Si534

REVISION D

QUAD FREQUENCY CRYSTAL OSCILLATOR (XO) (10 MHZ TO 1.4 GHZ)

Features

- Available with any-rate output frequencies from 10 MHz to 945 MHz and select frequencies to 1.4 GHz
- Four selectable output frequencies
- 3rd generation DSPLL® with superior jitter performance
- 3x better frequency stability than SAW-based oscillators
- Internal fixed crystal frequency ensures high reliability and low aging
- Available CMOS, LVPECL, LVDS, and CML outputs
- 3.3, 2.5, and 1.8 V supply options
- Industry-standard 5 x 7 mm package and pinout
- Pb-free/RoHS-compliant

Ordering Information:
See page 7.

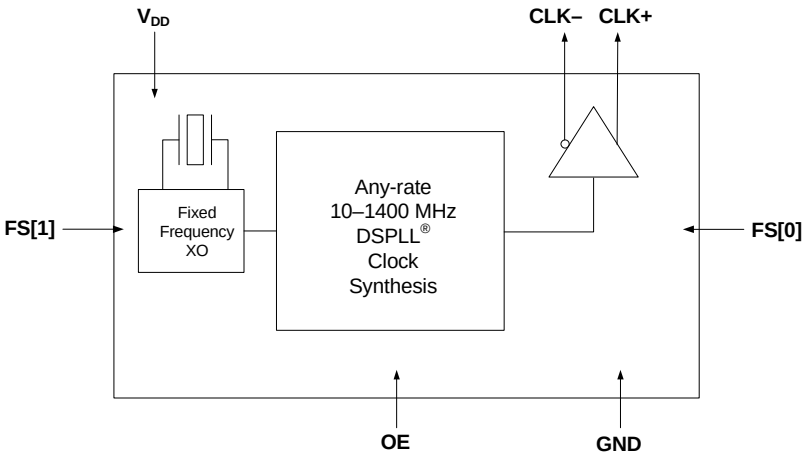
Applications

- SONET/SDH
- Networking
- SD/HD video
- Test and measurement
- Clock and data recovery
- FPGA/ASIC clock generation

Description

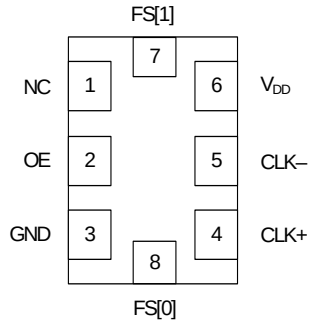
The Si534 quad frequency XO utilizes Silicon Laboratories' advanced DSPLL® circuitry to provide a low jitter clock at high frequencies. The Si534 is available with any-rate output frequency from 10 to 945 MHz and select frequencies to 1400 MHz. Unlike a traditional XO where a different crystal is required for each output frequency, the Si534 uses one fixed crystal to provide a wide range of output frequencies. This IC-based approach allows the crystal resonator to provide exceptional frequency stability and reliability. In addition, DSPLL clock synthesis provides superior supply noise rejection, simplifying the task of generating low jitter clocks in noisy environments typically found in communication systems. The Si534 IC-based XO is factory configurable for a wide variety of user specifications including frequency, supply voltage, output format, and temperature stability. Specific configurations are factory programmed at time of shipment, thereby eliminating long lead times associated with custom oscillators.

Functional Block Diagram

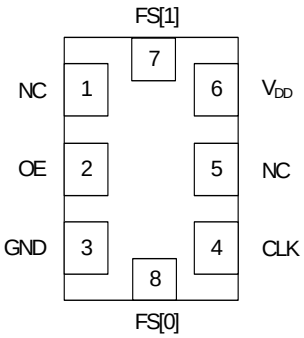


Pin Assignments:
See page 6.

