



**THE DATASHEET OF  
CY7B9945V-5AXCT**



## Features

- 500 ps max Total Timing Budget (TTB™) window
- 24 MHz–200 MHz input and Output Operation
- Low Output-output skew < 200 ps
- 10 + 1 LVTTTL outputs driving 50 Ω terminated lines
- Dedicated feedback output
- Phase adjustments in 625 ps/1300 ps steps up to +10.4 ns
- 3.3-V LVTTTL/LVPECL, Fault Tolerant, and Hot Insertable Reference Inputs
- Multiply or Divide Ratios of 1 through 6, 8, 10, and 12
- Individual Output Bank Disable
- Output High Impedance Option for Testing Purposes
- Integrated Phase Locked Loop (PLL) with Lock Indicator
- Low Cycle-cycle jitter (<100 ps peak-peak)
- 3.3 V Operation
- Industrial Temperature Range: –40 °C to +85 °C
- 52-pin 1.4 mm TQFP package

## Functional Description

The CY7B9945V high-speed multi-phase PLL clock buffer offers user selectable control over system clock functions. This multiple output clock driver provides the system integrator with functions necessary to optimize the timing of high performance computer and communication systems.

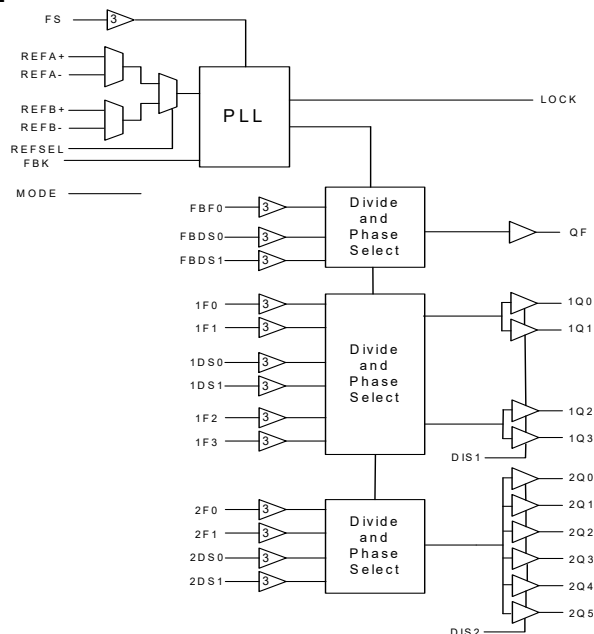
The device features a guaranteed maximum TTB window specifying all occurrences of output clocks. This includes the input reference clock across variations in output frequency, supply voltage, operating temperature, input edge rate, and process.

Ten configurable outputs each drive terminated transmission lines with impedances as low as 50 Ω while delivering minimal and specified output skews at LVTTTL levels. The outputs are arranged in two banks of four and six outputs. These banks enable a divide function of 1 to 12, with phase adjustments in 625 ps–1300 ps increments up to ±10.4 ns. The dedicated feedback output enables divide-by functionality from 1 to 12 and limited phase adjustments. However, if needed, any one of the ten outputs can be connected to the feedback input as well as driving other inputs.

Selectable reference input is a fault tolerant feature that enables smooth change over to a secondary clock source when the primary clock source is not in operation. The reference inputs and feedback inputs are configurable to accommodate both LVTTTL or Differential (LVPECL) inputs. The completely integrated PLL reduces jitter and simplifies board layout.

For a complete list of related documentation, [click here](#).

## Logic Block Diagram

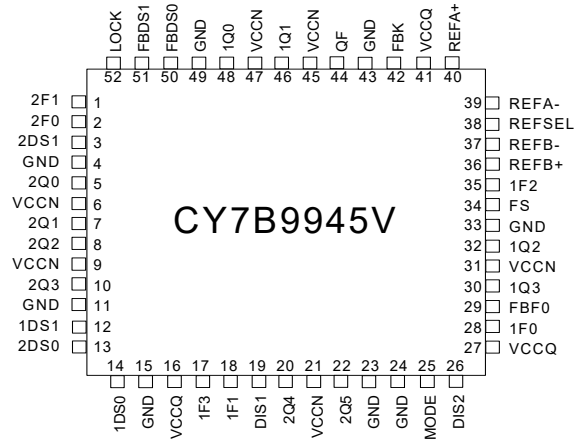


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Pinouts

Figure 1. 52-pin TQFP pinout



## Pin Definitions

| Pin                                 | Name                       | I/O    | Type              | Description   |
|-------------------------------------|----------------------------|--------|-------------------|---|
| 34                                  | FS                         | Input  | Three level Input | <b>Frequency Select.</b> This input must be set according to the nominal frequency ( $f_{NOM}$ ). See <a href="#">Table 1 on page 5</a> .   |
| 40, 39, 36, 37                      | REFA+, REFA-, REFB+, REFB- | Input  | LVTTL/ LVDIFF     | <b>Reference Inputs.</b> These inputs can operate as differential PECL or single-ended TTL reference inputs to the PLL. When operating as a single-ended LVTTL input, the complementary input is left open.   |
| 38                                  | REFSEL                     | Input  | LVTTL             | <b>Reference Select Input.</b> The REFSEL input controls the configuration of reference input. When LOW, it uses the REFA pair as the reference input. When HIGH, it uses the REFB pair as the reference input. This input has an internal pull down.                                       |
| 42                                  | FBK                        | Input  | LVTTL             | <b>Feedback Input Clock.</b> The PLL operates such that the rising edges of the reference and feedback signals are aligned in phase and frequency. This pin provides the clock output QF feedback to the phase detector.  |
| 28, 18, 35, 17, 2, 1                | 1F[0:3], 2F[0:1]           | Input  | Three level Input | <b>Output Phase Function Select.</b> Each pair determines the phase of the respective bank of outputs. See <a href="#">Table 3 on page 6</a> .  |
| 19, 26                              | DIS[1:2]                   | Input  | LVTTL             | <b>Output Disable.</b> Each input controls the state of the respective output bank. When HIGH, the output bank is disabled to HOLD-OFF or High-Z state; the disable state is determined by MODE. When LOW, outputs 1Q[0:3] and 2Q[0:5] are enabled. See <a href="#">Table 5 on page 8</a> . |
| 14, 12, 13, 3                       | [1:2]DS[0:1]               | Input  | Three level Input | <b>Output Divider Function Select.</b> Each pair determines the divider ratio of the respective bank of outputs. See <a href="#">Table 4 on page 6</a> .  |
| 29                                  | FBF0                       | Input  | Three level Input | <b>Feedback Output Phase Function Select.</b> This input determines the phase of the QF output. See <a href="#">Table 3 on page 6</a> .   |
| 50, 51                              | FBDS[0:1]                  | Input  | Three level Input | <b>Feedback Output Divider Function Select.</b> This input determines the divider ratio of the QF output. See <a href="#">Table 4 on page 6</a> .   |
| 48, 46, 32, 30, 5, 7, 8, 10, 20, 22 | 1Q[0:3], 2Q[0:5]           | Output | LVTTL             | <b>Clock Outputs with Adjustable Phases and <math>f_{NOM}</math> Divide Ratios.</b> The output frequencies and phases are determined by [1:2]DS[0:1], and 1F[0:3] and 2F[0:1], respectively. See <a href="#">Table 3 on page 6</a> and <a href="#">Table 4 on page 6</a> .                  |
| 44                                  | QF                         | Output | LVTTL             | <b>Feedback Clock Output.</b> This output is connected to the FBK input. The output frequency and phase are determined by FBDS[0:1] and FBF0, respectively. See <a href="#">Table 3 on page 6</a> and <a href="#">Table 4 on page 6</a> .   |
| 52                                  | LOCK                       | Output | LVTTL             | <b>PLL Lock Indicator.</b> When HIGH, this output indicates that the internal PLL is locked to the reference signal. When LOW, it indicates that the PLL is attempting to acquire lock.   |
| 25                                  | MODE                       | Input  | Three level Input | <b>This pin determines the clock outputs' disable state.</b> When this input is HIGH, the clock outputs disables to high impedance state (High-Z). When this input is LOW, the clock outputs disables to HOLD-OFF mode. When in MID, the device enters factory test mode.                   |
| 6, 9, 21, 31, 45, 47                | VCCN                       |        | PWR               | <b>Power Supply for the Output Buffers</b>  |
| 16, 27, 41                          | VCCQ                       |        | PWR               | <b>Power Supply for the Internal Circuitry</b>  |
| 4, 11, 15, 23, 24, 33, 43, 49       | GND                        |        | PWR               | <b>Device Ground</b>  |

