DN2.63x - 16 bit 10 GS/s Ethernet Arbitrary Waveform Generator

- **Fast 16 bit arbitrary waveform generator**
- **Up to 10 GS/s on one or 5 GS/s on two channels**
- **Output signal bandwidth up to 3.9 GHz**
- **Differential or single-ended output**
- **Single-ended output 1 Vpp/4 dBm into 50 Ω (2 Vpp into high impedance)**
- **Differential output level 2 Vpp/7 dBm into 100 Ω (4 Vpp into high impedance)**
- **Fixed trigger to output delay**
- **2 GiSample (8 GiSample as option) on-board memory**
- **Modes: Single-Shot, Repeated, Loop, FIFO, Multiple Replay**
- **Complete on-board calibration**

Multi-Tone DDS Option

The DDS firmware option adds a new output mode with 64 individually programmable DDS cores per card or internal module. Each core can be programmed for frequency, amplitude and phase. DDS commands can be issued with 3.2 ns spacing. Advanced commands like frequency slope, amplitude slope or digital outputs can be programmed. A programmable timer as well as external trigger can be used to advance DDS-commands.

- Ethernet Remote Instrument
- LXI Core 2011 compatible
- GBit Ethernet Interface
- Sustained streaming mode up to 100 MB/s
- Direct Connection to PC/Laptop
- Connect anywhere in company LAN
- Embedded Webserver for Maintenance/Updates
- Embedded Server option for open Linux platform

Operating Systems	**SBench 6 Professional Included**	**Drivers**
• Windows 7 (SP1), 8, 10, 11 Server 2008 R2 and newer • Linux 2.6 and newer • Windows/Linux 32 and 64 bit	• Acquisition, Generation and Display of analog and digital data • Calculation, FFT • Documentation and Import, Export	• LabVIEW, MATLAB • Python, C/C++, C#, Java, Julia • IVI

Model	Bandwidth	1 channel	2 channels
DN2.636-02	3.9 GHz	10 GS/s	5.0 GS/s
DN2.636-01	3.9 GHz	10 GS/s	
DN2.635-02	2.5 GHz	10 GS/s	5.0 GS/s
DN2.635-01	2.5 GHz	10 GS/s	
DN2.632-02	1.4 GHz	3.2 GS/s	3.2 GS/s
DN2.632-01	1.4 GHz	3.2 GS/s	

General Information

The 63xx series arbitrary waveform generators deliver the highest performance in both speed and resolution.The 63xx products offer best AWG performance for multiple channels and signal frequencies up to 3.9 GHz with a high output level of up 1 Vpp single-ended into 50 Ohm or 2 Vpp differential into 100 Ohm.

The generatorNETBOX can be installed anywhere in the company LAN and can be remotely controlled from a host PC. The DN2.63x series is based on the common API from Spectrum and uses the same software interface like all Spectrum products released since 2005.

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Software Support

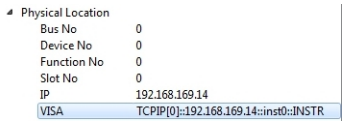
Windows Support

The digitizerNETBOX/generatorNETBOX/hybridNETBOX can be accessed from Windows 7, Windows 8, Windows 10, Windows 11 (either 32 bit or 64 bit). Programming examples for Visual C++, C++ Builder, LabWindows/CVI, Delphi, Visual Basic, VB.NET, C#, Julia, Python, Java and IVI are included.

Linux Support

The digitizerNETBOX/generatorNETBOX/hybridNETBOX can be accessed from any Linux system. The Linux support includes SMP systems, 32 bit and 64 bit systems, versatile programming examples for Gnu C++, Python, Julia as well as drivers for MATLAB for Linux. SBench 6, the powerful data acquisition and analysis software from Spectrum is also included as a Linux version.

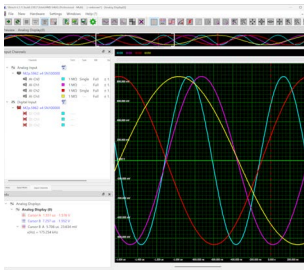
Discovery Protocol



The Discovery function helps you to find and identify any Spectrum LXI instruments, like the digitizerNETBOX and generatorNETBOX, available to your computer on the network. The Discovery function will also locate any Spectrum card products that are managed by an installed Spectrum Remote Server somewhere on the network.

After running the discovery function the card information is cached and can be directly accessed by SBench 6. Furthermore the qualified VISA address is returned and can be used by any software to access the remote instrument.

SBench 6 Professional



The digitizerNETBOX, generatorNETBOX and hybridNETBOX can be used with Spectrum's powerful software SBench 6 – a Professional license for the software is already installed in the box. SBench 6 supports all of the standard features of the instrument. It has a variety of display windows as well as analysis, export and documentation functions.

- Available for Windows 7 and newer and Linux Kernel 2.6 and newer
- Easy to use interface with drag and drop, docking windows and context menus
- Display of analog and digital data, X-Y display, frequency domain and spread signals
- Designed to handle several GBytes of data
- Fast data preview functions

IVI Driver

The IVI standards define an open driver architecture, a set of instrument classes, and shared software components. Together these provide critical elements needed for instrument interchangeability. IVI's defined Application Programming Interfaces (APIs) standardize common measurement functions reducing the time needed to learn a new IVI instrument.

The Spectrum products to be accessed with the IVI driver can be locally installed data acquisition cards, remotely installed data acquisition cards or remote LXI instruments like digitizerNETBOX/generatorNETBOX. To maximize the compatibility with existing IVI based software installations, the Spectrum IVI driver supports IVI Scope, IVI Digitizer and IVI FGen class with IVI-C and IVI-COM interfaces.

Third-party Software Products

Most popular third-party software products, such as LabVIEW, MATLAB or LabWindows/CVI are supported. All drivers come with examples and detailed documentation.

Embedded Webserver

The integrated webserver follows the LXI standard and gathers information on the product, set up of the Ethernet configuration and current status. It also allows the setting of a configuration password, access to documentation and updating of the complete instrument firmware, including the embedded remote server and the webserver.

NETBOX hardware features and options

LXI Instrument

The digitizerNETBOX and generatorNETBOX are fully LXI instrument compatible to LXI Core 2011 following the LXI Device Specification 2011 rev. 1.4. The digitizerNETBOX/generatorNETBOX has been tested and approved by the LXI Consortium.

