

Getting started in... Repeaters

LIMITED RANGE. Amateur radio repeaters started appearing in the 1970s when mobile operating became a whole lot easier thanks to the availability of compact crystal controlled narrow band FM (NBFM) transceivers. It soon became clear that simplex contacts on the move were limited on NBFM but, if a base station was well situated and could receive the individual mobiles, it could relay them on a different channel to a wider area – duplex operation.

EXTENDING THE RANGE. The UK's first repeaters started appearing 40 years ago and nowadays they exist on bands from 50MHz up to 10GHz, though most can be found on 2m or 70cm. The 'fairy story' here illustrates better than anything what a repeater is all about and variations of it have been used effectively to humorously describe what repeaters do.

"Once upon a time (well, come on, let's get in the mood!) there were two villages called East and West and in between them was a lofty peak. This caused no end of problems as villagers found their smoke signals couldn't be seen over the hill, shouting couldn't be heard either and there was only a lonely mountain path over the top. However, on this mountain (the lofty peak!) there lived a grumpy ogre (think of Shrek at this point) and he came up with the crafty idea of offering to relay messages between East and West by using his loud roar of a voice (keep thinking ogre). He told the villagers to whistle in a particular way

(how about a yodel, as 1750Hertz would have baffled simple villagers!), when he heard the yodel he would wake up, listen to the message and then repeat it so all could hear it in both valleys and beyond. So with this useful facility, relations between East and West improved and all lived happily ever after."

An amateur radio repeater is like the ogre on the hilltop, except that instead of waiting to hear the incoming message, once the wake-up call arrives, the relay starts straight away using a separate frequency, so it is easy to hold conversations.

BETTER COVERAGE. Repeaters were designed to assist mobile and hand portable operation primarily as they could hugely extend the range of communication. A half watt hand portable could make contact with stations well beyond simplex range by using repeaters (**Figure 1**) and this also opened up contact possibilities for people in low lying locations, those in remote areas with no other possibility of local contact and, of course, assist with emergency calls due to the coverage afforded and the greater probability of someone listening.

I remember many years ago getting a shattered windscreen during a long car journey in an area I was unfamiliar with and, thanks to a contact through the local repeater, a kind amateur directed me to a windscreen replacement depot and I got fixed and on my way again quickly. Calling on the local simplex calling channel was fruitless



PHOTO 1: A typical set of 2m cavity filters.

due to being in a remote country area, but the repeater was S9 plus.

So a repeater is a device with a receiver 'listening' for stations on one frequency and transmitting what it 'hears' to a wider area on a second frequency, thus greatly extending the range that mobile or portable stations would normally expect.

A CHANNEL PLAN. From the early days of repeaters back in the 70s it became clear that the band plans would need to accommodate repeaters. Initially at 2m and 70cm, duplex channels were set aside in-band. On the 2m band the difference in frequency between input and output is set at 600kHz, whilst on 70cm it is 1.6MHz. This created enormous constraints on the repeater builders as quite severe filtering was called for to prevent sensitive receivers being swamped (de-sensitised) by the nearby output channel transmitter that could be running up to 25 watts ERP.

The cavity filters shown in **Photo 1** (photo courtesy South Yorkshire Repeater Group) is an example of a 2m band set of cavity filters that will be tuned to minimise the breakthrough of signal from the transmitter to cause de-sensitisation of the receiver, which is listening only 600kHz away.

Those involved in building repeaters often came from professional radio backgrounds and would have access to the necessary test equipment to ensure the tight specifications were met.

Over the years more repeaters came on stream and most parts of the country became within range of at least one repeater. A special committee was established within the RSGB to oversee the applications and act as a band manager to ensure interference was minimised. Today this function is carried out by the Society's Emerging Technology Co-ordination Committee (ETCC).

REPEATERS DON'T JUST APPEAR! The ownership of repeaters, from the building of them to their administration, repairs