## Block Diagram Description

The PLL adjusts the phase and the frequency of its output signal to minimize the delay between the reference (REFA/B+, REFA/B-) and the feedback (FB) input signals.

The CY7B9945V has a flexible REF input scheme. These inputs enable the use of either differential LVPECL or single ended LVTTTL inputs. To configure as single ended LVTTTL inputs, leave the complementary pin open (internally pulled to 1.5 V), then the other input pin is used as a LVTTTL input. The REF inputs are also tolerant to hot insertion.

The REF inputs are changed dynamically. When changing from one reference input to the other reference input of the same frequency, the PLL is optimized to ensure that the clock outputs period is not less than the calculated system budget ( $t_{MIN} = t_{REF}$  (nominal reference period) –  $t_{CCJ}$  (cycle-cycle jitter) –  $t_{PDEV}$  (max. period deviation)) while reacquiring lock.

The FS control pin setting determines the nominal operational frequency range of the divide by one output ( $f_{NOM}$ ) of the device.  $f_{NOM}$  is directly related to the VCO frequency. The FS setting for the device is shown in [Table 1](#). For CY7B9945V, the upper  $f_{NOM}$  range extends from 96 MHz to 200 MHz.

**Table 1. Frequency Range Select**

| FS <sup>[1]</sup> | $f_{NOM}$ (MHz) |     |
|-------------------|-----------------|-----|
|                   | Min             | Max |
| LOW               | 24              | 52  |
| MID               | 48              | 100 |
| HIGH              | 96              | 200 |

### Time Unit Definition

Selectable skew is in discrete increments of time unit ( $t_U$ ). The value of a  $t_U$  is determined by the FS setting and the maximum nominal output frequency. The equation determines the  $t_U$  value as follows:

$$t_U = 1/(f_{NOM} \times N).$$

N is a multiplication factor that is determined by the FS setting.  $f_{NOM}$  is nominal frequency of the device. N is defined in [Table 2](#).

**Table 2. N Factor Determination**

| FS   | CY7B9945V |   |
|------|-----------|---|
|      | N         | $f_{NOM}$ (MHz) at which $t_U = 1.0$ ns |
| LOW  | 32        | 31.25                                   |
| MID  | 16        | 62.5                                    |
| HIGH | 8         | 125                                     |

**Note**

1. FB connected to an output selected for "Zero" skew (i.e., FBF0 = MID or XF[1:0] = MID).

### Divide and Phase Select Matrix

The Divide Select Matrix is comprised of three independent banks: two of clock outputs and one for feedback. The Phase Select Matrix, enables independent phase adjustments on 1Q[0:1], 1Q[2:3] and 2Q[0:5]. The frequency of 1Q[0:3] is controlled by 1DS[0:1] while the frequency of 2Q[0:5] is controlled by 2DS[0:1]. The phase of 1Q[0:1] is controlled by 1F[0:1], that of 1Q[2:3] is controlled by 1F[2:3] and that of 2Q[0:5] is controlled by 2F[0:1].

The high fanout feedback output buffer (QF) connects to the feedback input (FBK). This feedback output has one phase function select input (FBF0) and two divider function selects FBDS[0:1].

The phase capabilities that are chosen by the phase function select pins are shown in Table 3. The divide capabilities for each bank are shown in Table 4.

**Table 3. Output Phase Select**

| Control Signal |             | Output Phase Function |                  |                          |                  |
|----------------|-------------|-----------------------|------------------|--------------------------|------------------|
| <b>1F1</b>     | <b>1F0</b>  | <b>1Q[0:1]</b>        |                  |                          |                  |
| <b>1F3</b>     | <b>1F2</b>  |                       | <b>1Q[2:3]</b>   |                          |                  |
| <b>2F1</b>     | <b>2F0</b>  |                       |                  | <b>2Q[0:5]</b>           |                  |
|                | <b>FBF0</b> |                       |                  |                          | <b>QF</b>        |
| LOW            | LOW         | -4t <sub>U</sub>      | -4t <sub>U</sub> | -8t <sub>U</sub>         | -4t <sub>U</sub> |
| LOW            | MID         | -3t <sub>U</sub>      | -3t <sub>U</sub> | -7t <sub>U</sub>         | N/A              |
| LOW            | HIGH        | -2t <sub>U</sub>      | -2t <sub>U</sub> | -6t <sub>U</sub>         | N/A              |
| MID            | LOW         | -1t <sub>U</sub>      | -1t <sub>U</sub> | BK1Q[0:1] <sup>[2]</sup> | N/A              |
| MID            | MID         | 0t <sub>U</sub>       | 0t <sub>U</sub>  | 0t <sub>U</sub>          | 0t <sub>U</sub>  |
| MID            | HIGH        | +1t <sub>U</sub>      | +1t <sub>U</sub> | BK1Q[2:3] <sup>[2]</sup> | N/A              |
| HIGH           | LOW         | +2t <sub>U</sub>      | +2t <sub>U</sub> | +6t <sub>U</sub>         | N/A              |

**Note**

- The level set on FS is determined by the "nominal" operating frequency (f<sub>NOM</sub>) of the V<sub>CO</sub> and Phase Generator. f<sub>NOM</sub> always appears on an output when the output is operating in the undivided mode. The REF and FB are at f<sub>NOM</sub> when the output connected to FB is undivided.

