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Laser Output Meter

Alexander Meier, DG6RBP

Contents

A packed issue this time with topics from theoretical to constructional that will, I hope, interest all readers. Some of the articles are a result of the request for new authors, these are most welcome. I am always interested to receive new articles from new authors.

I am working on a new RSGB book, due to be published in April. A more detailed version of the article by André Jamet on a direct conversion 2m transceiver will be in the book.

I have been asked to publicise the 2003 Microwave Update. This will be a joint event with The Pacific North West VHF Society held in the Seattle, Washington area on September 25-28th 2003. Full details are shown on page 59 and on the VHF Communications web site.

73s - Andy

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Microtransmitter for L-band (microtx)

Following the invitation to write personal experience and ideas from VHF Communications, this is my solution to generate a stable signal on L-band. It is useful to transmit ATV, high speed digital signals or simply as local oscillator for a transverter.

1. Introduction

Most amateurs refuse to go on SHF bands because of the difficult to easily generate a stable and reliable signal. Normally this is achieved using an expensive chain of multipliers from a crystal oscillator. Tuning is the big obstacle, especially when only a simple test meter is available in the ham-shack. The project presented here will demonstrate that it is possible to do all that is required in a simple and easy manner.

Due to the growth of wireless technology and related applications, today it is easy to access complex circuitry without any dedicated instruments. I refer to developments in the field of micro-controllers and rf modules, today we can have complex functions ready to use in a single package:

- Microprocessors are made smaller having more peripherals and are re-programmable "in circuit".
- Wide band amplifiers, MMIC are matched to 50 ohms.
- Voltage controlled oscillators (VCO) and the components for the control of these (PLL).

Using these technological solutions, it is very easy to design a stable and re-programmable oscillator with few parts. The result is shown in the Fig 1, a small pcb gives a great circuit.

2. Circuit description

The circuit diagram is very simple (see Fig 2), a major note is the absence of any variable (externally tuneable) elements. The RF part is built around a commercial (ready-to-go) smd VCO functioning between 1100 and 1400MHz, ALPS model ED18-A. A buffer transistor and an MMIC amplifier are used for an output stage.

VCO control is achieved using a National PLL, LMX1501, programmed by a small and inexpensive micro-controller from Atmel, AT90S2343. This is the little member (dimensionally speaking) of the AVR family from Atmel, and has only 8 pins! With an internal oscillator

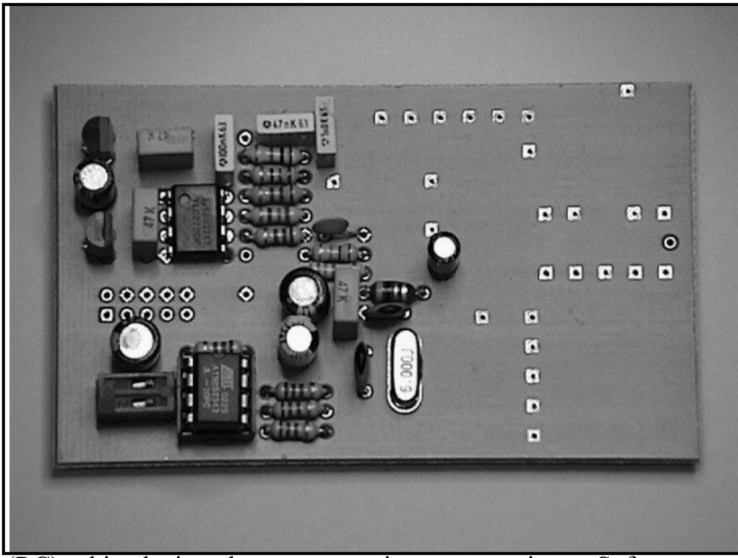

Fig 1: Picture of top side of completed Microtx.

(RC), this device does not require an external oscillator or crystal. Two pins are used for frequency selection. I wrote the program for this small micro-controller to select one of 4 frequencies used for ATV traffic in my country (Italy). These are 1224, 1240, 1256 and 1272MHz. Any change in the switch position during operation changes the output frequency, because the switch setting is checked continuously by the micro-controller. The loop filter is calculated for a VCO sensitivity Kvco=32MHz/V and a reference frequency Fref=25KHz, using National's information from the LMX1501 datasheet [3], all values were used to obtain a good carrier for ATV transmission. The LMX1501 is a good device that works well from VHF to SHF with enough sensitivity. It is fully programmable (pre-scaler, reference and divider) in serial mode using National's Microwire interface (3 wire: clock, data and latch). The PLL uses a 6MHz crystal for internal reference oscillator. Any other frequencies in the VCO's range of operation are possible by re-programming the micro-controller. For this reason I have made provision on the pcb for a connector used by the Atmel ISP dongle, this is not installed for normal and "standard ATV" versions. Software tools are available directly from Atmel [1] moreover a lot of suggestion and applications are available on the internet [2].

3. Construction

To make the circuit as simple as possible, I decided to use a mix of component technology, normal insertion parts for micro-controller, power regulation and loop filter, smd parts for the rf side. The pcb is designed in the same way: a component side with all insertion parts, and a solder side with all smd parts. This design reduces interference between rf parts and micro-controller without great screening or filtering. The bottom side is shown in Fig 3. Another design criteria was to use the minimum smd part's which are not currently accepted by radio amateurs. After component installation, no tuning is required for stable and controlled operation, this represent a big satisfaction for all! Measured power output (on my HP432A) is greater than +10dBm in all cases, and is suitable to

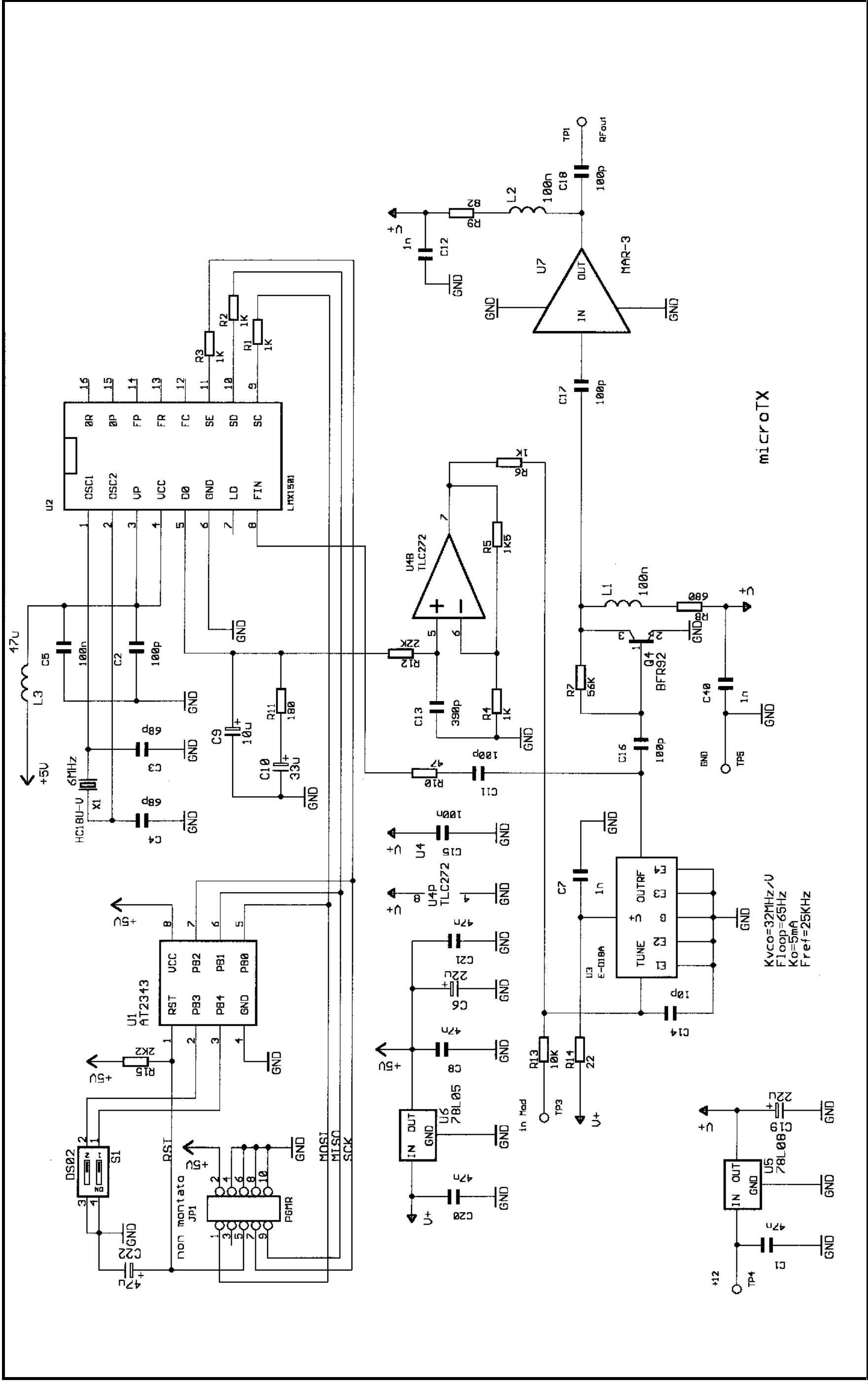

Fig 2: Circuit diagram for Microtx.

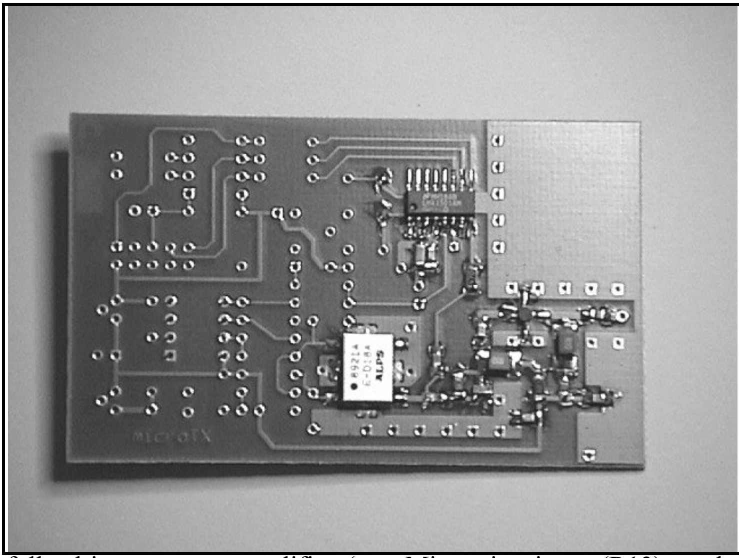

Fig 3: Picture of bottom side of pcb showing smd parts.

fully drive a power amplifier (e.g. Mitsubishi model M67715) to reach 2W output. The pcb, shown in Fig 4 (bottom) and Fig 5 (top), and all parts, are available by sending an email for the attention of IV3KAE to elenuova@tin.it

4. Applications

The primary use is an ATV transmitter and it is good practice to use a filter between base-band signal and modulation input (R13) as shown in Fig 6, but some others are possible (and tested). In order to have audio capability, you can use the circuit shown in Fig 7 as a 6.5MHz sub-carrier, and using the second half of U4 as audio amplifier. Set the inductor coil for centre frequency, RV2 for enough deviation and RV1 to set the sub-carrier level 14dB down from video carrier (with spectrum analyser). A prototype has flown on some model aeroplanes (RC) with good performance.

I have done a test as high speed digital transmitter simply by substitution of video base-band signal with a stream of 38400 Baud Manchester encoded data.

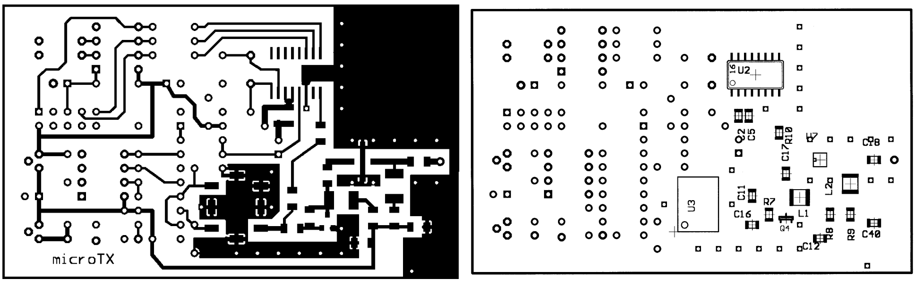

Fig 4: Bottom side of pcb for Microtx with smd component layout.

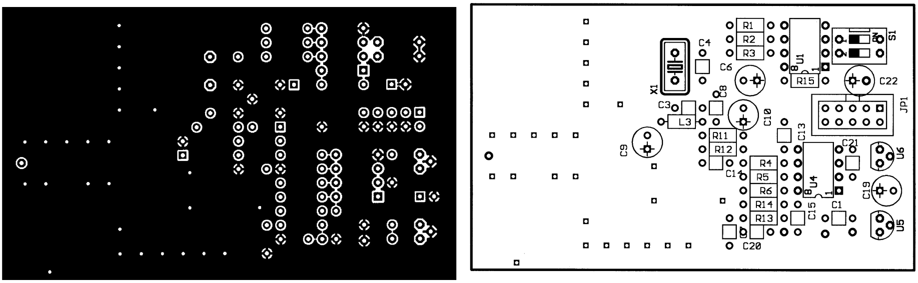

Fig 5: Top side of pcb for Microtx and normal insertion componet layout.

Another test was carried out for generation of 2400MHz using a doubler. I have programmed an output frequency of 1200MHz and connected the tx output to a simple doubler using a diode (HP2800) followed by a Murata filter for ISM band (2400-2480MHz), the filtered second harmonic was amplified by an MMIC (ERA3). In this manner a simple beacon for S-band was realised, again without tuning elements (Murata filter are small boxes without screws!).

For the satellite enthusiast, it is possible to use this circuit as local oscillator for a transverter for 144 - 1268MHz "mode L" up-link of satellites (i.e. AO-40). With a programmed 1124MHz output frequency, I feed a double balanced mixer (ADE-12 from Mini Circuits) in the LO port, and my 144MHz transmitter (with a VERY low level, controlled!) in the RF port and obtained a 1268MHz signal. Another Murata filter followed the mixer and a couple of MMICs amplified this signal to a +10dBm to drive the M67715 (2W, linear), usable for up-link to the satellite (together with a good antenna system).

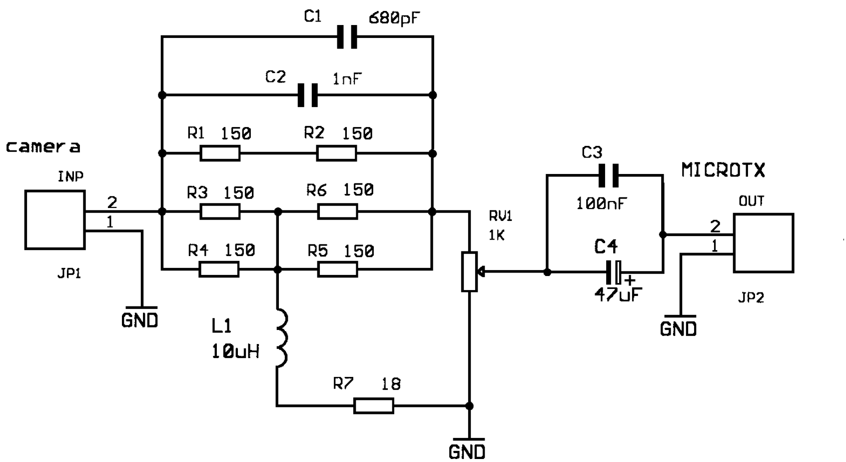

Fig 6 : Filter for use as ATV transmitter.

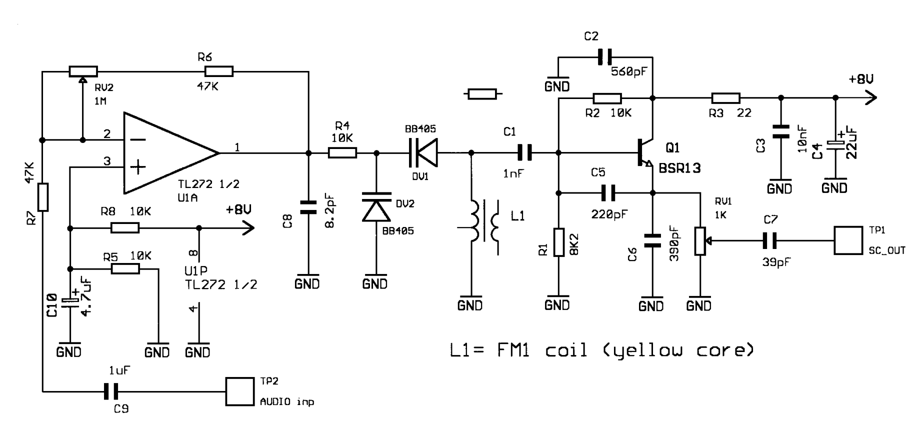

Fig 7 : Circuit for using 6.5MHz sub-carrier sound.

