A Publication
for the Radio-Amateur

Especially Covering VHF,
UHF and Microwaves

VHF communications

Volume No. 14 · Winter · 4/1982 · DM 6.—

Digital Storage

Displaying
Weather-Satellite Images
in Realtime

YU 3 UMV

VHF communications

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Contents

In the Focus

It is good to stop and look back at the end of a year, and ahead to the next. In edition 3/1982 I promised that VHF COMMUNICATIONS would focus itself, amongst other things, to picture reception and manipulation techniques. One of the many possible applications for this new technology is to be found in this edition: Weather-Satellite Image Reception and Display using a Digital Memory as a Scan Converter. It converts the slow-scan WEFAX transmission into a standard TV format so that it can be viewed on a TV monitor in real-time. Two editions later, a Synthetic-Color Module will be in focus, which converts grey-steps into color-shades. This synthetic-color technique is widely used to make tiny grey differences visible – or in the case of infra-red images from weather satellites: tiny temperature differences.

Another item of interest to be described in the 1983 volume will be an Automatic Noise-Figure Measuring System. Frequency range and measurement accuracy of this precision instrument will only be limited by the noise source (the most simple one was already published in Ed. 1/82).

Other major home-brew projects will be: The remaining two parts of the Versatile IF-Module (of which we can already offer all PC-boards and some critical parts – see p. 253), a tiny 2 m SSB-transceiver for portable use, a high-quality 2 m/70 cm transmitter, as well as receive and transmit equipment for the microwave bands. Furthermore: a broadband directional coupler for measurement of the return loss of receivers and preamplifiers in the frequency range of 2 to 1400 MHz.

These few highlights are just to show you that VHF COMMUNICATIONS and the technically-minded radio amateur should stick together to forward modern technology.

With kind 73s

your's

Robert E. Lentz

DL3WR

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Matjaž Vidmar, YU 3 UMV

A Digital Storage and Scan Converter for Weather Satellite Images

Part 1: Electronic Module

This article comprises three parts in which three individual PC-board modules will be described in detail: Electronic board YU 3 UMV 001, storage board YU 3 UMV 002, and synthetic-colour board YU 3 UMV 003. If synthetic colours are not required, the first two boards are sufficient to provide you with a video-weather satellite image on the screen of the monitor when provided with the 2.4 kHz subcarrier signal (for instance from module DC 3 NT 003). This image can be from one of the geostationary satellites such as METEOSAT, or from one of the polar-orbiting weather satellites of the NOAA and METEOR series. This in turn only depends on the extent of the RF-system used. All start, stop, and synchonizing functions for the various satellites are carried out automatically.

The synthetic-colour module converts the grey levels into appropriate colours, which are then fed to an oscillator that is modulated with this synthetic-colour signal. This can then be viewed on a conventional colour TV-receiver tuned to a suitable VHF-channel.

Just after this article was completed, and ready for printing, discussions were made between the author and editors, which led to a further development of this digital-storage module. This resulted in the use of 64 k memories which allow the spatial resolution of the module to be increased by four from the original 128 × 128 to 256 lines, 256 image points (pixels), and 64 grey levels. Since the re-writing of this article would delay the description of this interesting module too long, and since the described electronic module is not affected by this increase of resolution, we have decided to bring this article in its original form and to discuss the slight changes that must be made in Part 2 of this article. Part 2 will now describe the digital storage module having the higher resolution.

Please, do not be confused when references are made to the old 128 × 128 storage module.

INTRODUCTION

All slow-scan TV systems have one main disadvantage: The transmission time of an image is far longer than the storage time of the human eye. This means that slow-scan images cannot be viewed on a conventional cathode-ray tube, and that some form of storage is required in order to view the image information on the screen. In the past, various systems have been developed for this: Special long-persistance tubes for radar and SSTV, as well as a large number of electro-chemical methods for providing facsimile images. The principle of digital storage was, of course, known but was not used in practice due to the large amount of storage

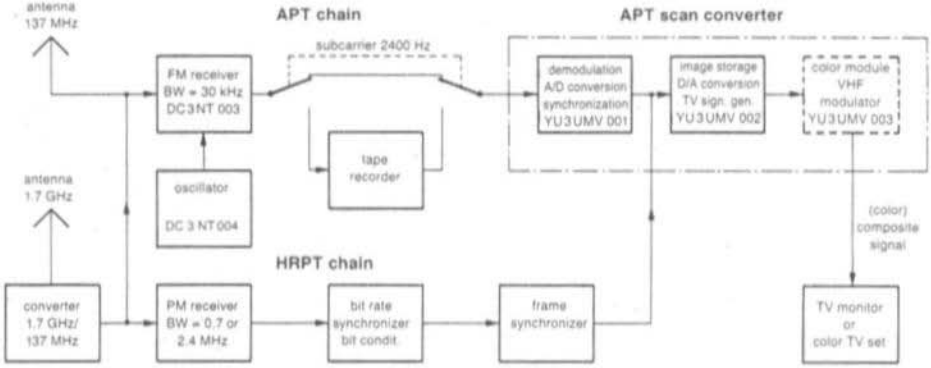

Fig. 1: Block diagram of a APT/WEFAX/HRPT station

required for each image. Fortunately, the price of digital MOS storage circuits has decreased continuously, and new types are becoming available with higher capacity and better usability. This means that digital storage modules cannot only be realized professionally, but now represent the most favorable method of displaying such images for radio amateurs.

The amount of storage required is dependent both on the spatial resolution (number of lines × the number of image points "pixels" per line) and also on the radiometric resolution (number of grey levels). Practical considerations limit the spatial resolution to values between 128 lines × 128 pixels (16 k storage) and 512 lines × 512 pixels (256 k storage). Lower resolution systems than with a 16 k storage would not be less expensive due to the extensive control electronics required. Larger systems having more than 256 k memory would not produce appreciably better results on conventional TV-tubes although they would be much more expensive.

On the other hand, the choice of the number of grey levels (radiometric resolution) is not as straight forward. Usually, 16 grey levels (including black and white) are chosen for low-cost systems and this corresponds to four bits of memory per pixel. Practical experiments have shown, however, that the radiometric resolution is far more important than spatial resolution when receiving satellite images. It has been found that images are still usable with a spatial resolution of only 64 pixels × 64 lines (less than one tenth of the original resolution), however, at least 64 grey levels (6 bits of memory per pixel) are required for an infra-red (IR) image to reduce the quantisization effects to a tolerable level.

The scan converter to be described in this article has a resolution of 128 pixels × 128 lines × 64 grey levels, provided by a 16 k × 6 bit memory. As can be seen in the block diagram given in **Figure 1**, the circuit is divided into two functional modules accommodated on two separate PC-boards. Module YU 3 UMV 001 is provided with the APT (or WEFAX) signal (modulated 2.4 kHz subcarrier) and converts it into a digital format suitable to be written into the digital memory. In addition to this, module 001 also decodes all the synchronizing information of the APT/WEFAX format, and contains the operating voltage supply for the whole digital storage.

Module YU 3 UMV 002 is provided with all signals generated in module 001, but is also designed to accept the output of a frame synchronizer for reception of high-resolution (HR)-digital images ("HRPT"), which are also transmitted by METEOSAT and NOAA. Module 002 also possesses a line-buffer memory (128 × 6 bit), a main frame memory (16 k × 6 bit), a TV synch. generator, driver circuits for the memories, and a D/A converter. The output of module 002 is an analog, video signal compatible to CCIR (320 lines per frame), which can be directly fed to a conventional video monitor.

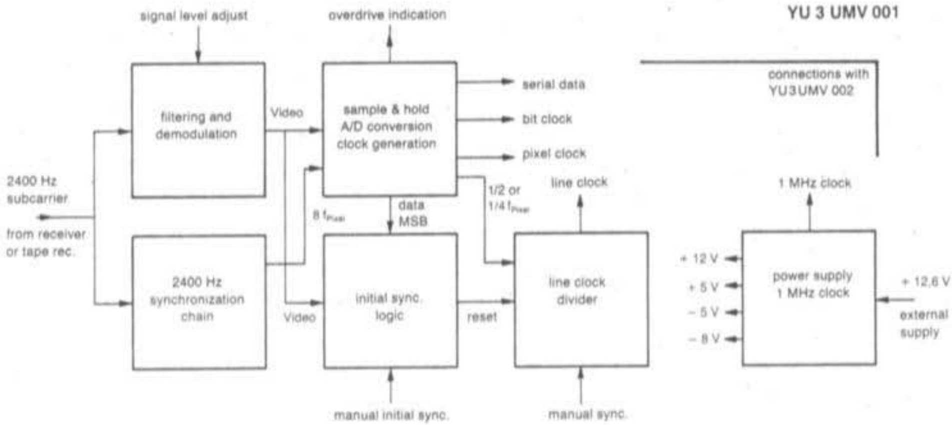

Fig. 2: Block diagram of the circuits on PC-board YU3UMV 001

A third, smaller PC-board YU 3 UMV 003 converts the grey levels into variable synthetic colours. This signal is then fed to a PAL modulator so that the weather satellite images can be viewed in synthetic colour on a free channel of a conventional colour TV-receiver. This module is not absolutely necessary, but one is able to use the facilities of synthetic-colours at little extra cost and you will be amazed at the effect this has on your visitors!

1. ELECTRONIC BOARD YU 3 UMV 001

The block diagram of this module is shown in **Figure 2**. The APT WEFAX signal is firstly filtered in a bandpass filter and demodulated. The analog, video signal is sampled and converted in an 8 bit A/D-converter. Only 6 bits are required, which are then converted into a serial format. Synchronization is obtained from the 2.4 kHz APT/WEFAX subcarrier and all clock signals are obtained from a PLL, which is synchronized to the 2.4 kHz subcarrier. This is followed by a chain of dividers. Additional circuits provide the initial synchronization (initial phasing) of the image. These circuits recognize the synchronizing sequences present in the video signal, and reset the line-frequency divider. It is possible for the image to be manually synchronized if these circuits are not able to recover the synchronizing pulses from the signal due to a poor signal-to-noise ratio.

The power supply procures all the required positive and negative supply voltages from a single, positive 12.6 V external supply (negative ground), which need not be stabilized. This means that the unit is portable, and can be driven, for instance, from a car battery. Module 001 also includes a 1 MHz clock oscillator, which is used to drive the TV-synch. generator on module 002.

1.1. Circuit Description

In order to describe the complex circuit more easily, it is to be divided into six parts. Each part corresponds to one block in Figure 2. All external connection points for input and output signals, potentiometers, switches, etc., are designated with Pt. 1.. for module 001. Arrows are given where interconnections are made on the PC-board.

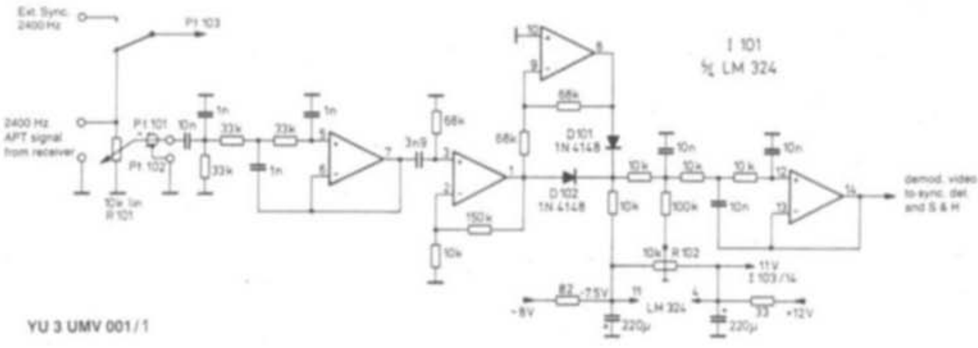

Fig. 3: Bandpass filter, video demodulator and low-pass filter

1.1.1. Filter and Demodulator

The filter and demodulator block is shown in **Figure 3**. The level potentiometer R 101 is accommodated on the front panel, and is followed by a bandpass filter for the APT/WEFAX signal. This is followed by the second amplifier of the LM 324, which drives the AM-demodulator equipped with D 101 and D 102, that is then followed by a lowpass filter for the video signal.

The circuit was designed to accept the APT-signals provided by a typical FM demodulator (TBA 120 or similar). Since the APT signal only contains useful information between 800 Hz and 4000 Hz, the S/N ratio can be considerably improved by filtering out out-of-band noise (e.g.: this is already made in module DC 3 NT 003). Since the FM-modulators on board the satellites do not employ preemphasis, the demodulated S/N will deteriorate with the square of the modulation frequency. This means that it is particularly important to filter out noise components above 4 kHz and to use a good, lowpass filter in conjunction with an operational amplifier. The filtering below 800 Hz is less demanding, and it is only necessary to efficiently suppress any 50 Hz power-line frequency interference, and this can be obtained by correct selection of the coupling capacitors.

The second operational amplifier drives the AM-demodulator – a full-way rectifier. Experiments have shown that it is not necessary to have a very good balance of the demodulator, and a simple inverter is satisfactory (third OpAmp). In addition to the required video signal, a very strong component at twice the subcarrier frequency (4.8 kHz) is present at the output of the rectifier. This should not be fed to the sample-and-hold circuit, and is therefore filtered out in an active lowpass filter using the fourth operational amplifier.

Trimmer R 102 is provided to adjust the DC-level of the video signal. This allows the black value of the image to be shifted to the commencement of the transfer curve of the A/D converter so that the available grey scale is used to the full.

1.1.2. The 2.4 kHz Synchonizing Chain

Figure 4 shows the 2.4 kHz synchonizing chain, which comprises a two-stage, narrow-band 2.4 kHz filter and a PLL-circuit with subsequent divider that generates all required frequencies for the clock generator, which are all phase-locked to the subcarrier signal. C-MOS inverters are used as active components in the 2.4 kHz filter since they have a smooth, well defined symmetrical limiting characteristic. This is not true for all conventional, operational amplifiers, which are subject to saturation, ringing, unbalanced limiting, and similar problems when operated with high-level signals. The given circuit allows wide tolerances of both active and passive components of the filter, and the high

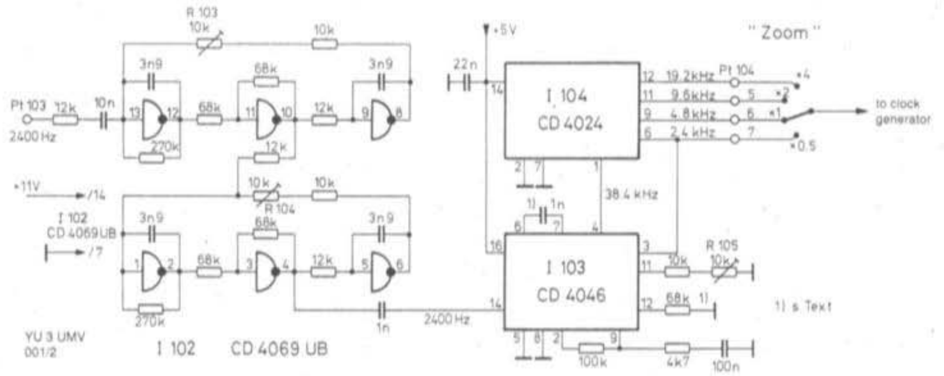

Fig. 4: Filter, 2.4 kHz synchronization, and divider for zoom-display

input impedance of the C-MOS inverters allows a wide choice of R and C values. It is only important that C-MOS gates of the A or UB series are used, since the B series has too high a non-compensated gain, and usually oscillates in feedback circuits.

The output of the filter is capacitively coupled to the self-biassing input of the well-known PLL circuit CD 4046. Its input has an internal bias voltage generator. Phase comparator I (exclusive or gate) is used, since some input pulses might be missing due to noise and/or deep modulation of the 2.4 kHz subcarrier. The VCO oscillates nominally at 38.4 kHz, which is 16 times the subcarrier reference frequency. Two components require mentioning: The 68 kOhm resistor at pin 12 is not really necessary for operation, but ensures a good commencement-of-oscillation for the VCO under any switch-on conditions. Wide tolerances are allowed for the VCO-portion of the CD 4046, and it may be necessary to modify the value of the VCO capacitor between connections 6 and 7.

The VCO frequency is divided by 16 in the CD 4024 binary counter. Frequencies of 19.2 kHz, 9.6 kHz, 4.8 kHz, and 2.4 kHz are present at the outputs of the CD 4024. These frequencies drive the clock generator via a selector switch on the front panel, and result in the pixel sampling frequency when divided by 8.

The choice of the sampling frequency is not trivial, and several factors have to be considered. The data rate of an APT-signal is approximately 3200 words per second. Since this is limited by the transmission channel bandwidth, it is no use having a higher sampling frequency. Furthermore, the sampling frequency must also be adapted to the size and format of the frame memory available. Since the available memory (128 × 128 pixels) is much smaller than the APT image format (800 × 800 pixels), it should be possible to display the complete image at reduced resolution, or to use various enlargements or zoomed sections of the image at higher resolution, or even original spatial resolution. This is possible by changing the pixel sampling frequency.

In theory, there is no relationship between the sampling frequency and the APT/WEFAX subcarrier frequency. In practice, however, the residual subcarrier frequency or its harmonics have to be filtered out carefully from the video signal. If these components reach the sample-and-hold circuit, they will heterodyne with the sampling frequency (or its harmonics) and will be visible as vertical bars in the image, (diagonal bars, if the two frequencies do not have a constant phase relationship to one another). In the case of a 16 k (128 × 128) memory, it is possible to select 2400 Hz or subharmonics as sampling frequency. Since no heterodyne products except a DC-component will be produced below the sampling frequency, far less filtering of the video signal will be required. However, it is important that the sampling frequency is phase-locked to the subcarrier frequency. Phase-locking of the sampling frequency to the sub-carrier frequency also results in other advantages: It provides an excellent tracking of tape-speed variations when displaying recorded images.

Table 1 gives the possible display formats on selecting these sampling frequencies: 2400 Hz, 1200 Hz, 600 Hz, and 300 Hz.

1.1.3. A/D Converter and Clock Generator

As can be seen in **Figure 5**, a C-MOS transmission gate (I 105) is used as sampling switch. The input impedance of the A/D converter ADC 0804 (National Semiconductor) is sufficiently high so that no additional amplifier is required for the holding function (100 nF capacitor). The 680 Ohm resistor from pin 9 (V_{ref}) to ground defines the dynamic range of the A/D converter from 0 V to approximately 2 V. The ADC 0804 has an internal clock oscillator (Schmitt-trigger gate) which is provided with

Weather satellite received	METEOSAT APT 240 lines p. m.	NOAA APT 120 lines p. m.
image format selector	METEOSAT/METEOR	NOAA
resolution selector "zoom"	x 4	x 4
	x 2	x 2
	x 1	x 1
	– – –	x 0.5 (VIS + IR)

Weather satellite received	METEOR 240 lines per minute	METEOR* 240 lines per minute
image format selector	METEOSAT/METEOR	METEOSAT/METEOR
resolution selector "zoom"	x 4	– – –
	x 2	x 4
	x 1	x 2
	– – –	x 1

* external sync. with 2400 Hz necessary

Table 1

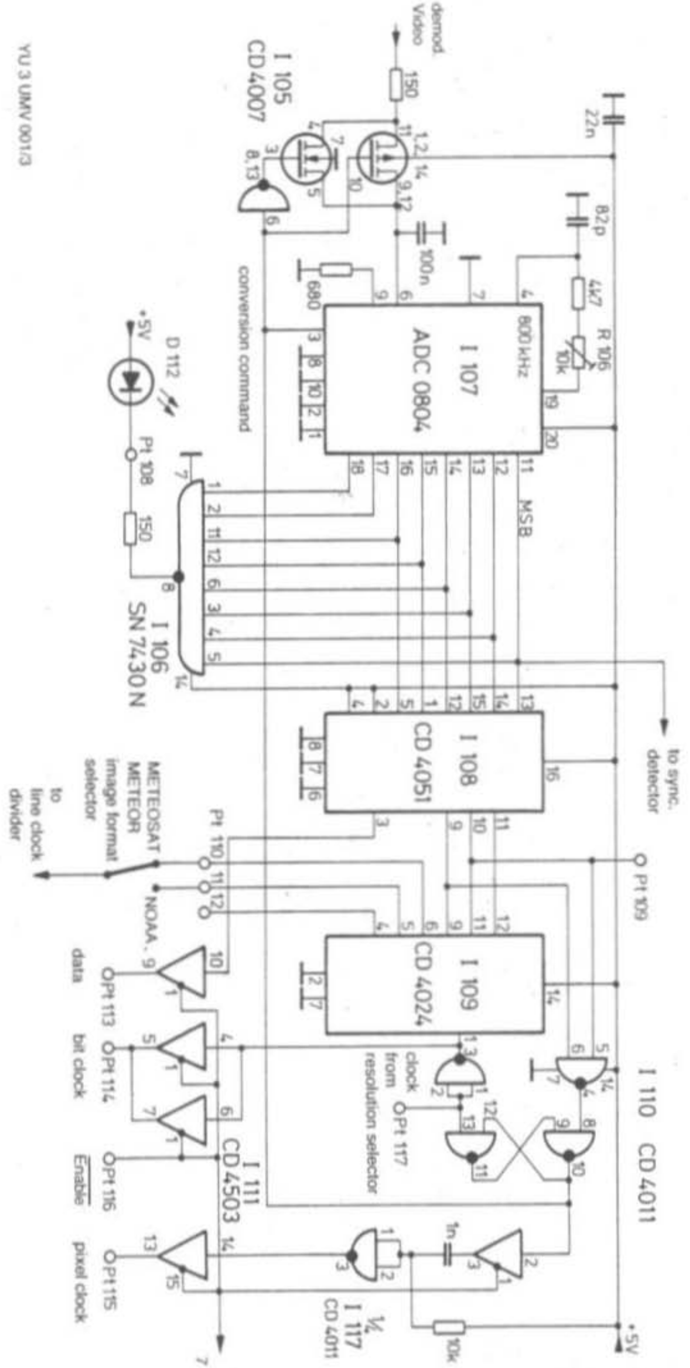

Fig. 5:
A/D converter, overload indicator, and clock generator

external components connected to pins 19 and 4, and R 106 is aligned to 800 kHz. A clock frequency of 800 kHz provides a conversion time of approximately 100 µs. The conversion is started at the leading edge of the conversion-command signal (see Figure 9). When conversion is completed, the data is transferred to the output storage of the ADC 0804. An 8-input NAND gate detects the over-range, which is displayed by a LED on the front panel. This indicator is very useful for adjusting the signal level at the input of the video demodulator correctly. The appropriate potentiometer is adjusted correctly when the LED just starts blinking, which indicates that the dynamic range of the A/D converter is being fully utilized, without excessive clipping.

