



SignalShark 3330 Outdoor Unit

SignalShark 3330 Outdoor Unit

Real-Time Remote Analyzer SignalShark® 3330, for the Detection, Analysis, Classification and Localization of RF Signals between 8 kHz and 8 GHz.

Supports automatic direction finding and localization via AoA and TDOA.

Solves complex measurement and analysis tasks reliably and quickly with outstanding RF performance.

Windows 10-based open platform for third-party applications.

- › IP65-rated robust and weatherproof die-cast aluminum housing
- › Stand-alone operation with LTE modem and DC power supply
- › Low power consumption
- › Open platform
 - › Third party applications can also be hosted on the Windows 10-based device with Intel quad-core processor.
- › Frequency range 8 kHz to 8 GHz
- › Wideband frequency monitoring with an extremely fast scan rate of up to 50 GHz/s
- › Covers whole frequency bands with a 40 MHz real-time instantaneous bandwidth and a very high frequency resolution
 - › FFT overlap at least 75 %
 - › FFT size: up to 16 384
- › Reliable signal detection due to signal duration with 100 % POI
 - › > 3.125 μ s without attenuation and spectral growth
 - › > 2 ns with attenuation proportional to the spectral growth
- › Measures weak signals in the presence of strong transmitters with a receiver based High Dynamic Range (HDR)
- › ITU-compliant measurements and applications
- › Two independent FFT and receiver path allowing signal visualization as well as signal analysis and demodulation at a time.
- › Common used SCPI standard for remote control
- › VITA 49 streaming (sample rate up to 25.6 MHz) allowing storage and post processing of the signal raw data.
- › VITA 49 FFT streaming span up to 40 MHz for overview display



The Compact Monitoring Station for All Situations

Seven Senses for Signals

Description

The "SignalShark 3330 Outdoor Unit" series is characterized by a robust and weatherproof die-cast aluminum housing with IP65 protection class, which is also used as a heat sink. The compact size allows the receiver to be mounted close to the antennas, keeping the antenna cables short and the resulting sensitivity high.

In addition to an outstanding dynamic range, the device offers three switchable antenna inputs, an integrated GNSS receiver and the option of using automatic Narda DF antennas for direction finding and localization.

The device is designed as an "open platform". The Windows10 operating system allows the use of additional 3rd party software on the device. Despite a maximum power consumption of 40 W, an efficient Intel quad-core processor provides the necessary performance.

SignalShark 3330 versions

The different versions of the SignalShark 3330 series cover a wide range of applications:

3330/101 SignalShark Outdoor Unit PoE Basic Set:

Data communication and power supply are provided via a single Gigabit Ethernet connection (PoE++). This allows the use of standard lightning protection components.

This product version is particularly suitable for the extension and modernization of existing infrastructure.

3330/102 SignalShark Outdoor Unit Modem R1 Basic Set

The data communication takes place via a mobile radio modem integrated in the device, which offers a direct VPN connection setup.

Additional monitoring software on the device allows data to be collected and, if necessary, compressed for transmission in the event of an incident.

For the power supply, a DC voltage source of 10 VDC to 30 VDC, such as a solar panel with rechargeable battery, can be used.

This variant offers the greatest possible flexibility.

For special events, an "ad hoc" monitoring network can be set up in a very short time.

From mounting on a lamppost to self-sufficient installation at the "green border" - without the need for additional infrastructure - a wide range of applications is covered.

Different versions of the "SignalShark Outdoor Unit Modem" are available depending on the region in which the device is to be used, taking into account the respective mobile radio frequency range. Your local Narda sales representative will be happy to assist you in the selection of the right version.



Fig. 1. The SignalShark Outdoor Unit and Automatic DF antenna for AoA and TDOA.

Tasks and Views

Customer applications have formed the basis for the design of the SignalShark family and the layout of the graphical user interface (GUI). This is most clearly seen in the concept of Tasks and Views.

All SignalShark devices are supporting the same GUI. The SignalShark 3330 Outdoor Unit can be accessed with remote desktop software via a network.

Tasks

Measurements often consist of a workflow of several steps, such as locating a signal in the spectrum, measuring its level and analyzing its behavior. This involves switching between different measurement modes and settings in each mode when a general-purpose analyzer is used.

However, with the SignalShark, the entire measurement workflow is handled by one or more measurement tasks. These tasks are shown as screen tabs, just like the web pages displayed by a web browser. Each task encapsulates all the measurement parameters and the underlying measurement engine mode. All the measurements in a task are performed at the same time. Up to six measurement visualizations (Views) can be added to adapt a task as required.