Located on the front panel is the main on/off switch, LEDs showing the LXI and Acquisition status and the LAN reset switch.

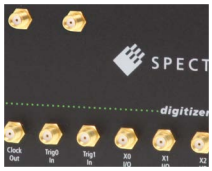
Chassis features

The chassis is especially designd for usage in different application arreas and has some advanced features for mobile and shared usage:

- stable metal chassis
- 8 bumper edges protect the chassis, the desk and other components on it. The bumper edges allow to store the chassis either vertically or horizontally and the lock-in structure allows to stack multiple chassis with a secure fit onto each other. For 19" rack mount montage the bumpers can be unmounted and replaced by the 19" rack mount option
- The handle allows to easily carry the chassis around in juts one hand.
- A standard GND screw on the back of the chassis allows to connect the metal chassis to measurement ground to reduce noise

based on ground loops and ground level differences.

Front Panel



Standard SMA connectors are used for all analog input signals and all trigger and clock signals. No special adapter cables are needed and the connection is secure even when used in a moving environment.

Custom front panels are available on request even for small series, be it BNC, LEMO connectors or custom specific connectors.

Ethernet Connectivity

The GBit Ethernet connection can be used with standard COTS Ethernet cabling. The integration into a standard LAN allows to connect the digitizerNETBOX/generatorNETBOX either directly to a desktop PC or Laptop or it is possible to place the instrument somewhere in the company LAN and access it from any desktop over the LAN.

DC Power Supply Option

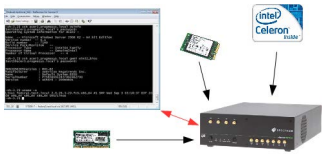
The digitizerNETBOX/generatorNETBOX/hybridNETBOX can be equipped with an internal DC power supply which replaces the standard AC power supply. This power supply options is available with an input range of nominal 24 V. Contact the sales team if other DC levels are required.

Using the DC power supply the device can be used for mobile applications together with a Laptop in automotive or airborne applications.

Boot on Power Option

The digitizerNETBOX/generatorNETBOX can be factory configured to automatically start and boot upon availability of the input power rail. That way the instrument will automatically become available again upon loss of input power.

Option Embedded Server



The option turns the digitizerNETBOX/generatorNETBOX in a powerful PC that allows to run own programs on a small and remote data acquisition system. The digitizerNETBOX/generatorNETBOX is enhanced by more memory, a powerful CPU, a freely accessable internal SSD and a remote software development access method.

The digitizerNETBOX/generatorNETBOX can either run connected to LAN or it can run totally independent, storing data to the internal SSD. The original digitizerNETBOX/generatorNETBOX remote instrument functionality is still 100 % available. Running the embedded server option it is possible to pre-calculate results based on the acquired data, store acquisitions locally and to transfer just the required data or results parts in a client-server based software structure. A different example for the digitizerNETBOX/generatorNETBOX embedded server is surveillance/logger application which can run totally independent for days and send notification emails only over LAN or offloads stored data as soon as it's connected again.

Access to the embedded server is done through a standard text based Linux shell based on the ssh secure shell.

AWG hardware features and options

Calibration on-board/factory/ISO/IEC 17025

All of the channels are calibrated in factory before the board is shipped. To compensate for different variations like PC power supply, temperature and aging, the software driver provides routines for an automatic on-board offset and gain calibration of output gain and offset. All the cards contain a high precision on-board calibration reference. As an option a ISO/IEC17025-compliant certificate is available with new cards and after recalibration.

Singleshot output

When singleshot output is activated the data of the on-board memory is played exactly one time. The trigger source can be either one of the external trigger inputs or the software trigger. After the first trigger additional trigger events will be ignored.

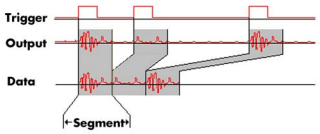
Repeated output

When the repeated output mode is used the data of the on-board memory is played continuously for a programmed number of times or until a stop command is executed. The trigger source can be either one of the external trigger inputs or the software trigger. After the first trigger additional trigger events will be ignored.

Single Restart replay

When this mode is activated the data of the on-board memory will be replayed once after each trigger event. The trigger source can be either the external trigger or software trigger.

Multiple Replay



The Multiple Replay mode allows the fast output generation on several trigger events without restarting the hardware. With this option very fast repetition rates can be achieved. The on-board memory is divided into several segments of the same size. Each segment can contain different data which will then be played with the occurrence of each trigger event.

FIFO mode

The FIFO mode is designed for continuous data transfer between remote instrument and PC memory or hard disk. The control of the data stream is done automatically by the driver on interrupt request. The complete installed on-board memory is used for buffer data, making the continuous streaming extremely reliable.

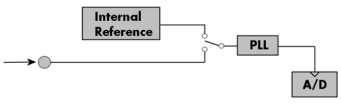
External trigger input

All boards can be triggered using an external analog or digital signal. The external trigger input has one comparator that can be used for standard edge and level triggers.

External clock input and output

Using a dedicated connector a sampling clock can be fed in from an external system. Additionally it's also possible to output the internally used sampling clock on a separate connector to synchronize external equipment to this clock.

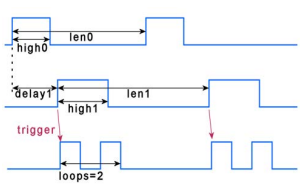
Reference clock



The option to use a precise external reference clock (normally 10 MHz) is necessary to synchronize the instrument for high-quality measurements with external equipment (like a signal source). It's

also possible to enhance the quality of the sampling clock in this way. The driver automatically generates the requested sampling clock from the fed in reference clock.

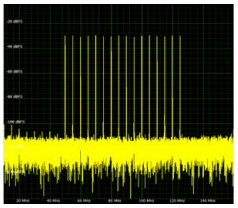
Firmware Option Digital Pulse Generator



The digital pulse generator option adds 4 internal independent digital pulse generators with programmable duty cycle, output frequency, delay and number of loops. These digital pulse generators can be triggered by software, hardware trigger or can trigger each other allowing to form complex pulse schemes to drive external equipment or experiments. The digital pulse generators can be output on the existing multi-XIO lines (X0, X1, ...) or can be used to trigger other pulse generators internally. Time resolution of the pulse generator depends on the cards type and the selected sampling rate and can be found in the technical data section.