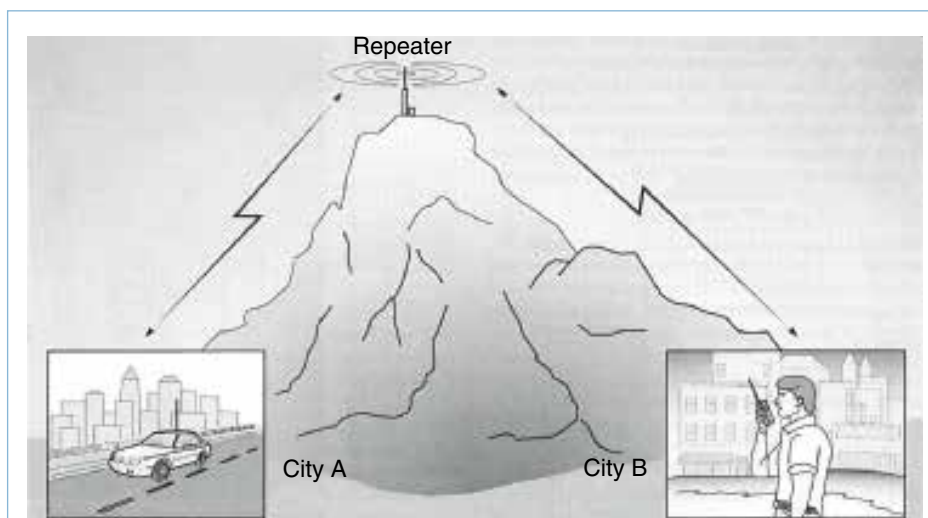


FIGURE 1: A repeater on a high point can greatly extend the range of mobile and hand portable stations.

and maintenance, are undertaken by local groups, often with a membership base paying a small annual fee to support their upkeep. A number of macro groups have developed over the years, the largest being the UKFM Group (Western) who list 17 repeaters on 4 bands in the north west of England.

It is an unwritten rule, but generally accepted, that repeater users join or contribute to their local repeater group; this gives them a sort of moral right to use other repeaters when they are travelling around. The myth that repeaters are owned and operated by the RSGB can be squashed. They are lovingly (usually) looked after by hard working and dedicated groups of local amateurs, sometimes with considerable cost involved.

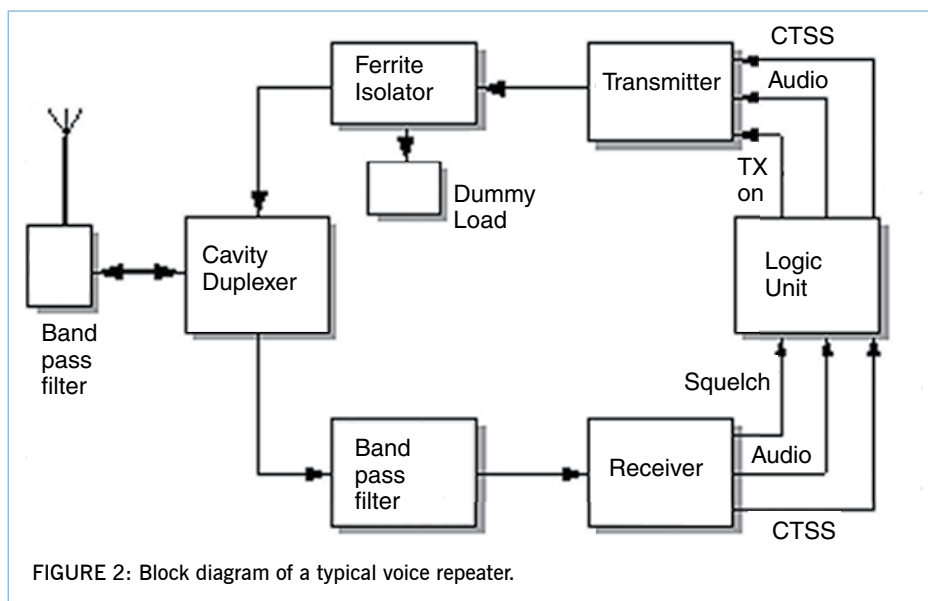
The location (site) for the repeater can often be a challenge. In the early days, the broadcasting organisations (BBC and IBA) welcomed amateur repeaters on their tall TV and radio masts for peppercorn rents and many of their employees were amateurs anyway. Since the 1980s, the revenue earning potential of mast sharing was realised by these broadcasters and commercial rentals soon priced most amateurs off the big masts.

Nowadays it is not unknown, indeed it is becoming more common, for repeaters to be located on private houses, often those of the repeater keeper (as the licence holder is known).

HOW THEY WORK. So what do they sound like and how do they function? It's more than just straight relaying of incoming signals. Repeaters have to be licensed. This is by a Notice of Variation (NoV) on an individual amateur's licence, an amateur known as the repeater keeper. He or she is responsible for ensuring that the repeater is working to spec, but will usually be backed up by other members of the group lending a helping hand technically.

