

2.5-V PHASE-LOCKED-LOOP CLOCK DRIVER

FEATURES

- Spread-Spectrum Clock Compatible
- Operating Frequency: 60 MHz to 220 MHz
- Low Jitter (Cycle-Cycle): ± 60 ps (± 40 ps at 200 MHz)
- Low Static Phase Offset: ± 50 ps
- Low Jitter (Period): ± 60 ps (± 30 ps at 200 MHz)
- 1-to-4 Differential Clock Distribution (SSTL2)
- Best in Class for $V_{OX} = V_{DD}/2 \pm 0.1$ V
- Operates From Dual 2.6-V or 2.5-V Supplies
- Available in a 28-Pin TSSOP Package
- Consumes < 100 - μ A Quiescent Current
- External Feedback Pins (FBIN, $\overline{\text{FBIN}}$) Are Used to Synchronize the Outputs to the Input Clocks
- Meets/Exceeds JEDEC Standard (JESD82-1) For DDRI-200/266/333 Specification
- Meets/Exceeds Proposed DDRI-400 Specification (JESD82-1A)
- Enters Low-Power Mode When No CLK Input Signal Is Applied or $\overline{\text{PWRDWN}}$ Is Low

APPLICATIONS

- DDR Memory Modules (DDR400/333/266/200)
- Zero-Delay Fan-Out Buffer

DESCRIPTION

The CDCVF855 is a high-performance, low-skew, low-jitter, zero-delay buffer that distributes a differential clock input pair (CLK, $\overline{\text{CLK}}$) to 4 differential pairs of clock outputs (Y[0:3], $\overline{\text{Y}}[0:3]$) and one differential pair of feedback clock outputs (FBOUT, $\overline{\text{FBOUT}}$). The clock outputs are controlled by the clock inputs (CLK, $\overline{\text{CLK}}$), the feedback clocks (FBIN, $\overline{\text{FBIN}}$), and the analog power input (AV_{DD}). When $\overline{\text{PWRDWN}}$ is high, the outputs switch in phase and frequency with CLK. When $\overline{\text{PWRDWN}}$ is low, all outputs are disabled to a high-impedance state (3-state) and the PLL is shut down (low-power mode). The device also enters this low-power mode when the input frequency falls below a suggested detection frequency that is below 20 MHz (typical 10 MHz). An input frequency-detection circuit detects the low-frequency condition and, after applying a >20 -MHz input signal, this detection circuit turns the PLL on and enables the outputs.

When AV_{DD} is strapped low, the PLL is turned off and bypassed for test purposes. The CDCVF855 is also able to track spread-spectrum clocking for reduced EMI.

Because the CDCVF855 is based on PLL circuitry, it requires a stabilization time to achieve phase-lock of the PLL. This stabilization time is required following power up. The CDCVF855 is characterized for both commercial and industrial temperature ranges.

AVAILABLE OPTIONS

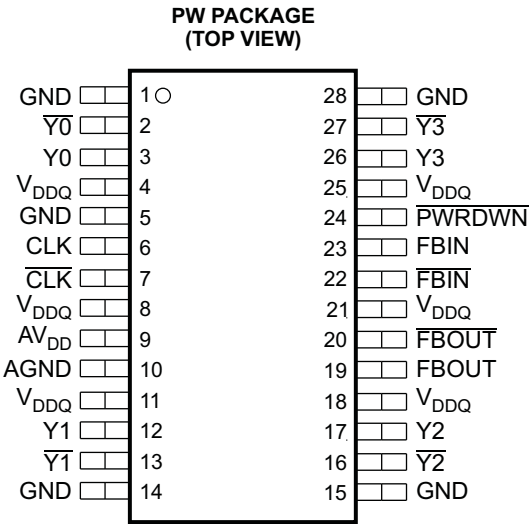
| T_A | TSSOP (PW) |
|---|------------|
| -40°C to 85°C | CDCVF855PW |



