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28MHz OPERATING

A large number of radio amateurs tend to look upon the 28MHz band as one of the best DX bands and so treat it like the 14MHz and 21MHz bands.

Long distance propagation on 28MHz is related to the 11-year sun-spot cycle, with the best results for intercontinental communications being obtained during periods of high sun-spot count. The peak of conditions in the current cycle occurred during the winter of 1980, but conditions last year also proved to be excellent, with the band opening up in late August.

During the summer months (May–September) 28MHz Sporadic-E conditions exist and most European countries can be contacted on a regular basis.

Unlike the other h.f. bands low power operation on 28MHz can give very good results; using powers of 10W or less many radio amateurs have had world-wide contacts on both c.w. and s.s.b.

As with the other h.f. bands propagation tends to swing from the east in the morning, to the west in the afternoon, although paths from several parts of the world will often exist simultaneously. Many operators have achieved WAC (worked all continents awards) in times as short as five minutes!

Apart from DX working via the ionosphere the 28MHz band exhibits several observable v.h.f. characteristics. Propagation modes, apart from line of sight, are by refractive, tropospheric, Sporadic-E, meteor scatter and auroral means, with the ranges obtained also being comparable with the v.h.f. bands.

One of the main reasons why 28MHz is often discarded for "local" ground-wave communication is because the band is approached with h.f. instead of v.h.f. techniques. At v.h.f. the correct antenna and polarisation are essential for good results. However, many radio amateurs try 28MHz for local use using multi-band verticals, beams, wire dipoles or even the proverbial "bit of wet string". A 28MHz beam will work well but only if you are in contact with another station using a beam with the same polarisation as your own. At least a 20dB loss can be expected in a cross-polarised contact between a station using a vertical and the other a horizontal antenna. It should be noted that this polarisation loss only occurs on ground-wave contacts and when using other modes of propagation that do not involve the signal going through the ionosphere. Multiple refraction causes polarisation shifts and signals arriving at a distant station may well be polarised at any angle. As this polarisation shift occurs in a very random manner it matters little for DX working what type of polarisation is used. For the sake of mechanical rigidity, and ease of mounting, the vast majority of 28MHz beams are mounted horizontally.

Because of the unpredictable and rapid polarisation changes, very good results can be obtained on the 28MHz band, for both DX and local working, using simple vertical antennas. However, experience over many years has shown that the majority of commercial amateur receivers and transceivers lack sensitivity around 28MHz. So, for good local results on 28MHz under "flat" conditions, you must use a good dedicated vertical antenna and a sensitive receiver, otherwise results will be far from expectations and discouraged operators will tend to go back to the v.h.f. bands.

Band Usage

Over the years operating frequencies for various modes have evolved and these are listed in Table 1.

The availability of a world-wide network of beacons enable operators to easily check the prevailing propagation characteristics at any given time. The RSGB also publish, on a monthly basis, propagation predictions that form a very useful guide.

Table 1
IARU Region 1 28MHz Band Plan
With UK Usage

Frequency (MHz)	Mode(s) and Uses
28·00–28·20	c.w.
28·10 ±50kHz	RTTY
28·105	Inter-UK c.w. working frequency
28·20–29·70	c.w./phone
28·20–28·30	Beacons (Region 1)
28·305	Inter UK s.s.b. calling frequency
28·68 ±5kHz	SSTV
29·4–29·55	Downlinks for Oscar series amateur satellites and their beacons
29·55	Alternative f.m. calling frequency
29·60	International f.m. calling frequency

Capabilities

It is not the purpose of this article to discuss in detail the ionospheric propagation properties of the 28MHz band, as this is well covered in most books dealing with amateur radio. We shall however look in some detail at the v.h.f. characteristics of the 28MHz band.

Let us take, for example, line of sight propagation, with a typical station consisting of a 100W s.s.b. transmitter and a 5/8λ ground-plane antenna 6m above ground level. You may expect a range of 80–110km when in contact with a similarly equipped station. Using f.m. the expected range would be between 56 and 80km, when no propagation enhancement is present. During "lift" conditions the ground-wave range may be greatly increased, with signals sometimes exhibiting slow fading characteristics. At such times the range may extend to 300km or more. Various scatter modes of propagation often occur with severe distortion of f.m. signals making these conditions mainly suitable for c.w. or s.s.b. contacts.

When Auroral propagation is present 28MHz signals are affected to a similar degree to the v.h.f. bands, with similar distances being worked. Meteor Scatter effects have also been observed at 28MHz, but very little work has been carried out in this area and as yet there appear to be no comparative studies between the 28MHz band and other v.h.f. bands.

28MHz Repeaters

The majority of the world's 28MHz repeaters are located in the USA, and Region 1 of the IARU does not at the moment encourage such devices. However, there is at least one 28MHz repeater operational in West Germany and one is planned for Sweden.

