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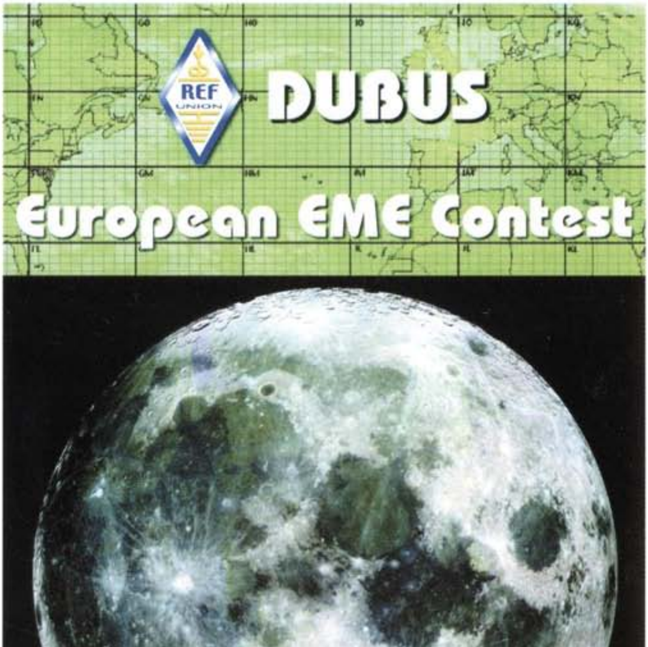
EU EME Contest: New Award



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Editorial

Dear DUBUS Reader!

Here is the summer issue 2006. The summer was hot and so was propagation. At least on 6m, 4m and 2m the Sporadic-E season was terrific. May be normal because we are in the minimum of the solar cycle who knows.... A new world record QSO took place on 2m between EA8 and YO4 over 4200km. In June and July there were several (!) days with double hop Sporadic E on 2m. On 4m also a new world record was set between CU8 and SV2. On 6m there have been dozens of days with multi hop Sporadic E from Europe into Japan and the Caribbean. Japan was wkd even from CT over 11.200km and hrd by 5T5SN, a new RX distance record. On the microwave bands a lot of thunderstorms and rain brought many nice QSOs via Rain Scatter. Expeditions to CT3, 4S, 7Q, C9 and other made the summer season interesting also for the EME freaks. So propagation wise nobody should complain.

In a few days there will take place the EME conference in Würzburg. The situation regarding CW and Digital is still unpleasant. The 70cm and up CW guys don't want to be bothered with the digital stuff any more although probably JT65 will be the dominating mode at least on 70 and 23cms very soon. From the digital lobby there is coming a proposal for new QSO rules intending to lower the necessary amount of transferred information content for a complete QSO to 16 bit. For sure this should be decided by IARU.

In Germany we have free press and DUBUS does no censorship on any articles or comments. This does not mean that we agree to all what is printed. So in case you disagree to something please send us your comments and we will print them.

Four years ago we have made a poll regarding the future content of DUBUS Magazine. We think that it is time again to ask the readers what they want to read in the future. Internet still changes a lot nowadays and we need to know in which direction we should go in the future. We plan to make the poll in the next issue 4/2006. So now we invite you to make suggestions about what we should ask in this poll.

Please keep sending your technical articles and activity reports to keep the magazine interesting and alive! Thank you!

73 from Joe, DL8HCZ / CT1HZE
and the DUBUS team!

Liebe DUBUS Leser!

Hier ist die Sommer-Ausgabe für 2006. Der Sommer war heiss, genauso wie die Bedingungen. Zumindest auf 6m, 4m und 2m war die Es-Saison unglaublich. Vielleicht ist das normal, weil wir uns im Sonnenfleckenminimum befinden, aber wer weiss das schon genau.... Ein neuenr Sporadic-E-Weltrekord über 4200km zwischen EA8 und YO4 wurde aufgestellt. Im Juni und Juli gab es mehrere Tage (!) mit Doppelhop-Öffnungen auf 2m. Auf 4m gibt es ebenfalls einen neuen Weltrekord zwischen CU8 und SV2. Auf 6m gab es dutzende von Tage mit Multihop-Es nach Japan und in die Karibik. Japan wurde sogar von CT aus über 11200km erreicht und von 5T5SN aus gehört, ein neuer RX Entfernungsrekord. Reichlich Gewitterregen sorgte für viele Regensactter-Verbindungen auf den Mikrowellenbändern. Expeditionen nach CT3, 4S, 7Q, C9 u.a. machten die Sommer-Saison auch für EME-Freaks interessant. Was die Bedingungen angeht, braucht man sich also nicht zu beklagen.

In einigen Tagen findet die EME-Konferenz in Würzburg statt. Die Lage bezüglich CW – Digital ist immer noch unerfreulich. Die 70cm + höher OPs wollen nichts mehr von dem digitalen Kram wissen, obwohl wahrscheinlich JT65 zumindest auf 70 und 23cm wohl bald die dominierende Betriebsart sein wird. Von der digitalen Lobby gibt es einen Vorschlag die Mindestanforderungen an den zu übertragenden Informationsgehalt für ein gültiges QSO auf 16 bit zu reduzieren. Sicherlich sollte darüber nur die IARU entscheiden.

In DL haben wir Pressefreiheit und DUBUS zensiert eingehende Artikel oder Kommentare nicht. Das heisst natürlich nicht, dass wir inhaltlich zu allem zustimmen, was abgedruckt wird. Falls jemand Kritik an einem Artikel üben möchte, drucken wir das gerne ab.

Vor 4 Jahren haben wir eine Umfrage zum zukünftigen Inhalt des DUBUS Magazins durchgeführt. Wir denken, dass es nun an der Zeit ist, die Leser erneut zu fragen, was in der Zukunft gedruckt werden soll. Das Internet ändert heutzutage nach wie vor viel und wir möchten wissen, welchen Weg DUBUS in der Zukunft gehen soll. Wir planen die Umfrage im nächsten Heft 4 durchzuführen. Wir bitten nun auch um Vorschläge, was für Fragen wir stellen sollen.

Bitte senden Sie weiter Ihre technischen Artikel und Aktivitätsberichte an die DUBUS, vielen Dank!

Vy 73 von Joachim, DL8HCZ / CT1HZE
und vom ganzen DUBUS-Team!

A Simple PANFI (SPANFI) – Concept and Implementation

by Ingo Gaspard, DF1VH, DF1VH@darc.de

Abstract

In this article a simple precision automatic noise figure indicator (SPANFI) for amateur use is described. With this equipment the measurement of gain and noise figure e.g. of preamplifiers for EME application is possible at the same time where measurement update rate is sufficient to allow real-time tuning of the device under test. Accuracy of the instrument is sufficient to measure noise figures below 1 dB in the frequency range up to 500 MHz by the use of noise generators of known excess noise ratio (ENR). As in commercial equipment higher frequency application is possible by use of external mixers and depends then only on the frequency range of the noise generator.

1. Introduction

In EME application the receiver performance is mainly determined – besides the antenna system – by the noise figure and gain of the first amplifier following the antenna. That holds also for new digital modes and the topic is therefore of interest for every EME enthusiast still today. Commercial equipment for measurement of noise figure and gain, like the famous HP8970 [5], is nearly not available on the surplus market and if so the price is out of reach for the average amateur. On the other hand solid state noise generators with calibrated ENR values which are a prerequisite for accurate and repeatable noise figure measurement results are available on nearly every ham flea market at affordable prices.

Different PANFIs where described in amateur radio literature in the past either as stand-alone equipment [1], [2] or as add-on for existing spectrum analyzers [3]. All these designs are some years old and thus this article aims at a more modern and at the same time simpler solution with at least the same accuracy.

The described PANFI is based on the well-known y-factor approach and here signal processing, control of noise source, A/D converter and display is performed by a small micro-controller. Also the RF part of the instrument is as simple as possible and makes use of standard modern semiconductor parts and an external RF bandpass filter for the frequency of interest without mixing to intermediate frequencies.

The outline of the article is as follows. In the next chapter some theory providing the basics of the measurement principle is given. Analysis of the logarithmic detector as key element of the PANFI follows the ideas of [6]. Chapter 3 describes the implementation including details on hardware and software as well as on alignment. Measurement examples are given in chapter 4 and show the appropriateness of the implemented solution. Conclusions and some ideas on further enhancements are given in the last chapter.

2. Theory of operation

The basic equation which is evaluated in the described simple precision noise figure indicator is given by

$$F = ENR - 10 \cdot \log10(y-1) \qquad (1)$$

where F is the noise figure in dB, ENR = 10*log10((T_hot-T_cold)/To) is the excess noise ratio of the noise source in dB connected to the input of the device under test (D.U.T.) and

$$y = Pon/Poff \qquad (2)$$

is the ratio of average noise powers Pon and Poff at the output of the D.U.T. delivered to the indicator. Pon corresponds to the case where the noise generator at the input of the D.U.T. is switched "on" (delivering noise temperature T_hot) whereas Poff is the D.U.T.s output power when the noise generator at the input is switched off (delivering noise temperature T_cold).

Eq. (1) is based on several simplifications:

1. The ambient temperature during the measurement is equal to the reference temperature To = 290 K (= 17 °C) and corresponds to the cold temperature of the noise source: To = T_cold.
2. The reflection coefficient of the noise source is zero for "on" as well as for "off" state. Thus there is no gain error apparent, see [2].
3. The noise figure of the indicator which measures the y factor is zero. Thus noise figure of the indicator in terms of a cascaded second stage contribution can be neglected.

More details and the derivation of Eq. (1) can be found in [2] and [5].
In this article we will emphasise on how to measure the y factor. As given in Eq. (2) it is the ratio of two power values which are both considered as originated from random motion of charge carriers, e.g. electrons in electrical conductors, caused by thermal agitation. This noise is called thermal noise, Nyquist noise, or Johnson noise [11]. The number of electrons is large and their motions are independent. Therefore, the variation in the rate of current flow or corresponding voltage across a resistor takes on a Gaussian probability density function (PDF) in accordance with the central limit theorem from statistics. Whereas the Gaussian PDF holds directly for thermal noise voltages in base-band the situation for band-passed noise is a little bit more complicated: using the in-phase (I) and quadrature (Q) representation of a bandpass signal, for both independent I- and Q-components the Gaussian PDF holds. The envelope or magnitude of the noise signal is given by

$$v_{env} = \sqrt{v_I^{\,2} + v_Q^{\,2}} \qquad (3)$$

where v_I is the in-phase and v_Q is the quadrature Gaussian distributed component of the noise.
The probability density function of v_{env} is no longer Gaussian distributed but its PDF is given by a Rayleigh distribution where

$$PDF(v_{env}) = \frac{v_{env}}{\sigma^2}\exp\left(-\frac{1}{2}\left(\frac{v_{env}}{\sigma}\right)^2\right) \qquad (4)$$

and σ^2 is the variance of the envelope voltage.

Due to dynamic range reasons e.g. in spectrum analyzers as well as in this SPANFI a logarithmic detector is used. Thus the Rayleigh PDF according Eq. (4) will change if we apply logarithmic processing to the envelope voltage. The log amplification acts as a compressor for large noise peaks; a peak of ten times the average level is only 10 dB higher. Instantaneous near-zero envelopes, on the other hand, contain no power but are expanded toward negative infinity decibels. Fig. 1 out of [6] shows a Rayleigh PDF according to Eq. (4). In Fig. 2 taken from [6] the PDF of the envelope after log processing is depicted.

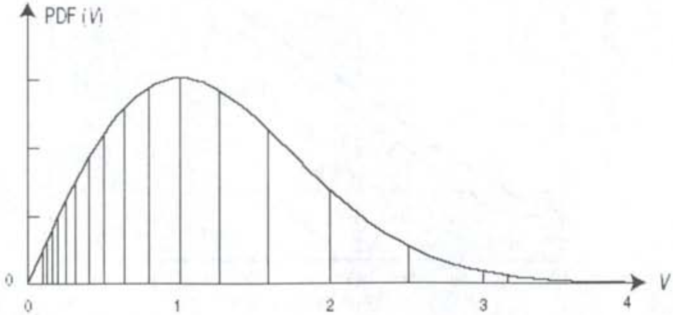

Fig. 1: Rayleigh distribution of noise envelope voltage taken from [6].
Abb. 1: Rayleigh-Verteilung der Rauschspannungshüllkurve, aus [6].

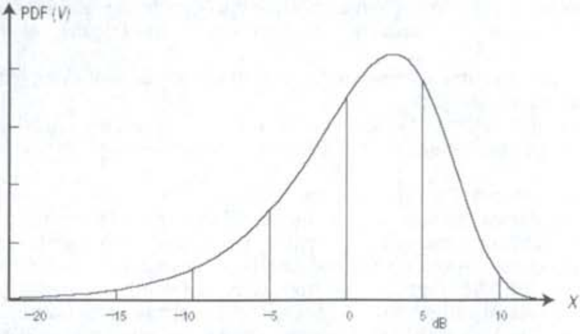

Fig. 2: Distribution of noise envelope voltage after log processing taken from [6].
Abb. 2: Verteilung der Rauschspannungshüllkurve nach Logarithmierung aus [6].

At the end we are interested in the average power coming from a series of instantaneous voltage values following the PDF according to Fig. 2. By averaging instantaneous power values, each calculated as a squared voltage value following the distribution in Fig. 2 divided by a resistor R the standard deviation of the result will decrease as the number N of instantaneous power measurements is increased corresponding to the following equation from [6]:

$$\sigma_m = 5.57dB/\sqrt{N} \quad (5).$$

In other words: if we take 10000 instantaneous noise power measurements where the results are given in dBm and average these values the average power of the noise can be determined with a standard deviation of less than 0.06 dB. The underestimation of the absolute value of our result e.g. due to averaging of log values instead of log processing of the average is not important due to the fact that we are dealing with noise power ratios as in Eq. (2) or differences of log values and that this kind of constant error is canceled when subtracting the two log values.

Real world log amplifiers suffer from a limited range: lower limit is given by noise floor and upper limit is determined by clipping. In Fig. 3 the log response of an AD8307 [7] at three different frequencies is shown. Below an input power of approx. –65 dBm noise is dominating and above + 10 dBm clipping can be seen.

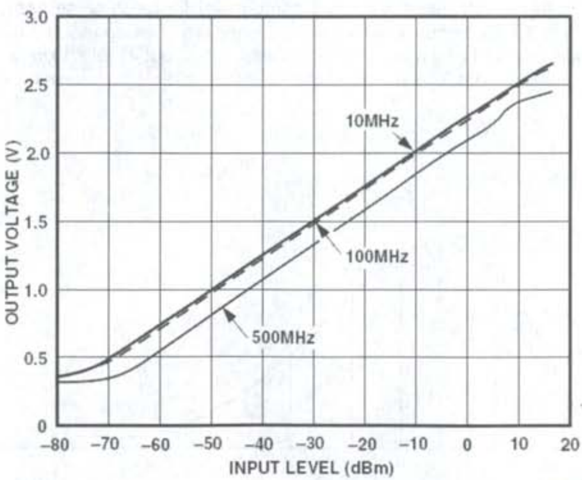

Fig. 3: Output voltage of the AD8307 at three different frequencies.
Abb. 3: Ausgangsspannung des AD8307 für drei verschiedene Frequenzen.

To hold the error in average noise power measurement below 0.1 dB due to these clipping effects the average noise power to be measured should be kept > 14 dB above the lower range limit of the log amplifier – in our AD8307 example > - 51 dBm. On the other hand to keep clipping effect error below 0.1 dB at the higher limit of the log amplifier range average noise power should be kept at least 7 dB below that limit – in our AD8307 example < + 3dBm [6].

At this point we are able to measure the y-factor of noise powers from Eq.(2) by using a log amplifier and averaging its instantaneous results to the required standard deviation of the result.
As mentioned before the derivation of noise power measurement was done for bandwidth limited noise. That bandpass limitation has to be chosen according different criteria:

1. The bandwidth should be small enough to allow a sufficient frequency resolution because we would like to have the noise figure result as a function of frequency.
2. The bandwidth should be as large as possible to keep additional amplification in front of the log detector/amplifier low. Remember that the available noise power is proportional to the bandwidth: Pn = kTB (k: Boltzmann constant, T: temperature, B: bandwidth), e.g. Pn = -104 dBm at room temperature in 10 MHz bandwidth.
3. We need statistical independent instantaneous noise power measurements to be averaged. As a rule of thumb the time difference between two successive instantaneous power measurements should be larger than 1/B to fulfil that demand. At the same time we would like to have a fast measurement repetition time to allow real-time alignment of the D.U.T., e.g. a preamplifier. In case of a small bandwidth we would require a long time between successive instantaneous power measurements to have them all statistical independent from each other and averaging of many values would be a lengthy task. Therefore we should allow the bandwidth to be as wide as possible.

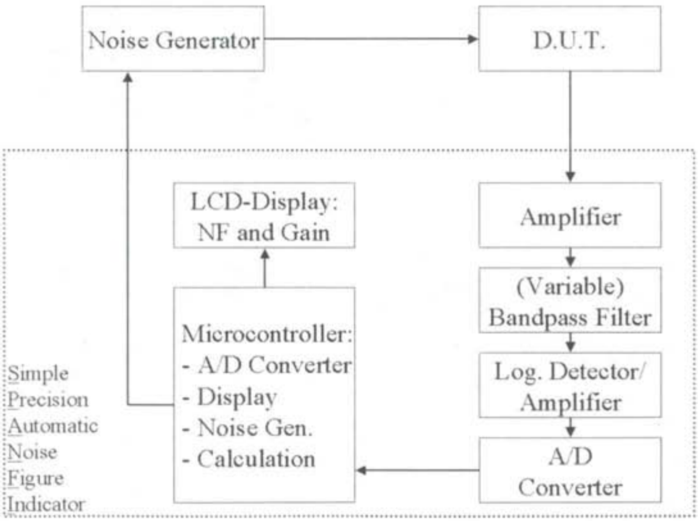

Fig. 4: Main building blocks of a SPANFI and measurement set-up.
Abb. 4: Hauptbestandteile eines SPANFI und Meßanordnung.

3. Implementation

3.1 General concept

In this chapter the implementation of a simple precision automatic noise figure indicator based on the theory introduced in the previous chapter is described in detail. Fig. 4 shows the main building blocks and the principle measurement set-up. A device under test is fed at its input by a noise generator of known ENR value. The D.U.T.s output is followed by a low noise broadband amplifier to bring the noise level to a value which can be processed later by the log amplifier / detector. In front of this stage a bandpass filter is inserted to allow frequency dependent measurements. Whereas it is desirable to use variable bandpass filtering here also fixed bandpass filtering e.g. for 144 MHz or 430 MHz could also be used. After log amplification / detection the result is A-to-D converted and the result is further processed in a micro-controller. The micro-controller performs averaging of instantaneous power values as well as control of the noise generator by means of switching it on and off. On the basis of the measured y-factor Eq. (1) is evaluated by a look-up table. To allow also gain measurements the noise power without the D.U.T. is measured during a calibration phase when switching on the SPANFI. Thus the actual gain is simply given by the difference of the log noise power measured with D.U.T. and without each when the noise generator is switched on.

3.2 Hardware

According to Fig. 4 a hardware to realise the SPANFI was developed. In Fig. 5 the circuit diagram of RF part of the SPANFI is depicted. The input of the circuit is connected to the output of the D.U.T. and consists of a three stage broadband amplifier each stage build of an ERA-3 with was chosen as a compromise of gain and noise figure. Between the second and the third stage an external variable bandpass filter is inserted which determines centre frequency and bandwidth of the measurement. Taking into account the insertion loss of the bandpass filter the overall gain of this amplification is about 65 dB. At the output of the third stage an AD8307 as log amplifier / detector is used. Its input is terminated with a resistor of 52 Ohms. In the original prototype realisation a Texscan/Trilithic variable octave bandpass filter either 5VF125/250-2-50-CC (125 MHz ...250 MHz) or 5VF250/500-2-50-CC (250 MHz ... 500 MHz) is used. The bandwidth of these filters is a constant fraction of 2% of the centre frequency, e.g. 2.5 MHz @ 125 MHz or 10 MHz @ 500 MHz centre frequency.

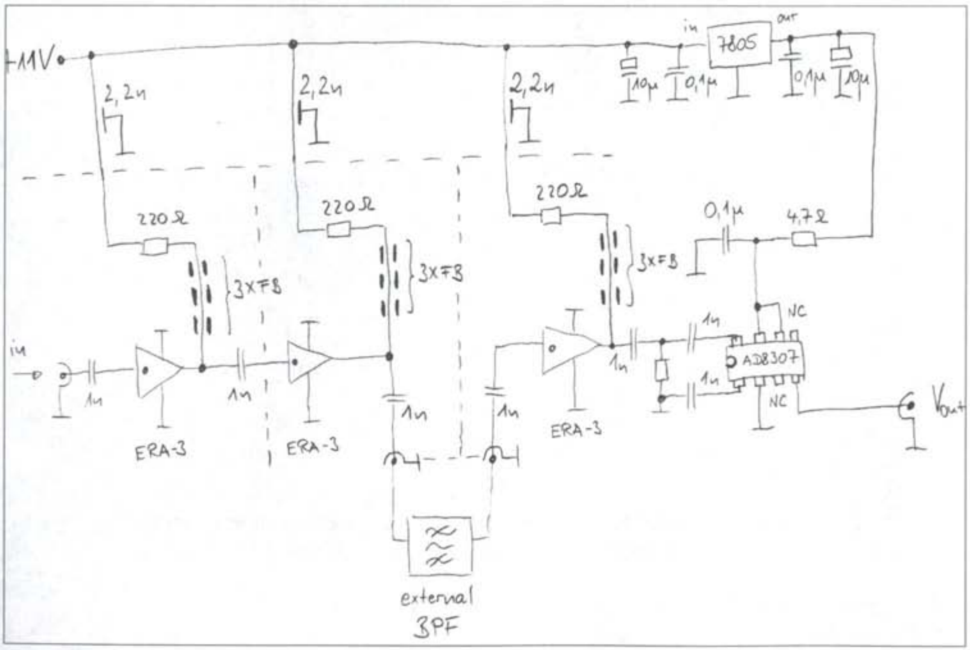

Fig. 5: RF part of the SPANFI.
Abb. 5: HF-Teil des SPANFI.

In Fig. 6 the RF part construction as "dead-bug" style within a shielded box is shown.

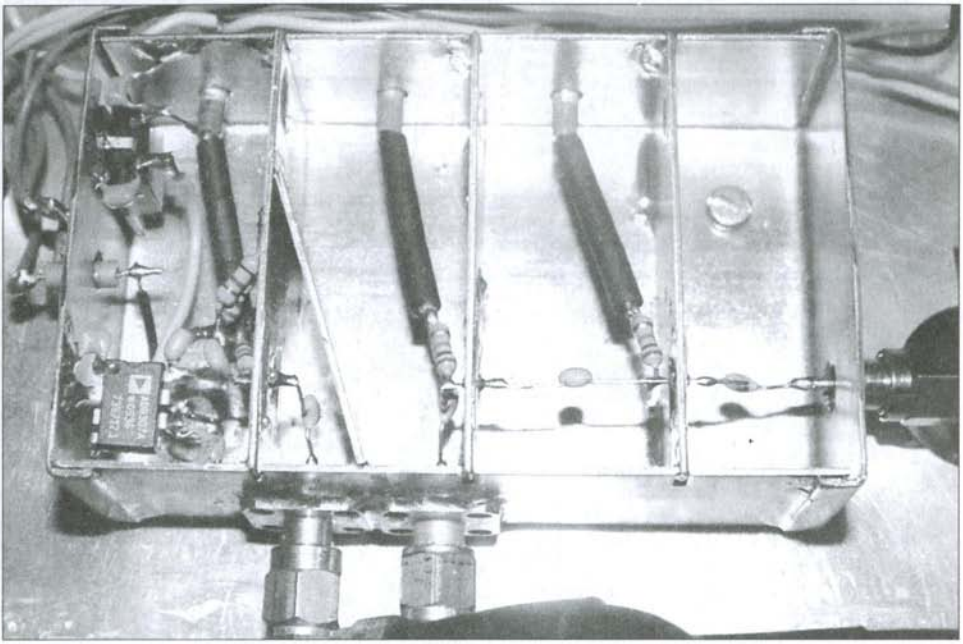

Fig. 6: "dead-bug" style construction of RF part in shielded box.
Abb. 6: Konstruktion des HF-Teils im "dead-bug" Stil in geschirmten Gehäuse.

The output voltage of the RF part in Fig. 5 is fed without any buffering into the A/D converter input of the digital part of the SPANFI depicted in Fig. 7. The A/D converter is a 12 Bit resolution LTC1860 which allows fast conversion of up to 250 ksps. Thus a fast measurement repetition is ensured. With the reference voltage of 4.095 V derived from the supply voltage a resolution of 1 mV is given. Together with logarithmic slope of typical 25 mV/dB of the AD8307 that results in 0.04 dB resolution for the least significant bit of the digital result. The main part of the digital circuit is an Atmel controller AT90S2313 clocked at 10 MHz which generates chip select and clock signals for the LTC1860 and switches the noise generator via an opto-coupler CNY-17 which can deliver a current of typical 20 mA for commercial noise generators like the Ailtech 7615 or HP456b. Also processing – described in further detail in the software chapter – as well as result display by means of two LEDs and a two-line LCD module is performed by this controller. Depending on the switch – "ENR1" and "ENR2" – two different ENR values for the noise generator are provided in the software. As mentioned an Ailtech 7615 with a nominal ENR of 15 dB is used. To realise a nominal ENR of 5dB the Ailtech 7615 together with a precision attenuator of 10 dB at its output is used. The resulting noise generator is of advantage due to an enhanced RF reflection behaviour, see [2], as well as a lower required dynamic range of the log amplifier in comparison to high value ENRs. Fig. 8 shows the realisation.

The last building block is the power supply given in Fig. 9. There is nothing special besides the series Zener diode – here a ZX10 - in the 28 V path in front of the variable voltage regulator uA78MG. That Zener diode together with the 10 kOhm resistor to ground limits the maximal voltage for the regulator input. Realisation of that part of the SPANFI is given in Fig. 10.

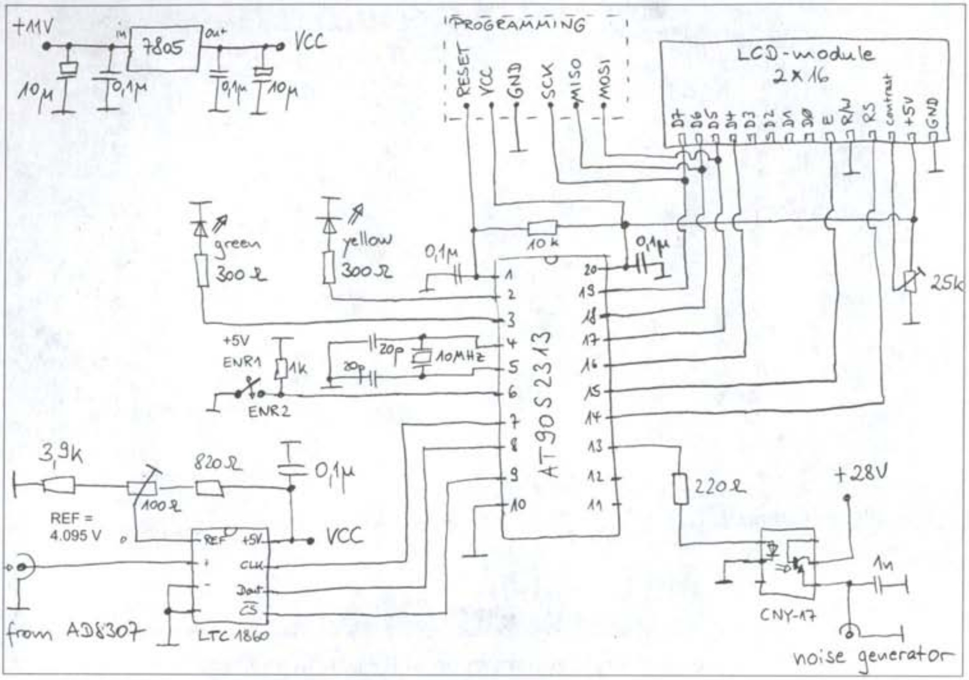

Fig. 7: Circuit diagram of the digital part of the SPANFI.
Abb. 7: Schaltbild des digitalen Teils des SPANFI.

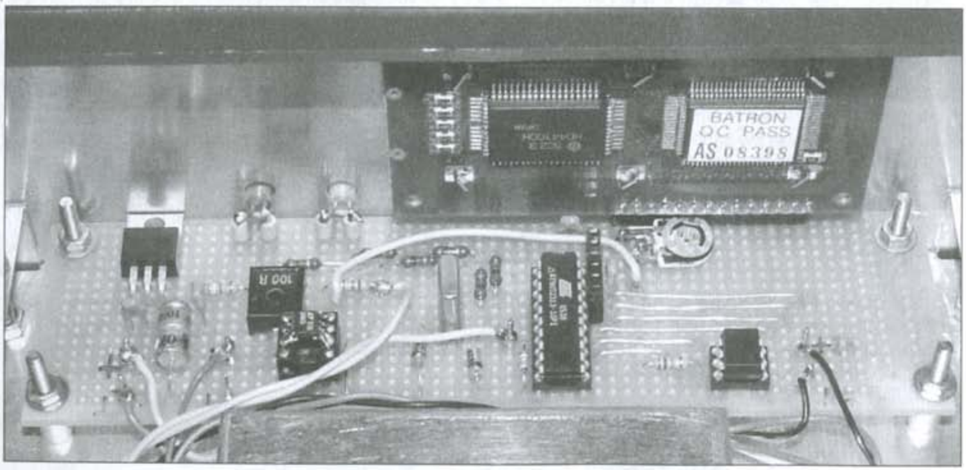

Fig. 8: Realisation of the digital part of the SPANFI.
Abb. 8: Realisierung des digitalen Teils des SPANFI.

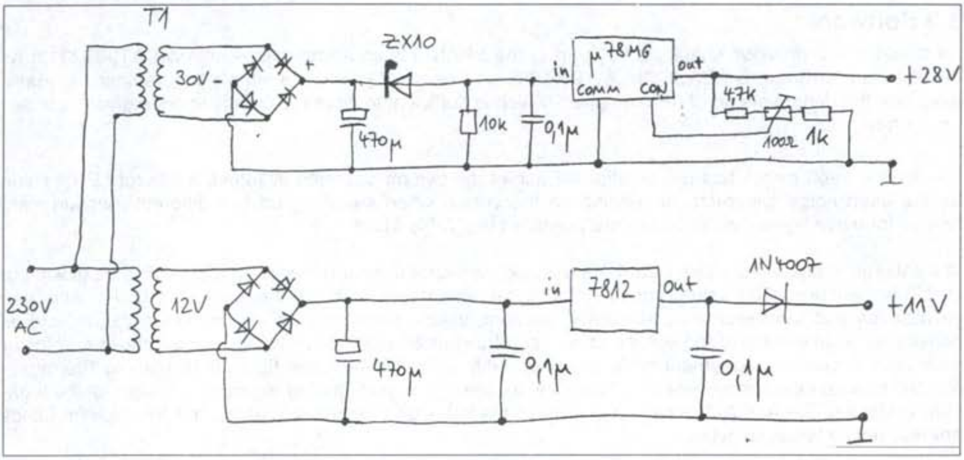

Fig. 9: Power supply circuit of the SPANFI
Abb. 9: Schaltbild des Netzteils des SPANFI.

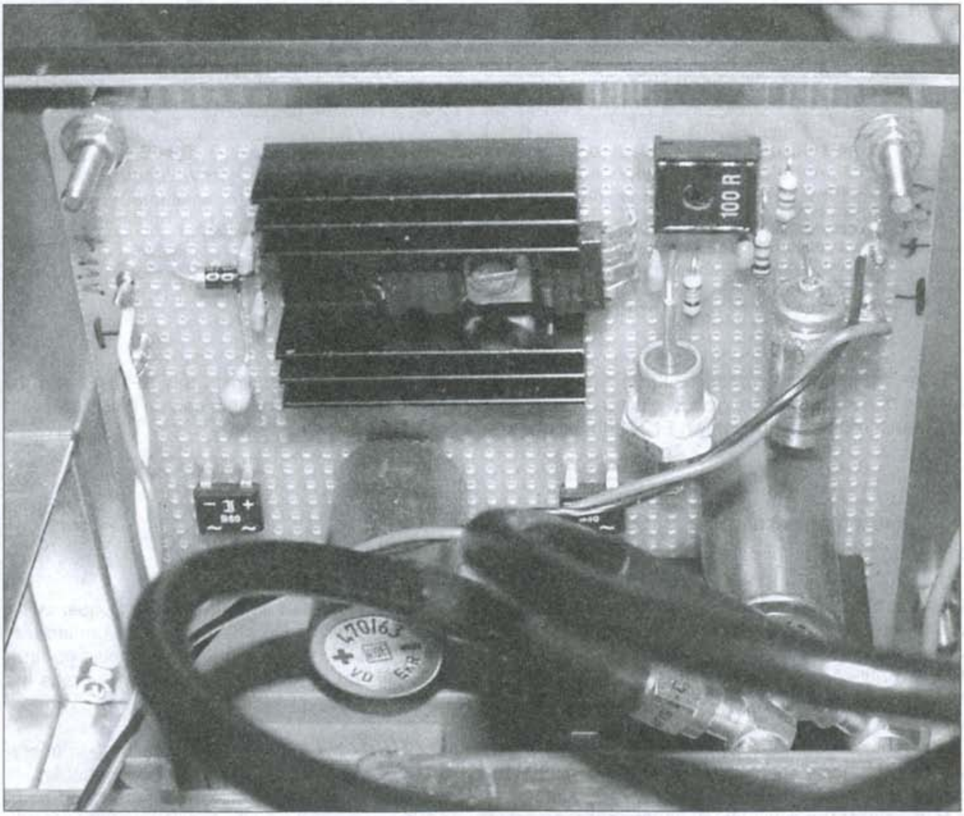

Fig. 10: Realisation of power supply.
Abb. 10: Realisierung des Netzteils.

3.3 Software

As stated in the previous chapter a key part of the SPANFI is an Atmel micro-controller AT90S2313. As development environment BASCOM-AVR-BASIC was used [10]. Besides simple programming in Basic language the demo version of this compiler - which is sufficient to write the complete code given in annex - is for free.

The mains on/off switch has two positions. Each of the two on positions assumes a different ENR value for the used noise generator: depending on the choice when switching on two different measurement ranges for noise figure measurement are possible (see Table 1).

In a calibration phase the noise power of the noise generator directly connected to SPANFI's input without D.U.T. is measured. This value is used in the measurement loop to derive the gain of the D.U.T. After that initialization and calibration a continuously repeating measurement loop is started where the Y factor is derived as a difference of log values of averaged instantaneous power values. According the Y factor measured in each measurement cycle a look up table value for the noise figure is displayed. The implemented look up tables represent Eq. (1) as well as some "software" tuning regarding variation of the logarithmic slope of the AD8307 which is typically 25 mV/dB. Due to memory reasons the two look up tables are realized as tables of bytes.

In Table 1 the main properties of the SPANFI with the actual software implementation are given.

	NF range 1	**NF range 2**
ENR of noise generator	15.53 dB	5.93 dB
Number of averaged instantaneous power measurements	N = 4096	N = 8192
Standard deviation of averaged power measurements, see Eq. (5)	σ_m = 0.087 dB	σ_m = 0.062 dB
Resolution of power measurement (25.55 mV/dB measured slope of AD8307 and 1 mV resolution of A-to-D conversion)	0.1566 dB/4mV (4mV stepsize is evaluated)	0.039 dB/mV (1mV stepsize is evaluated)
Noise figure range	0 ... 21 dB	0.04 ... 2.51 dB
Measurement update rate / duration of one measurement cycle	~ 3 sec.	~ 6 sec.

Table 1: Main properties of SPANFI.

It is recommended to measure the actual log slope of the AD8307 when building this SPANFI, e.g. by means of a signal generator and a precise attenuator. Then individual look up table can be calculated with the measured slope, the known ENR and Eq.(1).

4. Measurement examples

In Fig. 11 the parts for different measurement examples are depicted.

In a first measurement the noise figure of the SPANFI itself was measured as a function of frequency for the three different noise sources shown in Fig. 11. The result is given in Fig. 12. It should be noted that even for the same nominal ENR value of 15.5 dB significant differences between the three noise generators are obtained. The upper two curves are for two different Ailtech 7615 noise generators whereas the lower curves holds for a HP346b source.

Taking into account the typical noise figure of 3.5 dB @ 2 GHz for the ERA-3 and the calibration uncertainty of the noise sources – e.g. for the HP346b that is +/- 0.3 dB - the results seem to be reasonable.
In a second measurement example two commercial low noise amplifiers [9] were measured and compared against the available measurement protocol. The results are given in Table 2. Again results for gain and noise figure seem very reasonable and differences regarding noise figure lay well within calibration uncertainty of the noise generator.

Fig. 11: SPANFI, variable octave bandpass filters,
miComm LNAs (as D.U.T.s), different noise generators and fixed attenuator.
Fig. 11: SPANFI, variable Oktaven-Bandpassfilter,
miComm LNAs (als D.U.T.s), verschiedene Rauschgeneratoren und Abschwächer.

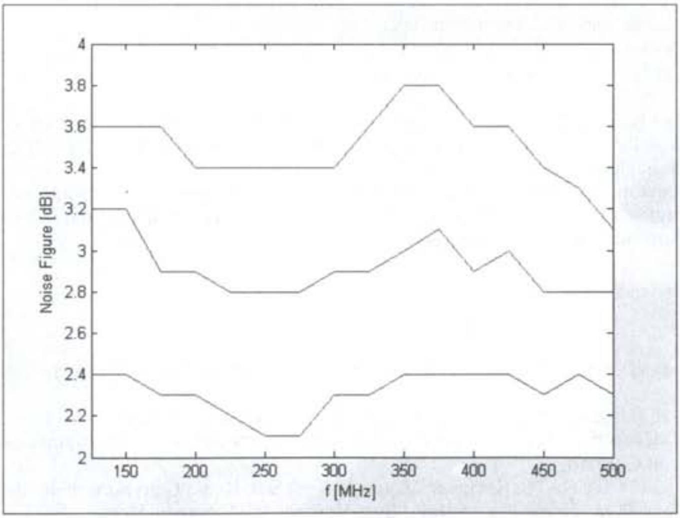

Fig. 12: Noise figure of the SPANFI as function of frequency for three different noise generators of nominal ENR = 15.5 dB: upper two curves for two different Ailtech 7615, lower curve for HP346b.

Abb. 12: Rauschzahl des SPANFI als Funktion der Frequenz für drei verschiedene Rauschgeneratoren mit nominalem ENR von = 15.5 dB: Die oberen zwei Kurven für zwei verschiedene Ailtech 7615, die untere Kurve für HP346b.

D.U.T.	Measurement results with SPANFI, ENR = 5.93 dB (Ailtech 7615 #9282 plus Weinschel 9,6 dB attenuator)	Values given in measurement protocol by DB6NT
144 MHz LNA miComm "L144QM" SN: #0120	NF = 0.13 dB Gain = 27.4 dB	NF = 0.21 dB Gain = 28.6 dB
432 MHz LNA miComm "L432QM" SN: #0128	NF = 0.09 dB Gain = 20.6 dB	NF = 0.33 dB Gain = 21.3 dB

Table 2: Comparing preamplifier measurement results.

5. Conclusions

In this article the concept and realization of a simple precision automatic noise figure indicator (SPANFI) was presented. Mainly two ideas were realized which make this SPANFI different from former PANFI implementations:

- Broadband noise amplification and use of a (variable) RF bandpass filter instead of a more complex superhet principle with mixing to and filtering at an IF.
- Digital averaging for decreased standard deviation of the measured power instead of analogue averaging/integration by (analogue) low pass filtering.

These ideas make realization much more simpler. However further improvements are possible by use of a "larger" microcontroller:

- Calculation of logarithm instead of look-up table.
- Consideration of the noise figure of the SPANFI itself in noise figure calculation of the D.U.T. (cascaded noise figure calculation).
- More accurate gain calculation (see [5]).
- Temperature compensation if ambient temperature is not 290 K.
- Faster A-to-D conversion, thus higher measurement rate.

Instead of variable bandpass filtering a couple of bandpass filters for fixed centre frequencies of interest could be used. Also the use of higher input frequency log amplifiers, like the AD8313 [7], could be realized – but at a decreased dynamic range.

I would like to thank my friend Bodo, DL2FCN, for his critic encouragement and some nice measurement evenings in his shack and Heinz, DJ5FN, for some comparing measurements in the microwave laboratory at University of Applied Science in Darmstadt.

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Annex: Source Code of Controller

```
'SPANFI: Simple Precision Automatic Noise Figure Indicator
'- ADC: LTC 1860
'- LCD: 2x16
'- switching of noise source at PB1
'- LED yellow at PD0 to show "on" state of noise generator
'- LED green at PD1 to show that calibration is finished
'
'*** v 0.2, date: 13.Feb.2006
'***
'*** DF1VH
'***
$regfile = "2313def.dat"              'AT90S2313
$crystal = 10000000                   'Quarz: 10 MHz

Dim A As Integer                      'temp var for ADC
Dim Resa As Integer                   'var for ADC result / noise figure in dB
Dim K As Byte                         'run var / gain
Dim L As Integer


Dim P1n As Long                       'power during calibration: noise generator connected to input of SPANFI
Dim P2f As Long                       'power at output of D.U.T. with noise generator "off" at input
Dim P2n As Long                       'power at output of D.U.T. with noise generator "on" at input
Dim N As Integer                      'number of averaged values
Dim Y As Integer                      'Y factor
Dim S As Byte                         'shift value


Ddrd.0 = 1                            ' port for yellow LED as output
Ddrd.1 = 1                            ' port for green LED as output
Ddrd.2 = 0                            ' ENR switch
Ddrd.3 = 1                            ' port for ADC Clock
Ddrd.4 = 0                            ' port for serial ADC result input
Ddrd.5 = 1                            ' port for CS of ADC


Ddrb.1 = 1                            ' port for noise generator switching


' alias names for adc control
Clk Alias Portd.3
Cs Alias Portd.5


Config Lcd = 16 * 2
Config Lcdpin = Pin , Db4 = Portb.4 , Db5 = Portb.5 , Db6 = Portb.6 , Db7 = Portb.7 , E = Portb.3 , Rs = Portb.2
Initlcd
Cls
Cursor Off

Main:
'intro
Cls
Lcd "***** DF1VH *****"
Lowerline
Lcd "** SPANFI v0.2 **"
Waitms 1000


' 0. init LCD and check of ENR switch
Cls

If Pind.2 = 0 Then
Lcd "ENR = 15.53 dB"
Else
Lcd "ENR =  5.93 dB"
End If


' 1. Calibration: only used for gain measurement of D.U.T.
'    therefore: power P1n for noise generator "on" as average of 16384 instantenuous values:
Lowerline
Lcd "CAL ..."

Portb.1 = 1
Portd.0 = 1
P1n = 0
For L = 1 To 16384
Gosub Adc
```

```
P1n = P1n + Resa
Next
'dividing result by 16384 by shift right operation
Shift P1n , Right , 14

' show that calibration is finished by switching on green LED
Portd.1 = 1


'2. repeated measurement in loop
Do

Portb.1 = 0
Portd.0 = 0
P2f = 0

' if wide nf range (and ENR1) then averaging over 4096 values, narrow range (and ENR2) averaging over 8192 instanteuous values
N = 8192
S = 13
If Pind.2 = 0 Then
N = 4096
S = 12
End If

'2.1 (average) power p2f for noise generator "off"
For L = 1 To N
Gosub Adc
P2f = P2f + Resa
Next
'dividing result by Sv by shift right operation
Shift P2f , Right , S

'2.2 (average) power p2n for noise generator "on"; yellow LED on/[off] when noise generator is on/[off]!
Portb.1 = 1
Portd.0 = 1
P2n = 0
For L = 1 To N
Gosub Adc
P2n = P2n + Resa
Next
'dividing result by Sv by shift right operation
Shift P2n , Right , S

'2.3 difference of log values is Y factor: Y = p2n - p2f
Y = P2n - P2f


'2.4 evaluate look up table for NF = ENR - 10*log10(Y)

Cls

If Pind.2 = 0 Then
' in case of enr=15.5 dB stepsize of y value is reduced to 0.16 dB
Shift Y , Right , 2

'Y is now considered as index of look up table
Y = Y - 7
'look into table Nf1 with index Y
K = Lookup(y , Nf1)

If Y < 0 Then
Lcd "NF =  ??      "

End If

If Y > 94 Then
Lcd "NF =  ??      "
Else
' diplay NF if valid value within look up table
Lcd "NF [0.1dB]=  " ; K
End If

Else

' in case of enr=5.93 dB
Y = Y - 129
'look into table NF2 with index Y
K = Lookup(y , Nf2)

If Y < 0 Then
Lcd "NF =  ??      "
End If
```

```
If Y > 47 Then
Lcd "NF = ??   "
Else
' diplay NF if valid value within look up table
Lcd "NF[0.01dB]= " ; K
End If

End If

'2.5 calculate and show gain
L = P2n - P1n
Lowerline

Shift L , Left , 2
'show gain value
Lcd "G [0.01dB]=" ; L

' 3. Loop for continuous measurement of Gain and NF
Loop

'A-to-D conversion subroutine follows:

Adc:
Set Cs                          'start of adc with cs=high
Reset Clk
Reset Cs                        'select chip
A = 0
Resa = 0
For K = 1 To 12                 'read 12 bits from adc
Resa = Resa * 2                 'shift one bit to left
Gosub Pulse                     'send clock pulse
Resa = Resa + A                 'grab last bit
If Pind.4 = 1 Then
A = 1
Else
A = 0
End If
Next
Set Cs
Return

Pulse:                          'clock frequency as fast as possible...
Set Clk

Reset Clk

 Return

'look up tables to translate Y factor into NF for two different ENR values

'ENR = 15.53 dB; Y measured between 0.4166627 dB and 15.649888 dB (7...100) where step size 0.1565625 dB
'here: NF*10 values in dB for this Y range when ENR = 15.53 dB assumed
Nf1:
Data 210 , 203 , 197 , 192 , 187 , 182
Data 178 , 174 , 170 , 166 , 163 , 159 , 156 , 153 , 150 , 147
Data 144 , 141 , 139 , 136 , 134 , 131 , 129 , 126 , 124 , 122
Data 119 , 117 , 115 , 113 , 111 , 109 , 106 , 104 , 102 , 100
Data 98 , 96 , 94 , 92 , 91 , 89 , 87 , 85 , 83 , 81
Data 79 , 77 , 76 , 74 , 72 , 70 , 68 , 67 , 65 , 63
Data 61 , 60 , 58 , 56 , 54 , 53 , 51 , 49 , 48 , 46
Data 44 , 43 , 41 , 39 , 38 , 36 , 34 , 33 , 31 , 29
Data 28 , 26 , 24 , 23 , 21 , 19 , 18 , 16 , 14 , 13
Data 11 , 10 , 8 , 6 , 5 , 3 , 2 , 0

'ENR = 5.93 dB (15.53 dB ENR source + 9.6 dB attenuator); Y measured between 5.0211423 dB and 6.9173719 dB (129...177) where step size
0.03914 dB
'here: NF*100 values in dB for this Y range when ENR = 5.93 dB assumed
Nf2:
Data 251 , 245 , 240 , 234 , 228 , 223 , 217 , 212 , 206 , 201
Data 195 , 190 , 184 , 179 , 173 , 168 , 163 , 157 , 152 , 147
Data 141 , 136 , 131 , 125 , 120 , 115 , 110 , 105 , 99 , 94
Data 89 , 84 , 79 , 74 , 69 , 64 , 58 , 53 , 48 , 43
Data 38 , 33 , 28 , 23 , 18 , 13 , 9 , 4
```

Einfaches automatisches Rauschzahl- und Verstärkungsmessgerät (SPANFI) – Konzept und Umsetzung

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Zusammenfassung

In diesem Artikel wird ein „simple precision automatic noise figure indicator (SPANFI)" für Amateurfunkzwecke beschrieben. Mit diesem Gerät ist gleichzeitiges Messen von Verstärkung und Rauschzahl z.B. von Vorverstärkern für EME möglich, wobei die Messrate so hoch ist, dass ein Abstimmen des Testobjekts in Echtzeit möglich ist. Die Genauigkeit des Gerätes ist ausreichend für Messungen von Rauschzahlen unter 1 dB im Frequenzbereich bis zu 500 MHz durch Verwendung von Rauschgeneratoren mit bekanntem ENR (excess noise ratio). Wie bei kommerziellen Geräten, ist das Messen auf höheren Frequenzen durch Verwendung externer Mischer möglich und ist dann nur abhängig vom Frequenzbereich des Rauschgenerators.

1. Einleitung

Bei EME-Anwendungen ist die Empfänger-Leistung – neben dem Antennensystem - hauptsächlich bestimmt durch die Rauschzahl und die Verstärkung der ersten Stufe hinter der Antenne. Das gilt natürlich auch für die neuen digitalen Modes und dieser Punkt ist deshalb auch heutezutage für jeden EME-Fan von Interesse. Kommerzielles Equipment zur Messung der Rauschzahl und der Verstärkung, wie der berühmte HP8970 [5], ist so gut wie nicht erhältlich auf dem Surplus-Markt und falls doch, dann ist der Preis außerhalb der Reichweite für den Durchschnittsamateur. Auf der anderen Seite sind Rauschgeneratoren mit kalibrierten Angaben zum ENR, die Voraussetzung für akurates und wiederholbares Messen sind, auf fast jedem Funkflohmarkt zu annehmbaren Preisen zu finden.
Verschiedene PANFIs wurden in der Amateurfunk-Literatur in der Vergangenheit beschrieben, entweder als komplettes Einzelgerät [1], [2] oder als Zusatz für einen vorhandenen Spektrum-Analyzer [3]. Alle diese Designs sind einige Jahre alt und deshalb verfolgt dieser Artikel eine modernere und gleichzeitig einfache Lösung mit wenigstens der gleichen Genauigkeit.
Der beschriebene PANFI basiert auf der bekannten Y-Faktor-Methode, wobei die Signalverarbeitung, die Kontrolle der Rauschquelle, A/D-Wandler und Display durch einen kleinen Mikrocontroller erledigt werden. Auch der HF-Teil des Gerätes ist so einfach wie möglich gestaltet und verwendet moderne Standard-Halbleiter und ein externes Bandpassfilter für die betreffende Frequenz, auf der gemessen wird, ohne auf Zwischenfrequenzen zu mischen.
Die Gliederung des Artikels ist wie folgt: Im nächsten Kapitel gibt es etwas Theorie zu den Grundlagen der Meßmethode. Die Analyse des logarithmischen Detektors als Schlüsselelement des PANFI folgt den Ideen in [6]. Kapitel 3 beschreibt die Realisierung inklusive der Details für Hardware und Software sowie den Abgleich. Beispiele für Messungen werden in Kapitel 4 gegeben. Sie zeigen die Eignung der realisierten Lösung. Fazit und einige Ideen für weitere Entwicklungen gibt es im letzten Kapitel.

2. Theorie der Funktionsweise

Die grundlegende Gleichung, die im beschriebenen SPANFI ausgwertet wird lautet:

$$F = ENR - 10 \cdot \log10(y-1) \qquad (1)$$

mit F gleich Rauschzahl (NF) in dB, ENR = 10*log10((T_hot-T_cold)/To) gleich dem Überschuß des Rauchverhältnisses der Rauschquelle in dB - angeschlossen an den Eingang des Testobjektes (Device under Test, D.U.T.) - und

y = Pon/Poff (2)

ist das Verhältnis der mittleren Rauschleistungen Pon und Poff am Ausgang des D.U.T. am Indikator anliegend. Pon entspricht dem Fall des eingeschalteten Rauschgenerators am Eingang des D.U.T. (Rauschtemperatur T_hot am Eingang) und Poff ist die Ausgangsleistung des D.U.T., wenn der Rauschgenerator am Eingang ausgeschaltet ist (Rauschtemperatur T_cold am Eingang).
Gleichung (1) basiert auf einigen Vereinfachungen

1. Die Umgebungstemperatur während der Messung ist gleich der Referenztemperatur To = 290 K (= 17 °C) und korrespondiert mit der kalten Temperatur der Rauschquelle, To = T_cold.
2. Der Reflektionskoeffizient der Rauschquelle ist Null für "an" genauso wie für "aus". Folglich tritt kein Gain-Fehler auf, siehe [2].
3. Die Rauschzahl des Indikators, der den Y-Faktor mißt, ist Null. Folglich kann die Rauschzahl der zweiten Stufe (Indikator) vernachlässigt werden.