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

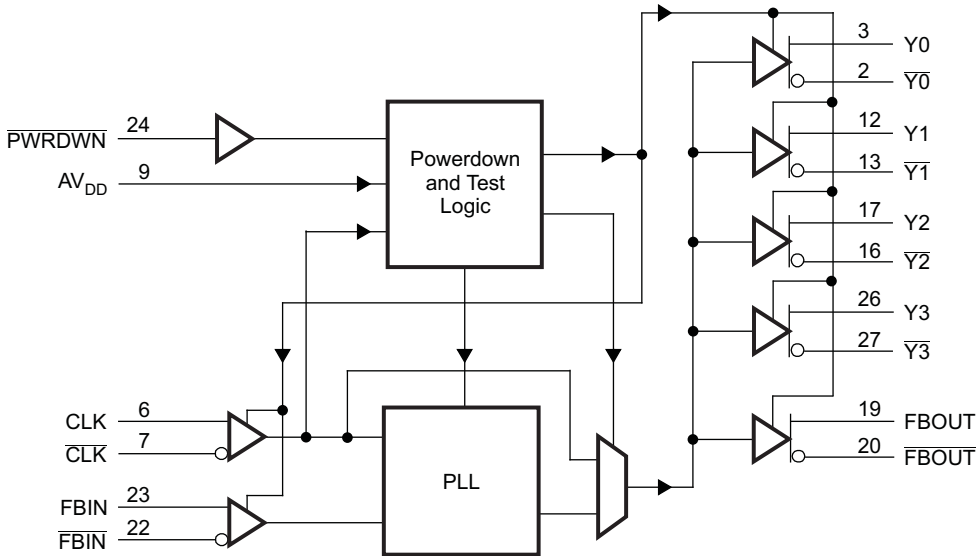
**FUNCTION TABLE
(Select Functions)**

| INPUTS | | | | OUTPUTS | | | | PLL |
|-------------|--------|---------|---------|---------|--------|-------|-------|--------------|
| AVDD | PWRDWN | CLK | CLK | Y[0:3] | Y[0:3] | FBOUT | FBOUT | |
| GND | H | L | H | L | H | L | H | Bypassed/off |
| GND | H | H | L | H | L | H | L | Bypassed/off |
| X | L | L | H | Z | Z | Z | Z | Off |
| X | L | H | L | Z | Z | Z | Z | Off |
| 2.5 V (nom) | H | L | H | L | H | L | H | On |
| 2.5 V (nom) | H | H | L | H | L | H | L | On |
| 2.5 V (nom) | X | <20 MHz | <20 MHz | Z | Z | Z | Z | Off |



P0043-02

FUNCTIONAL BLOCK DIAGRAM



B0196-02

Table 2. TERMINAL FUNCTIONS

| TERMINAL | | I/O | DESCRIPTION |
|--------------------------------|----------------------|-----|---|
| NAME | NO. | | |
| AGND | 10 | – | Ground for 2.5-V analog supply |
| AV _{DD} | 9 | – | 2.5-V analog supply |
| CLK, $\overline{\text{CLK}}$ | 6, 7 | I | Differential clock input |
| FBIN, FBIN | 22, 23 | I | Feedback differential clock input |
| FBOU, $\overline{\text{FBOU}}$ | 19, 20 | O | Feedback differential clock output |
| GND | 1, 5, 14, 15, 28 | – | Ground |
| PWRDWN | 24 | I | Output enable for Y and $\overline{\text{Y}}$ |
| V _{DDQ} | 4, 8, 11, 18, 21, 25 | – | 2.5-V supply |
| $\overline{\text{Y0}}$, Y0 | 2, 3 | O | Buffered output copies of input clock, CLK, $\overline{\text{CLK}}$ |
| Y1, $\overline{\text{Y1}}$ | 12, 13 | O | Buffered output copies of input clock, CLK, $\overline{\text{CLK}}$ |
| $\overline{\text{Y2}}$, Y2 | 16, 17 | O | Buffered output copies of input clock, CLK, $\overline{\text{CLK}}$ |
| Y3, $\overline{\text{Y3}}$ | 26, 27 | O | Buffered output copies of input clock, CLK, $\overline{\text{CLK}}$ |

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

| | | | |
|-------------------------------------|---|---|------------------------------------|
| V _{DDQ} , AV _{DD} | Supply voltage range | | 0.5 V to 3.6 V |
| V _I | Input voltage range ⁽²⁾⁽³⁾ | | –0.5 V to V _{DDQ} + 0.5 V |
| V _O | Output voltage range ⁽²⁾⁽³⁾ | | –0.5 V to V _{DDQ} + 0.5 V |
| I _{IK} | Input clamp current | V _I < 0 or V _I > V _{DDQ} | ±50 mA |
| I _{OK} | Output clamp current | V _O < 0 or V _O > V _{DDQ} | ±50 mA |
| I _O | Continuous output current | V _O = 0 to V _{DDQ} | ±50 mA |
| I _{DDS} | Continuous current to GND or V _{DDQ} | | ±100 mA |
| T _{stg} | Storage temperature range | | –65°C to 150°C |

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input and output negative voltage ratings may be exceeded if the input and output clamp current ratings are observed.
- (3) This value is limited to 3.6 V maximum.

