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USING THE GUNN 1070K

Firstly, thank you for buying this unit. It originated [illegible] the corners of [illegible] brought [illegible] the basis of a [illegible] then [illegible] turning [illegible] working [illegible] transceivers operating in the 10GHz amateur band. I'd also like to acknowledge the encouragement of members of the Microwave Society, particularly John [illegible], Glen Ross, G8MWR, for their constructive suggestions. If you are interested in 10GHz operation, membership of the Society is highly recommended. (Details from Glen Ross, G8MWR, 81 [illegible], COVENTRY.) If you are interested in microwaves generally, then the Microwave Newsletter edited [illegible] of the RSGB's Microwave Committee is essential reading. Membership Services at RSGB headquarters will provide information [illegible].

What's on the board?

The GUNN 1070K has all the electronics needed to make a complete transceiver when used in conjunction with a suitable microwave head. The microwave head will consist of two interrelated components: a Gunn diode oscillator and a diode mixer. Gunn diodes are negative resistance devices at microwaves and the diode across a suitable microwave tuned circuit, such as a waveguide cavity, will oscillate at a frequency [illegible] determined mainly by the dimensions of the tuned circuit. [illegible] the [illegible] frequency. The [illegible] oscillator [illegible] is significantly [illegible] the frequency [illegible] for a change from [illegible] to a [illegible] oscillators [illegible] known as 'pulling'. The other effect which [illegible] advantage in the GUNN 1070K is known as 'pushing'. By varying the supply voltage applied to the diode, the frequency will vary in a more or less linear fashion [illegible] is a function of both the individual diode and the [illegible] of the tuned circuit. If you are interested in the physics behind the operation of the Gunn diode, there is a [illegible] easy to understand description in the RSGB VHF/UHF Manual.

Oscillator pushing is used in conjunction with the GUNN 1070K to [illegible] tune the oscillator over the limited range needed for communication and to apply both modulation and automatic frequency control. The segment of the 10GHz band recommended for [illegible] operation in the UK lies between 10370 and 10450MHz ([illegible] 1 January 1983) and this can be covered quite easily using oscillator pushing, eliminating the need for mechanically complex tuning arrangements.

The power supply in the GUNN 1070K employs as its reference [illegible] 5.6V reference contained in the CA3130 [illegible]. A single section of a quad op-amp chip is used in a simple voltage regulator, the output voltage being set by VR1. Should the maximum voltage be insufficient for the diode in use, it can be increased by shunting [illegible] a resistor of suitable value. This will probably be in the range 10K - 50K; the smaller the value, the greater the maximum output voltage obtained.

The output of the voltage regulator drives a potential divider consisting of the tuning pot. and preset minimum voltage adjust, VR4. A unity gain, non-inverting power op-amp buffer provides sufficient output current capability to drive the Gunn diode, whilst containing internal short circuit protection. Protection for the Gunn diode from overvoltages is provided by a zener diode. This will require changing if the maximum output voltage is increased.
AFC and modulation are also applied to the power supply via modulation reference line. The AFC output of the CA3089E is buffered by op-amps operating in both inverting and non-inverting unity gain modes. This allows AFC operation with the local oscillator on either side of the incoming signal. The AFC sense is selected by means of a centre-off toggle switch - in the centre position the AFC is off, allowing normal operation. The tuning range does vary slightly with different AFC modes selected; however, this is not really a problem. Once used, AFC becomes addictive: once a signal - even one quite near to the noise - is captured it will happily stay within the passband quite happily for hours on end unless the system is disturbed. By connecting a centre-zero meter in series with a suitable resistor across the two AFC outputs, a tuning meter may be added.

A centre-off switch also selects the modulation source: both tone and speech modes are available. The tone source is a simple transistor phase-shift oscillator operating at around 1kHz, whilst the microphone amplifier is a dedicated IC incorporating AGC. The use of AGC ensures that it is very difficult indeed to overmodulate, even when operating on a hilltop in the middle of a gale (such is the microwave path!) Separate deviation adjustments are provided for each source.