The villagers' yodel, or wake up call, traditionally was a 1750Hz tone on the input transmission. Nowadays the more useful sub-audible tone, or CTCSS (continuous tone coded squelch signal) is used in most analogue voice repeaters – the use of different tones afford greater immunity to interfering signals and false keying. Also, repeaters are obliged under the terms of the licence to identify themselves at least every 15 minutes in Morse code. Listen and see if you can decode the callsign. All UK analogue speech repeaters will be GB3 plus 2 letters, for example GB3CF. This is excellent practice for newcomers in decoding Morse characters!

Repeaters are designed specifically for mobile and portable users and each 'over' will trigger a Morse 'K' (dah di dah) or, in some cases, just a single blip to indicate the repeater has heard that over and the next



station can go ahead.

Most repeaters will have a timer to prevent the input from being held on indefinitely; two or perhaps five minute timers are not uncommon. So don't rabbit on, keep your overs short and snappy, it makes for a more enjoyable experience anyway!

Incidentally, the use of CTCSS tones has been simplified somewhat by a pool of just 9 tones, each with an ident letter that is also broadcast with the repeater callsign to make it easier (**Figure 3**). Many amateurs will program in individual repeaters to their rigs complete with frequencies and CTCSS tones.

As we have seen, repeaters use two frequencies – an input (receiver) frequency and an output (transmitter) frequency. The list of channels allocated for repeaters depends on the band in question and tables of the repeater frequencies plus those repeaters using them are published widely, see www.ukrepeater.net for details.

Initially voice repeaters used 25kHz channel spacing, but with the growth of repeater applications and the general move in the radio industry to narrower channels, 12.5kHz is now used on 2m. Make sure your rig is set to 12.5kHz filtering when operating on frequencies in the 2m band and below.

CHANNELISATION. On 2m the lowest repeater channel is RV48, which listens for user input on 145.0MHz and repeats on an output channel at 145.6MHz. The next channel up is RV49, which is 145.0125MHz paired with 145.6125MHz and so on up to RV63.

On 70cm, the voice channels are a bit more complicated as there are effectively three different channel spacings. The original 'RB' series channels (RB0 to RB15) started at 433.0MHz for the repeater transmitter channel, paired with the repeater receiving channel on 434.6MHz. Next up was RB1

on 433.025MHz paired with 434.625MHz. Notice the Tx/Rx pairing is the other way round from 2m.

The difficulty with tight filtering coupled with increasing interference caused by repeaters to short range devices such as car door locking (key fobs) resulted in a search for a wider channel spacing, away from 433MHz. Some additional channels were identified, starting at repeat transmit 430.825MHz paired with repeater receiver listening on 438.425MHz. This 7.6MHz split was technically less challenging, but caused huge problems trying to get agreement with the Primary user of the band, as amateurs only have Secondary user rights on 70cm. The use of these wider channels has been somewhat restricted for this reason.

The third channel spacing arrangement came about with the development of digital modes such as D-Star (the subject of another article) and channels with 9MHz spacing have been used (439/430MHz).

OTHER MODES OF REPEATER. With voice repeaters well established by the late 1970s, attention soon shifted to other modes. Amateur television repeaters on the 23cm band (later also on 13cm and 3cm) sprang up, initially with wide band FM modulation, but more recently digital modes have prevailed. As with digital modes, television will be the subject of future articles.

With the growth of the internet came interest in protocols like Echolink and IRLP to link repeaters to the internet, connecting them in turn to repeaters sometimes the opposite side of the planet. Whether this is amateur radio in its purest sense is a moot point, but it does involve one amateur speaking to another using amateur radio frequencies!

GOOD PRACTICE GUIDE. Operating using voice repeaters requires *good practice* to be

observed and the question is often asked: just what *is* good practice? We also often hear one operator complaining about some aspect of another's operating.

Remember that repeaters are licensed on an *individual's* amateur radio licence (the repeater keeper), even though they may be part of a larger umbrella organisation such as the UKFM Group (Western) or the Central Scotland FM Group, for example. This means that this named person has the legal responsibility for ensuring the station adheres to the licence conditions and is operating correctly.

The keeper may have to switch off the repeater in certain circumstances.

It is also worth remembering that repeaters are licensed for all radio amateurs to use (provided that they operate within the terms and conditions of their licence, of course) whether or not they have contributed in any way to the upkeep of the repeater or are members of the group. There are no closed repeaters and anyone finding they are prevented from taking part should lodge a complaint to their RSGB regional member.

Here are some key points which should help new and experienced amateurs alike to get the best experience from using repeaters:

- 1 The ukrepeater.net website lists the parameters for all UK repeaters – check the details first and get an idea of the coverage footprint.
- 2 Check use of CTCSS tones – many repeaters need the correct sub-audible tone for operation.
- 3 If you are inexperienced, it is worth listening for a while before actually transmitting. This helps to give you an idea of who is around and what to expect.
- 4 Repeaters are designed to assist mobile and portable operation. Although fixed stations can use them, priority should always be to the mobile and hand portable user.
- 5 Leaving a break after a transmission is important as it allows the talk-through

timer on the repeater to reset and also gives a convenient gap for new stations to call in.

