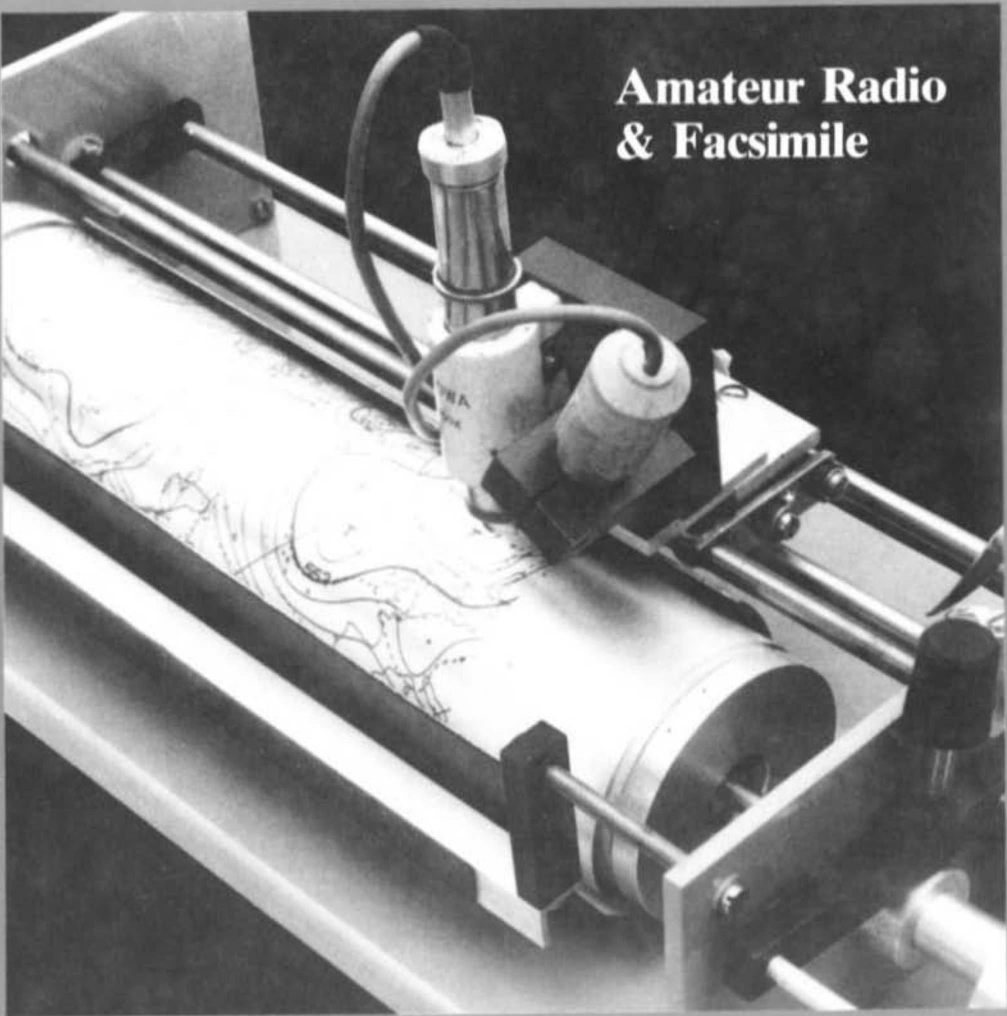
J 20 419 F

A Publication
for the Radio-Amateur

Especially Covering VHF,
UHF and Microwaves

VHF communications

Volume No. 12 · Winter · 4/1980 · DM 5.00



Firstly, the staff of VHF COMMUNICATIONS would like to wish all our readers and subscribers a very Happy and Prosperous New Year 1981. Terry Bittan, G 3 JVQ / DJ 0 BQ will be taking over as publisher of VHF COMMUNICATIONS and UKW-BERICHTE, and also the other activities under UKW-TECHNIK. This will in no way affect the magazines, and we will be doing

continued on page 193

Published by: Verlag UKW-BERICHTE,
Hans J. Dohlus oHG,
Jahnstrasse 14
D-8523 BAIERSDORF
Fed. Rep. of Germany
Telephones (0 91 33) 855, 856.

Publishers: T. Bittan, H. Dohlus

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

Advertising manager: T. Bittan

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

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

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

VERTRETUNGEN · REPRESENTATIVES :

Austria
Hans J. Dohlus, Creditanstalt Bankverein WIEN
Kto. 17-90.599, PSchKto. WIEN 1.169.146

Australia
WIA PO Box 150, TOORAK, VIC. 3142, Tel. 24-8652

Belgium
Stereohouse, Brusselsesteenweg 416, B-9218 GENT,
PCR 000-1014257 CCP, Tel. (091) 31 21 11

Denmark
Flemming Pedersen, OZ 8 GI, Logic Design ApS
Ribisvej 11, DK-7400 HERNING

France
Christiane Michel, F 5 SM, F-89 PARLY, Les Pillés

Finland
Timo Nopanen, OH 3 YW, Metsäter 10, SF-15610 LAHTI

Germany
Verlag UKW-BERICHTE, H. Dohlus oHG, Jahnstr. 14,
D-8523 BAIERSDORF, Tel. (09133) 855, 856.
Konten: Postscheckkonto Nürnberg 304 55-858,
Commerzbank Erlangen 820-1154

Holland
MECOM, PA 0 AER, PO Box 40, Coendersstraat 24,
NL-9780 AA BEDUM, Tel.05900-14390, Postgiro 39 86 163

Israel
Z. Pomer, 4 X 4 KT, PO Box 222, K. MOZKIN
26 100, Tel. 974-4-714078

Italy
Franco Armenghi, I 4 LCK, Via Sigonio 2,
I-40137 BOLOGNA, Tel. (051) 34 56 97

Luxembourg
P. Wantz, LX 1 CW, Télévision, DUDELANGE,
Postscheckkonto 170 05

New Zealand
E. M. Zimmermann, ZL 1 AGQ, PO Box 85,
WELLSFORD, Tel. 8025

Norway
Henning Theg, LA 4 YG, Postboks 70,
N-1324 LYSAKER, Postgirokonto 3 16 00 09

South Africa
SA Publications, PO Box 2232, JOHANNES-
BURG 2000, Telephone 22-1496

Spain + Portugal
Julio A. Prieto Alonso, EA 4 CJ, MADRID-15,
Donoso Cortès 58 5°-B, Tel. 243 83 84

Sweden
POLY RADIO, Östervärnsgatan 10,
S-21218 MALMÖ, Bo Nilsson, SM 7 FJE,
Tel. 040-292420, Pg: 431 56 99-1, Bg: 317-2939

Switzerland
Hans J. Dohlus, Schweiz.Kreditanstalt ZÜRICH,
Kto. 469.253-41; PSchKto. ZÜRICH 80-54.849

UK North
SOTA Communication Systems Ltd., 26 Childwall
Lane, Bowring Park, LIVERPOOL L 14 6 TX

UK South
VHF COMMUNICATIONS, Dept. 802, 20 Wallington
Square, WALLINGTON Surrey SM 6 8 RG

USA
O. Diaz, WB 6 ICM, Selecto Inc., 372d Bel Marin
Keys Blvd., NOVATO, CA 94947

Yugoslavia
Tito Cvrković, YU-56000 VINKOVCI, M. Gupca 27

VHF communications

Volume No. 12
Winter / Ed. 4
1980

A Publication for the Radio Amateur
Especially Covering VHF, UHF, and Microwaves

continued from left page

everything in our power to provide all readers with interesting magazines, and constructional projects. We would like to also introduce two new representatives: Ozzie Diaz, WB 6 ICM, and Flemming Pedersen, OZ 8 GI. We are sure that they will give the readers in their area excellent service.

A System for Reception and Display of METEOSAT Images

Part 6

by R. Tellert, DC 3 NT

The editors would like to point out that readers located to the West of the Greenwich meridian will be able to receive the GOES geostationary satellite which is located over the equator at the 70°W meridian. This satellite transmits the same type of APT-images as METEOSAT. The launch of METEOSAT 2 is still planned for February 1982.

The following modules are required for the complete FAX-system with mechanical display:

- **DC 3 NT 007 (start-stop-logic)**
- **DC 3 NT 010 (drum oscillator)**
- **DC 3 NT 011 (C-MOS switch)**
- **DC 3 NT 012 (system board)**
- **DC 3 NT 013 (diode matrix for the bus)**

After describing these PC-board modules, the construction of the FAX-machine is to be described; this will be followed by describing the CRT-module with its PC-board for the high-tension supply and the X, Y, and Z-amplifiers.

5.5. DC 3 NT 007

Module DC 3 NT 007 is responsible for the following tasks:

1. Start-stop evaluation for »stationary« FAX-transmission (METEOSAT/GOES etc.)
2. Evaluation and blanking of the non-required parts of the TIROS-N and NOAA-6 transmissions (visual or infrared).

The special features are to be explained briefly with the aid of the circuit diagram given in **Figure 46**.

5.5.1. Stationary Images

In the case of stationary FAX-transmissions such as those from METEOSAT, each image will commence with a start tone. This tone is between three and five seconds long, and is followed by the phase synchronizing pulses which mark the commencement of each line. The task of the start-logic is to only pass on those black/white transitions to the facsimile machine that follow the start tone.

This is made with the aid of an active filter, which filters out the start tone from the video signal, rectifies it and feeds it to a Schmitt-trigger. When a given threshold is exceeded, this will be actuated and will switch on the LED »START«. The transcient time is dependent on the filter bandwidth. In our case it is less than 0.1 s which means that it can be actuated during a picture transmission. A delay circuit (R/C-link) ensures, however, that a short actuation will not be processed as starting tone, and the R/C-link subsequent to the Schmitt-trigger will not actuate until after approximately 0.5 s.

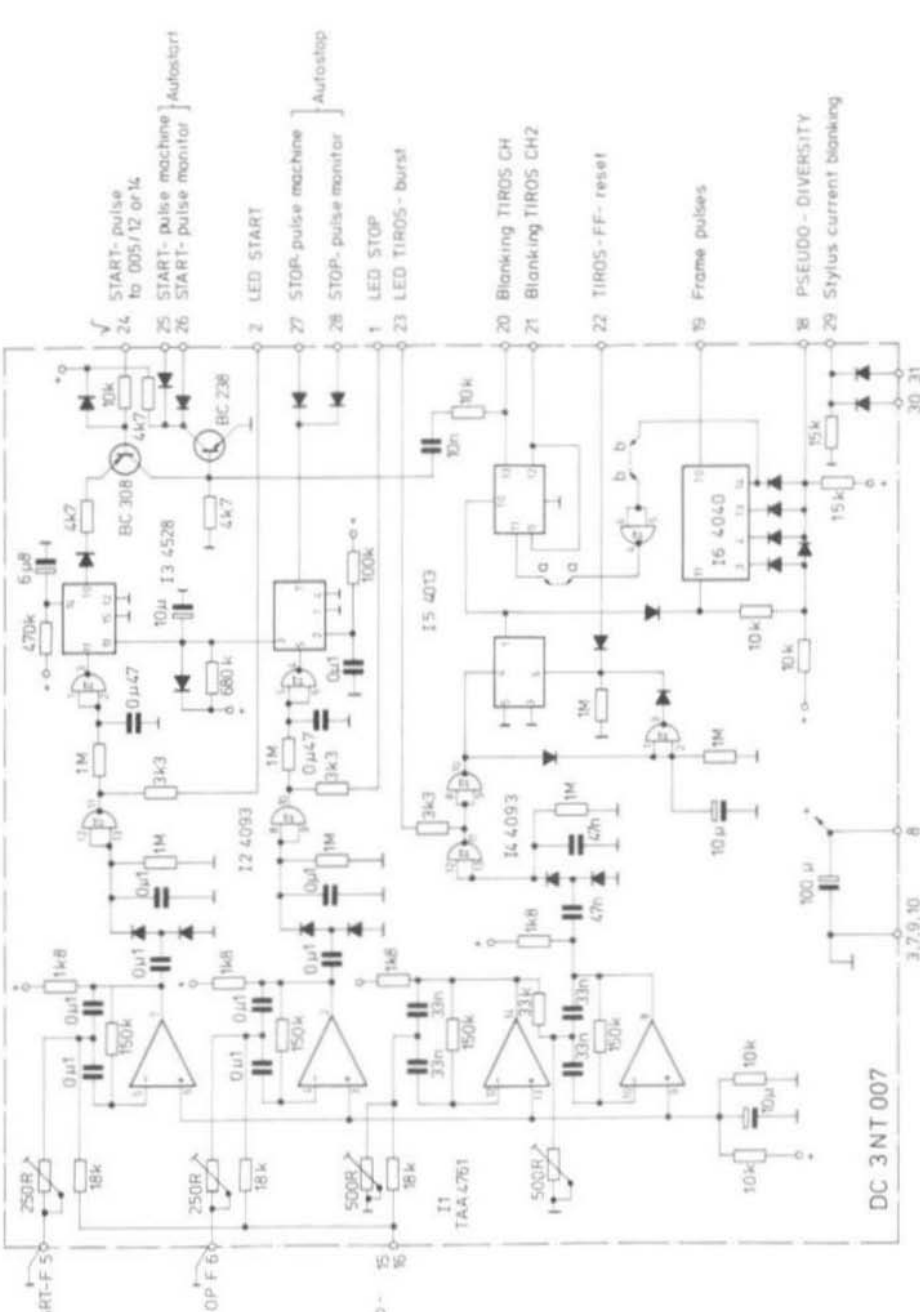


Fig. 46: The start-stop logic is contained in module DC 3 NT 007

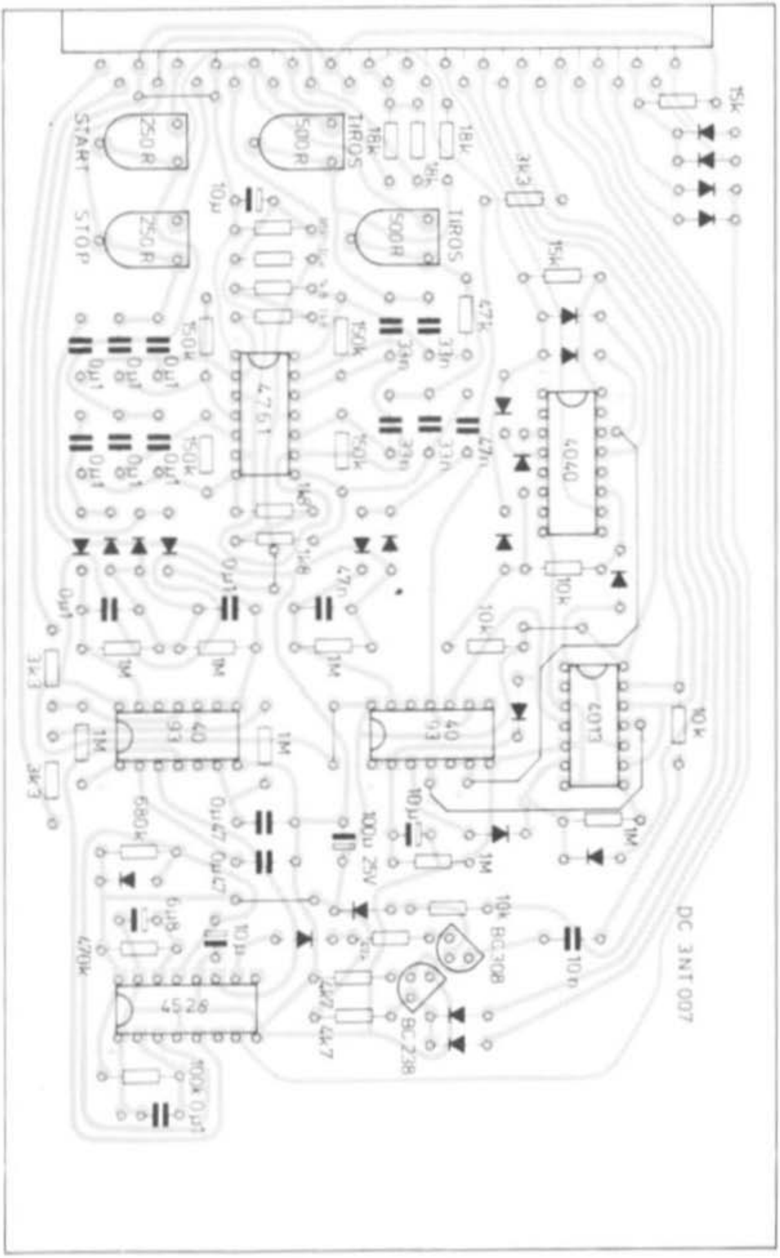


Fig. 47: Single-coated PC-board DC 3 NT 007 for the start-stop logic

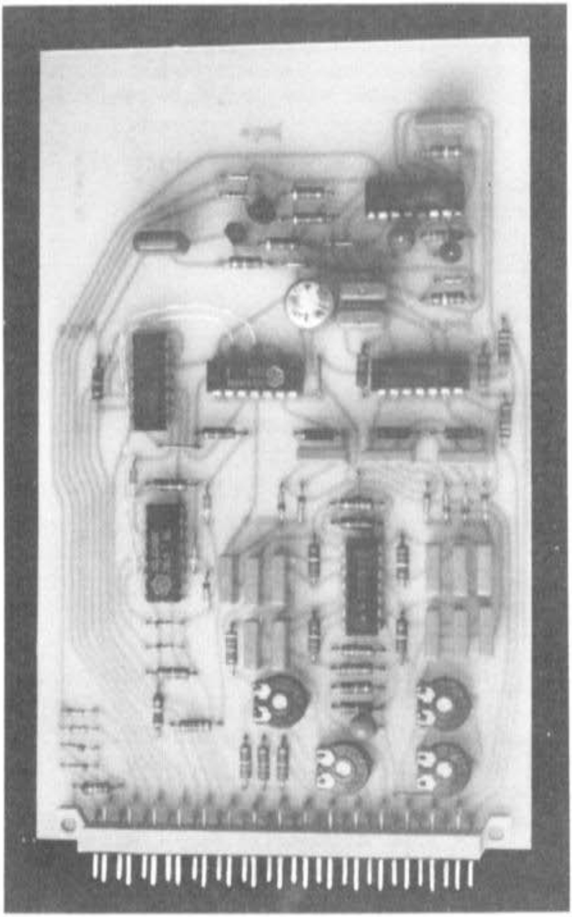


Fig. 48:
Photograph of the author's prototype DC 3 NT 007

After the completion of a known start tone, this second Schmitt-trigger will switch back after a delay of approximately 0.5 s. This starts a Monoflop (upper half of I 3) with a delay of approximately 3 s. It is only during this period that the start impulses (black/white transitions) can be fed to the start-flipflop of the FAX-machine or CRT-module !

The operation of the stop tone circuit is identical; however, there is no interconnection with the phase synchronization pulses since no stop pulses are given. A monoflop (lower half of I 3) will be started at the end of the stop tone, and this monoflop will generate a 10 ms stop pulse to the previously mentioned flipflop.

5.5.2. Images from Orbiting Satellites

In contrast to the »stationary« APT-transmissions from the geostationary satellites such as METEOSAT, the orbiting satellites do not transmit a start or stop tone since they give a continuous transmission of the area over which they are orbiting. The beginning of each line is in the form of a synchronizing burst.

A special feature of the TIROS-N and NOAA-6 satellites is that alternate lines are transmitted in two different spectral ranges. This was briefly mentioned in Part 3 of this article. The first evaluation circuit comprised two filters which were tuned to these two burst frequencies. They switched a flipflop; this circuit operated well at sufficient signal levels. However, when a burst could not be identified due to interference, this resulted in a bright (blanked) or dark (dual-trace) line. This led to in a deterioration of good images.

The following circuit only filters out the 1040 Hz burst (I 1, the lower amplifiers). Since one knows that the second burst will come exactly 0.25 s afterwards, virtually only two bursts are required for coding. The selected burst is filtered twice and sets a flipflop, which releases a counter (I 6) that in turn divides the frame pulses by 720. The output of the counter jumps to 000 after starting with the 1040 Hz burst, when TIROS transmits a new line. This jump controls a divide-by-two divider, whose two outputs (Q and $\overline{Q}$) provide the signal for blanking the non-required image (connections 20 and 21).

The first 1040 Hz burst commences the re-run. The subsequent switching of the 2:1 divider means that a start impulse is given per line. In the case of automatic film recording, this would mean that a new image will be started even when the satellite is not within the reception range. For this reason, the first flipflop is reset when no 1040 Hz burst is received for a period of 8 seconds.

5.5.3. Pseudo-Diversity

Before completing the description of this module, the output PSEUDO-DIVERSITY should be mentioned:

This output controls a circuit that switches the input of the receiver to a second antenna after each line of the image. If the field strength is higher, this antenna is used for the next line; if not, it will switch back to the first antenna.

5.5.4. Construction of DC 3 NT 007

A PC-board designated DC 3 NT 007 was developed for the construction of the circuit given in Figure 46. The component locations on this single-coated PC-board are given in **Figure 47**. This board has also the so-called Europa board size of 160 mm x 100 mm, and is equipped with a 31-pin connector which means that it can be inserted into the system board DC 3 NT 012. An older prototype is to be seen in **Fig. 48.**

5.5.5. Components of DC 3 NT 007

5 C-MOS-ICs:

1 piece 4013
1 piece 4040
2 pieces 4093
1 piece 4528

1 quadruple op. amp. TAA 4761

1 AF transistor BC 238, BC 413 or similar

1 AF-PNP transistor BC 308, BC 415 or similar

23 switching diodes 1 N 4148 or 1 N 4151

Plastic foil capacitors for 7.5 mm spacing:
1 x 10 nF, 4 x 33 nF, 2 x 47 nF, 9 x 0.1 μF, 2 x 0.47 nF

4 tantalum electrolytics, drop-type
10 μF / 25 V

2 trimmer potentiometers of each 250 Ω and 500 Ω, spacing 10/5 mm

All other resistors for 10 mm spacing

1 31-pin connector (DIN 41617)

5.5.6. Alignment of Module DC 3 NT 007

Four trimmer potentiometers are to be found on this board for alignment of the filter frequencies. For alignment, one will require a video signal having the required frequency. This signal can be generated externally in three ways:

1. A VCO can be frequency-modulated and this fed to the FM-demodulator
2. A 2.4 kHz oscillator is amplitude-modulated with the required frequency
3. The frequency doubling of the dual-path AM-demodulator can be used. This method is the simplest, since only a generator is required.

This can be achieved by setting **half the frequency** at the tone generator. This is then carried out in the following manner, in order to align the three filter frequencies of

300 Hz (START), 450 Hz (STOP), and 1040 Hz (TIROS/NOAA burst) :

1. Set the tone generator to 150 Hz and feed this to the VHF-input (AM-mode)
2. Connect an oscilloscope to the video input of DC 3 NT 007 (Pt 15) and align the amplitude of the tone generator so that approximately 3 to 4 V (peak-to-peak) can be measured at 300 Hz.
3. Do not alter this amplitude.
4. Connect the oscilloscope to pin 7 of I 1 and align the potentiometer nearest to pin 1 for maximum amplitude; the LED »START« will light.
5. Connect the oscilloscope to pin 2 of I 1, and set tone generator to 225.5 Hz. Align the potentiometer next to the START-potentiometer to maximum amplitude. The LED »STOP« will light.
6. Connect the oscilloscope to pin 14 of I 1 and set the tone generator to 520 Hz. Align the potentiometer in the vicinity of pin 12 for maximum amplitude.
7. Connect the oscilloscope to pin 8 and align the last potentiometer for maximum amplitude. The LED TIROS »Burst« will light.

5.6. Module DC 3 NT 010

This module was not planned originally. However, it was found after constructing the larger FAX-machine as described here, that the synchronous motor cannot start immediately in the full speed position, and it is necessary to commence with a lower frequency – as in the case of stepping motors – and continously increase this frequency up to the final speed. On reaching the nominal speed, the oscillator is switched over to the crystal-controlled frequency.