5. Conclusion

From my viewpoint, this is a simple solution, but demonstrates how it is possible to reach good results with low complexity for the experimenter. I hope that my idea will be useful to other radio amateurs.

6. References

[1] www.atmel.com

[2] www.avrfreaks.net

[3] www.national.com

Wolfgang Schneider, DJ8ES

Control Logic for a Switchable Attenuator

Commercial switchable attenuators frequently require a binary coded drive for the integrated switching stages. In order to set a value of, for example, 10dB, a 2dB and an 8dB attenuator must be activated. A simple logic circuit can handle the necessary conversion from decimal into binary signals. When a key is pressed, the attenuator can be switched in 1dB steps from 0dB up to a maximum of 127dB.
The circuit has deliberately been made discrete, with no micro-controller, this simplifies any modifications to individual requirements which may become necessary.

1. Introduction

The most effective method for assembling switchable attenuators is to arrange them in binary coded stages. The 1dB, 2dB, 4dB, 8dB, 16dB, ... structure allows all possible combinations of values to be put together with the least expense. The industrially manufactured, programmable attenuators from Weinschel, are built in this way. The models from the 3200-1 range are switchable, in 1dB steps, from 0dB up to a maximum of 127dB, with the frequency range extending from DC to 2 (3)GHz.

2. Circuit description

The drive logic circuit for programmable attenuators (Fig 1) consists of three sections.
First is the ICM 7217A (IC5) counter, with integrated display driver for seven segment displays. A three digit display is sufficient for the attenuation range set between 0dB and 127dB.

The second section consists of the drivers IC6 and IC7, together with the two counters IC2 and IC3.The programmable attenuator is driven by means of two drivers, each being an LM324 quadruple operational amplifier (IC6, IC7). The operational amplifiers operate as comparators in this circuit. The switching threshold lies at approximately 1.4V, defined by the voltage drop through the low-current LED D1.

The binary coding is generated by of two 4 bit 4516 counters (IC2, IC3). These are programmable forward/reverse counters with a reset system. The pre-set option for a desired value is not used in this version of the circuit.

The third section consists of the input circuit, the keys and the timer IC4. Three keys are sufficient to operate the drive logic: Up (S2), Down (S3) and Reset (S1). Each key has an anti-bounce circuit

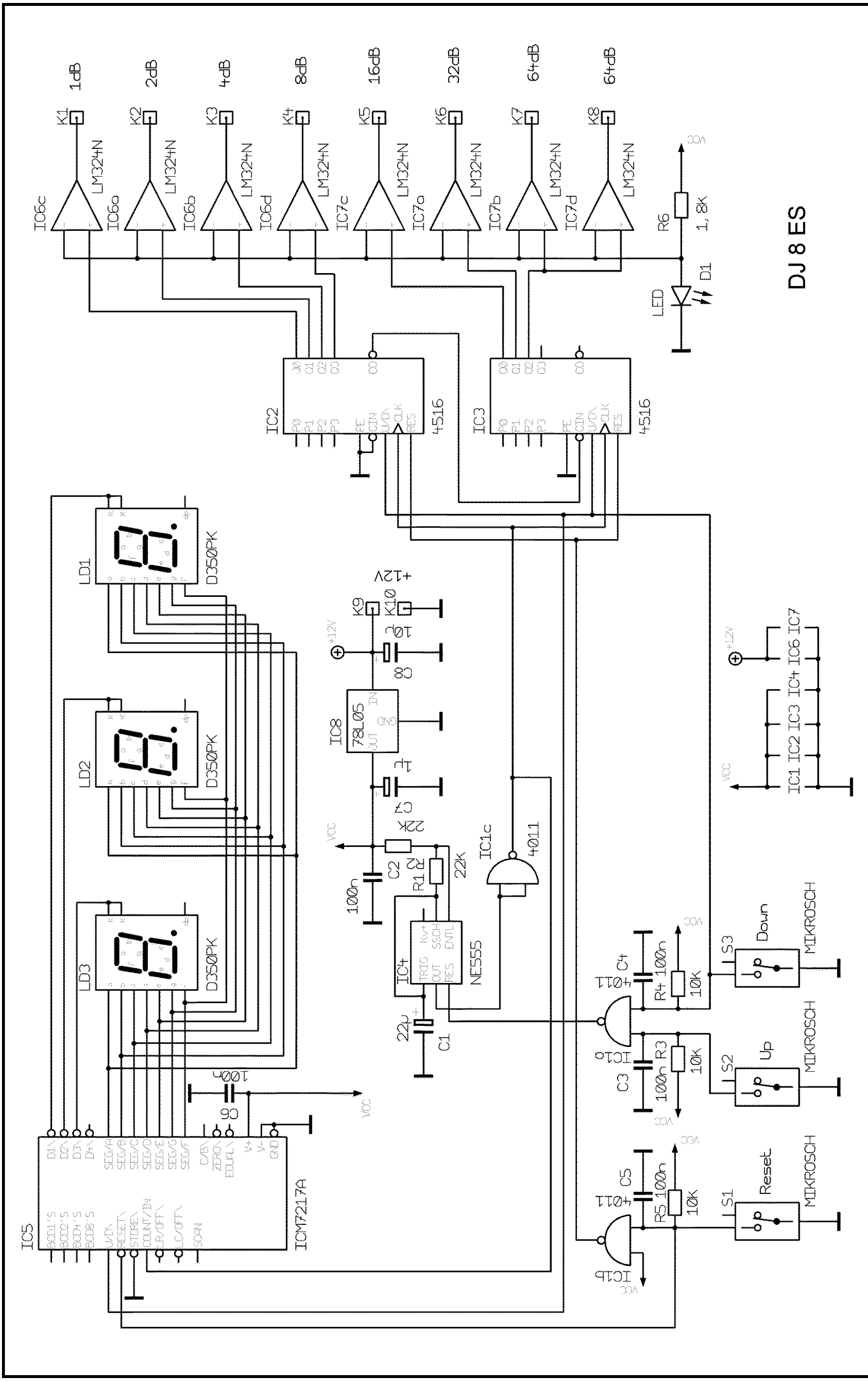

Fig 1: Circuit diagram of control logic.

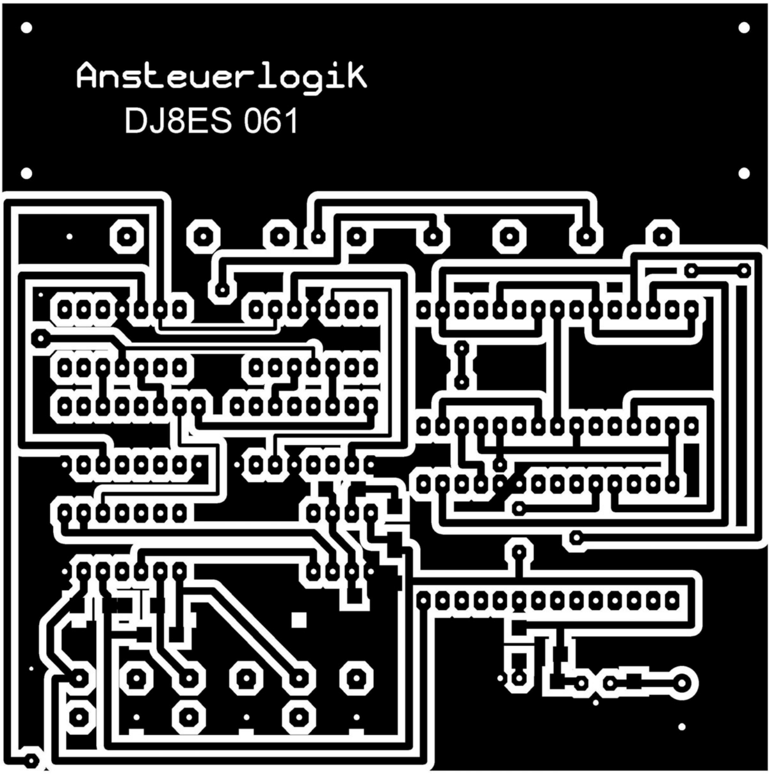

Fig 2 : Bottom side of Printed Circuit Board.

consisting of an R/C combination (10kOhm, 100nF). The control signals act on the counter modules either directly or as inverted signals (IC1, 4011) for resetting and up/down counting.

The timer, IC4, generates the actual counting pulse (with auto-repeat function). This pulse is controlled through the logical sum of the up/down keys, S2 and S3, using IC1a. If either of these two keys is pressed, then the output of IC1a goes to high signal and the NE555 timer emits counting pulses. The frequency is defined, at approximately 1 pulse/second, through the capacitor C1 (22µF) and the two resistors R1 and R2 (each 22kOhm).

3. Assembly instructions

The drive logic circuit, including the attenuator, can be mounted on a double-sided copper coated epoxy printed circuit board with the dimensions 102mm x 100mm (Figs 2 and 3).

When holes have been drilled in the board with a 0.8mm or 3.2mm drill for the fastening screws of the switchable attenuator, the components are mounted in any order, in accordance with Fig 4. It makes sense to use sockets for the seven segment displays and the corresponding counter/multiplex integrated circuits (IC5: ICM7117AIPI). All SMD compo-

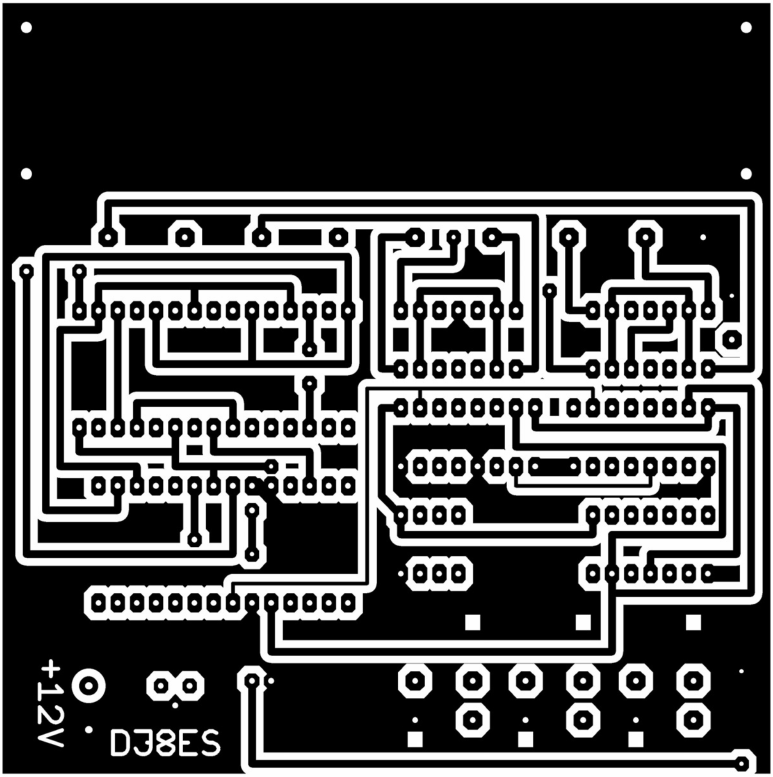

Fig 3 : Top side of Printed Circuit Board.

nents are mounted on the underside of the board (Fig. 5).

The board is through hole connected at various points, either with the leads for the components or with a thin copper wire. These points are to be soldered on both sides!

3.1. Parts list

IC1	4011, CMOS NAND gate
IC2, IC3	4516, CMOS counter module
IC4	NE555, Timer
IC5	ICM7217A, counter/display module
IC6, IC7	LM324N, operational amplifier
IC8	78L05, 5V voltage regulator
D1	LED green, low current
LD1-LD3	D350PK seven-segment display
C1	22µF, SMD, tantalum electrolytic capacitor
C7	1µF, SMD, tantalum electrolytic capacitor
C8	10µF, SMD, tantalum electrolytic capacitor
5 x	100nF, SMD 1206, ceramic
1 x	1.8kΩ, SMD 1206
3 x	10kΩ, SMD 1206
2 x	22kΩ, SMD 1206
2 x	Yellow Digitast key
1 x	Red Digitast key
3 x	1mm. terminal pin
1 x	DJ8ES 061 printed circuit board

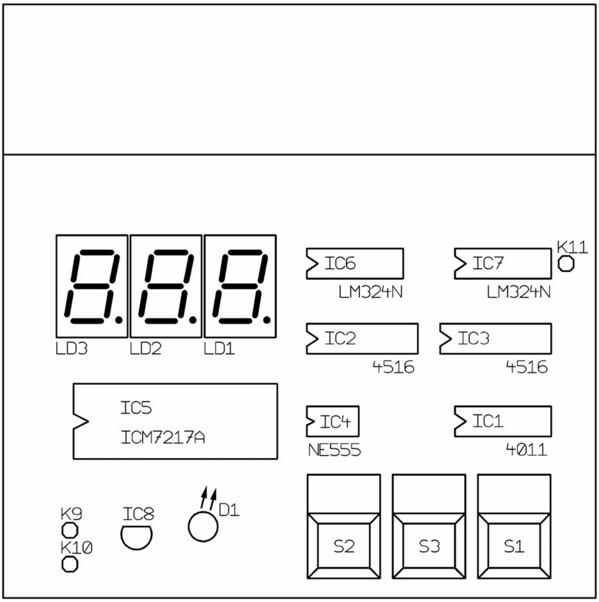

Fig 4 : Component layout showing non SMD parts.

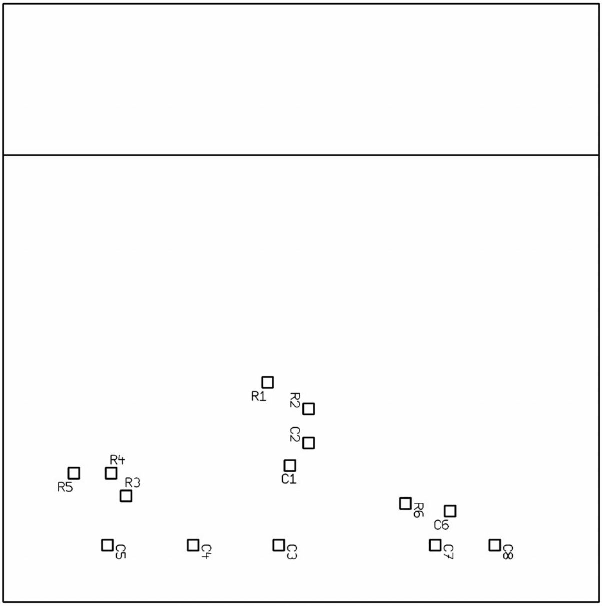

Fig 5 : Component layout showing SMD parts.

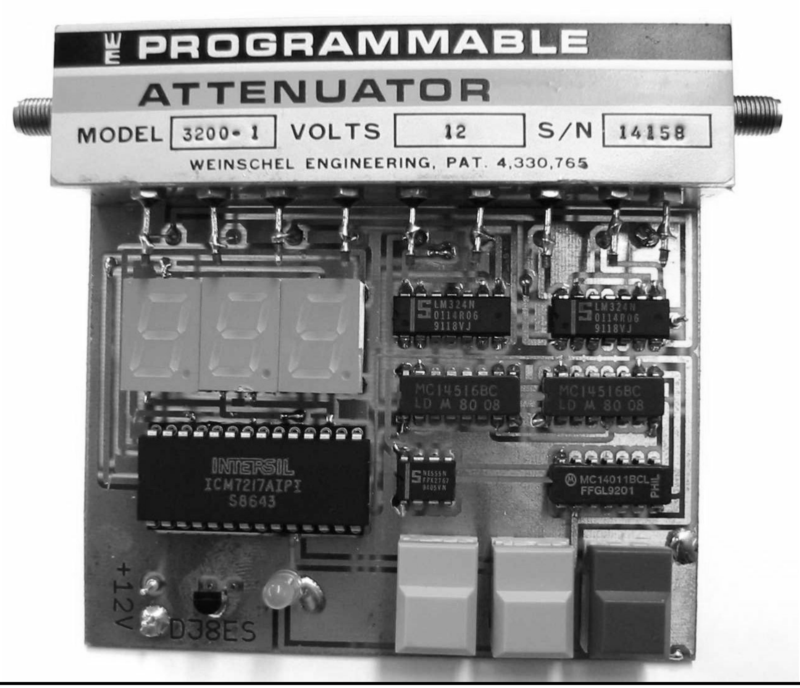

Fig 6 : Photograph of completed attuenator.