**Table 3. Output Phase Select (continued)**

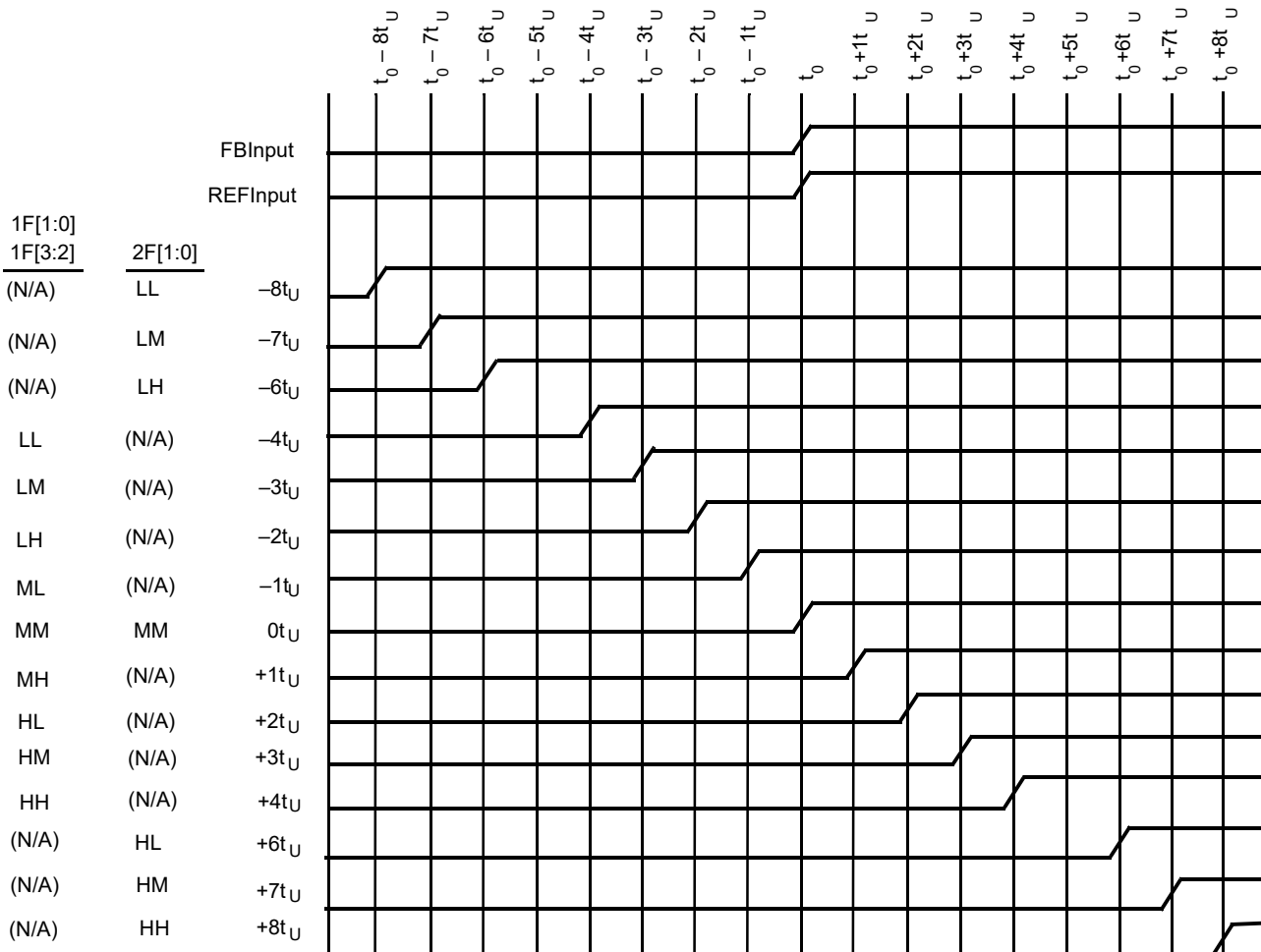
| Control Signal |      | Output Phase Function |                  |                  |                  |
|----------------|------|-----------------------|------------------|------------------|------------------|
| HIGH           | MID  | +3t <sub>U</sub>      | +3t <sub>U</sub> | +7t <sub>U</sub> | N/A              |
| HIGH           | HIGH | +4t <sub>U</sub>      | +4t <sub>U</sub> | +8t <sub>U</sub> | +4t <sub>U</sub> |

**Table 4. Output Divider Select**

| Control Signal     |                    | Output Divider Function |       |          |
|--------------------|--------------------|-------------------------|-------|----------|
| [1:2]DS1 and FBDS1 | [1:2]DS0 and FBDS0 | Bank1                   | Bank2 | Feedback |
| LOW                | LOW                | / 1                     | / 1   | / 1      |
| LOW                | MID                | / 2                     | / 2   | / 2      |
| LOW                | HIGH               | / 3                     | / 3   | / 3      |
| MID                | LOW                | / 4                     | / 4   | / 4      |
| MID                | MID                | / 5                     | / 5   | / 5      |
| MID                | HIGH               | / 6                     | / 6   | / 6      |
| HIGH               | LOW                | / 8                     | / 8   | / 8      |
| HIGH               | MID                | / 10                    | / 10  | / 10     |
| HIGH               | HIGH               | / 12                    | / 12  | / 12     |

Figure 2 on page 7 shows the timing relationship of programmable skew outputs. All times are measured with respect to REF with the output used for feedback programmed with 0t<sub>U</sub> skew. The PLL naturally aligns the rising edge of the FB input and REF input. If the output used for feedback is programmed to another skew position, then the whole t<sub>U</sub> matrix shifts with respect to REF. For example, if the output used for feedback is programmed to shift -4t<sub>U</sub>, then the whole matrix is shifted forward in time by 4t<sub>U</sub>. Thus an output programmed with 4t<sub>U</sub> of skew gets effectively be skewed 8t<sub>U</sub> with respect to REF.

Figure 2. Typical Outputs with FB Connected to a Zero-Skew Output [3]



**Note**

3. BK1Q denotes following the skew setting of indicated Bank1 outputs.

### Output Disable Description

The output of each output bank can be independently put into a HOLD OFF or high impedance state. The combination of the MODE and DIS[1:2] inputs determines the clock outputs' state for each bank. When the DIS[1:2] is LOW, the outputs of the corresponding banks are enabled. When DIS[1:2] is HIGH, the outputs for that bank are disabled to a high impedance (HI-Z) or HOLD OFF state. Table 5 defines the disabled outputs functions.

