

**2.5 V or 3.3 V, 10–220 MHz, Low Jitter,
5 Output Zero Delay Buffer**

Features

- 10 MHz to 220 MHz maximum operating range
- Zero input-output propagation delay, adjustable by loading on CLKOUT pin
- Multiple low-skew outputs
 - 30 ps typical output-output skew
 - One input drives five outputs
- 22 ps typical cycle-to-cycle jitter
- 13 ps typical period jitter
- Standard and high drive strength options
- Available in space-saving 150-mil SOIC package
- 3.3 V or 2.5 V operation
- Industrial temperature available

Functional Description

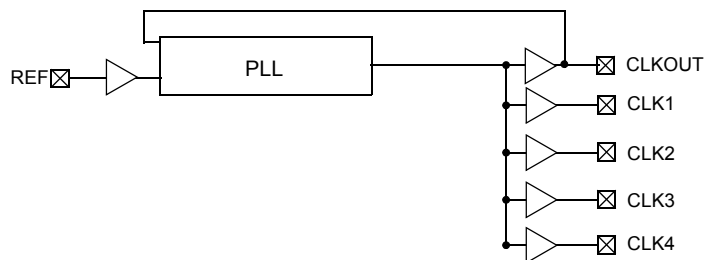
The CY23EP05 is a 2.5 V or 3.3 V zero delay buffer designed to distribute low-jitter high-speed clocks and is available in a 8-pin SOIC package. It accepts one reference input, and drives out five low-skew clocks. The –1H version operates up to 220 (200) MHz frequencies at 3.3 V (2.5 V), and has a higher drive strength than the –1 devices. All parts have on-chip PLLs which lock to an input clock on the REF pin. The PLL feedback is on-chip and is obtained from the CLKOUT pad.

The CY23EP05 PLL enters a power-down mode when there are no rising edges on the REF input (< ~2 MHz). In this state, the outputs are three-stated and the PLL is turned off, resulting in less than 25 μ A of current draw.

The CY23EP05 is available in different configurations, as shown in the Ordering Information table. The CY23EP05-1 is the base part. The CY23EP05-1H is the high-drive version of the –1, and its rise and fall times are much faster than the –1.

These parts are not intended for 5 V input-tolerant applications. For a complete list of related documentation, click [here](#).

Logic Block Diagram

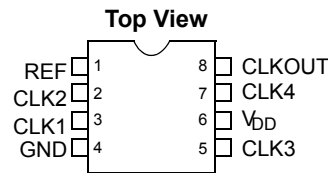


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Pin Configuration

Figure 1. 8-pin SOIC pinout (Top View)



Pin Description

| Pin No. | Signal | Description |
|---------|--------------------------|--|
| 1 | REF ^[1] | Input reference frequency |
| 2 | CLK2 ^[2] | Buffered clock output |
| 3 | CLK1 ^[2] | Buffered clock output |
| 4 | GND | Ground |
| 5 | CLK3 ^[2] | Buffered clock output |
| 6 | V _{DD} | 3.3 V or 2.5 V supply |
| 7 | CLK4 ^[2] | Buffered clock output |
| 8 | CLKOUT ^[2, 3] | Buffered clock output, internal feedback on this pin |

Zero Delay and Skew Control

All outputs should be uniformly loaded to achieve zero delay between the input and output. Since the CLKOUT pin is the internal feedback to the PLL, its relative loading can adjust the input-output delay.

The output driving the CLKOUT pin will be driving a total load of 5 pF plus any additional load externally connected to this pin. For

applications requiring zero input-output delay, the total load on each output pin (including CLKOUT) must be the same. If input-output delay adjustments are required, the CLKOUT load may be changed to vary the delay between the REF input and remaining outputs.

For zero output-output skew, be sure to load all outputs equally. For further information refer to the application note titled “CY2305 and CY2309 as PCI and SDRAM Buffers”.

Notes

1. Weak pull-down.
2. Weak pull-down on all outputs.
3. This output is driven and has an internal feedback for the PLL. The load on this output can be adjusted to change the skew between the reference and output.

Absolute Maximum Conditions

Exceeding maximum ratings may shorten the useful life of the device. User guidelines are not tested.

