



# CYPRESS

## CY29772

### 2.5V or 3.3V, 200-MHz, 12-Output Zero Delay Buffer

#### Features

- Output frequency range: 8.33 MHz to 200 MHz
- Input frequency range: 6.25 MHz to 125 MHz
- 2.5V or 3.3V operation
- Split 2.5V/3.3V outputs
- $\pm 2\%$  max Output duty cycle variation
- 12 clock outputs: drive up to 24 clock lines
- One feedback output
- Three reference clock inputs: crystal or LVCMOS
- 300ps max output-output skew
- Phase-locked loop (PLL) bypass mode
- Spread Aware™
- Output enable/disable
- Pin-compatible with MPC9772 and MPC972
- Industrial temperature range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- 52-pin 1.0-mm TQFP package

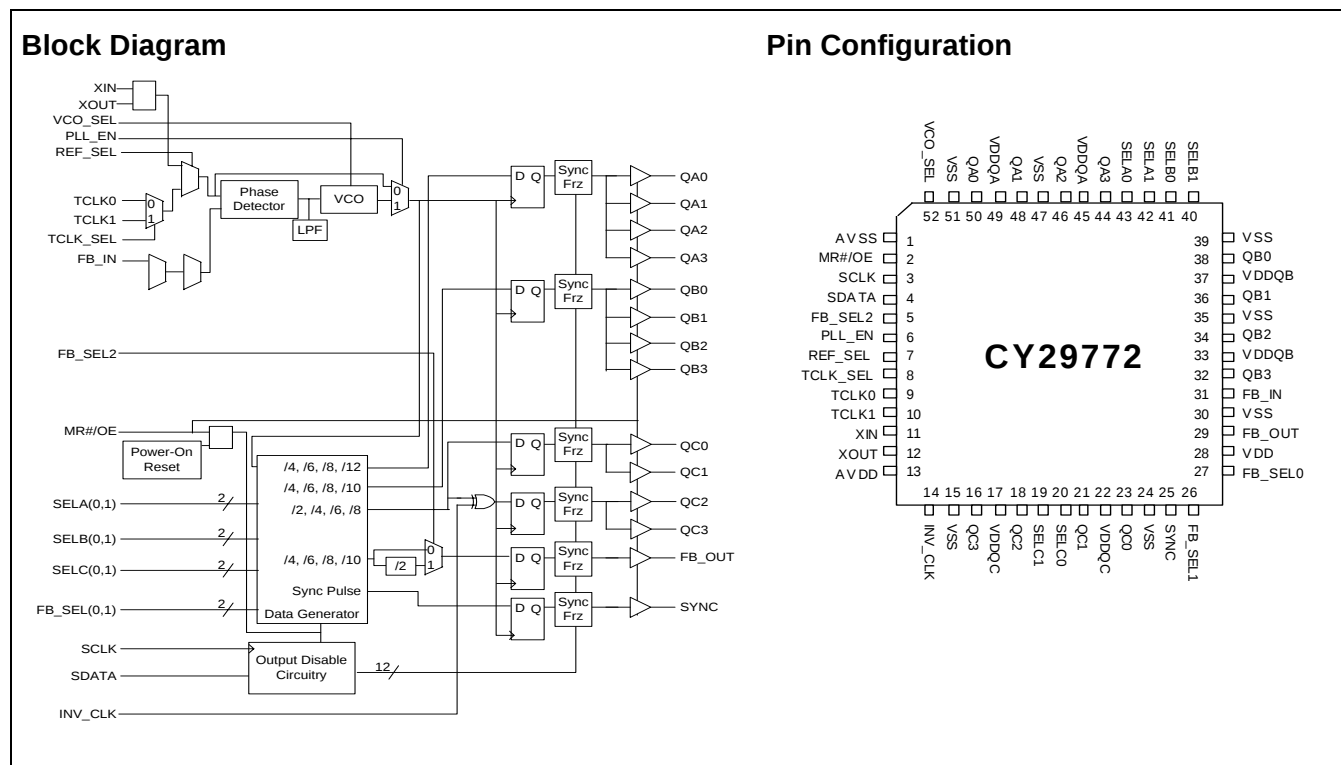
#### Description

The CY29772 is a low-voltage high-performance 200-MHz PLL-based zero delay buffer designed for high-speed clock-distribution applications.

The CY29772 features one on-chip crystal oscillator and two LVCMOS reference clock inputs and provides 12 outputs partitioned in three banks of four outputs each. Each bank divides the VCO output per SEL(A:C) settings, see *Functional Table*. These dividers allow output to input ratios of 8:1, 6:1, 5:1, 4:1, 3:1, 8:3, 5:2, 2:1, 5:3, 3:2, 4:3, 5:4, 1:1, and 5:6. Each LVCMOS-compatible output can drive  $50\Omega$  series- or parallel-terminated transmission lines. For series-terminated transmission lines, each output can drive one or two traces, giving the device an effective fanout of 1:24.

The PLL is ensured stable given that the VCO is configured to run between 200 MHz to 500 MHz. This allows a wide range of output frequencies from 8 MHz to 200 MHz. For normal operation, the external feedback input, FB\_IN, is connected to the feedback output, FB\_OUT. The internal VCO is running at multiples of the input reference clock set by the feedback divider, see *Frequency Table*.

When PLL\_EN is LOW, PLL is bypassed and the reference clock directly feeds the output dividers. This mode is fully static and the minimum input clock frequency specification does not apply.