4. Putting into operation

No calibration is required for the drive logic assembly for programmable attenuators. The counter and the attenuator are set to 0dB using the Reset key. The desired attenuation value can now be set, using the Up and Down keys.

The current consumption of the assembly, including the attenuator, is only 50mA in the initial position, which corresponds to the 0dB position, with an operational voltage of +12VDC. For this purpose, the terminal pin K11 is connected to K9 with the operational voltage. The total current consumption rises by about 10mA for each switching stage, up to a maximum of 130mA .

5. Literature references

[1] Model 3200 data sheet, Programmable Attentuators www.weinschel.com

[2] INTERSIL Data book/Applications Section ICM7217 Series INTERSIL INC., 1983

Peter Greil. DL7UHU

Amateur use of the optical spectrum (above 300GHz) Part 1

Nowadays, large quantities of data are transmitted in built up areas using optical directional radio links. The optical transmission technology for this is perfected and operationally reliable. Optical transmission has been used for telephone links for over 100 years. Recently radio amateurs have also devoted attention to this subject. The basic principles and the technology are described below.

1. Introduction

The optical range has been used for telephone transmissions for over 100 years, and in Germany the term "Lichtsprechen" ("optical speech") was coined for it. During the Second World War, the technology was used mainly for military purposes, and in the Cold War period it was widely utilised by agents and spies. Nowadays, enormous amounts of data are transmitted in the Gbit range in built up areas over links that are up to 5 km long, and several thousand kilometres between satellites.

Individual radio amateurs were experimenting in this field in the sixties. The level of activity increased when it became possible to use lasers.

The range that can be covered is essentially dependent on the location and, above all, on the weather. If visibility is very good, the power level is a less important factor.

National and international regulations are currently being revised, or introduced, and co-ordinated in order to provide unambiguous definitions for amateur radio in this area.

1.1. History

Alexander Graham Bell applied for a patent for his "photophone" back in 1880. This projected sunlight onto an acoustical recording diaphragm by means of a reflector and a lens system. The reception equipment was made up of a selenium detector and a telephone earpiece [16].

This process doubles the frequency at demodulation therefore meaningful understanding can only be achieved for of modulation of <20 % and then with "errors".

In Germany, the first time any practical use was made of this technology was for telephony during the First World War. The range was approximately 8km, and for telegraphy it exceeded 8km. By 1929 various types of apparatus were being manufactured in Germany and marketed under the description of "optical telephones".

The receiver cell in use was the Thallofide (Tl_2S) cell, developed in 1917. This is made from partly oxidised thallium sulphide, and used in a narrow range at approximately 950nm. Thallofide is toxic with the lower toxic limit for Tl_2S being 92.7µg/m³. It is a photo-resistor and is used with a screen and a red filter, and is easy to replace.

A selection from the 24 or more known types of equipment:

The OF 80, manufactured from 1934 or earlier, was the forerunner of the LiSpr 80 (supplied to the U.S.S.R. until 1939)

The OF 130, which contained only one common lens, with a diameter of 130mm, for transmission and reception, and used as a telescope objective.

The predecessor of the Li Spr 60/50 was the LiSpr a.

Whether it was deliberate or not, the descriptions of equipment and types were used for various applications (and not always correctly used) by manufacturers, users and other interested parties.

A silicon PIN diode is at least 1,000 more sensitive than the Tl_2S photo-resistor [3]. Although the receiver for the equipment consisted of nothing but the Tl_2S photo-resistor and a low-frequency amplifier, relatively long ranges were specified. For example, depending on the type of equipment and the diameter of the reception lens (50mm - 130mm), daylight telephony ranges for German equipment used in the Second World War period were specified as being between 2km and >15km. Messages were indeed reliably transmitted over these distances in normal weather.

Experiments in telegraphy using Italian optical telephone equipment from the Second World War period have yielded ranges of 30km or even 50km, while only 6 - 7 km. were specified, or 9km for telephony [4]. We shall discuss range specifications later.

Equipment was also manufactured that was equipped with a high-pressure gas filled lamp as a transmitter, which was directly modulated and could transmit on several channels.

Until as late as May 1951, development, manufacture and operation was prohibited in the allied zones and the subsequent Federal Republic. The author does not know when it became possible, for example, to apply for, and perhaps obtain, licenses from the Central Office for Telecommunications Technology in Darmstadt or the MPF in Berlin.

At the end of the fifties, assembly instructions for optical speech equipment began to appear in non-technical publications. They were intended for games and experiments to amuse the young. In the sixties, the “ASTRO Infraphon 6611” optical speech equipment was licensed by the Federal Post Office, and could therefore be operated without any license or fee. A permit was still required if the remote station was not on the same property.

In 1967, Conrad Electronic developed the “NORIS 6611 optical speech equipment”. It was sold in pairs for DM59.50 in kit form and for DM110 as a finished unit The “JO 4.01 optical speech equipment” was produced in the D.D.R. in 1985, it contained a “diaphragm” which could be used for recording.

With the coming of the laser, radio amateurs also began to intensify their experiments, often only in order to set up a one-way link to receive telegraphy.

No official licenses appear to have been issued, either there were simply no applications submitted, or a decision was taken on principle to issue no licenses. (Please contact the author via the publishers if you have any information on this).

At least one license was applied for in the D.D.R., the applicant being informed a year later that the application had been rejected.

In the sixties, experiments were carried out with Manfred (now DD6VGM) involving filament bulbs, which very quickly led to the conclusion that a minimum level of optical knowledge and a minimum expenditure on the mechanics is necessary to obtain consistent results.

The first fee paying licence was issued for radio experiments in the optical range of 400 to 420GHz on 10th June, 1996, to Michael Kuhne, DB6NT, and a later one to Helmut Neidel, DL1IN. On 6th January 1998 the two of them created their first link at 411GHz. Michael Kuhne did not use an LED, he used a Russian beam-lead diode, which was mounted at the focal point of a 16cm mirror. This acted as a nine times multiplier of the original quartz signal during transmission and as a mixer diode during reception. Helmut Neidel used a 51.4GHz Gunn oscillator signal in a mixer PLL, following eight times multiplication and a 4λ "long wire" the same diode illuminated a 16cm Fresnel lens.

My own attempts to gain licences in the nineties simply made no progress, although suitable provisions were made by the BAPT for commercial use.

Things really began to move forward in 1997, when a friend was found (Rainer Wilhelm, DH7RW, in BAPT Abstract 123). Links could be established at frequencies exceeding 300GHz under very good clear conditions. The first licence was issued on 22nd June 1998, and the callsign DA5FA was allocated. Following the later allocation of callsign DA5FB to Hans (DL7VJB), a two-way A2A link was established, on a lovely sunny day, on 5th June, 1999, over a distance of 680m. Since a station consisted of a separate transmitter and receiver, tuning to the remote station was very tedious. The quality of the link led me to think that there must be sufficient reserves available for greater distances.

I subsequently worked alone, using house walls and, in the hours of darkness, and listened to foliage of a poplar, as at a distance of 140m. FM experiments with a modified ELV kit at 30kHz/60kHz and again at 30kHz, were carried out in the middle of 2000. The results were documented and were also made available as "specifications" to other radio amateurs.

Hellmuth Cuno (DL2CH) developed the FM link further, and managed to create a complete laser transceiver. My areas were the mechanics and optics required, the basic principles and regulations for contests, and the regulations for neighbouring countries.

With regard to the approval required, conditions were subsequently adjusted through practice and experience, and approval became possible without the allocation of a special callsign.

2. Basic principles

2.1. Wavelengths and frequency ranges

The optical range begins at 300GHz, which corresponds to a wavelength of 1mm. Specifying the wavelength is normal for the practical frequency specification and thus the band description do not coincide with the wavelength specification in every case. The Ångström should no longer be used as a unit of measurement. Current bands are listed in Tables 1 to 3, without reference to national restrictions.

In order to avoid any clashes that might arise, the band classification shown should be used. The gaps between 3µm and 12µm, or 760nm and 780nm, may be necessary for reasons of classification until the IARU can impose a clarification throughout Europe, or all over the world (?). They are available for amateur radio, insofar as national restrictions do not apply (Table 3).

Table 1 : Europe [5]

Frequency	Wavelenghts	Description
300GHz - 100THz	**1mm** - 3µm	Infrared C
100THz - 214THz	**3µm** - 1.4µm	Infrared B
214THz - 384THz	**1.4µm** - 780nm	Infrared A
384THz - 750THz	**780nm** - 400nm	Visible
750THz - 952THz	**400nm** - 315nm	Ultraviolet A
952THz - 1071Thz	**315nm** - 280nm	Ultraviolet B
107THz - 1667THz	**280nm** - 180nm	Ultraviolet C

Table 2 : USA [20]

Frequency	Wavelenghts	Description
300GHz - 25THz	**1mm** - 12µm	FIR (Far Infrared)
25THz - 214THz	**12µm** - 1.4µm	IR (Infrared)
214THz - 394THz	**1.4µm** - 760nm	NIR (Near Infrared)
394THz - 750THz	**760nm** - 400nm	VIS (Visible)
750THz - 3000THz	**400nm** - 100nm	Ultraviolet

Table 3 : Reception [5]

Frequency	Wavelenghts	Description
300GHz - 25THz	**1mm** - 12µm	
100THz - 214THz	**3µm** - 1.4µm	Infrared B
214THz - 384THz	**1.4µm** - 780nm	Infrared A
384THz - 750THz	**780nm** - 400nm	Visible preferred 660nm ± 15nm
750THz - 952THz	**400nm** - 315nm	Ultraviolet A
952THz - 1071Thz	**315nm** - 280nm	Ultraviolet B
107THz - 1667THz	**280nm** - 180nm	Ultraviolet C

Note for all tables: Band descriptions are in bold

Table 4 : Operating and transmission modes.

AM Telegraphy	Rx: 625Hz	Optimal low frequency bandwidth dependant on speed
	Tx: 625Hz ±1Hz	Square wave 1:1 medium power A3 modulation
AM Telephony	Rx: 350Hz - 2.7KHz	Low frequency bandwidth 2.35KHz
	Tx: 350Hz - 2.7KHz	Speech
FM Telegraphy	Rx: 32.769KHz	Fixed frequency between 32 and 38KHz
	625Hz	High frequency bandwidth 3KHz
	625Hz	Optimal low frequency bandwidth dependant on speed
	Tx: 32.768KHz	Carrier adjustable between 32 and 38KHz
	625Hz ±1Hz	Sound modulation index 2
The modulation index for telephony has not been optimised		
FM Telephony	Rx: 32.768KHz	Fixed frequency between 32 and 38KHz
		High frequency bandwidth ?KHz
		Optimal low frequency bandwidth 2.35KHz
	Tx: 32.768KHz	Carrier adjustable between 32 and 38KHz
	350Hz ±2.7Hz	Speech

The verbal descriptions are a small selection from descriptions that sometimes contradict each other. In order to avoid the duplicated use of a wavelength and/or a frequency for 2 adjacent bands, the “>” sign was used.

National restrictions

The following restrictions apply in the 300GHz band, the operation of amateur radio equipment on the following frequencies will not be permitted in Germany in future, so please take this into account now:

300GHz to 444GHz
453GHz to 510GHz
546GHz to 568GHz
623GHz to 711GHz
730GHz to 732GHz
795GHz to 909GHz
926GHz to 945GHz
951GHz to 956 GHz

2.2. Modes and types of transmission

A list of the modes and sound frequencies used can be found in Table 4 below.

The 625Hz frequency was selected in order to reduce interference from the mains (50 / 60Hz) and its harmonics at (100 / 120Hz), for example, from illumination. The effect of the magnetic interference from the mains frequency with its harmonics, e.g. during experiments in buildings, is reduced.

2.3. Signal strength specification

It is not practicable to specify the input voltage for the “S-Meter” in relation to the input resistance. It is important, and helpful, to include the input power. Above 30MHz, 5µV into 50Ω corresponds to an S-Meter reading of S9. This gives an input power of 5×10^{-13}W, corresponding to 500pW.
However, specifying the input power alone still says nothing about the “field strength” present at the receiving point.

It is expedient to relate the input power to the reception area, which gives the “field strength”. Thus the remote transmitting station can determine the intensity of irradiation from itself at the receiving point. You should determine whether there may be a risk to your eyes.

So we return to what was normal in amateur radio by specifying of the received field strength, and move away from specifying the input voltage [17].

This means that specifying the signal strength for the remote station is more meaningful, and the receiving point knows the sensitivity of the receiver that is being used. To specify signal strength to two decimal places in the RST/M system, the radiation is measured in the usual 6dB steps. The description should simply be left to the RST/M system. With a high irradiation, the suffix (+ x dB) is required. The reception of weak satellite signals has been taken into account.

If we take dm² as the reception area, or a round area with a diameter of 1.13dm, we obtain the readings below. Here we are in the range of specifications S 1 to S 9 only for very sensitive receivers, and otherwise we are at S 9 + x dB.

Perhaps this will start people thinking about putting more energy into developing increasing receiver sensitivity:

S 1	7.63×10^{-16} W/m²
S 2	3.05×10^{-15} W/m².
S 3	1.22×10^{-14} W/m²
S 4	4.88×10^{-14} W/m²
S 5	1.95×10^{-13} W/m²
S 6	7.81×10^{-13} W/m²
S 7	3.13×10^{-12} W/m²
S 8	1.25×10^{-11} W/m²
S 9	5×10^{-11} W/m²

The S0 specification indicates that no meaningful data can be obtained.

The receivers S-Meter can be calibrated at no great expense see also vacuum range.

2.4. Signal generation

A laser does not have to be used as the transmitter, even if the classification refers to laser classes [5]. An LED, an LED group or another source may need to be allocated to a laser class to make the corresponding risks apparent. This also applies to transmitters that are driven by frequencies below 300GHz or generate their signals in another way.

2.5. Laser classes

If we purchase laser diodes, laser pointers or laser diode modules, we find a laser class specified on the equipment, or some other indication of possible risks. This has also begun to happen with LEDs.

The laser classes are clarified in DIN EN 60825-1, with particular reference to any possible health risk to the eye. The licence to use a laser class includes the corresponding indications regarding the safety required.

The specification of the maximum power as a limiting value, normal in amateur radio, is useful only under extreme conditions, due to the physiological effect in the optical range, and so is meaningful only in special cases for the radio amateur. Depending on the conditions, for laser class 3B, a power level of between 1.58mW and 150MW is permissible for our experiments. For an emission lasting 1ns, we can probably not carry out a QSO, but we can receive a reflection from a remote sphere in the sky.

The following numerical values do not take any modulation and/or keying into account. They are based on continuous wave power plotted against the angle of radiation, the duration and the wavelength, which is not given in full in every case. This is a simplified representation but the corresponding standard (DIN) should be utilised in every case, in order to detect the framework conditions.

Limiting value for accessible radiation, abbreviated to GZS (Grenzwert zugänglicher Strahlung), see Tables 5 and 6.

Table 5 : Old version of Laser Classes. (March 1997, expires 1/1/2004)

Laser Class 1

Sources that are safe under reasonable operating conditions

λ660nm	α < 11mrad	t 1ks	at 125µW
λ940nm	α 5mrad	t 1ks	at 360µW
λ400 - 550nm	α < 11mrad	t > 10ks - 500min	GZS 3.9µW
λ550 - 700nm	α < 11mrad	t > 10ks - 500min	GZS 3.9 - 125µW
λ700nm - 1.05µm	α < 11mrad	t > 1ks - 500min	GZS 120 - 600µW
λ 1.05 - 1.15µm	α < 11mrad	t > 1ks - 500min	GZS 600µW
λ 1.15 - 1.4µm	α < 11mrad	t > 1ks - 500min	GZS 4.8mW
λ 1.4 - 4µm	α < 11mrad	t > 10s - 500min	GZS 10mW

Laser Class 2

Sources of visible light only, in the range from 400nm to 700nm. In this range the eye is protected by natural reflex reaction.

λ400 - 700nm	α < 11mrad	t > 10s	at 1mW

Laser Clas 3A

Sources of visible light as in class 2 or other wavelenghts, viewed directly using optical aids (binoculars, telescope etc.) can be dangerous.

λ400 - 700nm	α < 11mrad	t > 10s - 500min	GZS 5mW
λ700nm - 1.05µm	α < 11mrad	t > 1ks - 500min	GZS 0.6 - 3mW
λ 1.05 - 1.15µm	α < 11mrad	t > 1ks - 500min	GZS 3mW
λ 1.15 - 1.2µm	α < 11mrad	t > 1ks - 500min	GZS 3 - 8mW
λ 1.2 - 1.4µm	α < 11mrad	t > 1ks - 500min	GZS 8mW
λ 1.4 - 1mm	α < 11mrad	t > 10s - 500min	GZS 50mW

Laser Class 3B

Sources that are usually only safe when viewed as diffuse reflections. A beam from the source is usually dangerous.

