

### 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 at 900 MHz

**ADL5591:** 30 dBm at 1900 MHz

#### Noise floor: -157 dBm/Hz

#### Sideband suppression

**ADL5590:** <-50 dBc at 900 MHz

**ADL5591:** <-47 dBc at 1900 MHz

#### Baseband common-mode bias: 1.5 V

#### LO leakage

**ADL5590:** -50 dBc at 900 MHz, P<sub>OUT</sub> = 5 dBm

**ADL5591:** -44 dBc at 1900 MHz, P<sub>OUT</sub> = 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 devices are compatible with enhanced data rates for GSM evolution (EDGE).

### FUNCTIONAL BLOCK DIAGRAM

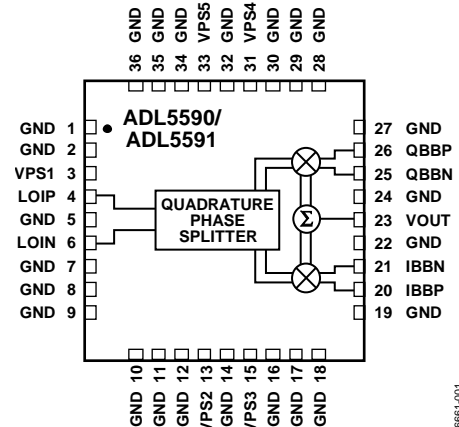


Figure 1.

06861-001

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

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**REVISION HISTORY**

**4/16—Rev. 0 to Rev. A**

Changes to Figure 1 .....	1
Changes to Figure 2.....	6
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Updated Outline Dimensions .....	8
Changes to Ordering Guide .....	8

**5/07—Revision 0: Initial Version**

## SPECIFICATIONS

$V_S = 5\text{ V}$ ;  $T_A = 25^\circ\text{C}$ ; 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 ( $f_{\text{BB}}$ ) = 1 MHz, unless otherwise noted.

Table 1.

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
Operating Frequency Range ADL5590		869 1805		960 1990	MHz MHz
ADL5590 @ $f_{\text{RF}} = 880\text{ MHz}$					
Output Power vs. Frequency vs. Temperature	$V_{\text{IQ}} = 1.0\text{ V p-p differential}$ $f_{\text{RF}} = 869\text{ MHz to }894\text{ MHz}$ $0^\circ\text{C to }85^\circ\text{C}$ $-25^\circ\text{C to }0^\circ\text{C}$	3.75	5.9 $\pm 0.1$ 0.01 0.01	8.0	dBm dB dB/ $^\circ\text{C}$ dB/ $^\circ\text{C}$
Sideband Suppression			-50		dBc
LO Leakage			-50		dBc
Output Return Loss			2.8		dB
Output P1 dB			16		dBm
Output IP3	$f_{1\text{BB}} = 3.5\text{ MHz}, f_{2\text{BB}} = 4.5\text{ MHz}, P_{\text{OUT}} = 0\text{ dBm per tone}$		29		dBm
Output IP2	$f_{1\text{BB}} = 3.5\text{ MHz}, f_{2\text{BB}} = 4.5\text{ MHz}, P_{\text{OUT}} = 0\text{ dBm per tone}$		66		dBm
Output Noise Density	$P_{\text{OUT}} = 5\text{ dBm}, 6\text{ MHz carrier offset}$		-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, $P_{\text{OUT}} = 3\text{ dBm}, 8\text{ PSK}$ 250 kHz carrier offset 400 kHz carrier offset 600 kHz carrier offset 1.2 MHz carrier offset		-42.5 -71.1 -78.5 -79.1		dBc dBc dBc dBc
RMS Error Vector Magnitude	$P_{\text{OUT}} = 3\text{ dBm}, 8\text{ PSK}$		0.5		%
Peak Error Vector Magnitude	$P_{\text{OUT}} = 3\text{ dBm}, 8\text{ PSK}$		1.5		%
ADL5590 @ $f_{\text{RF}} = 940\text{ MHz}$					
Output Power vs. Frequency vs. Temperature	$V_{\text{IQ}} = 1.0\text{ V p-p differential}$ $f_{\text{RF}} = 925\text{ MHz to }960\text{ MHz}$ $0^\circ\text{C to }85^\circ\text{C}$ $-25^\circ\text{C to }0^\circ\text{C}$	3.5	5.7 $\pm 0.1$ 0.01 0.01	7.75	dBm dB dB/ $^\circ\text{C}$ dB/ $^\circ\text{C}$
Sideband Suppression			-50		dBc
LO Leakage			-50		dBc
Output Return Loss			3.2		dB
Output P1 dB			16		dBm
Output IP3	$f_{1\text{BB}} = 3.5\text{ MHz}, f_{2\text{BB}} = 4.5\text{ MHz}, P_{\text{OUT}} = 0\text{ dBm per tone}$		29		dBm
Output IP2	$f_{1\text{BB}} = 3.5\text{ MHz}, f_{2\text{BB}} = 4.5\text{ MHz}, P_{\text{OUT}} = 0\text{ dBm per tone}$		70		dBm
Output Noise Floor	Baseband inputs biased to 1.5 V		-156.6		dBm/Hz
Modulation Spectrum	Relative to carrier in 30 kHz, $P_{\text{OUT}} = 3\text{ dBm}, 8\text{ PSK}$ 250 kHz carrier offset 400 kHz carrier offset 600 kHz carrier offset 1.2 MHz carrier offset		-42.5 -71.1 -78.5 -79.1		dBc dBc dBc dBc
RMS Error Vector Magnitude	$P_{\text{OUT}} = 3\text{ dBm}, 8\text{ PSK}$		0.4		%
Peak Error Vector Magnitude	$P_{\text{OUT}} = 3\text{ dBm}, 8\text{ PSK}$		1.4		%
ADL5591 @ $f_{\text{RF}} = 1850\text{ MHz}$					
Output Power vs. Frequency vs. Temperature	$f_{\text{RF}} = 1850\text{ MHz}$ $V_{\text{IQ}} = 1.0\text{ V p-p differential}$ $f_{\text{RF}} = 1805\text{ MHz to }1880\text{ MHz}$ $0^\circ\text{C to }85^\circ\text{C}$ $-25^\circ\text{C to }0^\circ\text{C}$	3.0	5.0 $\pm 0.1$ 0.011 0.011	7.0	dBm dB dB/ $^\circ\text{C}$ dB/ $^\circ\text{C}$
Sideband Suppression			-47		dBc