**Pin Description<sup>[1]</sup>**

| Pin                        | Name        | I/O    | Type    | Description                                                                                                                                        |
|----------------------------|-------------|--------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 11                         | XIN         | I      | Analog  | Crystal oscillator input.                                                                                                                          |
| 12                         | XOUT        | O      | Analog  | Crystal oscillator output.                                                                                                                         |
| 9                          | TCLK0       | I, PU  | LVC MOS | LVC MOS/LVTTL reference clock input.                                                                                                               |
| 10                         | TCLK1       | I, PU  | LVC MOS | LVC MOS/LVTTL reference clock input.                                                                                                               |
| 44, 46, 48, 50             | QA(3:0)     | O      | LVC MOS | Clock output bank A.                                                                                                                               |
| 32, 34, 36, 38             | QB(3:0)     | O      | LVC MOS | Clock output bank B.                                                                                                                               |
| 16, 18, 21, 23             | QC(3:0)     | O      | LVC MOS | Clock output bank C.                                                                                                                               |
| 29                         | FB_OUT      | O      | LVC MOS | Feedback clock output. Connect to FB_IN for normal operation.                                                                                      |
| 31                         | FB_IN       | I, PU  | LVC MOS | Feedback clock input. Connect to FB_OUT for normal operation. This input should be at the same voltage rail as input reference clock. See Table 1. |
| 25                         | SYNC        | O      | LVC MOS | Synchronous pulse output. This output is used for system synchronization.                                                                          |
| 6                          | PLL_EN      | I, PU  | LVC MOS | PLL enable/bypass input. When Low, PLL is disabled/bypassed. and the input clock connects to the output dividers.                                  |
| 2                          | MR#/OE      | I, PU  | LVC MOS | Master reset and Output enable/disable input. See Table 2                                                                                          |
| 8                          | TCLK_SEL    | I, PU  | LVC MOS | LVC MOS Clock reference select input. See Table 2.                                                                                                 |
| 7                          | REF_SEL     | I, PU  | LVC MOS | LVC MOS/LVPECL Reference select input. See Table 2.                                                                                                |
| 52                         | VCO_SEL     | I, PU  | LVC MOS | VCO Operating frequency select input. See Table 2.                                                                                                 |
| 14                         | INV_CLK     | I, PU  | LVC MOS | QC(2,3) Phase selection input. See Table 2.                                                                                                        |
| 5, 26, 27                  | FB_SEL(2:0) | I, PU  | LVC MOS | Feedback divider select input. See Table 6.                                                                                                        |
| 42, 43                     | SELA(1,0)   | I, PU  | LVC MOS | Frequency select input, Bank A. See Table 3.                                                                                                       |
| 40, 41                     | SELB(1,0)   | I, PU  | LVC MOS | Frequency select input, Bank B. See Table 4.                                                                                                       |
| 19, 20                     | SELC(1,0)   | I, PU  | LVC MOS | Frequency select input, Bank C. See Table 5.                                                                                                       |
| 3                          | SCLK        | I, PU  | LVC MOS | Serial Clock input.                                                                                                                                |
| 4                          | SDATA       | I, PU  | LVC MOS | Serial Data input.                                                                                                                                 |
| 45, 49                     | VDDQA       | Supply | VDD     | 2.5V or 3.3V Power supply for bank A output clocks. <sup>[2,3]</sup>                                                                               |
| 33, 37                     | VDDQB       | Supply | VDD     | 2.5V or 3.3V Power supply for bank B output clocks. <sup>[2,3]</sup>                                                                               |
| 22, 17                     | VDDQC       | Supply | VDD     | 2.5V or 3.3V Power supply for bank C output clocks. <sup>[2,3]</sup>                                                                               |
| 13                         | AVDD        | Supply | VDD     | 2.5V or 3.3V Power supply for PLL. <sup>[2,3]</sup>                                                                                                |
| 28                         | VDD         | Supply | VDD     | 2.5V or 3.3V Power supply for core and inputs. <sup>[2,3]</sup>                                                                                    |
| 1                          | AVSS        | Supply | Ground  | Analog Ground.                                                                                                                                     |
| 15, 24, 30, 35, 39, 47, 51 | VSS         | Supply | Ground  | Common Ground.                                                                                                                                     |

**Notes:**

1. PU = Internal pull up, PD = Internal pull down.
2. A 0.1μF bypass capacitor should be placed as close as possible to each positive power pin (<0.2"). If these bypass capacitors are not close to the pins their high-frequency filtering characteristics will be cancelled by the lead inductance of the traces.
3. AVDD and VDD pins must be connected to a power supply level that is at least equal or higher than that of VDDQA, VDDQB, and VDDQC power supply pins.

**Table 1. Frequency Table**

| Feedback Output Divider | VCO              | Input Frequency Range (AVDD = 3.3V) | Input Frequency Range (AVDD = 2.5V) |
|-------------------------|------------------|-------------------------------------|-------------------------------------|
| ÷4                      | Input Clock * 4  | 50 MHz to 125 MHz                   | 50 MHz to 95 MHz                    |
| ÷6                      | Input Clock * 6  | 33.3 MHz to 83.3 MHz                | 33.3 MHz to 63.3 MHz                |
| ÷8                      | Input Clock * 8  | 25 MHz to 62.5 MHz                  | 25 MHz to 47.5 MHz                  |
| ÷10                     | Input Clock * 10 | 20 MHz to 50 MHz                    | 20 MHz to 38 MHz                    |
| ÷12                     | Input Clock * 12 | 16.6 MHz to 41.6 MHz                | 16.6 MHz to 31.6 MHz                |
| ÷16                     | Input Clock * 16 | 12.5 MHz to 31.25 MHz               | 12.5 MHz to 23.75 MHz               |
| ÷20                     | Input Clock * 20 | 10 MHz to 25 MHz                    | 10 MHz to 19 MHz                    |
| ÷24                     | Input Clock * 24 | 8.3 MHz to 20.8 MHz                 | 8.3 MHz to 15.8 MHz                 |
| ÷32                     | Input Clock * 32 | 6.25 MHz to 15.625 MHz              | 6.25 MHz to 11.8 MHz                |
| ÷40                     | Input Clock * 40 | 5 MHz to 12.5 MHz                   | 5 MHz to 9.5MHz                     |

