1 ps Max Jitter Crystal Oscillator (XO) (10 MHz to 810 MHz)

Features

- Available with any-frequency output frequencies from 10 to 810 MHz
- 3rd generation DSPLL® with superior jitter performance: 1 ps max jitter
- Better frequency stability than SAW-based oscillators
- Internal fundamental mode crystal ensures high reliability
- Available CMOS, LVPECL, LVDS, and CML outputs
- 3.3, 2.5, and 1.8 V supply options
- Industry Standard 5x7 and 3.2x5 mm packages
- Pb-free/RoHS-compliant
- –40 to +85 ºC operating temperature range

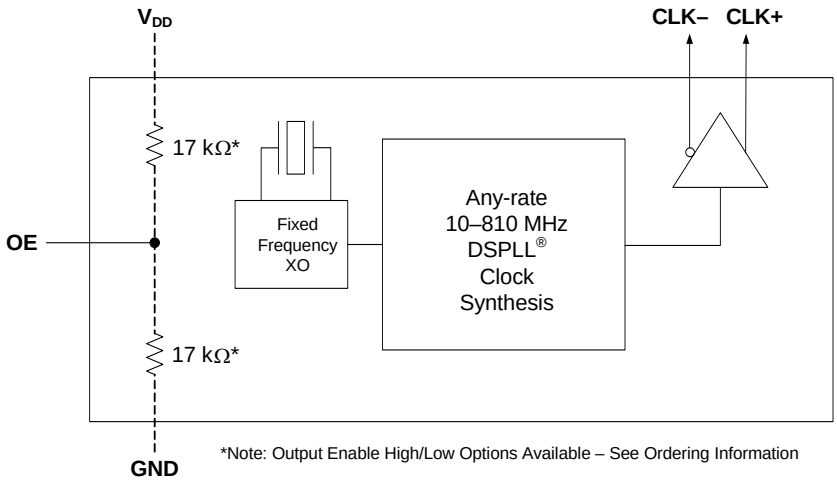
Applications

- SONET/SDH (OC-3/12/48)
- Networking
- SD/HD SDI/3G SDI video
- Test and measurement
- Storage
- FPGA/ASIC clock generation

Description

The Si590/591 XO utilizes Skyworks Solutions' advanced DSPLL® circuitry to provide a low jitter clock at high frequencies. The Si590/591 supports any frequency from 10 to 810 MHz. Unlike a traditional XO, where a unique crystal is required for each output frequency, the Si590/591 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 Si590/591 IC based XO is factory configurable for a wide variety of user specifications including frequency, supply voltage, output format, and stability. Specific configurations are factory programmed at time of shipment, thereby eliminating long lead times associated with custom oscillators.

Functional Block Diagram



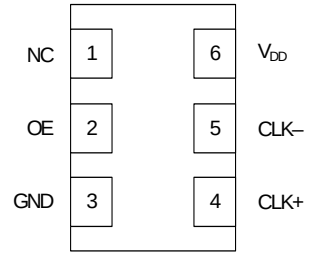
Ordering Information:

See page 8.

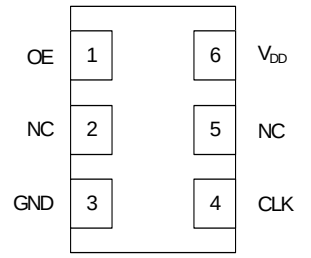
Pin Assignments:

See page 7.

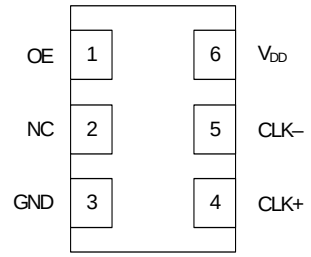
(Top View)



Si590 (LVDS/LVPECL/CML)



Si590 (CMOS)



Si591 (LVDS/LVPECL/CML)

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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	
		1.8 V option	1.71	1.8	1.89	
Supply Current	I_{DD}	Output enabled				mA
		LVPECL	—	110	125	
		CML	—	100	110	
		LVDS	—	90	100	
		CMOS	—	80	90	
		Tristate mode	—	60	75	
Output Enable (OE)[2]		V_{IH}	0.75 x V_{DD}	—	—	V
		V_{IL}	—	—	0.5	
Operating Temperature Range	T_A		–40	—	85	ºC

Notes:
1. Selectable parameter specified by part number. See Section 3. "Ordering Information" on page 8 for further details.
2. OE pin includes an internal 17 kΩ pullup resistor to V_{DD} for output enable active high or a 17 kΩ pull-down resistor to GND for output enable active low. See 3. "Ordering Information" on page 8.

