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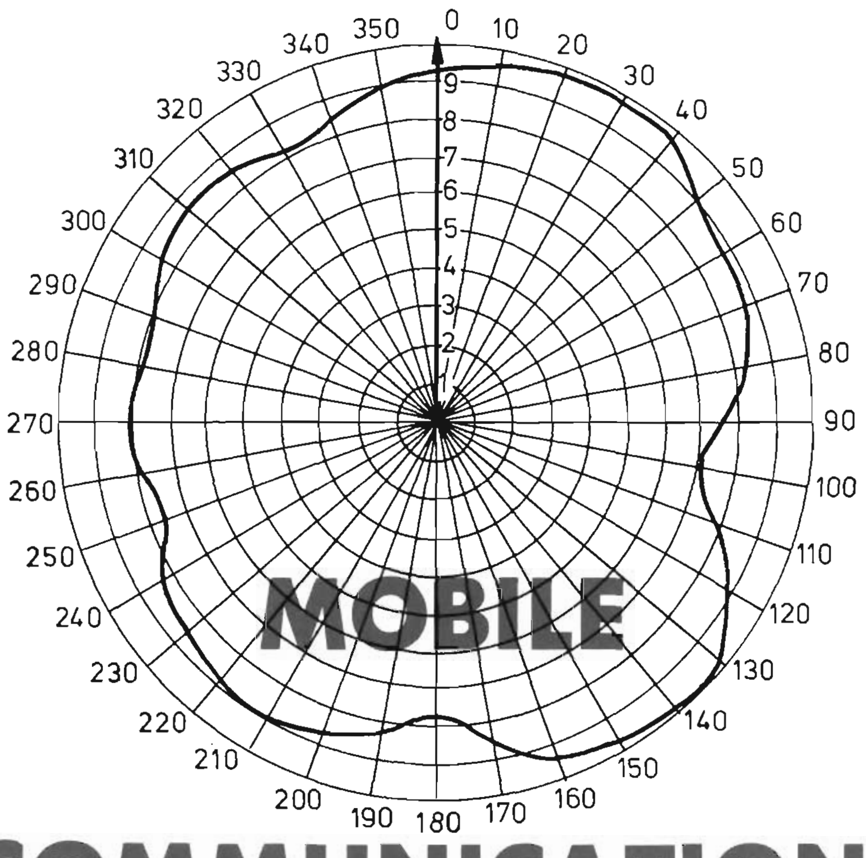

MOBILE COMMUNICATIONS

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A STEREO VHF/FM RECEIVER WITH FREQUENCY SYNTHESIZER

PART II: CONSTRUCTION

by J. Kestler, DK 1 OF

6. CONSTRUCTION

It is advisable for the modules VHF-amplifier, IF-amplifier, and frequency synthesizer to be completely screened according to good VHF practice. This is especially valid for the VHF-amplifier to ensure that the local oscillator radiation is kept to a minimum. Due to the high attenuation of the MOSFET preamplifier stage in the reverse direction, no oscillator radiation is to be expected via the antenna. If the complete tuner is not to be installed in a screened metal box, it is important for the IF-amplifier to be well screened so that no shortwave signals can be injected. Interference of this type can be heard when receiving weak VHF/FM stations as a very unpleasant heterodyne or birdies.

It is also advisable for the synthesizer module to be fully screened since the steep TTL-pulses possess a considerable harmonic spectrum. Of course, the frequency plan of the receiver could be designed so that no harmonics of the oscillator frequency divided by four fall into the required, or image frequency band (which would mean that no heterodynes would be present), however, the 428th harmonic of the phase-comparitor frequency (25 kHz) would interfere with the intermediate frequency. Furthermore, several harmonics of the 5 MHz crystal-controlled oscillator fall into the required frequency band. The harmonic order is, however, relatively high so that the interference amplitudes are very low and will be sufficiently suppressed when using a rational mechanical construction.

For this reason, all modules are provided with 25 mm high screening panels around the edge of each PC-board and are screwed to a metal chassis. It is advisable for the VHF and IF amplifiers to be mounted on one side of the chassis and the frequency synthesizer on the other. If the tuner is to be enclosed in a screened metal case, no covers will be needed on the individual modules. All DC connections are bypassed using feedthrough capacitors of 2 nF or more. The RF interconnections are made using thin coaxial cable (RG-174/U or similar).

6.1. VHF MODULE DK 1 OF 020

This module is mounted on a single-coated PC-board. The component locations are given in Figure 11. The spacing between the lower surface of the board and the chassis should amount to approximately 5 mm for all modules. Attention should be paid that this spacing is maintained when soldering the screening panels to the edge of the PC-boards. As can be seen in the photograph given in Figure 12, screening panels should be soldered into place over transistors T 201 and T 202. The required cut-outs for the two MOSFETS should be as small as possible.

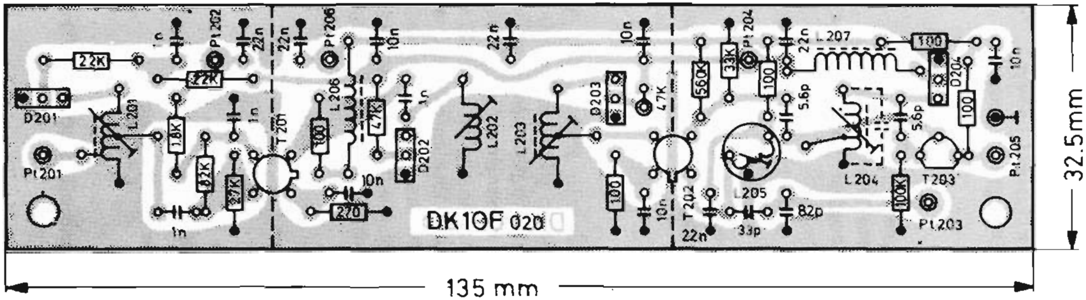


Fig. 11: Component locations on PC-board DK 1 OF 020

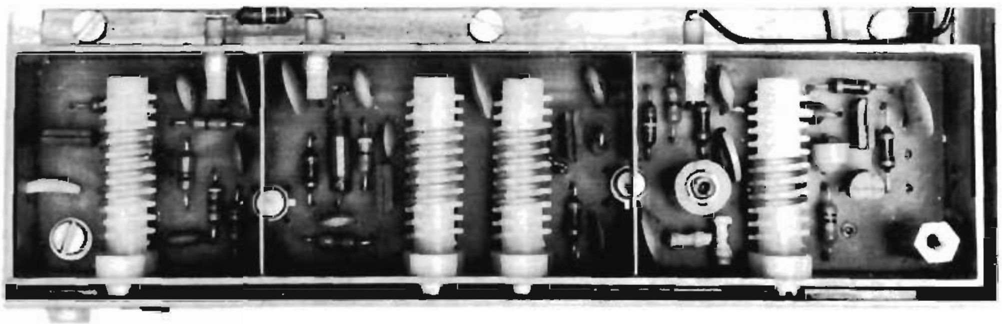


Fig. 12: Prototype VHF-module DK 1 OF 020

6.1.1. SPECIAL COMPONENTS

T 201, T 202: 40841, 40673, 3 N 140 (RCA) or similar dual-gate MOSFET
T 203: BF 245 A (TI) or W 245 A (Siliconix)

D 201 - D 204: Silicon varactor diode BB 104, green (Siemens)

L 201: 6 turns of 1 mm dia. (18 AWG) silver-plated copper wire wound on a 6 mm dia. coilformer, turns spaced 1 mm. VHF core (brown), first tap 1.25 turns (antenna), second tap 3.75 turns (gate) from the cold end.
L 202: As L 201, but without tap
L 203: As L 201, tap 3.75 turns from the cold end
Spacing L 202 - L 203: 12.5 mm (centre to centre)
L 204: 4 turns, otherwise as L 201, tap 1.25 turns from the cold end
L 205: 36 turns of 0.3 mm dia. (28 AWG) enamelled copper wire in special coil set.
L 206, L 207: Ferrite chokes of approximately 20 µH (not critical), spacing max. 17.5 mm

All capacitors: Ceramic disc-types for 5 mm spacing; tubular capacitors can be used for the IF-output (33 pF, 82 pF). A spacing of 10 mm or more is available for the resistors.

6.2. IF MODULE DK 1 OF 021

The board for this module is also single-coated and is shown in Figure 13. The interconnection between Pt 203 and Pt 211 can be made with a piece of insulated wire if it is not longer than approximately 2 cm. If greater lengths are required, coaxial cable should be used. In this case, the 82 pF capacitor (parallel to Pt 203) should be reduced by the value of the cable capacitance. RG-174/U cable exhibits a capacitance of approximately 1.5 pF/cm. The integrated amplifiers I 211 and I 212 should be soldered into place with the shortest possible connections; in the case of I 213, it is not advisable for a socket to be used. Figure 14 shows the author's prototype from the component and conductor side, where screening panels should also be provided.

6.1.2. COMPONENT DETAILS

I 211, I 212: CA 3028 or CA 3028 A (RCA)
I 213: TBA 120 or TBA 120 S (Siemens, AEG Telefunken)
(When using TBA 120 S, the 15 pF capacitors should be deleted)

T 211: BC 107, BC 108, BC 109 or suitable NPN-silicon transistor

D 211: AA 116 or similar germanium diode

L 211, L 212, L 213: 36 turns of 0.3 mm (28 AWG) enamelled copper wire in special coil set
L 214, L 215: 18 turns otherwise as above

All bypass capacitors (10 nF, 22 nF): Ceramic disc types

All other capacitors: Ceramic disc or tubular types

A spacing of 10 mm or more is available for the resistors

F 21 , F 212: Crystal filters TQF-2599 (TOYOCOM), available from the publishers.

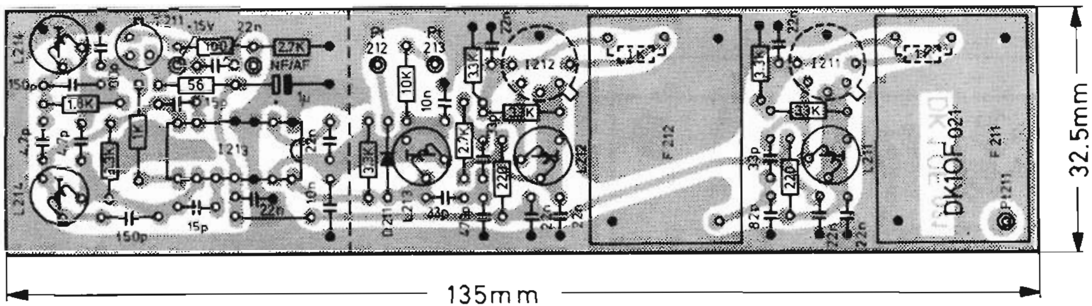


Fig.13: Component locations on PC-board DK 1 OF 021

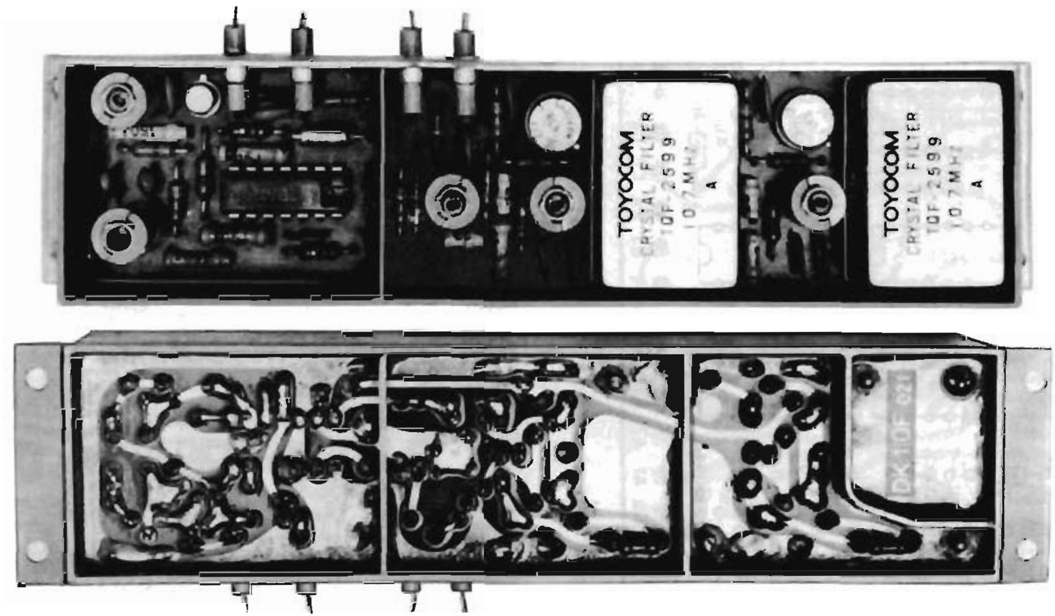


Fig.14: Prototype IF-module DK 1 OF 021

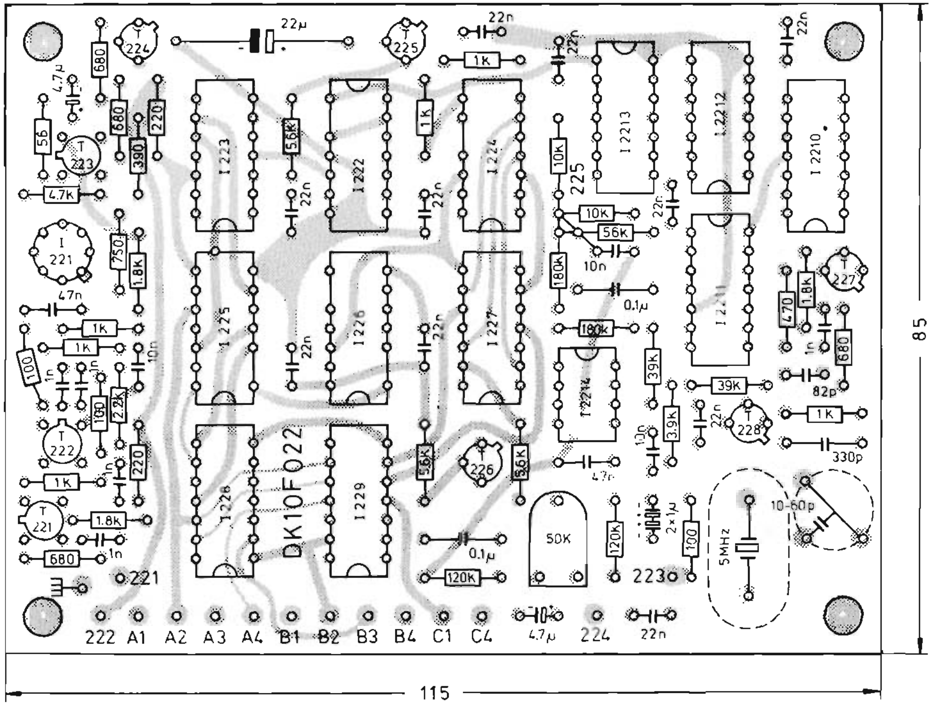


Fig.15: Component locations on PC-board DK 1 OF 022

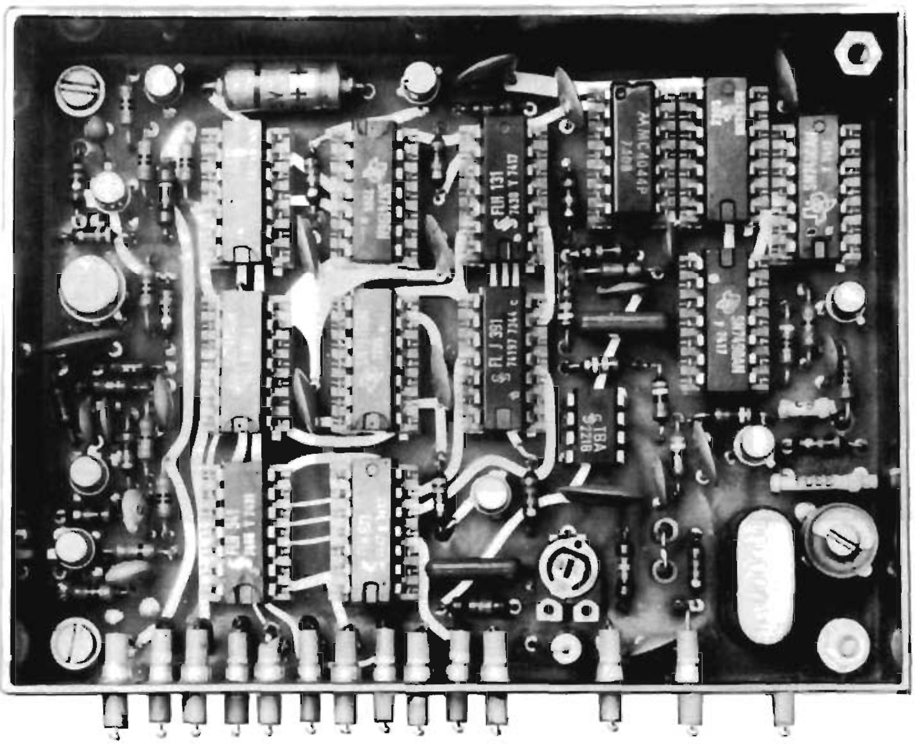


 Fig.16: Prototype of the synthesizer DK 1 OF 022

6.3. SYNTHESIZER MODULE DK 1 OF 022

The PC-board developed for this module is 115 mm x 85 mm. It is double-coated and possesses through contacts. Sockets can be used for all integrated circuits with the exception of the ECL flip-flop I 221. The frequency limit of the programmable frequency divider will still be in excess of 45 MHz. The use of sockets eases fault-finding at a later date.

6.3.1. COMPONENT DETAILS

I 221: SP 601 B (Plessey); new designation: SP 8601 BT
I 222, I 225, I 226: SN 74196 N (TI) or FLJ 381 (Siemens)
I 223: SN 74 H 102 N (TI)
I 224: SN 7430 N (TI) or FLH 131 (Siemens)
I 227: SN 74197 N (TI) or FLH 391 (Siemens)
I 228: SN 7486 N (TI) or FLH 341 (Siemens)
I 229: SN 7427 N (TI) or FLH 621 (Siemens)
I 2210, I 2211: SN 7490 N (TI) or FLJ 161 (Siemens)
I 2212: SN 7473 N (TI) or FLJ 121 (Siemens)
I 2213: MC 4044 P (Motorola)
I 2214: TBA 221 B (Siemens) or 741 CM (various manufacturers)

T 221, T 222: 2 N 5179 (RCA)
T 223: BF 272 (SGS)
T 224: 2 N 709 (Fairchild or other manufacturers)
T 225, T 227, T 228: 2 N 914, 2 N 708, BSY 18 or any similar types
T 226: BC 108 or similar NPN-silicon transistor

All capacitors: $\leq$ 47 nF: ceramic disc types

0.1 μF capacitors: Plastic-foil capacitors

1 μF, 4.7 μF, 22 μF: Aluminium or tantalum electrolytics

A spacing of 10 mm is available for all resistors

Crystal: 5.000 MHz $\pm 1 \times 10^{-4}$, parallel resonance (approx. 30 pF) HC-6/U

Series trimmer: Ceramic disc or plastic-foil trimmer of 10-60 pF,
10 mm dia.

Trimmer resistor: 50 kΩ trimmer for horizontal mounting, spacing 10/5 mm

The component locations are given in Figure 15; a photograph of the author's prototype is shown in Figure 16. The 82 Ω filter resistors at the data inputs are soldered into place between the PC-board and the feedthrough capacitors.

7. DIGITAL FREQUENCY SELECTOR SWITCHES AND PROGRAMMING

As can be seen in the table given in Section 5.2. of Part I, the programming of the variable frequency divider (inputs A_1 to C_4) is made in positive (non-inverted) BCD-code. This means that digital switches are required that also work in BCD-code. It is advisable for switches with an inverted BCD-coding to be used so that the data lines that are to be fed with the L-signal (low) can be grounded. The inputs that are provided with the H-signal (high) can then remain open circuit. Any spurious injections will be filtered out by the feedthrough capacitors.

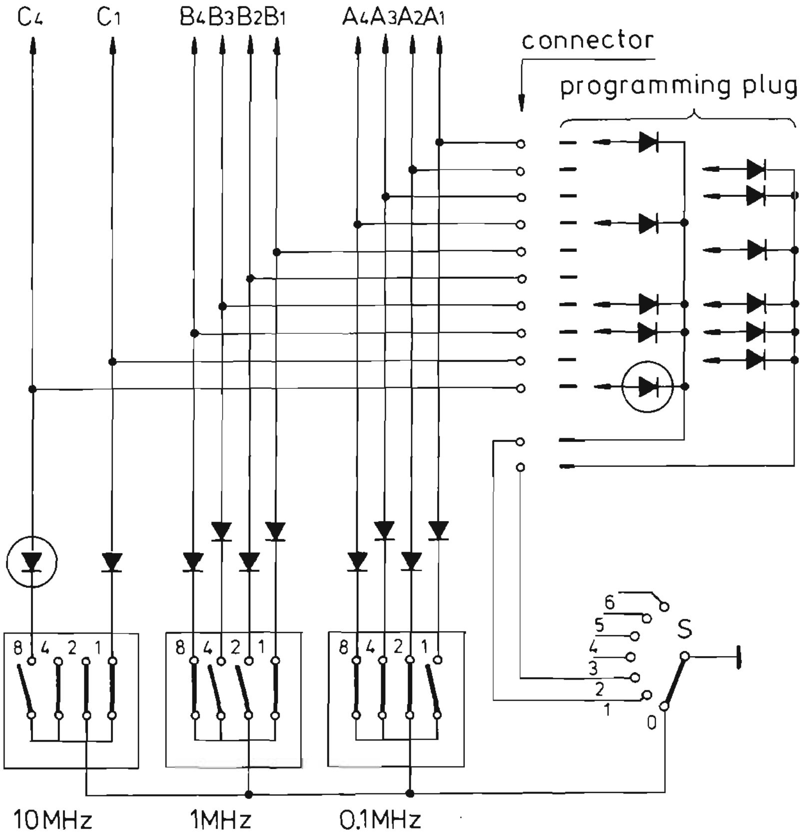


Fig.17: Channel selection and programming using inverted BCD-coded switches

The interconnection of the frequency synthesizer and inverted BCD-coded selector switches is given in Figure 17. The numbers given in the symbols for the switches give the valency of this contact. The "8" means that this contact is open when the number "8" has been selected, whereas the other contacts remain closed. In the case of the numeral "6", contacts "4" and "2" are open, whereas contacts "8" and "1" remain closed.

