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# MILITARY TECHNOLOGY

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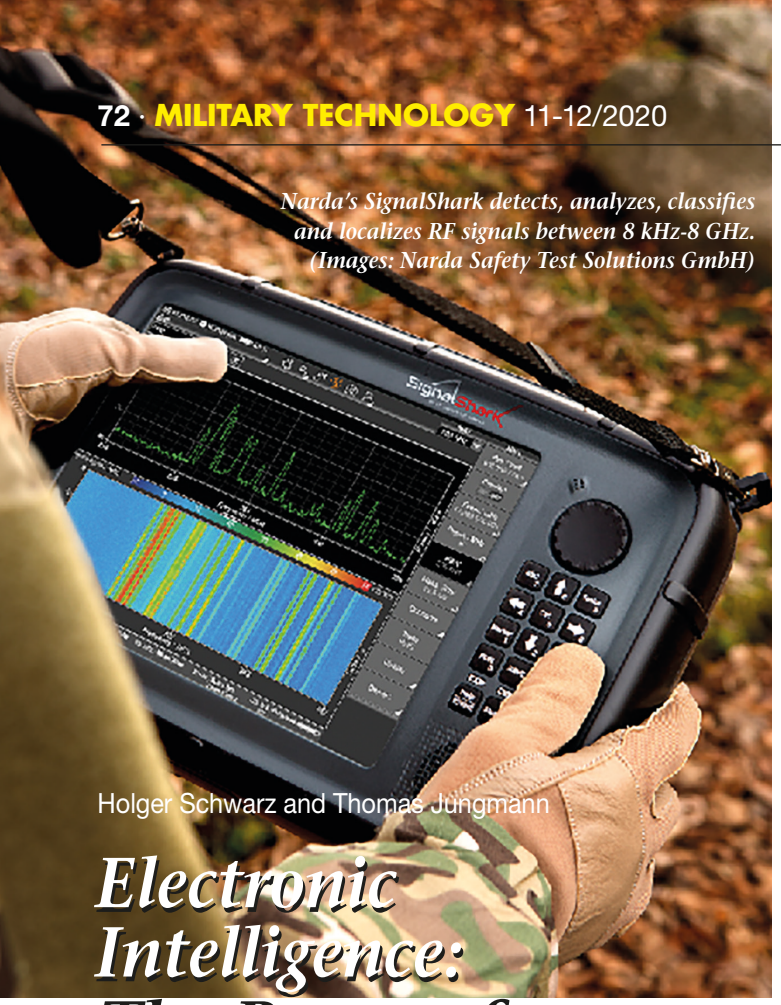


*Narda's SignalShark detects, analyzes, classifies and localizes RF signals between 8 kHz-8 GHz. (Images: Narda Safety Test Solutions GmbH)*

Holger Schwarz and Thomas Jungmann

# Electronic Intelligence: The Power of Spectrum Analysis

**Electronic warfare (EW) battalions support friendly forces by providing information about the opposing side. These highly specialized army teams are also tasked with disrupting enemy strategic communications, while protecting their own. New information technologies, and increasing digitalization, have resulted in a constant increase in the demands placed on EW units. In this context, the use of modern, powerful spectrum analyzers can provide decisive advantages.**

### Networked Operational Command

One of the principal aims in EW is intelligence superiority. Military action today is generally characterized by complex missions, planned over long distances, within a multinational environment. Success or failure depends to a large extent on the ability to exchange information quickly and securely, and to transmit signals unchallenged between entities, including intelligence, command and active systems. To increase military impact, radio channels must be secured to prevent enemy EW units from capturing and jamming signals. One protective measure is to determine how exposed field command posts or radio transmitters are, by ascertaining their electromagnetic fields (EMF). Armed with this knowledge, measures can be taken to minimize field emissions, to make them as invisible as possible to the enemy.

### Spectrum Analyzer and Receiver

The SignalShark family of instruments from German RF test and measurement specialist Narda Safety Test Solutions, amply demonstrates the potential for modern spectrum analyzers in military applications. All instruments in the range have identical measuring engines and are equipped with an onboard computer. Developed according with size, weight and power – cost (SWaP-C) criteria in mind, the differences lie only in the principal areas of application. They detect and analyze, classify and localize RF signals in the 8kHz-8GHz frequency range (see Table 1). These three commercial-off-the-shelf (COTS) components offer optimum performance in terms of speed, real-time bandwidth, dynamic range, and sensitivity.

