G3UKV

THE

MICROWAVE SOCIETY

81 RINGWOOD HIGHWAY, COVENTRY CV2 2GT

Telephone 0203 616941 G6UHF

THE

10 GHz.

DATAPACK.

ISSUE 5. **G8MWR.**

BASIC INFORMATION.

Most of the activity on 10 GHz is on wide band FM, there is a growing interest in SSB but this is a much more difficult mode to generate. The information given in this DATAPACK will concentrate on FM although much of it is common to all modes.

Many people are using the band for "home to home" links and are also using Data and ATV on the band. No straight answer can be given as to whether a particular home to home link will work, there is only one way to find out and that is try it and see. With the tremendous upsurge in activity it is certainly worth considering base station operation.

All activity is now centred around 10.37 to 10.4 GHz with SSB at the lower end and FM at the upper. One advantage of this narrower range is that mechanical tuning is no longer required, as it is easily possible to accomplish it by electronic means. There are several beacons avilable around 10.4 GHz which help in setting up and initial calibration.

Talkback is normally on two metres using a calling frequency of 144.175 and USB. If you only have FM for talkback you should use 144.525. Most talkback systems use something like an FT290 and an HB9CV. Due to the height of the sites and their very exposed nature this low power is adequate.

The distances covered are "optical" plus about 30% for bending effects. Distances depend on the height of the sites being used and paths of more than 100 KMs are easily workable from around 600 Ft ASL.

Transmit power is usually around 5 to 10 milliwatts on FM and around 1 milliwatt on SSB.

Aerials may be a simply made horn with a gain of up to 23 db or a dish of perhaps 24 inch diameter with a gain of around 33db which will give an ERP of about 5 to 10 watts. To get an extra S point or so requires that the size of the dish is dobled, this then produces problems of support, alignment and not least transport! The law of diminishing returns applies.

There is NO health hazard at these power levels. However common sense suggests that you should not stand in front of the dish for LONG periods and, because your eyes are very easily damaged by radiation, and this damage, once sustained, CANNOT BE REPAIRED..........

NEVER LOOK INTO THE WAVEGUIDE!

GETTING THE BITS.

The society maintains a supply of most of the hard to get parts and hardware. These are normally NEW and the prices are lower than you would generally find. We usually have waveguide in both WG16 and WG20 (24GHz), flanges in WG16 and WG20, Dishes in 16 and 24 inch sizes, Gunn and mixer diodes, PTFE tuning rods and top quality PCBs for the circuits in the DATAPACK.

Please check availability and price BEFORE ordering.

SOLFAN microwave heads are available from a member..........
Mr T Wraith, 33 Colebrook Rd, Swindon. at a cost of £15

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TECHNICAL CENTRES.

These are run by people who have the experience and equipment to help you if you get problems. Please write describing your problem BEFORE arranging a visit.

COVENTRY	G8MWR	81 RINGWOOD HIGHWAY,
WELWYN	G8FXM	45 POPPYFIELDS,
SWINDON	G3KEU	123 AVON MEAD, GREEN MEADOW,
SHEFFIELD	G8AGN	345 REDMIRES ROAD,
WOLVERHAMPTON	G8SWZ	167 ALLDERSLEY RD, TOTTENHALL,
MALVERN	G4TXG	126 LONGRIDGE ROAD,
HARTLEPOOL	G3NWU	73 EAMONT GARDENS,

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MICROWAVE AWARDS.

10 GHz	50 KMs	UPGRADE EVERY 25 KMs.
24 GHz	20 KMs	" " 10 KMs
47 GHz	5 KMs	" " 5 KMs

Submit £2 plus QSLs showing the location of BOTH sites.

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MEMBERSHIP LISTINGS.

These are in two forms at £1 each (approx 16 pages)

A) listed by callsign. B) listed by nearest large town.

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PATH LISTINGS.

Computer listings showing bearings and distance from ANY specified NGR to most of the well known microwave sites are available at a cost of £1.

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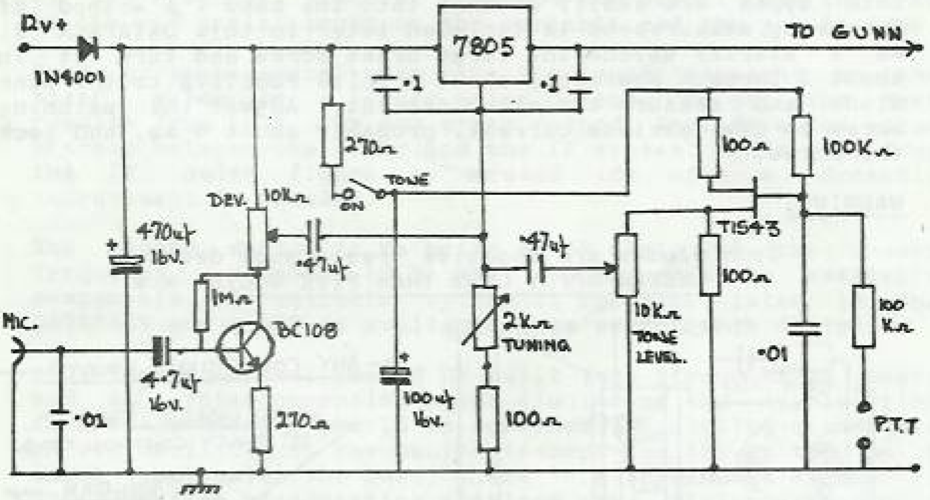
MODULATOR-PSU SYSTEM.

