

VHF/UHF Automatic Filters and Multicouplers For R&S®M3SR software defined radios

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R&S®FD221 UHF Automatic Filter
R&S®FU221 VHF Automatic Filter



VHF/UHF Automatic Filters and Multicouplers

At a glance

The R&S®FD221 und R&S®FU221 automatic filters are an essential part of radio equipment. They are used at radio sites where the reciprocal influence of neighboring radio systems must be selectively restricted. Selective restriction is the only way multiple radio systems can be simultaneously operated in very tight spaces. As a result, sustainable, higher quality radio links that are more reliable can be achieved.

The frequency-agile R&S®FD221 and R&S®FU221 filters protect the operator's radio system against third-party RF interference. The filters work in both the transmit and receive directions.

A wide variety of radio installations can be the source of unwanted RF interference. Frequent sources include broadcasting, microwave link and radar applications because they often operate with high transmit power. The filters protect the operator's radio system against such interference in the receive direction.

In the transmit direction, the filters protect sensitive third-party radio applications, such as navigation and radiomonitoring equipment, against the operator's out-of-band RF signals.

The filter effect in the receive and transmit directions also lets operators make economic use of their frequency bands. The frequency spacing between useful channels is substantially reduced, making it easier to install the required antennas.

R&S®FU221 VHF automatic filter



The physical spacing between the antenna sites is significantly reduced because the filters substantially increase the RF decoupling.

The highly selective filters are mechanically rugged and therefore can be used on board ships and semi-mobile facilities as well as in ground installations.

Key facts

- Excellent mechanical precision
- Short tuning time
- Power supplied directly from the radio system
- Available as two, three and four-way multicoupler
- Very low insertion loss

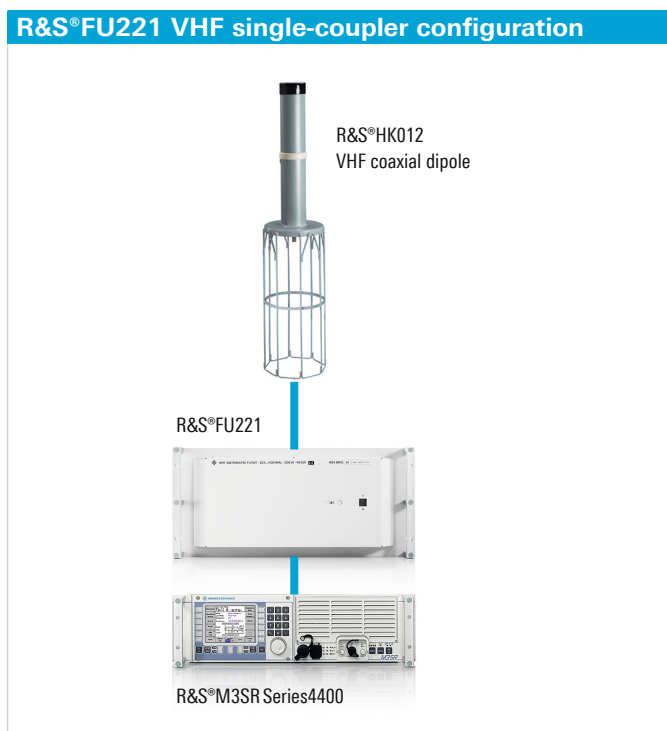
Benefits

Receiver benefits

- Suppression of out-of-band based intermodulation products by additionally attenuating all signals and their harmonics which are outside the receiving range and – due to nonlinearities and mixing – could cause intermodulation products to fall within the useful VHF or UHF band and interfere with reception
- Suppression of third-order crossmodulation products by attenuating strong interfering signals which could transfer their modulation to the wanted signal
- Increase of image frequency rejection by additionally attenuating signals defined as image frequency relative to the received frequency
- Prevention of desensitization (reciprocal mixing) by attenuating strong interfering signals which could otherwise transfer the noise sidebands of the receiver oscillator, mixed onto the interfering signal, to the useful band, thus reducing sensitivity

Transmitter benefits

- Attenuation of broadband transmitter noise caused by the radio oscillator or power amplifiers
- Suppression of spurious emissions caused by the radio power amplifier
- Suppression of harmonics mainly generated in the output stages
- Attenuation of transmitter (backward) third order or higher intermodulation products, mainly caused by simultaneously operating radio systems with co-sited transmitters



Design and functions

The R&S®FD221 and R&S®FU221 filters are made up of two coaxial resonators, fixed-coupled to form a compact two-section filter plug-in. Tuning is performed by altering the length of the longitudinally adjustable inner conductors. The gear is driven by a microprocessor-controlled high-precision stepping motor. Following a frequency change input from the radio, the inner conductors of the cavity resonators are driven to the appropriate position. An additional axle leads outward from the gear unit. A manual tuning knob can be fixed to this axle in the event of automatic tuning failure.