A fixed programming of the tuner can be achieved relatively easily and without much mechanical work. This is also given in Figure 17. The switch S allows the digital switches to be selected (position "0"), as well as various diode matrixs (switch positions 1, 2, 3, etc.). Each of these positions represents a fixed program (channel). The construction of such a programming circuit is achieved with the aid of a socket on the rear panel of the tuner which is connected to the data inputs A_1 to A_4 as well as to the switch S. The diodes are then soldered between the various pins of the plug according to the table given in Section 5.2. The data lines that are to carry "L"-signal must be connected with the diodes. A 21-pin connector is sufficient for a maximum of 11 preset channels. The described method allows the programming to be changed relatively easily without having to open the case.

If non-inverted BCD-switches are to be used, the following modifications will be required:

a) The polarity of all diodes shown in Figure 17 should be reversed

b) All data inputs A_1 to C_4 should be grounded by resistors of 180 Ω each

c) The centre contact of the switch is now not grounded, but connected to + 5 V

d) The diodes used for the programmed channels should be connected to the data lines which are at "H"-signal in the table.

Normal, multi-position switches with 10 or more positions can be used instead of the digital switches. Figure 18 shows how these can be connected. However, a large number of diodes (53 pieces) will be required.

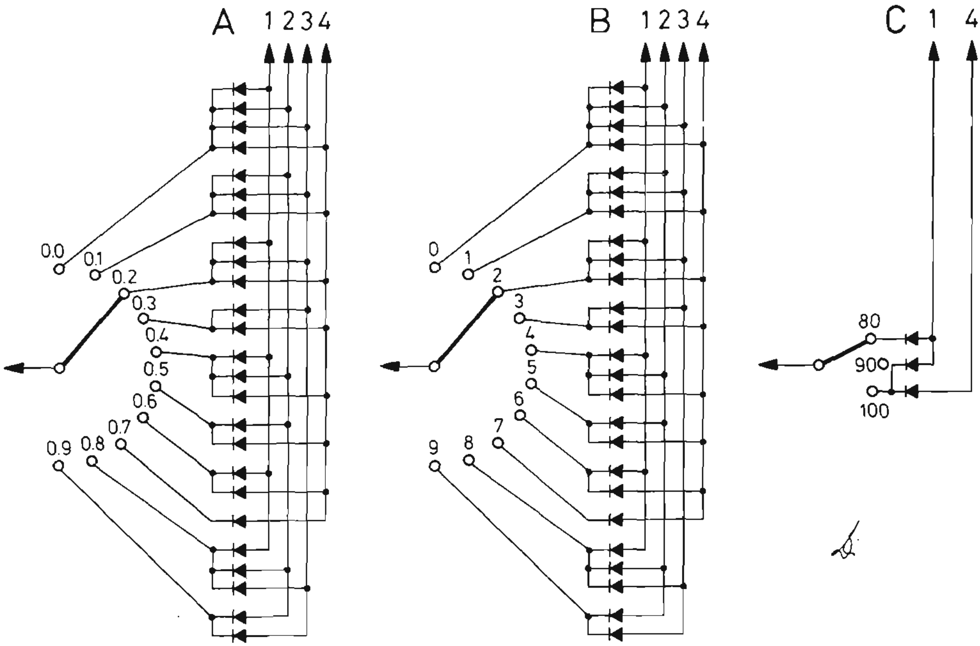


Fig.18: Using a multi-position switch for channel selection

8. PREPARATIONS AND ALIGNMENT

Before the three previously described modules are finally mounted in the case, it is advisable to check the operation and make a preliminary alignment. This allows any faults that may be present to be easily corrected. The final alignment is made with the various modules mounted in the unit, however, only small corrections will then be required.

8.1. TUNER AND IF-MODULES

The IF-output (Pt 203) should be connected to the input of the IF-amplifier (Pt 211) with the aid of a short piece of wire. The local oscillator output (Pt 205) remains disconnected at this point. A suitable antenna is connected to connection Pt 201 (50 - 75 Ω). The preamplifier stage is liable to oscillate if the matching is not correct (SWR > 3). The AF-output should be connected via a capacitor of 0.1 μF to an AF-amplifier with loudspeaker, or high-impedance headset. Connection Pt 204 is provided temporarily with a variable bias voltage of 0 to +12 V which can be obtained using a 10 kΩ potentiometer across the operating voltage. The control voltage input (Pt 202) is connected via a resistor of 120 kΩ to Pt 206. The operating voltage of the VHF and IF-modules is now switched on; this is followed by checking the source voltages of transistors T 201 and T 202; deviations of up to 50% are permissible, otherwise it will be necessary to exchange the transistors. If the tuning potentiometer is varied, several strong transmitters should be heard.

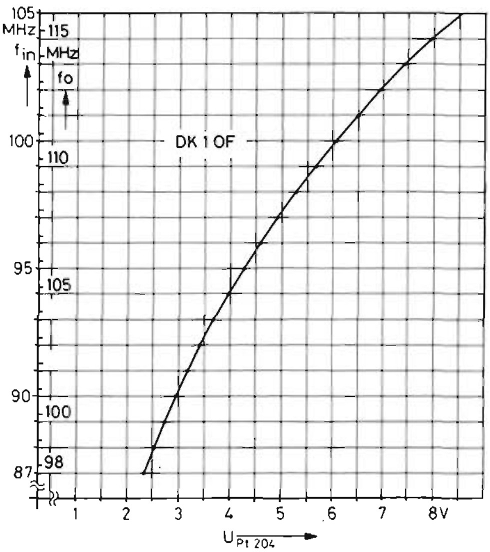


Fig. 19:

Tuning curve of the input frequency f_{in} or oscillator frequency f_o

It is firstly necessary to adjust the oscillator frequency range. This is extremely simple if a VHF frequency counter is available; it should be connected to Pt 205. Figure 19 shows the input, or oscillator frequency as a function of the tuning voltage. The core of inductance L 204 is adjusted at a tuning voltage of 2.5 V so that the oscillator operates at 98.5 MHz. If a frequency counter is not available, the frequency should be determined using strong VHF/FM transmitters whose frequency is known. If the voltage at Pt 204 is increased to 8.5 V, the oscillator should operate at 116 MHz, corresponding to a receive frequency of approximately 105 MHz. If the oscillator frequency range is too large at the given voltage swing of 2.5 to 8.5 V, it will be necessary to increase the value of 4.7 pF capacitor connected in parallel with L 204, or vice versa if the range is too small. The next standard values of 3.9 or 5.6 pF will most certainly be suitable. Deviations from the curve given in Figure 19 of ± 1 MHz at the lower and ± 2 MHz at the upper end of the band are permissible.

A voltmeter (1 V range, R $\geq$ 20 kΩ) should be connected between Pt 212 and Pt 213. A strong transmitter should be tuned in at the centre of the band (approx. 96 MHz) that is able to provide a reading on the S-meter. The input stages (L 201 to L 203, as well as the IF-circuits L 205 and L 211 to 213) should be aligned for maximum. Inductance L 214 can be coarsely aligned for minimum distortion.

8. 2. SYNTHESIZER MODULE

Finally, the frequency synthesizer is aligned. The oscillator input of the tuner (Pt 205) is connected using a piece of coaxial cable (length uncritical) to the input of the divider (Pt 221); the output (Pt 223) is connected to the tuning input (Pt 204) and the provisional bias voltage source is disconnected. After the digital switches have been temporarily connected to the data inputs, the operating voltages are connected to Pt 224 (+ 15 V) and Pt 222 (4. 9 to 5. 2 V, approx. 350 mA). The voltage at pin 3 of I 2213 is now measured via an 1 kΩ dropper resistor. If a voltage of 1. 5 to 3 V is indicated, the crystal oscillator and frequency divider (200) are probably working correctly. If an oscilloscope is available, it is, of course, easy to establish whether the 25 kHz square-wave signal is available at this point.

The voltmeter is now connected between Pt 223 and ground (range approx. 10 V), and a frequency of approximately 96 MHz is selected. The control circuit will lock in at a certain position when the 50 kΩ trimmer resistor is varied; this means that it should be possible to measure a tuning voltage of approximately 4. 6 V on the voltmeter corresponding to an input frequency of 96 MHz. In a synchronized state, the voltage at testpoint TP (Pt 225) should amount to approximately 1. 4 V; if required, it is possible to slightly vary the value of the 50 kΩ trimmer until this value is obtained.

8. 3. FINAL ALIGNMENT

As was mentioned previously, the final alignment is made when the individual modules have been interconnected together in its final case. A VHF/FM transmitter of moderate strength is selected, and the alignment of the input and IF-circuits is corrected measuring the voltage between Pt 212 and Pt 213; the oscillator adjustment should not have changed. If required, it can be corrected (L 204). A strong transmitter is now selected for alignment of the phase circuit (L 214, L 215). No other strong stations should be in the frequency range of $\pm$ 300 kHz. For example, it is assumed that the frequency is 97. 0 MHz. The DC-voltage values at the AF-output of the demodulator are now noted at the adjacent frequencies (in our example at 96. 8; 96. 9; 97. 0; 97. 1; 97. 2 MHz). These values are plotted in a curve as shown in Figure 7. After removing the core of L 215, inductance L 214 is aligned to obtain the most symmetrical curve. The amplitude of the measured voltage is not important since it is dependent on component tolerances. It will be in the order of 4 to 8 V at the centre frequency. The slope of the demodulator characteristic is determined by the damping resistors in parallel with L 214 and L 215.

After the most symmetrical curve has been aligned (the linearity will not be quite optimum), the DC-voltage value at the AF-output is noted with the transmitter tuned-in correctly. The core of inductance L 215 is inserted into the coil until the same value is just obtained. At this position, the reversal points of the discriminator characteristic will be symmetrical to the centre frequency.

This rather primitive alignment process will not be the most favourable method, and a swept-frequency system would simplify the IF-alignment considerably. However, the author has used the described alignment procedure several times on the prototype and has checked the alignment on a swept-frequency system. The deviations observed, were, however, not great enough that a reduction in quality was to be expected.

Finally, the alignment trimmer in series with the crystal is aligned. This is made by selecting a VHF/FM transmitter of moderate strength having no transmitters in the adjacent channels. Whilst observing the reading on a voltmeter connected between Pt 212 and Pt 213, the channel selector is switched to the adjacent channels. The trimmer capacitor is adjusted so that the reading is reduced by the same value at both sides of the required frequency.

9. ACCESSORIES

9.1. AGC AMPLIFIER WITH S-METER

High-quality HiFi receivers are usually equipped with an antenna rotator which means that some means of displaying the field strength of the transmitter must be provided to indicate when the antenna direction is correct. The AGC and indicator amplifier given in Figure 20 has been designed for this application. The input (Pt 233 and Pt 234) is connected to the DC-voltage output of the IF-amplifier (Pt 212 and Pt 213). The two transistors T 231 and T 232 form a differential amplifier similar to the classical tube voltmeter circuit having a very high input impedance to ensure that the rectifier circuit (D 211) is not loaded. The balancing resistor R 231 allows any differences between the two field-effect transistors to be compensated for. The meter is in the drain circuit. It is followed by a DC-voltage amplifier (I 231), which operates from supply voltages of + 15 V and - 6 V, in order to achieve a negative output voltage (Pt 236). The output of the AGC amplifier is connected to the AGC input of the VHF module (Pt 202).

A voltage deviation of + 6 to - 3 V reduces the RF gain by more than 50 dB so that the dynamic range of the indication is considerably increased. Trimmer resistor R 232 is aligned so that the AGC voltage at Pt 236 amounts to + 6 V without signal.

9.2. SQUELCH

Since VHF/FM broadcast transmitters transmit a continuous carrier, the squelch circuits used in conventional communications equipment will not be required. However, the noise in between stations should be suppressed during the tuning process. The voltage at Pt 225 can be used for this since it only possesses a value of 1.4 V in its locked-in condition. This voltage is larger or smaller during the tuning process according to the direction of the frequency change. The circuit diagram of this muting circuit is given in Figure 21. The DC-voltage from the phase comparitor (Pt 225) is fed via connection Pt 238 and a filter link (100 kΩ/10 nF) to the integrated amplifier I 232 and I 233. Since they are not provided with feedback, they operate at full gain as comparitors. If the input voltage increases above the potential of + 2 V determined by the diodes, the voltage at the output will become positive so that transistor T 233 will receive a positive gate voltage and will interrupt the AF-signal path. If, on the other hand, the voltage at Pt 238 falls below the switching threshold of the other amplifier (+ 0.7 V), the output voltage will be positive and transistor T 233 will be blocked. The RC-link (0.1 μF/1 MΩ) ensures that the switching voltage has a short rise-time, but a slow fall-time.

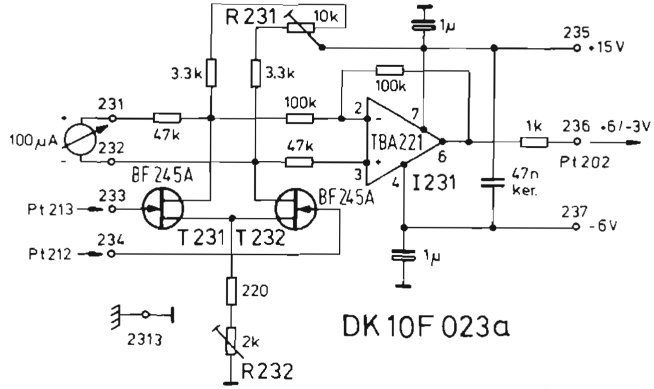


Fig.20: Circuit diagram of the AGC and S meter amplifier

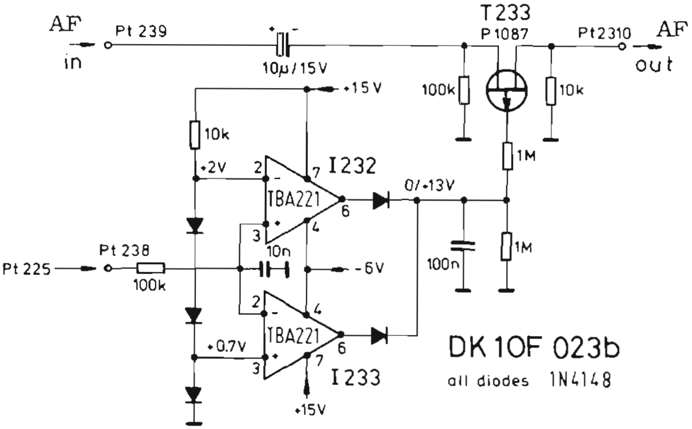


Fig.21: Circuit diagram of the squelch circuit

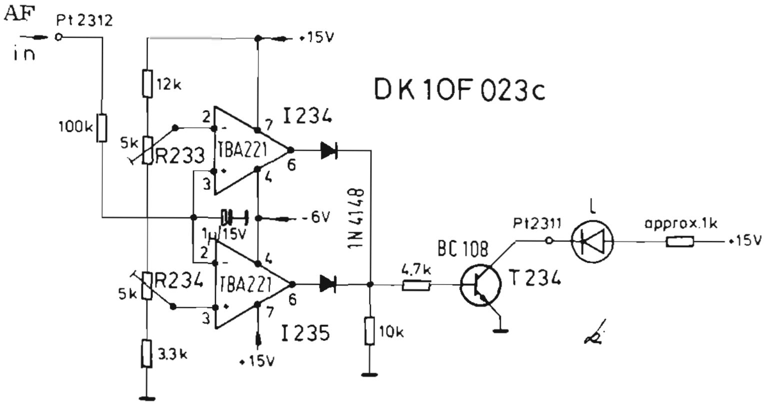


Fig.22: Circuit diagram of the tuning indicator

9.3. TUNING INDICATOR

As was mentioned in Part I of this article, the IF bandwidth of the VHF/FM receiver is greater than the channel spacing of the transmitters. This means that it is possible to tune-in a channel incorrectly, although this will not be heard. A circuit is to be described (Fig. 22) that switches-on a LED-indicator in this case. A suitable criterion is available in the form of the amplitude of the DC-voltage at the AF-output of the IF-module. As can be seen in Figure 7, this level varies by more than 0.5 V with a frequency error of 100 kHz (adjacent channel). The circuit is similar to that of the squelch, using a double-comparitor which then drives transistor T 234. This transistor then switches the operating current for the LED-indicator. The threshold values are adjustable with the aid of trimmer potentiometers R 233 and R 234. They are adjusted so that the LED-indicator is just reliably switched off when the transmitter is correctly adjusted.

9.4. PC-BOARD FOR AGC, SQUELCH AND TUNING INDICATOR

The three previously described circuits are accommodated on a single PC-board of 100 mm x 40 mm. This board has been designated DK 1 OF 023. The component locations are given in Figure 23.

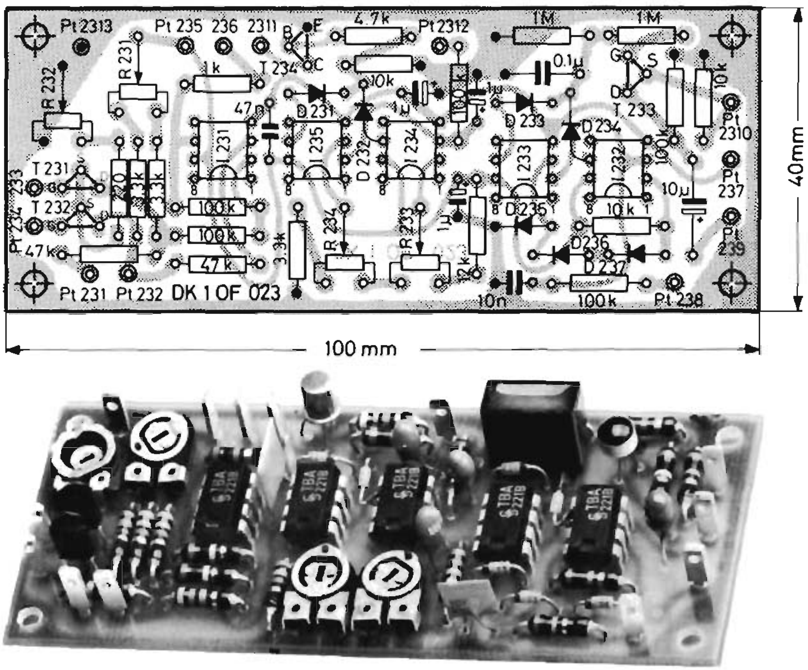


Fig. 23: Component locations and prototype of the AGC-amplifier, squelch, and tuning indicator

I 231 - I 235: TBA 221 B (Siemens) or 741 CM (various manufacturers)

T 231, T 232: BF 245 A (TI) or W 245 A (Siliconix)
T 233: P 1087, W 1087 (Siliconix) or 2 N 3820 (TI) or similar P-channel FET
T 234: BC 108 or similar silicon NPN transistor

All diodes: 1 N 4148 or similar silicon diodes

R 231 - R 234: Trimmer resistors for horizontal mounting, spacing 10/5 mm.

10. STEREO DECODER
10.1. CIRCUIT DESCRIPTION

The task of the stereo decoder given in Figure 24 is to regenerate the two AF-channels (L and R) from the demodulated IF-signal. Earlier stereo decoders used very few transistors but a large number of resonant circuits. This meant that they were often difficult to align. An integrated circuit has been available for several years now (RCA CA 3090) that only requires a single inductance in addition to the passive components. This integrated circuit possesses 125 transistors, 15 diodes and over 100 resistors. It exhibits very good specifications such as: Stereo channel separation > 40 dB, harmonic distortion < 0.3%, etc.) and requires virtually no alignment. It also offers automatic mono/stereo switching, as well as indication when a stereo transmission is present.

The multiplex signal from the squelch circuit (Pt 2310) is fed via Pt 241 and a coupling capacitor to pin 1 of the integrated stereo decoder I 241. The oscillator uses a series resonant circuit (L 241/C 241) and oscillates at twice the subcarrier frequency, e.g. 76 kHz. The RC-link at pin 14 is the filter of the phase-locked loop. The capacitor at pin 6 is used to filter the control voltage for the automatic mono/stereo switching. This voltage can be shorted partially via the 12 kΩ resistor and an external switch so that mono-reception of weak stereo transmissions is obtained. The resistor between pin 7 and pin 8 determines the threshold of the automatic switching; if the value is increased, the decoder will only be switched to stereo in the case of strong transmitters. Pin 12 is the output of the switching amplifier; an LED indicator can be directly connected via a dropper resistor to this point. The RC-links 10 kΩ/ 4.7 nF and pins 9 and 10 provide the required de-emphasis in order to compensate for the pre-emphasis provided at the transmitter. The audio output signals are fed via 1 µF coupling capacitors to the outputs Pt 244 and Pt 245. The operating voltage connected to connection Pt 246 is filtered again by the RC-link of 220 Ω/100 µF).

10.2 CONSTRUCTION

A single-coated PC-board designated DK 1 OF 024 has been designed for the stereo decoder. The dimensions are 60 mm by 40 mm. The component locations are given in Figure 25, and a photograph of the author's prototype in Figure 26.

10.3. COMPONENTS

I 241: Integrated stereo decoder CA 3090 Q or CA 3090 AQ (RCA)

L 241: 110 turns of 0.2 mm dia. (32 AWG) enamelled copper wire in a potted core of 14 mm dia. x 8 mm, A_L = 160 (B 65541 - K 0160 - A 022) with alignment components

C 241: Styroflex capacitor 3300 pF, spacing 12.5 mm

All electrolytics except 100 µF and 22 µF: Tantalum drop-types of ≥ 15 V

A spacing of 12.5 mm is available for the resistors.

