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2-Tone Generator For 145MHz

Wolfgang Schneider, DJ8ES

Contents

More good constructional articles in this issue, if you are working on an interesting project please look at the article request on page 215.

Unfortunately the cost of producing and distributing VHF Communications has risen over the past year therefore the subscription price for 2003 will go up slightly. I have tried to keep the increase as small as possible, it will increase by just 60 pence for a year's subscription. I hope that you will all subscribe again next year and encourage your colleges to subscribe as well.

73s - Andy

K M Publications, 63 Ringwood Road Luton, Beds, LU2 7BG, UK

Telephone / Fax +44 (0)1582 581051, email : andy@vhfcomm.co.uk

web : http://www.vhfcomm.co.uk

Gunthard Kraus, DG8GB

Determination Of Received Field Strengths In Uhf Range

The signal strengths of specific transmitters can be determined with a relatively small amount of measurement. In order to go from the signal strength to the field strength at a specific reception location, additional calculation work is needed.

A suitable set of measuring instruments is described below, together with the necessary conversion calculation and the evaluation of the results.

1. Foreword

Which of us has not sometimes wanted to know the precise field strengths of specific stations at our own reception location, identified only in bare outline by the allocation of S units? Or who would like to verify the correctness of diagrams and formulae concerning the propagation of electro-magnetic waves, or convert back from the measured field strengths to the transmitting power?

And now there is another brand new and very topical phenomenon. Thanks to the increase in the number of base stations in cellular networks (D1, D2, Eplus, VIAG, etc.) and the resulting increase in the number of antenna locations, disquiet is increasing in the population with regard to possible health risks. So it makes excellent sense (as well as being a delightful prospect) to determine such field strengths and compare them with the currently valid maximum values.

To this end, this article describes a simple procedure which requires only a calibrated spectrum analyser for the frequency range in question, which many amateurs have already acquired by now. With a suitable measurement antenna (costing from 50 to 100 Euros), we have assembled the complete measurement station the rest is calculation.

2. Measuring Instruments And Measurement Procedure

The measurement antenna used is a Discone broadband antenna (model SD 3000 U/N from SIRIOantenna) for the frequency range from 300MHz to 3,000MHz, which is marketed in Germany through UKW Berichte. Fig. 1 is intended to convey an impression of what this type of antenna looks like and how it is connected. The output section of this antenna passes through the short lower section of vertical tubing, and is linked to the spectrum analyser through

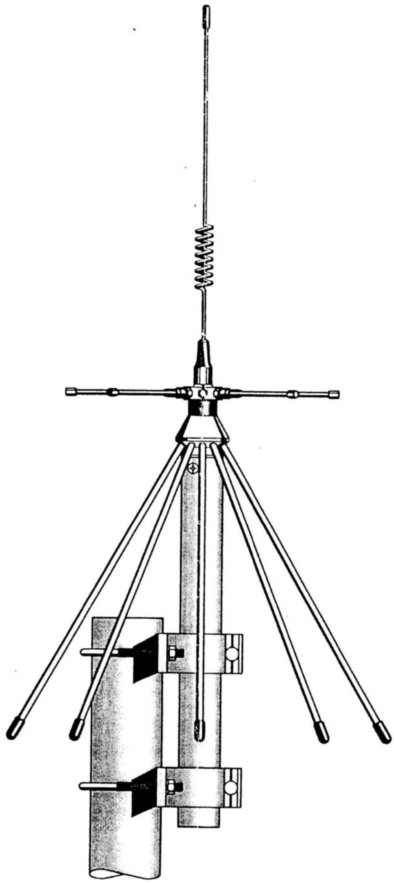


Fig. 1: This is what a broadband Discone antenna looks like. The antenna cable is fed from below through the short piece of tubing and connected to an N type socket.

an N-plug and an RG 214 cable approximately 1m long.

The electrical data for the antenna are:

- Antenna gain for the specified frequency range approximately 2.2dBi
- Characteristic Impedance: 50Ω, asymmetrical (N plug and socket connection)
- VSWR in specified frequency range see Figs. 2 and 3

The spectrum analyser is a widely obtainable HP1411 basic unit, with an 8555A insert from Hewlett Packard for the frequency range from 10MHz to 18GHz. The input impedance is 50Ω. Signal levels ranging from + 40dBm to less than 100dBm can be measured using the built-in reversible pre-divider.

Once the equipment has been assembled and warmed up, the analyser must first be calibrated, so that the output picked up from the antenna and passed on to the analyser can be determined as precisely as possible. Then the antenna and the analyser are connected, the target station is fixed in the middle of the screen, and the value is read off and noted. And thats all the rest is described more precisely in the following section.

3.

Calculation Of Field Strength From Measured Power

The field strength can be determined by calculations based on the power value determined with the spectrum analyser. The principle applied is as follows:

- Determine effective area of antenna

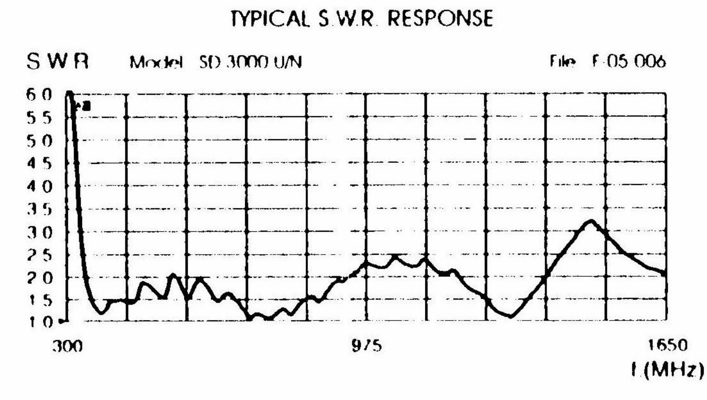


Fig. 2: **SWR response of antenna in frequency range 300 to 1,650MHz.**

- Calculate power per unit area at reception location
- Convert power per unit area into electrical and magnetic field strength

Derivation of procedure:

The effective power picked up by the measurement antenna and passed on (with correct matching) to the measurement receiver can be expressed as follows:

$$P_E = S \cdot F_E \qquad (1)$$

where:

S is the power per unit area in Watts per m^2

FE is the effective area of the antenna

The gain specification for the measurement antenna used refers to the isotropic radiator (which does not experience any directivity). A specific frequency applies to its effective area:

$$F_{isotrop} = \frac{\lambda^2}{4\pi} \qquad (2)$$

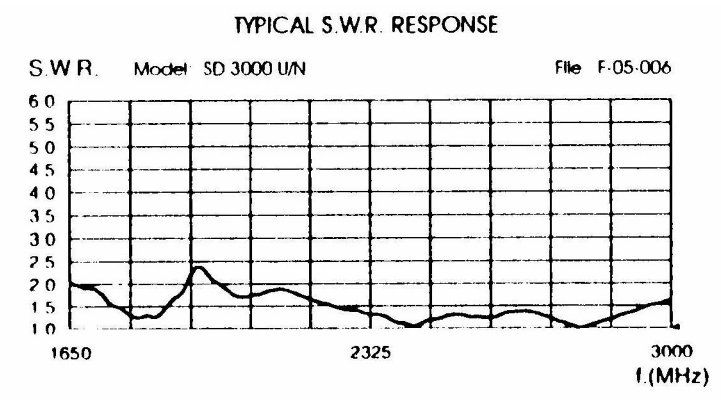


Fig. 3: SWR response of antenna in frequency range 1,650 to 3,000MHz

where:

λ is the wavelength corresponding to the operating frequency

According to the data sheet, the antenna gain for the measurement antenna is approximately 2.2dBi. The effective area is therefore larger, by a factor of:

$$10^{\frac{22}{10}} = 1.66 \quad (3)$$

than that of the isotropic radiator, and thus equals:

$$F_{Measured} = 1.66 \cdot \frac{\lambda^2}{4\pi} \quad (4)$$

Thus the evaluation is carried out as follows:

Step 1:

The valid effective area of the antenna is calculated for the reception frequency using the above formula.

Step 2:

Then the level, measured in dBm, is converted into power, using the following relationship:

$$P = 10^{\frac{measured}{10}} mW \quad (5)$$

Step 3:

This power should be divided by the valid effective area to obtain the target value, the power per unit area, S.

Step 4:

The power per unit area, S, is the Poynting vector, which points in the propagation direction of the wave and to which the electrical and magnetic field strengths are vertical. The E-field and H-field vectors are in phase in the Fraunhofer region (in relation to space and time), but they themselves are again vertically on top of each other. The equation generally valid for this relationship is:

$$\bar{S} = \frac{1}{2}\left(\bar{E} \times \bar{H}\right) \quad (6)$$

and if it is assumed that the antenna is optimally orientated and that we are actually in the genuine Fraunhofer region (which for some wavelengths is certainly the case):

$$S = \frac{1}{2} E \cdot H \quad (7)$$

E and H are linked with one another in the Fraunhofer region and in free space through the field resistance of free space in accordance with the following relationship:

$$\frac{E}{H} = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 120\pi\Omega \quad (8)$$

which gives a resistance of approximately 377Ω.

So now it is not difficult to convert the above formula for S to either E or H:

We then obtain for S:

$$S = \frac{1}{2} E\left(\frac{E}{120\pi\Omega}\right) = \frac{E^2}{240\pi\Omega} \quad (9)$$

Thus the electrical field strength E is found to be:

$$E = \sqrt{S \cdot 240\pi\Omega} \quad (10)$$

in Volts per metre, if S is inserted in Watts per m^2

Likewise, the formula for the magnetic field strength, H, is:

$$S = \frac{1}{2} H \cdot (120\pi\Omega \cdot H) = 60\pi\Omega \cdot H^2 \quad (11)$$

from which we obtain

$$H = \sqrt{\frac{S}{60\pi\Omega}} \quad (12)$$

in amperes per metre, if S is expressed in Watts per m^2

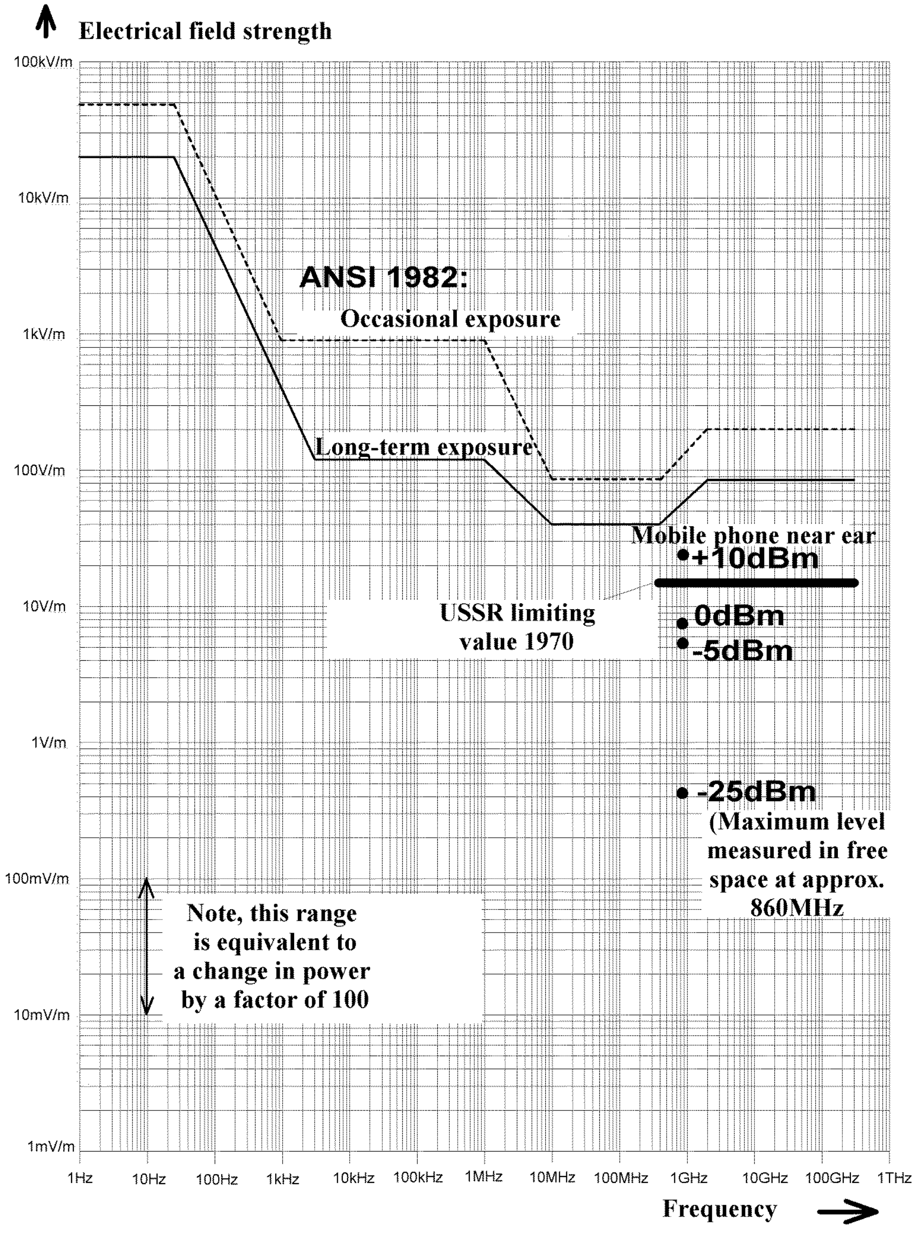


Fig. 4: Permissible electrical field strengths in the Western world. The values shown are the maximum, mean and minimum field strength values observed for the mobile telephone next to ear case at a measurement frequency of 950MHz

Level dBm	Power mW	S W/m²	S nW/m²	E V/m	H A/m
-25	0.00316	0.00024	24	0.425	0.0011
-5	0.316	0.024	2400	4.25	0.011
0	1	0.076	7600	7.57	0.02
+10	10	0.76	76000	24	0.063

Table 1: Measured levels, calculated power, power per unit area and field strengths for the GSM 900 example.

4.

Practical Example Of Measurement

Just for curiosity, and because this subject is creating quite a stir at the moment, we investigated the 900MHz frequency range of the GSM mobile telephone (at 950MHz) in greater detail, as a test case for the method presented.

Several newly installed base stations could be seen at the measurement location in the near and far distance, even with the naked eye. It was therefore to be expected that something would show up on the analyser screen. Thus several carriers could indeed be observed at once, the strongest of which briefly attained a maximum level of 25dBm.

Several such units were then moved one after another to a distance of less than 10cm. from the measurement antenna in order to simulate the circumstances in the head of a mobile phone user and the levels arising during telephoning were observed.

Here it became clear that the older versions, with an external stub antenna were considerably more dangerous for the user, since these types of antenna have a panaromic characteristic and thus give off equal amounts of radiation in all directions in the horizontal plane.

By contrast, the modern appliances with integrated stripline antennas on the circuit board weaken the level in the direction of the head by up to 15dB!

The outputs measured were mostly around 5 to 0dBm, but also attained peak values of between + 5 and 10dBm, depending on the pulsed mode in which these appliances are operating.

Evaluation:

Step 1:

For a measurement frequency of 950MHz, the value for the wavelength is:

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8 m \cdot \sec}{\sec \cdot 950 \cdot 10^6} = 0.315m = 31.5cm$$

From this, we can calculate the effective area of the antenna in accordance with the above formula (4) as:

$$F_{Measured} = 1.66 \cdot \frac{(31.5cm)^2}{4\pi} = 131cm^2$$

Step 2:

Now the levels measured are converted into a power reading, using formula (5), and then the power per unit area associated with the effective area of 131cm² is determined, and finally the field strengths using formulae (10) and (12) and a pocket calculator.

All the data for this application have been entered in Table 1. Here the power per unit area was expressed, not only in W/m², but also in an additional column, in the units most used in modern discussions (concerning the biological effects of electro-magnetic fields) *nanowatts per square centimetre*.

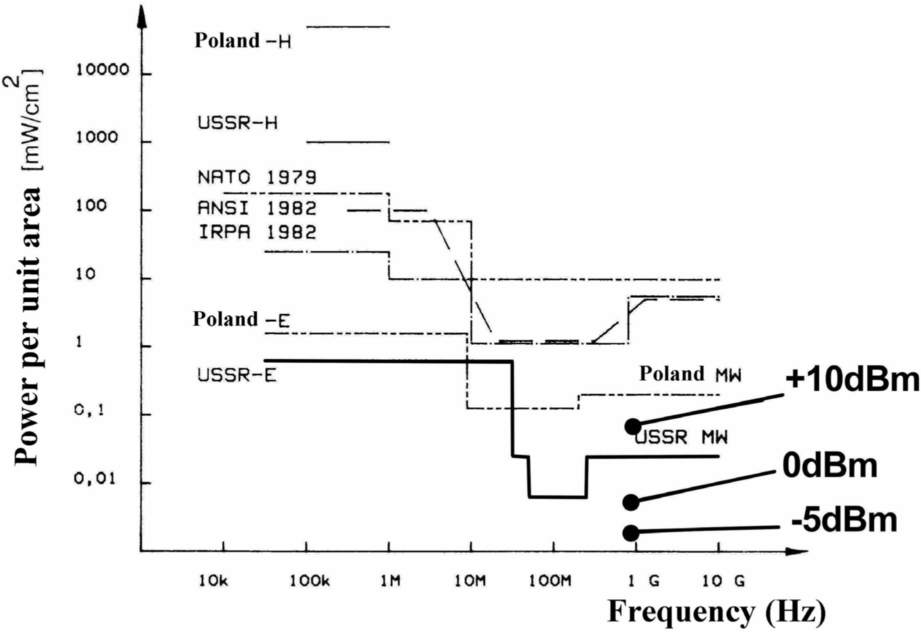


Fig. 5: The field strengths observed for mobile telephone next to ear, but this time in comparison to the limiting values for the former USSR and/or Poland.

5. Evaluation Of Measurement Results

We now faced up to the importance of the danger posed by such signal amplitudes for people. In this context, the diagram showing the limiting values currently valid in the Western world was downloaded from the Internet [3] and the observed short term maximum power (near field of mobile telephone) was recorded, with an electrical field strength of + 10dBm.

As can be seen, the values obtained are clearly below the dangerous limits all the more so if we try to fit the base station level of 25dBm measured in the open air into this diagram (Fig. 4).

Yet we should not omit to mention that

- There is massive agitation going on nowadays for considerably lower limiting values to be set, and
- Even more than 30 years ago, the former USSR introduced the lowest absolute maximum values in the world

Fig. 5 provides an opportunity for a direct comparison and for reflection. It shows the first three values from the table (source of diagram: [4]).

An interesting point in this context, if we observe several carriers close to each other with comparable power levels in the frequency band under investigation, then we obtain the total effect on an organism, the individual readings are first converted into power levels and then the total stress is determined via addition of these individual values. This is permissible, since these signals are not correlated.

6.

Practical Measurement In GSM 1800 Range

The circumstances in the national grid range were now investigated for comparison purposes.

A maximum level of 55dBm was obtained there, which naturally required a further treatment.

If the frequency is doubled, the wavelength in fact is halved, and thus - because of the quadratic relationship between the wavelength and the effective area the effective area falls to a quarter of the value of 131cm^2 used in the previous section.

This causes the power per unit area for the same power reading to rise to four times the previous level!

Yet even if this state of affairs is taken into account, the value for the existing power per unit area is in any case still a very long way below all risk limits.

7.

Possible Errors In The Measurement Procedure Used

Every measurement procedure and every set of measuring instruments is used on the assumption of ideal conditions. Applying the measurements to the real life is concerned with possible inaccuracies or sources of error.

