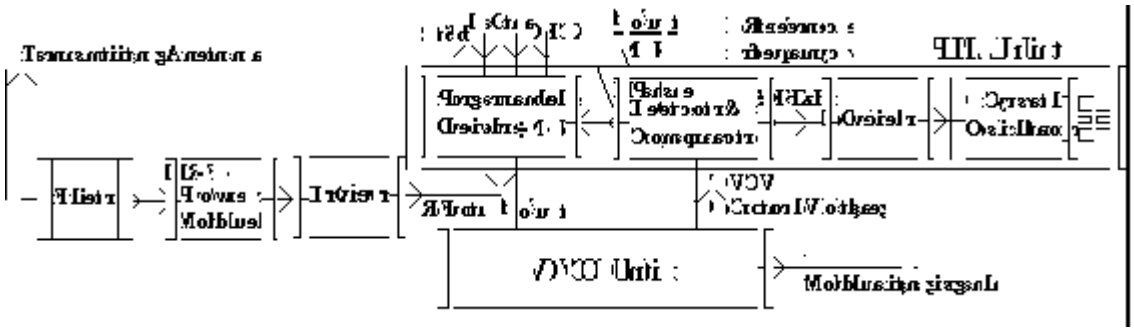
20W-FM Broadcast Range System

Introduction:



The figure shows a Block Diagram of the Frequency Synthesized Transmission section in Yaesu-23R (or similar).

Each time PTT is pressed; binary data is clocked then strobed by the programmable divider via Data-Ck-Stb inputs (these are coming from the set CPU) giving an N (The division ratio which is the decimal equivalent of the strobed binary data) corresponding to the displayed transmit frequency (on the LCD).

For a given transmitted frequency (f out) corresponding to a given N; assume a lock condition where $\frac{(f\ out)lock}{N}$ is exactly in phase lock with the 5KHz reference frequency and (f out)lock corresponds to (VCV)lock at the input of VCO.

In open loop condition VCV (the output of the phase Detector and Comparator) increases by increasing $\frac{f\ out}{N}$ (and the vice versa) while f out (the output freq. of VCO) decreases by increasing VCV (and vice versa).

In closed loop condition assume a differential increase Δf out in (f out)lock . This will be accompanied with an increase ΔVCV in (VCV)lock. The later increase will decrease f out to its original value (f out)lock . In other words a tend to increase or decrease f out will be reactly eliminated keeping f out at its lock value (f out)lock

Then in lock condition: Transmitted frequency = N x 5KHz .

A modulating signal superimposed on VCV can deviate f out around its center value (f out)lock corresponding to the center value of VCV which is (VCV)lock.

Example1:

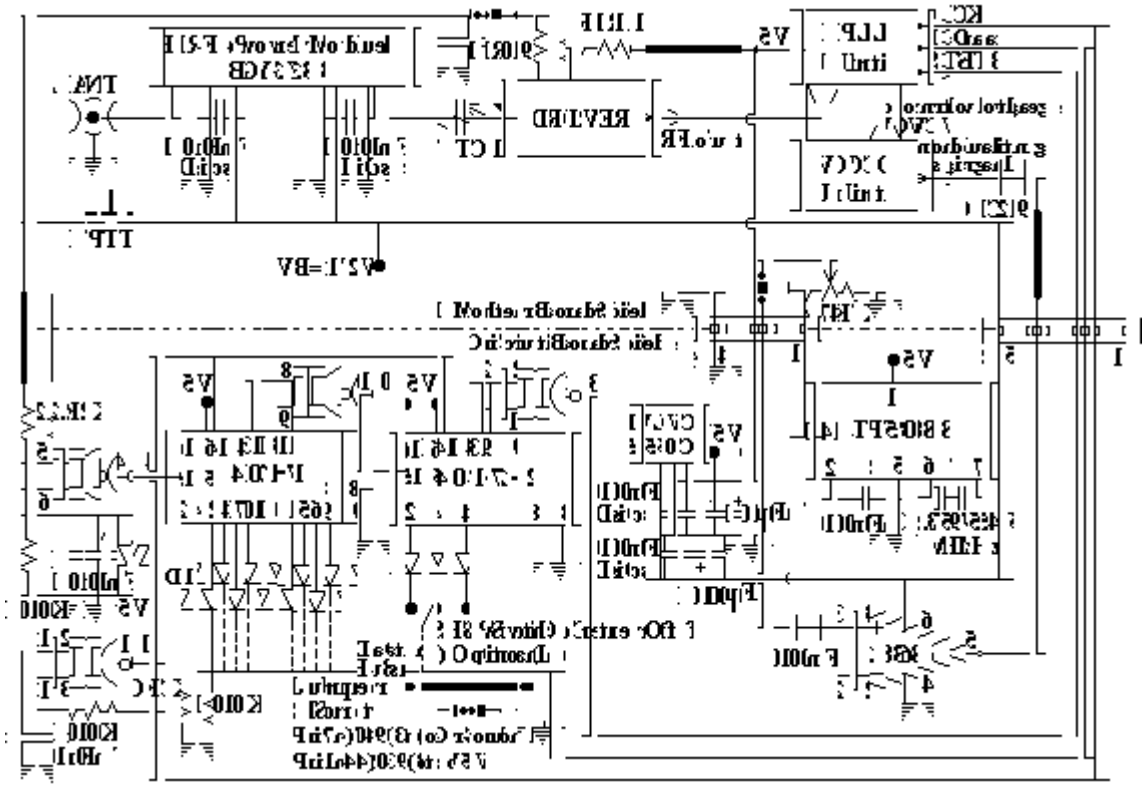
What will be the 16- Data bits (coming from the CPU) corresponding to a transmitted frequency of 92.320,107.520,136.000,140.000 and 160.000MHz