**Table 2. Function Table (Configuration Controls)**

| Control  | Default | 0                                                                                                                                                                                                                                                   | 1                                                                       |
|----------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| REF_SEL  | 1       | TCLK0, TCLK1                                                                                                                                                                                                                                        | Crystal oscillator                                                      |
| TCLK_SEL | 1       | TCLK0                                                                                                                                                                                                                                               | TCLK1                                                                   |
| VCO_SEL  | 1       | VCO÷2 (low input frequency range)                                                                                                                                                                                                                   | VCO÷1 (high input frequency range)                                      |
| PLL_EN   | 1       | Bypass mode, PLL disabled. The input clock connects to the output dividers                                                                                                                                                                          | PLL enabled. The VCO output connects to the output dividers             |
| INV_CLK  | 1       | QC2 and QC3 are in phase with QC0 and QC1                                                                                                                                                                                                           | QC2 and QC3 are inverted (180° phase shift) with respect to QC0 and QC1 |
| MR#/OE   | 1       | Outputs disabled (three-state) and reset of the device. During reset/output disable the PLL feedback loop is open and the VCO running at its minimum frequency. The device is reset by the internal power-on reset (POR) circuitry during power-up. | Outputs enabled                                                         |

**Table 3. Function Table (Bank A)**

| VCO_SEL | SELA1 | SELA0 | QA(0:3) |
|---------|-------|-------|---------|
| 0       | 0     | 0     | ÷8      |
| 0       | 0     | 1     | ÷12     |
| 0       | 1     | 0     | ÷16     |
| 0       | 1     | 1     | ÷24     |
| 1       | 0     | 0     | ÷4      |
| 1       | 0     | 1     | ÷6      |
| 1       | 1     | 0     | ÷8      |
| 1       | 1     | 1     | ÷12     |

**Table 5. Function Table (Bank C)**

| VCO_SEL | SELC1 | SELC0 | QC(0:3) |
|---------|-------|-------|---------|
| 0       | 0     | 0     | ÷4      |
| 0       | 0     | 1     | ÷8      |
| 0       | 1     | 0     | ÷12     |
| 0       | 1     | 1     | ÷16     |
| 1       | 0     | 0     | ÷2      |
| 1       | 0     | 1     | ÷4      |
| 1       | 1     | 0     | ÷6      |
| 1       | 1     | 1     | ÷8      |

**Table 4. Function Table (Bank B)**

| VCO_SEL | SELB1 | SELB0 | QB(0:3) |
|---------|-------|-------|---------|
| 0       | 0     | 0     | ÷8      |
| 0       | 0     | 1     | ÷12     |
| 0       | 1     | 0     | ÷16     |
| 0       | 1     | 1     | ÷20     |
| 1       | 0     | 0     | ÷4      |
| 1       | 0     | 1     | ÷6      |
| 1       | 1     | 0     | ÷8      |
| 1       | 1     | 1     | ÷10     |

**Table 6. Function Table (FB\_OUT)**

| VCO_SEL | FB_SEL2 | FB_SEL1 | FB_SEL0 | FB_OUT |
|---------|---------|---------|---------|--------|
| 0       | 0       | 0       | 0       | ÷8     |
| 0       | 0       | 0       | 1       | ÷12    |
| 0       | 0       | 1       | 0       | ÷16    |
| 0       | 0       | 1       | 1       | ÷20    |
| 0       | 1       | 0       | 0       | ÷16    |
| 0       | 1       | 0       | 1       | ÷24    |
| 0       | 1       | 1       | 0       | ÷32    |
| 0       | 1       | 1       | 1       | ÷40    |

Table 6. Function Table (FB\_OUT) (continued)

| VCO_SEL | FB_SEL2 | FB_SEL1 | FB_SEL0 | FB_OUT |
|---------|---------|---------|---------|--------|
| 1       | 0       | 0       | 0       | ÷4     |
| 1       | 0       | 0       | 1       | ÷6     |
| 1       | 0       | 1       | 0       | ÷8     |
| 1       | 0       | 1       | 1       | ÷10    |
| 1       | 1       | 0       | 0       | ÷8     |
| 1       | 1       | 0       | 1       | ÷12    |
| 1       | 1       | 1       | 0       | ÷16    |
| 1       | 1       | 1       | 1       | ÷20    |

**Absolute Maximum Conditions**

| Parameter        | Description                       | Condition                   | Min.  | Max.                  | Unit  |
|------------------|-----------------------------------|-----------------------------|-------|-----------------------|-------|
| V <sub>DD</sub>  | DC Supply Voltage                 |                             | −0.3  | 5.5                   | V     |
| V <sub>DD</sub>  | DC Operating Voltage              | Functional                  | 2.375 | 3.465                 | V     |
| V <sub>IN</sub>  | DC Input Voltage                  | Relative to V <sub>SS</sub> | −0.3  | V <sub>DD</sub> + 0.3 | V     |
| V <sub>OUT</sub> | DC Output Voltage                 | Relative to V <sub>SS</sub> | −0.3  | V <sub>DD</sub> + 0.3 | V     |
| V <sub>TT</sub>  | Output termination Voltage        |                             | −     | V <sub>DD</sub> ÷ 2   | V     |
| LU               | Latch-up Immunity                 | Functional                  | 200   | −                     | mA    |
| R <sub>PS</sub>  | Power Supply Ripple               | Ripple Frequency < 100 kHz  | −     | 150                   | mVp-p |
| T <sub>S</sub>   | Temperature, Storage              | Non-functional              | −65   | +150                  | °C    |
| T <sub>A</sub>   | Temperature, Operating Ambient    | Functional                  | −40   | +85                   | °C    |
| T <sub>J</sub>   | Temperature, Junction             | Functional                  | −     | +150                  | °C    |
| Ø <sub>JC</sub>  | Dissipation, Junction to Case     | Functional                  | −     | 23                    | °C/W  |
| Ø <sub>JA</sub>  | Dissipation, Junction to Ambient  | Functional                  | −     | 55                    | °C/W  |
| ESD <sub>H</sub> | ESD Protection (Human Body Model) |                             | 2000  | −                     | V     |
| FIT              | Failure in Time                   | Manufacturing test          | 10    |                       | ppm   |

