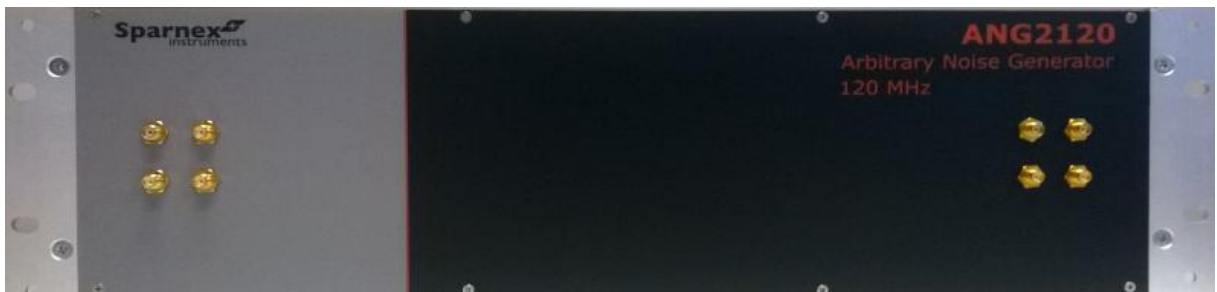


Next Generation of Noise Generators

New Industry Standard

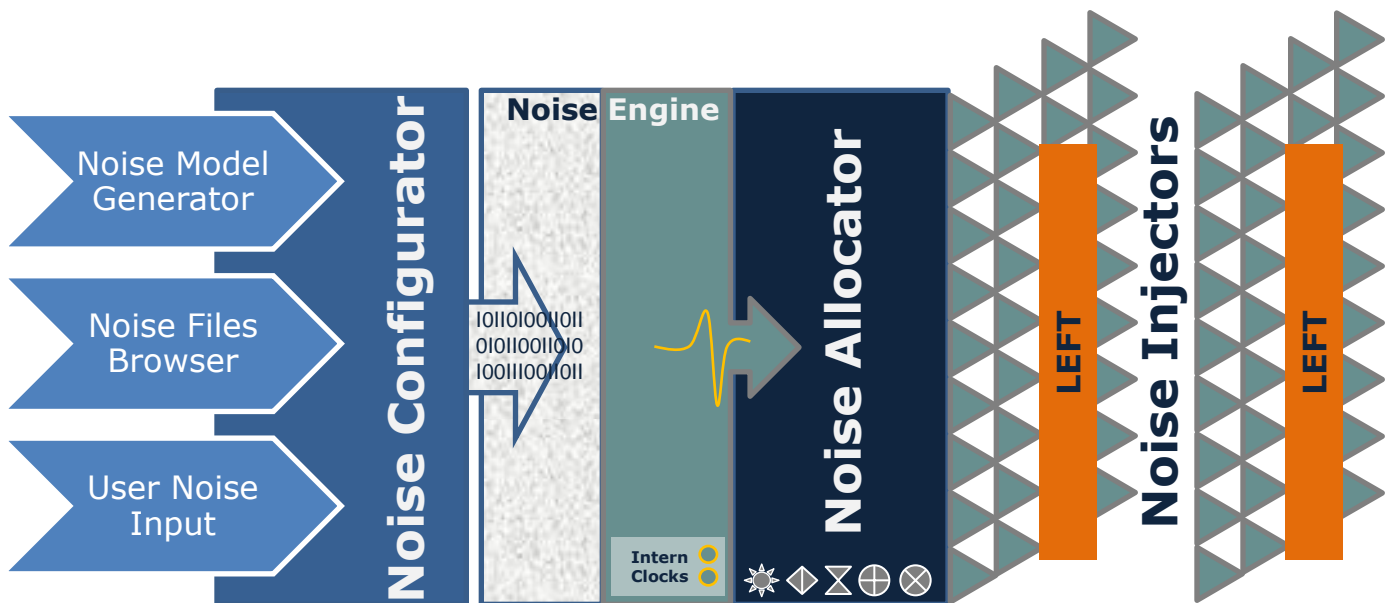
Broadband Access Products Certification



ITU-T based BBF recommendations

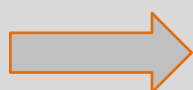
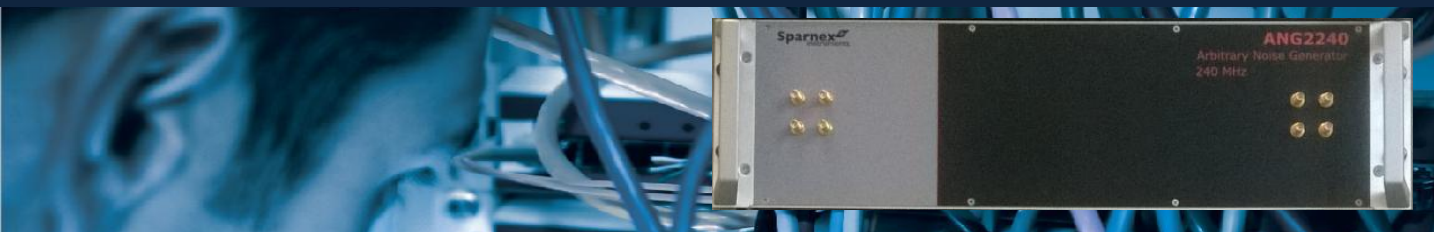
~ all issues annex a, annex b, annex J ~

