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VHF COMMUNICATIONS

A PUBLICATION FOR THE RADIO AMATEUR
ESPECIALLY COVERING VHF, UHF AND MICROWAVES

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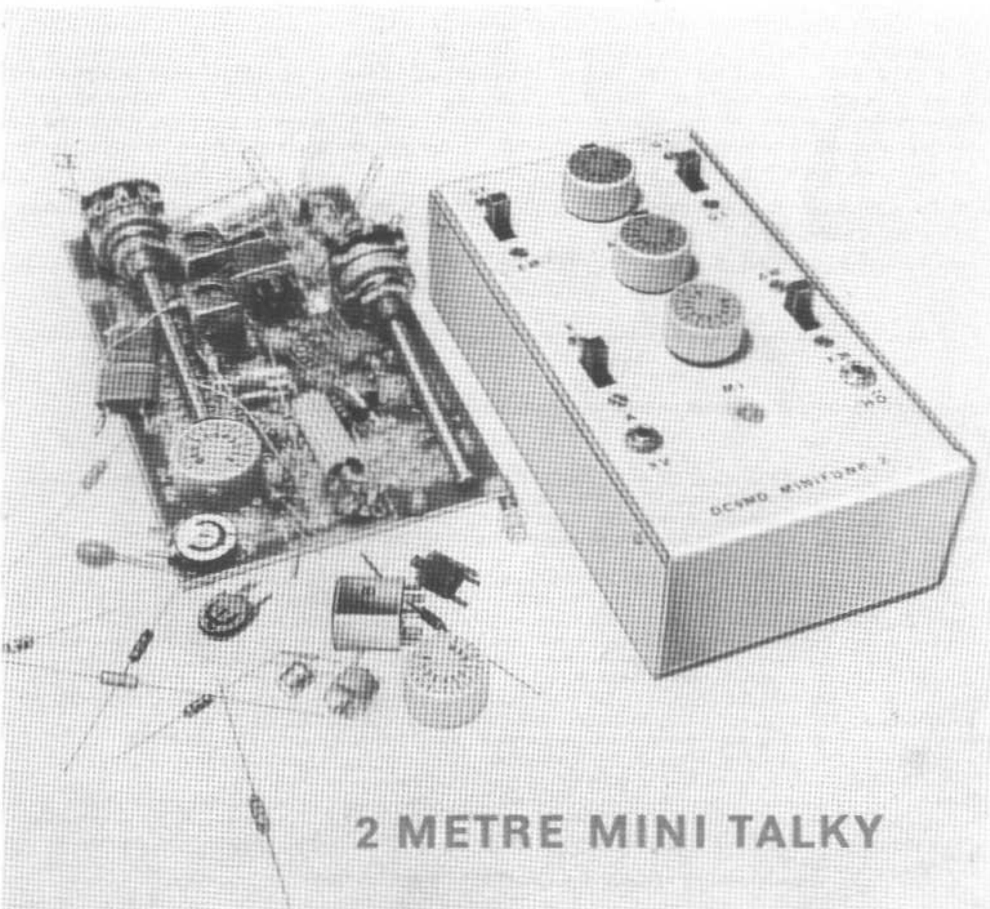

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A 2 m WALKY-TALKY

by H. Werner, DC 9 MD

INTRODUCTION

We carried out a designers competition in our German-language magazine UKW-BERICHTE to find the best design for a 2 m walky-talky. The small transceiver developed by H. Werner, DC 9 MD was awarded the first prize. The first part contains a technical description of the DC 9 MD walky-talky, the second and final part will cover the assembly and alignment.

1. CHARACTERISTICS

The competition conditions stated that a transceiver should be designed whose dimensions were so small that it would be possible to carry it with one at all times without any inconvenience. It was to represent a companion during hikes, business trips, amateur meetings, antenna measurements and similar activities. Two models are to be described: One for AM and a single transmit frequency; the other switchable AM/FM with two crystal-controlled transmit frequencies. The title photograph of this magazine showing the AM/FM model and the photograph in Fig. 1 of the AM model give an impression of the DC 9 MD walky-talky. Its specifications are as follows:

Width, height, depth (in millimetres) : 65 x 120 x 45
Weight: 310 g
RF-output after alignment for optimum amplitude modulation: approx. 15 mW
Peak carrier level: approx. 60 mW
RF-output in FM mode: approx. 60 mW
Receiver noise figure: 9 dB
Current requirements during reception: 15 mA, constant
Current requirements during transmit : 15 - 17.5 mA
Power source: 9 V transistor battery or nickel-cadmium accumulator of the same design (Varta Tr 7/8 : 70 mAh)
Semiconductor complement:

10 silicon NPN transistors	1 silicon Zener diode
2 silicon PNP transistors	1 silicon tuning diode
1 germanium demodulating diode	1 silicon diode for FM

The block diagram in Fig. 2 shows the stages and frequency processing of the unit. A 2-stage transmitter is used which is controlled from a 72 MHz crystal. The receiver is a superhet with an intermediate frequency of 10.7 MHz. The local oscillator operates in the range of 133.3 to 135.3 MHz and is tuned with the aid of a varactor diode. The operating points of the RF amplifier stage and the three IF amplifier stages are varied automatically and with the aid of a potentiometer which means that a very large control range of the RF gain is achieved.

After extensive measurements by the publishers and experimental operation by W. Messerschmid, DC 8 TN, it was found that the only unfavourable characteristic of the transceiver is in the slight radiation at three times the crystal frequency. This could cause TVI to CCIR television channel 11 (217.25 MHz). If the unit is to be used in built-up areas where this television channel is used, it is advisable for a small filter to be used, for instance, as described in (1).

Fig. 1: The DC 9 MD Walky-Talky

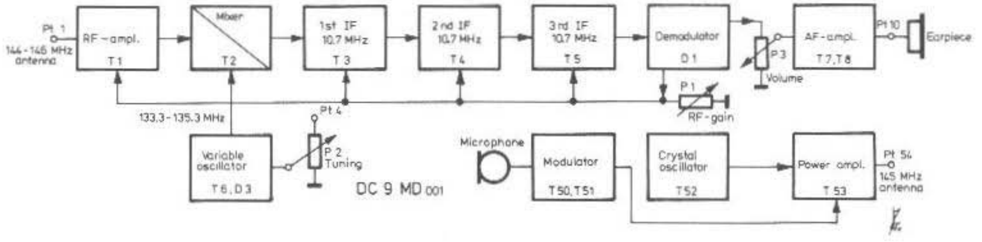


Fig. 2: Block diagram

The receiver sensitivity is very high in comparison to the transmit power. The selectivity is completely sufficient for normal operation; the demodulation of FM transmissions on the slope of the selectivity curve is achieved without problems due to the excellent frequency stability of the local oscillator.

The image frequency (122.6 - 124.6 MHz) will be audible when more than 20 µV are present at the antenna input. No IF break-through occurred even with an input signal of 20 mV. It is possible for spurious signals to be received at four frequencies between 20 MHz and 37 MHz at input voltage levels over 60 µV, however, DC 8 TN used this transceiver only a few kilometres from the powerful broadcasting transmitter station Mühlacker without noticing any interference.

2. CIRCUIT DESCRIPTION

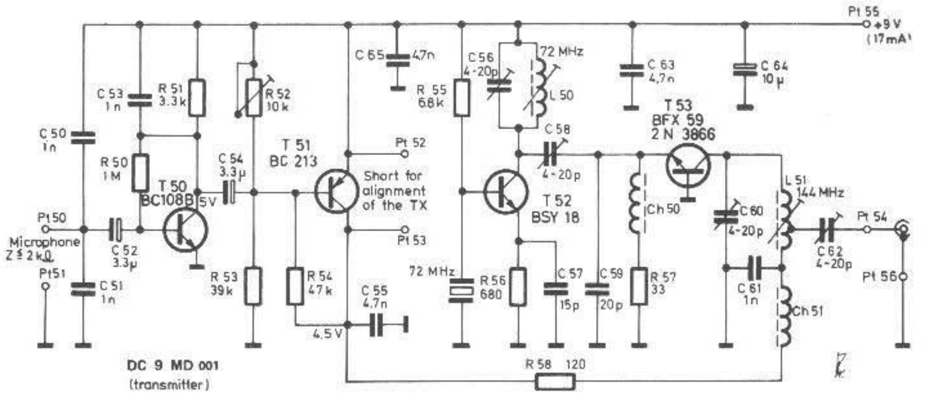
Although the transmitter and receiver are accommodated with their two audio amplifiers on a common printed circuit board, the circuits are to be described separately for reasons of clarity.

2.1. TRANSMITTER WITH MODULATOR

Fig. 3 shows the circuit diagram of the transmitter together with its amplitude modulator. As has already been mentioned, the transmitter has two stages and the crystal frequency is in the 72 MHz range. It has been found during experiments by the publishers that the transistor BSY 18 which is used as oscillator transistor T 52 cannot easily be exchanged for another type when using the given circuit.

The output stage equipped with transistor T 53 must operate at very low collector-emitter voltages because the output stage of the transmitter and the modulator are connected in series across the already relatively low operating voltage. This means that a high-gain type possessing a high transit frequency and correspondingly low reactive capacity is required. In the AM mode, the output transistor is only provided with approximately 4.5 V. Besides the transistor types BFX 59 and BSY 18, experiments made by the publishers have shown that type 2 N 3866 is also suitable, and is now offered at modest prices.

Of course, the output transistor of the transmitter is not operated anywhere near its maximum power capacity which is the reason why no cooling fins are required. In the modulation peaks, the output transistor receives double the voltage, e.g. the full operating voltage, so that the output power increases to four times that of the unmodulated carrier level. This condition can be achieved by short circuiting the modulator transistor T 51.



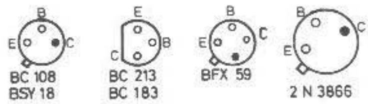


Fig. 3: Circuit diagram of the transmitter with modulator

Since the transmit alignment is made at the peak power level, connections Pt 52 and Pt 53 are provided for shorting the modulator transistor. The trimmer resistor R 52 allows the operating point of modulator and output stage to be adjusted to the carrier level.

An AF amplifier equipped with transistor T 50 completes the transmitter. The very simple method of stabilizing the operating point using a high-impedance base resistor means that a transistor with a very low base current is required, e. g. a transistor with high current gain. With the exception of this, any equivalent types can be used in this modulator stage. The bypass capacitors C 50 and C 51 suppress any RF voltage introduced into the modulator input. The sensitivity of the modulator is suitable for dynamic microphones; 2.5 mV (RMS) are sufficient for full modulation.

2.2. RECEIVER WITH AUDIO AMPLIFIER

Fig. 4 shows the circuit diagram of the complete receiver. The same is valid for the RF amplifier stage equipped with transistor T 1 in a common base circuit as was mentioned for the stages of the transmitter. With the given and proved circuit, transistor type BFX 62 (for preamplifier and mixer stages up to 1 GHz) cannot easily be replaced by other transistors such as the BF 224, unless a considerable reduction in sensitivity is acceptable.

The mixer stage equipped with transistor T 2 is not critical. It is possible for transistor type BF 224 to be used instead of the BFX 60. The three subsequent intermediate amplifier stages are equipped with low-reactive control transistors. Similar types could be used in place of the recommended BF 184.

The IF selectivity of the receiver is mainly determined by four IF transformers. Four of the five resonant circuits are in the form of screened miniature circuits with built-in capacitors which are manufactured in Japan.

The operating points of the RF amplifier and the three IF amplifier stages are determined by a variable voltage devider comprising resistor R 20 and potentiometer P 1. This manual RF gain is superimposed on to the rectified signal voltage from diode D 1 via decoupling resistor R 17 for the automatic gain control.

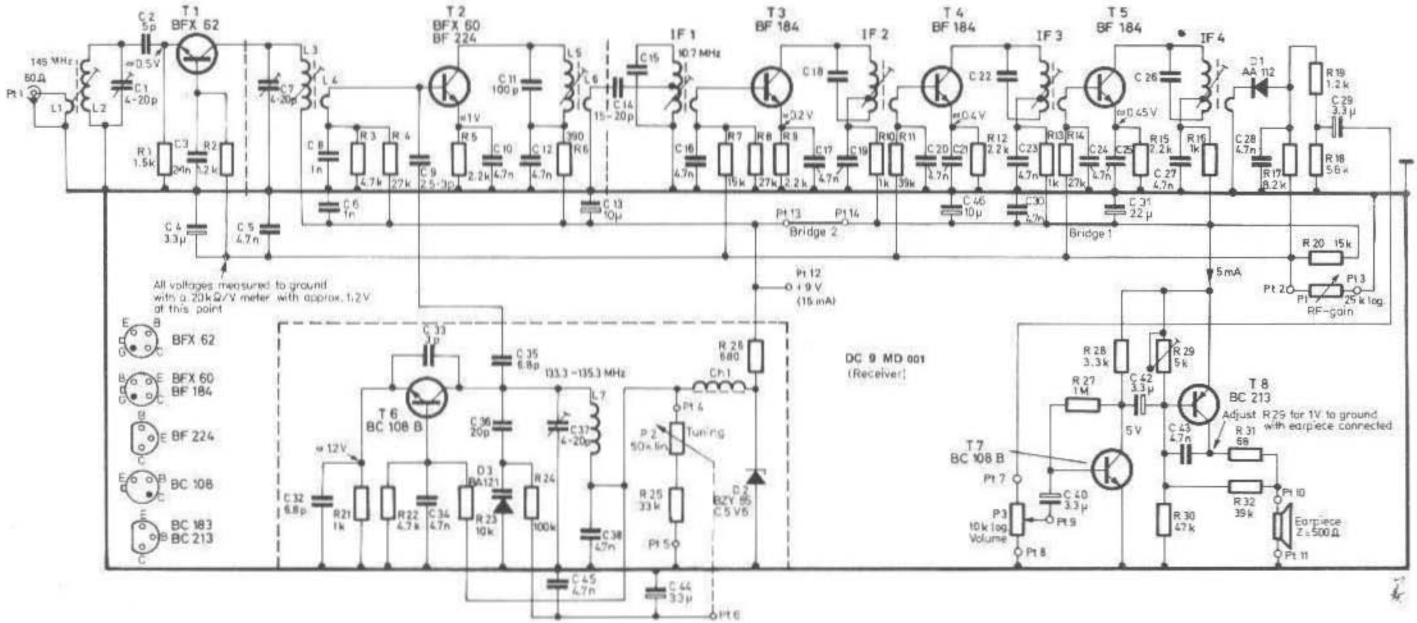


Fig. 4: Circuit diagram of the receiver

The AF voltage is fed via the volume potentiometer P 3 to a two-stage AF amplifier which is similar to the modulator. The audio output stage equipped with the silicon PNP transistor T 8 is adjusted to a lower collector current than the modulator stage because it is only necessary for an earpiece to be fed. Transistor T 7 must possess a high current gain for the same reason that was mentioned for T 50.

The transistor type used in the variable oscillator is not very critical. Transistor T 6 operates in a common base circuit, the collector-emitter capacitance is increased externally by capacitor C 33. The tuning diode D 3 is connected in parallel with the resonant circuit via C 36. This diode receives its tuning voltage via the decoupling resistor R 24 from the tuning potentiometer P 2. In order to ensure that the DC voltage across the varactor diode does not fall below the value of the peak RF voltage, resistor R 25 has been inserted between P 2 and ground. The supply voltage of the oscillator and the tuning diode has been stabilized with the aid of the Zener diode D 2 to 5.6 V. In order to increase the frequency stability further, the whole oscillator unit is enclosed in a small plate casing.

2.3. OPERATING THE WALKY-TALKY IN THE FM MODE AND VIA REPEATERS

It is extremely easy to modify the AM transceiver for FM operation on two channels. This can be made switchable so that the transceiver is capable of being switched to AM and FM. The described walky-talky has been successfully used over FM repeaters, and because this mode of operation is becoming popular, the modification for frequency modulation will be included in the construction.

3. CONSTRUCTION

3.1. COMPONENT DETAILS

T 1: BFX 62 (Siemens)
T 2: BF 224 (Texas Instruments Germany) or BFX 60 (Siemens)
T 3 - T 5: BF 184 (AEG-Telefunken)
T 6, T 7, T 50: BC 108 B, BC 183 B, 2 N 3904 or similar silicon NPN-AF types
T 8, T 51: BC 213, 2 N 3906 or similar silicon PNP-AF type
T 52: BSY 18 (Siemens)
T 53: BFX 59, BSY 18 (Siemens) or 2 N 3866

D 1: AA 112 (AEG-TFK), 1 N 52 or similar germanium demodulator diode
D 2: BZY 85/C5V6 (AEG-TFK) or ZF 5.6 (ITT-Intermetall), 1 N 752A
D 3: BA 121 (AEG-TFK), BA 110 (ITT-Intermetall) or BA 120 (Siemens) 1 N 5462 A

IF 1 - IF 4: Individual IF-circuits for 10.7 MHz with coupling link and built-in capacitors. 10 mm x 10 mm, 13 mm high; from 10.7 MHz IF transformer set.

All other inductances (six in number) are wound on 4.3 mm diameter coil formers. Attention should be paid that the coils are wound in the same direction. The coils should be glued into place after winding.

L 1: 1 turn of insulated wire wound onto the cold end of L 2
L 2: 4.5 turns of 0.5 mm dia. (24 AWG) silver-plated copper wire, coil length 7 mm, VHF core (brown)
L 3: 4 turns otherwise as for L 2
L 4: 2 turns of insulated wire wound onto the cold end of L 3
L 5: 28 turns of approx. 0.4 mm dia. (26 AWG) enamelled copper wire close wound; core with the red coloured point (SW/VHF core)
L 6: 4 turns, wire as for L 5, wound onto the cold end of L 5, glue into place
L 7: 3 turns of 0.5 mm dia. (24 AWG) silver-plated copper wire, coil length 7 mm, VHF core (brown)
L 50: 7 turns, as L 2, VHF core (brown)
L 51: 3 turns of 1 mm dia. (18 AWG) silver-plated copper wire. Coil tap 3/4 turns from the cold end. Turns spaced 2 mm, VHF core (brown)

Ch 1, Ch 50, Ch 51: subminiature 1.5 μH ferrite chokes (Delevan)

C 1, C 7, C 37, C 56, C 58, C 60, C 62: 4.5 - 20 pF miniature ceramic trimmers. 7 mm dia. (Philips)
C 11: 100 pF styroflex capacitor for 7.5 mm spacing
C 4, C 29, C 40, C 42, C 44, C 52, C 54: 3.3 μF tantalium electrolytic capacitor (drop type with 2.5 mm spacing)
C 13, C 46, C 64: 10 μF, otherwise as for C 4
C 31: 22 μF, otherwise as for C 4

All other capacitors are ceramic disc types for 2.5 mm spacing.

P 1 :	25 kΩ	+log.	Potentiometers approx. 16 mm dia. with 4 mm shaft
P 2 :	50 kΩ	lin.	
P 3 :	10 kΩ	+log.	
R 29 :	5 kΩ	lin.	Trimmer potentiometers for vertical mounting on printed circuit board. Spacing: 5/2.5 mm
R 52 :	10 kΩ	lin.	

All fixed resistors: carbon resistors mounted vertically on the PC-board

1 (2)	transmit crystals for half the output frequency 72.··· MHz) HC-18/U, HC-25/U
2 (4)	miniature sliding switches with two changeover contacts
2	jack sockets for 2.5 mm plugs
1	coaxial socket BNC type UG-290/U
1	miniature dynamic microphone, Z = 2 kΩ or less. Sensitivity approximately 0.14 mV/μbar with speech frequency response
1	miniature dynamic earpiece, Z = 500 Ω, with cable
3	knobs with scales for 4 mm shafts
1	9 V battery or nickel cadmium accumulator (Varta Tr7/8 : 70 mAh)
1	battery connector
1	crystal holder for the second crystal (HC-25/U)
1	printed circuit board DC 9 MD 001
1	casing.

All parts are available from the publishers.

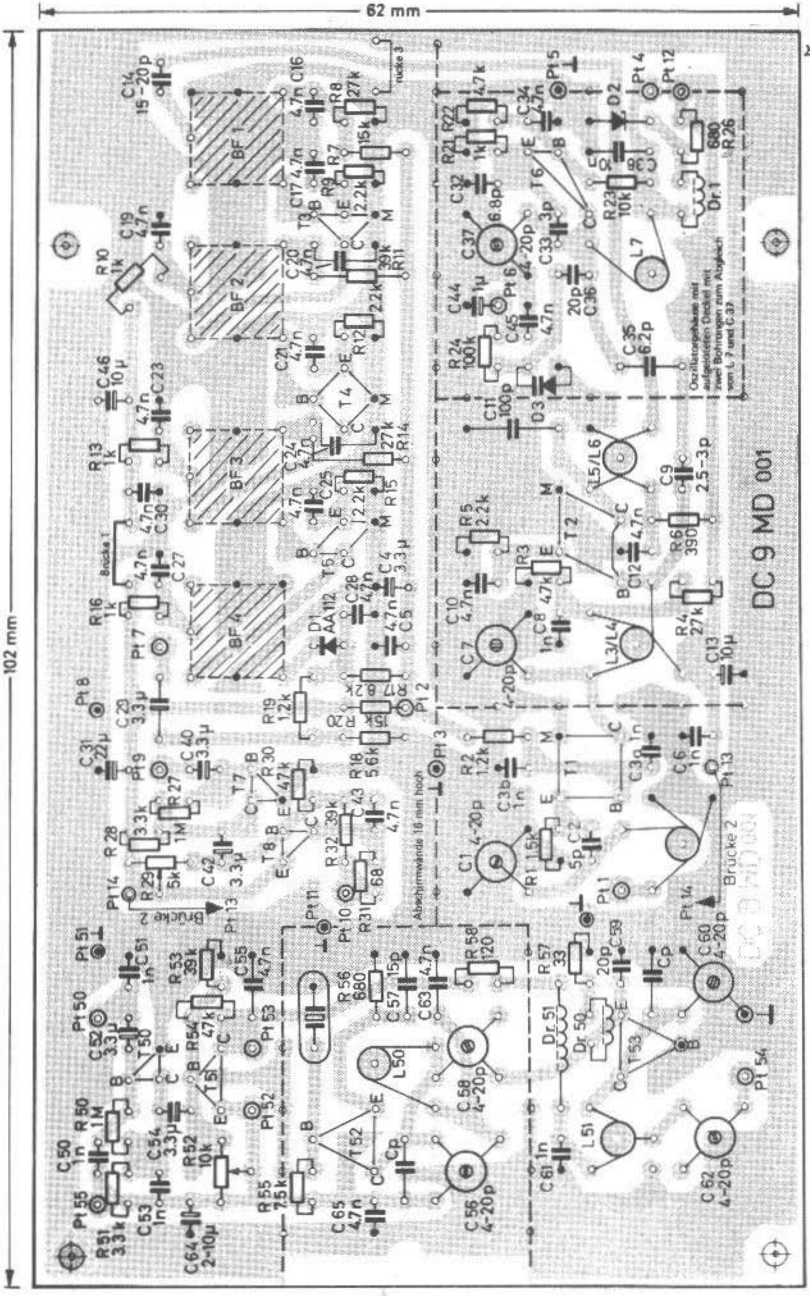


Fig. 5: Component location plan and PC-board DC 9 MD 001

3.2. PRINTED CIRCUIT BOARD DC 9 MD 001

The circuit of the DC 9 MD walky-talky is built up on a 102 mm x 62 mm printed circuit board which has been designated DC 9 MD 001. Fig. 5 shows an enlarged diagram of this PC-board and its component location plan. The holes for most components should be made with a 0.7 mm drill. A 1 mm drill should only be used for the wider connections of the trimmer capacitors and trimmer potentiometers. Larger drills will destroy the small copper surfaces. 4.3 mm holes are drilled for the six coil formers; the four mounting holes are 2.5 mm in diameter. Finally it is necessary for the small section on one end of the printed circuit board to be removed with the aid of a saw or file. This is to allow for the two mounting screws of the coaxial socket, and for the cable.