**DC Electrical Specifications** (V<sub>DD</sub> = 2.5V ± 5%, T<sub>A</sub> = −40°C to +85°C)

| Parameter        | Description                         | Condition                         | Min. | Typ. | Max.                 | Unit |
|------------------|-------------------------------------|-----------------------------------|------|------|----------------------|------|
| V <sub>IL</sub>  | Input Voltage, Low                  | LVC MOS                           | −    | −    | 0.7                  | V    |
| V <sub>IH</sub>  | Input Voltage, High                 | LVC MOS                           | 1.7  | −    | V <sub>DD</sub> +0.3 | V    |
| V <sub>OL</sub>  | Output Voltage, Low <sup>[4]</sup>  | I <sub>OL</sub> = 15mA            | −    | −    | 0.6                  | V    |
| V <sub>OH</sub>  | Output Voltage, High <sup>[4]</sup> | I <sub>OH</sub> = −15mA           | 1.8  | −    | −                    | V    |
| I <sub>IL</sub>  | Input Current, Low <sup>[5]</sup>   | V <sub>IL</sub> = V <sub>SS</sub> | −    | −    | −100                 | µA   |
| I <sub>IH</sub>  | Input Current, High <sup>[5]</sup>  | V <sub>IL</sub> = V <sub>DD</sub> | −    | −    | 100                  | µA   |
| I <sub>DDA</sub> | PLL Supply Current                  | AVDD only                         | −    | 5    | 10                   | mA   |
| I <sub>DDQ</sub> | Quiescent Supply Current            | All VDD pins except AVDD          | −    | −    | 8                    | mA   |
| I <sub>DD</sub>  | Dynamic Supply Current              | Outputs loaded @ 100 MHz          | −    | 135  | −                    | mA   |
| C <sub>IN</sub>  | Input Pin Capacitance               |                                   | −    | 4    | −                    | pF   |
| Z <sub>OUT</sub> | Output Impedance                    |                                   | 14   | 18   | 22                   | Ω    |

**DC Electrical Specifications** (V<sub>DD</sub> = 3.3V ± 5%, T<sub>A</sub> = −40°C to +85°C)

| Parameter        | Description                         | Condition                         | Min. | Typ. | Max.                  | Unit |
|------------------|-------------------------------------|-----------------------------------|------|------|-----------------------|------|
| V <sub>IL</sub>  | Input Voltage, Low                  | LVC MOS                           | −    | −    | 0.8                   | V    |
| V <sub>IH</sub>  | Input Voltage, High                 | LVC MOS                           | 2.0  | −    | V <sub>DD</sub> + 0.3 | V    |
| V <sub>OL</sub>  | Output Voltage, Low <sup>[4]</sup>  | I <sub>OL</sub> = 24 mA           | −    | −    | 0.55                  | V    |
|                  |                                     | I <sub>OL</sub> = 12 mA           | −    | −    | 0.30                  |      |
| V <sub>OH</sub>  | Output Voltage, High <sup>[4]</sup> | I <sub>OH</sub> = −24 mA          | 2.4  | −    | −                     | V    |
| I <sub>IL</sub>  | Input Current, Low <sup>[5]</sup>   | V <sub>IL</sub> = V <sub>SS</sub> | −    | −    | −100                  | µA   |
| I <sub>IH</sub>  | Input Current, High <sup>[5]</sup>  | V <sub>IL</sub> = V <sub>DD</sub> | −    | −    | 100                   | µA   |
| I <sub>DDA</sub> | PLL Supply Current                  | AVDD only                         | −    | 5    | 10                    | mA   |
| I <sub>DDQ</sub> | Quiescent Supply Current            | All VDD pins except AVDD          | −    | −    | 8                     | mA   |
| I <sub>DD</sub>  | Dynamic Supply Current              | Outputs loaded @ 100 MHz          | −    | 225  | −                     | mA   |
| C <sub>IN</sub>  | Input Pin Capacitance               |                                   | −    | 4    | −                     | pF   |
| Z <sub>OUT</sub> | Output Impedance                    |                                   | 12   | 15   | 18                    | Ω    |

**Notes:**

- Driving one 50Ω parallel-terminated transmission line to a termination voltage of V<sub>TT</sub>. Alternatively, each output drives up to two 50 Ω series-terminated transmission lines.
- Inputs have pull-up or pull-down resistors that affect the input current.

