MONTAGES DIVERS
SUR 6 cm

A Dual Mixer for 5760 MHz with Filter and Amplifier

This mixer for both transmit and receive sides of a transverter provides good performance.

By Paul Wade, N1BWT
161 Center Road
Shirley, MA 01464
email: n1bwt@iii.net

At Microwave Update '92 in Rochester, I presented a description of my modular building-block approach for assembling a transverter for 5760 MHz.[1] I've used this transverter for 3 years, and recently NJ2L described his transverter that uses the same mixer, so perhaps it's time to describe what we've learned and add some improvements.[2]

Mixer

The heart of any transverter system is the mixer, and there are few choices available for 5760 MHz. A recent article by N2SB described a transverter assembled from surplus components.[3] Many components used in the 5.9 to 6.4-GHz microwave relay band work well and are readily available at flea markets, but surplus mixers for this band are scarce, so homebrewing is necessary. One option, the KK7B no-tune transverter, has a simple bilateral mixer for this band, used for both receive and transmit, so switching is needed to use separate power amplifier and receive preamp.[4] Having separate mixers for transmit and receive is preferable so that each path may be optimized.

The KK7B transverter has a 1296-MHz IF, probably because of the difficulty of reproducibly making a sharp filter—or any other high-Q circuit—on a printed-circuit board at this frequency. The dimensions are too small and critical for normal printed-circuit tolerances.

Another transverter, with separate transmit and receive mixers, was described (in German) by DJ6EP and DC0DA and subsequently reprinted in *Feedpoint* and 73.[5 6] They also described a modification to use a surplus phase-locked microwave source as the local oscillator and made PC boards available, making it even more attractive. I assembled and tested a unit, but the results were abysmal. No apparent mixing was taking place and the only output was strong LO leakage. Closer examination of the mixer circuit suggested that it might be a harmonic mixer, operating with a half-frequency LO. This suspicion was confirmed when we located someone who could fake enough German to translate the article. At 5.7 GHz, the LO input impedance is effectively a short circuit and measures exactly that, preventing it from working as a normal mixer.

It was obviously time for a new design. Some time ago, I designed and built a series of balanced mixers using 90° hybrid couplers from 1296 to 5760 MHz.[7 8 9] Since these worked well as receivers, two mixers were in-tegrated with a third 90° hybrid coupler as a power splitter on a small Teflon PC board. The layout is shown in Fig 1. As expected, it worked well as a receive mixer, with about 7 dB of conversion loss. However, it worked poorly as a transmit mixer, with transmit conversion loss of around 25 dB. This nonreciprocal performance was a mystery until Rick, KK7B, steered me to an article that worked out the math explaining why a 90° hybrid-coupler balanced mixer works as a down-converter but not as an upconverter.[10] I had only worked out the down-converter case and assumed that it would be reciprocal.

One reason for choosing the 90° hybrid coupler is because it is a low-Q structure that uses wide, low-impedance transmission lines, so that dimensions are not extremely critical and performance should be repro-ducible.

The KK7B mixer used a 6/4-λ rat-race coupler, so the next version, shown in the photograph of Fig 2, used this structure for the transmit mixer (Notes 4 and 9). Line widths are somewhat narrower than the 90° hybrid coupler, but it is still a low-Q structure, so it should still be reproducible. This unit had much better transmit performance, about 8 dB of conversion loss, but its noise figure was not quite as good as the original receive mixer, so the original receive mixer was retained.

The final version integrates "pipe-cap" filters like those in the DJ6EP transverter onto the mixer board (Note 5).[5] These are copper plumbing pipe caps for 3/4-inch copper tubing, with probes 7/32-inch long and tuned with an 8-32 screw. Fig 3 is a cross-section sketch of a pipe-cap filter. Dimensions are from the measurements WA5VJB made on individual filters.[11] PC board layout is shown in Fig 4, and the only other components on the board are the mixer diode pairs and a 51-Ω chip resistor termination. IF attenuators like those in some of the no-tune transverters would also fit and are recommended for the transmit side. No through holes are needed for grounding—the radial transmission line stub acts as a broadband RF short. The diodes I used (Hewlett-Packard HSMS-8202) are inexpensive Ku-band mixer diode pairs; they are available from Down-East Microwave, as are the mixer boards.

Mixer Construction

Construct the circuit using minimal lead length on a Teflon PC board, with soldered sheet brass around the perimeter for SMA connector attachment. This is the procedure I use: The copper pipe-cap filter should be installed first, on the ground-plane side of the board. In preparation, I drill tight-fitting holes for the probes and make clearance holes in the ground plane around the probe holes. Then I measure from the holes and scribe a square on the ground plane that the pipe cap just fits inside. Next I prepare each pipe cap by drilling and tapping (use lots of oil) the hole for a tuning screw, then flattening the open end by sanding on a flat surface. Then I apply resin-paste flux lightly to the open end and the area around the screw hole. A brass nut, added to extend the thread length, is held in place by a temporary stainless-steel screw. (Solder won't stick to it.) Then I center the open end of the cap in the scribed square on the PC board—the flux holds it in place. Finally, I fit a circle of thin wire solder around the base of each pipe cap and nut, push down gently, and heat each pipe cap for a few seconds with a propane torch until the solder melts and flows into the joints. Don't be shy with the torch—melt the solder quickly and remove the heat.

After everything cools, the temporary stainless-steel screw should be replaced with 3/4-inch long brass tuning screws and locknuts. The remainder of the assembly is performed with a soldering iron, using the photograph of Fig 2 as a guide.

Local Oscillator

Microwave local oscillators normally start with a crystal in the 100-MHz range, followed by a string of multipliers. For 5760 MHz, a multiplication factor of 50 to 60 is necessary—not an easy task. Fortunately, there are many surplus phase-locked microwave sources (often called PLO bricks) available, made by companies such as Frequency West and California Microwave. These units were used in the 5.9 to 6.4-GHz communication band and provide more than enough LO power for the mixer (a 6-dB attenuator was needed with mine). Some units have an internal crystal oven; after a few minutes warm-up, stability is comparable to that of a VHF transceiver. Operation and tune-up of these units has been described by K0KE, WD4MBK and AA5C.[12 13 14] The sources can be used unmodified to provide high-side LO injection, above 5760 MHz, or modified to operate below 5760 for normal low-side injection.[15] Unless you are obsessive about direct digital readout, high-side injection using LSB and reverse tuning is perfectly acceptable. For CW operation, there is no difference.

Most of the available sources operate on -20 V. This is only a problem for portable operation. WB6IGP has described a +12 to -24-V converter, and surplus potted converters are occasionally found.[16] A three-terminal regulator IC provides the -20 V. In order to prevent switching noise generated by the converter from reaching the LO, the converter is contained in a metal box with RFI filtering on both input and output.

Conclusion

The dual mixer and two of the GaAs MMIC amplifiers described above could be the foundation of a decent rover station for 5760 MHz, and the addition of a waveguide filter is the next step toward a high-performance station. An obvious next step would be to integrate the MMIC amplifiers onto the dual mixer board; I haven't gotten around to that yet.

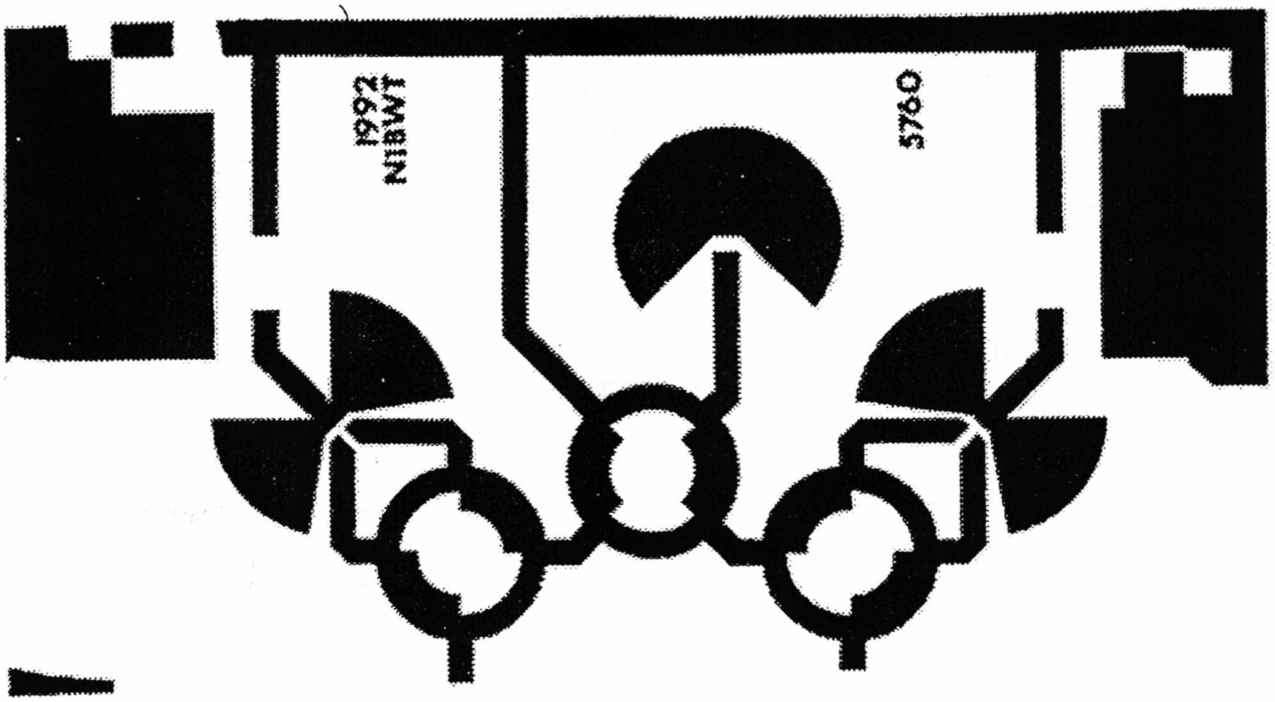


Fig 1—First dual mixer layout

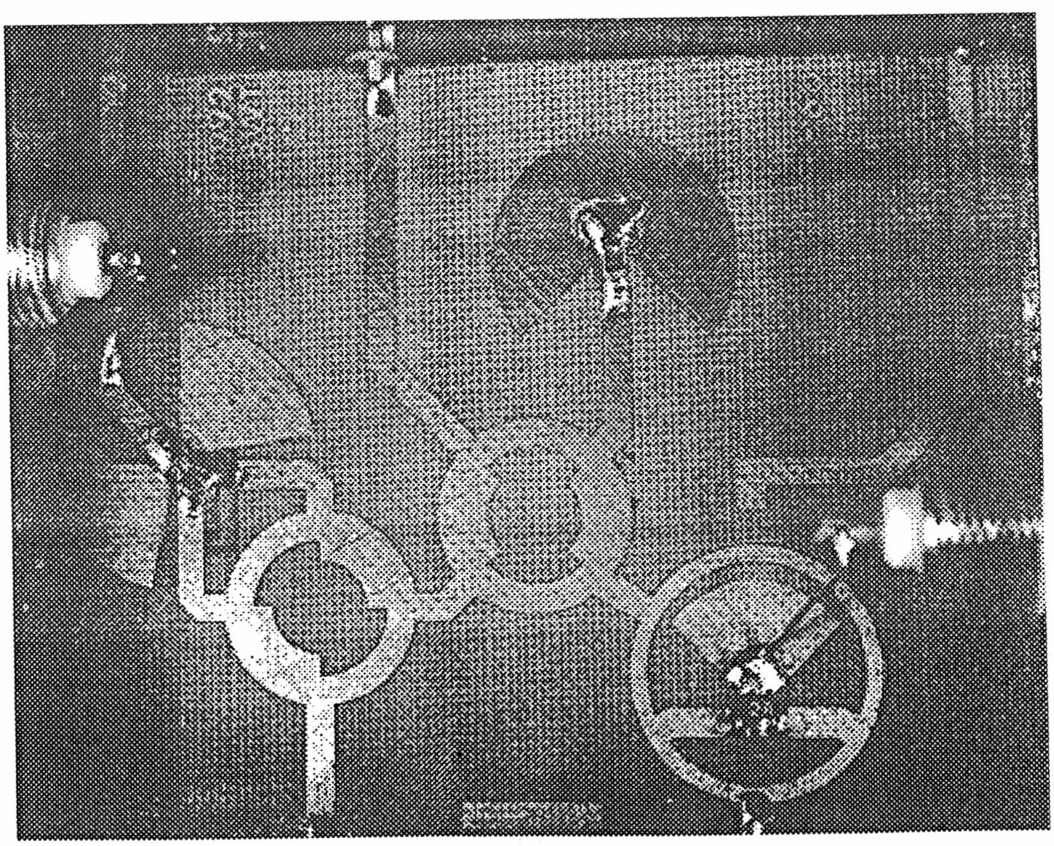


Fig 2

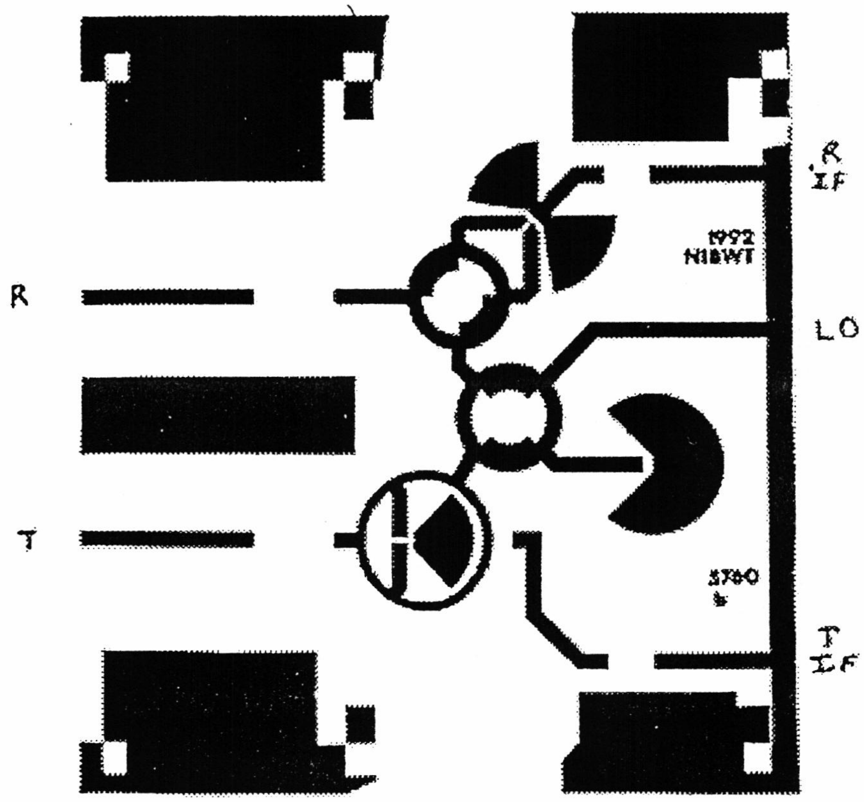


Fig 4—Layout of dual mixer with filters

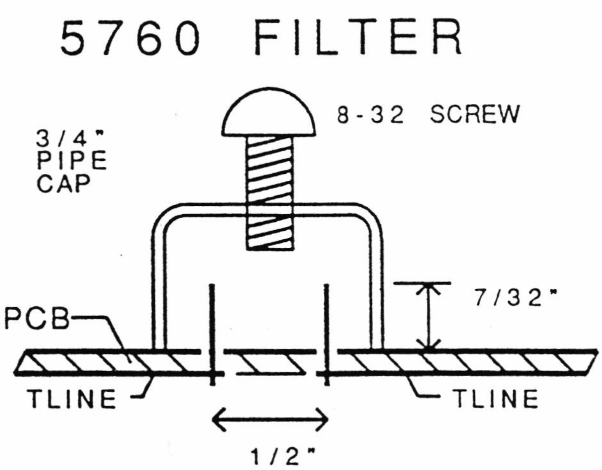


Fig 3—Pipe-cap filter cross-section

Notes

[1]Wade, P., N1BWT, "Mixers, etc., for 5760 MHz," *Proceedings of Microwave Update '92*, ARRL, 1992, pp 71-79.

[2]Healy, R., NJ2L, "A Modular, High-Performance 5.76-GHz Transverter," *QEX*, March 1995, pp 12-15.

[3]Cook, R., N2SB, "5760 MHz from the Junkbox," *QEX*, May, 1994, pp 20-24.

[4]Campbell, R., KK7B, "A Single-Board Bilateral 5760-MHz Transverter," *QST*, October 1990, pp 27-31.

[5]Wesolowski, R., DJ6EP, and Dahms, J., DCØDA, "Ein 6-cm-Transvertersystem moderner Konzeption," *cq-DL*, January 1988, pp 16-18.

[6]Houghton, C. L., WB6IGP, "Above and Beyond," *73*, December 1990, pp 61-62.

[7]Wade, P., WA2ZZF, "A High-Performance Balanced Mixer for 1296 MHz," *QST*, September 1973, pp 15-17.

[8]Wade, P., WA2ZZF, "High-Performance Balanced Mixer for 2304 MHz," *ham radio*, October 1975, pp 58-62.

[9]Keen, H. S., W2CTK, "Microwave Hybrids and couplers for Amateur Use," *ham radio*, July 1970, pp 57-61.

[10]Chang, K. W., Chen, T. H., Wang, H. and Maas, S. A., "Frequency Upconversion Behavior of Singly Balanced Diode Mixers," *IEEE Antennas and Propagation Society Symposium 1991 Digest, Vol 1*, pp 222-225, IEEE, 1991.

[11]Britain, K., WA5VJB, "Cheap Microwave Filters," *Proceedings of Microwave Update '88*, ARRL, 1988, pp 159-163.

[12]Ericson, K. R., KØKE, "Phase Lock Source Update," *Proceedings of Microwave Update '87*, ARRL, 1987, pp 93-95.

[13]Osborne, C., WD4MBK, "Surplus Microwave Local Oscillators, Evaluating and Modifying Them," *Proceedings of Microwave Update '88*, ARRL, 1988, pp 33-41.

[14]McIntire, G., AA5C, "Phase-Locked Microwave Sources," *Proceedings of Microwave Update '91*, ARRL, 1991, pp 113-136.

[15]Houghton, C. L., WB6IGP, "Above and Beyond," *73*, November 1991, pp 66-68.

[16]Houghton, C. L., WB6IGP, "Above and Beyond," *73*, July 1990, pp 68-69.

[17]Elmore, G., N6GN, "A Simple and Effective Filter for the 10-GHz Band," *QEX*, July 1987, pp 3-5.

[18]Hilliard, D., WØPW, "2 GHz to 6 Hz Power Amplifiers," *Proceedings of Microwave Update '87*, ARRL, 1987, pp 78-92.

A 6cm receiver based on a modified G3WDG 10GHz design ~

by Gus Coleman, G3ZEZ

I have recently finished a new receiver for the 5.7GHz (6cm) amateur band. It is based on the proven G3WDG 10GHz RX pcb and was tested at the 1996 Martlesham Round Table last November. It appears to work well.

In this receiver, all the relevant, original inductors have been lengthened by the 5760/10368 ratio and bent to fit the available space. The mixer loop has been cut and extended , using very thin copper foil, and superglued to the board.

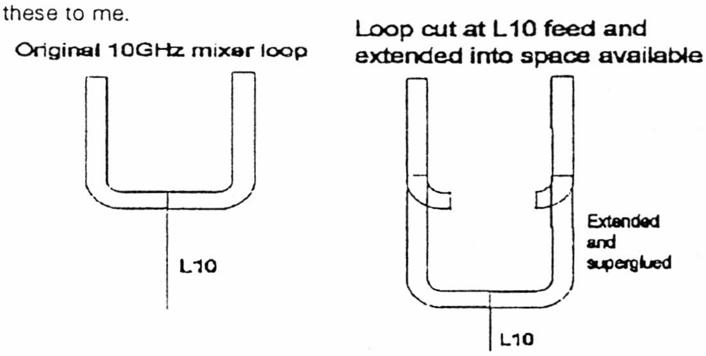
Both cavity resonators tune with the existing screws and have approximately 1mm of thread left. At first I put a spring washer under each screw to test the circuit but eventually I lengthened the screws to enable a lock nut to be fitted. The probes are full length veropins as supplied for the 10GHz kit. Perhaps these could be optimised at a later date.

The local oscillator is a DDK board retuned to give output at 1872MHz, using a crystal frequency of 117MHz. Each stage of this board is tuned as a doubler. Some modifications to the capacitor values and to the inductors on this pcb are needed to resonate at the required frequencies.

The receiver front end uses the "three for £1.99" GaASFets available from Birketts of Lincoln.

In my transmitter, which is CW only, I generate 10 watts at 960MHz from a 2C39A which is then fed up the mast via coaxial line to a cascaded doubler/tripler to produce 5760MHz. The final RF output is approximately 1 watt and is fed to the 1.2metre dish via waveguide

The diagram below shows the modifications to the mixer in the WDG RX pcb. Charlie kindly suggested these to me.



I have also built and used a 2 stage GaAsFet amplifier, to an American design. I hope this relatively simple way of getting going on 6cm encourages others to do the same.

73 from Gus, G3ZEZ **(and many thanks indeed Gus from the editor)**

Microwave Newsletter
JANV/FEV 97

5.7 GHz FREQUENCY SOURCE

G4JNT 15/1/94

Microwave Newsletter Mars 1995

This frequency source is intended primarily for use in 5.7 GHz beacons and is driven from a 320 MHz signal generated by a separate oscillator module [1]. Referring to Figure 1. a modamp at the input provides a good 50 ohm input match and, more importantly, is operated as a limiter providing constant drive to the following multiplier. The lineup consists of a tripler to 960 MHz, with a three stage filter on its output followed by a doubler to 1.92 GHz also with a three stage filter. A GaAs FET is used as the final tripler to 5.76 GHz. The wanted harmonic is selected by an output resonator consisting of a single quarter wave resonator made from a short length of Waveguide 18 shown in detail in Figure 2. Coupling into the resonator is by full length veropins inserted through the PCB and passing through 3mm diameter holes drilled in the waveguide section opposite the tuning screw. A second FET amplifies the output to around 10 - 12 dBm output level. P351108 (Black spot) devices were used here as I still have several of these, but slightly improved performance should be possible by substituting the MGF1302.

Construction is split between two PCBs which are butted together and soldered into the inevitable 7754 tinplate box, the layout is shown in Figure 3. The first PCB is standard fibreglass and holds the multiplier stages up to the 1.9 GHz filter output. The 5.7 GHz stages are constructed on 0.79mm PTFE board to minimise losses. 3mm wide copper tape or strip is soldered across the entire width to join the groundplanes together, another piece connects the RF tracks. Veropins are sprinked liberally around to provide grounding; one is fitted at each point marked with a circle in figure 3. The output filter is fitted by heating on a hotplate and tinning the complete underside, then transferring while still hot to the tinned PCB in a simalar way that the resonators are fitted in the 'WDG 10 GHz modules. The two holes for the coupling pins are aligned with the PCB holes and a large soldering iron can be used to maintain the temperature and complete the soldering operation. Since the resonator screw is completely contained within the waveguide, good soldering to the PCB is less important than for the WDG modules, but it is still important that there is good solder flow over the whole of the mating surfaces to prevent RF leakage across a poor earth from degrading filter rejection.

Setting up is straightforward. Set the FET gate voltage on TR3 to -2 to -2.5V and the drain current of TR4 to 30mA. Then apply RF drive and tune C4 for maximum emitter voltage on TR1 (if this greatly exceeds 0.7V, increase R3 to prevent excessive device dissipation) then adjust C8 to C10 for maximum TR2 emitter voltage. Measure the drain current of TR3 (either across R10 or by breaking the connection to the feedthrough pin) and tune C14 - C16 and the input matching capacitor C23 for a peak; Id should exceed 30mA. With a power meter, or by monitoring TR4 drain current, adjust the resonator for a peak in output power which should exceed 10 dBm. TR3 bias may be varied slightly to optimise output, but remember to re-tweak the resonator as the settings are interactive; readjustment of C23 will also probably be necessary. Do not be tempted to operate this stage at Idss (ie zero bias), although a minor output peak may be found here much better multiplier performance is obtained with the device biassed well beyond cut off and being briefly switched into conduction by the positive peaks of the RF waveform. Greater output could probably be obtained by increasing the supply voltage to TR3/4 to a maximum of 8V but this has not been tested.

The only spurious output of note is at 3.84 GHz, ie the second harmonic component of the penultimate multiplier stage. This was -35 dBc on the prototype unit and could be reduced at the expense of lowered output power by cutting the veropins shorter; this has not been tried as this frequency product will be easily removed by further filtering in later amplifier stages. All other spurious outputs are at a level of at least -50 dBc.

A complete source module could be produced in a longer housing by adding the oscillator components and PCB layout taken from the 3.4 GHz source described in the Microwave Newsletter October 1992.[2] and removing the input modamp. Some repositioning of the 300 MHz components will be necessary.

Notes

(1) *300 MHz Beacon Source, Microwave Newsletter Feb 1995*

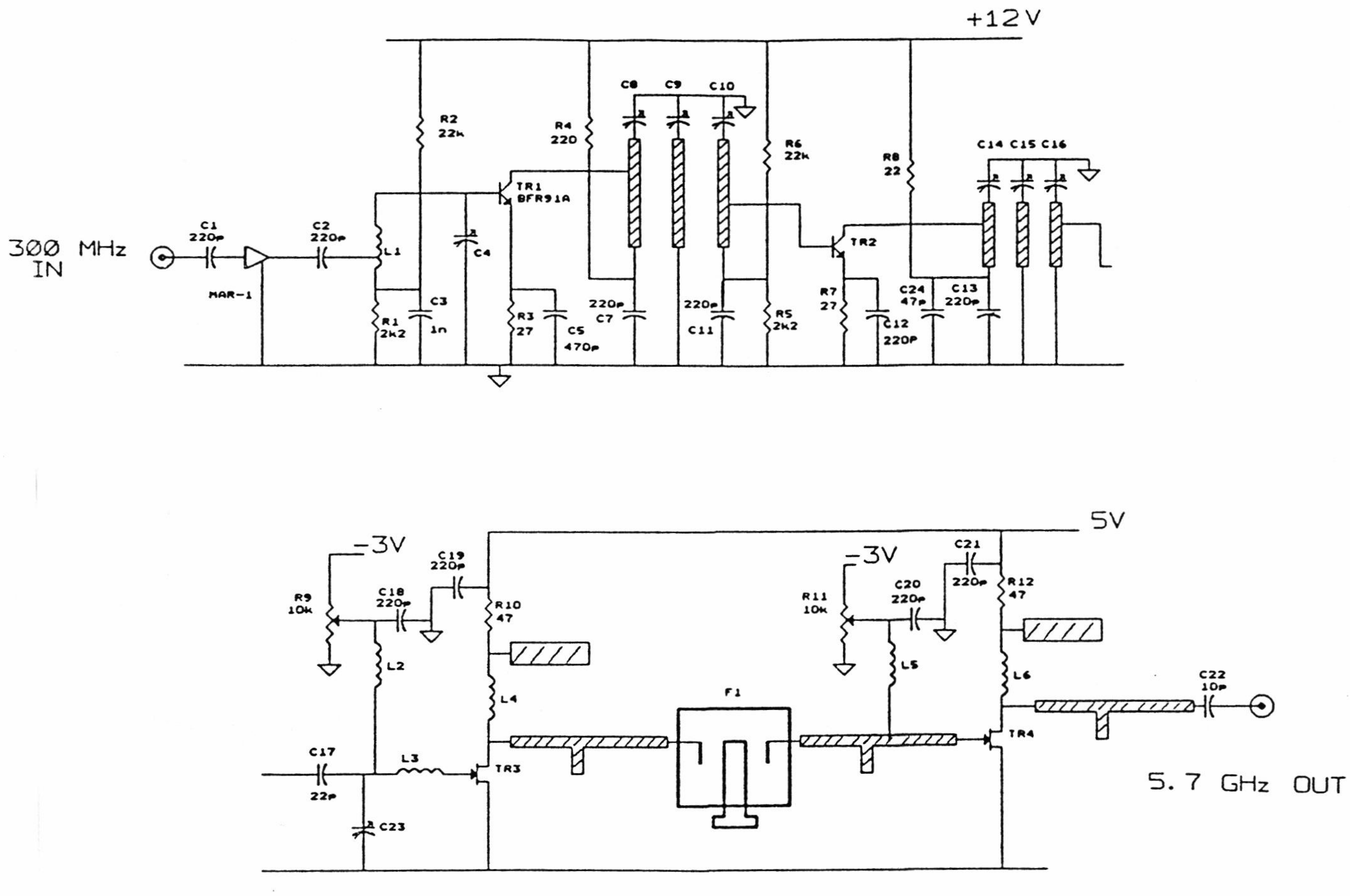
(2) *Any similarity between this design and the 3.4 GHz source referred to is purely incidental and no representation should be made or inferred with any other person either living or dead.*

COMPONENTS LIST

Quantity	Reference	Part	
8	C1,C2,C7,C13,C18,C19, C20,C21	220p	0805 SMT
1	C3	1n	"
1	C5	470p	"
1	C12	220P	"
1	C17	22p	"
1	C22	10p	"
1	C11	100p	ATC A
1	C24	47p	ATC A
1	C4	10p Trimmer	
7	C8,C9,C10,C14,C15,C16 C23	6pf Sky Trimmers	
2	R1,R5	2k2	1206 SMT
2	R2,R6	22k	"
2	R3,R7	27	"
1	R4	220	"
1	R8	22	"
2	R9,R11	10k	"
2	R10,R12	47	0805 SMT
2	TR1,TR2	BFR91A	
2	TR3,TR4	P351108 or MGF1302	
1	IC1	MAR-1 or MAR-7	

FRE023 Regulator board.

