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Especially Covering VHF, UHF and Microwaves

VHF communications

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Guenter Prokoph, DL 5 NP

80-Channel Handheld Transceiver for the 2 m Band

This article describes the construction of a handheld transceiver for the two metre band. During its development, particular attention was paid to keep the circuitry techniques straight forward together with low-current consumption and small dimensions.

1. TECHNICAL DATA

The following technical specifications were achieved: –

Synthesizer

Number of channels:	80
Channel spacing:	25 kHz
Channel selection:	coded switch
Current consumption:	approx. 10 mA / 10 V
Harmonic suppression:	60 dB

The synthesizer may be built separately by cutting this part of the PCB from the whole or by developing it separately. The synthesizer alone may be required, for example, to equip an existing quartz transceiver.

Receiver

Principle:	double-superfet with IFs at 10.7 MHz and 455 kHz
Sensitivity:	0.15 μV for 10 dB S / N
AF output power:	200 mW (approx.)
Current consumption inc. synthesizer (Squelch active)	approx. 20 mA

Transmitter

Output power:	0.6 W (approx.)
Harmonic suppression:	50 dB min.
Current consumption with synthesizer:	150 mA (approx.)

Dimensions

PCB:	100 × 70 mm
Equipment:	148 × 74 × 30 mm

2. CIRCUIT DESCRIPTION

The complete circuit schematic of the 2 metre handheld transceiver is shown in **fig. 1.**

2.1. Synthesizer

The synthesizer produces the transmitted signal directly and also the local oscillator (LO) signal for the first IF of the receiver mixer. This means that two bands of signals are supplied, 144 to 146 MHz and 133.3 to 135.3 MHz for the transmitter and the first IF of 10.7 MHz respectively. The

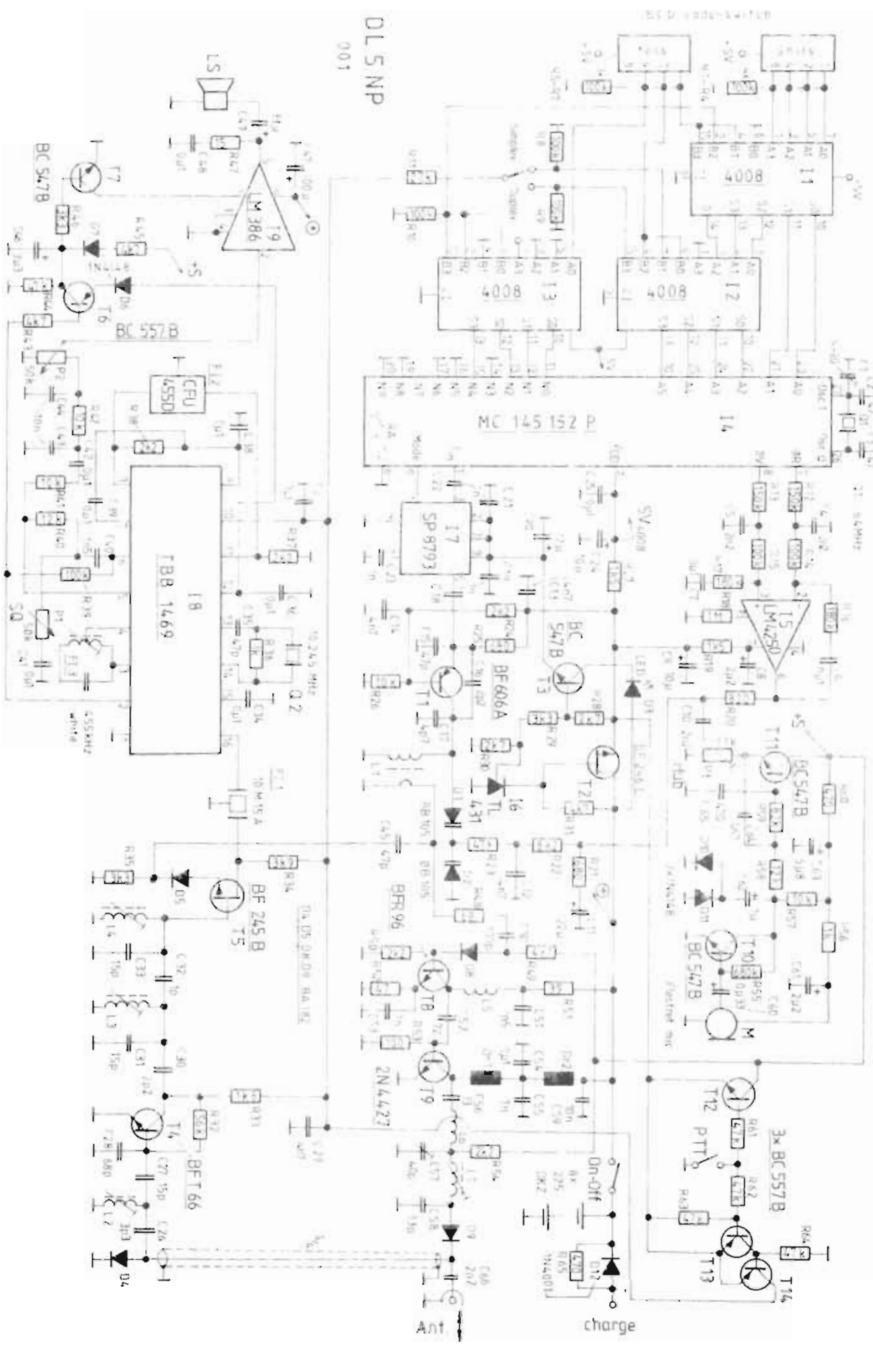


Fig. 1: Complete schematic of the 80-channel handheld 2 metre transceiver

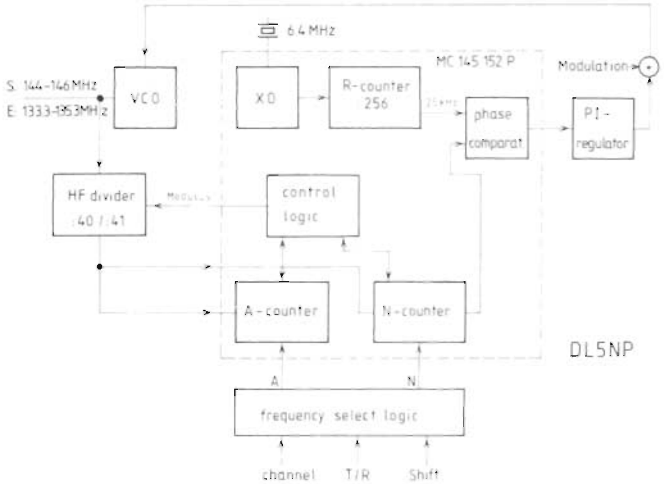


Fig. 2: Block schematic of the synthesizer

channel separation is 25 kHz and the HF output power about 3 mW. The current consumption was kept under 10 mA.

The heart of the frequency conditioning is the Motorola IC MC 145 152 P. This is a CMOS integrated circuit, which, because of its very low-current consumption, is particularly suitable for battery operation. Besides the considerable circuitry of the phase discriminator, the chip contains the reference oscillator with a selectable programmable divider (R-counter). Two further counters, A and N, are employed in the HF divider, but they must be supplemented by the addition of an external input divider.

Fig. 2 shows how the MC 145 152 P chip fits into the whole concept. The phase-comparator reference signal at 25 kHz is taken from dividers driven by a 6.4 MHz crystal oscillator. The VCO output is taken to a high-speed divider which, dependent on the mode-input level, divides the frequency by 40 or 41. As well as the A and N counters, the PLL chip contains a programmable HF divider. Its division ratio V is calculated: V = 40 N + A where N and A are adjustable division ratios for the requisite counter.

These selections are carried out by a frequency selection logic which, besides the setting of the channel-code selector switch, also takes into account information such as, send / receive change-over and working mode (simplex or duplex). The integrated phase discriminator is supplemented by an external PI regulator in order to extract the control voltage. The control voltage is superimposed on the modulating signal on "transmit". An example of the A and N counter programming will make this clearer:

Assuming a VCO frequency of 145.350 MHz is required, V = 145350 / 25, i. e. V = 5814. The values for A and N are found by dividing V by 40. The integral proportion of the result gives the programming for N and the remainder amounts to A. In the example: 5814 / 40 = 145 remainder 14. N is set to 145, A to 14.

Now for the circuit details: The VCO uses the BF 606 A PNP transistor (T 1). This has the advantage that the frequency-determining tuned-circuit inductance is connected directly to earth, thus obviating problems with decoupling components. The oscillator operates in a common-base circuit with capacitive feedback from collector to emitter. The power output depends upon the transistor working-point and can be varied by altering the value of R 25. The capacitive diodes allow a tuning range from approximately 130 to 150 MHz. The HF energy for transmitter and receiver is taken from the tuned circuit by means of a coupling coil.

The high-speed divider (I 7) is capacitively coupled to the low-impedance emitter of the oscillator transistor. The Plessey low-power ECL chip SP 8793 is employed here? This integrated circuit can work with input signals up to 225 MHz whilst requiring only an input power of 26 mW. Depending on the logic level on pin 1, the applied frequency will be divided either by 40 or 41. The resulting signal of about 3.5 MHz is fed, via C 22, into the MC 145152P input.

The crystal Q 1, two capacitors and a trimmer complete the integrated circuit oscillator. The reference oscillator can be adjusted exactly to its nominal frequency of 6.4 MHz by means of the trimmer. The 6.4 MHz synchronizing signal is divided by 256 in the R-counter. The resulting signal is available for the control of the phase comparator. The adjustment of the R-counter's division factor is accomplished by an appropriate wiring of the three RA inputs of the MC 145 152 P. Logic 1 may be achieved by simply leaving the pins concerned open, as integrated pull-up resistors have been provided for all logic inputs.

At the outputs Φ R and Φ V of the PLL chip the control information is available. According to the preset deviation of the VCO from its nominal frequency, short negative impulses appear at either one of the two pins. Unfortunately short impulses occur at both outputs even in the "lock" condition. The length of each impulse is only 120 ns and the repetition frequency is 25 kHz. These impulses would overextend the dynamic common-mode suppression of the following operational amplifier. This would result in a break-through onto the control output and thereby causing an undesirable frequency modulation of the VCO frequency. The capacitors C 4 and C 5 are largely effective in attenuating these short impulses. The behaviour of the control, however, is barely affected by these small capacitors.

The PI regulator itself, contains the low-power operational amplifier chip LM 4250 (I 5). Its current consumption may be adjusted by a resistor connected from pin 8 to ground. It has been set, in this case, to less than 1 mA. The smoothed VCO control signal is available at the output (pin 6). The RC combination R 21 / C 11 reduces the influence of the op-amps. internal noise. C 12 is an HF decoupling capacitor. The modulating audio signal is fed via C 10 to the VCO input in the "transmit" condition.

The frequency selection logic is realized by the use of only three CMOS binary adders (ICs 1, 2 and 3). They convert the BCD coding of the channel-selector switch (chan. 00 = 144.000 MHz, chan. 79 = 145.975 MHz) into binary logic. The frequency shift for the receiver local oscillator on "receive" and in "radio relay" operation is also provided here. On the "receive" condition the local-oscillator signal lies 10.7 MHz under the receive frequency. The Tx / Rx change-over switching is carried out by a high-level on the middle contact of the simplex / duplex selection switch. This potential is taken via R 11 from the receiver supply.

In radio relay operation the transmit channel must be selected. The receive frequency is raised 600 kHz higher. This has the advantage that it is possible to listen on the lower band merely by switching to simplex. The displacement is not possible for all channels as eventually the adder will overflow. For the relay frequencies R 0 to R 9 this effect does not occur. Besides this, the possibility of working outside the two metre band is avoided.

The voltage stabilizer uses a circuit with a programmable shunt regulator (I 6) and a field-effect transistor (T 2). Using this type of circuit ensures that the difference between regulated and unregulated inputs does not adversely influence the stabilisation greatly (battery operation!). The stabilized voltage at the FET's source is about 8 V. The 5 V supply potential for the ECL divider is obtained via T 3. An LED may be added to the transistor collector circuit without any additional current consumption as an "on" indicator.

2.2. Receiver

The receiver concept uses the double superheterodyne principle with IF 1 at 10.7 MHz and IF 2 at 455 kHz. At an input sensitivity of less than 0.2 μV the current consumption is under

10 mA in "standby" (muted). The RF pre-amplifier uses a bipolar transistor BFT 66, which, with a collector current of only 3 mA, offers a good compromise between gain, low-noise and large-signal handling capabilities. It proved unnecessary to provide HF neutralization as no signs of unstability could be detected with any of the test examples constructed. The input is matched by the selective combination L 2, C 26, C 27 and C 28.

The amplified signal frequency is taken via C 30 to a two-stage band-pass filter onto the mixer gate of the FET mixer T 5. The local-oscillator signal is fed to the FET's source.

The band selection for the first IF is accomplished by a crystal filter (FL 1), type 10 M 15 A. This is a high-impedance device at both input and output terminals and, correctly terminated, results in minimal passband ripple. The 10.7 MHz signal from the filter is then amplified by a Siemens TBB 1469 IC (I 8). It is then fed to the second mixer where it is translated in frequency to 455 kHz by mixing it with 10.245 kHz (LO 2). The active part of LO 2 is also integrated in I 8.

The resulting second IF is filtered by a ceramic filter (FL 2) with a 15 kHz bandpass (CFU 455 D). Following the selection, amplification and limiting, the signal is demodulated in a quadrature demodulator. The necessary phase-shifter circuit consists of a miniature IF filter with a white marker. In order to increase the circuit Q, the inductor tap must be employed.

The audio output is extracted from pin 5 of I 8 and then fed to a low-pass filter C 43, R 42 and C 44 and on to the audio amplifier via a potentiometer gain control P 2. The audio amplifier is an LM 386 (I 9) which drives a loudspeaker.

The circuit between pins 5 and 2 of the TBB 1469 (I 8) is utilized as part of the squelch facility. By means of external circuitry, a high-pass amplifier is formed which is adjusted by the squelch potentiometer P 1. The noise peaks charge up capacitor C 46 via T 6 and switch on transistor T 7. The AF amplifier LM 386 (I 9) is then rendered inoperative by a ground on pin 1. The current consumption of I 9 falls almost to zero under these conditions. Under "transmit" conditions the IC is muted via R 46 and D 7.

2.3. Transmit/Receive Switching

The transmitter is equipped in two stages. The output power amounts to approximately 0.6 Watt at an input current of 130 mA. The coupling between the penultimate amplifier (BFR 96) and the final amplifier (2N 4427) is broadbanded. This obviates the requirement for alignment tuning. The matching from the final-stage transistor to the antenna is accomplished by a combination of series resonant circuit L 6/ C 56 and the Pi-filter C 57/ L 7/ C 58. This coupling suppresses harmonic radiation by more than 50 dB.

The antenna change-over is effected, without contacts, with the aid of PIN diodes. In the "receive" condition the diodes D 4 and D 9 are blocked and the quarter-wave line works only as an extension of the antenna lead. On "Transmit" a DC is fed via R 54 to the diodes. The diodes conduct causing an HF short-circuit directly at the receiver input. The quarter-wave line is then open-circuited at its other extremity, thus allowing the transmitted signal to pass to the antenna via D 9.

2.4. Modulation Amplifier

The modulation amplifier is split into a pre-amplifier and a low-pass filter. The elektret-microphone signal is amplified by T 10. Diodes D 10 and D 11 form an amplitude limiter. The following active, low- pass filter has a turn-over frequency of approximately 3.3 kHz, it also lifts the amplitude of frequencies around 2 kHz in order to improve speech intelligibility. The output level of the amplifier, together with the frequency deviation, can be adjusted by means of P 3.

3. CONSTRUCTION AND ADJUSTMENT

For this project a printed circuit board was designed with dimensions of 100 × 70 mm. **Fig. 3** shows the two-sided board designated DL5NP 001. For the construction – besides the necessary care – the following miniature components are necessary:

Component Guide:

Integrated circuits:
I 1, I 2, I 3: CD 4008; RCA, MC 14008; Motorola
I 4: MC 145 152 P; Motorola
I 5: LM 4250; National
I 6: TL 431 C; Texas Instruments
I 7: SP 8793; Plessey
I 8: TBB 1469; Siemens
I 9: LM 386; National

Transistors:
T 1: BF 606 A; BF 451; Siemens, Valvo
T 2: BF 246 C; Valvo, Texas Instruments, Siemens
T 3, T 7, T 10, T 11: BC 547 B, various manufacturers
T 4: BFT 66, Siemens
T 5: BF 245 B; Valvo, Texas Instruments, Siemens
T 6, T 12, T 13, T 14: BC 557 B; various manufacturers
T 8: BFR 96; Siemens, Valvo
T 9: 2 N 4427; Valvo, Motorola

Diodes:
D 1, D 2: BB 105 G, BB 505 G; Valvo, Siemens
D 3: LED (red), 3 mm dia
D 4, D 5, D 8, D 9: BA 182, BA 243; Siemens, Valvo
D 6, D 7, D 10, D 11: 1 N 4148; various manufacturers
D 12: 1 N 4001; various manufacturers

Crystals:
Q 1: 6.4 MHz, 30 pF parallel resonance, 10 ppm; Helpert
Q 2: 10.245 MHz, series resonance; Helpert

Filters:
FL 1: Crystal filter 10 M 15 A; Helpert
FL 2: Ceramic filter CFU 455 D; Murata, Helpert
FL 3: Miniature IF filter 455 kHz, 7 × 7 mm, white; Helpert

Wound components:
L 1: primary 3 turns, 0.3 CuL, secondary 1/2 turn, 0.3 CuL on coil kit 7 V 1 S (Neosid, Helpert)

L 2 to L 7: 3 turns, 0.3 CuL on coil kit as L 1, but L 5 and L 6 without core
Ch 1: 4 turns, 0.3 CuL on 4 mm VHF core
Ch 2: 5 × 0.3 CuL thro' ferrite bead

Capacitors:
smaller than 4.7 nF: EPDU ceramic 2.5 mm grid as well as e. g. Sibatit 5 mm grid
Electrolytics: Tantalum 16 V

Resistors:
Type 0207 or 0204, carbon film

Potentiometers:
P 1, P 2: e. g. Miniature cermet pots. 50 K; (Mütron)
P 3: Miniature pot. 50 K (flat) 5 × 10 mm grid

Other components:
2 Miniature code switches BCD; e. g. Kundisch MS 20.01, (Mütron)
Miniature toggle switch (on / off / call)
Push buttons for PTT and later call tone
Antenna socket (BNC)
Charge socket e. g. 3 mm jack
Batteries e. g. 8 × 255 DKZ; Varta
Cable: RG-174 U for antenna etc. connections.
Housing: e. g. tinplate WB 13; (Schubert)

[Note: Proper names in brackets are German component supply Firms]

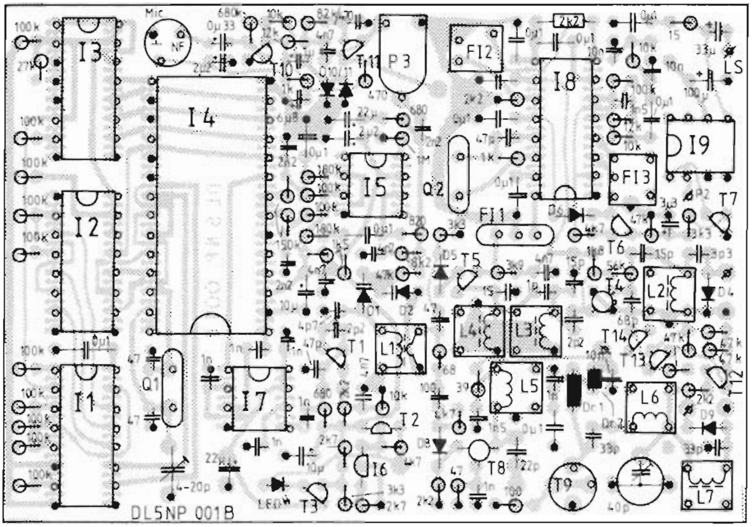


Fig. 3: Component mounting plan of the two-sided PCB DL5NP 001

Upon assembly of the components, care should be exercised to keep all connections as short as possible. The upper side of the PCB is unetched copper and serves as the ground plane. Accordingly, most ground connections must be made on the component side. The drillings for these ground connections are shown in the component plan of **fig. 3** as a solid dot. In order to ease the construction, a proportion of the ground wiring is made on the track side of the PCB. In such cases, just one through connection to the ground plane per track will suffice. Components carrying RF, however, should be soldered to the component side. Drillings not marked with a dot should be chamfered with a 3 mm drill on the component plan in order to prevent component leads from contacting ground. The given orientation of upright soldered resistors should be strictly followed as their connecting wires may be used as solder-tags for external connections. The construction should follow complete circuit lines in order that a systematic testing may be undertaken as the construction progresses. This procedure can save elaborate testing for faults on a fully constructed unit. The chokes and coils are made according to the sketches of **fig. 4.**

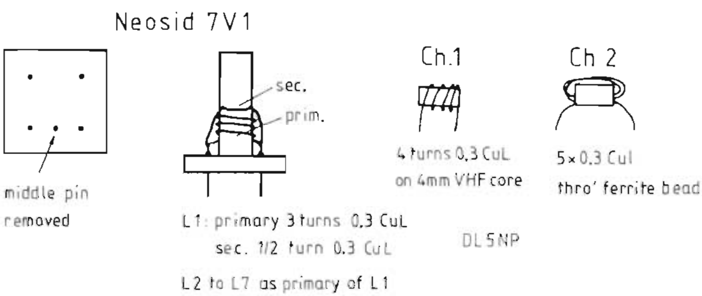


Fig. 4: Details of chokes and coils

3.1. Synthesizer Construction

First of all, the voltage stabilizers and VCO components are mounted. The LED indicator may also be wired in at this point. The correct sense of the coils should be noted when winding L 1. The ground connection of the coupling loop should be soldered to the PCB ground plane (upper side). This is not difficult when using a sharply tipped soldering iron. The connection tabs on the screening can must be removed as the can is soldered directly to the ground plane.

