

Getting started on 3cm

Brian Coleman and Ian Lamb describe how to become operational on the 10GHZ band with minimum effort.



Figure 1: Quickstarter mounted on the feed arm of a surplus TVRO Offset dish with internal shot inset

10GHz QUICKSTARTER. 10GHz is the most popular of the higher amateur radio microwave bands and provides abundant opportunity for challenging operation. The current UK (terrestrial) distance record of 1347km was made between two home stations. This might be a surprise for those who don't know the band or who perhaps thought DX could only be worked between mountain tops. There are, of course, many opportunities for those who want to work from portable locations and the compact size and light weight of the system described here makes this not only possible but also very enjoyable and rewarding. The purpose of this article is to describe how to become operational on the 10GHz band with minimum effort but with a system which provides a sound basis for future development. Even in its basic form, hilltop contacts to 300 or 400km should be possible and even from the average home station location such distances are possible during enhanced propagation conditions that include rain scatter and thermal inversions.

The system consists of a DB6NT transverter, a suitable relay with associated drive circuit all housed in a weatherproof plastic enclosure. The transverter is small and light enough to be mounted, with the appropriate feed horn, on the support arm

of a small, surplus, TVRO offset dish, and the feed horn is mounted in place of the original LNB, see **Figure 1**. Thus the need for waveguide (plumbing) is minimised.

While 200mW output might sound like low power (QRP), a small TV Receive Only (TVRO) dish will provide about 30dBi of gain and thus achieve an Effective isotropic Radiated Power (EIRP) of about 200W.

THE TRANSVERTER. Kuhne Electronic (DB6NT) offers the modern MKU 10 G2, high performance 10GHz transverter either as a ready-built module or as a kit. Whilst the kit is easy to build, this route should only be taken by experienced home constructors who are well versed in working with surface mount components. To help you decide if this approach is for you, you can download the manual free from the Kuhne Electronic web site. See web search. Whilst the kit comes with adequate instructions, John Hazell, G8ACE, has written some additional notes – a link to which can be found in the hardware section of the UK Microwave Group web site. See the web search for the URL.

Any 144MHz band transceiver that can provide between 200mW and 2W output can be used to drive the transverter. A multimode transceiver is preferred as most communications on 10GHz takes place

using either SSB or CW. A transceiver used for this purpose is known as an Intermediate Frequency (IF) rig. The actual transceiver output power is not too critical as an adjustable attenuator inside the transverter allows the user to set full 10GHz output for any input in this range. The small, battery powered, Yaesu FT290 or FT817 are commonly used as IF transceivers by microwave operators.

THE CHANGE OVER RELAY. The transverter has separate RF connectors (SMA) for RF in, RF out and IF. Whilst there is no requirement for an RF relay between the transceiver and the transverter, an external coaxial change over relay is required between the transverter and the antenna.

A coaxial relay that has reasonably low loss (< 1dB) and sufficient port to port isolation at 10GHz may sound like it would be expensive, they are, in fact, quite common and appear frequently at mobile radio rallies and on eBay. Prices are normally in the range £10 to £25 depending on type and condition. Make sure that the relay you buy is useable at 10GHz before you part with your money. These relays invariably have SMA connectors. An example is shown in **Figure 2** but they come in a variety of shapes, sizes and colours and most commonly have a 28V coil. These will operate satisfactorily down to about 20 volts, but the simple circuit shown in **Figure 3** can be used to operate them from a 12V supply. If, at a later date, you add a power amplifier you will need to think about sequencing the relay to avoid damage to the PA or transverter front end. You should check the relay for correct operation at DC before connecting it to the transverter. C1 may need some adjustment. Too small a value and the relay won't close, too large a value and it has an excessive hang time when switching from transmit to receive the feed horn.



