869 MHz to 1990 MHz Quadrature Modulators

ADL5590/ADL5591

FEATURES

- **Operating frequencies**
  - **ADL5590: 869 MHz to 960 MHz**
  - **ADL5591: 1805 MHz to 1990 MHz**
- **Output compression point P1dB: 16 dBm**
- **Output third-order intercept point OIP3**
  - **ADL5590: 29 dBm @ 900 MHz**
  - **ADL5591: 30 dBm @ 1900 MHz**
- **Noise floor: −157 dBm/Hz**
- **Sideband suppression**
  - **ADL5590: <−50 dBc @ 900 MHz**
  - **ADL5591: <−47 dBc @ 1900 MHz**
- **Baseband common-mode bias: 1.5 V**
- **LO leakage**
  - **ADL5590: −50 dBc @ 900 MHz, P_{OUT} = 5 dBm**
  - **ADL5591: −44 dBc @ 1900 MHz, P_{OUT} = 5 dBm**
- **Single supply: 4.75 V to 5.25 V**
- **Package: 36-lead, 6 mm × 6 mm LFCSP**

APPLICATIONS

- **Wireless infrastructure**
- **Optimized for GSM transmitters**

GENERAL DESCRIPTION

This family of monolithic RF quadrature modulators is designed for use from 869 MHz to 960 MHz and from 1805 MHz to 1990 MHz. Excellent phase accuracy and amplitude balance enable high performance, direct RF modulation for communications systems.

The ADL5590 and ADL5591 can be used as direct RF modulators in digital communications systems such as those using the Global System for Mobile Communications (GSM) network. In addition, the parts are compatible with enhanced data rates for GSM evolution (EDGE).

This family is fabricated using an advanced silicon-germanium bipolar process from Analog Devices, Inc., and is available in a 36-lead, exposed paddle LFCSP. The devices operate from −40°C to +85°C.

FUNCTIONAL BLOCK DIAGRAM

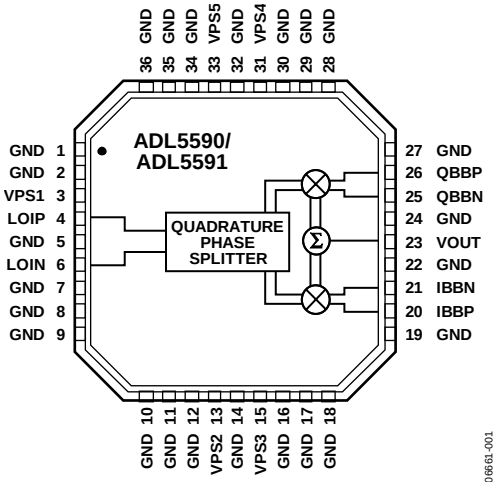

Figure 1.