After connecting the supply voltage of 10 V, the stabilizer may be tested for correct operation. The voltage at the source of T 2 should be approximately 8 V when the stabilizer is loaded with, at least, the VCO. The voltage at the emitter of T 3 should be approximately 5 V. The LED does not indicate, at this stage, as no current is flowing through T 3.

To test the VCO, a frequency counter is connected to the coupling coil of L 1. A provisional diode tuning-voltage, variable between 2 and 6 V (normally supplied by a potentiometer accross the supply voltage), is connected via R 22. The core of L 1 is then adjusted for a tuning range of about 130 to 150 MHz. If this range cannot be achieved, C 17 may be removed. When tuning the core, the utmost care must be used as it is easily broken and tends to jam in the coil former. A correctly-fitting screw driver should be used (or better still, the correct size of trimming tool).

If all is satisfactory, the construction may proceed with the ECL divider SP 8793 and associated components. In the interests of avoiding parasitics no IC holder is used, the IC being soldered directly into position. Pin 1 of the IC is temporarily connected to ground. At pin 3 the output (input divided by 40) may be seen with an oscilloscope or a counter. The temporary earth on pin 1 may then be removed.

The locating of the rest of the synthesizer's components may then proceed. The author soldered these directly to the board but if IC holders are used, they must be of very high quality which permit grounding on the component side. In any case, great care must be used in effecting and soldering the ground connections as in the event of mistakes the IC, or – holder, is very difficult to remove. When the wire bridges I 4/pin 3 – C 25, C 25 – I 2/pin 16 are completed, the whole frequency-generation chain may be tested.

After switching in the suppy voltage, the VCO must be adjusted to a frequency of 144.000 MHz. Small departures from this may be taken up by C 1. The carrier can be monitored with a two metre receiver. The two code-selection switches are wired-in and the output frequency can be switched from channel to channel. The tuning voltage at the output of I 5/pin 6 to L 1 must be adjusted to 5 V when channel 79 (145.975 MHz) has been selected. Now the duplex/simplex switch may be added.

When the middle contact of this switch is connected to the CMOS supply voltage, the VCO should jump to the receiver local-oscillator frequency. Operation of the switch causes the channels 40 to 49 (R0 to R9) to change in frequency by 600 kHz. When all of these tests have been satisfactorily completed then the synthesizer may be considered as working normally.

3.2. Receiver Construction

The components for the receiver are mounted on the PCB from left to right. The crystal Q 2 cover and the crystal filter cover are soldered directly to the PCB ground plane (top side). The same goes for the pre-amplifier transistor BFT 66 and the cold ends of coils L 3 and L 4. The coil kits must be correctly constructed and aligned with the appropriate PCB drillings before the screening cans are fitted. Also, the transmit/receive-switch components around T 3, T 4 and T 5 must be put in at this stage. The connections to the loudspeaker and squelch potentiometer are made with a small diameter screened AF cable. The λ / 4 transformer, consisting of 33 cm of RG174U, is connected at the receiver end only, the free end being used provisionally as a receiver test input. Between the accessible connecting wires of R 46 and R 54, combination D 7/R 45 is inserted. The latter components should be covered by a piece of insulated sleeving.

When all the requisite wire bridges **(fig.5)** have

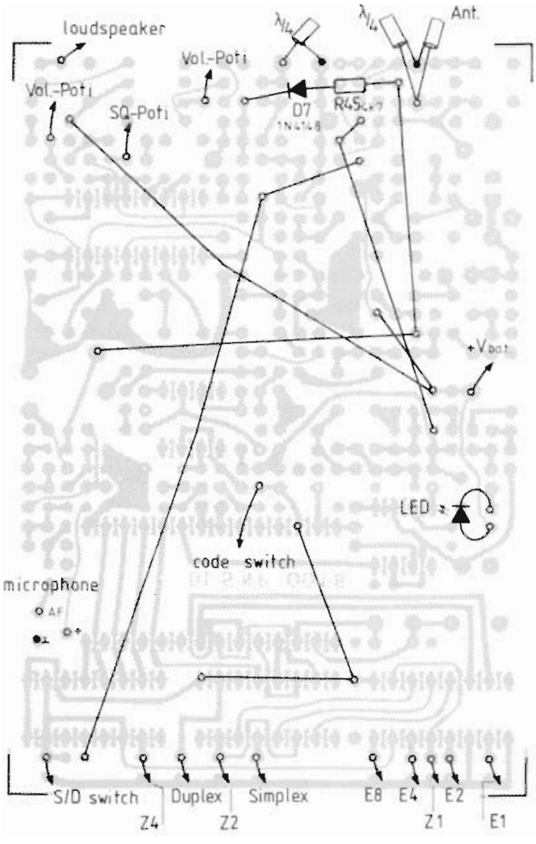


Fig. 5:
Connections, wire bridges and components on the PCB

been wired-in, the receiver alignment and testing can commence. For amateurs possessing the necessary test instruments, signal generator, sweeper etc., the alignment will present few problems. Those not so fortunate as to have access to test equipment should adhere to the following procedure:

First check the function of the transmit/receive change-over. The receiver's 8 V supply will be present until the PTT-switch contacts are grounded, thereby simulating the "transmit" condition. P 1 is set to minimum and P 2 to maximum. The loudspeaker will emit some noise which, with FL 3, can be tuned to maximum.

The antenna can now be connected and the code switch operated to select a high-signal level transmission (e.g. a radio relay station etc.) When this is being done, the correct position of the simplex/duplex switch must be made. The transmitter should already be heard in the loudspeaker. Inductances L 2, L3, and L 4 are then adjusted in turn for the best possible reception. For an indicator, an oscilloscope can be connected to the 455 kHz output of the ceramic filter. FL 3 is then adjusted for the best intelligibility. The tuning is repeated, but this time, when the receiver has been tuned to a weak signal. If the loudspeaker output is insufficient, a 10 μ F tantalum capacitor may be connected between the pin 1 (+ Ve) and pin 8 of the LM 386. It must be pointed out, however, that operating the receiver at a high audio output level will tend to run-down the batteries so much quicker.

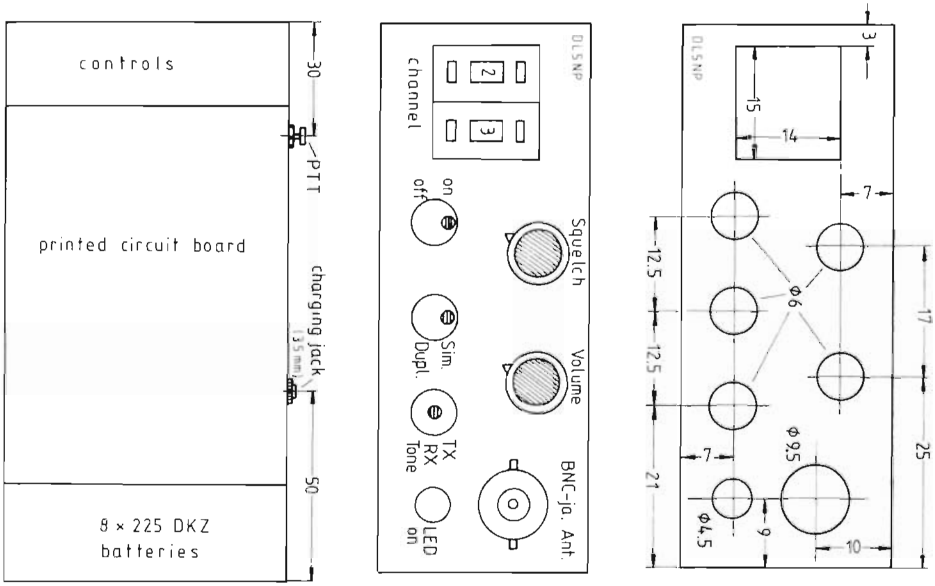


Fig. 6: Dimensions of tin-plate housing

3.3 Construction of the Transmitter

Basically the same rules of construction apply to the transmitter as to the other parts of the transceiver. Inductors L 5 and L 6 are installed without a core. Take care that transistor T 9's case does not contact ground. The cooling of this transistor is effected by means of an appropriately bent tin-plate heat sink. D 9 is not installed for the moment. Instead, a power meter (or an SWR meter plus dummy load) is connected to the output of the pi-filter. The PTT-switch contacts are bridged and L 7 and C 57 are iterated until a maximal output power has been tuned. A power of about 600 mW should be achieved. The antenna change-over can now be completed. Capacitor C 66 is soldered directly to the antenna socket. The tuning of the transmitter power stage and receiver input circuit should now be checked once more.

The transmitter deviation is best adjusted with the aid of another station's signal report. The frequency response may be adjusted by changing the values of C 10 and C 60 if it should be necessary to compensate for the characteristics of the electret microphone. If the limit comes in too early, the gain may be reduced by a resistance in the microphone lead.

4. HOUSING THE TRANSCEIVER

The author used a tin-plate box WB 13, dimensions 148 × 74 × 30 mm, for the housing. The PCB is soldered, at its sides, to the housing for the necessary mechanical stability. In order to in-

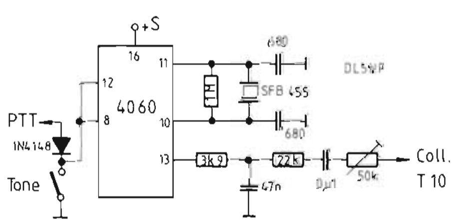


Fig. 7: A stable call-tone generator

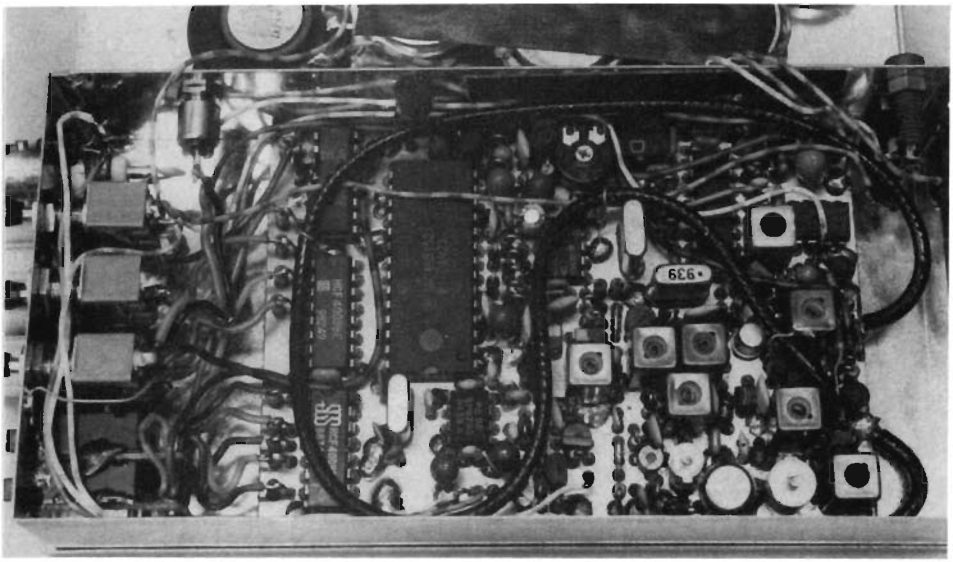


Fig. 8: Prototype showing also part-view of cover containing batteries and microphone

crease the mounting area, available for the operating control components, part of the tin-plate lip was removed at appropriate points. The code switch had to be shortened, with a fret-saw, in order to make it fit. Further details of the construction may be seen from **fig. 6.** Other forms of packaging are, of course, possible but they all must be of metal on account of the necessary RF screening required.

5. CALLING-TONE FACILITY

A signal from a call generator is easily introduced to the collector of T 10. The generator may be constructed on a piece of veroboard and mounted pick-a-back style on to the main board. Many call-tone circuits (e.g. using the NE 555) have been published and the author used the one shown in **fig. 7.** This proved particularly stable as far as temperature was concerned. A ceramic resonator SFB 455 (Murata) is driven, in the 4060 oscillator circuit, at a frequency of 448 kHz, somewhat under its midband frequency. After a division by 256, the 1750 Hz call-tone frequency is obtained. Operating the call button the transmitter automatically modulates. The deviation can be adjusted by the 50 k Ω potentiometer.

6. REFERENCES

(1) Motorola:
Data Book
RF Semiconductors 1980

(2) Texas Instruments:
Linear Circuits Data Book 1984

(3) Plessey Semiconductors:
SP 8000 High Speed Dividers
Integrated Circuits Handbook 1982

(4) Motorola:
CMOS Data Manual Special
Functions 1983

A. R. Jenkins, ZL 2 TVT

Active Probe Scaler 400-1300 MHz

The attached circuit schematic should prove a valuable accessory to those enthusiasts who desire means of measuring 400-1300 MHz with an excellent degree of sensitivity, combined with simple frequency counter modifications, which correct the display reading in conjunction with the prescaler division of 256. I.e. if the probe input frequency is 1296 MHz then the counter display also indicates this value.

1. CIRCUIT DESCRIPTION

The input transistor MRF901 and the Philips Broadband Amp OM361 amplify the sensed frequency, which is fed into the RCA CA3179 ECL Scaler. The ECL level signal output being 5.0625 MHz when 1296 MHz is sensed, is directed to a phantom fed modified input of any frequency counter which must supply a relatively clean 12 V positive regulated rail. The DC is thus fed down the coax and AC decoupled to the input of the 78L05 regulator, which supplies the required regulated +5V to the 1st and 3rd stages. The decoupled 12V input is fed to the OM361 which requires same for correct operation. The broadband tuning on the input of the OM361 will help improve the pick-up sensitivity at 1296 MHz, and whilst no accurate sensitivity figures are available, the 1152 MHz diode multiplier in the author's 1296 MHz receive converter is easily sensed and would only be a few milliwatts.

To ensure favourable sensitivity, all connections should be short and bypass capacitors of the chip variety, though it is not necessary to use the expensive ATC Brand. The less expensive WESCAP or Vitramon work well. The probe components are mounted within one of the smaller Eddystone diecast boxes and suspended 80 metre style on top of a double-sided G10 laminate which has both planes grounded to the bottom of the box. The input connector should be of miniature low-loss variety and the pick-up loop is approx. 50mm teflon with a 1 turn loop one end and matching plug the other end. This allows the operator to hold the probe in one hand and direct the insulated pick-up loop sensor in close proximity to RF without fear of any metallic contact.

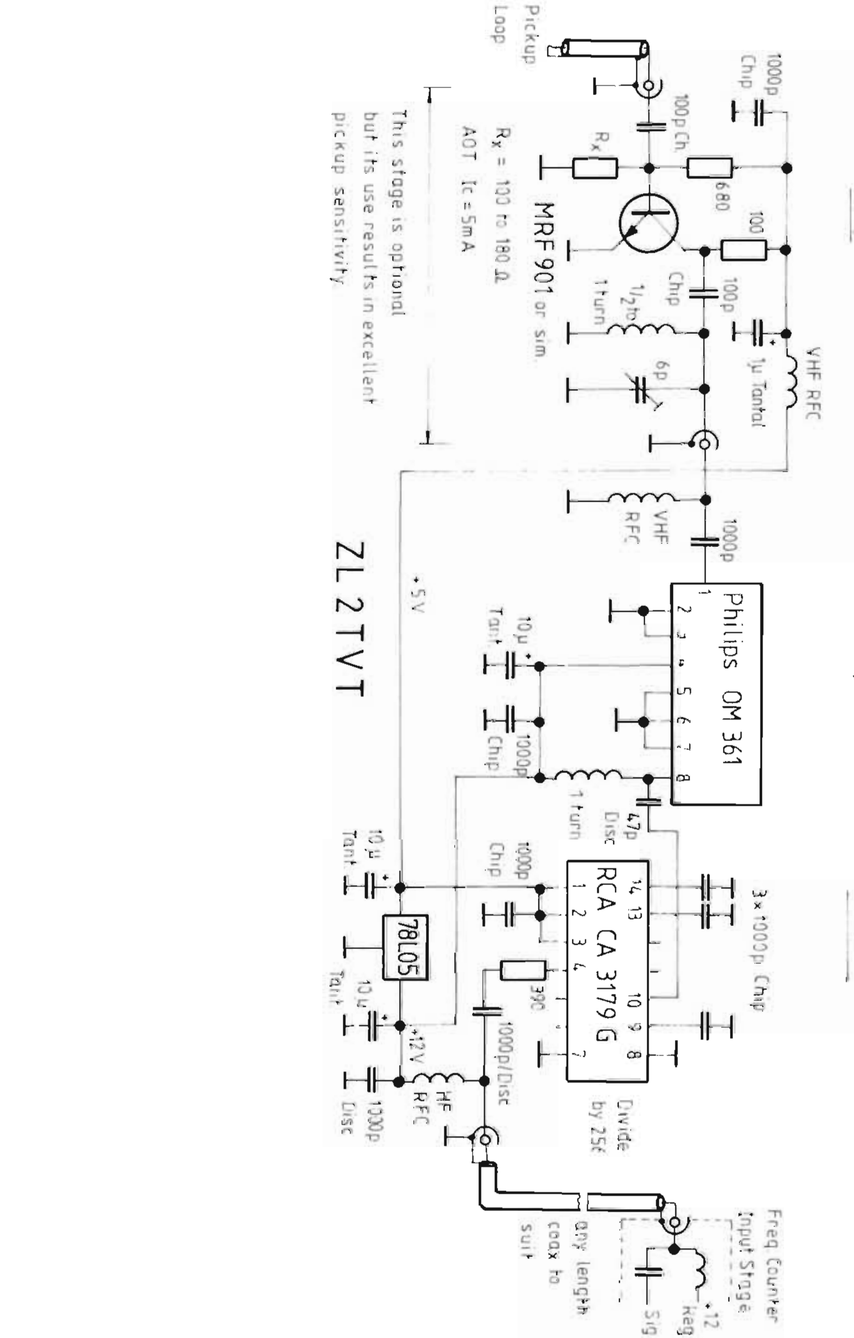


Fig. 1: Circuit schematic of the Probe Scaler 400 - 1300 MHz

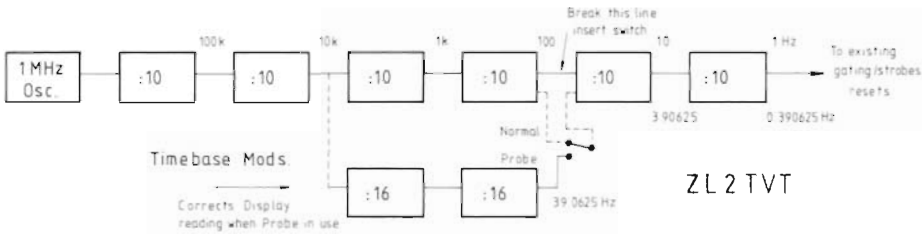


Fig. 2 a: Frequency counter with timebase modifications

2. INDIRECT MEASUREMENT

The loop pick-up is most desirable for indirect measurement as the sensor is held only close enough to ensure a stable reading and does not upset or overload any circuitry. Direct electrical connection, whilst possible, is probably not advisable at these frequencies as the pick-up sensitivity is excellent in its present form.