Supply voltage to ground potential-0.5 V to 4.6 V

DC Input Voltage $V_{SS} - 0.5 \text{ V}$ to 4.6 V

Storage temperature -65 °C to 150 °C

Junction temperature 150 °C

Static discharge voltage

(per MIL-STD-883, Method 3015 > 2000 V

Operating Conditions

| Parameter | Description | Min | Typ | Max | Unit |
|-------------------|--|------|-------|-----|----------|
| $V_{DD3.3}$ | 3.3 V supply voltage | 3.0 | 3.3 | 3.6 | V |
| $V_{DD2.5}$ | 2.5 V supply voltage | 2.3 | 2.5 | 2.7 | V |
| T_A | Operating temperature (ambient temperature) – Commercial | 0 | – | 70 | °C |
| | Operating temperature (ambient temperature) – Industrial | -40 | – | 85 | °C |
| $C_L^{[4]}$ | Load capacitance, < 100 MHz, 3.3 V | – | – | 30 | pF |
| | Load capacitance, < 100 MHz, 2.5 V with high drive | – | – | 30 | pF |
| | Load capacitance, < 133.3 MHz, 3.3 V | – | – | 22 | pF |
| | Load capacitance, < 133.3 MHz, 2.5 V with high drive | – | – | 22 | pF |
| | Load capacitance, < 133.3 MHz, 2.5 V with standard drive | – | – | 15 | pF |
| | Load capacitance, > 133.3 MHz, 3.3 V | – | – | 15 | pF |
| | Load capacitance, > 133.3 MHz, 2.5 V with high drive | – | – | 15 | pF |
| C_{IN} | Input capacitance ^[5] | – | – | 5 | pF |
| BW | Closed-loop bandwidth, 3.3 V | – | 1–1.5 | – | MHz |
| | Closed-loop bandwidth, 2.5 V | – | 0.8 | – | MHz |
| R_{OUT} | Output impedance, 3.3 V high drive | – | 29 | – | Ω |
| | Output impedance, 3.3 V standard drive | – | 41 | – | Ω |
| | Output impedance, 2.5 V high drive | – | 37 | – | Ω |
| | Output Impedance, 2.5 V standard drive | – | 41 | – | Ω |
| t_{PU} | Power-up time for all V_{DDs} to reach minimum specified voltage (power ramps must be monotonic) | 0.01 | – | 50 | ms |
| Theta $J_A^{[6]}$ | Dissipation, junction to ambient, 8-pin SOIC | – | 131 | – | °C/W |
| Theta $J_C^{[6]}$ | Dissipation, junction to case, 8-pin SOIC | – | 81 | – | °C/W |

Notes

4. Applies to Test Circuit #1.
5. Applies to both REF Clock and internal feedback path on CLKOUT.
6. Theta J_A , EIA JEDEC 51 test board conditions, 2S2P; Theta J_C Mil-Spec 883E Method 1012.1.

Electrical Specifications

3.3 V DC

| Parameter | Description | Test Conditions | Min | Typ | Max | Unit |
|---------------------------|---------------------------|--|-----|-----|-----------------------|------|
| V _{DD} | Supply voltage | | 3.0 | 3.3 | 3.6 | V |
| V _{IL} | Input LOW voltage | | – | – | 0.8 | V |
| V _{IH} | Input HIGH voltage | | 2.0 | – | V _{DD} + 0.3 | V |
| I _{IL} | Input leakage current | 0 < V _{IN} < V _{IL} | –10 | – | 10 | μA |
| I _{IH} | Input HIGH current | V _{IN} = V _{DD} | – | – | 100 | μA |
| V _{OL} | Output LOW voltage | I _{OL} = 8 mA (Standard Drive) | – | – | 0.4 | V |
| | | I _{OL} = 12 mA (High Drive) | – | – | 0.4 | V |
| V _{OH} | Output HIGH voltage | I _{OH} = –8 mA (Standard Drive) | 2.4 | – | – | V |
| | | I _{OH} = –12 mA (High Drive) | 2.4 | – | – | V |
| I _{DD} (PD mode) | Power down supply current | REF = 0 MHz (Commercial) | – | – | 12 | μA |
| | | REF = 0 MHz (Industrial) | – | – | 25 | μA |
| I _{DD} | Supply current | Unloaded outputs, 66-MHz REF | – | – | 30 | mA |

Electrical Specifications

2.5 V DC

| Parameter | Description | Test Conditions | Min | Typ | Max | Unit |
|---------------------------|---------------------------|--|-----------------------|-----|-----------------------|------|
| V _{DD} | Supply voltage | | 2.3 | 2.5 | 2.7 | V |
| V _{IL} | Input LOW voltage | | – | – | 0.7 | V |
| V _{IH} | Input HIGH voltage | | 1.7 | – | V _{DD} + 0.3 | V |
| I _{IL} | Input leakage current | 0 < V _{IN} < V _{DD} | –10 | – | 10 | μA |
| I _{IH} | Input HIGH current | V _{IN} = V _{DD} | – | – | 100 | μA |
| V _{OL} | Output LOW voltage | I _{OL} = 8 mA (standard drive) | – | – | 0.5 | V |
| | | I _{OL} = 12 mA (high drive) | – | – | 0.5 | V |
| V _{OH} | Output HIGH voltage | I _{OH} = –8 mA (standard drive) | V _{DD} – 0.6 | – | – | V |
| | | I _{OH} = –12 mA (high drive) | V _{DD} – 0.6 | – | – | V |
| I _{DD} (PD mode) | Power Down supply current | REF = 0 MHz (commercial) | – | – | 12 | μA |
| | | REF = 0 MHz (industrial) | – | – | 25 | μA |
| I _{DD} | Supply current | Unloaded outputs, 66-MHz REF | – | – | 45 | mA |