Mehr Details und die Ableitung für Formel (1) findet man in [2] und [5].
In diesem Artikel werden wir den Schwerpunkt darauf legen, wie man den Y-Faktor misst. Wie in Gleichung (2) gegeben, ist er das Verhältnis von zwei Leistungen, von denen bei beiden angenommen wird, dass sie durch zufällige Bewegung von Ladungsträgern stammen, z.B. Elektronen in elektrischen Leitern, verursacht durch thermische Anregung.
Dieses Rauschen nennt man thermisches Rauschen, Nyquist Rauschen, oder Johnson Rauschen [11].
Die Zahl der Elektronen ist groß und ihre Bewegungen sind unabhängig. Deshalb folgt die Schwankung des Stromflusses oder der entsprechenden korrespondierenden Spannung über einem Widerstand einer Gauss`schen Wahrscheinlichkeitsdichtefunktion (PDF) in Übereinstimmung mit dem zentralen Grenzwertsatz der Statistik. Während die Gauss`sche PDF direkt für thermische Rauschspannungen im Basisband gültig ist, sieht die Situation für bandpassgefiltertes Rauschen etwas komplizierter aus:
Verwendet man für ein Bandpass-Signal die In-phase (I)- und Quadratur (Q)-Darstellungen, gilt für beide unabhängigen I- und Q-Komponenten die Gauss`sche PDF. Die Hüllkurve der resultierenden Rauschspannung ist gegeben durch

$$v_{env} = \sqrt{v_I^{\,2} + v_Q^{\,2}} \qquad (3)$$

wobei v_I die in-phase und v_Q die quadrature Gauss-verteilten Komponenten des Rauschen sind. Die Wahrscheinlichkeitsdichtefunktion von v_{env} ist nicht länger Gauss-verteilt, sondern die PDF entspricht einer Rayleigh-Verteilung, mit

$$PDF(v_{env}) = \frac{v_{env}}{\sigma^2} \exp\left(-\frac{1}{2}\left(\frac{v_{env}}{\sigma}\right)^2 \right) \qquad (4)$$

und σ^2 ist die Varianz der Hüllkurvenspannung.
Aus Gründen des Dynamikbereiches wird z.B. in Spektrumanalysatoren genauso wie in diesem SPANFI ein logarithmischer Detektor verwendet. Deshalb wird die Rayleigh PDF nach (4) verändert, wenn wir eine logarithmische Verarbeitung der Hüllkurvenspannung durchführen. Die logarithmische Verstärkung arbeitet wie ein Kompressor für größe Rauschspitzen: eine Spitze von dem Zehnfachen des Durchschnittspegels liegt nur 10 dB höher. Augenblickliche Hüllkurven nahe Null, andererseits, enthalten keine Leistung, werden aber vergrößert bis zu unendlich großen negativen dB-Werten. Abb. 1 aus [6] zeigt eine Rayleigh PDF entsprechend Gleichung (4). In Abb. 2 aus [6] ist die PDF der Hüllkurve nach Logarithmierung abgebildet.

Letztendlich sind wir an der mittleren Leistung aus einer Serie momentaner Spannungswerte interessiert, die der PDF nach Abb. 2 folgen. Durch Bilden eines Mittelwerts der momentanen Leistungswerte, jeder errechnet als Quadrat des Spannungswertes folgend der Verteilung in Abb. 2 geteilt durch einen Widerstand R, wird die Standardabweichung des Ergebnisses abnehmen mit der Zunahme der Anzahl N von momentanen Leistungsmessungen, entsprechend folgender Formel aus [6]:

$$\sigma_m = 5.57 dB / \sqrt{N} \qquad (5).$$

Mit anderen Worten: Wenn wir 10000 momentane Messungen der Rauschleistung nehmen, wobei die Ergebnisse in dBm angegeben sind, und von diesen Werten den Mittelwert errechnen, kann die durchschnittliche Leistung des Rauschens mit einer Standardabweichung von weniger als 0.06 dB bestimmt werden. Die Unterschätzung des absoluten Wertes unseres Ergebnisses z.B. durch das Berechnen des Durchschnitts der logarithmierten Werte anstatt einer Logarithmierung des Mittelwerts ist unbedeutend aufgrund der Tatsache, dass wir es mit Verhältnissen von Rauschleistungen zu tun haben wie in Gleichung (2) bzw. Differenzen von logarithmierten Werten und dieser konstante Fehler sich auslöscht, wenn man die beiden logarithmierten Werte substrahiert.

Logarithmische Verstärker leiden in der Realität an einem begrenzten Dynamikbereich: Das untere Limit ist gegben durch das Grundrauschen und das obere Limit ist durch Klippen begrenzt. In Abb. 3 ist das logarithmische Verhalten eines AD8307 [7] für drei verschiedene Frequenzen gezeigt. Unter einer Eingangsleistung von etwa -65 dBm dominiert das Rauschen und oberhalb + 10 dBm kann man Klippen erkennen.

Um den Fehler bei der Messung zur Bestimmung der mittleren Rauschleistung unter 0.1 dB zu halten, sollte aufgrund dieser Klipping-Effekte die durchschnittliche Rauschleistung, die gemessen wird, >14 dB oberhalb des unteren Limits des log. Verstärkers, in unserem AD8307-Beispiel > -51dBm, liegen. Auf der anderen Seite sollte, um den Fehler durch den Klipping-Effekt am oberen Ende des Bereichs des log. Verstärkers unter 0.1 dB zu halten, die mittlere zu messende Rauschleistung wenigstens 7 dB unterhalb dieser Grenze liegen, in unserem AD8307-Beispiel < + 3dBm [6].

Nach dieser einführenden Theorie sind wir in der Lage, den Y-Faktor der Rauschleistungen von Gleichung (2) zu messen, indem wir einen log. Verstärker verwenden und den Durchschnitt der momentanen Ergebnisse mit der entsprechend gewünschten Standardabweichung des Ergebnisses bilden.
Wie zuvor erwähnt, wurde die Ableitung der Rauschleistungsmessung für ein bandbreitenbegrenztes Rauschen durchgeführt. Diese Bandbreitenbegrenzung muss nach folgenden verschiedenen Kriterien erfolgen:

1. Die Bandbreite soll schmal genug sein, um eine ausreichende Frequenzauflösung zu erlauben, weil wir das Ergebnis der Rauschzahl als Funktion der Frequenz haben möchten.

2. Die Bandbreite soll so groß wie möglich sein, um zusätzliche Verstärkungen vor dem log. Detektor/Verstärker niedrig zu halten. Zur Erinnerung: Die verfügbare Rauschleistung ist proportional zur Bandbreite: Pn = kTB (k: Boltzmann-Konstante, T: Temperatur, B: Bandbreite), z.B. Pn = -104 dBm bei Raumtemperatur bei 10 MHz Bandbreite.

3. Wir benötigen statistisch unabhängige momentane Messungen der Rauschleistungen zur Durchschnittsberechnung. Als Daumenregel gilt, dass die Zeitdifferenz zwischen zwei aufeinander folgenden momentanen Leistungsmessungen größer als 1/B sein sollte, um diese Forderung zu erfüllen. Gleichzeitig wollen wir eine schnelle Wiederholzeit für die Messungen haben, um Echtzeit-Abgleich des D.U.T., z.B. eines Vorverstärkers, zu ermöglichen. Im Fall einer schmalen Bandbreite würden wir eine lange Zeit zwischen zwei momentanen Leistungsmessungen benötigen, damit diese statistisch unabhängig voneinander sind und die Durchschnittsberechnung vieler Werte wäre eine langwierige Angelegenheit. Deshalb sollten wir eine möglichst große Bandbreite zulassen.

3. Realisierung

3.1 Generelles Konzept

In diesem Kapitel wird die Realisierung eines einfachen („simple") „precision automatic noise figure indicators" basierend auf der Theorie, die im vorigen Kapitel eingeführt wurde, im Detail beschrieben. Abb. 4 zeigt die Hauptbestandteile und den prinzipiellen Messaufbau. Ein Testobjekt (D.U.T.) wird an seinem Eingang mit einem Rauschgenerator mit bekanntem ENR gespeist. Der Ausgang des D.U.T geht auf einen rauscharmen Breitband-Verstärker, um das Rauschniveau auf einen Wert zu bringen, der später von dem log. Verstärker / Detektor verarbeitet werden kann. Vor dieser Stufe befindet sich ein Bandpassfilter, um frequenzabhängige Messungen durchführen zu können. Es ist wünschenswert variable Bandpassfilter zu verwenden, es können aber hier auch feste Bandpassfilter, z.B. für 144 MHz oder 430 MHz verwendet werden. Nach der log. Verstärkung / Detektion wird das Ergebnis A-D-gewandelt und in einen Mikrocontroller weiterverarbeitet. Der Mikrocontroller erledigt das Berechnen der Durchschnittswerte aus momentanen Leistungswerten genauso wie die Kontrolle des Rauschgenerators durch An- und Ausschalten. Als Grundlage des gemessenen Y-Faktors wird Gleichung (1) mit einer Tabelle ausgewertet. Um auch Verstärkungsmessungen zu ermöglichem, wird die Rauschleistung ohne D.U.T. während einer Kalibrierphase beim Einschalten des SPANFI gemessen. Die aktuelle Verstärkung wir einfach aus der Differenz der mit und ohne D.U.T. gemessenen log. Rauschleistung bei eingeschaltetem Rauschgenerator errechnet.

3.2 Hardware

Entsprechend Abb. 4 wurde eine Hardware zur Realsierung des SPANFI entwickelt. In Abb. 5 ist das Schaltbild des HF-Teils des SPANFI gezeigt. Der Eingang der Schaltung wird mit dem Ausgang des D.U.T. verbunden, er besteht aus einem dreistufigen Breitbandverstärker, wobei jede Stufe aus einem ERA-3 besteht, der als Kompromiss zwischen Verstärkung und Rauschzahl ausgewählt wurde.

Zwischen der zweiten und dritten Stufe ist ein externes, variables Bandpassfilter eingefügt, das die Mittenfrequenz und Bandbreite der Messung bestimmt. Unter Berücksichtigung der Einfügedämpfung des Bandpassfilters beträgt die Gesamtverstärkung etwa 65 dB. Am Ausgang der dritten Stufe wurde ein AD8307 als log. Verstärker / Detektor verwendet. Sein Eingang ist mit einem 52 Ohm-Widerstand abgeschlossen. Bei der Realisierung des Prototyps wurde ein variables Oktave-Bandpaßfilter von Texscan/Trilithic verwendet (5VF125/250-2-50-CC [125 MHz ...250 MHz] bzw. 5VF250/500-2-50-CC [250 MHz ... 500 MHz]). Die Bandbreite dieser Filter ist ein konstanter Bruchteil von 2% der Mittenfrequenz, z.B. 2.5 MHz @ 125 MHz oder 10 MHz @ 500 MHz Mittenfrequenz.

In Abb. 6 ist der HF-Teil als "dead-bug" Aufbau in einem geschirmten Gehäuse gezeigt.

Die Ausgangsspannung des HF-Teils in Abb. 5 wird ohne weiteren Anpassverstärker in den Eingang des A/D-Wandlers des digitalen Teils des SPANFI geführt, siehe Abb. 7. Der A/D-Wandler ist ein LTC1860 mit 12 bit Auflösung, der schnelle Wandlung bis zu 250 ksps erlaubt. Somit wird eine schnelle Meßrate gesichert. Mit der Referenzspannung von 4.095 V, die aus der Versorgungsspannung gewonnen wird, ist eine Auflösung von 1 mV gegeben. Zusammen mit der logarithmischen Steigung von typ. 25mV/dB des AD8307 resultiert dies in 0.04 dB Auflösung für das niederwertigste Bit des digitalen Ergebnisses. Der Hauptbestandteil der digitalen Schaltung ist ein Atmel Controller AT90S2313, der mit 10 MHz getaktet ist. Dieser erzeugt chip-select- und Taktsignal für den LTC1860 und schaltet den Rauschgenerator über einen Optokoppler CNY-17. Dieser kann einen Strom von typ. 20mA liefern, was für kommerzielle Rauschgeneratoren wie Ailtech 7615 oder HP456b ausreicht.
Auch die Ergebnisberechnung – wie im Detail im Software-Kapitel beschrieben – sowie die Ergebnisanzeige durch zwei LED und ein zweizeiliges LCD-Modul wird durch diesen Controller geleistet. Abhängig vom Schalter „ENR1" und „ENR2" werden zwei verschiedene ENR-Werte für den Rauschgenerator in der Software ermöglicht. Wie erwähnt wird ein Ailtech 7615 mit nominalem ENR von 15 dB verwendet. Um ein nomnales ENR von 5 dB zu realisieren, wird der Altech 7615 zusammen mit einem Präzisionsdämpfungsglied von 10 dB an seinem Ausgang verwendet. Der daraus resultierende Rauschgenerator ist von vorteilhafter durch ein verbessertes HF-Reflektionsverhalten, siehe [2], sowie einen niedrigeren benötigten Dynamikbereich des log. Verstärkers im Vergleich zu Rauschgeneratoren mit höherem ENR. Abb. 8 zeigt die Realisierung.
Der letzte Schaltungsteil ist die Stromversorgung, dessen Schaltung in Abb. 9 zu sehen ist. Hier gibt es nichts Besonderes, außer der Zener-Diode in Serie, hier eine ZX10, im 28-V-Pfad vor dem variablen Spannungsregler uA78MG. Diese Zener-Diode zusammen mit dem 10 kOhm Widerstand nach Masse limitiert die maximale Spannung für den Eingang des Reglers. Die Realisierung dieses Teils des SPANFI zeigt Abb. 10.

3.3 Software

Wie im vorigen Kapitel erwähnt, ist ein Atmel Mikrocontroller AT90S2313 ein Hauptbestandteil des SPANFI. Als Entwicklungsumgebung wurde BASCOM-AVR-BASIC verwendet [10]. Neben einfacher Programmierung in Basic, ist die Demo-Version dieses Compiler – die ausreicht, um den kompletten Code zu schreiben, der im Anhang beigefügt ist – kostenlos verfügbar.

Der Haupt-Ein-Aus-Schalter hat zwei Positionen. Jede der beiden „Ein"-Positionen nimmt einen anderen ENR-Wert für den verwendeten Rauschgenerator an: Abhängig von der Wahl beim Einschalten, sind zwei verschiedene Messbereiche für die Rauschzahlmessung möglich (Siehe Tabelle 1).

In einer Kalibrierungsphase wird die Rauschleistung des Rauschgenerators, der direkt an den Eingang des SPANFI angeschlossen ist, ohne D.U.T. gemessen. Dieser Wert wird in der Messschleife verwendet, um die Verstärkung des D.U.T. zu messen. Nach dieser Initialisierung und Kalibrierung startet eine sich kontinuierlich wiederholende Messschleife, wobei der Y-Faktor als Differenz der Mittelwerte von logarithmierten, momentanen Leistungswerten erhalten wird. Passend zum Y-Faktor, der in jedem Messzyklus gemessen wurde, wird ein Wert für die Rauschzahl aus der Tabelle angezeigt. Die implementierten Tabellen entsprechen Gleichung (1) sowie etwas „Software" Tuning bezüglich der Variation der logaritmischen Steigung des AD8307, die typisch 25mV/dB ist. Aus Speicherplatzgründen sind die beiden Tabellen als Byte-Tabellen realisiert.
In Tabelle 1 sind die Haupteigenschaften des SPANFI mit der aktuellen Software-Implementierung angegeben.

	NF Bereich 1	**NF Bereich 2**
ENR des Rauschgenerators	15.53 dB	5.93 dB
Anzahl der momentanen gemittelten Leistungsmessungen	N = 4096	N = 8192
Standardabweichung der gemittelten Leistungsmessungen, siehe Gleichung. (5)	σ_m = 0.087 dB	σ_m = 0.062 dB
Auflösung der Leistungsmessung (25.55 mV/dB gemessen für AD8307 und 1 mV Auflösung für A-D-Wandlung)	0.1566 dB/4mV (4mV Schrittgröße festgesetzt)	0.039 dB/mV (1mV Schrittgröße festgesetzt)
Noise figure Bereich	0 … 21 dB	0.04 … 2.51 dB
Dauer eines Meßzyklus / Aktualisierungsrate der Messung	~ 3 sec.	~ 6 sec.

Tabelle 1: Haupteigenschaften des SPANFI.

Es empfiehlt sich, die tatsächliche log. Steigung des AD8307 zu messen, wenn man dieses SPANFI nachbaut, z.B. mit Hilfe eines Signalgenerators und eines präzisen Abschwächers. Dann kann eine individuelle Nachschlagetabelle mit der gemessenen Steigung, dem bekannten ENR und Gleichung (1) berechnet werden.

4. Bespiele für Messungen

In Abb. 1 sind Komponenten für verschiedene Beispielmessungen abgebildet.
In einer ersten Messung wurde die Rauschzahl des SPANFI selbst bestimmt als Funktion der Frequenz für die drei verschiedenen Rauschquellen, die in Abb. 11 gezeigt sind. Das Ergebnis zeigt Abb. 12. Es soll angemerkt werden, dass selbst für denselben nominalen ENR-Wert von 15.5 dB signifikante Unterschiede zwischen den drei Rauschgeneratoren erhalten wurden. Die oberen zwei Kurven sind für zwei verschiedene Ailtech 7615 Rauschgeneratoren, die untere Kurve ist für eine HP346b Quelle.
Unter Berücksichtigung der typischen Rauschzahl von 3.5 dB @ 2 GHz für den ERA-3 und die Unsicherheit der Kalibrierung der Rauschquellen, für die HP346b z.B. sind es +/- 0.3 dB, sind die Ergebnisse annehmbar.
In einem zweiten Meßbeispiel wurden zwei kommerzielle rauscharme Verstärker [9] gemessen und mit dem verfügbaren Meßprotokoll verglichen. Die Ergebnisse zeigt Tabelle 2. Wieder sind die Ergebnisse für Gewinn und Rauschzahl sehr annehmbar und die Unterschiede bezüglich der Rauschzahl lagen innerhalb der Kalibrier(un)genauigkeit des Rauschgenerators.

D.U.T.	**Meßergebnisse mit SPANFI, ENR = 5.93 dB (Ailtech 7615 #9282 plus Weinschel 9,6 dB Dämpfungsglied)**	**Werte aus dem Meßprotokoll von DB6NT**
144 MHz LNA miComm "L144QM" SN: #0120	NF = 0.13 dB Gain = 27.4 dB	NF = 0.21 dB Gain = 28.6 dB
432 MHz LNA miComm "L432QM" SN: #0128	NF = 0.09 dB Gain = 20.6 dB	NF = 0.33 dB Gain = 21.3 dB

Tabelle 2: Vergleich von Vorverstärker-Messungen.

5. Fazit

In diesem Artikel wurde das Konzept und die Realisierung eines einfachen automatischen Präzisions-Rauschzahlmeßgerätes (SPANFI) vorgestellt. Hauptsächlich wurden zwei Ideen realisiert, die dieses SPANFI von früheren PANFI-Realisierungen unterscheidet:

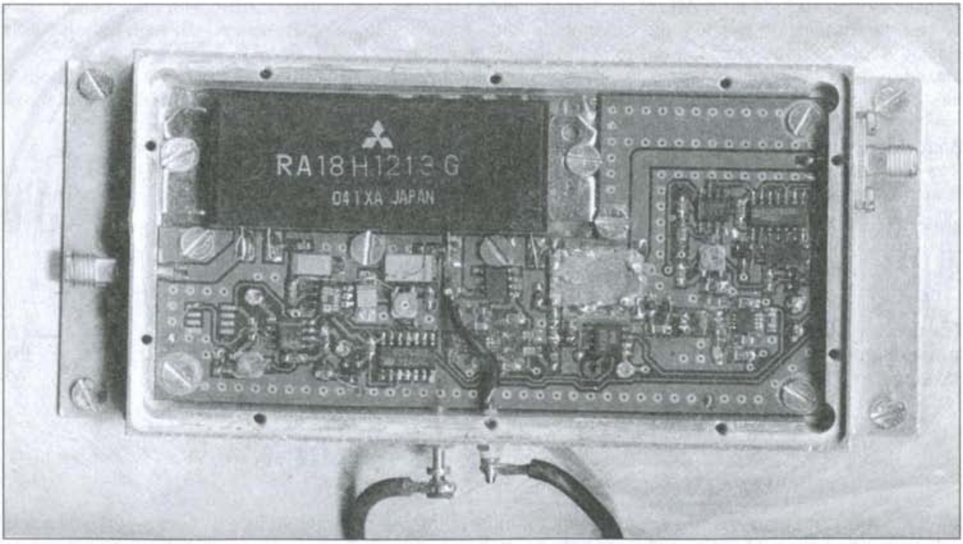
- Breitbandige Verstärkung des Rauschens und Verwendung eines (variablen) HF-Bandpassfilters anstatt eines komplexeren Superhet-Prinzips mit Mischung auf und Filterung bei einer ZF.
- Digitales Mitteln zur Verringerung der Standardabweichung der gemessenen Leistung anstatt analoger Mittelung/Integration durch (analoges) Tiefpass-Filtern.

Diese Ideen machen die Realisierung sehr viel einfacher. Weitere Verbesserungen sind aber möglich durch Verwendung eines „größeren" Mikrokontrollers:

- Berechnung des Logarithmus anstatt der Verwendung von Tabellen.
- Berücksichtigung der eigenen Rauschzahl des SPANFI bei der Rauschzahl-Berechnung des D.U.T. (kaskadierte Rauschzahlberechnung).
- Genauere Verstärkungsberechnung (siehe [5]).
- Temperaturkompensation, wenn die Umgebungstemperatur nicht 290 K beträgt.
- Schnellere A-D-Wandlung für schnelleren Meßzyklus.

Anstatt variabler Bandpassfilter können auch einige Bandpassfilter für feste Frequenzen verwendet werden. Auch die Verwendung von log. Verstärkern mit höherer Eingangsfrequenz, wie dem AD8313 [7] könnte realisiert werden, allerdings bei veringertem Dynamikbereich.

Ich möchte meinem Freund Bodo, DL2FCN, für die kritischen Diskussionen und einige schöne Meß-Abende in seinem Shack danken, und Heinz, DJ5FN, für einige Vergleichsmessungen im Mikrowellenlabor der Hochschule Darmstadt.



18 W / 1,3 GHz PA
using Mitsubishi Module RA18H1213G (Fig. 4)

18 W / 1,3 GHz PA using Mitsubishi Module RA18H1213G

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Introduction

Inspired from a lecture [1] and a qrl project a PA with a Mitsubishi RA18H1233G is described, which replaces the M57762. OM Rech used a "simple" network around the hybrid. Because MOS-FETs are used, a Gate bias up to 5V has to be applied at <1mA making class C-, B-, AB- and A-service possible. The old module didn't support this. Unfortunately this doesn't work good, below 5V amplification and linearity drops. The Author has shown this project in [14], here is the revised version.

Datasheet, things to look at

First page of datasheet [2] shows >18W for the RA18H1213G under following conditions:

Operating voltage = 12,5 V
Gate-bias VGG = 5 V
P in 200 mW
Frequency range 1,24 to 1,3 GHz
Efficiency > 20 %

At zero bias P in is attenuated up to 60dB. Table 1 compares the data of the old and new module. Frequency range and P out are equal, efficiency is >20% against >28% of the old module. Suppression of the first harmonic is 15dB worse. In a diagram we see >58dB attenuation for the first and >42dB for the second harmonic.
These values are better at 1240MHz than at 1300MHz. Input swr of the MOSFET module is worse, linear amplification is 10dB higher. IMD of d3 and d5 is 4dB and 6dB worse at 14W PEP. The new module shall be resistant against oscillation; the old module had no such statement. Behavior with high output swr is similar. Table 2 shows the comparison of the maximum ratings.
Maximum operating voltage is similar, the old modules can take much more P in, the MOSFET module has 5W higher P out. Operating- and storage temperatur are equal. The MOSFET module has no maximum current rating, the diagrams show up to 10A, above 8A it is out of linear service.
Both modules have three stages. The channel temperatures of the three transistors can be found in table 3 for Pout = 18 W, VDD = 12,5 V; Pin = 200 mW.
Channel temperature Tch can be calculated as:

$$T_{ch} = T_{case} + (V_{DD} \bullet I_{DD} - P_{out} + P_{in})\, R_{th(ch-case)}$$

For good long thermal stability the case temperature should be held below 90°C. With 60°C ambient temperature and 18W P out and efficiency □T = 20% the heat sink needs a thermal resistance incl. the loss module – heat sink of:

$$R_{th(case-air)} = \frac{T_{case} - T_{air}}{\frac{P_{out}}{\eta_T} - P_{out} + P_{in}}) = \frac{90\,°C - 60\,°C}{\frac{18\,W}{0{,}2} - 18\,W + 0{,}2\,W} = 0{,}42\frac{°C}{W}$$

Mechanically both modules are equal except 1mm in width, the old module has an "extra pin" which has to be grounded. Gate bias should be bypassed with 4,7nF and 22µF.
In an internet article Steve Kostro, N2CEI, shares his experiences with the RA18H1213G. He discusses the poor efficiency and the need of a good mechanical contact of module flange and heat sink.

Sym-bol	Parameter	Test Conditions	M57762		RA 18H1213G			Unit
			Min	Max	Min	Typ	Max	
F	Frequency	**M57762:**	1240	1300	1240		1300	MHz
P_o	Output Pwr	$V_{cc1} = V_{cc2} = 12{,}5$ V;	18		18			W
η_T	Efficiency	$V_{BB} = 9$ V; $P_{in} = 1$ W;	28		20			%
$2f_o$	Distance to 1st Harmonic	$Z_G = Z_L = 50\ \Omega$ **RA18H1213G**: $V_{DD} = 12{,}5$ V $V_{GG} = 5$ V;		-45			-30	dBc
ρ_{in}	VSWR	$P_{in} = 200$ mW;		2,0			3,0	-
I_{BB}	Gate Current	$Z_G = Z_L = 50\ \Omega$		500		1		mA
G_p	Linear Amplification	$V_{cc1} = V_{cc2} = 12{,}5$ V; $V_{BB} = 9$ V; $P_{in} = 10$ dBm; $Z_G = Z_L = 50\ \Omega$	13		23			dB
IMD_3		$V_{cc1} = V_{cc2} = 12{,}5$ V;		-24			-20	dBc
IMD_5		$V_{BB} = 9$ V; $\Delta f = 10$ kHz; $P_{out\ PEP} <= 14$ W; $Z_G = Z_L = 50\ \Omega$		-31			-25	dBc
-	Stability	$V_{DD} = 10 – 15{,}5$ V; $V_{GG} = 5$ V; $P_{in} = 0 – 25$ dBm ; $P_{out} = 1$ up to 18 W (Pout controlled by V_{GG}); Load-VSWR = 3	No date		No parasit. oscillations			-
-	Load-VSWR Compatibility	$V_{cc1} = V_{cc2} = 12{,}5$ V; $V_{BB} = 9$ V; $P_{out} = 18$ W; $Z_G = 50\ \Omega$; Load-VSWR = 16 (all phase angles)	No worsening or destruction		No worsening or destruction			-

Table 1 - Electrical Data for Modules M57782 and RA18H1213G

Sym-bol	Parameter	Test Conditions		Figure		Unit
		M57762	RA18H1213G	M57762	RA18H12G	
V_{CC}	Supply Voltage	k. A	$V_{GG} < 5$ V; $Z_G = Z_L = 50\ \Omega$	17	17	V
V_{GG}	Gate Voltage	k. A.	$V_{DD} < 12{,}5$V; Pin = 0 mW $Z_G = Z_L = 50\ \Omega$	10	6	V
I_{CC}	Total Current	k.A.	k. A.	8	k. A.	A
$P_{in(max)}$	Input Power	$V_{cc1} = 12{,}5$ V; $V_{BB} = 9$ V; $Z_G = Z_L = 50\ \Omega$	f = 1,24 – 1,30 GHz $Z_G = Z_L = 50\ \Omega$	2	0,3	W
$P_{out(max)}$	Output Power	$Z_G = Z_L = 50\ \Omega$		25	30	W
$T_{C(OP)}$	Temp. of case under operation	k. A.		-30 bis 110	-30 bis 110	°C
T_{stg}	Storage Temp.			-40 bis 110	-40 bis 110	°C

Table 2 - Max. Ratings for M57782 und RA18H1213G

This is not true for the MOSFET module, see pic. 1.

Near the mounting holes the flange is 0,09 ±0,02 mm deeper than under the module! Even with the use of thermal grease the heat cannot be transferred to the heat sink properly! The old modules were flat. Steve has flattened these aereas to get a plain surface.

The parts of the module are mounted on ceramic substrate, which is soldered to a copper flange. The transistors are bonded to the metal, their ports are wire bonded to the substrate. The data sheet mentions the need of the flatness of the heat sink to be within 50µm, otherwise the substrate might collapse.
The torque of the mounting screws has to be 0,4 to 0,6 Nm. After mounting, the pins can be soldered to the print. Because of the missing gnd-pin, blocking of VDD is difficult. Steve has killed a device while being lax on this point. He installed 2 screws near the VDD and VGG pins and put a copper shield above the module housing. This cured the oscillations.

	P_{in} (W)	P_{out} (W)	$R_{th(ch\text{-}case)}$ (°C/W)	I_{DD} @η_T = 20% (A)	V_{DD} (V)	T_{ch} (°C)
1	0,2	1,3	4,5	0,55	12,5	T_{case} + 26
2	1,3	6	3,2	2,0		T_{case} + 65
3	6	18	1,6	4,5		T_{case} + 70,8

Table 3 - Transistor Channel Temperatures at nominal Output

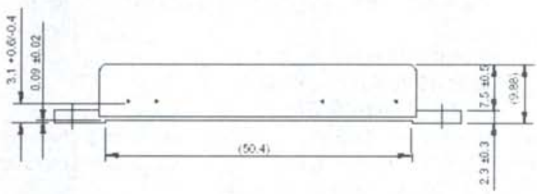

Fig. 1: Mechanical Dimensions RA18H1213G

Block Diagram 1,3 GHz Amlifier

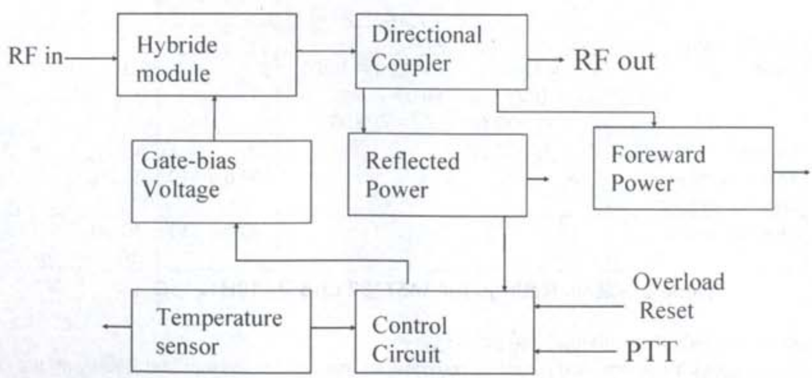

Fig. 2

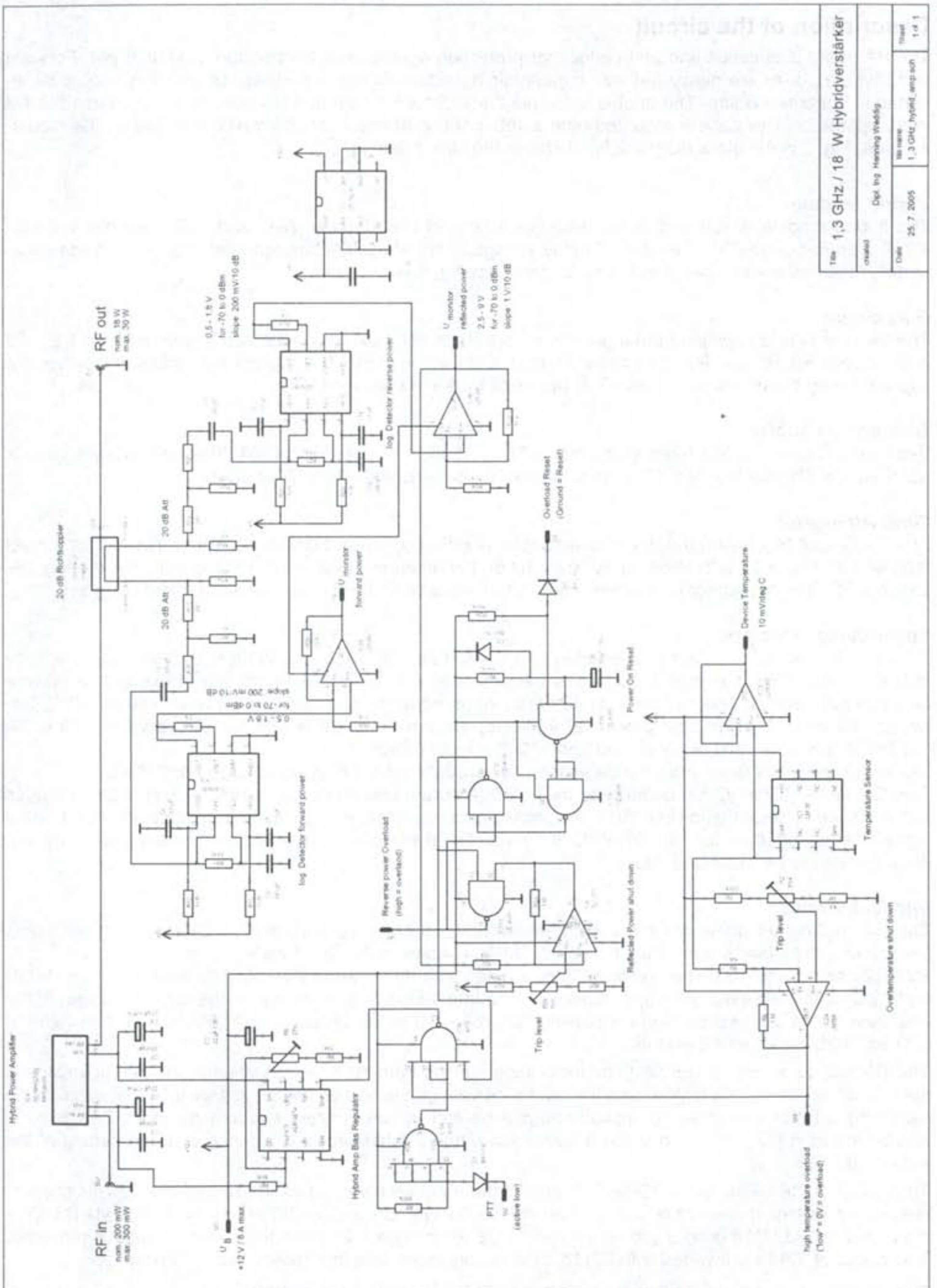

Fig. 3 Circuit Diagramm

Description of the circuit

The PA has a bias circuit and an interlock for protection against over temperature and high swr. Forward and reverse power are measured with logarithmic detectors. There is no lowpass unit, this should be inserted in the antenna line. The double sided print is 10,24 x 5,12 cm and fits into a milled AL-case ZG 4-2 from Telemeter. This case is mounted onto a 160 x 100 x 40 mm heat sink which is milled on the mounting side. Fig. 2 is the block diagram, fig. 3 shows the circuit design.

Hybrid module

The hybrid module is screwed direct onto the bottom of the AL-case. Bias and VDD are blocked with 4,7nF Ceramic- and 22µF Tantal-C. Supply voltage is fed via a feedthrough filter (not seen in the schematic), mounted in the small side of the AL-case, see fig. 4.

Bias circuit

The variable bias is supplied from a „low drop"- regulator ADP 667. It's value can be altered from 1,2 – 5V with trimmer R8. R8 and R9 don't allow the bias to grow above 6V. The regulator operates only, when pin 5 is low (Shdn = „shut down"). This pin is operated by the interlock- circuit.

Directional coupler

Because stripline couplers have a directivity of only 15dB, a „Xinger®" 1D1304-20 coupler from Anaren is used. At 1,3 GHz the loss is 0,18dB, output coupling is 22dB and directivity is 30dB.

20dB Attenuator

At 18W Output (42,5dBm) the directional coupler (22dB coupling) produces +20dBm forward with perfect load and also reverse with short- or open circuit on the antenna. Because this is too much for the log. detector, a 20dB PI attenuator is inserted. The 0 Ohm resistors R15/R21 are inserted for test purposes.

Logarithmic detectors

Forward- and reflected power are detected with AD 8313's. They accept –65 up to 0 dBm. Output voltage is 0,45 to abt. 1,7V, the logarithmic curve has a steepness of abt. 20mV/dB, adjustable with a resistor between pin 7 and 8. Thermal error (at 900MHz, input between –60 ...-10dBm) is abt. –0,019 dB/°C. Between –60 and –10dBm input power (at 900MHz) the error is –1dB at +85°C, compared to +25°C. At 1,9GHz this error is valid between –50 and –10dBm input power.

The circuit design is taken from the datasheet. IC7 produces the 5V supply voltage from VDD.

Two OP amps (IC8a, IC 8b) buffers the max. 400µA output current of the detectors. The output voltages are available at solder pins (St4, St5). A schottky-diode detector would have been sufficient, but it has a higher thermal coefficient of abt. 2mV/°C and a non linear behavior. The effect of a ssb-signal on the log. detection has to be examined later.

Interlock circuit

The buffered output signal of the reverse detector drives the inv. Input of OP IC9. Grounding of pin 8 puts this OP into „high bias mode", Vu x f is now 1,7MHz, risetime is 3,6V/µs (see [9]).

R24/R23 sets Vu to 100. The inv. Input is connected with the slider of R26. At 12V supply voltage 44mV up to 2,2V can be set with R26 (as reference). The Interlock is now a function of the supply voltage. In the final design this is cured through connecting R25 resp. R3 to the Output of IC7 (5V const.). The value of R3 resp. R25 are altered therefore.

The OP acts as a comparator. With minor voltage coming from the reverse detector, the output voltage is abt. 10,5V. When getting higher than the reference voltage the output swings to nearly 0V. To avoid faulty triggering, a hysteresis could be applied trough a resistor between output and non inv. input. Design hints can be found in [12,13]. [13] has the disadvantage, that the hysteresis is a function of the setting of the pot.- meter R26.

The output of the OP drives a RS-flipflop, built of the nand schmidttriggers IC11c and IC11d. This guaranties proper switching even when the errorsignal rises slowly. Grounding St6 resets the flipflop via D3. During power up R32/C15 does a „power on reset". D2 discharges C15 when the supply voltage is removed. The output of IC11b is inverted with IC11b, beeing connected with the "reset input" of the flipflop.

The inverting output of the flipflop is connected to St7 and one input of nand IC5b.

The sensor in IC1 measures the temperature on the print. This is not the temp. of the hybrid but a course function of it. Output of IC1 is buffered with IC2b. When the output voltage raises above the reference given trough pot.-meter R2 IC2a swings to 0V. This signal is given into a second input of nand IC5b.

A PTT signal (0V = tx) can be put into St2. A "low" at one of the inputs switches the output of IC5b to high, IC7 delivers no bias to the hybrid.

Construction

Pics. 5, 6, 7 show the layout of the doublesided print and the component layout. To be able to test the interlock, the hybrid and the detectors should not be mounted now.

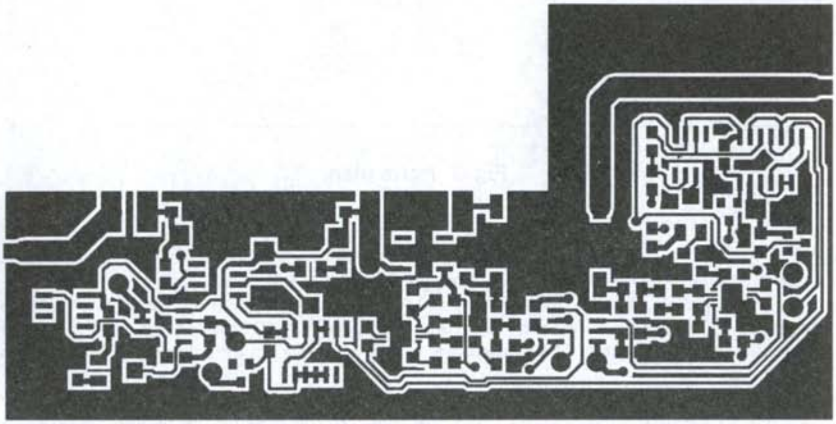

Fig. 5 Layout top

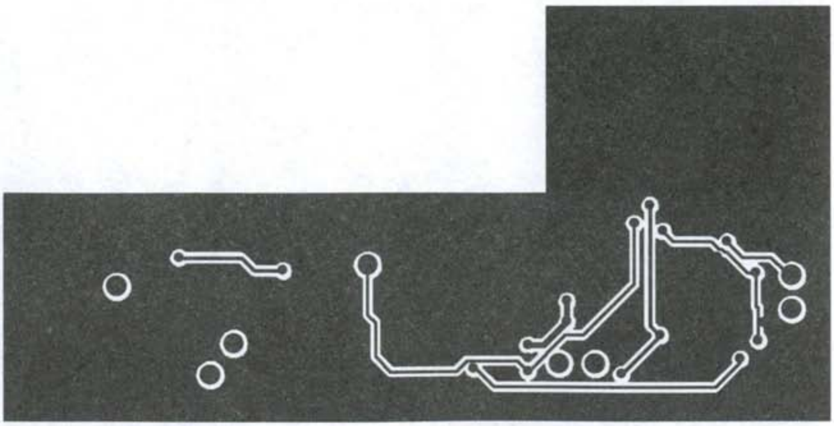

Fig. 6 Layout bottom

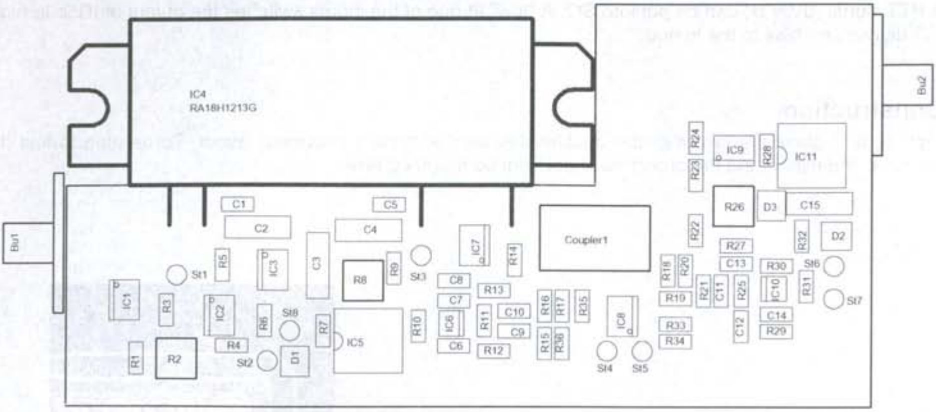

Fig. 7 Parts plan

Firing up

Interlock- and bias-circuit are tested before mounting the print into the case.
A voltage of 12V is applied into St3, gnd to gnd foil of the print. Gnd impulse on St6 produces a reset.
Put a voltage into IC8b through connecting pin 3 with the slider of a 10 turn pot. Set R26 to middle range. Measure the voltage at pin3 with a DMM, raise the voltage with the pot until pin 6 of IC9 drops to 0V. Pin 5 of IC3 shows now 12V.
Carefully reduce the voltage at pin3 of IC8b, until the schmidttrigger falls back, a hysteresis has to be seen. Now a gnd to St6 resets the interlock, pin5 of IC3 falls to 0V. Bias for the hybrid can be set with R8. Maximum setting should be 5V, operational setting is abt. 3V. Now the detectors can be inserted, the print can be mounted into the case and the hybrid can be mounted. The case should be screwed to a proper heatsink. The author used a black heatsink 160 x 100 x 40 mm. The mounting surface had been milled. This heatsink had to be cooled with a fan (Papst 120 * 120 mm; 12 V) at continous service.
First test should be done without applying rf power to see if oscillations occur. Connect a dummy to input and output and raise bias slowly. The supply current should raise linear. Any abrupt raise indicates an oscillation. Then low input power can be applied to test the module.

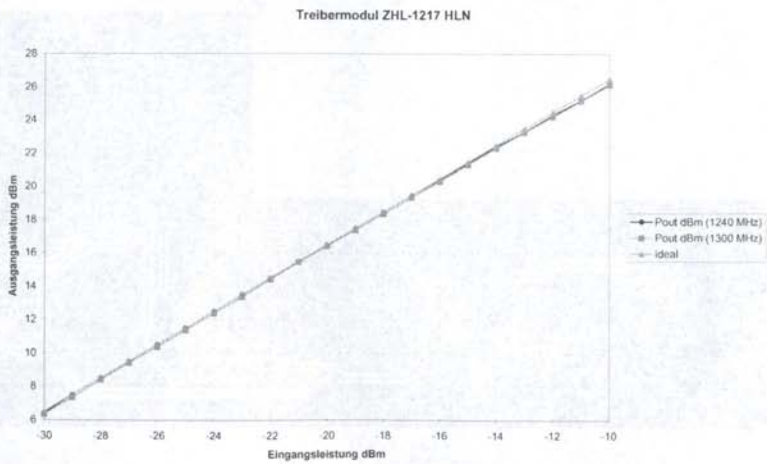

Fig. 8

Measurement results

Output, 1dB compression, efficiency

To get the required 200mW for full output of the hybrid, a broadband amp (Mini Circuits ZHL-1217 HLN) was inserted after the generator. Fig. 8 shows linearity and frequency response. The ZHL is linear up to +26dBm.

Hybridmodul RA 18H1213G
V_{DD} = 12,5 V; V_{GG} = 3,6 V

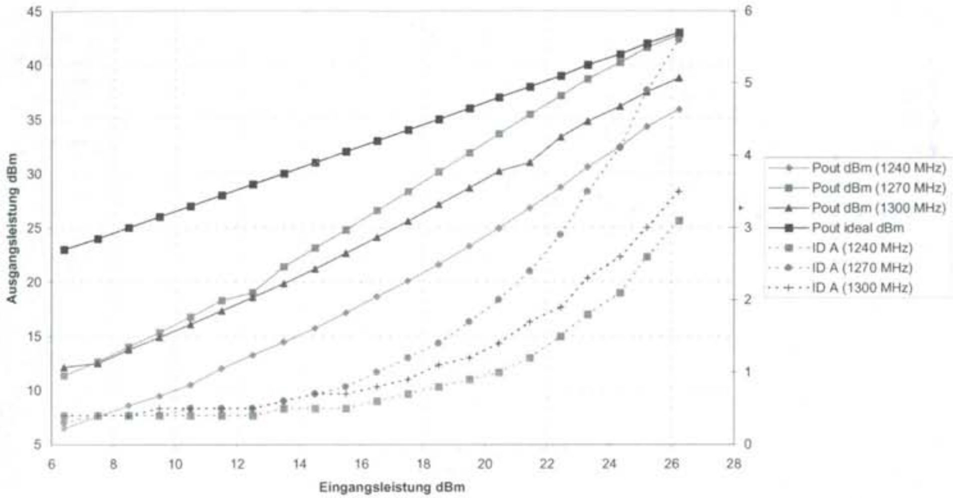

Fig. 9

Hybridverstärker RA18H1213G
V_{GG} = 4 V; V_{DD} = 12,5 V

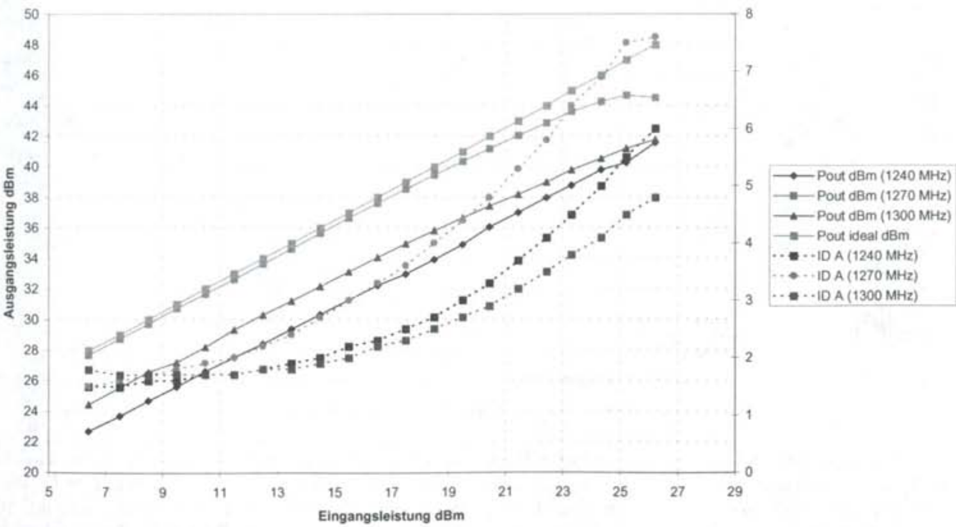

Fig. 10

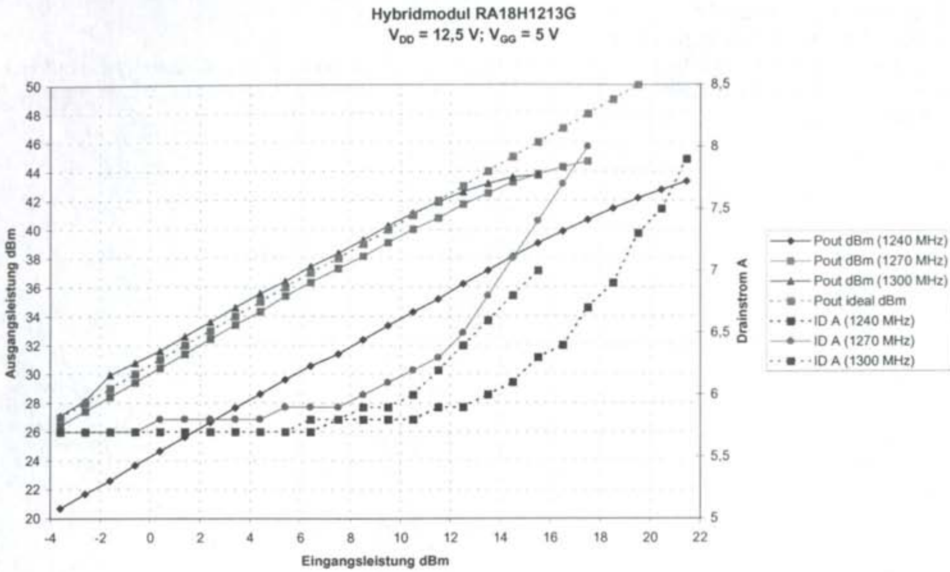

Fig. 11

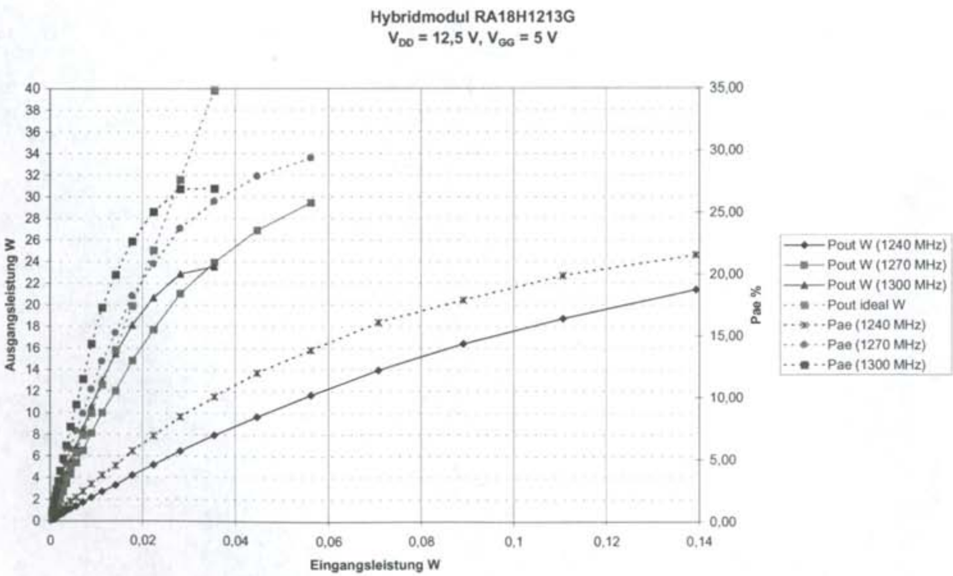

Fig. 12

A bias of 3,6V gives a quiescent current of 300mA. Output as function of input is shown in fig. 9 . Nonlinearity and linear distortion are clearly visible. Despite quiescent current it looks like class B or C. With 4,0V bias and 1,5A quiescent current linearity is better, but the linear distortion is still there, see fig. 10. The module seems to be tuned to 1270MHz. With 5,0V bias and 5,7A it looks like fig. 11. Amplification at 1270 and 1300MHz is nearly equal, at 1240MHz it drops heavily.

Efficiency (Pae = "power added efficiency") is poor, 22 to 30%, see fig. 12. The datasheet mentions abt. 30%.

Page 3 of the datasheet shows output power to be 1240 MHz +35 dBm, 1270 MHz + 41 dBm, 1300 MHz + 36 dBm) at +10dBm input. The linear distortion is documented here, it's not a result of my construction!

