A Survey of 2 Meter/70 Centimeter Diplexers

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So What's a Diplexer?

A *diplexer* is a device that accepts a wideband signal and splits it into two signals that, in some way, divide up the wideband signal. It will also work the other way and combine two signals at different frequencies into a combined signal at a single port. The word *triplexer* is used to describe a similar function with three ports while *multiplexer* is used as a general term for this function. Note that we are quite used to this idea—the coax coming from a 20 meter Yagi includes many signals from at least 14 to 14.35 MHz. We take it for granted that our receiver will separate them. If we have two receivers connected, we perform the diplex function—without a second thought!

To add to the linguistic confusion, the term *duplexer* is often used to describe a diplexer that performs the splitting function between frequencies that are much closer together. This would be used as part of a 2 meter repeater, for example, in which a 100 W transmitter may share an antenna with a receiver looking for signals in the μV range with a separation of only 600 kHz. This allows simultaneous transmit and receive or *duplex* operation—hence duplexer. Often the words are used interchangeably. You will see

Bottom Line

Diplexers can be a useful addition to the multiband VHF station. The reviewed units all work as advertised.

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similar units using different names.

We have selected readily available units from four different manufacturers—Comet, Diamond, DCI and MFJ—for this evaluation. As noted in each description, each manufacturer offers other part numbers with slightly different features, such as different connector genders or types—select carefully so you won't need adapters or extra cables for your installation. Some offer triplexers as well as diplexers with different break frequencies. In addition, DCI offers single band, or multiband filters without the diplexer function.

Why Might We Want One?

The typical use of these devices is to separate or combine signals on two bands, in this case 2 meters and 70 cm, to take advantage of dual-band antennas when faced with dual antenna ports. Or conversely, you can split the output from a single antenna port so that two antennas can be used, one for each band. Figures 4, 5 and 6 should give you the idea. Note that they can be used with RF from one band at a time or on both, as is the case with some dual-band radios that can operate both bands simultaneously, serving as translators or as between band repeaters.

The idea of using a single feed line to two antennas, with the diplexer at the antenna location is attractive, especially if it will allow purchase of a single more expensive lower loss coax cable (don't forget to include the additional diplexer loss in your analysis). A triplexer can be employed to also drive an HF or 6 meter antenna from the same cable. Note that none of these units is designed to be out in the weather, so a housing will have to be devised for the antenna end.

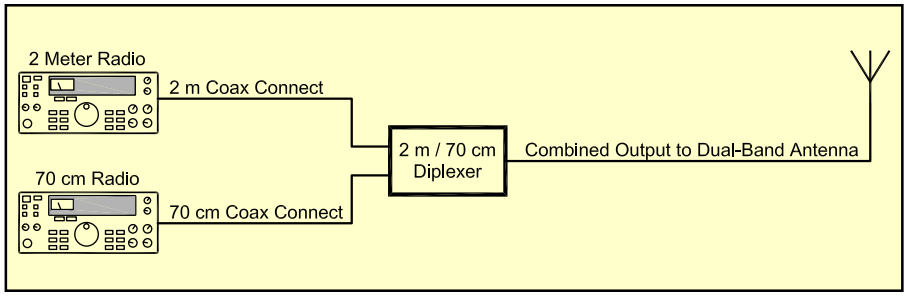


Figure 4—A diplexer used to connect two radios (or a single radio with separate antenna ports) to a dual-band antenna.

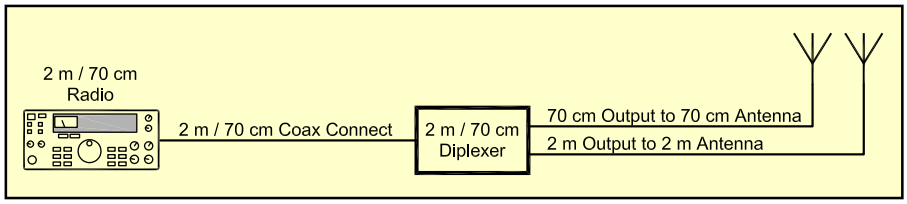


Figure 5—A diplexer used to connect a radio with a single antenna port to antennas for each band.

