Success story continues: The R&S®DDF04E direction finder succeeds the R&S®PA100

The R&S®PA100 family of Doppler direction finders has for decades been in use in large numbers in air and maritime traffic control worldwide. It is now being gradually phased out and replaced by the R&S®DDF04E digital direction finder for traffic control. This new generation can take bearings on up to 32 frequency channels using only one direction finder.

One direction finder for up to 32 frequency channels – with high DF accuracy and sensitivity

The R&S®PA100 Doppler direction finder family, deployed in large numbers worldwide, now has a high-speed successor: the R&S®DDF04E digital direction finder for traffic control (FIG 1). Conventional DF systems for traffic control consist of multiple DF plug-in modules connected to the same DF antenna. Each of these plug-in modules is a full-featured fixed-frequency direction finder. In contrast, the R&S®DDF04E state-of-the-art digital wideband direction finder is fast enough to process a multitude of frequency channels simultaneously: Between 100 MHz and 450 MHz, it can monitor up to 32 channels (optionally) at the same time, with high DF quality and high measurement speed on all channels. This allows parallel monitoring of typical aviation distress frequencies such as 121.5 MHz and 243 MHz, and any activity on these frequencies immediately triggers an alarm to the controller.

The receiver characteristics of the R&S®DDF04E, such as large-signal immunity, selectivity and sensitivity, are excellent. In fact, the R&S®DDF04E exceeds the recommendations of the International Telecommunication Union (ITU) for direction finders and monitoring receivers in many cases and also meets the stringent requirements of Deutsche Flugsicherung GmbH (German air navigation services organisation).

FIG 1 The R&S®DDF04E digital direction finder for traffic control. Standard PCs can be used to control the direction finder and display the results, which greatly reduces the costs per workstation and increases flexibility.

Another major advantage of the R&S®DDF04E is that it is ideally suited to handle forthcoming ATC requirements. For example, the 8.33 kHz channel spacing for aeronautical radio is already integrated. In addition, the frequencies of the channels being monitored can be changed via mouse click.

The R&S®DDF04E uses the correlative interferometer DF method. This method is based on measuring the phase differences between the antenna elements of a circular-array DF antenna, permitting the use of wide-aperture antennas. The higher level of DF accuracy and immunity to reflections is particularly evident when compared to conventional Watson-Watt DF methods, which are still used in maritime traffic control applications.

Example of application in air traffic control

R&S®DDF04E at Brumowski air base in Austria (ICAO code: LOXT)

The Brumowski air base of the Austrian Air Force, which is under the control of the Austrian Federal Ministry of Defense and Sports (BMLVS), is located west of Vienna, in Langenlebarn near Tulln. The air base houses the maintenance hangar 1, the air support wing, a school for air and anti-aircraft defense and the federal school for aeronautical engineering.

The R&S®PA008 direction finder, installed in the 1980s, operated reliably throughout the many years and contributed significantly to overall air traffic safety – until aging of the system and its limitation to only four DF channels prompted the BMLVS to purchase a replacement.

The R&S®ADD050SR DF antenna was mounted on a steel mast five meters high, together with an LED obstruction light (FIG 2). This mast height is a compromise between contradictory technical requirements: To avoid nulls in the vertical antenna pattern resulting from ground reflections, the mast height should be kept as low as possible; for increasing the range, however, a higher mast would be necessary. Except for reliable grounding of the antenna, no other measures are required because the antenna elements and the DF receiver are already equipped with integrated lightning protection. An insulated and fully air-conditioned outdoor cabinet at the mast base houses the DF equipment and the DF server. Suitable overvoltage arresters for the power supply and data lines were installed at the housing inlet.

The data connection to the control units for the two radar workstations and for the tower workstation runs via a four-wire VDSL data modem (copper cables). A PC in the equipment room for online monitoring allows direct access to the server PC and to the workstations. Two compact R&S®GB4000T control units in the radar room and one in the tower are specially designed for use in air traffic control consoles. They are touch input devices (TID) and are also used, for example, to operate R&S®Series4200 airborne radios via voice over IP.

The R&S®GB4000T control unit is used for the controller settings and as an additional display if the radar fails, or to monitor an additional frequency of neighboring civil airports or airfields. The tower workstation is equipped with an R&S®EB110 miniport receiver and the R&S®GB4000V audio unit.

Photo: Author

FIG 2 The R&S®DDF04E direction finder at Brumowski air base. An insulated and fully air-conditioned outdoor cabinet at the mast base houses the DF equipment and the DF server.

