

Direction finding using sensor array processing

General

The development of the classic DF methods was aimed at designing antenna configurations that allowed bearings to be determined using a circuit design as simple as possible. It was important to establish a simple mathematical relationship between the antenna signals and the direction of the incident wave largely independent of frequency, polarization and environment.

With the development of digital signal processing, new approaches have become possible:

- With high-speed signal-processing chips now available, the requirement for a simple and frequency-independent relationship between the antenna signals and the bearing no longer applies. Even highly complex mathematical relationships can be evaluated in a reasonably short period of time for determining the bearing, or handled quickly and economically by means of search routines
- Numeric methods allow the separation of several waves arriving from different directions even with limited antenna apertures (high-resolution methods, super-resolution, multiwave resolution)

Basic design

Fig. 16 shows a typical hardware configuration of a DSP-based direction finder [12].

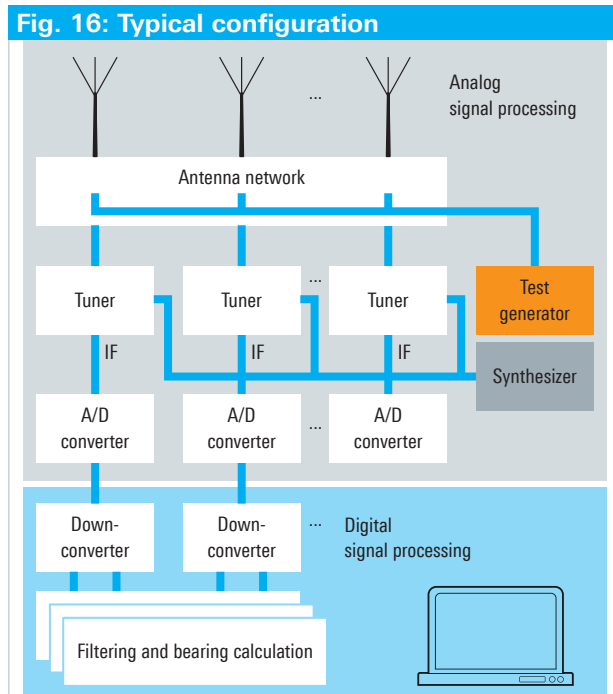
The outputs of the individual antenna elements are usually first taken to a network that contains the following, for instance:

- Test signal inputs
- Multiplexers if the number N of antenna outputs to be measured is higher than the number H of receive sections (tuners and A/D converters) in the direction finder

The signals are then converted to an intermediate frequency that is appropriate for the selected sampling rate of the A/D converters and digitized. To reduce the data volume, the data is digitally downconverted into the baseband. The complex samples $x_i(t)$ ($i = 1, 2, \text{ to } N$) of the baseband signals are filtered for the desired evaluation bandwidth and applied to the bearing calculation section.

Fig. 17 shows a typical implementation including a nine-element circular array antenna and a three-path receiver.

The signals of the antenna elements are measured sequentially based on three-element subarrays.



Typical configuration of a DSP-based direction finder.

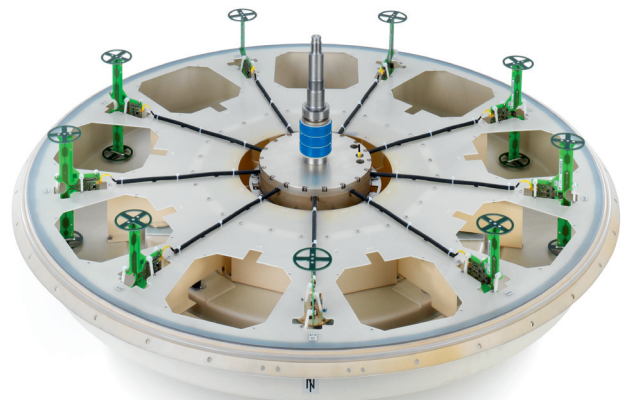
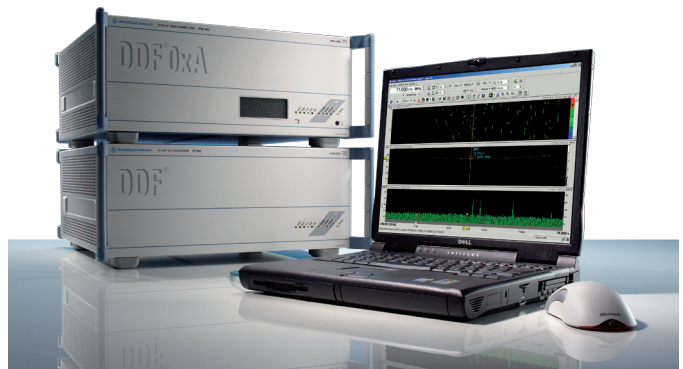


Fig. 17: DSP-based R&S®DDF06A broadband direction finder for the frequency range from 0.3 MHz to 3000 MHz and circular array antenna (R&S®ADD153SR, without cover) for the 20 MHz to 1300 MHz range.