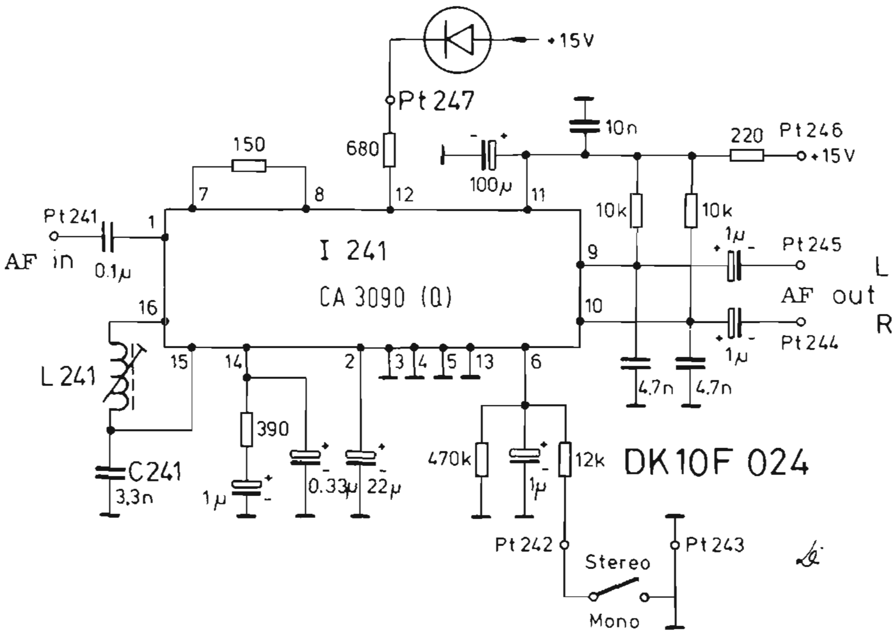


Fig. 24: Circuit diagram of the stereo decoder

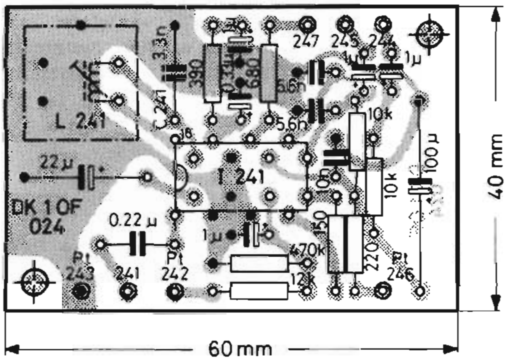


Fig. 25: Component locations on PC-board DK 1 OF 024

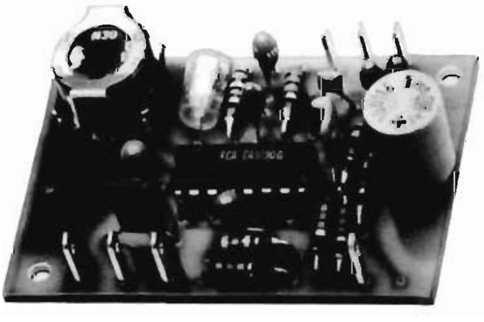


Fig. 26: Prototype of the stereo decoder

10.4 ALIGNMENT OF THE STEREO DECODER

The stereo decoder is firstly connected to the other part of the receiver, after which it is connected to the operating voltage. If a frequency counter is available, it can be connected via a capacitor of 100 pF to pin 15 of the integrated circuit and the frequency of the oscillator aligned to exactly 76 kHz with the aid of the core of inductance of L 241. The AF-input (Pt 241) should be disconnected during this measurement. If a frequency counter is not available, a weak stereo transmitter should be used for alignment. The core of L 241 should be adjusted carefully until the stereo indication actuates. The RF-input voltage is decreased using a 50 Ω composite potentiometer in the antenna line. Inductance L 241 is aligned until the stereo indication only actuates within a narrow range. It is important that the phase position of the regenerated subcarrier coincides exactly during demodulation of the difference signal (L - R), since distortion will increase rapidly otherwise due to the double sideband conversion. The above alignment procedure has been found to be very successful.

11. FINAL NOTES

Well-filtered and stabilized voltages are required for the described tuner. This is to ensure that the quality of the received transmission is not deteriorated due to "internal interference". The five modules described in this article form a complete HiFi-tuner for direct connection to a high-quality stereo amplifier.

A suitable power supply is to be described in one of the next editions of VHF COMMUNICATIONS. This power supply will provide all voltages required by the tuner.

A TRANSMIT MIXER AND LINEAR AMPLIFIER FOR 23 cm USING FOUR 2 C 39 TUBES

by R. Jux, DJ 6 UT and H. Dittberner, DL 3 MH

This mixer and linear amplifier for 23 cm is constructed from brass plate, which can be cut and soldered together easily. Four 2C39 tubes are used, each rotated through 180° so that the smallest possible spacing exists between the anode chamber of one tube and the cathode chamber of the next. The first tube is used as mixer and the subsequent three stages are linear amplifiers for 23 cm. Being a linear amplifier, the described module can be used for all modes.

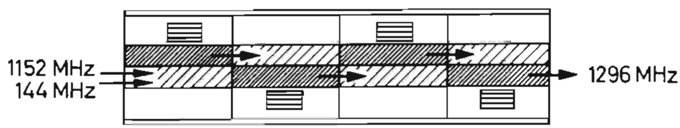


Fig. 1: Principle of the mixer/linear amplifier module

The mixer stage is fed with a crystal-controlled signal of 1152 MHz at a power-level of approximately 2 W, as well as with a signal to be converted that is in the range of 144 to 146 MHz at a level of 300 mW. If only the CW and FM modes are to be used, the crystal oscillator module can be modified to another crystal frequency so that 1296 MHz results. In this case, the whole linear amplifier including mixer stage can be used for amplification. There are several possibilities of providing the oscillator voltage required, and further details in the form of a block diagram regarding this are to be given at the end of this article. The last frequency doubler is to be described which is also equipped with a 2C39 tube.

The following article is to describe the construction and alignment of this mixer/linear amplifier module in detail. The construction of this module from brass plate and not from lathed and milled parts does make the manufacture possible to a large number of amateurs, however, we are dealing with UHF cavity resonators, which means that the parts must be constructed carefully. A large number of these modules have been constructed and are working successfully. Several photographs and diagrams are given to assist construction.

1. MECHANICAL CONSTRUCTION OF THE CHASSIS

The photographs given in Figures 2 and 3 show the finished chassis which must be constructed firstly.

1.1. MATERIAL AND DIMENSIONS

Semi-hard brass plate of 1.5 mm thickness is used for all parts of the described module. It is possible for all parts to be cut by hand, but attention must be paid that the given dimensions are maintained. The following parts are required:

Part	No. required	Dimensions	Notes
Grid plate	1	71 x 284.5 mm	Fig. 4
Side panels	2	39.5 x 284.5 mm	Fig. 5a, 5b
Intermediate panels	6	71 x 50 mm	Fig. 6
End plates	2	93 x 101.5 mm	Fig. 7 (Bend up at the dashed lines)
Anode chamber cover	4	70 x 74 mm	Fig. 8
Anode plates	4	65 x 65 mm	Fig. 9
Dielectric plates	4	65 x 65 mm	As Fig. 9 but from insulating material such as PC-board without copper coating. 0.5 mm thick
Covers	4	65 x 65 mm	As Fig. 9 but from insulating material such as PC-board without copper coating. 1.5 mm thick.

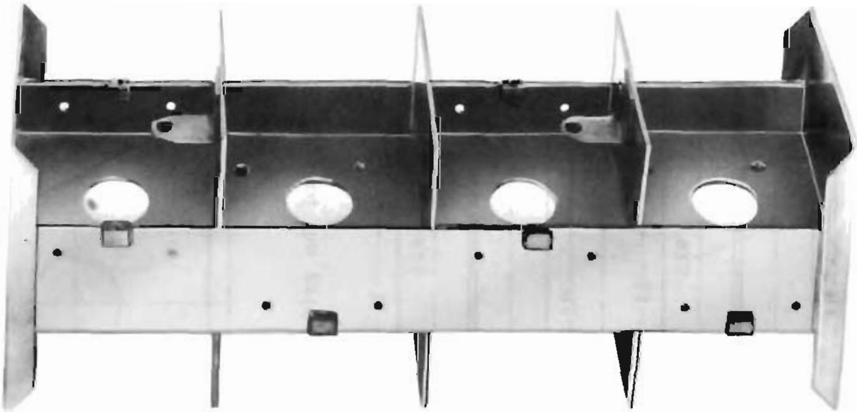


Fig.2: Lower side of the chassis before silver plating

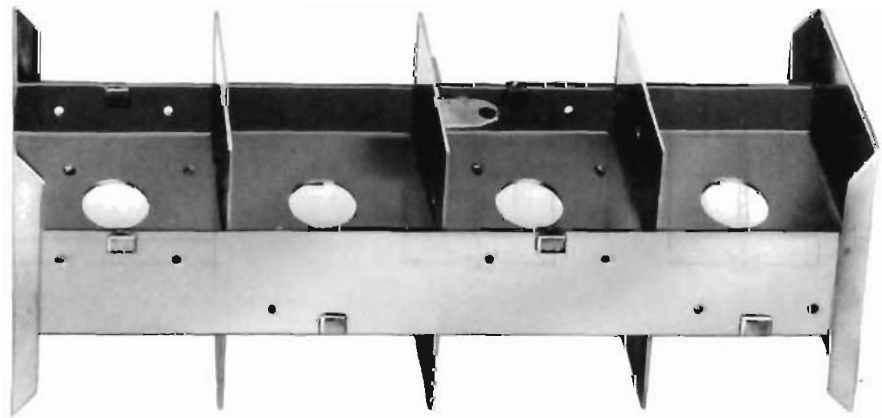


Fig.3: Upper side of the chassis

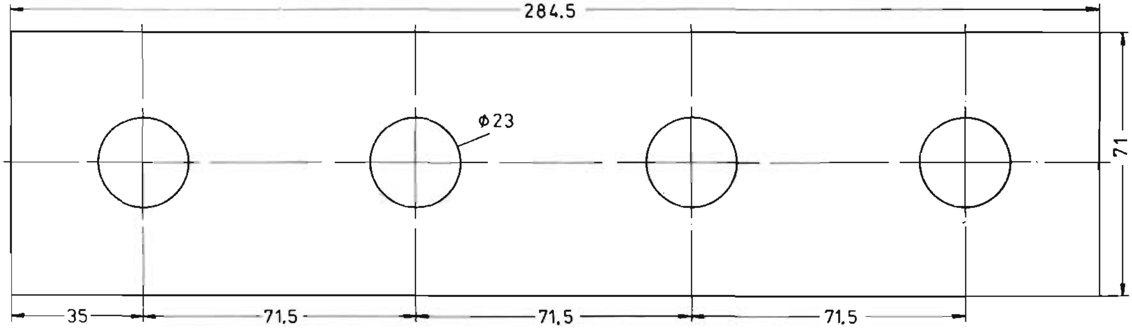


Fig.4: Dimensions of the grid plate

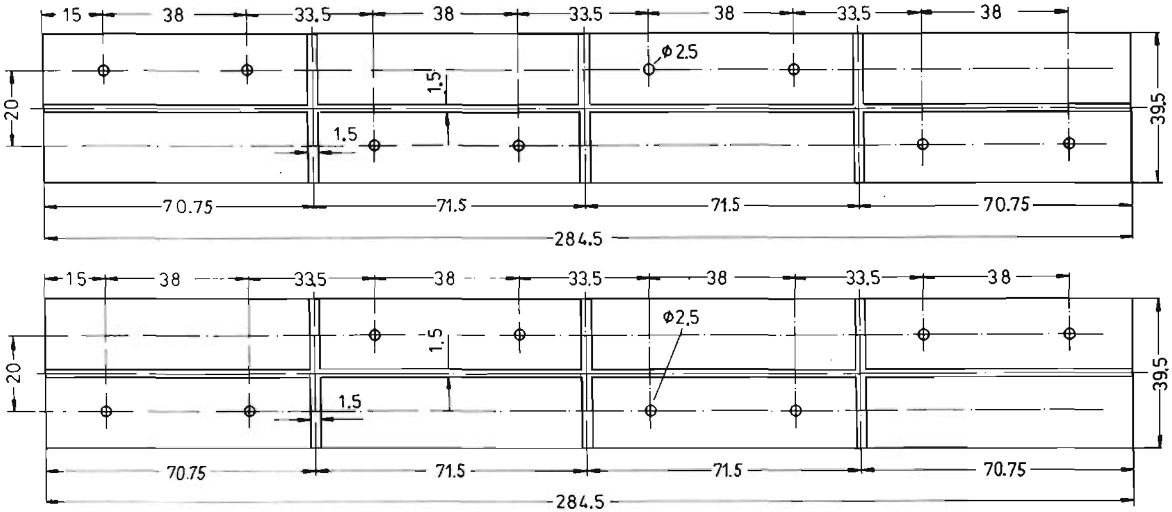


Fig.5: Dimensions of the two side panels

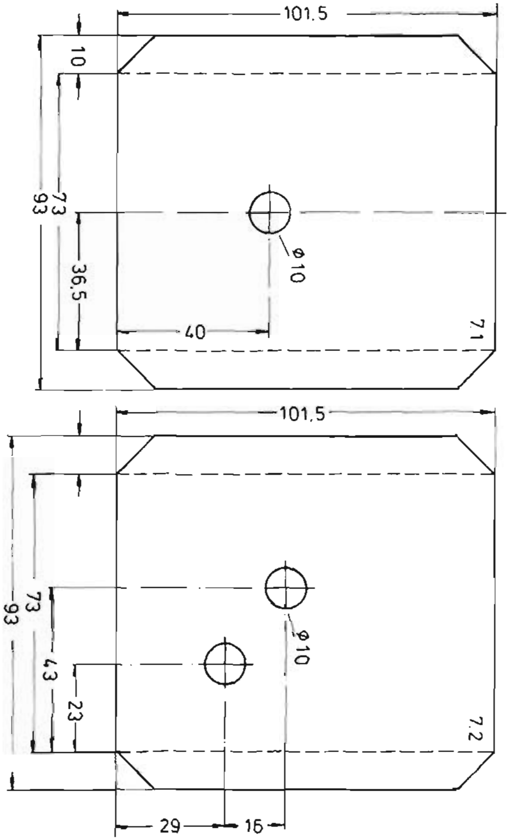


Fig.7: The two end plates

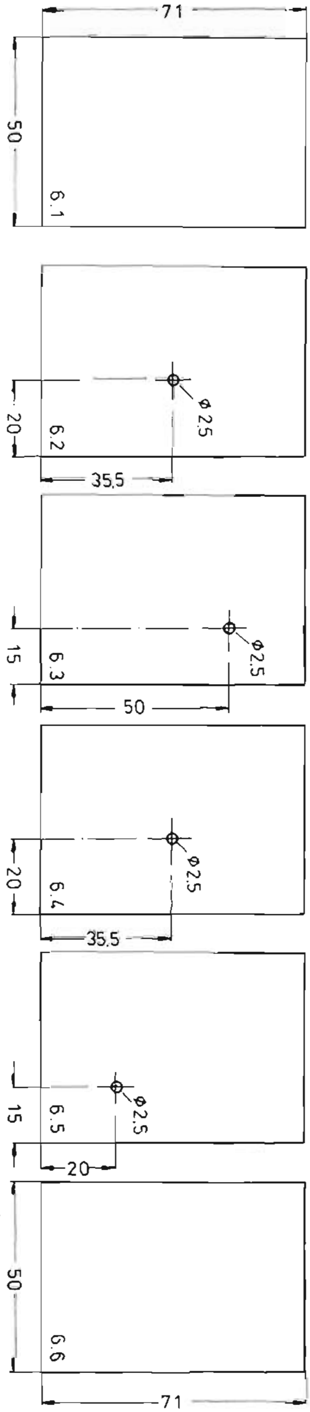


Fig.6: The six intermediate panels

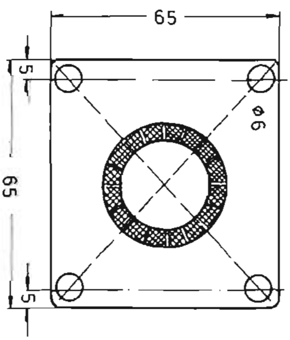


Fig. 9:

Anode plates (4 pcs.)
Dielectric plates (4 pcs.)
Cover plates (4 pcs.)

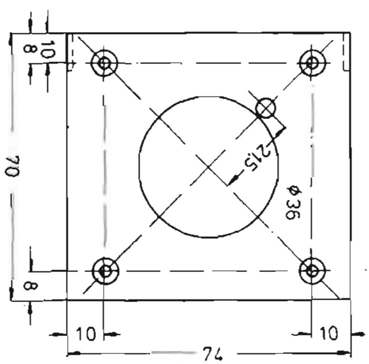


Fig. 8:

Anode cavity cover

1.2. CONSTRUCTION OF THE CHASSIS BY HARD SOLDERING

After all the required parts have been cut, they should be drilled with the required holes according to the drawings. The two end plates should be bent as shown in Figure 7 so that 73 mm spacing exists between the reinforcing edges and the grid plate after the side panels have been soldered into place. In order to ensure that the spacing of 73 mm results, the side panels should be carefully fitted into the slots shown in Figure 5. The width is dependent on the material used, thus 1.5 mm, and the depth amounts to 0.5 mm. This can be done with a small drill and a saw blade of 1.5 mm thickness. If this is not possible, it would also be possible for the chassis to be constructed using soft solder (See Section 1.3.).

After the slots have been sawn, the side plates are pushed past the grid plate and the two end plates are placed over them facing the correct direction. If the end plates have been bent correctly, they will clamp the various parts together. Attention should be paid that the grid plate is exactly at the centre of the end plate. It is now possible for the six intermediate panels (Fig. 6) to be inserted in the correct positions. The whole chassis is now hard soldered.

Three mounting brackets are required for the cathode trimmers on the intermediate panels 6.1., 6.3., and 6.5. The dimensions and positions are given in Figure 10. They are also hard soldered or screwed into place. Finally, it is necessary to mount the insolating supports above the cathode connections. In the author's prototype, rectangular metal blocks with a 3 mm threading were soldered to the outside of the side panels which can be seen clearly in Fig. 3. Of course, it is also possible to solder 3 mm nuts at the required positions.

1.3. CONSTRUCTION OF THE CHASSIS BY SOFT SOLDERING

In this case, it is necessary to change the dimensions of the metal parts slightly: Grid plate 70 x 282.5 mm and intermediate panels 70 x 50 mm.

When soft soldering the chassis, the grid plate, side panels and end pieces are fitted together and the end pieces are bent tightly and exactly so that the individual pieces are held together firmly. The various plates are now soldered together at certain points. Attention should be paid that no soldering is made within the chamber but on the outside. The intermediate panels can now be inserted and fixed into place. Finally the whole chassis can be soft soldered together.

Four wooden blocks having the same size as the cavity resonators simplify the construction. They are placed into the cavity chamber after which the intermediate panels are inserted. This allows a construction without milling and sawing.

The heat capacity of the completed chassis is so great that there is no danger of the chassis coming apart whilst soldering on the anode chamber covers or when soldering the trimmer and feedthrough capacitors into place. Of course, attention must be paid that the chassis does not get too warm.

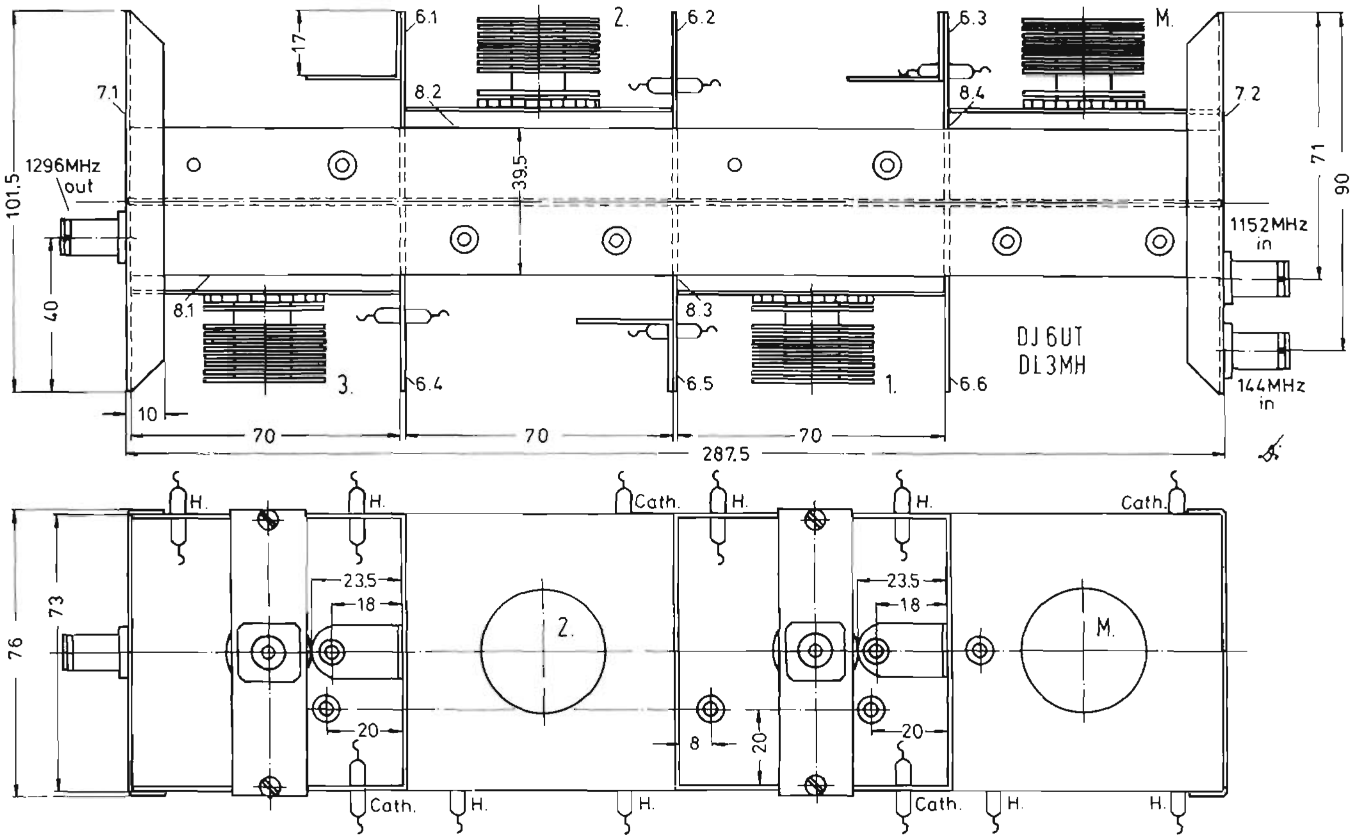


Fig.10: Drawing of the complete mixer/linear amplifier module from the side and above

2. CONSTRUCTION OF THE OTHER PARTS OF THE CHASSIS

The photographs of the completed module given in Figures 11 and 12 give an idea of the positions of these parts. Figure 10 should also be referred to in this section. Further details are given during the various steps.