TR-100/TR-105/TR-114/TR-115/BBF-337/BBF-380/TR-249/TR-208



High-precision versatile Arbitrary Noise Generator

ANG 2240 platform



**15 kHz ~ 240 MHz
2 channels**



**Simulate disturbers in wired networks
Define maximum performance of broadband connections**

Coaxial Cable ~ Telephony Twisted Pairs ~ Electricity Network

combined with Sparnex Instruments
Line Simulators model types :

Coax

**LSX 2200-C
LSX 2201-C
PLS 30**

Twisted Pair

**LSX 2020
LSX 2025
LSX 2030
LSX 2200
LSX 2201
LSX 2208
VCX n.8**

Electric cable

**PLS 2014
PLS 2015
PLS 2016
PLS 26**

**! Noise Injectors !
Return loss
Better than >-25 dB**

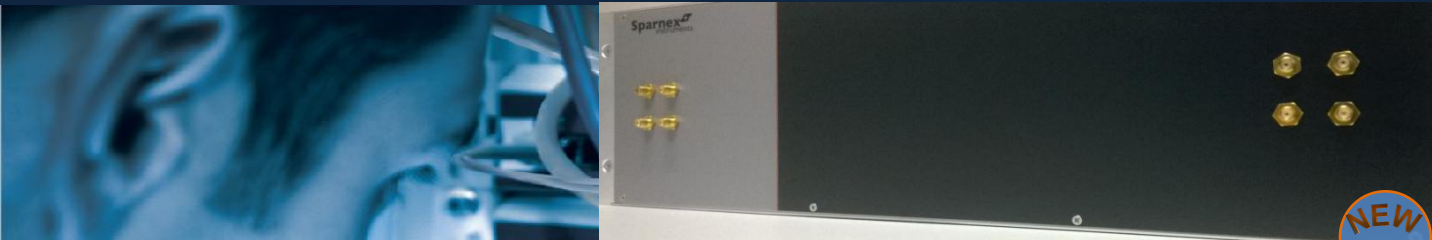


**Library based Noise Test Profiles
for all Broadband technologies**

**xDSL * G.fast * G.hn * PLC * RPF
ITU-T / IEEE / BBF / ETSI / BQL**

ANG - Arbitrary Noise Generator platform

High-precision versatile ANG noise generation platform



Copper wire-line transmission such as ADSL, SHDSL, VDSL2 is still the dominant broadband access technology to the home. As optical networks expand closer to the homes, there is even more pressure to increase the bandwidth over copper.

Recently introduced transmission technologies such like Vectoring, SuperVectoring, G.fast106, G.fast212, PLC MiMo .. break new speed records – some beyond 1 Gbps. Higher bandwidth is possible with shorter distances of copper pairs, combined with sophisticated algorithms like Vectoring that recovers data present on adjacent pairs in a multi-pair bundle.

Other modems apply MiMo techniques like for in-home Internet distribution over the Phase, Neutral and Earth carriers of the electricity network, or use coaxial cables.

There are a number of consequences.

- these new technologies are much more sensitive to disturbers
- as frequency bands increase they interfere with the environment and suffer more from EMI
- new transmission schemes have to fit with legacy networks without loss of speed or quality
- the access network and in-home distribution network use the same frequency band requiring for interference and co-working mechanism testing
- band-plans beyond 35 MHz is an area with other electrical rules, effects and phenomenae
- impedance, phase/delay become even more dominant than signal attenuation

And still modems should be miniature, EMI/EMC neutral, interoperable, should cope with country regulations, combine more functions, reach the benchmark speed in different working conditions, be compliant to ITU-T, allow for remote monitoring, consume low energy, address the safety and security rules, cost-effective, reliable, software upgradable ... while technologies converge and tend to become very complex.

Such challenging problems require a team of smart engineers who need the very best tools and test instruments !