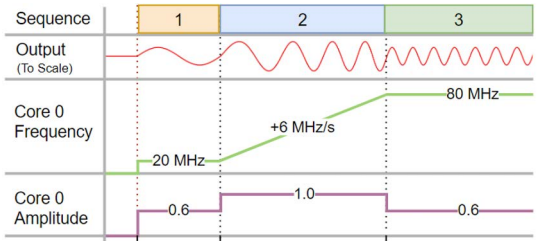
The pulse generator option is a firmware option and can be later installed on all shipped cards.

Firmware Option Multi-Tone DDS



DDS - Direct Digital Synthesis - is a method for generating arbitrary periodic waveforms from a single, fixed-frequency reference clock and is widely used in signal generation applications. The DDS functionality implemented on Spectrum Instrumentation's AWGs is based on the principle of adding multiple "DDS cores" to generate a multi-carrier (multi-tone) signal, with each carrier having its own well-defined frequency, amplitude and phase. The right-hand frequency plot shows 16 tones. In addition to these static parameters, there are also built in dynamic parameters like frequency and amplitude slope to allow for intrinsic linear changes for multiple cores.

Below, the example sequence of three commands for a single core, shows a fixed 20 MHz frequency with 60% amplitude in step 1, a 10 seconds frequency ramp with 6 MHz/s slope and full 100% amplitude in step 2 and finally, in step 3, a fixed 80 MHz frequency with 50% amplitude. Each step consists of only 3 to 4 single line commands to set the mode, frequency, amplitude and timing.



Each of the cores can either be added together and output, or specific groups of cores can be added together and output on a specific hardware output channel. A fast DMA mode allows the use of individual DDS command sequences for programming more advanced frequency changes, like shaped slopes or modulated sine signals.

The DDS option is a firmware option that can be field installed on all shipped cards and generatorNETBOX products. Each single internal AWG card of the generatorNETBOX can get this option with the full set of DDS cores for each AWG card.

DDS Control

DDS Control is a free to use software for operating the Direct Digital Synthesis (DDS) firmware option available for Spectrum's Arbitrary Waveform Generator and DDS product lines. It is a good starting tool to familiarize yourself with the Spectrum DDS functionality of your card. With DDS, the card can output a certain number of sine waves (carriers), that are generated with the firmware DDS cores. DDS control can program these DDS cores statically with DDS dialogs, or it allows the user to program full sequences (or patterns) of commands in an exact timed manner. It can setup the cards for specific core and hardware setups. The parameters lists can loop either infinitely long or a specific number of times. Saving and loading of setups and sequences is possible.

DN2 / DN6 Technical Data

Definitions

Specifications (spec)
Figures are valid for products stored for at least 2 hours inside the specified operating temperature range, after a 30 minute warm-up, after running an on-board calibration and with properly cooled products. Data published in this document are specifications (spec) only where specifically indicated. Figures marked with (spec) are calibrated to the specification during production and during factory calibrations.

Typical (typ)
Figures marked with (typ) are a characteristic performance that most of the manufactured instruments will meet due to design. Typical figures are measured during production but cannot be calibrated.

Measured (meas)
A figure measured during development to communicate expected performance. The figure is measured in lab environment with an environmental temperature between 20°C and 25°C and an altitude of less than 100 m.

Nominal (nom)
The value of this figure is determined by design and is not measured nor calibrated.

Analog Outputs

Resolution (nom)		16 bit	
D/A Interpolation		no interpolation	
Output Mode	software programmable	Single-Ended or Differential	
Output Enable/Disable (nom)	software programmable	Output disable cuts connection to DAC and terminates connector with 50 Ω to GND	
Single-Ended		**into 50 Ω**	**into high impedance**
Output amplitude (nom)	software programmable	±1 mV up to ±500 mV	±2 mV up to ±1 V
		Amplitude values below ±100 mV into 50 Ω (±200 mV into high impedance) are generated by reduction of digital samples.	
Stepsize of output amplitude (nom)		1 mV	2 mV
Output offset (nom)	software programmable	±500 mV	±1.0 V
Maximum output voltage, offset + amplitude (nom)		±750 mV	±1.5 V
Differential		**into 100 Ω**	**into high impedance**
Output amplitude, differential signals (nom)	software programmable	±2 mV up to ±1 V	±4 mV up to ±2 V
		Amplitude values below ±200 mV into 100 Ω (±400 mV into high impedance) are generated by reduction of digital samples.	
Stepsize of output amplitude (nom)		2 mV	4 mV
Common Mode Voltage (nom)	software programmable	±500 mV	±1.0 V
Max common mode + single-ended amp (nom)		±750 mV	±1.5 V
DAC Differential non linearity (nom)	DNL, DAC only	±2.2 LSB typical	
DAC Integral non linearity (nom)	INL, DAC only	±9 LSB typical	
Output resistance (nom)		50 Ω	
Output coupling (nom)		DC	
Minimum output load (nom)		0 Ω (short circuit safe)	
Output amplitude accuracy DC (spec)		±2 mV ±1% of programmed output amplitude	
Output offset accuracy DC (spec)		±2 mV ±1% of programmed offset	
Offset temperature drift (meas)	after warm-up and calibration	TBD	
Gain temperature drift (meas)	after warm-up and calibration	TBD	
Calibration	Internal	Self-calibration is done on software command and corrects against the on-board references. Self-calibration should be issued after warm-up time.	
Calibration	External	External calibration calibrates the on-board references used in self-calibration. All calibration constants are stored in non-volatile memory. Optional ISO/IEC17025-compliant certificate. A yearly external calibration is recommended.	