The parallel data at the outputs of the ADC 0804 are serialized in the multiplexer (I 108) where the two lowest-valency bits are suppressed. The radiometric resolution of 6 bits ≙ 64 grey levels is dertermined at this point.

The multiplexer CD 4051 is driven by the divider CD 4024 (I 109), and converts the parallel data into serial form, being fed to pin 3 of one of the buffer amplifiers, from where they are fed via Pt 113 to module YU 3 UMV 002 for storage.

The clock generator also includes a decoder logic to generate the conversion command and pixel clock. Finally, the operation of the buffer amplifiers should be described through which all output signals from module 001 are fed: Serial data, coherent bit-clock, pixel-clock, and line-clock (see Figure 7). The gates with three possible output states (tri-state gates) are normally switched on when the enable input Pt 116 is grounded; if, however, Pt 116 is connected to + 5 V, this will disable the tristate buffers so that signals from another source, such as the frame synchronizer shown in Figure 1, can be fed to module 002.

The line sampling clock is derived from the pixel sampling clock. It is important here to know that the line sampling clock is only equal to the image line frequency when the maximum geometrical resolution is to be retained. If an image is to be displayed at reduced resolution,m it is not only necessary to reduce the pixel sampling clock to lower the horizontal resolution, but it is also necessary to reduce the line sampling clock to lower the vertical resolution in order to avoid a severe, geometrical distortion. For example, if the image is to be displayed at 1/4 of the original resolution (nearly the whole image in the case of a 128 × 128 memory), then the pixel sampling rate should be lowered to 1/4 of the maximum sampling rate, and only every fourth line of the image should be written into the memory. This means that the ratio between the pixel sampling frequency and the line sampling frequency remains constant for a fixed image format and memory size. In the case of a 128 x 128 memory, displayed on a TV-screen having a 4:3 aspect ratio, the ratio between the two sampling frequencies is 600 for geostationary satellites such as METEOSAT and both METEOR standards, and 1200 for NOAA satellites.

A half and a quarter of the pixel sampling frequency are available at the outputs of divider I 109 (pin 6 and pin 5). A further division by 300 is performed by the line clock divider (I 118 and I 119 in Figure 7) which provides the required ratios of 600 or 1200 between the two sampling frequencies. Auxiliary outputs are provided for other satellite standards, for example for the (very seldom active) METEOR IR-transmissions which require a ratio of 150 between the two sampling frequencies.

These auxiliary outputs are Pt 109 and Pt 112.

1.1.4. Synchronizing Logic

The initial synchronizing logic (see **Figure 6**) can operate automatically by decoding the start and stop tones of the geostationary (METEOSAT) WEFAX transmission, or manually by decoding the synchronizing pulses of METEOSAT, NOAA, or METEOR. The three PLL tone decoders of the LM 567 series are aligned to 300 Hz, 450 Hz, and 840 Hz. Since very high capacitance values would be required in the output-filter outputs (pin 1) of the first two decoders (I 112 and I 113), external delay gates are connected to their outputs (pin 8). The 300 Hz and 450 Hz decoders control an RS flipflop to implement the automatic start-stop function.

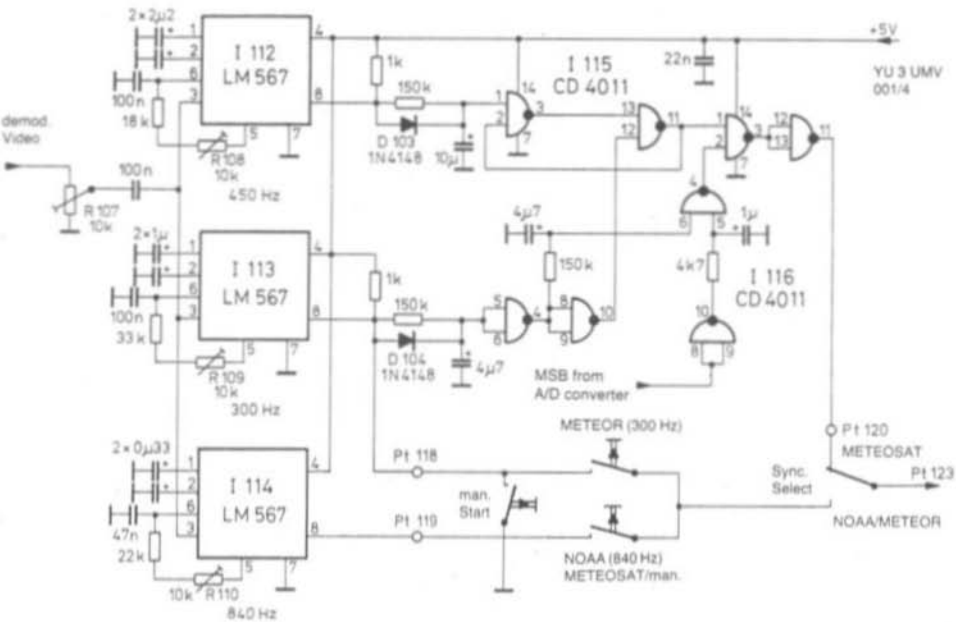

Fig. 6: Tone decoder and synchronizing logic

A delayed 300 Hz pulse connects the highest-valency bit (MSB) from the A/D converter to the reset of the line clock divider. The synchronizing pulses which immediately follow the 300 Hz start tone, synchronize the line divider automatically.

The integrated circuit LM 567 is a narrow-band tone decoder and it is not very suitable to detect very short tone bursts such as the horizontal synchronizing pulses of the NOAA and METEOSAT images (7 cycles). The operation of the 840 Hz detector is not very reliable since it is also sensitive to image patterns similar to synchronizing pulses, and to noise, and it is sometimes necessary to repeat the manual synchronizing process. On the other hand, METEOR satellites with 120 lines/min. have far longer synchronizing bursts (16 cycles) but, unfortunately, the frequency of these bursts is not exactly 300 Hz and a separate tone decoder would be required to obtain better results.

However, the S/N ratio is usually very poor at the beginning of signal acquisition when receiving polar orbiting satellites, especially when using simple omnidirectional antennas.

1.1.5. Line Clock Divider

The line clock divider **(Figure 7)** comprises two dividers. The first is a divide-by-three (I 118 and two NAND-gates [I 117]) which is followed by a divide-by-100 (I 119). The divide-by-three divider can also be preset to divide by two or by four using two pushbuttons. In this manner, a slightly higher or lower line clock frequency can be generated to manually shift the image in either direction.

The amount of shift is proportional to the time the pushbuttons are depressed. The diodes at the output of the by-100-divider CD 4518 (I 114) are connected as an AND-gate to narrow the output pulse. This is required for some satellite standards, for instance to receive the METEOR IR-images (20 lines/min.)

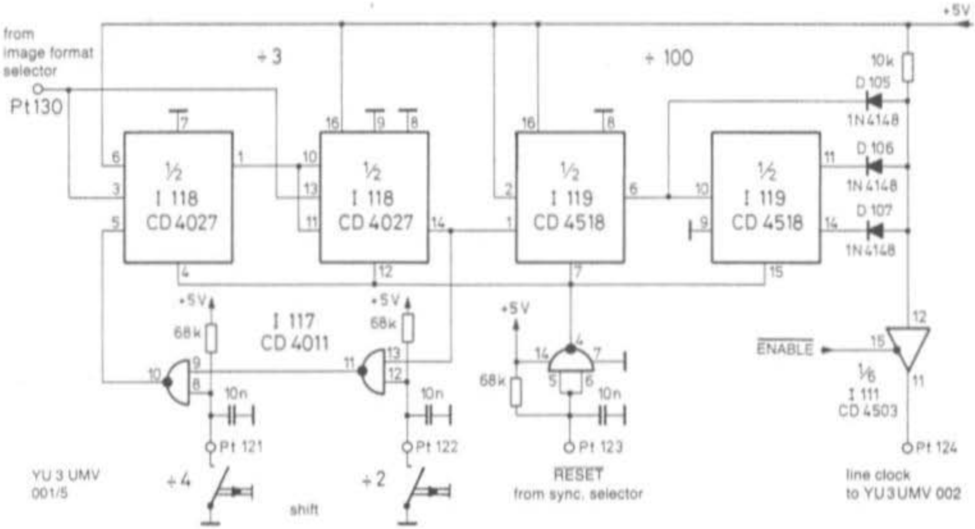

Fig. 7: Divider for line clock and image shift

1.1.6. Power Supply and 1 MHz Oscillator

The power supply accommodated on the PC-board YU 3 UMV 001 (see **Figure 8**) also supplies the stabilized voltages for module 002. The nominal value for the external voltage at Pt 125 is 12.6 V, however, the whole unit will operate between 10 and 15.5 V at normal ambient temperatures. The overall current drain is in the order of 400 to 450 mA. Diode D 110 protects the circuits against incorrect polarity, and the AF-choke suppresses the pulses from the digital circuits in order to ensure that they are not fed to the receiver via the power supply line. A three-terminal voltage regulator supplies a

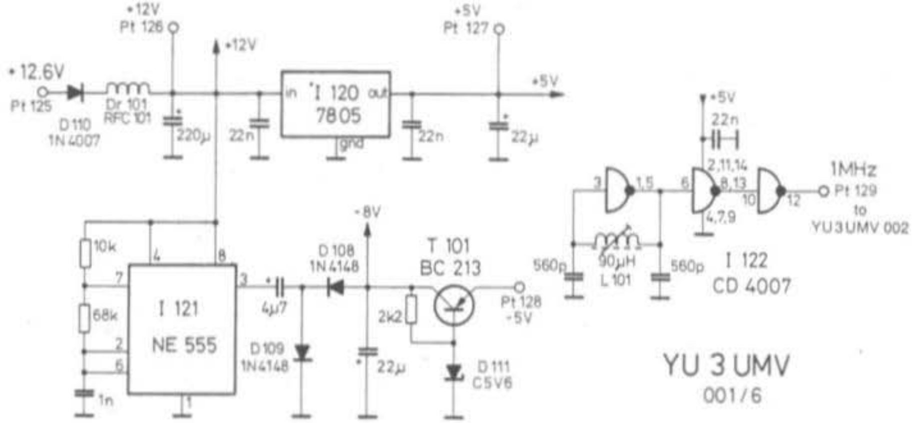

Fig. 8: Power supply from one current source, and the 1 MHz oscillator

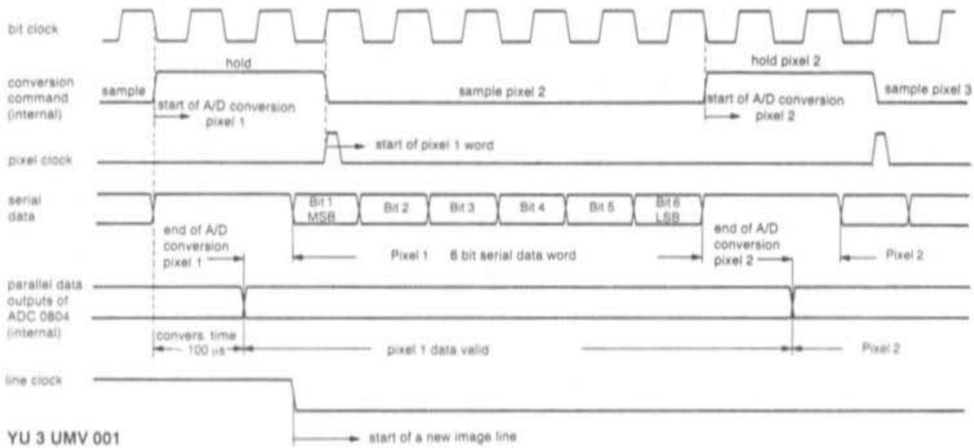

Fig. 9: Output data format generated on PC-board YU 3 UMV 001

voltage of + 5 V; it should be mounted on a suitable heat sink (or cabinet). No insulation is required since the heat sink of the 7805 is grounded. A clock generator circuit type NE 555 is connected as multivibrator, and its output AC-voltage is rectified in a fullwave rectifier in order to obtain approximately − 8 V. The − 5 V supply voltage required is obtained using a simple zener diode/transistor regulator.

PC-board 001 is also equipped with a 1 MHz LC-oscillator, from which the horizontal and vertical TV-frequencies on module 002 are derived. Since the format of the TV-signal generated on module 002 does not correspond exactly to CCIR (320 lines instead of 312.5 lines per frame), a variable oscillator is preferable to a crystal oscillator. Practical experiments have shown that some TV-monitors (or modified TV-receivers) are more sensitive to variations of the line frequency (loss of horizontal synchronization), whereas others are more sensitive to fluctuations of the frame frequency (interference with the 50 Hz power line). This can be compensated for by carefully aligning L 101.

1.2. CONSTRUCTION

Printed circuit board YU 3 UMV 001 has dimensions of 85 mm × 190 mm and is single-coated. The component locations are shown in **Figure 10**, and **Figure 11** shows a photograph of the author's prototype.

Due to the low spacing of the holes on the PC-board, it is necessary for the resistors to be mounted vertically, and an additional 7 bridges are also required:

A: Reset 4518, 4027
B: + 12 V supply
C: − 8 V supply
D: A/D converter: MSB
E: Ground for 4051
F: Conversion command
G: Demodulated video voltage.

The 30 connection points designated with Pt 1.. in the circuit diagrams are connected to switches, pushbuttons, potentiometers, and other connection points, also on PC-board 002

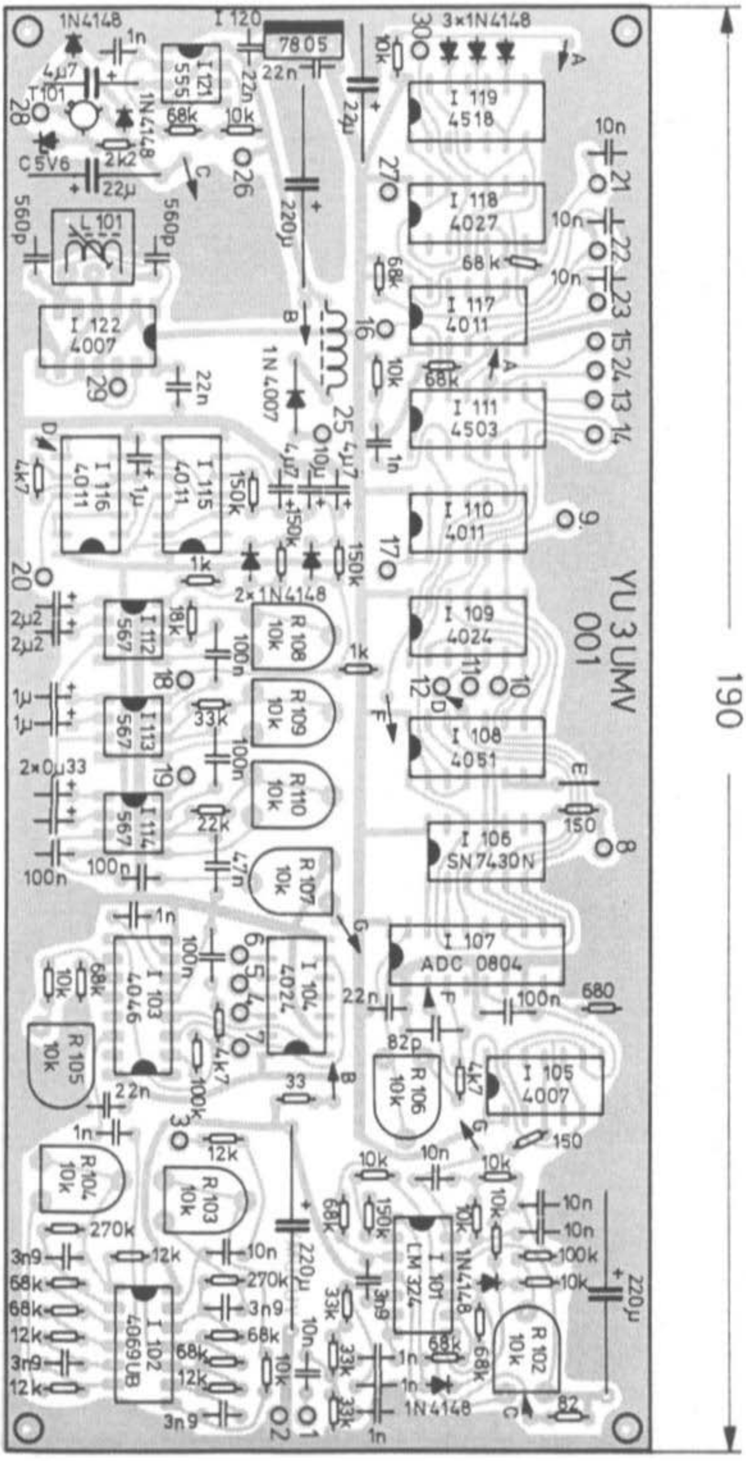

Fig. 10:
Component location plan of the single-coated PC-board YU 3 UMV 001

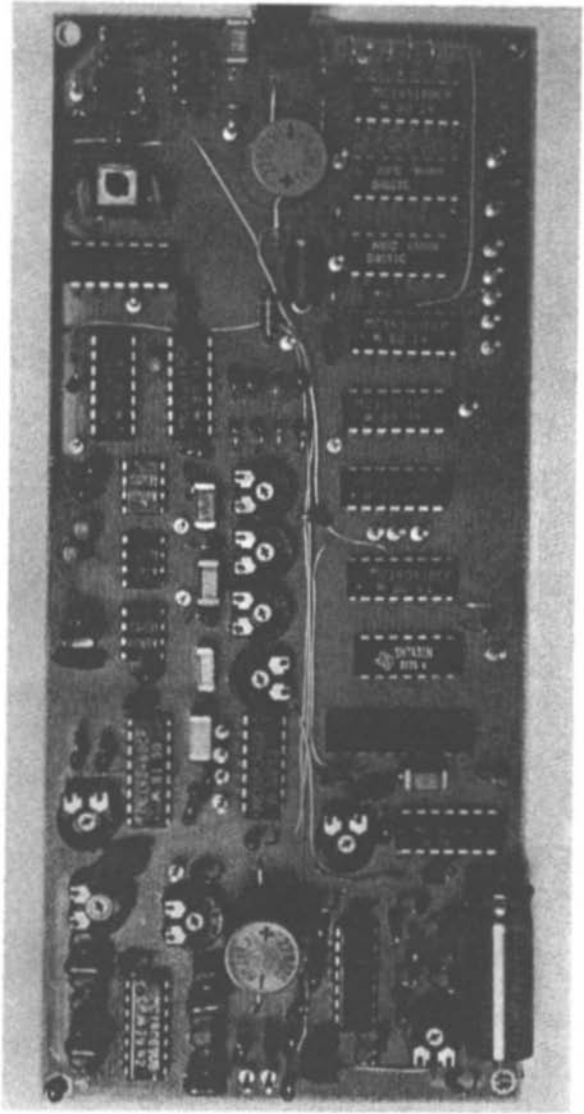

Fig. 11:
Photograph of a prototype YU3UMV 001

(and 003). Solder pins should be used here. It is not recommended that IC-sockets be used, since in our experience, it is especially the (cheap) sockets that cause more problems than the integrated circuits themselves. Of course, one must pay considerable attention to ensure that the integrated circuits and bridges are inserted and connected correctly, and that good solder joints are made. It is extremely difficult to find such faults afterwards!

It is not necessary for this module to be screened, however, the whole digital storage and scan converter should be enclosed in a metal case, as is usual in amateur radio applications.

1.3.
Components for YU 3 UMV 001

ADC 0804	National Semiconductor	1 pc.
BC 213, BC 415	PNP AF-transistor	1 pc.
CD 4007	C-MOS IC (various manufact.)	2 pcs.
CD 4011	C-MOS IC (various manufact.)	4 pcs.
CD 4024	C-MOS IC (various manufact.)	2 pcs.
CD 4027	C-MOS IC (various manufact.)	1 pc.
CD 4046	C-MOS IC (various manufact.)	1 pc.
CD 4051	C-MOS IC (various manufact.)	1 pc.
CD 4069 UB	C-MOS IC (various manufact.)	1 pc.
CD 4503	C-MOS IC (various manufact.)	1 pc.
CD 4518	C-MOS IC (various manufact.)	1 pc.
LM 324	Quadruple OpAmp	1 pc.
NE 555, LM 555	Clock generator circuit	1 pc.
NE 567, LM 567	Tone decoder	3 pcs.
SN 7430 N	8-NAND, TTL	1 pc.

All these integrated circuits are in a dual-in-line case!

7805	5 V stabilizer	1 pc.
C5V6	Zener diode, approx. 200 mW	1 pc.
LED	Type and colour as required	1 pc.
1 N 4007	Rectifier diode	1 pc.
1 N 4148, 1 N 4151	Switching diode	9 pcs.
Six-hole ferrite core (Philips)		1 pc.
Variable inductance, approx. 90 µH, dimensions 10 × 10		1 pc.

or Neosid type 5960 (black/red/red) for which new holes must be drilled!