Unfortunately, this principle cannot be achieved so simply in our application, since the commencement of the image must be defined. Since the metalized paper will always receive a new start after removing

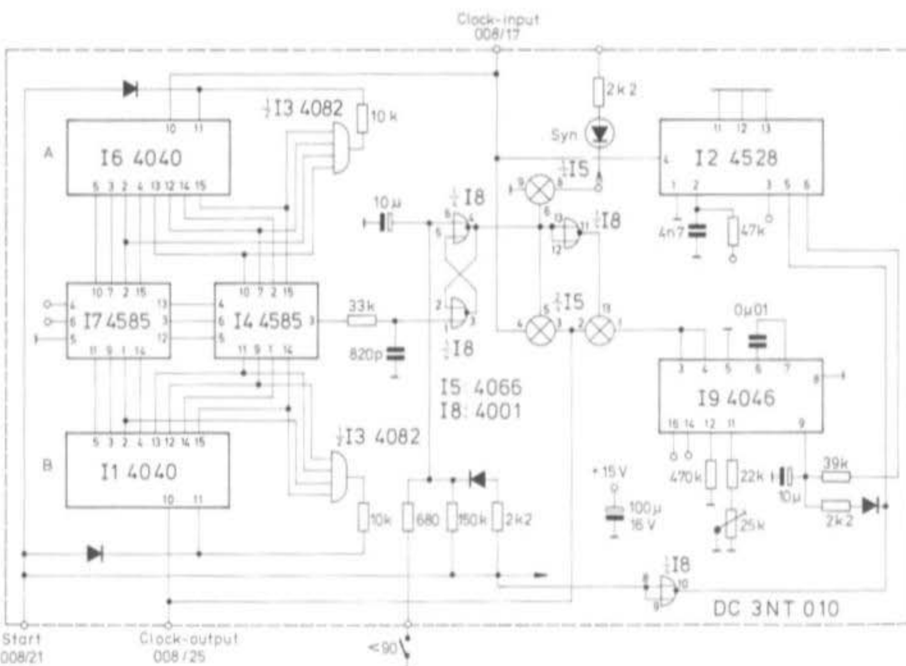


Fig. 49: Frequency generator module for the drum motor

the last image (one always cuts off more paper than actually required for the image). it is not always the same position of the drum that is the commencement of the image, but the actual position of the drum before starting. For this reason, one adjusts the drum before starting so that the stylus is placed at the edge of the paper.

The solution to this problem electrically is given in **Figure 49**. It mainly consists of three functional parts:

- Start-VCO
- Counter and comparator of nominal and actual drum position
- Changeover switching from VCO to reference frequency.

It is necessary for the VCO to run up to a frequency that is 10 to 15 % higher than the nominal frequency required for the various speeds (see Part 4). This guarantees that the nominal and actual value of the drum position coincide within 10 lines, and that the reference frequency is selected. This means that it is necessary to switch the VCO together with the drum speed.

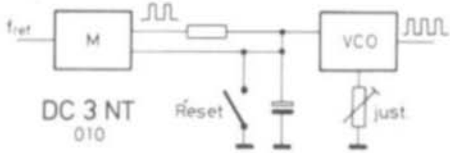


Fig. 50: Principle of the motor starting circuit

Figure 50 shows that this can be carried out in a simpler manner. A monoflop driven by the reference frequency and an R/C-link is connected to its output. The maximum voltage across the capacitor is proportional to the input frequency. If the time constants are selected to be sufficiently long (approx. 0.4 s) and if the capacitor is discharged for starting, the characteristic given in **Figure 51** will be obtained.

The subsequent VCO is now aligned so that an output of 6.36 kHz (approx. 10 % more than nominal) is provided at an input frequency of 5.76 kHz – corresponding to 240 lines per minute.

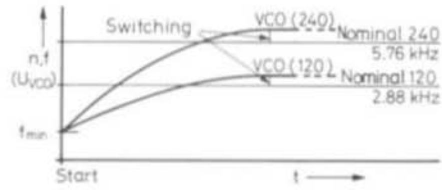


Fig. 51: Time diagram

The second part of the circuit ensures that the electronic circuit notes the starting position of the drum by comparing it with the ideal position (i.e. when the drum had immediately the full speed), and switches to the reference frequency when identical.

Since one will be operating with 1440 pulses per drum revolution, it is necessary for the two counters to also divide by 1440. One counter is connected to the reference frequency, and the other to the output pulses. Two 4-Bit comparators generate the synchronizing signal for switching to the reference frequency.

It is necessary for both counters to be reset to zero before starting. Since identical phase will be present at times during the runup period (and immediately after start), a further timing stage must be provided to ensure that the changeover to the reference oscillator is not made too soon. This delay circuit must also be reset. When using the 8-Bit comparator, the error between nominal and actual value is $< 1\%$.

5.6.1. Construction of DC 3 NT 010

The drum oscillator shown in Figure 49 can be accommodated on a 100 mm x 60 mm large, double-coated PC-board with through contacts. The component locations on this board (DC 3 NT 010) are given in **Figure 52**, and **Figure 53** shows a photograph of the author's prototype.

5.6.2. Components for DC 3 NT 010

9 C-MOS-ICs:

		1 piece	4001
2 pieces	4040	1 piece	4082
1 piece	4046	1 piece	4528
1 piece	4066	2 pieces	4585

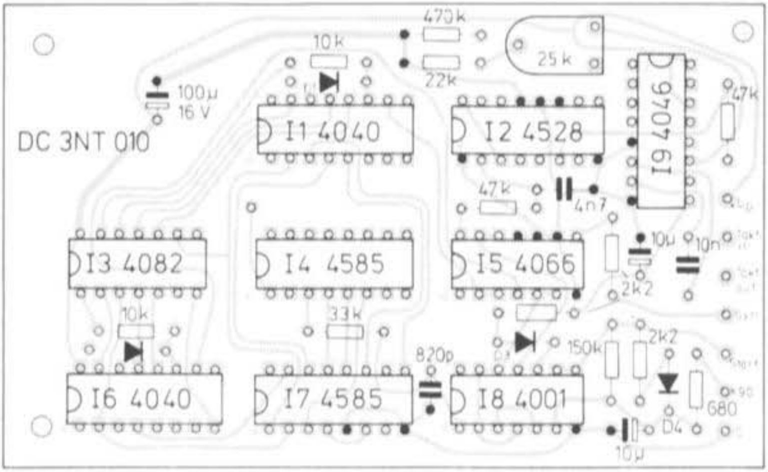


Fig. 52: Component location plan of the double-coated PC-board DC 3 NT 010

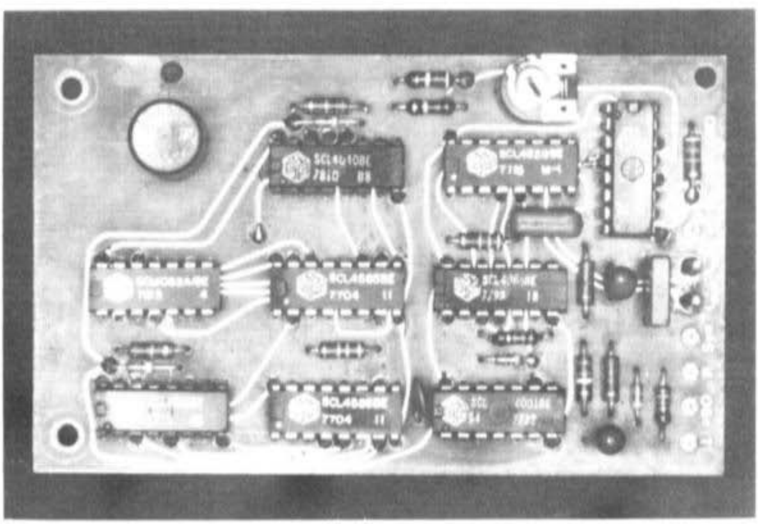


Fig. 53: Photograph of the author's prototype DC 3 NT 010

4 switching diodes 1 N 4148, 1 N 4151 or similar

1 LED

1 aluminium electrolytic 100 µF / 25 V, spacing 5 mm

2 tantalum electrolytics (drop), 10 µF/25 V

1 plastic foil capacitor 10 nF, spacing 7.5 mm

1 plastic foil capacitor, 4.7 nF, spacing 7.5 mm

1 ceramic or styroflex capacitor, 820 pF, spacing 5 mm

1 trimmer potentiometer 25 kΩ, spacing 10/5 mm

All fixed resistors: spacing 10 mm.

5.6.3. Installation of DC 3 NT 010

Module DC 3 NT 010 is not accommodated on the system board, but is connected to board DC 3 NT 008. Figure 33 gives a dashed connection from pin 17 (clock output) to pin 25 (clock input). Module DC 3 NT 010 is looped into these connections.

Pin 21 (output of the start-stop flipflops of the machine) indicates that a start-process is commencing, and for this reason it is connected to the input »Start« of module DC 3 NT 010.

The following connections are additionally required:

Ground, + 15 V

Output »Syn« is connected via a LED and a series resistor to + 15 V; this will light when the reference frequency has been selected.

Connection »< 90« is grounded at speeds of 48, 60, and 90 lines per minute,since it is not necessary at these speeds for the oscillator to be commenced at a lower frequency.

5.6.4. Alignment of DC 3 NT 010

For aligning this module, the FAX-machine is started and a speed of 240 lines per minute selected. After a few seconds, the VCO trimmer potentiometer (25 kΩ at I 9) is aligned so that a frequency of 6.36 kHz is measured at pin 4 of the 4046. No further alignment is required.

5.7. Module DC 3 NT 011

This module is the so-called »Switching Board« which has the task of replacing a multi-layer switch for selecting the audio sources and drum speeds. The pilot tone required for operation in conjunction with a tape recorder is switched together with the audio source; the time constants in the time base generator circuit as well as the amplitudes of the synchronous motor voltages are set together with the speed.

The circuit of the electronic switching, which is made in MOS-technology, is given in **Figure 54**. The drum speed is switched in the integrated circuit I 1 (4051), which has 7 switches. The BCD-orders and the speeds are given adjacent to the circuit.

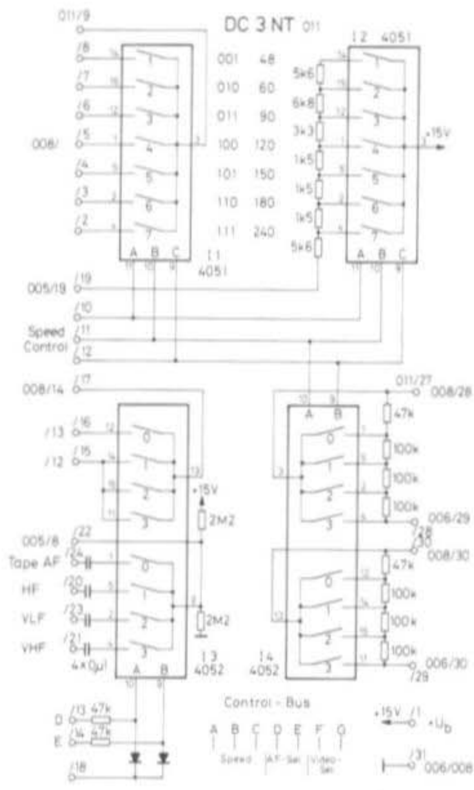


Fig. 54:
Electronic switches, in 4 ICs replace a mechanical multi-layer switch

I 2 switches a voltage divider chain which influences the previously mentioned time constant via connection 19 of module DC 3 NT 005. The various audio sources such as VHF, VLF, or HF receiver, and tape recorder are selected in the integrated circuit I 3 (4052). Finally, I 4 sets the required operating voltage for the drum motor of the FAX-machine to the various drum speeds.

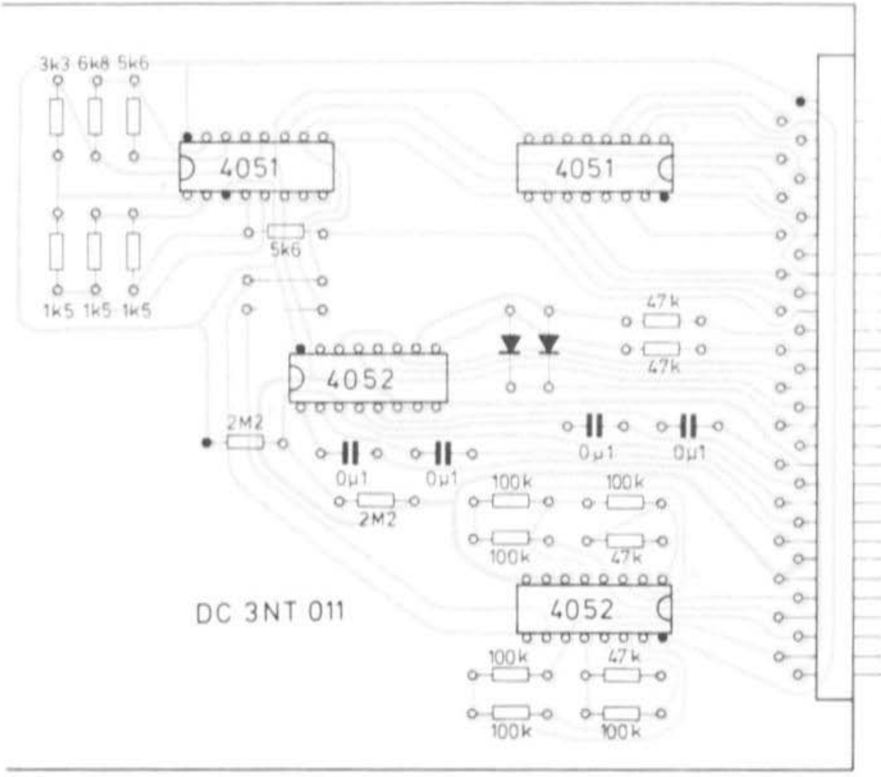


Fig. 55: Component locations on the single-coated PC-board DC 3 NT 011

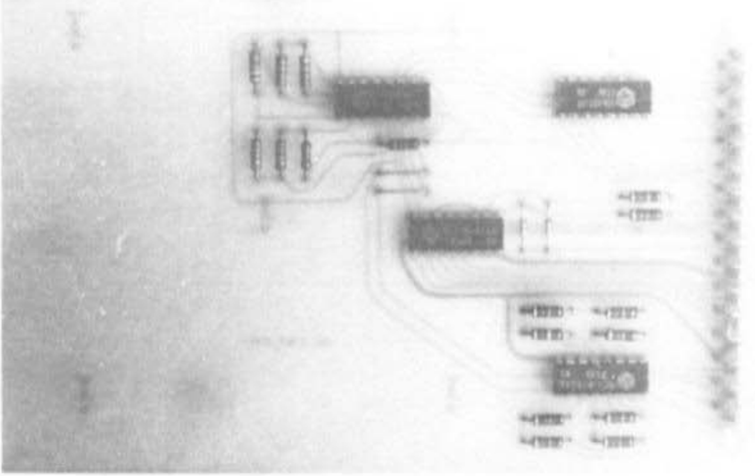


Fig. 56: Photograph of the author's prototype module DC 3 NT 011

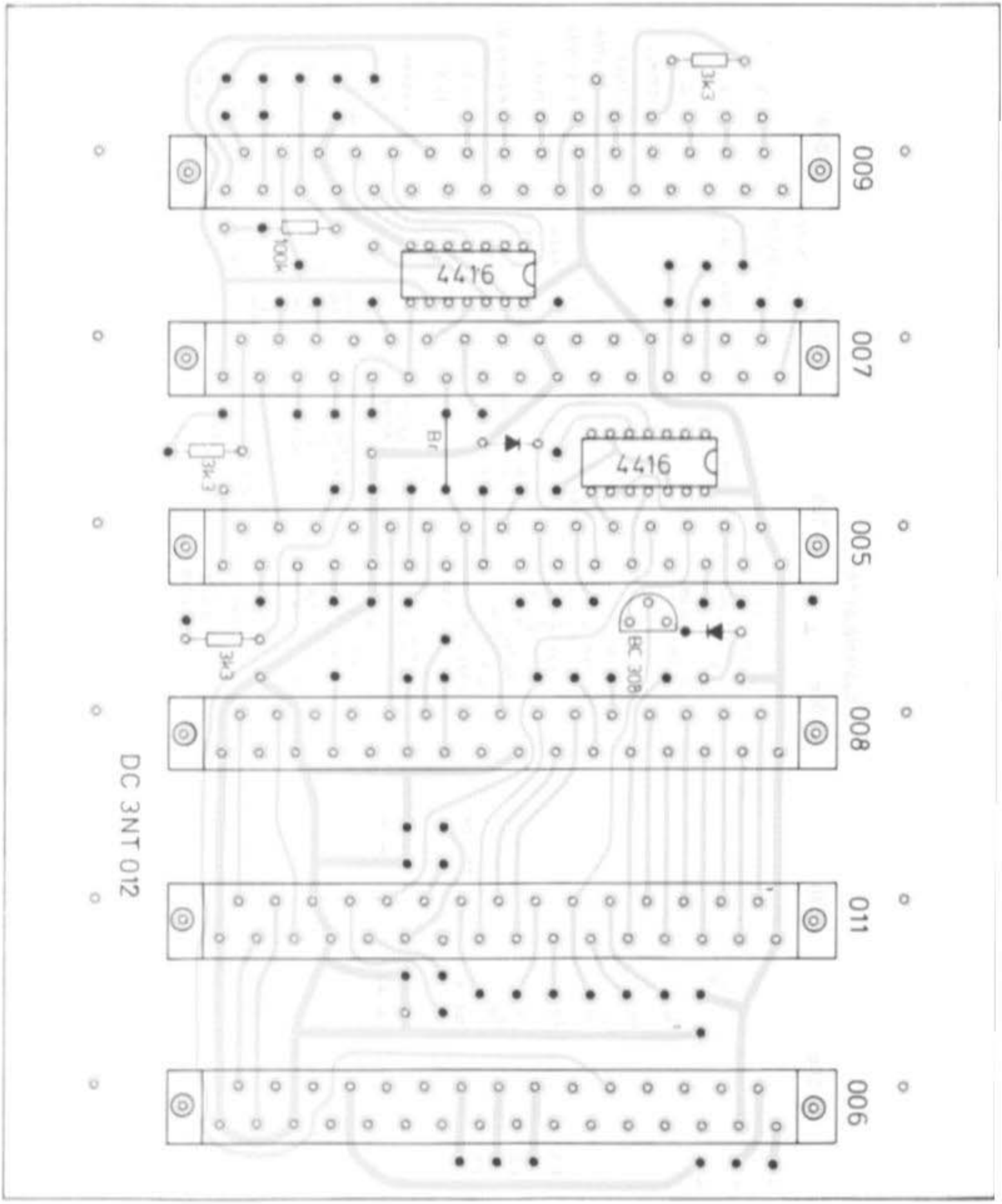


Fig. 57: Double-coated system board DC 3 NT 012 (160 mm x 135 mm)

The drive of the MOS-switch is made via the control bus; as has been previously mentioned, this switch is binary coded. The relationships are shown in the small table given in Figure 54.

The connection points of the individual boards are given in the circuit diagram of the switching board for further information, and to aid fault-finding, if required. However, one need not worry about the wiring, since this is made with the system board which is to be described in section 6.

5.7.1. Construction of DC 3 NT 011

The switching board DC 3 NT 011 is single-coated **(Figure 55)** and also possesses the Europa board size of 160 mm x 100 mm, although one third of the board is empty and could be deleted. **Figure 56** shows a photograph of an old prototype that does not possess a number of capacitors and resistors. The two required bridges and the connector strip can be seen.

5.7.2. Components for DC 3 NT 011

4 C-MOS-ICs:
2 pieces 4051
2 pieces 4052

2 switching diodes 1 N 4148 or similar

4 ceramic or plastic foil capacitors 0.1 μF, spacing 7.5 mm

All resistors: 10 mm spacing

1 31-pin connector strip (DIN 41617)

5.8. Module DC 3 NT 012

The so-called system board is provided for the interconnection of the following modules:

DC 3 NT 005 (video board)
DC 3 NT 006 (power supply and output stages for the drum motor)
DC 3 NT 007 (start-stop logic)
DC 3 NT 008 (frequency generator)
DC 3 NT 009 (CRT drive X-Y-Z)
DC 3 NT 011 (switching board)

A circuit diagram of this board is not given, since it would only tend to confuse, and because the connection points are given in each individual circuit diagram.

Figure 57 shows the component locations of this double-coated PC-board in a reduced manner. The actual size of the board is 160 mm x 135 mm. The component side only contains the 6 connector strips and clamps for the six previously mentioned modules, as well as two integrated circuits (4416) for the control bus and an AF-transistor.

A large number of solder pins must be soldered to the conductor side of the board, and these are marked as black dots in Figure 57. The two diodes (1 N 4148 or similar) and four resistors are finally also mounted on the conductor side of the board **(Figure 58)**.

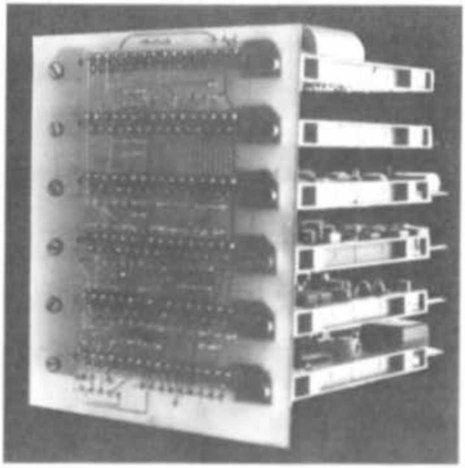


Fig. 58: Photograph of a completely equipped system board DC 3 NT 012

5.9. Module DC 3 NT 013

The diode matrix DC 3 NT 013 is built up on a single-coated PC-board (see **Figure 59**). Switching diodes can be soldered into place on this board for selection of up to nine different programs.

Each program represents a correct combination of drum speed, audio source, suitable demodulator, required image channel

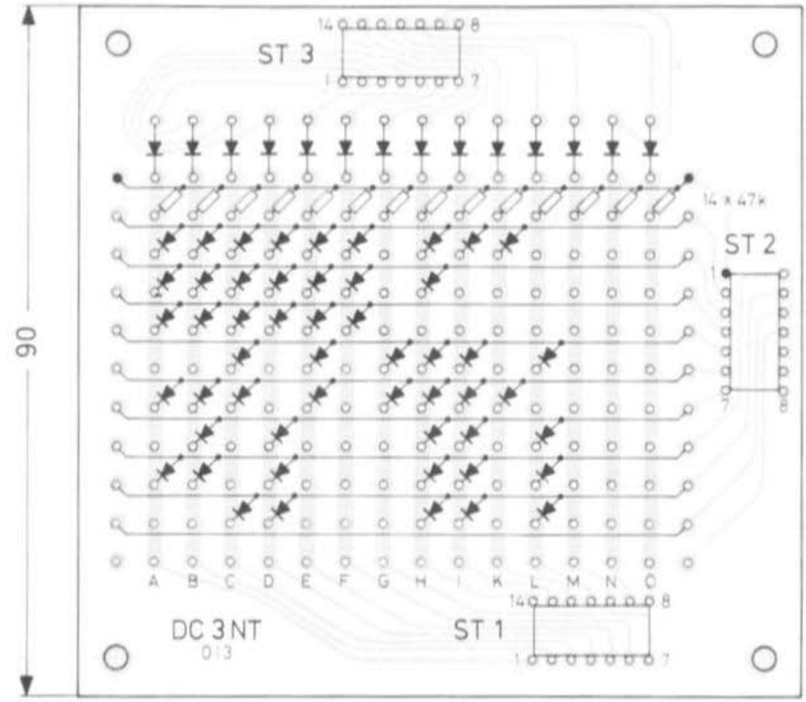


Fig. 59: Diode matrix DC 3 NT 013 for 10 different programs

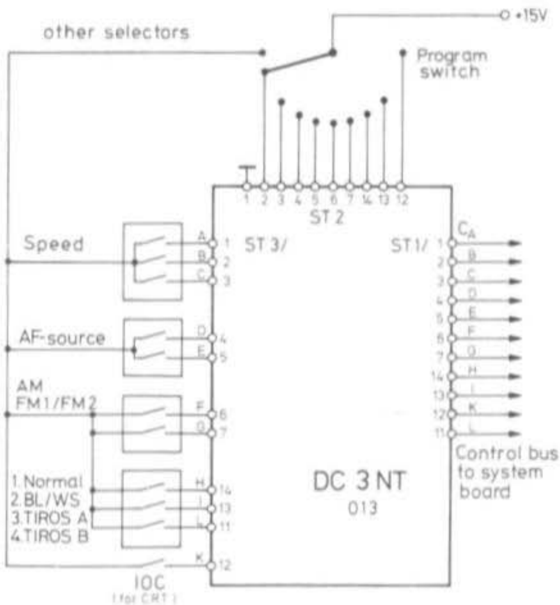


Fig. 60: Connections between diode matrix, program switch, and additional switches

(TIROS and NOAA), required index of co-operation, and required equalization of the grey tones or monochrome levels of the FAX-machine.

PC-board DC 3 NT 013 is 95 mm x 90 mm. The horizontal lines over the complete length of the board represent 10 wire bridges made from 0.8 to 1 mm thick, silver-plated copper wire. These wires are placed approximately 8 mm above the board. The resistors and the diodes are now soldered vertically from these wires to the required points on the board.

