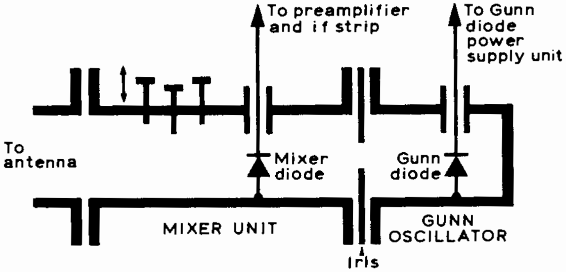


Fig 18.41. In-line mixer/oscillator, block diagram (G3RPE/G3WDG)

rotated. Care should be taken to remove burrs, especially from the areas in contact with the diode and the insulation. Both the iris plate and the spacer plate (if used) must be flat in order to ensure good contact and maintain the Q of the cavity; these plates are best sawn from sheet rather than cut by tinsmith's shears.

A simple 10GHz Gunn oscillator and mixer

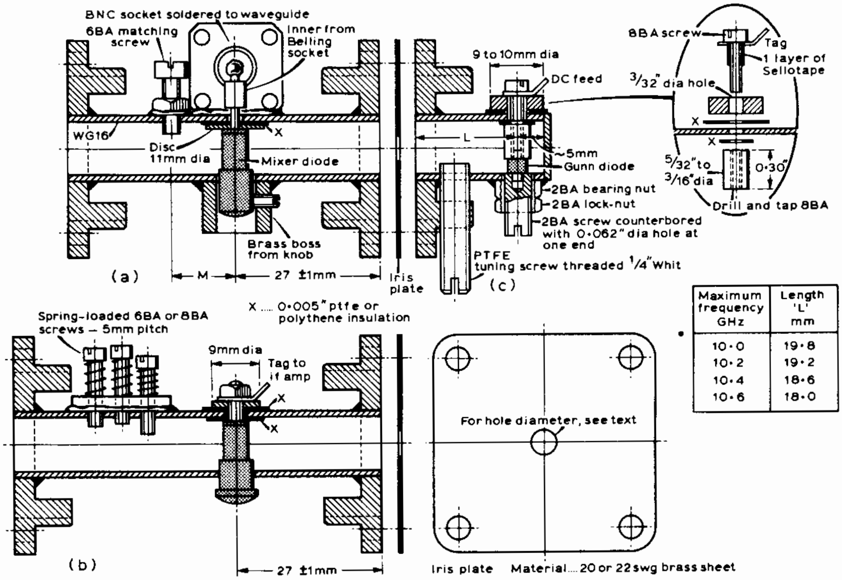
This design was originally described in [15], primarily as a receiver "head" with limited transmit capability. The Gunn oscillator is a particularly reliable and reproducible design and the in-line mixer is described here (rather than in the earlier section on waveguide components or the later section on 10GHz down-converters) because it is a natural companion to the oscillator.

The receiver schematic is shown in Fig 18.41. It consists of a simple mixer assembly which is connected directly to a Gunn oscillator of the type whose cavity is defined by an iris. The mixer uses a length of waveguide into which is fitted the mixer diode, the hot end of which is decoupled and feeds the i.f amplifier in the conventional way. Diodes of the 1N23 type are recommended; those with the later prefixes (E, F) are preferred for their lower noise figures.

The signal-input end of the guide can be any convenient length and is fitted with a matching screw (or screws) to match the mixer diode to the waveguide. The length of the waveguide at the local oscillator end is critical; it needs to be made electrically an odd number of quarter guide wavelengths, i.e. $n \times \lambda_g/4$, where n is 1, 3, 5, 7 etc, as is convenient. This rear cavity is closed by the same iris as that used to define the Gunn oscillator cavity.

Two forms of the mixer assembly which were developed quite independently are shown in Fig 18.42a and b. A third method of mixer decoupling is shown in Fig 18.43 and Fig 18.44, which shows a complete assembly of mixer and oscillator. Also shown is a recommended design of Gunn oscillator which is a modification of the G8APP design [14] with a fixed, rather than adjustable, rf short. A feature of the design given in Fig 18.42a is that it requires a minimum amount of tools in its fabrication. Points that can be made with respect to its construction are:

1. First drill a hole about 3/32in (2.4mm) centrally through the both broad faces of a suitable length of WG16 and open one of them to 0.25in (6.4mm) diameter.



