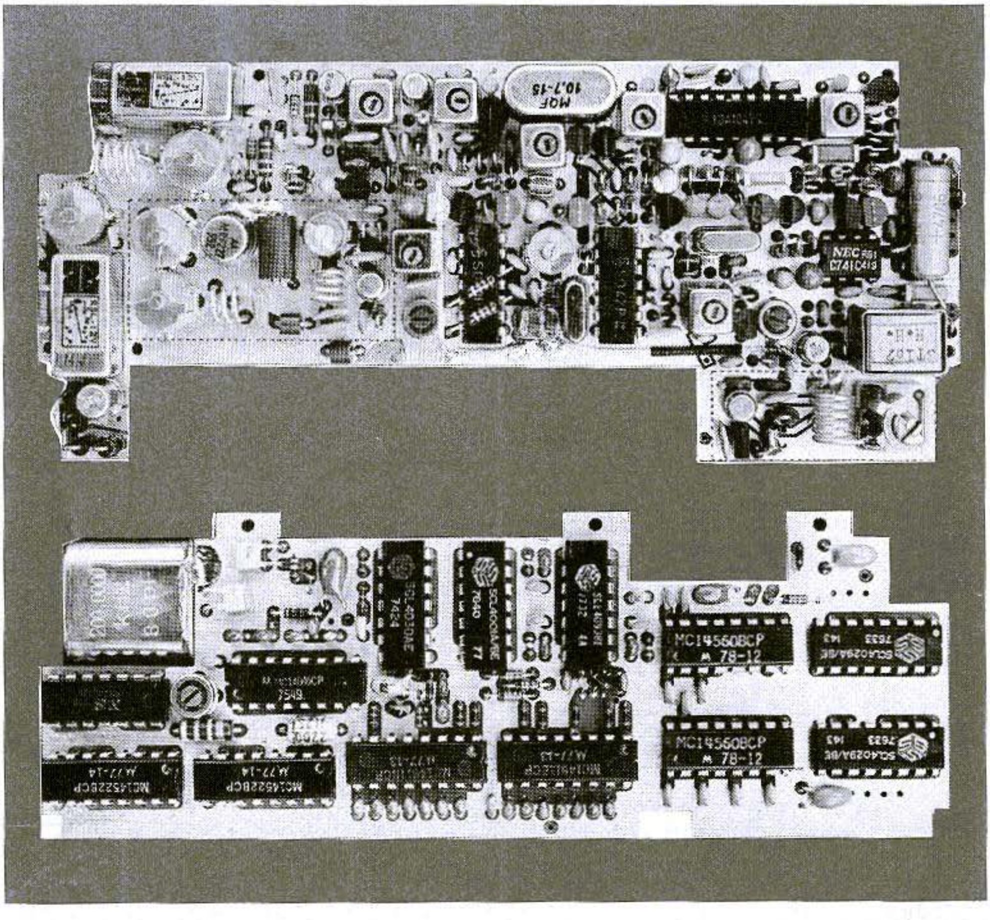
J 20 419 F

VHF COMMUNICATIONS

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

VOLUME No. 11 SPRING 1/1979 DM 5.00



VHF COMMUNICATIONS

Published by:
Verlag UKW-BERICHTE · Hans J. Dohlus oHG · Jahnstrasse 14 · D-9523 BAIERSDORF
Fed. Rep. of Germany · Telephones (0 91 33) 855, 856.

Publishers:
T. Bittan, H. Dohlus

Editors:
Terry D. Bittan, G 3 JVQ / DJ 0 BQ, responsible for the text
Robert E. Lentz, DL 3 WR, responsible for the technical contents

Advertising manager:
T. Bittan

VHF COMMUNICATIONS,
the international edition of the German publication UKW-BERICHTE, is a quarterly amateur radio magazine especially catering for the VHF/UHF/SHF technology. It is published in Spring, Summer, Autumn, and Winter. The subscription price is DM 18.00 or national equivalent per year. Individual copies are available at DM 5.00 or equivalent, each. Subscriptions, orders of individual copies, purchase of PC-boards and advertised special components, advertisements and contributions to the magazine should be addressed to the national representative.

Printed in the Fed. Rep. of Germany by R. Reichenbach KG · Krelingstr. 39 · 8500 Nuernberg

We would be grateful if you would address your orders and queries to your representative:

VERTRETUNGEN: REPRESENTATIVES:

Austria	Hans J. Dohlus, Creditanstalt Bankverein WIEN Kto.17-90.599; PSchKto. WIEN 1.169.146
Australia	WIA PO Box 150, TOORAK, VIC. 3142, Tel. 24-8652
Belgium	Stereohouse, Brusselsesteenweg 416, B-9218 GENT, Tel.(091) 31 21 11, PCR 000-1014257-25 CCP
Denmark	E. Halskov, OZ 7 LX, Sigersted Gl. Skole, DK-4100 RINGSTED, Postgiro 7 296 800, Tel. 03-616162
France	Christiane Michel, F 5 SM, F-89 PARLY, Les Pillés
Finland	see Sweden
Germany	Verlag UKW-BERICHTE, H.Dohlus oHG, Jahnstr. 14, D-8523 BAIERSDORF, Tel. 09133-855,856 Konten: Postscheckkonto Nürnberg 304 55-858, Commerzbank Erlangen 820-1154
Holland:	MECOM, PA 0 AER, PO Box 40, NL-9780 AA BEDUM, Tel. 05900-2780, Postgiro 39 86 163
Israel	Z. Pomer, 4 X 4 KT, PO Box 222, K. MOZKIN 26100, Tel. 974-4-714078
Italy	Franco Armenghi, I 4 LCK, Via Sigonio 2, I-40137 BOLOGNA, Tel. (051) 34 56 97
Luxembourg	P. Wantz, LX 1 CW, Télévision, DUDELANGE, Postscheckkonto 170 05
New Zealand	E. M. Zimmermann, ZL 1 AGQ, PO Box 85, WELLSFORD, Tel. 8025
Norway	Henning Theg, LA 4 YG, Postboks 70, N-1324 LYSAKER, Postgirokonto 3 16 00 09
South Africa	SA Publications, PO Box 2232, JOHANNESBURG 2000, Telephone 22-1496
Spain + Portugal	Julio A. Prieto Alonso, EA 4 CJ, MADRID-15, Donoso Cortès 58 5°-B, Tel. 243.83.84
Sweden	POLY RADIO, Östervärnsgatan 10, S-21218 MALMÖ, Bo Nilsson, SM 7 FJE, Tel. 040-292420 Pg: 431 56 99-1, Bg: 317-2939
Switzerland	Hans J.Dohlus, Schweiz.Kreditanstalt ZÜRICH, Kto.469.253-41; PSchKto. ZÜRICH 80-54.849
UK North	SOTA Communication Systems Ltd., 26 Childwall Lane, Bowring Park, LIVERPOOL L 14 6 TX
UK South	VHF COMMUNICATIONS, Dept. 802, 20 Wallington Square, WALLINGTON Surrey SM 6 8 RG
Yugoslavia	Tito Cvrković, YU-56000 VINKOVCI, M. Gupca 27

A PUBLICATION FOR THE RADIO AMATEUR
ESPECIALLY COVERING VHF, UHF AND MICROWAVES
VOLUME No. 11 SPRING EDITION 1/1979

First International Amateur-Radio Exhibiton in France, June 16th and 17th

This exhibition is taking place on June 16th and June 17th in Auxerre, one of the nicest cities in Burgundy. Saturday 10 - 19 h, and Sunday 10 - 18 h. Sunday evening hamfest with »buffet campagnard«. Entrance fee FF 6.00 for both days. Lottery. All leading manufacturers and dealers will be present. Further details available from our French representative, F 5 SM.

»SUEDWIND« – A 2 m FM-HANDHELD TRANSCEIVER WITH 80 or 396 CHANNEL SYNTHESIZER AND TOUCH-KEY OPERATION

PART 2: CONSTRUCTION, WIRING AND ALIGNMENT

by J. Becker, DJ 8 IL

5. CONSTRUCTION AND WIRING

5.1. Logic Board

The logic board **(Figure 17)** is designated DJ 8 IL 002. The dimensions are 137 mm x 49 mm. This board is double-coated and possesses through-contacts. Since the available height is limited, this PC-board is manufactured from only 0.6 mm thick material. Attention should be paid when soldering the integrated circuits into place that the PC-board is not bent. Due to the high number of integrated circuits, it was not possible for all connections to be printed on the board. For this reason, 21 lines must be wired on the conductor side of the board according to **Table 1**. This should be made with insulated wire of approximately 0.3 mm diameter, which should be glued to the board with a few drops of special quick-drying adhesive. **Figure 18** shows the complete logic board. The interpolator group (Figure 4; below) is mounted onto the conductor side of the board using two wires after the wiring of the unit is completed.

Wire No.	from IC/Pin	via IC/Pin	to IC/Pin
1	4029/E/1	....	74 C 93/1
2	4029/E/2	....	4560/E/6
3	4029/E/6	....	4560/E/14
4	4029/E/10	....	74 C 93/13
5	4029/E/11	....	4560/E/2
6	4029/E/14	....	4560/E/4
7	4029/Z/6	....	4560/Z/14
8	4029/Z/11	....	4560/Z/2
9	4029/Z/14	....	4560/Z/4
10	4560/E/10	4511/E/6 (1 MΩ)	4522/E/2
11	4560/E/11	4511/E/2 (1 MΩ)	4522/E/14
12	4560/E/12	4511/E/1 (1 MΩ)	4522/E/11
13	4560/E/13	4511/E/7 (1 MΩ)	4522/E/5
14	4560/Z/11	4511/Z/2 (1 MΩ)	4030/12
15	4560/Z/12	4511/Z/1 (1 MΩ)	4030/13
16	4560/Z/13	4511/Z/7 (1 MΩ)	4522/Z/5
17	4001/4	....	4522/Z/2
18	4001/6	....	4522/Z/11
19	4001/10	D 204 (a) or	74 C 93/14
20	4030/11	....	4522/Z/14
21	C 205 (3.3 μF)	....	D 201 (k), D 202 (a)

Table 1

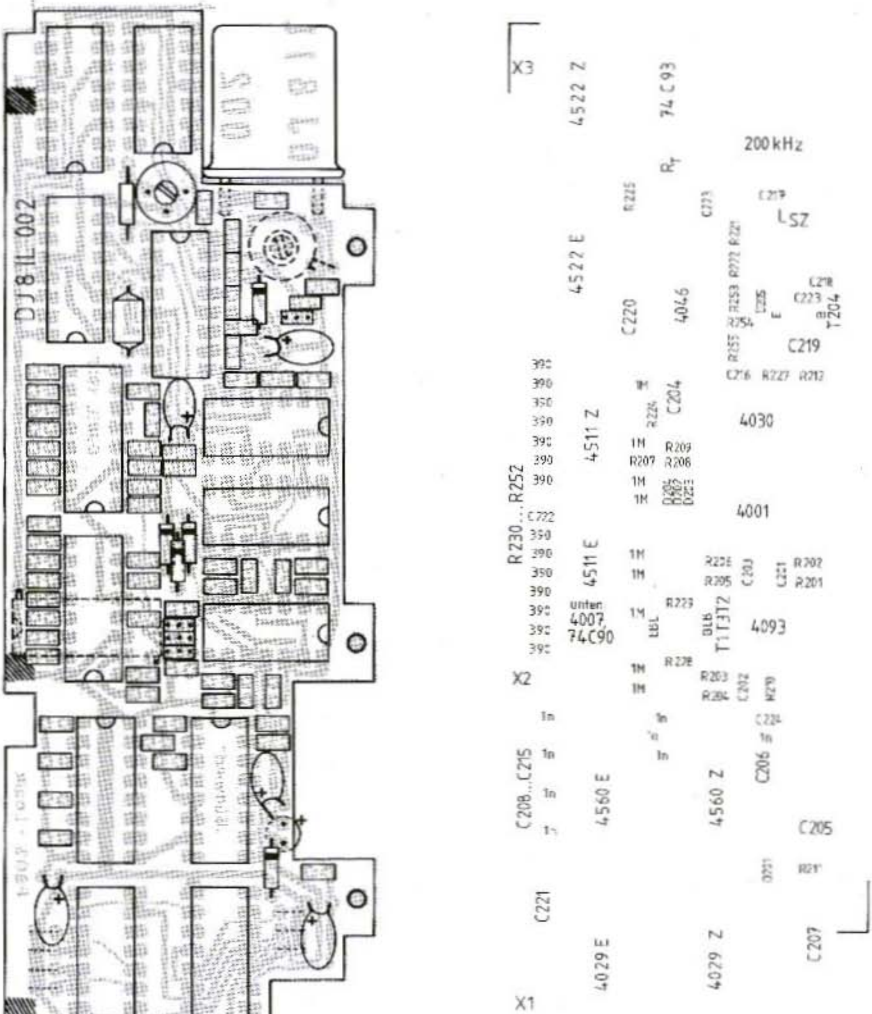


Fig. 17: PC-board DJ 8 IL 002 (logic board) with component locations.
C 222, 223, 224 (all 4n7 ceram.) for bypassing of U_S are not shown in Fig. 3.

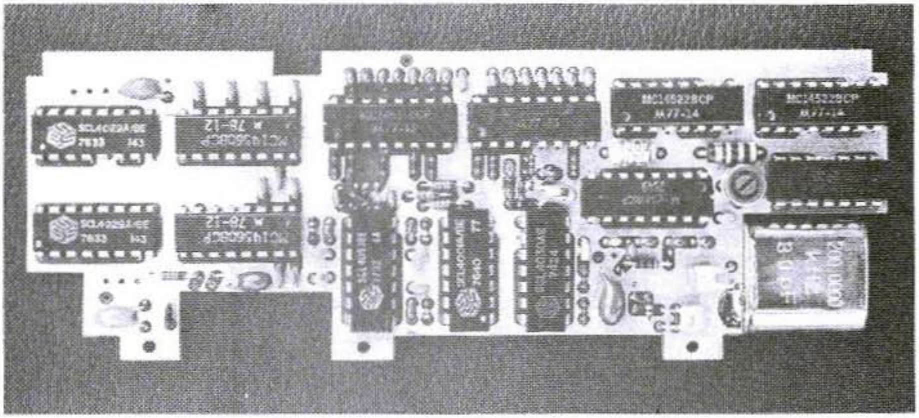


Fig. 18: Author's prototype of the logic board DJ 8 IL 002

5.2. RF/AF-Board DJ 8 IL 001

The component locations on the 153 mm x 65 mm PC-board DJ 8 IL 001 are given in **Fig. 19**. If the PC-board possesses through-contacts, it will only be necessary to solder on the conductor side of the board. Exceptions are: The two crystal cases, the outer conductors of the coaxial cables $b_1/b_2/$, v_1/v_2 and the rotary connection of C 55. If through-contacts are not available, it is necessary to firstly solder the ground connections on both sides of the board. The interconnections L 1 to C 1, L 14 to C 55, and R 42 to D 9 and D 10 are made using wire bridges. C 55 is mounted on the board with the aid of two solder pins of 1.3 mm diameter in addition to its ground connection. Inductance L 14 should be spaced 8 mm from the upper side of the PC-board. C 31 is located above the TBA 820. The PC-board is also designed for the installation of a TAA 611 C 12, which will require 1 mA less quiescent current. **Figure 20** shows a photograph of the completed RF/AF-board.

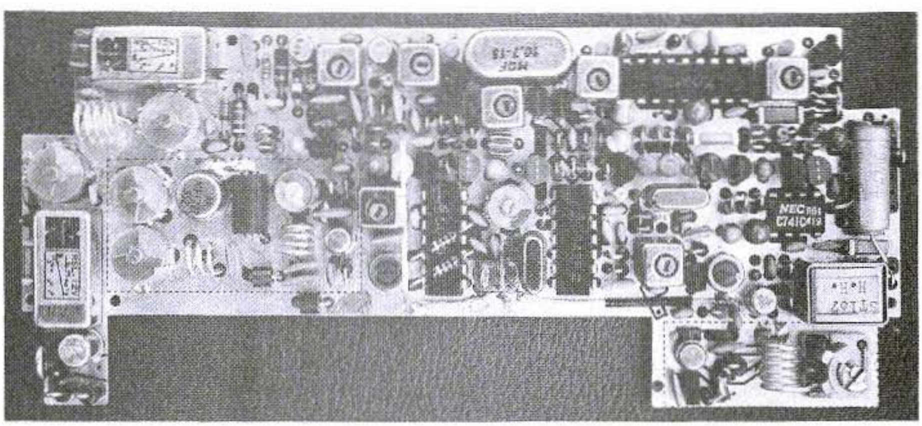


Fig. 20: Author's prototype of the RF/AF board DJ 8 IL 001

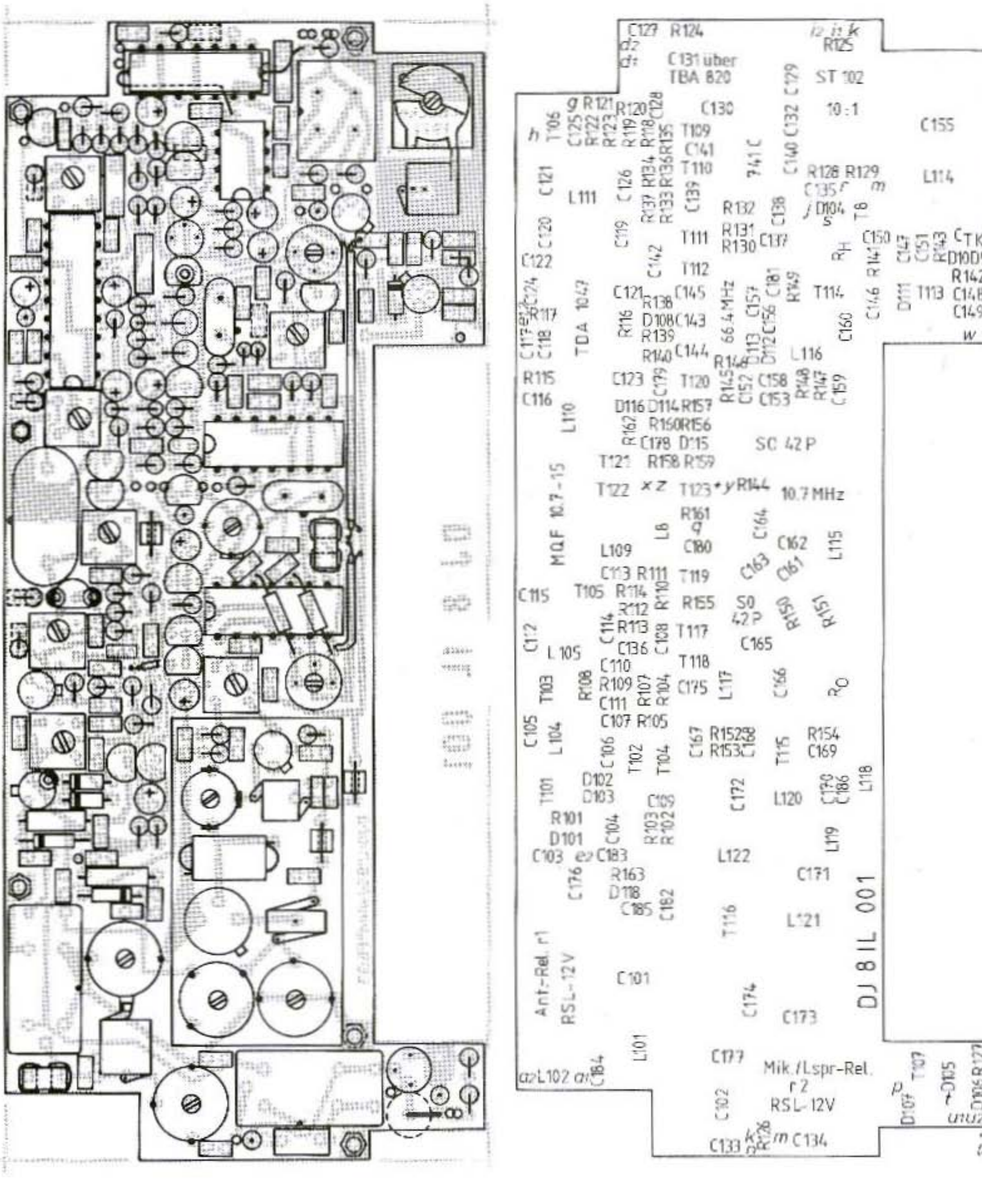


Fig. 19: PC-board DJ 8 IL 001 (RF/AF board) with component locations. R 106 (100 kΩ miniature) is not on this board; it has to be soldered on the copper-lane side, in parallel to C 106.

The dashed lines around the VCO and transmit amplifier show the positions of the screening panels. It was not necessary to screen the VCO in practice; however, a deterioration of the modulation quality was observed when the transmit amplifier was not screened.

The position of a 13.5 mm high screening chamber Z constructed from tin plate is given in **Figure 21**. Three holes of 4 mm diameter are provided in the cover above C 72, C 73 and C 74.

5.3. Case for Model C

After the chassis frame R **(Figure 21)** has been bent, drilled and sawn, rails A to D **(Figure 22)** should be soldered into place. Before doing this, it is necessary for the oxydization to be removed from frame and rails in a hydrochloric acid solution of 10 %. The surface of the L-rails to be soldered is then thinly tinned with the aid of a large soldering iron. After removing the residual flux, the rails are held into place against the frame. The rails are then heated with the aid of a soldering iron or similar until solder is able to flow along the surfaces to be soldered. Rails A and B should be filed afterwards in order to provide a cutout for the eight-pole miniature switch.

In order to obtain a sufficiently deep thread, brass nuts (M 2) are soldered onto the rails at the positions designated at 11 in Figures 21 and 22. They should be held into place during the soldering process with the aid of iron screws, which should be kept free of solder. The completed chassis frame **(Figure 23)** can be pickled mat, nickle or chrome-plated.

