

## DIFFERENTIAL OUTPUT SILICON OSCILLATOR

### Features

- Quartz-free, MEMS-free, and PLL-free all-silicon oscillator
- Any output frequencies from 0.9 to 200 MHz
- Short lead times
- Excellent temperature stability ( $\pm 20$  ppm)
- Highly reliable startup and operation
- High immunity to shock and vibration
- Low jitter:  $< 1.5$  ps rms
- 0 to 85 °C operation includes 10-year aging in hot environments
- Footprint compatible with industry-standard 3.2 x 5.0 mm XOs
- CMOS, SSTL, LVPECL, LVDS, and HCSL versions available
- Driver stopped, tri-state, or powerdown operation
- RoHS compliant
- 1.8, 2.5, or 3.3 V options
- Low power
- More than 10x better fit rate than competing crystal solutions



### Specifications

| Parameters            | Condition                                           | Min  | Typ      | Max       | Units |
|-----------------------|-----------------------------------------------------|------|----------|-----------|-------|
| Frequency Range       |                                                     | 0.9  | —        | 200       | MHz   |
| Frequency Stability   | Temperature stability, 0 to +70 °C                  | —    | $\pm 10$ | —         | ppm   |
|                       | Temperature stability, 0 to +85 °C                  | —    | $\pm 20$ | —         | ppm   |
|                       | Total stability, 0 to +70 °C operation <sup>1</sup> | —    | —        | $\pm 150$ | ppm   |
|                       | Total stability, 0 to +85 °C operation <sup>2</sup> | —    | —        | $\pm 250$ | ppm   |
| Operating Temperature | Commercial                                          | 0    | —        | 70        | °C    |
|                       | Extended commercial                                 | 0    | —        | 85        | °C    |
| Storage Temperature   |                                                     | -55  | —        | +125      | °C    |
| Supply Voltage        | 1.8 V option                                        | 1.71 | —        | 1.98      | V     |
|                       | 2.5 V option                                        | 2.25 | —        | 2.75      | V     |
|                       | 3.3 V option                                        | 2.97 | —        | 3.63      | V     |

#### Notes:

1. Inclusive of 25 °C initial frequency accuracy, operating temperature range, supply voltage change, output load change, first-year aging at 25 °C, shock, vibration, and one solder reflow.
2. Inclusive of 25 °C initial frequency accuracy, operating temperature range, supply voltage change, output load change, ten-year aging at 85 °C, shock, vibration, and one solder reflow.
3. See "AN409: Output Termination Options for the Si500S and Si500D Silicon Oscillators" for further details regarding output clock termination recommendations.
4.  $V_{TT} = .5 \times V_{DD}$ .
5.  $V_{TT} = .45 \times V_{DD}$ .

