{12} = (6.21 \times 10^9)(.75 \times 10^{-12}) = 4.66 \times 10^{-3}$

$B_1^J = 15.70 \times 10^{-3} = .0157$, $\frac{B_1^J}{Y_0} = \frac{.0157}{.0200} = .785$

FROM TABLE I

$\frac{b_1}{Y_0} = \frac{1.38}{1.42}$, THEN $J_{01} = \sqrt{\frac{G_A b_1 W}{g_0 g_1 w_1'}}$

$b_1 = (1.38)(.02) = .0276$ ≅ $\frac{1.42}{.0284}$

$J_{01} = \sqrt{\frac{(.04)(.0276)(0.20)}{(1)(1.1088)\ 1}} = \sqrt{\frac{2.0 \times 10^{-4}}{2.05}}$

$J_{01} = \frac{1.41}{1.43} \times 10^{-2} = .0141$ .0143

CHECK ON C_{01}:

$$w_0 C_{01} = \frac{J_{01}}{\sqrt{1-\left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.0143}{\sqrt{1-\left(\frac{.0143}{.040}\right)^2}}$$

$\frac{.0141}{.040} = .358$, $(.358)^2 = \frac{.124}{.128}$

$\frac{1.000}{.128}$ / $.872$, $\sqrt{.872} = .935$

$w_0 C_{01} = \frac{.0141}{.935} = .0151$ ($.0143$)

$C_{01} = \frac{.0153}{2\pi \times 10^9} = \frac{15.3 \times 10^{-12}}{2\pi}$

$C_{01} = \frac{2.4}{2.44}$ pf. → TOO LARGE!

TRY $C_{12} = .5$ pf.

$w_0 C_{12} = (6.21 \times 10^9)(.5 \times 10^{-12}) = 3.10 \times 10^{-3}$

6.07
4.97
3.10
14.14

$B_1^J = 14.14 \times 10^{-3} = .01414$

$\frac{B_1^J}{Y_0} = \frac{.01414}{.02} = .707$

$\frac{b_1}{Y_0} \cong \frac{1.41}{1.38}$

∴ C_{01} = 2A AGAIN TOO LARGE

TRY $Y_0 = \frac{1}{100} = .01$

THEN b_1 = .0142 , $J_{01} = \sqrt{\frac{(.04)(.0142)(.2)}{1.1088}}$

$J_{01} = 1.015 \times 10^{-2}$

$= \sqrt{1.025 \times 10^{-4}}$

$= .0102$

$\frac{J_{01}}{G_A} = \frac{.0102}{.04} = .255$, $\left(\frac{J_{01}}{G_A}\right)^2 = .065$

$\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2} = .967$

1.000
.065
.935

$\omega_0 C_{01} = \frac{.0102}{.967} = .0105$

$C_{01} = \frac{.0105}{2\pi \times 10^9} = 1.67$ pf.

TRY $C_1^t = .4$ pf. , $\omega_0 C_1^t = (6.21 \times 10^9)(.4 \times 10^{-12})$

$= 2.48 \times 10^{-3}$

ALSO $C_{12} = .5$ pf.

$\omega_0 C_{12} = (6.21 \times 10^9)(.5 \times 10^{-12}) = 3.11 \times 10^{-3}$

6.07
3.11
2.48
11.66

$\therefore B_J' = .01166$, $\frac{B_J'}{Y_0} = \frac{.01166}{.02} = .583$

FROM TABLE: $\frac{b_j}{Y_0} = 1.3$, $b_j = 26 \times 10^{-2} = .026$

$J_{01} = \sqrt{\frac{(.04)(.026)(.20)}{1.109}} = \sqrt{1.88 \times 10^{-4}} = 1.37 \times 10^{-2}$

$= .0137$

$\frac{J_{01}}{G_A} = \frac{.0137}{.04} = .342$, $(.342)^2 = .117$

1.000
.117
.883

$\omega_0 C_{01} = \frac{.0137}{.94} = .0146$, $C_{01} = \frac{.0146}{2\pi \times 10^9} = 2.32$ pf. $\sqrt{.883} = .94$

10/21/63 CONT. FROM p. 89

CONSIDER $G_A = \frac{1}{35\Omega} = .0286$, C_{01} STILL AT 1pf.

$$\frac{\omega_0 C_{01}}{G_A} = (1.98\pi \times 10^{-3})(35) = .218$$

$$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = .0475$$

1.000
.048
.952

$$1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = 1.048$$

$$\frac{\omega_0 C_{01}}{1+\left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{1.98\pi \times 10^{-3}}{1.048} = 5.93 \times 10^{-3}$$

WITH $C_1^t = .4$ pf.

$\omega_0 C_1^t = 2.48 \times 10^{-3}$

ALSO $C_{12} = .5$ pf., $\omega_0 C_{12} = 3.11 \times 10^{-3}$

ADDING THEM TOGETHER:

5.93
2.48
3.11
11.52 $\times 10^{-3}$

$\therefore B_1^J = .0115$

WITH $Y_0 = \frac{1}{50\Omega} = .02$

$$\frac{B_1^J}{Y_0} = \frac{.0115}{.020} = .575$$

FROM GRAPH $\frac{b_1}{Y_0} = 1.30$, $b_1 = .026$

$$J_{01} = \sqrt{\frac{(.0286)(.026)(.2)}{1.109}} = \sqrt{1.34 \times 10^{-4}}$$

$3\times10^{-2} \cdot 2\times10^{-2} \cdot (.2) = 1.2\times10^{-4}$

$J_{01} = 1.16 \times 10^{-2} = .0116$

$$\frac{J_{01}}{G_A} = \frac{.0116}{.0286} = .405 \quad , \quad \left(\frac{J_{01}}{G_A}\right)^2 = .164$$

$$1 - \left(\frac{J_{01}}{G_A}\right)^2 = .836 \quad , \quad \sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2} = .915$$

1.000
.164
.836

$$\omega_0 C_{01} = \frac{J_{01}}{\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.0116}{.915} = .0127$$

$$C_{01} = \frac{.0127}{6.21 \times 10^9} = \underline{2.04 \text{ pf.}}$$

Try $W = .15$ FOR LAST ATTEMPT

$$J_{01} = \sqrt{\frac{(.0286)(.026)(.15)}{1.109}} = \sqrt{1.005 \times 10^{-4}} \approx .010$$

ALSO TRY .2 db RIPPLE $g_1 = 1.30$

$$J_{01} = \sqrt{\frac{(.0286)(.026)(.15)}{1.30}} = \sqrt{.855 \times 10^{-4}} = .925 \times 10^{-2}$$

$$= .00925$$

$$\frac{J_{01}}{G_A} = \frac{.00925}{.0286} = .323 \quad , \quad \left(\frac{J_{01}}{G_A}\right)^2 = .1045$$

1.000
.105
.895

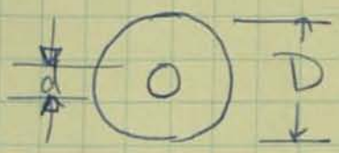
$$\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2} = .947$$

$$\frac{J_{01}}{\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.00925}{.947} = .00976$$

$$C_{01} = \frac{.00976}{6.21 \times 10^9} = \underline{1.57 \text{ pf.}}$$

10/21/63 CONT. FROM p. 91

GEOMETRY OF Y_0 LINE: (AIR)



$\frac{D}{d} = \frac{\frac{1}{8}}{\frac{1}{32}} = 4$

$Z_0 = 138 \log 4 = (138)(.603) = \underline{83.2\ \Omega}$

$Y_0 = .012$

Now consider .2 db ripple, $g_1 = 1.30$, $G_A = \frac{1}{35\Omega}$

$C_{12} = .5$pf.
$C_{01} = 1.0$pf.
$C_1^T = .4$pf.

$B_1^J = .0115$

$\frac{B_1^T}{Y_0} = \frac{.0115}{.012} = 0.958 \rightarrow$ Too large

Try $d = \frac{1}{16}$, $\frac{D}{d} = 2$, $\log 2 = .302$

$Z_0 = (138)(.302)$

$= \underline{41.6\ \Omega}$. WITH TEFLON $\sqrt{\varepsilon_r} = 1.45$ $Z_0 = \frac{41.6}{1.45} = 28.8$

$Y_0 = .024$

$\frac{B_1^J}{Y_0} = \frac{.0115}{.024} =$ use $\underline{.48}$

$\therefore \frac{b_1}{Y_0} = 1.25$, $b_1 = (1.25)(.024) = .030$

From here $\frac{b_1}{Y_0} = 1.55$, $b_1 = (1.55)(.012) = .0186$

Then $J_{01} = \sqrt{\frac{(.0286)(.0186)(.15)}{1.30}} = \sqrt{.613 \times 10^{-4}} = .00783$

$\frac{J_{01}}{G_A} = \frac{.00783}{.0286} = .274$, $\left(\frac{J_{01}}{G_A}\right)^2 = .075$

$1 - \left(\frac{J_{01}}{G_A}\right)^2 = .925$, $\sqrt{.925} = .963$, $\frac{J_{01}}{\sqrt{1-\left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.00783}{.963} = .0065$

$\frac{1.002}{.075}$
$\frac{.075}{.925}$

10/21/63 CONT. FROM p. 92

$$C_{01} = \frac{.00815}{6.21 \times 10^9} = 1.31 \text{ pf.}$$

ALSO, FROM GRAPH $\frac{l_1}{\frac{\lambda_0}{4}} \simeq .62$

ΔT 1. KMC $\frac{\lambda_0}{4} \simeq \frac{30a}{4} \cdot \frac{1}{2.5} = 3''$

$\therefore l_1 \simeq (.62)(3)'' = 1.86''$

TO CHECK VALUE OF $C_{01} = 1.3$ pf.

$$\frac{\omega_0 C_{01}}{G_A} = .218 \quad \frac{1.3}{1.0} = .283$$

$$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = .0801$$

$$\frac{\frac{\omega_0 C_{01}}{G_A}}{1+\left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{(1.3)(1.9811 \times 10^{-3})}{1.0801} = 7.47 \times 10^{-3}$$

THEN $B_1^J = 7.47 \times 10^{-3} + 3.11 \times 10^{-3} + 2.48 \times 10^{-3}$
$= 13.06 \times 10^{-3}$

7.47
3.11
2.48
13.06

$Z_0 = 83.2$ $\frac{B_1^J}{Y_0} = \frac{13.06 \times 10^{-3}}{.012} = 1.09$

FROM GRAPH $\frac{b_1}{Y_0} = 1.64$, $b_1 = .0197$

$$J_{01} = \sqrt{\frac{(.0286)(.0197)(.15)}{1.30}} = \sqrt{.65 \times 10^{-4}} = .0081$$

$.81 \times 10^{-2}$

$$\frac{J_{01}}{G_A} = \frac{.0081}{.0286} = .283, \quad \left(\frac{J_{01}}{G_A}\right)^2 = .080$$

1.000
.080
.920

$\sqrt{.920} = .960$

$$\omega_0 C_{01} = \frac{.0081}{.960} = .0084$$

$$C_{01} = \frac{.0084}{6.21 \times 10^9} = 1.36 \text{ pf.}$$

PRETTY GOOD AGREEMENT.

10/21/63 CONT. FROM p. 93

FROM GRAPH THEN:-

$$\frac{l_1}{\frac{\lambda_0}{4}} = .58 \quad , \quad l_1 = (.58)(3.0) = \underline{1.74}"$$

USING .2 db RIPPLE

$g_0 = 1$, $g_1 = 1.3028$, $g_2 = 1.2844$, $g_3 = 1.9761$, $g_4 = .8468$

$g_5 = 1.5386$

SO FAR $C_{01} = 1.3$ pf.

$C_1^t = C_2^t = C_3^t = C_4^t = .4$pf. $\}$ $C_{12} = .5$ pf.

$$B_2^J = w_0 C_{12} + w_0 C_2^t + w_0 C_{23}$$

$w_0 C_{12} = 3.11 \times 10^{-3}$

$w_0 C_2^t = 2.48 \times 10^{-3}$

3.11
2.48
3.11
8.70

SELECT $C_{23} = .5$ pf.

$\therefore B_2^J = 8.70 \times 10^{-3}$, $\frac{B_2^J}{Y_0} = \frac{.0087}{.012} = 0.725$

$$J_{12} = \frac{W}{w_1'}\sqrt{\frac{b_2}{Y_0}} = 1.39 \quad , \quad b_2 = (1.39)(.012) = \underline{.0167}$$

$$J_{12} = \frac{W}{w_1'}\sqrt{\frac{b_1 b_2}{g_1 g_2}} = .15\sqrt{\frac{(.0197)(.0167)}{(1.302)(1.284)}} = .15\sqrt{1.965 \times 10^{-4}}$$

$$J_{12} = (.15)\ 1.402 \times 10^{-2} = \underline{.21 \times 10^{-2}}$$

$$w_0 C_{12} = .21 \times 10^{-2}$$

$$C_{12} = \frac{.21 \times 10^{-2}}{6.21 \times 10^9} = .0338 \times 10^{-11}$$

$$C_{12} = .338 \text{ pf.}$$

TRY $C_{12} = .8$ pf., $w_0 C_{12} = (6.21 \times 10^9)(.8 \times 10^{-12})$
$= 4.968 \times 10^{-3}$

THEN $B_2^J = 10.56 \times 10^{-3}$ $\frac{B_2^J}{Y_0} = \frac{10.56 \times 10^{-3}}{.012}$

4.968
3.11
2.48
10.56

$= 0.88$

$\frac{b_2}{Y_0} = 1.48$, $b_2 = (.012)(1.48) = .0178$

$\frac{(.0197)(.0178)}{(1.303)(1.284)} = 2.09 \times 10^{-4}$

$\sqrt{2.09} \times 10^{-2} = 1.45 \times 10^{-2}$

$J_{12} = (.15)(1.45 \times 10^{-2}) = .218 \times 10^{-2}$

& $C_{12} = .35$ pf.

$B_3^J = w_0 C_{23} + w_0 C_3^1 + w_0 C_{34}$

TRY $C_{12} = .34$ pf ALSO $C_{23} = C_{34} = .5$ pf

~~B_3^{TH} $w_0 C_{12} = (6.21 \times 10^9)($~~.

3.11
3.11
2.48
8.70 $\times 10^{-3}$

$B_3^J = 8.70 \times 10^{-3}$

THEN $b_3 = .0167$

$J_{23} = .15 \sqrt{\frac{(.0167)^2}{(1.284)(1.976)}} = (.15)(.0167)\sqrt{\frac{.394}{(.15)(.0167)(.628)}}$

$J_{23} = 1.57 \times 10^{-3}$

$w_0 C_{23} = 1.57 \times 10^{-3}$, $C_{23} = \frac{1.57 \times 10^{-3}}{6.21 \times 10^9} = .253$ pf.

GO BACK NOW AND TRY B_2' WITH STUB T_0 SUPPRESS SWO

AGAIN $B_2^J = 8.70 \times 10^{-3}$, $\frac{B_2^J}{Y_0} = 0.725$

$\frac{b_2}{Y_0} = 1.25$ $b_2 = (1.25)(.012) = .015$

CONT. FROM p. 95 10/22/63

$$J_{12} = .15\sqrt{\frac{(.0197)(.015)}{(1.30)(1.28)}} = .15\sqrt{1.78\times10^{-4}}$$

$$= (.15)\ 1.34\times10^{-2} = .2\times10^{-2} = .0020$$

$$w_0 C_{12} = .002, \quad C_{12} = \frac{.002}{6.21\times10^{9}} = 0.323\ pf$$

TO CALCULATE C_{23}

$$B_3^J = w_0 C_{23} + w_0 C_3^t + w_0 C_{34}$$

~~TRY AGAIN~~ TRY $B_3^J = 7.0\times10^{-3}$, $\frac{B_3^J}{Y_0} = \frac{.007}{.012} = .583$

$\therefore$ b_3 USING $5w_0$ REJECTION GRAPH

$$\frac{b_3}{Y_0} = 1.15, \quad b_3 = (1.15)(.012) = .014$$

$$J_{23} = .15\sqrt{\frac{(.015)(.014)}{(1.28)(1.98)}} = .15\sqrt{.828\times10^{-4}} = (.15)(.91)\times10^{-2}$$

$$J_{23} = .136\times10^{-2}$$

$$C_{23} = \frac{.136\times10^{-2}}{6.21\times10^{9}} = .22\ pf.$$

TO CALCULATE C_{34}

TAKE $B_4^J = 7\times10^{-3}$, $\frac{B_4^J}{Y_0} = .583$

USING $3w_0$ REJECTION GRAPH

~~$\frac{b_4}{Y_0} = 1.3$, $b_4 = (1.3)(.012) = .0156$~~

~~$J_{34} = .15\sqrt{\frac{(.015)(.0156)}{(1.98)(.847)}} = .15\sqrt{1.4\times10^{-4}}$~~

~~$= (.15)(1.18)\times10^{-2} = .177\times10^{-2}$~~

CONT. FROM p. 96 10/22/63

$C_{34} = \frac{.177 \times 10^{-2}}{6.21 \times 10^9} = .28\ pf.$

TO CALCULATE C_{45} I USED WRONG EQUN. FOR LAST B_J

SO FAR WE HAVE:

$C_{01} = 1.3\ pf.$, $C_{12} = .32\ pf.$, $C_{23} = .25\ pf.$

B_1 3 W$_0$ REJECTION B_2 5 W$_0$ REJECTION B_3 5 W$_0$ REJECTION

MUST USE:

$$B_n^J = \left(w_0 C_{n-1,n} + w_0 C_n^t + \frac{w_0 C_{n,n+1}}{1 + \left(\frac{w_0 C_{n,n+1}}{G_B}\right)^2} \right)$$

$$B_4^J = \left[w_0 C_{34} + w_1 C_4^t + \frac{w_0 C_{45}}{1 + \left(\frac{w_1 C_{45}}{G_B}\right)^2} \right]$$

IN THIS CASE $G_B = \frac{1}{50} = .02$, LET $C_{34} = .5\ pf.$, $C_{45} = 1.0\ pf.$

$w_0 C_{45} = (6.21 \times 10^9)(1.0 \times 10^{-12}) = 6.22 \times 10^{-3}$

$\frac{w_0 C_{45}}{.02} = \frac{.00622}{.02} = .31$, $\left(\frac{w_0 C_{45}}{G_B}\right)^2 = .096$

$B_4^J = 3.11 \times 10^{-3} + 2.48 \times 10^{-3} + 5.66 \times 10^{-3}$

$= 11.25 \times 10^{-3}$

$\frac{B_4^J}{Y_0} = \frac{11.25 \times 10^{-3}}{.012} = .94$

$\frac{b_4}{Y_0} = 1.56$ FOR 3 W$_0$ REJECTION.

$b_4 = (1.56)(.012) = .019$

$J_{45} = \sqrt{\frac{G_B\, b_4 W}{g_n g_{n+1} w_1'}} = \sqrt{\frac{(.02)(.019)(.15)}{(.847)(1.54)}} = \sqrt{\frac{.438 \times 10^{-4}}{.662}} = .662 \times 10^{-2}$

$\frac{6.22}{1.096} = 5.66$

2.48

3.11

11.25

$\frac{.011}{.02}$

CONT. FROM p. 97 10/22/63

$$w_0 C_{45} = \frac{J_{45}}{\sqrt{1-\left(\frac{J_{45}}{G_B}\right)^2}}, \quad J_{45} = \frac{1.71\times10^{-2}}{.662}$$

$$\frac{J_{45}}{G_B} = \frac{1.71\times10^{-2}}{.02} = .855$$

$$\left(\frac{J_{45}}{G_B}\right)^2 = .730, \quad \sqrt{.89} = .945$$

$$w_1 C_{45} = \frac{1.71\times10^{-2}}{.52} = 3.29\times10^{-2}$$

$$C_{45} = \frac{3.29\times10^{-2}}{6.21\times10^{9}} = 5.3 \text{ pf.}$$

GO BACK & PICK UP J_{34}, B_3

$b_3 = .014$, $b_4 = .019$

$$J_{34} = .15\sqrt{\frac{(.014)(.019)}{(1.97)(.85)}} = .15\sqrt{1.59\times10^{-4}}$$

$$J_{34} = (.15)(1.26\times10^{-2}) = .189\times10^{-2}$$

$$C_{34} = \frac{.189\times10^{-2}}{6.21\times10^{9}} = .305 \text{ pf.}$$

WE THEN HAVE:

$C_{01} = 1.3$ pf., $C_{12} = .32$ pf., $C_{23} = .22$ pf., $C_{34} = .305$ pf.

$\{C_{45} = 5.3$ pf.

AT THIS POINT LET US RUN BACK THRU WITH THESE RESULTING VALUES:

CALCUL. B_1^T USING $C_1^t = .4$ pf. & $C_{12} = .32$ pf., $G_A = .0286$

FROM p. 93 $\frac{w_0 C_{01}}{1+\left(\frac{w_0 C_{01}}{G_A}\right)^2} = 7.47\times10^{-3}$

$w_o C_{12} = (6.21 \times 10^9)(.32 \times 10^{-12}) = 1.99 \times 10^{-3}$, $w_o C_1^t = 2.48 \times 10^{-3}$

$B_1^J = 7.47 \times 10^{-3} + 2.48 \times 10^{-3} + 1.99 \times 10^{-3}$

$B_1^J = 11.94 \times 10^{-3}$, $\frac{B_1^J}{Y_0} = \frac{.01194}{.012} = .995$

7.47
2.48
1.99
11.94

FROM $3\omega_0$ GRAPH:

$$\frac{b_1}{Y_0} = 1.57 \quad , \quad \frac{l_1}{\lambda_0/4} = .86$$

$b_1 = (1.57)(.012) = .0189$

$J_{01} = \sqrt{\frac{(.0286)(.0189).15}{1.303}} = \sqrt{6.22 \times 10^{-5}} = \sqrt{.622 \times 10^{-4}}$

$J_{01} = .79 \times 10^{-2}$, $\frac{J_{01}}{G_A} = \frac{.79 \times 10^{-2}}{.0286} = .276$

.090
.03

$\left(\frac{J_{01}}{G_A}\right)^2 = .0762$, $1 - \left(\frac{J_{01}}{G_A}\right)^2 = .238$

1.0000
.0762
.9238

$\sqrt{.924} = .962$

$w_o C_{01} = \frac{J_{01}}{\sqrt{1 - \left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.79 \times 10^{-2}}{.962} = .82 \times 10^{-2}$

$C_{01} = \frac{.82 \times 10^{-2}}{6.21 \times 10^9} = 1.32$ pf.

