R&S®DDF0xA/E Digital HF/VHF/UHF Direction Finders

Super-resolution DF method identifies co-channel signals

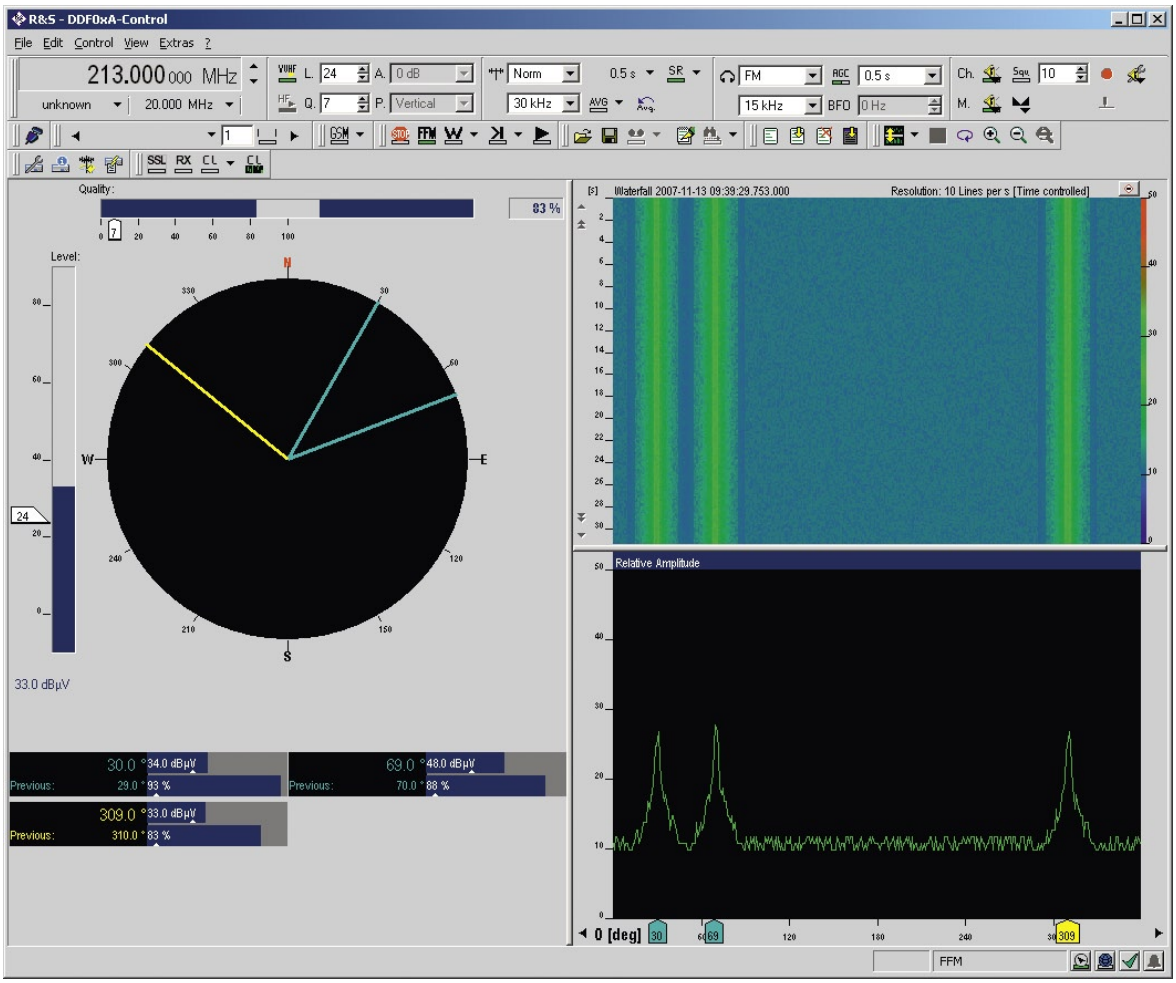
A super-resolution DF method is now available as an option for the R&S®DDF0xA/E family. It can determine the bearings of multiple emissions on the same frequency and adds to the existing DF methods.

The challenge: co-channel interference

Most radio DF methods are based on the assumption that a specific frequency is occupied exclusively by the transmitter of interest. However, if additional transmitters are operating on the same frequency, direction finding may be impaired – a problem referred to as co-channel interference. In this case, the DF result depends on the level ratio of the transmitters. If one of the transmitters is clearly stronger than the others, its direction is displayed with slight DF errors. If the transmitters have similar levels, the DF result is normally incorrect. This applies equally to all conventional DF principles including correlative interferometer, Doppler, and Watson-Watt methods.