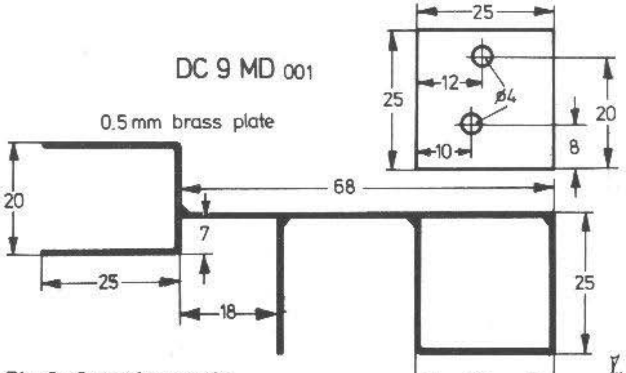


Fig. 6: Screening panels

The screening panels should be built up and mounted into place before mounting the other components onto the printed circuit board. The shape and the dimensions of these panels are given in Fig. 6. The individual pieces are soldered together and mounted onto the printed circuit board using short pieces of wire which are placed through the PC-board at the designated positions. After this, it is possible for the components to be mounted onto the printed circuit board and for the three bridges (1 and 3 on the component side and bridge 2 insulated on the conductor side of the board) to be soldered into place. Connection tags are not necessary at the connection points since all interconnections to the components mounted on the casing are directly soldered to the printed circuit board. Fig. 7 shows the completed board of the prototype. The crystal holder for the second transmit crystal is on the upper left hand side. If the second channel is to be used, a cut-out on the printed circuit board must be provided for this holder.

3.3. PREPARATION OF THE CASING

The light aluminum casing has the dimensions 120 mm x 63 mm x 34 mm. It is provided with a U-shaped cover. Fig. 8 indicates the positions and the dimensions of all holes and cut-outs required.

The microphone is glued into place. The microphone cut-out can be protected against humidity using a piece of plastic foam. After this, the three potentiometer, the two (4) sliding switches, the two jack sockets and the BNC socket are mounted. A solder tag should be placed under one of the mounting screws of the BNC socket which is then used as ground connection.

Finally, the four brackets shown in Figure 8 should be provided for mounting the printed circuit board and screwed to the casing. If a second crystal is to be used, the holder should be glued to the casing beside the BNC socket and a corresponding cutout provided in the printed circuit board.

3.4. ASSEMBLY

The completed printed circuit board is placed beside the completed casing as shown in Fig. 9. Most interconnections are made with thin, screened cables. The sketch given in Fig. 10 shows where the cables and leads are to be soldered. The ground connections between printed circuit board and casing or controls are not made via the four brackets but with the aid of the screening of the individual cables and two extra ground connections. The interconnections should be just long enough that it is possible for the casing and printed circuit board to form an angle of 90° from another (as in Fig. 9). Figure 11 shows the interconnections in the form of a wiring diagram.

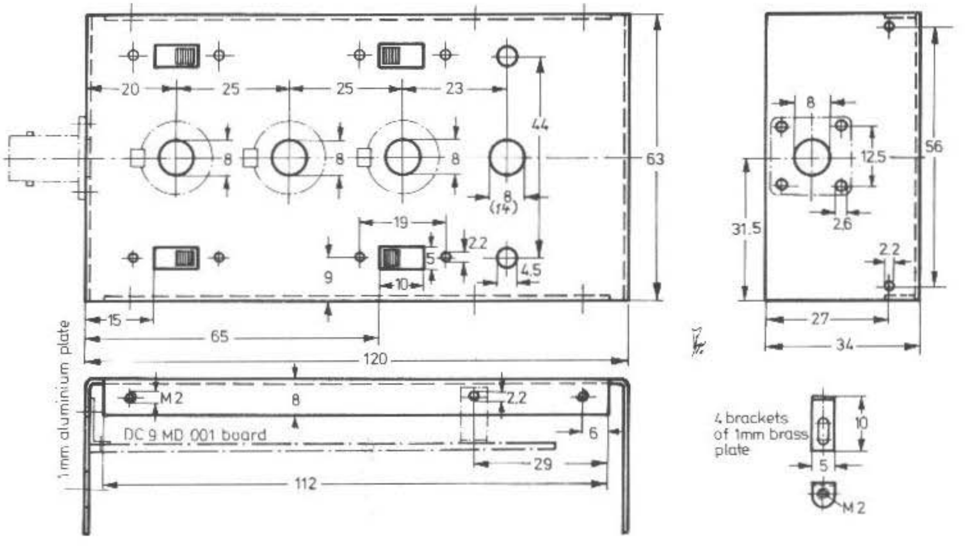


Fig. 8: Dimensional diagram of the case

4. EXTENSION FOR TWO CRYSTAL-CONTROLLED CHANNELS AND AM/FM SWITCHING

The modification of the transmitter for two switchable channels as well as AM or NBFM switching is shown in the partial circuit diagram given in Fig. 12. The required crystal is grounded via switch S 3 and is thus able to oscillate. Crystal Q 2 is the fixed crystal, the additional crystal Q 1 is plugable which means that it can be exchanged as required.

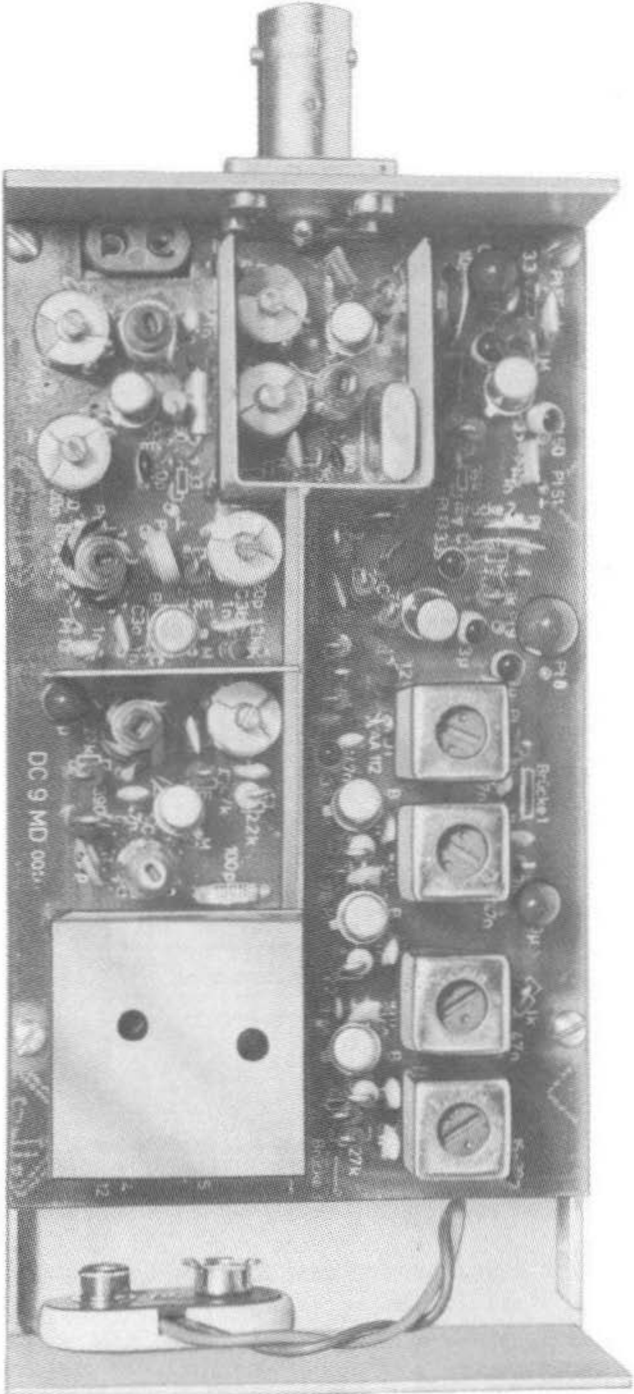


Fig. 7: Photograph of the completed prototype

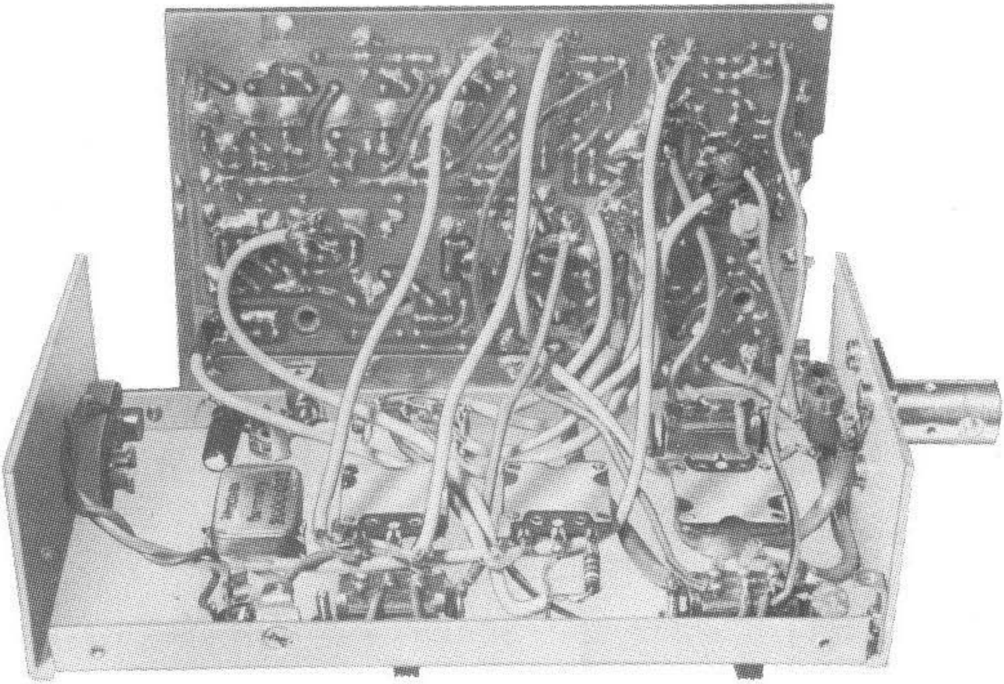


Fig. 9: Photograph showing the interconnections between PC-board and controls

The narrow band frequency modulation is generated with the aid of the parallel capacitor of 47 pF which is more or less grounded by the diode in step with the audio frequency (2). Switch S 4a connects the required audio voltage from the modulator transistor T 51 via a decoupling resistor to the diode, whereas during amplitude modulation the final transistor of the transmitter is modulated. A second contact S 4b connects the full operating voltage to the output stage in the FM mode so that it operates at the peak power level of approx. 60 mW.

The additional components and connections have already been included in the previous illustrations. The 47 pF capacitor, the 2.7 kΩ resistor and the diode are soldered directly onto the corresponding conductor lanes. An insulated support point can be provided by separating a piece of the ground surface from ground with the aid of a file.

5. ALIGNMENT

The printed circuit board should now be installed so that the conductor lanes and controls are accessible for measurements. The cover of the VFO casing is soldered into place after completion of the alignment.

5.1. ALIGNMENT OF THE TRANSMITTER

1. Tune a two metre receiver to twice the crystal frequency.
2. Switch S 2 to transmit, switch S 4 to FM.
3. Connect a terminating resistor (antenna) via a reflectometer (3) to the BNC socket.

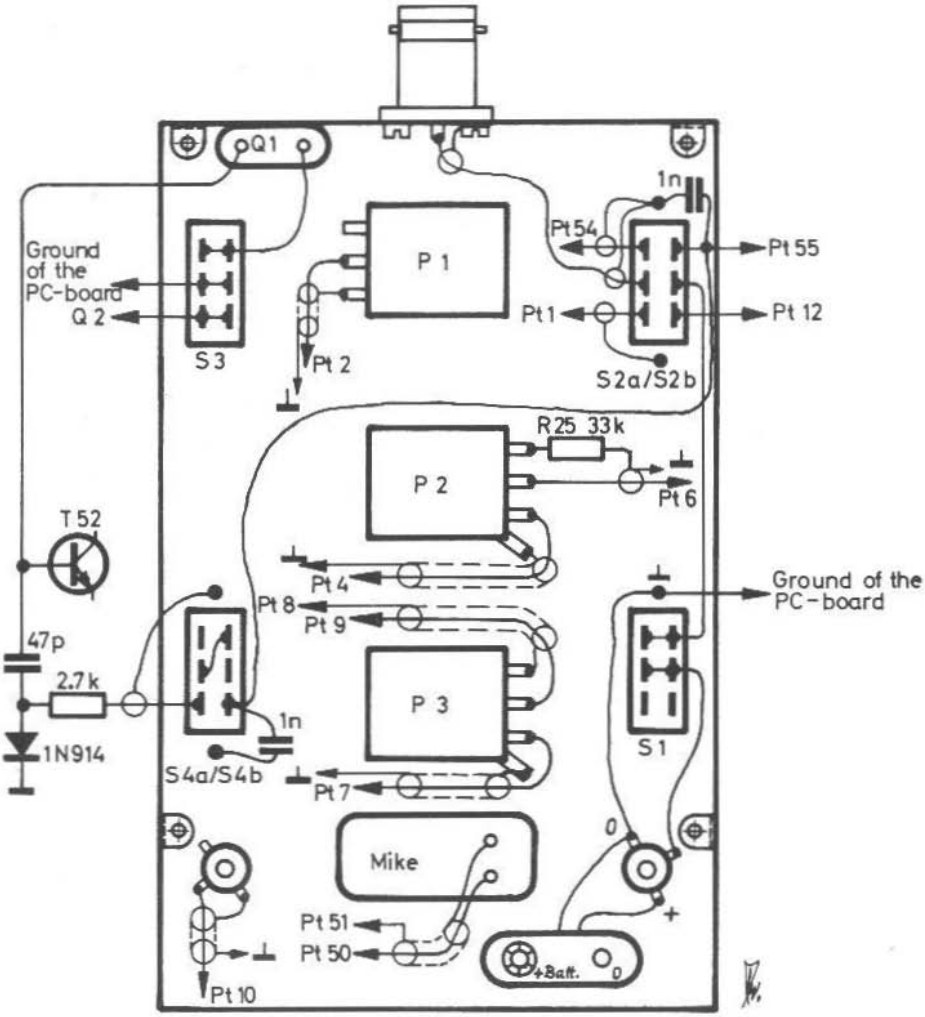
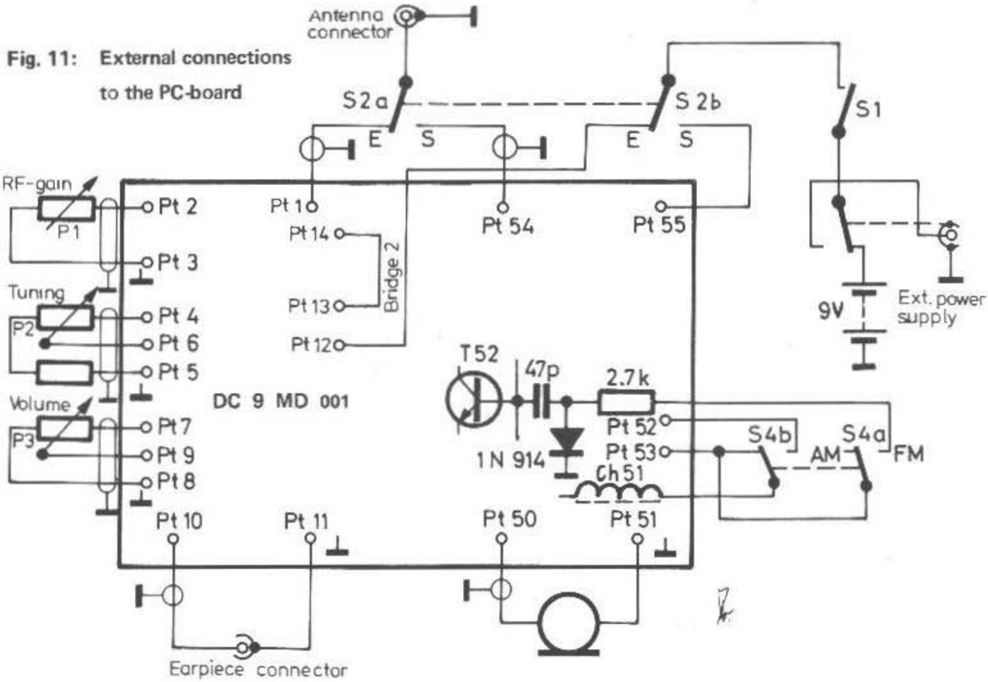


Fig. 10: **Wiring diagram**

Fig. 11: External connections to the PC-board



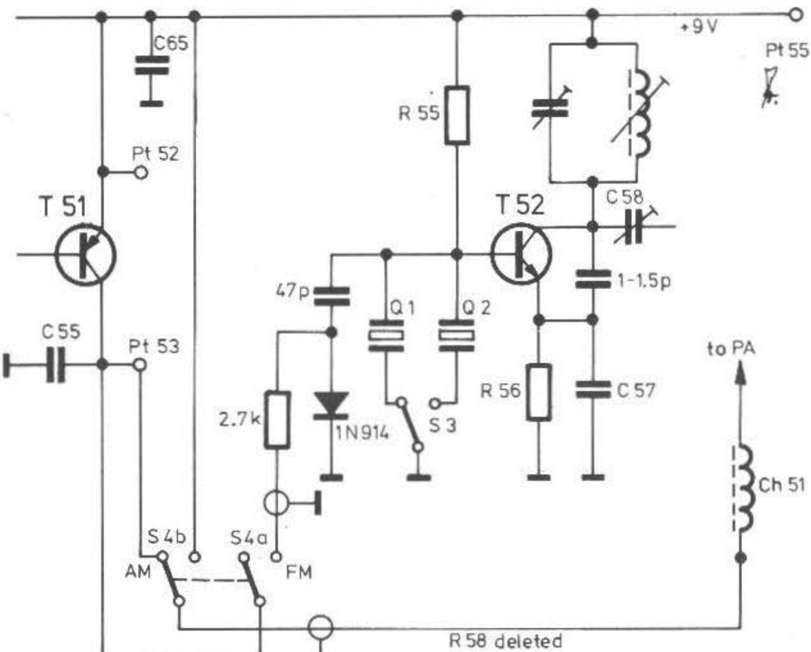


Fig. 12: Partial circuit diagram of the transmitter showing modifications for two transmit frequencies and AM-FM switching

4. Adjust trimmer resistor R 52 to the base end so that transistor T 51 is blocked.
5. Connect the 9 V battery via a mA-meter.
6. Adjust trimmer capacitor C 58 for minimum capacitance
7. Adjust trimmer capacitor C 56 and inductance L 50 until the oscillator is audible on the receiver.
8. Increase the capacitance of C 58. Current should increase, realign the crystal oscillator if it no longer oscillates due to the higher load.
9. Adjust trimmer capacitor C 60 and C 62 as well as inductance L 51 for maximum indication on the reflectometer. Find the optimum position for capacitor C 58.
10. Allowing the transmitter to continue transmitting, place switch S 4 to AM. Measure the collector voltages of transistors T 50 and T 51. Nominal values are given in Fig. 3. Adjust the voltage at T 51 with trimmer resistor R 52.
11. Attempt modulation. The optimum frequency modulation should be adjusted with R 52 and L 50. Optimum amplitude modulation is obtained by carrying out the described peak-power alignment in the FM position and subsequently reducing the carrier to 1/4 of the output power using R 52.

5.2. ALIGNMENT OF THE RECEIVER

1. Insert the earpiece, place switch S 2 to receive. Measure the total current and the nominal voltages as given in Fig. 4. Align the audio output stage with the aid of trimmer resistor R 29.
2. Align the resonant circuit of the VFO (L 7, C 37) with the aid of a dip-meter to approximately 134 MHz.
3. Couple the dip-meter to inductance L 5, fully insert the cores of circuits IF 1 - IF 4 and tune the dip-meter until a frequency in the region of 10.7 MHz is audible. The IF circuits can then be aligned for maximum volume of the modulated dip-meter.
4. Connect an antenna for the 2 m band and tune in a strong signal or one's own transmitter. It may be necessary for trimmer C 37 to be tuned somewhat.
5. Align the VHF circuits of the preamplifier and mixer stage for optimum reception reducing the signal of the transmitter at the same time. Correct the alignment of the IF circuits.
6. Solder on the cover of the VFO casing (only at two corners)
7. Adjust the VFO range with the aid of signals of known frequency (calibration spectrum generator). The width of the tuning range can be altered by exchanging capacitor C 36. The position is determined by trimmer capacitor C 37.
8. Tune in an extremely weak signal and carry out a fine alignment. The potentiometer P 1 (RF-gain) should not be adjusted for highest noise but for the optimum reception.
9. Due to the difference between individual transistors, it is advisable in some cases for the oscillator voltage to be varied at the mixer stage. This is the reason why the coupling capacitor is split up; capacitor C 9 is accessible outside of the screening can.