The range includes a compact, real-time handheld Spectrum Analyzer and Receiver, suitable for both stationary and mobile use. This is accompanied by the Remote Unit, a remote-control version for centrally-controlled monitoring of systems spread over a large area or separated by long distances. The new Outdoor Unit can be mast-mounted and used for unattended 24/7 autonomous monitoring in the open, with power supplied from a solar panel. This last unit is anything but a passive receiver: it can evaluate data, using the built-in intelligence common to the entire family. This has the advantage that the Outdoor Unit does not flood a continuous monitoring operation with data, as it only transmits captured data that has been previously defined as relevant – transmitting it to the command centre automatically.

### Onboard Computer and Open Platform

These RF measuring instruments feature an integrated computer running Windows 10, with all the flexibility that this operating system offers. This means that spotters can analyze, record, visualize and export measurement results immediately, while still in the field. Everything needed for the mission exists in the robust Handheld Unit, with integrated antenna – no separate PC is required.

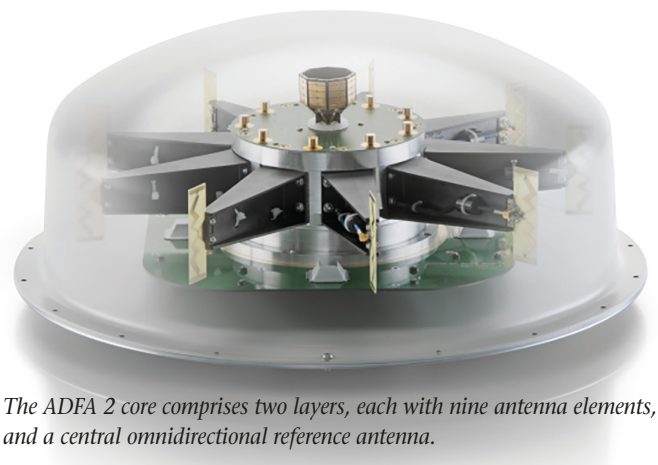
The SignalShark is designed as an open platform, meaning it only uses standard protocols, such as SCPI (for remote control), VITA49 and PYTHON. Narda offers open interfaces, and cooperates with practically all the large systems manufacturers. For individual services or special functions, it is possible to load customer-defined, manufacturer-independent software packages onto the spectrum analyzer in order to, for example, decode or eavesdrop on enemy communications. Also, spotters can connect additional sensors, test modules, or modems to the USB 3.0 host, depending on task requirements. Since the operating system is Windows, the necessary drivers will usually be present.

### Intercepting Enemy Communications

The SignalShark's open platform – together with appropriate software such as Decodio or Procitec – allows direct signal analysis of enemy digital communications, from classification through decoding. This means that captured information can be used and evaluated right there and then, also using the onboard computer. Data does not need to be transmitted from the receiver back to a command centre for evaluation. Since the enemy can gain information about the spotter's position as soon a message is transmitted, this offers real tactical advantage.

### High Dynamic Range

A high dynamic range takes on special meaning when it comes to localizing interference signals, because the actual interference is often only weakly received. The enemy will often choose a location surrounded by



*The ADFA 2 core comprises two layers, each with nine antenna elements, and a central omnidirectional reference antenna.*

| | |
|---|---|
| Frequency range | 8 kHz to 8 GHz |
| Real time bandwidth | 40 MHz |
| Operating temperature | -10 °C to +55 °C |
| Battery operating time | 3 h (nominal), hot swappable battery pack |
| Dimensions | 231 × 333 × 85 mm<br>(9.09“ × 13.11“ × 3.35“) |
| Weight | 4.4 kg<br>(basic unit including battery) |
| Scan rate | > 50 GHz/s @ RBW = 1.6 MHz |
| Full span | > 32 GHz/s @ RBW = 100 kHz |

*Table 1: Narda SignalShark specifications*

| | |
|---|---|
| Frequency range | 10 MHz to 8 GHz |
| Dimensions | 219 x 480 mm (8.62“ x 18.9“) |
| Weight | 6.5 kg (14.3 lbs.) |
| Bearing uncertainty | f < 200 MHz: < 3° RMS (typical)<br>f > 200 MHz: < 1° RMS (typical) |
| Equipment: | Electronic compass<br>GNSS receiver with antenna and PPS output<br>Vehicle mounting kit |

*Table 2: ADFA 2 Automatic DF Antenna specifications*

strong signals from which to transmit. High Dynamic Range (HDR) describes the ability of a monitoring receiver to reliably detect low levels that are covered by much greater signals. This requires resolution of the conflict between the highest possible sensitivity to low levels and maximum immunity to saturation by stronger signals in the direct vicinity.