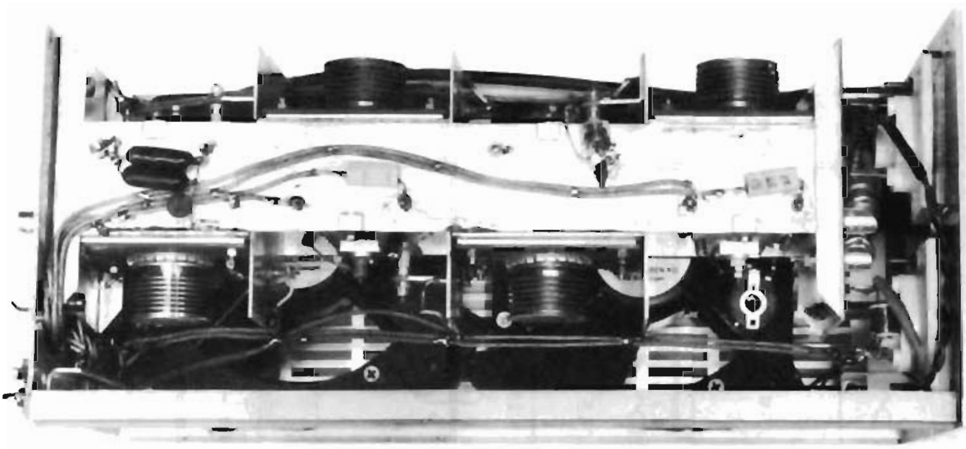


Fig. 11: Prototype module from DL 3 MH

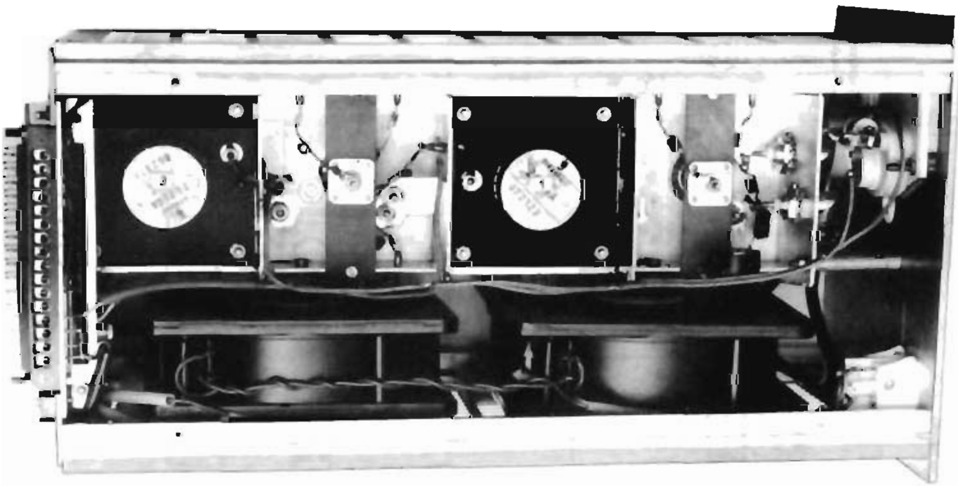


Fig. 12: Prototype from the side

2.1. CONTACT STRIPS FOR THE GRID AND ANODE PLATES

The length of the contact strips for the anodes and grids of the tubes is designed so that the rings are firmly held in the appropriate holes. Figure 13 shows how the contacts should be after completion. The contact rings should now be soft soldered into place.

After completion, the chassis, cover of the anode chambers (Fig. 8), and anode plates should be silver plated. Unfortunately, it is not always easy to find such a company that is willing to silver plate small quantities. It is a matt silver finish that is required, and the type of silver plating used for cups and knives etc. is not very suitable.

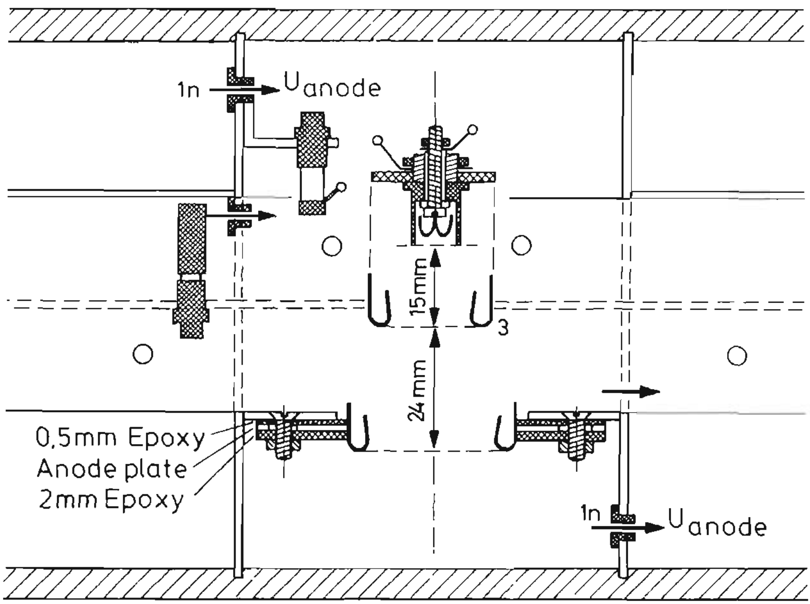


Fig. 13: Tube contacts, installation of the trimmers and feedthroughs

2.2. FURTHER PREPARATIONS AND INSTALLATION OF THE TRIMMERS

Ten ceramic tubular trimmers having a capacitance of less than 5 pF are required for the module. The authors used professional trimmers which are shown in the illustrations.

The three trimmers C 6, C 10 and C 14 in the mounts on the cathode side of the tubes are placed as they are into the hole of the mount and soldered. These capacitors are not critical so that other capacitor types can be used.

The other seven trimmers should be modified: The short cap with the solder tag is removed. This can easily be achieved with the aid of a pocket knife. Small silver-plated tubes should be used instead of these caps. The length of these pieces of tube is 13 mm for C 4, C 8, and C 12, and 18 mm for trimmers C 3, C 7, C 11 and C 15 (Fig. 14). These tubes are made from semi-hard brass strips, 0.5 mm thick. They are then shortened to 13 or 18 mm and rolled around a drill shaft that is a few tenths of a mm narrower than the ceramic part of the trimmer. After silver plating, the tubes should fit tightly on the ceramic part of the trimmer.

A wire of at least 1 mm diameter is now soldered to trimmers C 4, C 8, and C 12. The bent end should be just as long as the trimmer body, and should be soldered with a sufficient amount of solder along the whole length so that there is sufficient mass to ensure that the joint does not open on heating the chassis or making other solder connections to the other end of the wire. The three trimmers are now dismanteled, and the wire placed through the ceramic feed-through of the anode chamber. The main part of the trimmer is now placed through the hole in the grid plate, into the silver-plated tube, and soldered into place.

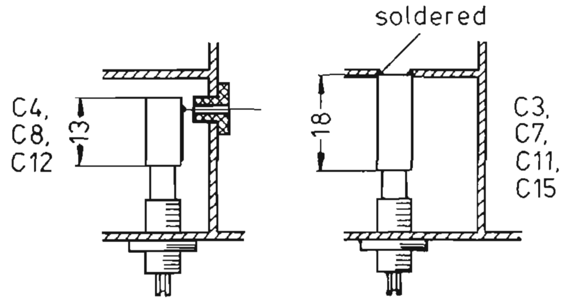


Fig. 14: Installation of the tubular trimmers

The main parts of the trimmers C 3, C 7, C 11, and C 15 are soldered into place in the holes of the grid plates. The tubes must be mounted after soldering the anode chamber covers into place. This is made through the holes opposite each of these trimmers (See Section 2.5.).

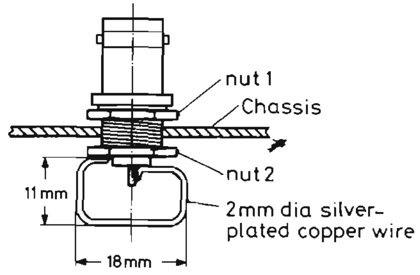
2.3. INSTALLATION OF THE FEEDTHROUGH CAPACITORS

A total of 16 feedthrough capacitors are required whose values should be in the order of 100 pF. If this value should not be sufficient, it is always possible to solder a disc capacitor in parallel. The feedthrough capacitors can be soldered into place; however, it is advisable to use types with a screw-fitting for the high voltage lines due to their higher voltage ratings. In fact, the latter type have been found more favourable, since a large number of the capacitors for solder mounting break even at relatively low temperatures.

2.4. PREPARATION AND INSTALLATION OF THE BNC-OUTPUT CONNECTOR

The BNC output connector is variable on the front panel of the output stage. A BNC connector is used with long threading; the spring, or locking washer should be removed. A second nut is required so that the connector can be countered after the correct output coupling has been found.

The first nut is screwed loosely to the end of the threading, after which the connector is placed through the hole in the anode chamber. The second nut is now screwed into place at *the beginning of the threading and soldered to* the connector. It is now possible to solder the coupling link between inner and outer conductor of the BNC connector. The dimensions of this output link are given in the opposite drawing. It is made from 2 mm diameter silver-plated copper wire.



It has been found that there is some danger of the solder melting later. It is not possible to hard solder the coupling link to the connector, since this would damage the teflon dielectric. It is therefore necessary for both ends of the coupling link to be provided with enough solder so that they are completely covered. It should then be possible to solder the anode chamber of the output stage without unsoldering the coupling link at the same time.

2.5. PREPARATIONS AND SOLDERING OF THE ANODE CHAMBER COVERS

The following must be done before silver plating:
Covers 1 and 4 (designated 8.1. and 8.4. in Fig. 10) are provided with cut-outs at the outer corners so that they can be fitted closely to the end pieces. As can be seen in Figure 8, the four covers are provided with a hole for the tubes of the trimmers C 3, C 7, C 11, and C 15 in addition to the large central hole which must be at least 2 mm larger than the contact ring of the anode plate. In addition to this, four countersunk screws are soldered to the corners. This is to mount the anode plate, dielectric plate and covers together as is shown in Figure 13. These screws should be hard soldered since they would not remain soldered if soft solder were to be used.

The silver-plated anode chamber covers can now be soft soldered into place on the resonator chambers. This is done by mounting the anode plates with dielectric and cover loosely and plugging everything together with the aid of an old 2C39 tube. This ensures that the contact rings are truely concentric to another. The holes for the trimmer capacitors must also be exactly opposite the main part of the trimmer which is mounted on the grid plate. It is then possible to fix the cover into place by soft soldering at several positions around the edge. After this, the tube and dielectric plates are removed and the soldering process is completed.

2.6. MANUFACTURE OF THE CATHODE CONTACTS

Four modified BNC panel connectors are used for the cathode/heater contacts. The outer conductors of the BNC connectors are shortened so that 10 mm to 11 mm remains when measured from the flange end. The outer conductor is now provided with four narrow slots so that it can spring back slightly. The inner conductor is now removed and replaced by a screw. A piece of contact strip as used for the anode and grid contacts is now soldered into the slot at the head of the screw. A drawing of this is given in Figure 13.

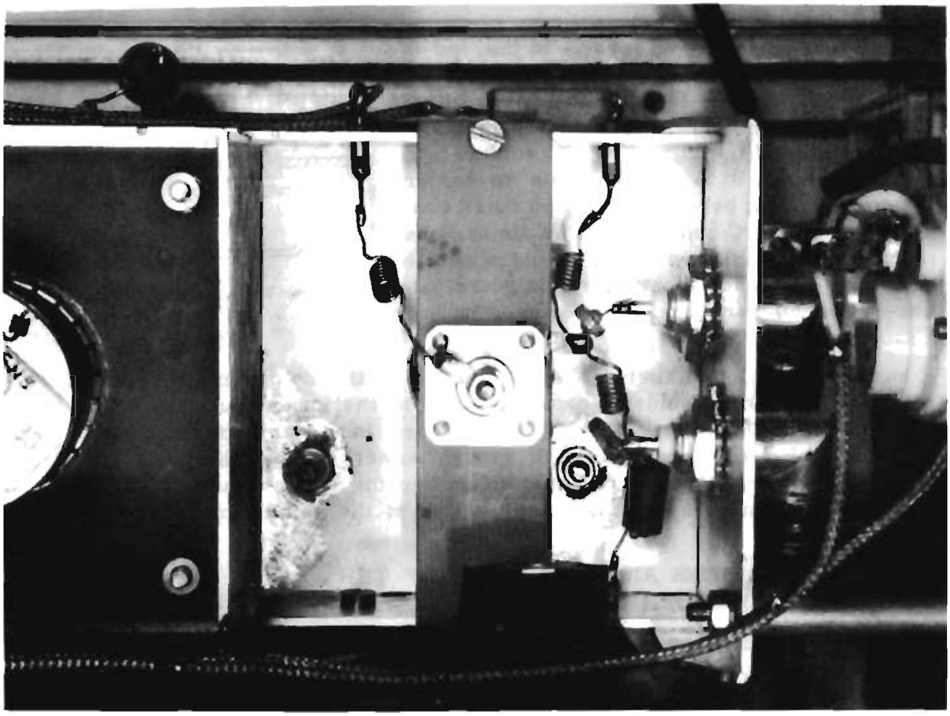


Fig. 15: Close-up view of the cathode side of the mixer stage

If BNC connectors are not to be used, it is possible to make the contacts from brass tape. This means that the insulated support shown in Figure 15 will no longer be required.

3. ELECTRICAL CONNECTION

It is now time to install the chokes, coupling and bypass capacitors, as well as the cathode and heater resistors (Fig. 16). With the exception of L 2 (Six-hole ferrite core), all chokes are $\lambda/4$ chokes from approximately 0.5 mm diameter enamelled copper wire, wound on a 3 mm diameter former, self supporting.

The value of the cathode resistors R 1 to R 4 must be optimized during the alignment process; it is very dependent on the state of the tube, drive level and alignment. Values between 50 Ω and 100 Ω can be used to start with.

In order to ensure operation quickly, it is advisable to heat up the tubes with a heater voltage of 6.3 V, and to switch in dropper resistors after one minute so that the heater voltage drops to approximately 5.5 V. Further details were given in (1).

The coupling and bypass capacitors are all given in the circuit diagram. The value of 100 pF for the latter is only an orientation value. Probably not all of these capacitors are really necessary, however, they seem very advisable at both ends of the cathode chokes.

The four tubes are cooled by two axial blowers in the author's prototype. The tubes are mounted in the case so that they are horizontal and are cooled by the air flowing from below. These blowers are very quiet and only a slight hiss can be heard. Unfortunately, they can only be obtained for a voltage of 115 V (Papst 4800), which means that two must be connected in series when used on 220 V AC. This cooling is very efficient so that it is possible to run the power amplifier stage from an anode voltage of 750 V. The blowers should be switched on together with the heater voltage.

A multi-pin connector is provided on the rear panel for monitoring all operating and measuring voltages. Three BNC connectors are also provided for the 1152 MHz and 144 MHz input freqiencies and for the 1296 MHz output. The feeding of the mixer inputs along the whole length of the module results in a tendency to oscillation, which requires some neutralization.

All operating and measuring voltage lines should be screened, and grounded where possible. It is possible that twisting the wires would be sufficient, but this was not tried.

The coaxial cable from the input of the mixer, where a corner BNC connector should be used, is passed along the lower aluminium rail to the rear panel of the module. It is then screened using a thin brass strip which is bent around it. It was also necessary for the two BNC sockets to be grounded to the chassis of the module using an 8 mm wide brass strip, even though both connectors are mounted on metal panels. This will not be necessary if both connectors are mounted on the front panel.

Two meters are required: One each for the anode current of the mixer and output stage (The author did not monitor the intermediate tubes). It is easy to see on the anode current meter of the mixer whether the mixer is oscillating. The current should drop considerably on removing the 144 MHz signal (Power mixer).

4. ALIGNMENT

If one is not able to measure the local oscillator frequency of 1152 MHz (Absorption wavemeter), it is advisable to prealign the module using a 1296 signal from a 70 cm transmitter and varactor tripler. Since a power mixer is being used, an input power of approximately 1 W will be required, that is fed to the 1152 MHz input. This is followed by connecting the local oscillator signal to the input. If the output power is approximately the same, then its frequency can be assumed to be correct.

The mixer stage is provided with an anode voltage of 300 V for the preliminary alignment, and the intermediate and output stages 500 V. The mixer is driven with 300 V at all times, whereas the intermediate stages can be increased to 600 V and the output stage to 750 V later. During the alignment process, the stage being aligned and the previous stages are provided with anode current. Each stage is aligned for maximum voltage drop across the cathode resistor of the following stage. It has been found that no orientation values can be given since there are great differences between individual tubes. As an example, the voltage drop across the cathode resistor of tube 2 amounted to 0.1 V without drive and 2.1 V under full drive conditions.

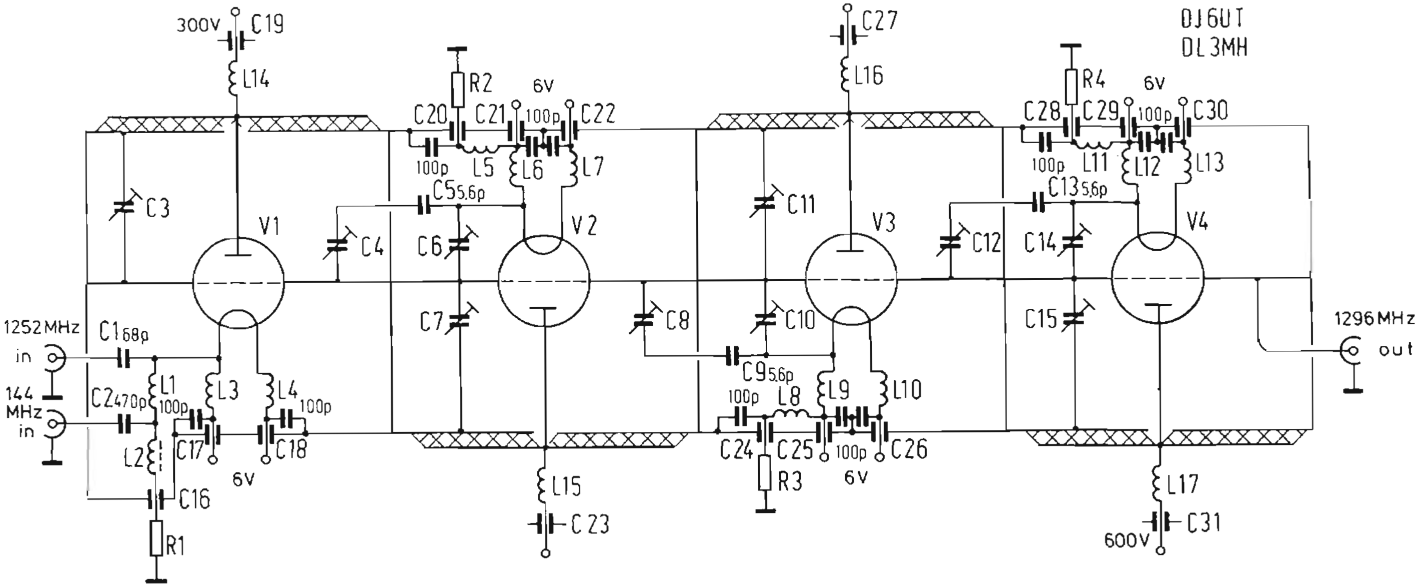


Fig.16: Circuit diagram of the 1296 MHz mixer/linear amplifier module

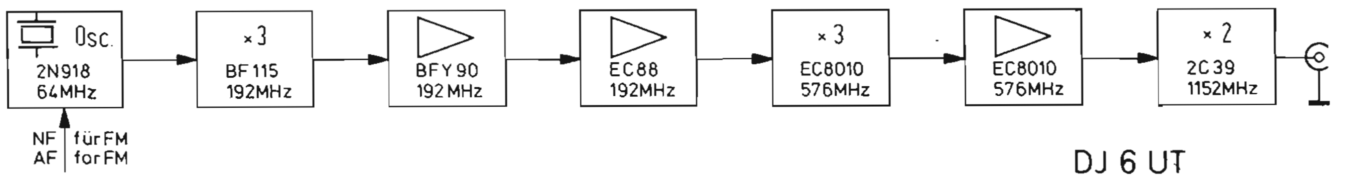


Fig.17: Block diagram of a suitable local oscillator

A certain care must be taken whilst aligning the tubular trimmers. The spindle should not be inserted too far since it could fall into the cavity. One could then try and drill a hole opposite the trimmer on the other side and try and rotate it back into the trimmer. This is, however, somewhat difficult. Furthermore, one should not adjust the trimmers too often since this will deteriorate the contacts of the trimmers.