After the alignment has been made, the printed circuit board can be screwed into place and the VFO screening lid can be soldered at all four corners. A final careful correction of the alignment completes the procedure.

6. AVAILABLE PARTS

The printed circuit board as well as a complete kit including all parts such as capacitors, resistors and casing are available from the publishers or their national representatives. Please see advertising pages.

7. REFERENCES

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VHF COMMUNICATIONS 1 (1969), Edition 4, Pages 205-208

(2) G. Damm: Frequency Modulation of Crystal Oscillators by Use of Resistor Diodes
VHF COMMUNICATIONS 2 (1970), Edition 1, Pages 25-27

(3) R. Griek: Stripline Reflectometers
in this Edition of VHF COMMUNICATIONS

VOLUME 1 (1969) and 2 (1970) of VHF COMMUNICATIONS

We would like to point out that all previous copies of VHF COMMUNICATIONS are still available. Since our magazine contains only technical articles of continuing interest and value, we ensure that back copies can always be provided for later subscribers. The price of the complete Volume 1 (1969) or 2 (1970) is DM 12,-- each for surface mail or DM 4,-- for individual copies. The airmail prices can be obtained from your national representative or from the publishers.

A QUADRUPLE QUAD ANTENNA - AN EFFICIENT PORTABLE ANTENNA FOR 2 METRES

by M. Ragaller, DL 6 DW

An unusual antenna is to be described which basically comprises four stacked two-element quad antennas for 2 m: the quadruple quad, however, does not consist of four separate antennas, but represents a mechanical and electrical unit by arranging the four radiators above another with $\lambda/4$ spacing. Fig. 1 shows a drawing of the antenna.

1. CHARACTERISTICS

The stacked quad exhibits a gain of 11 - 12 dB referred to a $\lambda/2$ dipole at a total height of little more than 2 m. The gain is achieved mainly due to the energy concentration in the vertical plane. The horizontal lobe is relatively wide. This is especially favourable for portable operation because the antenna need not be rotated so often as when using antennas whose gain is achieved by decreasing the width of the horizontal lobe.

The antenna-gain measurement was carried out as follows: The stacked quad was connected via a calibrated attenuator to a 2 metre receiver that was fed with a stabilized operating voltage. The S-meter reading was kept at the same value by varying the attenuator link. This means that the characteristics of the receiver do not affect the accuracy of the measurement. The accuracy is merely dependent on the characteristics of the attenuator link and on the environment. A small crystal-controlled transmitter fed a dipole spaced 200 m from the receiver. The operating voltage of the transmitter was also stabilized.

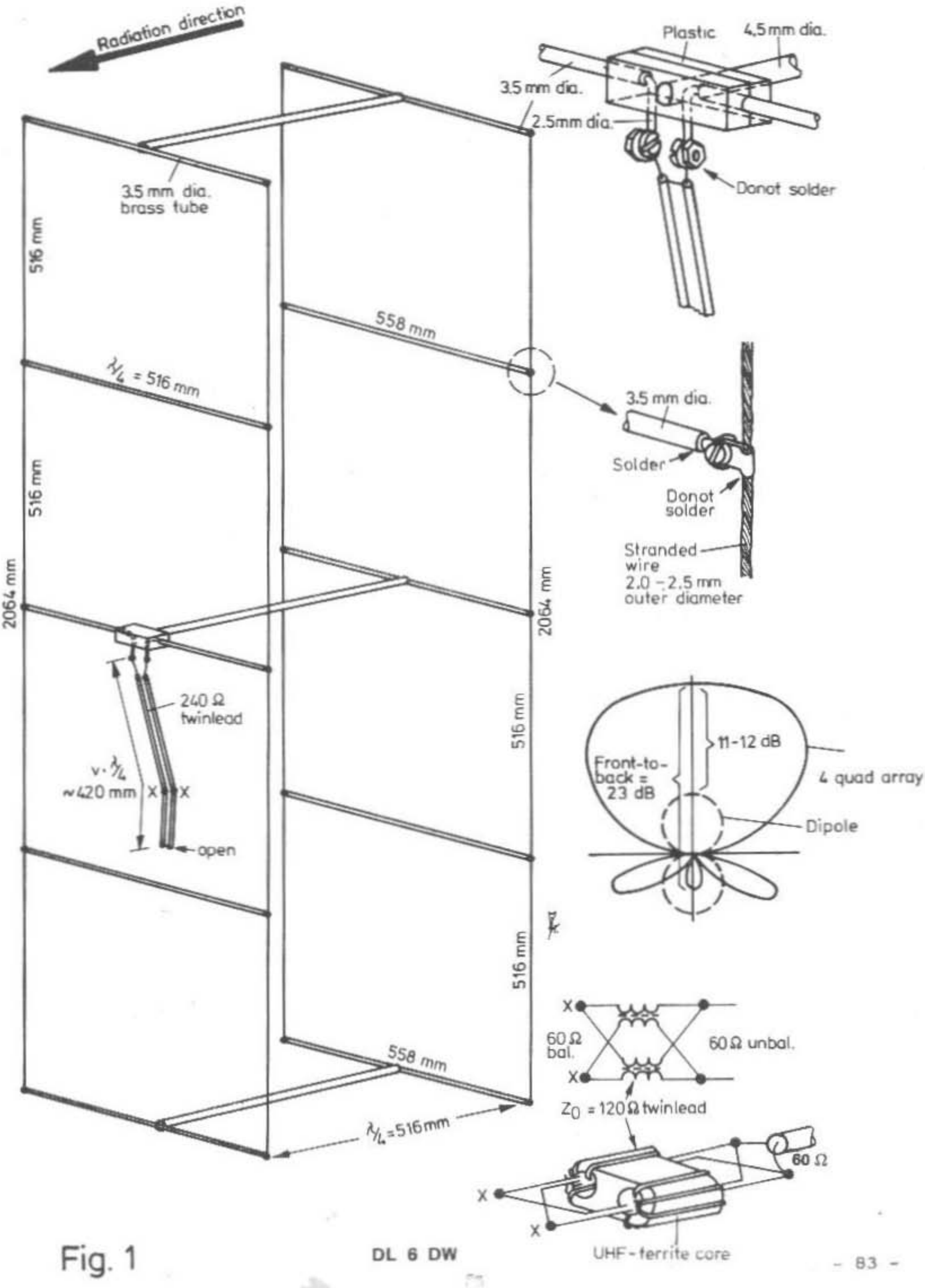
During the measurements, a front-to-back ratio of approximately 23 dB was determined. In addition to this, it was found that environmental effects such as adjustments on the antenna and walking around the antenna only caused slight variations on the given antenna characteristics. This feature, which is also exhibited by the HB 9 CV antenna, can be very valuable when space is limited.

2. DIMENSIONING

Three dimensions are very important for the characteristics of a two-element quad antenna: The circumference of the driven element (L_D), the circumference of the reflector element (L_R) and the spacing between the driven element and the reflector. The dimensions given in Fig. 1 deviate from the recommendations of the listed references. The reasons for these deviations - that were obtained experimentally - will be described in the following sections.

2.1. DIMENSIONS OF THE DRIVEN ELEMENT

The dimensions given in Fig. 1 for the driven element of 516 mm per side (corresponding to a circumference of 2064 mm) correspond exactly to λ. This deviates from the recommendations of (1), where resonance of the driven element was present without additional stubs when the total circumference of the quad was approximately 1.5% greater than λ. The described stacked radiator is, however, really in resonance at 145 MHz which the author assumes is due to the shortening effect of the relatively thick "rungs" used. A mean shortening factor of approximately 0.96 - which was also given in (1) - would even overcompensate for the required lengthening factor of 1.015.



Radiation direction
Plastic
4,5 mm dia.
3,5 mm dia.
2,5mm dia.
Donot solder
3,5 mm dia. brass tube
516 mm
558 mm
λ/4 = 516 mm
3,5 mm dia.
Solder
Donot solder
Stranded wire 2,0 - 2,5 mm outer diameter
2064 mm
2064 mm
240 Ω twinlead
v · λ/4 ~420 mm
X X
open
516 mm
11-12 dB
Front-to-back = 23 dB
4 quad array
Dipole
60 Ω bal.
60 Ω unbal.
558 mm
Z0 = 120 Ω twinlead
λ/4 = 516 mm
60 Ω
X
X
UHF - ferrite core

Fig. 1

DL 6 DW

2.2. REFLECTOR DIMENSIONS

The circumference of the reflector amounts to twice 516 mm and twice 558 mm, e.g. to a total of 2148 mm. These dimensions correspond to 1.04 λ, which also deviates from the values given in (1). During the measurements, it was found, however, that these dimensions together with the selected spacing between driven element and reflector exhibited a higher front-to-back ratio and a lower environmental dependence.

2.3. SPACING BETWEEN DRIVEN ELEMENT AND REFLECTOR

Whereas a spacing of 178 mm (0.08 λ) is recommended in (1) between the driven element and reflector in order to obtain a feedpoint impedance of approx. 70 Ω, the author increased the spacing to 516 mm (0.25 λ). At a spacing of 0.15 λ (most favourable value according to (2)) and less, it was found that the front-to-back ratio was very dependent on the environment. Since it was also mentioned in (2) that the inductive component of the feedpoint impedance would be varied towards zero on increasing the reflector spacing and that the active component will be increased with constant gain, the author decided to use the larger spacing.

3. CONSTRUCTION

The most important details for the construction are given in Fig. 1. The four stacked driven elements and reflectors are made up from twisted copper wire and brass tube (for the rungs). They are joined together by three 516 mm long brass tubes of 6 mm diameter. Smaller drawings show the connection points and the feedpoint. An electrical λ/4 piece of 240 Ω twin lead is connected as a stub to the feedpoint. A 60 Ω balun is connected to points "X" - "X". The balun is built up as shown in the diagram from a ferrite core with two holes into which a 120 Ω twin lead has been inserted. The position "X" - "X" must be found experimentally in order to obtain the lowest standing wave ratio. In the author's case, this position was found approximately 200mmabove the open end of the stub.

4. EXPERIENCE GAINED WITH THE QUADRUPLE QUAD ANTENNA

The described antenna is very neutral to wind which means that it will not be rotated. This characteristic is very useful during portable operation. A 3.5 m or 4 m long mast can easily be made out of tent poles. The mounting of the antenna is carried out very quickly because only the three intermediate tubes and the antenna cable have to be connected. The dismantled antenna can be rolled up and easily be accommodated in a rucksack. The antenna can also be hung from a tree or building, etc. and can be rotated using two guidelines which are drooped from the lower corners of the antenna to the ground. Using a 1 W transmitter and the described antenna, several contacts were made over a distance of 570 km between the Yugoslavian coast at Pula and Lecce/Copertino in Italy. The antenna height was only 10 m; of course, the evening inversions above the Adriatic Sea helped to achieve the reports of 57 to 58.

5. REFERENCES

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Deutscher Militärverlag, Edition 7 (1969), Pages 219, 220, 423, 424
Telekosmos-Verlag, Stuttgart, Edition 3 (1968), Pages 142, 303, 304

(2) Rint, Handbuch für Hochfrequenz- und Elektrotechniker
Verlag für Radio, Phono-, Kinotechnik, Berlin, Vol II, Pages 395 etc.

STANDING WAVE RATIO AND CABLE ATTENUATION

by J. Sturm, DC 6 YE

A standing wave meter or reflectometer is becoming more and more a standard piece of measuring equipment of radio amateurs. In order to simplify its use, the following article is firstly to provide a table for calibrating the scales of home-made units. Furthermore, the effect of cable attenuation on the result of the measurement is discussed and a diagram for correcting this is given. Since the cable attenuation must be known, finally a table is given with the essential specifications of a number of modern coaxial cables.

1. THE STANDING WAVE RATIO

The standing wave ratio (SWR) is usually determined by adjusting the forward power reading to full-scale deflection (100%) and subsequently reading off the reflected power reading. The standing wave ratio is obtained according to the following formula:

$$SWR = \frac{1 + \frac{U_{refl.}}{U_{forw.}}}{1 - \frac{U_{refl.}}{U_{forw.}}}$$

This formula has been used for calculating a number of values. Table 1 is the result of this and will save the reader a considerable amount of calculation. The SWR value corresponding to the reflected power reading as well as the reflected power $P_{refl.}$ in percent of the forward power can be read off directly.

$U_{refl.}$	SWR	$P_{refl.}$	$U_{refl.}$	SWR	$P_{refl.}$	$U_{refl.}$	SWR	$P_{refl.}$	$U_{refl.}$	SWR	$P_{refl.}$
1.0	1.02	0.01	5.7	1.12	0.33	20	1.5	4	43	2.5	18
1.5	1.03	0.02	6.1	1.13	0.37	23	1.6	5.3	44	2.6	19
2.0	1.04	0.04	6.5	1.14	0.42	26	1.7	6.8	46	2.7	21
2.4	1.05	0.06	7.0	1.15	0.49	29	1.8	8.4	47	2.8	22
3.0	1.06	0.09	7.4	1.16	0.55	31	1.9	9.6	49	2.9	24
3.4	1.07	0.12	7.8	1.17	0.61	33	2.0	11	50	3.0	25
3.9	1.08	0.15	9.0	1.20	0.81	36	2.1	13	60	4.0	36
4.3	1.09	0.19	11	1.25	1.21	38	2.2	14	71	6.0	50
4.8	1.10	0.23	13	1.3	1.69	40	2.3	16	82	10	67
5.2	1.11	0.27	17	1.4	2.89	41	2.4	17	100	∞	100

Table 1: Determination of the standing wave ratio and the reflected power from the $U_{refl.}$ reading.

2. EFFECT OF CABLE ATTENUATION

Normally, the reflectometer is located in the vicinity of the radio station, and therefore, at the commencement of a more or less long antenna feeder. Whereas the forward power is measured directly at the transmitter, the power that is classed as the reflected power will have passed through the cable in both directions before being indicated. This means that the attenuation of the reflected power along the cable previous to the measurement will decrease the reflected power reading and will thus improve the measured standing wave ratio.

This error can be avoided by placing the reflectometer directly at the antenna or by taking the attenuation into consideration by calculating the cable attenuation. One example may indicate the necessity of such a correction: An indicated standing wave ratio of 1.5 : 1 together with a cable attenuation of 6 dB (30 metres of RG 58 C/U at 145 MHz) would mean an actual standing wave ratio at the antenna of 9 : 1 or a reflected power of 65% !

The diagram given in Fig. 1 allows determination of the actual standing wave ratio as a function of the cable attenuation.

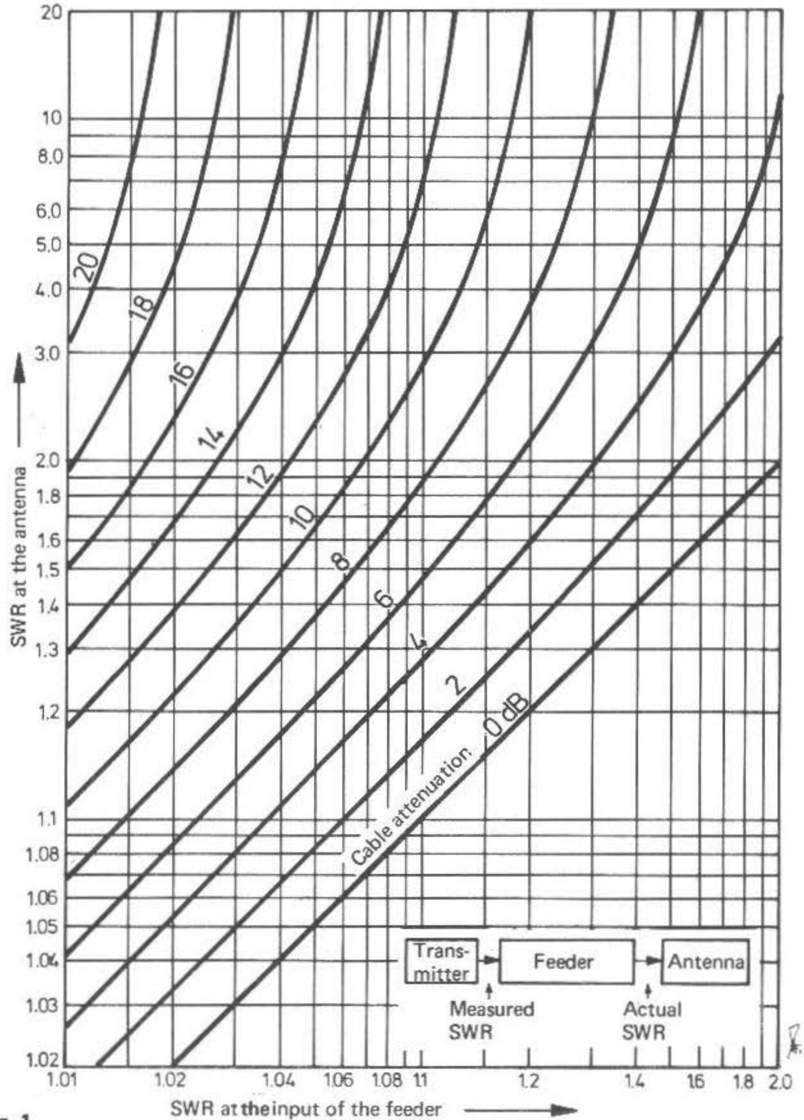


Fig. 1

A load impedance X deviating from the impedance Z of the cable will be transformed into an impedance X' by the cable up to the transmitter output. The transmitter output stage is now tuned for maximum power reading. After removing the reflectometer, the cable is shorter by the length of the reflectometer which means that the load impedance X is transformed to another impedance X''. The different reactive component then detunes the output stage and the different real component represents another loading. Both effects result in a reduction in output power.

If the transformation relationship should not be affected on inserting the reflectometer, the measuring lead must be brought to an electrical length of $\lambda/2$ using an additional length of cable. If the measurements are to be made at different frequencies, a special extension cable is required for each frequency. The mechanical length of the reflectometer-cable combination should be V x $\lambda/2$. The velocity factor V for the cable possess approximately the following values:

Solid polyethylene dielectric	:	V = 0.66
Foam polyethylene dielectric	:	V = 0.82
PTFE (Teflon) dielectric	:	V = 0.7

3. DATA OF SEVERAL SELECTED CABLES

Table 2 lists the specifications of a number of selected cables for establishing the attenuation of the antenna feeder. For each plugged connection, clamps etc. approximately 1 to 2 dB should be added. The values given in table 2 are based on listed values and are tailored to the amateur frequencies. Attenuation and power values were obtained by interpolation, the values given in brackets were found by extrapolation.

The given transmission power is the maximum value at an ambient temperature of 40 °C and exact matching. In practical operation, the amateur should remain well below these power limits due to the standing waves that will be present. The price comparison is only provided to allow the amateur to compare the technical specifications against the expense of such cables; of course, the purchase price for the amateur can differ greatly from these prices according to the source. A large number of companies require a minimum order which can amount to hundreds of metres.

Cables with PTFE (Teflon) dielectrics are approximately ten times as expensive as normal cables and the attenuation values are not considerably better. Their improved heat resistance and insulation values are hardly of interest to the amateur. The RF cables according to military specification MIL-C-17 with their higher frost resistance and further mechanical characteristics are of unnecessarily high quality. The attenuation values of such cables are mostly unfavourable when considering the price. Surplus RG cables manufactured during the fifties will probably no longer correspond to the values listed at that time. Coaxial cables with stranded inner conductors should not be used for fixed installations, because, firstly, they are more expensive, and, secondly, possess a 20% higher attenuation than cables with solid inner conductors.

Cables with foam polyethylene dielectrics have a favourable attenuation-price relationship, however, sharp bends must be avoided on installation because the inner conductor is not so well centred as with solid dielectrics. Solid dielectrics provide a better longitudinal constancy of the impedance.

Cable No:		1	2	3	4	5	6	7	8	9
Inner conductor diameter in mm-Type: Solid, stranded, tubular		1.4 S	1.4 S	2.3 S	3.5 S	0.48 St	0.51 St	0.9 St	2.3 St	6.3 Tub.
Dielectric: Solid polyethylene PE Foam polyethylene FPE Teflon PTFE		FPE	FPE	PE	Air	PE	PTFE	PE	PE	Air
Sheath diameter in mm		6.5	7.2	12.6	16	2.54	2.79	5.0	10.3	23
Impedance	Ω	60	60	60	60	50	50	50	50	50
Attenuation in dB/100 m	29 MHz	(3.5) -	(3.2) -	2.3 3300	1.3 6000	15 -	15 -	8.5 550	3.4 1900	0.83 9500
Underneath: max. power in watt	145 MHz	9 -	8 -	6 1300	3 2600	39 -	40 -	20 220	8.7 760	1.9 4200
	435 MHz	18 -	14 -	11 710	5.5 1500	69 -	70 -	34 130	15 380	3.3 2400
	1.3 GHz	(36) -	(28) -	22 350	9 850	(130) -	(140) -	65 70	32 210	6 1300
Price relationship		157	161	705	2050	126	131	208	478	2270

Cable No. - Manufacturer - type of cable		
1	Kathrein-Werke, Rosenheim W.Germany, Type 6754	
2	Karl Stolle Kabel und Antennenfabrik, Lünen W.Germany, Type 0514 S	
3	AEG-Telefunken, Type HFE 2,3/10 B	
4	AEG-Telefunken Type Flexwell HF 3,4/10	
5	Amphenol and other comp.,	type RG 174/U (subminiature)
6	Amphenol and other comp.,	type RG 188 A/U "
7	Amphenol and other comp.,	type RG 58 C/U
8	Amphenol and other comp.,	type RG 213/U (formerly RG 8 A/U)
9	AEG-Telefunken,	Type Flexwell HF 5/8 Zoll

When connecting coaxial cables, attention must be paid that no humidity is able to find its way into the coaxial cable. Very special measures must be taken with air-spaced cables where special air-tight connectors of the cable manufacturer should be used.