Intelligent circuit board design, coupled with high-quality components, ensure that SignalShark brings minimal noise and high intermodulation immunity together in one device. The low noise receiver module determines its low Displayed Average Noise Level (DANL), which illustrates its high sensitivity. But it is the combination of the DANL with immunity parameters IP2 and IP3 that gives it its excellent dynamic range. The values for SignalShark are almost identical to the values theoretically determined by the International Telecommunication Union (ITU) for the ideal monitoring receiver.

### High Real-time Bandwidth

The spectrum analyzer has a real-time bandwidth (RTBW) of 40 MHz, meaning that the receiver can also capture brief, sporadically occurring signals within this bandwidth in real time without gaps, and without missing a single event. This is guaranteed by a probability of intercept (PoI) of 100% for signals with a signal duration of >3.125 microseconds. This means the device can monitor entire communications channels in real time, without needing to ‘hop’ from one frequency to another.

### Maximum Interoperability

With the SignalShark turnkey solution, spotters can always use the same instrument for their entire mission spectrum, regardless of which form factor they choose. This means that all results from the various instrument types are always displayed using the same graphical user interface (GUI). This avoids communication errors when transferring data from device A to instrument B, which could otherwise occur due to component interoperability problems.

### Automatic DF Antenna

Direction finding (DF) and localization of interference signals is one of the original tasks of EW. To achieve this effectively, spotters can connect the SignalShark to Narda’s Automatic Direction Finding Antenna 2 (ADFA 2) which can, within seconds, accurately and reliably determine the direction of origin of signals between 10 MHz-8 GHz, without being affected by reflections. A bearing cycle takes just 1.2 milliseconds and can achieve a typical accuracy of up to 1° RMS (see Table 2). The ADFA 2 can be used universally for both mobile and stationary applications, combining the minimum of equipment outlay with an extremely broad spectrum.

Its core comprises two layers, each with nine antenna elements (dipoles) and a central omnidirectional reference antenna, which actually allows observation of the spectrum during DF operations. It also has two orthogonal coils for frequencies below 200 MHz, which allow DF according to the Watson-Watt principle. Automatic DF with a single-channel receiver is based on measurement of the phase difference between antenna elements. The greater the separation between elements and the detected phase difference, the more reliable the bearings will be. The dipoles here are measured against the reference antenna, an intelligent principle that allows an affordable single-channel system to produce the same extremely stable measurement results as those otherwise reserved for much more expensive multichannel systems.

### Spectrum Monitoring and DF

The ADFA 2 can perform general monitoring – for example, in reconnoitering an enemy position – thanks to its omnidirectional element. When radiation is detected, the direction of origin can be immediately detected, by measurements within the automatic DF antenna. The SignalShark can also act as a sensor for a TDOA system, providing I/Q data with highly precise timestamps. A TDOA network can thus be built up using the Decodio software, for example – or a hybrid combining AOA and TDOA with the automatic DF antenna. When the two results are correlated, the accuracy of localization increases.

The DF antenna can be easily mounted on a vehicle roof using its magnetic base, for operations in frontier regions, for example. Inside the vehicle, display options include heatmap overlay on a stored map, as well as straightforward display of the direction on the SignalShark screen. The instrument’s localization software automatically indicates signal direction, requiring neither external PC nor additional personnel.

### Conclusions

EW operations are becoming more and more complex. Modern spectrum analyzers like the Narda SignalShark have great potential to keep up with this irreversible future trend. It features superior values in terms of speed, real-time bandwidth, dynamic range, and sensitivity, and is compact, powerful, affordable and flexible – used for stationary or mobile applications – all of which bring strategic advantages in military use. Intelligent technologies and progressive concepts such as open architecture bring the highest degree of flexibility – important prerequisites to ensure forces are ready for developments in information technologies and the consequences of digitalization.

*The SignalShark range of spectrum analyzers offers significant tactical benefits*

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