Trigger

Available trigger modes	software programmable	External, Software, Or/And, Delay	
Trigger edge	software programmable	Rising edge, falling edge or both edges	
Trigger delay	software programmable	0 up to (256 GiS - 32) in steps of 32	
Trigger holdoff (for Multi)	software programmable	0 up to (256 GiS - 32) in steps of 32	
Memory depth	software programmable	64 up to (Installed memory / channels) in steps of 64	
Multiple Recording segment size	software programmable	64 up to (Installed memory / channels) in steps of 64	
Internal/External trigger accuracy		1 sample	
Multiple Replay re-arming time (nom)	single card star-hub synchronized card	64 samples 800 samples	
Trigger to Output Delay (meas)	M5i.635x/636x (10 GS/s) M5i.633x (3.2 GS/s)	~470 ns ~710 ns	
External trigger		**Ext**	**X0, X1, X2, X3**
External trigger type		single level comparator	3.3V LVTTL logic inputs
External trigger impedance (typ)	software programmable	50 Ω or 3 kΩ	For electrical specifications refer to the „Multi Purpose I/O lines" section.
External trigger input level (nom)		±5 V	
External trigger over voltage protection (nom)	50 Ω termination	±20 V	
	3 kΩ termination	7 Vrms	
External trigger sensitivity, mini signal swing (nom)		200 mVpp	
External trigger level (nom)	software programmable	±5 V with a stepsize of 10 mV	

Trigger edge	software programmable	Rising edge, falling edge or both edges	
External trigger bandwidth (typ)	50 Ω	DC to 2 GHz	DC to 125 MHz
	3 kΩ	DC to 750 MHz	n.a.
	10 kΩ	n.a.	DC to 125 MHz
Minimum external trigger pulse width		≥ 2 samples	≥ 2 samples
Resulting max detectable trigger frequency		[Current Samplerate]/2	[Current Samplerate]/2

Clock

Clock Modes	software programmable	internal PLL, external reference clock, star-hub synchronization clock
Internal clock accuracy (spec)		≤ ±1 ppm
Clock setup range		base frequency or divided base frequency
Clock setup base frequencies	M5i.632x	3.2 GS/s
	M5i.635x	10 GS/s
	M5i.636x	10 GS/s
Clock setup divider		power of 2: 2, 4, 8, 16, 32, ... , 524288, 1048576
Clock setup examples	M5i.632x	3.2, 1.6 GS/s, 800, 400, 200, 100 MS/s, ..., 1.6 kS/s
	M5i.635x	10.0, 5.0, 2.5, 1.25 GS/s, 625, 312.5 MS/s, ..., 5 kS/s
	M5i.636x	10.0, 5.0, 2.5, 1.25 GS/s, 625, 312.5 MS/s, ..., 5 kS/s
External reference clock range (nom)	software programmable	≥ 2 MHz and ≤ 750 MHz in steps of 2 MHz
External reference clock input impedance (typ)		50 Ω fixed
External reference clock input coupling (nom)		AC coupling
External reference clock input edge		Rising edge
External reference clock input type		Single-ended, sine wave or square wave
External reference clock input swing (nom)	min max	200 mVpp 3 Vpp
External reference clock input max DC voltage (nom)		±10 V (with max 3.0 V difference between low and high level)
External reference clock input duty cycle (nom)		45 % to 55 %
Clock setup granularity when using reference clock		divider: maximum sampling rate divided by: TBD
Internal reference clock output type		Single-ended, AC-coupled, LVPECL, 720 mVpp (typ)
Internal reference clock output frequency		clock setup base frequency / 64 (example: clock 3.2 GS/s -> output 50.000 MHz)
Star-Hub synchronization clock modes	software programmable	Internal clock, External reference clock
Channel to channel skew on one card (meas)		TBD ns
Skew between star-hub synchronized cards (nom)	software programmable	skew adjustable up to ±127 ps

Multi Purpose I/O lines (front-plate)

Number of multi purpose lines		four, named X0, X1, X2, X3
Input: available signal types	software programmable	Logic Trigger, Asynchronous Digital-In, Synchronous Digital-In (Digitizer only), Timestamp Reference Clock (Digitizer only)
Input: impedance (nom)	software programmable	10 kΩ to 3.3 V or 50 Ω to GND
Input: maximum voltage level (nom)		-0.5 V to +4.0 V
Input: signal levels (nom)		3.3 V LVTTL (Low ≤ 0.8 V, High ≥ 2.0 V)
Input: bandwidth (typ)		125 MHz
Output: available signal types	software programmable	Asynchronous Digital-Out, Trigger Output, Run, Arm, System Clock, Synchronous Digital-Out (AWG only)
Output: impedance (nom)		50 Ω
Output: signal levels (nom)		3.3 V LVTTL
Output: type (nom)		3.3 V LVTTL, TTL compatible for high impedance loads
Output: drive strength (nom)		Capable of driving 50 Ω loads, maximum drive strength ±48 mA
Output: internal update rate	M5i.332x, M5i.333x, DNx.332-xx, DNx.333-xx	Current sampling clock ≤ 3.2 GS/s: 1/4 of sampling clock Current sampling clock > 3.2 GS/s: 1/8 of sampling clock
Output: internal update rate	M5i.335x, M5i.336x, DNx.335-xx	Current sampling clock ≤ 5.0 GS/s: 1/4 of sampling clock Current sampling clock > 5.0 GS/s: 1/8 of sampling clock
Output: internal update rate	M5i.63xx, DNx.63xx DNx.63x-xx	Current sampling clock ≤ 5.0 GS/s: 1/4 of sampling clock Current sampling clock > 5.0 GS/s: 1/8 of sampling clock
Output: min high/low time (nom)		4 ns
Output: max signal frequency (typ)		125 MHz

Option M5i.63xx-DDS64 (64 tone DDS firmware)

Number of available DDS cores per AWG card	635x, 636x	64 @ 2.5 GS/s 32 @ 5 GS/s 16 @ 10 GS/s		
	632x	64 @ 1.6 GS/s 32 @ 3.2 GS/s		
DDS core routing options	software programmable	Routed cores can be individually activated for output Ch0: 64 or 32 cores Ch1: 32 cores		
DDS commands	individual for each core	Frequency, Amplitude, Phase, Frequency Slope, Amplitude Slope		
DDS commands	for all cores	Reset, Execute Now, Execute at Trigger/Timer		
DDS command transfer mode		single or DMA		
DDS time resolution (nom)		10 GS/s (100 ps)		
DDS single command time resolution (nom)	635x, 636x 632x	3.2 ns 5 ns		
DDS timer resolution (nom)	software programmable	Minimum	Maximum	Step
	635x, 636x	38.4 ns	450360 s > 5 d 3.2 ns × (2^{47}-1)	3.2 ns
	632x	60 ns	703687 s > 8 d 5 ns × (2^{47}-1)	5 ns
DDS frequency range (nom)	per core programmable	min: 0 Hz, max: [Current Samplerate], step: [Current Samplerate]/2^{32}		
DDS amplitude range (nom)	per core programmable	min: -1.0, max: +1.0, step: 0.0000305 (1/(2^{15}-1))		
DDS phase range (nom)	per core programmable	min: 0°, max: 359.912°, step: 0.08789° (360°/2^{12})		
DDS command buffer	single mode DMA mode	4Ki commands 512Mi commands in on-board RAM. More commands can reside in DMA buffer in PC-RAM. 2Gi commands with memory option.		
Min user software to analog output latency (meas)	single mode DMA mode	4 µs 26 µs		
Max continuous DDS command rate (meas)	single mode DMA mode	TBD 3.3 MCommands/s		