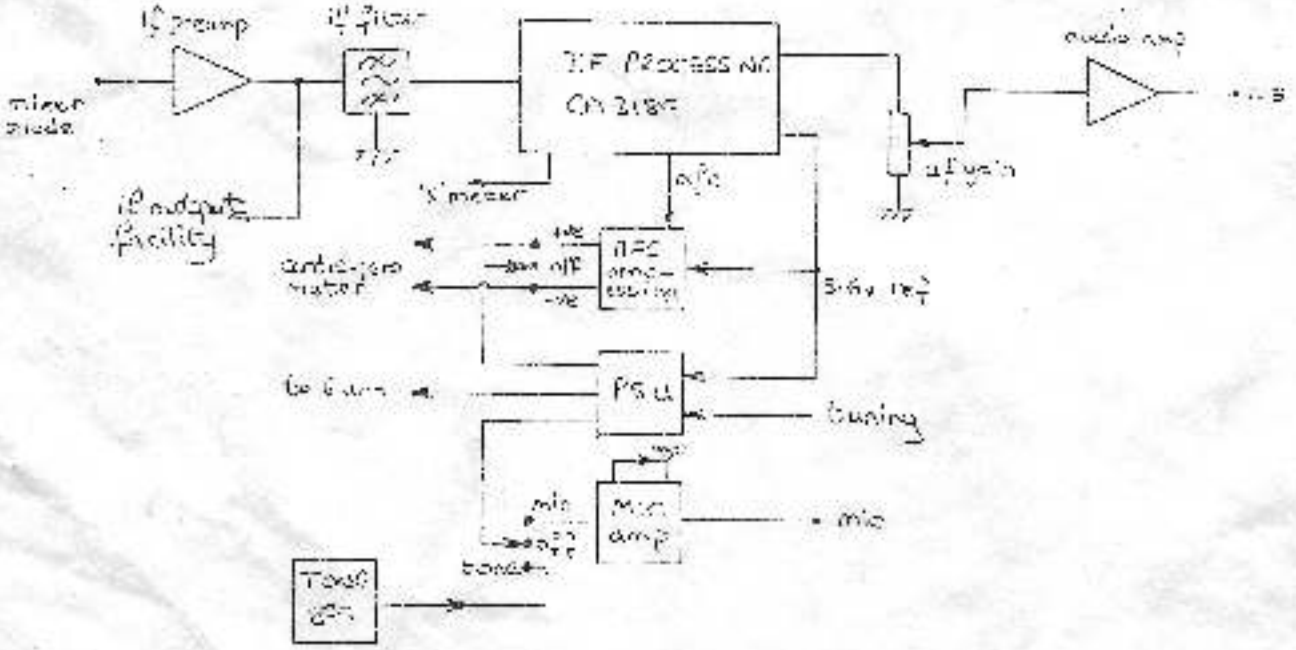
The receiver intermediate frequency is at 10.7MHz. This has been chosen for several reasons although it does, however, have some minor disadvantages. The major reasons for using 10.7MHz are concerned with elimination of the need to mechanically retune the oscillator or to use a separate transmitter which occurs if higher i.f.'s are employed, simplicity, ease of obtaining good i.f. performance at a reasonable cost, inherent compatibility for full-duplex operation, and low losses associated with cable runs should the microwave head be operated remotely. The major disadvantage with the use of such a low i.f. frequency in microwave terms is concerned with the generation of noise sidebands by the Gunn oscillator. All oscillators generate noise about the carrier; the amount generated is a function both of the device and the circuitry surrounding it. The noise sidebands generated can be thought of as having two origins: those due to amplitude modulation of the oscillator (by both noise generated within the device and external to it) and by the phase modulation which happens whenever an oscillator is amplitude modulated. In the case of simple systems such as typical amateur 10GHz equipment, the major problem comes from the amplitude noise component, as the phase noise components are cancelled in the mixer. With modern Gunn diodes, particularly those intended for doppler radar (or burglar alarm) use, the problems are not at all serious and can usually be completely forgotten.

