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DATA SHEET

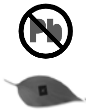
SE2600S: 2.4 GHz WLAN Switch/Low-Noise Amplifier Front-End

Applications

- IEEE802.11b DSSS WLAN
- IEEE802.11g/n OFDM WLAN
- Embedded systems

Features

- Integrates an SP3T switch and LNA with bypass mode
- Gain: 12 dB
- Noise Figure: 1.8 dB
- Bluetooth® path loss: 0.5 dB
- Small WLCSP (11-bump, 1.07 x 1.05 x 0.38 mm) 250 µm ball pitch package (MSL1, 260 °C per JEDEC-J-STD-020)



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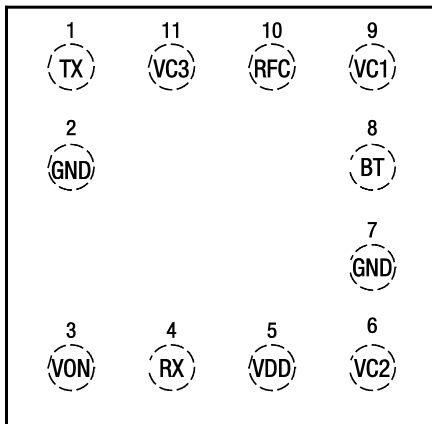


Figure 2. SE2600S Pinout – 11-Bump CSP (Top View, Bumps Down)

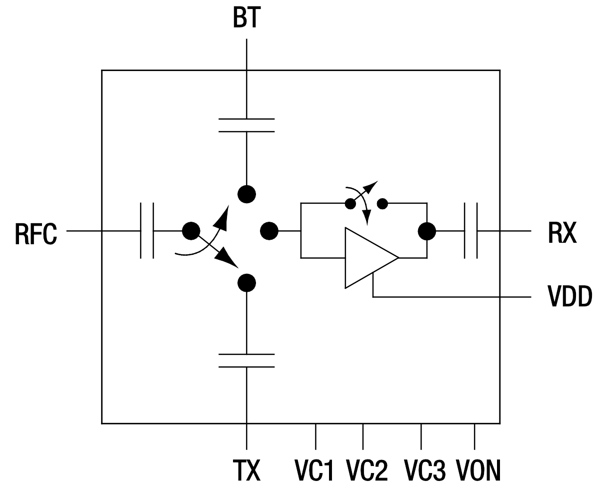


Figure 1. SE2600S Block Diagram

Description

The SE2600S is an integrated Front-End Module (FEM) with a Bluetooth port to complement WLAN chipsets with an integrated Power Amplifier (PA).

The SE2600S integrates a Single-Pole, Triple-Throw (SP3T) switch and Low-Noise Amplifier (LNA) with a bypass mode in an ultra-compact package. The device is capable of switching between WLAN receive, WLAN transmit, and Bluetooth.

The SE2600S is provided in a small, 11-bump, 1.07 x 1.05 mm Wafer Level Chip Scale Package (WLCSP). A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

Table 1. SE2600S Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	TX	WLAN transmit port	7	GND	Ground
2	GND	Ground	8	BT	Bluetooth port
3	VON	LNA control signal	9	VC1	BT switch control pin
4	RX	WLAN receive port	10	RFC	RF common port (antenna)
5	VDD	Positive power supply voltage	11	VC3	Transmit switch control pin
6	VC2	Receive switch control pin			

Table 2. SE2600S Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{DD}	0	3.6	V
DC input on control pins		–0.5	V_{DD} + 0.5	V
Transmit input power, RFC terminated in 50 Ω match	P_{IN}		+27	dBm
Operating temperature	T_A	–40	+85	°C
Storage temperature	T_{STG}	–40	+150	°C

Note: Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

***CAUTION**: Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times. The SE2600S ESD threshold level is 1000 VDC using Human Body Model (HBM) testing.*

Table 3. Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage	V_{DD}	2.7	3.3	3.6	V
Control voltage (relative to GND = 0 V)	V_{CTL}	0		V_{DD}	V
Operating temperature	T_A	–40	+25	+85	°C

Electrical and Mechanical Specifications

The absolute maximum ratings of the SE2600S are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Tables 4 through 7.