- The specified antenna gain of 2.2dB was assumed to be constant for the entire frequency range. Should variations occur the level of the changes is known and the right correction can be undertaken for the selected measurement frequency.
- The power matching must be as correct as possible everywhere (the reflection factor r and/or the VSWR may not exceed a specific maximum value over the entire frequency range). Should this condition not be fulfilled, then the power reading and the power per unit area calculated from it will be too low.

The diagrams shown in Fig. 2 are valid for the measurement antenna used at 950MHz:

VSWR approximately 2.2

If the following formula is applied to this, a reflection factor is calculated of:

$$|r| = \frac{VSWR-1}{VSWR+1} = \frac{2.2-1}{2.2+1} = 0.375 = 37.5\%$$

The lower reading (in dB) brought about by this mismatching then amounts to:

$$\Delta a = 10 \cdot \log \frac{1}{1-|r|^2}$$

$$\Delta a = 10 \cdot \log \frac{1}{1-|0.375|^2} = 0.66dB$$

- With longer feeds to the antenna, the attenuation of the measurement cables used becomes noticeable. At the frequency f = 950MHz, this value should still lie below 20dB per 100m.

However, a cable length of 2m between the antenna and the measurement receiver causes an additional attenuation (and thus a reduction in the calculated power per unit area) of approximately 0.4dB.

- The natural frequency response of the spectrum analyser has a direct influence on the power reading and the power per unit area derived from it, and must therefore be taken into account. In the measurement range from 0 to 2GHz, it goes up to a maximum of 1dB as the frequency rises, and likewise leads to a lower reading.
- Measurements must be carried out in the Fraunhofer region of the radiator. Moreover, no echos from any buildings or objects may influence the result thus, we are dealing only with free field measurements.

To sum up, it can be said that the reading displayed and utilised for the calculations should be increased by approximately 2dB in order to balance out most of the errors occurring.

8.

Literature Used

[1] Edmund Stirner Antennas Vol. 1: Basic Principles Hüthig Verlag ISBN 3-7785-0962-4

[2] John D.Kraus Antennas McGrawhill International Editors ISBN 0-07-100482-3

[3] Homepage of Munich Technical University Link: http://www.hfs.ei.tum.cie

[4] Käs / Pauli Microwave Engineering Franzis-Verlag 1991 ISBN 3-/7723-5594 -3 Chapter 3: Biological Effects of Microwaves

9.

Reference Sources

SD 3000 Broadband Round Omnidirectional Antennas, Technical Association for Radio Accessories,

UKW Berichte

Baiersdorf

Tel. 09133-77980

Fax 09133-779833

Winfried Bakalski DL5MGY

Baluns for microwave applications - part 2

Continuation

To determine the track widths of a microstrip-based LC balun [9], it is best to use the “Transmission Lines” tool from Serenade, or something similar such as, for example, Appcad [S2]. Here we obtain a width of approximately 1.15mm. for a 50Ω line.

4.1. Dimensioning of an ideal LC balun in accordance with Section 2:

For the load R_L = 50Ω and a differential input impedance of R_1 = 28Ω, we obtain a characteristic impedance of

$$Z_C = \sqrt{R_1 \cdot R_L} = 37.4\Omega$$

Thus with f = 2.45GHz, we can use the formulae (1) to get the values for C = 1.73pF and L = 2.43nH. Fig. 6 shows the Serenade circuit diagram for the first simulation run and Fig. 7 shows the result, which reproduces a differential feeding of the balun with two ideal transformers (S_{33}). To ensure that this differential impedance does not arise due to complete asymmetry of the two connections, the two connections for the differential input must be individually inspected for two-port balance. With a symmetrical resistance of 28Ω, this gives the termination through 2 x 14Ω (port 1 (S_{11}) and port 2 (S_{22})). We can already recognise the phase displacement by 90° of connections 1 and 2 on the Smith chart (Fig. 7) whilst perfect matching is obtained differentially (port 3).

4.2. Substitution of concentrated structural elements:

First the substrate wavelength is determined for the simulation:

$$\lambda_{op} = \frac{1}{f_{op} \cdot \sqrt{\varepsilon_{reff} \cdot \varepsilon_0 \cdot \mu_0}}$$

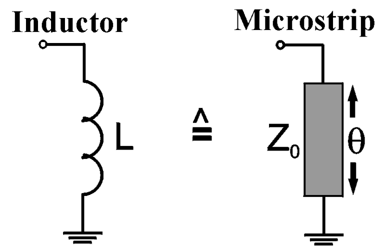
where

f_{op} is the operating frequency and

$\varepsilon_{r,eff}$ the effective permittivity.

An estimation with $\varepsilon_{r,eff} \cong \varepsilon_r$ as start parameter is completely adequate for the following simulation, but the calculated lengths will all depart somewhat from the physical lengths.

Substitution of L1 [1]:



$$\omega_{L1} = Z_0 \cdot \tan\theta \qquad \theta < 90^o \left(90^o \; \frac{\lambda_{op}}{4} \right)$$

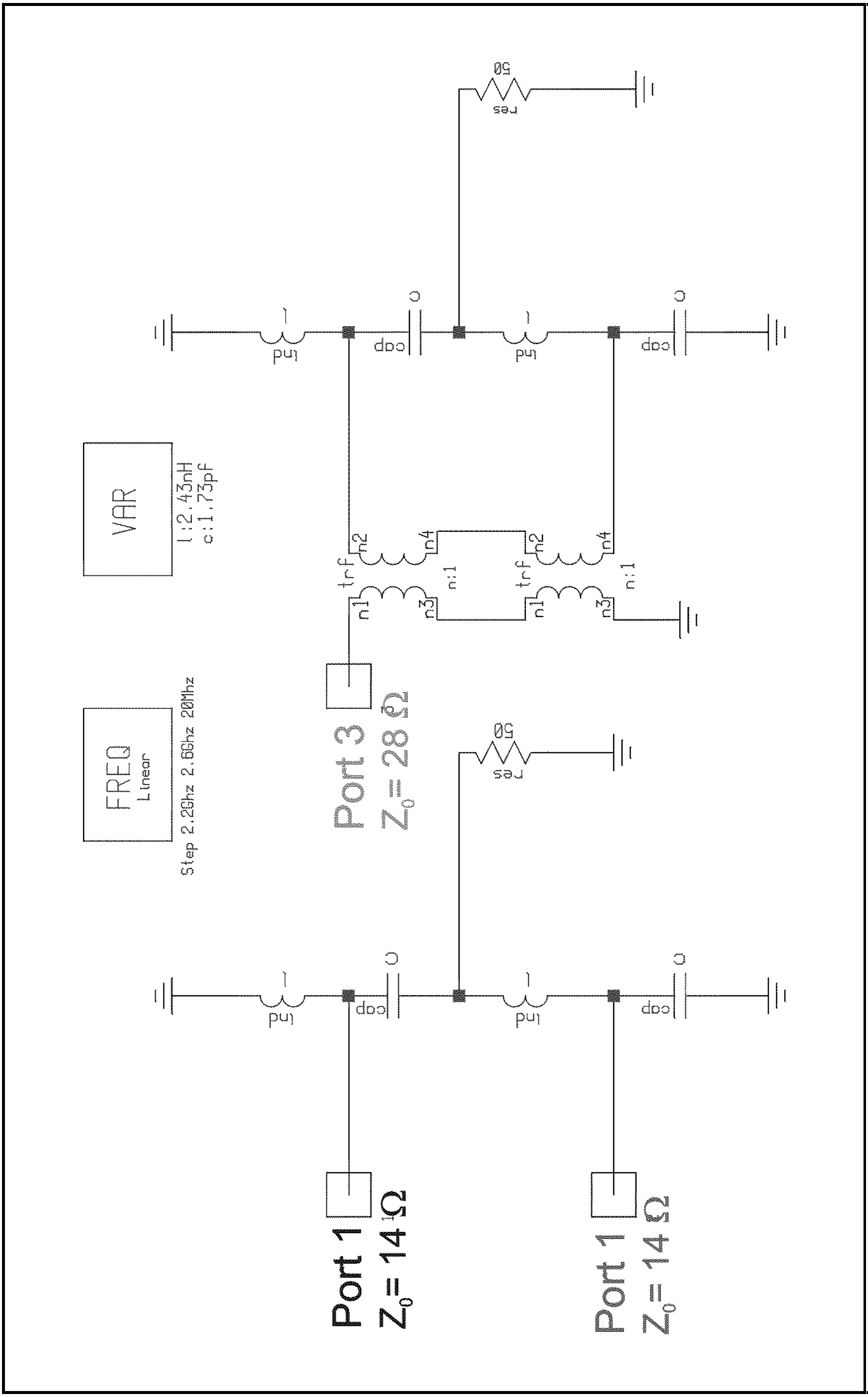


Fig 6 : Circuit diagram from Ansoft for the ideal LC balun.

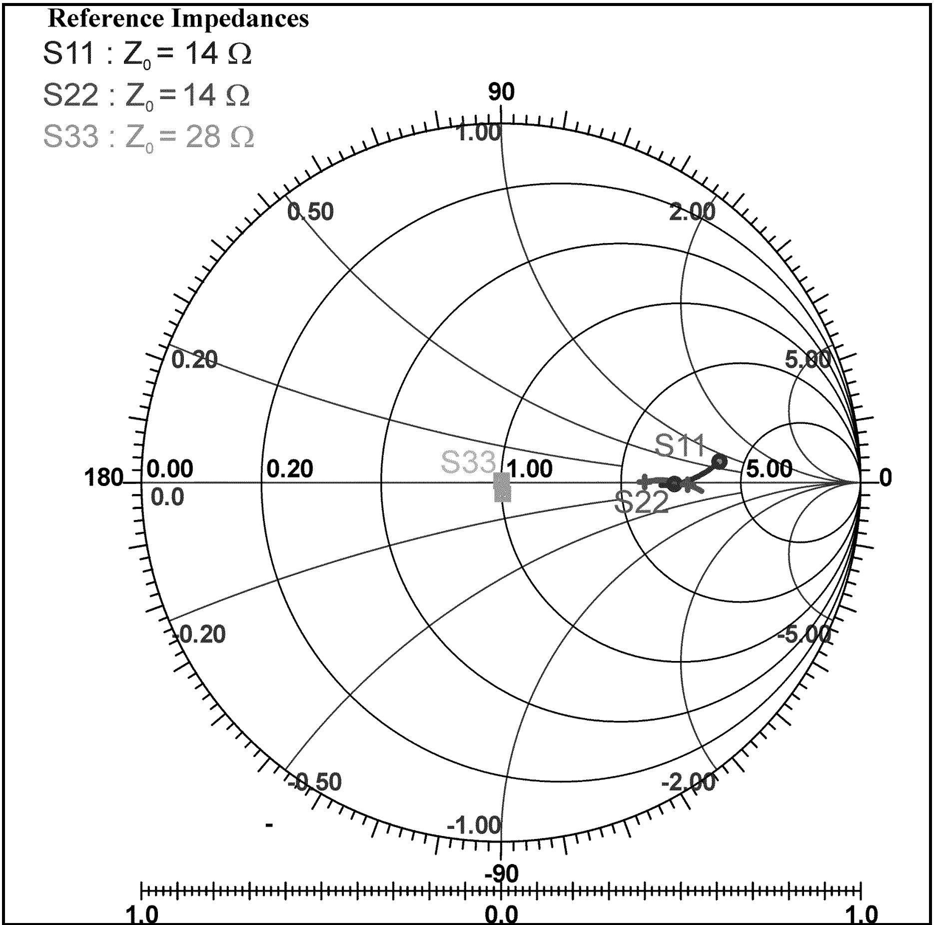


Fig. 7: Impedances of LC balun: S_{11} and S_{22} represent the impedance of a connection to earth in each case. Note the 90° phase displacements of S_{11} and S_{22}.

If we select Z_0 = 38Ω for this, we obtain for

$$\tan\theta = \frac{2\pi \cdot 2.45GHz \cdot 2.43nH}{38\Omega} \approx 1$$

With the relationship tan (45°) = 1, we obtain the length of the microstrip, since correspondingly.

$$\frac{\lambda_{op}}{8} = 45^o$$

The length is calculated using λ_{op} = 67mm at

$$L_1 = \frac{67mm}{8} \approx 8.3mm$$

as the start parameter for the following simulation.

Substitution of C1 [1]:

The substitution of the series capacitance is not possible unless a λ/4 phasing line is used. Since a line of this kind of length would lead to a severe limitation of the

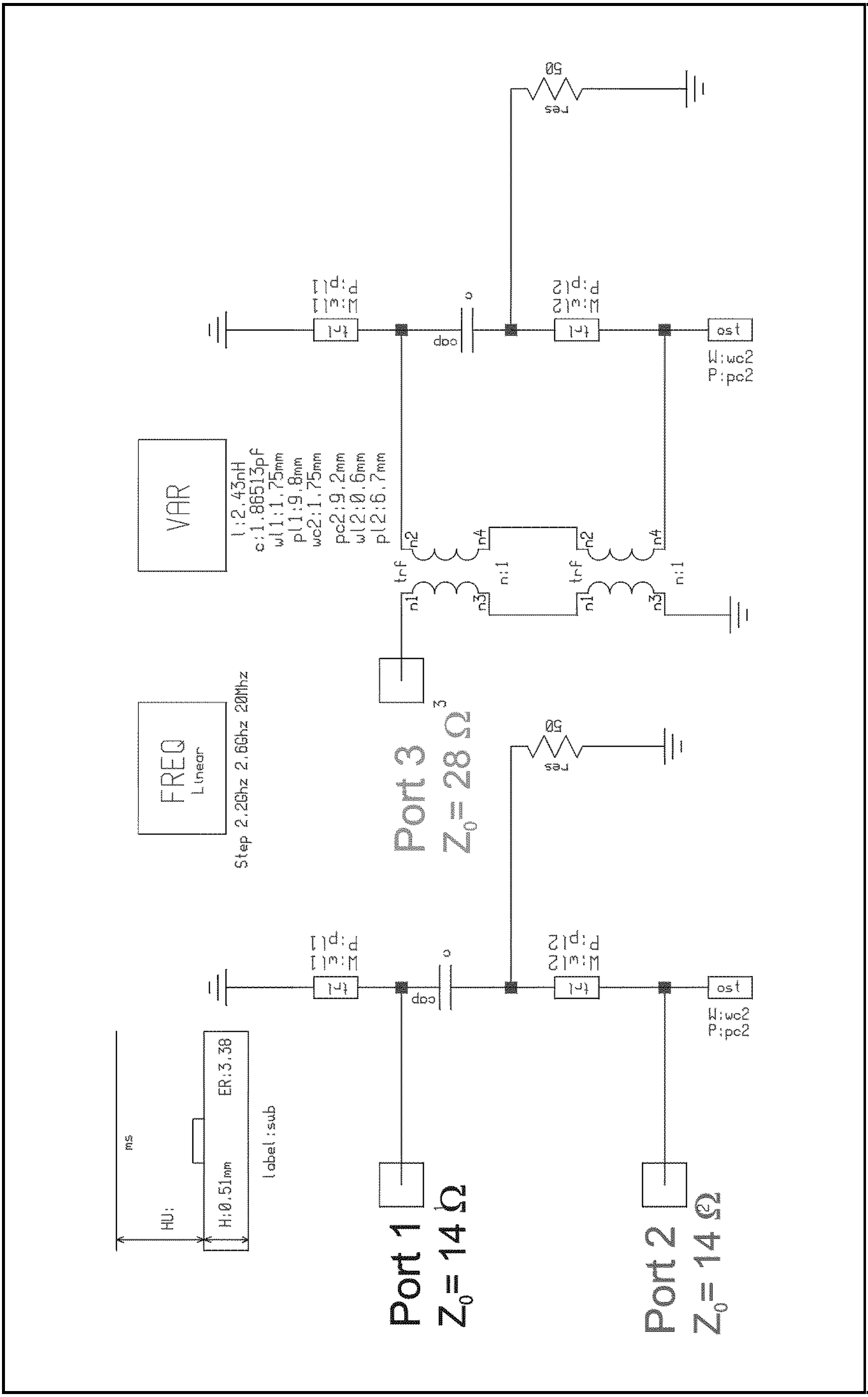


Fig 8 : Circuit diagram from Ansoft Seranade with substituted elements.

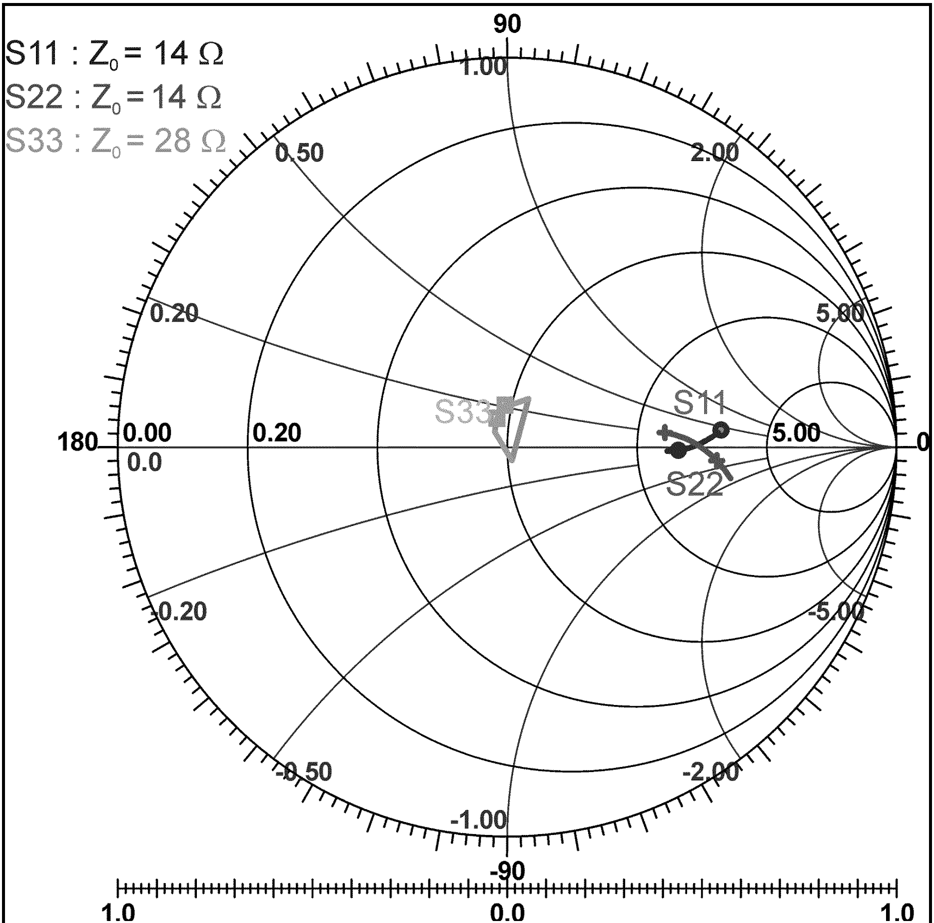
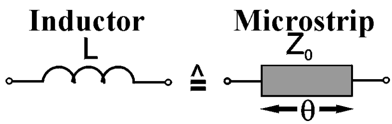


Fig. 9: Simulation result following substitution.