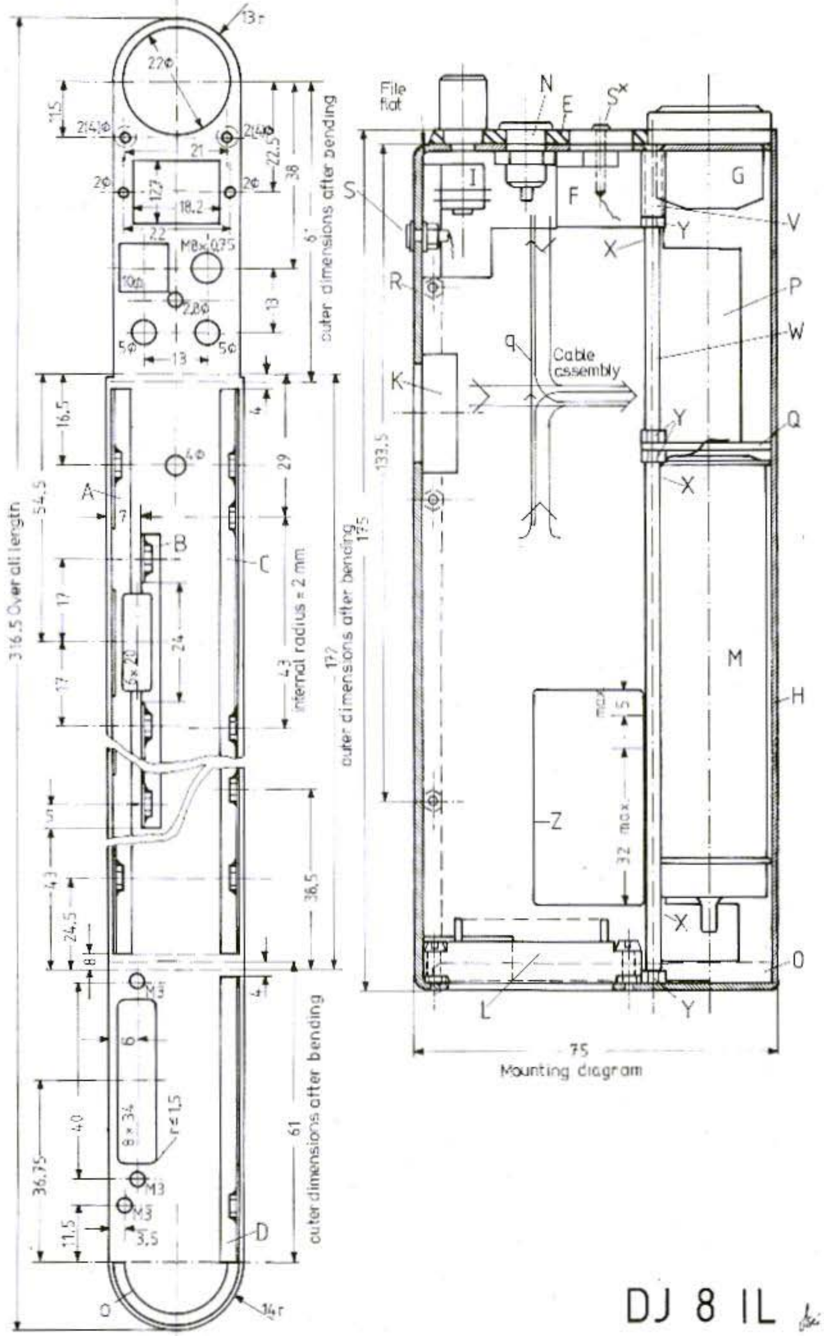
This is followed by mounting all control components onto the chassis frame. Depending from the manufacturer, it may be necessary for the 13-pole connector strip L to be filed down to 45.5 mm. The 8-pole DIL-switch is glued into place using a dual-component adhesive. After this, it is provided with R 213 to R 220 (Figure 4) and 12 stranded wires of 20 cm in length. The two 7-segment LED displays are glued into place with fast drying adhesive behind the red plexiglas screen A **(Figure 24)**, after which it is provided with 16 stranded wires. It is possible, after this, for the completed RF/AF board to be screwed into place in the frame. Finally, the threaded bar W with seven M 3 nuts modified according to Figure 24 and the accumulator mount Q are fixed into place. These two parts and the bent sides of the frame are fitted correctly, countered and fixed into place by soldering Q to the RF/AF board.
The logic board is soldered into place and connected after fixing the central cable assembly.

5.4. Wiring

The rough position of the wiring assembly is given in Figure 21 (right). Interconnections of the RF/AF board are designated with small letters, e.g. s, t, d_1, d_2; lines with logic signals are designated with capital letters. In the component location plan (Figure 19), lines c_1 - c_4 to the volume control are not given; they are directly soldered into place at the top of R 18, R 19, R 23 and R 22. Lines e_1, e_2, n and t are connected to the top of R 17, R 26 and D 5, which is only used for this purpose (keep short). Three lines: the antenna cable to the front, e_2, and PTT_2 are fed along the inside of the frame (glued with fast-drying adhesive). The antenna cable to the rear connector is placed below this.

The 10 wires from behind the accumulator to in front of the accumulator are provided using two screened stereo cables (four-core screened cable of 2 mm outer diameter):

1. Screened cable along the accumulator near to the threaded bar: k, m, r, A_2, screen = j;
2. Screened cable along the accumulator near to the RF/AF board: l, s, u_2, Z_2, screen = p.



Frame(R) before bending with rails A,B,C,D soldered into place (see text)

Fig. 21: Case construction C; chassis frame and construction

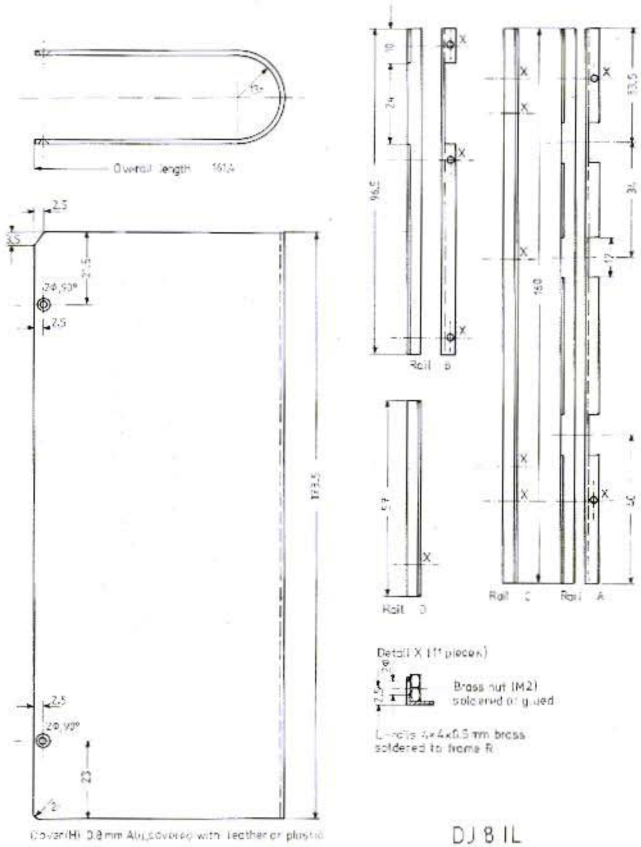


Fig. 22: Case cover H and L-rails of the chassis frame C

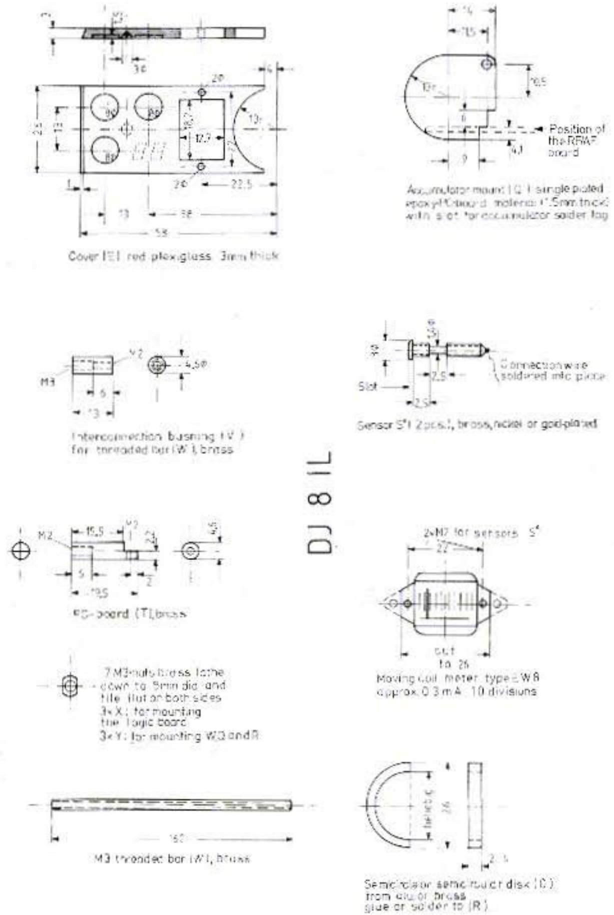


Fig. 24: Small parts for case C

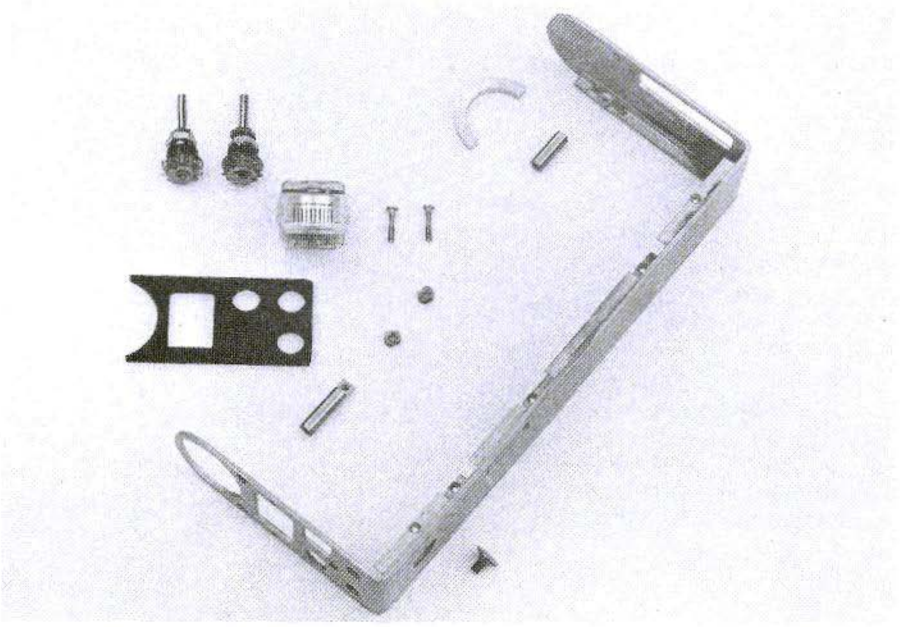


Fig. 23: The complete case frame C

At the front left, the following are wired: d_1, four times d_2, e_1, f, g, c_1 - c_4, i_1 and i_2; in the area behind the connector strip are: n, u_1, and t.

The coaxial cable v_1/v_2 from the VCO is fed as shown in Figure 19 directly along the PC-board, and the outer conductor is soldered to the upper side of the board at both ends. Line b_1/b_2 to the RX-mixer is fed approximately 12 mm further along the board and then at a height of approximately 12 mm across the board above L 17, where the outer conductor is soldered into place on the screening can and then up to C 10 beside which the inner conductor connection is located (screen remains disconnected).

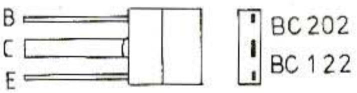
A cross-shaped cable assembly is used for the connection of the logic board. The left arm with wires S_1 - S_{11}, PTT_1 and h is fed from the center of the DIL-switch and combined over T 12 with the main cable assembly from the front which comprises the lines A_1, Z_1, q, K_1, A_1 - G_1, A_2 - G_2, B, $\overline{B}$, D, $\overline{D}$ and I/f_0 (23 cores) and with another cable assembly from the rear, coming from the center of the RF/AF-board which comprises lines q, x, y, z and + D. All wires in the cable assembly are made from stranded wire with the exception of w, x, y, z, q and + D, which are in the screened audio cable.

The logic board is fitted into place and mounted to the frame using the three screws and the three nuts soldered to the threaded bar. This is then folded out by approximately 100°. In this position, the unit is held in place and the wires of the cable assembly are fed to the various locations. Lines A_2, Z_2 and u_2 are added from the two screened audio cables, and w direct from the VCO. The lengths of the wire should be cut so that the fold of the cable assembly is on the left below the threaded bar when the logic board is folded into place.

6. PARTS LIST

6.1. Semiconductors and Capacitors

10x 1 N 4151
2x BA 379 (Siemens, TFK)
3x 1 N 4003 or 1 N 4007
3x BB 209 (Siemens)
1x C 8 V 2
1x BZX 75 C 2 V 1 (ITT, Philips)
1x LED 3 mm diameter
1x BFT 66 (Siemens)
2x BF 450
1x BF 240
1x 2 N 4072 (Motorola)
1x MRF 227 (Motorola)
5x BC 238 C or BC 413 C
5x BC 308 C or BC 415 C
1x BC 327-25 (Siemens, TFK)
1x BC 202 blue (AF miniature PNP, Siemens)
3x BC 122 blue (AF miniature, NPN, Siemens)



Ceramic disk capacitors,	1x	2.7 pF
type 1 B (grey)	1x	4.7 pF
Spacing 2.5 mm, high quality	2x	6.8 pF
± 2 %	4x	15 pF
	5x	47 pF
	6x	100 pF
	1x	220 pF
	6x	470 pF
	1x	C 217, C 218
Ceramic disk capacitors	20x	1 nF
type II (yellow or brown)	3x	2.2 nF
Spacing 2.5 mm, lower	5x	4.7 nF *)
quality ± 20 %	8x	10 nF *)
	3x	22 nF *)

C 148: 68 nF ± 10 %

MKM (Siemens)	1x	10 nF (C 142)
Spacing 7.5 mm	1x	47 nF *) (C 126)
± 5 %	1x	68 nF *) (C 134)
	1x	0.22 µF *) (C 129)

1x AC 153 (or AC 188)
1x 2 N 4861 (Texas)
1x BF 245 A
1x 2 N 4416
1x 40673 or 40841 (RCA)
1x TBA 820 (SGS-ATES)
1x TDA 1047 (Siemens)
1x 741 C or TBA 221 B
2x SO 42 P (Siemens)
2x MAN 3 (Philips, Monsanto)
1x 4046 (Motorola, Fairchild, not RCA)
2x 4522 (Motorola)
2x 4560 (Motorola)
2x 4511
1x 4001
1x 4007 only with 400 channels
2x 4029
1x 4030
1x 4093
1x 74 C 93 (NS)
1x 74 C 90 only with 400 channels

Styroflex 25 V DC
± 5 % max.

1x 47 pF (C 116)
3x 100 pF (C 112/115/121)
2x 1.5 nF (C 143/144)
1x 2.2 nF (C 220)

Aluminium-electrolytics 14 V DC

1x 47 µF (C 131)

Tantalum electrolytics	1x	0.1 µF
drop type ≧ 16 V DC	1x	0.22 µF
	1x	0.47 µF
	4x	1 µF
Tantalum electrolytics	2x	2.2 µF
drop type ≧ 10 V DC	1x	3.3 µF
	2x	4.7 µF
	2x	6.8 µF
	1x	10 µF
	1x	22 µF
	1x	47 µF

*) or multi-layer ceramic types

6.2. Trimmer Capacitors, Trimmer Potentiometers, Resistors, Wires, Crystals

Component	Manufacturer
1 air-spaced trimmer 2 - 13.5 pF, type 11 LJ 7	Tronser
1 plastic foil trimmer 1.8 - 22 pF, 7.5 mm diameter	Philips
1 ceramic disk trimmer 7.5 mm diameter, 6 - 30 pF	Stettner
1 plastic foil trimmer 10 mm dia., 5 - 60 pF, No. 808/3	Philips
3 plastic foil trimmers 10 mm dia., 4 - 40 pF, No. 808/3	Philips
3 trimmer potentiometers max. 8 mm dia., max. 5 mm high one each: 1 x 200 Ω / 20 kΩ / 500 kΩ, e.g. type 171 or 170	Vitrom

Resistors on the RF/AF board: max. 2.5 mm dia., spacing ≦ 10 mm, tolerance ± 5 %.

Resistors on the logic board: miniature types with ± 20 % tolerance (except R 25 that may be larger, and R 253, R 254, R 255, which should have a tolerance of ± 5 %);
Most favorable type: spacing ≦ 2.5 mm.

Wires: Miniature coaxial cable 1.17 mm outer diameter; type 50 VMTX, 55 Ω, Teflon-insulated.

Stereo audio cable: 4 cores plus screen, 2 mm outer diameter.
For logic cable assemblies; stranded wire.

For wire wrapping on the logic board, it is better to use stretched, tin-plated wire with heat-proof insulation of approx. 0.3 mm diameter.

Silver-plated copper wire of 0.5 and 1 mm diameter.

Crystals:

66.4 MHz series resonance HC-18/U: KVG type: XS 6106 L
(or better quality: XS 6306, since this crystal mainly determines the frequency accuracy).

10.7 MHz parallel resonance with 30 pF, HC-18/U: XS 6104 L *)
200 kHz parallel resonance with 30 pF, HC-6/U: XS 0501 *)
*) amateur quality is sufficient for these.

Resistor table: Logic board: (Miniature types)

330 Ω	1 x 3.3 kΩ	20 x 1 MΩ
	2 x 12 kΩ	4x 4.7 MΩ
	5 x 22 kΩ	
	1 x 39 kΩ	
	4 x 100 kΩ	470 kΩ ± 5 %

RF/AF board: ± 5 % throughout, normal types

6.3. Larger Components

Component	Manufacturer
Microphone-Loudspeaker 0.2 / 0.5 W, 50 Ω, type 370 A 1	Holmco, Berlin
Meter EW 8, approx. 0.3 mA	
Coaxial connector HFB 5/3 (M 8 x 0.75)	Schützinger, Stuttgart

Coaxial plug HFS 5/2 for telescopic antenna	Schützinger, Stuttgart
2 pieces multi-position switch (2 x 6), short-circuited, max. 13 mm dia.; e.g. MY 1/2x6 k/T 12	EBE GmbH., Leinfelden (Germany)
or PS 613/1/2x6 k/12/1/5.8	Erni (Switzerland)
Connector strip 13-pole, with gold-plated contacts	Siemens
2 matching plugs (for car mounts and battery charger)	
Miniature toggle switch, 8-pole, with dual in line case	Grayhill, type 76 P 08
2 pieces national-RSL-12 V relais	National
1 changeover, screened	
Nickel-cadmium battery, type 10 x 225 DKZ	Varta-Deac
Monolythic crystal filter MQF 10.7-15; bandwidth 15 kHz	AEG-Telefunken
Microphone transformer 1:10, potted, type ST 102	Haufe, Usingen (Germany)

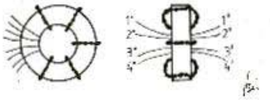
Components for the case:

Versions A and B (milled):	Brass 58 ⊐-profile 20 x 30 mm Brass 58 ⊐-profile 30 x 6 mm
Versions C and D (sawn and bent):	Brass 63 – plate of 1.5 mm thick
Brass 58 L-profile rail 4 x 4 x 0.5 mm:	Graupner
Brass 58 O-profile, 5 mm diameter	
Required for all versions:	0.8 mm aluminium plate (cover) Brass threaded rod (M 3) Brass nuts (M 3) Brass nuts and screws (M 2) Tin plate of approx. 0.2 mm thick for PA screening

6.4. Coil Data

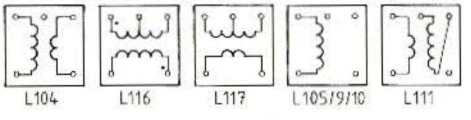
L 101:	Self-supporting, 4 turns of 1 mm dia., silver-plated copper wire, inner dia. 5 mm, length 1.3 mm per turn
L 114:	self-supporting, 5.5 turns of 1 mm dia., silver-plated copper wire, inner dia. 5 mm, length 1.3 mm per turn. Coil tap at 1 and 2 turns; pay attention to direction of winding (photograph)
L 120:	self-supporting, 4 turns of 1 mm dia. silver-plated copper wire, inner dia. 4 mm, length 1.2 mm per turn
L 121:	self-supporting, 2.5 turns of 1 mm dia., silver-plated copper wire, inner dia. 4 mm, length 1.5 mm per turn Coil tap at 0.75 turns facing downwards (photo)
L 103, L 106: L 107, L 113:	Ferrite bead 3.5 mm dia. x 3 mm, on transistor lead; use non-conductive ferrite material !
L 118, L 119:	Ferrite bead lying on board with ⊓ shaped wire of approx. 0.5 - 0.8 mm dia.
L 108:	Ferrite bead with 5.75 turns of 0.3 mm dia. enamelled copper wire 
L 122:	Ferrite 6-hole core of 6 mm dia. x 10 mm with 2.5 turns of 0.5 mm dia. wire (Philips 4312 020 36700)

L 102:	Ferrite coil 6/3/3/made from material Fi 01 u 8 (violet) with 2.75 turns of 0.3 mm dia. enamelled copper wire
L 115:	Ferrite coil 6/3/3 as above with 4 x 5.75 turns of 0.3 mm dia. enamelled copper wire. 4 wires should be stranded together before winding the coil. . = Start, ' = Finish



L 112:	Special coil set, transformation ratio 1:10, core type E 10, potted core 0.4 H: 40 H / 170 Ω: 2.2 kΩ
L_{SZ}:	approx. 1.5 to 3 mH, max. 11 mm dia., e.g. 325 turns of 0.1 mm dia. enamelled copper wire wound in a potted core (not required for crystals from VHF COMMUNICATIONS)
L 104:	Special coil set, 4 turns + 1 turn of 0.3 mm dia. enamelled copper wire and violet core (commence with 2 x 1 turn stranded together)
L 116:	as L 104, but 10 turns + 2 x 2 turns of 0.3 mm dia. enamelled copper wire (10 turns inside and on top of this 2 x 2 turns stranded together in an insulated tube. (● = commencement of winding)
L 117:	as L 104, but 2 x 3 turns + 1 turn of 0.3 mm dia. enamelled copper wire (commence with center tap, 2 x 3 turns wound up in a opposite direction, place one turn in an insulating tube at the bottom of the coil)
L 105, L 109:	Special coil set, 16 turns of stranded wire 12 x 0.03 (or if not available 0.1 mm dia. enamelled copper wire) with ferrite pin and potted core from Fi 05 f 7 (orange). (Wind as close as possible, if possible in a single layer).
L 110:	22 turns, otherwise as L 105, L 109
L 111:	16 turns + 4 turns. Stranded wire as previously given (16 turns wound on the inside and 4 turns on the outside), otherwise as L 105, L 109.

Coil connections:
(as seen from above)



Further details regarding winding the coils:

The windings of L 104, L 105, L 109, L 110, L 111, L 115, L 116, L 117 should be glued into place after winding with a dual-component adhesive; in the case of L 109, L 110, L 111, L 105, also the potted core.

The space left in inductance L 114 should be filled with dual-component adhesive to suppress any microphonic effects: use only a little adhesive at a time, repeating this process every few hours or days until full !

The coil taps on L 114 and L 121 should be made with 0.5 mm dia. silver-plated copper wire after tapping or drilling a 0.6 mm dia. hole in the coil. During the soldering process, push the neighbouring windings away in order to avoid any short-circuit.

Japanese IF-circuits can be used for L 105, L 109 and L 110 (the center pin of L 109 should be removed); however, measurements on a number of such circuits have shown that the Q is only in the order of 20, compared with 90 obtained with home-made IF-inductances. The ultimate selectivity is mainly dependent on this Q. The pins of the coil formers are only able to withstand a short soldering period ! The IF-inductances are easier to wind than the VHF inductances.

7. ALIGNMENT

7.1. Any wiring faults in the frequency selection logic will be noticed immediately on counting the channels. The adding network + 20 and the PLL-logic is checked by counting the transmit frequencies.

Two simple probes are given in **Figure 25** for checking the operating points and oscillation amplitudes. A capacitor of a few pF previous to the coaxial measuring cable is sufficient for coupling a sensitive VHF-counter with 50 Ω input.

