SpinSpectra-NSMS

Noise Spectrum Measurement System

Micro Magnetics
Sensible Solutions

SpinSpectra-NSMS Noise Spectrum Measurement System

SpinSpectra-NSMS is used to measure the intrinsic noise of a sensor, an electronic device, or a new electronic or magnetic material as a function of frequency from 0.01 Hz to 700 kHz. This process is generally called the measurement of noise spectrum, which potentially can reveal the physical sources or mechanisms of noise generation.

A high performance sensor tends to have very low noise in a broad frequency range. In the example of a magnetic sensor, the magnetic field detectability of a sensor is determined by the intrinsic noise of the sensor. Noise characterization can reveal physical behaviors that may be difficult to detect in other experiments. For sensing applications, it is important to understand noise in relation to signal levels and to develop manufacturing processes to reduce the intrinsic noise.

With NSMS, an engineer can easily measure various kinds of noises, such as 1/f noise, Johnson-Nyquist noise, Shot noise, random telegraphy noise (RTN), or Barkhausen noise. NSMS can also be used as ultra-low noise spectrum analyzer or amplifier. The sample device or device-under-test (DUT) is enclosed in an electrically shield space to eliminate environmental and extrinsic noises.

NSMS is designed for basic and applied research, as well as for product development and quality control. For example, a scientist can use NSMS to measure the quantum noise of nanoscale semiconductor devices such as quantum dots, nanotubes, or two dimensional electron gases. In R&D fields, a researcher can measure the ultimate sensitivity of magnetic sensors, accelerometers, microphones, biomedical sensors, or photo-detectors.

The NSMS displays the spectrum of sensed signals between 0.01 Hz and 700 kHz. It can also display the noise versus time.

The NSMS offers high performance at a reasonable cost. The NSMS is equipped with a dedicated computer and flat-panel display, allowing a user to control the operation of the NSMS through a friendly User-Interface. The noise spectrum is displayed in real-time and stored in a digital file for analysis after measurement. The user can control conditions of noise spectrum measurement on the User-Interface. For example, for ultralow noise measurement, the user can select a longer data acquisition time to improve the statistics of the data. The user can also control the applied voltage to a

device under test and measure the effect of the bias voltage to the noise spectrum. The NSMS offers unprecedented versatility and efficient control.

Features

- Frequency range: 0.01 Hz to 700 kHz
- Ultralow noise proprietary auto-correlation amplifier
- Data acquisition and analysis system
- Operating software for controlling data acquisition and for spectrum display
- Automatic generation of spectrum data files in text format
- Computer with flat panel display
- Electrical cables for various modules
- Manual of operation

Applications

- Measurement of intrinsic noise and ultimate sensitivity of sensors
- Measurement of spectrum of sensed signal
- Electrical or magnetic spectrum of ambient environment
- Zero field confirmation in Faraday cage or zero Gauss chamber
- Frequency spectrum of electrical sources (cell phones, computers, instruments, etc.)
- Determination of noise types (1/f, Lorentzian noise, RTN, white noise, etc.)
- Development of ultralow noise sensors or devices
- Development of high performance materials
- Development of single-electron transistors or devices
- Study of disorders in devices and materials
- Study of thermally induced noises
- Study of single-molecule biological detectors

Self-calibration of Noise Spectrum

The NSMS has a built-in white noise spectrum generator as a standard. This allows the system to be self-calibrated over the whole frequency range. Once the self-calibration is activated, the system will measure the gain of the NSMS' electronics and compare the measured spectrum with the standard spectrum. The operating software will normalize the gain function so that the measured noise spectrum is absolutely calibrated. This easy operation gives the user assurance that the NSMS always generates the correct amplitude of noise across the whole frequency range.

Input Channel

The NSMS has a differential input with 4 nV/$\sqrt{H_Z}$ input noise. A line filter (50 H_Z or 60 H_Z) and a 2× line filter (100 H_Z or 120 H_Z) can be selected to reduce the power line related interference.

Auto-correlation Amplification

To eliminate non-intrinsic noises and interference, the NSMS uses auto-correlation amplifier circuitry. Autocorrelation is the cross-correlation of a signal with itself. Using this method, only the intrinsic electric noises of the DUT are amplified for measurement, whereas extrinsic noises (interference, circuit noise, etc.) are rejected by the amplifier. With auto-correlation, the NSMS is capable of measuring ultralow noise.