Three DIL-sockets are to be found on the edge of the PC-board. These are provided for the wiring shown in **Figure 60** which is made with the aid of plugs and flat cable. The three plugs are connected as follows:

ST 1: Control bus to the system board

ST 2: Program switch:

Pin 1 = Ground
Pin 2 = METEOSAT
Pin 3 = TIROS, CH A
Pin 4 = TIROS, CH B
Pin 5 = VLF BL/WT 120
Pin 6 = VLF grey levels/240
Pin 7 = HF BL/WT 60
Pin 14 = HF BL/WT 90
Pin 13 = HF BL/WT 120
Pin 12 = not connected

ST 3: to the individual switches for programming as required

The following table shows the programs selected by the author as recommendation. A program or mode switch is required for programming. This can be a single-layer rotary switch having ten positions; it switches the operating voltage to the selected group of diodes so that the BCD-information is passed to the MOS-switch (DC 3 NT 011) via the control bus.

This description has now described all modules with the exception of DC 3 NT 009, which is required for the photographic recording together with the picture tube. This means that the electronics for the FAX-machine are complete, and it can be enclosed in a cabinet and provided with the required connectors, switches, controls and indicators.

A B Speed C	**CBA** 001 = 48 010 = 60 011 = 90 100 = 120	101 = 150 110 = 180 111 = 240	
D AF Selection E	**ED** 00 = Tape 01 = HF 10 = VLF 11 = VHF	C_{Tape} = 1	Additional Input: C_{Tape} = 0 = Tape has priority !
F AM/FM G FM 1/FM 2	**FG** 00 FM HF 01 FM VLF	**FG** 10 AM 11 AM	
H CH A/CH B I NOAA/Norm.	**IH** 00 = CH B 01 = CH A	**IH** 10 = Dark (illegal) 11 = Normal (Reset TIROS)	
K Index of Cooperation	1 = 288 0 = 576	for picture tube	
L Normal/ Weather Map	0 = Normal 1 = Weather Map	for FAX machine	
M = Meteor 250/1200 Hz burst			

Table: Control bus

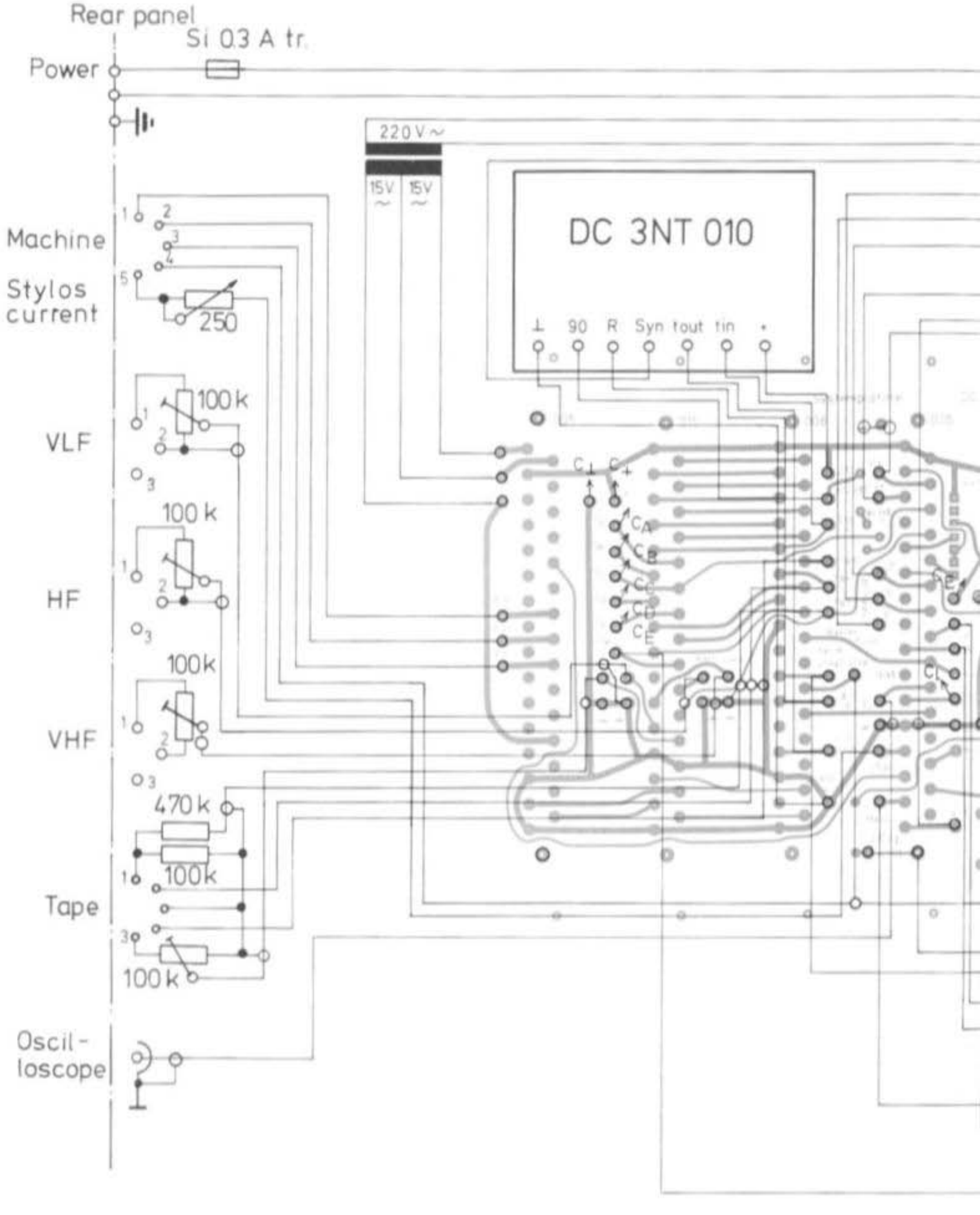
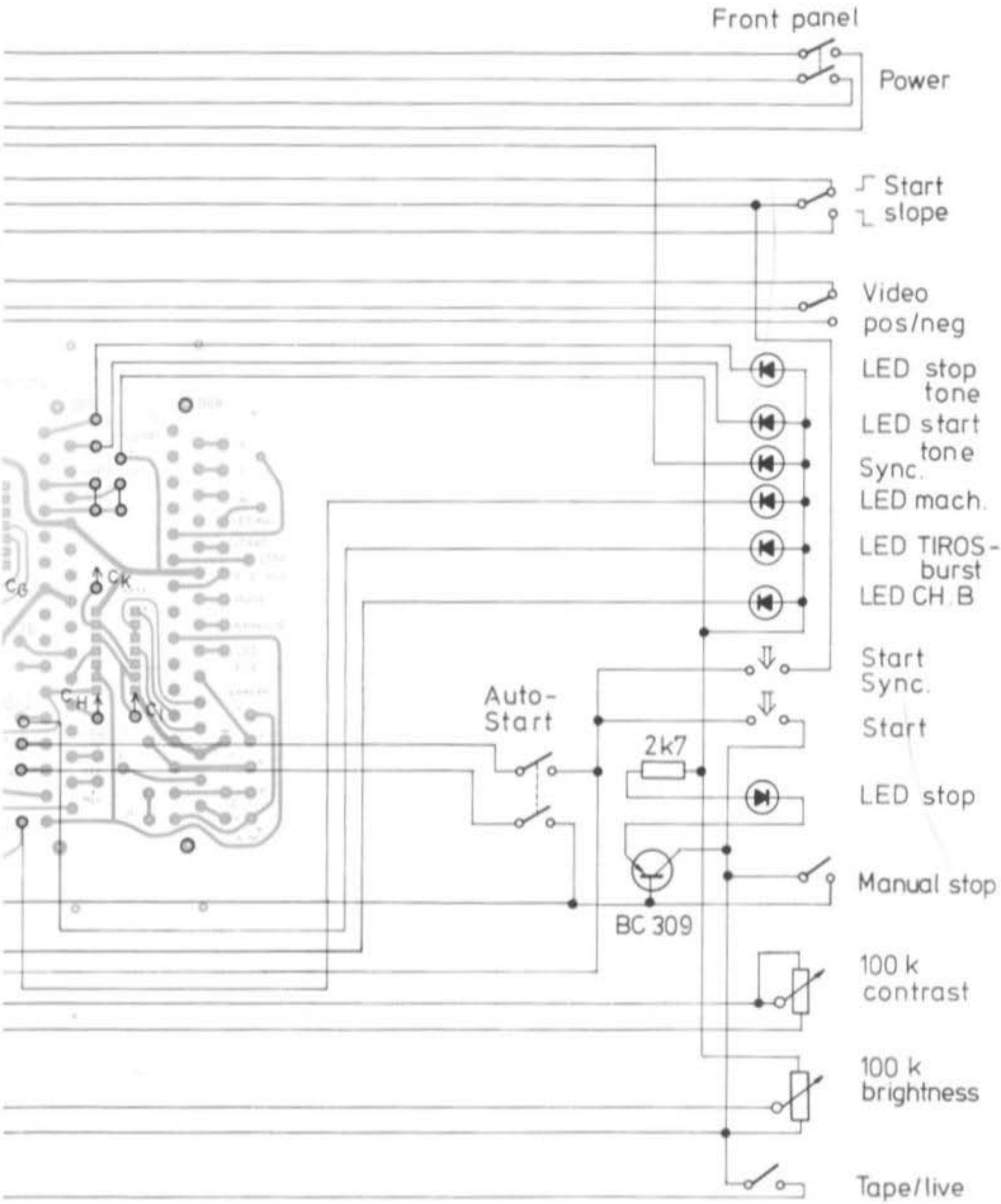


Fig. 61: Wiring plan of the »electronic module«


Front panel
Power
Start
slope
Video
pos/neg
LED stop
tone
LED start
tone
Sync.
LED mach.
LED TIROS-
burst
LED CH B
Start
Sync.
Start
Auto-
Start
2k7
LED stop
Manual stop
BC 309
100 k
contrast
100 k
brightness
Tape/live

6. CONSTRUCTION AND WIRING OF THE WHOLE UNIT

The system board, the PC-boards DC 3 NT 010 and 013, as well as a power transformer (2 x 15 V/65 VA) should now be mounted in a cabinet of your choice. Attention should only be paid that the solder pins on the conductor side of the system board remain accessible, since the interconnections to the connectors, switches, controls, and indicators are soldered to these pins as shown in **Figure 61**. The connections and controls can be placed on the front or rear panels as required.

In the case of the author's prototype, 3 and 5-pin DIN-connectors were used for connection to the periphery equipment and each connection provided with a trimmer potentiometer for level adjustment. A BNC-connector can be used for interconnection to the oscilloscope. The contrast and brightness controls are used fairly often and should therefore be mounted on the front panel.

The LEDs can be arranged functionally and mounted around the mode switch or adjacent to the other switches in a similar manner to that shown in Figure 60.

Further Planning

The boards required for operation of the CRT-module are accommodated in the cabinet of this module with the exception of the previously mentioned board DC 3 NT 009, which should be inserted into the system board later. This means that the »electronic« module only contains the parts given in Figures 60 and 61.

Now to our »mechanical specialists«: The FAX-machine will be described in one of the next editions of VHF COMMUNICATIONS. It is virtually impossible to give the detailed mechanical drawings in this magazine, and would take up too much space in it. For this reason, these drawings will be available separately from the publishers or your national representative for the equivalent of DM 6,—. These drawings can be used in conjunction with the description of the FAX-machine which is to be given in the magazine.

A Simple Converter for Reception of Weather Satellites in Conjunction with 2 m FM Receivers

by H. Kulmus, DJ 8 UZ

The orbiting weather satellites such as TIROS-N, NOAA-6, and METEOR transmit their APT-weather images (1) in the satellite frequency range between 136 and 138 MHz. Since these transmissions are frequency-modulated, it is possible to monitor these satellites by converting this band to 144-146 MHz and using a conventional 2 m FM-receiver.

The described converter was developed to receive these frequencies in a simple manner. Only two semiconductors are used. The converter is designed for those readers that have often thought about receiving weather satellites, but have been waiting for a simple means of doing this. The simplicity of the design and the use of readily available components means that construction can be made by newcomers and shortwave listeners.

CIRCUIT DESCRIPTION

As can be seen in **Figure 1**, the input signal from the antenna is fed via a two-stage bandpass filter for the weather satellite band 136-138 MHz to the VHF-preamplifier equipped with the well-known MOSFET-type BF 900. Gate 2 of this transistor is accessible via a feedthrough capacitor so that the gain of the VHF-preamplifier can be reduced automatically or manually. This allows the gain to be set within limits to suit the subsequent 2 m FM-receiver. The most simple means of reducing the gain would be to ground connection Pt 2 via a switch.

The VHF-preamplifier stage is followed by a second two-stage bandpass filter for the frequency range of 136 to 138 MHz, which possesses a coupling link for the mixer

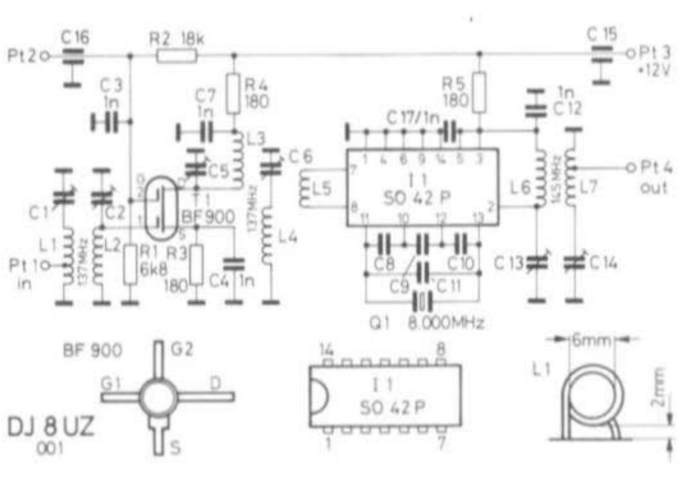


Fig. 1:
Receive converter 136-138 MHz/144-146 MHz

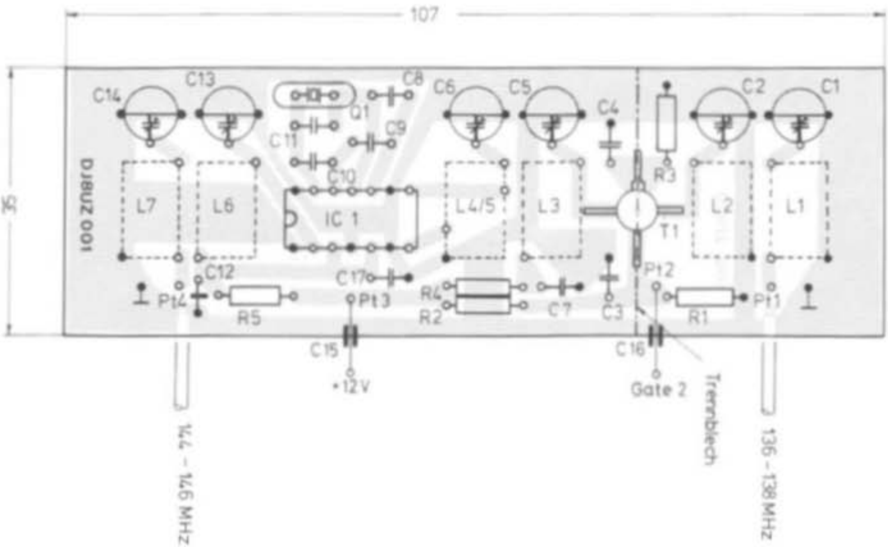


Fig. 2: PC-board of the weather satellite converter, double-coated

coupling. The mixer is equipped with an integrated circuit type SO 42 P that converts the satellite band to 144-146 MHz with the aid of an 8 MHz crystal-frequency.

The output coupling is made via a two-stage bandpass filter for a frequency range of 144 to 146 MHz.

The converter is designed for an operating voltage of 12 V, but will still operate even with less than 6 V, of course, at lower gain.

COMPONENTS

T 1:	BF 900 (Texas Instruments)
I 1:	SO 42 P (Siemens)
Q 1:	8000 MHz, HC-18/U
L 1 - L 4, L 6, L 7:	5.5 turns of 1 mm dia. silver-plated copper wire wound on a 6 mm former, self-supporting, mounted 2 mm over the board. Coil tap on L 1 and L 7: 0.75 turns from the cold end.
L 5:	1.5 turns of insulated wire wound in between the turns of L 4, according to the hole spacing on the board.
R 1:	6.8 k
R 2:	18 k
R3, R4, R5:	180 Ω
C 1, C 2, C 5, C 6, C 13, C 14:	1.4 - 10 pF plastic foil trimmers 7 mm dia. (yellow)

All ceramic capacitors are for 5 mm spacing, and possess the following values:

C 3, C 4, C 7, C 12, C 17:	1 nF to 10 nF
C 8:	39 pF
C 9:	100 pF
C 10:	33 pF
C 11:	22 pF
Case:	Metal plate with covers: 37 mm x 111 mm x 30 mm

Input and output connectors:
BNC (or direct cable connection)

C 15, C 16:	Feedthrough capacitor 1 nF (value uncritical)

CONSTRUCTION

The 107 mm x 35 mm large board is double-coated, whereby the upper side is used as ground surface and only the lower side is etched. The component locations are shown in **Figure 2**. Construction is simplified by using an available metal plate case, and the complete screening will reduce the direct reception of 2 m signals. The screening panel across the input transistor is provided to ensure stable operation of this stage.

It is recommended for the construction to be made in the following order:

1. Drill all holes in the metal plate case for the connectors (or hole for the cable) and for the feedthrough capacitors.
2. Solder the frame of the case together and solder in the feedthrough capacitor.
3. Drill the PC-board with a 1 mm diameter drill (1.3 mm for the trimmer), and countersink all holes with exception of the ground connections, so that no short-circuits to ground occur. A hole with a diameter of 5.5 mm is drilled in the board for the VHF-transistor, which is soldered to the conductor lanes later.
4. Fit the PC-board to the case before mounting the components, and solder into place. Make the interconnections to the feedthrough capacitors for the + 12 V and gate 2.
5. Fit the screening plate across the VHF-preamplifier transistor and solder into place.
6. Prepare the inductances and solder into place. The direction of winding is given by the holes in the board, and attention must be paid to this.

   Firstly mount the input and output circuits, and solder the wires for the coil tap into place. Inductance L 5 is wound from insulated wire in the turns of L 4 and should be installed at the same time.
7. Equip the board with the trimmers, resistors, and capacitors.
8. The SO 42 P is now soldered into place without socket.
9. The BF 900 is now soldered to the conductor lanes from below.

   CAUTION: Make sure that it is the right way round !
10. Solder the crystal into position.

This completes the construction, and it is now only necessary for the converter to be aligned.

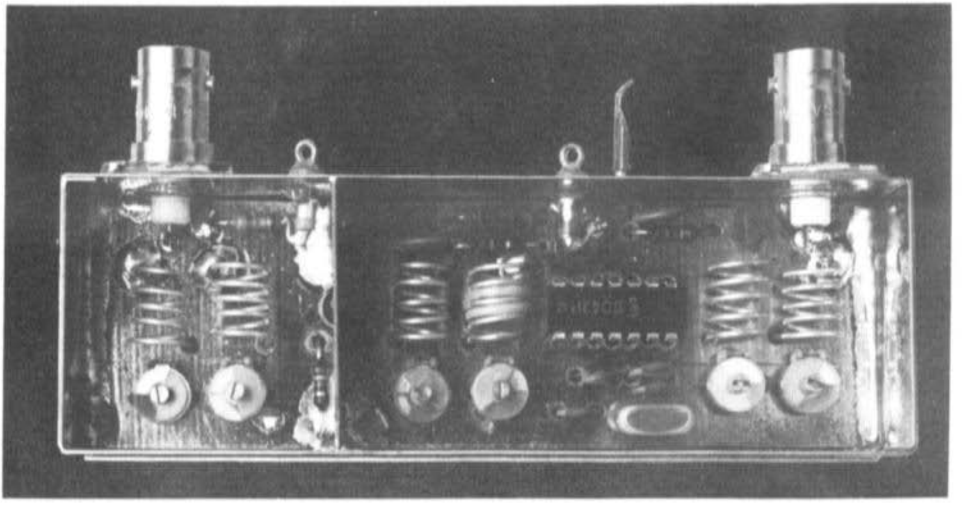


Fig. 3: A screening panel is soldered across the VHF-preamplifier transistor

ALIGNMENT

Connect an operating voltage of 12 V and check to see that the current drain is in the order of approx. 7 mA. The operation of the crystal oscillator can be checked with the aid of a frequency counter using a small coupling capacitor connected to pin 10 or 12 of the SO 42 P. A frequency of 8 MHz should be present.

After this, it is only necessary for the resonant circuits to be aligned at the center of the band. A signal generator having a good calibration (or checked against a frequency counter) simplifies the alignment process and is to be recommended.

NOTES

The described converter was developed so that it is very easy to construct. The author would therefore like to discuss a few of its special features and limitations.

The crystal frequency of 8.000 MHz was selected due to the availability of such crystals. The eighteenth harmonic (8 MHz x 18 = 144 MHz) that is audible at the bottom of the 2 m band, will not interfere with reception, since no satellite signals are active in this frequency range. It can therefore be used as a frequency marker.

Since the frequency spacing between 136 and 144 MHz is so low, there is bound to be a certain amount of breakthrough from the 2 m band. For instance, it is possible for the repeater output frequency of 145.625 MHz to interfere with the TIROS-N transmissions that are converted to 145.620 MHz. However, this will only be the case when the 2 m signal is extremely strong.

Of course it would be possible to select a different crystal frequency; this frequency must be lower than 8 MHz, and a disadvantage is that the scale will no longer be proportional.

Since the FM-transmissions from the satellite possess a frequency deviation of 9 kHz, some distortion will occur when using narrow-band amateur FM-receivers. This would be a disadvantage when making weather satellite images, but this converter was not constructed with such applications in mind, but more for monitoring this frequency range.

REFERENCES

(1) T. Bittan: Reception of the METEOSAT Weather Satellite
VHF COMMUNICATIONS 10, Edition 3/1978, pages 169-172

An Up-Converter for Extending the Frequency Range of Signal Generators

by J. M. Noding, LA 8 AK

It is not a new idea to extend the frequency range of a signal generator with the aid of a mixer. A large number of obsolete signal generators are to be found in amateur shacks that do not possess a VHF-range, and even less a UHF-range. If the signal generator signal is converted from HF to VHF or UHF, using a modern Schottky diode ring mixer, it is possible to obtain a very large level range with a good level accuracy over a wide frequency range.

The principle of this method is given in the block diagram **(Figure 1)**. This assumes a signal generator that has a frequency range of up to at least 15 MHz and is extended up to 144 MHz with the aid of a crystal-controlled wideband mixer. The loss of the mixer can be taken from the data sheet as first approximation and be brought to a rounded value with the aid of simple attenuators (e.g. 10 dB).

The switchable attenuator shown in Fig. 1 need only operate at the lower frequency; it is used to extend the level range of the signal generator.

Figure 2 shows the resulting circuit which comprises a crystal oscillator, tripler, and an amplifier which drives the ring mixer via a matching link with approximately 10 mW. A DC-voltmeter can be connected to test-point TP 1 for alignment of the oscillator chain.

The ring mixer type SBL-1 (MCL) used by the author has a conversion loss of 6.2 dB when driven at this level, which is a very typical value. The Pi-attenuator link at the input of 0.8 dB, and one at the output with 3 dB, ensure that the overall loss amounts to 10 dB. Since these ring mixers only achieve their given data with exactly 50 Ω termination at all ports, it is not a bad idea to design the two Pi-attenuator links for higher values – for instance 3.8 dB at the input and 10 dB at the output.

This results in an overall conversion loss of 20 dB, which corresponds to 1/10 of the output voltage read off on the signal generator.

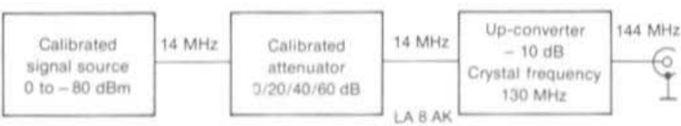


Fig. 1: Using a linear mixer with a high dynamic range to extend the frequency range of a signal generator

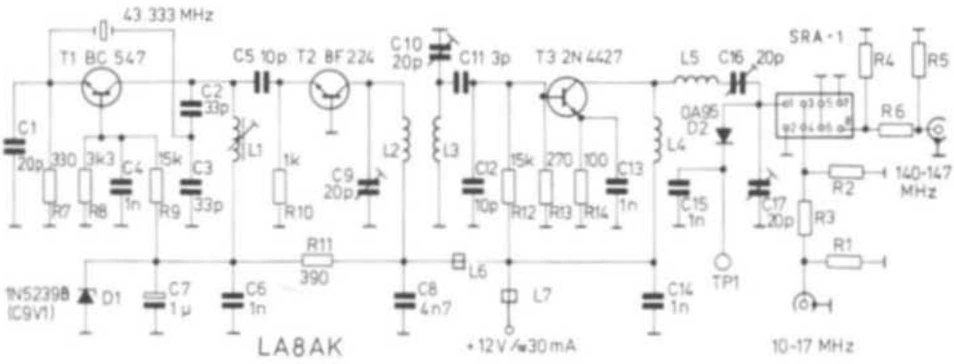


Fig. 2: Recommended circuit for a linear up-converter with suitable oscillator chain

CONSTRUCTION AND COMPONENT DETAILS

The circuit given in **Figure 2** can be accommodated on PC-board DK 1 OF 042 (1). Several circuit details were also taken from this module. Further details about the components and especially the inductances can also be taken from this article.

