A 2 m / 70 cm diplexer with a difference

By Frank, ZS6TMV / PA3GMP

based upon a design by Henk, PA0HVA, published in Elektron, June 1994

Diplexers-filters intended to split and combine signals on different frequency bands -generally use conventional L/C networks: a low pass filter for the 2 m band and a high pass filter for the 70 cm band, each consisting of several coils and capacitors with a cut-off frequency around 250 MHz or so. The maximum RF power that the diplexer can handle depends mainly on the breakdown voltage of the capacitors. Your average ceramic capacitor is rated at 50 V, so your diplexer will start to burn out at about 50 W. High voltage (trimmer) capacitors can be hard to find, and can be bulky enough to interfere with optimal filter construction, thereby increasing the diplexer's insertion loss and reducing its suppression.

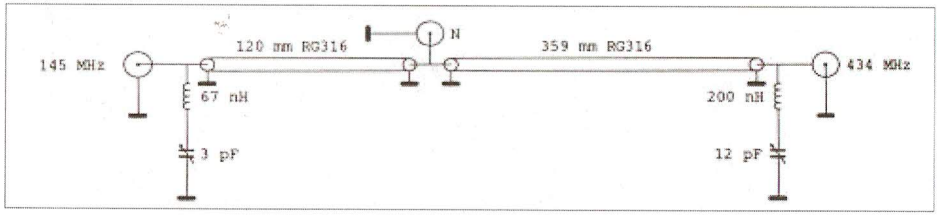
The diplexer described below takes a different approach to the task at hand. It is based upon two quarter wave coax stubs, each combined with a simple filter that only requires one trimmer capacitor each. At resonance, the filter grounds one end of the stub, this results in a high impedance for that frequency at the other end of the stub.

For example, a 145 MHz signal connected to the left hand side (2 m) terminal will traverse the left hand side coaxial line to the common terminal, virtually without experiencing any loss. The left hand side filter resonates at 434 MHz, and will therefore not affect the 145 MHz signal. The right hand side L/C circuit is resonant at 145 MHz, though, and the right hand side end of the right hand side coaxial stub will therefore be grounded. The right hand side coax stub will present a very high impedance to the common terminal as a result, thereby stopping the 145 MHz signal from continuing into the right hand side coaxial line. The same (in the opposite direction) applies to signals at 434 MHz.

This results in a diplexer that can be used to connect two antenna's to a dual band transceiver, or two single band transceivers to a dual band antenna.

Construction is simple, but must be done accurately, and it is important to use the proper components.

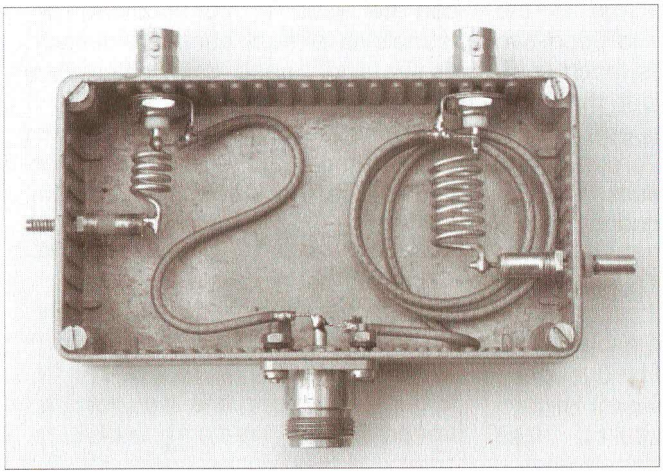
(Continued on page 16)



(2 m/70 cm diplexer from page 15)

The coaxial cable should ideally be RG-316, which is a very thin, 50 ohm coax with Teflon insulation and dielectric. Its velocity factor is 0,695, which means that a quarter wave stub for 145 MHz will be 359 mm, and 120 mm for 343 MHz. The main advantage of RG-316 over RG-174 (another thin but non--Teflon 50 ohms coax) is that good, short soldered connections can easily be made to the braiding, which is essential for the filter's performance. Other coax could be used as well, but thicker cable (such as RG-58) makes it more difficult to solder the cable and fit it in, while non-Teflon varieties are much more difficult to solder close to the dielectric. Some alternatives are RG-142 (more or less a Teflon variety of RG-58), RG-174 (thin, non-Teflon, with a higher insertion loss than RG-317) or, if you really have no other option, RG-58. If you use anything else than RG-316, though, YOU MUST OBTAIN THE EXACT VELOCITY FACTOR for the cable you use from the manufacturer's data sheet. Do not guess, do not use rule of thumb, do not use the specs for the same type of cable from another manufacturer. Then recalculate the length of the stubs to the millimetre.