The HOLD OFF state is a power saving feature. An output bank is disabled to the HOLD OFF state in a maximum of six output clock cycles from the time the disable input is HIGH. When disabled to the HOLD OFF state, outputs are driven to a logic LOW state on their falling edges. This makes certain that the output clocks are stopped without a glitch. When a bank of outputs is disabled to HI-Z state, the respective bank of outputs go High-Z immediately.

**Table 5. DIS[1:2] Functionality**

| MODE     | DIS[1:2] | 1Q[0:3], 2Q[0:5] |
|----------|----------|------------------|
| HIGH/LOW | LOW      | ENABLED          |
| HIGH     | HIGH     | HI-Z             |
| LOW      | HIGH     | HOLD-OFF         |
| MID      | X        | FACTORY TEST     |

### Lock Detect Output Description

The LOCK detect output indicates the lock condition of the integrated PLL. Lock detection is accomplished by comparing the phase difference between the reference and feedback inputs. Phase error is declared when the phase difference between the two inputs is greater than the specified device propagation delay limit  $t_{PD}$ .

When in the locked state, after four or more consecutive feedback clock cycles with phase errors, the LOCK output is forced LOW to indicate out-of-lock state.

When in the out-of-lock state, 32 consecutive phase errorless feedback clock cycles are required to enable the LOCK output to indicate lock condition (LOCK = HIGH).

If the feedback clock is removed after LOCK has gone HIGH, a "Watchdog" circuit is implemented to indicate the out-of-lock condition after a time-out period by deasserting LOCK LOW. This time out period is based upon a divided down reference clock.

This assumes that there is activity on the selected REF input. If there is no activity on the selected REF input then the LOCK detect pin does not accurately reflect the state of the internal PLL.

### Factory Test Mode Description

The device enters factory test mode when the MODE is driven to MID. In factory test mode, the device operates with its internal

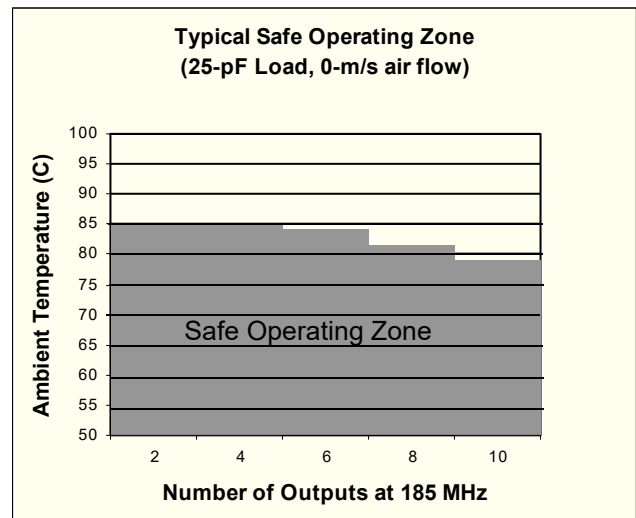
PLL disconnected; input level supplied to the reference input is used in place of the PLL output. In TEST mode the FB input is tied LOW. All functions of the device remain operational in factory test mode except the internal PLL and output bank disables. The MODE input is designed as a static input. Dynamically toggling this input from LOW to HIGH temporarily causes the device to go into factory test mode (when passing through the MID state).

When in the test mode, the device is reset to a deterministic state by driving the DIS2 input HIGH. Doing so disables all outputs and, after the selected reference clock pin has five positive transitions, all internal finite state machines (FSM) are set at a deterministic state. The states depend on the configurations of the divide, skew and frequency selection. All clock outputs stay in High-Z mode and all FSMs stay in the deterministic state until DIS2 is deasserted. This causes the device to reenter factory test mode.

### Safe Operating Zone

Figure 3 shows the operating condition of the device not exceeding its allowable maximum junction temperature of 150°C. Figure 3 shows the maximum number of outputs that can operate at 185 MHz (with 25 pF load and no air flow) or 200 MHz (with 10-pF load and no air flow) at various ambient temperatures. At the limit line, all other outputs are configured to divide-by-two (i.e., operating at 92.5 MHz) or lower frequencies. The device operates below maximum allowable junction temperature of 150 °C when its configuration (with the specified constraints) falls within the shaded region (safe operating zone). Figure 3 shows that at 85 °C, the maximum number of outputs that can operate at 200 MHz is 6.

**Figure 3. Typical Safe Operating Zone**



## Absolute Maximum Conditions

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

|  |                            |
|--|----------------------------|
| Storage Temperature .....                    | -40 °C to +125 °C          |
| Ambient Temperature with Power Applied ..... | -40 °C to +125 °C          |
| Supply Voltage to Ground Potential .....     | -0.5 V to +4.6 V           |
| DC Input Voltage .....                       | -0.3 V to $V_{CC} + 0.5$ V |

|   |            |
|---|------------|
| Output Current into Outputs (LOW) .....                   | 40 mA      |
| Static Discharge Voltage (MIL-STD-883, Method 3015) ..... | > 1100 V   |
| Latch-up Current .....                                    | > ± 200 mA |

## Operating Range

| Range      | Ambient Temperature | $V_{CC}$   |
|------------|---------------------|------------|
| Commercial | 0 °C to +70 °C      | 3.3 V ±10% |
| Industrial | -40 °C to +85 °C    | 3.3 V ±10% |

