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28/144 MHz Transverter

Transverters for the 2m. band are always topical. In an attempt to match the current state of the art in amateur radio technology, a transverter was developed, with the help of modern components, which converts the 144 - 146 MHz range into the 10m. band.

Concepts such as high-level signal strength and test signal spectral purity have taken on increasing significance in recent times. The criterion that equipment can be copied with security is also of great importance for the author.

The transverter described below represents a circuit which corresponds to today's requirement profile.

1. CIRCUIT DESCRIPTION

Fig.1 shows a detailed circuit diagram of the 28/144 MHz transverter. In synthesising the frequency, we went back to a circuit proven many times. The crystal oscillator oscillates at 116 MHz with a U310 (T_1). This signal is amplified by the next stage. An MSA1104 (IC_1) integrated broad-band amplifier is used here. It supplies an output level of 50 mW.

The SRA1H high-level ring mixer requires an oscillator level of

+ 17 dBm (50 mW). This type can be used at up to 500 MHz.

The Pi damping element, consisting of R_1 to R_3, is used for the control transmitter output adaptation. For a "clean" transmission signal (intermodulation products with multi-tone control

P_{in}	dB	R_1	R_2	R_3
1 mW	0 dB	---	0 Ω	51 Ω
2 mW	3 dB	300 Ω	18 Ω	300 Ω
5 mW	7 dB	120 Ω	47 Ω	120 Ω
10 mW	10 dB	100 Ω	68 Ω	100 Ω
20 mW	13 dB	82 Ω	100 Ω	82 Ω
50 mW	17 dB	68 Ω	180 Ω	68 Ω
100 mW	20 dB	62 Ω	240 Ω	62 Ω

All values are taken from the E12 or E24 ranges

Table 1: Resistance values for the damping element

Fig.1: Transverter Circuit Diagram

< 50 dB), the ring mixer must be driven to full output at max. 1 mW (0 dBm). Table 1 shows the resistance values needed for the damping element plotted against the output selected. All specifications can be traced back to standard values.

The damping element simultaneously serves the ring mixer as a broad-band 50Ω cut-off. Parallel to this, the received signal is measured with a high impedance and matched to a BF981 (T_1) - a low-noise transistor stage which provides the intermediate-frequency amplification required - using L_3 and C_1.

The 2m. received signal is transformed onto the gate of the BF981 (T_1) through a Pi filter (aerial impedance 50Ω). The pre-amplifier is followed by a 2-circuit filter. At the same time, the operating voltage supplied (+ 12 V) is switched through the PIN diode, D_1 (BA886).

In the transmission mode, diode D_1 (BA886) is activated. The signal first passes through a 3-circuit filter. The subsequent amplifier is assembled with integrated broad-band amplifiers (IC_1, IC_2, IC_3). The combination of MSA0104, MSA0304 and MSA1104 guarantees an output level of 50 mW (+ 17 dBm) here, with a good 40 dB amplification.