Figure 2: A typical SMA relay suitable for use at 10GHz

FIGURE 3

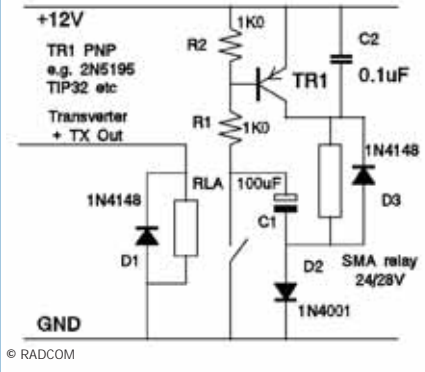


Figure 3: A circuit to drive a 24V or 28V relay from a 12V supply

FIGURE 5

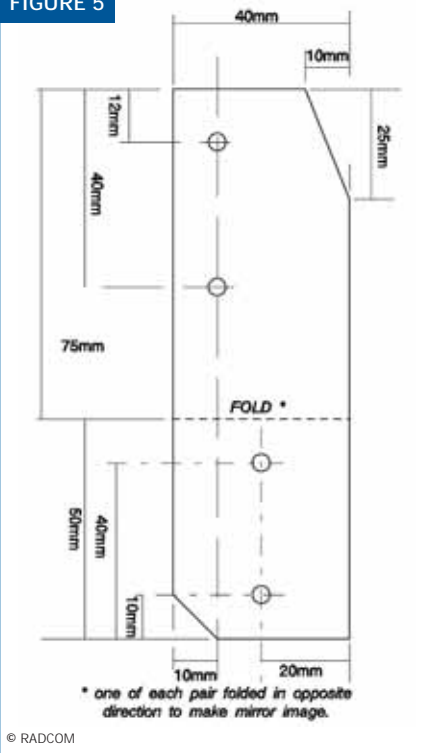


Figure 5: Feed horn fixing brackets

Coaxial cable is lossy at 10GHz so its use is kept to an absolute minimum. Waveguide is much less lossy but can put some constructors off. In the Quickstarter, the transverter is purposely located very close to the dish feed point to minimise the feeder length. The feed system consists of two components, combined into one assembly. The components are a coax to waveguide transition and a feed horn designed to provide efficient illumination of the dish. An SMA to waveguide transition is shown in Figure 4. These are easier to make than you might think, but for those unwilling to try, the complete transition can be supplied by, for example, the UK Microwave Group. The critical dimensions are the centring of the SMA connector, the length of probe within the waveguide and the distance from the probe to the waveguide plug (short circuit) to the rear. If you have access to the necessary test equipment the probe can be made oversized and trimmed down for minimum

FIGURE 4

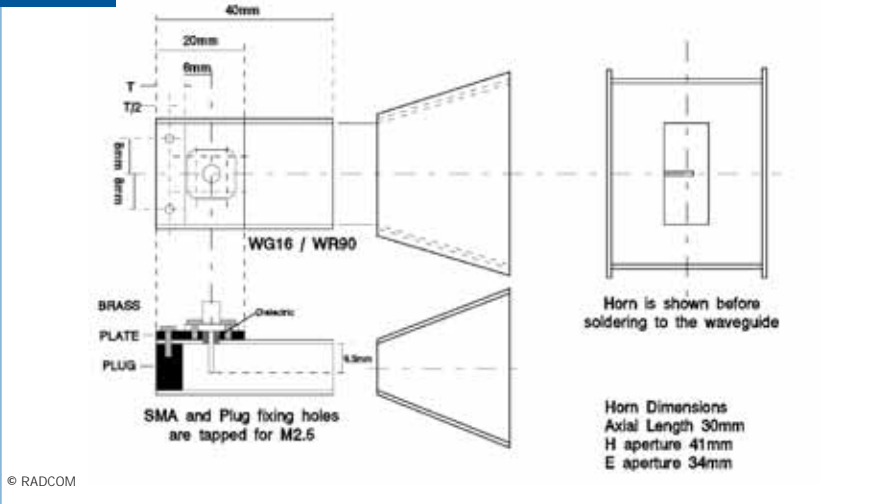


Figure 4: SMA to waveguide transition and feed horn

return loss (best SWR). If you follow the dimensions shown you will have a satisfactory transition. Construction details and a template for making the 10GHz feed horn from copper laminate can be found on the G4NNS webpage. See the web search section for the URL.

