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|------------------------|------------------------|---|
| <b>SPECIFICATIONS:</b> | Output Frequency Range | 1960 to 2360MHz @3dB  |
|                        | Output Level           | +3 to +9dBm ( Depends On Input frequency & Drive )  |
|                        | Spurious Output        | Refer to <a href="http://www.minikits.com.au/eme139.htm">www.minikits.com.au/eme139.htm</a> |
|                        | Input Frequency Range  | 490 to 590MHz 4x ( Approx ) +3 to +7dBm   |
|                        | Alternative Input      | 980 to 1180MHz 2x , ( 653 to 787MHz 3x ) +3 to +7dBm  |
|                        | Powersupply            | +11 to 15 Volts @ 75mA  |

**DESCRIPTION & FEATURES:** The complete Multiplier is built on a 86x39mm size PC board & takes around 1 hour to construct. The Multiplier PCB is intended as a Local Oscillator for 2400MHz Receive Converters, or Transverters with IF's of 144, 432, & 435MHz. The nominal output level from the Multiplier is between +3 & +8dBm depending on input frequency, & drive level. The PCB has been designed so that it can be used for various applications including the standard setup as a 2x to 4x multiplier, a simple bandpass filter without amplification, or a gain stage & filter. The standard multiplier configuration is to use a 564MHz input & 4x Multiplier for a 2256MHz output. An ERA3 amplifier was chosen as it makes a very effective frequency multiplier up into the GHz region. For good harmonic output, the optimum drive to the ERA3 is +3dBm. The 4th harmonic of 2256MHz along with other harmonics is filtered by a 3 section 1/2 wave filter & then amplified by an ERA1 amplifier to around +7dBm @ 2256MHz.

#### CONSTRUCTION:

1. The PCB supplied is a professionally made plated through hole board & requires no drilling of holes for components. A good quality RF connector is required on the output of the Multiplier to minimize any loss. The input connection can be connected directly with mini 50ohm Teflon coax to save cost. I used **SMA09** connectors with the 4 legs cut off on both input & output & soldered them directly to the Tinplate/brass to make it easier for testing. A Feedthrough capacitor was fitted close to one of the +9volt power connections on the board. **Before starting construction refer to the board overlay diagrams that show various line up options for the three Kits that are available. Refer to the notes section on cutting the board for 2400MHz use.**

2. The first part of construction is to solder thin tin plate or brass strip around the board to form a box. **The width of the strip & at what height the strip is soldered to the board depends on what kit line up you are building. It is suggested that you look at the images of the prototypes on the Mini-Kits web site to give an idea on how to do this, especially the EME139 KIT3.** ( [www.minikits.com.au/eme139.htm](http://www.minikits.com.au/eme139.htm) ) With the EME139 KIT1 & 2 it is suggested that a 1/2 " to 3/4" wide strip be used, & the EME139 KIT3 1/2" strip. With the KIT1 & 2 the board is fitted halfway down the strip allowing enough room to fit SMA09 sockets. **With the EME139 KIT3, it is important to solder the strip on both boards so that the bottom of each PCB sits 1mm above the bottom of the strip allowing just enough to solder the board to the strip. This will allow 2 EME139 boards to be fitted back to back & have a 2mm distance between the bottom sides of the two boards.** Remember to solder the ends of the 1/2 wave striplines to the sides of the box for earthing.

3. Next drill any holes for mounting of the SMA connectors & feedthrough capacitor starting with a small 1mm drill bit & working up in size. Try to mark the holes for the SMA sockets pin so that pin will sit just above the PCB stripline. This will avoid any damage to the stripline when drilling through the box. **Be very careful here as drill bits tend to grab & can cause the tinplate or brass to grab which can cut fingers etc. I recommend either a small vice to hold the work, or if you don't have a drill press then use a canvas glove to hold the work flat on the edge of a bench.** The drill press can also be manually rotated with larger drill bits to avoid any accidents.

## 1960 to 2360MHz 4x MULTIPLIER EME139

4. Follow the PCB overlay diagrams carefully, by checking the components and placing them onto the board. Most components are mounted on the track side of the board. To solder in the chip capacitor & resistors, use a pair of tweezers to hold them in place, soldering one side first then the other side. The ERA amplifiers require the legs bent slightly to fit the board. Simply hold the ERA on a flat surface & half way along each lead, press down on the lead with a jewelers screwdriver or tweezers until the end of the lead sits flat & parallel to the bottom of the ERA device. ( **ERA-SM versions already have the leads bent as required** ). Then simply solder the ERA devices to the tracks on the board.

