AN1408: Ultra Series Si54x/6x Ultra Low Jitter XO and VCXO Frequently Asked Questions

This document answers the most frequently asked questions (FAQs) for the Si540/1/2/4/5/6/7/8/9 and Si560/1/2/4/5/6/7/9 Ultra Low Jitter XO and VCXO products. See the chart below for more details on the devices covered by this document.

Table 1. Covered Products

Type	Product	Number of Frequencies	Phase Jitter (fs RMS)	Frequency Range (MHz)
Ultra Series XO	Si545	Single	80	0.2 to 1500
	Si546	Dual		
	Si547	Quad		
	Si548	Any (I^2C-enabled), 6-pin		
	Si549	Any (I^2C-enabled)		
	Si540	Single	125	
	Si541	Dual		
	Si542	Quad		
	Si544	Any (I^2C-enabled)		
	Si560	Single	90	0.2 to 3000
	Si561	Dual		
	Si562	Quad		
	Si564	Any (I^2C-enabled)		
Ultra Series VCXO	Si565	Single	100	
	Si566	Dual		
	Si567	Quad		
	Si569	Any (I^2C-enabled)		

Skyworks Solutions, Inc.   •   Phone [949] 231-3000   •   sales@skyworksinc.com   •   www.skyworksinc.com
207118B   •   Skyworks Proprietary Information   •   Products and Product Information are Subject to Change without Notice
1   February 24, 2026

Table 2. Frequently Asked Question Links

Question Category	Cross-Reference Link
Packaging	1.1. "Are pinouts, PCB land patterns, and package dimensions compatible with industry standards?"
	1.2. "What is the material composition of the pins?"
Quality and production	2.1. "What about RoHS, REACH, or other materials related compliance information?"
	2.2. "Are the oscillator products available in tape and reel?"
Thermal and soldering	3.1. "What is the maximum operating junction temperature of these devices?"
	3.2. "What are the max reflow temperatures and profiles recommended for "lead-free" and "leaded" solder reflow processes?"
General part functionality	4.1. "What is the state of the output when it is disabled by OE?"
	4.2. "What happens to the output clock when the Frequency Select (FS) pin is toggled?"
	4.3. "Can these oscillators output a sine wave instead of a square wave?"
	4.4. "What is the recommended power supply setup for VDD for these oscillators?"
I^2C Communication Questions	5.1. "What is the I2C address of my custom oscillator?"
	5.2. "Can the SCL and SDA pins be left floating on an I2C-enabled oscillator?"
VCXO Functionality Questions	6.1. "What is Absolute Pull Range (APR)?"
	6.2. "Why is there no min APR listed for 2.5 V or 1.8 V when kV = 60 ppm/V, or 1.8 V when kV = 75 ppm/V?"

Table 3. Product Links

Link Type	Link
Part Number Lookup Utility	tools.skyworksinc.com/TimingUtility/timing-part-number-search-results
Oscillator Product Pages	www.skyworksinc.com/Products/Timing-Oscillators
Oscillator Phase Noise Lookup Utility	www.skyworksinc.com/tools/oscillator-phase-noise
Evaluation Boards / Development Kits	www.skyworksinc.com/Products/Timing/Evaluation-Kits#collapseOscillator
Quality and Reliability Reports	www.skyworksinc.com/Quality
Request Technical Support	www.skyworksinc.com/support

1. Packaging Questions

1.1. Are pinouts, PCB land patterns, and package dimensions compatible with industry standards?

- Yes, the single frequency devices allow drop-in replacement of existing XOs or VCXOs.
- The dual and quad frequency devices allow drop-in or minimal change replacement of many similar XOs or VCXOs.
- PCB land pattern and package dimension information can be found in device data sheets in the Oscillators product pages.