**AC Electrical Specifications** ( $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ ) [6]

| Parameter     | Description                             | Condition                | Min. | Typ.    | Max.  | Unit |
|---------------|-----------------------------------------|--------------------------|------|---------|-------|------|
| $f_{VCO}$     | VCO Frequency                           |                          | 200  | –       | 380   | MHz  |
| $f_{XTAL}$    | Crystal Frequency Range                 | see Table 7              | 10   | –       | 25    | MHz  |
| $f_{in}$      | Input Frequency                         | +4 Feedback              | 50   | –       | 95    | MHz  |
|               |                                         | +6 Feedback              | 33.3 | –       | 63.3  |      |
|               |                                         | +8 Feedback              | 25   | –       | 47.5  |      |
|               |                                         | +10 Feedback             | 20   | –       | 38    |      |
|               |                                         | +12 Feedback             | 16.6 | –       | 31.6  |      |
|               |                                         | +16 Feedback             | 12.5 | –       | 23.75 |      |
|               |                                         | +20 Feedback             | 10   | –       | 19    |      |
|               |                                         | +24 Feedback             | 8.3  | –       | 15.8  |      |
|               |                                         | +32 Feedback             | 6.25 | –       | 11.8  |      |
|               |                                         | +40 Feedback             | 5    | –       | 9.5   |      |
|               |                                         | Bypass mode (PLL_EN = 0) | 0    | –       | 200   |      |
| $f_{refDC}$   | Input Duty Cycle                        |                          | 25   | –       | 75    | %    |
| $t_r, t_f$    | TCLK Input Rise/Fall Time               | 0.7V to 1.7V             | –    | –       | 1.0   | ns   |
| $f_{MAX}$     | Maximum Output Frequency                | +2 Output                | 100  | –       | 190   | MHz  |
|               |                                         | +4 Output                | 50   | –       | 95    |      |
|               |                                         | +6 Output                | 33.3 | –       | 63.3  |      |
|               |                                         | +8 Output                | 25   | –       | 47.5  |      |
|               |                                         | +10 Output               | 20   | –       | 38    |      |
|               |                                         | +12 Output               | 16.6 | –       | 31.6  |      |
|               |                                         | +16 Output               | 12.5 | –       | 23.75 |      |
|               |                                         | +20 Output               | 10   | –       | 19    |      |
|               |                                         | +24 Output               | 8.3  | –       | 15.8  |      |
| $f_{SCLK}$    | Serial Clock Frequency                  |                          | –    | –       | 20    | MHz  |
| DC            | Output Duty Cycle                       | $f_{MAX} < 100$ MHz      | 47.5 | –       | 52.5  | %    |
|               |                                         | $f_{MAX} > 100$ MHz      | 45   | –       | 55    |      |
| $t_r, t_f$    | Output Rise/Fall times                  | 0.6V to 1.8V             | 0.1  | –       | 1.0   | ns   |
| $t_{(\phi)}$  | Propagation Delay (static phase offset) | TCLK to FB_IN            | –125 | –       | 125   | ps   |
| $t_{sk(O)}$   | Output-to-Output Skew                   | Skew within Bank A       | –    | –       | 75    | ps   |
|               |                                         | Skew within Bank B       | –    | –       | 100   |      |
|               |                                         | Skew within Bank C       | –    | –       | 150   |      |
| $t_{sk(B)}$   | Bank-to-Bank Skew                       |                          | –    | –       | 400   | ps   |
| $t_{PLZ, HZ}$ | Output Disable Time                     |                          | –    | –       | 10    | ns   |
| $t_{PZL, ZH}$ | Output Enable Time                      |                          | –    | –       | 10    | ns   |
| BW            | PLL Closed Loop Bandwidth (–3 dB)       | +4 Feedback              | –    | 1.3–2.0 | –     | MHz  |
|               |                                         | +6 Feedback              | –    | 0.7–1.3 | –     |      |
|               |                                         | +8 Feedback              | –    | 0.9–1.3 | –     |      |
|               |                                         | +10 Feedback             | –    | 0.6–1.1 | –     |      |
|               |                                         | +12 Feedback             | –    | 0.6–0.9 | –     |      |
|               |                                         | +16 Feedback             | –    | 0.4–0.6 | –     |      |
|               |                                         | +20 Feedback             | –    | 0.6–0.9 | –     |      |

**Note:**

6. AC characteristics apply for parallel output termination of  $50\Omega$  to  $V_{TT}$ . Outputs are at same supply voltage unless otherwise stated. Parameters are guaranteed by characterization and are not 100% tested.

**AC Electrical Specifications** ( $V_{DD} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ ) (continued)<sup>[6]</sup>

| Parameter       | Description           | Condition                                     | Min. | Typ. | Max. | Unit |
|-----------------|-----------------------|-----------------------------------------------|------|------|------|------|
| $t_{JIT(CC)}$   | Cycle-to-Cycle Jitter | Same frequency (125 MHz)<br>RMS ( $1\sigma$ ) | –    | 7    | 30   | ps   |
|                 |                       | Same frequency                                | –    | –    | 150  |      |
|                 |                       | Multiple frequencies                          | –    | –    | 435  |      |
| $t_{JIT(PER)}$  | Period Jitter         | Same frequency (125 MHz)<br>RMS ( $1\sigma$ ) | –    | 6    | 30   | ps   |
|                 |                       | Same frequency                                | –    | 45   | 75   |      |
|                 |                       | Multiple frequencies                          | –    | –    | 235  |      |
| $t_{JIT(\phi)}$ | I/O Phase Jitter      |                                               | –    | –    | 150  | ps   |
| $t_{LOCK}$      | Maximum PLL Lock Time |                                               | –    | –    | 1    | ms   |