4. REFERENCES

WNFB No. 2/Aug. 1969 and No. 1/Jan. 1967
Bird Electronic Corp., Cleveland/Ohio
Data sheets of the mentioned manufacturers and distributors

SIMPLE STRIPLINE REFLECTOMETERS FOR 144 MHz and 432 MHz

by R. Griek, DK 2 VF

The following article describes two reflectometers: one for the two metre and one for the 70 centimetre band. The main and auxiliary arms are etched on a double-coated printed circuit board. The connection sockets, terminating resistors and demodulator circuits are also accommodated on the printed circuit board which means that construction is extremely simple. Figure 1 shows photographs of both reflectometers. Of course, such reflectometers are not suitable for high-precision measurements but are sufficient for general measurements and continuous monitoring of antenna systems for two metres and 70 centimetres.

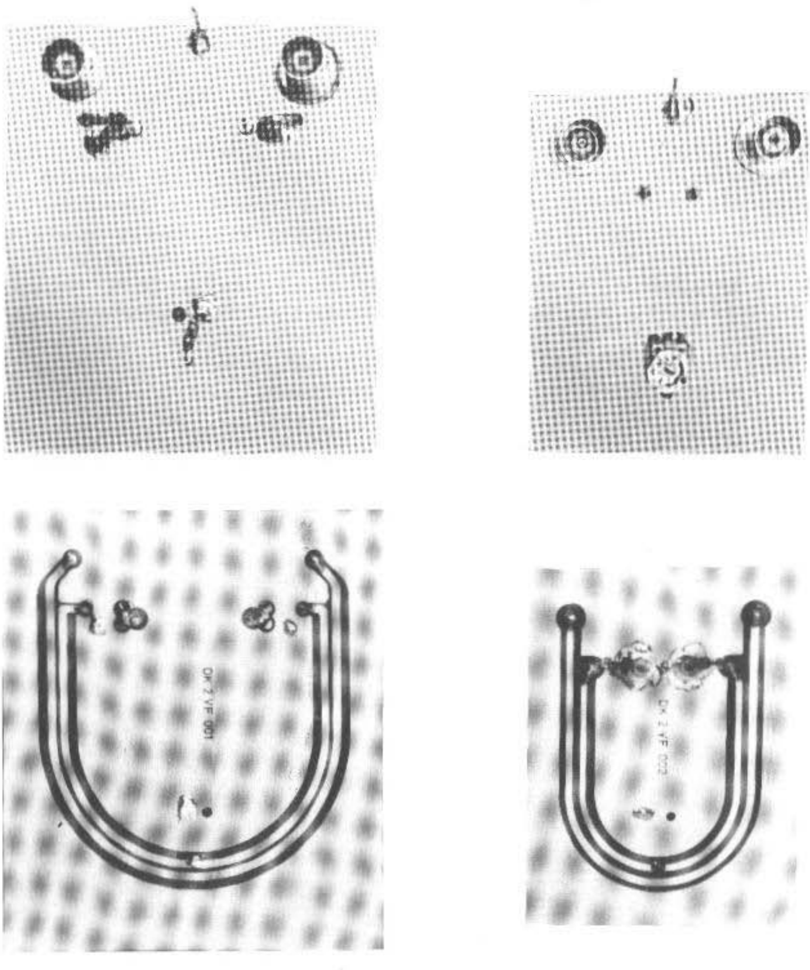


Fig. 1: The two stripline reflectometers seen from the conductor and component side

1. CONSTRUCTION

Figure 2 shows the conductor and component side of the printed circuit board of the two metre reflectometer, which has been designated DK 2 VF 001. The dimensions are 90 mm long and 80 mm wide. This compact design has been obtained by using arched lines. The auxiliary arms are connected together and possess a common terminating resistor having a value of half the line impedance.

The same is, of course, also valid for the 70 cm version of the reflectometer. Its PC-board is designated DK 2 VF 002; the dimensions are 73 mm long and 57 mm wide. The conductor and component sides of the 70 cm reflectometer board are shown in Figure 3.

The copper coating on the component side of the printed circuit board is only removed at those positions where the components are connected through the board to the conductor side. The coating can be removed using a 4 mm drill or similar. All grounded connections are placed through the board and are soldered to the ground surfaces of both sides. The coaxial sockets (BNC: UG - 1094/U) are shortened with a saw and file so that they can be directly soldered to the ground surface on the component side of the board. The centre connections are passed through the board where they are soldered to the main arm. Another possibility is for 9.5 mm holes to be drilled in the printed circuit board; the nuts of the sockets are then screwed on so far that the threading corresponds to conductor surface of the PC-board, where they are soldered into place. Straight, short as well as thin copper or brass strips are then used to connect the centre pins of the sockets to the shortened conductor lanes. This second possibility obviates the need of shortening the BNC sockets and the two ground surfaces will be connected together by the sockets themselves.

Although they can be used as they are, the reflectometers are usually enclosed in a small casing made from metal sheet or PC-board material. The conductor lanes should be spaced at least 10 mm from the casing.

1.1. COMPONENTS

The following components are required per reflectometer:

- 2 Coaxial sockets: BNC type UG 1094/U for single hole mounting
- 2 Germanium diodes AA 112, OA 90, 1 N 87 A or similar
- 1 Trimmer resistor 100 Ω for horizontal mounting in standard spacing 10 mm/5 mm or a fixed resistor of approx. 30 Ω (see Section 2)
- 2 Bypass capacitors 10 - 22 nF, 5 mm spacing (for DK 2 VF 001)
- 2 Feedthrough capacitors 100 - 500 pF, approx. 4 mm dia. (for DK 2 VF 002)

2. ALIGNMENT

The two DC outputs of the described reflectometer are connected to a μA meter via a single-pole switch and a 100 kΩ potentiometer. If a 100 μA meter is used full-scale deflection will be obtained at approximately 30 mW with DK 2 VF 001 or 100 mW with DK 2 VF 002. A 1 mA meter requires about 100 mW at 144 MHz (DK 2 VF 001) for FSD. At higher power levels, the reading is reduced using the 100 kΩ potentiometer.

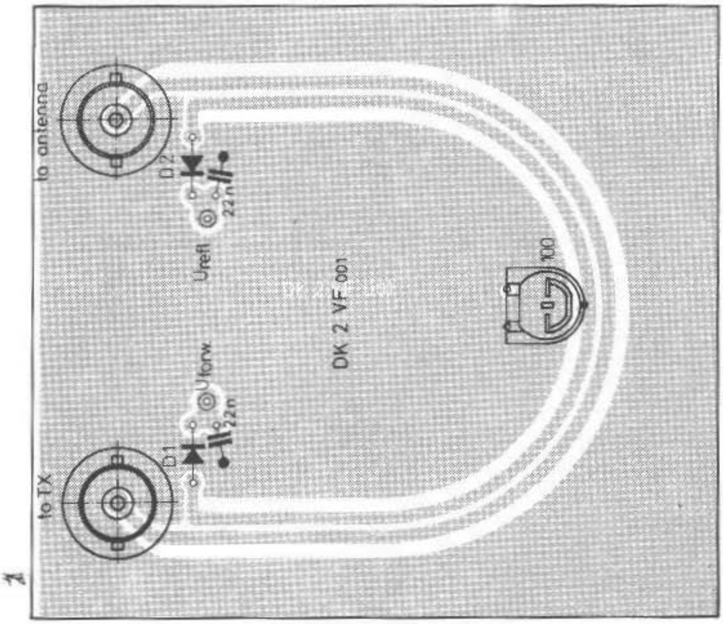


Fig. 2: PC-board DK 2 VF 001 for the 2 m reflectometer

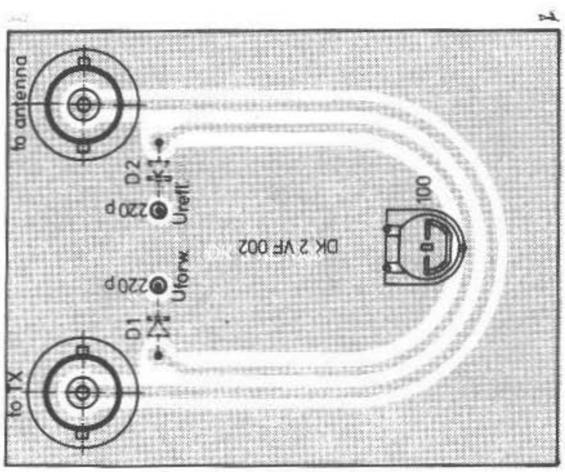


Fig. 3: PC-board DK 2 VF 002 for the 70 cm reflectometer

For the alignment, the antenna socket is terminated with an accurate terminating resistor. The forward power reading should now be adjusted to 100% and the trimmer potentiometer terminating the auxiliary arm is aligned for lowest reflected power reading. Since the forward power reading will also be altered, it is necessary to correct this alignment several times. The trimmer potentiometer can then be replaced by a fixed resistor of the same value between 25 Ω and 35 Ω. If the reflectometer is to be used at an impedance of 60 Ω, the required value will be about 30 Ω, for 52 Ω = 26 Ω and 70 Ω = 35 Ω etc. The author was able to reduce the reflected power reading of the 145 MHz reflectometer (DK 2 VF 001) further by winding the connection lead of a 33 Ω resistor in a helical manner (4 turns on a 1.5 mm former). However, such measures must be found experimentally.

3. OPERATION

The standing wave ratio (SWR) is usually measured by adjusting the forward power reading to full scale deflection (100%) and subsequently reading off the reflected power indication. The standing wave ratio is obtained according to the following formula:

$$SWR = \frac{1 + \frac{U_{refl.}}{U_{forw.}}}{1 - \frac{U_{refl.}}{U_{forw.}}}$$

A table calculated according to this formula is given in Table 1 of (1). It also lists the reflected power as a function of the standing wave ratio.

It is also mentioned in (1) how high-quality terminating resistors can be manufactured at home: One only requires a 50 or 100 metre roll of coaxial cable which offers an attenuation of 10 dB to 20 dB at the frequency of interest. The input of the cable is provided with a coaxial plug and the output terminated with a 60 Ω, 52 Ω or 70 Ω resistor according to the impedance of the line. A normal carbon resistor is suitable.

If the standing wave ratio at the end of the cable is, for instance, 3.0 : 1, it will be seen in Figure 1 of (1) that with a cable attenuation of 10 dB, a standing wave ratio of 1.1 : 1 at the cable input will be present. With a cable attenuation of 20 dB, this will be even reduced to the very acceptable value of 1.01 : 1.

The power capacity of such "terminating resistors" is very high. For instance, if 100 W is fed to the input of the cable, the carbon resistor will only have to dissipate 1 W if the cable attenuation amounts to 20 dB. The cable length corresponding to this and other attenuation values are given in (1) for various cables.

4. AVAILABLE PARTS

The printed circuit boards DK 2 VF 001 and 002 are available from the publishers or their national representatives. Please see advertising page.

5. REFERENCES

(1) J. Sturm: Standing Wave Ratio and Cable Attenuation
In this edition of VHF COMMUNICATIONS

OSCAR 6 - TECHNICAL DESCRIPTION AND PROJECT STATUS

taken from several AMSAT publications

The next amateur radio satellite is already in development and, partially under construction. This satellite is called AMSAT - OSCAR - B (A-O-B) before launch and will be designated OSCAR 6 when in orbit. The Radio Amateur Satellite Corporation, abbreviated AMSAT, in Washington, D.C. in USA is responsible for coordination of the project. The individual modules come from amateur groups in Australia, Europe and the USA.

The task of AMSAT is to develop amateur radio satellites with a long operational life. This is to be achieved using solar cells as power source. The regular and reliable usability of such satellites is especially designed to improve amateur radio communications on the VHF and UHF bands of 144 MHz and 432 MHz. Future amateur radio satellites, commencing with OSCAR 6, are to carry internationally usable repeaters for amateur radio communication.

Concrete recommendations were available after AMSAT published the conditions for the AMSAT-OSCAR-B satellite (1) in March 1970. A detailed description was passed on to the NASA some time ago; the following sections are to give extracts from this report (2), which the editors consider will be of interest.

1. TECHNICAL DESCRIPTION

A-O-B is a small satellite that allows radio communication between modestly equipped amateur radio stations. The spacecraft will be equipped with two or three alternately operating repeaters, a multi-channel command decoder unit and a telemetry system. The power is taken from solar cells. The satellite will be constructed for a life of at least one year.

1.1. GENERAL DATA

OSCAR 6 is to be brought into orbit in the same manner as OSCAR 5, as bypack on a THOR-DELTA-Rocket. It is hoped that a circular orbit over the poles will be obtained (90^{o} with respect to the equator) at a height of 1200 to 1600 km, which is the same as for the weather satellites of the ESSA series. The shape of OSCAR 6, or A-O-B is specified by the SECOR satellites that are usually carried as bypack with the THOR-DELTA. This is because the same mounting structure is to be used. The virtually cubical shape of the satellite has the dimensions of approximately 35 cm x 30 cm x 25 cm; its weight is in the order of 25 kg.

One of the three axes is stabilized in orbit using a permanent magnet rod. The same device was used successfully in Australis-OSCAR 5: The satellite axis was parallel to the magnetic lines of the earth within a week after launch. Since the two other axes remain unstabilized, which means that the satellite can roll about the two other axes, only omnidirectional or at best, dipole antennas can be used.

The area of the satellite surface covered with solar cells together with the calculation of the time that the satellite is in the shadow of the earth (during which a nickel-cadmium accumulator is used for the power supply), suggests that a continuous primary power of 6 to 8 W can be expected.

1.2. THE REPEATERS

The repeaters operate alternately and are switched on and off by a timer. However, a specific repeater can be selected and the output power controlled by remote control from the ground station. Each repeater radiates a beacon frequency modulated with telemetry signals at the band limit of its transmit band. Besides providing the required measured values, it is useful as a frequency and field-strength standard. The beacon signal simplifies the alignment of the antenna for the amateur ground station and enables a compensation of the Doppler shift and selection of the required transmit power.

The repeaters use the 2 m and 70 cm band for up link (from the ground station to the satellite) and the 10 m, 2 m and 70 cm bands for down link (from the satellite to ground). This means that radio amateurs equipped for duplex operation can monitor their own signal and transmit frequency and are able to match their output power and transmit frequency to the changing conditions. It would also be possible for the ground station to use an automatic frequency and power control system.

1.2.1. THE FM-REPEATER

The first repeater is to be developed and constructed by the Project Australis Group in Melbourne, Australia who also constructed the Australis-OSCAR 5. For OSCAR 6, a FM repeater with four channels is planned. The gain and output power for each of the four channels can be controlled from the ground; the maximum output power is 1 W per channel.

The following frequencies are planned:

Up link:	145.800	145.850	145.900	145.950	MHz
Down link:	432.200	432.250	432.300	432.350	MHz

The 2 m signals from the ground station are demodulated and passed to a transmitter operating on the corresponding 70 cm frequency which retransmits the signal to ground. The repeater is provided with an automatic frequency control in order to compensate for the Doppler-shift as well as for compensating for excess frequency deviation. The received signals are hard amplitude-limited in this repeater; this means that it will only be able to transpose frequency-modulated transmissions.

1.2.2. THE LINEAR REPEATER

The second repeater, which is the responsibility of the Euro-OSCAR group of DJ 4 ZC/DJ 5 KQ in Marbach, West Germany, is a linear repeater. This means that the 50 kHz bandwidth is able to be used for any modulation mode. The repeater operates according to the relatively new technique of elimination and restoration of the envelope of a signal to obtain high efficiency for the limited power system on the satellite (3). The output power amounts to 10 W PEP. Since the 70 cm band is also used for radar direction finding, the repeater is to be provided with a pulse-type interference blanking circuit for suppression of wideband interference from pulse radar equipment. The centre frequencies are:

Up link:	432.150 MHz
Down link:	145.950 MHz
Bandwidth:	50 kHz

Further specifications are at present:

Maximum output power:	10 W PEP
Low power mode:	2.5 W PEP
Beacon frequency:	145.975 MHz
Input sensitivity for full output:	-103 dBm (1.5 μV/50 Ω)

1.2.3. THE 2 m - 10 m REPEATER

The third repeater which is planned for the A-O-B satellite is the AMSAT 2/10 repeater. This satellite is under development by several AMSAT members in Washington and Texas, USA. It is a linear repeater that will receive signals in the 2 m band, will amplify them and retransmit them in the 10 m band. This repeater is to be added since the 10 m beacon of Australis OSCAR 5 demonstrated that this band is also useful for amateur satellite repeaters. Another reason was that probably more radio amateurs are able to operate on these two bands than at UHF.

The circuits for this repeater were also designed by Karl Meinzer, DJ 4 ZC, of the Euro-OSCAR group.

The basic data for the AMSAT 2/10 linear repeater are, at present:

Input centre frequency:	145.950 MHz
Output centre frequency:	29.5 MHz
Beacon frequency:	29.450 MHz
Repeater bandwidth:	120 kHz at -3 dB, 150 kHz at -6 dB and 240 kHz at -10 dB
Repeater output power:	1.3 to 2 W PEP
Input sensitivity:	Approx. -100 dBm for full output

1.3. AUXILIARY EQUIPMENT

Besides the described repeaters, a decoder system for the command signals from the control station on the ground as well as a telemetry system are to be provided.

The command decoder is also to be constructed by the Project Australis-Group. The new decoder uses modern COS/MOS integrated circuits which exhibit a very low power consumption, and which have not been tested in space. The decoder can be equipped for a maximum of 35 different control signals. Its main task is to provide a reliable remote control of the repeaters so that any possible interference to other radio services can be prevented.

The telemetry system is also to be developed and constructed by the Australian amateur group. Its signals can be directly printed out on amateur RTTY stations. A frequency shift keying of 850 Hz and a speed of 60 words per minute are planned. In addition to this, a format is to be used that is suitable for directly feeding a small digital computer for evaluation. Any station with a perforator can retransmit the received data on shortwaves for evaluation at the AMSAT Headquarters. Previous to launching, calibration tables will be published which will allow individual evaluation.

2. PRESENT STATE OF DEVELOPMENT

The latest information that is available before going to press is the AMSAT Newsletter of March 1971 (5) in which the following state of development was given. It was stated that although the hardware for AMSAT-OSCAR B under construction by the Project Australis-Group, the Euro-Oscar-Group and AMSAT Groups are progressing well, very little hardware is ready for flight tests. They are waiting for the hardware to be delivered and tested before making any final announcements of exactly what will be flown on AMSAT-OSCAR B. From this it can be taken that no final decisions as to the equipment of the satellite have been made.

Aircraft tests are already planned for the 2 m/10 m repeater. It is planned to have the first aircraft test in the Washington/Baltimore, USA area on Sunday, May 2nd, 1971. If this is successful, a longer flight should be made over the weekend of May 15th, and May 16th. It is therefore assumed that the 2 m/10 m repeater is at a high stage of development, although it was mentioned in (5) that further work is required to provide the nominal 2 W output with good efficiency and linearity using power supply voltages in the range of 12 to 15 V.

With respect to the linear repeater of the Euro-OSCAR Group in West Germany, it is stated that thermal-vacuum-electrical tests have been made on the prototype that is under construction at the moment. It was also stated that tests similar to the flight test of the 2 m/10 m repeater will be carried out during July and August of this year using the other repeaters intended for flight on A-O-B or later satellites. It is therefore assumed that the other repeaters will be available by this time. The mechanical construction of the casings of the individual modules as well as the spacecraft structure according to the plans of the A-O-B project leader Jan King, W3GEY, has been completed by Bob Sprole, W2QJT. Several solar cell paddles that were left over from NASA and ESSA satellite programs were made available to AMSAT. Several of these paddles are being modified for the outer surfaces of the A-O-B satellite. In addition to this, AMSAT has been provided with nickel-cadmium accumulators which will be tested according to the charge-discharge cycles at the anticipated load. Previous experience and results from experiments with the solar cells and accumulators indicate that an active satellite life of over a year is to be expected.

A prototype of the 4-channel FM repeater has been in operation on a tower in Melbourne, Australia and a constructional prototype is, at the moment, being tested on balloon flights.

The EURO-OSCAR linear repeater has been tested at various states of development in balloon flights by the ARTOB-group and has been used by radio amateurs in a radius of over 500 km from Hannover, North Germany.

Work has also begun on the remote control modules. A prototype of the command decoder is completed. The command coder for the ground control station is in the breadboard state, a prototype is under preparation. A special coder for the telemetry signals of OSCAR satellites has been developed by John Goode, W 5 CAY, and has been built up in the laboratory. With this coder, the telemetry data are transmitted as numerals in morse code. This means that only pencil and paper, as well as the calibration information, are necessary for reading and evaluating the data supplied by the satellites.

In conjunction with the A-O-B satellite project, an agreement was made between Australia and the USA with respect to the passing of information from and to third persons as long as this information refers to amateur satellites. This agreement is an advance on the agreement that was valid for OSCAR 5.

3. REFERENCES

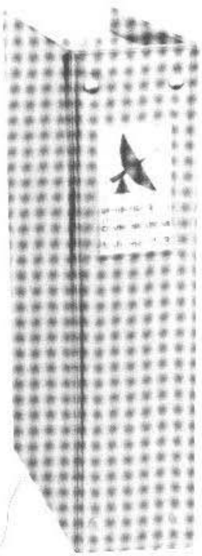
(1) George V. Kinal: Call for Experiments for AMSAT-OSCAR-B
AMSAT NEWSLETTER 2 (1970), No. 1, Pages 14-15

(2) George V. Kinal: AMSAT-OSCAR-B Report
AMSAT NEWSLETTER 2 (1970), No. 3, Pages 10-11

(3) Karl Meinzer: A Frequency Multiplication Technique for VHF and UHF SSB
QST 54 (1970), No. 10, Pages 32-35

(4) Dr. Perry I. Klein: Current Activity - AMSAT-OSCAR-B
AMSAT 1970 Annual Report (November 1970)

(5) AMSAT NEWSLETTER, Volume III, Number 1, March 1971.



SUMMER HOLIDAY

The Publishers and the Material Sales Department will be taking their summer holiday during the month of August 1971. Since we are not able to dispatch orders or answer queries in this period, some delays could be encountered in receiving your orders or answers. If you require items within this period, please order them well before hand.

PROJECT MOONRAY

In 1960 N.K. Marshall, W 6 OLO/2 proposed the original concept of a lunar-based UHF-repeater for amateur telecommunications as a natural follow-on to the OSCAR satellite programme. In 1967 NASTAR (Nassau College Amateur Satellite Tracking, Astronomy and Radio) took over the sponsorship and organization of the concept which is now known as project MOONRAY.