A PCB for this circuit is available from us.

The basic piece of microwave equipment is the Gunn diode. Before we can get this to operate we need a well stabilised low voltage supply capable of operating over the range of 5 to 10 Volts at a current of around 100 ma. This can have the modulator and tone oscillator built in and then becomes the basis of the whole system.
The complete circuit can be built on a piece of Veroboard or on the PCB which is available from us. The 7805 will not require a heatsink due to the low current drawn by the Gunn.



The microphone input will accept most dynamic mikes and the controls are self explanatory; the MOD and TONE level controls are presets. The microphone PTT switch can be used to overide the tone oscillator making it impossible to "talk over" the tone.
The Gunn supply should vary from around 5 to 10 volts as the FINE TUNE is rotated, giving a tuning range of about 50 MHz.
If a scope is available the tone and mod levels on the Gunn line can be set to about 100mv pk to pk. Final adjustment will have to be made with a station some miles away.
When on RX the tone oscillator may be used in the same way as a BFO.
If the mic PTT switch has a second set of contacts these should be arranged to short the microphone while on RX to stop any mic pickup being superimposed on the RXd signal.
Some balancing of the controls may be required to avoid a small shift in frequency when going from TONE to MOD. This is caused by different leakage currents in the capacitors going to the top of the FINE TUNE control

THE MICROWAVE HEAD.

Most people do not build the microwave head due to the availability of the SOLFAN unit, but for those who do wish to build their own full details are available from us.

THE SOLFAN HEADS.

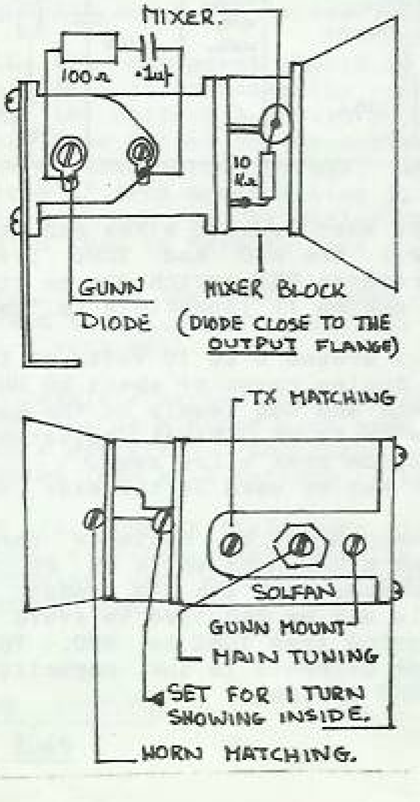
These are available in two types, one containing just the Gunn oscillator assembly and the other with a built in mixer. The first type can be used with a home built mixer for which details are shown below.

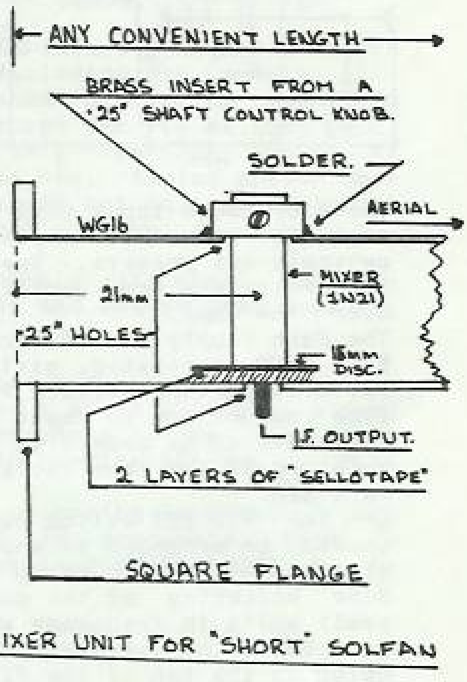
SETTING UP.

Both types are easily retuned into the band (a method of frequency measurement is included later in this DATAPACK). As a starter unlock the large brass screw and turn it in about 2 turns. Now apply about 8 Volts POSITIVE to the Gunn diode and measure the mixer current. Adjust the matching screw to give maximum current, probably about 4 ma, and lock the screw.

WARNING.

Gunn diodes are negative resistance devices
* * NEVER APPLY LESS THAN FIVE VOLTS * *





MIXER UNIT FOR "SHORT" SOLFAN

THE RECEIVER SYSTEM.

The receiver system, in this context, consists of the IF strip, demodulator and audio output stages. The microwave head that feeds this system may take many forms.

The IFs in common useage are 10.7, 30 and 100 MHz. No real advantage is to be gained from any of these IFs and the choice is purely a matter of convenience although with the availability of the MuTeK board and our own PCBs most people are now using 10.7 MHz.

The simplest way to obtain this part of the system is to use a cheap portable FM receiver tuned to around 100 MHz, clear of any broadcast signals. Connect the output from the head to the rod aerial input on the portable and the job is done.

Most portable receivers take the input straight to the mixer, which is a rather noisy device. To get the best results from this, or any other method, include a low noise pre-amp between the mixer and the IF system. This will drop the IF noise figure to around 1db with a dramatic improvement in results.

The second method is to build an IF strip at the chosen frequency, usually 10.7 MHz, using readily available components. A suitable system is described later in the DATAPACK and a PCB is available from us for this design.

