

Procom repeater duplexers

We look at the DPF 2/33 for 2m
and DPF 70/6 for 70cm



PHOTO 1: DPF2/33 2m band 6 cavity duplexer.



PHOTO 2: DPF70/6 70cm band 6 cavity duplexer.

INTRODUCTION. A duplexer is a device that allows a transmitter and a receiver to simultaneously connect to a common antenna and operate without mutual interference or damage.

There are two basic types of duplexer: band pass and band reject. The latter type is better suited to closely spaced transmit and receive frequencies, such as those used within the amateur 144 – 146MHz amateur band. Within this band, speech repeaters use a transmitter to receiver separation of just 600kHz (~0.4%).

The Procom DPF 2/33-250 144MHz band duplexer examined here is a bandpass/reject type [1]. The one supplied for review was tuned to 145.100MHz and 145.700MHz (Channel RV56).

The second duplexer reviewed here, also from Procom, is the smaller DPF 70/6. It is meant for a wider transmitter/receiver frequency separation of between 9 and 13MHz. The review unit was supplied set for 9MHz separation, with the high frequency cavities tuned to 439.6625MHz and the low frequency cavities tuned to 430.6625MHz. These frequencies correspond to D-Star channel RV773.

2m DPF 2/33-250. This is a 6 cavity duplexer intended for the 140 to 175MHz band (which, of course, includes the amateur 145MHz band). It is designed for use in talk through

repeaters with a transmitter-to-receiver frequency separation of 600kHz. Its power rating is up to 300W, depending on insertion loss adjustment. As measured, the supplied duplexer should be able to handle the full 300W, although this is unlikely to be required in UK amateur repeater service. The DPF2/33 is shown in **Photo 1**.

Six cavities are used; three in the transmit path and three in the receive path. Each cavity is 125cm tall and has a claimed Q of around 8000. The common antenna connection uses an N type connector, as do the receiver and transmitter port connections. Interconnection between the cavities is by means of RG214 coaxial cables. For rigidity, the six cylindrical cavities are strapped to two 19 inch aluminium mounting bars. The duplexer weighs 19.2kg.

Each of the cylindrical cavities is made of specially electroplated and painted aluminium. The lower part of each resonator is made of untreated copper while the upper (moving part) of the resonator is silver plated aluminium. The cavities are tuned by means of a large bolt-type plunger adjuster, whilst the coupling within each cavity is a resonant helical inductor. A trimmer capacitor allows for optimum matching.

Figure 1 shows the measured frequency response of the transmitter and receiver paths of the duplexer, and **Table 1** gives the measured results for return loss (match) and insertion loss in dB.

DPF70/6. This 70cm device is also a 6 cavity duplexer, but of much smaller dimensions than the DPF 2/33. Procom specify the DPF70/6 for use over the 406 to 470MHz frequency range with transmit to receive separation of 9 to 13MHz (~2 – 3% at 435MHz). Note that these filters are not suitable for the narrow 1.6MHz split used by most speech repeaters within the 70cm band.

The higher frequency of operation, increased transmitter to receiver frequency separation and lower power rating all allow the duplexer to be much more compact than the 2m band version. The DPF70/6 weighs less than 1kg. **Photo 2** shows the 70cm band duplexer.

All six cavities are made from extruded aluminium and secured to a folded metal frame for rigidity. Interconnection between the cavities is by means of semi-rigid coaxial cable. Cavity tuning is by means of a threaded rod into the top of each cavity. The Procom web page shows the DPF70/6 with BNC connectors as standard. The supplied unit was fitted with N type connectors for improved performance.

These filters are suitable for use within the D-Star allocation in the 70cm band. Maximum power rating is given as 50W. **Figure 2** shows the measured frequency response on both the transmit and receive path of the DPF70/6 and **Table 2** gives the

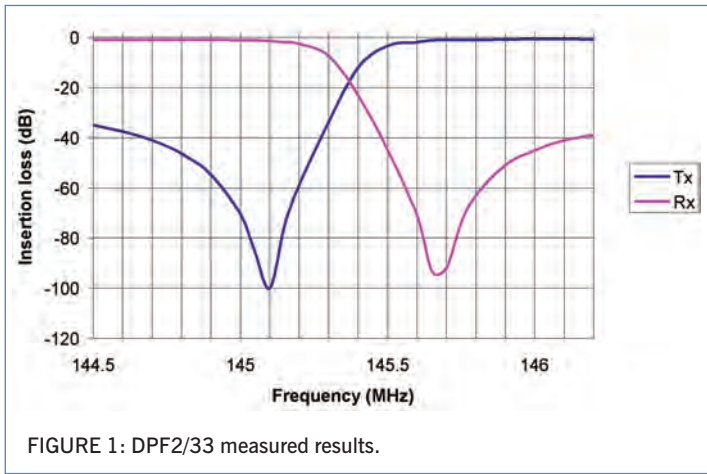


FIGURE 1: DPF2/33 measured results.