Table 2. CLK± Output Frequency Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Nominal Frequency[1,2]	f_O	LVPECL/LVDS/CML	10	—	810	MHz
		CMOS	10	—	160	
Initial Accuracy	f_i	Measured at +25 °C at time of shipping	—	±1.5	—	ppm
Total Stability		Note 3, second option code “D”	—	—	±20	ppm
		Note 3, second option code “C”	—	—	±30	ppm
		Note 4, second option code “B”	—	—	±50	ppm
		Note 4, second option code “A”	—	—	±100	ppm
Temperature Stability		second option code “D”	—	—	±7	ppm
		second option code “C”	—	—	±20	ppm
		second option code “B”	—	—	±25	ppm
		second option code “A”	—	—	±50	ppm
Powerup Time[5]	t_{OSC}		—	—	10	ms

Notes:
1. See Section 3. "Ordering Information" on page 8 for further details.
2. Specified at time of order by part number.
3. Includes initial accuracy, temperature, shock, vibration, power supply and load drift, and 10 years aging at 40 °C. See 3. "Ordering Information" on page 8.
4. Includes initial accuracy, temperature, shock, vibration, power supply and load drift, and 15 years aging at 70 °C. See 3. "Ordering Information" on page 8.
5. 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_{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	
CMOS Output Option[3]	V_{OH}		0.8 x V_{DD}	—	V_{DD}	V
	V_{OL}		—	—	0.4	
Rise/Fall time (20/80%)	t_R, t_F	LVPECL/LVDS/CML	—	—	350	ps
		CMOS with C_L = 15 pF	—	2	—	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. Sinking or sourcing 12 mA for V_{DD} = 3.3 V, 6 mA for V_{DD} = 2.5 V, 3 mA for V_{DD} = 1.8 V.

Table 4. CLK± Output Phase Jitter

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Phase Jitter (RMS)[1] for 50 MHz ≤ F_{OUT} ≤ 810 MHz (LVPECL/LVDS/CML)	ϕ_J	12 kHz to 20 MHz	—	0.5	1.0	ps
Phase Jitter (RMS)[1] (LVPECL/LVDS/CML)	ϕ_J	12 kHz to 20 MHz, 155.52 MHz output frequency	—	0.4	0.7	ps
Phase Jitter (RMS)[2] for 50 MHz ≤ F_{OUT} ≤ 160 MHz (CMOS)	ϕ_J	12 kHz to 20 MHz	—	0.6	1.0	ps

Notes:
1. Refer to AN256 for further information.
2. Single-ended CMOS output phase jitter measured using 33 Ω series termination into 50 Ω phase noise test equipment. 3.3 V supply voltage option only.

Table 5. CLK± Output Period Jitter

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Period Jitter*	J_{PER}	RMS	—	—	3	ps
		Peak-to-Peak	—	—	35	
***Note:** Any output mode, including CMOS, LVPECL, LVDS, CML. N = 1000 cycles. Refer to AN279 for further information.						

\

Table 6. Environmental Compliance and Package Information

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 and Fine Leak	MIL-STD-883, Method 1014
Resistance to Solder Heat	MIL-STD-883, Method 2036
Contact Pads	Gold over Nickel

Table 7. Thermal Characteristics

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

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
5x7mm, Thermal Resistance Junction to Ambient	θ_{JA}	Still Air	—	84.6	—	°C/W
5x7mm, Thermal Resistance Junction to Case	θ_{JC}	Still Air	—	38.8	—	°C/W
3.2x5mm, Thermal Resistance Junction to Ambient	θ_{JA}	Still Air	—	31.1	—	°C/W
3.2x5mm, Thermal Resistance Junction to Case	θ_{JC}	Still Air	—	13.3	—	°C/W
Ambient Temperature	T_A		–40	—	85	°C
Junction Temperature	T_J		—	—	125	°C

Table 8. 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	2500	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 at https://www.skyworksinc.com/Product_Certificate.aspx for further information, including soldering profiles.

2. Pin Descriptions

(Top View)