Rev. 0
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REVISION HISTORY

5/07—Revision 0: Initial Version

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SPECIFICATIONS

V_S = 5 V; T_A= 25°C; LO = 2 dBm; baseband I/Q amplitude = 1 V p-p differential sine waves in quadrature with a 1.5 V dc bias; baseband I/Q frequency (f_{BB}) = 1 MHz, unless otherwise noted.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
Operating Frequency Range					
ADL5590		869		960	MHz
		1805		1990	MHz
ADL5590 @ f_{RF} = 880 MHz					
Output Power	V_{IQ} = 1.0 V p-p differential	3.75	5.9	8.0	dBm
vs. Frequency	f_{RF} = 869 MHz to 894 MHz		±0.1		dB
vs. Temperature	0°C to 85°C		0.01		dB/°C
	−25°C to 0°C		0.01		dB/°C
Sideband Suppression			−50		dBc
LO Leakage			−50		dBc
Output Return Loss			2.8		dB
Output P1 dB			16		dBm
Output IP3	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = 0 dBm per tone		29		dBm
Output IP2	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = 0 dBm per tone		66		dBm
Output Noise Density	P_{OUT} = 5 dBm, 6 MHz carrier offset		−155		dBc/Hz
Output Noise Floor	Baseband inputs biased to 1.5 V		−156.6		dBm/Hz
Modulation Spectrum	Relative to carrier in 30 kHz, P_{OUT} = 3 dBm, 8 PSK				
	250 kHz carrier offset		−42.5		dBc
	400 kHz carrier offset		−71.1		dBc
	600 kHz carrier offset		−78.5		dBc
	1.2 MHz carrier offset		−79.1		dBc
RMS Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		0.5		%
Peak Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		1.5		%
ADL5590 @ f_{RF} = 940 MHz					
Output Power	V_{IQ} = 1.0 V p-p differential	3.5	5.7	7.75	dBm
vs. Frequency	f_{RF} = 925 MHz to 960 MHz		±0.1		dB
vs. Temperature	0°C to 85°C		0.01		dB/°C
	−25°C to 0°C		0.01		dB/°C
Sideband Suppression			−50		dBc
LO Leakage			−50		dBc
Output Return Loss			3.2		dB
Output P1 dB			16		dBm
Output IP3	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = 0 dBm per tone		29		dBm
Output IP2	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = 0 dBm per tone		70		dBm
Output Noise Floor	Baseband inputs biased to 1.5 V		−156.6		dBm/Hz
Modulation Spectrum	Relative to carrier in 30 kHz, P_{OUT} = 3 dBm, 8 PSK				
	250 kHz carrier offset		−42.5		dBc
	400 kHz carrier offset		−71.1		dBc
	600 kHz carrier offset		−78.5		dBc
	1.2 MHz carrier offset		−79.1		dBc
RMS Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		0.4		%
Peak Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		1.4		%
ADL5591 @ f_{RF} = 1850 MHz	f_{RF} = 1850 MHz				
Output Power	V_{IQ} = 1.0 V p-p differential	3.0	5.0	7.0	dBm
vs. Frequency	f_{RF} = 1805 MHz to 1880 MHz		±0.1		dB
vs. Temperature	0°C to 85°C		0.011		dB/°C
	−25°C to 0°C		0.011		dB/°C
Sideband Suppression			−47		dBc
LO Leakage			−44		dBc

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Parameter	Conditions	Min	Typ	Max	Unit
Output Return Loss			5.4		dB
Output P1 dB			16		dBm
Output IP3	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = −1 dBm per tone		30		dBm
Output IP2	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = −1 dBm per tone		60		dBm
Output Noise Density	P_{OUT} = 5 dBm, 6 MHz carrier offset		−156		dBc/Hz
Output Noise Floor	Baseband inputs biased to 1.5 V		−157		dBm/Hz
Modulation Spectrum	Relative to carrier in 30 kHz, P_{OUT} = 3 dBm, 8 PSK				
	250 kHz carrier offset		−42.5		dBc
	400 kHz carrier offset		−71.3		dBc
	600 kHz carrier offset		−79.4		dBc
	1.2 MHz carrier offset		−80.2		dBc
RMS Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		0.5		%
Peak Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		1.7		%
ADL5591 @ f_{RF} = 1960 MHz					
Output Power	V_{IQ} = 1.0 V p-p differential	2.5	4.7	6.5	dBm
vs. Frequency	f_{RF} = 1930 MHz to 1990 MHz		±0.1		dB
vs. Temperature	0°C to 85°C		+0.011		dB/°C
	−25°C to 0°C		+0.011		dB/°C
Sideband Suppression			−48		dBc
LO Leakage			−44		dBc
Output Return Loss			6.0		dB
Output P1dB			16		dBm
Output IP3	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = −1 dBm per tone		30		dBm
Output IP2	$f1_{BB}$ = 3.5 MHz, $f2_{BB}$ = 4.5 MHz, P_{OUT} = −1 dBm per tone		60		dBm
Output Noise Density	P_{OUT} = 5 dBm, 6 MHz carrier offset		−156		dBc/Hz
Output Noise Floor	Baseband inputs biased to 1.5 V		157		dBm/Hz
Modulation Spectrum	Relative to carrier in 30 kHz, P_{OUT} = 3 dBm, 8 PSK				
	250 kHz carrier offset		−42.5		dBc
	400 kHz carrier offset		−71.4		dBc
	600 kHz carrier offset		−79.7		dBc
	1.2 MHz carrier offset		−80.5		dBc
RMS Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		0.5		%
Peak Error Vector Magnitude	P_{OUT} = 3 dBm, 8 PSK		1.6		%
LO INPUTS	LOIP, LOIN				
LO Drive Level[1]		−1	+2	+5	dBm
Input Return Loss	ADL5590 @ f_{RF} = 880 MHz		7.5		dB
	ADL5591 @ f_{RF} = 1850 MHz		10.7		dB
BASEBAND INPUTS	Pins IBBP, IBBN, QBBP, QBBN				
I and Q Input Bias Level			1.5		V
Bandwidth (3 dB)			250		MHz
Differential Input Impedance			9		kΩ
POWER SUPPLIES	Pin VPS1 to Pin VPS5				
Voltage	Full specification	4.75		5.25	V
	Degraded specification	4.5		5.5	V
Supply Current					
ADL5590			170		mA
ADL5591			170		mA