Repeaters in the 28MHz band have their own output frequencies on 29·62MHz, 29·64MHz, 29·66MHz and 29·88MHz with their associated input frequency 100kHz lower at 29·52MHz etc. The modulation used is f.m. and a number of the devices have a fairly narrow deviation requirement, typically of 1·5kHz.

As the transmitter and receiver sections are located on different sites, often separated by as much as 16km, it is difficult to know in advance if it is possible to work the repeater, even if you can hear the output in the UK. Nevertheless, with the right conditions these repeaters can be contacted.

In the USA many of the 28MHz repeaters have input facilities on other frequencies within the 50MHz, 144MHz and 432MHz bands. It is thus quite possible to work stations in the USA who are using low power v.h.f./u.h.f. equipment, mobile or even portable, to access the repeater.

Equipment for 28MHz

Apart from the wide range of multi-band h.f. amateur transceivers now available there are other possibilities.

(1) For amateurs who have a 144MHz band transceiver, Microwave Modules offer a 144/28MHz transverter (MMT28/144) that, when used in conjunction with a 144MHz transceiver, gives very good performance. This option would be of particular interest to the Class B licence holders who have just obtained the full Class A licence, but cannot afford the purchase of expensive multiband h.f. equipment. Even if you only have 144MHz f.m. equipment 28MHz activity using this mode is growing in the UK and amongst many DX stations.

(2) The conversion of CB equipment is also possible though care should be taken as it is often only the older types of CB equipment that can be easily converted to cover 28MHz. *See this month's Editorial page for the latest legal information on conversions.*

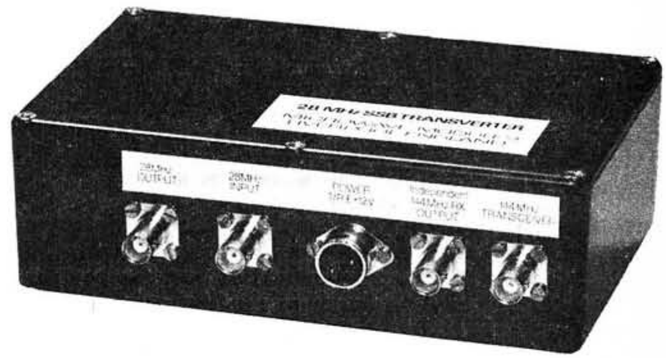
(3) Again for f.m. only the conversion of low band p.m.r. equipment should not prove too difficult. In the 1960s many BCC69 sets were converted for use on 28MHz a.m.

(4) The majority of CB antennas can be easily modified to operate on 28MHz and as readers are aware these are readily available.

(5) The 10-UK group also hopes to publish details of a home constructed 144/28MHz transverter.

Using a variety of equipment, from the most expensive FT-901 to a home constructed set based on modified CB p.c.b.s and home-made p.a. unit, an active f.m. net on 29·6MHz is operational in the Harlow/Bishop's Stortford area, with many other stations in the London, Royston, Newmarket and Bury St. Edmunds region participating. Under the right conditions many DX stations have been worked on this frequency including Japan, Australia and New Zealand.

During the summer months daily contacts are held with many European countries (Denmark, Germany, Sweden etc.). In every case for successful results in this net stations using dedicated 28MHz antennas and sensitive receivers have always scored over those using makeshift or multiband antennas. Mobile to mobile results, over varied terrain, generally produce better results than the 144MHz band. On 28MHz little fast "flutter" is experienced when working mobile as is found on the v.h.f. bands.



The Microwave Modules MMT28/144 linear transverter, a popular means of access to 28MHz for 144MHz transceiver owners.

Antennas

As with all amateur operations the consideration of the antenna is most important, if good results are to be achieved.

One of the basic antennas for 28MHz is the λ/4 ground-plane, which is simple to construct and easy to match. However, the λ/4 vertical is still 1·8dB worse than a λ/2 dipole and it does not have adequate low angle radiation for ground-wave working, although it is quite acceptable for DX working. As the vertical element is increased in length the radiation angle is reduced but the feed impedance is increased.

A λ/2 vertical has a good low angle of radiation but a rather high feed impedance, making matching difficult as it is a voltage fed device. The λ/2 vertical does not need radials but sometimes the addition of short radials can aid matching and the radiation pattern.

As the length of the radiating element is increased the impedance drops once again, but the radiation angle remains low. The best all round vertical antenna for 28MHz is the 5λ/8 as this has good low angle radiation and is easy to match. A 3λ/4 has an ideal feed impedance of 50–60Ω, but the radiation pattern is inferior to the 5λ/8.

Matching the 5λ/8 has to be done with the addition of series inductance to bring down the base impedance. As a guide, antennas of up to λ/4 require series inductance; from λ/4 to λ/2 require series capacitance, except when approaching a λ/2. Radiating elements of from λ/2 to 3λ/4 require series inductance. Based on this information a 5λ/8 antenna needs a λ/8 inductive match to provide a 50Ω base impedance.