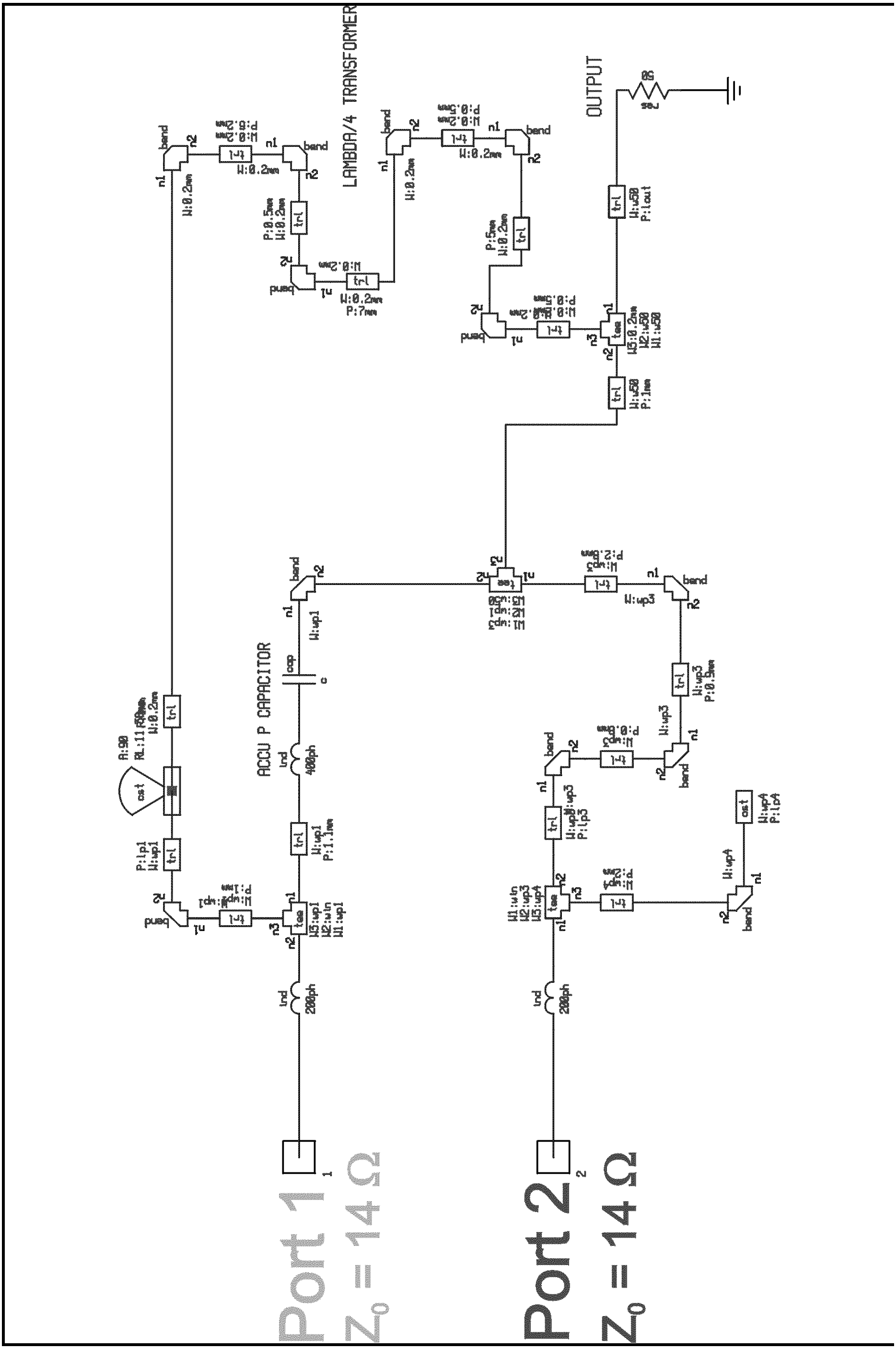
operating bandwidth of the balun, this capacitance is retained as a separate structural element. In the course of the simulation, it will become clear that the feed inductances (tracks) lead to a reduction in the capacitance initially calculated. The reason for this lies in the phase displacement by the connection lines and inductances (e.g. caused by bond inductances in chip capacitors, but also by the inductive element of the capacitor itself).

Substitution of L2 [1]:



$$\omega_{L2} = Z_0 \cdot \sin\theta \qquad \theta < 90^o \left(90^o = \frac{\lambda_{op}}{4} \right)$$

The inductance obtained from the LC balun corresponds to that from L_1. Since for this application the stripline length is limited by the layout, we must select a


LAMBDA/4 TRANSFORMER
OUTPUT
ACCU P CAPACITOR
Port 1
Z0 = 14 Ω
Port 2
Z0 = 14 Ω

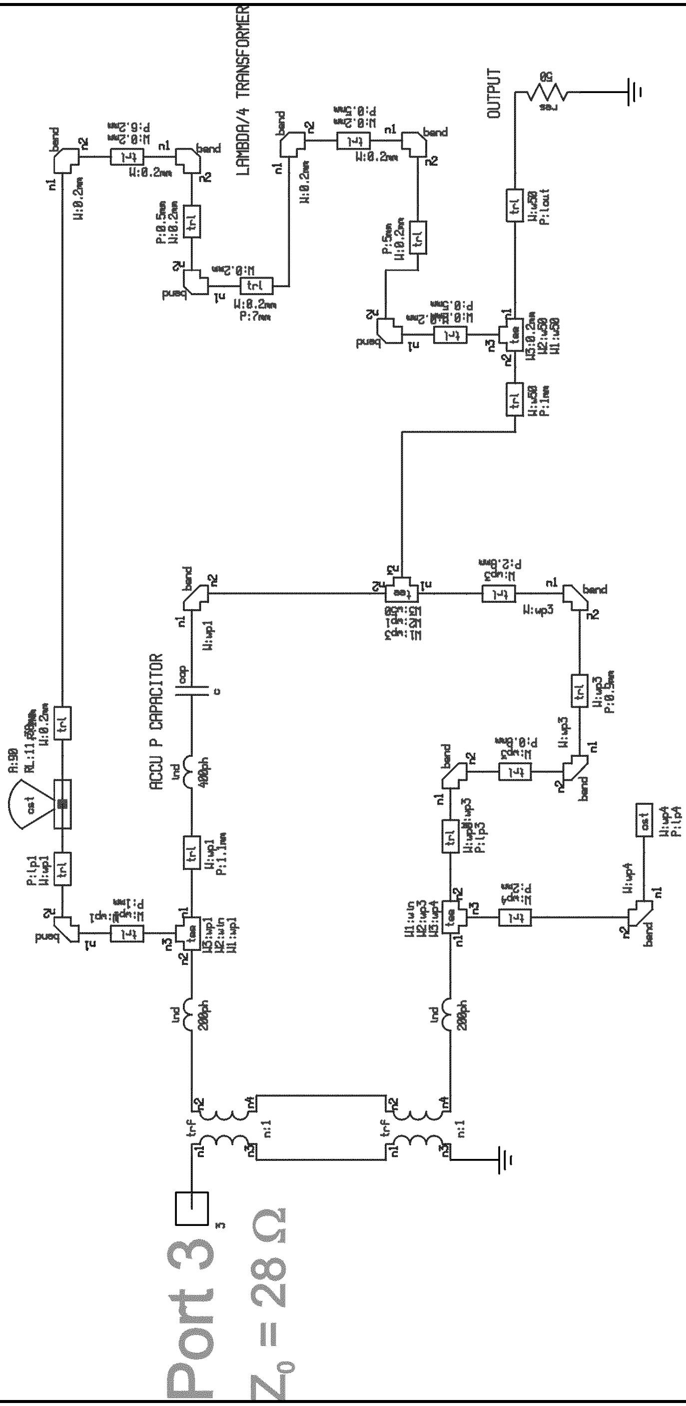


Fig 10 : Overall circuit diagram of balun.

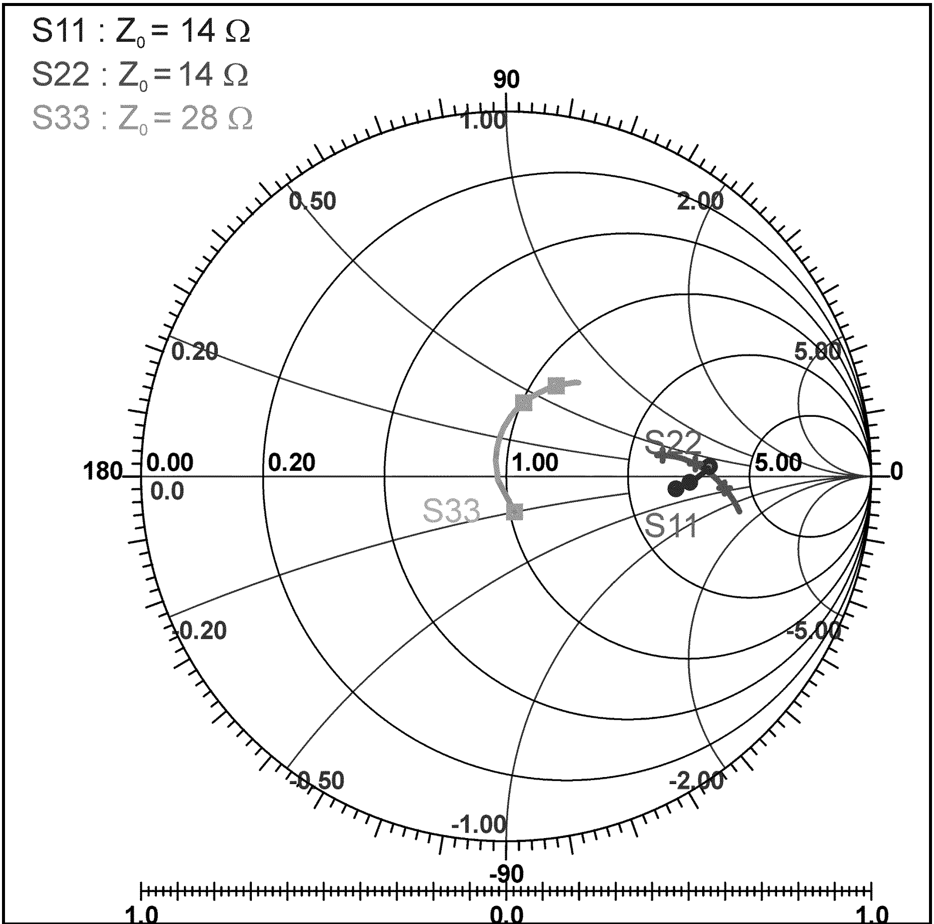


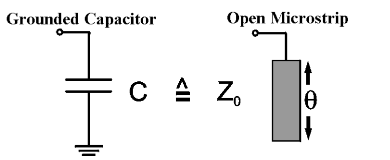
Fig 10 : Balun simulation results.

higher value for Z_0 here, which is expressed in terms of a thinner stripline. If, for example, an impedance is selected of $Z_0 = 72\Omega$ (corresponds here to a width of 0.6mm.), then using the above expression we obtain:

$$\sin\theta = \frac{2\pi \cdot 2.45GHz \cdot 2.43nH}{72\Omega} \approx 0.5$$

and using arcsin (0.5) = 30°, this gives us a microstrip length of approximately 5.6mm.

Substitution of C2 [1]:



$$\omega C_2 = \frac{\tan\theta}{Z_0} \qquad \theta < 90^o \left(90^o \frac{\lambda_{op}}{4} \right)$$

The substitution of the capacitance, C_2, can be very simply accomplished by using an open microstrip. If, as in L_1, we

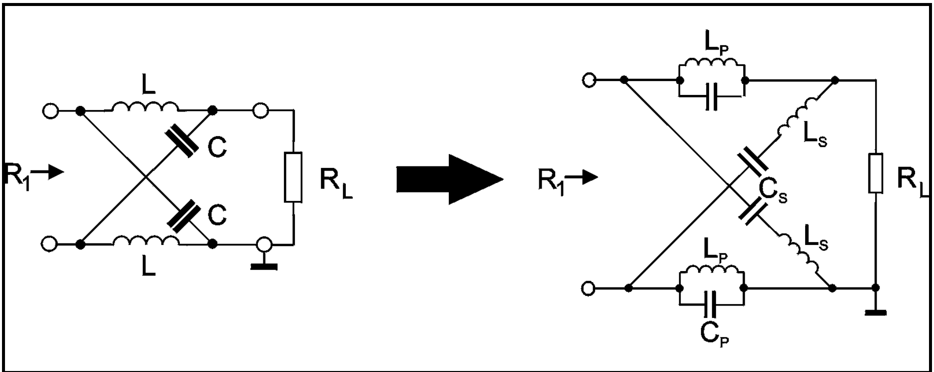


Fig 12 : LC balun bridge with common impedances.

select an impedance, Z_0 = 38Ω, then we obtain

$$\tan\theta = 2\pi \cdot 2.45GHz \cdot 1.73pF \cdot 38\Omega \approx 1$$

and this gives a length of 8.3mm. as the start parameter.

4.3. Optimising of substituted elements

Since the calculated values due to the use of $\varepsilon_{r,eff} = \varepsilon_r$ represent only start parameters ($\varepsilon_{r,eff}$ is actually dependent on both the track width and the frequency), the LC balun must be further optimised. However, this step need not be carried out so intensively, since some further displacement can be brought about through the use of the T-pieces. Ansoft Serenade can calculate a Smith chart which is identical to that of the LC balun (Figs. 8 and 9).

4.4. Insertion of T-pieces and matching of layout to geometrical requirements

We should proceed by stages here, and incorporate and simulate one T-piece after another into the circuit diagram. The incorporation of such T-pieces has a very strong influence on the behaviour of the bridge (alteration of microstrip lengths) and because of the large number of variables it becomes even more difficult to optimise the situation. Fig. 10 shows the resulting overall circuit diagram, with a DC feed for the high-level stage transistors of the power amplifier. Fig. 11 shows the final results of the matching circuit.

4.5. The dual-band LC balun [9]

It would often be an advantage if the Balun could be used for any two different frequency ranges simultaneously (e.g. for 2m and 70cm band applications). This is in fact possible if a parallel resonant circuit is used instead of the inductance, L, and a series resonant circuit instead of the capacitance, C (Fig. 12).

The bridge now exhibits interesting frequency dependent behaviour, as can be seen from Fig. 13.

For frequencies which are lower than the frequency of resonance of the resonant circuit, this balun behaves like a standard LC balun. If the frequency is increased, then the roles of the capacitance and the inductance are reversed. If the bridge is re-designed to become a push-pull power amplifier for the application, then we obtain the circuit diagram shown in Fig. 14. This already contains the power supply feed. For frequencies exceeding 2GHz, the use of radial stubs is recommended, in addition to capacitors with high nominal values.

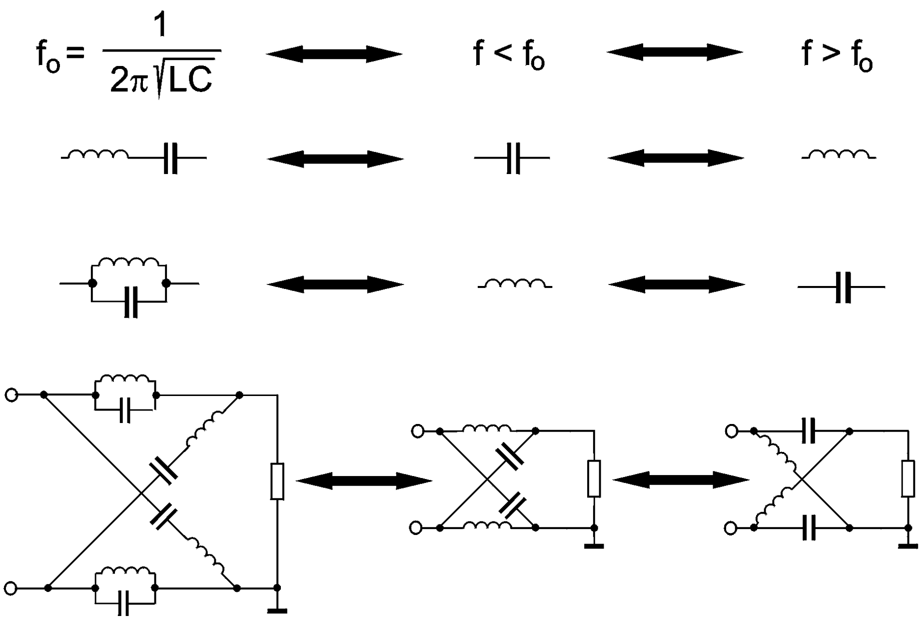


Fig 13 : Behaviour of LC balun with frequency.

For the calculations of the dual-band balun, the following procedures can be specified:

1. First all impedances and the operating frequencies are established. The circuit frequencies are calculated, using the formulae

$$\omega_1 = 2\pi f_1 \quad \text{and} \quad \omega_2 = 2\pi f_2 \quad (\omega_2 > \omega_1)$$

The characteristic impedances of the bridge circuit can be calculated using

$$Z_{C1} = \sqrt{R_1 \cdot R_L} \quad \text{and} \quad Z_{C2} = \sqrt{R_2 \cdot R_L}$$

This makes it clear that even frequency-dependent load impedances can be brought into play for the calculations.

2. For L_s, L_p and C_s, C_p, the following expressions are

$$L_S = \frac{\omega_1 \cdot Z_{C1} + \omega_2 \cdot Z_{C2}}{\omega_2^2 - \omega_1^2}$$

$$L_p = \frac{Z_{C1} \cdot Z_{C2} \cdot \left(\frac{\omega_2}{\omega_1} - \frac{\omega_1}{\omega_2}\right)}{\omega_1 \cdot Z_{C1} \cdot \omega_2 \cdot Z_{C2}}$$

$$C_S = \frac{\frac{\omega_2}{\omega_1} - \frac{\omega_1}{\omega_2}}{\omega_1 \cdot Z_{C2} \cdot \omega_2 \cdot Z_{C1}}$$

$$C_p = \frac{\omega_1 \cdot Z_{C2} \cdot \omega_2 \cdot Z_{C1}}{Z_{C1} \cdot Z_{C2} \cdot \left(\omega_2^2 - \omega_1^2\right)}$$

It is again very important to note that these expressions are valid only for ideal structural elements. i.e., for a real layout both the feed sections and the parasitic elements of the structural components have to be taken into account. In real structures, this will mean the resonant circuits have to be "stretched" in their frequencies of resonance.

Thus the use of S-parameter files is just

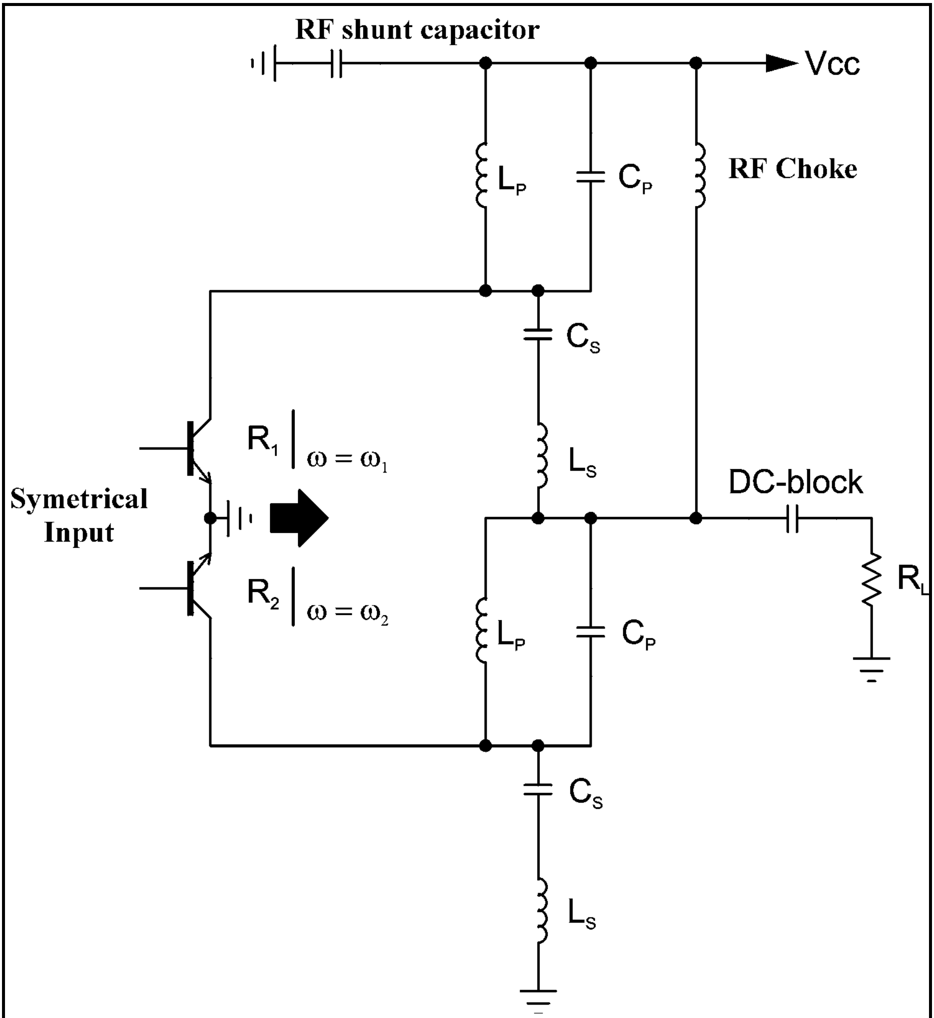


Fig 14 : Dual band LC balun.

as important in the simulation as the precise entering of the layout into the corresponding simulator. Stage by stage insertion of line sections and T-pieces is recommended, as is already done with LC-baluns based on microstrips.