Electrical Specifications

3.3 V and 2.5 V AC

| Parameter | Description | Test Conditions | Min | Typ | Max | Unit |
|---------------------------------|---|---|------|-----|-----|------|
| 1/t ₁ | Maximum frequency ^[7] (input/output) | 3.3 V high drive | 10 | – | 220 | MHz |
| | | 3.3 V standard drive | 10 | – | 167 | MHz |
| | | 2.5 V high drive | 10 | – | 200 | MHz |
| | | 2.5 V standard drive | 10 | – | 133 | MHz |
| T _{IDC} | Input duty cycle | < 133.3 MHz | 25 | – | 75 | % |
| | | > 133.3 MHz | 40 | – | 60 | % |
| t ₂ ÷ t ₁ | Output duty cycle ^[8] | < 133.3 MHz | 47 | – | 53 | % |
| | | > 133.3 MHz | 45 | – | 55 | % |
| t ₃ , t ₄ | Rise, fall time (3.3 V) ^[8] | Std drive, CL = 30 pF, < 100 MHz | – | – | 1.6 | ns |
| | | Std drive, CL = 22 pF, < 133.3 MHz | – | – | 1.6 | ns |
| | | Std drive, CL = 15 pF, < 167 MHz | – | – | 0.6 | ns |
| | | High drive, CL = 30 pF, < 100 MHz | – | – | 1.2 | ns |
| | | High drive, CL = 22 pF, < 133.3 MHz | – | – | 1.2 | ns |
| | | High drive, CL = 15 pF, > 133.3 MHz | – | – | 0.5 | ns |
| t ₃ , t ₄ | Rise, fall time (2.5 V) ^[8] | Std drive, CL = 15 pF, < 133.33 MHz | – | – | 1.5 | ns |
| | | High drive, CL = 30 pF, < 100 MHz | – | – | 2.1 | ns |
| | | High drive, CL = 22 pF, < 133.3 MHz | – | – | 1.3 | ns |
| | | High drive, CL = 15 pF, > 133.3 MHz | – | – | 1.2 | ns |
| t ₅ | Output to output skew ^[8] | All outputs equally loaded | – | 30 | 100 | ps |
| t ₆ | Delay, REF rising edge to CLKOUT rising edge ^[8] | PLL enabled at 3.3 V | –100 | – | 100 | ps |
| | | PLL enabled at 2.5 V | –200 | – | 200 | ps |
| t ₇ | Part to part skew ^[8] | Measured at V _{DD} /2. Any output to any output, 3.3 V supply | –150 | – | 150 | ps |
| | | Measured at V _{DD} /2. Any output to any output, 2.5 V supply | –300 | – | 300 | ps |

Notes

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

Electrical Specifications (continued)

3.3 V and 2.5 V AC

| Parameter | Description | Test Conditions | Min | Typ | Max | Unit |
|-------------------------------------|------------------------------|--|-----|-----|-----|------|
| t_{LOCK} | PLL lock time ^[9] | Stable power supply, valid clocks presented on REF and CLKOUT pins | – | – | 1.0 | ms |
| T_{JCC} ^[9, 10] | Cycle-to-cycle jitter, peak | 3.3 V supply, > 66 MHz, < 15 pF | – | 22 | 55 | ps |
| | | 3.3 V supply, > 66 MHz, < 30 pF, standard drive | – | 45 | 125 | ps |
| | | 3.3 V supply, > 66 MHz, < 30 pF, high drive | – | 45 | 100 | ps |
| | | 2.5 V supply, > 66 MHz, < 15 pF, standard drive | – | 40 | 100 | ps |
| | | 2.5 V supply, > 66 MHz, < 15 pF, high drive | – | 35 | 80 | ps |
| | | 2.5 V supply, > 66 MHz, < 30 pF, high drive | – | 52 | 125 | ps |
| T_{PER} ^[9, 10] | Period jitter, peak | 3.3 V supply, 66–100 MHz, < 15 pF | – | 18 | 60 | ps |
| | | 3.3 V supply, > 100 MHz, < 15 pF | – | 13 | 35 | ps |
| | | 3.3 V supply, > 66 MHz, < 30 pF, standard drive | – | 28 | 75 | ps |
| | | 3.3 V supply, > 66 MHz, < 30 pF, high drive | – | 26 | 70 | ps |
| | | 2.5 V supply, > 66 MHz, < 15 pF, standard drive | – | 25 | 60 | ps |
| | | 2.5 V supply, 66–100 MHz, < 15 pF, high drive | – | 22 | 60 | ps |
| | | 2.5 V supply, > 100 MHz, < 15 pF, high drive | – | 19 | 45 | ps |

Notes

9. Parameter is guaranteed by design and characterization. Not 100% tested in production.

10. Typical jitter is measured at 3.3 V or 2.5 V, 29°C, with all outputs driven into the maximum specified load. Further information regarding jitter specifications may be found in the application notes, "Understanding Data Sheet Jitter Specifications for Cypress Products."