L1 2 turns 0.5mm ECW, 3mm inside dia. 8mm long
L2 22mm 0.5mm ECW bent into Zig-Zag shape
L3 20mm " " " into hairpin shape
L4/5/6 Approx 10mm long 0.2mm dia. wire fitted as shown



5.7 GHz BEACON SOURCE G4JNT 17/1/95

Fig 1

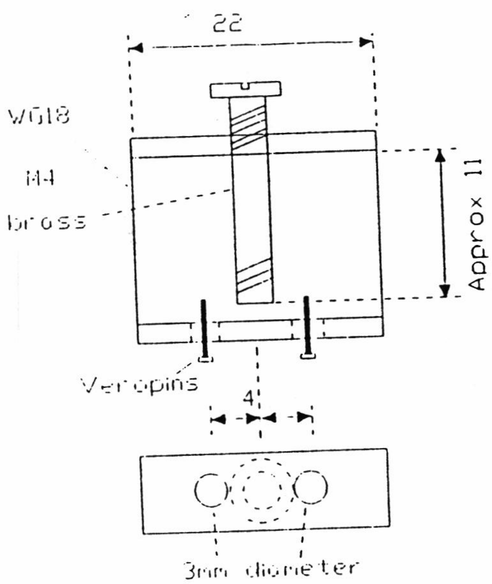


Fig 2

5.76 GHz FILTER

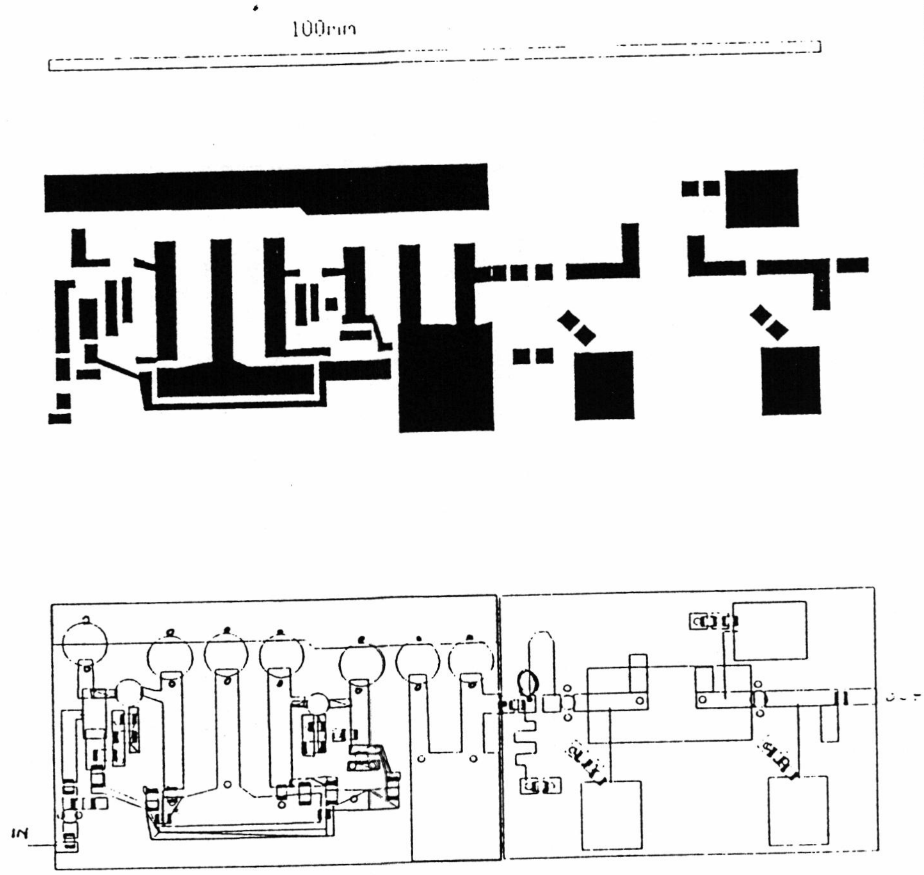


Fig 3 PCB Layout

A 300 MHz SOURCE FOR MICROWAVE BEACONS

by Andy, G4JNT

(montage à associer à la description précédente)

This unit is designed to allow the oscillator section of microwave beacons to be located in a temperature stable environment such as a building at ground level, whilst still allowing the high frequency sections to be masthead mounted to minimise feeder losses. The design was produced for the proposed GB3SC# 2.3 - 24 GHz suite of beacons on the South Coast where it is intended to have the five master oscillators together in a temperature controlled bunker used for all the other on site PMR equipment.

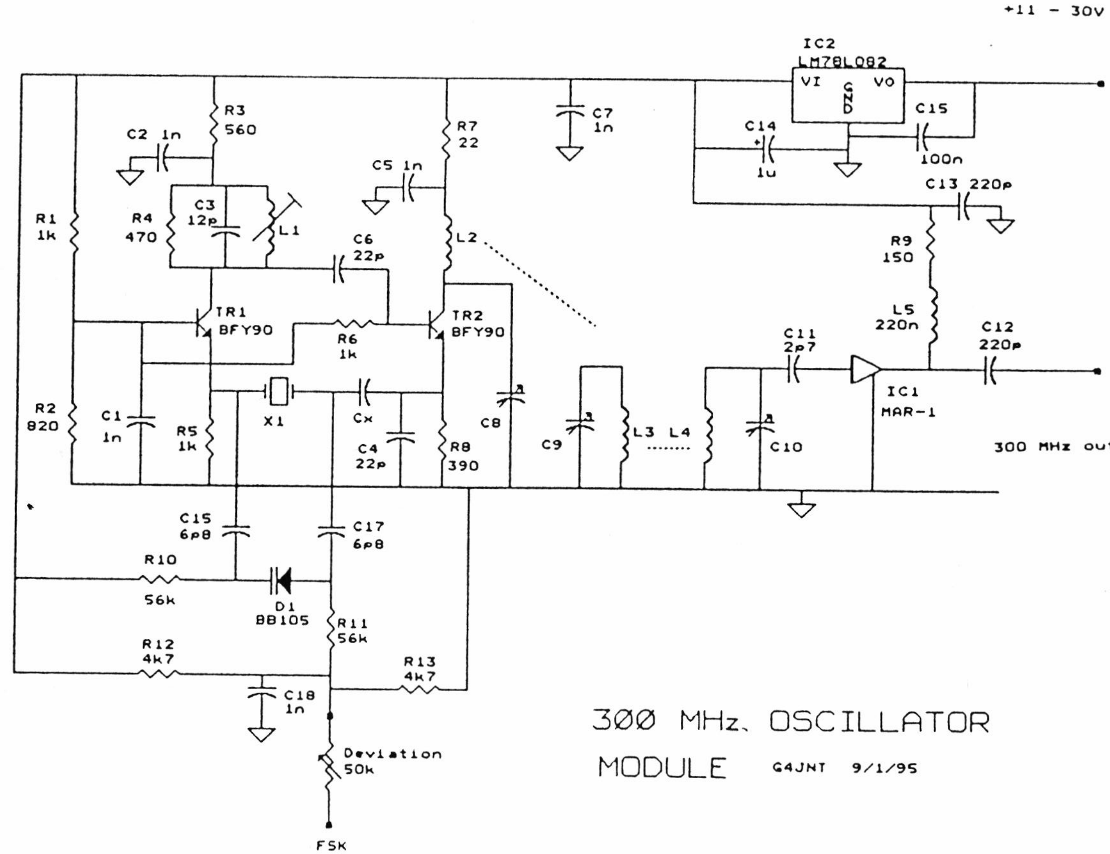
DESIGN

Referring to figure 1, the oscillator is taken directly from the well proven Butler design used in the 'DDK 001/4 etc operating in the 90 to 110MHz region. In these designs the third or fourth harmonic of the crystal frequency is extracted directly from the second oscillator stage (the limiter). The same approach is used in this module, with the added advantage that the 300 MHz generated is an ideal frequency for feeding up long lengths of relatively low cost coax without adding to the frequency multiplication hardware at the mast head.

Since the oscillator could be co-sited with many other non amateur receivers at a typical beacon site, an extra filtering stage has been added to reduce the prospect of embarrassing leakage at other crystal harmonic frequencies; it also means that the beacon signal will be that bit cleaner as far as 90 MHz sidebands go! To complete the module, a modamp is used as an output buffer to give plenty of drive to subsequent equipments and give a healthy 50Ω output impedance. Output power is typically 13 Dbm with the third harmonic selected, but if this is felt to be too high (Note 1) it can be reduced by increasing the value of R9, so reducing the modamp bias current. FSK keying circuitry is included within the module by a varicap in parallel with the crystal. This is adequate for the small frequency shifts required for most microwave beacons of less than 1 ppm, but if wider shifts are needed it might be preferable to use a varicap in series as suggested by G4DDK recently.

The entire module is operated through an internal 8.2V Dc regulator, including the modamp, so that the oscillator can be powered from any DC source from 11 to 40V. Regulator power dissipation at the higher voltages may be a bit critical though for long term reliability, and a higher current device might be required to allow the heat to be removed satisfactorily. Total current consumption is in the order of 50mA.

A crystal heater could be added if it is felt necessary, but the main advantage of this build approach is that the entire oscillator / multiplier assembly is small enough for the whole unit to be temperature controlled. Several such modules could share a common heater and control circuit - this is the intended route for GB3SC#



300 MHz. OSCILLATOR MODULE G4JNT 9/1/95

Fig 1

PARTS LIST

R2	820	
R5,R1,R6	1k	
R8	390	
R4	470	
R3	560	
R7	22	
R9	150	
R10,R11	56k	
R12,R13	4k7	
R14	50k	Preset
C1,C2,C5,C7,C18	1n	Ceramic
C4,C6	22p	
C13,C12	220p	
C3	10 - 15pF as required	
C11	2p7	
C15,C17	6p8	
C15,C17	6p8	
C14	1u	Tant
C15	100n	"
C8,C9,C10	10p preset or (6p for 400 - 500 MHz output)	
L1	Toko MC119 200nH, Cirkit Stock No. 35-11954.	
L2,L3,L4	2 turns .8mm dia. silver plated wire, 3mm inside dia. stretched to fit hole spacing. L4 tapped at approx 0.5 turn.	
D1	BB105	
TR2,TR1	BFY90	
IC1	MAR-1	
IC2	LM78L082	
X1	90 - 110 MHz Crystal	

Note 1

A subsequent design for a 5.7 GHz beacon source (to be published shortly) uses a modamp at the input of a multiplier chain in order to maintain a constant drive level to the subsequent stage and to ensure 50Ω input impedance. The use of a limiting amplifier at this point is far more important than having one at the oscillator output, and leads to the somewhat dubious situation of being able to have over 20 dB of feeder loss between the two modules. If this is considered to be excessive just remove the modamp in the source box with its associated bias components and bridge the tracks, taking the output directly from the filter. It should still be possible to get around 0 dBm output level.

CONSTRUCTION

A through hole double sided PCB is used rather than a surface mount version, since in this case only minor advantage could be taken of the reduced size. The PCB and component layout is shown in Figure 2 and fits in the ubiquitous 37 x 74 mm tinplate box, type number 7752. Note that all the PCB holes need to be counterbored on the upper groundplane side.

To set up, adjust L1 to resonance by listening on a band 2 receiver or scanner for the oscillator starting up. If resonance is not achieved then change the value of C3 within the range 8.2 - 15 pF until it is. As with all the 'DDK oscillators, Cx may or may not be needed to reliably achieve the correct output frequency; try value around 30 pF if it is. Finally, using a diode probe or power meter tweak C8 - C10 for maximum output; the tuning of C9 will be quite sharp.

Prototypes have been tested at output frequencies of 320 MHz (x 18 = 5760) and 283 MHz (x 12 = 3400), with minor C3 variations both fired up straight away.

No tests have been made selecting the fourth harmonic for output rather than the third, but there is no reason why this should not be possible if the coils are made a bit smaller; the filtering is potentially adequate for use even to the fifth harmonic at 500 MHz (try 20mm long loops of silver plated 1.6mm diameter wire mounted 5mm above the board for this frequency range)

The layout in the tinplate box, with the RF output adjacent to the 12V input pin, allows a choke to be added off-board to allow DC to be fed to a head unit, dispensing with the need for any DC supply cables.

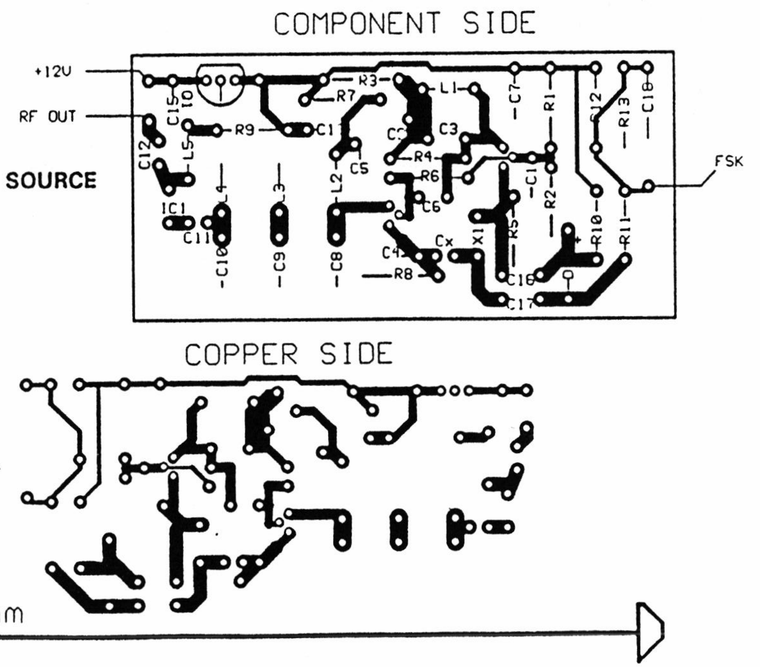


Fig. 2
300MHz BEACON SOURCE
PCB LAYOUT

Frequency Doubler from 2.5 GHz to 5 GHz using GaAs FET

by Jürgen Dahms DC0DA   Dubus 2/84

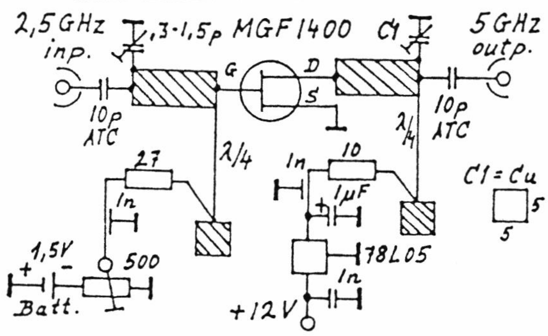
E. In the amateurradio section GaAs FET's are used mostly for amplifier applications in the prestage- or medium power range. But without any problems GaAs FET's are usable also as active frequencymultiplier especially in the short high frequency range with efficient success. Multipliers using varactor diodes, high mechanical performance is necessary, have an efficiency of mostly no more than 50%.
For set up a 10 GHz transverter (IF 144 MHz) under using a subharmonic mixer, a LO frequency of 10244/2 (MHz)= 5112 MHz is to produce. The needed 2556 MHz are easily to produce using low cost silicontransistors as BFR34A, BFQ65, BFQ69, BFR91, HXTR3101 a.s.o., because only a low power signal is necessary to drive the GaAs FET doubler. After passing the FET-doubler the signal must be filtered because the input- and other harmonic products are standing with nearly the same level on the drain of the GaAs FET. Good success shows the here discribed single circuit filter. (voir § Filtres)
The printed circuit bord and the resonatorcircuit is calculated by DK2AB using a microcomputer program.

fout = 5112 MHz
modifiable pour
fout = 5616 MHz

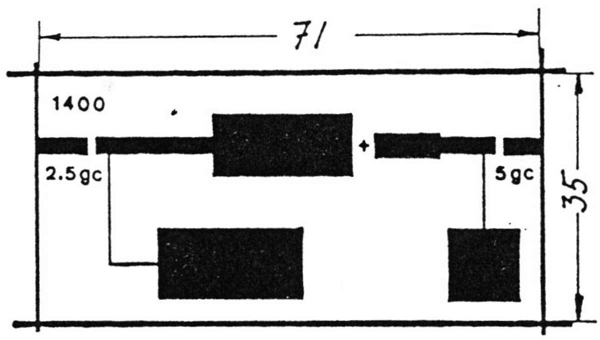
f in = 2556 MHz   P in = 18 mW
f out= 5112 MHz   Pout = 34 mW
Vp = 2.8 dB
P out gemessen mit nachgeschaltetem Resonatorfilter.
Durchgangsdämpfung = .5 dB
Unterdrückung der 2556 MHz=>55 dB
P out measured including resonatorfilter. Insertionloss of the filter=.5dB. Rejection of 2556 MHz => 55 dB.

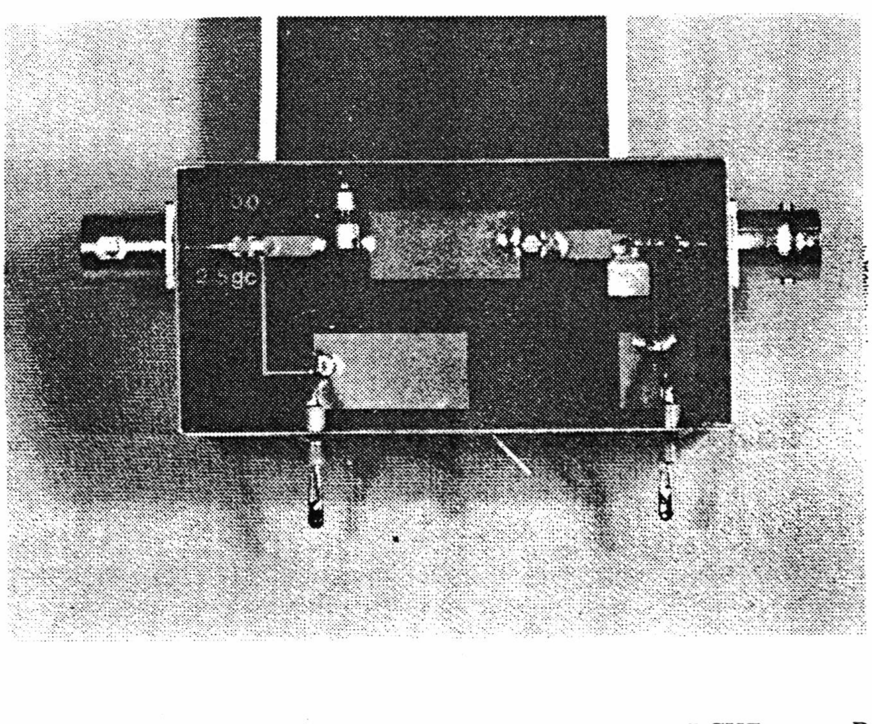
UDS = 4.6 V
UGS = -.6 V
Id = 40 mA

GaAs-FET Doubler 2.5 GHz to 5 GHz



Printed circuit board DC0DA
Frequency GaAs-FET Doubler
RT DUROID   RT 5870 0.79 mm





6 cm

Deux ensembles sont en construction. Le premier prototype me fournit 210 mW en sortie, le facteur de bruit doit être identique au montage sur 10 GHz ou meilleur. L'oscillateur local est le montage de G4DDK modifié, suivi d'un doubleur maison. Le transverter est le montage de DB6NT avec une platine d'alimentation et de commutation OM. L'antenne est une parabole de 90 cm. Des détails sont donnés figures 2, 3 et 4.

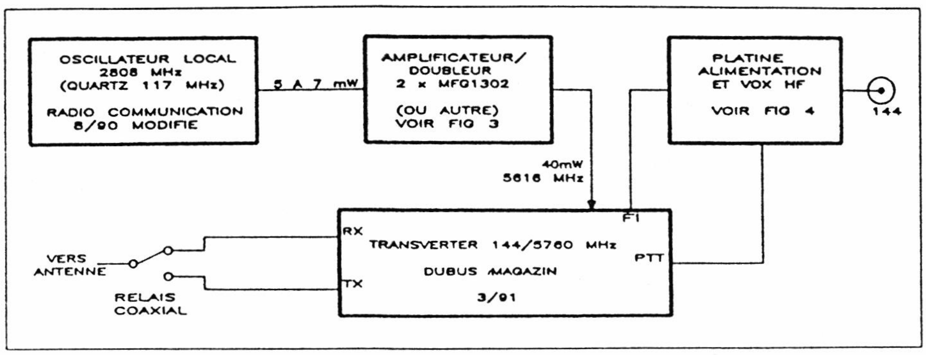


Figure 2
Transverter 6 cm 5,7 GHz.

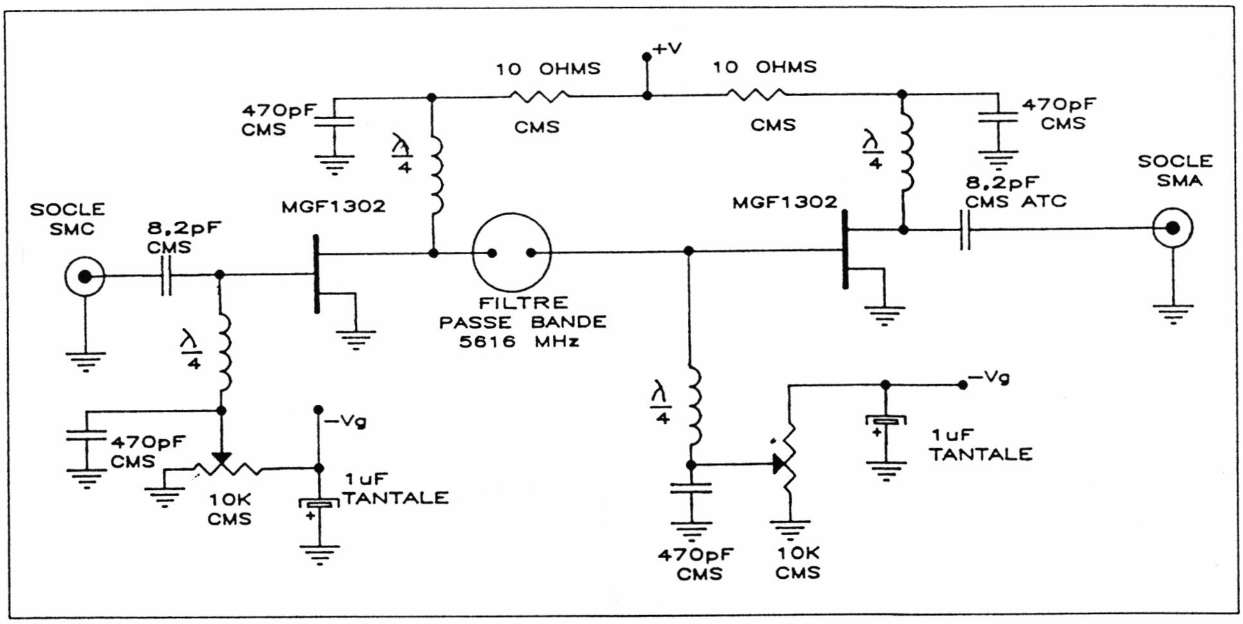


Figure 3
Doubleur amplificateur

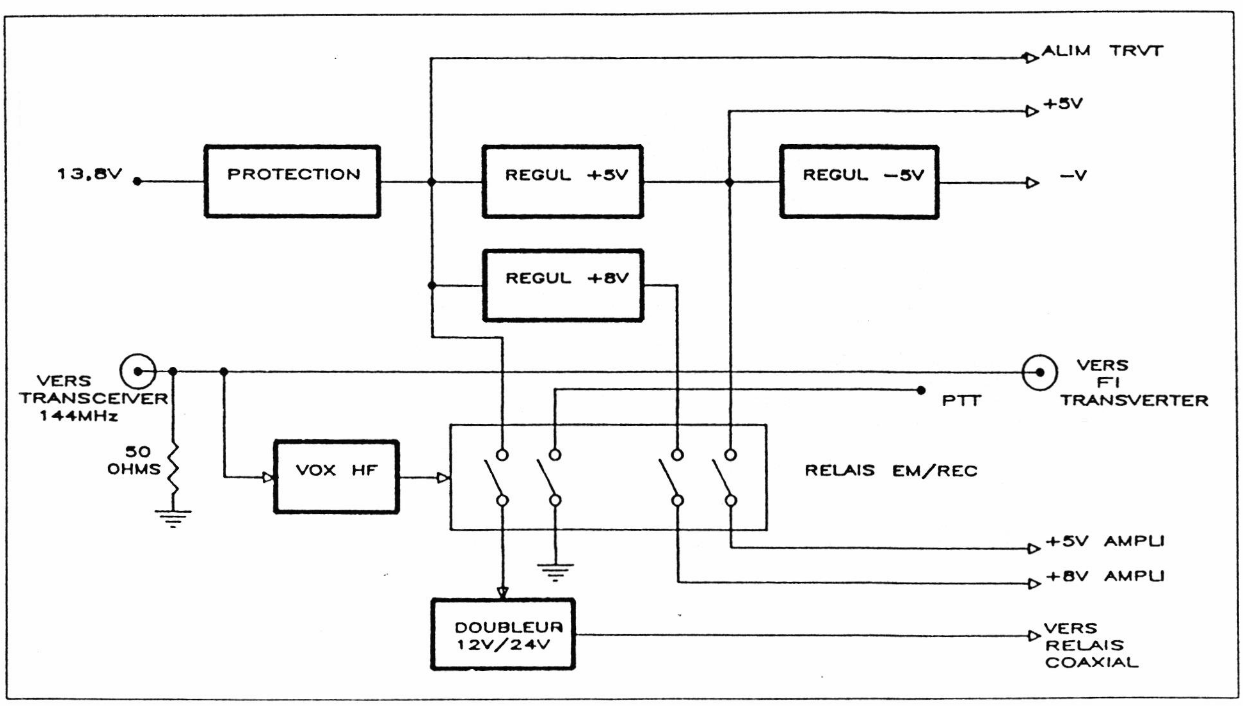


Figure 4
Platine alimentation vox transverter 5,7 GHz

MONTAGES A DIODES SUR 6 cm

VARACTOR QUINTUPLER FOR 6 cm

by Jürgen Dahms, DC Ø DA

E.:
BXY 38 varactor diodes enable efficiencies around 10 % at 1152 MHz input powers up to 4 W.

The author made the waveguide section (inner dim.: 35 x 16 mm^2) of copper sheets, 1 mm thick. The use of 0.5 mm brass sheets should be preferred, because it can be soldered easily with a 100 W soldering iron while the stability is sufficient. The tuning stubs are brass screws with M3, M4, M5, and M6 threads. Their penetration depths as they are shown in Fig. 1 may serve for first tuning test. The optimum positions depend on the diode used and will be found by mutual tuning.
Diodes of the types BXY 28, BXY 38 etc. are usable. They are supported on one side by a home made bypass capacitor and on the other side by a M8 screw. The diode is to insert and remove through the M8 nut, which is soldered on the waveguide. The bypass capacitor is made of copper sheet, 20 x 8 mm^2, 1.5 mm thick, and a PTFE foil, 22 x 9 mm^2, 0.3 mm thick.
The input coupling network is shown in fig. 2. It consists of a pi-section followed by a series resonant circuit. Input power is fed to the varactor through the bypass capacitor. So its value shall not exceed 3 pF, shortcircuiting only 5760 MHz and not 1152 MHz.
The optimum value of the resistor depends on the diode and on the input power as well. A 250 kOhm potentiometer is recommended.
L1 is a 20 mm long piece of wire of 1 mm diam. L2 is of the same wire, forming one turn, wound on a rod of 4 mm diam (s. photograph).

The quintupler is operating as beacon on 5760.6 MHz at the author's QTH.

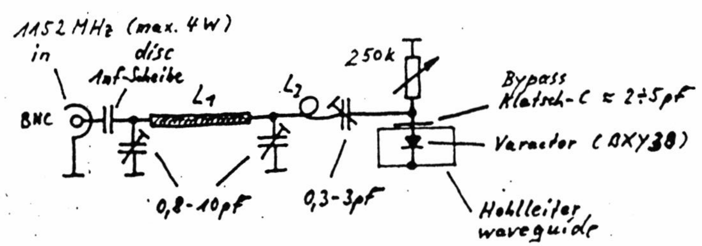


Fig. 2

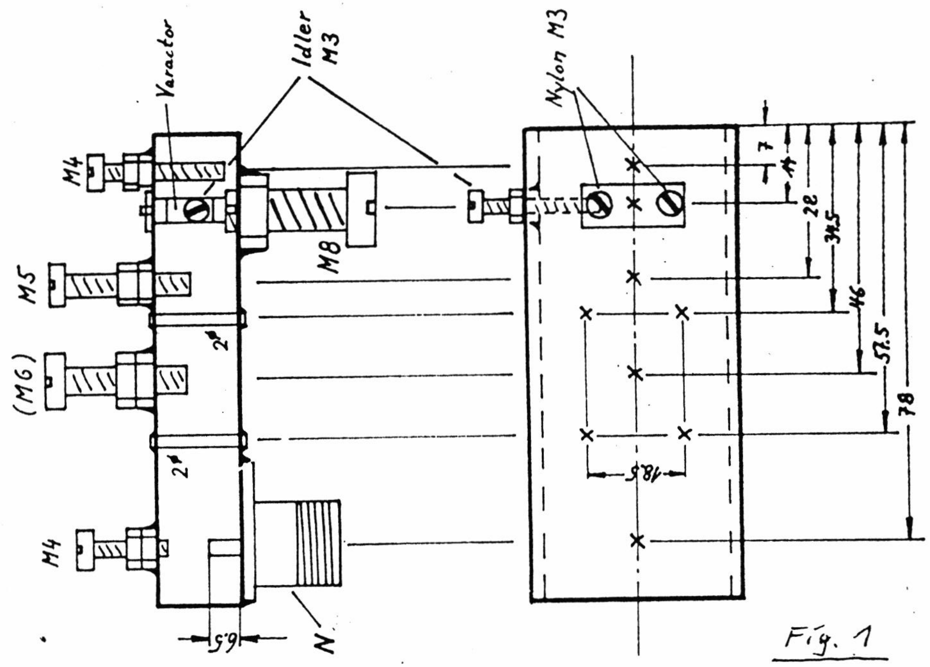
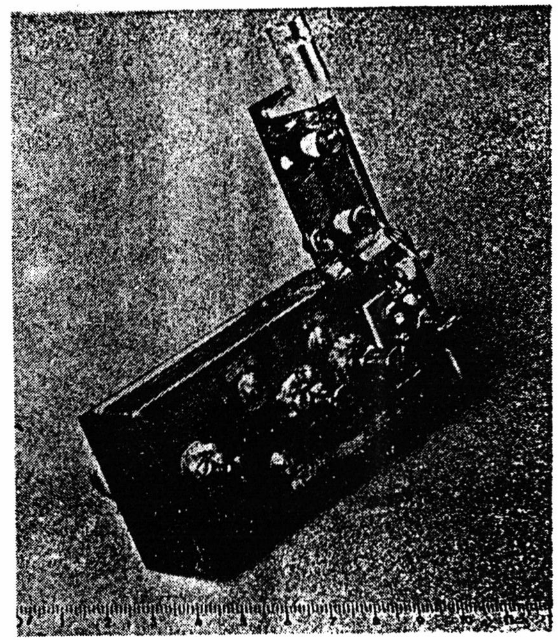


Fig. 1



MULTIPLIER FROM 70cm TO 13, 9 AND 6cm

DUBUS 3/83

by Claus Neie, DL 7 QY

E. : This multiplier is useful to get IF-frequencies for linear mixer or as a direct transmitter multiplier. There are Step Recovery diodes used (fig. 1). The following description is for 13cm. For 9cm only L4 and L5 have to be changed to L4 ≡ and L5 ≡. For 6cm the dividing barrier with the window at the secondary part has to be removed, in the filter section has a stripe line filter replaced. The input power can be between 50mW to 5W. With 0.5 W input the output power is at 13cm 90mW, at 9cm 40mW and at 6cm about 18mW. It is possible to use this multiplier also for 3cm (about 12mW output), but the tests are not complet at this time. Results of this tests are following in the next Dubus. The case form of the diode can be outline 40 or 31 (fig. 1). The dates are from HP, but also similar Step Recovery diodes from other companies are useful. For 13cm use type 800 or 801, for 9cm 0805 or 0806 and for 6cm 0810 or 0811. Fig. 2 shows the circuit. At fig. 3-7 the mechanical details are shown. Fig. 10 shows the version with the stripe line filter. The mechanical filter details shows fig. 11 . If there is a great call for this filter, it is possible to get it by me for own costs. The electric dates of the filter are shown at fig. 14-16. Fig. 14 shows the pass band, fig. 15 the near selection, fig. 16 far-off selectivity. Fig. 12 shows a multiplier for 6cm and fig. 13 for 9cm. Fig. 17 shows a single filter where the measurement was done.