THERMAL CHARACTERISTICS

| R _{θJA} for TSSOP Package ⁽¹⁾ | |
|---|----------|
| Airflow | High K |
| 0 ft/min (0 m/min) | 94.4°C/W |
| 150 ft/min (45.72 m/min) | 82.8°C/W |

- (1) The package thermal impedance is calculated in accordance with JESD 51.

RECOMMENDED OPERATING CONDITIONS

| | | | | MIN | NOM | MAX | UNIT | |
|--|---|---|-----------------|------------------------------------|------|---------------------------|------|---|
| Supply voltage | | V _{DDQ} | PC1600 – PC3200 | | 2.3 | | 2.7 | V |
| | | AVDD | | V _{DDQ} – 0.12 | | 2.7 | | |
| V _{IL} | Low-level input voltage | CLK, $\overline{\text{CLK}}$, FBIN, $\overline{\text{FBIN}}$ | | V _{DDQ} /2 – 0.18 | | | V | |
| | | $\overline{\text{PWRDWN}}$ | | –0.3 | | 0.7 | | |
| V _{IH} | High-level input voltage | CLK, $\overline{\text{CLK}}$, FBIN, $\overline{\text{FBIN}}$ | | V _{DDQ} /2 + 0.18 | | | V | |
| | | $\overline{\text{PWRDWN}}$ | | 1.7 | | V _{DDQ} + 0.3 | | |
| DC input signal voltage ⁽¹⁾ | | | | –0.3 | | V _{DDQ} + 0.3 | V | |
| V _{ID} | Differential input signal voltage ⁽²⁾ | DC | CLK, FBIN | V _{DDQ} = 2.3 V – 2.7V | 0.36 | V _{DDQ} + 0.6 | V | |
| | | | | V _{DDQ} = 2.425 V – 2.7 V | 0.25 | V _{DDQ} + 0.6 | | |
| | | AC | CLK, FBIN | V _{DDQ} = 2.3 V – 2.7 V | 0.7 | V _{DDQ} + 0.6 | | |
| | | | | V _{DDQ} = 2.425 V – 2.7 V | 0.49 | V _{DDQ} + 0.6 | | |
| V _{IX} | Input differential pair cross voltage ⁽³⁾⁽⁴⁾ | | | V _{DDQ} /2 – 0.2 | | V _{DDQ} /2 + 0.2 | V | |
| I _{OH} | High-level output current | | | | | –12 | mA | |
| I _{OL} | Low-level output current | | | | | 12 | mA | |
| SR | Input slew rate | | | 1 | | 4 | V/ns | |
| T _A | Operating free-air temperature | | | –40 | | 85 | °C | |

(1) The unused inputs must be held high or low to prevent them from floating.

(2) The dc input signal voltage specifies the allowable dc execution of the differential input.

(3) The differential input signal voltage specifies the differential voltage |V_{TR} – V_{CP}| required for switching, where V_{TR} is the true input level and V_{CP} is the complementary input level.

(4) The differential cross-point voltage is expected to track variations of V_{CC} and is the voltage at which the differential signals must cross.

ELECTRICAL CHARACTERISTICS

over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|---|--|---------------------------|---------------------|---------------------------|------|
| V _{IK} Input voltage, all inputs | V _{DDQ} = 2.3 V, I _I = –18 mA | | | –1.2 | V |
| V _{OH} High-level output voltage | V _{DDQ} = min to max, I _{OH} = –1 mA | V _{DDQ} – 0.1 | | | V |
| | V _{DDQ} = 2.3 V, I _{OH} = –12 mA | 1.7 | | | |
| V _{OL} Low-level output voltage | V _{DDQ} = min to max, I _{OL} = 1 mA | | | 0.1 | V |
| | V _{DDQ} = 2.3 V, I _{OL} = 12 mA | | | 0.6 | |
| V _{OD} Output voltage swing ⁽²⁾ | Differential outputs are terminated with 120 Ω, C _L = 14 pF (See Figure 3) | 1.1 | | V _{DDQ} – 0.4 | V |
| V _{OX} Output differential cross-voltage ⁽³⁾ | | V _{DDQ} /2 – 0.1 | V _{DDQ} /2 | V _{DDQ} /2 + 0.1 | V |
| I _I Input current | V _{DDQ} = 2.7 V, V _I = 0 V to 2.7 V | | | ±10 | μA |
| I _{OZ} High-impedance-state output current | V _{DDQ} = 2.7 V, V _O = V _{DDQ} or GND | | | ±10 | μA |
| I _{DDPD} Power-down current on V _{DDQ} + AV _{DD} | CLK and $\overline{\text{CLK}}$ = 0 MHz; $\overline{\text{PWRDWN}}$ = Low; Σ of I _{DD} and A _I _{DD} | | 20 | 100 | μA |
| A _I _{DD} Supply current on AV _{DD} | f _O = 170 MHz | | 6 | 8 | mA |
| | f _O = 200 MHz | | 8 | 10 | |
| C _I Input capacitance | V _{DDQ} = 2.5 V, V _I = V _{DDQ} or GND | 2 | 2.5 | 3.5 | pF |

(1) All typical values are at a nominal V_{DDQ}.