ALL the equipment should be built into strong METAL boxes and ALL interconnecting leads (including the supply line from the battery) should be screened. Decoupling capacitors should be fitted to the cables (except the IF) at the point where they enter the box. There is a tremendous amount of stray RF from broadcasting stations etc, flying around on a hilltop and it is easier to keep it out in the original build than to have to cure the trouble later.

Try to make the whole system reasonably rain proof, you are bound to get caught sooner or later and soaked gear does not work very well.

A complete system should draw about 200 ma at 12 volts so the use of a Nicad pack made up of C cells will give a full day's operating. Another excellent power source is a fully sealed lead acid battery as used in burglar alarms.

If full DUPLEX (telephone style) operating is required then both stations must use the same IF frequency. This is becoming more common but most operating still tends to be done on SIMPLEX.

I F PREAMPLIFIER.

The IF pre-amp to be described is a wide band unit and may be used at frequencies up to well over 200 MHz. It uses an IC type SL560c which is also available from RS components as part number 303-214 type RS560c.

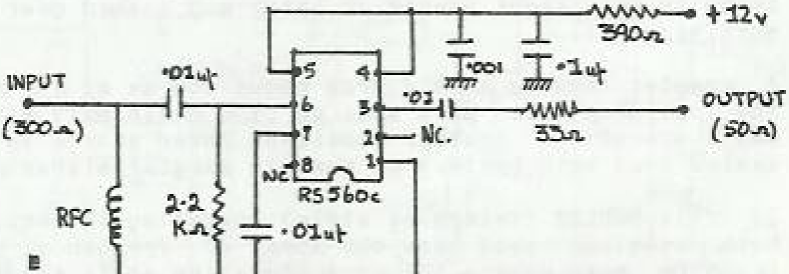
The IC is housed in an eight pin package and has some very interesting features.

A) Gain of up to 40 db.
B) Noise figure less than 2db.
C) Useable to over 300 MHz.
D) Low power consumption.

The circuit shown below has been optimised for use with input impedances of about 300 ohms (typical microwave mixer) giving a noise figure of <2db and a gain in excess of 30 db at frequencies up to 120 MHz falling to 20db at 200 MHz. These figures are sensibly constant over a supply voltage range of 9 to 12 volts. If the connection between pins 4 and 5 is removed the gain will increase by 10db. This should not normally be required. The output impedance is designed for use into 50 ohm systems and therefore is ideal as part of a remote head. The pre-amp is "wide open", suitable tuned circuits or filters could be used to restrict the reponse. A simple method is to place a series tuned circuit at the required frequency in series with the output line.

When making the unit leave as much copper as possible to act as a ground plane and fit all decoupling capacitors as close as possible to the pins of the IC. The RFC should be around 100 microhenries at 10.7 MHz and at 100 MHz could consist of about 20 turns of thin wire wound on a small former.

Fit the unit as close to the head as is reasonably possible and keep all leads short.



ALL CAPACITORS ARE DISC CERAMIC TYPES.

THE IF / AF STRIP.

A PCB for this circuit is available from us.

This circuit uses only two easily available ICs and should be built on a peice of double sided PCB material, one surface of which should be used as a ground plane.

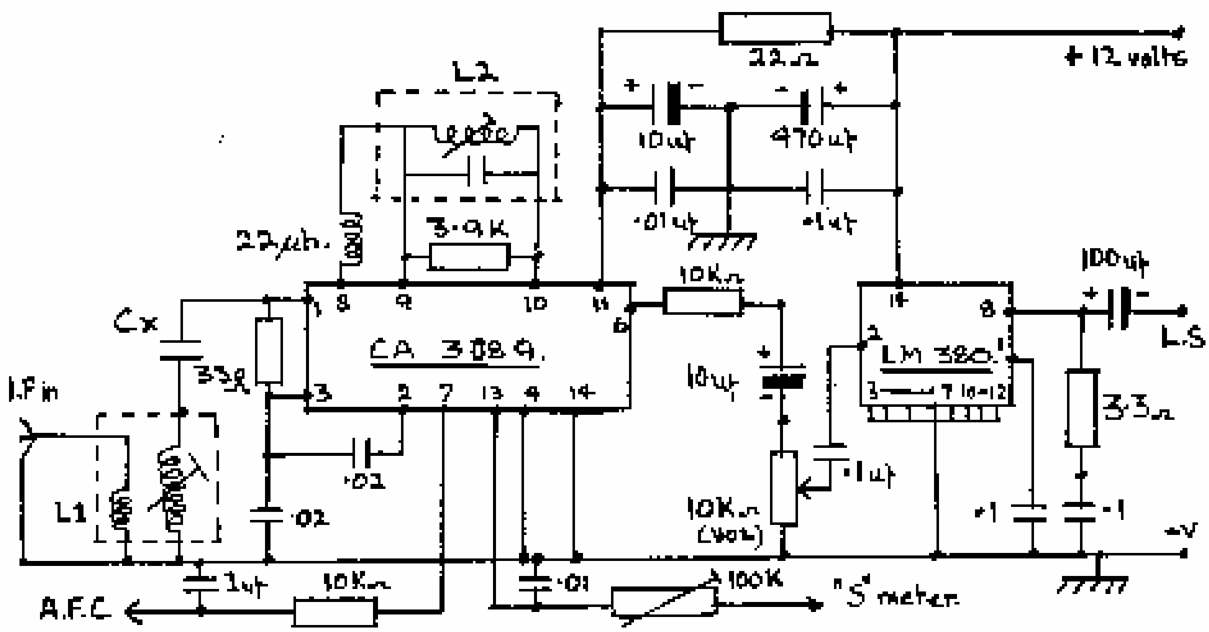
The circuit may be fed directly from the mixer unit but for best results a pre-amp should be used.(This is included as part of the PCB we supply).