The three 220 µF capacitors are aluminium electrolytics for 25 V, with a spacing of max. 27.5 mm.

The other 13 polarized capacitors are tantalum electrolytics. The non-polarized capacitors for a spacing of 7.5 mm or 5 mm are plastic foil capacitors. Ceramic disk capacitors having a low temperature coefficient can be used for the 82 pF and 560 pF types. It is only necessary for ceramic capacitors to be used for the 22 nF bypass capacitors.

Since all resistors are mounted vertically, various sizes are suitable. The nine trimmer potentiometers have a spacing of 10/5 mm.

1.4.
Connecting and Preparing the Electronic Board

Firstly check the three voltages generated on the PC-board, after which the three oscillators (38.4 kHz, 800 kHz, and 1000 kHz) should be aligned to their nominal frequencies. After this, it is possible for the three tone decoders to be aligned to 450 Hz, 300 Hz, or 840 Hz. This can be carried out by measuring the free-running frequency with the aid of an audio frequency counter, or by driving them one after another using an exactly calibrated audio generator and observing the locking-in process at pin 8.

This can be carried out using the live signals from METEOSAT where the start and stop tones are repeated approximately every 4 minutes (see VHF COMMUNICATIONS). However, the 840 Hz tone burst transmitted by NOAA is very short, and alternates very rapidly with the 1040 Hz burst which means that this tone decoder can only be aligned with the aid of measuring equipment.

The circuit of the electronic board has been explained extensively so that on can carry out a large number of measurements and checks on the circuit based on these descriptions, according to one's own experience, and the amount of measuring equipment available. If no component, or soldering errors are present, it is possible for this board to be connected directly to module 002 after carrying out the previously mentioned adjustments, and to carry out the final alignment during practical operation. A wiring plan, and alignment details are to be described together with PC-board YU 3 UMV 002. The description of module 001 is now to be completed with a table showing the relationship of the alignment components.

Component number	Function	Notes
R 101	Subcarrier level	Potentiometer on the front panel
R 102	Base of the grey staircase	
R 103, R 104	Center frequency of the 2.4 kHz-filter	to max. at I 103/14
R 105	PLL-center frequency: 38.4 kHz	I 102/10; approx. 1.5 V
R 106	800 kHz oscillator in ADC 0804	I 107/19: 800 kHz (high-imped.)
R 107	Drive level for tone decoder	Align for secure lock-in
R 108	450 Hz tone decoder	measured at pin 5
R 109	300 Hz tone decoder	measured at pin 5
R 110	840 Hz tone decoder	measured at pin 5
L 101	1000 kHz	I 122/12:1000 kHz

Editorial Note:

As mentioned in the introduction, the spatial resolution of this digital-storage module was increased from 128 × 128 to 256 × 256. Only a few modifications are required to the electronic board YU 3 UMV 001, and these will be discussed in Part 2 of this article, which will now describe the digital storage with the higher resolution.

Hans-Joachim Senckel, DF 5 QZ

A 6 cm Transmitter for FM and SSB

In order to contribute to the »pile-up« on the 6 cm band, mentioned by DD Ø QT in Edition 2/82 (1), the author is to describe a matching transmitter for the described receive converter.

1. DESCRIPTION

Firstly, the author modified the receive converter described in (1) to make an FM-transmitter (see **Figure 1**). The efficiency of the varactor diode was improved by providing an idler circuit, and an additional matching screw. Three further compensation screws were provided between filter and N-connnector **(Figure 2)**, to optimize the matching of the waveguide transition. A screw was also provided for compensating the output coupling pin, but was not required in practice. The waveguide transition is flanged on; it can be exchanged for a diode probe (1N21) for measuring purposes.

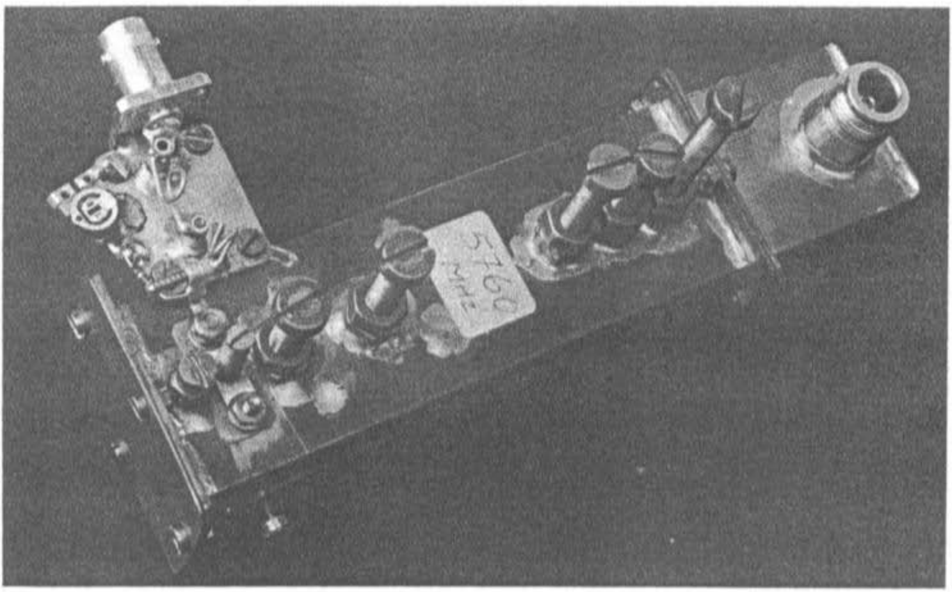

Fig. 1: The frequency multiplier (FM)-transmitter based on the receive converter described in (1)

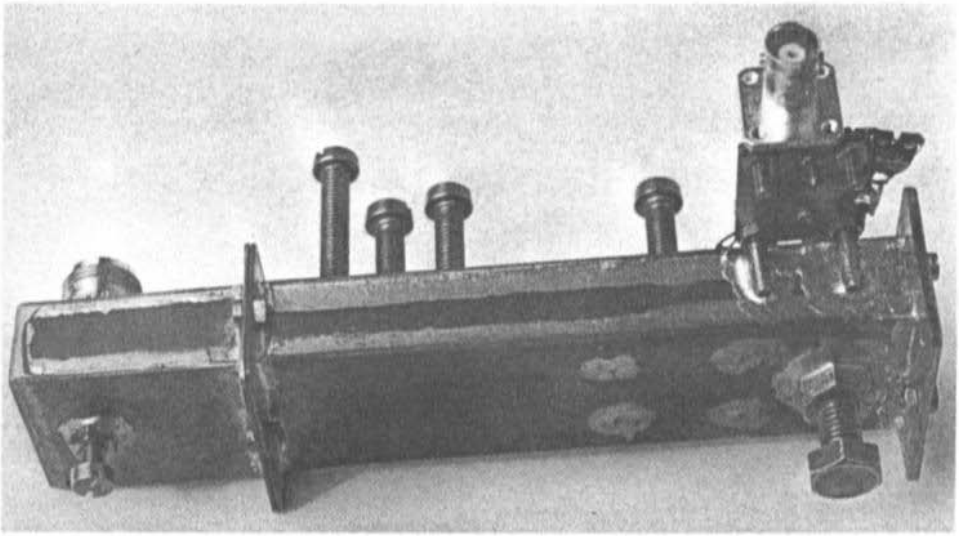

Fig. 2: **The screw for the varactor diode, the filter pins, and the output compensating screw can be seen on the lower side of the multiplier transmitter.**

It was found during the subsequent communication experiments in FM to a fixed station over a path of 35 km that the readability was not sufficiently good due to the low field-strength (15 dB). This led to the construction of an SSB transmitter **(Figure 3)**. This version is also based on the receive converter. The receive mixer diode is replaced by a storage varactor, and those modifications that were made to the FM-transmitter were added. The varactor diode is provided with the required local oscillator frequency via the matching network shown in **Figure 4**. The subsequent filter ensures sufficient selectivity. The filtered oscillator signal is fed to the mixer diode. The 144 MHz SSB signal is fed to the mixer diode via a further matching network **(Figure 5)**. The required signal is passed through a filter as described in (2) to the output coupling connector (waveguide transition). Compensation screws are again provided for optimum matching. It was possible using this transmitter to operate two-way SSB communication.

2. CONSTRUCTION

The waveguide can be made from 0.8 mm to 1.0 mm brass plate. The inner dimensions are 34.8 mm x 15.8 mm. The nuts for the M5 or M6 tuning screws and compensation screws, as well as the N-connector(single-hole mounting) are soldered into place. If BXY ... types are to be used as varactor or mixer diode, the mount described in (1) should be used. When using

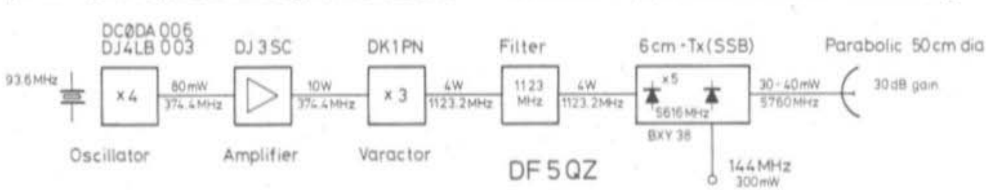

Fig. 3: **The SSB transmitter can be combined from modified modules described in VHF COMMUNICATIONS**

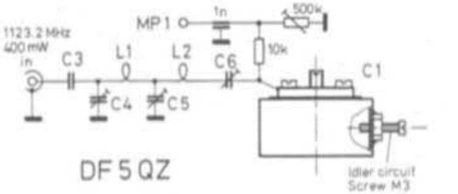

Fig. 4: Matching network for the local oscillator frequency 1123.2 MHz/4 W

L 1: 1 turn of 1.5 mm dia. silver-plated copper wire wound on a 6 mm former, self-supporting, soldered between the trimmers;

L 2: 1 turn of 0.8 mm dia. silver-plated copper wire wound on a 5 mm former, self-supporting;

C 3: Chip capacitor, 270 to 1000 pF

C 4 – C 6: Highest possible quality tubular or spindle trimmer 0.3 – 6 pF

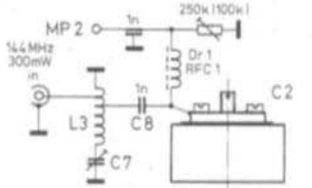

Fig. 5: Matching network for the 144 MHz signal

L 3: 6 turns of 1 mm dia. silver-plated copper wire wound on a 6 mm former, self-supporting, soldered between ground and C 7;
Coil tap to connector: 1 turn; for C 8: 1.5 turns from the cold end

RFC 1: 50 cm 0.4 mm dia. enamelled copper wire wound on 3 mm former

C 7: Air-spaced trimmer (tronser) max. 34 pF

C 8: Ceramic capacitor 1 nF

low-cost diodes (case similar to 1N21), the values given in the constructional diagram **(Figure 6)** are valid.

The matching networks are made on PC-board material and are soldered to the side of the completed waveguide **(Figure 7)**.

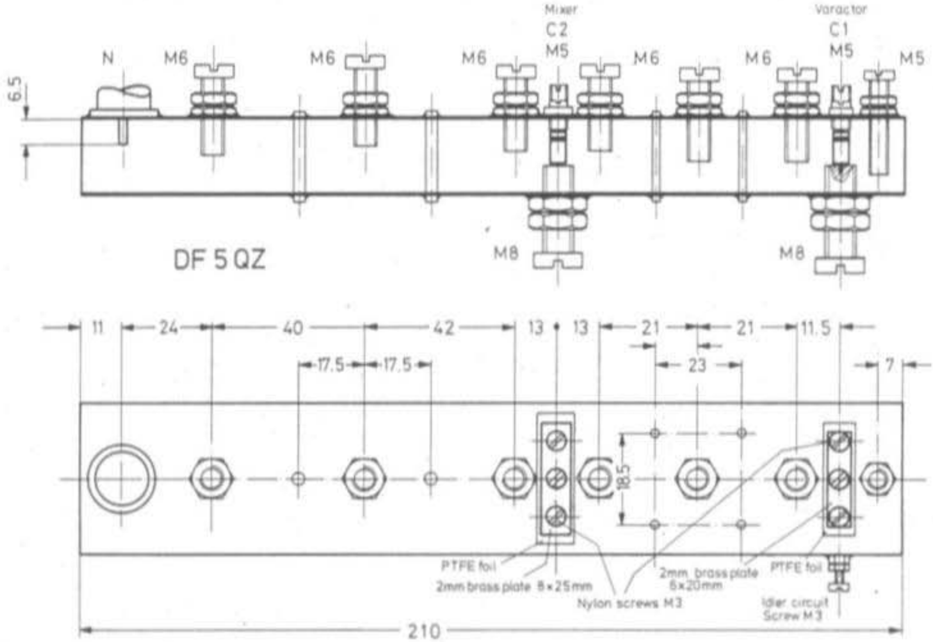

Fig. 6:
Dimensions of the transmit converter: Top and side view
Waveguide: R 70 (WR 137/WG 14)
C 1, C 2: Home-made bypass capacitors with PTFE foil as described several times in this magazine
Multiplier diode: BXY 38 (Philips) or similar
Mixer diode: 1 N 23 or cheap alternative

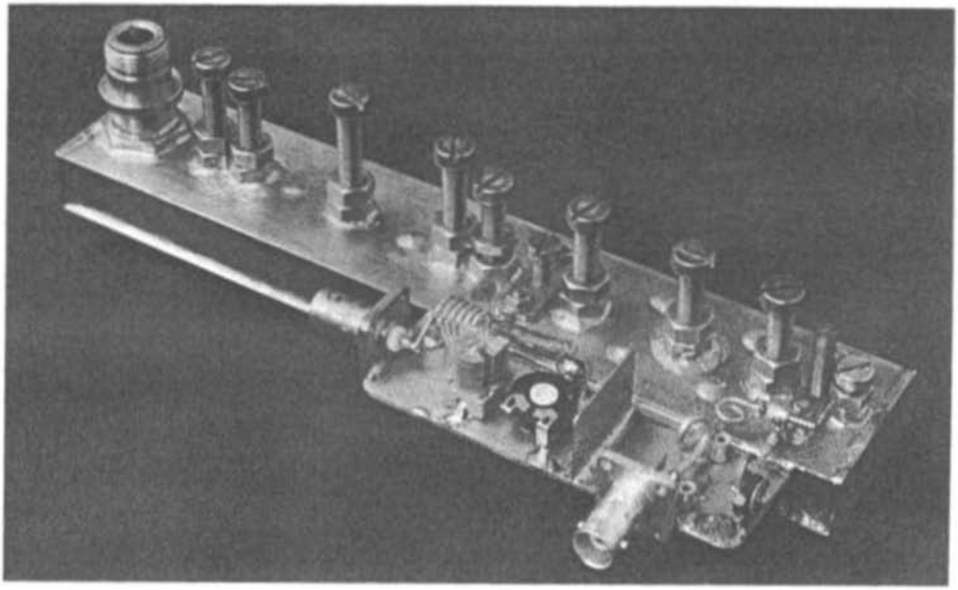

Fig. 7:
The transmit converter 144/5760 MHz in a waveguide confi guration with the matching networks for local oscillator and signal frequency soldered into place

3. ALIGNMENT

Firstly, feed an oscillator power of 3 to 4 W at 1123.2 MHz via the matching network to the varactor diode. The input circuits are aligned for maximum current on a mA-meter connected between testpoint MP 1 and ground. In addition to this, a suitable reflectometer should be connected between frequency multiplier and oscillator in order to allow alignment to obtain an optimum standing wave ratio.

Subsequent to this, the alignment screw of the local oscillator filter should be tuned for maximum mixer diode current. The mixer diode current can be read off on an mA-meter connected between testpoint MP 2 and ground. The insertion depth of the M6 filter screw amounts to approximately 5 mm at 5616 MHz. The fourth harmonic will be energized at a depth of approximately 12 mm.

The required frequency filter subsequent to the mixer diode is also tuned together with the local oscillator frequency. A diode probe connected to the output coupling connector, or a suitable wattmeter, are used to indicate the SHF-output. All screws can now be aligned for maximum output power.

After completing the alignment, the mixer diode is fed with a 144 MHz signal of approximately 300 mW via the matching network. Finally, the matching circuit comprising L 3 and C 7 is optimized so that the oscillator output power on the diode probe falls off noticeably. The filter screw after the mixer diode is rotated out by 1 to 2 mm and thus tuned to maximum output power of the required signal (5760 MHz). If the input power from the oscillator is now removed from the frequency multiplier, no output power should be indicated on the SHF-probe. The same is valid when disconnecting the 144 MHz signal.

After this, all circuits are aligned alternately for maximum output power at the required frequency. The adjustment of the compensation screws can only be made with the aid of a partner station with S-meter or on a spectrum analyzer. The load resistor of the mixer diode is also aligned for best SSB modulation by monitoring the output signal.

4. MEASURED RESULTS

Both described transmitters were examined on a spectrum analyzer and measured. The input power from the oscillator (1123.2 or 1123.5 MHz) amounted to 4 W. The FM-transmitter provided an output power of 380 mW at 5760 MHz with an input power of 4 W. The SSB transmitter provided an output power of 40 mW using the same oscillator power together with a 144 MHz signal of 300 mW. The image rejection amounted to −38 dB and the suppression of the local oscillator frequency was measured to be −18 dB. The microwave diodes used in the transmitter are so-called low-cost diodes (R. Heidemann, DC3QS). We know from experience that the efficiency can be increased by using special microwave diodes such as the BXY 38, or BXY 41.

A 50 cm parabolic reflector with a horn for 5760 MHz was used as antenna, and has a gain of approximately 30 dB. The partner station DC Ø DA used a 70 cm parabolic with combined horn for 13 cm and 9 cm (approx. 20 dB). The reports over a distance of 35 km, which is a poor path, amount to 10 dB over noise in the SSB mode.

5. REFERENCES

(1) Thomas Morzinck, DD Ø QT:
A Receive Converter for the 6 cm Band
VHF COMMUNICATIONS 14,
Edition 2/82, Pages 89-93

(2) Rolf Heidemann, DC 3 QS:
Receive Mixer for the 6 cm Band
VHF COMMUNICATIONS 12,
Edition 1/1980, Pages 46-50

Josef Fehrenbach, DJ 7 FJ

Straight-Through Mixer for 24 GHz

Many of those having experience in wide-band communications on the 10 GHz band, have, maybe, often wished to continue these activities to the next higher amateur band. The technology used on the 24 GHz band is similar to that of 10 GHz, with exception of the dimensions. The additional path loss with fog and rain has been found not to be a problem in experiments made over 50 to 120 km. The free-space path loss at 24 GHz, is, it is true, 7.6 dB more than at 10 GHz, however, that can be compensated for by using antennas of the same size. On the other hand, this has the disadvantage of decreasing the beamwidth.

Virtually no 24 GHz components are available on the surplus market and a similar module to the 10 GHz gunnplexer manufactured by Microwave Associates does not exist, at least not at a reaşonable price. Oscillators can be home-made or are available for approximately DM 300,— from various manufacturers. Circula-

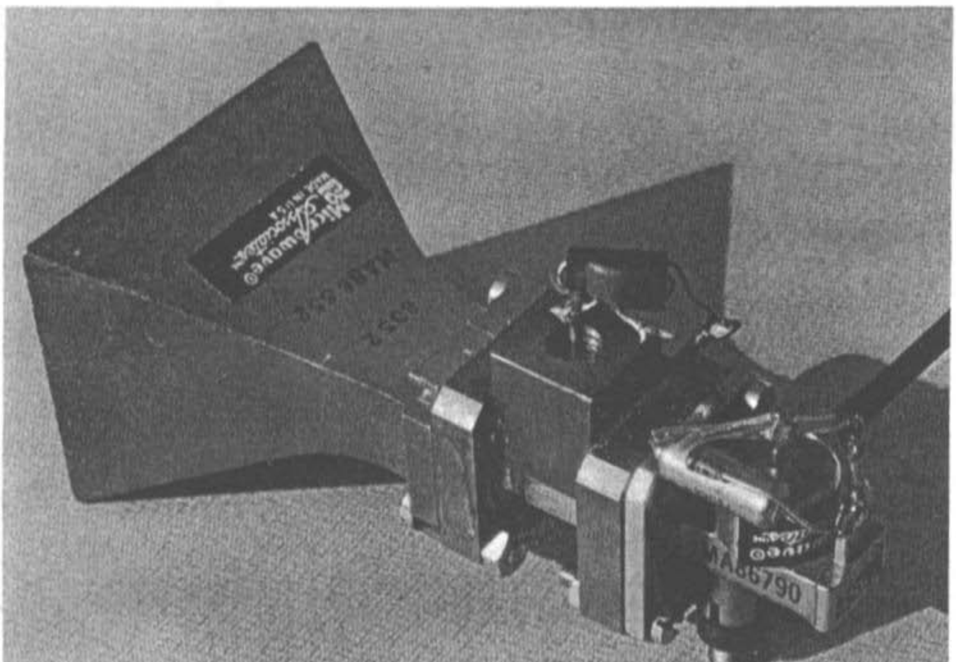

Fig. 1: The whole 24 GHz transceiver comprising Gunn oscillator, straight-through mixer, and horn antenna, is only 86 mm high.

tors for the K-band are very expensive. For this reason, a system comprising oscillator and straight-through mixer is more advisable for amateur applications.

1. PRINCIPLE OF OPERATION

The straight-through mixer is installed in a waveguide type R 220 which is terminated by two matching flanges. One side of the mixer is connected to an oscillator with iris, and the other side to an antenna (see **Figure 1**).