The prototype manufactured by DL 3 MH was operated with an injection power of 2 W from the local oscillator (1152 MHz), and a signal power of 500 mW at 144 MHz. The alignment is firstly made with the side panels of the case removed, and corrected after these panels have been mounted into place.

The output connector is rotated for maximum output power. The external nut should be tightened until the connector can just be rotated with the cable connected. It is then tightened completely after the most favourable position has been found. If the module is aligned at 1297 MHz, no further alignment will be required over the whole of the 2 MHz wide communications band.

The output power was measured with the aid of a terminating resistor and through-line probe. It amounted to 22 W at a plate voltage of 750 V for the output stage. The mixer stage was driven with 1.9 W at 1152 MHz and 0.5 W at 144 MHz. According to the experience gained using several different tubes type 2C39 A and 2C39 BA, it should still be possible to increase the power output further. Unfortunately, no further tubes were available at the time of measurement, especially none of the YD-series, so that it is difficult to give the values for the output power when using better tubes. This form of construction does have a certain weakness: the coupling from stage to stage: It is not optimized and the usual gain per stage of 10 dB (at low power levels) has not been achieved.

5. LOCAL OSCILLATOR INJECTION

There have been so many descriptions showing how the 1152 MHz local oscillator signal can be generated from a lower frequency crystal that it is not to be repeated in detail here. The basic set-up is shown in Figure 17. However, the last doubler stage equipped with the 2C39 tube is to be described in more detail (Fig. 18). A similar construction is used as for the transmit mixer module. The modified trimmers 7 and 8 and BNC connector 12 have also been used for the cathode/heater connections. The main support is the grid plate 1; the side panels of the cavity are soldered to this plate. The anode cavity cover 4 is very similar to those used in the mixer module with dielectric plate 3 and insulating plate 5. The cathode chamber can remain open or closed. The cathode connection 12 and two brackets for the feedthrough capacitors 15 are mounted on an insulated support, which ensures that the tube is mounted correctly within the chamber.

It is only important that the cavity dimensions of 70 mm by 70 mm by 20 mm be maintained exactly. When driven sufficiently, e.g. from an EC 8020 tube, and modification of the frequency plan, it is possible to use this stage as power amplifier in an FM/CW transmitter.

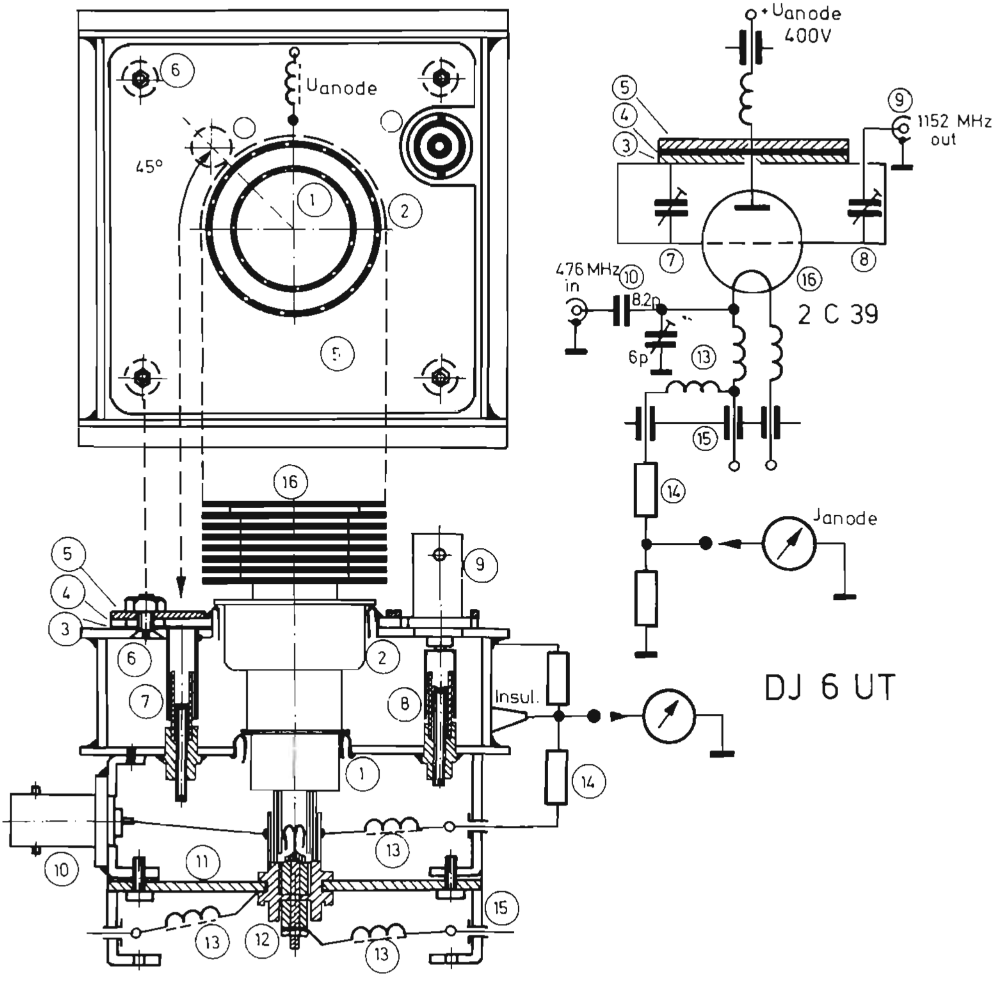


Fig. 18: Last frequency doubler 476/1152 MHz of the local oscillator

6. REFERENCES

(2) A. Trautrim: A Stripline Power Amplifier for 70 cm Using a 2C39 Tube
VHF COMMUNICATIONS 4, Edition 3/1974, Pages 144-157.

A RECEIVE CONVERTER FOR THE 13 cm BAND WITH DIODE MIXER

by A. Schädlich, DL 2 AS

A simple, but relatively high performance converter is to be described for the 13 cm band (2304 MHz to 2306 MHz). The main features of this converter are the single diode mixer without preamplifier stage using air-spaced stripline circuits for selectivity at SHF-level. The circuitry and construction are very similar to the 23 cm converter described in (1). However, $\lambda/2$ striplines are used for the 13 cm converter that are tuned with the aid of home-made trimmer capacitors.

No components are required that are expensive or difficult to obtain. Furthermore, hardly any metal work is required. The dimensions of the converter are 110 mm x 68 mm x 43 mm and the weight is only 160 g. This means that it is extremely suitable for mountain top field days where compact dimensions and light weight are extremely important.

The sensitivity of this converter is mainly dependent on the diodes used in the mixer and on the first intermediate frequency amplifier. The author was not able to measure the noise figure, but comparison to another converter equipped with a BFR 14 transistor in the preamplifier shows that the described converter was inferior by approximately 3 dB.

1. CIRCUIT DESCRIPTION

The circuit diagram of the converter is given in Figure 1. The local oscillator frequency uses a 40 MHz crystal since crystal oscillators using the third overtone operate more stably and are easier to align than those using the fifth or even seventh overtone. It is often very time-consuming to find the required neutralization inductance to compensate for the capacitance of the crystal holder. The frequency (40 MHz) of the crystal oscillator is multiplied by nine in two tripler stages. A high-quality UHF preamplifier transistor in a TO 72 metal case is used for the first three stages. The author used transistors BFX 89 (Siemens), but similar types with a transit frequency of 1 GHz from other manufacturers can be used. It is possible that the circuit will also operate with cheaper transistors, however, considerable time can be saved when high-quality transistors are used, especially where little measuring equipment is available, and the constructor does not have a great deal of experience at SHF.

The 360 MHz signal is fed via a bandpass filter to transistor T 4, which amplifies the signal to approximately 60 mW. A wellknown transistor type 2 N 3866 is used here which should be soldered into place with the shortest possible connection leads. This transistor operates in class AB with a quiescent current of approximately 4 mA. Editorial note: Transistors are obtained under the designation 2 N 3866 from a large number of semiconductor manufacturers which differ so greatly from another that they can hardly be classed as the same transistor type. Some of these transistors hardly provide any gain, whereas others oscillate wildly even in the DC-test circuit. This means that attention must be paid that these or other standard transistor types are obtained from wellknown manufacturers and not from third, fourth or even lower quality sources.

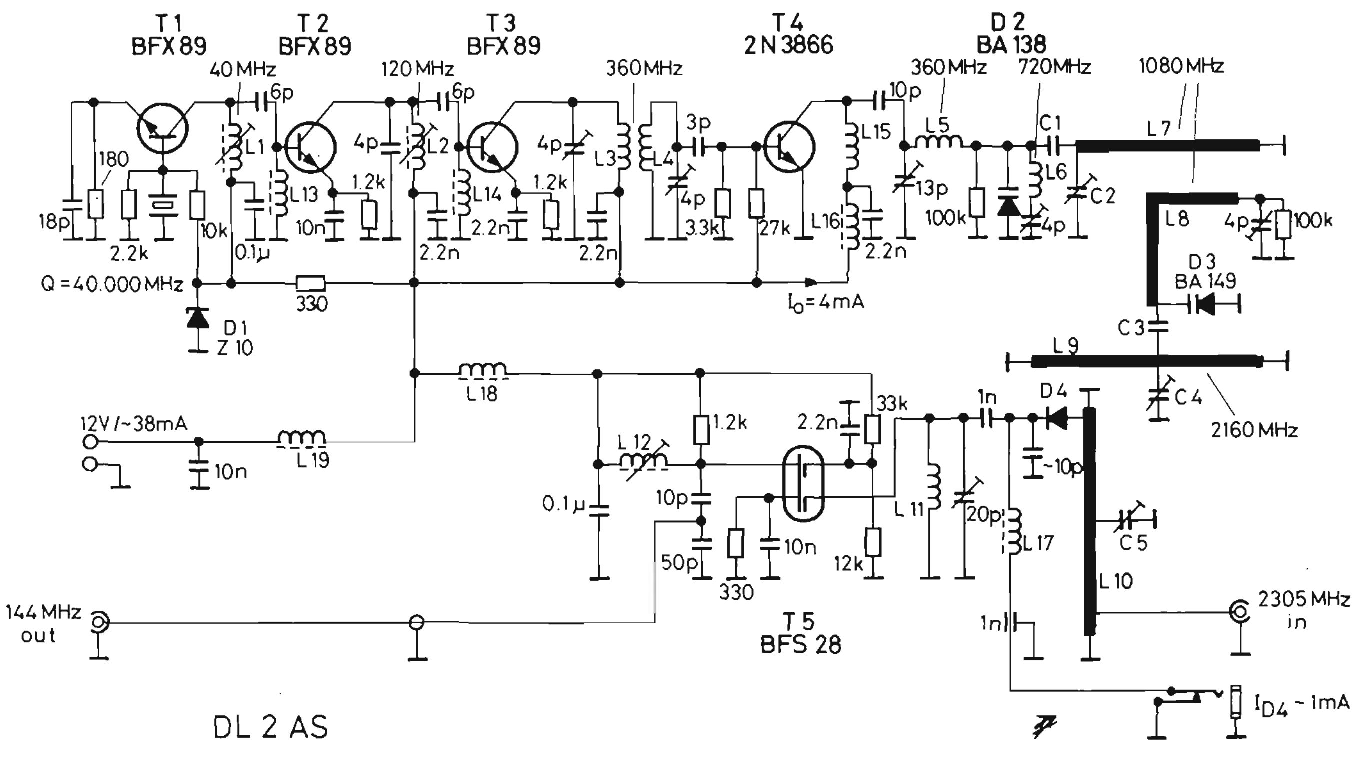


Fig.1: Circuit diagram of the 13 cm receive converter

The frequency of 360 MHz must now multiplied by six. This is obtained in two varactor multipliers: The first multiplier uses a diode BA 138 or BB 105 for D 2 and triples the frequency to 1080 MHz; the second multiplier uses a diode BA 149 or BB 105 as D 3 which doubles the signal to the required output frequency of 2160 MHz. This frequency plan allows the alignment to be made step by step. Furthermore, the large frequency spacings improve the selectivity of the lower frequency, intermediate stages of the local oscillator. A $\lambda/4$ air-spaced stripline is used at 1080 MHz, and a similar stripline of $\lambda/2$ in length at 2160 MHz.

The 2304 MHz input circuit comprises a $\lambda/2$ line which is capacitively shortened at the centre (max. voltage) with the aid of a home-made trimmer with which it is aligned. The input socket is galvanically connected near to one end of the line; and the mixer diode is connected to the other end of the stripline circuit with the aid of a clamp. This can be seen clearly in the photograph of the authors prototype given in Figure 2. It will be seen that the diode is mounted to one end of the 2160 MHz stripline circuit and is thus coupled to the local oscillator. The IF-side of the mixer diode is also held in a clamp which is soldered to a small metal disc which forms an SHF bypass capacitor of a few pF using a PTFE (teflon) foil between it and the ground surface.

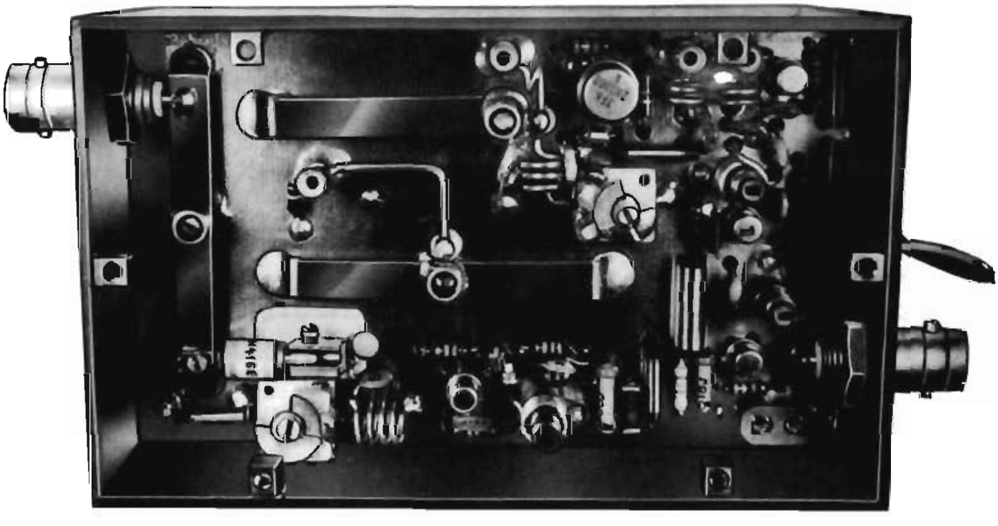


Fig. 2: Upper view of the author's prototype

The author uses a point-contact diode type 1 N 416 (which is equivalent to type 1 N 21) as mixer diode. The last letter of the designation ("E" in the prototype) indicates the maximum noise figure of the diode, which decreases in alphabetical sequence: E = 7 dB at 3 GHz; G = 5.5 dB at 3 GHz, etc. These specifications are valid for a local oscillator power of 0.5 mW. If a letter "R" is given at the end of the designation, this will indicate that the polarity of the diode is reversed. For amateur application, this will only mean that the meter for monitoring the diode current should also be reversed. Of course, a SHF Schottky diode could also be used instead of the point-contact diode (for example HP 2817). In this case, no clamps are required and the diode can be soldered into place using extremely short connections.

The author did not use a built-in meter for monitoring the diode current. An external meter was connected via a connector during the alignment process. At one time, it was necessary to monitor the diode current on switching on a SHF converter, however, this is no longer necessary when using modern techniques. Nowadays, it is relatively easy to design the local oscillator circuit so that it will operate reliably under fluctuations of the operating voltage and temperature, as well as under shock conditions.

A dual-gate MOSFET transistor (T 5) is used as IF preamplifier. It is connected to the SHF bypass capacitor of the mixer diode. The input and output circuits of this stage are tuned to 145 MHz. Neutralization is not required. The author used a transistor type BFS 28 (Philips), however, the wellknown RCA types 40673 or 40841 are just as suitable.

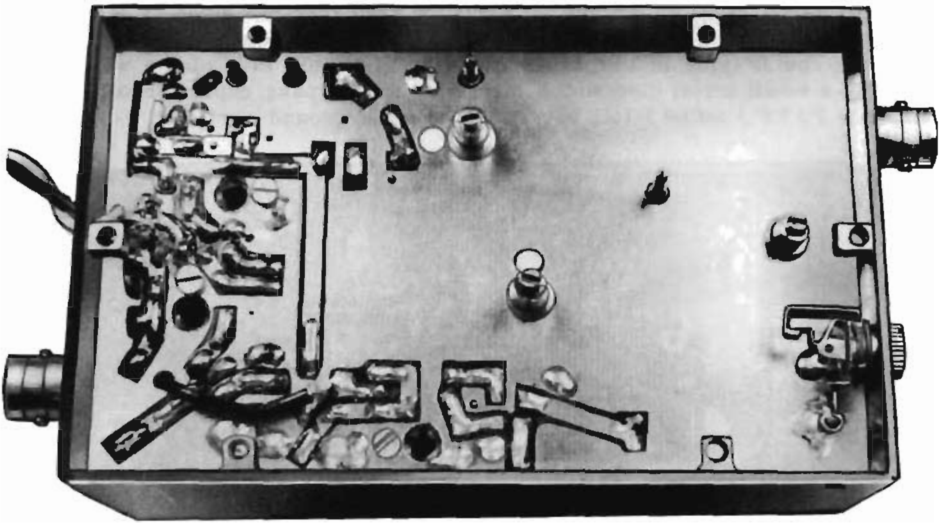


Fig. 3: Lower view of the author's prototype

2. CONSTRUCTION

The described 13 cm converter is built up on a 107 mm x 65 mm double-coated PC-board. A framework of 40 mm high panels of single-coated PC-board material are soldered to the board. Upper and lower panels of the same material are screwed into place after completion. A lower view of the author's prototype can be seen in the photograph given in Figure 3. It will be seen that only a few printed conductors are present for the first oscillator stages and for the IF preamplifier. The upper side of the PC-board (Figure 2) is not etched; it is only necessary for a small area around the holes to be removed so that the components are not shorted to the ground surface. The ground connections of the bypass capacitors, the cold ends of the inductances, striplines, trimmers and the emitter of transistor T 4 are directly soldered to the copper surface on the component side of the board (Fig. 2). Figures 4 to 8 give the dimensions of the individual parts of the converter including the striplines and trimmers.

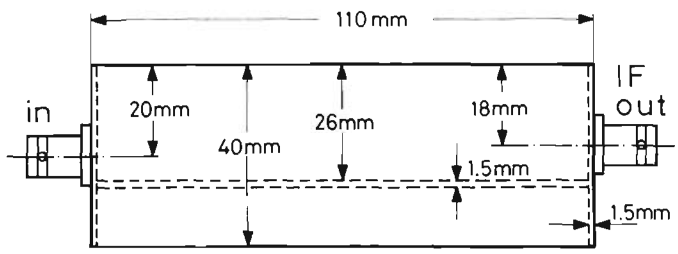


Fig.4: Dimensions of the case

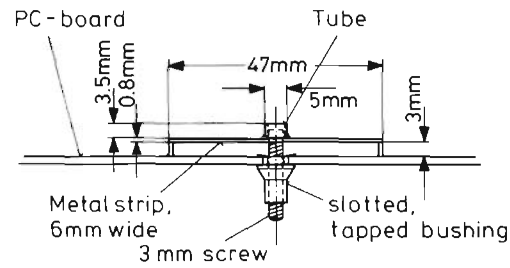


Fig.6: Stripline L 7 of the oscillator

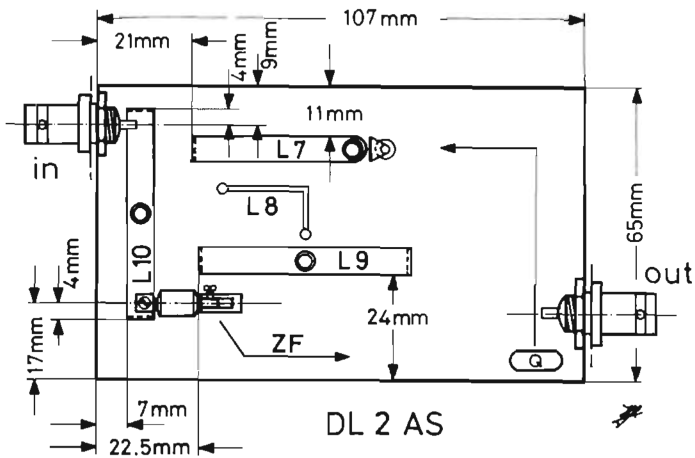


Fig.5: Upper side of the PC-board
with striplines and diode

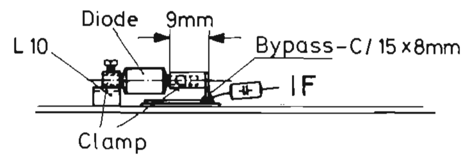


Fig.7: Diode holder

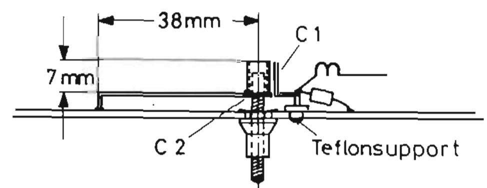


Fig.8: Striplines L 9 and L 10

2.1. INDUCTANCES

L 1: 19 turns of 0.3 mm dia. (29 AWG) enamelled copper wire wound on a 5 mm coilformer with core (red)
L 2: 5.25 turns of 1 mm dia. (18 AWG) silver-plated copper wire wound on a coilformer and core as L 1
L 3, L 4: 2.5 turns of 1 mm dia. (18 AWG) silver-plated copper wire wound on a 4 mm former, self-supporting
L 5: 3 turns, otherwise as L 3
L 6: 1 turn, otherwise as L 3
L 7: Stripline see Figure 6
L 8: 28 mm length of 1.5 mm dia. (15 AWG) silver-plated copper wire spaced 3.5 mm from the ground surface
L 9, L 10: Striplines see Figure 8
L 11: 4 turns of 1 mm dia. (18 AWG) silver-plated copper wire wound on a 5 mm former, self-supporting
L 12: 3.75 turns of 1 mm dia. (18 AWG) silver-plated copper wire wound on a 5 mm coilformer with core (red)
L 13: 20 turns of 0.3 mm (29 AWG) enamelled copper wire wound on a ferrite pin of 3.5 x 13 mm
L 14, L 16 - L 19: 20 turns of 0.3 mm dia. (29 AWG) wound on a ferrite pin of 2.5 x 12 mm
L 15: 5 turns of 0.5 mm dia. (24 AWG) enamelled copper wire wound on a 2.5 mm former, self-supporting

3. ALIGNMENT

The alignment of oscillators and frequency multipliers has been described so often in this magazine that this need not be described in detail here. However, a dip-meter for frequencies up to 180 MHz and an absorption wavemeter up to 2.5 GHz (2) should be available. It is important that all stages are not connected to the operating voltage during the alignment process but are connected one after the other (commencing at the crystal oscillator) during the alignment process. The alignment can be classed as satisfactory when no jumps of the current flow or oscillator power are noticed when varying the operating voltage in the order of 7 V to at least 14 V.