Since the circuit given in Figure 2 is actually only an example on how such an up-converter can be constructed, complete constructional details are not to be given.

Mainly the inexpensive mixer types such as IE-500, MD-108, SRA-1 or SBL-1 will be used for this application, which means that all frequencies between 5 and 500 MHz can be achieved as long as a suitable oscillator circuit is provided. Such mixers require an oscillator power of 5 to 10 mW for most favorable operation; one should be able to measure approximately 0.6 V at the test-point when using a high-impedance voltmeter. The conversion loss of such mixers is in the order of 5.5 to 7 dB. The exact value is dependent on the frequency, the oscillator level, and on the individual mixer.

The following table gives the required resistance values for the Pi-attenuator links (rounded values):

Attenuation dB	R 1 = R 2 Ω	R 3 Ω
0.8	910	5.6
3.0	300	18
3.8	220	22
6.0	150	39
10.0	100	68

USING THE MIXER AS »WAVE ANALYZER«

The author has also used the described mixer module the other way round, in other words using an oscillator frequency of 143 MHz to convert signals on the 2 m band to an intermediate frequency of 1 to 3 MHz. When using a 20 dB amplifier (e.g. BF 900) at the IF-output (pin 3 and 4), it is possible to drive a cheap oscilloscope, and, for instance, to examine one's own SSB-signal for distortion, or for adjusting the shape of the keying envelope in CW by altering the time constant in the keying line. The latter example shows how a difficult problem can be solved simply.

REFERENCES

(1) J. Kestler: A 29 MHz Transverter for Use with 145 MHz Transceivers VHF COMMUNICATIONS 12, Edition 2/1980, pages 88-95

Spectrum Analyzer for VHF/UHF Amateurs Constructing a Home-Made Universal HF-Module

by E. Berberich, DL 8 ZX

The description of the first spectrum analyzer at the VHF-UHF Convention 1976 in Munich, and in VHF COMMUNICATIONS led to a large number of letters from amateurs that wished to construct such a spectrum analyzer. Unfortunately, the construction difficulties with respect to the RF-input module, and the small frequency range of the first version were not really able to satisfy the demands that were placed on it. The development and construction of a suitable RF-input module is extremely difficult for radio amateurs that do not have access to a large amount of expensive measuring equipment (QRL). For this reason, a new conception was developed that can be realized using conventional modules and components. This new design was described at the VHF-UHF Convention 1980 in Munich and is now to be described in this article.

1. METHOD OF REALIZING THIS AIM

In order to display a wide frequency range at one time, it is necessary to use a high first intermediate frequency (IF) and an oscillator that can be swept electronically over a correspondingly wide range. There are several possibilities of avoiding construction of these critical modules.

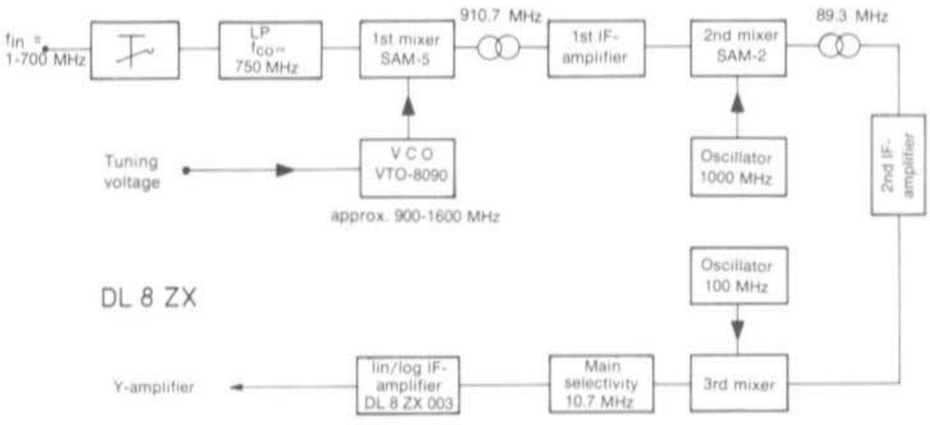


Fig. 1: A spectrum analyzer using professional RF-components

1.1. Use of Industrial RF-Modules

Complete ring mixers for 50 Ω are available on the market that can be used up to very high frequencies. VCO-modules are also available for the VHF to SHF range. The required high-pass and low-pass filters, as well as calibrated attenuators are also available from well-known companies. **Fig.1** shows the use of such components in conjunction with a spectrum analyzer (S.A.). The only, but important disadvantage is the price of these modules, which is usually far more than is available for one's hobby.

1.2. Use of a Cable-TV-Tuner

Special tuners are manufactured for cable television (CATV) that can be tuned continuously from 40 to 300 MHz and operate with a first IF of 600 MHz. CATV-tuners also have good large-signal handling capabilities.

Figure 2 gives the block diagram of a spectrum analyzer using a CATV-Tuner. This SA can cover the frequency range of 0.1 to 40 MHz, and 40 to 300 MHz in two switchable bands. However, it is not easy to obtain such tuners from the service department of the TV-manufacturers, or CATV-companies; presumably, because they think one wishes to tap into their cable system without paying the monthly fees ! For this reason, the author attempted to find a further solution to the problem.

1.3. UHF-TV-Tuner as Tunable First IF-Amplifier

A spectrum analyzer can also be realized using a UHF-tuner from a TV-receiver. Since it is to be used in a measuring system having a high dynamic range, a TV-tuner should be found having large-signal handling capabilities, that does not use a self-excited mixer. A further advantage would be a tunable input circuit and a 75 Ω IF-output.

As far as the author knows, no separate UHF-tuner is manufactured in Germany, but he found a suitable tuner in a Japanese TV-receiver: This used a UHF-tuner using metal-plate chambers with tunable input stage, as well as possessing a separate oscillator and diode mixer. This tuner is readily available in Germany from the service departments of the largest mail-order company.

For those readers that are not able to obtain such a tuner, it is possible that this could be obtained for you in Germany at low cost.

Figure 3 shows the final solution in the form of a block diagram. In order to avoid expensive coaxial switches, each frequency band possesses its own input connector. The range switching is made at the input of the tuner with the aid of PIN-diodes. In order to obtain a constant sensitivity over the whole tuning range, the tuner must have a slightly sloping frequency response.

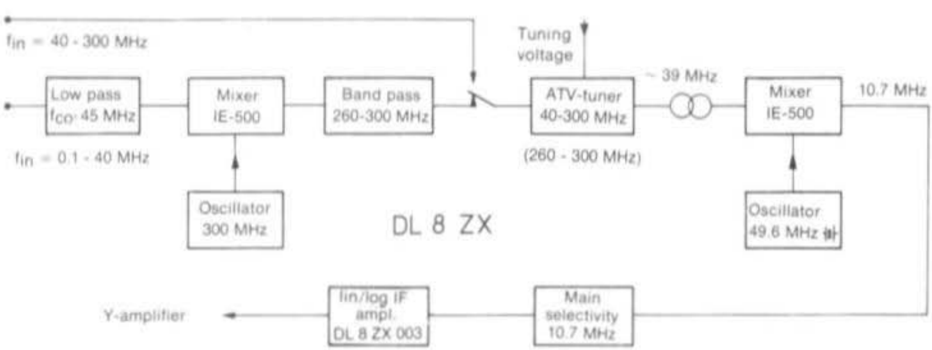


Fig. 2: An amateur spectrum analyzer using a CATV-tuner as tunable 1st IF-amplifier

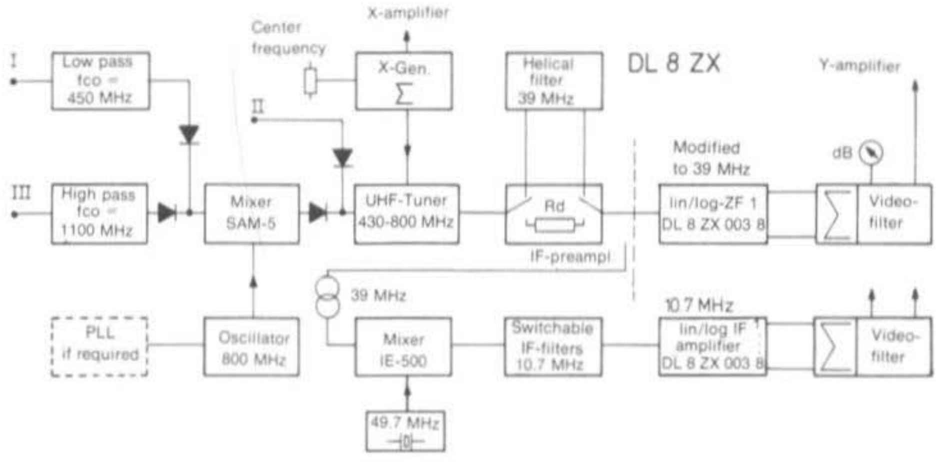


Fig. 3: The final design using a TV-UHF-tuner in the 1st IF

The measuring accuracy is mainly determined by this characteristic.

As can be seen in the block diagram, three frequency ranges of approximately 400 MHz each are obtained in a simple manner: A lower band from approximately 1 MHz (lower cut-off frequency of the mixer used) to 400 MHz (I), the direct tuning range of the tuner from approximately 430 to 800 MHz (II), and finally an upper band (III), representing the image frequency of the lower band, which covers from 1230 to 1600 MHz.

Of course, all UHF-SHF-constructors will have noticed that the most important frequency range in the order of 1150 MHz, which is used as local-oscillator frequency for virtually all microwave amateur bands, is not covered. For this reason, the 800 MHz oscillator is designed to be tunable from 710 to 800 MHz. This means that it is possible to shift the frequency range somewhat when the mixer is used (premix-operation). This first local oscillator could be locked to a 72 MHz crystal oscillator using a PLL-circuit in conjunction with a switchable divider (by ten or by eleven). If narrow-

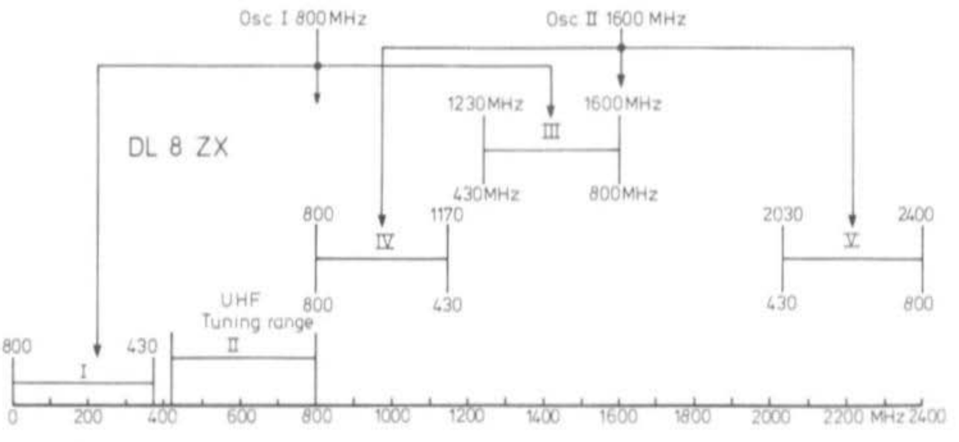


Fig. 4: Frequency plan for the final spectrum analyzer shown in Fig. 3

band filters are used in the first IF, these measures are absolutely necessary for suppressing the interference deviation.

Figure 4 shows a frequency plan which allows two further frequency ranges to be obtained using a second local oscillator. These ranges (IV) and (V) have still not been realized by the author.

2. THE FINAL CIRCUIT

As has already been mentioned, the spectrum is to be constructed as given in Fig. 3. Further details are now to be given regarding various modules.

2.1. Input Low-pass Filter for Range I

The low-pass filter for 450 MHz is constructed in a metal-plate case of 37 mm x 111 mm. The inductances **(Figure 5)** consist of so-called Z-strips manufactured by Minimount. These self-adhesive epoxy-glass fibre strips with copper coating are available in approximately 100 mm length for the various impedances (50 Ω, 60 Ω, 75 Ω, and 100 Ω). Defined inductances can be manufactured using these strips and the following inductance values were calculated for the various stripline widths (impedances):

50 Ω: 3.9 nH;	60 Ω: 4.7 nH;
75 Ω: 5.8 nH;	100 Ω: 7.8 nH.

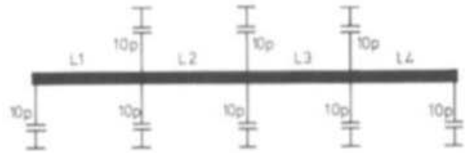


Fig. 5:
A low-pass filter for range I
L 1 - L 4: each 35 mm long, 100 Ω stripline manufactured by Minimount

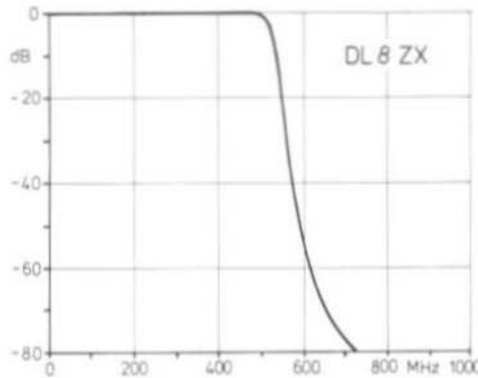


Fig. 6:
Characteristic of the low-pass filter given in Fig. 5

Of course, these values are only present when the striplines are glued to a metal surface. The 100 Ω line was selected for the low-pass filter in order to obtain the smallest possible construction. The measured attenuation curve is given in **Figure 6.**

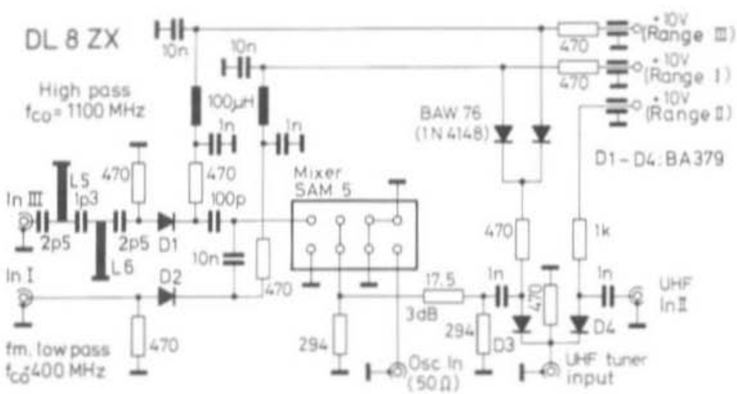


Fig. 7:
Premixer module with SHF high-pass filter and PIN-diode switch

2.2. 1100 MHz High-Pass Filter and Mixer

The SHF high-pass filter, PIN-diode switch, ring mixer, and a 3 dB attenuator for the IF-output are combined as shown in **Fig. 7** to form a »premixer« module. The high-pass inductances L 5 and L 6 have an inductance of 4 nH and have been constructed in printed technology.

The arrangement of the components is very critical in this module if the cross-talk between the three channels is to be kept to a low value. For this reason, a premixer-board was developed that may be described later.

2.3. Oscillator Module

The local oscillator frequency of 710 to 800 MHz is firstly generated in a free-running oscillator as shown in **Figure 8**. The resonant circuit inductance L 2 comprises a 3 cm long piece of 1.5 mm dia. silver-plated copper wire. A varactor diode type BB 105 is coupled to this line and used for tuning.

The oscillator drives into an aperiodic buffer with feedback, and a 3-stage low-pass filter. The filter is constructed in the same manner as the input low-pass filter for range I; inductances L 7, L 8, and L 9 are a single piece of 100 Ω stripline onto which the capacitors are soldered with a spacing of 17 mm each.

2.4. IF-Amplifier and Selectivity

The first IF of 39 MHz provided by the tuner is too low to obtain a high image rejection. For this reason, the dynamic range of the indicator was limited to 80 dB. This means that only 8 stages of the linear/logarithmic IF-amplifier DL 8 ZX 003 (VHF COMMUNICATIONS 2/1977) are used.

In the case of the author's prototype, the conversion to 10.7 MHz was not used in order to avoid unwanted reception points. When using an optimum construction, however, it is possible for double conversion to be realized satisfactorily in order to improve selectivity. The advantages of these measures were discussed in the previous publication, as well as in (3).

In the case of the author's prototype, only the selectivity of the 39 MHz-circuits is effective. The resulting overall bandwidth of approximately 600 kHz is too wide for narrow-band displays. Unfortunately, no commercially available crystal filters are known for a frequency of 39 MHz; crystal filters are available for 35.4 MHz / B = 8 kHz (Philips), 41 MHz / B = 7 kHz (Toyocom), but are too far from the required frequency of 39 MHz.

For this reason, the author calculated and constructed a helical bandpass filter for 39 MHz for the prototype system. Low-capacitance relays are used to switch this filter into the signal path when required (Fig. 3).

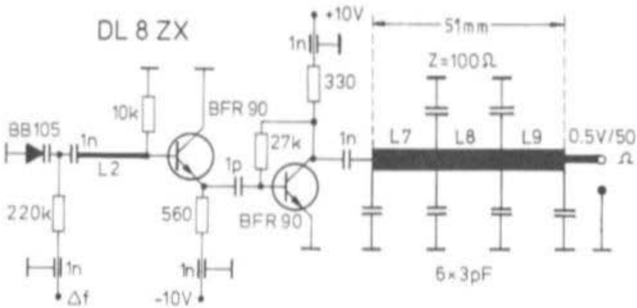


Fig. 8:
An 800 MHz VCO

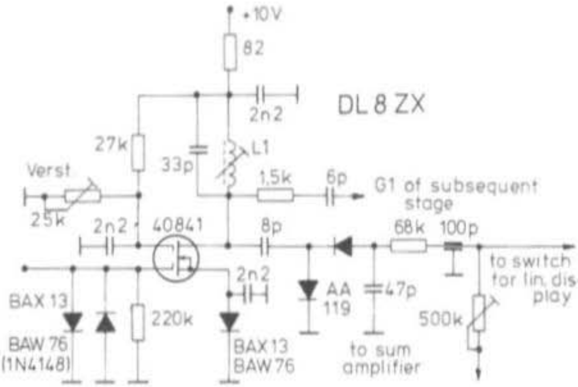


Fig. 9: The IF-stages of module DL 8 ZX 003 are modified for 39 MHz

Fig. 9 shows one stage of the IF-amplifier DL 8 ZX 003 which has been modified for 39 MHz. Inductance L 1 consists of 11 turns of 0.4 mm dia. cotton-covered, enamelled copper wire, wound on a 4.3 mm coil former with violet core. If the inductances are enclosed in cans that are not too small, it is possible for the screening panels between the individual stages to be deleted.

A short description of the linear/logarithmic IF-amplifier is now to be given, since it forms the heart of the spectrum analyzer.

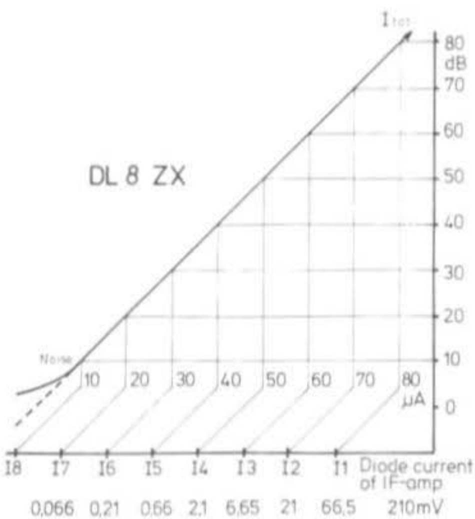


Fig. 10: Development of the logarithmic scale

In order to obtain a dB-linear (in other words a logarithmic) scale over a large dynamic range, it is possible to use a so-called successive rectifier amplifier. It consists of several identical amplifier stages with a built-in rectifier. The amplifiers are connected in series and are adjusted for 10 dB per stage. A stage with an input impedance in the order of zero Ω adds the rectifier currents and passes them on to the Y-amplifier of an oscilloscope. **Figure 10** shows the development of the virtually ideal dB-linear scale.

A voltage-linear display is also possible and this is the reason for the designation: linear/logarithmic amplifier. This can be selected with switch S 1 **(Figure 11)** to find the amplifier stage 2 to 9 that is still operating in its linear range, according to the input level.

The impedance converter (LM 324) is followed by an active low-pass filter with variable bandwidth, equipped with a compensated operational amplifier type L 141 for stability reasons. A meter is also connected here for reading off the amplitude value of an individual spectral line, which is usually more accurate than when using an oscilloscope.

2.5. IF-Preamplifier

The diode mixer used in the UHF-tuner has quite a good large-signal handling capability, but exhibits a conversion loss. For

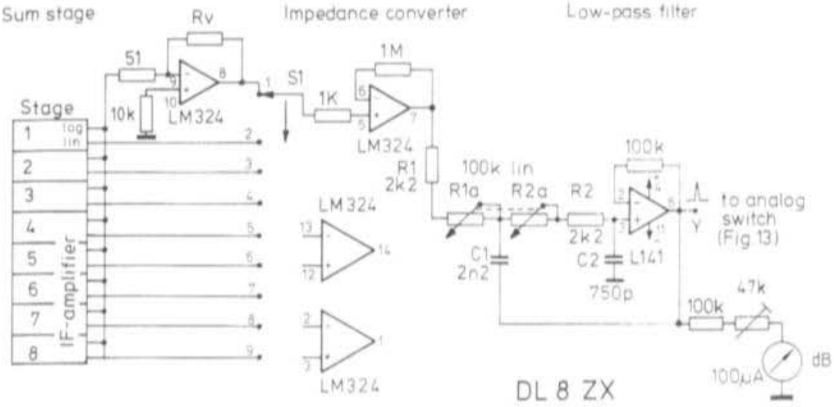


Fig. 11: Generation of the Y-signal and indicator circuit

this reason, a low-noise preamplifier as shown in **Figure 12** is connected in front of the linear/logarithmic IF-amplifier.

An additional filter can be connected at the output of this amplifier for improving selectivity. If the filter is bridged, resistor R_d is provided to compensate for the conversion loss of this filter in the passband range. In this manner it is possible to adjust the overall gain to be the same in every operating mode.

This circuit is also able to compensate for gain fluctuations during premix-operation by altering the G 2-voltage. Trimmer resistors are provided for this, which are switched with a further wafer of switch S 2. All inductances are wound on 4.3 mm dia. coil formers with violet cores.

2.6. Deflection Module

Since most oscilloscopes do not have an output for sawtooth voltage, the deflection voltage is generated in the spectrum analyzer. Specialists can thus use an additional possibility of equalizing the tuning voltage for frequency-linear display on the X-axis.

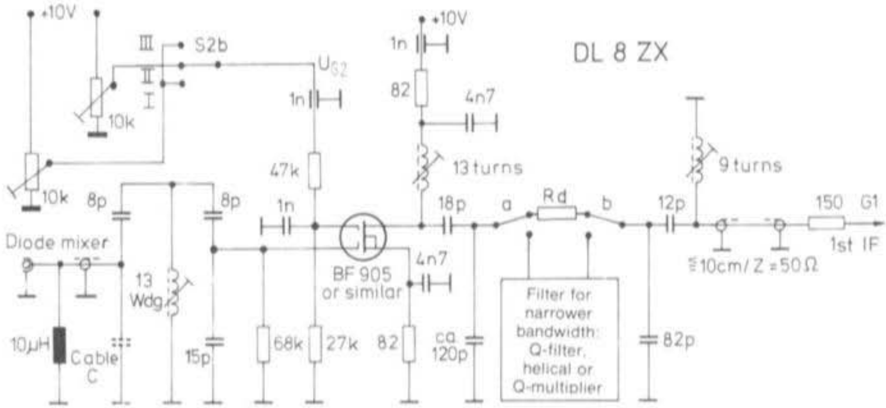


Fig. 12: IF-preamplifier for 39 MHz

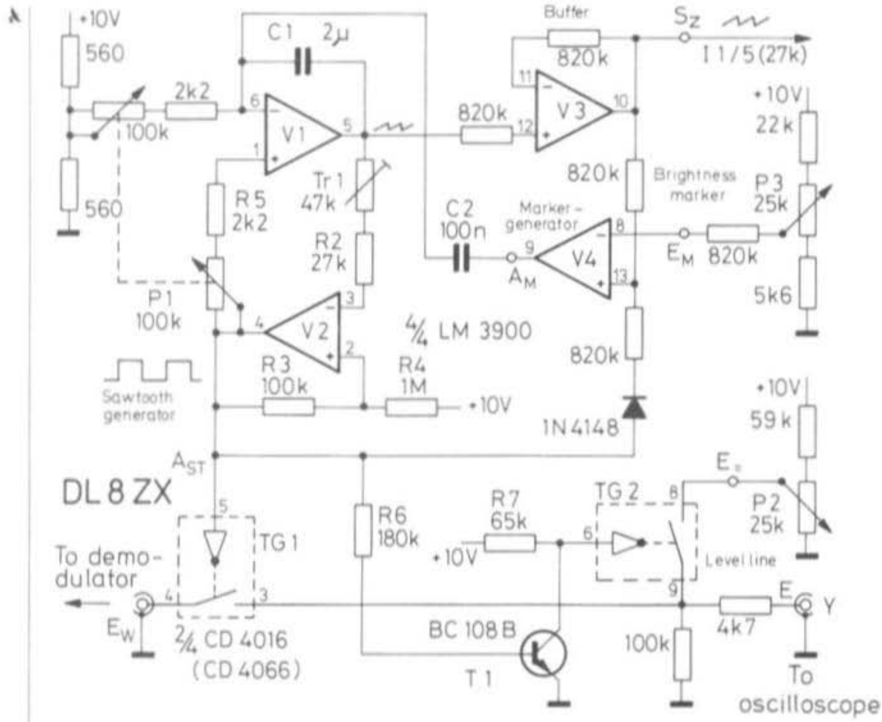


Fig. 13: Sawtooth generator for the X-deflection

The author used a deflection module as described in (2), that was modified so that the X-deflection frequency is continuously variable **(Figure 13)**. This is made with the tandem-potentiometer P 1. This adjustability is required for matching to the transcient behaviour of different IF-filters.