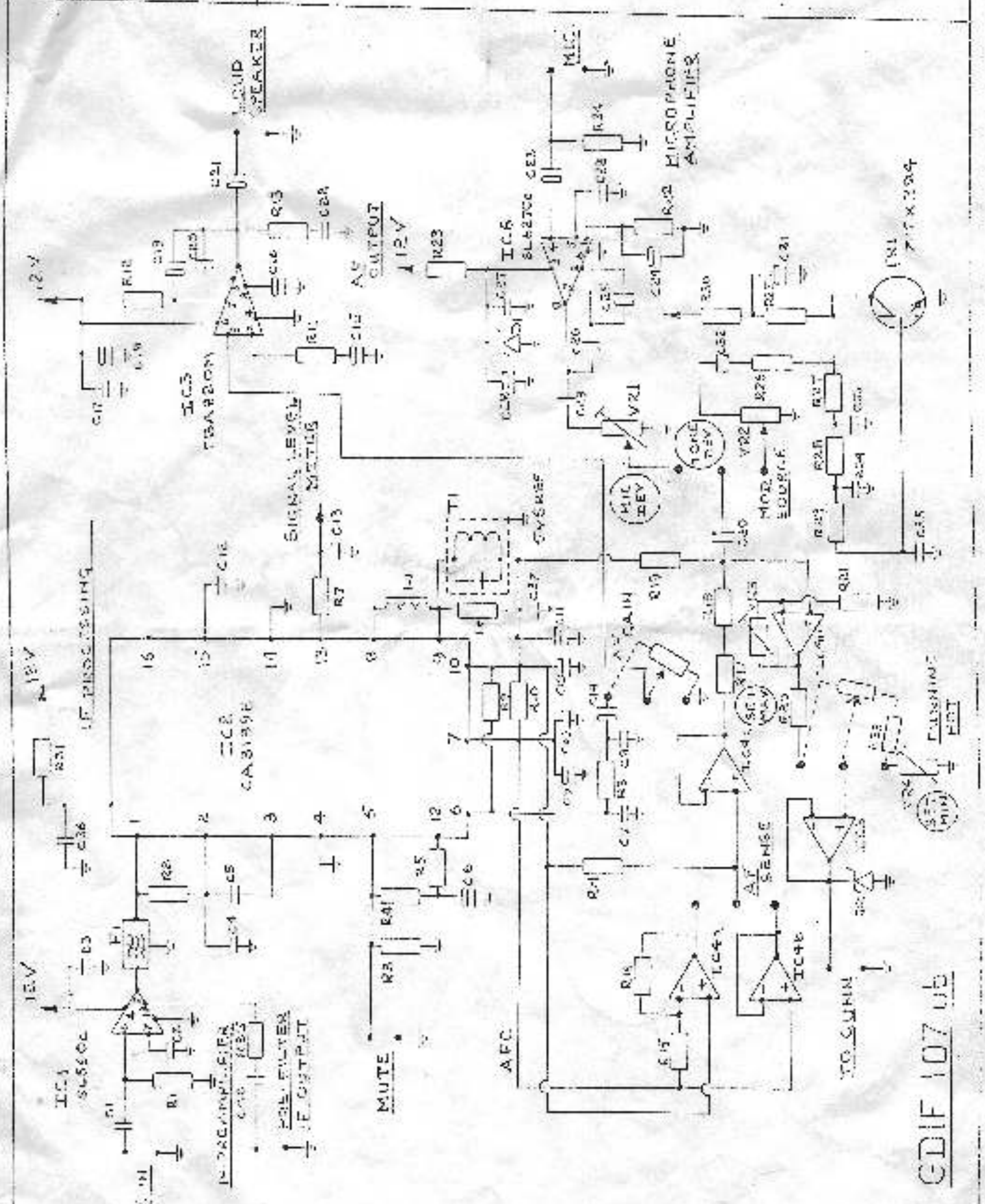
A [illegible] in (CA 3089?) is used as the head amplifier. This [illegible] a [illegible] impedance of around [illegible] ohms [illegible] [illegible] [illegible] [illegible] if output impedance of around [illegible] ohms. Some sort of impedance matching is [illegible] for optimum performance. [illegible] could be [illegible] a component such as a pi network, [illegible] this will probably not be noticeable rather than [illegible] [illegible] transistor supplied with the [illegible] [illegible] There is also less chance of [illegible] things wrong with the [illegible].