Co-channel interference regularly occurs in practice. In fact, it is partly even a characteristic of a transmission method:

- In the HF range, propagation characteristics are continuously changing. Emissions may sometimes travel much farther than originally planned and thus be received in areas where a different station transmits on the same frequency.



User interface of the R&S®DDF05A direction finder with the R&S®DDF-SR super-resolution option when determining the bearings of three co-channel signals.

- Defective electronic devices may produce electromagnetic interference that occurs on the frequency of transmitters.
- In single-frequency networks such as those used in DAB / DVB, multiple transmitters transmit the same signal on the same frequency from different sites. This is done to improve the transmission quality.
- Sometimes, specific transmitters are intentionally jammed. In this case, an interfering signal is sent on the same frequency.
- When working with the code division multiple access (CDMA) method, which is used by the Universal Mobile Telecommunications System (UMTS) mobile radio standard, many stations simultaneously transmit signals in the same frequency range. The receivers can distinguish the different signals by means of the spreading code which is superimposed on the message.

Up to seven co-channel signals can be identified

To allow the bearings of co-channel signals to be taken, Rohde & Schwarz is now making a super-resolution DF method available for its R&S®DDF0xA / E family [*]. This method is offered as the R&S®DDF-SR option and supplements the DF methods already available. As "super-resolution" in its name implies, this DF method is able to resolve a wave field with multiple signals on the same frequency. The number and angle of incidence of the waves are first calculated precisely and then displayed. The new option allows you to take the bearings of up to seven different signals on the same frequency. The number depends on the angle of incidence and the S/N ratio.

An excellent price/performance ratio is attained by cleverly using the three receive channels of the R&S®DDF0xA / E DF family. To make this possible, DF antennas whose antenna elements can be combined into various subgroups must be utilized. The new R&S®ADDxxxSR DF antennas are ideal for this task.

The figure illustrates the user interface of the R&S®DDF05A direction finder with the R&S®DDF-SR super-resolution option. In the example, the direction finder receives three transmitters on the same frequency. The algorithm automatically recognizes the number of transmitters and displays the results as follows:

- All DF results are simultaneously displayed in the azimuth dial. The selected result is highlighted in yellow.
- The bearing, receive level, and DF quality (as a numeric value) for all signals are displayed.
- The receive level and the DF quality of the selected signal are displayed as a bargraph.

More information about our extensive portfolio of direction finders at www.rohde-schwarz.com

REFERENCES
[*] R&S®DDF0xE: Complex radio scenarios at a glance. News from Rohde & Schwarz (2003) No. 180, pp 54–57.

You can activate the new super-resolution DF method by means of a mouse-click in the R&S®DDF Control graphical user interface if you suspect that multiple transmitters are transmitting on the same frequency. Low DF quality often in conjunction with a strong fluctuation in the DF value is a reliable indicator.

By offering its new R&S®DDF-SR option, Rohde & Schwarz for the first time provides an economical method for taking bearings in accordance with the super-resolution DF method. In addition to high immunity to reflections and immunity to strong transmitters, the R&S®DDF0xA / E direction finders thus lay claim to yet another unique aspect by including this new method.

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Technical background

Conventional DF methods are based on the assumption that the frequency channel of interest has only one dominating wave. However, this may not be the case due to factors such as the following:

- Spectral overlapping (e. g. CDMA) occurs among the wanted signals being evaluated.
- High-amplitude interferers also occur in addition to the wanted signal (e. g. electromagnetic interference).
- Multipath propagation is present (e. g. reflections off buildings).

The DF errors that arise will make the results unusable.

Conventional DF technology offers two countermeasures:

- If the interferer component is lower in power than the wanted signal component, the DF error can be minimized by dimensioning the direction finder accordingly – in particular by selecting an antenna aperture that is large enough.
- If the interferer component is equal to or greater than the wanted signal component, you can take separate bearings of non-correlated signals using high-resolution wideband direction finders. You can benefit from the spectral differences of the signals.

Super-resolution DF methods offer a systematic solution to this problem: They allow you to calculate the number of waves involved and their angle of incidence. This is done either model-based by using the maximum likelihood method or by means of principal component analysis (PCA) of the antenna data. The new R&S®DDF-SR super-resolution option makes use of PCA.