After enlisting the aid of a number of highly qualified technical advisors (who were all radio amateurs) NASTAR finalized most of the important parameters for MOONRAY I. At present the design, development and testing of an operational prototype is in progress and the final construction of a flight model will be available shortly.

It is hoped that NASA will be able to take the repeater to the moon on one of the remaining APOLLO flights. If this is possible, one of the Astronauts will set-up and activate MOONRAY I on the lunar surface. The repeater is planned to have a continuous operational life of at least a year.

MOONRAY is to be a free-access UHF-repeater for world-wide line-of-sight communications on the international 70 cm band. Advantages offered to NASA in return could be the use as emergency communications link for the Astronauts in the case of an unlikely but possible failure of the regular communications facilities and as a landing site beacon for later landings.

MOONRAY I will be equipped with a highly sensitive receiver, signal processor, identifier, timer, six to eight channels of telemetry, a laser receiver with optical system and, of course, a transmitter for retransmission of the received signals. Power will be taken from an isotope-fueled thermoelectric generator with a half-value life of 87 years. The final package will be in the form of a metal cylinder of approximately 15 cm in diameter and 25.5 cm long. It will stand on three retrectable or folding legs. A special aiming device is to be provided to point the antenna accurately to earth.

The up-link frequency is to be 439.9 MHz and the down-link frequency 430.1 MHz. The 10 kHz bandwidth will accept all modes. The recommended modes are, in order of preference: CW, FSK, MCW, AFSK, NBFM, SSB and AM.

MOONRAY's callsign will be the identifier "SS" in morse code. The repeater will operate on a continuous duty basis 24 hours a day with one minute intermissions every ten minutes to transmit the identifier together with a telemetric sequence.

To be able to communicate via the repeater, amateur ground stations will require antennas of at least 15 dB gain that are capable of tracking the moon and low-noise (max. 3 dB) crystal-controlled converters at 430.1 MHz with stable tunable IF's (good communications receivers). On the transmit side it is estimated that 50 W output will be required on 439.9 MHz for CW, whereas more power will be required for the other modes up to 1 kW for slow-scan TV.

If further information is required on MOONRAY, please contact:
NASTAR, PO. box T, SYOSSET, NY 11791, USA

REFERENCES

N.K. Marshall: Project Moonray Fact Sheet
AMSAT Newsletter of March, 1971
-BQ-

A 28 MHz - 432 MHz TRANSMIT CONVERTER WITH FET-MIXER

by F. Weingärtner, DJ 6 ZZ

There are three main methods of obtaining a transmit signal on the 70 cm band:

1. Frequency multiplication, including tripling from 2 metres using varactor diodes.
2. Conversion of a 2 metre signal with the aid of an auxiliary frequency of 288 MHz (144 + 288 = 432).
3. The conversion of a 10 metre signal with an auxiliary frequency of 404 MHz (28 + 404 = 432).

Each concept has advantages and disadvantages; the simple multiplication is not suitable for single sideband modulation. The conversion from the 2 metre band has the disadvantage of causing spurious signals because 70 cm signals will be also generated due to unwanted tripling of the 2 metre signal which is difficult to avoid. A frequency conversion from the 10 metre band requires the use of a shortwave transmitter from which a modulated 10 metre signal can be taken at a low level. This means that the described transmit converter is especially suitable for those amateurs that have shortwave equipment.

A transmit converter is to be described that converts the frequency range of 28 to 30 MHz to 432 MHz. Figure 1 shows the transistorized module which is built up on a double-coated epoxy PC-board having the dimensions 125 mm x 85 mm. The push-pull mixer stage is equipped with junction field effect transistors, the output stage with the Overlay transistor 2 N 3866 which provides an output power of approximately 200 mW. Since an operating voltage of only 12 V is required, this module is also suitable for mobile and portable operation. The stripline circuits used in this design mean that no screening need be provided between the individual stages and that construction is very simple. For fixed operation, the operating voltage of the output transistor can be increased to 18 V and the output fed to a linear amplifier stage, such as described in (1).

1. CIRCUIT DETAILS

The circuit of the transmit converter is given in Fig. 2. The auxiliary frequency of 404 MHz is derived from a 67.333 MHz crystal. This signal is firstly tripled and then doubled in the subsequent stages. A further stage amplifies the 404 MHz signal up to a value suitable for mixing.

The overtone crystal oscillator is equipped with a PNP silicon transistor so that inductance L 1 can be soldered directly to ground. In the following stages, it is important that the emitter is grounded in a low-inductive manner. This is the reason why inexpensive NPN transistors are used that receive their collector voltage via chokes. It is therefore possible for the inductances to be soldered to the ground surface.

The push-pull mixer is equipped with field effect transistors type BF 245 C. The same type of circuit has been used by the author in transmit mixers for shortwave and for 2 metres (2). The source connections are grounded via resistors of 270 Ω that are bypassed with respect to radio frequencies.

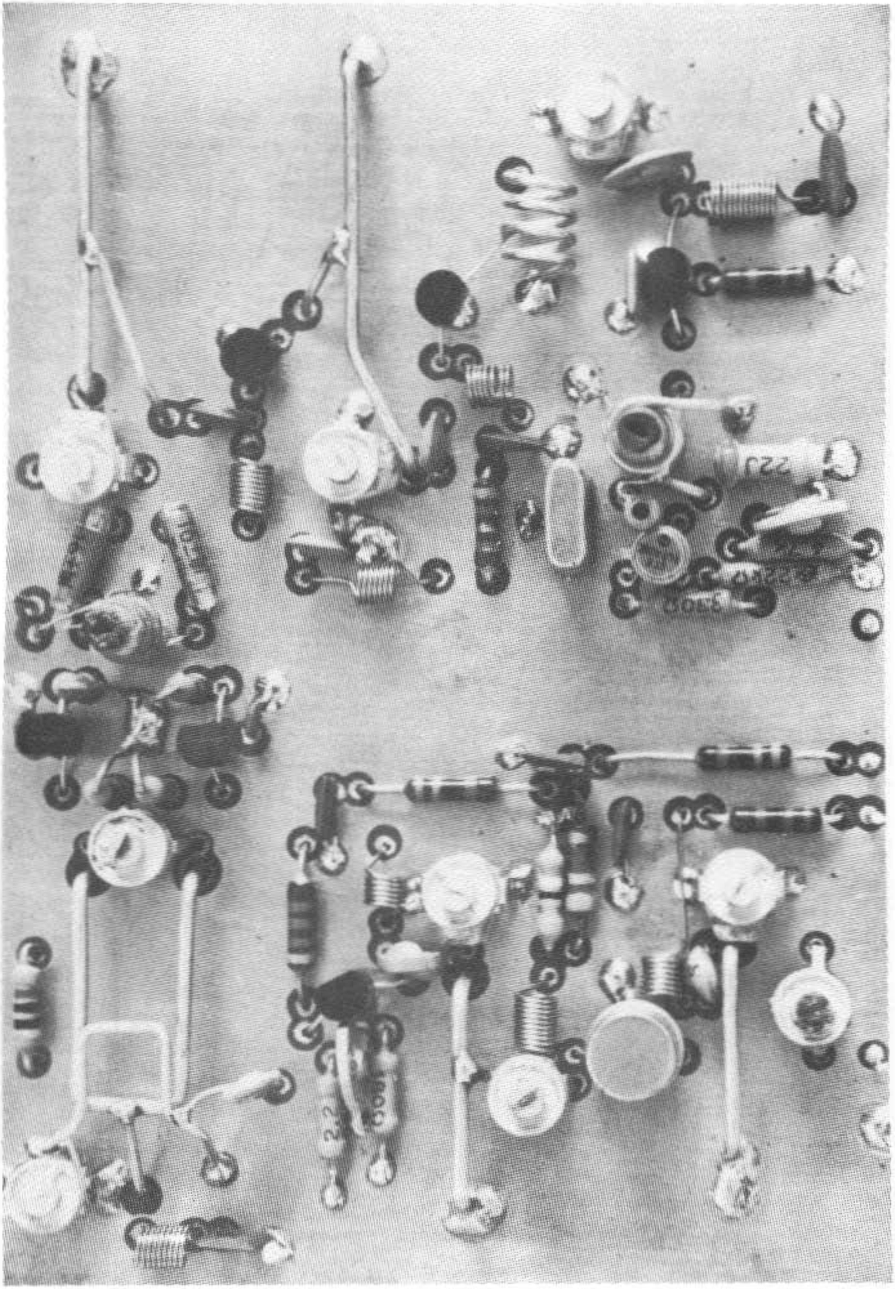


Fig. 1: The transmit converter DJ 6 ZZ 002

The gate connections are grounded via 4.7 kΩ resistors and connected to the push-pull resonant circuit aligned to the 10 metre band. This resonant circuit is provided with a coupling link into which the 10 metre signal is fed. The capacitance of the 10 m resonant circuit is provided by the two, equally great capacitors C 15 and C 16 which are series connected. The 404 MHz auxiliary signal is fed from the 404 MHz resonant circuit L 5/C 14 to this point.

The push-pull Lecher circuit of the mixer stage is aligned to the 70 cm band with trimmer capacitor C 19. A bandpass filter results together with the tuned coupling link L 9. The output signal of the mixer is fed to the first linear amplifier (T 7) at low impedance via a capacitor of 5 pF.

The two linear amplifier stages operate in conjunction with $\lambda/4$ stripline circuits. The collector voltage is fed to the transistors via chokes. The output matching is adjustable with the aid of a trimmer capacitor. Bypass capacitors with capacitance values suitable for UHF as well as decoupling resistors complete the circuit.

1.1. THE MIXER STAGE

Experiments were made using a transistor mixer equipped with a single BF 224. It was found that the output signal of the mixer was sufficient for driving the linear amplifier stages. However, the 404 MHz auxiliary signal was not suppressed sufficiently. During the punctuation pauses, the 404 MHz signal at the output (Pt 6) amounted to approximately 20% of the maximum output power.

The relatively small frequency spacing between the required and the auxiliary frequency when converting from 10 m to 70 cm is the cause of this. A push-pull mixer suppresses the auxiliary frequency considerably better; the field effect transistors used in this circuit ensure that the spurious and harmonic signals are very low.

2. CONSTRUCTION

The transmit converter is built up on a double-coated PC-board having the dimensions 125 mm x 85 mm. The printed circuit board has been designated DJ 6 ZZ 002. Figures 3 and 4 show both sides of the board and its component location plan. On the component side, only those positions have been etched where connections must be made through to the conductor side. This means that a virtually unbroken ground surface results on the component side of the board so that no neutralization is required even after installing the transmit converter into other equipment. All ground connections of inductances, capacitors, resistors and transistors are directly soldered to this ground surface. In order to ensure that no short circuits can occur, attention must be paid during the mounting of resistors and chokes that a slight spacing exists between these components and the ground surface.

The stripline circuits are made from 1.5 mm diameter silver-plated copper wire or approximately 3 mm wide brass strips. The ground ends are bent so that the stripline circuits possess a spacing of approximately 4 mm to the ground surface on the component side after being soldered into place. The hot ends of the lines are soldered to the appropriate holes in the PC-board or directly to the trimmer capacitors if their construction allows this.

Ceramic disc capacitors are used for aligning the resonant circuits. All types can be used for the coupling capacitors that are small enough to be accommodated on the printed circuit board. However, the bypass capacitors must be very low-inductive ceramic disc types.

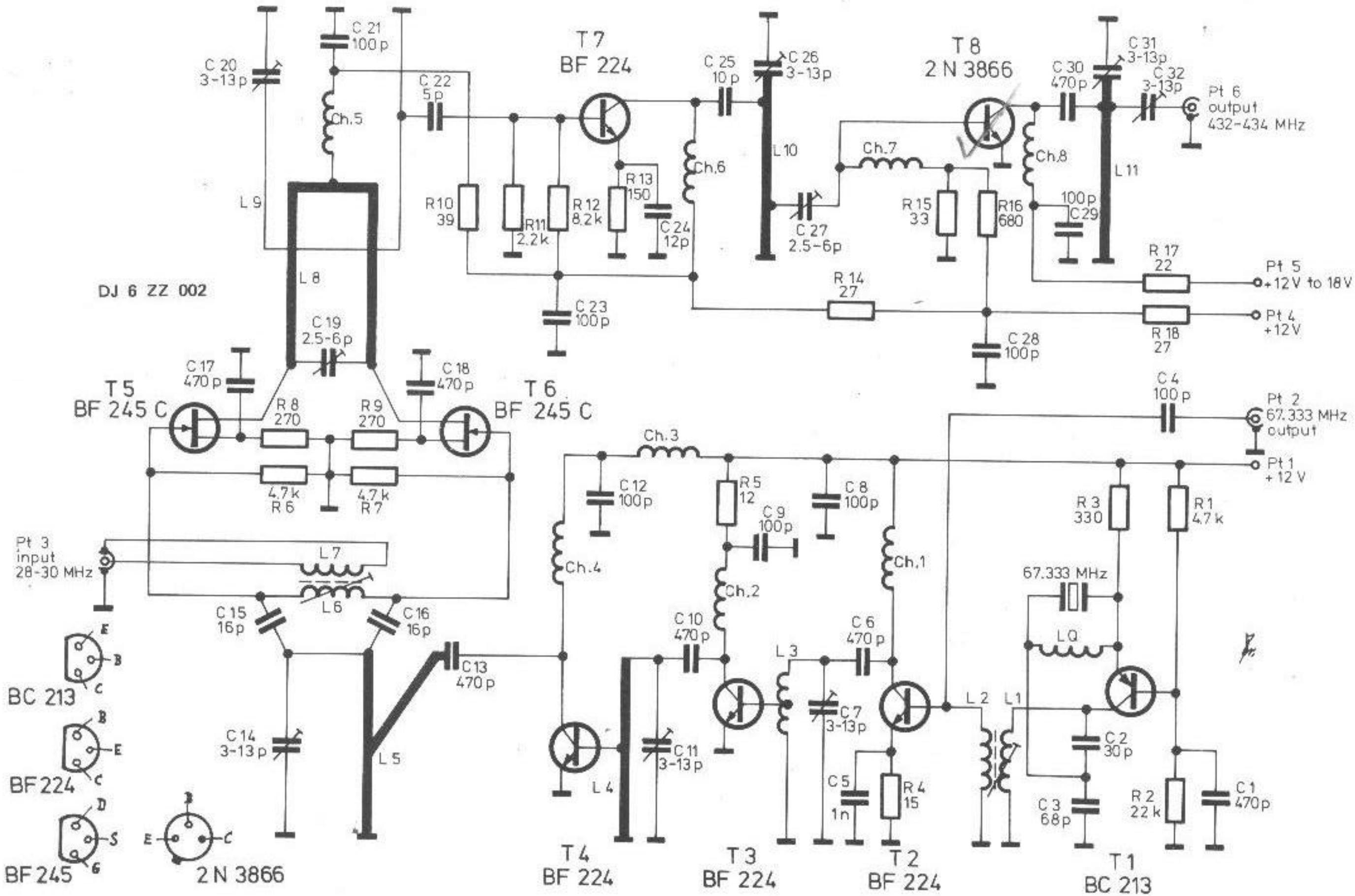


Fig. 2:, Circuit diagram of the 10 m/70 cm transmit converter

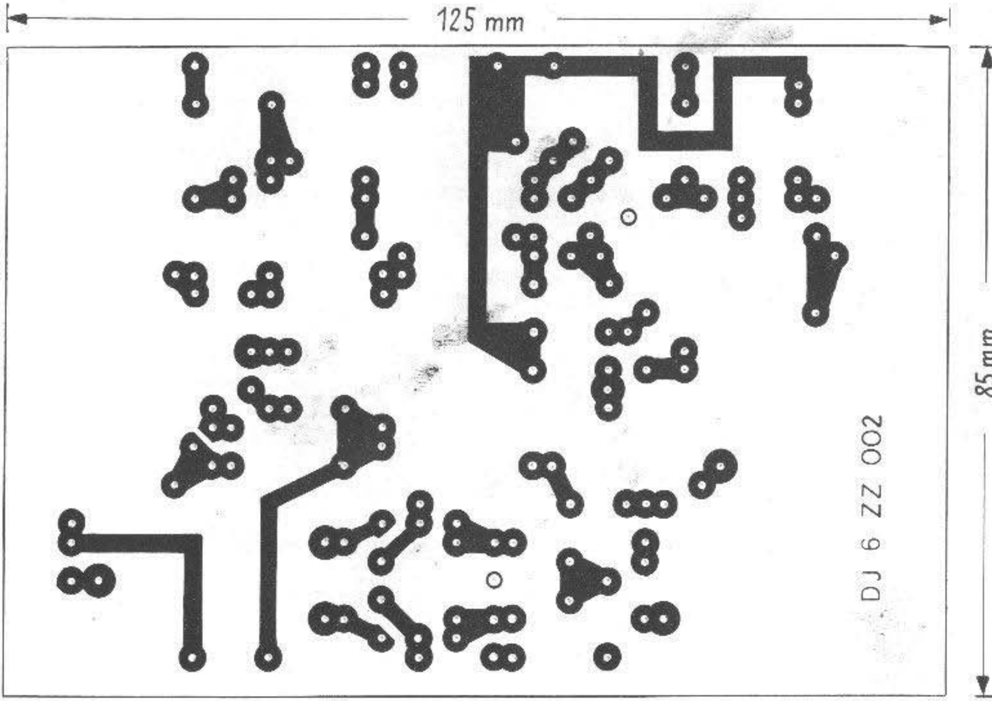


Fig. 3: Conductor side of the PC-board DJ 6 ZZ 002

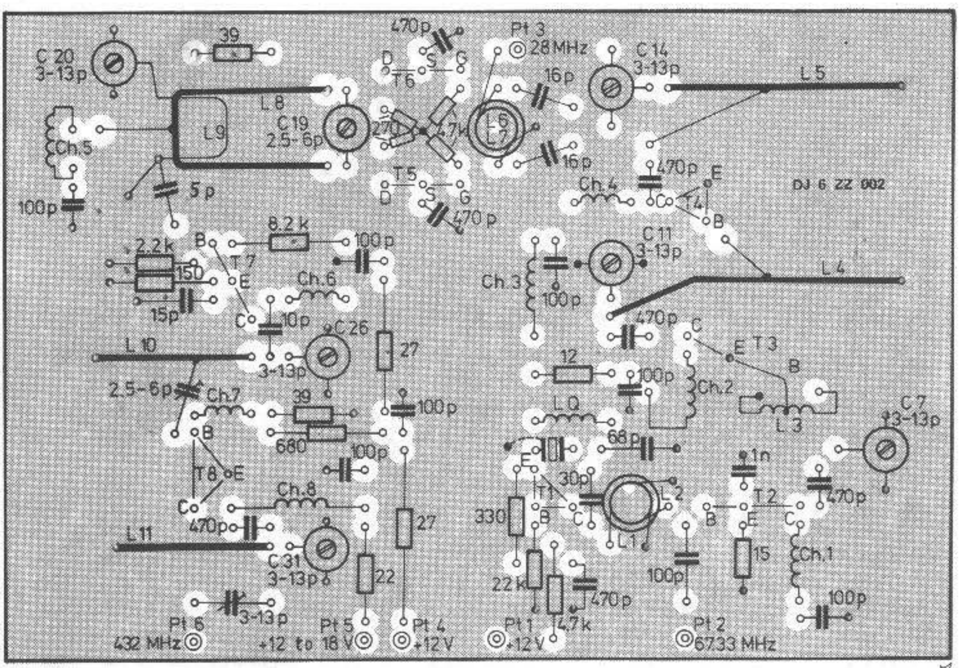


Fig. 4: Component location plan to DJ 6 ZZ 002

2.1. SPECIAL COMPONENTS

T 1: 2 N 2907 A, 2 N 3702 or BC 213 (PNP silicon AF transistors)
T 2, T 3, T 4, T 7: BF 224 or BF 173 (Texas Instruments Germany)
T 5, T 6: BF 245 C (TI Germany) or TIS 88, 2 N 5245
T 8: 2 N 3866

L_Q: 15 turns of 0.4 to 0.5 mm dia. (25 AWG) enamelled copper wire, close wound onto a 4 mm former. Self-supporting.
L 1: 6.5 turns of 1 mm dia. (18 AWG) silver-plated copper wire wound on a 5 mm diameter coil former with shortwave core.
L 2: 1.5 turns of 0.4 - 0.5 mm dia. (25 AWG) enamelled copper wire wound in the last few turns at the cold end of L 1.
L 3: 4 turns of 1 mm dia. (18 AWG) silver-plated copper wire wound on a 5 mm former, coil tap 1.5 turns from the cold end. Self-supporting, coil length 10 mm.
L 4: 1.5 mm dia. (15 AWG) silver-plated copper wire, 45 mm long, bend and tapping point 15 mm from the cold end.
L 5: Wire as for L 4, 40 mm long, straight length 30 mm, tapping point 15 mm from the cold end.
L 6: 20 turns of 0.4 - 0.5 mm dia. (25 AWG) enamelled copper wire, otherwise as L 1.
L 7: 3 turns; wire as for L 6, wound onto the centre of L 6.
L 8: Wire as for L 4, 60 mm long, bent in the form of a U with an inner spacing of 8 mm, with centre tap.
L 9: 1 mm dia. (18 AWG) silver-plated copper wire, 40 mm long, bent in the form of a U, with inner spacing of 7 mm, tap 10 mm from the cold end.
L 10: Wire as for L 4, 35 mm long, straight length 20 mm, tap 12 mm from the cold end.
L 11: Wire as for L 4, 30 mm long, straight length 20 mm.

All chokes are made from 0.4 - 0.5 mm dia. (25 AWG) enamelled copper wire close wound onto a 3 mm former, self supporting.

Ch 1: 11 turns
Ch 2: 6.5 turns
Ch 3: 6 turns
Ch 4, Ch 5: 8.5 turns
Ch 6: 5.5 turns
Ch 7: 10 turns
Ch 8: 7 turns

C 7, C 11, C 14, C 20, C 26, C 31, C 32: 3.5 - 13 pF
Ceramic miniature disc trimmers 7 mm diameter
C 19, C 27: 2.5 - 6 pF ceramic miniature disc capacitors (or 3.5 - 13 pF)

3. ALIGNMENT

A modulated 29 MHz signal with variable amplitude, an RF meter (SWR meter) with terminating resistor or matched antenna, and a receiver for the 70 cm band are required for alignment.