:Solution

In case of 92.320MHz

N = 92320KHz / 5KHZ = 18464 = 0100100000100000

20W-FM Broadcast Range Transmitter / Encoder



For programming the transmit frequancy:

4017 – 1 pin Number								Basic Operating Frequency kHz
2	4	7	10	1	5	6	9	
1	X	X	X	1	X	1	X	88320
1	X	X	X	1	X	1	1	88960
1	X	X	X	1	1	X	X	89600
1	X	X	X	1	1	X	1	90240
1	X	X	X	1	1	1	X	90880
1	X	X	X	1	1	1	1	91520
1	X	X	1	X	X	X	X	92160
1	X	X	1	X	X	X	1	92800
1	X	X	1	X	X	1	X	93440
1	X	X	1	X	X	1	1	94080
1	X	X	1	X	1	X	X	94720
1	X	X	1	X	1	X	1	95360
1	X	X	1	X	1	1	X	96000
1	X	X	1	X	1	1	1	96640
1	X	X	1	1	X	X	X	97280
1	X	X	1	1	X	X	1	99920
1	X	X	1	1	X	1	X	98560

1	**X**	**X**	**1**	**1**	**X**	**1**	**1**	**99200**
1	**X**	**X**	**1**	**1**	**1**	**X**	**X**	**99840**
1	**X**	**X**	**1**	**1**	**1**	**X**	**1**	**100480**
1	**X**	**X**	**1**	**1**	**1**	**1**	**X**	**101120**
1	**X**	**X**	**1**	**1**	**1**	**1**	**1**	**101760**
1	**X**	**1**	**X**	**X**	**X**	**X**	**X**	**102400**
1	**X**	**1**	**X**	**X**	**X**	**X**	**1**	**103040**
1	**X**	**1**	**X**	**X**	**X**	**1**	**X**	**103680**
1	**X**	**1**	**X**	**X**	**X**	**1**	**1**	**104320**
1	**X**	**1**	**X**	**X**	**1**	**X**	**X**	**104960**
1	**X**	**1**	**X**	**X**	**1**	**X**	**1**	**105600**
1	**X**	**1**	**X**	**X**	**1**	**1**	**X**	**106240**
1	**X**	**1**	**X**	**X**	**1**	**1**	**1**	**106880**
1	**X**	**1**	**X**	**1**	**X**	**X**	**X**	**107520**

1 Connected to Data Bus via Diode

X Not Connected

Notes:

1- Each Basic Frequency can be shifted by 160KHz & 320KHz using a SPDT center OFF switch (optional) refer to circuit Diagram.

2- We add to VCO either 22 or 33pF; 22 pF for higher freq.'s and 33 pF for lower frequencies.

3- We modify variable inductor in VCO to get a DC voltage in the range from 0.5V to 1.5V at point under letter B in PLL Unit when transmitting.

4- Adjust the 47 KΩ potentiometer to get an AC output voltage at pin5 (386) of about 2Volt.

5-100nF disc should be connected to the battery terminals (the entrance).

In the figure shown a Full WBFM-Transmitter based on VCO-PLL units and few components laying on the Mother Board of a Yaesu-23R set (the upper parts of the fig. where all other parts and components were taken apart)

Here we have used the RF power module BGY33 to give about 20W output power in the FM Broadcast range (using an ordinary FM radio for reception).

We can use the power module of the same set to get about 4W- WBFM in frequency range from 132MHz to 136MHz (using modified FM radio for reception) or even we can use the power module of an old set (old power module) to get about 2W in the FM Broadcast range 106-108MHz.