TO CALCULATE B_{22}^J: USING $C_{12} = .32$ pf., $C_{23} = .22$ pf.
$C_2^t = .4$ pf. & $5\omega_0$ REJECTION

$B_2^J = w_o C_{12} + w_o C_2^t + w_o C_{23}$, $w_o C_{23} = (6.21 \times 10^9)(.22 \times 10^{-12}) = 1.37 \times 10^{-3}$

$= 1.99 \times 10^{-3} + 2.48 \times 10^{-3} + 1.37 \times 10^{-3}$

1.37
2.48
1.99
5.84

$B_2^J = 5.84 \times 10^{-3}$ $\frac{B_2^J}{Y_0} = \frac{5.84 \times 10^{-3}}{.012} = 0.487$

FROM $5\omega_0$ GRAPH

$\frac{b_2}{Y_0} = 1.08$, $b_2 = (1.08)(.012) = .013$

$\frac{l_2}{\lambda_0/4} = .70$

CONT. FROM p. 99 10/22/63

$$J_{12} = .15\sqrt{\frac{(.0189)(.013)}{(1.303)(1.284)}} = .15\sqrt{1.47\times10^{-4}} = (.15)(1.21\times10^{-2})$$

$$J_{12} = .181\times10^{-2}$$

$$C_{12} = \frac{.181\times10^{-2}}{6.21\times10^{9}} = .292\,pf.$$

TO CALCULATE B_3^J USING $C_{23} = .22pf.$ $C_{34} = .30pf.$

$$B_3^J = \omega_0 C_{23} + \omega_0 C_3^* + \omega_0 C_{34}, \quad \omega_0 C_{34} = (6.21\times10^9)(3\times10^{-12}) =$$

$$= 1.37\times10^{-3} + 2.48\times10^{-3} + 1.86\times10^{-3}$$

$$B_3^J = 5.71\times10^{-3}, \quad \frac{B_3^J}{Y_0} = \frac{5.71\times10^{-3}}{.021} = .476$$

1.37
2.48
1.86
5.71

$$\frac{l_3}{\lambda_0/4} = .75$$

.005
.021

AT $5\omega_0$ REJECTION.

$$\frac{b_3}{Y_0} = 1.07, \quad b_3 = (1.07)(.012) = .0128 \;\underline{\approx}\; .013$$

$$J_{23} = .15\sqrt{\frac{(.013)(.013)}{(1.284)(1.976)}} = .15\sqrt{.665\times10^{-4}} = (.15)(.816\times10^{-2})$$

$$= .123\times10^{-2}$$

$$C_{23} = \frac{.123\times10^{-2}}{6.21\times10^{9}} = 2.198\,pf.$$

TO CALCULATE B_4^J WITH $G_0 = \frac{1}{50}$ ~~$C_{23} = .198$~~ $C_{34} = .30pf.$ & $C_{45} = 5.3\,pf.$

$(6.21\times10^9)(1.16\times10^{-12})$

$$\omega_0 C_{45} = 3.29\times10^{-2}, \quad \frac{\omega_0 C_{45}}{G_0} = \frac{9.95\times10^{-3}}{.02} = 0.498$$

9.95×10⁻³

.020
.02

$$\left(\frac{\omega_0 C_{45}}{G_0}\right)^2 = .248, \quad \frac{\omega_0 C_{45}}{1+\left(\frac{\omega_0 C_{45}}{G_0}\right)^2} = \frac{9.95\times10^{-3}}{1.248} = 7.98\times10^{-3}$$

$$\omega_0 C_{34} = 1.86\times10^{-3},$$

$$B_4^J = 12.52\times10^{-3}$$

1.86
2.48
12.52×10⁻³

CONT. FROM p. 100 10/22/63

$\frac{B_4^J}{Y_0} = \frac{12.52 \times 10^3}{13.19 \times 10^{-3}} = \frac{1.04}{.012}$ $\quad \frac{l_4}{\frac{\lambda_0}{4}} = .9$

FROM $3\omega_0$ GRAPH $\frac{b_4}{Y_0} = 1.60$, $b_4 = (1.60)(.012) = (.0192)$

$J_{34} = .15\sqrt{\frac{(.013)(.0192)}{(1.976)(.847)}} = .15\sqrt{\frac{154 \times 10^{-4}}{1.49}} = (.15)(1.22 \times 10^{-2})$

$J_{34} = .183 \times 10^{-2}$

$C_{34} = \frac{.183 \times 10^{-2}}{6.21 \times 10^9} = \frac{.294 \simeq .30}{.30 \text{ pf.}}$

TO CALCULATE C_{45}, $G_B = .02$

$J_{45} = \sqrt{\frac{(.02)(.0192)(.15)}{(.847)(1.539)}} = \sqrt{\frac{.442 \times 10^{-4}}{.804}} = \frac{.665}{.665} \times 10^{-2}$

$\frac{J_{45}}{G_B} = \frac{.665 \times 10^{-2}}{.02} = .332$

$\left(\frac{J_{45}}{G_B}\right)^2 = .110$, $\sqrt{1 - \left(\frac{J_{45}}{G_B}\right)^2} = .945$ $\quad \frac{1.000}{.110}$ / $.890$

w. $C_{45} = \frac{.665 \times 10^{-2}}{.945} = .705 \times 10^{-2}$

$C_{45} = \frac{.72 \times 10^{-2}}{6.21 \times 10^9} = 1.13 \text{ pf.}$

$\frac{\lambda_0}{4} = \frac{30 \text{ cm.}}{4} \cdot \frac{1}{2.54} = 2.94''$

FINAL TABLE OF VALUES.

$C_{01} = 1.32 \text{ pf.}$, $l_1/\lambda_0/4 = .86$ @ $3\omega_0$ REJECTION $l_1 = 2.53$

$C_{12} = 0.29 \text{ pf.}$, $l_2/\frac{\lambda_0}{4} = .75$ @ $5\omega_0$ REJECTION $l_2 = 2.20$

$C_{23} = 0.20 \text{ pf.}$, $l_3/\frac{\lambda_0}{4} = .75$ @ $5\omega_0$ REJECTION $l_3 = 2.20$

$C_{34} = 0.30 \text{ pf.}$, $l_4/\frac{\lambda_0}{4} = .90$ @ $3\omega_0$ REJECTION, $l_4 = 2.65$

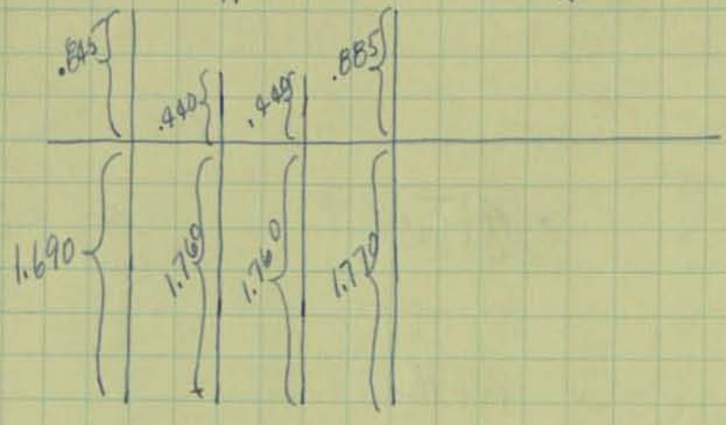
$C_{45} = 1.13 \text{ pf.}$ $\quad G_A = \frac{1}{35\Omega} = .0286$

$G_B = \frac{1}{50\Omega} = .020$

CONT. FROM p. 101 10/23/63

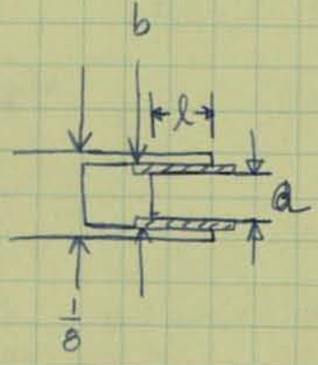
FOR THE 3 W.D. CASE THE SHORTED STUB IS 2 TIMES THE OPEN. FOR THE 5 W.D. CASE THE SHORTED STUB IS 4 TIMES THE OPEN STUB.

$\frac{2.53}{3} = .845$ (2) $= 1.690$ $\quad \frac{2.65}{3} = .885$ (2) $= 1.770$ $\quad \frac{2.20}{5} = .440$ (4) $= 1.760$



PHYSICAL SIZE OF CAPACITORS:

ASSUME SERIES CONDUCTOR DIAMETER IS .125



TRY $d = \frac{1}{16} = .0625$, $\{ b =$

$C = \frac{.225\, k\, A}{t}$

OR $C = \frac{.614\, k}{\log_{10} \frac{b}{a}}$ $\mu\mu f/in$

USING TEFLON .010 THICK

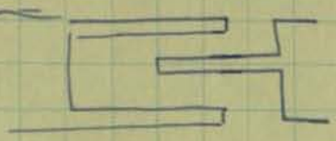
$C = \frac{(.614)(2.1)}{\log \frac{.0825}{.0625}} = \frac{1.29}{\log 1.32} = \frac{1.29}{.122} = 10.57$ pf./in

FOR $C_{01} = 1.32$ pf., $C_{12} = .29$ pf., $C_{23} = .20$ pf.

$l_{01} = .125$, $l_{12} = .0274$, $l_{23} = .0190$

$l_{3a} = .0204$, $l_{25} = .107$

CONSIDER SMALL CAP. .20 - .29 - .30 PARALLEL PLATE



$a = .0625$

$b = .0925$

.1250
.0925
2|.0325
.0162
WALL THICKNESS

$\log \frac{b}{a} = \log 1.48 = .172$

$C = \frac{.629}{.172} = 7.5 \text{ pf/in}$

Now $\ell_2 = \frac{.29}{7.5} = .0387$

CONSIDER PARALLEL PLATE

$C = \frac{.225\ k\ A}{t}$, $A = \pi r^2 = \pi \left(\frac{1}{16}\right)^2$

$= .0123$

$t = \frac{(.225)(2.1)(.0123)}{C} = \frac{.00582}{C}$

$.4 \times 10^{-2}$

FOR $C_{12} = .29$, $t_{12} = .020$

FOR $C_{23} = .20$, $t_{23} = .029 \approx .030$

FOR $C_{34} = .30$, $t_{34} = .020$

10/30/63 1.7 – 2.1 kmc BANDPASS FILTER

$$W = 2\,\frac{2.1-1.7}{2.1+1.7} = 2\,\frac{.4}{3.8} = 21\%$$

$$\omega_0 = 2\cdot 2\pi\left(\frac{1.7\cdot 2.1}{3.8}\right)\times 10^9 = \underline{11.8\times 10^9 \text{ Rad/sec.}}$$

$$f_0 = \frac{11.8}{2\pi} = \underline{1.88 \text{ Kmc.}}$$

WISH TO PRIMARILY REJECT $\frac{f_0}{2} = .94$ Kmc.

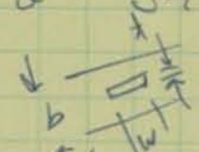
$$w' = \frac{2w_1'}{W}\left(\frac{w-w_0}{w}\right)$$

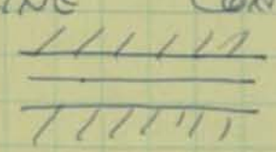
$$w' = \frac{2}{.21}\left(\frac{.94}{.94}\right) \cong .1$$

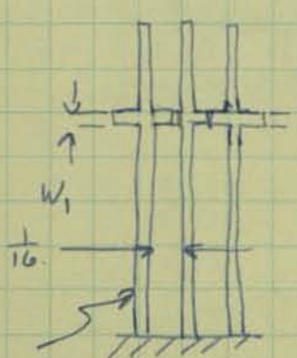
THE LOSS FOR .1 db RIPPLE AT $\frac{f_0}{2}$ IS ABOUT 55 db FOR $n=3$

g VALUES: $g_0 = 1$, $g_1 = 1.0315$, $g_2 = 1.1474$, $g_3 = 1.0315$, $g_4 = 1.0000$

CONSIDER FOLLOWING STRIPLINE CONSTRUCTION







FOR 50Ω LINE

$50\sqrt{\varepsilon_r} \cong 80\Omega$.

$\frac{t}{b} = \frac{.002}{.062} \cong .016$

$\frac{W}{b} = .45$, $W_1 = \frac{.46}{16} = .0287$

$$\therefore C_1 t = C_2 t = C_3 t = C t = \frac{1}{v_p Z_0}\cdot\frac{1}{16}\cdot 1.254 = \frac{.159}{(1.6)(3\times 10^{10})(50)}$$

$= .066$ pf. $\cong$ 0.07 pf

ALSO LET $G_A = G_B = \frac{1}{50\Omega} = .02$

$$B_1^J = \left(\frac{w_0 C_{01}}{1+\left(\frac{w_0 C_{01}}{G_A}\right)^2} + w_0 C_1^+ + w_0 C_{12} \right)$$

TRY $C_{01} = 1.5\,pf$ & $C_{12} = 1.0\,pf.$

$w_0 C_{01} = (11.8\times10^9)(1.5\times10^{-12})$

$w_0 C_{01} = 17.7\times10^{-3}$, $\frac{w_0 C_{01}}{G_A} = \frac{17.7\times10^{-3}}{.02} = 0.885$

$\left(\frac{w_0 C_{01}}{G_A}\right)^2 = .783$, $\frac{w_0 C_{01}}{1+\left(\frac{w_0 C_{01}}{G_A}\right)^2} = \frac{17.7\times10^{-3}}{1.783} = 7.93\times10^{-3}$

$w_0 C^+ = (11.8\times10^9)(.07\times10^{-12}) = .825\times10^{-3}$

$w_0 C_{12} = (11.8\times10^9)(1.0\times10^{-12}) = 11.8\times10^{-3}$

$B_1^J = 20.5\times10^{-3}$

11.8
.8
7.9
20.5 $\times10^{-3}$

ΣB_1^J ALSO LET $Y_0 = .02$

$\frac{B_1}{Y_0} = \frac{20.5\times10^{-3}}{.02} = 1.025$

FOR $3w_0$ REJECTION:

$\frac{b_1}{Y_0} = 1.57$, $b_1 = (1.57)(.02) = .0314$

$J_{01} = \sqrt{\frac{G_A b_1 W}{g_0 g_1 w_1'}} = \sqrt{\frac{(.02)(.031)(.21)}{1.03}} = \sqrt{1.26\times10^{-4}}$

$J_{01} = 1.12\times10^{-2}$, $\frac{J_{01}}{G_A} = \frac{1.12\times10^{-2}}{.02} = 0.56$

$\left(\frac{J_{01}}{G_A}\right)^2 = .31$

1.000
.31
.690

$w_0 C_{01} = \frac{1.12\times10^{-2}}{\sqrt{.69}} = \frac{1.12\times10^{-2}}{.83} = 1.35\times10^{-2}$

$C_{01} = \frac{1.35\times10^{-2}}{11.8\times10^{+9}} = 1.14\,pf.$

10/30/63 CONT. FROM p. 105

ESTIMATE $C_{12} = .5\,pf.$ & $C_{23} = 1.14\,pf$

$B_2^J = w_0 C_{12} + w_0 C^t + w_0 C_{23}$ $\quad w_0 C^t = .825 \times 10^{-3}$

$w_0 C_{12} = (11.8 \times 10^9)(.5 \times 10^{-12})$

$= 5.9 \times 10^{-3}$, $w_0 C_{23} = (11.8 \times 10^9)(1.14 \times 10^{-12}) = 13.5 \times 10^{-3}$

$B_2^J = 19.2 \times 10^{-3}$

13.5
5.9
.8
19.2 $\times 10^{-3}$

$\frac{B_2^J}{Y_0} = \frac{19.2 \times 10^{-3}}{.02} = 0.96$, $\frac{l_2}{\lambda_0/4} = .625$

$\frac{b_2}{Y_0} = 1.55$, $b_2 = (1.55)(.02) = .0310$

$J_{12} = \frac{W}{w_1'}\sqrt{\frac{b_1 b_2}{g_1 g_2}} = .21\sqrt{\frac{(.031)(.031)}{(1.031)(1.147}} = \frac{(21)(.031)}{\sqrt{1.18}}$

$J_{12} = \frac{.0065}{1.09} = .0060$

$w_0 C_{12} = .0060$, $C_{12} = \frac{.0060}{11.8 \times 10^9} = \frac{6}{11.8} \times 10^{-12}$

$C_{12} = \cancel{.80}\ .51\ pf.$

$B_3^J = \left[w_0 C_{23} + w_0 C^t + \frac{w_0 C_{34}}{1 + \left(\frac{w_0 C_{34}}{G_B}\right)^2} \right]$

ESTIMATE $C_{23} = \cancel{.80}\ .5\ pf.$ $\quad C_{34} = 1.14\ pf.$

$w_1 C_{23} = (11.8 \times 10^9)(.5 \times 10^{-12}) = \cancel{5.9} \times 10^{-3}$

$w_0 C_{34} = 13.5 \times 10^{-3}$, $\frac{w_0 C_{34}}{G_B} = \frac{13.5 \times 10^{-3}}{.02} = .675$

$\left(\frac{w_1 C_{34}}{G_B}\right)^2 = .455$

$$\frac{W_0 C_{34}}{1+\left(\frac{W_0 C_{34}}{G_B}\right)^2} = \frac{11.8\times10^{-3}}{1.455} = 8.11\times10^{-3}$$

8.11
5.90
.80
14.81

$B_3^J = 14.81\times10^{-3}$, $\frac{B_3^J}{Y_0} = \frac{14.81\times10^{-3}}{.02} = 0.74$

$\frac{b_3}{Y_0} = 1.42$, $b_3 = .0284$ $\quad \frac{l_3}{\lambda_0/4} = .69$

$$J_{23} = .021\sqrt{\frac{b_2 b_3}{g_2 g_3}} = .21\sqrt{\frac{(.031)(.028)}{(1.147)(1.032)}}$$

$$= .021\sqrt{7.33\times10^{-4}} = (.21)\ 2.71\times10^{-2}$$

$J_{23} = 5.7\times10^{-3}$

$C_{23} = \frac{5.7\times10^{-3}}{11.8\times10^{9}} = .48$ pf.

$$J_{34} = \sqrt{\frac{G_B b_3 W}{g_3 g_4 W_1'}} = \sqrt{\frac{(.02)(.028)(.21)}{(1.147)\ 1.032}} = \sqrt{1.14\times10^{-4}}$$

$= 1.07\times10^{-2}$, $\frac{J_{34}}{G_B} = \frac{1.07\times10^{-2}}{.02} = .535$

$\left(\frac{J_{34}}{G_B}\right)^2 = .286$

1.000
.286
.714

$$\omega_0 C_{34} = \frac{1.07\times10^{-2}}{\sqrt{.714}} = \frac{1.07\times10^{-2}}{.845} = 1.27\times10^{-2}$$

$C_{34} = \frac{12.7\times10^{-3}}{11.8\times10^{9}} = 1.08$ pf.

11/7/63 CONT. FROM p. 107

TRY $C_{01} = C_{34} = 1.10$ pf.

$C_{12} = C_{23} = .50$ pf.

$\ell_1 = \ell_3 = .69 \frac{\lambda_0}{4}$, $\ell_2 = .625 \frac{\lambda_0}{4}$

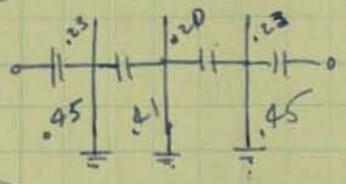
$f_0 = 1.88$ kmc, $\frac{\lambda_0}{4} = \frac{1}{4} \frac{3 \times 10^{10}}{1.88 \times 10^9 \, 2.54} = 1.57$" IN AIR

IN REX# 1422

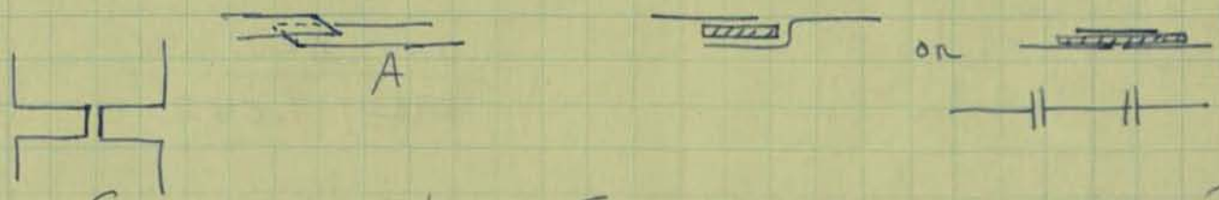
$\frac{\lambda_0}{4} = \frac{1.57}{1.6} = 0.98$

$\ell_1 = .68 = \ell_3$, $\ell_2 = .61$

$\frac{\ell_1}{2} \cong .23$ $\frac{\ell_2}{2} \cong .20$



PHYSICAL CONSTRUCTION OF CAPACITIES:



CONSIDER $b = .125$ INSTEAD OF .0625

THEN $W = .056$ FOR 50Ω LINE { ALSO USING CONSTRUCTION A

$C_{pf} = \frac{.225 \, \epsilon_r \, A}{t}$, { $\epsilon_r = 2.1$ - TEFLON

$t = \frac{(.225)(2.1)(.0035)}{C_{2pf}} = \frac{1.65 \times 10^{-3}}{C_{pf}}$ $A = \frac{1}{16} \times .056 = .003$

IF $A = \frac{1}{8} \times .056 = .007$, $t = \frac{3.3 \times 10^{-3}}{C_{pf}}$

Run #2

DATE 7-31 1963
EQUIP. USED Boonton 74C-S8
TAKEN BY Chen
REQUESTED BY J.S.

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.	