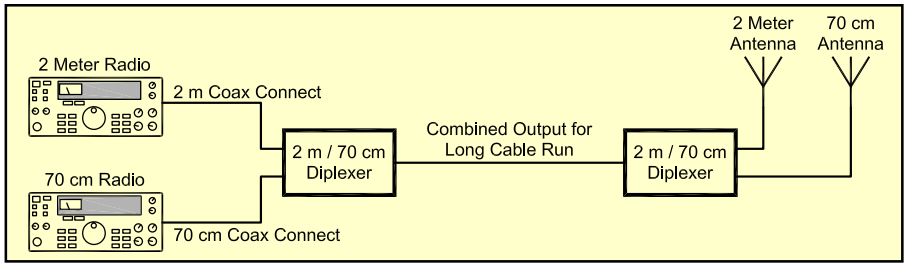


Figure 6—A diplexer used to connect two radios (or a single radio with separate antenna ports) to two antennas sharing a single coax cable.

How Do They Work?

The short answer is that they use filtering, as you would expect. We have actually included two different categories of devices in one review, since they can fit in the same spot. The smaller units employ high-pass and low-pass filters to perform the split. The larger DCI device employs sharp band-pass filters to not just split the frequencies, but to restrict throughput to just the two bands to eliminate out of band interference—more later.

Notice that the smaller ones' low-pass ports work right down through the MF/HF range, so they can be used for combined MF/HF/VHF (some include 222 MHz) operation, if that provides a useful function.

How Well Do They Work?

They all meet their specifications and perform very well at what they do. Table 2 and Figures 7 through 10 provide the story. The unit you choose may depend on the connector types and genders you need, the mounting arrangements, or which one your retailer has in stock. Frankly, the differences among the three "diplexer-only" units are quite small. In the section on the DCI unit we'll discuss more about why you might (or might not) want to pay the extra cost for the additional filtering.

Table 2
2 Meter/70 cm Diplexer Measured Performance Data

Insertion Loss	*2 MHz*	*14 MHz*	*28 MHz*	*50 MHz*	*146 MHz*	*440 MHz*
Comet CF-4160	< 0.1 dB	< 0.1 dB	< 0.1 dB	0.3 dB	0.4 dB	< 0.1 dB
DCI 144-148/438-450-DX-DB	N/A	N/A	N/A	N/A	0.8 dB	0.7 dB
Diamond MX-72D	< 0.1 dB	< 0.1 dB	< 0.1 dB	< 0.1 dB	0.2 dB	0.3 dB
MFJ 961B	< 0.1 dB	< 0.1 dB	< 0.1 dB	< 0.1 dB	0.2 dB	0.3 dB

Input SWR	*2 MHz*	*14 MHz*	*28 MHz*	*50 MHz*	*146 MHz*	*440 MHz*
Comet CF-4160	1:1	1:1	1:1	1.1:1	1.3:1	1.1:1
DCI 144-148/438-450-DX-DB	N/A	N/A	N/A	N/A	1.1:1	1.1:1
Diamond MX-72D	1:1	1:1	1:1	1:1	1.1:1	1.4:1
MFJ 961B	1:1	1:1	1:1	1:1	1.1:1	1.3:1