The state of the SE2600S is determined by the logic provided in Table 8.

Table 4. SE2600S Electrical Specifications: DC Characteristics (Note 1)
(V_{DD} = 3.3 V, T_A = +25 °C, All Unused Ports Terminated With 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
LNA current	I_{DD}	High gain mode Bypass mode		10	13 60	mA µA
LNA control current	I_{CTL}				20	µA
BT port control current	I_{C1}				20	µA
TX port control current	I_{C3}				20	µA
Control voltage: High Low	 V_{IH} V_{IL}		 2.7 0		 3.6 0.3	 V V

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 5. SE2600S Electrical Specifications: AC Characteristics, Transmit (RFC to TX Port) (Note 1)
(VC1 = VC2 = VON = 0 V, V_{DD} = 3.3 V, T_A = +25 °C, All Unused Ports Terminated With 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency	f		2.4		2.5	GHz
Insertion loss	IL			0.5	0.7	dB
Input return loss	S_{11}			–16	–14	dB
Output return loss	S_{22}			–16	–14	dB
Switch isolation	Iso	VC3 = 0 V	23			dB
1 dB Input Compression Point	IP1dB		+31			dBm
Turn-on/turn-off time	T_{ON}, T_{OFF}	90/10% of final output power level			400	ns

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 6. SE2600S Electrical Specifications: AC Characteristics, Bluetooth (RFC to BT Port) (Note 1)
(VC2 = VC3 = VON = 0 V, V_{DD} = 3.3 V, T_A = +25 °C, All Unused Ports Terminated With 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency	f		2.4		2.5	GHz
Insertion loss	IL			0.5	0.7	dB
Input return loss, BT port	S_{11}			–16	–14	dB
Output return loss, BT port	S_{22}			–16	–14	dB
Switch isolation	Iso	VC1 = 0 V	25			dB
1 dB Input Compression Point	IP1dB		+31			dBm
Turn-on/turn-off time	T_{ON}, T_{OFF}	90/10% of final output power level			400	ns

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 7. SE2600S Electrical Specifications: Receive Characteristics (RFC to RX Port) (Note 1)
(VC1 = VC3 = 0 V, V_{DD} = 3.3 V, T_A = +25 °C, All Unused Ports Terminated With 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency	f		2.4		2.5	GHz
Receive gain, LNA enabled	S_{21}		+11	+12	+13	dB
Receive gain, LNA bypassed	S_{21_BYP}		–4	–3		dB
Input return loss	S_{11}			–10	–8	dB
Output return loss	S_{22}			–10	–8	dB
Noise Figure	NF			1.8	2.0	dB
1 dB Input Compression Point	IP1dB		–6	–5		dBm
Turn-on/turn-off time	T_{ON}, T_{OFF}	90/10% of final output power level			400	ns

Note 1: Performance is guaranteed only under the conditions listed in this Table.

Table 8. SE2600S Control Logic

Mode	Path	VC1 (Pin 9)	VC2 (Pin 6)	VC3 (Pin 11)	VON (Pin 3)
All off	N/A	0	0	0	0
Transmit	TX to RFC	0	0	1	0
Bluetooth	RFC to BT	1	0	0	0
High gain (receive)	RFC to RX	0	1	0	1
Bypass (receive)	RFC to RX	0	1	0	0

Note: "0" = 0 V to +0.3 V. "1" = +2.7 V to +3.6 V. Any state other than described in this Table places the switch into an undefined state. An undefined state will not damage the device.

Evaluation Board Description

The SE2600S Evaluation Board is used to test the performance of the SE2600S LNA FEM. An Evaluation Board schematic diagram is provided in Figure 3. Table 9 provides the Bill of Materials (BOM) list for Evaluation Board components. An assembly drawing for the Evaluation Board is shown in Figure 4.

