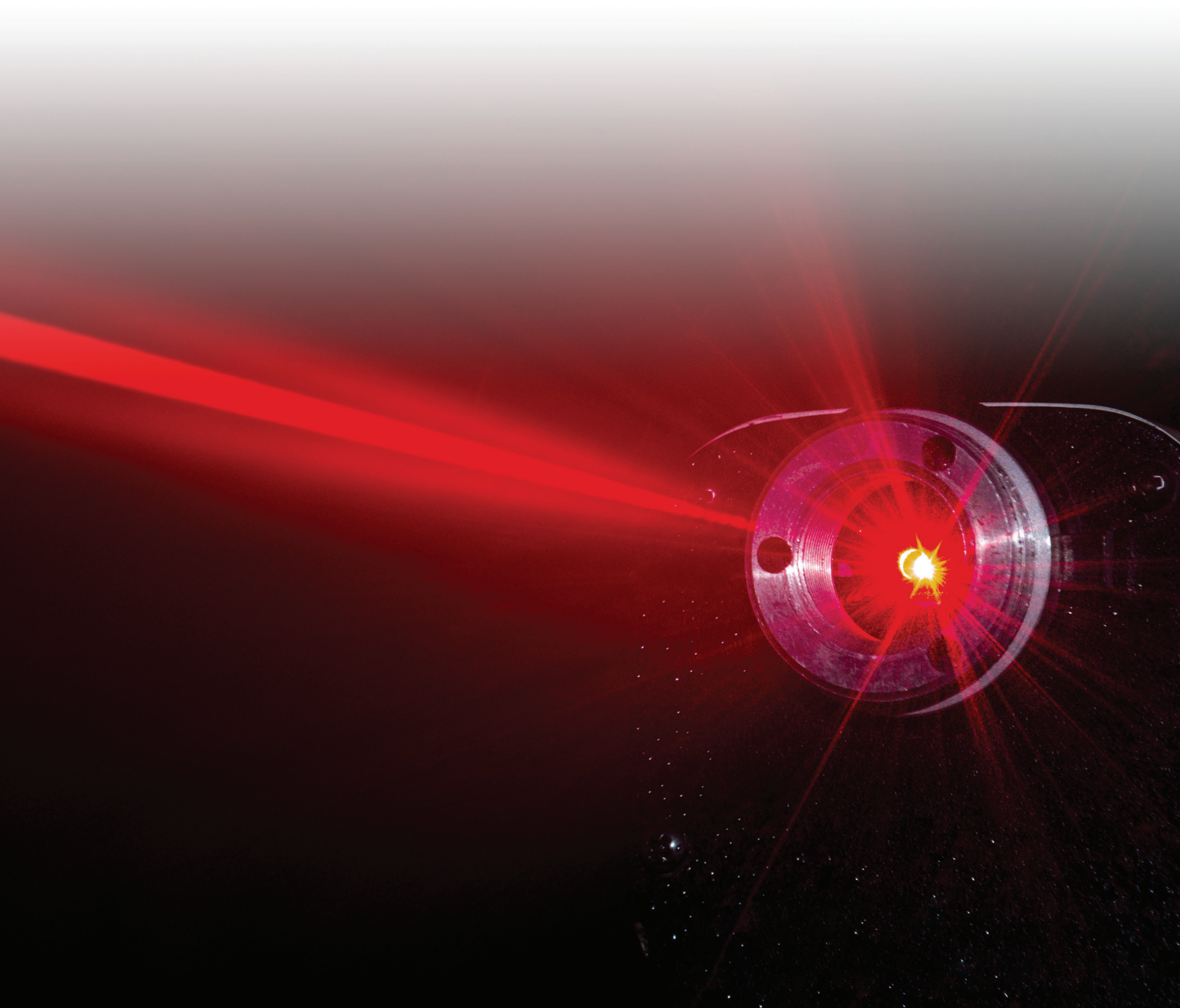
Noisecom

Directed Energy Weapons Development Solutions



As the aerospace and defense industry adapts to evolving challenges, it prompts innovation of modern, high-tech weaponry. One of these emerging technologies is in directed energy weapons (DEW), which are designed to neutralize long-range targets with pinpoint accuracy using highly focused laser energy, delivering an edge over traditional weaponry to counter arising security threats across all domains. DEW can provide an endless magazine if enough power is available, thus eliminating the logistical problems of finite ammunition supplies and lowering the total cost per shot. Its speed-of-light delivery can neutralize distant targets while significantly reducing collateral damage. In addition, DEW offer a wide range of platform flexibility, capable of launching from large vehicles; ships at sea; fixed, land-based structures; and airborne platforms, among others.