SIGNAL LEVEL AT 15% ≠ 20 mv.
>100 MΩ = ∞

X Row	UNIT No.	Coff.	RMΩ	Row	UNIT	Coff	RMΩ	Row	UNIT	Coff	RMΩ
1	1	.41	∞	3	1	.48	∞	5	1	.94	∞
-	2	1.0	30		2	.34	∞		2	.32	∞
-	3	.36	∞		3	.87	20		3	.80	10
-	4	.37	∞		4	.80	∞		4	.81	40
	5	1.0	5		5	.35	.2		5	.77	30
	6	.36	∞		6	9.00	.1		6	.78	∞
	7	.93	∞		7				7	.88	∞
	8	.84	∞		8	.80	5		8		
	9	.84	∞		9	.76	∞		9	.92	∞
	10	.82	30		10	.74	∞		10		
	11	1.01	∞		11				11	.31	∞
	12	.82	∞		12	.95	25		12	.78	70
	13	.79	50		13	.76	∞		13	.77	∞
	14	.30	∞		14	.86	∞		14	.71	∞
	15	.83	∞		15	.72	50		15	.81	∞
	16	.80	∞		16	.82	∞		16	.88	50
	17	.89	∞		17	.76	90		17	.30	∞
	18	.97	∞		18	.36	∞		18	.81	∞
	19	.82	35		19	.94	∞		19		
	20	.86	∞		20	1.0	.2		20	.33	∞
	21	.83	∞		21	.76	∞		21	.79	∞
	22	.69	∞		22	.76	∞		22	1.08	∞
	23	.77	∞		23	.65	∞		23	.89	∞
	24				24	1.05	.2		24	.86	∞
	25	.86	∞		25	.84	∞		25	.83	∞
				4	1	.76	∞	6	1	.75	∞
2	1	.77	∞		2	.33	10		2	.83	40
	2				3	.80	∞		3		
	3	.76	15		4	3.75	.2		4	.32	∞
	4	.72	90		5	.81	∞		5	.84	40
	5	1.8	30		6	.78	∞		6	1.03	∞
	6	3.5	.5		7	.38	∞		7	.76	∞
	7	.71	30		8	.79	30		8	.81	∞
	8	.31	∞		9	.87	50		9	.85	∞
	9	.74	∞		10	1.80	∞		10	.74	50
	10	.95	5		11	.84	17		11	.89	∞
	11	.83	30		12	.87	∞		12	.85	∞
	12	.80	∞		13	.75	∞		13	.93	∞
	13	.72	∞		14	.85	13		14	.77	∞
	14	.71	10		15	.79	∞		15	.99	∞
	15	.84	∞		16	.70	∞		16	.81	∞
	16	.80	∞		17	.34	∞		17	.94	∞
	17	.81	∞		18				18	1.12	12
	18	.36	∞		19	.77	∞		19	.54	8
	19	.81	∞		20	.92	∞		20	.71	∞
	20				21				21	.79	∞
	21	.76	40		22				22	.82	25
	22	.92	∞		23	.85	∞		23	.81	∞
	23	4.	small		24	1.01	70		24	.80	∞
	24	5.5	10		25	.70	∞		25	.77	50
	25	.32									

DATE SEPT. 19 1963
EQUIP. USED BOONTON C. BRIDGE
TAKEN BY O. WETTERHORN
REQUESTED BY J. L.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

( ) FT CLASS Run # 3
REMARKS
GROUP

LOT No.	DE	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP.	

LOT No.	UNIT No.	0 Cov pf.	1 R-Ma	2 UNIT No.	3 Cov pf.	4 R-Ma	5 UNIT No.	6 Cov pf.	7 R-Ma	8	9
	1	1.132	300	[illegible]			100	.976	120		
	2	.928	00	51	1.11	120	01	.999	30		
	3	1.097	300	52	1.114	120	02	1.07	300		
	4	1.04	160	53	1.111	300	03	1.05	300		
	5	1.11	260	4	1.05	300	04	1.09	300		
	6	1.15	9	5	1.14	25	05	.99	110		
	7	1.02	100	6	1.07	50	06	.91	300		
	8	.3	00	7	1.07	90	07	.39	00		
	9	1.04	250	8	1.05	300	08	1.05	100		
	10	1.18	10	9	.9	00	09	1.17	300		
	11	.97	35	60	1.03	300	110	1.05	300		
	12	1.11	70	1	1.07	300					
	13	.94	250	2	.96	300					
	14	1.19	18	3	.71	50					
	15	1.05	300	4	.98	00					
	16	1.10	300	5	1.18	8					
	17	[illegible]	00	6	1.06	180					
	18	1.08	25	7	1.17	18					
	19	1.09	130	8	1.09	400					
	20	1.32	10	9	1.03	70					
	21	.97	120	70	.55	50					
	22	1.07	200	1	1.06	49					
	23	1.13	300	2	1.12	49					
	24	1.02	300	3	1.11	160					
	25	.99	70	4	.96	00					
	26	1.00	80	5	1.08	300					
	27	1.01	50	6	1.13	300					
	28	1.09	300	7	1.05	300					
	29	.77	300	8	1.09	300					
	30	1.07	300	9	1.2	70					
	31	1.16	300	80	1.06	150					
	32	1.10	300	1	1.14	300					
	33	1.07	50	2	1.03	40					
	34	1.1	160	3	1.14	0.2					
	35	1.12	4	4	1.05	300					
	36	1.02	300	5	1.16	10					
	37	1.07	17	6	1.13	300					
	38	1.07	300	7	1.05	300					
	39	.31	0	8	.97	300					
	40	1.11	300	9	1.13	13					
	41	1.—	0.15	90	1.02	300					
	42	.97	8	1	1.01	300					
	43	.74	300	2	1.09	300					
	44	.95	50	3	1.07	300					
	45	1.02	300	4	.31	00					
	46	1.02	33	5	1.10	300					
	47	.95	00	6	1.09	30					
	48	.36	00	7	.97	150					
	49	.28	00	8	1.04	300					
	50	1.02	120	9	1.11	50					

THIS DATA IS NOT TAKEN ON THE CRIBORNE BRIDGE THE BRIDGE WAS "Calibrated" using diode 163 CP, # approximately the same Reading as given by the original bridge

R values ABOVE 10mA are at I at 50mA

.007

= 1.3061

FOR $C_{01} = 1.1$ p.f. , $t = \frac{.0033}{1.1} = .003$

FOR $C_{12} = .5$ p.f. $t = \frac{.0033}{.5} = .0066 \simeq .007$

CONSIDER A COMB LINE DESIGN WITH

$f_1 = 2.7$ Kmc $\{ f_2 = 3.3$ Kmc. , $f_0 = 3.0$ Kmc

$f_1 = 2.175$ Kmc $f_2 = 2.225$ Kmc , $f_0 = 2.2$ Kmc

CONSIDER A 4 RESONATOR 50Ω INPUT AND OUTPUT DESIGN.

IF WE SELECT $\theta_0 = \frac{\lambda}{8}$ AT 3.0 Kmc

THEN $l_0 = \frac{1}{8} \frac{3 \times 10^{10}}{3 \times 10^9} 2.54 = 0.492$ IN AIR

2.2×10^9 .671

$W = \frac{\omega_2 - \omega_1}{\omega_0} = \frac{f_2 - f_1}{f_0} = \frac{.6}{3.0} = .20$ .023

220 ρ

LET $\theta_0 = \frac{\pi}{4}$ RAD $= 45^\circ$ $\frac{Y_{aj}}{Y_A} = .677$ } FOR $j = 1$ TO 4

IN THIS CASE $\frac{b_j}{Y_A} = .870$

THEN FOR .1 db RIPPLE $g_0 = 1$, $g_1 = 1.1088$, $g_2 = 1.3061$

$g_3 = 1.7703$, $g_4 = 0.8180$, $g_5 = 1.3554$. , $\{ w_1' = 1$

$\frac{G_{T1}}{Y_A} = \frac{W \frac{b_1}{Y_A}}{g_0 g_1 w_1'} = \frac{(.20)(.870)}{(1)(1.1088)} = 0.157$ $\frac{.023}{} \simeq .0180$

$\sqrt{\frac{G_{T1}}{Y_A}} = .134$, $1 - \sqrt{\frac{G_{T1}}{Y_A}} = .866$ $\frac{1.000}{-.134}$ $.866$

$$\frac{J_{12}}{Y_A} = \frac{W}{\omega_1'}\sqrt{\frac{(b_1/Y_A)(b_2/Y_A)}{g_1 g_2}} = \frac{1.023(.2)(.870)}{\sqrt{(1.1088)(1.3061)}} = \frac{.1740}{\sqrt{1.445}}$$

$$= \frac{.174}{1.201}$$

$$\frac{J_{12}}{Y_A} = .145 \quad .017$$

$$\frac{J_{23}}{Y_A} = \frac{.174}{\sqrt{(1.3061)(1.7703)}} = \frac{.174}{\sqrt{2.315}} = \frac{.174}{1.520}$$

$$\frac{J_{23}}{Y_A} = .115 \quad .013$$

$$\frac{J_{34}}{Y_A} = \frac{.174}{\sqrt{(1.7703)(.818)}} = \frac{.174}{\sqrt{1.45}} = \frac{.174}{1.205}$$

$$\frac{J_{34}}{Y_A} = .145 \quad .017$$

$$\frac{G_{T4}}{Y_A} = \frac{W\left(\frac{b_4}{Y_A}\right)}{g_4 g_5 \omega_1'} = \frac{(.20)(.870)}{(.818)(1.3554)} = 0.157 \quad .018$$

$$\frac{376.7\ Y_A}{\sqrt{\epsilon_r}} = \frac{376.7}{50} = 7.55 \quad \text{FOR AIR}$$

$$\frac{C_0}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(1 - \sqrt{\frac{G_{T1}}{Y_A}}\right) \qquad .866$$

$$= 7.55\left(1 - \sqrt{.157}\right) = 7.55\ (1 - .397) \qquad \begin{array}{r} 1.000 \\ .397 \\ \hline .603 \end{array}$$

$$\frac{C_0}{\epsilon} = 4.55, \quad 6.53$$

ALSO $$\frac{C_{n+1}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(1 - \sqrt{\frac{G_{TN}}{Y_A}}\right) = \begin{array}{l} 4.55 \\ 6.53 \end{array}$$

$$\frac{C_1}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(\frac{Y_{A1}}{Y_A} - 1 + \frac{G_{T1}}{Y_A} - \frac{J_{12}}{Y_A} \tan\Theta_0 \right) + \frac{C_0}{\epsilon}$$

$$= 7.55 \left(.677 - 1 + .157 - .145 \cdot 1 \right) + 4.55$$

$$= -2.350 + 4.55$$

$$-2.43$$

$$\frac{C_1}{\epsilon} = 2.20 \quad 4.10$$

Also $\frac{C_4}{\epsilon} = \frac{376.7\ Y_A}{\sqrt{\epsilon_r}} \left(1 - \sqrt{\frac{G_{Tn}}{Y_A}} \right)$

$\therefore \frac{C_4}{\epsilon} = 2.20 \quad 4.10$

$$\frac{C_2}{\epsilon} = \frac{376.7\ Y_A}{\sqrt{\epsilon_r}} \left(\frac{Y_{A2}}{Y_A} - \frac{J_{i-1,i}^{1,2}}{Y_A} \tan\Theta_0 - \frac{J_{j,j+1}^{2,3}}{Y_A} \tan\Theta_0 \right)$$

$$= 7.55 \left(.667 - .145 - .115 \right) = (7.55)(.407)$$

$$\frac{C_2}{\epsilon} = 3.07 \quad 4.95$$

$$\frac{C_3}{\epsilon} = 7.55 \left(.667 - .115 - .145 \right)$$

$$\frac{C_3}{\epsilon} = 3.07 \quad 4.95$$

For the Mutual Capacitances

$$\frac{C_{01}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A - \frac{C_0}{\epsilon} = 7.55 - 4.55 \quad 6.53$$

$$\frac{C_{01}}{\epsilon} = \frac{3.00}{1.02} = \frac{C_{45}}{\epsilon}$$

$$\frac{C_{1,2}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(\frac{J_{1,2}}{Y_A} \tan\Theta_0 \right)$$

$$= (7.55)(.145) = \underline{1.095} \quad \frac{.128}{.017}$$

$$\frac{C_{2,3}}{\epsilon} = 7.55 \left(\frac{J_{2,3}}{Y_A} \tan\Theta_0 \right) = (7.55)(.115) = \underline{.868} \quad \frac{.098}{.013}$$

$$\frac{C_{3,4}}{\epsilon} = 7.55 \left(\frac{J_{3,4}}{Y_A} \tan\Theta_0 \right) = (7.55)(.145) = \underline{1.095} \quad \frac{.128}{.017}$$

FOR LUMPED CAPACITIES.

$$C_1^S = Y_A \left(\frac{Y_{adj}}{Y_A} \right) \frac{\omega\tau \tan\Theta_0}{\omega_0}, \quad \omega_0 = 2\pi\, 3\times10^9 = 18.85\times10^9$$

$$2.2 \quad = 13.80\times10^9$$

$$C_1^S \ldots C_n^S = \frac{1}{50}(.677)\frac{1}{18.85\times10^9} = .72 \text{ pf.}$$

$$13.80 \quad .98 \text{ pf.}$$

$$\begin{array}{r} 2.50 \\ -1.71 \\ \hline .79 \end{array}$$

TABULATION OF CAPACITIES

$$\frac{C_0}{\epsilon} = \frac{C_5}{\epsilon} = 4.55 \quad 6.53$$

$$\frac{C_1}{\epsilon} = \frac{C_4}{\epsilon} = 2.20 \quad 4.10$$

$$\frac{C_2}{\epsilon} = \frac{C_3}{\epsilon} = 3.07 \quad 4.95$$

$$\frac{C_{01}}{\epsilon} = \frac{C_{45}}{\epsilon} = 3.00 \quad 1.02$$

$$\frac{C_{12}}{\epsilon} = \frac{C_{34}}{\epsilon} = 1.095 \quad .128$$

$$\frac{C_{23}}{\epsilon} = .868 \quad .098$$

$$C_{j,j=1-4}^S = .72\text{pf.} \quad .98\text{pf.}$$

$$\frac{W_2}{b} = .3\left(2.50 - \underset{.85}{\underset{.80}{\cancel{.40}}} - \cancel{.54}\right) \quad .71$$

$$= (.3)(\cancel{1.50}) = \cancel{.450} \quad .237$$

$$\boxed{W_2 = \cancel{.412}\ .059}$$

$$\frac{W_3}{b} = .3\left(2.50 - \underset{1.00}{\cancel{1.08}}\right) - (3)(1.42)$$

$$= .426$$

$$\boxed{W_3 = \cancel{.412}\ .059}$$

CALCULATION OF PHYSICAL GEOMETRY:

SELECT $t = .125$, IF $\frac{t}{b} = .4$

$$b = \frac{.125}{.4} = .312$$

OR SELECT $t = .0625$

$$b = \frac{.0625}{.4} = .156$$

IF $b = .25$

$$\frac{t}{b} = \frac{\frac{1}{16}}{\frac{1}{4}} = .25$$

TRY $\frac{t}{b} = .2$

$$b = \frac{.0625}{.2} = .308$$

~~if $\frac{t}{b} = .5$, $b = .25$~~

2.05 − 1.38 = .67

3.27 − 1.46 = 1.81

2.07 − .99 = 1.06

FOR S_{01} USING $b = .308$

$\frac{S_{01}}{b} = .1$, $S_{01} = (.1)(.308) = .0308 = S_{45}$

2.50 − 1.00 = 1.50

$\frac{S_{12}}{b} = .29$, $S_{12} = (.29)(.308) = .089 = S_{34}$

2.50 − 1.08 = 1.42

$\frac{S_{23}}{b} = .35$, $S_{23} = (.35)(.308) = .108$

LET $\frac{t}{b} = .4$, $t = .100$

$b = .25$

FOR $b = .25$

$\frac{S_{01}}{b} = .115$, $S_{01} = .0288$ ($S_{01} = .102$)

$\frac{S_{12}}{b} = .31$, $S_{12} = .0775$ ($= S_{34}$)

$\frac{S_{23}}{b} = .37$, $S_{23} = .0925$

$\frac{S_{01}}{b} = \frac{S_{45}}{b} = .41$, $C_{1c} = .53$

$\frac{S_{12}}{b} = \frac{S_{34}}{b} = 1.07$ (.27), $\left(\frac{C_{1c}}{\ell}\right)_{12} = .85$

$\frac{S_{23}}{b} = \frac{.45}{1.13}$ (.28), $\left(\frac{C_{1c}}{\ell}\right)_{23} = .86$

ALSO $\frac{C'_1}{\ell} = .93$, $\frac{1}{2}\left(1 - \frac{t}{b}\right) = .3$

$\frac{W_0}{b} = .3\left(\frac{6.53}{2} - .93 - .53\right) = (.3)(1.81) = .543$

$W_0 = 1.71$, $\frac{W_1}{b} = .3(2.05 - .53 - .85) = (.3)(.67) = .201$ (.318), $W_1 = .050$ (.079)

CONT. FROM p. 113 11/22/63

CALCULATION OF W FOR $b = .25$

$$\frac{C_f'}{\epsilon} = .745$$

$$\left.\frac{C'_{fe}}{\epsilon}\right|_{01} = .145 \quad , \quad \left.\frac{C'_{fe}}{\epsilon}\right|_{12} = .35 \quad , \quad \left.\frac{C'_{fe}}{\epsilon}\right|_{23} = .41$$

$$\frac{W_k}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \left(\frac{C'_{fe}}{\epsilon}\right)_{k-1,k} - \left(\frac{C'_{fe}}{\epsilon}\right)_{k,k+1}\right]$$

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

$$= \frac{1}{2}(.75)\left[\frac{1}{2}(4.55) - (.745) - (.145)\right]$$

2.275

$$\frac{W_0}{b} = (.375)(1.385) = .519$$

$$\begin{array}{r} .745 \\ .145 \\ \hline .890 \end{array}$$

$$\begin{array}{r} 2.275 \\ .890 \\ \hline 1.385 \end{array}$$

$$\boxed{W_0 = .130}$$

$\frac{C_\epsilon'}{\epsilon}$ $\frac{C'_{fe}|_{01}}{\epsilon}$ $\frac{C'_{fe}|_{12}}{\epsilon}$

$$\frac{W_1}{b} = .375\left[\frac{1}{2}(2.20) - (.145) - (.35)\right]$$

1.10

$$= (.375)(.605) = .227$$

$$\begin{array}{r} .145 \\ .350 \\ \hline .495 \end{array}$$

$$\begin{array}{r} 1.100 \\ -\ .495 \\ \hline .605 \end{array}$$

$$\boxed{W_1 = .0567}$$

$$\frac{W_2}{b} = (.375)\left[\frac{1}{2}(3.07) - (.35) - (.41)\right]$$

1.535

$$\frac{W_2}{b} = (.375)(.775) = .291$$

$$\begin{array}{r} 1.535 \\ .760 \\ \hline .775 \end{array} \qquad \begin{array}{r} .41 \\ .35 \\ \hline .76 \end{array}$$

$$\boxed{W_2 = .0726}$$

USE SIMPLE CONSTRUCTION OF TEFLON SHEET FOR END LOADING CAPACITORS.

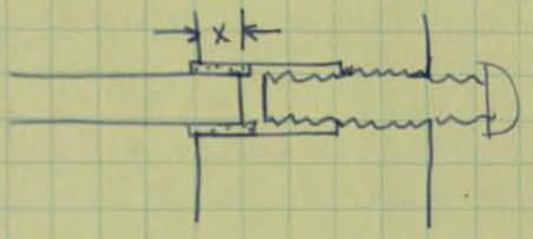
$C = \frac{.225\ \epsilon_r\ A}{t}$; WITH $C = .72pf.$, $\epsilon_r = 2.1$

$\frac{A}{t} = \frac{C}{.225\,\epsilon_r} = \frac{.72}{(.225)(2.1)} = 1.525$, $A = \frac{C\,t}{.225\,\epsilon_r}$

$A = \frac{1\ .010}{.225\ \ 2.1}$ USING TEFLON

$A = \frac{1}{42.2} = .024$

CONSIDER CONSTRUCTION:



$l(.112) = .024$

$l = \frac{24}{112} = .21$

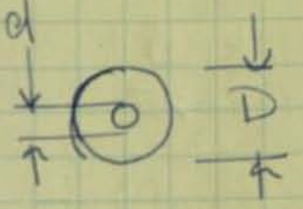
IF $t = .005$, $A = (1.525)(5.0 \times 10^{-3}) = 7.63 \times 10^{-3}$

USING WIDTH OF .060

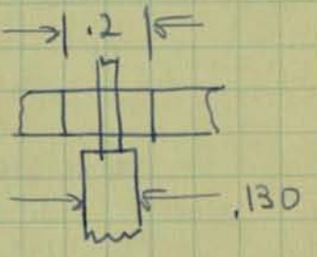
$l \cdot .060 = 7.63 \times 10^{-3}$, $l = \frac{7.63 \times 10^{-3}}{060. \times 10^{-3}} = .127$

∴ LET $X \cong \frac{1}{16}$ & PICK UP REST OF CAPACITY WITH TUNING SCREW.
OR ≅ .050

FOR 50 Ω INPUT GEOMETRY IN AIR



IF $D = .200$



LET $D = .130 + 2(.025) = .180$

$50 = 138 \log \frac{D}{d}$, $\frac{D}{d} = 2.3$

$d = \frac{.180}{2.3} \cong .078$

.200
.130
2 | 070
.035

1/2/63 INTERDIGITAL FILTER DESIGN.

FOR 4.45 Kmc TO 4.875

$$f_o = \frac{4.450 + 4.875}{2} = \frac{9.325}{2} = 4.663 \text{ Kmc}$$

4.875
4.450
.425

$$\frac{.425}{4.875} = 8.7\%$$

CONSIDER FILTER CUTOFFS SET AT 4.4 - 4.9 Kmc
WITH $f_o = 4.625$ Kmc

$$\frac{.500}{4.625} = 10.8\%$$

FUNDAMENTAL / HARMONIC FREQ. ARE THEN (USING 4th HARM.)

FUND. 1.1 Kmc. TO 1.225 Kmc (.550 TO .612 Kmc AT ½ FUND.)

2nd 2.2 Kmc. TO 2.450 Kmc

3rd 3.3 Kmc. TO 3.675 Kmc

CONSIDER INSTEAD 4.425 Kmc. AND 4.900 Kmc

FUND. 1.106 Kmc TO 1.225 Kmc (.553 - .616)

TO CALCULATE THE NO. OF RESONATORS TO PROVIDE 70 db

$$w' = \frac{2w_1'}{W}\left|\frac{w - w_0}{w_0}\right| \qquad W = \frac{w_2 - w_1}{w_0}$$

$$= \frac{.4750}{4.6625}$$

$$|w'| = \frac{2.1}{.102}$$

at f = .616

$$W = .102$$
$$.1019$$

4.45
4.900
2 | 9.325
4.663

$$\frac{w'}{w_1'} = \frac{2}{W}\left(\frac{w - w_0}{w_0}\right)$$

4.900
4.425
.475

$$= \frac{2}{.102}\left|\frac{.616 - 4.663}{4.663}\right| = \frac{1}{.051}\left(\frac{4.047}{4.663}\right) = 17.0$$

663
616
.047

$$\left|\frac{w'}{w_1'}\right| - 1 = 16$$

CONSIDER STOPPING 3RD HARM

$3f_1 =$ 3.336 KMC – 3.675 KMC

$\frac{w'}{w_1'} = \frac{2}{.102}\left|\frac{3.675 - 4.663}{4.663}\right|$,

4.663
3.675
.988

$= \frac{1}{.051}\left(\frac{.988}{4.663}\right) = 4.15$

$\left|\frac{w'}{w_1'}\right| - 1 = 3.15$

$n = 5$ GIVES ABOUT 72 db.

