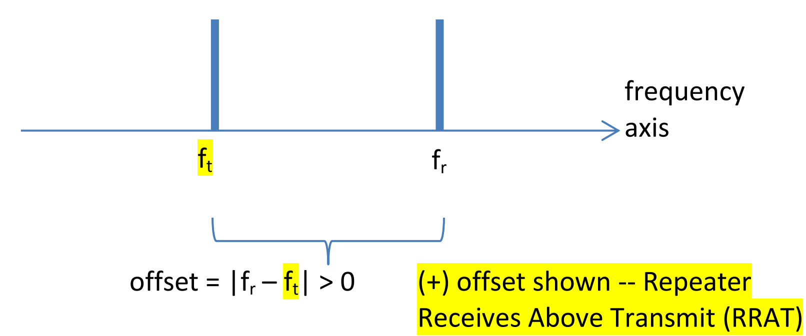
REPEATER PAIRS

Ever find yourself confused, even momentarily, about the frequencies your radio uses to work a particular repeater? Come on now, admit it, I have on occasion. So let's review how repeater frequency pairs are specified and correlate them to your radio. This material relies heavily on the section headed Frequencies on the Wikipedia page http://en.wikipedia.org/wiki/Amateur_radio_repeater.

Let's get a clear picture in our minds of what is happening. The basic relationship to fix in our minds with regard to repeater pairs is:

- **(+)** offset means the Repeater Receives on a frequency **Above** the one it Transmits on, think **+RRAT** as a mnemonic
- **(-)** offset means the repeater receives on a frequency **below** the one it transmits on
- Operator's radio displays the frequency its **receiver** is tuned to
- Offset amount -- disregard the negative sign if there is one. Engineers refer to this as the absolute value or magnitude of the quantity between those vertical bars. The offset amount is the **separation** between the RECEIVE and the TRANSMIT frequencies.
- Offset direction accounts for the sign, positive as pictured in the diagram here, negative if reversed

<table>
<tr><th>PERSPECTIVE</th><th>TRANSMIT</th><th>RECEIVE</th><th>OFFSET AMOUNT</th><th>OFFSET DIRECTION</th></tr>
<tr><td>Repeater Radios</td><td>transmitter tuned to f_t</td><td>receiver tuned to f_r</td><td>$|f_r - f_t|$</td><td>(+) if $f_r - f_t > 0$
(-) if $f_r - f_t < 0$</td></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>Operator Radio</td><td>f_r</td><td>f_t</td><td colspan="2" rowspan="2">Some radios display the offset direction</td></tr>
<tr><td>Operator Display</td><td></td><td>receiver tuned to f_t</td></tr>
</table>

Circumstances may compel the use of non-standard offsets. When this occurs, the relevant coordinating body may authorize an exception or the control operator may proceed on a non-interfering basis. Repeaters operating this way are said to be using odd splits, or oddball splits.

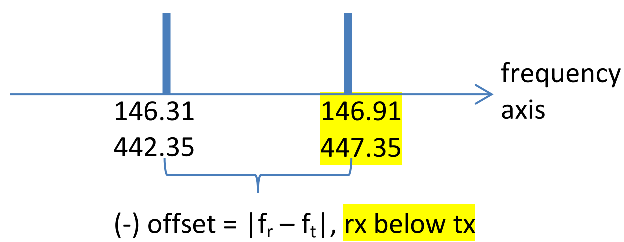
This is rarely encountered nowadays, but was common in the early days of amateur radio. For one such account, see **A HISTORY OF THE ST. CROIX VALLEY REPEATER ASSOCIATION 1976-1981**, by Jeff Iverson, WB9DAN, February 2006 at https://sites.google.com/site/stcroixvalleyhamradio/forming-of-the-scvra .

Also, see http://www.eham.net/articles/9947 for a very interesting discussion about the pros and cons of using non-standard, i.e., odd or oddball splits for modern repeaters.

Now, let's proceed to the two ways of specifying repeater pairs, I'll call them: **ARRL** and **XO**. The first is the terminology in use today, as in **The ARRL Repeater Directory 2013/2014**. The other is of historical interest, worthwhile to deepen our understanding and comfort old codgers. For examples, let's talk about the repeater pairs assigned to the local repeaters control operated by Dave KØIRP.