Switching Waveforms

Figure 2. Duty Cycle Timing

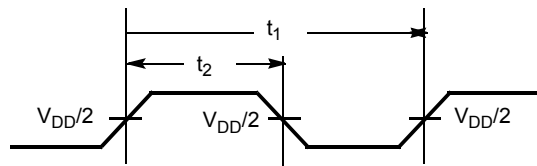


Figure 3. All Outputs Rise/Fall Time

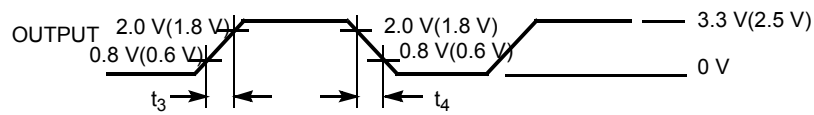


Figure 4. Output-Output Skew

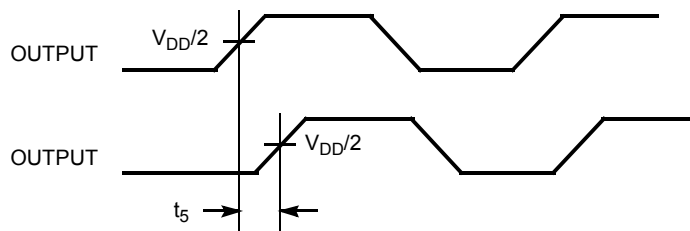


Figure 5. Input-Output Propagation Delay

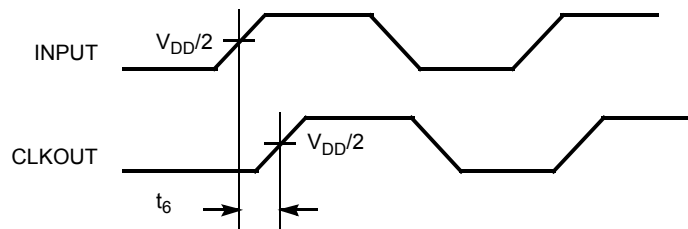
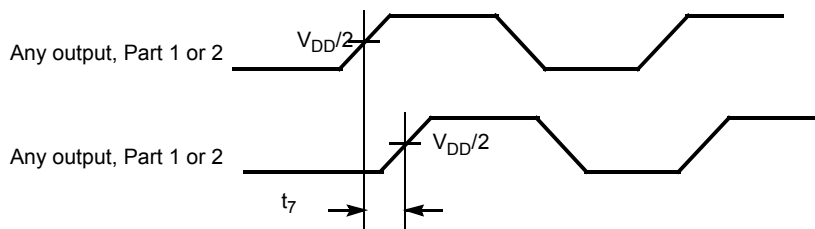
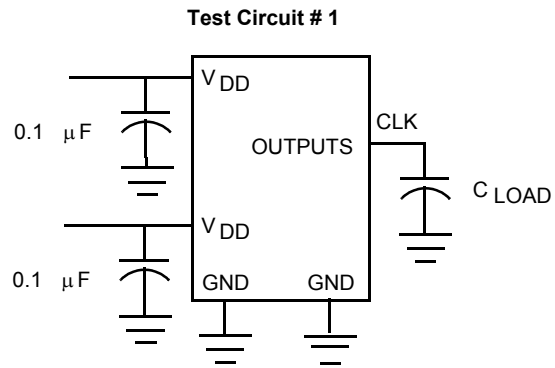


Figure 6. Part-Part Skew



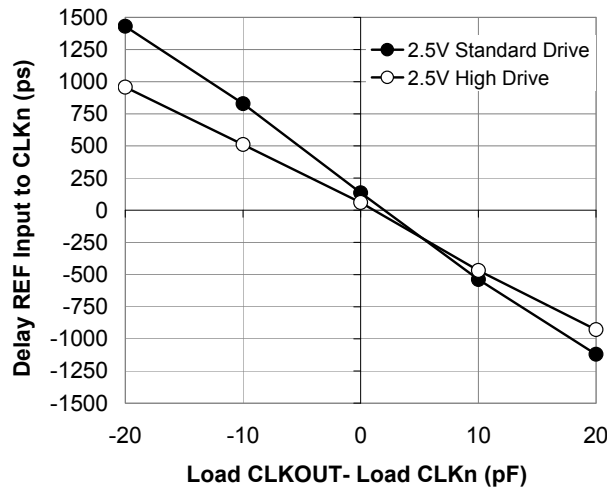
Test Circuits

Figure 7. Test Circuit



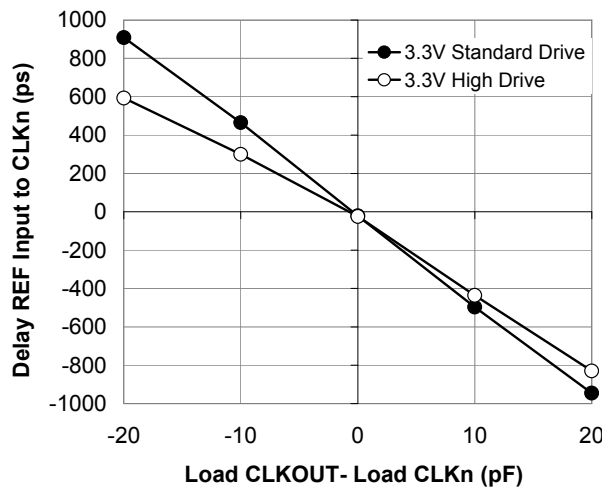
Supplemental Parametric Information

Figure 8. 2.5 V Typical Room Temperature Graph for REF Input to CLKn Delay versus Loading Difference between CLKOUT and CLKn



Data is shown for 66 MHz. Delay is a weak function of frequency.