The mixer is designed for oscillators having approximately 10 mW output power. The power loss in the transmit branch is in the order of 3 dB. The mixer diodes should be spaced $\lambda_{wg}/4$ from the iris (λ_{wg} = waveguide wavelength). Since $\lambda_{wg}/4$ is in the vicinity of the edge of the flange, a spacing of 3 $\lambda_{wg}/4$ was selected. If an oscillator is to be used without iris, it will be necessary to change the following dimensions: In this case, the mixer diode must be spaced $\lambda_{wg}/4$ or $\lambda_{wg}/4$ plus any number of $\lambda_{wg}/2$ from the Gunn diode. The mixer can be equipped with three tuning screws (M2) spaced $\lambda_{wg}/4$ from another. The position with respect to the mixer diode is not critical (**Figure 2**). The author, however, did not use tuning screws since they only provided a sensitivity improvement of approximately 1 dB in his prototype.

The waveguide wavelength λ_{wg} can be calculated as:

$$\lambda_{wg} = \frac{\lambda}{\sqrt{1 - \left(\frac{\lambda}{2a}\right)^2}}$$

λ = Wavelength in air or 12.42 mm for 24.150 GHz

a = internal dimension of the wide side of the waveguide; with R 220, a = 10.67 mm.

This results in λ_{wg} = 15.22 mm; $\lambda_{wg}/4$ = 3.82 mm, and 3 $\lambda_{wg}/4$ = 11.45 mm.

The case of the mixer diode is either 100 or 119 **(Figure 3)**.

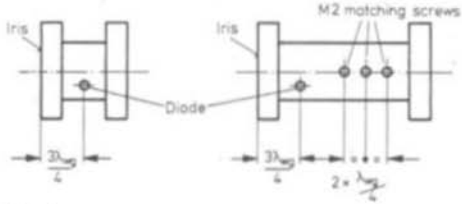

Fig. 2: Construction of the straight-through mixer, both with and without matching screws

Special mixer diodes such as the BAT 14 are suitable, but also detector diodes will offer a sufficiently good sensitivity. The author used the K-band detector diode MA 40277 manufactured by Microwave Associates. The well-known 1N26 is not suitable for consctructing straight-through mixers, according to the author, due to its construction.

The mixer diode should be mounted on the side of the waveguide since the conversion current would otherwise be too great. The current should not be less than 400 to 500 µA, and not much more than 4 mA.

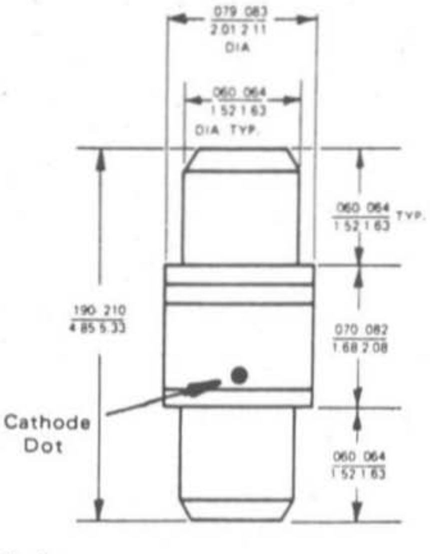

Fig. 3: The diode case type 119 together with its dimensions in inch and mm.

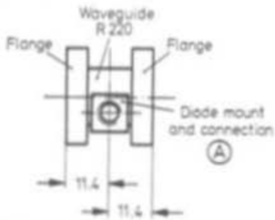

Fig. 4:
Main dimensions of the straight-through mixer

2. CONSTRUCTION

A certain amount of mechanical skill is required for construction, and it is advisable to have access to a lathe (or to know someone who has both!).

Firstly saw off a piece of waveguide that is approximately 1 to 2 mm longer than required, (see **Figure 4**). Usually, the flanges are rather loose on the waveguide, and it is therefore advisable to make several center taps around the inner hole until they fit more tightly.

After waveguide and flanges are ready, part A (**Figure 5**) should be prepared to the outer dimensions and provided with a center, 1.7 mm hole. Preferably, one should use a 10 mm rectangular brass profile for this part. The lip at the lower end is only provided to form a stop for fixing it previous to soldering, and is not absolutely necessary. It is also possible for part A to be made from round material.

Part B should be made on a lathe. The tightly fitting flanges are now placed in the correct position on the waveguide, after which part A is fixed into position using a small vice; after this, all parts are soldered to the waveguide. Any protruding pieces of waveguide are now removed with the aid of a file so that they form a flat surface with the flange. They can then be polished using emery cloth.

It is also possible to solder in steps by using normal solder for the first parts and solder with a lower melting point afterwards. With care, it is possible to avoid unsoldering the previously made joints.

Part A covers one hole in each of the two flanges. Usually, this is not important since it is sufficient to screw on the flange with the aid of three screws. For those who want to use four screws, it is possible for part A to be provided with a slot on the side that allows longer screws to be used.

The 1.7 mm hole in part A is now continued through both waveguide walls, which ensures that the mounting hole for the diode is correct. After this, the hole in part A can be extended to 4.5 mm diameter together with the soldered waveguide. The other parts are made according to the dimensions given in Figure 5 and mounted as shown in **Figure 6**. Part D can be made from an M6 screw, and does not necessarily need to be brass.

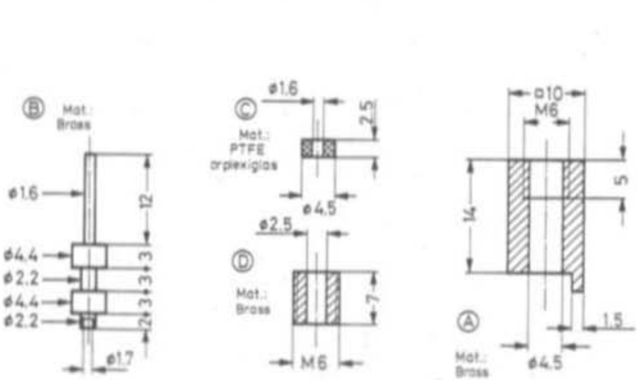

Fig. 5:
The four parts of the diode mount

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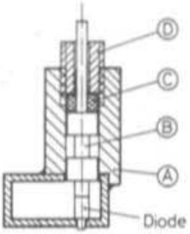

Fig. 6:
Cross section of the waveguide and diode mount

3. OPERATION

Install the diode carefully. Mount the oscillator to one flange, and connect the antenna to the other flange or leave it free. Measure the diode current to ground using an ammeter with the oscillators switched on; it should be in the order of 0.5 to 4 mA.

4. TIPS

4.1. Using Mixer Diodes

Mixer or detector diodes are very sensitive to static charge. This means that good care should be taken and they should be handled in the same way as older MOSFETs without internal protection. After installing the diode, the connection pin should always be galvanically grounded (for example, using a 6-hole ferrite choke). If a diode has been damaged, it is not always noticed immediately since it still has a slight diode-behaviour, in other words the forward and reverse current are still somewhat different, but are not in the original relationship to another. This can be easily checked with the aid of an ohmmeter. A mixer equipped with a damaged diode is usually 10 to 20 dB less sensitive than a correct one.

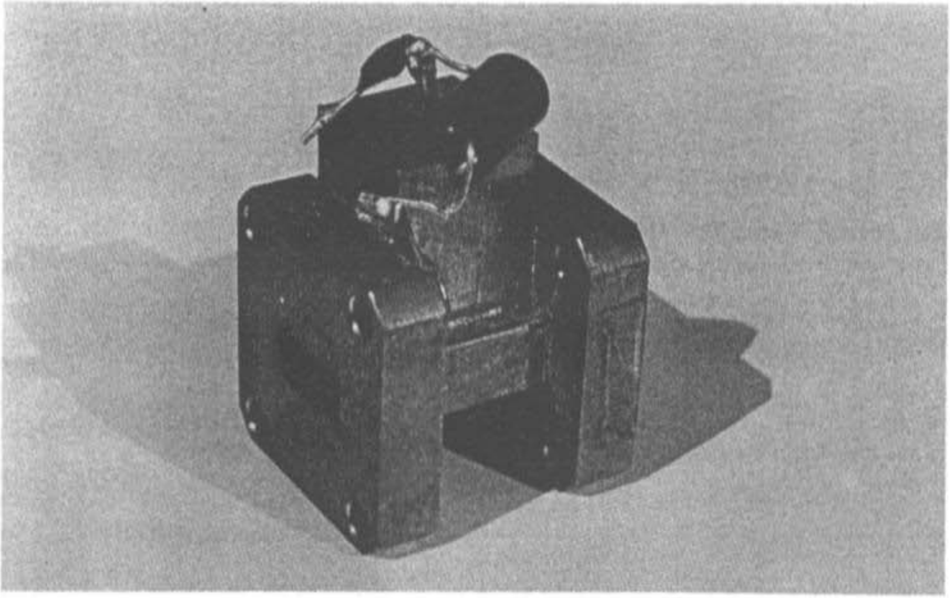

Fig. 7: The completed 24 GHz straight-through mixer

4.2. Type of Waveguide

If another waveguide is to be used to construct an efficiently operating mixer, it is only necessary to calculate the waveguide wavelength and to install the diode also at a spacing of 3 $\lambda_{wg}/4$ from the iris. However, the author recommends R 220 since this is the most common type of waveguide for the K-band. Measuring equipment, attenuators, external mixers of spectrum analysers, directional couplers, and other equipment all use this type of waveguide. If one then has access to such equipment, (and some lucky amateurs have), one will be angry to find that one cannot connect it.

4.3. Oscillators

It should be noted during construction of Gunn oscillators that it is possible for an oscillator to oscillate in the incorrect mode. The frequency will be a few GHz too high, and will hardly be affected by the tuning screws. In this case, the connected mixer will not indicate any, or a very low conversion current, although the current and voltage values are correct at the Gunn oscillator. In such cases, the Gunn diode usually has sought its $\lambda/2$ resonance from its location to the side-wall of the waveguide. This can usually be avoided by careful construction of the oscillator, and especially of the diode mount. A further measure is to use a waveguide type for the oscillator where the required frequency is at its lower limit. This means that the path from the center of the waveguide (usual location of the Gunn diode) to the side-panel is so short that the resulting $\lambda/2$ path results in a frequency at which the Gunn diode will no longer oscillate. In the case of 24 GHz, this would result in an oscillator having an iris suitable for R 320, with the rest of the module using R 220.

Attention should be paid with the iris of a Gunn oscillator that it is not too small, since it is easily possible to lose 10 dB of transmit energy. If the power can be measured in some way, even if only relatively, it is advisable to increase the size of the iris until one comes to the point where the output level hardly increases. It is then possible for the iris to be left as it is, or to make a second one with a slightly smaller size. The somewhat greater instability of the oscillator with respect to external effects can usually be compensated for using an AFC circuit.

Fortunately, Germany is one of those countries having a low inflation rate – 5 to 6% per year. Even so costs do increase even here and **we must raise the subcription rate from DM 20.00 to DM 22.00** (10% over a period of two years). This increase is just able to maintain the quality of VHF COMMUNICATIONS both with respect to technical content and appearance.

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Erwin Schaefer, DL 3 ER

A Spectrum Generator for the 24 GHz Band

A signal generator is also required for test and calibration applications even on the 10 GHz and 24 GHz bands. In this frequency range, professional measuring equipment is usually either completely inaccessible, or so large and heavy that it is impossible to lend them out over the weekend. Luckily, very many checks can be made with relatively simple signal sources and these can be simply constructed at home.

A very useful calibration spectrum generator for the 10 GHz band was described in (1). A similar unit has been used bythe author for four years now, and the obtainable output power could be increased considerably by use of a fast, storage varactor. When driven with a crystal-controlled signal at 100 MHz and provided with a subsequent 3-stage waveguide, the output frequency is sufficiently pure and provides sufficient power in order to synchronize a power-Gunn oscillator in the frequency range between 10.0 and 10.5 GHz.

This article is to describe such a module for the 24 GHz band, whose output power is sufficiently great that it is possible to cover a range of more than 500 m when using antenna gains in the order of 30 to 40 dB and in conjunction with conventional receive systems used for amateur communications. When used in conjunction with a home-made waveguide attenuator, it is possible for relative measurements of the sensitivity of receivers to be made.

1. THE CIRCUIT

As can be seen in the simplified block diagram given in **Figure 1**, the calibration spectrum generator comprises three modules that are driven from a DC-voltage of 12 V. The circuit is accommodated in a TEKO-box type 2B.

The first module is a 50 MHz crystal-controlled oscillator, which is followed by a 50 MHz amplifier that increases the output power to 1 W. This signal drives a storage varactor D which works into a λ/2 resonator.

The resonator is the third module and consists of a piece of waveguide type WR-42 (R 220). The resonator is completely coupled to the main waveguide (possibly complete with antenna) and is strongly dampened. For this reason, it is not necessary to provide a tuning screw or a plunger.

The author used a storage varactor type BXY 18 AB (Siemens), and was able to obtain an output power of 1.2 mW in the 24 GHz range. Unfortunately, no equipment was available to measure the spectral power distribution; however, it can be estimated to be as follows assuming a bandwidth of approx. 2 GHz:

$$P_s \approx \frac{P_{out}}{B/f}$$

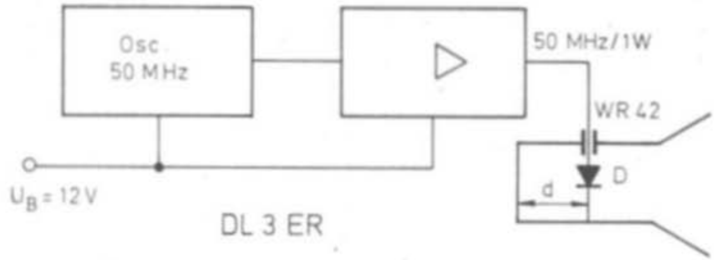


Fig. 1: Calibration spectrum generator for the 24 GHz band

where

P_s = Power of **one** spectral line
P_{out} = Measured total output power
B = Bandwidth in which lines appear
f = Spacing between spectral lines (here: 50 MHz)

$$P_s \approx \frac{1.2\ \text{mW}}{40} \approx 30\ \mu\text{W}$$

2. CONSTRUCTION OF THE DRIVE CIRCUIT

In the auhtor's prototype, an available crystal oscillator manufactured by the US-company »Monitor« was used. This oscillator operates from 5 V DC-voltage and provides an output frequency of 50 MHz at two antiphase TTL-outputs. It is immaterial which output is used.

Virtually any circuit can be used to replace this oscillator, and examples are given in (2). Attention should only be paid that the subsequent amplifier is able to provide at least 0.5 W for the storage varactor.

The most interesting part of the circuit is given in **Figure 2**. Due to the high heat-loading of the transistor 2N 3866, it is very important to provide a heat sink. The output power and thus the operating point of the storage varactor D can be adjusted with the aid of the emitter resistor R 1.

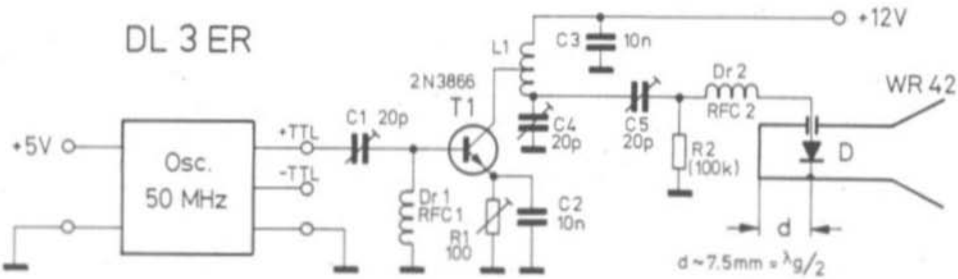


Fig. 2: 50 MHz amplifier with coupling to the varactor

Matching is made using the trimmer capacitor C 5 and inductance RFC 2, whose spacing between turns should be determined experimentally.

The given values for C 5, RFC 2, and R 2 have been found to be favorable in the author's prototype. According to the characteristics of the diode, some changes may be required, at least to RFC 2 and R 2. The most favorable adjustment is best made experimentally, by monitoring the output power with the aid of a power meter or measuring detector.

2.1. COMPONENTS

Oscillator:	TTL clock, 50 MHz (Monitor, type 801280)
T 1:	2N 3866, 2N 4427 or similar with cooling fins
D:	BXY 18 AB (Siemens) or similar storage varactor
C 1, C 4, C 5:	Plastic foil trimmer 20 pF (Philips, green)
C 2, C 3:	10 nF ceramic bypass capacitor
R 1:	100 Ω trimmer potentiometer
R 2:	100 kΩ carbon resistor, optimize the value experimentally !
L 1:	7 turns of 0.8 mm dia. silver-plated copper wire wound on a 6 mm former, self-supporting, approx. 15 mm in length, coil tap at the center
RFC 1:	7 turns of enamelled copper wire, 0.3 mm dia. wound on a 3.5 mm former, self-supporting
RFC 2:	12 turns wire and former as for RFC 1; optimize turn spacing experimentally !

Since the oscillator module will usually be home-made in most cases, the author does not consider it necessary to provide a PC-board for the 50 MHz amplifier, since the construction is not critical. The only important point is that a defined ground connection exists between the oscillator and amplifier, and to the waveguide module.

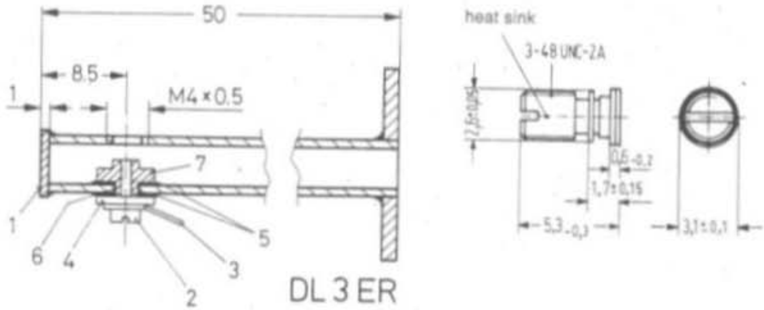
3. CONSTRUCTION OF THE WAVEGUIDE MODULE

Figure 3 shows the overall construction of the waveguide module complete with soldered flange, and a small lathed piece; the shape and dimensions match the previously mentioned diode. Since this type of diode possesses a flat surface, a matching piece (part 7) is required that must be installed in an insulated manner. The drive power can then be fed via the solder tag. The center frequency of the dampened resonator is dependent on dimension »d«, which is 8.5 mm in our case. The heat sink of the diode has a USA-thread, which can be fitted through an M 4 fine thread with the aid of the adapter (part 8).

If one is not able to cut this thread, this can be made as follows:

Solder a M 5 nut to the waveguide. The thread adapter (part 8) is provided with a M 5-thread on the outside, and a flat surface with the outer diameter of the 3-48UNC-thread on the inside. A small disk is now made from approx. 0.2 mm thick spring bronze, which is pushed through the hole of the threaded adapter. The disk is provided with a centrical hole through which the diode thread can be screwed. This disk fixes the diode in the adapter hole and is used as stop.

The centrical hole should be made on a lathe, however, it is possible for it to be made with the aid of a drill. It is not neceassry for it to fit exactly to part 7, which means that a slight excentricity is not important.



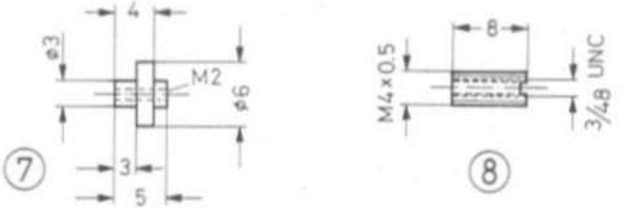


Fig. 3:
Waveguide module, part 7, and diode BXY 18 AB

If necessary, the author is willing to make such adapters in exchange for the actual costs involved.

3.1. COMPONENTS

1 Terminating panel, brass 1 mm thick
2 M 2 screw, 5 mm long
3 Solder tag
4 6 mm dia. disk, 1 mm thick, brass, centrical hole of 3 mm dia.
5 2pieces, PTFE disk, 7 mm dia., 0.1 mm thick, centre hole of 3 mm dia.
6 Insulating bushing for the screw, PTFE, or Sellotape
7 Lathed piece according to detailed drawing, material: brass
8 Adapter 3/48 UNC to M 4 x 0.5 for BXY 18 AB. Material: Brass

4. REFERENCES

(1) U. Mallwitz, DK 3 UC:
Calibration-Spectrum Generator for the Microwave Bands up to 10 GHz
VHF COMMUNICATIONS 11, Edition 1/1979, page 43

(2) B. Neubig, DK 1 AG:
Design of Crystal Oscillator Circuits
VHF COMMUNICATIONS 11, Edition 3/1979, pages 174-190

VHF communications

Index of Volume 15 (1982)

Bernd Bartkowiak, DK 1 VA

A Compact 70 cm Transverter for 2 m Transceivers

This transverter allows equipment designed for 144 MHz to be used on the 70 cm band. The described module is a linear converter for the frequency range between 432 and 434 MHz, and is especially designed for SSB operation. Of course, it is also possible for it to be used for RTTY, FAX, Slow-scan-TV or FM. The transverter requires a drive power of between 2 and 200 mW at 2 m, which will provide an output power of approximately 50 mW without limiting on the 70 cm band with a spurious rejection of up to 60 dB. An output power of approximately 200 mW is available under full drive conditions (FM). On the receive side, a modern dual-gate MOSFET provides a minimum noise figure of 1.8 dB. These are excellent values for a module that is only 185 mm × 63 mm × 37 mm including BNC connectors. For this reason, it is very suitable for portable operation (e.g. mountain field-day). For mobile and fixed-station operation, one only needs to add a suitable linear amplifier.

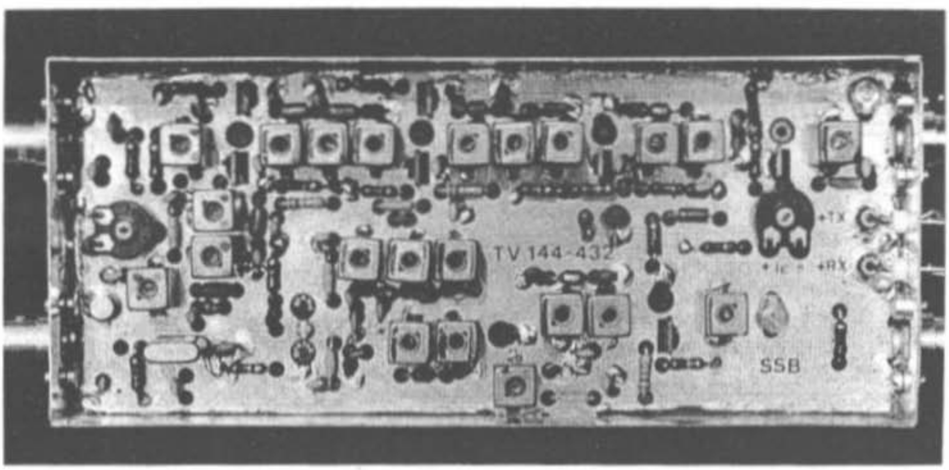


Fig. 1: No inductances or chokes must be wound for this 2 m/70 cm transverter, however the compact construction with short connections requires some experience.

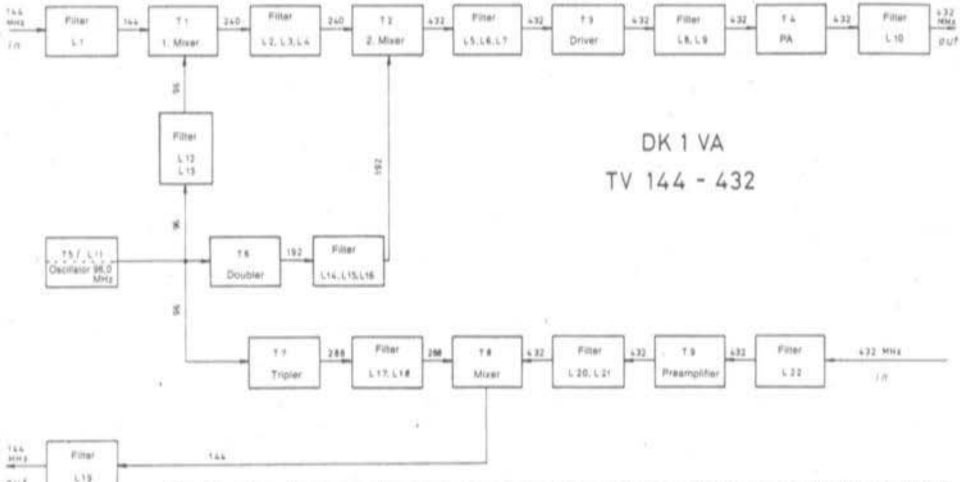


Fig. 2: One single master crystal supplies three mixers; note the large number of filters

Of course, only the most modern components can be used to obtain this quality and such compact dimensions, and considerable care must be taken during construction. This means that the informations given for construction, especially those regarding the virtually non-existent connection lead length must be adhered to, and some experience with UHF-technology should be available before commencing construction of this module. A prototype is shown in Figure 1.

CIRCUIT DESCRIPTION

Figure 2 shows the various stages and filters together with the frequency plan in the form of a block diagram. This allows the operation of the module to be seen clearly. One will notice that the built-in crystal oscillator drives three different mixers: Two in the transmit path (double conversion) and one in the receive path. For this reason, a very low-noise 96 MHz oscillator was developed for this application.

The detailed circuit diagram is given in **Figure 3**. The injected 144 MHz transmit signal of max. 200 mW (when P 1 is rotated to the ground connection) is mixed in the first mixer T 1 with the 96 MHz signal from the bandpass filter. The signal is then passed through a three-stage filter comprising L 2 – L 4 and the 240 MHz conversion product is fed to the second mixer T 2. It is mixed here to the final frequency in the 432 MHz band with the aid of the 192 MHz carrier obtained via doubler T 6 and the three-stage filter comprising L 14, L 15, and L 16. The subsequent linear amplifier equipped with transistors T 3 and T 4 amplifies the required signal to approximately 50 mW (+ 17 dBm). The filters comprising inductances L 5 to L 10 provided between the second mixer and the 70 cm output ensure an excellent spectral purity of the required signal which has more than 60 dB spurious rejection. It is only the first harmonic at 864 MHz that is only suppressed by approximately 45 dB.

The received 70 cm signal is fed to the very low-noise dual-gate MOSFET T9, followed by a bandpass filter comprising inductances L 20 and L 21, and a dual-gate MOSFET mixer. The mixer is provided with a local oscillator signal of 288 MHz via the bandpass filter comprising L 17 and L 18.

A built-in, integrated 9 V voltage stabilizer ensures that the transverter is virtually independent of voltage fluctuations in the range of 12.0 to 13.8 V.

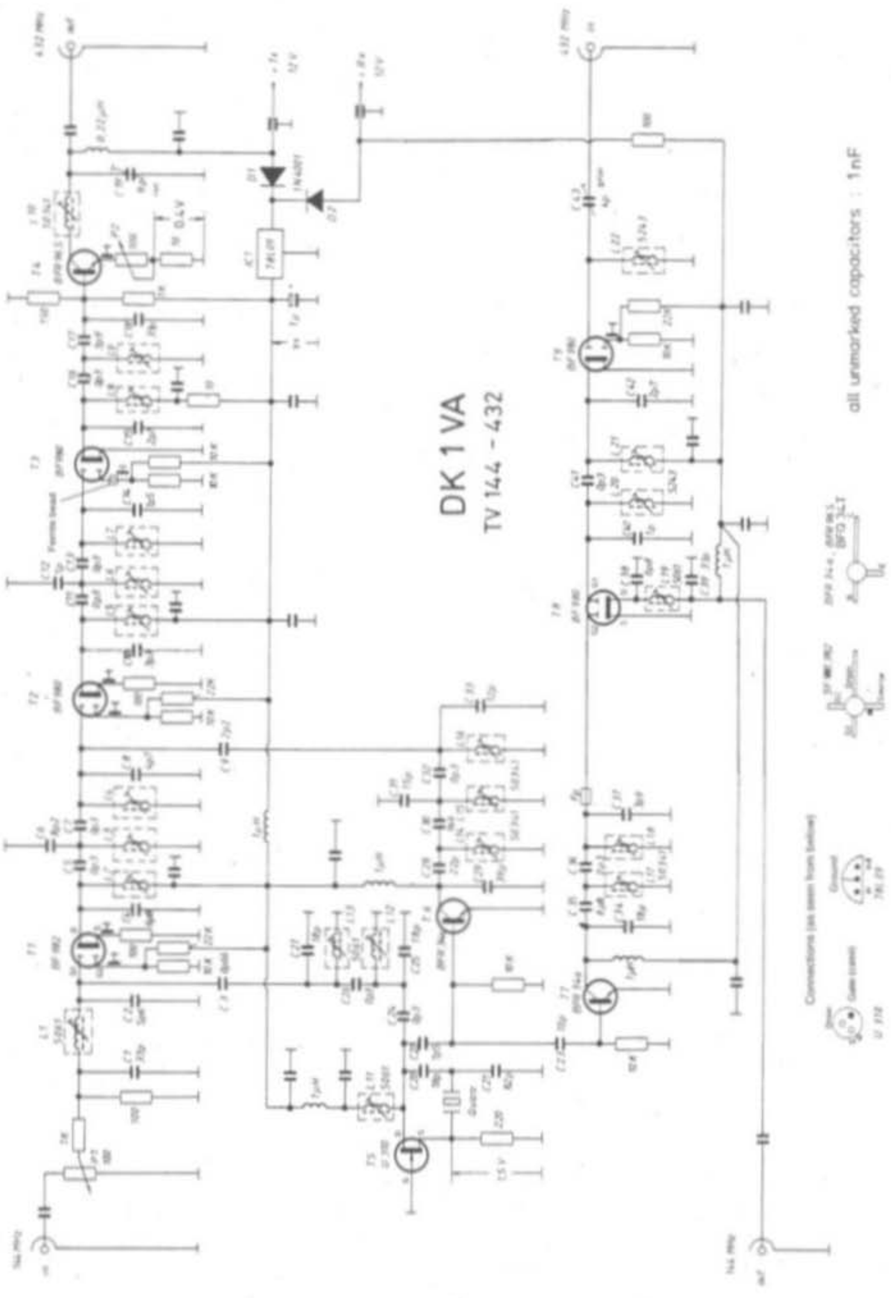


Fig. 3: The transverter only requires 9 transistors.

1.1. Component Details

T 1:	BF 982 (Philips)
T 2, T 3:	BF 980 (Philips)
T 4:	BFR 96 S or BFQ 34 T (Philips)
T 5:	U310 (Siliconix)
T 6, T 7:	BFR34A (Siemens)
T 8, T 9:	BF980 (Philips)
I 1:	78L09 (Fairchild, National Semiconductor)
D 1, D 2:	1 N 4001

Three ready-wound filters are used:

5061 = blue/brown (5 pcs.)
5243 = white/black/black (7 pcs.)
50341 = brown/black/black (10 pcs.)

L 1:	5061
L 2, L 3, L 4:	50341
L 5:	5243
L 6:	50341
L 7:	5243
L 8, L 9:	5243
L 10:	50341
L 11 – L 13:	5061
L 14 – L 16:	50341
L 17 – L 18:	50341
L 19:	5061
L 20 – L 22:	5243

Miniature chokes, spacing 10 mm:
0.22 μH: 1 pc.
1 μH: 5 pcs.

8 pcs. chip capacitor 1 nF (at T 1, T 2, T 3, T 4, and T 9)

C 19: encapsulated plastic foil trimmer 8 pF
C 43: as C 19, 4 pF (green)

2 pcs. feedthrough capacitors 1 nF for solder mounting, short size

12 pcs. ceramic droptype capacitors: **0.3 pF**: C 5, C 7, C 11, C 13, C 16, C 26, C 30, C 32, C 36, C 41
0.7 pF: C 3
1.5 pF: C 22

All other capacitors are ceramic disk types for a spacing of 2.5 mm.

All resistors: Composite carbon types for a spacing of 10 mm.

P 1, P 2: 100 Ohm trimmer potentiometers, horizontal mounting, spacing 10/5 mm

In addition:
2 ferrite beads, 3 mm long,
2 PTFE feedthroughs
4 BNC flange connectors
1 metal case 148 × 64 × 36
1 crystal 96.000 MHz, HC-18/U

2. CONSTRUCTION

The circuit given in Figure 3 is accommodated on a double-coated PC-board of 145 mm × 60 mm (**Figure 4**). The component side possesses a continuous ground surface which is only drilled or etched free around the components that are not grounded. With the exception of T 5, all transistors require 5 mm holes, and the two feedthrough capacitors 2.6 mm holes. All other holes are made with a 0.8 mm drill. For seven of the eight chip capacitors, 1 mm wide and 7 mm long slots are required on the PC-board at the marked positions. Most components are mounted on the PC-board before it is soldered into the metal box. The few components that are mounted later are mentioned in the following instructions.

2.1. Identify the inductances according to the colour code; remember that the module will not function if the wrong inductances are inserted!

5061: Dots blue/brown; 50341: Lines brown/black; 5243: Lines white/black.

If the inductances type 5061 possess a plastic base plate, this should be removed. In addition to this, the one connection lead that is not required should be removed carefully. In the case of the other two inductance types, the three non-required connections should be removed.

In some cases, the ground tabs of the inductance cases are used as through-contacts to the cold end of the winding. Some of these tabs must, however, be removed which can be seen clearly from the holes in the PC-board. If the hole is missing, it is then necessary for the tab to be removed. Finally, it should be mentioned that the case of the inductance should directly touch the ground surface of the board and should be soldered to it on two sides. After carrying out these preparations, it is now possible for inductances L 1 to L 10 to be soldered into place.

2.2. This is followed by mounting inductances L 11 to L 22, but L 19 is not soldered into place in order to ease the soldering of the board into the case later.

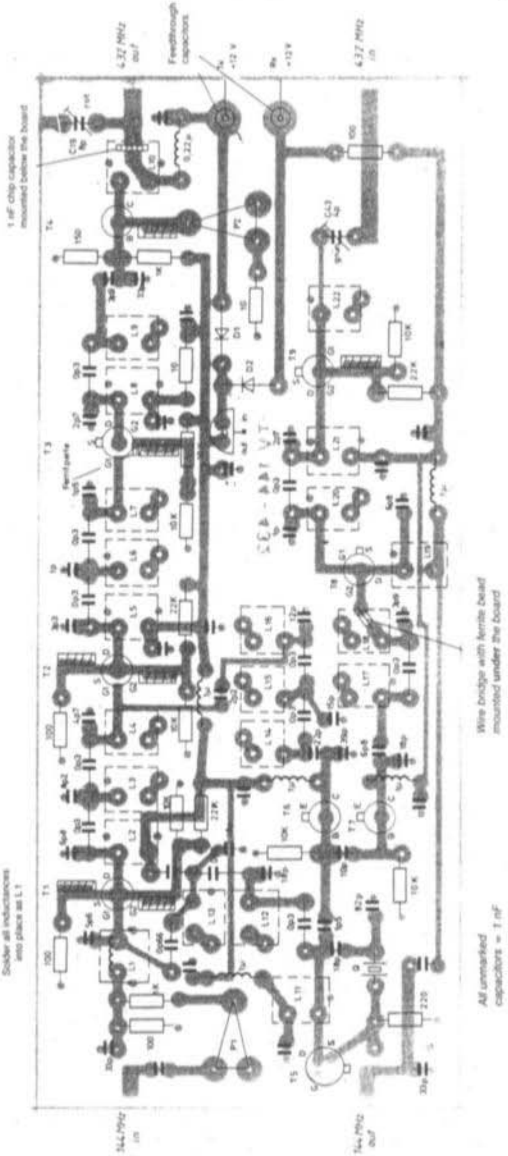


Fig. 4: Component locations; all unmarked capacitors have 1 nF

2.3. This is followed by soldering the seven chip capacitors into place from the conductor side of the board until they protrude by approximately half. They are firstly soldered carefully to the ground surface and then to the appropriate conductor lane on the lower side of the board. The voltage side of the chip capacitor should, of course, not have any contact whatsoever to the ground surface!

2.4. The ceramic capacitors are now soldered into place. **Their connections must be as short as possible!** Especially those capacitors in the resonant circuits (for instance C4, C8, C10) must be installed so that their ground wires are extremely short. It is favorable to remove the protruding ceramic material on the connection wires so that the capacitors can be mounted even closer to the PC-board. **In addition to this, attention must be paid that the capacitors are not mixed up, since the module will most certainly not operate with incorrect values!** This means that the capacitors should all be soldered into place after they have been identified clearly. Capacitor C3 is the only coupling capacitor in a drop-type case with 0.7 pF; it is advisable to find this capacitor firstly and solder it into place.

No ground hole is provided for the 1 nF capacitor at the cold end of L2; in such cases, the appropriate connection wire is bent directly at the ceramic body of the capacitor and soldered to the ground surface of the board. The 33 pF capacitor C39 is not soldered into position at this time.

2.5. With the exception of three pieces, all resistors are soldered into place. The exceptions are: the two 100 Ohm source resistors of T1 and T2, as well as the 150 Ohm base resistor of T4.

2.6. The two trimmer potentiometers can now be soldered into place. One connection of P1 should be soldered to the ground surface.

2.7. After this, the chokes can be installed: Firstly select the choke with the lowest number of turns, which is the collector choke of T4. The connection wires of the chokes should be bent carefully in order to ensure that the ends of the choke windings are not disconnected from the connection wires.

2.8. Attention must be paid to polarity when installing the voltage stabilizer I 1, the two diodes, and the tantalum electrolytic.

2.9. It is now possible for the transistors to be installed. **With the exception of T3 and T5,** the connections of all transistors are shortened to 2 mm in length. It is recommended that a colour point be used to mark the drain or collector so that the transistor is inserted correctly! The transistors are then inserted into their holes on the PC-board from the conductor side so that their shortened connections touch the associated conductor lanes. The source connections of transistors T3, T8, and T9 are directly grounded. In this case, the 5 mm hole should be somewhat extended at the appropriate position using a thin file so that the source connection can be bent by 90° through the board, bent further by 90°, and soldered to the ground surface. The same is valid for the emitter connections of T6 and T7.

Gate 2 of transistor T3 is not connected directly to the appropriate conductor lane, but is connected to the conductor lane via a piece of wire through a ferrite bead. This measure suppresses any tendency to oscillation with some transistors having a very high gain, and is carried out as follows:
Approximately 3 mm from the gate 2-conductor lane near the 5 mm hole are filed away, the G 2-connection of T3 is bent 90° from the PC-board and shortened to approximately 1 mm. A 3 mm ferrite bead is then placed on an approx. 8 mm long piece of wire (from a resistor or capacitor lead), after which the protruding ends are bent by 90°, whereafter this bridge is soldered to the gate 2-connection at one side and to the conductor lane/chip capacitor at the other side.

Finally, transistor T5 is placed into the PC-board from the ground side and the tab soldered to the PC-board. The conductor lanes for drain and source of this transistor are very close together, and attention must be paid that no unwanted short circuit is made at this position.

2.10. The BNC-connectors should now be prepared. The PTFE-insulation of the connecting pins should be removed with the aid of a file on one side so that the PC-board can be directly soldered to the center pin of the connector, and does not touch the insulation. The pins of the connectors should be shortened to approx. 1 mm in length.

2.11. The connectors are screwed into the case so that the PC-board can be directly soldered to the pins of all four connectors.

To check this, the pieces of the case should be fitted together temporarily and the board laid into place without soldering.

The holes for the two feedthrough capacitors on the board must be made at the appropriate side of the case (see Figure 1). They should match the holes for the PTFE feedthroughs, and will then automatically ensure that the narrow edges of the case fit into the two cutouts at the two corners of the board.

When these conditions are fulfilled, the case and the board are fixed with a few soldered points. Finally, the BNC-pins are soldered to their appropriate conductor lanes and the ground surface of the board soldered around the edge to the case. One of the covers can be pushed into place to ensure that it fits, but should not be soldered into place at this point.

2.12. The rest of the components can now be soldered into place: The two 100 Ohm resistors and the 150 Ohm resistor; trimmer C 19 is soldered at the cold end via a conductor lane to the case; the crystal is placed onto the board so that it touches the PC-board surface and it should be soldered quickly to the ground surface.

The feedthrough capacitors are placed to the board from the ground side and soldered around the hole circumference. The connections of the PTFE feedthroughs are shortened, after which they are placed through the case from the outside and soldered to the feedthrough capacitors. On the conductor side of the board, the wires for the feedthrough capacitors are bent, shortened, and then soldered to the appropriate conductor lanes.

The chip coupling capacitor is mounted vertically in the slot in the conductor lane in front of the connector.

At this point, only one ferrite bead should be left, which is placed through a piece of wire, and bent by 90°. The ends are then shortened to approximately 2 to 3 mm, and this choke is finally soldered onto the cutout of the conductor lane between G2 of T8 and the appropriate connection of L18.

3. CONNECTION AND ALIGNMENT

Firstly turn the wiper of P2 away from the 10 Ohm resistor (lowest quiescent current). Terminate the 432 MHz output with 50 Ohm, connect 12 V to the feedthrough of the transmit converter (+ TX) and check the following DC-voltages:

+9 V at the output of the voltage stabilizer I 1. Align P2 to obtain a voltage of +0.4 V across the 10 Ohm emitter resistor of T4, which corresponds to a quiescent current of 40 mA.

Further voltages are given in Table 1.

3.1. Alignment of the Transmit Converter

One requires a UHF-probe in conjunction with a high-impedance DC-voltmeter (μA-multimeter, tube/FET-voltmeter, oscilloscope, etc.) and an output power indicator (UHF mW-absorption wattmeter or UHF probe connected to a 50 Ohm terminating resistor).

The UHF-probe is now connected to the base of T6. The 96 MHz oscillator is synchronized by rotating the core of L11. The oscillation should cease abruptly at both sides of the oscillation range on rotating the core in and out. Briefly disconnect the operating voltage, after which the oscillator should immediately commence oscillation on reconnection.

Connect the UHF probe to gate 1 of T1 and align L12 and L13 for maximum reading (approx. 70 mV at 96 MHz). The resonance of these circuits is very noticeable due to the low damping.

Connection	Gate 2	Drain/Coll.	Source/Emitter	Base
T 1	2.8 V	9 V	0.2 V	—
T 2	2.8 V	9 V	0.3 V	—
T 3	4.5 V	8.9 V	—	—
T 4	—	12 V	0.5 V	1.2 V
T 5	—	9 V	1.5 V	—
T 6	—	9 V	—	

Table 1

Connect the probe to gate 1 of T 2 and align L 14, L 15, and L 16 for maximum voltage (approx. 250 mV at 192 MHz).

In order to simplify the following alignment steps, the following preliminary adjustments should be made:

L 1: Insert the core by 1/3
L 2, L 3: Rotate the core fully out
L 4: Fully insert to its stop, and then turn back by two full turns;
L 5: Fully insert, then turn back by 3 turns
L 6: Fully in, 4 turns back
L 7: Fully in, 3 turns back
L 8: Fully out
L 9: Fully in, 3.5 turns back
L 10: Fully out

The 144 MHz drive signal can now be connected. It can be between 2 and 200 mW according to the position of the input attenuator P 1. If the circuit is operating correctly, a power of between 1 and 10 mW should be measured at the output immediately.

Inductances L 1 to L 16 (with the exception of L 11!) should be aligned for maximum output power. Since the resonant circuits of the filters affect another, they must be aligned alternately several times. This will then automatically result in the most favorable spurious rejection.