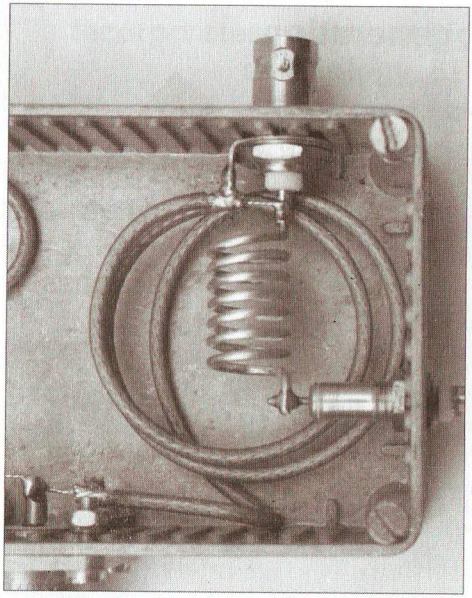
The trimmer capacitors should be of the best quality you can get. Ceramic types are preferable because they can take higher voltages (and therefore more RF power) while tubular capacitors are preferred from a construction standpoint because they can be mounted directly into the chassis of the box. (Hint: that old valve radio stuff that you passed up on, the last time you were at a ham radio flea market generally has the caps you need!) I used tubular trimmer capacitors of 6 and 12 pF for 70 cm and 2 m, respectively. It does not really matter if the caps you use are a few pF over the 'desired' capacity -that is why they call them "variable." The ones I used are rated at well over 200 V, which means that the diplexer allows for more power than my ham radio license.



The coils are made out of 1,5 mm solid copper wire. I used silver plated wire, but you can also use enamelled copper wire without any appreciable loss of filter quality. The coil for 2 m (200 nH) consists of 7 windings on the smooth

(Continued on page 17)

(2 m/70 cm diplexer from page 16)



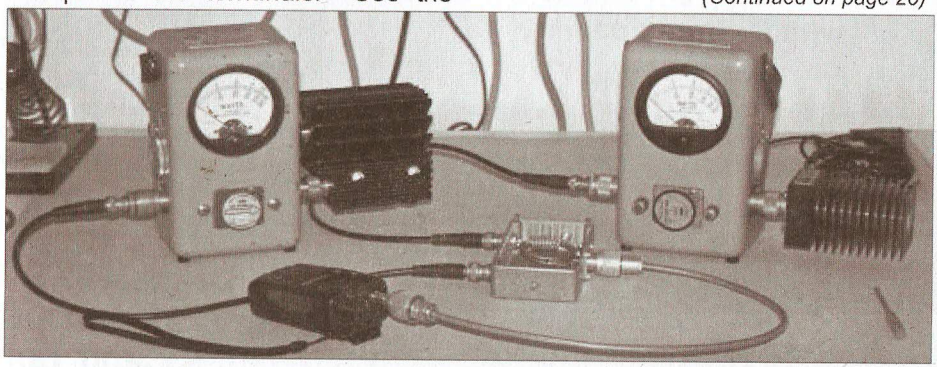
end of a 9 mm drill bit, stretched until the length of the coil is 20 mm. The one for 70 cm (67 nH) has 5 windings on a 6 mm drill bit, stretched until the coil is 10 mm long.

The shield of the coax is soldered directly to the lugs, while the core is clipped off at a length of 5 mm or so, and connected to the centre pin of the terminals. See the photo for construction details.

Note that the length of the wire between coax and centre pin is not counted as part of the length of the stub, i.e. the 70 cm stub should be 120 mm along the length of the shield, plus 5 mm of bare centre lead at each end.

Alignment is simple. Apply a 145 MHz signal to the common terminal. Connect a power meter (SWR meter, directional watt meter or RF volt meter) to the 434 MHz terminal, and a 50 ohms dummy load to the 2 m terminal. Adjust the 145 MHz variable capacitor until the RF signal at the 434 MHz terminal dips to zero. Then move the power meter to the 2 m terminal and the dummy load to the 70 cm terminal, apply a 434 MHz signal to the common terminal, and adjust the 434 MHz variable capacitor until the RF signal at the 145 MHz terminal dips to zero. (Don't get confused here: you should connect the Wattmeter to the 2 m terminal when adjusting the 70 cm filter using a signal at 434 MHz, and vice versa!) I used two separate Wattmeters, but this is by no means necessary.