∴ Try $n = 6$. FOR A .01 db RIPPLE.

$w_1' = 1$ $g_0 = 1$

$g_1 = .7813$, $g_2 = 1.3600$, $g_3 = 1.6896$, $g_4 = 1.5350$, $g_5 = 1.4970$

$g_6 = .7098$, $g_7 = 1.1007$.

FROM TABLE II IN MATTHAEI – PGMTT

$\Theta_1 = \frac{\pi}{2}\frac{w_1}{w_0} = \frac{\pi}{2}\left(1 - \frac{w}{2}\right) = (1.57)(.949) = 1.4908$

$(1.5708)(.9491)$

1.0120
.1102
.8,98

$\Theta_1 = 1.4908$

$\frac{J_{01}}{Y_A} = \frac{1}{\sqrt{g_0 g_1 w_1'}} = \frac{1}{\sqrt{.7813}} = \frac{1}{.885} = .8839$

1.0000
.0509
.9401
.0509
.9491

$\frac{J_{01}}{Y_A} = 1.130$ 1.1313, $\left(\frac{J_{01}}{Y_A}\right)^2 = 1.28$ 1.2798

CORRECTION OF Θ_1 (.07)(.102) = .007183

∴ $W = .1090$ $\frac{W}{2} = .0545$
$.15$ $.075$

1.0060
.0545
.9455

.1019
.0071
1090

$\Theta_1 = 1.4852$

1.450

$$\left.\frac{J_{k,k+1}}{Y_A}\right|_{k=1 \text{ TO } n-1} = \frac{1}{w_1'\sqrt{g_k g_{k+1}}}$$

$$\frac{J_{12}}{Y_A} = \frac{1}{\sqrt{g_1 g_2}} = \frac{1}{\sqrt{(.7813)(1.3600}} = \frac{1}{\sqrt{1.06}} = \frac{1}{1.03}$$

1.0626 1.0308

$$\frac{J_{12}}{Y_A} = \underset{\sim}{0.970}\ \underline{.9701} \qquad \left(\frac{J_{12}}{Y_A}\right)^2 = \underset{\sim}{.942}\ \underline{.9411}$$

$$\frac{J_{23}}{Y_A} = \frac{1}{\sqrt{(1.3600)(1.6896)}} = \frac{1}{\sqrt{2.30}} = \frac{1}{1.5158} =$$

$$\frac{J_{23}}{Y_A} = \underset{\sim}{0.660}\ \underline{.6597} \qquad \left(\frac{J_{23}}{Y_A}\right)^2 = \underset{\sim}{.436}\ \underline{.4352}$$

$$\frac{J_{34}}{Y_A} = \frac{1}{\sqrt{(1.6896)(1.5350)}} = \frac{1}{\sqrt{2.595}} = \frac{1}{1.61}$$

2.5935 1.6104

$$\frac{J_{34}}{Y_A} = \underset{\sim}{0.622}\ \underline{.6210} \qquad \left(\frac{J_{34}}{Y_A}\right)^2 = \underset{\sim}{.387}\ \underline{.3856}$$

$$\frac{J_{45}}{Y_A} = \frac{1}{\sqrt{(1.535)(1.4970)}} = \frac{1}{\sqrt{2.30}} = \frac{1}{1.5158}$$

2.2978

$$\frac{J_{45}}{Y_A} = \underset{\sim}{0.660}\ \underline{.6597}$$

$$\frac{J_{56}}{Y_A} = \frac{1}{\sqrt{(1.4970)(.7098)}} = \frac{1}{\sqrt{1.06}} = \frac{1}{1.03}$$

$$\frac{J_{56}}{Y_A} = \underset{\sim}{0.970}$$

$$\frac{J_{67}}{Y_A} = \underset{\sim}{1.130}$$

$$N_{K,K+1}\Big|_{K=1 \text{ TO } n-1} = \sqrt{\left(\frac{J_{K,K+1}}{Y_A}\right)^2 + \frac{\tan^2\Theta_1}{4}}$$

$\Theta_1 = 1.4852$ RADIANS $= 85.0954°$

1 RADIAN $= 57.2956°$

sin 1.485 = .9963 (2175)

Cos 1.485 ~~= .0867~~ .08569111

tan Θ = 11.627

FOR SLIDE RULE ACCURACY $\Theta_1 = 85.10°$ $83.00°$

$\tan\Theta_1 = 11.664$, 8.144 ; $\tan^2\Theta_1 = 136.0$, 135.19, 66.3

$\frac{\tan^2\Theta_1}{4} = 34.0$ 33.80 16.60

$$N_{12} = \sqrt{\left(\frac{J_{12}}{Y_A}\right)^2 + \frac{\tan^2\Theta_1}{4}} = \sqrt{.942 + 34.0} = \sqrt{34.94}$$

.941 ; 33.80, 16.60 ; 34.74, 17.54

$N_{12} = 5.91$ 5.89 4.19

16.60 + .94 = 17.54 ; 33.80 + .94 = 34.74

$$N_{23} = \sqrt{.436 + 34.0} = \sqrt{34.44}$$

34.24

$N_{23} = 5.87$ 5.85 4.13

16.60 + .44 = 17.04 ; 33.80 + .44 = 34.24

$$N_{34} = \sqrt{.387 + 34.0} = \sqrt{34.39}$$

34.19

$N_{34} = 5.86$ 5.85 4.12

16.60 + .39 = 16.99 ; 33.80 + .39 = 34.19

$N_{45} = 5.87$, $N_{56} = 5.91$

TO CALCULATE h FOR MATTINAEIS EQUATIONS.

USING $\frac{2C_{K-1,K}}{\epsilon} + \frac{C_K}{\epsilon} + \frac{2C_{K,K+1}}{\epsilon} \cong 5.4$

FOR $K = n/2$ FOR n EVEN

SINCE $n = 6$, $2\frac{C_{23}}{\epsilon} + \frac{C_3}{\epsilon} + 2\frac{C_{34}}{\epsilon} = 5.4$

CONT. FROM p. 119 12/5/63

$$\left.\frac{C_K}{\epsilon}\right| = \frac{376.7}{\sqrt{\epsilon_r}} h Y_A \left[N_{K-1,K} + N_{K,K+1} - \frac{J_{K-1,K}}{Y_A} - \frac{J_{K,K+1}}{Y_A}\right]$$

$K=2$ TO $n-1$

$$\left.\frac{C_{K,K+1}}{\epsilon}\right| = \frac{376.7\, h\, Y_A}{\sqrt{\epsilon_r}} \left(\frac{J_{K,K+1}}{Y_A}\right)$$

$K=1,\ n-1$

$$2\frac{C_{23}}{\epsilon} + \frac{C_3}{\epsilon} + 2\frac{C_{34}}{\epsilon} = 5.4$$

$$\therefore \frac{376.7}{\sqrt{\epsilon_r}} h Y_A \left\{ 2\frac{J_{23}}{Y_A} + 2\frac{J_{34}}{Y_A} + \left[N_{23} + N_{34} - \frac{J_{23}}{Y_A} - \frac{J_{34}}{Y_A}\right] \right\} = 5.4$$

$$\frac{376.7}{\sqrt{\epsilon_r}} h Y_A \left[\frac{J_{23}}{Y_A} + \frac{J_{34}}{Y_A} + N_{23} + N_{34}\right] = 5.4$$

$\therefore$ FOR $n=6$

$$h = \frac{5.4}{\frac{376.7}{\sqrt{\epsilon_r}} Y_A \left[\frac{J_{23}}{Y_A} + \frac{J_{34}}{Y_A} + N_{23} + N_{34}\right]}$$

LET $Y_A = \frac{1}{50}$, $\sqrt{\epsilon_r} = 1$

$$h = \frac{(5.4)(50)}{(376.7)\left[.660 + .622 + 5.87 + 5.86\right]}$$

.621 5.85 5.85

.07001 4.13 4.12

.660
.622
5.870
5.860
13.012
13.008

$$h = .055$$

.055

.075

$$M_1 = Y_A\left[\frac{J_{01}}{Y_A}\sqrt{h} + 1\right] = \frac{1}{50}\left[1.13\sqrt{\frac{.055}{.075}} + 1\right] = \frac{1.266}{50}$$

(1.13)(.235)
.266 .276
.310

1.310/50

.0262

.0253 .0253

$$M_6 = Y_A\left[\frac{J_{6,7}}{Y_A}\sqrt{h} + 1\right] = .0253$$

.660
.622
4.130
4.120
9.532

CONT. FROM p. 120 12/6/63

$$\frac{C_0}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left[2Y_A - M_1\right] = (376.7)\left(\frac{2}{50} - .0253\right)$$

$$\frac{C_0}{\epsilon} = \frac{5.27}{5.54} = \frac{C_1}{\epsilon}$$

5.537

.026
.0400
.026
.014

.0400
.0253
.0147

$$\frac{C_1}{\epsilon} = \frac{C_6}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left\{Y_A - M_1 + h\,Y_A\left[\frac{\tan\theta_1}{2} + \left(\frac{J_{01}}{Y_A}\right)^2 + N_{12} - \frac{J_{12}}{Y_A}\right]\right\}$$

8.14
11.627

$$= 376.7\left\{.020 - .0253 + (.055)(.020)\left[\frac{11.664}{2} + 1.280 + 5.91 - 0.970\right]\right\}$$

4.19
5.89

.026
.075
5.832
5.813

$$= 376.7\left[-.0053 + .00110\,(12.05)\right]$$

12.01
.01325

.0137
−.0053
.0084

5.81
1.25
5.89
12.98
.97
12.01

5.832
1.28
5.91
13.022
.970
12.052

$$\frac{C_1}{\epsilon} = \frac{3.01}{2.98} = \frac{C_6}{\epsilon}$$

2.64

$$\frac{C_2}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\,h\,Y_A\left[N_{12} + N_{23} - \frac{J_{12}}{Y_A} - \frac{J_{23}}{Y_A}\right] = \frac{C_5}{\epsilon}$$

.075

$$= (376.7)(.055)(.02)\left[5.91 + 5.87 - .970 - .660\right]$$

5.89
4.19
5.85
10.15
4.13
10.14

$$\frac{C_2}{\epsilon} = \frac{4.19}{4.21} = \frac{C_5}{\epsilon}$$

3.78

5.89
5.85
11.74
1.63
10.11

.970
.660
1.630

$$\frac{C_3}{\epsilon} = \frac{C_4}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\,h\,Y_A\left[N_{23} + N_{34} - \frac{J_{23}}{Y_A} - \frac{J_{34}}{Y_A}\right]$$

.075
5.85
5.85
.621
4.13
4.12

$$= (376.7)(.055)(.02)\left[5.87 + 5.86 - .660 - .622\right]$$

.075
.565
10.45
10.42
6.97

5.91
5.87
11.78
−1.63
10.15

.660
.622
1.282

5.87
5.86
11.73
− 1.28
10.45

$$\frac{C_3}{\epsilon} = \frac{4.29}{4.33} = \frac{C_4}{\epsilon}$$

3.94

.660
.621
1.281

5.85
5.85
11.70
+.28
10.42

4.13
4.12
8.25
− 1.28
6.97

CONT. FROM p. 121 12/9/63

$$\frac{C_{01}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_2}}(M_1 - Y_A) = 376.7(.0253 - .020)$$

.006

0253
0200
.0053

$$\frac{C_{01}}{\epsilon} = \frac{2.00}{2.26} = \frac{C_{67}}{\epsilon}$$

$$\frac{C_{12}}{\epsilon} = \frac{376.2 h\, Y_A}{\sqrt{\epsilon_2}}\left(\frac{J_{12}}{Y_A}\right) = (376.7)(.075)(.055)(.02)(.970)$$

0.415
.414

$$\frac{C_{12}}{\epsilon} = \frac{C_{56}}{\epsilon} = 0.403 \quad .550 \quad .402$$

$$\frac{C_{23}}{\epsilon} = (0.415)\left(\frac{J_{23}}{Y_A}\right) = (0.415)(.660) = .274$$

$$\frac{C_{23}}{\epsilon} = \frac{C_{45}}{\epsilon} = 0.274 \quad .372 \quad .273$$

$$\frac{C_{34}}{\epsilon} = (0.415)(.622) = 0.258$$

$$\frac{C_{34}}{\epsilon} = 0.258 \quad .257 \quad .352$$

GETTING $S_{K,K+1}$ FROM GETSINGERS CHARTS.
(USING $t/b = .2$) $b = .308$

$\frac{C_{01}}{\epsilon} = 2.0$ $\frac{S_{01}}{5} = 0.16$, $S_{01} = .049$

$\frac{C_{12}}{\epsilon} = .403$ $\frac{S_{12}}{5} = 0.57$, $S_{12} = 0.176$

$\frac{C_{23}}{\epsilon} = .274$ $\frac{S_{23}}{5} = 0.69$, $S_{23} = 0.212$

$\frac{C_{34}}{\epsilon} = .258$ $\frac{S_{34}}{5} = 0.71$, $S_{34} = 0.218$

CONT. FROM p. 122 12/10/63

CONSIDER $\frac{t}{b} = .3$, $t = .0625$

$$b = \frac{.0625}{.3} = .208$$

THEN

$\frac{S_{01}}{b} = .195$ $.175$ $\quad S_{01} = .0405$ $.036$

$\frac{S_{12}}{b} = .635$ $.535$ $.630$ $\quad S_{12} = .137$ $.111$

$\frac{S_{23}}{b} = .750$ $.655$ $.670$ $\quad S_{23} = .156$ $.136$

$\frac{S_{34}}{b} = .770$ $\quad S_{34} = .160$ $.139$

NO IMPORTANT CHANGES.

GETTING $\frac{W_k}{b}$ FROM GETSINGER

$$\frac{W_k}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \frac{(C'_{fc})_{k-1,k}}{\epsilon} - \frac{(C'_{fc})_{k,k+1}}{\epsilon}\right]$$

FOR $k = 1$ TO 6

$\frac{1}{2}\left(1 - \frac{t}{b}\right) = \frac{1}{2}(.7) = .35$

$(C'_{fc})_{01} = .25$ $.23$

$(C'_{fc})_{12} = .62$ $.56$

$(C'_{fc})_{23} = .67$ $.62$

$(C'_{fc})_{34} = .68$ $.63$

$$\frac{W_1}{b} = .35\left[\frac{1}{2}\frac{C_1}{\epsilon} - \frac{(C'_{fc})_{01}}{\epsilon} - \frac{(C'_{fc})_{12}}{\epsilon}\right]$$

C_1/ϵ: 2.64, 3.01

$= .35\left[\frac{1}{2}(2.98) - .25 - .62\right]$ (.25 → .23; .62 → .56)

1.49

$\frac{W_1}{b} = .217$ $.224$ $.186$ $\quad W_1 = .045$ $.039$

(.35)(.62) 1.51 → .047

$$\frac{W_2}{b} = .35\left[\frac{1}{2}\frac{C_2}{\epsilon} - \frac{(C'_{fc})_{12}}{\epsilon} - \frac{(C'_{fc})_{23}}{\epsilon}\right]$$

C_2/ϵ: 3.78, 4.19

$= .35\left[\frac{1}{2}(4.21) - .62 - .67\right]$ (.62 → .56; .67 → .62)

2.10, 2.11

$\frac{W_2}{b} = .287$ $.283$ $.248$ $\quad W_2 = .0595 \approx .060$

(.35)(.82) .81 → .059 → .052

$$\frac{W_3}{b} = .35\left[\frac{1}{2}\frac{C_3}{\epsilon} - \frac{(C'_{fc})_{23}}{\epsilon} - \frac{(C'_{fc})_{34}}{\epsilon}\right]$$

C_3/ϵ: 4.29

$.35\left[\frac{1}{2}(4.33) - .67 - .68\right]$ (.67 → .62; .68 → .63)

216, 2.15

$\frac{W_3}{b} = .284$ $.280$ $.252$ $\quad W_3 = .059$

(.35)(.81) .80 → .058 → .052

$.35\left(1 - \frac{t}{b}\right) = (.35)(.7) = .245$

1.49 + .87 + .62

.62 + .67 + 1.29

2.11 + 1.29 + 0.82

2.16 + 1.35 + 81

67 + 68 + 1.35

CONT. FROM p. 123

12/10/63

APPLYING WIDTH CORRECTION TO $W_1 = .045$

$$\frac{w'}{b} = \frac{(.07)(1 - t/b) + w/b}{1.20} = \frac{(.07)(.7) + .224}{1.20}$$

$$\frac{w'}{b} = .222 \quad , \quad w' = .046$$

SUMMARY OF DIMENSIONS:

W_1 DIMENSIONS OF END COUPLING STUBS

W_2

W_3

$$\frac{w_0}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C_f'}{\epsilon} - \left(\frac{C_{fe}'}{\epsilon}\right)_{01}\right]$$

FOR $\frac{t}{b} = .3$, $\frac{C_f'}{\epsilon} = .8$

$$\therefore \frac{w_0}{b} = .35\left[\frac{1}{2}\,5.54 - .8 - .25\right]$$

$$\frac{w_0}{b} = .602 \quad , \quad w_0 = .125$$

SUMMARY OF DIMENSIONS

$w_0 = w_7 = .125$

$w_1 = w_6 = .046$

$w_2 = w_5 = .060$

$w_3 = w_4 = .059$

$s_{01} = .049$

$s_{02} = .176$

$s_{23} = .212$

$s_{34} = .218$

CALCULATE RESONATOR LENGTHS

$\ell_{5.4-5.4} = .464$,

$$\ell_{4.45-4.875} = \frac{5.650}{4.663} \times .464 =$$

$$1.211 \times .464 = .5619$$

12/15/64 COMB LINE DESIGN AT X-BAND

$f_1 = 8.5$ Kmc $f_2 = 9.6$ Kmc.

TRY 6 RESONATORS : $n = 6$

$$w = \frac{w_2 - w_1}{w_0} = \frac{9.6 - 8.5}{9.05} = \frac{1.1}{9.05} = .121 \simeq .12$$

FROM p. 109

SELECT $\Theta_0 = \frac{\lambda}{8}$ AT 9.05 Kmc.

$$l_0 = \frac{1}{8} \times \frac{3 \times 10^{10}}{(9.05 \times 10^9)(2.54)} = 0.163" \text{ IN AIR.}$$

SOLVING FOR $\left.\frac{b_j}{Y_A}\right|_{j=1 \text{ TO } n} = .870$ AGAIN SINCE $\Theta_0 = 45°$ WE SELECT $\frac{Y_{aj}}{Y_A} = .677$

FOR .1 db RIPPLE, $n = 6$, $g_0 = 1$ $w_1' = 1$

$g_1 = 1.1681$, $g_2 = 1.4039$, $g_3 = 2.0562$, $g_4 = 1.5170$

$g_5 = 1.9029$, $g_6 = 0.8618$, $g_7 = 1.3554$.

$$\frac{G_{T1}}{Y_A} = \frac{w \frac{b_1}{Y_A}}{g_0 g_1 w_1'} = \frac{(.12)(.870)}{(1.0)(1.168)} = .0893$$

$$\frac{J_{12}}{Y_A} = .12 \frac{(.870)}{\sqrt{(1.168)(1.404)}} = \frac{.1045}{\sqrt{1.64}} = \frac{.1045}{1.28}$$

$$\frac{J_{12}}{Y_A} = .0816$$

$$\frac{J_{23}}{Y_A} = \frac{.1045}{\sqrt{(1.404)(2.056)}} = \frac{.1045}{\sqrt{2.890}} = \frac{.1045}{1.7} = .0615$$

CONT. FROM p. 125

$$\frac{J_{34}}{Y_A} = \frac{.1045}{\sqrt{(2.056)(1.517)}} = \frac{.1045}{1.77} = .059$$

3.12

$$\frac{J_{45}}{Y_A} = \frac{.1045}{\sqrt{(1.517)(1.903)}} = \frac{.1045}{1.70} = .0615$$

2.88

BEING SYMMETRICAL

$$\frac{J_{56}}{Y_A} = .0816 \quad \left\{ \frac{G_{T6}}{Y_A} = \frac{G_{T1}}{Y_A} = .0893 \right.$$

AGAIN, FROM p. 110 $\frac{376.7\ Y_A}{\sqrt{E_2}} = 7.55$ FOR AIR

$$\frac{C_0}{\epsilon} = 7.55\left(1 - \sqrt{\frac{G_{T1}}{Y_A}}\right) = 7.55\left(1 - \sqrt{\frac{G_{TN}}{Y_A}}\right) = \frac{C_{n+1}}{\epsilon}$$

$$\sqrt{\frac{G_{T1}}{Y_A}} = \sqrt{.0893} = .284 \quad .299$$

1.000
.284
.716

1.000
.299
.701

$$\frac{C_0}{\epsilon} = \frac{C_7}{\epsilon} = (7.55)(.716) = 5.40 \quad .701 \quad 5.28$$

$$\frac{C_1}{\epsilon} = 7.55\left(.677 - J_1 + .089 - .0820\right) + 5.40 \quad .677 \quad .766 \quad 5.28$$

$$= -2.38 + 5.40$$

5.40 − 2.38 = 3.02 ; 5.28 − 2.88 = 2.90

$$\frac{C_1}{\epsilon} = \frac{C_6}{\epsilon} = 3.02 \quad 2.90$$

$$\frac{C_2}{\epsilon} = \frac{C_5}{\epsilon} = 7.55\left(.677 - \frac{J_{12}}{Y_A} - \frac{J_{23}}{Y_A}\right) = 7.55(.677 - .082 - .062)$$

$$\frac{C_2}{\epsilon} = \frac{C_5}{\epsilon} = 4.02$$

.677 − .144 = .533 ; .082 + .062 = .144

$$\frac{C_3}{\epsilon} = \frac{C_4}{\epsilon} = 7.55(.677 - .062 - .059)$$

$$= 4.20$$

.677 − .121 = .556 ; .059 + .062 = .121

$$\frac{C_{01}}{\epsilon} = \frac{376.7\, Y_A}{\sqrt{\epsilon_r}} - \frac{C_0}{\epsilon} = 7.55 - \text{5.40}\ \ 5.28$$