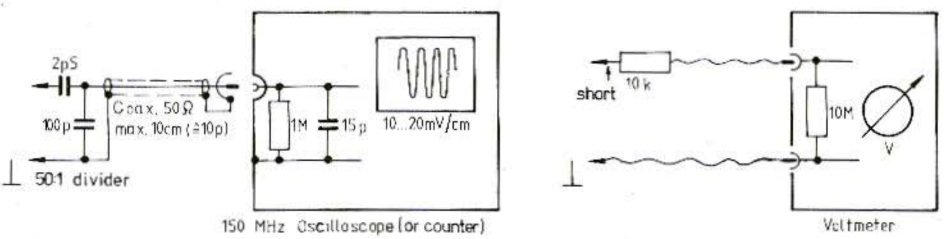


Fig. 25: Alignment aids

7.2. Oscillators

PLL-crystal oscillator and doubler:	Test point R 146 / D 112 / D 113 f_{nom} = 132.800.0 MHz pulling range > 1 kHz; adjustment accuracy ≈ 50 Hz
Transmit mixer – crystal oscillator:	Test point C 161 / C 162 or C 162 / C 163 f_{nom} = 10.700.0 MHz pulling range ≈ 1.4 kHz adjustment accuracy ≈ 20 Hz
Reference frequency:	Test point: pin 9 of IC 74 C 93; f_{nom} = 100.000 kHz permissible tolerance approx. ± 5 Hz

Adjustment of the VCO (receive mode at channel 00):
The tuning voltage (w) should be at its lower limit at approximately 60 % of the maximum capacitance of C 155. This voltage is determined by D 205 and is in the order of 3.8 V. The voltage (w) is now adjusted to be 1 V higher by inserting the rotary plates of C 155; the side lines at a spacing of ± 25 kHz from the carrier will still be sufficiently suppressed (see section 4.2.1. and Figure 5). The voltage (w) will be reduced by 0.5 V when the cover is fitted.

A frequency check at the antenna in the transmit mode on channel 00 should result in:
f_{nom} = 144.000.0 MHz ± 100 Hz. A temperature dependence of approximately – 400 Hz/10°C was measured. This was mainly caused by the 66.4 MHz crystal oscillator.

7.3. Receiver

The IF-circuits and VHF intermediate stage L 4 can be trimmed for maximum S-meter reading whilst receiving a 2 m signal, however, a frequency modulated signal generator (± 4 kHz deviation) and an oscilloscope (connection n) will be required if an accurate alignment of the IF-bandpass curve is to be made. Inductance L 11 is aligned for maximum audio amplitude, and inductances L 9 and L 10 are aligned alternately several times for minimum distortion of the sine-wave signal. The signal generator should be connected to the rear antenna connector and its level should be in the order of 100 µV.

The image trap is aligned with the aid of C 1 with the transceiver set to channel 60, and the image frequency of 124.100 MHz aligned for minimum S-meter reading. After this, the signal generator voltage is reduced to approximately 1 µV and C 2 aligned for maximum S-meter reading at 145.500 MHz, followed by inductances L 4 and L 5.

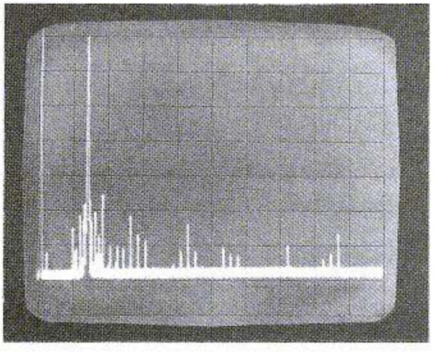


Fig. 26:
Harmonic and spurious signals in the transmitter spectrum in the frequency range from 0 to 1 GHz
V: 10 dB/div; H: 100 MHz/div

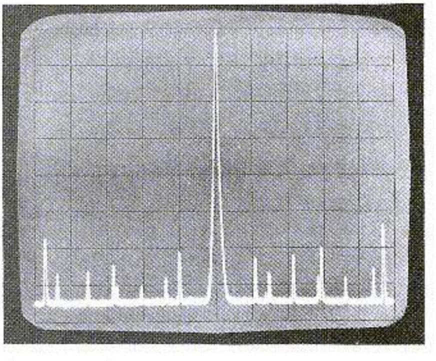


Fig. 27:
Spectral purity of the transmit signal (channel 40) in the range of ± 5 MHz from the carrier.
V: 10 dB/div; H: 1 MHz/div

7.4. Transmitter

The calling tone oscillator is aligned to 1750 Hz with the aid of R_T (Figure 4): Test point pin 4 of the 4046, tuning range ≈ 1.1 kHz. The frequency deviation of the calling tone should be adjusted using a modulation meter or similar test to ± 4 kHz. The maximum frequency deviation is in the order of ± 6 kHz. Trimmer R_6 (Figure 3) should remain in its center position. If a spectrum analyzer is available, it is possible to improve the transmit spectrum by adjustment of the VCO frequency suppression **(Figure 26)**. Finally, the transmitter is aligned with the aid of L 17, C 72, C 73, and C 74 in several runs at channel 50 to obtain maximum output power at a current drain of approximately 225 mA. In order to compare the specifications, one can feed the transceiver from an external source at 12.7 V within discharged accumulator. If no measuring equipment is available, it is possible to align according to the meter; however, it is necessary for the rear antenna connector to be terminated with 50 Ω.

8. REFERENCES

(1) U.L. Rohde: Zur optimalen Dimensionierung von UKW-Eingangsteilen
INTERNATIONALE ELEKTRONISCHE RUNDSCHAU 1973, 3, pages 103 - 108

(2) D. Briggmann: Vielkanaloszillator für das 2-m-Band in C-MOS-Technik
FUNKTECHNIK 1974, 21, page 757

(3) Measurements made by DK 5 SQ

(4) D.E. Schmitzer: Speech Processing
VHF COMMUNICATIONS 2, Edition 4/1970, pages 217 - 224

(5) D.E. Schmitzer: Steep-skirted Active Audio Filters
VHF COMMUNICATIONS 2, Edition 4/1970, pages 210 - 216

(6) D. Kesner: Dynamische Probleme und Ausgangsstörspannungen
in phasenstarren Schleifen (PLL)
KOMPASS 1974, 2, pages 8 - 14

(7) K. Hoerschelmann, W. Kranwetvogel:
BFT 66 – ein extra rauscharmer Breitbandtransistor für Frequenzen bis 1 GHz
Siemens-BAUTEILE REPORT 12, 1974, 3, pages 57 - 60 Figure 4

(8) H.M. Kleinmann: Application of Dual-Gate MOSFET in Practical Radio Receivers
RCA-Application Note ST-3486

(9) B. Lübbe: Mini-MOSFET Converter for 2 m
VHF COMMUNICATIONS 5, Edition 4/1973, pages 234 - 239

A TRANSISTORIZED LINEAR AMPLIFIER FOR THE 23 cm BAND

by U. Beckmann, DF 8 QK and J. Dahms, DC 0 DA

Amateur radio activity in the frequency range between 1250 and 1300 MHz is increasing considerably. This does not only comprise SSB communications at 1296 MHz (23 cm), but also amateur television (ATV) operation at 1251 MHz (24 cm). Modern, efficient semiconductors, as well as constructional designs for preamplifiers (1), receive (2) and transmit mixers (3), (4), have also played an important part in this interest. The disadvantage has been that the described transverters did not provide sufficient power levels, which meant that they had to be used together with a tube power amplifier. This, of course, is a great disadvantage for portable operation.

A transistorized linear amplifier is now to be described which allows output powers in the order of several Watts to be generated in this frequency range. The linear amplifier modules are designed for linear operation and are therefore suitable for SSB and ATV operation. Details are also to be given for using them in the FM-mode.

1. TRANSISTOR SELECTION

Only a few types were found to be suitable for this application. Most transistors that operate with a reasonable efficiency in the 1300 MHz area require operating voltages of 24 V and more, and they are mainly designed for use in a grounded base circuit. After considering the costs, the following types were finally selected and tested in experimental circuits: BFR 63, 64, 65, 94; BFQ 34; BFT 98; BLX 98.

The best transistor for use with an operating voltage of 12 V was found to be a new transistor manufactured by Philips: BFQ 34. A single and a parallel amplifier are to be described using this transistor type. The highest output power was obtained using transistor type BLX 98, which, unfortunately, requires an operating voltage of 25 V, and only provides a power gain of 3 dB.

2. MOST FAVORABLE STAGE SEQUENCE

When constructed favorably and aligned, the transmit converter DF 8 QK 001 (4) will provide an output power of approximately 220 mW when the output stage is equipped with a BFR 64 transistor. On the other hand, if a BFR 94 is used in the output stage, the output power can be increased (in the experience of the author) to approximately 400 mW. Since the case dimensions are virtually the same, it is also possible to use transistor type BFQ 34 for the last stage on this board. This allows the power gain to be increased by nearly 3 dB, and will provide an output power of 600 mW.

This is sufficient to fully drive the parallel linear amplifier equipped with two BFQ 34 to an output power of 3 W, which is to be described later. The single stage equipped with BFQ 34 would be overdriven with a drive power of 600 mW, and would no doubt be destroyed. This single stage is designed for cases where 200 to 300 mW are to be increased to a higher level.

All previously mentioned values are valid for SSB operation at an operating voltage of 12 V. The manufacturer gives a maximum permissible operating voltage of 15 V for transistor type BFQ 34. For amateur applications, the operating voltage should not be higher than 13.5 V, since otherwise the transistor could be destroyed when the matching is not optimum.

The authors recommend the previously mentioned sequence as the best combination providing a minimum of construction and high efficiency. The available output power of 3 W in the SSB-mode should be sufficient for most portable applications. For fixed-station operation, this set-up can be followed by a cavity amplifier equipped with the 2 C 39 which can be driven up to approximately 35 W. **Figure 1** shows a block diagram of such an arrangement.

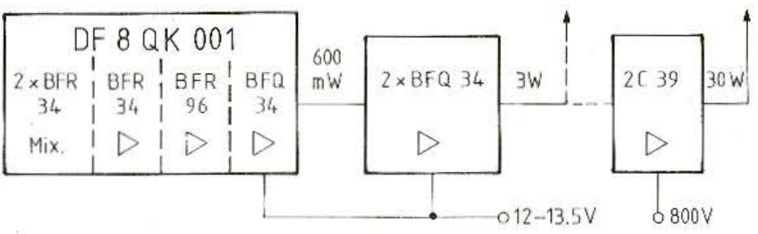


Fig. 1: Recommendation for the stage sequence of a transmit converter and linear amplifier

An attempt was also made to further amplify the output power of a parallel linear amplifier equipped with two BFQ 34 using a BLX 98 transistor. This transistor was operated at 25 V and a quiescent current of 850 mA. The gain amounted to approximately 3 dB up to an output power of approximately 7 W. All stages operated in a very stable manner.

From the large number of developments, two modules are to be described that are of interest for construction. In order to keep the costs as low as possible, normal 1.5 mm thick, double-coated epoxy PC-board material was used for the boards. The constructor can decide which transistor at which drive power and operating voltage is most suitable for him from the power diagram.

3. SINGLE-STAGE LINEAR AMPLIFIER

The circuit of the amplifier given in **Figure 2** is in principle very simple. Either the BFR 94 or BFQ 34 can be used, however, the higher operating voltage is only valid for the BFR 94. Whether the amplifier will operate efficiently or not depends on the care taken during construction, which is now to be described in detail.

Figure 3 shows a photograph of the author's prototype amplifier, and **Figure 4** shows the double-coated PC-board whose dimensions are 94 mm x 74 mm. The ground surface remains virtually intact on the lower side, whereas the striplines are etched on the upper, component side of the board, and ensure the input and output matching together with the plastic foil trimmers. The linear amplifier is virtually identical to the last linear amplifier stage on PC-board DF 8 QK 001; this means that the same is valid for the construction of this amplifier as was mentioned in that article (4).

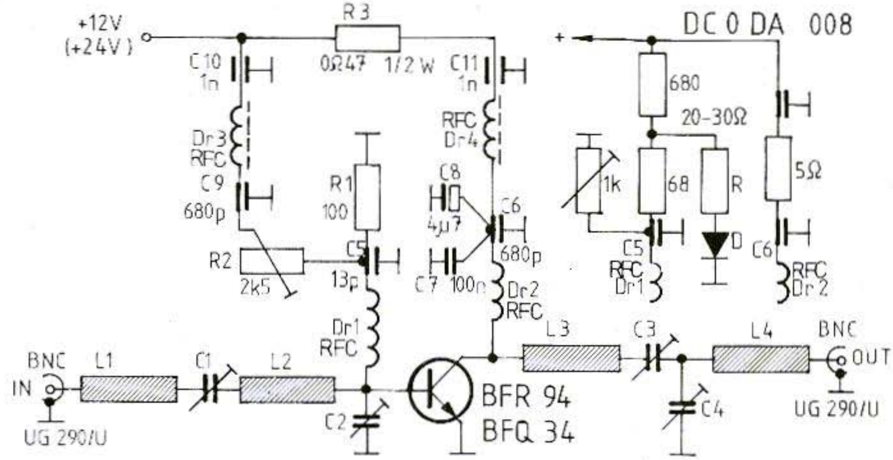


Fig. 2: Single-stage linear amplifier for BFR 94 or BFQ 34 with two different base-voltage circuits. The higher operating voltage can only be used in conjunction with the BFR 94.

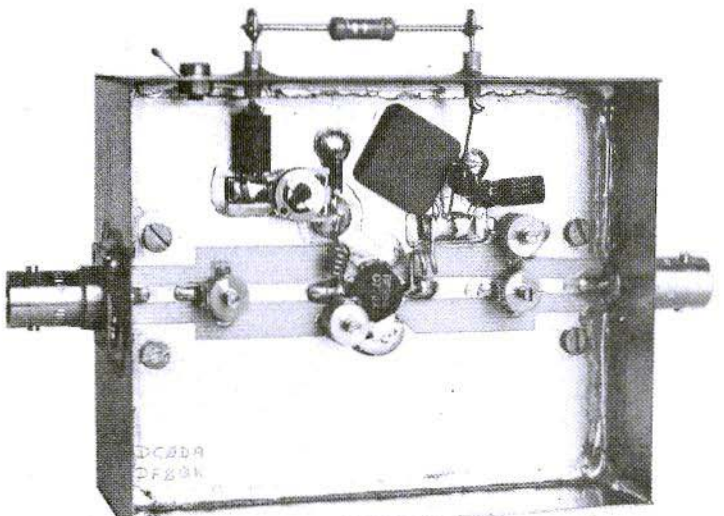


Fig. 3: The single-stage amplifier with screening panels and ideally connected BNC connectors

Special care must be taken on installing the transistor into the PC-board. In order to ensure »through-contacting« of the emitter connections, the cut-out for the transistor is filed out slightly at both emitter sides so that at least a 5 mm wide strip of copper foil can be placed from one side of the board to the other.

These strips are used to make a large-area connection of the upper and lower ground surfaces of the board to the emitter connection strips which should fit flatly onto the board. This can be seen in **Figure 5** showing a cross-section without solder.

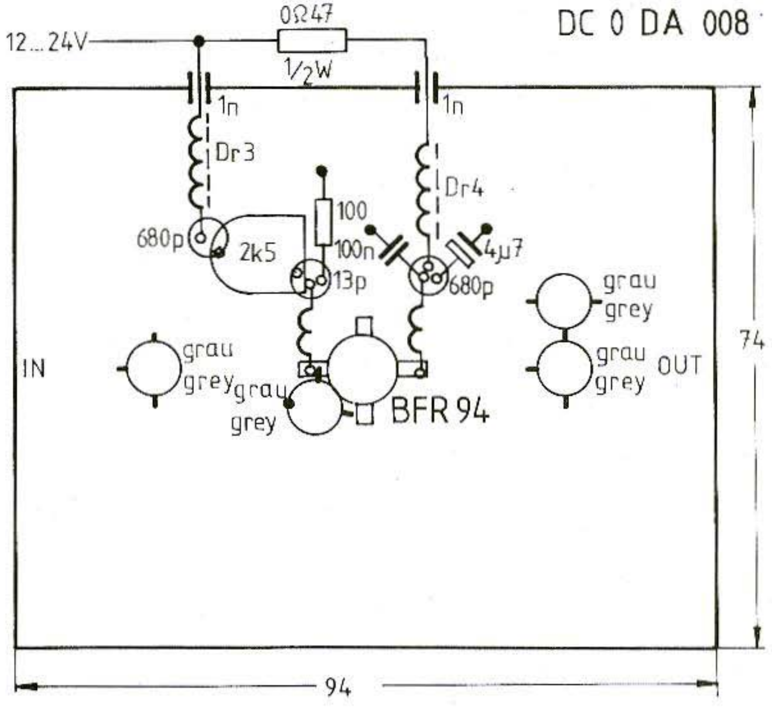


Fig. 4:
The BFQ 34 can also be used on the PC-board

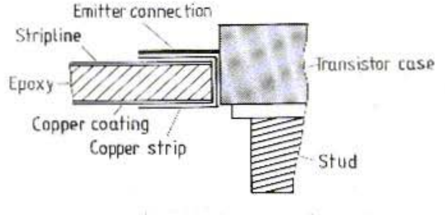


Fig. 5:
This shows how the emitter connections can be »through-contacted«

The PC-board should be sawn or cut at the input and output (approx. 8 mm 2 mm) to allow fitting of the BNC-flange connectors. The protruding PTFE-insulation around the center pin of these connectors is removed with a knife so that the pin can lay at the same level as the board over its whole length when mounted later. The two ground connections of trimmer capacitor C 1 and C 3 are bent outward at right angles and shortened to approximately 2 mm so that they fit exactly on the stripline.

After mounting the components, the PC-board is provided with tin plate panels around the edge that should have a height of at least 25 mm. The upper and lower side of the PC-board should then be soldered all around the edge to this screening panel. Finally, a suitable heat sink is cut so that it fits into the plate casing, and is screwed into place using the threaded bolt of the transistor. It is possible when soldering the PC-board into place to adjust the panel so that the heat sink disappears within this case itself.

3.1. Components for the Single-Stage Amplifier

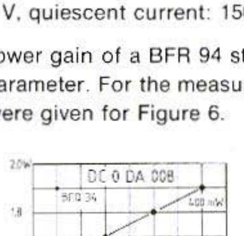
Transistor:	BFR 94 or BFQ 34 (Philips)
C 1 - C 4:	Plastic foil trimmer 6 pF (grey), 7.5 mm dia. (Philips)
C 5:	ceramic disk capacitor without connections, 13 pF
C 6, C 9:	ceramic disk capacitor without connections, 680 pF
C 7:	ceramic capacitor 100 nF
C 8:	4.7 μF Tantalum electrolytic, drop type
C 10, C 11:	ceramic feedthrough capacitor of approx. 1 nF solder fitting
R 1:	100 Ω composite carbon resistor
R 2:	2.5 kΩ trimmer potentiometer (spacing 10/5)
R 3:	0.47 Ω composite carbon resistor
RFC 1:	3 turns of 0.5 mm dia. enamelled copper wire, inner dia. 3 mm, self-supporting
RFC 2:	2 turns of 1 mm dia. silver-plated copper wire, inner dia. 3 mm, self-supporting
RFC 3:	6-hole ferrite core (Philips)
RFC 4:	1 turn of enamelled copper wire through a ferrite bead

3.2. Adjustment of the Quiescent Current and Measured Values

If the described linear amplifier is equipped with a transistor BFR 94, a quiescent current of 60 to 100 mA is selected with the aid of the trimmer potentiometer. This is independent of the selected operating voltage of 12 to 24 V. On the other hand, the operating voltage should not exceed 13.5 V in the case of the BFQ 34; the quiescent current should be adjusted to 80 mA.

The values that can be obtained after favorable alignment are given in the following diagrams. They were measured in conjunction with a transistor BFR 94. **Figure 6** shows the output power that can be achieved with a BFR 94 as a function of the operating voltage at a drive power of 200 mW or 400 mW. At the bottom of the diagram, one will find the measured DC current power (quiescent current times operating voltage) so that one is able to obtain an idea of the efficiency. Only one measured value is given for transistor type BFQ 34 that shows the higher gain of this type. This measured value is given by the following parameters: operating voltage 12 V, quiescent current: 150 mA, drive power: 200 mW.

Figure 7 gives the power gain of a BFR 94 stage as a function of the operating voltage using the drive power as parameter. For the measured value in the case of a BFQ 34, the same conditions are valid as were given for Figure 6.



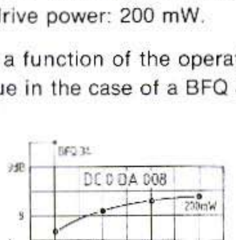


Fig. 6 and 7: Measurements on the single-stage linear amplifier; further details in text

4. PARALLEL POWER AMPLIFIER STAGE

A linear amplifier stage equipped with two parallel-connected BFQ 34 **(Figure 8)** is able to provide a maximum output power of 3.8 W at an operating voltage of 12 V and a drive power of 800 mW. A gain of approximately 7 dB is obtained from a total operating current of approximately 400 mA. It is also possible for the PC-board to be equipped with two BFR 94; such a linear amplifier provided an output power of approximately 3.5 W at an operating voltage of 20 V. This version of the linear amplifier can also be classed as a useful, inexpensive linear amplifier, since a linear amplifier equipped with a single transistor offering the same output power and gain at an operating voltage of 12 V in the linear mode would be far more expensive.

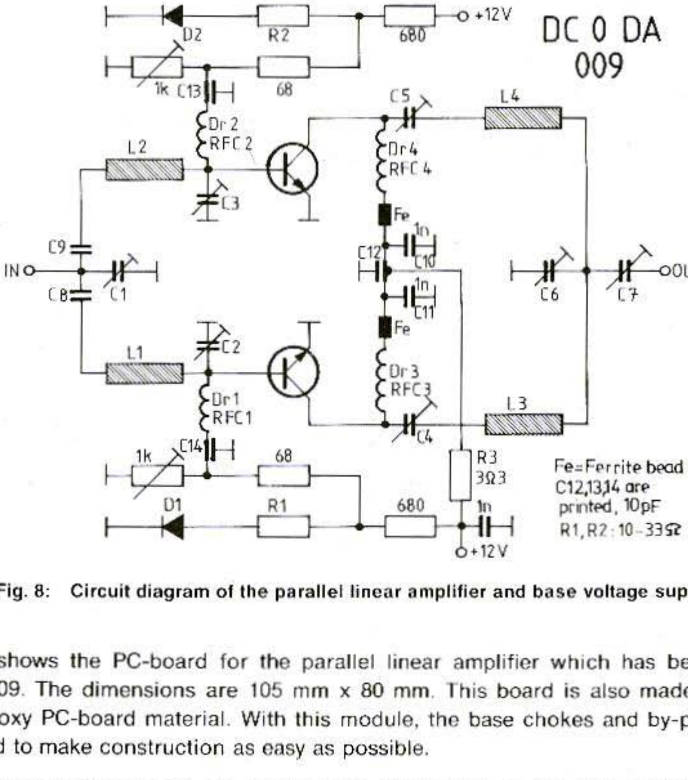


Fig. 8: Circuit diagram of the parallel linear amplifier and base voltage supply

Figure 9 shows the PC-board for the parallel linear amplifier which has been designated DC 0 DA 009. The dimensions are 105 mm x 80 mm. This board is also made from double-coated epoxy PC-board material. With this module, the base chokes and by-pass capacitors are printed to make construction as easy as possible.

As can be seen in **Figure 10**, all components are located on the etched side of the board. Diodes D 1 and D 2, which are used to thermally stabilize the quiescent current, are mounted directly on the ceramic case of the transistors. The cathode connections of the diodes are soldered to ground directly adjacent to the transistor in question, and the anode connections are connected via 27 Ω resistors to the appropriate conductor lane. A small amount of heat-conductive paste ensures a good heat-contact between transistor case and diode.