The deflection module also generates an Y-level line, as well as a brightness-marker on the X-axis. The oscilloscope used must, however, possess DC-coupled X and Y-amplifiers due to the slow processes present.

The description given in (2) described a suitable layout for this circuit.

The further processing of the X-deflection voltage, as well as the generation of the tuning voltage for the UHF-tuner is given in **Figure 14**. It should be mentioned that the tuning voltage must be extremely free of noise and hum voltages, since 60 mV will already cause a frequency shift of 1 MHz.

3. CONSTRUCTION DETAILS

All modules should be constructed in metal-plate cases, and all DC and audio-frequency voltages should be fed via feed-through capacitors in order to achieve that every module is RF-tight. All modules are then accommodated in a common metal case, whose dimensions are sufficiently large so that any interaction between the modules can be compensated for by changing the position of that module in the case. A large number of very strong transmitters (SW, VHF-broadcasting, TV) are to be found in this wide frequency range, and it is necessary to ensure that these are not introduced into the system. It is also necessary to provide a power-line filter, but this is only of advantage when the rest of the case is RF-tight.

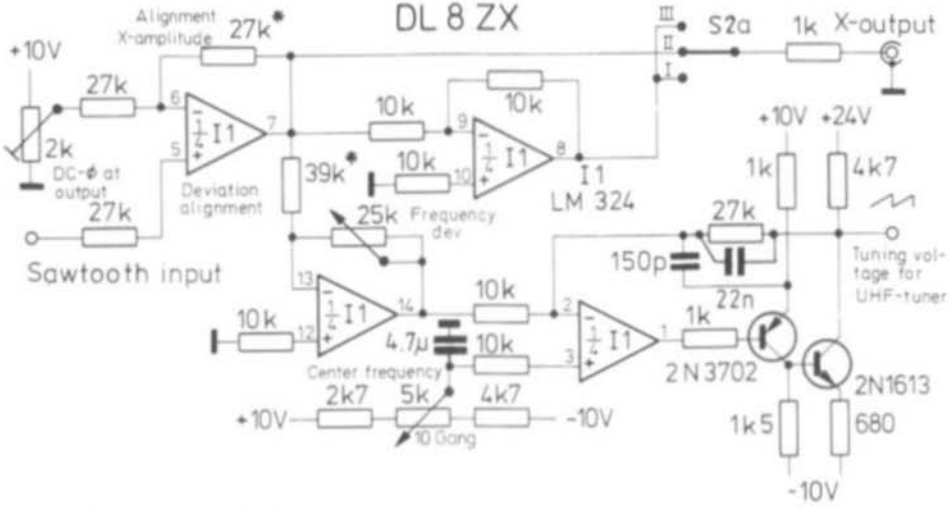


Fig. 14: Generation of the X-deflection and tuning voltage for the UHF-tuner

4. SENSITIVITY, CALIBRATION

The author's prototype was designed for a maximum input voltage of 30 mV for full-scale indication (frequency range II). The two premixer-ranges I and III exhibit an additional attenuation of approximately 10 dB, which limits the dynamic range to 70 dB. This loss was compensated for – within limits – by using an IF-preamplifier (see 2.5.) whose gain was variable. Fixed attenuator-links or a built-in calibrated attenuator can be used for attenuating higher input levels. Such attenuators are available commercially from approx. DM 350.—.

When the frequency deviation is switched off, it is possible to use the spectrum analyzer as measuring receiver; in this case, the VCO can be swept manually using a potentiometer. The built-in meter then indicates the level. Since the spectrum analyzer operates in a dB-linear manner, the meter will not require a special calibration.

The modulation of radio signals can be monitored using suitable demodulators connected to the IF-output.

Finally, it is possible to provide a frequency marker for the frequency axis, which is loosely coupled to the input. For instance, the calibration spectrum generator described by DC 6 HY would be suitable for this.

The spectrum analyzer could be extended by a number of further possibilities that allow this system to be extended to form a versatile and inexpensive measuring system for radio amateurs. Of course, it is not able to compete with expensive, professional analyzers.

The author and the publishers would like to hear your views on improving or simplifying construction, and on any additions that come to mind.

5. REFERENCES

(1) E. Berberich, DL 8 ZX: A Spectrum Analyzer for Amateur Applications VHF COMMUNICATIONS 9, Edition 2/1977, pages,109-120

(2) M. Arnoldt: Erzeugung von Spektrumdarstellungen im UKW-Bereich Funkschau 1977, Edition 11, page 489

(3) Dr. Ing. W. Schmitz: Spektrum-Analysatoren Elektronik-Industrie, Edition 12/1979, and 1/1980

A Home-Made Reflectometer for VHF and UHF Applications Manufactured from Readily Available Plumbing Material

by H. C. Als, DC 4 IQ

There are a number of cheap reflectometers on the market for HF that can be used with some reservations at 144 MHz. There are also a number of expensive UHF reflectometers. However, there seems little between these two extremes. For this reason, the author is to describe a good reflectometer that can be home-constructed using copper tubes that are readily available at plumbers and hardware shops.

No lathing, or special skill is required. It is suitable for use in the frequency range from 2 m to 23 cm. Its intrinsic standing wave ratio was measured in the laboratories of VHF COMMUNICATIONS for the following amateur bands:

Frequency	Return loss	VSWR
145 MHz	33 dB	1.05
432 MHz	30 dB	1.07
1296 MHz	26 dB	1.11

Inspiration came from ARRL publications (Antenna Handbook and VHF Manual), in which a reflectometer was described using such plumbing material, as well as ideas for making the demodulator probes from the RSGB (VHF/UHF Manual). However, these dimensions were given in inches, which caused some problems. In order to obtain an impedance of 50 Ω, one requires

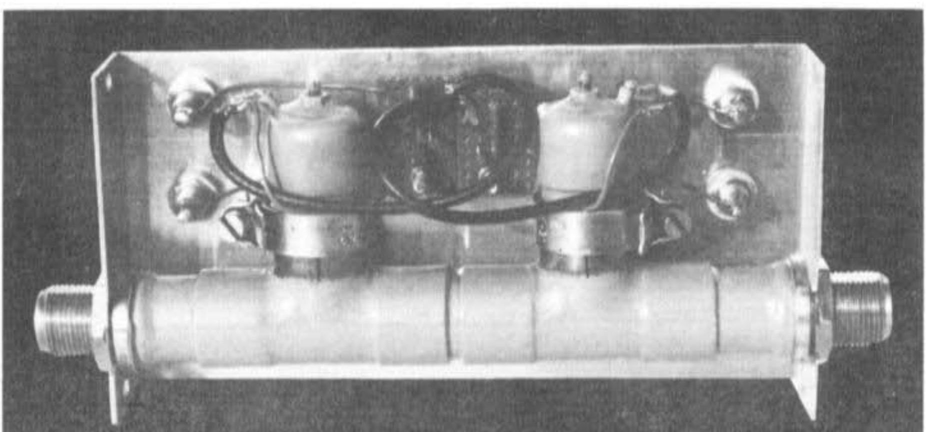


Fig. 1: VHF-UHF reflectometer (diodes mounted outside of the probed for experimental purposes)

a diameter ratio between outer and inner conductor of D/d = 2.3; it is necessary to do some calculations to find the correct tubes from the available standard material.

As can be seen in **Figure 1**, the solution was found when using 18 mm diameter copper tube with the matching T-pieces and covers. This standard material possesses an inner diameter of 16 mm; when using a brass tube of 7 mm outer diameter as inner conductor, the impedance Z can be calculated as follows:

$$Z = 60 \ln D/d = 60 \ln 16/7 = 49.60\ \Omega$$

CONSTRUCTION

As can be seen in **Figure 2**, the reflectometer is 140 mm long from flange to flange. This means that it can be mounted in a TEKO box size 4 A. If a larger box is available, it is possible for the outer 18 mm diameter tubes to be made longer, without affecting the characteristics of the reflectometer. The directivity and coupling attenuation are dependent on the shape and spacing of the coupling links in the demodulator probes.

Required Components

150 mm long, 18 mm dia. copper tube
2 pieces T-pieces, 18 mm, copper
2 pieces cover, 18 mm copper
2 pieces N-connectors (50 Ω), single-hole mounting
Brass tube: 4 mm outer diameter, 3.0 to 3.2 mm inner diameter, approx. 130 - 140 mm long
(Tube: 5 mm outer diameter, 4.0 to 4.2 mm inner diameter, approx. 120 mm long)
Brass tube: 7 mm outer diameter, 5.2 mm inner diameter, approx. 130 mm long
Threaded rod, brass, M 3, approx. 80 to 90 mm long
2 pieces threaded bushings, M 3, approx. 5 mm long
2 pieces feedthrough capacitors, approx. 1 nF for solder mounting
2 pieces Schottky diodes hp 2800, or similar
2 pieces resistors 51 Ω (if not available, 47 or 56 Ω), low inductivity
Various small components such as washers, and nuts.

The inner conductor of the reflectometer should possess 7 mm diameter. However, in order to mount this to the short N-connector, an additional 4 mm diameter tube is provided inside the main inner conductor. Since all N-connectors are not exactly identical, it is not possible to give the exact length for these tubes. The exact length

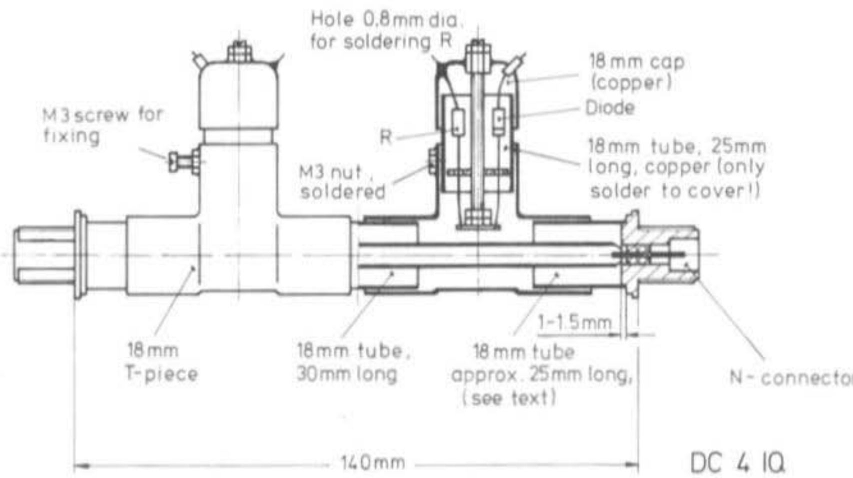


Fig. 2: Construction and dimensions of the reflectometer

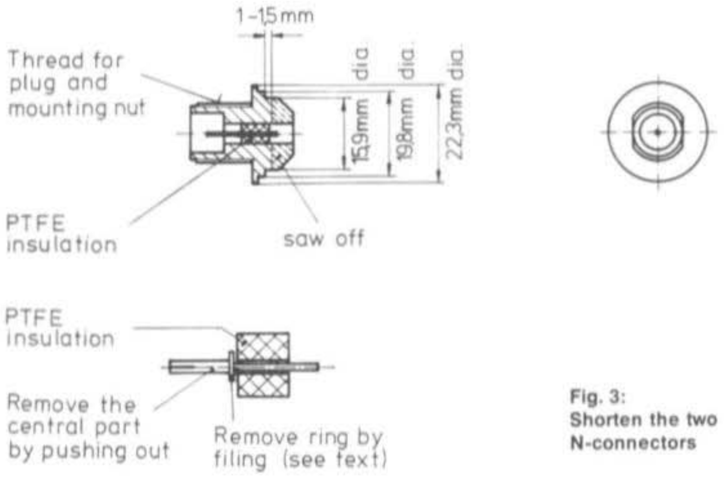
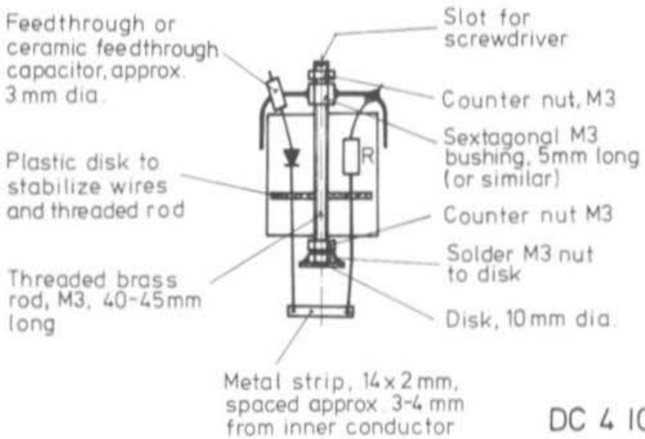


Fig. 3: Shorten the two N-connectors

can be determined by taking the overall length of 140 mm and deducting the length of the PTFE part of the connectors from the flange up to the inner conductor.

Figure 3 shows the preparation of the connectors. The center pins of the two connectors are soldered into the 4 mm tube which has been slotted to allow a better fitting. Attention should be paid that the center pins are fixed in the correct position until the soldering process has been completed. The collars around the center pins must then be filed down somewhat so that the PTFE part and the outside of the connector can be pushed on from the outside during the mounting process.

The 7 mm tube is also slotted at both ends (make four slots of 5 mm in length), after which it is filed down conically. It is then placed over the 4 mm tube and center pins and soldered into place centrically. In order to ensure that the 7 mm tube is placed concentrically on the 4 mm tube, it is possible to insert the 5 mm tube given in brackets in the parts list. The material used for this auxiliary tube is unimportant since no HF-field is present within the 7 mm tube. Finally, the transition from the 7 mm tube to the center pins of the sockets should be filed conically.



DC 4 IQ

Fig. 4: Construction of the demodulator probes

The next step is the construction of the outer conductor by cutting the 18 mm diameter tube into the pieces shown in **Fig. 2.** After this, they are plugged together with the T-pieces, and the length is adjusted by temporarily placing the prepared N-connectors into place. If everything fits, the individual parts can be soldered together. Soft soldering has been found satisfactory.

The next step is to place one of the N-connectors on the prepared inner-conductor system, pass the inner conductor into the outer conductor, after which the other connector is inserted into place. After ensuring, that everything fits correctly, the whole assembly should be held in a vertical position, after which the lower connector is soldered into place. The reflectometer is then turned around by 180°, after which the other connector is also soldered into place. This process is to ensure that no solder can fall into the reflectometer.

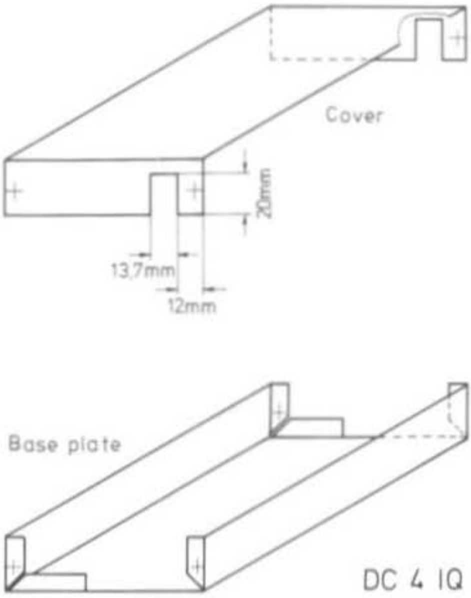


Fig. 5: Preparation of the TEKO-box A 4

The demodulator probes should now be made as shown in **Figure 4**. The piece of 18 mm tubing is now soldered to the cover, but not to the reflectometer (T-piece). This must remain adjustable and can be fixed later using a screw (solder a nut around the hole in the T-piece, as indicated in Fig. 4), or by using a clamp (see photograph), after sawing a slot in the T-piece. This type of construction allows adjustment of the diode probes, and also the exchange of any defective components.

A disk of 10 mm diameter is provided at the end of the M 3 threaded rods. The task of this is to reduce the aperture in the T-piece so that any interference to the homogenity of the coaxial construction is kept to a minimum. Both probes are aligned later by sliding within the T-piece, and by adjusting the disk in order to provide the same voltage with a given, constant power. This is made by setting the first probe, turning the reflector around and adjusting the second.

Figure 5 shows the preparation of the TEKO-box for installation of the reflectometer. As can be seen in the photograph given in Figure 1, the indication is separate and can be connected using suitable connectors. The photograph also shows that the author has mounted the diodes and their bypass capacitors on a piece of Vero board mounted between the demodulator probes and that these are fed with coaxial cable. This type of construction was used only for experimenting with various diodes, and is not to be recommended for construction of the reflectometer.

Editorial Note:

Not only the given Schottky diodes are suitable for this application, but also germanium diodes such as AA 138 or – even better – point contact diodes such as the well-known 1 N 21. Further information on the selection of the diodes, calibration of a reflectometer, and on this measuring technology was given in the following article:

Tiefenthaler, OE 5 THL, and Rößle, DJ 1 JZ: A Precision Reflectometer for VHF and UHF Applications with an Impedance of 50 Ω
VHF COMMUNICATIONS 6, Edition 1/1974 pages 2 - 17.

A Simple Two-Band Omnidirectional Antenna for 2 m and 70 cm

by K. J. Schöpf, DB 3 TB

Vertical polarized, omnidirectional antennas are very popular on the 2 m and 70 cm band for FM-communication via repeaters, and in conjunction with mobile stations. The advantage is that no rotator is required.

Unfortunately, each mast tube only possesses one end for mounting such antennas, which means that only one such antenna can be mounted. The other antenna would then have to be mounted on the side of the mast, which will cause a considerable distortion of the omnidirectional characteristic. In order to avoid this, the author attempted to find some way to combine an antenna for the 2 m and 70 cm bands so that they could be used independently from another, but still represent an optimum for each of these bands.

The basic form of the antenna is a $\lambda/2$-fed dipole, which has the advantage of a low angle of radiation, and does not require the use of radials.

MANUFACTURE

The antenna can be constructed simply from brass or copper tubes that are readily available in model and hardware shops.

MATERIAL

Brass or copper, where not otherwise given. All dimensions are given in mm.

The 70 cm J-antenna (parts 1-5) and the 2 m coaxial part (6-9) are firstly assembled, but not soldered together. After alignment, the soldering should be made with a 100 W soldering iron in order to avoid »dry« joints.

Approximately 1 m outer insulation is removed from a coaxial cable type RG-58/U. This coaxial cable is then passed through the lower (2 m) radiator (part 6), and is used as feeder for the 70 cm J-antenna, and is soldered into place according to the drawing.

Part	Type	Outer dia.	Inner dia.	Length
1	Tube/rod	4 mm	–	320 mm
2	Tube	6 mm	4 mm	120 mm
3	Tube	7 mm	6 mm	250 mm
4	Tube/rod	4 mm	–	181 mm
5	Plate 0.5 - 1 mm thick, 20 mm wide, approx. 60 mm long			
6	Tube	6 mm	4 mm	920 mm
7	Plastic, 6 mm inner dia., approx. 10 mm thick. Outer dimensions to fit part 8. Can be made, for instance, from epoxy glass fibre.			
8	Tube: Wall thickness	1-2 mm	18-25 mm	505 mm
9	Disk, 6 mm inner dia. Outer dimensions to fit part 8, up to 5 mm thick. Can be cut from minimum 2 mm plate. Coaxial cable type RG-58/U, min. 1.5 m			

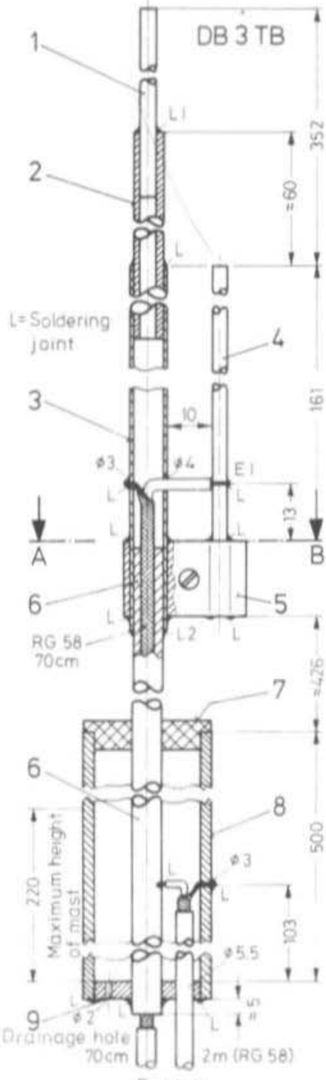


Fig. 1: A combined omnidirectional antenna for 2 m and 70 cm (not to scale)

A - B

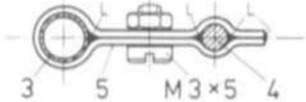


Fig. 1a: Cross section A - B

ALIGNMENT

The 70 cm J-antenna is placed temporarily on part 6 and built up as far as possible from other metal surfaces. A VSWR-meter is now connected in the feeder to the 70 cm transceiver and the antenna aligned for most favorable standing-wave-ratio by altering the length of part 1 (solder joint L 1). It may be necessary to change feed-point E 1 when using tubes of different diameters.

After successfully aligning the 70 cm antenna, the VSWR-meter is then placed in the 2 m feeder and the 2 m coaxial antenna is aligned by altering the length of part 6 (solder joint L 2) for most favorable standing wave ratio.

Caution must be paid with standing wave meters only possessing one meter:

A minimum return power indication does not always mean best VSWR, since the forward power can also be reduced under extreme mismatch conditions. For this reason, it is necessary for the forward power to also be monitored. A VSWR of 1.5 or less is completely satisfactory, since this represents an efficiency of 96 %; (9.6 W will be radiated, for instance, in the case of 10 W transmit power into the antenna). Even a VSWR of 2 (η = 89 %) is still satisfactory.

The length of the feeder cable to the antenna is far more important, since RG-58/U already possesses an attenuation of approximately 50 dB loss per 100 m at 450 MHz. It is therefore advisable to keep the RG 58/U cable as short as possible, and for the feeder to be extended using RG-213/U cable.

The antenna can be mounted to the mast with the aid of tubular clamps. It is advisable for the antenna to be protected against corrosion in some manner.

REFERENCES

K. Rothammel, DM 2 ABK:
Antenna Book, Franckh'sche Verlagsbuchhandlung Stuttgart

Krauss: Antennas; McGraw-Hill Verlag New York/London

An »OSCAR« Piptone-Generator, BK-Operation and Sidetone for the IC-202, IC-402 and IC-245

by E. Lautenbacher, DC 5 NN

Many of our readers will have noticed the somewhat complicated two-hand operation required during CW-operation with transceivers IC-202, IC-402, and IC-245. This was the reason why the author developed the following circuits:

- **Piptone generator for SSB**
- **BK-operation in CW (automatic transmit-receive switching on keying)**
- **Sidetone when operating CW (for IC-202 and IC-245 not equipped for this).**

There is very little room for mounting such accessories in these units, which means that the dimensions must be kept as small as possible.

CIRCUIT DESCRIPTION

The audio generator is in the form of a phase-shift generator (see **Figure 1**). The circuit is identical to that provided in the IC-202 S and therefore need not be described in detail here. A reduction of the value of R 1 - R 3, or C 1 - C 3 will increase the frequency, and vice versa.