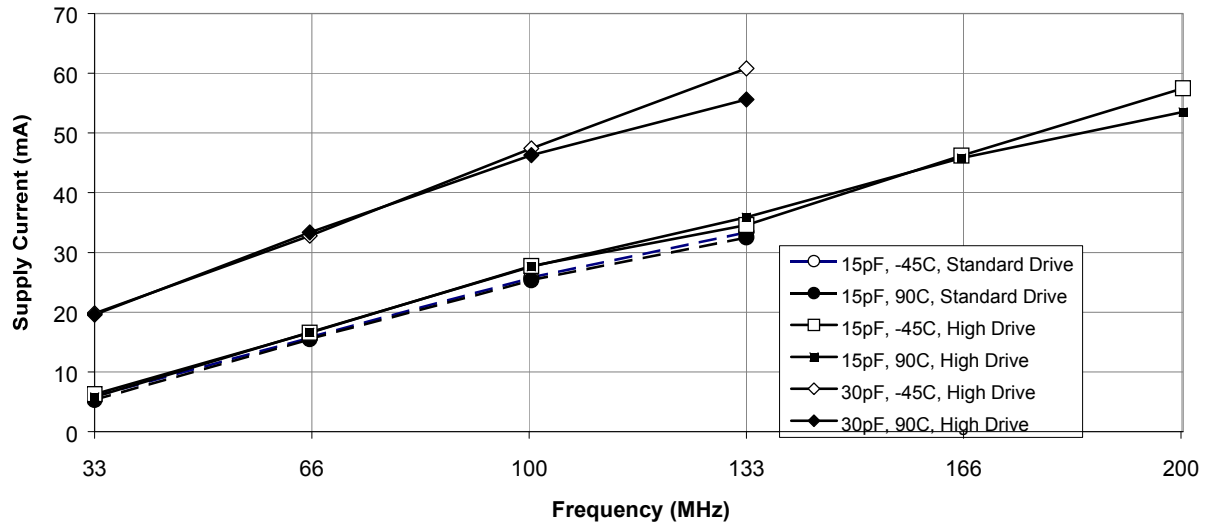
Figure 9. 3.3 V Typical Room Temperature Graph for REF Input to CLKn Delay versus Loading Difference between CLKOUT and CLKn



Data is shown for 66 MHz. Delay is a weak function of frequency.

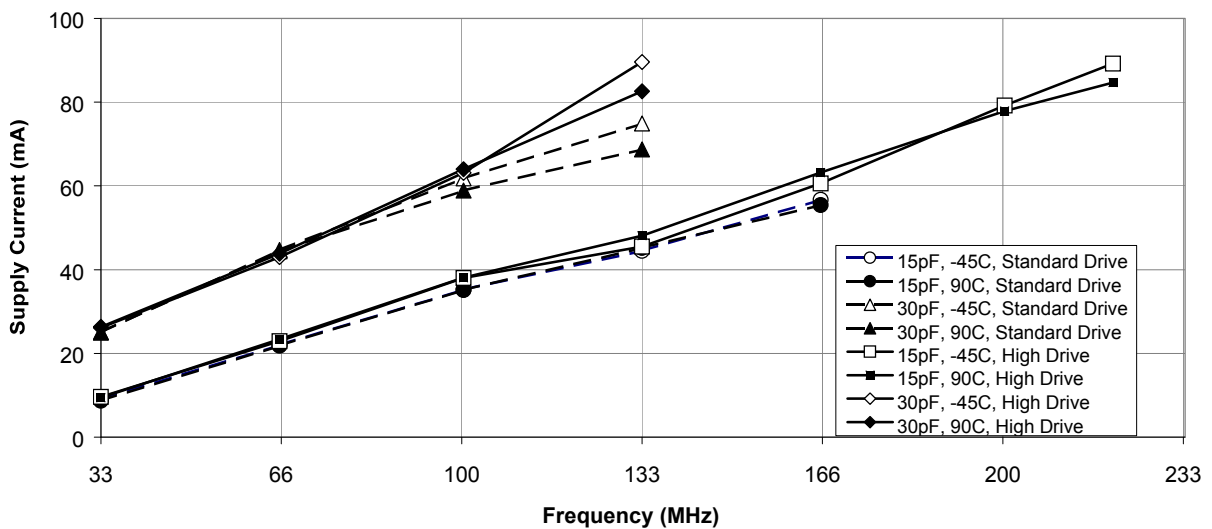
Supplemental Parametric Information (continued)

Figure 10. 2.7 V Measured Supply Current versus Frequency, Drive Strength, Loading, and Temperature



Note that the 30 pF data above 100 MHz is beyond the data sheet specification of 22 pF.

Figure 11. 3.6 V Measured Supply Current versus Frequency, Drive Strength, Loading, and Temperature



Note that the 30-pF high-drive data above 100 MHz is beyond the data sheet specification of 22 pF.

Supplemental Parametric Information (continued)

Figure 12. Typical 3.3 V Measured Cycle-to-cycle Jitter at 29 °C, versus Frequency, Drive Strength, and Loading

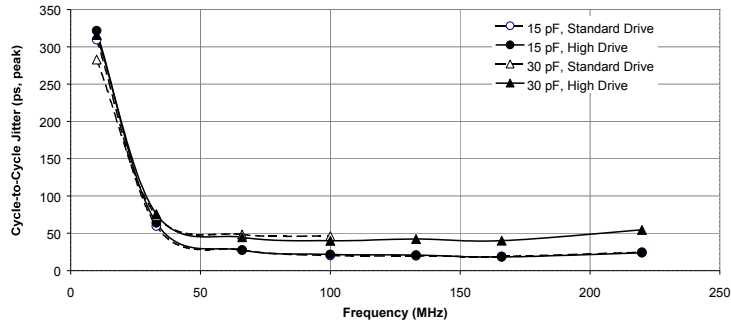


Figure 13. Typical 2.5 V Measured Cycle-to-cycle Jitter at 29 °C, versus Frequency, Drive Strength, and Loading

