# Universal Serial Bus Transceiver with Level Translator

## Features

- Complies with USB Specification Rev 1.1 & 2.0
- Supports full speed (12Mbit/sec.) and low speed (1.5Mbits/sec.) modes
- Integrated 5V to 3.3V regulator
- Used as a USB device transceiver or host transceiver
- $V_{BUS}$ disconnection indication through $V_P$ and $V_M$ outputs
- Two single-ended receivers with hysteresis
- USB Detection of $V_{BUS}$ via level translator
- Stable RCV output during SE0 condition
- Low power operation from $V_{CC}$
- Supports 1.65V to 3.6V I/O voltage levels
- Full industrial operating range -40 to 85 °C
- Available in small HBCC-16 and TSSOP-16 packages

## Applications

- Wireless handsets
- Digital still cameras
- PDAs (Personal Digital Assistants)
- IAs (Information Appliances)

## Product Description

The CM2400-02/03/04 Universal Serial Bus (USB) transceiver is fully compliant with the USB specification Rev 1.1 and 2.0. It supports a speed of 12Mbits/s (Full Speed Mode).

An internal level shifter allows interface to Application Specific ICs (ASICs) and Programmable Logic Devices (PLD's) running at core voltages of 1.65V to 3.6V.

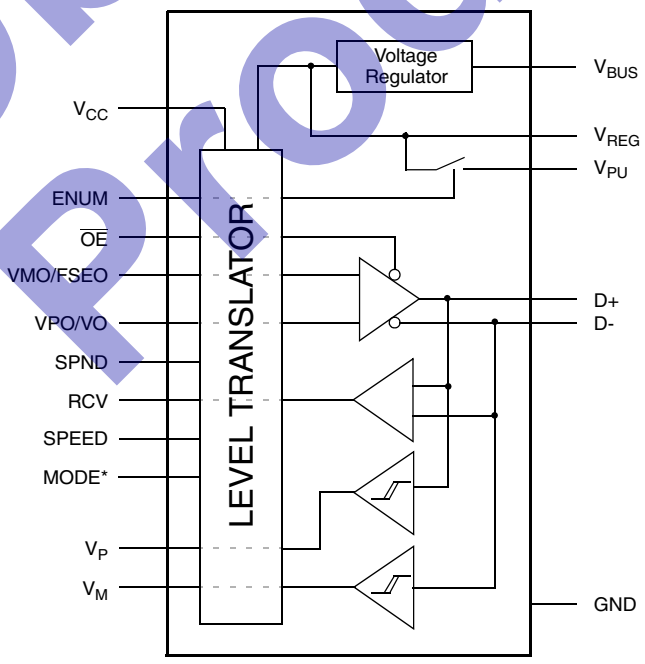
The CM2400-02/03/04 features an internal 5V to 3.3V regulator which is used to power the USB transceiver via the USB supply $V_{BUS}$.

The CM2400-04 features a Mode Input pin (MODE) which allows the device to operate in either single or differential input mode.

This device is ideal for portable electronic devices such as mobile phones, digital still cameras, PDAs (Personal Digital Assistants) and IAs (Information Appliances). The CM2400-02/03/04 is packaged in a small form-factor 16-lead HBCC or TSSOP package to conserve board space.