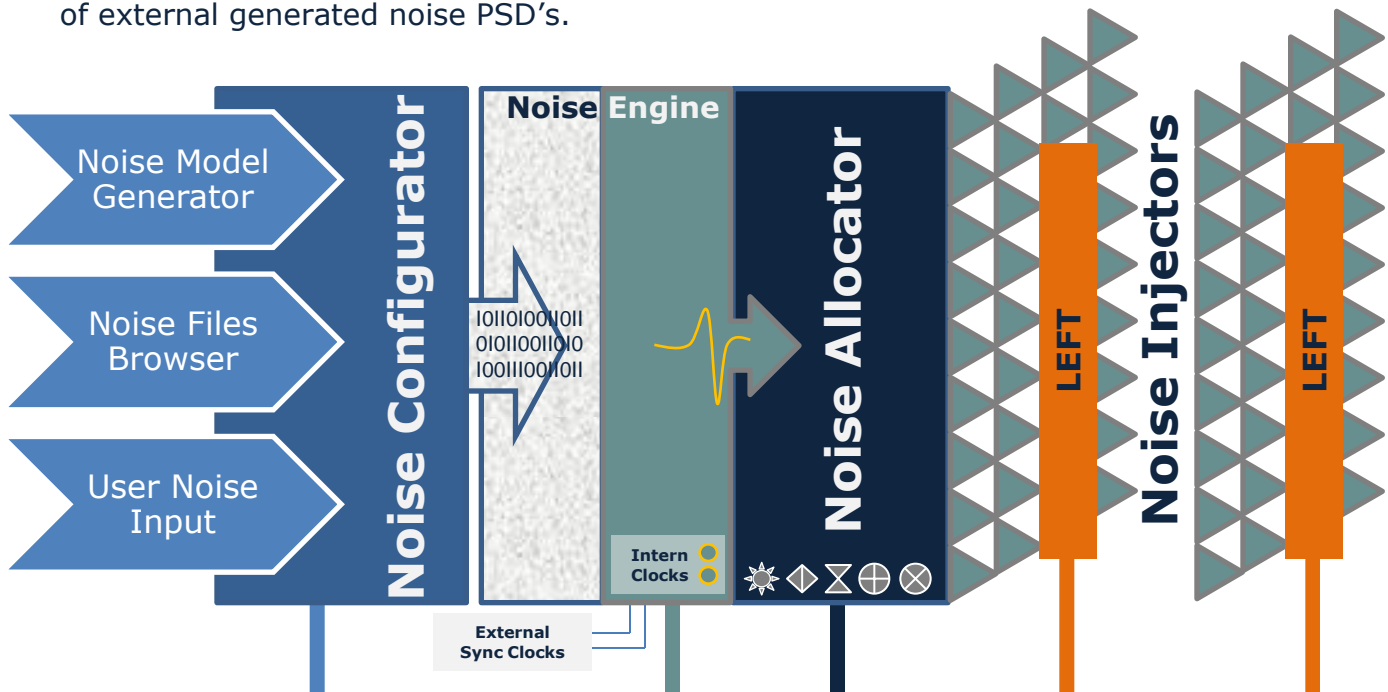
The new Sparnex Instruments ANG is markets' *most precise and versatile Noise Generation platform* designed to test the next generation of broadband transmission products. It complements the high-end ITU-T compliant Sparnex Instruments LSX Multi-Line simulators turning this platform in an Industry Standard for interoperability, performance and benchmark testing of broadband access and in-home broadband distribution products.

ITU-T G.9700-9701, G.9960 G.hn, G.9963 MiMo, HPAV2, IEEE 1901

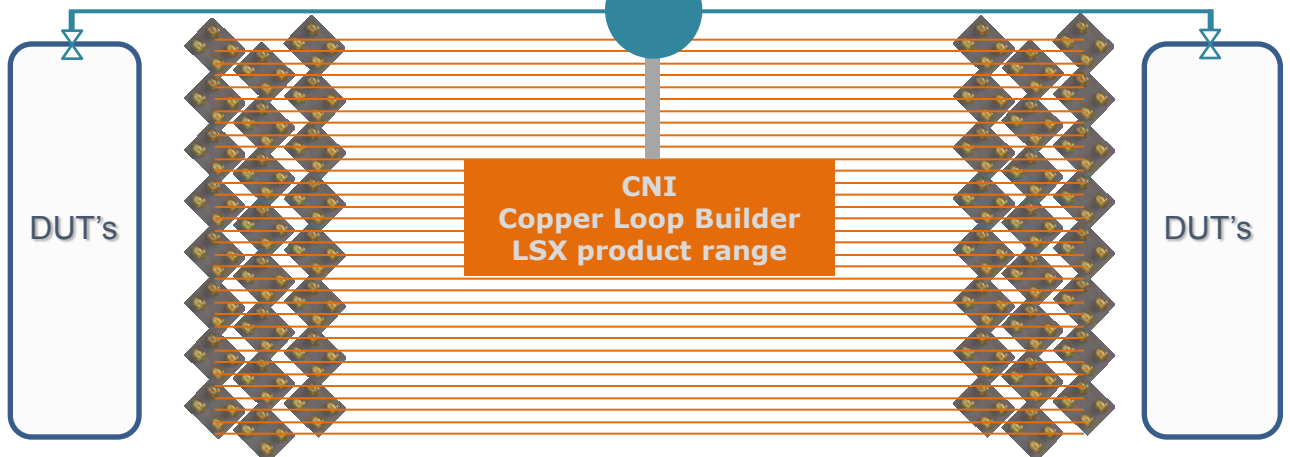
ANG - Concept

The concept of the new generation of Sparnex Instruments' Arbitrary Noise Generators is a highly sophisticated approach for many reasons:

- it provides yet the tools for testing the Next Generation of Broadband transmission technologies and products that will come to the market in the next 5-10 years;
- the ANG product line is fully compatible with all SI products. The focus is on integration of different test functionalities in one platform with the objective that lab technicians with only few training are able to run any test manually, or in a fully automated way;
- ANG is an open platform that can be loaded with different formats of external generated noise PSD's.