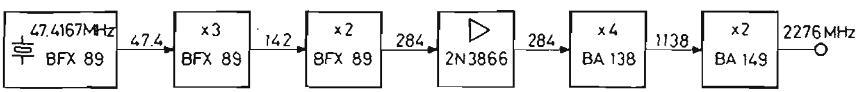


Fig.9: Block diagram of the local oscillator showing the frequency plan for an IF of 28 - 30 MHz

4. INTERMEDIATE FREQUENCY OF 28 - 30 MHz

The local oscillator circuit used in the described converter has been constructed several times, also for an intermediate frequency of 28 to 30 MHz. In the latter case, a crystal of 47.4167 MHz is used and the frequency plan is as given in Figure 9. It is only necessary for the inductances to be altered; no modifications to the transistor complement have been made. Of course, the image frequency is passed virtually unattenuated when this low IF is used. For this reason, the measured noise figure should be increased by 3 dB when the measurement is made without using a narrow bandpass filter. This means that it is advisable for a preamplifier stage and a selective intermediate circuit to be used.

5. REFERENCES

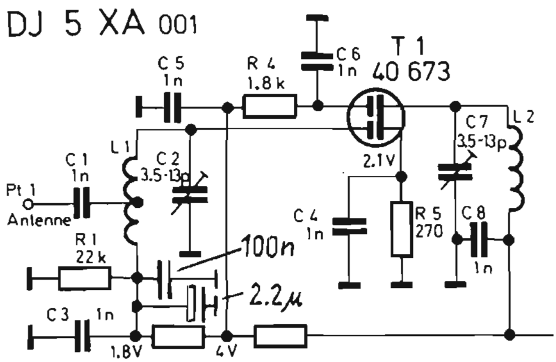
(1) L. Wagner and H. W. Binder: A 23 cm Converter with Hot-Carrier Diode Mixer
VHF COMMUNICATIONS 3, Edition 3/1971, Pages 134-140

(2) K. Hupfer: A Home-made SHF Wavemeter
In this Edition of VHF COMMUNICATIONS.

NOTES AND MODIFICATIONS

1. MINI-MOSFET CONVERTER DJ 5 XA 001

This converter, which was described in Edition 4/73 can be overloaded by strong medium or shortwave transmitters. This is because the converter input circuit is only bypassed for VHF frequencies (C 3 : 1 nF). The provision of two capacitors of 100 nF and 2.2 μF respectively will ensure that no RF-voltages are present across the gate voltage divider. The circuit of the input stage of the converter given below shows where these capacitors should be connected.



2. SSB EXCITER WITH RF-CLIPPER DK 1 OF 018

The cheaper Schottki ring mixer IE-500 is often used in this module instead of the SRA-1. The only differences between the data of these two mixers are that the lower frequency limit of the IE-500 is 5 MHz compared with 0.5 MHz with the SRA-1. However, it has been found that connections 2, 7, 5 and 6 are grounded to the case although this is not given in the data sheets of this mixer. When using the IE-500 in the circuit designed for the SRA-1, these internal connections will short out the RF-voltages if the coloured feedthrough is connected to F 181 as described. It is therefore necessary to rotate the IE-500 through 180° so that the coloured feedthrough is now connected to the components 470 Ω/33 pF.

ANTENNA NOTEBOOK

ANTENNAS FOR MOBILE TELECOMMUNICATIONS

by T.Bittan, DJ Ø BQ / G 3 JVQ

1. TYPES OF ANTENNAS USED FOR MOBILE COMMUNICATIONS

1.1. VERTICAL POLARIZATION

Vertical polarization is the most favoured polarization for mobile telecommunications. The main reasons for this are that vertical antennas are nonobtrusive and offer omnidirectional radiation. Since most mobile communications are made by reflection, and since most of the reflecting surfaces (lampposts, TV masts etc.) are vertical, this polarization does seem to offer a number of advantages over horizontal polarization.

The disadvantage of vertical polarization is mainly the higher attenuation on some paths such as in wooded areas, forests, built-up areas without suitable reflections, etc. Another disadvantage of vertical polarization is the large variation in signal strength whilst in motion. This is due to the multiple path propagation which cause the two or more signals to add when in phase, and cancel another out when 180° out-of-phase. This can cause fluctuations of the field strength of more than 70 dB.

1.1.1. VERTICALLY POLARIZED MOBILE ANTENNAS

The first fact that must be considered is that the characteristics of the vertically polarized mobile antenna are more important than its listed gain. In the case of an omnidirectional antenna, an increase in gain can only be obtained when the beamwidth in the other plane is decreased. This decrease in beamwidth, however, can mean that far less reflecting bodies can be "illuminated" by the mobile antenna, and instead of increasing signal strength, a reduction can take place.

The gain figures listed by the manufacturers for mobile antennas are usually referred to a $\lambda/4$ groundplane. These values can be measured under line-of-sight conditions. This is, of course, hardly ever the case in practice where the effective antenna height is low. Gain figures of 0 dB for a $\lambda/4$ whip, 3 dB for $5/8\ \lambda$, 4 dB for a stacked colinear of $\lambda/4$ and $5/8\ \lambda$, and 5 dB for a stacked $5/8\ \lambda$ colinear are reasonable values that are obtained under line-of-sight conditions.

The vertical beamwidths of various lengths of mobile whips are given in Figures 1 to 4. It will be seen that the gain is not only achieved by narrowing the vertical beamwidth, but by also lowering the angle of radiation. This is, of course, an advantage when in flat country where no obstructions are present in the signal path. When the vehicle is, however, surrounded by high buildings, lampposts, etc., or in a valley surrounded by hills or mountains, this decrease in beamwidth will probably bring more disadvantages than advantages.

Experiments made using the various types of vertically polarized antennas showed that although the $5/8\ \lambda$ whip antenna in the centre of the car roof usually represented the best antenna for stationary operation, the advantages were soon lost whilst in motion. Since the $5/8\ \lambda$ whip only "illuminates" a smaller

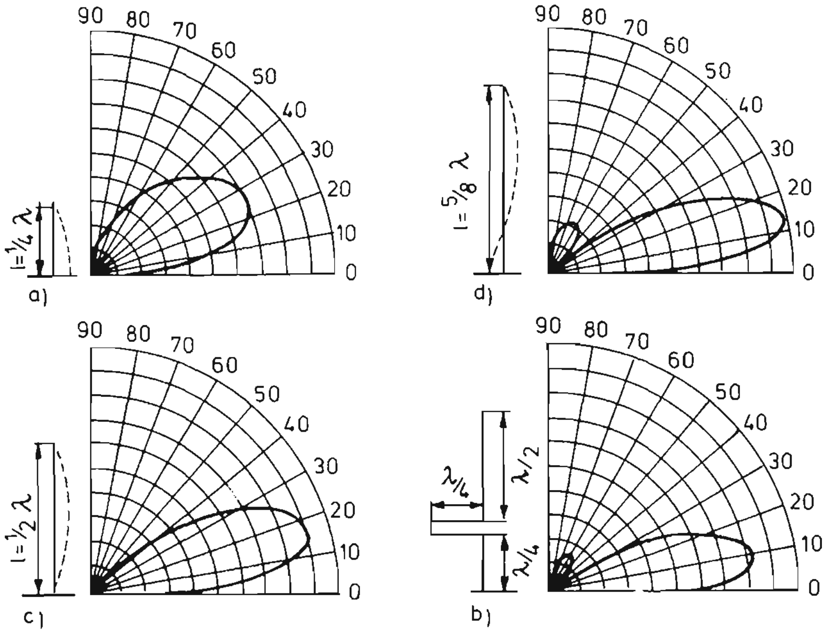


Fig. 1-4: Vertical radiation patterns of vertically polarized mobile antennas

area liable to reflect the signal, the amount of fading is far greater. Fading swings of 70 dB at spacings of $\lambda/4$ are not uncommon under reflection conditions. A $\lambda/4$ whip antenna on the roof was measured to be 2 dB to 3 dB down on a $5/8\ \lambda$ whip at the same position under line-of-sight conditions. Under normal conditions, the $\lambda/4$ provided a far more constant signal strength and the fading swing was far lower. A $\lambda/4$ whip in the centre of the roof was always superior to a $5/8\ \lambda$ whip mounted on the front or back wing of the car whilst in motion, whereas they provided virtually the same signal strength under stationary, line-of-sight conditions.

The greatest advantages of the $\lambda/4$ whip over the $5/8\ \lambda$ whip were whilst travelling at higher speeds. Measurements made at 120 km/h showed that the $\lambda/4$ whip provided a mean signal strength of approximately 20 - 25 dB more than the $5/8\ \lambda$ whip. This was mainly due to the bending of the latter in the wind, which tilts the angle of radiation up in the direction the car is travelling. The $\lambda/4$ whip hardly affected by the wind due to the lower wind surface and leverage.

Measurements made with various antennas on the front and rear wings of the car have shown that the $5/8\ \lambda$ whip is far superior to the $\lambda/4$ whip due to the higher effective height of the current lobe.

1.1.2. CONCLUSION ON VERTICALLY POLARIZED ANTENNAS

A $\lambda/4$ whip located in the centre of the roof represents the best antenna when operation is usually made during motion. If the operation is mainly whilst stationary, the $5/8\,\lambda$ at the centre of the car roof is approximately 2 - 3 dB superior but it may be necessary to drive the car $\lambda/4$ backwards or forwards to find the best position. If it is not possible to drill a hole in the roof of the car, consider using a magnetic mount antenna, or making a magnetic mount from an old loudspeaker magnet.

If the antenna can only be mounted on the front or rear wing, then a $5/8\,\lambda$ whip should always be used. Several countries such as West Germany have forbidden the use of the stainless steel $5/8\,\lambda$ whips except on the car roof due to the danger of injuring pedestrians whilst making fast turns. The flexibility of these whips makes them also very unsuitable electrically. The stiffer glass-fiber types such as those manufactured by HMP (Jaybeam) and Kathrein were the most satisfactory types.

1.2. HORIZONTAL POLARIZATION

For mobile applications, fieldstrength of a horizontally polarized signal is usually far more constant than with vertical polarization. This is because the direct wave is far less attenuated, and because less multiple reflections are present. Furthermore, the horizontally polarized antennas usually take up far more space in the horizontal plane than the very thin whip of a vertically polarized antenna. This, in itself, tends to provide a small amount of diversity. In other words the fading swing of a horizontally polarized signal is far less than that of a vertically polarized signal, assuming, of course, that each is received using an antenna matching the polarization of the signal to be received.

1.2.1. HORIZONTALLY POLARIZED MOBILE ANTENNAS

The main problem with horizontally polarized mobile antennas is to obtain a really omnidirectional characteristic. The actual radiation characteristics do not vary as much as with vertical whips as long as the antennas are at least $\lambda/2$ above the car roof.

The following types of horizontally polarized antennas are suitable for mobile operation: Halo, crossed dipole, canted dipole, big wheel. Each has advantages and disadvantages which are to be discussed.

1.2.1.1. HALO

This is without doubt the most popular mobile antenna for horizontal polarization. It is compact and not very obtrusive. However, its radiation pattern is not truly omnidirectional as can be seen in Figure 5. A square halo seems to provide a better omnidirectional characteristic since the bend is usually made at the centre of the current lobe. A gamma match is usually used which possesses an inherent relatively low bandwidth in the order of 600 kHz to 800 kHz (This is the reason why most amateur antennas from the USA have such a limited bandwidth, Editors). The antenna possesses a gain in the order of -2 to -3 dB (Square Halo).

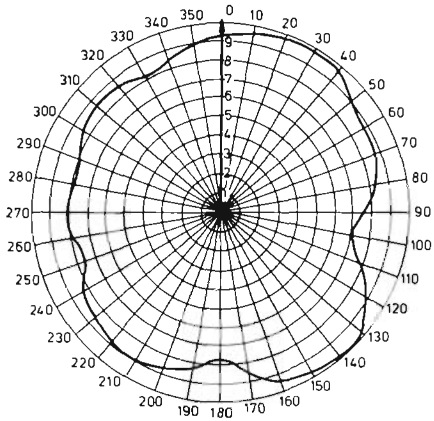


Fig. 5: Horizontal radiation pattern of a Halo antenna

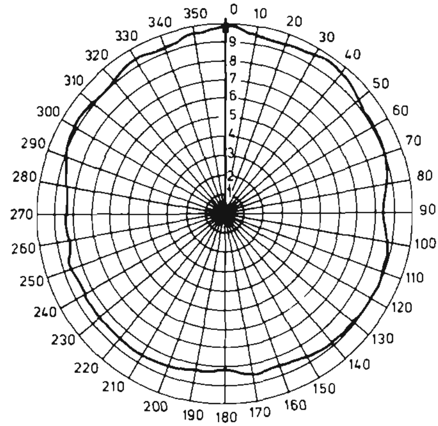


Fig. 6: Horizontal radiation pattern of a crossed dipole

1.2.1.2. CROSSED DIPOLE (TURNSTYLE)

When feeding a crossed dipole in quadrature (90° phase shift) using a phasing cable as described for circular polarization (2) it is possible for an extremely good omnidirectional characteristic to be obtained. Once again, a gain of -2 to -3 dB is exhibited. Since this type of antenna is far more obtrusive than the halo and does not offer any great advantages over it, crossed dipoles tend to be used more as omnidirectional antenna for fixed station use than for mobile applications. The radiation pattern is given in Figure 6.

1.2.1.3. CANTED DIPOLE

The canted dipole was very popular in West Germany several years ago. This was probably due to the fact that it was the only mobile antenna manufactured for horizontal polarization that was manufactured in West Germany at that time. Although the canted dipole does not exhibit the deep notches to the side encountered with a straight dipole, it is still far from being omnidirectional as can be seen in Figure 7. This is not always a disadvantage since the station to be worked may be in that direction. However, an omnidirectional antenna is required for the described application, which means that the canted dipole is less suitable than the halo.

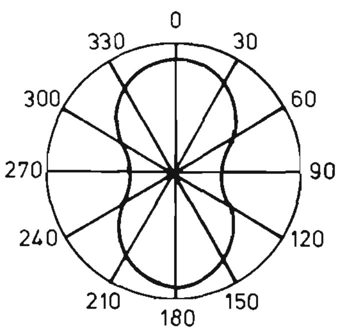


Fig. 7: Horizontal radiation pattern of a canted dipole

1.2.1.4. BIG WHEEL

This antenna was quite popular a few years ago and fantastic gain figures were given for it. The antenna actually comprises three endfed dipoles. Due to its omnidirectional characteristics and no beamwidth reduction in the vertical plane it seems impossible to the author that any gain can be exhibited since gain can only be achieved with a reduction in beamwidth in one of the planes. It will be seen, however, that the big wheel is not truly omnidirectional, and it is therefore possible that a slight gain is provided in the three major lobes, and a slight loss in between. The author is to carry out experiments for a later project in the near future and will establish the actual gain values.

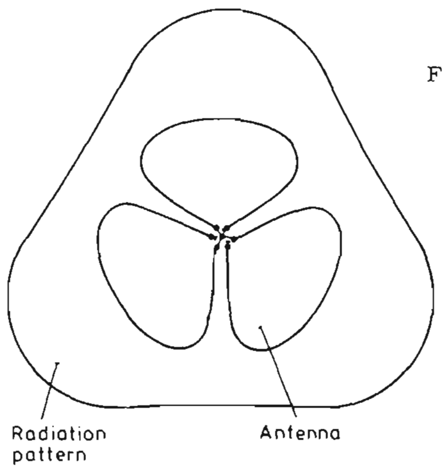


Fig. 8: Horizontal radiation pattern of a Big Wheel antenna

1.2.2. CONCLUSION ON HORIZONTAL POLARIZATION

The halo antenna seems to offer the most favourable characteristics since very few mobile operators would be willing to mount such large arrays as crossed dipoles and big wheels on their vehicles as a permanent installation. The halo antenna can be mounted on one half of a ski rack, or possibly with a small mast and one or two loudspeaker magnets. If more gain is required, two or more halos could be stacked one above the other.

2. FINAL CONCLUSION

It has been found that horizontal polarization provides a far more homogeneous field for mobile communications than vertical polarization. Of course, it is not possible to change the polarization of the transmitting station, and one cannot expect all repeater stations, for instance, the change over to horizontal polarization.

There are three main factors affecting the propagation in mobile communications. These are firstly polarization shifts occuring during the reflection process. Secondly fading due to in-phase and out-of-phase signals in the case of multiple reflections (usually repeating themselves every $\lambda/4$). The third main factor is the screening effect.

The second part of this article is to describe how a few mobile antennas were designed to obtain the advantages of various types of mobile antennas without suffering the disadvantages. This is based on over two years of experiments and development. To be described are a circular-polarized omnidirectional mobile antenna, as well as an electronically switched directional array for mobile use.

The first antenna provides a very homogeneous reception of both vertical and horizontally polarized signals and virtually solves the first two main problems of polarization shift and fading due to multiple reflections. This is obtained using the inherent diversity effect between the two basic parts of the antenna (= $\lambda/4$ diversity).

The second antenna was developed whilst studying the diversity problem and is based on phasing principles. Details are to be given how this can be used to advantage for both mobile and fixed station applications.

3. REFERENCES

(1) Karl Rothammel: Antennenbuch
Fourth Edition 1973

(2) T. Bittan: Antenna Notebook: Further Details on Circular Polarization
VHF COMMUNICATIONS 7, Edition 1/1975, Pages 21-25.

PRELIMINARY EVALUATION OF THE TELEMETRY FROM OSCAR 7

by R. Niefind, DK 2 ZF

The following article is to give details and explanations regarding the telemetry data transmitted by OSCAR 7. Various little-known relationships are to be described with the aid of diagrams which are based on approximately 20 000 measured values, or approximately 830 data per channel. This data was gathered in the period from 15 November 1974 to 8 December 1974 and from 17 December 1974 until 15 January 1975. The second period of observation was made on board a ship during the voyage between the Persian Gulf via Cape Town to Europe. This allows several comparisons to be made.

The measured values mainly referred to the operation of the 2 m/10 m transponder. When the 70 cm/2 m transponder was in operation, this was usually used for communication. In this case, only one line of data was recorded at the beginning and end of the pass. This is, of course, too little for evaluation.

Orbit 452 was observed together with DL 3 SK in Flensburg and DL 3 OO in Lübeck, West Germany. At this time, the author was in the Indian Ocean at a position of 9° north and 54° east. The observation at three different locations allowed data to be received over a period of 35 minutes. Since considerable data on this orbit is available, it is to be discussed in detail. Unfortunately, such multiple observations could only be made from time to time.

Monitoring of the 10 m beacon was sometimes very difficult in Europe since several stations carried out communication on the beacon frequency. In addition to this, it was impossible to monitor the beacon of OSCAR 7 during January 1975, since the noise generated in the OSCAR 6 transponder was stronger than the 29.502 MHz beacon.

1. EXPLANATION OF THE INDIVIDUAL TELEMETRY CHANNELS

Since detailed data with nominal and typical values were given in the AMSAT-Newsletter of December, 1974, it is only necessary for the most important details to be summarized. Figure 1 shows a block diagram of the transponder.

Channel 1 A gives the data on the total current of the four surfaces of solar cells. Current values in the order of max. 2.3 A (telemetry number 78) are possible. Typical values should, however, be between 1 A (34) and 2 A (68). The total area of solar cells allow a maximum of 14.7 W to be generated.

Channels 1 B to 2 A indicate the individual current values from the four separate surfaces. The following maximum current values were determined before launching:

+X : 1445 mA; -X : 1452 mA; +Y : 1445 mA; -Y : 1499 mA.