A robust and mechanically stiff layout together with temperature-stable filter bodies ensure compliance with specifications:

- Throughout the entire temperature range
- Under 100% duty-cycle high-power operation

The control cable between the filter and the radio unit provides the operating DC voltage as well as the necessary frequency and other control information.

Multicoupler capability

Up to four filters can be combined using a VHF or UHF two or four-way combining array to create a multicoupler solution. Only a single antenna is needed to couple multiple transmitters or receivers.

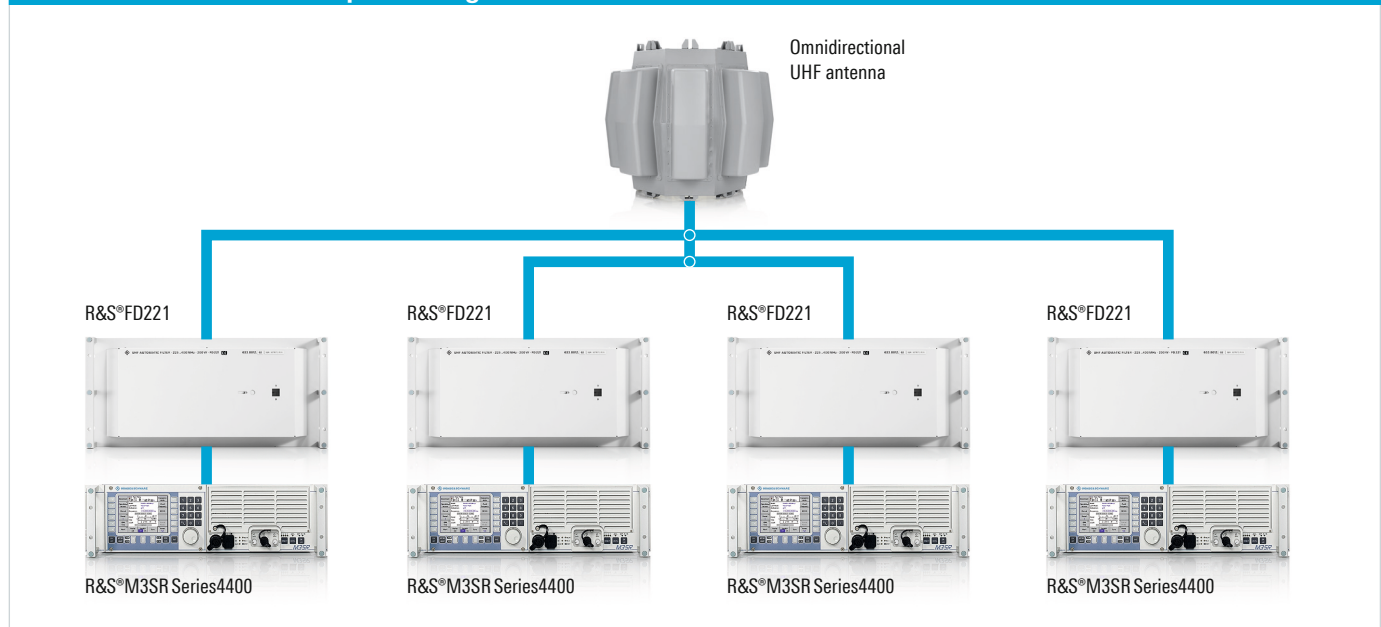
Such a multicoupler solution consists of a starpoint and a multistage quarter-wave transformation line toward the common antenna ensuring good matching of the filter inputs to the input impedance of the antenna over the entire VHF or UHF band. The multicouplers are thus suitable for operation at any frequency in the band. Such multicoupler configurations with extremely low insertion loss are an outstanding feature of the R&S®Fx221 filter units.

The R&S®FD221 and R&S®FU221 can be mounted in racks. The R&S®FU221 VHF filters are installed horizontally while the R&S®FD221 UHF filters are installed vertically. The multicouplers are connected using specially designed RF lines to optimize the RF coupling of the filters.

Because a multicoupler RF interface is required, a distinction is made between lower and upper filters for vertically installed R&S®FD221 filters. Both the upper and lower filter types can be ordered separately.

The unused filter plug-in of a three-port automatic multicoupler is covered with a blank panel. The blank panel can be replaced with a suitable filter at a later point in time.