Following the "head" amplifier, [illegible] before the passband defining filter, an i.f. output is provided from the board via pins 21 & 22, allowing use to be made of the 10.7MHz i.f. before limiting and demodulation by the FM processing chip. The passband [illegible] [illegible] if [illegible] to ensure that the centre frequency of the i.f. passband is 10.7MHz [illegible] [illegible] [illegible] [illegible] the filter [illegible] the CA3089 i.f. [illegible] ic, which provides limiting and demodulation [illegible]. The CA3089 provides a signal level meter output which will drive a small 200uA meter [illegible] and also [illegible] [illegible] tuning meter.

The audio output stage is a TBA 820M ic, that produces sufficient audio power for most applications, without the "latch-up" problems which are often [illegible] running [illegible] of output i.c.s or [illegible] transistors.

Block Schematic.





mutek limited Bradworthy Holsworthy Devon EX22 7TU (040924)1543 Date 7-84 Sheet 5 of 10 [illegible] 13cm Component Schedule

R1	10k	C1-5	10n	IC1	[illegible]
R2	330k	C6	2u2 [illegible]	IC2	[illegible]
R3	100k	C7	10n	IC3	[illegible]
R4	33k	C8	n10	IC4	TL06[illegible]
R5	470R	C9-10	10u [illegible]	IC5	[illegible] 759
R6	5k6	C11-13	10n	IC6	SL6[illegible]
R7	10k	C14	2u2 [illegible]		
R8	2k2	C15-16	100u [illegible]	L1	22u[illegible]
R9	4k7	C17	[illegible]	T1	[illegible]
R10	4k7	C18	100u [illegible]		
R11	[illegible]	C19	[illegible] F.F.	X1	[illegible] 10.7
R12	56R	C20	n47		
R13	1k0	C21	[illegible] F.F.		
R14	33k	C22	220n		
R15	33k	C23	[illegible]		
R16	33k	C24	4u7 [illegible]		
R17	100R	C25-26	[illegible]		
R18	39k	C27	10n		
R19	[illegible]	C28	2u2 [illegible]		
R20	470R	C29	10u [illegible]		
R21	[illegible]	C30	220n		
R22	1M	C31	2u2 [illegible]		
R23	[illegible]	C32	[illegible]		
R24	[illegible]	C33-36	10n		
R25	[illegible]	C37	10u [illegible]		
R27	47k	C38-[illegible]	10n		
R28	[illegible]				
R29	47k				
R30	10R				
R31	51k				
R33	4k7				
R34	68k				
R35	1k0				
VR1-4	22k				

[illegible] 04

[illegible]

Building a system.

Integrating the G0IF 10/0H with the rest of your 10GHz system isn't a difficult job. However, if you spend a little time thinking about what you want to achieve, it will make life simpler still! Most people will want to use the board in conjunction with a surplus doppler module to operate over long line-of-sight paths. In this case the choice of the doppler module is very important; the most successful modules for this purpose being based upon a "throughline" mixer in which the oscillator is coupled to the mixer through an iris. Other units in which the oscillator and mixer are mounted side-by side in the waveguide can be used, however, these are not really capable of the performance of the throughline mixer, particularly when used with a reasonably large antenna, as the physical offset causes significant differences in the radiation pattern. Nevertheless this is still possibly a convenient way of making simple low performance systems for short distance line-of-sight links. If you want the highest performance, the G3WDG/G3[illegible] design for a throughline mixer which appeared in Radcom, June 1978 can be thoroughly recommended. This can be built with hand tools and is not too difficult to set-up. Even with small antennas such as the 16dB horns frequently found on burglar alarm modules it should be possible to cover line-of sight paths of around 30km between two identical modules. It is even possible to cover a few km using just the open end of the waveguide as an antenna! With real antennas such as 18" dishes, a pair of units will be able to cover free-space paths of several hundred kilometres as well as some obstructed paths. We've listed some references at the end of this note which will help with designs for any of these components and with system analysis.

Putting it in a box.