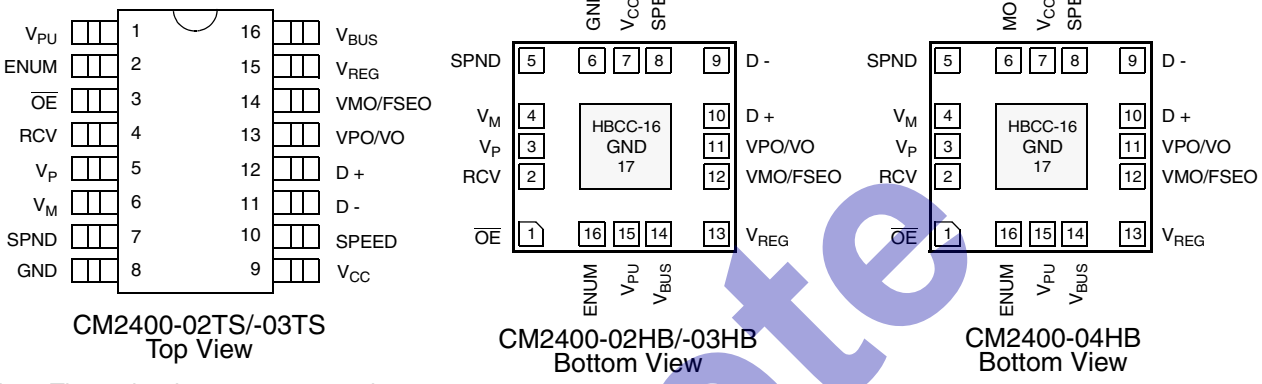


## Simplified Block Schematic




* MODE pin available on CM2400-04 only.

## PACKAGE / PINOUT DIAGRAM




CM2400-02TS/-03TS
Top View

CM2400-02HB/-03HB
Bottom View

CM2400-04HB
Bottom View

Note: These drawings are not to scale.

## PIN DESCRIPTIONS

| HBCC-16 PINS | TSSOP-16 PINS | NAME | DESCRIPTION |
|---|---|---|---|
| 1 | 3 | $\overline{OE}$ | Input for Output Enable (Active low). Enables transceiver driver to transmit data on the USB bus. When $\overline{OE}$ pin = LOW, driver circuitry is enabled. |
| 2 | 4 | RCV | Differential receiver output of D+ and D- input data lines. The output state of RCV is preserved and stable during an SE0 condition. |
| 3 | 5 | $V_P$ | Single-ended D+ receiver output for detection of a single-ended zero or error conditions |
| 4 | 6 | $V_M$ | Single-ended D- receiver output for detection of a single-ended zero or error conditions. |
| 5 | 7 | SPND | Suspend input. Allows the device to enter a low power state while the USB is inactive. |
| 6 | 8 | MODE | Mode input (CM2400-04). Selects between differential ($V_{PO}$, $V_{MO}$) and single-ended mode ($V_O$, FSEO). |
| | | GND | Ground input (CM2400-02/03). |
| 7 | 9 | $V_{CC}$ | Supply voltage for digital I/O pins. Voltages supported: 1.65 to 3.6V. |
| 8 | 10 | SPEED | Speed Input. If SPEED is logic '1', selects full speed. If SPEED is logic '0', selects low speed. SPEED changes slope rise and fall time on D+ and D-. |
| 9 | 11 | D- | Negative USB data connection. |
| 10 | 12 | D+ | Positive USB data connection. In full-speed connect mode, connect to $V_{PU}$ via a 1.5kΩ resistor. Tolerance of this resistor is defined in the USB specification REV 1.1 & 2.0 |
| 11 | 13 | VPO/VO | Driver data input. |
| 12 | 14 | VMO/FSEO | Driver data input. |
| 13 | 15 | $V_{REG}$ | Regulated supply voltage output during USB operation of $V_{BUS}$. 1µF decoupling capacitor is required. |
| 14 | 16 | $V_{BUS}$ | Supply voltage input. Can be directly connected to USB $V_{BUS}$. |
| 15 | 1 | $V_{PU}$ | Pull-up supply voltage. Pin function is controlled by input ENUM. |

| PIN DESCRIPTIONS (CONT'D) | | | |
|---|---|---|---|
| 16 | 2 | ENUM | Enumerate, allows software to control connection of the external pull-up via the level translator. If ENUM = LOW then $V_{PU}$ is floating. If ENUM = HIGH then $V_{PU}$ is internally connected to $V_{REG}$. |
| 17 | – | GND | The ground terminal is connected to the exposed diepad (heatsink). |

## Ordering Information

| PART NUMBERING INFORMATION | | | | | |
|---|---|---|---|---|---|
| PADS/ LEADS | Package | Standard FInishing | | Lead-free FInishing[2] | |
| | | Ordering Part Number[1] | Part Marking | Ordering Part Number[1] | Part Marking |
| 16 | HBCC-16 | CM2400-02HB | CM240002HB | CM2400-02HA | CM240002HA |
| 16 | TSSOP-16 | CM2400-02TS | CM240002TS | CM2400-02TR | CM240002TR |
| 16 | HBCC-16 | CM2400-03HB | CM240003HB | CM2400-03HA | CM240003HA |
| 16 | TSSOP-16 | CM2400-03TS | CM240003TS | CM2400-03TR | CM240003TR |
| 16 | HBCC-16 | CM2400-04HB | CM240004HB | CM2400-04HA | CM240004HA |

Note 1: Parts are shipped in Tape & Reel form unless otherwise specified.
Note 2: Lead-free, 100% tin plated.