A random display reading is evident on the author's frequency counter when no input is available at the probe input and probably due to a high frequency oscillation within the probe due to the high gain, but disappears when a valid signal is sensed.

3. FINAL NOTE

Modifications to an existing frequency counter are simple being the addition of two divide by 16 devices either TTL or CMOS to suit and one switch. This slows the gating etc. by a factor of 2.56, but is a small price to pay for a counter which reads correctly.

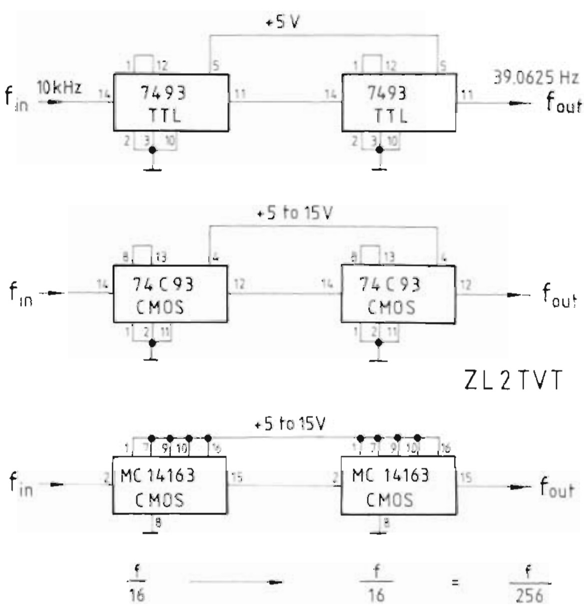


Fig. 2 b:
Three versions of utilizing various counters in timebase modification

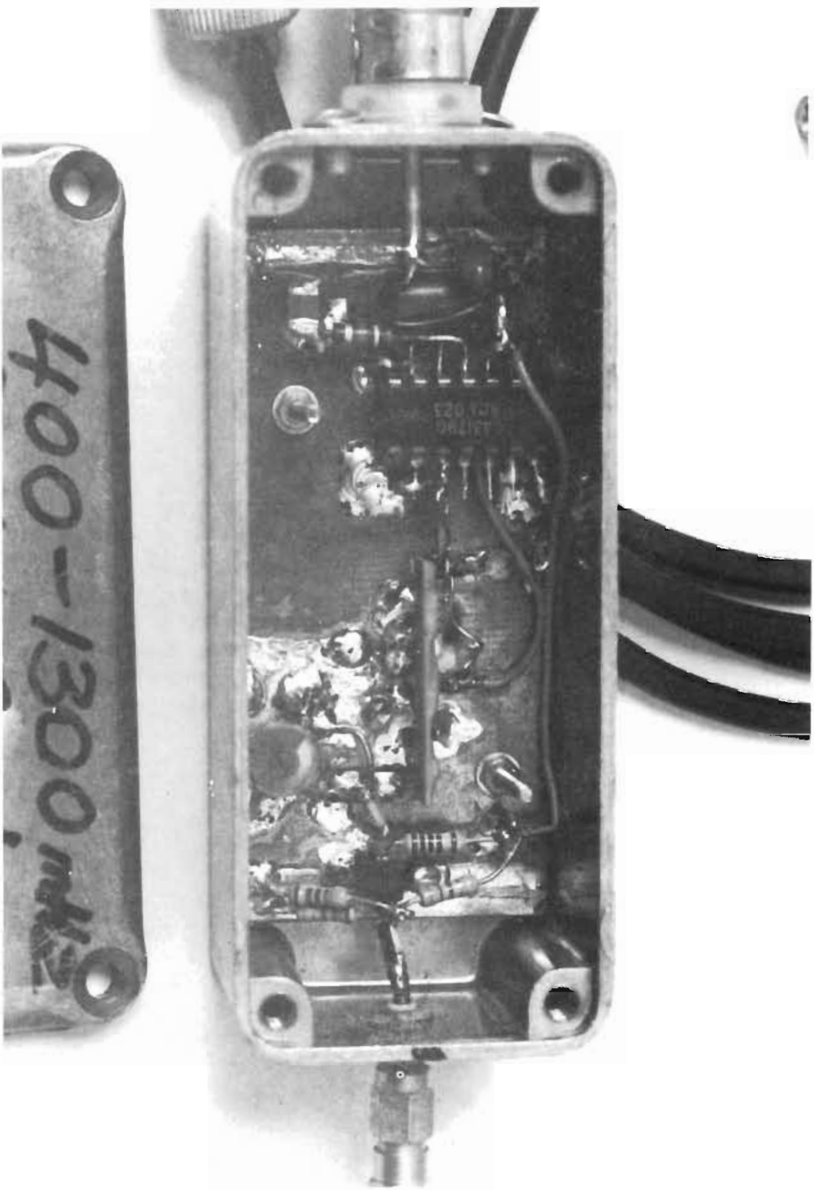


Fig. 3: Photograph showing the internal view of the described Probe Scaler

Fig. 4: Photograph showing the author's original design

Guenter Sattler, DJ 4 LB

SDA 3202 – A New PLL IC for up to 1.5 GHz

The Phase-Locked-Loop (PLL) circuit SDA 3202, with an integrated frequency divider, is a new Siemens chip in the SDA (Siemens-Digital-Abstimmsystem) series developed for television sets. It enables a crystal controlled adjustment of voltage controlled oscillators (VCO) at a 62.5 kHz channel spacing and is suitable for all amateur use where – kHz or Hz steps are not required. A possible application is for wideband systems such as AM or FM amateur television (ATV). The PLL frequency synthesizer can replace the usual multiplication of a crystal source (s) and the accompanying filtering measures necessary to minimize harmonics.

1. MEASUREMENTS ON THE SDA 3202

The SDA 3202 works in the frequency range 16 to 1500 MHz – the upper limit being that of the integrated divider. The curves of **fig. 1**, comprising Siemens data up to 950 MHz and the author's tests above 1 GHz (abridged), show merely the largest and the smallest RF input powers at which the integrated divider is able to function. The upper limiting frequency of twenty-five examples (tested using IC sockets on a PCB) lay within a

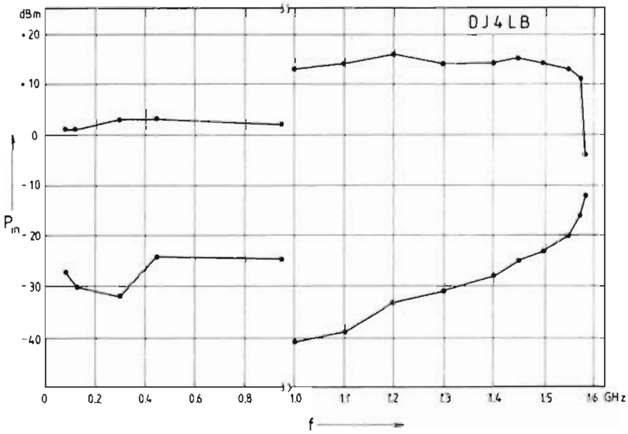


Fig. 1: Dynamic range versus frequency of the SDA 3202. Up to 950 MHz; given in the data sheet.

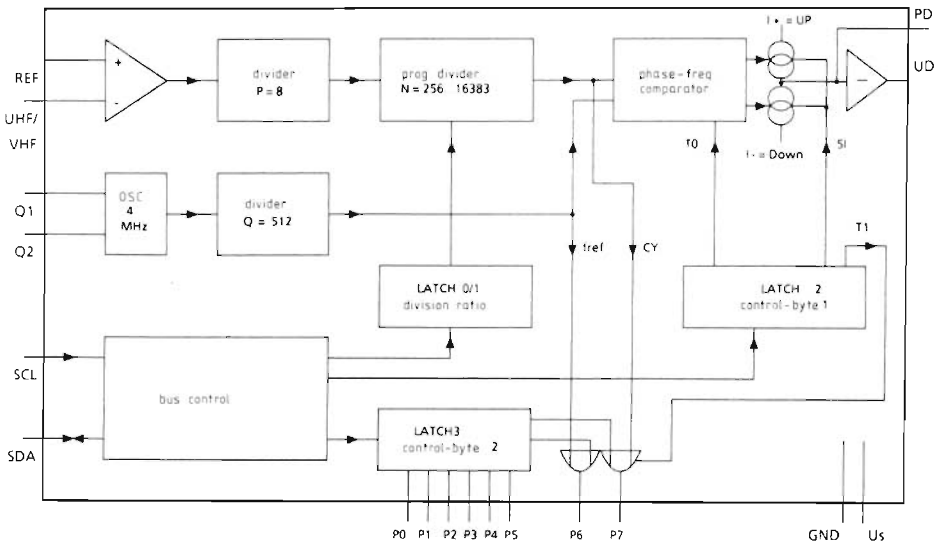


Fig. 2: SDA 3202 (Siemens) block diagram

range of 1560 to 1605 MHz. In association with the high-speed 2 : 1 pre-scaler NEC μ PB 581 C the subject chip is able to stabilize VCO frequencies in 125 kHz steps to approximately 3 GHz.

2. APPLICATION IN TV RECEPTION

Fig. 2 shows the block-diagram. The VHF/UHF input signal frequency is divided, according to the programming, and compared with a crystal controlled reference source of 4 MHz divided by 512 i.e., 7.8125 kHz. The frequency/phase detector controls the tuning of the VCO and uses external components for the loop filter.

A tuner may be employed for ATV reception in the 23 cm band for the production of the satellite receiver's first IF e.g. the IC UT-06B (Sanshin elec.). This chip uses an oscillator at 70 MHz above the received frequency (900 - 1500 MHz) and the half-frequency of the oscillator is used for a frequency counter and/or PLL operation using an input power of - 12 to - 15 dBm. A typical application circuit for the SDA 3202 is shown in **fig. 3** with, as far as is possible, the oscillator frequency (and the consequent 5 × diode tuning) together with the frequencies of the rest of the tuned-circuit in 125 kHz steps.

3. EXPERIMENTS

In the TV set, the 40-pole user-specified microcomputer SDA 2011 controls the PLL module. The interface is the I^2C Bus which needs two lines (SDA=data, SCL=sync.) for the serial data transfer.

Under experimental conditions, the SDA 3202 may be programmed by hand. Just a toggleswitch is required for the data and a push button for the

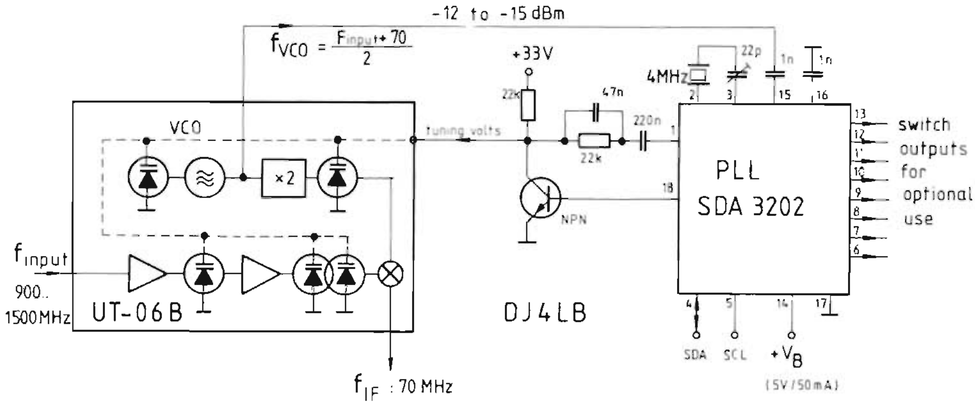


Fig. 3: Typical application circuit

synchronizing. A contact anti-bounce circuit and a few minutes time are also required. The schematic is given in **fig. 4.**

The logic arrangement of the telegram-bytes is shown in **table 1.** The address-byte differentiates the PLL circuit from other chips at the I²2 C Bus.

The two divider-radio arranged bytes may be also identified directly with the given frequency. The Siemens "supplement" for the 23 cm band (1240 - 1340 MHz): The bit n14 given in the table as 0 may also be set at 1 whereby the highest programmable frequency results in 2048 MHz (theoretically) and not 1024 MHz.

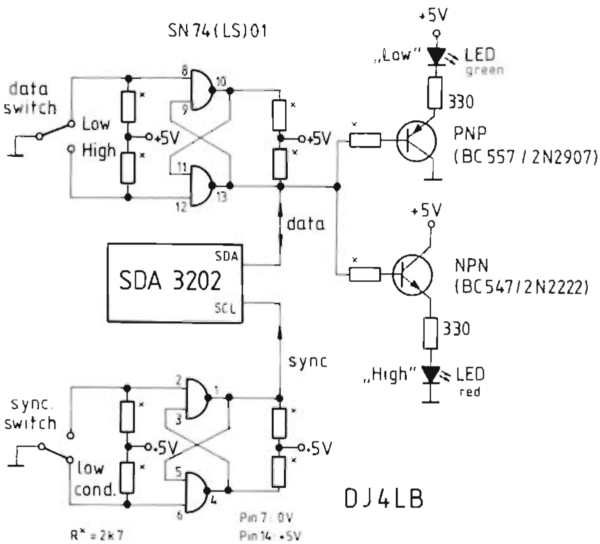


Fig. 4:
Circuit of test manual control of I² C-bus controlled chip

SDA 3202 Logic Arrangement

Table 1: Telegram-Bytes arrangement

MSB A = Acknowledge

Addressbyte	1	1	0	0	0	0	1	0	A	
prog. divider Byte 1	0	0	n13	n12	n11	n10	n9	n8	A	← division ratio n
		1024	512	256	128	64	[illegible]	16		
prog. divider Byte 2	n7	n6	n5	n4	n3	n2	n1	n0	A	
	8	4	2	1 MHz	500 k	250 k	125 k	62,5 KHz		← frequency
control info Byte 1	1	5I	T1	T0	1	1	1	0	A	
control info Byte 2	P7	P6	P5	P4	P3	P2	P1	P0	A	

Total division ratio N = sum n

N = 8192*n13 + 4096*n12 + 2048*n11 + 1024*n10 + 512*n9 + 256*n8 + 128*n7 + 64*n6 + 32*n5 + 16*n4 + 8*n3 + 4*n2 + 2*n1 + n0

Band sel.:

P 3 ... P 0 = 1 Current sink is activ

Pump current change-over

5I = 1 high current (typ. 150 µA)

DJ 4 LB

Port outputs:

P7 ... P4 = 1 Open collector output is active

Test mode:

T1,T0 = 0,0 Normal operation

T1 = 1 devided input freq. on P 7 and devided crystal freq. (7.8125 kHz) on P 6 for freq. measurement

Example:

The stabilizing of a VCO at 1296 MHz: Bit n14, n12 and n8 = 1, all other divider bits are zero.

3.1. Data input

Start condition = start of every telegram:
When SCL is HIGH, SDA is LOW.
Stop condition = telegram end:
When SCL is HIGH, SDA is HIGH

The date, selected by the switch LOW (L) or HIGH (H) is, with every positive flank of the synchronizing (L to H upon pressing the push-button), taken over by the PLL circuit control. This control "acknowledges" (A) every accepted byte by sending the bi-directional data bus to L as long as the following 9th sync. is H. This state of acknowledge is recognizable, irrespective of the date-switch setting, as the green LED (= LOW) only is illuminated.

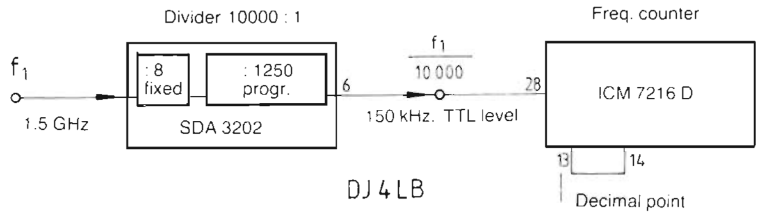


Fig. 5: The SDA 3202 as a 1.5 GHz decade frequency scaler for direct control of the counter IC ICM7216/7226 at TTL level (5)

3.2. The SDA 3202 as a counter frequency divider

The internal frequency divider of the SDA 3202 may also be used as pre-scaler for a frequency counter **(see figs. 5 and 6)** as the divided input frequency may be extracted from the IC by means of a "test-mode" (T 1 = 1 in the first control byte). It appears, at TTL level, at the open-collector output port 7 (pin 6) which should be connected to an external pull-up resistor of 2.7 KΩ to the 5 V rail. This output can be directly connected to the input of the integrated circuit counter ICM 7216 or ICM 7226.

Refering to the publication (1), the ICM 7216 D counter is preceded by a preseater of 10 000 : 1 pin 13 (dp) connected to point 14. By this means, the decimal point is independent of the gate time as it is always located at the end of a whole number of MHz.

It will be noticed, that the output level of the pre-scaler μPB 581 C is - 8dBm, this being exactly the input level required by the SDA 3202 at its highest usable frequency. It is thus possible to build a frequency counter, which functions up to a frequency of 3.1 GHz, with only three integrated circuits.

4. REFERENCE

(1) Hanschke, W., DC Ø RZ:
C-MOS Frequency Counter for 10 Hz to 1 GHz VHF COMMUNICATIONS Vol.16, Ed.3/1984, Pages 182-187

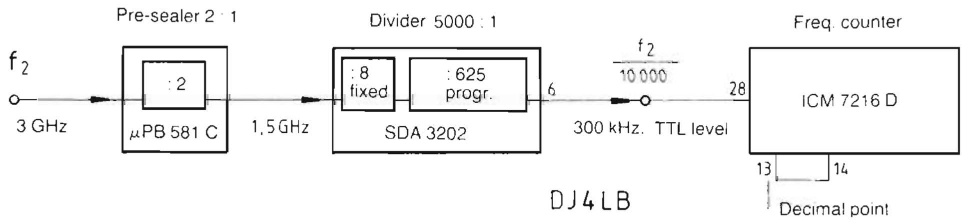


Fig. 6: The SDA 3202 as a decade frequency scaler with a 2 : 1 3GHz pre-scaler driving the ICM 7216/7226 directly at TTL level

Klaus-Dieter Broeker, DK 1 UV

Coaxial Power Amplifier for the 13 cm Band Using Tube TH 6885

A transmitter power amplifier is described which uses a normal commercial tube and which may be constructed with only a little lathe-work as great emphasis has been placed upon simplicity of construction. A power output of 75 Watt is easily achieved in the 13 cm band with only 900 V at 300 mA anode supply at a power gain of 10 dB. A higher anode potential, together with the appropriate level of forced air cooling, will yield considerably more output power. The anode construction may be seen in fig. 1 as the cooling duct has been removed.

1. THE TUBE

The electronic power tube TH 6885 (or TH 021 A, or TH 310) is manufactured by the French electronic firm of Thomson-CSF. It is a glass / metal triode using planar technology with an anode dissipation of 250 Watt. The cathode is indirectly heated with 6.3 V at 2.1 A. The heater must be on for at least two minutes before power can be applied. The transconductance of the TH 6885 is 25 mA / V and the following interelectrode capacitances are specified:

grid - cathode:	
cold:	12.00 pF
warm:	14.00 pF
anode - grid:	3.60 pF
anode - cathode:	0.06 pF

The maximum permitted anode voltage is 1200 V and the maximum continuous anode current is given as 250 mA. The manufacturer specifies a maximum working frequency of 3 GHz. At maximum anode dissipation the tube must be cooled with air flowing at around 600 litres per minute. The pressure drop at this level is about 5 g / cm^2.

2. RESULTS OBTAINED

With 10 W drive from a 2 C 39 BA the TH 6885 delivered an output power of 80 W. At this output, the anode current rose from a quiescent 100 mA to 300 mA. The power gain was measured at 9 dB.

Increasing the drive from the 2 C 39 BA to 20 W resulted in a 150 W output power, the gain being 8.8 dB. This power is, however, not permitted, neither by the manufacturer nor by the amateur licensing authorities.

In order to save the constructor some possible experimental work, a few failures should be mentioned at this point. A 9 cm band version was designed and built but the results were disappointing.