The connections to the board needed to get your system running are detailed in Fig.2. The tuning and signal level meters are optional and can be ommitted if not required. Likewise the mute can be disabled by shorting the 'mute' terminal pin to ground. The AFC and modulation select switches are centre-off toggle switches, although these could be replaced by rotary switches if desired. The main tuning control is preferably a ten-turn 5k linear law potentiometer. If this is not available, then a conventional 270 degree pot. with slow-motion drive could be used. A 10k log pot. is suitable as the af gain control: if a control fitted with internal switch is available, then this can be used for on/off switching. Note that no reverse polarity protection is fitted to the board. This is best fitted to the power input socket.
As the output impedance of typical mixer diodes is of the order of 200-400 ohm and the source impedance required by the preamp for minimum noise figure is around 50 ohms some matching is required. A 4:1 (impedance) broadband transformer is supplied: the red winding is low impedance

whilst the green side is high impedance. By decoupling the 'cold' end of the transformer, the diode current can be easily measured. The microphone amplifier is intended for use with low impedance (<200 ohm) dynamic microphones. NOTE THAT IT IS POSSIBLE TO BLOW THE AUDIO OUTPUT I.C. IF ITS OUTPUT IS SHORT CIRCUITED.

It is a good idea to mount the microwave head in a box, and even to surround it with polystyrene foam. A diecast box large enough to house the electronics as well is probably a good idea, as any chance of r.f. breakthrough will be minimised.

Setting-up.

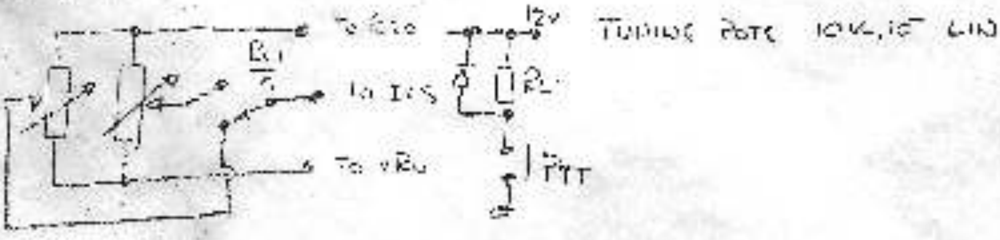
The setting up procedure breaks down into two phases; getting the oscillator onto frequency and then setting up the tuning, limits and deviation controls.
Before connecting the Gunn, turn the AFC and modulation switches to their 'OFF' positions. Connect a voltmeter between pins 19 and 20. Turn the tuning pot. fully clockwise and adjust VR3 for 8V output. Now turn the tuning pot. fully counterclockwise and adjust VR4 for 6V output. If these adjustments are not straightforward, the tuning pot is probably connected the wrong way round. Once the power supply is set up and rotation of the tuning pot. varies the output voltage smoothly from 6 to 8.0V, set the output voltage to 7.5V. Switch off, and connect the Gunn oscillator - making sure that the polarity is correct. If the oscillator has been designed for positive ground operation, it will be necessary to carefully remove the Gunn diode and replace it 'the other way round'. With low-power diodes, this will not cause any damage, however, care should be taken with heatsinking of high power diodes. Connect the Gunn oscillator to the power supply and with the aid of a suitable instrument adjust the mechanical tuning control to a frequency of oscillation at the centre of the band desired. (This will usually now be 10368MHz.) Now set the the tuning control to maximum output and carefully adjust VR3 for the highest frequency available. It will usually be found that the voltage tuning characteristic flattens off rather severely at this point: the maximum voltage should be adjusted to just prior to this.
Once the maximum frequency has been set, turn the tuning pot. fully counterclockwise and adjust VR4 to the point where the output power just begins to fall steeply. This is the lowest frequency point at which the Gunn oscillator will oscillate reliably. Now measure the total tuning range and if necessary, adjust the mechanical tuning to centre the tuning range around the required frequency. Once the tuning range has been set, it should remain reasonably stable. It should only be necessary to adjust the mechanical tuning slightly if the load which the oscillator sees is changed significantly.
The simplest way to set the deviation controls is to get reports from another station, however if another source of unmodulated 100Hz is available, the facility exists to set these controls using the receiver circuitry already on the board. Tune in the source and monitor the audio output.

of the G3IF 10?ub, then simply adjust the tone and speech levels until they sound right. Headphones are recommended for this job.

