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 (V_{EN})
- 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)

Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04–0074.

Description

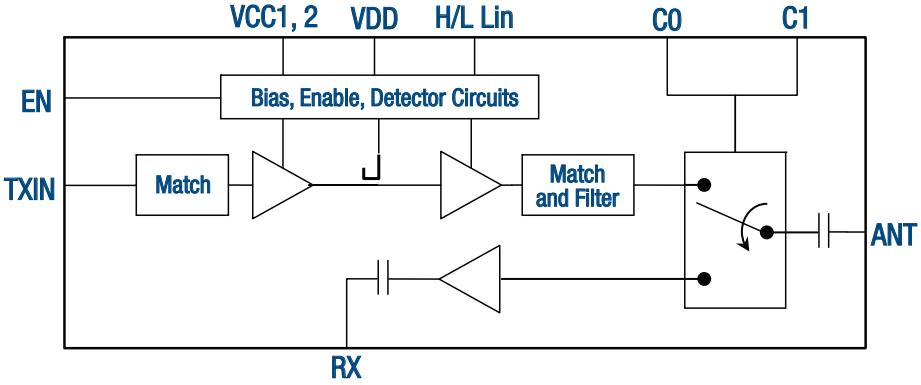
The SE5012T is a 5 GHz front-end module offering high linear power for wireless LAN applications. It incorporates a power detector for control of the output power.

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 V or 21 dBm at V_{CC} = 5.0 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

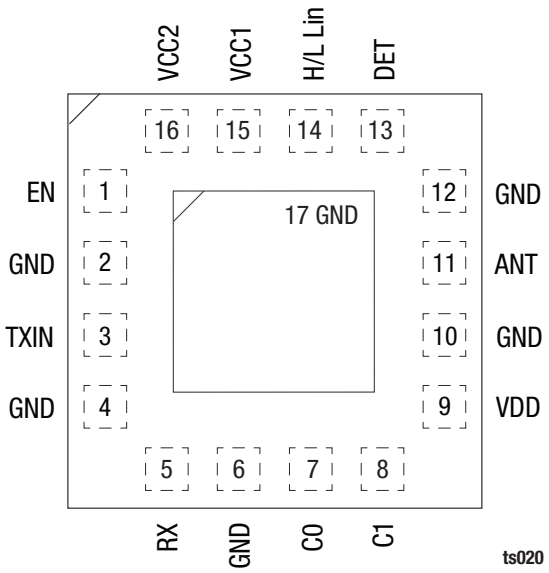


Figure 2. SE5012T Pinout (Top View

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	V_{CC}	–0.3	+5.5	V
Supply voltage on pin VDD	V_{DD}	–0.3	+3.6	V
DC input on Enable	V_{EN}	–0.3	+3.6	V
RF input power, RFout into 50 Ω match	TX_{IN}		12	dBm
Storage temperature range	T_{STG}	–40	+150	°C
Junction temperature	T_J		+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	V_{CC}	3.0	5.5	V
Supply voltage on pin VDD	V_{DD}	3.0	3.6	V
Ambient temperature	T_A	–40	+85	°C