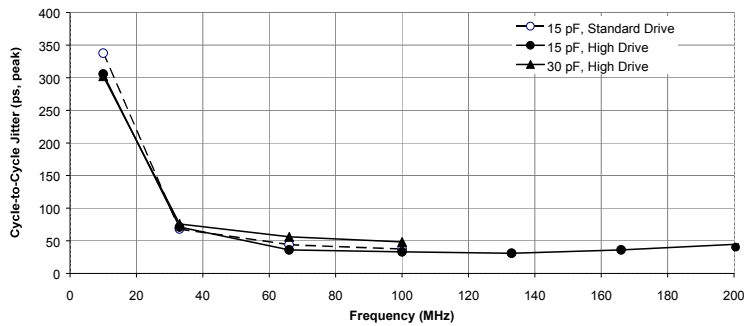


Figure 14. Typical 3.3 V Measured Period Jitter at 29 °C, versus Frequency, Drive Strength, and Loading

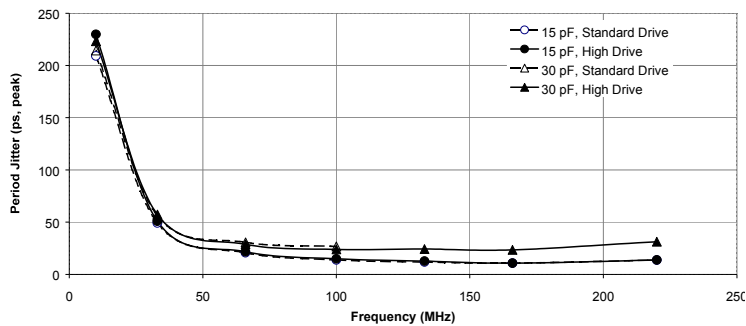
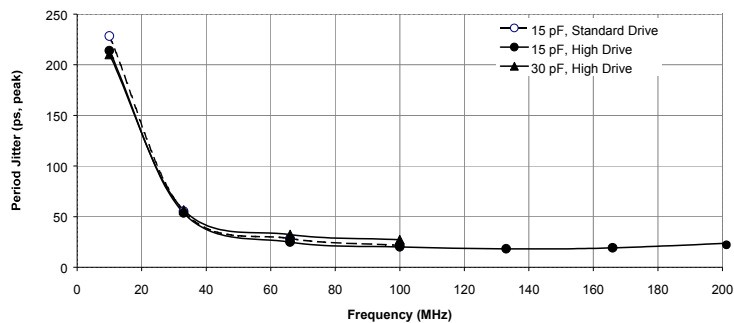
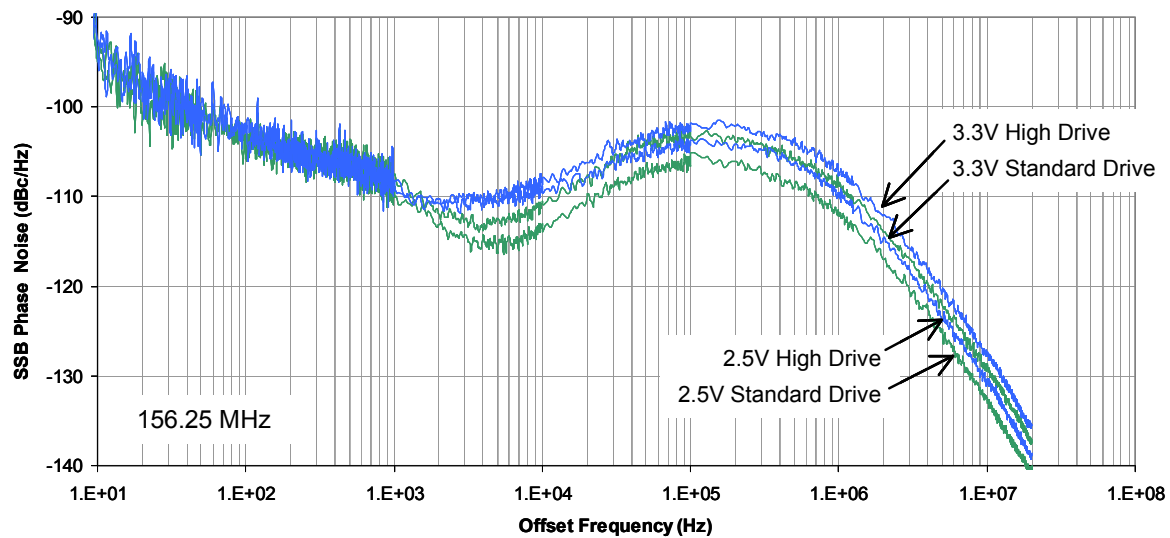
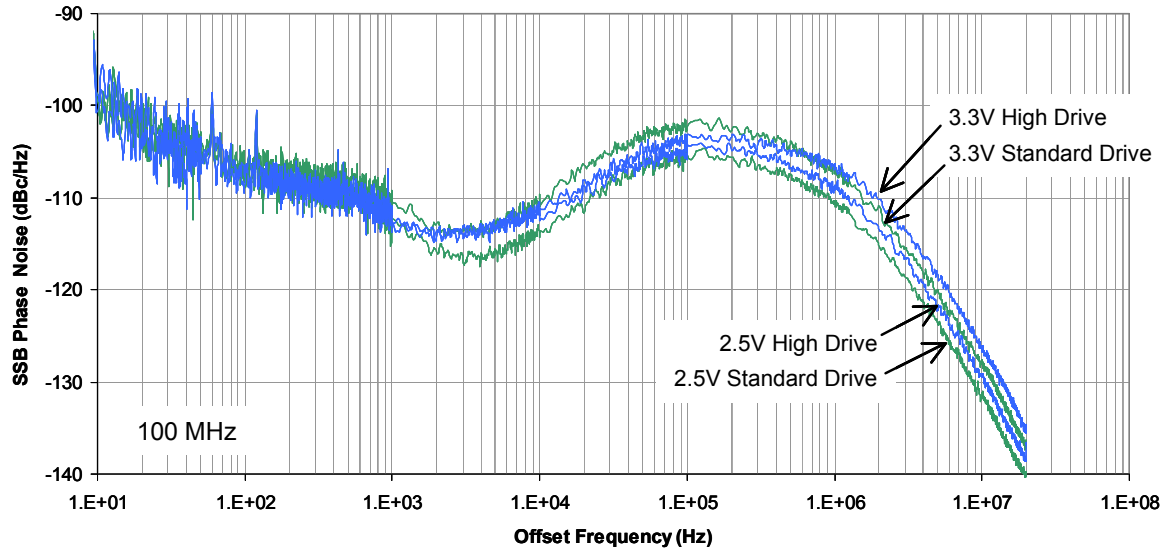


Figure 15. Typical 2.5 V Measured Period Jitter at 29 °C, versus Frequency, Drive Strength, and Loading



Supplemental Parametric Information (continued)

Figure 16. 100 MHz (top) and 156.25 MHz (bottom) Typical Phase-noise Data versus V_{DD} and Drive Strength [11]



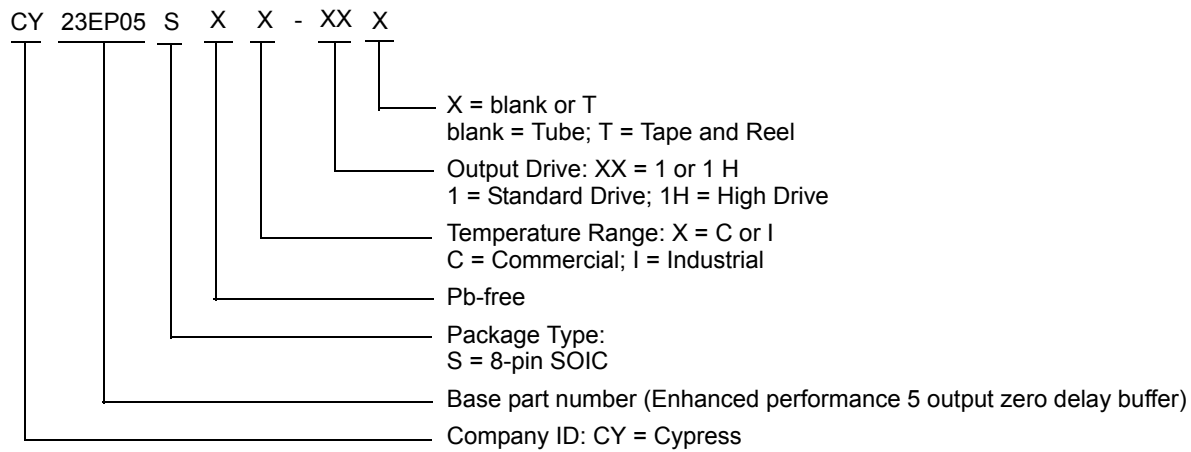
Note

11. Typical jitter is measured at 3.3 V or 2.5 V, 29°C, with all outputs driven into the maximum specified load. Further information regarding jitter specifications may be found in the application notes, "Understanding Data Sheet Jitter Specifications for Cypress Products."

Ordering Information

| Ordering Code | Package Type | Operating Range |
|-----------------|----------------------------|-----------------|
| Pb-free | | |
| CY23EP05SXC-1 | 8-pin SOIC | Commercial |
| CY23EP05SXC-1T | 8-pin SOIC – Tape and Reel | Commercial |
| CY23EP05SXI-1 | 8-pin SOIC | Industrial |
| CY23EP05SXI-1T | 8-pin SOIC – Tape and Reel | Industrial |
| CY23EP05SXC-1H | 8-pin SOIC | Commercial |
| CY23EP05SXC-1HT | 8-pin SOIC – Tape and Reel | Commercial |
| CY23EP05SXI-1H | 8-pin SOIC | Industrial |
| CY23EP05SXI-1HT | 8-pin SOIC – Tape and Reel | Industrial |