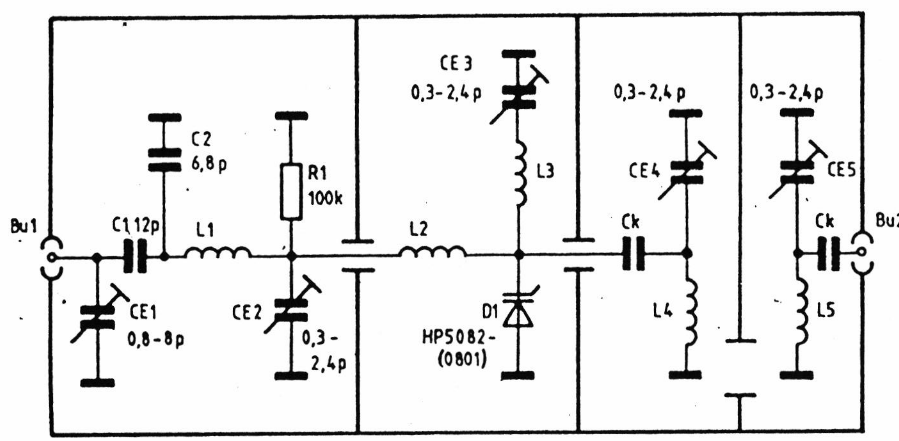
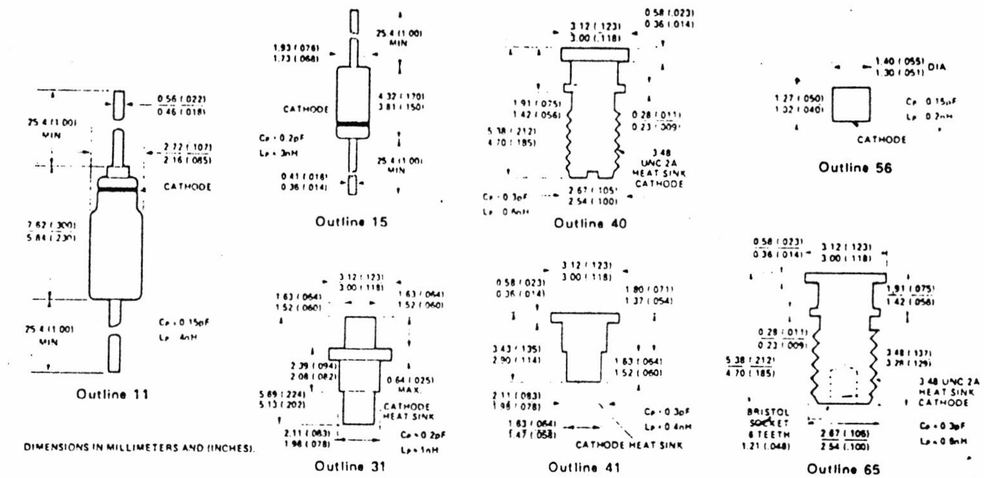


Fig 2

Package Dimensions



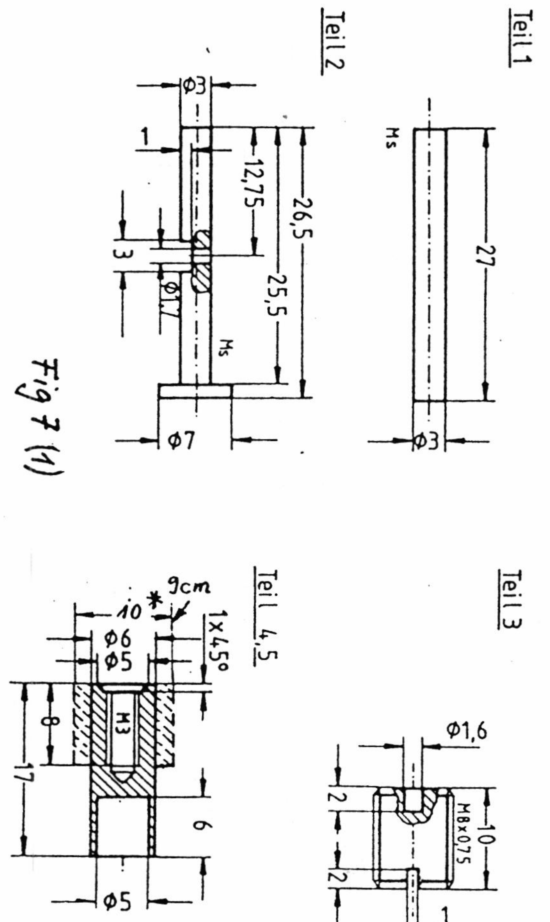
Diodes for High Efficiency Multipliers (All Specifications at T_A = 25°C)

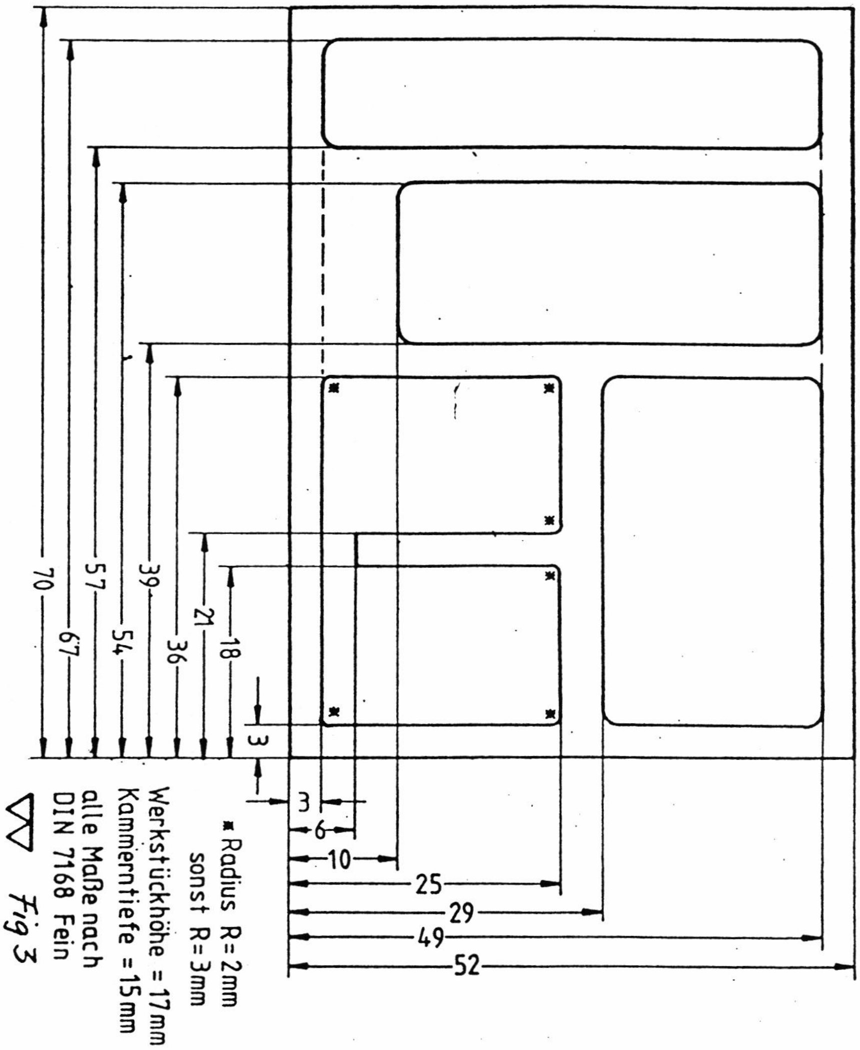
Fig. 1

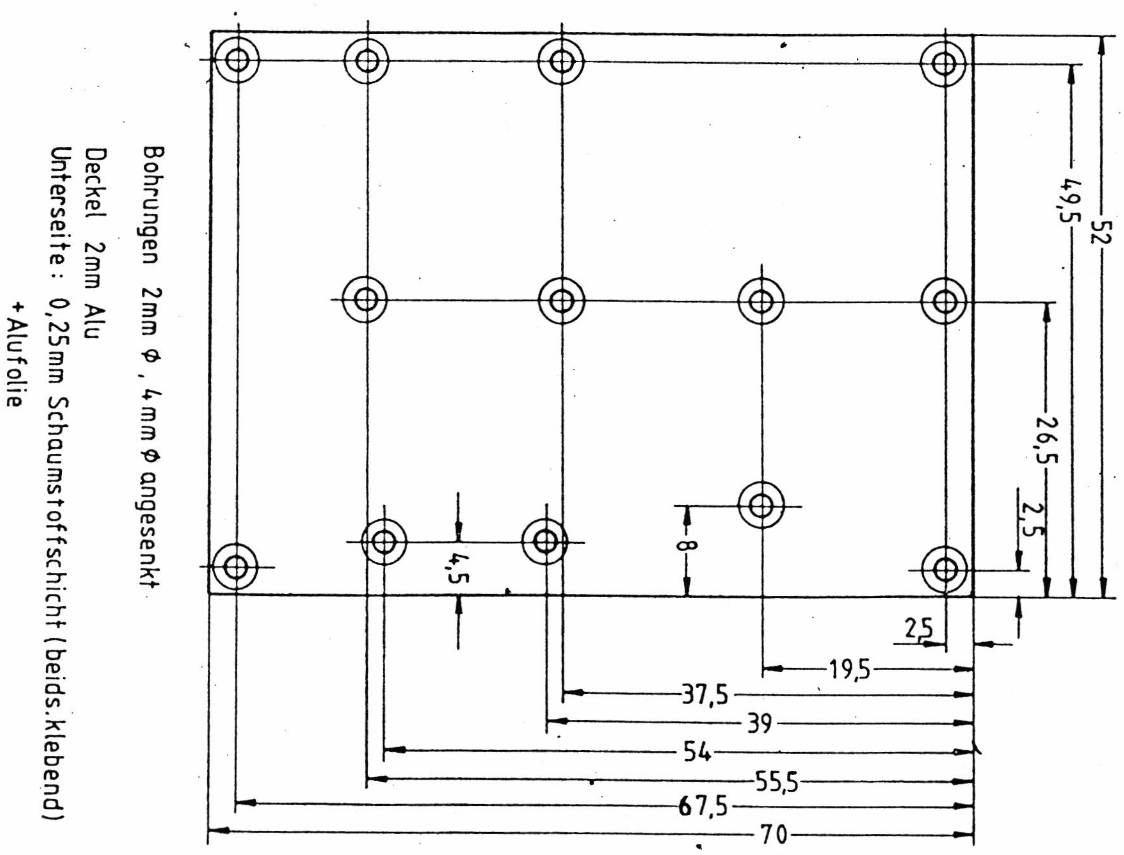
Ceramic Packaged Diodes

ELECTRICAL SPECIFICATIONS / TYPICAL PARAMETERS

Part Number 5082-	Junction Capacitance at -6V, $C_{j(-6)}$ [1] [pF] Min.	Max.	Minimum Breakdown Voltage, V_{BR} at I_R = 10μA [V]	Minimum Cutoff Frequency, f_c [2] [GHz]	Package Outline	Output Frequency Range [GHz]	Output Power, P_o [3] [W]	Lifetime, τ [ns]	Transition Time t_t [ps]	Transition Time Charge Level [pC]	Thermal Resistance, Θ_{jc} [°C/W]
X 0800 0801 0802	3.5	5.0	75	100	40 31 41	1-3	10	250	350	1500	15
X 0805 0806 0807	2.5	3.5	60	140	31 40 41	3-5	6	100	250	1500	20
X 0810 0811 0812	1.5	2.5	60	140	31 40 41	5-8	4	100	200	1000	25
0820 0821 0822	0.7	1.5	45	160	31 41 40	7-10	2.5	50	100	300	30
0830 0831	0.35	1.2	25	200	31 41	8-12	1.0	20	75	300	45
0835 0836 0885	0.1	0.5	15	350	31 41 56	10-20	0.3	10	50	100	60


Teil 2
Teil 1
Teil 4,5
Teil 3
Ms
M3
M8x0,75
Fig 7 (1)


* Radius R=2mm
sonst R=3mm
Werkstückhöhe =17mm
Kammerntiefe =15mm
alle Maße nach
DIN 7168 Fein
Fig 3


Bohrungen 2mm ϕ, 4mm ϕ angesenkt
Deckel 2mm Alu
Unterseite: 0,25mm Schaumstoffschicht (beids.klebend)
+Alufolie
Fig 5

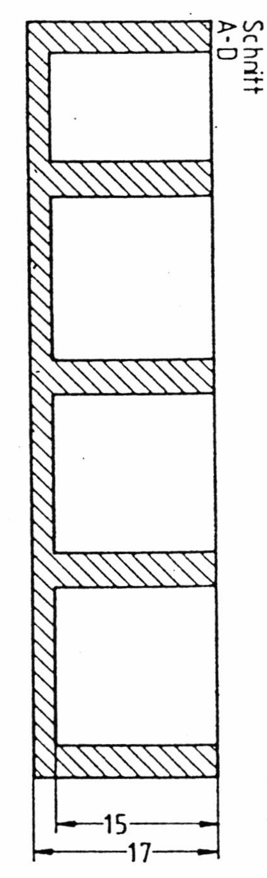
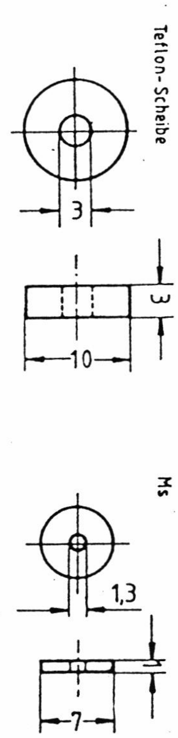

Schnitt
A-D
Fig 4

Fig 7(2)



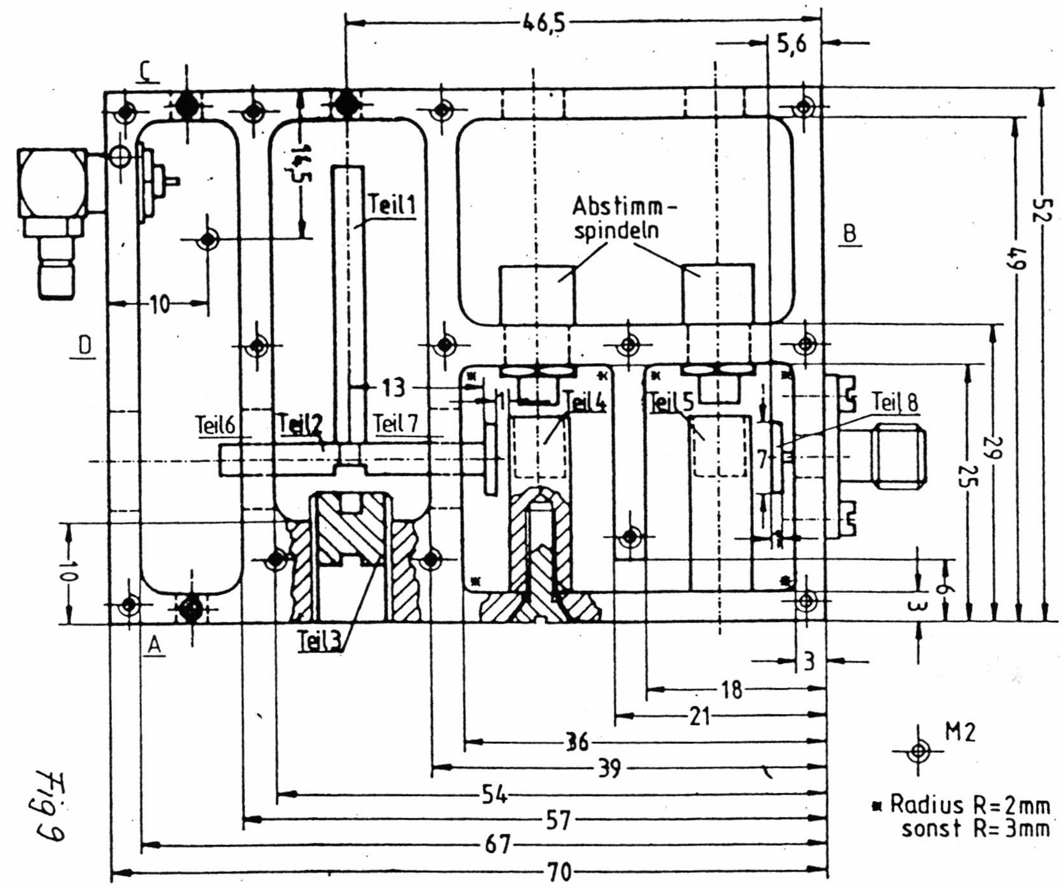


Fig 9

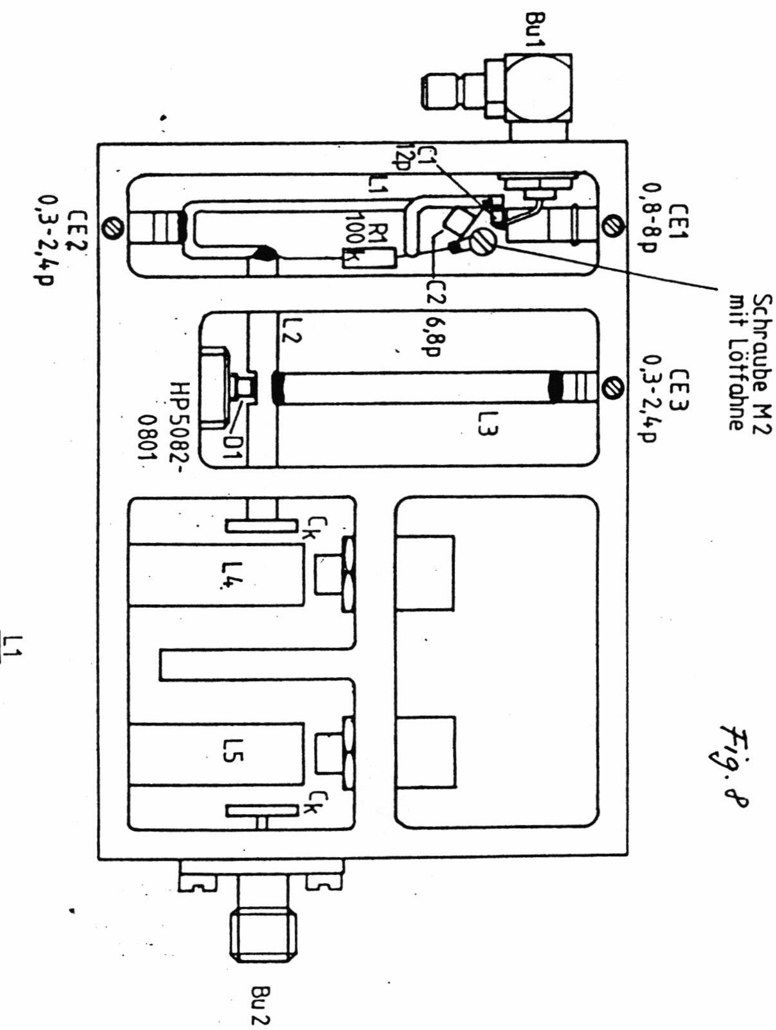


Fig 8

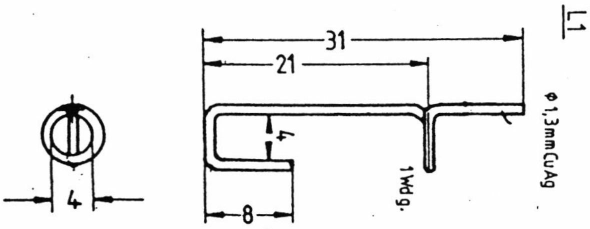


Fig 7(3)

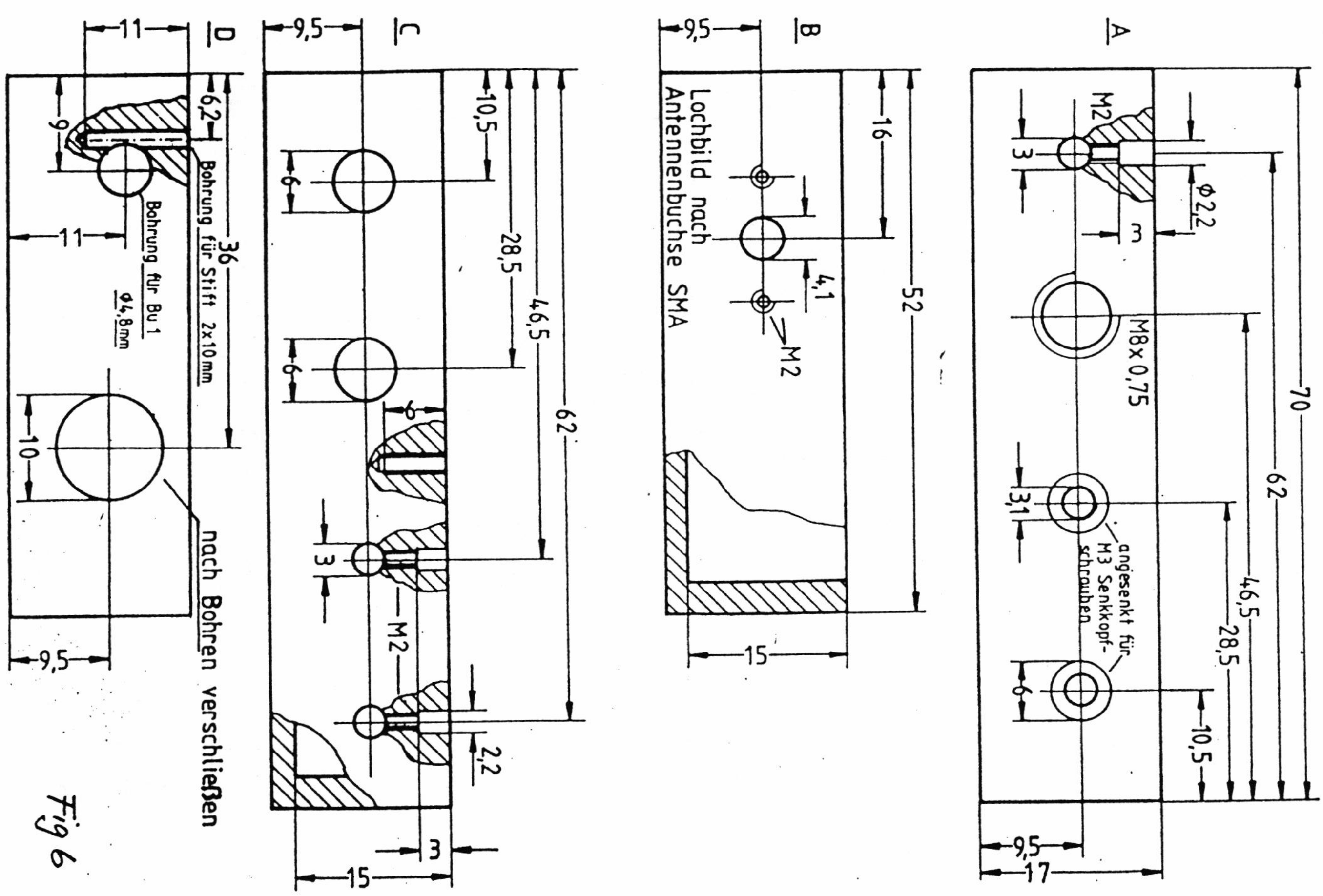


Fig 6

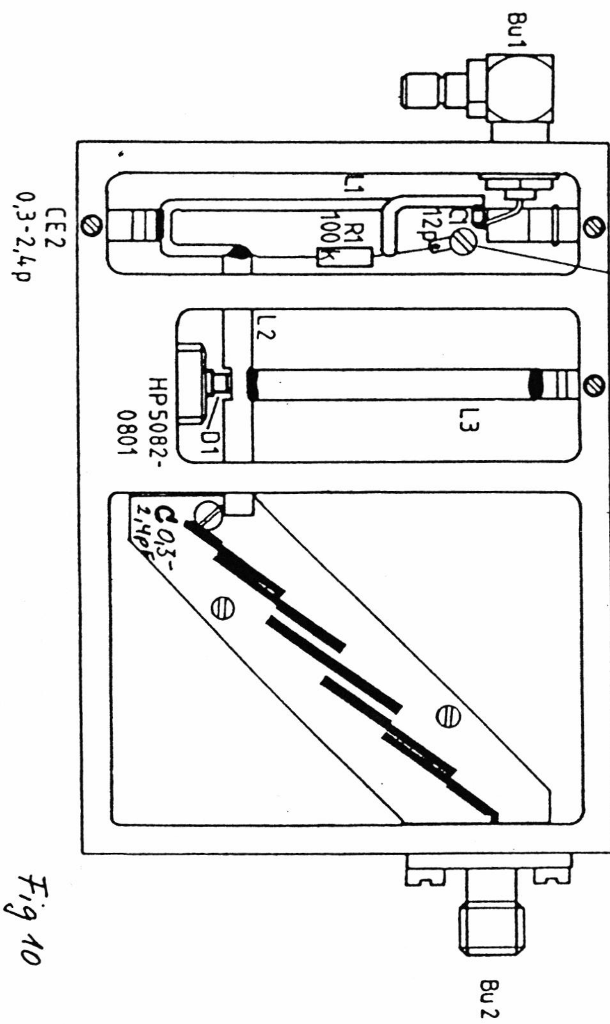


Fig 10

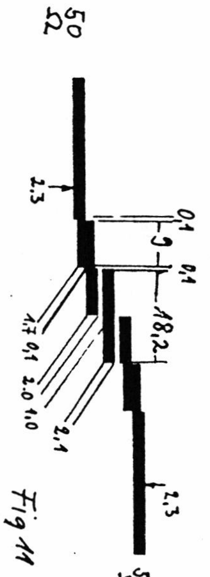


Fig 11

DUROID εr = 2,35 0,79mm

Fig 12

Fig 13

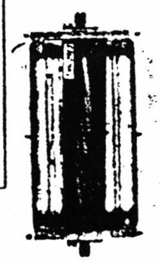


Fig 17

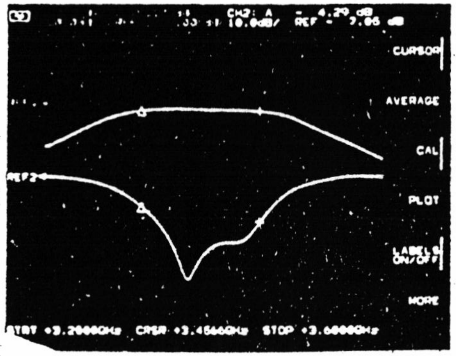


Fig 14

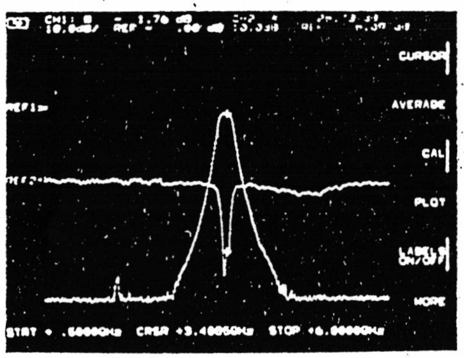


Fig 15

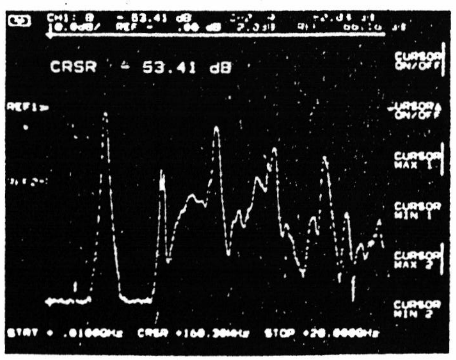
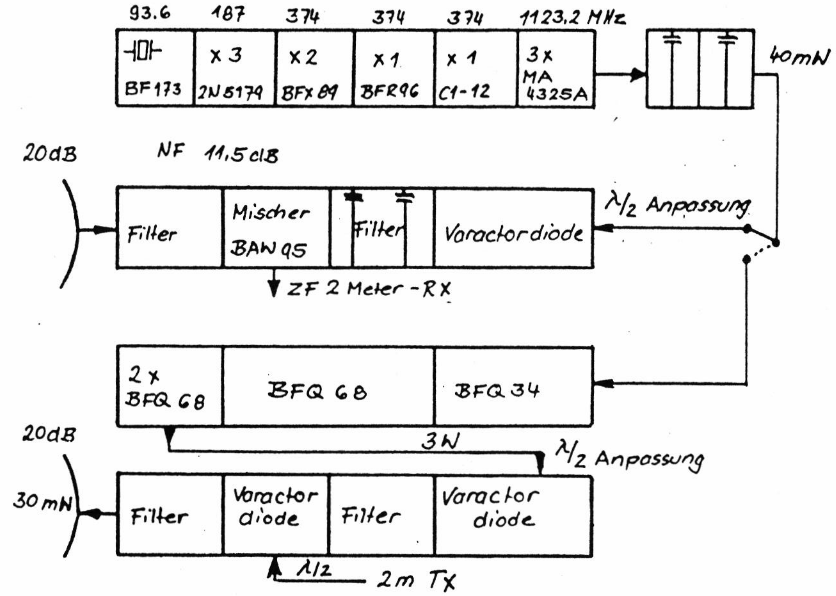


Fig 16

DC∅DA's

Station für 5760 MHz



DUBUS 1/82

Thomas Morzinck, DD Ø QT

A Receive Converter for the 6 cm Band

VHF COMMUNICATIONS 2/82

»How was it during the contest ?«
»Phantastic ! Especially the enormous pile-up on 6 cm !«
»Pile-up on 6 cm ???«
»Of course, two stations in only nine hours .....«

INTRODUCTION

This fictitious conversation clearly describes the present situation on the so-called 6 cm band, whose narrow-band section is from 5760 to 5762 MHz.