λ400nm - 1mm	α < 11mrad	t > 10s - 500min	GZS 500mW

2.6. Daytime visibility range

Meteorological visibility, as observed in weather stations, is defined as the greatest distance from which a black object of sufficient size (angle of vision 0.5° to 5°) can be seen against the horizon with the naked eye and at which it's outlines are recognisable. Telescopes and the like may not be used here.

A normal pencil at the end of an outstretched arm can be seen at an angle of vision of approximately 0.5°.

Television masts, church towers, high chimneys, monuments, etc. can be used as visual markers.

The "black object" in the above definition should not be taken too seriously. The difference in luminance is a physiological factor in visual observation. The human eye recognises a difference if the object has about 95 to 98% of the luminance of the background (the horizon). The reference value for visibility is the horizon, even if it's luminance is changeable, e.g. for the morning sky and evening sky in the East or the West.

The range reported at a weather station is the worst visibility at any compass point on the horizon, so there should be poor visibility over approximately a 30degree sector. The code 89 in the SYNOP code for visibility (VV) means, “visibility exceeds 70km”. If we look at this critically, the very fine sub-division of visibility in the weather code is not adhered to at all weather stations. The range of visibility has no decisive significance for the weather forecast. Yet the differences in visibility are taken very seriously for visibility ranges of up to approximately 5,000m, since they are particularly important for flying (visual flight).

2.7. Range

In the following, daytime visibility range is understood as having the meteorological definition given above, so visibility range does not necessarily refer to seeing an object.

It makes sense to be within the visibility range to begin with. Eyesight, the lasers frequency and the frequency dependent sensitivity of the detector, the attenuation problems in the atmosphere due to water vapour, carbon dioxide and other gases in the infra red are the criteria. The atmosphere is always a non-homogenous medium as the distance increases, due to the different temperature layers. The light beam becomes “curved”, even if only the effects of this can be observed. This often happens when making measurements using a theodolite in cities, therefore these measurements are therefore restricted to short distances. For this reason, measurements over greater distances are carried out on 2 days with as much variation in the weather as possible. Links parallel to the ground at the normal distance can be extremely misleading, so please choose the right links for experiments.

If the stations are 20m above the ground, the beam is displaced, at a distance of 6km, by 1m in the course of a day. At a height of 4m, the displacement is 5.1m, and at the standard height of 1.5m. it is considerably more. The displacement changes with the distance, double the distance equals four times the displacement! As long as your eye is on the finder and your finger is on the sighting device, or as long as effective control can be exercised using a 4 quadrant detector or the like, the process can and will be stabilised.

It is usually not possible to distinguish whether the “mechanics” and/or the optics and/or the atmosphere has/have “moved”. So reliable links can be used only up to 3km (5km), but then they can be used almost permanently. As the height increases, the attenuation is reduced more and more. At a height of 4,000m, the attenuation is only 1/1000 of the attenuation at sea level. For this reason, no attempt was made to carry out precise observations concerning the weather, the height and other parameters to determine the range. This would be outside the framework and would be of little use in practice, since we are in fact working in “real time”.

It is expedient to specify the vacuum range. For a daytime visibility range of 500km, 99% of the vacuum range is obtained. If we take the equipment parameters as given and use the equipment sensibly, the range depends on the weather and the condition of the atmosphere. A pre-condition is that the sites have been sensibly selected. Information in [1] is highly recommended. It contains comprehensive basic principles, with comprehensive calculations and also measurements for Berlin, Karl-Marx-Stadt (Chemnitz), Dresden (highest attenuation), Greifswald, Leipzig and Warnemünde (lowest attenuation).

Table 6 : New version of Laser Classes (Issued November 2001, valid in Germany since 1st November 2001).

Laser Class 1

Sources that are safe under reasonable operating conditions.

λ315nm - 400nm	t 1ks - 500min	GZS 7.9µW
λ1.4µm - 4µm	t 10s - 500min	GZS 10mW
λ4µm - 1mm	t 10s - 500min	GZS 1000W/m^2

Laser Class 1M

Sources that are safe under reasonable operating conditions except when optical equipment is in use.

λ315nm - 400nm	t 1ks - 500min	GZS 7.9µW
λ1.4µm - 4µm	t 10s - 500min	GZS 10mW
λ4µm - 1mm	t 10s - 500min	GZS 1000W/m^2

Laser Class 2

Sources that are safe under reasonable operating conditions. Eye protection normally ensured by lid closing reflex.

λ400nm - 700nm	α <1mrad	t>0.25s	GZS 66.7mW

Laser Class 2M

Sources that are safe under reasonable operating conditions. Eye protection normally ensured by lid closing reflex except when optical equipment is in use.

λ400nm - 700nm	α 100mrad	t>0.25s	GZS 66.7mW

Laser Class 3R

Source that could be dangerous if anyone looks directly into the beam.

λ315nm - 400nm	t 1ks - 500min	GZS 40µW
λ1.4µm - 4µm	t 10s - 500min	GZS 50mW
λ4µm - 1mm	t 10s - 500min	GZS 5000W/m^2

Laser Class 3B

Source that are normally dangerous if anyone looks directly into the beam.

Attenuation at 920nm per km. for:

50%-70% of time attenuation <1.3dB
82%-90% of time attenuation <4dB
98%-98.5% of time attenuation <40dB

A 99.9% certainty for transmission in the open air is possible only over a few hundred metres at an acceptable cost. Equipment for serious users is commercially advertised and used only at distances of up to 3km and in exceptional cases up to 5km.

As radio amateurs, we must use the times and the weather when the attenuation is relatively small.

Range specifications for a combination of transmitter and receiver (Tx/Rx) are rarely meaningful, since the specifications for this usually do not include the weather and the attenuation required, or else they can not be reproduced.

For commercial equipment in the DDR, ranges were specified at a visual range of 5km and a signal-to-noise ratio of 10dB. For the JO 4.02 unit (specified range 5km), this gives a range of 15km for a visual range of 70km. The vacuum range is 20km for the signal-to-noise ratio mentioned. This gives a considerably greater range under amateur radio conditions. It is necessary to specify the vacuum range because this completely dispenses with the weather and thus the atmosphere. It is expedient if it is based on equipment with the same characteristics as the remote station. The vacuum range can be calculated theoretically or determined practically.

If you can not use a second transmitter, receiver or transceiver of the same type, a combination can be used. This might be a telescopic sight, LED/Laser diode module with a short length, so that you can ignore the attenuation. Good visibility is needed and it is important that the radiation cross-section of the transmitter exceeds the receiver area. It must be possible to reduce the receiver area by a defined amount, for example by means of a 3 section screen. Once contact has been made, the receiver area should be reduced while the signal received corresponds to the values expected for the signal-noise ratio and the limiting range.

At first the maximum daylight visibility range was given for VV = 89 as >500km. It is anyone's guess why it was changed down to 70km. With a daytime visibility range of 18km, for two items of equipment with different vacuum ranges of 30km and 100km, a relative range is obtained usually only a range described as being of 10km or 16km. The longer the vacuum range, the closer the relative range comes to the visibility range. If you can see the remote station, that does not always mean that you can also work with it, and vice versa.

To be continued.

X.
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André Jamet F9HX

2m Direct Conversion Transceiver

1. Why make your own transceiver for the 2 meter band?

In fact the purpose of this transceiver is to drive an SHF transverter and to replace the familiar IC202 used for this job. This old friend is a very simple, robust, low phase noise rig, without the bells and whistles found on modern equipment. My IC202 is at the end of its life after years of transporting to the top of mountains so it is time for a replacement.

The aim of this design is to get the same good characteristics as the older one with some useful additional accessories.

2. Specifications

We need to cover the most frequently used range for an SHF tunable IF, 144.000 to 144.200MHz. As for the IC202, we will use a VCXO to get the same low phase noise characteristic. A set of four crystals provides four ranges in accordance with our needs. A frequency meter is useful to arrange a contact on a given frequency. The sensitivity required is not as critical as for an EME receiver. It is very convenient to have variable selectivity to improve the signal/noise ratio mainly in CW. A stable and accurate S meter is needed to allow reliable signal strength reports. The audio output power must be high enough to overcome the ambient QRM when we work with a team! For the transmitter one watt power output (+30dBm) is enough to drive an SHF transverter in CW and SSB modes. Some accessories are desirable to make contacts easier, a “roger” beep at the end of the message, “dots” to identify a very weak signal and a “parrot” for calling CQ.

One important thing is the ergonomics. When we are at the top of mountains and it is freezing we have to wear gloves or to have numb fingers. In both cases it is very uncomfortable to manage with very small push buttons. Therefore, our transceiver must have large knobs!

3. Principles

It would be easy to retain the same architecture as the one used in the IC202:

Receiver with:

- A simple conversion with a 10MHz intermediary frequency including a crystal filter, followed by a product detector

Transmitter with:

- SSB generation by filtering, using the same filter as in receiver.

The direct conversion with ZIF (zero intermediate frequency) has recently found its way into wireless and cellular mobile communications systems. Since it is in the aim of amateur radio to investigate new fields, I thought it could be interesting to try the direct conversion concept with a 2m transceiver. As far I know, the only work in this field has been done by S53MV who described Weaver based transceivers for 1.3, 2.3, 5.7 and 10GHz [1].

4. Description

The block diagram (Fig 1) shows two sections, receiver and transmitter. The common circuits are the local oscillator, the power supply, the auxiliary circuits and the antenna relay.

For receive, the antenna is matched to a low noise FET by a simple LC circuit. The output is fed to an MMIC through a bandpass filter. This is followed by a Mini Circuits demodulator that generates I and Q audio signals. Two identical channels amplify these to give a compressed and filtered signal. These consist of a two stage AGC amplifier with pass-band filtering. These feed Hilbert filters providing different phasing to produce the single side band required after adding.

An elliptic 8th order filter using a capacitor switching IC gives an adjustable bandwidth from one to three kilohertz. A one watt audio amplifier ensures a loud signal from the speaker.

The demodulator is fed by the LO that consists of four VCXO switched from the front panel and multipliers to get a VHF signal at the receive frequency. A high dynamic range logarithmic IC is used for the S meter.

In the transmitter, modulation is obtained from a microphone or a one kilohertz signal for CW, TUNE or DOTS, these signals being produced by an auxiliary oscillator. A compressor stage is included to improve the efficiency and avoid splatters. A Voice Record and Playback IC allows a twenty seconds message for CQ.

5. Construction

The photographs (Figs 2 - 4) show that the transceiver is housed in a case large enough to hold eight PCB including three that are shielded for the VHF, LO and frequency meter PCBs. A 4 to 5 inch loudspeaker is fixed to the top of the case. Many holes ensure suitable ventilation. All knobs to be used during a contact are located on the front panel with an LCD display for frequency and the strength signal. On the rear panel, there are knobs and jacks not often used.

6. Result

Compared to the old IC202, the actual sensitivity is at least equal, -120dBm for 10dB S/N ratio. Accessories are a very convenient plus. The modulation quality is very good and efficient both for receive and transmit. The carrier and undesirable side band emissions are in line

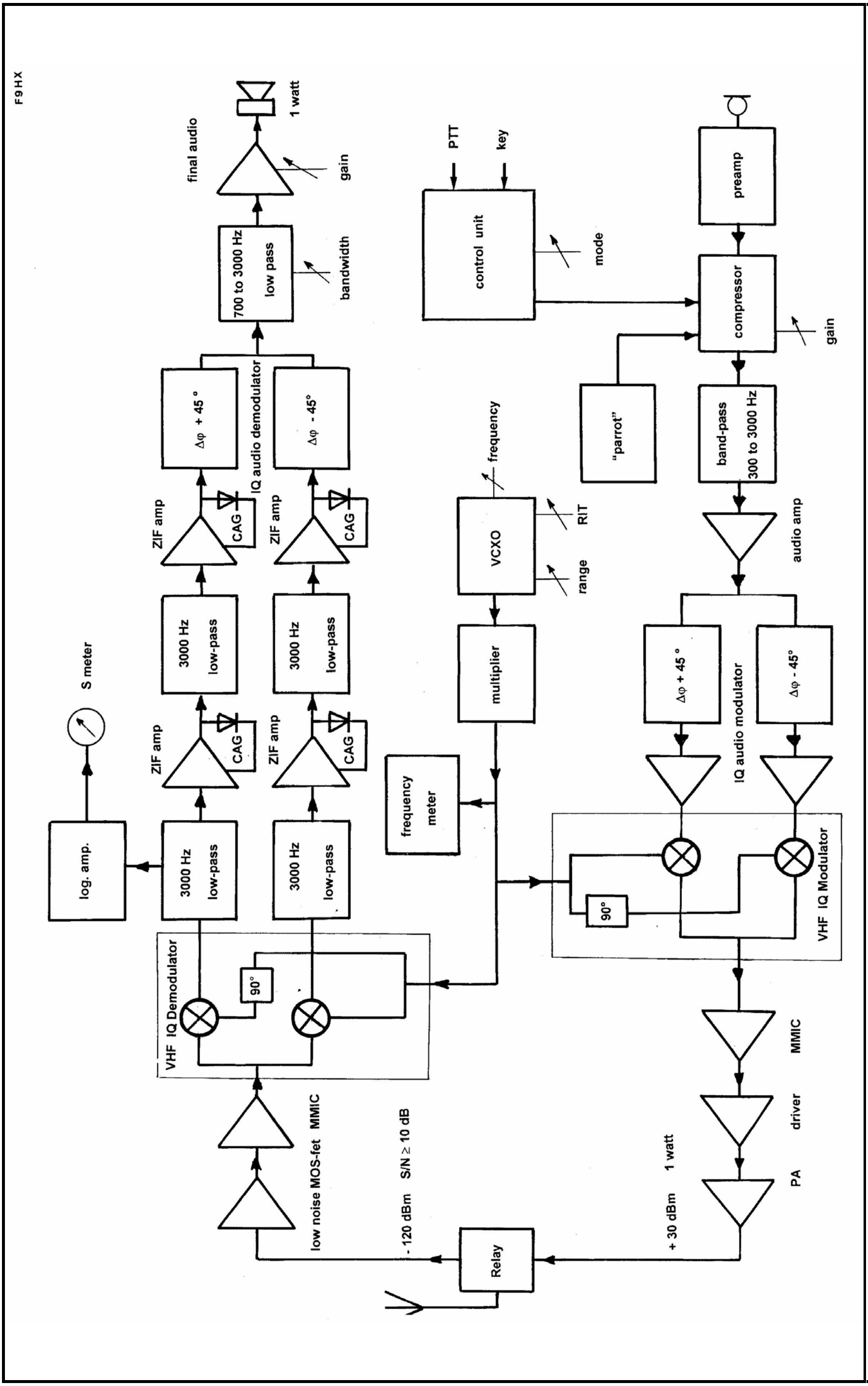

Fig 1 : Block diagram of the 2m direct conversion transceiver.

Fig 2 : Photograph of the completed 2m direct conversion transceiver.

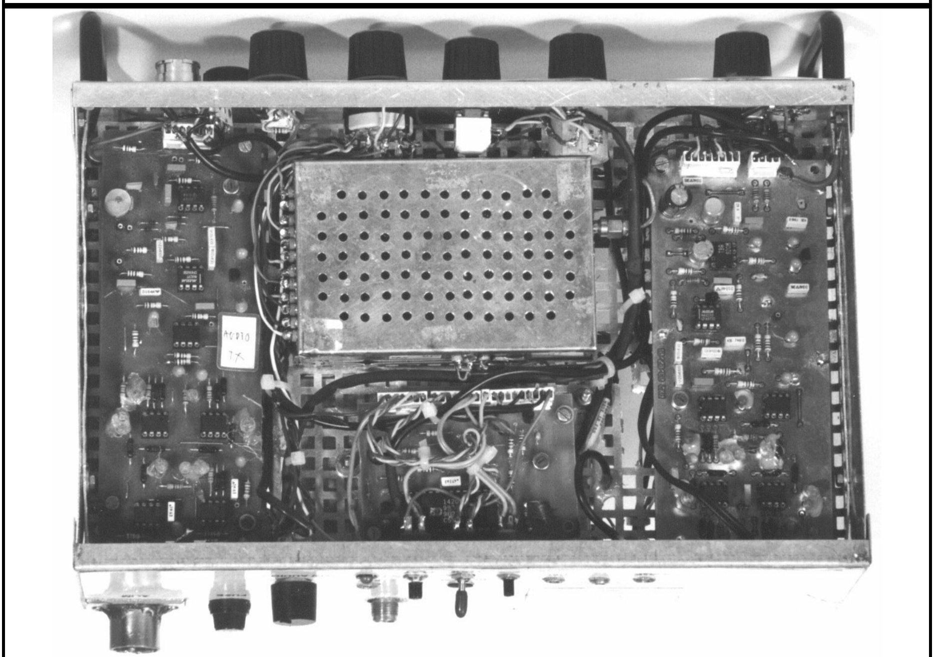

Fig 3 : Photograph showing the internal construction of the 2m direct converasion transceiver.