## Electrical Characteristics

Over the Operating Range

| Description                                    |                           | Test Conditions  | Min                  | Max                  | Unit |
|--|---------------------------|--|----------------------|----------------------|------|
| LVTTL HIGH Voltage                             | (QF, 1Q[0:3], 2Q[0:5])    | $V_{CC} = \text{Min}, I_{OH} = -30 \text{ mA}$   | 2.4                  | -                    | V    |
|  | LOCK                      | $I_{OH} = -2 \text{ mA}, V_{CC} = \text{Min}$  | 2.4                  | -                    | V    |
| LVTTL LOW Voltage                              | (QF, 1Q[0:3], 2Q[0:5])    | $V_{CC} = \text{Min}, I_{OL} = 30 \text{ mA}$  | -                    | 0.5                  | V    |
|  | LOCK                      | $I_{OL} = 2 \text{ mA}, V_{CC} = \text{Min}$   | -                    | 0.5                  | V    |
| High impedance State Leakage Current           |                           |  | -100                 | 100                  | µA   |
| LVTTL Input HIGH                               |                           | $\text{Min} \leq V_{CC} \leq \text{Max}$   | 2.0                  | $V_{CC} + 0.3$       | V    |
| LVTTL Input LOW                                |                           | $\text{Min.} \leq V_{CC} \leq \text{Max.}$   | -0.3                 | 0.8                  | V    |
| LVTTL $V_{IN} > V_{CC}$                        |                           | $V_{CC} = \text{GND}, V_{IN} = 3.63 \text{ V}$   | -                    | 100                  | µA   |
| LVTTL Input HIGH Current                       |                           | $V_{CC} = \text{Max}, V_{IN} = V_{CC}$   | -                    | 500                  | µA   |
| LVTTL Input LOW Current                        |                           | $V_{CC} = \text{Max}, V_{IN} = \text{GND}$   | -500                 | -                    | µA   |
| Three level Input HIGH <sup>[4]</sup>          |                           | $\text{Min} \leq V_{CC} \leq \text{Max}$   | $0.87 \times V_{CC}$ | -                    | V    |
| Three level Input MID <sup>[4]</sup>           |                           | $\text{Min} \leq V_{CC} \leq \text{Max}$   | $0.47 \times V_{CC}$ | $0.53 \times V_{CC}$ | V    |
| Three level Input LOW <sup>[4]</sup>           |                           | $\text{Min} \leq V_{CC} \leq \text{Max}$   | -                    | $0.13 \times V_{CC}$ | V    |
| Three level Input HIGH Current                 | FS[0:2],IF[0:3],FBDS[0:1] | $V_{IN} = V_{CC}$  | -                    | 200                  | µA   |
|  | 2F[0:1],[1:2]DS[0:1],FBFO |  | -                    | 400                  | µA   |
| Three level Input MID Current                  | FS[0:2],IF[0:3],FBDS[0:1] | $V_{IN} = V_{CC}/2$  | -50                  | 50                   | µA   |
|  | 2F[0:1],[1:2]DS[0:1],FBFO |  | -100                 | 100                  | µA   |
| Three level Input LOW Current                  | FS[0:2],IF[0:3],FBDS[0:1] | $V_{IN} = \text{GND}$  | -200                 | -                    | µA   |
|  | 2F[0:1],[1:2]DS[0:1],FBFO |  | -400                 | -                    | µA   |
| Input Differential Voltage                     |                           |  | 400                  | $V_{CC}$             | mV   |
| Highest Input HIGH Voltage                     |                           |  | 1.0                  | $V_{CC}$             | V    |
| Lowest Input LOW Voltage                       |                           |  | GND                  | $V_{CC} - 0.4$       | V    |
| Common Mode Range (Crossing Voltage)           |                           |  | 0.8                  | $V_{CC} - 0.2$       | V    |
| Internal Operating Current                     | CY7B9945V                 | $V_{CC} = \text{Max}, f_{\text{MAX}}^{\text{[5]}}$   | -                    | 250                  | mA   |
| Output Current Dissipation/Pair <sup>[4]</sup> | CY7B9945V                 | $V_{CC} = \text{Max}, C_{\text{LOAD}} = 25 \text{ pF}, R_{\text{LOAD}} = 50 \Omega \text{ at } V_{CC}/2, f_{\text{MAX}}$ | -                    | 40                   | mA   |

### Notes

- These inputs are normally wired to  $V_{CC}$ , GND, or left unconnected (actual threshold voltages vary as a percentage of  $V_{CC}$ ). Internal termination resistors hold the unconnected inputs at  $V_{CC}/2$ . If these inputs are switched, the function and timing of the outputs may glitch and the PLL may require an additional  $t_{\text{LOCK}}$  time before all data sheet limits are achieved.
- This is for non-three level inputs.

### Capacitance

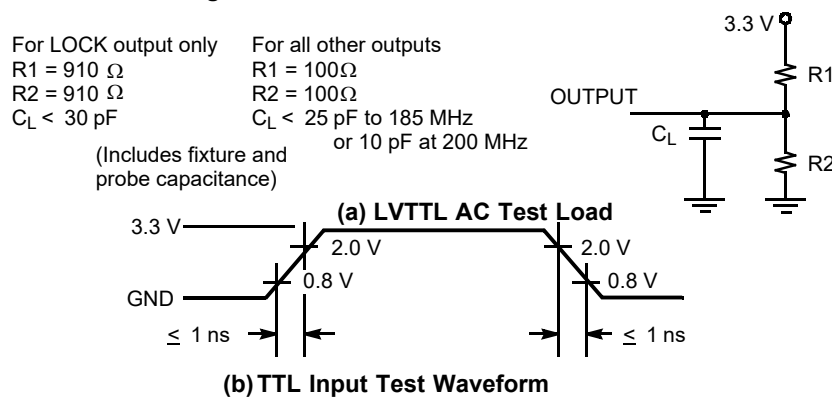
| Parameter       | Description       | Test Conditions  | Min | Max | Unit |
|-----------------|-------------------|--|-----|-----|------|
| C <sub>IN</sub> | Input capacitance | T <sub>A</sub> = 25 °C, f = 1 MHz, V <sub>CC</sub> = 3.3 V | –   | 5   | pF   |

### Thermal Resistance

| Parameter [6]   | Description                              | Test Conditions   | 52-pin TQFP | Unit |
|-----------------|--|---|-------------|------|
| θ <sub>JA</sub> | Thermal resistance (junction to ambient) | Test conditions follow standard test methods and procedures for measuring thermal impedance, in accordance with EIA/JESD51. | 55          | °C/W |
| θ <sub>JC</sub> | Thermal resistance (junction to case)    |   | 16          | °C/W |

### AC Test Loads and Waveforms

Figure 4. AC Test Loads and Waveforms [7]



**Notes**

- 6. These parameters are guaranteed by design and are not tested.
- 7. Assumes 25 pF Maximum Load Capacitance up to 185 MHz. At 200 MHz the maximum load is 10 pF.

## Switching Characteristics

Over the Operating Range [8, 9, 10, 11, 12]