Pre-defined scripts – test scenario programmer



Noise Control Software

Noise Data Input and Creation NCS – NBS - NIS

- **NCS** Noise Creation Software allows to model up to 7 different type of noises with NEXT, FEXT, on-the-fly USER and Line Type/Length Attenuation filters.
- **NBS** Noise Browser Software gives access to an exhaustive library of pre-programmed noise-files designed according Standard Recommendations.
- **NIS** Noise Import Software converts User PSD files .csv, .Jason/Matlab, .xls files for use in NCS or for direct noise generation output.

Noise Configurator Tools - NCT

Noise Configurators assemble, mix and adjust output levels of NCS, NBS or USER files that are created in Time or Frequency domain before they are sent to the Noise Engine. *This allows to reduce the number of hardware noise channels.*

Noise Allocator - NAS

NAS Noise Allocator Software allocates noises to one or several output ports as a combined, added, amplified or multiplied signal in a continuous, periodic or repeated time-frame based on test scenario's that emulates a typical use case.

Pre-defined Scenario's - PDS

The PDS Pre-defined Scenario function is an one button selection for instantly run of a pre-programmed noise configuration. This can be one single PSD, a consecutive PSD or intermittent PSD to one or several ports in a script of events that requires process monitoring of the Devices under Test during which data is interchanged between DPU/DSLAM and CPE's (or external traffic generators) with pass-and-proceed or fail-and-interrupt the noise generation, or even stop the entire test. PDS also interacts with the LSX Line Simulators for automatic change of line parameters. It allows to program micro-interrupts on certain ports, to turn on-and-off noise and lines on other ports as well as it communicates with the DUT's and external or SI test equipment like the TGA traffic generator and the ICXACT spectrum analyzer in order to report the gathered results in the RPG Report Generator.

TEST Report Generator - TRG

The RPG Report Generator gets the output from all connected test instruments and from the Devices under Test. The RPG automatically generates the Test Reports. Pre-programmed ITU-T or other Standardisation body related use test cases with Pass-Fail tables can be selected in the PDS library. Test, configuration and customer specific information such as calibration data, Profiles under test, DuT or SuT ... can be programmed in RPG by the lab manager or the test engineer. Proprietary use test cases with Pass/Fail criteria can be created with the Test Scenario Programmer.

Noise Control Software

Test Scenario Programmer - TSP

The Test Scenario Programmer is a tool to program tests with the use of all software tools that are available - NCS – NBS – NIS – NAS, based on existing or new created noise PSD/libraries. The TSP has a direct interface with the CNI Copper network builder and Noise graphical user Interface software.

Copper Network Builder & Noise Interface - CNI GUI

The CNI is a TAB-based graphical user interface that gives access to:

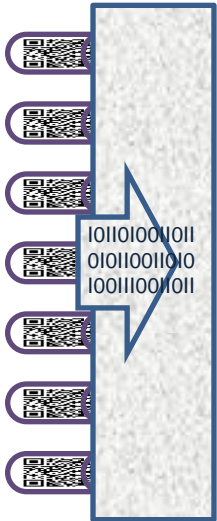
- the Line Simulators where line types, loops, bridge taps and lengths can be programmed or can be selected from the pre-programmed Loop library
- the Noise Browser NBS to select noises
- the NAS to allocate noises to ports – DSLAM/DPU and CPE's
- the PDS to load a complete pre-programmed test scenario
- the TSP to create and store own test cases
- the connected traffic generator like TGA
- the DSLAM/DPU when drivers are installed
- other test instruments when appropriate drivers are installed
- the TRG report generator

The screenshot shows the ICL Client software interface with several key components highlighted by callouts:

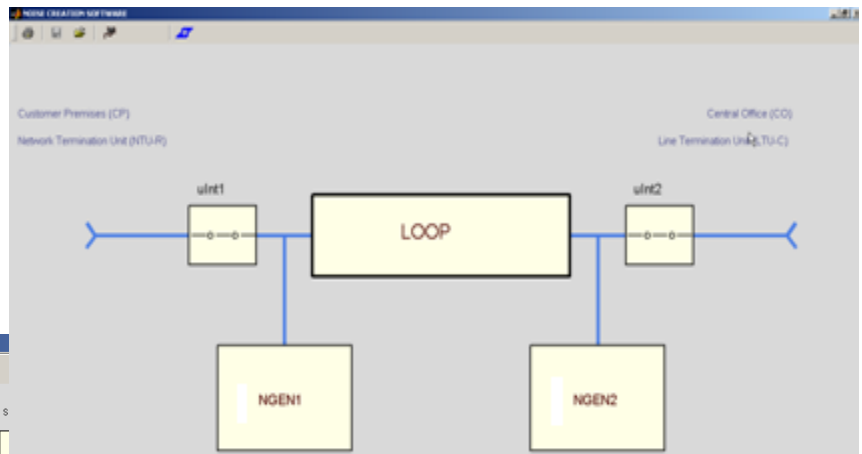
- Loaded test case:** Points to the 'Performance Table' tab, which displays a table of test parameters.
- check test table:** Points to the 'Performance Table' tab.
- Configure/select tests:** Points to the 'Performance Table' tab.
- Communicate with ICL server:** Points to the 'Status' section, which shows 'Checking initialized noises... Ready.'
- Select TAB per test function/equipment:** Points to the 'Pre-defined Scenario', 'Noise', 'Test Loop', and 'Performance Table' tabs.
- Expand with test functions:** Points to the 'Performance Table' tab.
- Execute Self Test:** Points to the 'Self Test' button.
- ICL command for automation:** Points to the 'Command Pane' showing a loaded command: 'C:\Sparnex.LSX2030_vx\ICL_Server\PerfTables\Table_Table_8_3_26.bin'
- check line & length show graphs:** Points to the 'Loop Preview' section, which shows a line diagram and a graph.
- Browse:** Points to the 'Load Pre-defined Scenario' tree view.
- System Interface:** Points to the overall software interface.

STEP	Pulse Width Ts	Noise Applied	Noise Applied	Upstream			Downstream			SELECTED
				Expect	Measu	NM	Expect	Measu	NM	
init		-120 dBm/Hz A	-120 dBm/Hz A	0			0			
pause 30 sec		-120 dBm/Hz A		0			0			X
1		-120 dBm/Hz A	REIN	0			7644			
3		-120 dBm/Hz A	REIN	0			3900			
4		-120 dBm/Hz A	REIN	0			1900			
5		-120 dBm/Hz A	REIN	0			600			

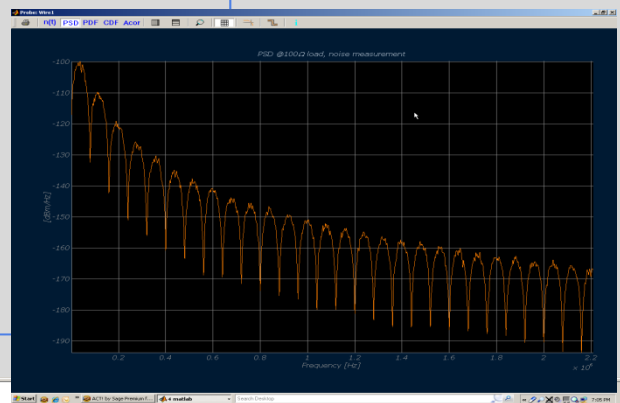
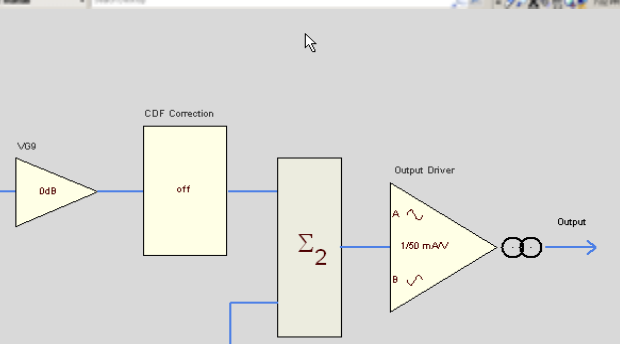
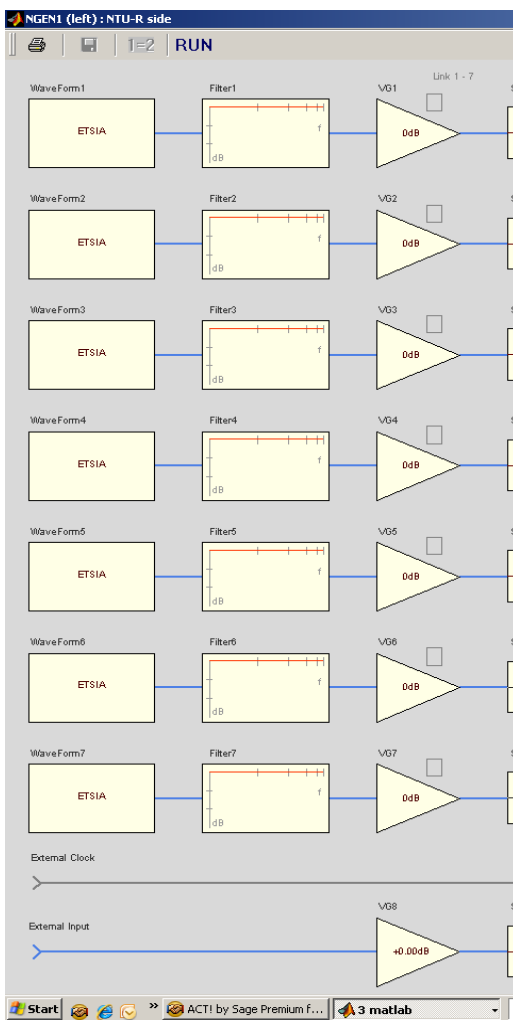
All what can be pre-processed digitally ... is processed digitally



NCS – NBS – NIS – NCT are tools to model noise and noise scenario's that are pre-processed in software before sending it to the analog part of the Noise Generator. It saves hardware (noise channels) without compromising the flexibility of generating complex dynamic noise scripts. Different FPGA's generate precisely all PSD/Noise Events in frequency and time domain upfront A/D conversion with outstanding accuracy.