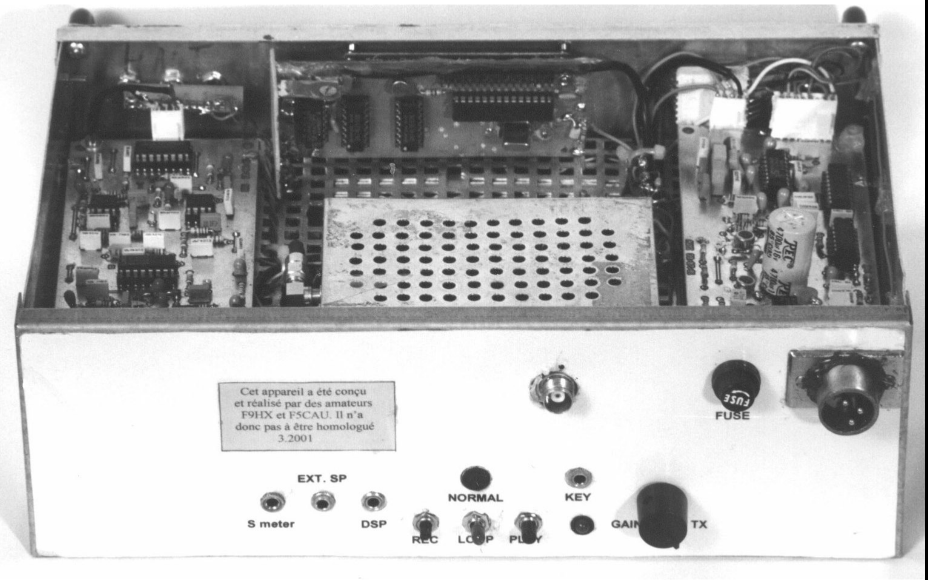

Fig 4 : Photograph showing the rear panel of the 2m direct conversion transceiver.

with common practice.

The use of the transceiver as a receiver for 144MHz gives two familiar problems. As in all direct conversion receiver we can see the LO injection at the antenna. In fact, it is not illegal since the signal is our band and the level is quite low. On the contrary, in a classical superhet, the LO is not in an amateur band and any radiation is illegal! The second drawback is a lack of protection against very strong signals in or out of the received band. This is due to a poor linearity of the demodulator and it is difficult to improve it.

When used to drive a transverter, none of those problems are significant and our challenge is won!

7.

Conclusion

The aim of this article is not to give full constructional detail of the transceiver since it would take to much space in VHF Communications! For those interested, a comprehensive one hundred page French document is available on the following web site http://perso.wanadoo.fr/f5cau with a mailing facility through agit@wanadoo.fr. The document includes all circuit diagrams, PCB drawings, photographs, details of construction, list of suppliers for special components, advice for adjustment and result of measurements is available. A more comprehensive version of this article is due to be published in a new RSGB publication called Practical Microwaves, being edited by the editor of VHF Communications. The transceiver contains two PIC micro controller, one for general control and one for the frequency counter. The HEX code for these two PICs can be downloaded from the VHF Communications web site.

8.

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Fig 5 : Picture of the author, André Jamet, F9HX/P, and F6BEG/P, 27th May 2001, Mont Pilat, France (JN25HV), operating on 144MHz and 10GHz.

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A complete index for VHF Communications from 1969 to the current issue is available on the VHF Communications Web site - http://www.vhfcomm.co.uk. The index can be searched on line or downloaded in pdf of Excel format so that it can be printed or searched on your own PC. If you are not connected to The Internet you can write or fax K. M. Publications for a printed copy of the index which will cost £2.50 plus postage.

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Sigurd Werner, DL9MFV

Frequency multiplier for 76GHz with an integrated amplifier

This article describes a simple design for a 76GHz transmitter. It comprises a multiplier circuit from 9.5 to 76GHz and a final amplifier, built with just two semiconductor chips from United Monolithic Semiconductors. The output is relatively broadband giving 14mW at 76,032MHz. The article demonstrates the extraordinary efficiency of this new chip technology plus the miniaturisation of the construction.

1. Introduction

In my scientific work, I am concerned with the non-thermal effects of modulated high frequency [1]. Due to possible "molecular resonances", the range between 70 and 80GHz is of special interest. To be able to research this a suitable signal source is needed such as a Gunn oscillator. Unfortunately these have a small "pullable" range (frequency change). This meant that we needed to use a standard low frequency OCXO (around 100MHz) with a suitable frequency multiplier.

The frequency multiplier described below (9.5 to 76GHz) with integrated final amplifier is a typical spin-off product from this scientific project. It is demonstrated that, with just a very few GaAs semiconductor chips, efficient signal sources can be manufactured for this frequency range (both broad band and narrow band). They are very suitable, for example, as GHz radio beacons, but access to "Bond technology" is a precondition for their manufacture.

2. Concept and selection of semiconductors

The block diagram for this design is shown in Fig 1, it comprises:

- A stable OCXO with an output frequency of 99MHz e.g. the design by DF9LN [2], which is very popular with radio amateurs.
- A frequency multiplier to 9.5 GHz e.g. a modified version of the design by DB6NT [3].
- An eight times multiplier circuit to 76GHz with an integrated final amplifier.

Since the first two blocks are already documented [2, 3] and are already familiar to most microwave constructors, therefore only the last block is described below.

This multiplier, from 9.5 to 76GHz uses

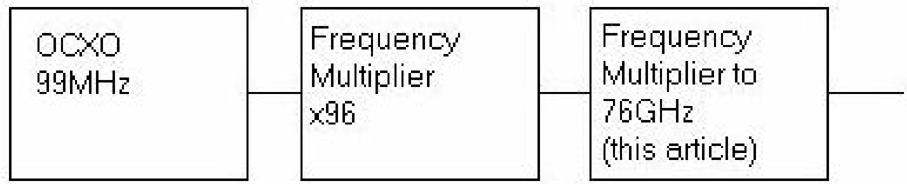

Fig 1: Block diagram of a complete 76GHz source.

just two semiconductor chips from United Monolithic Semiconductors (UMS).

The feed frequency of 9.5GHz is first quadrupled, using the CHX 2092a chip, to 38GHz. Then the signal is doubled to 78GHz by the CHU 2277 chip, and finally the signal obtained is amplified.

Both GaAs multipliers were initially assembled separately and their performance is described in the following section.

2.1 10 - 40GHz frequency multiplier: Type CHX 2092a

The multiplier works with feed frequencies of 8 to 10GHz. The signal is doubled twice here and finally amplified [4].

Monitoring the output signal with a spectrum analyser (HP 8565A and mixer 11517A), shows that the basic frequency (e.g. 9.5GHz) and the third harmonic are attenuated by more than 25dB. The second harmonic is suppressed by at least a further 15dB (in ratio to the 38GHz signal). This gave grounds for hoping that a 38GHz output filter could be dispensed with.

An output of 6mW was obtained without any trouble from a drive input of approximately 15mW at 9.5GHz. The bias voltage supplied to gates 1 and 2 was minus 0.6V in each case, and to gate 3 minus 0.15V. The drain voltage was set at plus 3.6V (60mA; without selection 20mA!). A negligible increase in output tuning and a simultaneous increase in the drain voltage to 4V (80mA) gives an output exceeding 15mW at 38GHz.

2.2 W band multiplier and PA type: CHU 2277

A drive power like this would mean that this semiconductor was over driven. Its typical drive power would be less than 3mW. In addition to the frequency doubler, the chip is also has a four stage amplifier. Due to the internal bias network, we only need two voltages [5], minus 3.8 - 4.5V (about 13mA) and plus 4.5V (130mA). The chip has two output ports. The power measured at the main port was approximately 11mW, measured using the Anritsu MP 416A waveguide head or a calibrated detector, including an isolator from Millitech for this frequency range. Since only one output signal is needed, the secondary port was terminated with a 50Ohm dummy load.

3. Eight times multiplier from 9.5 to 76GHz

3.1 Mechanical and electrical structure

Based on the values measured in the individual models, it was decided to connect the two chips in series with no

Fig 2 : Construction of the frequency multiplier in a brass housing. The positions of the substrates and the two semiconductor chips can be seen in the milled channels.

filter. A housing, about the size of a matchbox was milled from brass (35.5mm x 31mm x 13.5mm, Fig. 2) and gold plated. A simple SMA plug with a thin connecting pin (0.3mm) was mounted at the input (9.5GHz),. The 76GHz output at the main port of the CHU 2277 is a 50Ohm microstrip on a ceramic substrate (1.1mm wide, 0.25mm high). This is inserted into a WR-12 waveguide (3.1mm x 1.55mm, cut-off frequency 48GHz) (see Fig 3). The ground plane of the substrate is inserted into the waveguide (approximately 0.9mm long) was ground using a miniature mill.

The waveguide is made from the two brass blocks of the housing at this point. A 4/40 screw (diameter approximately 2.85mm) is fitted in a small cover, acts as a non-contact piston (see Fig 4).

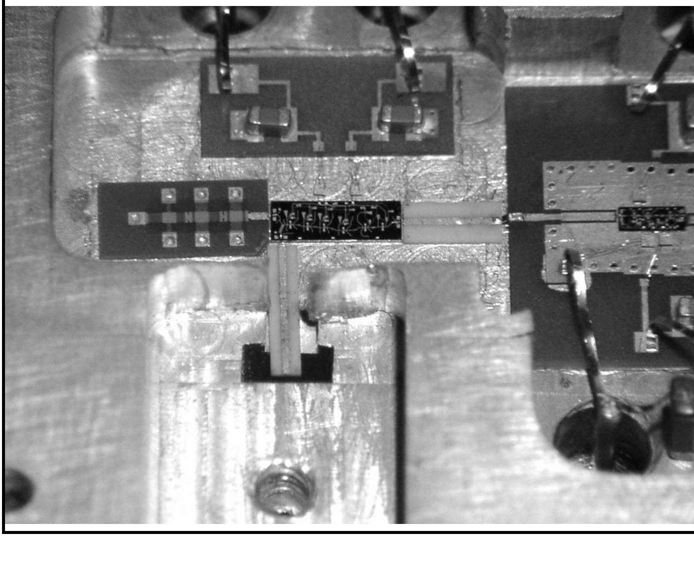

Fig 3 : Detail view of the output circuit with the cover of the waveguide removed.

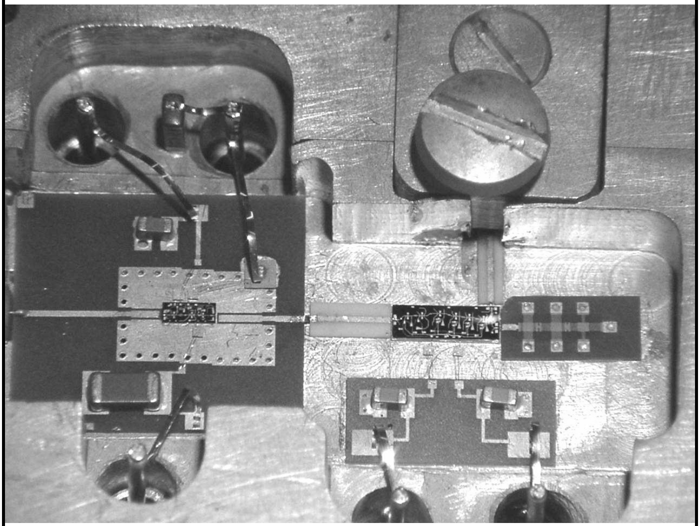

Fig 4 : Detail view of the circuit showing both semiconductor chips and the interconnections.

The carrier substrate for the quadrupler chip (9.5 to 38GHz) is a thin (0.25mm) ceramic plate made from aluminium nitride (AlN, ε = 9.0). The microstrips are butted up to the chip surfaces, as in the 47GHz project, [6], using transition pieces. Underneath the chip surface is a groove approximately 2mm deep fitted with a thin attenuation mat (1mm thick). The AlN substrate was glued onto the housing using a mat impregnated with silver conducting adhesive [7].

The 38GHz signal is fed through a short 50Ohm microstrip, made from ceramic, to the W band doubler. This chip sits on a miniature platform (height 0.15mm) in the brass base of the housing, in order to balance the height difference between the chip (height 0.1mm) and the ceramic substrate (height 0.25mm). This chip and all additional substrates were fixed directly onto the housing using silver conductive adhesive.

The secondary port of the CHU 2277 is terminated with a 50Ohm network (see Figs 3 and 4). The resistors used for this

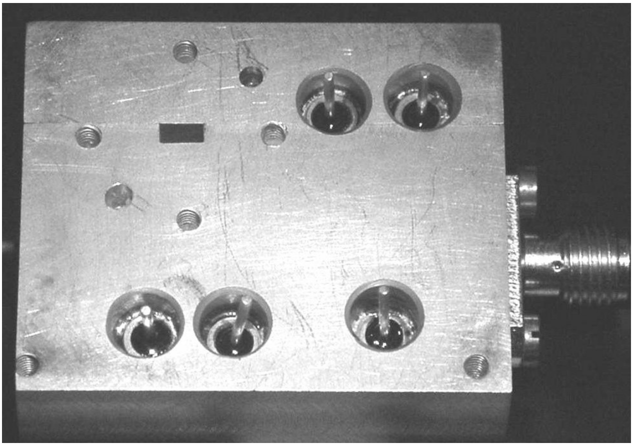

Fig 5 : Rear view of the completed unit showing the waveguide port.

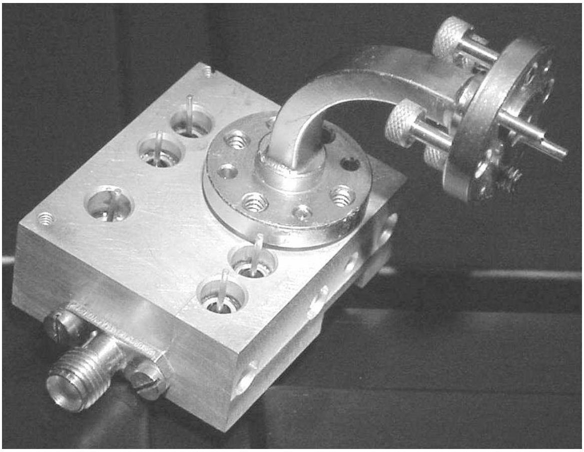

Fig 6 : Rear view of the completed unit showing the external waveguide fitted.

were etched out of the conducting layer of the substrate.

The main port is connected to the waveguide through a short microstrip as described above. The connection for additional waveguide segments is located on the rear of the housing (Fig. 5 and 6). An adjuster screw (M1) in the wave guide part of the housing, about 6/4λ from the feeder point, had no positive effect and was omitted from later assemblies.

The power leads for the chips are first decoupled by 100pF single layer capacitors and subsequently by 100nF ceramic capacitors, and are then taken out, using feedthrough capacitors (approximately 3nF), through the base of the housing. The chips were "bonded" using thermo-compression (supported by ultra-sound) in the so-called wedge-wedge process [6].

Because of the relatively low current consumption of the semiconductors and the good thermal conductivity of the AlN substrate, and/or of brass, special measures for additional temperature control can be omitted.

3.2 Results

The following control voltages and HF lines were selected for optimised drive of the multiplier:

Quadrupler chip CHX 2092a:

- Gate 1 and 2, minus 0.85V (precisely the "pinch-off" of the semiconductor)
- Gate 3, minus 0.1V, drain, 3.8V (60mA)
- Drive power at 9.5GHz approximately 4mW.

W Band chip CHU 2277:

- minus 4.8V (approximately 13mA)
- plus 5.0V (approximately 210mA).

The signal source is operating almost optimally under these conditions. The output at 76,032MHz was 12mW. By fitting small metal lugs (0.5mm x 0.25mm!) to improve the chip matching, a higher output of a good 14mW (11.5dBm) was attained.

The 13dBm referred to in the data sheet [5] (measured on the wafer!) was thus not quite attained. By optimising the transition from the stripline to the WR-12 waveguide, and by improving the matching of the subsequent waveguide curve, undoubtedly a few more mW can be obtained.