The battery voltage is given in channel 3 A. OSCAR 7 is equipped with a nickel-cadmium accumulator comprising ten cells. Since this accumulator is nearly always fully charged, the voltage is usually between 13 V and 15 V. In contrast to OSCAR 6, OSCAR 7 possesses a positive energy balance, in other words,

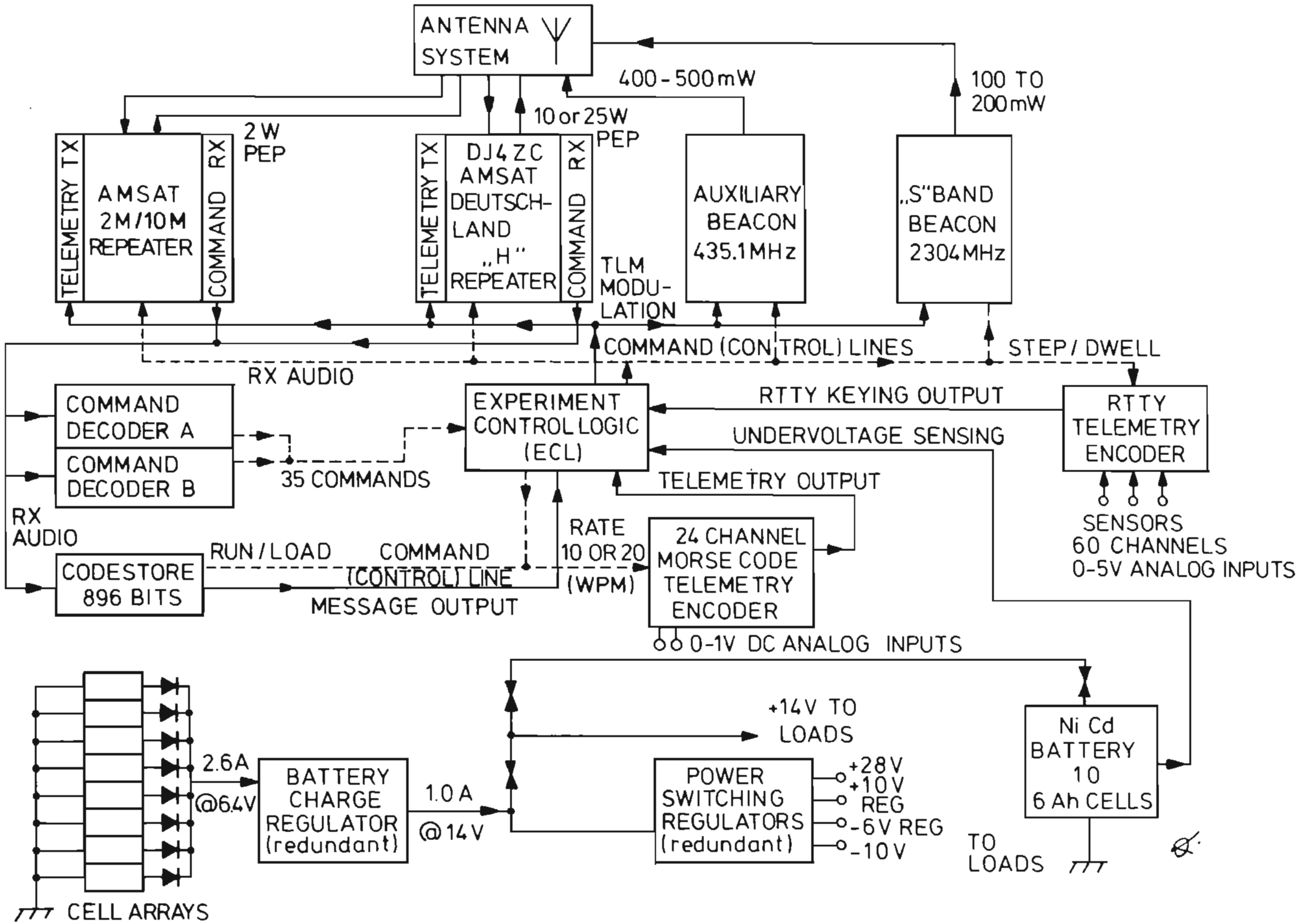


Fig.1: Block diagram of the electronic circuits in OSCAR 7

it produces more energy than is required. If the voltage should drop to below 12.1 V (telemetry number 57) for any reason, the satellite will automatically switch to mode D (battery charge, no transponder in operation).

Half the battery voltage is indicated in channel 3 B. The probe for this channel is to be found above the fifth cell. This measured value allows information to be gained whether all cells are charged homogeneously. The half of the battery voltage should coincide as exactly as possible to half the total voltage. If these values do not coincide, this will mean that one or more of the battery cells will have changed their characteristics.

In the case of OSCAR 6, 18 individual cells were selected from approximately 100 cells whose nominal voltages at full charge did not differ more than 0.5 mV (1). This was made in more than 2000 hours of experiments.

Channel 5 D refers to the power-switching regulators and voltage converters.

The satellite contains several modules that generate various supply and reference voltages from the battery source. A number of important voltages and currents are monitored. With the exception of the unstabilized 28 V voltage that varies together with the battery voltage, all other voltages should be constant.

The voltage values of 9 V and 28 V are only available in mode A. In all other modes, they are switched-off. The current of the switching regulator should remain constant and indicate values in the order of 54 mA. In modes B and C, this value should be in the order of 27 mA.

Channel 3 C gives data on the battery charge regulator. A critical part of the satellite is the battery charge regulator (BCR). This regulator converts the voltage of 6.4 V obtained from the solar cells to 14 V required for charging battery. This voltage conversion must be made at high efficiency in order to ensure the lowest heat dissipation. The battery charge regulator must also ensure that the battery is not overcharged since this would heat up the battery.

Since this unit is so important for the operation of OSCAR 7, two such modules are provided. If one of these circuits should fail, it would automatically switch over to the second. Under normal conditions, battery charge regulator No. 1 is usually in operation since only this module can be monitored by the CW telemetry data. The second regulator can be switched on by ground control. The following represent typical data of the battery charge regulator, and the associated telemetry number is given in brackets:

	sunlight	shadow
Regulator 1 in operation, battery is charging	6.4 V (43)	2.5 V (17)
Regulator 2 standby, battery is charging	4.8 V (32)	4.5 V (30)
Regulator 1 in operation, battery charged	8.5 V (57)	2.5 V (17)
Regulator 2 standby, battery charged	5.0 V (33)	4.5 V (30)

Channels 3 D, 4 A, 4 B, 4 C, 4 D and 5 A indicate various temperatures. All thermistors on board OSCAR 7 measure the temperature in an inverted manner: A high telemetry number indicates a low temperature and vice-versa. When comparing the formula for determining the temperature, it will be seen that there is a difference between the RTTY- and CW-telemetry. This is caused

by a lower input impedance of the RTTY decoder than was calculated previously and this was established only a few days before the launch. On the other hand, the equations for the RTTY telemetry are now very exact so that the tolerance is in the order of $\pm$ 0.15 ^{o}C.

All temperatures in OSCAR 7 are lower than have been measured with previous amateur radio satellites. The average values of the electronic circuitry are in the order of normal ambient temperatures, whereas the battery is slightly warmer. The temperature fluctuations of the +X and +Z surfaces is surprisingly small. It was assumed that a greater dependence would be shown according to the position of the sun. The power amplifier of the 70 cm/2 m transponder is somewhat warmer than the surrounding modules when in operation. The temperature of the output stage of the 10 m transmitter obtained values of 51 ^{o}C.

Channels 2 B, 6 A, 6 B, 6 C indicate the output power levels. These channels indicate the output power levels and are the most difficult to calibrate since the measured value is dependent on the load impedance. Since it is virtually impossible to determine the impedance of antennas in space, no great accuracy was possible. It is only the output power indication of the 10 m transmitter that can be classed as being accurate. These channels indicate mean output power levels and not PEP values. The peak-power levels are always higher, and channel 2 B will indicate that the 70 cm/2 m transponder is fully driven, or already overloaded at a telemetry indication of 00 (8 W).

2. FURTHER DETAILS REGARDING THE MEASURED VALUES OF CHANNEL 1 A

Only the UHF beacon was in operation during the first two days after launching, and both transponders were switched off. During this period, channel 1 A (total current) virtually always gave an indication. After several days, however, only the value "00" was shown and no special attention was paid to this at that time.

The evaluation of approximately 500 data (orbits 001 - 299) showed a dependance of channel 1 A on channel 3 A (total battery voltage). Figure 2 shows the data of the various orbits in the form of a diagram. The vertical axis shows in how many cases an indication was made in channel 1 A at the given battery voltage. It is given in percent. It will be clearly seen in the diagram that at least in 50% of the observed cases that an indication of the total current took place at voltages of over 14.0 V. At voltages of less than 13.8 V, however, it will be seen that channel 1 A of the telemetry only brought an indication in three cases. The numbers given above the diagram show how often the battery voltage was observed (e.g. 14.9 V : 29 times).

After observing this surprising fact, the dependence was checked during orbits 395 to 712. This shows clearly that the indication given in channel 1 A is very dependent on the battery voltage. Starting at 13.7 V, the indication is practically always "00".

In addition to this, it will be seen that the battery voltage is usually higher. The reason for this is probably that the observations were made during orbits where the satellite was not above the horizon for European stations. Whilst

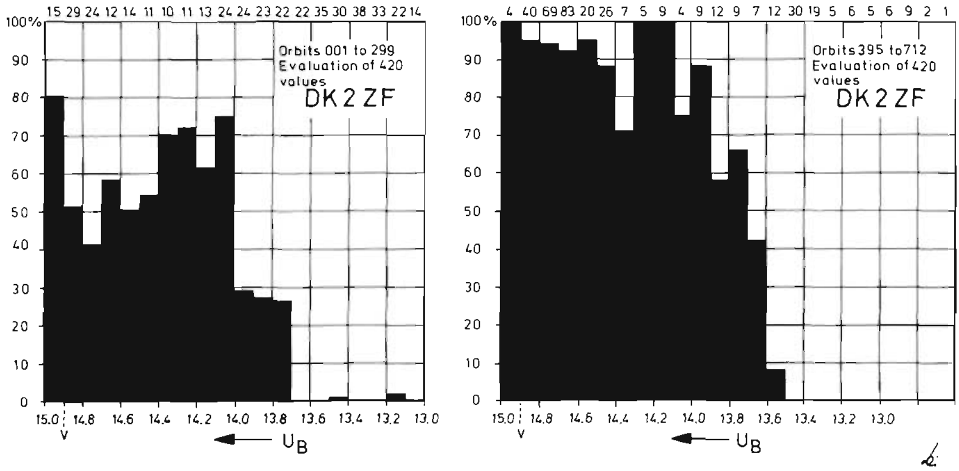


Fig. 2: Dependance of the indication in channel 1 A from the battery voltage

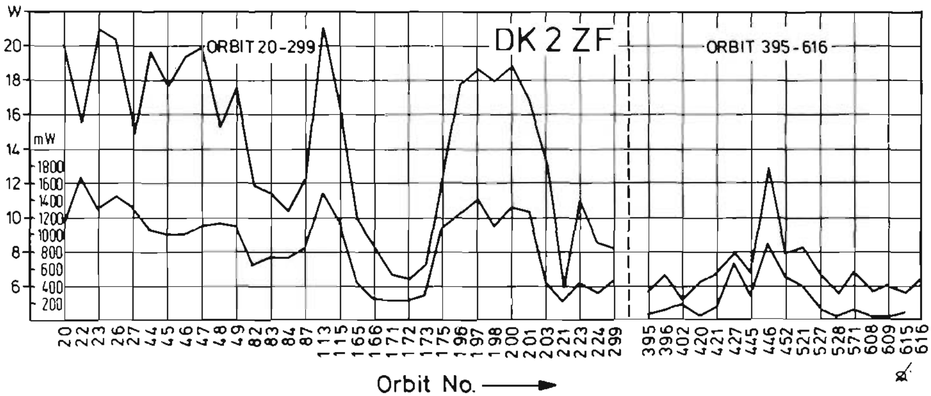


Fig. 3: Solar cell power and RF-output power of the 10 m transmitter

sailing around the African continent, only three ZS6-stations and one ZE7-station were heard. The activity in this part of the world is therefore very low which means that the satellite is operating under no-load conditions.

3. RELATIONSHIP BETWEEN OUTPUT POWER OF THE TRANSPONDER AND THE CURRENT SUPPLIED BY THE SOLAR CELLS

During the first days after launching when none of the transponders were in operation, channel 1 B to 2 A indicated either "00" or "99" when in the shadow of the earth. After the transponders were switched into operation, numbers in the order of 70 were indicated when orbiting the dark side of the earth. This indicated that the indication was effected by the RF-power output of the transponder.

The diagram given in Figure 3 possesses two curves: The upper curve shows the average power provided by the solar cells. This value has been obtained by adding the values given in channels 1 B to 2 A. The lower curve indicates the output power of the 10 m transponder. Only those orbits have been used in this diagram where at least eight measured values per channel could be received. Orbits 20 - 299 were observed in Europe, whereas the other orbits were observed on board the ship.

Two relationships can also be seen in this diagram. It will be seen that the solar cells produce power levels in the order of 10 to 21 W whilst passing Europe. According to AMSAT-information, only 14.7 W could be generated and the average value should even be less than this.

The higher power value indicated for these solar cells seems to be dependent on the output power of the transponder. When not within the range of European stations, considerably lower powers are indicated (with one exception). Of course, the output power is far lower when not in the range of European stations and is usually in the order of 60 to 200 mW, and maximum 500 mW.

It is therefore assumed that a high output power level effects the indication of the solar cell current. Up to approximately 500 mW power output, values are indicated that coincide to the technical specifications. If the power output increases above this level, the current values of the solar cells do not seem to be correct. This could be checked when switching off the receiver of the transponder by ground control. In this case, the same characteristics would be present as when flying over the areas of the earth with low amateur activity. If the current values of the solar cells then coincide to the specified values, this would indicate that the above diagnosis is correct.

4. RELATIONSHIP BETWEEN TELEMETRY DATA RECEIVED AT THREE DIFFERENT LOCATIONS

As has been previously mentioned, orbit 452 was observed at three different locations. It will be clearly seen that the relationships in the satellite change when it comes over the horizon for European stations, somewhat south of Cairo.

The diagram given in Figure 4 gives three curves: The emitter current of the output transistor (I_EPA), the temperature of the power amplifier (PA-temp.) as well as the output power of the transponder (P_{out}). The diagram clearly shows the relationships between the increase of emitter current and resulting

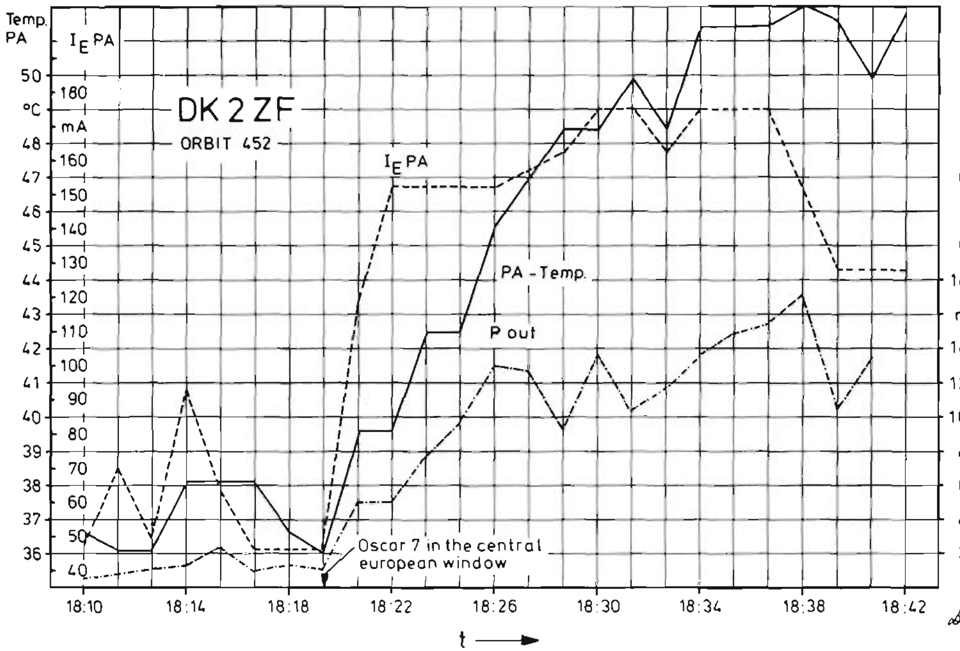


Fig.4: Three telemetry values recorded at three different locations

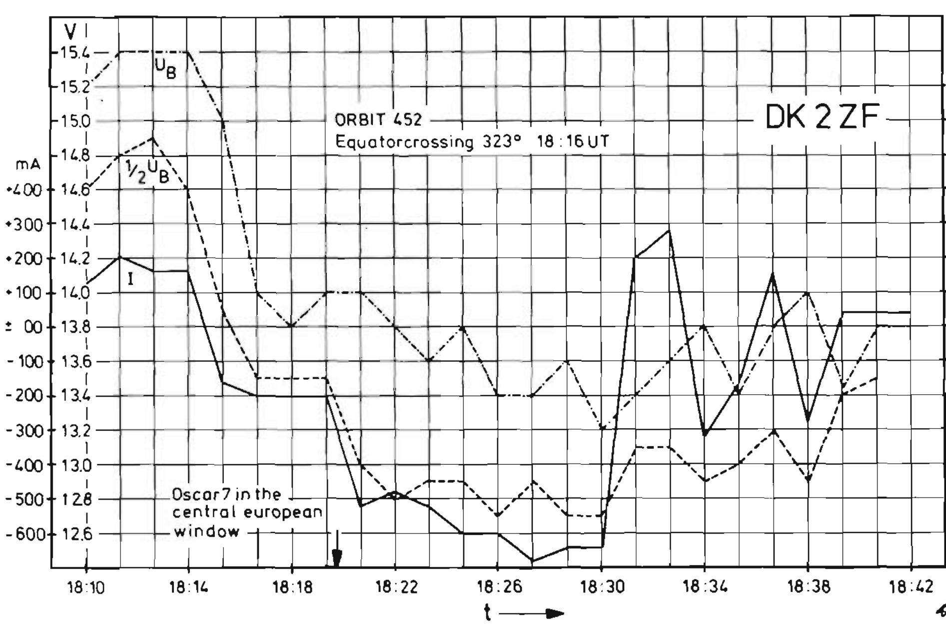


Fig.5: Three further telemetry values during orbit 452

temperature increase on increasing the output power level. This behaviour could also be observed with OSCAR 6.

The second diagram given in Figure 5 for this orbit also gives three curves that run in an inverse manner. These are the values for the battery voltage, half the battery voltage as well as the charge or discharge current. The battery voltage starts off very high and drops as soon as it comes into the European window. At the same time, the voltage indicated in telemetry channel 3 B also drops. Since the satellite is still in the shadow of the earth at 18 : 10 UT, only very little power is generated. The battery provides power from approximately 18.14 UT. This continues then until 18.30 UT. After this, the curve increases rapidly since the battery charges for a short period of time. Finally, positive and negative current values are indicated. It is assumed that the satellite has left the night-side of the earth and that the solar cells will be in sunlight.

The third diagram of this orbit given in Figure 6 shows the curves for three temperature values. There is very little difference in these values and little information can be gained. The base-plate temperature increases at approximately 18.20 UT from 17.5 °C to 25 °C. This happens at the same time as the increase of output power in the transponder.

5. OBSERVING THE MOVEMENT OF THE SATELLITE IN SPACE

During orbit 608, it was observed whilst recording the telemetry data that one of the solar cells possessed a regular maximum of current which repeated itself at regular intervals. On evaluating this phenomena graphically, it could be seen that OSCAR 7 was rotating around its own axis with great regularity. The movement was such that the +Y-surface was firstly facing the sun followed by the -X-surface, the +X-surface and finally the +Y-surface. The lowest curve in Figure 7 shows the current values of the opposite surface, e.g. +Y to -Y, +X to -X.

According to the experience of the author, this evaluation did not seem to be possible if the output power of the transponder was low. If the output power increases to values in excess of 500 mW, channels 1 B to 2 A will indicate values that cannot be correct. This has been mentioned previously. This means that if the rotation of the satellite in space is to be determined, attention should be paid that the output power of the satellite is less than 500 mW; channel 6 A should therefore indicate values of less than 28. Otherwise, it will be impossible to establish the position of the satellite with respect to the sun.

The diagram given in Figure 8 shows the evaluation of orbit No. 171. The relationship between the currents of the solar cell surfaces is also visible here. It will be seen from the diagram that when the -Y and +X surfaces are facing the sun, the +Y and -Y surfaces only produced a very low current. Furthermore, it will be seen that only one of the X-surfaces can produce current, either +X or -X, but not both at the same time. At very high output levels from the transponder, it has been observed often that virtually equal currents have been given for both the +X and -X surfaces. This is, however, physically impossible.

AMSAT have planned the Wednesday for experimental use. No communication over the satellite should be made on this day. This makes it ideally suitable for making the given observations. Unfortunately, one always observes G, F, and DL-stations communicating over the satellite on Wednesday.