7.55 − 5.28 = 2.27 ; 7.55 − 5.40 = 2.15

$$\frac{C_{01}}{\epsilon} = \frac{C_{67}}{\epsilon} = \text{2.15}\ \ 2.27$$

$$\frac{C_{12}}{\epsilon} = 7.55\,(.082) = .620 = \frac{C_{56}}{\epsilon}$$

$$\frac{C_{23}}{\epsilon} = 7.55\,(.062) = .465 = \frac{C_{45}}{\epsilon}$$

$$\frac{C_{34}}{\epsilon} = 7.55\,(.059) = .445$$

For $C_j^s = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\text{cot}\,\theta_0}{\omega_0}$

$$\omega_0 = 2\pi f_0 = 2\pi\ 9.05 \times 10^9 = 56.8 \times 10^9$$

$$C_j^s = \frac{(.02)(.677)}{56.8 \times 10^9} = .238\ \text{pf.}$$

$\frac{(2)(\frac{1}{4})}{8} \times 10^{-3} \times 10^{-9} = .25 \times 10^{-12}$

From p. 113

$t = 1/16$, $b = 1/4$, $\frac{t}{b} = .25$

$\frac{C_{01}}{\epsilon} = \text{2.15}\ 2.27$	$\frac{S_{01}}{b} = \text{.165}\ .155$	$S_{01} = \text{.041}\ .039$	, $\left(\frac{C_{fe}'}{\epsilon}\right)_{01} = .20\ .19$	
$\frac{C_{12}}{\epsilon} = 0.620$	$\frac{S_{12}}{b} = .470$	$S_{12} = .119$	, $\left(\frac{C_{fe}'}{\epsilon}\right)_{12} = .48$	
$\frac{C_{23}}{\epsilon} = 0.465$	$\frac{S_{23}}{b} = .560$	$S_{23} = .140$	, $\left(\frac{C_{fe}'}{\epsilon}\right)_{23} = .54$	
$\frac{C_{34}}{\epsilon} = 0.445$	$\frac{S_{34}}{b} = .576$	$S_{34} = .144$	, $\left(\frac{C_{fe}'}{\epsilon}\right)_{34} = .55$	

1/16/64 CONT. FROM p. 127

CALCULATION OF WIDTHS FROM p. 114

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

$$\frac{C_f'}{\epsilon} = .745 \quad , \quad \frac{(C_{fc}')_{01}}{\epsilon} = .20 \text{ (.19)}$$

$$\frac{1}{2}\left(1-\frac{t}{b}\right) = \frac{1}{2}(.75) = .375$$

$$\frac{W_0}{b} = .375\left(\frac{5.40}{2} - .745 - .20\right)$$

5.28 / 2 = 2.64; 2.70

$$\frac{W_0}{b} = .637 \text{ (.656)} \quad , \quad W_0 = .159 \text{ (.164)} = W_7$$

$$\frac{W_k}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \frac{(C_{fc}')_{k-1,k}}{\epsilon} - \frac{(C_{fc}')_{k,k+1}}{\epsilon}\right]$$

$$\frac{W_1}{b} = .375\left(\frac{3.02}{2} - .20 \text{ (.19)} - .48\right)$$

2.90 / 2 = 1.45; 1.51

$$\frac{W_1}{b} = .0311 \text{ (.292)} \quad , \quad W_1 = .077 \text{ (.073)} = W_6$$

$$\frac{W_2}{b} = .375\left(\frac{4.02}{2} - .48 - .54\right)$$

2.01

$$\frac{W_2}{b} = .371 \quad , \quad W_2 = .093 = W_5$$

$$\frac{W_3}{b} = .375\left(\frac{4.20}{2} - .54 - .55\right)$$

2.10

$$\frac{W_3}{b} = .379 \quad , \quad W_3 = .095 = W_4$$

IN SUMMARY:

$$W_0 = W_7 = .159 \text{ (.164)}$$
$$W_1 = W_6 = .073 \text{ (.077)}$$
$$W_2 = W_5 = .093$$
$$W_3 = W_4 = .095$$

11/11/64

$t = .100$ $b = .250$ $\frac{t}{b} = .4$ $\frac{C_0'}{\epsilon} = .930$

$\frac{C_{01}}{\epsilon} = 2.27$ $\frac{S_{01}}{b} = .210$ $S_{01} = .052$ $\left(\frac{C_f'}{\epsilon}\right)_{01} = .31$

$\frac{C_{12}}{\epsilon} = .620$ $\frac{S_{12}}{b} = .550$ $S_{12} = .137$ $\left(\frac{C_f'}{\epsilon}\right)_{12} = .64$

$\frac{C_{23}}{\epsilon} = .465$ $\frac{S_{23}}{b} = .635$ $S_{23} = .159$ $\left(\frac{C_f'}{\epsilon}\right)_{23} = .70$

$\frac{C_{34}}{\epsilon} = .445$ $\frac{S_{34}}{b} = .65$ $S_{34} = .162$ $\left(\frac{C_f'}{\epsilon}\right)_{34} = .710$

$= .45 pf/in$

pf/in

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

$$\frac{1}{2}\left(1 - \frac{t}{b}\right) = \frac{1}{2}(.60) = .300$$

$$\frac{W_0}{b} = .3\left(\frac{5.2 pf}{2.70} - .930 - .31\right)$$

$\begin{array}{r} .930 \\ .310 \\ \hline 1.240 \end{array}$ $\begin{array}{r} 2.70 \\ -1.24 \\ \hline 1.46 \\ .3 \\ \hline .438 \end{array}$

$\frac{W_0}{b} = .438$ $\boxed{W_0 = .110 = W_7}$

$\frac{W_1}{b} = .3\left(\frac{2.9 pf}{1.45} - .31 - .64\right) = .150$

$\begin{array}{r} .31 \\ .64 \\ \hline .95 \end{array}$ $\begin{array}{r} 1.45 \\ -.95 \\ \hline .50 \\ .3 \\ \hline .150 \end{array}$

$pf/cm = .34 pf/in$

$.64 pf/in$

$\frac{W_1}{b} = .150$ $\boxed{W_{01} = .038 = W_6}$

$A = \frac{.12}{22.5(2.1)} = .0023$

$x = .034$ $W_1 = .073$

$x = \frac{\text{dimple}}{85 \times 10^{-3}} \cong .025$ in

1/16/64 CONT. FROM p. 127

CALCULATION OF WIDTHS FROM p. 114

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

$$\frac{C_f'}{\epsilon} = .745 \quad , \quad \frac{(C_{fc}')_{01}}{\epsilon} = .20$$

$$\frac{1}{2}\left(1-\frac{t}{b}\right) = \frac{1}{2}(.75) = .375$$

$$\frac{W_0}{b} = .375\left(\frac{5.40}{2} - .745 - .20\right)$$

$$\frac{W_0}{b} = .156 \quad , \quad W_0 = .164 = W_7$$

$$\frac{W_k}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \frac{(C_{fc}')_{k-1,k}}{\epsilon} - \frac{(C_{fc}')_{k,k+1}}{\epsilon}\right]$$

$$\frac{W_1}{b} = .375\left(\frac{3.02}{2} - .20 - .48\right)$$

$$\frac{W_1}{b} = .0311 \quad , \quad W_1 = .077 = W_6$$

$$\frac{W_2}{b} = .375\left(\frac{4.02}{2} - .48 - .54\right)$$

$$\frac{W_2}{b} = .371 \quad , \quad W_2 = .093 = W_5$$

$$\frac{W_3}{b} = .375\left(\frac{4.20}{2} - .54 - .55\right)$$

$$\frac{W_3}{b} = .379 \quad , \quad W_3 = .095 = W_4$$

In Summary:

$$\left\{\begin{array}{l} W_0 = W_7 = .164 \\ W_1 = W_6 = .077 \\ W_2 = W_5 = .093 \\ W_3 = W_4 = .095 \end{array}\right.$$

(cont. from p. 128)

$\frac{w_2}{b} = .3\left(\frac{4.02}{2.01} - .64 - .70\right) = .198$

$\frac{w_2}{b} = .198$ $\boxed{w_2 = .050 = w_5}$

$\frac{w_3}{b} = .3\left(\frac{4.20}{2.10} - .70 - .71\right) =$

$\frac{w_3}{b} = .207$ $\boxed{w_3 = .052 = w_4}$

$w_0 = w_7$ .110

$w_1 = w_6$ .038

$w_2 = w_5$ .050

$w_3 = w_4$ .052

.64
.70
1.34

2.01
−1.34
.66
.3
.198

.70
.71
1.41

2.10
−1.41
.69
.3
.207

= .45 pf/in

pf/in

pf/in = .34 pf/in

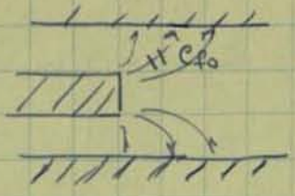
.64 pf/in

$A = \frac{\cdot}{(2.5)(2.1)} = .00$

$x = .034$ max, $W_1 = .073$

$85.\times 10^{-}$ 225

TO CALCULATE EFFECT OF FRINGING CAPACITY OF END OF RESONATORS:

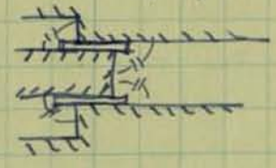


$\frac{C'_{f_0}}{\epsilon} = .745 \cong .75$

$\epsilon = 8.85 \times 10^{-12}$ FARADS/METER

$\therefore C'_{f_0} = 6.6 \times 10^{-12}$ FARADS/METER $= 6.6$ pf./M.

FOR .005" TEFLON SPACER



$\frac{t}{b} = \frac{.0625}{.0725} = .86$

$\frac{C'_{f_0}}{\epsilon} \cong 2.0$, $C'_{f_0} = 17.7 \times 10^{-12}$ f./m. $= .177$ pf/cm. $= .45$ pf/in

IN TEFLON $\frac{n}{2}$ .75pf./in FOUR CAPACITORS 3.0 pf./in

FOR n=1 $(3.0)(.077) = .25$ pf. .13 pf

n=2 $(3.0)(.093) = .28$ pf. .14 pf.

n=3 $(3.0)(.095) = .28$ pf. .14 pf.

TRY .010 SPACERS OR .020

$\frac{t}{b} = \frac{.0625}{.0825} = .76$, $\frac{C_{f_0}}{\epsilon} \cong 1.5$, $C_{f_0} = .133$ pf/cm. $= .34$ pf/in

$2 C_{f_0} = .64$ pf/in

p. 115

$C' = .72 \times \frac{3}{10}$ net

$\cong .24$ pf APPEARS TO BE ABOUT 0.1 pf.

TRY C = 0.1 PARALLEL PLATE CAPACITY

FROM p. 115 $\frac{A}{t} = \frac{(.1)}{(.225)(2.1)} .01 = 2.12 \times 10^{-3}$

USE .085 AS AVE. WIDTH. $\therefore .085 = 2.12 \times 10^{-3}$

$x = \frac{2.12 \times 10^{-3}}{85 \times 10^{-3}} \cong .025$

C = .12 pf.

$A = \frac{.12}{22.5(2.1)} = .0025$, $t = .010$

$x = .034$ USE $W_1 = .073$

CONT. FROM p. ~~129~~ 109 1/27/64

LET $f_1 = \frac{2.1}{3} = 9$ kmc , $f_2 = \frac{3.3}{3} = 1.1$ kmc.

$f_0 = 1.0$ kmc. , $w_0 = 6.28 \times 10^9$

IN THIS CASE EVERYTHING STAYS THE SAME

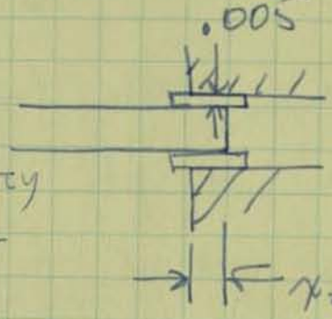
EXCEPT: $C_j^s\Big|_{\text{NEW TOT}} = Y_A \left(\frac{Y_{Aj}}{Y_A}\right) \frac{\omega_0}{w_0}$

$C_j^s = (.02)(.677)\frac{1}{6.28\times10^9} = \frac{(2)(6.77)}{6.28}$ pf.

$\boxed{C_j^s = 2.16 \text{ pf.}}$

AND $\frac{\lambda_0}{8} = \frac{1}{8}\frac{3\times10^{10}}{1\times10^9}\frac{1}{2.54} = 1.48"$

at 1kmc



SINCE THIS IS 3X CAPACITY USED ON p. 115

AND WE WOUND UP WITH ABOUT $x_1 = .035$ ~~.040~~

TRY $x_2 = .125$ ~~.125~~ ≈ .110

COMB LINE FOR 1720 mc TO 1800 mc. SOURCE

1/29/64

$f_0 = 1760$ mc.

1720
1800
2 | 3520
1760

TRY 10% BANDWIDTH

$.1 = \frac{\Delta f}{1760}$, $\Delta f = 176$ mc, $\frac{\Delta f}{2} = 88$ mc.

1760
+ 88
1848

1760
− 88
1672

$f_1 = 1672$ mc, $f_2 = 1848$ mc

$W = 0.1$, $\omega_0 = 1.76 \times 10^9$ 2π

$\omega_0 = 11.1 \times 10^9$

LET $\Theta_0 = 45°$ $\frac{Y_{aj}}{Y_A} = .677$

IN THIS CASE: $\frac{b_j}{Y_A} = .870$

$C_j^s = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\cot \Theta_0}{\omega_0} = \frac{(.02)(.677)}{11.1 \times 10^9} = \frac{(2)(6.77)}{11.1}$ pf.

$C_j^s = 1.22$ pf

IF $\Theta_0 = 30°$, $\cot 30° = \frac{1.732}{1}$

$C_j^s = \frac{(.02)(.677)}{11.1} 1.732 = 2.11$ pf.

THEN $\frac{b_j}{Y_A} = .677 \left(\frac{1.732 + \frac{\pi}{6} \cdot 4}{2} \right)$

6.28/3 = 2.09
1.73
3.82

$\frac{b_j}{Y_A} = (.677)(1.91) = 1.29$

LET n=4 .1 db Ripple.
1.1088, 1.3061, 1.7703, 0.8180, 1.3554

$\frac{G_{T'}}{Y_A} = \frac{W \frac{b_1}{Y_A}}{g_0 g_1 \omega_1'} = \frac{(.1)(1.29)}{1.109} = 0.116$

$\frac{J_{12}}{Y_A} = (.1) \frac{(1.29)}{\sqrt{(1.109)(1.306)}} = \frac{.129}{\sqrt{1.45}} = \frac{.129}{1.205} = .107$

CONT. FROM p. 131 1/29/64

$$\frac{C_0}{\epsilon} = 7.53\left(1 - \sqrt{.116}\right) = 7.53\,(.659)$$

1.0000
.341
.659

$$\frac{C_0}{\epsilon} = 4.97$$

$$\frac{C_1}{\epsilon} = 7.53\left[.677 - 1 + .116 - (.107)\cdot\left(\frac{1}{1.732}\right)\right] + \frac{C_0}{\epsilon}$$

.0618

.677
.116
.793

$$= -2.02 + 4.97$$

4.97
2.02
2.95

$$\boxed{\frac{C_1}{\epsilon} = 2.95}$$

−1.062
.793
−.269

$$\frac{C_{01}}{\epsilon} = 7.53 - 4.97$$

7.53
4.97
2.56

$$\boxed{\frac{C_{01}}{\epsilon} = 2.56}$$

USING $b = .25$, $t = \frac{1}{16}$, $t/b = .25$

$\therefore$ $\frac{S_{01}}{b} = .140$, $\boxed{S_{01} = .035}$, $\left.\frac{C_{fc}}{\epsilon}\right|_{01} = .175$

$$\frac{C_{12}}{\epsilon} = 7.53\left(.107 \cdot \frac{1}{1.732}\right) = (7.53)(.062) = .467$$

$\frac{S_{12}}{b} = .555$, $\boxed{S_{12} = .139}$ $\left.\frac{C_{fc}}{\epsilon}\right|_{12} = .540$

$$\frac{W_1}{b} = .375\left[\frac{1}{2}\cdot 2.95 - .175 - .540\right]$$

1.475

.540
.175
.715

$$\frac{W_1}{b} = (.375)(.760) = .285$$

1.475
−.715
.760

$$\boxed{W_1 = .071}$$

$$\frac{J_{23}}{Y_A} = \frac{(.1)(1.29)}{\sqrt{(1.306)(1.770)}} = \frac{.129}{\sqrt{2.31}} = \frac{.129}{1.52}$$

$$\frac{J_{23}}{Y_A} = .085$$

$$\frac{C_2}{\epsilon} = 7.53\left(.677 - .107/1.732 - .085/1.732\right)$$

$$= 7.53\,(.677 - .062 - .049) = (7.53)(.566)$$

$$\frac{C_2}{\epsilon} = 4.26$$

$$\frac{C_{23}}{\epsilon} = 7.53\left(\frac{.085}{1.732}\right) = (7.53)(.049) = .369$$

$$\frac{C_{23}}{\epsilon} = 0.369$$

$$\frac{S_{23}}{b} = .63, \quad \boxed{S_{23} = .158} \qquad \left.\frac{C_{1e}'}{\epsilon}\right|_{23} = .570$$

$$\frac{W_2}{b} = .375\left[\frac{1}{2}\cdot\overset{2.13}{4.26} - .540 - .570\right] = (.375)(1.02)$$

$$\frac{W_2}{b} = .382, \quad \boxed{W_2 = .095}$$

$$\frac{W_0}{b} = .375\left[\frac{1}{2}\cdot\overset{2.49}{4.97} - .745 - .175\right]$$

$$\frac{W_0}{b} = .588, \quad \boxed{W_0 = .147}$$

$W_0 = W_5 = .147$
$S_{01} = .035$
$W_1 = W_4 = .071$
$S_{12} = .139$
$W_2 = W_3 = .095$
$S_{23} = .158$

$$l = \frac{1}{12}\,\frac{3\times10^{10}}{1.76\times10^{9}\,2.54}$$

$$l = .56$$

.062
.049
.111

.677
−.111
.566

.570
.540
1.110

2.13
−1.11
1.02

.745
.175
.920

2.49
−.92
1.57

CONT. FROM p. 133. 1/29/64

TO CALCULATE END CAPACITY LOADING:

$C_j^s = 2.11$ pf.

ASSUME. WIDTH OF .060

FROM p. 115 $\alpha = .058$ FOR $C = .72$ pf.

IN THIS CASE TRY $\alpha = .140$ FOR $C = 2.11$ pf.

$f_1 = 4350$ mc $\quad f_2 = 5050$ mc

X-BAND WAVEGUIDE IMPEDANCE AT

OUTPUT FREQ. OF 8.5 - 9.6 Kmc (AT 9.0 Kmc)

$$Z_0 = 377 \frac{\lambda_g}{\lambda} \frac{\pi}{2} \frac{b}{a} \qquad \frac{\lambda_g}{\lambda} = 1.46$$

FOR RG 52/U WAVEGUIDE

$$Z_0 = (377)(1.46) \frac{\pi}{2} \frac{.4}{.9} = 384\ \Omega.$$

IF WE SELECT $Z_0 = 200\ \Omega$. { FIND b

$$b = \frac{Z_0}{377} \frac{\lambda}{\lambda_g} \frac{2}{\pi} a$$

$$b = (200) \frac{1}{1.46} \frac{2}{\pi} .9 = .208$$

2/27/64 CONSIDER 2.7-3.2 KMC OUTPUT WITH 6 RESONATORS.

FOR .1 db RIPPLE $g_0 = 1$, $w_1' = 1$

1.1681, 1.4039, 2.0562, 1.5170, 1.9029, 0.8618, 1.3554.

TRY $\Theta_0 = 30°$ $\cot 30° = 1.732$

$f_1 = 2.7$ kmc
$f_2 = 3.2$ kmc

$2\overline{)5.9}$ 2.95

TO FIND LOSS AT 3.375 kmc.

$$W = \frac{w_2 - w_1}{w_0} = \frac{.500}{2.95} = .169$$

$$\frac{w'}{w_1'} = \frac{2}{W}\left(\frac{w - w_0}{w_0}\right) = \frac{2}{.169}\left(\frac{3.375 - 2.950}{2.950}\right)$$

3.375
2.950
425

$$\frac{w'}{w_1'} = (11.8)\left(\frac{.425}{2.950}\right) = 1.7$$

$$\left|\frac{w'}{w_1'}\right| - 1 = .7$$

FOR 6 RESONATORS $L_A = 36$ db

NEED $n = 9$ FOR 65 db
OR $n = 8$ FOR 56 db.