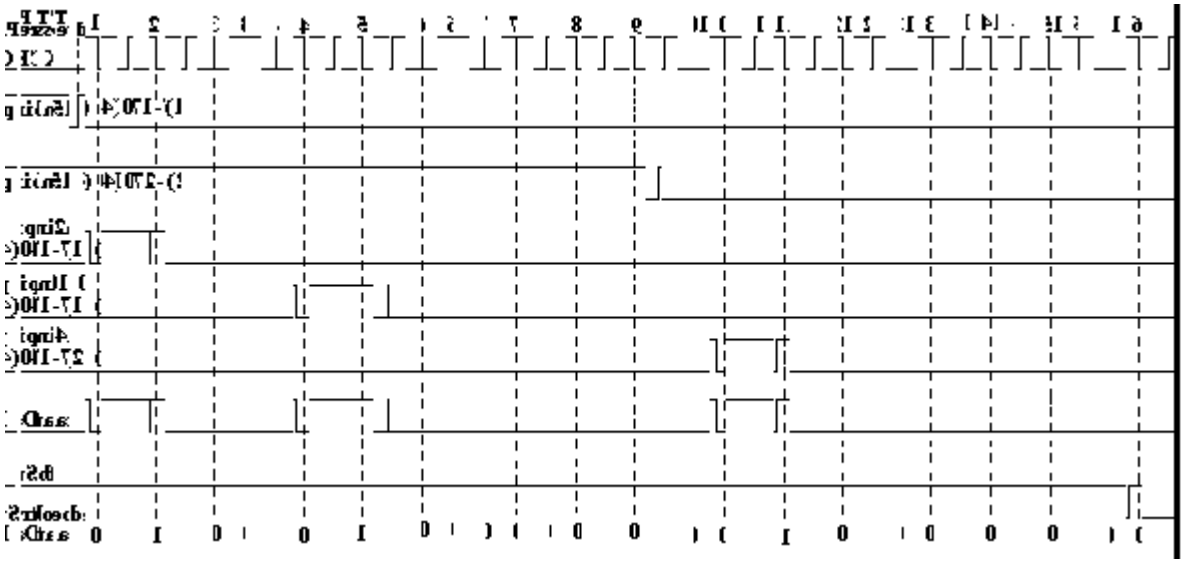
The lower part of the figure is a circuit board including two sections: -

The Encoder section where we have used a DTMF-Encoder (5088) to get digit-C DTMF code, this signal was amplified by 386 and injected to the VCO as a modulating signal.

The second section is the control part which generates the Ck,Data and Stb signals required for the PLL unit (simulating those generated by the CPU of the original set) to give the programmed transmitted frequency .

The original 5V regulator is put on the same lower part to give the required 5V line for both parts.

The function of the control section is best understood by an example.



Example2:
Refer to the 1st figure; a diode is connected between the data bus and pin2 (4017-1). Assume the connection of another 2 diodes from pin10(4017-1) and pin4 (4017-2) to the data bus what will be the transmitting frequency?

Solution:
Pressing PTT will put 15(4017-1) low and prior to this:
The data line goes high once (for one full cycle) slightly after the first +ve CK transition, 2ndly slightly after the 4th +ve CK transition and 3rd slightly after the 10th +ve CK transition (refer to the fig. Above).
They will not go high any more (keeping PTT pressed) why?
The answer:because slightly after the 9th +ve CK transition; pin13(4017-1) goes high inhibiting the counter and after the 16th +ve CK transition pin13(4017-2) goes high inhibiting the counter .
Note that when 13(4017-1) goes high ;the Reset input of (4017-2) goes low.
A –ve transition at the Reset input while the CK input high will clock the counter making pin2(4017-2) goes high slightly after the 9th +ve CK transition .
Slightly after the 16th +ve CK transition; Stb line goes low; strobing the 16 data bits from a 16-bit shift register (clocked by the same clock pulses).
The 1st data bit is the MSB and the equivalent decimal will be;

N = 0100100000100000 =18464

Transmit freq. =18464 x 5KHz = 92.320MHz

Example3:
How can you program the transmitter for the other transmission frequencies in example1?

Example4:
How can you program the transmitter for Digit A or B code?

Control & Encoder Circuit Board
For 20W- FM Broadcast Range Transmitter / Encoder

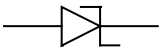
1. On a strip board write from left to right the letters A to X and from up to down the numbers 1 to 16.
2. Cut the board over the holes of number 16 to get (24 holes x 15 holes) rectangular board.
3. Cut a square over CD1/CD2 also over VX5/VX6.
4. Cut the board over the holes;
   CD3/ABCDEFGH5/NOPQRST4/WX7/ABCDEFGH13
   ABCDEFGHNOPQRSU9/MNOPQRSTUVWX12
5. Use IC Bases

Pin1 (4017) Pin 16	A7 - A4
Pin1 (4017) Pin 16	H11 - H14
Pin1 (4093) Pin 14	N6 - N3
Pin1 (5088) Pin 14	M13 - M10
Pin1 (386) Pin 8	U13 - U10