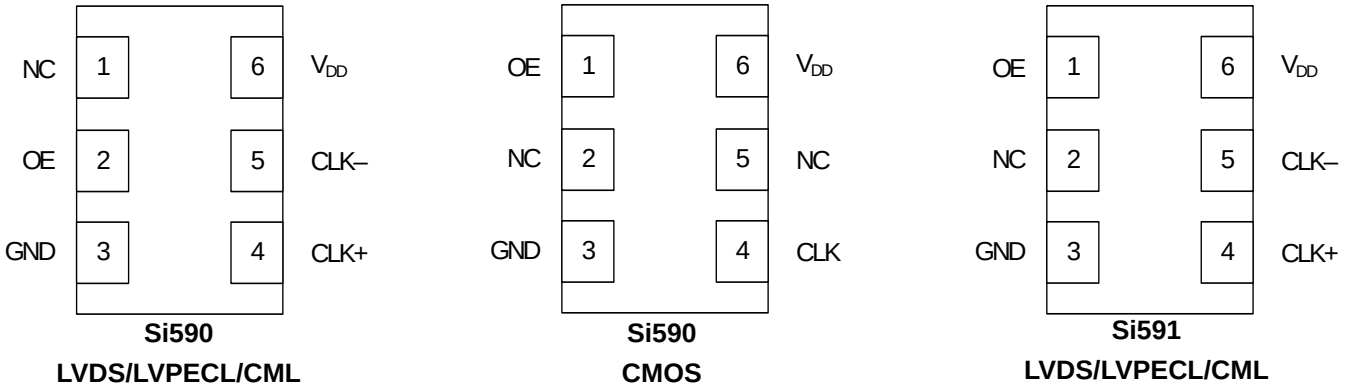


Table 9. Pinout for Si590 Series

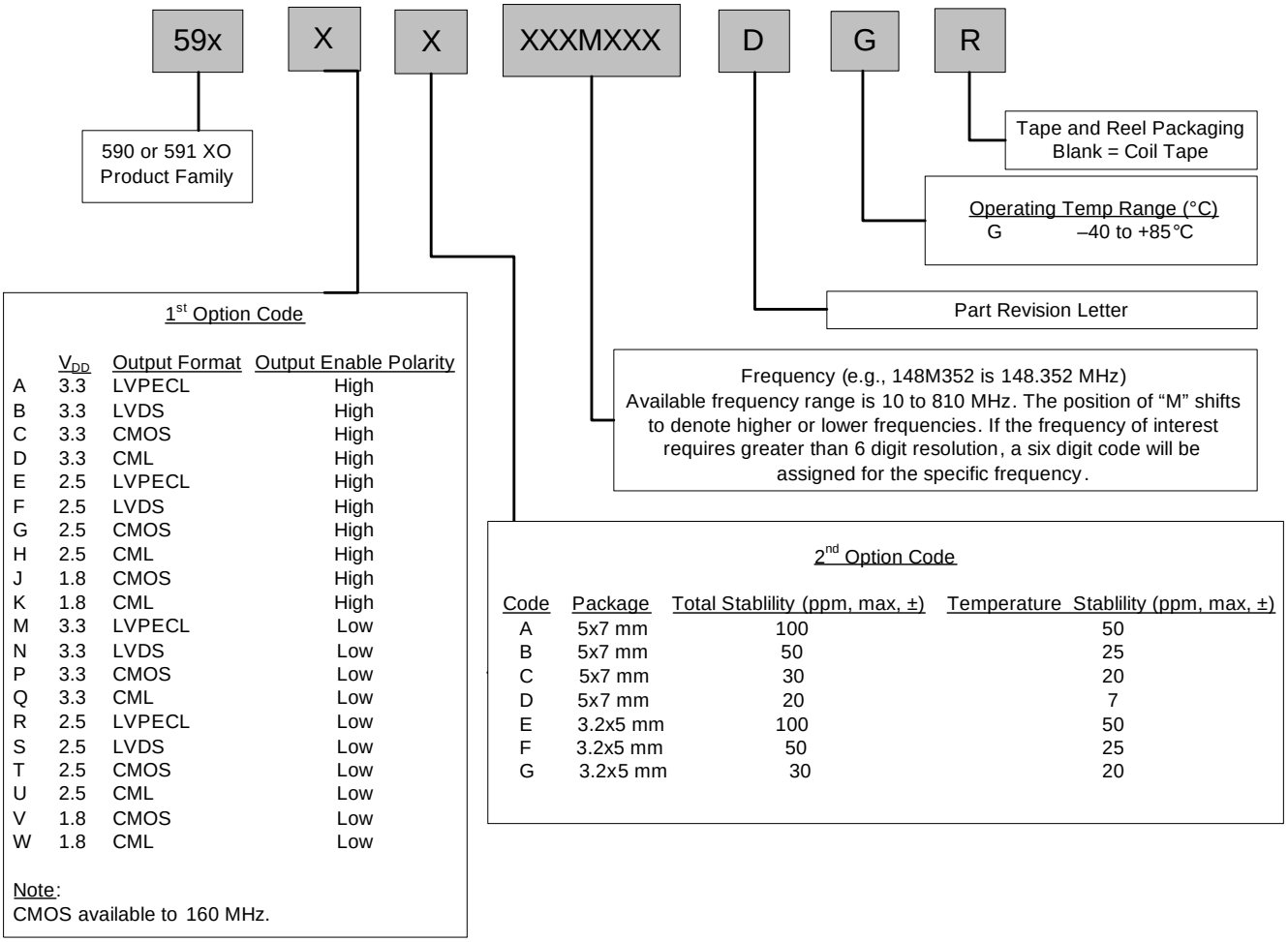
Pin	Symbol	LVDS/LVPECL/CML Function	CMOS Function
1	OE*	No connection Make no external connection to this pin	Output enable
2	OE*	Output enable	No connection Make no external connection to this pin
3	GND	Electrical and Case Ground	Electrical and Case Ground
4	CLK+	Oscillator Output	Oscillator Output
5	CLK–	Complementary Output	No connection Make no external connection to this pin
6	V_{DD}	Power Supply Voltage	Power Supply Voltage
***Note:** OE pin includes an internal 17 kΩ pullup resistor to V_{DD} for output enable active high or a 17 kΩ pulldown resistor to GND for output enable active low. See 3. "Ordering Information" on page 8.			