The reasons for the low activity – and not only on 6 cm – are, of course, well known, and are not to be discussed in this article, with the exception of one of them. If someone is interested in this frequency range and goes looking for some constructional articles, he will find very little, whether this is for converters, or for frequency multipliers (4). For this reason, the references at the end of this article will give several useful publications for constructions on this band.

MUST IT ALWAYS BE WAVEGUIDE ?

Mechanical work is very difficult for many readers, especially when such things as a lathe are not available. On the other hand, a mechanical construction is often the only possibility in order to become active in the SHF-range at an acceptable price. This is especially valid for the reproducibility of constructional articles. The question whether a converter functions is usually decided by the noise figure, which is the most important criterium for converter constructors. Unfortunately, it increases on increasing the frequency, especially when one attempts to reduce the size of converters using »normal« technology to achieve higher frequency ranges. More regarding this problem was described by Dahms in (7), and Heidemann in (3).

For this reason, the constructional article published by Neie (1) was not suitable for me, although no external oscillator chain was required and one could be able to avoid the »two-box« construction with intermediate connections.

The remaining waveguide-constructions described in (2) and (3) have been combined by me, and the results of this combination are now to be described in detail. The construction is mainly based on details given by Kuhne (2), and it is only the input coupling that has been replaced by the wideband waveguide-coaxial transition described in (3).

The operation will be seen easily in **Figure 1**: Both the input signal from the N-connector, and the oscillator signal generated in the varactor multiplier are filtered out in filter 1, or 2 respectively and fed to the central mixer diode. The IF-output coupling is made – as usual – via a bypass capacitor (C 1). A suitable IF-amplifier is, for instance, one of those described in (4) or (7).

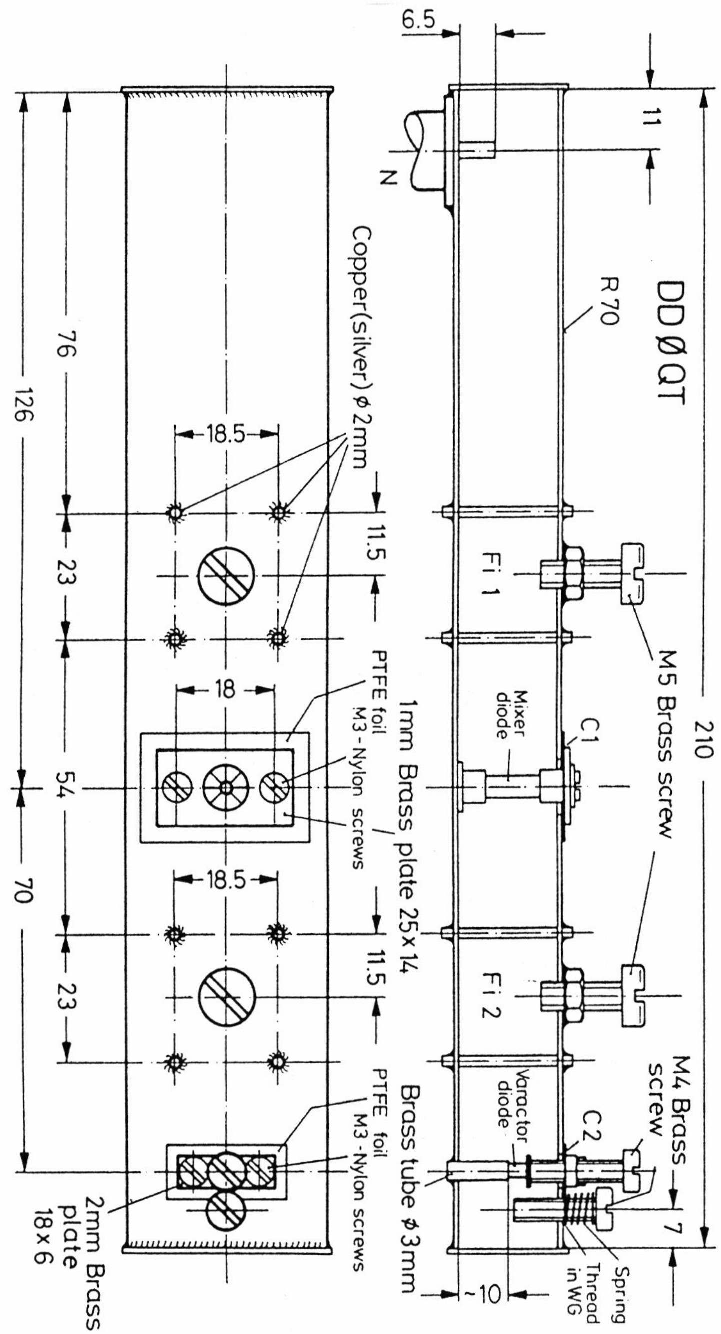


Fig. 1: The converter is built into a piece of waveguide. It consists mainly of: wideband coax/WG transition, signal frequency filter (Fi 1), mixer diode, LO-frequency filter (Fi 2), and varactor multiplier

SPECIAL FEATURES

In contrast to the construction in (3), the varactor stage is integrated into the waveguide. The most important modification is the circuit of the multiplier stage, which multiplies by five. This is now very simple since it can be driven by a standard 1152 MHz oscillator chain, which is most certainly already available in the shacks of most UHF-SHF amateurs. In order to obtain the required local oscillator frequency of 5616 MHz necessary for an IF of 144 MHz, it is only necessary to exchange the 96 MHz crystal for one of 93.6 MHz. The required alignment corrections at 1123.5 MHz are very small, and will always be within the alignment range of the trimmers and inductances.

A further difference to (2) is the tuning screw between varactor diode and waveguide termination. This considerably improves the efficiency and provides a higher mixer diode current. A further alignment possibility using a screw between filter 2 and the varactor diode was found to be without effect, and can therefore be deleted.

CONSTRUCTION

A short piece of R 70 (WR 137 or WG-14) was used as waveguide. The inner dimensions are now to be given so that any interested constructor can make it from 1 mm to 2 mm thick brass plate, if he is not able to obtain a suitable waveguide. The inner dimensions are: 34.8 mm x 15.8 mm. All important dimensions can be taken from Figure 1, and need not be discussed here.

IMPORTANT COMPONENTS

Varactor diode: BXY 28 or BXY 38 (Philips)

Mixer diode: BAW 95 (Philips)

C 1, C 2: Home-made plate capacitor with PTFE-foil (maybe with glass fibre), approx. 0.13 mm thick size: 30 x 18 or 22 x 10 mm

C 3: 6 pF plastic foil trimmer, 7.5 mm dia. (Philips: grey)

C 4, C 5: 6 pF ceramic tubular trimmer (Philips)

C 6: Chip capacitor 100-1000 pF

L 1: 1 turn of 1 mm dia. silver-plated copper wire wound on a 4 mm former, self-supporting

L 2: Brass strip 14 x 5 mm 0.5 mm thick, mounted approx. 5 mm over the ground surface

FURTHER DETAILS

The eight filter wires should be soldered into place. This is followed by soldering the nuts for the M 5 tuning screws to the outside of the waveguide. This is made as follows:

A M 5-thread is cut into the waveguide and a nut together with an **aluminium** screw screwed into place so that it fits tightly. It is now possible for the soldering process to be carried out without danger.

The greatest problem is the mount for the mixer diode in the waveguide, which is not too accessible due to the filter.

However, this difficulty can be solved quickly using the following trick:

A hole of 2 mm in diameter is drilled directly opposite the hole for C 1, which must be central to the later position of the diode. It is now possible for the diode mount to be screwed tight with the aid of an M 2 screw and nut through this hole. The waveguide can now be heated from below without worrying about the shifting of the diode mount. Of course, it is necessary for the corresponding surface in the waveguide and the lower side of the diode mount to be solder-plated beforehand, and this should not be too thick, otherwise the mount could be tilted ! The screw can be removed after the soldering process – the mount should then be in its correct position !

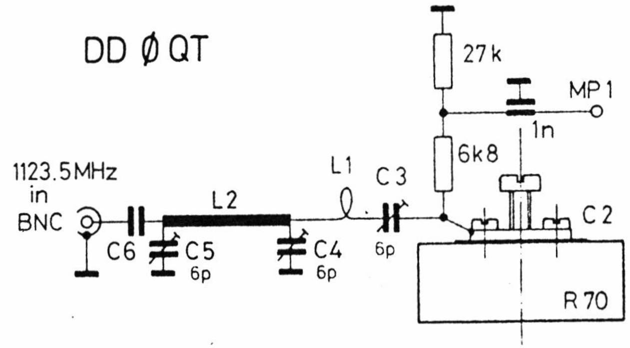


Fig. 2:
The varactor multiplier is driven with approx. 100 mW at 1123.5 MHz via this circuit

For mounting the modules »IF-preamplifier« and »varactor multiplier/input circuits« **(Figure 2)**, it is necessary for two brass plates of 0.5 - 1.0 mm thickness to be hard-soldered to the waveguide for use as mounting flanges. After carrying out the metal work, it is possible for the PC-boards to be placed slightly under these brass plates and soldered into place using a 100 W soldering iron. This can be seen in the photograph of the author's prototype in **Figure 3**.

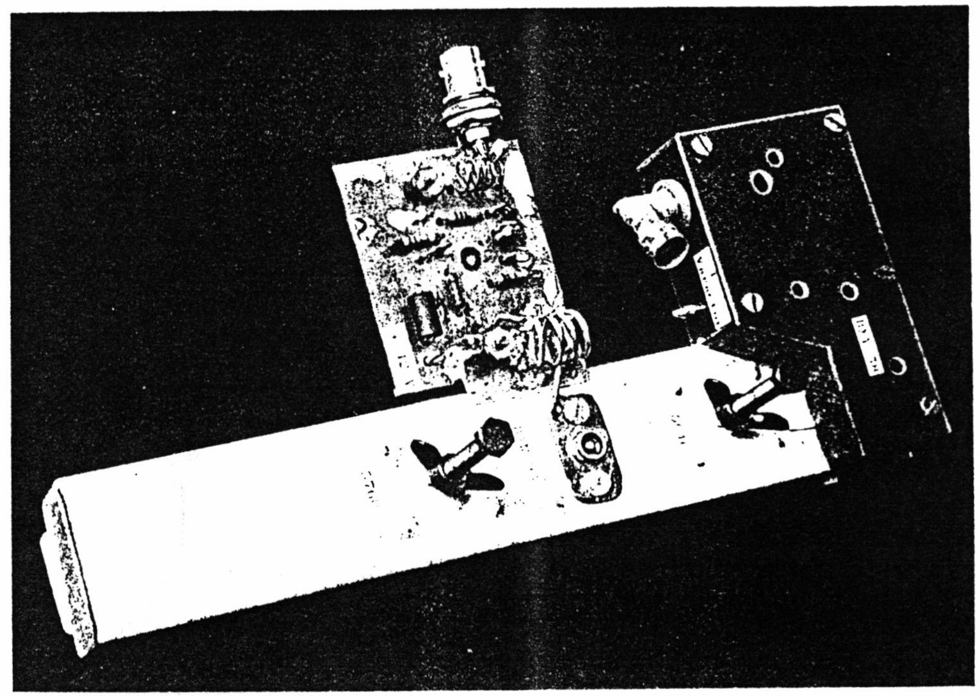


Fig. 3: Photograph of the author's prototype converter

ALIGNMENT

Inject an oscillator power of approximately 100 to 200 mW at 1123.5 MHz. The input circuits of the varactor multiplier should be aligned with the aid of a μA (mA)-meter connected between testpoint 1 and ground. All further alignments are made for maximummixer diode current.

Several indications of mixer diode current will result on tuning the screw of filter 2. The correct maximum resulted in the author's prototype at a slight insertion depth of the M 5-screw into the waveguide.

When correctly aligned to 5760 MHz, the position of the screw of filter 1 will only be slightly different from that of filter 2 !

MEASURING RESULTS

The noise figure of the converter was measured to be 9 to 10 dB when using a random diode type BAW 95. Further measured values can be seen in **Table 1**.

Input power 1123.5 MHz	Mixer diode current BXY 38	Mixer diode current BXY 28
120 mW	4 mA	2.5 mA
700 mW	45 mA	25 mA

The measurement up to 120 mW was made after reducing the input power, but **without** realignment.

After removing the mixer diode and tuning both filters to 5616 MHz, an output power of approximately 65 mW was measured at the input socket (1123.5 MHz in: 700 mW, varactor: BXY 38).

FINAL NOTES

Several things can be improved on this converter and the main thing would be the varactor multiplier. If a short-circuit plunger and a diode mount that can be shifted vertically were to be used, I am sure that the efficiency could be increased to more than 10 %. The IF-output coupling using a bypass capacitor is also lossy, and the choke output coupling used in (3) should be able to increase the sensitivity.

The author would like to thank Rolf Heidemann, DC 3 QS for his assistance during the measurements.

REFERENCES

(1) Cl. Neie, DL 7 QY:
5760/28 MHz Converter (6 cm)
DUBUS-Information, Edition 1/77, page 20 ff.

(2) M. Kuhne, DB 6 NT:
A 6 cm Waveguide Converter
DUBUS-Information, Edition 2/79

(3) R. Heidemann, DC 3 QS:
Receive Mixer for the 6 cm Band
VHF COMMUNICATIONS, Volume 12, Edition 1/1980, pages 46-50

(4) Cl. Neie, DL 7 QY:
QRV on 9 cm and 6 cm (and 3 cm as well) with Narrowband Equipments
DUBUS Information, Edition 4/76, page 179 ff. (page 185 f.) – or in: VHF-UHF Technik, page 210 ff. (page 216 f.) – Berlin 1978

(5) Cl. Neie, DL 7 QY:
High Power Varactor Frequency-Multipliers
DUBUS Information, Edition 3/80

(6) Cl. Neie, DL 7 QY:
Multi-Band-Strahler 1-12 GHz
DUBUS Information, Edition 2/80

(7) J. Dahms, DC Ø DA:
Interdigital Converters for the GHz Amateur Bands – Interdigital Filters Extended to Form Receive Converters
VHF COMMUNICATIONS, Volume 10, Edition 3/1978, pages 154-168

Hans-Joachim Senckel, DF 5 QZ

A 6 cm Transmitter for FM and SSB

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

1. DESCRIPTION

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

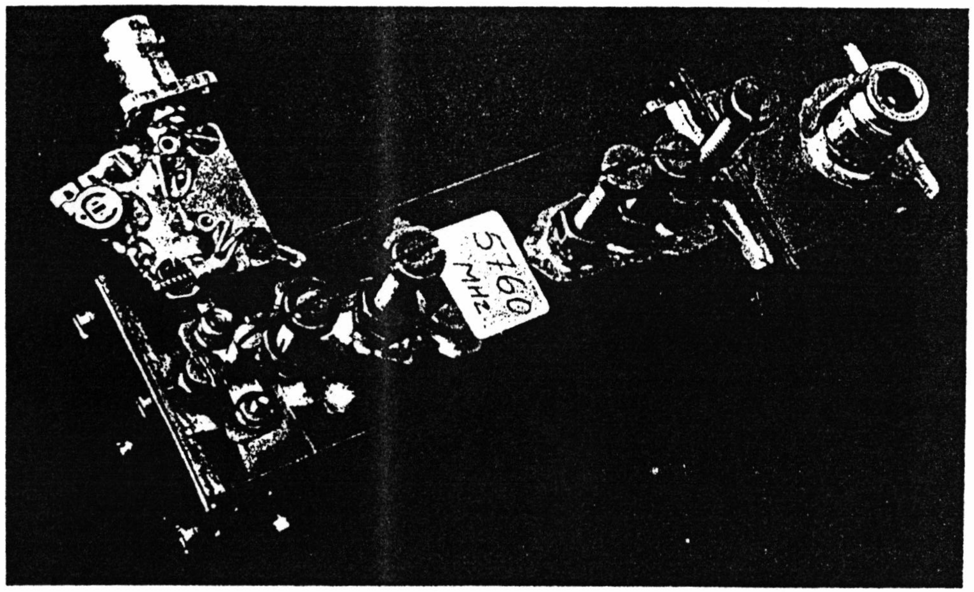


Fig. 1: The frequency multiplier (FM)-transmitter based on the receive converter described in (1)

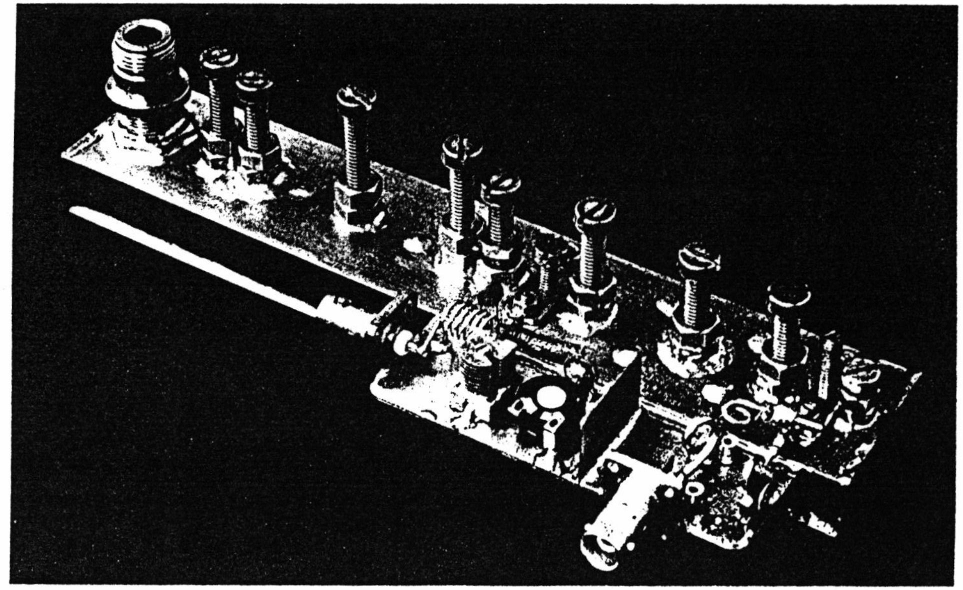


Fig. 7:
The transmit converter 144/5760 MHz in a waveguide confi guration with the matching networks for local oscillator and signal frequency soldered into place

3. ALIGNMENT

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

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

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

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

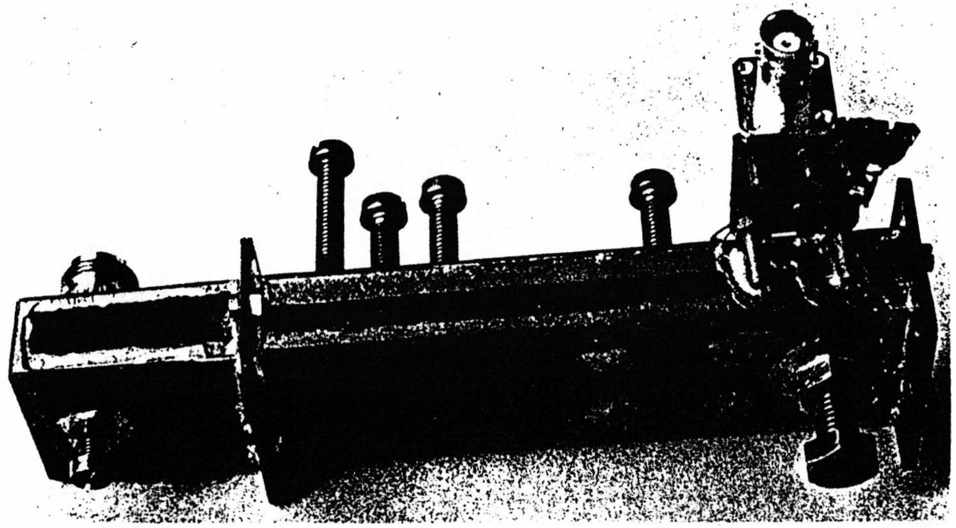


Fig. 2: **The screw for the varactor diode, the filter pins, and the output compensating screw can be seen on the lower side of the multiplier transmitter.**

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

2. CONSTRUCTION

The waveguide can be made from 0.8 mm to 1.0 mm brass plate. The inner dimensions are 34.8 mm x 15.8 mm. The nuts for the M5 or M6 tuning screws and compensation screws, as well as the N-connector(single-hole mounting) are soldered into place. If BXY ... types are to be used as varactor or mixer diode, the mount described in (1) should be used. When using low-cost diodes (case similar to 1N21), the values given in the constructional diagram **(Figure 6)** are valid.

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

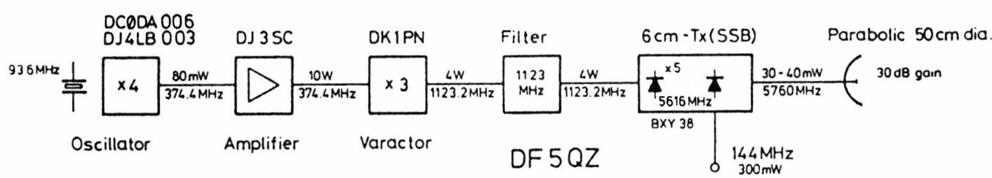


Fig. 3: **The SSB transmitter can be combined from modified modules described in VHF COMMUNICATIONS**

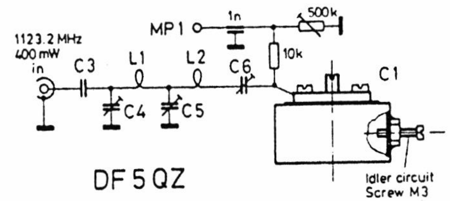


Fig. 4: Matching network for the local oscillator frequency 1123.2 MHz/4 W

L1: 1 turn of 1.5 mm dia. silver-plated copper wire and on a 6 mm former, self-supporting, soldered between the trimmers;
L2: 1 turn of 0.8 mm dia. silver-plated copper wire wound on a 5 mm former, self-supporting;
C3: Chip capacitor, 270 to 1000 pF
C4 – C6: Highest possible quality tubular or spindle trimmer 0.3 – 6 pF

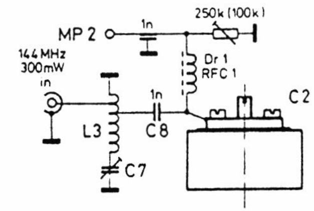


Fig. 5: Matching network for the 144 MHz signal
L3: 6 turns of 1 mm dia. silver-plated copper wire wound on a 6 mm former, self-supporting, soldered between ground and C7;
Coil tap to connector: 1 turn; for C8: 1.5 turns from the cold end
RFC1: 50 cm 0.4 mm dia. enamelled copper wire wound on 3 mm former
C7: Air-spaced trimmer (tronser) max. 34 pF
C8: Ceramic capacitor 1 nF

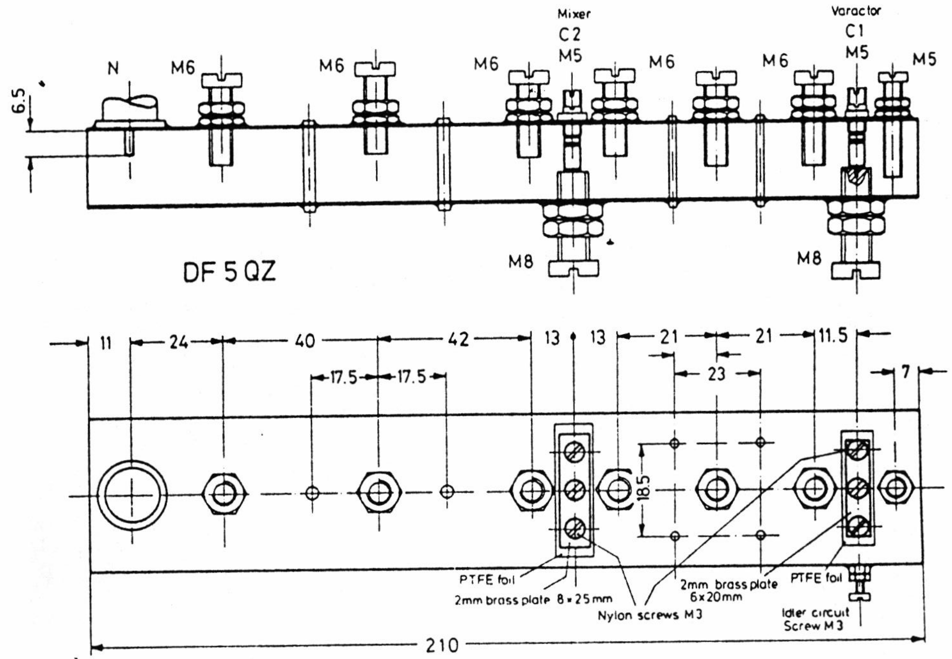


Fig. 6:
Dimensions of the transmit converter: Top and side view
Waveguide: R 70 (WR 137/WG 14)
C1, C2: Home-made bypass capacitors with PTFE foil as described several times in this magazine
Multiplier diode: BXY 38 (Philips) or similar
Mixer diode: 1 N 23 or cheap alternative

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

4. MEASURED RESULTS

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

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

5. REFERENCES

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

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

EXPERIENCES ON 5.7GHz -- notes on a waveguide transverter by G8GDZ and G6KOA

This transverter system is based on the G3JVL mixer (see the "Technical Collection" published by RSGB) and is for 5760MHz. The mixers were built some years ago as separate waveguide/ flange assemblies.

A transverter was needed in a hurry so the extra waveguide parts, ex commercial units, (waveguide 14 post filters and local oscillator multipliers), were added. These were successfully retuned from 6GHz. The two waveguide assemblies were doubled back on each other so that the transverter could be built into a 19 inch case.

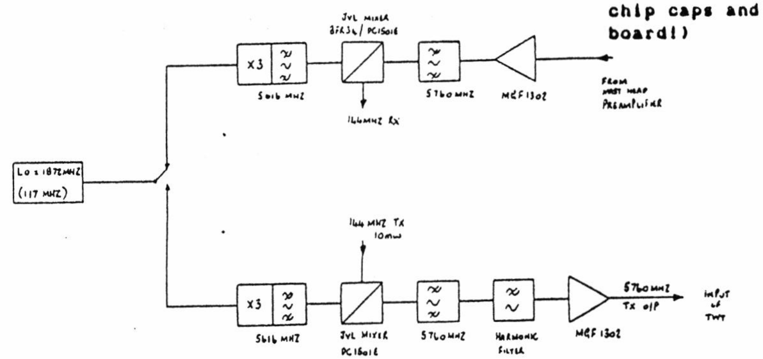
A local oscillator was derived to produce 50mW via an isolator and changeover relay at 1872MHz. The receive multiplier is driven via a 3dB pad.

The transmit output was measured at 1.2mW at the harmonic filter point via a SMA/WG14 transition. This is not quite enough to drive our TWT to the full 10w output so a MGF1302 buffer-amplifier was added. This achieved 12dB gain. A variable pad was also added for presetting the TWT input level. An identical amplifer was built for the receiver.

G6KOA built the mast head preamp system and on the first attempt, using a MGF1402 as the first stage, a gain of 20dB with a noise figure of 3dB was achieved (this was measured at the Martlesham Round Table).

A pair of SMA/WG14 transitions were made to complete the RX/TX interface to the "outside world", with no problems. The following performance figures were obtained:

TX harmonic filter o/p	=	1.2mW at 5760.1MHz
TX mixer current (LO)	=	6mA
TX mixer current (LO +144MHz)	=	9.6mA
Local osc at mixer input(TX)	=	6.5mW
TX at 144MHz	=	10.0mW
RX mixer current	=	2mA
SMA/WG14 transition insertion loss	=	0.1dB, SWR = 1.2:1 as per G3WDG in Radcom Aug 81 (tuning screw added)
MG1302 Amplifier gain	=	13.0dB at 5760.1MHz (Similar to PA2HWG in 4/83 VHFComms but using all the "wrong" components (250pF chip caps and RSGB CuClad PTFE board!)



Microwave Newsletter November 1990

5.76 GHz Up-Converter

DUBUS 1/90

Leif Hansen, LA6LCA
(Translation provided by LA8AK)

In this circuit the 5 th harmonic of the 1123.2 MHz LO is multiplied with the 144 MHz IF in transmit mode. In receive mode the module supplies 5616 MHz LO for the RX-mixer.

The converter is built on standard teflon laminate (epsilon = 2.5, H=0.79 mm). The PCB can be seen in Figure 1. Circuit diagram is in Figure 2. The 1123.2 MHz injection signal should have a power level of 24 ..27 dBm (250..500 mW). If a good varactor diode is used an efficiency of 15 percent may be achieved. This has been measured in RX-mode. If used as an TX-mixer output is some 6...10 dB lower. The total efficiency for transmit mode may not be substantially high, but as a positive point this concept is very simple and easy to be put into operation.

We have made some 10 to 15 similar converters for TX/RX on 6 cm. This module has been successfully used by several Norwegian and Danish SHF-amateurs. Also our 6 cm beacon uses this module.

Technical Reports: 5.76 GHz Up-Converter by LA6LCA

Alignment is fairly easy. First the tube capacitors in the input circuit are tuned for resonance at 1123 MHz. The most critical adjustment is the correct alignment of the 5616 LO bandpass filter. With a sharp knife (scalpel) the length of the half-wavelength filter sections can be adjusted. Also small matching stubs can be soldered in parallel. During the alignment a spectrum analyzer can be useful but also other means may be useful like an absorption frequency meter.

With 500 mW of LO-drive the multiplier gave 75 mW output. The TX-output was measured with 7.5 mW. For best linearity not more than 10 mW on 144 MHz should be applied. Proper LO-drive on 1123.2 MHz is 500 mW.