**AC Parameters** ( $V_{DD} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ ) <sup>[6]</sup>

| Parameter    | Description                             | Condition                | Min. | Typ. | Max.   | Unit |
|--------------|-----------------------------------------|--------------------------|------|------|--------|------|
| $f_{VCO}$    | VCO Frequency                           |                          | 200  | –    | 500    | MHz  |
| $f_{XTAL}$   | Crystal Frequency Range                 | see Table 7              | 10   | –    | 25     | MHz  |
| $f_{in}$     | Input Frequency                         | +4 Feedback              | 50   | –    | 125    | MHz  |
|              |                                         | +6 Feedback              | 33.3 | –    | 83.3   |      |
|              |                                         | +8 Feedback              | 25   | –    | 62.5   |      |
|              |                                         | +10 Feedback             | 20   | –    | 50     |      |
|              |                                         | +12 Feedback             | 16.6 | –    | 41.6   |      |
|              |                                         | +16 Feedback             | 12.5 | –    | 31.25  |      |
|              |                                         | +20 Feedback             | 10   | –    | 25     |      |
|              |                                         | +24 Feedback             | 8.3  | –    | 20.8   |      |
|              |                                         | +32 Feedback             | 6.25 | –    | 15.625 |      |
|              |                                         | +40 Feedback             | 5    | –    | 12.5   |      |
|              |                                         | Bypass mode (PLL_EN = 0) | 0    | –    | 200    |      |
| $f_{refDC}$  | Input Duty Cycle                        |                          | 25   | –    | 75     | %    |
| $t_r, t_f$   | TCLK Input Rise/Fall Time               | 0.8V to 2.0V             | –    | –    | 1.0    | ns   |
| $f_{MAX}$    | Maximum Output Frequency                | +2 Output                | 100  | –    | 200    | MHz  |
|              |                                         | +4 Output                | 50   | –    | 125    |      |
|              |                                         | +6 Output                | 33.3 | –    | 83.3   |      |
|              |                                         | +8 Output                | 25   | –    | 62.5   |      |
|              |                                         | +10 Output               | 20   | –    | 50     |      |
| $f_{MAX}$    | Maximum Output Frequency<br>(continued) | +12 Output               | 16.6 | –    | 41.6   | MHz  |
|              |                                         | +16 Output               | 12.5 | –    | 31.25  |      |
|              |                                         | +20 Output               | 10   | –    | 25     |      |
|              |                                         | +24 Output               | 8.3  | –    | 20.8   |      |
| $f_{SCLK}$   | Serial Clock Frequency                  |                          | –    | –    | 20     | MHz  |
| DC           | Output Duty Cycle                       | $f_{MAX} < 100$ MHz      | 48   | –    | 52     | %    |
|              |                                         | $f_{MAX} > 100$ MHz      | 45   | –    | 55     |      |
| $t_r, t_f$   | Output Rise/Fall times                  | 0.55V to 2.4V            | 0.1  | –    | 1.0    | ns   |
| $t_{(\phi)}$ | Propagation Delay (static phase offset) | TCLK to FB_IN, same VDD  | –125 | –    | 125    | ps   |
| $t_{sk(O)}$  | Output-to-Output Skew                   | Skew within Bank A       | –    | –    | 75     | ps   |
|              |                                         | Skew within Bank B       | –    | –    | 100    |      |

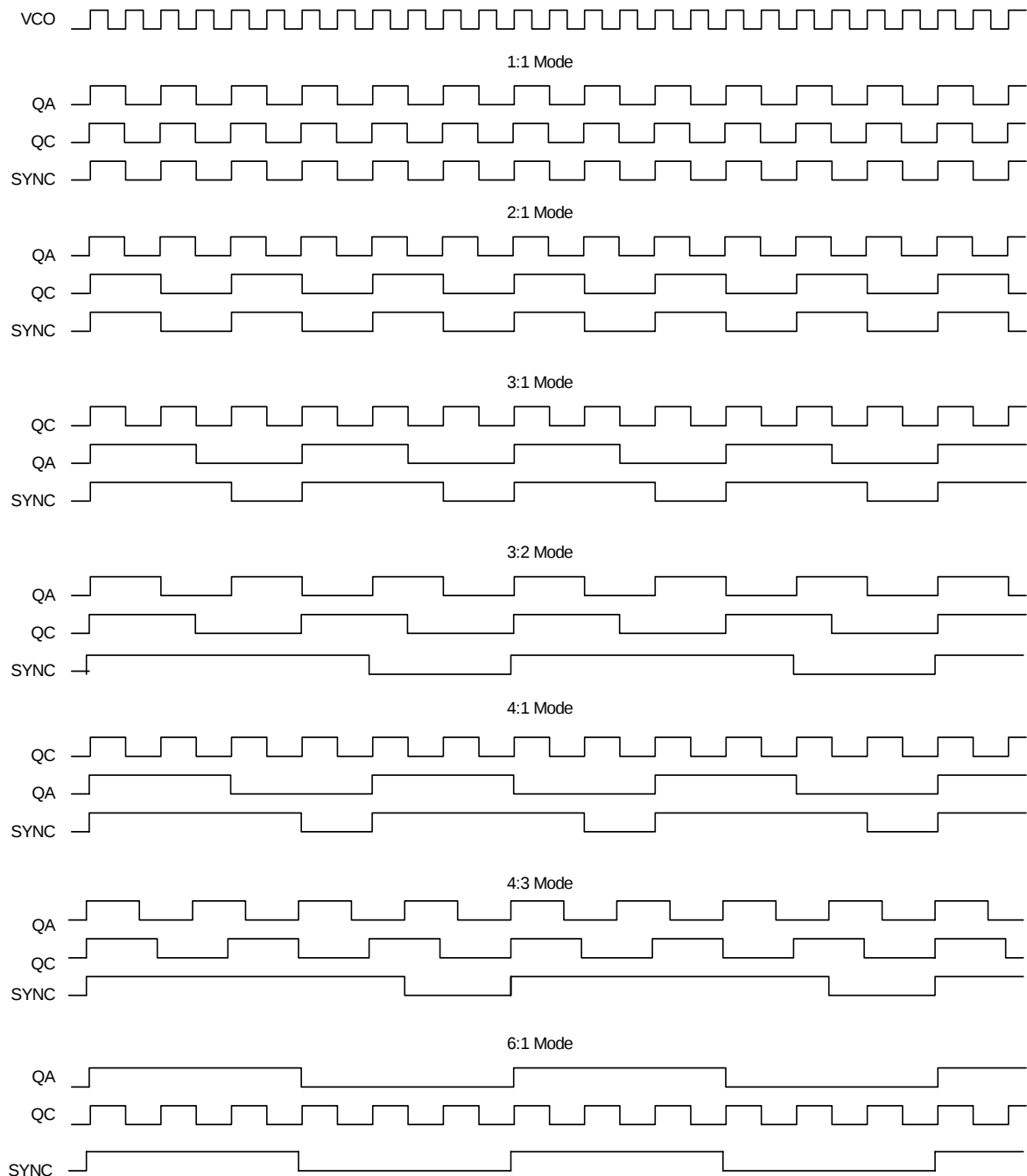
**AC Parameters** ( $V_{DD} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ ) (continued)<sup>[6]</sup>