The SignalShark provides several task modes to support a wide variety of measurement applications.

Spectrum (Scan) Mode

This mode supports measurement of the spectrum over the full frequency span of 8 kHz to 8 GHz in a single measurement at a maximum measurement speed of 50 GHz/s.

Real-Time Spectrum Mode

Real-Time Spectrum mode enables spectrum measurements with a frequency span of up to 40 MHz in real-time. All frequencies within the frequency span are acquired simultaneously with no time gaps and with a FFT frame overlap of 75%. The FFT frame overlap increases to 87.5% for frequency spans of 20 MHz or less. A second digital down converter is used at the same time for analyzing and demodulating the I/Q data of a separate channel within the 40 MHz real-time bandwidth. The frequency and bandwidth of this channel are selectable.

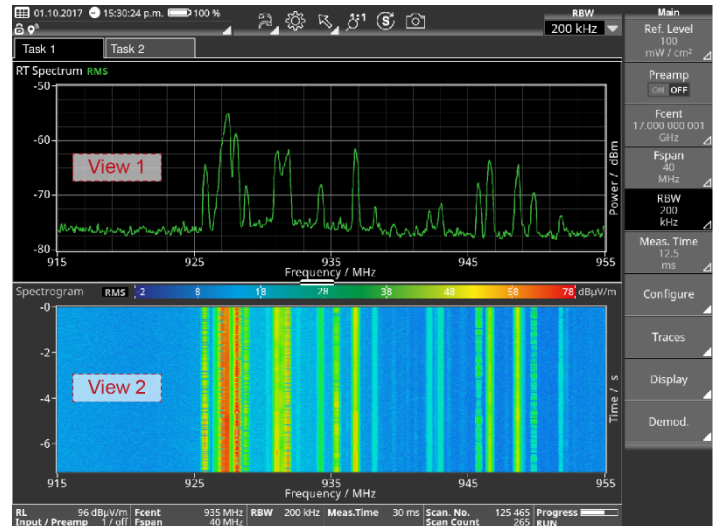


Fig. 2. RT Spectrum view (View 1) and Spectrogram view (View 2) in a task (Task 2)

Auto DF Mode

This mode supports the use of the Narda Automatic DF Antenna (ADFA). Each bearing cycle can be as short as 1.2 ms and even the bearings of pulsed signals can be reliably determined as long as the minimum pulse and gap durations are somewhat longer than 2 cycle times. The optional available map and localization functionality, which is integrated into the SignalShark GUI, allows the reliable localization of transmitters. The sophisticated state of the art algorithm based on the bearing statistics reliably eliminates the influence of false bearings on the localization result, as long as there are enough line of sight bearings available from enough locations.

Real-Time Streaming Mode

I/Q data can be streamed at sample rates of up to 25.6 MHz using the VITA 49 protocol (option). The stream sink can be an external device connected via the LAN interface or a third party application running on the SignalShark itself.

Views

Measurements are visualized by means of different views. The frequency domain and channel level can be viewed at the same time, for example, by adding a spectrum view and a level meter view to a measurement task.

- › **Spectrum** (scanned or real-time)
 - Shows level versus frequency
 - › Up to **eight** different **traces** based on the +Pk, RMS, Avg, -Pk, or Sample detectors and the maximum, average, or minimum long-term trace functions.
 - › Up to **eight** spectrum **markers** are available.
 - › Each marker supports one of the following additional measurement functions according to ITU:
 - noise power density
 - channel power
 - occupied bandwidth, with additional automatic center frequency and channel power measurement.
- › **Peak Table** (of Spectrum)
 - A list of relevant signal peaks in the measured spectrum.