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6.

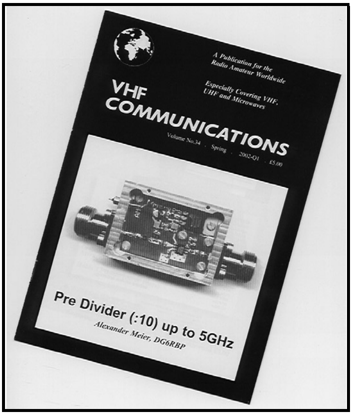
Software On The Internet:

[S1] Ansoft Serenade 8.5: A restricted student version is available http://www.ansoft.com

[S2] Appcad 2.0: This is a freely available tool for all possible calculaitons involving electrical engineering and metrology http://www.agilent.com/

[S3] Eagleware Genesys: Not to be confused with the Eagle CAD program from Cadsoft. You can also, from time to time, find a demo version of the Eagleware Genesys Suite on this page http://www.eagleware.com

WRITE IT YOURSELF...



VHF Communications is a mixture of technical articles, explanations of basic principles and DIY assembly instructions. The content for these articles are nearly all submitted by loyal readers of UKW Berichte, the German version of the magazine, with some articles from VHF Communications readers. The reasons that people write and submit articles are varied.

It has become clear recently that our readers would like to read more short articles on DIY assembly and application circuits, but we cannot do that without the help of our readers

You may have thought about getting something published on a current project. It doesn't matter if it is a DIY project such as an amplifier, a converter, a mixer or a measuring aid just have a go, it wont commit you to anything.

We will be happy to look through your draft and discuss the steps you would need to take before it becomes a published article. So come on, lets get the show on the road and give other readers the chance to find out about <u>your</u> project.

You can contact either VHF Communications or UKW Berichte

VHF Communications

Tel/Fax +44 1582 581051

Email: andy@vhfcomm.co.uk

UKW Berichte

Tel.: +49 9133-779811

Fax: +49 9133-779833

E-mail: ukwberichte@aol.com

73s

Andy Barter, G8ATD
(VHF Communications)

Eberhard L.Smolka, DB7UP
(UKW Berichte)

Wolfgang Schneider, DJ8ES

2-Tone Generator For 145Mhz

An RF amplifier stage is not only classified by amplification, which is as high as possible, and thus by its maximum output. What is frequently not taken into account, but is decisive for the signal quality, is the inter-modulation performance.

In practice, because of the gain characteristic, which is not completely linear, RF amplifiers are bound to produce distortion. A standard method for measuring this inter-modulation, e.g. in SSB amplifiers, is the 2-tone measurement. TV engineering uses a 3-tone measuring procedure!

1. General

In order to measure the inter-modulation behaviour of an amplifier stage, two signals of equal strength with frequencies f1 and f2 are applied to the input of this stage. The amplifier produces a spectrum of inter-modulation products from these signals. Particularly critical in practice are the third order (2f1-f2; 2f2-f1) and of the fifth order (3f1-2f2; 3f2-2f1).

Fig. 2 gives a graphical representation of the position of these inter-modulation products.

The objective, e.g. in SSB amplifiers, is to ensure that the third-order inter-modulation products are below 40dB in relation to the pure tone. Considerably tighter values apply to pre-stages and mixers. Should these quality criteria not be taken into account in design of an SSB transmitter, it leads to poor modulation quality and a broad signal. For receiver pre-stages, this lack of quality is clearly shown by the so-called "plug effect".

To be able to measure the inter-modulation products, the 2-tone generator must itself produce a high-quality signal.

The equipment described here completely fulfils this requirement (Fig. 3). The output level is +10dBm (10mW) for each pure tone.

The selection of this signal level represents a compromise between acceptable cost and versatility. Thus the 2-tone generator can be used in the same way for measurements on pre-amplifiers and transmitting amplifiers. Should a higher output level be required, then a suitable power amplifier can be used with the 2-tone generator for 145MHz. OM Carsten Vieland (DJ4GC) has already tackled this subject some years ago in [5].

The two frequencies, f1 = 144.850MHz and f2 = 145.150MHz, permit both the measurement of the third-order and fifth-

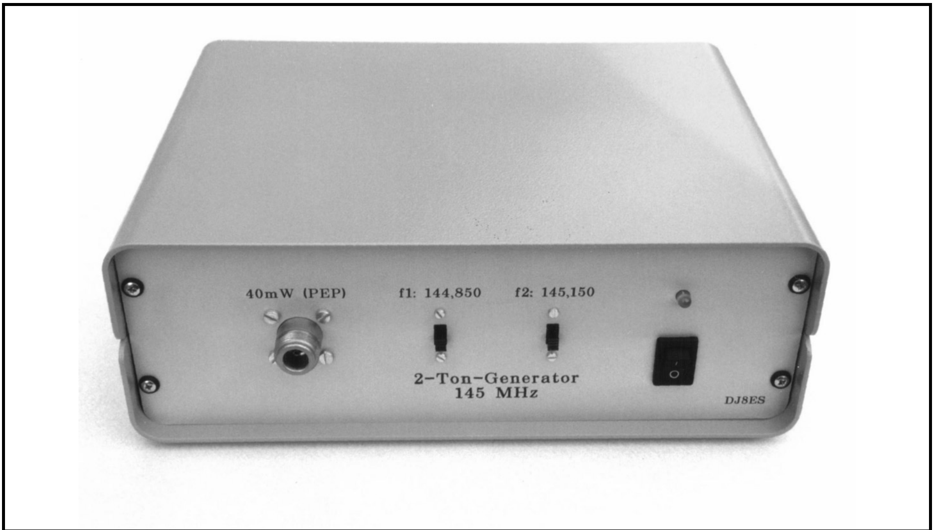


Fig. 1: 2-tone generator for the 2m band, ready for operation in a housing.

order inter-modulation products using a spectrum analyser and the use of receiver to measure levels. All frequencies of interest lie within the 2m band.

2. Circuit Description For Quartz Oscillator

The quartz oscillator using a U310 FET (T1) has a circuit which has been well-tried over the years. It has developed into a standard in the VHF range and beyond as an oscillator for microwave applications.

What is new here is the additional low-pass filter in the power supply. The voltage regulator noise is suppressed by an RC network, consisting of an R3/C19, after the 78L09 linear regulator (IC1).

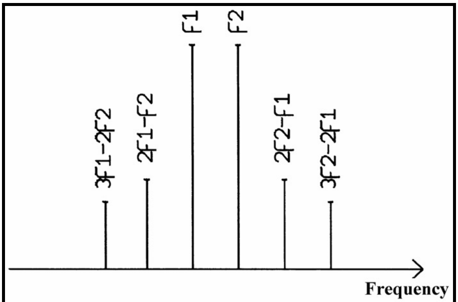


Fig. 2: Symbolic representation of a 2-tone signal with third-order and fifth-order inter-modulation products.

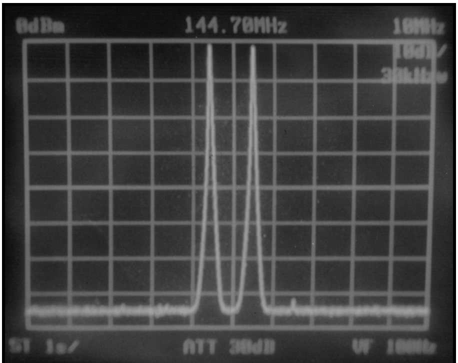


Fig. 3: A screen photo of the output spectrum allows us to recognise the high spectral purity of the 2-tone signal.

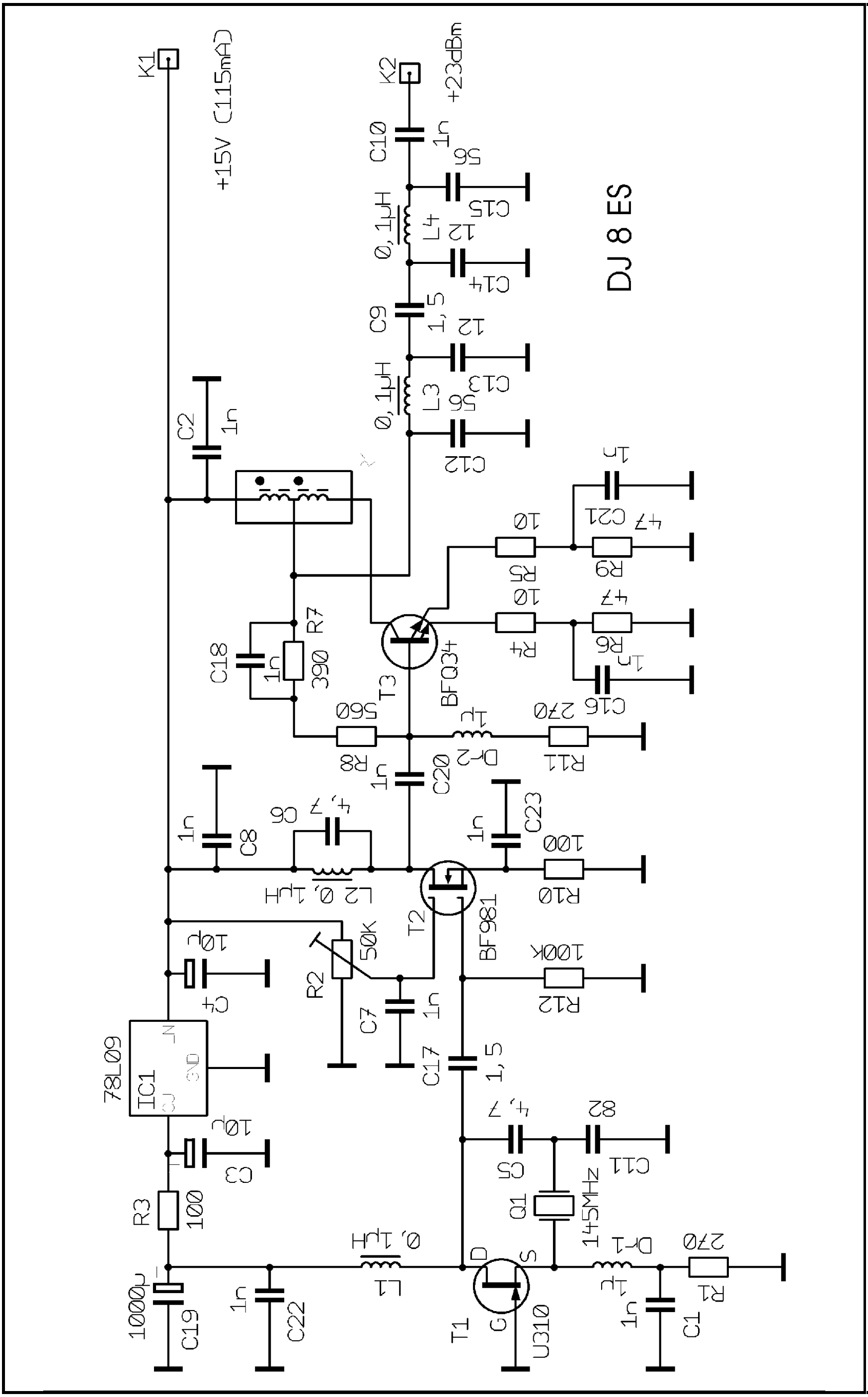


Fig 4 : Circuit diagram of 145MHz oscillator.

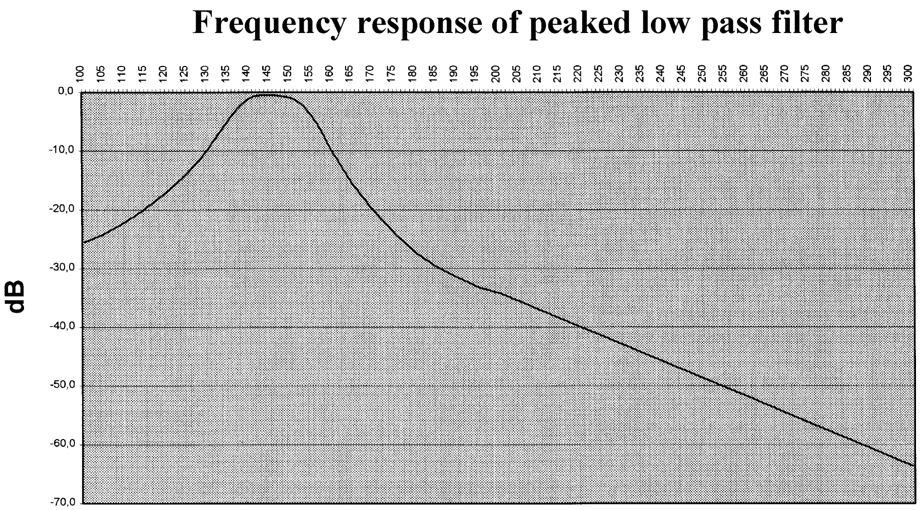


Fig 5 : Frequency response of the output filter in the oscillator (peaked low pass for 145MHz).

This has a direct influenced the quality of the quartz oscillator circuit.

The subsequent amplifier stage using a BF981 dual-gate MOSFET (T2), raises the oscillator signal to a maximum of +7dBm (5mW). The amplification of this stage can be adjusted over a wide range, using the 50kΩ trimmer.

The resonant circuit in the drain (L2/C6) is very broad in 50Ω technology, due to the high load presented by the following amplifier.

The final amplifier using a BFQ34 transistor (T3), increases the output to a maximum of +24dBm (250mW). The input and output impedance of the amplifier 50Ω. The current consumption for this stage is approximately 80mA (±15%), depending on the output, adjusted using the trimmer.

The low-pass filter at the output of the oscillator has a decisive influence on the spectral purity of the output signal at 145MHz. The insertion loss of the filter is approximately 1.3dB. The first harmonic at 290MHz is suppressed by more than 60dB. Fig. 5 shows the frequency response of the low-pass filter.

The output signal of the oscillator at 145MHz was investigated in greater detail by an Advantest R4131 spectrum analyser at an output of + 23dBm (200mW). No harmonic or spurious outputs were detectable with the measurement rig used. The level range which can be detected exceeded 80dBc.

2.1. Quartz oscillator parts list (for each individual oscillator assembly!)

T1	U310, transistor
T2	BF981, transistor
T3	BFQ34, transistor
IC1	78L09, voltage regulator
L1-L4	BV5061 Neosid 0.1µH ready-made coil
Q1	145MHz quartz, HC-18/U, series, 7th overtone (e.g. 144.850MHz and 145.150MHz for the 2nd oscillator)
TR1	Bifilar transformer, 2 x 7 turns

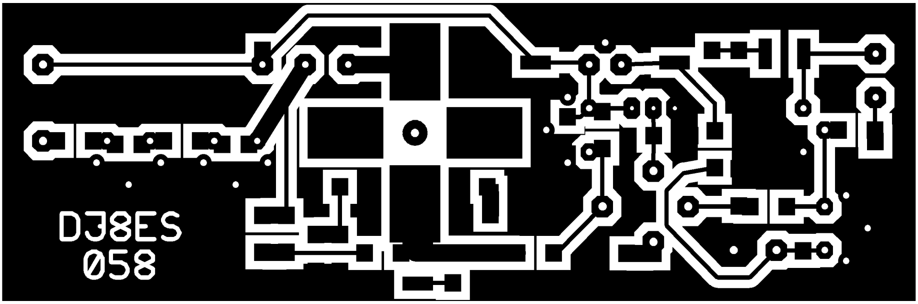


Fig 6 : PCB layout for 145MHz oscillator (not to scale).

	on ferrite core
R2	50kΩ spindle trimmer, 64 W model
C19	1,000µF electrolytic capacitor, 16V, radial
C3,C4	10µF electrolytic capacitor, SMD, 1812 model
Dr1,Dr2	1µH choke, SMD, 1812 model
1 x	DF-C 1nF, solderable
1 x	SMA flanged bush
1 x	WB housing, 37mm x 111mm x 30m.
1 x	printed circuit board DJ8ES 058

All other components in SMD 1206:

C1, 2, 7, 8, 10, 16, 18, 20-23	1nF
C5,6	4.7pF
C9	1.5pF
C11	82pF
C12,15	56pF
C13,14	12pF
C17	1.5pF
R1,11	270Ω
R3,10	100Ω
R4,5	10Ω
R6,9	47Ω
R7	390Ω
R8	560Ω
R12	100kΩ

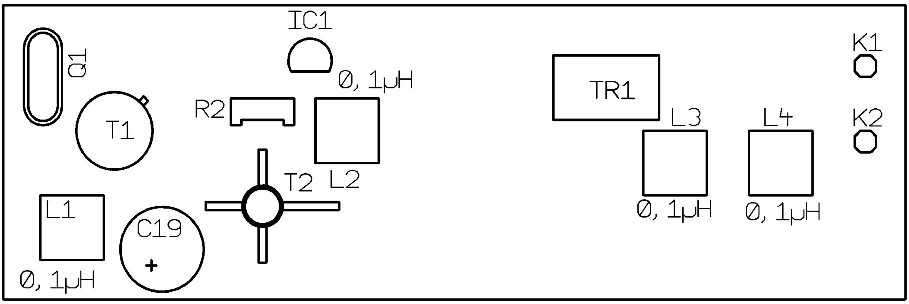


Fig 7 : Component layout for 145MHz oscillator (top side).

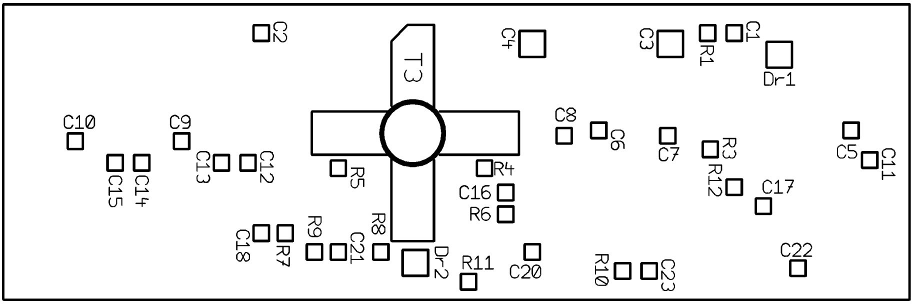


Fig 8 : SMD component layout for 145MHz oscillator (foil side).