All decoupling capacitors should be disc ceramic types, fitted as close as possible to the pins of the IC and all track lengths should be kept as short as possible to avoid instability.

An AFC output is available if required but this would need the use of a more complex MOD/PSU board. For normal operating it is not required but for a home to home link it would be essential.

The only adjustments required are to set L1 for the best quieting on a weak signal and then adjust L2 for the best quality recovered audio.

S meter sensitivity is a matter of choice and is set by adjusting the 100K preset in series with the meter to give a reading which seems "about right" to you!.



Cx .01uf disc capacitor or 280 KHz bandwidth ceramic filter

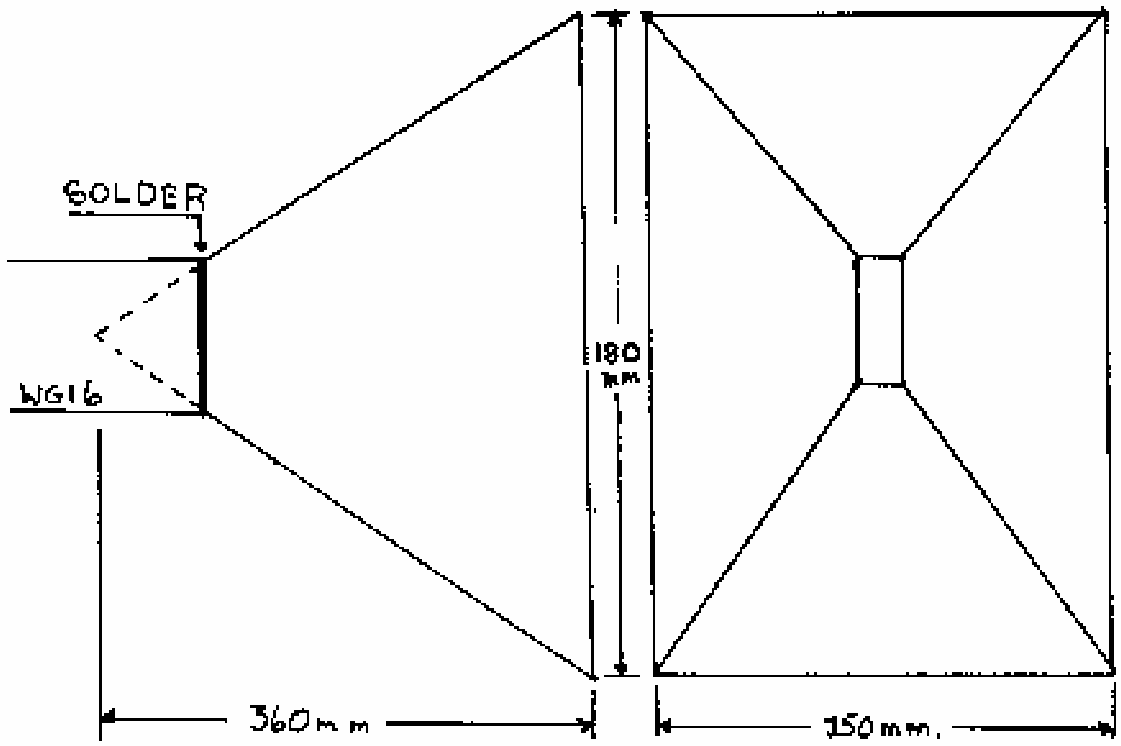
L1.......Toko KAC 6184 L2.......Toko KACSK 586

THE HORN AERIAL.

The horn aerial has several specific advantages. It is very easy to build, the gain is predictable, it is very tolerant of small dimensional errors and as it is "self terminating" there are no problems with SWR. It makes a very good reference aerial against which to judge other systems.

The material may be tin plate or any easily soldered material. Old 1 gallon oil cans are a useful source of supply

The design shown will give a gain of around 20db. Horns may be built to any gain required but above 23db they become very large and a dish makes more sense.



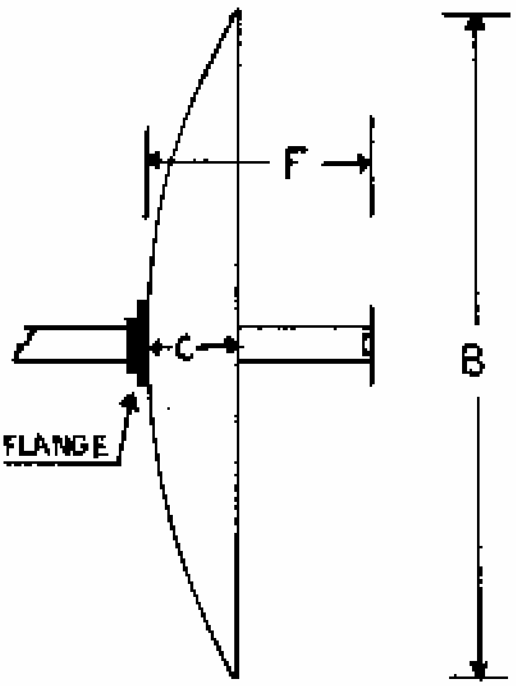
The dotted section shown in the waveguide does not exist. It is only shown to make measurement easier.