Table 10. Pinout for Si591 Series

Pin	Symbol	LVDS/LVPECL/CML Function
1	OE*	Output enable
2	No connection Make no external connection to this pin	No connection Make no external connection to this pin
3	GND	Electrical and Case Ground
4	CLK+	Oscillator Output
5	CLK–	Complementary output
6	V_{DD}	Power Supply Voltage
***Note:** OE pin includes an internal 17 kΩ pullup resistor to V_{DD} for output enable active high or a 17 kΩ pulldown resistor to GND for output enable active low. See 3. "Ordering Information" on page 8.		

3. Ordering Information

The Si590/591 XO supports a variety of options including frequency, temperature stability, output format, and V_{DD}. Specific device configurations are programmed into the Si590/591 at time of shipment. Configurations can be specified using the Part Number Configuration chart below. Skyworks Solutions provides a web browser-based part number configuration utility to simplify this process. To access this tool refer to https://www.skyworksinc.com/en/Products/Timing. The Si590 and Si591 XO series are supplied in an industry-standard, RoHS compliant, 6-pad, 5 x 7 mm and 3.2 x 5 mm packages. The Si591 Series supports an alternate OE pinout (pin #1) for LVPECL, LVDS, and CML output formats. See Tables 9 and 10 for the pinout differences between the Si590 and Si591 series.



	V_{DD}	Output Format	Output Enable Polarity
A	3.3	LVPECL	High
B	3.3	LVDS	High
C	3.3	CMOS	High
D	3.3	CML	High
E	2.5	LVPECL	High
F	2.5	LVDS	High
G	2.5	CMOS	High
H	2.5	CML	High
J	1.8	CMOS	High
K	1.8	CML	High
M	3.3	LVPECL	Low
N	3.3	LVDS	Low
P	3.3	CMOS	Low
Q	3.3	CML	Low
R	2.5	LVPECL	Low
S	2.5	LVDS	Low
T	2.5	CMOS	Low
U	2.5	CML	Low
V	1.8	CMOS	Low
W	1.8	CML	Low

Code	Package	Total Stablility (ppm, max, ±)	Temperature Stablility (ppm, max, ±)
A	5x7 mm	100	50
B	5x7 mm	50	25
C	5x7 mm	30	20
D	5x7 mm	20	7
E	3.2x5 mm	100	50
F	3.2x5 mm	50	25
G	3.2x5 mm	30	20

Figure 1. Part Number Convention

4. Package Outline Drawing: 5 x 7 mm, 6-pin

Figure 2 illustrates the package details for the 5 x 7 mm Si590/591. Table 11 lists the values for the dimensions shown in the illustration.