The PC-board is also provided with tin plate panels which are then soldered to the continuous ground surface on the lower side of the board. The same is valid for the installation of the BNC connectors as was given in section 3. Finally, the PC-board is screwed to a heat sink with the aid of the transistor bolts and four additional screws **(Figure 11)**.

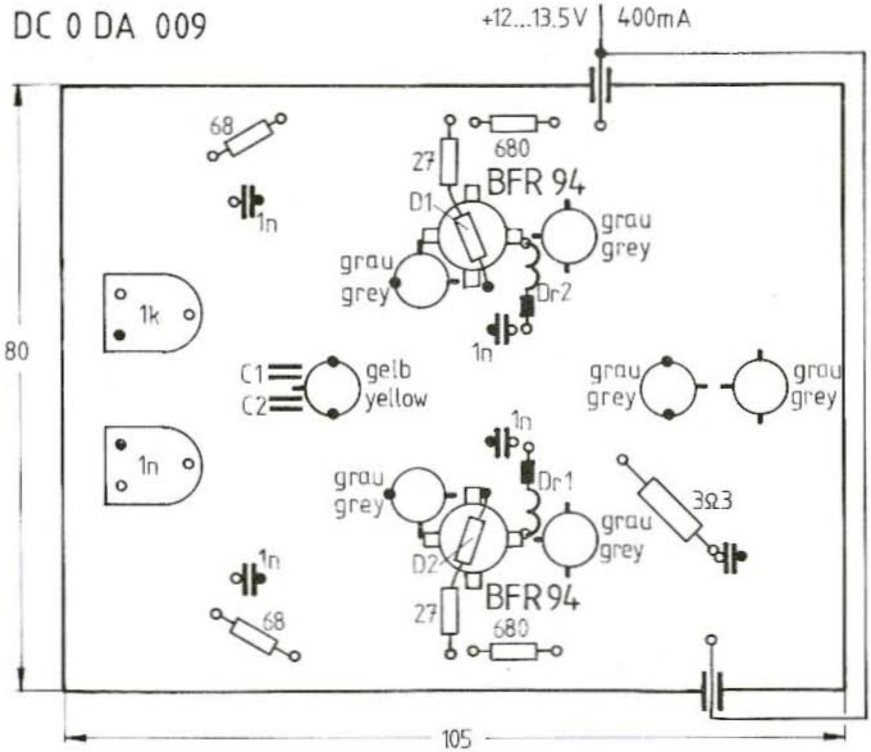


Fig. 9: The PC-board of the parallel linear amplifier is also from epoxy PC-board material

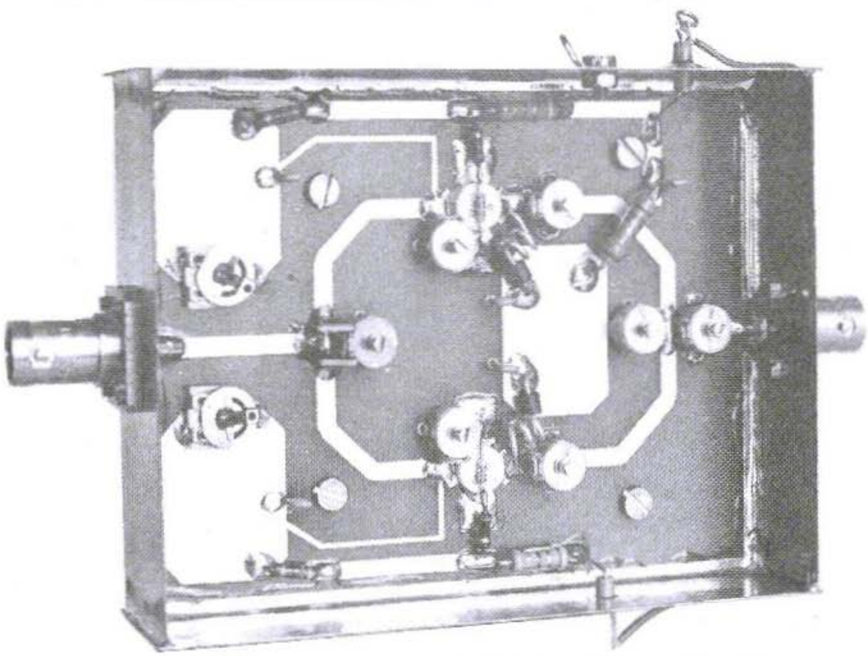


Fig. 10: Both base chokes and by-pass capacitors are printed

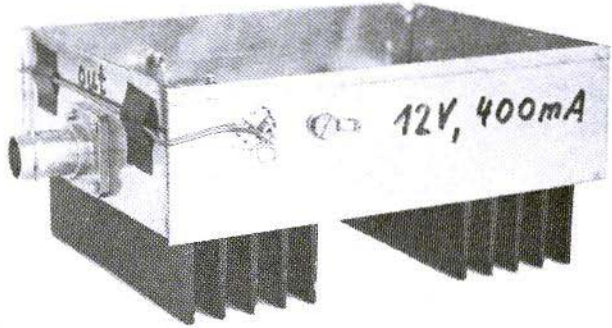


Fig. 11: Photograph of the completed amplifier without cover

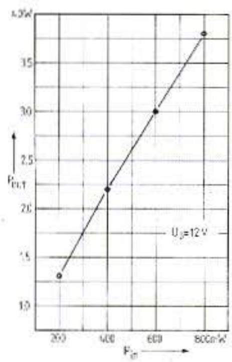


Fig. 12:
Measured values of a parallel linear amplifier equipped with two BFQ 34 transistors

4.1. Components for the Parallel Linear Amplifier

T 1, T 2: BFQ 34 or BFR 94 (Philips)

D 1, D 2: 1 N 914, 1 N 4148, 1 N 4151

C 1 - C 7: Plastic foil trimmer, 7.5 mm dia. (Philips)
C 1: 10 pF (yellow), C 2 - C 7: 6 pF (grey)

C 8, C 9: Chip capacitors of between 50 and 100 pF

C 10, C 11: 1 nF ceramic disk capacitors with connection leads
(keep connections as short as possible !)

RFC 1, RFC 2: printed

RFC 3, RFC 4: 2 turns of 1 mm dia. silver-plated copper wire, inner dia. 3 mm, one ferrite bead placed over the cold end of the chokes, self-supporting

R 1: 1 - 3.3 Ω, 0.5 W

All other resistors: miniature composite carbon resistors

Trimmer potentiometer: 1 kΩ, horizontal mounting, spacing 10/5 mm

4.2. Alignment and Measured Values

The alignment is made in a similar manner to that of the previously mentioned single transistor linear amplifier. In addition, it is important to obtain the highest possible balance. The DC-balance under cold and warm conditions can be checked by placing 1 Ω resistors (select two of the same value !) in series with the collector chokes. The SHF balance can only be roughly obtained by using the same trimmer adjustments.

The transfer characteristics of the described parallel linear amplifier is shown as a diagram in **Figure 12**.

5. LINEAR AMPLIFIER EQUIPPED WITH TRANSISTOR TYPE BLX 98

This stage is not to be described in detail since it is necessary for it to be operated from a high voltage (25 V) and a high quiescent current (850 mA). Also, the power gain only amounts to approximately 3 dB. The circuit is given in **Figure 13**; of interest is the stabilizer circuit for the quiescent current as recommended by Philips. Very high stability was observed, even under continuous operation. However, it was found necessary to provide a very large heat sink. The photograph given in **Figure 14** allows several construction details to be seen: for example a PTFE-board and air-spaced trimmers have been used.

Transistor type BLX 98 (Philips) is still too expensive for the radio amateur, and for this reason this can only be classed as an experiment. For economic reasons, tubes such as the 2 C 39 should be used when output powers in excess of 4 W are required.

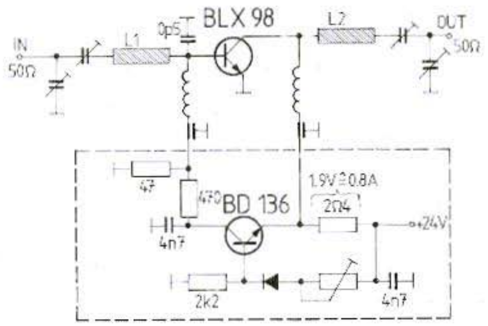


Fig. 13: SHF and stabilizer circuit for a BLX 98

6. ATV OPERATION

When used in the ATV-mode, the output power of the transmit converter DF 8 QK 001 (4) amounts to approximately 120 to 150 mW before the synchronizing pulses are limited. If a transistor BFQ 34 is used in the last stage of this board instead of the BFR 94, a higher output power will be obtained in the ATV-mode. This can be increased still further using the single-stage linear amplifier equipped with a BFR 94 or BFQ 34 which brings the output power to approximately 700 mW. A further increase in power using a subsequent parallel-linear amplifier did not bring as much as in the SSB-mode, and its application is therefore not considered worthwhile.

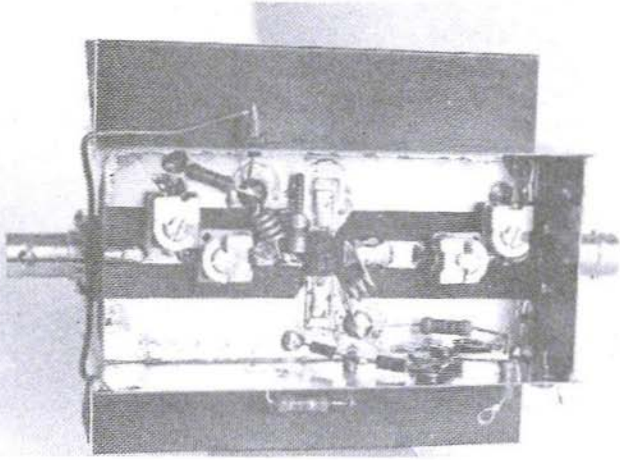


Fig. 14: Photograph of a linear amplifier equipped with a BLX 98

7. REFERENCES

(1) J. Dahms: A Three Stage Preamplifier for the 23 cm Band
VHF COMMUNICATIONS 9, Edition 4/1977, pages 221 - 228

(2) J. Dahms: Interdigital Converters for the GHz Amateur Bands
VHF COMMUNICATIONS 10, Edition 3/1978, pages 130 - 144

(3) H. Fleckner: A SHF Transmit Converter with Varactor Diode Having High Efficiency and Low Intermodulation
VHF COMMUNICATIONS 10, Edition 2/1978, pages 66 - 81

(4) U. Beckmann: A Linear Transverter for 28 MHz - 1296 MHz with Push-pull Mixer
VHF COMMUNICATIONS 9, Edition 4/1977, pages 212 - 220

A TRANSMIT MIXER AND LINEAR AMPLIFIER FOR THE 13 cm BAND EQUIPPED WITH A 2 C 39 TUBE

by H.J. Senckel, DF 5 QZ

The following description of a 13 cm linear amplifier is similar to that suggested by N. Foot, WA 9 HUV. The described mechanical construction has been considerably simplified, and is thus suitable for those amateurs that are not able to carry out fine metalwork.

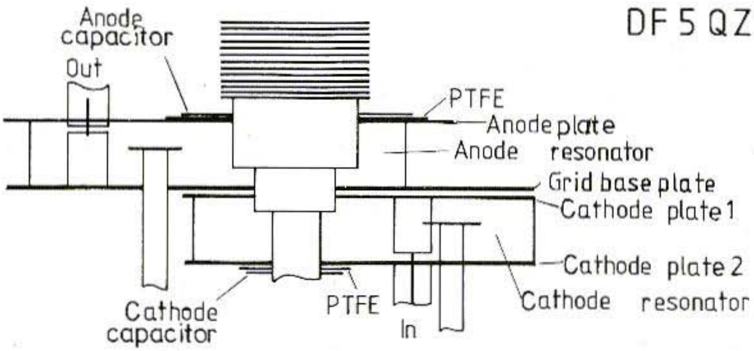


Fig. 1: Construction of the 2 C 39 amplifier-mixer for the 13 cm band

1. PRINCIPLE

Tubes of the 2 C 39 family are usually operated in a grounded grid circuit. The way in which the required grid bias voltage can be generated was described in (1). The anode and cathode are both within a cavity resonator, which can be aligned to resonance at 2304 or 2400 MHz with the aid of a tuning plunger. The input coupling to the cathode circuit and the output coupling from the anode circuit are fixed. The principle of the construction is shown in **Figure 1**. This amplifier can provide an output power of 25 W at an anode voltage of 800 to 900 V, and an anode current of 100 mA. The maximum gain is in the order of 10 dB. The main feature of this amplifier is that it is not built up coaxially **(Figure 2)**.

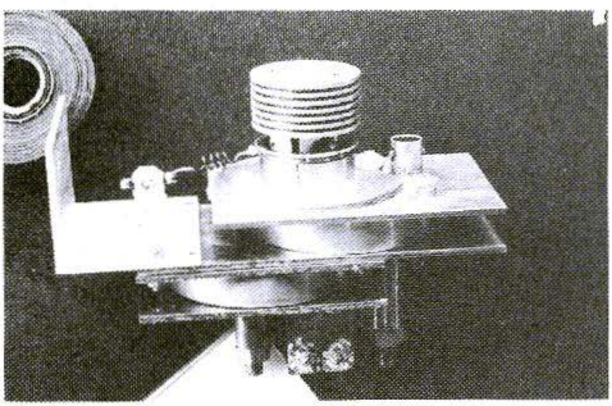


Fig. 2: Photograph of the author's prototype

It is also possible to use this stage as a mixer virtually without modification if the cathode resonator is aligned to the local oscillator frequency (e.g. 2160 MHz), and if the drive signal (144 MHz) is fed to the tube as shown in **Figure 3**.

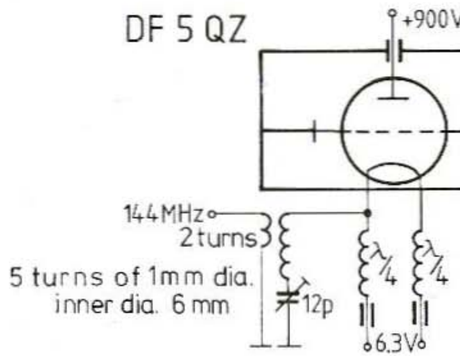


Fig. 3: Input coupling of the 144 MHz signal in the case of a mixer

2. CONSTRUCTION OF THE PARTS

All parts required for construction of this amplifier are given in **Figures 4 and 5**. It is favorable to commence construction with the contact rings. It is necessary for the cathode ring, anode ring, and an anode capacitor ring to be made using a lathe. The four plates can be cut out using a fret saw if they cannot be cut using shears. The given holes are then drilled.

The holes through the contact rings should be made using a stand drill so that they are exactly vertical to another. It is very important that all dimensions are maintained exactly so that no difficulties occur during assembly. The author has found it practical to prepare a template (pattern) made from card to simplify the drilling process.

The guide tubes for the two tuning plungers are firstly drilled out to a diameter of 5 mm and then provided with a M 6 thread. The cathode capacitor plate is sawn out from a 1.5 mm thick copper plate. A spring-loaded copper strip should now be soldered around the circumference of the 10 mm hole in the center of this plate to fit the cathode connection of the tube. If this is not possible, a 10 mm diameter brass tube should be drilled out to the diameter of the cathode connection, cut somewhat using the fret saw, after which it is soldered into the hole on the capacitor plate. The height of this tube should amount to 12 mm.

The two coupling pins for the input and output connectors are not given in the drawings. These are manufactured from 7 mm diameter brass tube. A M 3 nut is soldered into both ends of this tube. It is now necessary for the BNC-connectors (single-hole mounting) to be prepared. The threaded flange is shortened to a length of 2 mm and the remaining inner conductor removed. This is then soldered into the M 3 nut at one end of the previously made coupling pins. Attention should be paid that the length is correct: when the BNC inner conductor is placed into the connector, the coupling pin should be at the same height as the plate, or cathode chamber. Due to the somewhat difficult soldering, it is not possible to give the dimensions exactly in mm. However, the author is sure that the reader will understand how these parts should be prepared.

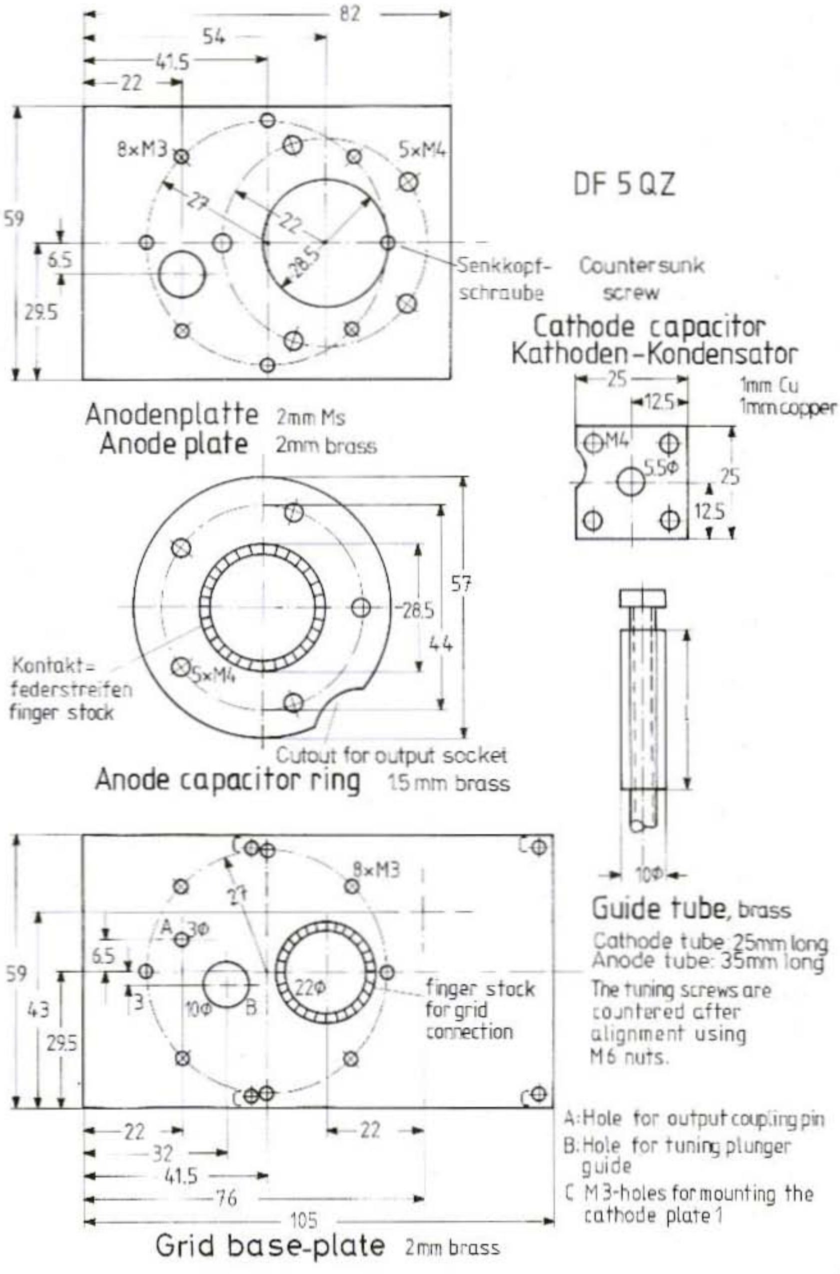


Fig. 4: Dimensional diagram for the anode plate, anode-capacitor ring, grid-base plate, cathode capacitor, guide tubes

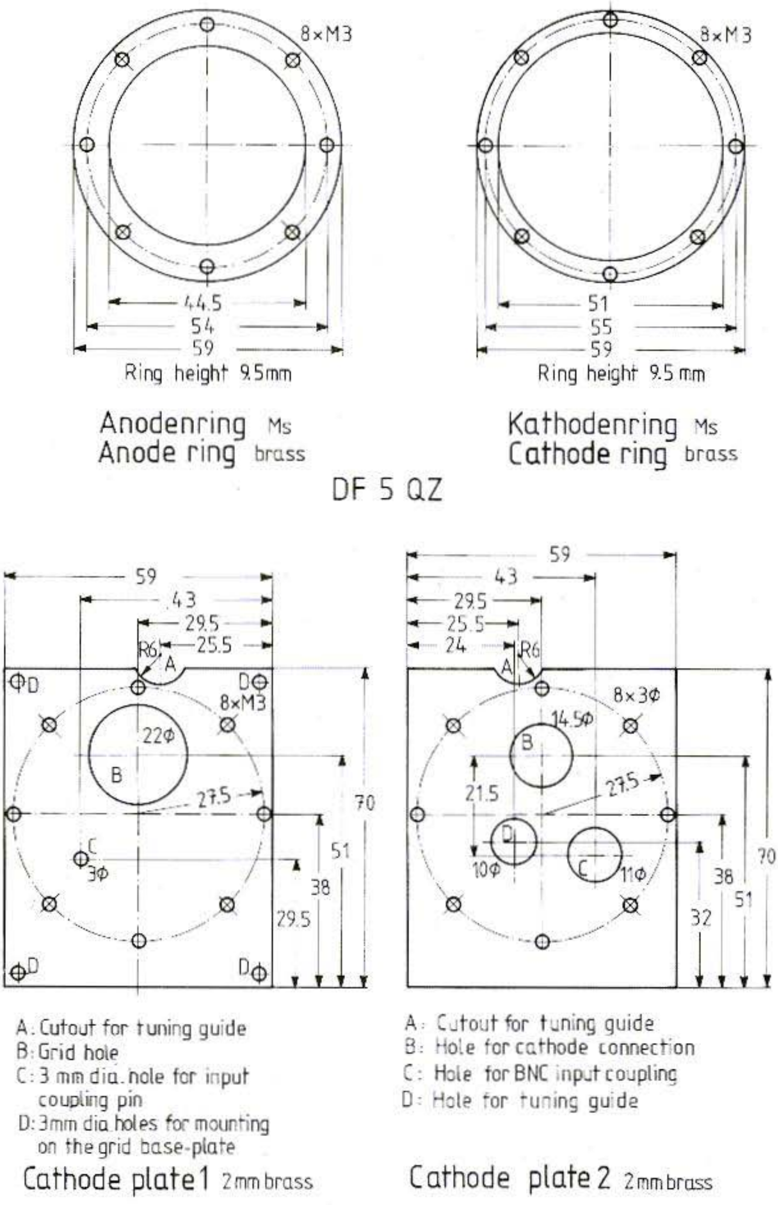


Fig. 5: Dimensional diagram for anode ring, cathode ring, cathode plate 1 and 2

PTFE foil of approximately 1 to 1.5 mm thickness (uncritical) is used as dielectric of the capacitors. The foil is cut so that approximately 1 to 2 mm protrudes from between the plates.

A contact strip is now also soldered into place around the hole in the grid plate, and the actual soldering carried out on the anode resonator side.

All M 3 -holes in the grid plate, as well as all M 3 and M 4-holes in the anode plate should be countersunk on the outside. This countersinking of the holes ensures that no high-voltage flashover can occur at these points.

It is now necessary for the anode capacitor ring to be sawn, which the author lathed from a solid bar. Of course, it is also possible for it to be made from a metal plate onto which a contact strip for the anode connection has been soldered into place. This construction has the advantage that a lathe is only necessary for manufacturing the rings of the anode and cathode resonator.