Maximum frequency GHz	Length 'L' mm
10·0	19·8
10·2	19·2
10·4	18·6
10·6	18·0

Fig 18.42. Detail of construction of the mixer oscillator of Fig 18.41

2. Remove the brass centre boss from a knob intended to be used with a 0.25in (6.4mm) shaft by breaking away the surrounding plastic. Fit the two flanges in their positions and solder these and the boss in a single operation. The latter may be jigged using a 0.25in (6.4mm) drill shank. Note that the position of the input flange is not critical in any way, but that at the oscillator end should be within about 1mm of that specified.

3. Drill and tap the holes for the matching screw(s). Remove any excess waveguide projecting from the flanges by sawing, filing and finally by grinding on wet silicon carbide paper backed by a sheet of glass. Carefully remove burrs from the inside of the guide, especially where the insulation is to be fitted.

4. If the only diode available is of the fixed collet type, carefully file away the lip so that the connection is uniformly 0.25in (6.4mm) diameter. If the diode available is of the removable collet type, an earthing block such as that shown in Fig 18.41 can be used instead of the modified fixed collet.

5. Drill the hole in the capacitor plate so that it is a tight fit on the diode pin. When assembling, press the diode against the wall of the guide before tightening the grub screw.

The construction of the design given in Fig 18.42b is similar, but in this case the diode is bolted to the bypass capacitor at one end, while the other end is made a tight fit in the wall of the guide. In mixer diodes that are reversible, it will be found that one pin is solid and, preferably, this pin should be threaded. The pin is undersized for the 8BA thread specified, so forces involved in tapping the thread are small; it can be done while holding the diode with the fingers.

The fabrication of the Gunn oscillator should present few problems. Constructional details are given in [14] if these are required. An alternative to the turned mounting post was suggested by G4DDK [16] who found that the brass bolt from the old type of ceramic-bodied mica compression trimmer capacitor can be used. It is removed by breaking away the ceramic body and consists of a thin disc at the top, suitable for decoupling, and is tapped approximately 8BA for a bolt to pull it to the top of the waveguide. The same tapped hole, enlarged slightly at the end remote from the disc, serves as the diode mounting hole.

Heatsinking in this design is certainly adequate for the low power diodes which generate up to about 20 or 30mW and which dissipate about 1W. It is insufficient for high power devices which dissipate about 10W. Note that for many low power Gunn diodes, the connection with the flange should be made negative.

Alignment can be simply achieved without elaborate test gear if the following method is used:

1. Connect the input of the mixer via a variable attenuator to a suitable rf source, which can conveniently be the Gunn local oscillator to be used. Inject rf at the *signal* frequency and adjust the matching screw(s) to maximise the mixer current while, at the same time, setting the variable attenuator so that this maximum occurs at the optimum value for the particular mixer diode being used. For point contact diodes, a current of 250 to 500μA is suitable. The matching screw(s) should then be locked in position. During this operation the rear end of the mixer cavity should be closed with either the iris to be used or by a blank plate.

2. With the input connected to a matched load and the Gunn oscillator fitted in its normal position, alter the size of the hole in the iris plate until the diode current is the

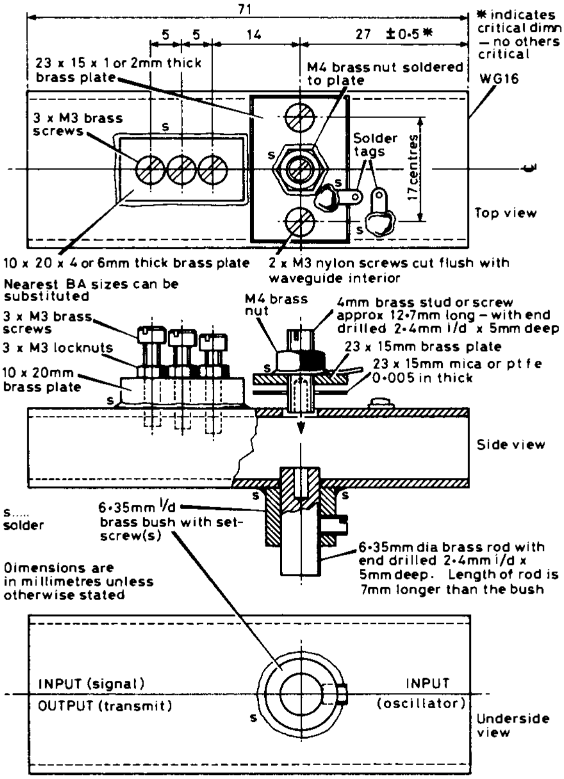


Fig 18.43. Alternative mixer decoupling arrangement (G3PFR)

same as that in 1. Obviously the size of the hole will depend on the output power of the oscillator, but will normally be within the range 3 to 6mm diameter.

