Product Bulletin

DAC5687 Interpolating DAC High-Performance, Low-Noise for 3G Wireless Transmission

The dual-channel DAC5687 combines high speed with exceptionally low noise and design flexibility for third-generation (3G) wireless transmission and other applications. The high-performance DAC provides 16-bit resolution at up to 500 MSPS and can support lower input rates through interpolation. Its flexible input and output options and operating modes support a variety of design configurations. The superior device performance helps reduce component counts and manufacturing costs. All of these features make the DAC5687 an outstanding choice for demanding applications including:

- Cellular base station transmit channels
  - CDMA: WCDMA, CDMA2000™, IS-95, TD-SCDMA
  - TDMA: GSM, IS-136, EDGE/UWC-136
- Fixed wireless transmitters
- Software-defined radio
- Cable modem termination
- High-end medical imaging

Design Flexibility
From input to output, the DAC5687 provides design flexibility. The device supports real or complex inputs, with options for single-port interleave data, even and odd multiplexing of half-rate input data, and a first-in/first-out (FIFO) input buffer that can be clocked externally or internally to simplify timing issues. Integrated 2x, 4x and 8x interpolation filters enable the use of lower input sampling rates which significantly reduce electromagnetic interference (EMI).

Key Features
- 16-bit, 500 MSPS
- Full IQ compensation including offset, gain and phase
- Selectable 2x-8x interpolation
- Complex mixer with programmable NCO and fixed-frequency mixer with Fs/2 or Fs/4
- Flexible support for real, complex and differentiated rate inputs
- Low noise
  - SNR: >75 dBFS at 500 MSPS, 25 MHz
  - IMD3: >81 dBc IMD3 at 500 MSPS, 25 MHz

The DAC5687 offers options for complex and real outputs with differential outputs scalable from 2 to 20 milliamps (mA). The device's 32-bit programmable numerically controlled oscillator (NCO) controls a complex mixer for fine output resolution. Additionally, a fixed-frequency mixer divides sampling frequency by 2 or by 4 (Fs/2, Fs/4) for coarser resolutions and an associated power savings. The mixers can also be combined to span a wider range of frequencies with fine resolution.

The two integrated DAC channels support single-sideband or dual-channel operation. In addition, the DAC5687 is the first DAC available with complete integrated IQ compensation including phase, gain and offset control. This feature enables the optimization of the direct up-conversion architecture using IQ modulators.
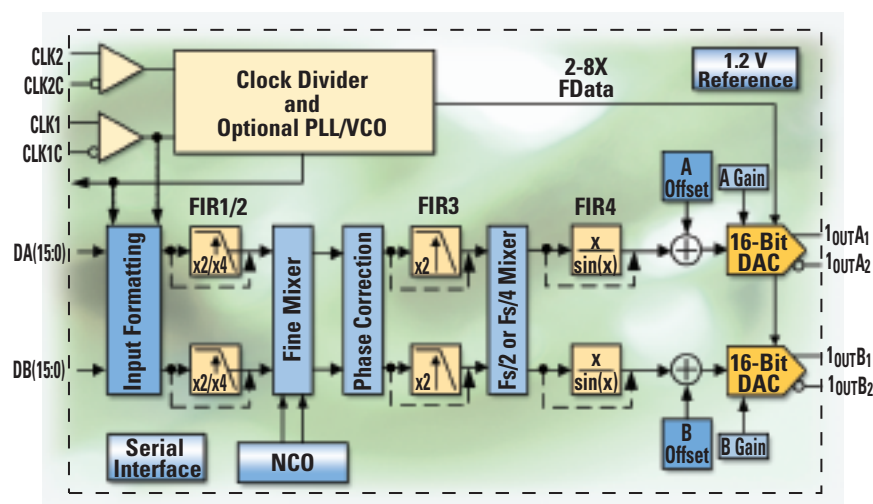
DAC5687 internal block diagram.

