FlexDDS-NG DUAL

Dual-Channel 400 MHz Agile Waveform Generator

- Excellent signal quality
- Rapid parameter changes
- Phase-continuous sweeps
- High speed analog modulation
The FlexDDS-NG has an internal reference with 2.5ppm over a -30 to +75°C temperature range that can be digitally tuned. For higher stability or to phase-lock multiple devices you can use the external 10 MHz input.

RF output full-scale power adjustment. This sets the amplifier gain covering a full scale RF output power range from below -40 dBm to +10 dBm.

Scale the RF level to your needs without losing any bit of resolution in the DDS.

RF output on/off master switch, one for each channel.

Three digital IOs can be configured for various functions including fast on/off, triggering, changing sweep direction, interrupting sweeps, quickly switching output profiles or as outputs e.g. to control post amplifiers or get notified of end-of-sweep.

Configurable LEDs enable you to immediately see the signal states so you spend less time debugging.

Two dedicated analog inputs for analog modulation: These inputs are digitally sampled and allow you to perform amplitude/phase/frequency or even polar I/Q modulation at a rate of 62.5 MS/s with 12 to 14 bits resolution.

Modulation gain and offset are programmed digitally and can be tuned on the fly without the need to change any analog circuits.

Two independent digitally synthesized RF outputs covering a frequency range of 0.3 to 400 MHz; with up to +10 dBm you can drive e.g. mixers directly.

DDS technology guarantees precisely controlled phase, amplitude and frequency and enables many more advanced features like agile frequency hops, phase-continuous frequency sweeps or known phase relationships.

Auxiliary RF outputs for monitoring (-5 dBm).

USB interface to computer: Easy access as virtual COM port, no special drivers needed, no baud rate configuration (any Windows version since XP and Linux).
FlexDDS-NG DUAL is a dual-channel phase continuous direct digital signal synthesizer. Based on the successful design of the FlexDDS multi-channel RF source developed for the Max Planck Institute for Quantum Optics, FlexDDS-NG is the next generation waveform generator which deliberately targets the needs of experimental physicists.

### Main Features

- **Direct digital synthesis (DDS)** at 1 GS/s and 14 bit resolution enables highly configurable and precisely repeatable signal generation with a frequency range from 0.3 to 400 MHz (resolution 0.23 Hz)
- Two independent output channels with precisely known phase relationship
- One DDS Command Processor (DCP) per channel with 8 ns timing resolution and separate instruction cache (4096 entries) enables fast real-time control of all signal parameters and execution of complex sequences with deterministic timing
- Versatile signal generation: Phase-continuous linear frequency/amplitude sweeps with external hold and direction inputs, phase ramps, fast profile switching, RAM playback, separate amplitude sweep generator, delay/timing generator
- Two independent high speed analog modulation inputs: Amplitude, phase, frequency or polar modulation from analog signal sources with up to 20 MHz bandwidth; slope and intercept of the transfer function can be digitally set
- Excellent signal quality (low phase noise, spurs, harmonics) with an RF output level up to +10 dBm (2 V_{pp}) into 50 Ω e.g. to drive mixers directly
- Fast output on/off functionality: No signal leakage in off state
- Three real-time digital IOs for external triggering and other functions

### Typical Applications

- Driving AOMs (acousto-optic modulators)
- Ultra-cold atom experiments; coherent atom manipulation
- BEC evaporation ramps
Overview

The FlexDDS-NG DUAL is a dual-channel waveform generator. Each RF generator channel features a 1 GS/s DDS synthesizer (AD9910) followed by a variable, highly linear output amplifier. A dual-channel analog-to-digital converter (ADC) can capture analog modulation signals at 62.5 MS/s. All components are controlled by an FPGA that implements, for each channel, a Digital Command Processor (DCP) and the analog sample rescaler. A 120 MHz ARM processor handles the USB connection.

Firmware updates for new features are performed over the USB link by the customer without the need to remove the FlexDDS-NG DUAL from the setup.

The Digital Command Processor enables real-time signal control

- Each output channel features a dedicated Digital Command Processor (DCP) with deterministic timing that controls the 1 GS/s DDS generator (AD9910)
- The FlexDDS-NG can execute signal updates either self-timed (timing resolution 8 ns) or by waiting for external trigger events from the digital IOs
- Each DCP has a high speed memory holding up to 4096 instructions (more can be loaded via the USB on the fly)
- Less than 2 µs per update of frequency + phase + amplitude together
- Up to 8 independently programmable profiles for frequency, phase and amplitude which can be switched within nanoseconds
- The digital IOs can also be used as outputs to perform real-time control tasks (e.g. switching attached amplifiers)

Waveform Generation Features

- Linear phase, frequency and amplitude sweeps (phase-continuous)
- Up to 1024 words (32bit) internal RAM (inside DDS core AD9910) for storage and playback of complex output sequences
- Analog modulation: Phase, frequency, amplitude, polar
- Precision: 16 bit phase offset word (0.005° resolution), 14 bit amplitude scaling (0.006%), 32 bit frequency tuning (0.23 Hz)
- Output frequency range 0.3 to 400 MHz, output power up to +10 dBm
Ramp/Sweep Generator