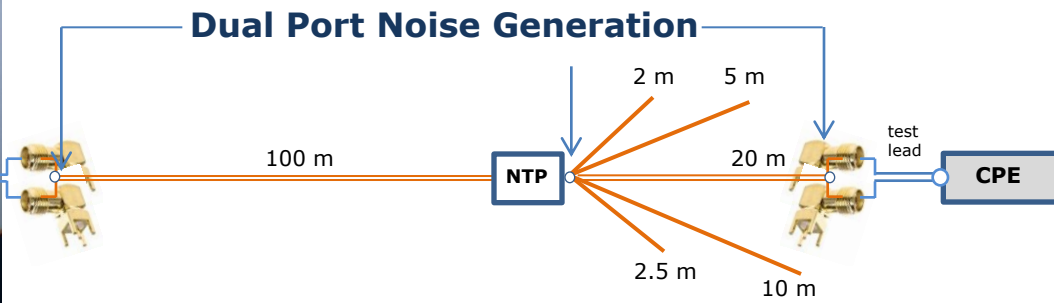
Line modeling automatically adjust noise levels at electrical length of requested test point according the corresponding line transfer parameters.



All what can be pre-programmed is pre-programmed.



Example for G.fast ID-337 Interoperability test plan



Short disconnect Test	✓
Long disconnect Test with LOS failure	✓
Long disconnect Test with LOR failure	✓
Dying gasp Test	✓
SHINE stability Test	✓
REIN stability Test	✓
Fluctuating RFI Noise Present at Initialization Test	✓
Stationary RFI Noise Present at Initialization	✓
Fluctuating RFI Noise Present at Showtime	✓
Stationary RFI Noise Present at Showtime	✓
Single-line Basic Throughput Test	✓

Inventory data Test	✓
TDD Inter-frame Gap Test	✓
DS and US ratio configuration (Mds) Test	✓
Accelerated MTBE Test	✓
Discontinuous operation Test	✓
Bit swap Test	✓
SRA Downshift Test	✓
SRA Upshift Test	✓
FRA & SRA Upshift Test	✓
RPA Test	✓
RMC bit loading configuration Test	✓

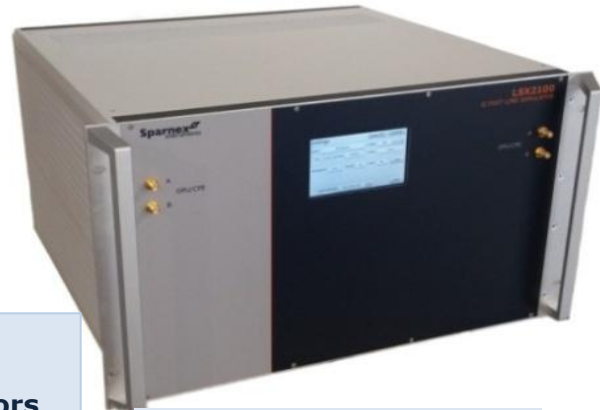
One platform ... many different technologies under test

Example for TR-100 Test Result Report – part of RPG

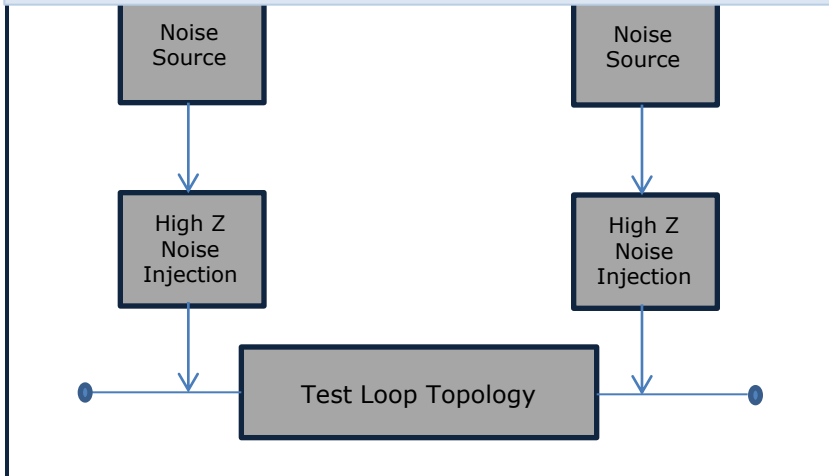
Table A.2-19/TR-100: White Noise Impairment testprofile A2P_RA_F_30000k							
A2_19	ds_speed	ds_snr	us_speed	us_snr	Expected us_speed	Expected ds_speed	[OK/Fail]
A2_19(250)	25023	12.4	1143	10.8	1048	23800	OK
A2_19(1250)	22736	10	1133	11.2	1048	22048	OK
A2_19(1750)	17921	10.3	1155	10.9	1048	17340	OK
A2_19(2500)	11055	10.1	1089	10.1	1048	10432	OK
A2_19(3250)					1004	6100	Fail