## Specifications

| ABSOLUTE MAXIMUM RATINGS | | |
|---|---|---|
| PARAMETER | RATING | UNITS |
| ESD Protection (All Pins except D+/D- pins, HBM, See Note 1) | ±1000 | V |
| ESD Protection (D+/D- pins, HBM, See Note 1) | ±4000 | V |
| $V_{BUS}$ | [GND - 0.5] to +5.5 | V |
| $V_{CC}$ | [GND - 0.5] to +6.0 | V |
| $V_I$ (INPUT) | [GND - 0.5] to [$V_{CC}$ + 0.5] | V |
| Storage Temperature Range | -65 to +150 | °C |
| Operating Temperature Range Junction | -40 to +150 | °C |

Note 1: Equivalent to discharging a 100pF capacitor via a 1.5kΩ resistor (Human body model).

| STANDARD (RECOMMENDED) OPERATING CONDITIONS | | | | | |
|---|---|---|---|---|---|
| SYMBOL | PARAMETER | MIN | TYP | MAX | UNITS |
| $V_{BUS}$ | USB $V_{BUS}$ Supply | 4.0 | 5.0 | 5.5 | V |
| $V_{CC}$ | DC System Supply | 1.65 | 3.3 | 3.6 | V |
| $V_I$ | DC Input Voltage | 0 | - | $V_{CC}$ | V |
| $V_{I(AI/O)}$ | Analog I/O Pins (D+, D-) | 0 | - | 3.6 | V |
| $T_A$ | Ambient Operating Temperature Range | -40 | - | +85 | °C |

## Specifications (cont'd)

| ELECTRICAL OPERATING CHARACTERISTICS (SEE NOTE 1) | | | | | | |
|---|---|---|---|---|---|---|
| **Supply Pins ($V_{BUS}$ = 4.0V to 5.5V; $V_{CC}$ = 1.65V to 3.6V)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| $V_{REG}$ | Regulated supply output | Unloaded | 3.0 | 3.3 | 3.6 | V |
| $I_{BUS}$ | Operating supply current | Full-speed TX and RX; $C_L$=50pF on D+/D- outputs; Note 2 | | | 8 | mA |
| $I_{BUS(IDLE)}$ | Supply current during full speed idle and SE0 | Full-speed idle; Notes 3 & 4 | | | 500 | µA |
| $I_{BUS(DIS)}$ | Disable mode supply current | $V_{CC}$ not present; Note 4 | | | 60 | µA |
| $I_{BUS(SUSP)}$ | Suspend mode supply current | SPND = HIGH; Notes 3 & 4 | | | 60 | µA |
| $I_{CC}$ | Operating I/O supply current | Full-speed TX and RX; Note 5 | | | 1.0 | mA |
| $I_{CC(STAT)}$ | Static I/O supply current | Full-speed idle, SE0 or suspend; Note 5 | | | 1.0 | µA |
| $I_{CC(SHARE)}$ | Supply current during sharing mode | $V_{BUS}$ not connected; Note 5 | | | 1.0 | µA |
| $I_{DX(SHARE)}$ | D+/D- load current during sharing mode | $V_{BUS}$ not connected; ENUMERATE = LOW; Note 5 | | | 1.0 | µA |
| $V_{TH(VBUS)}$ | $V_{BUS}$ supply detection threshold | Supply lost | | | 0.8 | V |
| | | Supply present | 2.4 | | | V |
| $V_{TH(VCC)}$ | $V_{CC}$ supply detection threshold | Supply lost (USB_D low) | | | 0.5 | V |
| | | Supply present | 1.4 | | | V |
| **Digital Pins ($V_{BUS}$ = 4.0V to 5.5V; $V_{CC}$ = 1.8V ± 0.15V)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| $V_{IL}$ | Logic LOW input voltage | | | | 0.5 | V |
| $V_{IH}$ | Logic HIGH input voltage | | 1.2 | | | V |
| $V_{OL}$ | Logic LOW output voltage | $I_{OL}$ = 100µA<br>$I_{OL}$ = 2mA | | | 0.15<br>0.40 | V<br>V |
| $V_{OH}$ | Logic HIGH output voltage | $I_{OH}$ = 100µA<br>$I_{OH}$ = 2mA | 1.50<br>1.25 | | | V<br>V |

