

circuit packaging for uhf double-balanced mixers

Versatile PC board
for dual-inline packaged
double-balanced
mixer modules
provides
flexible operation
from dc to
500 MHz

The use of double-balanced mixers in transmit and receive converters has been explored in numerous magazine articles.¹⁻⁵ The construction of mixers for vhf and uhf service is a relatively straightforward matter, and consists of a quad of matched Schottky-barrier diodes in a ring or bridge arrangement and two wideband toroidal transformers.⁶ However, with the cost of commercial double-balanced mixer modules now less than \$10, it hardly pays for the experimenter to build his own.

I was first introduced to commercial double-balanced mixers by Joe Reisert, W1JR, who showed me how to use a dual-inline packaged mixer in a 432-MHz converter.⁷ He later published information on a DIP pinout which is now used by many manufacturers for dc-500 MHz mixers.⁸ (see **table 1**). The standardization of flatpack microwave mixers allowed me to develop a universal PC layout for use at 1296 MHz.⁹ In this article I will present a similar PC layout for use with any of the uhf mixer modules listed in **table 1**.

mixer circuits

The double-balanced mixer circuit shown in **fig. 1** is based upon an article by Reisert.⁸ Except for different pin-numbering schemes used by various manufacturers, **fig. 1** is an accurate representation of all the mixers in **table 1**.

Note that two pins (3 and 7 in **fig. 1**) are connected together to form the i-f port. In some (but not all) mixers, these pins are tied together internally. To build a circuit board which is compatible with all the

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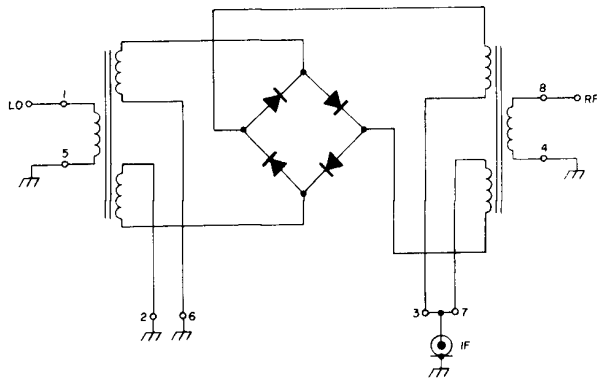


fig. 1. Practically all uhf double-balanced mixer modules use the circuit shown here, consisting of four hot-carrier diodes and input and output transformers. Some units are grounded internally, as discussed in the text.

mixers in table 1, there must be a circuit trace between these pins. Also, in some mixers, the ground points (shown as pins 2, 4, 5, and 6 in fig. 1) are internally connected to the mixer case; in others they are not. Therefore, the PC board must provide for external grounding of these pins.

Of course, in mixers which are not internally grounded, it would be possible to connect pins 2 and 6 together for use as the i-f port, and ground pins 3 and 7. Similarly, if pin 1 were grounded, pin 5 could serve as the LO port. The same possibilities hold for

table 1. Pin compatible dual-inline package double-balanced mixers. This list is not complete but gives an indication of the wide variety of pin-compatible mixers available on the market.

type	frequency	isolation (dB)	price (approx)
	range (MHz)		
Anzac MD108	5 - 500	25	\$ 8
Anzac MD109	0.2 - 200	25	17
Anzac MD142	10 - 1000	20	55
Mini-Circuits SBL-1	1 - 500	30	4
Mini-Circuits SRA-1	0.5 - 500	30	10
Mini-Circuits SRA-5	5 - 1500	25	30
Merrimac 117A	0.5 - 500	30	10
Merrimac DMS-2-200	1 - 400	30	25
Cimarron CM-1	5 - 500	25	6
Cimarron CM-2	5 - 1200	20	15
Summit 769E	5 - 500	30	25
Summit 761	3 - 1000	35	40
Watkins-Johnson M6E	5 - 500	30	37

Anzac Electronics, 39 Green Street, Waltham, Massachusetts 02154

Mini-Circuits Lab, 837-843 Utica Avenue, Brooklyn, New York 11203

Merrimac Industries, 41 Fairfield Place, West Caldwell, New Jersey 07006

Cimarron Division, Vari-L Company, 3883 Monaco Parkway, Denver, Colorado 80207

Summit Engineering, Post Office Box 938, Bozeman, Montana 59715

Watkins-Johnson Company, 3333 Hillview Avenue, Palo Alto, California 94304

pins 4 and 8 at the rf port. For that matter, in any double balanced mixer the rf and LO ports are completely interchangeable. However, since grounding is to be provided on the PC board, an internally grounded mixer will require a particular orientation on the board (more on this later).

