

**DATA SHEET**

# SE5012T: 5 GHz Front-End Module with Power Detector

## Applications

- 5 GHz WLAN (IEEE 802.11a/g/n)
- Access points, PCMCIA, PC cards

## Features

- 5 GHz front-end module with PA, LNA, and T/R switch
- Integrated power amplifier enable pin (VEN)
- Buffered, temperature-compensated power detector
- 5 V or direct-to-battery operation
- 3% EVM, 64 QAM, 54 Mbps: +17 dBm @ 3.3 V or +21 dBm @ 5 V
- 30 dB typical gain
- Lead free, halogen-free, ROHS compliant QFN (16-pin, 3 mm × 3 mm × 0.55 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



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## Description

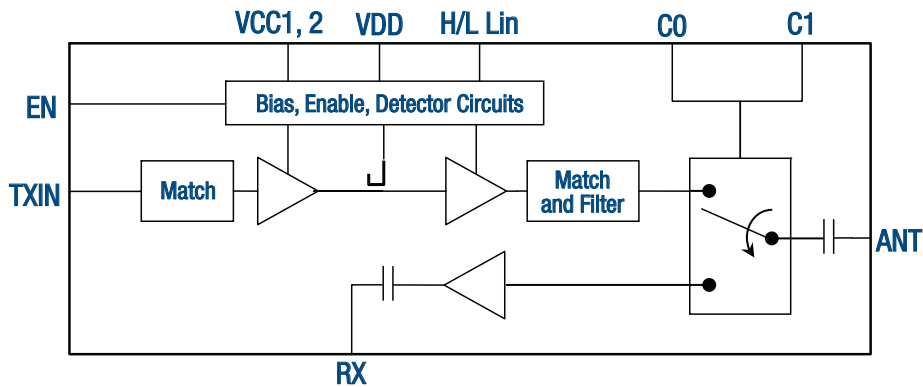
The SE5012T is a 5 GHz front-end module offering high linear power for wireless LAN applications. It incorporates a power detector for control of the output power.

The SE5012T offers a high level of integration for a simplified design, providing quicker time to market and higher application board production yield. The device integrates the input match, inter-stage match, a temperature-compensated, load-insensitive power detector with 20 dB of dynamic range, a 3.8 GHz notch filter, a T/R switch, and LNA.

For wireless LAN applications, the device meets the requirements of IEEE 802.11a and delivers approximately +17 dBm of linear output power at  $V_{CC} = 3.3\text{ V}$  or 21 dBm at  $V_{CC} = 5.0\text{ V}$ .

The SE5012T integrates the reference voltage generator, allowing for a true 1.8 V CMOS compatible digital EN (enable) function to turn the power amplifier on and off.

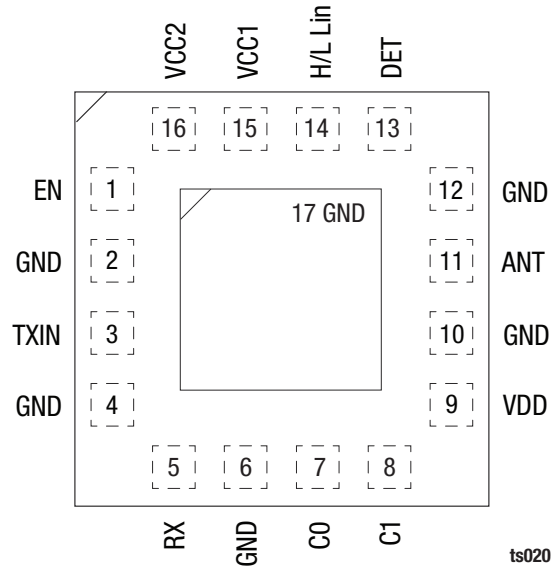
A block diagram of the SE5012T is shown in Figure 1. The device package and pinout for the 16-pin QFN are shown in Figure 2. Signal pin assignments and functional pin descriptions are described in Table 1.



Note: The TXIN has a DC short to ground.  
An external blocking capacitor is recommended at the TXIN port.