At a drive input of 6 W from a YD 1060, the output obtained from the TH 6885 was only 6 W i. e. a gain of 0 dB – the DC anode current was 320 mA.

Also worthy of mention, perhaps, is an earlier attempt to make a 13 cm-band amplifier from four

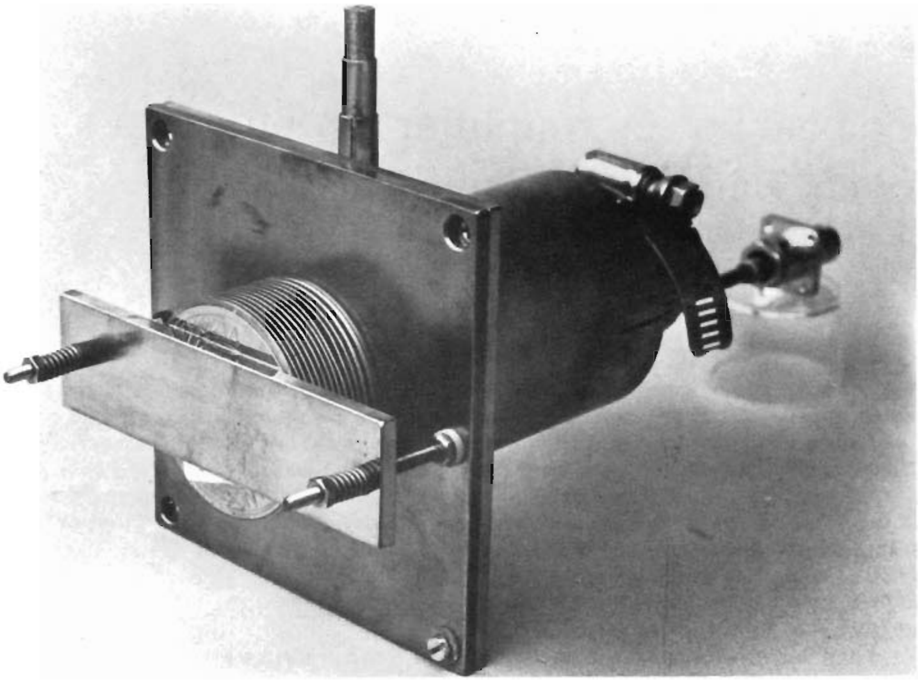


Fig. 1: The electronic tube TH 6885 with its narrowly spaced cooling-fins sprung firmly into position (insulation and cooling ducts removed)

2 C 39 BAs. The amplifier was a lot of trouble to build but the gain was only 2 dB.

3. DIMENSIONS

The anode resonator is electrically 3 λ / 4 long and the cathode resonator 5 λ / 4. The shorting plunger is λ / 4 long with a 5 % velocity factor.

Both, anode and cathode resonators represent capacitive shorted coaxial tuned-circuits whose mechanical lenth L can be calculated by means of the well-known formula (1):

$$L = \frac{\lambda_E}{360} \, [\, 90 - \arctan (2 \pi \times f_E \times C \times Z) \,] \qquad (1)$$

where

λ_E = equivalent wavelength = $\frac{3 \times 10^5}{f_E}$ (mm)

f_E = equivalent frequency: for 3 λ / 4 = f / 3 and for 5 λ / 4 = f / 5

C = tube capacitance for the anode resonator $C = 3.6\ pF = 3.6 \times 10^{-12}\ F$ for the cathode resonator $C = 14\ pF = 14 \times 10^{-12}\ F$

Z = characteristic impedance of coaxial resonator = 60 ln D / d
where D = int. dia of outer tube
d = ext. dia for grid tube
for the anode circuit:
$Z = 60 \ln 50 / 28 = 34.7\ \Omega$
for the cathode circuit:
$Z = 60 \ln 26 / 14 = 37.1\ \Omega$

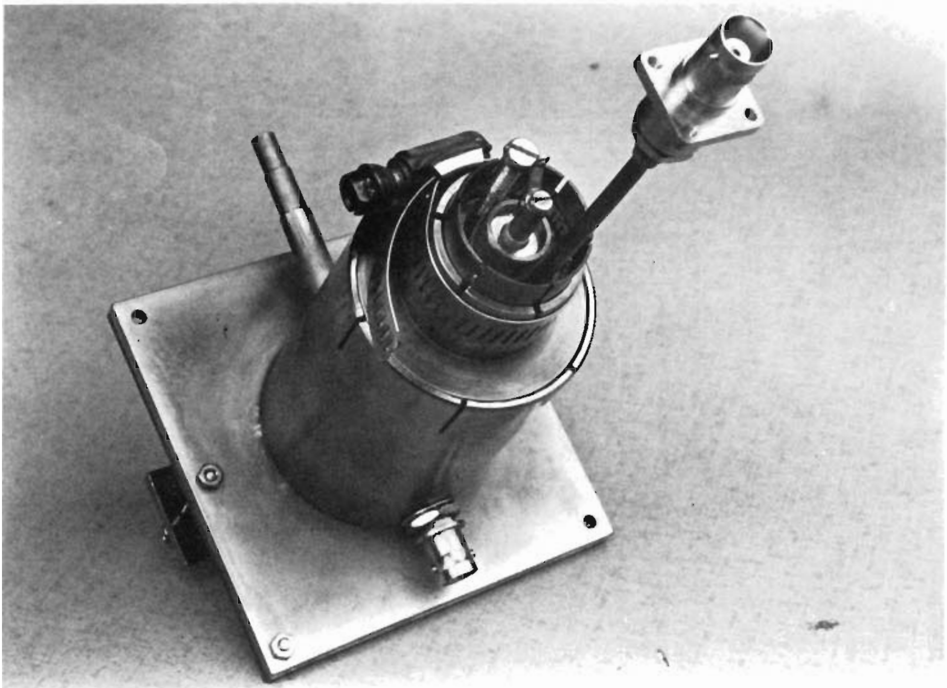


Fig. 2: The PA's cathode (anode pipe clip removed)

At this point it may be mentioned, that at high values of anode resonator impedances there may be problems with the tuning elements and tuning range at the higher frequencies. This means that when Z = 60 Ω the tuning plunger at 2320 MHz is in resonance since it has a longer length than the inner conductor.

The length of the shorting plunger is calculated by formula (2)

$$L_{KS} = \frac{3 \times 10^5 \times 0.95}{4\,f\,(\text{MHz})} \qquad (2)$$

The construction may be determined for other frequencies by converting the formula. The author has the results for the 70 cm and 23 cm bands and may be obtained by sending an SAE to VHF COMMUNICATIONS.

An electrical schematic is quite superfluous but the quiescent current adjusting circuit was taken from the transistor circuit of LA 8 AK (VHF COMMUNICATIONS 4 / 1981). **Fig. 2** shows the amplifier from the cathode side.

4. CONSTRUCTION

Fig. 3 shows a cross-sectional view of the stage but without dimensions. Three types of contact material are employed, all of which may be obtained from the firm Feuerherd of Berlin quoting the part-number given. The output coupling is made via a BNC socket which, at this power and

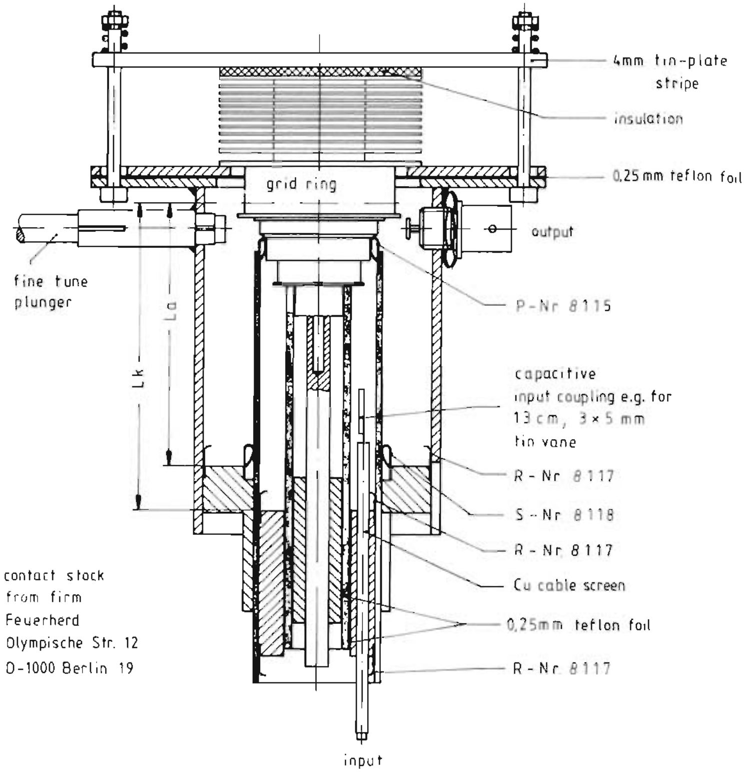


Fig. 3: Coaxial PA for 70 cm, 23 cm or 13 cm using the tube TH 6885 or TH 021 A

frequency, is not ideal – an N socket or 3.5 / 9.5 socket, with a threaded portion for depth adjustment, would be much better. The input coupling uses a semi-rigid, copper-screened cable (e. g. SR-3 from the firm Suhner).

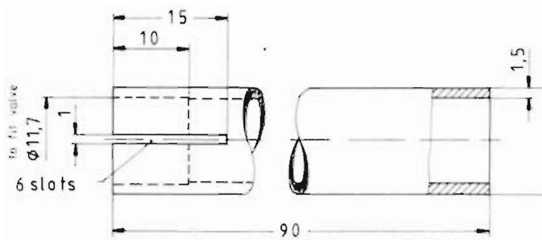
If the stage is driven in the quarter-wave mode – e. g. in the 70 cm-band – an inductive coupling is recommended. It consists of a small loop of the inner conductor and proved to be very succesful. The connection to the semi-rigid cable can, again, be made with a coaxial cap with an N socket or with a modified BNC socket fitted with a 3 mm cable insert.

The parts are fabricated according to **figs. 4 to 7.** All rough edges should be removed with emery-cloth.

First, the anode cylinder (dia 54 × 2 mm) is turned from a 76 mm length and brazed onto a brass plate of (100 × 100 × 2.5 mm). The assembly is turned transversely to plane the surface and a hole of 45 mm diameter cut out.

The grid cylinder (14 mm dia × 11.90 mm long) must be turned internally in order that the cathode connection of the electronic tube may pass almost to the full length of the slots with a tight sliding fit.

The heater contacts consist of a 5 mm dia brass rod having an internal 20 mm long 2 mm threaded section. This rod is cut with a fine hack-saw blade, twice across the diameter in quadrature, to a length of 15 mm in order that it makes a tight push fit into the electronic tube's heater connection.



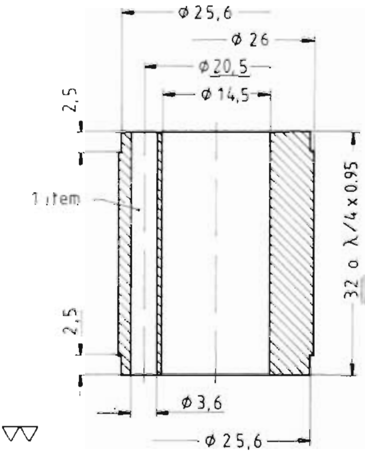


Fig. 4: Grid cylinder and grid shorting plunger

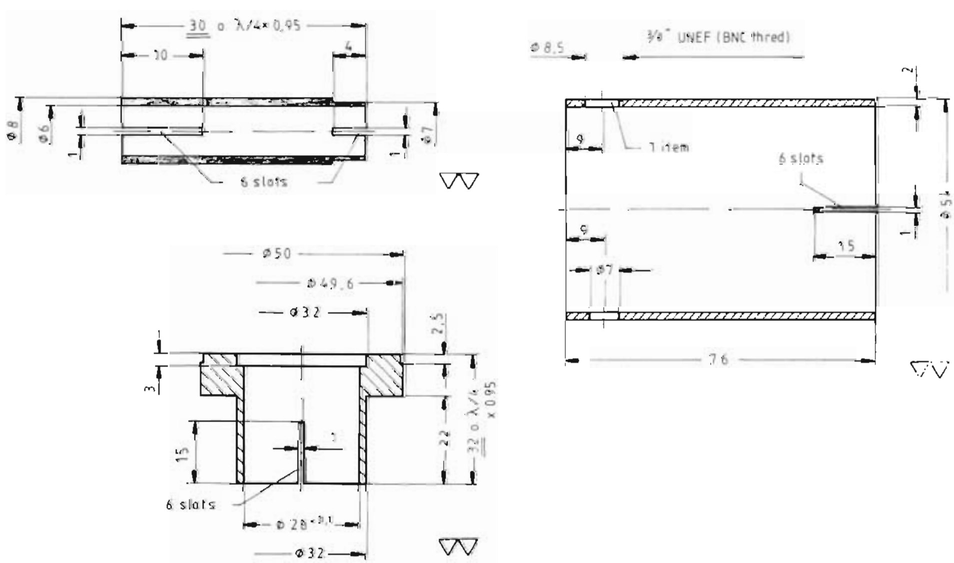


Fig. 5: Tuning plunger tube guide, anode resonator cylinder and shorting plunger (centre)

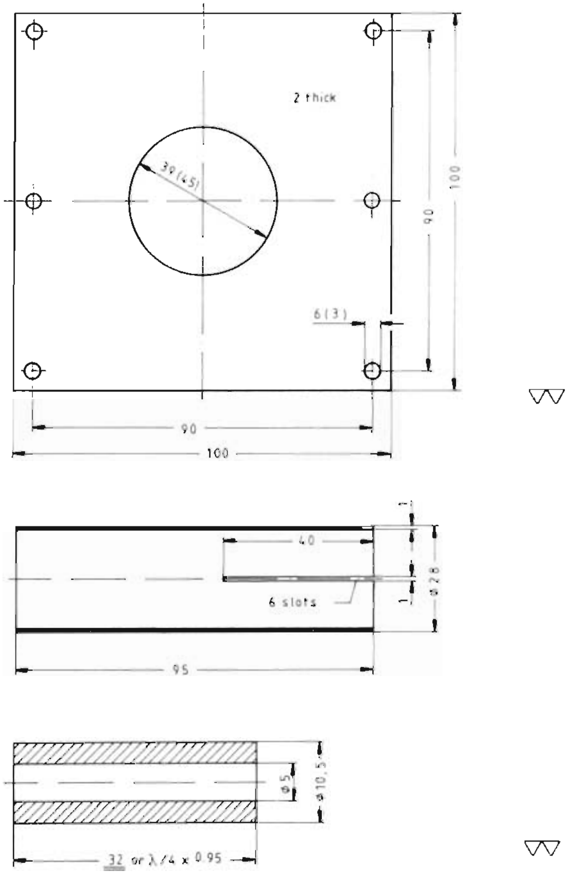


Fig. 6: Anode plate or its cover plate (dimensions in brackets), anode cylinder and brass shorting plunger for the heater connections

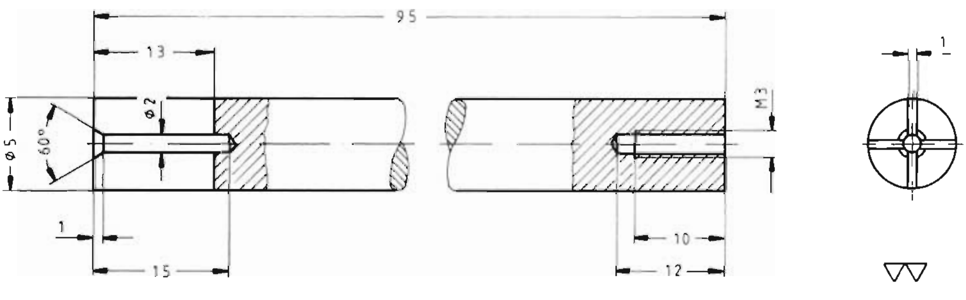


Fig. 7: Brass heater connector rod

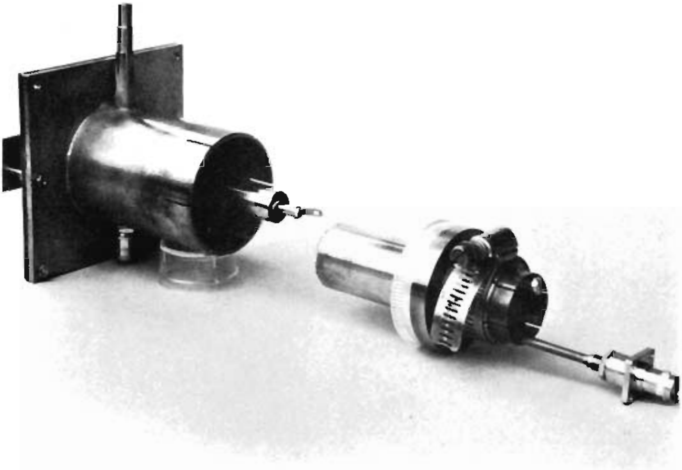


Fig. 8:
Grid cylinder and anode shorting plunger withdrawn

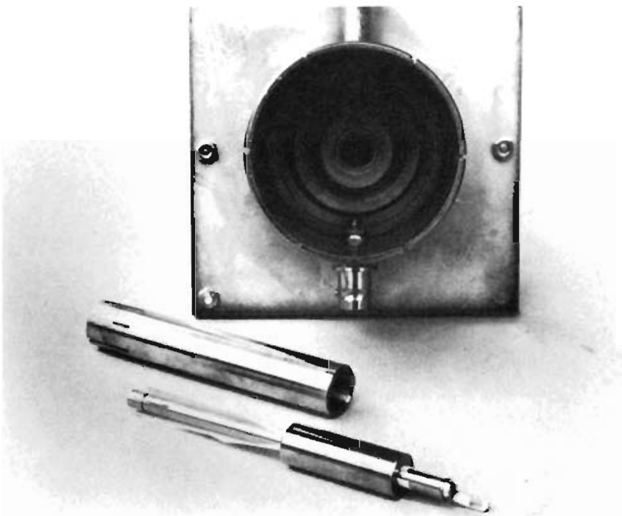


Fig. 9:
Anode cylinder with output coupling showing heater connecting rod in foreground

The tuning plunger for "fine tune" consists of a 6 mm dia brass rod of optional length.

The fine cooling fins of the anode cause a relatively high air resistance which must be overcome with a powerful blower (Schubert). An air-duct may be fabricated from insulated cardboard and installed according to the positioning and type of blower used. Also not shown are the proprietary tube fixing clips which lock the two shorting plungers into position. One of them may be recognized in the photographs of the PA in the disassembled state (**fig. 8, 10 and 11**).

The photographs give a "plastic" impression of the parts and their assembly, but they do give the

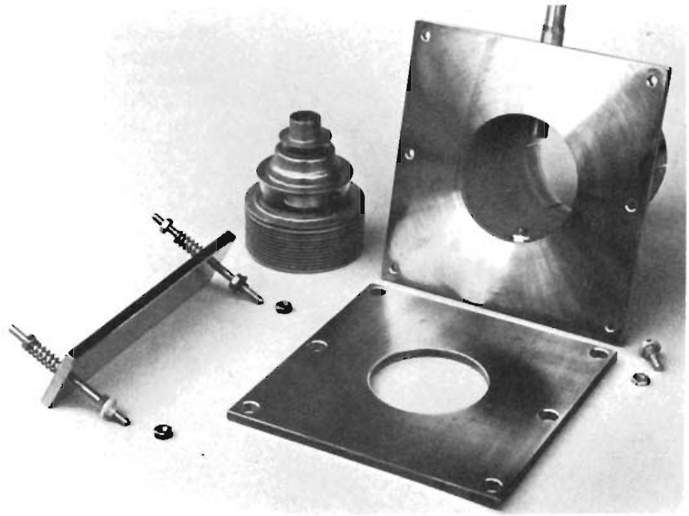


Fig. 10:
Fine tuning and anode cavity output coupling

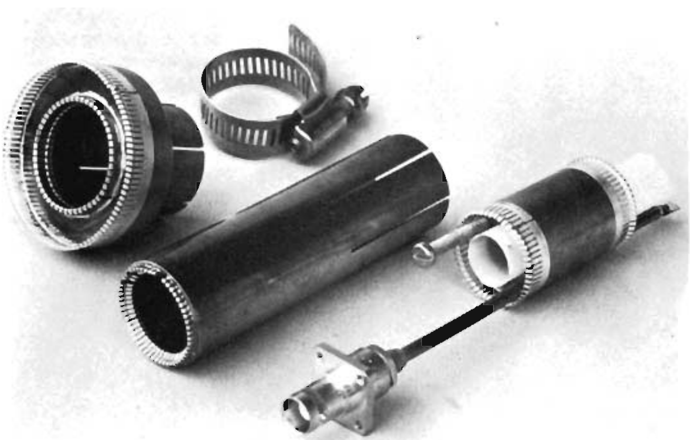


Fig. 11:
The long 3 mm screw enables the cathode shorting plunger to be tuned

uninitiated an idea of the construction. It should be noted, that the insulating material between the anode plates and between the heat-sink and pressure plate have been removed for the photographs.