External trigger to DDS output change (meas)	635x, 636x 632x	approx. 735 ns approx. 1060 ns
Maximum external re-trigger rate (meas)	635x, 636x 632x	35.2 ns 55 ns
Number of DDS options per generatorNETBOX		Each generatorNETBOX DN6.63x contains multiple AWGs with either one or two channels. The user can individually decide how many of these internal AWGs should be equipped with the DDS option. Each single internal AWG needs a separate license.

Option M5i.xxxx-PulseGen

Number of internal pulse generators	4
Number of pulse generator output lines	4 (Existing multi-purpose outputs X0 to X3)
Time resolution of pulse generator	Pulse generator's sampling rate is derived from instrument's sampling rate and value can be read out. Pulse generator update rate are: 33xx: Base Sampling Rate x Channels / 32 (max 10 GS/s x 1 ch / 32) = 312.5 MS/s (3.2 ns) 63xx: Sampling Rate x Channels / 32 (max 10 GS/s x 1 ch / 32) = 312.5 MS/s (3.2 ns)
Programmable output modes	Single-shot, multiple repetitions on trigger, gated
Programmable trigger sources	Software, Card Trigger, Other Pulse Generator, XIO lines.
Programmable trigger gate	None, ARM state, RUN state
Programmable length (frequency)	2 to 4Gi samples in steps of 1 (32 bit)
Programmable width (duty cycle)	1 to 4Gi samples in steps of 1 (32 bit)
Programmable delay	0 to 4Gi samples in steps of 1 (32 bit)
Programmable loops	0 to 4Gi samples in steps of 1 (32 bit) with 0 = infinite loops
Output level of digital pulse generators	Please see section of multi-purpose I/O lines.

Bandwidth, Flatness and Slewrate

	Output Mode	Single-Ended Amplitude	Differential Amplitude	M5i.636x DNx.636-xx	M5i.635x DNx.635-xx	M5i.632x DNx.632-xx
Maximum Output Rate				10 GS/s	10 GS/s	3.2 GS/s
-3dB Bandwidth (typ)		±250 mV	±500 mV	3.9 GHz	2.5 GHz	1.4 GHz
-3dB Bandwidth (typ)		±500 mV	±1 V	2.9 GHz	2.5 GHz	1.4 GHz
Amplitude Flatness 0.5 dB (typ)				DC to 2.0 GHz	DC to 2.0 GHz	DC to 1.2 GHz
Slew rate (meas)	Single-Ended			4.1 V/ns	3.5 V/ns	2.3 V/ns
Slew rate (meas)	Differential			8.2 V/ns	7.0 V/ns	4.6 V/ns
Rise/Fall time 20% to 80% (meas) (step response)				150 ps	170 ps	260 ps
Rise/Fall time 10% to 90% (meas) (step response)				200 ps	245 ps	380 ps

Dynamic Parameters

Noise		Single-Ended Output		Differential Output	
Output Level in 50 Ω / 100 Ω		±250 mV	±500 mV	±500 mV	±1000 mV
NSD (typ)		-151 dBm/Hz		-157 dBm/Hz	
SNR (typ)	636x	53.1 dBc	59.1 dBc	65.1 dBc	71.1 dBc
	635x	56.0 dBc	61.0 dBc	67.0 dBc	73.0 dBc
	632x	58.5 dBc	64.5 dBc	69.5 dBc	75.5 dBc
SFDR excl. Harmonics (typ)		-90.0 dBc		-90.0 dBc	
ENOB based on SNR (typ)	636x	8.5 bit	9.5 bit	10.5 bit	11.5 bit
	635x	8.8 bit	9.8 bit	10.8 bit	11.8 bit
	632x	9.4 bit	10.4 bit	11.3 bit	12.3 bit

Harmonics	Single-Ended Output											
Output Frequency	20 MHz		100 MHz		500 MHz		1000 MHz		1500 MHz		2000 MHz	
Output Level into 50 Ω	±250 mV	±500 mV	±250 mV	±500 mV	±250 mV	±500 mV	±250 mV	±500 mV	±250 mV	±500 mV	±250 mV	±500 mV
THD (typ)	-64.4 dB	-58.7 dB	-60.6 dB	-54.2 dB	-46.8 dB	-40.8 dB	-38.8 dB	-31.9 dB	-36.9 dB	-26.1 dB	-31.8 dB	-21.7 dB
HD2 (typ)	-66.5 dB	-59.0 dB	-60.6 dBc	-54.5 dBc	-46.8 dBc	-41.1 dBc	-38.8 dBc	-32 dBc	-37.7 dBc	-27.8 dBc	-32.2 dBc	-24.6 dBc
HD3 (typ)	-79.4 dB	-75.1 dB	-79.5 dBc	-68.5 dBc	-67.9 dBc	-55.7 dBc	-62.9 dBc	-49.1 dBc	-44.4 dBc	-31.1 dBc	-42.7 dBc	-24.6 dBc
HD4 (typ)	-95.0 dB	-92.0 dB	-90.5 dBc	-81.8 dBc	-90.0 dBc	-63.7 dBc	-98 dBc	-50.4 dBc	-78 dBc	-46.1 dBc	-	-
	Differential Output											
Output Level into 100 Ω			±500 mV	±1 V	±500 mV	±1 V	±500 mV	±1 V	±500 mV	±1 V	±500 mV	±1 V
THD (typ)			-76 dB	-67.5 dB	-66.6 dB	-53.3 dB	-60.2 dB	-48.3 dB	-46.2 dB	-33.1 dB	-42.1 dB	-27.6 dB
HD2 (typ)			-77.4 dBc	-76.7 dBc	-82 dBc	-93 dBc	-63.9 dBc	-56.8 dBc	-73.2 dBc	-52.7 dBc	-45.6 dBc	-41.1 dBc
HD3 (typ)			-82 dBc	-68.2 dBc	-66.8 dBc	-53.2 dBc	-64.1 dBc	-49.3 dBc	-46.2 dBc	-33.1 dBc	-44.8 dBc	-27.8 dBc
HD4 (typ)			-94 dBc	-100 dBc	-95 dBc	-93 dBc	-68.7 dBc	-68.9 dBc	-93 dBc	-70.1 dBc	-	-