Example of application in air traffic control

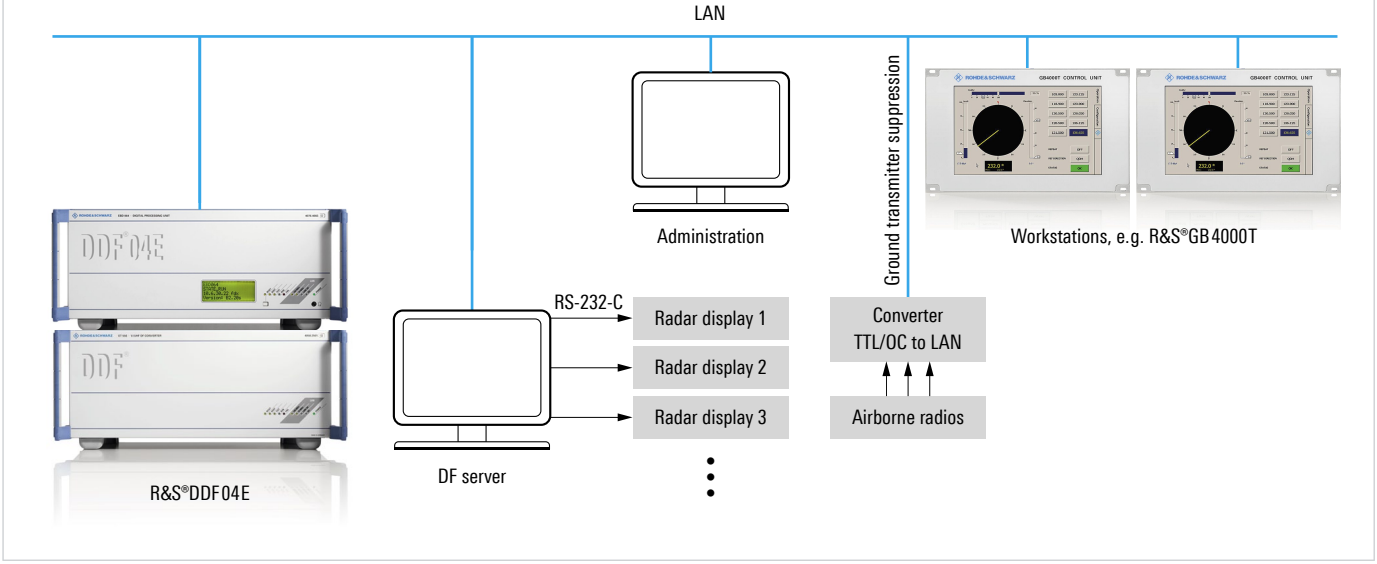

FIG 3 Typical air traffic control system featuring the R&S®DDF04E digital direction finder for traffic control.

Wide frequency range with only one antenna

The R&S®ADD050SR wide-aperture DF antenna covers the entire frequency range of the R&S®DDF04E, from 100 MHz to 450 MHz. With a diameter of 3 m and a total of nine antenna elements, it offers high DF accuracy and sensitivity plus outstanding immunity to reflections. For mobile and semi-mobile use, the R&S®ADD153SR compact antenna with a diameter of 1.1 m is available.

Simple networking and control

Standard PCs can be used to control the direction finder and display the results. This greatly reduces the costs per workstation and increases flexibility. For example, TIDs such as the R&S®GB4000T and, in mobile systems, laptops can be utilized. The direction finder and the PCs (control PC and DF server) can be networked via LAN (TCP/IP); standard products can also be used for this purpose (FIG 3).

Customer-specific traffic management systems and/or radar displays can likewise be linked via LAN. As an alternative, RS-232-C interfaces are available. The data format matches that of the R&S®PA100 – which can therefore be replaced with an R&S®DDF04E with no additional effort. Control information for ground transmitter suppression is first converted to the TCP/IP format by means of one or more converters. The data can then be queried and utilized by the R&S®DDF04E via the network.

Built-in selftest (BITE) capabilities are indispensable, particularly in safety-relevant applications such as air and maritime traffic control. The R&S®DDF04E continuously checks the measured values of more than 170 test points during operation and compares the results with the nominal values. A value outside the nominal value range automatically triggers an error message.

Robert Matousek

Key features of the R&S®DDF04E at a glance

- Parallel direction finding on up to 32 channels (optional) with the same high level of DF quality and sensitivity on all channels
- Seamless coverage of a wide frequency range from 100 MHz to 450 MHz with only one DF antenna
- Future-ready through simple change of the receive frequency and number of channels via the control software, as well as through the forthcoming 8.33 kHz channel spacing that is already integrated
- Standard PCs, monitors and network technology for control and display
- Flexible networking of direction finder, data server and display units via Ethernet
- Output of results on radar displays and in traffic management systems via an RS-232-C or TCP/IP interface