Mini-Kits® 500MHz LOCAL OSCILLATOR EME65B VER4

SPECIFICATIONS:	Oscillator:	Butler Design (Using 5th Overtone Series Resonant Crystals)
	Output Frequency Range:	400 – 540MHz **400MHz Kit** 540 – 600MHz **500MHz Kit**
	RF Output Power:	Up To +10dBm (10mW)
	Spurii:	At Least 50dB Down
	Power Supply:	+12Volts 110mA
	Kit Web Page:	**www.minikits.com.au/eme65b.htm**

DESCRIPTION: The local oscillator will provide a frequency stable +10dBm of output in the 400 to 600MHz range suitable for Transverters & Converters from the UHF to Microwave bands. There is currently two Kits available with minor component changes for the frequency ranges covering 400 – 540MHz, (400MHz Kit), & 540 – 600MHz, (500MHz Kit). The oscillator is built on a double sided PC board measuring 67 x 47mm, & should take a couple hours to construct & align. The circuit description will describe the frequencies of the tuned circuits for a 404MHz output local oscillator to suit a 432/28MHz Transverter. The oscillator uses two BFR92A surface mounted transistors in a Butler type design oscillating at the Crystals 5th overtone frequency of 67.3333MHz. Because of the light crystal loading, the Butler oscillator offers far better short term stability than the more common colpitts type oscillator. The updated version of the kit now uses a BAS70-04 schottky diode pack across the 1st BFR92A transistors tuned circuit L1/C1 that do the limiting, (harmonic generation).The second BFR92A transistors output circuit is tuned to the crystals third harmonic (202MHz). The third transistor a BFR93A surface mounted transistor doubles the output from the BFR92A, (202MHz) to the final frequency of (404MHz). Double tuned circuits are used at both the 202MHz stage, & the 404MHz stage to reduce unwanted oscillator harmonics. The design has not been tested outside the 400 to 600MHz range, but should work up to perhaps 700MHz with component changes. One limiting factor for use above 600MHz, are the lengths of the two output stripline inductors (L4 & 5), & trimmer capacitors (CT3 & 4) used.

CONSTRUCTION:

1. The PC board supplied is a double sided plated through hole board, with one side being a ground plane. The dark pads shown on the PC board overlay diagram indicate the earth (ground) plated hole connections. **Refer to the parts list & overlay diagrams for the component values used for either the 400MHz or 500MHz Kit that you are building.**

2. Refer to the Kits web page, (www.minikits.com.au/eme65b.htm) for detailed construction pictures. The surface mount components, BFR92As, BFR93A, & two 1nF chip capacitors are installed on the trackside of the PC board, use a pair of tweezers to hold them in place while soldering. All other conventional components are then installed from the top groundplane side. Next install the trimmer capacitors, & place a wire link into option 2 on the PC board for initial testing.

3. Next wind the two coils L2 and L3 on a 3mm drill bit & mount them 2.5mm above the PCB groundplane. **(Refer to the coil winding details on the parts list page for the number of turns that you require).** Count the number of coil turns by looking down at the top of the coil & counting the hoops. An extra 1/2 a turn is required on one end of each coil to loop around to reach the hole in the board, this is counted as a 1/2 a turn. These are rather critical, so take your time to make sure that you have got them correct. Depending on the amount of turns required for the frequency range, will depend on whether the coils have to be close wound, or spaced out evenly to a total length of 6mm to fit the holes in the board.

4. There are a few additions to the circuit to improve instability issues. Refer to the Top & Bottom overlay diagrams & the www.minikits.com.au/eme65b.htm Kit web page on how they are fitted. A BAS70-04 diode pack is soldered

across the Toko coil L1 on the bottom side of the board. Then solder a 22pF leaded ceramic capacitor from the emitter of the first BFR92A transistor to ground. Refer to the bottom PC board overlay diagram on how they are fitted. Also solder a 1nF chip capacitor from the 560ohm resistor lead on the top of the PC board to ground.

5. When mounting the Crystal, the outer casing needs to be soldered to the top ground plane of the PC board for stability. Carefully quickly solder a short length of 0.7mm TCW wire between the crystals casing & the top of board. **Excess heat with a soldering iron on the crystals case can damage the crystal.** Refer to Option 3 below if you are fitting a Crystal Heater to the Crystal.

CONNECTIONS: The RF output connection should be made using direct connection with miniature 50 ohm RG178 teflon coax, or a SMA09 connector.

