

R&amp;S®DDF0xA/E and R&amp;S®DDF195 Digital Direction Finders

## The world's first VHF-UHF direction finding antennas for all polarizations

The R&S®ADD157/R&S®ADD197 dual-polarized VHF-UHF DF antennas are the world's first antennas of their kind that can receive both vertically and horizontally polarized signals.



FIG 1 The R&S®ADD157 dual-polarized VHF-UHF DF antenna.

### Why horizontal polarization?

Direction finders are normally equipped with vertically polarized antennas, making it impossible for them to perform accurate direction finding when they encounter signals with strictly horizontal polarization. For example, this is what happens in direction finding involving FM and TV transmitters which are commonly equipped with horizontally polarized antennas (see box).

Normally, of course, there is no need for direction finding with FM and TV transmitters since their locations are well known. However, in the case of illegal transmitters using horizontally polarized transmitting antennas, vertically polarized DF antennas and triangulation do not work. In these cases, DF antennas with vertical and horizontal polarization are needed.

One obvious (but very poor) solution would be to simply rotate the vertically oriented dipole antenna elements by 90° so that they are horizontal. However, this results in an overly directional receiving characteristic. The DF accuracy and sensitivity would be inadequate in certain directions and it would not be possible to aurally monitor signals from those directions.

### The solution: dual polarization

Rohde & Schwarz is now the first manufacturer worldwide to develop DF antennas that combine both types of polarization while maintaining compact dimensions (FIG 1). In the free space between the nine vertically polarized dipole antenna elements, nine additional horizontally polarized loop antennas have been inserted that are selected using

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switches. These loop antennas are significantly more complex than simple wire loops and have been extensively optimized. Using the tried-and-tested correlative interferometer DF method, their performance exceeds all expectations and is nearly identical for both types of polarization.

The new R&S®ADD157 (for the R&S®DDF0xA/E direction finder family) and R&S®ADD197 (for the R&S®DDF195 direction finder) dual-polarized VHF-UHF DF antennas have a wide frequency range from 20 MHz/40 MHz to 1300 MHz. The frequency range for horizontal polarization begins at 40 MHz. With both polarization types, high DF accuracy of 1° RMS is achieved above 200 MHz (2° RMS below 200 MHz). The DF sensitivity and the immunity to reflections clearly surpass the typical values for commercially available equipment due to the two nine-element antenna arrays. FIG 2 shows the DF sensitivity of

the R&S®ADD157 versus frequency for horizontal and vertical polarization.

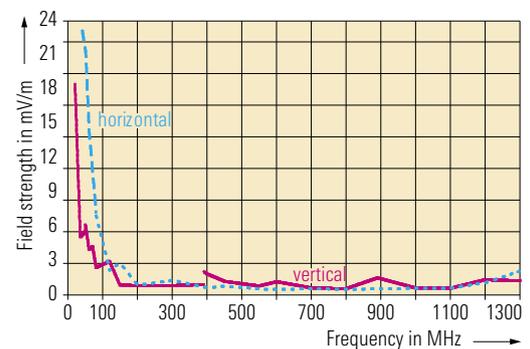
The user can conveniently set the type of polarization using the direction finder's graphical user interface. The correct setting can be determined quickly and reliably by comparing the DF quality. If the DF value changes significantly after the polarization type has been changed, then a reflection was measured first, followed by the direct wave from the direction of the transmitter.

Since the two new DF antennas can precisely locate any horizontally polarized transmitter, signals from FM and TV transmitters can be used to orient the direction finder to north and to check it. Transmitters of this type are ideal since they continuously broadcast a strong, undistorted signal from a known location, making it easy to check the DF accuracy and north setting.

Another frequent signal type with horizontal polarization comes from radar systems. Using the new R&S®ADD157/197 dual-polarized DF antennas, it is now possible to perform direction finding on radar systems too. With these capabilities, the two new DF antennas represent a new standard in this frequency range.

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**FIG 2** Typical DF sensitivity of the R&S®ADD157 DF antenna versus frequency (for 2° RMS, 600 Hz bandwidth, 1 s averaging).



## Why normal DF antennas are incapable of receiving horizontally polarized signals

Around the world, direction finders used for locating transmitters are typically equipped with a vertically polarized DF antenna. These DF antennas usually consist of multiple vertical dipole antennas arranged in a circular array. For example, FIG 3 shows the R&S®ADD050 from Rohde & Schwarz, a DF antenna that has nine elements for the frequency range from 20 MHz to 200 MHz and a diameter of 3 m.

Direction finders with vertically polarized antennas are not capable of accurately taking bearings on signals with strictly horizontal polarization. This is the case, for example, in DF applications involving FM and TV transmitters which are usually equipped with horizontally polarized transmitting antennas and mounted on high masts for better coverage. If the DF antenna is also located in an elevated position on a mast or on a roof, it will have more or less line-of-sight contact with the transmitting antenna.

Under these circumstances, erroneous results can be produced as the undistorted, horizontally polarized FM/TV signals reach the vertically polarized DF antenna. There are basically two effects that cause problems in this scenario:

- ◆ The received signal induces currents in the electrically conductive antenna structure. The vertical components of the resulting secondary fields disrupt the DF process.
- ◆ In addition to the direct wave, the DF antenna also receives reflected waves with a combination of vertical and horizontal polarization. Direction finders are normally better at measuring the vertical components of reflections than the directly received signal. This can produce extremely erroneous results due to the reflections. However, the poor DF quality usually provides a warning about this problem when it is present.



**FIG 3** R&S®ADD153 DF antenna (top of mast) and R&S®ADD050.