The fitting of the anode plates must be very carefully carried out. All drillings and edges must be lightly chamferred-off in order to discourage high-voltage arcing. The insulation of screw holes uses the same parts employed in the fitting of power transistors. The anode supply voltage should be connected directly to the plate and not above the cooling fins.

VHF communications

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Peter Gerber, HB 9 BNI

Antenna-Position Calculations for Measurements of Cosmic Radio Sources and EME-Communications

In the last few years there have been various techniques given which allow the quality of a VHF / UHF receiving system to be determined by means of measuring the Sun's radio noise or noise from cosmic radio sources (1, 2, 3, 4). One problem of such measurement, is the position in the sky of the object concerned. When using the Sun or the Moon, in good visibility, it is only a matter of sighting the antenna along the boom, but cosmic radio sources in Middle Europe cannot always be identified by sight owing to prolonged cloud-cover and one must resort to a few calculations.

This article describes a simple method to calculate both azimuth and elevation headings. These calculations may be carried out easily by means of a small programmable pocket calculator within an accuracy of one degree. This is sufficient accuracy for amateur antennas.

Calculation by means of a calculator is, in any case, quicker than using tables as, for example, described in (5).

1. A LITTLE ASTRONOMY

The position of a body in the sky is mostly given in the so-called "moving equatorial system". In this system, the position of a fixed star is always the same – at any rate for our purposes. The Sun and the Moon are moving objects in this system.

The reference plane of the moving equatorial system is the plane of the equator projected into the celestial sphere. The angular zero point is the direction of the so-called "spring-equinox". The size of this angle is designated "right ascension" (RA).

From the reference plane extends the graduations of the declension (DE) to the north and to the south corresponding to the lines of latitude on earth.

A point, that remains stationary in the moving equatorial system, moves – as far as earth's mid-point is concerned – once in about 24 hours around the earth. A further system of co-ordinates exists, called the „fixed equatorial system", which moves with the turning of the earth and is therefore fixed relative to the earth. A point that is always stationary over the same spot on the earth's surface (e. g. a geo-stationary satellite) has, in this system, fixed co-ordinates. The co-ordinates in this system are called "hour angles" (HA) and declination (DE). The declination is, of course, the same as that for the moving equatorial system.

The transition from moving to a fixed system is carried out by the following transformation:

HA = sidereal time (ST) − RA
DE = DE

The sidereal time is the hour angle of the spring-equinox, but for more exact information see (6).

From the „moving equatorial system" one can convert to the „horizontal system" by means of a known formula (5). The co-ordinates in the horizontal system are azimuth (AZ), counted here from north eastwards, and elevation (EL). Both these quantities can be used to programme antenna rotors.

1.1. Sidereal Time

For the transition from moving to the fixed equatorial system a knowledge of sidereal time is necessary. This is calculated from the time of day (HH.hh in hours and decimals, UT) and the position of the earth in its orbit around the Sun. The latter can be calculated but the exact calculation is too complicated and involved for a pocket calculator. In order to obtain a usable accuracy, the following formula is sufficient:

$ST = 99.5^\circ - L_B + HH\ 15^\circ + DY\ 0.986$
where L_B = longitude of observer where east is negative.

DY = The observation day in the year (Julian calendar).

The day number can be taken from a Julian calendar of worked out as follows:

$DY = 31\,(M - 1) + D$ for $M \leq 2$
$DY = 31\,(M - 1) - \mathrm{Int}\,(0.4\,M + 2.3) + D$ for $M > 2$

where M = Month of year i. e. 1 = January etc.
D = Day of Month

The formulae are not valid for a leap-year but the error is in any case, less than 1°. This value of sidereal time is calculated in degrees.

The right-ascension (RA) is normally given in time scale, i. e. in hours and minutes and must be converted to degrees by noting that 24 hours is 360°, therefore 1 hour = 15°.

2. AZIMUTH AND ELEVATION

The azimuth and the elevation may now be calculated as follows:

$$EL = \arcsin(\sin B \sin DE + \cos B \cos DE \cos HA)$$

$$AZ = \arctan \frac{\cos DE \sin HA / \cos EL}{(\sin B \cos DE \cos HA - \cos B \sin DE) / \cos EL}$$

Where B = latitude of the observation point

With these formulae the azimuth is not yet exactly determined because it must be corrected for the right quadrant:

if $AZ < 0$ then $AZ = AZ + 180^\circ$
if numerator > 0 then $AZ = AZ + 180^\circ$

With these formulae the elevation and azimuth in reference to fixed stars of still sources can be calculated. The right-ascension and the declination of the sources can be taken from (1).

2.1. Sun and Moon

The Sun and Moon move with respect to a fixed star and therefore no definate position can be given to them. The positions are able to be determined however – but with complicated formulae – on a home computer for example. It is easier though, to consult tables e. g. (7). These tables contain the right ascension and declination of these celestial objects, daily for zero hour UT. If a more exact result is required, it is better to interpolate between two observational times taken 48 hours apart.

A program of these basic rules can be obtained from the author by sending a cassette and an SAE. This program is suitable for the calculator family Casio FX-720 / PB-410.

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Konrad Hupfer, DJ 1 EE

A 20 W Linear Amplifier for the 23 cm Band

In the 1/84 edition of VHF COMMUNICATIONS (1) there was a description of a 10 Watt linear amplifier using a 25 V power supply. It also mentioned experiments on an NEC transistor, which, with a working voltage of only 13.5 V, produced a maximum output power of 20 W. With possible battery operation in mind, this semi-conductor is of interest for portable use and therefore quidance in the form of circuit schematic, construction and a few data curves is given in this article.

1. THE CIRCUIT

The circuit shown in **fig. 1** is similar to the experimental circuit given in (1). It was, however, completed by the addition of trimmers C 3 and C 4 for base and collector matching respectively. Capacitor C 3 can be a ceramic with a value of 2 pF but it must be soldered using the shortest-

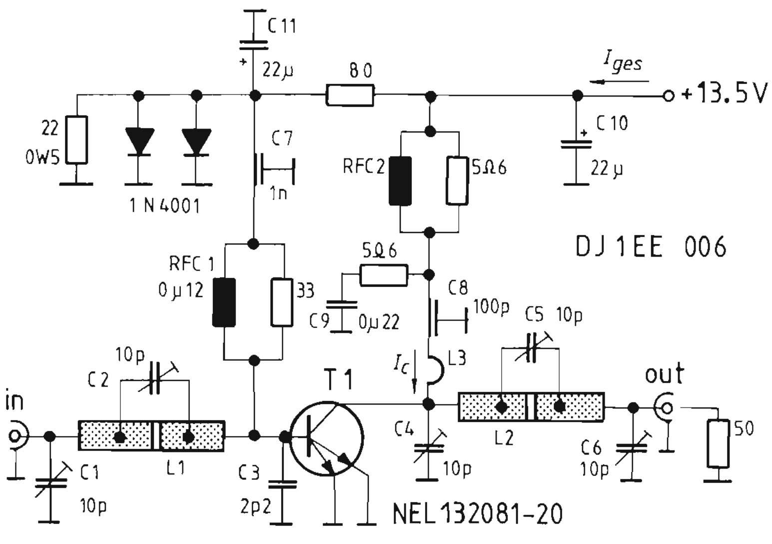

Fig. 1: Single stage linear PA can deliver 20 W at 1296 MHz

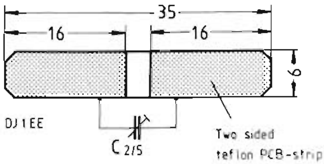

Fig. 2: Low-loss stripline circuits using two-sided copper teflon PCB material

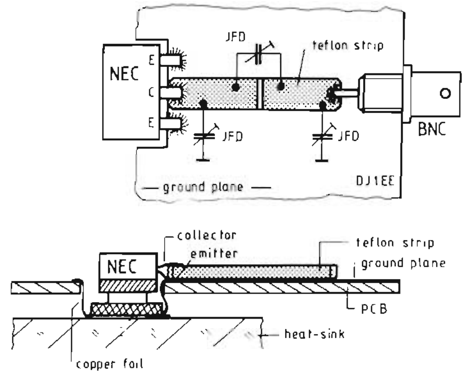

Fig. 3: Mounting and connecting the NEL 132081 transistor

possible connections between the base electrode and ground. The requisite inductance consists, here also, of a double-sided, copperclad PTFE (teflon) strip of PCB material with suitable discontinuities in the copper for the appropriate trimmers C 2 and C 5 – the unbroken copper side being soldered directly to the (cheaper) epoxy-glass PCB. The inductor strip dimensions are given in **fig. 2**.

It is recommended that trimmers C 4 to C 6 (approx. 10 pF) are concentric air-trimmers (JFD, Tekelec). These make the job of tuning considerably easier, and at less risk, than with ceramic or foil spindle trimmers.

The bias supply for the base consists of the circuit proposed in (1) using an LM 723 and a BD 135. The simple circuit given in **fig. 1** (NEC application note) was tried in a test circuit but it was found that the more detailed circuit was preferred, especially in cases where the temperature range is large (– 10 to + 50° C) and / or the heat-sink is small.

2. CONSTRUCTION

The construction information given in (1) together with setting up and tuning instructions are, of course, to be followed here. When mounting the transistors (**fig. 3**) take heed of the unusual arrangement of the pins; the chamferred tab is the base connection. The more important components are as follows: –

T 1:	NEL 132081-20 (NEC)
C 1 to C 3:	mini foil trimmer (SKY green)
C 4 to C 6:	microwave trimmer 10 pF (JFD, Tekelec)
L 1, L 2:	2 × Cu sided teflon PCB 1.4 mm thick strips (**see fig.2**)
L 3:	Cul wire 20 mm long, 0.5 mm dia
Ch 1:	Mini wide band choke 0.12 μH
Ch 2:	6 holed core choke (Valvo)

3. TEST RESULTS

As **fig. 4** indicates, the NEL 132081 transistor can deliver a power output up to 17 W in linear operation (at amateur quality) using a power supply of 13.5 V. The total base current and the efficiency depend, naturally, upon the type of bias circuit used. The curves shown in **fig. 4** are based upon the simple circuit given in **fig. 1** with a quiescent collector current of 200 mA. Two examples were tested which exhibited a wide disparity of results, indicating that the amplifier can turn out differently from the norm. In conclusion a few general obser-

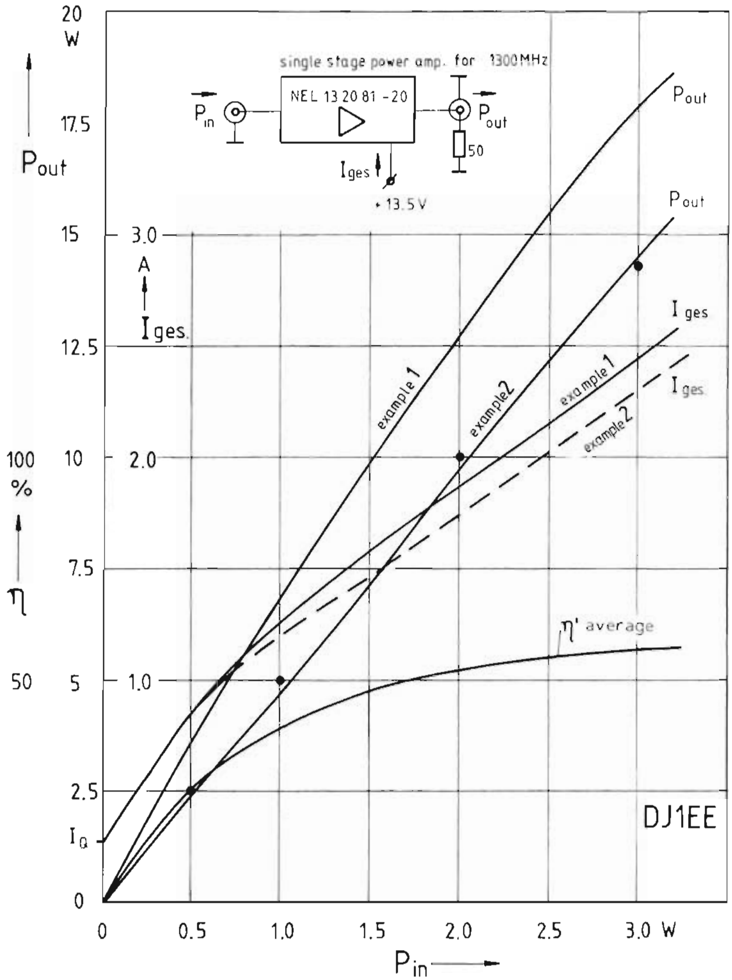

Fig. 4: Output power, total input current as well as the average efficiency of two transistor examples

vations:
This kind of amplifier in class AB operation is only stable with certain loads and generators. This may be ascertained by a perusal of the S-parameters. Stability is assured under a wide band, resistive 50 ohm load but definately not when the antenna is disconnected. The amplifier must always have a load connected before the supply voltage is applied.

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Franz R. Rathenow, DF 9 ZT

Oil Cooling for High-Power Tubes

In the design and operation of power tubes, the removal of heat from the tube must always be considered. Amateur power amplifiers are generally air-cooled but when the power output approaches the limit, quite large quantities of air become necessary. This requires a powerful forced air cooling system – which causes noise. In general, this noise cannot be reduced to the point where it becomes unobtrusive expecially when listening to very weak signals. The solution is liquid cooling, oil or water, preferably the former.

A suggestion on water cooling by DL Ø HC gave me the idea of developing a similar system. The system built by DD 8 DA in Bochum used copper-tube coolers and a car radiator as a heat exchanger. Sewing-machine oil served as the coolant. Actually, various types of oil may be employed for this purpose – my choice lay in a low-viscosity oil, Shell Tellus C 10, which appears to be readily abtainable. The important points about the selection of an oil are; it must be thin (a viscosity of 10 according to DIN 51519) and capable withstanding heat without breakdown of its properties. Also, it must not cause corrosion and must have a high-insulation resistance. Distilled water has the disadvantage of being a catalyst for corrosion. Finally the coolant should have a high-breakdown voltage.

Fig. 1: The modified 2 C 39 heat-sink (left) and the coolant jacket with inlet and outlet connections

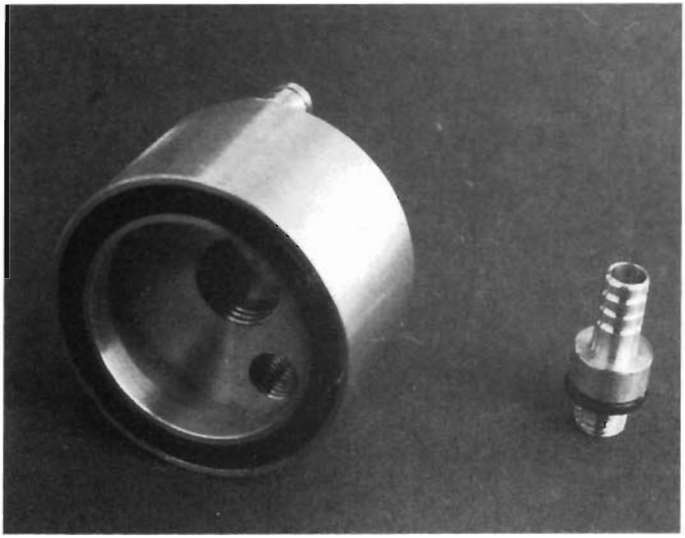


Fig. 2:
Coolant jacket showing sealing ring together with a pipe connector

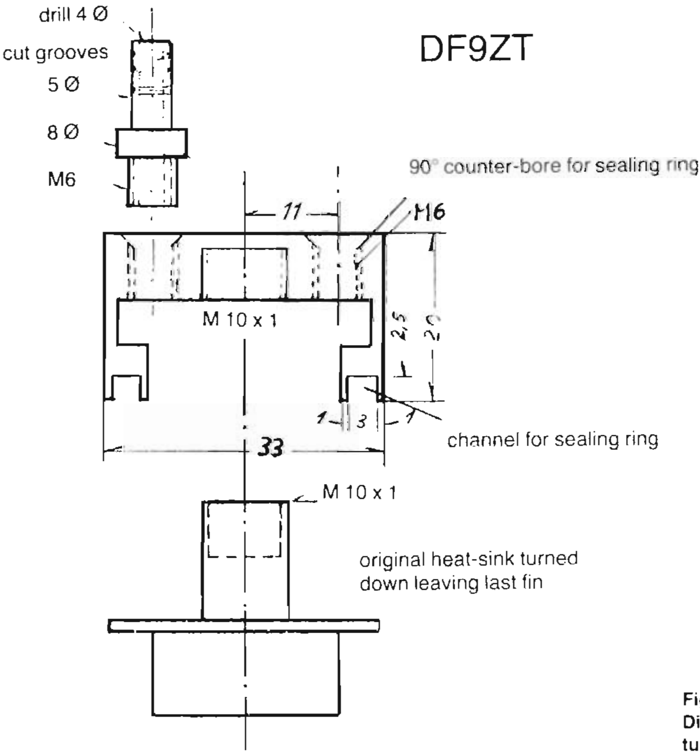


Fig. 3:
Dimensions of turned parts

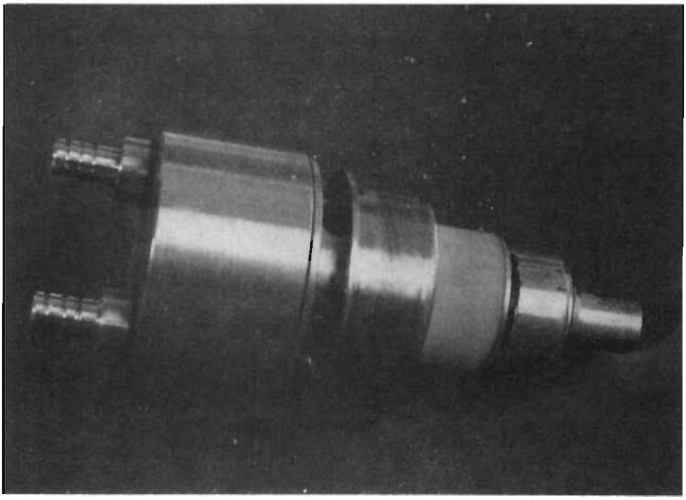


Fig. 4:
A 2 C 39 complete with coolant jacket

1. PRINCIPLE

In order to clarify the function of the complete system, the problem, of conducting heat away, must be considered a little more closely. The heat to be removed is developed at the anode of the power tube. The heat is normally dissipated by air flowing over the enlarged (with fins) surface of the anode. In this proposed system the same principle applies but the coolant is not air, but oil. This serves as a transport medium for the heat from the valve to the heat exchanger which is mounted some distance away and which dissipates the coolant heat into the surrounding air.

If this heat exchanger (radiator) is large enough, a blower becomes unnecessary. Since the radiator may be mounted just about anywhere it can be made as large as necessary, thus making a noisy blower superfluous or perhaps, at most, an almost silent fan would suffice.

2. CONSTRUCTIONAL DETAILS

Taking the normal heat-sink of the 2 C 39 tube family, all the fins must be removed with a lathe, except the lowest one, so that a cylindrical middle portion of 10 mm diameter remains. An M 10 × 1 screw thread is then cut on this cylinder and the modified heat-sink then like the left-hand object in **fig.1**.

The right-hand object in **fig. 1** (and LH in **fig. 2**) is a cap which has also been turned on a lathe, provided and with a blind threaded hole, into which the heat-sink is screwed. Into the circumference, a channel has been cut in which to locate the sealing ring.

