

## DN6.63x - 16 bit 10 GS/s Ethernet Arbitrary Waveform Generator

- Fast 16 bit arbitrary waveform generator
- 2, 3, 4, 5 or 6 channels with 10 GS/s or 4, 6, 8, 10 or 12 channels with 5 GS/s
- Output signal bandwidth up to 3.9 GHz
- Differential or single-ended output
- Single-ended output 1 Vpp/4 dBm into 50  $\Omega$  (2 Vpp into high impedance)
- Differential output level 2 Vpp/7 dBm into 100  $\Omega$  (4 Vpp into high impedance)
- 4, 6, 8, 10 or 12 GiSample standard acquisition memory
- 16, 24, 32, 40 or 48 GiSample 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

|                                                                                                                                                                                                                   |                                                                                                                                                                                                                                  |                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Operating Systems</b> <ul style="list-style-type: none"> <li>• Windows 7 (SP1), 8, 10, 11</li> <li>• Server 2008 R2 and newer</li> <li>• Linux 2.6 and newer</li> <li>• Windows/Linux 32 and 64 bit</li> </ul> | <b>SBench 6 Professional Included</b> <ul style="list-style-type: none"> <li>• Acquisition, Generation and Display of analog and digital data</li> <li>• Calculation, FFT</li> <li>• Documentation and Import, Export</li> </ul> | <b>Drivers</b> <ul style="list-style-type: none"> <li>• LabVIEW, MATLAB</li> <li>• Python, C/C++, C#, Java, Julia</li> <li>• IVI</li> </ul> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|

| Model      | Maximum speed |           | Maximum channels |          | Bandwidth |
|------------|---------------|-----------|------------------|----------|-----------|
| DN6.635-04 | 2 channels    | 10.0 GS/s | 4 channels       | 5.0 GS/s | 2.5 GHz   |
| DN6.635-06 | 3 channels    | 10.0 GS/s | 6 channels       | 5.0 GS/s | 2.5 GHz   |
| DN6.635-08 | 4 channels    | 10.0 GS/s | 8 channels       | 5.0 GS/s | 2.5 GHz   |
| DN6.635-10 | 5 channels    | 10.0 GS/s | 10 channels      | 5.0 GS/s | 2.5 GHz   |
| DN6.635-12 | 6 channels    | 10.0 GS/s | 12 channels      | 5.0 GS/s | 2.5 GHz   |
| DN6.632-04 | 4 channels    | 3.2 GS/s  | -                | -        | 1.4 GHz   |
| DN6.632-06 | 6 channels    | 3.2 GS/s  | -                | -        | 1.4 GHz   |
| DN6.632-08 | 8 channels    | 3.2 GS/s  | -                | -        | 1.4 GHz   |
| DN6.632-10 | 10 channels   | 3.2 GS/s  | -                | -        | 1.4 GHz   |
| DN6.632-12 | 12 channels   | 3.2 GS/s  | -                | -        | 1.4 GHz   |

## 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

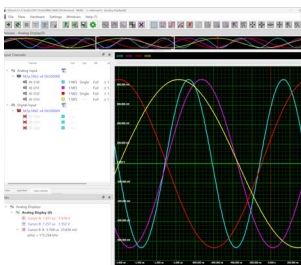
|                   |                                        |
|-------------------|----------------------------------------|
| Physical Location |                                        |
| Bus No            | 0                                      |
| Device No         | 0                                      |
| Function No       | 0                                      |
| Slot No           | 0                                      |
| IP                | 192.168.169.14                         |
| VISA              | TCP/IP[0]:192.168.169.14::inst0::INSTR |

The Discovery function helps you to find and identify any Spectrum LXI instruments, like the digitizerNETBOX and generatorNETBOX, avail-

able 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 func-

tions.

- 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

## 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 2.5 GHz with a high output level of up to 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.

