

SPECIFICATIONS:	Bandwidth	3250 – 3550MHz +/- 3dB
	Gain	>26dB 3300 – 3550MHz
	Noise Figure	<2dB (Typically 1.6dB @ 3350MHz)
	Local Oscillator	PLL VCO 2300MHz
	I/F Output	950 – 1250MHz Output for 3250 – 3550MHz RX
	Power	12 – 18volts 130mA

DESCRIPTION & FEATURES: The complete receive converter is built on a single 55 x 78mm size PC Board & takes around 3 to 4 hours to build & test. The converter is a broadband NO-Tune design using hairpin filters that cover 3250 to 3550MHz. 50ohm striplines with Monolithic Amplifiers, (MMICs), & SMD components are used for consistency in performance, & to ensure that construction errors are kept to a minimum due to the different construction techniques used from one constructor to the next. A Mini-Circuits ADE35 Mixer has been used , as it is low cost & has good performance. The local oscillator uses a Phase Locked Loop (PLL) for minimal drift & requires no tuning. The converter has 26dB gain & a 1.65db noise figure, & the I/F output frequency is 950-1250MHz, and can be connected directly to the input of a Analogue Satellite Receiver.

RECEIVE SECTION: Refer to the circuit diagram. The RF input amplifier stage consists of single MGA86576 HP GaAs MMIC amplifier providing around +23dB gain & a <2dB noise figure at 3400MHz. Bias for the GaAs MMIC amplifier is via a 82ohm resistor from the 8volt regulator. The MGA86576 has an internal self bias network so the bias resistors value is not too critical. The RF input stripline filter has a 250MHz -3dB bandwidth from 3300 to 3550MHz with approximately – 3dB loss. The signal then passes to the input of the ADE35 mixer. The ADE35 3.5GHz mixer has a loss of around 9.8dB maximum & is specified as a 1500MHz maximum IF, & is used in this design up to 1250MHz. An ERA2 wideband IF amplifier follows the mixer with around 15dB gain. A 1/4 wave open stub made from 50ohm cable is used on the output of the mixer to attenuate the 2300MHz local oscillator signal from being amplified in the ERA2 & appearing on the IF output.

LOCAL OSCILLATOR & PLL: The oscillator uses a tiny SMD Maxim MAX2753 VCO, (Voltage Controlled Oscillator) IC. The IC has an internal oscillator tuned circuit & varicap diode that can produce an output between 2100 & 2600MHz. The MAX2753 VCO is locked by a MC12179 PLL to 2300MHz, & produces around –8dBm output which drives an ERA1 amplifier to around +7 to +10dBm output. This level is then suitable to drive the input of the ADE35 Mixer. The MC12179 PLL IC is a complete single frequency divide by 256 PLL with an internal reference oscillator & charge pump cct. For the required VCO frequency of 2300MHz, a 8.984375MHz crystal, (2300 div 256) is required as a reference for the MC12179. A portion of the 2300MHz output from the ERA1 driver is fed back into pin 4 of the MC12179 phase comparator.

CONSTRUCTION:

- 1. This Kit uses a Teflon PC board that can be difficult to work with, so care must be taken when drilling any holes in the board. Blunt drill bits seem to be the best if done by hand. A power drill or press should never be used as it will tend to rip the board.**
- 2. The first part of construction is to carefully round the edges of the board with a sharp knife, & fabricate some thin 20mm, (3/4 “) wide brass strip around the outside of the board to form a box. Mark & bend the brass until it fits correctly, & solder the joint to form a box. Next using a ruler, align the board to approximately half way down the inside of the brass strip box. Next mark the positions for holes that are required for the Antenna & IF output connectors. drill holes in the brass to mount suitable connectors for the Antenna & I/F output connectors. Only SMA connectors are recommended for the Antenna & IF output connections. A F type socket could be fitted on the IF output, but these are difficult to solder to the board. Use a ruler**

3.4GHz Receive Converter EME111

to mark the position of the holes in the brass to be 1mm above the top surface of the PC board. This will suit the small diameter of SMA connector pins. Start with a small 1mm drill bit & drill through the brass to mark the position of the holes. Next open the holes up with a 3mm diameter bit. **Be very careful here as the drill bits can tend to grab on the brass & could cause a serious injury. Make sure that you clamp the assembly in a vice when drilling.** Next align the board in the Brass box with the holes slightly above the top of the striplines. Check the height of the board with the ruler & tack solder the board to the inside of the brass box. When you are happy with it, solder it all the way around on both sides of the board. Fit the SMA connectors. The center pin of the connectors need to be shortened & filed to suit the striplines. Align the SMA connectors & solder the center pin to the stripline.