Parameter	Test Conditions/Comments	Min	Typ	Max	Unit
LO Leakage			-44		dBc
Output Return Loss			5.4		dB
Output P1 dB			16		dBm
Output IP3	$f_{1BB} = 3.5 \text{ MHz}$ , $f_{2BB} = 4.5 \text{ MHz}$ , $P_{OUT} = -1 \text{ dBm}$ per tone		30		dBm
Output IP2	$f_{1BB} = 3.5 \text{ MHz}$ , $f_{2BB} = 4.5 \text{ MHz}$ , $P_{OUT} = -1 \text{ dBm}$ per tone		60		dBm
Output Noise Density	$P_{OUT} = 5 \text{ dBm}$ , 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, $P_{OUT} = 3 \text{ dBm}$ , 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	$P_{OUT} = 3 \text{ dBm}$ , 8 PSK		0.5		%
Peak Error Vector Magnitude	$P_{OUT} = 3 \text{ dBm}$ , 8 PSK		1.7		%
<b>ADL5591</b> @ $f_{RF} = 1960 \text{ MHz}$					
Output Power	$V_{IQ} = 1.0 \text{ V p-p}$ differential	2.5	4.7	6.5	dBm
vs. Frequency	$f_{RF} = 1930 \text{ MHz}$ to 1990 MHz		$\pm 0.1$		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	$f_{1BB} = 3.5 \text{ MHz}$ , $f_{2BB} = 4.5 \text{ MHz}$ , $P_{OUT} = -1 \text{ dBm}$ per tone		30		dBm
Output IP2	$f_{1BB} = 3.5 \text{ MHz}$ , $f_{2BB} = 4.5 \text{ MHz}$ , $P_{OUT} = -1 \text{ dBm}$ per tone		60		dBm
Output Noise Density	$P_{OUT} = 5 \text{ dBm}$ , 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, $P_{OUT} = 3 \text{ dBm}$ , 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	$P_{OUT} = 3 \text{ dBm}$ , 8 PSK		0.5		%
Peak Error Vector Magnitude	$P_{OUT} = 3 \text{ dBm}$ , 8 PSK		1.6		%
<b>LO INPUTS</b>					
LO Drive Level <sup>1</sup>	LOIP, LOIN	-1	+2	+5	dBm
Input Return Loss	<a href="#">ADL5590</a> @ $f_{RF} = 880 \text{ MHz}$		7.5		dB
	<a href="#">ADL5591</a> @ $f_{RF} = 1850 \text{ MHz}$		10.7		dB
<b>BASEBAND INPUTS</b>					
I and Q Input Bias Level	Pins IBBP, IBBN, QBBP, QBBN		1.5		V
Bandwidth (3 dB)			250		MHz
Differential Input Impedance			9		k $\Omega$
<b>POWER SUPPLIES</b>					
Voltage	Pin VPS1 to Pin VPS5	4.75		5.25	V
	Full specification	4.5		5.5	V
	Degraded specification				
Supply Current			170		mA
<a href="#">ADL5590</a>			170		mA
<a href="#">ADL5591</a>			170		mA

<sup>1</sup> LO drive in excess of 5 dBm can be provided to further reduce noise at 6 MHz carrier offset.