R&S®FD221 UHF multicoupler configuration



The RF connections for the multiport automatic multicouplers can be simply plugged in, substantially simplifying rack installation. The precise mechanical design facilitates direct plug-in of the RF connectors.

The photos below show rack-installed R&S®FD221W4 and R&S®FU221W4 multicouplers with UHF and VHF filters.



R&S®FD221W4 (UHF) vertical multicoupler rack installation.



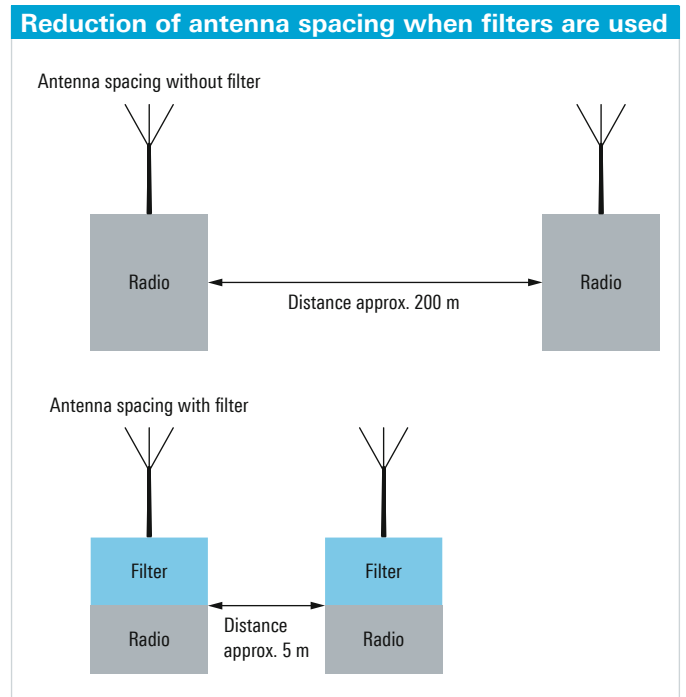
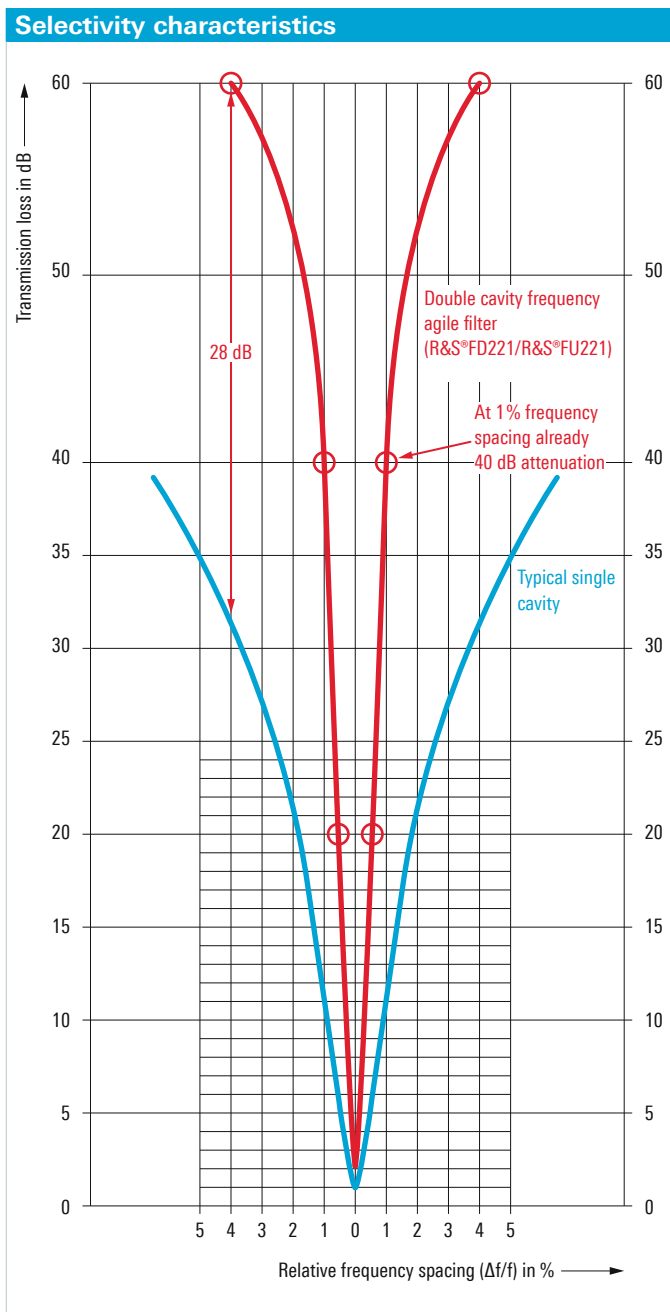
R&S®FU221W4 (VHF) horizontal multicoupler rack installation.