5. Install the two PCB pins supplied to the +9 volt connections on the board & solder into place ( **Groundplane Side** ). Connect some suitable thin hookup wire between the two pins on the bottom side of the board. Using another length of hookup wire connect one of the PCB pins to the Feedthrough Capacitor that you have soldered onto the Tin / brass box.

6. The 9 Volt 7809T regulator can be mounted close to the feedthrough capacitor on the side of the Tin / Brass Box as shown on the Website. The metal tab is soldered to the Tin / Brass for the earth connection & some minor heat sinking. Solder the two 10uF EXR capacitors to either side of the regulator as shown. Make sure that the -ve connectors are soldered to the Tin / Brass Box earth.

7. The bias resistors for the ERA amplifiers have been selected for a +9 volt supply only. If you decide to either use the Multiplier on another voltage, then you will have to recalculate the resistor values to suit. The voltages for the ERA devices are quite critical when using them as multipliers & amplifiers. The output Spectrum & level will change dramatically either side of the nominal 9 volts used.

8. **Additional construction Information for the EME139 KIT3:** The PCB pins need to be fitted correctly to allow the RF & +9 volt connections of the two boards to be connected together. When the two boards are fitted back to back, this allows the +9 volt connections on both board to be connected, & the RF out from the ERA2 on board 1 to connect to the input of board 2. **Don't fit any PCB pins to any other holes or to the second filter board. Before the two board are soldered together along the 2 strip boxes make very sure that you have wired the +9 volt connections on board 1 together with the wire supplied.** A number of striplines need to be connected on the second filter board with thin brass or foil strips. Refer to the [www.minikits.com.au/eme139.htm](http://www.minikits.com.au/eme139.htm) web site pictures on how to do this.

**TESTING:** All the filters are pretuned, so no alignment is required.

1. Connect a suitable Power Meter or Spectrum Analyzer to the output connection & apply +3dBm 2mW oscillator drive signal to the input of the Multiplier. You can check the output of the multiplier against the tested results on the Mini-Kits website to make sure that it is working correctly. ( [www.minikits.com.au/eme139.htm](http://www.minikits.com.au/eme139.htm) ). Most +7dBm mixers only require +1dBm or more to work well. So don't be too worried if you cannot get the full output.

### NOTES:

1. Chip components crack easily so if you have problems getting the kit going properly, check for broken chip caps throughout the signal path. **A few extra chip capacitors have been included with the kits.**

2. The Multiplier PCB can be used on 2400 to 2500MHz by simply cutting around 2mm from each side of the board, ( 4mm Total ). Mark the board carefully with a steel rule & scribe, & then grind the board down with a bench sander until you have the required width.

3. The Multiplier is also suitable as a 2x multiplier ( 1200 to 2400MHz ) for ATV use. Simply cut the board as in 2 above & construct a ERA3/5 multiplier line up as per the overlay diagram.

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4. Do not fit a bypass capacitor on the end of the 1/4 wave bias line on the ERA3. It was found during testing that fitting a bypass capacitor here caused the ERA3 to become unstable & not produce good harmonic output. A bypass capacitor on the ERA1 or 2 was found to work fine & should be used.

5. For extra filtering, another EME139 PCB can be added on the output of the first board as in the KIT3. With the EME139 KIT3 the ERA1 was replaced with an ERA2 for the extra gain due to the additional loss through the second EME139 PCB board filter. The 2256MHz output from the EME139 KIT3 measured +7dBm on the prototype.

### PARTS LIST:

#### RESISTORS

1 x 120R     1206 SMD Resistor  
1 x 150R     1206 SMD Resistor

#### CAPACITORS

6 x 10pF     SMD 0805 Chip Capacitor  
2 x 1nF       SMD 0805 Chip Capacitors  
2 x 10nF      SMD 0805 Chip Capacitors  
1 x 1nF       Feedthrough Capacitor  
2 x 10uF      EXR Electrolytic Capacitor

#### SEMICONDUCTORS

1 x ERA3       Mini-Circuits Amplifier  
1 x ERA1       Mini-Circuits Amplifier **KIT1**  
1 x ERA2       Mini-Circuits Amplifier **KIT3**  
1 x 7809T       9 Volt Regulator TO220

#### MISCELLANEOUS

1 x PC Board   EME139 PCB   **2 x EME139 PCB   KIT3**  
1 x Instructions   EME139  
4 x 1mm PCB pins  
1 x 150mm wire wrap wire  
**EME139 KIT1/3**