Evaluation Board Setup Procedure

Step 1: Connect system ground to pin 1 of the J14 header.

Step 2: Apply 3.3 V to pin 14 of the J14 header.

Step 3: Select a path/mode according to the information in Table 8. For the J14 header pinout, refer to the Evaluation Board silkscreen and schematic in Figure 3.

NOTE*: In case only three controls are available from the application, (transmit, receive, and Bluetooth), connect the VC2 and VON signals together. In this configuration, the LNA is always "on" in receive mode (corresponding to high gain mode in Table 8). The LNA 3rd Order Input Intercept Point (IIP3) is > +5 dBm.*

Evaluation Board Losses

The board losses from the RF connectors of the Evaluation Board to the pins of the SE2600S are:

RFC: 0.175 dB
TX: 0.165 dB
RX: 0.175 dB
BT: 0.21 dB

Package Dimensions

The PCB layout footprint for the SE2600S is provided in Figure 5. Typical case markings are shown in Figure 6. Package dimensions for the 11-bump WLCSP are shown in Figure 7, and tape and reel dimensions are provided in Figure 8.

Package and Handling Information

Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SE2600S is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design and SMT Assembly Guidelines for Wafer Level Chip Scale Packages*, document number 201676.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

Underfill Requirements

The assembly of a WLCSP onto an electrical substrate requires special handling and normally needs an underfill liquid epoxy mold compound. When fully cured, the underfill material forms a rigid, low-stress seal that dissipates stress on solder joints and extends thermal cycling performance. Skyworks recommends the use of Loctite Hysol 4549 as an underfill material, which should be cured for 30 minutes at +165 °C.

If the WLCSP is attached without an underfill, the circuit is more susceptible to mechanical damage. Damage can even occur if components in close proximity to the WLCSP are soldered or unsoldered on the substrate without evenly preheating the entire board and die. Mechanical damage to the solder joint between the board and die could result, which may impact electrical connectivity.

Pad Coordinates

The SE2600S pad coordinates are provided in Table 10 (also refer to the pinout diagram in Figure 2). The origin of the coordinates (i.e., X = 0, Y = 0) is located at the center of the SE2600S package. Sense is top view through package (PCB footprint).