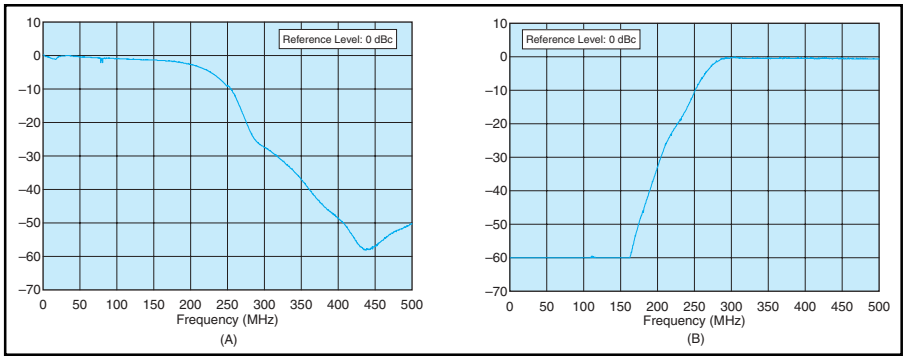


Figure 7—Frequency response plots of Comet CF4160K diplexer—at A, low-pass port; at B, high-pass port.

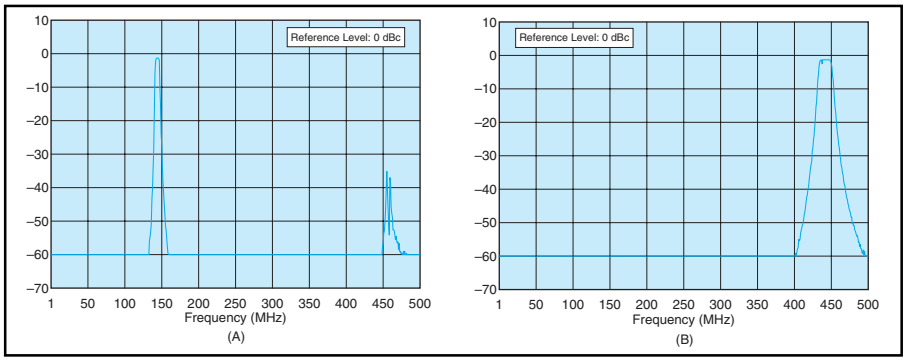


Figure 8—Frequency response plots of DCI 144-148/438-450-DX-DB diplexer/band pass filters—at A, low-pass port; at B, high-pass port.

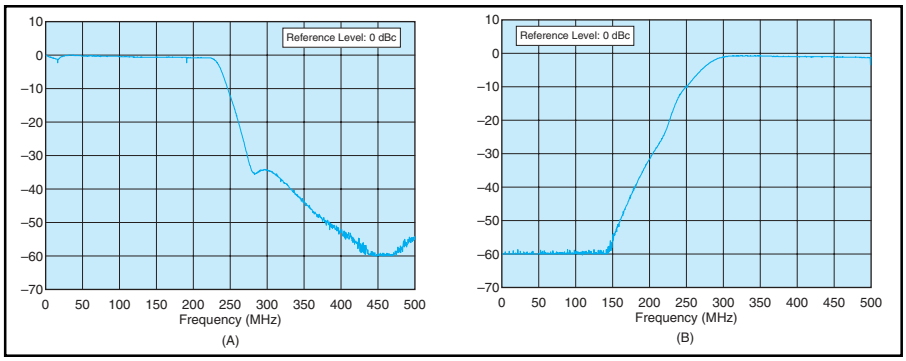


Figure 9—Frequency response plots of Diamond MX-72D diplexer—at A, low-pass port; at B, high-pass port.

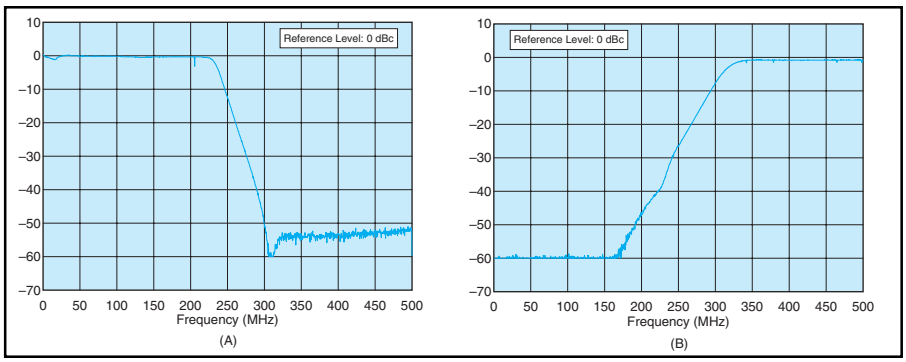


Figure 10—Frequency response plots of MFJ 961B diplexer—at A, low-pass port; at B, high-pass port.