(Top View)



(LVDS/LVPECL/CML)



(CMOS)

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1. Electrical Specifications

Table 1. Recommended Operating Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Supply Voltage[1]	V_{DD}	3.3 V option	2.97	3.3	3.63	V
		2.5 V option	2.25	2.5	2.75	V
		1.8 V option	1.71	1.8	1.89	V
Supply Current	I_{DD}	Output enabled LVPECL CML LVDS CMOS	 — — — —	 111 99 90 81	 121 108 98 88	mA
		Tristate mode	—	60	75	mA
Output Enable (OE) and Frequency Select FS[1:0][2]		V_{IH}	0.75 x V_{DD}	—	—	V
		V_{IL}	—	—	0.5	V
Operating Temperature Range	T_A		–40	—	85	ºC

Notes:
1. Selectable parameter specified by part number. See Section 3. "Ordering Information" on page 7 for further details.
2. OE and FS[1:0] pins include a 17 kΩ pullup resistor to V_{DD}.

Table 2. CLK± Output Frequency Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Nominal Frequency[1,2]	f_O	LVPECL/LVDS/CML	10	—	945	MHz
		CMOS	10	—	160	MHz
Initial Accuracy	f_i	Measured at +25 °C at time of shipping	—	±1.5	—	ppm
Temperature Stability[1,3]			–7 –20 –50	— — —	+7 +20 +50	ppm
Aging	f_a	Frequency drift over first year	—	—	±3	ppm
		Frequency drift over 20-year life	—	—	±10	ppm
Total Stability		Temp stability = ±7 ppm	—	—	±20	ppm
		Temp stability = ±20 ppm	—	—	±31.5	ppm
		Temp stability = ±50 ppm	—	—	±61.5	ppm

Notes:
1. See Section 3. "Ordering Information" on page 7 for further details.
2. Specified at time of order by part number. Also available in frequencies from 970 to 1134 MHz and 1213 to 1417 MHz.
3. Selectable parameter specified by part number.
4. Time from powerup or tristate mode to f_O.

Table 2. CLK± Output Frequency Characteristics (Continued)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Powerup Time[4]	t_{OSC}		—	—	10	ms
Settling Time After FS[1:0] Change	t_{FRQ}	Both FS[1] and FS[0] changing simultaneously	—	—	20	ms

Notes:
1. See Section 3. "Ordering Information" on page 7 for further details.
2. Specified at time of order by part number. Also available in frequencies from 970 to 1134 MHz and 1213 to 1417 MHz.
3. Selectable parameter specified by part number.
4. Time from powerup or tristate mode to f_O.

Table 3. CLK± Output Levels and Symmetry

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
LVPECL Output Option[1]	V_O	mid-level	V_{DD} – 1.42	—	V_{DD} – 1.25	V
	V_{OD}	swing (diff)	1.1	—	1.9	V_{PP}
	V_{SE}	swing (single-ended)	0.55	—	0.95	V_{PP}
LVDS Output Option[2]	V_O	mid-level	1.125	1.20	1.275	V
	V_{OD}	swing (diff)	0.5	0.7	0.9	V_{PP}
CML Output Option[2]	V_O	2.5/3.3 V option mid-level	—	V_{DD} – 1.30	—	V
		1.8 V option mid-level	—	V_{DD} – 0.36	—	V
	V_{OD}	2.5/3.3 V option swing (diff)	1.10	1.50	1.90	V_{PP}
		1.8 V option swing (diff)	0.35	0.425	0.50	V_{PP}
CMOS Output Option[3]	V_{OH}	I_{OH} = 32 mA	0.8 x V_{DD}	—	V_{DD}	V
	V_{OL}	I_{OL} = 32 mA	—	—	0.4	V
Rise/Fall time (20/80%)	t_R, t_F	LVPECL/LVDS/CML	—	—	350	ps
		CMOS with C_L = 15 pF	—	1	—	ns
Symmetry (duty cycle)	SYM	LVPECL: V_{DD} – 1.3 V (diff) LVDS: 1.25 V (diff) CMOS: V_{DD}/2	45	—	55	%

Notes:
1. 50 Ω to V_{DD} – 2.0 V.
2. R_{term} = 100 Ω (differential).
3. C_L = 15 pF