2.2. Quartz oscillator assembly instructions

The quartz oscillator circuit for 145MHz is built on a 34mm x 108mm epoxy printed circuit board, copper-coated on both sides (Fig. 6). It fits into a commercially available 37mm x 111mm tinplate housing 30 mm high.

For the 2-tone generator, two oscillator assemblies are required with identical components. The only difference is the quartz crystal.

First drill the board with a 0.8 or 1mm drill, and then all holes for connections can been countersunk with a 3mm drill (N.B.: the copper remains on the connections to earth, e.g. the filter pots are soldered on both sides!). The SMA flanged bush and the feedthrough capacitor are fitted first. The board is inserted into the housing and sits comparatively low in the housing. The earth surfaces are soldered round both sides to the tinplate housing. The maximum fitting height is determined by the 1,000µF electrolytic capacitor.

2.3. Putting the quartz oscillator into action

Once the boards for the two quartz oscillators have been fully assembled, they should first checked for any possible placement faults. When all components are correctly inserted and soldered, the

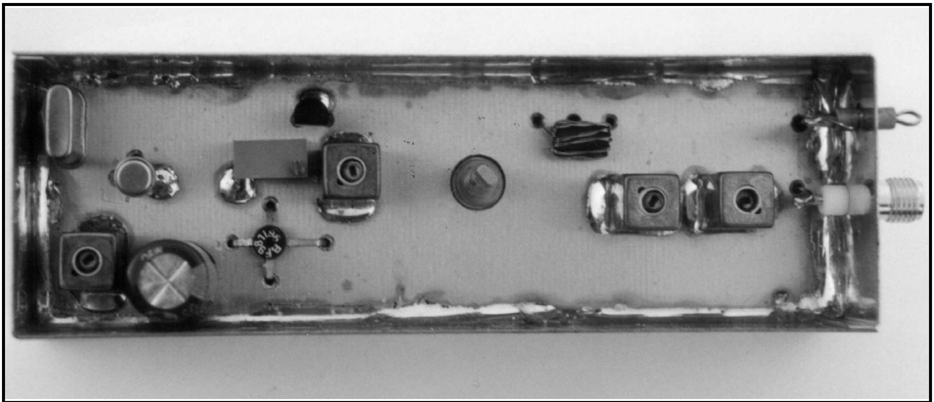


Fig 9 : Ready to operate 145MHz oscillator assembly.

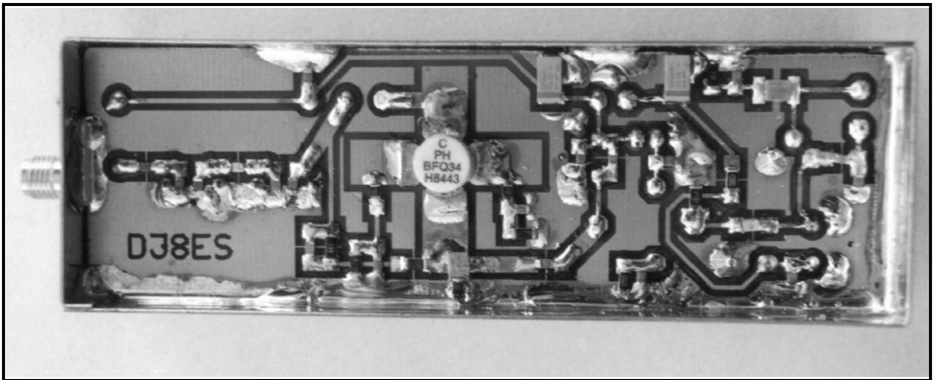


Fig 10 : Ready to operate 145MHz oscillator assembly showing SMD components on foil side of PCB.

first oscillator for 145MHz can be put into operation.

The supply voltage is +15V, with a current of approximately 100mA. The current varies by approximately 15%, depending on the output selected. This level can be adjusted between + 3dBm (2mW) and +24dBm (250mW) using the 50kΩ trimmer at G2 of the BF981 (T2). Pre-setting the output to +20dBm (100mW) is advantageous for subsequent use in the finished two-tone generator for 145MHz.

First the quartz oscillator (T1, U310) is put into operation. When the core is carefully rotated in the coil (0.1 µH), the circuit should start to oscillate. The core is fixed somewhat below the point for maximum output so that the oscillator starts reliably.

To measure the power, a suitable milli-watt meter can be connected at the output. Be careful, the power level is a maximum of 250mW. The low-pass filter at the output is then to be adjusted to the maximum output level by alternately trimming coils L3 and L4. The fine tuning of coil L2 completes the calibration procedure.

3.

Combiner circuit description

The combiner adds the signals, f1 and f2, of the two quartz oscillators (Fig. 11). The inputs are connected using a 3dB attenuator for better de-coupling. The bifilar transformer, TR1, combines the two input signals.

The circuit contains no active components, which would unnecessarily degrade the signal quality.

Each signal branch contributes (fairly precisely) 10dB to the signal loss, 3dB is due to the attenuator and 7dB to the actual combiner. For a drive output of 2 x 100mW (+20dBm), there is thus a 2-tone signal at the output of the assembly with a total output of 20mW (+13dBm).

3.1. Combiner parts list

R1-3 50Ω, SMD, model 1206

R4,6,7,9 300Ω, SMD, model 1206

R5,R8 18Ω, SMD, model 1206

TR1 Transformer, 7 turns, 0.2mm enamelled copper wire, bifilar wound on ferrite bead

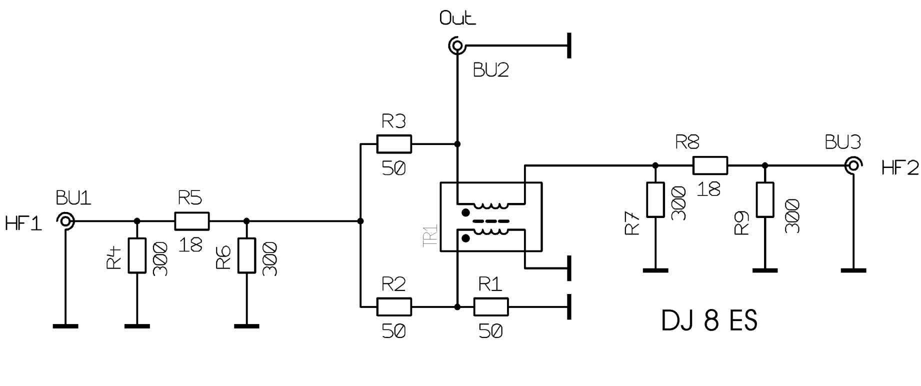


Fig 11 : Circuit diagram of combiner for two frequencies in 2m band.

3 x SMA flanged bush

1 x tinplate housing, 37mm x 55mm x 30mm

1 x printed circuit board DJ8ES 059

3.2. Combiner assembly instructions

The combiner assembly is constructed on a 34mm x 54mm epoxy printed circuit board, copper-coated on both sides (Fig. 12). It fits into a commercially available 37mm x 55.5mm x 30mm tinplate housing.

The printed circuit board is assembled from the foil side only, 0.8mm holes are first drilled for the transformer, TR1. Apart from the connection to earth, these holes are countersunk on the earth surface using a 3mm drill. The connection to earth is soldered on both sides.

Before the assembly in accordance with the assembly drawing in Fig. 13, the printed circuit board is inserted into the tinplate housing with the SMA sockets already fitted. The earth surfaces should be soldered to the housing rim on both sides.

Anyone who cannot afford the cost of special 50Ω resistors can use100Ω resistors in parallel (piggyback). For reasons of symmetry, these resistors should be measured as precisely as possible in advance!

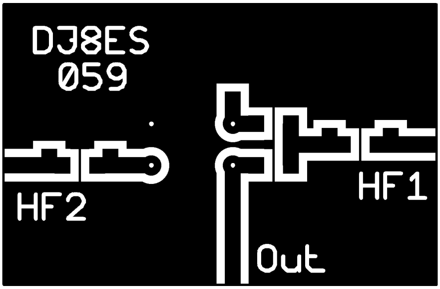


Fig 12 : PCB layout for combiner (not to scale).

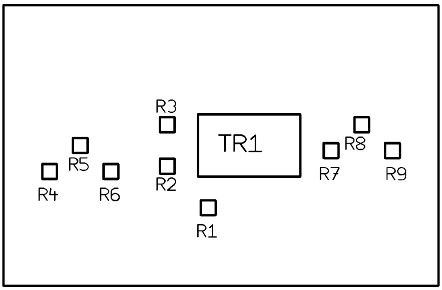


Fig 13 : Component layout for the combiner, all components are mounted on the foil side.

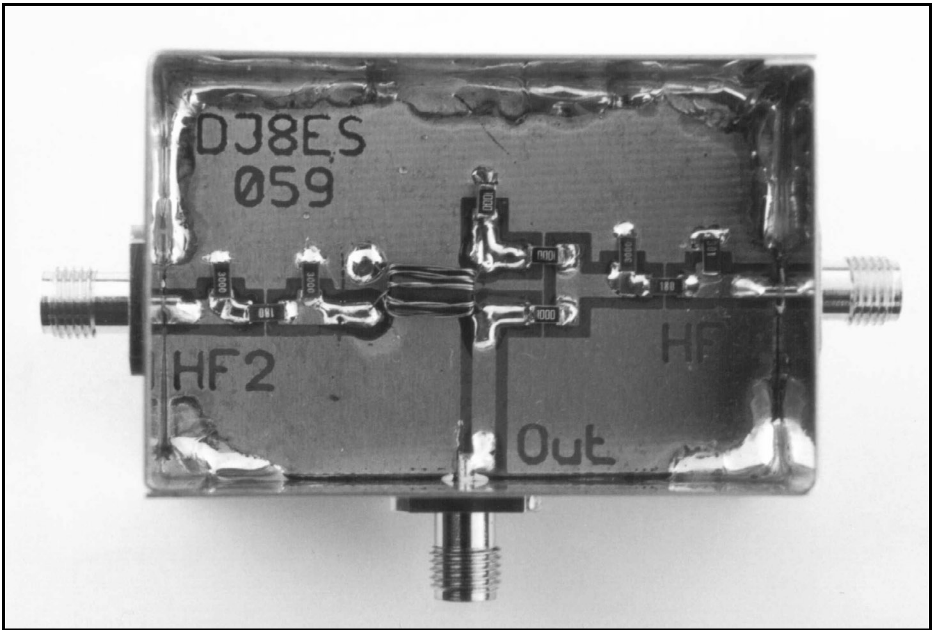


Fig 14 : Combiner for the 145MHz 2-tone generator, assembled and ready to operate.

4.

2 x 15 v power supply

Each of the two crystal oscillators is powered by its own supply voltage (15V, 100mA). The two linear regulators (IC1, IC2) keep the voltage stable at the required value. In other respects, the circuit for the power supply (2 x 15V) in Fig. 15 is self-explanatory.

The assembly is built on a 100mm x 75mm epoxy printed circuit board, copper-coated on one side (Fig. 16). During assembly set-up, particular attention should be paid to the 230V connection side and the fuse and the transformer, see Fig 17. The safety regulations required are described in DIN EN 60065 (VDE 0860) for audio, video and similar electronic apparatus (October, 1998 version).

4.1. Parts list

TR1	Transformer, 18V, 555mA, type EI48/16.8 10 VA
BR1	B40C1500, bridge rectifier
IC1,IC2	7815, 15V voltage regulator
C1	1,000µF electrolytic capacitor, radial, RM, 7.5mm.
C2,C3	47µF electrolytic capacitor, radial, RM 5mm.
C4,C5	100nF, ceramic, RM 2.5mm.
F1	100mA fine-wire fuse, delayed action, D = 5mm. x 20mm.
2 x	profile heat sinks SK 104 38.1 STS, can be soldered in
1 x	fuse holder for printed circuit board mounting
5 x	1mm soldering studs
1 x	printed circuit board DJ8ES 060

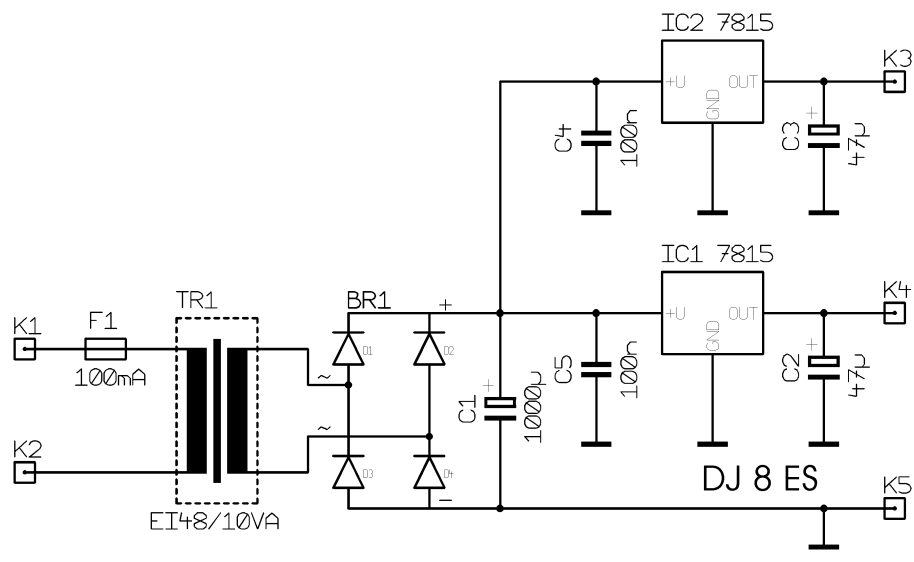


Fig 15 : Circuit diagram for 2 x 15V power supply.

5. Putting into operation

Once all assemblies have been constructed ready for operation and positioned in a suitable housing, the two-tone generator can be put into operation as a whole for the first time.

The two oscillator assemblies can be individually connected in the specimen apparatus (Fig. 18). The RF level for each oscillator is individually set at +10dBm (10mW), measured at the output socket of the apparatus. If both

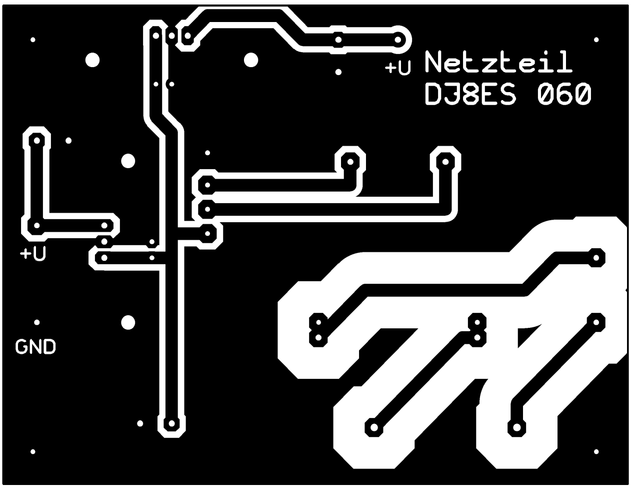


Fig 16 : PCB layout for power supply (not to scale).

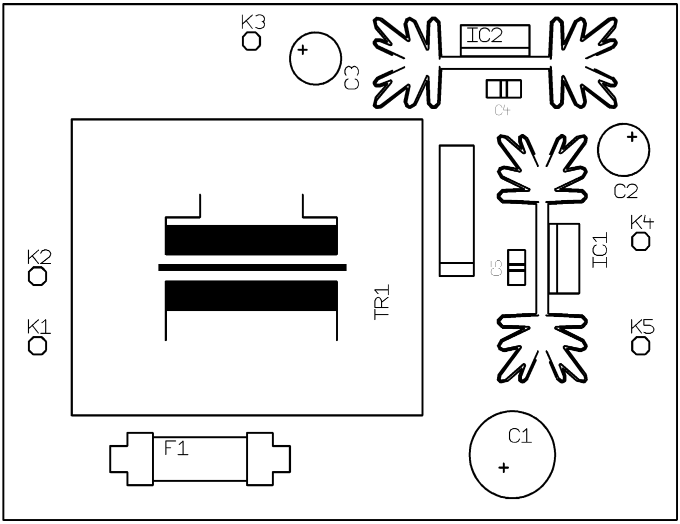


Fig 17 : Component layout for power supply.

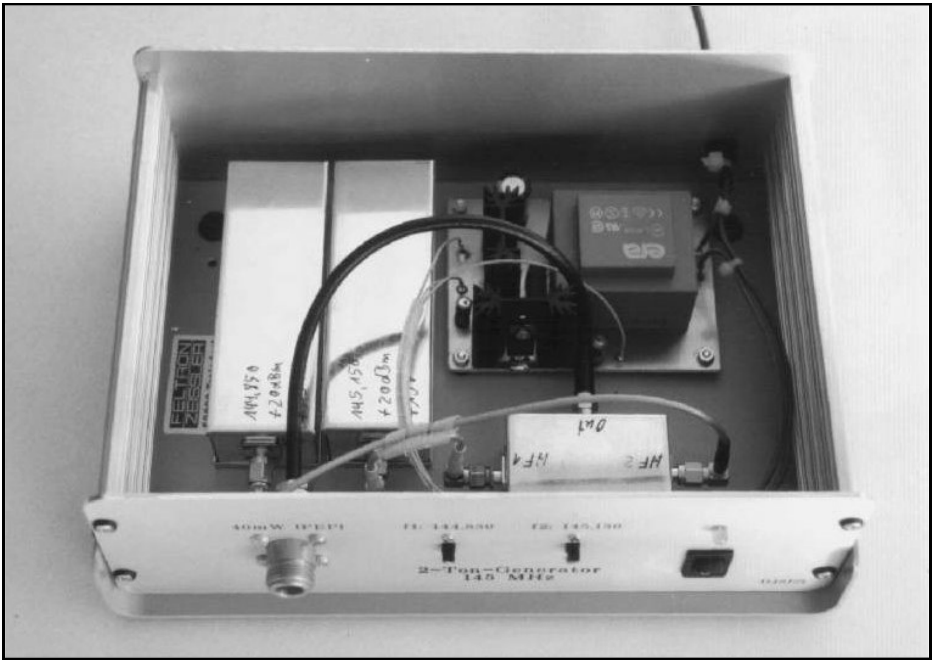


Fig. 18 : View into open specimen apparatus. The two oscillator assemblies for 144.950 MHz and 145.150 MHz are mounted in the left-hand half. The combiner sits directly behind the front panel and the power supply assembly is some way behind that.

assemblies are switched on, the total signal measures +13dBm (20mW) or 40mW PEP.

The two-tone signal is now visible at 145MHz on a connected spectrum analyser. Fig. 3 shows the good signal quality of this generator. It should be taken into account here that most spectrum analysers are already extremely over-modulated at such an output level and produce inter-modulation products themselves! Such signals can be measured only using a series-connected 20dB or 30dB attenuator.

6.

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Gunthard Kraus, DG8GB

Problems With Running Puff On Windows 98, Windows ME And Windows XP, And How To Eliminate Them

Anyone who is tempted by the adverts and impulsively buys himself/herself a modern PC will no doubt be looking forward to using a fast new computer. You eagerly install everything in accordance with old and imperfect programs. You set up your Puff directory, copy all the files into it, configure an attractive icon (for example, a radio-telescope) and happily click it. However, your mood suddenly becomes considerably darker, for what appears on the computer is not the familiar Puff Start screen you expected, but usually the succinct message Fatal Error. The aim of this article is to give you some help and get Puff running properly again on Windows.

1. Fault-finding

Let's look at the individual causes of faults and how to correct them.

1st cause of trouble: Version of Puff too old

Let's not beat about the bush, old versions of Puff from before 24th October 1998 are basically no longer capable of running on fast computers (unfortunately fast here means anything with a clock speed exceeding 133MHz). The reason for this is a bug in the programming language used (Turbo Pascal), which leads to a Runtime Error message. This was not eliminated until the insertion of a patch into version 2.1 of Puff, from the above date.