| Parameters                                                                         | Condition                                                      | Min                          | Typ  | Max                          | Units    |
|------------------------------------------------------------------------------------|----------------------------------------------------------------|------------------------------|------|------------------------------|----------|
| Supply Current                                                                     | LVPECL                                                         | —                            | 34.0 | 36.0                         | mA       |
|                                                                                    | Low Power LVPECL                                               | —                            | 19.3 | 22.2                         | mA       |
|                                                                                    | LVDS                                                           | —                            | 14.9 | 16.5                         | mA       |
|                                                                                    | HCSL                                                           | —                            | 25.3 | 29.3                         | mA       |
|                                                                                    | Differential CMOS(3.3 V option, 10 pF on each output, 200 MHz) | —                            | 33   | 36                           | mA       |
|                                                                                    | Differential CMOS(3.3 V option, 1 pF on each output, 40 MHz)   | —                            | 16   | —                            | mA       |
|                                                                                    | Differential SSTL-3.3                                          | —                            | 24.5 | 27.7                         | mA       |
|                                                                                    | Differential SSTL-2.5                                          | —                            | 24.3 | 26.7                         | mA       |
|                                                                                    | Differential SSTL-1.8                                          | —                            | 22.2 | 25                           | mA       |
|                                                                                    | Tri-State                                                      | —                            | 9.7  | 10.7                         | mA       |
|                                                                                    | Powerdown                                                      | —                            | 1.0  | 1.9                          | mA       |
| Output Symmetry                                                                    | $V_{DIFF} = 0$                                                 | $46 - 13 \text{ ns}/T_{CLK}$ | —    | $54 + 13 \text{ ns}/T_{CLK}$ | %        |
| Rise and Fall Times (20/80%) <sup>3</sup>                                          | LVPECL/LVDS                                                    | —                            | —    | 460                          | ps       |
|                                                                                    | HCSL/Differential SSTL                                         | —                            | —    | 800                          | ps       |
|                                                                                    | Differential CMOS, 15 pF, ≥80 MHz                              | —                            | 1.1  | 1.6                          | ns       |
| LVPECL Output Option (DC coupling, 50 Ω to $V_{DD} - 2.0 \text{ V}$ ) <sup>3</sup> | Mid-level                                                      | $V_{DD} - 1.5$               | —    | $V_{DD} - 1.34$              | V        |
|                                                                                    | Diff swing                                                     | .720                         | —    | .880                         | $V_{PK}$ |
| Low Power LVPECL Output Option (AC coupling, 100 Ω Differential Load) <sup>3</sup> | Mid-level                                                      | —                            | N/A  | —                            | V        |
|                                                                                    | Diff swing                                                     | .68                          | —    | .95                          | $V_{PK}$ |
| LVDS Output Option (2.5/3.3 V) ( $R_{TERM} = 100 \Omega$ diff) <sup>3</sup>        | Mid-level                                                      | 1.15                         | —    | 1.26                         | V        |
|                                                                                    | Diff swing                                                     | 0.25                         | —    | 0.45                         | $V_{PK}$ |
| LVDS Output Option (1.8 V) ( $R_{TERM} = 100 \Omega$ diff) <sup>3</sup>            | Mid-level                                                      | 0.85                         | —    | 0.96                         | V        |
|                                                                                    | Diff swing                                                     | 0.25                         | —    | 0.45                         | $V_{PK}$ |
| HCSL Output Option <sup>3</sup>                                                    | Mid-level                                                      | 0.35                         | —    | 0.425                        | V        |
|                                                                                    | Diff swing                                                     | 0.65                         | —    | 0.82                         | $V_{PK}$ |
|                                                                                    | DC termination per pad                                         | 45                           | —    | 55                           | Ω        |
| CMOS Output Voltage <sup>3</sup>                                                   | $V_{OH}$ , sourcing 9 mA                                       | $V_{DD} - 0.6$               | —    | —                            | V        |
|                                                                                    | $V_{OL}$ , sinking 9 mA                                        | —                            | —    | 0.6                          | V        |
| SSTL-1.8 Output Voltage <sup>4</sup>                                               | $V_{OH}$                                                       | $V_{TT} + 0.375$             | —    | —                            | V        |
|                                                                                    | $V_{OL}$                                                       | —                            | —    | $V_{TT} - 0.375$             |          |
| SSTL-2.5 Output Voltage <sup>4</sup>                                               | $V_{OH}$                                                       | $V_{TT} + 0.48$              | —    | —                            | V        |
|                                                                                    | $V_{OL}$                                                       | —                            | —    | $V_{TT} - 0.48$              |          |
| SSTL-3.3 Output Voltage <sup>5</sup>                                               | $V_{OH}$                                                       | $V_{TT} + 0.48$              | —    | —                            | V        |
|                                                                                    | $V_{OL}$                                                       | —                            | —    | $V_{TT} - 0.48$              |          |
| Powerup Time                                                                       | From time $V_{DD}$ crosses min spec supply                     | —                            | —    | 2                            | ms       |
| OE Deassertion to Clk Stop                                                         |                                                                | —                            | —    | $250 + 3 \times T_{CLK}$     | ns       |
| Return from Output Driver Stopped Mode                                             |                                                                | —                            | —    | $250 + 3 \times T_{CLK}$     | ns       |
| Return From Tri-State Time                                                         |                                                                | —                            | —    | $12 + 3 \times T_{CLK}$      | μs       |

