

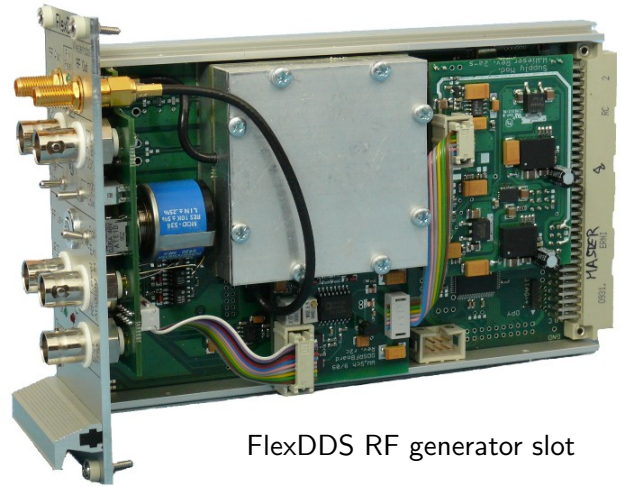
Flexible Multi-Channel Phase-Coherent RF Source

Features

- Multi-channel operation with precisely known and adjustable phase relationship between channels
- Real-time control of all signal parameters
- Phase-continuous frequency tuning
- Computer interface (e.g. USB 2.0 link)

Components

- **FlexDDS-Rack:** 19" rack which integrates the computer interface and power supplies. The rack can hold up to 8 independent **FlexDDS** RF generator slots and 1 frontpanel controller slot (**FlexDDS-FPctl**).
- **FlexDDS:** RF generator slot module
- **FlexDDS-FPctl:** Slot module for reference clock and trigger.



FlexDDS RF generator slot



Full rack

General Description

FlexDDS is a multi-channel phase-coherent RF source. The design deliberately targets the needs of experimental physicists who want to control all signal parameters in real-time from a computer. Initially, a series of actions (like changes in amplitude or frequency, start of frequency sweeps, ...) is compiled into commands which are then transferred to the FlexDDS-Rack via a USB link. Each time a (real-time asynchronous) trigger input is activated, FlexDDS-Rack executes one or several commands and waits for the next trigger event. There is no limit on the number of successive commands as they are loaded continuously from the host computer.

One outstanding feature of FlexDDS is its defined and known phase relationship between channels. For example, two channels can easily be set up to produce an RF output at the same frequency and with equal phase. Slightly detuning the frequency of one channel will then linearly increase the phase difference between the two channels.

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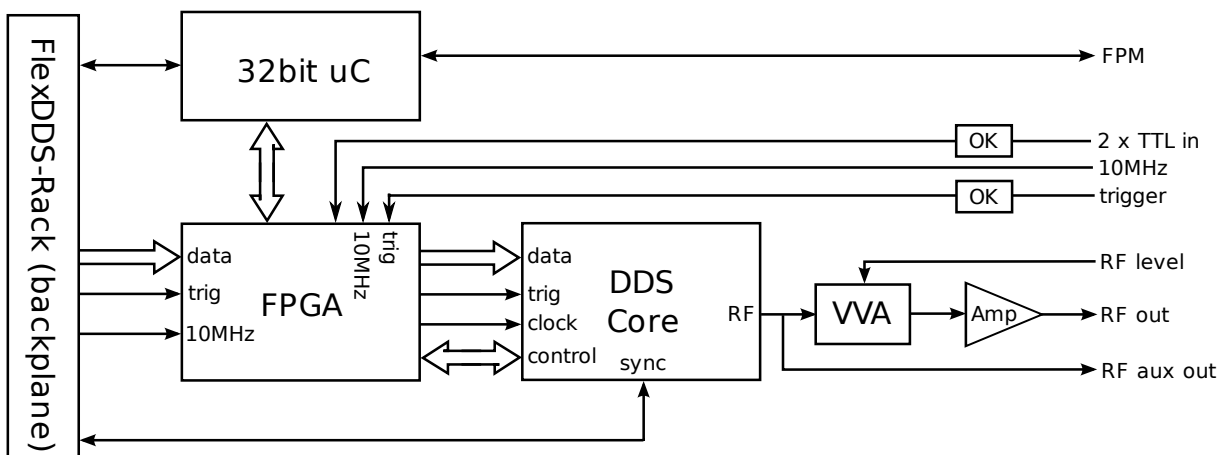
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Detailed features of FlexDDS-Rack:

- Up to 8 independent RF generator slots which can be made to run completely synchronously (phase-coherent).
- Slots can be phase-aligned to each other (e.g. sine waveform on slot 1 and cosine waveform on slot 2). This alignment is a consequence of slot synchronization and is hence completely repeatable, even after power-cycling.
- Separate real-time trigger input to start actions (like frequency changes, sweeps, ...) allows to trigger any combination of up to 8 slots simultaneously.
- 10 MHz reference clock input and separate reference clock output for synchronization.