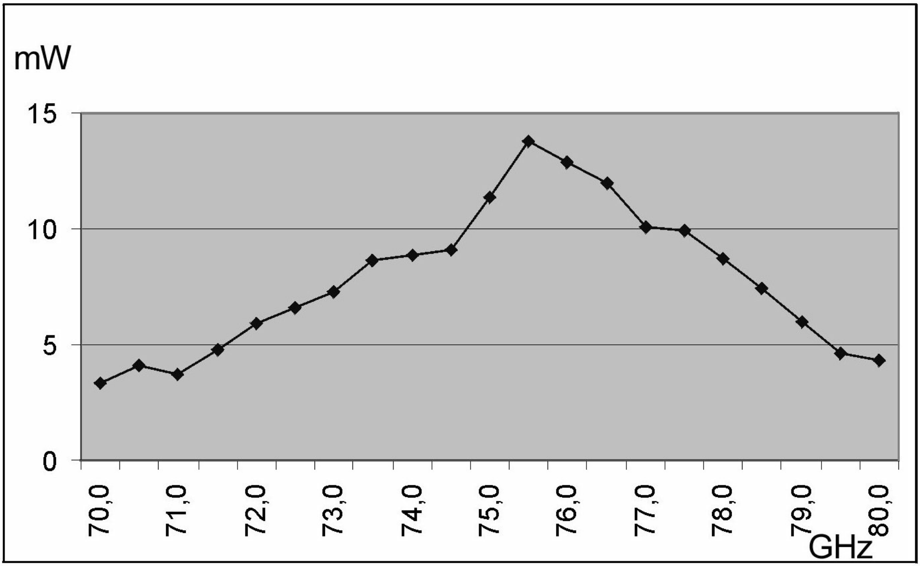

Fig 7 : The output characteristic of the un-optimised frequency multiplier.

It is not necessary to apply attenuation material in the 4.1mm deep "brass bath" since cover effects were scarcely measurable. The relatively wideband characteristics of the circuit layout is astonishing. The -3dB range of the un-optimised output extends from 72.7 to 78.7GHz (see Fig. 7).

Other examples of the signal source reached the "sound barrier" of 13dBm output and indeed comfortably exceeded it, with 14.2dBm (26.4mW).

3.3. Conclusion and future projects

Using only two semiconductor chips, a 9.5GHz signal is quadrupled to 76GHz and amplified to an acceptable output exceeding 13dBm.

An interesting 76GHz transceiver could be constructed by combining a suitable W band mixer (e.g. CHM 2179a from UMS [8]) and using both output ports of the CHU 2277 chip.

The possibility of using a chip with a Q band VCO (output frequency 38GHz) and integrated Ku band oscillator (12.7GHz, with subsequent tripler), which are characteristics offered by the UMS chip CHV 2243 [9], is currently being investigated to replace almost all components before the 38GHz doubler.

Finally, I would like to thank the numerous people who have assisted me and contributed to making the project a reality:

- Mr. Evers and Dr. Hechtfischer (DG4MGR) for very kindly allowing me to work in the clean room
- Dr. Jünemann (DK7AH) for the use of the ceramic substrates
- Most of all Mr. W. Hohenester (all Fa. Rohde & Schwarz, Munich), my mentor and helper for all RF problems, who introduced me to this technology.

I would also like to thank J. Ehrlich (DF3CK), who provided support when mechanical problems occurred and was always available for discussion and constructive criticism. And finally, I am also indebted to M. Münich (DJ1CR, MPI for Plasma Physics, Munich) and Dr. Massler (Institute for Applied Solid Body Physics, Freiburg), who were a great help to me in calibrating my measuring equipment.

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Alexander Meier, DG6RBP

Laser output meter

Using laser light for communication has aroused new interest in amateur radio circles since Hans-Hellmuth Cuno (DL2CH) published his views [1]. However measuring equipment for determining the optical output of a laser is usually very expensive and/or there are no instructions for assembling it as a DIY project. In addition to the theoretical principles, the article below also describes a simple DIY apparatus for measuring laser output.

1. Introduction

1.1 The optical spectrum

The optical spectrum range begins at a wavelength of 100nm with ultraviolet light (UV) and ends after the infrared range (IR) at 1mm. Between these is the range of visible light, from about 380 to 780nm. Fig 1 clarifies this and can also be used to identify important laser wavelengths. This diagram can be downloaded, in colour, from the Internet. [2]

The human eye does not perceive all wavelengths in the visible spectrum with the same intensity. In the daytime, we see green light best at a wavelength of 555nm. At night, this is displaced slightly into the blue-green at 507nm. Fig 2 represents the sensitivity of the eye for daytime and night-time vision, the data for this can be found in [3]. Now it can be understood why, in spite of identical output, that we perceive red laser light at 635nm to be approximately seven times brighter than laser light at 670nm, which is also red!

1.2 Laser diodes

In order to imprint information onto a laser beam, the beam must be modulated. This is very easily using laser diodes, and more importantly, it doesnt cost much. This is why laser diodes are used almost exclusively in amateur radio. It should be pointed out that in practice specific light diodes are also often used for optical communication. In [4], we find a comprehensive article describing practical operations for communications with LEDs and lasers.

In the optical spectrum range, we normally refer to wavelengths in nm and not frequencies. By contrast in amateur radio it seems that specifying the frequency in THz is becoming generally accepted.

The wavelengths of the most frequently used laser diodes are typically 635, 650, 670 and 780nm. Table 1 shows typical applications.

Laser diodes with a wavelength of 635nm are very close to the wavelength of the familiar red, helium-neon gas laser (632.8nm).

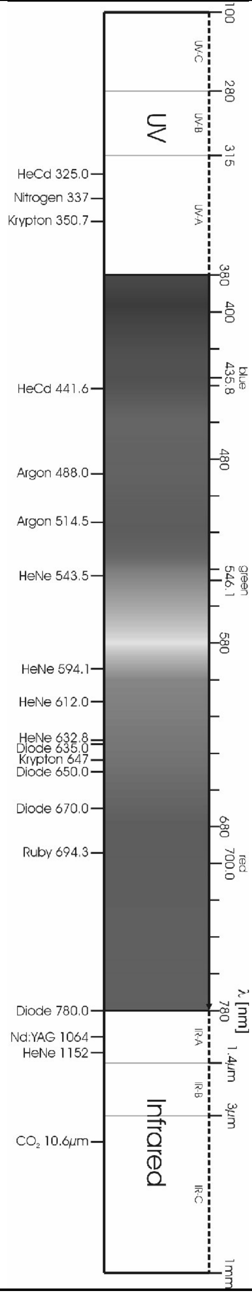

Fig 1: The optical spectrum from infrared through visible light to ultra violet.

Table 1: Typical applications for laser diodes.

Wave-length	Type	Application
635nm	Red	DVD player/laser pointer
650nm	Red	DVD player/laser pointer
670nm	Red	Laser pointer
780nm	Infra-red	CD player, CD writer

Special care should be taken with laser beams in the near infra-red range. The human eye cannot see this light very well (see sensitivity of the eye, Fig 2), but nevertheless it is focused onto the retina! Even if we see nothing, or just a weak point of light, the beam can be powerful enough to cause serious damage to the eye.

Thus the basic principle is that you never look into a laser beam, even for wavelengths outside the visible spectrum!

2. Values and units in photometry

In the measurement of optical radiation, we differentiate between radiometric and photometric values. In contrast to radiometric values, photometric readings use the degree of spectrum sensitivity to make evaluations (Fig 2).

Consequently, photometric values are mainly used for the characterisation of lamps or light diodes. The luminous intensity (light flux per solid angle) is expressed in candelas, or the intensity of light (light flux per area) in lux.

The power of a laser is measured in Watts as a radiometric value, the so-called radiation capacity, P. The sensor used for measurement must acquire the entire laser beam, i.e. the diameter of the sensor must be greater than that of the laser beam.

Because of its divergence, a laser beam

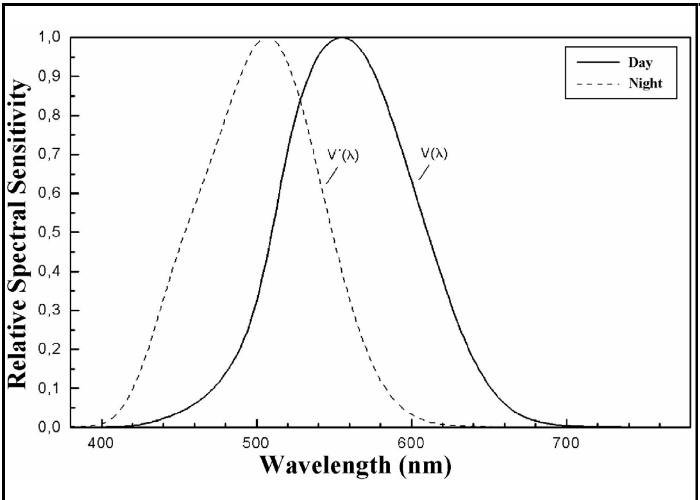

Fig 2 : Sensitivity of the eye for day time and night time.

has a relatively large beam diameter after travelling a great distance. At a distance of several kilometres, the beam has a diameter of one or more metres. Thus it is no longer possible to easily acquire the entire laser beam with a sensor. By contrast, it is possible to measure the output per sensor area. This is a further radiometric value and is designated as the intensity of irradiation, E (output per area). The unit is consequently W per m² or W per mm².

The power levels for the laser diodes in most frequent use are typically between 3 and 5mW. These laser diodes are put to use in equipment such as CD players, CD-ROMs, DVDs and laser pointers. Depending on the operating current and the optics (lenses) used, we typically measure an optical output between 0.5 and 3mW for laser pointers, and usually far less than 1mW for CD players. Other equipment such as laser printers or CD writers uses laser diodes with a power of several tens of milliwatts.

Lasers with an output of less than 1mW are usually relatively harmless. On the other hand, when using lasers with higher outputs, you should clearly be aware of what you are doing and have a suitable knowledge of protection against laser radiation [5,6]. Irrespective of the output of a laser, the basic principle naturally applies, never look into the beam, and certainly not using when optical instruments e.g. magnifying glasses!

3.
Laser output meter

Various items of professional measuring equipment are available for optical output measurement. Measuring equipment that can only measure individual laser wavelengths is frequently described as laser output measuring equipment. With more universal equipment it possible to adjust the wavelength between 400 and over 800nm in small steps e.g. 1nm. These are called optical output measuring equipment.

Depending on the application (continuous-wave lasers, pulsed lasers, lasers with lower or higher output levels, etc .), there are sensors of varied kinds: bolometers, calorimeters, pyroelectric equipment, photoelectric equipment, etc.

The equipment used for amateur radio consists almost exclusively of modulated low-powered continuous-wave lasers (

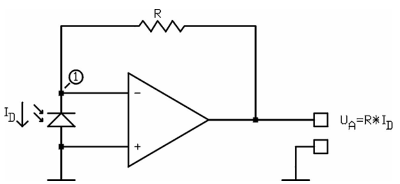

Fig 3 : Current/voltage converter amplifier.

<5mW) operating at specific wavelengths. This considerably simplifies the development of laser output measuring equipment.

The most suitable units for use as sensors are photo diodes, optical outputs from the nW range right up to several mW can be detected. The problem is that the sensor area must acquire the entire laser beam to measure the radiation capacity. Also the sensor should not be overloaded. Thus in practice the choice is usually a large surface photo diode, something like the IPL 10050 [7] with a sensor area of 41.3mm². The price of such a diode is about 50euros.

If light falls onto a photo diode, a current flows through it from the cathode to the anode. If we operate the photo diode with a large (infinitely large) load resistor and measure the voltage, this increases in a logarithmic relation with the intensity of irradiation. If, on the other hand, the photo diode is short circuited, then the current passing through it increases proportionately with the density of illumination!

Thus short circuit operation is best suited to the development of output measuring equipment. In practice, we use an operational amplifier for this purpose and operate it as a current/voltage converter (Fig 3).

If we want to measure very low levels of radiation (nW range), we should use an operational amplifier with FET inputs, because of it's lower input currents. The photo diode is located directly between the two inputs. Since the inverted input forms a virtual earth, the diode is effectively short circuited. When the diode is irradiated, a current then flows, depending on the polarity of the diode, from or to node 1. The operational amplifier then adjusts its output voltage accordingly, so that the entire current flows through the resistor, R. The size of the resistance directly determines the transfer ratio. For example, a resistance of 1kOhm generates an output voltage of 1V for a photo-current of 1mA.

One big disadvantage of photo diodes is the dependency of the photo-current on the wavelength of the radiation. Depending on the structure of the photo diode, it has maximum response at approximately 800 to 900nm. Fig 4 shows the spectrum response for the IPL 10050 photo diode in the visible spectrum range. As the A/W unit suggests we obtain, for example, a photo-current of 0.5mA with a radiation capacity of 1mW on the sensor area.

To be able to acquire various wavelengths with laser output measuring equipment, we need a switching option. The four wavelengths that are usually sufficient for the requirements of radio amateurs are 635, 650, 670 and 780nm.

Unfortunately, even with photo diodes of the same type, the spectrum response fluctuates by several percent from photo diode to photo diode. In practice, this means that every photo diode (and thus also every output meter) has to be individually calibrated!

To measure the spectrum response and to calibrate the equipment, we need an expensive measurement rig (Fig 5).

Using a monochromator, an individual, adjustable wavelength (or a narrow range) is filtered out of a lamp spectrum. With the help of a subsequent lens system, a parallel beam is formed, so that the sensor area of the photo diode is

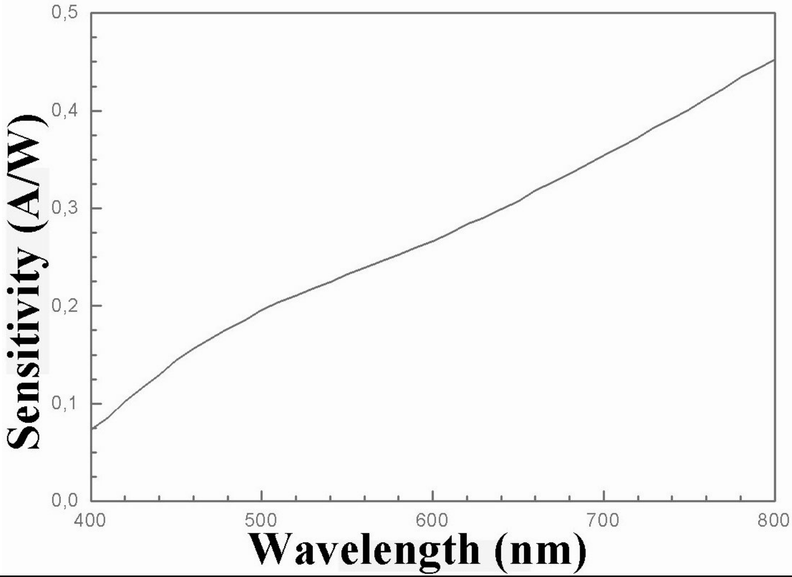

Fig 4 : Spectral response of the IPL 10050 photo diode from 400 to 800nm:
635nm 0.295A/W
650nm 0.307A/W
670nm 0.326A/W
780nm 0.434A/W

completely and uniformly irradiated.

Now we measure the density of illumination at the desired wavelengths with a calibrated optical output meter and a known sensor area, Aref. Then we replace the sensor of the output meter with the unknown photo diode (DUT) and individually measure the photo-current at the same wavelengths. Since the area of this photo diode is also completely irradiated we are measuring the photo-current per sensor area, A_{DUT}. From this, the spectrum response, S, can be calculated:

$$S = \frac{I_{DUT}}{P_{ref}} \cdot \frac{A_{ref}}{A_{DUT}} \qquad \left[\frac{A}{W}\right]$$

Due to the high expense, radio amateurs can hardly carry out this measurement themselves. On the other hand, calibration by a calibration service is much too precise for amateur purposes, and the associated costs exceed 500euros.

Another option is to calibrate the output meter using a diode laser with a suitable wavelength and a known and regulated output. There are only four wavelengths where this is more effective than measur-

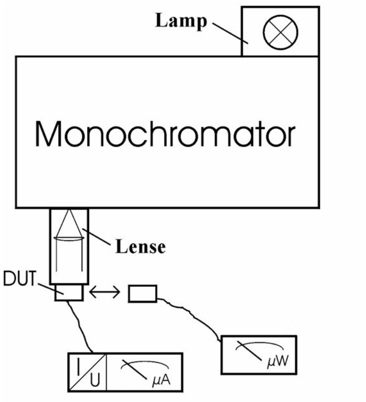

Fig 5 : Method used to measure the spectrum response of a photo diode.

ing each photo diode on the monochromator.

4. The simple LPM-10 laser output meter

4.1 Circuit description

The circuit diagram of the laser output meter is illustrated in Fig. 6. It's design is very simple and, with the exception of the photo diode, requires no special components. The measurement range and the calibrated wavelengths were chosen for the measurement of laser diodes, as used in amateur radio. This meter is also suitable for checking laser pointers or measuring the output of a He-Ne gas laser.

