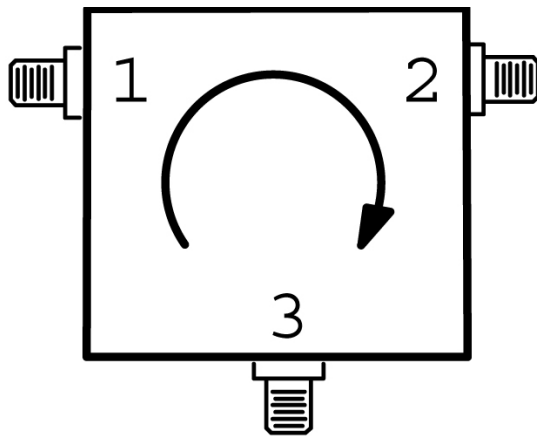


Retuning Circulators

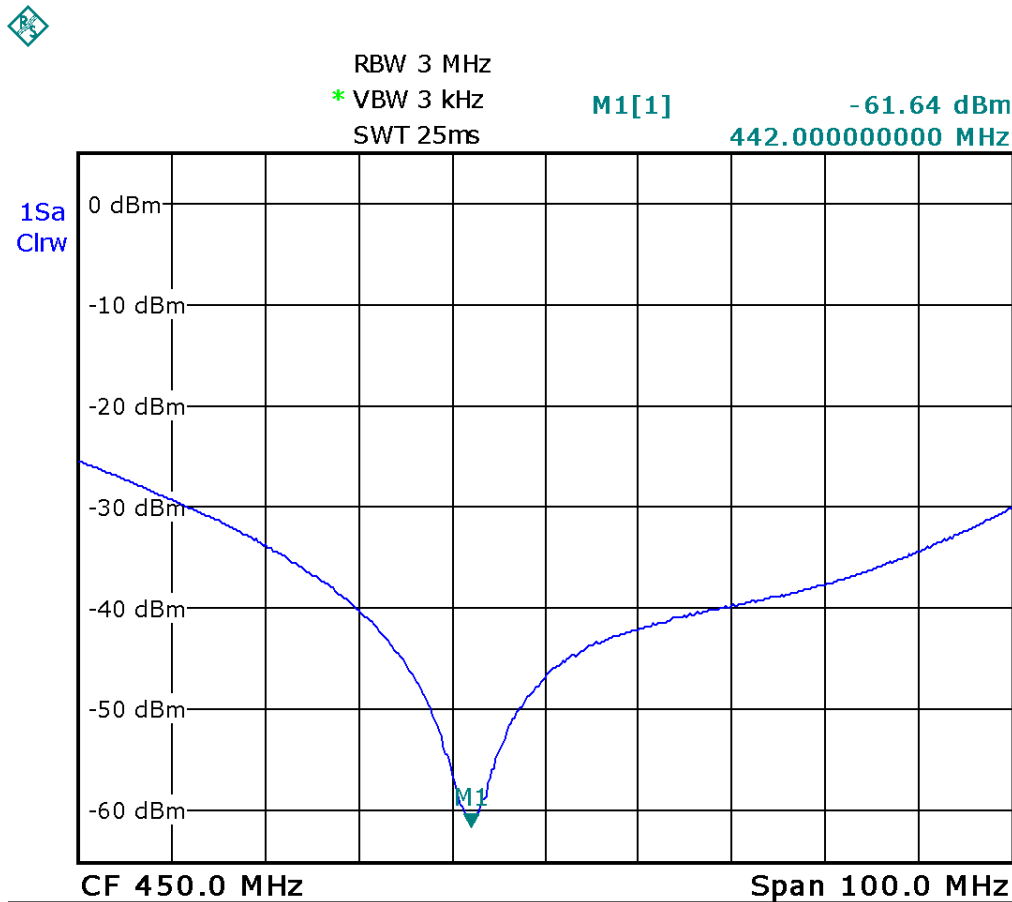
Kent Britain WA5VJB



Circulators are very handy problem solvers, but circulators for the ham bands are pretty rare. Like so many other commercial products, they can be retuned to the ham bands.



Here is a diagram of the basic circulator. The signal can go from Port 1 to Port 2, and from Port 2 to Port 3, and from Port 3 back to port 1. i.e. the signal path is a circle. Here is one typical application, the transmitter goes on Port 1, a Dummy load on Port 3, and the amplifier or an outside antenna goes on Port 2. Now any reflected power goes straight to the Dummy load. This way the transmitter sees a 1 to 1 SWR even if the antenna falls down. Another place where this is handy is when your transmitter is co-located with a bunch of other transmitters. Often the RF power from the other transmitters gets into your transmitter and mixes in your transmitter's final. Your radio may be perfectly clean on the bench, but putting out garbage when installed at a location with other transmitters. A circulator on your final can stop this kind of intermod.



400 MHz to 500 MHz Sweep Output to Input of the Circulator in the Photo

I think I can safely skip Ferroresonance at this point, but circulators contain a strong magnet, and the strength of the magnetic field is an important part of the circulator design.

My personal record is retuning an 18 GHz circulator to 24 GHz with 6 very strong magnets. My 2 Meter EME station contains a 144 MHz circulator between the GaAs FET preamp and a pretty high Q filter. Retuning it to 144 MHz was quite a stretch, it was originally designed for 123 MHz.

Typically you can retune a circulator +/- 2 or 3% very easily, +/- 10% is often possible. Start by feeding signal feed backwards through the circulator. That is the signal generator on port 2, a dummy load on port 3, and your detector or receiver on Port 1. You should see something like 10 to 20 dB of loss. Now dig out some magnets, frig magnets, old speakers, or my personal favorite, magnets out of other old circulators. Hold the magnet on the circulator and watch the loss go up. Loss went down??? Flip over the magnet! Also move it around looking for that sweet spot. You are tuning for max loss. One magnet helped? Try two! Again my personal record was 6 stacked magnets, But one magnet will return most circulators.

Here is the plot of that 465 MHz circulator in the photo and the magnet that made it a 442 MHz circulator with 60 dB of isolation. And it's not a bad idea to check old circulators, the magnets tend to weaken with age and they usually move up in frequency a bit. Something else you can tweak for best system performance.

One last note, the dummy load can end up with nearly 100% of the transmitters output. Got a 50 watt repeater? You need a load that can handle 50 watts for the minutes, hours, days, it will take you get out there and fix things.