An alternative method of alignment used by G3WDG is to attach the receiver to the antenna/waveguide run which is to be used. If this method is used, it is recommended that alignment is carried out outdoors with the antenna pointed at the sky, otherwise reflections from nearby objects (indoor or outdoor) can give rise to confusing results. For initial tests an iris about 3/16in (4mm) is suggested. The matching screw (or screws) is adjusted to set the mixer current to about 250μA. If the current is greater than this, even with no screw penetration into the guide, then the iris should be reduced in diameter. Conversely, if the mixer current obtained with a maximum recommended screw penetration of 3–4mm is still less than the optimum value, then the size of the iris should be increased. If the size exceeds about 6mm, then there is a risk that the stability of the Gunn oscillator might be adversely affected. If the mixer current is still too low, then a fault in construction, a poor mixer diode, a poor Gunn diode or a badly matched antenna should be suspected. The latter can be checked by substituting a large horn (or any other well-matched load) for the antenna in question. If correct operation is obtained,

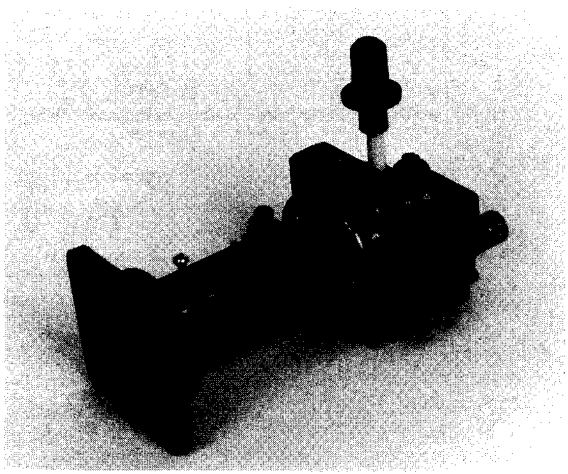


Fig 18.44. Photograph of the oscillator/mixer constructed as shown in Fig 18.43. (G3PFR). Photo: G6WWM

then the matching of the original antenna should be improved using, for example, another set of matching screws fitted adjacent to the antenna. It is also possible that either the Gunn diode or mixer might be at fault; this can be checked by direct substitution of either or both, one at a time.

Alternative configurations of the mixer assembly are possible. The critical dimension of the mixer assembly is the length of the guide between the diode and the iris. This was determined experimentally by fabricating an adjustable iris from 0.02in (0.5mm) thick sheet 0.9in (22.9mm) wide which was bent into the form of a square "U" with base 0.4in (10.16mm) wide. Using the set-up described under alignment, the position of the iris, penetration of the matching screws and the insertion loss of the attenuator were adjusted at signal frequency to peak at the optimum current for the mixer diode. It was found that moving the iris away from its best position by up to 1mm could be compensated for by readjustment of the matching screws. The value given in Fig 18.42, 27mm, represents a compromise length between 10.0 and 10.5GHz. It is somewhat smaller than the values calculated for $3\lambda_g/4$ at these frequencies, namely 29.8 and 27.4mm respectively.

The same procedure is recommended if it is desired to optimise the mixer assembly at another frequency, or to lengthen the cavity by making it $5\lambda_g/4$ or $7\lambda_g/4$ in order to fit a wavemeter. Other Gunn oscillators which employ an iris or its equivalent at the output flange can be substituted directly.

As noted earlier, some of the local oscillator power is radiated from the antenna port and may be used as a low power transmitter. By increasing the size of the hole in the iris plate, the amount radiated may be increased to make the transmitter more effective, although the reduced Q of the oscillator cavity resulting from this change means that the efficiency of the receiver will be impaired. Despite this, the performance of such equipment should be competitive with that of most other wideband transceiver configurations. The size of the iris should not exceed about 6mm diameter, otherwise the stability of the Gunn oscillator may be seriously affected. The in-line receiver is fairly sensitive to antenna match and significant variations in mixer current may be seen with different antennas.