## Software Defined Radio with Real IF DAC output

The DAC5687 interpolation filters increase the complex sample rate by 2x-8x, which combined with the digital mixing capability and 32-bit NCO allows flexible placement of the signal at intermediate frequencies up to 250 MHz with less than 1 Hz resolution. The optional integrated PLL and VCO provides a simplified clocking architecture.
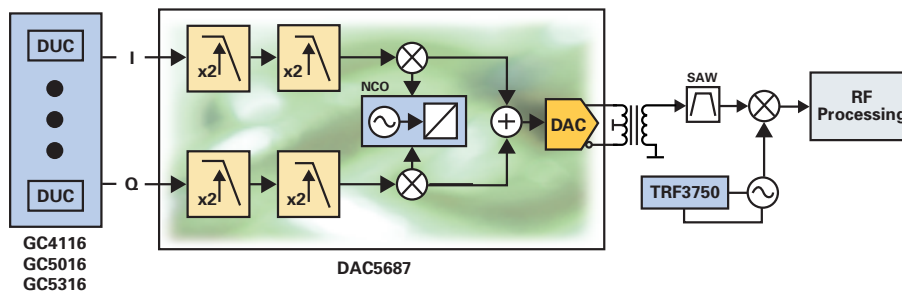
## WCDMA Test Model 1 at 30.72 MHz (left) and 153.6 MHz (right)
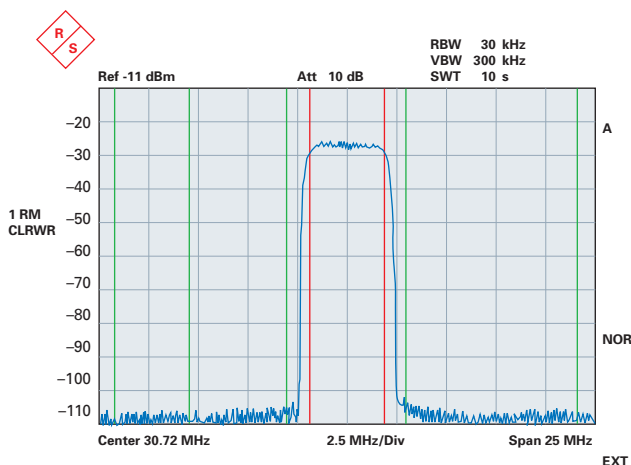
Tx Channel		WCDMA PWD	
Bandwidth	3.84 MHz	Power	−8.11 dBm
Adjacent Channel		Lower	−81.16 dB
Bandwidth	3.84 MHz	Upper	−80.16 dB
Spacing	5 MHz		
Alternate Channel		Lower	−83.28 dB
Bandwidth	3.84 MHz	Upper	−82.66 dB
Spacing	10 MHz		
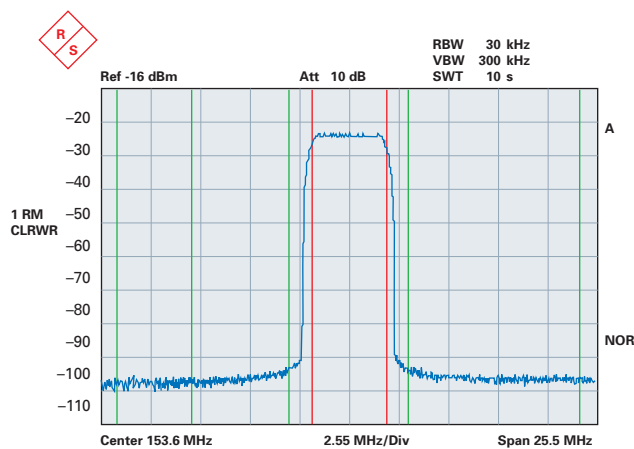
| Tx Channel		WCDMA PWD	
Bandwidth	3.84 MHz	Power	−9.88 dBm
Adjacent Channel		Lower	−71.47 dB
Bandwidth	3.84 MHz	Upper	−71.10 dB
Spacing	5 MHz		
Alternate Channel		Lower	−73.38 dB
Bandwidth	3.84 MHz	Upper	−72.16 dB
Spacing	10 MHz		