ALIGNMENT:

1. Alignment is straight forward although some form of wavemeter or spectrum analyzer is an enormous help, as the trimmer capacitors have a large adjustment range. Set the trimmer capacitors to approximately 1/2 mesh for an initial starting point, & terminate the oscillators output into a 50 ohm diode detector probe. At UHF frequencies, a 47 ohm resistor mounted on the rear of a BNC connector with a 1N5711 Shottky or 1N4148 diode will do as a RF indicator of relative power.

2. Disconnect the wire link near the crystal & connect the supplied 47 ohm resistor between the two BFR92A transistors emitter connections. This effectively will allow the oscillator to free run at the resonant frequency of L1/C1 without the crystal. Monitoring the signal on a either a wavemeter or a scanner tuned to the crystal frequency, e.g. 94MHz, 96MHz, or (67.333MHz with 432/28MHz Transverter), adjust the oscillator coil L1, (Toko Coil) until you hear the signal. It will not be all that stable or easy to tune exactly, but you should try & tune it within a few kHz.

3. Tune L2 & L3, either use a wavemeter or Spectrum Analyzer tuned to 202MHz, or monitor the voltage drop across the 10ohm resistor in the collector circuit of the BFR93A. Once this has been peaked some output should be evident from the diode detector probe. Peak L4 & L5 for maximum output at the correct frequency, & then readjust L2 & L3.

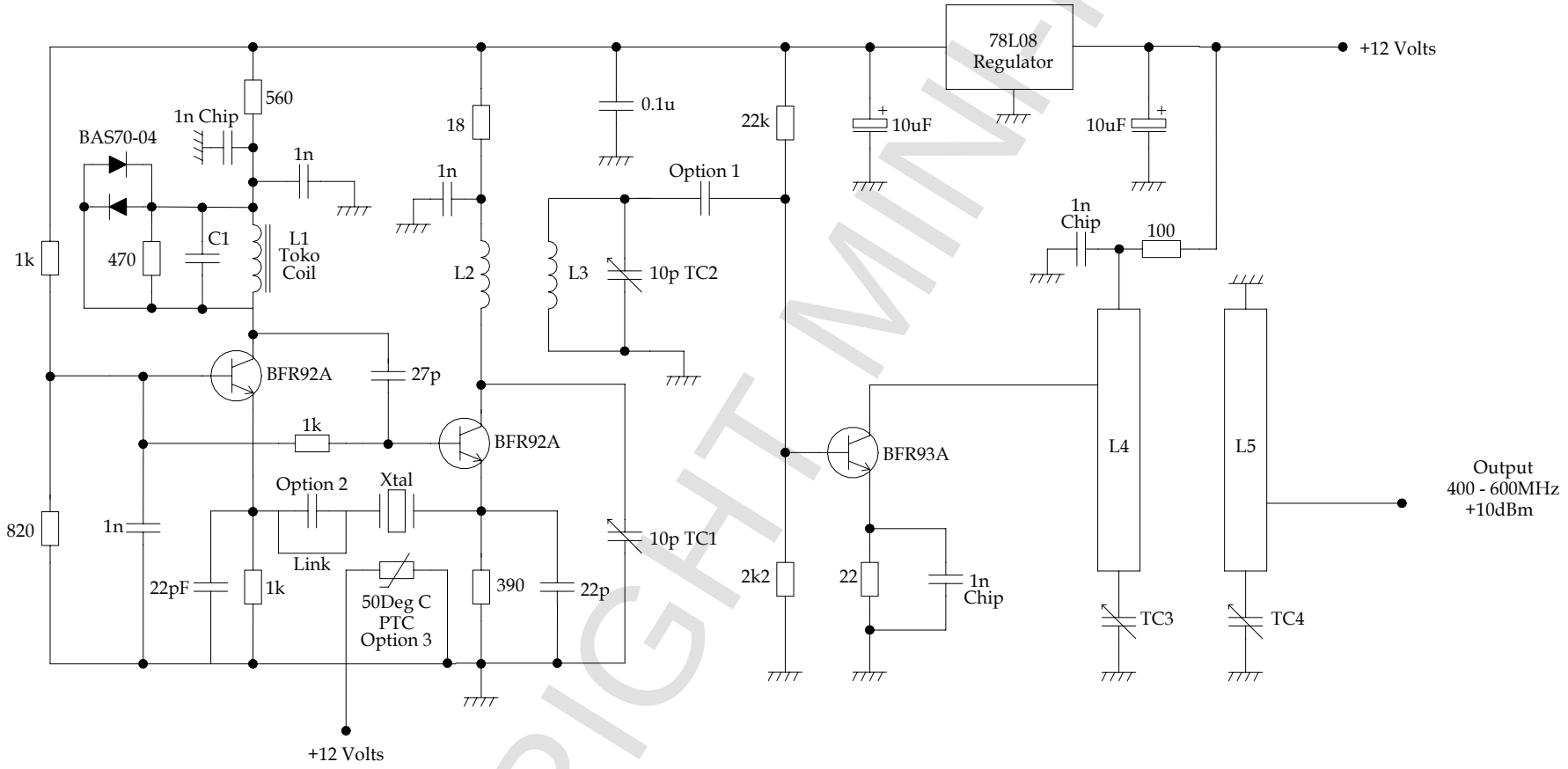
4. After alignment install the board in its final position & adjust the oscillator coil to the correct frequency. **L1 is not normally used to adjust the frequency of the oscillator but can be used to trim it slightly if the crystal is only off a few hundred Hz.** If the oscillator cannot be brought onto frequency with a slight 1/2 turn trim of L1 then link L1 should be removed & either a small value inductor or capacitor can be fitted to bring it onto frequency. If the crystal is high in frequency then an inductor should be used, & if low then a NPO capacitor is used. At 100MHz a 100nH inductor would move the crystal frequency down around 2kHz, & a capacitor of around 15pF would move it up about the same amount.