3. The Circuit Board supplied is not a plated through hole board, so 0.7mm holes need to be drilled in the board to fit 0.7mm TCW links to connect the top ground plane earth connections to the bottom groundplane side of the board. These links are shown as black dots on the component overlay diagram.

4. Drill all holes for the ERA & MGA amplifiers. Start with a small PCB drill & work your way up to a 2.5mm diameter bit. **Be very careful with the hole size for the MGA86576. If you drill it any larger than the components diameter, then you will have problems with its short leg connections & stability.** A slightly blunt bit is better as it doesn't tend to rip the board material. **All drilling should be done by hand, don't use electric drills etc unless you want to destroy the board.**

5. Follow the component overlay diagram and circuit carefully, by checking the components and placing them onto the board. All components except the 7808T, Crystal, & MMIC amplifiers, are mounted on the top track side of the board. Most components are SMD, which makes it easy to build the downconverter without having to make sure that leads on components are kept short as with conventional components. **The 8.2pF ATC chip capacitor should be mounted with the writing on the side, not the top.** It is best to build the kit in stages starting with the smallest components, followed by the larger ones. To solder in the chip resistors & capacitors, a pair of tweezers are used to hold the component in place, soldering one side first then the other side. **A fine solder like 0.45mm to a maximum of 0.7mm should be used to solder the components into place. Don't use too much solder on the ends of the surface mount components as this can cause extra mechanical stress.**

6. **Before soldering in the MMIC amplifiers, use a sharp scalpel to scrape around the edges of the drilled mounting holes on the track side of the board to clear away any copper that may still be present from drilling.** The copper will also have to be cut away on the bottom groundplane side of the holes using a sharp scalpel, where the input & output leads of the MMIC amplifiers go. When soldering in the MMIC amplifiers, the in & output connections are bent up 90 degrees, & passed up through the mounting hole from the bottom groundplane side of the board, & bent out on the other side, & soldered to the striplines. The input & output legs can be left long, but the earth legs must be kept as short & direct to the groundplane as possible for stability. **This is especially important with the MGA86576 as it has very short leads which makes it very difficult to mount.** Make sure that you put the amplifiers in the right way around, ERA devices have a faint painted dot near the input lead. The MGA86576 has a black dot near the input lead. **The MGA86576 needs to be mounted from the groundplane side of the board with the ground leads soldered directly to the groundplane.**

7. Mount the 7808T regulator on the groundplane side of the board. Refer to the correct polarity as shown in the component overlay diagram. **Remember to solder the center pin to the groundplane for earthing.** Depending on the voltage level that is input to the converter, will depend on whether the regulator may need some form of heatsinking. In most cases the metal tab of the regulator can just be soldered to the copper groundplane.

8. Connect two lengths of insulated hook up wire on the groundplane side of the PCB, to connect points A to A, & points B to B as indicated on the component overlay diagram.

9. If the downconverter is to be powered via the coaxial cable to the I/F output connector, then a printed 1/4 wave RF decoupling Choke is etched on the PC board output as shown on the PC board overlay diagram. If the downconverter is to be powered by a separate supply, then a suitable feedthrough capacitor should be mounted on the brass box for the power con-

3.4GHz Receive Converter EME111

nection, & the RF decoupling choke should be cut near the IF output stripling & then connected with a short length of hookup wire to the feedthrough capacitor instead of the I/F output stripline.

TUNE UP:

1. You should now be at a stage when you are ready to apply power to the downconverter. First check your construction carefully, & make sure that there are no shorts on the input & output connections of the 7808T regulator with respect to earth with a multimeter. **Also check that the regulators center pin is earthed to prevent overvoltage to the circuitry.** Apply power to the converter & check the voltages as shown on the circuit diagram. **Be careful not to short any connections on the MMIC amplifiers as it can destroy them.**

2. **First check that the PLL is locked by measuring the voltage on pin2 of the MAX2753. The voltage should be around 0.4volts for a 2300MHz output.**

3. Connect the downconverter to a suitable satellite receiver or module, & tune the Satellite receiver to 1010MHz. Check that the voltage from the Satellite receiver is present & around 12 to 14 volts. Attach a suitable 3400MHz antenna to the downconverter & tune in a 3310MHz signal. Some slight adjustment of the Satellites receivers IF frequency may be required.