Table 4. SE5012T Electrical Specifications: Control Logic Characteristics (Note 1)
(V_{CC} = 5.0 V, V_{DD} = V_{EN} = 3.3 V, T_A = +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	I_{CC}_802.11a	P_{OUT} = 21 dBm, 54 Mbps, 64 QAM, V_{CC} = 5.0 V, H/L Lin = 3.3 V		270	350	mA
		P_{OUT} = 17 dBm, 54 Mbps, 64 QAM, V_{CC} = 3.3 V, H/L Lin = 3.3 V		195		mA
LNA supply current	I_{DD}	V_{EN} = C0 = 0 V, C1 = 3.3 V		13		mA
Supply current	I_{OFF}	V_{EN} = 0 V, no RF, C0 = C1 = 0 V measured on VCC, VDD pins		20	50	µA
Logic high voltage	V_{ENH}		2.8		3.6	V
Logic low voltage	V_{ENL}		–0.3		0.3	V
Input current logic high voltage	I_{ENH}	10 kΩ on chip pull down resistor		330	400	µA
Input current logic low voltage	I_{ENL}			<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)
(V_{CC} = 3.0 V to 5.5 V, V_{DD} = V_{EN} = 3.3 V, T_A = +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 = V_{CTL_ON} – V_{CTL_OFF}	2.8		3.6	V
High loss switch control voltage	OFF	Low state = V_{CTL_OFF} – V_{CTL_OFF}	0		0.3	V
Control input capacitance	C_{CTL}				100	pF
Control line current	I_{CTL}	V_{CTL} = V_{CTL_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)
(V_{CC} = 5.0 V, V_{DD} = V_{EN} = C0 = H/L Lin = 3.3 V, C1 = 0 V, T_A = +25 °C, as Measured on the SE5012T-EK1 Evaluation Board, Unless Otherwise Noted)

Parameter		Symbol	Test Condition	Min	Typical	Max	Units
Frequency range		f_{L_U}		5.15		5.85	GHz
Output power OFDM signal, 64 QAM,	EVM = 3%	P_{OUT}	V_{CC} = 5.0 V	19	21		dBm
			V_{CC} = 3.3 V		17		dBm
	EVM ≤ 1.5%		V_{CC} = 5.0 V		12		dBm
			V_{CC} = 3.3 V		9		dBm
Output 1 dB compression point, no modulation		P_{1dB}	V_{CC} = 5.0 V		27		dBm
			V_{CC} = 3.3 V		24		dBm
Input return loss		S_{11}	P_{IN} = –25 dBm		12		dB
Small signal gain, P_{IN} = –25 dBm		S_{21}		29		36	dB
Small signal gain variation		ΔS_{21}	Gain variation over single 40 MHz channel			0.5	dB
			Gain variation over band		4		dB
Out of band gain		$S_{21\_3.8}$	Gain at 3.8 GHz			15	dB
Harmonic		2f	P_{OUT} = 17 dBm, OFDM		–50	–45.2	dBm/MHz
		3f			–50	–45.2	dBm/MHz
Rise and fall time		t_R, t_F			0.5		µs
Stability		STAB	P_{OUT} = 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 P_{IN} equal to P_{OUT} = 21 dBm at 50 Ω, 54 Mbps, 64QAM, V_{CC} = 5.5 V, VSWR = 6:1, all phases	No damage			
Robustness to input power		Robust	P_{IN} = 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_{CC} = 3.0 V to 5.5 V, V_{DD} = C1 = 3.3 V, V_{EN} = C0 = 0 V, T_A = +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_{OUT}		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	RX_{RL}	At the antenna port		12		dB
Output return loss		At RX RF output		8		dB
Input $P1_{dB}$	RX_IP1_{dB}	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 $IP1_{dB}$			0	dBm
Transmit power at Rx output	TX_{LEAK}	V_{EN} = C0 = H/L Lin = 3.3 V, C1 = 0 V, 24 dBm at the ANT port		–13		dBm
T/R on/off switching speed	$t_{ON/OFF}$	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_{CC} = 3.0 V to 5.5 V, V_{DD} = V_{EN} = C0 = 3.3, C1 = 0 V, f = 5.4 GHz, T_A = +25 °C as Measured on the SE5012T-EK1 Evaluation Board, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
P_{OUT} detect range	P_{DR}		0		$P1_{dB}$	dBm
Detector voltage	V_{DET22}	P_{OUT} = 22 dBm	0.80		0.95	V
Detector voltage	V_{DET16}	P_{OUT} = 16 dBm	0.60		0.65	V
Detector voltage	V_{DET2}	P_{OUT} = 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.