3. ASSEMBLY

Firstly, the prepared BNC-connectors and the guide tubes for the tuning plungers are soldered into place. This can be done by laying the brass plates on the heating plates of an electric cooker. The assembly sequence is then as follows:

Screw the M 6 tuning screw into the guide tube on the grid plate; slide in the output coupling tube complete with the previously soldered BNC-pin into the BNC flange; screw the anode ring to the anode plate and grid plate; the nylon screws used for mounting the anode capacitor plate must be firstly placed through the anode plate from the anode resonator side; all M 3-countersunk screws used for screwing the ring to the two plates should now be filed flat; the anode capacitor plate should now be placed into position, together with the PTFE-foil, onto the protruding nylon screws, and screwed into place; before tightening the nylon nuts, insert a tube to ensure that the parts are fitted correctly.

Finally, the output coupling tube is tightened using a M 3-screw on the grid plate side. It is also necessary for the screw to be filed flat at this position.

The mounting of the cathode resonator is made in the same manner: The M 6 tuning screw is screwed into the guide tube, the input coupling tube into the BNC-flange and the cathode capacitor together with PTFE insulation tightened slightly with the aid of the nylon screws. Finally, the cathode ring between the two cathode plates should be mounted and the M 3-countersunk screws filed flat on the grid side. Finally, the cathode resonator is screwed onto the grid base plate. After inserting the tube, the cathode capacitor is screwed tightly. The mechanical assembly is now completed. The photographs given in **Figures 6 to 9** show various stages of assembling.

The operating voltages are fed to the amplifier via $\lambda/4$ chokes that are made from enamelled copper wire (approx. 0.5 mm dia., 3 cm long). A bracket is mounted in front of the cathode capacitor in which the two feedthrough capacitors for the heater voltage are soldered into place. This bracket is also used for mounting the series-resonant circuit for 144 MHz when used as mixer. Of course, a number of further possibilities exists.

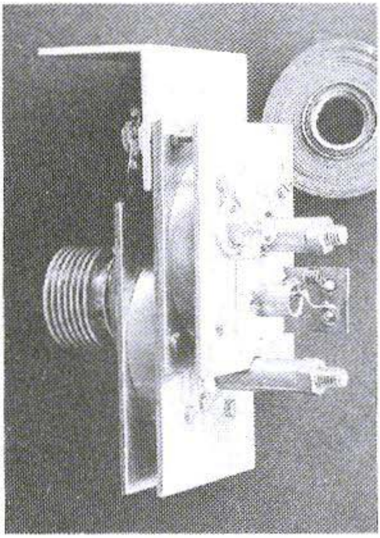


Fig. 6: Author's prototype from the cathode side

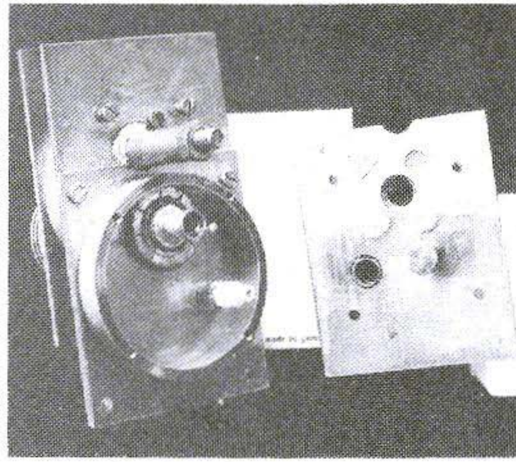


Fig. 7: Internal view of cathode resonator

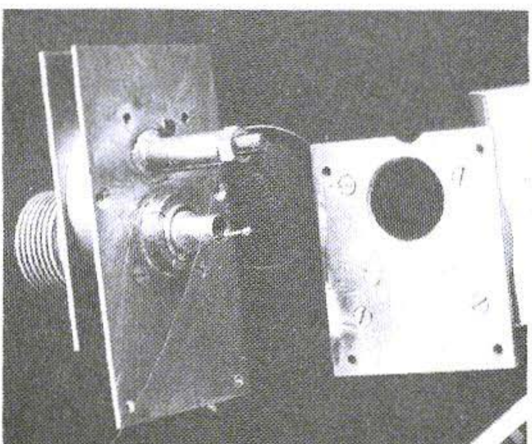


Fig. 8: View with cathode resonator removed

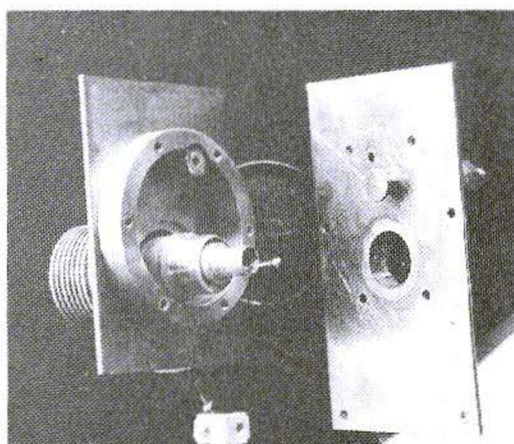


Fig. 9: View with dismantled anode resonator

4. ALIGNMENT

A meter having a full-scale deflection of 100 mA is now connected in the anode voltage line. Where this is not desirable due to the high-voltage present, it is also possible for it to be connected in the cathode circuit; however, in this case the grid current will also be measured. The local oscillator frequency of 2160 (or 2276) MHz is now fed to the input connector mounted on the cathode resonator; this should be made at a power level of between 100 and 500 mW. The 144 MHz signal is also connected and should have a power level of approximately 1 W. The output connector of the anode resonator should be terminated, at least with a 1 W lamp.

After connecting the heater and plate voltages, the anode quiescent current should be adjusted to 25 to 30 mA. The anode current should increase to approximately 60 mA on adjusting the tuning plunger in the cathode resonator. The alignment of the anode resonator should cause the lamp to light brightly.

The subsequent linear amplifier should be aligned in the same sequence. At an anode voltage of 900 V, and when driven by the previously mentioned mixer, a plate current of approximately 90 mA should be obtained. Unfortunately, output power measurements were not possible at this frequency.

Continuous operation has shown that no thermal effects are present and all stages operate reliably.

5. REFERENCES

(1) D. Vollhardt: Gittervorspannungs-Erzeugung für Gitterbasis-Stufen
mit geerdetem Steuergitter
UKW-BERICHTE 12, Edition 2/1973, pages 105 - 106

New 23 cm Linear Transverter from UKW-TECHNIK: UTT 1296/28

This 23 cm transverter is completely ready-to-operate and is enclosed in an attractive cabinet. The receive converter comprises a five-stage interdigital filter, a low-noise preamplifier with 3x BFR 34 A, and a sensitive IF preamplifier. The transmit converter comprises a push-pull transistor mixer and three-stage linear amplifier. The same stable local oscillator module is used for both transmit and receive.

SPECIFICATIONS

Transmitter	Maximum drive:	0.5 W
	Output power:	0.7 W typ.
	Carrier and image rej.:	20 dB min.
Receiver	Noise fig. (single-sideband):	4 dB min.
	Overall gain:	30 dB
	IF-bandwidth	2 MHz
	Operating voltage:	12.5 V ± 1.5 V
	Dimensions:	255 x 75 x 200 mm

THE 10 GHz AMATEUR BAND
Considerations of Present and Future Technologies

Based on a Lecture at the 1977 VHF Convention in Weinheim

Second and Concluding Part

by D. Vollhardt, DL 3 NQ

3. IMPROVEMENTS AND CONSEQUENCES WITH RESPECT TO THE TECHNICAL EQUIPMENT

3.1. Technical Limitations of Simple Wideband Systems

It is advisable to examine the possibilities and limitations of the systems classed in section 1. The following considerations are to be based on a line-of-sight path of 230 km which is also used in example 2 of appendix I. The signal-to-noise ratio at the receiver is to be calculated.

It is assumed that a Gunn oscillator is available at the transmit side with an output power of 10 mW ($\triangleq -20$ dBW), as well as antennas having a gain of 25 dB_i (over isotropic) at both ends. Furthermore, it is assumed that the IF used has an effective bandwidth of 250 kHz, and that the efficient mixer (without preamplifier) exhibits a noise figure of 10 dB.

However, since the AF-spectrum subsequent to the discriminator possesses a very much narrower bandwidth, it is not only the bandwidth of the IF-channel that must be considered, but twice the effective AF-bandwidth due to the component of both sidebands. If no additional measures have been provided, this will be in the order of 10 to 15 kHz, which means that 12.5 kHz can be used in the calculation. The bandwidth value to be calculated is thus not 250 kHz, but only 25 kHz.

According to (8) thermal noise amounts to 4×10^{-21} W/Hz bandwidth. This results in a noise power of 1×10^{-14} W, or 150 dBW (ref. 1 W) including the 10 dB noise figure in the case of an effective bandwidth in the receive channel of 25 kHz.

As has been previously mentioned, the path loss at 10 GHz for a line-of-sight path is:
$a = 113 + 20 \times \log 2\ D$. For a path of 230 km, the following would result: $a = 113 + 47 = 160$ dB; this would have a negative sign since it is loss.

If one calculates which signal power is available at the input of the receiver, the following will result:

Transmitter output:	− 20 dBW
Path loss:	− 160 dB
Antenna gain:	+ 50 dB
Signal power at RX:	− 130 dBW

When the waveguide losses are not taken into consideration, the required signal will be approximately 20 dB over the noise at the input of the receiver.

At this signal-to-noise ratio, the threshold level is exceeded considerably which means that the signal-to-noise ratio resulting from the actual RF bandwidth is achieved fully at AF-level, and will amount to approximately 17 dB at a modulation index of 5. This is added to the 20 dB signal-to-noise ratio at the input resulting in a total of approximately 37 dB. This is more than sufficient for amateur radio communication. The assumed antenna gain of 25 dB_i is obtained when using horn radiators of approximately 55 cm in length (9), which are still easy to handle.

For amateur radio communication, a signal-to-noise ratio of approximately 15 dB at AF-level is sufficient and could be obtained at a power level of – 140 dBW at the receiver input, which, for example, could be obtained using antennas having only 20 dB gain.

It is now necessary to discuss the so-called threshold level briefly. This is to be done with the aid of the following sketch and two references:

»Each modulation mode which obtains a gain in signal-to-noise ratio due to a reduction in bandwidth, will possess a more or less sharply defined threshold value for the ratio of signal-to noise. This threshold must be obtained or exceeded if the advantages of this method are to be achieved. The only mode that is independent of a threshold is SSB« (17).

»The threshold is defined as the point at which a 1 dB reduction of the RF carrier level results in 2 dB reduction of the AF signal-to-noise ratio. In the case of the carrier this occurs at noise ratios of 9 to 13 dB, which increases with increasing modulation index« (18). Further details regarding this can be taken from (19).

To summarize, it will be seen that it is necessary to exceed this threshold level, and that this point is the limit of transmission when using wideband systems. Above this limit, the AF signal-to-noise ratio gains can be obtained up to several orders of magnitude, whereas below it these gains do not only drop very rapidly to zero, but also obtain negative values; this underlines the necessity of high antenna gains, especially for wideband systems.

3.2. Antennas

The cheapest way of improving systems on the 10 GHz band is to use larger antennas. However, it must be taken into consideration that further difficulties are envolved when increasing antenna gain (in addition to the frequency inaccuracy): namely the narrower will be the beamwidth in the horizontal and vertical planes. In the case of 25 dB horn antennas, the 3 dB beamwidths are virtually ± 10°, and this beamwidth will be reduced to a few degrees when parabolic dishes are used; this will be obtained with sidelobe attenuations of 20 dB and more! From experience, it is known that it is virtually impossible under poor visibility conditions to set up the antenna according to map and compass without a VHF link.

One must consider carefully whether it is advisable for antennas with more than 30 dB_i gain to be used for portable operation. A parabolic dish of approximately 50 cm diameter which is required for this gain can still be used in unfavorable weather conditions, which cannot be said for dishes of 1 m diameter and more when used at exposed sites.

Larger dishes are therefore mainly suitable for operation from fixed stations. In this case, it is necessary to examine the adjustment accuracy and repeatability of antenna rotators on the market and to compare them critically to the 3 dB beamwidth of the antenna. As has been mentioned previously, it is also advisable to use some form of vertical tilting.

3.3. Improvements that can be made to Wideband Systems

The previous considerations have shown that it is only advisable for large parabolic dishes to be used when the frequency error problems can be eliminated. The information given in section 1.1.3. also underlines this.

Less than 1 μW would be required for the reference pilot signal at 10 GHz, even at high injection losses, and it would be possible to generate this in a single frequency multiplier stage. Modern step-recovery diodes (15) already provide sufficient power when they are driven with approximately 200 MHz (frequency multiplication by approximately 50 times). Also cheap Schottky diodes are able to provide sufficient power at 10 GHz when they are driven with 400 to 500 MHz at 50 to 100 mW (frequency multiplication factor 20 to 25).

An improvement of approximately 10 dB can be achieved by reducing the effective AF bandwidth in the receiver to 5.8 kHz instead of 12.5 kHz, (+ 3.3 dB) and by transmitting a higher modulation index (+ 6.7 dB) by limiting the AF-spectrum of the transmitter.

A further improvement can be obtained using PLL-FM demodulator circuits that are able to demodulate low-bandwidth signals at the noise threshold better than conventional discriminators, which are usually not tuned correctly anyway !

In this manner, it is possible to achieve an improvement of approximately 10 dB even when using the FM-concept. If this is used in conjunction with a 10 dB to 15 dB higher antenna gain, the system improvement of 20 to 25 dB does not only offer a considerable improvement over quasi line-of-sight paths for regular communications, but also allows simple inversion conditions to be utilized. This then makes 10 GHz fixed-station operation interesting.

3.4. Narrow-Band Systems

The inherent limitations on portable operation with respect to weight, dimensions, and power line independence are not valid for fixed-station operation. For this reason, those amateurs that wish to utilize the technical possibilities to the full, have a number of possibilities of improvement. This can be made especially in drastically reducing the bandwidth at the transmitter and receiver. The limits of the antenna system were discussed fully in section 3.2.

The limit of bandwidth reduction in the receiver is reached where the transient times of narrow-band filter circuits, and the ever increasing demands on the frequency stability become unpractical. In the case of 10 GHz communication, this limit is obtained at a bandwidth of approximately 100 Hz. The required short-term stability of the frequency would then amount to 10^{-9}; in this case, rapid communication in CW would be possible. The following considerations are, however, based on an effective bandwidth of 1 kHz, a value which is often to be found in good fixed-station receivers. Furthermore, the results can also be used for future SSB operation at a later date. The lower frequency stability demands of one order of magnitude are also far easier to achieve for the transmitter and receiver oscillators.

3.4.1. Improvement of the Signal-to-Noise Ratio in the Receiver

An effective bandwidth of 1 kHz requires a good crystal-controlled oscillator in a crystal oven as well as a frequency multiplier chain that is able to provide approximately 3 mW at 10 GHz with sufficiently suppressed noise sidebands. Such oscillators can be achieved at low cost, and it is only a matter of time before such designs are published.

As was mentioned in section 1.4. it is not unrealistic to obtain an improvement of 2 to 4 dB in the receiver input circuit. During the construction of preamplifier stages, it is necessary for the information given in (13) to be observed. It is necessary to select a high intermediate frequency to obtain a sufficient image rejection when converting down from the 3 cm band. A good 70 cm converter used as first IF-stage could provide an acceptable solution. It is not really a disadvantage that one only has a tuning range of 2 MHz, since narrow-band transmissions are to be made in the frequency band 10368 and 10370 MHz in simplex.

If the whole 3 cm band is to be covered, it is possible to modify a UHF TV-tuner. **Figure 1** shows the resulting tuning curve of such a modified tuner, which was equipped with a 3:1 reduction.

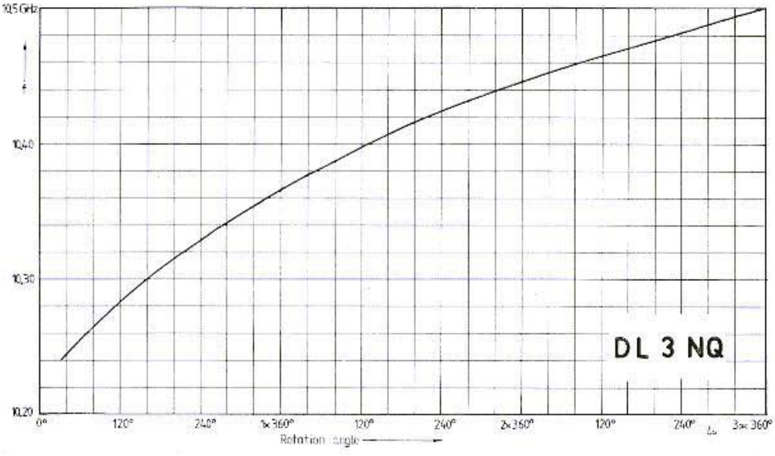


Fig. 1: Tuning curve of a modified UHF-TV tuner

3.4.2. Higher Output Power

Section 1.3. provided information regarding this that can be used without modification for CW communications. When based on the example given in section 3.1., it will be seen that it is possible to obtain a system improvement of 20 dB by increasing the output power of the transmitter to 1 W. Unfortunately, this is still rather expensive.

Of course, one must place at least the same demands on the transmitter with respect to frequency stability, as were made on the receiver. The design of a suitable crystal oscillator was described in (14).

It is even more important with high-power transmit signals than with local oscillator signals for receivers that no low-frequency, spurious or parametric oscillation occurs in the frequency multiplier chains. It is even more difficult to localize the source of noise sidebands and spectra. They may not only be generated in the transistor and varactor multiplier stages, but often come from the power supplies, which are used to supply the active stages. This was mentioned previously in (16). Integrated voltage stabilizers of the first and second generation usually provide a DC-voltage modulated with noise voltages of several mV. Voltage sources for 10 GHz narrow-band systems should not have residual AC-components, including noise, in excess of 1 mV (peak-to-peak).

4. SUMMARY

The wideband technology using Gunn oscillators will no doubt dominate 10 GHz portable operation for some time due to its simplicity. No doubt, it will be improved with respect to the frequency stability and it is possible for its performance to be increased in this manner together with increasing antenna gains until a limit is reached at approximately two orders of magnitude above present possibilities. This means that it will also be of interest for fixed stations, where a further improvement would be possible by using higher-powered transmitters.

In the long term, narrow-band technology will become more important for fixed-station operation; firstly in the form of CW, and then slowly but surely also SSB. When referred to the example given in section 3.1., the calculated signal-to-noise ratios for various conditions can be compared with another in the following table. These values are based on an input noise figure of 10 dB at 10 GHz, as well as on the assumption that no pre- or deemphasis is used.

	FM Wideband Systems			Narrow-Band Systems		
a) Signal power – 130 dBW (as assumed in 3.1.):						
Effective bandwidth (AF):	12.5 kHz	5.8 kHz	3 kHz	2.5 kHz	1 kHz	0.1 kHz (IF or AF)
Modulation index:	approx. 5	approx. 10	approx. 20	–	–	–
Signal-to-noise ratio:	37 dB	47 dB	56 dB	30 dB	34 dB	44 dB
b) Signal power – 140 dBW (fading or small antennas)						
Effective bandwidth (AF):	12.5 kHz	5.8 kHz	3 kHz	2.5 kHz	1 kHz	0.1 kHz (IF or AF)
Modulation index:	approx. 5	approx. 10	approx. 20	–	–	–
Signal-to-noise ratio:	15-18 dB	appr.20 dB	appr. 20 dB	20 dB	24 dB	34 dB
c) Signal power – 145 dBW:						
Effective bandwidth (AF):	12.5 kHz	5.8 kHz	3 kHz	2.5 kHz	1 kHz	0.1 kHz (IF or AF)
Modulation index:	approx. 5	appr. 10	appr. 20	–	–	–
Signal-to-noise ratio:	appr. 1 dB	appr. – 5 dB	appr. –12 dB	15 dB	19 dB	29 dB

When considering these values, one can be sure that the 3 cm band will no doubt provide even more surprises for well-equipped radio amateurs, than are known at the present time.

APPENDIX I

Details regarding Figures 2 and 3

The circular curvature of the earth is distorted to form an elliptical curvature due to the use of different scales for height h (in m) and distance D (in km). The exact relationship for true line-of-sight over mean sea level at an earth radius R is given as follows:

$$D = 10^{-3} \times \sqrt{2 \times R \times 10^3 \times h + h^2}$$

R = 6370 km / D in km / h in m.

For the distances to be considered, this expression can be approximated by the following equation:

$$D = 3.54 \times \sqrt{h}$$

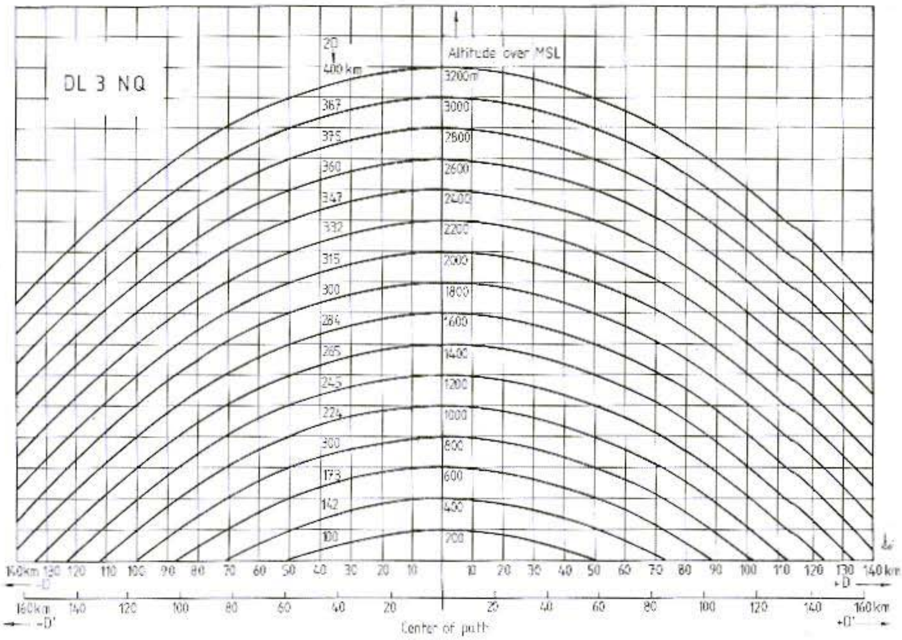


Fig. 2: Line-of-sight horizon for altitudes up to 3200 m

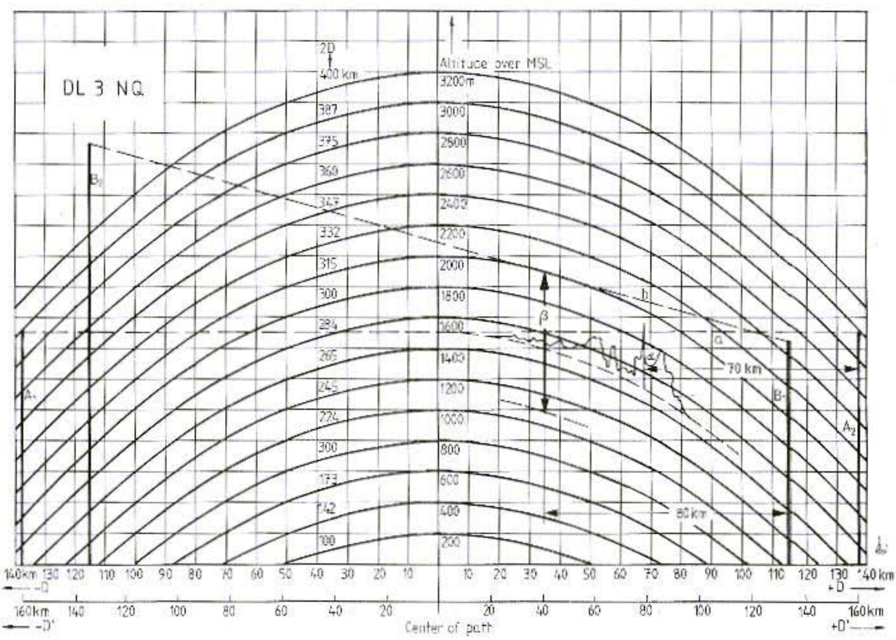


Fig. 3: Examples 1 and 2 inserted into Figure 2

The resulting parabolic arcs are given for heights up to 3200 m so that a value D is obtained by following the parabolic curve associated to any given height over MSL. This results in the maximum possible line-of-sight over MSL.