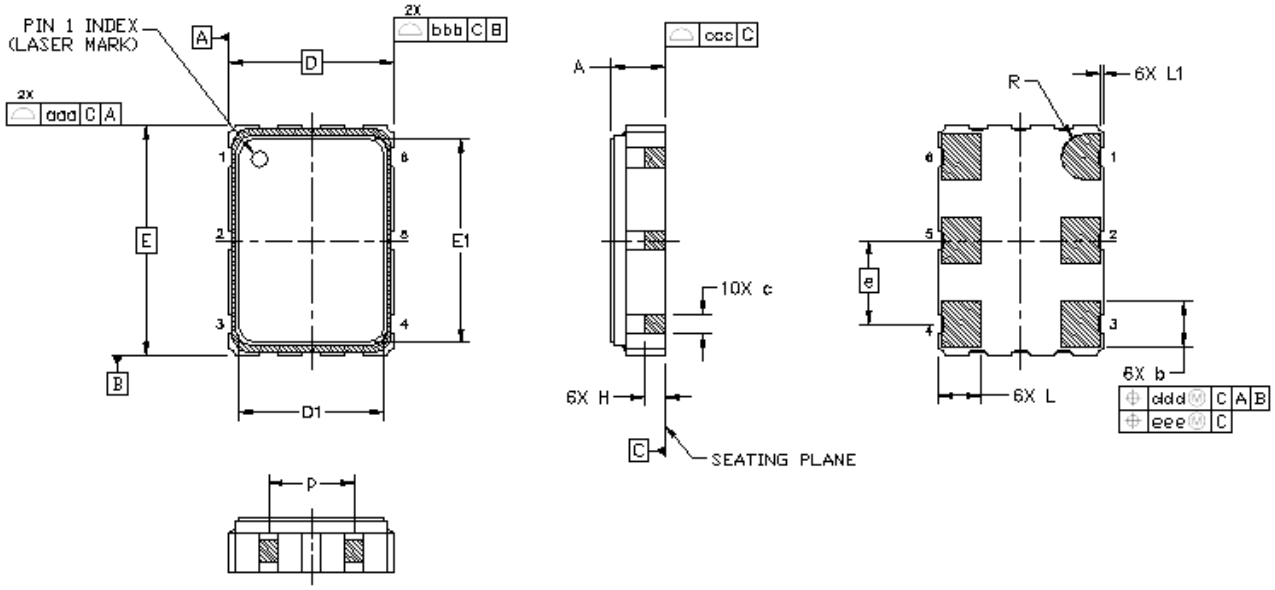


Figure 2. Si590/591 Outline Diagram

Table 11. Package Diagram Dimensions (mm)

Dimension	Min	Nom	Max
A	1.50	1.65	1.80
b	1.30	1.40	1.50
c	0.50	0.60	0.70
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	0.05	0.10	0.15
p	1.80	—	2.60
R		0.70 REF	
aaa		0.15	
bbb		0.15	
ccc		0.10	
ddd		0.10	
eee		0.05	

5. PCB Land Pattern: 5 x 7 mm, 6-pin

Figure 3 illustrates the 6-pin PCB land pattern for the 5 x 7 mm Si590/591. Table 12 lists the values for the dimensions shown in the illustration.

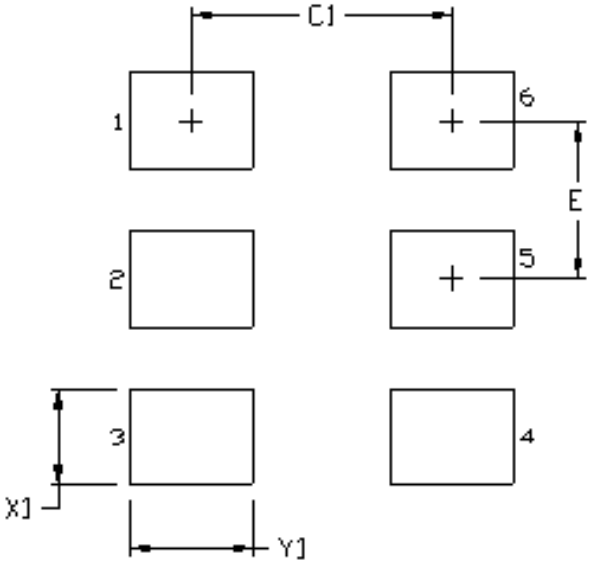


Figure 3. Si590/591 PCB Land Pattern

Table 12. PCB Land Pattern Dimensions (mm)

Dimension	(mm)
C1	4.20
E	2.54
X1	1.55
Y1	1.95

Notes:

General

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing is per the ANSI Y14.5M-1994 specification.
3. This Land Pattern Design is based on the IPC-7351 guidelines.
4. All dimensions shown are at Maximum Material Condition (MMC). Least Material Condition (LMC) is calculated based on a Fabrication Allowance of 0.05 mm.

Solder Mask Design

1. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60 µm minimum, all the way around the pad.

Stencil Design

1. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
2. The stencil thickness should be 0.125 mm (5 mils).
3. The ratio of stencil aperture to land pad size should be 1:1.

Card Assembly

1. A No-Clean, Type-3 solder paste is recommended.
2. The recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

6. Package Outline Drawing: 3.2 x 5 mm, 6-pin

Figure illustrates the package details for the 3.2 x 5 mm Si590/591. Table 13 lists the values for the dimensions shown in the illustration.