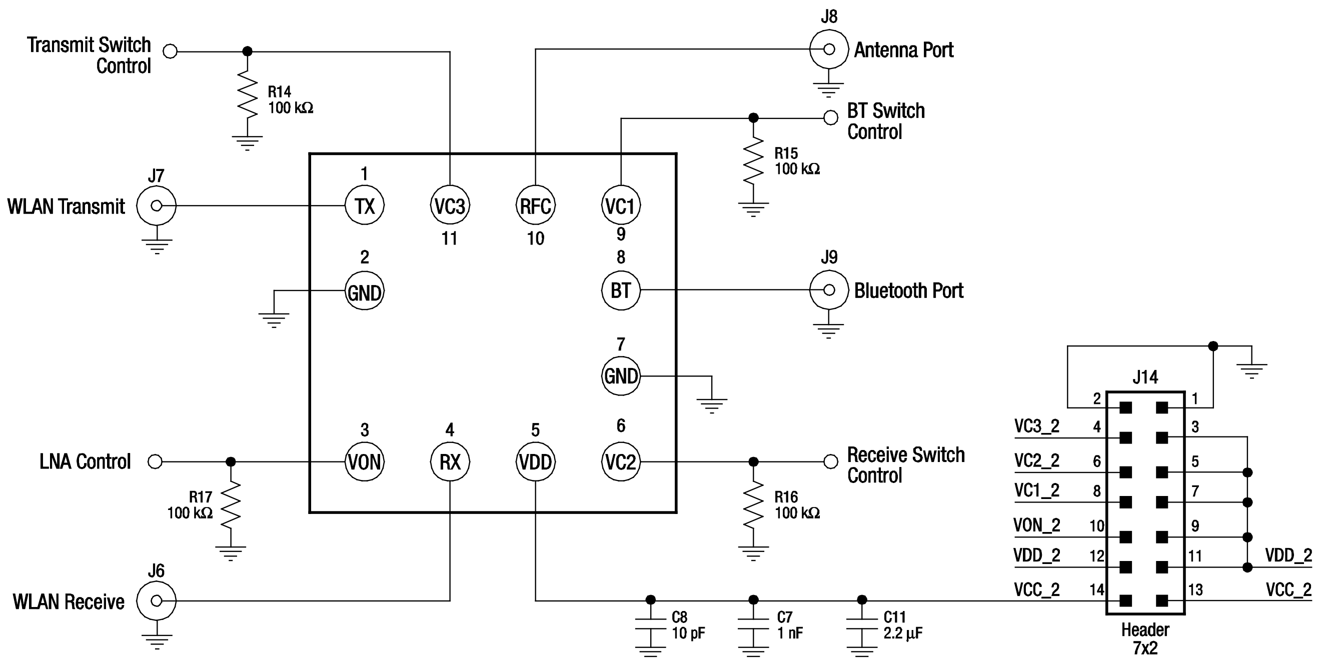


Figure 3. SE2600S Evaluation Board Schematic

Table 9. SE2600S Evaluation Board Bill of Materials (BOM)

Component	Value	Size	Manufacturer	Manufacturer's Part #	Characteristics
C7	1 nF	0402	Murata	GRM155R71H102KA01	Multi-layer ceramic
C8	10 pF	0402	Murata	GRM1555C1H100JZ01	Multi-layer ceramic
C11	2.2 μF	0603	Murata	GRM188R71A225KE15D	Monolithic ceramic
J14	–	100 mil	Samtec	TSW-107-07-G-D	7x2 100 mil pin header
R14, R15, R16, R17	100 kΩ	0402	Panasonic	ERJ2GEJ104	Thick film chip resistor

Table 10. SE2600S Bump Pad Coordinates

Bump Number	Bump Label	Bump Coordinates	
		X (μm)	Y (μm)
1	TX	–375	+375
2	GND	–375	+125
3	VON	–375	–375
4	RX	–125	–375
5	VDD	+125	–375
6	VC2	+375	–375
7	GND	+375	–125
8	BT	+375	+125
9	VC1	+375	+375
10	RFC	+125	+375
11	VC3	–125	+375