METALWORK. Many of us find metalwork a challenge so I have kept the metalwork for this project very simple. It should be possible to fashion the various parts from surplus aluminium sheet, of 1.0 to 1.5mm thickness, using basic tools such as a hack saw, drill and vice. Essentially there are 6 basic components: a pair of right angle brackets to clamp the horn in place, shown in Figure 5, a pair of right angle brackets to clamp the unit onto the feed support arm of the dish shown in Figure 6, and two plates to clamp the transverter in place, shown in Figure 7. The pairs of clamps are folded in opposite directions to form mirror images of each other. The plastic enclosure is available from Maplin, type MB6, code YN39. For portable operation the enclosure only needs a few drilled holes. For a more permanent installation, it should be painted with a reflective paint e.g. silver and thoroughly sealed against rain ingress. Some people prefer to add a small drain / breather hole at the lowest point of the enclosure.

I have not shown the hole positions as they will vary according to the dish used and its feed support arm in particular. What is important is that the centre line of the feed support arm and the feed horn are aligned. The brackets allow adjustment of the whole assembly on the feed support arm and alignment of the feed horn to

place it at the focus and pointing at the centre of the dish.

THE ANTENNA. Surplus TVRO dishes often appear at mobile rallies and can often be found as scrap. What is important is that the profile is in good condition and that the feed support arm is included. If it still has the Low Noise Block (LNB) converter or its fixing clamp attached, so much the better, as this will give a clear idea of where the focus is located. If this is unknown it can be calculated using the W1GHZ program HDL_Ant. See the websearch section for the URL. Use the "Offset dish calculation" option, enter the frequency (10368MHz), the large "diameter" of the dish, the small "diameter" of the dish, the depth at the deepest point and the distance of the deepest point from what is described as the "bottom" edge of the dish. As we will be using the dish mounted on its side, this point is perhaps best described as the edge nearest the feed arm and I will refer to it as

FIGURE 6

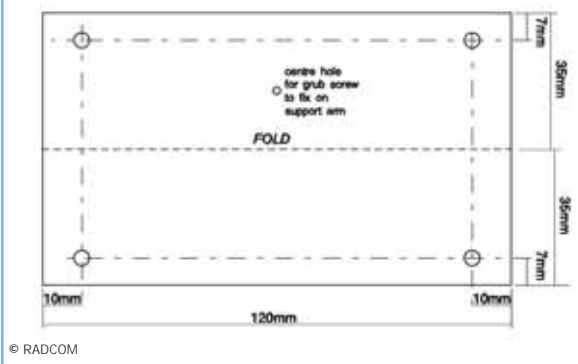


Figure 6: Support arm brackets

FIGURE 7

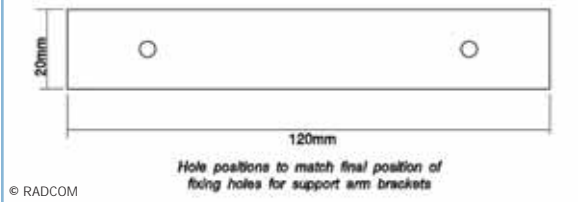


Figure 7: Clamping plates for the transverter

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the “feed point edge”. The software will then provide the location of the focus in terms of distance from the feed point edge and the opposite edge of the dish. It also provides a calculated gain. For terrestrial operation I prefer to use offset dishes mounted on their side as this makes mounting them on a vertical mast much simpler and avoids the critical adjustment of elevation which is otherwise needed. The exact method of mounting depends upon the construction of the dish. Usually there is a bracket at the rear of the dish which fixes the feed support arm and the mounting brackets. The screws fixing this to the dish can be replaced by studding (usually M6) and a plate or angle sections fixed to the rear, see **Figures 8 and 9**. The plate or angle sections then have holes drilled for standard mast clamps. These holes should be positioned to give the best balance point for the dish, transverter and cables.

The direction in which the dish points in terms of azimuth, when mounted on its side, may appear a bit of a mystery but in fact is usually described by the line from the feed point edge of the dish to the centre of the horn. See **Figure 11**. This is because offset dishes are usually sections of a normal parabola which includes the centre at the feed point edge. Calibration can be confirmed by listening to a signal on a known bearing and, unlike elevation, can easily be compensated using a rotator or by hand. With the offset dish mounted on its side like this it is also easy to add an additional feed horn for another band (such as 5.7GHz) although, as both feed horns cannot occupy the same place, there will be some offset in azimuth between the two (or more) bands.