(2) The differential output signal voltage specifies the differential voltage |V_{TR} – V_{CP}|, where V_{TR} is the true output level and V_{CP} is the complementary output level.

(3) The differential cross-point voltage tracks variations of V_{DDQ} and is the voltage at which the differential signals must cross.

ELECTRICAL CHARACTERISTICS (continued)

over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | MIN | TYP ⁽¹⁾ | MAX | UNIT |
|-------------------|--|--|--------------------------|-----|--------------------|------|------|
| I _{DD} | Dynamic current on V _{DDQ} | Without load | f _O = 170 MHz | | 65 | 80 | mA |
| | | | f _O = 200 MHz | | 75 | 90 | |
| | | Differential outputs terminated with 120 Ω, C _L = 0 pF | f _O = 170 MHz | | 110 | 140 | |
| | | | f _O = 200 MHz | | 120 | 150 | |
| | | Differential outputs terminated with 120 Ω, C _L = 14 pF | f _O = 170 MHz | | 130 | 160 | |
| | | | f _O = 200 MHz | | 140 | 170 | |
| ΔC | Part-to-part input capacitance variation | V _{DDQ} = 2.5 V, V _I = V _{DDQ} or GND | | | | 1 | pF |
| C _{I(Δ)} | Input capacitance difference between CLK and \overline{CLK} , FBIN and \overline{FBIN} | V _{DDQ} = 2.5 V, V _I = V _{DDQ} or GND | | | | 0.25 | pF |

TIMING REQUIREMENTS

over recommended ranges of supply voltage and operating free-air temperature

| PARAMETER | | MIN | MAX | UNIT |
|---|-----------------------------|-----|-----|---------|
| f_{CLK} | Operating clock frequency | 60 | 220 | MHz |
| | Application clock frequency | 90 | 220 | |
| Input clock duty cycle | | 40% | 60% | |
| Stabilization time (PLL mode) ⁽¹⁾ | | | 10 | μ s |
| Stabilization time (bypass mode) ⁽²⁾ | | | 30 | ns |

(1) The time required for the integrated PLL circuit to obtain phase lock of its feedback signal to its reference signal. For phase lock to be obtained, a fixed-frequency, fixed-phase reference signal must be present at CLK and V_{DD} must be applied. Until phase lock is obtained, the specifications for propagation delay, skew, and jitter parameters given in the switching characteristics table are not applicable. This parameter does not apply for input modulation under SSC application.

(2) A recovery time is required when the device goes from power-down mode into bypass mode (AV_{DD} at GND).

SWITCHING CHARACTERISTICS

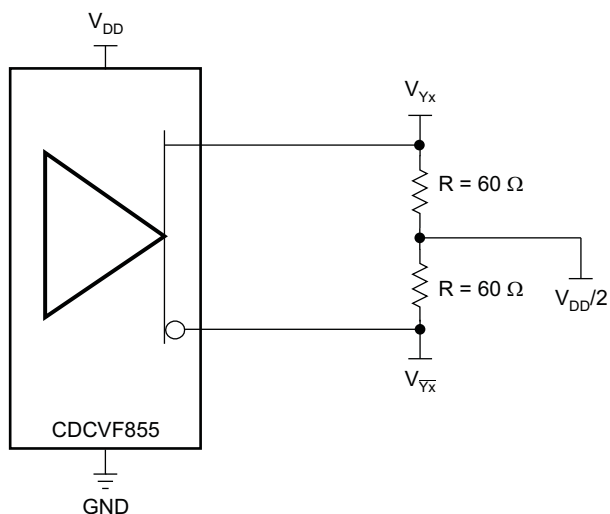
over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|------|-----|-----|------|
| $t_{PLH}^{(1)}$ Low- to high-level propagation delay time | Test mode/CLK to any output | | 3.5 | | ns |
| $t_{PHL}^{(1)}$ High- to low-level propagation delay time | Test mode/CLK to any output | | 3.5 | | ns |
| $t_{jit(per)}^{(2)}$ Jitter (period), see Figure 7 | 100/133/167 MHz (PC1600/2100/2700) | –65 | | 65 | ps |
| | 200 MHz (PC3200) | –30 | | 30 | |
| $t_{jit(cc)}^{(2)}$ Jitter (cycle-to-cycle), see Figure 4 | 100/133/167 MHz (PC1600/2100/2700) | –60 | | 60 | ps |
| | 200 MHz (PC3200) | –40 | | 40 | |
| $t_{jit(hper)}^{(2)}$ Half-period jitter, see Figure 8 | 100/133/167 MHz (PC1600/2100/2700) | –100 | | 100 | ps |
| | 200 MHz (PC3200) | –75 | | 75 | |
| $t_{slr(o)}$ Output clock slew rate, see Figure 9 | Load: 120 Ω , 14 pF | 1 | | 2 | V/ns |
| t_{ϕ} Static phase offset, see Figure 5 | 100/133/167/200 MHz | –50 | | 50 | ps |
| $t_{sk(o)}$ Output skew, see Figure 6 | Load: 120 Ω , 14 pF; 100/133/167/200 MHz | | | 40 | ps |