5. Check that the oscillator starts every time when power is applied. If the adjustment in the alignment note 2 above has not been done, then the crystal may not start reliably. Output from the oscillator board on a schottky diode probe should read about 1v DC when connected to a digital multimeter, or +10dBm on a suitable Microwave Power meter, or Spectrum Analyzer.

OPTION 1. A 15pF capacitor is supplied as standard to produce +10dBm (10mW) Output from the oscillator. It can be replaced with a 4p7 for approximately +7dBm output if required.

OPTION 2. A 50 degrees Centigrade, 12 volt PTC, (Positive Temperature Coefficient) Thermistor can be fitted to 50 deg C, (HY-Q TS07S) crystals for better stability. The PC board allows the Thermistor to be mounted up against the Crystal, & heat shrink used to hold it against the crystal. **Heaters should not be fitted to crystals like standard 25 deg C room temperature types as they can be damaged.**

OPTION 4. For experimenters that may want to change the design to suit their application. The EME65B Kit page on the website has detailed information on how to modify the design to improve performance. Some of the



EME65B 500MHz Local Oscillator

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DATE	17-9-2009
PROJECT	500MHz Oscillator
FILE	EME65B.SKF

improvements for Oscillator phase noise are very difficult to measure & are not essential for SSB use up to 10GHz. Further phase noise improvements may be worth experimenting with when using very narrow band weak signal digital modes. A future PC board upgrade will allow for easy fitment of the changes but many of these can easily be made to the standard board.

PARTS LIST:

RESISTORS

1 x 18R	1/4 Watt Resistor
1 x 22R	1/4 Watt Resistor
1 x 47R	1/4 Watt Resistor (used to align only)
1 x 100R	1/4 Watt Resistor
1 x 390R	1/4 Watt Resistor
1 x 470R	1/4 Watt Resistor
1 x 560R	1/4 Watt Resistor
1 x 820R	1/4 Watt Resistor
3 x 1k	1/4 Watt Resistor
1 x 2k2	1/4 Watt Resistor
1 x 22k	1/4 Watt Resistor

CAPACITORS

1 x 15pF	Ceramic Capacitor **(Option 1)**
2 x 22pF	Ceramic Capacitor
1 x 15pF	Ceramic Capacitor **(C1 500MHz)**
1 x 22pF	Ceramic Capacitor **(C1 400MHz)**
1 x 27pF	Ceramic Capacitor
3 x 1nF	Ceramic Capacitor
3 x 1nF	0805 Chip Capacitor
1 x 0.1uF	Monolythic Capacitor
2 x 10uF	EXR or Tantalum Capacitor
2 x 10pF	Yellow Trimmers (**TC 1&2**)
2 x 5pF	Grey trimmers **(TC 3&4 500MHz)**
2 x 10pF	Yellow Trimmers **(TC 3&4 400MHz)**

INDUCTORS, RF CHOKES, FILTERS

1 x TOKO	MC120 0.13uH **(L1 400MHz)** E526HNA100114
1 x TOKO	MC120 0.1uH **(L1 500MHz)** E526HNA100113

SEMICONDUCTORS

1 x 78L08	Regulator
1 x BAS70-04	Diode Schottky
2 x BFR92A	SMD RF Transistor
1 x BFR93A	SMD RF Transistor

MISCELLANEOUS

1 x PC Board	EME65B
1 x Instructions	EME65
2 x PCB Pins	1mm

1 x 200mm 0.8mm Emamelled Copper Wire

OPTIONAL

1 x HY-Q GJ05S or TS07S Crystal to Suit

1 x 50deg C PTC Thermistor & a short length of heat shrink tubing.