- › **Spectrogram** [Option]
 Visual representation of the recorded spectrums versus time. Colors represent the signal level. The smallest selectable time resolution is 31.25 μ s. Detectors compress the high-speed real-time spectrums down to the selected time resolution. Up to three spectrograms with different detectors are available concurrently.
- › **Persistence** (of real-time Spectrum) [Option]
 Displays the spectrums as level versus frequency. Color indicates rate of occurrence. Sporadic signals can be detected easily.
- › **Level Meter** [Option]
 Shows the results from an independent receiver path with channel filters:
 - › Channel levels measured using up to three different detectors are available simultaneously.
 - › Filters and detectors for EMC measurements are MIL and CISPR compliant.
 - › Tone Search: The level of one of the detectors modulates the pitch of an audible tone. This is useful for manual direction finding using a handheld directional antenna, and for PIM hunting.
 - › Modulation detectors for AM, FM and PM. Up to 4 different detectors are available simultaneously.
- › Frequency offset
- › AFC
- › Azimuth direction of the external antenna handle with integrated compass.
- › Audio demodulator [Option] for AM, Pulse, CW, ISB, USB, LSB, FM, PM, or I/Q with squelch and AGC function. The demodulator and its menu is also available in other views.
- › **Map** [Option]
 Visualization of the current position and measurement results on a map:
 - › Labels for each stored data set
 - › Bearings
 - › Localization based on statistical evaluation of the bearings and displayed as a transparent heatmap overlay and an ellipse indicating the uncertainty.
 - › Multiple localization results
- › **Bearing** [Option]
 Shows azimuth, elevation, DF quality, and omnidirectional RMS level derived from the Narda automatic DF antenna (ADFA).
- › **VITA 49 IQ Streaming and FFT Streaming** [Option]
 Shows the basic measurement parameter settings while streaming I/Q data according to the Vita 49 standard.

Tasks and Views					
		Measurement Engine or Task Mode			
		<i>Spectrum (Scan)</i>	<i>RT (Real-Time) Spectrum</i>	<i>Auto DF</i>	<i>RT Streaming</i>
View	Spectrum	✓	RT	✓	
	Peak Table (of Spectrum)	✓	RT	✓	
	Spectrogram	✓	RT		
	Persistence		RT		
	Level Meter		✓		
	Map	✓	✓	✓	
	Bearing			✓	
	VITA 49 FFT Streaming				✓
	VITA 49 IQ Streaming				✓

Definitions and Conditions

Conditions

Unless otherwise noted, specifications apply after 30 minutes warm-up time within the specified environmental conditions.

Specifications with limits

These describe product performance for the given parameter covered by warranty. Specifications with limits (shown as <, ≤, ≥, ±, max., min.) apply under the given conditions for the product and are tested during production, considering measurement uncertainty.

Specifications without limits

These describe product performance for the given parameter covered by warranty. Specifications without limits represent values with negligible deviations, which are ensured by design (e.g. dimensions or resolution of a setting parameter).

Typical values (typ.)

These characterize product performance for the given parameter that is not covered by warranty. When stated as a range or as a limit (shown as <, ≤, ≥, ±, max., min.), they represent the performance met by approximately 80% of the instruments. Otherwise, they represent the mean value. The measurement uncertainty is not taken into account.

Nominal values (nom.)

These characterize expected product performance for the given parameter that is not covered by warranty. Nominal values are verified during product development but are not tested during production.

Uncertainties

These characterize the dispersion of the values attributed to the measurands with an estimated confidence level of approximately 95%. Uncertainty is stated as the standard uncertainty multiplied by the coverage factor k=2 based on the normal distribution. The evaluation has been carried out in accordance with the rules of the "Guide to the Expression of Uncertainty in Measurement" (GUM).

Data

Specifications^a

SignalShark 3330 Outdoor Unit

Frequency						
Frequency range		8 kHz to 8 GHz				
Scan rate		> 50 GHz/s @ RBW = 1.6 MHz				
(full span)		> 32 GHz/s @ RBW = 100 kHz				
RBW (RT Spectrum)		1 Hz to 800 kHz				
RBW (Scan Spectrum)		1 Hz to 6.25 MHz				
CBW (Level Meter)		25 Hz to 40 MHz				
EMC filter bandwidth		10 Hz, 100 Hz, 200 Hz, 1 kHz, 9 kHz, 10 kHz, 100 kHz, 120 kHz & 1 MHz				
(Spectrum and Level Meter)						
Detectors (Spectrum and Level Meter)		+Pk, RMS, -Pk, Avg and Sample				
CISPR Detectors (Level Meter)		Cpeak (quasi-peak), CRMS & CAvg (EMC filter with CISPR bandwidth must be selected)				
SSB phase noise	f_c	df = 1 kHz	df = 10 kHz	df = 100 kHz	df = 1 MHz	df = 10 MHz
	10 MHz	< -120 dBc (1/Hz)	< -130 dBc (1/Hz)	< -135 dBc (1/Hz)		
	1 GHz	< -90 dBc (1/Hz)	< -101 dBc (1/Hz)	< -101 dBc (1/Hz)	< -112 dBc (1/Hz)	< -132 dBc (1/Hz)
Internal reference frequency		Deviation:				< 1 ppm
		(includes initial deviation, aging within the first 2 years, and temperature response)				