If the inductance L_Q is correctly dimensioned, the crystal oscillator will only oscillate at the nominal frequency. The subsequent frequency multiplication stages are aligned with the aid of the trimmers for the highest collector current of each following stage. The current via transistor T 2 amounts to approx. 25 mA when the oscillator is operative. The resonant circuit of the 404 MHz buffer stage is aligned with capacitor C 14 for maximum voltage drop across the source resistors R 8 and R 9 of the mixer stage. The voltage drop should be equally great across both resistors.

If this is not the case, one or the other transistor in the mixer circuit should be exchanged if components C 15 and C 16, R 6 and R 7 as well as R 8 and R 9 are equally great and the resonant circuits comprising L 6 and L 8 are built up symmetrically.

An operating voltage of 12 V is now connected to connection point Pt 4 and a 10 m signal of approximately 0.5 V is fed to input Pt 3. The signal should be modulated so that it can be identified in the 70 cm receiver. If the signal is not to be heard at the expected frequency, the crystal will not be synchronizing the oscillator correctly. By carefully aligning inductor L 1, the correct adjustment can rapidly be found. If the crystal oscillator only operates within narrow tuning limits due to the correct dimensioning of inductance L_Q, these instructions are irrevelant.

The output filter of the mixer stage is now aligned for maximum collector current of transistor T 7 with the aid of trimmer capacitor C 19 and C 20. Inductance L 9 should be located as near as possible to L 8. At the same time, inductance L 6 should be aligned for maximum. At this point, the resonant circuits of the oscillator portion should be aligned for maximum current through transistor T 7 (highest conversion gain).

Finally, a terminating resistor with power indication is connected to the output (Pt 6) and the output stage connected via Pt 5 to the operating voltage. It is now possible for the collector circuits and the matching trimmers of the two linear amplifier stages to be aligned for maximum output power. It is advisable for the whole alignment to be repeated several times. The output power finally amounts to more than 200 mW. It can be increased to approximately 300 mW by connecting an operating voltage of 18 V to point Pt 5.

On increasing the drive from the 10 m transmitter, the output power is only increased to a certain limit. If this limit is exceeded, the output power will be reduced. It is therefore important that the most favourable drive level is found and maintained.

The bandwidth of the converter is so great that the output power does not fall noticeably within the frequency range of 432 to 434 MHz. This means that a correction is not necessary when tuning within the 70 cm band.

If spurious oscillations occur during the alignment, the cause will be in the output coupling from the push-pull mixer. Either the capacitance of trimmer C 20 is too low, or the tap is too far from the cold end of inductance L 9.

4. EXTENDING THE TRANSMIT CONVERTER FOR TRANSCEIVE OPERATION

The described module can be combined with a 70 cm converter for transceive operation. However, the prerequisite of this is that the same crystal oscillator is used for the transmit and receive mixer. The following frequencies can be tapped off from the transmit converter for feeding the oscillator portion in a receive converter: 67.333 MHz via a capacitor from the base of transistor T 2, 202 MHz from inductance L 3 (1 turn from the cold end), or 404 MHz near the cold end of inductance L 5.

If these signals are not sufficient for driving the receive converter, it will be necessary to provide an amplifier stage because a greater loading of the oscillator stages of the transmit converter module is not permissible. Connection point Pt 2 is provided for tapping off the frequency 67.333 MHz.

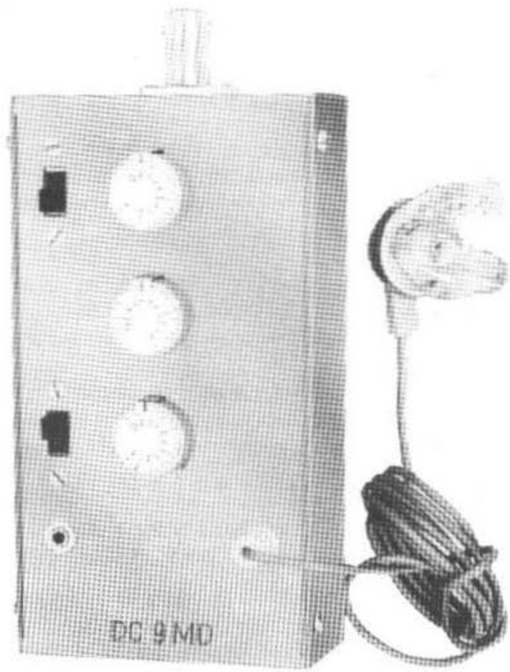
5. AVAILABLE PARTS

The printed circuit board DJ 6 ZZ 002 and various components are available from the publishers or their national representatives. Please see advertising pages.

6. REFERENCES

(1) K. Eichel: Strip-line Transverter for 70 cm
VHF COMMUNICATIONS 2 (1970), Edition 4, Pages 225-239

(2) F. Weingärtner: FETs in the 28/144 MHz Transverter DJ 6 ZZ 001
VHF COMMUNICATIONS 2 (1970), Edition 2, Pages 103-104



PLUG-IN MODULAR EQUIPMENT

by D. E. Schmitzer, DJ 4 BG

Small aluminium cases have been available on the market for some time now. The author thought that such boxes would be ideal for building screened modular equipment based on printed circuit boards. The advantages of the modular system are explained in detail in (1): The construction of complicated equipment, such as an SSB transceiver or a transmitter for several modes, can be greatly simplified when it is reduced to individual circuit modules that can be aligned and tested. After this it is only necessary for the modules to be connected together.

This results in a high rejection of spurious radiation and injection as well as in a high degree of decoupling between individual modules. Even the less experienced amateur is able to construct high-quality and complicated equipment relatively easily. Finally, another advantage of the modular system is that individual modules can be replaced by improved or circuits modified without having to modify the whole equipment.

If economical plugged connectors are used, the modular system can be built up in a virtually professional manner using plug-in modules.

1. THE CASE

The author's system is based on the TEKO-cases that are available freely on the European market. These cases are available in two different heights (28 mm or 42 mm) and four different lengths (37, 57, 102 and 141 mm); the width is always 72 mm. For most applications, case sizes 3A (102 x 71 x 28 mm) or 4A (141 x 71 x 28 mm) should be suitable. A height of 28 mm is even sufficient for large components such as the KVG crystal filters of the XF-series. If higher components are to be used, it is possible to use sizes 3B and 4B. However, one should firstly consider whether it would not be more favourable to mount large components such as a modulating or power transformer at some other position in the equipment, so that the larger TEKO-case does not take up too much room.

A certain amount of preparation is required before the TEKO case is suitable for use as a plug-in module. This is now to be explained in more detail; Fig. 1 to 4 give the relevant dimensions and positions.

A mounting for the printed circuit board should be provided in the lower part of the case. This can be done by either drilling four 2.7 mm holes at the positions shown in Figure 1 and inserting 2.6 mm diameter, 15 mm long screws or by gluing 2.6 mm diameter, 12 mm long screws to the designated positions with a two-component adhesive (UHU-plus). A cutout must be sawn or filed from the lower part at one side of the case through which the 13-plug protrudes (see shaded area in Figure 1). If the printed circuit boards are to be mounted from the wired side, the two holes on the front edge should be drilled out to 3.2 mm after which 3 mm diameter nuts are glued opposite to them on the inside of the case, as is also shown in Fig. 1.

It is also necessary for a portion of the cover to be sawn and filed to accommodate the 13-pole plug. The dimensions are given in Figure 1.

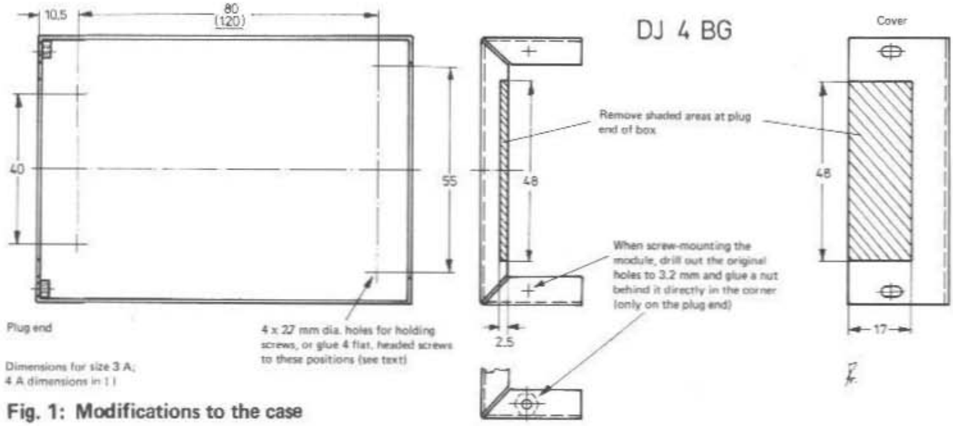


Fig. 1: Modifications to the case

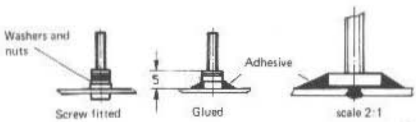


Fig. 2: Mounting of the holding screws

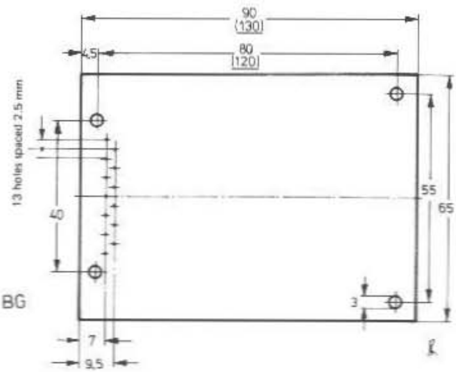


Fig. 3: Board dimensions
for case size 3 A. ( ) = 4 A

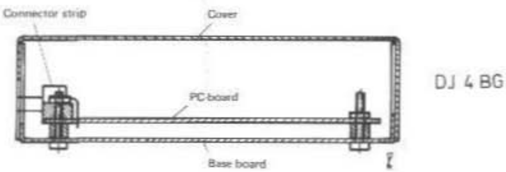


Fig. 4: Sectional drawing through a module in a 3 A case

Height: 28

Length	37	57	102	141
Width	71	71	71	71
TEKO-No.	1 A	2 A	3 A	4 A

Height: 42

Length	37	57	102	141
Width	71	71	71	71
TEKO-NO.	1 B	2 B	3 B	4 B

If the simple screw mounting is chosen, four screw heads will protrude on the outside of the casing which may be a disadvantage when the modules are mounted close together. Countersunk screws cannot be used due to the thin aluminium plate of these cases. However, the screws can be glued to the inner surface of the case. Figure 2 gives further information. The stability of the adhesive is actually more than sufficient for all expected stress that can be placed on it. However, if more stability is required, this can be obtained by drilling a conical hole below the head of the screw which then forms a rivet type anchor after hardening. It is advisable to place a piece of adhesive tape over the hole so that the adhesive cannot drop through.

The mounting screws are now provided with spacer bushings, washers or nuts with a total height of 5 mm. Such a spacing should be sufficient for avoiding any short circuits between board and case. The remaining height inside the case is 19.5 mm; in comparison, the height of the XF-series of crystal filters is 19 mm.

1. PRINTED CIRCUIT BOARD AND CONNECTORS

Printed circuit boards of 90 mm by 65 mm or 130 mm by 65 mm can be accommodated in cases 3A and 4A respectively. This still allows sufficient room for a 13-pole connector that coincides with the outer surface of the case. Since the female connector is placed within the casing after the module has been plugged into position it is possible for the lower surface of the case to be screwed to the chassis if this is required. The preparations for this are also shown in Figure 1. It is important that the case of the module always has a good contact to the chassis.

The dimensions of the PC-boards as well as the holes required for the connectors are given in Figure 3. A sectional drawing through a completed module is shown in Figure 4. Of course, the described system can be modified at will; for instance, if an extremely compact construction is required, two such modules can be joined together and the PC-boards mounted using common tapped bushings of 2.6 mm diameter.

3. AVAILABILITY

Although these casings seem to be readily available in Europe, the publishers will stock a number of 3A-casings for future designs which will appear in later editions of this magazine.

The connectors are already available from the publishers. Please see advertising page. The publishers also have tailored, undrilled PC-boards for these cases from single or double-coated epoxy PC-board material. The dimensions are 90 mm by 65 mm or 130 mm by 65 mm. Please see advertising page.

4. EDITORIAL NOTES

An example of such modular equipment is given in (1) in this edition of VHF COMMUNICATIONS. The individual modules will be described in later editions of this magazine.

5. REFERENCES

(1) D. E. Schmitzer: A Modular Receiver System
in this edition of VHF COMMUNICATIONS

A MODULAR RECEIVER SYSTEM

by D. E. Schmitzer, DJ 4 BG

INTRODUCTION

As was already mentioned in (1), aluminium casings such as those manufactured by Teko provide the amateur with a simple way of constructing screened modular equipment. This allows complicated equipment to be reduced to individual modules which can be understood, modified or exchanged more easily. An example of such a module was the speech processor described in (2). This article is to give an insight into a modular receiver system of which the individual modules will be described in later editions of VHF COMMUNICATIONS.

1. AN FM/AM RECEIVER FOR MOBILE OPERATION

The following modules are designed to form a receiver that is suitable for both the AM and FM-modes - popular via repeaters and with direct communication -. Not only crystal-controlled channels are to be provided but also a variable frequency oscillator. AM transmissions are processed in a separate IF strip for this mode. The power consumption of this receiver is very low, which means that it is very suitable for mobile and portable operation.

Further modules are to be developed for the CW and SSB modes, as well as modules for a matching transmitter.

The block diagram in Figure 1 shows the interconnection between the individual modules and indicates the versatility of the modular system. As far as it is possible and recommendable, the input and output impedances of the RF and IF modules will be maintained at 60 Ω so that good matching is guaranteed between individual modules.

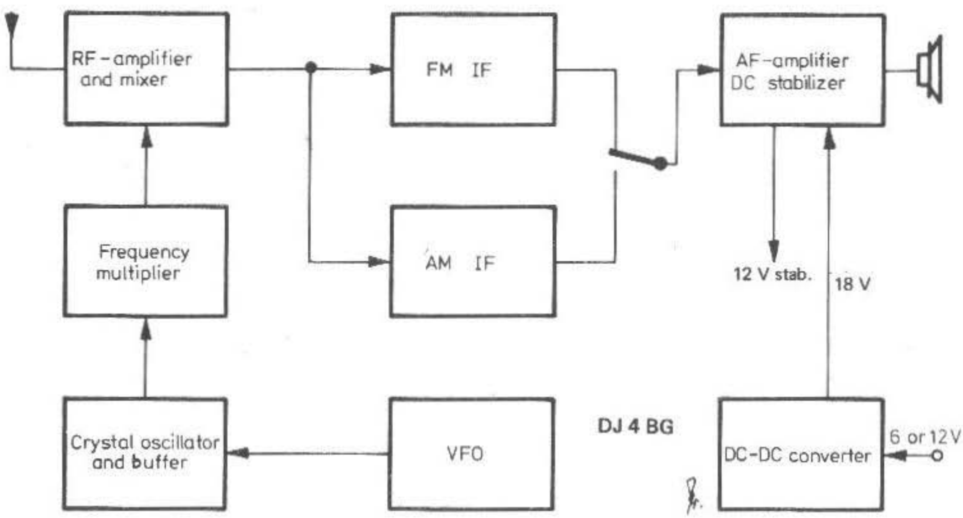


Fig. 1: Block diagram of a modular FM/AM receiver

1.1. DC-DC CONVERTER

In its basic form the DC-DC converter is designed for use with the receiver (e.g. input voltage 6 V, output 18 V at a maximum of 400 mA, efficiency 70%). However, it is possible by adding power transistors such as 2 N 3055 or 2 N 3771 etc. and a suitable transformer, for it to be extended for power outputs of up to 100 W.

1.2. AUDIO AMPLIFIER AND VOLTAGE STABILIZER

The printed circuit board of the audio amplifier also accommodates a voltage stabilizer, which provides a stabilized voltage of 6 V to 24 V according to the selected components. The audio amplifier, which is based on (3), can be extended using external power transistors and used as a modulator with output power levels in the order of 20 W. The voltage stabilizer (4) can also be extended for output currents of up to approximately 5 A.

1.3. FM IF-AMPLIFIER

The FM IF-amplifier is equipped with a crystal discriminator (5) and is therefore extremely easy to construct. Only one resonant circuit is used which is simply aligned for maximum gain. According to the frequency of the crystal discriminator, the module can be used for intermediate frequencies of 9 MHz or 10.7 MHz.

1.4. RF-AMPLIFIER

The RF-amplifier corresponds to the latest state-of-the-art and is equipped with dual-gate MOSFETs. Together with the employed single superhet principle, the receiver exhibits a very high cross-modulation rejection even in the AM-mode. A crystal filter is used directly after the mixer circuit as was recommended in (6). The bandwidth of this filter is suitable for FM, however, its high ultimate rejection can also be utilized for the other modes. This means that an inexpensive crystal filter will be sufficient in a subsequent CW/SSB IF-module (e.g. XF-9A).

1.5. CRYSTAL OSCILLATORS

This module is equipped with three crystal oscillators that can be aligned separately and are switched into operation via DC-lines. A buffer is provided for a variable frequency oscillator which can also be switched on over a DC-line. This means that the signals of the selected crystal oscillator or VFO can be taken from the same output. In an SSB/CW receiver, this module could, for instance, be equipped with both sideband crystals and a CW-BFO crystal.

1.6. FREQUENCY MULTIPLIER

The frequency multiplier module transposes the frequencies of the oscillator module (approximately 17 MHz) to the required frequency band in the region of 135 MHz.

1.7. VARIABLE FREQUENCY OSCILLATOR

A variable frequency oscillator provides far more versatility on the band. However, this module can be modified for other applications and frequencies in the range of 3 MHz to 40 MHz; it is merely necessary to re-dimension the frequency dependent components.

1.8. AM IF-AMPLIFIER

The receiver is extended for AM-transmissions by provision of an AM IF-module; the AM-FM switching is made in the AF-plane.

2. CW/SSB RECEIVER

The described AM/FM receiver concept can be extended for reception of CW and SSB transmissions by the addition of an SSB IF-module. Since a higher frequency stability is required in this mode, the VFO signal is not frequency-multiplied but is converted to a higher frequency by beating it with a crystal-controlled signal. This also occurs in a Teko-module which accommodates the crystal oscillator, mixer and filter links.

2.1. A SHORTWAVE RECEIVER

Of course, these modules are not limited to VHF-UHF applications and can be used equally well on the shortwave bands.

Figure 2 shows an example of how a small, but efficient SSB/CW receiver can be constructed by adding a suitable RF module and VFO to the CW/SSB IF and AF-modules. Such a receiver is invaluable on holiday (vacation), business trips or for portable operation. Since the oscillator is tuned with varactor diodes, it is not only possible to keep the input circuits aligned to the selected frequency but also to control a similar transmit VFO. A more accurate tracking of the frequency results when the same BFO and conversion system is used for both receiver and transmitter.

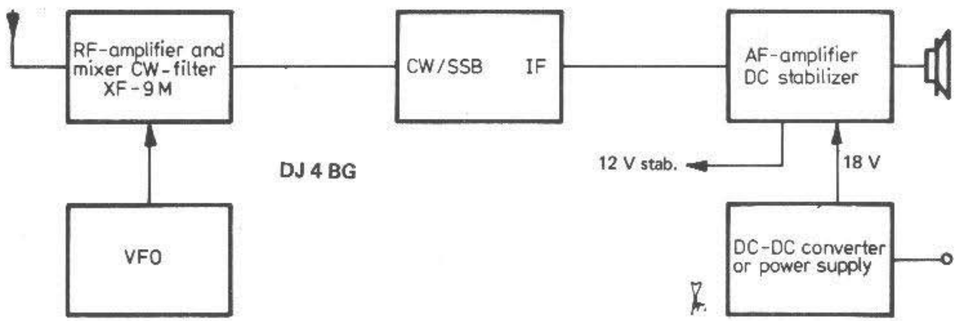


Fig. 2: Block diagram of a modular CW/SSB receiver for a shortwave band for power line or battery operation

2.2. FURTHER NOTES

Some of the modules such as the VFO, frequency multiplier or AF-amplifier and of course the previously described speech processor (1) can be used equally well for applications in a transmitter, which can be operated from the extended DC-DC converter during portable operation.

The described applications are only meant to be a stimulation for construction of versatile modular equipment. Naturally, the range of possible combinations and applications is virtually unlimited.

Of course, one of the greatest advantages of the modular system is the fact that technical improvements and utilization of the latest components does not require the whole receiver to be modified; this is only made on the module in question whereas all other modules remain in their previous state. In this way, it is possible for equipment to be kept absolutely state-of-the-art or modernized step-by-step without re-designing the whole concept. Even for fault-finding and repair, the modular system has the advantage that the malfunction can be more easily localized to the defective module and it is, of course, easier to understand the operation of an individual module than a complete unit with all components on a common printed circuit board. Professional electronics, including space communications, have been using modular systems for quite a long time. Of course, the advantages for professional applications are mainly in the quick replacement of defective modules which could also be important to a great number of amateur stations such as repeaters, emergency networks etc.

Of course, it is also more economical to modify or modernize one module than to re-build a complete unit for a certain application. An idea of a receiver built-up by the author in the Teko-modular system is given in Figure 3. This is the receiver shown in the block diagram Fig. 1.

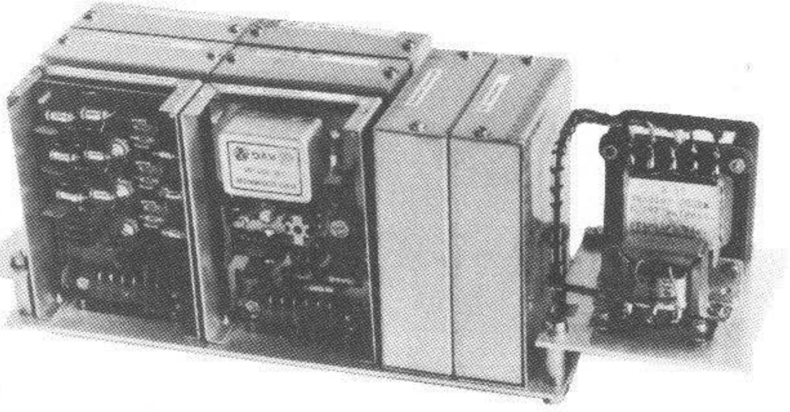


Fig. 3

The author hopes that this article will stimulate design of modular systems by other amateurs. Several of the mentioned modules will be described in detail in later editions of VHF COMMUNICATIONS.