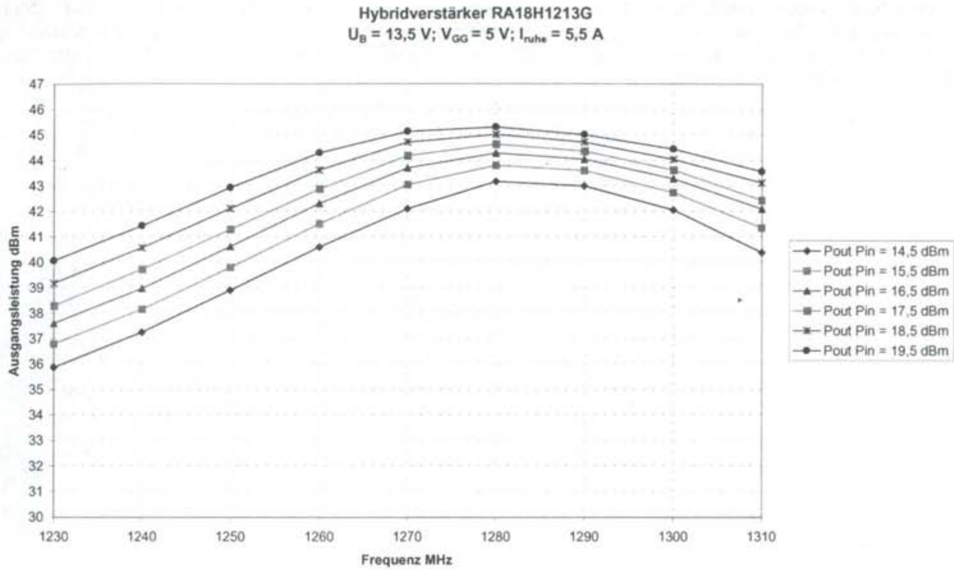

Fig. 13

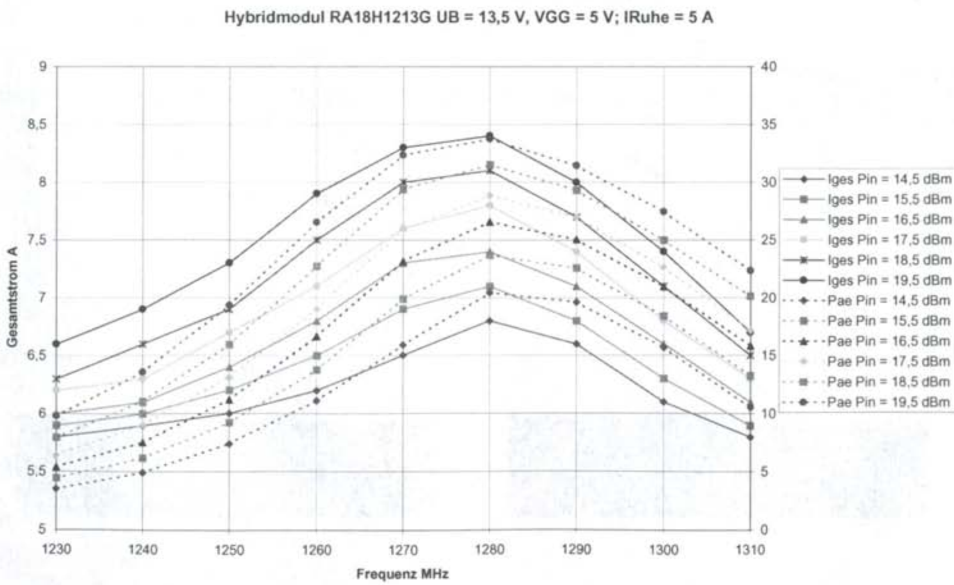

Fig. 14

Fig. 13 shows output power versus frequency at constant input power with 5,0V bias. The linear distortion can be seen. Fig. 14 shows current consumption and efficiency versus frequency at constant input power. Best efficiency occurs at 1270MHz.
For comparison, a M57762 module (made by RSE Elektronik) was measured under similar conditions, see fig.15. This module has a flat frequency response!
Further tests showed a saturation of the forward power log. detector. A greater value of the attenuator's series resistor didnt cure that. The detectors are usable up to 0dBm (see [7]), but the are linear only up to -6dBm. The directivity of the coupler is only 10dB in my construction, when measured at the outputs of the detectors. There is some spillover.

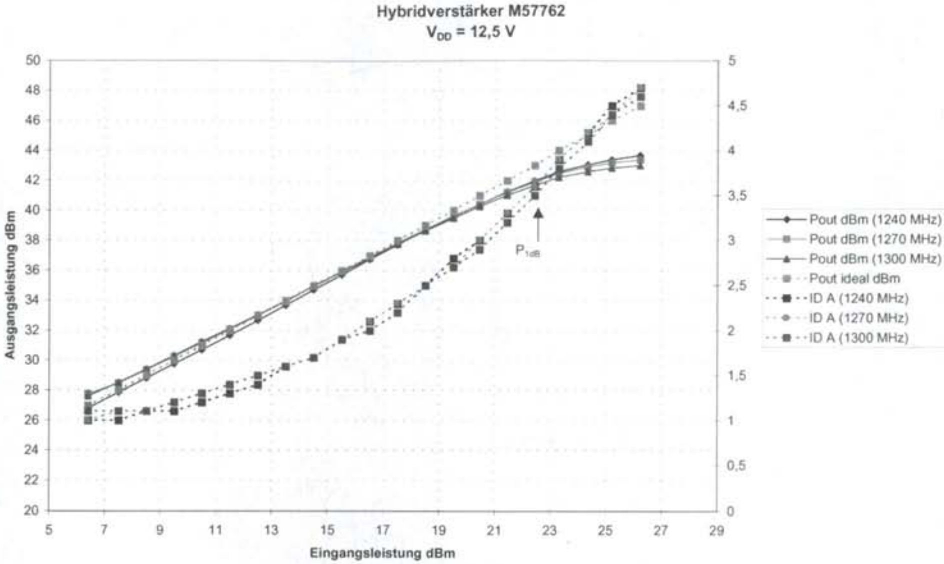

Fig. 15

Harmonic suppression

Pic 16, 17, 18 show the harmonics at full output on 1240, 1270 and 1300 MHz. Only the first harmonic is visible at abt. 52dB down.

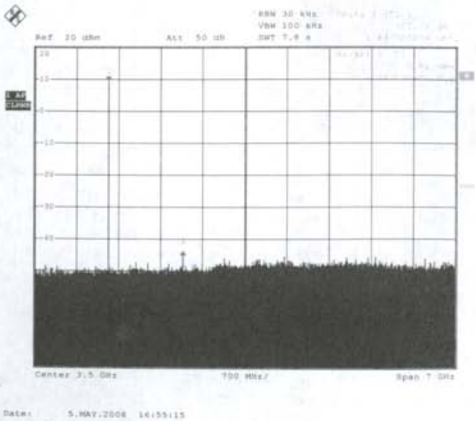

Fig. 16

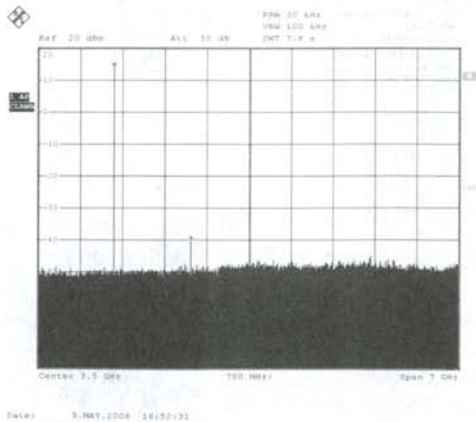

Fig. 17

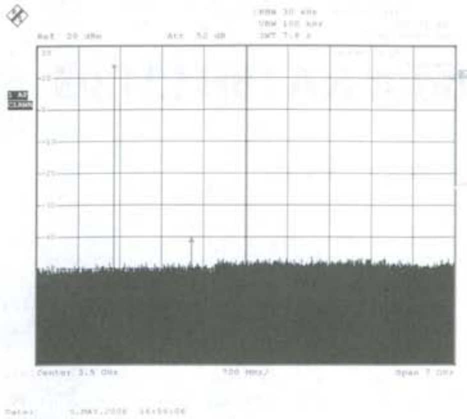

Fig. 18

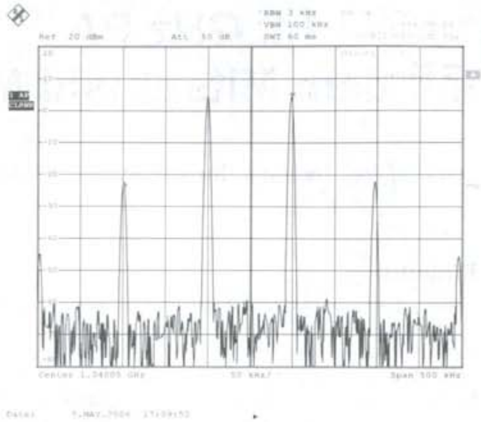

Fig. 19

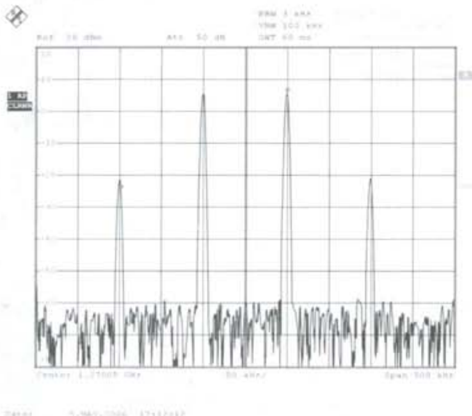

Fig. 20

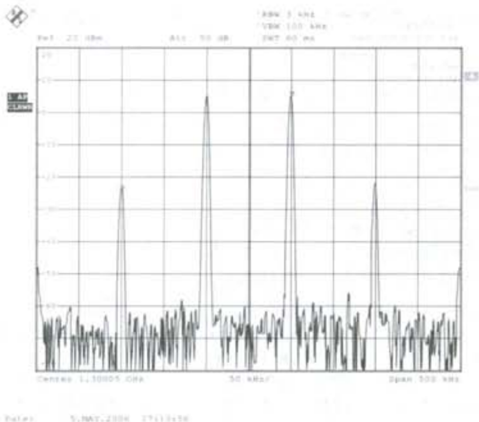

Fig. 21

IMD

The amplifier was driven to 14W PEP (41,46dBm PEP = 35,46dBm/signal) with two signals at 100kHz separation on 1240, 1270 and 1300 MHz. The IMD does not change with narrower separation. The datasheet mentions 20dBc at frequency separation of 10kHz. Fig. 19 to 21 show the results. Cable attenuation of 1,3dB has to be added.

Conclusion

The hybrid amplifier RA18H1213G is worse than the old M57762 concerning linear distortion and power-consumption/efficiency.

18 W / 1,3 GHz PA mit dem Mitsubishi Modul RA18H1213G

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Einleitung

Angeregt durch einen Vortrag [1] und aufgrund eines QRL-Projekts wird der Entwurf einer Linear-Endstufe mit dem Mitsubishi Hybridmodul RA18H1213G beschrieben. Dieses Modul ist der „Nachfolger" des mit mit Bipolar-Transistoren aufgebauten, nicht mehr hergestellten und deshalb nur noch in Restbeständen erhältlichen Moduls M57762.

Nach OM Rech ist nur eine „einfache" Außenbeschaltung notwendig. Wegen des Einsatzes von MOS-Transistoren im Modul muß für die Ruhestromeinstellung eine Gate-Vorspannung im Bereich bis maximal 5V angelegt werden, der Strom in das Modul beträgt nur ca. 1 mA. Damit sollte „die freie Wahl" des Arbeitspunktes vom C- über B-, AB- bis zum reinen A-Betrieb möglich sein. Diese Einstellbarkeit besteht bei dem Vorgängermodul nicht. Leider funktioniert diese „freie" Einstellbarkeit des Arbeitspunkts nicht gut, da mit Gate-Spannungen kleiner 5 V die Verstärkung und Linearität stark zurück gehen. Der Verfasser hat in [14] bereits über diese Endstufe berichtet, hier wird die überarbeitete Schaltung und Meßergebnisse vorgestellt.

Datenblattangaben, Fallstricke

Auf der ersten Seite des Datenblatts [2] wird das Modul RA18H1213G mit einer Ausgangsleistung von >18 W unter folgenden Betriebsbedingungen spezifiziert

Betriebsspannung = 12,5 V
Gate-Vorspannung V_{GG} = 5 V
Eingangsleistung von 200 mW
Frequenzbereich von 1,24 bis 1,3 GHz
Wirkungsgrad > 20 % angegeben.

Bei einer Gate-Vorspannung von 0 V wird das Eingangssignal um bis zu 60 dB gedämpft. In der Tabelle 1 werden die wichtigsten elektrischen Daten des alten und neuen Moduls gegenüber gestellt.

Bei beiden Modulen ist der Frequenzbereich und die Ausgangsleistung gleich. Etwas störend erscheint der niedrige garantierte Wirkungsgrad von >20% gegenüber >28 % beim Vorgängermodul. Auch der Abstand der ersten Oberwelle zur Grundwelle unterscheiden sich bei beiden Modulen, er ist beim MOSFET Modul um 15 dB schlechter. In einem Diagramm werden jedoch Oberwellenabstände von > 58 dB für die erste und >42 dB für die zweite Oberwelle ausgewiesen. Der Oberwellenabstand ist bei 1240 MHz besser als bei 1300 MHz.

Das Eingangs-VSWR ist beim MOSFET-Modul schlechter als beim M57782. Dafür ist die lineare Verstärkung beim MOSFET-Modul um 10 dB höher. Intermodulationsprodukte dritter und fünfter Ordnung sind bei der Ausgangsleistung von 14 W PEP beim MOSFET-Modul um 4 bzw. 6 dB schlechter. Interessant ist der Hinweis, dass das MOSFET-Modul gegen wilde Schwingungen unempfindlich ist, diese Angabe fehlt beim Vorgängermodell. Das Verhalten bei Fehlabschluss des Ausgangs ist bei beiden Modulen gleich. In der Tabelle 2 (s. engl. Text) werden die maximal zulässigen Daten gegenüber gestellt.

Beide Module haben bezüglich der maximalen Versorgungsspannung gleiche Grenzwerte. Der M57762 verträgt eine erheblich höhere Eingangsleistung. Die maximale Ausgangsleistung ist beim RA 18H1213G um 5 W höher. Arbeits- und Lagertemperaturbereich sind bei beiden Modulen gleich. Beim MOSFET-Modul wird kein maximaler Gleichstrom angegeben, laut Diagrammen kann er jedoch bis 10 A betragen, jedoch ist das Modul bei Strömen > 8 A schon nicht mehr im linearen Betrieb.

Beide Module sind dreistufig aufgebaut. Bezüglich der Bemessung des Kühlkörpers sind im Datenblatt für den RA18H1213G folgende Angaben für die Kanaltemperaturen der drei Transistoren bei folgender Betriebsbedingungen zu finden: Pout = 18 W, VDD = 12,5 V; Pin = 200 mW, siehe Tabelle 3:

Die Kanaltemperatur Tch wird mit folgender Formel berechnet:

$$T_{ch} = T_{case} + (V_{DD} \bullet I_{DD} - P_{out} + P_{in}) \bullet R_{th(ch-case)}$$

Für die Langzeitstabilität sollte die Temperatur des Modulgehäuses unter 90 °C gehalten werden. Bei einer Temperatur der Umgebungsluft T_{air} = 60 °C, einer Ausgangsleistung von 18 W und dem Mindestwirkungsgrad η_T = 20% muß der Kühlkörper folgenden Wärmewiderstand einschließlich des Kontaktwiderstands (Modul – Kühlkörper) aufweisen:

$$R_{th(case-air)} = \frac{T_{case} - T_{air}}{\frac{P_{out}}{\eta_T} - P_{out} + P_{in}}) = \frac{90\,°C - 60\,°C}{\frac{18\,W}{0{,}2} - 18\,W + 0{,}2\,W} = 0{,}42\frac{°C}{W}$$

Die mechanischen Abmessungen beider Module sind bis auf 1 mm in der Breite gleich, jedoch hat der M57762 fünf Anschlusspins gegenüber vier beim RA18H1213G. Der „Extrapin" beim M57762 ist ein Massepin, der mit der Basisplatte („fin") verbunden ist.

Für die Abblockung der Versorgungsspannung und der Gate-Vorspannung werden die Parallelschaltung eines 4,7 nF und eines 22 µF Kondensators angegeben. Beim Stöbern im Internet fand der Verfasser einen interessanten Artikel [3], in dem Steve Kostro N2CEI über seine Erfahrungen mit dem Aufbau und Test des Moduls berichtet. Auch er geht ausführlich auf die Interpretation des Wirkungsgrads ein. Es ist verständlich, daß aufgrund der hohen abzuführenden Ver-lustwärme ein guter metallischer Kontakt zwischen dem Flansch des Hybrids und dem Kühlkörper beste-hen muß. Dies ist jedoch beim RA18H1213G nicht der Fall, siehe Bild 1.

Im Bereich der beiden Befestigungslöcher rechts und links neben dem Modulgehäuse ist der Flansch um 0,09 +/-0,02 mm tiefer als die Fläche unter dem Modul! Damit ist die Wärmeabfuhr auch bei Verwendung von Wärmeleitpaste auf der großen Fläche unterhalb des Moduls nicht gewährleistet! Die alten Module weisen diese „Besonderheit" nicht auf, wahrscheinlich sind diese Vertiefungen auf den Stanzvorgang bei der Herstellung der Grundplatte zurück zu führen.

Steve empfiehlt, den Überstand mittels Schmirgelpapier abzuschleifen, um eine ebene Unterseite des Moduls zu erhalten.

Die Bauteile des Moduls sind auf einem Keramiksubstrat aufgebracht, das auf den Kupferflansch gelötet ist. Die Transistoren sind auf das Metall gebondet, die elektrischen Verbindungen zu den Bauteilen auf dem Keramiksubstrat werden mittels dünner Drähte sprich „wire bonding" hergestellt.

Im Datenblatt ist der Hinweis zu finden, daß die Unebenheit des Kühlkörpers unterhalb des Moduls 50 µm nicht überschreiten darf, da andernfalls des Keramiksubstrat brechen kann. Das Modul muß erst auf den Kühlkörper geschraubt werden, das Drehmoment für die Befestigungsschrauben soll 0,4 bis 0,6 Nm betragen Danach können die Anschlußleitungen des Moduls mit der übrigen Schaltung verlötet werden.

Durch den nicht herausgeführten Massepin ist die induktionsarme Abblockung der Versorgungsspannun-gen schwierig. Steve berichtet von einer sofortigen Zerstörung des Moduls bei Nichtbeachtung. Er hat deshalb bei seinem Aufbau zwei zusätzliche Schrauben in der Nähe der Versorgungsspannungspins vor-gesehen und das Hybridmodulgehäuse mit einem Abschrimblech aus Kupfer versehen. Danach hat er keine Schwingneigung mehr festgestellt.

Schaltungsbeschreibung

Die Endstufenschaltung enthält neben dem Hybridmodul und der Vorspannungserzeugung Überwa-chungsschaltungen („Interlock"), die das Modul gegen Fehlabschluß und Übertemperatur schützen. Die Vorwärts- und Rückleistung am Ausgang des Moduls werden mit je einem logarithmischen Detektor ge-messen.

Auf ein Tiefpaßfilter am Ausgang des Moduls wurde aus Platzgründen verzichtet, es sollte jedoch beim Betrieb zwischen Ausgang des Moduls und der Antenne in den Signalweg eingefügt werden.

Die Zusatzschaltungen finden auf einer doppelseitigen Leiterplatte mit den Abmessungen von 10,24 * 5,12 cm Platz, das in einem gefrästen Aluminiumgehäuse ZG 4-2 der Firma Telemeter untergebracht ist. Das Gehäuse ist auf einen an der Oberseite plan gefrästen Kühlkörper mit den Abmessungen 160 * 100 * 40 mm und dem Wärmewiderstand von 0,7 K/W aufgeschraubt. Bild 2 zeigt das Blockschaltbild; Bild 3 den Schaltplan.

Hybridmodul

Das Hybridmodul wird direkt auf den Boden des gefrästen Gehäuses aufgeschraubt. Gemäß Datenblatt werden die Gate-Vorspannung und die Versorgungsspannung mit einer Kombination eines 4,7 nF Keramikkondensators und 22 µF Tantalkondensators gesiebt. Die Versorgungsspannug wird über ein Durchführungsfilter (im Schaltplan nicht eingezeichnet), das in die Schmalseite des Gehäuses eingeschraubt wird, zugeführt, siehe Bild 4.

Vorspannungserzeugung

Die einstellbare Vorspannung wird mittels des „low drop" Spannungsregler ADP 667 von Analog Devices aus der Versorgungsspannung erzeugt. Die Spannung kann mit dem Trimmpotenziometer R8 im Bereich 1,2 bis 5 V verändert werden. R8 und 9 sind so dimensioniert, dass die maximal zulässige Gate-Vorspannung von 6 V nicht überschritten werden kann. Das IC gibt nur dann eine Spannung ab, wenn Pin 5 (Shdn = „shut down") auf Massepotenzial liegt. Deshalb ist dieser Pin mit dem Ausgang der Überwachungsschaltung verbunden.

Richtkoppler

Da einfache Streifenleitungsrichtkoppler nur eine Direktivität von ca. 15 dB aufweisen, wurde ein für Mobilfunkbereiche dimensionierter „Xinger®" Koppler 1D1304-20 der Firma Anaren eingesetzt. Bei der Frequenz 1,3 GHz beträgt laut Datenblatt [6] die Durchgangsdämpfung 0,18 dB, die Koppeldämpfung 22 dB und die Direktivität 30 dB.

20 dB Abschwächer

Bei einer Ausgangsleistung des Hybridmoduls von 18 W = 42,5 dBm und der Koppeldämpfung des Richtkopplers von 22 dB beträgt die Leistung an dem Koppelausgang (Vorwärtsleistung) +20 dBm, wenn die Last (Antenne) optimal angepaßt ist; bzw. +20 dBm am Rückwärtsleistungsausgang bei Leerlauf / Kurzschluß des Antennenausgangs. Da mit diesen Leistungen der Detektor übersteuert wird, weist an den Koppelausgängen des Richtkopplers je ein 20 dB Abschwächer eingefügt, der als Pi-Glied beschaltet ist. Die „Nullohm" Widerstände R15 / R21 sind für Testzwecke (Messungen eingefügt, durch Auslöten können am Ausgang des Richtkopplers bzw. Eingang des Detektors Adapter für Messgeräte eingefügt werden, ohne die Schaltung zu beeinflussen.

Logarithmische Detektoren

Zur Detektion der hin- und rücklaufenden Leistung wurde je ein logarithmischer Detektor des Typs AD 8313 eingesetzt. Der nominelle Eingangsleistungsbereich ist laut Datenblatt [7] von –65 dBm bis 0 dBm. Der Ausgangsspannungsbereich geht von 0,45 V bis ca. 1,7 V, die Steilheit der logartihmischen Kurve liegt bei ca. 20mV/dB, sie kann mit dem externen Widerstand zwischen Pin 7 und 8 auf den genauen Wert eingestellt werden. Der Temperaturfehler (für eine Eingangsfrequenz von 900 MHz im Eingangspegelbereich –60 bis –10 dBm) liegt bei –0,019 dB/°C. Laut Datenblatt beträgt der Fehler bei 900 MHz im Pegelbrerich –60 bis –10 dBm bezogen auf +25 °C bei +85 °C –1 dB, bei 1,9 GHz wird dieser Fehler im Pegelberich –50 bis –10 dBm eingehalten.

Die externe Beschaltung des Detektors wurde dem Datenblatt entnommen. Die Versorgungsspannung von +5 V wird aus der 12 V Spannung für das Hybridmodul mittels eines Festspannungsreglers IC7 gewonnen. Da der Ausgang des logarithmischen Detektors einen Strom von 400 µA liefern kann („source"), wird zur Pufferung der als Elektrometerverstärker geschaltete Operationsverstärker (IC8a bzw. IC8b) ein-gesetzt. Die jeweilige Ausgangsspannung ist für Monitorzwecke an einen Lötstift (St4, St5) auf der Leiterplatte geführt.

Für die Detektion Der Ausgangsleistung des Hybrids nicht unbedingt ein hoher „dB-linearer" Dynamikbereich benötigt, ein „einfacher" Gleichrichter mit einer Schottkydiode hätte benutzt werden können. Jedoch hat der Diodendetektor neben einem Temperaturkoeffizienten von ca. –2mV/°C eine starke vom Eingangspegel abhängige nichtlineare Kennlinie.

Welchen Einfluss ein SSB-Signal auf die logarithmische Detektion hat, muß im praktischen Aufbau unter-sucht werden.

Überwachungsschaltung

Das gepufferte Signal des Detektors für die Rückwärtsleistung wird auf den invertierenden Eingang des Operationsverstärkers IC9 geführt. Durch die Verbindung von Pin 8 mit Masse wird der Operationsverstärker in den „high bias mode" geschaltet, das Verstärkungs-Bandbreiten-Produkt ist in dieser Betriebsart 1,7 MHz, die Anstiegszeit 3,6 V/µs. Nähere Informationen sind in [9] zu finden.

Durch die Beschaltung mit den Widerständen R24/R23 ist die Verstärkung auf 100 eingestellt. Der nichtinvertierende Eingang ist mit dem Abgriff des Trimmpotenziometers R26 verbunden. Mit dem Trimmpoti können bei einer Betriebsspannung von 12 V Spannungen von 44 mV bis 2,2 V eingestellt werden. Damit ist die Referenzspannung eine und damit das Abschaltkriterium eine Funktion der Versorgungsspannung. Beim endgültigen Layout wird diese Abhängigkeit dadurch behoben, dass der obere Anschluss von R25 bzw. R3 an die mit IC7 stabilisierte 5 V Versorgungsspannung angeschlossen wird. Der Widerstandswert von R3 bzw. R25 wird entsprechend abgeändert.

Durch die hohe Verstärkung wird der Operationsverstärker durch die vom Detektor kommende Spannung teilweise übersteuert und wirkt damit als Komparator.

Wenn die Detektorspannung (gewonnen aus der rücklaufenden Leistung) sehr viel kleiner als die mit dem Potenziometer eingestellte Spannung ist, hat die Spannung am Ausgang des Opamps einen Wert von ca. 10,5 V, sie sinkt, wenn die Eingangsspannung in die Nähe der Potenziometerspannung kommt, d.h. die Differenz der Spannungen am invertierten und nichtinvertierten Eingang multipliziert mit dem Verstär-kungsfaktor (hier 100) einen Wert ergibt, der größer als der obere Grenzwert der Ausgangsspannung ist.des Opamps ist. Die Ausgangsspannung ist nahe 0 V (der untere Grenzwert der Ausgangsspannung), wenn die Eingangsspannung merklich höher ist.

Um Störungen zu durch Fehltriggerungen zu vermeiden, könnte es sinnvoll sein, den Operationsverstär-ker selbst mit einer größeren Hysterese der Schaltpunkte zu versehen, d.h. ihn als „linearen" Schmittrigger zu beschalten, indem eine positive Mittkopplung über einen Widerstand vom Ausgang zum nicht in-vertierenden Eingang geschaltet wird. Die Bemessungsgrundlagen sind z.B. in [12, 13] zu finden. Diese Variante hat nach [13] jedoch den Nachteil, dass die Höhe der Hysterese eine Funktion der Potenziometerstellung ist.

Der Ausgang des Operationsverstärkers ist mit dem einen Eingang des Nand-Schmitttriggers in IC11d verbunden. IC 11c und IC11d sind als RS-Flipflop geschaltet. Die Schmitrigereingänge stellen ein sicheres Schalten auch bei „langsamen" Flanken des Eingangssignals sicher. Das Flipflop kann durch Verbinden des Steckeranschlusses St6 mit Masse rückgesetzt werden, der über die Diode D3 mit einem Eingang von IC11a verbunden ist. Damit beim Anlegen der Versorgungsspannung das Flipflop definiert rückgesetzt wird, ist mit dem RC-Glied R32/ C15 eine Einschaltrücksetzschaltung („power on reset") realisiert, die mit dem zweiten Eingang von IC11a verbunden ist. D2 entlädt den Elko C15 beim Abschalten der Versorgungsspannung, um eine problematische Entladung über die IC-interne Schutzschaltung zu verhindern. Das Ausgangssignal von IC11b wird mit IC 11b invertiert, es ist mit dem „Rücksetzeingang" des Flipflops verbunden. Der invertierende Ausgang des Flipflops ist mit St7 und einem Eingang des Vierfach-Nandgatters IC5b verbunden.

Mit dem Temperatursensor in IC 1 wird die Temperatur auf der Leiterplatte gemessen, sie entspricht zwar nicht genau der Temperatur des Hybrids, kann jedoch „Schätz-Anzeige" für die Erwärmung des Hybrids herangezogen werden. Das Ausgangssignal von IC 1 wird mit IC 2b gepuffert.
Bei Überschreitung eines mit dem Trimmpotenziometer R2 einstellbaren Schwellwertes geht der Ausgang des als Komparator geschalteten Operationsverstärker IC 2a auf 0 V. Sein Ausgang ist mit einem weiteren Eingang des Nandgatters IC5b verbunden.
Über St2 kann ein PTT-Signal (0 V entspricht Sendebetrieb) zur Steuerung der Gate-Vorspannung herangezogen werden. Wenn einer der vier Eingänge von IC5b logisch „low" ist, ist sein Ausgang „high", damit gibt der Spannungsregler IC 7 keine Gate-Vorspannung zum Hybridmodul weiter..

Aufbau

Die Bilder 5, 6 und 7 zeigen das vergrößerte Layout der doppelseitigen Leiterplatte und den Bestückungsplan. Die Leiterplatte sollte zunächst ohne die beiden logartihmischen Detekoren und dem Hybridmodul bestückt werden, um die Funktion der Überwachungsschaltung testen zu können.

Inbetriebnahme

Vor Einbau der Leiterplatte in das Gehäuse wird die Funktion der Überwachungsschaltung und der Einstellbereich der Gate-Vorspannung kontrolliert. Dazu verbindet am ein externes Netzgerät (+12 V) mit St3, 0 V mit der Masse der Leiterplatte und kontrolliert die Spannung an Pin 5 von IC 3 (0V),. Notfalls wird einen Reset durch kurzzeitiges Verbinden von St6 mit Masse durchgeführt.
Man verbindet Pin 3 von IC8b mit dem Abgriff eines 10 Gang Wendelpotentiometers, stellt das Poti R26 auf Mittelspannung, mißt mit einem DVM die Spannung an Pin 3 von IC9, erhöht die Spannung an Pin 3 und beobachtet mit einem weiteren DVM (oder anderem Indikator) die Spannung an Pin 6 von IC9. Sie soll auf 0 V springen, wenn die Spannung an Pin 3 überschritten wird. Die Spannung an Pin 5 von IC3 ist jetzt 12 V. Durch Verkleinern der Wendelpotispannung unter die eingestellte Spannung an Pin 3 muss der Schmitttrigger bei einer Spannung zurück kippen, die kleiner als die Spannung an Pin 3 ist, (Hysteresis). Jetzt kann durch Verbinden von St6 mit Masse die „Überlast" zurückgesetzt werden, die Spannung an Pin 5 von IC3 springt auf 0 V. Durch Verändern der Potistellung von R8 kann die Gate-Vorspannung für das Hybridmodul verändert werden, sie sollte sich nicht größer als auf +5 V einstellen lassen. Das Poti ist dann so einzustellen, daß die Gate-Vorspannung ca. 3 V beträgt.
Nach dem Einlöten der beiden logarithmsichen Detektoren, Einbau der Leiterplatte in das Gehäuse Einlöten des Hybridmoduls und Aufschrauben des Gehäuses auf einen ausreichend dimensionierten Kühlkörper ist der Verstärker für Tests betriebsbereit.
Der Verfasser verwendet einen schwarz eloxierten Kühlkröper 160 * 100 * 40 mm , dessen Oberseite plan gefräst wurde. Bei Dauerbetrieb erwärmte sich dieser Kühlkörper jedoch sehr stark, so daß für eine zusätzliche Kühlung ein Lüfter (Papst 120 * 120 mm; 12 V) eingesetzt wurde.
Beim Test des Verstärkers ist er zunächst ohne Eingangssignal auf mögliche Schwingneigung zu testen, dazu wird die Gate-Vorspannung bei abgeschlossenem Eingang und angeschlossenen Dummyload am Ausgang langsam erhöht und der Versorgungsstrom beobachtet. Ein plötzlicher starker Anstieg ist ein Zeichen für eine Schwingneigung. Wenn diese Tests erfolgreich verlaufen sind, kann man mit niedriger Eingangsleistung beginnend, das Modul testen.

Meßergebnisse

Ausgangsleistung, Linearität (1 dB Kompression), Wirkungsgrad

Da das Hybridmodul für die Vollausteuerung bis zu 200 mW benötigt, die ein "üblicher" Meßsender nicht liefern kann, wurde zwischen Meßsender und Hybridverstäker ein breitbandiger Kleinleistungsverstärker (Mini Circuits ZHL-1217 HLN) dem Modul vorgeschaltet. Die Linearität und Frequenzgang (1240 MHz; 1300 MHz) ist in Bild 8 zu sehen. Der ZHL ist bis Ausgangsleistungen von +26 dBm linear, wie die mit eingezeichnete ideale Kennlinie beweist.
Bei einer Gate-Vorspannung von 3,6 V fließt ein Ruhestrom von 300 mA. Die Ausgangsleistung als Funktion der Eingangsleistung ist in Bild 9 zu sehen. Die starke Nichtlinari-tät bei der Aussteuerung und der Frequenzgang sind klar zu erkennen, das Verhalten ähnelt trotz Ruhestrom eher dem eines B- oder C-Betriebs.
Bei einer Gate-Vorspannung von 4,0 V, Ruhestrom 1,5 A; siehe Bild 10 ist zwar die Aussteuerung linearer, der große Frequenzgang fällt jedoch wieder auf. Das Modul scheint auf die "Mittenfrequenz" des 23 cm Bandes 1270 MHz optimiert zu sein. Ein ähnliches Bild ergibt sich, wenn man die Gate-Vorspannung auf 5,0 V einstellt, es fließt dann ein Ruhestrom von 5,7A; siehe Bild 11..
Die Verstärkung des Hybrids sit für 1270 und 1300 MHz jedoch "dichter" beieinander, nur bei 1240 MHz ist ein starker Verstärkungsabfall zu beobachten.
Auch der Wirkungsgrad (Pae = "power added effichency" d. h. der Wirkungsgrad unter Berücksichtigung der Eingangsleistung) ist nicht gerade hoch, zwischen 22 und 30 %. siehe Bild 12. Laut Datenblatt sollte der Wirkungsgrad um 30 % liegen.

Schaut man sich die Diagramme des Datenblatts [2]; Seite 3 "Output power gain and Drain current versus input power) genauer an, liest man z.B. für eine Eingangsleistung von +10 dBm folgende Ausgangsleistungen ab: 1240 MHz +35 dBm, 1270 MHz + 41 dBm. 1300 MHz + 36 dBm).

Die starke Abhängigkeit der Verstärkung über der Frequenz.wird also auch im Datenblatt bestätigt und ist keine Folge des Aufbaus! In einem weiteren Versuch wurde deshalb bei einer Gate-Vorspannung von 5 V und jeweils konstanter Eingangsleistung die Ausgangsleistung als Funktion der Frequenz gemessen, siehe Bild 13. Der starke Frequenzgang wird bestätigt. In Bild 14 werden Gesamtstrom und Wirkungsgrad als Funktion der Frequenz bei jeweils konstanter Eingangsleistung dargestellt, der maximale Wirkungsgrad wird auf der "Mittenfrequenz " 1270 MHz erreicht. Als Vergleich wurde ein Hybridmodul M57762 (Fertigmodul von RSE Elektronik) unter gleichen Bedingungen durchgemessen, siehe Bild 15. Der starke Frequenzgang tritt an diesem Modul nicht auf!

Bei weiteren Tests wurde festgestellt, daß der logarithmische Detektor für die Vorwärtsleistung übersteuert werde, dies konnte durch eine Vergrößerung des Längswiderstands des Abschwächers nicht beseitgt werden, da offensichtlich das Übersprechen zu hoch ist. Laut Datenblatt [7] sind die Detektoren für Ein-gangsleistungen bis 0 dBm brauchbar, der "dB-lineare" Bereich geht jedoch bis ca. –6 dBm. Auch die Direktivität des Richtkopplers im vorliegenden Aufbau beträgt nur ca. 10 dB, gemessen an den Ausgängen der beiden logarithmischen Detektoren.

Oberwellenunterdrückung

Die drei Bilder 16, 17 und 18 zeigen die Oberwellen des Aufbaus bei Vollaussteuerung auf den Grundwellenfrequenzen 1240, 1270 und 1300 MHz. Es ist nur die erste Oberwelle sichtbar, die mit ca. 52 dB bezogen auf die Grundwelle unterdrückt ist.

Intermodulationsmessung

Bei der Intermodulationsmessung wurde der Hybrisverstärker auf 14 W PEP (entsprechend 41,46 dBm "PEP" = 35,46 dBm/Ton) mit zwei Signalen, die einen Frequenzabstand von 100 kHz aufweisen, auf den Frequenzen 1240, 1270 und 1300 MHz durchgeführt. Das Intermodulationsverhalten verändert sich bei niedrigeren Frequenzabständen nicht. Im Datenblatt werden von 20 dBc für Frequenzabstände von 10 kHz angegeben.

Bei den in den Bildern 19 bis 21 dargestellen Ausdrucken ist die Dämpfung von 1,3 dB des Kabels zwischen dem Leistungsabschwächer und Spektrumanalysator zu berücksichtigen.

Fazit

Der Hybridverstärker RA18H1213G ist bezüglich Frequenzgang und Stromaufnahme/Wirkungsgrad seinem bipolaren Vorgänger M57762 deutlich unterlegen.

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A Simple Circular Polarizer for 10GHz

by Marko Cebokli, S57UUU

Abstract

A simple polarizer based on Ku-band satellite TV hardware (orthomode couplers and feedhorns) and a dielectric delay plate, suitable for 10GHz EME is described. The main goal was a no-tune design that can be easily reproduced without measuring equipment, but still achieves high quality

1. Introduction

For a long time, the only serious argument against use of circular polarization for EME has been that, for a typical radio amateur, it is difficult to achieve good circular polarization. This was based mainly on the experience with screw polarizers, which indeed require careful tuning with suitable measurement equipment, and linear orthomode plus 90 degree hybrid combinations, where the connecting cables have to be made with high precison and are prone to losses etc. However, a few years ago, when Zdenek OK1DFC introduced the septum polarizer to the amateur radio Moonbounce community [1], this changed dramatically. Now everybody with moderate metal working skills (cutting sheet metal to measure and joining a few such pieces) could build a working no-tune circular polarizer, with separate ports for left and right hand circular polarizations. While the septum can still work perfectly on 10GHz and higher, the dimensions become a bit small for precise cutting with hand tools. So for a long time I had the idea of using Ku-band satellite TV components like orthomodes couplers, feedhorns etc. and design a feeding system based on them. At the 02 EME conference in the Czech republic, SM6CKU gave me an orthomode/feedhorn combination and I promised to design a polarizer for it.

2. Transition - Polarizer - Feedhorn...

There seems to be a widespread confusion among HAMs about what is a "dish feed"! Most published "recipes" are in fact what should be called a "feeding system", because they join together several independent components. In a well designed feed, these should be independent of each other. There is no such thing as a "septum feed"! We only have a septum polarizer, which can be used as a part of a CP feeding system. For example a linear polarized VE4MA design combines three parts:

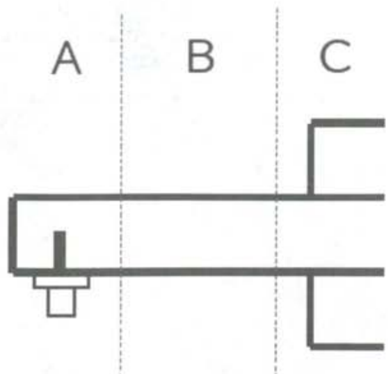

Fig 1. The VE4MA feed: A = transition, B = waveguide, C = radiator
Abb. 1 Das VE4MA-Feed: A = Übergang, B = Wellenleiter, C = Strahler

First comes the coax to waveguide transition "A", which must bring the EM wave from the coax cable into the waveguide in a well matched way. This is its only task - in a well designed feed it has no effect on the directional pattern. Another way of bringing the wave into the round waveguide could be used here (for eample a rectangular/round WG transition) without affecting the pattern. Then comes a section of waveguide "B". On first sight, this does not seem to be important/necessary, but it serves to supress any higher modes that could have been launched by the probe in the coax/WG transition. Such modes could distort the radiation pattern of the feedhorn, if they would arrive at the aperture. The attenuation of below-cutoff modes in a waveguide is extremely high, so a very short section is enough to prevent this from happening. It is the task of this section to assure that the coax/WG transition and the feedhorn are really independent of each other. In a well designed system, its length should not be important, provided it is long enough to kill the higher modes. However in HAM practice, there usually is some interaction among the parts. Most often, the radiatig section is not well matched and some reflection happens there. This is usually compensated by detuning the coax/WG transition. In this case, the length of the WG section is important, since the reflections at the transition and aperture must cancel out. And last but not least, comes the radiating structure "C", the real feedhorn, in the VE4MA case a parasitically excited coaxial resonator. This determines the radiation pattern of the feed - and the pattern will be always the same, regardless of how you have excited the (fundamental mode) field in the waveguide. Again, a different radiating section (for example W2IMU) could be used here to get a different pattern. Even with a "coffee can feed", there is a "radiating section" which can be treated separately, namely its aperture. For a circular v

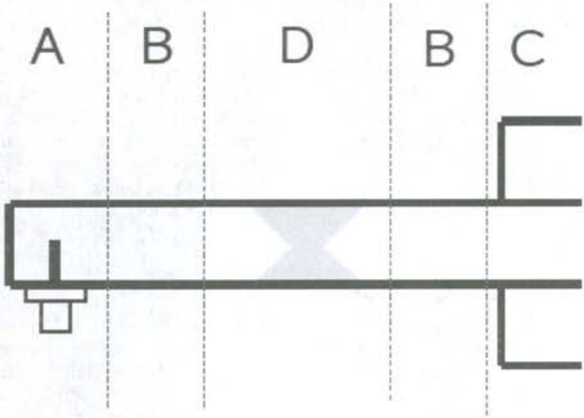

Fig 2. A circular polarized feed: A = transition, B = waveguide, C = radiator, D = polarizer
Abb. 2 Ein zirkular polarisiertes Feed: A = Übergang, B = Wellenleiter, C = Strahler, D= Polarisator

Again, in a well designed system this component should be independent of the others, so any type of polarizer can be used with any type of radiator. (The original OK1DFC version of septum has square waveguide output, so another component, a square to round transition, must be added if standard feedhorns based on round waveguide are to be used.)

3. Ku-Band Satellite Components

Modifying Ku-band LNBs into 10GHz low noise preamplifiers has a long tradition among microwave HAMs. But there exists a whole bunch of other Ku-band components often available for cheap at fleamarkets and general junk, that could be abused for HAM purposes on the 10GHz band: See Fig. 3.
They all use R 120 (WR-75) rectangular and 19mm diameter round waveguides. (Strangely, this is not a standardized size for round waveguides! For example C104 (WC80) for 10-13.7GHz is 20.24mm and C120 (WC69) for 11.6-15.9GHz is 17.475mm) The idea here is to use a satellite linear orthomode coupler and add a simple circular polarizer. This way we get a circular ortho, with two separate R 120 ports for left and right hand polarization.

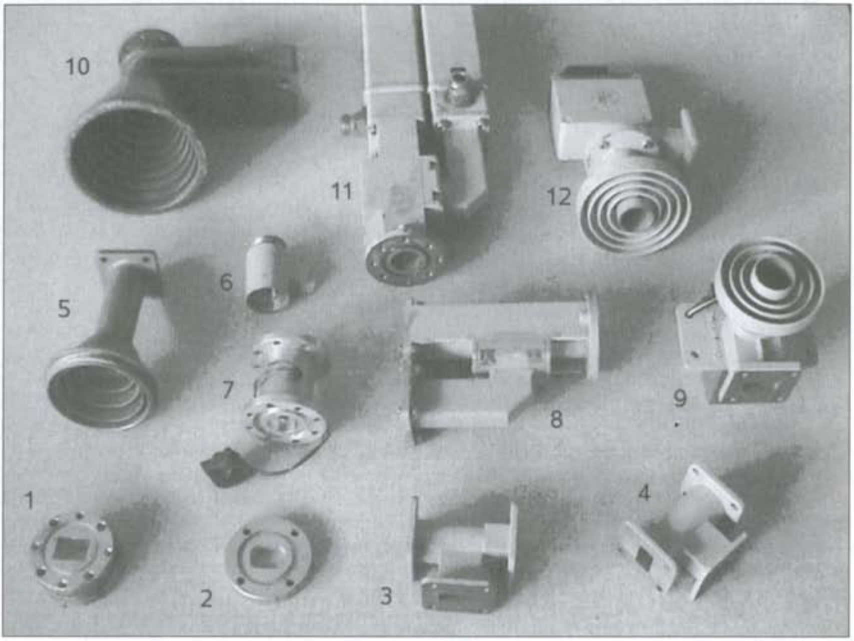

Fig 3. 1 = two stage rectangular/round transition; 2 = single stage rectangular/round transition; 3,4,8 = linear orthomode couplers; 5 = feedhorn for offset dish; 6,7 = ferrite polarotors; 9,12 = mechanical polarotors with feedhorns for central fed dish; 10 = feedhorn for Gregorian system; 11 = linear orthomode with two LNBs.
Abb. 3: Verschiedene Teile aus der SAT-Technik für 10 GHz

4. The Dielectric Plate Polarizer

A circularly polarized wave can be thought of as two linear polarized mutually perpendicular (for example, at + and - 45 degrees) waves with 90 degrees of phase offset:

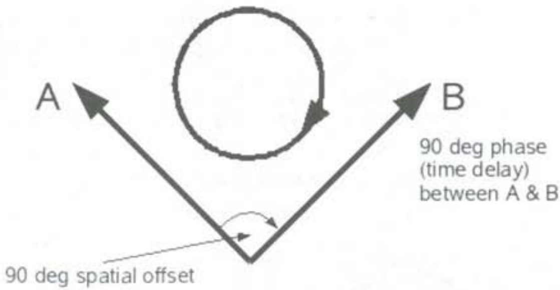

Fig 4. Making a circular wave from two linear ones
Abb. 4. Erzeugen einer zirkularen Welle aus zwei linearen Wellen

A linear vertically polarized wave can also be thought of as a sum of two perpendicular linear waves at + and - 45 degrees, but with zero phase offset:

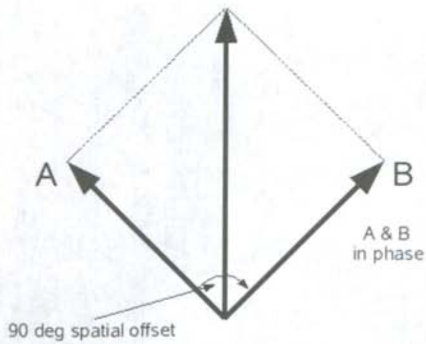

Fig 5. Making a linear wave from two linear ones
Abb 5. Erzeugen einer linearen Welle aus zwei linearen Wellen

Looking at the pictures above, one can easily see that all that has to be done to change fig 5 into fig 4 (linear into circular) is to delay one of the 45 degree components 90 degrees in phase, relative to the other. There are several ways to achieve this, for example two rows of screws at 45 degrees, or a waveguide that has different dimensions (and hence different propagation speeds) in the two 45 degree planes - a squeezed tube [2]. [7]. Another way is to load the waveguide with dielectric in a suitable way, for example by putting a sheet of dielectric material into the waveguide at a 45 degrees angle to the incoming linear polarization [3].

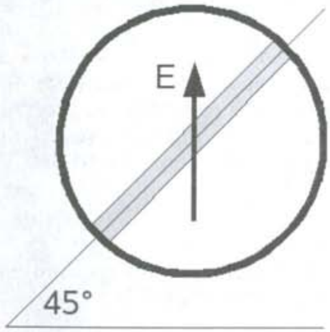

Fig 6. A dielectric plate polarizer (grey) in a round waveguide
Abb 6. Eine dielektrischer Plattenpolarisator (grau) in einem runden Wellenleiter

Doing this, one has to be careful not to cause too much reflections in the waveguide. An old rule of waveguide plumbing says: do things gradually to reduce reflection. Following this rule, the dielectric plate is shaped like this:

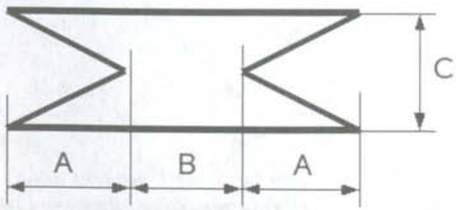

Fig 7. The shape and dimensions of the dielectric plate
Abb. 7 Die Form und die Abmessungen der dielektrischen Platte

Of course the dielectric material used must be of low loss at the operating frequency. First thing that comes to mind is PTFE, but it is soft (doesn't keep shape very well) and it is hard to glue into place. I did first experiments with PTFE but then changed to PMMA ("plexiglass").

Loss wise it is no worse than PTFE (negligible losses in both cases), but its hardness is "just right", easy to cut and file while stable in form. Easier to glue, too. I've designed the 10.4GHz version to fit into the 19mm round waveguide used by the satellite TV industry. Individual pieces will differ in diameter by a few tenths of a mm. I suggest filing the plate so that it fits tightly, this way it might not even be necessary to glue it in. On the feedhorn given to me by SM6CKU, the bore is somewhat conical, (a requirement of the casting / molding process?) so the plate nicely "wedges" into position. I made the plate by first cutting it out with a jigsaw, making it slightly bigger than required, and then filing it to measure.
The dimensions for 4.3mm thick PMMA are **A=16mm, B=11mm, C=19mm**. To get better than 1dB axial ratio, the tolerances should be within 0.5mm - not too hard to achieve. Drawing a template on mm paper can help here. The 45 degree angle at which the plate has to be placed into the waveguide is quite critical, should be within a couple of degrees.

5. Receiver Protection

The R 120 flange on the satellite ortho is ideal for a modified LNB type preamplifier. However, the isolation between the ports is typically around 20dB, not enough to protect the LNA from the EME transmitting power levels. A simple zero-loss receiver protection switch can be made by simply inserting a metal pin into the RX waveguide using a spring loaded solenoid coil:

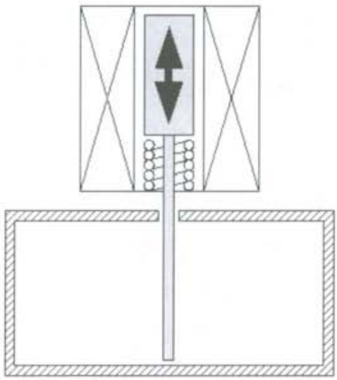

Fig 8. A simple way to protect the receiver
Abb. 8 Eine einfache Methode den Empfänger zu schützen

Solenoids from old relays, washing machine valves, etc can be used. 20..30dB can be achieved even without the probe having contact with waveguide walls. Together with the port isolation, this gives a comfortable margin for receiver protection.

6. But I have heard that circular polarization is worse for EME....

There were rumors of this kind circulating around the EME community, but they aren't true. In my paper at the 2000 EME conference in Rio [4] I have described at length why circular is better. At that time I did not yet know about the differential depolarization at the Moon, so let's take a look at that. Luckily, WA5WJB has put some hard to find old lunar radar papers online (most relevant is [5]), so we can see what empirical measurements have shown. When superficially looking at these papers (for example seeing figure 4 in [5] without reading the fine print below it) one can really get the false illusion that there is a problem with circular. But reading them carefully, going through the math and numbers, one can see that this is not the case. So, in short, what can be concluded from these papers? Relevant for our discussion are the differences in depolarization between linear and circular, which are described there. As can be seen from figs 5 and 7 in [5], this happens predominately at the outer rim of the lunar disk, where the incidence angle is above 45 degrees (cos < 0.7 in the above mentioned figures). In that area the polarization ratio is cca 7dB (83% vs 17%) for linear and 3dB (50% vs 50%) for circular. This means 0.8dB of loss for linear vs 1.8dB for circular. That would be a 1dB advantage for ALIGNED linear (I've shown in my Rio paper [4] that in a typical EME situation, polarization is almost never aligned, causing on average more than 1 dB of loss). But these numbers hold only for the outer limb of the Moon, which only contributes a small part of the echo. Integrating the 3.8cm numbers in table 1 from [5], (see spreadsheet [6]) one can see that this outer part (>45 degrees) contributes only cca 20% of the total returned echo. Weighing the depolarization curves in figs 5 and 7 of [5] with the values from table 1 from the same paper, one can estimate that the effective depolarization ratios of the whole moon are cca 9.5dB (89% vs 11%) for linear and 8dB (86% vs 14%) for circular. This is 0.5dB vs 0.65dB loss for linear and circular, respectively. This means that the "circular depolarization penalty" is only 0.15dB!

Obviously, the "circular depolarization penalty" is significantly smaller than the "linear nonalignment penalty", as I described my Rio paper. And more than that - the 0.15dB signal deficit is of the diffuse part from the rim, which contributes most of the Doppler broadening! This means that the "good signal" (specular part from the center of the lunar disk) vs "bad signal" (Doppler broadened diffuse part from the rim) ratio is BETTER for the circular polarization!
Ergo: IT MAKES A LOT OF SENSE TO USE CIRCULAR POLARIZATION FOR EME!!