The transmit-receive switching, and piptone generator **(Figure 2)** consist of a monostable stage and four switching stages. All transistors have only two states: On or off.

In the receive mode, Pt 2 will be at high impedance, T 4 will conduct, T 2 will be blocked, T 1 will conduct, and T 3 will be blocked. This means that Pt 8 will be at high impedance (original transmit-receive or PTT-contact).

In the transmit mode with key or PTT-button depressed, Pt 2 will be grounded, T 4 will be switched off, T 2 will conduct, T 1 will be switched off and T 3 will conduct. This occurs immediately, and Pt 8 will be at ground potential.

Switching from transmit to receive:

After opening Pt 2, the monoflop will return to the receive mode after charging C 1 via R 3 (time constant approx. 0.69 x R x C). This means that the transmitter will remain in the transmit mode for a short period after releasing the key. Nothing further happens in the CW-mode.

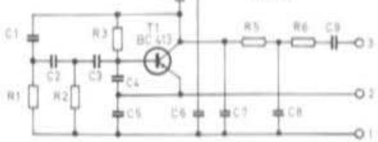


Fig. 1: Tone generator

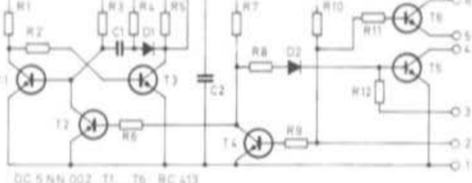


Fig. 2: BK »Piptone« control circuit

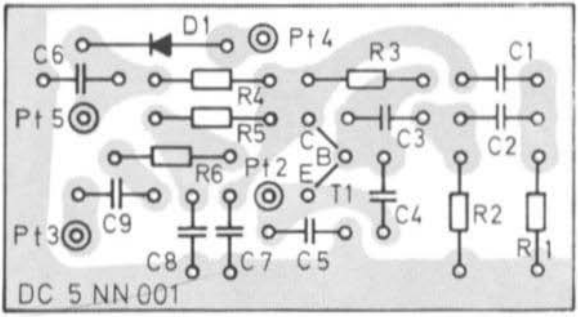


Fig. 3: PC-board DC 5 NN 001 (Fig. 1)

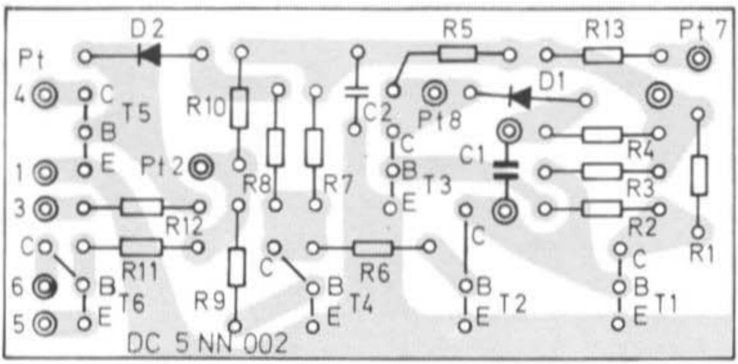


Fig. 4: PC-board DC 5 NN 002 (Fig. 2)

In the SSB-mode, however, T 6 will conduct after releasing the PTT-button and will switch 9 V from Tx + SSB to the tone generator. This is connected via a resistor of approx. 1 MΩ and 1 nF to the input of the transmit modulator (pin 2 of the AF-IC). The keying line is grounded by T 5. This means that the pip generator is active until the monoflop returns to the receive mode. If a shorter tone is required (a somewhat longer time constant is required in the CW-mode), it is possible for an additional resistor (approx. 27 kΩ) to be connected via a diode from the Tx + SSB connection.

CONSTRUCTION

The two circuits can be constructed using a single-coated PC-board.

Figure 3 shows the small 37.5 mm x 20 mm PC-board for the tone generator (DC 5 NN 001), and **Figure 4** the PC-board for the transmit-receive switching (DC 5 NN 002), whose dimensions are 47.5 mm x 22.5 mm. The holes in the boards should be a maximum of 1 mm diameter, since miniature components are used exclusively in the construction of these circuits. The capacitors are ceramic types for 16 V having a spacing of 5 mm. The transistors are bent over so that the flat side of their plastic cases touches the PC-board. Capacitor C 1 of module DC 5 NN 002 is connected with the aid of two wires (see **Figure 5**) and can be located at a suitable position in the transceiver; in the case of the IC-202/402 this can be behind the LED.

The PC-boards are mounted with the components facing downwards. It is advisable

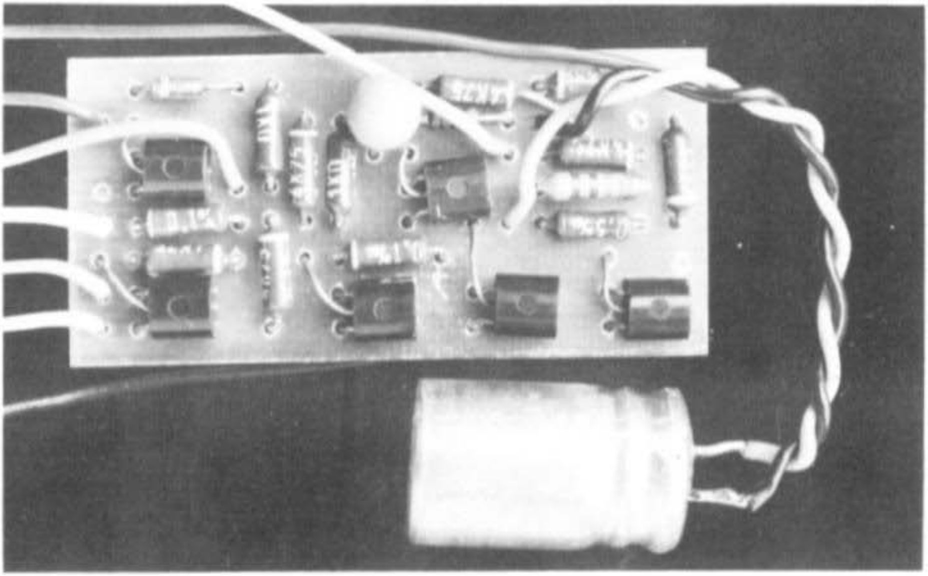


Fig. 5: Photograph of the author's prototype module DC 5 NN 002

to provide a plastic foil between the boards and the other components, and to glue plastic foil to the inner side of the metal cover.

REQUIRED PARTS

Tone Generator:

R 1, R 2, R 4:	4 k 7
R 3:	560 k
R 5, R 6:	22 k
C 1, C 2, C 3:	10 nF
C 4, C 7:	47 pF
C 5, C 6:	470 pF
C 8:	3.3 nF
C 9:	10 nF
T 1:	BC 109, BC 413 or similar
D 1:	1 N 4148, 1 N 4151 or similar

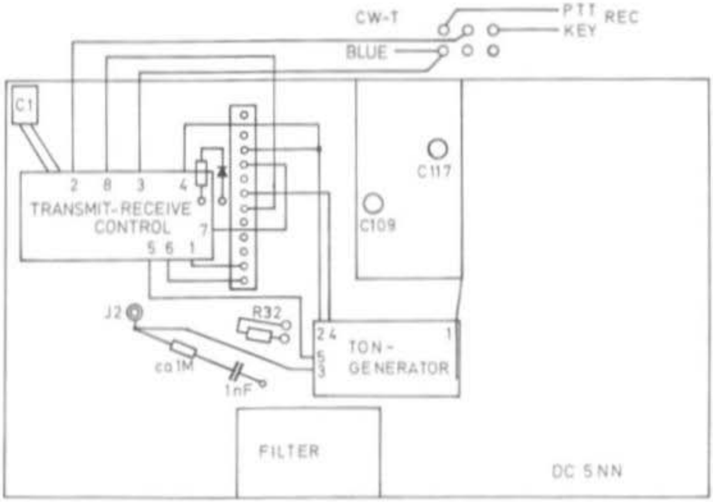


Fig. 6: Wiring plan for the two accessory modules

BK-Circuit

R 1, R 4, R 5, R 6, R 8, R 9, R 11, R 12:	4 k 7
R 2:	10 k
R 3:	15 k
R 3':	approx. 27 k
R 7, R 10:	1 k
R 13:	82 Ω
C 1:	330 μF
C 2:	10 μF
T 1 - T 6:	BC 168, BC 413 or similar
D 1, D 2:	1 N 4148, 1 N 4151 or similar

MODIFICATION OF THE IC-202 FOR SIDETONE OPERATION

Remove C 109 and C 117. Unsolder R 32 from the emitter of Q 14, and solder to R 62 on the neighbouring PC-board; in other words to W 2 (brown lead).

Connect the tone generator:

Pt 1 to ground using a 1 mm wire to the screening of transmit mixer and driver.

Solder Pt 2 to »KEY« (3); Pt 3 to »J 2« or R 31, and Pt 4 to »CW T +« (6) (connector strip).

The sidetone should be audible when depressing the CW-key in the CW-T position.

INSTALLATION OF THE PIPTONE GENERATOR IN THE IC-202

Connect a diode in series with R 68. Remove the black, the two grey, and the two green leads from the CW-T/REC switch. Delete the black lead (ground). Also remove the grey and green leads that lead to the connector strip. The wiring is then made as shown in **Figure 6**.

For those readers that have difficulties in installing these units, further details can be obtained from the author for installation in the IC-202, IC-202 S, and IC-402.

Local Oscillator, Transmit Mixer, and Linear Amplifier for the 9 cm Band

by H.J. Senckel, DF 5 QZ

Disk-seal triodes such as the YD 1060 and 2 C 39 are just still suitable for use in the 9 cm band, where a frequency range of 3456 to 3458 MHz is reserved for narrow-band communications. The following article is to describe a three-stage transverter equipped with such tubes, of which one is used as mixer, and the other two as linear amplifiers. This can provide an output power of approximately 5 W (single tone). The author has been active with this station on 9 cm SSB.

Figure 1 shows a block diagram of the complete transmit-receive converter for the 9 cm band. The well-known interdigital-filter converter described in (1) by J. Dahms is used as receive converter. The local oscillator module comprises the following four modules:

- A crystal-controlled module DC 0 DA 005 (2), but without transistor T 6 and without the multiplier diode. This means that an output power of approximately 100 mW is available at 384 MHz;
- A modified power amplifier DJ 3 SC 001 (3), equipped with a transistor type C 12-12 in the output;
- A varactor tripler as described by DK 1 PN (4) using the base-emitter diode of a 2 N 3375;

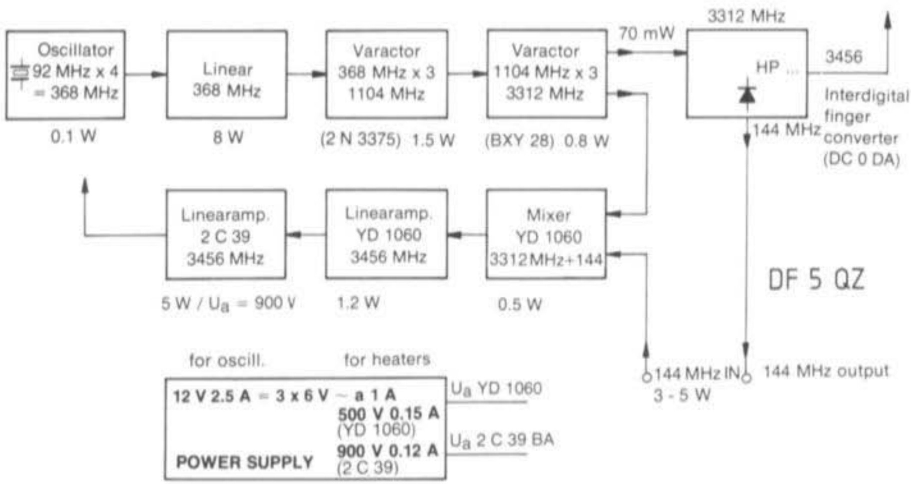


Fig. 1: Block diagram of the 3456 MHz transverter

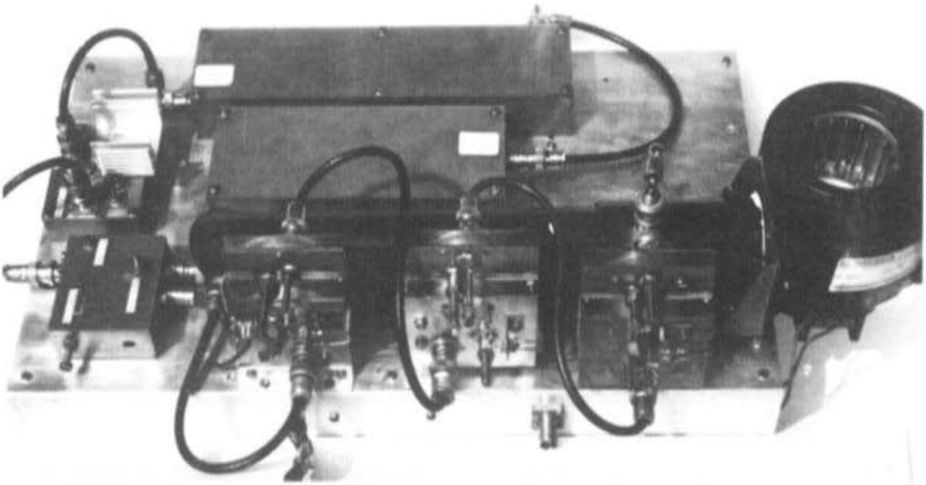


Fig. 2: Prototype of the transmit-receive converter including local oscillator (rear), varactor multipliers (left), mixer (front row, left), and the two linear amplifiers (front row, center and right)

- As well as a further tripler which is to be described in more detail in this article. This tripler possesses an output for the receive and transmit mixers.

The photograph in **Figure 2** shows how this local oscillator module is combined with the mixer and linear amplifier stages on a common chassis. The three tube-equipped stages are arranged so that they can be cooled using a single radial blower. The receive converter is accommodated elsewhere. The output stage of the transverter is to be found on the right-hand side near to the blower; a 6 W lamp is used in the photograph as »dummy-load«.

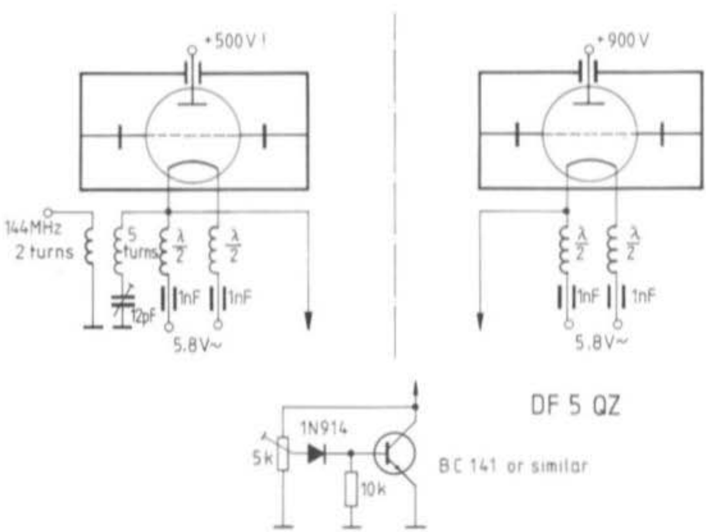


Fig. 3: Circuit diagram of the mixer (left) and linear amplifier stages (right), as well as the bias two-pole

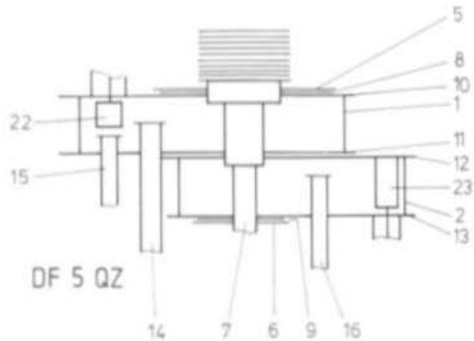


Fig. 4: Construction of mixer and linear amplifier stages using YD 1060 or 2 C 39 tubes

1. THE TUBE STAGES

Experiments have shown that it is preferable to use the YD 1060 as mixer tube instead of the 2 C 39. This is also the case in the subsequent driver stage. However, it was found that more output power was provided when using a 2 C 39 in the output stage, even though it is operated at its upper frequency limit. The output power to be expected is also dependent on the selected anode voltage of the output tube; the output power at 1000 V is approximately 50 % higher than at 500 V, however, the life of the tube will be considerably reduced. The voltage and current values will be given in the alignment instructions.

The tube YD 1060 belongs to the disk-seal triode family and it is operated in the same manner as a 2 C 39 in a grounded grid circuit. The grid bias voltage is generated in a simple two-pole, comprising a transistor, a diode, and two resistors that connects one side of the heater connection to ground. It is therefore necessary to provide separate heater windings for each tube and for them not to be grounded. This has been described often in the past, e.g. in (5). The only difference between the mixer and the linear amplifier stages is the transformer input coupling of the 144 MHz drive signal **(Figure 3)**, otherwise the stages are identical.

The principle of the mechanical construction is given in **Figure 4**. The anode and cathode have their own cavity resonator which can be brought to resonance by adjusting the plunger. Whereas the input coupling to the cathode circuit is fixed, the output coupling for the anode circuit can be varied with the aid of a compensating pin.

1.1. Construction of the Parts

All parts required for construction of one stage are given together with their dimensions in the individual diagrams, and listed in the parts list.

Construction is begun with the rings shown in **Figure 5**, which are the only parts that must be constructed using a lathe.

The cathode plates 1 and 2 **(Figure 6)**, the anode and grid plate **(Figure 7)** can be cut with the aid of a fret saw or with guillotine. The given holes should be drilled as accurately as possible. For this reason, it is

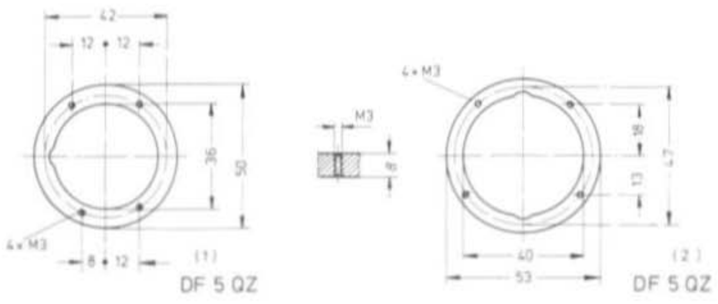


Fig. 5: Anode ring (left) and cathode ring (right) Thickness of both rings: 8 mm

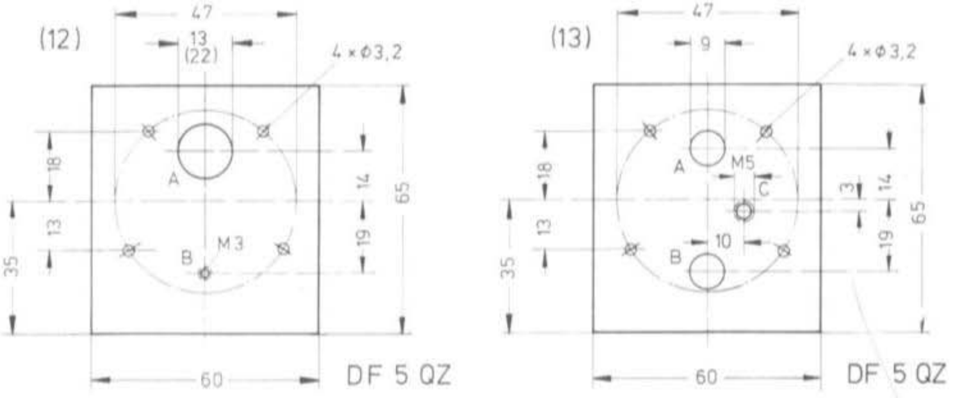


Fig. 6: Cathode plate 1 (left) and 2 (right)

advisable for the rings to be drilled using a stand drill and provided with a M 3-thread. The plate and the appropriate ring should then be clamped together after which the holes are marked. This will ensure that the holes coincide.

One can also use a hardboard drilling template. Anyway, the number of holes should not frighten anybody away from constructing this transverter, since the author is able to construct such a stage during a long weekend using normal tools.

The different dimensions of the tubes YD 1060 and 2 C 39 must be taken into consideration for some parts. These are given in the following table:

Part	Dimensions YD 1060	Dimensions 2 C 39
Cathode plate 1	Grid hole 13	22 mm
Anode plate	Anode hole 16	20 mm
A-capacitor ring	Anode hole 19	26 mm
C-capacitor	Cathode tube 8	9 mm

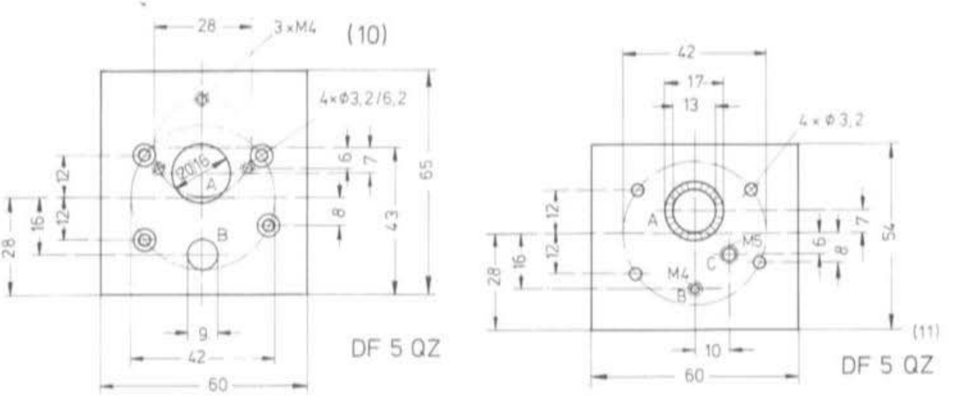


Fig. 7: Anode plate (left) and grid plate (right)

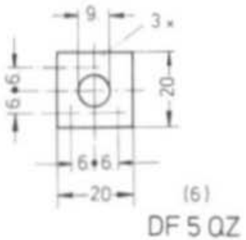


Fig. 8: Cathode capacitor

The differing dimensions for the 2 C 39 are given in brackets in the drawings.

The cathode capacitor **(Figure 8)** is made from 1 mm thick brass or copper plate. This is followed by soldering the 10 mm long cathode tube (part 7, not illustrated) into the 8 mm hole at right angles to the plate. This points outward after assembly, and accommodates the cathode connection of the tube. In order to ensure that the contact is good, the tube should be slotted with a fret saw before soldering into place, and it is advisable to check the fitting by sliding it over the cathode connection of the tube.

The cylinder-heads of the tuning screws (parts 14, 15, and 16, not illustrated) are filed down until they are completely flat.

The two coupling pins (parts 22 and 23) are also not shown in the drawings. They are manufactured from 6 mm brass tube. M 3-nuts should be soldered into place at both ends of the input coupling tube (cathode resonator). The output coupling tube is only provided with such a nut at one end.

This is followed by preparing the BNC-connectors (single-hole mounting). The threaded flange is shortened to 2 mm and the remaining inner conductor is pulled out. This is then soldered into the M 3-nut at one end of the previously prepared coupling pins. If the inner conductor is then pushed back into the connector, it will be seen that the anode and cathode ring will not allow a vertical position of the coupling pin. It is therefore necessary for these two rings to be filed down at this position so that the coupling pins can just approach these points with a spacing of approximately 0.5 mm. However, they should not be allowed to touch them after assembly. The mounting of the coupling pins in this way is very important with respect to the operation of the stage !

The length of the anode output coupling pin should amount to half the height of the ring, whereas the length of the cathode input coupling pin is as long as the height of the cathode cavity. In this type of work, it is often easier to try assembly rather than to attempt to maintain accurate dimensions. The anode coupling pin is finally filled with solder and filed flat at the side facing the compensating trimmer.

PTFE foil of 0.5 to 1 mm thick (uncritical) is used as dielectric for the capacitors. The foil pieces are cut with scissors so that approximately 1 mm is visible from under the plates.

A contact strip is soldered around the grid hole in the grid plate (part 11), and this is used as grid connection for the tube. This is made from the anode side.

It is necessary to countersink all the M 3 and M 4 holes where the plates overlap. This is also valid for the M 4-holes in the anode plate, in which plastic screws are to be used later. The countersunk shape of the holes ensures that no high-tension flashover can occur here.

The anode capacitor ring **(Figure 9)** is cut with the aid of a fret saw from 1 mm plate. After this, the contact strip for the plate connection is soldered into place. If no such contact strips are available, the contacts can be made as follows:

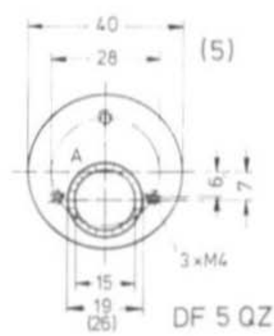


Fig. 9: Anode capacitor ring

The hole for the anode connection is not sawn out completely, but left as a number of segments that can be bent down to form a ring around the anode connection of the tube. It is possible, afterwards, for these to be pressed against the connection using a pipe clamp.