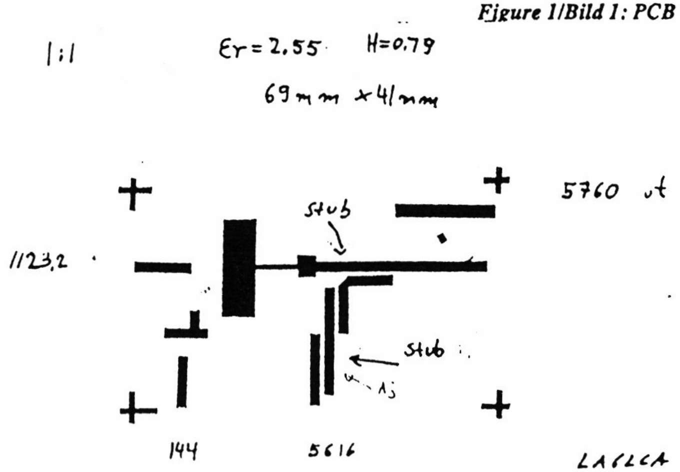


Figure 1/Bild 1: PCB

Components:

The selection of components offers several alternatives. For most of the parts the juke box as a source is just right. Some special parts are:

DR: Murata DRD099UE044 (Dielectric Resonator)
D1: 1N5157/5156/MA44643B (Varactor Diode)
Rb : 24 kOhms

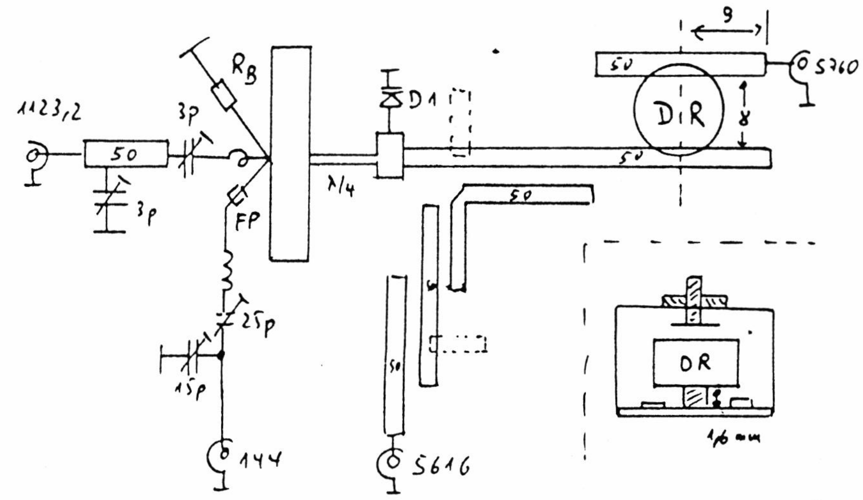
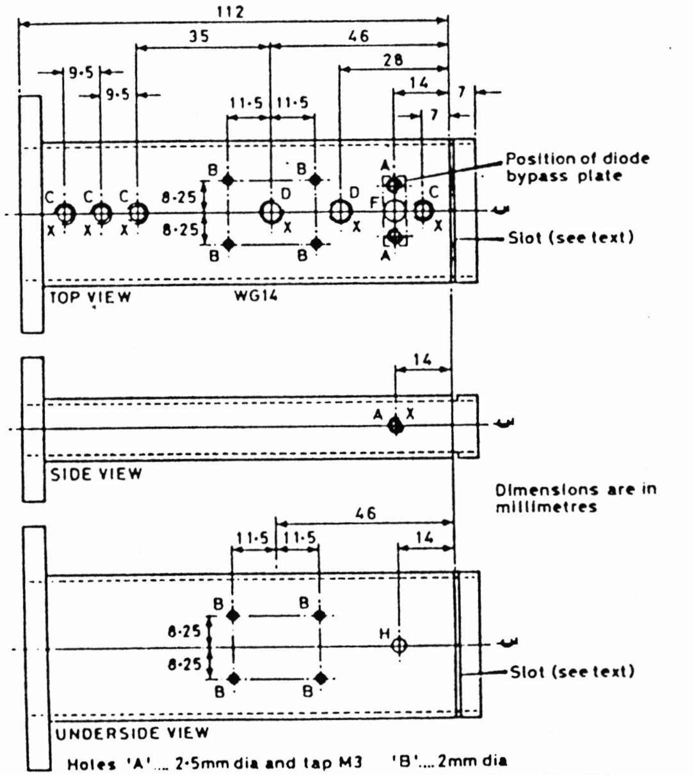


Figure 2/Bild 2: Circuit Diagram/Schaltung

A varactor multiplier for 5·7GHz

Dave Robinson, G4FRE, has sent details of a 1,152—5,760MHz varactor multiplier which he has developed from a number of previous designs (DF5QZ, DD0QT and DC0DA). With 2·5W drive, up to 270mW output power has been obtained, which is considerably more than has been achieved using "high order" multipliers from 384MHz. It can be used in its own right as a cw/fm transmitter, or as a drive source for an ssb mixer.

Details of the G4FRE multiplier are given in Figs 1–5. Dave has supplied the following constructional notes. First, cut the waveguide to length and square off the ends. Make a mark 7mm from one end, and scribe a line



Holes 'A'.... 2·5mm dia and tap M3 'B'.... 2mm dia
'C'.... 4·2mm dia and tap M5 'D'.... 5mm dia and tap M6
'E'.... 3·3mm dia and tap M4 'F'.... 6·5mm dia 'G'.... 3·1mm dia
'H'.... 3mm dia 'X' indicates that the hole is for a tuning screw

Fig 1. Mechanical details of waveguide assembly

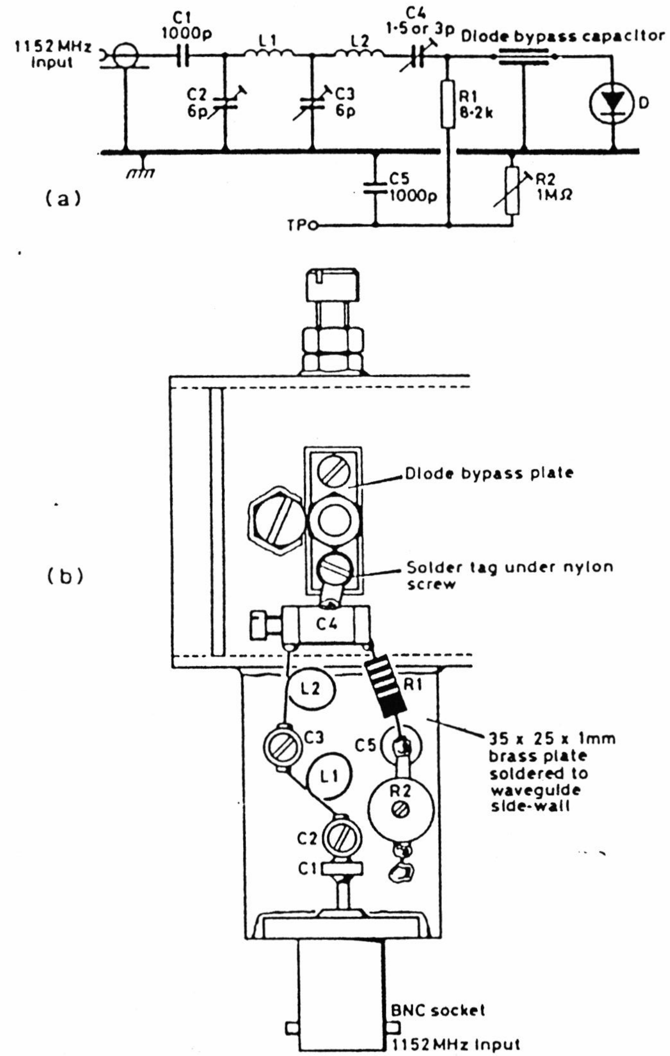


Fig 5. Input matching network. (a) Circuit diagram. (b) Layout: C1, C5, 1,000pF leadless disc; C2, C3, 6pF tubular trimmer; C4, 1·5 or 3pF ptfe tubular trimmer; L1, 1t 1·6mm wire 6mm dia; L2, 1t, 1mm wire 6mm dia; R1, 8·2kΩ 0·125 (⅛) W; R2, 1MΩ preset pot; D, BXY28E, BXY39E or VSC64J varactor diode

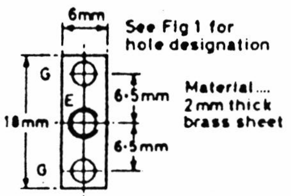


Fig 2. Diode bypass plate details

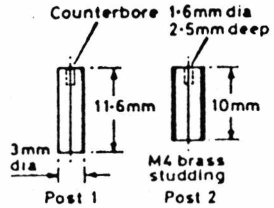


Fig 3. Diode post details

through this mark across the top face of the waveguide, and then continue the line around the other three faces (see Fig 1). Cut a slot in the top and bottom faces using a junior hacksaw. This is best done by starting to cut at one side, and then continuing the cut across to the other side, rather than trying to cut the slot all at once. Next, mark out the positions for all the holes (except for the holes "A" and hole "F"), relative to the left-hand edge of the slot. The diode bypass plate should then be fabricated, as shown in Fig 2. Initially, the holes in the plate should be drilled 2·5mm. Using the plate as a template, drill the holes designated "A" and "F" in the waveguide 2·5mm. Open out the holes to the sizes/threads shown. All the other holes can then be drilled, and tapped as appropriate.

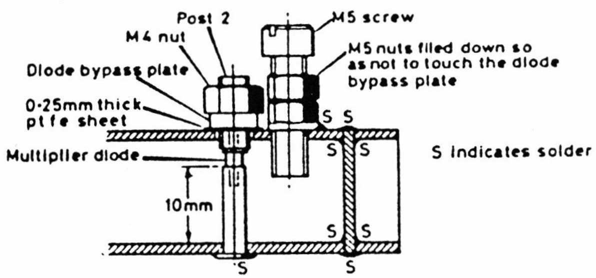


Fig 4. Diode mount details

The end plate, which fits into the slots previously cut, can then be made (34·8 by 18 by 0·6mm brass or copper). Four lengths of 2mm copper wire (preferably silver plated) are then fitted through the waveguide via the 2mm holes. Cut off, leaving about 1mm of wire protruding on either side. The diode posts are made next (see Fig 3). If a lathe is not available, take great care to drill the 1·6mm holes centrally to avoid diode breakage later.

Deburr the inside faces, and fit the end plate into position. Using stainless steel or rusty screws, jig nuts into position at holes "C" and "D" in the top face, and hole "A" in the sidewall. The waveguide assembly can then be soldered (including the end plate, 2mm wires and bottom diode post), using a hotplate or a gas torch (eg a Ronson). Before the assembly cools, solder the 1mm plate (which is made from a 25 by 50mm piece of brass, folded into an L-shape) to the sidewall, as shown in Fig 5.

The final stage of assembly is to build the input matching network, details of which are given in Fig 5. First, place the diode bypass plate and the ptfe insulation in position. Use nylon screws to fix these to the waveguide, and include a solder tag under the screw nearest to the plate on the sidewall. After building the rest of the matching network, fit the diode into its mount (see Fig 4), and fit the tuning screws (each with a lock-nut).

The alignment details are as follows. Apply drive through a 3dB attenuator, and adjust C2, C3 and C4 for maximum dc voltage on TP1. The multiplier tuning screws can then be adjusted for maximum output. G4FRE recommends using a 3dB attenuator (eg a length of cable) on the input, as this improves the stability of the multiplier. With no attenuator, there was a tendency for the multiplier to oscillate into poorly-matched loads. The performance of the prototype (with a 3dB attenuator at the input) was as follows. With 3W drive (at input to attenuator) an rf output of 110mW was obtained with a BXY28E diode. With 5W drive, the BXY28E gave 150mW, while 200mW was obtained from a VSC64J, and 275mW from a BXY39E.

(Microwave Newsletter Technical Collection)

4.1 5.7GHz Transverter Designs

4.1.1 page1

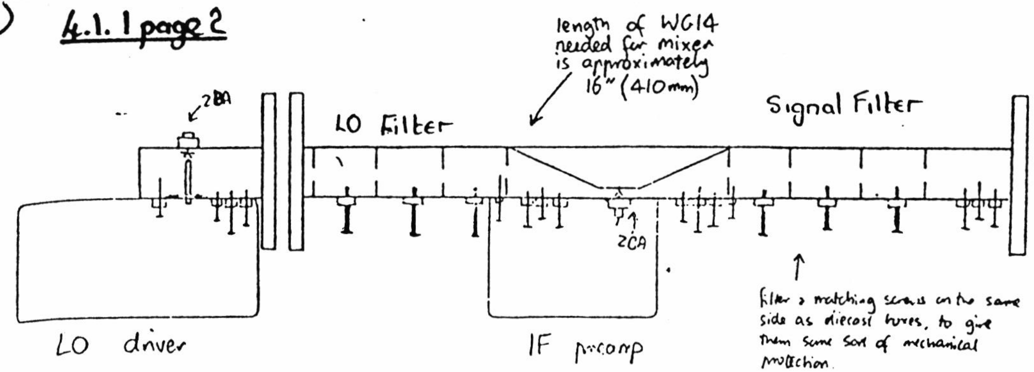
5.7GHz 'JVL Transverter - G4CNV

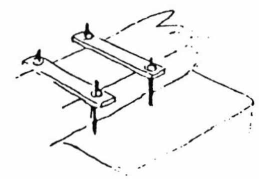
The following design is a scaled-up version of the 10GHz design. The LO and signal filters were designed by G3WDG, the step-recovery multiplier and mixer cavity were scaled by G4CNV from the 10GHz 'JVL. The design incorporates all the features found to be useful in the 10GHz design, so this is closer to a 'second generation' version. The dimensions are shown in the figures. Construction is fairly straightforward, though the following points are worth noting :

1. It is preferable to build the LO source and filter/mixer units as separate assemblies. This makes alignment more straightforward.
2. The diagrams show the LO driver and IF preamp units mounted in diecast boxes strapped to the waveguide. This is a reasonably elegant way of building the transverter, but beware of suspending the transverter directly by its input/output flange, as this puts excessive mechanical strain on the waveguide soldered joints. It is better to use a pair of coax-WG transitions and heliax, or flexiguide (if available) to connect to the antenna.
3. The 347.4MHz source (93.6MHz crystal) delivers 2.5W to the step-recovery multiplier. It consists of the usual "balloon board" (Microwave Committee design) + BGY22 or Wood & Douglas PA. The balloon board should be mounted in its own separate diecast box, which contributes to its stability.
4. The reduced-height waveguide mixer easily justifies the extra effort in building it, and makes the mixer matching screws practically unnecessary In G4CNV's version, within 10 minutes of starting alignment, we had 4mA mixer current. "Remarkably uncritical" was G3YGF's comment on alignment of the 10GHz one.
5. The IF preamp diecast box also contains a low-voltage drop reverse-supply protected regulator (08/80 Newsletter), which also contributes to the excellent frequency stability of the transverter. Both G4KGC and G4CNV have noted that the stability on 5.7GHz seems more than twice as good as on 10GHz. Though this is thought to be due to building the thing properly, having made all the mistakes once on 10GHz!
6. The IF preamp and control circuitry for use with an IC202 are shown in the diagram. There is little or no difference between this IF preamp and G3WDG's circuit (Radcom, April 1980) - it was simply a matter of availability of transistors.
7. Assembly follows usual waveguide construction practice, jigging tuning and matching screw nuts in place with chrome-plated screws, and soldering everything in one go. The one noticeable difference is that much more heat is needed than for WG16, so use a hotplate on the kitchen stove (made from scrap aluminium sheets), heat everything to just below solder melting-point, and solder using a Ronson blowtorch or soldering iron. Use a good flux (Bakers fluid or similar), and, of course, make sure everything is properly clean to start with.
8. Unfortunately, the procedure recommended for alignment of the 10GHz version is unlikely to be useful due to lack of 5.7GHz wideband components (Gunn osc. etc). However, anyone who has gone through the exercise of aligning a 10GHz JVL will have some idea of what to look for. We cannot yet suggest a foolproof method, but if anyone has any ideas, we'd be most interested to hear them. In the meantime, it will probably be necessary to seek the help of someone with access to professional test equipment, or use the facilities available at Microwave Round Tables.

For any further information or advice, don't hesitate to contact G4CNV, G3WDG, G3JVL or any of the Microwave Committee.

4.1.1 page2





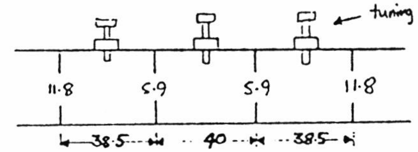
diecast boxes bolted to w/G by 30mm-long M3 bolts and 2 off 2" x 5/16" x 1/8" brass straps.

filter tuning screws are 4BA/M3
matching screws are 4BA/M3
intra-filter mixer matching screws are 8BA/M2
mixer matching screws are probably unnecessary

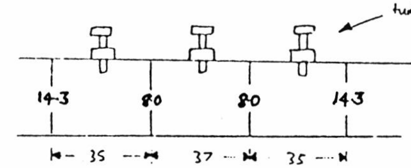
G4CNV

WG14 Filter dimensions (G3WDG)

LO filter 5616MHz, 20MHz b/w, ε = 0.3333



SIG filter 5760MHz, 60MHz b/w, ε = 0.1

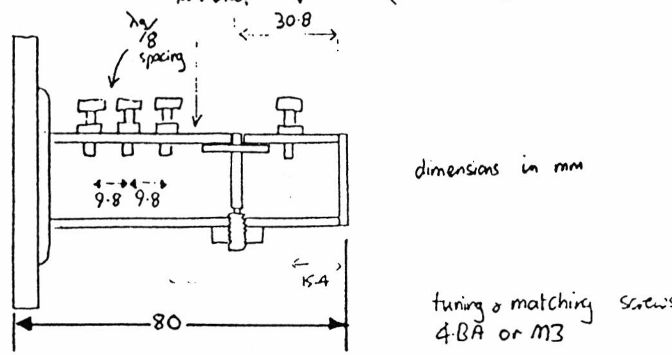


iris thickness 0.6mm

all dimensions in mm
use Copper WG14, or filter insertion losses will be excessive.

4.1.1 page 3

5.7 GHz step-recovery diode multiplier dimensions

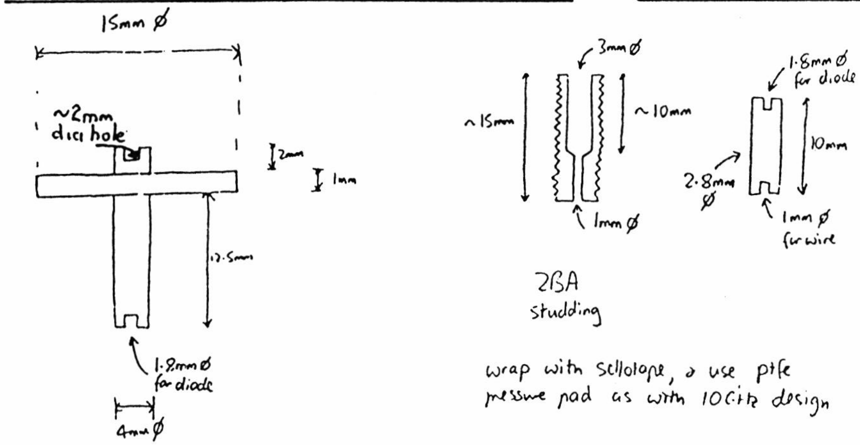


dimensions in mm

tuning & matching screws 4BA or M3

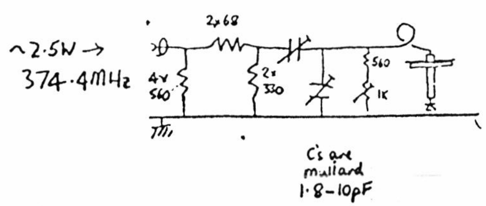
5.7 GHz step-recovery multiplier post dimensions

mixer post dimensions



wrap with sellotape, & use ptfe pressure pad as with 10GHz design

374.4 MHz i/p matching exactly as for 10GHz design ("Microwaves" March 76 Radcom)



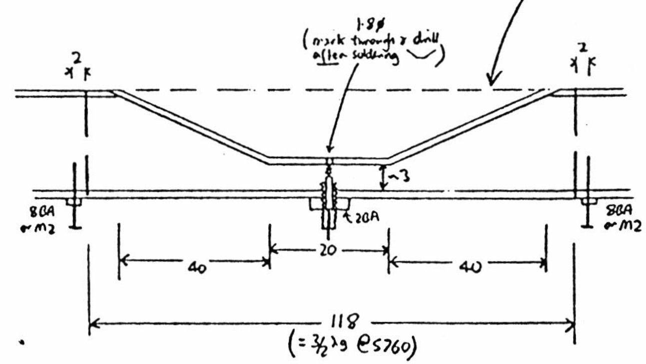
C's are mullard 1.8-10pF

4.1.1 page 4

5,7 GHz reduced-height guide mixer

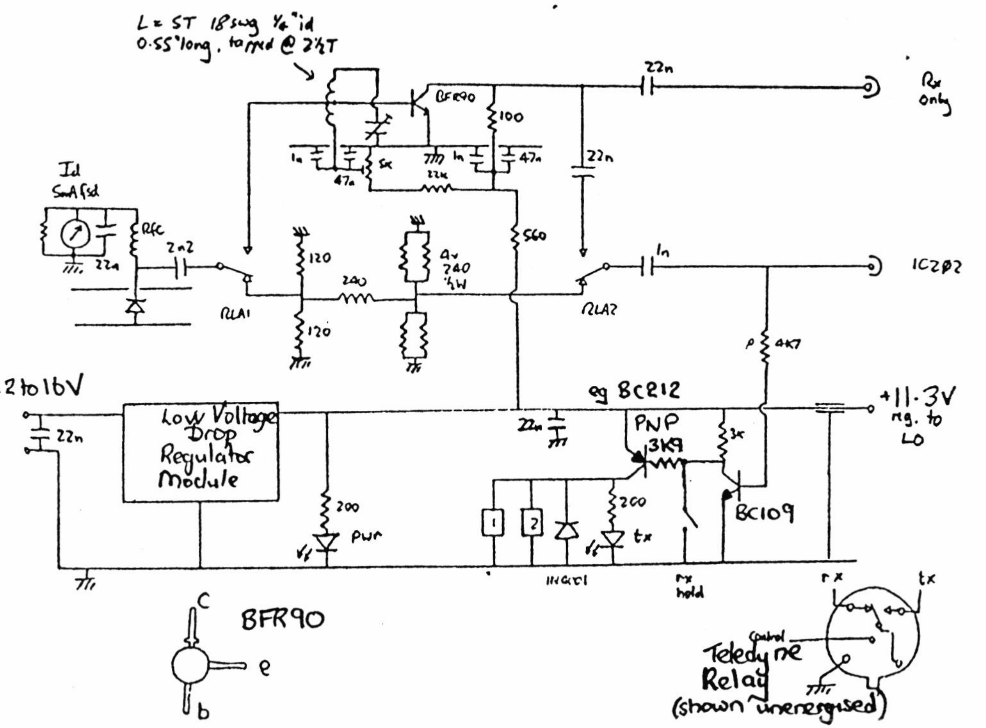
(scaled from G3JVL design, 01/81 Newsletter)

Broad face of W/G removed, but leave walls intact right to the top for rigidity. Bend from 18 or 16g brass or copper, lay in place, & solder at the same time as everything else. Nuts jigged with chrome-plated screws in tapped holes in W/G. Soldering best done on kitchen stove with big hotplate, heated to just below solder MP, and use Ronson torch for each joint in turn. Make sure everything's clean to start with, & use good flux (Bakers' fluid)



all dimensions in mm

G4CNV



ANTENNES 6 cm

PREAMBULE

Le numéro spécial antennes a décrit plusieurs sources ou antennes pour le 5,7 Ghz .

Vous trouverez , au début de ce chapitre , une copie de la plupart de ces descriptions .

Cela fait peut-être double emploi avec le numéro spécial d'HYPER que vous avez déjà mais pensons à ceux qui n'ont pas le spécial antennes et qui veulent avoir un document complet sur le 6 cm .

Les extraits du spécial antennes inclus dans ce numéro sont les suivants :

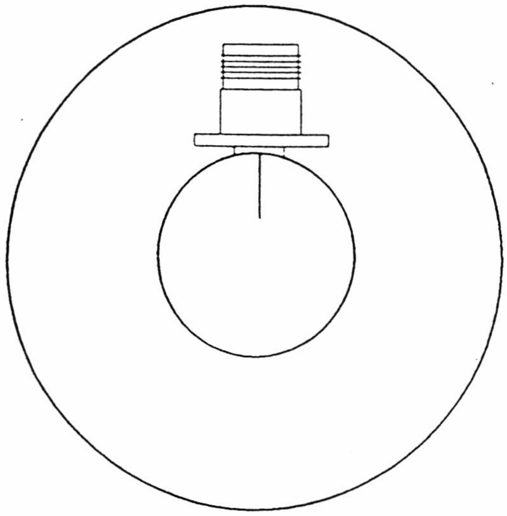
- Source VE4MA
- Source JA1VOK
- Source WB5LUA
- Source avec tube Cu
- Source type " penny feed "
- Réseau d'antennes SSFIP F5JWF
- Antenne omni. F5JWF
- Triband dish feed WA3RMX

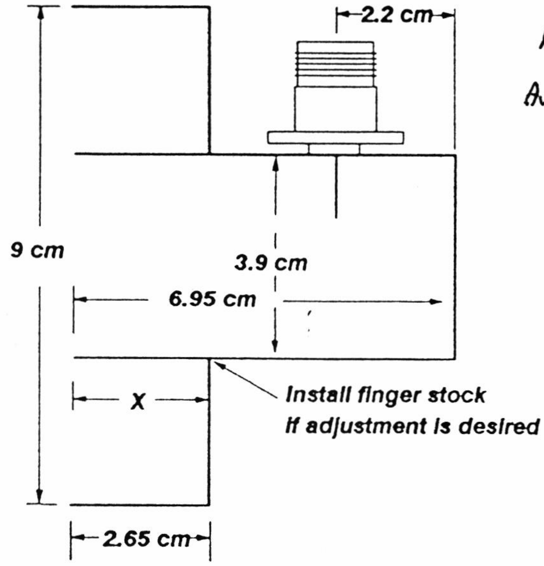
Un article a aussi éte extrait d' HYPER No 12 paru en Juin 97 :

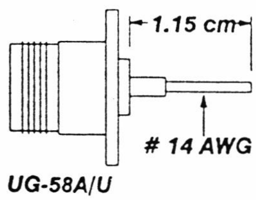
- Source VE4MA avec tube Cu F6DPH

VE4MA 5760 MHz LINEAR POLARIZATION FEEDHORN

Feed point Avril/Mai 95







Distance X (cm) can be varied for different f/D ratios

f/D	0.5	0.45	0.40	0.35	0.30	0.25
LoNoise	2.13	2.27	0	2.84	3.1	3.2
MaxGain	2.52	0	2.9	3.1	3.3	N/A

Hole drilled for connector is 3/8 in (0.953 cm).

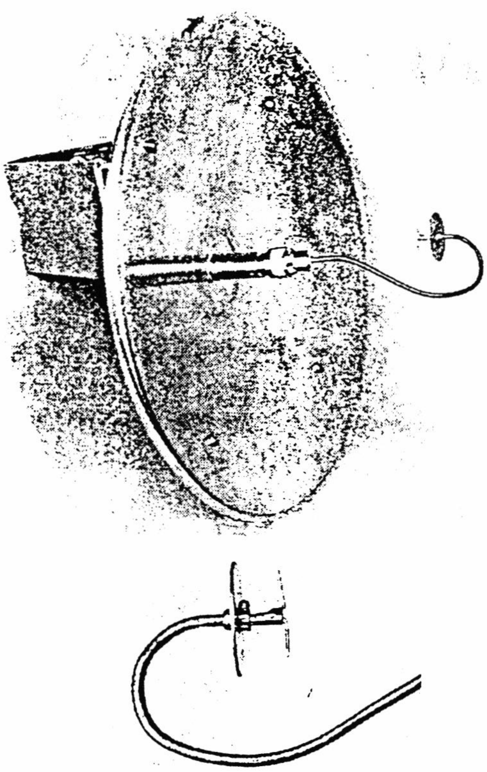
Main waveguide is 1.5 inch Copper Water Pipe

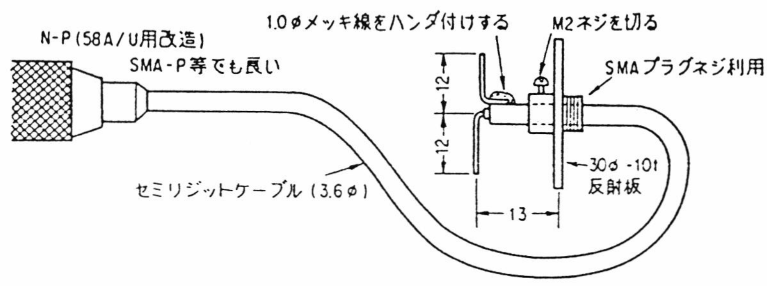
VSWR measured 1.12: 1 (25 dB return loss) With Ring

VSWR measured 1.08: 1 (29 dB Return Loss) No Ring

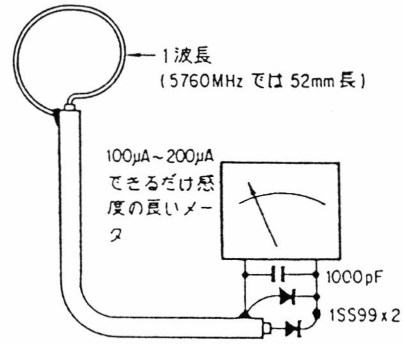
Connector is supported on horn surface using 2 #4-40 screws, then soldered. Do not allow screws to penetrate into main W/G.

Fill area under connector with Epoxy for mechanical strength

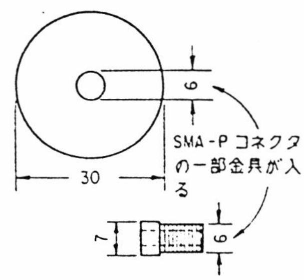




簡易電界強度計



反射板の製作例

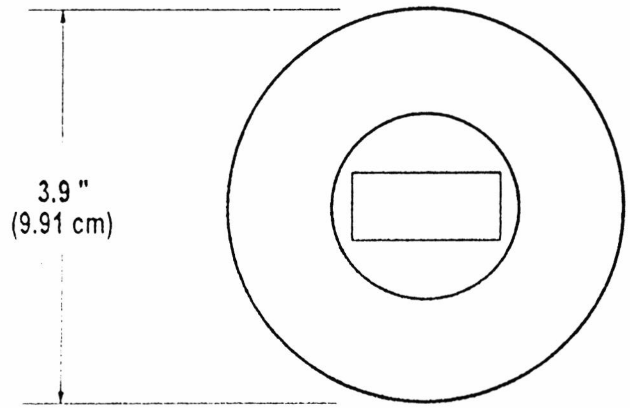


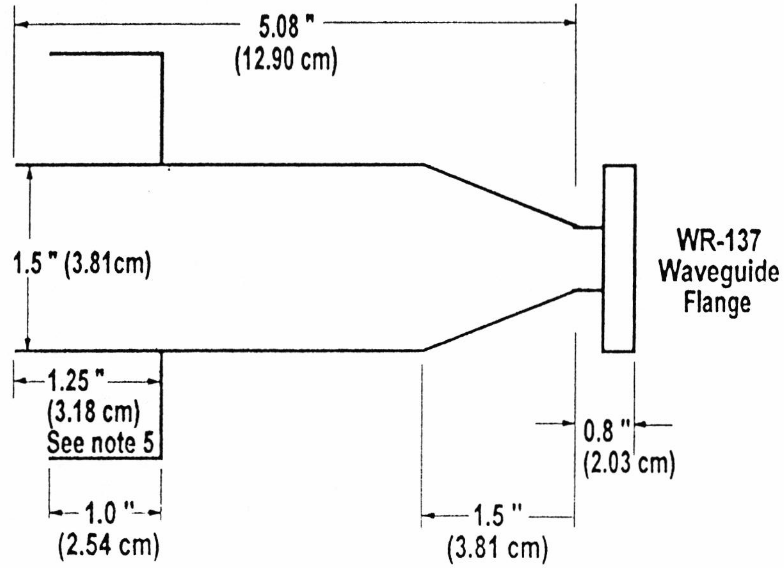
5760 MHz Dish Feed:

Feed Point Dec 93 / Janv 94

JA1VOK passing along this interesting and simple dish feed. The article also includes a microwave Field Strength Meter. All dimension are in millimeters, just a few scaling factors and feed will work fine on 2304, 3456, or 10368 MHz.