The simplest method of construction is to leave tabs on the long edges of the panels. These are then bent over and soldered to the adjacent panels. This will hold the sides rigid whilst the full length of the edge is soldered. Solder is very lossy at 10 GHz so

KEEP SOLDER OUTSIDE THE SYSTEM.

With the long side of the waveguide vertical, polarisation is horizontal. This is the accepted polarization for ALL modes.

DISH AERIALS AND FEEDS.



The focal plane of a dish is found using F=B*B/(C*16) with all dimensions in the same units.

The gain of a dish depends on its size and the frequency.

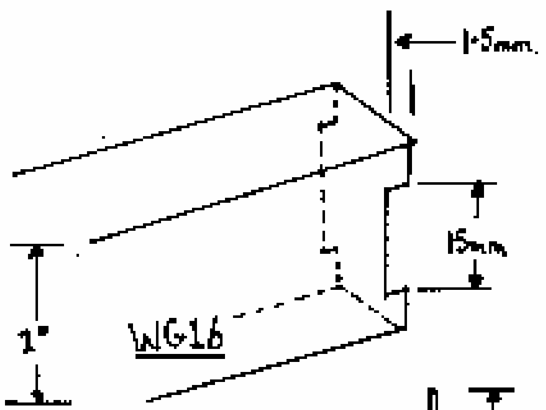
At 10 GHz:

12 inch.........28 db.
18 inch.........31 db.
24 inch.........34 db.
36 inch.........37 db.

Care should be taken when mounting the feed to make sure that it is centralised properly. If this is not done the dish will "squint".

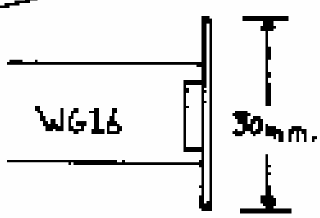
THE PENNY FEED.

This is a very simple feed system to construct.



A slot 15 mm long and about 1.5 mm deep is cut in the end of both wide faces of the waveguide. The end of the guide is then closed using a metal disc 30 mm in diameter which is mounted centrally on the guide.

KEEP SOLDER OUTSIDE THE GUIDE.



The radiating point is located at the slot and should be positioned at the focal point of the dish. This point may be checked by pointing the dish at the Sun on a bright day. The light rays should focus at the slots on the end of the guide.

FREQUENCY MEASUREMENT.

This method of measuring frequency at microwaves is very simple and with care will give an accuracy at 10 GHz of +/- 10 MHz. The same system can be used on other bands and it relies on using "invisible" Lecher lines.

METHOD.

First fix the microwave head firmly to a solid support. Any movement will spoil the accuracy of the result.
Apply the normal operating voltage to the Gunn diode and connect a millameter to measure the mixer current. When the Gunn is switched on you should get a reading of one to three millamps on the meter.

Take a flat piece of metal and keeping it parellel to the head move it slowly away whilst watching the mixer current. As you move the plate this will vary, move the plate until a minimum is found and mark the position of the plate. Continue to move the plate until the next dip is found and mark the point.

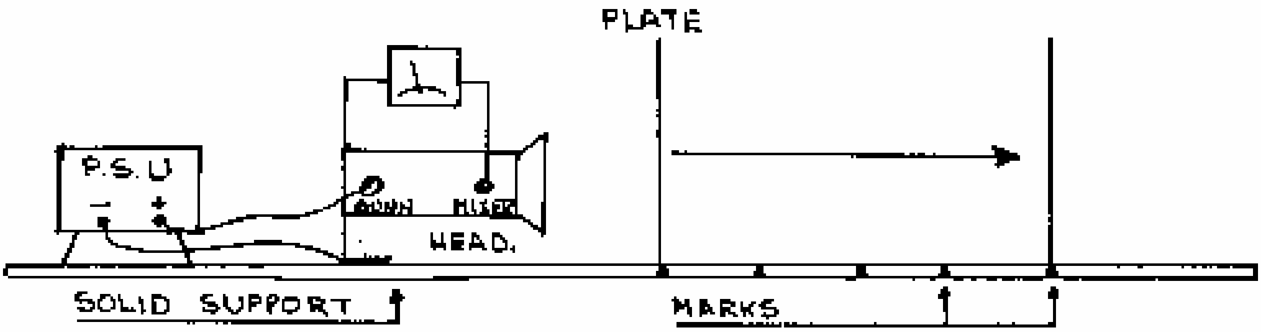
The distance between the two points is a half wavelength and from this the frequency can be calculated. The accuracy of this measurement system can be much improved if you go through several dips and then average the distance.

CALCULATION.

The frequency in GHz is found using

$$\frac{150}{\text{Length in millimetres.}}$$

DIAGRAM.



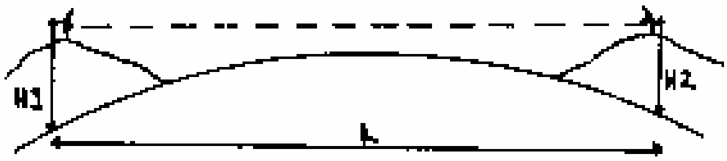
PATH CONTOURS.

New equipment should always be checked out over a path where both ends can be seen. When paths of extended length are attempted a check of the ground profile should be made before the path is attempted. The nature of the check can vary from trivial to extensive.

If there is some doubt as to the viability of the path a quick check can be made as follows:

A) If the path is fairly flat, as in figure 1;

Figure 1.



The path should be workable if $L < 4.12 * (\sqrt{H1} + \sqrt{H2})$
With L in kms and H1, H2 in metres.