(Continued on page 20)



(2 m/70 cm diplexer from page 17)

Measured performance

The suppression of the diplexer is especially important when you use the diplexer to connect one dual band antenna to two single band transceivers. A single band radio can be expected to have an input filter providing at least 20 to 30 dB of suppression of out- of- band signals. That brings the minimum total suppression to 45-55 dB or so, which means that if you use two single band transceivers and one dual band antenna, 100 W at 145 MHz will result in only a few mW into the first stage of your 70 cm transceiver, and vice versa. Both transceivers will be able to handle this with ease.

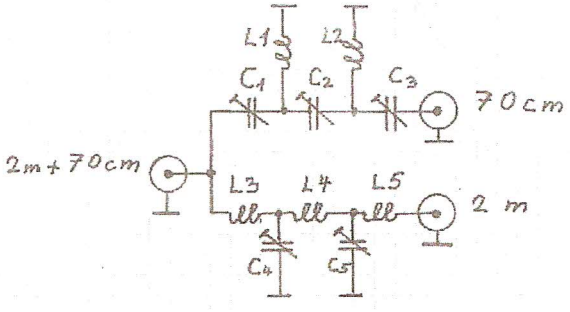
Frequency	Suppression	Insertion loss	SWR
144 MHz	26 dB	0,15 dB	1,05 : 1
145 MHz	40 dB	0,15 dB	1,02 : 1
146 MHz	26 dB	0,15 dB	1,05 : 1
432 MHz	29 dB	0,25 dB	1,03 : 1
434 MHz	40 dB	0,25 dB	1,04 : 1
436 MHz	29 dB	0,25 dB	1,06 : 1

Diplexer – 2m / 70cm

Article by HB9ABX, reprinted from Anode, Club Newsletter of West Rand Radio Club

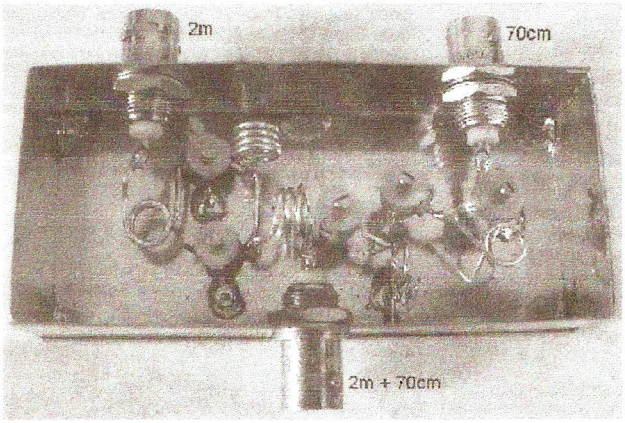
"The names DUPLEXER and DIPLEXER are very similar and frequently confused.

The duplexer is a device that separates two frequencies within the same band, while the diplexer is a device which separates two different bands.



DIPLEXER HB9ABX

The diplexer normally requires only low pass and high pass circuits while the duplexer requires much more selective circuits. This DIPLEXER separates 2m from 70cm on the same coax cable. It allows the use of 2 antennas over the same cable and permits transmission on one band and simultaneous reception on the other band when connected on the side of the antennas. Or use two pieces of equipment (one VHF and one UHF) when used on the side of the transceiver.



The following data have been measured on 50 ohm input and 50 ohm output:

Separation of the two bands is very high (over 70 db)

Insertion loss is negligible (less than 0.2 db)

Its easily built into a metallic box measuring 8cm x 4cm x 2cm or similar (E.g. TEKO 372)

List of components:

L1 = 1 turn 6mm diameter, 1mm silver wire
L2 = same as L1 (orientation 90 deg in respect to L1)
L3 = 3 turns 6mm diameter, 1mm silver wire
L4 = 4 turns 6mm diameter, 1mm silver wire
L5 = same as L3
C1 = foil trimmer capacitor 15pf (3-15pf)
C2 = same as C1
C3 = same as C1
C4 = foil trimmer capacitor 40pf (4-40pf)
C5 = same as C4
3 HF chassis plugs 50 Ohm (e.g.BNC)
1 metal box e.g. TEKO 372

(Note that the inductors (photograph) are placed at right angles to each other. This is important and is done to minimise magnetic coupling between them)

Ω