Intermodulation Distortion	Single-Ended Output or Differential Output					
Output Frequency	500 MHz ±0.5 MHz		1 GHz ±1.0 MHz		1.5 GHz ±5.0 MHz	
Output Level in 50 Ω	±250 mV	±500 mV	±250 mV	±500 mV	±250 mV	±500 mV
IMD3 (typ)	-76.0 dBc	-66.5 dBc	-67.4 dBc	-53.8 dBc	-55.4 dBc	-39.4 dBc

Phase Noise and Jitter	Single-Ended Output or Differential Output				
Output Frequency	20 MHz	125 MHz	500 MHz	1 GHz	1.5 GHz
Output Level in 50 Ω	±500 mV	±500 mV	±500 mV	±500 mV	±500 mV
Offset 10 Hz (typ)	-95 dBc/Hz	-79 dBc/Hz	-67 dBc/Hz	-61 dBc/Hz	-57 dBc/Hz
Offset 100 Hz (typ)	-117 dBc/Hz	-104 dBc/Hz	-94 dBc/Hz	-85 dBc/Hz	-81 dBc/Hz
Offset 1 kHz (typ)	-128 dBc/Hz	-113 dBc/Hz	-101 dBc/Hz	-96 dBc/Hz	-91 dBc/Hz
Offset 10 kHz (typ)	-148 dBc/Hz	-128 dBc/Hz	-116 dBc/Hz	-110 dBc/Hz	-107 dBc/Hz
Offset 100 kHz (typ)	-155 dBc/Hz	-144 dBc/Hz	-133 dBc/Hz	-127 dBc/Hz	-124 dBc/Hz
Offset 1 MHz (typ)	-156 dBc/Hz	-153 dBc/Hz	-146 dBc/Hz	-140 dBc/Hz	-137 dBc/Hz
Offset 10 MHz (typ)	-156 dBc/Hz	-154 dBc/Hz	-154 dBc/Hz	-155 dBc/Hz	-153 dBc/Hz
Offset 40 MHz (typ)	-156 dBc/Hz	-154 dBc/Hz	-154 dBc/Hz	-155 dBc/Hz	-153 dBc/Hz
Jitter - Integration range 1 kHz - 10 MHz (typ)	200 fs	200 fs	180 fs	180 fs	170 fs

All the dynamic parameter measurements were done at maximum output rate, i.e. 10 GS/s (for the 636x and 635x family) and 3.2 GS/s (for the 632x family).
THD, SFDR and NSD are measured at the given output level and 50 Ohm termination, differential outputs are measured with a Balun. Calculations are done with built-in calculations from an Siglent SVA1032X Spectrum Analyzer. All available D/A channels are activated for the tests. SNR and SFDR figures may differ depending on the quality of the used PC. NSD = Noise Spectral Density, THD = Total Harmonic Distortion, SFDR = Spurious Free Dynamic Range. Phase Noise and Jitter is measured with a Holzworth HA7062C Phase Noise Analyzer using a measuring range from 10 Hz to 40 MHz and an integration range for the jitter measurement of 1 kHz to 10 MHz.

Connectors

Analog Inputs (one for each single-ended input)	33x		SMA female	Cable-Type: Cab-3mA-xx-xx
Analog Outputs (two for each differential output)		63x	SMA female	Cable-Type: Cab-3mA-xx-xx
Clock Input	33x	63x	SMA female	Cable-Type: Cab-3mA-xx-xx
Clock Output	33x	63x	SMA female	Cable-Type: Cab-3mA-xx-xx
Trg0 Input	33x	63x	SMA female	Cable-Type: Cab-3mA-xx-xx
X0	33x	63x	SMA female	Cable-Type: Cab-3mA-xx-xx
X1	33x	63x	SMA female	Cable-Type: Cab-3mA-xx-xx
X2	33x	63x	SMA female	Cable-Type: Cab-3mA-xx-xx
X3	33x	63x	SMA female	Cable-Type: Cab-3mA-xx-xx

Connection Cycles

All connectors have an expected lifetime as specified below. Please avoid to exceed the specified connection cycles or use connector savers

SMA connector	500 connection cycles
Power connecctor	500 connection cycles
LAN connector	500 connection cycles

Option digitizerNETBOX/generatorNETBOX embedded server (DN2.xxx-Emb, DN6.xxx-Emb)

CPU	Intel Quad Core 2 GHz	
System memory	4 GiByte RAM	
System data storage	Internal 128 GByte SSD	
Development access	Remote Linux command shell (ssh), no graphical interface (GUI) available	
Accessible Hardware	Full access to Spectrum instruments, LAN, front panel LEDs, RAM, SSD	
Integrated operating system	OpenSuse 12.2 with kernel 4.4.7.	
Internal PCIe connection (PCIe bus connection is shared amongst all internal digitizer/generator modules)	DN2.20, DN2.46, DN2.47, DN2.49, DN2.60, DN6.46, DN6.49:	PCIe x1, Gen1
	DN2.59, DN2.65, DN2.80, DN2.81, DN6.59, DN6.65:	PCIe x1, Gen1
	DN2.22, DN2.33, DN2.44, DN2.63, DN2.66, DN2.96, DN2.82:	PCIe x1, Gen2
	DN6.22, DN6.33, DN6.44, DN6.63, DN6.66, DN6.96:	PCIe x1, Gen2