The two projections are the coolant input and output connection-lugs, which may also be mounted on the side of the cap, if so desired. The drillings in the cap for these coolant connectors are counter-bored in order to locate sealing rings (**fig. 3**). The connectors are screwed into the cap with a 6 mm thread. These constructional points are shown in the sketch of **fig. 3** and the completed heat-sink, shown in **fig. 4**, is mounted on the tube (using a little heat-paste).

VITON tubing, with a 4 mm internal diameter, is used to conduct the oil in and out of the heat-sink. This typ of tube can withstand oil and temperature and is also a good insulant. PVC tubing, on the other hand, is not suitable owing to its inability to withstand heat. Silicon pipe is also unsuitable, as oil is able to leach through it.

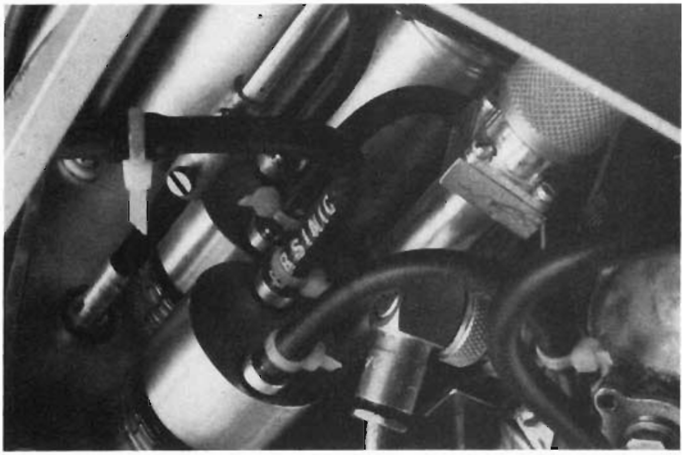


Fig. 5: Two transmitter oil-cooled tubes

The input and output tubes are secured to the connectors using pipe, or cable clips as in **fig. 5**. Branch fittings may be fabricated from copper in the form of "T" pieces. These allow other electronic tubes to be cooled from the same installation.

The oil is circulated by a small squirell-cage induction-motor powered, centrifugal pump as in **fig. 6**. A suitable pump is recommended in the parts list. An important point to look for on the pump is the letter "h" appended to the stock number – this signifies that it is the hot water version. The normal version of the pump is not suitable.

The connection between pump and radiator can utilize a PVC pipe which must be laid as evenly and short as possible in order to avoid pressure drops. All pipes are secured with pipe clips.

Finally, the radiator consists of copper fittings and tubes. Six copper „T" pieces with suitable distancing copper tubes are soldered together and attached to the rear of the PA cabinet as in **fig. 7**. It must be ensured that a diagonal coolant flow ensues (from top right to bottom left or vice versa). The oil filter-cap is screwed onto an expansion cylinder which can take about 10 % of the total volume of oil. The author's installation used 180 ccm, therefore an expansion tank of 20 ccm was sufficient.

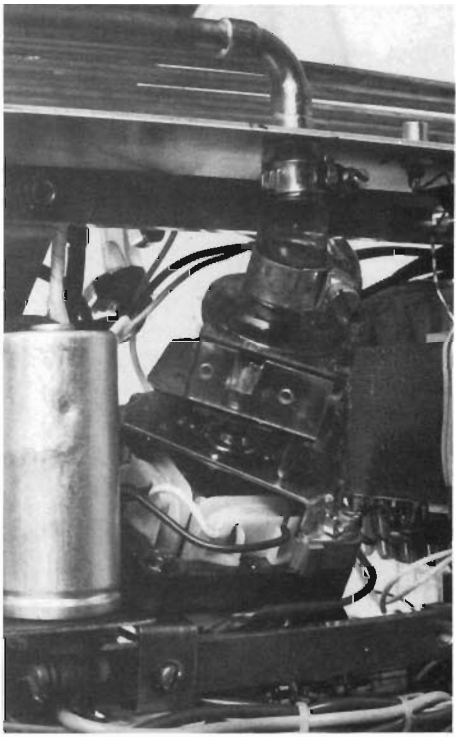


Fig. 6: Motor and circulation pump

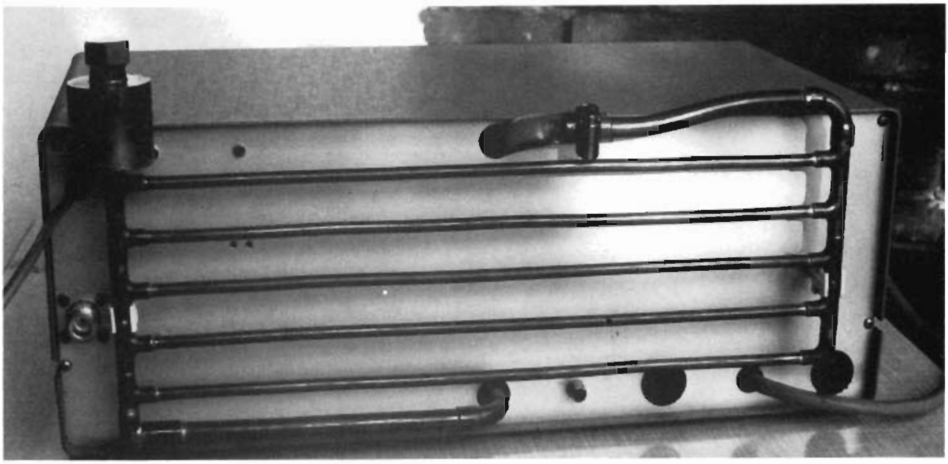


Fig. 7: Radiator with expansion cylinder on the rear of the PA

2.1. Parts list

Quantity	Nomenclature - Dimensions	Source
1	squirrel cage motor	Surplus
1	pump PSN-Komet (hot water model) stock number p 111 h (about DM 36.—)	Plastik-Schelter D - 8500 Nürnberg-Reichelsdorf Vogtsbergstraße 26 Telefon: 0911 - 63 62 28
3 m	copper-tube 6 mm dia	Plumbers
14	"T" pieces for above dia pipe	Plumbers
3	elbows 10 mm	Plumbers
30 cm	copper pipe 10 mm dia	Plumbers
1	10 / 15 transition connecting piece	Plumbers
1	connecting sleeve for 35 mm tubing	Plumbers
2	1 mm copper washers	Plumbers
1	screw-on cap	Plumbers
20 cm	PVC tube 10 mm int. dia	Industry wholesaler
5 cm	PVC tube 15 mm int. dia	Industry wholesaler
50 cm	VITON tube 4 mm int. dia	Industry wholesaler
4	pipe clips 14 mm dia	Industry wholesaler
2	pipe clips 18 mm dia	Industry wholesaler
12	cable clips for 6 mm dia	Electronic Shop
10 cm	Alu tube 34 mm dia	non-ferres-metal supplies
15 cm	Alu tube 10 mm dia	non-ferres-metal supplies
6	Sealing rings 6 x 2 mm, VITON quality	Industry wholesaler
3	Sealing rings 25 x 3 mm, VITON quality	Industry wholesaler

3. CONCLUDING OBSERVATIONS

Particular care is required when filling the system with coolant oil in order to prevent the formation of air bubbles in the tubing. Air bubbles cause the cooling circulation to be interrupted owing to the pump sucking-in air.

As a safety measure, a small circuit-breaker, held in by a thermostat on the electronic tube via an operational amplifier, was installed. Should the temperature exceed 100° C the anode voltage is removed via the pre-heat control circuitry.

The author cools both his penultimate and PA stages with the same installation. A total anode dissipation of 250 watt is accomodated. After a minute of continuous full output power the anode coolant jacket temperature reaches 80° C. For contest operation or continuous carrier output, the radiator should be cooled with an air-fan.

Oil stains may be dealt with by a light application of methylated spirits.

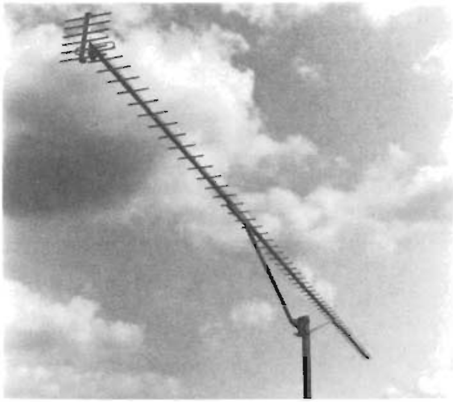
In conclusion, I would like to thank Alwin Kratz, DL 6 FBT, without whose help and ideas this project could not have been accomplished.

New High-Gain Yagi Antennas

The SHF 6964 is a special antenna for the **space communication allocation** of the 24 cm band. The maximum gain of this long Yagi is 19.9 dB_d at 1269 MHz and falls off quite quickly, as with all high-gain Yagis, with increasing frequency. We do not, therefore, recommend this type of antenna for operation at 1296 MHz but for **ATV applications** at 1152 MHz it is eminently suitable. There is no 24 cm ATV antenna on the world market which possesses more gain.

The mechanics are precise, the gain frequency-swept and optimised. Measurements carried out during heavy rain show that the antenna is not detuned by moisture.

Length:	5 m
Gain: 22 dB_i, i. e.	19.9 dB_d
Beam-width:	13.6°
Front / Back ratio:	26 dB
Side-lobes:	− 17 dB
VSWR ref. 50 Ω:	1.2 : 1
Mast mounting: clip (max).	52 mm
Stock-No. 0103	**Price: DM 298.—**



The SHF 1693 is a special version for the **reception of METEOSAT 2**. This unobtrusive alternative to a 90 cm diameter parabolic antenna enables, with the aid of a modern pre-amplifier or down-converter, noise-free weather picture reception.

Length:	3 m
Gain: 20.1 dB_i, i. e.	18 dB_d
Beam-width:	16.8°
Front / Back ratio:	25 dB
Side-lobes:	− 17 dB
Stock-No 0102	**Price: DM 398.—**

Harald Fleckner, DC 8 UG

Two-Band (1.2 – 2.4 GHz) Feed-Horn for Parabolic Antennas

The frequency range above 1000 MHz is increasingly being "discovered" by more radio amateurs and employed for ATV-relays, OSCAR 10 with its "mode L", and the reception of weather pictures at 1700 MHz. No doubt the availability of proprietary modules and equipment has assisted in the increased popularity of this part of the spectrum. In almost all cases, the parabolic antenna appears to offer sufficient radiated power output coupled with a good signal to noise ratio. In order to be able to utilize either a full or a wire-net reflector in a large frequency band, either a broadband feed-horn or a primary feed-horn is required.

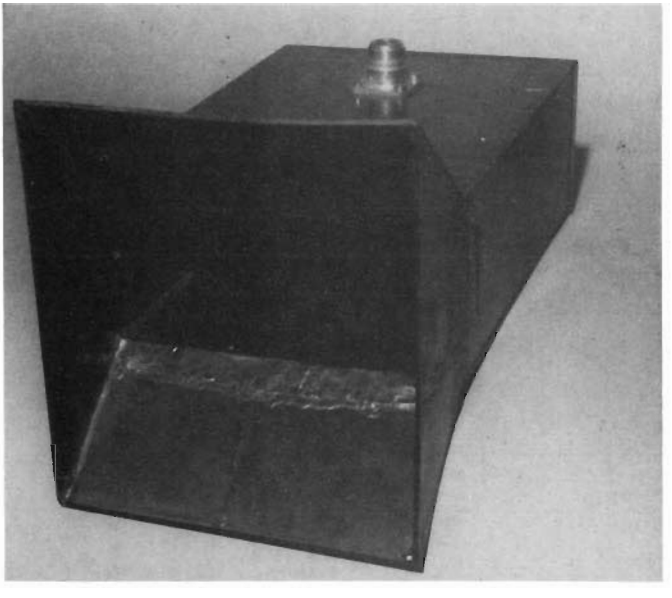


Fig. 1:
In the position shown, the wideband primary radiator has vertical polarization

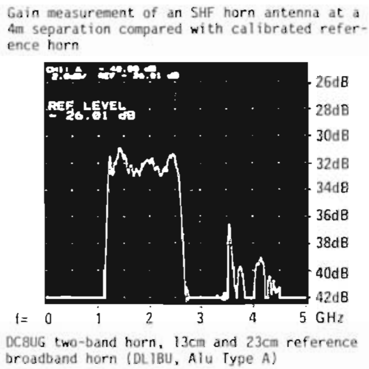


Fig. 2:
The usable frequency range is sharply defined owing to the waveguide cut-off frequencies

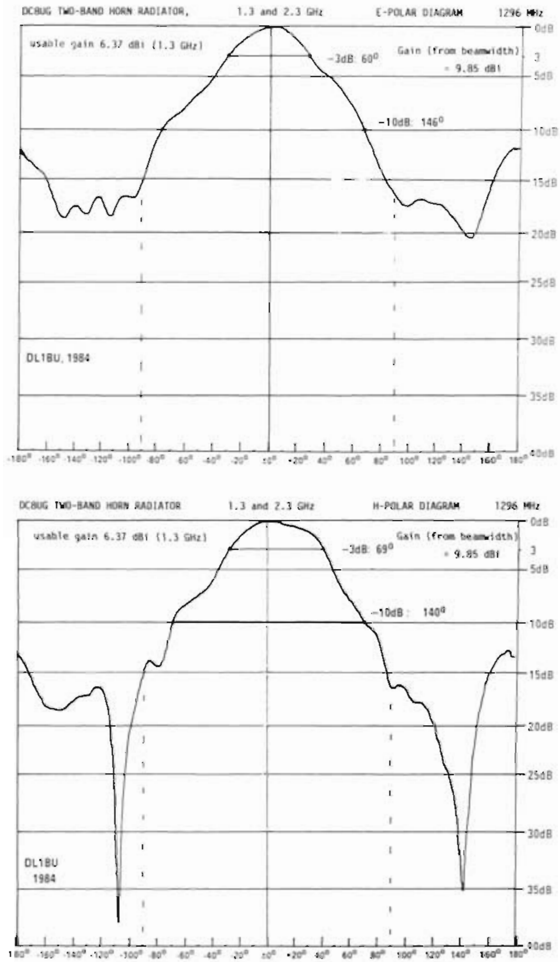
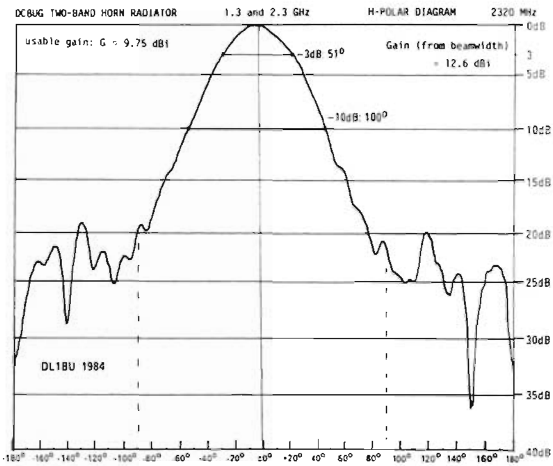


Fig. 3:
Polar plot at 1296 MHz

The broadband primary radiator described in (1) is a high-gain feed-horn which works correctly only with very shallow parabolic mirrors (f / D > 0.5 where f = focal length). The feed-horn described in this article (**fig. 1**), however, is suitable for mirrors with a focal length to diameter relationship of 0.4 – a very useful value. It works well between 1.2 and 2.4 GHz. One of the antennas fitted with this feed-horn has a working range extending from the OSCAR mode L up to METEOSAT reception and on to the 12 cm band.

1. THE RADIATOR'S CONSTRUCTIONAL PRINCIPLE

The constructional principle, first employed by DB 1 PM, is a rectangular waveguide to coaxial transition common at higher frequencies. The rectangular aperature of the waveguide determines the useful frequency range of the transition.



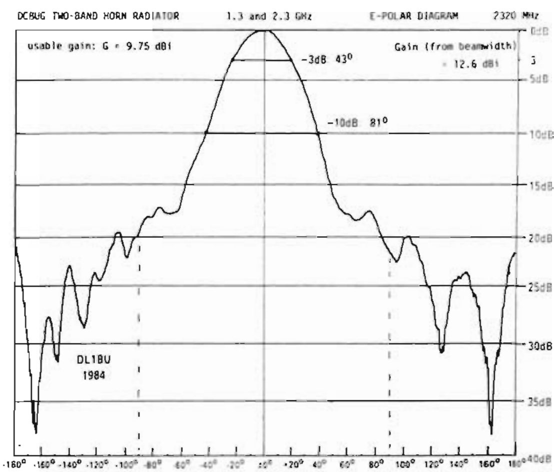


Fig 4: Polar plot at 2320 MHz

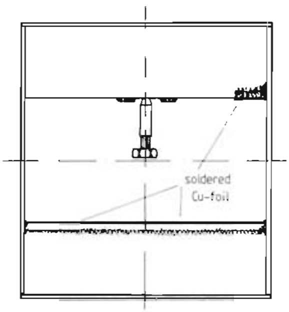


Fig. 5:
Frontal view of radiator

For the lowest usable frequency this is the limit of the H_{10}-mode of the rectangular waveguide – the relevant dimension being that of the width in the H-plane. The upper frequency range is determined by a clearly defined mode formation which still radiates output power – the mode not being that of the basic mode. Above this frequency the horn radiator is no longer usable. The feed-horn, presented in this article, has limits of 1200 and 2400 MHz as clearly shown in **fig. 2.**

In order that both E- and H-planes possess identical polar diagrams consistent with an optimum beamwidth (at −10 dB) at the lower working frequencies, the coaxial to waveguide transition is fitted with a small horn (**fig. 1**). The horn takes a square form when viewed from the front. Guenter Schwarzbeck, DL 1 BU, measured the horn's polar diagram and verified the design objectives for the 23 cm band (**fig. 3**) at the higher frequencies, however, the beamwidth becomes smaller as the feed-horn gain increases (**fig. 4**).

The actual radiation surface area of the mirror is therefore not fully utilized in the 12 cm band as the − 10 dB points do not lie at the perimeter of the dish but some way inside it. The size of the secondary radiator (i. e. the mirror's diameter) is determined by the feed-horn working frequency range and should not be under 1.2 m, otherwise the gain of the antenna will be compromised more severely than any advantage gained from windage. Dishes of 1.2 m diameter reach their optimum gain of about 20 dB rel. dipole when driven at 1296 MHz.

2. MECHANICAL CONSTRUCTION

Figures 5, 6 and 7 show the dimensions of the feed-horn and **fig. 8** a frontal view through the aperature. Brass, copper plate or copper-plated epoxy / SRPB (paxolin) may be used in the construction. The latter material results in a particularly lightweight construction eminently suitable for portable work.

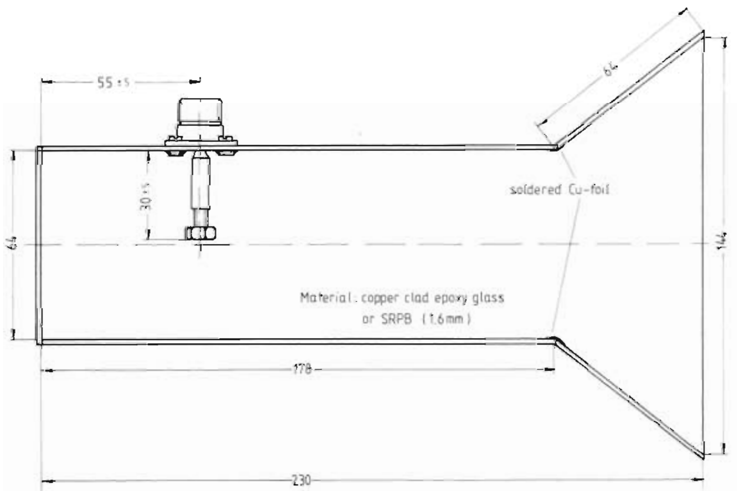


Fig. 6: Dimensions of wideband primary radiator

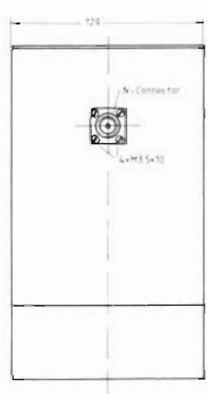


Fig. 7: Top view

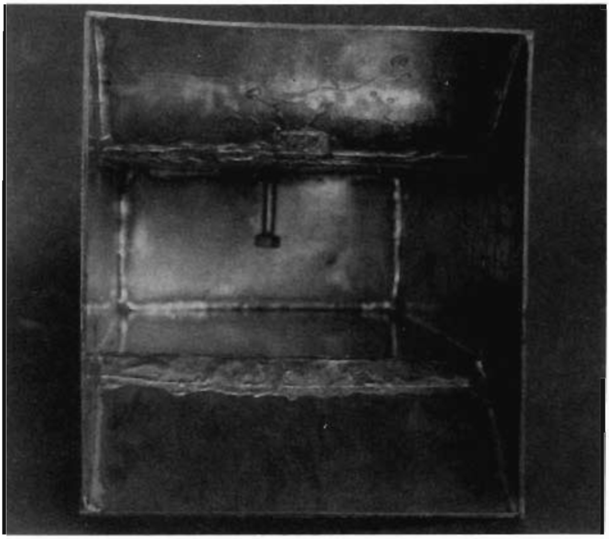


Fig. 8: View into aperature

The coaxial input coupling is carried out by means of a normal panel-mounting N socket, the four mounting-screws of which form the ground bonding – the nuts being soldered to the (inside) copper film. The launch-probe consists of a 6 × 1 mm brass tube soldered axially to the N socket centre connection pin. The end of this tube is tapped to allow an M 5 × 10 mm screw to provide variable length adjustment of the launch-probe – with locking nut. It is also recommended that provision be made to make the launch-probe / input connector assembly variable in position with respect to the back wall of the feed-horn. The matching can then be optimized to suit a particular band of frequencies. The feed-horn, photographed in figs. 1 and 8, has a 55 mm spacing from the back wall resulting in a return loss greater than 15 dB at 1250 and 1450 MHz. By means of 10 mm slots the assembly may be adjusted ± 5 mm, from the nominal 55 mm, thus allowing an optimal adjustment at 1296 MHz.