B) If the path contains a significant obstruction as in figure 2;

Figure 2.

The path may be workable if $L < 4.12 * (\sqrt{H1-H3} + \sqrt{H2-H3})$
With all units as in figure 1.

BENDING.

Under normal "K" factor conditions the optical range at 10 GHz is in fact (optical * 1.33), and the previous information allows for this automatically.
If in doubt about a path always try it on several occasions, the procedures described above are only approximate and propogation methods such as diffraction, scattering or ducting may make it work

Computer listings from your specified NGR to most main microwave sites in the country are available from us.

PROPAGATION AND THE WEATHER.

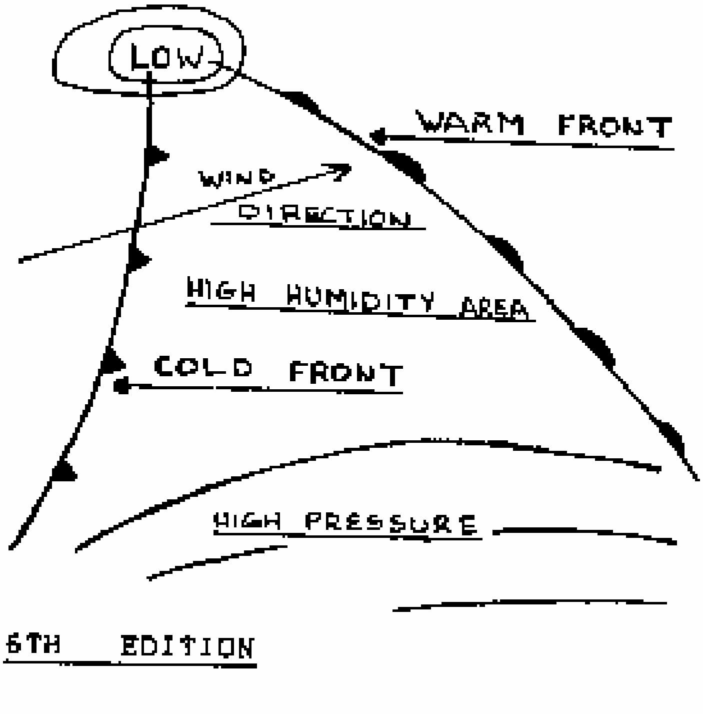
All radio signals suffer a small degree of bending caused by small variations in the density of the air they pass through. In average weather conditions the density of the air gradually decreases with an increase in height and this effect is known as the "Lapse rate". This condition produces "Standard refraction" and its effect on radio waves is to make them try to follow the curvature of the Earth.

In practice standard refraction bends the wave to the degree where the Earth appears to have a radius of 4/3 its true value, the "K" factor.

Temperature and humidity cause the major changes in air density; low temperature and high humidity causing the greatest bending effect. Humidity contributes the major effect but as its value increases there is a tendency towards rain, which has an absorbing effect on the waves; although if enough power is available the droplets may scatter the signal and aid communication.

When attempting an especially long path it is an advantage to choose a period of high humidity and this is best done by consulting the Atlantic weather map as shown on BBC TV weather forecasts.

The thing to look for is a wedge of air trapped between a leading "warm" front and a trailing "cold" one (see the sketch). The fronts are usually rain bearing and the trick is to catch the humid air between them. Both stations need to be in this air and attempts to work through a front over paths exceeding 4/3 are doomed to failure. The worst conditions in which to try are during the clear showery air behind a cold front. The "K" factor is then less than 1.33 and in severe cases a condition known as "sub refraction" can occur.



Under these conditions the air density close to the ground is marginally less than in the air above and when this occurs microwave signals bend AWAY from the Earth's surface and so reduce the workable path.

A classic path is the one from Mynydd Maen to Walbury Hill. This just works under normal conditions, fails completely in clear weather and is superb when there are conditions of high humidity.

MARKER GENERATOR.

One of the major problems for the newcomer is knowing if he is on frequency. If you use a wavemeter with 10 MHz resolution then you will have to tune over a 20 MHz range to be sure of hearing the other fellow (and that assumes he is accurately on frequency). It would be a good idea if we could agree on common working frequencies and all get accurately on them.

Most people operating on 10 GHz have VHF transceivers capable of generating channelised FM. If we can relate the 10GHz frequencies to VHF it would be possible to eliminate the uncertainties.

We suggest that 10.386 and 10.387 GHz are used for 10.7 MHz based duplex. These can be generated as 432.75 MHz times 24 or as 144.25 times 72. It is not possible to multiply to exactly 10.7 MHz below any frequency appearing as a 25 KHz increment at 432 MHz however 432.3 times 24 gives 10.375.2 GHz which is within the passband of most WBFM systems. 144.10 MHz times 72 is the same.

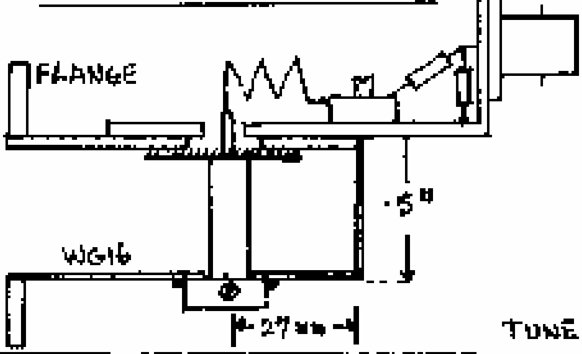
How do we multiply from VHF / UHF ? A spare mixer unit driven with about 50 to 100 milliwatts of VHF is more than enough. I use a surplus SIM-2 mixer with a simple matching network. This diode will stand a lot more incident power but this will result in a short and merry life. The normal 1N21 and 1N23 types work well.