Ethernet specific details

LAN Connection		Standard RJ45	
LAN Speed		Auto Sensing: GBit Ethernet, 100BASE-T, 10BASE-T	
LAN IP address	programmable	DHCP (IPv4) with AutoIP fall-back (169.254.x.y), fixed IP (IPv4)	
Sustained Streaming speed (typ)		DN2.20, DN2.46, DN2.47, DN2.49, DN2.60 DN6.46, DN6.49	up to 70 MByte/s
		DN2.59, DN2.65, DN2.22, DN2.33, DN2.44, DN2.63, DN2.66, DN6.59, DN6.65, DN6.22, DN6.33, DN6.44, DN6.63, DN6.66	up to 100 MByte/s
Used TCP/UDP Ports		Webserver: 80 VISA Discovery Protocol: 111, 9757 Spectrum Remote Server: 1026, 5025	mDNS Daemon: 5353 UPNP Daemon: 1900

AC Power connection details (default configuration)

Mains AC power supply	Input voltage: 100 to 240 VAC, 50 to 60 Hz
AC power supply connector	IEC 60320-1-C14 (PC standard coupler)
Power supply cord	power cord included for Schuko contact (CEE 7/7)

DC 24 V Power supply details (DN2 only, option DN2.xxxx-DC24)

Input Voltage	18 V to 36 V
Power supply connector	screw terminal
Power supply cord	no cord included

Serial connection details

Serial connection (RS232)	DN2 with hardware ≥ V11 DN6 with hardware ≥ V10	For diagnostic purposes only. Do not use, unless being instructed by a Spectrum support agent.

Certification, Compliance, Warranty

Conformity Declaration	EN 17050-1:2010	General Requirements
EU Directives	2014/30/EU	EMC - Electromagnetic Compatibility
	2014/35/EU	LVD - Electrical equipment designed for use within certain voltage limits
	2011/65/EU	RoHS - Restriction of the use of certain hazardous substances in electrical and electronic equipment
	2006/1907/EC	REACH - Registration, Evaluation, Authorisation and Restriction of Chemicals
	2012/19/EU	WEEE - Waste from Electrical and Electronic Equipment
	2006/66/EC	On batteries and accumulators and waste batteries and accumulators
Compliance Standards	EN 61010-1: 2010	Safety regulations for electrical measuring, control, regulating and laboratory devices - Part 1: General requirement
	EN 61187:1994	Electrical and electronic measuring equipment - Documentation
	EN 61326-1:2021	Electrical equipment for measurement, control and laboratory use
	EN 61326-2-1:2021	EMC requirements - Part 1: General requirements EMC requirements - Part 2-1: Particular requirements - Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications
	EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances
Product warranty	5 years starting with the day of delivery	
Software and firmware updates	Life-time, free of charge	

DN2 specific Technical Data

Environmental and Physical Details DN2.xxx

Dimension of Chassis without connectors or bumpers	L x W x H	366 mm x 267 mm x 87 mm
Dimension of Chassis with 19" rack mount option	L x W x H	366 mm x 482.6 mm x 87 mm (2U height)
Weight (1 internal acquisition/generation module)		6.3 kg, with rack mount kit: 6.8 kg
Weight (2 internal acquisition/generation modules)		6.7 kg, with rack mount kit 7.2 kg
Weight (DN2.33x or DN2.63x)		5.9 kg, with rack mount kit 6.4 kg
Warm up time (meas)		30 minutes
Operating temperature (nom)		0°C to 40°C
Storage temperature (nom)		-10°C to 70°C
Humidity (nom)		10% to 90%
Dimension of packing (single DN2)	L x W x H	470 mm x 390 mm x 180 mm
Volume weight of Packing (single DN2)		7.0 kg

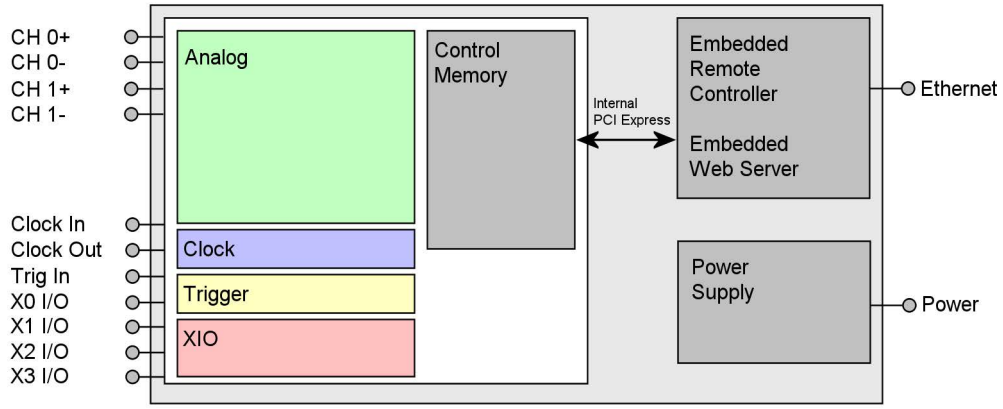
Power Consumption

	230 VAC		12 VDC (obsolete)		24 VDC	
1 channel versions (meas)	0.33 A	76 W	TBD	TBD	TBD	TBD
2 channel versions (meas)	0.33 A	77 W	TBD	TBD	TBD	TBD