3. AVAILABLE PARTS

The Teko-cases, the printed circuit boards as well as kits of the individual modules will be made available to readers after each module has been described in this magazine.

4. REFERENCES

(1) D. E. Schmitzer: Plug-in Modular Equipment
in this edition of VHF COMMUNICATIONS

(2) D. E. Schmitzer: Speech Processing
VHF COMMUNICATIONS 2 (1971), Edition 4, Pages 217-224

(3) D. E. Schmitzer: The Integrated Audio Amplifier PA 237
in this edition of VHF COMMUNICATIONS

(4) H. J. Franke, H. Kahlert: DC Voltage Stabilizer with the Integrated Circuit LM 305
in this edition of VHF COMMUNICATIONS

(5) D. E. Schmitzer: Experiments with a Crystal Discriminator
VHF COMMUNICATIONS 2 (1970), Edition 3, Pages 147-152

(6) D. E. Schmitzer: A Modern Concept for Portable 2 Metre Receivers
VHF COMMUNICATIONS 1 (1969), Edition 2, Pages 115-122

The RSGB have been forced to increase their prices due to higher printing and postal charges. The new prices with effect from March 1st, 1971, are:

RADIO COMMUNICATION HANDBOOK	DM 38.--
VHF-UHF MANUAL	DM 15.20

VHF CONGRESS WEINHEIM (W. GERMANY) 1971

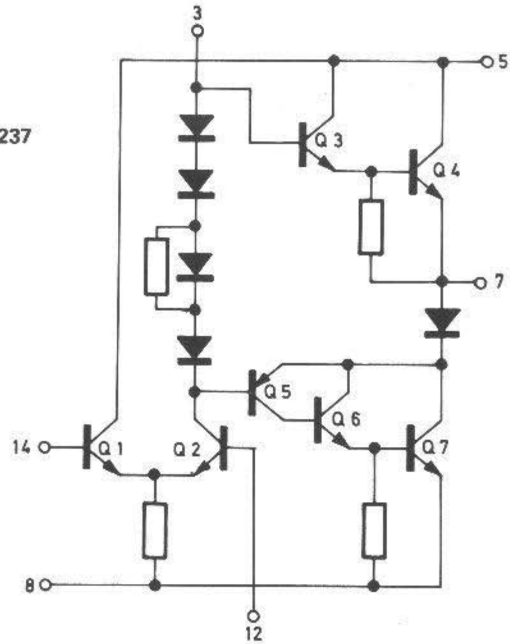
We would like to point out that the annual VHF Congress is once again taking place in Weinheim, near Heidelberg/W. Germany. This year the conference is to be held on the 18th and 19th of September. It offers continuous lectures by outstanding European VHF/UHF/SHF amateurs as well as facilities for discussion groups on diverse topics appertaining to amateur radio at the higher frequencies. We extend a cordial welcome to all VHF/UHF amateurs.

AN INTEGRATED AUDIO AMPLIFIER USING THE PA 237

by D. E. Schmitzer, DJ 4 BG

The integrated circuit PA 237 is one of a series of integrated audio amplifiers manufactured by General Electric. The series consist of types PA 234, PA 237 and PA 246 which are designed for operating voltages of 24 V to 37 V and for maximum power levels of 1 W, 2 W or 5 W. The two-watt type PA 237 is favourable in price and provides sufficient power output for amateur applications even at lower voltages. Applications for this integrated audio amplifier were studied and the component and measured values are given in tabular form for various operating voltages between 9 and 24 V.

Fig. 1: Circuit of the integrated circuit PA 237



1. THE INTEGRATED CIRCUIT

The integrated circuit PA 237 consists of 7 transistors (6 NPN and 1 PNP), 5 diodes and 4 resistors that are built up on a common silicon substrate. The circuit is given in Fig. 1. The output stage (Q 4, Q 7) is in the form of a series-connected push-pull output stage (and not as a complementary pair). The driver transistors (Q 3, Q 6) are current amplifiers and form a Darlington stage together with the final transistors. A PNP transistor (Q 5) is connected before one branch for phase reversal. The high current gain of the two branches Q 3, Q 4, or Q 5, Q 6, Q 7 results in a high input impedance. Since this input impedance is also the terminating impedance for the previous stage, the preamplifier stage achieves a high voltage gain ($V = S \times R_C$). This is the reason for the very high input sensitivity of this module.

The preamplifier stage is in the form of a differential amplifier (Q 1, Q 2) with both inputs accessible (14 and 12). The output voltage is in the same phase as at one input (14). It is, however, in antiphase with the voltage at the other input so that an external feedback can be introduced. This isolation of the inputs results in clear circuitry and very high input impedances.

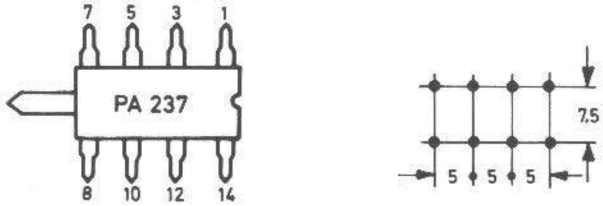


Fig. 2: Case, connections and hole spacings for PC-board mounting

The integrated circuit PA 237 is accommodated in a flat plastic case possessing 4 connections on each side (dual-in-line case). Fig. 2 shows the arrangement of the connections as well as the plan of the holes that must be made on a printed circuit board. At one end of the case, a strip protrudes from the casing which is connected to the substrate and is designed for heat dissipation. This cooling strip must be at the same electrical potential as connection point 8 (ground). At input powers in excess of 1 to 1.5 W, it is necessary that it is soldered to a heat sink. At lower power levels, it is sufficient for it to be placed through a slot in the printed circuit board and soldered to the ground surface.

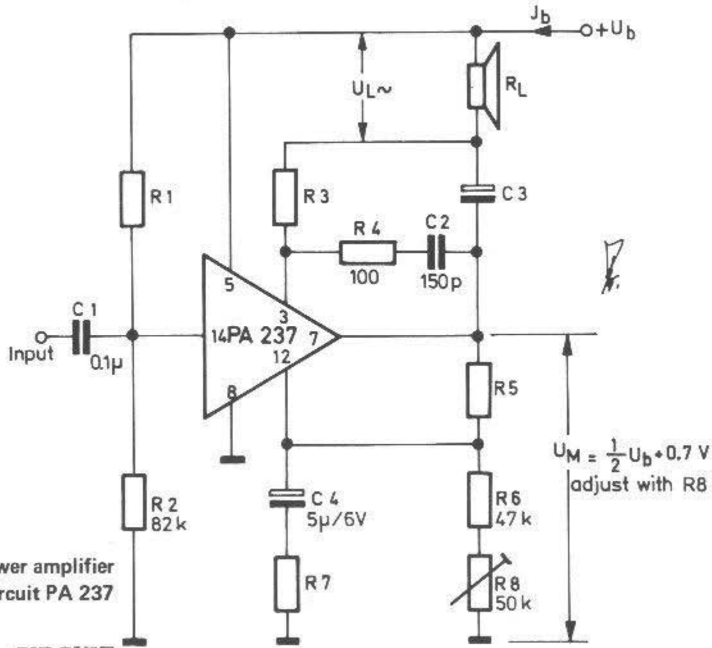


Fig. 3: Transformer-less power amplifier with the integrated circuit PA 237

2. THE EXTERNAL CIRCUIT

Fig. 3 indicates how the integrated circuit is extended by external components to form a complete audio amplifier. The voltage divider comprising resistors R 1, R 2, determines the operating point of the preamplifier stage. The operating points of the output stage groups are determined by the wiring of connections 3 and 12. Trimmer resistor R 8 is provided in series with resistor R 6 so that even the very small, inavoidable circuit unbalance can be compensated for. The highest drive range and thus the maximum output power is achieved by exact balancing.

If this increase in output power of 10 - 20% is not required, R 8 can be deleted and R 6 will have the same value as R 2. Otherwise, resistor R 8 should be adjusted so that approximately 0.7 V more than half the operating voltage is available at connection 7 without driving the amplifier.

Deviating from the circuit given by the manufacturers (1), resistor R 4 has been inserted in series with capacitor C 2. This was found to be necessary in order to neutralize the amplifier even when operating with true resistive loads. With a load having an inductive component (loudspeaker, modulation transformer) the danger of breaking into oscillation is lower, however, resistor R 4 has no adverse effect and it is advisable for it to be used.

4. CONSTRUCTION

During the design of a suitable printed circuit board for this integrated audio amplifier, a few modifications were made to the basic circuit by the editors of VHF COMMUNICATIONS. The first modification (Figure 4) was to provide a transformer for matching the output of the amplifier to the required load impedance. With transformer, the amplifier can be used for amplitude modulation of transmitters with input power levels up to approximately 1.2 W or with high-impedance loudspeakers, e.g. dynamic earphones.

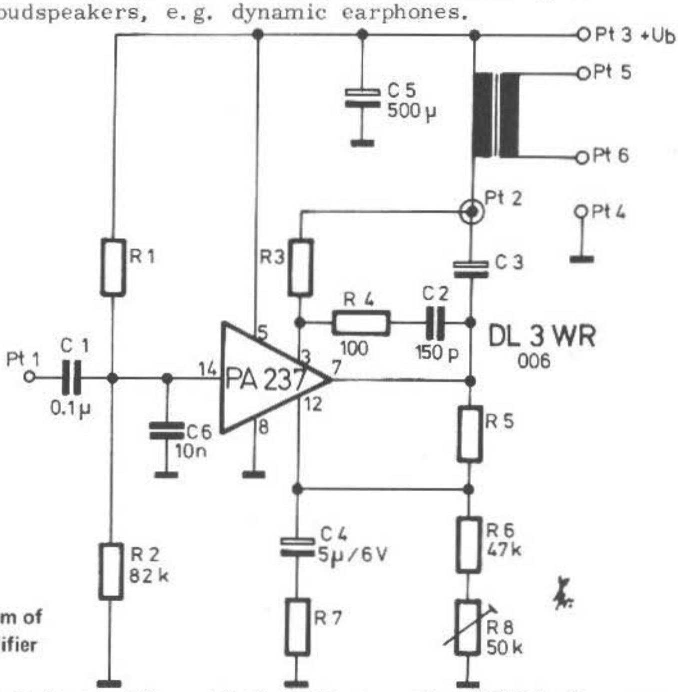


Fig. 4: Modified circuit diagram of the PA 237 audio amplifier

The second modification is to provide an electrolytic capacitor (C 5) of approx. 0.5 to 1 mF for filtering the operating voltage. It was only possible after providing this capacitor for the amplifier to be operated on a very simple, stabilized power supply.

The third modification that was necessary is the provision of capacitor C 6 in order to neutralize the amplifier with the input open. When using the amplifier in conjunction with a transmitter, a resistor of 1 kΩ should be connected in the microphone lead directly in front of connection Pt 1.

U_b	9 V				12 V				13,5 V					18 V					24 V				
R 1	300 kΩ				330 kΩ				330 kΩ					680 kΩ					680 kΩ				
R 3	8,2 kΩ				12 kΩ				12 kΩ					15 kΩ					15 kΩ				
R 5	150 kΩ				150 kΩ				150 kΩ					330 kΩ					330 kΩ				
R 7	1 kΩ				1 kΩ				1 kΩ					2,2 kΩ					2,2 kΩ				
I_{bo}	3 mA				3 mA				4,4 mA					4 mA					6,2 mA				
R_L	7,5	15	22	47	7,5	15	22	47	7,5	15	22	47	120	7,5	15	22	47	120	15	22	47	120	Ω
P_{out}	0,34	0,21	0,16	0,08	0,71	0,49	0,36	0,18	0,96	0,63	0,50	0,26	0,14	1,59	1,41	1,12	0,57	0,24	2,4	2,0	1,08	0,45	W
P_{in}	0,82	0,46	0,34	0,18	1,6	0,94	0,68	0,35	2,1	1,23	0,89	0,46	0,26	3,5	2,4	1,77	0,88	0,38	4,2	3,14	1,63	0,7	W
$I_{b\,max}$	91	51	38	19,5	134	78	57	29	155	91	66	34	19	195	133	98	49	21	175	131	68	29	mA
η	41	45	47	46	44	52	52	52	46	51	56	57	55	45	59	64	64	63	57	63	66	64	%
$U_{L\sim}$	1,6	1,8	1,9	2,0	2,3	2,7	2,8	2,9	2,7	3,1	3,3	3,5	3,7	3,5	4,6	5,0	5,2	5,4	6	6,6	7,1	7,3	V
$U_{in\sim}$	24	21	21	19	27	27	26	25	29	29	29	28	27	38	44	45	43	43	51	53	54	54	mV

Table 1: Component and measured values of the integrated audio amplifier PA 237

R_L (Ω)	7.5	15	22	47	120
C 3 (μF)	500	500	250	100	50

3. MEASURED VALUES

The measured values obtained with the circuit shown in Fig. 3 are given in table 1. The table also gives the missing component values that are dependent on the selected operating voltage. With the exception of the quiescent current, all measured values were measured at a frequency of 1 kHz and at a drive level by which the output voltage across the load resistor was still just undistorted on a scope. With the strong feed-back used, this corresponds, in the experience of the writer, to a harmonic distortion factor of not more than 3%. If a higher harmonic distortion factor is permissible, it is possible for higher drive levels to be used whereby the values of output power, efficiency and current requirements increase slightly.

The half-power frequencies of the output power (-3 dB) are below 100 Hz and above 50 kHz.

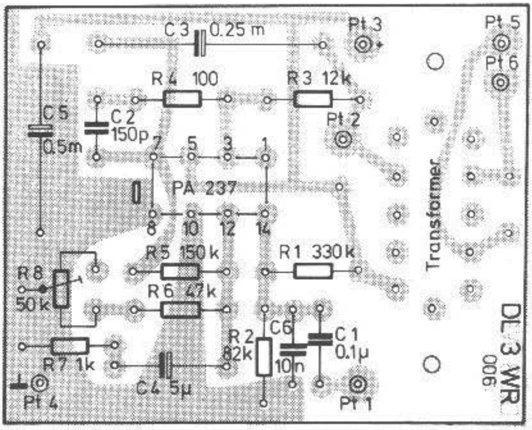


Fig. 5: Printed circuit board DL 3 WR 006 together with component location plan (values valid for U_b = 12 V)

The modified audio amplifier is accommodated on the printed circuit board DL 3 WR 006 whose dimensions are 70 mm x 55 mm. Fig. 5 shows the printed circuit board and the corresponding component location plan. If the amplifier is to be used with a 8 Ω loudspeaker, e.g. without transformer, it is possible for the printed circuit board to be shortened. The loudspeaker should then be connected to connection points Pt 2 and Pt 3. With a loudspeaker of different impedance or when the audio amplifier is to be used as modulator, the output voltage should be taken from points Pt 5 and Pt 6.

The miniature trimmer resistor R 8 can, of course, be replaced by a fixed resistor after establishing the required value for the integrated circuit.

5. COMPONENT DETAILS

C 1: 0.1 μF/plastic foil (spacing: 10 mm)
C 2: 150 pF ceramic tubular or disc capacitor
C 3: 250 μF/10 V tantalium electrolytic capacitor (25 mm long)
C 4: 4.7 μF/6 V electrolytic capacitor (12 mm long)
C 5: 500 μF/15 V tantalium electrolytic capacitor (20 to 25 mm long)
C 6: 0.01 μF/plastic foil (spacing: 7.5 mm)

Transformer:
Type C transformer (EK 25 S) input impedance 7.5 Ω; P_{AF} = 0.7 W, without gap for use with loudspeakers with impedances differing from 8 Ω
For instance: Z_{out} ≐ 250 Ω for dynamic earphones of the german PTT
Primary : 90 turns of 0.4 mm (26 AWG) enamelled copper wire
Secondary : 515 turns of 0.3 mm (29 AWG) enamelled copper wire

Modulation transformer for a transmitter with 12 V/100 mA:
Z_{in} = 7.5 Ω, Z_{out} = 120 Ω; P_{AF} = 0.7 W; Air gap: one thickness of insulating tape

Type C transformer (EK 25 S):
Primary : 150 turns of 0.3 mm dia. (29 AWG) enamelled copper wire;
Secondary : 600 turns of 0.3 mm dia. (29 AWG) enamelled copper wire.

The number of turns is not too critical.

6. AVAILABLE PARTS

The printed circuit board DL 3 WR 006, the integrated circuit, transformer kit as well as a kit of parts are available from the publishers or their national representatives. Please see advertising page.

7. REFERENCES

(1) Data sheet of the PA 237, published by General Electric.

UNIVERSAL POWER SUPPLY USING AN INTEGRATED DC VOLTAGE STABILIZER

by H. J. Franke, DK 1 PN and H. Kahlert, DL 3 YK

The following article describes how easily a modern, high-quality stabilized DC power supply can be constructed (and is constructed in professional electronics). Those parts of the stabilizer circuit that are responsible for the stabilization factor and other decisive characteristics of the stabilizer are combined in an integrated circuit. The only external connections required in addition to the DC source and voltage divider for adjusting the output voltage, are the power transistors which are dimensioned according to the current values for which the stabilizer is designed.

1. THE MONOLITHIC VOLTAGE STABILIZER LM 305

An economical type has been selected from the large number of integrated voltage stabilizers available on the market: type LM 305 manufactured by National Semiconductor (NS) or SG 305 of Silicon General (SG). Table 1 contains the most important specifications of this integrated circuit:

Input voltage:	8 to 40 V	Load regulation:	0.1 %
Quiescent current:	2 mA	Long-term stability:	0.1 %
Power dissipation:	500 mW	Temperature dependence:	0.3 %/°C
Output voltage:	4.5 to 30 V	Interference suppression:	0.01 %/°C
Voltage stabilization:	0.06 %/V		

The complete circuit of the LM 305 is given in Figure 1 which shows an impressive arrangement of integrated components, including a field effect transistor and a capacitor.

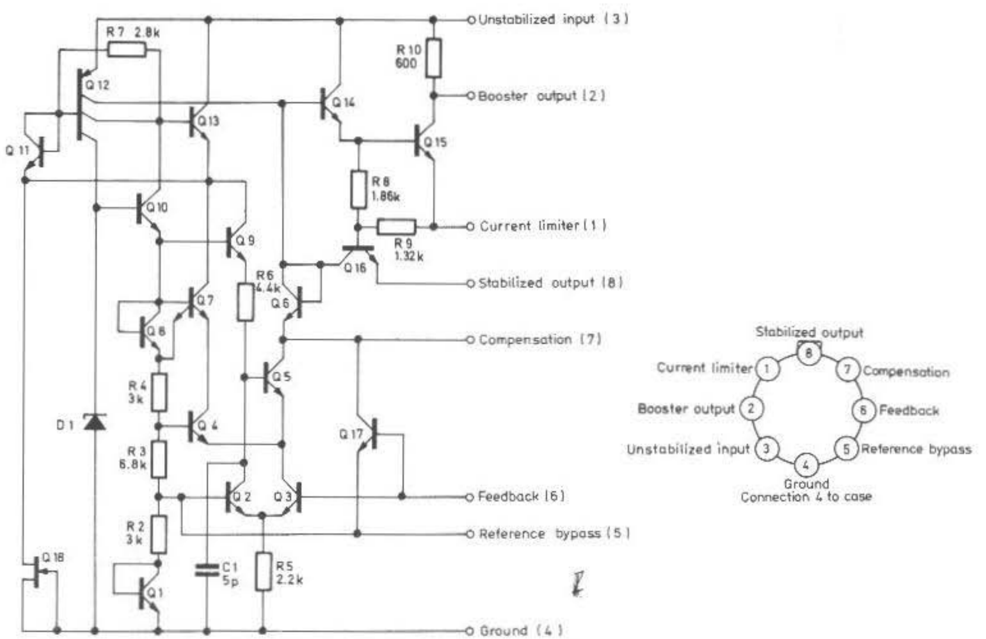


Fig. 1: Circuit and connections of the monolithic voltage stabilizer LM 305

Figure 2 shows a diagram of a typical voltage stabilizer circuit using the integrated circuit LM 305. The integrated circuit IC 1 controls transistor T 1 (a silicon PNP type) which in turn feeds the power transistor T 2 (for instance: 2 N 3055). A stabilizer circuit dimensioned as shown may be loaded up to 2 A and can provide a maximum output voltage of 28 V. The power transformer, rectifier and filter capacitor should be suitable for these values.

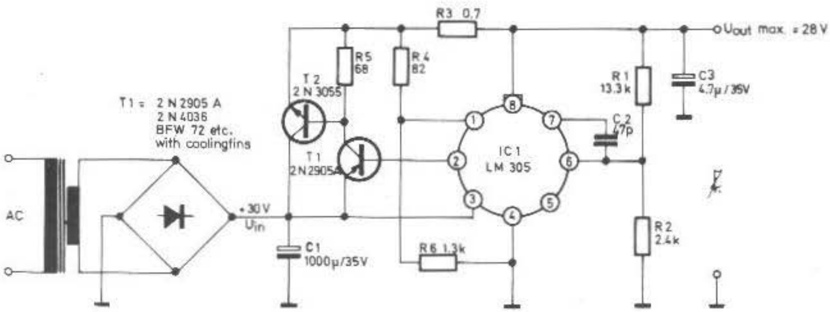


Fig. 2: Circuit of a 2 A stabilizer with current limiting

1.1. CURRENT LIMITING

The output current generates a voltage drop across resistor R 3 which can be used to actuate current limiting. The type of circuit shown in Fig. 2 effects a reduction of the voltage and current values on exceeding a certain output current threshold. The value of this limit is determined by resistor R 3 and the voltage divider R 4/R 6. Since the resistance values are dependent on the output voltage U_{out}, this type of circuit is suitable for applications with fixed output voltages.