- Each channel has an integrated **32 bit 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.
- External digital inputs allow to **temporarily freeze the ramp** generator (ramp hold) or to **change the direction** at any time.
- New ramps can be triggered from the completion of the previous ramp allowing **piece-wise linear ramps**.
- Precisely selectable start and end points (frequency: 0.23 Hz resolution).
- Selectable ramp step size (e.g. frequency: 0.23 Hz resolution).
- Selectable ramp speed (16 bit resolution): 4 ns to 260 µs per ramp step.
- Independent control of ramp speed and step size for both positive and negative slopes.
- Configurable **ramp end behavior**:  
  - Keep end value (normal)  
  - Jump back to the start value  
  - Change direction and ramp back again.

Versatile Signal Generation

- RF signal generation is **fundamentally phase-continuous** due to the DDS design.
- Precise and known phase relationship between the output channels can be established if desired.
**FlexDDS-NG DUAL: Features**

**High Speed Analog Modulation**

- **Two independent analog inputs** allow you to modulate the generated RF signal
- **Amplitude, frequency, phase** (16 bit) and **polar** (2 x 8 bit) modulation formats supported
- **Fully digital design:** The analog modulation input is digitized at a sample rate of 62.5 MHz (12 or 14 bit resolution). The modulation parameters are then **computed** from these sample values with **adjustable coefficients** (offset and slope) and fed into the DDS core at a rate of 62.5 MHz.
- **A short latency** of 0.3 µs allows you to implement fast analog control loops
- Input specs: ±1 V range, 50 Ω termination, 20 MHz bandwidth

**RF Outputs with Adjustable Level and Fast On/Off**

- A **variable output amplifier** with a full-scale output from -40 to +10 dBm allows you to scale the RF level to your needs without losing any bit of resolution in the DDS
- **Fast transition:** Less than 4 ns from on to off; pulse length down to 12 ns
- **No signal leakage** in off state: The on/off functionality stops waveform generation itself rather than merely attenuating the synthesized RF output
- **External on/off** via digital BNC inputs (0.1 µs response delay, see image)
- Separate „RF kill“ switches to manually suppress off RF output at the amplifier, independent of the DDS waveform generator
- Dedicated **amplitude ramp generator** to linearly sweep up/down the amplitude in 8 µs to 4 s
- Output power variation **below ±0.8 dB over full frequency range** (typ.)
FlexDDS-NG DUAL: Signal Quality

Signal Quality

- **Internal low jitter** 1 GHz sample clock generator
- **Low RF output phase noise** (see figure below):
  - At 200 MHz: -100 dBc/Hz @ 3 kHz offset from carrier (typ.)
  - < -110 dBc/Hz @ 300 kHz offset
- **Frequency stability**: built-in reference oscillator with 2.5 ppm drift over -30 to +75°C temperature range

- **Very low harmonics and spurs** can be important, e.g. when driving mixers:
  A new improved amplifier design features a 2nd and 3rd harmonic below -45 dBc for output power levels up to +10 dBm. Harmonics are even lower for reduced output power and low frequencies, e.g. -60 dBc at 80 MHz and full output power (see figures below)
- **Very low crosstalk**: Channel-to-channel isolation better than 100 dB

Narrow band phase noise at 360 MHz:
-100 dBc at 300 kHz offset measured in a 10 Hz RBW corresponds to -110 dBc/Hz phase noise (at 300 kHz from carrier)

Harmonics at 82 MHz and +10 dBm output power:
Harmonics at ~60 dBc for 2nd and 3rd, ~70 dBc for 4th;
non-harmonic spurs below -75 dBc (barely visible)

Harmonics and spurs at 208 MHz and +10 dBm output power:
2nd and 3rd harmonic at ~45 dBc
The two peaks on the right are the 4th harmonic and the mirror frequency at 1 GHz-208 MHz (both below -50 dBc)
FlexDDS-NG DUAL: Connectivity and Remote Control

A simple USB link connects your computer to the FlexDDS-NG DUAL. The device automatically registers itself as a virtual COM port (VCP)

- Easy to use
- **Text-based command protocol** can be accessed easily from nearly any programming environment
- **LabView** support routines help you to get started quickly
- Operating system support: All Windows versions from XP to 10 as well as any recent Linux (no extra drivers needed)

Digital IOs and LEDs

- Three configurable digital IOs (3.3V or 5V logic, TTL compatible)
- Configurable for diverse functions, e.g. trigger input, RF on/off, ramp/sweep direction selection, ramp/sweep hold or fast profile switching
- Can be used as digital output to e.g. control external amplifiers or monitor internal states
- Several LEDs on the front panel can be configured to reflect a variety of functions/signals to help you set up your experiment

Questions?

Need extra features or more than two channels?

Not sure if it fits your needs?

Contact us!

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