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

|                                  |                                        |
|----------------------------------|----------------------------------------|
|                                  |                                        |
| <b>Welcome</b>                   |                                        |
| Instrument Model                 | DN2.465-08                             |
| Manufacturer                     | Spectrum GmbH                          |
| Serial Number                    | 1234                                   |
| Description                      | digitizerNETBOX                        |
| LXI Features                     | LXI Core 2011                          |
| LXI Version                      | LXI Device Specification 2011 rev. 1.4 |
| Host Name                        | 192.168.169.23                         |
| mDNS Host Name                   | digitizerNETBOX.local                  |
| MAC Address                      | 0C:C4:7A:B3:C2:A2                      |
| TCP/IP Address                   | 192.168.169.23                         |
| Firmware Revision                | 62                                     |
| Software Revision                | 5.17.17117                             |
| Instrument Address String [VISA] | TCP/IP::192.168.169.23::INSTR          |
| LAN ID Indicator                 | <input type="button" value="Enable"/>  |

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

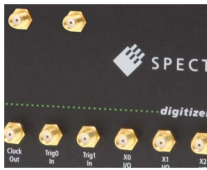


The digitizerNETBOX and generatorNETBOX are fully LXI instrument compatible to LXI Core 2011 following the LXI Device Specification

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.

## 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.

## Ethernet Connectivity

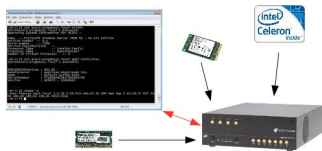


The GBit Ethernet connection can be used with standard COTS Ethernet cabling. The integration into a standard LAN allows to connect the digitizerNETBOX/generatorNETBOX either directly to a desktop PC or Laptop or it is possible to place the instrument somewhere in the company LAN and access it from any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

## 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 accessible 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/IEC 17025-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.

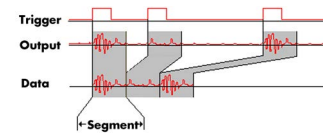
## Repeated output

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.

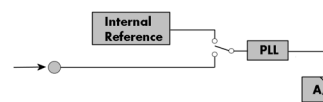
## External trigger input

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

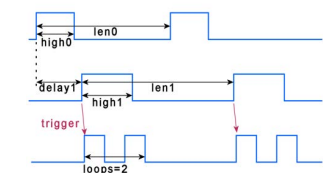
Using a dedicated connector a sampling clock can be fed in from an external system. Additionally it's also possible to output the internally used sampling clock on a separate connector to synchronize external equipment to this clock.

## 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



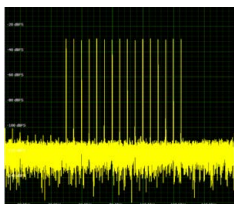
The digital pulse generator option adds 4 internal independent digital pulse generators with programmable duty cycle, output frequency, delay and number of loops.

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.

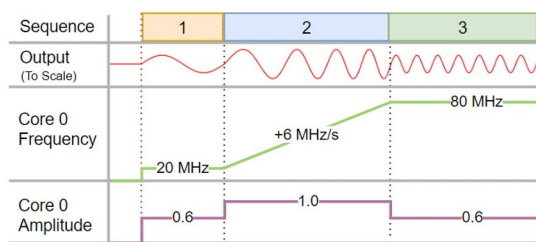
The pulse generator option is a firmware option and can be later installed on all shipped cards.