Ordering Code Definitions

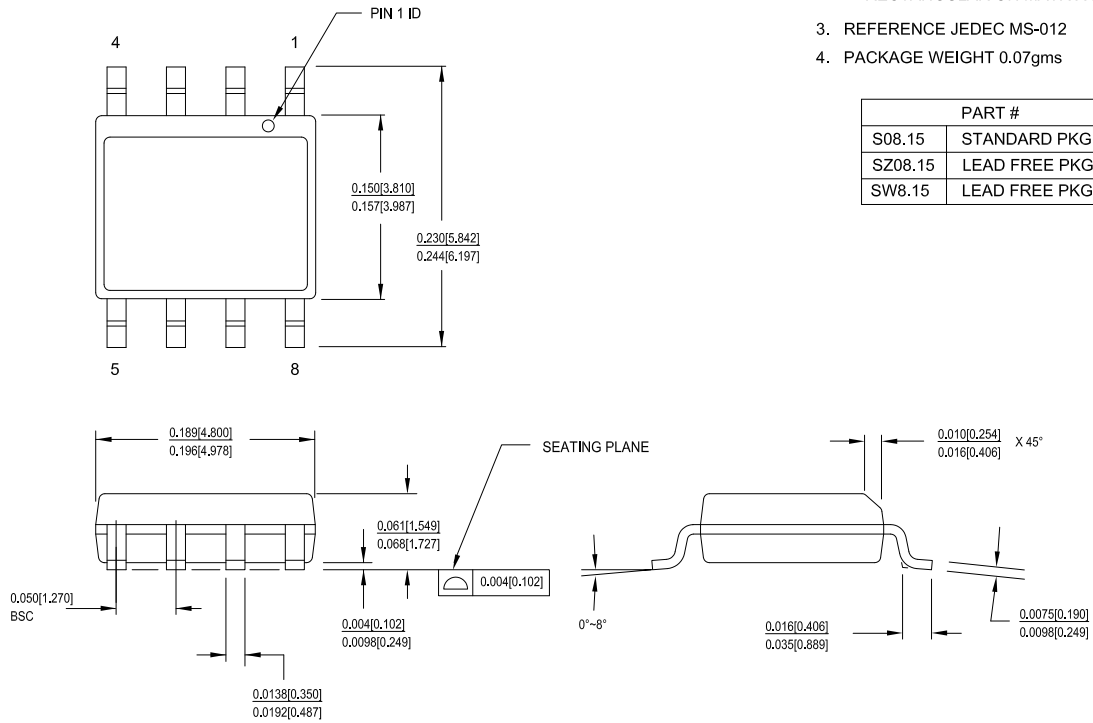


Package Drawing and Dimensions

Figure 17. 8-pin SOIC (150 Mils) S0815/SZ815/SW815 Package Outline, 51-85066

1. DIMENSIONS IN INCHES[MM] MIN. MAX.
2. PIN 1 ID IS OPTIONAL, ROUND ON SINGLE LEADFRAME RECTANGULAR ON MATRIX LEADFRAME
3. REFERENCE JEDEC MS-012
4. PACKAGE WEIGHT 0.07gms

| PART # | |
|---------|---------------|
| S08.15 | STANDARD PKG |
| SZ08.15 | LEAD FREE PKG |
| SW8.15 | LEAD FREE PKG |



51-85066 *F

Acronyms

Table 1. Acronyms Used in this Document

| Acronym | Description |
|---------|--|
| AC | Alternating Current |
| DC | Direct Current |
| PCI | Peripheral Component Interconnect |
| PLL | Phase-Locked Loop |
| SDRAM | Synchronous Dynamic Random Access Memory |
| SOIC | Small-Outline Integrated Circuit |

Document Conventions

Units of Measure

Table 2. Units of Measure

| Symbol | Unit of Measure |
|--------|------------------------------|
| dBc | decibels relative to carrier |
| °C | degree Celsius |
| Hz | hertz |
| MHz | megahertz |
| μA | microampere |
| mA | milliampere |
| W | ohm |
| pF | picofarad |
| ps | picosecond |
| V | volt |
| W | watt |

Document History Page

| Document Title: CY23EP05, 2.5 V or 3.3 V,10–220 MHz, Low Jitter, 5 Output Zero Delay Buffer | | | | |
|---|---------|-----------------|-----------------|--|
| Document Number: 38-07759 | | | | |
| Revision | ECN | Orig. of Change | Submission Date | Description of Change |
| ** | 349620 | RGL | See ECN | New data sheet |
| *A | 401073 | RGL | See ECN | Updated Delay vs. Load graph with standard drive data Added Phase-noise graph |
| *B | 413826 | RGL | See ECN | Minor Change: typo – changed from CY23EP05SXC-T to CY23EP05SXC-1T |
| *C | 3273677 | CXQ | 06/07/2011 | <p>1) Added typical column to the Operating Conditions table. Included 3.3 V and 2.5 V typical specs for the two V_{DD} rows.</p> <p>2) All BW, R_{OUT}, and Theta J_A specs are moved to typical column with only dashes left in the Min and Max columns. Removed the “(typical)” note from the description cells for these specs.</p> <p>3) All other specs just have a dash for the new typical column cells.</p> <p>4) Changed I_{II} spec in Electrical Specifications and Electrical Specifications tables from +/- 10 µA max to -10 µA min and 10 µA max.</p> <p>5) Added typical column to the DC Electrical Specifications tables. Typical column is all kept dashes except for the first row V_{DD} (3.3 V or 2.5 V respectively).</p> <p>6) Changed t₇ spec from +/- 150 ps max to -150 ps min and 150 ps max (same for the 300 ps spec).</p> <p>7) Updated package drawing to latest revision.</p> <p>8) Added Ordering Code Definitions, Acronyms, Units sections.</p> |
| *D | 4402737 | AJU | 06/09/2014 | <p>Updated Package Drawing and Dimensions: spec 51-85066 – Changed revision from *D to *F.</p> <p>Updated in new template.</p> <p>Completing Sunset Review.</p> |
| *E | 4578443 | AJU | 11/25/2014 | Added related documentation hyperlink in page 1. |

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