Other uses

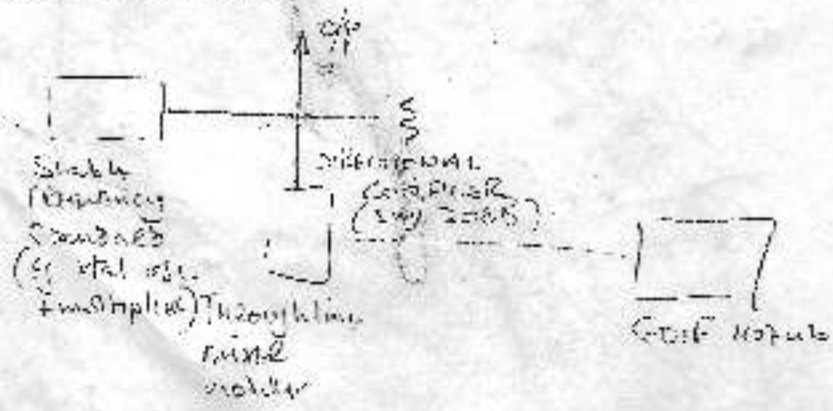
The G3IF 10?ub can be used in applications other than that of a simple duplex transceiver. One of the simplest extensions is to allow operation as a single frequency (simplex) transceiver. It is possible to do this really quite simply. By relay switching the outputs of two different tuning pots from a push-to-talk line, independent tuning of the transmit and receive frequencies is easily achieved.

Independent t/r switching.



Because the G3IF 10?ub has excellent noise performance, one application is to frequency lock a Gunn oscillator to a stable source. This has several applications: it can be used, for instance, to stabilise the frequency of a wide-band beacon transmitter, or to generate a local oscillator capable of sufficient stability to allow the use of nbfm with its consequent system performance gain. It is unfortunately not possible to obtain a sufficiently narrow spectral line to allow the use of ssb or conventional cw modes. (Most of the energy is, however, still contained within a 1kHz bandwidth) although the system bandwidth can be reduced by accepting that there will be no normal note to a cw signal and taking what sounds like an incredibly rough signal on an ssb receiver. Keying is best accomplished by frequency shift keying the crystal controlled reference. If the G3IF 10?ub is to be used in just a frequency locking application then there is some advantage in increasing the loop bandwidth by reducing the value of C11. Some experimentation may be required here.

Frequency locking



Useful references and further reading.

Radio Communications

Jul. 1984	p[illegible]	Basic transceiver systems
Jan. 1981	p47	Fixed operation using passive reflectors
Mar. 1981	p211	Path Plotting
Feb. 1981	p14[illegible]	[illegible] Sighting Compass
Dec. 1980	p[illegible]	Tropo openings
Apr. 1980	p382	Tropo openings
Sep. 1980	p[illegible]	Calculating bearings and distances from National Grid references
Nov. 1980	p[illegible]	Aligning antennas accurately
Nov. 1979	p1044	Propagation enhancements
Feb 1978	p[illegible]	Microwave path checking
May 1979	p432	Performance of equipment over line of sight paths
Jun. 1979	p492	Introducing 10GHz Transceiver
Oct. 1978	p[illegible]	Superefraction
Nov. 1978	p985	Superefraction
Jun. 1977	p453	Superefraction
Feb. 1976	p123	G8PFF Gunn oscillator
Mar. 1976	p194	Dustbin lids as dish
May 1976	p352	Xtal controlled frequency marker
Oct. 1976	p737	Simple dish feed
Feb. 1975	p135	Self calibrating wavemeter
Apr. 1975	p261	High Q wavemeter
Oct. 1973	p612	Directional Coupler based transceiver
Jan. 1972	p61	Horn antenna design
Apr. 1972	p269	Horn antenna design

Practical Wireless
June, July, and August 1981. The PW Mixer Microwave transceiver.