### 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.

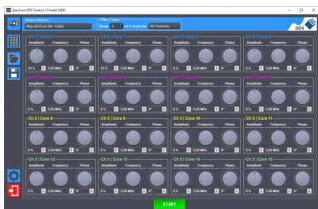
Below, the example sequence of three commands for a single core, shows a fixed 20 MHz frequency with 60% amplitude in step 1, a 10 seconds frequency ramp with 6 MHz/s slope and full 100% amplitude in step 2 and finally, in step 3, a fixed 80 MHz frequency with 50% amplitude. Each step consists of only 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 $\Omega$ to GND                                                                                                                                                     |                            |
| <b>Single-Ended</b>                              |                               | <b>into 50 <math>\Omega</math></b>                                                                                                                                                                                                         | <b>into high impedance</b> |
| Output amplitude (nom)                           | software programmable         | $\pm 1$ mV up to $\pm 500$ mV<br>Amplitude values below $\pm 100$ mV into 50 $\Omega$ ( $\pm 200$ mV into high impedance) are generated by reduction of digital samples.                                                                   | $\pm 2$ mV up to $\pm 1$ V |
| Stepsize of output amplitude (nom)               |                               | 1 mV                                                                                                                                                                                                                                       | 2 mV                       |
| Output offset (nom)                              | software programmable         | $\pm 500$ mV                                                                                                                                                                                                                               | $\pm 1.0$ V                |
| Maximum output voltage, offset + amplitude (nom) |                               | $\pm 750$ mV                                                                                                                                                                                                                               | $\pm 1.5$ V                |
| <b>Differential</b>                              |                               | <b>into 100 <math>\Omega</math></b>                                                                                                                                                                                                        | <b>into high impedance</b> |
| Output amplitude, differential signals (nom)     | software programmable         | $\pm 2$ mV up to $\pm 1$ V<br>Amplitude values below $\pm 200$ mV into 100 $\Omega$ ( $\pm 400$ mV into high impedance) are generated by reduction of digital samples.                                                                     | $\pm 4$ mV up to $\pm 2$ V |
| Stepsize of output amplitude (nom)               |                               | 2 mV                                                                                                                                                                                                                                       | 4 mV                       |
| Common Mode Voltage (nom)                        | software programmable         | $\pm 500$ mV                                                                                                                                                                                                                               | $\pm 1.0$ V                |
| Max common mode + single-ended amp (nom)         |                               | $\pm 750$ mV                                                                                                                                                                                                                               | $\pm 1.5$ V                |
| DAC Differential non linearity (nom)             | DNL, DAC only                 | $\pm 2.2$ LSB typical                                                                                                                                                                                                                      |                            |
| DAC Integral non linearity (nom)                 | INL, DAC only                 | $\pm 9$ LSB typical                                                                                                                                                                                                                        |                            |
| Output resistance (nom)                          |                               | 50 $\Omega$                                                                                                                                                                                                                                |                            |
| Output coupling (nom)                            |                               | DC                                                                                                                                                                                                                                         |                            |
| Minimum output load (nom)                        |                               | 0 $\Omega$ (short circuit safe)                                                                                                                                                                                                            |                            |
| Output amplitude accuracy DC (spec)              |                               | $\pm 2$ mV $\pm 1\%$ of programmed output amplitude                                                                                                                                                                                        |                            |
| Output offset accuracy DC (spec)                 |                               | $\pm 2$ mV $\pm 1\%$ 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/IEC 17025-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<br>star-hub synchronized card           | 64 samples<br>800 samples                             |                                                                               |
| Trigger to Output Delay (meas)                        | MSi.635x/636x (10 GS/s)<br>MSi.633x (3.2 GS/s)      | $\sim 470$ ns<br>$\sim 710$ ns                        |                                                                               |
| External trigger                                      |                                                     | <b>Ext</b>                                            | <b>X0, X1, X2, X3</b>                                                         |
| External trigger type                                 |                                                     | single level comparator                               | 3.3V LVTTTL logic inputs                                                      |
| External trigger impedance (typ)                      | software programmable                               | 50 $\Omega$ or 3 k $\Omega$                           | For electrical specifications refer to the „Multi Purpose I/O lines“ section. |
| External trigger input level (nom)                    |                                                     | $\pm 5$ V                                             |                                                                               |
| External trigger over voltage protection (nom)        | 50 $\Omega$ termination<br>3 k $\Omega$ termination | $\pm 20$ V<br>7 Vrms                                  |                                                                               |
| External trigger sensitivity, mini signal swing (nom) |                                                     | 200 mVpp                                              |                                                                               |
| External trigger level (nom)                          | software programmable                               | $\pm 5$ V with a stepsize of 10 mV                    |                                                                               |