## 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
$\theta_{JA}$ (Exposed Pad 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

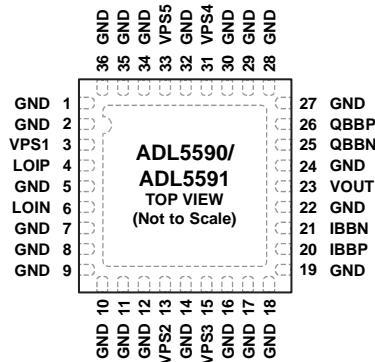
Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation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

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS



**NOTES**  
 1. EXPOSED PAD. CONNECT THE EXPOSED PAD TO THE GROUND PLANE VIA A LOW IMPEDANCE PATH.

0986-1-002

Figure 2. 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. Connect all pins to the same supply. To ensure adequate external bypassing, connect 0.1 $\mu$ F capacitors between each pin and ground.
4, 6	LOIP, LOIN	Local Oscillator Input. 50 $\Omega$ 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 $\Omega$ , internally biased RF output. Pin must be ac-coupled to the load.
	Exposed Pad	Exposed Pad. Connect the exposed pad to the ground plane via a low impedance path.

**BASIC CONNECTIONS**

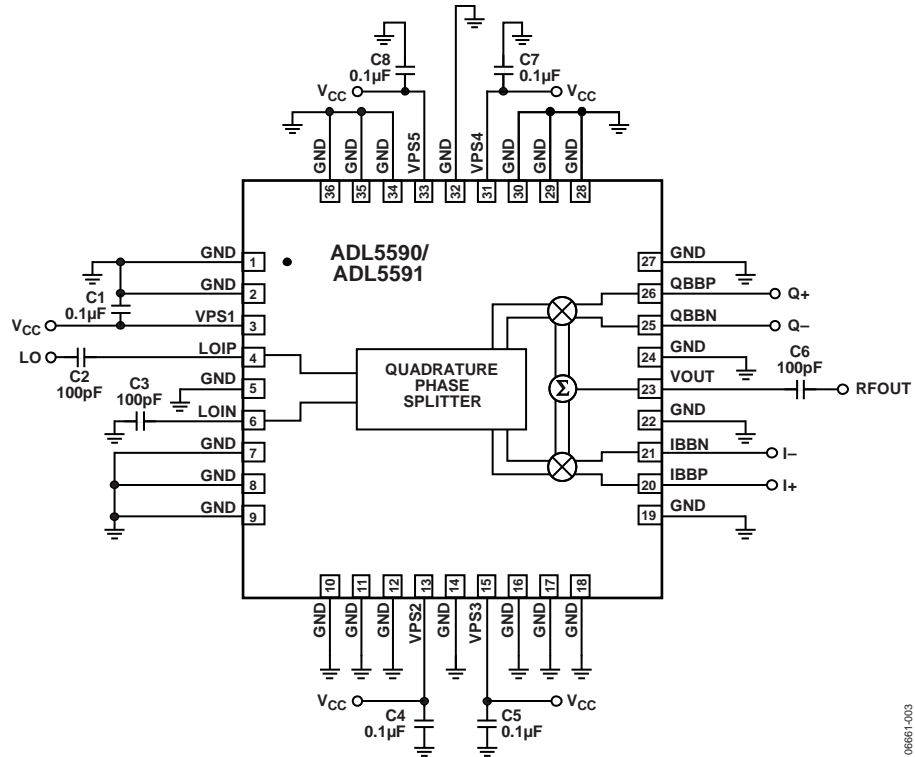
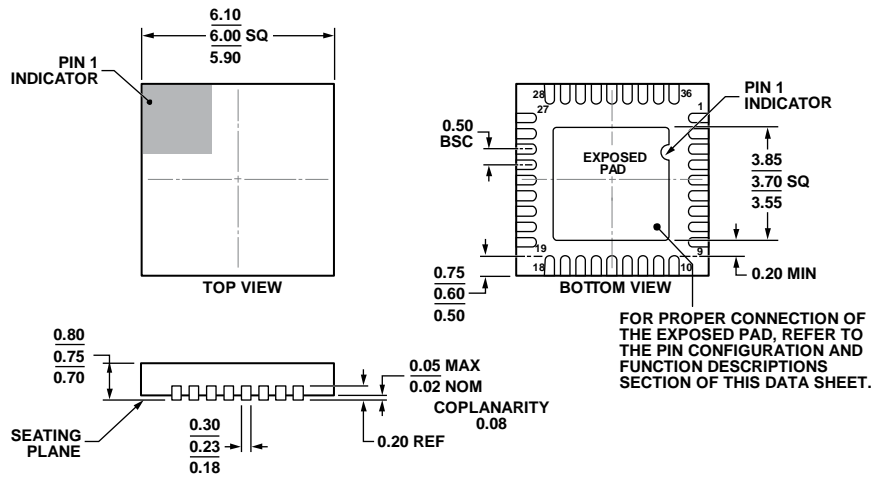


Figure 3. Basic Connections for Operation

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OUTLINE DIMENSIONS



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COMPLIANT TO JEDEC STANDARDS MO-220-WJJD-1.

Figure 4. 36-Lead Lead Frame Chip Scale Package [LFCSP]  
6 mm × 6 mm Body and 0.75 mm Package Height  
(CP-36-4)

Dimensions shown in millimeters

ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
ADL5590ACPZ-R7	-40°C to +85°C	36-Lead LFCSP, 7" Tape and Reel	CP-36-4
ADL5591ACPZ-R7	-40°C to +85°C	36-Lead LFCSP, 7" Tape and Reel	CP-36-4

<sup>1</sup> Z = RoHS Compliant Part.