(1) Refers to the transition of the noninverting output.

(2) This parameter is assured by design but cannot be 100% production tested.

PARAMETER MEASUREMENT INFORMATION



S0229-02

Figure 1. IBIS Model Output Load

PARAMETER MEASUREMENT INFORMATION (continued)

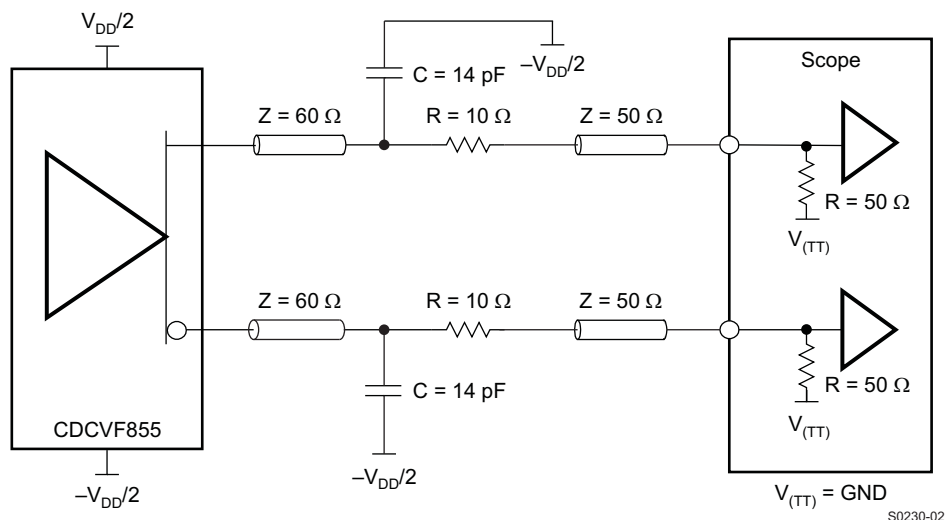


Figure 2. Output Load Test Circuit

