K172. Wide Band Synthesised FM Transmitter

First, download the main documentation from:

www.kitsrus.com/pdf/k172v21.pdf

Please read this text together with the main document. This text was written by Harry Lythall (SM0VPO), the designer of this circuit.

The FM Transmitter kit provides two transmitting frequencies set by the two crystals provided. You can use other crystals to transmit on other frequencies.

Assembly

First check the components against the Components Listing. During assembly there are several points to note:

- Mount the MICrophone on some wire several inches away from the board.
- Only the MB506 has an IC socket. Mount the 3 other ICs directly onto the PCB.
- Make sure coil L3 does not touch the ecap C13
- Some resistors are mounted standing up on the PCB.
- The body of the resistor goes to the circle on the overlay.
- D2 the zener diode, the band goes to the circle

Make sure the wire legs of the ferrite coil L1 & coil L3 are free from enamel and solder well to the pad, no dry joints. Go to Section 6 to Align the Kit.

A simple single wire aerial of about 74cm soldered to RF+ is sufficient to start. (Nothing is attached to RF-.)

More Discussion by Harry

1. Power Supply "Star" Formation

1. You can see from the circuit diagram that the power distribution to the various parts of the circuit is a ***star*** formation with each end of the star individually decoupled. This decoupling prevents audio and RF ripples traveling from one part of the circuit to another: R6 with C24/C25, R19 and C26, R12 and C15/C16. This technique is very effective, as evidenced by spectrum analyzer displays. The crystal oscillator, and each of the digital chips, have internal switching spikes, which generate RF and audio noise. The CD4040 divides 6MHz down to 700kHz, but other circuits give further divisions extending well into the audio range. There is a possibility of capacitative pickup by the microphone circuits. This is why you always find these circuits at opposite ends of the board.

2. Theoretically, The Kit Should Not Work At All!

In order to have a true phase locked loop, the reference oscillator signals have been divided to the same frequency. Their phase relationships are compared. Long before any frequency error, there will always be a phase error, and it is this phase error that is compared. The Phase Lock Loop (PLL [the loop]) is maintained "in-lock" and a phase error causes a correction voltage to correct the error. It is normal for a small phase error to occur, but this is corrected by the loop.

With wideband frequency modulation (WBFM) the frequency change is so great that the phase error runs away, and slips into the next cycle: more than 360 degrees of phase change. It may slip not one cycle, but many hundreds of cycles before the loop can once again become locked. The circuit continually tries to recapture the oscillator, but it cannot. So, when modulation is applied, there can never be a true phase lock.

To get a true phase lock you must divide sufficiently to get the phase within one radian (57 degrees). To get less than one radian phase change you would need to divide the deviation by the lowest frequency, eg, 75,000Hz deviation divided by 20Hz (lowest modulating frequency), which is 4000, but this corresponds to only one cycle. To deviate by less than one radian you would need to multiply the divide rate by "**π**" [π = 3.142] times that, which is a bit over 12,000. This represents the minimum divide rate required to achieve a true phase lock in a WBFM transmitter that could handle music. This simple project uses a divide rate of only 128, and therefore the divide rate is not sufficient to achieve a true phase lock.

3. So How Can We "Lock" The Transmitter Frequency To A Crystal?

The CD4046 has two different phase discriminators. One is a normal phase discriminator. The second is much more advanced and uses master/slave flip-flops, which are switched on, or off, depending upon the period time of the two input frequencies. The end result is an output which is **high** (10v DC) or **low** (0v DC), depending upon which frequency is the highest. If frequency A is greater than B, then the output is high, and it will stay there as long as the error remains. If frequency B is greater than A, then the output will become low, and remain there for the duration of the error. If the two frequencies have the same phase, then the output becomes "**Tristate**" (High impedance: floating = neither high nor low). It is because of this Tristate property of the CD4046 PLL chip that this simple synthesizer circuit is possible. The CD4046 is in reality used as a **Frequency Detector,** as opposed to a **Phase Detector**. Normally this property would be used to bring the synthesizer into lock if there were a major disturbance to the loop, such as initial power-up. A conventional phase detector would then be used to maintain the loop in lock. We are using the complex detector to keep the transmitter in lock, even with large frequency changes caused by modulation.

With our VHF synthesiser circuit, modulation causes the frequency to vary. The **average frequency** will give an **average correction voltage,** which will keep it within a kHz or so of the nominal frequency. WBFM has a deviation of +/-75kHz (150kHz total), so a momentary carrier error of just 1kHz is negligible, and still well within the channel allocation.

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COMPONENTS

Resistors 5%, carbon.

10R	R6 R10 R12 R19 brown black black	4
82R	R14 grey red black	1
330R	R13 orange orange brown	1
1K	R8 brown black red	1
2K2	R16 R18 R25 red red red	3
3K3	R26 orange orange red	1
4K7	R1 R3 R20 yellow violet red	3
22K	R22 R23 red red orange	2
47K	R7 R11 yellow violet orange	2
100K	R9 R15 R17 R24 brown black yellow	4
220K	R4 R5 red red yellow	2
1M	R2 R21 brown black green	2

Ceramic caps:

4p7	C30	1
12p	C11	1
15p	C7	1
27p	C8	1
47p	C17 C18 C22 C20 C21 C23	6
330p	C9	1
1n 102	C6 C12 C19 C27	4
10n 103	C1	1
22n 223	C2 C3 C5 C10 C14 C16 C24	7

Ecaps:

10uF/25 or 50V	C4 C15 C25 C26 C28 C29	6
220uF/16V	C13	1

30pF trimmer	1
1N4004 diode	1
Zener diode 16V D2	1
BC547B TR1 TR4	2
2N2369 TR2 TR3	2
Crystal 6.000MHz	1
Crystal 6.025MHZ	1
SPDT switch	1
78L05 IC5	1
RF Choke L1	1
7 ½ turn enamelled coil L3	1
4001 IC4	1
4040 IC2	1
4046 IC3	1
MB506 IC1	1
8 pin IC socket	1
K172v21 PCB	1

4. Amplify the Output

Connect the RF output (both RF+ and RF-) from Kit 172 to Kit 171 to boost the signal to around 250mW.

We will soon make a PCB with K172v21 and K171 on the same PCB. Later we will add a Stereo Encoder so the FM is in stereo.

For more information visit

http://w1.859.telia.com/~u85920178/