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**Figure 1. SE5012T Block Diagram**



**Figure 2. SE5012T Pinout (Top View)**

**Table 1. SE5012T Signal Descriptions**

Pin	Name	Description	Pin	Name	Description
1	EN	PA enable	9	VDD	LNA supply voltage
2	GND	Ground	10	GND	Ground
3	TXIN	5 GHz TX RF input signal	11	ANT	5 GHz antenna output
4	GND	Ground	12	GND	Ground
5	RX	5 GHz LNA output signal	13	DET	Power detector output
6	GND	Ground	14	H/L Lin	High-low linearity control
7	C0	Switch control logic 1	15	VCC1	Power amplifier supply voltage
8	C1	Switch control logic 2	16	VCC2	Power stage supply voltage

### Electrical and Mechanical Specifications

The absolute maximum ratings of the SE5012T are provided in Table 2. Recommended operating conditions are specified in

Table 3. Electrical specifications are provided in Tables 4 through 9. Figure 3 shows the power detector characteristics.

**Table 2. SE5012T Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage on pins VCC1, VCC2	VCC	-0.3	+5.5	V
Supply voltage on pin VDD	VDD	-0.3	+3.6	V
DC input on Enable	VEN	-0.3	+3.6	V
RF input power, RFout into 50 Ω match	TXIN		12	dBm
Storage temperature range	TSTG	-40	+150	°C
Junction temperature	TJ		+150	°C
Electrostatic discharge: Human Body Model (HBM), Class 1B	ESD		500	V

**Note 1:** 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.

**Note 2:** These are stress ratings only. Exposure to stresses beyond these maximum ratings for a long period of time may cause permanent damage to, or affect the reliability of the device. Avoid operating the device outside the recommended operating conditions defined below.

**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.

**Table 3. SE5012T Recommended Operating Conditions**

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage on pins VCC1, VCC2	VCC	3.0	5.5	V
Supply voltage on pin VDD	VDD	3.0	3.6	V
Ambient temperature	TA	-40	+85	°C

**Table 4. SE5012T Electrical Specifications: Control Logic Characteristics (Note 1)**

(VCC = 5.0 V, VDD = VEN = 3.3 V, TA = +25 °C as Measured on the SE5012T-EK1 Evaluation Board, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Supply current, transmit mode	ICC_802.11a	POUT = 21 dBm, 54 Mbps, 64 QAM, VCC = 5.0 V, H/L Lin = 3.3 V		270	350	mA
		POUT = 17 dBm, 54 Mbps, 64 QAM, VCC = 3.3 V, H/L Lin = 3.3 V		195		mA
LNA supply current	IDD	VEN = C0 = 0 V, C1 = 3.3 V		13		mA
Supply current	I <sub>OFF</sub>	VEN = 0 V, no RF, C0 = C1 = 0 V measured on VCC, VDD pins		20	50	μA
Logic high voltage	VENH		2.8		3.6	V
Logic low voltage	VENL		-0.3		0.3	V
Input current logic high voltage	IENH	10 kΩ on chip pull down resistor		330	400	μA
Input current logic low voltage	IENL			<1		μA

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

**Table 5. SE5012T Electrical Specifications: Switch Logic Characteristics (Note 1)**  
 (VCC = 3.0 V to 5.5 V, VDD = VEN = 3.3 V, TA = +25 °C as Measured on the SE5012T-EK1 Evaluation Board, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Low loss switch control voltage	ON	High state = VCTL_ON – VCTL_OFF	2.8		3.6	V
High loss switch control voltage	OFF	Low state = VCTL_OFF – VCTL_OFF	0		0.3	V
Control input capacitance	CCTL				100	pF
Control line current	ICTL	VCTL = VCTL_ON		2	10	μA

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

**Table 6. Switch Control Logic Table**

C0	C1	EN	Hi/L Lin	ANT
All other states	OFF	ON	ON	Tx
OFF	OFF	OFF	D/C (Note 1)	Rx bypass
OFF	All other states	OFF	D/C (Note 1)	Rx LNA ON
All other states	All other states	Unsupported state		