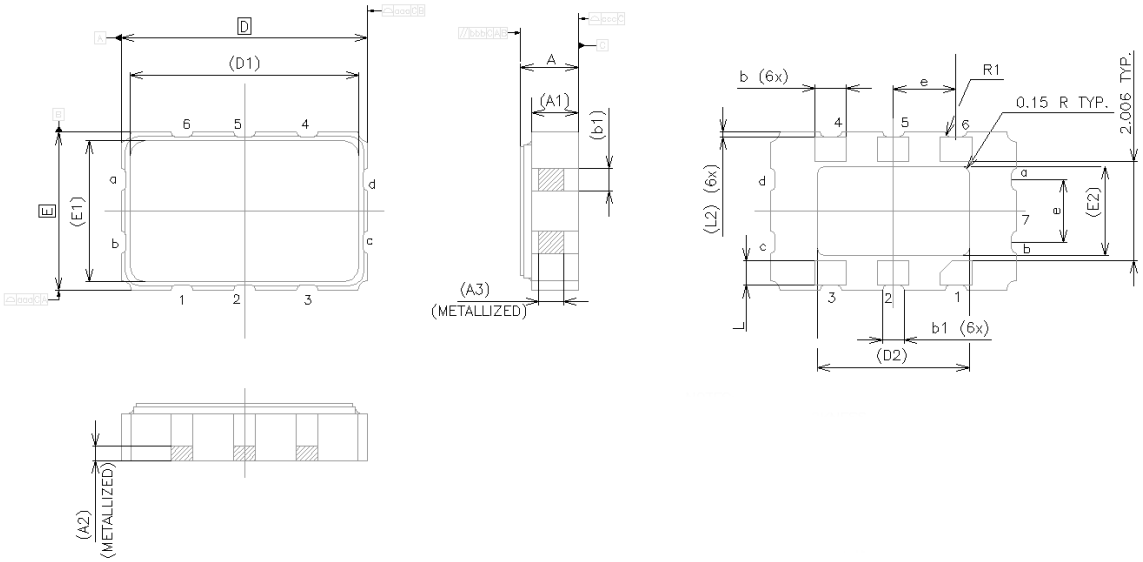


Figure 4. Si590/591 Outline Diagram

Table 13. Package Diagram Dimensions (mm)

Dimension	Min	Nom	Max		Dimension	Min	Nom	Max
A	1.02	1.17	1.32		E1	2.85 BSC		
A1	0.99	1.10	1.21		E2	1.91 BSC		
A2	0.5 BSC				L	0.35	0.45	0.55
A3	0.30 BSC				L2	0.05	0.10	0.15
b	0.54	0.64	0.74		R1	0.10 REF		
B1	0.35	0.45	0.55		aaa	0.15		
D	5.00 BSC				bbb	0.15		
D1	4.65 BSC				ccc	0.08		
D2	3.38 BSC				ddd	0.10		
e	1.27 BSC				eee	0.05		
E	3.20 BSC							

Notes:

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

7. PCB Land Pattern: 3.2 x 5 mm, 6-pin

Figure 5 illustrates the 6-pin PCB land pattern for the 3.2 x 5 mm Si590/591. Table 14 lists the values for the dimensions shown in the illustration.

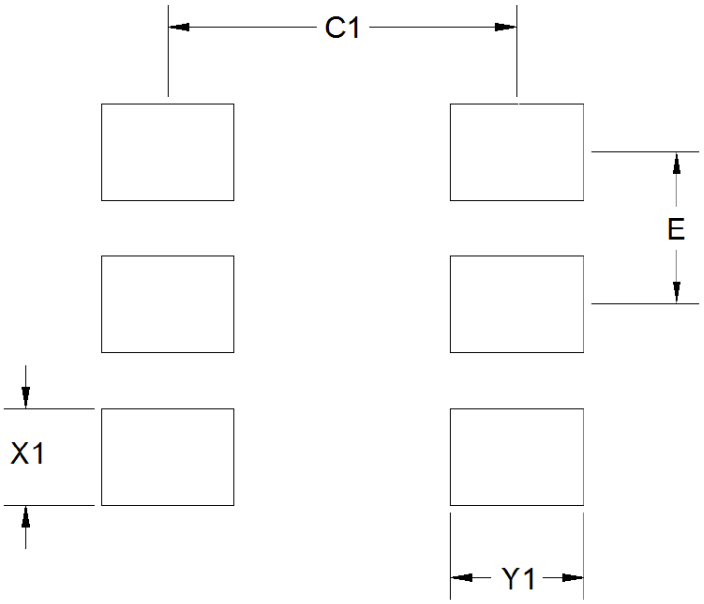


Figure 5. Si590/591 PCB Land Pattern

Table 14. PCB Land Pattern Dimensions (mm)

Dimension	(mm)
C1	2.91
E	1.27
X1	0.80
Y1	1.10

Notes:

General

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing is per the ANSI Y14.5M-1994 specification.
3. This Land Pattern Design is based on the IPC-7351 guidelines.
4. All dimensions shown are at Maximum Material Condition (MMC). Least Material Condition (LMC) is calculated based on a Fabrication Allowance of 0.05 mm.

