{ SA }
Series

SAN-90
9 kHz-9 GHz

Real-Time
Spectrum Analyzer

HAROGIC

USB
REAL-TIME SPECTRUM
ANALYZER

SAN Series
4.5/6/9 GHz

HAROGIC

BENCHMARK USB SPECTRUM ANALYZER

The SAN Series sets a new standard for USB-based spectrum analyzer. Built on a high-performance superheterodyne architecture with up to 14-stage preselection filter, it delivers exceptional noise performance, wide dynamic range, and image rejection. Combining fast sweep speeds with cost efficiency, the SAN Series provides laboratory-grade precision in a highly portable form factor.

EASE OF USE AND COMPACT DESIGN

The compact form factor allows easy system integration while maintaining high RF performance such as spectral purity, making it well suited for space- and cost-limited applications.

UNIFIED API SUPPORT

All models share a unified API, enabling seamless hardware migration without code changes. Supports C/C++, C#, Python, MATLAB, Qt and LabVIEW on Windows and Linux.

ALL-INCLUDED SOFTWARE PACKAGE

Standard measurement functions include channel power, occupied bandwidth, XdB bandwidth, harmonic measurements, AM/FM demodulation, and automatic phase noise measurement.

Key Features

- High-performance superheterodyne receiver with up to 14-stage preselection filters
- Frequency range: 9 kHz to 4.5/6/9 GHz
- 1 GHz DANL: -168 dBm/Hz
- 9 GHz DANL: -167 dBm/Hz
- 1 GHz phase noise: < -110 dBc/Hz@10 kHz
- 1 GHz phase noise measurement: < -125 dBc/Hz@10 kHz
- Analysis bandwidth: 50 MHz / 100MHz (opt.50)
- Sweep speed: > 1 THz/s (RBW = 250 kHz)
- IF and image rejection: > 95 dBc
- Built-in GNSS, supports frequency calibration
- USB3.0/2.0 Type-C interface
- Unified APIs and examples supported
- Windows 11/10/8/7 (x86, x64) supported
- Debian 12/11/10 (x64, AArch64) supported
- Ubuntu 24.04/22.04/20.04/18.04 (x64, AArch64) supported
- Standard SCPI protocol supported

Main Working Modes Overview

Multiple primary working modes: Standard Spectrum Analysis, IQ Streaming, Power Detection Analysis, Real-Time Spectrum Analysis, Phase Noise Measurement, Basic Vector Modulation Analysis (opt.71), Pulse Analysis (opt.72), Harmonic Analysis and Heat Mapping.

### SAStudio4 Main Working Modes Overview

■ Standard Spectrum Analysis Mode

This mode provides a wide range of measurement functions, including full-span sweep, channel power, OBW, ACPR, IM3 and SEM. It also supports spectrum recording and playback. Combined with auxiliary tools such as signal tracking, peak table, and amplitude correction, it delivers a one-stop platform for comprehensive spectrum analysis.
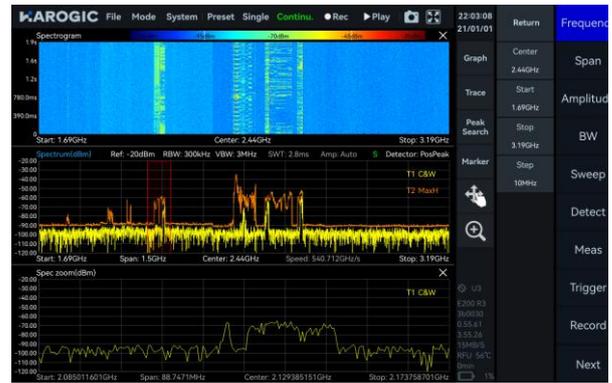
■ IQ Streaming Mode