The launch-probe length influences the feed-horn matching – the prototype is set to 32 mm long.

At the transition of the horn flare-out, the discontinuity in the PCB copper cladding must be bridged with thin-sheet copper strip, soldered so that a uniform surface results.

The completed horn is treated both internally and externally with a plastic spray film in order to protect it from the elements. The aperature may be sealed with a piece of 10 mm thick expanded polystyrene.

3. TEST RESULTS

The test measurements were undertaken by Guenter Schwarzbeck DL 1 BU (well-known technical reviewer) in the course of a large investigation into primary radiators. The feed-horn built by the author and shown in the photographs was used.

Fig. 2 shows the result of the gain measurement in comparison with a calibrated test-horn. The band-filter characteristic of the feed-horn, with its clearly defined limiting frequencies, will be recognized.

The following **table 1** gives the working gain of the horn-radiator together with its 3 dB and 10 dB beamwidths in both the E-and the H-planes. It may be seen that at 1296 MHz the E-and the H-beamwidths are practically identical. Also, the

		1296 MHz	2320 MHz	
DC 8 UG	gain ref. isop	6.37 dBi	9.75 dBi	All values in brackets denote – 10 dB beamwidth gains
Two-band Horn-radiator 13 / 23 cm	3 dB E-beamwidth	60° (146)	43° (81)	
	3 dB H-beamwidth	69° (140)	51° (100)	
	gain dBi (from beamwidth)	9.85 dBi	12.6 dBi	

These horn-radiators were tested at the amateur frequencies of 1.3 GHz, 2.3 GHz, 3.4 GHz and 5.7 GHz: the weather-satellite frequency of 1.7 GHz was also partly included. The polar diagrams were also taken, for a few horn-radiators, at the highest frequency afforded by the coaxial technique, 8.4 GHz. The beamwidth was 9° and the gain 25 dBi. The figures in brackets are the – 10 dB beamwidth, this being an important parameter when using the radiator as a parabolic-antenna, feed-horn.

Table 1

broadband radiator exhibits a gain of 6.4 dB at 23 cm and 9.8 dB at 12 cm with reference to an isotropic radiator.

Figures 3 and 4 show the polar diagrams for the amateur bands. Finally, **fig. 9** shows that the return loss / SWR, in the usable frequency range, is better than 10 dB / 2 : 1. The high-pass characteristics of the rectangular waveguide may also be clearly seen. The characteristic impedance under the cut-off frequency (here at 1.1 GHz) is unreal (inductive) thus simulating a highly reactive choke.

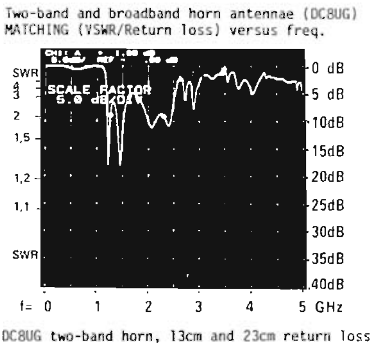


Fig. 9: Matching versus frequency

4. CONCLUSION

This two-band radiator is characterized by its simple construction, its low weight and its versatility. It will be of interest for contest and portable stations which are active in the frequency range between 1.2 and 2.4 GHz. Amateurs who, until now, have used their parabolas only for weather satellite reception can now install this feed-horn and use it for both, send and receive on the neighbouring amateur bands.

5. REFERENCES:

(1) Neie, C.:
Multi-Band-Strahler 1 - 12 GHz,
DUBUS-Info 2 / 1980, Pages 66 - 76

Harjo Schroeter, DK 3 VF and Willy van Driesche, ON 6 VD

Digital Picture Storage for SSTV, FAX and WEFAX

The digital picture store (1) published a few years ago by YU 3 UMV processes AM signals using a 2400 Hz sub-carrier sent from the weather satellites. These weather satellite facsimile (WEFAX) transmissions are related to the various other facsimile emissions (FAX) and slow-scan television (SSTV). Unfortunately, the transmission standards took their own individual paths making an eventual common standard, such as that discussed by ON 6 VD in (2), only a flight of fancy. It is, however, possible for the digital picture storage to be so modified, and extended, that all the current WEFAX, FAX and SSTV transmissions may be reproduced.

This may be carried out, as ON 6 VD has, by modification (greatly) to the original YU 3 UMV printed circuit boards and by developing other, supplementary boards. On the other hand, a new, but fairly large board is described here which will embody all the neces-

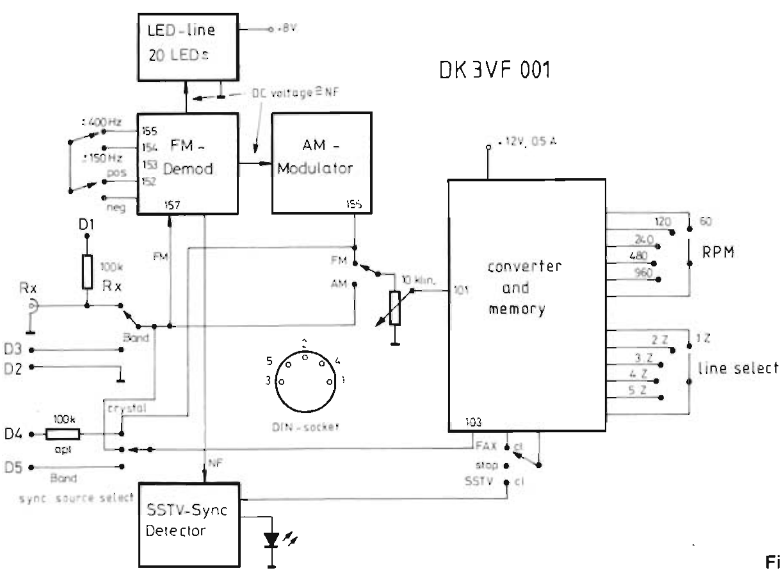


Fig. 1: Block diagram

sary modifications, such as combined control electronics and memory and a few other components normally mounted elsewhere, such as tuning indicator, switches, sockets etc. In this relatively simple manner, a really versatile picture receiver has been created. The many owners of YU 3 UMV boards, who have followed the published modifications to the original circuit will already have had enough advice upon how to proceed with further modifications.

1. CONCEPT

The equipment comprises, as fig. 1 indicates, one large and four small functional circuits, a five-pole socket and various switches. The WEFAX amplitude-modulated (AM) signals, from either a recorder or directly from a radio receiver, are processed in the manner described in (1). An FM demodulator with tuning indicator and an AM modulator has been fitted for the reception of FAX transmissions. This functions by converting the FM signal into an AM signal which can be further processed in exactly the same manner as a WEFAX signal (3). A further supplementary circuit for the reproduction of SSTV will be discussed later in more detail.

In order to keep the wiring and cabling within bounds, one large board is to be preferred to several small ones. This board requires one supply potential of 12 volts, the auxiliary supplies of + 8.5, + 5 and − 5 volts being derived from on-board sources. The design has also taken into account the proposals given in (4) and (5) which, by means of divider and transistor, provide picture displacement and also provide the RAMs with pull-up resistors. The latter must, however, be placed in an upright position in order to conserve space. They are connected together at their upper extremity and then taken to the + 5 volt supply.

Finally, it may be worth mentioning, that provision has been made for a stereo tape recorder to record and reproduce all AM and FM transmissions. The modulation being recorded in one channel, and the 2.4 kHz sub-carrier on the other channel.

2. CIRCUIT DETAILS

It would be going too far to describe again the circuitry of the YU 3 UMV equipment. Instead, only those circuits which have been modified will be dealt with. The reference at (1) must be at hand, in any case, for the reconstruction described here to be undertaken. In order to proceed systematically, all the relevant circuit diagrams are reviewed in **table 1** as follows: −

a) YU 3 UMV 001 circuits
   - Fig. 3: remains unmodified
   - Fig. 4: PLL and frequency divider modified; becomes here **fig. 2**
   - Fig. 5: ADC 0804 changed to 1.25 MHz by reducing capacitor at I 107 pin 4 from 82 pF to 56 pF
   - Fig. 6: Tone decorder and sync. logic changed; becomes here **fig. 3**
   - Fig. 7: remains unmodified
   - Fig. 8: An 8 V stabilizer 7808 has been added and + 12 V supply decoupled with 10 μ F tantalum

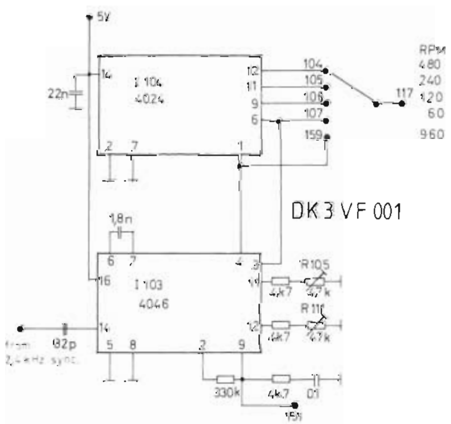


Fig. 2: Augmented circuit for reception of 15 Hz SSTV (USA) and 960 RPM FAX

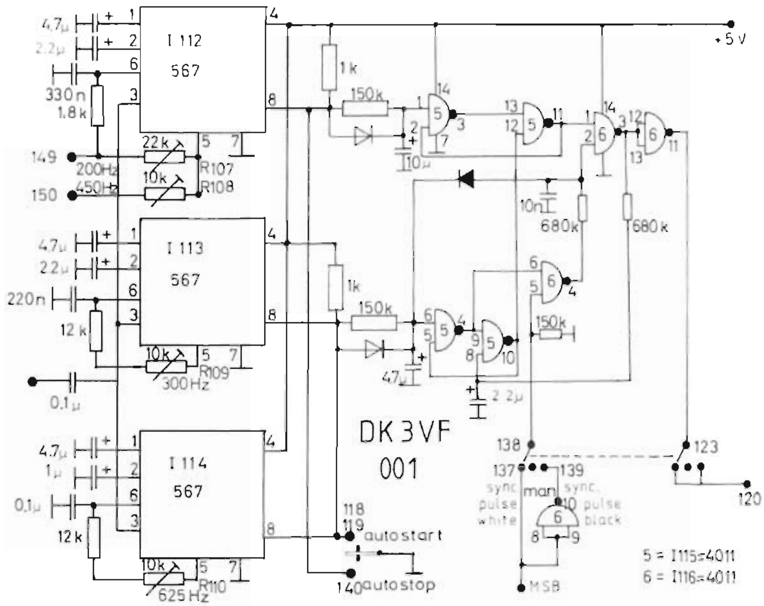


Fig. 3: Modified tone decoder and synchronizing logic

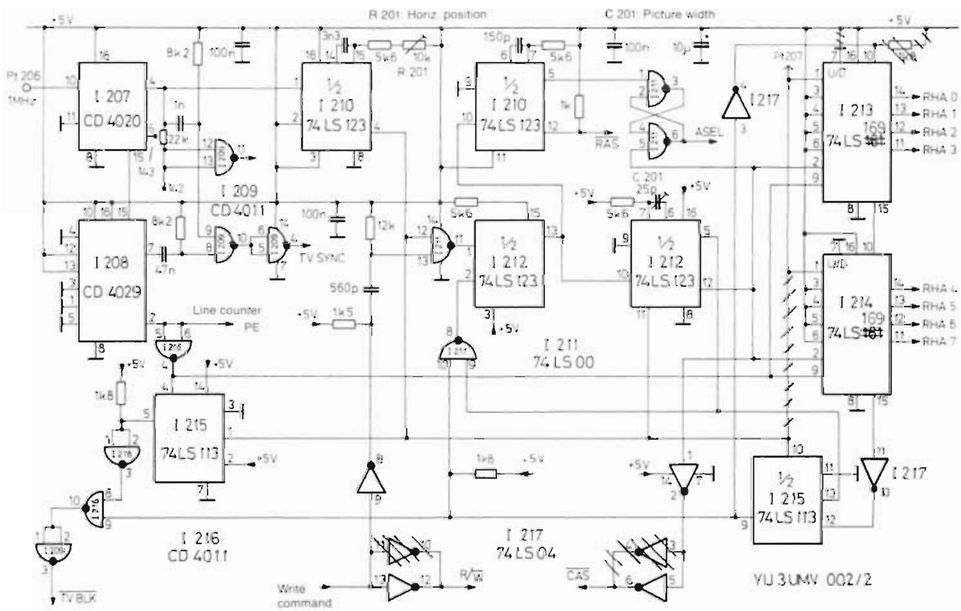


Fig. 4: Modified circuit for TV sync. and horizontal sync.

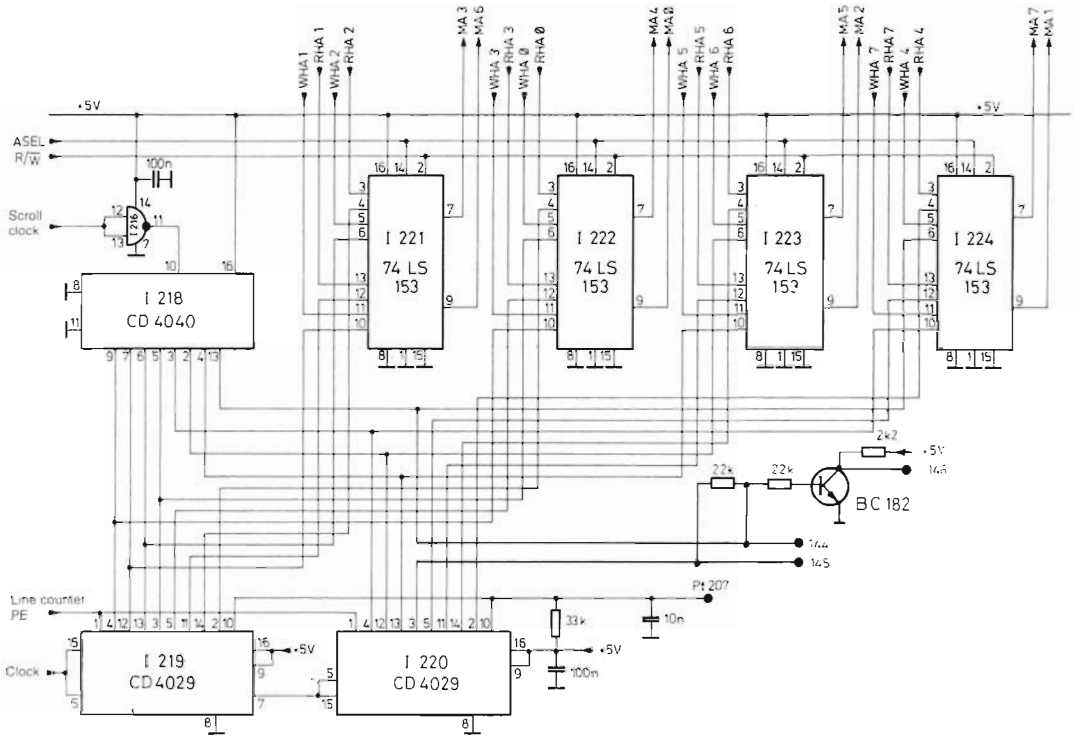


Fig. 5: Modified circuit for vertical sync. and address multiplex

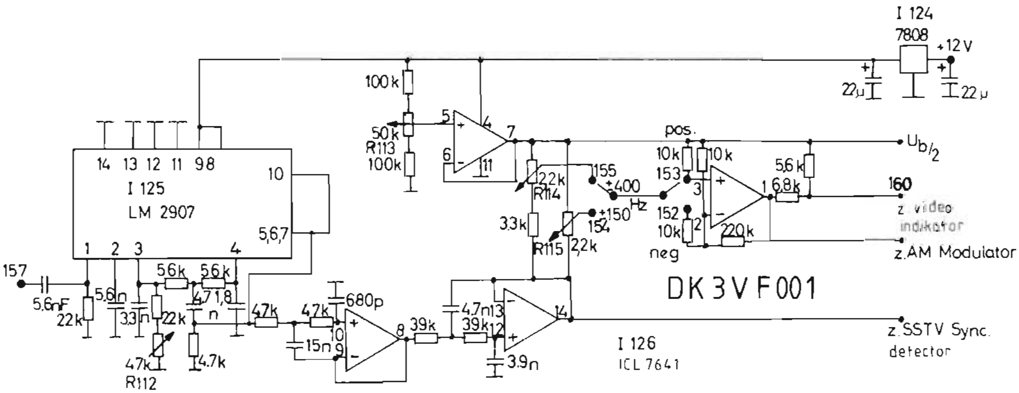


Fig. 6: Additional circuit FM demodulator

b) YU 3 UMV 002 circuits
   Fig. 13: remains unmodified
   Fig. 14: modified; becomes here **fig.4**
   Fig. 15: modified; becomes here **fig. 5**
   Fig. 16: remains unmodified

c) New circuits
   Fig. 6: FM demodulator
   Fig. 7: AM modulator
   Fig. 8: Tuning indicator
   Fig. 9: auxiliary circuit for line selection
   Fig. 10: auxiliary circuit for picture displacement
   Fig. 11: SSTV sync. detector
   Fig. 13: PCB DK 3 VF 001 connections diagram

Table 1: Review of relevant diagrams

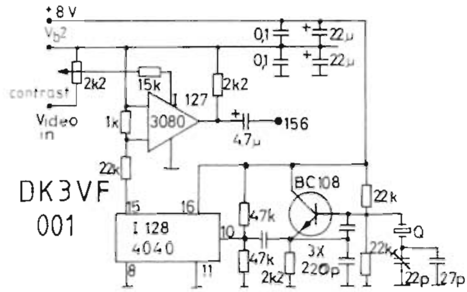


Fig. 7: Additional circuit AM modulator

In order that FAX signals can be processed, the FM signal must first of all be demodulated into a video signal (**fig. 6**). It must then be filtered and amplified with an operational amplifier such as type TL 084, or better still, the ICL 7641. The signal, at this point, could be easily inverted or a choice made, in a simple fashion, between a positive and a negative picture but without influence to the position of the synchronizing pulses.

The following amplitude modulator, modulates the video signal on to a 2.4 kHz carrier which has been derived from a 4915.2 kHz crystal-controlled oscillator and appropriately scaled down in frequency (**fig. 7**). This is accomplished in a CA 3080 chip. In order that the 2.4 kHz signal may be used for synchronizing the following picture memory, this crystal oscillator should be adjusted exactly to its nominal frequency by means of a counter.