So in a case like this, just get hold of the most recent issue of version 2.1. You must check the date of issue immediately when you unwrap and/or install puff.exe file.

2nd cause of trouble: The adjustments necessary for correct operation on Windows have not been made.

This is unfortunately a normal cause of this problem! So lets just go through the correct installation procedure nice and slowly.

First step:

If necessary, unpack all Puff files and/or copy them into a newly set up Puff directory on the hard disk.

Second step:

Close all windows applications, plus Windows Explorer. All you should have in front of you is the Start screen.

Third step:

Right-click on an empty part of the screen with the mouse and call up New and then Link. Then press the Search key, move into the Puff directory and open the puff.exe file.

Confirm with OK, and first establish the name for the icon (e.g. Puff 2.1). Then find a nice little picture for it. Click on OK again and this stage is over. The Start icon for Puff will now appear in Desktop.

BUT PLEASE DONT TRY AND START UP STRAIGHT AWAY THINGS ARE ABSOLUTELY BOUND TO GO WRONG!

Fourth step:

Right-click once only with the mouse on this new Puff Start icon and call up Properties. Now select the Main Memory option. Youll see at once that Windows has pre-set Auto in all fields. For a conventional memory this has to remain under Altogether and Original Background Memory.

But you should change the other settings (EMS Expansion Memory, XMS Supplementary Memory and the main memory for the MS-DOS protection mode DPMI) to 4096 kilobytes. And that should certainly solve this problem!

A short test (call up Puff after saving the new settings) demonstrates success immediately (even on the most recent XP version).

2.

Other bad habits

Another bad habit observed in Windows mode:

Unfortunately, in many cases, the problems on Windows ME are more serious. As a sorely afflicted PC user, you first just start the program, pre-set some components in field F3 and assemble your circuit in field F1. And lo and behold the equals sign (e.g. needed to set the earthing point) has disappeared. All attempts to re-program the keyboard using Windows (to German Keyboard) are in vain.

There's only one method which works.

Take the computer into DOS mode and press every key on the keyboard one after another. The character assigned to each key will be brought up in turn on the screen. If you still can't find anything, then switch to upper case and repeat the check. And if that still doesnt help, just switch to <ALT> and/or <ALT GR> and check again. The sign just must be somewhere!

Thats exactly what happened to me, it was in a quite different place (in my case directly next to the backspace key, so there was no need to switch round). We may suspect it has something to do with the original American keyboard. Puff can be run as usual but the user needs a while to get used to the changes in operation. (Crazily enough, using a modern laptop with Windows XP this procedure was suddenly not needed any more, since everything functioned correctly!)

While were on the subject, perhaps I could point out another apparent error which newcomers to Puff often encounter when they first start up the program and Windows is unfairly blamed for the problems. What happens is that some signs are not shown correctly when the components are entered. Almost everyone finds out about this first by the incorrect “Ohm” sign (Ω).

On such computers, it is the selected “Code page for the control panel” which is behind the problem, because almost all PCs sold on the German market install page 850 when they start up. But the correct keyboard assignment for Puff can be obtained only with code page 437!

The associated setting can be found at the end of the config.sys file. In a case like this, it needs to be altered at the points shown in bold.

Example:

....

files = 10

buffers = 10

dos = high.umb

stacks = 9,256

lastdrive = z

device = display.sys con = (ega,, 2)

country = 049.850.country.sys

install = mode.com con.cp prepare =((850 437) ega.cpi)

install = mode.com con cp select = 437

install = keyb.com.gr,, keyboard.sys

3. Printout

In conclusion, a few more words on the printout from the screen and the results using Windows.

There is no need to struggle with the original DOS drivers contained in the program. Just take the line of least resistance. It looks like this:

First step:

Download the free IrfanView graphics software from the Internet (it has now been recognised as one of the best!) and install it on the computer.

Second step:

Following a Puff simulation, press the Print key on the keyboard

Third step:

Move into IrfanView and select the option Insert from the Process menu. The stored Puff screen is then transferred from the intermediate memory into the operational window.

Fourth step:

In the Image menu, there is an option for selecting Negative and altering the printout in such a way that the background becomes white and all diagrams appear white (saves toner or ink during printout). And anyone who doesnt need anything better than black-and-white representations can also select Convert into shades of grey. Then everything is turned into a purely black-and-white document.

Fifth step:

Now the results obtained using Windows can be printed out with the usual quality.

Thats it then I hope you have lots of fun with Puff, which should be easy to operate and give you very accurate simulations.

And one more confidential tip although the PUFFP test version supplied on diskette when you buy the software (for operating in protected mode) is error-free, it simulates with a maximum of 1,000 points instead of 500 points in the standard version.

Alexander Meier, DG6RBP

Video Signal Recognition, ATV Squelch

The presence of a video signal can be recognised using a synchronisation signal detector.

If a video signal is present, this circuit extracts the synchronisation signals and uses them to detect the frame change signal. An adjustable time delay prevents problems caused by interfering signals. An automatic change over to a second video source completes the circuit, which is described below.

1. Introduction

Details of circuits which recognise a video signal have already been published on several occasions [1, 2]. Usually a filter allows only the horizontal frequency to pass through (15625Hz for PAL) and subsequently to be detected.

In the circuit described here, another method is proposed. A sync-separator IC screens out the synchronisation signals from the video signal, then the frame change signal triggers a monostable. A signal is thus obtained which changes from low to high level when a video signal is recogised. An adjustable time delay is then created using a simple RC network and a comparator.

A micro-controller could also be used instead of the monostable, RC network and comparator. This is certainly more flexible, due to its programming options, but it would make the circuit unnecessarily expensive without any real advantages. It would also be necessary to consider possible software crashes in long-term operation and to take suitable measures (Watchdog).

In this version, it is also possible to switch automatically to the signal from a second input (e.g. test pattern, information program) by means of an integrated relay. An adjustable response time suppresses the reaction to interfering signals (e.g. radar signals) or to short interruptions to reception. The circuit thus becomes a complete ATV squelch.

ATV relays or amateur radio TV stations are typical applications for this ATV squelch, together with other video applications.

2. Circuit Description

The ATV squelch circuit diagram is shown in Fig. 2. The video signal to be evaluated arrives at the sync separator U1 via a low-pass filter comprising of R2 and C1. The filter attenuates the high

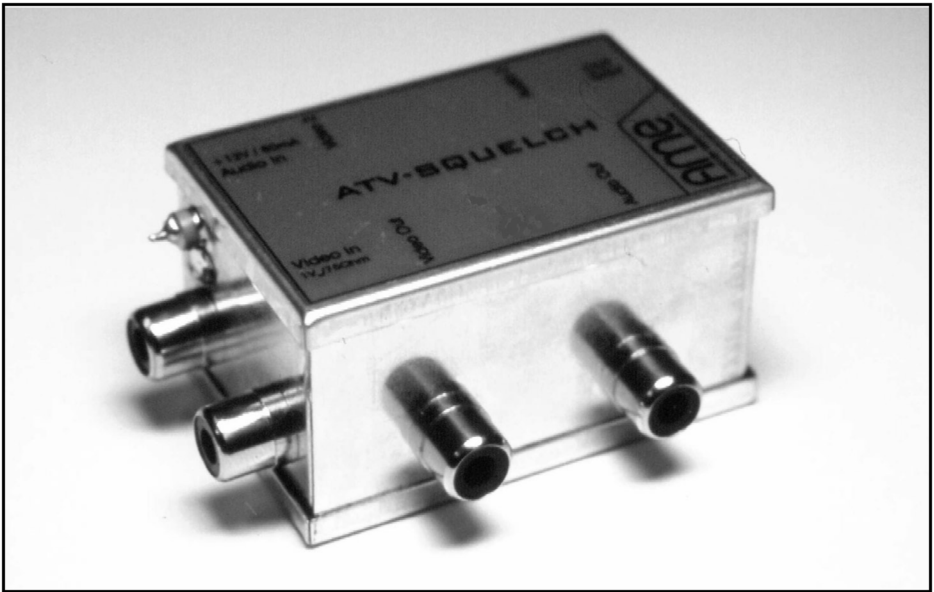

Fig. 1: The assembled ATV squelch ready for operation in the tinplate housing.

frequencies, which are unnecessary for evaluation (image contents, noise) and thus makes very good video signal recognition possible, even for poor reception signals.

The sync separator input is relatively high-impedance at > 10k Ohms, and imposes practically no load on the video signal. If the video signal does not have a termination (a sink of 75 Ohms), the input circuit can be terminated at 75 Ohms with the plug-in bridge, J1.

For a video signal which is satisfactorily received, the amplitude of the input signal should be 1V p-p into 75 Ohms. During the period of time in which a video signal is applied to the input, but when the circuit has not yet switched it to the output due to the delay selected, there is no termination (unless J1 is plugged in), therefore a double voltage (2V p-p) is applied at the input of U1. The IC can handle this without any problems. In contrast to this it also processes very noisy video signals that can arise when reception is poor.

The resistor, R3, was calculated for the PAL colour television standard which is used in Germany [3]. The sync-separator IC makes several outputs available: the vertical signal, a combined vertical/horizontal signal, a signal for recognising the colour burst, and a frame change signal.

In order to produce a stable image for the eye, our television picture consists of 25 frames per second. These are divided into two halves, so that finally we see 50 half-frames per second. The frame change signal at pin 7 of U1 alters its level for each frame change so that normally a frequency of 25Hz can be measured. If there is no longer a video signal at the input, the output remains unaltered at the last level. There is a problem in that an interfering signal (e.g. radar) can also lead to a level change. But we can control this by means of the adjustable response and switching time.

The frame change signal arrives at the input of the re-triggerable monostable, U2A. This reacts only to the positive edge, and thus only to a frame change. If

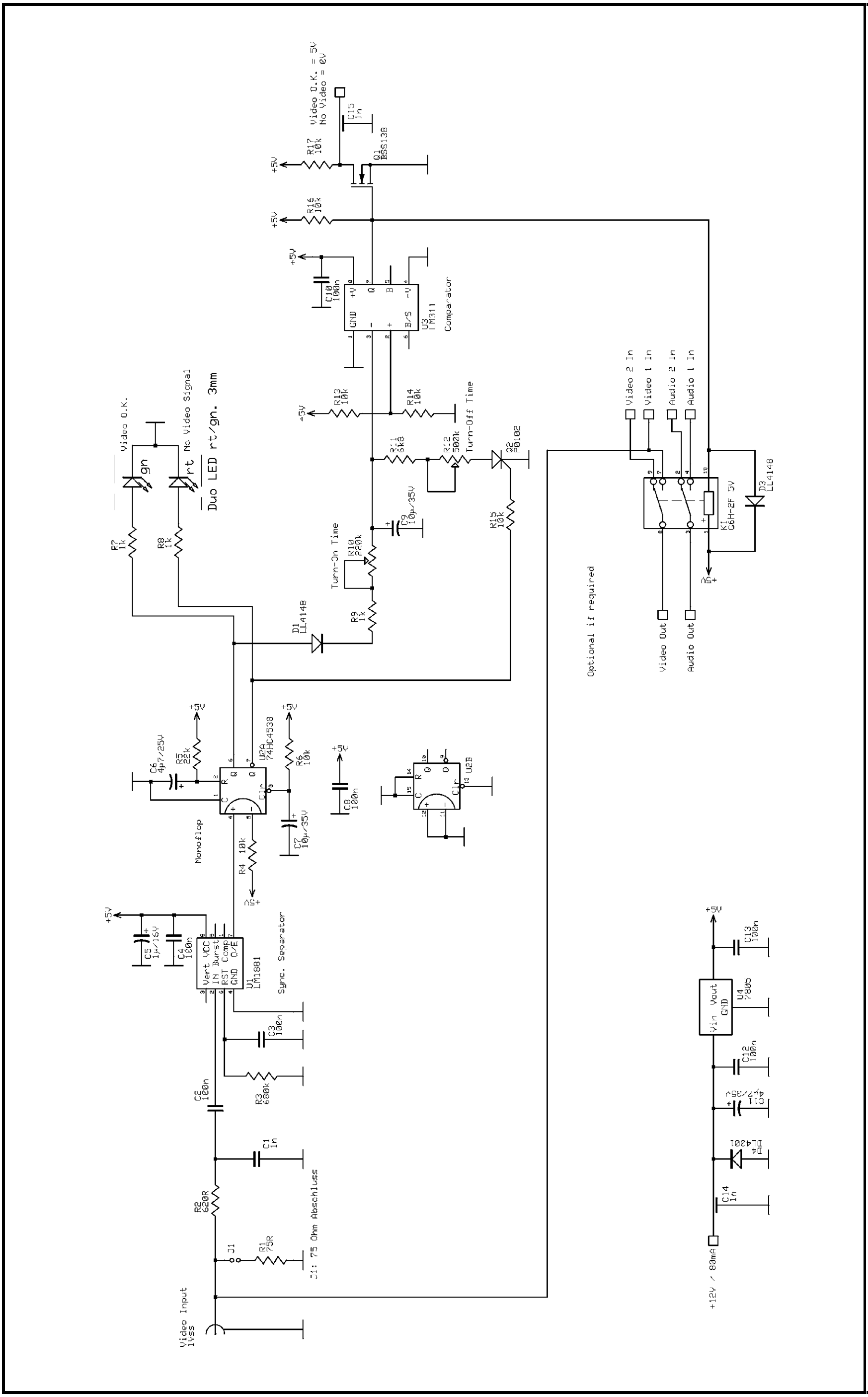

Fig 2 : Circuit diagram of ATV squelch by DG6RBP.

a video signal is present, the output pin 6 is at a high level (5V) and the LED is green, or otherwise it is red. This LED is connected before the response delay or slow switch, it directly indicates the condition of the input signal. A poor signal which is interrupted can be recognised by a flickering of the LED.

The time constant (R5/C6) of the monostable has been calculated in such a way that, even if the signal is missing for scarcely more than one complete frame the time is nearly expired. It would be possible to have a slow time at this point, but it offers no advantages. On the contrary, we would no longer be able to recognise short interruptions to the input signal from the LED.

The capacitor, C7, prevents any possible false output signals from the monostable while the operating voltage is being applied.

As already mentioned, the circuit should not recognise the presence of the input signal until it has been applied to the input for longer than an adjustable period of time. Likewise the change-over relay (or the circuit output) should not open until an input signal has not been applied for a separately adjustable period of time. Relatively small interruptions to the video signal (or synchronous signal) are permitted during both these times.

The monostable output charges the capacitor, C9, through an adjustable resistor (R10, switching time). As soon as the voltage at the capacitor exceeds the comparison voltage of approximately 2.5V, pre-set by the voltage divider, R13/R14, the comparator, U3, discharges its output (open collector) to earth. The relay, K1, then switches the recognised video signal through to the output. A control signal is provided by the FET, Q1, which changes to + 5V. This is just a control signal (e.g. for further processing in the control computer of an ATV relay), and it is not suitable for directly operating an external relay. For this purpose, another transistor would have to be used as a driver.

If we require only the control output without a change-over relay, we do not need to fit this relay. The resistor, R16, ensures the functioning of the control signal even without a relay.

In order to be able to set the switching time and the opening time independently of one another, the output of the monostable may cannot discharge the capacitor, C9, the diode, D1, being used to prevent this happening. If the input signal disappears, C9 is discharged in a controlled manner through the adjustable resistor, R12 (opening time) using the thyristor, Q2.

The voltage supply is fed to the circuit through a 1nF feedthrough capacitor. The diode, D4, acts as a reverse battery protection. The supply voltage of 12V (± 10%) is stabilised at 5V using the voltage regulator, U4. When the relay switches, the current is just 80mA. A higher input voltage is not possible, due to the higher power loss and the associated increased heating dissipation of U4.

3. Assembly

The ATV squelch circuit is assembled on a 54mm x 36mm double-sided epoxy printed circuit board, (Figs. 3a and 3b). The circuit board is through-hole plated and tin-plated. Through-platings are created only at the points necessary i.e. not on the normal soldering areas for conventional components.

First, the housing is drilled, or even better punched. The mid-points of the cinch jacks are about 10mm. away from the housings underside.

Since space is very limited, we should be careful to ensure that the jacks do not touch any components on the printed circuit board when it is fitted! We should also select cinch jacks with as short a

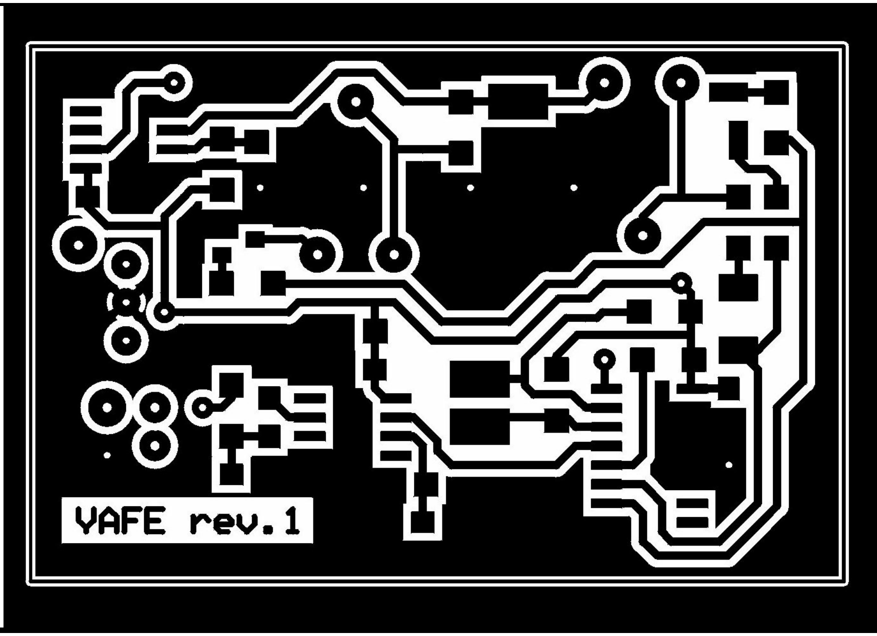

Fig. 3a: Layout of components side (not to scale!).

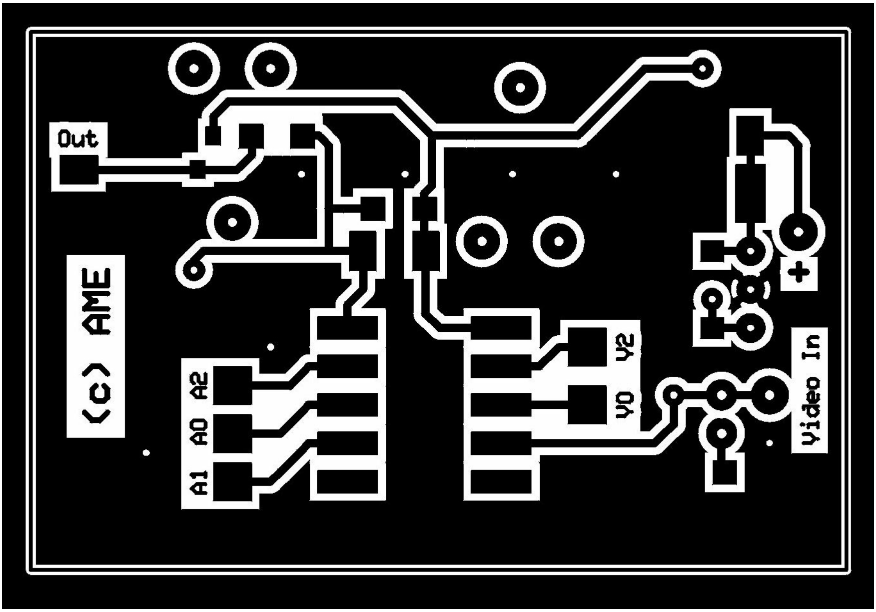

Fig. 3b: Layout of foil side (not to scale!)