Table 4. CLK± Output Phase Jitter

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Phase Jitter (RMS)[1] for $F_{OUT} \geq$ 500 MHz	ϕ_J	12 kHz to 20 MHz (OC-48)	—	0.25	0.40	ps
		50 kHz to 80 MHz (OC-192)	—	0.26	0.37	ps
Phase Jitter (RMS)[1] for F_{OUT} of 125 to 500 MHz	ϕ_J	12 kHz to 20 MHz (OC-48)	—	0.36	0.50	ps
		50 kHz to 80 MHz (OC-192)[2]	—	0.34	0.42	ps
Phase Jitter (RMS) for F_{OUT} of 10 to 160 MHz CMOS Output Only	ϕ_J	12 kHz to 20 MHz (OC-48)[2]	—	0.62	—	ps
		50 kHz to 20 MHz[2]	—	0.61	—	ps

Notes:
1. Refer to AN256 for further information.
2. Max offset frequencies: 80 MHz for FOUT $\geq$ 250 MHz, 20 MHz for 50 MHz $\leq$ FOUT <250 MHz, 2 MHz for 10 MHz $\leq$ FOUT <50 MHz.

Table 5. CLK± Output Period Jitter

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Period Jitter*	J_{PER}	RMS	—	2	—	ps
		Peak-to-Peak	—	14	—	ps

***Note:** Any output mode, including CMOS, LVPECL, LVDS, CML. N = 1000 cycles. Refer to AN279 for further information.

Table 6. CLK± Output Phase Noise (Typical)

Offset Frequency (f)	120.00 MHz LVDS	156.25 MHz LVPECL	622.08 MHz LVPECL	Units
100 Hz	–112	–105	–97	dBc/Hz
1 kHz	–122	–122	–107	
10 kHz	–132	–128	–116	
100 kHz	–137	–135	–121	
1 MHz	–144	–144	–134	
10 MHz	–150	–147	–146	
100 MHz	n/a	n/a	–148	

Table 7. Environmental Compliance

The Si534 meets the following qualification test requirements.

Parameter	Conditions/Test Method
Mechanical Shock	MIL-STD-883, Method 2002
Mechanical Vibration	MIL-STD-883, Method 2007
Solderability	MIL-STD-883, Method 2003
Gross & Fine Leak	MIL-STD-883, Method 1014
Resistance to Solder Heat	MIL-STD-883, Method 2036
Moisture Sensitivity Level	J-STD_020, MSL1
Contact Pads	Gold over Nickel

Table 8. Thermal Characteristics

(Typical values TA = 25 ºC, V_{DD} = 3.3 V)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Thermal Resistance Junction to Ambient	θ_{JA}	Still Air	—	84.6	—	°C/W
Thermal Resistance Junction to Case	θ_{JC}	Still Air	—	38.8	—	°C/W
Ambient Temperature	T_A		–40	—	85	°C
Junction Temperature	T_J		—	—	125	°C

Table 9. Absolute Maximum Ratings[1]

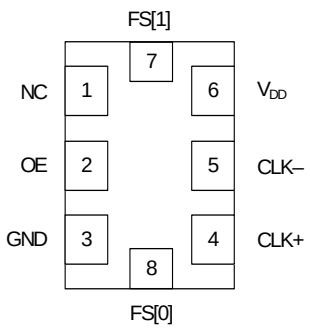
Parameter	Symbol	Rating	Units
Maximum Operating Temperature	T_{AMAX}	85	ºC
Supply Voltage, 1.8 V Option	V_{DD}	–0.5 to +1.9	V
Supply Voltage, 2.5/3.3 V Option	V_{DD}	–0.5 to +3.8	V
Input Voltage (any input pin)	V_I	–0.5 to V_{DD} + 0.3	V
Storage Temperature	T_S	–55 to +125	ºC
ESD Sensitivity (HBM, per JESD22-A114)	ESD	2000	V
Soldering Temperature (Pb-free profile)[2]	T_{PEAK}	260	ºC
Soldering Temperature Time @ T_{PEAK} (Pb-free profile)[2]	t_P	20–40	seconds

Notes:

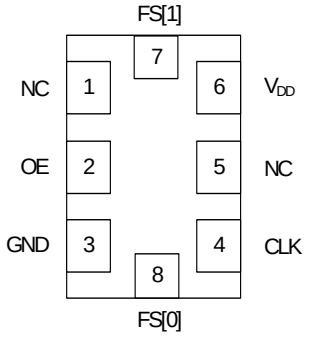
1. Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Functional operation or specification compliance is not implied at these conditions. Exposure to maximum rating conditions for extended periods may affect device reliability.
2. The device is compliant with JEDEC J-STD-020C. Refer to Si5xx Packaging FAQ available for download at www.silabs.com/VCXO for further information, including soldering profiles.