5760 MHz LINEAR POLARIZATION FEEDHORN WITH WR-137 FLANGE





NOTES

1. Modified original VE4MA scalar feedhorn of date 95 02 28 for use with WR-137 flange. The end of the 1.5 " copper pipe pipe was formed to fit a short length of WR-137 waveguide and soldered.
2. Return Loss measured at 26 dB
3. Copper pipe length should be optimum but can be trimmed for best return loss.
4. Scalar ring is bottom section of a 1 lb. coffee can 1.0 " high. Hole in end of can should be cut slightly smaller in diameter to be a tight fit around 1.5 " pipe.
5. For my f/d of 0.4, I place the opening of the circular waveguide 0.25 " in front of scalar ring. Probably still not optimum. Should be made variable. Reference original VE4MA drawing for suggestions for use with other f/d ratios.
6. I don't believe taper of 1.5 " pipe is that critical as long as length of main waveguide can be trimmed for best return loss.

DRAWING NOT TO SCALE	5760 MHz WR-137 FEEDHORN
07-23-95	Engineering Sketch by Al Ward WB5LUA

Feedpoint Oct/Nov 95

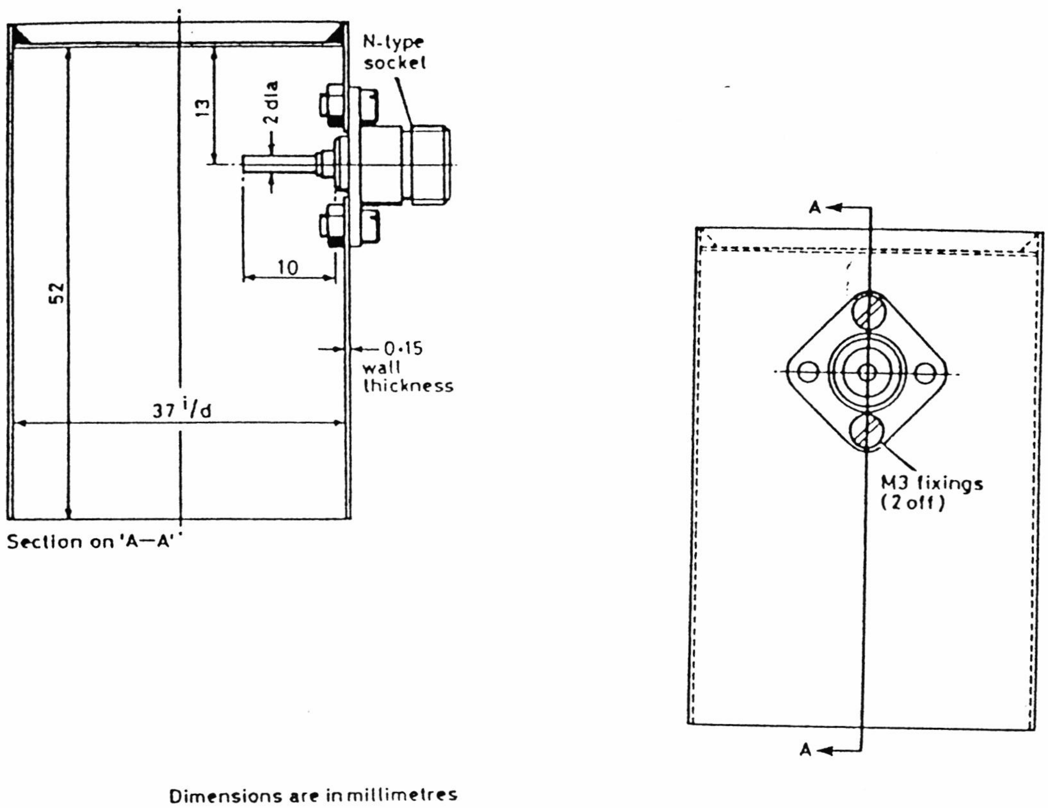
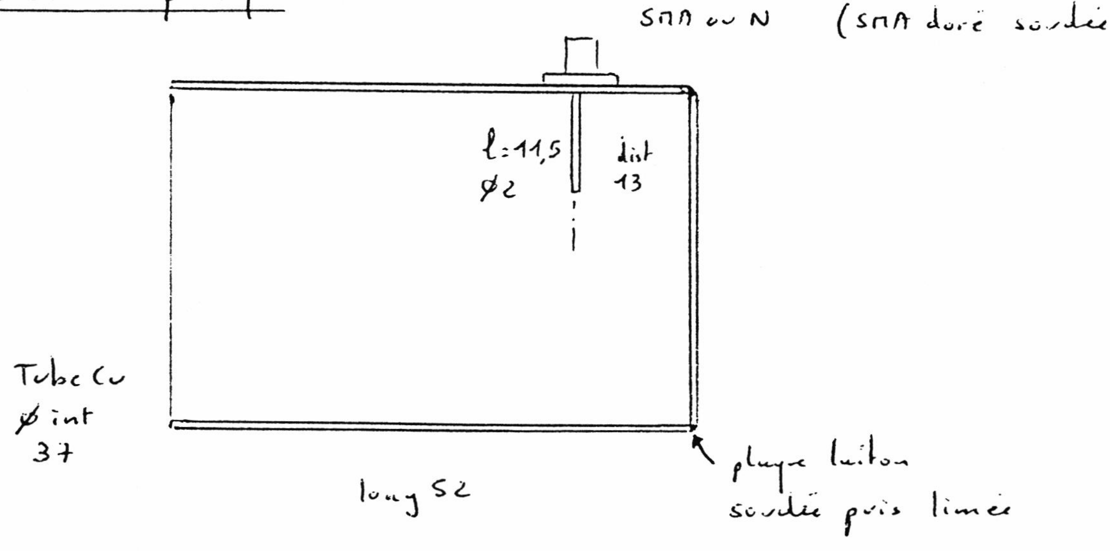


Fig 17.23. 5.7GHz feed horn. Although an N-type socket is shown, an SMA socket could equally well be used

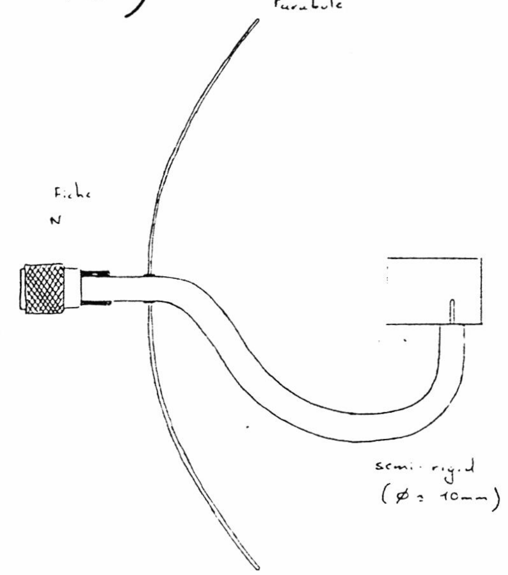
Realisation pratique



Autre possibilité de montage :

(utilisé par F1JGP/p sur une idée de F6CGB)

Le semi-rigid doit avoir un certain diametre afin que l'ame fasse ∅ 2mm (ou alors monter une sonde de 2mm sur l'ame de petit diametre)



VHF/UHF Manual

A simple waveguide feed for short focal length dishes

The dishes that amateurs inherit are often of the short focal length type; that is, the ratio of the focal length to the diameter of the dish typically is in the region 0·25–0·3.

The design of a suitable feed is shown in Fig 161. It is constructed by cutting two grooves in the end of a length of waveguide of appropriate size, and soldering on a circular end disc. The length of the slot formed, and also the diameter of the disc, are probably not critical within a few per cent, and the width of the slot even less so. Values for λ and λ_g for frequencies of amateur interest, together with details of suitable waveguides, are given in Table 14. Signals having the standard horizontal polarization are produced when the broad faces of the guide are vertical.

The feed can be used without any attempt to improve the match—the vswr is typically about 1·5:1. The match may be improved by conventional matching screws which preferably are fitted behind the dish as shown in order to reduce unwanted resonances. An elegant alternative method, which at the same time can be used in weatherproofing the system, is shown in the top figure. In this, a Perspex sleeve is made a sliding fit on both the end disc and the waveguide. By adjusting its position, the right proportion of power in the correct phase is fed back into the feed to cancel that reflected by the mismatch.

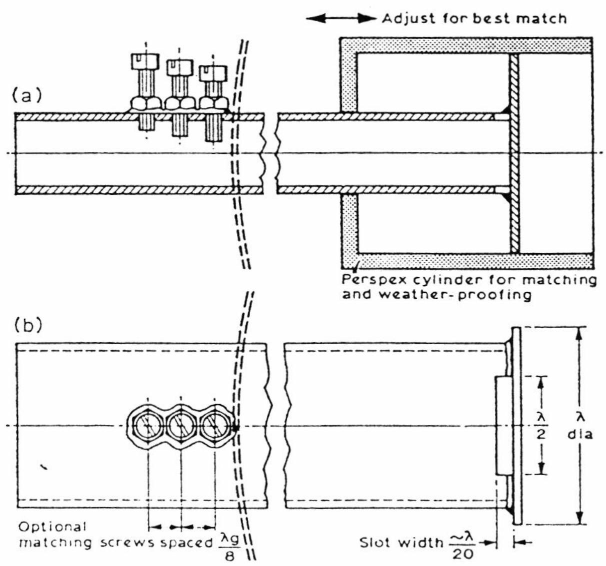


Fig 161. A simple feed for dishes having an f/D ratio of 0·25–3. Matching can be done either by matching screws as shown or as in (a) by using a Perspex matching (and weatherproofing) sleeve. (b) Side view of feed

Table 14

Centre frequency (MHz)	Suitable waveguide	λ (mm)	λg (mm)
1,297	WG6	231	324
2,305	WG8	130	162
3,457	WG10	86·7	109
5,761	WG14	52·0	78·2
10,050	WG16	29·8	39·4
10,369	WG16	28·9	37·3
24,193	WG20	12·4	15·2

RESEAU D'ANTENNES SSFIP POUR LE 5,76 GHz

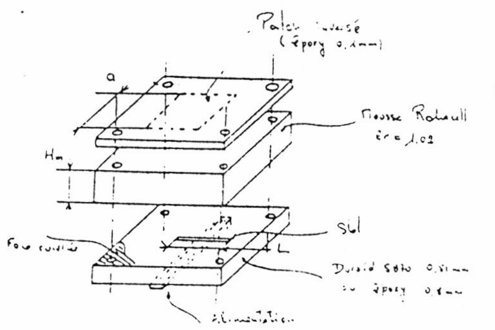
PHILIPPE - F1JWF

HURK INFOS N°37 été 90

Cet article présente la réalisation d'une antenne planaire SSFIP par la bande des 6 cm. On peut réaliser ce type d'antenne avec du circuit imprimé.

1 - STRUCTURE SSFIP (Strip Slot Foam Inverted Patch)

De nouvelles structures ont été développées pour améliorer les performances des antennes hyper. Ce type d'antenne possède 3 plans différents :



Le circuit imprimé inférieur (alimentation) excite le patch supérieur par l'intermédiaire de la fente.

Ces structures possèdent principalement deux avantages :

- Bande passante supérieure aux structures microrubans traditionnelles,
- Rayonnement des lignes d'alimentation dans la direction de propagation négligeable.

Pour l'instant, il n'existe pas de modèle théorique permettant le calcul de ces structures.

La première étape du travail a été la recherche par tatonnement des dimensions d'un élément SSFIP pour le 5,76 GHz.

2 - ELEMENT SSFIP 5,76 GHz

Cette recherche par tatonnement a été effectuée pour deux types de substrat (pour l'alimentation) :

- DUROID 5870 h = 0,51 mm ε_r = 2,33
- EPOXY h = 0,8 mm ε_r = 4,3

A cette étape du travail il était intéressant d'évaluer les pertes dans ces deux matériaux afin de déterminer les dimensions optimales de l'antenne. En effet, dans les antennes planaires, il existe un optimum pour la surface lorsque les pertes du réseau d'alimentation atteignent 3dB, car on peut estimer qu'en doublant la surface de l'antenne on double également les pertes. Donc, les 3 dB gagnés avec l'augmentation de surface sont aussitôt perdus dans les lignes d'alimentations.

Les pertes dans l'époxy ont été mesurées à 18 dB/m !! L'époxy est donc à proscrire en ondes SHF pour des antennes dépassant une dizaine de centimètres.

Par contre, le Duroïd (Duroïd 5870 → 3dB/m) permet l'alimentation d'antennes beaucoup plus grandes. C'est donc ce substrat qui a été retenu pour l'alimentation.

Pour ce substrat, on trouve qu'un élément SSFIP ayant les dimensions suivantes rayonne assez bien :

L = 16 mm a = 18,5 mm Hm = 3 mm

Pour cet élément, on mesure :

g = 6,3 dB +/- 0,5 dB (Chambre anéchoïque + antenne de référence)

SWR à 5,76 GHz : 1,07:1 (Network Analyser HP 8510)

Diagramme de rayonnement en annexe 1

On constate que cet élément utilisé seul ne possède qu'un gain limité.

3 - RESEAU D'ANTENNES

Sur la base de l'élément SSFIP du paragraphe précédent, un réseau d'antennes a été constitué.

Les dimensions du réseau ont été fixées par des critères de prix et d'encombrement à 297 mm x 180 mm.

Sur cette surface, il est apparu judicieux de placer 4 x 8 éléments (4 dans le plan horizontal, champ E et 8 dans le plan vertical, plan H). Les raisons de ce choix sont les suivantes :

- La distance entre élément doit être comprise entre 0,5λ et 1λ. Au dessus de cet intervalle, plusieurs lobes principaux apparaissent. En dessous, le rayonnement n'est plus perpendiculaire à la surface.
- Il faut laisser suffisamment de place pour les lignes d'alimentation.

Bien que le maximum de gain soit obtenu lorsque les 4 x 8 éléments sont alimentés avec la même amplitude, il est apparu intéressant de pondérer la puissance sur chacun des éléments de manière à ajuster le niveau des lobes secondaires.
Rappelons que la pondération de la puissance sur les différents éléments du réseau fait varier le niveau des lobes secondaires alors que la variation de la phase permet d'ajuster la direction du lobe principal, (ex. : Balayage électronique).

Après plusieurs simulations, (prg CHEBY [1]) en tenant compte du diagramme de rayonnement de l'élément SSFIP du paragraphe 2, on choisit une pondération de puissance selon une distribution de TCHEBYCHEFF (niveau des lobes secondaires constant) avec un niveau des lobes secondaires de :

plan E : - 15 dB
plan H : - 22 dB

Cette pondération possède les caractéristiques suivantes :

° Plan E 4 x 0,85 niveau des lobes secondaires exigé : - 15 dB

pondération	élément 1	1 W
	élément 2	0,5637 W

directivité : 8 dB

° Plan H 8 x 0,7 niveau des lobes secondaires éxigé : - 22 dB

pondération	élément 1	1 W
	élément 2	0,7427 W
	élément 3	0,3952 W
	élément 4	0,2346 W

directivité : 10,3 dB

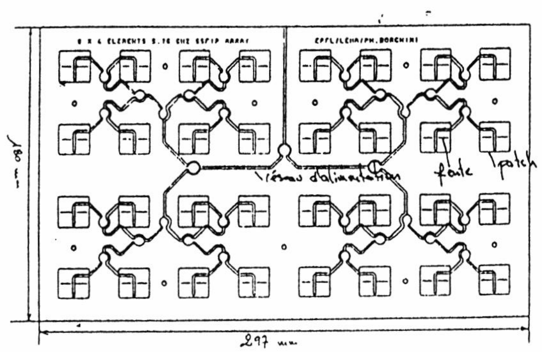
Le gain théorique du réseau sera donc :

g = go + DE + DH = 6,3 + 8 + 10,3 = 24,6 dB

go = gain d'un élément
DE = directivité plan E
DH = directivité plan H

Pratiquement la pondération de puissance a été effectuée à l'aide de diviseurs de WILKINSON.

La superposition des trois masques photographiques utilisés pour la gravure des circuits est montrée ci-dessous :

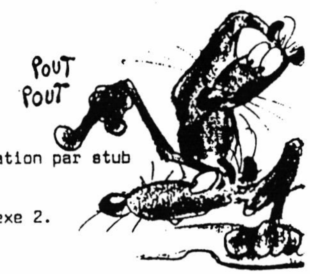


L'ensemble circuits imprimés et mousse est maintenu par des entretoises et monté dans un cadre plastique.

4 - MESURES

Mesures chambre anéchoïque avec antenne de référence.

Gain g = 22,7 dB +/- 0,5 dB
Angle d'ouverture à -3dB plan E : 14°
Niveau lobes secondaires plan E : -16 dB
Angle d'ouverture à -3dB plan H : 10°
Niveau lobes secondaires plan H : -24 dB



Mesures Network Analyser HP 8510

SWR à 5,76 GHz : 1,00 : 1 adaptation par stub
Bande passante SWR 2 : 230 MHz

Les diagrammes de rayonnement se trouvent en annexe 2.

5 - REMARQUES

L'antenne réalisée possède un gain comparable à ce que l'on peut obtenir avec un cornet mais pour un encombrement très réduit.

L'utilisation d'une structure SSFIP permet d'avoir une bonne maîtrise des lobes secondaires car les lignes d'alimentation ne viennent pas perturber le rayonnement principal.

Les pertes dans l'antenne valent environ 2 dB ce qui peut être gênant, (facteur de bruit) dans certain cas.

Le prix de l'ensemble est essentiellement dû au coût du substrat Duroïd, soit 300 à 400 FF.

Notons pour terminer qu'il existe un nouveau substrat faible perte destiné aux hyper :

Polypropylène : ε_r = 2,18
Perte = 0,8 dB/m à 5 GHz (Duroïd 5870 = 3 dB/m)
Prix = 0,20 FF/cm2 (Duroïd 5870 = 0,50 FF/cm2)

A vérifier !

Ce substrat devrait permettre de fabriquer des antennes beaucoup plus grandes pouvant rivaliser avec certaines paraboles.

73 F1JWF

Resultats des simulations et mesures page suivante

BIBLIOGRAPHIES

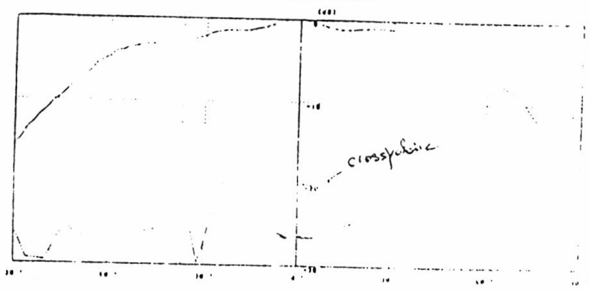
[1] Antenna design using PC
D. POZAR 86

2] Réseau d'antennes SSFIP pour la bande amateur des 6cm
PH. BORGHINI Juin 89

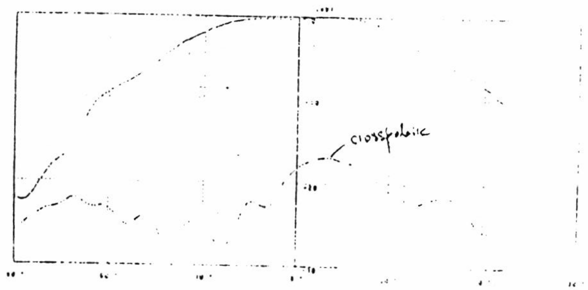
Annexe 1

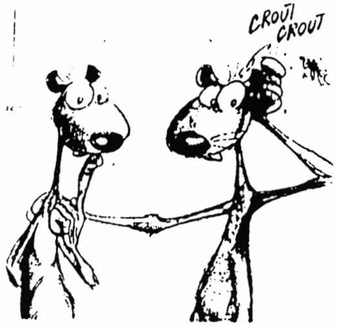
Diagrammes de rayonnement de l'élément SSFIP Duroïd

plan H

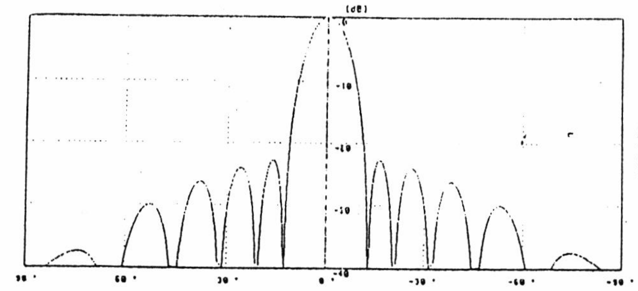


plan E

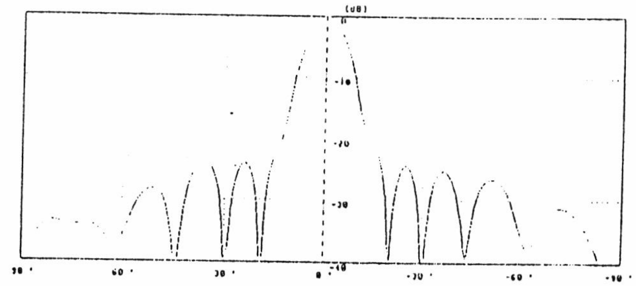




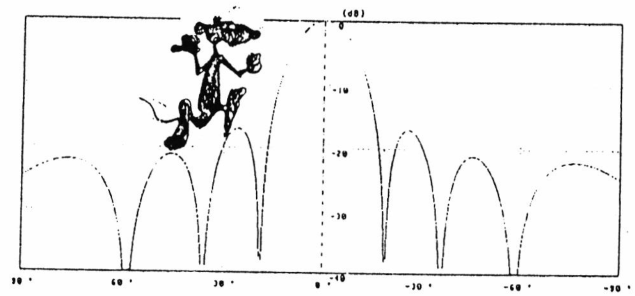
Annexe 2



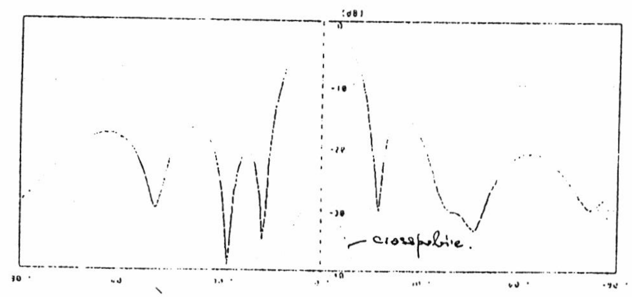
8 x 0,7 λ
Simulation



8 x 0,7 λ
Mesure



4 x 0,85 λ
Simulation



4 x 0,85 λ
Mesure.

Antenne « Slotted waveguide » pour balise

F5jwf
Philippe

Hyper Spécial Antennes

La description qui suit présente la réalisation d'une antenne « slotted waveguide » utilisable pour un émetteur balise sur 6cm. Ce type d'antenne est réalisé à l'aide de guide d'onde et permet d'obtenir une dizaine de dB de gain tout en gardant un rayonnement plus ou moins omni dans le plan horizontal.

Le calcul des dimensions de l'antenne est relativement aisée. (cf Microwave antennas §4.9.2). Le facteur prédominant est le couplage des slots par rapport au guide. Plus le nombre de slots est important (donc plus le gain croit) plus le couplage doit être faible. C'est évident, il faut laisser de l'énergie dans le guide pour les slots suivants. La désaxe du slot par rapport au centre du guide permet de modifier le couplage. Celui-ci est nul lorsque le slot est centré sur le grand côté du guide.
La longueur d'un slot doit être de $\lambda_0 /2$. La distance entre deux slot doit être de $\lambda_g/2$. La largeur d'un slot est plus délicate à déterminer: elle devrait être de 1/20 de λ_g mais j'ai obtenu de meilleurs résultats avec une fente plus étroite (≈ 1.6mm).

Calcul des différentes dimensions:

Longueur d'un slot: $Ls = \lambda_0 /2$
Largeur d'un slot: $Ws \approx 1.6mm$ (ou ev. $\lambda_g /20$)
Espacement entres slots $Ss = \lambda_g /2$

Désaxe des slots:

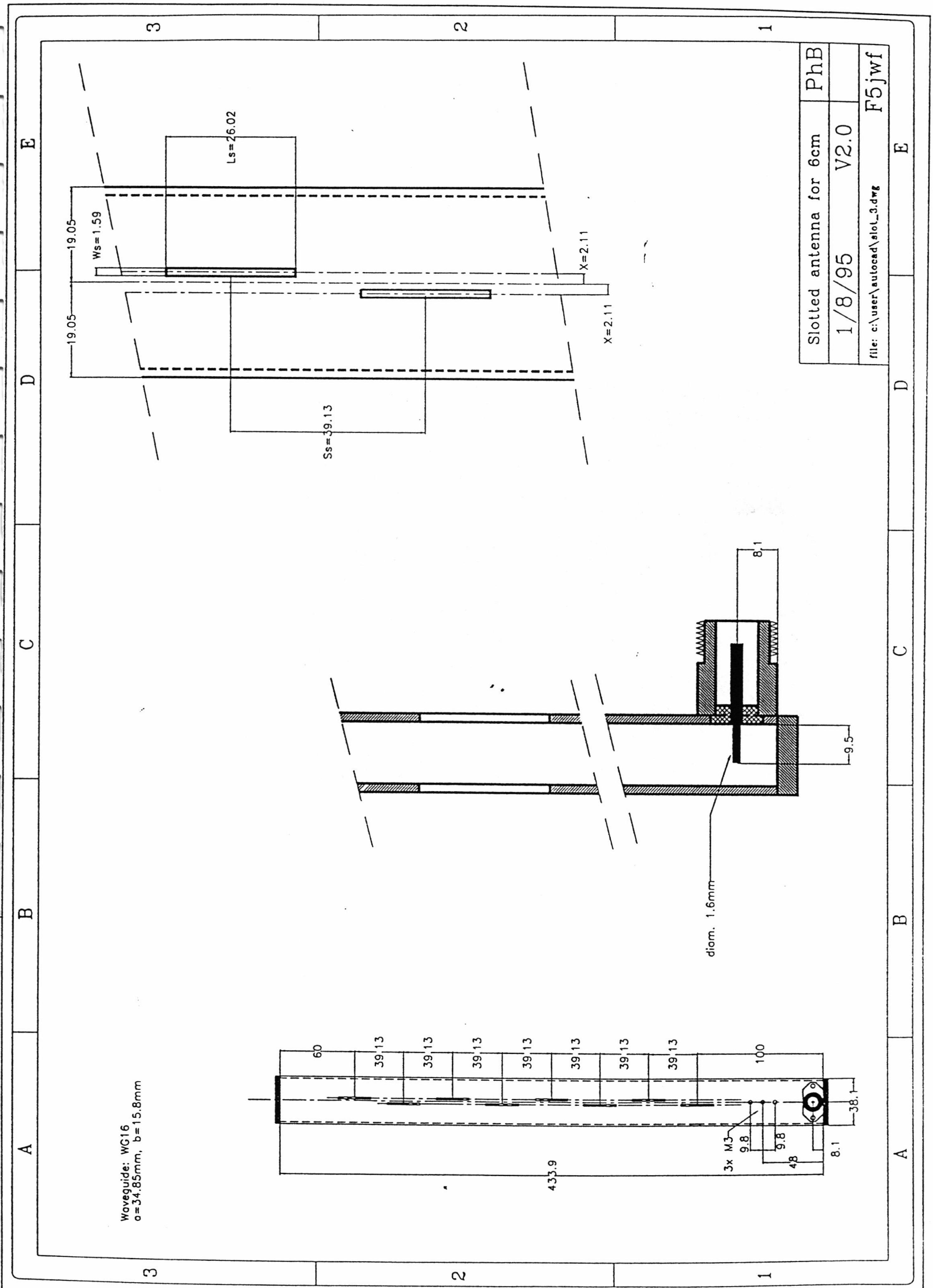
$$X = \frac{a}{\pi} \cdot Arc\sin\left[\sqrt{\frac{g}{g1}}\right] \quad \text{avec} \begin{cases} g = \dfrac{1}{N} \\ g_1 = 2.09 \cdot \dfrac{\lambda_g}{\lambda_0} \cdot \dfrac{a}{b} \cdot \cos^2\left(\dfrac{\pi \cdot \lambda_0}{2 \cdot \lambda_g}\right) \end{cases}$$

Espacement entre le sommet du guide et
l'extrémité du dernier slot: $L_{end} = i^* \lambda_g /2$ avec i: impair

Antenne réalisée pour le 6cm.

f_0= 5.76GHz — dimensions guide WG16: a=34.85mm — λ_0 = 52.03mm
N= 16 slots — b=15.8mm — λ_g = 78.25mm

Longueur d'un slot:	Ls = 26.02mm
Largeur d'un slot:	Ws ≈ 1.6mm
Espacement entres slots	Ss = 39.127mm
Désaxe des slots:	X = ± 2.109mm
Espacement entre le sommet du guide et l'extrémité du dernier slot:	L_{end} = 39.127 (Valeur théorique) Optimisation Return loss: Lend ≈ 47mm

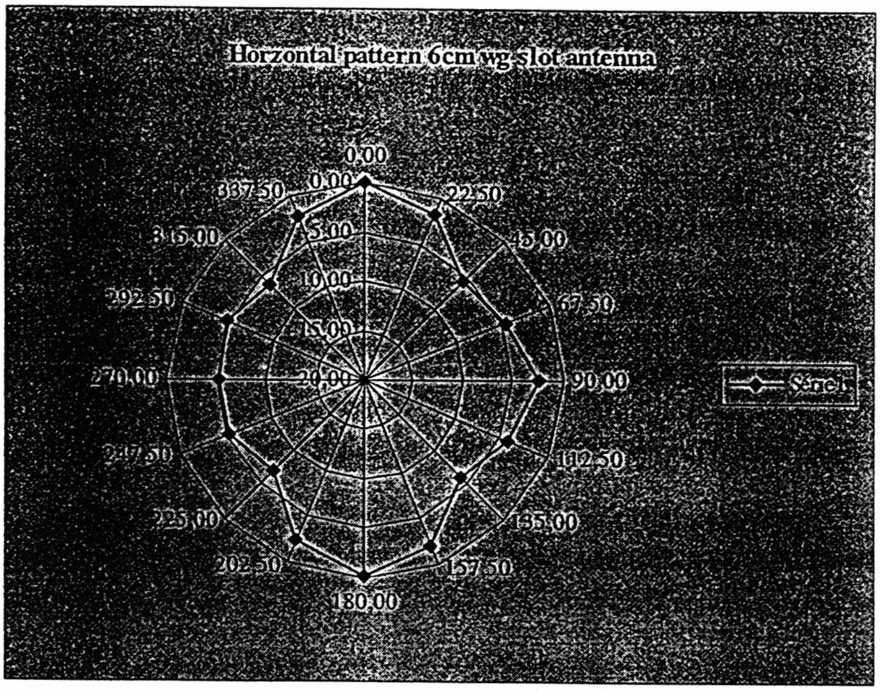

Slotted antenna for 6cm
PhB
1/8/95
V2.0
F5jwf
file: c:\user\autocad\slot_3.dwg
Ls=26.02
Ws=1.59
19.05
19.05
X=2.11
X=2.11
Ss=39.13
8.1
9.5
diam. 1.6mm
Waveguide: WG16
a=34.85mm, b=15.8mm
60
39.13
39.13
39.13
39.13
39.13
39.13
39.13
100
38.1
3x M3
9.8
9.8
48
8.1
433.9

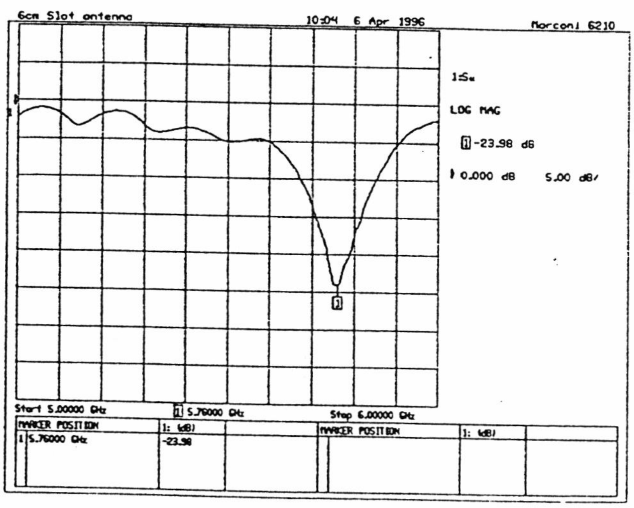
Mesures

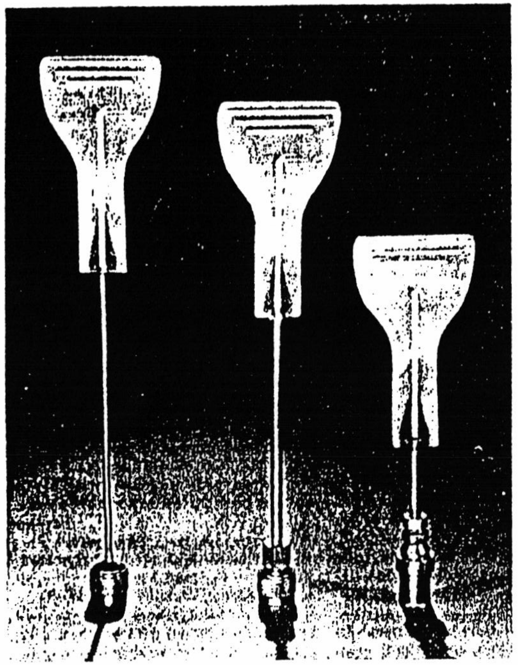
J'ai mesuré cette antenne à l'aide d'une cornet de référence. J'obtiens 12.3 dB de gain. La circularité n'est trop mauvaise: le point de rayonnement minimum est 7dB en dessous du rayonnement dans l'axe.
Le return loss est de l'ordre de -24dB (sans l'aide des vis d'accord).