Since DEW provide a unique response to rapidly emerging global threats, many industries and military branches are channeling research and development (R&D) efforts toward directed-energy technologies poised for near-term deployment. However, certain design issues must be addressed in order to achieve the high power levels necessary to support laser-based DEW deployment in critical security operations. To reach the optical powers required for laser weaponry, multiple laser modules are combined into a single beam, but the high optical intensity of each module over the fiber can generate Stimulated Brillouin Scattering (SBS) issues, which create a sizeable and destructive return loss.

Noisecom noise generators and standalone noise sources can address the critical needs of SBS reduction by driving coherence spreading to minimize retroflected scattering, allowing for high optical power transmission. Coherence spreading using a random noise source reduces each laser module's sharp waveform (peak power) by modulating the phase of the laser. Although the peak power is reduced, the average power remains the same, therefore the overall optical power of the laser is maintained while at the same time reducing the negative effects of SBS.

Using a Noisecom Additive White Gaussian Noise (AWGN) source offers a cost-effective, easy-to-use, environmentally robust, and compact coherence-spreading methodology that delivers truly random noise for high-power lasers ranging from R&D designs to production-ready systems. For over 30 years, Noisecom has been designing noise generation devices and instruments for Carrier-to-Noise, signal jamming and impairment, multipath fading, satellite test, and calibration across a wide variety of industries. Noisecom has a depth of experience unmatched in the industry and works closely with technical end users to find the right project for the application with both off-the-shelf and customized solutions. This experience and close relationship with customers and markets has led to the development of programmable AWGN generators, amplified noise modules, and integrated solutions specifically designed to address SBS reduction to support high optical power in laser-based DEW design.

Customization

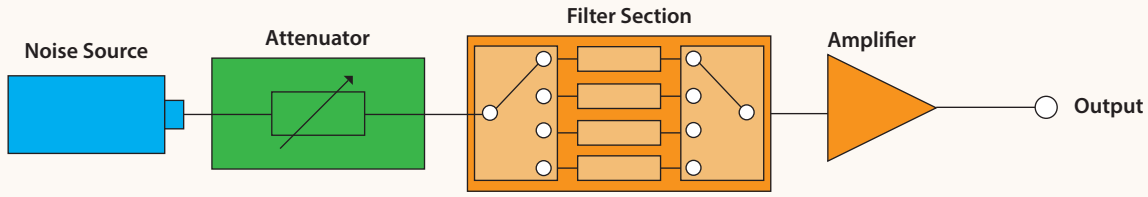
Each system is different, and the set of SBS challenges vary in every device or system. This diverse range of unique laser system requirements is why Noisecom products, from self-contained benchtop instruments to individual amplified noise modules, are highly customizable to meet the unique needs of challenging applications. Products can be customized to include precision attenuators, filters, and single/multiple stage amplifiers to serve DEW still under test or ready for production. Whether it is a single component or integrated system, Noisecom has a broad range of capabilities and solutions for every budget.

SBS Reduction in Product Development

In order to progress laser-based DEW passed the experimental stage into practical, high-performing military weapons, designers need a flexible means to validate their designs and finalize specifications. Choosing an approach to manage SBS-related issues in the lab may be very different than the approach needed while in the field, or even when deployed as part of a DEW system. In many cases a fixed output noise source is the ultimate solution for reducing SBS in DEW designs, however, these noise sources do not give designers the flexibility and control they need during development to optimize performance. Programmable noise generators provide a high level of control over noise that can be injected into a system by providing variable attenuation, filtering, and amplification, enabling a broad range of noise generation capabilities for design validation and determining the exact noise output for any laser system requirement.