In practical operation, this transverter can be supplemented with any power

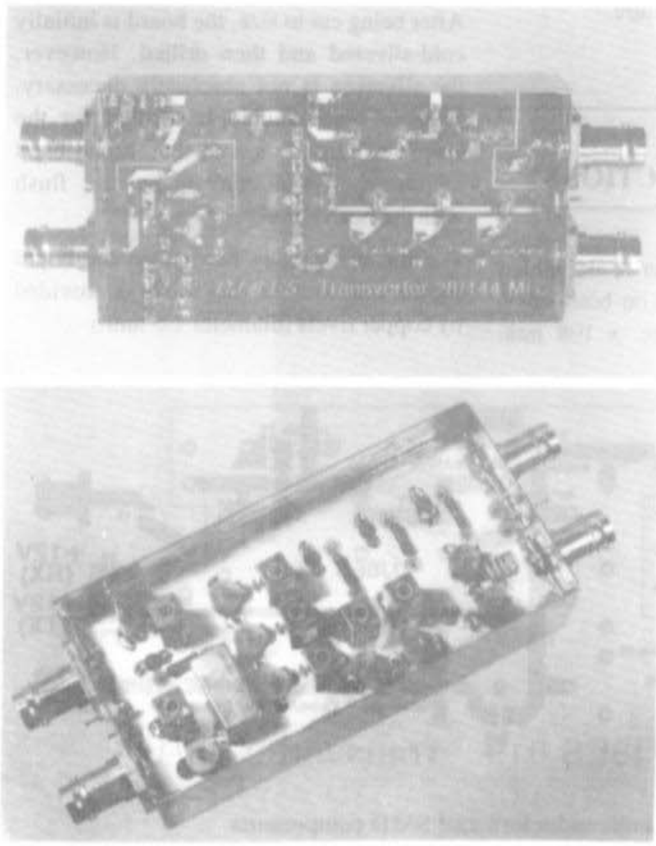

Fig.2: Specimen Transverter

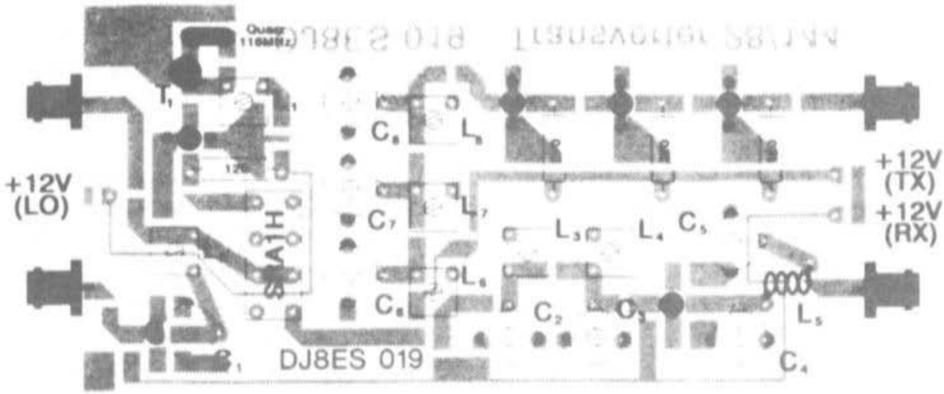

Fig.3: Transverter seen from the components side

amplifiers. In this case, additional harmonic filtration can be recommended. Suitable suggestions can be found in the relevant amateur radio literature.

2. ASSEMBLY INSTRUCTIONS

The 28/144 MHz transverter is assembled on an epoxy board, coated on both sides, with dimensions of 54 mm. x 108 mm. A board of this size can be incorporated into a standard tinplate housing (55.5 mm. x 111 mm. x 30 mm.).

After being cut to size, the board is initially cold-silvered and then drilled. However, the silvering is not absolutely necessary. Suitable holes should be drilled for the stripline transistors and the broad-band amplifiers. These components are flush with the board level.

The through-plating needed on the board for the coils and the ring mixer is provided by copper rivets (diameter 1.5 mm.).

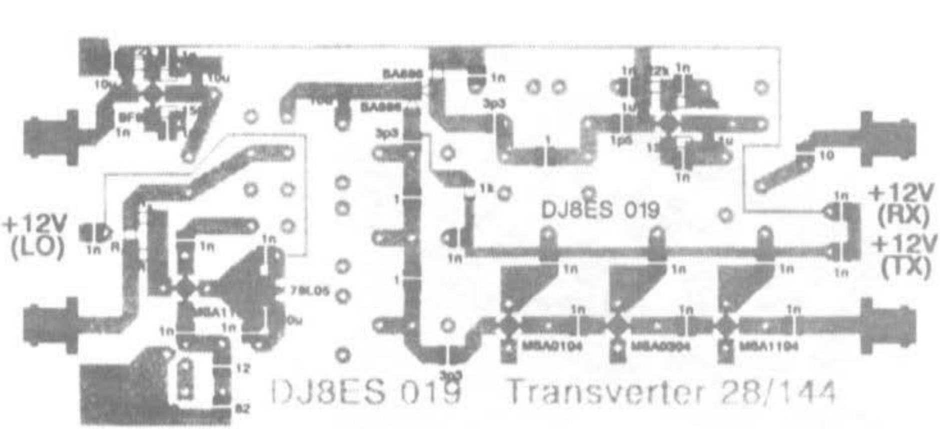

Fig.4: Track side with semiconductors and SMD components

After the drilling, the holes for the crystal, the trimmer, the Neosid coils, etc. can be reamed out on the earth side of the board (fully coated side) using a 2.5mm. drill. N.B.: earth connections must be left untouched! Recesses measuring app. 1 x 8 mm. should be sawn on the board edges concerned for the BNC bushes.

Once this preliminary work has been disposed of, the board can be sprayed with solderable lacquer.