This mode supports up to 100 MHz analysis bandwidth and allows IQ data acquisition through multiple trigger methods. It provides IQ time-domain waveform display, spectrum and spectrogram views, AM/FM demodulation, and digital down conversion (DDC).
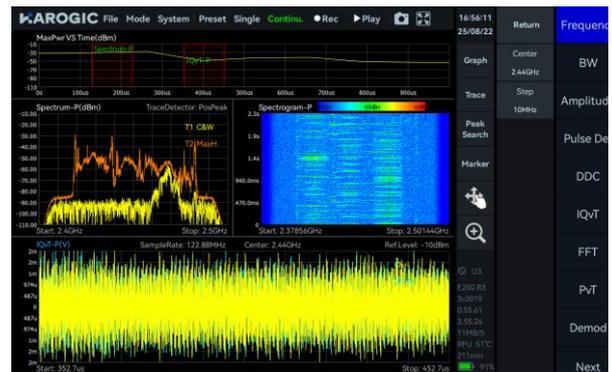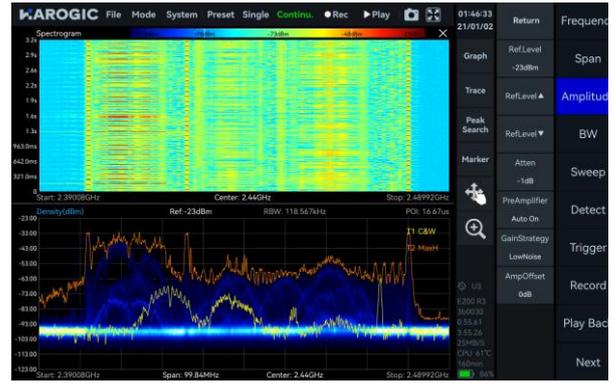

■ Power Detection Analysis Mode

This mode enables detection and analysis of time-domain signals within the analysis bandwidth, making it suitable for applications focused on in-band power-versus-time relationships, such as pulse signal measurements.

Real-time Spectrum Analysis Mode

This mode is powered by a high-speed FPGA-based FFT engine, featuring with strictly gapless and overlap-free FFT, achieving true real-time monitoring across the full bandwidth.

Basic Vector Modulation Analysis Mode (opt.71)

This mode supports demodulation of 2ASK, 2FSK, 4FSK, GMSK, BPSK, QPSK, 8PSK, 16QAM, 64QAM, 128QAM, and 256QAM signals.
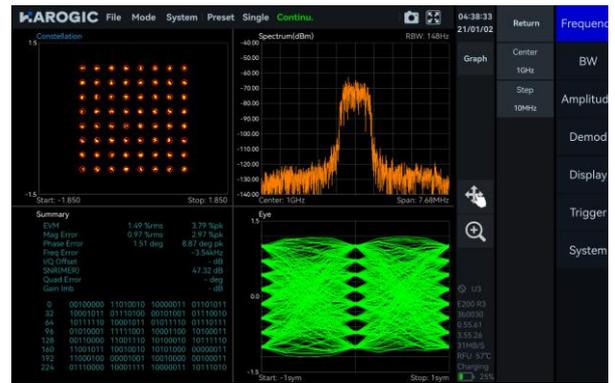
Harmonic Analysis Mode

This mode supports detection and measurement of up to 10 harmonic components, including harmonic peaks, harmonic channel power, and total harmonic distortion.

Phase Noise Measurement Mode

This mode supports offset ranges from 1 Hz to 10 MHz for evaluating carrier phase stability. With the built-in automatic carrier search function, the software can quickly locate the target carrier without manual adjustment.

■ Pulse Analysis (opt.72)

This mode supports the measurement of pulse signals with a pulse width of 32 ns and above, provides key measurement results including peak level (dBm), reference level (dBm), peak-to-reference ratio, droop, overshoot, ripple, rise/fall time, rise/fall edge, pulse width, period, and duty cycle.

■ Mapping Mode

This mode integrates GNSS positioning functionality and enables the generation of heat maps and other graphical visualizations in map view. It displays key information within a defined area, including Channel Power, Occupied Bandwidth, Coordinates (Latitude/Longitude), Altitude, Pixel Position, and Azimuth. It is ideal for applications such as radio monitoring and interference analysis.
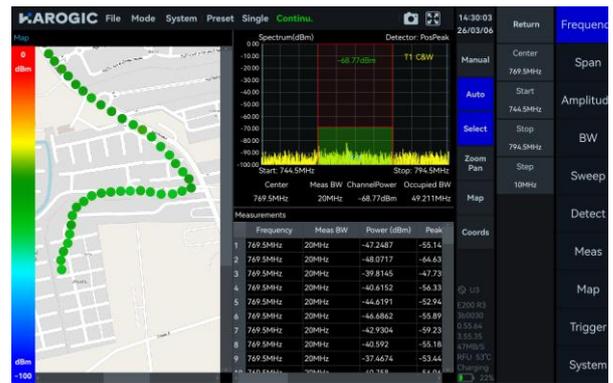
Main Functions Overview