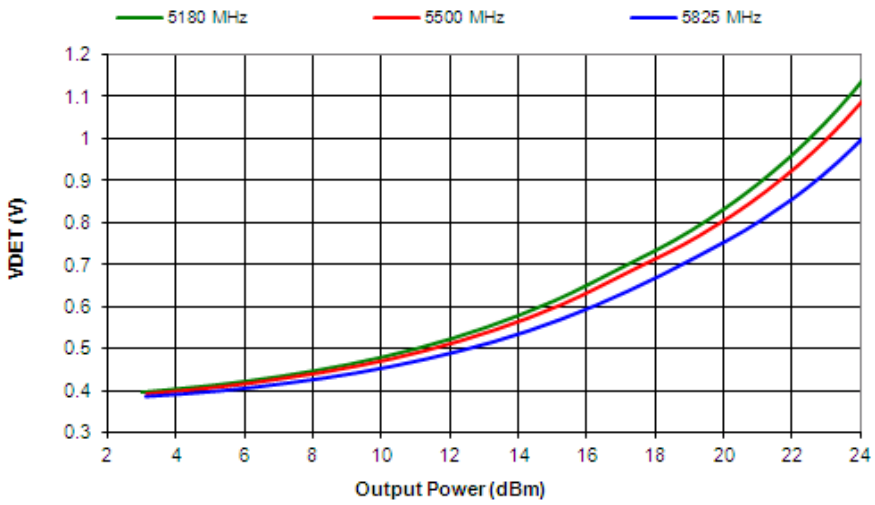


Figure 3. Power Detector Performance vs Frequency

Package Dimensions

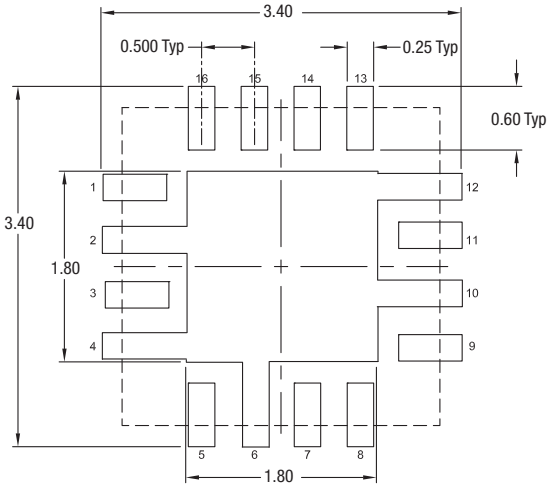
The PCB layout footprint for the SE5012T is provided in Figure 4. Typical part markings are shown in Figure 5. Package dimensions are shown in Figure 6, and carrier tape dimensions are provided in Figure 7.

Package Handling Information

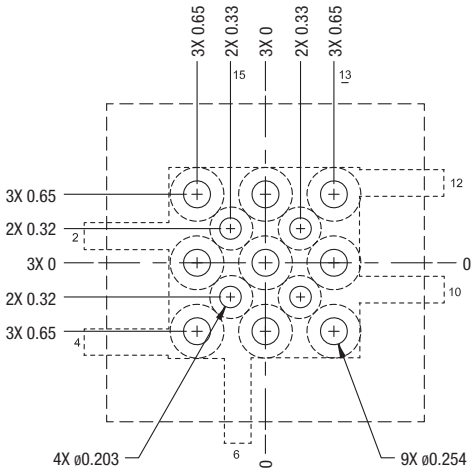
Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

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.

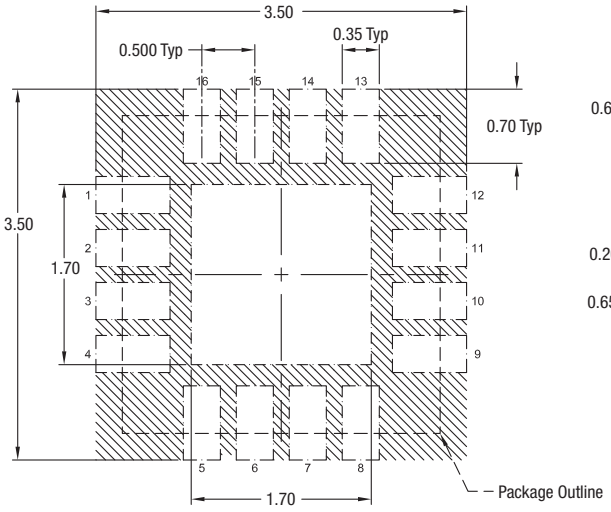
Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.