A varactor tuned oscillator

G4EBF and G8EXL [17] suggested mounting a surplus varactor tuning diode in a cavity behind a Gunn diode, rather than alongside it as discussed earlier. Their arrangement is shown in Fig 18.45 and was found to give a change in frequency in excess of 100MHz for a 12V change in tuning bias. The diode will typically withstand a reverse bias of 30V. At this extreme, a change of frequency of the order of 200MHz should be seen. The mounting arrangement for both diodes can be similar to that for Gunn diodes in the oscillators previously described. The dimensions were derived experimentally and some further experimentation may be necessary to optimise the performance of this type of oscillator. As shown, modulation is achieved by applying the modulating voltage to the varactor and the Gunn bias is derived from the varactor tuning supply. With the supplies as shown, the frequency stability will be fairly poor and it may be preferred to use a conventional power supply/modulator for the Gunn and use a separate stabilised supply for varactor tuning. When configured as shown, the exact value of the Gunn series resistor must be selected to suit the particular Gunn diode in use.

Using "surplus" Gunn oscillators

Large numbers of doppler intruder alarm Gunn oscillators and some oscillator/mixers have appeared on the surplus market. Many are dual-cavity side-by-side or "piggy-back" types and are not readily adaptable for amateur use, other than as a source of good mixer and Gunn devices, or for stripping to recover ready made chokes and other mounting/decoupling components.

There are, however, a few types around which can be used directly and effectively. A notable example of an oscillator of excellent design which is still in current production and available from the normal commercial sources, as well as surplus, is the Mullard CL8630 Gunn Oscillator. At first glance the waveguide appears too small for a 10GHz Gunn, but the flange mates with a square WG16 flange and it is intentional that there is a step in waveguide size at this point. This step performs the same function as an iris. The oscillators are normally on a frequency of 10.687GHz, but the tuning screw can be adjusted to pull the frequency down into the amateur band. Usually it is possible to pull them down to 10.1GHz, but there will certainly be no trouble in using them at 10.3 to 10.4GHz. The oscillator is shown in Fig 18.46 and some data for it is also given there. For anyone interested in designing a Gunn mount, some lessons can be learned from this module, as the frequency is remarkably insensitive to the close proximity of objects

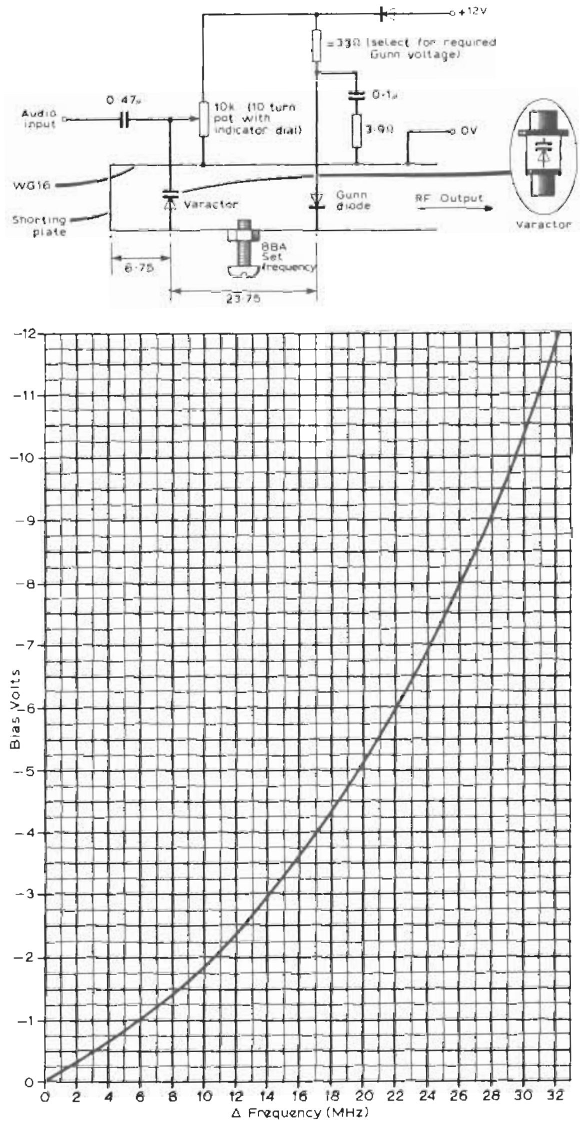


Fig 18.45. (a) Construction of a simple varactor tuned Gunn oscillator (G8EXL) (b) typical characteristics of a varactor tuned Gunn oscillator

(eg. hands) near the open flange, unlike many other designs examined.

Another oscillator which has been found to be satisfactory is made by Solfan in the USA. No technical details are available. However, as will be seen in Fig 18.47, this is a heavy die-cast unit of the iris defined type. It is pretuned by means of a large brass screw and the frequency might lie commonly around 10.68GHz. There are two slightly different types available which differ only in the presence or