## Notes:

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2. Inclusive of 25 °C initial frequency accuracy, operating temperature range, supply voltage change, output load change, ten-year aging at 85 °C, shock, vibration, and one solder reflow.
3. See “AN409: Output Termination Options for the Si500S and Si500D Silicon Oscillators” for further details regarding output clock termination recommendations.
4.  $V_{TT} = .5 \times V_{DD}$ .
5.  $V_{TT} = .45 \times V_{DD}$ .

| Parameters                 | Condition                                                    | Min | Typ | Max | Units     |
|----------------------------|--------------------------------------------------------------|-----|-----|-----|-----------|
| Return From Powerdown Time |                                                              | —   | —   | 2   | ms        |
| Period Jitter (1-sigma)    | Non-CMOS                                                     | —   | 1   | 2   | ps<br>RMS |
|                            | CMOS, $C_L = 7$ pF                                           | —   | 1   | 3   | ps<br>RMS |
| Integrated Phase Jitter    | 1.0 MHz – min(20 MHz,<br>$0.4 \times F_{OUT}$ ), non-CMOS    | —   | 0.6 | 1   | ps<br>RMS |
|                            | 1.0 MHz – min(20 MHz,<br>$0.4 \times F_{OUT}$ ), CMOS format | —   | 0.7 | 1.5 | ps<br>RMS |

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Package Specifications

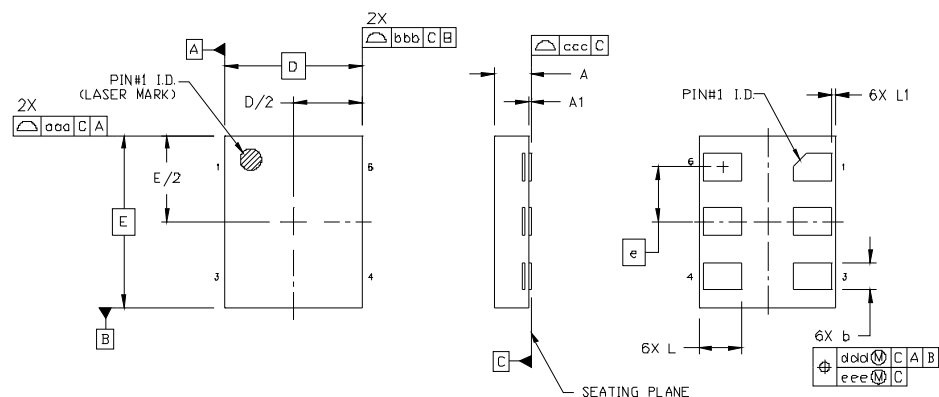


Table 1. Package Diagram Dimensions (mm)

| Dimension | Min       | Nom  | Max  |
|-----------|-----------|------|------|
| A         | 0.80      | 0.85 | 0.90 |
| A1        | 0.00      | 0.03 | 0.05 |
| b         | 0.59      | 0.64 | 0.69 |
| D         | 3.20 BSC. |      |      |
| e         | 1.27 BSC. |      |      |
| E         | 4.00 BSC. |      |      |
| L         | 0.95      | 1.00 | 1.05 |

| Dimension | Min  | Nom  | Max  |
|-----------|------|------|------|
| L1        | 0.00 | 0.05 | 0.10 |
| aaa       | —    | —    | 0.10 |
| bbb       | —    | —    | 0.10 |
| ccc       | —    | —    | 0.08 |
| ddd       | —    | —    | 0.10 |
| eee       | —    | —    | 0.05 |