Note 1: D/C = don't care

**Table 7. SE5012T Electrical Specifications: AC Characteristics (Transmit Characteristics) (Note 1)**  
 (VCC = 5.0 V, VDD = VEN = C0 = H/L Lin = 3.3 V, C1 = 0 V, TA = +25 °C, as Measured on the SE5012T-EK1 Evaluation Board, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f <sub>L,U</sub>		5.15		5.85	GHz
Output power OFDM signal, 64 QAM,	EVM = 3%	VCC = 5.0 V	19	21		dBm
		VCC = 3.3 V		17		dBm
	EVM ≤ 1.5%	VCC = 5.0 V		12		dBm
		VCC = 3.3 V		9		dBm
Output 1 dB compression point, no modulation	P <sub>1dB</sub>	VCC = 5.0 V		27		dBm
		VCC = 3.3 V		24		dBm
Input return loss	S <sub>11</sub>	PIN = -25 dBm		12		dB
Small signal gain, PIN = -25 dBm	S <sub>21</sub>		29		36	dB
Small signal gain variation	ΔS <sub>21</sub>	Gain variation over single 40 MHz channel			0.5	dB
		Gain variation over band		4		dB
Out of band gain	S <sub>21_3.8</sub>	Gain at 3.8 GHz			15	dB
Harmonic	2f	P <sub>OUT</sub> = 17 dBm, OFDM		-50	-45.2	dBm/MHz
	3f			-50	-45.2	dBm/MHz
Rise and fall time	t <sub>R</sub> , t <sub>F</sub>			0.5		μs
Stability	STAB	P <sub>OUT</sub> = 17 dBm, 54 Mbps, 64QAM, VSWR = 6:1, all phases	All non-harmonically related outputs less than -50 dBc/100 kHz			
Tolerance to output load mismatching	Rugged-ness	Constant PIN equal to P <sub>OUT</sub> = 21 dBm at 50 Ω, 54 Mbps, 64QAM, VCC = 5.5 V, VSWR = 6:1, all phases	No damage			
Robustness to input power	Robust	PIN = 12 dBm, CW, VSWR = 6:1, all phases	No damage			

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

**Table 8. SE5012T Electrical Specifications: AC Characteristics (Receive Characteristics) (Note 1)**  
 (V<sub>CC</sub> = 3.0 V to 5.5 V, V<sub>DD</sub> = C1 = 3.3 V, V<sub>EN</sub> = C0 = 0 V, T<sub>A</sub> = +25 °C as Measured on the SE5012T-EK1 Evaluation Board, All Unused Ports Terminated with 50 Ω, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f <sub>OUT</sub>		5.15		5.85	GHz
Insertion loss	RX	Bypass mode: C0 = C1 = 0 V		-5		dB
Rx gain		High gain mode	11	14		dB
Noise figure	NF	High gain mode		2.5	3.5	dB
Input return loss	RXRL	At the antenna port		12		dB
Output return loss		At RX RF output		8		dB
Input P1dB	RX_IP1dB	Measured at ANT port, high gain mode	-6	-5		dBm
		LNA bypass mode		10		dBm
Max 2.4 GHz interferer power	RX_2.4int	1 dB degradation of IP1dB			0	dBm
Transmit power at Rx output	TXLEAK	V <sub>EN</sub> = C0 = H/L Lin = 3.3 V, C1 = 0 V, 24 dBm at the ANT port		-13		dBm
T/R on/off switching speed	ton/OFF	C0, C1 (50%) to RF output (10% or 90%)		300		ns

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

**Table 9. SE5012T Electrical Specifications: Power Detector Characteristics (Note 1)**  
 (V<sub>CC</sub> = 3.0 V to 5.5 V, V<sub>DD</sub> = V<sub>EN</sub> = C0 = 3.3, C1 = 0 V, f = 5.4 GHz, T<sub>A</sub> = +25 °C as Measured on the SE5012T-EK1 Evaluation Board, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
P <sub>OUT</sub> detect range	PDR		0		P1dB	dBm
Detector voltage	V <sub>DET22</sub>	P <sub>OUT</sub> = 22 dBm	0.80		0.95	V
Detector voltage	V <sub>DET16</sub>	P <sub>OUT</sub> = 16 dBm	0.60		0.65	V
Detector voltage	V <sub>DET2</sub>	P <sub>OUT</sub> = 2 dBm	0.25		0.35	V
Output impedance	PDZOUT			5		kΩ