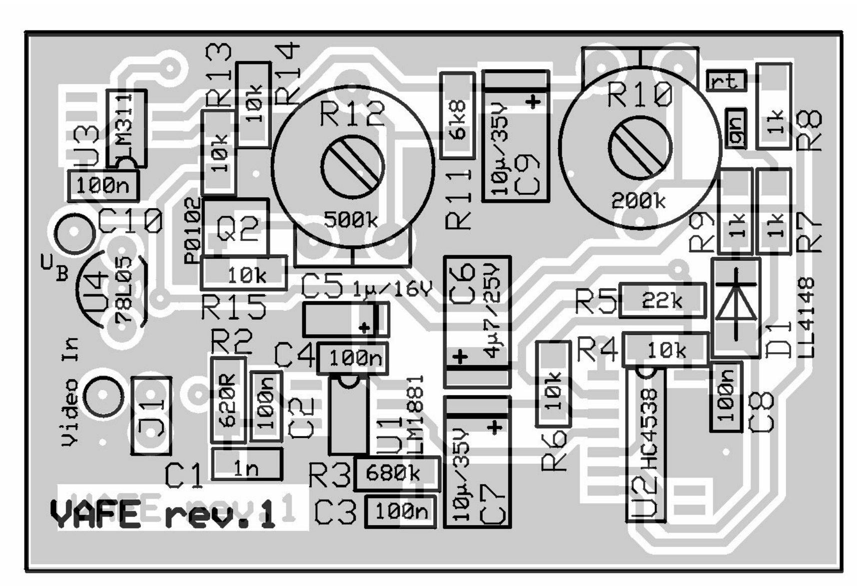

Fig. 4a:Component layout (mainly SMD) on topside

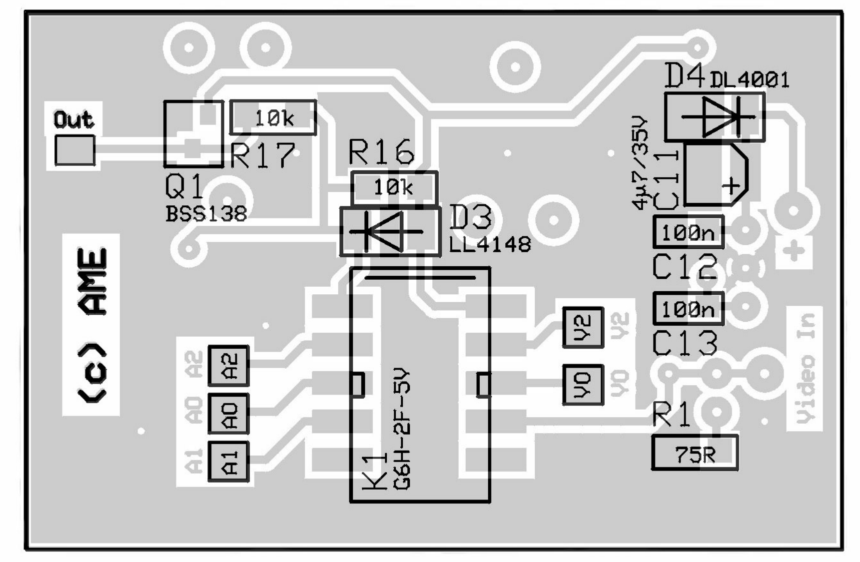

Fig. 4b:Component layout solder side with SMD components

thread length as possible.

The board is now inserted at a distance of about 10mm. from the top edge of the housing and soldered all round.

Next the components are mounted on the board first all the SMD components and then the other parts. Lastly, the two potentiometers, R10 and R12, together with the voltage regulator, U4, are soldered onto the two sides of the printed circuit board. Figs. 4a and 4b show the components drawings.

Finally, the cinch jacks, feedthrough capacitors and the LED are fitted. A thin cable is used for the connections to the corresponding soldering pads. After an initial functional test, the circuit is ready for operation.

4. Parts List

1 x	printed circuit board, DG6RBP-003
1 x	tinplate housing, 55 x 37 x 30mm
R1	75 Ohms, SMD 1206
R2	620 Ohms, SMD 1206
R7,R8,R9	1 kOhm, SMD 1206
R11	6.8 kOhms, SMD 1206
R4,R6,R13-17	10 kOhms, SMD 1206
R5	22 kOhms, SMD 1206
R3	680 kOhms, SMD 1206
R10	220 kOhms, PT 10
R12	500 kOhms, PT 10
C1	1 nF, SMD 0805
C14, C15	1 nF feedthrough capacitor
C2-4,C8,C10,C12,C13	100 nF, SMD 0805
C5	1µF/16 V, SMD tantalum
C6	4.7µF/25 V, SMD tantalum
C11	4.7µF/35 V, SMD electrolytic capacitor
C7,C9	10µF/35 V, SMD tantalum
D1,D3	LL 4148, SMD diode
D4	DL 4001, SMD diode
Q1	BSS 138
Q2	P0102 BL
U1	LM 1881 M (SMD)
U2	74 HC 4538 (SMD)
U3	LM 311 M (SMD)
U4	78L05 (TO-92)
K1	Omron G6H-2F (SMD)
J1	Jumper, RM 2.54
1	Duo LED, 3 mm., red/green,
1	Mounting for LED
6	Built-in cinch jacks

5. Putting Into Operation

The video input signal is connected to the video-in jack if no use is made of the integrated change-over relay and only the switching signal output is of interest.

If required the plug-in bridge J1, which terminates the input at 75Ohms, is inserted. The plug-in bridge is accessible once the housing cover has been removed.

If the integrated change-over switch is to be used, the video signal to be tested is connected to the video-in jack and the associated audio signal to audio-in. The alternative video and audio signals are connected to the video 2 and/or audio 2 inputs. The video-out output should be connected to equipment with a 75Ohms

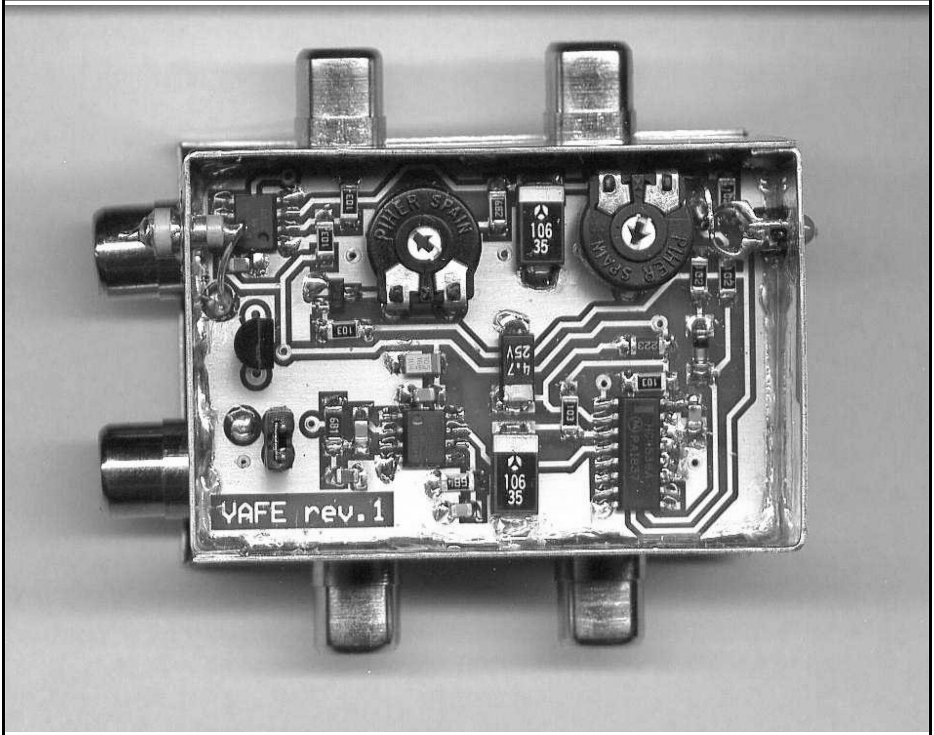

Fig. 5a: The completely assembled topside of the ATV squelch, already fitted into a tinplate housing with jacks.

terminating resistance. The audio output is likewise connected to the corresponding equipment (e.g. ATV transmitter).

Neat earth connections for the video signals are very important for satisfactory functioning of the squelch. It is the cinch plug-in connections where connection problems often occur, depending on the quality of the plugs and jacks. If there is no earth connection at all, a video signal is continuously faked by the sync separator, U1.

The switch signal output OUT 0/5V is a pure switch signal and may not be loaded. It can be used for further processing in a control computer or for triggering a relay with a corresponding driver. If the switch signal output is connected to other equipment (e.g. a control computer) bifilar cord should be used (for signal and earth).

When the supply voltage has been switched on, the module is ready for operation. The two-colour LED shows the condition at the video-in input. This reacts to the input signal independently of any specified switch delay or slow release. This gives a direct visual monitoring of the input signal.

If the LED is green, a video signal is being applied to the input. If the LED is red, there is no video signal. If the LED is flickering, this indicates a weak signal (poor reception) with interruptions to the synchronisation.

The potentiometer for setting the switching time, ton (R10) is set to the right-hand maximum (long delay), and the other potentiometer, toff (R12) to the left-hand maximum (short delay).

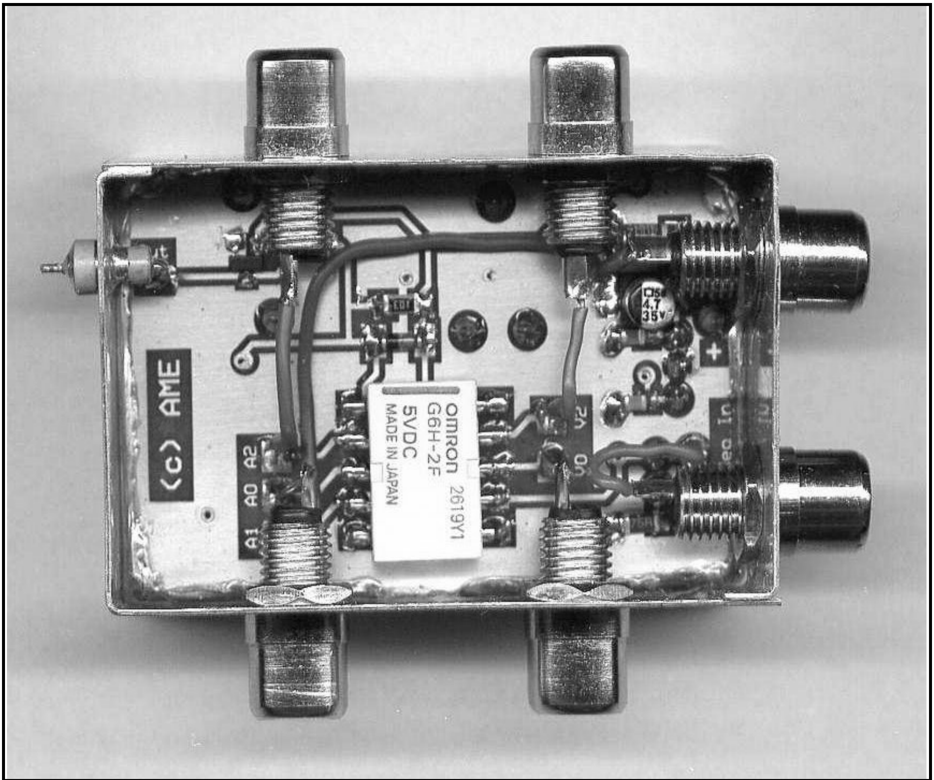

Fig. 5b:The underside of the ATV squelch with changeover relay (centre of picture) and cinch jacks.

If an input signal is applied for longer than ton, then the switch signal output switches to + 5V and the relay switches from video and tone channel 2 to the video-in and audio-in input. The switch signal output and the relay drop out again if the video signal at the video-in input is no longer available for longer than toff. Very short interruptions to the input signal are ignored, depending on the setting of ton and toff.

The switching delay, ton, is thus set (by turning to the left) in such a way that the reception of interference (e.g. radar in the 23cm. band) does not cause the switching relay to operate. The slow release, toff, is set (by turning to the right) in such a way that a poor reception signal with interruptions to the synchronous signal (recognisable by the flickering of the LED) does not lead to the relay dropping out. Neither delay should be set to be any longer than necessary.

The longer the delay time is, the more insensitive the squelch becomes for both interference and weak reception signals! A long slow release compensates for interruptions to synchronisation for poor reception signals, but, in combination with a badly selected delay times, can favour the reaction to interference! The squelch must therefore be optimally balanced to the facts at the reception location.

In general only screened cables should be used for the video and sound signals, and all connecting cables should be as short as possible!

6.
Technical Data

Operating voltage:

+12V DC

Current consumption:

Max. 80mA (relay switched on)

Max. 50mA (relay off)

Video-in input signal:

(F)BAS, PAL, 1V p-p

(NTSC version on request)

Video-in input impedance:

10k Ohms or 75Ohms (plug-in bridge)

Type of detection:

Frame change pulse

Response time:

Adjustable, approximately 50ms to 1.5s

Slow release:

Adjustable, approximately 50ms to 4s

Switch signal output:

+5V (input signal recognised)

0V (no input signal recognised)

Display: two-colour LED:

Red: no sync signal at video input

Green: sync signal at video input

Changeover switch:

For an image and sound channel (mono)

Input voltage in each case max. 2V p-p

Operating temperature range:

+10 to +35°C.

Dimensions:

(L x B x H) 55mm. x 36mm. x 30mm. (without connecting jacks)

7.
Literature References

[1] ATV squelch / synchronous evaluator: *TV-Amateur*, no. 123, fourth quarter 2001, Amateur Television Association (AGAF = Arbeitsgemeinschaft Amateurfunkfernsehen)

[2] Video interruption indicator; ELV Journal; No. 3/96, pp. 50-51; ELV, Leer

[3] Data sheet LM1881 National Semiconductors, April, 2001 www.national-.com

ATV Squelch, Alexander Meier, DG6RBP *TV-Amateur*, no. 124, first quarter 2002

Robert Tyrakowski, DK7NT

Frequency Indicator For Portable Radio Equipment

The options for setting and reading off the frequency on portable radio equipment are usually unsatisfactory. Even on modern equipment a digital indicator for a precise tuning is often missing. This article describes a universal display unit with low current consumption and small dimensions.

1. Introduction

Happily, portable radio equipment has recently been developed which can replace the tried and tested transceivers such as the IC202 and the FT290 as versatile tuners for transverters. One big disadvantage of this new equipment is the lack of options for setting and reading off the frequencies desired, since purely digital frequency generation using DDS has still not been generally accepted. Attempts to compensate for these disadvantages with standard frequency counter circuits and standard display units have been made, but the take-up is relatively poor due to the size and the excessively high current consumption.

In principle, the solution put forward here falls back on tried and tested frequency counter engineering. However, the main difference lies in the fact that the most modern components have been used to implement the design. Mind you, this path does not make it any easier to procure the components or assemble the circuit. Additional work is required for the one-off programming of the components. But why cant we make use of modern technologies in amateur radio?

2. Concept

In the development of the display unit, we have fallen back on the standard principle of frequency counters that consist of an input stage, a gate circuit, a counter, a display unit and a control unit. In the selection of the components, care was taken to ensure that the counter consisted of as few elements as possible. In addition, these were also selected with a view to ensuring a low current consumption.

In order to obtain as much flexibility as possible, a software controlled micro-controller solution was selected. Fig. 1 shows the block diagram of the frequency display.

The core of the counter is formed by two main components. First a processor, an 8051 derivative from Atmel, type

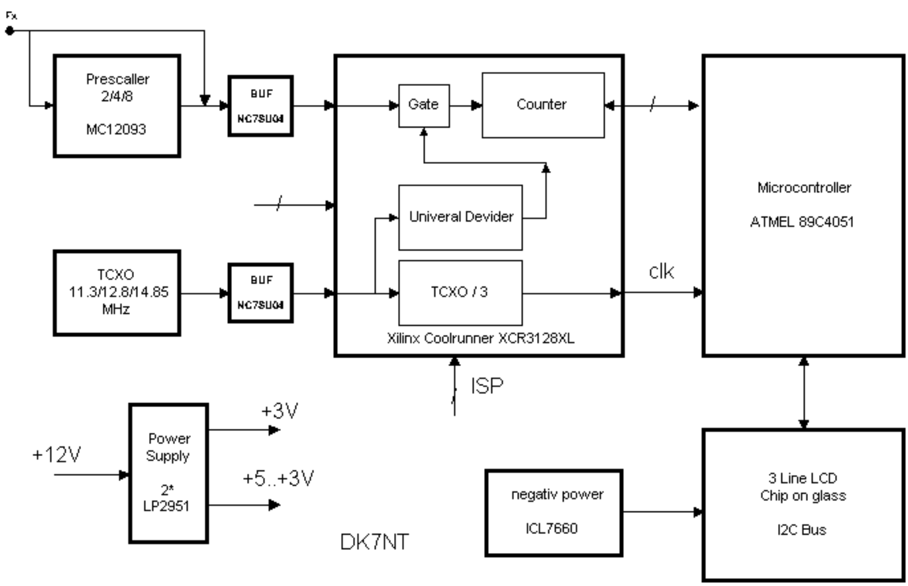

Fig 1 : Block diagram of frequency display for portable radio equipment.

AT89C4051 [3], and then the Xilinx CPLD [2]. (Customer Programmable Device) XCR3128XL.

The micro-controller uses software to operate all components of the counter and the display of the counter result on the LCD display. The FPGA (Field Programmable Gate Array) includes all of the logic for the counter, so that only the power supply, the level switching, the

Fig 2 : Example of 3 line display.

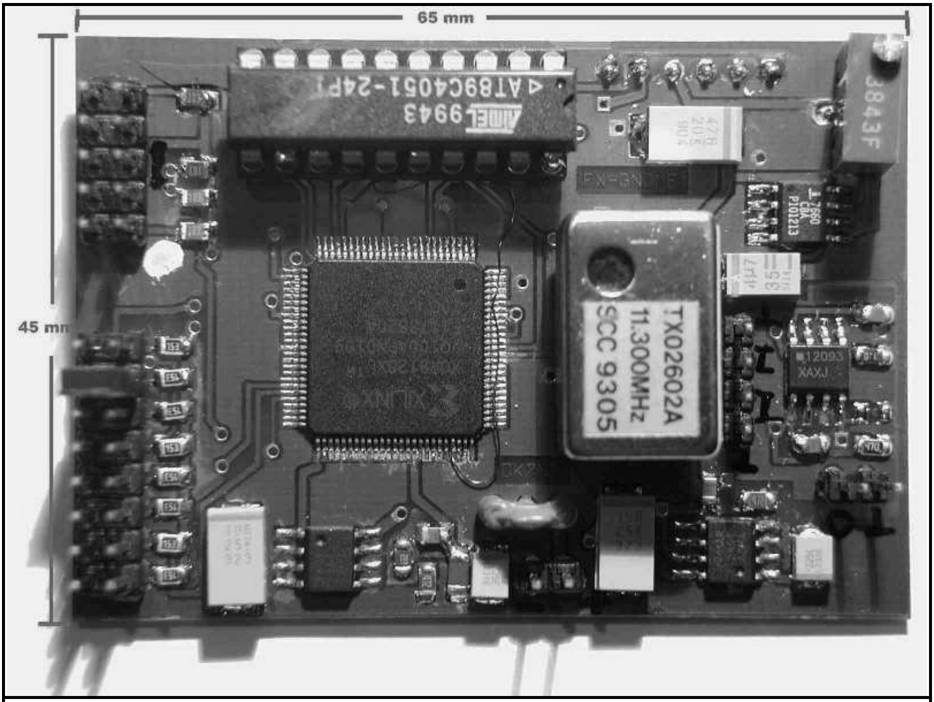

Fig 3: View of assembled printed circuit board of the frequency counter unit.

pre-divider and the LCD display are externally connected.