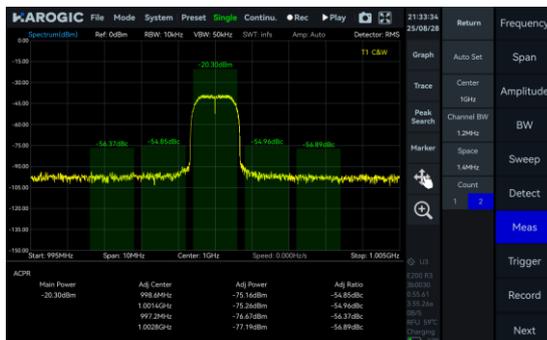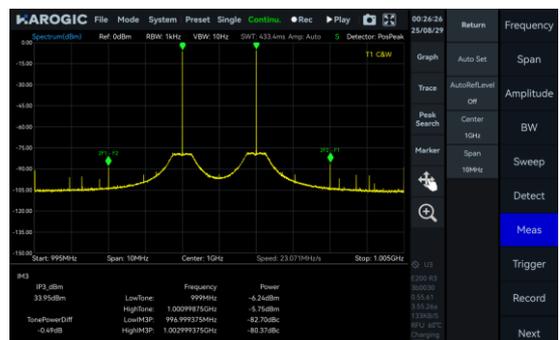### ■ Channel Power

■ OBW

■ ACPR

■ IM3

■ SEM

■ AM/FM Demodulation

■ Antenna Factor

■ Amplitude Offset

■ Signal Track

■ Peak Table
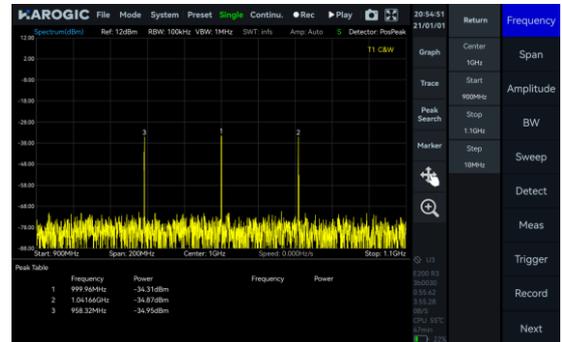
■ Data Record and Playback

■ Multiple Unit Display

Specifications*

FREQUENCY

	SAN-45	SAN-60	SAN-90
Frequency range	9 kHz to 4.5 GHz	9 kHz to 6 GHz	9 kHz to 9 GHz
Reference clock	Internal or external, manual correction or GNSS calibration is available		
Frequency accuracy	TCXO (std.)	<0.5 ppm, manual correction is available	
	OCXO (opt.01)	<0.2 ppm, manual correction is available	
	Frequency correction via GNSS	<0.05 ppm when GNSS is locked	
Aging and temperature stability	TCXO (std.)	<1 ppm/year, <1 ppm	
	OCXO (opt.01)	<1 ppm/year, <0.15 ppm	
Built-in GNSS 1PPS accuracy	± 100 ns		

SPECTRUM PURITY

SSB phase noise (dBc/Hz)
Guaranteed/Typical

Carrier frequency	1 GHz	4.5 GHz	6 GHz	9 GHz
100 Hz	-85 / -88	-78 / -81	-75 / -78	-74 / -77
1 kHz	-97 / -99	-90 / -93	-86 / -89	-88 / -91
10 kHz	-110 / -112	-103 / -106	-100 / -103	-99 / -102
100 kHz	-114 / -115	-104 / -107	-104 / -107	-99 / -102
1 MHz	-131 / -132	-119 / -122	-118 / -121	-116 / -119

Residual response (dBm)
RBW = 1 kHz
Guaranteed/Typical

Reference level (R.L.)	0 dBm	-50 dBm
9 kHz to 100 MHz	-90 / -94	-115 / -117
100 MHz to 4.5 GHz	-90 / -95	-120 / -128
4.5 GHz to 6 GHz	-90 / -96	-120 / -130
6 GHz to 9 GHz	-90 / -98	-120 / -129

Image rejection	>90 dBc, >95 dBc (Typical)
IF rejection	>90 dBc, >95dBc (Typical)
Local oscillator related spurious	<-65 dBc Center frequency ± (N/M) × 125 MHz, N, M = 1, 2, 3, 4, 5…

IIP3/IIP2 (dBm)
Typical

Carrier frequency	1 GHz	4.5 GHz	6 GHz	9 GHz
R.L. = 20 dBm	42/80	37/80	32/80	36/80
R.L. = 0 dBm	23/80	22/80	20/80	14/80
R.L. = –20 dBm	3/60	3/45	–1/45	–5/45