Note 1: Operating Characteristics are over Standard Operating Conditions unless otherwise specified.
Note 2: Equivalent to discharging a 100pF capacitor via a 1.5kΩ resistor (Human body model).
Note 3: Excluding any load current and $V_{PU}$/VSW source current to 1.5kΩ and 15kΩ pull-up and pull-down resistors (200 µA).
Note 4: Current is drawn from VBUS of Host when device is a peripheral.
Note 5: Low current ideal for battery powered applications.

## Specifications (cont'd)

| ELECTRICAL OPERATING CHARACTERISTICS (CONT'D) | | | | | | |
|---|---|---|---|---|---|---|
| **Digital Pins ($V_{BUS}$ = 4.0V to 5.5V; $V_{CC}$ = 2.5V ± 0.2V)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| $V_{IL}$ | Logic LOW input voltage | | | | 0.7 | V |
| $V_{IH}$ | Logic HIGH input voltage | | 1.7 | | | V |
| $V_{OL}$ | Logic LOW output voltage | $I_{OL}$ = 100µA<br>$I_{OL}$ = 2mA | | | 0.15<br>0.40 | V<br>V |
| $V_{OH}$ | Logic HIGH output voltage | $I_{OH}$ = 100µA<br>$I_{OH}$ = 2mA | 2.15<br>1.90 | | | V<br>V |
| **Digital Pins ($V_{BUS}$ = 4.0V to 5.5V; $V_{CC}$ = 1.65V to 3.6V)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| $V_{IL}$ | Logic LOW input voltage | | | | 0.3 * $V_{CC}$ | V |
| $V_{IH}$ | Logic HIGH input voltage | | 0.6 * $V_{CC}$ | | | V |
| $V_{OL}$ | Logic LOW output voltage | $I_{OL}$ = 100µA<br>$I_{OL}$ = 2mA | | | 0.15<br>0.40 | V<br>V |
| $V_{OH}$ | Logic HIGH output voltage | $I_{OH}$ = 100µA<br>$I_{OH}$ = 2mA | $V_{CC}$ - 0.15<br>$V_{CC}$ - 0.40 | | | V<br>V |
| **Analog I/O Pins ($V_{BUS}$ = 4.0V to 5.5V; $V_{CC}$ = 1.65V to 3.6V)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| $V_{DI}$ | Differential receiver input sensitivity | $\lvert V_I(D+) - V_I(D-) \rvert$ | 0.2 | | | V |
| $V_{CM}$ | Differential receiver common mode voltage | | 0.8 | | 2.5 | V |
| $V_{IL}$ | Single-ended receiver logic LOW input voltage | | | | 0.8 | V |
| $V_{IH}$ | Single-ended receiver logic HIGH input voltage | | 2.0 | | | V |
| $V_{HYS}$ | Single-ended receiver Hysteresis voltage | | 0.4 | | 0.7 | V |
| $V_{OL}$ | Logic LOW output voltage | $R_L$ = 1.5KΩ tied to +3.6V | | | 0.3 | V |
| $V_{OH}$ | Logic HIGH output voltage | $R_L$ = 15KΩ tied to GND | 2.8 | | 3.6 | V |
| $I_{LZ}$ | OFF-state leakage current | | | | ±1 | µA |
| $C_{IN}$ | Transceiver Capacitance | Pin to GND | | | 20 | pF |
| $R_{SW}$ | Internal switch resistance at $V_{PU}$ | | | 50 | | Ω |
| $Z_{DRV}$ | Driver output impedance (includes 33 ohm 1% resistor) | Measured with steady-state drive; See Note 6 | 28 | 39 | 44 | Ω |

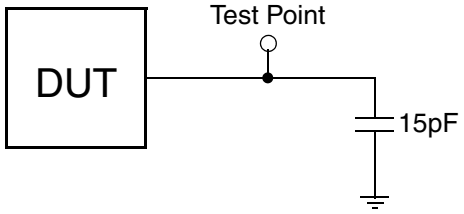
Note 6: Rev 2.0 states $Z_{DRV}$ must be between 28Ω and 44Ω when the driver is not high speed capable.