The Noisecom UFX7000B programmable noise generator provides a flexible architecture to create the unique noise signals required for reducing SBS in laser system designs. Precision components provide high output power and superior flatness while controllable attenuators, switches, and filters ensure that noise is generated and applied to the system at the right power levels and frequency bands. The output from the UFX7000B is connected to an optical phase modulator that is connected to the laser pump to directly drive coherence spreading. Combining a noise source with variable attenuation, filtering, and amplification enables the UFX7000B Series to deliver a programmable, self-contained unit that suits a variety of design needs. Due to the instrument's high level of versatility and control over noise power levels and frequencies, it is an ideal device for proof-of-concept DEW in the R&D stage to aid designers in determining system requirements and specifications.

Inside the Noisecom UFX7000B

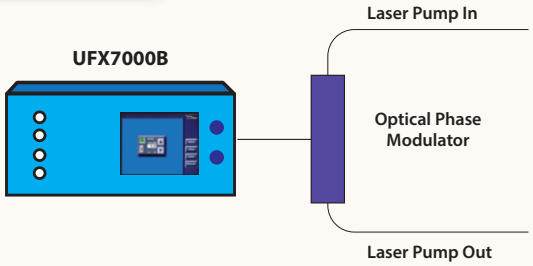


Used to create complex custom noise signals for a broad range of microwave and RF applications along with high-power laser systems, the Noisecom UFX7000B Series programmable benchtop AWGN generator features a powerful single board computer that controls a flexible architecture to create unique, sophisticated noise signals. The UFX7000B Series includes a noise source and an attenuator, which allows designers to change the output power level of noise within a dynamic range of 127 dB in 1 dB steps. Attenuation in 0.1 dB steps is also available, offering the highest level of noise control. The UFX7000B can be configured and customized to include up to five filter paths to change the video bandwidth and provide noise band limiting capabilities, which can help pinpoint the most appropriate bandwidth of noise for specific laser system designs. Amplification of the signal is also available for up to +30 dBm. The generator can be controlled directly through an intuitive touch screen or remotely through Ethernet or GPIB connections.

SBS Reduction in Product Development (continued)

The UFX7000B precision programmable noise generator acts as a complete, self-contained coherence spreading solution for SBS reduction through coherence spreading. The user-controllable output of the AWGN signal is ideal for validating and verifying design alternatives during development. The internal attenuation, filtering, and amplification capabilities of the generator provide the flexibility in frequency, band limitation, and power level adjustment that system designers need to optimize their laser system performance. The UFX7000B Series provides a noise source with a wide range of frequency bands up to 40 GHz, the ability to control attenuation of output power in 0.1 dB steps, band limiting capabilities supported by multiple filter paths, and signal amplification up to +30 dBm.

SBS Reduction in Product Development with the UFX7000B



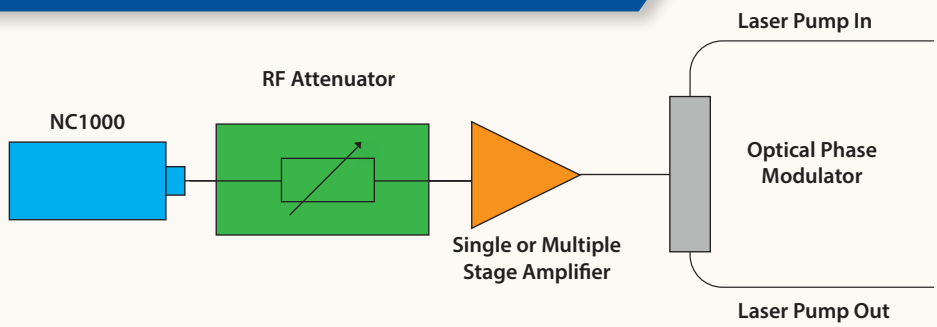
Controlled through an intuitive touchscreen, the UFX7000B enables designers to determine and define the necessary RF bandwidth and noise power levels that travel through a laser system's optical phase modulator to achieve SBS reduction and optimal DEW performance. While initial development and evaluation is typically conducted in a controlled lab or benchtop environment real world testing is required before designs can move to deployment. The next phase of product testing utilizes test chambers that subject the laser weapon to various simulated environmental conditions it will encounter in the field, such as extreme temperatures, vibrational stresses, high altitudes, and moisture exposure. Designers can use the UFX7000B remotely via ethernet or GPIB control alongside other electrical and optical test equipment to perform dynamic changes of RF bandwidths and noise power output during these environmental tests. This remote control capability of the UFX7000B expedites the testing process by rapidly pinpointing the changes that must be made in the DEW design for it to properly perform while operating in harsh field conditions.