^a RF data apply in the temperature range 20 °C to 26 °C at a relative humidity of between 25 and 75 %

Amplitude			
HDR (High Dynamic Range)	SignalShark can detect low level signals even in the presence of very strong signals. It does this by combining high sensitivity with a wide intermodulation-free dynamic range. The DANL and IP2 / IP3 values stated below are valid at the same setting.		
DANL (Noise Figure) @ attenuator = 0 dB, no preamp	1 MHz ≤ f ≤ 44 MHz	< -160 dB (mW/Hz)	(resultant noise figure < 14 dB)
	44 MHz < f ≤ 3 GHz	< -159 dB (mW/Hz)	(resultant noise figure < 15 dB)
	44 MHz < f ≤ 3 GHz	-162 dB (mW/Hz) (typ.)	(resultant noise figure 12 dB)
	3 GHz < f ≤ 8 GHz	< -152 dB (mW/Hz)	(resultant noise figure < 22 dB)
2 nd order intercept point (IP2, 2 tones) @ attenuator = 0 dB, no preamp	4 MHz ≤ f < 42 MHz ^b	> 60 dBm	
	42 MHz ≤ f ≤ 8 GHz	40 dBm (typ.)	
3 rd order intercept point (IP3, 2 tones) @ attenuator = 0 dB, no preamp	3 MHz < f ≤ 44 MHz	> 20 dBm	
	3 MHz < f ≤ 44 MHz	26 dBm (typ.)	
	44 MHz < f ≤ 630 MHz	> 4 dBm	
	630 MHz < f ≤ 3 GHz	> 6 dBm	
	44 MHz < f ≤ 3 GHz	14 dBm (typ.)	
	3 GHz < f ≤ 8 GHz	> 5 dBm	
3 GHz < f ≤ 8 GHz	12 dBm (typ.)		
Level uncertainty	9 kHz ≤ f ≤ 8 GHz	< ± 2 dB	
Residual spurs ^c @ attenuator = 0 dB	8 kHz ≤ f ≤ 44 MHz	< -120 dBm	exceptions < -100 dBm
	44 MHz < f ≤ 3 GHz	< -115 dBm	exceptions < -100 dBm
	3 GHz < f ≤ 6 GHz	< -110 dBm	exceptions < -95 dBm
	6 GHz < f ≤ 8 GHz	< -105 dBm	exceptions < -85 dBm
IF rejection	> 80 dB		
Image rejection	> 80 dB		

Real-Time Spectrum		
Signal duration for 100 % POI	@ RBW = 800 kHz	> 3.125 μs without attenuation and spectral growth
		> 2 ns with attenuation proportional to the spectral growth
Spectrum rate	1.6 million spectra / s	@ RBW = 800 kHz and 75 % FFT Overlap
FFT overlap	Fspan > 20 MHz	75 %
	Fspan ≤ 20 MHz, RBW ≤ 400 kHz	87.5 %

^b Component at f1 + f2 is measured in the direct band (Fcent ≤ 64 MHz in real-time mode)

^c Typically with only few exceptions. These are documented in the calibration certificate

RF Input		
Type (switchable)	3 x N-connector, 50 Ω (female)	
RF destruction limit	20 dBm	
Max. nominal RF level	15 dBm	
Maximum DC voltage	25 V	
Return loss	12 kHz ≤ f ≤ 3 GHz	> 9.54 dB
	3 GHz < f ≤ 6 GHz	12 dB (typ.)
	6 GHz < f ≤ 8 GHz	10 dB (typ.)
Isolation between used and unused inputs	8 kHz ≤ f ≤ 1 GHz	60 dB (nom.)
	3 GHz	50 dB (nom.)
	8 GHz	35 dB (nom.)