Pour ceux que ça intéresse, j'ai éventuellement quelques longueurs de WG16 d'avance (tel 50 56 72 03).

73 à tous et bonne bidouille.







A Triband Microwave Dish Feed

Been looking for a slick way to get on 2304, 3456 and 5760 MHz with a single dish antenna? Look no farther!

By Tom Hill, WA3RMX
19335 NW Walker Rd
Beaverton, OR 97006

QST 08-90 A5

Many hams today think of microwaves as the province of wizards and experimenters. Fortunately, that stigma is disappearing now that commercial transverters, amplifiers, antennas and other needed accessories have become widely available, and now that no-tune-transverters[1,2] and simplified construction ideas are in wide use. *This* construction article is intended for everyone; no machine tools or exotic materials are needed. In fact, this project doesn't require anything expensive or hard to obtain. After the parts are gathered, you can accomplish the construction work in one concentrated evening, or over a leisurely weekend. It's a great project for groups interested in starting up some microwave work for events such as the ARRL VHF/UHF contests.

A triband microwave antenna? Why not? If we can do it for HF, we can do it for the microwaves! This feed covers the 2304, 3456 and 5760-MHz bands in one unit that's designed for use in a single dish—with no adjustments—while you switch among the three bands. If you want to build your own dish feed, the simplicity of this design makes it a real winner. And, it's available—ready to mount to your feed line or connector—from Down East Microwave.[3] Dish antennas are available at hamfests and from other sources.[4]

[1]Notes appear on p 27.

The Past

I used to use separate feeds for each band. These were the well-known, dipole/splash-plate feeds, which are excellent performers. These feeds require machine work to build, and often quite a lot of fussing to change one for another when switching bands. The alternative is to have a separate dish for each band, which is not very practical for a fixed station, and is simply unworkable for portable operation. Another disadvantage is the cost of the dipole/splash-plate feeds: After the large initial investment ($70 or so each if purchased new), the possibility of damage still looms. When the wind picks up, as it is wont to do, the dish may fall over on its face, squashing the feed.

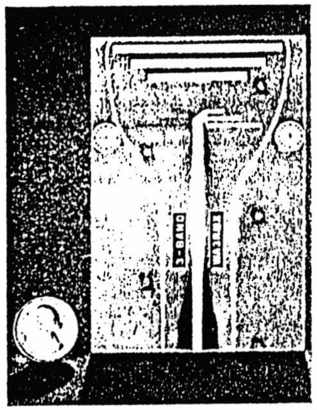


Fig 1—The triband dish feed is etched on common FR4 PC-board material.

Initial Requirements

After building a new triband SSB rig for the microwaves, I decided that a new feed arrangement was also needed to simplify setup and operation. I developed a list of requirements based on my past experience with dishes:

1. The new system must cover all three bands at once. (No more feed changing during DX pileups!) Also, no adjustments should be needed when changing bands, such as moving the mounting hardware to accommodate differing phase centers.

2. Complete broadbandedness is *not* desirable; the antenna should reject signals outside of the amateur bands, such as radar, satellite-TV uplinks, etc.

3. It should be easy to build (a PC board would be best). No machine work should be required; hand tools only.

4. It should be cheap. (Not so much crying when it's broken during a windy mountaintop expedition, as spares can be on hand.)

5. No exotic materials should be needed. It must be made from commonly available parts.

6. Must be rugged and easy to carry (flat is good).

7. Must not be affected too adversely by rain. My dipole/splash-plate feeds have a section of transmission line open to the air. Here in Oregon, the frequent rain fills up those feeds, rendering them useless until emptied (and often leaving them corroded as well).

8. Performance must not be more than 2 dB worse than the single-band feeds, and hopefully not even that bad.

The resulting triband feed meets all of these goals. The feed is etched on both sides of a standard FR4 (G-10) circuit board, then sprayed with clear urethane coating to protect the copper against weathering. The board requires no holes, nor any connections between the front and back sides of the circuit board. See Fig 1. The finished assembly is shown in Fig 2, mounted in a dish with semirigid coax.

Fig 2—The first prototype triband feed, mounted in a 19-inch dish, has performed well from my rooftop for almost two years.

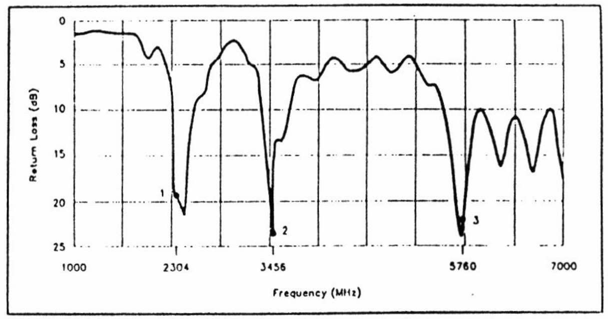


Fig 3—A network-analyzer plot showing the return loss (another way of expressing SWR) of a prototype feed. The greater the return loss, the better the SWR. (For more information on return loss, see K. Kleinschmidt, Ed., *The 1990 ARRL Handbook* (Newington: ARRL, 1989), p 35-38, and W. Hayward and D. DeMaw, *Solid-State Design for the Radio Amateur*, second printing (Newington: ARRL, 1986), pp 154-155.

How It Works

The triband feed is a variation of the original dish feeds, which consisted of a dipole driven element and a single reflector. The triband feed has three driven elements attached to a common feed point, and three separate reflectors. The lengths of the three driven elements have been adjusted to compensate for proximity to, and the detuning effects of, the other elements.

The elements are positioned for a common phase center for all three bands. This obviates the need for adjustments when changing bands. The 5760-MHz dipole is farthest from the dish surface. The lower-frequency dipoles distort the 5760-MHz dipole's radiation pattern more than if the order was reversed, but this placement facilitates the common phase center.

The balun is a simple, slowly tapered transition from microstripline at the end of the board where the connector mounts, to balanced line as it moves toward the dipoles. Although it's a compromise to allow printing the whole assembly, this technique is surprisingly effective.

Material and Results

The SWR is typically better than 1.5:1 on the two lower bands and better than 2:1 on 5760 MHz. See Fig 3. SWR varies somewhat from one feed to another, and is affected slightly by the mounting method. The feed helps to reject some of the extraneous signals sometimes found outside the amateur bands on the same mountaintops that you'll occupy for your DXpeditions!

The board material dramatically affects these results. I used a 3- × 4-1/2-inch piece of 1/16-inch-thick FR4 material with 1-ounce copper on both sides, and presensitized with positive-acting resist. (Although I used Injectorall type 40P board from the local parts store, PC-board material without the positive resist shouldn't affect performance.) Other manufacturers' FR4 boards will probably work fine, but if you use another material (phenolic, Teflon®, epoxy-paper, etc), or one of a different thickness, you will have to make major changes to the dimensions of both the transmission line and the elements.

I have tested only the configuration shown here. It works so well, both electrically and mechanically, that I didn't try others. Teflon (either woven mat or the amorphous types, such as Rogers Duroid™) would exhibit slightly lower loss, but at the price of much less mechanical strength.

I used a protective spray coating from the local parts store (Fine-L-Kote UR spray urethane conformal coating, made by Tech Spray, stock no. 1711-16S). I suspect that many other plastic spray coatings will work fine, but I have not tried any, so, as in all microwave work, if you change the recipe, you are on your own. Extensive tests have shown that the resonant frequencies of the feed move less than 25 MHz after the spray is applied, causing only negligible changes in SWR. The copper patterns have been designed to account for the presence of the plastic coating, but you can omit it without performance problems. Still, I recommend the plastic coating—especially around the edges of the board, which can absorb water if left unprotected—for outdoor use.

When tested in a 1-meter dish (f/D = 0.31), and compared to dipole/splash-plate feeds, the triband feed's gain, although somewhat less than that of optimized single-band units, is still very good. See Table 1. Some of this loss is due to suboptimal dish illumination and some is a result of dielectric loss in the circuit-board material (more on this later). The three reflectors are not optimal (they replace three separate round discs), and the three driven elements "argue" with each other. But that's the price of a PC-board, do-all feed! For critical long-haul, weak-signal work, consider keeping a set of optimized, single-band feeds handy.

This feed handles enough power for a very effective mountaintop station, and I

Table 1
Gain Differences Between PC-Board Triband Feed and Optimized Dipole/Splash-Plate Feed

Frequency	*Triband Feed Loss*
2304 MHz	0.75 dB
3456 MHz	1.25 dB
5760 MHz	1.5 dB

have regularly put 20 W through it with no trouble. But there is a limit: Al Ward, WB5LUA, tested a copy of this feed with 200 W of 2304-MHz RF for an extended time during the January 1990 ARRL VHF Sweepstakes contest. Even a small amount of dielectric loss was enough to precipitate spectacular heat damage, as shown in Fig 4. The board was burned so badly that all the copper fell off, predictably causing a rather severe SWR increase. I recommend not applying more than 20 W to this feed![5]

Construction

To build the triband feed, first etch the patterns on the front and back of the board. The full-size patterns are shown in Fig 5. The front pattern is dimensioned so that you can easily check the board size before etching. Fig 6 is an X-ray view of the board showing the feed's apparent

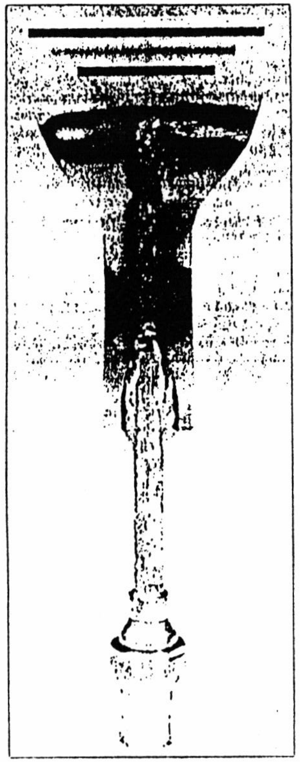


Fig 4—This triband feed was tested with 200 W of 2304-MHz RF; it failed. Don't apply more than 20 W to this feed!

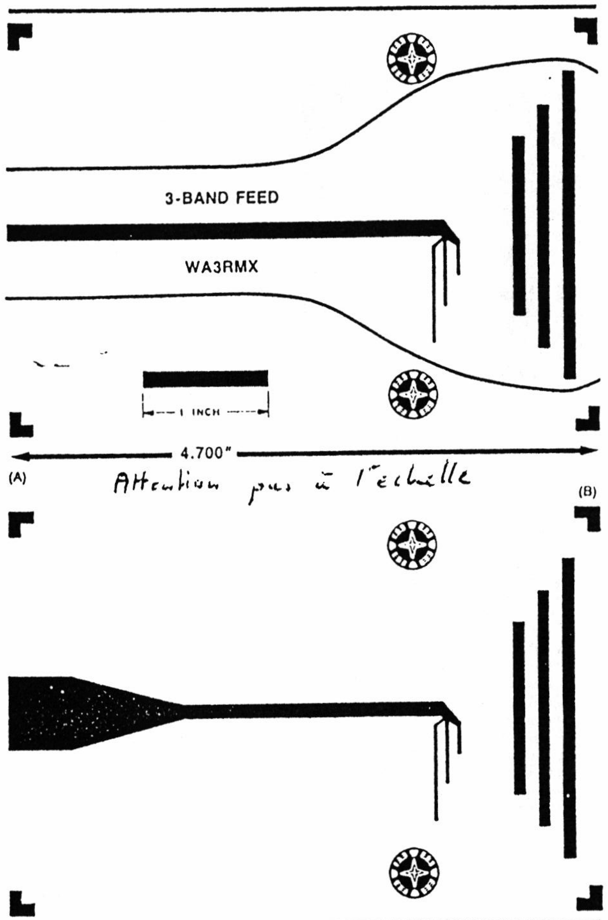


Fig 5—PC-board pattern for the triband dish feed. At A, the front pattern is shown. It includes a rule for checking the board size before etching. At B, the back side of the board is shown. Accurate registration of the patterns is important; the alignment should be within 0.030 inch for best performance.

phase center. Accurate registration of the front and back patterns is fairly critical; testing has shown that the two sides should be aligned to within at least 0.030 inch for good performance and low SWR. Pattern alignment can be achieved either by drilling two pilot holes in the unetched board at the locations of the two bullseyes on the artwork, or by carefully taping the edges of the artwork together and clamping the unetched board between them before exposure. (I prefer the drilling method.)

After etching and washing the board, cut away the excess board material just inside the cut lines on the front artwork. Be sure to remove *all* metal from the cut lines.

Mount a connector to the board in whatever arrangement suits your dish. I suggest you use semirigid 50-Ω coax, either 0.250 or 0.375 inch in diameter, with a connector to fit the feed line to the rig (see the title photo). Prepare the board and the coax to fit each other as shown in Fig 7. You can also mount a connector right to the

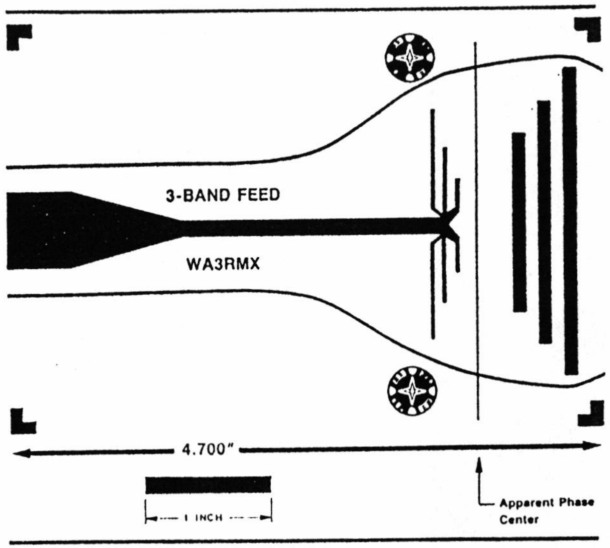


Fig 6—An X-ray view of the PC board, showing the apparent phase center of the feed. Place this part of the feed at the focal point of your dish, as described in the text.

board, as shown in Fig 8, trimming off the excess copper on the top. In any case, use the shortest leads possible: Even 1/16 inch or less excess wire kills performance at 5760 MHz!

I built one triband feed using the popular 0.141-inch-diameter semirigid coax (UT-141), as this is readily available at hamfests and from suppliers that cater to microwave hobbyists. Although this works

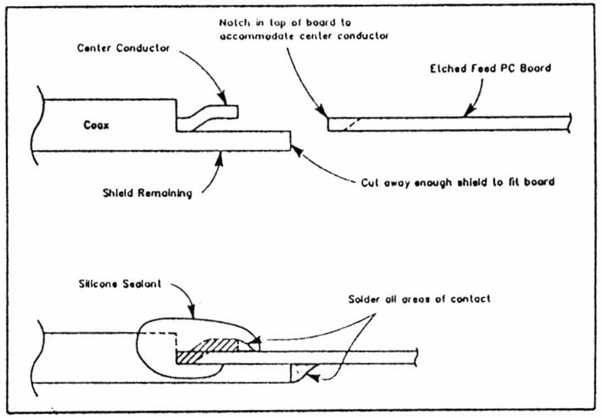


Fig 7—Prepare the Hardline for mounting to the dish-feed PC board by cutting away half the shield and dielectric from the cable over a distance long enough to ensure a solid mechanical connection to the board. Then, bend the center conductor slightly and fit it into a notch in the PC board, as described in the text.

electrically, UT-141 is too weak to hold the feed in place except with very gentle handling. If UT-141 is all that you have available, use it; it works fine for light-duty service. If you do use such small Hardline, flatten the part of the shield to be soldered to the back side of the board. The board is thicker than the spacing from the center conductor to the shield, and the center conductor shouldn't be as long as would be necessary for it to wrap around to the front side of the board.

I use a GR874 connector on my portable version of the feed, which allows quick assembly and disassembly, but it also allows water to enter the connection if it's used in heavy rain. My permanently mounted versions all use N connectors for water-resistant, low-SWR connections. If you expect to use the feed in the rain, it is a good idea to mount it in the dish at a slight angle from the horizontal to allow runoff. (If water pools on the flat upper surface of the feed, dielectric loading will detune the antenna.)

After the mechanical and electrical assembly is finished, spray the plastic coating onto the board. After it dries, apply some electronics-grade (non-acidic) silicone sealant to the area of the solder connection to seal out moisture, especially if the feed is to be used extensively outdoors. For this purpose, I use Dow no. 3145 silicone sealant.

Now, mount the feed in the dish, with the apparent phase center (Fig 6) at the focal point of the dish. My tests showed that, although it's a compromise, this is the best feed placement for all three bands. To find the focal point of a dish, use the equation $f = D^2 \div 16h$, where D is dish diameter and h is dish depth (see Fig 9). The triband feed works well with dishes having f/D ratios from 0.25 to 0.4, which is the range over which I've tested the feed.

Operation

With one of these feeds in a 30-inch-diameter dish, I have made 80-mile 2304-MHz FM contacts with 100 mW—with plenty of signal to spare. On SSB, greater range can be obtained, or much lower power used. Lynn Hurd, WB7UNU, and I have made 115-mile contacts with 50 mW of SSB on 2304 MHz using these feeds at each end—stuck straight up into the air, without dishes! In a test to see what is possible using minimal power over a line-of-sight path, we set up 50-mW SSB rigs with 29-inch dishes at each end, each equipped with a triband feed. Communicating over a 66-mile path, we added attenuators in the feed line to one rig until the SSB signal was just barely readable. With *50 dB* of added attenuation, we still had readable signals. (This corresponds to ½ *microwatt* of transmitter power to the antenna!) We were pleased.

Roger McCoy, W7ADV, and I made a 130-mile 2304-MHz contact over an obstructed path using 29-inch dishes

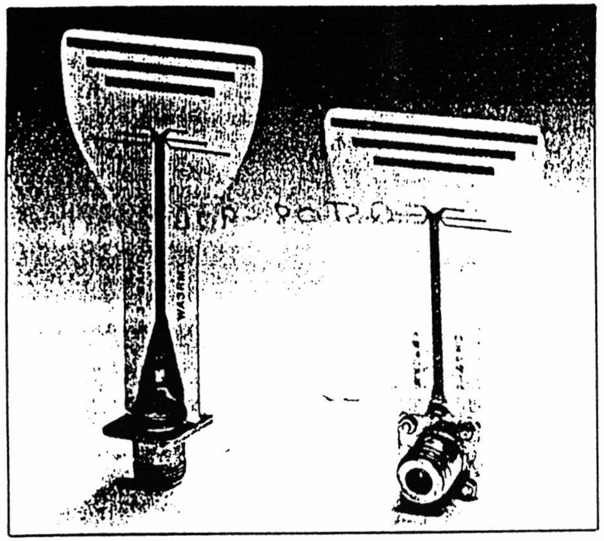


Fig 8—Two prototype triband feeds with N connectors mounted directly to the PC boards. When mounting connectors this way, be sure to minimize stress on the feed resulting from feed-line strain.

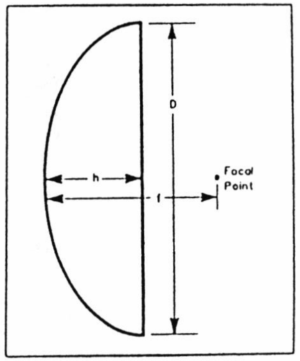


Fig 9—Measure the proportions of your dish and calculate the location of the focus as described in the text.

equipped with triband feeds at each end, by using the tip of Mt Hood (12,000 feet above sea level) as a knife-edge diffractor. We first tried this with 20 W and had fine signals, so we also tried CW and managed a weak contact with only 100 mW.

At the extreme, I have even used a triband feed to make 10-mile contacts with 25 mW *on 10 GHz*. Although far from optimal, the feed still radiates a signal at 3 cm! Three VUCC awards each on 2304, 3456 and 5760 MHz have been earned with copies of this feed. WB7UNU (grid CN85NL) and I (CN85NM) each use these feeds in 19-inch dishes on our roofs, and regularly chat on 2304 and 3456 MHz (5760-MHz signals don't make it too well through the grove of trees on my neighbor's property).

I hope this article helps generate more activity on the microwave bands. With the triband feed and the simple transverters now on the market, it's easier than ever before to put together lots of roving stations for the VHF and microwave contests. VUCC, here we come!

Acknowledgments

Thanks to Deane Kidd, W7TYR, for his help with the artwork and his untiring encouragement. Also, thanks to WB5LUA for his high-power tests, and to W7ADV and WB7UNU for their help field-testing the prototypes.

Notes

[1]R. Campbell, "A No-Tune Transvertor for 3456 MHz," *QST*, Jun 1989, pp 21-26.
[2]No-tune transverter kits for 903, 1296, 2304 and 3456 MHz, as well as preamps and accessories, are available from Down East Microwave, RR 1, Box 2310, Troy, ME 04987, tel 207-948-3741.
[3]See Note 2. The triband feed is priced at $20 plus shipping and handling. *The ARRL and QST in no way warrant this offer.*
[4]Spun-aluminum dishes are available in several sizes (24, 36, 48, 60 and 72 inches) from Antenna Center, 505 Oak St, Calumet, MI 49913, tel 906-337-5062. The 24- and 36-inch models are UPS-shippable; prices range from $36 (24 in.) to $190 (72 in.) plus shipping and handling.
[5]For those who have higher power available and want the advantages of the triband feed, I plan to submit a follow-up article to *QEX* that will give a board pattern for Duroid material. That feed won't be nearly as rugged as the FR4 board, but it will handle more power.

Tom Hill, licensed since 1971, is a Principal Engineer in the Microwave and RF Instruments Division of Tektronix, Inc, in Beaverton, Oregon. He's mainly active at VHF and higher, although his station includes antennas and equipment for all bands from 1.8 MHz through 47 GHz, and he's working on others!

Tom has earned VUCC awards on the 3.4, 5.7, 10 and 24-GHz bands, and shares the current North American DX record on 24 GHz and the current world DX record on 47 GHz, all of which he has achieved with equipment he's built from his own designs.

A TRIBAND MICROWAVE DISH FEED - notes gleaned from QST, courtesy of ARRL

The August issue of QST Magazine carries a most interesting article by Tom, WA3RMX, on a triband feed for the 2.3,3.4 and 5.7GHz bands. No adjustments are needed when changing bands. It is cheap to make, using hand tools only and no exotic materials are required. The performance is no worse than 1.5dB down on single band feeds. The feed is etched on both sides of a standard FR4(G-10) pc board, sprayed with clear urethane coating as a weatherproofing. The board requires no holes nor any connections between one side of the pcb and the other.

Three driven elements are etched onto the pcb and attached to a common feed point. Three separate reflectors are employed. The elements are positioned for a common phase centre for all three bands. A simple microstripline balun is mounted on the end of the board, close to the connector. SWR is typically better than 1.5:1 on the two lower bands and better than 2:1 on the highest band. Teflon (PTFE) board was not used for this attenna as it would have a lower mechanical strength than the 1/16 inch thick FR4 material employed (1 ounce copper on both sides).

In operation the feed happily copes with 20 watts but a test at 200 watts led to a severe increase in SWR as the board burnt away!

The construction is very straightfoward: etch the patterns shown on the next page onto the front and back of a 3" x 4.5" piece of pcb. The front pattern includes a scale against which the track dimensions can be checked. If you use the pattern shown in this newsletter you will have to enlarge it from A5 size to A4 to get back to full size dimensions. Also shown is an "X-Ray" view of the completed feed. It is important to accurately align both sides of the board to within at least .030". Pattern alignment is obtained by drilling two pilot holes in the unetched part of the board, at the location of the two "bullseyes" in the artwork. After etching be sure to cut away all excess board material to the cut lines shown in the artwork for the front board. A semi-rigid coax feed can be connected or an N socket can be mounted directly on the board. If using the latter technique be sure to trim all the excess copper on the top. The shortest leads possible should be used.

The feed is mounted so that the apparent phase centre (see X-Ray diagram) is at the focal point of thev dish. The feed works well with dishes having f/d ratios around 0.25 to 0.4.

extrait de "Microwaves Newsletter"

(reprise de l'article de QST)

SOURCE 5760 MHz (6 cm)

F1BJD

Source 5760 MHz (6 cm) réalisée dans du tube Cu standard Ø 38/40 .

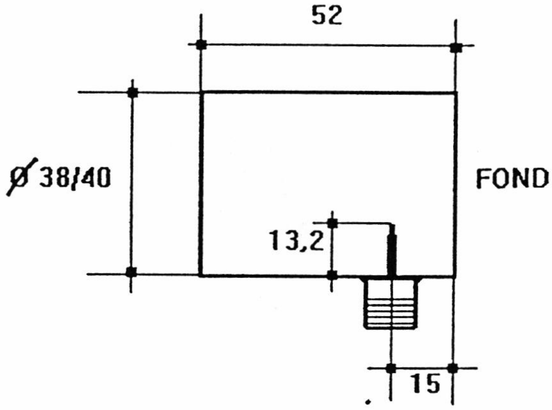
La fixation se fera par 3 pattes à 120° ou par la plaque du fond de source au choix de chacun .

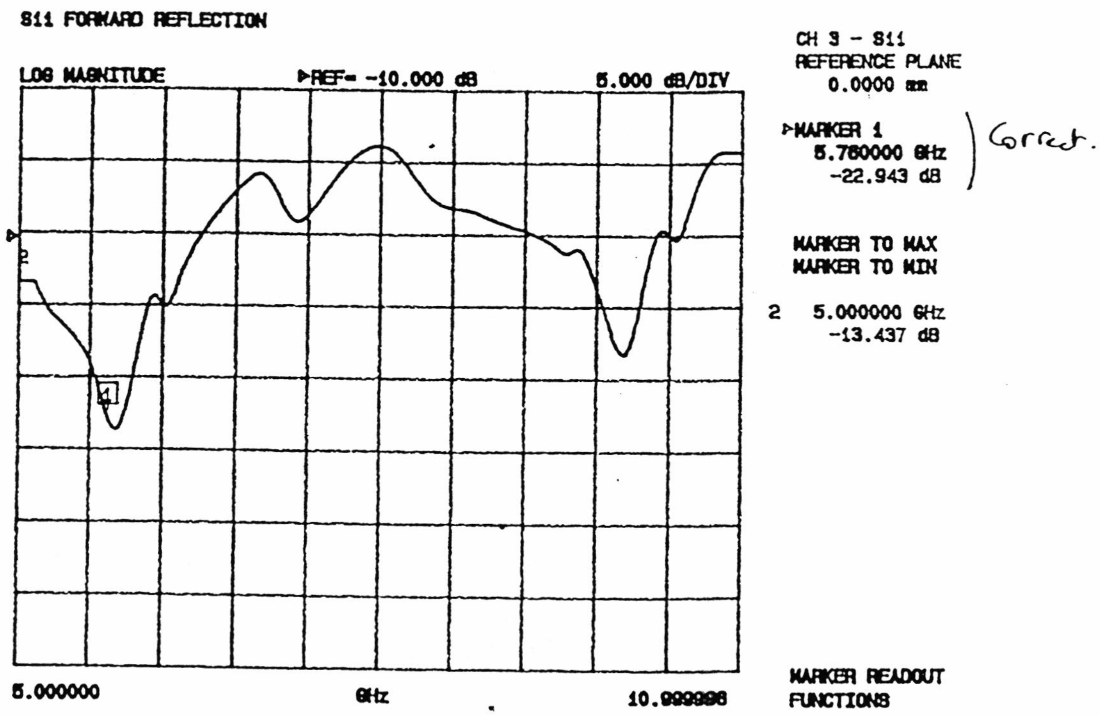
La fiche N ou SMA suivant équipement .