## Specifications (cont'd)

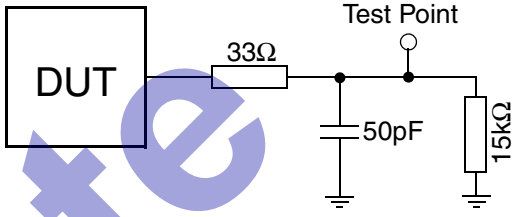
| ELECTRICAL OPERATING CHARACTERISTICS (CONT'D) | | | | | | |
|---|---|---|---|---|---|---|
| **Driver Characteristics & Timings (Full-speed mode only, SPEED=HIGH)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| $t_{FR}$ | Rise time | $C_L$ = 50 to 125pF, measured 10% to 90% ($V_{OH}$-$V_{OL}$); See Figure 6 | 4 | | 20 | ns |
| $t_{FF}$ | Fall time | $C_L$ = 50 to 125pF, measured 10% to 90% ($V_{OH}$-$V_{OL}$); See Figure 6 | 4 | | 20 | ns |
| FRFM | Differential rise / fall time matching ($t_{FR}$ / $t_{FF}$) | Excluding the first transition from idle state | | 100 | | % |
| $V_{CRS}$ | Output signal crossover voltage | Excluding the first transition from idle state; See Figure 9 | | 1.65 | | V |
| $t_{PLH(DRV)}$ | Driver propagation delay ($V_O$ / $V_{PO}$ ➔ D+ / D- ; FSEO / $V_{MO}$ ➔ D+ / D- | LOW-to-HIGH transition; See Figure 9 | | | 18 | ns |
| $t_{PHL(DRV)}$ | | HIGH-to-LOW transition; See Figure 9 | | | 18 | ns |
| $t_{PHZ}$ | Driver disable delay ($\overline{OE}$ ➔ D+ / D-) | HIGH-to-OFF; See Figure 7 | | | 15 | ns |
| $t_{PLZ}$ | | LOW-to-OFF; See Figure 7 | | | 15 | ns |
| $t_{PZH}$ | Driver enable delay ($\overline{OE}$ ➔ D+ / D-) | OFF-to-HIGH; See Figure 7 | | | 15 | ns |
| $t_{PZL}$ | | OFF-to-LOW; See Figure 7 | | | 15 | ns |
| **Driver Characteristics & Timings (Low-speed mode only, SPEED=LOW)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| $t_{LR}$ | Rise time | $C_L$ = 200 to 600pF, measured 10% to 90% ($V_{OH}$-$V_{OL}$); See Figure 6 | 75 | | 300 | ns |
| $t_{LF}$ | Fall time | $C_L$ = 200 to 600pF, measured 10% to 90% ($V_{OH}$-$V_{OL}$); See Figure 6 | 75 | | 300 | ns |
| FRFM | Differential rise / fall time matching ($t_{FR}$ / $t_{FF}$) | Excluding the first transition from idle state | 80 | | 125 | % |
| $V_{CRS}$ | Output signal crossover voltage | Excluding the first transition from idle state; See Figure 9 | 1.3 | | 2.0 | V |
| **Receiver Timings (Full-speed and low-speed modes)** | | | | | | |
| **SYMBOL** | **PARAMETER** | **CONDITIONS** | **MIN** | **TYP** | **MAX** | **UNITS** |
| Differential Receiver | | | | | | |
| $t_{PLH(RCV)}$ | Driver propagation delay (D+ / D- ➔ RCV) | LOW-to-HIGH transition; See Figure 8 | | | 15 | ns |
| $t_{PHL(RCV)}$ | | HIGH-to-LOW transition; See Figure 8 | | | 15 | ns |
| Single-ended Receiver | | | | | | |
| $t_{PLH(SE)}$ | Driver propagation delay (D+ / D- ➔ $V_P$ / $V_M$) | LOW-to-HIGH transition; See Figure 8 | | | 18 | ns |
| $t_{PHL(SE)}$ | | HIGH-to-LOW transition; See Figure 8 | | | 18 | ns |

## