

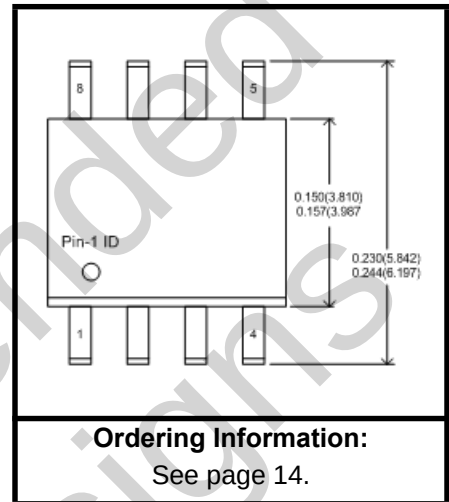


# THE DATASHEET OF SL23EP05SC-1HT

## LOW JITTER AND SKEW 10 TO 220 MHz ZERO DELAY BUFFER (ZDB)

### Features

- 10 to 220 MHz operating frequency range
- Low output clock jitter:
  - 50 ps-typ cycle-to-cycle jitter
  - 20 ps-typ period jitter
- Low output-to-output skew: 30 ps-typ
- Low product-to-product skew: 60 ps-typ
- Wide 2.5 V to 3.3 V power supply range
- Low power dissipation:
  - 16 mA-max at 66 MHz and VDD = 3.3 V
  - 14 mA-max at 66 MHz and VDD = 2.5 V
- One input drives five outputs organized as 4+1
- SpreadThru™ PLL that allows use of SSCG
- Standard and High-Drive options
- Available in 8 pin SOIC and TSSOP packages
- Available in Commercial and Industrial grades



### Applications

- Printers and MFPs
- Digital Copiers
- PCs and Work Stations
- Routers, Switchers and Servers
- Digital Embedded Systems

### Benefits

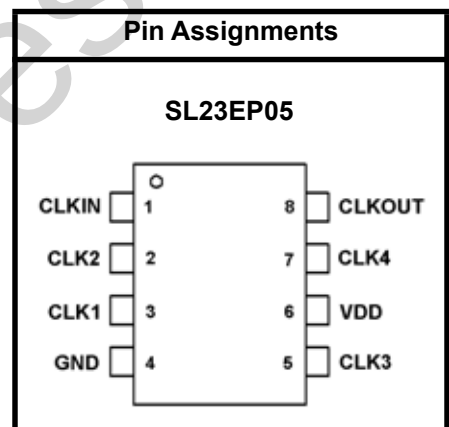
- Up to five distribution of input clock
- Standard and High-Drive levels to control impedance level, frequency range and EMI
- Low power dissipation, jitter and skew
- Low cost

### Description

The SL23EP05 is a low skew, low jitter, and low power Zero Delay Buffer (ZDB) designed to produce up to five clock outputs from one reference input clock for high speed clock distribution applications. The product has an on-chip PLL which locks to the input clock at CLKIN and receives its feedback internally from the CLKOUT pin.

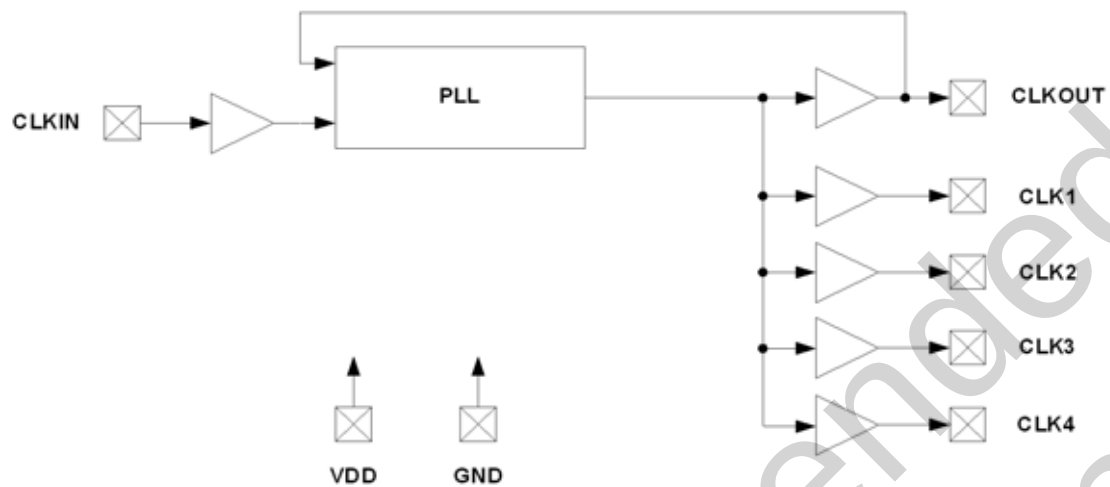
The SL23EP05 is available with two drive strength versions called -1 and -1H. The -1 is the standard-drive version and -1H is the high-drive version. The SL23EP05 high-drive version operates up to 220 MHz and 180 MHz at 3.3 V and 2.5 V power supplies, respectively. The standard drive version -1 operates up to 200 MHz and 167 MHz at 3.3 V and 2.5 V, respectively.

The SL23EP05 enter into Power Down (PD) mode if the input at CLKIN is less than 2.0 MHz or there is no rising edge. In this state all five outputs are tri-stated and the PLL is turned off leading to less than 10  $\mu$ A of power supply current draw.



Patents pending

## Functional Block Diagram



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## 1. Electrical Specifications

**Table 1. DC Electrical Specifications ( $V_{DD} = 3.3\text{ V}$ )**

Unless otherwise stated for both C and I Grades.

| Parameter                 | Symbol | Test Condition                   | Min | Max          | Unit          |
|---------------------------|--------|----------------------------------|-----|--------------|---------------|
| Supply Voltage            | VDD    |                                  | 3.0 | 3.6          | V             |
| Input LOW Voltage         | VIL    |                                  | —   | 0.8          | V             |
| Input HIGH Voltage        | VIH    |                                  | 2.0 | $V_{DD}+0.3$ | V             |
| Input Leakage Current     | IIL    | $0 < V_{IN} < 0.8\text{ V}$      | —   | $\pm 10$     | $\mu\text{A}$ |
| Input HIGH Current        | IIH    | $V_{IN} = V_{DD}$                | —   | 100          | $\mu\text{A}$ |
| Output LOW Voltage        | VOL    | IOL = 8 mA (Standard Drive)      | —   | 0.4          | V             |
|                           |        | IOL = 12 mA (High Drive)         | —   | 0.4          | V             |
| Output HIGH Voltage       | VOH    | IOH = -8 mA (Standard Drive)     | 2.4 | —            | V             |
|                           |        | IOH = -12 mA (High Drive)        | 2.4 | —            | V             |
| Power Down Supply Current | IDDPD  | CLKIN = 0 MHz (Commercial)       | —   | 10           | $\mu\text{A}$ |
|                           |        | CLKIN = 0 MHz (Industrial)       | —   | 25           | $\mu\text{A}$ |
| Power Supply Current      | IDD    | All Outputs CL = 0, 66-MHz CLKIN | —   | 16           | mA            |

**Table 2. DC Electrical Specifications ( $V_{DD} = 2.5\text{ V}$ )**

Unless otherwise stated for both C and I Grades.

| Parameter                 | Symbol | Test Condition                   | Min          | Max          | Unit          |
|---------------------------|--------|----------------------------------|--------------|--------------|---------------|
| Supply Voltage            | VDD    |                                  | 2.3          | 2.7          | V             |
| Input LOW Voltage         | VIL    |                                  | —            | 0.7          | V             |
| Input HIGH Voltage        | VIH    |                                  | 1.7          | $V_{DD}+0.3$ | V             |
| Input Leakage Current     | IIL    | $0 < V_{IN} < 0.8\text{ V}$      | —            | $\pm 10$     | $\mu\text{A}$ |
| Input HIGH Current        | IIH    | $V_{IN} = V_{DD}$                | —            | 100          | $\mu\text{A}$ |
| Output LOW Voltage        | VOL    | IOL = 8 mA (Standard drive)      | —            | 0.5          | V             |
|                           |        | IOL = 12 mA (High drive)         | —            | 0.5          | V             |
| Output HIGH Voltage       | VOH    | IOH = -8 mA (Standard drive)     | $V_{DD}-0.6$ | —            | V             |
|                           |        | IOH = -12 mA (High drive)        | $V_{DD}-0.6$ | —            | V             |
| Power Down Supply Current | IDDPD  | CLKIN = 0 MHz (Commercial)       | —            | 10           | $\mu\text{A}$ |
|                           |        | CLKIN = 0 MHz (Industrial)       | —            | 25           | $\mu\text{A}$ |
| Power Supply Current      | IDD    | All Outputs CL = 0, 66 MHz CLKIN | —            | 14           | mA            |

Table 3. AC Electrical Specifications ( $V_{DD} = 3.3\text{ V}$  and  $2.5\text{ V}$ )

| Parameter                                                              | Symbol         | Test Condition                                                          | Min  | Typ | Max | Unit |
|------------------------------------------------------------------------|----------------|-------------------------------------------------------------------------|------|-----|-----|------|
| Maximum Frequency<br>(Input=Output) <sup>1</sup>                       | FMAX           | 3.3 V High Drive                                                        | 10   | —   | 220 | MHz  |
|                                                                        |                | 3.3 V Standard Drive                                                    | 10   | —   | 200 | MHz  |
|                                                                        |                | 2.5 V High Drive                                                        | 10   | —   | 180 | MHz  |
|                                                                        |                | 2.5 V Standard Drive                                                    | 10   | —   | 167 | MHz  |
| Input Duty Cycle                                                       | INDC           | <135 MHz, $V_{DD} = 3.3\text{ V}$                                       | 25   | —   | 75  | %    |
|                                                                        |                | <135 MHz, $V_{DD} = 2.5\text{ V}$                                       | 40   | —   | 60  | %    |
| Output Duty Cycle <sup>2</sup>                                         | OUTDC          | <135 MHz, $V_{DD} = 3.3\text{ V}$                                       | 45   | —   | 55  | %    |
|                                                                        |                | <135 MHz, $V_{DD} = 2.5\text{ V}$                                       | 40   | —   | 60  | %    |
| Rise, Fall Time (3.3V)<br>Measured at:<br>0.8 to 2.0 V <sup>2</sup>    | tr/f3.3        | High drive, CL = 15 pF, >135 MHz                                        | —    | —   | 0.5 | ns   |
|                                                                        |                | Std drive, CL = 15 pF, <170 MHz                                         | —    | —   | 1.5 | ns   |
|                                                                        |                | High drive, CL = 30 pF, <100 MHz                                        | —    | —   | 1.5 | ns   |
|                                                                        |                | Std drive, CL = 30 pF, <100 MHz                                         | —    | —   | 2.5 | ns   |
| Rise, Fall Time (2.5) <sup>2</sup><br>Measured at: 0.6 to 1.8 V        | tr/f2.5        | High drive, CL = 15 pF, >135 MHz                                        | —    | —   | 1.5 | ns   |
|                                                                        |                | Std drive, CL = 15 pF, <135 MHz                                         | —    | —   | 2.5 | ns   |
|                                                                        |                | High drive, CL = 30 pF, <100 MHz                                        | —    | —   | 2.5 | ns   |
| Output-to-Output Skew <sup>2</sup>                                     | t <sub>1</sub> | All outputs CL = 0, 3.3 V supply,<br>2.5 V power supply, standard drive | —    | 30  | 90  | ps   |
|                                                                        |                | All outputs CL = 0, 2.5 V power supply,<br>high drive                   | —    | 40  | 100 | ps   |
| Delay Time, CLKIN Rising<br>Edge to CLKOUT Rising<br>Edge <sup>2</sup> | t <sub>2</sub> | PLL enabled @ 3.3 V                                                     | -100 | —   | 100 | ps   |
|                                                                        |                | PLL enabled @ 2.5 V                                                     | -200 | —   | 200 | ps   |
| Part-to-Part Skew <sup>2</sup>                                         | t <sub>3</sub> | Measured at $V_{DD}/2$ . Any output to any<br>output, 3.3 V supply      | -150 | —   | 150 | ps   |
|                                                                        |                | Measured at $V_{DD}/2$ . Any output to any<br>output, 2.5 V supply      | -300 | —   | 300 | ps   |

**Notes:**

1. For the given maximum loading conditions. See CL in Operating Conditions Table.
2. Parameter is guaranteed by design and characterization. Not 100% tested in production.

Table 4. AC Electrical Specifications ( $V_{DD} = 3.3\text{ V}$  and  $2.5\text{ V}$ )

| Parameter                                                                                                          | Symbol  | Test Condition                                                                 | Min | Typ | Max | Unit |
|--------------------------------------------------------------------------------------------------------------------|---------|--------------------------------------------------------------------------------|-----|-----|-----|------|
| PLL Lock Time[9]                                                                                                   | tPLLOCK | From 90% of V <sub>DD</sub> to valid clocks presented on all output clock pins | —   | —   | 1.0 | ms   |
| Cycle-to-cycle Jitter                                                                                              | CCJ *   | 3.3 V supply, >66 MHz, <15 pF, Standard Drive                                  | —   | 50  | 125 | ps   |
|                                                                                                                    |         | 3.3 V supply, >66 MHz, <30 pF, High Drive                                      | —   | 70  | 140 | ps   |
|                                                                                                                    |         | 3.3 V supply, >66 MHz, <30 pF, Standard Drive                                  | —   | 80  | 170 | ps   |
|                                                                                                                    |         | 2.5 V supply, >66 MHz, <15 pF, High Drive                                      | —   | 50  | 80  | ps   |
|                                                                                                                    |         | 2.5 V supply, >66 MHz, <15 pF, Standard Drive                                  | —   | 90  | 200 | ps   |
|                                                                                                                    |         | 2.5 V supply, >66 MHz, <30 pF, High Drive                                      | —   | 100 | 250 | ps   |
| Peak Period Jitter                                                                                                 | PPJ *   | 3.3 V supply, >100 MHz, <15 pF, Standard Drive                                 | —   | 30  | 65  | ps   |
|                                                                                                                    |         | 3.3 V supply, 66–100 MHz, <15 pF, Standard Drive                               | —   | 40  | 75  | ps   |
|                                                                                                                    |         | 3.3 V supply, >66 MHz, <30 pF, High Drive                                      | —   | 60  | 120 | ps   |
|                                                                                                                    |         | 3.3 V supply, >66 MHz, <30 pF, Standard Drive                                  | —   | 70  | 150 | ps   |
|                                                                                                                    |         | 2.5 V supply, > 100 MHz, <15 pF, High Drive                                    | —   | 20  | 45  | ps   |
|                                                                                                                    |         | 2.5 V supply, 66–100 MHz, <15 pF, High Drive                                   | —   | 20  | 60  | ps   |
|                                                                                                                    |         | 2.5 V supply, >66 MHz, <15 pF, Standard Drive                                  | —   | 60  | 120 | ps   |
| *Note: Typical jitter is measured at 3.3 V or 2.5 V, 30°C with all outputs driven into the maximum specified load. |         |                                                                                |     |     |     |      |

**Table 5. Operating Conditions**Unless otherwise stated  $V_{DD} = 2.5\text{ V}$  to  $3.3\text{ V}$  and for both C and I Grades.

| Parameter                       | Symbol | Test Condition                      | Min   | Max | Unit |
|---------------------------------|--------|-------------------------------------|-------|-----|------|
| 3.3 V Supply Voltage            | VDD3.3 |                                     | 3.0   | 3.6 | V    |
| 2.5 V Supply Voltage            | VDD2.5 |                                     | 2.3   | 2.7 | V    |
| Operating Temperature (Ambient) | TA     | Commercial                          | 0     | 70  | °C   |
|                                 |        | Industrial                          | -40   | 85  | °C   |
| Load Capacitance                | CLOAD  | <220 MHz, 3.3 V with High Drive     | —     | 15  | pF   |
|                                 |        | <200 MHz, 3.3 V with Standard Drive | —     | 15  | pF   |
|                                 |        | <180 MHz, 2.5 V with High Drive     | —     | 15  | pF   |
|                                 |        | <167 MHz, 2.5 V with Standard Drive | —     | 15  | pF   |
|                                 |        | <200 MHz, 3.3 V with High Drive     | —     | 22  | pF   |
|                                 |        | <180 MHz, 3.3 V with Standard Drive | —     | 22  | pF   |
|                                 |        | <167 MHz, 2.5 V with High Drive     | —     | 22  | pF   |
|                                 |        | <134 MHz, 2.5 V with Standard Drive | —     | 22  | pF   |
|                                 |        | <133 MHz, 3.3 V with High Drive     | —     | 30  | pF   |
|                                 |        | <100 MHz, 3.3 V with Standard Drive | —     | 30  | pF   |
|                                 |        | <80 MHz, 2.5 V with High Drive      | —     | 30  | pF   |
|                                 |        | < 67 MHz, 2.5 V with Standard Drive | —     | 30  | pF   |
| Input Capacitance               | CIN    | CLKIN pin                           | —     | 5   | pF   |
| Closed-loop bandwidth           | CLBW   | 3.3 V, (typical)                    | 1-1.5 |     | MHz  |
|                                 |        | 2.5 V, (typical)                    | 0.8   |     | MHz  |
| Output Impedance                | ZOUT   | 3.3 V, (typical), High Drive        | 29    |     | Ω    |
|                                 |        | 3.3 V, (typical), Standard Drive    | 41    |     | Ω    |
|                                 |        | 2.5 V, (typical), High Drive        | 37    |     | Ω    |
|                                 |        | 2.5 V, (typical), Standard Drive    | 41    |     | Ω    |

**Table 6. Thermal Characteristics**

| Parameter                              | Symbol | Test Condition          | Min | Typ | Max | Unit |
|----------------------------------------|--------|-------------------------|-----|-----|-----|------|
| Thermal Resistance Junction to Ambient |        | Still air               | —   | 110 | —   | °C/W |
|                                        |        | 1 m/s air flow          | —   | 100 | —   | °C/W |
|                                        |        | 3 m/s air flow          | —   | 80  | —   | °C/W |
| Thermal Resistance Junction to Case    |        | Independent of air flow | —   | 35  | —   | °C/W |

**Table 7. Absolute Maximum Rating**

| Parameter                        | Test Condition                 | Min   | Max          | Unit |
|----------------------------------|--------------------------------|-------|--------------|------|
| Supply voltage, $V_{DD}$         |                                | −0.5  | 4.6          | V    |
| All Inputs and Outputs           |                                | −0.5  | $V_{DD}+0.5$ | V    |
| Ambient Operating Temperature    | In operation, C-Grade          | 0     | 70           | °C   |
| Ambient Operating Temperature    | In operation, I-Grade          | −40   | 85           | °C   |
| Storage Temperature              | No power is applied            | −65   | 150          | °C   |
| Junction Temperature             | In operation, power is applied | —     | 125          | °C   |
| Soldering Temperature            |                                | —     | 260          | °C   |
| ESD Rating (Human Body Model)    | JEDEC22-A114D                  | −4000 | 4000         | V    |
| ESD Rating (Charge Device Model) | JEDEC22-C101C                  | −1500 | 1500         | V    |
| ESD Rating (Machine Model)       | JEDEC22-A115D                  | −200  | 200          | V    |

## 2. General Description

The SL23EP05 is a low skew, low jitter Zero Delay Buffer with very low operating current.

The product includes an on-chip high performance PLL that locks into the input reference clock and produces five output clock drivers tracking the input reference clock for systems requiring clock distribution.

## 3. Input and Output Frequency Range

The input and output frequency range is the same. However, it depends on  $V_{DD}$  and drive levels as given in the below Table 8.

**Table 8. Input/Output Frequency Range**

| $V_{DD}$ (V) | Drive | Min (MHz) | Max (MHz) |
|--------------|-------|-----------|-----------|
| 3.3          | HIGH  | 10        | 220       |
| 3.3          | STD   | 10        | 200       |
| 2.5          | HIGH  | 10        | 180       |
| 2.5          | STD   | 10        | 167       |

If the input clock frequency is DC (0 to  $V_{DD}$ ), this is detected by an input frequency detection circuitry and all five clock outputs are forced to Hi-Z. The PLL is shutdown to save power. In this shutdown state, the product draws less than 10  $\mu$ A supply current.

## 4. SpreadThru™ Feature

If a Spread Spectrum Clock (SSC) were to be used as an input clock, the SL23EP05 is designed to pass the modulated Spread Spectrum Clock (SSC) signal from its reference input to the output clocks. The same spread characteristics at the input are passed through the PLL and drivers without any degradation in spread percent (%), spread profile and modulation frequency.

## 5. High and Low-Drive Product Options

The SL23EP05 is offered with High-Drive “–1H” and Standard-Drive “–1” options. These drive options enable the users to control load levels, frequency range and EMI control. Refer to the AC electrical tables for the details.

## 6. Skew and Zero Delay

All outputs should drive the similar load to achieve output-to-output skew and input-to-output specifications given in the AC electrical tables. However, Zero delay between input and outputs can be adjusted by changing the loading of CLKOUT relative to the banks A and B clocks since CLKOUT is the feedback to the PLL.

## 7. Power Supply Range ( $V_{DD}$ )

The SL23EP05 is designed to operate in a wide power supply range from 2.250 V (Min) to 3.360 V (Max). This power supply range complies with 3.3 V $\pm$ 10% and 2.5 V $\pm$ 10% standard power supply requirements used in most systems. An internal on-chip voltage regulator is used to supply PLL constant power supply of 1.8 V, leading to a consistent and stable PLL electrical performance in terms of skew, and jitter and power dissipation.

## 8. External Components and Design Considerations

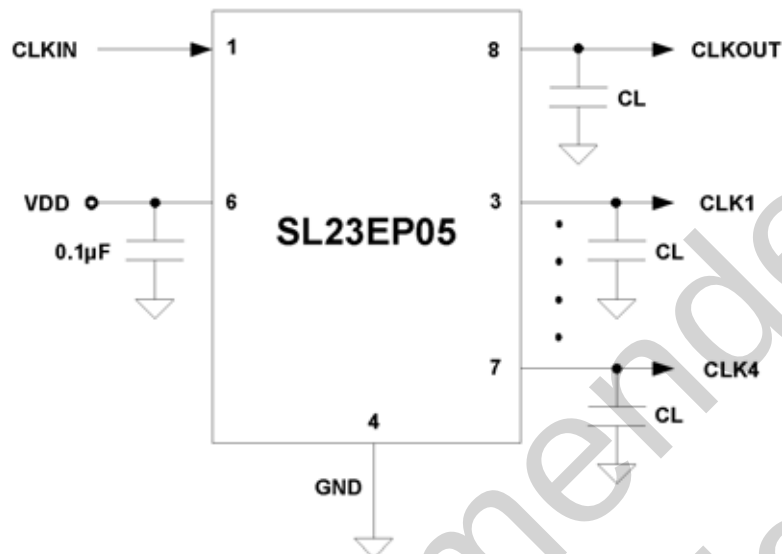


Figure 1. Typical Application Schematic

### 8.1. Comments and Recommendations

**Decoupling Capacitor:** A minimum decoupling capacitor of 0.1  $\mu\text{F}$  must be used between VDD and VSS on the pins 6 and 4. Additional capacitors may be necessary depending on the application. Place the capacitor on the component side of the PCB as close to the VDD pin as possible. The PCB trace to the VDD pin and to the GND via should be kept as short as possible. Do not use vias between the decoupling capacitor and the VDD pin.

**Series Termination Resistor:** A series termination resistor is recommended if the distance between the output (SSCLK) and the load is over 1.5 inches. The nominal impedance of the SSCLK output is about 30  $\Omega$ . Use 20  $\Omega$  resistor in series with the output to terminate 50  $\Omega$  trace impedance and place 20  $\Omega$  resistor as close to the clock outputs as possible.

**Zero Delay and Skew Control:** All outputs and CLKIN pins should be loaded with the same load to achieve “Zero Delay” between the CLKIN and the outputs. The CLKOUT pin is connected to CLKIN internally on-chip for internal feedback to PLL, and sees an additional 2 pF load with respect to the clock pins. For applications requiring zero input/output delay, the load at the all output pins including the CLKOUT pin must be the same. If any delay adjustment is required, the capacitance at the CLKOUT pin could be increased or decreased to increase or decrease the delay between clocks and CLKIN.

For minimum pin-to-pin skew, the external load at the clocks must be the same.

## 8.2. Switching Waveforms

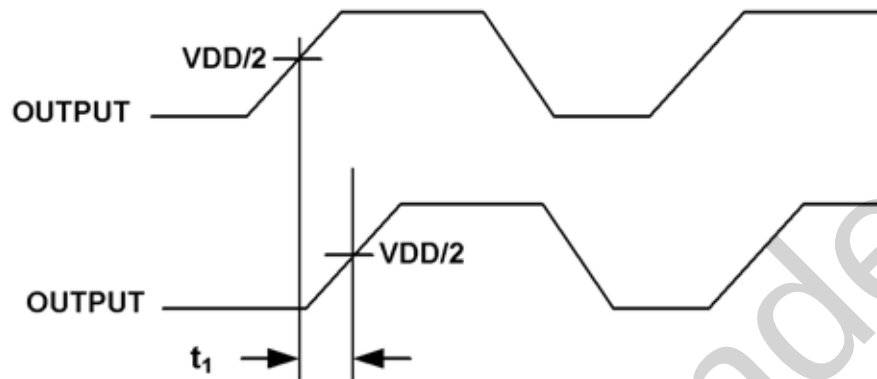


Figure 2. Output to Output Skew

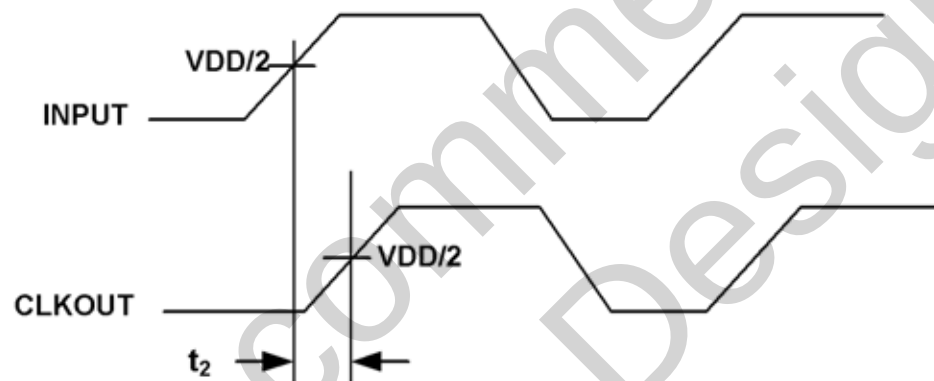


Figure 3. Input to Output Skew

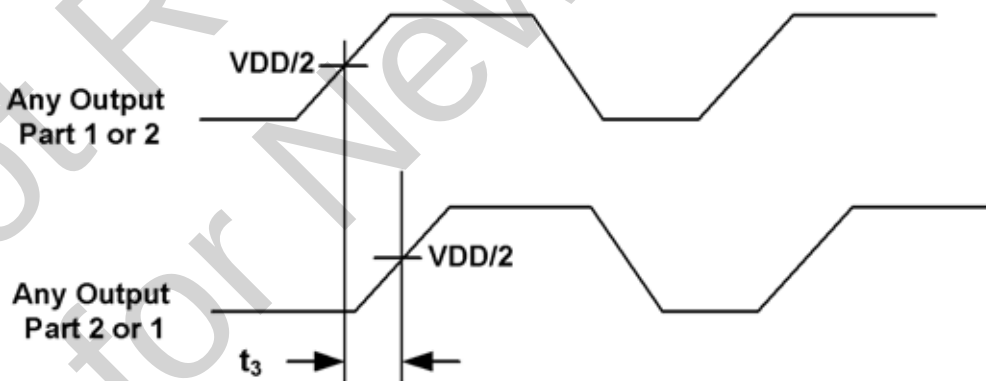


Figure 4. Part-to-Part Skew

## 9. Pin Descriptions

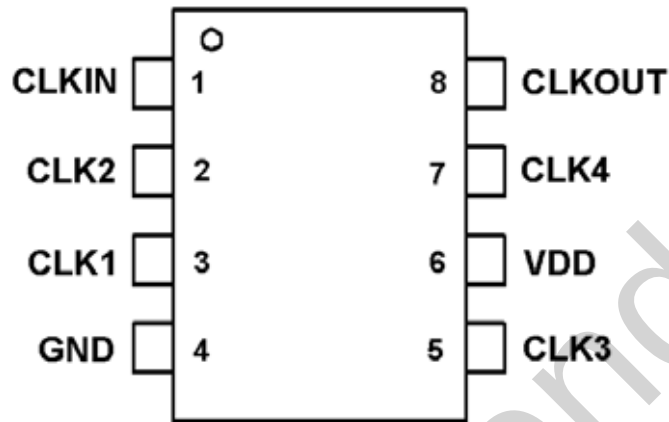


Figure 5. 8-Pin SOIC

Table 9. Pin Descriptions

| Pin Number | Pin Name | Pin Type | Pin Description                                                                                   |
|------------|----------|----------|---------------------------------------------------------------------------------------------------|
| 1          | CLKIN    | Input    | Reference Frequency Clock Input. Weak pull-down (150 k $\Omega$ ).                                |
| 2          | CLK2     | Output   | Buffered Clock Output Weak pull-down (150 k $\Omega$ ).                                           |
| 3          | CLK1     | Output   | Buffered Clock Output. Weak pull-down (150 k $\Omega$ ).                                          |
| 4          | GND      | Power    | Power Ground.                                                                                     |
| 5          | CLK3     | Output   | Buffered Clock Output. Weak pull-down (150 k $\Omega$ ).                                          |
| 6          | VDD      | Power    | 3.3 V or 2.5 V Power Supply.                                                                      |
| 7          | CLK4     | Output   | Buffered Clock Output. Weak pull-down (150 k $\Omega$ ).                                          |
| 8          | CLKOUT   | Output   | Buffered Clock Output. Used for Internal Feedback to PLL Input. Weak pull-down (150 k $\Omega$ ). |

## 10. Package Outline and Dimensions

### 10.1. 8-Lead SOIC (150 mm)

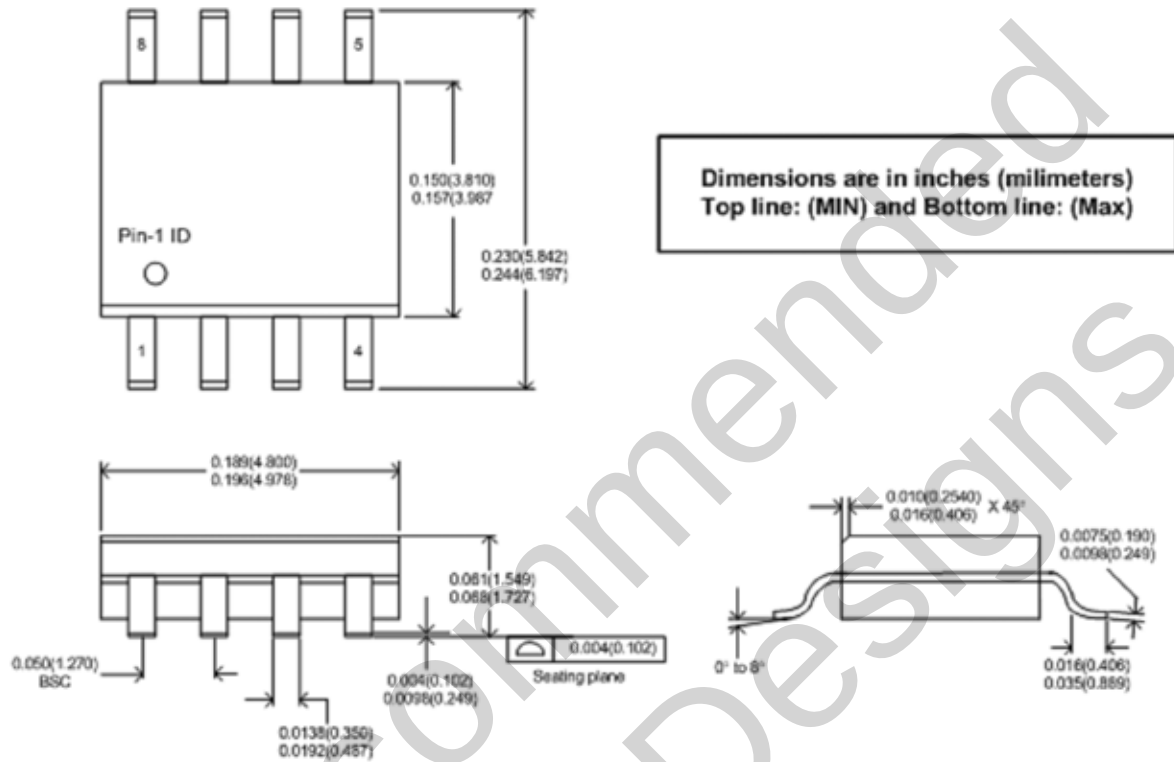


Figure 6. 8-Lead SOIC (150 mm)

## 11. Ordering Guide

**Table 10. Ordering Guide**

| Ordering Number                                                                                                                                                                                | Shipping Package | Package    | Temperature |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------|-------------|
| SL23EP05SC-1                                                                                                                                                                                   | Tube             | 8-pin SOIC | 0 to 70°C   |
| SL23EP05SC-1T                                                                                                                                                                                  | Tape and Reel    | 8-pin SOIC | 0 to 70°C   |
| SL23EP05SI-1                                                                                                                                                                                   | Tube             | 8-pin SOIC | –40 to 85°C |
| SL23EP05SI-1T                                                                                                                                                                                  | Tape & Reel      | 8-pin SOIC | –40 to 85°C |
| SL23EP05SC-1H                                                                                                                                                                                  | Tube             | 8-pin SOIC | 0 to 70°C   |
| SL23EP05SC-1HT                                                                                                                                                                                 | Tape & Reel      | 8-pin SOIC | 0 to 70°C   |
| SL23EP05SI-1H                                                                                                                                                                                  | Tube             | 8-pin SOIC | –40 to 85°C |
| SL23EP05SI-1HT                                                                                                                                                                                 | Tape & Reel      | 8-pin SOIC | –40 to 85°C |
| SL23EP05BSI-1H                                                                                                                                                                                 | Tube             | 8-pin SOIC | –40 to 85°C |
| SL23EP05BSI-1HT                                                                                                                                                                                | Tape & Reel      | 8-pin SOIC | –40 to 85°C |
| <b>Notes:</b><br>1. The SL23EP05 products are RoHS compliant.<br>2. Minimum Order Quantity (MOQ) is for production orders. Silicon Labs provides lesser quantities for pre-production samples. |                  |            |             |



## 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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