SBS Reduction in System Deployment

Once laser systems move from the initial design stages and are prepared to be released for production, SBS reduction needs to be managed by smaller, compact, lower-cost noise sources that can be deployed in each manufactured system. While in the lab, engineers must determine the right frequency bands and power levels of a noise source for coherence spreading to later be fixed and packaged in something that can be embedded into the final design. This is where engineers would typically identify and select an amplified noise module that produces the exact noise signal they need based on the development work with a production generator. The fixed output module is carefully selected for the specific laser system it will be embedded in for deployment.

Producing AWGN up to +13 dBm in a compact, low-cost form factor, the NC1000 amplified noise module delivers the exact noise signal at the right power level and in the right bands for a deployed laser system. Inside the NC1000 module is a hermetically packaged noise diode that has been pre-selected for special performance characteristics. The standard module is designed for a 50 Ω load impedance and has bandwidths from 10 MHz to 18 GHz. Beyond the standard configuration in the product range, various customizations are available to meet specific requirements.

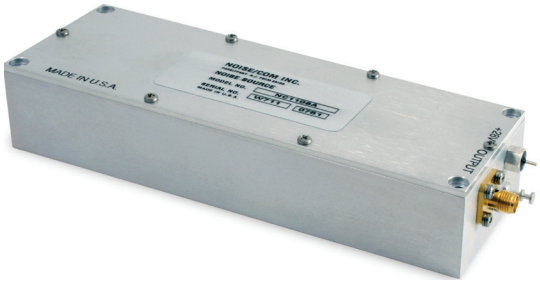
SBS Reduction in System Deployment with the NC1000



The compact and cost-effective NC1000 amplified noise module acts as a standalone fixed noise source that integrates directly into the completed, deployment-ready system. In this case, the noise is delivered to the optical phase modulator through specific attenuation and amplification stages to deliver the exact output power required. The frequency range and band of the NC1000 was selected by the designer precisely for this design. In certain applications, specific attenuation and amplification can be built into the NC1000, and a customized noise source can be connected directly to the optical phase modulator, which can reduce physical footprint and total cost.

NC1000 Amplified Noise Source

The NC1000 series modules produce white Gaussian noise up to +13 dBm. The high power modules are designed for secure communication and signal jamming, while the low power modules with high crest factor are used for signal impairment in BER, and Jitter applications. Each module contains a hermetically packaged noise diode that has been pre-selected for special performance characteristics. The standard module is designed for a 50 Ω load impedance.



High Power Modules

50 Ω Load Impedance (Package 1, +28 VDC Operation is standard)

Model	Frequency Range	Output Characteristics				I (max)
		Power (dBm)	dBm/Hz	Flatness (dB)	μV/√Hz	(mA)
NC1101A	10 Hz - 20 kHz	+13	-30	±0.5	7071	70
NC1103A	10 Hz - 500 kHz	+13	-44	±0.5	1414	150
NC1105A	10 Hz - 10 MHz	+13	-57	±.75	316	160
NC1107A	100 Hz - 100 MHz	+13	-67	±1.0	100	160
NC1108A	100 Hz - 500 MHz	+10	-77	±1.5	31.6	160
NC1109A	100 Hz - 1 GHz	+10	-80	±2.0	22.4	160
NC1110A	100 Hz - 1.5 GHz	+10	-82	±2.0	18.2	160

High Crest Factor Modules

50 Ω Load Impedance (Package 3, +15 VDC operation is standard)