If the signal is extended to twice its length, one will obtain a new point having the same height over MSL at a distance of 2 D. In other words, the maximum possible optical line-of-sight distance between two points of the same height is 2 D. The signal will just touch the earth surface at the center of the path.

Usually, one does not have the sea surface, or even a sea level path between two such points, but continental topography. This can be superimposed on the parabolic curves by placing each of the critical heights on the planned path at the correct distance and height in the vertical plane of the diagram. It is advisable to use survey maps having a scale of 1:100.000 or 1:25.000.

Example 1:

At a height of 1500 m, one has a line-of-sight distance of 137.5 km to a point at sea level. If another mountain of 1500 m was present at twice this distance, which we will designate as A_1 and A_2 at + D and – D, they will only see each other when a height of zero MSL is present at the center of the path. The slightest obstacle in the center of this path, as well as an obstacle of only 400 m in height at a distance of 70 km from A_2 will interrupt the 275 km path a at point α **(Figure 3)**.

Example 2:

Communication is to be made from Feldberg in the Black Forest with an altitude of 1450 m over MSL to the Zugspitze in Bavaria with an altitude of approximately 2750 m over MSL. The path distance is 230 km. The two obstructions B_1 and B_2 are entered into the diagram (Fig. 3) at $\pm$ D = 115 km, and the two tops joined together with line b. The parabolic arc associated with the distance of 115 km is now followed and it will be seen that a minimum spacing of 900 m (β) exists between line b and this arc. After studying the map, one finds that no heights of 900 m over MSL are present at the center of this arc, and especially not at a distance of 80 km from Feldberg. This means that line-of-sight conditions are present on this path and 10 GHz communication should be possible without difficulty. A calculation of the path loss is given in section 3.

Three things should be noted:

In order to take the quasi line-of-sight into consideration, as described in section 2.2., corresponding scales for values D' are given in Figures 2 and 3.

When communication is to be made over large distances where the electromagnetic wave touches the ground surface, an additional absorption loss of several 10 dB will be exhibited according to the type of surface. This means that a corresponding power reserve must be planned for such communication, or one should at least not calculate with a K-value of greater than 1 (use scale D instead of D').

In professional tele-communications, it is usual to calculate the signal path so that it does not enter the first Fresnel zone. This has not been taken into consideration for amateur communications. This zone has the form of a narrow ellipsoid whose focal points are the transmit and receive antenna. For 10 GHz the maximum diameter of the ellipsoid is:

$d = 2.45 \times \sqrt{D}$ D = half the path length in km / d = diameter in m

If an obstacle is present within this zone, multi-path propagation will be caused by reflection, and thus cause fluctuations of the field strength. Of course, this is not permissible for professional telecommunications, however, radio amateurs are used to communicating under QSB conditions. The Fresnel zone should considered when planning a fixed link.

APPENDIX II

Provisional Band Plan for the 3 cm Amateur Band

At the beginning of 1977, it could be seen that new concepts were becoming popular using lower intermediate frequencies than the previously used IF in the order of 100 MHz. Since both intermediate frequencies are equally poor with respect to image rejection, preference should be given to the lower IF (30 MHz) due to the possibility of electronic tuning. The lower tuning range of varactor-tuned equipment, however, makes some form of band plan necessary for 3 cm communications.

The first proposal of a band plan was based on the views of English 3 cm activity groups, and on the frequency allocations available on the continent; the main features were:

a) Acceptance of the internationally agreed CW/SSB band between 10368 and 10370 MHz (144 MHz x 72)
b) Consideration of the simplex systems with 100 MHz IF
c) Consideration of the duplex systems with 30 MHz IF
d) Compatability between 100 MHz and 30 MHz systems on a channel
e) Safety spacing between the wideband FM channels and the CW/SSB band at 10368 MHz.

This proposal was used in contests after summer 1977 by many continental stations. As it was found in the last quarter of 1977 that the method described in section 1.1.3. was becoming popular, the original proposal was reconsidered and extended. It then concluded the following additions:

f) Separate allocations for stabilized and unstabilized FM-systems
g) Repeater band at 3 cm
h) Recommendations for fixed links
i) Recommendations for ATV in the 3 cm band
k) Recommendations for possible space communications
l) Recommendations for beacons

This proposal was brought forward by the SHF manager of the German ARC as official recommendation to the SHF group of region 1 in April 1978 in Hungary. Since other societies had different ideas and wanted partially to take intermediate frequencies of 75 MHz and 144 MHz into consideration, it was very difficult to obtain a coordination within region 1. The following gives the main points that were agreed:

10000-10500 MHz	Allocated band in DL, DM, G, LA, OK, ON, OZ, PA, HA, F, SP, OH
10250-10500 MHz	Allocated band in HB, OE, LX, YU
10400-10500 MHz	Allocated band in I
10080-10082 MHz	Low-band for duplex with 144 MHz IF (England)
10224-10226 MHz	High-band for duplex with 144 MHz IF (England)
10250-10290 MHz	ATV

5. REFERENCES

(1) Dr. D. Evans: Getting Started on the 10 GHz Band
VHF COMMUNICATIONS 9, Edition 1/1977, pages 19 - 29

(2) C. Neie: QRV auf 10 GHz
DUBUS 5/1975 and 1/1976

(3) Fisk jr.: Solid-state Microwave RF-Generators
Ham Radio Magazine April 1977, page 10

(4) B. Heubusch, Dr. Hock, H. Knauf: Introduction to Microwave Techniques and a Description of a 10 GHz Transceiver
VHF COMMUNICATIONS 9, Edition 2/1977, pages 66 - 70

(5) B. Heubusch, Dr. Hock, H. Knauf: A Transceiver for 10 GHz, Part 2
VHF COMMUNICATIONS 9, Edition 3/1977, pages 168 - 178

(6) B. Heubusch, Dr. Hock, H. Knauf: A Transceiver for 10 GHz, Part 3
VHF COMMUNICATIONS 9, Edition 4/1977, pages 247 - 255

(7) K. Hirschelmann: 10 GHz-Amateurfunkbetrieb mit dem Gunnplexer MA-87127
CQ-DL 1977 Heft 10, Seite 382

(8) R. Lentz: Noise in Receive Systems
VHF COMMUNICATIONS 7, Edition 4/1975, pages 217 - 235

(9) T. Kölpin: Further Data for Construction of Horn Antennas for the 10 GHz Band
VHF COMMUNICATIONS 9, Edition 3/1977, page 167

(10) H. Fleckner: An SHF Transmit Converter with Varactor Diode with High Efficiency and Low Intermodulation
VHF COMMUNICATIONS 10, Edition 1/1978

(11) A. Leinemann: Troposphärische Überreichweiten bei VHF und UHF Funkverbindungen
UKW-BERICHTE 13, Edition 1/1973, pages 37 - 43

(12) D.L. Haarsager: Microwave Path Evaluation
Ham Radio Magazine January 1978, page 40

(13) D. Vollhardt: Mixer and Preamplifier at SHF
VHF COMMUNICATIONS 8, Edition 4/1976, pages 234 - 242

(14) R. Görl: A Standard Frequency Oscillator with an Accuracy of 10^{-8}
VHF COMMUNICATIONS 7, Edition 2/1975, pages 118 - 126

(15) H. Fleckner: Diode Applications in Frequency Multipliers for the Microwave Range
VHF COMMUNICATIONS 10, Edition 3/1978, pages 145 - 153

(16) H.J. Franke: Zener Diode Noise in Oscillator and Multiplier Circuits
VHF COMMUNICATIONS 9, Edition 2/1977, pages 98 - 99

(17) Meinke/Gundlach: Taschenbuch der Hochfrequenztechnik
2. Auflage, Seite 1347

(18) Handbuch für Hochfrequenz- und Elektro-Techniker
Band VIII, Seite 497

(19) H.J. Griem: Vorzüge und Nachteile verschiedener Senderarten im Amateurfunkverkehr
UKW-BERICHTE 7, Edition 1/1967, pages 28 - 44

CALIBRATION-SPECTRUM GENERATOR FOR THE MICROWAVE BANDS UP TO 10 GHz

by U. Mallwitz, DK 3 UC

The principle of the spectrum generator is by no means new, however, the practical construction should be of interest. Since harmonics of the 2 m band are present in all of the microwave bands, one will require a 2 m transmitter whose frequency is accurate to the last kHz digit (counter). This is used to drive the module shown in **Figure 1**; a power level of 10 to 100 mW is suitable for this. If the output of the transmitter is in this range, trimmer potentiometer R 1 can be deleted. Otherwise R 1 allows power levels of up to 0.5 W to be used. Of course, an attenuator pad using three fixed resistors can be used after determining the required value.

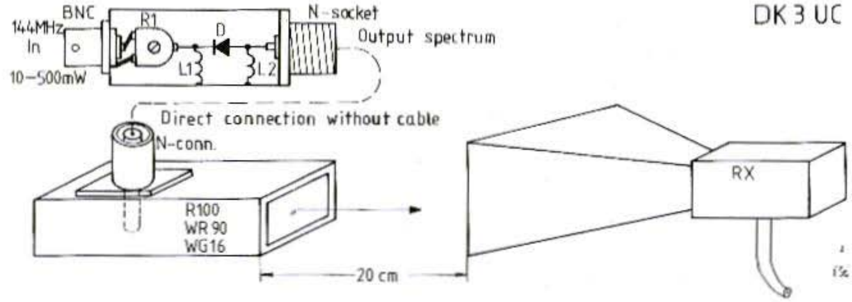


Fig. 1

Any Schottky diode (such as HP 2800) can be used for diode D. The author used diode type P 081 B in his prototype. The inductance values are:

L 2:	4 turns of 0.2 mm dia. enamelled copper wire, self-supporting, inner dia. 4 mm
L 1:	10 turns of 0.3 mm dia. enamelled copper wire, self-supporting, 5 mm inner dia.

A simple transition from coaxial cable to waveguide is shown on the left in Figure 1, which radiates sufficient harmonic energy to produce a S 9 signal on a 3 cm receiver with horn antenna spaced approximately 20 cm from the open end.

The described harmonic generator is just as suitable for wideband and narrow-band applications.

Figure 2 shows an even simpler version for the 3 cm band. This uses a 1 N 23 diode in a closed waveguide which is driven with a 2 m, 70 cm, or 23 cm signal. A flange is not required, and construction completely uncritical.

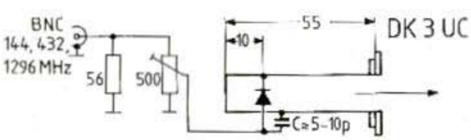


Fig. 2

A FM TRANSCEIVER FOR THE 2 m BAND
Part 1: The Receiver

by J. Kestler, DK 1 OF

A synthesizer in C-MOS technology suitable for use with 2 m transceivers was described in (1). The following articles are to describe matching VHF, ZF and AF-stages for transmitter and receiver so that it is possible to construct a complete transceiver around this synthesizer. Due to the low power consumption of the synthesizer, the transceiver is very suitable for mobile applications. The additional modules can be operated from an unstabilized voltage of between 11 and 14 V.

1. VHF/IF CIRCUITS OF THE RECEIVER

If one is willing to invest so much time and effort, it is possible to construct receiver input circuits using a special feedback circuit in the input amplifier, equipped with high-current FETs, Schottky ring mixers and PIN diodes that exhibit extremely good large-signal handling capabilities and are extremely sensitive (2). As was demonstrated clearly in (3), the local oscillator with its noise spectrum often determines the large-signal handling capabilities of the receiver. Let us carry out this calculation with the values of a FM-receiver:

It is assumed that the sideband noise SBN of the synthesizer amounts to − 140 dB/Hz (this seems to be rather optimistic) at 100 kHz spacing from the carrier. At a bandwidth of 15 kHz for the wanted signal (corresponding to a bandwidth factor P_B = 42 dB) and a noise figure of 3 dB (≙ S = − 137 dBm) the interfering signal P_S can have a maximum level of:

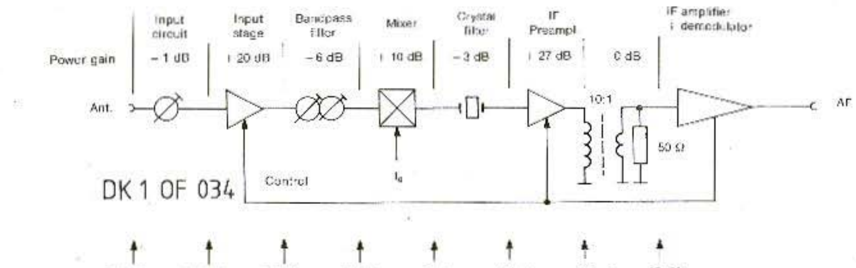
$$P_S = -SBN + S - P_B = 140 - 137 - 42 = -39\ \text{dBm}$$

This amounts to an input voltage of approximately 2 mV at 50 Ω. Such input levels can still be processed well with MOSFETs in the preamplifier and mixer stages as long as the VHF preamplification is not unnecessarily high and when the main selectivity (crystal filter) immediately follows the mixer. For some time now, the trend to single-conversion superhets is noticeable in professional communication equipment; double-conversion superhets with a lower second IF and cheap ceramic filters are only found in low-price imported equipment.

1.1. Circuit Description

The block diagram and level plan of the receiver are given in **Figure 1**. Three resonant circuits are used for ultimate selectivity and image rejection. One of these stages is provided in front of the controlled preamplifier, and the other two are used as bandpass filter after this stage. The actual control is somewhat delayed in that the gain is not reduced until the antenna voltage is greater than approximately 9 µV. This ensures that full sensitivity remains for reception of weak stations.

Since the overall gain in front of the crystal filter is kept as low as possible, and since the input of the integrated IF-amplifier/demodulator is to be terminated at low impedance in order to reduce its sideband noise, it is necessary to provide an IF preamplifier. This amplifier is also controlled and ensures that the IF-amplifier is brought into limiting by the intrinsic noise of the VHF-stages.



Noise	0,06 µV 50 Ω	0.18 µV 300 Ω	7,2 µV 5 kΩ	0,9 µV 300 Ω	5 µV 1 kΩ	3.6 µV 1 kΩ	180 µV 5 kΩ	18 µV 50 Ω
Control threshold	9 µV	20 µV	800 µV	100 µV	550 µV	400 µV	20 mV	2 mV
Large-signal	2 mV	4,5 mV	180 mV	22 mV	120 mV	-	-	-

Fig. 1: Block diagram and level plan of the FM receiver

In the »large signal« line in **Figure 1**, an interference signal is assumed that is not within the passband range of the crystal filter, and therefore is not able to cause a gain reduction of the preamplifier. One can see that the mixer will be provided with an interference voltage of 22 mV at the input, which means that no overload will occur at the calculated limit of the antenna voltage of 2 mV.

The detailed circuit diagram of the VHF/IF module of the receiver is given in **Figure 2**. The signal from the antenna is fed via Pt 341 to inductance L 1 of the input circuit, which ensures a certain amount of selectivity, as well as the transformation for matching the antenna to the preamplifier transistor T 341. The new transistor type BF 900 was selected, which according to the manufacturer's specifications exhibits a noise figure of 2 dB (at 200 MHz) and a slope of 14 mS. Inductance L 2 suppresses parasitic oscillations in the UHF range, and comprises a ferrite bead that is placed over one of the connection wires of the coupling capacitor. The control voltage is connected via Pt 343, filtered twice and fed to both gates of the input transistor.

The primary circuit of the capacitively coupled bandpass filter comprising L 3 and L 4 are in the drain circuit of the preamplifier. This method of coupling (capacitive coupling at the base) was selected since reproducible relationships result that ease construction (mechanical dimensions are uncritical); furthermore, it is possible for the coupling factor to be changed during development by varying the capacitance values. The secondary circuit of the bandpass filter is provided with a coil tap (L 4) so that the input impedance of the mixer transistor T 342 is not able to dampen the circuit to any great degree. The oscillator signal from the synthesizer is fed in via Pt 342 to gate 2; a wideband transformation link comprising L 5 and the input capacitance of T 342 ensures a good matching to a 50 Ω cable.

The mixer stage is followed by the crystal filter F 1 whose input and output matching is assured by R 1 / C 1 and R 2 / C 2. The dual-gate MOSFET T 343 represents a controlled IF-preamplifier that is able to drive the IF-amplifier/demodulator I 341 (CA 3089) at low impedance via the transformer comprising L 7 / L 8.

The demodulator portion of I 341 is in the form of a crystal discriminator, and a monolythic double-resonator F 2 (dual) is used as frequency (better: phase) determining network. The circuit used is described in detail in (4), and other applications of this new, relatively inexpensive component are explained.

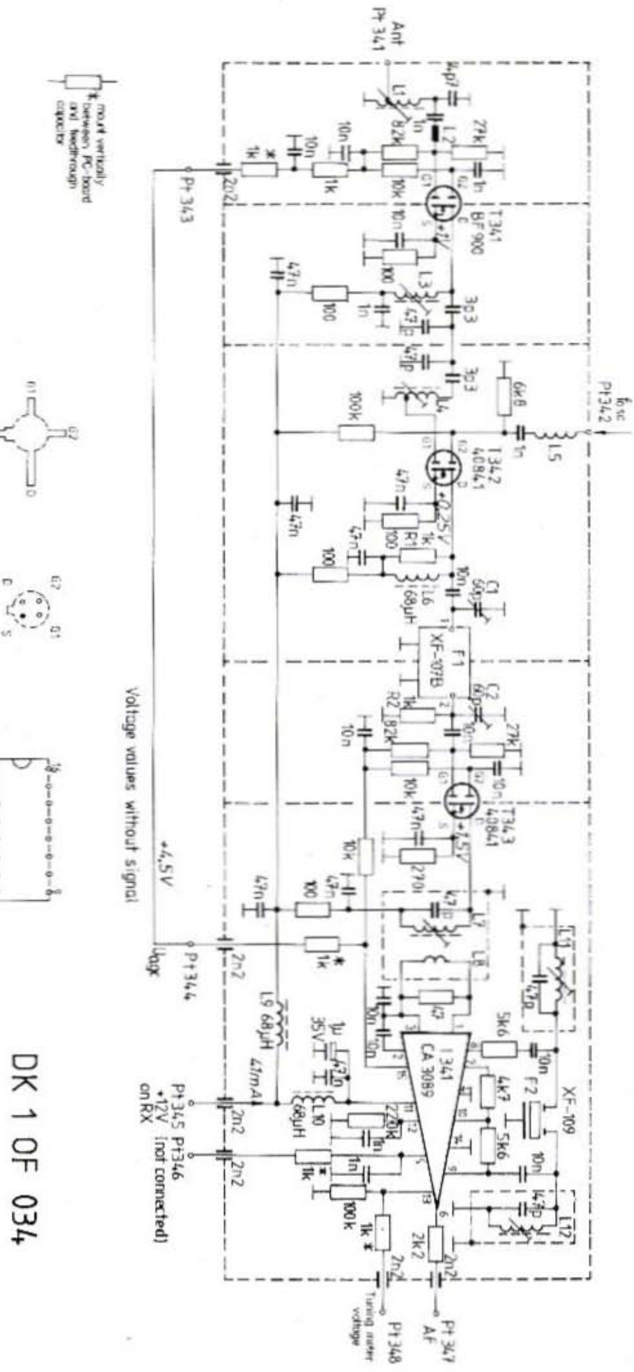


Fig. 2: FM-receiver for the 2 m band without oscillator and without AF-amplifier

In contrast to (5), the author is of the opinion that a narrow-band (crystal) discriminator most certainly brings advantages in comparison with a simple LC-circuit, especially with respect to ignition noise. The field strength-dependent squelch and S-meter characteristic are still satisfactory when using the CA 3089.

The IF-passband curve and demodulator characteristic are given in **Figure 3**, which were photographed from the screen of a swept-frequency measuring system.

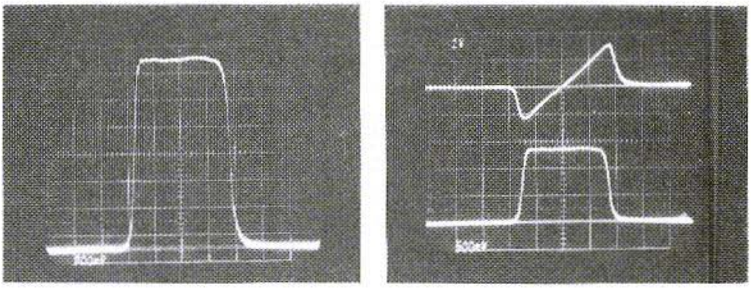


Fig. 3: Oscilloscope traces of IF-bandpass and demodulator characteristics

The operating voltage is fed to connection Pt 345; a DC-voltage is available at Pt 348 that is a measure of the IF-input voltage at I 341. **Figure 4** shows the relationship between IF and DC-voltage, as well as the control voltage for the VHF-preamplifier stage at Pt 344. Connection Pt 347 is the AF-output of the circuit; it is possible to mute the AF-output signal of the CA 3089 (squelch), however, this input is not used.