6. Jumpers from Component side ;
   IN1/LQ1/FS2/AI3/CL3/DF3/JT7/HJ8
   KW9/AJ10/AE15/FL15/I13-M14/J13-Q14/U6-X14.

7. Jumpers from Strip Side ;
   B3 - Q9 / E14 - N9 / G14 - R3

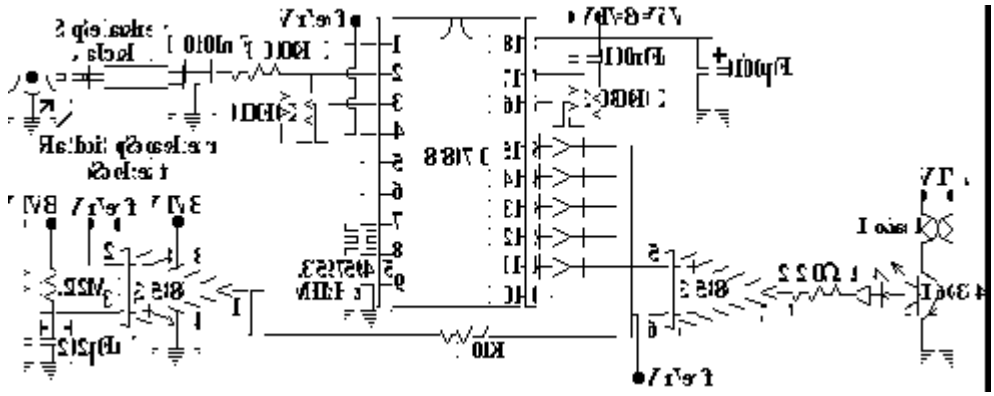
8. The components ;

5V Regulator	I JK14	Face to Down
	TS8	5V - Zener
10nF	N2 - O1	lay to the left
+100µF-	KJ11	lay to Upward
100nF	SU7/TW14/NQ15	
100nF Disc	I6-J5/J6-K5	
+10µF-	I4-J3	
100KΩ	PQ2/RU8	
Xal	R14-S15	

2.2KΩ is soldered to R7, the other terminal should be connected later by wire to one terminal of PTT.
100KΩ is soldered to J9 and the other long terminal is left open then three diode anodes are soldered to B8,E10,G10 (the cathodes are cut and left open).
The cathode of the diode connected to B8 is soldered to the long terminal of the 100KΩ (both are stand) and also to the pole of a SPDT-Switch(via a wire).
The other two cathodes are soldered to the terminals of the switch.

9. 4-pin Socket 1 to 4 M9-T15-I15-J15
   5-pin Socket 1 to 5 L14-Cathode of diode(soldered toB8)-P8-X9-K15

Digit-C DTMF Decoder



:**Circuit Analysis**

When VB is connected ;Vref goes approxmately to VB/2 then 1(358) is low (why?); .preventing 5&7(358) from going high and the Load from going ON

After a safety time; the voltage at 3(358) goes higher than Vref and 1(358) goes high.

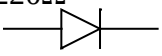
When a DTMF Corresponding to Digit C is present then 11, 12, 13 ,14& 15 go high then also 5(358) goes high; activating the load.

The 300 KΩ should be changed to accept only slightly longer duration for the Digit in case where selective DTMF Calling is interferable.

Using one more transistor,how can you modify the circuit to decode any other Digit?

Circuit Board for Digit-C DTMF Decoder

1- On a strip board write from left the letters A to X and from up the numbers 1 to11.
2- Cut the board over the holes of number 11 to get (24 holes x 10 holes) board.
3- Cut the board over the holes: CDEFGHIJKPQS6/O3/R7
4- Jumpers from Component side: FO1/CF9/FQ10/CO4/KT10/M5-S4
5- The components:

Pin1(8870) Pin 9	CK8	
Pin1(358) Pin 4	PS8	
100KΩ	DE9/AD10	
300KΩ	DE4	(270KΩ + 33KΩ)
2.2MΩ	OR10	
10KΩ	M8-P9	
220Ω	QW1	
	MG2/MH3/MI4/MJ1/SO2	
- LED +	V3-W2	head comes out of the board to Wright
D634	TUV8	lay upward with face down
-100µF+	LO8	lay upward
-220µF+	S10-R9	lay to Wright
100nF	AB5	lay upward
100nF	C1-D3	lay to Wright
Xal	I J9	lay over 8870 with body jumpered to L8
- Circuit Battery +	T2-P4	
- Load Battery +	T3-X4	
-Speaker +	KB9	
Load	U2-X5	

6- Shorts: OP5/KL8/ST8/Q7-R6

Finally, Circuit Battery and Speaker terminals should be tied together and fixed to the board ; also should Load and Load Battery terminals.