The BNC flanged bushes must touch the cover edge with their flanges. If the board is now inserted in such a way that the bush pins are supported (cut off projecting Teflon collars with a knife first), it must still be possible to put the top cover on satisfactorily after a test insertion of the filter coils and the crystal.

When the board has been soldered to the side surfaces of the housing, the components are actually inserted.

3. COMMISSIONING

The following measuring equipment should be available for the initial commissioning and subsequent balancing:

- → Multimeter
- → Frequency counter
- → Diode probe
- → Wattmeter and
- → 2m received signal

First the oscillator is set using the tuned amplifier circuit, L[illegible]. The power consumption of this operational unit is 65 mA, of which 55 mA are needed just for the MSA1104 broad-band amplifier (IC[illegible]).

Only the 3-circuit filter (C[illegible] to C[illegible]) should be balanced in the transmission branch. The approximate trimmer locations are shown in the wiring diagram.It should be possible to measure a current of 130 mA with an operational voltage of + 12 V. This is already an indication that the amplifier stages are functioning satisfactorily. If the input damping element is dimensioned as described in Table 1, then an output exceeding 50 mW can be expected. Possible harmonics (oscillator, image frequency, etc.) are attenuated by better than 55 dB.

The initial receiver balancing can be done directly using a strong received signal (e.g. 2m. beacon). Here the 2-circuit filter (C[illegible], C[illegible]) should be carefully set for the best signal strength. A further filter is positioned on the intermediate frequency level (28 MHz) after the mixer. Here the trimmer, C[illegible], is balanced to the maximum signal. Naturally, the direct coupling of the parallel circuit influences the transmission branch. But this influence does not have any effect, as appropriate reserve capacity is available. The optimising of the signal-noise ratio (PI filter with C[illegible], C[illegible] and L[illegible] at the receiver input) concludes the balancing.

At only 20 mA, the current consumption for the receiving branch is very low. The noise factor is app. 2 dB and the transmission amplification is app. 20 dB.

4. FINAL COMMENTS

The author is making successful use of the transverter described, with a masthead pre-amplifier and a power amplifier.

Modern hybrid modules are almost available as amplifier stages. With such components, the output signal of 50 mW can be increased to 20 W in one go. I intend to describe an amplifier of this type in a later article. Here too, the minimal external wiring of the hybrid modules provides for copying without any problems.

The results achieved with the 28/144 MHz transverter demonstrate once again that outstanding results can be obtained even with homemade equipment. Units like these can be assembled and successfully operated even without a wide range of measuring equipment.

5. PARTS LIST

IC	TA78L09F (SMD) regulator
IC, IC	MSA1104 (Avantek)
IC	MSA0104 (Avantek)
IC	MSA0304 (Avantek)
T	U310 (Siliconix)
T, T	BF981 (Siemens)
D, D	BA886 PIN diode (SMD)
L, L, L	BV5061 Neosid coil
L, L, L	0.1 µH, blue/brown
L	BV5048 Neosid coil, 1 µH, yellow/grey
L	4.5 winding, 1 mm. CuAg wire
C	30 pF foil trimmer (red), 7.5mm. grid (Valvo)
C - C	12 pF foil trimmer (yellow), 7.5mm. grid (Valvo)
Q	HC18U or HC25U 116 MHz crystal
1 x	SRA1H high-level ring mixer
2 x	120Ω, 0.5 W carbon film
1 x	220Ω, 0.5 W carbon film
1 x	270Ω, 0.5 W carbon film
4 x	BNC flanged bush (UG-290 A/U)
3 x	Teflon bushes
1 x	tinplate housing; 55.5 x 111 x 30 mm.
9 x	copper rivets (1.5 mm dia.)

All other components in SMD format:

2 x	1 µH choke
3 x	10 µH choke
1 x	10 µF/20 V tantalum

Ceramic capacitors	Resistors
3 x 1 pF	1 x 150Ω
1 x 1.5 pF	2 x 220Ω
1 x 2.2 pF	2 x 1 kΩ
4 x 3.3 pF	2 x 10 kΩ
1 x 10 pF	2 x 22 kΩ
1 x 12 pF	1 x 82 pF
17 x 1 nF	

6. LITERATURE

(1) Rolf Albert, DK 8 DD: Compact 2m. transverter with low-noise preliminary stage and clean transmission signal; VHF Communications, 3/81

(2) Wilhelm Schürings, DK 4 TJ and Wolfgang Schneider, DJ 8 ES: Universal transverter concept for 28, 50 and 144 MHz; VHF Communications, 3/91