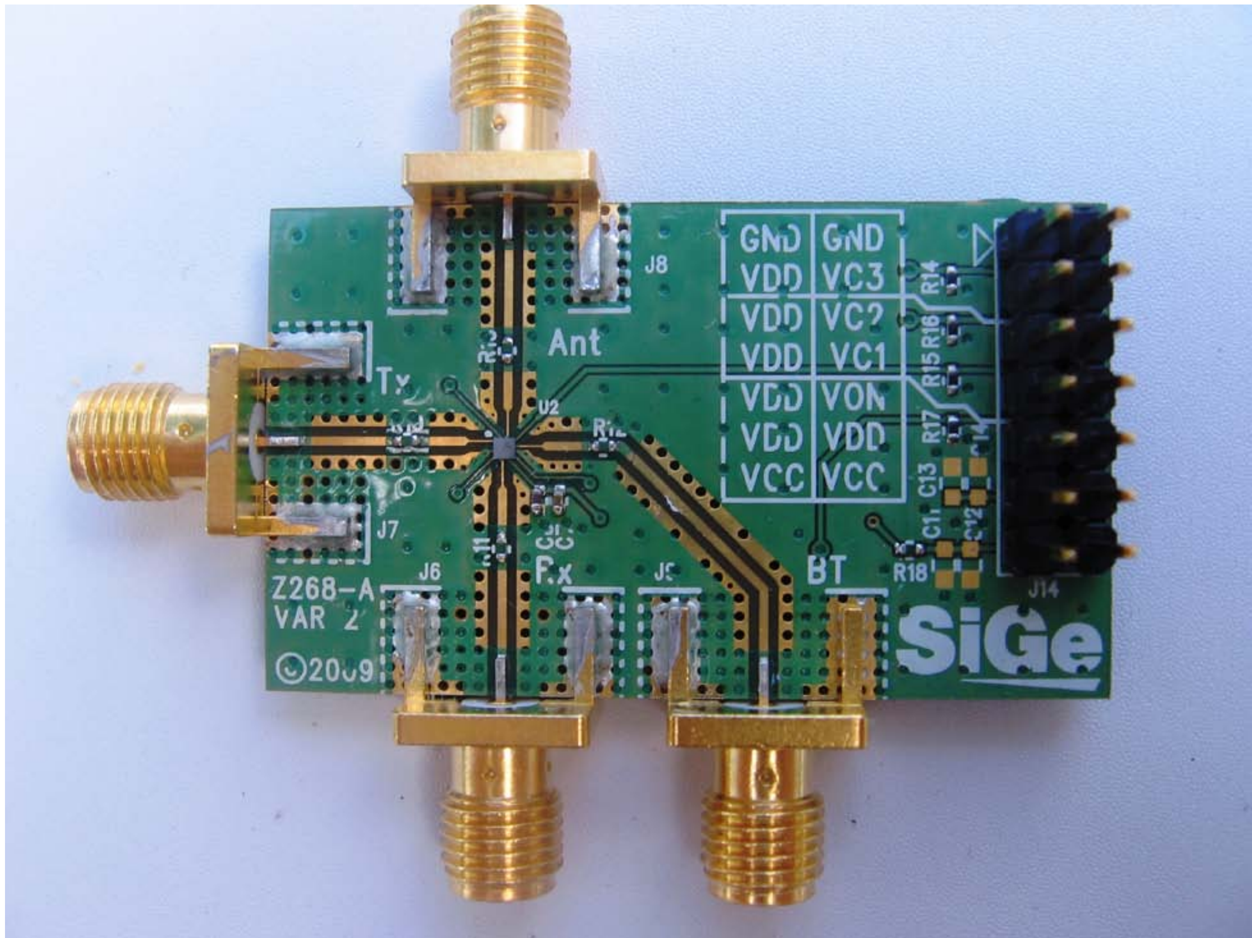
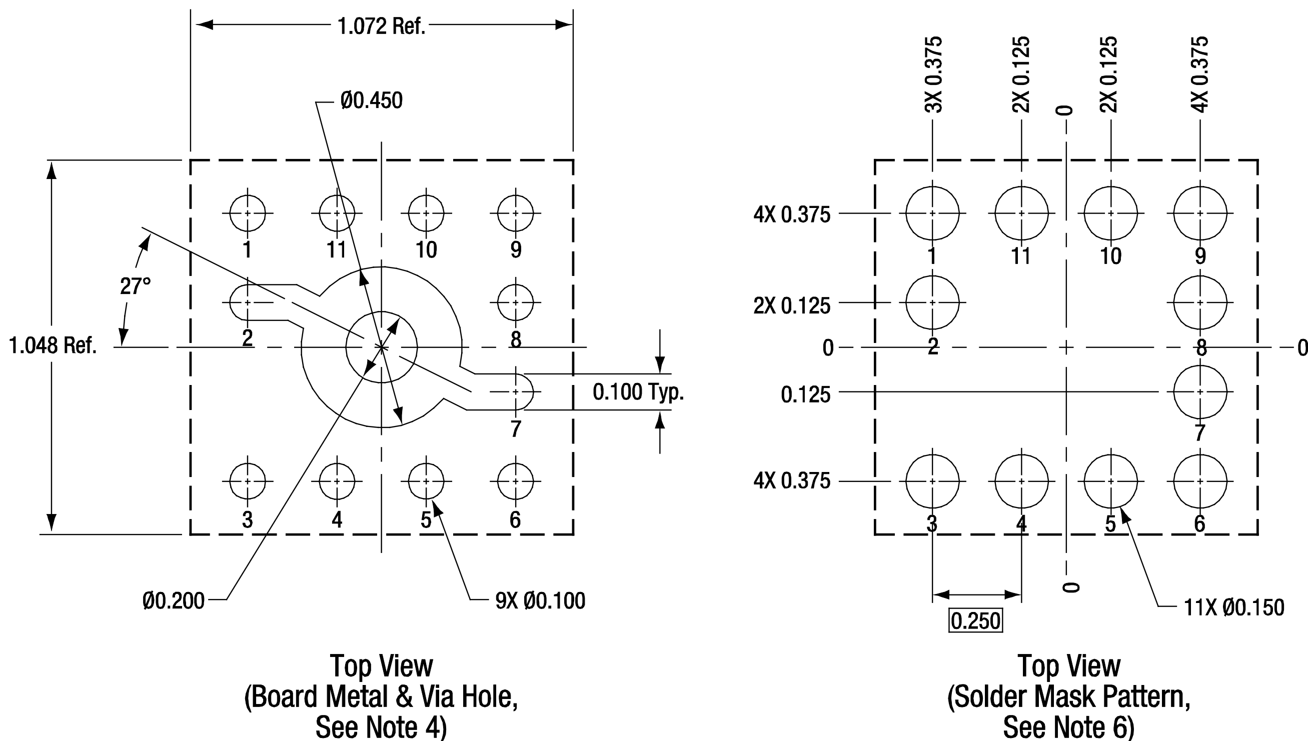