1.2. What is the material composition of the pins?

- The pad composition on the 5 x 7 mm and the 3.2 x 5 mm CLCC packages is NiAu.
  - Ni (Nickel) thickness ranges between 1.27 and 8.89 μm.
  - Au (Gold) thickness ranges between 0.3 and 1.0 μm.
- The pad composition on the 2.5 x 3.2 mm package is ENEPIG (NiPdAu)
  - Ni (Nickel) thickness ranges between 3 and 8 μm.
  - Pd (Palladium) thickness ranges between 0.1 and 0.2 μm.
  - Au (Gold) thickness ranges between 0.03 and 0.12 μm.
- Refer to the Skyworks Certificate of Conformance web page (search by part number) to find the Certificate of Conformance for the materials used in this device.

2. Quality and Production Questions

2.1. What about RoHS, REACH, or other materials related compliance information?

Refer to the Skyworks Certificate of Conformance web page for full RoHS, REACH and other material composition information. Please make sure you type the entire part number, including the dash suffix.

2.2. Are the oscillator products available in tape and reel?

Yes, all oscillator products are available in tape and reel with an 8 mm pitch and 12 mm or 16 mm carrier tape width for the different package types (see Table 4).

To specify tape and reel, please include the "R" suffix on the part number when you place your oscillator order. For example, the "R" at the end of the 540AAA100M000CCGR part number specifies the tape and reel option. Please refer to the Look Up an Oscillator or Clock web page for additional part number information.

Note: *Part numbers that do not include an "R" suffix are shipped in coil tape. This uses the same carrier tape dimensions with trailer and footer, but does not include a reel hub. Coil tape part numbers (without an "R" suffix) are typically only used for small quantity orders and tape and reel part numbers (with an "R" suffix) should be used for larger quantities.*

Tape and reel specifications are shown in Table 4, Table 5, Figure 1, and Figure 2. Quantity information for all Skyworks products are available upon request from your local sales representative.

Table 4. Tape and Reel Specifications

Pkg	No. of Leads	Package Description	Carrier Tape							Parts per Meter	Reel Size Diameter (inch)	Reel Hub Diameter (inch)	Pin-1 Orientation (Quadrant)
			Width	Pitch	Pocket Size								
			W (mm)	P1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	K1 (mm)					
CLCC	4, 6, 8	CLCC 3.2x5	12	8	3.7	5.5	1.4	N/A	125	7	2.5	1
CLCC	4, 6, 8	CLCC 5x7	16	8	5.6	7.6	1.9	N/A	125	7	2.5	1
DFN	4, 6, 8	DFN 2.5x3.2	12	8	2.75	3.45	1.05	N/A	125	7	2.5	1
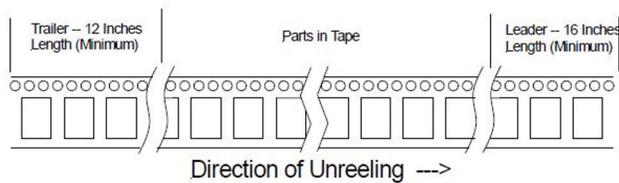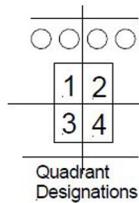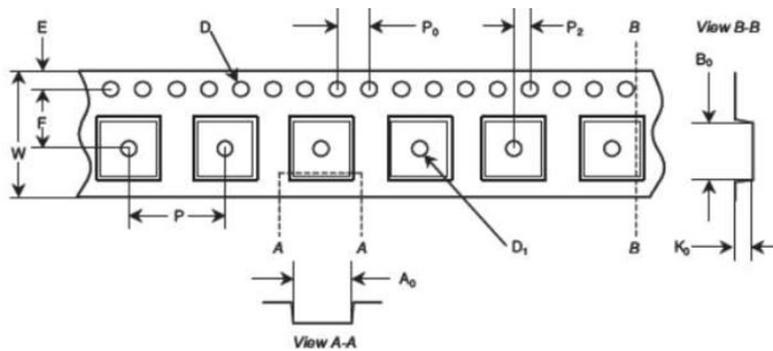
Tape Pitch	8 mm
Minimum Number of pockets for leader	51
Minimum Number of pockets for trailer	39