D4, the photo diode is in short circuit mode in this circuit. The MAX495 is used as an operational amplifier, it's input and output swing covers the entire supply voltage range (Rail-to-Rail). U2, the voltage regulator reduces the battery voltage to 5V to supply the operational amplifier, it must not be operated at more than 6V. Other rail-to-rail operational amplifiers with operational voltages exceeding 5V have proved to be inferior to the MAX495.

C2 acts as a simple low pass filter for the current/voltage converter. It thus produces the average when modulated lasers are being measured. It is not necessary to measure the peak value for use in amateur radio, and therefore this facility has not been provided. Using a moving coil meter, modulated lasers can be measured with modulation frequencies of between 50Hz and 50kHz, with a 20 to 80% pulse width.

The display is calibrated for the wavelengths in question using the adjustable resistors, R1 to R4. In normal mode, the wavelength is selected using switch S1.

The readings are displayed on a 100µA moving coil meter scaled for a full-scale value of 5mW. A high quality meter should be used. A digital meter has more disadvantages than advantages in this situation, readings are displayed with a precision that is not present, or the value displayed oscillates so much that it can not be read off if you shake while the laser pointer is pointed at the sensor. Two suitable small lamps (e.g. T1, 5V/60 mA) are wired in series to illuminate the moving coil meter.

Switch S2 acts as an on/off switch, illuminates the moving coil meter and also has a position for checking the battery voltage. An arc at the end of the meter scale shows the battery voltage, the battery voltage indicated being between 8 and 9V. Should the battery voltage fall below 8V, the battery should be replaced to make sure that the voltage regulator has a sufficient input voltage.

A 9V alkaline battery is used for the power supply allowing the meter to be used on the move. If it is used exclusively in the laboratory, a stabilised 9V plug in power supply can be used instead of the battery.

The two diodes, D1 and D2, act as a reverse battery protection and for isolation if the power supply is connected while a battery is installed.

To suppress external light interference, the photo diode is mounted at the end of a 25mm long, black plastic tube. An adjustable zero point is not required with this meter.

The version described here can be adapted to ones own requirements e.g. for other wavelengths or measurement ranges.

4.2 Assembly instructions

Initially all the wired components are assembled on the printed circuit board (Fig 7). The size of the PCB is 100mm x 40mm, as shown in the component layout (Fig 8). There are no special features to

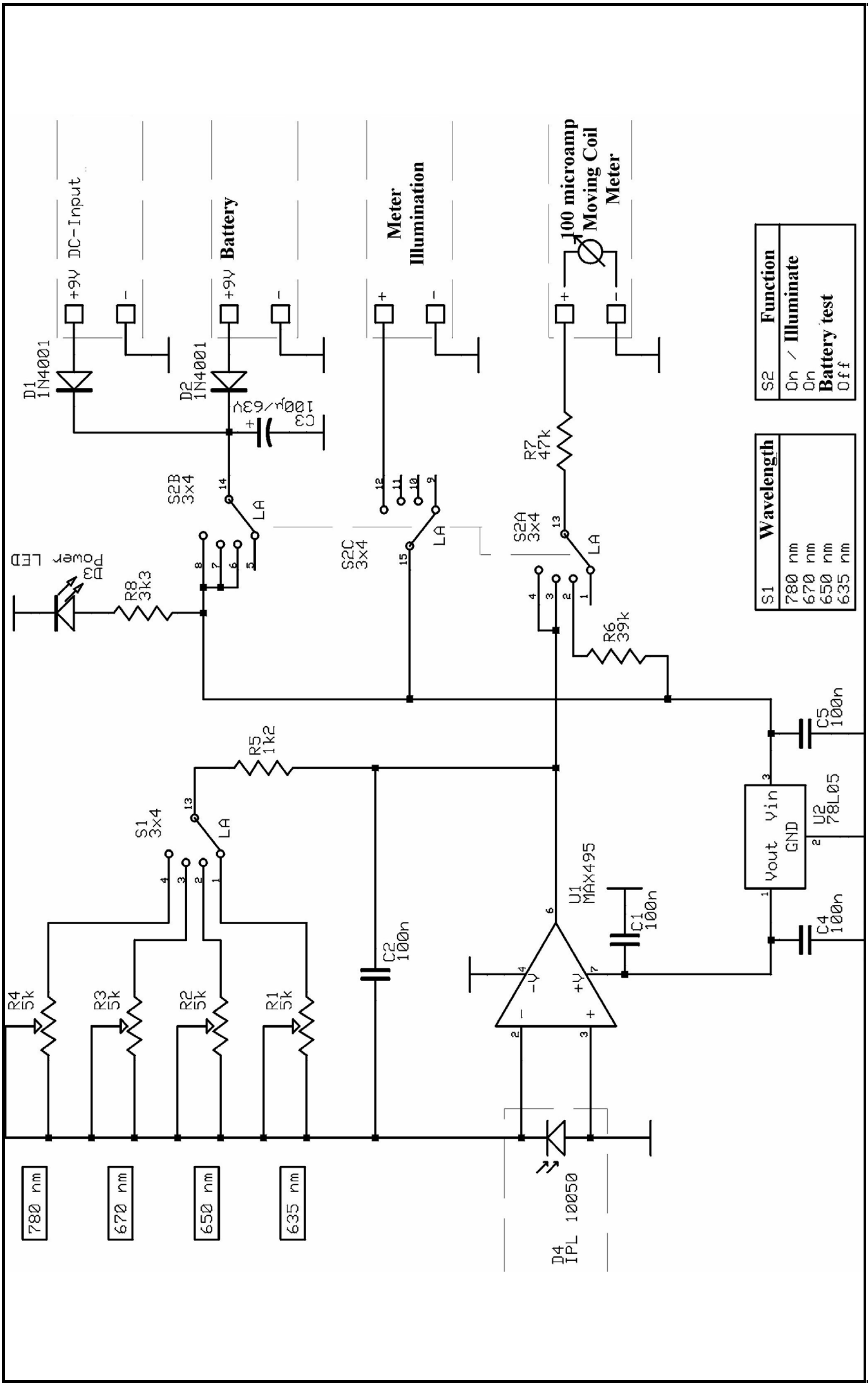

Fig 6 : Circuit diagram of the LPM-10 laser output meter.

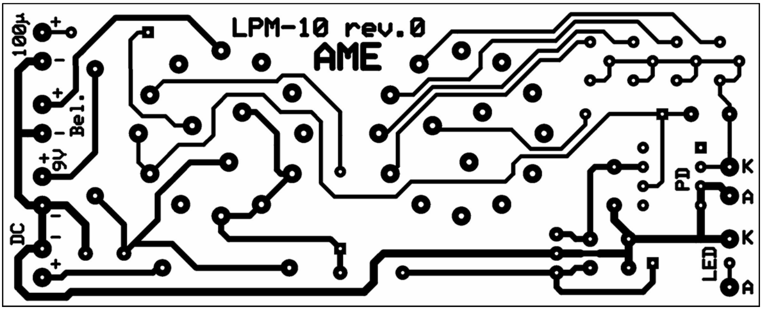

Fig 7 : Printed circuit board layout for the laser output meter (DG6RBP-004).

be taken into consideration here.

Next, the photo diode is fitted on the round sensor printed circuit board (Fig 9). The small marking on the photo diode identifies the anode.

The sensor board and the main board are connected by a short piece of RG174 or RG316 coaxial cable.

To house the sensor board, a black plastic tube is prepared, with a diameter of 30mm and a length of 25mm. This has a 14.5mm hole drilled in the centre. To mount the photo diode, the tube is turned inwards a little at one end. Two M2 screws are used to fasten both the sensor board and the sensor tube behind a front plate. The precise form of the sensor tube can be left to ones own devices.

After an initial function test with a laser pointer, the meter can be calibrated. This is most easily done using regulated diode lasers of a suitable wavelength and with a known power.

4.3. Parts list

R1-R4	5kΩ	Trimmer 64Z,25 turn
R5	1.2kΩ	1/4W
R6	39kΩ	1/4W
R7	47kΩ	1/4W
R8	3.3kΩ	1/4W
C1,C2,C4,C5		100 nF, MKS-2, RM5

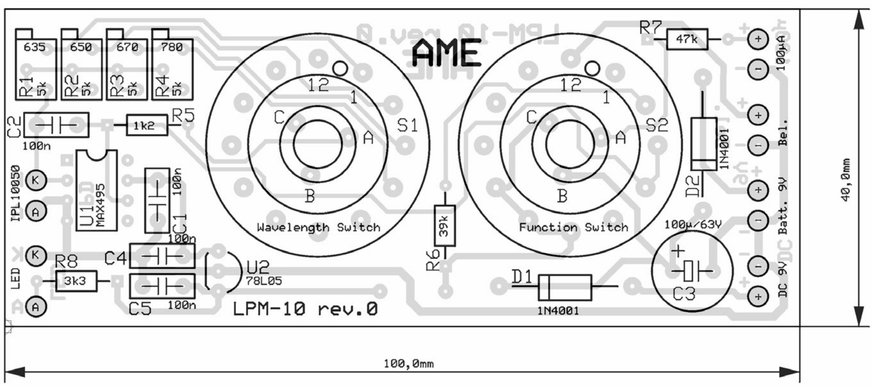

Fig 8 : Component layout for the laser output meter.

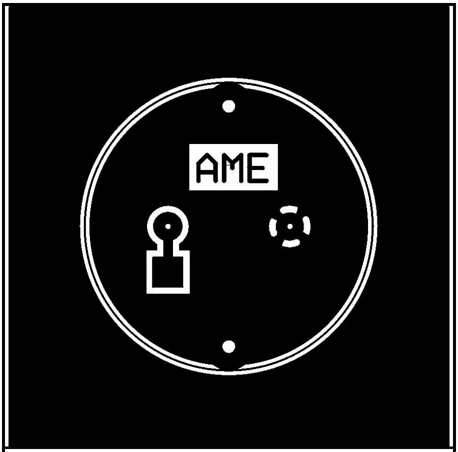

Fig 9 : Printed circuit board for sensor (DG6RBP-005).

C3	100µF 63V, RM5
D1,D2	1N4001
D3	LED green 3 mm, low current
D4	IPL 10050 [7]
U1	MAX 495 + IC base, 8-pin
U2	78L05, 5V voltage regulator
S1,S2	Rotary switch, 3x 4 positions
2	Knobs for rotary switch
1	Holder (Clip) for LED
1	DG6RBP meter PCB
1	DG6RBP sensor PCB
1	Moving coil instrument, 100µA, with 2 small lamps, T1, 5V/60mA
1	Battery compartment for 9V battery
1	DC socket 2.5mm
1	Plastic tube for sensor
5-10 cm	RG-316

4.4 Technical data

Measurement range:	0 to 5mW
Wavelengths:	635, 650, 670 and 780nm
Measurable Laser types:	CW and modulated (50Hz - 50kHz, 20 - 80% pulse width, display of average
Precision:	Dependent on calibration, typically ±5...10%
Sensor area:	41.3mm²
Display:	Iluminated moving coil instrument (100µA)
Power supply:	9V battery or stabilised 9V plug-in power supply
Current consumption:	max. 10mA or 70mA (illuminated display)

5. Use of measuring equipment

For output measurement, the angle that the laser beam illuminates the sensor area is one factor of decisive importance. If the beam illuminates sensor at an angle of 90°, the laser beam is reflected by the photo diode back to the laser. Part of this would enter the laser, and the remainder would be reflected back to the sensor (multiple reflection).

With diode lasers, this can lead to a drop in the output, while with He-Ne gas lasers it can lead to an increase. This leads to quite enormous errors in the test results, quite apart from the fact that it can also lead to a fault in the laser.

Precise readings are obtained when the angle between the laser beam and the sensor is approximately 5°. The best solution is to erect a low wall made of black cardboard near the laser, in order to identify the position of the reflected beam. This is still a powerful beam and has no business in anyones eyes!

For the measurement, the laser is displaced and/or tilted until the reflected beam appears on the cardboard wall a short distance from the laser. The slightly tilted laser should be in line with the centre line of the sensor. It is extremely important that the sensor captures the entire laser beam. Otherwise, the output reading displayed will be too low! With a

Fig 10 : The prototype of the LPM-10 laser output meter.

little practice, youll quickly get the hang of it. Fig 11 shows the test rig clearly.

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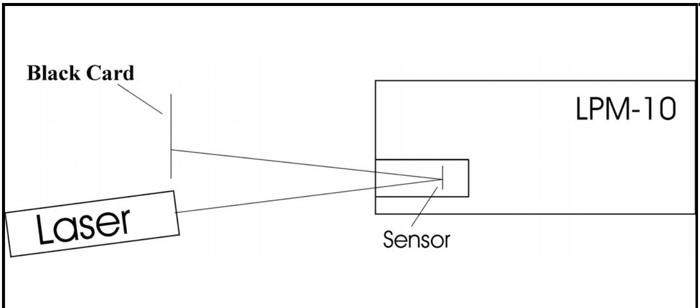


Fig 11 : LPM-10 test rig.

Bernd Bartkowiak, DK1VA

Coax cable and connectors

Time after time, one has the alarming experience of realising just how careless many radio amateurs are when it comes to plugs for coax cable. At any frequencies exceeding 1GHz, cable attenuation plays a considerable role in the power loss and thus in the efficiency of a radio installation.

1. Introduction

Low attenuation coax cables of around 10mm in diameter, e.g. AIRCOM PLUS and ECOFLEX are available to the radio amateur at reasonable prices. But what about coax connectors? The connectors designed for these coax cables are known to be rather expensive so can't we save a bit here?

The subject of N type connectors is unfortunately not considered to be very important by some radio amateurs. People stock up with low price connectors at flea markets, in the firm belief that they have got a bargain. The cable is then laid for the installation, the connector is just fitted on and the jobs done.

2. Search for reasons

Only later comes the great awakening that the signals are getting weaker and weaker, the links are getting poorer, etc.

The cause: Water is getting into the cable!

Water penetrates further and further into the cable due to capillary action. Oxidation colours the cable green or black. The cable attenuation is multiplied many times over.

If we look for an explanation, we frequently find the following reasons.

2.1. The cable sheath is damaged!

This happens quickly if the cable is not laid carefully enough.

The sheath can be damaged on sharp edges. A cut a few millimetres long is sufficient to set off the disastrous process. Water penetrates in and even infiltrates the screen.

One should be aware of the fact that the coax cables used in amateur radio *are not water tight along their length*. This is irrespective of whether they are the familiar RG type of cable or the more modern versions with film and sheath screening.

Fig 1 : N type plug with extended body and improved clamp. This plug was specifically designed for use with AIRCOM plus cable.

This means that through capillary action the water penetrates deeper and deeper into the cable along the outer conductor, and so meter after meter is destroyed.

In contrast to this, professional low loss coax cables are usually water tight along their length. A corrugated copper sheet replaces the screen sheath. This is wound around the dielectric, it overlaps and is seamlessly welded. The welds are then tested for air tightness.

So please take care: Coax cables with screen sheath are not water tight, so you must be careful when laying them!

2.2. Unsuitable N type connectors or "Not all connectors are the same!"

This starts with electrical values. Whats the situation with return loss (VSWR)? Some extremely poor values have been measured, less than 5dB. If we examine this more closely, we find that the connectors simply have the wrong dimensions!

The diameter ratio of the internal pin to the bore in the connector body is incorrect, which has caused an embarrassing impedance jump within the connector housing.

What about the connector dimensions? Are the rubber gasket, the contact socket and the nut exactly right for the cable in question? Are there any installation instructions for the connector with dimensioned sketches showing the exact cutting lengths for the cable?

If these questions can not be answered with an unambiguous "yes", then caution is needed!

For coax cables such as AIRCOM PLUS and ECOFLEX, there are specially developed connectors, their dimensions have been precisely matched to the dimensions of the cable. They have been electrical optimised using TDR analysis, so that the position of any impedance jump can be pinpointed precisely.

Elongated connector housings and pre-

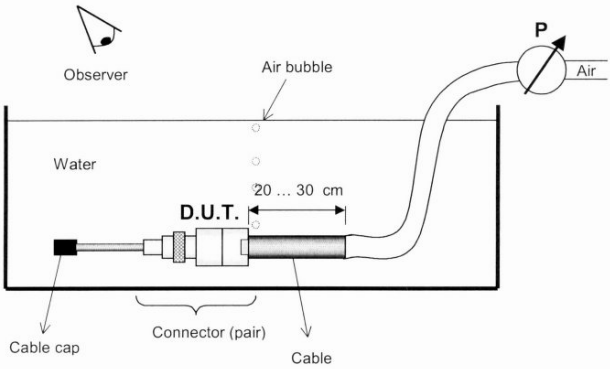
	Test report
HF-Prüffeld	Water penetration test for connectors

Specification: ☐ IP 67 ☑ IP 68

Test device:
A connector pair with mounted cable sample is connected to an air pressure system and immersed in a water basin (figure). The defined pressure is made during a defined time. During the test the connectors shall be inspected for escape of air bubbles:

No air bubbles may leak through the connector.