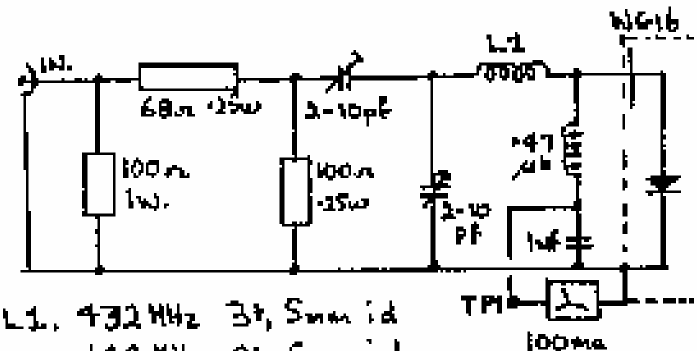
If you do not have a spare mixer then build one from the details shewn below, it entails very little metal work.

A small metal plate should be soldered to the WG16 and the components are mounted on this. The diagrams are self explanatory.

This unit will give very accurate frequencies but, due to the number of harmonics produced and to image responses, you will still need to do a rough set up BEFORE using this unit.

FOR DETAIL SEE PAGE 4.





L1. 432MHz 3t, 5mm id
144MHz 8t, 5mm id.

TUNE FOR MAX CURRENT: REMOVE METER: EARTH TP1

10 GHZ ATV.

All the following informaton came from members and the originators of the circuits are believed to be the contributors. If this is not so and any copyright material is used without acknowledgement we express our regret and would be pleased to give credit to the originals in the next edition of the newsletter.

A lot of information has been received and rather than trying to seperate it we thought it would be better to give you as much information as possible and then you can sort out your own method of putting a system together. The first,and possibly the simplest ideas come from G6YBC and the first method is shown in Fig 1.

A diagram of the usual camera connector pin out is given in Fig 2. The next idea given in Fig 3 could easily be built as a simple outrigger to be used with the Society transmit board. All that would be required is a simple switch as shown in the diagram. Fig 4 gives a block diagram of the complete system and makes use of a video/sound combiner board that was described in CQTV 133. (This is the magazine of the ATV club).

The pre-amp shown in Fig 4 can be obtained by a slight mod to the Society RX board and this is shown in Fig 5. A circuit for obtaining an ATV signal from the CA 3089 chip is shown in Fig 6. This has not been tried with the 3189 but may well work. If you want to put this mod on one of our RX boards you will have to remove the ceramic filter and replace it with a .01 disc ceramic. If this is not done then the bandwidth of the receiver will be to narrow.

A circuit for a video clamp is given in Fig 7. This could be easily built as a veroboard add on to the main board. The associated TV receiver must be able to handle FM sound and if this is not the case then G6YBC advocates the use of an FM sound board as described in CQTV 122 and 123. We have no intention of making our own combiner and FM receiver boards as these units are readily available and there is no sense in " splitting the market".