Although the radiation pattern from a 5λ/8 is slightly worse than that of a centre-fed vertical dipole, it has higher gain because the lobe is more concentrated. If you lengthen the vertical still further to 7λ/8, and introduce series capacitance, you will obtain two lobes, both in phase, and a gain of 1·2dB over the basic 5λ/8 system.

Wherever possible mount vertical antennas in the clear and remote from other antennas. For ground-wave use, of course, the higher you can mount the antenna the better.

Mobile Antennas

The λ/4 vertical, full size or loaded, can be used with reasonable success but will require a good ground-plane system. It is essential to mount such an antenna in the centre of the car roof; gutter or wing mounting of a λ/4 antenna can produce results as much as 20dB down. With a bumper mounted λ/4 antenna the loss is even worse!

The conventional 5λ/8 antenna is too large to be used whilst mobile, but helically wound versions have proved to be very good in use, even when gutter, wing or bumper mounted. The smallest helically constructed antenna should on no account be shorter than 1·4m. Within the bounds of mechanical stability and safety the rule is the longer the better.

Further Improvements

Having now obtained or modified some equipment to work within the 28MHz band do not use poor quality coaxial cable to feed your antenna.

The performance of many multi-band transceivers falls off at around 28MHz, and to make the most of the station a good low noise pre-amp may be needed. However, care must be exercised, too much gain will degrade the performance of the receiver and also affect the dynamic range. Use enough gain to overcome receiver noise; optimise the pre-amplifier for best noise figure, not gain, and follow it with a resistive attenuator to reduce the gain to something in the order of 6–15dB. Do not adjust bias voltages in order to reduce receiver gain as this will degrade the noise figure.

The 10-UK Group

There still remains a vast amount of research to be carried out on 28MHz propagation. Increased amateur activity on the band will assist in the compiling of further information.

In order to stimulate more activity on 28MHz a group called 10-UK has been formed and its members are only too willing to pass on any specific information to anyone who is interested enough in 28MHz to join.

The address to write to is, **10-UK c/o N. O'Brien G3ZEV, 88 The Maples, Harlow, Essex.**

At 1·7MHz, the 28MHz band has the widest bandwidth of any h.f. band and it is up to radio amateurs to make full use of this allocation, both during the DX period and also when the band is only usable for fairly local contacts.

References

Radio Communication—RSGB
Amateur Radio Operating Manual—RSGB
Members of the 10-UK Group

MODS No. 16

▶▶▶*continued from page 32*

Mr Godfrey wants to know how to extend the frequency range of his FT-208R.

Mr P. Bidwell G6DAU, wants any mods for the Standard C-58.

Jon Kempster wants any mods for the FRG-7.

Roger Smith G6DJL, has written to me twice because he wants me to send him all the mods that I have for the IC-2E. As I hope you will have read Roger, I cannot answer letters. The only way to obtain information that has been printed in this column is to buy the relevant back issue. An index of Mods appeared in the April 1982 issue and the address of the Back Numbers Department is at the front of every issue.

Several people, including Mr A. C. Thomas and Mr R. G. Wojcieechowski, have asked about The Users International Radio Club that I mentioned some time ago. It's a club for Trio and Icom users and full details are available from Mr W. J. Bryan G3RKC, who is QTHR. (Note—"QTHR" means "Address correct in the current Callbook".)

Andrew Haigh G6BJA, and Don Peters are two of the people who have written in with requests for mods to the FT-290R. I have several mods for this set in the pipeline and I hope to devote next month's column to covering both the FT-290R and the FT-480R.

If you can help with any of the above requests or if you have a mod or a request that you would like published, please write to me, R. S. Hall at Room 301, Hatfield House, Stamford Street, London SE1 9LS.

UNCLE ED

▶▶▶*continued from page 33*

voltmeters (high coil resistance values) will make you wonder if the printer hasn't left out the decimal point, for you'll find figures like 15 or 20 per cent, even for good quality movements. Before you get too worried, I should explain that, because of the large value of series multiplier resistor that will have to be used to produce the required full scale deflection (f.s.d.) range, any inaccuracy in the internal resistance value will be swamped.

For example, suppose that we have a 100μA movement with an internal resistance of 2000Ω, and we want to use it to make a voltmeter with an f.s.d. of 50V. To draw 100μA from 50V, the total circuit resistance (by Ohm's Law) must be $50 \div (100 \times 10^{-6}) = 50 \times 10^4 = 500\,000\Omega$, or half a megohm. The resistance of the multiplier must therefore be $500\,000 - 2000 = 498\,000\Omega$ (498kΩ).

If the meter movement's internal resistance of 2kΩ is specified to ±15 per cent, its true value can lie anywhere between 1700 and 2300Ω, in other words ±300Ω. An error of 300Ω in 500 000Ω is only 0·06 per cent, and obviously not worth worrying about, as it will be totally lost in the possible inaccuracy of the multiplier resistance value, which will be typically ±1 per cent. It's all relative, you see.

Next month, I plan to answer a cry from the heart from several readers, and try to explain the relationship between d.c. input power, carrier power and peak envelope power of a radio transmitter. See you then.