THE COMET CF-4160J 2 METER/ 70 CM DIPLEXER

The Comet CF-4160 series is rated at 800 W PEP on 2 meters and 500 W PEP on 70 cm, notably higher than some units. This unit can be mounted via two holes on the side of the body. The CF-4160 series is available in three connector configurations—all have an SO-239 (female "UHF" connector) on the common port. The '4160J we tested has SO-239s on all ports. The '4160I has a PL-259 (male "UHF" connector) on the on the 2 meter port and a "Type N" male (a better constant impedance connector, more suited for serious 70 cm operation) on the 70 cm port. The '4160K has PL-259s on both band ports.

They offer a number of other configurations as well. The CF-416 series has pigtails on the band ports to connect to radios without added cables. The CF-142 is similar but groups 222 MHz with the 70 cm band port. They also offer diplexers designed to support the specific port allocations of the IC-706 and FT-100 radios and *triplexers*, with a separate HF port. Check their Web site for the exact configuration and frequency grouping you need, chances are they have one. *US Distributor:* NCG Companies, 1275 North Grove St, Anaheim, CA 92806; tel 800-962-2611; **www.cometantenna.com**. Diplexer prices (with connectors), around $49, with leads around $50, triplexers around $75.

THE DCI 144-148/438-450-DX-DB 2 METER/70 CM DIPLEXER AND BAND-PASS FILTERS

As noted previously, this unit is different than the others. While it splits (or combines) signals from the two bands, it does so very sharply to eliminate out-of-band signals. Its price tag is higher and it inserts a bit more loss, but significantly reduces out-of-band sources of intermodulation distortion and receiver overload. It also restricts reception to the

amateur bands only, eliminating reception of aircraft, public service, marine and weather channels—the sources of most intermod problems. This unit is rated at 200 W on each channel.

Let's digress a moment and discuss intermod. This is a topic that receives a lot of attention when discussing HF transceiver performance, but not as much on VHF. The receivers in many VHF transceivers make a point of indicating that their front ends are wide open so other services can be received. This can be an important feature for some users. On the other hand, the same design can cause serious reception problems. All designs require choices and often compromise.

Perhaps a few examples will help.[3] Let's say you are listening to a distant repeater at 146.35 MHz and you have a TV channel 2 transmitter and an FM broadcast transmitter at 91.1 MHz nearby. Channel 2 has the picture carrier at 55.25 MHz and this will mix in your receiver to result in a second-order intermodulation product at 146.35 MHz. Some receiver front ends will keep out these far-off-frequency signals, and some won't. An example of a third-order response that will almost always get in is the product of 2F1–F2 where both frequencies are near the desired signal. We'll use round numbers, if you are in the vicinity of a strong business or paging transmitter at 156 MHz and another at 166 MHz. All three signals will make it through the receiver front end to the first mixer. The spurious response will be right on 146 MHz (312–166=146). There are many other possible combinations—and they all happen at once.

Depending on the relative levels of the signals, the spurious response could capture the receiver making reception difficult. Reading from the DCI specification sheet, with their unit the 156 MHz signal will be down 40 dB and the 166 MHz signal down 70 dB. This is very likely to make the problem go away, especially since third order IMD drops three times as fast as the signals. A diplexer only unit will happily pass all signals without attenuation, which is great if you want to check the weather.

I used to work and commute along Route 128 outside of Boston. This road seemed to have TV and radio towers every quarter mile and to those who tried to keep in touch using 2 meters it became known as "intermod alley." If you are faced with such problems, you may well consider it a reasonable trade to give up listening to weather channels in order to hear your friends on 2 meters.