LSX 2201 - One single solution for all tests -

ID-337 Interop & WT-380 Performance G.fast Test Recommendation



The test set-up requires 2 type of equipments:
 ➤ the line/loop simulator
 ➤ the noise generator and noise injectors



LSX 2201 combines Noise Generator and Loop Simulator in 1 test set-up

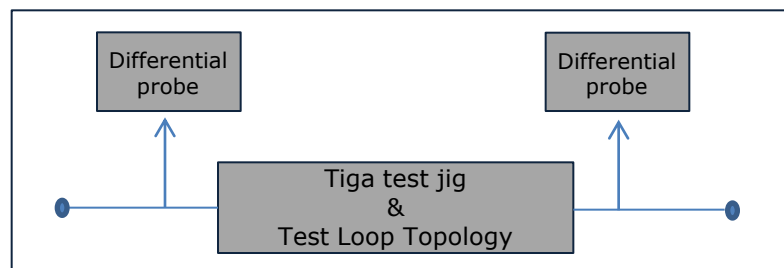
LSX 2201 allows for automated 337 tests

Test Results based on LSX 2201 are repeatable comparable & consistent at each 5 m step-size

No 'performance numbers' discussion

PSD Limit Mask Test	✓
Sub-carrier Masking Test	✓
PSD Shaping Test	✓
RFI Notching Test	✓
UPBO Test	✓
TIGA Test	✓

PSD tests



Interoperability tests

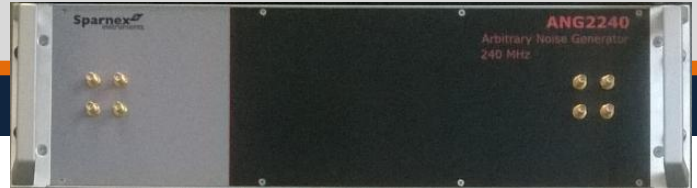
Functional tests

Performance tests

Operator specific tests

ANG 2240

DUT to ANG



- Available for 35 MHz - 120 MHz - 240 MHz (16 bits – 1,25 GSPS)
- Expansion of Line Simulators
 - LSX 2030 V~35 MHz: ADSL, ADSL2plus, SHDSL, VDSL, (EUR, US, Japan)
 - LSX 2200 G.fast Single pair simulator ~ 212 MHz
 - LSX 2208 G.fast 8 pair NEXT/FEXT Generator 212 MHz
- Database of noises like for TR100-114 i1/2/3, ATP-337, TR-249, WT-380
- Compatible with ENI (Noise Injection from DC up to 212 MHz)
- Transparent for RPF (Reverse Power Feeding ETSI 102 629 / TS 101 548)
- Multiple internal clocks derived from master clock
- 2 External Noise Sync Clock inputs (AMI) – optional
- Symmetric and A-symmetric, dynamic and static noise generation
- NBS Noise Browser Software (libraries per Standard Recommendations)
- NCS Noise Creation Software: 7 independent programmable noise sources
 - Sampling rate configurable # sampling 240K, 480K, 960K, 1.92M, 3.84M
 - Configurable Crest factor with CDF correction
 - Variable gain per noise source in steps of 0.01 dB
 - Programmable NEXT/FEXT/USER and line type/length attenuation filters
 - Library of WGN noise, colored AWG noise, RFI noise, PSTN & RPF noise
 - Noise source mixing/adding function
 - Programmable consecutive and repetitive Impulse Noise Interference
 - Programmable REIN, SHINE, PEIN, RFI notches
- Programmable Micro-Interrupts in ms, interval time, total test time
- NIS Noise Import Software/time & frequency domain Matlab csv, Json, ..
- PDS Pre-defined Noise Scripts according to Standards (libraries)
- Compatible with RPG Report Generator
- Compatible with CNi integrated GUI (control all elements of test bench)
- Set of ICL commands for each test equipment (Telnet sessions)
- 10/100 base-T CLI interface ICL controlled for remote/automated testing

Output ports ANG:	Dual output port (Left/Right)
Output signal ANG:	4 dBm @ 50 Ohm (8 dBm with balun 100 Ohm noise injection)
Electrical:	110/220 VAC ~ 50/60 Hz protected 250 VDC / 60 mA
Connectors:	Ethernet 10/100 base-T CLI – ICL controlled 2 x SMA to LSX Line Simulators / ENI Noise injector Mains connector (fused)
Mechanical:	19" subrack 3 U (HE) ENI noise injector built-in
Weight:	7.5 kg
Ordering number:	95.21.2035 (35 MHz) .2120 (120 MHz) .2240 (240 MHz)
Service contracts:	Extended Warranty – Service support– Service 24/7 – Calibration – Software Upgrade Service

