Pulse compression analysis in radar systems

A new option for the R&S®FSW signal and spectrum analyzer analyzes how radar system components influence the performance of pulse compression.

Today's pulse radar systems frequently use pulse compression techniques. These techniques improve the range resolution and range using the same output power. For this purpose, the transmission pulse is initially extended and modulated over time. Known transmission signal types include linear frequency modulation (also called a chirp) and binary phase shift keying (BPSK) with Barker codes. In the radar receiver, the receive signal is compressed using a matched filter or correlation. This improves the time resolution and the range resolution by a factor of the compression.

Measuring the pulse length is not enough for a measurement-based evaluation of the range resolution. Instead, a signal analyzer, similarly to a radar receiver, must analyze the transmission signal via a suitable matched filter. This is where the R&S®FSW signal and spectrum analyzer with the R&S®FSW-K6S time sidelobe measurement option comes into play. R&S®FSW-K6S is an upgrade to the R&S®FSW-K6 pulse measurements option (page 38) and requires this option.

The R&S®FSW displays the compressed pulse in the time domain as a result (see figure). An expansion of the impulse response (the mainlobe), which leads to a poorer range resolution, is easy to detect. Any additionally occurring time sidelobes or range sidelobes, as well as other influences from filters, amplifiers or other components of the radar transmitter, are also easy to identify. An important measurement parameter is, in particular, the spacing of the sidelobes with respect to level and time because the sidelobes appear as ghost targets. In addition to the compressed pulse, the R&S®FSW outputs a table showing the width of the mainlobe, as well as the level and time spacing of the time sidelobes (sidelobe suppression, sidelobe delay) along with the power contained in the mainlobes and sidelobes. The frequency- and phase-error displays for the original pulse also help to identify possible causes of error.

Because numerous signal types much more complex than chirp or Barker codes are also used today – many of them have a proprietary format – the R&S®FSW can load user-specific filters as I/Q data, making it an all-purpose measuring instrument.

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Window 3 (Correlated Magnitude) shows the mainlobe and time sidelobes for a radar pulse spread by means of a Barker code. In addition, we can see that the sidelobe suppression limited by the code being used is approx. 21 dB.