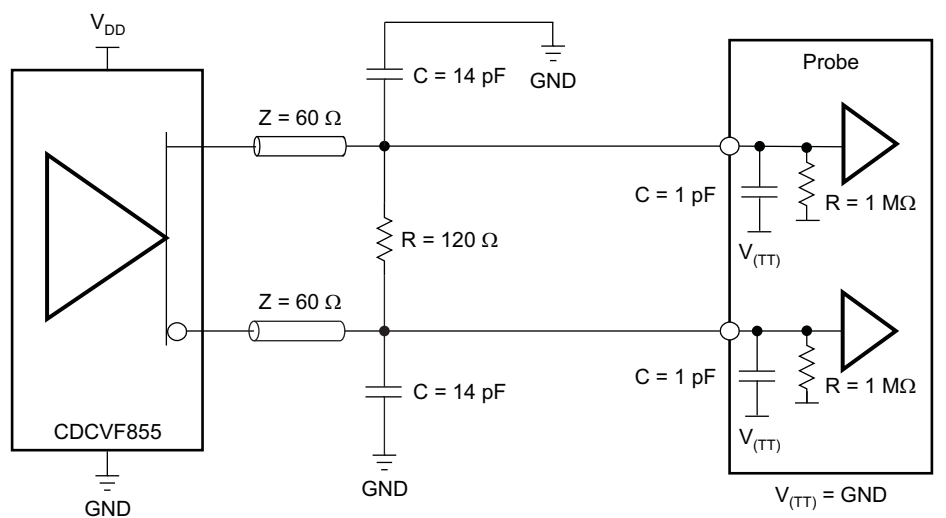
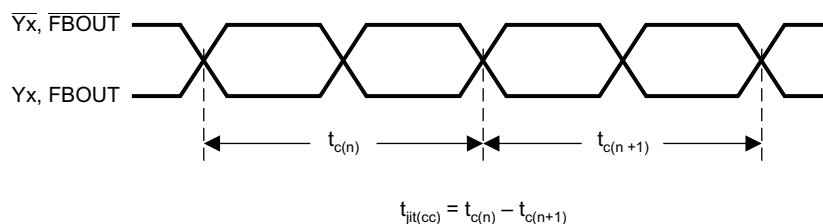
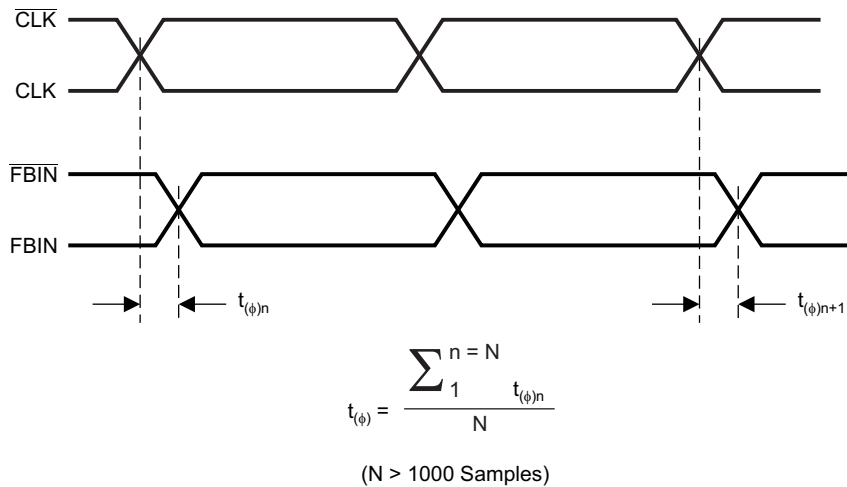


Figure 3. Output Load Test Circuit for Crossing Point

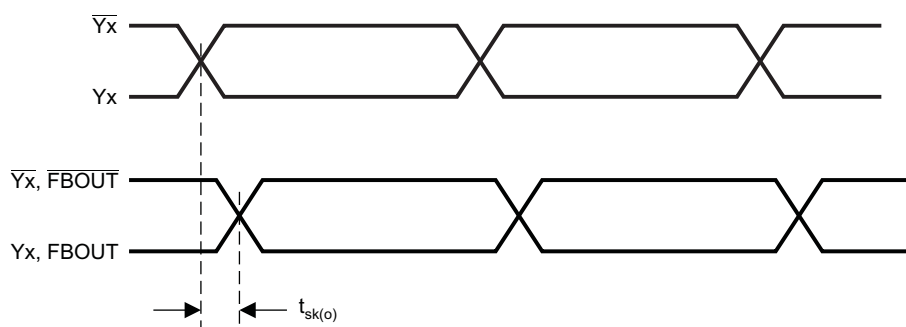


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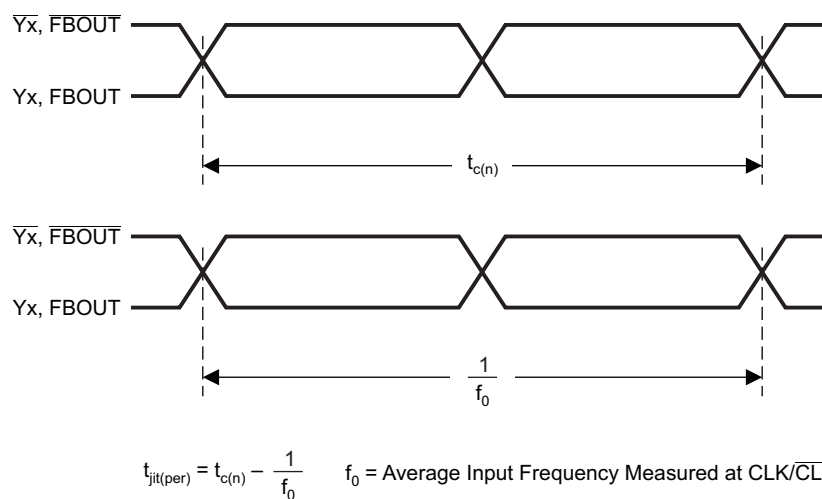
Figure 4. Cycle-to-Cycle Jitter