The core of L 10 remains turned out completely, and the trimmer capacitor C 19 is aligned for maximum output power, which should go into saturation at approximately 200 mW. The drive power is now reduced until the output power does not exceed 50 mW when driven with a single tone; in this case, the module will operate in a very linear manner.

If a sensitive UHF-voltmeter having a low input capacitance is available, it is possible for the alignment of the transmit mixer to be made stage by stage:
Alignment of the oscillator and the inductances L 12 to L 16 as described previously;
Injection of the 144 MHz drive signal;
Connect the UHF-probe to gate 1 of T2. Align L 2, L 3, and L 4 alternately for maximum. Disconnect the drive power and check to see whether the measured voltage falls to zero. If this is not the case, an incorrect alignment must have been made to another frequency than 240 MHz.

Connect the UHF-probe to gate 1 of T3. Align L 5, L 6, and L 7 to maximum; finally carry out a fine alignment of L 1 to L 4.

Connect the UHF-probe to the base of T 4, and align L 8 and L 9 for maximum voltage.

A noticeable output power should now be indicated so that it is possible for an alternate fine alignment to be carried out, as previously described.

3.2. Alignment of the Receive Converter

Connect a 70 cm antenna and 144 MHz receiver. Connect 12 V to the feedthrough + RX.

Connect the UHF-probe to gate 2 of T 8 and align inductances L 17 and L 18 for maximum voltage (approx. 200 mV at 288 MHz).

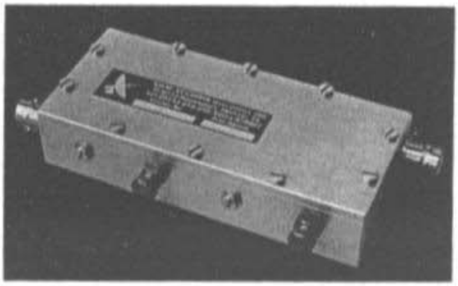
Align L 19 for maximum noise in the 2 m receiver.

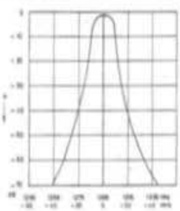
Inject a 432 MHz signal from a signal generator, or tune the receiver to a strong beacon transmitter. Rotate out the core of L 22 completely, and insert trimmer capacitor C 43 by half. Align L 20 and L 21 for maximum overall gain. Align L 17 to L 21 for maximum gain. The core of L 22 remains in its fully-out position.

Finally align C 43 for best signal-to-noise ratio. This can be made either on a noise-measuring system or in conjunction with a weak beacon transmitter.

4. SPECIFICATIONS

Frequency range (MHz): 144 – 146/432 – 434
Output power at 433 MHz: typ. 50 mW
Required drive power at 145 MHz: 2 to 200 mW, adjustable
Spurious rejection: typ. 60 dB
Suppression of inband products: 60 dB at P_{out} = 10 mW
Noise figure of the receive converter: better than 2.5 dB
Sideband noise of the oscillator: Better than – 140 dB/Hz at a spacing of 20 kHz
Operating voltage range: 12 to 13.8 V
Current drain in receive mode: typ. 60 mA at 12.5 V
Current drain in transmit mode: typ. 65 mA at P_{out} = 50 mW
Dimensions in mm (without connectors): 148 × 63 × 37 mm





Eugen Berberich, DL 8 ZX

A Spectrum Analyzer for VHF/UHF Amateurs

Part 2: PC-Board for the Premixer Module

In Edition 4/1980 of VHF COMMUNICATIONS, the author described a spectrum analyzer for home construction for the three frequency ranges of: 1 – 400 MHz, 430 – 800 MHz, and 1230 – 1600 MHz. A so-called premixer was required for the lowest and highest frequency ranges. The position of the components in this module is rather critical if the cross-talk between the channels is to be kept low. The author informed us in the original article that he would describe a proved PC-board for the premixer module. In addition to this, further details are to be given regarding a 39 MHz helical filter with Q-multiplier for the intermediate frequency of the spectrum analyzer.

1. CIRCUIT OF THE PREMIXER

The circuit diagram given in Figure 7 of the original article was further improved in the development of the final version which is shown in **Figure 1.**

Switching diodes type BA 182 (or BA 283) are used for switching the frequency ranges. The high-pass filter for frequency range III (1230 – 1600 MHz) comprises printed inductances (L 5 and L 6) and three ceramic capacitors (C 1 – C 3). The Schottky ring mixer type SAM-5 (Mini-Circuits) requires an oscillator power of 7 dBm (5 mW). According to the data sheet, the input frequency range is from 5 to 1500 MHz. According to this, the premixer will not operate optimumly in the last 100 MHz of range III. The attenuator link comprising resistors R 5, R 6 and R 7 provides a wideband, ohmic termination at the output of the ring mixer (pins 3 and 4). It is not necessary to procure exotic resistance values in order to achieve an exact 3.0 dB attenuation; when using the given values, a good matching is obtained with 3.15 dB. Finally, it should be mentioned that the values of both chokes RFC 1 and RFC 2 are not critical.

2. CONSTRUCTION

PC-board DL 8 ZX 004 was developed for the premixer. The dimensions are 35 mm × 70 mm, and it is double-coated, (see **Fig. 2**). The component side of the board is in the form of a continuous ground surface, which is only broken around the connection leads of the components that are not grounded, with the aid of a drill. The module must be completely screened by mounting it in a conventional metal box.

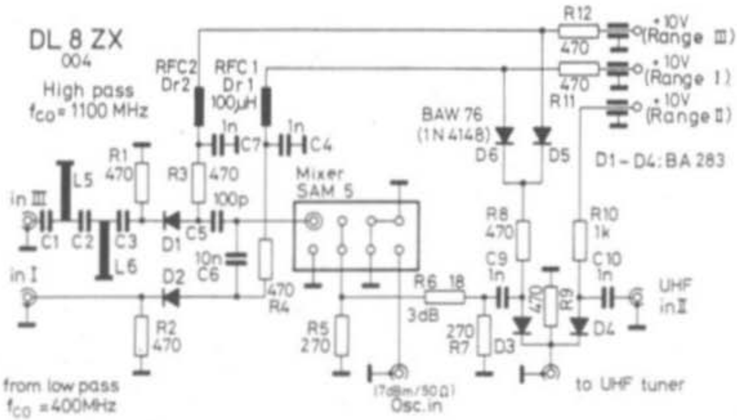


Fig. 1: The premixer module has three measuring inputs. Two of these are converted with the aid of a wideband ring mixer, the third can be directly connected to the tuner without conversion.

Three feedthrough capacitors and five miniature coaxial connectors are installed in the side panels. If required, it is possible for coaxial cable to be directly soldered to the PC-board and to be passed through the side-panel of the box using tubular rivets.

3. A HELICAL FILTER FOR 39 MHz WITH Q-MULTIPLIER

A 39 MHz IF-preamplifier was shown in Figure 12 of the original publication. The helical filter with Q-multiplier is now to be described to allow this amplifier to be realized.

Figure 3 shows a two-stage bandpass filter made from so-called helical circuits whose high Q is to be increased further using a Q-multiplier. It is equipped with the high-power FET P 8000 (P 8002). The circuit diagram shows the transistor and other parts outside of the main circuit for clarity; however, the transistor, three chokes, ferrite bead, as well as the bypass capacitors and resistor are actually installed within the two-chamber box. One feedthrough capacitor, each, connects the circuit to the operating voltage and to the potentiometer for adjustment of the Q-multiplier.

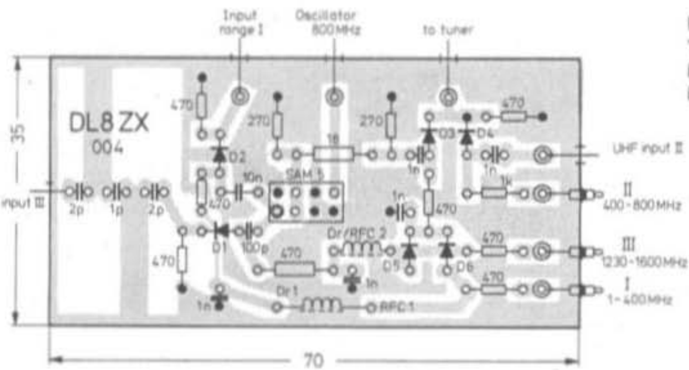


Fig. 2: The PC-board of the premixer is double-coated and is installed in a metal case.

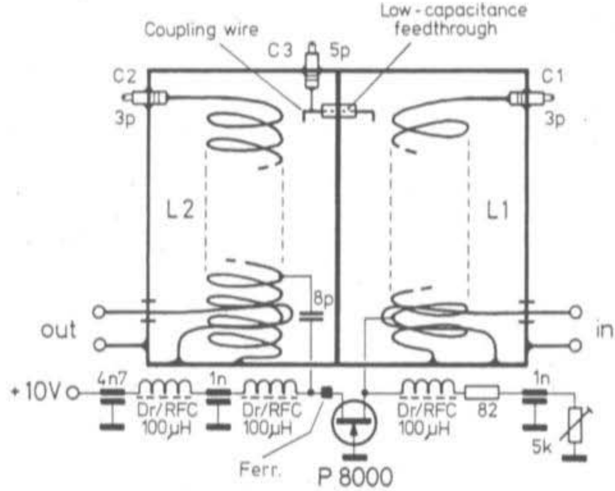


Fig. 3: Two-stage helical filter with Q-multiplier for the 39 MHz IF.

The helical bandpass filter is designed for installation in two metal-plate cases whose dimensions are 74 × 111 × 50 mm (dimensions of the cover). The inductances are constructed as follows:

L 1: 21 turns of silver-plated copper wire of 1.5 mm dia., wound on a 25 mm former, self-supporting, coil tap: 1 turn from the cold end.

L 2: As L 1, but coil tap at 4 turns from the cold end.
Input and output coupling: one turn, each, of insulated wire at the cold end of L 1, or L 2.

In order to avoid any microphonic-type effects due to shock, the two coils should be supported by PTFE-supports or strips at the center.

The inductances are pulled out to approximately 3/4 of the length of the case, and brought to resonance by adjusting the ceramic tubular trimmers C 1 and C 2. A coupling wire is provided between the hot (capacitive) ends of the coils. Trimmer C 3 extends the wire to form a capacitive voltage divider which allows the coupling to be varied.

A compromise must be found between the slope of the passband curve and stability. Since all adjustments affect each other, a swept-frequency system can only be avoided if one has considerable experience in this type of adjustment. The alignment is carried out after all other modules are operating correctly. The alignment is made by connecting an input signal and aligning the module according to the indication on the oscilloscope.

The editors and staff of VHF COMMUNICATIONS would like to wish all readers a happy and prosperous New Year.

We are sorry that you have received this edition too late, but this was caused by the unfortunate death of our printer, Mr. Gert Reichenbach, who fell sick and died whilst preparing this edition.

Friedrich Krug, DJ 3 RV

A Versatile IF-Module Suitable for 2 m Receivers, or as an IF-Module for the SHF Bands

Part IV: Construction of the Crystal Filter Module DJ 3 RV 001

As was mentioned in Part 3 of this series, Part 4 is to commence the actual construction together with the final circuit diagrams, component location plans, and photographs of the author's prototypes. This part is to describe the first of a total of four PC-board modules: The crystal filter module. It is to be described in two different versions so that it is possible to use any available crystal filters already in your possession.

4. CONSTRUCTION

As was mentioned in the first part of this series, a careful construction and alignment is required if the individual modules are to function correctly. The required isolation between the modules can only be achieved by constructing the circuits in metal boxes and by providing a consequent bypass and choking of all supply voltages and control lines, as well as connecting the input and output signals with the aid of screened cables.

4.1. INPUT CIRCUIT

The constructional details given in the original descriptions are sufficient for constructing the modules of the input circuit: DJ 7 VY 002, DJ 7 VY 003, DJ 7 VY 004, and DK 1 OF 044/045. It is, however, advisable to install these circuits in a case and to isolate, and screen the leads in the same manner as to be described for the IF-modules.

Unfortunately, the DJ 7 VY boards do not fit into available metal cases, which means that these must be constructed. If one has difficulties in obtaining the smaller feedthrough capacitors with threads suitable for the aluminium case of oscillator DJ 7 VY 004, one can use the larger case type A 110.

In the case of the noise blanker DJ 7 VY 003, only special filter crystals should be used in the crystal filter, and not cheap CB-crystals. The author measured a number of CB-crystals from the Far East and found that their Q was too poor, and that they possessed strong spurious resonances in the vicinity of the nominal frequency.

The digital readout DK 1 OF 044/045 caused interference in the author's prototype due to harmonics of the multiplex signal, and for this reason it was completely screened in metal gauze.

4.2. IF-MODULE

The required division of the IF-module onto four PC-boards was shown in Figure 4 of Ed. 2/82 of VHF COMMUNICATIONS. All boards have identical dimensions of 72 mm × 146 mm and fit into the available metal case. This ensures a simple, mechanical construction, however, leads to a high density of components on the PC-board. The use of the given components is therefore not only necessary for reasons of a reliable, electrical operation of the circuits, but also for space reasons.

4.2.1. Crystal Filter Module DJ 3 RV 001

In many letters and telephone calls to the author, readers requested that the board of the crystal filter module be developed so that the large number of available crystal filters of different sizes and impedance could be used on it.

For this reason, two different versions are to be described. PC-board DJ 3 RV 001a can be equipped with three, monolithic crystal filters having a pin spacing of 13.5 mm or 17.8 mm with different impedances of ≧ 500 Ohm, as well as a discretely constructed crystal filter with an impedance of Z_F = 500 Ohm II 30 pF. PC-board DJ 3 RV 001b is only able to accept discretely constructed crystal filters. Due to the larger dimensions of these filters, only three such filters can be accommodated on the PC-board, two of which must have an impedance Z_F = 500 Ohm. Impedance transformation can only be provided for the center filter on the PC-board, which allows a filter having a higher impedance (e. g. XF-9E) to be used. Of course, it is not necessary for these two boards to be exclusively equipped with 9 MHz crystal filters, however, the inductance and capacitor values are not given for other center frequencies.

Circuit Description

The operation of the circuit was described in detail in part 2 (VHF COMMUNICATIONS 2/82). In order to understand the construction description and the selection of the components, the circuit operation is to be briefly described and the values that have been changed with respect to Figure 10 and Figure 12 are to be discussed in somewhat more detail. The circuits diagrams of both versions are given in **Figures 37 and 38**. They differ only in the number of filters, and in the simpler construction of the operating point adjustment for the BFQ 69 for compactness reasons.

The input bandpass filter comprising L 1, C 1, and L 2, C 2 provides a wide-band, ohmic input impedance of 50 Ohm, which is provided by R 1 in the stopband range, and by the transformed input impedance of the common-gate FET amplifier transformed by Tr 1 in the passband range. Transformer Tr 1 has a turns-ratio of 3:2 and provides a resistance transformation of 1:0.444. In order to obtain an input impedance of 50 Ohm, it is necessary for the operating point of the parallel-connected FET T 1 to be selected so that an input impedance of 22 Ohm results at the source. The operation point is adjusted with the aid of R 2. A fixed resistor is provided at this position since the transistors must be selected to have the same operating point before installation.

Since very few readers will have a measuring system to enable the transistors to be measured dynamically at 9 MHz, it is recommended that the DC-operating points be measured. In the circuit given in **Figure 39**, the source-gate voltage U_{SG} of all P 8002 should be measured with a digital voltmeter at the drain currents of I_{D1} = 22.5 mA, I_{D2} = 25 mA, and I_{D3} = 27.5 mA, and noted.

The static slope can be calculated from these measured values according to the following equation:

$$S = \frac{I_{D3} - I_{D1}}{U_{GD1} - U_{GD3}}$$

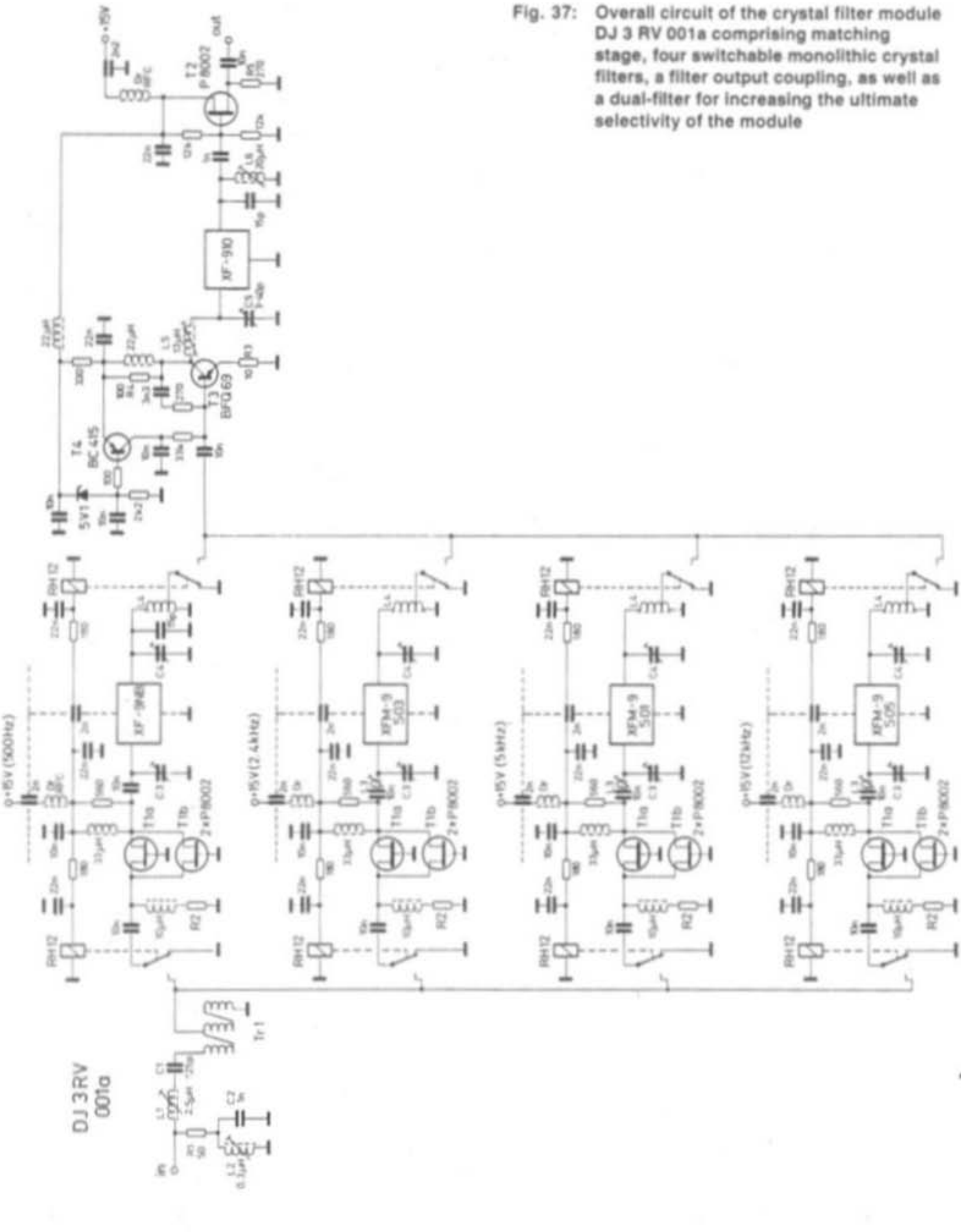
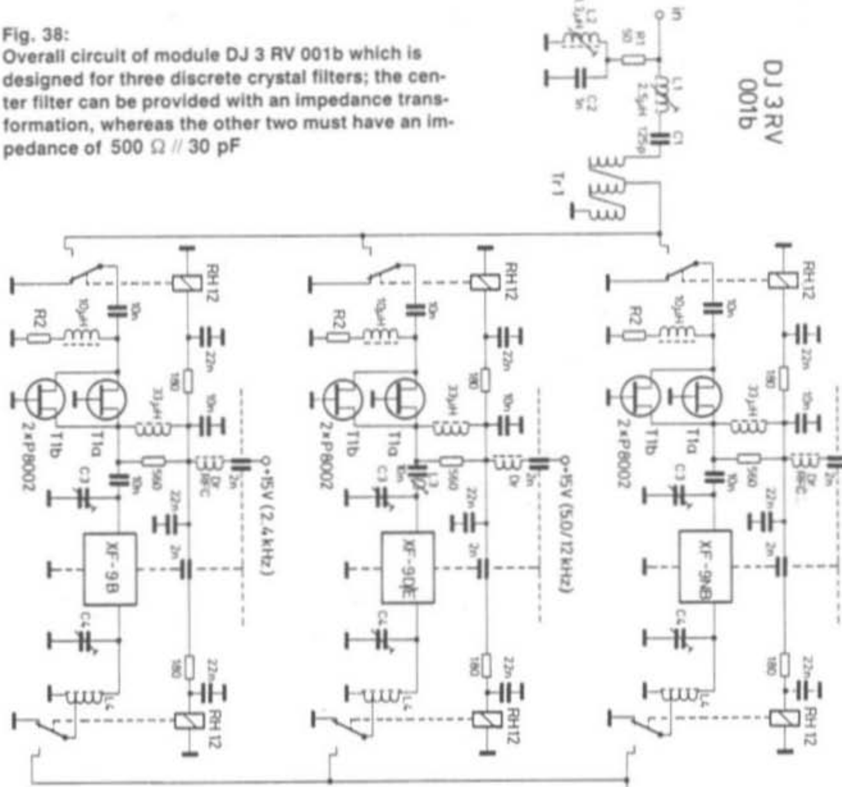


Fig. 37: Overall circuit of the crystal filter module DJ 3 RV 001a comprising matching stage, four switchable monolithic crystal filters, a filter output coupling, as well as a dual-filter for increasing the ultimate selectivity of the module

Fig. 38:
Overall circuit of module DJ 3 RV 001b which is designed for three discrete crystal filters; the center filter can be provided with an impedance transformation, whereas the other two must have an impedance of 500 Ω // 30 pF



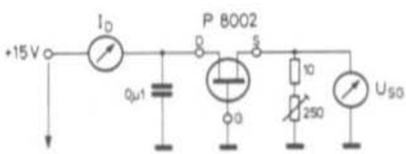


Fig. 39:
Measuring circuit for determining the operating point and slope of the power FETs.