Immunity to External Interference

The NSMS is equipped with an electromagnetic shielding enclosure to reduce the external electromagnetic field interference. The DUT is mounted inside a conductive enclosure known as Faraday cage, which is included in the NSMS package. The coupling between the DUT and the NSMS is well designed and configured to reduce the external interference. Following a standard procedure, a user can connect the DUT to the NSMS without much concern on external interference. In noise measurement, external interference can be a hindrance in extracting the intrinsic noises generated by a DUT. The NSMS is strongly immune against external interference.

Low Noise Rechargeable Battery Operation

The noise from a power supply can often affect intrinsic noise measurement. The NSMS is equipped with a rechargeable battery to power the NSMS during operation. The battery eliminates potential noises from the power supply, enabling NSMS for ultralow noise measurement. The battery is automatically charged when the NSMS is not in use. The battery is also used to bias the DUT if needed.

Computer Control and Display

The NSMS is fully controlled by an industrial-strength Window based computer with a large flat panel display. The NSMS operating software controls the self-calibration process and the whole noise spectrum measurement. It provides the user with a complete set of functions and control parameters. It allows the noise spectrum to be displayed in different format (varying scales and frequency range, etc.). Because of the large memory provided by the computer, the NSMS can record noise spectrum over long time to improve data statistics. The high processing power of the computer allows the user to perform fast data acquisition and after-measurement thorough analysis on noise spectrum.

Easy Operation

The NSMS is simple to use. All functions are set on the computer's User Interface, and measurement parameters and conditions are displayed on the large flat panel. The noise spectrum data is automatically saved on the computer.

SpinSpectra-NSMS Specifications

Input Channel

Voltage input	Differential
Bandwidth (-3dB)	0.01 H_z to 700 kH_z
Sensitivity	4 nV

Noise (typical)	4 nV/$\sqrt{H_z}$ at 10 H_z
Gain accuracy	±1%
Line filtration	50 H_z or 60 H_z and 100 H_z or 120 H_z
ADC resolution	16 bits
Sample rate	
Maximum	1.00 MS/s multichannel (aggregate)
Minimum	No minimum
Timing accuracy	50 ppm of sample rate
Timing resolution	10 ns
Maximum working voltage for analog inputs (Signal + common mode)	±11 V of AI GND

Measurement

Noise spectrum acquisition time	30 seconds (typical), 1 second (minimum)
Noise self-calibration time	30 seconds
Minimum noise measurement	300 Ohm Johnson noise effective
Random telegraph noise measurement	Yes
Noise versus frequency measurement	Yes
Noise type	1/f noise, Johnson-Nyquist noise, Shot noise, RTN, Barkhausen noise
Noise spectrum chart scale	Linear or Log
Bias voltage to Device-under-Test	0 to 15 V
Noise data storage	Continuous
Noise data format	Text file

Computer and Display

Operating system	Window 7 Pro.
Chassis	4U Rack Mount Chassis with 3 x front 5.25" bays and 1 x front 3.5" bay
Motherboard	Asus Motherboard with Intel H61 Chipset - Supports Intel's 3rd Gen 22nm Ivy Bridge Core i3/i5/i7 Processors

Processor	2.6 GHz Intel Celeron Dual-Core CPU (2MB L2 Cache)
Memory	4GB DDR3 1600MHz System Memory
Hard Drive	500GB Western Digital 7200RPM SATA HDD
LAN	Onboard Gigabit LAN
Video	Onboard Intel Video via DVI and VGA
Audio	Onboard HD Audio
Ports	Ten USB 2.0 ports (2 Front, 6 Rear, 2 ports via internal headers)
One DVD Writer One DVI One Gigabit network interface	
Display	20-inch Diagonal LED Monitor

General

Power	300W, 100/120/220/240 VAC, 50/60 H_z
Dimensions	20.5×26.4×22.6 (WHD)
Weight	About 150 lbs.
Operating temperature	0 to 50 °C
Storage temperature	-40 to 70 °C
Operating humidity	10 to 90% RH, noncondensing
Storage humidity	5 to 95% RH, noncondensing
Indoor use only	
Warranty	One year parts and labor on defects in materials and workmanship