Detailed features of each FlexDDS RF generator slot:

- DDS (direct digital synthesis) core operating at 1GSps with 14 bit output DAC
- Output frequency range 0.3 MHz to 400 MHz (sine wave)
- 32bit frequency tuning word (resolution 0.23 Hz)
- 16bit phase offset word (0.0055° resolution)
- Analog amplitude attenuator with $>35\text{dB}$ dynamic range (ext. level input or potentiometer)
- Additionally, output amplitude digitally controllable with 14bit resolution (linear scale)
- Fast digital RF switch with $>60\text{dB}$ attenuation of the output frequency (OSK); optionally allows to linearly ramp down/up the RF output power.
- Less than $2\mu\text{s}$ per update of frequency + phase + amplitude (per channel)
- Up to 8 independently programmable profiles for frequency, phase and amplitude which can be selected/switched even faster
- Linear phase, frequency and amplitude sweeps (see below)
- Up to 1024 words (32bit) internal RAM for storage and playback of complex output sequences
- Maximum RF output level $+10\text{dBm}$ into 50 ohm
- Separate auxiliary RF output for monitoring (-5dBm into 50 ohm)



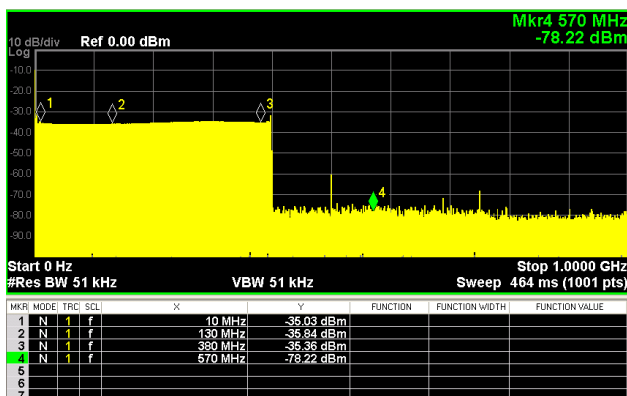
Structure of a FlexDDS RF slot attached to the backplane (left). OK=Optocoupler, VVA=voltage variable attenuator

Features of the integrated ramp generator

FlexDDS integrates a 32bit ramp generator which allows to sweep either frequency, phase or amplitude from a defined start point to a defined end point. The RF output stays phase-continuous before, during and after the ramp.

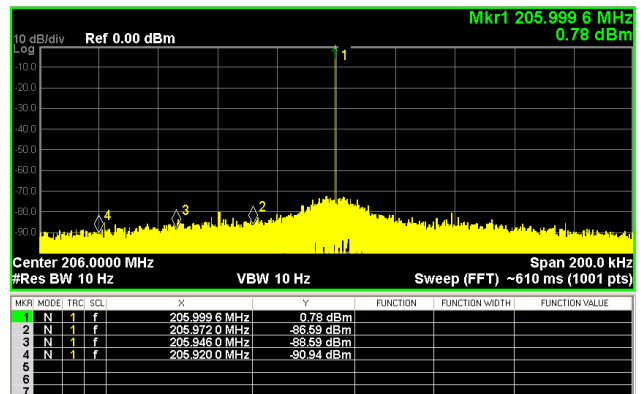
- Precisely selectable start and end points (frequency: 0.23Hz resolution)
- Selectable ramp step size (e.g. frequency: 0.23Hz resolution)
- Selectable ramp speed (16 bit resolution): 4ns to 260 μ s per ramp step
- Independent control of ramp speed and step size for both the positive and negative slope
- Configurable ramp end behavior:
 - Keep end value (normal)
 - Jump back to the start value
 - Change direction and ramp back again
- Optional external ramp hold input to temporarily freeze the ramp generator
- Optional external ramp direction input

Output power versus frequency



Output power level measured with spectrum analyzer while rapidly sweeping the output frequency from 300kHz to 400MHz. Observed power level variation is 1dB.