Figure 4. SE2600S Evaluation Board Assembly Diagram



1. All dimensions are in millimeters
2. Dimensioning and tolerancing per ASME Y14.5M-1994.
3. Unless specified, dimensions are symmetrical about center lines.
4. Via hold recommendations: 30-35 µm Cu via wall plating, via holes should be tented with solder mask on the backside and filled with solder.
5. Solder stencil recommendations: no stencil recommended.
6. Solder mask recommendations: contact board fabricator for recommended solder mask offset and tolerance.

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Figure 5. SE2600S PCB Layout Footprint

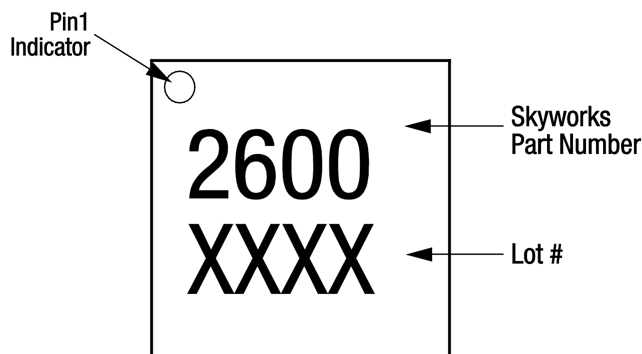
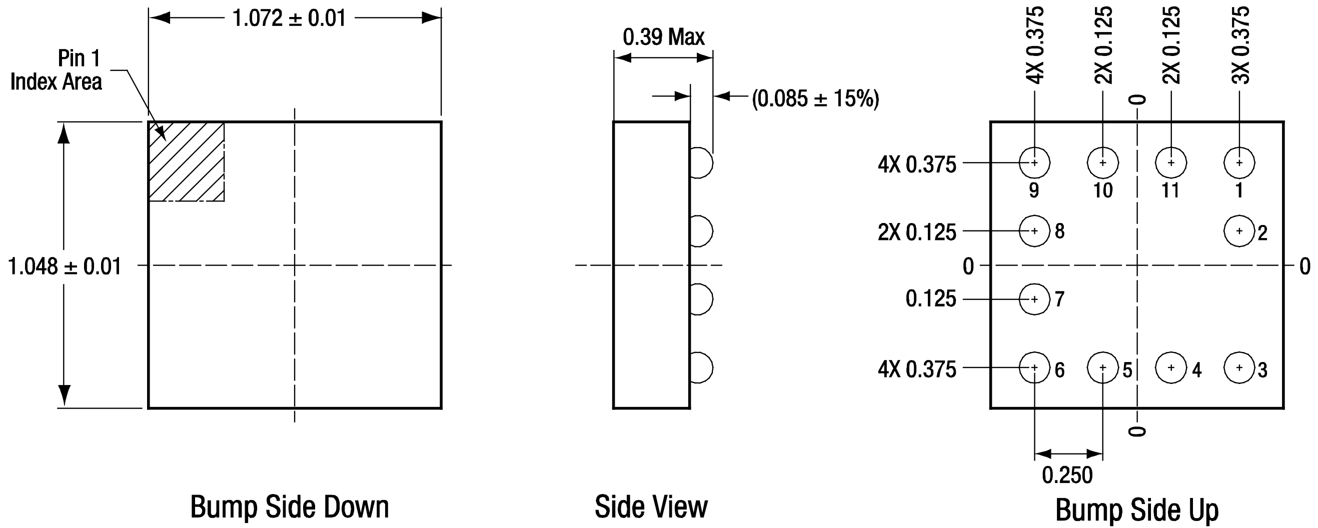