Figure 1. Standard Carrier Tape Dimensions
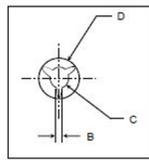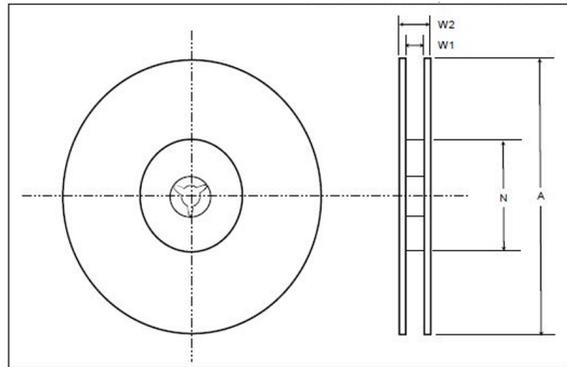
Figure 2. Reel Diagram (7 in.)

Table 5. Minimum Number of Pockets for Leader and Trailer

		Symbol	Carrier Tape Width	
			12 mm	16 mm
Flange	Diameter (mm)	A	330.0	330.0
	Space between flange (mm)	W1	12.8	16.8
	Thickness (mm)	W2	18.2	22.2
Hub	Outer diameter (mm)	N	102.0	102.0
	Arbor hole diameter (mm)	C	13.0	13.0
	Key slit width (mm)	B	2.0	2.0
	Key slit width (mm)	D	20.2	20.2

3. Thermal and Soldering Questions

3.1. What is the maximum operating junction temperature of these devices?

- The devices were designed to support a maximum operating junction temperature of 125 °C. This internal temperature should not be exceeded during device operation.
- Operating ambient temperature range is –40 °C to +85 °C. Operation at temperatures outside of this range poses the risk of not meeting data sheet performance specifications.

3.2. What are the max reflow temperatures and profiles recommended for "lead-free" and "leaded" solder reflow processes?

- For lead-free processes, the Peak/Classification Temperature (Tp) is 260 °C.
- For leaded (SnPb) processes, the Peak/Classification Temperature (Tp) is 240 °C.
- Refer to the latest JEDEC specification (IPC/JEDEC J-STD-020C, July 2004). Excerpts below are included for reference only, to be used as starting values for developing a specific assembly profile.
- All temperatures refer to the top side of the package, measured on the package body surface.

Table 6. JEDEC J-STD-020 Specification Excerpt (Reference Only)

Profile Feature	SnPb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (Tsmax to Tp)	3 °C/second max	3 °C/second max
Preheat • Temperature Min (Tsmin) • Temperature Max (Tsmax) • Time (tsmin to tsmax)	100 °C 150 °C 60 to 120 seconds	150 °C 200 °C 60 to 180 seconds
Time maintained above: • Temperature (TL) • Time (tL)	183 °C 60 to 150 seconds	217 °C 60 to 150 seconds
Peak/Classification Temperature (Tp)	240 °C	260 °C
Time within 5 °C of actual Peak Temperature (tp)	10 to 30 seconds	20 to 40 seconds
Ramp-down rate	6 °C/second max	6 °C/second max
Time 25 °C to peak temperature	6 minutes max	8 minutes max

4. General Part Functionality Questions

4.1. What is the state of the output when it is disabled by OE?

The output is tri-stated in high-Z.

4.2. What happens to the output clock when the Frequency Select (FS) pin is toggled?

When the FS pin changes, the oscillator effectively reboots. The output is squelched until the driver is ready to provide a stable clock at the new frequency. When it is ready, the driver is enabled and the clock begins toggling without any glitches.

4.3. Can these oscillators output a sine wave instead of a square wave?

No, they cannot. Skyworks oscillators are only designed to produce square waves.