Table 2. Pad Connections

|   |                                            |
|---|--------------------------------------------|
| 1 | OE                                         |
| 2 | NC—Make no external connection to this pin |
| 3 | GND                                        |
| 4 | Output                                     |
| 5 | Complementary Output                       |
| 6 | VDD                                        |

Table 3. Tri-State/Powerdown/Driver Stopped Function on OE (3rd Option Code)

|         | A         | B         | C          | D          | E              | F              |
|---------|-----------|-----------|------------|------------|----------------|----------------|
| Open    | Active    | Active    | Active     | Active     | Active         | Active         |
| 1 Level | Active    | Tri-State | Active     | Power-down | Active         | Driver Stopped |
| 0 Level | Tri-State | Active    | Power-down | Active     | Driver Stopped | Active         |

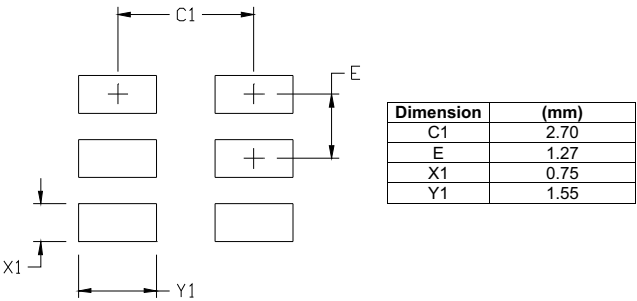
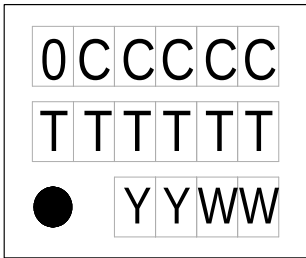


Figure 1. Recommended Land Pattern



0 = Si500  
CCCCC = mark code  
TTTTTT = assembly manufacturing code  
YY = year  
WW = work week

Figure 2. Top Mark

## Environmental Compliance

| Parameter                    | Conditions/Test Method            |
|------------------------------|-----------------------------------|
| Mechanical Shock             | MIL-STD-883, Method 2002.4        |
| Mechanical Vibration         | MIL-STD-883, Method 2007.3 A      |
| Resistance to Soldering Heat | MIL-STD-202, 260 C° for 8 seconds |
| Solderability                | MIL-STD-883, Method 2003.8        |
| Damp Heat                    | IEC 68-2-3                        |
| Moisture Sensitivity Level   | J-STD-020, MSL 3                  |

## Ordering Information

The Si500D supports a variety of options including frequency, output format, supply voltage, and tri-state/powerdown. Specific device configurations are programmed into the Si500D at time of shipment. Configurations are specified using the figure below. Silicon Labs provides a web-based part number utility that can be used to simplify part number configuration. Refer to [www.silabs.com/SiliconXOPartnumber](http://www.silabs.com/SiliconXOPartnumber) to access this tool. The Si500D XO series is supplied in a ROHS-compliant, Pb-free, 6-pad, 3.2 x 4.0 mm package. Tape and reel packaging is available as an ordering option.



## DOCUMENT CHANGE LIST

### Revision 0.2 to Revision 0.3

- Revision B to Revision C updated in Ordering Information
- 0 to 85 °C Operating Temperature Range option added

### Revision 0.3 to Revision 1.0

- Clarified SSTL specifications.
- Revised Differential CMOS supply current values.
- Clarified Differential CMOS supply current loading conditions.

### Revision 1.0 to Revision 1.1

- Updated Ordering information for  $\pm 250$  ppm from 0 to +85 °C.
- Updated jitter from 1.5 ps to 1.5 ps rms.
- Updated operating temperature to include extended commercial at 0 to +85 °C.
- Updated features to include LVPECL, LVDS, and HCSL.

**NOTES:**



## ClockBuilder Pro

One-click access to Timing tools, documentation, software, source code libraries & more. Available for Windows and iOS (CBGo only).

[www.silabs.com/CBPro](http://www.silabs.com/CBPro)



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