7. Conclusion

Being a very lazy person myself, I can understand that people who have working linear systems are reluctant to make modifications on them, therefore they do not like the idea that others would go circular. However experimenting with and modifying our hardware should be a part of the hobby, shouldn't it? Personally, I have both linear and circular feeds for my dish, so I have no vested interest here. But from own operating experience, I know that linear stinks...

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Ein einfacher zirkularer Polarisator für 10 GHz

von Marko Cebokli, S57UUU

Zusammenfassung

Ein einfacher Polariator, basierend auf Bauteilen aus dem TV-Satelliten-Ku-Band (orthomode Koppler und Feedhorn) und einer dielektrischen Verzögerungsplatte, passend für 10 GHz EME wird in diesem Artikel beschrieben. Das Hauptziel war ein Design, das keine Abstimmung benötigt, und leicht ohne Meßmittel nachgebaut werden kann und trotzdem hohe Qualität hat.

1. Einleitung

Für lange Zeit war das einzige ernstzunehmende Argument gegen die Verwendung zirkularer Polarisation bei EME, dass es für einen durchschnittlichen Funkamateur sehr schwierig ist, eine gute zirkulare Polarisation zu realisieren. Dies basierte vorwiegend auf den Erfahrungen mit Schrauben-Polarisatoren, die in der Tat ein sehr sorgfältiges Abstimmen mit passenden Messmitteln erfordern und linear-orthomode plus 90-Grad-Hybrid-Kopplern, bei denen die Verbindungskabel mit hoher Präzision gemacht werden müssen und die anfällig für Verluste sind etc. Vor einigen Jahren jedoch, als Zdenek, OK1FDC, den Septum-Polarisator im EME-Amateurfunk einführte [1], hat sich dies drastisch geändert. Nun kann jeder, der bescheiden Fähigkeiten in der Metallbearbeitung hat (Metallbleche auf Maß schneiden und einige dieser Teile verbinden), einen funktionierenten zirkularen Polarisator selbst bauen, der nicht abgestimmt werden muß und getrennte Eingänge für link- und rechtdrehende Polarisation hat. Das Septum kann zwar perfekt auf 10 GHz und höher arbeiten, aber die Abmessungen werden ein wenig klein für das präzise Schneiden mit Handwerkzeug. Deshalb hatte ich schon für längere Zeit die Idee, Komponenten aus dem Satelliten-TV-Bereich (Ku-Band) zu verwenden, wie Feedhorn, orthomode Koppler usw., und ein Feed-System basierend darauf zu entwickeln. Auf der EME-Konferenz 2002 in Tschechien hat SM6CKU mir eine orthomode-Feedhorn-Kombination übergeben und ich habe versprochen, dafür einen Polarisator zu entwickeln.

2. Übergang - Polarisator - Feedhorn...

Es scheint eine weitverbreitete Verwirrung bei den Funkamateuren darüber zu geben, was ein "Feed" für einen Spiegel darstellt! Die meisten publizierten „Rezepte" sind in der Tat das, was man ein „Feed-System" nennen sollte, weil sie in sich mehrere unabhängige Komponenten vereinen. In einem gut designten Feed sollten diese unabhängig voneinander sein. Es gibt nicht so etwas wie ein „Septum-Feed"! Wir haben nur einen Septum-Polarisator, der als Teil eines CP Feed-Systems verwendet werden kann. Zum Beispiel kombiniert ein linear polarisiertes VE4MA-Design drei Teile. Siehe Abb. 1.

Als erstes kommt der Übergang „A" von koaxial auf Wellenleiter, der die elektromagnetische Welle in einer gut anpassenden Weise vom Koaxkabel in den Wellenleiter bringen muß. Dies ist seine einzige Aufgabe – in einem gut designten Feed hat dieser keinen Einfluß auf das Richtdiagramm. Ein anderer Weg die Welle in den runden Wellenleiter zu bringen, kann hier auch verwendet werden (z.B. eine Übergang von rechteckigem Wellenleiter auf runden). Dann folgt ein Abschnitt des Wellenleiters „B". Auf den ersten Blick scheint dieser nicht wichtig oder nötig zu sein, aber er dient dazu, irgendwelche höheren Modes, die von der Einkopplung im Koax-Wellenleiter-Übergang ausgehen könnten, zu unterdrücken. Solche Modes könnten das Strahlungsdiagramm des Feedhorns stören, falls sie die Öffnung erreichen. Die Abschwächung unterhalb des Cutoffs in einem Wellenleiter ist sehr hoch, so dass ein sehr kurzes Stück ausreicht, um dies zu verhindern. Zweck dieses Stückes ist, sicherzustellen, dass der Koax-Wellenleiter-Übergang und das Feedhorn wirklich unabhängig voneinander sind. In einem gut designten System sollte die Länge nicht wichtig sein, vorausgesetzt es ist lang genug, um die höheren Modes auszulöschen. In Amateur-Sytemen allerdings ist meistens etwas Wechselwirkung zwischen den Teilen.

Meistens ist die strahlende Sektion nicht gut angepasst und es tritt dort etwas Reklektion auf. Das wird meist durch Verstimmen des Koax-Wellenleiter-Übergangs ausgeglichen. In diesem Fall wird die Länge der Wellenleiter-Sektion wichtig, weil die Reflektionen am Übergang und der Öffnung sich auslöschen müssen. Last not least kommt die strahlende Struktur „C“, des echte Feedhorn, im VE4MA-Fall ein parasitär erregter koaxialer Resonator. Dieser bestimmt das Strahungsdiagramm des Feed – und das Diagramm wird immer gleich sein, egal wie man das Feld (im Grundmodus) im Wellenleiter erzeugt hat. Also, nochmals, ein anderes strahlendes System (z.B. W2IMU Horn) könnte hier verwendet werden, um ein anderes Diagramm zu erreichen. Sogar mit einem „Kaffeekannen-Feed“ gibt es eine „strahlende Sektion“, die getrennt gesehen werden kann, nämlich die Öffnung. Für eine zirkular polarisierte Antenne müssen wir eine weitere Komponente hinzufügen, den Polarisator. Siehe Abb. 2

Nochmals, in einem gut designten System sollte diese Komponente unabhängig von den anderen sein, so daß jede Art von Polarisator mit jeder Art von Strahler verwendet werden kann. (Die originale Version des OK1DFC-Septum hat einen quadratischen Wellenleiter-Ausgang, so dass eine weitere Komponente, ein Übergang von quadratisch auf rund, hinzugefügt werden muß, wenn Standard-Feedhörner, die auf runden Wellenleitern basieren, verwendet werden sollen.)

3. Satelliten-Komponenten aus dem Ku-Band

Das Modifizieren von Ku-Band-LNBs in rauscharme 10-GHz-Vorverstärker hat bei den Mikrowellen-Amateuren eine lange Tradition. Aber es existiert eine ganze Menge anderer Ku-Band-Komponenten, die oft billig auf Flohmärkten erhältlich sind, sowie allgemeiner Schrott, der für Amateur-Zwecke im 10-GHz-Band missbraucht werden kann. Siehe Abb. 3.

Sie alle verwenden rechteckigen R 120 (WR-75) und runden Wellenleiter mit 19mm Durchmesser. (Komischerweise ist dies keine Standard-Größe für runde Wellenleiter!. Z.B. hat C104 (WC80) für 10-13.7GHz 20.24mm und C120 (WC69) für 11.6-15.9GHz hat 17.475mm). Die Idee hier ist, einen linear-orthomode-Koppler aus dem Satellitenbereich zu verwenden und einen einfachen zirkularen Polarisator hinzuzufügen. Auf diese Weise erhalten wir zirkular ortho mit zwei R120 Eingängen für links- und rechtdrehende Polarisation.

4. Der dielektrische Platten-Polarisator

Eine zirkular polarisierte Welle kann gedanklich bestehen aus zwei linear polarisierten gegenseitig senkrecht stehenden Wellen (z.B. bei + und - 45 Grad) mit 90 Grad Phasendifferenz. Siehe Abb. 4.

Eine linear vertikal polarisierte Welle kann auch gedanklich betrachtet werden als Summe zweier senkrecht aufeinander stehender linearer Wellen bei + und - 45 Grad, aber ohne Phasendifferenz. Siehe Abb. 5.

Beim Betrachten der Abbildungen kann man leicht erkennen, dass alles, was getan werden muss, um Abb.5 in Abb. 4 (linear zu zirkular) zu verändern, das Verzögern einer der beiden 45-Grad-Komponenten um 90 Grad-Phasenwinkel relativ zur anderen ist.

Es gibt verschiedene Wege, dies zu erreichen, z.B. zwei Reihen von Schrauben bei 45 Grad oder ein Wellenleiter, der andere Abmessungen hat (und damit andere Ausbreitungsgeschwindigkeit) in den beiden 45-Grad-Ebenen hat – eine „squeezed“ Tube (gedrückter Wellenleiter) [2], [7]. Ein anderer Weg ist, den Wellenleiter mit einem Dielektrikum in einem geeigneten Weg zu beladen, z.B. ein Stück dielektrisches Material im Wellenleiter in einem 45-Grad-Winkel zur eintreffenden linearen Polarisation [3].

Wenn man dies tut, muß man vorsichtig sein, um nicht zu viele Reflektionen im Wellenleiter zu verursachen. Eine alte Regel des Hohlleiter-Bauers besagt: Mach es stufenweise, um Reflektionen zu reduzieren. Dieser Regel folgend, ist die dielektrische Platte geformt wie in Abb. 7 zu sehen. Natürlich darf das verwendete dielektrische Material nur geringe Verluste auf der Arbeizsfrequenz haben. Als erstes kommt einem PTFE in den Sinn, aber es ist weich (d.h. behält seine Form nicht gut) und es ist schwierig es an seinem Platz einzukleben. Zuerst habe ich mit PTFE experimentiert, dann aber zu PMMA („Plexiglas“) gewechselt.

Bezüglich der Verluste ist es nicht schlechter als PTFE (vernachlässigbare Verluste in beiden Fällen), aber seine Härte ist gerade richtig, leicht zu schneiden und feilen und das bei stabiler Form. Auch ist es leichter zu verkleben. Ich habe die 10.4 GHz-Version so entwickelt, dass sie in den runden 19mm Wellenleiter der Stalliten-TV-Industrie passt. Die individuellen Stücke werden sich im Durchmesser um wenige Zehntel-Millimeter unterscheiden. Ich schlage vor, die Platte so zurecht zufeilen, dass sie stramm passt. Auf diese Weise braucht man sie eventuell nicht mal festkleben. Bei dem Feedhorn, das mir SM6CKU gegeben hat, ist der Durchmesser etwas konisch im Verlauf (eine Anforderung des Guss-/Pressprozesses?), so dass die Platte wunderbar in Position festkeilt. Ich habe die Platte hergestellt, indem ich die zuerst mit einer Laubsäge etwas größer als benötigt ausgesägt habe und dann mit einer Feile auf das genaue Maß gebracht habe.

Die Abmessungen für 4.3mm dickes PMMA sind: **A=16mm, B=11mm, C=19mm**. Um ein besseres axiales Verhältnis als 1 dB zu erhalten, sollten die Abweichungen innerhalb 0.5mm liegen, was nicht so schwierig ist. Eine Vorlage auf Millimeterpapier zu zeichnen, kann helfen. Der 45-Grad-Winkel mit dem die Platte im Wellenleiter platziert werden muß, ist ziemlich kritisch und muß innerhalb weniger Grad genau liegen.

5. Schutz für den Empfänger

Der R120-Flanch des Satelliten-Orthos ist ideal für einen aus einem LNB modifizierten Preamp. Jedoch ist die Isolation zwischen den Ports typisch um die 20 dB, was nicht genug ist, um den LNA vor den Leistungen bei EME-Betrieb zu schützen. Eine einfacher verlustloser Empfängerschutzschalter kann hergestellt werden, indem einfach ein Metallpin in den RX-Wellenleiter Mittels einer mit einer Feder versehenen Magnetspule eingeführt wird. Siehe Abb. 8. Spulen von alten Relais, Wachmaschinen etc können verwendet werden. 20 bis 30 dB können erreicht werden, sogar ohne dass der Stift Kontakt mit der Wand des Wellenleiters hat. Zusammen mit der Iolierung der Ports ergibt das einen komfortablen Spielraum für den Schutz des Empfängers.

6. Aber ich habe gehört, dass zirkulare Polarisation schlecht bei EME ist...

Solche Gerüchte kreisen in der EME-Gemeinschaft herum, aber sie sind nicht wahr. In meinem Vortrag auf der EME Konferenz 2000 in Rio [4] habe ich ausführlich beschrieben, warum zirkular besser ist. Zu der Zeit habe ich noch nichts über die verschiedene Depolarisation auf dem Mond gewusst, also schauen wir uns das an: Glücklicherweise hat WA5VJB einige schwer zu findende Radar-Daten des Mondes online verfügbar gemacht (besonders relevant ist [5]), so dass wir sehen können, was empirische Messungen zeigen. Wenn man oberflächlich auf diese Daten schaut (z.B. auf Abb. in [5] ohne das Kleingedruckte darunter zu lessen), kann man wirklich leicht die falsche Illusion bekommen, dass es ein Problem mit Zirkular gibt. Aber, wenn man sorgfältig die Mathematik und Zahlen durchliest, kann man sehen, dass dies nicht der Fall ist. Also, in Kürze, was kann aus diesen Daten geschlossen werden? Relevant für unsere Diskussion sind die Unterschiede der Depolarisation zwischen Linear und Zirkular, die dort beschrieben sind. Wie von Abb. 5 und 7 in [5] gesehen werden kann, geschieht dies hauptsächlich auf dem äußeren Rand der Mondscheibe, wo der Einfallswinkel über 45 Grad liegt (cos < 0.7 in den oben erwähnten Abbildungen). In diesem Gebiet ist das Polarisationsverhältnis ca. 7dB (83% zu 17%) für Linear und 3dB (50% zu 50%) für Zirkular. Das bedeutet 0.8 dB Verlust bei Linear im Vergleich zu 1.8dB bei Zirkular. Das wäre ein 1dB Vorteil für übereinstimmende lineare Polarisation (Ich habe in meinem Rio-Aufsatz [4] gezeigt, daß in einer typischen EME-Situation die Polarisation fast nie übereinstimmend ist und einen Durschnittsverlust von über 1 dB verursacht). Aber diese Zahlen gelten nur für den äußeren Bereich des Mondes, der nur zu einem kleinen Teil des Echos beiträgt. Durch Integration der 3.8cm-Daten aus Tabelle 1 in [5], (siehe Tabellenkalkulation [6]) kann man sehen, dass dieser äußere Bereich (>45 Grad) nur zu etwa 20% des gesamten Echos beiträgt. Durch Bewerten der Depolarisations-Kurven in Abb. 5 und 7 in [5] mit den Werten aus Tabelle 1 aus derselben Quelle kann man abschätzen, dass die effektiven Depolarisationsverhältnisse des ganzen Mondes ca. 9.5dB (89% zu 11%) für Linear und 8dB (86% zu 14%) für Zirkular betragen. Das ist 0.5dB Verlust für Linear bzw. 0.65dB für Zirkular. Das bedeutet, dass der "zirkulare Depolarisationnachteil" nur 0.15 dB beträgt! Ganz offensichtlich ist der "zirkulare Depolarisationnachteil" bedeutend geringer als der „lineare Nichtübereinstimmungsnachteil", wie er in meinem Rio-Aufsatz beschrieben wurde. Darüberhinaus stammt das 0.15dB Signaldefizit aus dem diffusen Teil des Mondrandes, der am meisten zur Dopplerverschiebung beiträgt! Dies bedeutet, dass das Verhältnis von „gutem Signal" (vom spiegelnden Teil vom Zentrum der Mondscheibe) gegenüber dem „schlechten Signal" (Dopplerverschmierter diffuser Teil des Randes) besser bei der zirkularen Polarisation ist!
Ergo: ES MACHT VIEL SINN, ZIRKULARE POLARISATION FÜR EME ZU VERWENDEN!!

7. Schluss

Da ich selbst zu den trägen Menschen gehöre, kann ich verstehen, dass die, die mit linearen Systemen arbeiten, sich weigern, Modifikationen daran vorzunehmen. Deshalb mögen sie auch den Vorschlag nicht, dass andere zirkular gehen sollen. Jedoch sollte Experimentieren und Modifizieren unserer Hardware ein Teil unseres Hobbys sein, oder? Persönlich verwende ich für meinen Spiegel beides, lineare und zirkulare Feeds, also habe ich diesbezüglich kein persönliches Interesse. Aber aus meiner eigenen praktischen Erfahrung weiß ich, das linear stinkt.....

8. Referenzen Siehe engl. Text.

Yagis for the 70 MHz Amateur Band

by Martin Steyer, DK7ZB

More and more countries permit amateur radio operation on 70 MHz. Unfortunately the radio amateurs in DL can only listen, when the interesting 4m band is activated from other places. Anyway here are described high performance yagis which are easy to build. DL`s may use them for crossband operation,

Electrical concept

These yagis were designed by calculations basing on the approved 50 MHz antennas. Successfully built in G, OZ and 9A, they base on the 28Ω concept, which has been presented already several times, e.g. in [1]. This impedande provides a balanced ratio of all parameters which are important for a yagi (gain, pattern, matching characteristics). Base of the radiator is the in the middle interrupted stretched dipole which is easy to align and much easier to realize mechanically than a folded dipole. A double parallel quarter wave line made from 75Ω coaxial cable with a resistance of 37,5Ω is used as transformator and simple **(mantlewave?)** block at the same time. The schema of this match is shown in figure 1. The calculation of these yagis was made with „YO" [2] and „EZNEC+4" [3]. The data are shown in table 1.

Mechanical realisation

If one wants to visualise the dimensions of these yagis on could bring to mind that for the 4m band they have roughly the double dimensions as for the 2m band. For the boom a 20x20x2mm aluminium profile is suitable. The elements could be chosen from 10x1mm or 12x1mm aluminium tubes. For both the dimensions are shown in tabes 3 to 5. The distances correspond to the drilling holes for the elements measured from the reflector end. The auxiliary elements are fixed with black Polyamid brackets [4, 5] and 3mm stainless steel screws. (Figure 2). The dipole is interrupted in the middle by about 12mm. The shown dimensions are measured from one end to the other. Figure 3 shows better than any word how the mechanic clould be realised. For the dipole an istallation socket (IP54) is used. The quarterwave line leads to a by an angle grounded jack. Table 2 shows the lengths for different types of cable. The values are given for the outer shielding.For better mechanical stability a piece of GFK is fitted in the middle of the dipole which is fixed by a 3mm screw on the boom. Fixing on a pole could be done by an aluminium angle and an exhaust bracket (Figure 4).

Alignment and initial operation

Without any measurements and alignment the SWR should always be below 1.3 which is totally sufficient for receive purposes. This value can be improved with the help of an analyzer by changing the length of the dipole. The 2 element version is relatively narrow, the broadest match shows the 5 element yagi, beacuse this one got especially graduated directors.
Just with the 2 element yagi crossband QSOs with stations from G and 9A took place. Figure 5 shows the 5 element 28Ω Yagi at Adam, 9A4QV. Ahead there is 6 element 28Ω Yagi for 2m.
All relevant data (E and H pattern, SWR response) for free space are supplied in the addendum. More yagis for 4m and other bands are described on my homepage [6]. There one can download also the EZNEC files as ZIP file for own developments and und comparisons.

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[4] Fa. Attila Kocis Kommunikationstechnik, Tulpenweg 3, 96269 Grossheirath, Tel.: 09565 - 616 472, http://www.nuxcom.de

[5]: Fa. KONNI, Michelrieder Straße 8, 97839 Esselbach, http://www.konni-antennen.de/

[6]: Homepage DK7ZB, http://www.qsl.net/dk7zb

Type	Boom length	Gain/Gewinn	Front/Back	SWR <1,5
2-El.-28Ω	0,45m	4,4dBd	14dB	1,3MHz
3-El.-28Ω	1,32m	5,7dBd	25dB	1,6MHz
5-El.-28Ω	3,20m	8,6dBd	25dB	2,2MHz

Table 1 / Tabelle 1: Data of the yagis / Kurzdaten der Yagis

Type	Dielectricum	V	Lenght/Länge
RG-59	Voll-PE	0,667	712mm
RG-179	Teflon	0,71	758mm
CATV/SATV	FoamPE / Schaum-PE	0,82	876mm

Table 2: Lengths of the λ/4 lines for the impedance matching 28/50Ω by two parallel 75Ω coaxial cables - Längen der λ/4-Leitungen für die Impedanzanpassung 28/50Ω aus zwei parallelen 75Ω-Koaxkabeln

	Element Position	Element Length (10mm)	Element Length (12mm)
Rad	0mm	2092mm	2088mm
Dir	430mm	1938mm	1930mm

Table 3: Dimensions 2 element Yagi - Abmessungen der 2-Element-Yagi

	Element Position	Element Length (10mm)	Element Length (12mm)
Refl.	0mm	2154mm	2150mm
Rad	660mm	2026mm	2020mm
Dir	1320mm	1890mm	1880mm

Table 4: Dimensions 3 element yagi - Abmessungen der 3-Element-Yagi

	Element Position	Element Length (10mm)	Element Length (12mm)
Refl.	0mm	2102mm	2100mm
Rad	440mm	2038mm	2032mm
Dir 1	935mm	1944mm	1934mm
Dir 2	2115mm	1910mm	1900mm
Dir 3	3200mm	1870mm	1860mm

Table 5: Dimensions 5 element yagi - Abmessungen der 5-Element-Yagi

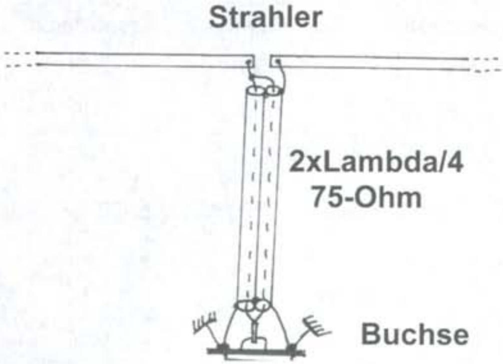


Figure 1: Schema 28/50Ω match with parallel 75Ω cables
Bild 1: Schema der Anpassung 28/50Ω mit parallelen 75Ω-Kabeln

Figure 2: Mounting the elements with Polyamide brackets (only bottom parts)
Bild 2: Befestigung der Elemente mit den Polyamid-Klammern (nur Unterteile)

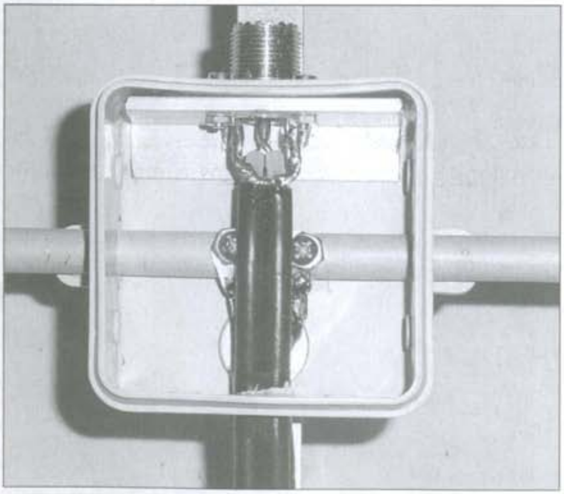


Figure 3: Socket with transformation line and coax jack
Bild 3: Die Dose mit Anpaßleitung und Koaxbuchse

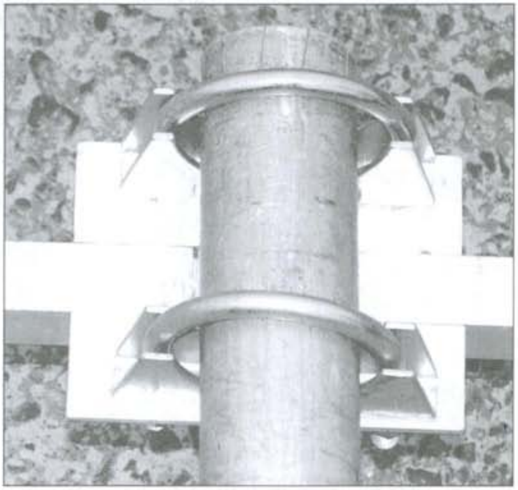


Figure 4: Mounting on a pole
Bild 4: Befestigung Boom/Mast

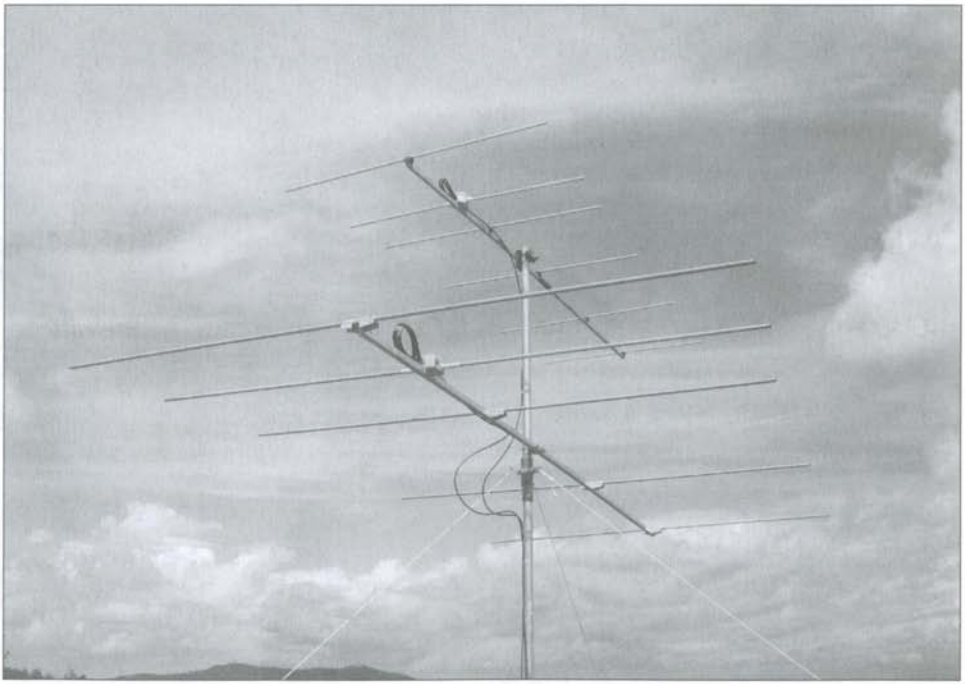
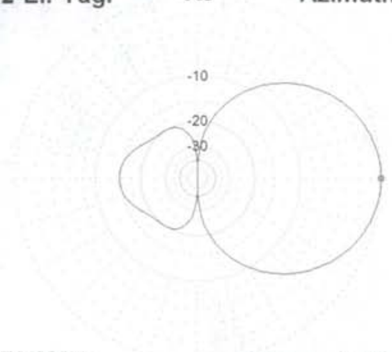


Figure 5: 5 element yagi for 4m at 9A4QV below a 6 element 28Ω Yagi for 2m
Bild 5: Die 5-Element-Yagi bei 9A4QV unter einer 6-El.-28Ω-2m-Yagi

2-El.-Yagi **Azimuth**

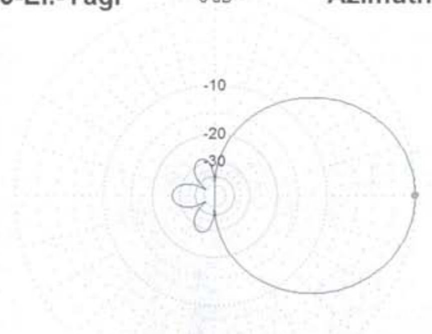


70,2MHz **0dB=4,41dBd**

2-El.-Yagi **Elevation**

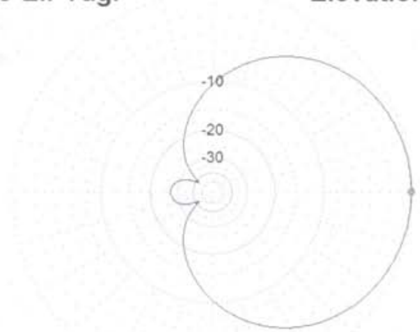
70,2MHz **0dB=4,41dBd**

3-El.-Yagi **Azimuth**



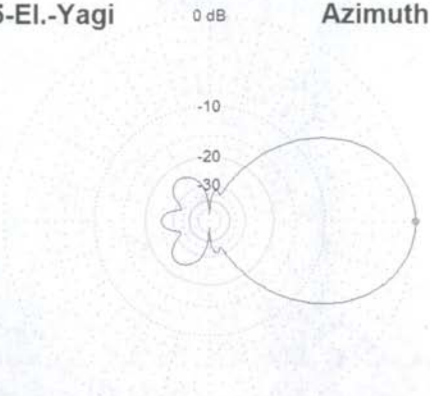
70,2MHz **0dB=5,75dBd**

3-El.-Yagi **Elevation**



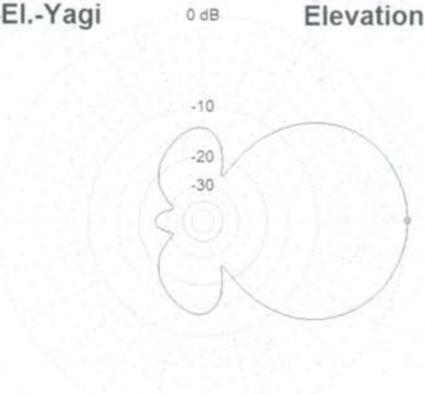
70,2MHz **0dB=5,75dBd**

5-El.-Yagi **Azimuth**



70,2MHz **0dB=8,61dBd**

5-El.-Yagi **Elevation**



70,2MHz **0dB=8,61dBd**

Yagis für das 70-MHz-Amateurfunkband

von Martin Steyer, DK7ZB

Immer mehr Länder gestatten auf 70MHz Amateurfunkbetrieb. Wie auch bei der Erweiterung des 40m-Bandes oder einer weiteren Liberalisierung des 6m-Zuganges können Funkamateure in DL leider nur zuschauen, bzw. zuhören, wie anderenorts das interessante 4m-Band aktiviert wird. Um wenigstens mit Crossband-Betrieb dabei zu sein, sollen hier einige einfach aufzubauende, aber leistungsfähige Yagis vorgestellt werden.

Das elektrische Konzept

Die Yagis entstanden durch Umrechnung und Weiterentwicklung aus schon bewährten 50MHz-Antennen. In G, OZ und 9A schon mit Erfolg nachgebaut, beruhen sie auf dem 28Ω-Konzept, das schon verschiedentlich vorgestellt wurde, z.B. in [1].

Dieser Strahlungswiderstand ergibt ein ausgewogenes Verhältnis aller für Yagis wichtigen Parameter (Gewinn, Richtdiagramm, Anpassungsverlauf). Grundlage des Strahlers ist der in der Mitte unterbrochene, gestreckte Dipol, der sich leicht abgleichen läßt und mechanisch viel einfacher als ein Faltdipol zu realisieren ist. Dazu wird eine doppelte, parallel geschaltete Viertelwellenleitung aus 75Ω-Koaxkabel mit 37,5Ω Wellenwiderstand als Transformationsglied und gleichzeitig vereinfachte Mantelwellensperre eingesetzt. Das Schema dieser Anpassung ist in Bild 1 zu sehen. Die Berechnung der Yagis wurde mit „YO" [2] und „EZNEC+4" [3] durchgeführt. Die Kurzdaten sind in Tabelle 1 zusammengestellt.

Mechanische Umsetzung

Wer sich eine Vorstellung von den Größen der Yagis machen will, sollte sich vergegenwärtigen, daß sie für das 4m-Band etwa die doppelten Abmessungen wie die für das 2m-Amateurband haben. Für den Boom bietet sich 20x20x2mm-Vierkantrohr aus Aluminium an, die Elemente können wahlweise aus 10x1mm- oder 12x1mm-Alu-Rundrohr bestehen. Für beide Möglichkeiten sind die Abmessungen in den Tabellen 3-5 enthalten. Die Abstände entsprechen den Bohrlöchern für die Elemente vom Reflektor her gemessen. Die Parasitärelemente werden mit den bekannten schwarzen Polyamid-Elementklammern [4, 5] und 3mm-Edelstahlschrauben befestigt (Bild 2). Das Erregerelement wird in der Mitte ca. 12mm unterbrochen, die gegebenen Abmessungen beziehen sich auf das Maß von Spitze zu Spitze. Bild 3 gibt besser als viele Worte wieder, wie die Mechanik aussehen kann. Es wird eine IP-54-Installationsdose für den Strahler eingesetzt, die Viertelwellenleitung führt zu einer über einen Winkel geerdeten Buchse. In Tabelle 2 sind die Längen für verschiedene Kabeltypen zusammengefasst, die Werte gelten für die äußere Abschirmung. Zur Verbesserung der mechanischen Stabilität wird durch ein eingezogenes GFK-Stück in der Dipolmitte eine 3mm-Schraube zur Befestigung am Boom verwendet.

Als Befestigung zu einem Tragemast kann ein Aluwinkel und eine Auspuffschelle dienen (Bild 4).

Abgleich und Inbetriebnahme

Ohne Meßgeräte und weiteren Abgleich sollte das SWR immer schon unter 1,3 liegen, was für Empfangszwecke völlig ausreicht. Mit einem Analyzer kann man diesen Wert durch Längenveränderung des Strahlers noch weiter verbessern. Dabei ist die 2-Element-Yagi relativ schmalbandig, am breitesten ist der Anpassungsverlauf bei der 5-Element-Yagi. Dieser wurde durch entsprechende Längenstaffelung der Direktoren ein bandfilterartiger SWR-Verlauf verpasst. chon mit der 2-Element-Yagi gelangen Crossband-QSOs mit G- und 9A-Stationen. In Bild 5 erkennt man die 5-Element-28Ω-Yagi bei Adam, 9A4QV. Darüber ist eine 6-Element-28Ω-Yagi für 2m angeordnet.

Alle relevanten Daten (Azimuth- und Elevationsdiagramme, SWR-Verlauf) für den Freiraum werden im Anhang zusammengefasst. Weitere Yagis für 4m und weitere Bänder finden sich auf meiner Homepage [6]. Dort können auch die EZNEC-Files für eigene Entwicklungen und Vergleiche als ZIP-Datei heruntergeladen werden.

Literatur

Siehe engl. Text.

RF PIN Regulator

by Ulrich Graf, DK4SX, **Ulrich.Graf@BenQ.com**

In order to fit an RF power control to a 2m transceiver, a variable PIN attenuator has been designed. Usually PIN attenuators are only useable up to a certain power level, above which they produce significant intermodulation distortion. In the available 2m transceiver the attenuator could be inserted only at a stage where RF levels of about +6 dBm were measured with IMD suppression better than 45dB. With the circuit shown, it was possible to adjust the power downward by a factor of 10 (10dB) while maintaining similar IMD performance.

The signal flow in the above circuit is from right to left. In se-quence from input to output, the circuit consists of a preset potentiometer R10 (see later) and two cascaded pi attenuators: R3-D2-R4 followed by R2-D1-R3. In order to provide reasonably good impedance matching under all conditions, the circuit was dimensioned to give a minimum attenuation of 2.5 dB and a minimum return loss of 10 dB. The highest attenuation is determined by the parallel combinations of D2 / R6 and D1 / R5. The IMD suppression becomes worse as the attenuation is increased (because the diode current is decreased) but the resistance in parallel with each diode ensures that the allowable IMD level is not exceeded. However, this design feature limits the maximum achievable attenuation from a single pi stage, so two pi stages had to be combined in series.

In order to obtain the lowest possible attenuation at the minimum setting, it was necessary to work with a quite high current through the diodes. The parallel resistors R2 and R3 have series capacitors to avoid shunting DC current away from the diodes. The parallel resistors R5 and R6 have slightly different values. R6 is a bit lower in resistance than R5, which means that this stage (D2) produces a little less attenuation. To compensate, the following stage can have a slightly higher attenuation without affecting IMD performance because it is 'protected' by the first stage. The series potentiometer R10 at the input is a miniature potentiometer that is used to adjust the basic gain in the TX chain.

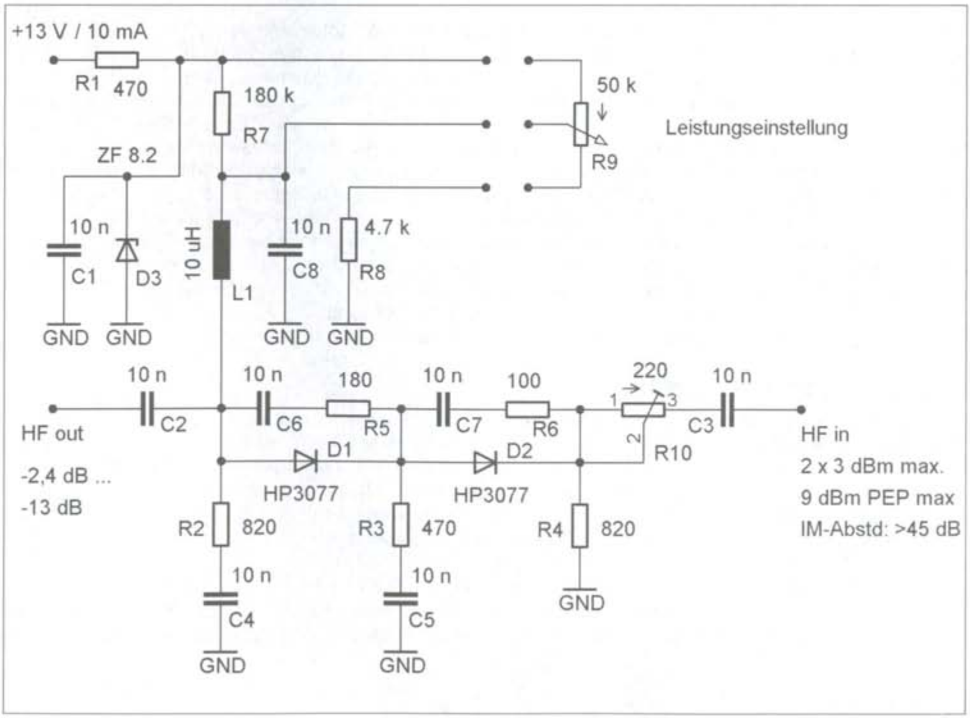


Fig.: Circuit Diagram

The voltage of the regulator is supplied by a Zener diode (D3) and stabilized to 8.2V in order to prevent changes of attenuation and output power due to different voltages when operat-ing with batteries. Total current consumption is 10mA. R7 is used for equalising the characteristic curve in order to get a quite linear response according to the angle of rotation of the potentiometer. If one needs a bit more than just the 10 dB of attenuation it is possible to increase the values of R5, R6 and the potentiometer, for the price of a few dB worse IM distortion.

Leistungs-PIN-Regler

von Ulrich Graf, DK4SX, Ulrich.Graf@BenQ.com

Zur Nachrüstung einer Leistungsregelung für einen 2 m-Transceiver wurde ein PIN-Regler entworfen. Üblicherweise sind PIN-Regelstufen nur bis zu einer bestimmten Leistungsgrenze brauchbar; darüber hinaus erzeugen sie erhebliche Intermodulationsstörungen. Im vorhandenen UKW-SSB-Transceiver konnte die Regelstufe jedoch nur an einer vorhandenen Schnittstelle eingefügt werden, an der HF-Pegel bis etwa +6 dBm zu messen waren. Mit der gezeigten Schaltung ließ sich die Leistung um den Faktor 10 (10 dB) abregeln, bei einem Intermodulationsabstand von >45 dB.

Die Schaltung setzt sich im Wesentlichen aus zwei Dämpfungsgliedern zusammen. R2, R3 und R4 bilden mit den Dioden D1 und D2 zwei hintereinander geschaltete PI-Glieder. Um eine Mindestanpassung zu gewährleisten, wurde diese so dimensioniert, dass sich eine geringste Dämpfung von etwa 2,5 dB ergab und eine Anpassung von 10 dB. Bei höchster Dämpfung bestimmt die Parallelschaltung aus D1 und R5 bzw. D2 und R6 die Durchlassdämpfung. Da im abgeregelten Zustand, also bei zunehmender Dämpfung die Aussteuerfähigkeit der Dioden bis zu einer gewissen Grenze abnimmt, also der Intermodulationsabstand geringer wird, entlastet der

Parallelwiderstand die Diode so weit, dass der Mindest-IM-Abstand nicht unterschritten wird. Da so allerdings die maximal erzielbare Dämpfung je PI-Glied nicht allzu hoch war, mussten zwei Glieder in Serie geschaltet werden.

Um die Einfügedämpfung möglichst gering zu halten, war es erforderlich, den Durchlassstrom durch die Dioden möglichst hoch auszulegen. Aus diesem Grund dürfen über die Parallelwiderstände bzw. über R2 und R3 keine DC-Ströme fließen, da sie Shuntzweige zu den Dioden bilden. Sie müssen daher mit Serienkondensatoren entkoppelt sein. Die Parallelwiderstände sind etwas unterschiedlich ausgelegt. R6 ist etwas niederohmiger; d.h. dieses Glied der Dämpfungskette macht etwas weniger Dämpfung. Da es aber das nachfolgende Glied entlastet, darf dieses dafür eine etwas höhere Dämpfung bewirken. Allerdings sind jetzt Eingang und Ausgang des Reglers genau festgelegt.

Der Serienregler R10 ist ein Miniaturpotentiometer, das der Einstellung der Grundverstärkung des Sendepfads dient. Um bei Batteriebetrieb die Dämpfung und damit die Sendeleistung nicht vom Ladezustand der Batterien abhängig zu machen, ist die Versorgung des Reglers über die Z-Diode D3 auf 8,2 V stabilisiert. Die Gesamtstromaufnahme ist 10 mA. R7 dient der Entzerrung der Regelkennlinie, damit die Dämpfung einigermaßen linear vom Drehwinkel des Pots abhängig ist. Wer etwas mehr als nur 10 dB Dämpfung benötigt, kann – unter Einbuße einiger dB am IM-Abstand – sowohl den Wert des Pots, als auch der Widerstände R5 und R6 erhöhen.

The case if the varying Sun Noise

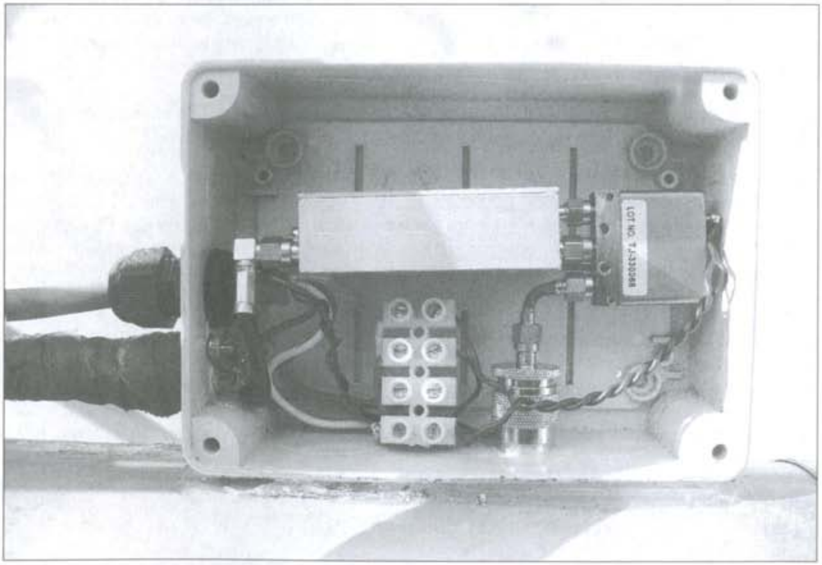
by Doug McArthur, VK3UM

We all hate an intermittent. They always occur at the wrong times and when eventually found you 'kick yourself' for not finding it earlier. This can be an embarrassment to your technical prowess as well. With that in mind, the following saga may just help some one, some time in the future.

I try to check my Sun noise, on both 70 and 23cm, prior to an operating stint to ensure that I have not become an unwitting Alligator. This of course is not always possible and if by chance you take three 'Y's to get Jays call sign, you have a real problem Houston! In this case you can guarantee it will cost serious beer at the next EME Conference!

The intermittent I am about to describe had been bugging me for ages. My reason for detailing the problem is that you may find it an interesting exercise of analytical thinking. The symptoms pointed to the root cause of the problem. However for most of us it is very easy to get side tracked and become embroiled in a mind set of what you think "is the obvious", and plow on ignoring the "it could not possibly be that".

I have the ability to measure Sun noise on both 70 and 23 cm simultaneously and I know the relationship between both bands at any given Solar Flux. In my case 23cms provides ~3-3.5dB higher Sun noise than 70cms. Thus I have a reference point for any untoward variations. (EMECalc has proved to be well within ±5 sfu www.sm2cew.com)



The preamp set up

(See photo) The pre amp DC supply and isolation relay (SMA) is fed with a separate cable. The output of the pre amp is returned to the shack in LDF 2-50. (3/8" heliax). The SMA isolation relay common is directly connected to the preamp input (SMA Male) and the normally closed SMA contact is terminated with a SMA 50 Ω precision resistor. The normally open contact connects to the receiver probe (Male Type N) via short link of semi rigid then to a SMA to N adapter. The relay is normally activated on receive and de-energized on transmit where it terminates pre amp. The SMA relay can also be de-energized separately for termination measurements. Viz, whilst receiving, the SMA relay is energized. Although the thought of having a relay active on receive does not appeal to me this does provide a fail safe situation (power or relay failure) and a 'mechanically pressurized contact', should contact resistance (in the NO mode) be seen as a potential problem.

The effect!

• Sun noise on 23cms would unexpectedly drop by ~8dB or more and echo's reduced by a similar amount.

• it seemingly was also associated to occur after a period of operating.

• Cold Sky [CS] to termination (normally ~6.8dB), would appear to remain the same.

• CS to ground would be reduced to ~1.5dB (normally ~6.5dB).

(I cannot fully illuminate my dish with ground noise due to my mechanical and terrain limitations and the figures are commensurate with the illumination achieved.)

Actions

• When it first happened I suspected the worse and changed the pre amp to no avail although in doing so the problem did come clear. I realized I had not found the problem and it would re occur ... but when? ... I was not disappointed!

• All S connectors were then thoroughly checked for tightness and a couple were deemed suspect. One SMA hard line link connection inner was possibly a tad too short and was re-terminated. It "came good" during the process.

• A week or so later the problem manifested itself again and the SMA relay was replaced. Again the problem disappeared believing me to think it was indeed the relay. At that time I was using the NC contacts to feed the preamp (relay activated on transmit). All was again normal for a few days then the problem returned during another operating stint.

• I replaced the relay with another "new one". At the time when "asking around", I received feed back from several sources that SMA relays, the ones we see from disposal sources, "can be nothing but trouble". That sort of convinced me it was the relay.

• Again the symptom reoccurred after a half dozen QSO's or so. (two faulty relays ?)

• I removed that relay. Burnished all contacts (and its brother) with the preferred low voltage AC and duly reinstalled the original. I also changed the operating condition such that on receive the relay would be now be energized. All returned to normal and worked this way for a week or so without the slightest hint of trouble ... fixed!

• wrong! Again it failed during another operating stint. It now appeared highly likely (obvious dear Douglas?) that it was not the relay and must be between the relay and the probe itself. (noting all along the CS to ground and CS to termination measurements)

• this left the link, the SMA to N adapter and the N female socket with probe attached. I deemed at the time the most likely culprit would be the mating of the inner of the SMA adapter to N socket. I pondered that I had some how come by a 75Ω adapter but could not believe they would make such a thing. (a few weeks prior I had found a BNC to N 75Ω adapter, (assuming wrongly it was in fact 50Ω), that caused me considerable grief.. (it now resides somewhere, an adapter throw distant, in my top paddock!)

• I removed the preamp and checked the DC connection between the probe and link. Perfect! Then I "accidentally" went from probe to ground and found ~8.3Ω !!! I then removed the link, still there, then the adapter, still there ... it was the N female probe it self !! I did have the presence of mind to return to the main shack and obtain a dental mirror to inspect and locate the culprit. Naturally it was in an impossible position, and tipping the dish upside and shaking the feed was quickly discounted ... It appeared to be a very small piece of a single strand from a coax braid! Removing it with a jewelers screwdriver was difficult and I was not 100% sure it was achieved initially. I ran the 500volt megger over it, pushed probed and gave it 'heaps' and could not fault it at all. Now many weeks later the problem has not re appeared. It is really fixed ...

On hind site one can postulate at the apparent interaction between both coupled RF on transmit and the induced movement during the various fault finding processes. The actual effect should have led to a far speedier diagnosis and location, but I put it down to but yet another "Seniors moment"! It does however highlight the advantage of regularly measuring your stations performance and being able to reciprocate your measurements accurately and prompted me to write this article. The symptoms told me all along where it had to be, finding it was however another matter.

How Many Bits Are Copied in a JT65 Transmission?

by Joe Taylor, K1JT

Recent evidence suggests that some in the EME community are confused about what is actually copied over the radio path when using the JT65 communication protocol. Although the full technical details of JT65 have been published elsewhere, [1] and source code for the program WSJT is openly available, [2] those resources may seem overly technical for non-specialists in communication theory. This brief note is intended to help WSJT users and nonusers alike to understand what happens during the processes of transmitting, receiving, and decoding a JT65 signal. I have taken special care to use language, units of measurement, and terms of reference familiar to amateurs using traditional weak-signal coding and modulation techniques.

User Information, Encoding, and Channel Symbols

Standard JT65 messages contain 72 bits of user information—typically two 28-bit callsigns [1], a 15-bit grid locator, and one bit to indicate the message type. A Reed Solomon (63,12) error-correcting code translates the 72 message bits into 63 six-bit "channel symbols." Thus, every transmission includes 6 × 63 = 378 information-carrying bits and has a redundancy ratio of 378/72 = 5.25. It is important to understand that the user message is not transmitted in its "natural" sequence of syllables or characters (as it would be in normal speech, Morse code or ASCII data, for example). Instead, the user information is mathematically encoded so that it is spread throughout the entire sequence of 63 symbols. This fact has profound implications when comparing JT65 with traditional modes. First, the distribution of redundant information is designed so as to maximize the potential recovery of the full message content, even when the signal-to-noise ratio (SNR) is so low that many symbols from the transmitted sequence are lost in the noise. Second, a brief signal dropout of a few seconds will have quite different effects in JT65 compared with a traditional sequential mode. In a sequential mode, the dropout will simply result in the loss of those characters that were being transmitted at the time. But in JT65 encoding, the brief loss of signal will not affect any part of the message in particular; the impact is statistical, affecting recoverability of the entire message. These fundamental differences make it difficult to directly compare the performance of JT65 and traditional sequential modes.

After a JT65 message has been encoded into its 63 channel symbols, the symbols are transmitted one by one using 64-tone frequency shift keying (FSK). A 65th audio tone, two tone-intervals below the lowest data tone, is used to facilitate accurate synchronization of time and frequency between transmitter and receiver. The overall modulation scheme can thus be described as 65-FSK. Half of the transmitted energy is devoted to the essential task of synchronization: during each 46.8 s transmission, 63 sync-tone intervals are inserted at specified locations among the 63 data tones, following a prescribed pseudo-random pattern.
Pictorial representations of the spectrograms of two JT65 transmissions are presented in Figure 1. Time increases from left to right in the figure, and frequency from bottom to top of each panel. Each black dot corresponds to a transmitted tone. For each transmission, 63 of the tones convey the encoded channel symbols, while the remaining 63 (along the bottom of each panel) are the sync tone. The upper spectrum represents the message "VK7MO K1JT FN20", while the lower one is "VK7MP K1JT FN20". Only one character in the message has changed, but 52 of the 63 channel symbols are different. This fact illustrates the extraordinary power of the RS(63,12) code used in JT65: the sequences of channel symbols for any two of the 272 possible JT65 messages can never have more than 11 symbol values in common. This is the reason that complete messages can be received exactly as sent, even when many channel symbols have been corrupted or lost in the noise.

Analysis of a Received JT65 Signal

WSJT begins the analysis of a JT65 signal by identifying the sync tone and using it to establish its frequency offset (relative to the nominal 1270.5 Hz) and the time offset caused by propagation delay and computer clock errors. Spectral analysis is then carried out for each of the 63 intervals containing the information-carrying channel symbols. This process yields measurements of signal power for each symbol, divided into 64 frequency bins. The bin with largest power yields the most probable value of the symbol being received at that moment; the second largest corresponds to the second most probable symbol value, and so on, down to the smallest. Thus, the information conveyed by each symbol is partly contained in its most probable value, but additional

[1] The number of licensed amateur radio operators is less than 222 (roughly 4.2 million), so in principle 22 bits would be enough to encode a callsign. JT65 uses 28 bits for this task, however, so I adopt the latter number throughout this paper.

information is contained in a series of other possible values, with progressively decreasing probabilities of being correct. Each correctly received symbol conveys 6 of the 378 transmitted bits.
Study of Figure 1 should make it clear that there is no obvious correspondence between individual characters in a message and particular values or locations in the encoded sequence of channel symbols. As stated earlier, all of the message information is mixed together and mathematically distributed over the entire sequence. A correctly received message may result from as few as 12 channel symbols received with high confidence, or all 63 symbols received with relatively low individual confidence, or any of a wide range of possibilities between these two extremes. The spectra of JT65 signals received over the air will differ from the idealized ones shown in Figure 1 because they include random noise and fading signals. The statistical properties of signal and noise variations will determine the levels of confidence assigned to individual symbol values.