Solder Mask Design

1. All metal pads are to be non-solder mask defined (NSMD). Clearance between the solder mask and the metal pad is to be 60 µm minimum, all the way around the pad.

Stencil Design

1. A stainless steel, laser-cut and electro-polished stencil with trapezoidal walls should be used to assure good solder paste release.
2. The stencil thickness should be 0.125 mm (5 mils).
3. The ratio of stencil aperture to land pad size should be 1:1.

Card Assembly

1. A No-Clean, Type-3 solder paste is recommended.
2. The recommended card reflow profile is per the JEDEC/IPC J-STD-020C specification for Small Body Components.

8. Si590/Si591 Top Marking: 5 x 7 mm

Figure 6 illustrates the mark specification for the 5 x 7 mm Si590/Si591. Table 15 lists the line information.

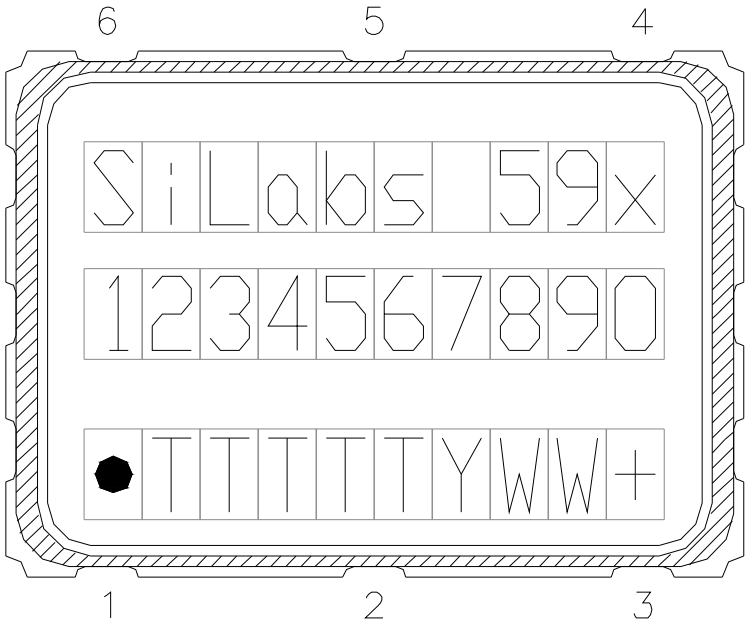


Figure 6. Top Mark Specification

Table 15. Si59x Top Mark Description

Line	Position	Description
1	1–10	"SiLabs"+ Part Family Number, 59x (First 3 characters in part number where x = 0 indicates a 590 device and x = 1 indicates a 591 device)
2	1–10	Si590, Si591: Option1 + Option2 + Freq(7) + Temp Si590/Si591 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: 2009 = 9)
	Position 8–9	Calendar Work Week number (1–53), to be assigned by assembly site
	Position 10	"+" to indicate Pb-Free and RoHS-compliant

9. Si590/Si591 Top Marking: 3.2 x 5 mm

Figure 7 illustrates the mark specification for the 3.2 x 5 mm Si590/Si591. Table 16 lists the line information.

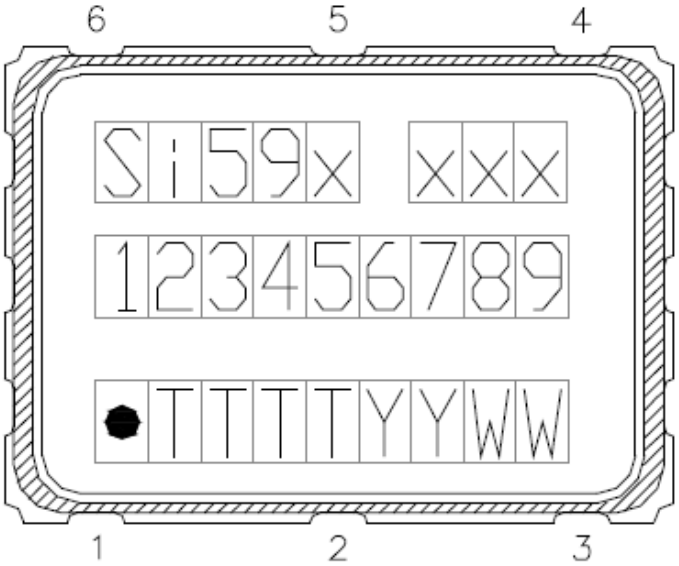


Figure 7. Top Mark Specification

Table 16. Si59x Top Mark Description

Line	Position	Description
1	1–5	"Si"+ Part Family Number, 59x (First 3 characters in part number where x = 0 indicates a 590 device and x = 1 indicates a 591 device)
	6–8	Crystal trace code (3 alphanumeric characters assigned by assembly site)
2	1–9	Si590, Si591: Option1 + Option2 + Freq(7) Si590/Si591 w/ 8-digit resolution: Option1 + Option2 + ConfigNum(6)
3	**Trace Code**	
	Position 1	Pin 1 orientation mark (dot)
	Position 2	Product Revision (D)
	Position 3–5	Tiny Trace Code (3 alphanumeric characters per assembly release instructions)
	Position 6–7	Year (last two digits of year), to be assigned by assembly site (ex: 20017 = 17)
	Position 8–9	Calendar Work Week number (1–53), to be assigned by assembly site