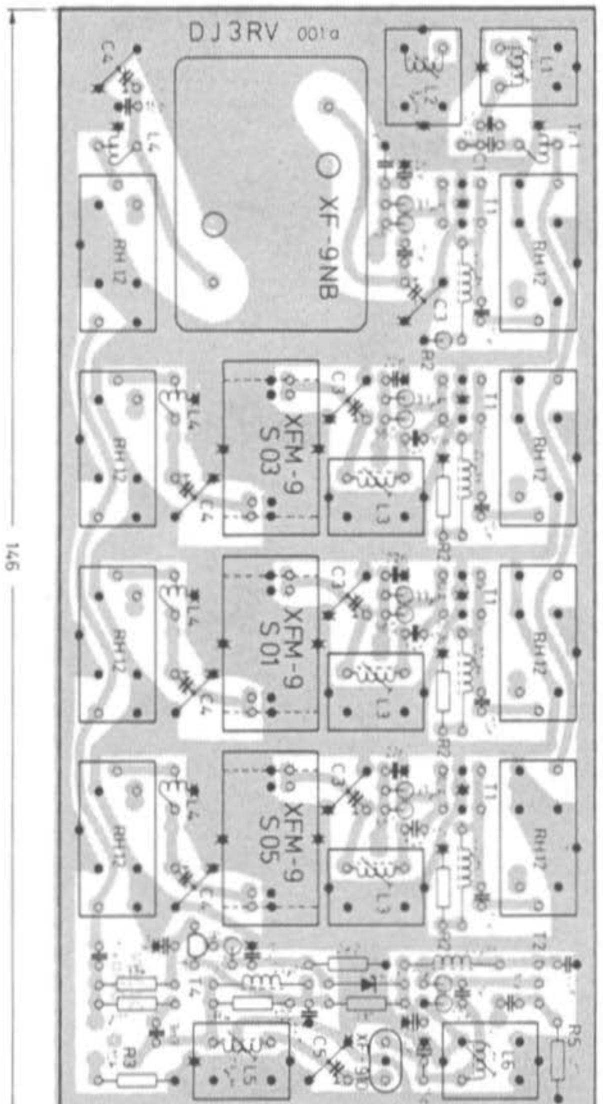


Fig. 40a: Component locations on board DJ3RV 001a

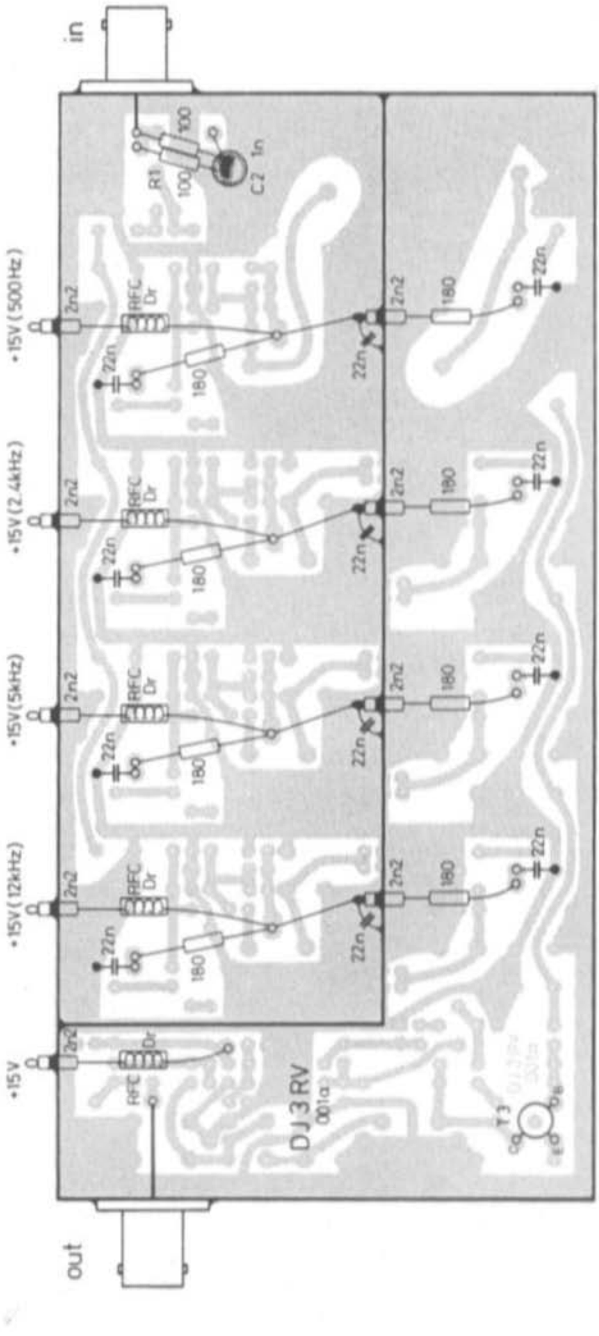


Fig. 40b: Component locations on the conductor side of DJ3RV 001a

To form T 1, two transistors having the same source-gate voltage U_{SG2} are connected together, and the deviation must not be more than a maximum of 10%. The values for the slope should be added and should amount to approximately 45 mS.

If this is the case, the value of R 2 is obtained from the following equation:

$$R2 = \frac{U_{GD2}}{2\,I_{D2}}$$

The nearest value of resistor is then used.

If the overall slope is greater than 45 mS, the values for the lower drain current should be used, and at lower slope, the values for the higher drain current. The author was able to select the required four pairs from a total of 25 P 8002.

The output impedance of the FET-amplifier is formed by the parallel connection of the 560 Ohm resistor and the filter impedance of approximately 500 Ohm, or the filter impedance transformed up to 500 Ohm. The 33 µH-choke is provided for the DC-supply. It is important that the intrinsic resonant frequency of this choke is much greater than the intermediate frequency.

In the case of filter impedances of more than 500 Ohm, an impedance transformation is made with L 3 and C 3 according to the equations given in Section 3.1.4.

The 10 nF capacitor between drain and L 3 is provided for DC-blocking. It can be replaced by a bridge when using filters that have no galvanic connection at the input.

A resonant circuit comprising C 4 and L 4 is present at the output of the filter. The input impedance of BFQ 69 is matched to the filter with the aid of the coil tap on L 4. The coil tap is therefore dependent on the impedance of the filter. The filters are aligned for the best passband curve with the aid of C 3, C 4, and possibly L 3.

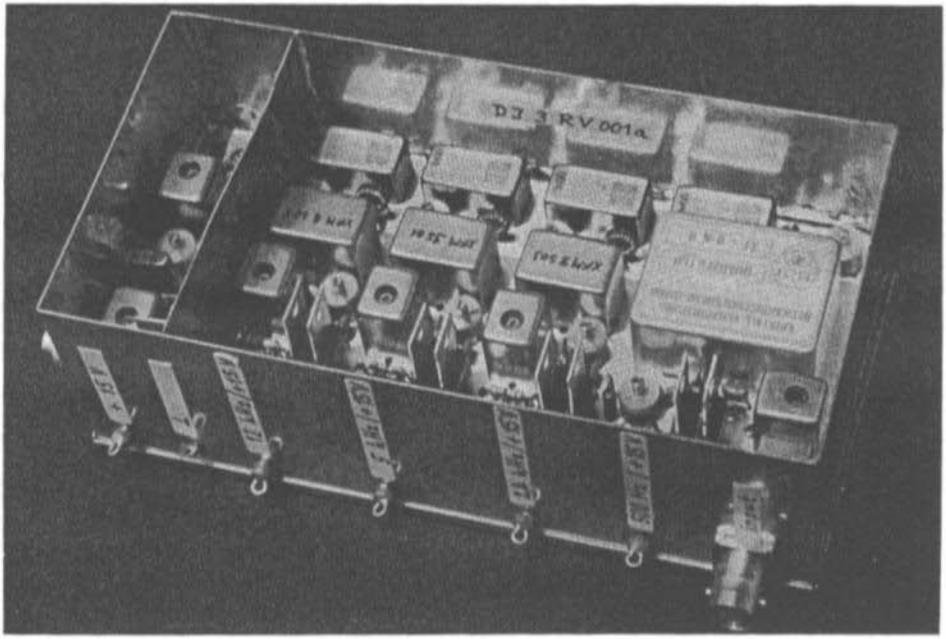


Fig. 41a: Photograph of the author's prototype showing the connections

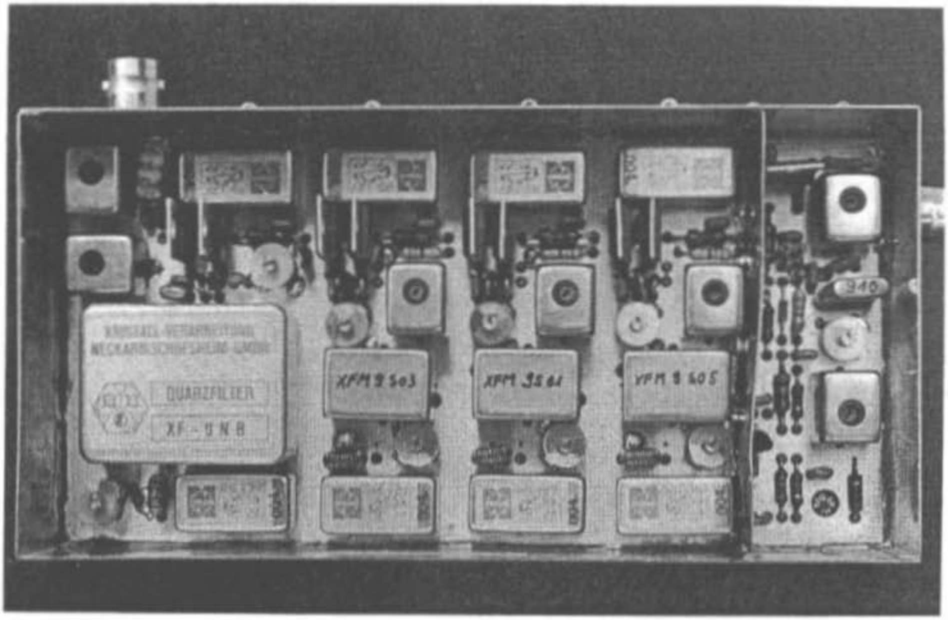


Fig. 41b: It is necessary to bend the intermediate panel in order to find sufficient room between the components; the heat sink strip between T 1 and the case has still not been provided.

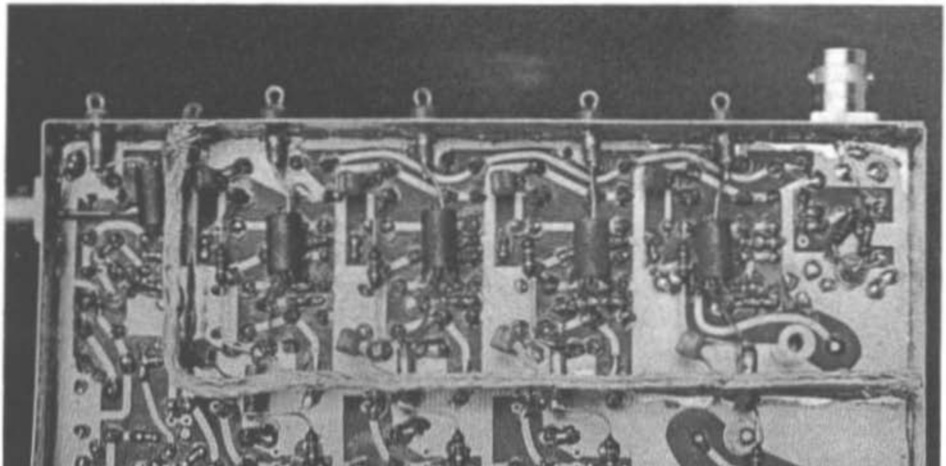


Fig. 41c: On the conductor side, the components for the power supply of transistor T 3 and a part of the wideband termination for the ring mixer of the previous module are accommodated.

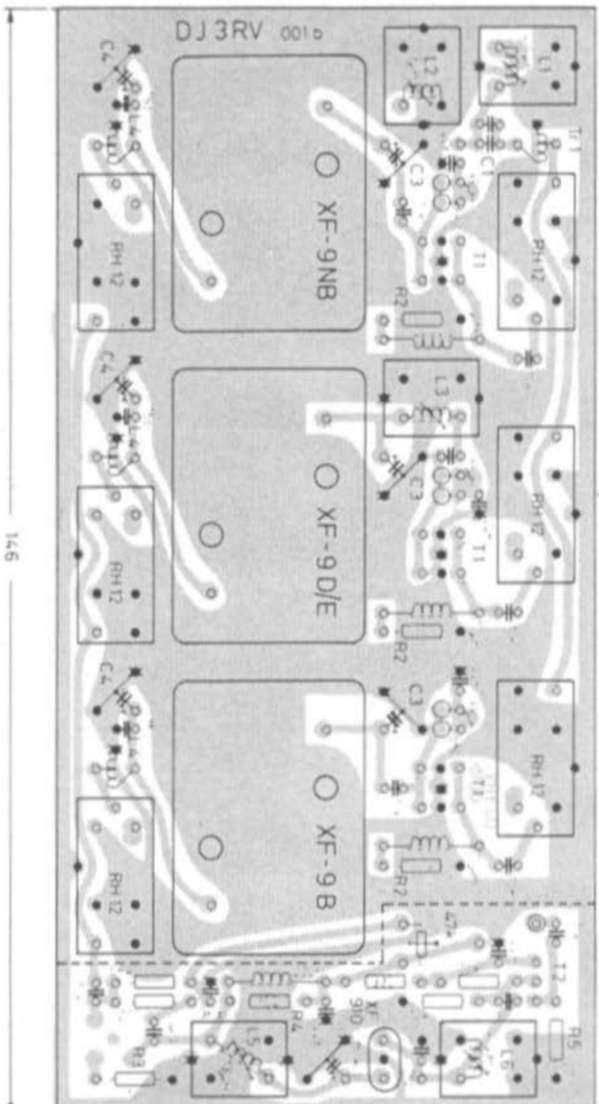


Fig. 42a: Component locations on PC-board DJ3RV 001b

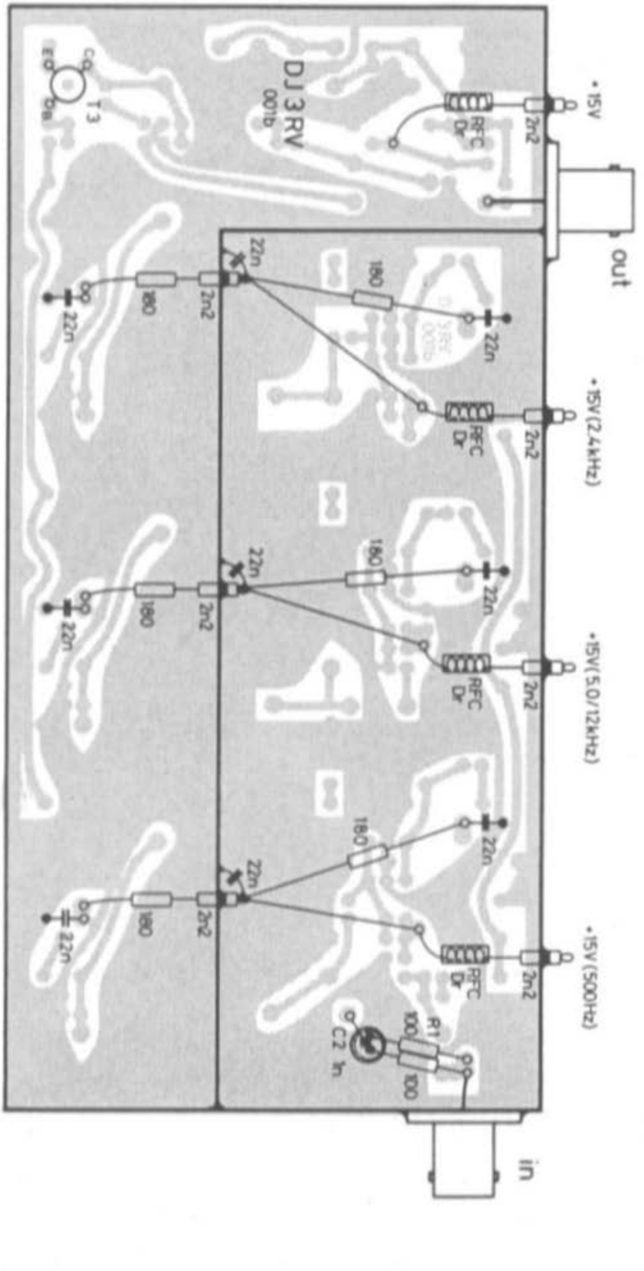


Fig. 42b: Component locations on the conductor side of the DJ3RV 001b

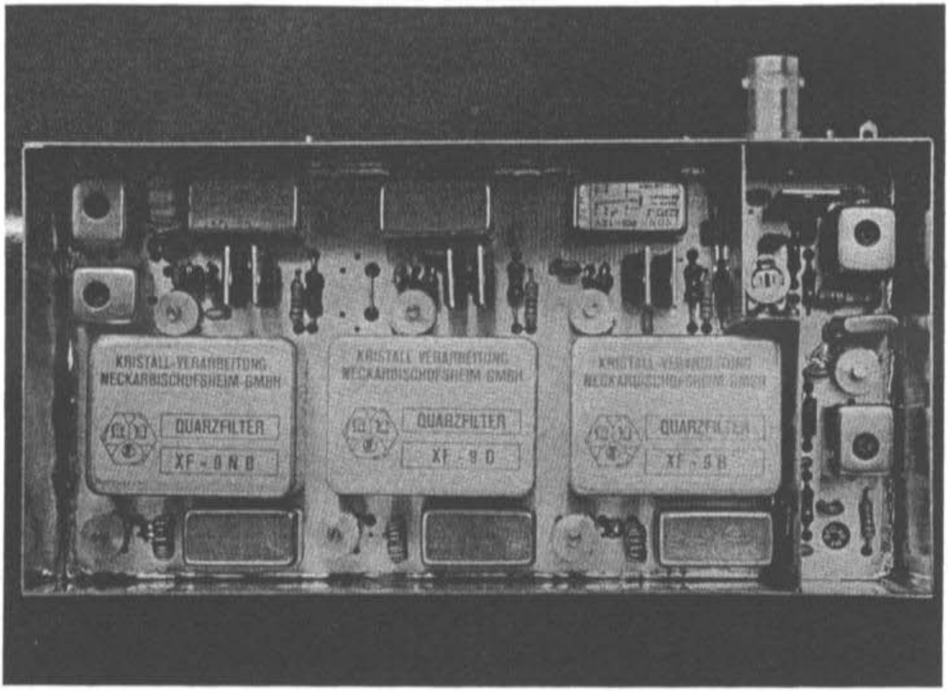


Fig. 43a: In order to cool the pairs of transistors, metal strips should be made between these and the case.

The input impedance of the BFQ 69 is virtually constant in the passband range of the subsequent filter XF – 910, and is mainly dependent on R 3 and R 4. An input impedance of 100 Ohm results with R 3 = 10 Ohm and R 4 = 100 Ohm.

These two resistors determine the gain of the stage, which has been selected here so that the dynamic range of the subsequent, controlled IF-amplifier is utilized to the full. An increase in gain is possible by reducing the value of R 3. With R 3 = 8.2 Ohm, the input impedance of the BFQ 69 will amount to approximately 90 Ohm, with R 3 = 4.7 Ohm to approx. 75 Ohm.

The stage will show a tendency to instability if the value of R 3 is reduced further, or if R 4 is increased.

The operating point of the BFQ 69 is fixed in version ‚a' at a collector current of approximately 15 mA.

In version ‚b', this operating point is set with the aid of the 47 kOhm trimmer potentiometer and can be measured as a voltage drop of 5 V across the 330 Ohm resistor in the collector connection.

The collector impedance is matched to the impedance of the filter with the aid of L 5 and C 5.

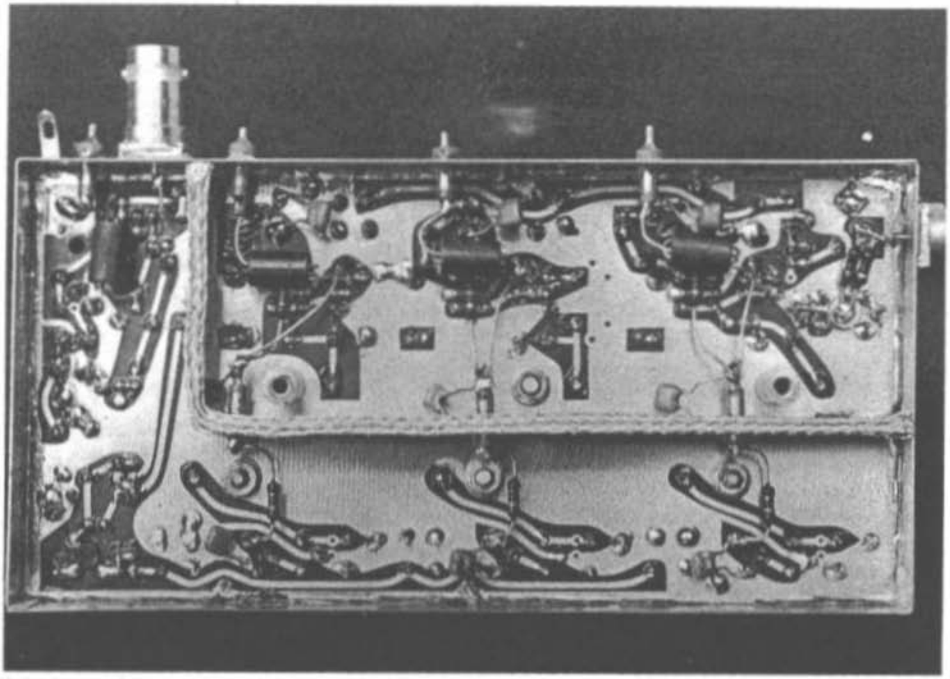


Fig. 43b: Photograph of the conductor side of module DJ3RV 001b

Attention must also be paid at this position that the intrinsic resonant frequency of the 22 µH-choke is much greater than that of the intermediate frequency.