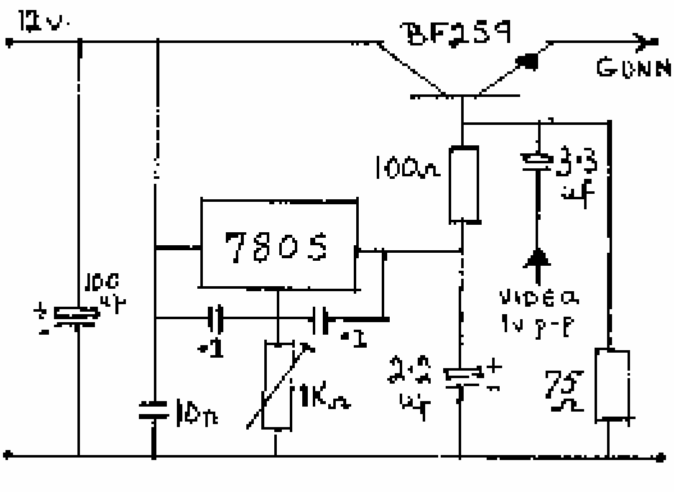


FIG 1. VIDEO MODULATOR

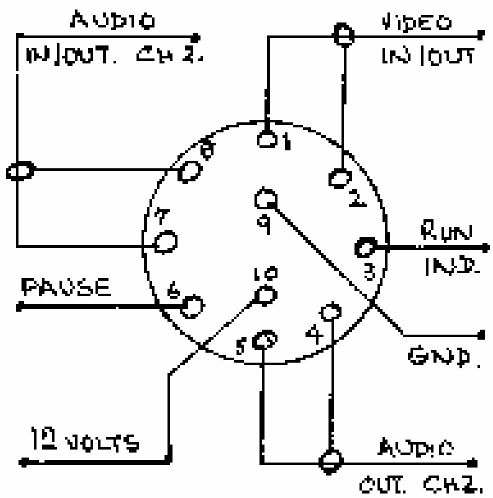


FIG 2. CAMERA PIN-OUT

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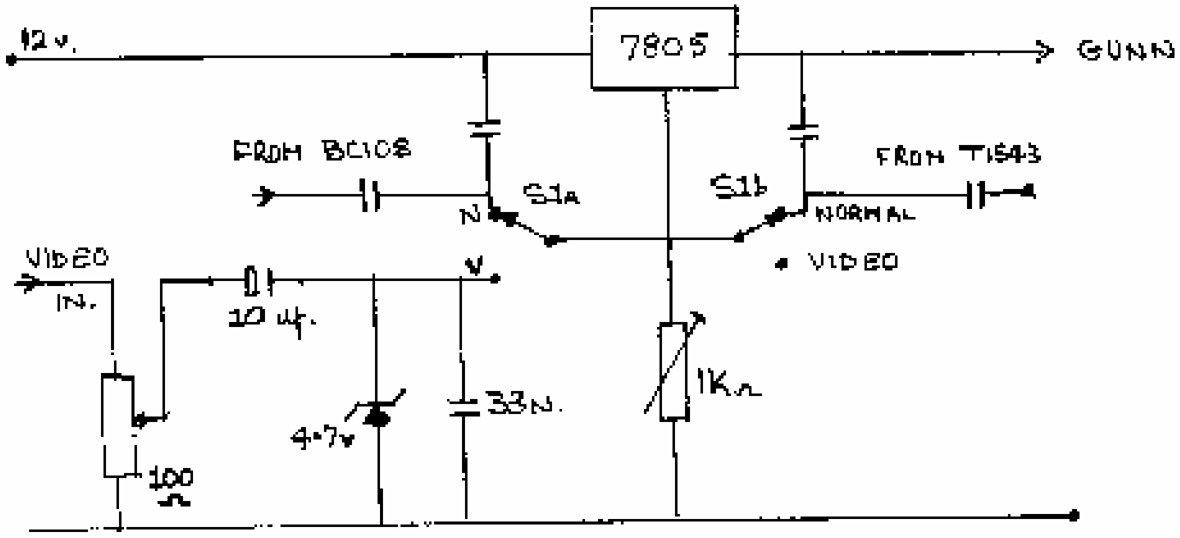

FIG 3. MODIFICATION TO SOCIETY TX BOARD.

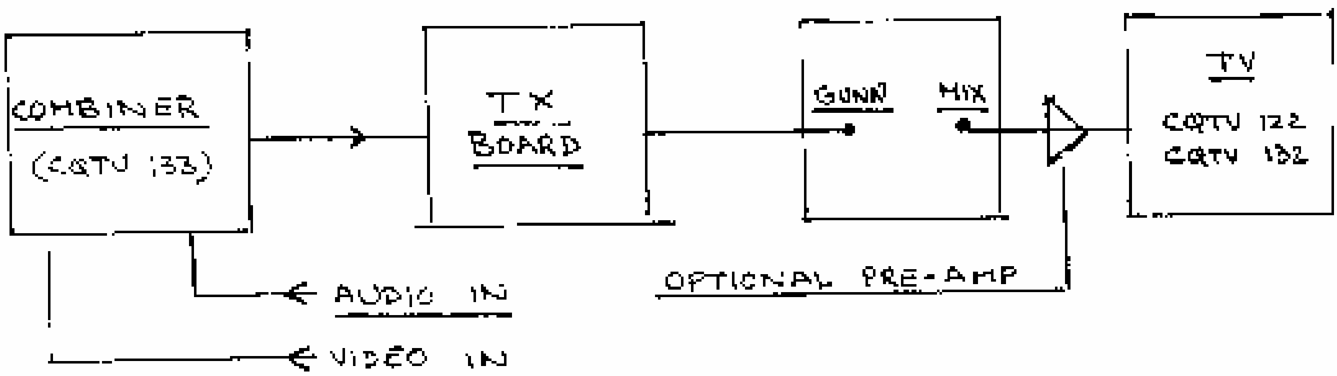

FIG 4. BLOCK DIAGRAM OF COMPLETE SYSTEM.

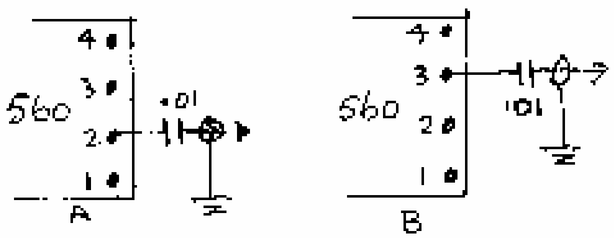

FIG 5.

A WIDEBAND OUTPUT CAN BE TAKEN FROM PIN 2 OR PIN 3 OF THE SL560C I.C. DEPENDING ON BOARD VERSION.

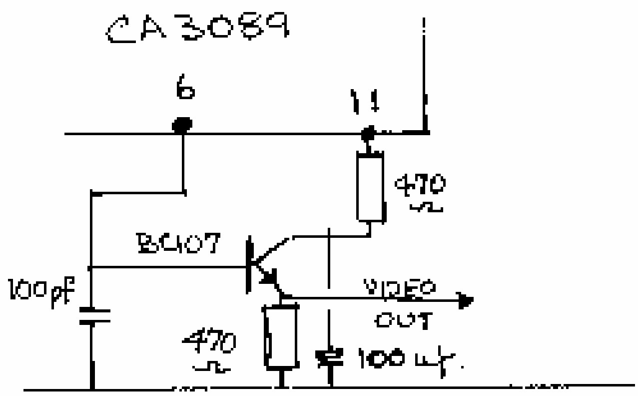

FIG 6

VIDEO OUTPUT FROM CA3089

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