Revision History

Revision 1.2

June, 2018

- Changed “Trays” to “Coil Tape” in 3. "Ordering Information" on page 8.

Revision 1.1

December, 2017

- Added 3.2 x 5 mm package.

Revision 1.0

- Updated 2.5 V/3.3 V and 1.8 V CML output level specifications in Table 3 on page 4.
- Updated Si590/591 devices to support frequencies up to 810 MHz for LVPECL, LVDS, and CML outputs.
- Separated 1.8 V, 2.5 V/3.3 V supply voltage. specifications for CML output in Table 3 on page 4.
- Updated Note 1 of Table 4 on page 4 to refer to AN256.
- Updated Table 4 on page 4.
  - Updated phase jitter specification.
- Updated Table 6 on page 5 to include the "Moisture Sensitivity Level" and "Contact Pads" rows.
- Updated Figure 3 and Table 15 on page 13 to reflect specific marking information.
- Added Table 7, “Thermal Characteristics,” on page 5.
- Rearranged sections to conform to new quality standard.

Revision 0.4

- Added ±7 ppm temperature stability ordering option in Table 4 on page 4 and Figure 1 on page 8.

Revision 0.3

- Updated Table 4 on page 4 by adding the 155.51 MHz “Phase Jitter (RMS) (LVPECL/LVDS/CML)” row.
- Updated and clarified Table 6 on page 5 to correct typos and include the “Moisture Sensitivity Level” and “Contact Pads” rows.
- Corrected BSC value in rows D and E in Table 11 on page 9.

Revision 0.25

- Total Stability Maximum changed to ±30 in Table 2 on page 3.
- Total Stability Maximum changed to ±30 in Figure 1 on page 8.

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Skyworks:

590CA112M192DG 591NB500M000DG 590CA66M7340DG 590CA50M1000DG 590AA125M000DG
590AA200M000DG 590CA16M0000DG 591FB125M000DG 590BB120M000DG 590CD24M5760DG
590BD10M0000DG 590CC100M000DG 590AC290M122DG 590CA32M9560DG 590BC16M9344DG
590CA113M000DG 590CA27M5000DG 590PA40M0000DG 590CC32M8200DG 591SC75M0000DG
590CA12M0000DG 590CC26M0000DG 590AC100M000DG 590CA50M0000DG 590DA435M350DG
590BB125M000DG 591BD250M000DG 591BB100M000DG 591BB212M500DG 591FA000274DG
590BB148M350DG 591SA314M500DG 590FA350M000DG 590BD125M000DG 591FC200M000DG
591KC125M000DG 591DD417M000DG 591BB360M000DG 591BB155M520DG 591BC125M000DG
591BC125M000DGR 591BB148M350DG 590BB600M000DG 590BB300M000DG 590AB27M0000DG
591FB100M000DG 591BD148M500DG 590CD11M2896DG 590PD24M9981DG 591MB10M0000DG
590WB50M0000DG 590BC296M703DG 591BD210M000DG 591AC50M0000DG 590BD296M704DG
590CC128M000DG 590CD80M0000DG 590BC297M000DG 591BD122M880DG 591DD25M0000DG
590CD98M3040DG 591SA312M500DG 591FA135M000DG 590AD433M920DG 590FD125M000DG
590JD48M0000DG 591AD74M1758DG 591BD500M000DG 590CB90M3168DG 591BD125M000DG
590CD70M6560DG 590BD297M000DG 591BD435M000DG 591AD74M2500DG 590BB148M500DG
590BB122M880DG 590CD22M5792DG 590CD10M0000DG 590CD24M9981DG 590DA145M825DG
590BD500M000DG 590BD360M000DG 591BD322M266DG 591AD25M0000DG 591EB000106DG
591FB85M0000DG 590CD27M0000DG 591BD155M520DG 590AA306M250DG 591BB300M000DG
590AD280M000DG 590BC40M0000DG 590KA800M000DG 591BB125M000DG 590JB140M000DG
591BD200M000DG 590SB25M0000DG 591BA100M000DG 590AC10M0000DG 590CC20M0000DG