| Parameter     | Description  | CY7B9945V-2 |      | Unit            |
|---------------|--|-------------|------|-----------------|
|               |  | Min         | Max  |                 |
| $f_{in}$      | Clock Input Frequency  | 24          | 200  | MHz             |
| $f_{out}$     | Clock Output Frequency   | 24          | 200  | MHz             |
| $t_{SKEWPR}$  | Matched Pair Skew [13, 14], 1Q[0:1], 1Q[2:3], 2Q[0:1], 2Q[2:3], 2Q[4:5]  | –           | 200  | ps              |
| $t_{SKEWBNK}$ | Intrabank Skew [13, 14]  | –           | 250  | ps              |
| $t_{SKEW0}$   | Output-Output Skew (same frequency and phase, rise to rise, fall to fall) [13, 14]                                     | –           | 250  | ps              |
| $t_{SKEW1}$   | Output-Output Skew (same frequency and phase, other banks at different frequency, rise to rise, fall to fall) [13, 14] | –           | 250  | ps              |
| $t_{SKEW2}$   | Output-Output Skew (all output configurations outside of $t_{SKEW0}$ and $t_{SKEW1}$ ) [12, 15]                        | –           | 500  | ps              |
| $t_{CCJ1-3}$  | Cycle-to-Cycle Jitter (divide by 1 output frequency, FB = divide by 1, 2, 3)   | –           | 150  | ps<br>Peak-Peak |
| $t_{CCJ4-12}$ | Cycle-to-Cycle Jitter (divide by 1 output frequency, FB = divide by 4, 5, 6, 8, 10, 12)                                | –           | 100  | ps<br>Peak-Peak |
| $t_{PD}$      | Propagation Delay, REF to FB Rise  | –250        | 250  | ps              |
| TTB           | Total Timing Budget window (same frequency and phase) [16, 17]   | –           | 500  | ps              |
| $t_{PDDELTA}$ | Propagation Delay difference between two devices [18]  | –           | 200  | ps              |
| $t_{REFpwh}$  | REF input (Pulse Width HIGH) <sup>[8]</sup>  | 2.0         | –    | ns              |
| $t_{REFpwl}$  | REF input (Pulse Width LOW) <sup>[8]</sup>   | 2.0         | –    | ns              |
| $t_r/t_f$     | Output Rise/Fall Time <sup>[21]</sup>  | 0.15        | 2.0  | ns              |
| $t_{LOCK}$    | PLL Lock Time From Power Up  | –           | 10   | ms              |
| $t_{RELOCK1}$ | PLL Relock Time (from same frequency, different phase) with Stable Power Supply  | –           | 500  | μs              |
| $t_{RELOCK2}$ | PLL Re-lock Time (from different frequency, different phase) with Stable Power Supply <sup>[20]</sup>                  | –           | 1000 | μs              |

### Notes

8. This is for non-three level inputs.
9. Both outputs of pair must be terminated, even if only one is being used.
10. Each package must be properly decoupled.
11. AC parameters are measured at 1.5 V, unless otherwise indicated.
12. Test Load  $C_L = 25$  pF, terminated to  $V_{CC}/2$  with 50Ω up to 185 MHz and 10 pF load to 200 MHz.
13. Tested initially and after any design or process changes that affect these parameters.
14. TTB is the window between the earliest and the latest output clocks with respect to the input reference clock across variations in output frequency, supply voltage, operating temperature, input clock edge rate, and process. The measurements are taken with the AC test load specified and include output-output skew, cycle-cycle jitter, and dynamic phase error. TTB is equal to or smaller than the maximum specified value at a given output frequency.
15. SKEW is defined as the time between the earliest and the latest output transition among all outputs for which the same phase delay has been selected when all outputs are loaded with 25 pF and properly terminated up to 185 MHz. At 200 MHz the max load is 10 pF.
16. Guaranteed by statistical correlation. Tested initially and after any design or process changes that affects these parameters.
17. Rise and fall times are measured between 2.0 V and 0.8 V.
18.  $f_{NOM}$  must be within the frequency range defined by the same FS state.
19.  $t_{pWH}$  is measured at 2.0 V.  $t_{pWL}$  is measured at 0.8 V.
20.  $f_{NOM}$  must be within the frequency range defined by the same FS state.

**Switching Characteristics** (continued)

Over the Operating Range [8, 9, 10, 11, 12]

| Parameter  | Description   | CY7B9945V-2 |       | Unit |
|------------|---|-------------|-------|------|
|            |   | Min         | Max   |      |
| $t_{ODCV}$ | Output duty cycle deviation from 50% <sup>[21]</sup>                        | -1.0        | 1.0   | ns   |
| $t_{PWH}$  | Output HIGH time deviation from 50% <sup>[22]</sup>                         | -           | 1.5   | ns   |
| $t_{PWL}$  | Output LOW time deviation from 50% <sup>[22]</sup>                          | -           | 2.0   | ns   |
| $t_{PDEV}$ | Period deviation when changing from reference to reference <sup>[23]</sup>  | -           | 0.025 | UI   |
| $t_{OAZ}$  | DIS[1:2] HIGH to output high-impedance from ACTIVE <sup>[24, 25]</sup>      | 1.0         | 10    | ns   |
| $t_{OZA}$  | DIS[1:2] LOW to output ACTIVE from output is high impedance <sup>[25]</sup> | 0.5         | 14    | ns   |

**Notes**

21. SKEW is defined as the time between the earliest and the latest output transition among all outputs for which the same phase delay has been selected when all outputs are loaded with 25 pF and properly terminated up to 185 MHz. At 200 MHz the max load is 10 pF.

22. Measured at 0.5 V deviation from starting voltage.

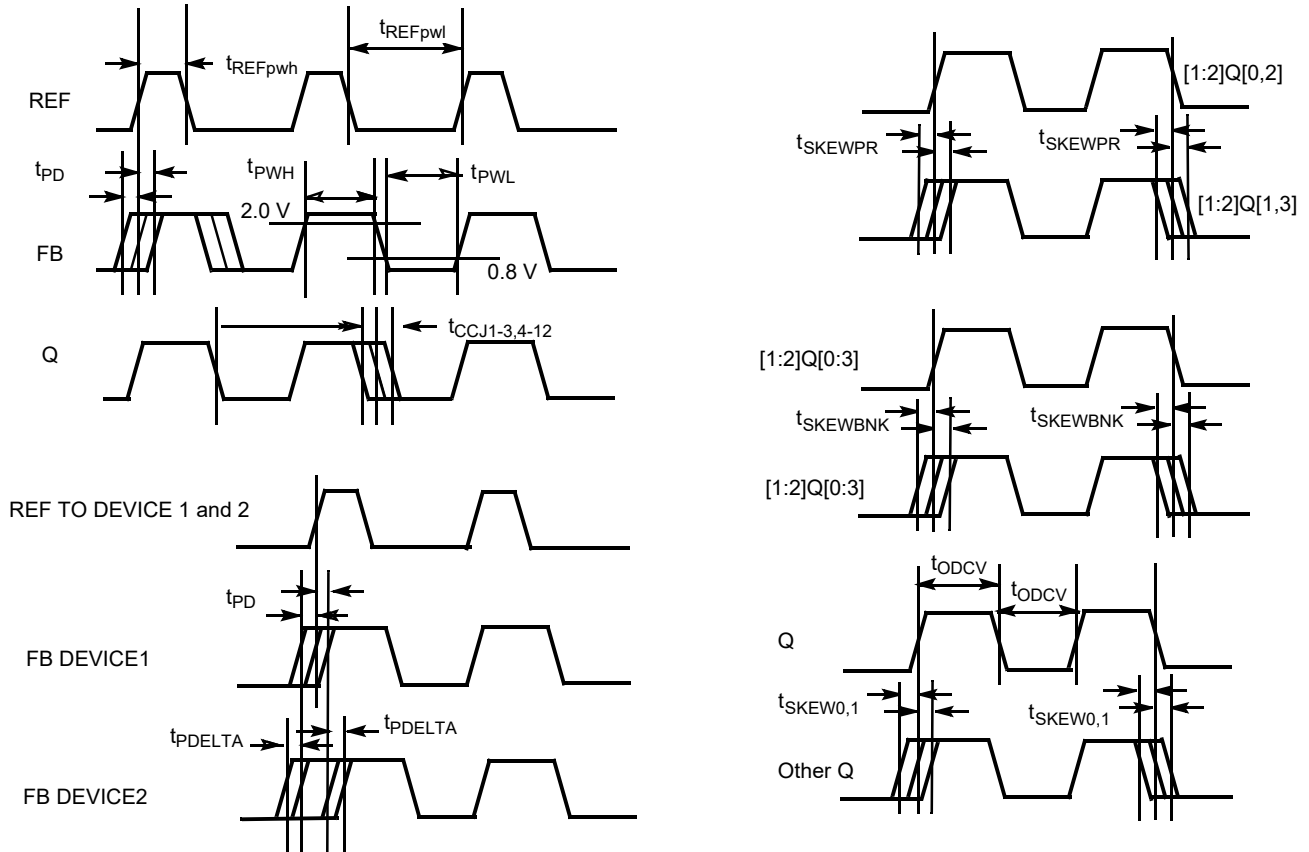
23. For  $t_{OZA}$  minimum,  $C_L = 0$  pF. For  $t_{OZA}$  maximum,  $C_L = 25$  pF to 185 MHz or 10 pF to 200 MHz.