When the mixer has been properly grounded, and the i-f pins have been tied together, the three mixer ports can be connected to coaxial connectors. To minimize impedance discontinuities it is advisable to use 50-ohm microstrip transmission lines when interfacing the mixer to coaxial connectors.

circuit board

Fig. 2 is a full-sized layout of a circuit board which will accommodate any of the mixers listed in table 1. As with all microstripline circuits, it is etched on one side of double-sided printed circuit material. The other side remains unetched and serves as a ground-plane. The dimensions of the circuit were chosen to provide a good impedance match to 50 ohms at all

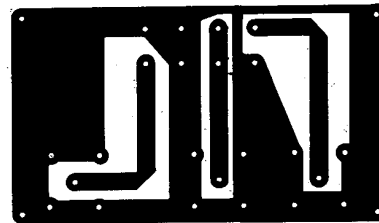


fig. 2. Full-size printed-circuit board for dual-inline packaged double-balanced mixer modules.

ports (1/16 inch or 1.5mm thick fiberglass-epoxy circuit board). At the operating frequencies of these mixers the thickness of the copper cladding is of little consequence; I used 2-ounce copper (about 2.8 mils or 70 microns thick) with no observed difficulties in either performance or etching.

The active pins of the mixer, as well as the center pins of the three coaxial connectors, must all be isolated from ground. This can be easily accomplished by using a 1/8 inch (3mm) twist drill as a countersink to remove the groundplane metallization from around the active pins as shown in fig. 3. Drilling instructions for the etched board are also shown in fig. 3. Note that all mixer and coax connector pins require no. 56 (1.2mm) clearance holes, while the no. 42 (2.4mm) mounting holes in the corner of the board easily accommodate no. 4 (M3) mounting hardware. This circuit board is designed to be used as the top cover of a Pomona Electronics 2417 die-cast aluminum box. This enclosure provides excellent shielding as well as an attractive appearance, as seen in the photograph.

coaxial connectors

High quality coaxial connectors are recommended to minimize impedance mismatches at uhf. I have had excellent results with type SMA connectors, a military designation standing for Sub-Miniature, Type A. The SMA connector is a gold-plated precision threaded unit, with a 3mm reference plane dimension. They were originally developed by the Omni-Spectra Company under their brand designation OSM, a name by which they are often referred regardless of the manufacturer. SMA-compatible connectors have become a standard catalog item of numerous companies; the ones I use are E. F. Johnson JCM series. Their female chassis connector (part no. 142-2098-001) costs less than \$3.00 and operates well into the microwave region. For interconnection to other modules, you will want to make up a few jumper cables. These can be fitted with E. F. Johnson 142-0261-001 plugs which mate well with the female chassis connector and cost about the same.

mixer pinouts

If you examine the data sheets of the mixers listed in **table 1**, you can be easily misled into believing that the devices have different pinouts. This is because the manufacturers use different pin numbering sequences, as shown in **fig. 4**. Fortunately, all suppliers mark pin 1 in some way, usually by providing an odd-colored glass bead at the seal. Regardless of the pin numbering scheme, the internal mixer configuration is basically the same. Thus it's possible to install all these mixers on the same circuit board.

Installation of the mixer on the board is straightforward. With the board oriented as shown in **fig. 3** (groundplane side up, coax connectors toward you),

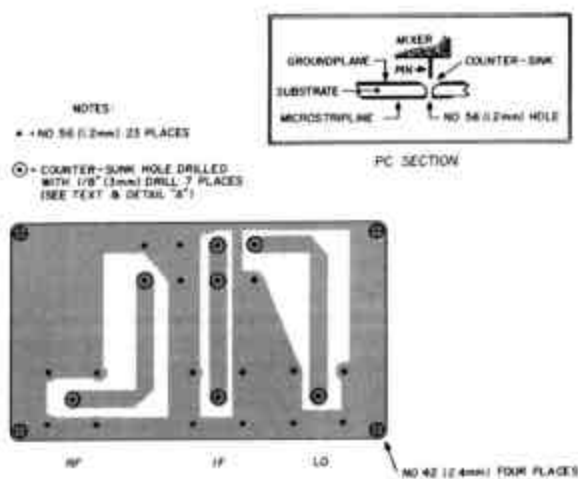


fig. 3. Drilling instructions for the double-balanced mixer circuit board. Indicated holes must be countersunk to eliminate short circuits to ground.

position the mixer so pin 1 (the one with the odd-colored bead) is away from you and toward the right. The pins will fall readily into place, and can be soldered to the microstrips on the opposite side of the board.

When installing the coax connectors, run a bead of solder around the connector body on the ground-plane side of the board; then solder the four ground pins on the microstrip side. This provides

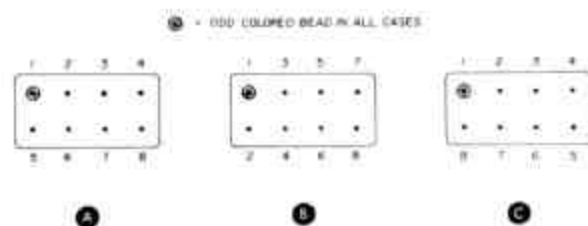


fig. 4. Pin numbering arrangements used by various manufacturers of double-balanced mixer modules.

"through-the-board" grounding of the applicable mixer pins.

parts availability

Most of the manufacturers listed in **table 1** will sell their mixers directly to the individual experimenter in small quantities; a few may require that orders be placed through a regional representative. Circuit boards can be etched from the artwork in **fig. 2**.*

*Etched, drilled, and plated circuit boards are available for \$4.50 from Microcomm, 14908 Sandy Lane, San Jose, California 95124, postpaid.

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ham radio