This unit is thoughtfully provided with the warning not to change the adjustments. I strongly suggest that you follow this advice and not tighten the exposed tuning screws!

DCI makes a number of models, including single and dual band units that just filter and don't perform the diplexing function. Modules for the European bands 144-146 and 430-440 MHz are available. There is probably a model that will help resolve most V/UHF out of band interference problems. *Manufacturer:* DCI Digital Communications, 20 S Plains Rd, Emerald Park, SK S4L 1B7, Canada; tel 800-563-5351; **www.dci.ca**. Price: 144-148/438-450-DX-DB diplexer, or dual band filter, $170; single band filters $100 to $120, depending on band.

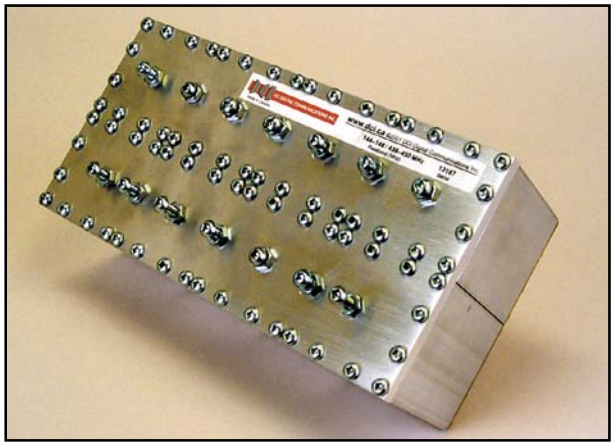
THE DIAMOND MX-72D 2 METER/ 70 CM DIPLEXER

The Diamond MX-72D is similar in size to the other "diplexer only" units. This one mounts with an adhesive pad on the bottom panel of the unit and is rated at 1 kW PEP on HF, 400 W PEP (150 W FM) on 2 meters and 250 W PEP (100 W FM) on 70 cm. As with the Comet series, this unit is available with different combinations of connectors and with or without cable leads. Both diplexers and triplexers are available and Diamond even has two triplexers, the MX2000 and MX3000 that work into the microwave region. The MX-2000 has a port for MH/HF to 6 meters, one for 2 meters and the third covers the 70 cm and 33 cm bands. The MX3000 has a port for MF through 2 meters, one for 70 cm and another for 33 and 23 cm. A serious V/UHF operator could save some expensive coax runs with these, at the cost of some triplexer loss.

Manufacturer: Diamond Antennas, division of RF Parts, 435 S Pacific St, San Marcos, CA 92078; tel 760-744-0900; **www.rfparts.com/diamond/**. Price: MX-72D, $44; other diplexers, $47 to $75; triplexers, $80 to $100.

THE MFJ-961B 2 METER/70 CM DIPLEXER

MFJ offers two diplexer versions. The MFJ-961B is a straightforward diplexer with SO-239 connectors and feet designed to rest on a desk or shelf. The MFJ-961BN is similar in configuration but has female N connectors on all ports. While no documentation is provided



[3]E. Hare, "Intermod—A Modern Urban Problem," *QST*, Aug 1996, p 40. Also available at **www.arrl.org/tis/info/intermod/intermod.html**.

with the unit, an instruction sheet with specifications is available on the MFJ Web site. Either unit is rated to handle 500 W to 35 MHz, 300 W to 225 MHz and on the 70 cm port. Manufacturer: MFJ Enterprises Inc, 300 Industrial Park Rd, Starkville, MS 39759; tel 800-647-1800; **www.mfjenterprises.com**. Price: either unit, $30.

USING DIPLEXERS IN THE REAL WORLD

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After reading Joel's explanation of diplexers, one can generally understand why they come in handy. Simply put, a diplexer can be used to *separate* a common signal port to be able to drive two antennas, or visa-versa. A diplexer combined with more serious filters can significantly reduce intermodulation distortion caused by out of band signals and the resulting mixer byproducts. I am fortunate that I don't live in or near an area prone to intermod, so I was unable to verify the benefit of sharp band-pass filters. The Laboratory tests speak for themselves on that front.