The same can be done for the grid connection:

The grid hole in part 11 can be sawn out so that it is somewhat larger, after which a narrow tin plate strip of 0.2 to 0.5 mm thick is soldered into place. After this, the plate is rubbed down with fine emery cloth, checking with the tube all the time until it fits correctly. This method is also used by the author.

1.2. Parts for one Mixer or Linear Amplifier Stage

Part	Description – Material – Dimensions (in mm)
1	Anode ring, brass, inner diameter 36, outer diameter 50
2	Cathode ring, brass, inner diameter 40, outer diameter 53
3	Anode contact ring
4	Grid contact ring
5	Anode capacitor ring, tin or brass plate, 0.5 - 1 mm thick
6	Cathode capacitor, material as part 5
7	Cathode tube, brass or copper for YD 1060: inner diameter 7, outer diameter 8 for 2 C 39: inner diameter 8, outer diameter 9
8	Dielectric for anode capacitor, PTFE, approx. 0.2 thick, 42 mm dia.
9	Dielectric for cathode capacitor, PTFE, approx. 0.2 thick, 22 x 22
10	Anode plate, brass, 2 mm thick, 65 x 60
11	Grid plate, brass, 2 mm thick, 60 x 54
12	Cathode plate 1, brass, 2 mm thick, 65 x 60
13	Cathode plate 2, as part 12
14	Anode-tuning screw, brass, M 5 x 40
15	Output coupling, compensating screw, brass, M 4 x 40
16	Cathode-tuning screw, brass, M 5 x 40
17	Input BNC-connector (single-hole)
18	Output BNC-connector (single-hole)
19	Counter nut for anode tuning M 5
20	Counter nut for cathode tuning M 5
21	Counter nut for compensating screw M 4
22	Output coupling pin, brass, 6 mm outer diameter
23	Input coupling pin, brass, 6 mm outer diameter
24	M 3 screws, brass
25	M 4 screws, nylon
26	M 3 screws, nylon
27	M 4 nuts, nylon
28	M 3 nuts, nylon
29	Bracket, brass, 10 x 20
30	Feedthrough capacitors 1 nF
31	$\lambda/4$ chokes: 2 cm, 1 mm dia., silver-plated copper wire, wound on 2.6 mm former
32	Ceramic or plastic foil trimmer, 22 pF
33	Series inductance for 144 MHz: 5 turns of 1 mm dia. wire wound on a 8 mm former
34	Input coupling inductance for part 33: 2 turns of insulated wire

2. ASSEMBLY

The assembly is commenced by soldering the BNC-connectors into place. This can be simplified by placing the anode and grid plate on the plate of an electric cooker.

This is followed by screwing in the tuning plungers, not forgetting the counter nuts. The output coupling tube together with the BNC-pin is placed into the BNC-connector, after which the anode ring is screwed together with the anode and grid plates. The nylon screws for mounting the anode capacitor plate must be firstly placed through the anode plate from the anode cavity side. It is necessary to file down all M 3 countersunk screws that are between two plates.

The anode capacitor plate is now mounted on the protruding nylon screws together with its PTFE insulation, after which the nylon nuts are screwed into place. A tube should be inserted and the adjustment of the parts made in a most favorable manner before finally tightening them.

The cathode resonator is mounted in the same manner. This is commenced by firstly mounting the M 5 tuning plunger and then inserting the coupling tube into the BNC-connector. The cathode capacitor together with its PTFE dielectric is then screwed into place with the aid of the nylon screws, after which the cathode ring is mounted between the two cathode plates, and the M 3 countersunk screws are filed down flat on the grid side.

Finally, the cathode resonator is screwed onto the grid plate and tightened after inserting the tube.

The assembly is completed after mounting the bracket for the feedthrough capacitors in the vicinity of the cathode capacitor. This is made by using one of the screws holding the cathode ring. In the case of the mixer stage, this bracket can also support the series-resonant circuit for 144 MHz. **Figure 10** shows a photograph of a mixer, and two linear amplifier stages as seen from the cathode side. **Figure 11** shows a photograph of one of the stages as seen from the anode side.

The operating voltages are fed to the stage via $\lambda/4$ chokes.

If it is possible to silver-plate the metal parts, this should be done. The described stages will operate without silver-plating, but the efficiency is lower.

3. ALIGNMENT

Firstly check the insulation of the anode and cathode capacitor using an ohmmeter. This is followed by inserting the tubes as far as they will go.

The alignment is commenced with the mixer stage, which is provided with an anode voltage of maximum 500 V via a 100 mA meter. The heater voltage should be a maximum of 6.0 V. It should be possible to align an anode quiescent current of

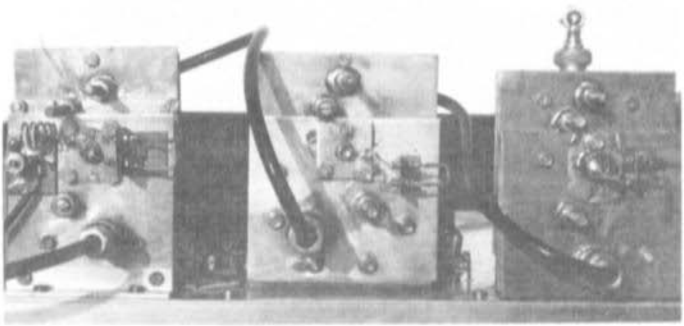


Fig. 10: The three tube-stages as seen from the cathode side

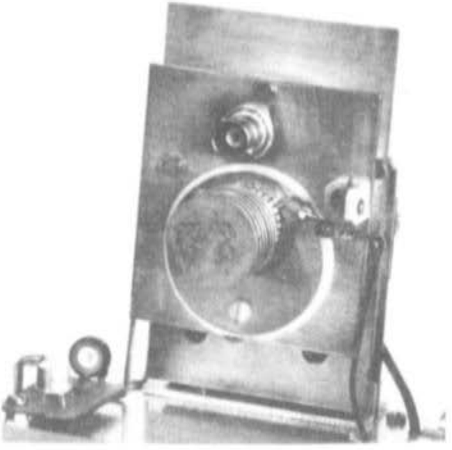


Fig. 11: Anode side including bias two-pole

10 mA with the aid of the trimmer of the bias two-pole.

The input connector on the cathode resonator is now connected to the local oscillator; the last tripler should provide a frequency of 3312 MHz with an output power of at least 500 mW. The cathode resonator should now be resonated by adjusting the tuning plunger. This should be seen as an increase in current of 10 to 20 mA.

A 144 MHz signal with a power of approximately 3 W is now fed to the coupling link of the series circuit. The plate current should further increase, and the trimmer of the 144 MHz circuit should be aligned for maximum (approx. 50 mA).

A reflectometer such as that described by OE 5 THL / DJ 1 JZ (6) and a frequency meter similar to that described by DJ 1 EE (7) are very useful for aligning the anode resonator. The author used a 0.6 W lamp mounted on a BNC-connector for preliminary alignment and as load resistor. It will be seen that the lamp will light up at two positions on aligning the anode tuning plunger. The strongest of the two is the oscillator frequency and one will find the weaker, required frequency by rotating out the plunger to the mixed, sum frequency of 3456 MHz.

This adjustment must be made carefully with the plunger tightened. This is made easily by tightening the counter nut somewhat and by rotating the tuning screw with a pair of pliers.

The most favorable power matching is made finally using the compensating screw. This trimmer potentiometer can also be adjusted to select the most favorable operating point for the tube. In the author's prototype, an output power of approximately 0.5 W was obtained.

The subsequent linear amplifier stage equipped with the YD 1060 is aligned in a similar manner. The quiescent current of this stage should amount to approximately 35 mA, and increase to approximately 55 mA when driven with the 3456 MHz signal. The anode resonator is aligned as described above, after which the compensating screw of the output coupling of the mixer stage is adjusted to match the input impedance. This is followed by aligning the compensating screw of the first linear amplifier stage. The small load (lamp) will be overloaded, if everything is working correctly.

The second linear amplifier stage equipped with the 2 C 39 will draw a quiescent anode current of 50 mA at an anode voltage of 500 V. This will increase to 95 to 100 mA after tuning the cathode circuit. If one would also like to observe the »expensive« microwave power, it is possible to load the anode circuit with a 10 W lamp and to align the output stage to resonance.

If the 2 C 39 is operated with an anode voltage of 900 V, the quiescent current should be set to 25 mA. The anode current will increase to 130 mA under drive conditions, and will be reduced to 100 mA under resonance conditions. This corresponds to an input power of 90 W. The author was not able to measure the output power, but this is estimated to be in the order of 5 W.

4. TRIPLER 1104/3312 MHz

The circuit diagram of the last frequency tripler is given in **Figure 12**, and its dimensions in **Figure 13**. A 25 mm high case with

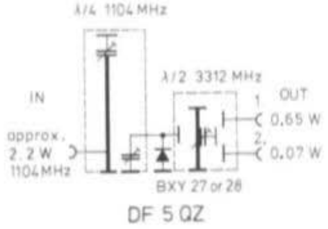


Fig. 12:
Circuit diagram of the 3312 MHz tripler

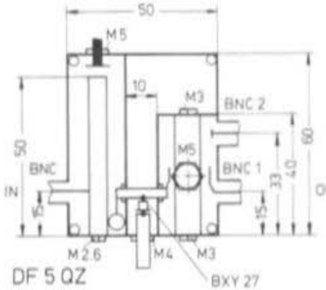


Fig. 13:
The most important dimensions of the tripler

the given dimensions is made from single-coated PC-board material. The two coaxial circuits are mounted in the center of the resulting chambers. Due to the author's poor experience with λ/4 circuits, λ/2 circuits were selected for the output circuit. The resonance was found to be much sharper, and it was virtually impossible to incorrectly align to 2108 MHz.

The heads of the two M 5 tuning screws should be filed flat. The tuning screw for the λ/2 output circuit will be behind the tube from the open side, which means that it must be inserted beforehand.

An interconnecting tube of 3 mm diameter is to be found between the two chambers. This is provided with a 1.5 mm hole in the center for fitting the varactor diode. A M 4-screw is mounted opposite this hole and its flat end is also provided with a 1.5 mm hole. As can be seen in Figure 13, it is thus possible for the diode to be carefully clamped. Before installing the diode, a pencil line should be drawn on its ceramic case so that approximately 50 kΩ can be measured in the blocked direction.

Thin copper strips of approximately 5 mm wide, and 8 to 10 mm in length, are now soldered to the ends of the interconnection tube, as well as to the inner conductor of the output coupling connector 1. The strip in the 1104 MHz chamber is soldered to the surface of the tubular trimmer; the inner conductor of the input socket is soldered in a similar manner to the inner conductor of the coaxial circuit. The photograph given in **Figure 14** shows the completed prototype, as well as a 368/1104 MHz tripler.

4.1. Parts for the 1104/3312 MHz Tripler

Parts / Material – Dimensions in mm

1. Single-coated PC-board material
2. Insulated nipple such as for mounting power transistors
3. BXY 27 or BXY 28 (Philips)
4. BNC-flange connectors (3 pieces)
5. Ceramic tubular trimmer 6 pF (Philips), 1 piece
6. Tuning screws M 5, brass, 20 mm long, 2 pieces
7. Counter nuts for part 6
8. Diode mount M 4, copper
9. Counter nut to part 8
10. M 3 screws
11. Nuts for part 10
12. 1104 MHz resonator: 6 mm tube, copper or brass, 50 mm long
13. 3312 MHz resonator: 8 mm tube, copper or brass, 40 mm long
14. Coupling tube, brass or copper, 3 mm dia., 15 mm long
15. Copper foil, approx. 0.1 mm thick

4.2. Alignment of the Tripler

An input power of approximately 1.5 to 2 W is required at 1104 MHz. This is fed to the input socket. A Schottky diode bypassed with approximately 50 pF is connected to the output socket 1 and connected to a μA-meter. An indication should be easily found on rotating the tuning plunger of the 1104 MHz circuit. Finally, the tubular trimmer of the 1104 MHz output coupling link should be aligned for maximum output power. The

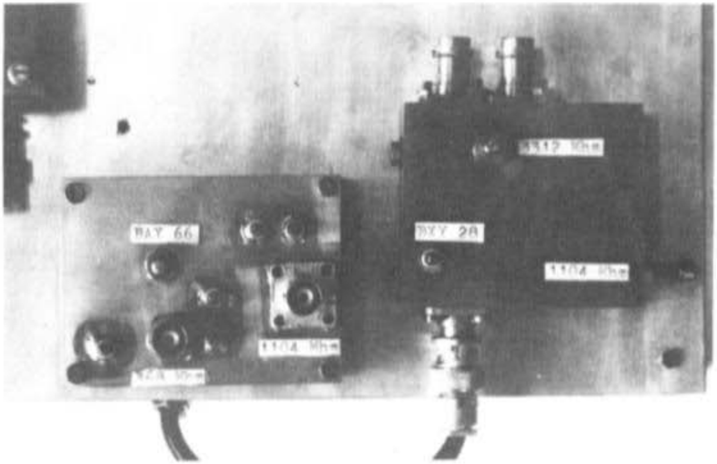


Fig. 14: Prototype of the two series-connected triplers

following alignment of the 3312 MHz circuit will be very sharp, and cause a rapid increase in current on the meter.

This is followed by alignment of the two coupling links in the 3312 MHz circuit. These are bent carefully and systematically with the aid of a plastic tool and continued until a stable maximum output power is achieved. Of course, it is necessary for the trimmers to be slightly corrected during this process.

Finally, the covers should be mounted into place and the trimmers corrected for maximum output power. The power values given in **Figure 12** were measured selectively in the laboratory of VHF COMMUNICATIONS. The output connector BNC 2, does not possess a coupling link but its inner conductor provides enough power for the receive converter.

4.3. Application for 10 GHz

It is possible for the 3312 MHz signal to be tripled once again to 9936 MHz and then mixed with a 432 MHz (SSB) signal to generate 10368 MHz. The author plans to amplify the 3312 MHz signal up to approximately 6 W using two YD 1060-stages and to triple the frequency with a further BXY 27. The output signal will then be mixed with approximately 0.5 W at 432 MHz to provide 10368 MHz SSB.

5. REFERENCES

(1) J. Dahms: Interdigital Converters for the GHz Amateur Bands
VHF COMMUNICATIONS 10, Edition 3/1978, pages 154 - 168

(2) J. Dahms: A Local Oscillator Module for 200 mW at 1152 MHz
VHF COMMUNICATIONS 10, Edition 1/1978, pages 18 - 22

(3) G. Freytag: A Transistorized Linear Amplifier for 70 cm
VHF COMMUNICATIONS 6, Edition 1/1974, pages 30 - 37

(4) H. J. Franke: A 70 cm / 23 cm Stripline Varactor Tripler
VHF COMMUNICATIONS 2, Edition 3/1970, pages 160 - 165

(5) D. Vollhardt: Gittervorspannungs-Erzeugung for Gitterbasis-Stufen mit geerdetem Steuergitter
UKW-BERICHTE 12, Edition 2/1972, pages 105 - 106

(6) Tiefenthaler/Rössle: A Precision Reflectometer for VHF and UHF Applications with an Impedance of 50 Ω
VHF COMMUNICATIONS 6, Edition 1/1974, pages 2 - 17

(7) K. Hupfer: An SHF Wavemeter
VHF COMMUNICATIONS 7, Edition 2/1975, pages 90 - 92

A Microcomputer for Amateur Radio Applications

Part 4: The Input-Output Unit

by W. Kurz, DK 2 RY

Part 2 and 3 described the CPU, memory and bus. This part is to describe the input-output unit. Before commencing the description of the modules, a few points are to be discussed that make this system different from other microcomputers.

PROGRAM LANGUAGES

The described microcomputer system for amateur radio applications uses program language »Assembler«. Another language that is used often in conjunction with microcomputers is the problem-orientated language »Basic«. The advantage of a »Assembler« is in the higher operating speed and the lower memory requirements. An Assembler program generates all machine instructions, since the symbolic instruction that is written, corresponds to a machine instruction. The disadvantage of »Assembler« is that it is difficult to read, which results in complicated programs.

With »Basic« on the other hand, there are two different types of translating programs: »Compiler« and »Interpreter«. A translation program will always be required since the machine can only carry out machine instructions with the exception of when one programs in machine language. In the latter case, a translating program would not be required. In the case of the »Assembler« program language, this translation program is called »Assembler«, whereas it is either »Compiler« or »Interpreter« in the case of »Basic«.

Compilers are still not common in conjunction with microcomputers, since they require mass memories for translation, such as floppy disks. Compilers generate machine instructions in the same manner as Assemblers, however, a compiled instruction written in »Basic« no longer corresponds to an individual machine instruction, but represents a whole program sequence.

Interpreters do not generate machine instructions. An Interpreter compares the symbolically written instruction with its stored program libary, and then carries out the stored program sequence (interpretation). For this reason, the Interpreter must be continuously in the memory – in contrast to Assembler and Compiler – if such a Basic program is to run.

The type of memory is basically immaterial. It can be fixed-program memories or read-write memories. Basic-Interpreters are usually supplied in form of a cassette. If this Interpreter is used, the memory must, of course, be a write-read memory. It should be noted that a certain Interpreter can only be used for a certain microcomputer system; unless, of course, its ports are modified to suit the other system.

An interface has one or more ports. The ports are directly connected to the periphery. The input-output modules can be programmed, which means that it is possible to inform them whether they are to be used as output or input. This is made with the aid of a control word.

Small Basic-Interpreters (2-3 k) cannot be used for amateur radio applications; especially not for satellite tracking. One requires from the Interpreter that it contains all transcendental functions (especially angular functions), and is able to carry out floating operations. Approximately 8-12 k are required for this.

It is possible to estimate one's memory requirements: If the Interpreter has, for instance, 12 k and is supplied in the form of a cassette, this will mean that one will need at least 12 k write-read memory capacity. Since the programs, data memories and the stack also require write-read memory capacity, this will increase the memory capacity requirements to approximately 14 to 16 k (at an expense of approx. DM 1000.—).

The great advantage of Basic is the clear conception of this program language. It is practically a colloquial language (English). For this reason, Basic is very easy to learn. A further advantage is the exchangeability of Basic-programs. Since an Interpreter does not generate machine code, Basic is virtually independent of the system used. A Basic-program made by another programmer, will be able to run in one's own system after making a few adjustments to one's own Basic-Interpreter.

4. INPUT-OUTPUT UNIT

Let us now leave the program languages and go back to the hardware of microcom-

Fig. 27: The Z 80 PIO

puter systems. The input-output unit is now to be described. The task of an input-output unit is to read information from the data bus and to feed them to external units (periphery), or – vice versa – to pass on data from the periphery to the data bus and to inform the CPU of their presence so that it is able to carry out the required processing steps.

The input and output process is either made in parallel, in which case one designates it as a parallel-interface, or in series, when it is designated as series-interface. In our case, parallel-interfaces are used.

4.1. The Z 80 PIO

The Z 80 PIO is a programmable parallel-interface with two ports. The connection diagram of the Z 80 PIO is given in **Fig. 27**. The connections designated with D 0 to D 7 are the data inputs-outputs. The data is passed on to the ports designated A 0 to A 7 or B 0 to B 7 respectively according to the programming.

A STB and B STB are the Strobe-inputs. If a Strobe-input is at L-level, the Z 80 PIO can request an interrupt, if programmed.

The outputs A RDY and B RDY provide the acceptance signals that the data has been accepted.

Connections 24 (IEI) and 22 (IEO) are the inputs or outputs for the interrupt priority. In the case of the highest-priority module, the IEI (Interrupt Enable In) is connected to + 5 V, so that it can request an interrupt at any time (if permissible). The IEO (Interrupt Enable Out) is connected to the IEI of the module of the next lower priority, and so on. This is called »Daisy chain interrupt control«. It is possible, in this manner, to guarantee the priority of the individual modules, so that only one module can request an interrupt if no higher priority module has already requested one.

The Z 80 PIO can be programmed to four different modes:

- Byte-input
- Byte-output
- Bidirectional
- Bit-input-output

In the case of the Bit-input-output mode, any connection of a port can be programmed for input or output.

The Z 80 PIO receives information whether the data word on the data bus is a control word or data via connection 5 (C/D SEL).

B/A SEL is for port selection.

Further details regarding programming of the Z 80 PIO and the time diagrams are not to be discussed here. If further information is required, this can be done by reading (1).

4.2. The 8255

A programmable parallel-interface with 3 ports having the designation 8255 is used in addition to the Z 80 PIO. Since this module is not a typical Z 80-interface, the »Daisy chain« is missing. However, since no interrupt operation is made via the 8255, this is not required.

In our application, the 8255 is only used for giving the angular information to the digital rotator control (2).

The connection diagram of the 8255 is given in **Figure 28**. Connections PA 0 to PA 7, PB 0 to PB 7, and PC 0 to PC 7 are the inputs-outputs of the three ports A, B, and C. They are selected via the »Port-Select« inputs A 0 and A 1 (pin 9 and 8) as shown in **Table 1**.

A 1	A 0	RD	WR	CS	Operation	
0	0	0	1	0	Port A	→ Bus
0	1	0	1	0	Port B	→ Bus
1	0	0	1	0	Port C	→ Bus
0	0	1	0	0	Bus	→ Port A
0	1	1	0	0	Bus	→ Port B
1	0	1	0	0	Bus	→ Port C
1	1	1	0	0	Control word	
x	x	x	x	1	Inactive	
1	1	0	1	0	Non-permissible condition	

Table 1

The 8255 is set to mode 0 input with the aid of the reset-input (pin 35). Furthermore, all registers are set to zero. The 8255 can be set to three different modes with the aid of the control word:

Mode 0: Simple input/output
Mode 1: Strobed input/output
Mode 2: Bidirectional input/output

Further details regarding the programming are given in (3). In the case of mode 0, each port is programmable separately to input or output. Mode 1 and 2 allow interrupt-requests. In this case, port C is split into two 4-Bit wide ports. These are used for generation of the control signals.

In the case of input IBF (Input Buffer Full), Strobe and INTR (Interrupt Request) are generated, whereas ACK (Acknowledge) and INTR are generated in the case of output OBF (Output Buffer Full). These can be used for controlling the periphery unit. The ports A and B are then used for input or output. If an output has taken place, the data will be continuously available at the output of the port (also at the Z 80 PIO), independent of whether the module is active or not.

They can only be changed after a new output instruction is given. This means that they are accessible at any time.

If the module is programmed to input, the data from the periphery unit is only passed on to the data bus as long as the module is active and has $\overline{RD}$ L. This ensures that no conflict takes place between machine instructions and memory requests.

4.3. The SN 74 LS 373

The integrated circuit SN 74 LS 373 is a so-called »Transparent Octal D-Latch«, which means that it is an 8-Bit memory complete with output buffers. This module is, in contrast to the 8255 and Z 80 PIO, not programmable. It is used for intermediate storage of data that are to be passed on to the periphery unit at a certain time.

The connection diagram is given in **Fig. 29**. It is possible for the data to be outputted using the output control. The »Enable Gate« $\overline{G}$ is used for passing the data to the 8 D-flipflops. The operation of the module is shown in **Table 2**.