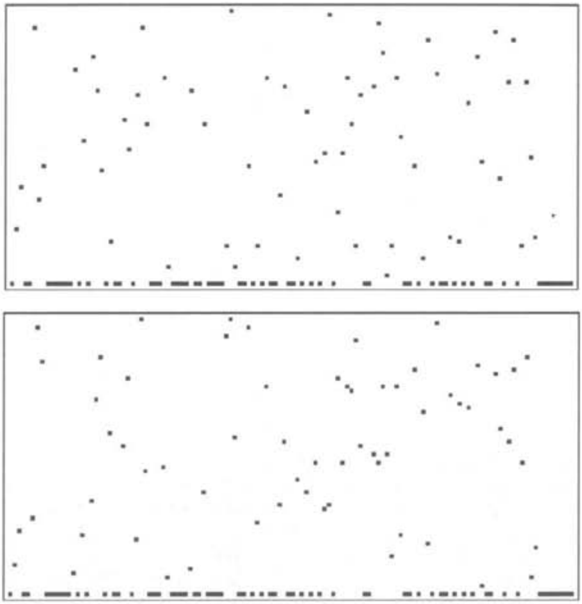


Fig. 1.— Idealized spectrograms of the JT65 transmissions for "VK7MO K1JT FN20" (top) and "VK7MP K1JT FN20" (bottom). The horizontal axis represents 46.8 s of time; the vertical axis of each panel represents frequency over the range of 65 tones used by JT65. Black marks indicate transmitted tones, corresponding to the encoded channel symbols. The pseudo-random pattern along the bottom of each panel is the synchronizing tone. Note that although the two messages are nearly identical, the patterns of channel symbols are almost entirely different (except for the pattern of the synchronizing tone, which is always the same).

Hard and Soft Symbols

As an educational exercise for myself, and to help answer for everyone the question posed in the title, I have carried out a series of explicit measurements of the number of correctly copied channel symbols in JT65 transmissions. One thousand simulated transmissions were generated at each SNR between 0 and −40 dB in 2500 Hz bandwidth, in 1 dB steps. These transmissions were received and analyzed, and the number of correctly copied symbols determined for each one. The averaged results for each signal level are plotted as the solid curve in Figure 2. The probability of correct symbol reception depends only on signal-to-noise ratio; it is independent of details of any decoding algorithms that might be used subsequently, in a program like WSJT, to convert the raw channel symbols into callsigns or other user information.
Up to this point, discussion of the reception of channel symbols has been limited to "hard" decisions: a symbol's value has been taken as the index of its frequency bin with the highest measured power. However, significant additional information is contained in the actual values of the power measurements, which can be used to indicate which symbols are the most reliable and to produce "soft symbol" probabilities.
At low SNR, many symbols that were not correctly received as the most probable value will be correct as the second most probable, and others as the third, fourth, and so on. Relatively few correct symbol values will be found among the lowest-ranking probabilities. To provide quantitative examples of this type of information, the dashed and dotted curves in Figure 2 illustrate the

average number of received symbols for which the correct value was found in the top 2, 4, or 8 of the 64 spectral power measurements. An ideal decoding procedure takes advantage of all soft-decision information through the full range of probabilities.

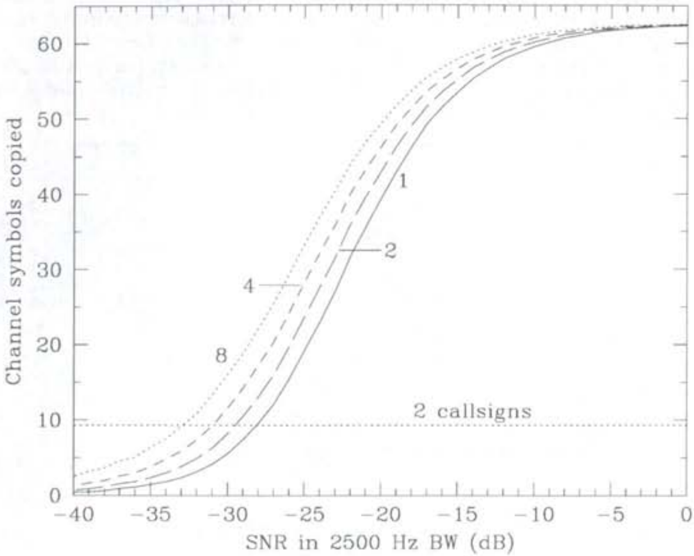


Fig. 2.— Measurements of the number of correctly copied channel symbols over a simulated radio path, plotted as a function of SNR on the WSJT scale and assuming 64-FSK modulation and noncoherent detection. Generated JT65 signals were degraded by Rayleigh fading and by additive white Gaussian noise. The solid curve (labeled "1") gives hard-decision results; the remaining curves provide some indication of the soft-decision information by showing the average number of times that the correct symbol fell in the top 2, 4, or 8 of the 64 measurements of spectral power. Adjustments were made to the curves to remove the biasing effects of accidentally correct symbol values. The dotted horizontal line shows the equivalent number of bits in two 28-bit callsigns.

Decoding the Message

Figure 2 shows that at SNRs down to −20 dB, JT65 signals transfer an average of more than 39 correct hard-decision channel symbols from transmitter to receiver. With the Reed Solomon (63,12) code used in JT65, 38 correct symbols are always enough to guarantee complete reception of a 72-bit user message with high confidence, even if only a hard-decision decoder is used. If the locations of symbols likely to be unreliable are known—those during a signal fadeout, for example—these can be flagged as "erasures," and a smaller number of correct symbols will then suffice for decoding. Better still, true soft-symbol information may be used. WSJT is packaged with a compiled version of the Koetter-Vardy algebraic softdecision decoding algorithm, [3] which takes partial advantage of probabilistic information on the most probable and second most probable values of every symbol. The KV algorithm can decode single JT65 transmissions down to about −25 dB, again with very high confidence in the result. As can be seen in Figure 2, at still lower signal levels the number of correctly copied channel symbols decreases. The hard-decision number falls to 9.3 (the equivalent of two JT65 callsigns) slightly below −28 dB. This signal level is close to the typical lower limit for decoding by the JT65 Deep Search (DS) algorithm, which will be described next. An ideal JT65 decoder would create two-dimensional arrays like those depicted in Figure 1 for all possible messages, and would cross-correlate each one of them with the corresponding soft-symbol array for the received signal. Any JT65 message different from the one actually transmitted would produce 11 or fewer matching channel symbols, whereas the correct message would exhibit (soft) matches for all 63. The correlation procedure would make use of the full soft-information content, and a quantitative indication of the resulting confidence level would be provided for any decoded message. Unfortunately, an exhaustive search of every possible JT65 message is not computationally feasible.

However, since the list of active EME stations is no more than a few thousand, and since activity patterns change rather slowly with time, it is perfectly feasible for WSJT to carry out an exhaustive search for callsigns in that relatively short list. Such a procedure is the basis of the JT65 Deep Search algorithm. When using the DS decoder, WSJT forms a large number of hypotheses about what message a JT65 signal might contain, based on the receiving station's call and the contents of a callsign database.

Each hypothesis is tested to see whether the received symbols match those of the hypothetical encoded message. This algorithm can be programmed to result in the high-confidence decoding of any one of the hypothesized messages, but no others. An exhaustive search is the optimal decoding strategy, in the sense of achieving the best possible decoder performance. When practicable, it is usually the method of choice.

Levels of Confidence

The number of hypothetical messages tested during a JT65 Deep Search is typically between 14,000 and 20,000. The decoder's task is to determine whether one of these messages matches the transmitted one to some specified level of confidence, or to establish that none of them does. To illustrate how this process works, Figure 3 shows examples of correlations obtained when doing the simulations reported in this paper. The top panel is for signal-tonoise ratio −26 dB, and the bottom for −28 dB. Dots represent correlations of the noisy, fading signals against the message actually transmitted, for 1000 different simulations at each signal level. Crosses show correlations against incorrect messages selected at random from the group of all possible JT65 messages. It is easy to see that with a threshold set at about 3 correlation units, the decoder can make sure that nearly all transmissions at −28 dB and higher will be decoded correctly and that there will be very few false decodes.
Recent versions of WSJT produce numerical confidence levels on an arbitrary 0 to 10 scale monotonically related to the scale used in Figure 3. Roughly speaking, level 3 on WSJT's scale implies moderately high confidence, and anything over 6 implies high or very high confidence. In normal practice the operator will have other relevant information available, so WSJT requires the operator to make all final decisions about valid copy.

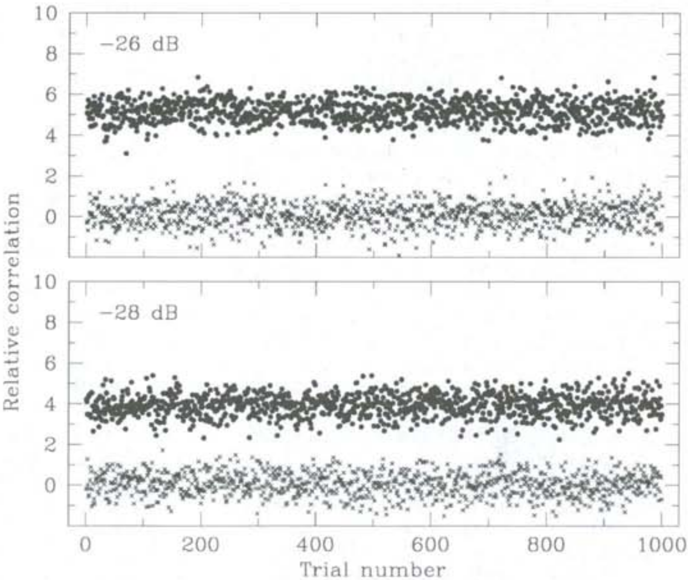


Fig. 3.— Examples of correlation values produced by the Deep Search decoder for four different groups of 1000 simulated transmissions. The signal-to-noise ratios were set at −26 dB (upper) and −28 dB (lower), on the WSJT scale. Dots represent correlations against correct messages, while crosses represent incorrect messages. A decoding threshold set at about 3.0 would assure that nearly all transmissions above −28 dB will be decoded correctly, with few decoding errors.

Summary and Conclusions

To provide succinct answers to the question posed in the title, a subset of the measurements obtained in the simulations is summarized in Table 1. Entries are included for SNRs between −18 and −28 dB, at 2 dB intervals, and for convenience the results are quoted in channel symbols, bits, and equivalent 28-bit callsigns. Even at the lowest usable signal levels, around −28 dB, the number of hard-decision bits correctly copied over the radio path exceeds the number required to convey two callsigns.

The numbers in Table 1 are conservative lower limits, because they are based on hard decisions only. Soft-decision information adds significantly to the totals and further enhances the sensitivity as well as the levels of confidence that can be assigned to decoded messages.

SNR (dB)	Channel symbols	Bits	Equivalent callsigns
−18	46.9	281	10.1
−20	39.6	237	8.4
−22	31.9	191	6.9
−24	23.1	139	4.9
−26	15.5	93	3.3
−28	9.6	58	2.1

Table 1. Hard-decision channel symbols copied over the air, per JT65 transmission.

The information presented here should lay to rest any fears that when using its Deep Search decoder, JT65 might not transfer enough channel symbols over the radio path to satisfy traditional requirements for valid QSOs. It is certainly true that at the lowest usable signal levels, between −25 and −28 dB on the WSJT scale, some prior information about active stations is required for the Deep Search decoder to succeed. Of course, prior information of this type is advantageous when trying to make a difficult contact or identify a weak station calling CQ, using any mode, for exactly the same reason—it gives the decoder, consciously or otherwise, some idea of what message content to look for. Helpful lists of "good calls" have been a part of contesting and weak signal amateur communications for decades. It has never been considered illegitimate to possess or make use of such information in the process of copying a weak signal, as long as the copy is truly accomplished. Figure 2 and Table 1 show that this condition is easily met by JT65. In an article recently published [5] in DUBUS, Klaus von der Heide, DJ5HG, presented an analysis of the decoders used in WSJT with the goal of promoting an objective discussion of what constitutes a minimum valid QSO. Using the formalism of information theory, he showed that the KV decoder meets a "strict" definition of a QSO, while the DS decoder meets a "dynamic" definition. The difference between the two is that the strict definition requires that all necessary information be treated as unknown at the start of a QSO, while the dynamic definition acknowledges that some information (such as one's own callsign) may be known, and still other information might be found in a list. Traditional practice has always accommodated the inevitable knowledge of one's own callsign, and has also accepted that lists and schedules do not invalidate QSOs. A mode like JT65 that uses compressed, structured messages cannot account for individual parts of a message such as characters in callsigns, because they are not transmitted as such. One can still insist, however, that a sufficient number of channel symbols be copied over the air, and that operator confidence in the decoded message meets a suitably high standard. The measurements described in this paper show that the JT65 Deep Search decoder passes these tests easily—and therefore that it, too, produces valid QSOs in terms of traditional amateur practice. The article by DJ5HG quite properly calls attention to the fact that the number of distinct messages decodable by the Deep Search algorithm is no larger than several times the length of the callsign database. Information theory says that if all hypothetical messages constructed from that database are assumed equally likely, the quantity of transferred user information can be taken as the base-2 logarithm of the number of decodable messages.

The resulting number of bits—approximately 14.2 for the default Deep Search setup of WSJT—is a useful and valid measure of the previously unknown information transferred when such a message is decoded. In a scheduled QSO, whatever the modulation mode, the number of transferred, previously unknown bits may be even smaller. However, these measures of the quantity of transferred information should not be confused with the number of probabilistically evaluated, information-carrying symbols or bits conveyed over the radio path from transmitter to receiver. The latter quantities—those illustrated in Figure 2 and Table 1 of this paper—are roughly analogous to characters or other fragments copied from a marginal CW signal. They carry proportionally more weight in JT65, however, because of the strong error-correcting code and because the process of synchronization fixes the exact location of each symbol within the transmitted sequence. Signal strength variations provide the JT65 decoders with important probabilistic information about which received symbols are the most reliable. Together, these factors lead to the very high level of QSO integrity that is achieved with JT65.

Literature

[1] J. Taylor, K1JT, "The JT65 Communications Protocol", QEX, September-October 2005, pp. 3–12.

[2] Source code can be downloaded from http://developer.berlios.de/projects/wsjt/.

[3] R. Koetter and A. Vardy, "Soft-Decision Algebraic Decoding of Reed Solomon Codes," in IEEE Transactions on Information Theory, 49, 2809–2825, 2003.

[4] K. von der Heide, DJ5HG, "Minimal QSOs and Their Validity," DUBUS, 35, No 1, pp. 38–53, 2006.

Recommended Procedures for Random Digital EME

Joe Taylor, K1JT

Around the year 2000 a growing number of VHF enthusiasts began experimenting with digital coding and modulation techniques that show great promise for enhanced weak signal communications. Early efforts included the computer-aided high-speed CW mode of 9A4GL, designed for meteor scatter, and a multi-tone frequency-shift keying mode called PUA43, developed by W7PUA and intended for EME. At about the same time, modes like PSK31 (by G3PLX) and MFSK16 (ZL1BPU and IZ8BLY) were becoming popular on the HF bands. My own software program WSJT was based in part on the pioneering work of these and other amateurs; my goal was to make the advantages of digital communications conveniently and widely available to VHF/UHF weak signal enthusiasts. WSJT began seeing worldwide use for VHF meteor scatter QSOs in mid-2001, and for EME some nine months later. The presently popular EME mode called JT65 was incorporated into the program in late 2003.

Not surprisingly, the new weak-signal modes first gained popularity among a subset of amateurs who were familiar with computers and digital electronics, as well as being skilled in VHF/UHF weak signal techniques. The new developments came at a time of rapidly increasing use of the internet for general communication. As a consequence, technical development and popularity of the new weak-signal protocols benefited enormously from suggestions, advice, feedback, and other information exchanged via email reflectors and internet chat rooms. Special purpose "loggers" like *Ping Jockey Central,* the *JT65 EME Link,* and the *ON4KST EME Chat* sprang up to help experimenters coordinate their early efforts with the new software. These loggers made it very easy to find willing QSO partners and to make real-time schedules.

I think all of these developments have been good for Amateur Radio, and for the VHF/UHF weak-signal community in particular. However, in this brief note I wish to suggest that there is more to amateur EME operation than simply making pre-arranged QSOs. *Any* contact with a fellow amateur using signals reflected from the moon is exciting, a significant achievement, and something to be proud of; but it is *especially* rewarding when a QSO begins with the pleasant surprise of someone answering your CQ without pre-arrangement through another medium. My goal here is to suggest operating procedures that should help to facilitate more widespread access to those very pleasant moments of surprise. Protocols like JT65—and others that will surely succeed it—can enable amateur radio contacts with signals too weak to be audible. Such signals can't be found by the traditional method of slowly tuning the band with the headphones on, listening for weak carriers.

Even worse, for many of us such procedures serve mainly to locate the ubiquitous "birdies" that plague us in this increasingly electronic age. We are fortunate, however, that digital technology has brought us the capabilities of spectroscopic visual aids that make it easy to find weak JT65 signals in a specified region of a VHF/UHF band. The JT65 synchronizing tone, which carries half of the energy of every transmission, is readily distinguishable from birdies because JT65 transmissions start on an odd or even UTC minute and end about 47 seconds later, with somewhat longer "off" periods in between. Operators who make the effort to install a software package like Linrad (by SM5BSZ) or Winrad (I2PHD), and the hardware to support it, can have a panoramic view of all the signals in a 90 kHz band segment and can watch the behavior of those signals over time. With such a system it is easy to pick out the potentially workable JT65 signals on one's favorite band.

Most operators use WSJT with a standard SSB transceiver providing a bandwidth of little more than 2 kHz, and the waterfall spectral display built into WSJT was configured with this limitation in mind. Until many operators have upgraded their stations to include the capabilities of a wide bandwidth Linrad-like display, random digital EME operation will be greatly facilitated if we can designate relatively narrow sub-bands where such activity can be concentrated—standardized "meeting places" where QRV operators can find one another without relying on information from another source. To make my proposal specific,

Table 1 contains suggested sub-bands to be used for random digital EME activity on our worldwide VHF and UHF bands.

Frequency Range (MHz)
50.185 – 50.195
144.115 – 144.135
432.060 – 432.070
1296.060 – 1296.070

Table 1. Suggested sub-bands for concentration of random digital EME.

As far as I am aware, these suggested frequency ranges conform well with existing band plans and operating practices in most parts of the world. The center frequencies of 50.190, 144.125, 432.065, and 1296.065 MHz are close to the activity centers already being used for JT65 EME on these bands. The frequencies 432.065 and 1296.065 MHz have helpful mnemonic advantages, so I have placed them at the centers of suggested 10 kHz ranges which seem suficient for present levels of activity. On 2 meters, where JT65 EME activity is much greater, I suggest a 20 kHz range. In North America 144.140 is used as a calling frequency for the FSK441 meteor-scatter mode, so I have avoided that frequency. To accommodate operators in Japan, who are required to transmit JT65 below 144.100, I suggest a secondary sub-band 40 kHz below the one listed in Table 1, centered at 144.085 MHz. If an operator who must transmit above 144.100 .nds a JA station calling CQ on 144.082, I suggest that a reply should be made on 144.122, exactly 40 kHz higher—and vice-versa. Of course, one should be aware of other (possibly regional) uses of these band segments, and always operate accordingly. If split-frequency operation is required, such as when working between Japan and the United States on 2 meters, care must be taken not to cause QRM on the transmitting frequency. Remember that EME Doppler shifts can be substantial on the higher bands— as much as 3 kHz at 1296 MHz. I believe that the frequency ranges suggested in Table 1 are consistent with present practices for digital EME; if I have overlooked some important constraint, I trust that a suitable modification to Table 1 can be found and agreed upon. Let us suppose that the worldwide EME community agrees to the suggestions outlined above. (The basic ideas have been discussed on the Moon-Net email reflector already, with positive responses.) What other operating procedures could be adopted to help us find one another on the bands and optimize our available time for making digital EME QSOs? I suggest that in general we should listen first near the center of the relevant sub-band. If this frequency seems unused and is free of local problems, it should be a good place to call CQ. If the center frequency is busy, or perhaps you have a strong local birdie there, move up or down in small steps, say 1 kHz. During contests or special activity weekends the whole sub-band may become busy; in such cases one can move farther up or down from the nominal center frequencies.

The bandwidth of a JT65 transmission in the A, B, and C submodes is about 178, 355, and 711 Hz, respectively. More than 25 JT65B signals can be squeezed into a 10 kHz window without interference. Moreover, the JT65 decoders cope surprisingly well even when two signals overlap in frequency. Local interference from another EME-class station can be a problem; in such cases, the best recourse is usually to transmit in the same sequence (first or second) as that used by other stations in your area. When contending with signals reflected from the moon, a bit of QRM can be almost welcome. WSJT can easily decode several different signals that were received simultaneously, and it's fun to keep track of who else is active while you are on the air.

Our operating procedures should be friendly to SWLs and third-party listeners. After a QSO is finished, stay where you are for at least a few minutes, listening for possible tailenders.

If you originated a QSO by calling CQ, another station may call when you finish; ifyou answered someone else's CQ, a third station may want to work you afterward. Commoncourtesy dictates that he will probably not call right on the frequency you have been using.

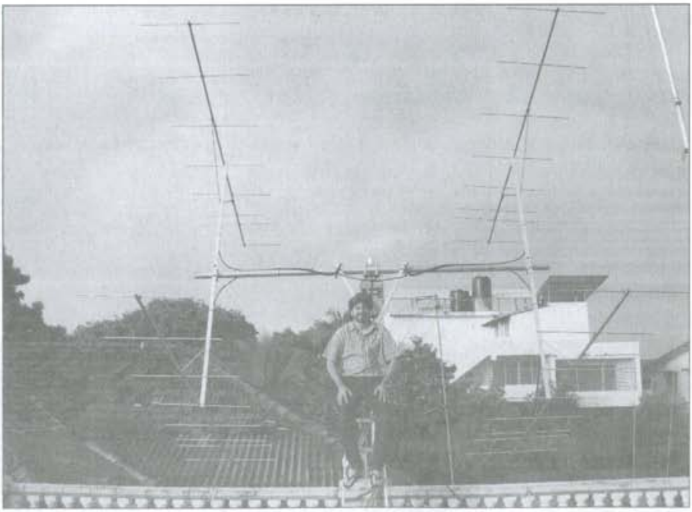
Considering the bandwidths of JT65 signals, I suggest calling up or down by something like 0.5 to 1 kHz in such situations. By the same token, I recommend listening carefully after your QSOs, both on your own frequency and slightly higher. A future version of WSJT may increase the available bandwidth by a factor of two or more, if your receiving hardware can support it. This would make such procedures significantly easier.

Special circumstances sometimes apply to DXpeditions, rare DX stations, and "big guns" in contest situations—in other words, whenever many stations are simultaneously calling a single desired station. Under normal activity conditions, minimal JT65 EME QSOs generally proceed something like the example shown at the left in Table 2. When there is a significant chance of confusion about who has transmitted a message or who it may be intended for, callsign-tagged formats should be used for messages 4 and 5, as shown on the right in Table 2. JT65 provides for other message formats, as well, including ones with numerical signal reports. If you are unsure of the available message formats and capabilities, refer to the WSJT User's Guide for details and instructions on their use.

Normal activity	Pileup situations
1. CQ RN6BN KN95	1. CQ 3Y0X EC41
2. RN6BN K1JT FN20	2. 3Y0X K2TXB FM29
3. K1JT RN6BN KN95 OOO	3. K2TXB 3Y0X EC41 OOO
4. RO	4. 3Y0X K2TXB RO
5. RRR	5. K2TXB 3Y0X RRR
6. 73	6. 73

Table 2. Recommended message formats for minimal EME QSOs using JT65.

When designing the standard JT65 message formats, I imagined that the mode might be used in terrestrial VHF/UHF contests where grid locators are part of the required exchange. In EME QSOs the locators are largely superfluous and could well be eliminated. A future version of WSJT may provide enhanced performance for messages that contain a callsign but no locator, as well as for callsign-tagged messages with reports or acknowledgments. If you agree with the sentiments I have expressed here, please help to spread the word— and lead others by your own example! When you are QRV on the moon, call CQ somewhere in the sub-bands listed in Table 1, starting near the center and working outward as QRM requires. Post a CQ notice on the logger, if you wish, encouraging others to come and find you . . . and then wait for the special pleasant surprise when a new "initial" or an old friend unexpectedly responds to your call. Better still, when activity levels are suficient, forget the logger and just call CQ! Practice random operating so that you can do it easily during contests, without external aids. Self-spotting and other real-time liaison are forbidden in many contests, including the European EME Contest sponsored by DUBUS and REF.



Bob Sutton, ZL1RS, operating 2m EME from Sri Lanka as 4S7CCG (MJ96)

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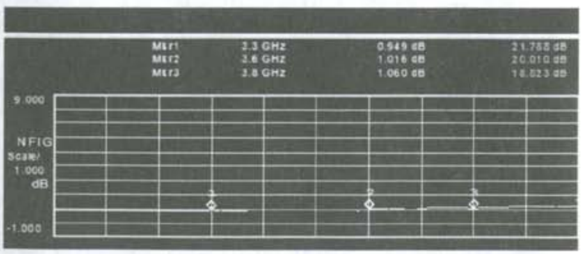
RF3866 Noise Figure vs Frequency - 3.5 GHz WiMAX



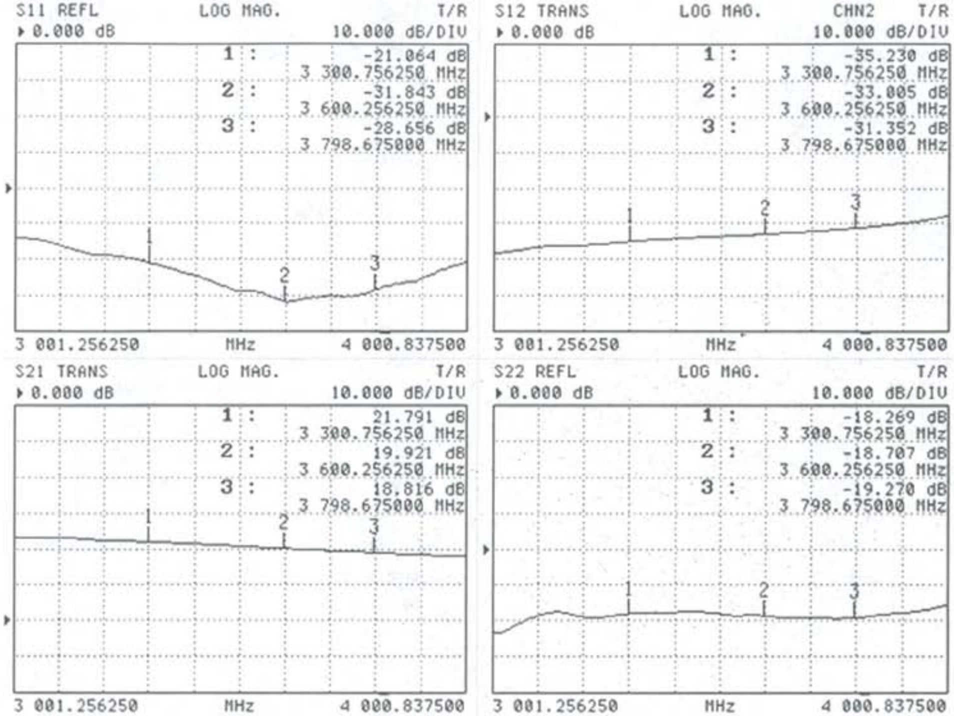
Performance Table

Part	Frequency (MHz)	Supply Configuration	Voltage	Unit	Current	Unit	Gain	Unit	Noise Figure	Unit	OIP3	Unit	OP1dB	Unit	S11	Unit	S22	Unit
RF3861	380-3800	Single-Stage	2.5-6.0	V	80	mA	14.5	dB	0.9	dB	35.5	dBm	22.5	dBm	-11	dB	-20	dB
RF3863	380-3800	Single-Stage	2.5-6.0	V	80	mA	14.5	dB	0.7	dB	37.0	dBm	22.5	dBm	-11	dB	-20	dB
RF3865	380-3800	Dual-Stage	2.5-6.0	V	180	mA	30.0	dB	0.9	dB	36.0	dBm	22.5	dBm	-10	dB	-15	dB
RF3866	380-3800	Dual-Stage	2.5-6.0	V	180	mA	30.0	dB	0.7	dB	36.0	dBm	22.5	dBm	-10	dB	-15	dB
RF3867	380-3800	Dual-Channel	2.5-6.0	V	80	mA	16.0	dB	0.7	dB	35.5	dBm	22.5	dBm	-11	dB	-20	dB

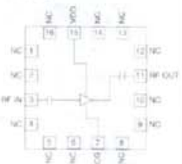
Note: Performance Table reflects typical data taken at 1700-2200 MHz. Please refer to RFMD datasheet for additional information.

Configuration Overview

RF3866 S-Parameter Data for 3.5 GHz WiMax



RF3861



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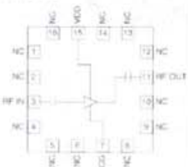
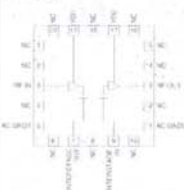


RF3865



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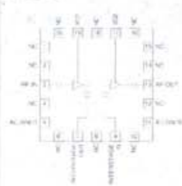
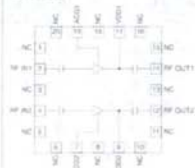


RF3867



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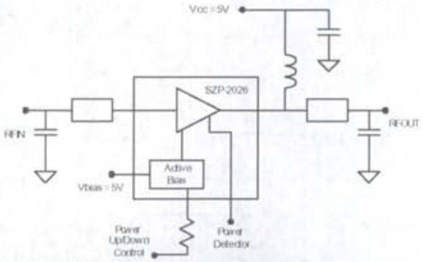
Product Description

Sirenza Microdevices' SZP-2026Z is a high linearity single stage class AB Heterojunction Bipolar Transistor (HBT) amplifier housed in a proprietary surface-mountable plastic encapsulated package. This HBT amplifier is made with InGaP on GaAs device technology and fabricated with MOCVD for an ideal combination of low cost and high reliability.

This product is specifically designed as a flexible final or driver stage for 802.16 and 802.11 equipment in the 2.2-2.7GHz bands. It can run from a 3V to 6V supply. It is prematched to ~5 ohms on the input for broadband performance and ease of matching at the board level. It features an output power detector, on/off power control, ESD protection, excellent overall robustness and a proprietary hand reworkable and thermally enhanced SOF-26 package. This product features a RoHS Compliant and Green package with matte tin finish, designated by the 'Z' suffix.

Functional Block Diagram



Preliminary

SZP-2026Z

2.2-2.7GHz 2W InGaP Amplifier

RoHS Compliant & Green Package

Proprietary SOF-26 Package

Product Features

- **P1dB = 33.5dBm @ 5V, 2.4GHz**
- **802.11g 54Mb/s Class AB Performance**
  Pout = 26dBm @ 2.5%EVM, Vcc 5V
  Pout = 27dBm @ 2.5% EVM, Vcc 6V
- **On-chip Output Power Detector**
- **Input Prematched to ~5 ohms**
- **Proprietary Low Thermal Resistance Package Hand Solderable and Easy Rework**
- **Power up/down control < 1µs**

Applications

- **802.16 WiMAX Driver or Output Stage**
- **2.4GHz 802.11 WLAN and ISM Applications**

Key Specifications

Symbol	Parameters: Test Conditions, 2.5-2.7GHz App circuit, $Z_0 = 50\Omega$, $V_{CC} = 5.0V$, Iq = 445mA, $T_{BP} = 30°C$	Unit	Min.	Typ.	Max.
f_O	Frequency of Operation	MHz	2200		2700
P_{1dB}	Output Power at 1dB Compression – 2.7GHz	dBm	31.5	33	
S_{21}	Small Signal Gain – 2.7GHz	dB	11.3	12.8	
Pout	Output power at 2.5% EVM 802.11g 54Mb/s - 2.5GHz	dBm		26.2	
IM3	Third Order Suppression (Pout=23dBm per tone) - 2.7GHz	dBc		-45	-42
NF	Noise Figure at 2.7GHz	dB		4.3	
IRL	Worst Case Input Return Loss 2.5-2.7GHz	dB	8	12	
ORL	Worst Case Output Return Loss 2.5-2.7GHz	dB	8	12	
Vdet Range	Output Voltage Range for Pout=10dBm to 33dBm	V		0.85 to 1.4	
I_{cq}	Quiescent Current (V_{cc} = 5V)	mA	395	445	495
I_{VPC}	Power Up Control Current (V_{pc} = 5V)	mA		2.1	
I_{leak}	Vcc Leakage Current (V_{cc} = 5V, V_{pc} = 0V)	µA			10
$R_{th, j-l}$	Thermal Resistance (junction - lead)	°C/W		12	

Typical Performance 2.4-2.5GHz App Circuit (Vcc=5V, Icq=445mA, * 802.11g 54Mb/s 64QAM)

Parameter	Units	2.4GHz	2.5GHz
Gain	dB	13.3	13.0
P1dB	dBm	33.5	33.3
Pout @ 2.5% EVM*	dBm	26	26
Current @ Pout 2.5% EVM*	mA	550	545
Input Return Loss	dB	16	12
Output Return Loss	dB	16	16

Typical Performance 2.5-2.7GHz - Refer to page 1 table

Pin Out Description

Pin #	Function	Description
1	VBIAS	This is the supply voltage for the active bias circuit.
2	RFIN	This is the RF input pin and has a DC voltage present. An external DC block is required.
3	VPC	Power up/down control pin. The voltage on this pin should never exceed the voltage on pin 3 by more than 0.5V unless the supply current from pin 3 is limited < 10mA.
4	VDET	This is the output port for the power detector. It samples the power at the input of the amplifier.
5	RFOUT/VCC	This is the RF output pin and DC connection to the collector.
6	NC	This pin is not connected internal to the package. Buss it to pin 5 as shown on the app circuit to achieve the specified performance.
GND	GND	These pins are DC connected to the backside paddle. They provide good thermal connection to the backside paddle for hand soldering and rework. Many thermal and electrical GND vias are recommended as shown in the landing pattern.

Absolute Maximum Ratings

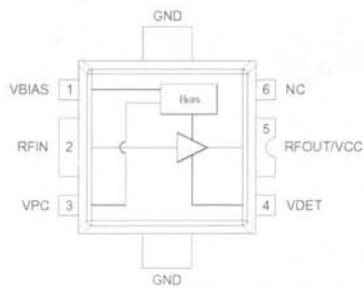
Parameters	Value	Unit
VC1 Collector Bias Current (I_{VC1})	1500	mA
**Device Voltage (V_{cc})	7.0	V
Power Dissipation	6	W
Operating Lead Temperature (T_L)	-40 to +85	°C
*Max RF output Power for 50 ohm continuous long term operation	30	dBm
Max RF Input Power for 50 ohm output load	28	dBm
Max RF Input Power for 10:1 VSWR output load	23	dBm
Storage Temperature Range	-40 to +150	°C
Operating Junction Temperature (T_J)	+150	°C
ESD Human Body Model	1000	V

Operation of this device beyond any one of these limits may cause permanent damage. For reliable continuous operation the device voltage and current must not exceed the maximum operating values specified in the table on page one.

Bias conditions should also satisfy the following expression:
$I_D V_D < (T_J - T_L) / R_{TH}, j\text{-}l$

* With specified application circuit.
** No RF Drive

Simplified Device Schematic



Caution: ESD Sensitive

Appropriate precaution in handling, packaging and testing devices must be observed.

Product Description

Sirenza Microdevices' SZP-3026Z is a high linearity single stage class AB Heterojunction Bipolar Transistor (HBT) amplifier housed in a proprietary surface-mountable plastic encapsulated package. This HBT amplifier is made with InGaP on GaAs device technology and fabricated with MOCVD for an ideal combination of low cost and high reliability.

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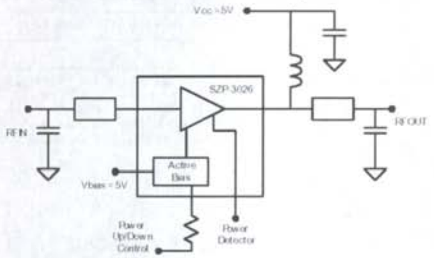
Functional Block Diagram



Preliminary

SZP-3026Z

3.0-3.8GHz 2W InGaP Amplifier

Proprietary SOF-26 Package

Product Features

- P1dB = 33.6dBm @ 5V
- 802.11g 54Mb/s Class AB Performance
  Pout = 26dBm @ 2.5% EVM, Vcc 5V, 570mA
  Pout = 27dBm @ 2.5% EVM, Vcc 6V, 513mA
  On-chip Output Power Detector
- Input Prematched to ~5 ohms
- Proprietary Low Thermal Resistance Package
  Hand Solderable and Easy Rework
- Power up/down control < 1μs

Applications

- 802.16 WiMAX Driver or Output Stage
- WLL

Key Specifications

Symbol	Parameters: Test Conditions, 3.4-3.6GHz, 5V App circuit, $Z_0 = 50\Omega$, $V_{CC} = 5.0V$, Iq = 385mA, $T_{BP} = 30°C$	Unit	Min.	Typ.	Max.
f_O	Frequency of Operation	MHz	3000		3800
P_{1dB}	Output Power at 1dB Compression – 3.5GHz	dBm	31.7	33.2	
S_{21}	Small Signal Gain – 3.5GHz	dB	10.5	12.0	
Pout	Output power at 2.5% EVM 802.11g 54Mb/s - 3.5GHz	dBm		26.0	
IM3	Third Order Suppression (Pout=23dBm per tone) - 3.5GHz	dBc		-43	-40
NF	Noise Figure at 3.5GHz	dB		5.1	
IRL	Worst Case Input Return Loss 3.4-3.6GHz	dB	14	18	
ORL	Worst Case Output Return Loss 3.4-3.6GHz	dB	7	10	
Vdet Range	Output Voltage Range for Pout=10dBm to 33dBm	V		0.9 to 2.2	
I_{cq}	Quiescent Current (V_{cc} = 5V)	mA	347	385	424
I_{VPC}	Power Up Control Current (V_{pc}=5V)	mA		2.3	
I_{leak}	Vcc Leakage Current (V_{cc} = 5V, V_{pc} = 0V)	μA			10
$R_{th, j-l}$	Thermal Resistance (junction - lead)	°C/W		12	

BLF369

VHF power LDMOS transistor

Rev. 01 — 13 April 2006 | Objective data sheet

1. Product profile

1.1 General description

A 500 W LDMOS RF Power transistor for broadcast transmitter applications and industrial applications in the HF/VHF band.

Table 1: Typical performance

Typical RF performance at V_{DS} = 32 V and T_h = 25 °C in a common-source 225 MHz test circuit.[1]

Mode of operation	f (MHz)	P_L (W)	$P_{L(PEP)}$ (W)	G_p (dB)	η_D (%)	IMD3 (dBc)
CW, class AB	225	500	-	18	60	-
2-tone, class AB	f_1 = 225; f_2 = 225.1	-	500	19	47	−28

[1] T_h is the heatsink temperature.

CAUTION

This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling.

1.2 Features

- Typical CW performance at 225 MHz, a drain-source voltage V_{DS} of 32 V and a quiescent drain current $I_{Dq} = 2 \times 1.0$ A:
  - Load power P_L = 500 W
  - Gain $G_p \geq 18$ dB
  - Drain efficiency η_D = 60 %
- Advanced flange material for optimum thermal behavior and reliability
- Excellent ruggedness
- High power gain
- Designed for broadband operation (HF/VHF band)
- Source on underside eliminates DC isolators, reducing common-mode inductance
- Easy power control

1.3 Applications

- Communication transmitter applications in the UHF band
- Industrial applications in the UHF band

PHILIPS

Microwave Europe

Editor: Simon Lewis, GM4PLM

Hello and welcome to another microwave column. The summer finally arrived and this has coincided with some excellent microwave propagation. Plenty of activity but again no band reports. If you work some good paths over the next month please send in a report so we can see what you have been up to! Not so much in the post box this month so its up to you. 73 Simon.

STOP PRESS!

New UK 10 GHz Distance Record.

At 0520UTC on Sunday 16 July, Ian Lamb, G8KQW, has broken the UK 10 GHz distance tropo record with a QSO with Lars-Bertil, SM4DHN for a new distance of **1,347km**. Ian reports "This was an unbelievable contact for me, not only because of the sheer distance involved but also because both Lars-Bertil and I are located several hundred kilometres inland at either end of the path." Soon after the record breaking contact, he also worked SM6AFV (1,192km) and SM6HYG (1,118km). All the contacts took place during a period of strong tropospheric ducting between the UK and Europe. What makes these QSOs particularly impressive is that Ian was only using his low power 2W system used for lining up 24 GHz contacts! Ian said his success was down to "being in the right place at the right time".
Congratulations all.

More records were also set during this period. Now a report on **first OZ-SM to GM on 9cms** . Nick GM4OGI writes….."So far the first part of July has been a case of rebuilding the station. I can now run on 23cm (140w + 67 element at 40 feet), 9cm (40w + 1m dish although with limited take-off), and 3cm (1w + 80cm at 35 feet). On 5th July I completed the first OZ-GM contact on 3.4GHz with OZ1CTZ (0558 ut) ...and some words extracted from my copious notes in my microwave workbook:

15th July - The microwave bands open at about 08:30utc when I hear LA4SHF on 1296MHz. From about 16:00utc the three JO57 beacons were well established on 23cm. No other signals were noted on any other bands. 19:22 utc I heard OZ1UHF on 9cm for the first time. Arranged a sked with SM6HYG but found signals, whilst clear on Spectran, were too weak to be audible. We repeated the attempts several times throughout the evening with the same result. Concluded that propagation was probably troposcatter and would require some thought to some king of agreed procedure.

16th July - 05:00utc Band scan revealed little activity (weak JO57 beacons on 23cm). 05:18utc OZ5SHF on 1296.902 at rst 549, SK7MHL on 1296.970 at rst 519 and OZ7IGY on 1296.930 rst 559 were all good signals along with Bornholm radar. The JO57 beacons and LA4SHF also audible. 05:29utc OZ1CTZ, Brian hears my 13cm beacon 05:35utc work OZ1CTZ on 23cm (59+20dB). Very strong SSB signal. 05:42utc work OZ1CTZ on 9cm SSB for our first voice contact on the band. Exchange 59 reports 05:54utc try working SM6HYG again but again signals are too weak to copy audibly. 06:05utc All beacons on 23cm previously recorded are at good strength and OZ1UHF on 9cm still around rst 529. 06:37utc work SM6AFV on 23cm, signals very strong and we try on 3cm but hear nothing. Suspect poorly performing 3cm system. 06:50utc called by SM6HYG on 23cm who notes that my signal on 23cm is very strong. We move to 3400.200MHz and work each other straight away on cw rst 519 at 06:55utc. Easy when it works! At 09:50utc still hearing OZ1UHF on 3.4GHz....and note that in general activity has dropped off. Receive phone call from GM4LBV who relays a message indicating that **LA will have a 3.4GHz allocation** later this year.......
Regards Nick - GM4OGI

23cm Portable Operating whilst on holiday was a most interesting learning curve writes Ray GM4CXM. Usually I primarily use 2m/70cm and HF, with the developed interest in 23cm and combined with a desire to visit somewhere in the UK not previously toured, East Anglia proved a good choice.

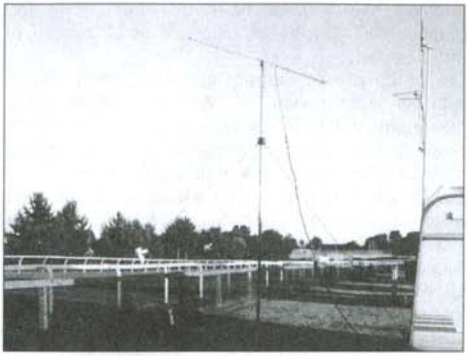
The holiday consisted of 2 days at Northampton to enable my XYL Sandra to visit the only Charles Rennie Mackintosh interior design outside of Scotland. We were located on a plateau at Sywell, just to the north west of Northampton and a clear take off in all directions. No contacts were made despite plenty CQ's. The lack of internet access was a drawback.

Beacons heard: GB3ANG, GB3MLE, GB3USK, GB3IOW, GB3MHL.

We then proceeded to Cambridge for 3 days which provided me with the opportunity to visit the IWM Duxford Exhibition. Radio was an almost non-starter as we found the Caravan Club site was located in an old lime quarry and surrounded by cliffs! I tried 23cm but was only able to copy MHL via A/C so most contacts were on 2m/70cm FM. The move to Great Yarmouth (or rather "Yarmouth" as I was corrected in stating) was the iceing on the cake. The Caravan Club site was located in the middle of the racecourse and therefore the site abounded with loads of rules and restrictions. This is a good time to describe the set-up!

FT736R 10w + SP23MK2 and Nick 'OGI's 34el m2 on a 2 section 14'/15' mast plus rotary bearing.

FT736R + MM 100w Brick to 2m Halo @ 10' or vertical at 15' If the 2m vertical wasn't in use this was quickly replaced by a 70cm vertical.



Tie off points were intially the racecourse rail (x2) and this was replaced after a few days due to a complaint by the warden! Also added (by request) was a few shopping bags to guy ropes and feeder to aid visibilty. The site was approximately 400m from the sea and a clear take-off in all directions. Numerous "locals" were worked and a bit of DX! One aspect of great interest was beacon monitoring and frequency checking.

GM4CXM

I noted numerous movements since the Jan/Feb opening. One problem was the intense heat in the awning but references against GB3MHL helped against drift differences. Beacons hrd:

GB3NO 1296.998.6
GB3IOW 1296.894.6
GB3MLE 1296.930.5 (Carrier) 1296.931 (Ident)
GB3USK 1296.874.9
DB0JO 1296.852.1
DB0VC 1296.918.3
PI7QHN 1296.816 (VARIABLE A LITTLE)
LA4SHF 1296.883.5 TO 1296.886.7 !!!!!!!
LA1UHG 1296.851.1
OZ1UHF 1296.954.9
OZ5UHF 1296.902.1

Worked: IO86, JO01, JO02, JO22, IO92, JO58, IO87, JO33, JP60, JO46, JO67, JO28, JO59.

Despite the good conditions, little inland penetration was noted. On most occasions, stations inland from me couldn't get into the lift and on others I could hear them working DX I couldn't hear. The number of stations using dishes was surprisingly high.
73 Ray GM4CXM

UkuG Appoints New Beacon List Keeper

It gives me much pleasure to announce that Nick Shaxted, GM4OGI has very kindly accepted the responsibility of UK Microwave Group Beacon List Keeper. Many of you will already be aware of the work Nick has done in this field. He has been supplying me with updated beacon lists for my personal website and for the UKuG website for some time now. Before Nick started his updates, the beacon lists tended to be inaccurate and unreliable in places. Nick approaches this work with real dedication and with a distinct raison d'etre as you can read from his own words:
" The role a beacon plays in the hobby is usually taken for granted but is usually the first thing people look for when starting out on a new band or when assessing conditions when switching over to a new band. Beacons are paramount in the hobby and having a reliable and trustworthy information resource is an essential part of that structure."
Nick will appreciate receiving beacon information from you at any time, from both the UK and Europe. The listings will be kept from 23cm right up to our highest millimetre bands on which we have beacons. Let's support him as much as we can in his endeavour. His work will complement that which the new UKuG Beacon Working Group will be doing on the practical side of helping beacon builders realise their projects. On your behalf, UKuG is also hard at work behind the scenes liaising with Ofcom over beacon application and licensing procedures. he next few years should see the UK Microwave beacon system system greatly improved and hopefully be the envy of the "rest". We can do it folks... it just needs all of us to help when and where we can.
Many thanks, Peter, G3PHO Chairman UK Microwave Group www.microwavers.org
Reports can be sent to Nick GM4OGI at
nick.shaxted@blueyonder.co.uk

Weinhein 2006

The "51st UKW-Tagung Weinheim" takes place at Saturday, September 23, 2006 in the building of "Karl Kübel Schule, Bensheim", and sunday September 24,2006 at our local Clubstation , DLØWH, in D-69469 Weinheim.
You can find more info on the website at www.ukw-tagung.com

Microwave Japan

Seiji Fukushima, Ph.D, JH6RTO

Recently I listened to a lecture by JH2CLV, Tatsumi about a 2m amplifier using a 3-500Z, which is usually employed only in a HF linear. His talk was quite interesting and he was glad to give me a grant to present a summary of his talk in DUBUS. In addition, the recent 6m open from Japan is summarised.

2m 500W Amplifier Using a 3-500Z, Tatsumi Mochizuki, JH2CLV

Introduction

A 3-500Z tube is usually employed only in a HF linear; however, I just measured a resonant frequency of a plate and a grid to find it is about 160 MHz. This project was challenging but I succeeded in a 2m 500W amplifier. My goal was the 500W output, the efficiency of higher than 50%, and the compactness. This is quite small and compact, as shown in Fig. 1. My short report is a summary of the homebrew amplifier.

Tank circuit

This is a grounded grid amplifier, as shown in Fig. 2 on the next page. One of the features is an output tank circuit of serial resonance. A basic circuit with parameters can be found in Ref. 1. Now I show you some details. The inductor L2 is a 3-turn, 5mm-diameter copper pipe and its inner diameter is 25mm. VC2 (3pF with some stray capacitance) was originally a 30pF/3kV variable capacitor but was modified to 3pF/75kV by removing some blades by myself. The L2 functions as heat radiator as well. The output power goes out through L3 (1-turn, 20mm-diameter). The DC voltage is supplied to the middle of L2 through RFC1 (10-turns, 10mm-diameter). Rf (22ohms/5W x 3, parallel) that is connected to the cathode avoids self oscillation. These three resistors reduce the gain but the stabile operation is prior. An input tank circuit is a parallel resonant type.

Key components

First I used a 3-500Z (plate loss: 400W) but later changed it to 3-500ZGC that has a marginal plate loss of 600W. The 3-500ZGC is made in China although the quality seems high and controlled.

Following is a key component list:

Tube socket: FAL's SK-410, Plate cap: Kenwood's, the same as used in TL-922, Coaxial cable: Must be a high temperature cable using Teflon insulator, Coaxial relay: Toyo Tsusho's CX-800N, Power transformer: Capacitance of 700VA, a special order, Zener diode: NEC's RD-9B.

Adjustment

Before tuning it on, we must verify if the input and output tank circuits are resonant in the 2m band. In addition, RFC1 must NOT be resonant in the band. Insert L3 into the cold-end of L2 by half of the diameter.

Let us do pre-adjustment at the amplifier TX on with an input power of 2W. After setting Ig to maximum and Ip to maximum by VC1 and VC2, respectively, tune the output power to maximum by VC3. Then, adjust the coupling between L2 and L3. This is very critical and affects the power and efficiency. As the coupling decreases, the gain increases but the amplifier becomes easier to oscillate. Take care not to touch the high voltage on L2. Please use plastic rod. I used a tooth brush, for example. Repeat the pre-adjustment procedures and make the output power maximum.

Next, increase the input power to 20W and repeat the pre-adjustment. Then, adjust the L1 place and VC1 capacitance for the minimum VSWR. Set the input VSWR to minimum and Ig to maximum simultaneously by VC1, set both the output power and Ip to maximum simultaneously by VC2, and set the output power to maximum by VC3. Repeat these procedures. The output power of 450 to 500W may be obtained easily for the 20W input power. You must always read the input VSWR; otherwise your final device of the exciter might be damaged when the amplifier is self-oscillated. Also take special care that you do not touch high voltage and that you do not expose yourself to high RF power.