|                                            |                       |                                         |                        |
|--------------------------------------------|-----------------------|-----------------------------------------|------------------------|
| Trigger edge                               | software programmable | Rising edge, falling edge or both edges |                        |
| External trigger bandwidth (typ)           | 50 $\Omega$           | DC to 2 GHz                             | DC to 125 MHz          |
|                                            | 3 k $\Omega$          | DC to 750 MHz                           | n.a.                   |
|                                            | 10 k $\Omega$         | n.a.                                    | DC to 125 MHz          |
| Minimum external trigger pulse width       |                       | $\geq 2$ samples                        | $\geq 2$ 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)                      |                                  | $\leq \pm 1$ ppm                                                                                                                                                            |
| Clock setup range                                   |                                  | base frequency or divided base frequency                                                                                                                                    |
| Clock setup base frequencies                        | M5i.632x<br>M5i.635x<br>M5i.636x | 3.2 GS/s<br>10 GS/s<br>10 GS/s                                                                                                                                              |
| Clock setup divider                                 |                                  | power of 2: 2, 4, 8, 16, 32, ... , 524288, 1048576                                                                                                                          |
| Clock setup examples                                | M5i.632x<br>M5i.635x<br>M5i.636x | 3.2, 1.6 GS/s, 800, 400, 200, 100 MS/s, ..., 1.6 kS/s<br>10.0, 5.0, 2.5, 1.25 GS/s, 625, 312.5 MS/s, ..., 5 kS/s<br>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            | $\geq 2$ MHz and $\leq 750$ MHz in steps of 2 MHz                                                                                                                           |
| External reference clock input impedance (typ)      |                                  | 50 $\Omega$ 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<br>max                       | 200 mVpp<br>3 Vpp                                                                                                                                                           |
| External reference clock input max DC voltage (nom) |                                  | $\pm 10$ 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 $\pm 127$ 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 DigitalIn, Synchronous Digital-In (Digitizer only), Timestamp Reference Clock (Digitizer only)  |
| Input: impedance (nom)             | software programmable                         | 10 k $\Omega$ to 3.3 V or 50 $\Omega$ to GND                                                                                |
| Input: maximum voltage level (nom) |                                               | -0.5 V to +4.0 V                                                                                                            |
| Input: signal levels (nom)         |                                               | 3.3 V LVTTTL (Low $\leq 0.8$ V, High $\geq 2.0$ 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 $\Omega$                                                                                                                 |
| Output: signal levels (nom)        |                                               | 3.3 V LVTTTL                                                                                                                |
| Output: type (nom)                 |                                               | 3.3 V LVTTTL, TTL compatible for high impedance loads                                                                       |
| Output: drive strength (nom)       |                                               | Capable of driving 50 $\Omega$ loads, maximum drive strength $\pm 48$ mA                                                    |
| Output: internal update rate       | M5i.332x, M5i.333x,<br>DNx.332-xx, DNx.333-xx | Current sampling clock $\leq 3.2$ GS/s: 1/4 of sampling clock<br>Current sampling clock $> 3.2$ GS/s: 1/8 of sampling clock |
| Output: internal update rate       | M5i.335x, M5i.336x,<br>DNx.335-xx             | Current sampling clock $\leq 5.0$ GS/s: 1/4 of sampling clock<br>Current sampling clock $> 5.0$ GS/s: 1/8 of sampling clock |
| Output: internal update rate       | M5i.63xx, DNx.63xx<br>DNx.63x-xx              | Current sampling clock $\leq 5.0$ GS/s: 1/4 of sampling clock<br>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<br><br>632x                          | 64 @ 2.5 GS/s<br>32 @ 5 GS/s<br>16 @ 10 GS/s<br>64 @ 1.6 GS/s<br>32 @ 3.2 GS/s                                                                                                                                                                                                                                           |         |         |      |         |                                                |        |       |                                              |      |
|---------------------------------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|------|---------|------------------------------------------------|--------|-------|----------------------------------------------|------|
| DDS core routing options                          | software programmable                           | Routed cores can be individually activated for output<br>Ch0: 64 or 32 cores<br>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<br>632x                              | 3.2 ns<br>5 ns                                                                                                                                                                                                                                                                                                           |         |         |      |         |                                                |        |       |                                              |      |
| DDS timer resolution (nom)                        | software programmable<br>635x, 636x<br><br>632x | <table> <tr> <th>Minimum</th><th>Maximum</th><th>Step</th></tr> <tr> <td>38.4 ns</td><td>450360 s <math>&gt; 5</math> d<br/>3.2 ns <math>\times (2^{47}-1)</math></td><td>3.2 ns</td></tr> <tr> <td>60 ns</td><td>703687 s <math>&gt; 8</math> d<br/>5 ns <math>\times (2^{47}-1)</math></td><td>5 ns</td></tr> </table> | Minimum | Maximum | Step | 38.4 ns | 450360 s $> 5$ d<br>3.2 ns $\times (2^{47}-1)$ | 3.2 ns | 60 ns | 703687 s $> 8$ d<br>5 ns $\times (2^{47}-1)$ | 5 ns |
| Minimum                                           | Maximum                                         | Step                                                                                                                                                                                                                                                                                                                     |         |         |      |         |                                                |        |       |                                              |      |
| 38.4 ns                                           | 450360 s $> 5$ d<br>3.2 ns $\times (2^{47}-1)$  | 3.2 ns                                                                                                                                                                                                                                                                                                                   |         |         |      |         |                                                |        |       |                                              |      |
| 60 ns                                             | 703687 s $> 8$ d<br>5 ns $\times (2^{47}-1)$    | 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° ( $360^\circ/2^{12}$ )                                                                                                                                                                                                                                                            |         |         |      |         |                                                |        |       |                                              |      |
| DDS command buffer                                | single mode<br>DMA mode                         | 4Ki commands<br>512Mi commands in on-board RAM. More commands can reside in DMA buffer in PC-RAM.<br>2Gi commands with memory option.                                                                                                                                                                                    |         |         |      |         |                                                |        |       |                                              |      |
| Min user software to analog output latency (meas) | single mode<br>DMA mode                         | 4 $\mu$ s<br>26 $\mu$ s                                                                                                                                                                                                                                                                                                  |         |         |      |         |                                                |        |       |                                              |      |
| Max continuous DDS command rate (meas)            | single mode<br>DMA mode                         | TBD<br>3.3 MCommands/s                                                                                                                                                                                                                                                                                                   |         |         |      |         |                                                |        |       |                                              |      |