PARAMETER MEASUREMENT INFORMATION (continued)

T0175-01

Figure 5. Phase Offset

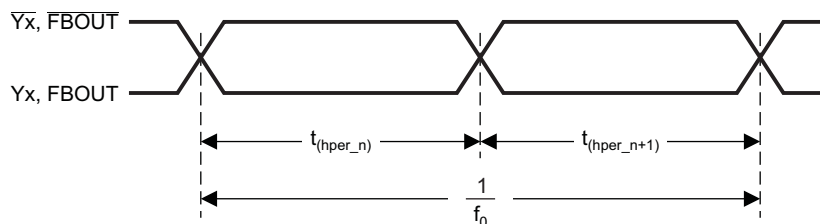
T0176-01

Figure 6. Output Skew

T0177-01

Figure 7. Period Jitter

PARAMETER MEASUREMENT INFORMATION (continued)

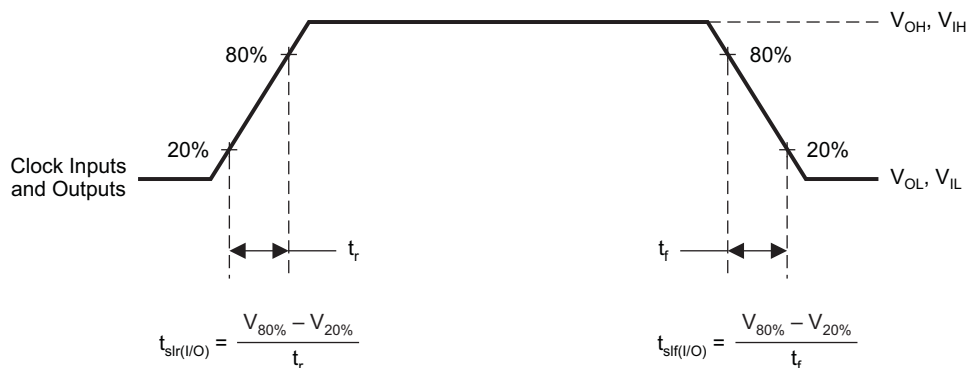


$$t_{jit(hper)} = t_{hper_n} - \frac{1}{2 \times f_0}$$

$n = \text{Any Half Cycle}$
 $f_0 = \text{Average Input Frequency Measured at CLK}/\overline{\text{CLK}}$

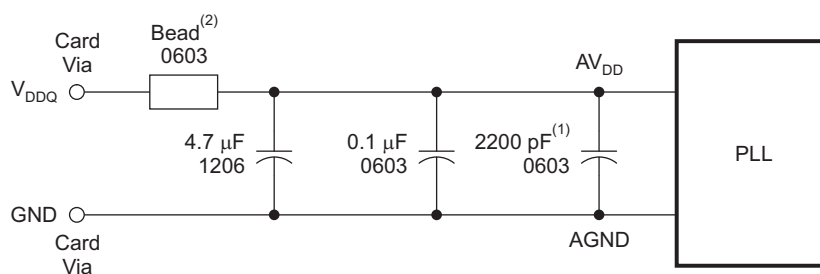
T0178-01

Figure 8. Half-Period Jitter



T0179-01

Figure 9. Input and Output Slew Rates



S0232-01

(1) Place the 2200-pF capacitor close to the PLL.

(2) Recommended bead: Fair-Rite P/N 2506036017Y0 or equivalent (0.8 Ω dc maximum, 600 Ω at 100 MHz).

NOTE: Use a wide trace for the PLL analog power and ground. Connect PLL and capacitors to AGND trace and connect trace to one GND via (farthest from the PLL).

Figure 10. Recommended AV_{DD} Filtering

PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|-----------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| CDCVF855PW | Active | Production | TSSOP (PW) 28 | 50 TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | CDCVF855 |
| CDCVF855PW.A | Active | Production | TSSOP (PW) 28 | 50 TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | CDCVF855 |
| CDCVF855PWG4 | Active | Production | TSSOP (PW) 28 | 50 TUBE | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | CDCVF855 |
| CDCVF855PWR | Active | Production | TSSOP (PW) 28 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | CDCVF855 |
| CDCVF855PWR.A | Active | Production | TSSOP (PW) 28 | 2000 LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | CDCVF855 |