ANG 2240 - E

DUT to LSX



- Available for 35 MHz - 120 MHz - 240 MHz (16 bits – 1,25 GSPS)
- Expansion of Line Simulators
 - LSX 2030 V~35 MHz: ADSL, ADSL2plus, SHDSL, VDSL, (EUR, US, Japan)
 - LSX 2200 G.fast Single pair simulator ~ 212 MHz
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- Database of noises like for TR100-114 i1/2/3, ATP-337, TR-249, WT-380
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- Multiple internal clocks derived from master clock
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- Symmetric and A-symmetric, dynamic and static noise generation
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- 10/100 base-T CLI interface ICL controlled for remote/automated testing

Output ports ANG:
Output signal ANG:
Electrical:

Dual output port (Left/Right)

4 dBm @ 50 Ohm

**110/220 VAC ~ 50/60 Hz
protected 250 VDC / 60 mA**

Connectors:

Ethernet 10/100 base-T CLI

**2 x 2 SMA (2 AB-ports) to DUT + 2 x 2 SMA to LSX LineSim
Mains connector (fused)**

Mechanical:

19" subrack 3 U (HE)

Weight:

6,9 kg

Ordering number

95.20.2035 (35 MHz) .2120 (120 MHz) .2240 (240 MHz)

Service contracts:

**Extended Warranty – Service support– Service 24/7 -
Calibration – Software Upgrade Service**

Ordering information

Noise Generator - 2 ports



Dual output port ANG 2030 ~ ANG 2120 ~ ANG 2240

- 95.21.2035 (ANG 2030 / 15 kHz ~ 35 MHz)
- 95.21.2120 (ANG 2120 / 1 MHz ~ 120 MHz)
- 95.21.2240 (ANG 2240 / 1 MHz ~ 240 MHz)
- 95.00.9015 controller
- 96.00.0011 ICL Server ICL control with 10/100base-T
- 96.21.0101 CNI – GUI Graphical Interface
- 96.21.0201 NBS Noise Browser
- 96.21.0305 NCS 3.39 Noise Creation Software
- 96.21.0311 NIS Noise Import Software
- 96.21.0321 NCT Noise Configurator Tool – part of NCS
- 96.21.0401 NAS Noise Allocation Software
- 96.21.0801 TRG Test Report Generator
- 96.21.0701 TSP Test Scenario Programmer
- 96.21.0601 NE Noise Events (impulse noise, RFI, ..)

➤ PDS Predefined Scripts ~ automated acc. Standard

- ❖ 98.21.0001/2/3 Y Extended Warranty
- ❖ 98.21.1000 Service support
- ❖ 98.21.5xxx Country Service 24/7
- ❖ 98.21.3001/2/3 Y Calibration
- ❖ 99.21.4001 Software Upgrade Service



Order nr	Library	America	Europe	Japan	PDS
96.21.1101	TR-60 S(H)DSL	X	X		96.29.1101
96.21.1211	TR-100 issue 1 ADSL/ADSL2plus annex a	X			96.29.1211
96.21.1212	TR-100 issue 1 ADSL/ADSL2plus annex b		X		96.29.1212
96.21.1221	TR-100 issue 2 ADSL/ADSL2plus annex a	X			96.29.1221
96.21.1222	TR-100 issue 2 ADSL/ADSL2plus annex b		X		96.29.1222
96.21.1231	TR-100 issue 3 ADSL/ADSL2plus annex a	X			96.29.1231
96.21.1232	TR-100 issue 3 ADSL/ADSL2plus annex b		X		96.29.1232
96.21.1311	TR-114 issue 1 VDSL2 annex a	X			96.29.1311
96.21.1312	TR-114 issue 1 VDSL2 annex b		X		96.29.1312
96.21.1313	TR-114 issue 1 VDSL2 annex j			X	96.29.1313
96.21.1321	TR-114 issue 2 VDSL2 annex a	X			96.29.1321
96.21.1322	TR-114 issue 2 VDSL2 annex b		X		96.29.1322
96.21.1323	TR-114 issue 2 VDSL2 annex j			X	96.29.1323
96.21.1331	TR-114 issue 3 VDSL2 annex a	X			96.29.1331
96.21.1332	TR-114 issue 3 VDSL2 annex b		X		96.29.1332
96.21.1333	TR-114 issue 3 VDSL2 annex j			X	96.29.1333
96.21.1410	TR-249 Vectoring VDSL2	X	X	X	96.29.1410
96.21.1510	BBF-337 G.fast Interoperability (v1 15.06/2016 ref. 6.1/6.3-6.13/7.1-7.6)				96.29.1510
96.21.1610	BBF-380 G.fast Performance	X	X	X	96.29.1610
96.21.1710	TR-208i1 PLC / G.hn	X	X		96.29.1710