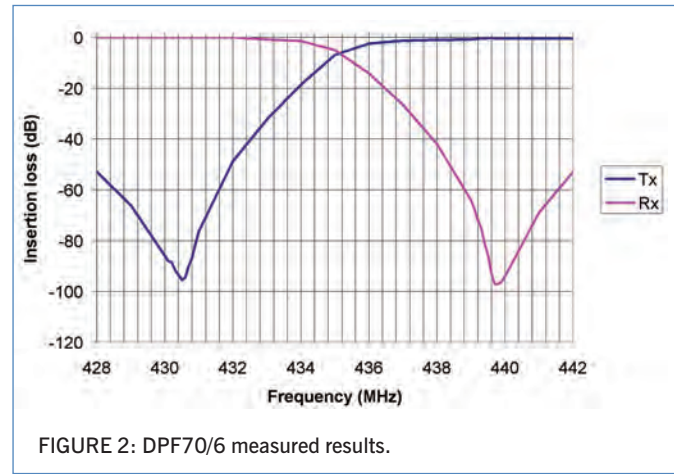


FIGURE 2: DPF70/6 measured results.

measured results for insertion loss, isolation and match.

The test equipment used in these tests is shown in **Table 3**. All measurements were made with the HP8754A network analyser except for isolation. The HP8754A has a dynamic range of 80dB which is insufficient to measure the near-100dB isolation of the duplexer. The signal generator and spectrum analyser are easily able to measure this range with ± 2 dB estimated uncertainty. The signal generator and spectrum analyser were locked to a Z3801 GPS disciplined 10MHz reference.

SUMMARY. The duplexer is an essential part of any repeater that uses a common antenna or closely spaced antenna array. The overall performance of the repeater critically depends on the insertion loss,

transmitter to receiver isolation and stability of the duplexer. It is important for quality of service that these parameters are as good as can be achieved. This means using a proven duplexer design. The Procom 2m band duplexer is not cheap but is of the highest quality and should give many years of trouble-free operation. For 70cm D-Star operation the DPF70/6 should prove a good investment. Its measured performance is excellent and the mechanical construction used appears very rugged and suitable for a tough life in an amateur repeater environment. It is perhaps worth adding that groups using these duplexers should ensure they use good quality coaxial cables between the radios and the duplexer and again between the duplexer and the antenna or some of the excellent performance advantages could be lost due to signal leakage.

Both duplexers are well constructed and easily meet their respective performance claims. The DPF2/33-125 140-175MHz 125mm Cavity Duplex Filter costs £3,447.72 but Procom UK Sales Ltd [2] offer a discount to any amateur club wishing to purchase this duplexer. The smaller DPF70/6 406-470MHz 6 cavity $\frac{1}{4}$ wave resonator duplexer is £255.66. Note that while this smaller style filter is suitable for wide split 70cm repeaters, the narrower 1.6MHz split would require a UHF cavity filter similar to the DPF2/33-125 VHF unit tested here, eg the DPF70/33-125 which costs £3,034.54, though again Procom UK Sales Ltd offer amateur groups a discount.

REFERENCES

- [1] Procom DK: www.procom.dk/eng/
- [2] Procom UK: www.procomuk.co.uk

TABLE 1: DPF2/33 test results. All measurements were made with the unused ports terminated in 50Ω unless otherwise stated.

| Parameter | Manufacturers claim | Measured by G4DDK |
|-----------------------------------|---------------------|------------------------------|
| <i>Insertion loss</i> | | |
| Tx to antenna connector | <1.5dB (145.700MHz) | 1.1dB (145.700MHz) |
| Antenna to Rx connector | <1.5dB (145.100MHz) | 1.3dB (145.100MHz) |
| <i>Matching</i> | | |
| Return loss at antenna connector | >14dB | 24dB ± 1 dB (145.100MHz) |
| Return loss at Tx connector | >14dB | 29dB ± 1 dB (145.700MHz) |
| Return loss at Rx connector | >14dB | 21dB ± 1 dB (145.100MHz) |
| <i>Isolation</i> | | |
| Tx conn. to Rx conn. (145.700MHz) | 88dB (interpolated) | 99dB ± 2 dB |

TABLE 2: DPF70/6 test results. All measurements were made with the unused ports terminated in 50Ω unless otherwise stated.

| Parameter | Manufacturers claim | Measured by G4DDK |
|-----------------------------------|----------------------|-------------------------------|
| <i>Insertion loss</i> | | |
| Tx to antenna connector | <1.2dB (439.6625MHz) | 0.8dB (439.6625MHz) |
| Antenna to Rx connector | <1.2dB (430.6625MHz) | 0.6dB (430.6625MHz) |
| <i>Matching</i> | | |
| Return loss at antenna connector | | 30dB ± 1 dB (439.6625MHz) |
| Return loss at Tx connector | | 33dB ± 1 dB (430.6625MHz) |
| <i>Isolation</i> | | |
| Tx conn. to Rx conn. (438.900MHz) | >85dB | 96dB ± 2 dB |

TABLE 3: Measuring equipment used.

| Measurement | Test equipment used |
|--|---|
| Return loss, insertion loss and frequency response | HP 8754A Network analyser + HP 8502A transmission test set + HP908A 50Ω terminations |
| Isolation | HP 8592L spectrum analyser + Rohde and Schwarz SMG signal generator. Both GPS locked. |