- 6 The recognised calling protocol is “This is (your callsign) listening through (repeater callsign)”
- 7 If you find you can hear the other station on the input channel then consider moving to a simplex channel, especially if the repeater may be busy.
- 8 Your callsign should be given with sufficient frequency to identify you, though it would not normally be given on every over, especially if these are short and snappy!
- 9 If the repeater is busy, remember that many repeater sites have other repeaters on different bands that might be worth checking out.
- 10 Sadly, repeaters have sometimes attracted antisocial and illegal use. If this happens then the best rule is to ignore it. Leave the repeater keeper or those empowered to deal with the problem the ability to record and track down the misuse.

Repeaters are provided by a dedicated group of radio amateur enthusiasts – if you are a regular user on your local repeater then why not make a donation, or join the group behind the repeater.

Note that this operating guide is based on the use of analogue voice repeaters. Different procedures apply for television and digital modes.

BELLS AND WHISTLES. Apart from internet linking, TV and digital modes mentioned previously, some repeaters have been permitted to carry the GB2RS news bulletins, others have been permitted to give relevant announcements about the repeater to be broadcast and others give the user an indication of frequency stability or other parameters about the transmission.

REPEATER LINGO. Since repeaters came onto the scene, a certain parlance has developed around them. The term *listening through* refers to the duplex operation of the repeater.

Deaf is a derogatory term used when a repeater might have a de-sensitisation problem perhaps due to the filtering not being properly aligned or an imbalance between transmit and receive coverage potential.

K-Break is a short gap in transmission that users should leave when they end an over, to allow the repeater to reset its timers before the other stations comes in. It is also courtesy to use this *K-Break* as a chance for other stations to join in by giving their callsign.

Timeout is what happens when an input transmission has exceeded the timer set by the repeater control equipment, or ‘logic’.

Usually the repeater will simply shut down when timeout occurs.

The term *logic* is used to describe the controller system that determines the way the repeater functions.

APPLYING FOR A REPEATER NoV. The majority of repeater applications come from those already involved, usually through an established repeater group who perhaps wish to extend coverage in an area, or perhaps where a site change has become necessary or where a gap in coverage has been identified that could be filled.

An online form captures the necessary information that will then be vetted by RSGB volunteers serving on the Society's ETCC before Ofcom are asked to issue a Notice of Variation (NoV).

Amongst the details requested is what is known as closedown operators. It is a requirement of the licence that individuals can be called upon 24/7 to close down the repeater acting on instruction from the licensing authority (Ofcom). Each of these closedown operators, of which the repeater keeper must be one, gives contact phone numbers and indicative times to get to site.

The application process will demonstrate technical competence, very much required for a wide area repeater operating unattended on a prominent remote site in prime radio spectrum! Once licensed (NoV issued) the successful applicant has 3 months to get the repeater up and running. In most cases the repeater keeper is raring to go and will have the new unit operational very soon thereafter.

FOOTNOTE. It is only fair to say that repeaters have had their share of controversy over the years. Some, especially in the earlier years, claimed they were not proper amateur radio; others declaimed them for attracting the misuse that sadly has been an issue in some areas. I have always had the opinion that the strength of amateur radio is that there are so many things you can get involved in with the hobby, repeater operation is just one. Many amateurs use repeaters *and* do other things in the hobby.

WEBSEARCH

The website www.ukrepeater.net is perhaps the definitive location for information on Britain's repeaters, with a wealth of lists, maps and information. Look also at some of the better individual repeater group web sites, for example:
www.cambridgerepeaters.net
www.southyorkshirerepeatergroup.co.uk
www.arfon.info
www.ukfmgw.org.uk
www.sargroup.co.uk
 Further information on special operating modes can be found at:
www.d-staruk.co.uk
www.batc.org.uk
www.echolink.org
www.irfp.net
www.rsgb.org

Tone A = 67.0Hz (-)	Tone B = 71.9Hz (-...)
Tone C = 77.0Hz (-.-)	Tone D = 82.5Hz (-.)
Tone E = 88.5Hz (.)	Tone F = 94.8Hz (.-.)
Tone G = 103.5Hz (--)	Tone H = 110.9Hz (....)
Tone J = 118.8Hz (.---	

FIGURE 3: The nine CTCSS tones used by UK repeaters.