Filter selectivity

The figure on the left shows the filter selectivity versus the relative frequency in %. The double cavity arrangement of the R&S®Fx221 filters achieves substantially higher selectivity than single cavity solutions. When the operator's transmit frequency has a 4% frequency spacing, the stopband attenuation of the R&S®Fx221 filter is about 28 dB higher than that of a standard single cavity solution. The high selectivity of the R&S®Fx221 filters is shown in the figure. Such filters make it easier to implement a sophisticated RF system.

For instance, the R&S®Fx221 filters substantially lower the antenna spacing required between transmitter and receiver. In the case of a system with a broadband noise of -150 dBc (1 Hz) and a desensitization of > 80 dB, antenna spacing is typically about 200 m without filters (see figure below). The filters significantly reduce the required spacing to approximately 5 m.

These filters make it possible to implement high-performance VHF/UHF radio systems in the tightest of spaces.



Product overview

Designation	Type
UHF automatic filters and multicouplers	
UHF automatic filter ¹⁾ , 225 MHz to 400 MHz, 300 W FM, 19" plug-in, 5 HU	R&S®FD221
Spare model for R&S®FD221W2, spare/extension model for upper two filters of R&S®FD221W4 (models .02/.03/.04), spare model for R&S®FD221W4 (model .12) ²⁾ ³⁾	R&S®FD221
Spare/extension model for lower two filters of R&S®FD221W4 (models .02/.03/.04) ²⁾	R&S®FD221
UHF two-port multicoupler, 225 MHz to 400 MHz, 300 W FM, with mounting kit for special 19" rack, with 2 filters	R&S®FD221W2
UHF four-port multicoupler ⁴⁾ , 225 MHz to 400 MHz, 300 W FM, with mounting kit for special 19" rack, with 4 filters	R&S®FD221W4
UHF three-port multicoupler, 225 MHz to 400 MHz, 300 W FM, with mounting kit for special 19" rack, with 3 filters	R&S®FD221W4
VHF automatic filters and multicouplers	
VHF automatic filter ¹⁾ , 100 MHz to 162 MHz, 300 W FM, 19" plug-in, 5 HU	R&S®FU221
Spare model for R&S®FU221W2 or R&S®FU221W4, extension model for R&S®FU221W4 ⁵⁾	R&S®FU221
VHF two-port multicoupler, standard type, 100 MHz to 162 MHz, 300 W FM, 19", 10 HU ⁵⁾	R&S®FU221W2
VHF four-port multicoupler, standard type, 100 MHz to 162 MHz, 300 W FM, 19", 20 HU ⁵⁾	R&S®FU221W4
VHF two-port multicoupler, special model, 19", 20 HU ⁶⁾ , extendible to 4 ports	R&S®FU221W4
VHF three-port multicoupler, special model, 100 MHz to 162 MHz, 300 W FM, 19", 20 HU, extendible to 4 ports ⁶⁾	R&S®FU221W4
Control cables	
Filter control cable for R&S®M3SR Series4400, length: 2 m	R&S®ZT297-3
Filter control cable for R&S®M3SR Series4400, length: 5 m	R&S®ZT297-3

¹⁾ 19", rack plug-in, 5 HU with standard (screw-connected) RF connectors, for standalone filter (not multicoupler) use.

²⁾ Vertical ½ 19" plug-in, 10 HU, with plug-in RF connectors for automatic connection with the multicoupler combining array.

³⁾ The R&S®FD221W2 (model .02) consists of two R&S®FD221 (model .03) UHF filters and one UHF two-way combining array.

⁴⁾ The R&S®FD221W4 (model .02) consists of two R&S®FD221 (model .03) upper filter plug-ins side-by-side, two R&S®FD221 (model .04) lower filter plug-ins side-by-side, and one UHF four-way combining array.

⁵⁾ The R&S®FU221W4 (model .02) consists of four R&S®FU221 (model .03) VHF filters and one VHF four-way combining array.

⁶⁾ Delivered with 50 Ω terminators for open extension port(s).

The radio systems described are hardware- and software-configurable. The system delivered has the configuration as confirmed in the order.

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PD 5214.4594.12 | Version 04.00 | March 2019 (ch)
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