General Specifications 3330/01		
Attenuator	0 to 30 dB (0.5 dB steps)	
Digitizer	16 Bit	
GNSS	Embedded receiver (GPS/QZSS, GLONASS, BeiDou, Galileo)	
Internal non-removable memory	SSD, mSATA,	30 GB system partition 28 GB configuration, settings and user data
GNSS antenna input (for additional, external GNSS antenna)	1 x SMA, 50 Ω, female (DC voltage for active antennas is supplied)	
Ethernet	1 x GigE (10/100/1000Base-T), RJ45 (protective housing for connector: CNLINKO, BD-24-RJ45-P02)	
External power supply:	PoE++, 60 W	
	Plug type: RJ45 with waterproof housing	
Passive cooling	Fanless design for low maintenance operation.	
Dimensions (H × W × D) (incl housing, without connectors)	151 mm × 356 mm × 353 mm (5.94" × 14.02" × 13.90")	
Weight	Approx. 13 kg / 28.66 lb (with ice creation the weight can increase significantly)	
Country of origin	Germany	

General Specifications 3330/02		
Attenuator	0 to 30 dB (0.5 dB steps)	
Digitizer	16 Bit	
GNSS	Embedded receiver (GPS/QZSS, GLONASS, BeiDou, Galileo)	
Internal non-removable memory	SSD, mSATA	30 GB system partition 28 GB configuration, settings and user data
GNSS antenna input (for additional, external GNSS antenna)	1 x SMA, 50 Ω, female (DC voltage for active antennas is supplied)	
LTE	1 x SMA, 50 Ω, female	
External power supply:	Basic unit, DC input: 10 to 30 VDC, ≥ 45 W	
	Plug type: 3-pin with waterproof housing (CNLINKO: BD-24-C03PE-01-002)	
Dimensions (H × W × D) (incl housing, without connectors)	151 mm × 356 mm × 353 mm (5.94" × 14.02" × 13.90")	
Weight	Approx. 13 kg / 28.66 lb (with ice creation the weight can increase significantly)	
Country of origin	Germany	

Remote Control and Streaming	
Remote control protocol	SCPI
FFT streaming	VITA49 compliant
I/Q streaming	VITA49 IQ-Streaming, sample rate up to 25.6 MHz
Remote Software	Remote Desktop for PC, Tablet and Smartphone (Windows, Android, IOS)
PC Software	SignalShark Tools