| Parameter             | Description                          | Condition                            | Min. | Typ.      | Max. | Unit |
|-----------------------|--------------------------------------|--------------------------------------|------|-----------|------|------|
|                       |                                      | Skew within Bank C                   | –    | –         | 150  |      |
| tsk(B)                | Bank-to-Bank Skew                    |                                      | –    | –         | 325  | ps   |
| t <sub>PLZ</sub> , HZ | Output Disable Time                  |                                      | –    | –         | 8    | ns   |
| t <sub>PZL</sub> , ZH | Output Enable Time                   |                                      | –    | –         | 8    | ns   |
| BW                    | PLL Closed-Loop Bandwidth<br>(–3 dB) | ÷4 Feedback                          | –    | 1.3 - 2.0 | –    | MHz  |
|                       |                                      | ÷6 Feedback                          | –    | 0.7 - 1.3 | –    |      |
|                       |                                      | ÷8 Feedback                          | –    | 0.9 - 1.3 | –    |      |
|                       |                                      | ÷10 Feedback                         | –    | 0.6 - 1.1 | –    |      |
|                       |                                      | ÷12 Feedback                         | –    | 0.6 - 0.9 | –    |      |
|                       |                                      | ÷16 Feedback                         | –    | 0.4 - 0.6 | –    |      |
|                       |                                      | ÷20 Feedback                         | –    | 0.6 - 0.9 | –    |      |
| t <sub>JIT(CC)</sub>  | Cycle-to-Cycle Jitter                | Same frequency (125 MHz)<br>RMS (1σ) | –    | 7         | 30   | ps   |
|                       |                                      | Same frequency                       | –    | –         | 100  |      |
|                       |                                      | Multiple frequencies                 | –    | –         | 375  |      |
| t <sub>JIT(PER)</sub> | Period Jitter                        | Same frequency (125 MHz)<br>RMS (1σ) | –    | 6         | 30   | ps   |
|                       |                                      | Same frequency                       | –    | 45        | 75   |      |
|                       |                                      | Multiple frequencies                 | –    | –         | 225  |      |
| t <sub>JIT(φ)</sub>   | I/O Phase Jitter                     | I/O same VDD                         | –    | –         | 150  | ps   |
| t <sub>LOCK</sub>     | Maximum PLL Lock Time                |                                      | –    | –         | 1    | ms   |

**SYNC Output**

In situations where output frequency relationships are not integer multiples of each other the SYNC output provides a signal for system synchronization. The CY29772 monitors the relationship between the QA and the QC output clocks. It provides a low going pulse, one period in duration, one period prior to the coincident rising edges of the QA and QC outputs.

The duration and the placement of the pulse depend on the higher of the QA and QC output frequencies. The following timing diagram illustrates various waveforms for the SYNC output. Note that the SYNC output is defined for all possible combinations of the QA and QC outputs even though under some relationships the lower frequency clock could be used as a synchronizing signal.



**Figure 1.**

## Power Management

The individual output enable / freeze control of the CY29772 allows the user to implement unique power management schemes into the design. The outputs are stopped in the logic '0' state when the freeze control bits are activated. The serial input register contains one programmable freeze enable bit for 12 of the 14 output clocks. The QC0 and FB\_OUT outputs can not be frozen with the serial port, this avoids any potential lock up situation should an error occur in the loading of the serial

data. An output is frozen when a logic '0' is programmed and enabled when a logic '1' is written. The enabling and freezing of individual outputs is done in such a manner as to eliminate the possibility of partial "runt" clocks.

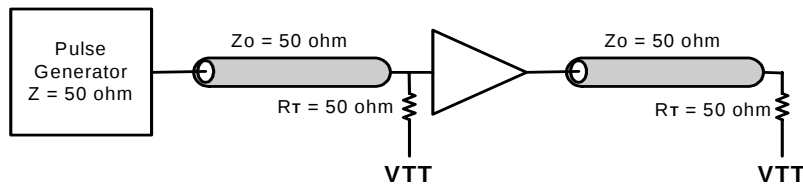
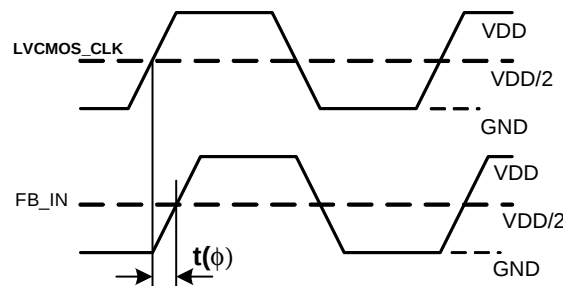
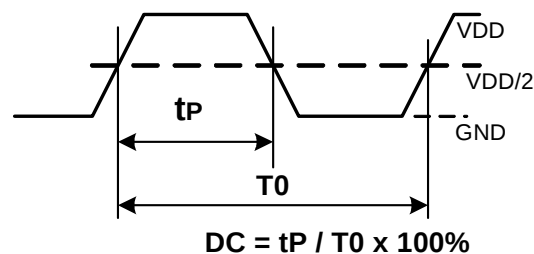
The serial input register is programmed through the SDATA input by writing a logic '0' start bit followed by 12 NRZ freeze enable bits. The period of each SDATA bit equals the period of the free running SCLK signal. The SDATA is sampled on the rising edge of SCLK.