#### RESISTORS

2 x 120R     1206 SMD Resistor  
1 x 150R     1206 SMD Resistor

#### CAPACITORS

6 x 10pF     SMD 0805 Chip Capacitor  
2 x 1nF       SMD 0805 Chip Capacitors  
2 x 10nF      SMD 0805 Chip Capacitors  
1 x 1nF       Feedthrough Capacitor  
2 x 10uF      EXR Electrolytic Capacitor

#### SEMICONDUCTORS

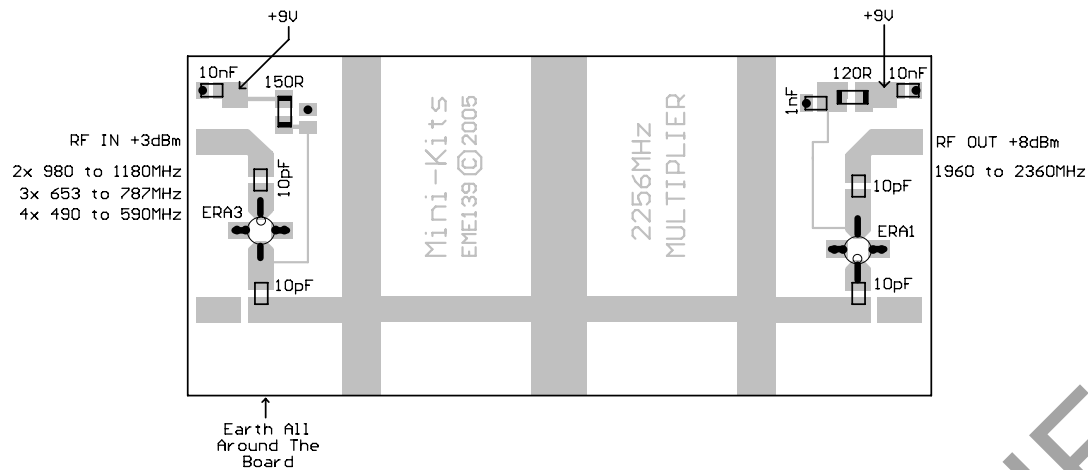
1 x ERA3       Mini-Circuits Amplifier  
1 x ERA5       Mini-Circuits Amplifier  
1 x 7809T       9 Volt Regulator

#### MISCELLANEOUS

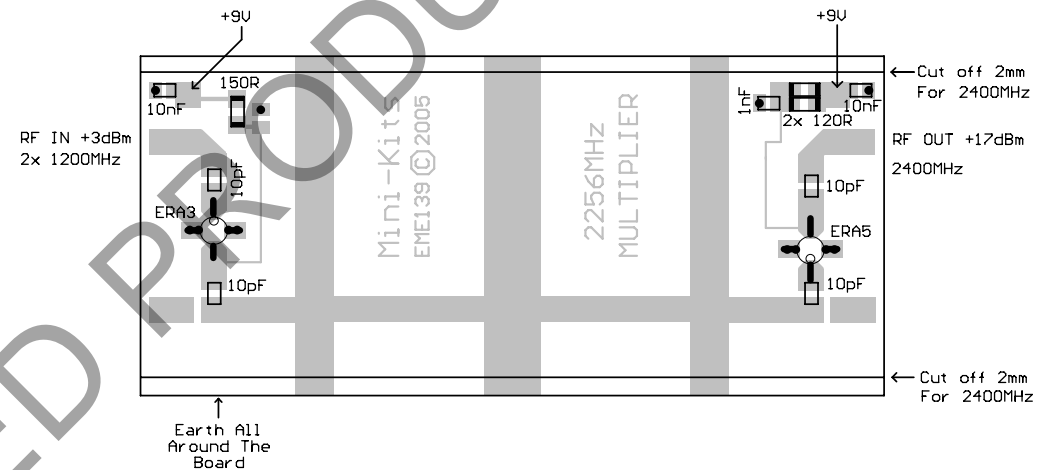
1 x PC Board     EME139 PCB  
1 x Instructions   EME139  
4 x 1mm PCB pins  
1 x 150mm wire wrap wire  
**EME139 KIT2**

Please Refer To [www.minikits.com.au/eme139.htm](http://www.minikits.com.au/eme139.htm) for Construction Pictures & Information

EME139 KIT1 2x 3x 4x MULTIPLIER



EME139 KIT2 EXTRA OUTPUT



EME139 KIT3 2x 3x 4x MULTIPLIER EXTRA FILTERING

