VHF-UHF Direction Finder DDF190

Digital direction finding from 20 to 3000 MHz to ITU guidelines

DDF190, the youngest member of the new digital DF family, has now been launched on the market. This compact DF add-on for VHF-UHF receivers is available at an extremely favourable price. It operates on the correlation principle and is mainly used for locating sources of interference and unauthorized emitters.

Digital signal processing coupled with innovative RF technology has set new standards in many fields and direction finding is one of them. DDF190, a fully remote-controlled DF add-on for commercial receivers with an unregulated 10.7-Hz or 21.4-MHz IF output follows on from the fast Scanning Direction Finder DDF0xS [1] and Monitoring Direction Finder DDF0xM [2]. ESMC and ESN from the Rohde & Schwarz receiver program are ideal for use with DDF190, which is a very cost-effective way of adding an extremely broadband direction finder to high-quality measuring and monitoring systems.

DDF190’s design meets the recommendations in the ITU Spectrum Monitoring Handbook [3]. The wide frequency range from 20 to 3000 MHz and high system accuracy make DDF190 ideal for civil radio-monitoring tasks. Thanks to its compact design it can be used for mobile as well as stationary applications (FIG 1). Since DDF190 is also system-compatible, it can be used as a stand-alone unit or be networked for a variety of system applications. The whole frequency range is covered with just two antennas. Since only one coaxial cable and control cable are required to connect up DF Unit EBD190, installation is simple and low-cost. The direction finder can, of course, be powered from a battery or the AC supply. In both cases the DF unit provides the supply voltage for the active antennas. When used for stationary applications, the antennas can be located up to 95 m from the DF unit using the standard cable sets. For cables longer than 40 m an additional power supply unit is provided.

Direction Finder DDF190 operates as a correlative interferometer and can handle all types of modulation. The direction finding procedure makes use of digital signal processing. The phase differences between the antenna voltages generated by the signal received by the antennas are compared with reference values and then checked for maximum correlation. The advantage of this DF method is that, because antenna elements do not need to be grouped into subarrays, wide-aperture DF antennas can be used covering large frequency ranges with a minimum number of antenna elements.

Operation

DF Unit EBD 190 is operated using a clearly layed-out front panel keypad and a large LCD (FIG 3). All functions required during operation are under direct key control. The receiver is operated separately, but the interfaces for antenna range selection are supported. Since direction finding is performed by sequential scanning of the DF elements, and only one receiver is used, switching noise is produced in the AF signal of the receiver. To eliminate this noise when aural monitoring is being performed, scanning and so direction finding may be switched off. Selectable averaging times (0.1 to 5 s) and matched filtering in DDF 190 (1 to 100 kHz) considerably improve bearing accuracy – particularly in the case of noisy signals or signals with interference.

Three operating modes and two display modes optimize direction finding for various applications.

In normal mode the DF process is controlled by a selectable squelch threshold which is compared with the currently received, relative IF level. It is best to
use this mode for monitoring radio networks or simplex communication. Bearings of short-duration signals (minimum 50 ms) can also be taken. As the selected averaging is cancelled at the end of a signal, the bearing display follows the changing directions of incidence without any delay.

In continuous mode direction finding is performed continuously. With sliding averaging, the display is updated every 0.5 s. This means that direction finding can be performed on weak signals or signals with a very large bandwidth.

The gate mode is used for bearings on keyed transmitters as the squelch threshold is also activated but the averaging memory is not cleared if the signal is below the threshold. Integration over many pulses is therefore possible.

The DF display comprises a three-digit number and a radius for indicating direction. The DF quality, derived from the correlation function, is displayed with each DF value. For stationary applications, a compass with north adjustment is used as a reference and the vehicle axis for mobile applications. The latter is crucial when the vehicle is being used for homing. In this case a compass is also used to continuously indicate where north is with respect to the vehicle. Vector direction finding with QDM as used in air traffic control can also be selected.

In each of these modes DF values can also be displayed as a histogram in addition to the display mode already referred to. This is very useful for analyzing communication networks: all DF values obtained since this display mode was activated are displayed as rays, the length of each ray being a measure of the frequency of occurrence of the bearing angle it represents. Results can also be displayed and printed out as lists. Postprocessing functions like smoothing, determination of local maxima and sorting support histogram analysis.

On power up of the direction finder, the system environment (antennas, class of receiver, compass) is automatically determined. A realtime clock outputs a time marker for each bearing taken. This facilitates bearing/emitter assignment in networked DF and radiolocation systems.
Antennas

The range 20 to 1300 MHz is covered by Antenna ADD190. Its small diameter of only 1 m and the uncriticality of polarization make the antenna ideal for mobile applications although it also has considerable advantages in stationary use. Thanks to its small size, it is unobtrusive, protected as standard against direct lightning strikes and can withstand wind speeds of 200 km/h.

Antenna ADD071 is provided for the UHF range 1.3 to 3 GHz. Designed as a circular array of dipoles in front of a reflector, ADD071 may be fitted on the same mast as ADD190 (FIG 4). This combination is already available as standard.

An electronic compass add-on may be fixed to the antennas for automatic direction finding referred to north.

System compatibility

DF Unit EBD190 provides remote control via a serial RS-232-C interface. Remote control (virtual control panel) is identical to front-panel operation. The DF unit also provides an RS-422/RS-485 and a TTL parallel interface for the connected receiver. Character sequences for receiver control are passed on by the DF unit. Compact commands and configurable message formats reduce the required communication capacity to a minimum. Two modes using a minimum number of messages are provided in addition to the three operating modes: timed single and repetitive DF. An external control input is provided for a radio modem; this does not affect direction finding in any way (internal transmitter suppression).

To create larger systems with DF stations at any location, Rohde & Schwarz offers comprehensive solutions into which DDF190 can be directly integrated. Radiomonitoring System TS9965 [4] provides fully automatic monitoring, measurements and analysis to CCIR and ITU recommendations. In the DF measurement mode, results from several DF stations can be handled and marked on a digitized map. Within this system, DDF190 may be connected to receivers with IEC/IEEE-bus control in unmanned stations. Channel and frequency scans are also supported. The Radiolocation System RAMON-locate [5] was designed to accommodate the DDF190/ESMC combination.

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REFERENCES


Condensed data of VHF-UHF Direction Finder DDF190

- Frequency range (depending on receiver and DF antenna)
  - VHF/UHF: 20 to 1300 MHz
  - UHF: 1.3 to 3 GHz
- DF error
  - 2° rms (30 to 80 MHz)
  - 1° rms (80 to 1300 MHz)
  - 2° rms (1.3 to 2.7 GHz)
- DF sensitivity
  - VHF/UHF
  - UHF
- Minimum signal duration
  - approx. 50 ms
- Bandwidths
  - 1/2.5/8/25/100 kHz

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