24. Tested initially and after any design or process changes that affect these parameters.

25. These figures are for illustration purposes only. The actual ATE loads may vary.

**AC Timing Diagram**

**Figure 5. AC Timing Diagram**

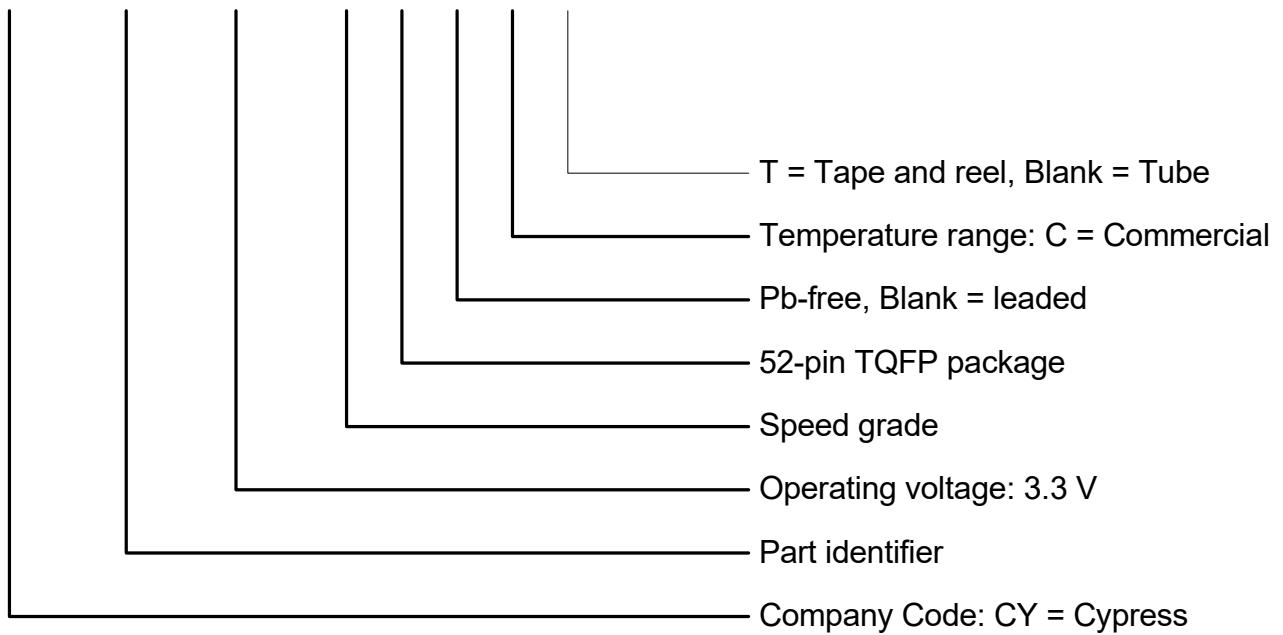


**Ordering Information**

| Propagation Delay (ps) | Max. Speed (MHz) | Ordering Code   | Package Name | Package Type                | Operating Range |
|------------------------|------------------|-----------------|--------------|-----------------------------|-----------------|
| Pb-free                |                  |                 |              |                             |                 |
| 250                    | 200              | CY7B9945V-2AXI  | AZ52         | 52-pin TQFP                 | Industrial      |
|                        | 200              | CY7B9945V-2AXIT | AZ52         | 52-pin TQFP – Tape and Reel | Industrial      |

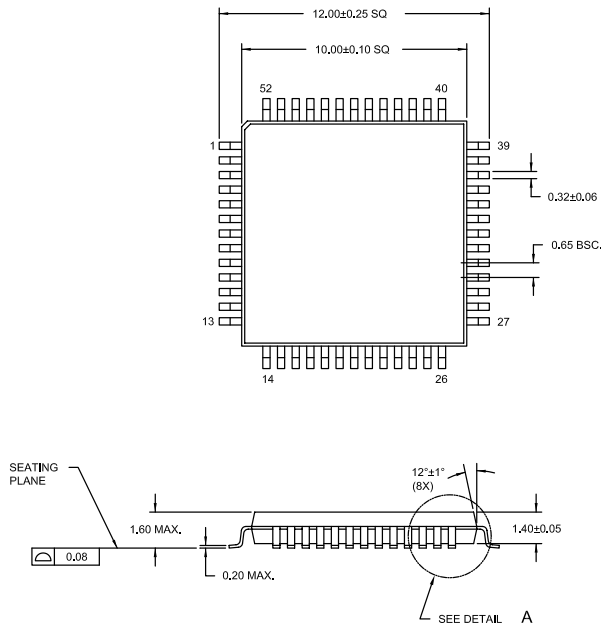
**Ordering Code Definitions**

CY XXXXXX V - 2 A X C I



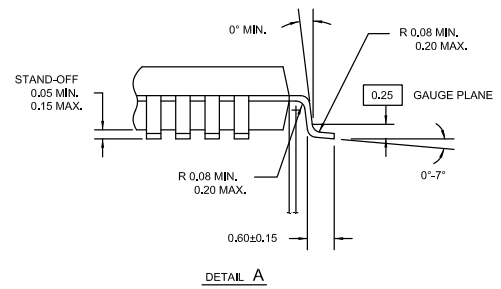
Package Diagram

Figure 6. 52-pin TQFP (10 × 10 × 1.4 mm) Package Outline, 51-85131



DIMENSIONS ARE IN MILLIMETERS

Package Weight - Refer to PMDD spec.