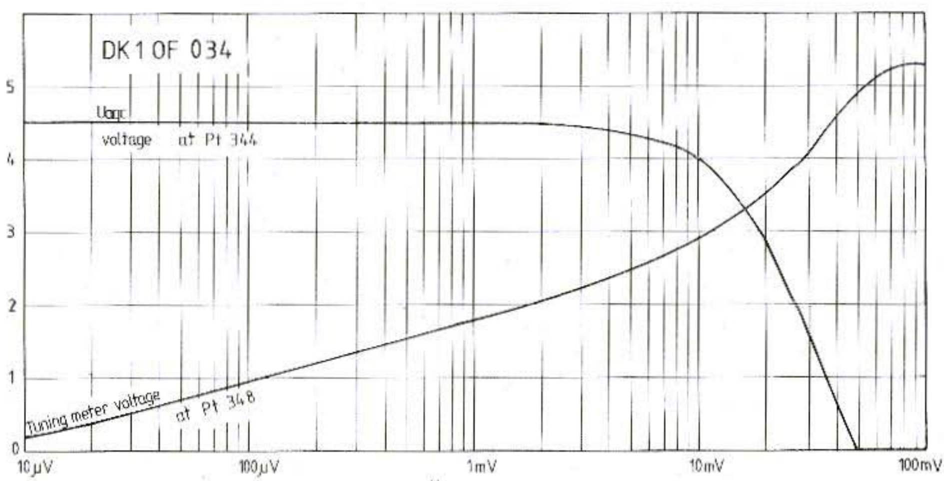
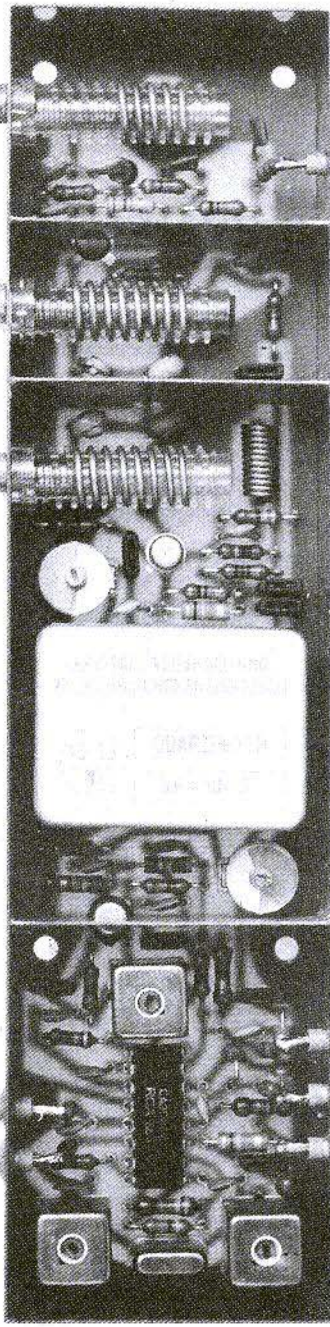


Fig. 4: Output voltages of the CA 3089



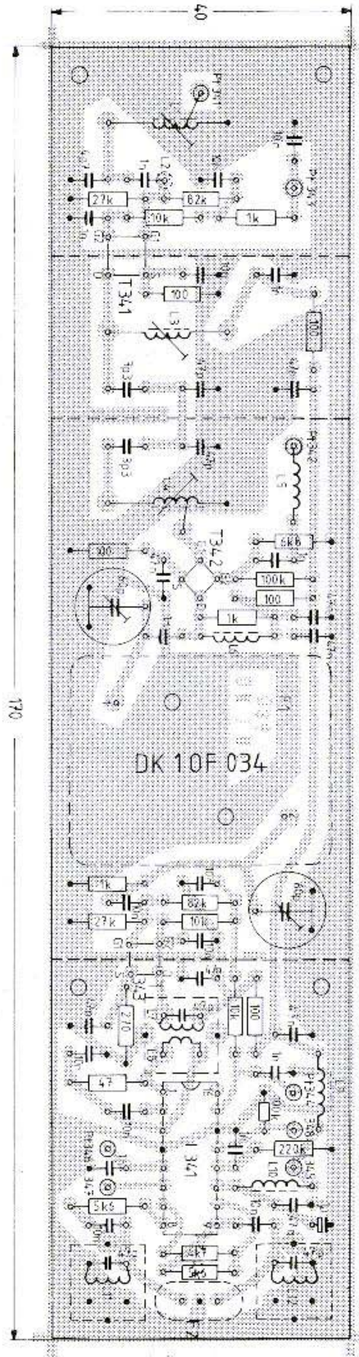


Fig. 5 and 6: PC-board and photograph of the author's prototype

1.2. Construction of the VHF/IF Module

In order to ensure simple construction, a single-coated PC-board of 170 mm x 40 mm has been developed and is designated DK 1 OF 034. Before mounting the components, this board should be provided with a 30 mm high screening panel around the edge of the board made from brass or tin plate (0.5 mm thick); the feedthrough capacitors and the coil formers for L 1, L 3 and L 4 are mounted on this panel. The spacing between the lower side of the board and the lower edge of the screening panel should amount to approximately 8 mm.

The component location plan of this board is given in **Figure 5**. As can be seen in the photograph of the author's prototype given in **Figure 6**, three screening panels are soldered into place on the upper and lower side of the board. A screening panel is also mounted below the crystal filter to ensure that no capacitive coupling is made from input to output. Thin coaxial cable (RG-174) is used for the antenna and local oscillator connection, and is soldered to the corresponding positions (Pt 341, Pt 342) on the conductor side of the board.

1.3. Special Components

T 341:	BF 900 (Texas Instruments)
T 342, T 343:	40841 or 40673 (RCA)
I 341:	CA 3089 E (RCA) without socket !
F 1:	Crystal filter 10.7 MHz/15 kHz bandwidth, e.g. XF-107 B (KVG) or 014 CF/901 TM (ITT)
F 2:	Monolythic resonator XF-109 (KVG)
C 1, C 2:	Plastic foil trimmer, 60 pF, 10 mm dia.
L 1:	5 turns of 1 mm dia. silver-plated copper wire, on 6 mm dia. coil former, VHF-core, coil tap at 2 turns from the ground end
L 2:	ferrite bead (see text)
L 3:	8 turns as L 1, but without tap
L 4:	8 turns, tap 3 turns from the ground end, otherwise as L 1
L 5:	12 turns of 0.8 mm dia. enamelled copper wire, inner dia. 3 mm, self-supp.
L 6, L 9, L 10:	Ferrite chokes, 68 µH, spacing 10 mm
L 7, L 11, L 12:	35 turns of 0.1 mm dia. enamelled copper wire, close wound in a single layer, using special coil set, 47 pF styroflex capacitors within the screening can
L 8:	4 turns of insulated wire on L 7

All other capacitors: ceramic disk type (30 V)

2. AF-CIRCUIT OF THE RECEIVER

This module comprises an active AF-filter, squelch and an integrated AF amplifier. The circuit diagram is given in **Figure 7**. The AF signal from the demodulator is fed via connection Pt 351 to the emitter follower T 351, which feeds it at low impedance to the subsequent active low-pass filter comprising T 352.

This lowpass filter with a cut-off frequency of 3 kHz is used to suppress high-frequency noise components in the AF-spectrum, which improves the readability of weak input signals. Furthermore, it also suppresses a large amount of the distortion during the reception of signals that are using too high a frequency deviation.

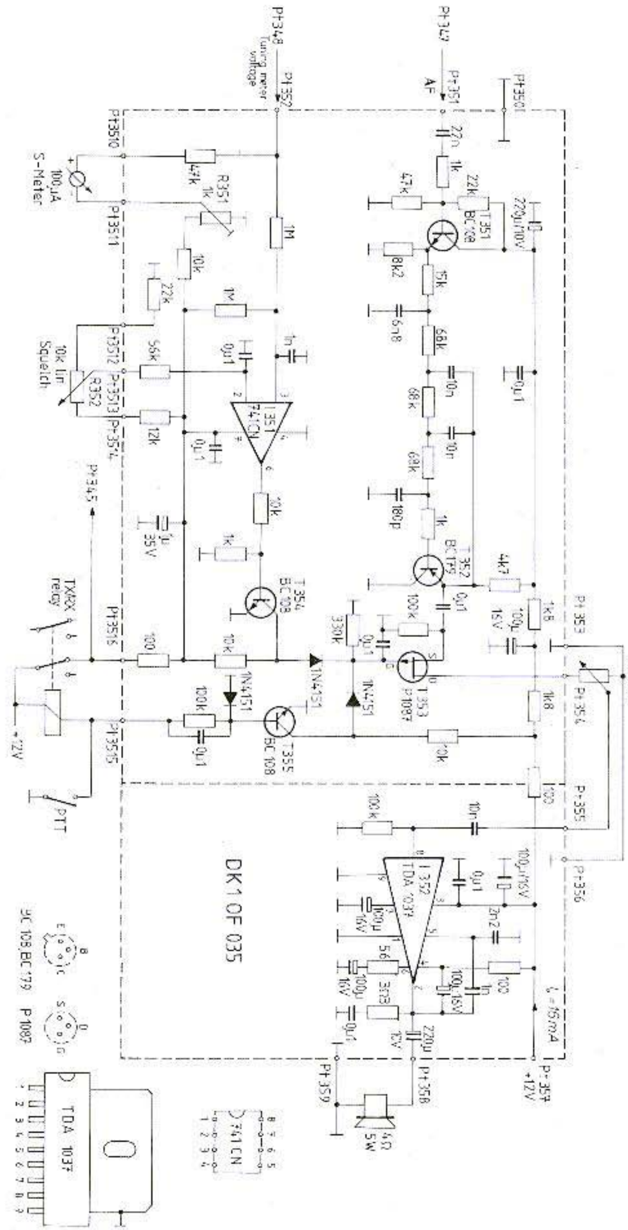


Fig. 7: Matching AF-amplifier with active filter, squelch and 5 W output power

The field-strength dependent DC-voltage of the CA 3089 is fed to connection Pt 352; as soon as this voltage exceeds a predetermined threshold adjustable with R 352 (squelch), amplifier I 351 (used as comparator) will switch on transistor T 354. This will, in turn, close the analog switch T 353 and allow the AF-signal to be fed via the volume control to the AF-amplifier. It will be seen that a field-strength dependent squelch is used here, whose threshold is variable in a range of approximately 80 dB (see Figure 4).

Transistor T 355 is used to block the AF-path immediately on depressing the PTT button. This ensures that no unpleasant clicks are observed. The S-meter is connected between connections Pt 3510 and Pt 3511. Potentiometer R 351 allows the S-meter to be aligned to zero without signal. **Figure 8** shows the relationship between the input VHF-voltage and S-meter reading.

An integrated circuit TDA 1037 is used as AF-output stage I 352. This stage will provide an output power of 5 W into a 4 Ω loudspeaker at an operating voltage of 14 V (mobile operation with motor running) which should be more than sufficient for mobile operation.

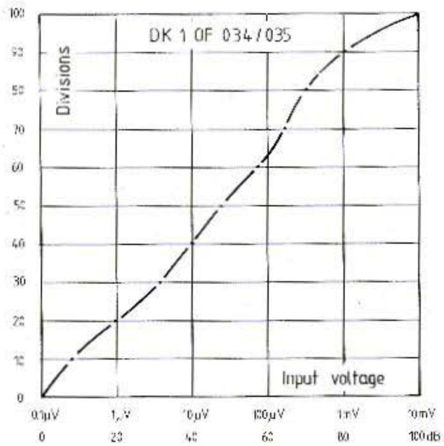


Fig. 8: Calibration curve of the S-meter

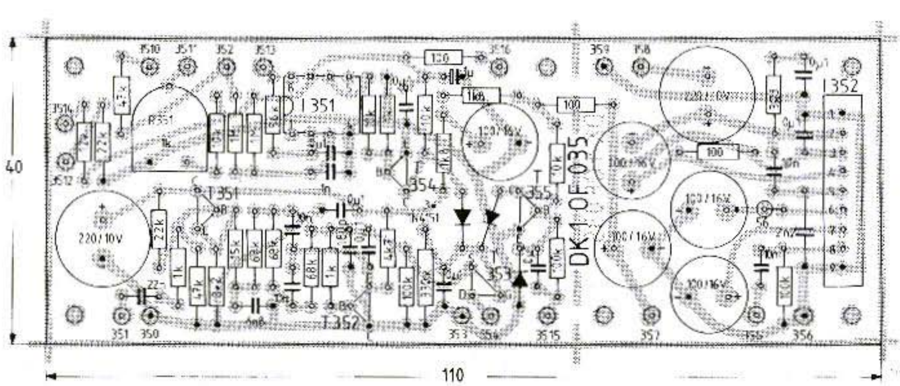


Fig. 9: PC-board of the AF-module

2.1. Construction

This module can be constructed using the 110 mm x 40 mm PC-board DK 1 OF 035. It is designed so that it can be cut at the dashed line when another output stage is to be used (see **Figure 9**). If the full AF-output power is required, it is advisable for the heat sink of I 352 to be mounted on a larger metal surface so that a good heat transfer is possible (paste). An electrical insulation is not necessary, since the heat sink is at ground potential. **Figure 10** shows a photograph of the author's prototype.

2.2. Special Components

I 351:	741 CN or TBA 221 B
I 352:	TDA 1037 (Siemens)
T 351/354/355:	BC 108, BC 413 or similar
T 352:	BC 179, BC 415, or similar
T 353:	P 1087 (Siliconix) or 2 N 5116

All capacitors with the exception of electrolytics: ceramic disk or multi-layer capacitors.

R 351: 1 kΩ trimmer potentiometer, spacing 5/10 mm, for horizontal mounting

Fig. 10: Photograph of the author's prototype

3. ALIGNMENT OF THE RECEIVER

The following alignment instructions are given especially for those constructors that do not possess an extensive range of measuring equipment. However, it is necessary to have a DC multimeter (R ≧ 20 kΩ/V).

Firstly, the VHF/IF portion is activated by feeding the operating voltage of 12 V to connection Pt 345, connecting Pt 343 and Pt 344 together, and connecting 47 Ω terminating resistors into position instead of the antenna and oscillator. The operarting points of transistors T 341, T 342 and T 343 are now checked by measuring the voltage drop across their source resistors. Deviations in the range of + 50 % to – 25 % of the orientation values given in Figure 2 are satisfactory; if larger differences exist, the appropriate MOSFET should be replaced by another one. A voltage of approximately 4.5 V should be present at Pt 344.

The oscillator is now connected to Pt 342 and switched on. The most favorable oscillator voltage is obtained when the voltage at the source of T 342 drops by approximately 10 to 20 %. If this drop is too high, an attenuator should be provided. The voltmeter is now connected between Pt 348 and ground (1 V range) and capacitors C 1, C 2 and inductance L 7 aligned for maximum reading. If the AF-module is connected temporarily, and Pt 341 connected to a suitable antenna, it should be possible to receive several strong stations. Inductances L 3 and L 4 are now aligned alternately at an input frequency of approximately 145.5 MHz for maximum voltage at Pt 348. The alignment of L 1 should be made with the aid of a weak signal for maximum signal-to-noise ratio. The two discriminator circuits L 11 and L 12 are aligned for minimum distortion. It is possible for the distortion factor to be reduced still further by correcting C 1 and C 2.

Finally, the antenna is once again replaced by a terminating resistor. The synthesizer is now switched in steps of 10 channels (10,20 to 70,79) and the voltage at Pt 348 observed. It is now possible to obtain a constant gain over the whole band by slight correction of L 3 and L 4.

If a swept-frequency measuring system and oscilloscope are available, the alignment will be, of course, considerably simpler and now doubt exacter. For the IF-alignment, the swept-frequency generator is connected to the oscillator input Pt 342, and the oscilloscope to Pt 348. Inductance L 7 is now aligned for maximum signal, and C 1 and C 2 for minimum ripple. The oscilloscope is then connected to Pt 347 and L 11 / L 12 aligned alternately for best balance and linearity of the discriminator curve. The swept-frequency generator is connected to the antenna input for alignment of the VHF-circuits, and the RF-probe ($C \leqq 2$ pF) connected to gate 1 of the mixer transistor T 342. It is now possible for the intermediate bandpass filter L 3 /L 4 to be aligned. The dip at the center of the band, and drop-off at the band limits amount to approximately 1.5 dB. Alignment of L 1 is best made with the aid of a noise generator, and the measuring receiver can be connected to pin 1 of I 341.

No tendency to oscillation was determined during the alignment process. The preamplifier stage remains stable even with the antenna input short-circuited or disconnected.

The other modules of the transceiver, e.g. the transmitter module, will be described in part 2 of this article.

REFERENCES TO PART 1

(1) G. Heeke: A Synthesizer for the 2 m Band in C-MOS-Technology
VHF COMMUNICATIONS 10, Edition 3/1978, pages 130 - 144

(2) M. Martin: A new Type of Preamplifier for 145 MHz and 435 MHz Receivers
VHF COMMUNICATIONS 10, Edition 1/1978, pages 30 - 36

(3) M. Martin: Rauscharmer UKW-Oszillator
CQ-DL 10/1977, page 387 ff

(4) B. Neubig: Monolithische Quarzfilter
Funkschau 50 (1978), Edition 10, pages 438-441

(5) J. Becker: »SÜDWIND« – A 2 m FM Handheld Transceiver with 80 or 396 Channel Synthesizer and Touch-Key Operation
VHF COMMUNICATIONS 10, Edition 4/1978, pages 194 - 212

A POWER SUPPLY FOR 9 TO 15 V / 25 A

by H. Liers, DB 7 ES

Transistor linear amplifiers are becoming more and more popular in amateur radio stations. These amplifiers require high currents at stabilized voltage values of between 12 and 14 V. For this reason, the author considered that there would be most certainly interest in such a power supply for home construction. The power supply is designed so that it can be extended to over 30 A by provision of a suitable transformer (220 V / 19 V / 35 A ~). It possesses the following features:

- The power supply will not be affected by strong RF fields
- The output is not grounded
- Connected consumers are reliably protected against overvoltages
- The power supply is completely short-circuit-proof (continuously)
- Voltage and current are zero after electronic switch-off under short-circuit conditions
- The output voltage is stable up to the adjustable maximum limit
- The residual hum voltage at maximum load only amounts to max. 20 mV
- Switching-on under load up to a maximum of 25 A is possible without transient problems
- Electronic switch-off is possible without discharge process
- Power supply is immediately ready for operation after removing the short-circuit
- Meters for I = 25 A and U = 15 V as well as indicator lamps for power, operational readiness, and failure of the power semiconductors or fuses are provided.

1. OPERATION

The circuit diagram of the power supply is given in **Figure 1**. The large filter capacitors C 2 and C 3 are charged via resistor R 2 after switching on the power supply with the aid of switch S 1. Thyristor Ty 1 will be triggered immediately on reaching its trigger voltage via the relay contact and R 20 ensuring that the driver transistor T 2 does not receive any drive due to the voltage drop across R 17. This means that the output of the power supply will be without voltage momentarily.

Within a fraction of a second, the charge voltage will exceed the value of the zener diode D 2 (18 V), and the relay will switch to the direct connection. Thyristor Ty 1 is switched off by depressing S 2, and the power supply will be ready for operation. It is possible to switch S 2 even under load conditions.

Resistor R 2 limits the transient charge current so that the rectifier and transformer are not excessively loaded, and that the domestic fuse will not blow.

The required output voltage of the power supply can be varied in the range of 8.4 V and 16.2 V with the aid of potentiometer R 30. The safe operating range is between 9 V and 15 V, and no voltage drop will be exhibited up to the full current load of 25 A (in contrast to many current-limiting power supplies on the market). The measuring path is formed by the impedance of meter M 2 and resistors R 25 (25 A-range), R 26 (15 A-range) and R 27 (6 A-range). The circuit used controls the voltage drop across this measuring path completely until the appropriate maximum value is obtained (according to where the consumer is connected). Under overload conditions, thyristor Ty 1 will be triggered and will switch off the drive of T 2, and thus the following pass transistors instantaneously.

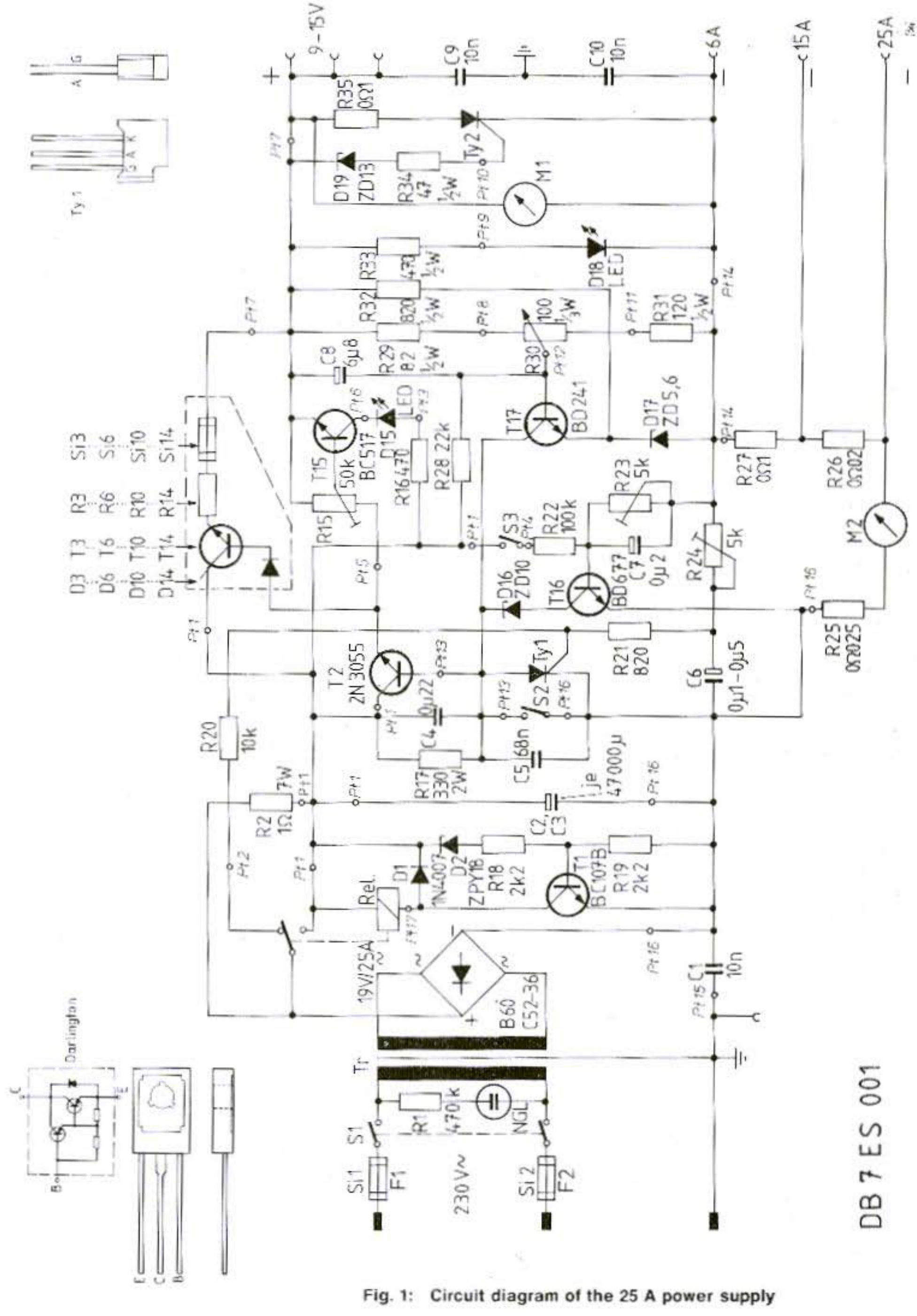


Fig. 1: Circuit diagram of the 25 A power supply

After removing the overload consumer, the power supply is immediately ready for operation and can be switched on again by depressing S 2 momentarily. It is possible with the aid of trimmer resistor R 24 for the switch-off thresholds of 6/15/25 A to be shifted by several A. Capacitor C 6 determines the switch-off time. If a value of 0.1 μF is used, the circuit will actuate so sensitively that the transient current surge in a consumer is sufficient to trigger the circuit. The value of C 6 can be increased up to 0.5 μF to suit individual requirements.

Since the switch-off process after actuating the main switch S 1 would take several seconds due to the high charge capacitance of 90 mF (90.000 μF) if no further measures were taken (according to whether a consumer is connected or not), this process has been accelerated to approximately 1.5 s by causing the relay to become deenergized and trigger thyristor Ty 1 as soon as the voltage across C 2 / C 3 has dropped below 18 V. The output of the power supply is therefore disconnected. This circuit is able to withstand a continuous switching with the aid of S 1 under all conditions.

An emergency switch-off is obtained by depressing S 2 until the consumer is removed from the power supply. This manual, electronic instantaneous switching has proved itself in practice.