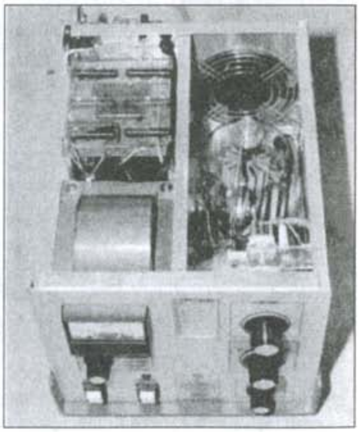


Fig. 1

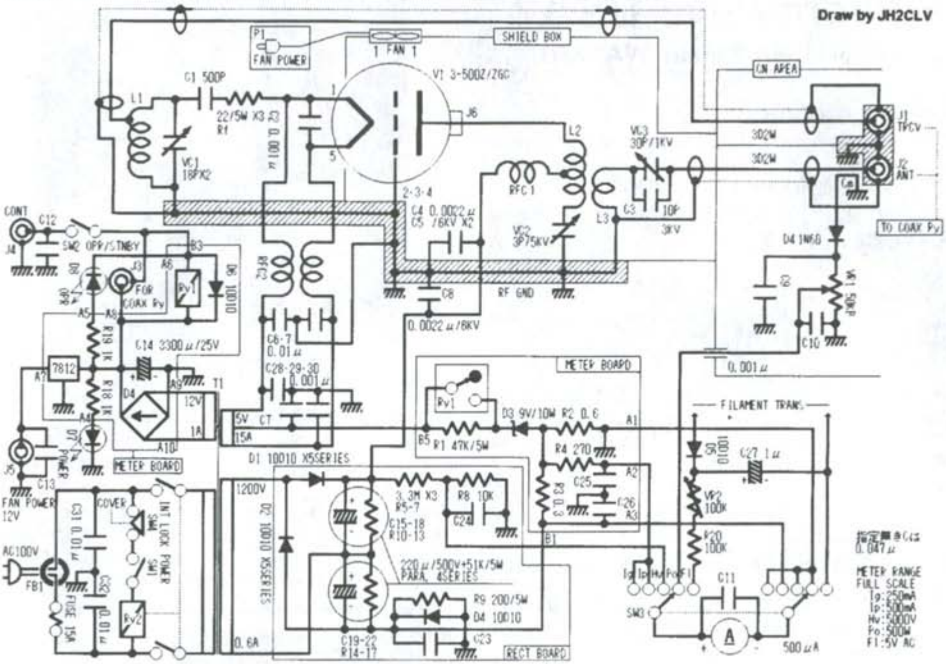
Conclusion

A homebrew 2m, 500W amplifier was demonstrated, which employed a 3-500Z tube. The details are described in my website at
http://www5a.biglobe.ne.jp/~jh2clv/
http://www5a.biglobe.ne.jp/~jh2clv/pdf/3-500z2m.pdf (in Japanese unfortunately)

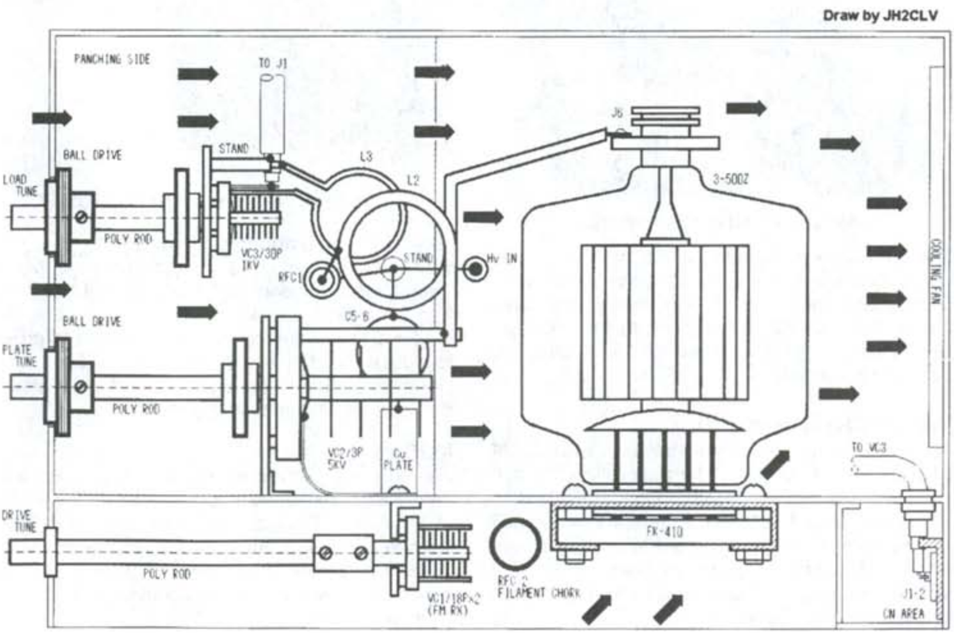
Reference

1) V/UHF Manual, RSGB.

Circuit



Final Box Image

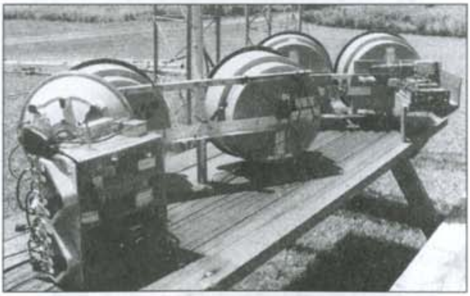


Microwave USA
Editor: Kent Britain, WA5VJB

NE8I - 47 GHz VUCC
From the ham with the worlds best Microwave QSL cards, I had the honor of processing NE8I'sapplication for a 47 GHz VUCC.

NE8I wkd WW8M/p from 5 grids on 47 GHz

This award for working 5 grids. Loyd's longest 47 GHz QSO was 110 km, but more notable was that 4 of the QSO's were non-LOS.



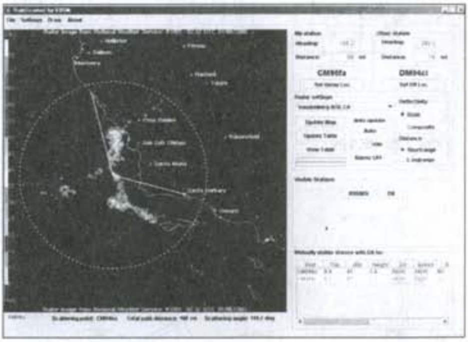
NE8I – 47 GHz equipment

The contacts were made across Lake Michigian with both stations located at the edge of the water. Signals were good on 47 GHz, better than even the 24 GHz and 10 GHz signals. Much longer attempts over water are planed for the August and September contests.

New 24 GHz record in ZL
From down south we have word of a new ZL 24 GHz record of 221 km between ZL1TPH and ZL2IP on the 12th of March. Congratulations to Steve and Ted. There was a quick attempt at 253 km, but you can be sure they are looking for longer paths and waiting for better weather. The 144.2 MHz liaison gear had been left behind so liaison was via text messaging.

ZL1TPH on 24 GHz

Software for 10 GHz Rain Scatter
10 GHz rainscatter is seeing a big increase in popularity. Andy, K0SM has written a program using real time Radar data from the National Weather service to calculate 10 GHz scatter paths. This program has helped many 10 GHz operators increase their State and Grid square totals. Download: www.frontiernet.net/~aflowers/rainscatter/



"Rainscatter" Screenshot by K0SM

New U.S. 2m transatlantic beacon
WA1ZMS is going soon to start up a 2 Meter TransAtlantic beacon. 100 watts on 144.285 MHz with 2 long Yagi's looking North East. He is applying for a FCC waver which will allow him to go up to 500 watts. Locator is FM07FM, 1280m a.s.l. We want people in the EU to start thinking about parking their antennas looking West.

MUD 2006
Again I want to invite everyone to Microwave Update 2006. Microwave Update will be held the 19th of October in Dayton, Ohio. For those who have been to the Dayton Hamfest, the Holiday Inn North is the same hotel that holds the VHF/UHF banquet. See www.microwaveupdate.org for more information. 73's Kent WA5VJB

VHF South America

Flàvio Archangelo, PY2ZX
PY2ZX@mandic.us

Digital Modes on 144 MHz

Orlando Luis Costa Neto, PY2ANE (GG66sh), made several 144 MHz DX experiences in July with the SlowFeldXPASS software, firstly designed for aircraft scatter in VLF and MW using one slow version of Hellschreiber, created by G3PPT in April, 2006.

He made contacts between Ribeirão Pires - Curitiba (about 350 km) and describes in VHF-DX list (July, 02, 2006) that "when a contact was impossible with Arnaldo PY5AQ (GG54HO) in BPSK31 or USB on 144,190 MHz, the new mode permitted clear copy with only 3 or 4 watts!". The same with Luiz Augusto PU5YFT in GG54JO with 3 watts, while no signal heard from this station in any other mode.

"According the creator, the software decodes until -30 dB, side-by-side with WSJT but with more advantages and real time reactions. There's a velocity limitation, but sufficient for exchange the calls, locators and essential data for a confirmed DX QSO". The software also can send messages like a "beacon".

Others Brazilians join the tests like PT9EW, PT9PA, PY2QP, PY2SRB, PY2OC, PY2BRZ, PU2KCX, ZZ2POW, ZZ2WCT (that gives some hours one interesting SlowFeld beacon). New experiences with PY2ANE, PY5AQ and PU5YFT are expected in 432/1296 MHz. Download the software at: http://www.lsear.freeserve.co.uk/slowfeldxpas.zip

For VHF-DX list: http://br.groups.yahoo.com/group/vhf-dx/

6 meters first USA - Montenegro

José Carlos da Silva, a Brazilian radio amateur (PY2DP) now living in Florida (N4IS), probably made the first USA - Montenegro QSO on 6 meters on July, 12 with YU6DZ at 1559 UTC. (ARRL News Letter #28)

Fantastic northern Sporadic E openings makes the magic band real again with transatlantic 50 MHz path and several interstate contacts on 144 MHz. Caribbean FM and TV broadcast were also captured in far places like the Carolinas.

Even QRP stations and stations with simple beams share this propagation in early July. The European stations worked in US are from Italy, France, Spain, England, the Canary Islands, Serbia, Belgium, Bulgaria, Azores and others.

6 meters from North Brazil

The same kind of propagation can be one of the explanations for the good job made by Paulo, PV8DX in the far north Brazil, in the State of Amapá, rare FJ92 grid with only dipole and 100 Watts. The contacts of Pedro, PV8ZX (GI64gl, 6 ele + 100W), in the State of Maranhão, suggest that this Brazilian portion, Guyanas, Venezuela and Colombia can join similar DX with USA and for the areas with an Atlantic shore also with Europe. Here some of the QSOs:

Here some of contacts of PV8DX:

K7BV/1	50110.0	0025	16 Jun 2006
W3LPL	50109.4	0025	16 Jun 2006
N3DB	50110.1	0028	16 Jun 2006
W3UR	50109.4	0030	16 Jun 2006
KP4SQ	50110.0	0039	16 Jun 2006
FM5JC	50110.2	1945	16 Jun 2006
F6KHM	50110.0	1842	20 Jun 2006
G0JHC	50110.0	1903	20 Jun 2006
PJ2BVU	50105.0	1744	22 Jun 2006
YV4DYJ	50105.0	1754	22 Jun 2006
FM5JC	50102.1	1342	15 Jul 2006
K1TOL	50110.0	1633	15 Jul 2006
VE9AA	50115.0	2033	15 Jul 2006
N1BUG	50131.9	2050	15 Jul 2006
KZ1Z	50130.0	2055	15 Jul 2006
W5EUQ	50131.0	2107	15 Jul 2006
G4PCI	50132.0	2115	15 Jul 2006
VE1YX	50132.0	2118	15 Jul 2006

PV8DX wkd also DL9USA in June!

Here some of contacts of PR8ZX:

FY7THF/B	50039.0	2019	16 May 2006
KP2HC	50125.0	2003	17 May 2006
WP4NIX	50125.0	2004	17 May 2006
FM5JC	50125.2	2005	17 May 2006
WP4NIX	50125.0	2005	17 May 2006
KP4SQ	50125.0	2013	17 May 2006
K1TOL	50110.0	1628	18 May 2006
N1MIW	50125.0	1651	18 May 2006
KB1LKB	50125.0	1656	18 May 2006
K1SG	50125.0	1715	18 May 2006
K3CWH	50125.0	1746	18 May 2006
FM5JC	50110.0	1751	18 May 2006
N1RAM	50125.0	1807	18 May 2006
W1OW	50125.0	1824	18 May 2006
N4AVV	50125.0	1831	18 May 2006
KA1OPD	50125.0	1853	18 May 2006
AG2A	50125.0	1855	18 May 2006
KA2CYN	50123.0	1858	18 May 2006
VE1YX	50123.0	1911	18 May 2006
N1RAM	50110.0	2009	18 May 2006
N3DB	50140.4	2141	24 May 2006
K7BV/1	50135.0	2327	28 May 2006
VE3GIB	50135.0	2333	28 May 2006
K2DRH	50135.0	2336	28 May 2006
W8IF	50135.0	2341	28 May 2006
VE2XK	50135.0	2344	28 May 2006
K2DRH	50135.0	2356	28 May 2006
K9DRG	50135.0	2358	28 May 2006
K8LEE	50135.0	0003	29 May 2006
K0GU	50125.0	2009	15 Jul 2006
AC5TM	50110.0	2027	15 Jul 2006

2 meters from Central Brazil

Adileu Pimenta, PT9PA, located in the city of Três Lagoas (GG49DF), is very active in weak-signals and in June and July he made several USB Tropo contacts with PY2, PY5, PY4 States. The longest contact, in July, 14, 2006, with Wellington, ZZ2WCT, in SSB that counts 655 km. Many others took place in nearby range.

70 centimeters from Southeastern Brazil

The Japy DX Group made 2 short portable operations in the mountains of Altinópolis (GG68hx) as PY2OC/PY2 and PY2MTM/PY2. In 432 MHz unexpected SSB contacts took place with the city of São Paulo region on the first day (June, 10), range about 300 km. During the second day (June, 17) the team did not find such propagation on UHF, the QSOs mainly took place on 144 MHz with PY2VNI, PY2ANE, PU2KCX, PY2NP, PY2OC, PY2VV, PY2EJ, PY2PVT, PU2WDV, PU2VMT, PY2HCD.

PY2SRB: New EME Contacts

Silvio Roberto Barbosa PY2SRB (GG48bc) is still very active in EME. Here some QSOs, including random:

144153.0	DK3WG	-20db JT65	1651	01 May 2006
144141.0	S51ZO	-29db best	1914	01 May 2006
144125.0	G4CBW	-26db JT65	2236	04 May 2006
144133.0	G4FUF	-23db JT65	0100	05 May 2006
144132.0	AA2MV	-23db JT65	2319	09 May 2006
144154.0	I2RV	-18db JT65	2350	09 May 2006
144123.0	SM5CUI	-20db JT65	0054	10 May 2006
144132.0	FM5CS	-26db JT65	0154	11 May 2006
144131.0	S52LM	-18db JT65	2216	12 May 2006
144125.0	SM2ILF	-20db JT65	1148	27 May 2006
144114.0	RK3FG	-14db JT65	1858	28 May 2006
144130.0	OH7PI	-19db	2009	28 May 2006
144143.0	W2CNS	-20db JT65	0112	02 Jun 2006
144119.0	F1DUZ	-24db JT65	1959	02 Jun 2006
144136.0	PE1BTX		2041	02 Jun 2006
144133.0	KD3UY	-21db JT65	0059	07 Jun 2006
144120.0	KC7V	-23db JT65	0322	07 Jun 2006
144132.0	AA9MY	-22db JT65	0350	07 Jun 2006
144132.0	WQ5S	-27db JT65	0410	07 Jun 2006
144122.0	YU7AA	-20db	2207	08 Jun 2006
144148.0	RA4AOR	-25db	0014	12 Jun 2006
144146.0	VK2KU	-25db	1333	15 Jun 2006
144145.0	EB5EEO	-19db	1018	17 Jun 2006
144130.0	YL2HA		0747	18 Jun 2006
144132.0	F6HVK	-19db JT65	1110	22 Jun 2006
144111.0	JM1GSH	-26db	0117	01 Jul 2006
144133.0	OK2POI	-25db	2211	04 Jul 2006
144132.0	HA5OV	-23db	2212	08 Jul 2006
144135.0	DK3EE	-20db	0359	16 Jul 2006
144141.0	EA3DXU	-24db	0556	16 Jul 2006
144122.0	RN6MT	-21db	0654	16 Jul 2006

American TEP Circuit

New table with Transequatorial QSOs data across the American sector made by this author in Excell format is available at: **http://dxnet.info/TEP_America_1.0.xls**

TEP Activity Week

For better future TEP results on 2m and other bands a TEP activity week may be organized at promising periods of the year by interested parties. This is a suggestion from PY2ZX.

New Beacon in Venezuela

A new beacon in 2 meter is going to be active in Venezuela FK60AD from the same owner of the YV4AB 6 meters beacon (50,025). This signal could be very important for TEP measures, or depending the antenna pattern, for Caribbean/North American Tropo/Es.

PY0FF/B delayed

Due to much QRL of the beacon constructor in DL the shipping of the 2m beacon for PY0FF (HI36) was delayed. Now it is planned that the beacon will be shipped until the end of the year.

CB144 Results

The 144 MHz Brazilian Contest 2006 spread their results. 145 stations took part in the event and the most distant QSO took place between PY4LOG (GG78qn) and PP5TR (GG52kh) with 830 km in CW.

Here the first 5 positions:

Points - Station - Location - Team

4.080.096 - PP5TR - GG52kh - PP5TR, PP5JR, PP5XX, PP5FMM, PP5ERE, PP5AMP

3.748.024 - PY4LA - GG66rw - PY4LA, PY2BBS, PY2PW, PY4LY, PY4LH

2.700.269 - PY2ENO - GG66ms - PY2ENO, PY2MTM, PY2OC, PY2ZX

1.711.954 - PY2ED - GG66fp - PY2ED

1.563.852 - PY2LEU - GG67ma - PY2LEU, PY2BU, PY2AE

FENARCOM

More than 1.200 visitors from 15 States visited between 14 and 16 of July 2006 the FENARCOM (Feira Nacional de Radioamadorismo e Comunicações) a Ham radio meeting and equipments trading in the city of Indaiatuba, State of São Paulo. Despite the numbers are modest if compared with Dayton or Friedrichshafen, it was the first professional event of this type for the segment in Brazil. ICOM and national factories of antennas, turners, sealers, receivers were present. Speeches about Software Defined Radio, Satellites, D-Star System and the debut of IC-7000 transceiver were also on the activities of the event.

2-m-EME News

Heinz Borde, DM2BHG
e-mail: Heinz.Borde@t-online.de

1. AROUND 2-m-EME

N6VMO: Thank you to the following stations for all your Father's Day efforts....

165400 2 -19 0.3 -563 4 # N6VMO AA7A DM43 OOO
174000 1 -28 0.1 -487 3 # n6vmo WQ5S EM13 OOO
175200 1 -23 0.2 -447 3 # N6VMO KC7V DM43 OOO
181600 3 -19 -0.2 -460 5 # N6VM0 K7MAC D OOO
185200 5 -19 -0.3 -501 2 # N6VNO W7IUV DN07 OOO
Incomplete QSO - Received incorrect callsign. We'll get it next time.

OA4CVT: Here my report of Jun-04-2006
EME QSO with RU1AA on 144.118 at 20:16Z, good copy of his traces here, best signal was -20dB. No luck with S52LM, no traces, maybe I need the 2nd antenna to copy him. At moment I am finishing the cabinet for the new amplifier here, the power supply has a new bank of capacitors and the meters are mounted.

DL8EBW: Hello dear EME-friends, was a bit more active in past days after rebuilding station here. Inbetween I be ready to run with seperate TX/RX lines and new 2x 12el M2 full elevation. Still not running will be the new rx ampl and also waiting on TS2000... so maybe a small improvement in future for my ears, hihi.
Was also spreading out the DQ2006R Call since 15.05. and was able to compare my old 1Y to the 2Y now. Will be able to spread that call up to mid of July 2006 - if anybody need, pse give me a call on the CHAT.

DL2ZC: Here is a brief summary of DF2ZC's EME-QSOs in April and May (and also the recent ones in June). Sadly I was busy at work and on business travel many days these months.That's why there were no 144 MHz EME NewsLetters for April and May. However, starting with June I'm happy to resume this service. My apologies to all.
Most of the contacts were "Random", i.e. I knew which station was calling on which frequency. This applies not only for the JT65 but also for the CW contacts. Single yagi stations are marked with a "*".

03/04/2006 08:10 YO5TP (*) KN16SS O RO JT65 EME -24
03/04/2006 13:40 JO1LVZ PM95TR RO O JT65 EME -27
03/04/2006 13:53 PA3CWN (*) JO33 O RO JT65 EME -25
03/04/2006 14:35 W9BLI EN64DP RO O JT65 EME -28
07/04/2006 12:09 VK2AWD QF56NG RO O JT65 EME -25
07/04/2006 12:30 VK1ZQR QF44MV O RO JT65 EME -26
07/04/2006 15:41 JF4TGO/8 QNØ2 RO O JT65 EME -22
08/04/2006 14:28 ZS6WB (*) KG44 RO O JT65 EME -22
08/04/2006 14:44 ZS6OB (*) KG44 RO O JT65 EME -22
09/04/2006 14:14 SP7DCS JO91MN RO O CW EME
09/04/2006 14:22 SV1BTR KM18NO RO O CW EME
23/04/2006 04:24 VU4AN (*) NK61 RO O JT65 EME -21
23/04/2006 08:57 DKØTU JO62PM O RO JT65 EME -18
09/05/2006 19:44 6V7A IK14 RO O JT65 EME -21
21/05/2006 03:10 4S7CCG MJ96WV O RO JT65 EME -24
26/05/2006 04:46 9J2JD (*) KH46 RO O JT65 EME -24
27/05/2006 11:07 FM5CS FK94LI O RO JT65 EME -16
27/05/2006 14:31 N6VMO CM94RT O RO JT65 EME -21
03/06/2006 17:40 TF/DL2NUD (*) HP96 RO O JT65 EME -21
03/06/2006 22:23 AA7A DM43AO RO O JT65 EME -15/-22
03/06/2006 22:31 KC7V DM43BS RO O JT65 EME -19/-26
05/06/2006 18:56 TF/DL2NUD (*) HP85 RO O JT65 EME -22
06/06/2006 18:04 TF/DL2NUD (*) HP84 RO O JT65 EME -19
07/06/2006 21:21 TF/DL2NUD (*) HP93 RO O JT65 EME -23

SP7DCS: I was active recently on 2m cw eme. My latest results are:
04.06.06 K4XR# sked, his first 2m cw eme qso (2yagis+qro)
17.06.06 OM5CM# sked, his first 2m cw eme qso (single 9el. YAGI + 750W !!!), new dxcc via eme
17.06.06 PA3CWN random, my second qso with Oene. This time Oene had smaller antenna and power (single 9el. YAGI + 325W !!!). Oene calculated his erp as 4.1kW - this is my best qrp 2m cw eme qso, and it was random
17.06.06 DQ2006R# sked, DL8EBW's station (2x12el+500W)
Condx were extremly good at Saturday. I had my own echo +30dB on Winrad. I was going to concentrate my activity on Sunday. But we had terrible WX in SP7... Rain, thunderstorm and high winds and I had to lower my antenna to ground to safe position. Unfortunatelly all skeds had to be canceled...(sorry friends) All arrays are safe:) I only had to repair preamp that was damaged during thunderstrom. It should be easy and I will be on air soon.

N1KI: My EME array was totally destroyed in a storm this afternoon. I have learned many things from my first two arrays, like using square tubing in the H-frame makes aligning the array much easier, so perhaps when I design and build the new array it will be more effective. I do not know when this will occur. Many thanks to all who have given me guidance on this reflector, and good luck to all.

SV1BTR: this is the report from my activity of Saturday July 1st, during the monthly DUBUS 2m cw eme event: Was happy to work 13 stations on random (no spots, no loggers, changing tx frequencies and often exchanging fully unknown text) with highlights CT1HZE (#437 2m cw eme) with a fantastic 529 signal, ZL3TY, G4DHF (David your new array works really FB, Congrats!). I was qrv a total of 4 hrs. Worked were: YO2AMU 539/559, IK2DDR 539/559, G4DHF 529/549 (later heard solid 539-549 in QSO with other friends), ZL3TY O/O, G3ZIG 529/529, SP9DCS 559/559, CT1HZE 529/539, LZ2US 559/429, LA8KV O/RO, F3VS 569/559, PA3DZL O/RO, SM2CEW 539/559, KM5PO 529/529.

SP7DCS: 19.06.06 DK4TG# - random assisted (I announced my qrg) During DUBUS 2m CW EME Activity Event - random unassisted, no loggers and no dxcl
01.07.2006 09:37 IK2DDR O/RO 1. IK2
01.07.2006 10:13 G4DHF 559/R549 2. G4 - FB with new array !!!
01.07.2006 10:28 G3LTF O/RO 3. G3 -single yagi
01.07.2006 10:37 YO2AMU O/RO 4. YO2
01.07.2006 10:53 SV1BTR R559/559 5. SV1
01.07.2006 11:48 LZ2US 539/R559 6. LZ2
01.07.2006 12:07 G3ZIG 539/R529
01.07.2006 12:17 SM2CEW 539/549 7. SM2
01.07.2006 12:23 CT1HZE# O/RO 8. CT1
Score: 9 x 8 = 72
I tried to be qrv in second pass for a short time but did not make any qso. Tropo contests made cw band seqment look like HF and it was impossible to work any cw eme in SP. Moreover neighbours asked me not to tx during soccer world cup..... So I had to make qrt in NA window:(Sorry, next time I hope to be full time!
I was also qrv on Monday (assisted - I announced my qrg):
03.07.06 SP2OFW sked via logger
03.07.06 JM1GSH#
03.07.06 UA9SL
03.07.06 DL7FF#
03.07.06 JH0MHE
03.07.06 JS3CTQ# sked via logger
So, now I have #226 on 2m CW EME.

Here the 2m - result from the R/U-stn --> June:
RU1AA KO48VR JT65B: with TF/DL2NUD (HP95), OH6KTL, YL3GDF, ZS6JDE, JA1RJU, JE5FLM and OA4CVT (DXCC #98)
RK3FG JT65B wkd this month: DQ2006P, RA3WDK, WA4NJP, WA6PXO, ZS6JDE and TK5JJ (DXCC#76, #629)
UA4AQLm JT65B new: EA5CJ, PA0V, DL9LBH, PA2DW, IW4ARD, RZ3AED, I3MEK, TF/DL2NUD (new DXCC), DL5GAC, ON4ARF, LZ1OA, PE1ITR, W2CNS, 4S7CCG (new DXCC), UA4NX, RX3AA and EA7HG.
RN6MT added in cw IK3MAC and K7AD.

DK3WG JT65B with: VK7JG, VK4CDI, TF/DL2NUD (IP05), I3MEK, TF/DL2NUD (HP95), K1JT and RZ3AED #953.
QSL-Mgr. for: RU1AA, RW1AW, RA3IS, RK3FG, RV3IG, RW3PX, UA3MBJ,RA4AOR, UA4ALU, UA4AQL, RN6MT, RV9JD, UA9FAD, UA9SL, UA9YLU, UR5LX and UX3LV.

G3LTF: I was on for part of the moonrise segment using the tropo system, 4.8L long yagi at 20m. The lower declination meant that the ground reflection area was more cluttered with trees than when the moon is at higher declination and so signals were weaker but I did have a nice QSO with Chris SP7DCS, (tnx) at 10.32 z and also heard G4DHF and my own echoes for about 10 minutes. I also heard SV1BTR and called a few times but no reply, but signals were not strong as by this time I was on the second lobe. No other signals heard.

2. EXPEDITIONS

ZL1RS/4S7CCG: working in Sri Lanka until Nov 2006, set up small home brew 2M antenna array on the office roof and also have a single long yagi for 70cm (also HB), EME operating hours are subject to work schedule and access to the office after hours, currently travelling with work and will not be active again until mid-July. 2M station ...
antenna - 4 x 8 element HB yagis
power - 2 x Mirage B3016 amplifiers combined for 300W, preamp - home brew GaAsFET at the feedpoint, QSO's so far - 28 JT65b, 1 CW

3. NEWs AND INFORMATION

Comment of a frustrated G3KEV on LF. Do we face the same development on VHF?: LF seems to be an all time low, no acty at all recently, it is hardly worth the effort. The internet and mobile phones seem to be a better bet, followed by vhf/uhf then hf if you want to talk to someone. Most operators are now appliance ops, no cw or technical skills required any more.The norm now is buy a box, plug in and go. In fact most amateurs today cannot solder, or even change a fuse, hardly amateur radio.

4. ONCE THERE WAS A CHAT ABOUT

(Chats of common iterest in INTERNET)

I am looking for a computer program which can analyze the statistical error rate of a cw transmission, under low signal to noise ratios, between two human operators with partial prior knowledge of the message contents. There are several analyses for digital communication systems, but, hard as I try I cannot seem to find anything on the on / off modulated continuous wave systems.
DJ5HG: We must differentiate between modulation and coding. On / off keying is a modulation while Morse is a code. The two symbols "ON" and "OFF" used in on/off keying do not differ as much as the two symbols used in BPSK. The difference is 3 dB

if in average the same power is used at the transmitter. If the transmitter is run at its upper limit in both cases then the difference is 6 dB. That's one reason why commercial systems do not use on / off keying.

I am just starting with EME and now I am trying to find the best tool for the job. As we have seen, unless used by competent operators, JT65's DS Mode has a slight chance of artificial characters being decoded. According to the experts, this does not happen in the cw mode of operation. So, that might make on / off keying the ethical choice for Amateur Radio Communications?
DF5HG: No, I am working on a classic CW mode decoded by the computer and using everything a computer can. My CW-Viterby decoder now is better than me, and additionally repeated callsigns are averaged and repeated passes too. Just for demonstration, DS also will be implemented. Of course there will be a non-vanishing probability of false decodes as with all transmission systems, CW included. The remaining difference between such a computerized CW mode and JT65 will rest on deficiencies of the Morse code compared to the RS code of JT65 and on the difference of the modulation scheme mentioned above, all in all about 6 dB. So, neither the modulation scheme nor the coding scheme are subject to any "ethical choice".

PA3CWN: I have a question about the TCXO-8 for a FT-100 because I experience some nasty drift in this rig lately. It seems that the TCXO-8 is no longer available here in PA and I was thinking of adding some other type. But I do not have any technical specifications of this TCXO at all. Hopefully someone knows an URL where I can find this. Other solutions are also welcomly received.
ZL1RS answers: The Kuhne xtal heater helped my IC706Mk2g as well ... as long as the fan is moded to work on rx to keep the radio cool and the room temperature is not too high. The Kuhne xtal heater works at about 40 degrees C and my IC706Mk2g gets hotter than this unless the internal cooling fan is running on RX as well as on TX. Once the radio internal temperature is over 40 degrees C the temperature stabilzing ability of the Kuhne xtal heater can no longer work. The fan mod for the IC706MK2 is easy to find on the Internet, but this may not be an issue for the FT100. I also have to keep the room temperature cool to stop the radio getting too hot. I run the A/C at 20 degrees C for this purpose ... and wear a coat when running EME! (Normally I live in 28-30 degrees C every day!). My drift has gone down from >20Hz per sequence, to <5Hz per sequence on 2M.

Elecraft K2 IF for EME
Is anyone using the Elecraft K2 transceiver on 28 MHz as the "IF" in an EME system? If so I would appreciate your evaluation of the K2 in terms of "receive" capability of weak EME cw signals.
N7LQ: I was using the K2 as my IF for about a year. I have since reverted back to an FT-101E as the K2 has a couple of problems that really bothered me for weak signal. I don't think they are a show stopper for most weak signal enthusiasts but they hit the wall with me.
1. The IF filtering has a fair amount of passband ripple, especially at wider bandwidths.
2. The RX frequency will shift when switching from USB to CW, by the offset amount you set the radio for. This was a real killer during contests. I have questioned them several times over the past 3 years on this and a fix is always "on the list" of things to do.
3. The PTT output from the radio, used to key your transverters/amps, operates QSK, there was no real fix available from K2, the comment to me was, "our customers will buy it anyway". so they would put it on the previously mentioned list.
4. The transverter level output really didn't operate the ALC very well and I ended up using a 30dB attenuator on the 10W output.
5. The microphone must be a condenser type. There was no provision to use a dynamic element, a personal issue, nothing more. I must note that compression on SSB was not that great even with their microphone(s). I realize you are after EME but I was using mine for both.
The K2 had, for me, a lot of promise. But I ended up going back to an analog radio, that was predictable and more usable, at least for me. The 101 can be modified to meet and perhaps exceed the K2 in the RX dept. And completely wipes the floor on TX, both CW and SSB. Unless QSK on EME is an aim of yours.
F6DRO: I am using one. Main pb, even with AF full strength, I have not enough noise in my ears. This is almost OK with SSB filters, but switching to CW narrow filters, it is not usable. I think pb is lack of IF gain. Very good noise blanker, but strong signal handling is not as good as a TS850 for example (it is an ultimate rejection filter problem). If you have no strong sigs around, and prefer to listen in 2K, or 1K8 like me it is OK.
PA2DW: There are only two things that bother me:
1. The throughput gain on 28 MHz seems to be low. I made a seperate output on the rig to bring the 28 MHz signal to my Drake R7/Tr7 combination and I have obviously more signal there. This of course could influence the overall noise floor...
The K2 really marvels at the lower HF-bands, but the front-end filters on 28 MHz are not that good. That is probably why the excellent strong-signal behaviour for which the K2 is well-known, is not too obvious on 28 MHz. I sometimes think about replacing the frontend filters, or to change the IF to 14 MHz.

2. The IF-filter seems to produce some ripple, as reported by another ham here on moonnet. Of course this is a killer in weak signal work! I have not noticed it myself, but heard others (PA0CHN) complain about it.

SM5BSZ: The problem is that it is really difficult if not impossible to make a sufficiently good LO. The problem is that any mixer is also an AM detector to some extent and therefore the AM component of the noise sidebands of the LO come inside the audio range and raise the noise loor.

Linrad is actually designed for an entirely digital radio, the first one available is the SDR-14. We can expect performance to improve and cost to decrease in coming years:

The SDR-14 has a limited dynamic range, but it is sufficient for 40 m in the evening here - and that is not really the case for all commercial transceivers.....

The WSE converters is a multiple conversion system 144-> 70 ->10.7->2.5-> baseband I and Q. It is designed as a reference system with higher performance than anything else to allow its usage for system testing. Have a look here:

http://www.sm5bsz.com/digdynam/practical.htm

The WSE units with a Delta44 soundcard has about 30 dB higher dynamic range than the SDR-14 for signals within the visible passband. Signals outside the visible range can be much stronger.

For an EMEer who places the noise floor of the preamp 20 dB above the internal noise of the main receiver the difference is 20 dB smaller.

Linrad is available as an exe file for Windows and as source code for Linux (from which "make linrad.exe" will generate the Windows executable). The WSE units are presented here:

http://www.sm5bsz.com/linuxdsp/optrx.htm

5. Treasury INTERNET

*** MAKE MORE MILES ON VHF* (DL8EBW)**

http://www.dl8ebw.de/ACTUAL/actual.html

* MAKE MORE MILES ON VHF - up-to-date infos (2006-06-04)about next VHF-expeditions comming up in the near future together with a new update form for user...

There will be NO announces anymore about updates at the CHAT, while some people called it SPAM and so you need to check the page time to time - normaly minimum 2 updates per day (morning 06UT / evening depence on qrl 18UT...)

* MAKE MORE MILES ON VHF -Page 2- refreshed daily infos if an expedition take part.

* Linktable to the M[ost] W[anted] S[quares]-Project were the archived maps from on 1996 to 2006 are available was updated with latest infos...

* LINKs to the different VHF-DATABASE´s of DL8EBW. Explanation what are the different types as well as online-links to the different programs use on it and a new update form for user...

* DOWNLOAD-AREA for Meteorscatter and WSJT-DATABASE 2.25 (CALLSIGN.TXT, CALL3.TXT for using with WSJT of K1JT)

* Guestbook-page for any ideas or critic...

* VHF-link page and many many more...

N1KI: I have posted a couple of pictures of the aftermath of a tree going through a small array on my web site http://home.comcast.net/~pdeporter/.

SW7QX: I have added a couple of pictures to my MSN webpage: http://groups.msn.com/W7QX

The electric part of the encoder is completed and works the same as the AMS adapter board.

The challenge is from this point on....THE MECHANICS OF THE ENCODER!

A **German Call Book** can be consulted at

http://ans.bundesnetzagentur.de/Amateurfunk/

After opening click on Rufzeichen,

W7QX: When I recently looked at VK5DJ's information, I had missed his reference to VK5ZAI's application of the encoder using the ANALOG output. Take a look:

http://www.electric-web.org/rotary_encoder.htm

7. MISCELLANEOUS

CW versus WSJT (by CT1DMK)

Being alone in the nature
Fighting the odds with my things
Crossing the skies to the moon
Feeling above all like a king

The tone and the noise altogether
The dashes and dots that should be...
emotions mixed up in my head
But that is what was sent to me.

An evening tuning the amp
or a late night with a key
transmitting it all to the end...

But now I heard there's a way
with hi-tech, it seems to be,
So what ! Would I say,
Who in the world think is possible
to be happier than me !

Luis Cupido, CT1DMK

EME Contest 2007
– Rules Update/ Change

6. QSO Points:

CW/SSB/DIGITAL:

100 points for each random QSO completed.

10 (ten) points for each sked QSO completed on 144/432/1296MHz.

100 points for each random or sked QSO completed on 2.3GHz or higher bands.

EME News
70cm & up
Editor: Bernd Wilde, DL7APV

Intro

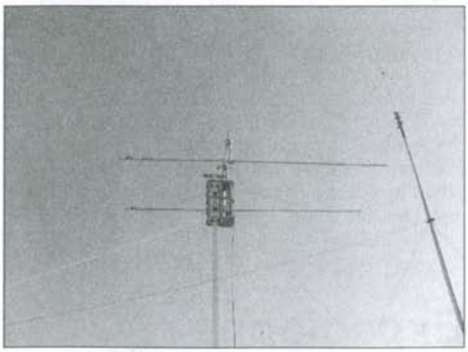
Last DUBUS activity time on 432 was a lot of fun. At the east window was not very much activity, but on the west window it was crowded like 20m. Join us next time!!

2006 ARRL EME contest will be

September 16-17	2304 MHz & Above
October 14-15	50 MHz to 1296 MHz
November 11-12	50 MHz to 1296 MHz

432 MHz

9H1TX reports from the fieldday of the clubstation **9H1MRL/P**. First of all thanks for making me a wonderful day yesterday. Sorry for the stations that we did not heard.
Stations worked : DL9KR RO 559 CW, HB9Q RO -13db JT65B, DL7APV calls -25db NC had to stop due sked as nil up on his sked, OK1DFC -27db JT65B, HB9Q RO 519 CW, N9AB -21db JT65B. Stations not seen DK3WG, G4RGK, W7ALW. Well it was a bit hard to work manual AZ/EL as it was windy but we did manage to work. We had some problem with the time as we cannot get connected with GPRS. Thank you all local Hams who helped me and you guys who called us, it was a very surprised day especially to me. 73's David 2x26el.BV, 0.2NF/150W,706MK2



9H1TX 2 yagi 432MHz

4S7CCG is not on 2m only but as well on 432. Bob wkd HB9Q on JT65. Bob has no preamp (the RX on the IC706 is nothing special at the end of 8M of coax!) He is sure he can work a few more stations when upgrading to a decent receiver preamp. The antenna is a modified 10wl, 32 element yagi that started life as a K1FO design and got optimized in YO. It should have 17.5dBd gain. Bob has abt. 50W at the antenna. 73, Bob zl1rs@yahoo.com

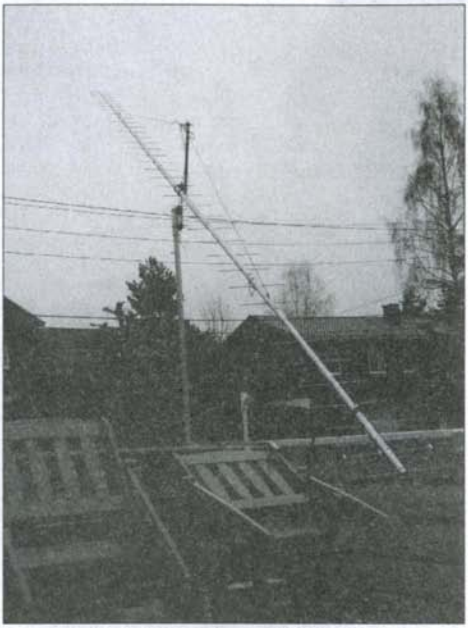
4S7CCG 432MHz K1FO- yagi

LA0BY made his first QSO on 432 with HB9Q. Viggo LA9NEA was also in the shack and surprised we heard Dan so well. I was using an IC-821H with 500 Hz CW filter, a 120 W solid-state PA 120 W with integral preamp, and the 38-ele-M2 yagi connected through 6 m Aircom Plus cable. As shown on the pictures my antenna was very close to the ground. The feed section was only 50 cm away from wet balcony furniture. The antenna may work better when the moon is towards south, and the antenna rear further away from the house. Will try also with other big guns a bit later. 73, Stefan

SM2BYA reports: I really enjoyed the 432 MHz CW activity event in July. Very good conditions and quite a bit of activity in spite of it being a low declination summer weekend. During the eastern window I worked DL7APV and JA6AHB, in the western window K2UYH, K5JL, DL9KR and SM2CEW. N9AB was putting in a great signal but CWNR; indicative of cross-polarisation –
I've had this problem with him in the past too. The high point was hearing W8TXT calling CQ at about 0645 with an excellent signal (RST 549). Copied him for several overs, but CWNR – the old familiar Yagi-Yagi problem again I guess. Gudmund

432 & up (net) news

9H1TX reports: Thanks for the big patience and experience of Al K2UYH today after some attempts we did qso on JT65C. The mainly problem was not to see Al or vica versa during all skeds with my small station but big drift from my 706 on TX/RX but seems that problem was solved with a Precision Crystal heater that was fixed this week that helped to decode very well. I will still be qrv at least this month than I will dismantle antennas and put up again 6m beam. But I will be qrv not much later and if things will keep going well maybe I try to put elevation. 73`s David, 2x8.5wl OPT 70, TE 4450G (140W)



LA0BY single yagi 432MHz

WA9KRT: the 70cm antennas are on the tower. Hope to be on shortly with 50w at 8x7.2 lambda 23 ele VE7BQH design.

WY6G: I've just seriously considered joining into the frey. I have an IC910H with 23 CM module. I part time on Hawaii Island with my location very shielded to the north by more of the mountain at about 1500 feet above me. Herb is thinking about 70 or 23 cm with an older C band dish or obtain Yagis. 73 Herb wy6g@hawaii.rr.com

HB9Q: Last Sunday I worked SV5BYR on 432 JT for his first EME and first JT QSO on 432. He has 2x18xy (circular, he loses 3 dB in RX and TX) and 50W. His signal was weaker then expected. So for the time being he is only workable for the very big guns! I also had a very fine CW QSO with S54T, Joze, running 1x21y and 100W on 432! Well done Joze! Vy 73 Dan

RW1AW reports: 03 jun testing autotraking my new dish and monitoring QRG 1296.030 and at 18.35 hrd very nice CQ from Michael and after 5min QSO CT3/DL1YMK is in my log : 0 559/ RO 559 . Many Thanks Michael for nice random QSO! wkd after that: OK1KIR, JA4KLC #, VK3UM, OK1DFC, GW3XYW #, F2TU, RW3BP, F2TU, G4CCH. RIG: 8m h.b dish F/D=0.57, 580W SSPA (~ 250-300W in feed) 0.18dB LNA W7CNK design (special Thanks to SV1BTR for this very nice Preamp!) RW1AW

23cm

LA8AV reports: LA9NEA and my self was testing my new 5,4 m dish and we was working RW3BP as the first contact on this new dish with RST 539. K9SLQ was 579 FB sigs. The testing of the dish was very good and we were able to detect echos with only 8W to the feed. Thanks to LA9NEA, Viggo, and LA8LF Anders, we was able to build this new dish in three weeks, and it was fully functionally with a new wooden tower after 4 weeks. We was starting on this project the 11th of June 2006. Looking forward to try with you all with the new dish! 73 Egil, 5,4m dish, VE4MA long feed, 400W, Preamp 0,38 db NF

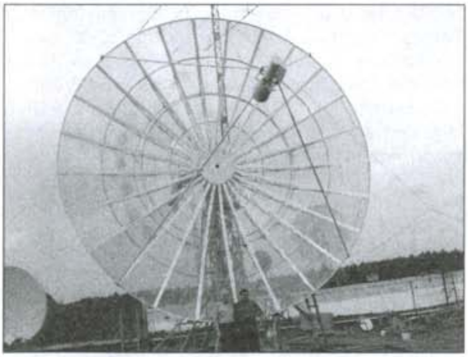
OK1KIR reports: before the 1296 MHz part of European World Wide EME Contest 2006 we QSO K5PJR as #204. Then in contest on May 6th K5JL; VE6TA; OZ6OL; HB9BBD; HB9Q; JA8IAD; JA4BLC; ES5PC; F6KHM; IK3COJ; IW2FZR; IK2MMB; G3LTF; ON7UN; LA8LF; F6CGJ; HB9SV; OH2DG; F2TU; G4CCH; SM3AKW; DL1YMK; RW3BP as #205; K2UYH; OK1CA; OK1DFC; OZ4MM; WA6PY; K4QI. On May 7th VA7MM as #206; JA6AHB; VK4AFL as #207; LX1DB; SM2CEW; G3LQR; N2UO as #208; PY5ZBU; SM3LBN as #209; K0YW; K5SO as #210 and at NA4N as #211.
We run TH308 350 W out, FHX35LG on RX, 4,5 m solid dish with el - az mount, circular polarization septum with choke, gain 31.85 dBd, cable loss 1,7 dB. Propagation condition during contest was moderate. The European VHF/UHF/SHF contest that was in parallel brings some interference. We prefer to select other date. 73 Vladimir, Tonda and Jan, OK1KIR team

Expeditions

DL8YHR will be qrv from **5A7A** on 432 in the last 2 weeks of November.

LY/DH8BQA made in June some QSO on 432MHZ from KO23, wkd DL7APV & DL9KR and from KO35 DL9KR. Rig was a single 21el F9FT and 200w. More at http://www.necg.de

The team of **W5LUA, K5GW, and WA5WCP** are pleased to announce an expedition to the states of CT, RI, MA, and possibly VT on 1296 MHz EME from August 13th GMT through the 21st GMT. Paul, WA5WCP has been working on a portable EME array for the past year and many of you have already worked the same installation that is going portable. The exact locations along with grid squares will be announced shortly. The call of W1AW will be used in Connecticut while WA5WCP will be used at all other locations.
Paul's equipment consists of a trailer mounted 10 ft dish with US Digital encoders and autotracking is done with K5GW software. Paul is using a Septum feed with a scalar ring and a W7CNK preamplifier. Paul uses an IC-910H and all operation will be done on CW. The amplifier runs about 300 watts from a WD5AGO 4 tube 2C39 amplifier. Paul has already worked 33 initials with this equipment so we are optimistic for a very successful expedition. If you have any questions, please feel free to contact email one of us. 73 from W5LUA, K5GW, WA5WCP and K1RQG



RW1AW new 8m Dish

13cm

OK1KIR : we were active in DUBUS contest on 13cm on 8th and 9th April. There was a lot of activity, weather was nice and we don´t had any serious problems with equipment, LO needs more stability. We used our 4.6 m dish with septum polarizer. Our output power was about 250 W. All together we worked 25 stations in contest and made 11 new initial, all CW. We worked :
7.4. VE6TA O/O #
8.4 all 2304/2304
OH2DG #46, OK1CA, WD5AGO #47, VE6TA, ES5PC, W5LUA, F2TU, WW2R #48,
2x 2424 JA4BLC, & JA8IAD #49,
2424/2304 JA6CZD #50, 2304/2304 HB9SV,
2320/2320 SK0UX #51, 2304/2304 OZ4MM,
2320/2320 G3LTF, OH2AXH, OE9ERC,
2304/2304 IK2RTI, 2320/2320 G3LQR,
2304/2304 WA9FWD #52 and HB9JAW 569/559.
On 9.4. 2304/2304 NA4N #53,
2424/2304 JA8ERE #54, 2320/2424 LX1DB and
2320/2320 CW DL4MEA #55.
Regards Tonda, Vladimir and Jan, OK1KIR team

5760MHz

OK1KIR April updates: We tried a sked on 5760.1 with JA6CZD on April 1st. The QSO was not confirmed.
On May23, 2006 at 02,23 UTC OK1KIR and VK3XPD succeeded in second trial and established new world EME distance record of 15,931 km on 5760,050 MHz exchanging reports M/O. Existing world record of 14,760 km (ZS6AXT - W7CNK) has been moved to second position in the historical tables. Sorry Ivo!
For OK1KIR this event brings another 30years anniversary enhancement!
Just on the same day, May 23, 1976, i.e. 30 yrs ago, OK1KIR made first ever EME QSO from OK land on 432 MHz with WA6LET. We borrowed a very deep 7m dish used by Astronomic Observatory of the Czech Academy of Science (which was a contemporary relict of 2nd World War - part of army radar originaly mounted on the railway wagoon - fortunaly for us not hitten by the allied air-forces, hi), we further somehow approx. in the feed point fixed a pair of crossed dipoles with reflectors, connected 2xGI7B PA in modified K2RIW design (finished by OK1DAK&OK1DAI through preceding night) giving some 800W of rf and "low noise" preamplifier with BFR90/91 (who does remember these expensive devices with NF under 2dB, hi)and succeeded ! Who interested, details compiled by OK1DFC on:
http://www.vhf.cz/index2.htm

VK3XPD reports from down under: this new World Record was also the FIRST ever 5760 MHz EME contact for Australia (VK) ! Signal Reports were "O" Copy from VK3XPD & "M" Copy from from OK1KIR. The OK1KIR station uses Circular Polarisation with a 60 Watt (SSPA) feeding a 4.5 metre dish. The VK3XPD station is a VE4MA Feed, Horizontally Polarised with a rear dish mounted TWTA feeding a 3metre dish. It is fully Coaxial (Coax Relay @ the Feed) because no Waveguide bits were available at the time.. so my in circuit losses are somewhat higher than a WG setup.
The event was also not without it's problems... my

TWTA recently developed an RF Output problem which resulted in the Output Power dropping (varying slowly and unpredictably) by up to 10 dB from the maximum available output of about 100 watts. Additionally, there were overcast conditions (no visible Moon) in VK and very poor wet weather in the Czech Republic at that time. I'm hoping to resolve my TWTA difficulties soon and chase a few more QSO's shortly. My thanks to Vlad & his OK1KIR Team for persisting....Cheers. Alan -.

JH1KRC, Mike, informs that he is currently starting to build an EME station for **5.7 and 10 GHz!**
He also sends news about the annual JA EME meeting, which this year was held in Tsuyama, Okayama on 27/28 May, The attendants were JH3ERQ, JF3HUC, JA4LJB, JA0EIV, JR4AEP, JA6DZI, JR3JLL, JS3SIM, JH4JLV, JH1KRC, JA4BLC and JA4HZN. Hata, JA4HZN, who is sometimes active on 1296, runs the guesthouse where the conference took place. An Agilent N8975A precision NF analyzer was used for NF measurements. All attendants received UHF/SHF isolators from the silent key JA1AUH's estate. JA1AUH, who passed away in April of last year, was a major contributor to the development of JA amateurs' technology. His precision NF meter design is still used by many JA EMEers. An Advantest R3767CH network analyzer was used to measure the isolators and hand-made filters. JA4BLC presented his feed-mount 20 W HPA/LNA/converter system for 5.7 GHz and discussed how he and JR4AEP (JR4ZZS owner) improved the azimuth control mechanism for their 9 m dish. JH1KRC showed the results of his experiments on 15 m EME and played recordings of his echoes. JA4DZI reported on the severe 23 cm noise generated from satellite TV converters, which are very common in Japan.

JA Conference: (L-R) in back, JH3ERQ, JF3HUC, JA4LJB, JA0EIV, and JR4AEP, in front, JA6DZI, JR3JLL, JS3SIM, JH4JLV, JH1KRC, JA4BLC, and JA4HZN

10GHz

Have a look at a very nice presentation on 10 GHz EME by Chris, **GW4DGU**, on
http://www.blaenffos.org/ .
Click on Beginner 10 GHz EME! Around 40 pages with very good information. Thanks Chris !!

We participated in 10 GHz polarization test with **IQ4DF**. Recorded files are at:
http://www.qsl.net/ok1vao/10GHz_pol_test.

OK1KIR participated in 10 GHz polarization test on April 2nd. The files can be downloaded from: http://www.qsl.net/ok1vao/10GHz_pol_test/

24 GHz

W5LUA: On June 23, LX1DB & G4NNS worked each other on 24 GHz for the first QSO for each then Al worked LX1DB on 24 GHz for LX1DB #2 QSO. LX1DB was Al's initial #4 on 24 GHz EME. 24 GHz EME activity in Europe has migrated from 24192 MHz down to 24048 MHz due to 24048 MHz being a primary allocation for amateurs while 24192 MHz is a secondary allocation in Region 1. The same is true in NA but moving weak signal terrestrial work from 24192 MHz down to 24048 MHz may be difficult. None the less, VE4MA and I have migrated our EME equipment down to 24048 MHz and anyone planning 24 GHz EME activity is encouraged to gear up for 24048.1 MHz

Silent key

Jean Pierre **F1ANH** passed away after a hard struggle against cancer. Few weeks ago, he was still on the air, finishing his last QSOs, over the thousands he had during his long Ham Radio life. He was a very good technician, and a great weak signal operator. He was giving his time, and much more, to the others. He was one of our references and more simply, he was our friend. We will deeply miss you Jean Pierre. 73 Herve F5HRY

Last

I hope to cu you all in Wuerzburg!!