T E S T R E S U L T S



Cable type :	***ECOFLEX 10***
Connector :	***N(m) - neue Generation***
Duration :	. 1 . . h
Air pressure (P) :	☐ 0,1 bar for IP 67 ☑ . 2 . . bar
Air bubbles ? ☑ No ☐ Yes	

Status: ☑ CONFORM ☐ FAIL

Signature: GV	Date: 21.02.02

Fig 2 : Laboratory test on ECOFLEX 10 cable fitted with the plug designed for this cable.

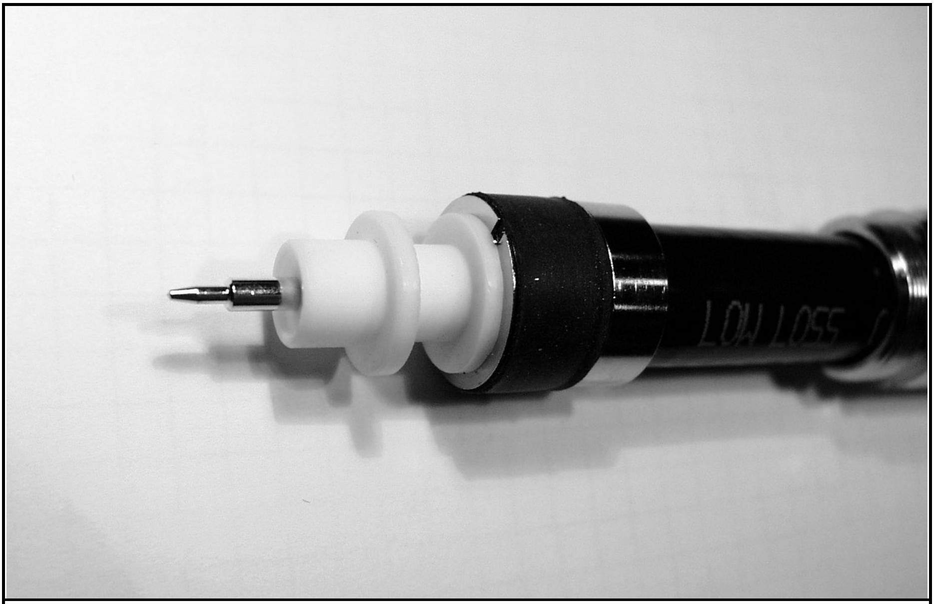


Fig 3 : The teflon inner part of a plug designed for use with ECOFLEX 15 cable. It is specially designed to reduce impedance jumps in the plug body.

cisely dimensioned rubber gaskets provide the required strain relief and water tightness.

These connectors are carefully tested. To do this a finished cable is exposed to a pressure of 2 bars in a water container for a period of 60 minutes. No air bubbles should be detected and no water should penetrate. Only then is the new connector satisfactory (See Fig 2).

3. Conclusion

Hundreds or thousands of euros are paid for a complete radio station, including antennas and cables. Saving just a few euros by buying a connector at what is assumed to be an advantageous price can, however, under certain circumstances, put the entire installation out of operation.

Thus, in our own interests, we should use only connectors tested and released for the individual coax cable. Greater care should be exercised in the laying of the cable, so that the cable is not bent and the sheath is not damaged.

4. Literature

[1] AIRCOMplus data sheet

[2] ECOFLEX-10 data sheet

E. Chicken MBE, G3BIK

A 10.7MHz i.f. probe

1. Introduction

Despite the advent of synthesisers this type of probe is still often used in professional circles for setting up crystal controlled uhf/vhf communication receivers such as in the PMR field (or their conversion by radio amateurs). The circuit diagram for a 10.7MHz i.f. probe (crystal heterodyne oscillator) is shown in Fig 1. It is used as an aid to adjust the receive frequency in any crystal controlled radio receiver that has a 10.7MHz first intermediate frequency.

2. Constructional notes

C1,2 and 3 are silver-mica capacitors. C4 and 5 are ceramic capacitors. All resistors are 1/8 watt metal film. Fig 2 shows how to cut the copper tracks to construct the i.f. probe on stripboard. Suitable 10.7MHz crystals are readily available at low cost. The completed unit should be enclosed in a small non-metallic box (e.g. plastic) with the push-button switch mounted on the box.

3. Adjustment of the probe's frequency

This is a once and for all adjustment, after which the probe is ready for use at any time. A non-metallic trimming tool is required, and some means of measuring the 10.7MHz crystal's frequency without physically contacting the oscillator circuit. If you have access to a synthesised hf broadcast receiver and a synthesised rf signal generator, a satisfactory method is:

- Tune the receiver to 10.7MHz
- Tune the signal generator to 10.7MHz with an un-modulated output
- The un-modulated carrier should be discernible on the receiver without an inter-connecting cable
- Press the activate button on the i.f. probe, it will probably cause a heterodyne tone to be heard on the receiver
- Adjust the probe's trimmer capacitor (CV1) to give a zero beat of the heterodyne tone,

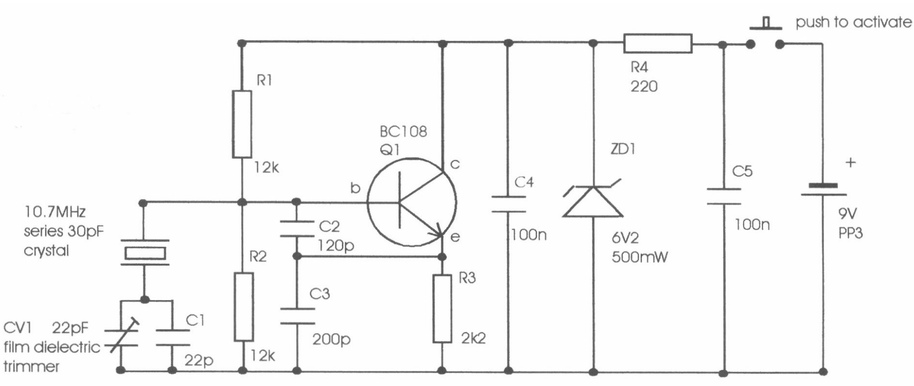


Fig 1 : Circuit diagram of 10.7MHz i.f. probe.

thereby setting the probe's frequency to exactly 10.7MHz

Alternatively use a frequency counter with a high impedance rf probe to measure the output frequency of the i.f. probe while CV1 is adjusted to give a 10.7MHz reading on the counter.

The i.f probe is now ready for use.

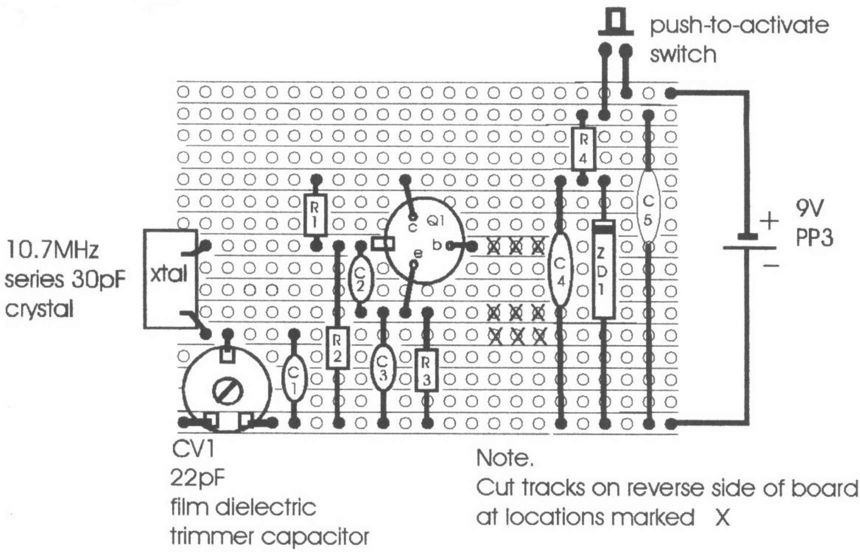


Fig 2 : Stripboard layout for 10.7MHz i.f. probe.

4. Using the probe

Connect the un-modulated output of a synthesised rf signal generator to the antenna input of the radio receiver to be tuned. Set the signal generator to precisely the intended receive frequency.

With it's activate button pressed, hold the 10.7MHz i.f. probe in close proximity to the receiver's 10.7MHz crystal filter stage.

If a heterodyne tone is heard from the loudspeaker, it means that the receiver is not quite on tune, hence the frequency of its local oscillator needs to be adjusted.

To do that, adjust the receiver's own local oscillator crystal trimmer for zero beat of the audible heterodyne tone. This will bring the receiver exactly on tune at the chosen frequency.

Microwave Update 2003 in Seattle

Microwave Update 2003 organisers and the Pacific Northwest VHF Society are joining forces to host a joint conference in the Seattle, Washington, area on September 25-28, 2003. Registrations for the joint conference will be accepted beginning April 1, 2003. Cost of the registration will be $40 prior to September 12, 2003, and covers all three days. Single-day or single-event registrations are not available. Late registrations, including at the door, will be $50.

Registration forms can be downloaded at www.microwaveupdate-.org or send a SASE to John Price, N7MWV, at 12026 81St Ave NE, Kirkland, WA 98034, and a form will be mailed to you. Completed registration forms and payment should be sent to the same address. Make checks payable to "Microwave Update 2003".

Joint conference sessions and the Saturday evening banquet will be held at the Everett Holiday Inn and Conference Centre, a short drive north of downtown Seattle. Special rates have been arranged with the hotel for conference participants. Rooms are $69 per night plus tax…a real bargain for the Seattle area! It is suggested that early reservations be made directly with the hotel at (425) 337-2900. Be sure to mention "Microwave Update" to get this rate. Reservations must be made by August 21 for this rate.

"White papers" are currently being solicited from potential authors and speakers for publication in the 2003 conference proceedings. Topics specifically of interest to Microwave Update attendees, as well as those on VHF and UHF subjects usually associated with the annual Pacific Northwest VHF Conference are solicited. Papers will be accepted until July 1, 2003, to allow enough time for printing. White papers should be sent directly to Jim Christiansen, K7ND, via e-mail at k7nd@att.net. MS Word format is preferred. Microwave Update 2003 and the Pacific Northwest VHF Society respectively will be the sole judges of whether presentation requests and white papers are accepted.

If you are interested in making a session presentation at one of the Microwave Update 2003 sessions, please respond to NU7Z (nu-7z@aol.com); for presentations at the Pacific Northwest VHF Conference sessions, contact N7CFO (n7cfo@ix.netcom.com). LCD projection equipment will be available for those using PowerPoint presentations. Slides and video presentations can be accommodated with advance notice.

Gunthard Kraus, DG8GB

Internet Treasure Trove

Antenna Design Calculator

Anyone who visits the homepage of "Q-Par Angus" is entering a forest of microwave antennas. Innumerable microwave antenna types, up to 100GHz, are designed, manufactured and marketed there, and there are detailed descriptions as well. One very nice gesture is a free "Antenna Design Calculator" in the form of two slide rules that can be downloaded. One deals with the connections between gain, efficiency, antenna diameter, frequency and beam width. The other can be used to investigate the relationships between antenna diameter, frequency and far field range. These are very informative and very easy to use. Highly recommended, you simply must have this on your own computer.

Address: http://www.q-par.com

AppCad , Version 3.0

This is brand new, the most recent Windows version of the "Personal Design Assistant for RF, microwave and wireless applications". A very long time ago, when Agilent was still called Hewlett Packard, this program existed on a 5 ¼ inch diskette. This ancient version can also still be downloaded, but it wont work properly except with pure DOS. But it still contains some things that were deleted later such as spiral inductor design, etc.

In the most recent version 3.0, not only have many details been improved, but also a new tool has been incorporated known as "Everything S-Parameters". It lives up to its name, for you can use it to analyse the S-parameter file of a component or a circuit, right down to the last detail. You can calculate some interesting facts from the analysis and then display them (e.g. to demonstrate stability circuits or noise factor curves, carry out matching procedures, etc.). This free package has grown to 14Mb and merits a more detailed description at some time in our section on "An interesting program".

Address: http://www.hp.woodshot.com

Antenna Systems Laboratory

Another source for antenna literature is in the form of a "Technical Journal". A range of scientific articles is on offer here, covering horn antennas, patch antennas, propagation experiments, etc. This is certainly very interesting for the specialist.

Address:
http://www.ee.fit.edu/electrical/asl_page/journal.htm

Radio Waves below 22kHz

Have you heard of Schumann resonances? Or can you sketch a Whistler receiver? If you want to close such gaps in your education, visit this Italian homepage. It is compulsory reading for those people who want to get involved with VLF, ULF or ELF. Anyone landing up here will find innumerable recommended links to follow.

Address: http://www.vlf.it

Transmitter Tour

What would it be like to go on a tour through various radio stations such as "Voice of America" etc. To savour the technical details of such high powered transmitters, as revealed in many illustrations and detailed explanations? Just go to "Jim Hawkin's Radio and Technology Page". The author has assembled more than 300 photos, and there's also plenty of material on the history of wireless transmission technology. Naturally, there are links for such modern subjects as DAB, etc. Extremely entertaining and never boring! If you want to learn a bit about the principles, then just enjoy "Electromagnetic Radiation explained"

Address:

http://hawkins.pair.com/radio.shtml

A Site for the practising RF engineer

A lot of stuff has been assembled here that people need more and more frequently. Two very fine and well produced features are the tutorials on direct conversion receivers and fractional N synthesisers. But there is also a complete page containing nothing but links to companies who offer application notes for downloading. Another important thing, here you can finally download the standards for the various modern communications systems such as GSM, 2G, GPRS, WLAN, WDCDMA etc. onto your own computer.

Address: http://www.rfengineer.cc/

RF-WEB

As down-to-earth as the name implies. A very comprehensive but very unimpressive site greets you, containing nothing but links to interesting aspects of radio frequency technology. But if you take a closer look at this list, then you will very soon be mentally begging the author's pardon, because not only is there an unbelievable amount available here, but it is a real Treasure Trove.

Address: http://www.rfweb.com

Online Education

Internet learning is continually on the increase, in our specialist subject as well, so we're giving two interesting links for better information here. The material available there is not intended for immediate downloading but for on screen training and/or further education. Professors, teachers and specialists have created the splendid lessons or learning packages, which makes for willing pupils. You'll have no trouble getting stuck in here, so to speak.

Address 1:
http://www.educatorscorner.com/tools/rf_corner/index.shtml

Address 2:
http://www.iec.org/online/tutorials

RF-Cafe

This, as you might expect, is a site where you just sit back and have a good old rummage around. You will undoubtedly know of, or you'll already have, a lot of the literature or software mentioned here, but the author never sits still and is always on the lookout for interesting new items (such as a waveguide filter designer).

Address:
http://www.rfcafe.com

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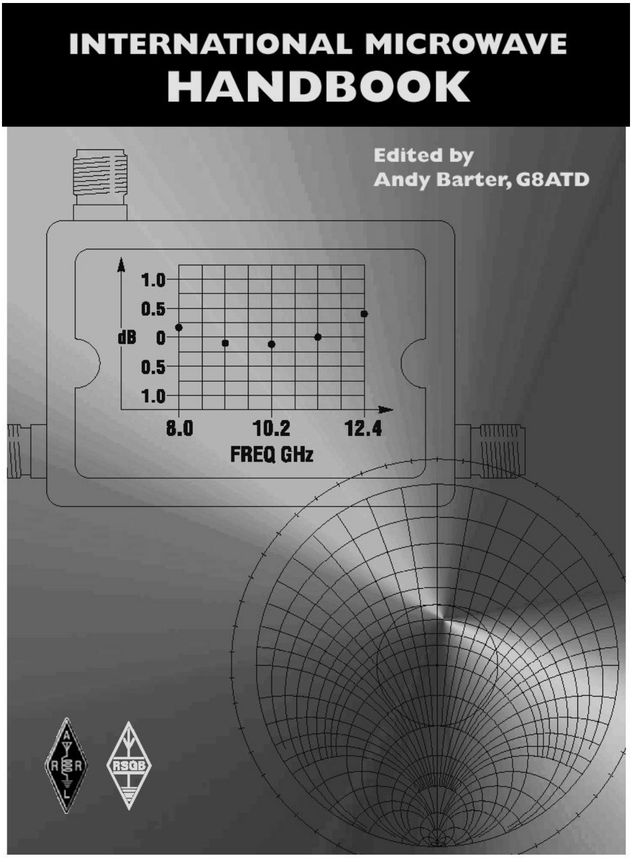

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