2. Pin Descriptions

(Top View)



LVDS/LVPECL/CML



CMOS

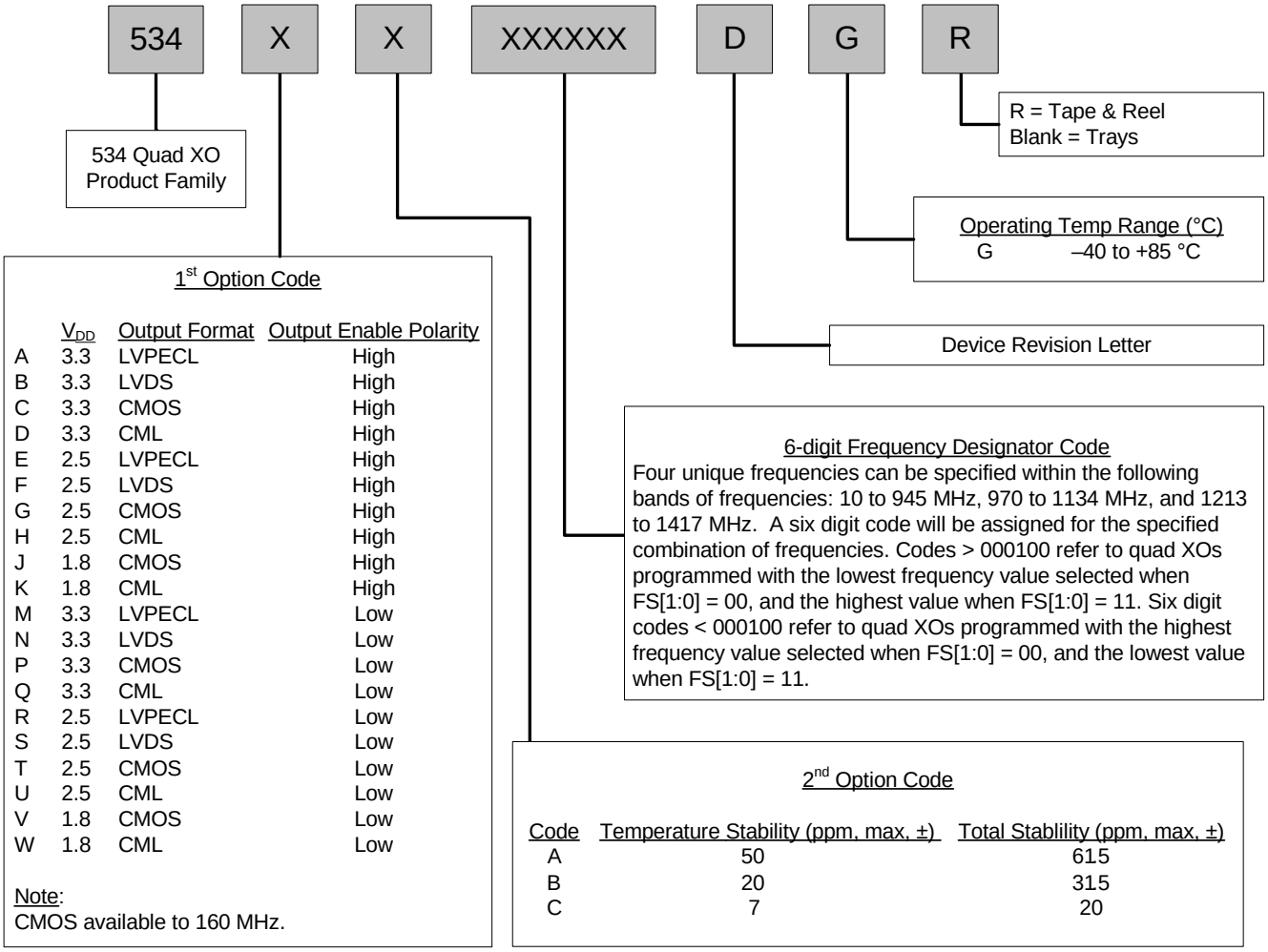
Table 10. Pin Descriptions

Pin	Symbol	LVDS/LVPECL/CML Function	CMOS Function
1	NC	No connection	No connection
2	OE*	Output enable 0 = clock output disabled (outputs tristated) 1 = clock output enabled	Output enable 0 = clock output disabled (outputs tristated) 1 = clock output enabled
3	GND	Electrical and Case Ground	Electrical and Case Ground
4	CLK+	Oscillator Output	Oscillator Output
5	CLK–	Complementary Output	No connection
6	V_{DD}	Power Supply Voltage	Power Supply Voltage
7	FS[1]*	Frequency Select MSB	Frequency Select MSB
8	FS[0]*	Frequency Select LSB	Frequency Select LSB

***Note:** FS[1:0] and OE include a 17 kΩ pullup resistor to V_{DD}. See Section 3. "Ordering Information" on page 7 for details on frequency value ordering.

3. Ordering Information

The Si534 XO supports a variety of options including frequency, temperature stability, output format, and V_{DD}. Specific device configurations are programmed into the Si534 at time of shipment. Configurations can be specified using the Part Number Configuration chart below. Silicon Laboratories provides a web browser-based part number configuration utility to simplify this process. Refer to www.silabs.com/VCXOPartNumber to access this tool and for further ordering instructions. The Si534 is supplied in an industry-standard, RoHS compliant, 6-pad, 5 x 7 mm package.



Example Part Number: 534AB000108DGR is a 5 x 7 mm quad XO in a 8 pad package. Since the six digit code (000108) is > 000100, f0 is 644.53125 MHz (lower frequency) and f1 is 693.48299 (higher frequency), with a 3.3 V supply, LVPECL output, and Output Enable active high polarity. Temperature stability is specified as ±20 ppm. The part is specified for a –40 to +85 C° ambient temperature range operation and is shipped in tape and reel format.

Figure 1. Part Number Convention

4. Outline Diagram and Suggested Pad Layout

Figure 2 illustrates the package details for the Si534. Table 11 lists the values for the dimensions shown in the illustration.

