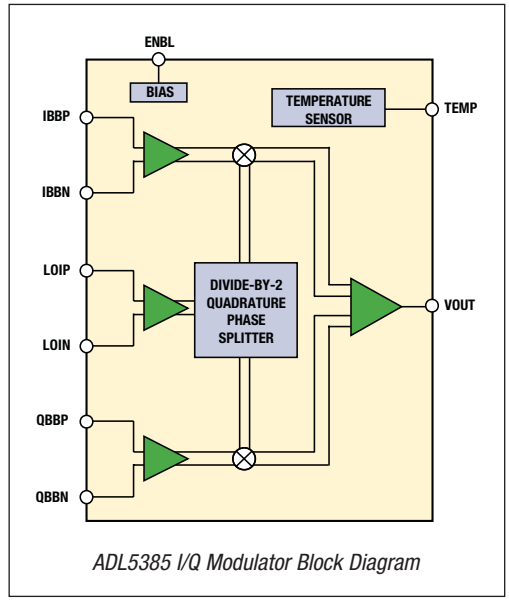
Broadband I/Q Modulator Eases Radio Design

Modern digital radio transmitter design poses increasing challenges for equipment designers. The trend towards greater throughput of data is increasing the modulation density and carrier bandwidths of transmitted signals. To maintain good adjacent channel power ratio (ACPR) while transmitting the same rms power level, components with lower intermodulation distortion and lower noise must be used.



ADL5385 I/Q Modulator Block Diagram

Baseband, IF, and RF bandwidth must be flat across the channel to maintain the spectral shape of the modulated carrier. When a radio transmitter design calls for operation over a very wide range of RF frequencies, the RF gain flatness of the overall signal chain becomes critical. Minimizing gain variations in the signal chain over frequency eases the burden of signal chain planning and budgeting.

The I/Q modulator is a critical component in the signal chain for modern digital transmitters. I/Q modulators perform the frequency translation that mixes the baseband signal to the desired location in the RF spectrum. An I/Q modulator consists of a local oscillator (LO) input that is split into in-phase (I) and quadrature (Q) components that are separated by 90°. These two signals drive separate mixers that are also driven by I and Q baseband signals. The outputs from both mixers are then summed to provide a modulated carrier either at RF or IF. The Analog Devices ADL5385 I/Q modulator contains these basic blocks (see illustration) and eases the designer's burden by providing broadband operation, high data rates, and excellent signal quality.

Many applications use a two-stage upconversion that requires more components, added cost, and complexity. The ADL5385 overcomes traditional polyphase limitations by utilizing an active divide-by-two LO splitter. The active splitter enables a wide tuning range that spans five octaves (50 MHz to 2.2 GHz). The LO and its complement are fed into two D flip flops. The output of the flip flops drives the mixer core. Because of the divide-by-two action of the LO signal, the LO must be twice the frequency of the desired RF output. LO symmetry is also extremely important as it directly contributes to the sideband suppression.

In single-channel modulation systems, data capacity can be increased by using higher order modulation techniques or by using more bandwidth. The challenge is to maintain flat gain across the bandwidth of the carrier to ensure that gain ripple is kept to a minimum, eliminating the need for precompensation. The ADL5385 0.1 dB baseband gain flatness extends out to 85 MHz, precluding the need for any precompensation for most applications.

Error vector magnitude (EVM) is a common measure of the quality of modulation of a signal, and it is directly affected by the quadrature and amplitude errors within the modulator. The amount of quadrature and amplitude errors can be gauged by observing the level of sideband suppression in a single-sideband spectrum. The native uncompensated sideband suppression of the ADL5385 is better than –38 dBc up to 900 MHz. Even higher performance can be achieved by adjusting the relative gain and phase of the baseband signals.

The low distortion of the ADL5385 enables it to achieve high output power levels with minimal adjacent channel leakage while allowing for less gain in the subsequent stages of the radio. This situation, along with the wide tuning range, permits the modulator to be used without factory calibration, significantly reducing the time and effort required for design and manufacturing.

To learn more about the ADL5385 and Analog Devices' extensive portfolio of RF and wireless components, visit *www.analog.com/LI-IQmod* or call 1-800-AnalogD. We offer data sheets, free samples, and additional information to help you with your radio design. ▶

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