[1] LO drive in excess of 5 dBm can be provided to further reduce noise at 6 MHz carrier offset.

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ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage, VPS1 to VPS5	5.5 V
IBBP, IBBN, QBBP, QBBN	0 V, 3 V
LOIP	10 dBm
Internal Power Dissipation	1155 mW
θ_{JA} (Exposed Paddle Soldered Down)	40°C/W
Maximum Junction Temperature	132°C
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Maximum Soldering Temperature	260°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

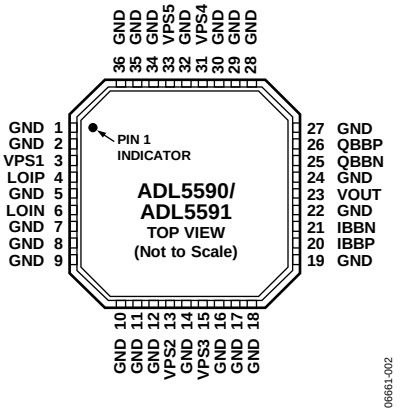

Figure 2. ADL5590/ADL5591 Pin Configuration

Table 3. Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 2, 5, 7 to 12, 14, 16 to 19, 22, 24, 27 to 30, 32, 34 to 36	GND	Ground. Connect to ground plane via a low impedance path.
3, 13, 15, 31, 33	VPS1, VPS2, VPS3, VPS4, VPS5	Positive Supply Voltage. All pins should be connected to the same supply. To ensure adequate external bypassing, connect 0.1 µF capacitors between each pin and ground.
4, 6	LOIP, LOIN	Local Oscillator Input. 50 Ω single-ended local oscillator input. Pins must be ac-coupled. AC-couple LOIN to ground and drive LO through LOIP.
20, 21, 25, 26	IBBP, IBBN, QBBN, QBBP	Baseband Inputs. Differential in-phase and quadrature baseband inputs. These high impedance inputs must be dc-biased to approximately 1.5 V dc. These inputs are not self-biased and must be externally biased.
23	VOUT	RF Output. Single-ended, 50 Ω, internally biased RF output. Pin must be ac-coupled to the load.
–	Exposed Paddle	Exposed Paddle. Connect to ground plane via a low impedance path.