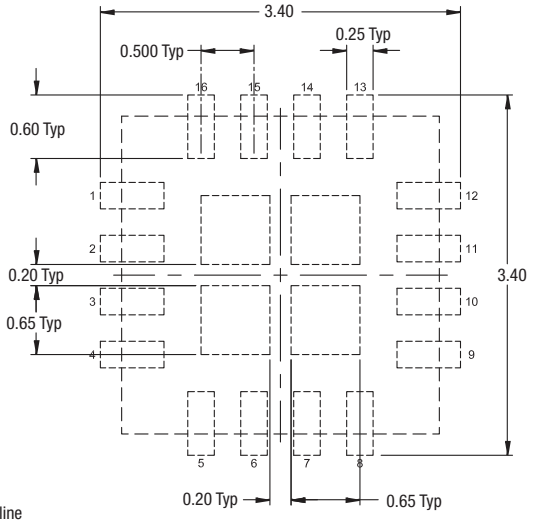
Board Metal



Via Pattern
(Note 4)



Solder Mask Pattern
(Note 6)



Stencil Pattern
(Note 5)

58% Solder Coverage
on Center Pad

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.

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Figure 4. PCB Layout Footprint for the SE5012T

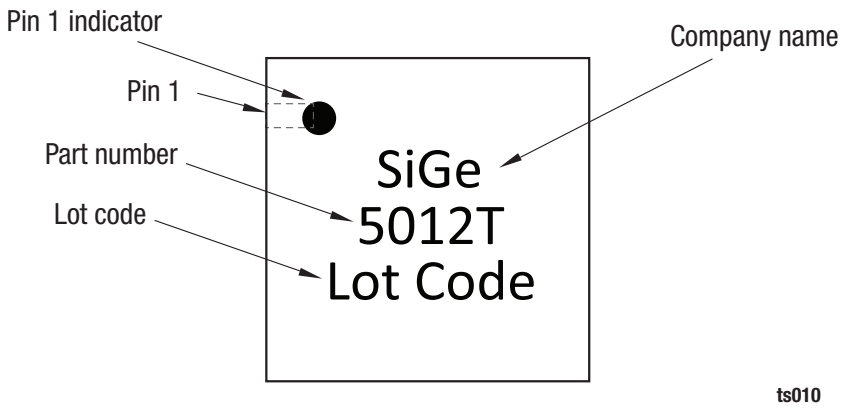
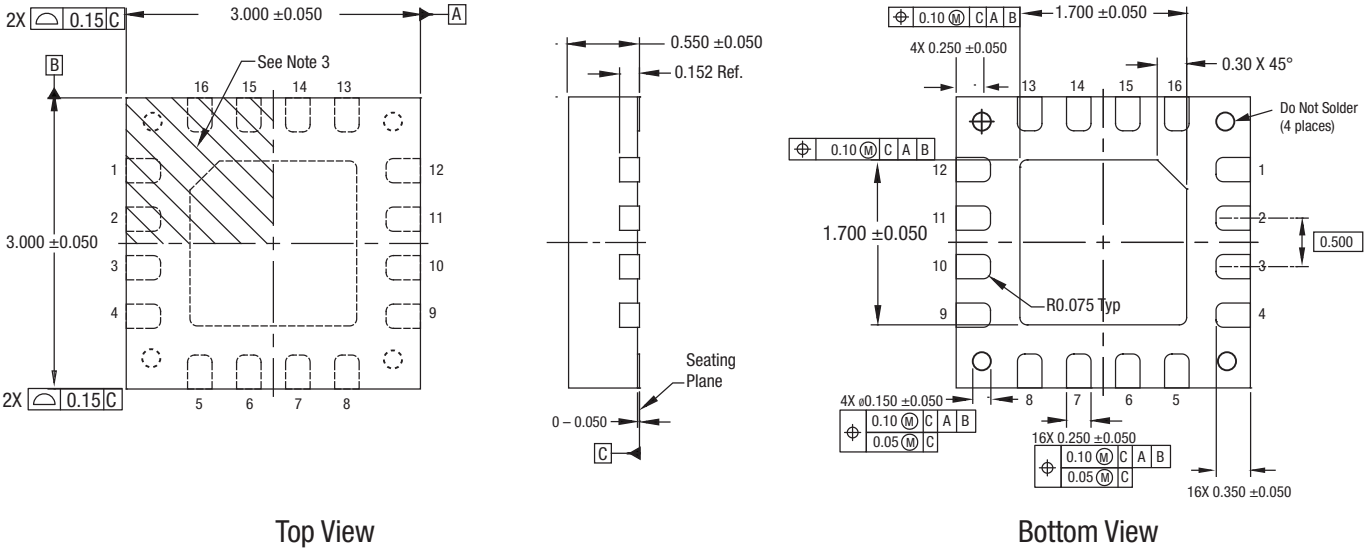