|                                              |                    |                                                                                                                                                                                                                                                   |
|----------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| External trigger to DDS output change (meas) | 635x, 636x<br>632x | approx. 735 ns<br>approx. 1060 ns                                                                                                                                                                                                                 |
| Maximum external re-trigger rate (meas)      | 635x, 636x<br>632x | 35.2 ns<br>55 ns                                                                                                                                                                                                                                  |
| Number of DDS options per generator          | NETBOX             | Each generator NETBOX 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:<br>33xx: Base Sampling Rate x Channels / 32 (max 10 GS/s x 1 ch / 32) = 312.5 MS/s (3.2 ns)<br>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<br>DNx.636-xx | M5i.635x<br>DNx.635-xx | M5i.632x<br>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)<br>(step response) |              |                        |                        | 150 ps                 | 170 ps                 | 260 ps                 |
| Rise/Fall time 10% to 90% (meas)<br>(step response) |              |                        |                        | 200 ps                 | 245 ps                 | 380 ps                 |

## Dynamic Parameters

| Noise                                      |      | Single-Ended Output |              | Differential Output |               |
|--------------------------------------------|------|---------------------|--------------|---------------------|---------------|
| Output Level in 50 $\Omega$ / 100 $\Omega$ |      | $\pm 250$ mV        | $\pm 500$ mV | $\pm 500$ mV        | $\pm 1000$ 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 $\pm 0.5$ MHz                      |              | 1 GHz $\pm 1.0$ MHz |              | 1.5 GHz $\pm 5.0$ MHz |              |
| Output Level in 50 $\Omega$ |  | $\pm 250$ mV                               | $\pm 500$ mV | $\pm 250$ mV        | $\pm 500$ mV | $\pm 250$ mV          | $\pm 500$ 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 $\Omega$                     |  | $\pm 500$ mV                               | $\pm 500$ mV | $\pm 500$ mV | $\pm 500$ mV | $\pm 500$ 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 connector | 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<br>(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:<br>DN2.59, DN2.65, DN2.80, DN2.81, DN6.59, DN6.65:<br>DN2.22, DN2.33, DN2.44, DN2.63, DN2.66, DN2.96, DN2.82:<br>DN6.22, DN6.33, DN6.44, DN6.63, DN6.66, DN6.96: | PCIe x1, Gen1<br>PCIe x1, Gen1<br>PCIe x1, Gen2<br>PCIe x1, Gen2 |