ARRL Standard Terminolgy

In this modern scheme, we specify the repeater transmit frequency and the direction of offset to the repeater receive frequency. We assume the standard amount for offset and fill in the rest. So, we write these specifications as 146.91 (-) and 447.35 (-). Spoken, we rely on context and say 691 down and 735 down. Written or spoken, we mean it looks like this to our radios:

<table>
<tr><th>PERSPECTIVE</th><th>TRANSMIT MHz</th><th>RECEIVE MHz</th><th>OFFSET AMOUNT</th><th>OFFSET DIRECTION</th></tr>
<tr><td>Repeater Radios</td><td>146.91
447.35</td><td>146.31
442.35</td><td>0.6 MHz
5 MHz</td><td>(-) so receive below transmit</td></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>Operator Radio</td><td>146.31
442.35</td><td>146.91
447.35</td><td rowspan="2">same as repeater</td><td rowspan="2">opposite from repeater's perspective</td></tr>
<tr><td>Operator Display</td><td></td><td>146.91
447.35</td></tr>
</table>

XO Terminology

Our second method was in use before synthesizers, back when oscillators were crystal controlled. I call this XO terminology because XO is a standard abbreviation for crystal oscillator (find a pretty good list of engineering abbreviations at http://www.interfacebus.com/Engineering_Acronyms_X.html).

A transceiver, which is a combined transmitter and receiver, would have two crystals, one for its transmitter XO and one for its receiver XO. If you talk with old hands like Dave KØIRP long enough, they'll tell you stories about how they would lend radios to cubbies sans transmitter crystal. Those cubbies would be able to receive Morris code, but without a transmit crystal they couldn't transmit. The old hand would withhold the transmit crystal from the cubbies until they got good enough at copying code to get their FCC license.

Before the late 1970s, much was left to context. Only the decimal parts of the repeater pair frequencies would be cited. Dave's repeaters would commonly be specified as "three-one nine-one" (31/91) and "three-five three-five" (35/35). Given enough context, hams would know to transmit on 146.31 or 442.35 MHz, if they could get the crystals, and to listen on 146.91 or 447.35 MHz. Life is much simpler with VCOs.

Reverse Splits

Back before tone squelch control came into common use, reverse splits were used in urban areas to reduce adjacent channel interference. To illustrate how this works, let's consider Dave's VHF (31/91) repeater. Suppose there is also a VHF (91/31) repeater operating somewhere not too distant but just out of range of each other.

Two repeaters operating reverse splits. This way, each operator hears the output of the repeater he is working, and also hears the transmissions of operators working the other repeater. The only drawback is that there appears to be more traffic on the channel. The benefit is that each repeater responds to only those operators working it.				
REPEATER	REPEATER TRANSMITS	REPEATER RECEIVES	OPERATOR #1	OPERATOR #2
(31/91)	146.91	146.31	tx 146.31 rx 146.91	
(91/31)	146.31	146.91		tx 146.91 rx 146.31

Notice that the two repeaters operating reverse split must be out of range of each other. Otherwise, they would lock each other up, responding to each other all the time. In urban areas, repeaters might be shielded from each other by buildings as well as by terrain features. Repeater lockups like this did occur and made for some interesting stories, providing motivation for the development of tone squelch control methods.

You might be interested to know that Dave's repeaters, his 691 and 735 machines, are fitted with **community panels**. This enables these machines to respond to most of the common CTCSS and DCS squelch control tones. This way, people driving through need not know a priori which tones are used by the repeaters in their current vicinity.

Dave's repeaters give precedence to CTCSS 151.4 Hz, but will respond to the mobile machine, as well, if it uses one of the other common tones. If you feel squishy on tone squelch, see my recent article posted in the repeaters category on the GGARC.org site. See http://www.eham.net/reviews/detail/6841 for a very good explanation of community panels.

One other characteristic of Dave's machines is that they are **polite repeaters**. No kidding. A polite repeater will postpone or cease its announcement or ID message when an operator keys it up. Exceptions to this, when a polite repeater will continue its message and block access by an operator, include messages dealing with weather, an emergency, announcements deemed critical, and some commands issued by the control operator.

See these pages for descriptions of repeaters having polite controllers:

- http://www.nhrc.net/nhrc-2/picrpt.php (how to build such a controller)
- http://www.waymarking.com/waymarks/WM5NXB
- http://mccrpt.com.p12.hostingprod.com/rc-100_repeater_controller

For a lot more on repeaters, check out http://www.ac6v.com/repeaterguide.htm . Meanwhile, set your squelch for another article from me soon.

By Dan Martin KDØSMP
With thanks to Dave Givan KØIRP for consultations. However, I lay claim to all mistakes and misunderstandings.