73 Bernd DL7APV

CONTEST-results

EME **ARI MARATON 2005** you will find at:
http://www.qsl.net/iw0bet/contest/EME2005_2.htm
73' de John iw0bet@ari.it
Award ARI MANAGER VUSHF & 50 MHz

Italian New Modes 2006 EME contest results

Foreword: In our contest participants are subdivided in classes based on their ERP (total antenna length and high or low power) so as to have a fair comparison of results and operator skill. Different points for random or assisted operation also reward operator skill. We are glad that a high percentage accepted the challenge of random operation, and wish to thank all those who sent in the log, with a special thank-you to Gabriel and Dave for having sent their control logs.

	Call	qso	it.	R/A	points
50 MHz					
1	W5UWB	1	A		3(no el
144 Mhz - Cat. A					
1	DJ7AL	6	1	R	81
2	SP9TTG	4	1	R	61
3	OK2POI	1	-	R	10
144 MHz - Cat. B					
1	YO3FFF	14	1	R	161
2	RA3WDK	6	1	R/A	67
3	RX6BS	1	1	R	31
4	KI0LE	2	-	R	20(no el
144MHz - Cat. C/D					
1	EA3DXU	48	5	R	585
2	S51ZO	26	5	R	365
3	SV8CS	21	3	R	283
4	S52LM	64	10	R/A	272
5	SV8KOM	27	5	R/A	262
6	EB1DNK	19	1	R	211
7	DL7UDA	10	2	R	142
8	JS3CTQ	14	1	A	50
8	PA5KM	14	1	A	50
10	W5UWB	5	-	A	15(no el
Control log on request					
	EA6VQ	45	7		
144 MHz - Crossed yagis - Cat. C					
1	9H1TX	30	4	R	384
144 MHz - Crossed yagis - Cat. D					
1	RA3AQ	66	5	R	765
2	LZ1DP	27	3	R	333
3	UX3LV	18	2	R	222
144MHz - Cat. E/F					
1	RA0FU	65	4	R	734
2	K7MAC	58	5	R/A	454
3	SM2ILF	37	4	R/A	447
4	YU150CF	92	7	A	441
5	RV9JD	27	3	R	333
6	JH0MHE	23	3	R/A	286
7	HB9Q	66	7	A	268
144 MHz - Crossed yagis - Cat. F					
1	RU1AA	117	10	R/A	1090
Control log on request					
	W5UN	22	7		
144 MHz - SWL					
1	JF4TGO/8	22	3		283
432 MHz - Cat. A					
1	JS3CTQ	1	-	R	10
2	W5UWB	1	-	A	3 (no el
432 MHz - Cat. B					
1	PE1ITR	6	-	R/A	32
432 MHz - Cat. C					
1	KI0LE	6	-	R	60
1	UT3LL	6	-	R	60
3	G4RGK	13	1	A	47
4	S51ZO	3	-	R	30
5	SV1AWE	3	-	A	9
432 MHz - Cat. E/F					
1	HB9Q	41	2	A	139
2	OK1DFC	12	1	R/A	120
3	JA6AHB	3	-	R	30
1296 MHz					
1	VA7MM	4	-	R/A	33
2	SM5LE	5	-	A	15
ITALIAN STATIONS					
50 MHz					
1	IW5DHN	3		A	9
144 MHz - Cat. B/C					
1	I0JU	7		R	70
2	IW4BIF	2		R	20
3	IW4EHV	1		A	3
3	IZ4FTE	1		A	3
3	IZ4GWE	1		A	3
144 MHz - Crossed yagis - Cat. C					
1	IK1UWL	38	R	380	
144MHz - Cat. D					
1	IK2DDR	43		R	430
2	I2RV	44		R/A	139
3	I1ANP	4		R	40
144 MHz - Crossed yagis - Cat. F					
1	IK3MAC	74		R	740
432 MHz - Cat. C					
1	IN3KLQ	5		R/A	36
2	I1NDP	2		R	20

Michael DL1YMK & Monika on Madeira – CT3, see report on next pages

CT3/DL1YMK – a two-band EME-DXpedition to Madeira Island

by Michael Kohla, DL1YMK

The very beginning of our 2006 moonbounce DXpedition was not really fun for Monika, my logistics manger, and myself: after a smooth flight from Düsseldorf airport to Funchal, the capital of Madeira, the landing approach was more than just bumpy- the plane was kind of wobbling because a very strong side winds. Hence, the captain of the Airbus 330 decided at a height of approx. 20 m above the Funchal-airstrip that it would not be a safe touchdown and made a start-over manoeuvre with this coloss of an airplane, producing some panic in not only Monika's face. With a wide loop over the island, the airplane made a second approach, which this time resulted in a hard, but safe landing on the short runway.

After collecting of 181kg of radio equipment (and two trousers and a t-shirt..) from the bulky luggage terminal, stuffed in 4 big aluminium flight boxes, we headed by taxi for our holiday home in the village of Camara de Lobos (IM12mp) on the southern coast of the island. Monika had chosen this particular house, an refurbished old Quinta, because of it's free take-off over the Atlantic Ocean (as the internet pics made believe...), which should guarantee a maximum moon window, even at the given low declination. At about 1600UT on the 1st of June, we arrived at the location, together with our friends Peter, DL7YS, and his wife Ulli. Peter would cope with the HF part of this holiday trip to CT3.

A first inspection of the location confirmed a widely unobstructed take-off, only the very eastern direction was blocked by a big tree in the garden, and also a hill top in about 3 km distance. As Doug, VK3UM, had alredy communicated by email his interest in setting up a distance record with CT3/DL1YMK, this enterprise now seemed to be very questionable, as in 85° AZ we definitely needed more than 6° EL, which at least would mean a lot of ground noise in VK-land...

On Friday morning, 2nd of June, we started to unpack and build up the dish, as well as the station. By 1630UT in the afternoon, all systems were go, the septum feed for 23cm installed in (what we believed to be) the focus of the preloaded/stressed dish, which looked at least as ugly as last year in EI. Our plan was, to be active on 23cm for the first activity weekend (03./04.06), in order to reach as many active stations as ever possible.

The moon was high up in the sky, but a first echo test revealed – nil! Oh boy, what's wrong? Carsten, DL6LAU, who can operate DL0SHF remotely from home, had offered in the forefield to provide us a beacon signal, whenever needed. It was needed now...Carsten agreed to appear some ten minutes later on 1296.030 MHz. In fact, we could copy him after correcting some offset of the dish in GM4JJJ's moonsked SW. We exchanged 549/O reports, this was the first CT3/DL ever..congrats to Carsten and Per! As I had the impression to be somewhat deaf, I asked Carsten to stay on with a beacon, in order to adjust the septum focus. In fact, this gave a major improvement by hearing our (because of apogee still faint) echoes , so I dared to spend a few CQ's. Guess what happened then: a major wooling broke loose, as I had never experienced that on the moon before. I really had problems to sort out the calls, as still I had the feeling of suboptimal receiving. There had been set up a few skeds for this Friday evening by the kind support of Joe, K1RGQ, in the Net Notes, but in the end of Friday some 16 stations were worked, the vast majority of these on random. A few sked takers called much earlier than planned, I guess they feared, Mr. Murphy could visit us before their turn, hi!

On Saturday, we changed the f/D-ratio of the mighty ugly dish, by stressing the struts with Peter's muscles a bit more to reduce the focal length, resulting in an overall better illumination of the dish by the special light-weight version of the septum feed. This was proved by an increase in sun noise, better echoes, and a much better receiving of the DL0SHFand OZ4MM beacons- a warm thanks to both stations for their constant support. We closed the activity weekend with another 21 initials and some dupes, a highlight being KL6M – I pulled Mike out of the white noise just before loosing the moon behind the westerly mountain ridge.

Unfortunately, both skeds with Doug, VK3UM, at our moonrise on Saturday and Sunday ended nil, as the moon was too far east for us, still totally blocked by that damned tree...We had to wait for a more southerly moonrise...

On Monday and Tuesday we added another 6 initials, including our first and only JT65c contact with Sam, G4DDK, before changing the feed to 70 cm, as scheduled for Wednesday,7th of June. This would be the ultimate challenge, as in case of success, the DXpedition would turn out as a true 2-band endeavour....

The 70cm hb feed is a 1wl closed loop, a modified version of a loop feed, described earlier in Dubus by CT1DMK. Knowing that the gain of a 4.1m dish on 70 would be marginal, we had to produce at least a reasonable power level. A tube amp would have been by far too heavy to fly into the island; fortunately, by intercession of Knut, DG0ZB, we got in contact with Bernhard Korte of BEKO, who immediately agreed to lend us one of his famous MOSFet HPA's for the DXpedition. The 600W-amp was picked up by Peter, DL7YS, during a very short-termed business trip to Munich end of May, so that Bernhard had to adapt the amp to our needs in some nightshifts – Berhard, tnx so much for your courtesy and engagement - this is true ham spirit! Of course the 35kg-amp resulted again in some extra weight and Euro's (and less socks...) for Peter....tnx agn.

We started on 70cm on Wednesday afternoon in a sked with Doug, but again nil, although I heard both calls during only one period for the first time – so still hope??- Doug ownes a 10m beauty!!

At 1744UT we definitely knew it was a 2-band DXpedition, by working Peter, SM2CEW as the first CT3/SM on 70cm – we really made it!! Peter was followed by Zdenek, OK1DFC, who, needless to quote, with this QSO made a 'double first' CT3/OK, mni congrats. Zdenek was kind enough to set up again a CT3/DL1YMK page on his website, so that some first pictures of our station appeared during the first week of our stay, as different from last years EI-trip we had fast internet access to transfer pics. On Wednesday we ended up with a total of 8 QSO's on 70, a highlight definitely being Jan's unequaled smashing signal, bringing DL9KR up to country #93 – let's see, Jan, what else we can contribute to your standings...At least the 70 cm activity was a nice contribution to our slimming program, as the mains fuse, installed in the kitchen, tripped countless times, while Txing on 70cm – " Peter, can you light a match to reset that dam' fuse, please ???" For this reason we never could go beyond the 500W mark.

The following Thursday, 8th, a long shout of relief yelled through the Quinta, when at 1758UT we managed to exchange O/O reports on 70cm with VK3UM – Doug, tnx for hanging on to us!! Although with 18534km earth surface distance we could not surpass the distance record still held by Al, K2UYH, we felt it was quite an achievement for a portable station. After a nil-attempt, K2UYH was qso'd on 09.06. also on 70 cm, although Al's moon was blocked by a tree...know that well, Al! In the morning of the 10th, we changed back to 23cm, for a successful QSO with Paul, WA6PY, before he was leaving for a business trip – easy copy both ends, if it weren't for that inhumane sked time: 0300UT. Paul, did you notice anything odd with my keying? Well, I had a few glasses of Madeira wine for diner, hi...

In the evening of the 10th, we definitely set a record then, by an easy armchair copy QSO with VK3UM on 23cm. Doug found out, it's a real VK distance record on 1296MHz. In the evening of the 12th we made the last 23cm QSO from CT3 with HB9BBD, which made us very happy, as we had missed Dominique in EI last year. After that initial #45 on 23cm, Monika and I changed the feed back to 70cm in the light of torches, for a very last try with Bernd, DL7APV. Three trials with Bernd had been nil so far, although I always had a pleasant copy of him, but power in CT3 was still a bit low....Anyway, this time we made it, Bernd was absolutely vertical, and I tried to adapt to it by switching polarization of the loop. We ended up with a total of 45 initials on 23cm and 13 initials on 70cm, which I think is a good reason to assume this DXpedition was a true success.

A big thanks again to all out there, having patiently looked for us on the moon, or giving us any kind of support! After a DXpedition always is before a DXpedition, so again the question is: where do we go next??

CU off the moon, Monika & Michael, DL1YMK

CT3/DL1YMK on 70cm and 23cm EME

Tropo Reports

2m, 70cm and up

Editor: Wolfgang Schneider, DJ8ES
DJ8ES@gmx.de

2m

CT1HZE, IM57nh, wkd
19.6.2006
2012 CU8AO HM49KL 55 55 1953km
2222 CU3EQ HM68 in FM via repeater 145.600
19.6. 17z - 20.6. 07z CU8DUB/B, HM49KL hrd
01.7.2006
1350 D44TD HK86NO 52 55 2676km
10.7.2006
2147 D44TD HK86NO 59 53 2676km

CU8AO, HM49KL, wkd:
1. June 2006
1353 EI8JK IO51DN 53 53 2132km
14. June 2006
1435 G4LOH IO70JC 55 55 2349km
6. July 2006
1950- G4LOH, G4CQM IO70, hrd EI5FK

LA0BY, JO59IX, wkd (>800 km)
2006-06-06:
DJ9MG (JO52TC); DM2RN (JO51UM); PA3EXB (JO33FD); PD5LO (JO32HR); PA1JAN (JO32KV); PI4TUE (JO21RK); PA3CEG (JO33FB)

2006-06-10:
PE1RCW (JO22MP); DF0CI (JO51CH); DL8YE (JO31MH); DL3YEL (JO41EV); DO5YLM (JO42GA); DH8IAB (JO30NO); PA2M (JO21IP); PE1GNP (JO31IX); OR0A (JO20KW); ON4PS/P (JO20KQ); LX/PA2CHR (JN29XV); DQ2006H (JO52GJ); DM1CG (JO31CG); PA3AJI (JO21JQ); DF5HC (JN49HT); DK5KMA (JO50IK); DK3WG (JO72GI); DL5ME (JO52SD); DM5CT (JO50LT); DK4U (JO42FD); PA2DW (JO22GD); DB1AI (JO42UH); DF2ZC (JO30RN); DO1BR (JO42AE); DJ9CZ (JO31BC); DL6BF (JO32QI); PA3AYD (JO21UU); DL2KK (JO30CU); DG5AAG (JO51CT); DK7ZB (JO51AE); DG6MBS (JO41AH); PA7AL (JO23VG); DF5DE (JO40CX); ON4IA (JO21SB); DO8CW (JO31UO); DO5SU (JO31SL); DL1QH (JO31NP); DG1DPN (JO31RL); DL8DAU (JO40ME); DB8KJ (JO30CM); HB9FAP (JN46EW); DK5RQ (JN68BV); DF8JD (JO31NF); DJ3OS (JN49FL); DK5WO (JO30AS); HB9FAP (JN46EW); HB9QQ (JN47KJ); DF6IY (JN48EU); DL8AKR (JO61AI); DK5WN (JO50HW); DF8DU (JO31OI); DK1VC (JO31RG); DJ7YR (JO41WN); DD4UO (JO42NN); DL5FDP (JN49LP); DL2YDB (JO42JE); PA1VW (JO22IN); DO1YMJ (JO31WS); DF8IK (JO30JT); DL8YAU (JO41HS); PD0RKC (JO23XE); DL1OJ (JO42QI); DK1FUN (JN49MR); PD0RF (JO32LT); DG4OAI (JO52AE); DL0VBG (JO51GW); PD0OYF (JO33BC); DL8AKI/P (JO51CH); DL2YDB (JO42JE)

2006-07-02:
DF0MTL (JO61JF); DB4BIN/P (JO42CN); G3VER/P (IO91RU); G5RR/P (IO93GC); DQ2006D (JO62NM); DF0YY (JO62GD)

06/07/15	2050	G7RAU	IO90IR	1274km
	2058	G8VHI	IO92FM	1120km
	2205	G4PBP	IO82WO	1137km
	2213	M0PRO	IO81VK	1244km
	2218	G4KWQ	IO92AQ	1123km
	2221	OK1KIM	JO60RN	1062km
06/07/16	0506	ON4ARF	JO10MV	1119km
	0548	G0BRC	JO01GH	1153km
	0725	DJ1HA	JO30JN	1076km
	0755	PD1DX	JO21AJ	1041km

Good tropo but very poor activity. During the evening the G-stations came in best while I was beaming to JO67, probably because of the extremely strong seaduct over the Skagerak. In the morning I heard the beacons GB3VHF, F5XAM, PI7CIS, PI7FHY for many hours. Heard also F4CQY/p in JN28 but he replied only QRZ LA0...? Rig: IC821H + PA (2 x MRF245), 180 W, 9-ele-yagi, 6 mAGL, 520 m asl. tnx for info Stefan

PA5DD, JO22IC, wkd May/Jun (>600km):
OZ2PBS (JO55XJ, 602km); OZ8ZS (JO55RT, 606km); OZ1PIF (JO65AN, 617km); OZ1MG (JO65CO, 629km); OZ1IEP (JO55XU, 633km); SK7MW (JO65MJ, 660km); SK7CY (JO65RJ, 683km); OZ6ABA (JO57DJ, 690km); LA7H (JO29PK, 818km); LA2Z (JO59EJ, 886km)
tnx for info Uffe

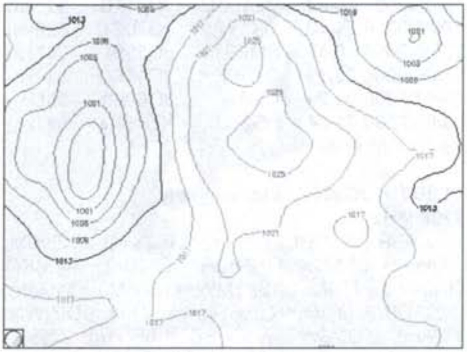
70cm

CT1HZE, IM57nh, wkd:
19.6.2006 2149 CU8AO 55 55 HM49kl 1953km

PA5DD, JO22IC, wkd May/Jun (>500km):
OZ1BEF (JO46OE, 542km); OZ9KY (JO45VX, 545km); OZ2LD (JO54TU, 552km); OZ9ZZ (JO46QK, 571km); OZ8ZS (JO55RT, 606km); OZ1IEP (JO55XU, 633km); SK7MW (JO65MJ, 660km); SM6OEW (JO67DA, 734km); SF6X (JO57TX, 789km); LA2Z (JO59EJ, 886km)
tnx for info Uffe

Good propagation condition, however little (or no?) activity?
As in every summer an increase of good propagation conditions can be noticed. Indications are large high pressure zones over central Europe. During the early morning hours of 10. June such conditions had build up. With the exception of a few beacon reports on 144 MHz and 10 GHz in the VHF/UHF cluster little activity was noticed. Sta-

tions like DL1SUN, SM6EAN, OZ1FF and OZ1CTZ reported on the GHz bands some QSO up to 400 km, however certainly better scores would have been possible.
During evening hours with improved propagation conditions the situation changes: on the same day the increased activity enabled LA0BY (JO59) and SM7WIL (JO65) to log a couple of stations in PA, ON, LX and HB9 (odx JO59/JO46 with ca 1500km). Nevertheless the activity was fairly low despite good conditions. Remember: good tropo conditions are not limited to the autumn months.



10. July '06:
A center of high pressure directly over europe

LA0BY, JO59IX, wkd (>600 km):
2006-06-10:
PE1RCW (JO22MP); DL8YE (JO31MH); ON4PS/P (JO20KQ); OR0A (JO20KW); DM1CG (JO31IC); PA2M (JO21IP); PE1GNP (JO31IX); ON4PS/P (JO20KQ); DL8DAU (JO40ME); DB8KJ (JO30CM); DD4UO (JO42NN); DL4OL (JO52BC); DF6IY (JN48EU); DL2YDB (JO42JE); DG4OAI (JO52AE)
2006-06-13:
DJ8MS (JO54VC); DL0VV (JO64AD); OH1F (KP01TK); DJ9KH/P (JO42OX); PA3FXB (JO33KC)
2006-07-02:
DL2HSX (JO51XA); DF0MTL (JO61JF); PI4GN (JO33II); DF0YY (JO62GD); DL5YYM (JO61JF); DL1ATI (JO50SU); DG6QF (JO61OA); OK4W (JO60JJ); DH1NFL (JO50VF); DM7A (JO60LK); M0GAV/P (IO93FL); G8OHM/P (IO82XJ); DK1IP (JO53EF); DL0VV (JO64AD)
tnx for info Stefan

G3XDY, JO02OB, wkd (>700km):

11.04.2006	SK7MW	JO65MJ	860km
07.05.2006	OK4W	JO6ØJJ	826km
07.05.2006	SK7MW	JO65MJ	860km
13.06.2006	OZ1IEP	JO55XU	818km
13.06.2006	OZ9KY	JO45VX	709km
01.07.2006	OZ9EDR/P	JO55KR	752km
02.07.2006	SK7MW	JO65MJ	860km
02.07.2006	DFØYY	JO62GD	773km

tnx for info John

Gute Bedingungen, aber wenig (oder keine?) Aktivität?
Auch in diesem Jahr treten Überreichweiten auf den VHF/UHF-Bändern in den Sommermonaten vermehrt auf. Ein vielfach wichtiger Indikator dafür sind ausgedehnte Hochdruckgebiete. So geschehen zum Beispiel in den frühen Morgenstunden des 10. Juni zwischen 6 und 8 Uhr (UT). Mal abgesehen von einigen Cluster-meldungen über Bakenbeobachtungen war auf den Frequenzen zwischen 144 MHz und 10 GHz nur wenig Funkaktivität zu erkennen. Zwar haben Stationen wie DL1SUN, SM6EAN, OZ1FF und OZ1CTZ, hier speziell auf den GHz-Bändern, das eine oder andere QSO mit Entfernungen bis zu 400km gefahren, aber sicherlich war hier noch mehr drin.
Wenn denn diese Überreichweiten in den Abendstunden auftreten, dann sind zumindest die Aktivitäten besser. So haben an diesem Tag zumindest LA0BY (JO59) und SM7WIL (JO65) eine Reihe von Verbindungen mit PA, ON, LX, DL und HB9 (odx JO59/JO46 über ca. 1500km) tätigen können. Aber insgesamt gesehen war die Aktivität nicht so wie es hätte sein können. Gute Tropo-Bedingungen mit Überreichweiten treten halt nicht immer nur im Herbst auf.

OZ1FF, JO45BO, wkd Jun/Jul '06 (>500km):
DF9IC (JN49IW, 743km); G0JJG (JO02LE, 604km); G3YDY (JO01FQ, 667km); G3LQR (JO02QF, 580km); G4DEZ (JO03AE, 588km); SM3LBN (JP80IO, 750km); SM4RPP (JO79HH, 567km). tnx for info Kjeld

OZ1IEP, JO55XU, wkd Jun '06 (>500km):

13/06/06 17:41	DB6NT	JO50VJ	608km
13/06/06 17:49	DG0VOG/P	JO60QU	564km
13/06/06 18:02	OH0JFP	KP00AB	668km
13/06/06 18:13	DF9IC	JN48IW	800km
13/06/06 18:14	DD0PX	JO30WQ	636km
13/06/06 19:36	DG1KJG	JO30NT	646km
13/06/06 19:49	SM3BEI	JP81NG	673km
13/06/06 20:26	G3LQR	JO02QF	799km
13/06/06 20:39	DL6NAA	JO50VF	626km
13/06/06 20:53	G3XDY	JO02OB	819km

tnx for info Carl

DL0GTH, JO50JP, wkd July '06:
OK2KRT (JN99CL, 545km); HA5KDQ (JN97LN, 686km); OM3U (JN88LE, 523km); G0VHF/P (JO01PU, 674km); HA6WK (N08FB, 756km); OK2SI (JN99FO, 559km); S52M (JN76BL, 524km); HA5FMV (JN97KR, 671km); OM3KHE (JN99JC, 598km); OM0C (JN88VJ, 564km); 9A2WR (JN95FQ, 792km); SP9OJQ (JN99IW, 568km); OM3KII (JN88UU, 535km); I4YNO

(JN54KP, 667km); I4LCK/4 (JN54PD, 724km); S57C (JN76PB, 608km); S59P (JN86AO, 592km); S59R (JN76OM, 562km); SP9KUP/P (JN99VS, 648km); SP9CP (JO90MT, 581km); SK7MW (JO65MJ, 549km); F6FJE/P (JN27LJ, 558km); SP9ZHR (JO90KG, 574km); HG6Z (JN97WV, 726km); OM3CQF (JN88RT, 521km); G3CKR/P (IO93AD, 917km); IK1PJU/1 (JN44CO, 699km); IK2ULB/2 (JN55EU, 534km); SP1EWO (JO92EE, 553km); OL7Q (JN99FN, 560km); OK2ER (JN99AT, 524km); F8DLS (JN19SE, 544km); OK2KCE (JN89XX, 514km); G3SDC/P (JO02ST, 681km); OK2FUG (JN99FU, 552km); OK5K (JN89VP, 511km); OZ9EDR/P (JO55KR, 565km); G0FBB/P (JO01LD, 692km); OZ6OL (JO65DJ, 538km); HB9AOF (JN36AD, 611km); OL7T (JN89SJ, 502km); OM3RRC (JN99CG, 552km); OM3W (JN99BB, 554km); SP9EML/9 (JN99MS, 595km); OK2KJT (JN99AJ, 536km); F6DVC/P (JN36BX, 532km); OK2UKG (JN99FU, 552km); SN9D (JN99MQ, 597km); SP6OJK/P (JO80VC, 500km); OK2KYC (JN99BM, 538km)

23cm + up

SM7ECM, JO65NQ, wkd

23 cm (>500km):

06/05/2006 21.08	PI9A	JO33FB	523km
06/05/2006 22.07	OK4W	JO60JJ	591km
06/05/2006 22.42	DM7A	JO60LK	586km
16/05/2006 17.17	SM4DXO	JP70VO	569km
16/05/2006 17.40	PA5DD	JO22IC	680km
16/05/2006 17.44	PA0S	JO21FW	705km
16/05/2006 18.09	PA3AWJ	JO21GW	701km
16/05/2006 18.28	DF9IC	JN48IW	809km
16/05/2006 18.34	DB6NT	JO50IT	602km
16/05/2006 19.00	SM0DFP	JO89VL	505km
16/05/2006 19.01	SK0CT	JO89XJ	503km
16/05/2006 19.02	SK0UX	JO99BM	520km
16/05/2006 19.03	SM0ERR	JO89WJ	501km
16/05/2006 19.15	SM3LBN	JP80IO	586km
16/05/2006 20.50	SM3BEI	JP81NG	663km
03/06/2006 18.34	DQ2006W	JO61CA	524km
04/06/2006 11.07	DM7A	JO60LK	586km
01/07/2006 22.02	DM7A	JO60LK	586km
01/07/2006 22.37	G0VHF/p	JO01PU	888km
01/07/2006 22.43	G5LK/p	JO02RF	856km
03/07/2006 20.30	ES2RJ	KO29KM	821km

13 cm (>400km):

23/05/2006 17.29	SA4Z	JO79OF	414km
23/05/2006 17.43	SM0DFP	JO89VL	505km
23/05/2006 18.25	SM5QA	JO89WJ	501km
27/06/2006 17.17	SA4Z	JO79OF	414km
27/06/2006 17.49	SM5QA	JO89WJ	501km
27/06/2006 18.18	SM0DFP	JO89VL	505km
01/07/2006 22.07	DM7A	JO60LK	586km
02/07/2006 07.58	PI4GN	JO33II	490km

6 cm (>300km):

06/05/2006 20.44	DF0YY	JO62GD	397km
23/05/2006 18.05	SM0DFP	JO89VL	505km
23/05/2006 18.30	SM5QA	JO89WJ	501km
16/06/2006 19.36	DL7YC	JO62PK	363km
27/06/2006 17.46	SM5QA	JO89WJ	501km
27/06/2006 19.12	SM0DFP	JO89VL	505km
01/07/2006 22.14	DM7A	JO60LK	586km

3 cm (>300km):

06/05/2006 20.55	DF0YY	JO62GD	397km
16/06/2006 16.39	DB6NT	JO50VJ	595km
16/06/2006 19.13	DL7YC	JO62PK	362km
16/06/2006 19.20	DL7VTX	JO62TM	354km
16/06/2006 20.13	DL4DTU	JO61TB	515km
16/06/2006 21.12	OK1YA	JO70GC	628km
27/06/2006 18.45	SM6BTT	JO58PI	317km
27/06/2006 20.32	OZ1FF	JO45BO	314km
01/07/2006 22.22	DM7A	JO60LK	586km
03/07/2006 21.04	ES2RJ	KO29KM	821km

tnx for info Anders

DL0GTH, JO50JP, wkd July ´06:

1296 MHz:

G0VHF/P (JO01PU, 674km); OK2KYC (JN99BM, 538km); S51ZO (JN86DR, 594km); I4LCK/4 (JN54PD, 724km); SK7MW (JO65MJ, 549km); OZ9EDR/9 (JO55KR, 565km); G4KIY (IO92WN, 783km); OM3W (JN99BB, 554km); S59R (JN76OM, 562km); OL7Q (JN99FN, 560km); OK2KCE (JN89XX, 514km); OM0C (JN88VJ, 564km); G5LK/P (JO02RF, 670km); OM3KII (JN88UU, 535km); IQ1KW (JN34NO, 726km); OM3KHE (JN99JC, 598km); OM5M (JN88RS, 523km); G3XDY (JO02OB, 684km); G4BEL (JO02BI, 762km)

2320 MHz:

PA6NL (JO21BX, 486km); OK2KJT (JN99AJ, 536km); OK2BFF (JO80HB, 419km); OM3W (JN99BB, 554km); ON4SHF (JO20KW, 417km); OM0C (JN88VJ, 564km); PA3AWJ (JO21GW, 458km); PI4GN (JO33II, 411km); IQ1KW (JN34NO, 726km); OZ1ALS/P (JO44XX, 485km); SK7MW (JO65MJ, 549km); PA0EZ (JO22OF, 425km); PA0S (JO21FW, 463km)

3400 MHz:

PA6NL (JO21BX, 486km); OL2R (JN89BO, 397km); OK5Z (JN89AK, 398km); DL1SUN (JO53PN, 326km); DK1CB (JO53CL, 317km); DL1SUZ (JO53UN, 330km); PA3AWJ (JO21GW, 458km); OL2R (JN89BO, 397km); PA0BAT (JO31FX, 336km); PA3AWJ (JO21GW, 467km)

OZ1FF, JO45BO, wkd 18th July (>500km):

17:44	DF9IC	JN48IW	743km
17:56	SM6QA	JO78FM	502km
18:13	GM4OGI	IO85DX	741km
19:00	G4DEZ	JO03AE	588km
19:33	G3XDY	JO02OB	601km
19:38	F5APQ	JO00XU	669km
19:43	G7UWA	JO02UU	548km
20:07	SA4Z	JO79OF	585km

20:33	SM7LCB	JO86GH	530km
20:42	G4EAT	JO01HR	656km
20:57	G4HUP	JO02PC	594km
20:59	G4WYJ	IO91VH	729km

tnx for info Kjeld

G3XDY, JO02OB, wkd

1.3GHz (>700km):

07.05.2006	OK4W	JO6ØJJ	826km
07.05.2006	DFØYY	JO62GD	773km
07.05.2006	DM7A	JO6ØLK	836km
10.05.2006	SM6HYG	JO58RG	947km
10.05.2006	LA3EQ	JO28UX	819km
10.05.2006	SM6AFV	JO67GQ	955km
04.06.2006	DM7A	JO6ØLK	836km
04.06.2006	DFØMTL	JO5ØSU	728km
04.06.2006	DKØNA	JO5ØTI	749km
09.06.2006	OZ6OL	O65DJ	816km
09.06.2006	SM6VTZ	JO58XJ	978km
11.06.2006	OZ8AFC	JO45WV	708km
01.07.2006	OZ9EDR/P	JO55KR	752km
02.07.2006	DLØVV	JO64AD	758km
02.07.2006	DM7A	JO6ØLK	836km
02.07.2006	SM7LCB	JO86GH	1100km
02.07.2006	SM7FMX	JO65KN	857km
02.07.2006	SM6DJH	JO58PI	946km
03.07.2006	SM7FMX	JO65KN	857km
04.07.2006	SK7MW J	O65MJ	860km

2.3GHz (>500km):

18.04.2006	DF9IC	JN48IW	633km
06.05.2006	DK6AS	JO52JJ	653km
07.05.2006	DLØGTH	JO5ØJP	683km
07.05.2006	DFØYY	JO62GD	773km
07.05.2006	DM7A	JO6ØLK	836km
07.05.2006	EI5HN	IO62OO	546km
10.05.2006	SM6AFV	JO67GQ	955km
10.05.2006	OZ8AFC	JO45WV	708km
11.05.2006	SM6EAN	JO57WQ	923km
11.05.2006	OZ1CTZ	JO46OE	693km
12.05.2006	OZ8AFC	JO45WV	708km
04.06.2006	DLØGTH	JO5ØJP	683km
11.06.2006	OZ1CTZ	JO46OE	693km
24.06.2006	OZ1FF	JO45BO	600km
01.07.2006	DKØZB	JO42HE	506km
01.07.2006	OZ1ALS/P	JO44XX	662km
02.07.2006	OZ9EDR/P	JO55KR	752km
02.07.2006	DL3IAS	JN49EJ	585km
04.07.2006	SM6HYG	JO58RG	947km

3.4GHz (>400km):

04.05.2006	DF9IC	JN48IW	633km
06.05.2006	GM4ISM/P	IO74WV	473km
06.05.2006	DK2MN	JO32PC	415km
07.05.2006	DLØV	JO31LG	406km
07.05.2006	EI5HN	IO62OO	546km
10.05.2006	SM6HYG	JO58RG	947km
04.06.2006	DK2MN	O32PC	415km
04.06.2006	DLØV	O31LG	406km
04.06.2006	DLØGTH	JO5ØJP	683km
11.06.2006	OZ8AFC	JO45WV	708km
01.07.2006	DK2MN	O32PC	415km
01.07.2006	DLØV	JO31LG	406km

5.7GHz (>400km):

06.05.2006	DK2MN	JO32PC	415km
10.05.2006	SM6HYG	JO58RG	947km
10.05.2006	SM6AFV	JO67GQ	955km
11.05.2006	SM6EAN	JO57WQ	923km
21.05.2006	G4ALY	IO7ØVL	416km
04.06.2006	DK2MN	JO32PC	415km
02.07.2006	OZ9EDR/P	JO55KR	752km
04.07.2006	SK7MW	JO65MJ	860km

10GHz (>400km):

06.05.2006	DK2MN	JO32PC	415km
10.05.2006	SM6HYG	JO58RG	947km
10.05.2006	SM6AFV	JO67GQ	955km
10.05.2006	OZ8AFC	JO45WV	708km
10.05.2006	OZ8AFC	JO45WV	708km
11.05.2006	SM6EAN	JO57WQ	923km
12.05.2006	OZ8AFC	JO45WV	708km
03.06.2006	DLØV	JO31LG	406km
04.06.2006	DK2MN	JO32PC	415km
24.06.2006	OZ1FF	JO45BO	600km
01.07.2006	OZ1ALS/P	JO44XX	662km
01.07.2006	DLØV	JO31LG	406km
02.07.2006	OZ9EDR/P	JO55KR	752km

tnx for info John

PA5DD, JO22IC, May/Jun wkd (>400km):

1296 MHz:

G4BRK (IO91HP, 419km); DF9IC (JN48IW, 451km); OZ1FF (JO45BO, 451km); G8OHM (IO92AJ, 454km); DJ8MS (JO64AD, 541km); OZ9KY (JO45VX, 545km); OZ2LD (JO54TU, 552km); OZ6OL (JO65DJ, 620km); OZ1BGZ (JO65AP, 623km); SK7MW (JO65MJ, 660km); SM7ECM (JO65NQ, 681km); SM6HYG (JO58RG, 810km)

2320 MHz:

SK7MW (JO65MJ, 660km); SM6HYG (JO58RG, 810km)

and also on 9, 6 and 3cm:

SM6HYG (JO58RG, 810km)

tnx for info Uffe

pse ur Tropo-Report to:

DJ 8 ES @ gmx.de

Aurora Reports

Editor: Stefan Heck, LA0BY
LA0BY@darc.de

Again very few openings this period, but some of them were quite nice in Northern Europe.
73, Stefan (LA0BY)

--------------------- 144 MHz ----------------------

LA0BY in JO59IX wkd on 144 MHz:

2006-06-06

1644	RX1AS	KO59FX	59A	59A	30°	1095km
1649	OH5LK	KP30ON	59A	59A	30°	910km
1656	OH8LRB	KP24HQ	52A	55A	30°	886km
1700	OH6NG	KP03TC	55A	57A	30°	674km
1701	LA8G	JP53GJ	59A	59A	30°	380km
1702	OH4LA	KP20LG	57A	57A	30°	788km
1703	OH3BYZ	KP21UA	55A	59A	30°	828km
1705	OH3KRH	KP21EB	57A	57A	30°	756km
1709	OH6MC	KP21PU	56A	53A	30°	813km
1715	ES2JL	KO29LL	55A	55A	30°	799km
1719	OH5LK	KP30ON	59A	59A	30°	910km
1720	OH1F	KP01TK	57A	57A	30°	615km
1722	OH6QR	KP22BN	57A	57A	30°	771km
1724	7S2AT	KP03BU	55A	55A	30°	654km
1725	SM3JLA	JP93LH	59A	59A	30°	571km
1727	OH6A	KP03SD	57A	55A	30°	672km
1730	SK7JD	JO87HS	55A	55A	30°	419km
1731	OH6BKO	KP01SC	55A	57A	30°	605km
1736	RA1ARM	KO49VX	52A	55A	30°	1058km
1738	OH6PA	KP02PL	55A	55A	30°	630km
1739	OH0AZ	JP90XI	57A	59A	30°	513km
1740	SM7ATL	JO86EQ	52A	55A	30°	493km
1746	ES4EQ	KO39CE	55A	55A	30°	875km
1747	ES7GN	KO28TI	55A	59A	30°	867km
1751	OH1ND	KP00XL	59A	59A	30°	623km
1802	ES5PC	KO38HJ	55A	55A	30°	921km
1832	SM2A	KP04NP	55A	57A	30°	746km
2008	SK3LH	JP93IH	52A	55A	30°	561km

2006-07-04

1811	SM3JLA	JP93LH	56A	55A	30°	571km
1814	OH6A	KP03SD	55A	55A	30°	672km
1904	OH6HFX	KP14RA	53A	55A	30°	801km
1906	7S2AT	KP03BU	55A	55A	30°	654km
1910	LA8KV	JP52QQ	55A	55A	30°	303km

RIG: IC-821H, PA 180W, antenna 2 x 9-ele-yagi

RK1B/p, KO79BW, wkd:

2006-06-06

1533	OH5LK	55A	KP30ON
1630	RX1AS	59A	KO59FX
1635	OH6MAZ	59A	KP21IG
1639	OH4LA	59A	KP20LG
1642	OH7PI	59A	KP32XG
1645	SM3JLA	59A	JP93LH
1646	7S2AT	59A	KP03BU
1647	ES3RF	59A	KO29AF
1650	OH6QU	57A	KP03SD
1651	SK3WK	57A	??
1654	OH1ND	51A	KP00XL
1658	SM2ILF	57A	KP04MM
1700	SM5CUI	57A	JO89WW
1705	ES2RJ	59A	KO29JM
1709	SM3BEA	59A	JP81NQ
1710	OH6MW	59A	KP20IM
1715	OH1ND	57A	KP00XL

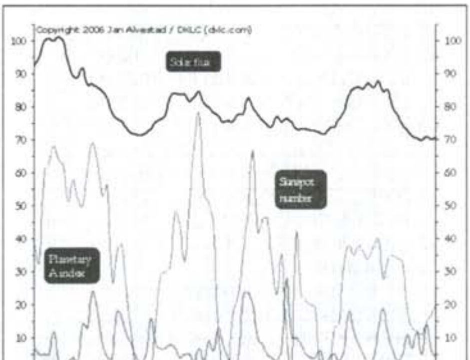
LA/PA5DD, JP54PB wkd:

2006-07-11 2040-2130z:
SM5CUI, OH6KTL, ES2WX, ES2RJ, SM3DTR, SM0HAX, LA9DFA, OH6MW, OH2LAK, OH4LA, SK4AO, OH1XT, SM3LBN, SM6HBI, RW1AY, SK6HD, OH2BN.

SK4MPI, JP70nj, Beacon Reports on 2m via Aurora:

Date	Time	from area
4.5.	1500-1600	OZ (JO65), OH5 (KP30)
6.5.	1400-1500	OH6 (KP02), EW (KO45)
	2030-2130	SM2 (KP03), SM6 (JO65)
7.5.*	1320	SM2 (Kp03)
11.5.	1445	OH5 (KP30)
18.5.	1535-1630	SM2 (KP03, KP15),
6.6.	1530-1700	ES (KO28), OZ (JO65)
8.6.	1615	SM2 (KP15)
15.6.	1525-1700	LA (JP33), DL (JO43)
29.6.	1418	SM2 (KP15)
4.7.*	1635-1700	LA (JP52), SM2 (KP02)
10.7.	1642	SM2 (KP15)
11.7.	2025	SM2 (KP03)
14.7.	1425	SM2 (KP15)

*** LA2VHF JP53EG**



Geomagnetic activity 24.04. - 16.07.2006

FAI News

Reports, Info, Theory

Editor: Dom Dehays, F6DRO
f6dro@aol.com

Building your own FAI opening:

Here his a suggested technique to run some FAI experiments using the tools we have at hand. Of course, it is not a 100% working technique, but after using it for a long time, I can say it often gives good results. First: look for a possible scatter point using LIVEMUF (Tnx G7RAU):

06 July 11:24z: DX de ON3VHF: 50180 OE4WHG 59+10 tks qso jn87
es from JO20EM to JN87BB on 50.180 (Az=110.06°)
(Distance = 941.58 KM) (Elevation = 10.90°)
(MUF = 71.50MHz) (Centre of path = JN58FW)
(Critical freq = 13.11MHz)
From JN03TJ try towards KO03PP (Az=45.18°)
(Elevation = 2.64°) (Distance = 1832.89 KM)
frequency of traffic = 69.34MHz
Livemuf screen for 06/07/2006 showing possible scattering around JN58

Look for some repetitive scatterings with MUF around 70 MHz or more but you can try lower MUF for experimental purposes. Scatterings from an working 144MHz also may work.

It is also possible you find high MUF not from an unique location but from several nearby squares, this is also OK (here JN58/48/49 showed increased MUF that day). On the exemple above, repetitive Es reflexion points, giving JN48/49/58/68 locations, were found on LIVEMUF. JN58 was selected as being mid point.
Second: Compute all possible grids you can work from this scattering point (here JN58) (Tnx DJ5HG)

Here you can see: SCP location (JN58). The required azimuth and elevation to reach it. Your horizon (circle around your own locator) and SCP horizon. Both intersect, so this scp is OK for you.
The bold line curve is the line along which you can work someone with the highest probability. You can also see thiner lines around the central bold line, these are possible locations for workable stations, but with deviation from the FAI scattering law. It can work also (and it worked that day). My experience is it is better to select stations located approximately at the same distance from SCP but this has to be investigated more in depth.
This day, for me it was for example possible to work to HA/OK, around KN06.

Third: warn and find partners:
Using CLX, tell you are calling CQ using the selected scp, or find partners directly on ON4KST by selecting stations located in the right place in the user list.
Results for 06/07/2006 1225>1242Z:
Worked HA8CE KN06, OK2POI, JN99 and OK2ZZ, JN89, using the selected JN58 scatterer. In the evening, same technique enabled me to work via JO20: YO2LEA, S54M and HA8CE.
I noticed at least for the JO20 scatter point that day and on several occurences, that I cannot hear stations located west of the scatterer (like G4LOH for example) while theory says the opposite.

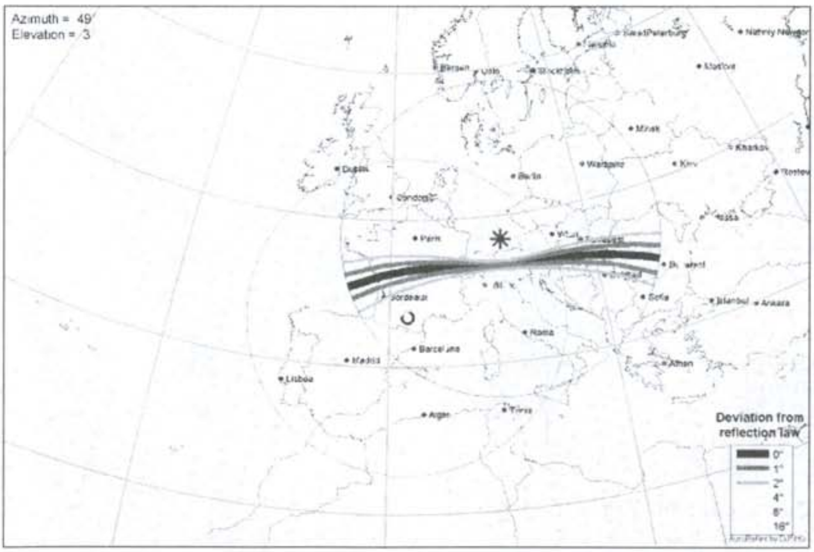


Fig. SCP computation using the very good DJ5HG software AuroReflex

Fourth: Report your qsos to f6dro@wanadoo.fr

LiveMuf by G7RAU at http://g7rau.demon.co.uk/ . This is access to web version. You can also use another more sophisticated version intalled directly on your own PC. AuroReflex and QTFgui by DJ5HG at http://www.qsl.net/dj5hg/

FAI at the Edge

Portugal to Azores in reality

Beeing at the very southwestern edge of continental Europe the chances to hear or work anybody from the west via FAI are very slim and I never really tried seriously.

On June 23rd at 23:00 UTC I checked the CU8DUB beacon on Flores Island (Azores, HM49KL) for Tropo and was surprised to hear it 52 with typical auroral sound. The maximum was about 15 deg. offset to the north than the direct path. A typical indication for FAI. I hrd CU8DUB for about 30 mins with 52F.

Volker, DF5AI, kindly provided the following two maps created by the Beamfinder software showing the FAI scatterpoint over IN01 suiting to the path from IM57 to HM49.
The second map shows all possible scatterpoints (the dots) and target (the dark areas) which are in reach via FAI from IM57.
So war from IM57 I hrd/wkd on 2m via FAI only I1 (JN34/35), I4 (JN54) and F (JN23). Would be interesting to verify the map in the future regarding DL, HB9, OE, I0, IT9 and ON.

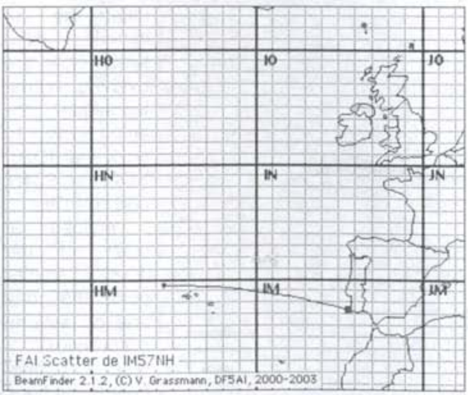


Fig.: The responsible FAI Scatter region over IN11 for the 2m QSO from CU8AO, HM49KL, to CT1HZE, IM57nh on July 4th over 1953km via FAI

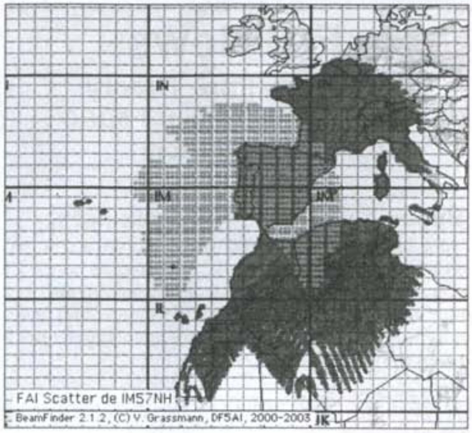


Fig.: All possible FAI target regions (black) for IM57 (the grey dots are the responsible scatter areas)

Knowing that FAI is possible to CU I checked the CU beacon again on July 4th in the evening at 21:00 z after a 1 hour Es opening to CU during noon time. I was not too surpised to find CU8DUB with 52F again with QTF 15 deg offset to north. Calling on 144.300 resulted in a QSO with CU8AO exchanging 51F reports at 21:17z.
This is supposed to be the very first FAI two way contact between Azores Islands and the European continent. QRB 1953km.
(CT1HZE, IM57nh)

Sporadic E
144 MHz – Reports

"Too many" days in 2006 with Sporadic E on 2m make it impossible to reprint all QSOs here in DUBUS. Furthermore it makes no sense at all to print again all what you find on the web already. As nobody is sending any reports to DUBUS any more we will NOT publish a comple 2m Es summary this year but will concentrate on the really rare long distances.
What is rare? I would say any distance up to 2100km is "easy" with any average station. Distances from 2200 km to 2400 km are rare and at least one QSO parter often has an excellent takeoff (free view over the water, like SV5, SV9 and 4X stations) or have an EME setup (like RN6BN, RA6DA, RA4AOR etc). This way sometimes even a bit more than 2400km are possible by Tropo enhaced single hop Es. These are single QSOs normally between "special" stations.
Really rare are double (or may be chordal) hop openings with distances from 2400/2500km up to 4200km. In 2006 we had this kind of opening on several (!) days and quite long (up to 1 hour).
The QSO considered as this type are BOLD in the following reports. There is still the "EA8 question": 2 x Es or Tropo + Es. I would say most of these openings are Tropo + Es, any way I am sure also 2 x Es took place this year from EA8 several times (to YO / I).
Joe, CT1HZE

Here the Es-Log from CT1HZE, IM57NH

June 7th, 2006

1812	IK7EZN	JN90 #

June 8th, 2006

1655	DK7DR	
	DK1MAX	
	DL5GAC	
1656	HB8ZCV	
	F5RRT	JN25
	DL5MAE	JN58
	HB9QQ	JN47
	HB9BNI	JN37
	DK5RQ	JN68
1657	DL5MAI	
	DC9RAR	JN68
1658	F5DCG	JN25
	F6BEG	JN25
	DF9UX	JN47
1659	HB4FE	
	DL5MHA	
	PA1VW	
1700	HB9BZA	
	PA3DOL	
	PA2DW	
	HB9DFG	JN37
1701	OK1TEH	JO70# 2343km
	OK1XN	JO70 2328km
	PD0FSB	JO22
1702	DL1NAW	
1703	HB9DRX	
1704	DF5DL	JN58
1705	OE5OLL	
1706	DL3MBG	JN67
	DR7C	JN67
1709	F6EGV	JN35
	OE9MON	JN47
1712	OE2UKL	
1714	DK3SE	JN47
1716	I8MPO	JN70
	DL5MCG	JN58
	IW1HUL	JN65
1718	IW3GXW	JN65
	IK8BIZ	JN70
1720	IK4GBZ	
1722	IK4CBO	
1723	IW2BAI	JN45
	F1RFH	JN23
	DL8OAI/p	
1724	F1AXS	JN23
1725	DL4DWA	JO61 2343km
1725	M0BPQ	
1726	M0UKR	
	G6WYH	JO01
	G4ZFJ	
	2E1HKB	
	G8IZY	
1727	G4DEZ	JO03
	G3UUT	
	SM7F?	hrd only
1728	G0KPW	
1729	G3ZEZ	JO01
	G4DHF	IO92
1730	G0ORG	JO02
1731	PD0ORT	JO23
	G8XIR	JO01
	DL8PK	C?
1733	IZ8DEO	JN70
1736	PA3CWN	JO33
1736	G4NRG	JO02
1737	G3BNE	JO01
	G6HIE	IO90
	G8HGN	JO01
	G1HWY	IO90
1738	G8IZY	
	I0RHJ	JN61
	IK0BZY	JN61
1739	G4AEP	IO91
1740	G1KAW	IO91
	G0NFA	IO91
	G3LTF	
	PA1GYS	
1741	OE2WMO	
	M0ITY	JO01
1742	PE2RMi	JO23
1748	G3BNE	
	G8WXU	JO01
1749	G0TMT	JO02
	G8SRL	JO01
1807	G3LQR	JO02

Difficult: open in two directions (G/PA and I) at the same time. Over 80 QSOs in 1 hour.

June 10th, 2006

1152	I8KPV	JN70
1154	IK8BIZ	JN70
1201	IW0FFK	JN61
1204	IK0XIH	JN61
1214	IW0BET	JN61
1218	F1ISM	JN09
	F6CBH	JN19
1219	F6HCI	
	F0EHA	IN98
1221	F6APE	IN97
1224	IZ0FWE	JN62 #

June 11th, 2006

1603	IV3HWT	JN65
	IK3COJ	
1606	Ik2YXK	JN45
1607	IZ2AAL	JN45
	S57GM	
	I2BGQ	JN45
1608	IW2CYS	JN45
1609	IN3TNW	JN56
	I1JTQ	JN35
1611	IW3GXW	JN65
	9A9UN	
1612	IV3DXW	JN65
	I1DMP	
	IW3HUL	JN65

1613 I2PY JN55
F1SPL JN33
1614 IW2HUS JN45
IZ2HXV JN55
1615 Ik2UIX JN45
1616 I4RHP
1617 I3MEK JN55
1618 S57TW
1619 IK4GRD JN54
1619 9A3JH
1620 IK2DSO
S51ZO JN65
1621 IQ2LO
1621 DJ9KV
1622 IK3COJ JN65
1623 IK8FOU JN70
OE5UAL
IK7LXW JN80
1624 IZ4BEH JN54
OE2WMO JN67
1625 DF2NS
1626 DL9MDC
1627 DL5MAE
1628 OE2LCM
1633 IK0RWX JN61
1636 IK1ZOF JN35
1638 DK5MY JN57
1639 IW2HAJ
1652 9A6R JN83 #
1653 DK1RWS JN68
1654 DF1CF JN57

1756 PA5KM hrd wkg <u>EA8!</u>
1756 PA3GFY
1758 PA3BIY
PA3DOL
1759 PA5WT
DF6IY JN48
DF5HC JN49
1800 DL8II JN49
DB9IZ JN49
DJ3OS JN49
1801 DJ0QZ
DL6SBM
1802 DK3SE
F6DDW JN38
1803 DB5WC JN49
HB9DRS JN37
DL5IO JN49
1804 HB9DKM
DL1NBM JN49
F6EKJ JN27
HB8BNI JN37
HB8DFG JN37
1805 HB9YBQ
HB9SJV
1806 DG1GOB
DG9MAQ
DH9GCD JN38
F4CYZ JN38
DK2DB JN48
DJ3JJ JN48
1807 DL4VS JN39
1808 F0CXO C?
F6HGC JN26
1809 DL3NDN JN59
DL3NCR JN48
1810 G4RRA
GW3NDB IO81
1811 DH3VE JN39
DK6FX JO30
DF1VW JN39
1812 G7RAU IO90
G4DBL
1813 DH0GHU JN38
1814 DB6NT JO50
1815 G4MKF
G4LOH IO70
Again about 90 QSOs.