4.4. What is the recommended power supply setup for VDD for these oscillators?

Supply Filtering

- The Si54x/Si56x family of oscillators has excellent power supply noise immunity, which greatly reduces the requirement for additional filtering components on the supply when space is a concern.
- To achieve peak performance for jitter and spur sensitive applications, we recommend using one 1 µF capacitor and one 0.1 µF capacitor connected between VDD and ground. These should be placed as close to the VDD pin as possible.
- While a series ferrite bead isn't required, one can be added as desired for additional noise immunity. Please ensure its current rating is sufficient for the chosen device variant.
- Note that even with supply filtering, the startup VDD waveform can show small amounts of ripple around 1.55 V during the initial startup ramp. This is entirely due to the normal startup behavior of the oscillator as internal blocks are powered on. The magnitude of this ripple is dependent on the amount of power supply bypass capacitance.

Supply Selection

- Please verify that a chosen supply meets the electrical specifications found in the device data sheet.
- The excellent Power Supply Noise Rejection (PSNR) immunity of the Si54x/Si56x family allows the use of dc-dc converters and load switches without a dedicated LDO regulator. These dc-dc converters and load switches frequently have extremely fast slew rates when enabled. If using one of these, ensure that its slew rate is slower than the maximum slew rate listed in the data sheet.
  - One dc-dc converter that has been proven to work is the LMZ10500 with the following modifications for a 1.8 V VDD application:
    - R_T = 294 kΩ
    - R_B = 130 kΩ
    - See the LMZ10500 data sheet for more details.
  - One load switch that has also been proven to work is the TPS22915C.

5. I^{2}C Communication Questions

5.1. What is the I^{2}C address of my custom oscillator?

Try using the Skyworks online Look Up an Oscillator or Clock to find the I^{2}C address of your custom oscillator. Just type in the full custom part number into the search bar and click **Search**. The resulting page shows all of the custom features associated with that part number.

5.2. Can the SCL and SDA pins be left floating on an I^{2}C-enabled oscillator?

Yes.

6. VCXO Functionality Questions

6.1. What is Absolute Pull Range (APR)?

- Absolute Pull Range of a VCXO is the amount of pull range left over after subtracting the worst case total stability of the VCXO from the total pull range of the VCXO.
- APR is useful because it describes the minimum pull range available for tracking a PLL reference clock.
- Skyworks is very conservative when calculating both Total Pull Range and Total Stability for the min APR calculation. All of the specs used to calculate pull range and stability are set to their worst-case tolerances, producing the minimum possible pull range and the maximum possible frequency stability offset. This is how we can confidently guarantee minimum APR performance across all parts produced for all time.
- If the minimum APR recommendations from the data sheet are properly followed, Skyworks can guarantee the VCXO will never run out of voltage control range over the lifetime of the part.
- You can also refer to AN266 for a more in-depth description of VCXO tuning slope, stability, and APR.

6.2. Why is there no min APR listed for 2.5 V or 1.8 V when kV = 60 ppm/V, or 1.8 V when kV = 75 ppm/V?

- The calculation of APR relies on both the total pull range of the part and the total stability of the part.
- Total pull range is directly proportional to the control voltage range and the chosen tuning slope (kV) value:

$$\pm Total\ Pull\ Range = 0.5 \times ControlVoltageRange \times kV$$

- As VDD decreases, the available control voltage range also decreases. Similarly, if the tuning slope (kV) is decreased, the full range of tunable frequencies dramatically decreases.
- When VDD and kV get small enough, the total pull range can get close to the total stability of the part, causing the min APR to be small. In cases where min APR is less than ±20 ppm, the VCXO could potentially have difficulty tracking a PLL reference clock as the part ages over time.

7. Revision History

Revision	Date	Description
B	February, 2026	Updated tape and reel information.
A	August, 2025	Initial Skyworks document release.