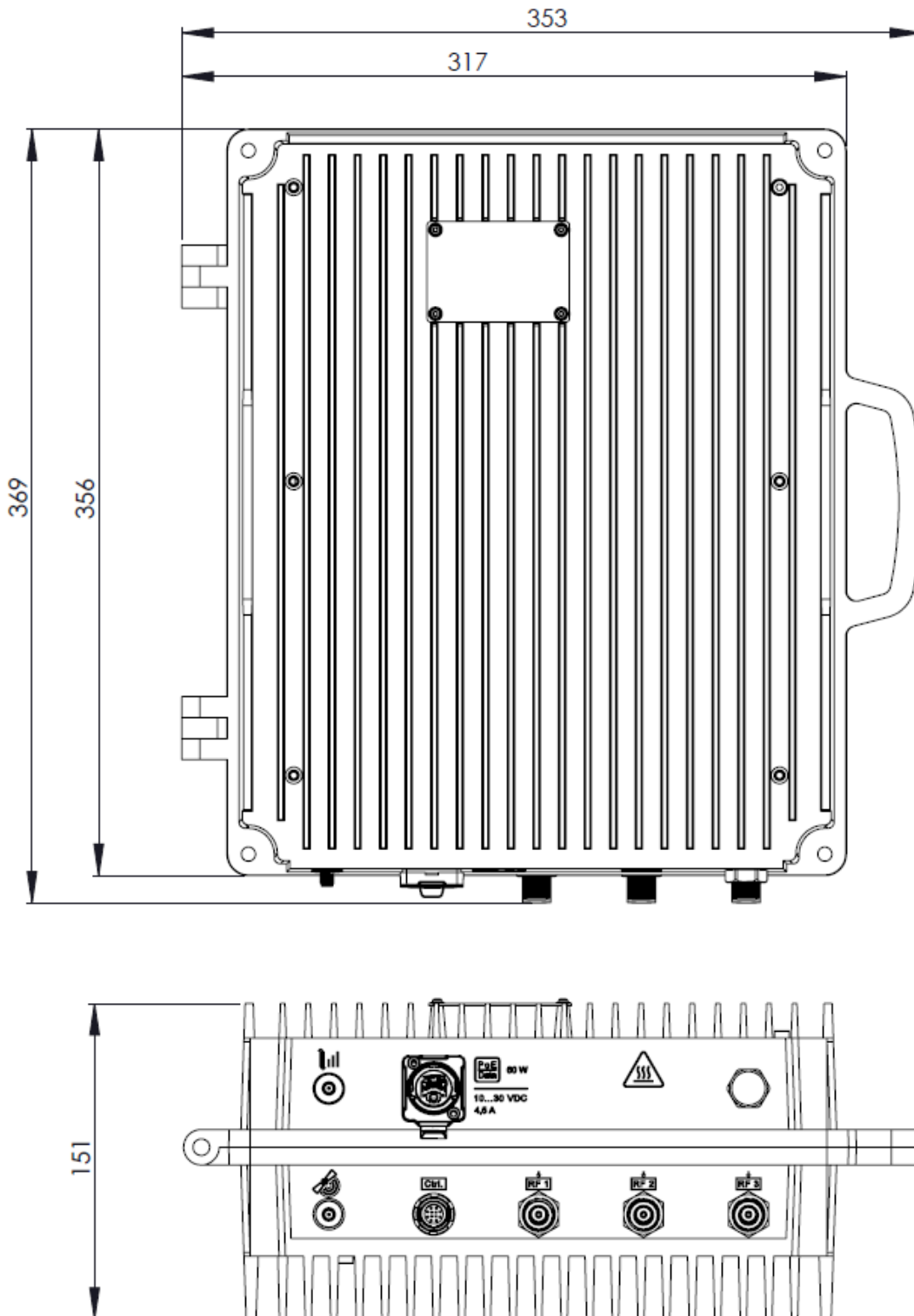
Additional Functions	
Noise power density measurement	Can be measured with up to eight markers at a time.
Channel power measurement	Can be measured with up to eight markers at a time.
Occupied bandwidth measurement	According to ITU-R SM.443-4, with additional automatic center frequency and channel power measurement. Can be measured with up to eight markers at a time.
Field strength measurement	According to ITU-R SM.378-7
CISPR Detectors	Cpeak (quasi-peak), CRMS & CAvg (EMC filter with CISPR bandwidth must be selected)
Modulation detectors	AM, FM and PM. Up to 4 different detectors are available simultaneously
Frequency offset measurement	For CBW ≤ 1 MHz (using modulation detectors)
Analog demodulation and recording	AM, Pulse, CW, ISB, USB, LSB, FM, PM, or I/Q signals can be demodulated with squelch and AGC function. The demodulated signal can be stored as WAV-file.
Tone Search	The level of one of the detectors modulates the pitch of an audible tone.
Automatic DF	Automatic bearing of transmitters using a Narda Automatic DF Antenna.
Automatic transmitter localization (Heatmap)	Automatic calculation of the transmitter location.
TDOA localization	With additionally available software package

Environmental Conditions (values subject to pending verification)		
MIL-PRF-28800F Class 2		Operating temperature ^d Storage temperature Operating humidity
Operating temperature ^d		-20 °C to + 55 °C
Humidity		< 29 g/m ³ (< 93 % RH at +30 °C)
IP class		IP 65
Climate ^d	Storage	1K3 (IEC 60721-3) extended to - 20 °C to + 70 °C
	Transport	2K4 (IEC 60721-3) restricted to - 20 °C to + 70 °C
	Operating	7K2 (IEC 60721-3) extended to - 20 °C to + 55 °C
Mechanical	Storage	1M3 (IEC 60721-3)
	Transport	2M3 (IEC 60721-3)
	Operating	7M3 (IEC 60721-3)

Compliance (values subject to pending verification)		
EMC	European Union	Complies with EMC Directive 2014/30/EU and IEC/EN 61326 -1: 2013
	Immunity	IEC/EN: 61000-4-2, 61000-4-3, 61000-4-4, 61000-4-5, 61000-4-6, 61000-4-11
	Emissions	IEC/EN: 61000-3-2, 61000-3-3, IEC/EN 55011 (CISPR 11) Class B
Safety		Complies with European Low Voltage Directive 2014/35/EU and IEC/EN 61010-1:2010
Material		Complies with European RoHS Directive 2011/65/EU

^d For low-maintenance operation, the system is passively cooled and therefore requires no fan. Protection against direct sunlight must be provided!

Drawing – SignalShark 3330/xx



All dimensions are given in mm.

The actual connectors depend on the selected device version.

Also consider the space needed for mounting adapters, wall mount adapter or mast mount adapter

For low-maintenance operation, the system is passively cooled and therefore requires no fan. **Protection against direct sunlight must be provided!**

Ordering Information

The SignalShark Basic Unit is included in all Basic Sets. Application Packages as well as Software Options and Accessories that provide additional signal analysis capabilities are also available.