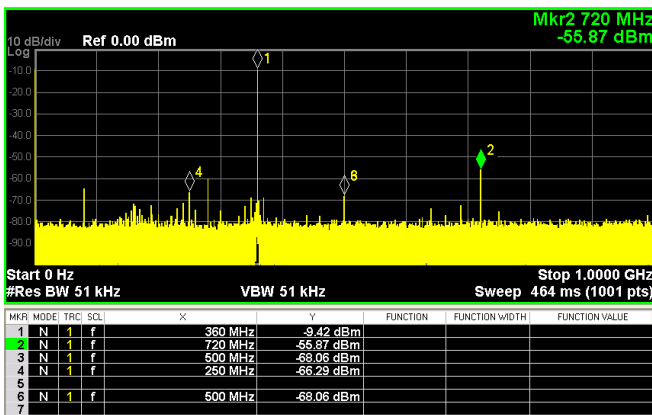
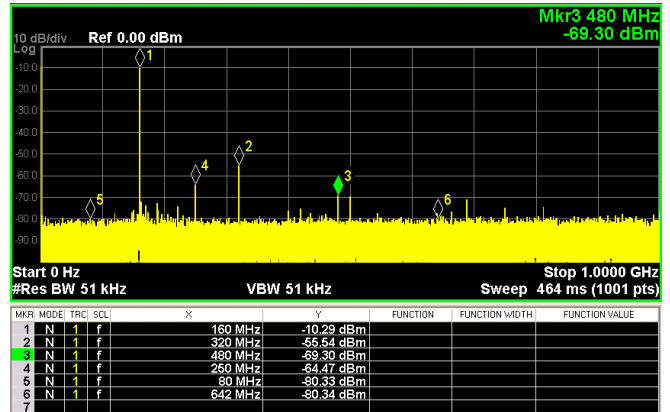
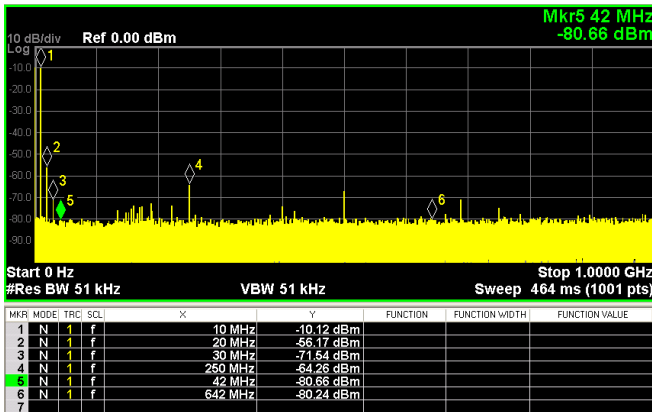
Narrowband SFDR at +10dBm



The noise “foot” around the primary output frequency is below -70dBc when measuring with 10Hz resolution. This corresponds to a narrowband noise power density of -80dBc/Hz.

Wideband SFDR at 0dBm (recommended output power level)

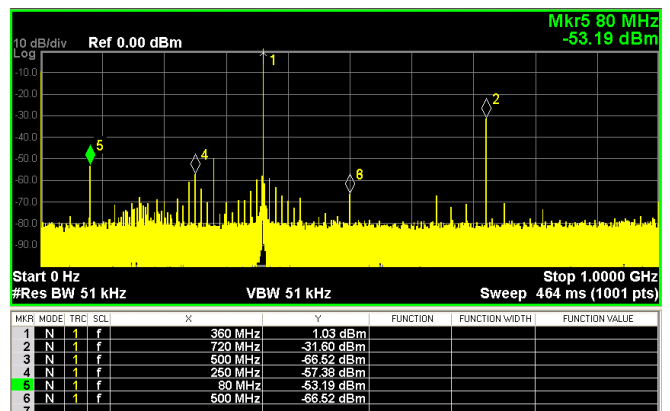
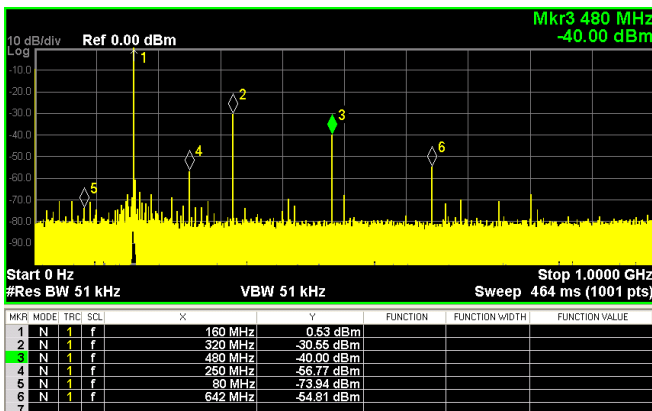
For applications requiring a high wideband **spurious free dynamic range (SFDR)**, it is recommended to use output power levels up to 0dBm. FlexDDS (Rev. 2c) provides an SFDR of 45dBc at 0dBm. For higher levels, second and third harmonics reduce the SFDR (see below).



Wideband SFDR for 10 MHz, 160 MHz and 360 MHz output at 0dBm. 10dB input attenuator makes displayed power levels 10dB smaller than real.

Wideband SFDR at +10dBm output power

Second and third harmonics generated in the output amplifier reduce the wideband SFDR for output levels above 0dBm. However, +10dBm may still be useful if a wideband SFDR of 30dBc is sufficient since in many cases it will allow you to directly drive e.g. a mixer and save you a dedicated amplifier.



Wideband SFDR for 160 MHz and 360 MHz output at 10dBm (10dB input attenuator).

Please note that the information provided in this data sheet is preliminary. Final specifications are believed to be similar or in some cases even better than specified here, although degradation of parameters in future revisions cannot be ruled out for certainty.