Different versions of LCD display can be used:

- 3 line and extremely low current drain called a chip-on glass display
- Extremely small 2 line display, type TRR6030 [5]
- 2 line LCD display of any size with a bus converter with its own micro-controller wired into the circuit.

All displays can display alpha-numeric characters and are connected through the PC bus. This also allows a simple separation of the counter electronics and the display, should this be necessary. The contrast of the LVD displays EA7123 and TRR6030 is not especially good, but nevertheless is reasonably legible. If necessary, the EA7123 display can be back-lit using various light sources. In cold conditions the legibility of the display reduces somewhat.

The pre-divider used is likewise an extremely low-current drain model in an SO8 housing. For 1.1GHz, the manufacturer Motorola [4] specifies a current consumption of approximately 4mA.

It might be asked why a CPLD was selected, and why more tasks were not transferred to the processor, or simply why were discrete logic modules not used? The answer is simple. The processor works only at 4 to 5MHz, and is thus much too slow to take over any further tasks for the counter. With the logic commonly used, you have to think how many ICs would be necessary to realise the following characteristics:

- Reversible 2 bit divider of 11.3/12.85/13.0 or 14.8MHz for a gate time of 100/10 or 1Hz
- The frequency counter gate circuit
- 28 bit counter for frequency counting
- The address decoding for reading out and programming with corresponding intermediate memories, together with bi-directional data buffer
- A port expansion for reading in the operating mode, the desired gate time, the offset selection, etc.
- A divider by 3 for the CPU clock
- Current consumption of approximately 3mA with an area of approximately 15mm. x 15mm.

In view of this background, it was simply the obvious thing to do to use a CPLD. Quite apart from the fact that the flexibility and reprogrammability in the development stage made things a bit easier.

3. Characteristics

One target in development was use in portable radio equipment, thus the display unit was chosen to have small dimensions and as low a current consumption as possible. Moreover, the frequencies normally used in amateur radio were taken into account and corresponding ranges were provided for, including transverter operation.

To display transmit and receive frequency, an offset can be added or subtracted in each case (also mixed). Any possible pre-dividers are taken into account here. It is thus possible for the user to provide for four different frequency pairs for reception and transmission. For use as a fine tuner with a transverter for the 23cm, 3cm or 1.3cm. band, the actual TX/RX frequencies can be easily displayed by changing the range. The user can carry out the pre-settings required with the aid of a PC tool.

If the built-in pre-divider is not used, the upper counter frequency is approximately 180MHz. A selection can be made between two gate times, of 1 second or 0.1 seconds. This means a resolution of the display to 1Hz or 10Hz. With a pre-divider, the input frequency is multiplied by 2, 4, 6 or x (with a pre-divider to the power x). Naturally, the resolution also falls by the same factor. The normal flickering of the last digit is prevented by means of the gate circuit and the software.

It is well known that a frequency counter is only as accurate as its reference. TCXOs (temperature-compensated quartz oscillators) used in mobile radios represent a good compromise between expenditure and precision. These oscillators are easy to obtain, can be well aligned and are relatively temperature stable. The display unit processes the various standard frequencies of TCXOs that can be adjusted using solder bridges on the printed circuit board.

In order to eliminate an additional crystal the TCXO frequency is divided by 3 and used as a clock for the micro-controller. It is irrelevant here that, depending on the TCXO, the frequency can lie between 3 and 5MHz.

4. Modes Of Operation

There are three system modes for the display unit, which are selectable using the PC tool. It is actually only the representation of the display that is matched to the individual mode. The function itself is not changed.

Mode 0:

- Frequency counter with on-board pre-divider.
- Value for divider factor in PC tool: 0
- The divider factor of 1, 2, 4 or 8 can be selected through 2 external plug-in bridges (divider A, divider B), with the on-board pre-divider automatically switching. Switching by reprogramming using the PC tool is not necessary.

Mode 1 is not available at present.

Mode 2:

- Frequency display for radio sets with on-board pre-divider.
- Value for divider factor in PC tool: 255
- The divider factor of 2, 4, or 8 can be selected through 2 external plug-in bridges (divider A, divider B), with the on-board pre-divider being switched automatically. Switching by reprogramming using the PC tool is not necessary.

Mode 3:

- Frequency display for radio sets with any pre-divider:
- Value for divider factor in PC tool: 2 to 254
- The divider factor for calculating the actual frequency depends only on the value that was pre-programmed with the PC tool. This must correspond to the divider factor of the external pre-divider and can lie between 1 and 254.

All modes have the following additional functions in common:

- No Flicker Of Last Digit (NFOLD):

  A software algorithm suppresses any flickering of the last digit. The algorithm suppresses the frequent changes of the last digit displayed by ± 1 if the difference between successive counts has not exceeded 1 for some seconds. Thus the actual counter value is displayed initially, and the NFOLD mode is then activated after a few seconds. This condition is signalled by means of a star (*) after the MHz legend. As soon as the difference between successive measurements exceeds 1, the NFOLD mode is de-activated once again. This mode can be switched off through a bit in the Special area of the PC set-up tool.

- Automatic Gate Selection (AGS):

  If the gate time is 1 second, and if the difference between two successive counter values exceeds 30Hz, the gate time is automatically switched to 0.1 seconds. If the difference from measurement to measurement is again less than 30Hz for some seconds, the system automatically switches back to a gate time of 1 second.

  This function is optional and can be selected through Autogate on/off plug-in bridges. If you wish, you can activate an underline (_) as a place marker if the 1-Hz digit is missing, through a bit in the Special area of the PC set-up tool.

The general rule for the frequency input is:

- For an actual divider factor of !:
- The frequency input is pin 1 of JP2
- For an actual divider factor of 2 to 255:

The frequency input is pin 1 of JP4 for the on-board pre-divider. For other external pre-dividers use their input. The output of the on-board pre-divider (pin 2 of JP1, 2) or the output of the external pre-divider must then be connected with pin 1 of JP2.

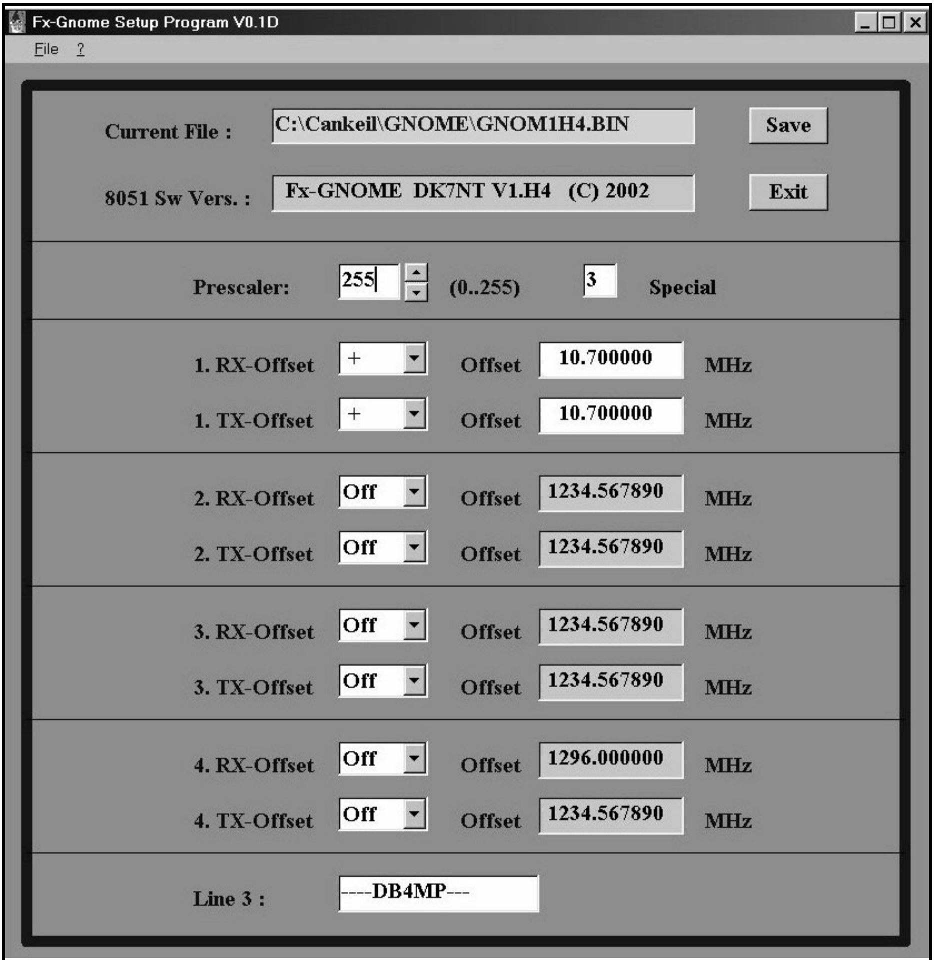

Fig 4 : This is how the Gnomesetup.exe auxiliary program looks on the screen.

If the on-board divider is not used for portable sets, it should not even be fitted; this saves current consumption. Otherwise it is automatically switched into a low-current drain mode.

4.1. Gnomesetup.exe PC Setup Tool

The set-up program is a PC program that can process the software of the micro-controller before it is programmed. For this the software for the 8051 derivative must be available in binary form (and thus not as a HEX file).

Fig. 4 shows the program interface

For every display record, the offset to the actual display must be manually calculated and entered accordingly. It can also be specified whether the offset is to be added to or subtracted from the counter value or whether no offset should be used. In this case, the counter indicates the measured frequency directly. If the pre-divider is used, the divider factor must also be entered in addition and taken into account.

The calculation formula is:

Offset display frequency ± (counter frequency * pre-divider factor) ± X

Here X indicates any value which, for example, compensates for any imprecision in the local oscillators (LO).

Let us mention once again here that the divider factors 0 and 225 have a special significance and select the mode.

The third line of the LCD display is available for any user text. However, it is a constituent part of the program of AT89C4051 and can not be altered except by re-programming the 8051 software.

The Special dot is provided for special functions. Each bit (8 options) can activate or de-activate a particular special function. The precise description can be taken from the Help function of the set-up tool.

Once all settings have been selected, the modified binary file is written back in again and is then ready for the programming of the micro-controller.

4.2. Setting options

For universal use, in addition to the general setting of "static" defaults through the PC set-up program Gnomesetup.exe, other "dynamic" setting options are available to the user. These can be implemented simply by introducing new solder bridges or through switches, without a program change.

- TCXO frequency:

  There are currently 4 frequencies that can be selected through solder bridges on the underside of the printed circuit board.

  11.3MHz, 12.8MHz, 13.0MHz and 14.85MHz via FS0, FS1, FS2.

- Gate time:

  A dynamic selection can be made between 2 (3) gate times, 1 second and 0.1 seconds (0.01 seconds possible, but function not guaranteed) via Gate A, Gate B.

- RX/TX change-over:

  An input is available for RX/TX change-over, (T/R) through Receive/Transmit. This acts on the addition/subtraction of the offset for the display.

- Offset selection:

  4 different offset pairs can be selected through 2 connections. Offset A, offset B

- Mode selection:

  4 different types of modulation can be selected through 2 connections for the display: CW, FM, LSB, USB, through mode A, mode B.

  AM can also be selected instead of LSB if pin 7 of the CPU is connected to GND through a wire bridge.

- AGS (automatic gate selection):

  This function can be switched on or off through a connection. Autogate on/off.

- Pre-divider factor:

  4 divider factors can be selected for the on-board pre-divider via 2 connections: /1, /2, /4, /8, using divider A, divider B

5.

Making One Of Your Own

As was initially stated, the targets provide for a small and low-current drain circuit. This is bound to lead to a very compact unit using SMD components. Because of its small size the CPLD cannot be dealt with neatly, except by experienced constructors. However, we are dealing with a DIY project here. So if enough interest is forthcoming there will be a follow-up article with assembly instructions. The frequency display, nicknamed FX-Gnome, has already been assembled and successfully used several times.

The PC set-up tool can be found on the compilers homepage [1], together with other instructions.

The program for the AT89C4051 (current version V1.4H) is also available there in binary form.

6. References

[1] DK 7 NT: http://www.qsi.net/dk7nt

[2] XILINX: http://www.xilinx.com/partinfo/data-book.htmcool

[3] ATMEL: http://www.atmel.com/atmel/products/

[4] MOTOROLA http://search.motorola.com/semiconductors/

[5] Conrad Electronic http://www.conrad.de

Gunthard Kraus, DG8GB

Internet Treasure Trove

PUFF and LINUX

Its taken a long time and more and more people have been asking for it. The homepage referred to below finally provides an adaptation program for operating the much-loved microwave CAD program Puff using Linux.

Of course, you have to read the instructions thoroughly. Of course, you need a free Turbopascal compiler (theres a link on the same page!). And of course theres still some delicate work to do before everythings up and running. But Linux users are used to that.

Address:

http://wwwhome.cs.utwente.nl/ptdeboer/ham/puff.html

Applied Radio Labs

This is a company in Australia that specialises in the problem area associated with VCO, PLL and noise. Thus we find here the SimPLL program for the design, optimising and simulation of PLL synthesisers. The program can be downloaded free. Of still greater interest are the basic articles on these subjects in the on-line tutorial, which you really should look at very well put together and easy to understand, in particular the sections on the basic facts about noise or sideband noise.

Address:

http://www.radiolab.com.au

Amateur Radio Download Page

There must certainly be a lot of these on the Internet, but this page offers a good mixture for various applications. Thus we find the following areas represented here:

- Legislation and regulations concerning amateur radio
- Low-frequency decoder
- Sat programs
- DSP applications
- Telex and packet radio programs
- Morse practise programs
- Weather satellite image evaluation
- Log book programs
- Locator programs
- Collected test questions, etc.

Address:

http://www.qsl.net/df0che/dwn.htm

FAISYN

The proven DOS filter calculation program, available for years, now has a Windows successor. Its easy to operate, a good, precise program, and it has the usual modern printing options. It comes over as a worthy representative of its name. However, the program must be either deleted or registered after a 30-day test period. Unfortunately, you then have to pay $99...

Address:

http://members.aol.com/faisyn/faisyn-.htm

Technical University Of Munich

The Electro-Technical Institute has collected some interesting things that can be downloaded from its RF section. We dont merely find collections of formulae and nomograms for all possible areas of high-frequency engineering here. This homepage is also very important as a source of diagrams with, in particular, the current limiting values for the electrical and magnetic field strengths of signals.

Address:

http://www.hfs.ei.tum.de

MSTRIP40

The title story in issue 2/2002 of VHF Communications dealt with this free EM simulator, and there are some good new features here. Professor Splitt has now posted the unrestricted full version on his homepage to be downloaded. The program makes it possible to simulate structures with a maximum of 5 layers.

The above article is available as a pdf file from the VHF Communications web site. In addition, the same article, in German, from issue 4/2001 of UKW Berichte can be obtained as a pdf file from the site below as German Operating Instructions. One particularly nice touch the many diagrams that unfortunately appeared only in black and white in the article are now suddenly aglow with their dazzling original colours!

I did find a printing error when I looked through the material, though. In Section 3, I used the Meteosat patch antenna as a typical example, and determined the radiation resistance in the fifth step. Almost everywhere (and in Fig. 17 too), we refer to a circuit with radius r = 0.7 for the reflection factor at the resonance point and for the rotation process which must be undertaken with the cursor. It would have to be in the text where we are instructed to rotate to the display rho - 0.07. Sorry, I really am, because the value of rho 0.7 is naturally the logical and correct choice!

Address:

http://www.intek.e-technik.th-kiel.de/splitt.htm

Microwave Engineering

This is one of those typically American technical reviews (similar to Microwave Journal) with a motley assortment of advertising, situations vacant and technical articles, which can be obtained free of charge following registration. There are also sections such as News or Features, which represent outstanding sources of information for the specialist. And you can also search the archives of previous issues.

It is also worth mentioning a new subsidiary site, which is concerned only with the area of modern semi-conductor engineering. The name chosen for it, GaAs-

NET is highly appropriate.

Address 1:

http://www.mwee.com

Address 2:

http://www.gaasnet.com

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Tel: +44 1582 581051
Fax: +44 1582 581051

Email: andy.@vhfcomm.co.uk

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BELGIUM - UKW-BERICHTE, POB 80, D-91081 BAIERSDORF, Germany. Tel: 09133-77980. Fax: 09133-779833 . Postgiro Nbg. 30445-858.

DENMARK - KM PUBLICATIONS , 63 Ringwood Road, LUTON, LU2 7BG, UK. Tel: +44 1582 581051. Fax: +44 1582 581051. Email: vhfsubs@vhfcom-m.co.uk

FRANCE - Christiane Michel F5SM, Les Pillets, 89240 PARLY, France
Fax: (33) 03 86 44 08 82 Tel: (33) 03 86 44 06 91

FINLAND - KM PUBLICATIONS , 63 Ringwood Road, LUTON, LU2 7BG, UK. Tel: +44 1582 581051. Fax: +44 1582 581051. Email: vhfsubs@vhfcomm.co.uk

GERMANY - UKW-BERICHTE, POB 80, D-91081 BAIERSDORF, Germany. Tel: 09133 7798-0. Fax: 09133 779833.

GREECE - KM PUBLICATIONS , 63 Ringwood Road, LUTON, LU2 7BG, UK. Tel: +44 1582 581051. Fax: +44 1582 581051. Email: vhfsubs@vhfcomm.co.uk

HOLLAND - KM PUBLICATIONS , 63 Ringwood Road, LUTON, LU2 7BG, UK. Tel: +44 1582 581051. Fax: +44 1582 581051. Email: vhfsubs@vhfcomm.co.uk

ITALY - R.F. Elettronica di Rota Franco, Via Dante 5 - 20030 Senago, MI, Italy
Fax 0299 48 92 76 Tel. 02 99 48 75 15

NEW ZEALAND - KM PUBLICATIONS , 63 Ringwood Road, LUTON, LU2 7BG, UK. Tel: +44 1582 581051. Fax: +44 1582 581051. Email: vhfsubs@vhfcomm.co.uk

NORWAY - WAVELINE AB, Box 60224, S-216 09 MALMÖ, Sweden. Tel: +46 40 16 42 66. Fax: +46 40 15 05 07. GSM: 0705 16 42 66
e-mail: waveline@algonet.se http://www.algonet.se/~waveline

SOUTH AFRICA - KM PUBLICATIONS , 63 Ringwood Road, LUTON, LU2 7BG, UK. Tel: +44 1582 581051. Fax: +44 1582 581051. Email: vhfsubs@vhfcomm.co.uk

SPAIN & PORTUGAL - JULIO A. PRIETO ALONSO EA4CJ, Donoso Cortes 58 5° -B, MADRID 15, Spain. Tel: 543 83 84

SWEDEN - WAVELINE AB, Box 60224, S-216 09 MALMÖ, Sweden. Tel: 040 16 42 66. Fax: 040 15 05 07. GSM: 0705 16 42 66 e-mail: waveline@algonet.se http://www.algonet.se/~waveline

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UNITED KINGDOM - KM PUBLICATIONS , 63 Ringwood Road, LUTON, LU2 7BG, UK. Tel: +44 1582 581051. Fax: +44 1582 581051. Email: vhfsubs@vhfcomm.co.uk

U.S.A. - GENE HARLAN, ATVQ Magazine, 5931 Alma Drive, Rockford, IL 61108, USA. Tel: Toll free USA only: 800 557 9469; Elsewhere: +1 815 398 2683; Fax: +1 815 398 2688
Email: atvq@aol.com

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