Figure 6. Typical Case Markings



All measurements are in millimeters.
Bunp material: lead-free solder
Bump pitch: 0.250 mm
Solder bump diameter: 0.114 mm ± 15%.
Wafer background thickness: 0.279 mm.

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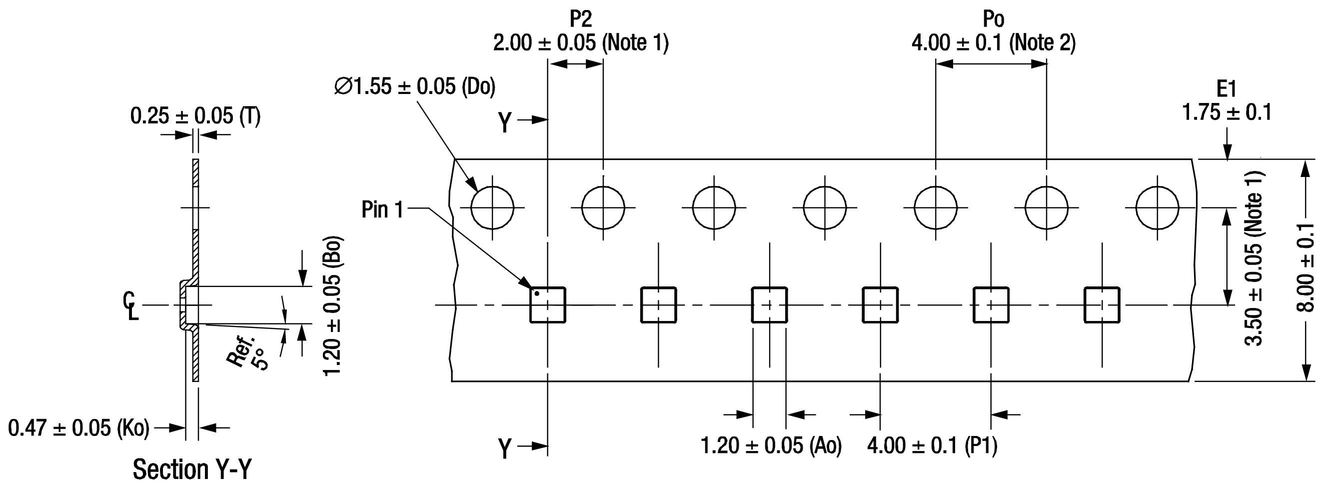
Figure 7. SE2600S 11-Bump WLCSP Package Dimensions



Notes:
1. *Measured from center line of sprocket hole to center line of pocket.*
2. *Cumulative toelrance of 10 sprocket holes is ± 0.20 mm.*
3. *Other material available.*

All measurements are in millimeters.

S2618

Figure 8. SE2600S Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SE2600S LNA Front-End	SE2600S-R	SE2600S-EK1

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