Fig. 28: The 8255

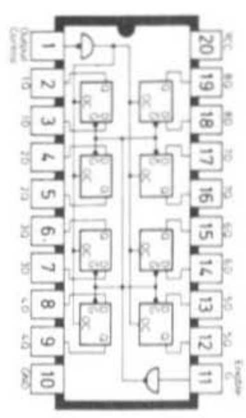


Fig. 29: The 74 LS 373
Q = Data Outputs
D = Data Inputs

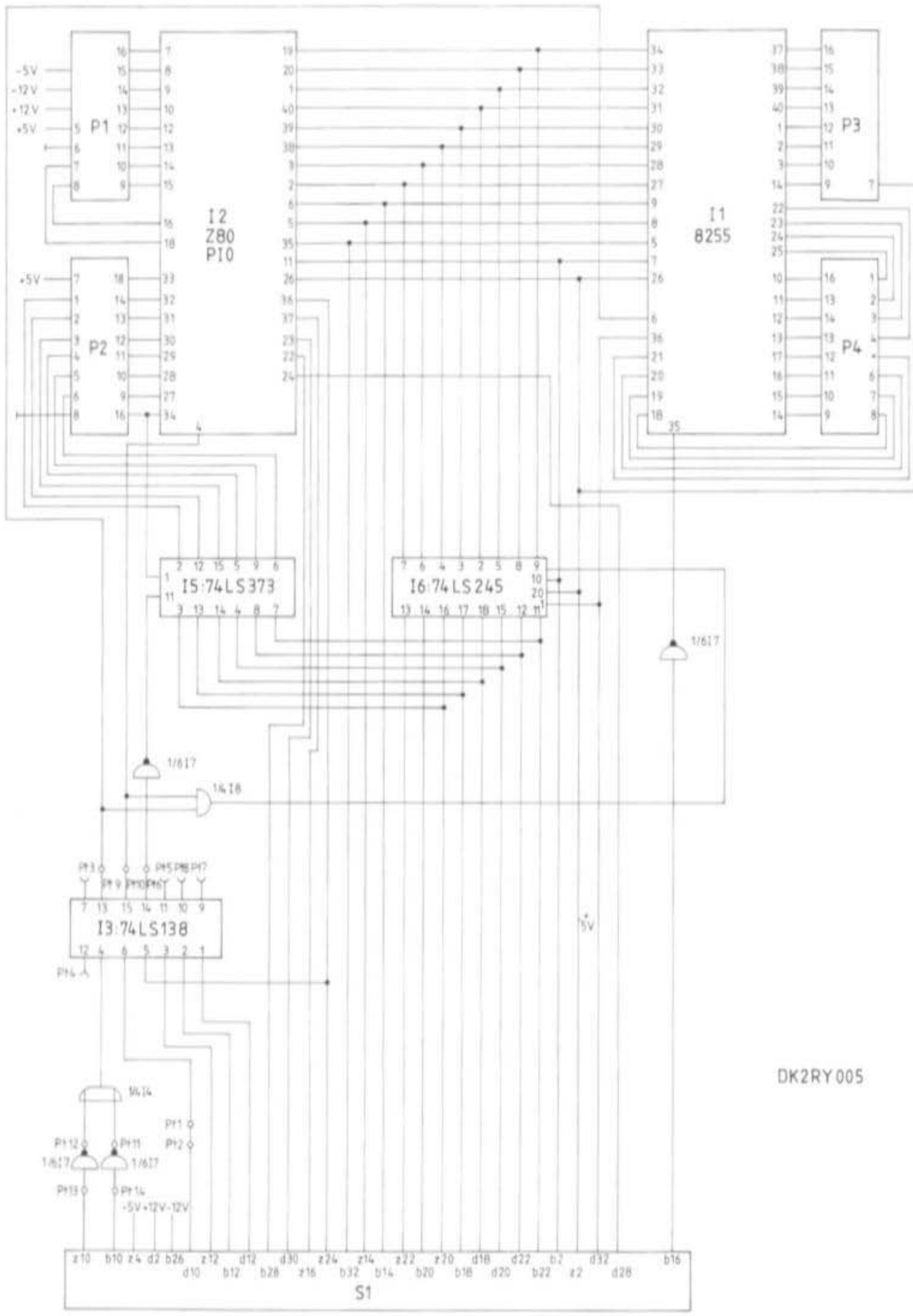


Fig. 30: Circuit diagram of the input-output unit

Output Control	Enable $\overline{G}$	D	Output
L	H	H	H
L	H	L	L
L	L	X	Q_0
H	X	X	tristate high-impedance

Table 2: Function of the SN 74 LS 373

X = Either H or L
Q_0 = Data word

Connections 1 D to 8 D are the data inputs, and 1 Q to 8 Q are data outputs. The integrated circuit SN 74 LS 373 is used for outputting the addresses to the 16-segment indicator.

4.4. Circuit Description

The input-output unit comprises, as previously mentioned, two modules: Z 80 PIO and 8255 (see **Figure 30**).

The Z 80 PIO is used for inputting the data from the keyboard and for outputting to the indicator. This is done by connecting port A to the keyboard. The data is passed to the bus and stored in the memory using an interrupt request. The data is fed to the indicator unit via port B. Previous to this, the address of the module that is to receive the information, is intermediately stored in the SN 74 LS 373.

Port B 7 of the Z 80 PIO is connected to the output control of the SN 74 LS 373. B 7 is then fed to L by the program. If the sign is then outputted, the address to which the sign must be written is then automatically available. Such a program where a sign is read from the keyboard, taken from the memory and outputted to the indicator unit, is called »Echoroutine«. This allows the sign to be checked.

In the case of an incorrect input, the sign can be deleted with the aid of the keyboard and re-inputted (»Rubout«).

As has already been mentioned, the second part of the input-output module (8255) is used for outputting the calculated angular values to the digital rotator control. It is programmed in »Mode 0 Output«. In the case of an output instruction, the data from the bus will be read out and passed on to the programmed port.

The output of the angular values is made in BCD-code. An angle of maximum 359 degrees is possible for the azimut, and a maximum of 180 degrees for the elevation; however, a maximum of 90 degrees is sufficient for elevation. If these values are given in BCD-code, the following will result:

Azimut:

0 =	L L L L	L L L L	L L L L
359 =	L L H H	L H L H	H L L H

Elevation:

0 =	L L L L	L L L L	L L L L
90 =	L L L L	H L L H	L L L L

It will be seen that 6 Bit remain over from the port total of 24 Bit. These can be used, for example, for special controls of the digital rotator control. It would be possible, for instance, to determine via the keyboard whether the rotator control is to be made manually, or from the computer.

The interconnection to the rotator control is made via a 16-pole flat cable which is connected to P 3 and P 4 with the aid of a DIL-plug. The other end of the cable is connected to a special interface board which contains the output drivers and sockets for the digital rotator control: two boards each DK 1 OF 038 and DK 1 OF 039, as well as one board DK 1 OF 040. The description of this board will follow in the general description.

The keyboard is connected to connection P 2 using 16-pole flat cable, and the indicator unit also with 16-pole flat cable to connection P 1. The addresses of the ports are given in **Table 3** for those readers that wish to make their own additional programs:

Table 3:
Addresses of the Ports

Address	Module		
E 0 H	Data	Z 80 PIO	Port A
E 1 H	Data	Z 80 PIO	Port B
E 2 H	Control word	Z 80 PIO	Port A
E 3 H	Control word	Z 80 PIO	Port B
E 4 H - E 7 H	SN 74 LS 373		
E 8 H	Data	8255	Port A
E 9 H	Data	8255	Port B
E A H	Data	8255	Port C
E B H	Control word	8255	

The address selection is made with the aid of a 3-Bit demultiplexer type SN 74 LS 138. In order to ensure that the ports can only be addressed when an input-output request is made (IORQ at L), connection E 2 of the SN 74 LS 138 is connected to the IORQ-connection.

The address lines A 7 and A 6 are inverted using two inverters and connected to connection E 1 of the SN 74 LS 138 via an OR-gate. E 3 is directly connected to address line A 5. This ensures that the ports are clearly addressed.

In order to make it possible for the ports to be connected to other addresses (if the computer is to be extended), solder tags (Pt 1 to Pt 14) are provided in front of and behind the inverters, at connections A 3 to A 7 of the SN 74 LS 138, and in the interconnection between the address line and connection E 3. If one or more input-output modules are to be connected to other addresses, the corresponding lines should be disconnected, and reconnected to the solder tags with bridges so that the input-output module is connected to the selected address.

The principle of double buffering (4), is also used for the input-output process. A bidirectional bus driver type SN 74 LS 245 is used for this. Its connection $\overline{CE}$ is connected via an AND-gate with $\overline{CE}$ of the Z 80 PIO and the 8255, which means that it is only active when one of these modules is activated. The directional control of the SN 74 LS 245 is made via the $\overline{WR}$-output of the CPU.

The data inputs of the SN 74 LS 373 are directly connected to the bus, since it is a unidirectional driver and therefore does not require buffering. For those readers that do not wish to extend their computer system very far (minimum system), it is possible for the SN 74 LS 245 to be deleted. However, it is then necessary for connections A 0 to A 7 to be connected to the corresponding connections B 0 to B 7 (in a similar manner to 4).

4.5. Construction of the Input-Output Unit

The input-output unit is accommodated on a double-coated PC-board with through-contacts designated DK 2 RY 005. The dimensions of this board are 162 mm x 101 mm (see **Figure 31**).

The PC-board is provided with sockets for the integrated circuits on the component side of the board. 16-pin sockets should be soldered to the port connections P 1 to P 4 for the plugs of the interconnection cables. After mounting all components on the board (see **Figure 32**), the module will be ready for operation and can be plugged into one of the connection strips of the bus board (DK 2 RY 002). No alignment is necessary.

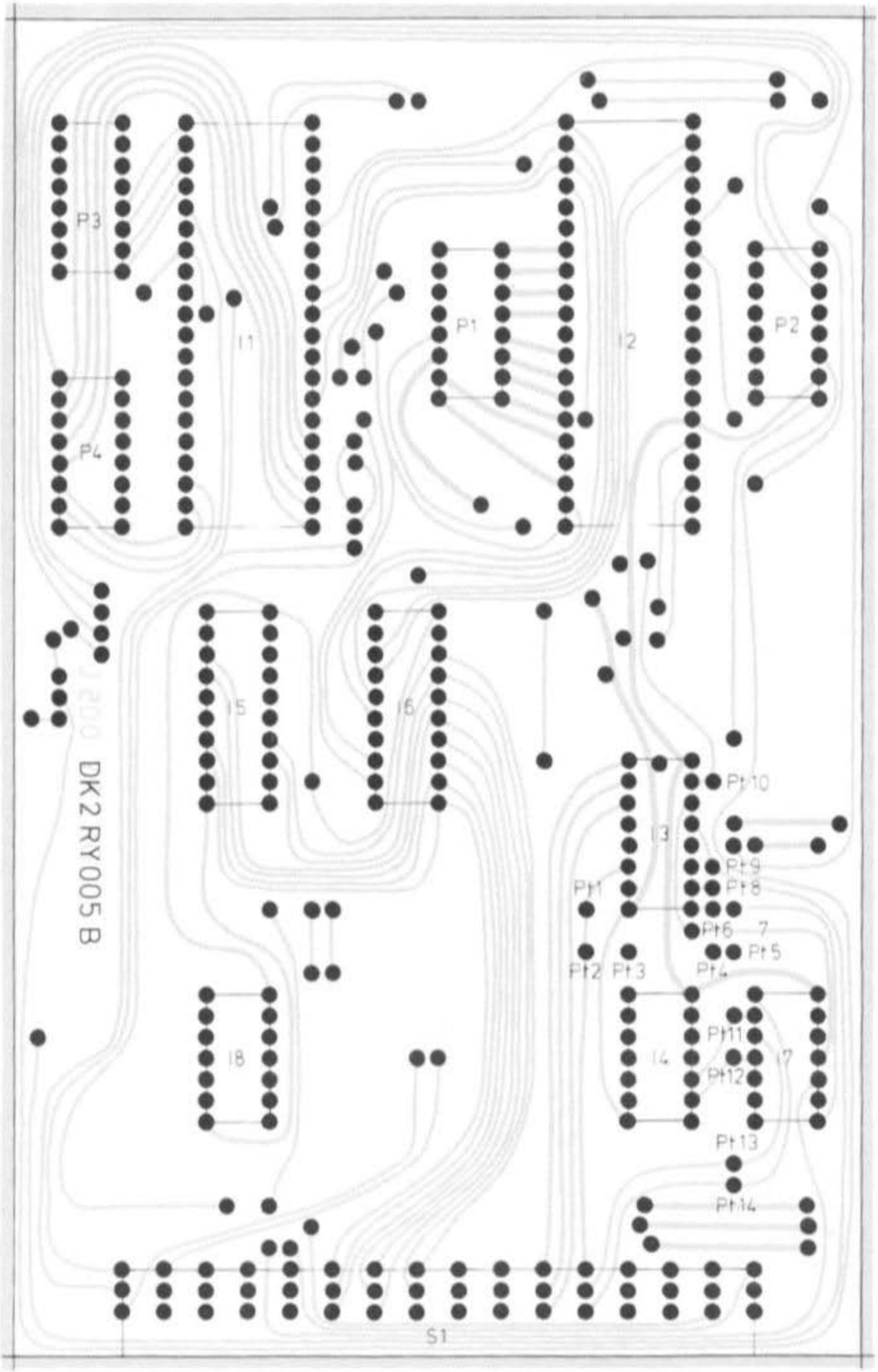


Fig. 31: PC-board DK 2 RY 005 of the input-output unit

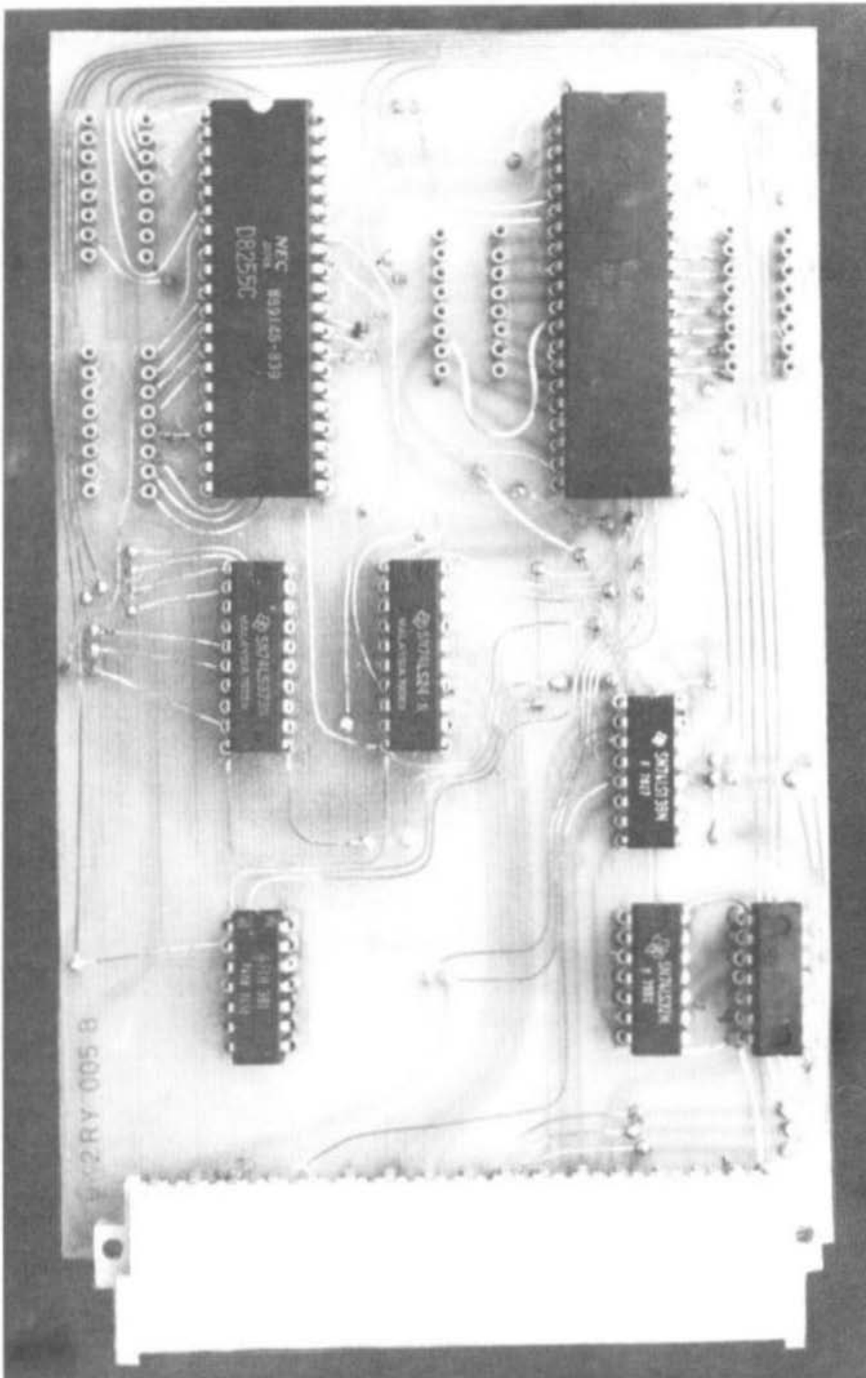


Fig. 32: Photograph of the author's prototype board for the input-output unit

4.5.1. Components

I 1:	8255 (INTEL) or SAB 8255 (Siemens)
I 2:	Z 80 PIO (ZILOG)
I 3:	SN 74 LS 138 (TI)
I 4:	SN 74 LS 32 (TI)
I 5:	SN 74 LS 373 (TI)
I 6:	SN 74 LS 245 (TI)
I 7:	SN 74 LS 04 (TI)
I 8:	SN 74 LS 08 (TI)
S 1:	Connector strip C 74334-A 40-A 60 (Siemens)

FURTHER DESCRIPTIONS

The next edition of VHF COMMUNICATIONS will describe the clock unit and the arithmetic-processor (DK 2 RY 006). This PC-board also accommodates the clock generator for the system. This will be followed in a later edition by the preliminary completion of the description which will describe the indicator unit, the power supply and interface board for digital rotator control.

Due to the confirmed interest from our readers, VHF COMMUNICATIONS will not only list the sources of the individual components, but will at least make all PC-boards and the programmed PROMs available.

The basic system of the microcomputer is ready for operation after construction of these boards and plugging in the programmed fixed-program memory, as well as the connection to the keyboard.

REFERENCES TO PART 4

(1) Data Sheet Z 80 PIO (Kontron, München)

(2) J. Kestler, DK 1 OF: The Electronic Control of Antenna Rotators. Part 2: Digital Programming with BCD-Inputs VHF COMMUNICATIONS 11, Edition 4/1979, pages 238-250

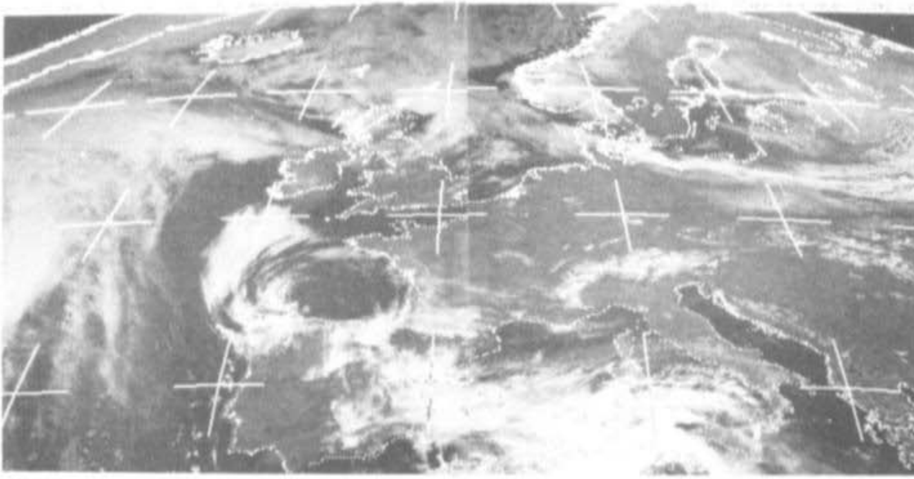
(3) Data Sheet of the 8255 (INTEL, SIEMENS)

(4) W. Kurz, DK 2 RY: A Microcomputer for Amateur Radio Applications, Part 3: Memory and System Bus VHF COMMUNICATIONS 12, Edition 3/1979, pages 179-191

MATERIAL PRICE LIST OF EQUIPMENT
described in Edition 4/1980 of VHF COMMUNICATIONS

DC 3 NT 007	**Start-Stop Logic**		**Ed. 4/1980**
PC-board	DC 3 NT 007	Single-coated, with plan	DM 20.—
Semiconductors	DC 3 NT 007	2 transistors, 23 diodes, 1 quad-op. amp., 5 C-MOS ICs	DM 40.—
Minikit	DC 3 NT 007	18 pl. foil, 4 tantalum, 1 alu. cap., 4 trimm. pot., 36 carbon resistors, 1 connector strip (31 pin)	DM 42.—
Kit	**DC 3 NT 007**	**complete with the above parts**	**DM 98.—**
DC 3 NT 010	**Motor-Starting Circuit**		**Ed. 4/1980**
PC-board	DC 3 NT 010	Double-coated, with plan	DM 38.—
Semiconductors	DC 3 NT 010	9 C-MOS ICs, 4 diodes, 1 LED	DM 52.—
Minikit	DC 3 NT 010	1 alu., 2 tantalum electrolytics, 3 pl. foil caps, 1 trimm. pot., 12 carbon resistors	DM 9.—
Kit	**DC 3 NT 010**	**complete with the above parts**	**DM 98.—**
DC 3 NT 011	**Switching Board**		**Ed. 4/1980**
PC-board	DC 3 NT 011	Single-coated, with plan	DM 20.—
Semiconductors	DC 3 NT 011	4 C-MOS ICs, 2 diodes	DM 26.—
Minikit	DC 3 NT 011	4 pl. foil caps, 19 carbon resistors, 1 31-pin connector	DM 15.—
Kit	**DC 3 NT 011**	**complete with the above parts**	**DM 59.—**
DC 3 NT 012	**System Board**		**Ed. 4/1980**
PC-board	DC 3 NT 012	Double-coated with thru-contacts	DM 48.—
Semiconductors	DC 3 NT 012	2 C-MOS ICs, 1 transistor, 2 diodes	DM 7.—
Minikit	DC 3 NT 012	4 carbon resistors, 100 solder pins, 6 31-pin connector strips (female)	DM 53.—
Kit	**DC 3 NT 012**	**complete with the above parts**	**DM 105.—**
DC 3 NT 013	**Diode Matrix**		**Ed. 4/1980**
PC-board	DC 3 NT 013	Single coated, without plan	DM 15.—
Minikit	DC 3 NT 013	66 diodes, 14 resistors, 1 min. switch	DM 57.—
Kit	**DC 3 NT 013**	**complete with the above parts**	**DM 70.—**
DJ 8 UZ 001	**Weather Satellite Converter**		**Ed. 4/1980**
PC-board	DJ 8 UZ 001	Double-coated, undrilled	DM 14.—
Semiconductors	DJ 8 UZ 001	1 DG-MOSFET, 1 IC	DM 13.50
Minikit	DJ 8 UZ 001	1 m silver-pl. wire, 6 pl. foil trimmers, 9 ceramic caps, 2 feedthru caps., 5 resistors	DM 14.50
Minikit 2	DJ 8 UZ 001	1 metal-plate case, 37 x 111 x 30 mm, 2 BNC-connectors	DM 9.80
Crystal	8.000 MHz	HC/18-U, parallel-res.	DM 16.—
Kit	**DJ 8 UZ 001**	**complete with the above parts**	**DM 64.—**
DL 8 ZX 003	**Log. IF-Amplifier for Spectrum Analyzers**		**Ed. 4/1980**
PC-board	DL 8 ZX 003	with plan	DM 13.50
Transistor	P 8002	Latest version of the wellknown low-noise large-signal FET P 8000	DM 9.80
Gunn-Diode	DGB 6844 C	Gunn-Element manufactured by Alpha Industries. Power: 50 mW at 10 GHz	DM 59.—

COMPLETE RECEIVE AND IMAGE PROCESSING SYSTEMS FOR THE METEOSAT AND GOES SATELLITES



We offer a complete system of inexpensive modules for professional applications. These are of special interest for meteological offices at smaller airports, for harbour and similar applications. They are also suitable for instruction at universities, and scientific institutes. A number of image processing systems and receivers are available to suit the application in question. Equipment is available, or under development for:

- The METEOSAT and GOES/GMS satellites in Geostationary orbit, or
- The NOAA and TIROS M satellites in polar orbits (136 - 138 MHz).

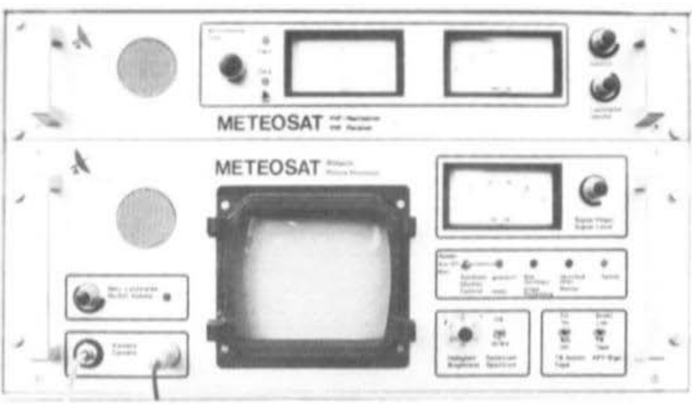
Technical specifications of the basic METEOSAT system:

PARABOLIC ANTENNA:
1.2 m dia., 24 dB gain

SHF-CONVERTER:
2-stage low-noise preamplifier with noise figure 3 dB

VHF-RECEIVER:
Noise figure 2 dB
AF-bandwidth: 800 - 4000 Hz
Subcarrier output: 2.4 kHz/1 V

VIDEO PROCESSOR:
Monitor tube and Polaroid camera



UKWtechnik Hans Dohlus oHG · Jahnstr. 14 · Postfach 80 · D-8523 Baiersdorf
Telefon 0 91 33 / 855 (Tag und Nacht)