Model	Frequency Range	Output Characteristics				I (max)
		Power (dBm)	dBm/Hz	Flatness (dB)	μV/√Hz	(mA)
NC1111A	1 GHz - 2 GHz	-10	-100	±2.0	2.24	250
NC1111B	1 GHz - 2 GHz	0	-90	±2.0	7.07	250
NC1112A	20 MHz - 2 GHz	-10	-103	±2.5	1.58	250
NC1112B	20 MHz - 2 GHz	0	-93	±2.5	5.02	250
NC1113A	10 MHz - 3 GHz	-10	-105	±2.5	1.12	250
NC1113B	10 MHz - 3 GHz	0	-95	±2.5	5.02	250
NC1124A	2 GHz - 4 GHz	-10	-103	±2.5	1.58	250
NC1126A	2 GHz - 6 GHz	-14	-110	±2.5	0.71	250
NC1126B	10 MHz - 6 GHz	0	-98	±3.0	2.8	300
NC1128A	10 MHz - 10 GHz	-17	-117	±3.0	0.32	250
NC1128B	10 MHz - 10 GHz	0	-100	±3.0	2.24	300
NC1120A	10 MHz - 18 GHz	0	-103	±3.0	1.58	500

UFX7000B Programmable Noise Generator

The Noisecom UFX7000B broadband AWGN noise generator has a powerful single board computer with flexible architecture used to create complex custom noise signals for advanced test systems. This versatile platform allows the user to meet their most challenging design requirements. Precision components provide high output power with superior flatness, and the flexible computer architecture allows control of multiple attenuators, switches, and filter banks.

Model	Frequency Range	Output Power	dBm / Hz	Flatness	µV / root Hz	Noise Attenuation
UFX7105B	10 Hz - 10 MHz	+13 dBm	-57 dBm	±0.5 dBm	316	0 - 127.9 dB, 0.1 dB steps
UFX7108B	100 Hz - 500 MHz	+10 dBm	-77 dBm	±1.0 dBm	31.6	0 - 127.9 dB, 0.1 dB steps
UFX7110B	100 Hz - 1.5 GHz	+10 dBm	-82 dBm	±1.5 dBm	18.2	0 - 127.9 dB, 0.1 dB steps
UFX7111B	1 GHz - 2 GHz	+10 dBm	-80 dBm	±1.5 dBm	22.4	0 - 127.9 dB, 0.1 dB steps
UFX7112B	1 MHz - 2 GHz	0 dBm	-93 dBm	±2.0 dBm	5.01	0 - 127.9 dB, 0.1 dB steps
UFX7113B	10 MHz - 3 GHz	0 dBm	-95 dBm	±2.5 dBm	5.01	0 - 127.9 dB, 0.1 dB steps
UFX7116B	10 MHz - 6 GHz	-12 dBm	-110 dBm	±3.0 dBm	0.071	0 - 127.9 dB, 0.1 dB steps
UFX7128B	10 MHz - 10 GHz	-17 dBm	-117 dBm	±3.5 dBm	0.3251	0 - 79.9 dB, 0.1 dB steps
UFX7218B	2 GHz - 18 GHz	-20 dBm	-122 dBm	±2.0 dBm	0.18	0 - 79.9 dB, 0.1 dB steps
UFX7226B	2 GHz - 26.5 GHz	-18 dBm	-122 dBm	±3.0 dBm	0.18	0 - 79.9 dB, 0.1 dB steps
UFX7240B	2 GHz - 40 GHz	-20 dBm	-126 dBm	±4.0 dBm	0.11	0 - 79.9 dB, 0.1 dB steps
UFX7911B	5 MHz - 1 GHz	+30 dBm	-60 dBm	±3.0 dBm	—	0 - 127.9 dB, 0.1 dB steps

Noisecom

Noisecom is a leader of RF and microwave noise sources for signal jamming and impairment, reference level comparison and calibration,receiver robustness testing, and jitter injection. Electronic noise generation devices from Noisecom come in a variety of product types including, noise diodes, built-in-test modules (BITE), calibrated noise sources, jitter sources, cryogenic noise standards and programmable instruments. Calibrated noise sources are available from audio to millimeter wavelengths in coaxial or waveguide modules. Programmable instruments are highly configurable and able to generate precise Carrier-to-Noise, Signal-to-Noise and broad band white noise. Noisecom products arecustomizable to meet the unique needs of challenging applications and can be designed for high power, high crest factor, specific filter responses with a wide selection of input and output options.

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