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

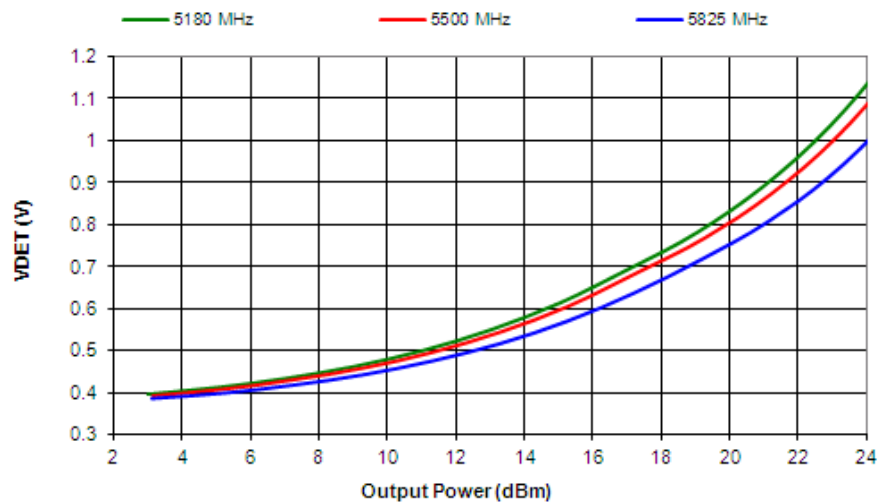


Figure 3. Power Detector Performance vs Frequency

## Package Dimensions

The PCB layout footprint for the SE5012T is provided in Figure 4. Typical part markings are shown in Figure 5. Package dimensions are shown in Figure 6, and carrier tape dimensions are provided in Figure 7.