4. Local oscillator rejection can be improved by fitting a 1/4 Wave open stub to the output of the mixer. **This is only an option & a Spectrum Analyser is required for this.** A short length of mini 50ohm coax has been supplied to make the stub. A small 0.7mm hole needs to be drilled though the output stripline from the mixers IF output. The coax is fitted from the groundplane side of the board with the center of the coax going through the hole & soldered to the stripline. The outer of the coax is soldered to the groundplane of the board. The output of the coax is open not shorted & is cut gradually with a sharp pair of sidecutters while monitoring the 2300MHz local oscillator breakthrough on the IF output with a Spectrum Analyser.

OPTIONS & NOTES:

1. If you have instability problems with the MGA86576, then a small piece of microwave absorb material can be added to the inside of the brass box near the antenna socket. This should not be required if you have mounted the MGA device correctly as in the construction notes & used a SMA socket for the antenna connection.

2. If you are going to use a Satellite receiver to directly power the downconverter via the cable, then check the LNB supply voltage from the Satellite receivers LNB connector before connecting to the downconverter. Some Satellite receivers allow the LNB voltage to be changed between 14 & 18 volts depending on whether Horizontal or Vertical polarization is selected. Use the 14volt position to reduce the heat sinking requirements of the 7808T regulator.

3. The downconverter requires no tuning of the bandpass filters as they have been modeled precisely to cover the frequency ranges advertised using the PCB material from our supplier. Any attempt to adjust the length of the filters printed lines will degrade the performance of the downconverter. If the PCB needs to be protected then clean the board with Alcohol, & spray on a clear PCB lacquer to protect the board. **The board should not be tinned with solder from a hot soldering iron as the heating process may burn the fiberglass dielectric & cause higher losses in the filters & 50ohm lines & degrade the performance of the converter.**

4. The <2dB noise figure of the downconverter is extremely good at 3.4GHz, & very little difference in picture noise level would be realized by going to <1dB or better with a preamplifier. Unlike lower frequencies, the downconverter should only be positioned at the antenna. It is suggested that the downconverter be mounted in suitable sealed plastic box. Instability could be a problem when using some diecast boxes due to waveguide effect within the box requiring microwave absorb material to absorb RF reflections.

5. For maximum noise figure performance from the downconverter, it needs to be connected directly to the antenna with a

3.4GHz Receive Converter EME111

very short length of coaxial cable. An offset feed dish could be used with the downconverter being mounted out on the LNB mounting arm in a box. A suitable feed can then be constructed & connected with a short length of UT141, or Quick Form 141 cable to the converter. For a TX RX system including a downconverter, TX power amplifier & other circuitry, a SMA microwave relay would be used as an antenna changeover adding a slight loss to the noise figure. Due to the extra size of a TX RX system, it would probably have to be mounted under or behind the dish, so connection to the dish feed would then require low loss flexible LMR400 Ultraflex or similar cable.

PARTS LIST:

RESISTORS

1 x 10R	SMD 1206 Resistor
1 x 82R	SMD 1206 Resistor
2 x 120R	SMD 1206 Resistor
1 x 270R	SMD 1206 Resistor
1 x 1K	SMD 1206 Resistor
1 x 10K	SMD 1206 Resistor
1 x 47K	SMD 1206 Resistor
1 x 100K	SMD 1206 Resistor

CAPACITORS

2 x 4p7	SMD 0805 Chip Capacitor
1 x ATC8p2	SMD 50mil Chip Capacitor
1x 10pF	SMD 0805 Chip Capacitor
1 x 22pF	SMD 0805 Chip Capacitor
3x 100pF	SMD 0805 Chip Capacitor
3 x 220pF	SMD 0805 Chip Capacitor
1 x 330pF	SMD 0805 or 1206 Chip Capacitor
3 x 1nF	SMD 0805 Chip Capacitor
4 x 10nF	SMD 0805 Chip Capacitor
2 x 0.1uF	SMD 0508 or 1206 Chip Capacitor

2 x 1uF SMD Tantalum Capacitor

1 x 10uF SMD Tantalum Capacitor

SEMICONDUCTORS

1 x 2v7 Zener	0805 SMD
1 x MGA86576	HP Amplifier
1 x ERA1	Mini-Circuits Amplifier
1 x ERA2	Mini-Circuits Amplifier
1 x ADE35	Mini-Circuits Mixer
1 x MC12179D	PLL IC
1 x MAX2753	2.4GHz VCO IC
1 x 7808T	Regulator

INDUCTORS

1 x 100nH	Choke SMD 0805
1 x 30mm length	mini 50ohm coax

MISCELLANEOUS

1 x 8.984375MHz	HY-Q GJ05S Crystal
1 x 100mm length	0.7mm TCW
1 x PC Board	EME111B
1 x Instructions	EME111

For Product Support www.minikits.com.au