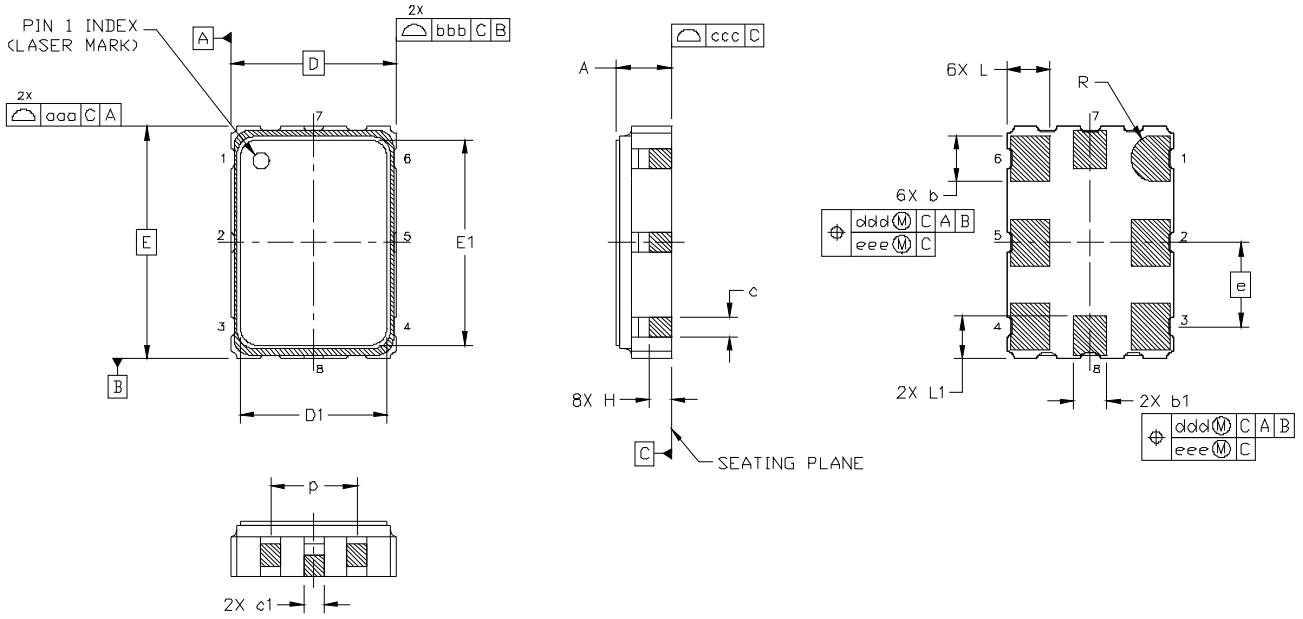


Figure 2. Si534 Outline Diagram

Table 11. Package Diagram Dimensions (mm)

Dimension	Min	Nom	Max
A	1.50	1.65	1.80
b	1.30	1.40	1.50
b1	0.90	1.00	1.10
c	0.50	0.60	0.70
c1	0.30	—	0.60
D		5.00 BSC	
D1	4.30	4.40	4.50
e		2.54 BSC	
E		7.00 BSC	
E1	6.10	6.20	6.30
H	0.55	0.65	0.75
L	1.17	1.27	1.37
L1	1.07	1.17	1.27
p	1.80	—	2.60
R		0.70 REF	
aaa	—	—	0.15
bbb	—	—	0.15
ccc	—	—	0.10
ddd	—	—	0.10
eee	—	—	0.05

Note:
1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.

5. Si534 Mark Specification

Figure 3 illustrates the mark specification for the Si534. Table 12 lists the line information.

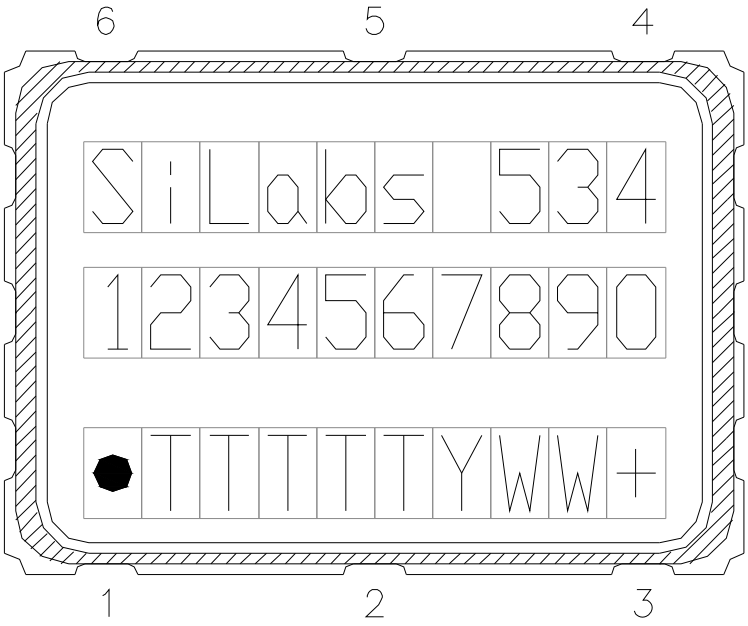


Figure 3. Mark Specification

Table 12. Si53x Top Mark Description

Line	Position	Description
1	1–10	"SiLabs 534"
2	1–10	Si530, Si531: Option1 + Option2 + Freq(7) + Temp Si532, Si533, Si534, Si530/Si531 w/ 8-digit resolution: Option1 + Option2 + ConfigNum(6) + Temp
3	**Trace Code**	
	Position 1	Pin 1 orientation mark (dot)
	Position 2	Product Revision (D)
	Position 3–6	Tiny Trace Code (4 alphanumeric characters per assembly release instructions)
	Position 7	Year (least significant year digit), to be assigned by assembly site (ex: 2007 = 7)
	Position 8–9	Calendar Work Week number (1–53), to be assigned by assembly site
	Position 10	"+" to indicate Pb-Free and RoHS-compliant

6. 8-Pin PCB Land Pattern

Figure 4 illustrates the 8-pin PCB land pattern for the Si554. Table 13 lists the values for the dimensions shown in the illustration.