AMPLITUDE

Max. input power (CW)	23 dBm	50 MHz to maximum frequency and preamplifier is off
	10 dBm	9 kHz to 50 MHz or preamplifier is on
Max. DC voltage	±10 VDC	
Display range	DANL to 30 dBm	
Level accuracy	± 1.0 dB from 20 ℃ to 30 ℃ typical conditions	± 1.5 dB over full temperature range all conditions
IF in-band flatness	< ±1.5 dB 50MHz analysis bandwidth	< ±2.0 dB 100MHz analysis bandwidth
Reference level	-70 dBm to +23 dBm	
RF preamplifiers	Auto or manual	
VSWR	<2.0:1 Nominal, 90 MHz to Max. Frequency	

Display average noise level (DANL)
dBm/Hz Guaranteed/Typical
RBW=1 kHz

	SAN-45		SAN-60		SAN-90	
Reference level	-20 dBm	-70 dBm	-20 dBm	-70 dBm	-20 dBm	-70 dBm
9 kHz to 1 MHz	-131 / -134	-141 / -144	-131 / -134	-141 / -144	-131 / -134	-141 / -144
1 MHz to 100 MHz	-151 / -154	-163 / -166	-151 / -154	-163 / -166	-151 / -154	-163 / -166
100 MHz to 3.0 GHz	-141 / -144	-165 / -168	-141 / -144	-165 / -168	-141 / -144	-165 / -168
3.0 GHz to 4.5 GHz	-142 / -145	-165 / -168	-142 / -145	-165 /-168	-142 / -145	-165 / -168
4.5 GHz to 6 GHz	-	-	-143 / -146	-165 / -168	-143 / -146	-165 / -168
6 GHz to 9 GHz	-	-	-	-	-144 / -147	-164 / -167

STANDARD SPECTRUM ANALYSIS

Detector	PosPeak, NegPeak, Sample, Average, RMS, MaxPower
RBW	0.1 Hz to 10 MHz
VBW	0.1 Hz to 10 MHz
Data chart	SAStudio4 software provides spectrum, spectrogram, historical trace
Measurements	Channel power, OBW, X dB bandwidth, Adjacent channel power ratio, IM3

Sweep Speed	RBW = 250 kHz	FPGA processing	≥ 1 THz/s
	RBW = 25 kHz	FPGA processing	> 300 GHz/s
	RBW = 1 kHz	CPU processing	> 4 GHz/s

IQ RECORDING

Continuous recording bandwidth	Maximum: 50 MHz
Burst recording bandwidth	Maximum: 50 MHz / 100 MHz (opt.50) The built-in memory depth is 128 Mbytes
IQ sample rate	Maximum: 62.5 MSPS / 125 MSPS (opt.50) Decimate factor: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048
External trigger response	Maximum frequency response: 500 times/s

DETECTION ANALYSIS

Min. time resolution	16 ns / 8 ns (opt.50)
Max. analysis bandwidth	50 MHz / 100 MHz (opt.50)
Detector	PosPeak, NegPeak, Sample, Average, RMS, MaxPower

REAL TIME SPECTRUM ANALYSIS

FFT analysis	FFT engine is implemented in FPGA. Frame compression and trace detection are supported. No missing samples between FFT frames			

FFT frame update rate=10^9 ns/(N × D × Minimum time resolution)
POI = 2 × N × D × Minimum time resolution
N for FFT points (4096, 2048, 1024, 512, 256, 128, 64, 32)
D for decimate factor (1, 2, 4, 8...)

Typical settings	FFT rate (times/s)		100%POI (us)	
	std.	opt.50	std.	opt.50
N = 4,096, D = 1	15,258	30,517	131.072	65.536
N = 32, D = 1	1,953,125	3.906,250	1.024	0.512

Max. analysis bandwidth	50 MHz / 100 MHz (opt.50)
Window function	B-Nuttall, Flat-top, LowSideLobe, Kaiser
RBW steps	≥12 grades
Amplitude resolution	0.5 dB

GENERAL

Input and output

RF input	N(F), impedance 50 Ω
Power	Type-C, 5V 3A supply capacity voltage range 4.75 to 5.25 V, ripple less than 200 mVp
USB port	Type-C, USB3.0 (USB2.0 bandwidth limited), 5V 0.9A power supply needed.
External trigger input	Integrated in AUXIO, 3.3V CMOS, high impedance
Trigger output	Integrated in AUXIO, 3.3V CMOS
GNSS antenna input	SMA (F)
Analog IF output	MMCX (F), maximum output power -25 dBm impedance 50 Ω, 312.5 MHz ± 50 MHz
External reference clock input	MMCX(F), 10 MHz, Amplitude ≥ 1.5 Vpp, impedance 330 Ω
Reference clock output	MMCX(F), 100 MHz, Amplitude ≥ 0.3 Vpp, programmable on/off