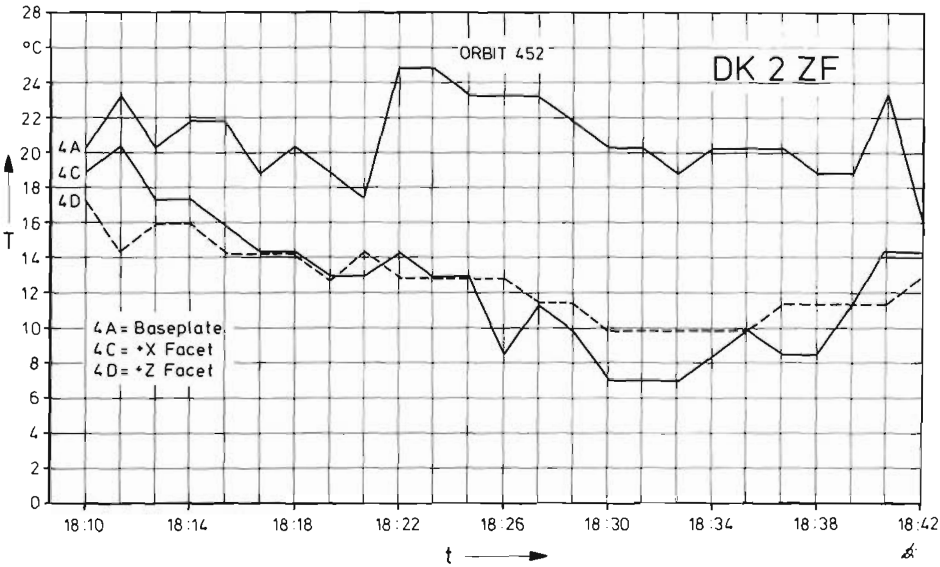


Fig.6: Three temperature values during orbit 452

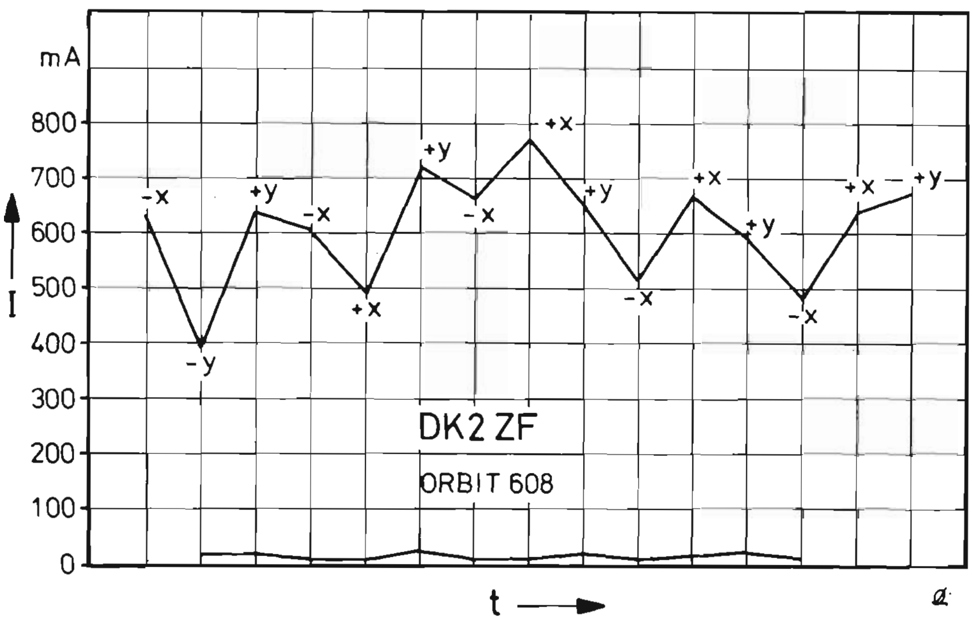


Fig.7: Maximum of the solar cell currents indicating a regular rotation of the satellite

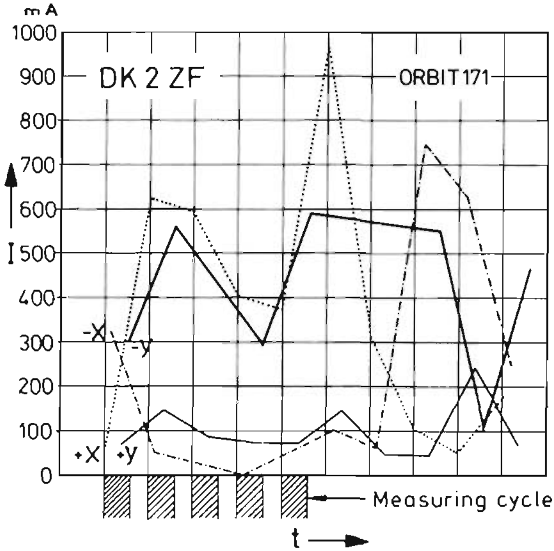


Fig. 8: Solar cell current during orbit 171

6. EQUATORIAL F-PROPAGATION

This interesting phenomena was observed by the author six times in conjunction with the 29.5 MHz beacon of OSCAR 7. The location at which these observations were made, were always in the vicinity of the equator, e.g. between 26° north and 18° south. It is not known that this type of propagation has been observed in Europe.

The satellite paths by which this effect has been observed have been marked on the map given in Figure 9. A dot together with a numeral marks the position of observation. The time of the equator crossing was re-calculated into local time since a deviation of one or more hours is present from the universal time, according to longitude. The portion of the satellite pass during which equatorial F-propagation took place (distorted signal), is marked with a thick continuous line. Three facts are very interesting:

> This effect was only noticed between 30° north and 30° south.
>
> The time of the equator-crossing in the case of these passes was always between 20.22 and 20.54 local time, and is therefore always limited to a very short period.
>
> It was found that this time was always around two hours after sunset.

This effect could only be observed by south-north passes, in other words, in the evening. In the morning, the beacon was always completely normal and of good strength. During the evening, the beacon signal was always extremely weak during the whole pass. The signal sounded as if two tones of different frequency were present which indicates dual-path propagation. After the satellite has left the zone of 30° north to 30° south, the signal strength increased and the signal distortion disappeared.

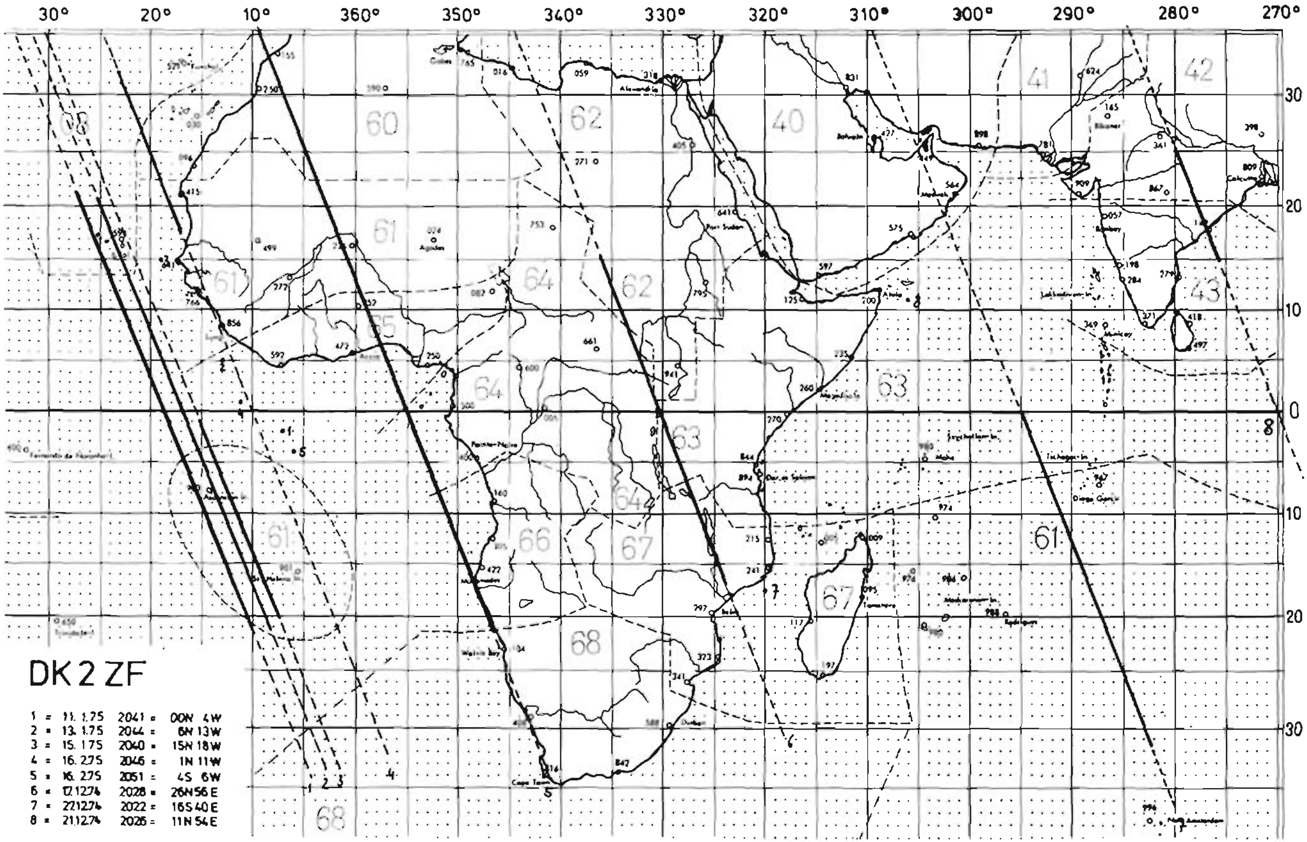


Fig. 9: OSCAR 7 passes by which equatorial F-propagation was observed

Similar distortion was observed in February 1974 in conjunction with the OSCAR 6 satellite. The observations were reported to DL 3 SK since the author assumed them to be caused by aurora. DL 3 SK was able to send back the data and observations of February 1974 and they were compared with those of December 1974 and January 1975. We were then surprised to determine that the observations made a year ago coincided well with the observations made at the present location and time. DL 3 SK compared the observations with data of magnetic instability. It was found that a geomagnetic instability appeared stronger than was to be expected due to a repetitive interference. It was now necessary to compare all observations with the data of the geometric instability in order to see whether any relationships exist.

The author is to record further observations using a taperecorder at a speed of 9.5 cm/s in order to allow interested parties to evaluate the signal on a spectrum analyzer.

It would also be interested to establish over which frequency range this can be observed. Observation should be made in the 2 m band, and it would also be favourable to transmit on the 70 cm band and to observe this signal with respect to distortion. Unfortunally, it is not permissible for amateur radio stations to be operated from German merchant vessels, which means that the author is only able to make passive observations.

7. EXPERIENCE GAINED WITH OSCAR 7

7.1. 70 cm/2 m TRANSPONDER

The Doppler-effect was found to be far less troublesome than was expected. It is only during the direct passes in the morning and evening where this effect caused difficulties, and it was sometimes difficult to carry out a relatively long QSO. One of the signals usually faded out so that it was no longer audible. This was mainly caused at a fact that most of the ground stations used 70 cm long yagi antennas with a very narrow vertical and horizontal beamwidth. This meant that it was necessary for the antennas to track the satellite accurately which was not always possible. The power required to work over the 70 cm/ 2 m transponder has been found to be in the order of 20 W.

Several days after launching, noise and bubbling sounds were observed from the satellite which were assumed to be overload effects. However, shortly afterwards, it was found that this cannot be due to overload. After the satellite came over the horizon on orbit No. 236, on December 4th, 1974, when the satellite was above the northern USSR, and no stations were working over the transponder, it was established that the 145.973 MHz beacon was modulating the whole transponder band. The noise in the required frequency band increased in time with the CW-telemetry. Just after this, a CQ was made in CW with the result that the CQ-call was to be heard over the whole transponder band. The stations G 3 LQR and F 9 FT were observed over the satellite with at least five spurious signals. The noise and bubbling effects disappeared completely at 13.02 universal time and the stations working over the transponder could only be heard on one discrete frequency.

Several extremely loud signals have been observed from the USA. Stations such as W Ø LER and W Ø PHD from Minnesota have been worked with 599 or 56 over a distance of 7500 km. W 3 FJ wrote on his QSL card: "Karl Meinzer, DJ 4 ZC made a superb performing transponder for OSCAR 7, congrats es thanks from us all". This sums up everything.

7.2. 2 m/10 m TRANSPONDER

In contrast to several other reports, the author has never had difficulty in working over this transponder. When using 10 W and two 14-element crossed yagi antennas that accurately track the satellite, the author's signal was heard with 569 to 599 on a 3-element yagi, MOSFET preamplifier and Drake R4B. Unfortunately, hardly any QSOs resulted since it seems that most of the stations did not have satisfactory antennas for the 10 m band. This meant that they were not able to copy 559 signals. The AMSAT have said again and again that a transistor preamplifier should always be used.

Using the described receiving system, the 29.502 MHz beacon was sometimes heard with 579 to 589.

7.3. THE 435.1 MHz BEACON

During the first two days after launching when only this beacon was in operation, it was possible to receive it with a seven-turn helical antenna for anti-clockwise circular polarization. The field strength was between 30 and 35 dB above noise. The signal strength was approximately the same as that of the OSCAR 6 beacon. Unfortunately, the output power of the beacon dropped to a few mW on November 28th, 1974 so that it only could be heard in the noise. During orbit 198 on December 1st, 1974, the nominal output power was again present and the beacon could be heard at full strength. After this, the beacon continued to transmit with a few mW.

Due to the disappointing results using yagis and a 48-element colinear antenna with OSCAR 6, it was decided to use circular polarization with OSCAR 7. It was never possible to receive a signal of constant strength from OSCAR 6 in order to receive complete sets of telemetry data.

By using circular- polarized antennas, the amount of data received was in the order of 95% to 98%, whereas a maximum of 70% of the radiated data could be received from OSCAR 6 using linear polarized antennas.

In order to allow comparisons between anti-clockwise and clockwise polarizations, two helical antennas were constructed and mounted one beside the other. One antenna was designed for clockwise circular polarization and the other for anti-clockwise. A TR-44 rotator was used and the two antennas could be tilted vertically up to 80°. Using a coaxial relay, each of the antennas could be switched to the transmitter or receiver. Since the beacon signal radiates an anti-clockwise circular polarization, the signal was stronger with the anti-clockwise helical antenna as was to be expected. On switching between the two antennas continuously every five seconds, it was noticed that the clockwise helical antenna was far more sensitive to fluctuations of signal strength. Sometimes, the signal was equally strong on both antennas; a short time afterwards, the signal on the anti-clockwise helical antenna was stronger than on the clockwise helical. Sometimes, the signal was extremely strong on the anti-clockwise antenna whereas no signal was audible whatsoever on the clockwise antenna.

The signal strength was recorded on a plotter during these experiments which allowed them to be seen clearly. However, since the whole system was still not calibrated, the first measurements were not recorded. Once a calibrated plotter is available, extensive experiments will be made. Unfortunately, the beacon is now no longer suitable for such experiments due to its loss of output power.

The author would like to underline that circular-polarized antennas are always better than those with linear polarization. This is not a matter of gain, but more a matter of reducing fading. Since the satellite is always within line-of-sight, the gain of an antenna is not so important as long as enough ERP is available. In fact, crossed dipoles can be used to save tracking the satellite with the antenna.

8. RTTY - TELEMETRY DATA

There were so many conflicting views on reception of the RTTY telemetry data. The author, who had never had any experience with RTTY, was not able to receive any data in this mode. After it was established a few days after launching that the mark-signal was not to be radiated, no further experiments were made since the available RTTY audio-converter was not suitable for this without modification.

In December and January, DK 4 LI was able to provide extensive data material after modifying his RTTY converter.

Since considerable time is taken to evaluate the data with conventional means (calculator, pencil and paper) only occasional checks have been made.

9. REFERENCES

(1) J.A. King: The Sixth Amateur Satellite - A Technical Report
QST, Volume 57 (1973) Edition 7, Pages 66-71

(2) J.A. Ratcliffe: Sonne, Erde, Radio
Die Erforschung der Ionosphäre, Page 212.

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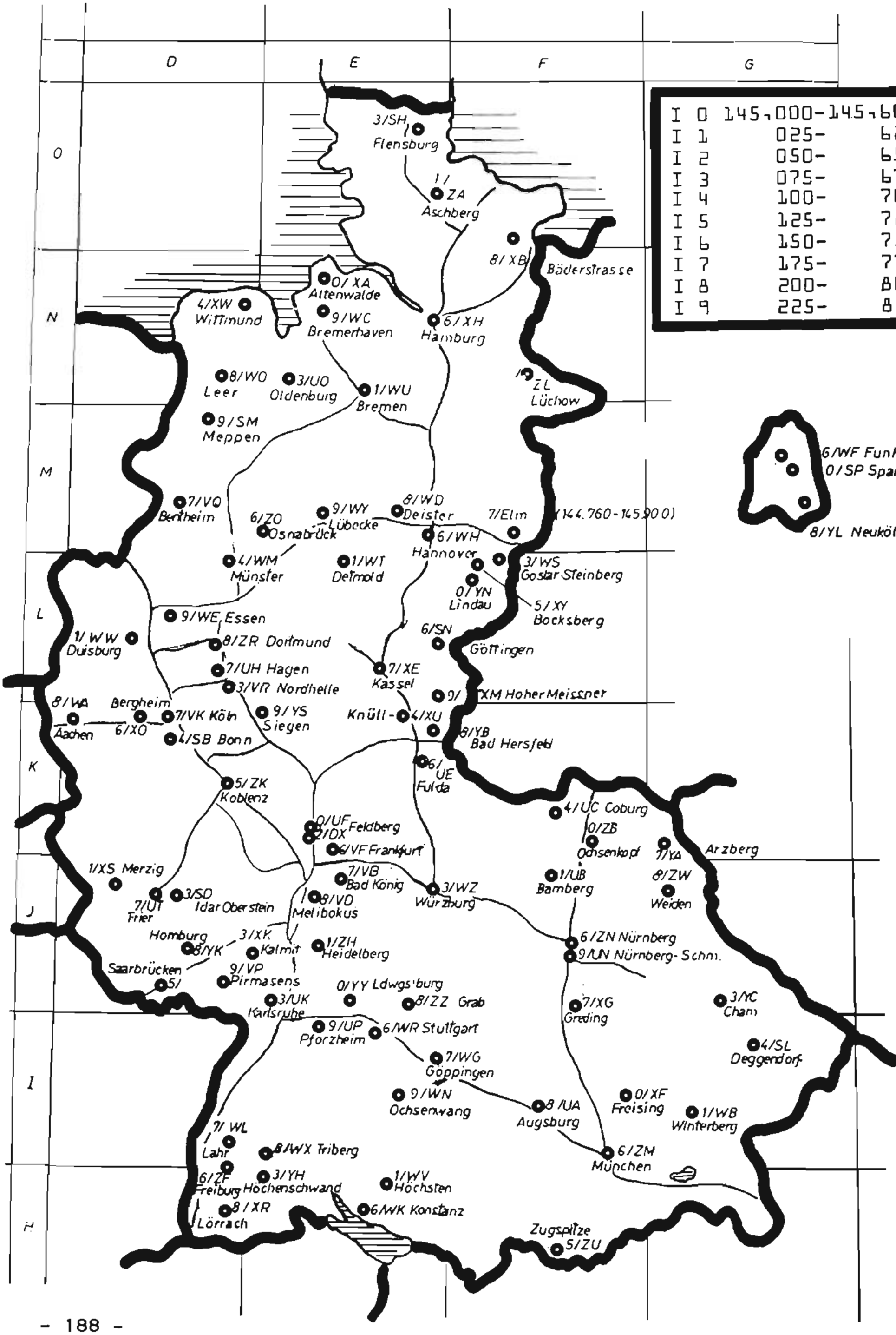

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2-m-SSB/FM-Transceiver SE 400 digital

Astounding that such a high-quality Braun product is available at such a low price.

There is no competition with respect to the sensitivity, cross modulation rejection and selectivity of the Braun SE 400 digital. The required mode: CW, USB, LSB, FM or FM-repeater is selected at the push of a button. Continuous tuning from 144 MHz to 146 MHz. Digital frequency readout. Automatic frequency shift of 600 kHz in the FM-repeater mode. Automatic sideband reversal can be selected for satellite communications (OSCAR 7).

Fully solid state with silicon transistor complement. Output power 10 W.
12 V operating voltage, and built-in AC power supply.

Built-in loudspeaker, S meter, Wattmeter, receiver fine tuning (RIT), squelch, and calling tone.

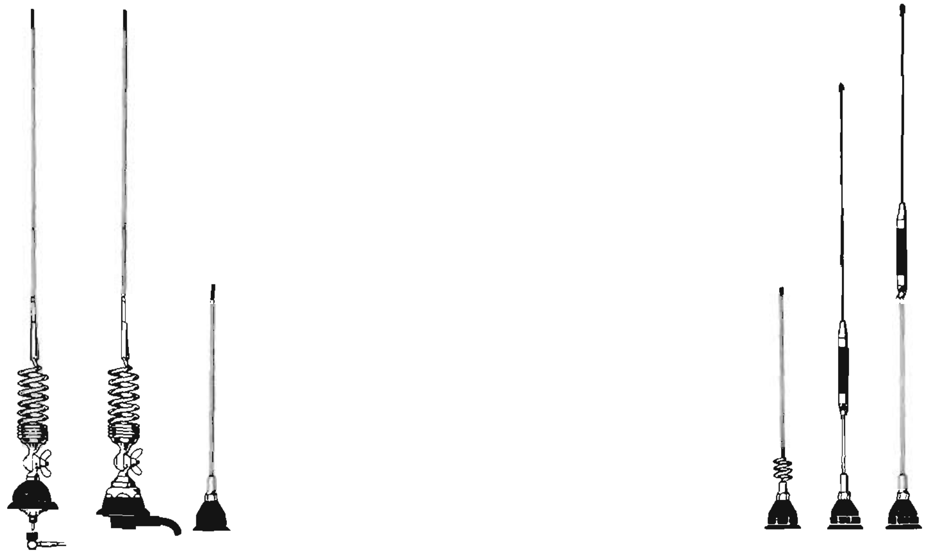
Write for full technical details

Karl Braun Communications Equipment

D-85 Nürnberg Deichslerstr. 13, W. Germany

mobile antennas

Introducing the J-BEAM range of very high-quality mobile antennas for all commercial frequencies and for the 2-m and 70-cm bands. Both stainless-steel and glass-fibre types are available. Below a few examples from the wide range of types from λ/4 to stacked 5/8 λ colinears for UHF.



Type TA   Type TA-S   Type TA 4   Type U 3   Type U 4   Type U 5

Model	Type	Frequency	Gain	Weight	Features
TA	5/8 λ	144-175 MHz	3 dB	275 g	Glass-fibre whip
TA-S	5/8 λ	144-175 MHz	3 dB	275 g	Glass-fibre with 5 m cable
TA 4	1/4 λ	144-175 MHz	0 dB	130 g	Stainless steel (PH 17-7)
U 3	5/8 λ	400-470 MHz	3 dB	100 g	Silver-plated, epoxy coated
U 4	Colinear	420-470 MHz	4 dB	150 g	Stacked λ/4 and 5/8 λ
U 5	Colinear	420-470 MHz	5 dB	175 g	Stacked 5/8 λ and 5/8 λ

Available via the representatives of VHF COMMUNICATIONS. Would professional customers please contact the Antenna Dept of VHF COMMUNICATIONS direct. Full catalogs of the wide range of professional antennas available on request.

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