51-85131 \*C

## Acronyms

**Table 6. Acronyms Used in this Document**

| Acronym | Description                                |
|---------|--|
| FSM     | Finite State Machine                       |
| LVPECL  | Low-Voltage Positive Emitter Coupled Logic |
| LVTTTL  | Low-Voltage Transistor-Transistor Logic    |
| OE      | Output Enable                              |
| RMS     | Root Mean Square                           |
| PLL     | Phase Locked Loop                          |
| TQFP    | Thin Quad Flat Pack                        |
| VCO     | Voltage Controlled Oscillator              |

## Document Conventions

### Units of Measure

**Table 7. Units of Measure**

| Symbol | Unit of Measure                            | Symbol | Unit of Measure               |
|--------|--|--------|-------------------------------|
| °C     | degrees Celsius                            | μVrms  | microvolts root-mean-square   |
| dB     | decibel                                    | μW     | microwatt                     |
| dBc/Hz | decibels relative to the carrier per Hertz | mA     | milliampere                   |
| fC     | femtoCoulomb                               | mm     | millimeter                    |
| fF     | femtofarad                                 | ms     | millisecond                   |
| Hz     | hertz                                      | mV     | millivolt                     |
| KB     | 1024 bytes                                 | nA     | nanoampere                    |
| Kbit   | 1024 bits                                  | ns     | nanosecond                    |
| kHz    | kilohertz                                  | nV     | nanovolt                      |
| kΩ     | kilohm                                     | Ω      | ohm                           |
| MHz    | megahertz                                  | pA     | picoampere                    |
| MΩ     | megaohm                                    | pF     | picofarad                     |
| μA     | microampere                                | pp     | peak-to-peak                  |
| μF     | microfarad                                 | ppm    | parts per million             |
| μH     | microhenry                                 | ps     | picosecond                    |
| μs     | microsecond                                | sps    | samples per second            |
| μV     | microvolt                                  | σ      | sigma: one standard deviation |

**Document History Page**

| Document Title: CY7B9945V RoboClock®, High-Speed Multi-Phase PLL Clock Buffer |         |                 |                 |  |
|---|---------|-----------------|-----------------|--|
| Document Number: 38-07336   |         |                 |                 |  |
| Revision  | ECN     | Orig. of Change | Submission Date | Description of Change  |
| **  | 111747  | CTK             | 03/04/2002      | New data sheet.  |
| *A  | 116572  | HWT             | 09/05/2002      | Updated <a href="#">Features</a> :<br>Added "500 ps max. Total Timing Budget™ (TTB™) window".  |
| *B  | 119078  | HWT             | 10/16/2002      | Updated <a href="#">Features</a> :<br>Removed "52-pin TQFP package".<br>Added "52-pin 1.4-mm LQFF package".<br>Updated <a href="#">Electrical Characteristics</a> :<br>Replaced "Three-level Input Pins (FS[0:2], 1F[0:3], 2F[0:1], [1:2]DS[0:1], FBFO, FBDS[0:1])" with "Three-level Input Pins (FS[0:2], 1F[0:3], 2F[0:1], [1:2]DS[0:1], FBFO, FBDS[0:1], MODE)" in sub section heading.<br>Updated details in "Test Conditions" and "Min." columns corresponding to I <sub>IHH</sub> , I <sub>IMM</sub> , I <sub>ILL</sub> parameters.<br>Changed maximum value of V <sub>COM</sub> parameter from "V <sub>CC</sub> " to "V <sub>CC</sub> - 0.2 V". |
| *C  | 124645  | RGL             | 03/20/2003      | Updated <a href="#">Features</a> :<br>Removed "52-pin 1.4-mm LQFF package".<br>Added "52-pin 1.4-mm TQFP package".   |
| *D  | 128464  | RGL             | 07/25/2003      | Updated <a href="#">Switching Characteristics</a> :<br>Added f <sub>in</sub> parameter and its corresponding details.  |
| *E  | 272075  | RGL             | 10/01/2004      | Minor Change: Fixed typo in <a href="#">Figure 2</a> .   |
| *F  | 1187144 | KVM             | 06/25/2007      | Changed status from Final to Preliminary.<br>Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Added Note "Not recommended for new designs." and referred the same note in CY7B9945V-5A1.<br>Updated to new template.   |
| *G  | 2761988 | CXQ             | 09/10/2009      | Fixed typo (Replaced "50W" with "50Ω" in all instances across the document).<br>Updated <a href="#">Ordering Information</a> :<br>No change in part numbers.<br>Replaced "Pb" with "pin" in "Package Type" column.<br>Referred Note "Not recommended for new designs" in all MPNs with Pb packages.  |
| *H  | 2891379 | KVM             | 03/12/2010      | Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Updated <a href="#">Package Diagram</a> :<br>spec 51-85131 – Changed revision from ** to *A.<br>Updated to new template.  |
| *I  | 2905846 | KVM             | 04/06/2010      | Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.  |
| *J  | 3196237 | BASH            | 03/15/2011      | Updated <a href="#">Ordering Information</a> :<br>No change in part numbers.<br>Added <a href="#">Ordering Code Definitions</a> .<br>Added <a href="#">Acronyms and Units of Measure</a> .<br>Updated to new template.<br>Completing Sunset Review.  |
| *K  | 4323331 | CINM            | 03/27/2014      | Updated <a href="#">Package Diagram</a> :<br>spec 51-85131 – Changed revision from *A to *C.<br>Updated to new template.<br>Completing Sunset Review.  |
| *L  | 4570146 | CINM            | 11/14/2014      | Updated <a href="#">Functional Description</a> :<br>Added "For a complete list of related documentation, <a href="#">click here</a> ." at the end.   |

**Document History Page** (continued)

| Document Title: CY7B9945V RoboClock®, High-Speed Multi-Phase PLL Clock Buffer |         |                 |                 |   |
|---|---------|-----------------|-----------------|---|
| Document Number: 38-07336   |         |                 |                 |   |
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| *M  | 5257087 | PSR             | 05/03/2016      | Changed status from Preliminary to Final.<br>Added <a href="#">Thermal Resistance</a> .<br>Updated to new template. |
| *N  | 5687997 | XHT             | 04/07/2017      | Updated to new template.<br>Completing Sunset Review.   |
| *O  | 5773768 | PSR             | 06/19/2017      | Updated <a href="#">Switching Characteristics</a> :<br>Removed "CY7B9945V-5" column.                                |
| *P  | 6536055 | XHT             | 04/08/2019      | Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Updated to new template.                 |

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