ANTENNA SUPPORT. The arrangement described is ideal for fixing the dish to a mast either for home station or portable operation. For portable operation a tripod, if a sufficiently sturdy one is available, is useful, but many potential sites have



Figure 8: Mounting arrangement for a surplus TVRO dish using angle sections



Figure 9: Mounting arrangement for a surplus TVRO dish using a plate.

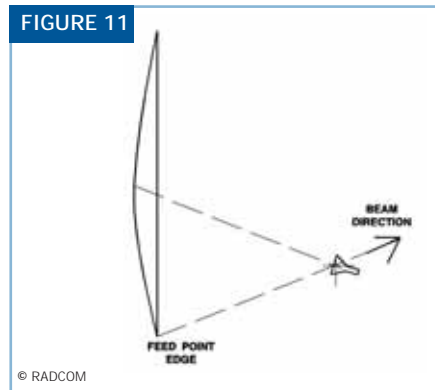


Figure 11: Caption ??

hedges or small trees that cannot be cleared with a tripod so a short mast is a good choice. With a 144MHz talk back antenna at the top and the dish mounted below the guys even a small mast can provide good support for a dish at a greater height than with a tripod. Some means of locking the azimuth will be necessary.

COAXIAL CONNECTIONS. As mentioned previously any coaxial cable will be lossy at these frequencies, as are most connectors. The preferred cable is RG402 (also available as UT141) semi rigid or the more flexible and easier to use equivalents such as Sucoflex and Quickform (Farnell 157-995). All these cables have an outside diameter (OD) of about 3.5mm and are used

with direct solder SMA connectors such as Farnell 105-6352. These cables frequently appear at mobile rallies with the connectors already fitted. They are unlikely to be the right length but can often be cut so that only one additional connector is needed. Avoid right angle connectors as these can present a mismatch and can be very lossy. Cut the cable to length using a junior hack saw. Remove the outer conductor by heavily scoring it all the way around with a sharp knife. Flex the cable holding the piece of outer you wish to remove, using pliers so that it breaks away quite easily. Then cut the inner conductor and insulation in accordance with the instructions for the connector you are using. The total amount of coaxial cable you need for this project is 150mm or less.

IF TRANSCEIVER. The most popular choices of IF transceiver are the FT290 Mk1 and the FT817 but other multi mode transceivers that can provide a suitably low level output can be used.

The FT290 Mk1 can be found second hand for around £100. It provides a DC output on the antenna line when in transmit mode and this is used to set the transverter to transmit.

It is also possible to do this by grounding the PTT line but if the DC on the IF line is used an additional connection is not needed. Without internal modification this is slightly harder to do for the FT817. However the circuit shown in **Figure 10** can be used. It has the slight disadvantage that if the FT817 is switched off while power is supplied to the transverter it will be switched to the transmit state. This is not likely to result in damage and as most people will turn off power to the transverter when the IF transceiver is off this is not likely to be a problem. The miniature DIN DATA plug is the same as on some old computer mice so you probably don't need to buy one! Whichever transceiver you choose set up your transverter to be driven with the minimum power.

CONCLUSION. The system described here will provide a quick and easy means of getting going on 10GHz and although not the cheapest route will provide good results and a sound basis for further development. With the growing popularity of microwave operation it is likely to retain its value. If you need help with the project contact a member of the UK Microwave group Technical Support Team (See web search).

WEB SEARCH

www.kuhne-electronic.de/english/transverter.htm
www.myweb.tiscali.co.uk/g4nns/FeedHorn.html
www.microwavers.org/

FIGURE 10

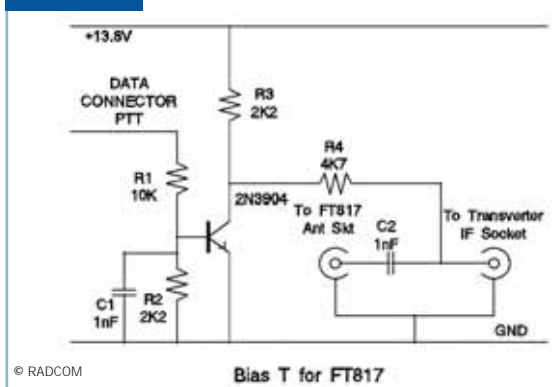


Figure 10: A Bias T for the FT817