The output impedance of the filter of 6 kOhm is realized with the aid of the two 12 kOhm resistors. The stray capacitances are trimmed out in the resonant circuit comprising L 6. The subsequent FET in a common source circuit guarantees a low-inpedance output of approximately 50 Ohm. The source resistance R 5 determines the current flowing through the FET, and thus also the output impedance.

A slope of 20 mS is required for an output impedance of approx. 50 Ohm. The value of R 5 can be calculated from the measured values in the following manner:

$$R\,5 = \frac{7.5\ V + U_{SG}}{I_D}$$

The output should always be operated into an ohmic termination of 50 Ohm, since the stage will show a tendency to self-oscillation if provided with a capacitive load such as a long unterminated coaxial cable!

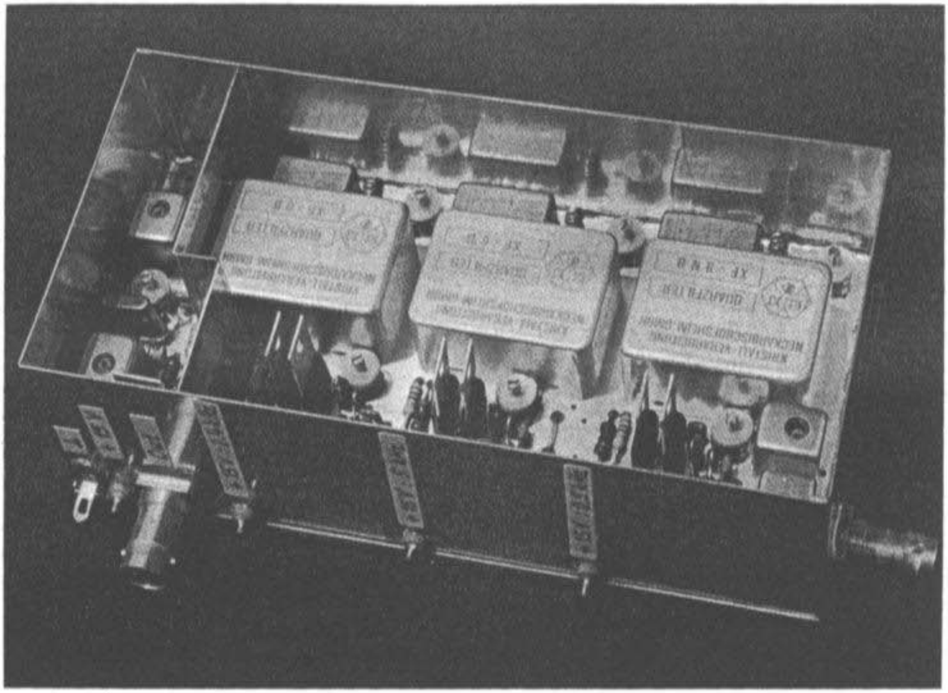


Fig. 43c: Author's prototype module DJ3RV 001b

Components

All components not specifically marked in the circuit diagrams, can be standard components of the given values.

Resistors:
Composite carbon resistors with a spacing of 10 mm;
Capacitors:
Ceramic capacitors for 2.5 mm spacing;
Feedthrough capacitors for solder mounting of 2 nF;
Chokes:
RF-chokes, Siemens B 78108 for spacings of 12.5 mm;
RFC-chokes: six-hole ferrite cores;

C 1: 125 pF made from two ceramic capacitors (100 pF + 22 pF in parallel)

C 2: 1 nF chip capacitor

C 3, C 4: Values given in Figure 4; plastic foil trimmer of 7.5 mm dia.

C 5: 40 pF plastic foil trimmer, 7.5 mm dia. (Philips: violet)

L 1: 2.5 μH, 15 turns of approx. 0.2 mm enamelled copper wire in coil set D41-2165, orange colour;

L 2: 0.3 μH, 5 turns of approx. 0.35 mm enamelled copper wire, otherwise as L 1;

L 3: Value in table 4, otherwise as L 1;

L 4: Value in table 4, toroid core, Siemens R 6.3 K1

L 5: 13 μH, 33 turns, otherwise as L 1;

L 6: 20 μH, 40 turns, otherwise as L 1;

Tr 1: 3 × 10 turns of approx. 0.35 mm enamelled copper wire, toroid core, Siemens R 10 N 30

Type of filter	Impedance	C 3	L 3	C 4	L 4
XF - 9 B XFM - 9 B	500 Ω ‖ 30 pF	3-40 pF violet	–	3-40 pF violet + 15 pF	33 turns/0.2 en. C tap: 14 turns
XF - 9 E XFM - 9 E	1.2 kΩ ‖ 30 pF	3-40 pF violet	10.5 μH 29.5 turns	3-40 pF violet + 15 pF	33 turns/0.2 en. C tap: 9 turns
XFM - 9 S 03	1.8 kΩ ‖ 3 pF	2-22 pF green	14 μH 34.5 turns	2-22 pF green	33 turns/0.2 en. C tap: 7 turns
XFM - 9 S 01	3.3 kΩ ‖ 2 pF	2-22 pF green	21 μH 42.5 turns	2-22 pF green	36 turns/0.2 en. C tap: 6 turns
XFM - 9 S 05	8.2 kΩ ‖ 0 pF	2-22 pF green	53 μH 54.5 turns	2-22 pF green	36 turns/0.2 en. C tap: 4 turns

Table 4: Transformation components for 9 MHz filters on DJ3RV 001

Construction Details

Figures 40 to 43 show the PC-board diagrams and components, as well as the two author's prototypes that include additional information regarding the arrangement of the components on the upper and lower sides of the boards.

The author's prototypes are double-coated, however, do not possess through contacts. All holes are 0.8 mm diameter.

Due to the high density of components, the PC-boards should be provided with the components in an certain sequence.

Firstly carry out the mechanical work:

- Drill the holes on the board; solder the board into the case with a spacing of 12 mm from the base plate;
- Drill the holes in the case and the lower screening panel, and solder into place;
- Solder the feedthrough capacitors and connectors into place.

The circuit is then completed:

- Starting at the output and continuing up to the 10 n coupling capacitor in the base line of the BFQ 69;
- Check the operation of the circuit and align the operating point and filter XF 910.

Place the upper screening panel into position and complete mounting the rest of the components. The points marked with crosses should be soldered on both sides of the board to ensure through-contacting.

Align the input filter so that it has a wideband impedance of 50 Ohm, and align the crystal filter for the required passband curve. If no impedance measuring unit is available, L 1 and L 2 should be aligned for minimum attenuation of the input filter!

The winding data of the inductances in the filter circuits are designed so that the cores are approximately 2 turns from the upper edge of the filter.

A further decoupling between input and output of the circuit can only be achieved when using screwed covers, which can be improved by providing a good contact between the screening panels and the cover using a length of coaxial sheathing as can be seen in **Figure 43b**.

This completes the construction of the crystal filter module.

MATERIAL PRICE LIST OF EQUIPMENT

described in Edition 4/1982 of VHF COMMUNICATIONS

DL 8 ZX 004	**Premixer for the Spectrum Analyzer**		Art. No.	**Ed. 4/1982**
PC-board	DL 8 ZX 004	Double-coated and etched, silvered	6725	DM 19.—
Parts	DL 8 ZX 004	1 ringmixer SAM-5, 6 diodes, 3 feed-through and 10 ceram. capacitors, 12 resistors, 2 RF chokes, 1 metal case		
Kit	**DL 8 ZX 004**	**complete with above parts**	**6726**	**DM 223.—**

DL 8 ZX	**Helical Filter for the Spectrum Analyzer**		**Ed. 4/1982**
Parts	DL 8 ZX Helical Filter: 2 metal cases, 4 m of silver-plated wire, 3 ceram. tubular trimmers, 1 ceram., 3 feed-through caps., 3 PTFE-feed-throughs, 3 RF-chokes, 1 ferrite bead, 1 resistor, 1 trimmer pot., 1 off P 8002		
Kit	**Helical filter, complete with above parts**	**6727**	**DM 49.—**

DK 1 VA	**Compact 70 cm Transverter for 2 m Transceivers**		**Ed. 4/1982**
PC-board	DK 1 VA 144-432, double-coated, drilled	6768	DM 37.—
Parts	DK 1 VA 144-432: all necessary parts including feed-throughs, BNC-sockets and drilled metal case		
Kit	**DK 1 VA 144-432, complete with all parts**	**6769**	**DM 248.—**

DJ 3 RV	**Versatile IF-Module**				**Ed. 4/1982**
PC-board	DJ 3 RV 001a	double-coated, drilled		6729	DM 25.—
PC-board	DJ 3 RV 001b	double-coated, drilled		6730	DM 25.—
PC-board	DJ 3 RV 002	double-coated, drilled		6749	DM 25.—
PC-board	DJ 3 RV 003	double-coated, drilled		6746	DM 25.—
PC-board	DJ 3 RV 004	double-coated, drilled		6748	DM 25.—
PC-board	DJ 3 RV 005	single-coated, drilled		6747	DM 18.—
P 8002	Power-FETs		packets of 10	9069	DM 89.—
BFQ 69	UHF transistor			9577	DM 8,50
Tinned-metal case		74 × 148 × 30		9501	DM 6,50
Toroid core	R6,3K1			9159	DM 1,50
Coil set	D41 – 2165	orange		9166	DM 2,50

Monolithic Crystal Filters from KVG
for the DJ 3 RV IF-Module (for instance)

			XFM-9B02	6809	DM 148.—
			XFM-9S01	6810	DM 148.—
XF-909	6800	DM 31.—	XFM-9S02	6811	DM 148.—
XF-910	6801	DM 38.—	XFM-9S03	6812	DM 148.—
XF-914	6802	DM 46.—	XFM-9S04	6813	DM 148.—
XFM-9A	6803	DM 118.—	XFM-9S05	6814	DM 148.—
XFM-9B	6804	DM 136.—	XFM-9S06	6815	DM 148.—
XFM-9C	6805	DM 121.—	XFM-9S07	6816	DM 148.—
XFM-9D	6806	DM 121.—	XFM-9S08	6817	DM 212.—
XFM-9E	6807	DM 121.—			
XFM-9B01	6808	DM 148.—			

For Technical Data see rear cover page of VHF COMMUNICATIONS

UKW**berichte** Terry D. Bittan · Jahnstr. 14 · Postfach 80 · D-8523 Baiersdorf
Tel. West Germany 9133-855. For Representatives see cover page 2

A) A complete system as kits

Part in the system	Described in Edition	Kit designation	Art. No.	Price DM
1. **Parabolic antenna,** 1.1 m diam., 12 segm. to be screwed or riveted together, 3 plastic supports for radiator	3/1979	**Set of 12 segm. + supports** **Riveting machine + rivets** **1.7 GHz Cavity radiator kit**	0098 0105 0091	**180.00** **93.00** **90.00**
2. **Low-noise amplifier for 1.7 GHz** (Originally described for use at 2.4 GHz, this unit is tuned to 1.7 GHz)	1/1980	**DJ6PI 010**	6565	**225.00**
3. **METEOSAT Converter,** consisting of two modules – Output first IF = 137.5 MHz)	4/1981 1/1982	**DJ1JZ 003** **DJ1JZ 004**	6705 6714	**189.00** **185.00**
4. **VHF Receiver,** frequency range: 136 – 138 MHz, Output: 2400 Hz sub-carrier	4/1979 1/1980	**DC3NT 003** **DC3NT 004**	6141 6145	**225.00** **80.00**
5. **Digital scan converter** (256 × 256 × 6 Bit)	4/1982 1/1983	**YU3UMV 001** **YU3UMV 002** }	6736	**675.00**
6. **PAL-Color module** with VHF mod.	2/1983	**YU3UMV 003**	6739	**150.00**

B) Aligned ready-to-operate PCB-modules and equipment

Cavity radiator for above parabolic antenna	0092	**150.00**
VHF receiver for 136 – 138 MHz, DC3NT 003	6731	**395.00**
Oscillator for VHF receiver, DC3NT 004	6732	**168.00**
Digital scan converter (256 × 256 × 6 Bit) YU3UMV 001 + 002	6734	**1150.00**
PAL-Color module with VHF oscillator YU3UMV 003	6738	**285.00**

C) A complete system, ready-to-operate in cabinets

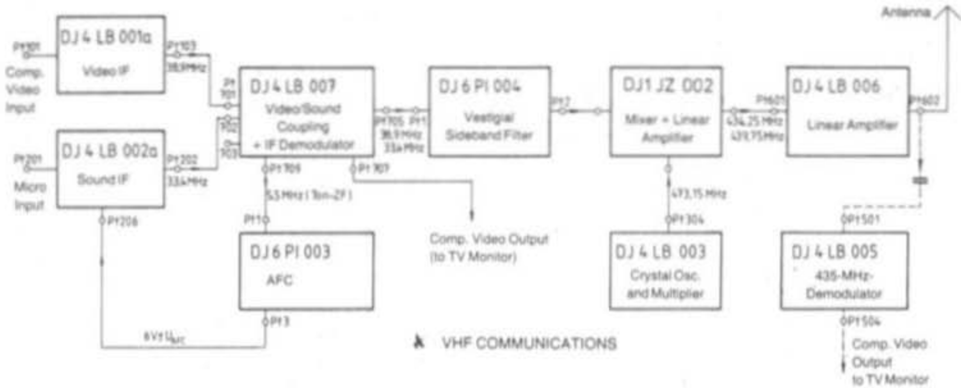
Parabolic antenna, 12 segments, riveting machine and rivets, cavity radiator, supports		**423.00**
METEOSAT converter with GaAs-FET preamplifier and mixer, 2 channels, in casing	3026	**645.00**
Antenna for orbiting satellites, DJØBQ-137 (VHF COMMUNICATIONS 4/1981)	0101	**198.00**
Power combiner for above, AT-137	0306	**98.00**
6-channel VHF receiver in cabinet, programmed for: 137,130/137,300/137,400/137,500/137,620/137,850 MHz	3300	**1298.00**
Digital scan converter, 256 × 256 × 6 Bit, with control electronic, in cabinet	6735	**1980.00**
PAL-Color module with VHF oscillator and power supply, in cabinet	6737	**650.00**
Video monitor, black/white, with 31 cm C.R.T.	3301	**550.00**

A new service of UKW-BERICHTE/VHF COMMUNICATIONS:

Dissemination Schedule of METEOSAT, incl. surface mail	**3.00**
Audio Compact Cassette with 2 × 30 minutes of selected subcarrier recordings of METEOSAT and NOAA, resp.	**25.80**

UKWberichte Terry D. Bittan · Jahnstr. 14 · Postfach 80 · D-8523 Baiersdorf
Tel. West Germany 9133-855. For Representatives see cover page 2

An Amateur-Television Transmitter for Home Construction



A television transmitter built from modules described in VHF COMMUNICATIONS is shown in the above **block diagram**. Each function is realised on an individual PC-board. Each PC-board is built into its own tinned-metal box, which leads to a very clean operation without unwanted stray coupling and without problems caused by radiation. Each module may be aligned and tested on its own. All this encourages the home constructor since it makes it easy to understand the different functions, and it finally leads to a high-value ATV transmitter to which all possible video sources (black/white or color) may be connected.

For an amplification of the transmit power, a variety of linear amplifiers for the 70 cm band may be used (not FM »linears« !), whereby care should be taken to adjust the drive so that the output power does not exceed half the PEP value of the SSB mode.

The ATV modules listed have been published by three authors. The descriptions are detailed and will enable successful duplication. They are to be found in the following **editions of VHF COMMUNICATIONS:**

VHF COMMUNICATIONS 1/1973
VHF COMMUNICATIONS 2/1973
VHF COMMUNICATIONS 2/1976
VHF COMMUNICATIONS 1/1977
VHF COMMUNICATIONS 4/1977
VHF COMMUNICATIONS 3/1981

This set of 6 editions is available at DM 24.—

Individual kits:

DJ 4 LB 001a	kit, complete	DM	98.—
DJ 4 LB 002a	kit, complete	DM	99.—
DJ 4 LB 007	kit, complete	DM	90.—
DJ 6 PI 003	kit, complete	DM	50.—
DJ 6 PI 004	ready-to-operate	DM	115.—
DJ 4 LB 003	kit, complete	DM	92.—
DJ 1 JZ 002	kit, complete	DM	131.50

Set of complete kits for the 70 cm ATV transmitter (without power amplifier)
comprising DJ 4 LB 001a, DJ 4 LB 002a, DJ 4 LB 007, DJ 6 PI 003, DJ 6 PI 004, DJ 4 LB 003, DJ 1 JZ 002 **DM 695.—**

Space and Astronomical Slides

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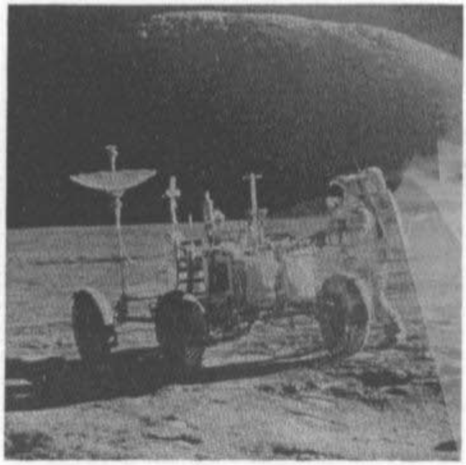

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1. Saturn and 6 of its moons 2. Saturn from 11 mio miles 3. Saturn from 8 mio miles 4. Saturn from 1 mio miles 5. Saturn and rings from 900.000 miles 6. Saturn's Red spot 7. Cloud belts in detail 8. Dions against Saturn 9. Dione close-up 10. Rhea 11. Craters of Rhea 12. Titan 13. Titan's polar hood 14. Huge crater on Mimas 15. Other side of Mimas 16. Approaching the rings 17. Under the rings 18. Below the rings 19. »Braided« F ring 20. Iapetus

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1. Solar System 2. Formation of the Planets 3. The Sun 4. Mercury 5. Crescent Venus 6. Clouds of Venus 7. Earth 8. Full Moon 9. Mars 10. Mars: Olympus Mons 11. Mars: Grand Canyon 12. Mars: Sinuous Channel 13. Phobos 14. Jupiter with Moons 15. Jupiter Red Spot 16. Saturn 17. Saturn Rings 18. Uranus and Neptune 19. Pluto 20. Comet Ikeya-Seki.

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1. Sun in Hα light 2. Total Solar eclipse 3. Outer corona 4. Corona from SMM satellite 5. Corona close-up 6. Solar magnetogram 7. Active regions in X-radiation 8. X-ray corona 9. A coronal hole 10. Solar flare 11. Active Sun 12. Eruptive prominence 13. Gargantuan prominence 14. Eruptive prominence 15. Huge Solar explosion 16. Prominence in action 17. Sun in action 18. Magnetic field loops 19. Prominence close-up 20. Chromospheric spray

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1. STS1 heads aloft 2. View from the tower 3. Tower clear 4, Launch profile 5. Payload bay open 6. STS control Houston 7. In orbit, earth seen through the windows 8. Bob Crippen in mid-deck 9. John Young 10. Approaching touchdown 11. After 54.5 hours in space Columbia returns to Earth. 12. Astronauts Crippen and Young emerge after the successful mission

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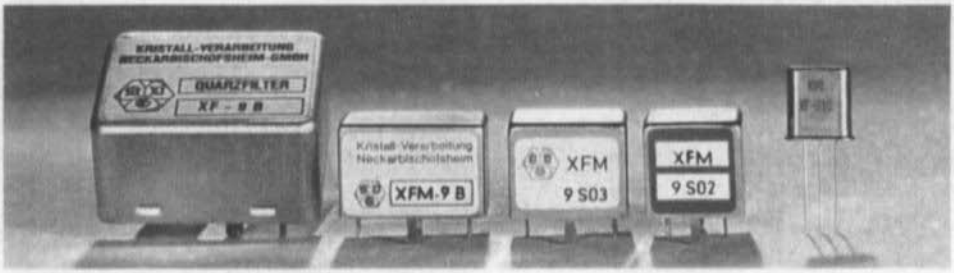

Case: 1 15 14 13 17

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		Type	Termination	Case	Type	Termination	Case
XF-9A	SSB	XFM-9A	500 Ω ‖ 30 pF	15	XFM-9S02	1.8 kΩ ‖ 3 pF	13
XF-9B	SSB	XFM-9B	500 Ω ‖ 30 pF	15	XFM-9S03	1.8 kΩ ‖ 3 pF	14
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XF-9D	AM	XFM-9D	500 Ω ‖ 30 pF	15	XFM-9S01	3.3 kΩ ‖ 2 pF	14
XF-9E	FM	XFM-9E	1.2 kΩ ‖ 30 pF	15	XFM-9S05	8.2 kΩ ‖ 0 pF	14
XF-9B01	LSB	XFM-9B01	500 Ω ‖ 30 pF	15	XFM-9S06	1.8 kΩ ‖ 3 pF	14
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