## Ethernet specific details

|                                 |                                                                                                                                                                                                  |                                        |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| LAN Connection                  | Standard RJ45                                                                                                                                                                                    |                                        |
| LAN Speed                       | Auto Sensing: GBit Ethernet, 100BASE-T, 10BASE-T                                                                                                                                                 |                                        |
| LAN IP address                  | DHCP (IPv4) with AutoIP fall-back (169.254.x.y), fixed IP (IPv4)                                                                                                                                 |                                        |
| Sustained Streaming speed (typ) | programmable<br>DN2.20, DN2.46, DN2.47, DN2.49, DN2.60<br>DN6.46, DN6.49<br>DN2.59, DN2.65, DN2.22, DN2.33, DN2.44,<br>DN2.63, DN2.66, DN6.59, DN6.65, DN6.22,<br>DN6.33, DN6.44, DN6.63, DN6.66 | up to 70 MByte/s<br>up to 100 MByte/s  |
| Used TCP/UDP Ports              | Webserver: 80<br>VISA Discovery Protocol: 111, 9757<br>Spectrum Remote Server: 1026, 5025                                                                                                        | mDNS Daemon: 5353<br>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<br>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<br>2014/35/EU<br>2011/65/EU<br>2006/1907/EC<br>2012/19/EU<br>2006/66/EC                 | EMC - Electromagnetic Compatibility<br>LVD - Electrical equipment designed for use within certain voltage limits<br>RoHS - Restriction of the use of certain hazardous substances in electrical and electronic equipment<br>REACH - Registration, Evaluation, Authorisation and Restriction of Chemicals<br>WEEE - Waste from Electrical and Electronic Equipment<br>On batteries and accumulators and waste batteries and accumulators                                                                                                                                                                                                                                |
| Compliance Standards          | EN 61010-1: 2010<br>EN 61187:1994<br>EN 61326-1:2021<br>EN 61326-2-1:2021<br><br>EN IEC 63000:2018 | Safety regulations for electrical measuring, control, regulating and laboratory devices - Part 1: General requirement<br>Electrical and electronic measuring equipment - Documentation<br>Electrical equipment for measurement, control and laboratory use<br>EMC requirements - Part 1: General requirements<br>EMC requirements - Part 2-1: Particular requirements - Test configurations, operational conditions and performance criteria for sensitive test and measurement equipment for EMC unprotected applications<br>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                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

**DN6 specific Technical Data**

**Environmental and Physical Details DN6.xxx**

|                                                    |           |                                       |
|----------------------------------------------------|-----------|---------------------------------------|
| Dimension of Chassis without connectors or bumpers | L x W x H | 464 mm x 431 mm x 131 mm              |
| Dimension of Chassis with 19" rack mount option    | L x W x H | 464 mm x TBD mm x 131 mm (3U height)  |
| Weight (2 internal acquisition/generation modules) |           | 12.5 kg, with rack mount kit: 13.1 kg |
| Weight (3 internal acquisition/generation modules) |           | 13.3 kg, with rack mount kit: 13.9 kg |
| Weight (4 internal acquisition/generation modules) |           | 14.1 kg, with rack mount kit: 14.7 kg |
| Weight (5 internal acquisition/generation modules) |           | 14.9 kg, with rack mount kit: 15.6 kg |
| Weight (6 internal acquisition/generation modules) |           | 15.7 kg, with rack mount kit: 16.3 kg |
| Warm up time                                       |           | 10 minutes                            |
| Operating temperature                              |           | 0°C to 40°C                           |
| Storage temperature                                |           | -10°C to 70°C                         |
| Humidity                                           |           | 10% to 90%                            |
| Dimension of packing (single DN6)                  | L x W x H | 580 mm x 580 mm x 280 mm              |
| Volume weight of Packing (single DN6)              |           | 19.0 kg                               |