1.1897, 1.4346, 2.1199, 1.6010, 2.1699, 1.5640, 1.9444, .8718
1.3554

TRY $\Theta_0 = 30°$, $\frac{Y_{ai}}{Y_A} = .677$, $Y_A = .02$

$$\frac{b_i}{Y_A} = .677\left(\frac{\cot 30° + .523 \csc^2 30°}{2}\right)$$

$$\frac{b_i}{Y_A} = (.677)\left[\frac{1.732 + (.523)(4)}{2}\right]$$

2.092
1.73^2
$2\overline{)3.824}$
1.912

$$= (.677)(1.912) = 1.295$$

$$\frac{G_{T1}}{Y_A} = \frac{W\frac{b_1}{Y_A}}{g_0 g_1 w_1'} = \frac{(.169)(1.295)}{1.1897} = 0.184$$

CONT. FROM p. 135

$$\frac{J_{12}}{Y_A} = \frac{(.169)(1.295)}{\sqrt{(1.19)(1.435)}} = \frac{.219}{\sqrt{1.71}} = \frac{.219}{1.31}$$

$$\boxed{J_{12}/Y_A = .167} = J_{78}/Y_A$$

$$J_{23} = \frac{.219}{\sqrt{(1.435)(2.12)}} = \frac{.219}{\sqrt{3.04}} = \frac{.219}{1.745}$$

$$\boxed{J_{23}/Y_A = .126} = J_{67}/Y_A$$

$$J_{34} = \frac{.219}{\sqrt{(2.12)(1.601)}} = \frac{.219}{\sqrt{3.40}} = \frac{.219}{1.845}$$

$$\boxed{J_{34}/Y_A = .119} = J_{56}/Y_A$$

$$J_{45} = \frac{.219}{\sqrt{(1.601)(2.17)}} = \frac{.219}{\sqrt{3.47}} = \frac{.219}{1.865}$$

$$\boxed{J_{45}/Y_A = .117}$$

$$\frac{C_0}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} Y_A \left(1 - \sqrt{\frac{G_{TI}}{Y_A}}\right)$$

$$= 7.53\left(1 - \sqrt{.184}\right) = (7.53)(.57)$$

$$\begin{array}{r} 1.00 \\ .43 \\ \hline .57 \end{array}$$

$$\begin{array}{r} .184 \\ +.677 \\ \hline 1.861 \\ -1.096 \\ \hline .861 \\ \hline -.235 \end{array}$$

$$\frac{C_0}{\epsilon} = 4.30 = \frac{C_9}{\epsilon}$$

$$\frac{C_1}{\epsilon} = 7.53\left[.677 - 1 + .184 - (.167)\frac{1}{1.732}\right] + 4.30$$

.096

$$= -1.73 + 4.30$$

$$\boxed{C_1/\epsilon = 2.57} = C_8/\epsilon$$

$$\begin{array}{r} 4.30 \\ 1.73 \\ \hline 2.57 \end{array}$$

$$\frac{C_2}{\epsilon} = 7.53\left[.677 - .167\frac{1}{1.732} - .126\frac{1}{1.732}\right]$$

$$= (7.53)(.508)$$

$$\boxed{\frac{C_2}{\epsilon} = 3.83} = \frac{C_7}{\epsilon}$$

$$\frac{C_3}{\epsilon} = 7.53\left[.677 - .073 - \frac{.119}{1.732}\right]$$

$$\frac{C_3}{\epsilon} = (7.53)(.535)$$

$$\boxed{\frac{C_3}{\epsilon} = 4.03} = \frac{C_6}{\epsilon}$$

$$\frac{C_4}{\epsilon} = 7.53\left[.677 - .069 - \frac{.117}{1.732}\right]$$

$$\frac{C_4}{\epsilon} = (7.53)(.540)$$

$$\boxed{\frac{C_4}{\epsilon} = 4.07} = \frac{C_5}{\epsilon}$$

$$\frac{C_{01}}{\epsilon} = 7.53 - 4.30$$

$$\boxed{\frac{C_{01}}{\epsilon} = \frac{C_{09}}{\epsilon} = 3.23}$$

$$\frac{C_{12}}{\epsilon} = 7.53\left(\frac{.096}{.167}{}^{.096}\,\frac{.167}{1.732}\right) = .723$$

$$\frac{C_{23}}{\epsilon} = 7.53\left(\frac{.073}{.126}{}^{.073}\,\frac{.126}{1.732}\right) = .550$$

$$\frac{C_{34}}{\epsilon} = 7.53\left(\frac{.069}{.119}{}^{.069}\,\frac{.119}{1.732}\right) = .520$$

$$\frac{C_{45}}{\epsilon} = 7.53\left(\frac{.068}{.117}{}^{.068}\,\frac{.117}{1.732}\right) = .512$$

.096
.073
.169

.677
− .169
.508

.073
.069
.142

.677
− .142
.535

068
069
.137

.677
− .137
.540

7.53
4.30
3.23

3/3/64 CONT. FROM p. 137

$f_0 = 2.95$ Kc., $\omega_0 = 2\pi f_0$

$= 18.5 \times 10^9 = 1.85 \times 10^{10}$

$$C_j^s = Y_A \left(\frac{Y_{air}}{Y_A}\right) \frac{\omega_1 \Theta_0}{\omega_0} = (.02)(.677)\frac{(1.732)}{1.85 \times 10^{10}}$$

$$\boxed{C_j^s = 1.27\ pf_0}$$

(.02)(.7)(t)

t

$.014 \times 10^{-10}$

1.4×10^{-12}

AGAIN USING $b = .25$ $\{ t = \frac{1}{16}$

$$\frac{t}{b} = .25$$

FORMULA FOR STRIP WIDTHS, CONTAINS

$$\frac{1}{2}\left(1 - \frac{t}{b}\right) = .375 \quad \& \quad \frac{C_f'}{\epsilon} = .745$$

$\frac{C_{01}}{\epsilon} = 3.23$, $\frac{S_{01}}{\Theta} = .105$, $\left(\frac{C'_{fc}}{\epsilon}\right)_{01} = .135$

$\frac{C_{12}}{\epsilon} = .723$, $\frac{S_{12}}{\Theta} = .430$, $\left(\frac{C'_{fc}}{\epsilon}\right)_{12} = .460$

$\frac{C_{23}}{\epsilon} = .550$, $\frac{S_{23}}{\Theta} = .510$, $\left(\frac{C'_{fc}}{\epsilon}\right)_{23} = .510$

$\frac{C_{34}}{\epsilon} = .520$, $\frac{S_{34}}{\Theta} = .525$, $\left(\frac{C'_{fc}}{\epsilon}\right)_{34} = .520$

$\frac{C_{45}}{\epsilon} = .512$, $\frac{S_{45}}{\Theta} = .530$, $\left(\frac{C'_{fc}}{\epsilon}\right)_{45} = .520$

$\omega_0/b = .476$

$\omega_1/b = .259$

$\omega_2/b = .365$

$\omega_3/b = .369$

$\omega_4/b = .373$

$$\frac{\omega_0}{b} = .375\left[\frac{1}{2}(4.30) - .745 - .135\right]$$

2.15

$= (.375)(1.27) = .476$

$.745 + .135 = .880$

$2.150 + .880 = 1.270$

$$\frac{\omega_1}{b} = .375\left[\frac{1}{2}(2.57) - .135 - .460\right]$$

1.285

$= (.375)(.690) = .259$

$1.285 + .595 = .690$

$.135 + .460 = .595$

$$\frac{\omega_2}{b} = .375\left[\frac{1}{2}(3.83) - .460 - .510\right]$$

1.915

$= (.375)(945) = .365$

$1.915 + .970 = .945$

$.460 + .510 = .970$

$$\frac{w_3}{b} = .375\left[\frac{1}{2}(4.03) - .510 - .520\right]$$

2.015

$$= (.375)(.985) = .369$$

2.015 − 1.030 = .985

.510 + .520 = 1.030

$$\frac{w_4}{b} = .375\left[\frac{1}{2}(4.07) - .520 - .520\right]$$

2.035

$$(.375)(.995) = .373$$

2.035 − 1.040 = .995

TABULATING:

$S_{01} = S_{89} = .0262 \doteq .026$, $w_0 = w_9 = .119$

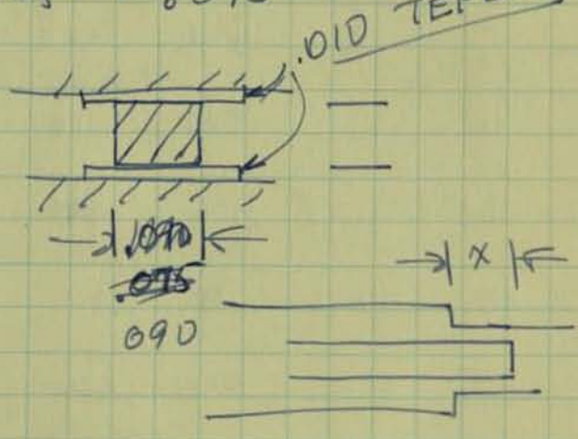
$S_{02} = S_{78} = .1075 \doteq .108$, $w_1 = w_8 = .065$

$S_{23} = S_{67} = .1275 \doteq .128$, $w_2 = w_7 = .091$

$S_{34} = S_{56} = .131 \doteq .131$, $w_3 = w_6 = .092$

$S_{45} = .1325 \doteq .133$, $w_4 = w_5 = .093$

FOR END CAPACITY:



$$\frac{1}{2}C = \frac{.225\,\varepsilon_r A}{.010}$$

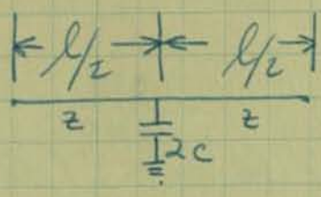
$$A = \frac{(.010)(1.27/2)}{(.225)(2.1)} = .0269 \text{ in}^2$$

$$X(.090) = \frac{.0269}{2}, \quad X = \frac{.0269/2}{.090} = .1494 \quad 0.3/2 = .150$$

LET $X \doteq .125$

$$l_0 = \frac{1}{12}\,\frac{3\times10^{10}}{2.95\times10^{9}\ 2.54} = .332$$

140 3/26/64 INPUT LOW PASS FILTER FOR X-BAND SOURCE.



$$Z_I = \pm\sqrt{\frac{B}{C}} = \pm Z\sqrt{\frac{1 - m\phi\tan\phi/2}{1 + m\phi\cot\phi/2}}$$

Try $f_1 = 5.0$ kc. $f_2 = 20.0$ kc. $\cap$ $180° = \phi_2$

$\therefore f_1 \cap \phi_1 = 45°$, 4.5 kc $\cap \phi_{4.5} = 40.5°$

SINCE $A = \cos\phi - m\phi \sin\phi$

AT CUTOFF $-1 = \cos 45° - m\frac{\pi}{4}\sin 45°$

$-1 = .707 - m\frac{\pi}{4}(.707)$

$m = \frac{(1.707)4}{.707\pi}$, $\boxed{m = 3.07}$

FOR THIS CASE: $\frac{Z_I}{Z} = \sqrt{\frac{1 - 3.07\phi\tan\phi/2}{1 + 3.07\phi\cot\phi/2}}$

.01745 rad = 1°

f(kc)	$\phi°$	$\frac{\phi}{2}°$	ϕ rad.	$\tan\frac{\phi}{2}$	$\cot\frac{\phi}{2}$	X $3.07\phi\tan\frac{\phi}{2}$	Y $3.07\phi\cot\phi/2$	$1-X$	$1+Y$	$\frac{1-X}{1+Y}$	$\sqrt{\frac{1-X}{1+Y}}$
3.34	30°	15	.524	.268	3.732	.432	6.00	.568	7.00	.081	.28
4.5	40.5°	20.25	.706	.369	2.710	.800	5.88	.200	6.88	.029	.17
6.0	45°	22.50	.785	.414	2.414	1.000	5.82	0	6.82	0	0
5.55	50°	25.0	.872	.466	2.145	1.250	5.75	-.250	6.75	-.037	j.19
6.67	60°	30.0	1.050	.577	1.732	1.860	5.59	-.860	6.59	-.130	j.36
9.00	81°	40.5	1.415	.854	1.171	3.71	5.10	-2.71	6.10	-.444	j.67
10.00	90°	45.	1.570	1.000	1.000	4.82	4.82	-3.82	5.82	-.655	j.81
13.500	121.5°	60.75	2.120	1.785	.560	11.60	3.64	-10.60	4.64	-2.28	j1.51
18.00	162.0°	81.00	2.825	6.314	.158	54.80	1.37	-53.8	2.37	-22.7	j4.77

f (kmc)	ϕ°	$Z_1 \neq 67\Omega$	Rot. $\phi/2$
3.34	30	18.8	
		11.4	
4.50	40.5	~~15.0~~	
5.00	45	0	
5.55	50	j 12.7	
6.67	60	j 24.1	
9.00	81	j 45.0	
10.00	90	j 54.2	
13.50	121.5	j 101.0	
18.00	162.0	j 319.0	

FOR MATCHING 11.4Ω AT 4.5 kmc TO 50Ω.

TRY 1 STEP TRANSFORMER Z_m

$$Z_m = \sqrt{(11.4)(50)} = 5\sqrt{22.8} = (5)(4.78)$$

$$Z_m = 23.9\ \Omega.$$

IN AIR $\frac{23.9}{188} = .173 = \log \frac{D}{d}$

$$\frac{D}{d} = 1.485, \quad d = \frac{.25}{1.485} = .169$$

142 4/1/64 5% BANDWIDTH C BAND FILTER

$f_1 = 5.830$ Kmc. $f_2 = 6.220$ Kmc

$f_0 = 6.025$ Kmc

6.220
5.830
2 | 12.050
6.025

TRY $n = 7$ RESONATORS

$W = \frac{.390}{6.025} = .065$

6.220
5.830
.390

WITH $g_0 = 1$, $w_1' = 1$

$g_1 = 1.1811$, $g_2 = 1.4228$, $g_3 = 2.0966$, $g_4 = 1.5733$, $g_5 = 2.0966$, $g_6 = 1.4228$

$g_7 = 1.1811$, $g_8 = 1.0000$.

$\theta_1 = \frac{\pi}{2}\left(1 - \frac{W}{2}\right) = (1.57)(.9676)$

1.0000
.0324
.9676

$\theta_1 = 1.52$ RAD.

$$\frac{J_{01}}{Y_A} = \frac{1}{\sqrt{g_0 g_1 w_1'}} = \frac{1}{\sqrt{1 \cdot 1.1811}} = \frac{1}{1.09} = .918$$

ALSO $\frac{J_{78}}{Y_A} = .918$

$$\frac{J_{12}}{Y_A} = \frac{J_{67}}{Y_A} = \frac{1}{\sqrt{(1.1811)(1.4228)}} = \frac{1}{\sqrt{1.68}} = .770$$

$$\frac{J_{23}}{Y_A} = \frac{J_{56}}{Y_A} = \frac{1}{\sqrt{(1.4228)(2.0966)}} = \frac{1}{\sqrt{2.98}} = .578$$

$$\frac{J_{34}}{Y_A} = \frac{J_{45}}{Y_A} = \frac{1}{\sqrt{(2.0966)(1.5733)}} = \frac{1}{\sqrt{3.30}} = .550$$

$\left(\frac{J_{01}}{Y_A}\right)^2 = .842$ $\left(\frac{J_{02}}{Y_A}\right)^2 = .593$ $\left(\frac{J_{23}}{Y_A}\right)^2 = .334$ $\left(\frac{J_{34}}{Y_A}\right)^2 = .302$

$\theta_1 = 1.52$ $\frac{180}{\pi} = 87^\circ$, $\tan\theta_1 = 19.08$

$\frac{\tan^2\theta_1}{4} = 91.0$ $\frac{\tan\theta_1}{2} = 9.54$

4/2/64 CONT. FROM p. 142

$$N_{12} = \sqrt{\left(\frac{J_{12}}{Y_A}\right)^2 + \frac{\tan^2\theta}{4}} = \sqrt{\frac{.170}{.593} + 91.0}$$

$N_{12} = 9.57 = N_{67}$

$$N_{23} = \sqrt{\left(\frac{J_{23}}{Y_A}\right)^2 + \frac{\tan^2\theta}{4}} = \sqrt{.334 + 91}$$

$N_{23} = 9.56$, $N_{34} = 9.56$

$N_{56} =$ $N_{45} =$

CALCULATE h FROM p. 120

$$h = \frac{5.4}{\frac{376.7}{\sqrt{\epsilon_r}} Y_A \left[\frac{J_{23}}{Y_A} + \frac{J_{32}}{Y_A} + N_{23} + N_{34}\right]}$$

$$h = \frac{5.4}{7.53(.578 + .550 + 9.56 + 9.56)}$$

9.56
2
19.12
.58
.55
20.25

$$h = \frac{5.4}{(7.53)(20.25)} = .0354$$

$h \approx .035$ $\sqrt{h} = .187$

$$M_1 = M_7 = Y_A \left[\frac{J_{01}}{Y_A}\sqrt{h} + 1\right] = .02\left[(.918)(.187) + 1\right]$$

.172

$= (.02)(1.172)$

$M_1 = M_7 = .0234$

$$\frac{C_0}{\epsilon} = \frac{C_8}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left[2Y_A - M_1\right] = 376.7\left[.04 - .0234\right]$$

.0400
.0234
.0166

$$\boxed{\frac{C_0}{\epsilon} = 6.25}$$

$$\frac{C_1}{\epsilon} = \frac{C_7}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left\{ Y_A - M_1 + h Y_A \left[\frac{\tan\theta_1}{2} + \left(\frac{J_{01}}{Y_A}\right)^2 + N_{1,2} - \frac{J_{1,2}}{Y_A} \right] \right\}$$

$$= 376.7\left\{ .02 - .0234 + (.035)(.02)\left[9.54 + .842 + 9.57 - .770 \right] \right\}$$

$$= 376.7\left[-.0034 + (.0007)(19.18) \right]$$

$$.0127$$

$$\frac{C_1}{\epsilon} = (376.7)(.0093)$$

$$.0127 - .0034 = .0093$$

$$9.54 + .84 + 9.57 = 19.95$$

$$19.95 - 0.77 = 19.18$$

$$\boxed{\frac{C_1}{\epsilon} = \frac{C_7}{\epsilon} = 3.50}$$

$$\frac{C_2}{\epsilon} - \frac{C_6}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}} h Y_A \left[N_{1,2} + N_{2,3} - \frac{J_{1,2}}{Y_A} - \frac{J_{2,3}}{Y_A} \right]$$

$$\frac{376.7}{\sqrt{\epsilon_r}} h Y_A = (376.7)(.035)(.02) = 0.264$$

$$\frac{C_2}{\epsilon} = 0.264\left(9.57 + 9.56 - .770 - .58 \right)$$

$$17.78$$

$$.77 + .58 = 1.35$$

$$9.57 + 9.56 = 19.13$$

$$19.13 - 1.35 = 17.78$$

$$\boxed{\frac{C_2}{\epsilon} = 4.70 = \frac{C_6}{\epsilon}}$$

$$\frac{C_3}{\epsilon} = \frac{C_5}{\epsilon} = (0.264)\left[N_{2,3} + N_{3,4} - \frac{J_{2,3}}{Y_A} - \frac{J_{3,4}}{Y_A} \right]$$

$$= (.264)\left(9.56 + 9.56 - .58 - .55 \right)$$

$$\frac{9.56}{2}$$

$$19.12 - 1.13 = 17.99$$

$$\boxed{\frac{C_3}{\epsilon} = \frac{C_5}{\epsilon} = 4.75}$$

$$\frac{C_4}{\epsilon} = .264\left[N_{3,4} + N_{4,5} - \frac{J_{3,4}}{Y_A} - \frac{J_{4,5}}{Y_A} \right]$$

$$= .264\left(9.56 + 9.56 - .550 - .550 \right)$$

$$19.12 - 1.10 = 18.02$$

$$\boxed{\frac{C_4}{\epsilon} = 4.75}$$

$$\frac{C_{01}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\left[H_1 - Y_A\right] = 376.7\,(.0234 - .02)$$

.0034

$$\boxed{\frac{C_{01}}{\epsilon} = \frac{C_{78}}{\epsilon} = 1.28}$$

$\frac{S_{01}}{b}$

$$\frac{C_{12}}{\epsilon} = \frac{C_{67}}{\epsilon} = \frac{376.7}{\sqrt{\epsilon_r}}\, Y_A \left(\frac{J_{12}}{\epsilon}\right)$$

$$= (.264)(.770)$$

$$\boxed{\frac{C_{12}}{\epsilon} = \frac{C_{67}}{\epsilon} = .203}$$

$$\frac{C_{23}}{\epsilon} = \frac{C_{56}}{\epsilon} = (.264)\left(\frac{J_{23}}{\epsilon}\right) = (.264)(.580)$$

$$\boxed{\frac{C_{23}}{\epsilon} = \frac{C_{56}}{\epsilon} = .153}$$

$$\frac{C_{34}}{\epsilon} = \frac{C_{45}}{\epsilon} = (.264)\left(\frac{J_{34}}{\epsilon}\right) = (.264)(.550)$$

$$\boxed{\frac{C_{34}}{\epsilon} = \frac{C_{45}}{\epsilon} = .145}$$

USING $\frac{t}{b} = .25$, $t = \frac{1}{16}$, $b = \frac{1}{4}$ $\Big\}$ $\frac{1}{2}\left(1 - \frac{t}{b}\right) = .375$

$\frac{C'_f}{\epsilon} = .745$

$\frac{S_{01}}{b} = .28$, $S_{01} = .070$, $\left(\frac{C'_{fe}}{\epsilon}\right)_{01} = .325$

$\frac{S_{12}}{b} = .815$, $S_{12} = .204$ $\left(\frac{C'_{fe}}{\epsilon}\right)_{12} = .640$

$\frac{S_{23}}{b} = .910$, $S_{23} = .227$ $\left(\frac{C'_{fe}}{\epsilon}\right)_{23} = .660$

$\frac{S_{34}}{b} = .925$, $S_{34} = .231$ $\left(\frac{C'_{fo}}{\epsilon}\right)_{34} = .660$

$$\frac{w_0}{b} = \frac{w_8}{b} = \frac{1}{2}\left(1 - \frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_0}{\epsilon}\right) - \frac{C'_f}{\epsilon} - \left(\frac{C'_{fe}}{\epsilon}\right)_{01}\right] = (.375)\left[\frac{6.25}{2} - .745 - .325\right]$$

$$3.125 - 1.070 = 2.055 \qquad .745 + .325 = 1.070$$

$$\frac{w_0}{b} = \frac{w_8}{b} = 0.770, \qquad w_0 = w_8 = 0.192$$

4/6/64 Cont. From p. 145

$$\frac{W_k}{b} = \frac{1}{2}\left(1-\frac{t}{b}\right)\left[\frac{1}{2}\left(\frac{C_k}{\epsilon}\right) - \frac{(C_{fc}')_{k-1,k}}{\epsilon} - \frac{(C_{fc}')_{k,k+1}}{\epsilon}\right]$$

C_1/ϵ $(C_{fc}')_{0,1}$ $(C_{fc}')_{12}$

$$\frac{W_1}{b} = .375\left[\frac{3.50}{2} - .325 - .640\right], \quad \frac{3.50}{2} = 1.75$$

$1.750 - .965 = .785$ $\quad .640 + .325 = .965$

$$\frac{W_1}{b} = .294, \quad W_1 = .076$$

~~.656~~ ~~.164~~

$$\frac{W_2}{b} = .315\left[\frac{4.70}{2} - .640 - .660\right], \quad \frac{4.70}{2} = 2.35$$

$2.35 - 1.30 = 1.05$ $\quad .660 + .640 = 1.300$

$$\frac{W_2}{b} = .394, \quad W_2 = .098$$

$$\frac{W_3}{b} = .375\left[\frac{4.75}{2} - .660 - .660\right], \quad \frac{4.75}{2} = 2.37$$

~~2.35~~

$2.37 - 1.32 = 1.05$ $\quad \frac{.660}{2} + 1.320$

$$\frac{W_3}{b} = .386, \quad W_3 = .098$$

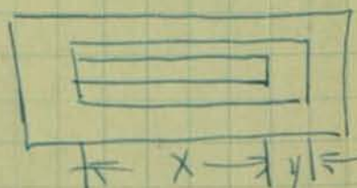
~~.096~~

$$\frac{W_4}{b} = .375\left[4.75 - .660 - .660\right], \quad W_4 = .098$$

~~.096~~

$S_{01} = S_{78}$	=	.070	$W_1 = .076$ ~~.164~~
$S_{12} = S_{67}$	=	.204	$W_2 = .098$
$S_{23} = S_{56}$	=	.227	$W_3 = .098$ ~~.096~~
$S_{34} = S_{45}$	=	.231	$W_4 = .098$ ~~.096~~

Rok 59-64



$x + y = .510$

$x = .427$

$t_0 = 6.15$

$$\frac{6.15}{6.025} = \frac{.427}{x'}, \quad x' = .418$$

$$\frac{6.15}{6.025} = \frac{.083}{y'}, \quad y' = .081$$

$x' + y' = .499 \approx .500$

4/15/64 X-BAND W.G. FILTER

$f_1 = 9.0$ Kmc, $f_2 = 9.6$ Kmc, 2 SECTION. $n=2$

IN THIS CASE WILL USE INDUCTIVE POSTS.