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BASIC CONNECTIONS

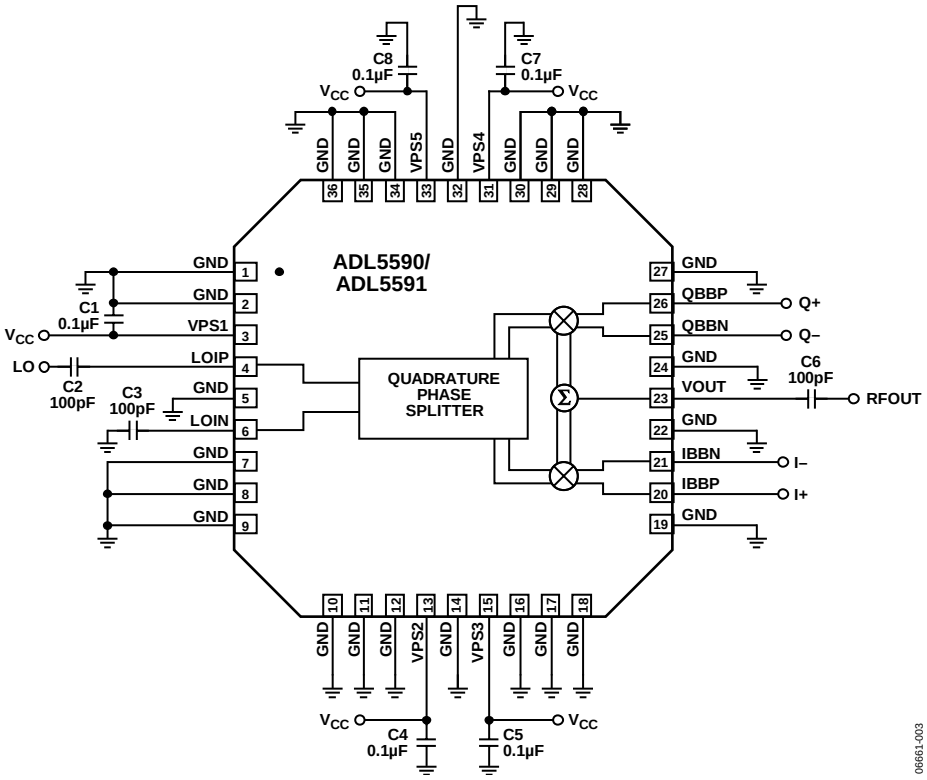

Figure 3. Basic Connections for Operation

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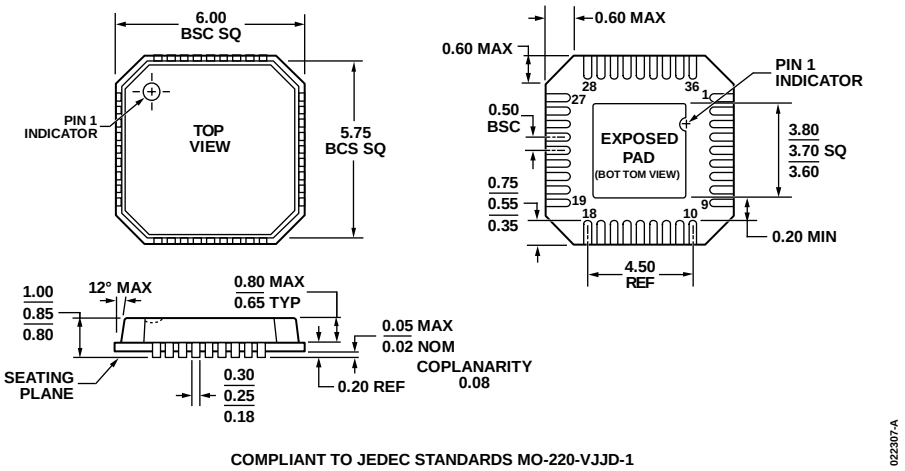
OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-220-VJJD-1

Figure 4. 36-Lead Lead Frame Chip Scale Package [LFCSP_VQ]
6 mm × 6 mm Body, Very Thin Quad
(CP-36-1)
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADL5590ACPZ-R7[1]	−40°C to +85°C	36-Lead LFCSP_VQ, 7" Tape and Reel	CP-36-1
ADL5591ACPZ-R7[1]	−40°C to +85°C	36-Lead LFCSP_VQ, 7" Tape and Reel	CP-36-1

[1] Z = RoHS Compliant Part.

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