La pinoche est réalisée en tube laiton Ø 3 et brin coulissant pour réglage Ø 2 .

Le TOS obtenu est de 1,5 voir courbe , remerciements à Jean-Jacques F1EHN pour la mesure.

VUE EN COUPE





SOURCE 5,7 GHz

F1BJD

Pourquoi ne pas utiliser le système des sources PROCOM (10 GHz/24 GHz) sur 6 cm 5.760 GHz ??

Après avoir relevé les dimensions de la source 10 GHz j'ai appliqué le coéfficient :

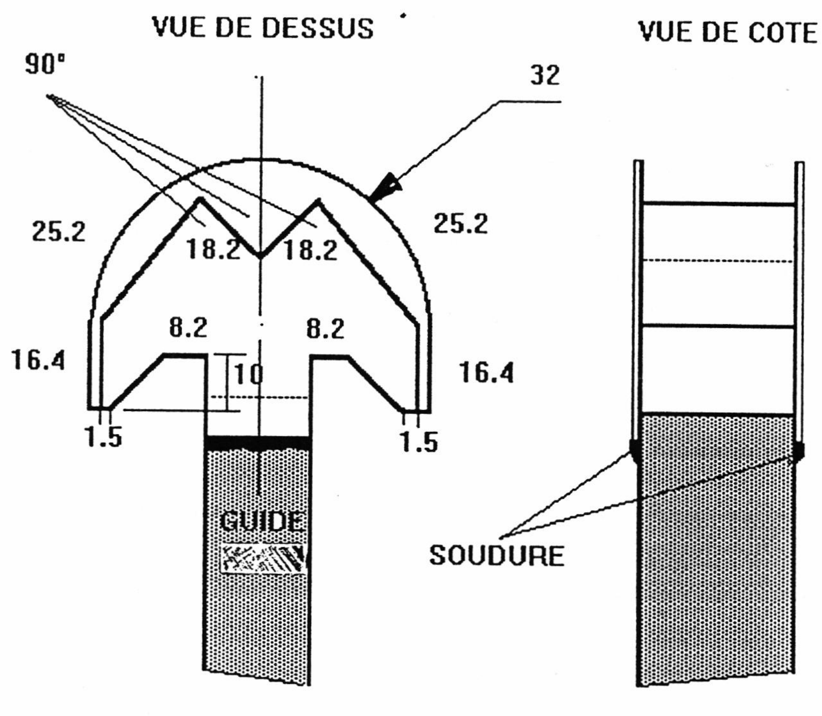
$$\frac{5760 \text{ MHz}}{10368 \text{ MHz}} = 0{,}555$$ pour le traçage des pièces en laiton voir croquis.

3 pièces constituent la tète dont 2 identiques en laiton 10 à 15 / 10 è , la pièce en forme de M 5 à 7 / 10 e (pas trop épais pour faciliter la mise en forme).

La hauteur du M doit être ajustée en fonction du guide WG13 / WR159 soit hauteur 40,39 et largeur 20,19.

Le tout est soudé à l'étain avec un gros fer > 150 W ou petit chalumeau à gaz, s'aider de petits serre-joints pour le maintient des 3 pièces pendant la soudure.

Pour la position optimum de la source j'ai utilisé un mesureur de champ à quelques mètres faire glisser la tète au bout du guide pour faire le maxi , et en // éffectuer le meilleur F/D . Repérez la position de la source avant la soudure finale sur le guide.



High-Performance Antennas for 5760 MHz

Measurements

The antenna range used the same superheterodyne ratiometry technique and setup described in "Practical Microwave Antennas, Part 3." Different mixers and filters were required, so we used home-brew mixers with integrated pipe-cap filters.[7] We were able to make measurements with only one milliwatt of transmitter power by adding a 30-MHz amplifier before the PANFI; the ability to add gain at a low frequency is a real advantage of the superheterodyne technique.

Measurement results are shown in Table 1. We did not have a standard-gain antenna available for 5760 MHz so we used two horn antennas as a gain reference. The *HDL_ANT* computer program described in the "Practical Microwave Antennas" series uses an algorithm for the gain of a horn that has proved quite accurate at 10 GHz, so we carefully measured the physical dimensions of the two horns in order to calculate their gain. When the gains were measured, we found a discrepancy of 0.6 dB in the gain of one horn relative to the other. Since we do not have a standard, there is no way to determine which is in error, so we split the difference. Therefore, the results shown in Table 1 are either 0.3 dB high or low, depending on which horn gain is incorrect, but this is still a small uncertainty for amateur measurements. An uncertainty of 0.3 dB translates into a range of possible efficiencies of 57% to 66% for the highest gain shown, listed as 61%, and a smaller range for lower efficiencies.

A note on measurement technique: we try to do blind measurements, where one person takes the readings sand another writes them down, with calculations done later, to limit the human tendency to find the "expected" result.

Dish Feeds for 5760 MHz

The whole point of these measurements is to find efficient feeds for a parabolic dish. Table 1 lists the results and shows several feeds with significantly better performance than previously published designs. Let's discuss them individually:

- WA3RMX triband feed:[8] Like all multiband antennas, this one is a compromise, and performance is significantly less than an optimum feed—less than 20% efficiency on a dish with *f/D* = 0.45. The original *QST* article suggests an *f/D* in the 0.25 to 0.4 range, which would be illuminated more efficiently but probably not with better than 30% efficiency. However, many successful contacts have been made using this feed, and it is highly recommended if a multiband antenna is the only way to get a station on 5760 MHz.
- Cylindrical waveguide feed horn: This was described by W0PW in *QEX* with versions for 3.456, 5.76, and 10.3 GHz.[9] WB1FKF made a copy of the 5760-MHz version, and we measured it on the recommended dish as well as on two others, all with *f/D* = 0.45. In all cases, the efficiency was 20 to 24%.

Like many folks getting started on a new band, WB1FKF copied the published dimensions but had no test equipment to check it out. Since he was able to make successful contacts with it, he assumed it was working well. After we found that the efficiency was rather low, he checked the return loss and found it to be 5 dB (VSWR ~ 3.5). The possible reflection loss for this mismatch is 1.65 dB, so the actual gain could be that much higher if the feed were perfectly matched. The resultant efficiency could then be as high as 35%.

Even though Don copied the published dimensions carefully, it is not surprising that the VSWR was high. This feed uses an E-field probe to excite the circular waveguide, and I have found the impedance of these probes to be extremely sensitive to their dimensions. The Kumar feed, below, also uses a probe to excite the circular waveguide, and it took a fair amount of cut-and-try to find the best combination of length and diameter for the probe.

- Kumar feed:[10] This scalar feedhorn has been described by VE4MA for 1296, 2304 and 3456 MHz.[11 12] I scaled the dimensions for 5760 MHz as shown in Fig 1, and K1DPP constructed one with compromise dimensions adjusted for available materials—for instance, the outer ring is made from a film can for a 100-foot roll of film. These compromise dimensions are not necessarily optimum. The probe length and diameter are very critical, so copies would probably require some tuning. Performance was excellent, with 61% efficiency on a 25-inch reflector. A later measurement on a 30-inch reflector of the same *f/D* was much worse—apparently something went wrong.

- Clavin feed:[13] I scaled the dimensions for 5760 MHz as shown in Fig 2 from my 10368-MHz version (see note 2), and K1DPP machined one. The critical dimension is the slot length, which I filed for best VSWR. This feed also showed very good performance with 57% efficiency. Unfortunately, the dimensions do not fit any readily available materials.
- Rectangular feed horn:[14] My initial estimate of the *f/D* for the 30-inch reflector was 0.47, so I designed a rectangular horn for an *f/D* = 0.47. The *HDL_ANT* program generated the horn template shown in Fig 3, which I used to make a horn of flashing copper. The horn, soldered to a piece of WR-137 waveguide, provides very good performance with 58% efficiency. The calculated phase center is 0.02 wavelengths inside the mouth of the horn so we can get a better estimate of the focal point than that found by fitting paper templates generated by *HDL_ANT*.
- Waveguide-to-coax transitions: At 10 GHz, we found that a WR-90-to-coax transition provides about 42% efficiency when used as a dish feed. This is valuable data because it is something readily available for comparisons if there are no antennas with known gain available. For 5760 MHz, there are three usable sizes of waveguide, and I found coax transitions for all three in my collection acquired at hamfests. We were surprised to find how well these worked: a WR-137 transition with a small rectangular flange provided 46% efficiency, close to our expectation, but transitions with large circular flanges showed much higher efficiencies: 56 and 58%. Finally, the highest efficiency was a WR-159 transition with rounded, rather than square, corners on the inside of the waveguide. While large circular flanges may provide the same effect as the choke flange for cylindrical waveguide feed horns described by WA9HUV,[15] we can offer no explanation for the performance of the rounded corner waveguide transition.

Recommendations

All the dishes we had available have an *f/D* ratio of 0.45. At this *f/D*, the Kumar, Clavin and rectangular feedhorn all offer very good performance. For dishes with other *f/D* ratios, the recommendations are the same as those offered in "Practical Microwave Antennas, Part 2" the Kumar and Clavin feeds are better for the *f/D* range of 0.35 to 0.45, while rectangular feedhorns may be optimized for any *f/D* greater than 0.45. If you find a surplus waveguide-to-coax transition, it may provide performance as good as the ones we measured, but be sure to adjust it carefully; as Table 1 shows, the focal distances, and thus the apparent phase centers, vary widely.

At 5760 MHz, the focal length of the dish is not quite as critical as at 10 GHz since a wavelength is nearly twice as long. However, two of the feeds in Table 1 were measured with varying focal distance to show the loss associated with small focal-length errors. Getting the feed exactly at the focal point is still the most important aspect of dish efficiency and gain.

Finally, match the impedance of the antenna to the transmission line—a low VSWR is important at all frequencies, and even more so at microwaves where transmission line losses are high. In "Practical Microwave Antennas" I made the assumption that this would be obvious, but our measurements here are a reminder that the obvious sometimes needs restatement.

Conclusion

It should be apparent that significant improvements in dish efficiency are available, compared to previously published feed designs for 5760 MHz. How significant? The measurements show a gain increase of

3 to 4 dB with no increase in dish size, weight or wind loading—enough to double the range of a pair of stations making this improvement.

Acknowledgment

Don Cook, K1DPP, provided both enthusiasm and machining skills for this project. Unfortunately, he became a Silent Key before it was completed. He was a true friend and helped all the hams who knew him; we all miss him.

Notes

(1) Wade, P., N1BWT, "Practical Microwave Antennas, Part 1," *QEX*, September 1994, pp 3-11.

(2) Wade, P., N1BWT, "Practical Microwave Antennas, Part 2," *QEX*, October 1994, pp 13-22.

(3) Wade, P., N1BWT, "Practical Microwave Antennas, Part 3," *QEX*, November 1994, pp 16-24.

(4) Lau, Z., KH6CP/1, "A 5616-MHz Local Oscillator," *QEX*, May 1993, pp 15-19.

(5) Cook, R., N2SB, "5760 MHz from the Junkbox," *QEX*, May 1994, pp 20-24.

(6) Lau, Z., KH6CP/1, "A Low-Noise PHEMPT Amplifier for 5760 MHz," *QEX*, September 1994, pp 28-31.

(7) Wade, P., N1BWT, "Mixers, Etc., for 5760 MHz," *Proceedings of Microwave Update '92*, ARRL, 1992, pp 71-79.

(8) Hill, T., WA3RMX, "A Triband Microwave Dish Feed," *QST*, August 1990, pp 23-27.

(9) Hilliard, D.L., W0PW, "Antenna Ideas for 3.5, 5.8, and 10,3 GHz," *QEX*, January 1988, pp 3-5.

(10) Kumar, A., "Reduce Cross-Polarization in Reflector-Type Antennas," *Microwaves*, March 1978, pp 48-51.

(11) Malowanchuk, B. W., VE4MA, "Selection of an Optimum Dish Feed," *Proceedings of the 23rd Conference of the Central States VHF Society*, ARRL, 1989, pp 35-43.

(12) Malowanchuk, B. W., VE4MA, "VE4MA 3456-MHz circular polarization feed horn," *Feedpoint*, November/December 1991, North Texas Microwave Society.

(13) Clavin, A., "A Multimode Antenna Having Equal E- and H-Planes," *IEEE Transactions on Antennas and Propagation*, AP-23, September 1975, pp 735-737.

(14) Evans, D., G3RPE, "Pyramidal horn feeds for paraboloidal dishes," *Radio Communication*, March 1975.

(15) Foot, N. J., WA9HUV, "Second-Generation Cylindrical Feedhorns," *Ham Radio*, May 1982, pp 31-35.

Table 1—Summary of 5.760 GHz Antenna Measurements

N1BWT, KB1VC, WB1FKF 10/29/94

ANTENNA	*FOCAL DIST (inches)*	*GAIN (dBi)*	*Efficiency*
Horn, Seavy SGA-50 (19.65 dBi calc)		19.3	53%
Surplus AT-802/UPM-9A horn (16.3 dBi calc)		16.6	51%
25-inch dish, $f/D = 0.45$, Satellite City, with the following feeds:			
Clavin feed	11.125	27.5	38%
Clavin feed	10.625	28.3	46%
Clavin feed	10.375	29.2	57%
Clavin feed	10.125	27.9	42%
Kumar (VE4MA) feed (0.25-inch projection)	11.5	29.5	61%
Cylindrical horn feed (1.625-inch ID)		25.3	23%
23-inch dish, antenna center 24 inch, $f/D = 0.45$, , with the following feed (24-inch OD but parabolic surface is 23-inch diameter):			
WA3RMX triband feed	10.875	23.3	17%
Cylindrical horn feed (1.625-inch ID)	11	24.5	23%
	10.625	23.7	19%
	11.5	24.7	24%
30-inch dish, $f/D = 0.45$, (lighting reflector), with the following feeds:			
Kumar (VE4MA) feed (0.25-inch projection)	13.9	(29.7) questionable—see text	(42%)
Rectangular horn, (optimum for $f/D = 0.47$) E=1.37 inch, H=1.6 inch	13.125	31.1	58%
	12.31	29.1	} focal sensitivity
	13.62	29.1	} focal sensitivity
Cylindrical horn feed (1.625-inch ID)	13.0	26.5	20%
Waveguide to coax transitions:			
WR-137 round flange (3.12-inch flange OD; FXR C601B)	13.625	30.9	56%
WR-137 rect. Flange (2.25 × 1.5-inch flange)	14.25	30.1	46%
WR-159 rect. Flange (2.5 × 1.75-inch flange; marked 549-033489-001 Rev E; waveguide has rounded inner corners, radius 0.25 inch)	12.625	31.3	61%
WR-187 round flange (3.62-inch flange OD; Waveline 301-NF)	12.5	31.1	58%

Range length = 110 feet. $2D^2/\lambda$ = 73 feet. Test height $\simeq$10 feet.

Focal distance: each feed was adjusted for maximum gain, except the WA3RMX triband feed, which was not adjustable and was measured to specified phase center. All other focal distances measured to outermost point.

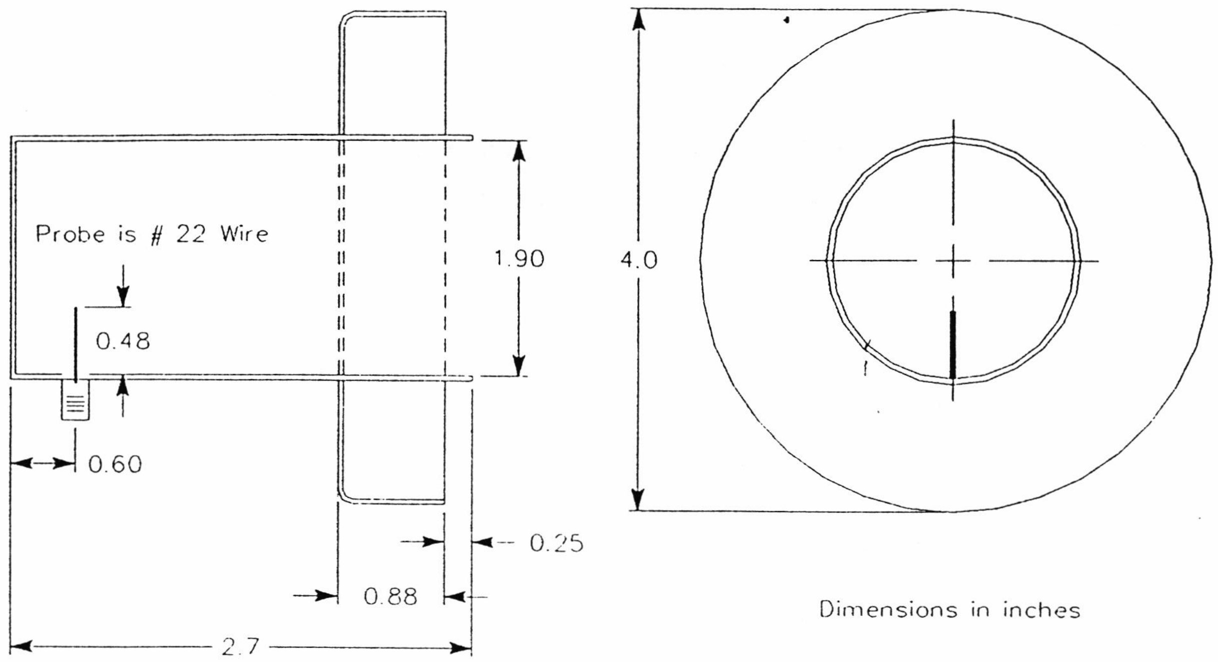


Fig 1—Kumar feed for 5760 MHz. Dimensions may not be optimum. An SMA connector is used.

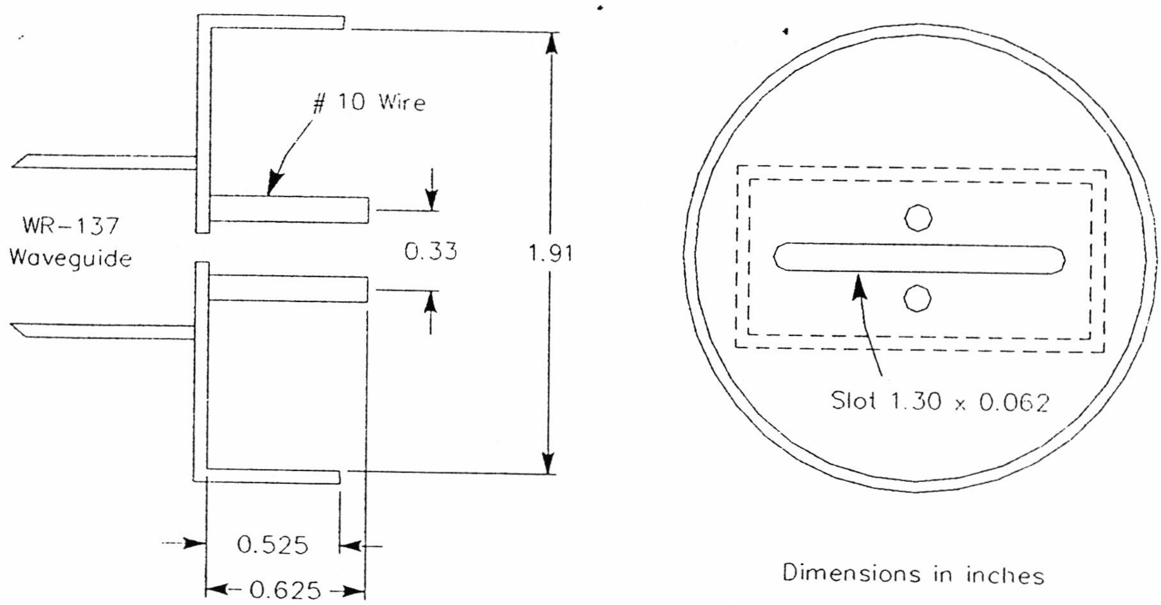


Fig 2—Clavin feed for 5760 MHz.

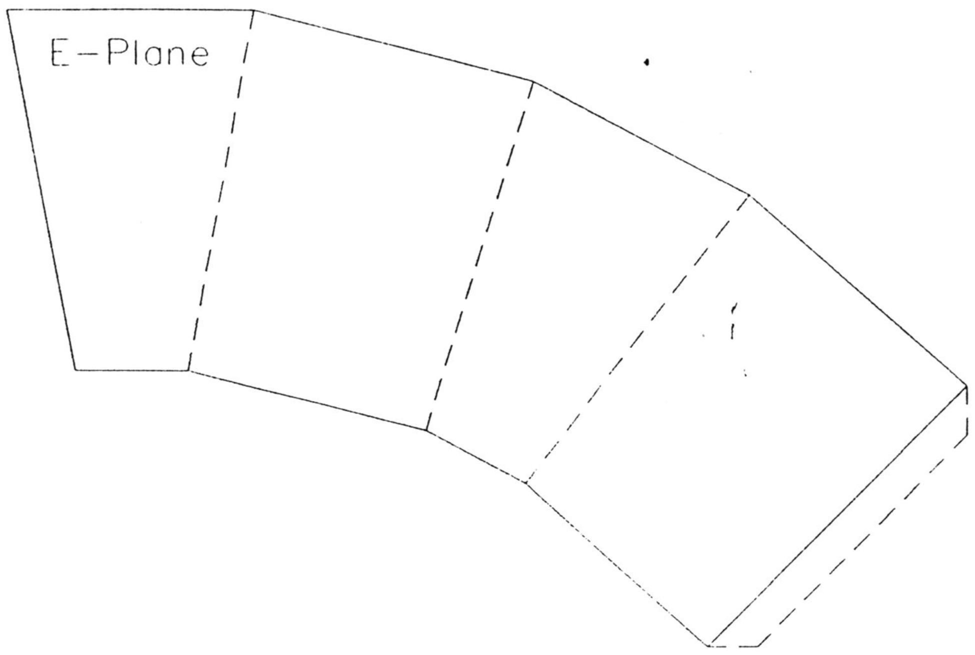


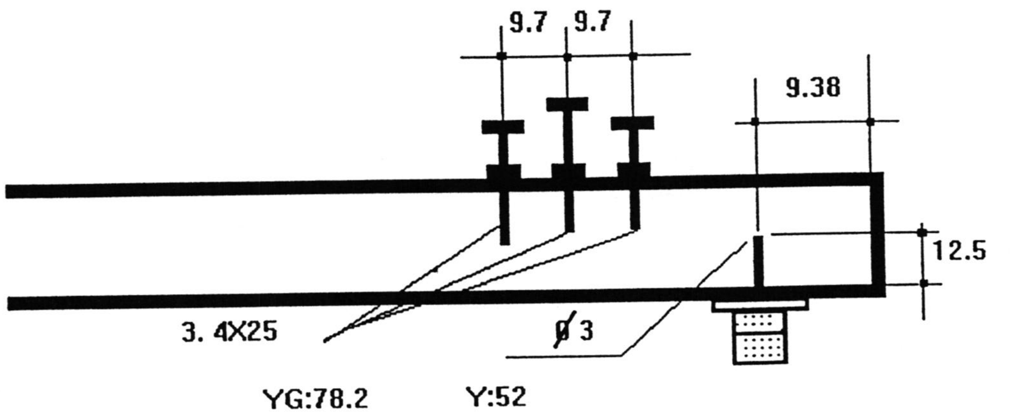
Fig 3—Full-size template for a 7.2-dBi horn for 5760 MHz, suitable for illuminating a dish with $f/D \approx 0.47$.

TRANSITION GUIDE / COAX. 5,7 GHz

F1BJD

Détail de la réalisation guide coax. pour le 5,7 GHz.

Le guide utilisé est un morceau de guide WG 13 / WR 159 (4,9 / 7,05 GHz).
Les côtes ont été calculées d'après des formules trouvées dans les revues spécialisées.
La fiche sera N ou SMA.
3 vis M4 x 25 en laiton assurent l'adaptation à l'antenne. espacement λG / 8
λ = 5760 MHz = 52 m/m
λG = 78,2
La distance fond de guide / pinoche 0,12 λG soit 9,38 m/m.
Hauteur de la pinoche 12,5 m/m Ø 3m/m.



ILLUMINATION 5760 Mhz

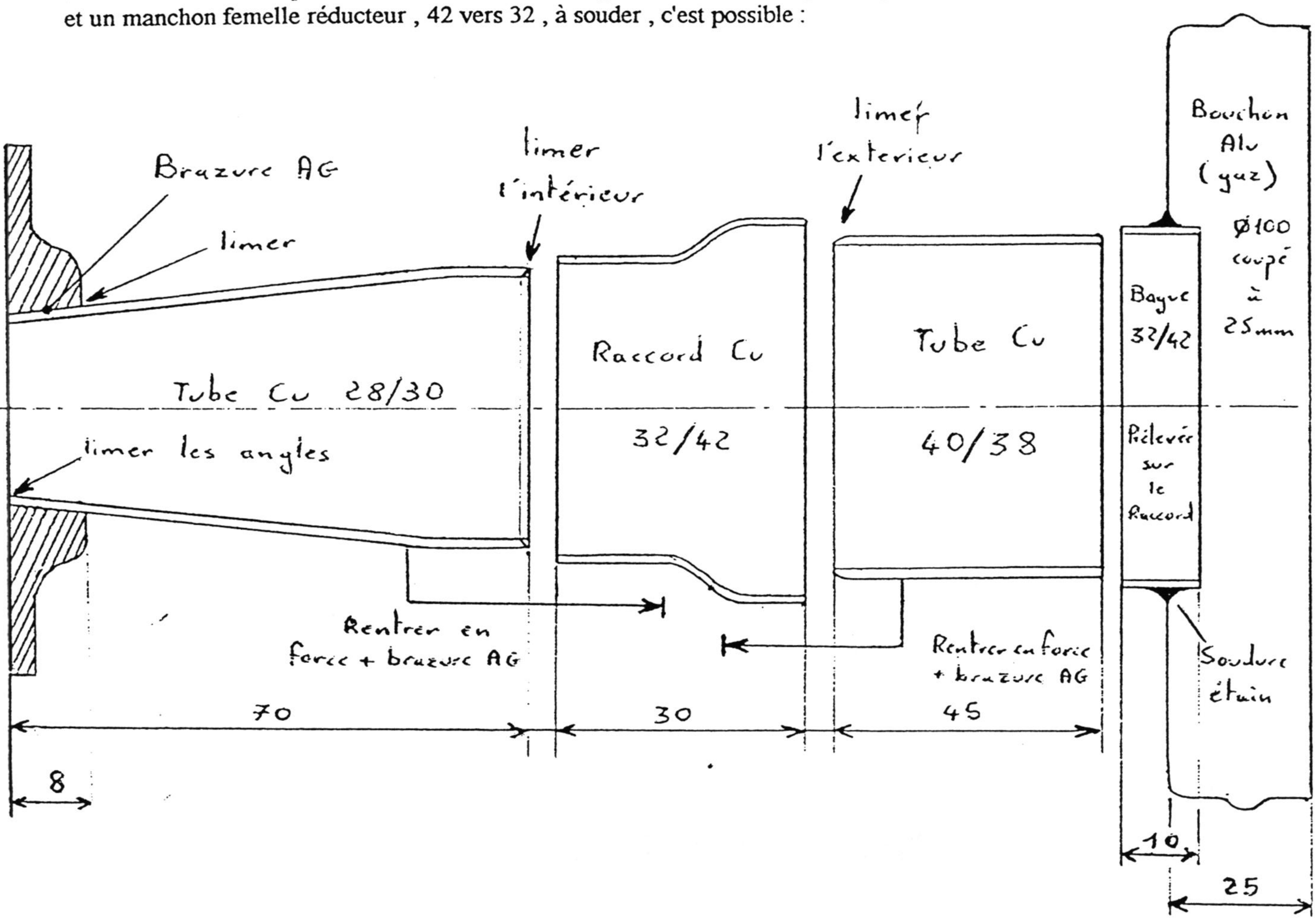
par ***Philippe , F6DPH***

VE4MA pour guide WR 137

Hyper N°12 Juin 97

(d'après WB5LUA / VE4MA)

Une description de cette source est parue dans CJ 96 (et dans HYPER spécial antennes) mais l'utilisation de tube 38 / 40 à réduire pour rentrer dans la bride du guide WR 137 n'est pas simple ! Par contre , avec du tube 28/30 et un manchon femelle réducteur , 42 vers 32 , à souder , c'est possible :



N'arrivant pas à former du tube cuivre 40 / 38 pour réaliser une illumination genre VE4MA / WB5LUA , j'ai utilisé du tube 28 / 30 qui se prête plus facilement à l'exercice ! Après avoir dévalisé le " Casto. " du coin , j'ai donc trouvé un raccord à souder de 32 / 42 permettant de revenir au tube 38 / 40 ou 40 / 38 (suivant le modèle) .

Une bague de 10 mm est prélevée et servira de coulisse et de support au bouchon en Alu (Pour échappement gaz , aussi chez Casto.) qui est perçé à un diamètre de 40 mm et coupé à 25 mm , puis soudé à l'étain sur la bague.

Cet ensemble est donc réglable en fonction du f/d de votre gamelle .

QSJ : Raccord 22 FF environ
Bouchon 45 FF ah ! ah ! Cher !! ou alors fond de boîte de conserve ...

La bride est de démontage et les tubes sont de récup...

Je peux fournir un peu de soudure étain pour Alu (gratos !)

Important :

L'ensemble est peint en fluo rose pour éviter de se la mettre dans l'oeil (la source ...) quand on tourne la parabole et en plus c'est très Joolî !! (sauf la coulisse qui sera collée à la colle AG après réglage)

Je dédie cet article à F1JPB !
F6DPH Philippe MILLET

Ref : DUBUS
FEEDPOINT Octobre / Novembre 1995

NOTES PERSONELLES :