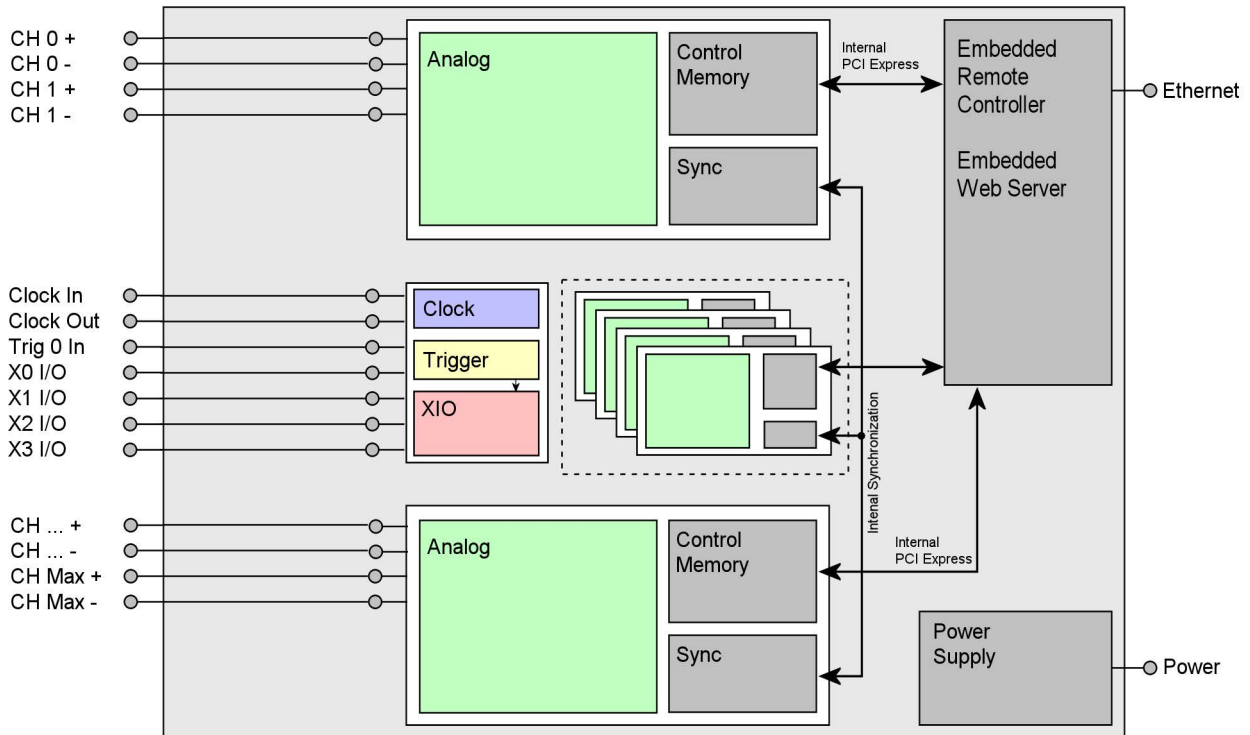
**Power Consumption**

|                            | 230 VAC |     |
|----------------------------|---------|-----|
| 4 channel versions (meas)  | TBD     | TBD |
| 6 channel versions (meas)  | TBD     | TBD |
| 8 channel versions (meas)  | TBD     | TBD |
| 10 channel versions (meas) | TBD     | TBD |
| 12 channel versions (meas) | TBD     | TBD |