Wideband Multicarrier 3G Transmitter

With a signal-to-noise ratio (SNR) of >75 dBFS and intermodulation (IMD3) of >80 dBc at 25 MHz, the DAC5687's exceptional dynamic range allows multicarrier systems to operate with higher output power. With a complex input rate specified up to 250 MSPS, the DAC5687 is capable of producing signals with up to 200 MHz bandwidth for systems such as digital predistortion (DPD).
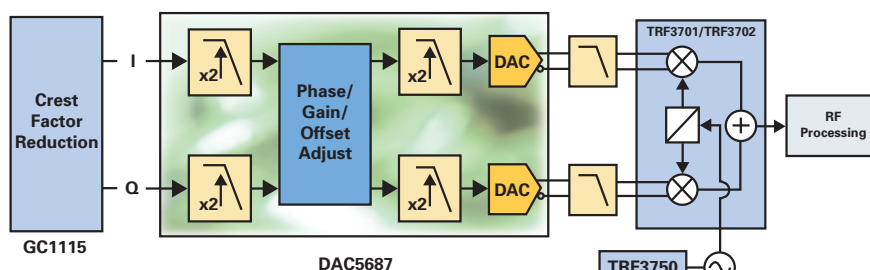
WiMAX/802.16 Dual Channel Transmitter

The DAC5687 can be configured with two independent signal paths. Fs/2 mixing after 2x and 4x interpolation provides the capability to increase the output IF up to 250 MHz. The outputs of multiple DAC5687s can be phase-synchronized for multiple antenna/beamforming applications.
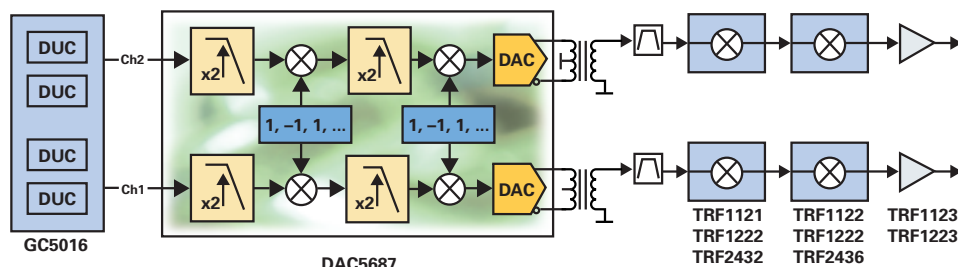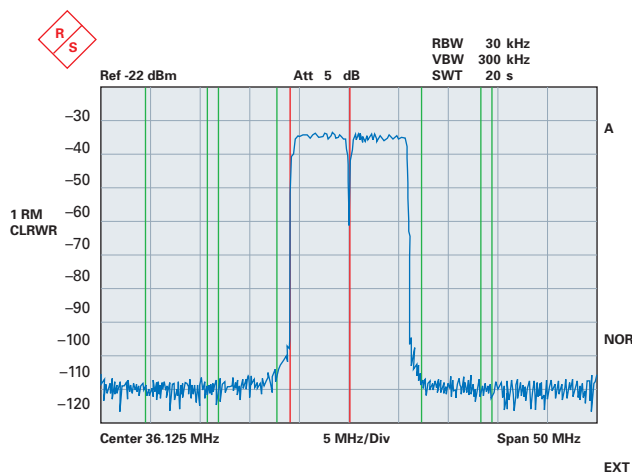

