CHAPTER FOUR

TYPES OF TRANSISTER OSCILLATORS

CLASS TWO, COMPUTER ENGINEERING TECHNIQE

A TRANSISTOR CAN WORK AS AN OSCILLATOR TO PRODUCE CONTINUOUS UNDAMPED OSCILLATOR OF ANY DESIRED FREQUENCY (ALL OSCILLATORS DO SAME FUNCTIONS.

THE DIFFERENCE BETWEEN DIFFERENT TYPES OF OSCILLATORS LIES IN THE METHOD BY WHICH ENERGY IS SUPPLIED TO THE CIRCUIT

TYPES:

1-TUNED COLLECTOR OSCILLATOR

2-COLPITT”S OSCILLATOR

3-HARTLEY OSCILLATOR

4-PHASE SHIFT OSCILLATOR

5-WIEN BRIDGE OSCILLATOR

6-CRYSTAL OSCILLATOR

1-TUNED COLLECTOR OSCILLATOR

THS OSCILLATOR IS SHOWN IN THE FIGURE:

THE FREQUENCY OF OSCILLATOR (f ) DEPENDS ON L1&L2 :

f=$\frac{1}{\begin{array}{c}2π\sqrt{L1C1}\\\end{array}}$

L1 &L2 ARE FOR THE PRIMARY AND SECONDARY OF TRANSFORMER

THE BIASING IS PROVIDED BY POTENTIAL DEVIDER CONNECTED IN THE BIASE CIRCUIT PROVIDES LOW REACTANCE PATH TO THE OSCILLATIONS

 Ex:THE TUNED COLLECTOR OSCILLATOR CIRCUIT USED IN THE LOCAL OSCILLATOR OF A RADIO RECEIVER MAKE UES OF AN LC TUNED CIRCUIT WITH L1=58.6 µH C1=300 pf ,CALCULATE FREQUENCY OF OSCILLATION : $ f=\frac{1}{\begin{array}{c}2π\sqrt{L1C1}\\\end{array}}=\frac{1}{\begin{array}{c}2π\sqrt{58.6\*10^{-6}\*300\*10^{-12}} \\\end{array}}=1199 KHz$

EX: FIND THE CAPACITANCE OF C REQUIRED TO BUILD AN LC OSCILLATOR THAT USED AN L1=1 mH TO PRODUCE A SINE WAVE OF FREQUENCY =1GHz.

SOLUTION :$ f=\frac{1}{\begin{array}{c}2π\sqrt{L1C1}\\\end{array}} C1=\frac{1}{\begin{array}{c}\\\end{array}L1(2πf)^{2}}$

C1=$\frac{1}{(1\*10^{-3})(2π\*1\*10^{12})^{2}}=2.53\*10^{-11}pF$

2-Colpittis Oscillator
 $f=\frac{1}{2π\sqrt{lC\_{t}}} $

$$C\_{T}=\frac{c\_{1}c\_{2}}{c\_{1}+c\_{2}}$$

 

EX: Determine

(a)operating freq (b) feedback fraction for colpitt’s oscillator

C1=0.001µF , c2=0.01µF , L=15µH

Solution

Ct=$\frac{c\_{1}c\_{2}}{c\_{1}+c\_{2}}=\frac{0.001\*0.01}{0.001+0.01}=9.09\*10^{-4}μF$

 =909\*10-12F

(b)feedback fraction:

 mv=$\frac{c\_{1}}{c\_{2}}=\frac{0.001}{0.01}=0.1$

3-HARTLEY OSCILLATOR $f=\frac{1}{2π\sqrt{CL\_{T}}} L\_{T}=L\_{1}+L\_{2}+2M$ M IS THE MUTUAL INDUSTANCE BETWEEN L1 AND L2



EX:CALCULATE (i)OPERATING FREQUENCY

 (ii)FEEDBACK FACTION FOR HARTLEY

L1=1000µH , L2=100µH, M=20µH

LT=1000+100+2\*20=1140\*10-6H

C=20PF=20\*10-12F

SOLUTION

$$f=\frac{1}{2π\sqrt{L\_{T}C}}=\frac{1}{2π\sqrt{1140\*10^{-6}\*20\*10^{-12}}}=1052 KHz$$