FOR AN .01 db RESPONSE:

1 : .449 : .408 : 1.101

$$\Omega = \pi \left[\frac{\lambda_{g_1} - \lambda_{g_2}}{\lambda_{g_1} + \lambda_{g_2}} \right], \quad \lambda_{g_1} = 1.9144''$$

$$\lambda_{g_2} = 1.6831''$$

$$\lambda_{g_1} + \lambda_{g_2} = 3.5975$$

$$\lambda_{g_1} - \lambda_{g_2} = .2313$$

$$\Omega = 3.14 \left(\frac{.231}{3.598} \right)$$

$$\boxed{\Omega = .202} \qquad \boxed{\Omega^2 = .041}$$

$$X_{01} = \frac{\Omega / \sqrt{g_0 g_1}}{1 - \frac{\Omega^2}{g_0 g_1}} = \frac{.202 / \sqrt{.449}}{1 - \frac{.041}{.449}} = \frac{.301}{.909}$$

$\frac{.202}{.671}$

$1.000 - .091 = .909$

$.0905$

$$\boxed{X_{01} = .331}$$

.184

$$X_{12} = \frac{.202 / \sqrt{(.449)(.408)}}{1 - \frac{.041}{(.449)(.408)}} = \frac{.202 / .429}{1 - .224} = \frac{.471}{.776}$$

$1.000 - .224 = .776$

$$\boxed{X_{12} = .606}, \quad \boxed{X_{23} = .331} \text{ + symmetry}$$

$$\phi_k = 180^\circ - \frac{1}{2}\left[\tan^{-1}(2X_{k-1,k}) + \tan^{-1}(2X_{k,k+1}) \right]$$

$\tan^{-1}(2X_{01}) = \tan^{-1} .662 = 33.5^\circ$

$\tan^{-1}(2X_{12}) = \tan^{-1} 1.212 = 50.5^\circ$

$\frac{84}{2} = 42$

$\phi_2 = \phi_1 = 180^\circ - 42^\circ = 138^\circ$

$180 - 42 = 138$

$\ell = \frac{138}{360} \lambda g_{9.3\text{mc}} = \frac{138}{360}(1.790) = .686$

CONT. FROM p. 147 4/15/64

$X_{01} = .331 = X_{23}$

$X_{12} = .606$

$\lambda_0 = \frac{3 \times 10^{10}}{9.3 \times 10^9 \; 2.54} = 1.27''$

$\frac{\lambda_{@9.3}}{a} = \frac{1.27}{.9} = 1.41$

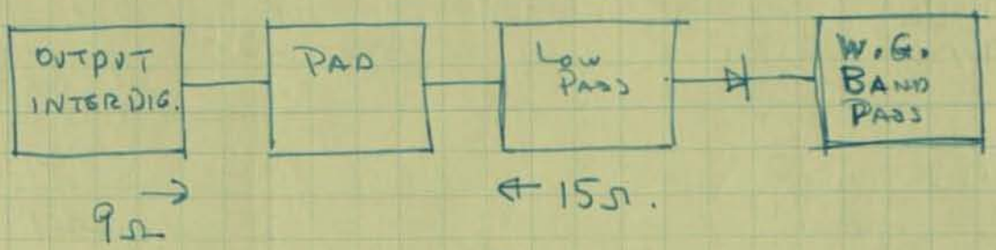
$Z_{0@9.3} = (377)\frac{\pi}{2} \cdot \frac{4}{.9} \; 1.41$

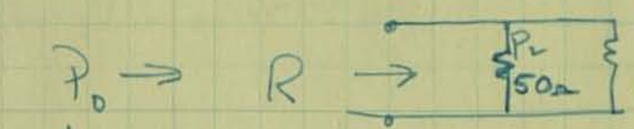
$Z_{0@9.3} = 371\,\Omega.$

$\frac{X_{01}}{Z_0} \frac{\lambda_g}{2a} = \frac{.331}{371} \frac{1.790}{(2)(.9)} = .0089 \approx .01$

TOO SMALL - OFF CHARTS

4/28/64 X-BAND SOURCE





$R = \frac{15 \cdot 50}{15+50} = \frac{750}{65}$

$R = 11.5\,\Omega$

$\frac{P_1}{P_2} = \frac{50}{15} = 3.33$, $\frac{P_2}{P_1} = .3$, $P_2 = .3P_1$

$P_1 + .3P_1 = 1$, $P_1 = \frac{1}{1.3} = .77$

$\frac{P_1}{P_0} = .77$, $\sqrt{\frac{P_1}{P_0}} = .88$

EQUIV. TO ABOUT 1.1 db PAD.

5/15/64 X - 7th BAND MULT.

7 | 9.0 - 9.6
1.29 - 1.37

$f_{o_1} = 1.29$ kmc, $f_{o_2} = 1.37$ kmc.

CONSIDER 8th HARMONIC OF 1.29 kmc.

$f_o = 10.3$ kmc., f_6 (1.) $= 8.22$

$W' = \frac{2w_1'}{w} \left| \frac{w - w_0}{w_0} \right|$, $f_o = 9.3$ kmc.

$\frac{f - f_o}{f_o} = \frac{10.3 - 9.3}{9.3} = \frac{1}{9.3}$

of $\left| \frac{8.2 - 9.3}{9.3} \right| = \frac{.78}{9.3} = .107$

$\Rightarrow f = \frac{f_2 - f_1}{f_o} = \frac{.600}{9.3} = .0645$

$W' = \frac{2}{.0645}(.107) = 3.32$

FOR .1db RIPPLE $\left| \frac{w'}{w_1'} \right| - 1 = 2.32$

CONSIDER 6th

6 | 9.0 - 9.6
1.5 - 1.6

LOOK AT $7 \times 1.5 = 10.5$

$\frac{f - f_o}{f_o} = \frac{10.5 - 9.3}{9.3} = \frac{1.2}{9.3} = .129$

$\frac{f_2 - f_1}{f_o} = .0645$

$\frac{w'}{w_1'} = \frac{2}{(.0645)}(.129) = 4.0$

$\left| \frac{w'}{w_1'} \right| - 1 = 3.0$

5 RESONATORS SHOULD GIVE 67 db.

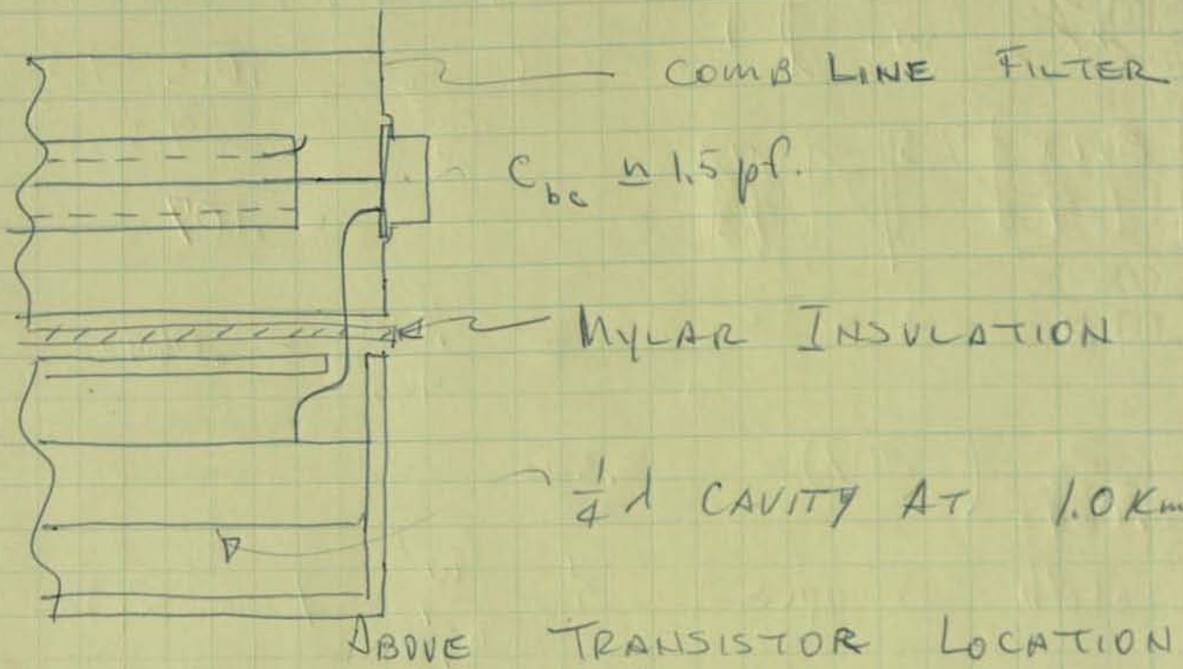
~~CONT. FROM p. 149~~ 5/20/64

5.4 - 5.9 Kmc SOURCE STRAIGHT FROM TRANSISTOR.

ASSUME USING 6th HARMONIC ∴

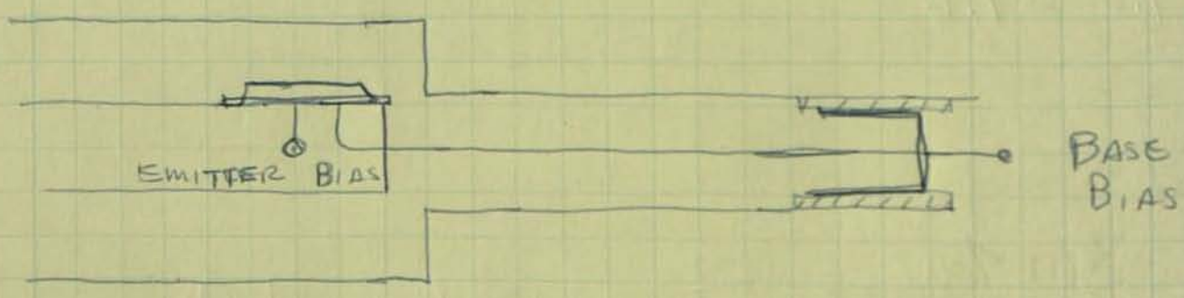
FUNDAMENTAL WILL BE .9 - 1.0 Kmc.

CONSIDER A COMB LINE OUTPUT FILTER



ABOVE TRANSISTOR LOCATION SHOULD WORK FOR ODD HARMONICS.

FOR EVEN!



CONSIDER APPROPRIATE COMB LINE DESIGN - FROM p. 131 $C_j^s = 2.7$ pf.

FOR $\theta_0 = 30°$

$$C_j^s = Y_A \left(\frac{Y_{aj}}{Y_A}\right) \frac{\cot\theta_0}{\omega_0}$$

IF $Y_{aj} = \frac{1}{70}$ $\quad C_j^s = \frac{1}{(70)\,2\pi\,5.65\times10^9} = .4\,pf.$

Try $\theta_0 = 30°$ $\quad Y_{aj} = \frac{1}{50}$

$$C_j^s = \frac{1.732}{50\,2\pi\,5.65\times10^9} = .98\,pf$$ Too Small!

OR $Y_{aj} = \frac{1}{25}$, $\quad C_j^s = 1.95\,pf.$

$\theta_0 = \frac{\pi}{180}\,30 = \frac{\pi}{6}$

$\therefore \frac{Y_{aj}}{Y_A} = 2.0$, SINCE $Y_A = 50\Omega$.

$$\therefore \frac{b_j}{Y_A} = 2.\left(\cot 30° + \theta_0 \csc^2 30°\right) = 1.732 + (.523)(2)^2$$

2.092
1.732
3.824

$$\frac{b_j}{Y_A} = 3.824$$

LET $f_1 = 5.350$ kmc., $f_2 = 5.950$ kmc.

$$W = \frac{f_2 - f_1}{f_0} = \frac{600}{5650} = .106$$

LET $n=5$ .1 db RIPPLE.

1.000 : 1.1468 : 1.3712 : 1.9750 : 1.3712 : 1.1468 : 1.000
g_0 g_1 g_2 g_3 g_4 g_5 g_6

$$\frac{G_{T1}}{Y_A} = \frac{W\,b_1/Y_A}{g_0 g_1 \omega_1'} = \frac{(.106)(3.824)}{1.147} = .354$$

$$\frac{J_{1,2}}{Y_A} = \frac{(.106)(3.824)}{\sqrt{(1.147)(1.371)}} = \frac{.406}{\sqrt{1.57}} = \frac{.406}{1.25} = .324$$

$$\frac{J_{2,3}}{Y_A} = \frac{(.106)(3.824)}{\sqrt{(1.371)(1.975)}} = \frac{.406}{\sqrt{2.71}} = \frac{.406}{1.65} = .246$$

$$\frac{C_0}{\epsilon} = \frac{376.7\,\gamma_A}{\sqrt{\epsilon_2}}\left(1 - \sqrt{\frac{G_{T_1}}{\gamma_A}}\right) = 7.53\left(1 - \sqrt{(.354)(.50)}\right)$$

1 − .595

.354

1.000 − .595 = .405

$$\boxed{\frac{C_0}{\epsilon} = 3.05}$$

$$\frac{C_1}{\epsilon} = 7.53\left(2 - 1 + .354 - .324\tan 30^\circ\right) + \frac{C_0}{\epsilon}\,3.05$$

(.181) $\frac{1}{1.732}$

$$= 7.75 + 3.05$$

2.354 − 1.324 = 1.030

$$\boxed{\frac{C_1}{\epsilon} = 10.8}$$

$$\frac{C_2}{\epsilon} = 7.53\left(2 - \frac{J_{12}}{\gamma_A}\tan 30^\circ - \frac{J_{23}}{\gamma_A}\tan 30^\circ\right)$$

$$= 7.53\left(2 - .181 - \frac{.246}{1.732}\right)$$

.142

2.000 − .323 = 1.677

.181 + .142 = .323

$$\boxed{\frac{C_2}{\epsilon} = 12.6}$$

$$\frac{C_3}{\epsilon} = 7.53\left(2 - .142 - \frac{J_{31}}{\gamma_A}\tan 30^\circ\right)$$

.142

2.000 − .284 = 1.716

$$\boxed{\frac{C_3}{\epsilon} = 12.9}$$

$$\boxed{\frac{C_{01}}{\epsilon} = 7.58 - 3.05 = 4.48}$$

7.53 − 3.05 = 4.48

$$\boxed{\frac{C_{12}}{\epsilon} = 7.53\,(.181) = 1.36}$$

$$\boxed{\frac{C_{23}}{\epsilon} = 7.53\,(.142) = 1.08}$$

TCY $\frac{t}{b} = .4$; $b = \frac{1}{4}$, $t = .100$

$\frac{C_{01}}{\epsilon} = 4.48$, $\frac{S_{01}}{b} = .110$, $\frac{(C'_{te})_{01}}{\epsilon} = .17$, $S_{01} = .028$

$\frac{C_{12}}{\epsilon} = 1.36$, $\frac{S_{12}}{b} = .330$, $\frac{(C'_{te})_{12}}{\epsilon} = .44$, $S_{12} = .083$

$\frac{C_{23}}{\epsilon} = 1.08$, $\frac{S_{23}}{b} = .390$, $\frac{(C'_{te})_{23}}{\epsilon} = .51$, $S_{23} = .095$

~~EL 12 9~~ LET $G_A = \frac{1}{35}$

Suppose $C_1^t = .5\ pf.$

Assume $C_{01} = 3.0\ pf.$

$\omega_0 = 6.21 \times 10^9$

$\omega_0 C_{01} = (6.21 \times 10^9)(3.0 \times 10^{-12})$
$= 18.63 \times 10^{-3}$

$\frac{\omega_0 C_{01}}{G_A} = (18.63 \times 10^{-3})(35) = 652 \times 10^{-3}$
$\frac{25}{.652}$
$.466$

$\left(\frac{\omega_0 C_{01}}{G_A}\right)^2 = \underset{.217}{.425}$

$\frac{\omega_0 C_{01}}{1 + \left(\frac{\omega_0 C_{01}}{G_A}\right)^2} = \frac{18.63 \times 10^{-3}}{1.425} = \underset{.013}{13.1 \times 10^{-3}}$
1.217 $.015$

$\omega_0 C_1^t = (6.21 \times 10^9)(.5 \times 10^{-12}) = \underset{.003}{3.11 \times 10^{-3}}$

LET ~~C_{12}~~ $C_{12} = 1\ \mu f.$

$\omega_0 C_{12} = 6.21 \times 10^9 \times 10^{-12} = .006$

$B_1^J = .013 + .003 + .006 = \underset{.022}{.024}$

$\frac{B_1^J}{Y_0} = \frac{.024}{.02} = \underset{1.75}{1.01}$ 1.2

$\frac{b_1}{Y_0} = 1.65$, $b_1 = (1.65)(.02) = \underset{.016}{.0330}$ $\underset{1.75}{.0350}$

$J_{01} = \sqrt{\frac{G_A b_1 W}{q_0 q_1 \omega_1'}} = \sqrt{\frac{(.033)(.20)}{(35)(1.109)}} = \sqrt{\underset{.00025}{.00017}} = \underset{.013}{.041}$

$Q_1 = .560$ To A

PAGCO.

$(.016)(25) = .40$ $\quad (J_{01}/G_A) = .16$

$\frac{J_{01}}{G_A} = (.013)(35) = .457$, $\left(\frac{J_{01}}{G_A}\right)^2 = .209$

$\frac{J_{01}}{\sqrt{1-\left(\frac{J_{01}}{G_A}\right)^2}} = \frac{.016}{.89} = \frac{.013}{.915} = \frac{.0147}{.0175}$ $\quad \frac{1.000}{.16} \; \frac{1.000}{.209}$ $\quad .84 \; .791$

$\sqrt{.791} = .89$

$\sqrt{.84} = .915$

$\therefore \omega_0 C_{01} = .0147$ $\quad .0175$

$C_{01} = \frac{.0147}{6.21 \times 10^9}$

$C_{01} = 2.37$ pf. $\quad$ 2.82 pf

CONSIDER $G_A = \frac{1}{25}$, $C_{01} = 2.40$

$\frac{\omega_0 C_{01}}{G_A} = (1.555 \times 10^{-1})(3) = .424$

TO CALCULATE C_{12}

USING $B_j^J\Big|_{j=2 \text{ to } n-1} = \omega_0 C_{j-1,j} + \omega_0 C_j^t + \omega_0 C_{j,j+1}$

$B_2^J = \omega_0 (C_{12} + .5 \text{pf} + C_{23})$

ESTIMATING $C_{12} = 1.0$pf., $C_{23} = 1.0$ pf.

USING $5\omega_0$ RESONATOR

$B_2^J = (6.21 \times 10^9)(2.5\frac{8}{2} \times 10^{-12}) = 15.5 \times 10^{-3}$

$= 1.55 \times 10^{-2}$

$\frac{B_2^J}{Y_0} = (1.55 \times 10^{-2})(25) = 38.8 \times 10^{-2} = .388$ $\quad .775$

$l_2 = .630$ $\quad \frac{l_2}{\lambda_0/4}$

$\frac{b_2}{Y_0} = 1.02$, $\quad b_2 = \frac{(1.02)(1.25)}{25\ 50} = .025$ $\quad 1.25$

$b_2 = .0408$ $\quad .0424$

$$J_{12} = .20\sqrt{\frac{b_1 b_2}{g_1 g_2}} = .20\sqrt{\frac{(.835)(.041)}{(1.109)(1.306)}}$$

$$= .20\sqrt{\frac{5.91}{4.53\times10^{-4}}} \qquad \frac{3.2}{1.6}\cdot 4\times10^{-4}$$
$$9.92\times10^{-4}$$

$$= (.20)\frac{(3.13)}{3.15}\times10^{-2} = \frac{.630}{2.44}\times10^{-2}$$
$$.488$$

$$J_{12} \approx .004 \quad .006$$

$$\frac{J_{12}}{Y_0 G_A} = (.006)(25) = .150, \quad \left(\frac{J_{12}}{G_A}\right)^2 = .0225$$

$$\omega_0 C_{12} = J_{12}$$

$$C_{12} = \frac{.00488}{.006} = \frac{6.21\times10^9}{} = 0.97 \text{ pf.}$$
$$.79$$

1.0000
.0225
.9775

To calculate C_{23}

$$B_3^J = \omega_0 (C_{23} + 0.5\text{pf.} + C_{34})$$

Estimate $C_{23} = .75$ pf. $\}$ $C_{34} = .75$ pf.

using $5\omega_0$ resonator

$$\therefore B_3^J = (6.21\times10^9)(2.0\times10^{-12}) = 12.42\times10^{-3}$$

$$\left(\frac{B_3^J}{Y_0}\right)^2 = .621 \quad \{ \quad \frac{b_2}{Y_0} = .787 \qquad \frac{.012.42}{.020} = .621$$

$\{ b_2 =$

$$\frac{l_3}{\frac{\lambda_0}{4}} = .530$$

$$\frac{B_3^J}{Y_0} = .621 \quad , \quad \frac{b_3}{Y_0} = 1.17 \quad , \quad b_3 = \frac{(1.17)}{.50} = .0234$$

$$J_{23} = W\sqrt{\frac{b_2 b_3}{g_2 g_3}} = .2\sqrt{\frac{(.025)(.023)}{(1.306)(1.770)}}$$

$$= .2\sqrt{2.49\times10^{-4}} = (.2)\ 1.58\times10^{-2}$$

$$J_{23} = .316\times10^{-2} \doteq .003$$

$$C_{23} = \frac{.00316}{6.21\times10^{+9}} = \boxed{.51\ \text{pfd}}$$

TO CALCULATE C_{34}

$$B_4^J = w_0 C_{3,4} + w_0 C_4^{\dagger} + \frac{w_0 C_{45}}{1+\left(\frac{w_0 C_{45}}{G_B}\right)^2}$$

ESTIMATE $C_{34} = .75\ \text{pf.}$, $C_{45} = 1.0\text{pf.}$

$$w_0 C_{45} = 6.21\times10^9 \cdot 1.0\times10^{-12} = 6.21\times10^{-3}$$

$$\frac{w_0 C_{45}}{G_B} = \frac{6.21\times10^{-3}}{.02} = \frac{.621}{2} \doteq .310$$