CMTS/VOD Four QAM Transmitter

The exceptional SNR of the DAC5687 enables a dual QAM transmitter in excess of the stringent DOCSIS specification, with >74 dBc and 75 dBc in the adjacent and alternate channels.
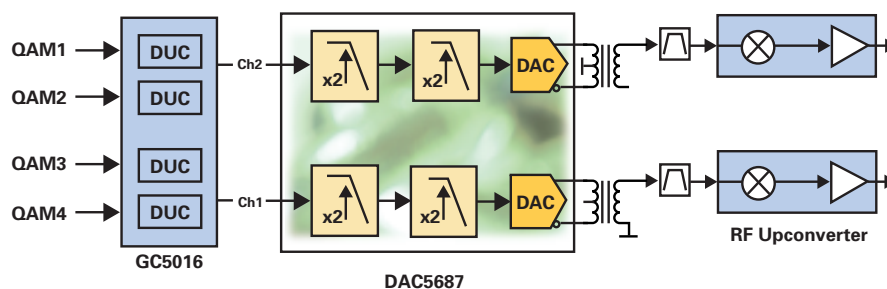
Two QAM255 carriers at IF = 36 MHz

Standard: NONE

Tx Channels

Ch1 (Ref)	−14.40 dBm
Ch2	−14.86 dBm
Total	−11.62 dBm

Adjacent Channel

Lower	−74.40 dB
Upper	−75.03 dB

Alternate Channel

Lower	−75.61 dB
Upper	−76.40 dB

High-Speed Test and Measurement Signal Generator

The flexible input of the DAC5687 allows use of the dual input ports with demultiplexed odd/even samples at a combined rate of 500 MSPS. Combined with the DAC's 16-bit resolution, the DAC5687 allows wideband signal generation for test and measurement applications.
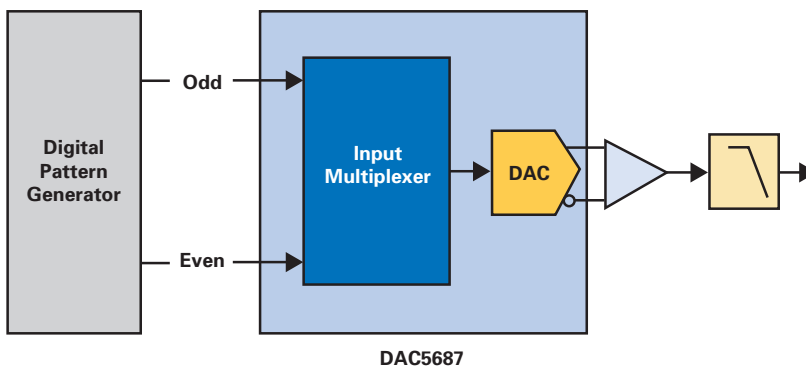
Exceptional Performance

The DAC5687 is among the industry's highest-performing DACs. The device features superior characteristics for linearity, noise, crosstalk and phase-locked loop (PLL) phase noise. The DAC5687 delivers SNR greater than 75 dBFS and IMD3 greater than 81 dBc. This, in turn, reduces radio frequency requirements and allows multi-carrier systems to operate with higher output power. These and other outstanding features provide clearer output signals which reduce the need for filtering, saving system components and board space.

The DAC5687 supports I/O voltages of 1.8 and 3.3 V, and has an integrated 1.2 V reference and PLL/VCO. Its low operating power of 700 mW at 500 MSPS helps to reduce overall operating costs, improve system reliability and enable higher base station channel density. An integrated sleep mode offers further power savings when the device is temporarily not in use.

With 100-pin, high-temperature quad flatpack (HTQFP), the DAC5687 is pin-compatible with TI's previous generation DAC5686, thus simplifying redesign efforts. For developers using DAC5687, TI provides an evaluation module (DAC5687EVM) and full documentation to ease integration into wireless base stations and other applications.

For More Information

To learn more about the DAC5687, or other TI wireless solutions, visit **www.ti.com/dac5687** Find out how the DAC5687 can add performance to your next design.

Get Started Today!

The DAC56887 evaluation module (EVM) provides design engineers with an easy-to-use development tool to evaluate product performance and ensure that your application requirements are met. To order an EVM, call your local TI sales representative.

For technical information on TI's high-speed solutions, get the new *Wireless Infrastructure Solutions Guide*. Download it at: **www.ti.com/wi**

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