For my part, I conducted straightforward transmitting and receiving tests. I wanted to verify basic operation of these units in the field. As radio equipment, I used my Yaesu FT-90R on 70 cm, an ICOM IC-229 for 2 meters and a Kenwood TH-205 (handheld transceiver) for monitoring 2 meters when necessary. The antennas consisted of a $^5/_8$-λ 2-meter Larsen mobile whip, an MFJ 2-meter/70-cm mobile whip, and a $^1/_4$-λ 70-cm whip. I ran 10 W on both bands, so we did not attempt to verify the power ratings.

As Joel mentions, the diplexers can come with different antenna connections. Given the radios' antenna connectors and those of the diplexers under test, I had to use a few gender changing adapters. For SWR measurements, I used a Daiwa CN630 V/UHF SWR meter.

I should mention that prior to my testing, I casually scanned both bands. I didn't hear anything significant, other than an occasional squelch break or a commercial service, sounding like paging.

Up first was the DCI model. The transceivers were attached to the band ports and the dual-band whip to the COMMON connector. I was able to bring up both 2 meter and 70 cm repeaters with no difficulty. Isolation between the bands seemed quite good for I was unable to hear either signal on the other band radio. Attenuation outside the amateur bands was quite good as well. I tuned to the strong 162.400 MHz NOAA weather broadcast without the diplexer in line. As soon as I attached the diplexer/band-pass filter, NOAA went away! I had the FT-90R scan the 70 cm band, looking for out of band signals. All I heard were hams talking on the local repeaters.

Next came the MX-72D. The radio/antenna configuration was similar, with the exception of having to use PL-258 barrel connectors for the radios. The results were very similar to the DCI, except that the NOAA broadcast was received at full strength, as you would expect based on the frequency response plot for this unit.

I was fortunate in that during the course of my testing, my wife needed to run a quick errand. My lovely bride accommodated the wires and whatnot splayed out in the truck! This errand took me to within a mile or so of both a firehouse and police station, each with their own large towers and various antennas. I thought for sure that if there were to be intermod, I'd get it here! While she did her errand, I quickly tested the MX-72D (since it was still connected). I didn't hear anything unusual. I installed the DCI as before, and conducted similar receiving tests. Again, scans just brought me to the hams on the local repeaters.

Since my time out was running short, I quickly receive-tested the MFJ-961B and CF-4160. As expected, the NOAA broadcasts came in loud and clear. Quick scans on 2 meters and 70 cm indicated no problems. And then it was time to go home!

With the MFJ-961B back in place, I ran my transmitting tests. As with the two previous units, I had no difficulty bringing up repeaters.

The CF-4160, like the others before it, operated normally on both transmit and receive tests. I noticed no degradation of signals on either band, and still nothing that came close to intermod.

Joel mentions there are a few antenna/radio combinations. For the purposes of my tests, I used both the two radio/one diplexer/one antenna, and one-radio/one diplexer/two antenna combinations. I also used the MFJ-916B and CF-4160 in the two-radio/two-diplexer/two-antenna configuration. I wanted to see what would happen! Not much, except to say that I was still able to bring up repeaters without difficulty. I also spoke with a ham on the 70 cm machine. He didn't indicate any problem with my signal.

When it came to SWR measurements, I noticed no significant increase at all with any of the diplexers in-line.

As can be seen from the frequency response charts, three of the diplexer-only units will pass any H/VHF signal up to its cutoff point. If you have an intermod problem, you may need the extra filtering that the DCI units provide at the cost of giving up general coverage, taking up more space and paying a bit more. If you are having problems, I'll bet the difference will be worthwhile.

On the other hand, if your problem were merely one of having a dual band radio with one antenna port, and you'd like to run separate antennas, the other units would work just fine. That was the point of the tests—to make sure that all units performed their functions—and they did. QST