The Microwave Society, "Data pack."

The RSGB VHF/UHF Manual contains many useful items.

Enjoy your microwaving!

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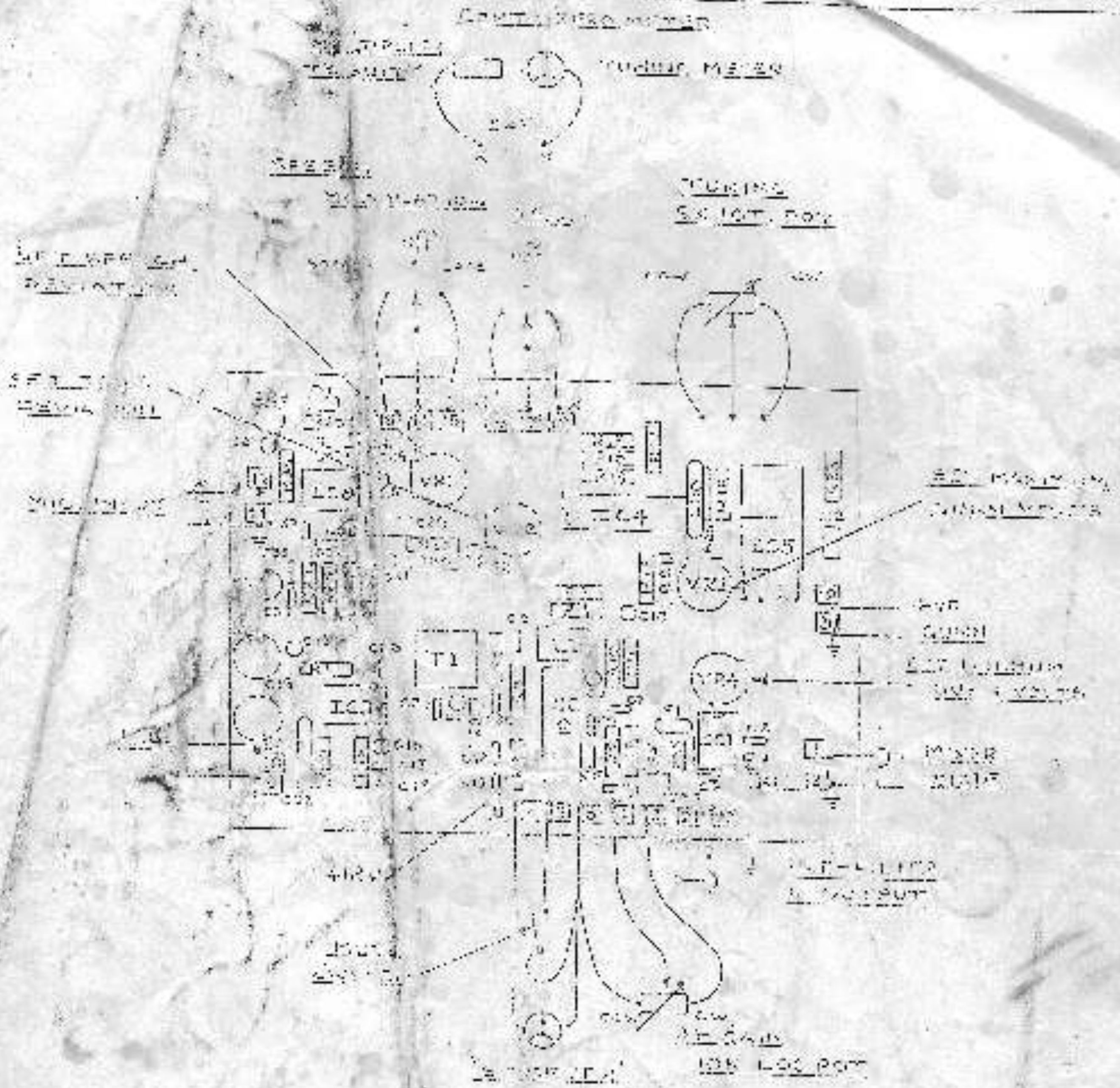

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