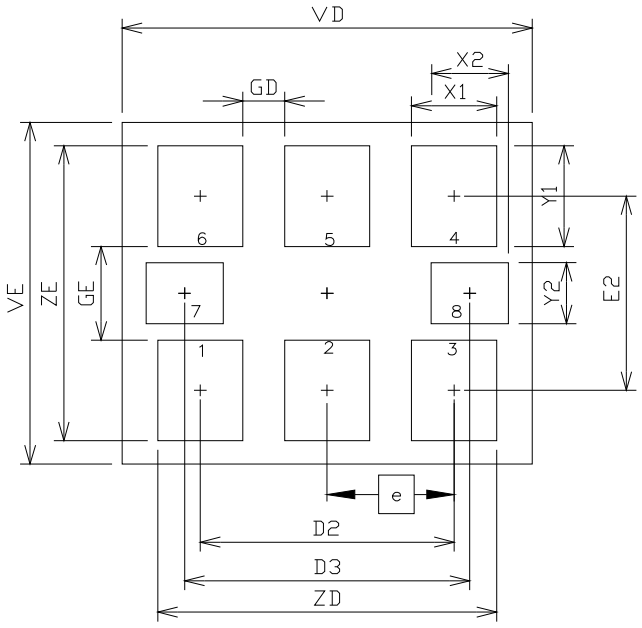


Figure 4. Si534 PCB Land Pattern

Table 13. PCB Land Pattern Dimensions (mm)

Dimension	Min	Max
D2	5.08 REF	
D3	5.705 REF	
e	2.54 BSC	
E2	4.20 REF	
GD	0.84	—
GE	2.00	—
VD	8.20 REF	
VE	7.30 REF	
X1	1.70 TYP	
X2	1.545 TYP	
Y1	2.15 REF	
Y2	1.3 REF	
ZD	—	6.78
ZE	—	6.30

Note:

1. Dimensioning and tolerancing per the ANSI Y14.5M-1994 specification.
2. Land pattern design follows IPC-7351 guidelines.
3. All dimensions shown are at maximum material condition (MMC).
4. Controlling dimension is in millimeters (mm).

DOCUMENT CHANGE LIST

Revision 1.0 to Revision 1.1

- Updated Table 1, “Recommended Operating Conditions,” on page 2.
  - Device maintains stable operation over –40 to +85 ºC operating temperature range.
  - Supply current specifications updated for revision D.
- Updated Table 2, “CLK± Output Frequency Characteristics,” on page 2.
  - Added specification for ±20 ppm lifetime stability (±7 ppm temperature stability) XO.
- Updated Table 3, “CLK± Output Levels and Symmetry,” on page 3.
  - Updated LVDS differential peak-peak swing specifications.
- Updated Table 4, “CLK± Output Phase Jitter,” on page 4.
- Updated Table 5, “CLK± Output Period Jitter,” on page 4.
  - Revised period jitter specifications.
- Updated Table 9, “Absolute Maximum Ratings[1],” on page 5 to reflect the soldering temperature time at 260 ºC is 20–40 sec per JEDEC J-STD-020C.
- Updated 3. "Ordering Information" on page 7.
  - Changed ordering instructions to revision D.
- Added 5. "Si534 Mark Specification" on page 9.

Revision 1.1 to Revision 1.2

- Updated 2.5 V/3.3 V and 1.8 V CML output level specifications for Table 3 on page 3.
- Added footnotes clarifying max offset frequency test conditions for Table 4 on page 4.
- Removed the words "Differential Modes: LVPECL/LVDS/CML" in the footnote referring to AN256 in Table 4 on page 4.
- Added CMOS phase jitter specs to Table 4 on page 4.
- Updated ESD HBM sensitivity rating in Table 9 on page 5.
- Updated Table 7 on page 5 to include the "Moisture Sensitivity Level" and "Contact Pads" rows.
- Revised Figure 2 on page 8 to reflect current package outline diagram.
- Updated Figure 3 and Table 12 on page 9 to reflect specific marking information. Previously, Figure 3 was generic.

Revision 1.2 to Revision 1.3

- Added Table 8, “Thermal Characteristics,” on page 5.

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