Finally, the overvoltage protection is to be described. This circuit is designed to protect the connected consumers in the case of a fault in the power supply and comprises zener diode D 19, resistors R 34, R 35, thyristor Ty 2 and fuses F 3 to F 6, F 10 or F 14. The operational readiness of this safety circuit can be checked at any time without damaging the power supply by increasing the voltage to 15 V or more without consumer. In this case, thyristor Ty 2 will be triggered via D 19 / R 34 and will short the output; the short-circuit switch-off in the 6 A-range will then be actuated internally. The power supply is immediately ready for operation after reducing the voltage across R 30 and actuating S 2.

The switching threshold of the overvoltage protection circuit can be increased by approximately 0.7 V per diode by using a series circuit of simple rectifier diodes of e.g. 1 N 4007 in series with D 19.

The pass transistors T 3 to T 6 or to T 10 or T 14 are protected by the base diodes D 3 - D 6 - D 10 - D 14 and fast-blow fuses against self-destruction.

The power supply will still remain operational even if one of the parallel power branches comprising the pass transistors and the appropriate compensation resistors and fuses fails.

The LED D 15 can, however, be adjusted with the aid of R 15 so that its light emission threshold (25 A) will also be actuated when one of the branches fails. It is then possible for the defective component to be determined and replaced.

A current limiting can be actuated via switch S 3. This circuit comprises the components D 16, T 16, R 22, R 23, and C 7. If the circuit is switched in, the base of the Darlington transistor T 16 will be provided with a bias voltage which can be adjusted with the aid of R 23 so that the current limiting begins at approximately 25 A (and 6 or 15 A). In excess of this value, the voltage will be controlled down steeply, but remains stabilized with the aid of zener diode D 16 at approximately 8.5 V at the output of the power supply. This guarantees that the heat effects remain within the limit given in section 3. When a short-circuit occurs in the current limiting mode, the power supply will be switched off as described previously with the aid of thyristor Ty 1. It is necessary for the trimmer potentiometers R 24 and R 23 to be adjusted so that the short-circuit protection circuit takes place in the lower range of the limiter voltage characteristic.

2. COMPONENTS AND CONSTRUCTION

The external design of the power supply is mainly dependent on the large components such as transformers, rectifiers, electrolytic capacitors C 2 / C 3, heat sinks and meters as well as on the taste and skill of the constructor. The following descriptions are therefore to be limited to exact details regarding reliable operation and the most important components. A 49 x 90 mm single-coated PC-board was developed for the low-power components. The component locations are given in **Figure 2**. The author uses this board with a 12-pole »Veroboard« connector system in order to improve the serviceability of the power supply. **Figures 3 to 5** show the author's prototype, and show how the power supply could be constructed mechanically.

Transformer:
Double C-core, approx. 500 VA, primary 230 V, with screen, secondary 19 V / 25 A AC

Silicon rectifier with integrated heat sink, type HS 4 E-B 60/52-36 An (Herrmann KG)

C 2, C 3: 47 mF (= 47,000 μF) / 25 V each, installated can, for screw mounting (M 12)
If capacitors are only available whose minus pole is not insulated from the case, it will be necessary for these two electrolytic capacitors to be mounted in an insulated manner. If this is the case, it is possible for Siemens type B 41 457 - B 5479 - T (65 mm dia., 90 mm long) to be used.

D 1:	1 N 4007
D 2:	ZPY 18 or BZY 97 / C 18
D 3 - D 14:	1 N 4001 (or 1 N 4007)
D 15:	LED (red, 5 mm dia.)
D 16:	ZD 10 or BZY 97 / C 10
D 17:	ZD 5.6 or BZY 97 / C 5 V 6
D 18:	LED (green, 5 mm dia.)
D 19:	ZD 13 or BZY 97 / C 13

T 1:	BC 107 B, BC 413
T 2:	2 N 3055 (B > 100, select)
T 3 - T 6:	4 x 2 N 3771; or T 3 - T 10: 8 x 2 N 3055; or T 3 - T 14: 12 x 2 N 3055

Transistors T 3 to T 6 or to T 8 or to T 14 should have approximately the same current gain factors of approximately 100. If the pass transistors have a lower current gain, e.g. of 60, it will be necessary for T 2 to exhibit B = 170. It is necessary for the driver and pass transistors to have a current gain of at least 10,000, and if possible of 15,000 together. If the resistance value of R 17 is reduced from 330 Ω to 270 Ω (3 W), a total current gain of 10,000 will be sufficient.

T 15:	BC 517 (TI) NPN low-power Darlington
T 16:	BD 677 (Siemens) NPN power Darlington
T 17:	BD 437 or BD 241 (B = 100 to 150)
Ty 1:	SCR 800/1 or similar 0.5 - 1 A thyristor (Siemens type BSt B 0106)
Ty 2:	HT 25/02-OG 1 (Herrmann KG) or Siemens BSt F 2540 or BSt D 03 13 S 6

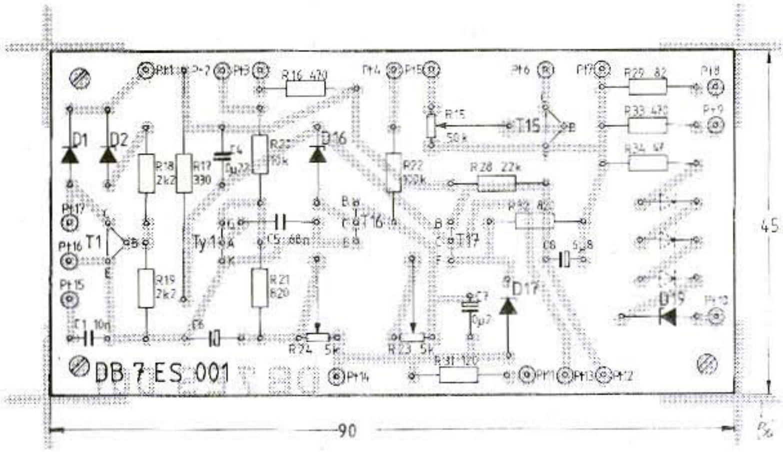


Fig. 2: PC-board for the low-power components

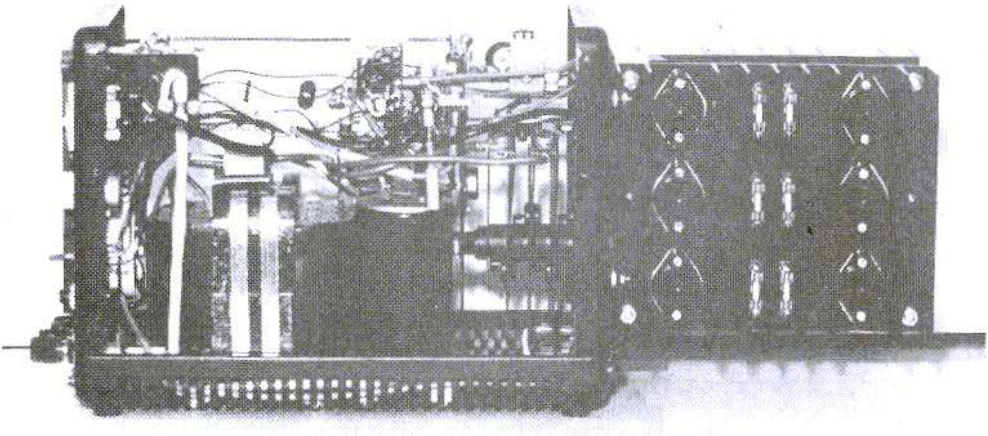


Fig. 3: Rear view showing heat sinks with 2 x 6 pass transistors

Resistors R 25, R 26, R 27, R 35 are made from resistance wire of 1 mm dia., 0.65 Ω/m.

R 25:	0.025 Ω = 4 wires of 18 cm in length, stranded together, and tin-plated at the ends for a length of 1 cm
R 26:	0.02 Ω = one wire of 5 cm in length
R 27:	0.1 Ω = one wire of 16 cm in length
R 35:	0.1 Ω = one wire of 16 cm in length

R 25 - R 27 should be mounted between ceramic supports; R 25 should also be provided with a small heat sink, R 26 and R 27 with ceramic beads. The wire lengths provide a certain reserve for soldering. They are calculated for a voltage drop of 0.7 V at M 2 + R 25 (+ R 26 / + R 27).

R 3 - R 6, or R 3 - R 10, or R 3 - R 14: 5 W wire-wound resistors (Vitrohm); these resistors are mounted on the heat sinks between the emitter tags and the fuse holder.
Values given below.

Due to the improved heat dissipation and lower costs for repair it is more favorable to use several (8 to 12) pass transistors.

Fuses:

F 1, F 2: 3.15 A medium blow

F 3 - F 6; or F 3 - F 10; or F 3 - F 14:

With 4 x 2 N 3771:	4 fuses of 10 A, fast-blow, compensating resistors R 3 - R 6: 0,05 Ω (2 x 0.1 Ω)
With 8 x 2 N 3055:	8 fuses of 6.3 A, fast-blow, compensating resistors R 3 - R 10: 0.1 Ω
With 12 x 2 N 3055:	12 fuses of 4 A, fast-blow, compensating resistors R 3 - R 14: 0,18 Ω

Heat sinks: 2 pieces of profile heat sinks type SE 53, without holes, 150 mm long for accommodation of a maximum of 2 x 6 pass transistors.

Relay: 3 changeover contacts of 10 A each, energizing coil 24 V / 0.1 A, or 2 changeover contacts of 15 A each (e.g. Siemens relay 15, type V 23009 - A 0007 - A 051).

Meter M 1: 15 V moving iron, calibration point at 3 V (Neuberger)
Meter M 2: 25 A moving iron, calibration point at 5 A (Neuberger)

In addition to the previously mentioned wire-wound resistors, the following resistors must also be designed for higher power levels:

R 2: 1 Ω / 7 W;	R 17: 330 Ω / 2 W;	R 30: 100 Ω / 0.3 W (pot.)
R 29: 82 Ω / 0.5 W;	R 31: 120 Ω / 0.5 W;	R 33: 470 Ω / 0.5 W;
R 16: 470 Ω / 0.5 W;	R 34: 47 Ω / 0.5 W;	R 32: 820 Ω / 0.5 W.

For power values up to 0.5 W, composite carbon resistors of 3 mm diameter and 9 mm in length will be satisfactory. Any resistors not mentioned above can be miniature types. The values are given in the circuit diagram.

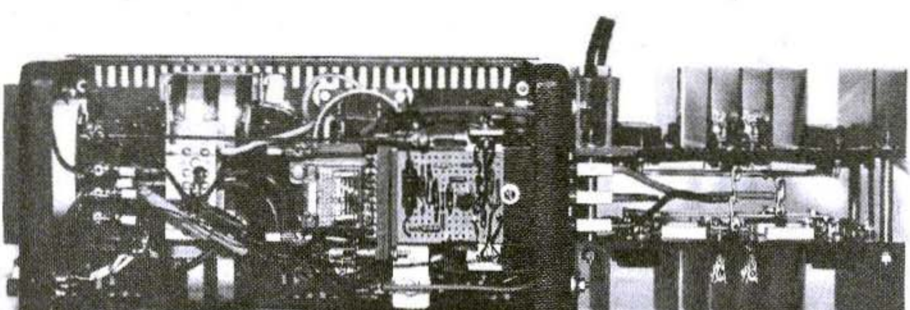


Fig. 4: View from above showing the relay, PC-board and inter-connections to the pass transistors

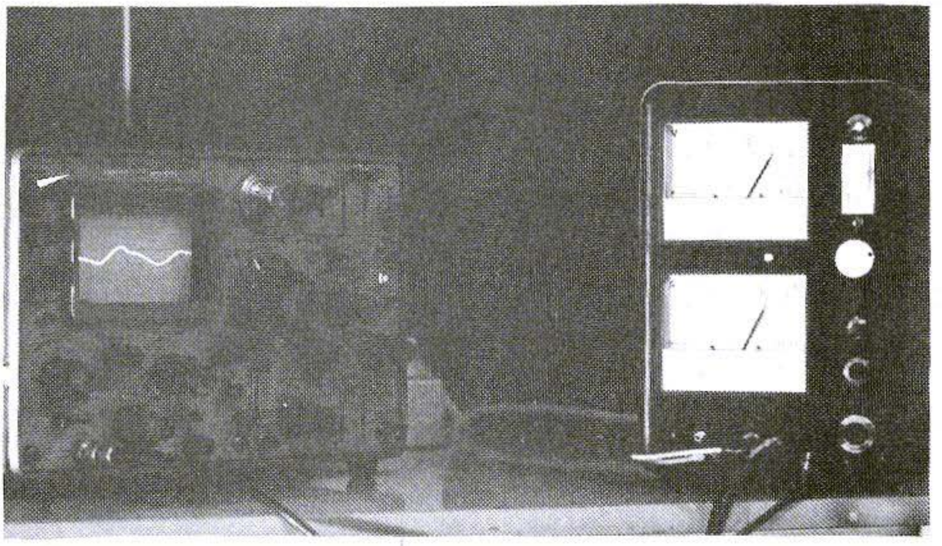
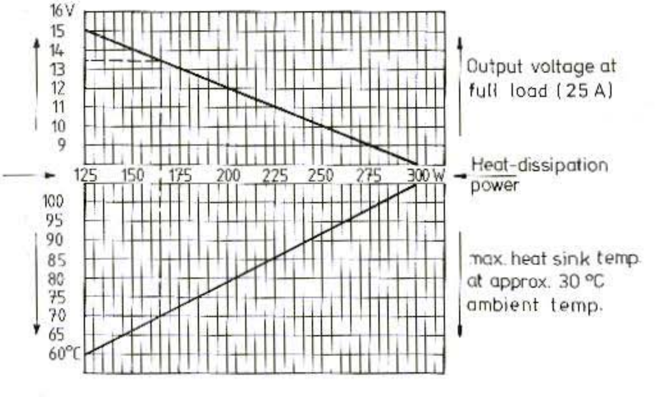


Fig. 5: The residual hum is only 20 mV at 13.5 V and 22 A

Fig. 6:
Heat dissipation and heat sink temperatures as a function of voltage at maximum current



DB 7 ES

3. APPENDIX: HEAT DISSIPATION

The diagram given in **Figure 6** shows how much heat dissipation is present as a function of the selected output voltage under full load conditions (25 A), and which temperatures must be dissipated by the heat sinks. An example of 13.5 V / 25 A is given in dashed lines; it will be seen that a dissipation power of 165 W is exhibited which results in a heat sink temperature of 70 °C.

The diagram is based on the following functions:

Two heat sinks type SK 53 of 0.5 °C/W heat resistance are used, and the pass transistors are mounted using heat-conductive paste. Furthermore, it is assumed that the ambient temperature is 30 °C, and that the DC-voltage at the collectors of the pass transistors will fall from 25 V to 20 V under full-load conditions (25 A).

INDEX TO VOLUME 10 (1978) OF VHF COMMUNICATIONS

7. 432 MHz BAND

8. SHF BANDS

MATERIAL PRICE LIST OF EQUIPMENT
described in Edition 1/1979 of VHF COMMUNICATIONS

DJ 8 IL	**»SUEDWIND« – 2 m HANDHELD SYNTHESIZER TRANSC.**		**Ed. 1/1979**
PC-board	Dj 8 IL 001	(thru-contacts)	DM 25.—
PC-board	DJ 8 IL 002	(thru-contacts, 0.6 mm thick)	DM 18.—
Semiconductors 1	DJ 8 IL 001/2	(26 transistors, 21 diodes)	DM 99.—
Semiconductors 2	DJ 8 IL 001/2	(20 ICs)	DM 105.—
Minikit 1	DJ 8 IL 001/2	(7 trimmer caps., all ceram., alu., plastic-foil and tantalum caps. – total 98 pieces)	DM 73.—
Minikit 2	DJ 8 IL 001/2	(3 trimmer pots., 61 carbon resistors, 39 subminiature resistors, miniature coax., connection wire and silver-plated wire)	DM 77.—
Minikit 3	DJ 8 IL 001/2	(2 relays, 7 coilsets, 2 toroids, 1 choke, 7 ferrite beads, 1 AF transformer)	DM 67.—
Microphone/Loudspeaker		Type Holmco 370 A 1	DM 30.—
NC-accumulator		Type 225 DKZ/12 V	DM 48.50
Crystal	66.400 MHz	HC-18/U	DM 30.—
Crystal	10.700 MHz	HC-18/U	DM 26.—
Crystal	200.000 kHz	HC- 6/U, parallel resonance	DM 44.—
Crystal filter	MQF 10.7 - 15	-	DM 136.—
Kit	**DJ 8 IL 001/2**	**with above parts**	**DM 698.—**

DC 0 DA/DF 8 QK	**TRANSISTOR LINEAR AMPLIFIER FOR 23 cm**		**Ed. 1/1979**
SINGLE-STAGE AMPLIFIER			
PC-board	DC 0 DA 008	(double-coated, without thru-contacts)	DM 14.—
Transistor	DC 0 DA 008	(1 BFQ 34 / Philips)	DM 29.—
Minikit	DC 0 DA 008	(4 pl.foil trimmers, 3 ceramic caps without leads, 1 ceramic cap., 1 tantalum cap, 2 feedthrough caps for solder-mounting, 1 ferrite bead, 1 6-hole ferrite choke, 2 BNC-flange connectors)	DM 19.—
Kit	**DC 0 DA 008**	**with above parts**	**DM 62.—**
TWO-STAGE AMPLIFIER			
PC-board	DC 0 DA 009	(double-coated, without thru-contacts)	DM 16.—
Semiconductors	DC 0 DA 009	(2 pcs. BFQ 34, 2 pcs. 1 N 4151 diodes)	DM 59.—
Minikit	DC 0 DA 009	(7 pl. foil trimmers, 2 chip caps., 2 ceram. caps., 2 ferrite beads, 2 feedthru caps. for solder mounting, 2 BNC flange conn., 2 trimmer pots., 7 resistors)	DM 23.—
Kit	**DC 0 DA 009**	**complete with above parts**	**DM 95.—**

DK 1 OF 034	**2 m FM-RECEIVER, RF/IF MODULE**		**Ed. 1/1979**
PC-board	DK 1 OF 034	(single-coated, with plan)	DM 12.—
Semiconductors	DK 1 OF 034	(1 IC, 3 transistors)	DM 20.—
Minikit 1	DK 1 OF 034	(3 coilformers with core, 3 coilkits, 1 ferrite bead, 3 ferrite chokes, 2 trimmer caps., 6 feedthru caps., 3 Styroflex caps., 25 ceramic bypass caps.)	DM 53.—
Minikit 2	DK 1 OF 034	(5 ceramic caps., 29 resistors, coil wire)	DM 12.—
Crystal filter	XF-107 B	-	DM 107.—
Monolithic crystal resonator		Dual XF-109	DM 17.—
Kit	**DK 1 OF 034**	**complete with above parts**	**DM 219.—**

DK 1 OF 035	**2 m FM-RECEIVER, AF-MODULE**		**Ed. 1/1979**
PC-board	DK 1 OF 035	(single-coated, with plan)	DM 10.—
Semiconductors	DK 1 OF 035	(2 ICs, 5 transistors, 3 diodes)	DM 24.—
Minikit 1	DK 1 OF 035	(15 ceramic caps., 1 tantalum cap., 7 alu caps., 1 trimmer pot.)	DM 27.—
Minikit 2	DK 1 OF 035	(2 ceramic caps., 32 resistors)	DM 8.—
Kit	**DK 1 OF 035**	**complete with above parts**	**DM 69.—**
Kits	**DK 1 OF 034/35with above parts**		**DM 279.—**

DB 7 ES	**STABILIZED POWER SUPPLY 9 V to 15 V / 25 A**		**Ed. 1/1979**
PC-board	DB 7 ES 001	(single-coated, with plan)	DM 9.—
Semiconductors 1	DB 7 ES 001	(13 transistors, 17 diodes, 2 LED's)	DM 85.—
Semiconductors 2	DB 7 ES 001	(2 thyristors, silicon rectifiers w/heat sinks)	DM 128.—
Minikit 1	DB 7 ES 001	(10 wire-wound resistors, resistance wire, 13 carbon resistors, 4 potentiometers)	DM 27.—
Minikit 2	DB 7 ES 001	(3 ceramic caps., 2 foil caps., 3 tantalum caps., 1 relay, 2 electrolytics)	DM 98.—
Meterset	DB 7 ES 001	Moving-iron meters for 15 V and 25 A	DM 84.—
Transformer	DB 7 ES 001	(double type C core, 500 VA, 230 V/19 V-25 A)	DM 172.—
Heat sink	DB 7 ES 001	(undrilled)	DM 32.—
Kit	**DB 7 ES 001**	**complete with above parts**	**DM 598.—**

Back Copies of VHF COMMUNICATIONS

Please remember that we have continued to reprint these editions since each is like a small handbook in itself. Do not forget there are no news columns and other information that becomes out-of-date, and the magazines contain only technical articles, most of which are still state-of-the-art today. All back copies are available back to 1970. We can offer these volumes at the following prices:

Any three volumes	DM 36.00
Any six volumes	DM 65.00
All nine volumes (1970-1978)	DM 95.00

Verlag UKW-BERICHTE, H. Dohlus oHG

Jahnstraße 14 – D-8523 BAIERSDORF

West-Germany · Telephone (0 91 91) 91 57 or (0 91 33) 855, 856

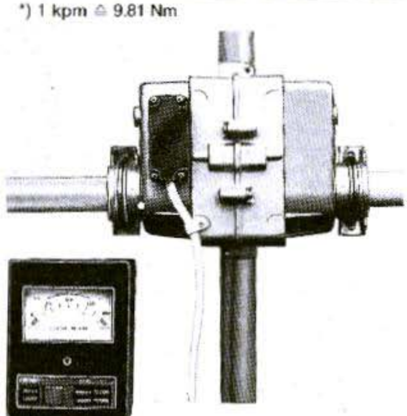
Bank accounts: Postscheck Nürnberg 30455-858 · Commerzbank Erlangen 820-1154 ·

ANTENNA ROTATING SYSTEMS

SPECIFICATIONS

Type of Rotator	KR 400	KR 600	KR 2000	MXX 1000	ART 8000	
Load	250	400	800	1000	2500	kg
Pending torque	800	1000	1600	1650	2450	Nm *)
Brake torque	200	400	1000	1200	1400	Nm *)
Rotation torque	40	60	150	180	250	Nm *)
Mast diameter	38 - 63	38 - 63	43 - 63	38 - 62	48 - 78	mm
Speed (1 rev.)	60	60	80	60	60	s
Rotation angle	370°	370°	370°	370°	370°	
Control cable	6	6	8	7	8	wires
Dimensions	270 x 180 ∅	270 x 180 ∅	345 x 225 ∅	425 x 205 ∅	460 x 300 ∅	mm
Weight	4.5	4.6	9.0	12.7	26.0	kg
Motor voltage	24	24	24	42	42	V
Line voltage	220 V / 50 Hz	220 V / 50 Hz	220 V / 50 Hz	220 V / 50 Hz	220 V / 50 Hz	
	50	55	100	150	200	VA

*) 1 kpm ≙ 9.81 Nm



Vertical Rotor KR 500
Especially designed for vertical tilting of antennas for EME, OSCAR etc.

Type	KR 500
Load	ca. 250 kg
Brake torque	197 Nm *)
Rotation torque	40 Nm *)
Horiz. tube diam.	32 - 43 mm
Mast diameter	38 - 63 mm
Speed (1 rev.)	74 s
Rotation angle	180° (+ 5°)
Control cable	6 wires
Line voltage	220 V/50 Hz 30 VA
Weight	4.5 kg