Overall / core weight	≤ 420 g / ≤ 195 g	
Overall / core dimensions (L × W × H)	≤ 163 x 66 x 37 mm / ≤ 109 x 50 x 16 mm	
Power consumption	≤ 20 W	
Packaging accessories	Flash disk * 1, USB 3.0 data cable * 1, USB power cable * 1, Power adapter * 1	
System requirements	Windows 11/10/8/7(x86, x64), Debian 12/11/10(x64, AArch64) Ubuntu 24.04/22.04/20.04/18.04(x64, AArch64)	
Operating/Storage temperature (Ambient)	T0 class (std.)	0 to 50 °C / -20 to +70 °C
	T1 class (opt.40)	-20 to +65 °C / -40 to +85 °C
	T2 class (opt.41), only core	-40 to +65 °C / -40 to +85 °C
Operating relative humidity	Ambient Temp.: 0 to 40 °C	5 to 75%
	Ambient Temp.: > 40 °C	5 to 45%

PHASE NOISE MEASUREMENT

Min. frequency offset	1 Hz			
Max. measurement frequency offset	10 MHz			
Trace smooth	Supported			
SSB phase noise (dBc/Hz) Guaranteed/Typical				
Carrier frequency	1 GHz	4.5 GHz	6 GHz	9 GHz
100 Hz	-90 / -94	-80 / -83	-80 / -83	-78 / -81
1 kHz	-113 / -117	-102 / -105	-100 /-103	-95 / -98
10 kHz	-120 / -125	-112 / -115	-109 / -112	-106 / -109
100 kHz	-126 / -129	-114 / -117	-111 / -114	-108 / -111
1 MHz	-136 / -139	-125 / -128	-123 / -126	-119 / -122
10 MHz	-140 / -143	-137 / -140	-137 /-140	-136 / -139

PULSE DETECTION

Min. pulse width	64 ns / 32 ns (opt.50)
Measurement parameters	Top Level, Base Level, Top/Base, Droop, OverShoot, Ripple, Rise Time, Rise Edge, Fall Time, Fall Edge, Width, PRI, Duty Cycle

AM DEMODULATION

Measurement parameters	Modulation depth, carrier power, modulation rate, signal-to-noise ratio, RMS power, total harmonic distortion, etc.	
Modulation rate test range	20 Hz to 10 MHz	
Modulation rate test accuracy	< 1 Hz when modulation rate < 1 kHz	< 0.1% when modulation rate ≥ 1 kHz
Modulation depth test range and accuracy	5% to 95%, ±5% (Nominal)	

FM DEMODULATION

Measurement parameters	Modulation frequency offset, carrier power, modulation rate, signal-to-noise ratio, RMS power, total harmonic distortion, etc.	
Modulation rate test range	20 Hz to 2 MHz	
Modulation rate test accuracy	< 1 Hz when modulation rate < 1 kHz	< 0.1% when modulation rate ≥ 1 kHz
Frequency offset test range and accuracy	1 kHz to 10 MHz, ±6% (Nominal)	

BASIC VECTOR
MODULATION ANALYSIS

Modulation type	ASK: 2ASK FSK: 2FSK, 4FSK MSK: GMSK PSK: BPSK, QPSK, 8PSK QAM: 16QAM, 32QAM, 64QAM, 128QAM, 256QAM
Symbol length	128 QAM and 256 QAM: 4000 Others: 2000
Symbol rate	(1/64 to 1/4) * sample rate, ≤ 32.5MSPS
Filter	Root raised cosine
Filter roll-off factor	0.01 to 0.99
Display	Spectrum, constellation, eye diagrams, measurement results
Measurement	EVM, amplitude error, phase error, frequency error, signal-to-noise ratio, part of the bitstream

*Specification applies under the following conditions:

(1) Start up and warm up for 10 minutes

(2) Ambient temperature 25 °C

(3) Typical and nominal values are not guaranteed and do not include measurement uncertainty

(4) Specifications may vary with hardware and software versions without prior notice

OPTIONS

Code		
01	Built-in OCXO reference clock	built-in hardware
05	Internal high precision GNSS	built-in hardware
20	AUXIO IO Expansion board	accessory
34	External omnidirectional antenna, 400MHz to 8000MHz, Gain<2dBi	accessory
35	External active directional antenna, frequency range: 0.5 to 10 GHz Gain: < 5 dBi (amp off); < 25 dBi(amp on)	accessory
40	T1 temperature class	built-in hardware
41	T2 temperature class, only available for core	built-in hardware
50	100 MHz analysis bandwidth	built-in hardware
71	Basic vector modulation analysis	software
72	Pulse analysis	software