Your local Narda sales representative can provide information about all the possible options and will be pleased to offer advice.

Basic Unit Sets

SignalShark Outdoor Unit PoE Basic Set 3330/101

SignalShark Outdoor Unit, PoE	Part number
<p>The Basic set contains the "SignalShark Outdoor Unit, PoE", as well as basic accessories and supports 40 MHz real-time spectrum analysis, marker, peak table and SCPI remote control functions.</p> <p>Includes:</p> <ul style="list-style-type: none"> › SignalShark Outdoor Unit, PoE › RJ-45-Plug waterproof › PoE++ Injector, 60 W › Wall Mount Bracket for SignalShark 3330 › Option, SCPI Remote Control › USB Stick: SW and Manuals, ordered options › SignalShark 3330 - Quick Start and Safety Instructions 	3330/101

SignalShark Outdoor Unit Modem R1 Basic Set 3330/102

SignalShark Outdoor Unit, Modem R1	Part number
<p>The Basic set contains the "SignalShark Outdoor Unit, Modem R1", as well as basic accessories and supports 40 MHz real-time spectrum analysis, marker, peak table and SCPI remote control functions.</p> <p>The LTE modem is intended for use in the following regions: Europe, the Middle East, Africa, Korea, Thailand, India, Malaysia</p> <p>Includes:</p> <ul style="list-style-type: none"> › SignalShark Outdoor Unit, Modem R1 › DC-Plug waterproof › LTE antenna › Wall Mount Bracket for SignalShark 3330 › Option, SCPI Remote Control › USB Stick: SW and Manuals, ordered options › SignalShark 3330 - Quick Start and Safety Instructions 	3330/102

Application Packages

The application packages make it easy to adapt SignalShark to your requirements. Each package typically consists of application-dependent hardware accessories and/or firmware options, and costs less than purchasing the items individually. Additional packages can be purchased as and when required.

Your local Narda sales representative will be happy to assist you in the selection of the right packages for your applications.

App. Package, Receiver	Part number
The Receiver Application Package guarantees situational awareness by providing gapless analysis of entire signal bands. It also enables demodulation of AM, FM, LSB, USB, and CW signals. Includes: <ul style="list-style-type: none"> › Option, Spectrogram (3310/95.002) › Option, Level Meter incl. Compass values (3310/95.003) › Option, Analog Demodulation (3310/95.007) 	3310/94.01

Software Options

Software options allows the adaption of the device feature set to your needs.

Description	Part number
40 MHz real-time Spectrum, Marker and Peak Table (included in SignalShark 3330 Basic Set)	Basic Set
Option, SCPI Remote Control (included in SignalShark 3330 Basic Set)	Basic Set
Option, Spectrogram	3310/95.002
Option, Level Meter incl. Compass values	3310/95.003
Option, Persistence (of real-time Spectrum)	3310/95.004
Option, Automatic DF Antenna Control, Bearing View	3310/95.005
Option, Mapping and Localization	3310/95.006
Option, Analog Demodulation	3310/95.007
Option, VITA 49	3310/95.014

Accessories

Description	Part number
PoE++ Injector, 60W (please select please select country specific power cord).	3330/90.01
Universal Surge Arrester for GBit Ethernet (DEHN 929 221)	3330/90.06
RF Adapter, N Male to SMA Female, 50 Ohm	3300/90.13
GNSS Antenna, Screw Mounting, Active	3330/90.04
LTE Antenna	3330/90.05
Mast Mounting Adapter for 3330/XX, D: 48mm to 200 mm	3330/90.07
Recovery media for SignalShark	3310/90.03
RF-Cable, DC to 8 GHz, N to SMA, 50 Ohm, 5 m	3603/02
RF-Cable, DC to 8 GHz, N to SMA, 50 Ohm, 15 m	3603/03

Antennas	Part number
Automatic DF-Antenna 1 Basic Set, 200 MHz to 2.7 GHz ^e	3360/101
Automatic DF-Antenna 2 Basic Set, 10 MHz to 8 GHz ^e	3361/101

^e Requires Option 3310/95.005 „Option, Automatic DF Antenna Control, Bearing View“

Narda DF Antennas - Datasheet

There is a separate DF antenna datasheet, which provides detailed information about the direction-finding antennas available from Narda.

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