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TAPE AND REEL INFORMATION



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CDCVF855PWR | TSSOP | PW | 28 | 2000 | 330.0 | 16.4 | 6.75 | 10.1 | 1.8 | 12.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CDCVF855PWR | TSSOP | PW | 28 | 2000 | 353.0 | 353.0 | 32.0 |

TUBE

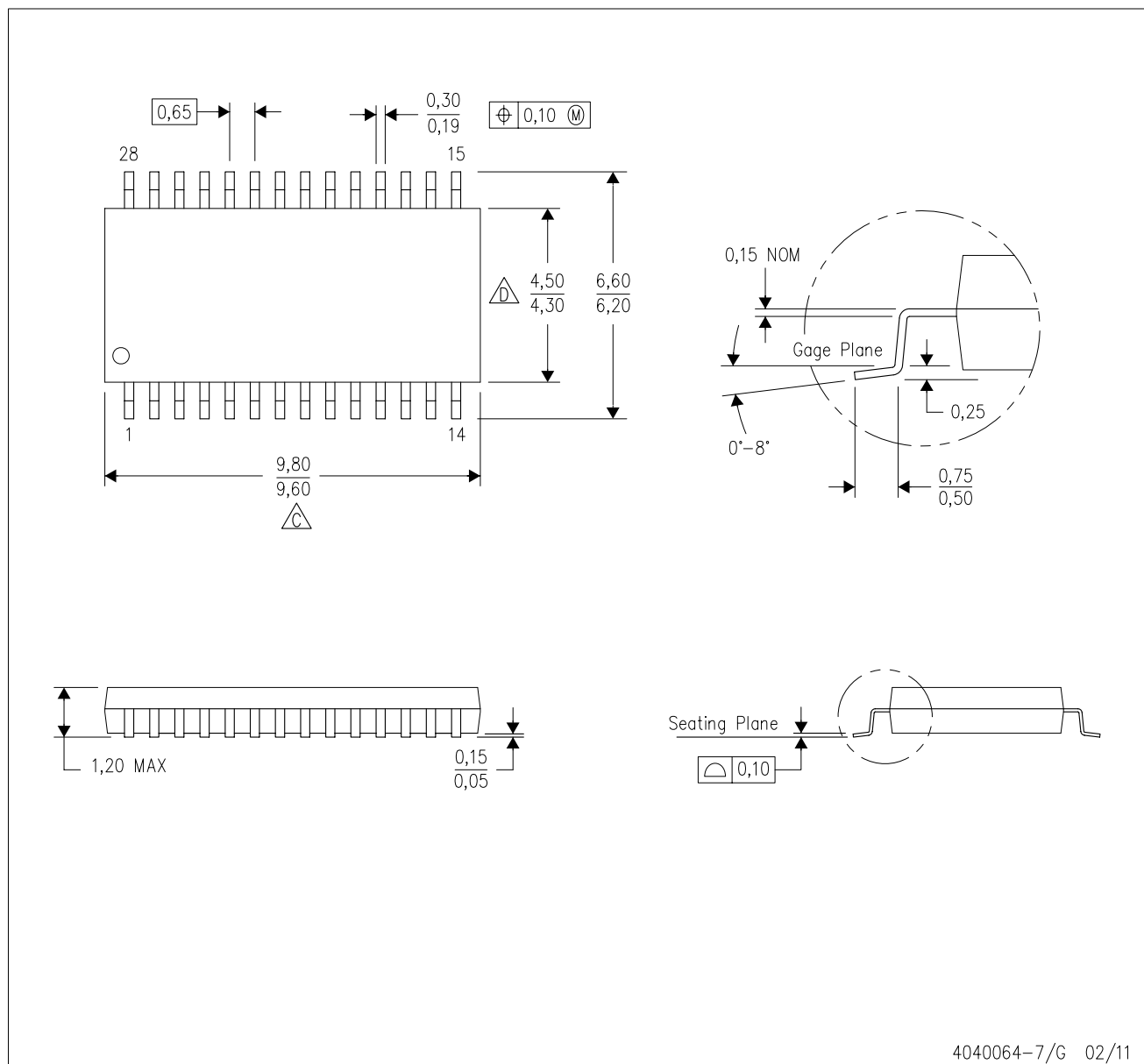


*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|--------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| CDCVF855PW | PW | TSSOP | 28 | 50 | 530 | 10.2 | 3600 | 3.5 |
| CDCVF855PW.A | PW | TSSOP | 28 | 50 | 530 | 10.2 | 3600 | 3.5 |
| CDCVF855PWG4 | PW | TSSOP | 28 | 50 | 530 | 10.2 | 3600 | 3.5 |

PW (R-PDSO-G28)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

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