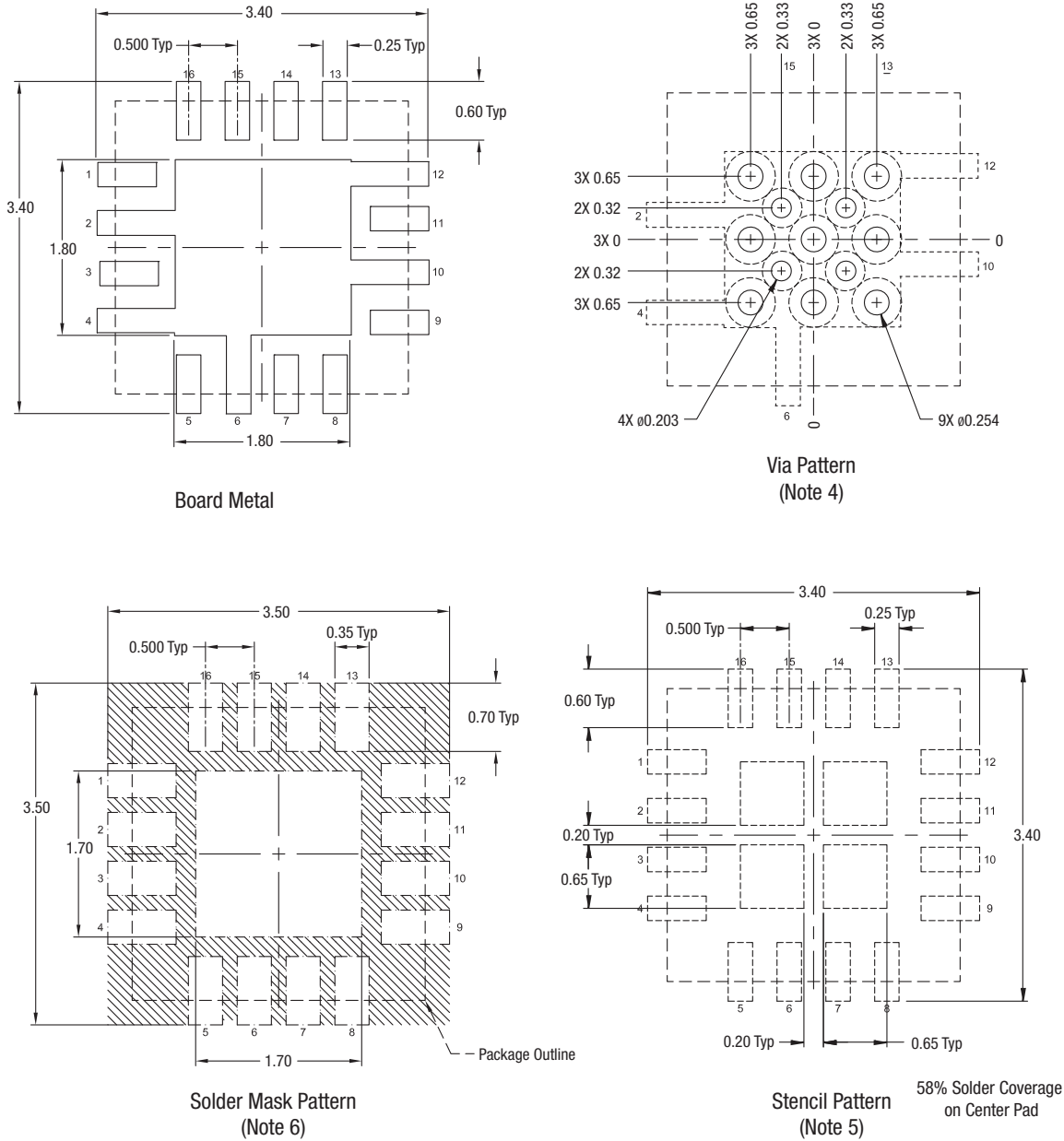
## Package Handling Information

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 SE5012T 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, *Solder Reflow Information*, document number 200164.

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.

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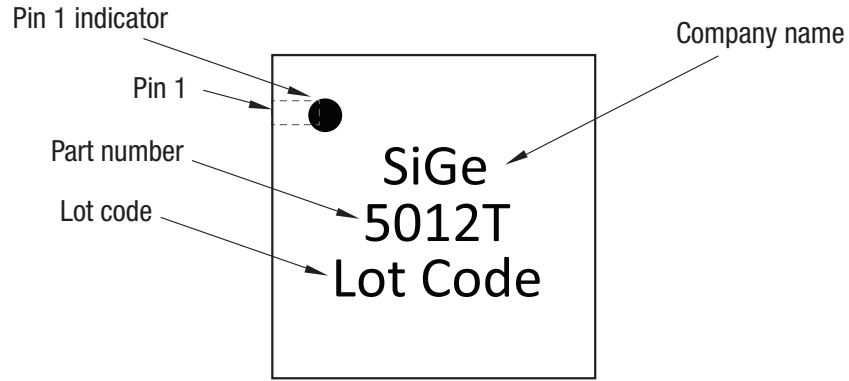


**Notes:**

1. All dimensions are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.
3. Unless specified, dimensions are symmetrical about center lines.
4. Via hole recommendations:  
0.025 mm Cu via wall plating (minimum),  
solder mask on the far side should tent or plug via holes.
5. Stencil recommendations:  
0.125 mm stencil thickness, laser cut apertures, trapezoidal walls and rounded corners offer better paste release.
6. Solder mask recommendations:  
Contact board fabricator for recommended solder mask offset and tolerance.

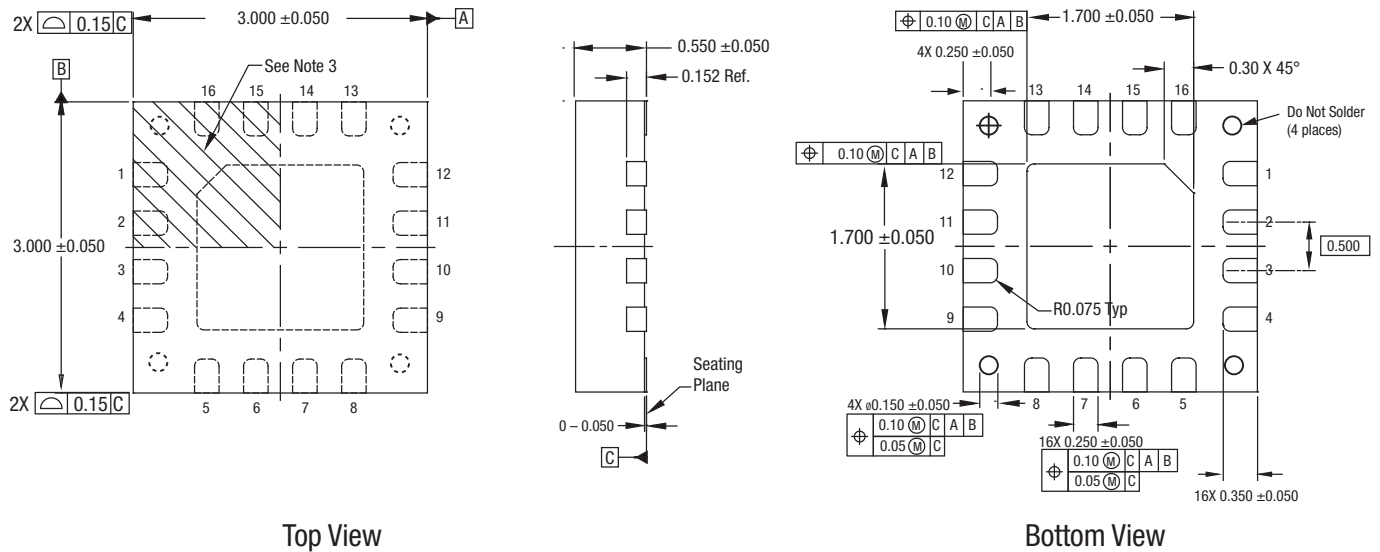
Y1642

**Figure 4. PCB Layout Footprint for the SE5012T**



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Figure 5. Typical Part Markings (Top View)