<u>June 13th, 2006</u>

0922 DF1CF JN57
0927 HB9JAW
0938 DQ2006U
0939 DL1MAJ
0941 GM4CXM IO75 #
0948 DC1RJ
0950 HB9DFG JN37
DF5NK
DF9TF JN37
0951 DF1SD
DD0NM
DJ4EJ
0952 DC7NF JN69
DL7HR JN58
0953 DK5EW JN47
DL5MAE JN58
0954 DL3RK
0956 DJ7KL
DJ9EV JN49
0957 DG2GEP JN48
DJ2IE
0958 DG6NF
0959 DO1SDJ JN49
1000 DL7AOM JO50
F6EKJ
1001 F1JFR JN38
1003 DF5BN JN49
DK1FUN
1004 DK2DB
1005 HB9BF
1006 DJ3OS
1007 DH9GCD
1007 DJ2IE
1008 DG1GOB
1008 DL6ZAU JO40
1012 DL4VS
1015 DK8VS JN39
DK0DK JN49
1019 I1DMP 52F/55F FAI
1040 DL5MAE

<u>June 18th, 2006</u>

1049 DK1KO JO53 2347km
1112 DK5DQ

<u>June 22nd, 2006</u>

1617 G8IZY IO91
1618 G3BNE
1619 G8RZA JO01
1623 G4DCV IO91
G3YYD IO91
G4DHF
1624 G4HSO IO91
1626 G4PCS
1627 G0KLX IO91

<u>June 27nd, 2006</u>

1715 EI4DQ IO51
EI7BO IO51
1719 EI5FK IO51
1723 EI2IP IO53
1727 EI8GQ IO51
1729 G4LOH IO70
1810 EI3GRB IO52 #
EI4DQ and EI5FK were in for almost one hour peaking 59+40.

<u>July 1st, 2006</u>

1807 I5BLH/5 JN53
1812 IK4WKU/4 hrd
It was open quite some time in the contest, hrd I4/5 wkg EA9 and EA5. Most Italians probably not beaming west....

<u>July 4th, 2006</u>

1210-1302 CU8DUB HM49KL

<u>July 5th, 2006</u>

0732 PI7CIS/B JO22
no stations qrv

<u>July 6th, 2006</u>

1328 GW8ASA
1330 G6CRV IO84 #
G8AXW IO83
GM0MDD/M IO75
1331 G4HGI IO83
1332 G4WDL
1333 G0WYY IO94
1334 G4PBP
G0LEE IO83
1339 GM0MDD IO75 @home

1342 G0HIS
1343 G8GXP
1344 GM3ZXE IO86 #
M0JKQ IO84
1345 GW3HWR IO71
1453 GI0KOW IO64

July 7th, 2006

1358 IK6XGR JN63
1428 IK5QLO JN53
1438 IV3DXW JN65
1439 IQ3AZ JN65
I2PG JN55
1440 IV3VFR JN65
IV3GBO JN66 #
1444 I3MEK JN55
1448 IK5ZUM JN54
1450 IZ5ANK
IK5CQV JN53
1451 IZ1ANK JN33
1458 IW3QTG JN65
S59F JN65
S50J JN65

July 8th, 2006

1415 CU8AO HM49KL
1434 CU3EQ HM68 #
wkd in FM on 144.325
CU8DUB/B hrd from 1415 to 1447 59+

July 9th, 2006

0935-0955 CU8DUB 59++
heavy QSB

July 10th, 2006

1846 I8KPV JN70

July 12th, 2006

1359 I5TWK/8 JN70
1400 IK8YOQ JN70
1405 IK8BIZ JN70
1407 I7CSB JN71 #
IC8FAX JN70
1409 IC8CQF JN70
1418 TA1D KN41LB 3263km
FIRST TA-CT
1419 IW0BET JN
1420 LZ1KJ KN31 3025km
1421 Z35Z KN11 2702km
1422 LZ5UV KN12 2793km
1424 YU1DGH KN03 2681km
1416 RA6DA KN96 4080km
1433 TA1D KN41 2nd QSO
1438 LZ3NY KN12 2800km
1439 LZ1AG KN22 2909km
1440 LZ2PI KN23 3013km
1441 YO3DMU KN34 3029km
1441 LZ2FO KN13 2767km
1442 LZ1BB KN12 2814km
1425 IZ6FHZ
1446 YU6A JN92 2458km
FIRST YU6-CT
1454 9A5AVS JN83
1502 YO4AUL KN44 3228km C?
1506 YT1VV KN04 JN94
1507 YT1ET KN04
1508 IK5OEK
1510 YU1EV KN04
1517 IZ1ANK
1518 YT7AT ?
1519 YO6AQF KN24
1520 YO9HP KN34 3026km
1520 YZ1KU KN04
1520 YU7EW KN05
1521 YZ1NOP JN94
1522 HA8BE KN06 2694km
1522 YO5OHY KN17 2875km
1524 YO2BBT KN05 2704km
1525 YU7ON KN04 2647km
1526 YU7KB JN94 2550km
1526 YO8AKS? C?
1527 9A2SB JN95 2452km
1527 I5LN JN53
1527 YU7EF KN04 2400km
1529 F1EYB JN23
1531 F6EGD JN24 #
Comment: This was the best Es during the last 6 years from my CT QTH. 1 hour continous double hop happens not too often. 45 QSOs, 7 new DXCCs and 17 new square. The signals of the double hop stations were WEAK! 51 to 55 maximal. Using now 4 x 11 ele Flexa Yagis instead of just 1 single one really made the difference. I am sure that most of these QSOs would not have took place without the 4 yagi array.

1736 OZ2TF JO46
1748 OZ1BEF JO46

July 16th, 2006

After the amazing double hop opening on July 12th I really did not expect this:
1007 9H1ET JM75
1011 9H5L JM75
1034 IT9VPT JM76
1036 9H1GB JM75
1038 9H1GP JM75
1039 9H1ES JM75
1054 9H1ZC JM75
1055 IW9GXT JM67
1111 SV3CYM KM08 hrd ups!
1120 IS0CBC JM49
1120 I8MPO JN70
SV8CS reported on KST chat that SV3s calling / hearing me... and then:
1126 SV3CYM KM08 # 2686
1127 SV3GKE/p KM17#2731km
1128 SV8AQX KM08 2585km
1128 SV1BSX/p KM17?
1129 EA6VQ JM19 #
1129 EA3CBH/6 JM19
1133 IK0SME
1134 SV3CYM KM08 again
1149 I8RPL JN70
1153 SV3EAO KM08 2686km
1155 IK8BIZ
1156 IK8YOQ
1203 I7A/B JN81 hrd
1203 TK5ZMB/B JN41 hrd
Again 30 mins double hop!

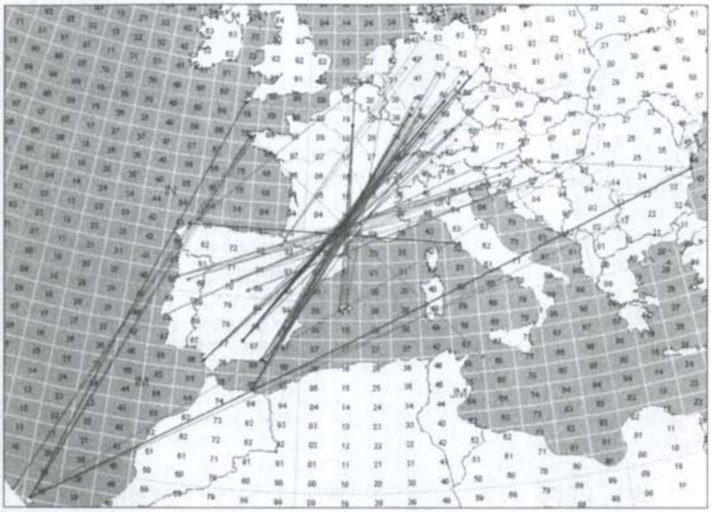
1525 I1JTQ JN35
1526 IW2DAL JN45
1541 F6EGD
1543 F1BKM IN98
1543 PE1HWO
1544 PA3FOC
1544 M3IMJ
1545 PA3DOL
1545 F6CWN
IW2BSQ JN45
1546 IW2NMZ
1546 PD1DX
1547 ON4ARF
1548 IW2NWV
1550 I1TEX JN53
1553 PA2M
G4EZT IO92
1555 PA3AYD
1555 G4CLA IO92
1559 G4ZTR
1600 G4FSG JO02
DL5MAE
1601 G0JJG
PA0C
I3MEK
G4EAT
1602 F6CWN
1605 LA5KO JO38 2565k NC!
G2MKF IO92
G1ZJP IO92
G4RUW IO91
1605 F6EKJ JN27
1607 G4ZFJ hrd
1608 G0LRP IO91
1609 ON4KHG JO10
DL5OM JO30

G0JBA JO01
1610 PA2CHR
PA3BIY
1611 PA3DZL
1612 ON7WP C?
F6CWN JN09 3rd time ☹
1613 PA4PS
G4ATX JO01
DF6NA JN49
1614 PA5WT
ON7KZ
DL1GI
1615 DC9EV
F6ACU JN38
1616 G7CIY JO02
DK3BU JO33
DK3EE JO41
1617 DK9IP
F9XG
F4CYZ
1619 G4DHF IO92
DH5HV JO31
1620 PA3FPQ
1621 DJ8RZ JN58
1622 DJ9CZ
ON4PS
1623 G4RUW IO91
1624 PD2TWO
1625 G4YTL
DK5RQ
1626 PD5LDI
1628 G6HKS
1630 DK5OC
DH4FAD
1631 DF1CF JN57

1622 DL4DWA
1623 SP6VGJ JO81HU
1627 SP6IWQ JO80HK
1630 OK1KT JO70WE
1631 OK2MWR JN99GR
1631 SP6WGJ JO81HU
1632 SP9TTG JO90
1633 SP7HKK JO91QI
1634 UT5ST
1635 DG0DRF JO71JS
1639 SP6RGB JO71SF

EB8BTV IL18qi wkd:
1655 DJ8RZ JN58RQ 3291km
1727 F4CYZ JN38SF 3030km
17?? OK1BYR JN79KT 3561km
1751 ON7GB JO21IA 3086km
1812 PA3BIY JO22EB 3157km
1852 PA3CMC JO21WI 3170km

HB9DFG JN37SM hrd:
1732 EB8BTV IL18QI 2982km



Map: 2m Es on June 25th

4293km from EA8 to YO!

July 20th, 2006

1843 G3LVP IO81
1845 G4DHF IO92
G4DEZ JO03
1846 G4MKF IO91
1859 G0KPW JO02
1900 G4ZFJ JO01

Other QSOs with interesting distances:

May 17th, 2006

DK0TU JO62PM hrd:
1517 CT1ART/B 599 IM67IH 2325 km

May 18th, 2006

TA7OM KN90UX wkd:
1620 DH2UAK JO71FU 2269km
1621 DL9USA JO71EN
1621 DD0VF JO61 2370 km

June 4th, 2006

G4LOH, IO70JC, wkd
1504 SV3GKE KM08VF 2505km

June 7th, 2006

G4LOH, IO70JC, wkd
1008 LZ1KG KN31cs 2583km
1010 YU1EV
1012 YT1VV JN94us 1960km
1012 LZ1ZP KN22id 2455km
1012 LZ1AG KN22id 2455km

June 11th, 2006

OK1DFC JN79gw wkd:
1701 EA8BEX IL27gx 3521km

DK1FG JN59 wkd:
1702 EA8BEX IL27GX 3310km

EA8AVI IL28GC wkd:
1610 DF1CF JN57FP 3207 km

ON6NL JO21UE hrd:
1804 EB8BTV

PA3DRL JO21PS wkd:
1729 EB8CME IL18TM 3151km

June 17th, 2006

EA8BEX, IL27gx wkd:
1101 IM0/IS0BRQ JM48ex 2518

June 25th, 2006

1225z:
YO4FNG KN44HE wkd
EA8AVI IL28GC 55 / 57
4293km!
NEW IARU Region 1 record!
And Es WORLD RECORD!
EA8AVI was also hrd at 1300 by LZ1BB KN12PQ, over 3824km and at 1315 by YO2LEA KN06wk over 3834km.

G4LOH, IO70JC, wkd
1155 EA8AVI IL28GC 2600km

July 4th, 2006

CU3EQ, HM68, wkd:
1315 CT4RK IM57 FM 144.325
Rig: 25W, Vertical

July 6th, 2006

F6KHM IN78RJ wkd:
1741 RA6DA KN96SA 3294km

EI5FK IO51RT wkd:
1750 YO4FNG KN44HE 2856km
at the same time EI5FK is hrd by **UY5ON KN89CW** for 2 minutes but no QSO. QRB: 3097km

July 12th, 2006

EA7TN IM66VP wkd:
1331 LZ1OA KN22TK 2786 hrd
1336 IW4DHA/4 JN64CA 1757
1337 IW0BET JN61FS 1701Km
1337 IK0NOJ JN61GV 1711Km
1340 LZ5UV KN12PR 2598Km
1341 HA0HO KN07SU 2581Km
1342 IK5OEA JN53PG 1659Km
1345 IK5YJY JN53PG 1659Km
1347 I3MEK JN55SJ 1772Km
1348 YU7EW KN05HP 2444Km
1349 I4CIL JN64AH 1757Km
1350 I7CSB JN71QQ 1937Km
1352 IK5CQV JN53DN 1596Km
1352 YT1ET KN04RR 2484Km
1353 IK4WMA JN54WG 1743Km
1353 I4RHP JN54QL 1716Km
1355 HA8UG JN97SA 2409Km
1356 9A6M JN86GA 2155Km
1359 YO5OHY KN17SP 2717
1400 YO3DMU KN34BJ 2844
1402 9A9AB JN86GA 2155Km
1402 HA5CW JN97PM 2410Km
1412 YU1EV KN04FR 2407Km

F0EJW IN78VK wkd:
1132 EA8BEX IL27gx 2472 Km
1139 EB8CDX IL18oi 2480 Km

LZ1ZP KN22ID wkd:
1344 CT1HZE IM57NH 2901
1409 EA4WT IN80KN 2319
1428 EA1FBF IN73WJ 2345

LZ2FO KN13KX wkd:
1341 CT1HZE IM57nh
1356 EA7HG 59/59 IM87
1407 EA7BYM 59/59 IM66

LZ2ZY KN13OT wkd:
1430 EA4TF M89AT

OR0A JO20KW wkd:
1340 SV9CVY KM25KA 2387 km

RA6DA KN96SA wkd_
1307 EA9IB IM85NG 3721 km!
1310 I7CSB JN71
1325 IZ6FHZ
1331 IZ2DJP/7 JN81AW
1335 EA7RZ IM86SU 3599km
1351 EA5EZJ IM98VX 3313km
1355 EA5AFP IM98VX 3313km
1357 EA5FUZ
1400 EA6DD JM19JK 3059km
1403 EA6VQ JM19MP 3066km
1417 EB3JT JN01UI 3055km
1418 EB3GAZ JN?
1425 EA3DUY JN12LD 2926km
1427 CT1HZE IM57NH 4080 km

2m Es on July 12th: CT to UA6 4080km

TA1D, KN41LB, wkd:
1212 F1GTU JN05IO
1215 F5OWL JN33CC
1315 F5ELL JN13RH
1318 CT1HZE IM57NH 3260 km
1319 F1EYB JN23KK
1327 EA3DXU
1328 F5VHX JN04
1329 F6HTJ JN12
1334 CT1HZE IM57NH agn
1337 EA3DUY JN12LD
1347 F4BWJ
1354 F1VJQ IN95OL 2450km

YO3DMU KN34BJ, wkd:
1318 EA9IB IM85NG 2663km
1326 EA7RF IM67WI 2808km
1341 CT1HZE IM57NH 3029km
1343 EA3DUY JN12LD 1891km
1344 EA7DUD IM76SR 2708km
1355 EA7RZ IM86SU 2544km
1400 EA7TN IM66VP 2851km

F4BWJ IN93MPwkd:
1425 RN6BN KN95LC 3143km

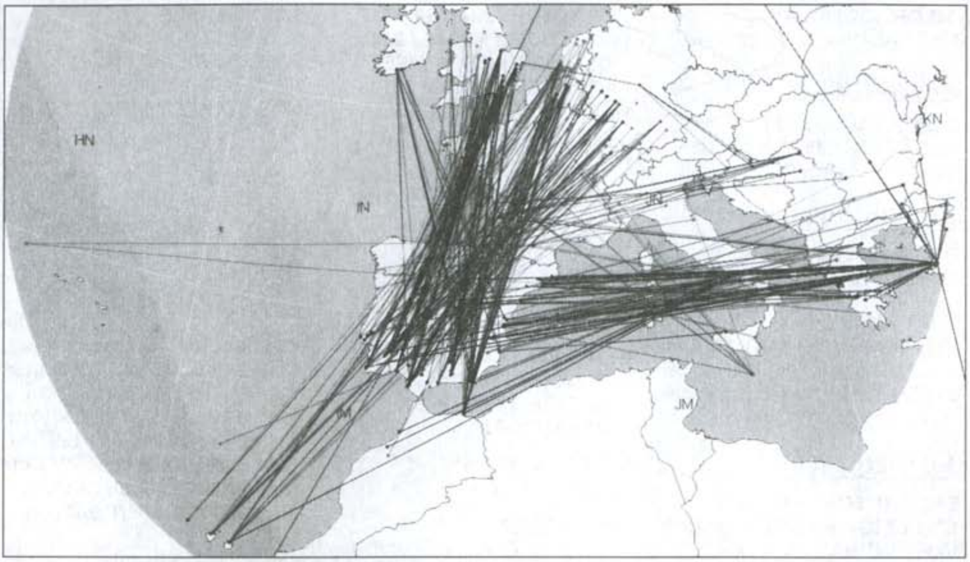
July 15th, 2006

I8MPO, JN70cn wkd:
1012 EA8AVI IL28GC 2743km

July 16th, 2006

HB9DFG JN37SM wkd:
1602 EA8AVI IL28GC 2935km
HB9DFG 16.7.:
A LiveMUF animation of this afternoons fine ES in 5 minute steps you can find here:
http://hb9dfg.webhosting.gs/LiveMUF/ES-2006-07-16-1440-1800UTC-5min-200ms.gif
and a 5 minutes long audio file with the QSO with EA8AVI and some PA-stations here:
http://hb9dfg.webhosting.gs/ES/ES_20060716_ea8avi_with_hb9dfg_and_some_more.wmv

EA8BPX, IL18SK wkd:
1632 PA3BIY JO22
1640 DL8GP JN39
1652 DK8VS JN39
1700 F4CYZ JN38SF
1700 DF8IK JO30JT
1701 DK3EE JO41
1706 DF2ZC, JO30RN 3174km



DH4FAJ JN49EX wkd:
1625 EA8AVI IL28FC 3162km

9A3JN JN95IN hrd:
1633 EA8/DL8FAW IL18AT 3703km

DF9IC JN48IW wkd:
1706 EB8BTV IL18QI 3138

EA4WT IN80KN wkd
1813 TA3KC KM38NN 2588
1813 LZ1ZX KN32IO 2477

HA5OV JN97NJ, wkd:
1312 EA9IB IM85NG 2268km
1401 EA7BYM IM66HM 2489km

IK8BIZ JN70GR wkd:
1017 5F50SG IM64QG
1023 EA8AVI IL28FC 3079km
1041 CN8NK IM63IM

IK8YOQ JN70GR wkd:
1018 5F50SG IM64qg
1026 EA8AVI IL28fc 3079km
1045 CN8NK IM63im

IW0FFK JN61FS wkd:
1025 EA8AVI IL28FC 2956km
1129 CQ3A IM12NR 2767km
1133 CN8NK IM63IM 1959 km

ON4KHG JO10XO wkd:
1619 EA8/DL6FAW IL18AT 3038

PA3BIY JO22EB wkd:
1552 EA8AVI IL28fc 3133 km
Hrd: EB8BTV, 41....52, IL18

SV3GKE/P KM17CX wkd:
1004 EA9IB IM85NG 2251 km
1127 CT1HZE IM57NH 2725 km
1158 CT1DIZ IM58KP 2720 km

TA3KC KM38NN wkd :
1446 EA3DXU JN11CM 2144km
EB5EA IM99TN
EA6VQ JM19MP
A5ZF IM98IW
EA6DD JM19MW
EA3DBJ JN00IR
EA3CQQ JN11
EA3DW JN11
EA1BFZ IN81SS 2532km
EA4WT IN80KN 2596km
EA4KR IN80ER 2637km
EA3DJL JN11CL
EA3TI JN11JT
EA3XU JN11CK
EA3ABZ JN11BP
F6FHP IN94TR 2378km
EA3ESE JN01WR
EA5AAJ IM99SL
EC5CR IM99
EB5EEO IM98KV 2447km
1708 EA5HB IM98DK 2505km

July 18th, 2006

1200 TF3BX HP94AD hrd
IK0SMG JN61 abt. 3300km

Map: 2m Es on July 16th: EA8 to I0, I8, DL, PA, ON, F, HB9

(TNX for maps to G7RAU / DM2SR)

After deadline:

July 22nd, 2006

CT1HZE, IM57nh hrd:
1742-1822 CU8DUB/B HM49kl

6m News

Reports, Expeditions, Infos

Editor: Joachim Kraft, DL8HCZ

Not normal

has been the multi hop E skip propagation from Europe to JA, USA, and Caribbean from the end of May to the end of July 2006. There were so many openings from DL to JA (06 to 09 UTC mostly), that it is impossible to list them all here. DK1MAX (JN58) reports about 10 days with QSOs to JA and worked in total over 100 QSOs to JA.

The JA's wkd even into EA3 and for the first time ever via short skip Es also to Portugal, CT:

On June 11th EA3AKY wkd JA7WSZ (10300km) and EA5BM wkd JA7QVI (10500km).

CT1HZE wkd on July 8th at 0737z JHORNN and JL3IQE both PM97. QRB is 11253 km. On July 14th CT1HZE wkd again into JA at 0727z: JHORNN, JA7QVI, JHOBBE, JA7EVP and JH7MSB.

Also 5T5SN (IK28) hrd several JA stations (> 13000km!) and he was also hrd in JA but could not make a complete QSO unfortunately.

From DL and most other EU countries the following stations / expeditons were worked on several occasions:

HI3TEJ, HI8ROX, VP5/W5SJ, V47KV, V25V, VP2V/W7XU, FM5JC, FM5AA, FG5GP, V44KAI, VP9GE, PJ2BVU, PJ7TM, KP2A, 9Y4AT, EY8MM, several KP4.

Impressing that even eastern EU (ES, LY, SP) wkd several times into the Caribbean.

On June 3rd VE7SL CN88 wkd IV3SIX JN65 (8700km)

One June 13th at 1947z 4X4DX wkd JW4GHA (4700km). JW4GHA had several good Es openings into EU in June/July.

On June 15th HV0A was qrv and wkd from 06 to 08 UT into JA and to EY8MM.

On June 16th from 1145 to 1535 a major opening took place from CT1HZE to W12345890 and VE123 resulting in 225 QSOs to 100 differernt grid squares!

Really remarkable was an opening on June 21st to Alaska: NL7Z, BP51, wkd from 1140z: PA4PA, DL9USA, OZ1DJJ, OZ1LO, OZ8RW, DL3DXX, DL2DXA, SM6CMU and DL7CM. PA, DL, OZ and SM were first ever QSOs on 6m to KL7.

Experienced long time 6m OPs compare these long openings into the Caribbean already with the best F2 days in 1989/1990 and 200/2001 in the solar maxima and say that some of these days with multi hop Es now have been even better.

Some other OPs now speculate that all this must be a new kind of propagation. Anyway there is no reason this. Also on 4m and 2m there have been many Es openings this year, even several double hop openings on 2m and this clearly shows that the Es activity this summer has been extremely high. On 6m on some days the band was almost open around the clock, may be with a short break in the night from 02 to 04 or so.

Also for the first time ever on 6m CT1HZE wkd into California on July 4th at 1525 UT: K6GXO from LA (DM04VL) 9222km was reached and at 1730z KE7V from (WA / CN88JB) was added. All were happy and sure that this would not happen too soon again, but on July 8th CT1HZE worked again into CA: K7JA DM03XS, 9262km. Chip reported later that he heard me for 1 hour. Amazing! But not the final. On July 17th there was another big opening into W12345890 for hours and just after midnight on July 18th at 0033z K7JA was wkd again!! Followed by W7UT DM37 – N6PEQ and W6YDX DM13 and N6KK DM03. Almost 200 QSOs to W/VE during this opening. At the same time other CTs, 250km north of CT1HZE were hrd from W7 / Montana, DN26.

Another "event" took place on July 13th when SV1DH wkd HP2AT (10570km) at 13.50z followed by JO7JGU (!) via long path multihop Es. Anyway this is a not well known callsign on 6m and confirmation is pending.

JT6M experiments by W5UWB

John W5UWB from EL17AX sent his report about 6m long distance QSOs using JT6M (and SSB/CW) when conditions were mariginal but promising toward Europe. JT6M is an interesting and successful way to work real DX when being at the edge of the path and signals to weak for CW.

5 July

1543 F1AKK JN39 CW

6 July

1318 S57RR JN65 SSB

1350 HA3UU JN96 CW

1353 IK0FTA JN61 CW

QRM vy bad for me from east coast USA stations - hard to get through them!

11 July

1402 IK2GSO	JN45np	9043 Km	JT6M
1417 IW3SNU	JN65ot	9300 Km	JT6M
1428 S59F	JN65tx	9316 Km	JT6M
1558 G4PCI	IO91al	8020 Km	JT6M

12 July

1402 IS0GQX	JM49oh	9419 Km	JT6M

14 July 2006 worked the following:

1630 EA7DUD	IM76tr	8507 Km	JT6M
1642 CT1HZE	IM57nh	8114 Km	CW
1656 EB1EHO	IN73em	8105 Km	JT6M

Rig: 6el at 65' agl, 1000w

Expeditions and News:

5A Libya: DL8YHR, DL9USA and many others will be qrv the last two weeks of November from JM62 on 6m with QRO. Normally no Es at this time of the year, but we have a prediction for the Leonid shower that says >100 meteors per hour on November 19th. This could be a chance to work them.

9Q Kongo: 9Q1D is qrv on 6m untill 31.12. Loc.: JI75PQ.

9V Singapur: PF5X is qrv as 9V1DX until October

2007 also on 6m. Rig:100w + 5/8 vertical.

A6 U.A.E.: A61Q - a resident - is very active on 6m now. Loc. LL75. QSL via EA7FTR.

C3 Andorra: C31BO is qrv on 6m since June 3rd with 100w. JN02SM. Also C31CT was qrv during July several times.

CN Marokko: W7EJ will be active again as CN2R in the end of October and will try also 6m EME. SV8CS is building a permanent contest QTH in **IM52**. He will be also qrv on 6m next year.

DU Philippines: DU7/PA0HIP is qrv until Oct. 6th from PK10wh on 6m, then 2 months back in PA and again 7 months in DU.

FM Martinique: F5JKK is qrv on 6m untill August 2007 as FM5JC. Locator is FK94LO.

FR/G Glorioso: F5OGL, F5JKK, F5CW etc. have again delayed there expedition.

GM Scotland: GM4PMK is active permanently from rare **IO66** square on 6m.

HS Thailand: 6m has been strictly forbidden in HS so far. Now there are indications that a beacon could be licenced as a first step.

JX Jan Mayen: JX9JOA stays until October 2006 and may show up on 6m.

OD / HZ Lebanon / Saudi Arabia: OD5SK is living now most of the time of the year in Saudi Arabia and is HZ1SK. Loc. Is KL91ON. Unfortunately 6m is forbidden at the moment in HZ.

PR8 Brazil, GI16GL: PR8/CT1DYX has got now his own call PR8ZX. He is qrv on 6m.

TA Turkey: TA2ZAF (ex TA2/OK1MU) is qrv for several years from Ankara, KM69KV, also on 6m. Pavel will try to activate several rare squares in TA on portable operations.

VP8 Falkland: A local group is planning a 6m EME activity. They also plan to erect a 6m beacon with the callsign VP8VHF.

VQ9 Diego Garcia: G4FJK is qrv as VQ9JK until the end of 2006 on 6m. Loc.: MI62EQ.

TF Island: TF/IW5CDE is qrv since June for 6 months on 6m but has not been hrd yet.

ZA Albania: ZA/UT7DW is qrv permanently on 6m. Loc. JN91WX. – ZA/IK0OKY goes QRT on 31.8. after several years of operation.

KM06/KM16 SV1VS/SV3 will be qrv from August 17 to September 10 also on 6m.

Beacons

A71A/B 50.006 MHz LL75, now 110W out instead of 8W (was hrd in CT/EA in July several times)

DB0DUB 50.083 MHz, JO30, 2 W ERP, omni horiz., proposal for autumn 2006

DB0HGW 50.083 MHz, JO64QC, 3dBW, proposal for summer 2006

DF0ANN 50.083 MHz, JN59PL, 2 W ERP, Halo horiz., qrv since June 7th from final QTH Moritzberg.

CT1ART/B 50.038 MHz, IM67AH, Yagi, QTF 270, proposal

SZ2DS 50.521 MHz, KM25, qrt untill the end of 2006

EI0SIX, 50052.0 MHz, IO63, 10w, halo, qrv.

HG1BVB/B 50.007 MHz, JN87FI, 2 x Dipole, omni, 10W, 725 m üNN, new qrv since June 5th.

S9SIX, JJ30HE, 50080 MHz, 3W, horiz, omni, 600m asl, qrv

Z2...SIX, KH52, 10w, halo, proposal

PR8ZIX 50.018 MHz, GI64, 50W, horizontal Loop, proposal

SR5SIX 50.023 MHz, KO02LL, 3W, 3 Ele., 240 Grad, 100 m als, qrv again since June. Call will change to SR5FHX.

ZS6SVJ/B 50.070 MHz, KG43FT, 5 W, Dipole horiz., N/S. New qrv since June. Beacon transmits CW, SSB and JT6M.

4m News

Reports, Expeditions, Infos

Editor: Joachim Kraft, DL8HCZ

New: DB6NT Transverter for 70 MHz

Kuhne Electronic offers a brand new high quality tranverter for the 4m band now!

OD - Lebanon

EI3IO reports that there will come a secondary allocation from 70.0 – 70.5 MHz for amateur radio in the Lebanon soon. Allthough due to the recent developments in the region one can not ecxpect any 4m activity too soon.

OX4MB beacon info

OZ1DJJ has installed the first OX 4m beacon in the end of July: OX4MB: 70012 kHz from GP47.

CU8DUB beacon

CU8DUB/B became qrv as proposed on 70612 kHz with 20W and a dipole from HM49KL (Flores Island, Azores) and was hrd the same day from CT via Es. The beacon was hrd in June/July from G, GM, EI, GW, OZ, PA, DL, F, S5, 9A, OE. On July 15th the beacon was hrd for several hours by SV2DCD KN00 over 4400km.

Faroer Islands on 4m

Carsten OY1CT is qrv with a modified FT847 and a dipole on 4m. Loc. IP62. Best way to catch him may be to ask for QSY when he is strong on 6m. OY9JD is working currently in Norway and is qrv from his home in OY not too often any more. Furthermore unfortunately also his transverter was broken and he was not able to TX on 4m during the good openings in June/July when he was operating on 6m. Also the 4m beacon is not working due to a faulty TX. Pity... no 4m QSOs took place from OY in 2006 so far.

Monaco on 4m

3A2LF has promised to modify his FT847 and become qrv soon on 4m. 3A/F5VKV is qrv sometimes from his QRL QTH with a vertical antenna in FM only. No 4m QSOs from 3A reported so far.

Luxembourg on 4m

LX1JX Jaquot is qrv from JO30AB with a 6 ele Yagi and TVTR since July 1st and made his first QSO on 4m with CT1HZE. Unfortunately no other stations from LX seem to be interested to become qrv on 4m. Anyway LX1JX plans to lend a second TVTR to any other LX station and may be also JN29, JN39 and JO20 will be active in 2007 this way.

CT1HZE, IM57nh, wkd on 4m:

30.5.2006
1630 S57A JN65 **FIRST S5-CT**
3.6.2006
0935 9A6R CW+SSB JN83# **FIRST 9A-CT**
1326 CU8AO HM49kl
1352 GM4ISM IO85
1417 GM4VVX IO78 #
4.6.2006
1448 YU7EF KN04 # **FIRST YU-CT**
6.6.2006
1625 SV2DCD KN00 **FIRST SV-CT**
1640 SV1DH KM18 #
1642 SV1AHX KM18
1905 YO2IS KN05 # **FIRST YO-CT**
10.6.2006
1555 OZ2SYV + OZ3ZW JO54
1601 OZ2PBS JO55#
11.6.2006
1043 DL3YEE JO42 (X-band 4m/6m)
21.6.2006
1139 SV1DH KM27 # Costas using his 6m yagi…
1441 9A2SB JN95#
1448 GU8FBO IN89
25.6.2006
1138 GD4GNH IO74
1.7.2006
1450 LX1JX JO30 # **FIRST LX-CT**
4.7.2006
1146 CT3HF IM12 # **FIRST CT3-CT**
10.7.2006
1800 YU1EU KN04
12.7.2006
0842 SV1OE KM17
0947 SV5BYR KM46 # **FIRST SV5-CT**
16.7.2006
0909 I0DLP/p JN61 #
0958 SV5BYR
1000 SV8CS KM07 #

This is just an extract of the most interesting QSOs. Many QSOs with G, GW, EI, S5 and 9A took place. Many openings when all UK beacons were hrd 599 at the same time. Anyway the activity from U.K. is disappointing. On SSB/CW always the same few stations qrv.

All CT's have their last day on 4m on August 31st. But there is hope that another 4m experiment will be allowed by the PTT for summer 2007. All CTs have to send their log/report now to the PTT.

CU8AO, HM49kl, wkd on 4m:

June 3rd 2006 first opening to OZ/G/GW:
1325 CT1HZE 59
1400 OZ1DJJ 55 JO65 3671km **FIRST CU-OZ**
1403 OZ2M 59 JO65
1409 GW8IZR 58 IO73 **FIRST CU-GW**
1410 OZ7IS 55 JO65 3691Km
1411 GM4ISM 59 IO85 **FIRST CU-GM**
1412 G4FUF 58 JO01
1415 G3WOS 55
1416 G4MKF 59
1416 OZ2LD 59 JO54 3498 km
1419 G3HWR 59
1421 OZ3ZW 59 JO54
1443 OZ2SYN 58 3545 km
1445 G0JHC 58 IO83
1449 G0JJL 59
July 6th
1630 9A6R 59 JN83 3988km, **FIRST CU-9A** and new world record QRB on 4m. Hrd SV1OE.
July 12th
1251 SV2DCD 58 KN00 4406km, **FIRST CU-SV** and new word record QRB on 4m.
Hrd SV1OE KM17 59
1847 2W0CDJ 59 IO71
1846 G4IGK 53 IO91ON
1849 G8HVY 59 IO90HW
1850 GD0TEP 59 IO74SD **FIRST CU-GD**
1851 G3VVR 58 IO83
1854 9A2SB 57 JN95GM
1857 GM4DIJ 59 IO84WW
1900 GW6JEO IO71LP
1901 G3LVP
1902 9A1Z 55 JN86FJ
1904 G4MKF 59 IO91HJ
1904 G4DEZ 59 JO03AE
1905 G8XZO IO90HW
1907 G4ZFJ JO01HO
1908 G3LQR JO02QF
1909 G3YSK 59 IO91HB
1910 G0IMG 55 JO02CA
1911 GW4ROV IO81JP
1912 GW8ASD 53IO83LT
1916 S51DI 55 JN75 **FIRST CU-S5**
July 16th
2100 9A5AA JN75XT

CT3HF, IM12OP, wkd 4m in SSB:

04.07.2006 11:47 CT1HZE IM57 **FIRST CT3-CT**
10.07.2006 18:33 CT1FFU IM59
10.07.2006 18:36 S51DI JN76 **FIRST S5-CT3**
16.07.2006 15:22 G0CHE IO90 **FIRST G-CT3**
16.07.2006 15:30 G3WXC IO90IM
16.07.2006 15:33 G4IGO IO80
16.07.2006 15:37 G3VXM IO90
20.07.2006 17:53 G8HVY IO90
20.07.2006 17:59 G8XZO IO90HW
20.07.2006 18:20 LX1JX JO30 **FIRST LX-CT3**
20.07.2006 18:36 G4ZFJ JO01HO

EUROPEAN EME Contest 2006 – CW Results *by F6HYE*

144 MHz

Place	Call	Points	QSO (+Sked)	Multi	Pwr	OP
1	IK3MAC	355200	96	37	QRO	MUL
						(I3YXQ, I3MEK)
2	SV1BTR	180090	62(+1)	29	QRO	SIN
3	SP7DCS	132500	53	25	QRO	MUL
						(SP7DCS, SP7MC)
4	LZ2US	103400	47	22	QRO	SIN
5	F3VS	98900	43	23	QRO	SIN
6	IK1FJI	69300	33	21	QRO	SIN
7	IK2DDR	34500	23	15	QRO	SIN
8	EA6VQ	29400	21	14		SIN
9	LZ1DP	24000	20	12	QRO	SIN
10	YO2AMU	20400	17	12	QRO	SIN
11	SK0UX	15400	14	11	QRO	MUL
						(SM0EPO,SM0MXO,SM0DFP,SM0NBJ,SM0LQB)
12	YO9FRJ	15000	15	10	QRP	SIN
13	I3EVK	12000	12	10	QRP	SIN
14	OZ4MM	9900	11	9	QRO	SIN
15	EA3DXU	8000	10	8	QRO	SIN
16	HA0HO	5600	8	7	QRO	SIN
17	YO3FFF	1600	4	4	QRP	SIN
17	YO8BCF	1600	4	4	QRO	SIN
17	9A9B	1600	4	4	QRP	SIN
20	PA3CWN	100	1	1	QRP	SIN-ASS
20	JS3CTQ	100	1	1	QRP	SIN-ASS

432 MHz

Place	Call	Points	QSO (+Sked)	Multi	Pwr	OP
1	NC1I	155000	50	31	QRO	SIN
2	OZ4MM	100000	40	25	QRO	SIN
3	SV1BTR	88800	37	24	QRO	SIN
4	VK3UM	68000	34	20	QRO	SIN
5	G3LTF	59800	26	23	QRO	SIN
6	DL1YMK	50000	25	20	QRP	SIN
7	OZ6OL	34000	20	17	QRP	SIN
8	F2TU	30000	20	15	QRO	SIN
8	OH2DG	30000	20	15	QRO	SIN
10	JA6AHB	22400	16	14	QRO	SIN
11	EA3DXU	16800	14	12	QRP	SIN
12	OK1DFC	15600	13	12	QRO	SIN
12	SP6JLW	15600	13	12	QRO	MUL
						(SP6JLW, SP6OPN)
14	S51ZO	14400	12	12	QRO	SIN
15	SM3AKW	11000	11	10	QRO	SIN
16	JH4JLV	6400	8	8	QRO	SIN
17	JA9BOH	4900	7	7	QRP	SIN
18	FR5DN	4200	7	6	QRO	SIN
19	YO2IS	1600	4	4	QRP	SIN
20	WA6PY	400	2	2	QRP	SIN

1296 MHz

Place	Call	Points	QSO (+Sked)	Multi	Pwr	OP
1	F6KHM	190400	56	34	QRO	SIN F5TTU
2	F2TU	184800	56	33	QRO	SIN
3	G4CCH	161200	52	31	QRO	SIN
4	OZ4MM	136300	47	29	QRO	SIN
5	HB9Q	112500	45	25	QRO	SIN-ASS
6	OK1KIR	102500	41	25	QRP	MUL-ASS
						(OK1DAI, OK1DAK, OK1DCI, OK1VAO)
7	SM3AKW	94300	41	23	QRO	SIN
8	OZ6OL	80500	35	23	QRO	SIN
9	ES5PC	73500	35	21	QRO	SIN
10	G3LTF	72600	33	22	QRO	SIN
11	DL1YMK	67200	32	21	QRP	SIN
12	F6CGJ	66000	30	22	QRO	SIN
13	ON7UN	59200	37	16	QRO	MUL
						(ON4ACA, ON4AMI, ON6LY, ON6MR, ON7UN)
14	IK3COJ	42500	25	17	QRP	SIN
15	JA6AHB	40000	25	16	QRO	SIN
16	IW2FZR	36400	28	13	QRP	SIN
17	OH2DG	30800	22	14	QRO	SIN
18	N2UO	27300	21	13	QRP	SIN
19	NA4N	24700	19	13	QRO	SIN
20	JA4BLC	22800	19	12	QRO	SIN
21	JA8IAD	20400	17	12	QRO	SIN
22	WA6PY	8880	11(+1)	8	QRO	SIN
23	VA7MM	8000	10	8	QRP	MUL
						(VE7CMK, VE7CNF)
24	IZ1BPN	7000	10	7	QRO	SIN
25	UT3LL	6000	10	6	QRP	SIN
26	W9IIX	3600	6	6	QRO	SIN
27	SM5LE	2040	5(+1)	4	QRP	SIN
28	SP6JLW	600	3	2	QRP	MUL see above
28	JA4LJB	600	3	2	QRP	SIN

2320 MHz

Place	Call	Points	QSO (+Sked)	Multi	Pwr	OP
1	F2TU	54000	27	20		SIN
2	OK1KIR	45000	25	18		MUL-ASS see above
3	OZ4MM	41400	23	18		SIN
4	ES5PC	33600	21	16		SIN
5	SK0UX	28500	19	15		MUL see above
6	G3LTF	23400	18	13		SIN
7	OH2DG	22400	16	14		SIN
8	IK2RTI	8800	11	8		SIN
9	JA4BLC	6400	8	8		SIN
10	JA8IAD	4900	7	7		SIN
10	WA6PY	4900	7	7		SIN
12	NA4N	4200	7	6		SIN
13	WW2R	3000	6	5		SIN
14	W9IIX	400	2	2		SIN

5700 MHz

Place	Call	Points	QSO (+Sked)	Multi	Pwr	OP
1	IK2RTI	900	3	3		SIN
1	OK1KIR	900	3	3		MUL-ASS see above
1	F2TU	900	3	3		SIN

Results 10000 MHz

Place	Call	Points	QSO (+Sked)	Multi	Pwr	OP
1	IQ4DF	7700	11	7		MUL
						(I4ZAU, I4CVC, IZ4BEH, SWL Luke)
2	OK1KIR	3500	7	5		MUL-ASS (see above)
2	F2TU	3500	7	5		SIN
4	F5JWF	3000	6	5		SIN
5	WA6PY	100	1	1		SIN

News & Comments

Editor: Joachim Kraft, DL8HCZ
info@DUBUS.de

- Beacon News

TK5ZMV 1296.920 MHz new qrv with one yagi to JN13.
GB3SSS 144.406, IO70IA: Changed QTF from VO1 to 252 deg. (CU and Caribbean) on July 5th. Was hrd the next day via Es from CU8AO. TNX to the keeper Davey G3AGA who agreed to the QTF change proposal from DL8HCZ.
EB3VHF 144.440 MHz, JN01SU, 20 W, Big Wheel, A1A, new
EB3UHF 432.460 MHz, JN01SU, 10W, 5/8, A1, proposal.
UU1DX/B 144.621 MHz, KN74BW, 4W, Dipol,e 350 m asl. New qrv since May.
DB0JT 144.428 MHz, JN67JT, 5 WERP, qrv again since June
ER1VHF 144.060 MHz, KN46kw, 5W, GP 5/8-lamda 3dBD, 180m asl. QRV.
FR1GZ/B 144.433 MHz, LG79, 50 w, 9 Ele Yagi, QTF 10 deg. to S7, A4., A6, VU.
RA3GFV/B is on new QRG 144.450 MHz, (ex 144.975)

DA5DUB experimental beacon

A 5KW ERP QRO beacon was licenced by the DL PTT in June. QTH will be JO40AQ and call DA5DUB. QRG 144.436. The beacon will start QRP with 2W vy soon.

New Transatlantic Beacon

WA1ZMS is erecting a new 2m Transatlantic Beacon in grid FM07. More Info see Microwave USA column.

- Expeditions

CN - IM52

Spiros, SV8CS, plans to be QRV as 5F3COM from Morocco (grid IM52JJ) on 6m, 2m, 70cm and 23cm starting in October. He plans to operate 2m EME with 4x8 el. and 350w. This will be a permanent contest QTH!

FS/PJ7 on EME

From about 6 to 11 November FS/ON4QX and PJ7/ON4QX plans to be active on 6m EME and may be also 2m EME.
Info: on4qx@telenet.be

JP43

LA1BFA has got a new summer QTH in JO43 and will be qrv on 2m via FSK-MS and on 6m from time to time.

KM19

SV/OE6IWG will be qrv from 28.8 to -7.9. om 2m via FSK-MS. Loc.: KM19uw.

5A - Libya

The 5A7A Expedition is now scheduled for Nov 15th to 28th. DL8YHR and DL9USA will be the OPs for 6m, 2m and 70cm, incl. EME. Loc. JM62. QSL via DL9USA.

HB0 – Liechtenstein

HB0/DG3XA is qrv in the September Contest (2./3.9.) on 2m with 180w + 17 Ele. from 2349 m asl.

- Infos

Weblink

A nice review of simple microwave antennas is on the web at: http://www.freescale.com/files/rf_if/doc/app_note/AN2731.pdf

Potential Threat to Amateur Bands in U.K.

AMSAT-UK warns that proposals under consideration in the UK to provide wireless broadband in rural areas could pose a threat to Amateur Radio and Amateur-Satellite services there. A recently published report from telecoms regulator Ofcom <http://www.ofcom.org.uk/research/technology/overview/ese/exempt/> explores various options to bring broadband to countryside communities. One option calls for the use of wireless broadband. The systems would require high power to cover the large geographical areas involved, however. The Ofcom report proposes power levels of up to 80 W EIRP in the 2.4 GHz band and 200 W EIRP in the 5 GHz band.
"It is hard to see how amateurs would be able to continue using these frequencies when faced by the high levels of interference from the high power applications envisaged by this report," an AMSAT-UK spokesperson said.
Ofcom notes that unlicensed broadband operators now may run 100 mW on 2.4 GHz and 2 W EIRP on 5.8 GHz. Both bands have Amateur Radio allocations, and AMSAT-UK worries that the high power levels outlined in the report could-cause serious interference to radio amateurs operating in those bands. The problem could be particularly severe on the 2400 to 2450 MHz band, used by "weak-signal" amateur satellites and amateur TV repeaters. The report makes no mention of Amateur Radio operation on the 2.4 GHz band.
AMSAT-UK notes that four amateur satellites currently under construction will use 2.4 GHz to provide worldwide communications. The Amateur Radio P5-A Mars orbiter, due to launch in 2009, will rely on 2.4 GHz as well. Also under threat would be a planned 2.4 GHz Amateur Radio video link from the International Space Station to schools as part of the Amateur Radio on the International Space Station (ARISS) educational outreach. (RSGB / ARRL-NL)

- Dates

Aug 25-27: Würzburg EME Conference: www.eme2006.com

Sept 10-15 European Microwave Week, Manchester
Web: http://www.eumw2006.com/

Sept 17: Crawley Roundtable (UK)

Sept 23: 51.UKW Tagung Weinheim: www.ukw-tagung.de/

Oct 19-22 Microwave Update, Dayton
www.microwaveupdate.org/

Nov 11-12 Martlesham Roundtable
http://mmrt.homedns.org/

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The high-performance transverter TR 144 H +40 with its outstanding characteristics is the result of a special circuit design. It is based on Kuhne electronic's long experience in the design of microwave transverters. The transverter was originally designed for VHF amateur radio applications, for example high performance contest stations. The receiver provides very good large-signal performance. It has an output IP3 of 40 dBm. The option "+40" was developed for the use with HF-transceivers like TEN-TEC ORION / FTDX-9000 / IC7800 / IC 756 PRO III and other high-end transceivers.

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IF Frequency range:	28 ... 30 MHz
IF Input power:	1 ... 50 mW
PTT control:	Contact closure to Ground
Output power:	25 Watts @ 50 Ohm, IM3 @ 20 Watts PEP 32 dB
Operating voltage:	13,8 V DC (12-14 V)
Current consumption:	typ. 6 A (TX)
RX Gain:	typ. 25 dB
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Dimensions mm:	270 x 260 x 80
Case:	aluminium
IF connector:	BNC-female
VHF connector:	N–female

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TR 144 H +40 1295,00 €
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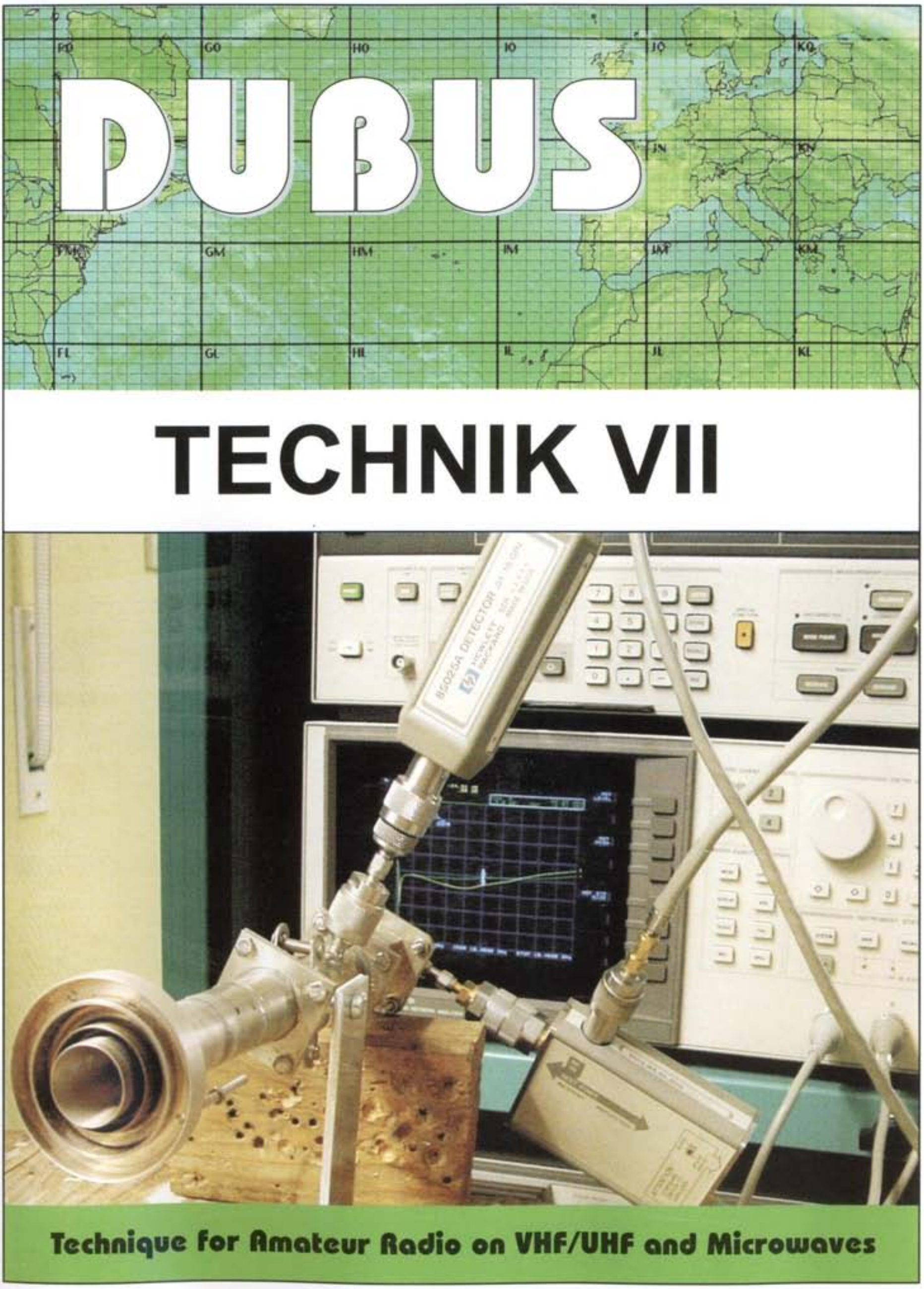
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