Figure 5. Typical Part Markings (Top View)



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.*

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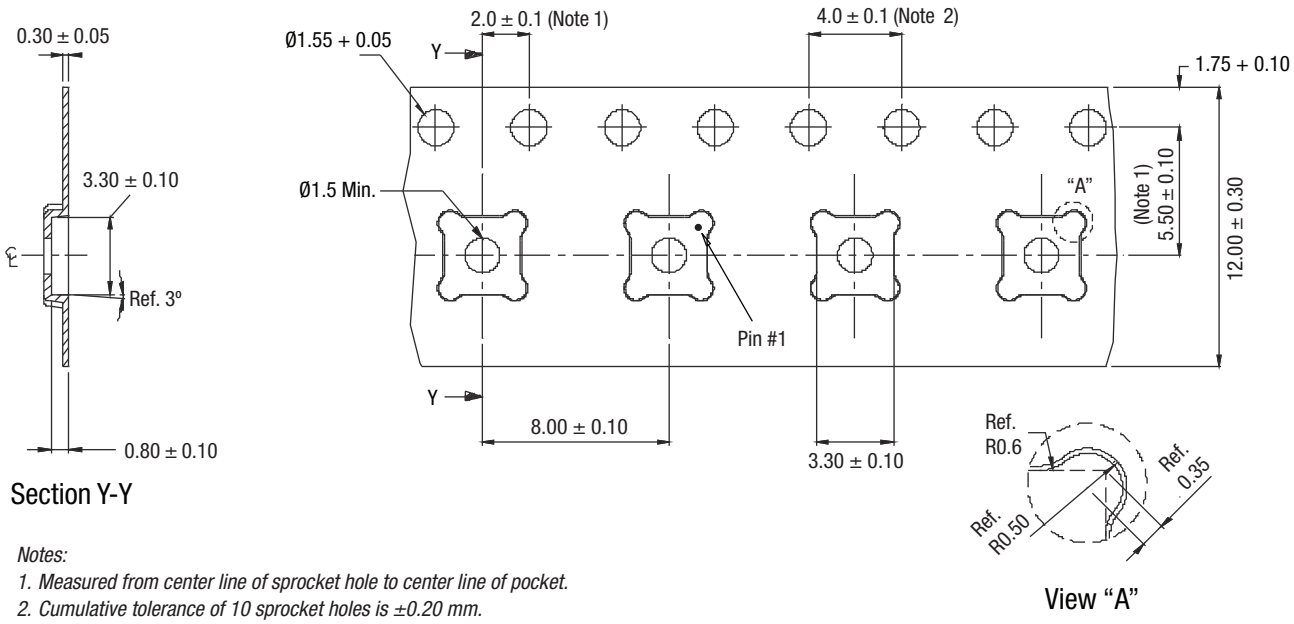
Figure 6. SE5012T Package Dimensions



Notes:

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

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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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