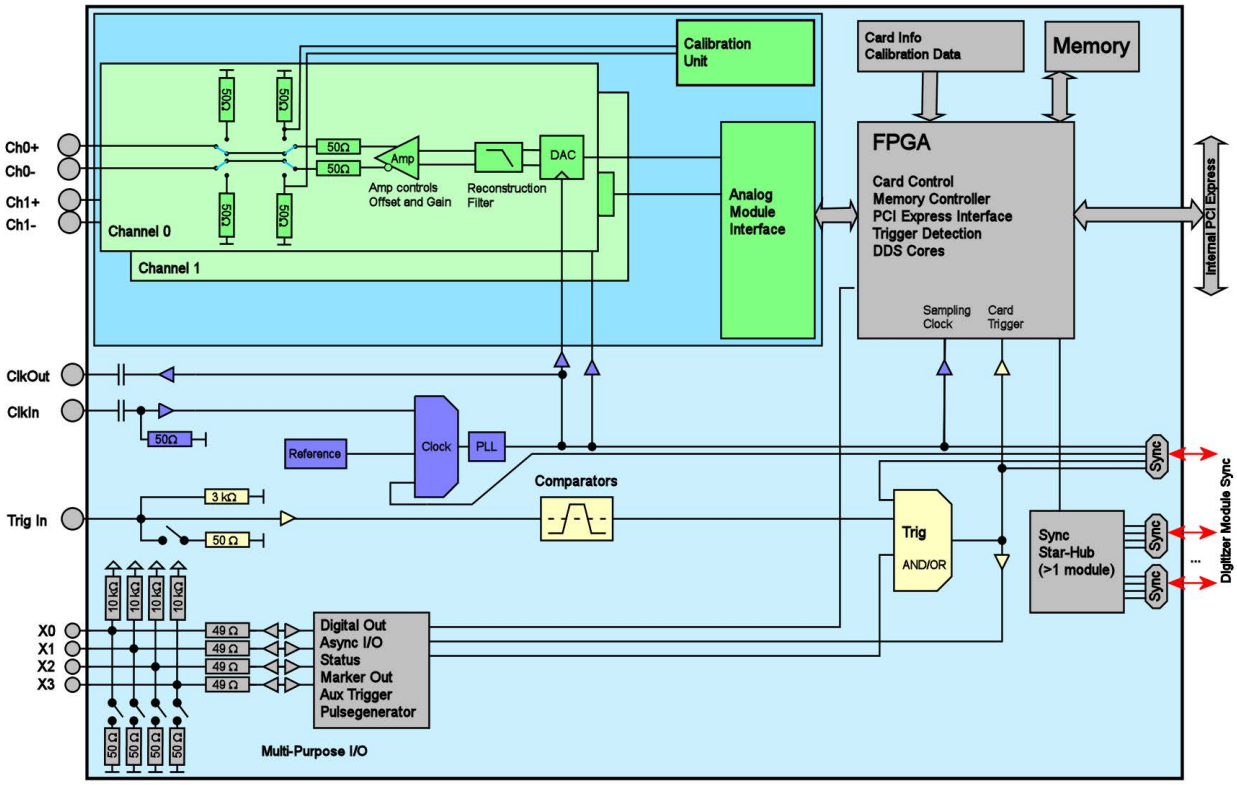
MTBF

MTBF (typ)	TBD

Block diagram of digitizerNETBOX DN2



Block diagram of generatorNETBOX internal AWG module DN2.63x



Order Information

The generatorNETBOX is equipped with a large internal memory for data storage and supports standard replay, FIFO replay (streaming), Multiple Replay, Continuous Replay (Loop) and Single-Restart. Operating system drivers for Windows/Linux 32 bit and 64 bit, drivers and examples for C/C++, Python, IVI (Scope and Digitizer class), LabVIEW (Windows), MATLAB (Windows and Linux), .NET, Java, Julia and a Professional license of the oscilloscope software SBench 6 are included.

The system is delivered with a connection cable meeting your countries power connection. Additional power connections with other standards are available as option.

generatorNETBOX DN2 - Ethernet/LXI Interface

Order no.	Bandwidth	Installed memory	Optional memory	1 channel	2 channels
DN2.632-01	1.4 GHz	2 GiSamples	8 GiSamples	3.2 GS/s	
DN2.632-02	1.4 GHz	2 GiSamples	8 GiSamples	3.2 GS/s	3.2 GS/s
DN2.635-01	2.5 GHz	2 GiSamples	8 GiSamples	10.0 GS/s	
DN2.635-02	2.5 GHz	2 GiSamples	8 GiSamples	10.0 GS/s	5.0 GS/s
DN2.636-01	3.9 GHz	2 GiSamples	8 GiSamples	10.0 GS/s	
DN2.636-02	3.9 GHz	2 GiSamples	8 GiSamples	10.0 GS/s	5.0 GS/s

Options M5i

Order no.	Option
M5i.xxxx-MEM8GS	Optional memory extension to 8 GiSamples (16 GiBytes) per internal module

Options DN2

Order no.	Option
DN2.xxx-Rack	19" rack mounting set for self mounting
DN2.xxx-Emb	Extension to Embedded Server: CPU, more memory, SSD. Access via remote Linux secure shell (ssh)
DN2.xxx-DC24	24 VDC internal power supply. Replaces AC power supply. Accepts 18 V to 36 V DC input. Screw terminals
DN2.xxx-BTPWR	Boot on Power On: the digitizerNETBOX/generatorNETBOX/hybridNETBOX automatically boots if power is switched on.

Firmware Options

Order no.	Option
M5i.63xx-DDS64	Firmware Option multi-carrier DDS mode: adds 64 programmable DDS cores to a single internal AWG. Please refer to the model overview in the data sheet to see how many AWG are installed in each dedicated DN2. Each core can be programmed with single commands for frequency, amplitude, phase, frequency slope, amplitude slope.
M5i.xxxx-PulseGen	Firmware Option: adds 4 freely programmable digital pulse generators that use the XIO lines for output (later installation by firmware -upgrade available)

Services

Order no.	Option
DN2.xxx-Recal	Recalibration of complete digitizerNETBOX/generatorNETBOX/hybridNETBOX DN2 including calibration protocol
DN2.Prot-17025	ISO 17025 Calibration Certificate for one DN2; add-on for new cards or for recalibration

Standard SMA Cables

The standard adapter cables are based on RG174 cables and have a nominal attenuation of 0.3 dB/m at 100 MHz and 0.5 dB/m at 250 MHz. For high speed signals we recommend the low loss cables series CHF.

for Connections	Connection	Length	to BNC male	to BNC female	to SMB female	to MMCX male	to SMA male	
All	SMA male	80 cm	Cab-3mA-9m-80	Cab-3mA-9f-80	Cab-3f-3mA-80	Cab-1m-3mA-80	Cab-3mA-3mA-80	
All	SMA male	200 cm	Cab-3mA-9m-200	Cab-3mA-9f-200	Cab-3f-3mA-200	Cab-1m-3mA-200	Cab-3mA-3mA-200	
Probes (short)	SMA male	5 cm		Cab-3mA-9f-5				

Low Loss SMA Cables

The low loss adapter cables are based on MF141 cables and have an attenuation of 0.3 dB/m at 500 MHz and 0.5 dB/m at 1.5 GHz. They are recommended for signal frequencies of 200 MHz and above.

Order no.	Option
CHF-3mA-3mA-200	Low loss cables SMA male to SMA male 200 cm
CHF-3mA-9m-200	Low loss cables SMA male to BNC male 200 cm

Technical changes and printing errors possible