Upon initial reception of a FAX transmission, there is always the problem of the correct adjustment of the picture dynamic range. A good adjustment guide can be obtained by displaying the video signals on a linear scale. The start tones, maximal black and white appear symmetrically disposed about the middle of the scale, thereby indicating the amount and direction the correction

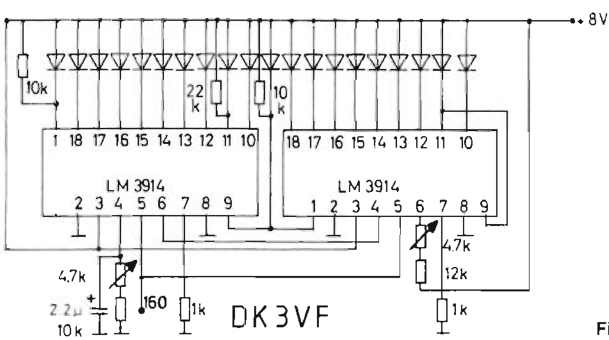


Fig. 8: Additional circuit tuning indicator

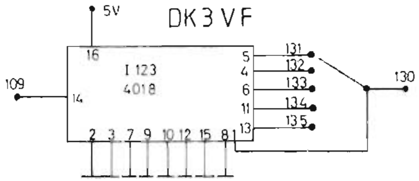


Fig. 9: Additional circuit for line selection

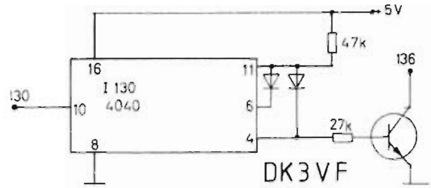


Fig. 10: Additional circuit for picture shift

should take. Such a scale is shown in **fig. 8** which comprises twenty LEDs controlled by two LM 3914 linear driver chips. This complete circuit is made using a small PCB which can be mounted directly on to the front panel.

In order that the equipment may be used for several FAX norms and / or speeds, the divider I 123 has been added (**fig. 9**). This enables a choise to be made of whether all lines are to be stored, very other, or every third, fourth or fifth. In practice, only three of the five possibilities are normally used for the reception of FAX signals.

The correct speed for SSTV pictures is 960 revolutions per minute (RPM) or 16 lines per second (2). The switch positions in fig. 2 have been extended to a fifth position to cater for this requirement. This switch may also be used to enlarge the size of the picture.

Two SSTV pictures may be stored in the memory, selected by the SSTV 1 / SSTV 2 switch (**figs. 5 and 12**).

The SSTV sync. pulse is extracted by the comparator shown in **fig. 11**. Upon reception of a tone of between 1100 and 1300 Hz and of longer than 4 ms duration, the comparator produces an impulse (Pt 147).

The sync. frequency of the analogue-to-digital converter ADC 0804 must around 1.25 MHz. For this, a capacitor of 56 pF is required at pin 4 and the period is adjusted by R 106 to about 0.8 μs.

Should SSTV stations be received which are using 15 lines per second (USA), the VCO frequency of PLL I 103 (**fig. 2**) should be lowered from 38.4 kHz (16 × 2.4 kHz) to 35.2 kHz (16 × 2.2 kHz). For this, the connecting point Pt 151 has been provided which must be switched to ground. The exact frequency is adjusted by means of preset R 111. The original frequency for

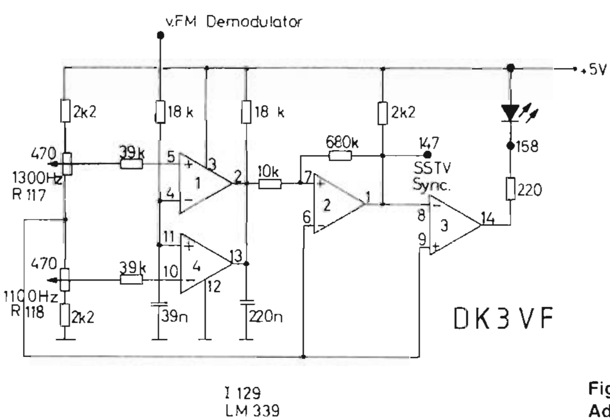


Fig. 11:
Additional circuit for SSTV sync. detector

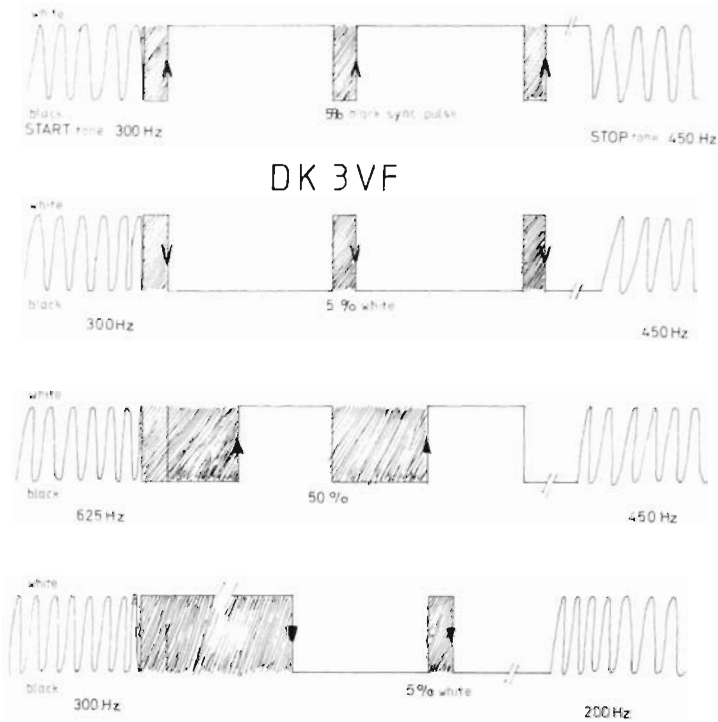


Fig. 12:
Four examples of synchronizing in a FAX transmission

European SSTV, 38.4 kHz, is adjusted by R 105 when Pt 151 is not grounded.

2.1. Automatic synchronizing circuit

The auto-synchronizing circuit described by YU 3 UMV operates only with the communication format similar to the single pulse sync. utilized by METEOSAT. In the FAX technique, however, there are other modes (**fig. 12**), which require other types of synchronizing circuits, such as:

1. The possibility to chose between "black" and "white" sync. pulses.
2. The possibility to chose between various start and stop frequencies.
3. The most difficult case, i. e. when the synchronizing pulse is not sent directly after the start tone (**fig. 12 lowest example**).

Case 1 in fig. 12 has the possibility to synchonize by using the MSB (most significant bit) from the A / D converter, either inverted or upright, corresponding either to white or to black.

A solution for case 3 would be achieved by means of an RS flip-flop which is primed by the start tone and reset shortly following the synchronizing-pulse leading edge. About 1.5 seconds is chosen for the 5 % sync. pulse and about 3.5 seconds for the 50 % sync. pulse as used by the French METEO station. If the start flip-flop has been reset, the line counter can no longer receive any further synchronizing pulses. The process can only start anew if another start pulse, manual or with 300 / 625 Hz tone, is applied.

As the synchronization of NOAA or METEOR pictures can be easily undertaken by hand, the decoder and synchronizing logic (**fig. 3**) for the above cases were modified. The tone decoder I 113 and I 114 are tuned to the start tone 300 or 625 Hz whilst the stop-tone decoder I 112, was made switchable between 200 and 450 Hz.

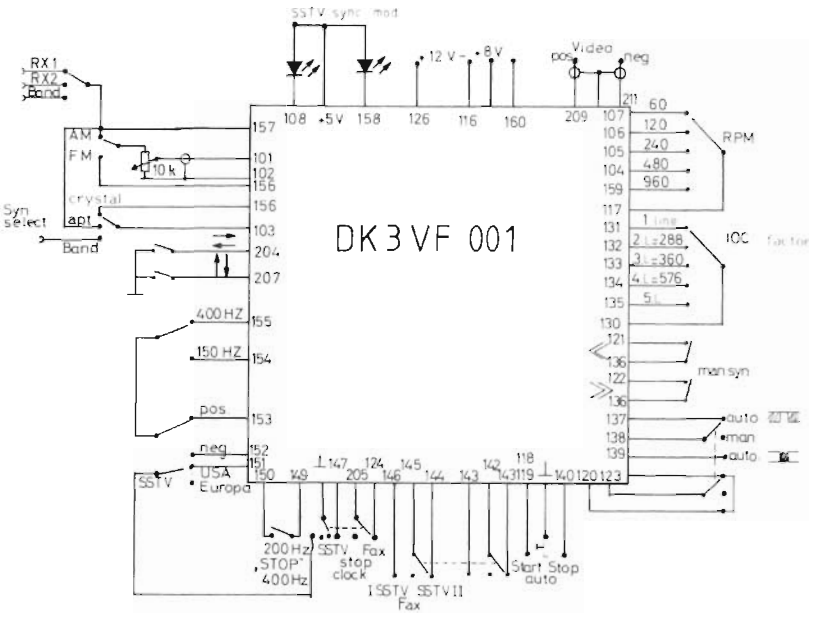


Fig. 13: External connections to PCB DK3VF 001

3. CONSTRUCTION

As mentioned in the introduction, the whole circuit with the exception of the tuning indicator, is accommodated on a single printed circuit board. This board is through-contacted, 200 × 200 mm in dimension and designated DK 3 VF 001 (**fig. 14**). The tuning indicator board DK 3 VF 002 is singlesided and 107 × 29 mm in dimension (**fig. 15**).

The construction is commenced,most usefully, with the power supply. The board requires 12 V at 500 mA when fully completed, other voltages are supplied by integrated circuit stabilizers, 7808 and 7805 together with a 555 multivibrator timer chip for the − 5 V supply. The latter, negative supply is necessary for the A / D converter and the video output. After the power-supply portions have been completed, they are tested at once.

The further construction should also proceed step by step, each circuit being tested upon completion. Piecemeal testing is necessary because eventual faults would be very difficult to locate on a completed unchecked board. In principle, integrated-circuit holders are unnecessary but they come in handy in the rare event that a chip proves defective. If holders are used, only good-quality types should be chosen.

Above all, pay strict attention to the anti-static measures when handling the CMOS chips. The RAM 4164 pull-up resistors (8 × 1 k and 2 × 470 Ω) are mounted vertically, connected together at their upper-connecting leads and supplied with + 5 V.

Around the tone-decorder chips (I 112 to 114), tantalum decoupling capacitors should be employed. The other capacitors and resistors should be of a modern construction in order that they suit the normalized component-lead hole spacing used on the PCB. Preset resistors are the horizontal type using the 10 / 5 mm fixing grid. The four double-pole change-over switches with a centre rest position are for: SSTV − stop − FAX, auto − manual, sync. select and SSTV I −

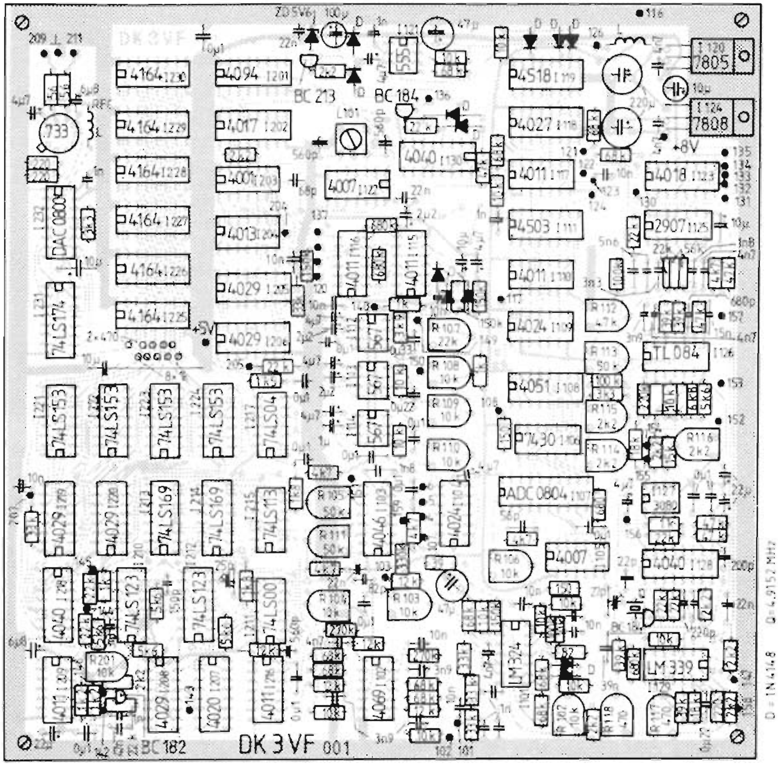
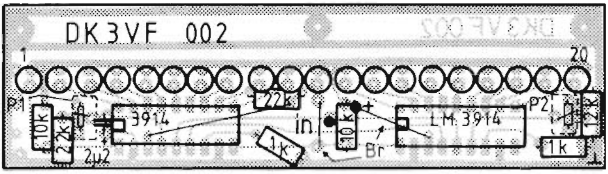


Fig. 14: Component layout on PCB DK3VF 001

FAX – SSTV II. The push-button switches are used for left and right picture displacement. The other switching functions utilize ten toggle switches. For more detailed information see **fig. 13** and **table 2**.

Rotary switch 1 × 5:	60 to 960 revs
Rotary switch 1 × 5:	1 to 5 line store
Rotary switch 1 × 3:	Rec. 1, Rec. 2, taperecorder
toggle switch SPDT:	positive – negative
toggle switch SPDT:	± 400 Hz / ± 150 Hz
toggle switch SPDT:	AM – FM
toggle switch SPDT:	stop 200 Hz – stop 450 Hz
toggle switch SPDT:	up / down
toggle switch SPDT:	left / right
toggle switch SPDT:	SSTV Europe / USA
toggle switch DPDT:	mains on / off
SPDT with centre rest:	auto start / stop
DPDT with centre rest:	select sync. source (Crystal / APT / tape)
DPDT with centre rest:	select sync. type (auto white / man. / auto black)
DPDT with centre rest:	line sync. SSTV / Stop FAX
DPDT with centre rest:	128 lines SSTV pic. 1 / FAX / 128 lines SSTV pic. 2
Push-button SPST:	left shift
Push-button SPST:	right shift

Table 2: Switch functions



P1 / P2 = 10k on the solder side

Fig. 15:
Component layout on PCB DK3VF 002

3.1. Main components

I 101:	LM 324
I 102:	4069
I 103:	4046
I 104:	4024
I 105, I 122,	4007
I 106:	74 LS 30 N
I 107:	ADC 0804
I 108:	4051
I 109:	4024
I 110, I 115, I 116,	
I 117, I 209, I 216:	4011
I 111:	4503
I 112, I 113, I 114,	567
I 118:	4027
I 119:	4518
I 120:	7805
I 121:	NE 555
I 123:	4018
I 124:	7808
I 125:	LM 2907
I 126:	ICL 7641
I 127:	CA 3080
I 128, I 130, I 218:	4040
I 129:	LM 339
I 201:	4094
I 202:	4017
I 203:	4001
I 204:	4013
I 205, I 206, I 208:	4029
I 207:	4020
I 210, I 212:	74 LS 123
I 211:	74 LS 00
I 213, I 214:	74 LS 169
I 215:	74 LS 113
I 217:	74 LS 04
I 219, I 220:	4029
I 221 .. I 224:	74 LS 153
I 225 .. I 230:	4164
I 231:	74 LS 174
I 232:	DAC 0800
I 233:	LM 733

23 LEDs

Indicator board: 2 × LM 3914

1 × 4915.2 kHz crystal: (Grundton HC-18 / U)

2 foil trimmers (Valvo green 20 pF)

Presets, 10 / 5 mm grid

500 Ω	2,5 kΩ	10 kΩ	25 (33) kΩ	50 kΩ
2	3	8	1	4

4. ADJUSTMENT

First of all, the new or modified circuits (importantly the AM / FM converter and the tuning indicator) will be considered. It must be mentioned that the two presets on the indication board are mounted upright.

All trimmers and presets should initially be set to their mid-range position. Starting with the indicator module and without input signal: pos. / neg. switch at "pos.", by adjusting the associated 4.7 k Ωpreset potentiometer to cause LED 1 (only) to illuminate. Now switch to "neg." and with the other preset cause LED 20 (only) to illuminate. As these presets are interactive in their effect upon the LEDs, some iteration between the two controls is necessary in order to illuminate either LED 1 or LED 20 at the appropriate setting of the pos. / neg. switch.

Now isolate Pt 153 (pos.) and with preset R 113 cause LED 11 to illuminate. Connect Pt. 153 again and feed in a 1900 Hz input signal. Adjust preset R 112 such that LED 11 illuminates whereas preset 114 (± 400 Hz) remains at its mid-scale setting.

Feed in a signal of 1500 Hz switch to "pos." and to ± 400 Hz. Preset R 114 is now adjusted in order that LED 1 (only) is lit. Then apply 1750 Hz, switch to ± 150 Hz and adjust preset R 115 in order that again, LED 1 illuminates. Vary the input frequency between 1750 and 2050 Hz (still switched to ± 150 Hz) and check that the applied signal corresponds with the illumination of the appropriate LED on the frequency scale. Switch to the ± 400 Hz range and vary the signal from 1500 to 2300 Hz and again check the accuracy of the LED indicator scale.

Table 3 will help to clarify the foregoing procedure:

Switch	LED 1	LED 11	LED 20
± 400 Hz	1500 Hz	1900 Hz	2300 Hz
± 150 Hz	1750 Hz	1900 Hz	2050 Hz

Table 3: Adjustment points for the two ranges

The potentiometer in the amplitude modulator circuit CA 3080 (**fig. 7**) varies the depth of modulation and thereby the picture contrast. This control is best adjusted during the reproduction of a picture. Optimum: 1 to 10 between min. and max. level of sub-carrier.

The crystal oscillator should be set initially to its nominal frequency with a counter and then, after a week or so of continuous operation, fine adjusted against a counter having a time base which can be checked against an off-air standard WWV, MSF, DCF 77 etc.

The adjustment of the tone decoder I 112, I 113 and I 114 is carried out with the frequencies given in fig. 3.
The correct adjustment can be made with a voltmeter or a DC oscilloscope on pin 8 of the appropriate IC.

5. REFERENCES

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MATERIAL PRICE LIST OF EQUIPMENT

described in edition 1 1986 of VHF COMMUNICATIONS

DL 5 NP	**80-Channel Handheld Transceiver for the 2 m Band**		Art. No.	**Ed. 1 1986**
PC-board	DL 5 NP 001	double-sided, single-etched, silvered, without comp. plan, bored	6948	DM 31.—
Kit	**DL 5 NP 001**	**with all components**	**6951**	**DM 389.—**
DK 3 VF	**Digital Picture Storage for SSTV, FAX and WEFAX**			**Ed. 1 1986**
PC-board	DK 3 VF 001	double-sided, thro'plated	6942	DM 99.—
PC-board	DK 3 VF 002	single-sided, not bored	6943	DM 16.—
Kit	**DK 3 VF 001 DK 3 VF 002**	**both PC-boards and all components**	**6944**	**DM 630.—**

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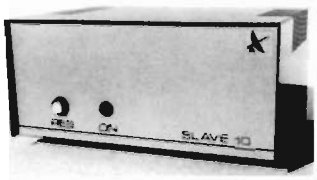

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- **connection to any computer possible via RS 232**
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- **OSCAR 10 software for the C 64 available**
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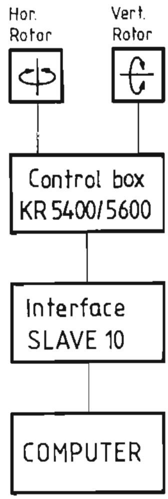
Table of commands:

command		response		function
R	CR	R	CR	rotation clockwise
L	CR	L	CR	rotation counter clockwise
U	CR	U	CR	rotation up
D	CR	D	CR	rotation down
S	CR	S	CR	all rotators stop
V	CR	V	CR	rotator stop vert.
H	CR	H	CR	rotator stop horiz
G xxxxyyyy	CR	G	CR	preset position
F	CR	F xxxxyyyy	CR	interrogation position

xxxx: Vertical position (4 digits)
yyyy: Horizontal position (4 digits)
CR: CARRIAGE RETURN

System's block diagram



Technical data:

Data exchange:	3-wire asynchron. full duplex input and output negative or positive
Data format:	1 start bit 8 data bits 2 stop bits
Baud rate:	1200 B / s
Power supply:	14 V unstab. via control box KR 5400 or KR 5600
Dimensions:	w x h x d = 160 x 80 x 130 mm

Special accessories:

Software on diskette for C 64	Art. nr. 1100	DM	48.—

Satellite rotator systems:

KR 5400	Art. nr. 1013	DM	809.—
KR 5600	Art. nr. 1014	DM	1070.—