For Kit Support Refer to www.minikits.com.au/kithelp.html

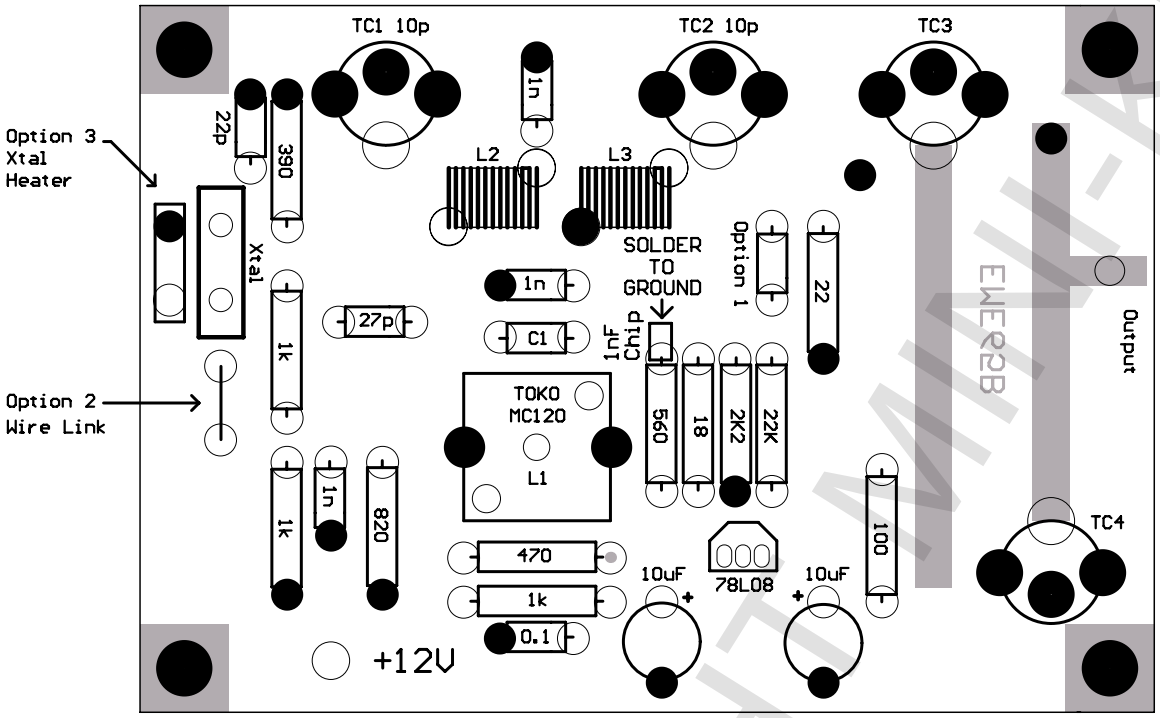
COIL WINDING DETAILS:

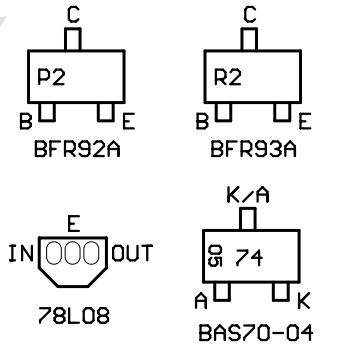
400MHz Version L2 & L3 6.5 Turns of 0.8mm ECW wound on a 3mm drill bit spaced slightly to fit the board.

500MHz Version L2 & L3 2.5Turns of 0.8mm ECW wound on a 3mm drill bit spaced out to fit the board.

The bottom of all coils are mounted 2.5mm above the PC board groundplane, using a ruler for measurement before soldering into place. **For detailed construction Pictures Refer to www.minikits.com.au/eme65b.htm**

TOP PCB OVERLAY DIAGRAM
500MHz LOCAL OSCILLATOR EME65B





COMPONENT PINOUTS
TOP VIEW

● PLATED THROUGH HOLES

BOTTOM PCB OVERLAY DIAGRAM