Notes:

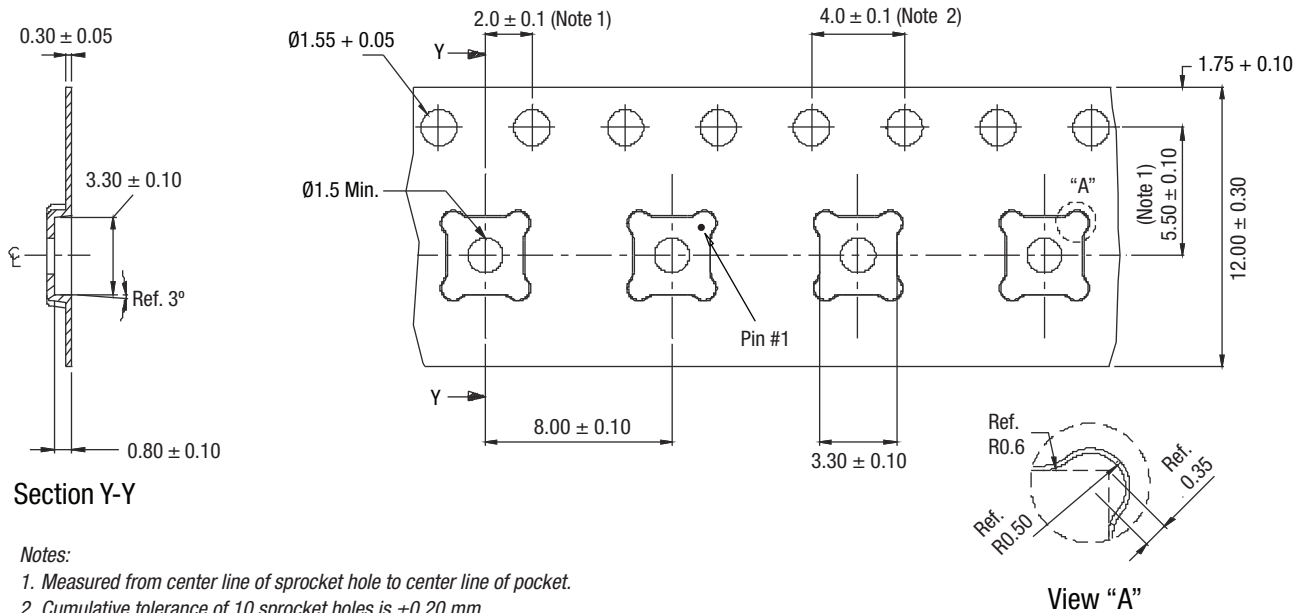
1. All measurements are in millimeters.
2. Dimensions and tolerances according to ASME Y14.5M-1994.  
Unless otherwise specified the following values apply:  
Decimal Tolerance: Angular Tolerance:  
X.X (1 place) ± 0.1 mm ± 1°  
X.XX (2 places) ± 0.05 mm  
X.XXX (3 places) ± 0.025 mm
3. Terminal #1 identification mark located within marked area.
4. Unless specified, dimensions are symmetrical about center lines.

Y0630

Figure 6. SE5012T Package Dimensions



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**Section Y-Y**

*Notes:*

1. Measured from center line of sprocket hole to center line of pocket.
2. Cumulative tolerance of 10 sprocket holes is  $\pm 0.20$  mm.
3. Other material available.
4. Typical SR of form tape from  $10^6$  to  $10^{11}$   $\Omega/SQ$ .
5. All measurements are in millimeters unless otherwise stated.

ts012

**Figure 7. SE5012T 16-pin QFN Carrier Tape Dimensions**

## Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SE5012T: 5 GHz Front-End Module with Power Detector	SE5012T	SE5012T-EK1

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