$$m\_{v}=\frac{L\_{2}}{L\_{1}}=\frac{100μH}{1000μH}=0.1$$

EX: 1PF CAPACITOR IS AVAILABLE .CHOOSE THE INDUCTANCE VALUES IN A HARTLEY OCSILLATOR . SO THAT f =1 MHz AND mv=0.2

$$m\_{v}=\frac{L\_{2}}{L\_{1}} 0.2=\frac{L\_{2}}{L\_{1}} L\_{1}=5L\_{2}$$

$$f=\frac{1}{2π\sqrt{L\_{T}C}}$$

$$L\_{T}=\frac{1}{C\left(2πf\right)^{2}}=\frac{1}{\left(1\*10^{-12}\right)\left(2π\*1\*10^{6}\right)^{2}}$$

 =25.3mH=L1+L2

5L2+L2=25.3 L2=4.22 mH

L1=5L2=5\*4.22=21.1mH

4-PHASE SHIFT OSCILLATOR $f\_{0}=\frac{1}{2πRC\sqrt{6}}$

R1=R2=R3=R C1=C2=C3=C

EX: IN THE PHAS SHIFT OSCILLATOR R1=R2=R3=1MΩ C1=C2=C3= 68 PF

 WHAT IS f0 :

$$f\_{0}=\frac{1}{2πRC\sqrt{6}}=\frac{1}{2π\*10^{6}\*68\*10^{-12}\sqrt{6}}=954Hz$$

EX:FIND R TO PRODUCE f0=800KHz, C=5PF

$$f\_{0}=\frac{1}{2πRC\sqrt{6}} \rightarrow R=\frac{1}{2πf\_{0}C\sqrt{6}}$$

$$R=\frac{1}{2π\*800\*10^{3}\*5\*10^{-12}\*\sqrt{6}}=16.2 KΩ$$

5-WIEN BRIDGE OSCILLATOR

$$f=\frac{1}{2π\sqrt{R\_{1}C\_{1}R\_{2}C\_{2}}}$$

IF R1=R2=R , C1=C2=C

EX: IN THE WIEN BRIDGE OSCILLATOR :

R1=R2=220 KΩ C1=C2=250 PF DETERMINE f:

$$f=\frac{1}{2πRC}=\frac{1}{2π\*220\*10^{3}\*250\*10^{-12}}Hz$$

 =2892Hz

6-TRANSISTOR CRYSTAL OSCILLATOR 

NOTE THAT IT IS A COLLPIT’S OSCILLATOR MODIFIED TO ACT AS A CRYSTAL OSCILLATOR $f\_{S}=\frac{1}{2π\sqrt{LC}} f\_{P}=\frac{1}{2π\sqrt{LC\_{T}}} C\_{T}=\frac{C\*C\_{m}}{C+C\_{m}}$

EX: A CRYSTAL HAS THICKNESS OF 1mm.

IF THE THICKNESS IS REDUCED BY 1% WHAT HAPPENS TO FREQUENCY OF OSCILLATION $f=\frac{K}{t} f α\frac{1}{t}$ NOTE: K IS CONSTANT

IF THE THICKNESS OF THE CRYSTAL IS REDUCED BY 1% THE FREQUENCY OF OSCILLATIONS WILL INCREASE BY 1%

EX:L= 1H , C=0.01PF , R=1000Ω , Cm=20PF NOTE: Cm IS A MOUNTING CAPACITANCE

CALCULATE fS , fP OF THE CRYSTAL

$$f\_{S}=\frac{1}{2π\sqrt{LC}}=\frac{1}{2π\sqrt{1\*0.01\*10^{-12}}}=1589KHz.$$

$$C\_{T}=\frac{C\*C\_{m}}{C+C\_{m}}=\frac{0.01\*20}{0.01+20}=9.99\*10^{-3}PF$$

$$f\_{P}=\frac{1}{2π\sqrt{LC\_{T}}}=\frac{1}{2π\sqrt{1\*9.99\*10^{-15}}}=1590KHz$$

fS=SERIES-RESONANT FREQUENCY

fP=PARALLEL-RESONANT FREQUENCY

SINCE CT < C THERFORE fP ALWAYS > fS

fS & fP ARE VERY CLOSE