$G_B = \frac{1}{50}$

$$\left(\frac{w_0 C_{45}}{G_B}\right)^2 = .096 \ , \ \frac{w_0 C_{45}}{1+(\ )^2} = \frac{6.21\times10^{-3}}{1.096}$$

$$= 5.67\times10^{-3}$$

$n = 4$

$$\frac{l_4}{\frac{\lambda_0}{4}} = .72$$

$$w_0 C_{3,4} = (6.21 \times 10^9)(.75 \times 10^{-12}) = 4.66 \times 10^{-3}$$

$$w_0 C_{,n}^{*} = 3.10 \times 10^{-3}$$

5.67
4.66
3.10
13.43

$$\text{TOP } \mathcal{B}_4 = 13.43 \times 10^{-3}$$

$$\frac{\mathcal{B}_4}{Y_0} = \frac{13.43 \times 10^{-3}}{.02} = \frac{1.343}{2} = .671$$

3 w_0 RESONANT

$$\therefore \frac{b_4}{Y_0} = 1.36, \quad b_4 = (1.36)(.02) = .0272$$

$$J_{34} = .2\sqrt{\frac{b_3 b_4}{g_3 g_4}} = .2\sqrt{(1.770)(.018)}$$

$$= .2\sqrt{\frac{(.023)(.027)}{(1.770)(.018)}} = (.2)\sqrt{4.29 \times 10^{-4}}$$

$$J_{34} = (.2)(2.07) \times 10^{-2} = .414 \times 10^{-2}$$

$$\pm .004$$

$$C_{34} = \frac{.004}{6.24 \times 10^9} \cong \boxed{.65 \text{ pf.}}$$

$$J_{45} = \sqrt{\frac{G_6 b_4 w}{g_4 g_5 \cdot 1}} = \sqrt{\frac{(.02)(.027)(.2)}{(.018)(1.355)}}$$

$$= \sqrt{.975 \times 10^{-4}} = .99 \times 10^{-2}$$

$$J_{45} \pm .01$$

$$\frac{J_{45}}{G_B} = \frac{.01}{.02} = .5, \quad \left(\frac{J_{45}}{G_B}\right)^2 = .25$$

$$\omega_0 C_{45} = \frac{J_{45}}{\sqrt{1-\left(\frac{J_{45}}{G_B}\right)^2}} = \frac{.01}{\sqrt{.75}} = \frac{.01}{.87}$$

$$\omega_0 C_{45} = .0115$$

$$C_{45} = \frac{.0115}{6.21 \times 10^{-9}} = \boxed{1.86 \text{ pf.}}$$

SINCE $f_0 = 1000$ mc.

$$\frac{\lambda_0}{4} = \frac{30 \text{ cm.}}{4\ 2.54} = 2.94"$$

TABULATING

$C_{01} = 2.82$

$C_{12} = .79$

$C_{23} = .51$

$C_{34} = .65$

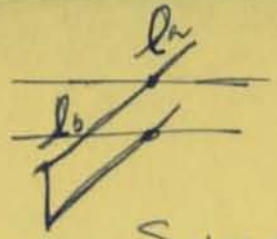
$C_{45} = 1.86$

$l_1/\lambda_0/4 = .560$, $l_1 = 1.65"$

$l_2/\lambda_0/4 = .630$, $l_2 = 1.85"$

$l_3/\lambda_0/4 = .530$, $l_3 = 1.56"$

$l_4/\lambda_0/4 = .720$, $l_4 = 2.12"$



FOR 3 ω_0 STUBS: SHORTED STUB IS TWICE OPEN. $l_b = 2 l_a$

$l_{a_1} = \frac{1.65}{3} = .55$, $l_{b_1} = 1.10$

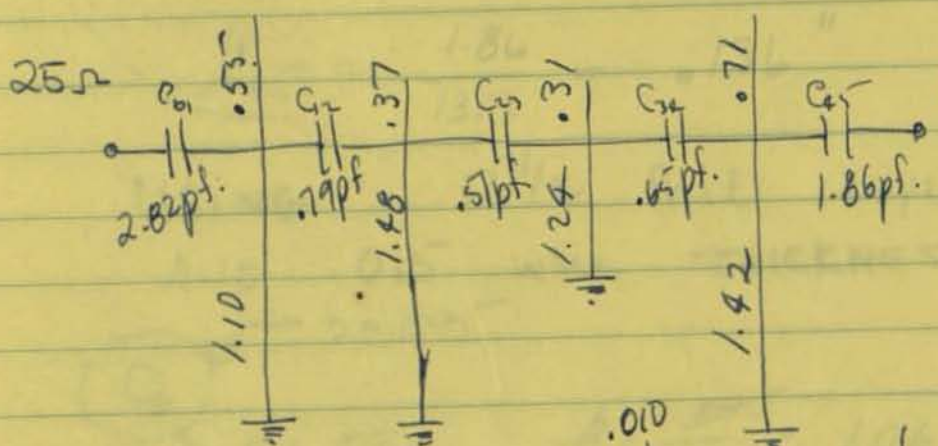
$l_{a_4} = \frac{2.12}{3} = .71$, $l_{b_4} = 1.42$

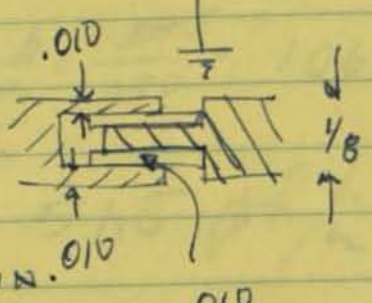
5 ω_0 STUBS: SHORTED STUB IS ~~4~~ TIMES OPEN $l_b = ~~4~~ l_a$

$l_{a_2} = \frac{1.85}{5} = .37$, $l_{b_2} = 1.48$

$l_{a_3} = \frac{1.56}{5} = .31$, $l_{b_3} = ~~1.28~~$ 1.24

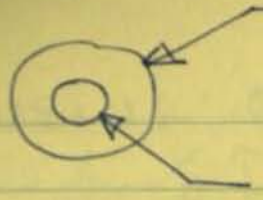
1.25
.32
1.60





FOR C_{01} & C_{45} USING 10 mil TEFLON.

.125
-.020
.105
.020
.085



$$\frac{b}{a} = \frac{.105}{.085} = 1.24$$

$$C = \frac{.614\,k}{\log_{10} \frac{b}{a}} \ \mu\mu f/in$$

USING TEFLON

$$C = \frac{(.614)(2.1)}{\log 1.24} = \frac{1.29}{.094} = 13.7 \ pf/in$$

FOR $C_{01} = 2.82$ pf.

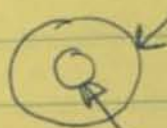
$$l_{01} = \frac{2.82}{13.7} = .206" \ (\text{To Long.})$$

FOR $C_{45} = 1.86$

$$l_{45} = \frac{1.86}{13.7} = .136"$$

USING 2 1/2 Mil MYLAR TAPE AND .015" WALL THICKNESS

$$\begin{array}{r} .125 \\ -.030 \\ \hline .095 \\ -.005 \\ \hline .090 \end{array}$$



$$\frac{b}{a} = \frac{.095}{.090} = 1.06$$

$\log 1.06 = .025$

$$C = \frac{1.29}{.025} = 51.5 \ pf/in$$

$$l_{01} = \frac{2.82}{51.5} = .0547 \approx .055$$

$$l_{45} = \frac{1.86}{51.5} = .036$$

USING PARALLEL PLATE CAP. - TEFLON pf.
& 1/8 DIA. DISCS.

$$t = \frac{.0058}{C}$$

$$t_{12} = \frac{.0058}{.79} = .00735 \approx \underline{.007}$$

$$t_{23} = \frac{.0059}{.51} = \underline{.011}$$

$$t_{34} = \frac{.0058}{.65} = \underline{.009}$$

$f_1 = 1000$ kc. (1.0 Kc.) $\quad f_2 = 1.2$ Kc.

$n = 5$

$nf_1 = 5.0$ Kc. , $nf_2 = 6.0$ Kc.

For 5th Harm.

$\frac{2}{2n+1} = \frac{2}{11} \approx 18\%$ $\quad \frac{200}{1100} = .182 \approx 18\%$

For ADJACENT SIDE BANDS.

IF USE 5.4 To 5.9 Kc.

$\frac{5.4}{5} = 1.080$ Kc. $\quad \frac{5.9}{5} = 1.18$ Kc.

$\omega_0 = \frac{2\omega_a\omega_b}{\omega_a+\omega_b}$ $\quad 2\pi f_0 = \frac{4\pi^2 f_a f_b}{2\pi(f_a+f_b)}$

$2\pi f_0 = \frac{4\pi^2}{2\pi}\frac{(1.08)(1.18)}{2.26} = \frac{2.26}{1.13} = 1.13$ Kc.

For .2 db ripple

$g_1 = 1.3028$, $g_2 = 1.2844$, $g_3 = 1.9671$

$g_4 = .8468$, $r_a = \frac{1}{r} = .6499 \approx 1.54$

$\delta = \omega_1'\left(\frac{\omega_b+\omega_a}{\omega_b-\omega_a}\right) = 1\frac{2.2}{.20} = 11.0$

$\frac{J_{45}}{Y_0} = \sqrt{\frac{\pi}{2\delta g_5 g_6}} = \sqrt{\frac{\pi}{2\cdot 11\cdot 1.5}} = \sqrt{.0953} = .31$

$\frac{B}{Y_0} = \frac{J/Y_0}{1-(J/Y_0)^2} = \frac{.31}{.047} = 6.61$ $\quad \frac{1.000}{.095}\ \frac{.905}{.953}\ \frac{.900}{.047}$

$Y_0 = \frac{1}{15}\Omega$

$B = \frac{.66}{15} = .044$, $C = \frac{.044}{2\pi\ 1.1\times 10^9} = 6.4$ µµf.

DATE 1-20 19 64
EQUIP. USED

1.

2.

$$\frac{J_{01}}{Y_0} = \sqrt{\frac{\pi}{2\delta g_0 g_1}} = \sqrt{\frac{\pi}{2^\circ 11^\circ 1.3}} = \sqrt{.110}$$

$$= .332$$

$$\frac{B_{01}}{Y_0} = \frac{J/Y_0}{1-\left(J/Y_0\right)^2} = \frac{.332}{.890} = .373$$

1.000
.110
.890

$$B_{01} = .0249 \quad , \quad C_{01} = \frac{.0249}{2\pi\ 1.13\times10^9}$$

$= \frac{25}{C}$

$$C_{01} = 3.5\ pf.$$

$$\frac{J_{45}}{Y_0} = \sqrt{\frac{\pi}{2\delta(1.54)(.847)}} = \sqrt{\frac{\pi}{2\delta\ 1.3}} = \frac{J_{01}}{Y_0}$$

$$\frac{K_{12}}{Z_0} = \frac{\pi}{2\delta\sqrt{g_1 g_2}} = \frac{\pi}{22\sqrt{(1.30)(1.28}} = \frac{\pi}{(22)(1.29)}$$

$$= .111 \quad , \left(\frac{K_{12}}{Z_0}\right)^2 = .0122$$

$$\frac{X_{12}}{Z_0} = \frac{K_{12}/Z_0}{1-\left(K_{12}/Z_0\right)^2} = \frac{.111}{.988} = .112$$

1.000
.012
.988

31

if $Z_0 = 15$, $X_{12} = 1.68 = \omega L_{12}$

$$L_{12} = \frac{1.68}{2\pi\ 1.13\times10^9} = \frac{1680\times10^{-12}}{2.26\pi} = 237\ \mu\mu h.$$

$$L_{12} = .237\ nh.$$

$(8.9 \times 10^{-2}) =$ ~~81~~ $\times 10^{-4}$

808

$$\frac{J_{23}}{Y_0} = \frac{\pi}{2\delta\sqrt{g_2 g_3}} = \frac{\pi}{22\sqrt{(1.28)(1.97)}} = \frac{.143}{\sqrt{2.52}}$$

$$= \frac{.143}{1.59} = .089, \quad \left(\frac{J_{23}}{Y_0}\right)^2 = .008,$$

1.000
.008
.992

$$\frac{B}{Y_0} = \frac{Y_0}{1-\left(\frac{J}{Y_0}\right)^2} = \frac{.089}{.992} = .091$$

$Y_0 = \frac{1}{15}$

$$B = \frac{.091}{15} = .00605$$

@ $f = 1.13$ Kmc.

$$C = \frac{.00605}{2\pi\ 1.13\times10^9} = \frac{6.05\times10^{-12}}{2.26\pi} = .85 \text{ pf.}$$

15Ω LINE IN K-9

$\sqrt{\varepsilon_r}\ 15 = 45\Omega.$

$\frac{W}{b} = 1.6$, if $b = \frac{1}{4}$

$\frac{t}{b} = \frac{.002}{.125}$

$$W = \frac{1.6}{4} = .4$$

if $b = \frac{1}{8}$

$W = .2$

For 1 TRANSFORMER $Z_m = \sqrt{50 \cdot 15} = 5\sqrt{30}$

$Z_m = 27.4.$

$\sqrt{\varepsilon_r}\ Z_m = 82.5$

$\frac{W}{b} = .67$

$W = \frac{.67}{8} = .084$

$W = \frac{}{8} =$ ~~.1~~

$Z = \omega L \frac{1}{v_p \cdot C}$

$Z_1 = \sqrt{\frac{L}{C}}$

$\beta = \omega \sqrt{LC}$

$Z_0 = \sqrt{\frac{L}{\frac{1}{v_p^2 L}}}$

$\frac{\omega}{\beta} = \frac{1}{\sqrt{LC}} = v_p$

$v_p^2 = \frac{1}{LC}, \; C = \frac{1}{v_p^2 L}$

1.6

$Z_0 = v_p L$

$Z_0 = \frac{c}{\sqrt{\varepsilon_r}} L$ henries/cm.

Desire $.237 \times 10^{-9}$ Henries in .125" length

$.125 \times 2.54 = .318$ cm.

$\frac{.237 \times 10^{-9}}{.318} = .745 \times 10^{-9}$ hen/cm.

$\sqrt{\varepsilon_r} = 3$ for K-9

$Z_0 = \frac{3 \times 10^{10}}{3} .745 \times 10^{-9} = 7.45 \Omega$

$\sqrt{\varepsilon_r} Z_0 = 22.4 \Omega$ for cut

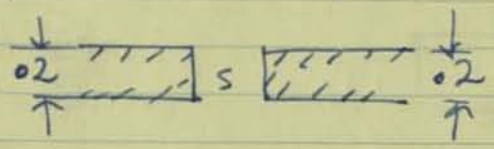
$\frac{D}{b} = .82, \; D = \frac{.82}{8} = .1$

let length be .0625

Then $\sqrt{\varepsilon_r} Z_0 = 44.8 \Omega$.

$\frac{D}{b} = .6$ $\quad D = .6b = \frac{.6}{8} = .075"$

To Calculate $C = .85$ pf
with .2 width



$\epsilon = .0885 \epsilon_0$ pf/cm

$\epsilon_r = 9$

$\epsilon = .7965$

$C_{f_0} = \frac{.85}{(.2)(2.54)} = 1.67$ pf/cm

$\frac{C_{f_0}}{\epsilon} = \frac{1.67}{.80} = 2.1$ $\frac{4}{2}$

$\frac{s}{b} = \frac{.025}{\cdot}$, $b = \frac{1}{8}$

$s = \frac{.025}{8} \cong .003$

Try $.005 = s$

Cal. of pf. $C = 3.5$ pf.

Consider Overlap of .084 wide transformer with .005 teflon

$$C = \frac{.225\, A\, k}{t}$$

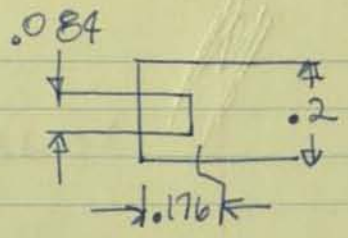
$$A = \frac{C t}{.225 k} = \frac{3.5 \times 10^{-12} (5 \times 10^{-3})}{.225 \quad 2.1}$$

$$A = \frac{(3.5)(5)}{(.225)(2.1)} \times 10^{-3} = 37 \times 10^{-3}$$

$$l \times .084 = .037$$

$$l = \frac{.037}{.084} = .44$$

TRY .002 THICKNESS



$A = 37 \times 10^{-3} \frac{2}{5}$

$A = 14.8 \times 10^{-3}$

$\ell = \frac{.015}{.084} = .176$

FOR INDUCTANCES – SHUNT.

FOR SHORTED 15Ω LINE.

$jX = j Z_0 \tan\theta$

$\tan\theta = \frac{X}{Z_0} = \frac{.237 \times 10^{-9}}{15}$ $\quad \theta = \frac{2\pi}{\lambda} \ell$

$\lambda = \frac{V_p}{f} = \frac{c}{\sqrt{\epsilon_r} f} = \frac{3 \times 10^{10}}{3} \frac{1}{1.1 \times 10^9} = \frac{10}{1.1}$ cm.
$= 9.1$

$\lambda = 3.58''$

$\ell = \frac{.237 \times 10^{-9}}{15} \frac{3.58}{2\pi}$

$$\frac{J_{01}}{Y_0} = \tan^{-1}\frac{\phi}{2} = .332$$

$$\frac{\phi}{2} = 18.35^\circ \;,\; \phi = 36.7^\circ$$

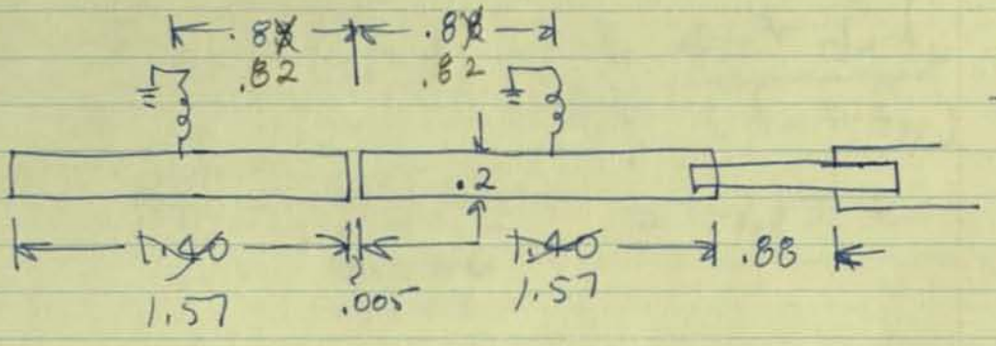
$$\frac{360^\circ}{36.7^\circ} = \frac{3.58}{\chi}$$

$$\chi = .365'' \;,\; \frac{\chi}{2} = .182$$

$\frac{3.58}{2} = 1.76$

$\frac{1.76}{2} = .88$

LENGTH OF RESONATORS = $1.76 - .19 = 1.57$



$1.76 + .19 = 1.57$

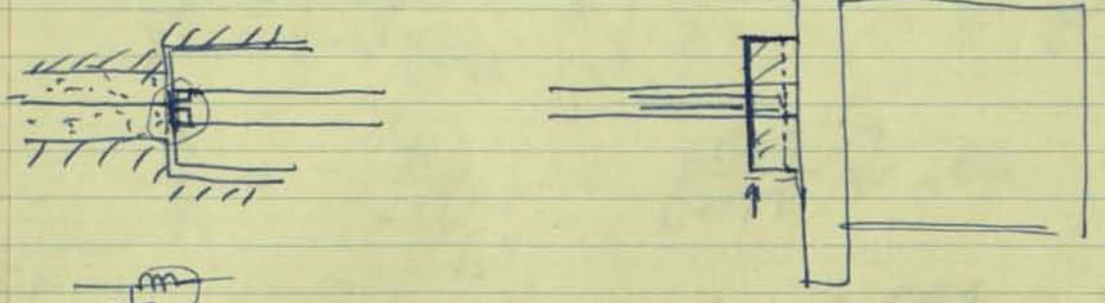
FOR A 50Ω LINE

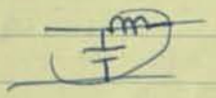
$\sqrt{\varepsilon_r}\,50 = 150$

$1.57 + 1.57 + .88 + .88 = 4.90$

$\frac{w}{b} = .19 \;,\; b = \frac{1}{8}$

$w = \frac{.190}{8} = .024$





$L = .237$ mh.

Consider K_{12} for ~~short~~ negative line lengths.

$\frac{K_{12}}{Z_0} = .111$, $\left(\frac{K_{12}}{Z_0}\right)^2 = .0122$

$\frac{X_{12}}{Z_0} = \frac{K/Z_0}{1-\left(\frac{K}{Z_0}\right)^2} = \frac{.111}{.988}$

$1.000 - .012 = .988$

$\frac{X_{12}}{Z_0} = .112$

$\tan\frac{\phi}{2} = \frac{K}{Z_0} = .111$

$\frac{\phi}{2} = 6.4^\circ$ $\quad \phi = 12.8^\circ$

$\frac{360}{12.8} = \frac{3.58}{x}$, $x = .127''$

$\frac{x}{2} = .063$

$L = .237$ mh

using 15 Ω $\quad \frac{X_{12}}{Z_0} = .112 = \tan\theta$

$\theta = 6.4^\circ$

$l = .063''$

~~if~~ $l = .125$ $\quad \theta = 12.6^\circ$

$\tan\theta = .223$

$\frac{X}{Z_0} = .223$

$Z_0 = \frac{X}{.223} = \frac{1.64}{.223}$

$= 7.35\ \Omega$.

$(7.35)\sqrt{5} = 22\ \Omega$.

$\frac{W}{6} = 3.75$

$W = \frac{3.75}{8} = .47$

$\frac{360}{\theta} = \frac{3.58}{.125}$

$\theta = 12.6$

$\theta = \frac{360}{3.58}$

$X = -\omega L$

$X = 2\pi \times 1.1 \times 10^9 \times .237 \times 10^{-9}$

$X = (2.2\pi)(.237)$

$= 1.64$

DATE 2-18 1964
EQUIP. USED Boonton 75A-SB
TAKEN BY RH
REQUESTED BY D Jones

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

ENGINEERING DATA

( ) T. CLASS
REMARKS
CUSTOMER
GROUP 704-7 Specia

LOT No.	DE.	OP.	GR.	TYPE No.	CL.	TE.	COND.	DATE	ELAPSED TIME	SP.	SP.

LOT No.	UNIT No.	OSC LEVEL .2V $C_{(pF)}$	R	G ε IV (mA)	
	51	.26	1M	—	
	52	.57	5	CHOP	
	53	.69	100	OPEN INTER.	0 output
	54	.74	5	23	
	55	.72	8	46	7 mW
	56	.85	12	30	
	57	.87	11	10	
	58	.60	2	53	
	59	.84	8	27	
	60	.70	3	18	
	61	.75	3	30	
	62	.72	4	5	
	63	.74	1	80	
	64	.78	2	44	
	65	.71	4	46	
	66	.66	2	30	4 mW
	67	.82	3.7	<5	
	68				
	69				
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	71				
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S 995

S-310A Rev.