If the output voltage is to be variable, a simpler circuit as given in Figure 3 should be used. In this circuit, the output current remains at the previous value on exceeding the threshold whereas the voltage is reduced to nearly zero. The dimensioning of the circuit is extremely simple and is not dependent on the output voltage. It is merely necessary for resistor R 3 to be dimensioned according to the maximum permissible current I_{max}:

R 3 = 0.35 V/I_{max}; with I_{max} in A, the value of R 3 will be in Ω.

The two circuits given in Figures 2 and 3 differ only in the type of current limiting, e.g. the voltage divider R 4/R 6 is deleted in Fig. 2. The circuit of Figure 3 can be easily extended for an output current of 2 A.

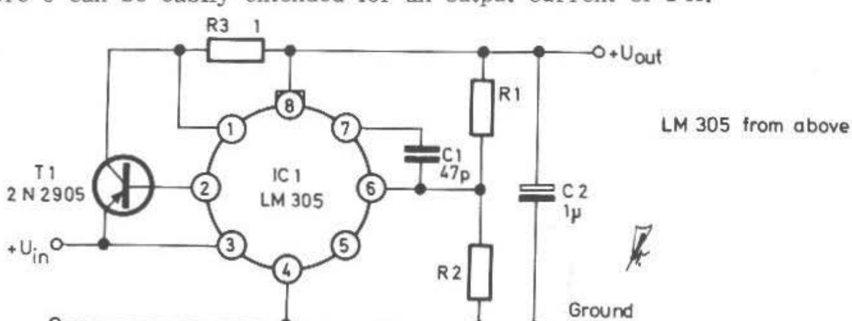


Fig. 3: Circuit of a stabilizer for 200 mA with simple current limiting

1.2. ADJUSTMENT OF THE OUTPUT VOLTAGE

The output voltage is determined by the voltage divider comprising resistors R 1 and R 2. In order to obtain optimum control characteristics, R 1 should be: R 1 = 1.11 x U_{out}, whereby U_{out} is in V and R 1 results in kΩ. R 2 can be read off from the curve given in Fig. 4.

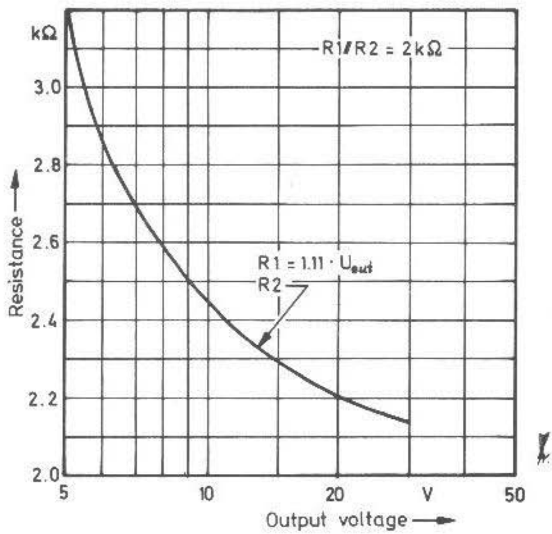


Fig. 4: Dimensioning of the voltage divider resistor R 2

Example: U_{out} = 12 V
R 1 = 1.11 x 12 = 13.3 kΩ
R 2 from Fig. 4 = 2.4 kΩ

If the output voltage is to be continuously variable, a potentiometer should be used for R 1 whose maximum value (corresponding to the highest voltage to be selected) is calculated as follows:

$$P\,1 = 1.11 \times U_{out\ max}$$

The wiper of the potentiometer P 1 is connected to connection 6 of IC 1; the "cold" end of the potentiometer is connected to the fixed resistor R 2, whose value is established for a mean output voltage on the curve given in Fig. 4 (e.g. 2.4 kΩ).

2. A PRACTICAL POWER SUPPLY WITH INTEGRATED VOLTAGE STABILIZER

The circuit of a practical voltage stabilizer is given in Figure 5. Basically, this circuit corresponds to that given in Figure 2. The additional half-wave rectifier circuit generates the plate voltage required for neon (nixie) tubes. The rectifier D 1 and the filtering capacitor C 6 are also accommodated on the printed circuit board of the stabilized power supply.

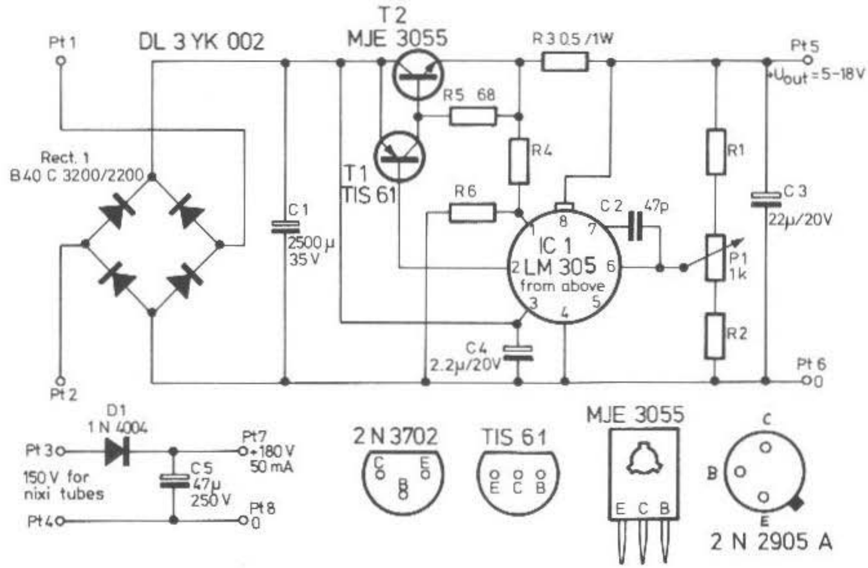


Fig. 5: Circuit of the practical stabilized power supply with IC

2.1. CHARACTERISTICS

The primary characteristics of a voltage stabilizer circuit are the variations of the output voltage as a function of fluctuations of the power line voltage and load. The following values are valid for the circuit given in Figure 5, equipped with a LM 300. The values will be even better with a LM 305.

Variation of the output voltage	at a power line voltage fluctuation of: -15 %	+ 15 %
Non-load	9 mV	7 mV
Full load (1 A)	14 mV	11 mV

Variation of the output voltage on altering the load from non-load to full load: 36 mV

Ripple on the output voltage at non-load: 4 mV_{pp} (noise)
Ripple on the output voltage at full load (1 A): 9 mV_{pp} (hum)

Output voltage	approx. 5 V	9 - 12 V	approx. 18 V
Min. AC input voltage under load	8.5 V	17 V	24 V
Max. output current	1 A	1 A	0.7 A
Current threshold	1.15 A	1.15 A	1.15 A

By dimensioning the circuit according to Figure 2, the maximum output current can be increased to 2 A. Of course, the power transformer must be capable of providing the minimum input voltage at the higher loading, and a more powerful transistor should be found for T 1 (see below). The mentioned heatsink is sufficient as long as the AC input voltage is not too high. It is not necessary to modify the printed circuit board.

2.2. DIMENSIONING OF THE COMPONENTS

The voltage stabilizer can be dimensioned for three output voltage ranges by altering the voltage divider R 1/R 2. Within this range, the output voltage is variable by adjustment of potentiometer P 1. The three ranges are:

5 V for digital circuits with TTL-ICs (SN 74..)
9 V - 12 V for all equipment described in VHF COMMUNICATIONS
18 V for older transistorized equipment

Resistor values changing with the required voltage range are given below:

	approx. 5 V	9 - 12 V	approx. 18 V
R 1	6.8 kΩ	15 kΩ	22 kΩ
R 2	3.6 kΩ	2.2-2.7 kΩ	2 kΩ
R 4	68 Ω	27 Ω	wire bridge
R 6	820 Ω	1 kΩ	Remove

The values of the other components are independent on the voltage range:

T 1: TIS 61 or 2 N 3702 (Silicon PNP, I_{Cmax} = 0.2 A) of Texas Instruments at higher output currents: 2 N 2905 A, BC 160 (ITT-Intermetall, AEG-Telefunken)
T 2: MJE 3055 (plastic version of the 2 N 3055) or 2 N 3055. Place three ferrox beads on to the emitter connection.
IC 1: LM 300, LM 305 (National Semiconductor) SG 300, SG 305 (Silicon General)
Rect. 1: Silicon rectifier B 40 C 3200/2200 (V = 40 V, I = 3.2 A) (Siemens, ITT-Intermetall)

D 1: Silicon diode 1 N 4004, BY 103 or similar
P 1: 1 kΩ ten-turn helical potentiometer for PC-board mounting. Spacing 12.5 mm/2.5 mm (Bourns 3009 P-1-102 or Amphenol T 2600 P) can be replaced by fixed resistors after establishing the exact values required

Heatsink: approx. 65 mm x 100 mm (see Fig. 7)

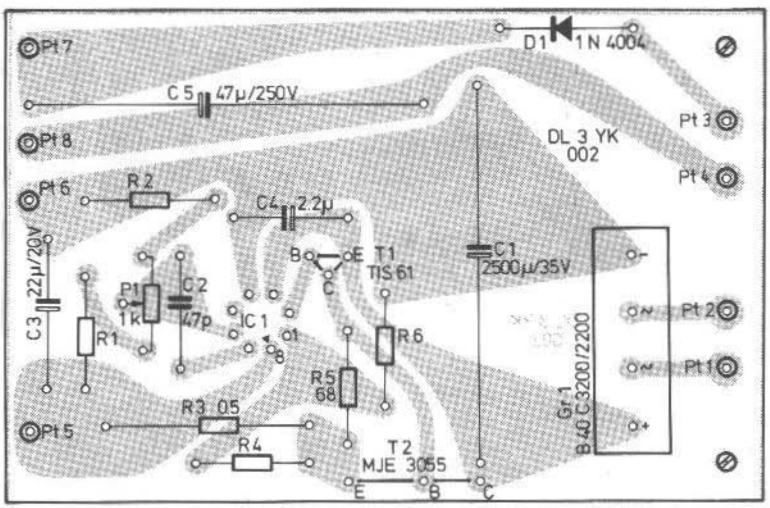


Fig. 6: Printed circuit board DL 3 Y K 002

3. CONSTRUCTION

With the exception of the power transformer and the power transistor T 2 (on the heatsink) all components are accommodated on a printed circuit board with the dimensions 100 mm by 65 mm. The PC-board, which has been designated DL 3 YK 002, is shown together with its component location plan in Fig. 6.

Transistor T 2 is screwed to the centre of the heatsink so that its connections protrude on the flat side. The printed circuit board is mounted to the heatsink above the connection leads of T 2 using 10 mm long spacer bushings.

The photograph in Figure 7 shows the author's prototype. The connection leads of transistor T 2 are lengthened and soldered to the tags provided on the printed circuit board. The emitter connection of the pass transistor is provided with three ferrox beads for suppression of RF oscillation.

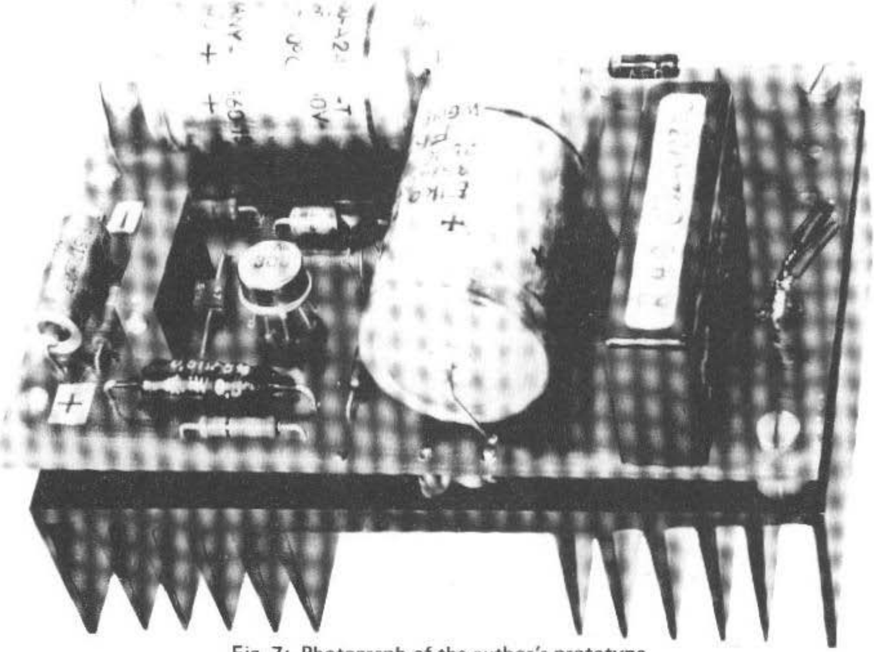


Fig. 7: Photograph of the author's prototype

If the metal type 2 N 3055 is used instead of the plastic type MJE 3055, a mica disc should not be placed between the case of the transistor and the heatsink so as not to hinder the heat conduction. However, in this case it is necessary for the stabilizer to be insulated from the other equipment. This can be achieved using a pertinax bracket which is mounted between the fins of the heatsink so that the power supply can be mounted approximately 5 to 10 mm from the chassis with the fins vertical. The hot air can then pass the cooling fins and between heatsink and PC-board without hinderance.

4. AVAILABLE PARTS

The printed circuit board DL 3 YK 002, the semiconductors, helical potentiometer and other components as well as kits are available from the publishers and their national representatives. Please see advertising pages.

MATERIAL PRICE LIST OF EQUIPMENT

described in VHF COMMUNICATIONS 2/1971.
For earlier equipment please see Editions 1/1971 and 4/1970.

DC 9 MD 001 — TWO METRE WALKY-TALKY

PC-board	DC 9 MD 001	(with printed plan)	DM 10.--
Semiconductors	DC 9 MD 001	(12 transistors, 4 diodes)	DM 61.30
Minikit 1	DC 9 MD 001	(6 coilformers, 4 IF transformers, 3 chokes)	DM 16.40
Minikit 2	DC 9 MD 001	(trimmer cap. set and 51 fixed capacitors) ..	DM 32.20
Minikit 3	DC 9 MD 001	(5 potentiometers, 40 carbon resistors) ..	DM 23.50
Minikit 4	DC 9 MD 001	(case, 4 sliding switches, 2 miniature jack plugs and sockets, 1 coax. socket, 3 scale knobs, 1 battery connector)	DM 30.--
Minikit 5	DC 9 MD 001	(microphone and ear set)	DM 32.60
Crystals	72,....	(HC-18/U) with holder	DM 33.--

Delivery approx. 4 weeks. Please state exact frequency.

A few standard frequencies (in MHz) are available ex stock:
72.025 / 72.050 / 72.075 / 72.100 / 72.125 / 72.150 / 72.175
72.200 / 72.225 / 72.250 / 72.275 / 72.300 / 72.325 / 72.350
72.375 / 72.400 / 72.425 / 72.450 / 72.475 / 72.500 / 72.575

Drill set	for PC-boards 0.7 mm and 1,0 mm diameter	DM 6.--
DC 9 MD 001/Kit 1	Complete kit with all components and drills, but without crystal	DM 198.--
DC 9 MD 001/Kit 2	Complete kit with all components, two drills and one crystal..	DM 230.--
DC 9 MD 001/Kit 3	Complete kit with all components, two drills and two crystals.	DM 260.--

DK 2 VF 001 + 002 — STRIPLINE REFLECTOMETERS

PC-board	DK 2 VF 001	(double-coated) for 144 MHz............	DM 11.--
PC-board	DK 2 VF 002	(double-coated) for 432 MHz............	DM 7.--

DJ 6 ZZ 002 — TRANSMIT CONVERTER 10 m / 70 cm

PC-board	DJ 6 ZZ 002	(double coated)	DM 16.50
Minikit	DJ 6 ZZ 002	(coil and trimmer set)	DM 7.--
Semiconductors	DJ 6 ZZ 002	(8 transistors)	DM 34.50
Crystal	67.333	(HC-6/U)	DM 18.--
Kit	DJ 6 ZZ 002	with all above components	DM 76.--

DL 3 WR 006 — INTEGRATED AUDIO AMPLIFIER with the PA 237

PC-board	DL 3 WR 006	(with printed plan)	DM 4.--
Semiconductors	DL 3 WR 006	(PA 237)	DM 16.70
Transformer Kit	DL 3 WR 003/S	(with glued EI core)..................	DM 7.50
Kit	DL 3 WR 006	with all above components	DM 28.20

DL 3 YK 002 — UNIVERSAL POWER SUPPLY with INTEGRATED STABILIZER

PC-board	DL 3 YK 002	(with printed plan)	DM 8.--
Semiconductors	DL 3 YK 002	(2 transistors/IC: LM 305 or SG 305, 1 diode, 1 bridge rectifier, ferrite beads)..	DM 58.10
1 kOhm	Potentiometer	10 turn heli-pot	DM 9.--
Kit	DL 3 YK 002	with above components	DM 75.10

CRYSTALS and CRYSTAL FILTERS for equipment described in VHF COMMUNICATIONS that are available ex stock. Only highest quality crystals are offered.

Crystal filter	XF-9A	(for SSB) with both sideband crystals	DM 106.--
Crystal filter	XF-9B	(for SSB) with both sideband crystals	DM 137.--
Crystal filter	XF-9C	(for AM; 3.75 kHz)	DM 137.--
Crystal filter	XF-9D	(for AM; 5.00 kHz)	DM 137.--
Crystal filter	XF-9E	(for FM; 12.00 kHz)	DM 137.--
Crystal filter	XF-9M	(for CW; 0.5 kHz) with carrier crystal	DM 106.--
Crystal discriminator	XD 09-03	matching XF-9E	DM 78.--

Crystal	96.0000 MHz (HC- 6/U) for 70 cm converters	(DL 9 GU, DL 9 JU) ..	DM 21.50
Crystal	96.0000 MHz (HC-25/U) for 70 cm converters	(DL 9 GU, DL 9 JU) ..	DM 28.--
Crystal	95.8333 MHz (HC-18/U) for 70 cm converters	(DC 6 HY)	DM 28.--
Crystal	84.5333 MHz (HC- 6/U) for 24 cm converters	(DL 3 WR)	DM 21.50
Crystal	65.5000 MHz (HC- 6/U) for 2 m converters	(DL 6 HA)	DM 16.50
Crystal	65.0000 MHz (HC- 6/U) for 2 m converters	(DL 6 HA)	DM 16.50
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Crystal	46.0000 MHz (HC-18/U) (DJ 7 ZV / DJ 9 ZR)	)	
Crystal	45.4780 MHz (HC-18/U) for VXO	(DJ 9 ZR)	DM 24.50
Crystal	42.0000 MHz (HC- 6/U) for 70 MHz converters	(G 3 JHM)	DM 15.60
Crystal	38.6667 MHz (HC- 6/U) for 2 m converters	(DL 6 SW, DL 6 HA) ..	DM 13.70
Crystal	27.8000 MHz (HC-18/U) for 24 MHz synthesis VFOs	(DL 3 WR 007) ..	DM 25.--

Standard frequency crystals

5.0000 MHz (HC- 6/U) for calibration spectrum generators (DC 6 HY) .... DM 25.--

1.0000 MHz (HC- 6/U) for calibration spectrum generators (DJ 4 BG, DC 6 HY) .... DM 20.50

100 kHz (HC-13/U) for calibration spectrum generators (DC 6 HY) .... DM 28.--

Crystals 72.... MHz (HC-6/U) for 2 metre transmitters (DJ 1 NB, DL 3 WR) Please state required frequency on ordering (Delivery 4 to 6 weeks) .... DM 21.50

HC-18/U crystals also available ex stock. Please see list with DC 9 MD Kit .... DM 33.--

Crystals other frequencies available (Please state frequency and type) (Delivery 6 to 8 weeks)

SPECIAL OFFERS as long as stock lasts:

PC-board	DL 9 GU 001	(with printed plan)	Edition 2/69	DM 3.--
PC-board	DJ 4 BG 003	(with printed plan)	Edition 1/70	DM 6.--
PC-board	DL 3 WR 003	(with printed plan)	Edition 2/70	DM 12.--
PC-board	DL 3 WR 004	(with printed plan)	Edition 2/70	DM 1.50

Overlay Power Transistors 2 N 3375 (5 W SSB with DJ 9 ZR 001) .... DM 32.--

BNC-Socket UG-290/U .... DM 3.20

OTHER EQUIPMENT and COMPONENTS

HB 9 CV Antenna for 145 MHz, chrome-plated, detachable including post and packing (surface mail) .... DM 40.--

Interdigital bandpass filter for the 23 cm band, similar to the description in QST, March 1968; ready to operate with BNC connectors .... DM 82.30
without connectors (delivery 6 to 8 weeks) .... DM 76.20

Completely ready-to-operate equipment

2 m converter	DL 6 HA 001	(IF: 28-30 MHz)	Edition 1/70	DM 134.80
70 cm converter	DL 6 GU 001	(IF: 144-146 MHz)	Edition 2/69	DM 196.50
70 cm receive converter	DC 6 HY 001		Edition 4/70	DM 179.60
70 cm transmit converter	DC 6 HY 002		Edition 4/70	DM 149.50
70 cm linear amplifier	DC 6 HY with EC 8020		Edition 4/70	DM 142.40

Tube EC 8020	for 70 cm transmitters DK 1 PN, DC 6 HY	DM 27.--
UHF tube socket	made of silicon glass fibre for EC 8020	DM 2.90
Dual-Gate MOSFET	with integrated protective diodes 40673 (RCA).......	DM 12.50

Connectors for PC-boards	13-pole connectors	set	DM 7.40
	21-pole connectors	set	DM 11.20

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RADIO COMMUNICATION HANDBOOK (RSGB)	incl. postage	DM 38.--
VHF - UHF MANUAL (RSGB)	incl. postage	DM 15.20
Empfangstechnik im UHF-Bereich, F. Möhring	(German)	DM 14.80
PAL-Farbfernsehtechnik, F. Möhring	(German)	DM 24.80
PAL-Farbfernseh-Servicetechnik, F. Möhring	(German)	DM 36.--
Schaltungstechnik von Schwarz-Weiß-Fernseh-Empfängern ...	(German)	DM 16.80
Taschenbuch für Funkamateure, Kortz/Lentz	(German)	DM 19.80
Antennenbuch, Rothammel	(German)	DM 24.--

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