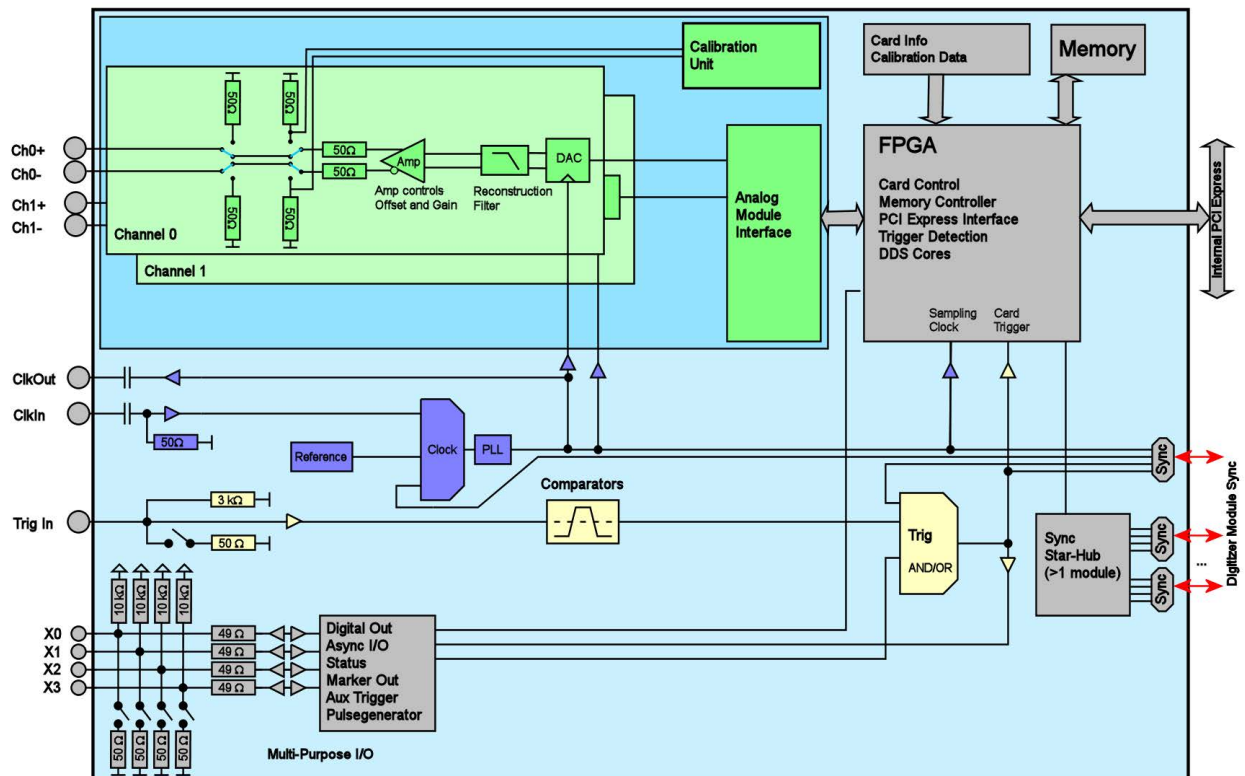
**MTBF**

|            |     |
|------------|-----|
| MTBF (typ) | TBD |
|------------|-----|

### Block diagram of digitizerNETBOX DN6



### Block diagram of generatorNETBOX internal AWG module DN6.63x



## 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 DN6 - Ethernet/LXI Interface

| Order no.  | D/A Resolution | Maximum Speed |           | Maximum Channels |          | Installed Memory | Available Memory Option |
|------------|----------------|---------------|-----------|------------------|----------|------------------|-------------------------|
| DN6.635-04 | 16 Bit         | 2 channels    | 10.0 GS/s | 4 channels       | 5.0 GS/s | 1 GiS/channel    | 4 GiS/channel           |
| DN6.635-06 | 16 Bit         | 3 channels    | 10.0 GS/s | 6 channels       | 5.0 GS/s | 1 GiS/channel    | 4 GiS/channel           |
| DN6.635-08 | 16 Bit         | 4 channels    | 10.0 GS/s | 8 channels       | 5.0 GS/s | 1 GiS/channel    | 4 GiS/channel           |
| DN6.635-10 | 16 Bit         | 5 channels    | 10.0 GS/s | 10 channels      | 5.0 GS/s | 1 GiS/channel    | 4 GiS/channel           |
| DN6.635-12 | 16 Bit         | 6 channels    | 10.0 GS/s | 12 channels      | 5.0 GS/s | 1 GiS/channel    | 4 GiS/channel           |
| DN6.632-04 | 16 Bit         | 4 channels    | 3.2 GS/s  |                  |          | 1 GiS/channel    | 4 GiS/channel           |
| DN6.632-06 | 16 Bit         | 6 channels    | 3.2 GS/s  |                  |          | 1 GiS/channel    | 4 GiS/channel           |
| DN6.632-08 | 16 Bit         | 8 channels    | 3.2 GS/s  |                  |          | 1 GiS/channel    | 4 GiS/channel           |
| DN6.632-10 | 16 Bit         | 10 channels   | 3.2 GS/s  |                  |          | 1 GiS/channel    | 4 GiS/channel           |
| DN6.632-12 | 16 Bit         | 12 channels   | 3.2 GS/s  |                  |          | 1 GiS/channel    | 4 GiS/channel           |

## Options M5i

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

## Options DN6

| Order no.     | Option                                                                                                          |
|---------------|-----------------------------------------------------------------------------------------------------------------|
| DN6.xxx-Rack  | 19" rack mounting set for self mounting                                                                         |
| DN6.xxx-Emb   | Extension to Embedded Server: CPU, more memory, SSD. Access via remote Linux secure shell (ssh)                 |
| DN6.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)                                                                                                                                                                          |

## Calibration

| Order no.       | Option                                                                                                                                                       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DN6.xxx-Recal   | Recalibration of complete digitizerNETBOX/generatorNETBOX DN6 including calibration protocol                                                                 |
| DN6.ProtN-17025 | ISO 17025 Calibration Certificate for one DN6; add-on for new cards or for recalibration.<br>N = number of internal cards: Prot2, Prot3, Prot4, Prot5, Prot6 |

## 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

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