| Start Bit | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 |
|-----------|----|----|----|----|----|----|----|----|----|----|-----|-----|
|-----------|----|----|----|----|----|----|----|----|----|----|-----|-----|

D0-D3 are the control bits for QA0-QA3, respectively  
D4-D7 are the control bits for QB0-QB3, respectively  
D8-D10 are the control bits for QC1-QC3, respectively  
D11 is the control bit for SYNC

**Figure 2.**
**Table 7. Suggested Oscillator Crystal Parameters**

| Parameter | Description                       | Conditions                                 | Min. | Typ. | Max.       | Unit   |
|-----------|-----------------------------------|--------------------------------------------|------|------|------------|--------|
| $T_C$     | Frequency Tolerance               |                                            | –    | –    | $\pm 1100$ | PPM    |
| $T_S$     | Frequency Temperature Stability   | ( $T_A -10^\circ$ to $+60^\circ\text{C}$ ) | –    | –    | $\pm 100$  | PPM    |
| $T_A$     | Aging                             | (First three years @ $25^\circ\text{C}$ )  | –    | –    | 5          | PPM/Yr |
| $C_L$     | Load Capacitance                  | The crystal's rated load                   | –    | 20   | –          | pF     |
| $R_{ESR}$ | Effective Series Resistance (ESR) |                                            | –    | 40   | 80         | Ohm    |


**Figure 3. LVCMOS\_CLK AC Test Reference for  $V_{DD} = 3.3\text{V}/2.5\text{V}$** 

**Figure 4. LVCMOS Propagation Delay  $t(\phi)$ , Static Phase Offset**

**Figure 5. Output Duty Cycle (DC)**

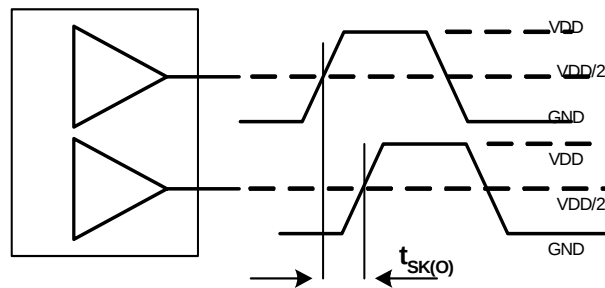


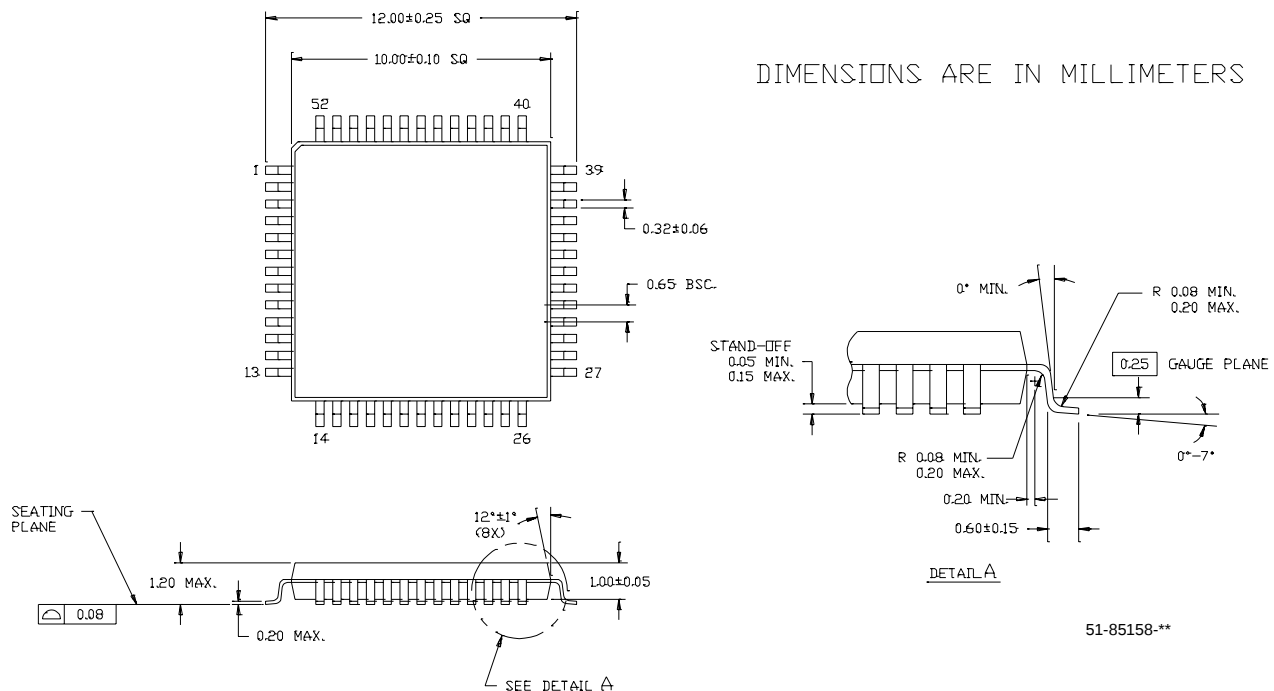
Figure 6. Output-to-Output Skew,  $t_{sk(0)}$

## Ordering Information

| Part Number | Package Type                | Product Flow               |
|-------------|-----------------------------|----------------------------|
| CY29772AI   | 52-pin TQFP                 | Industrial, -40°C to +85°C |
| CY29772AIT  | 52-pin TQFP – Tape and Reel | Industrial, -40°C to 85°C  |

## Package Drawing and Dimension

### 52-lead Thin Plastic Quad Flat Pack (10 x 10 x 1.0 mm) A52B



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**Document History Page**

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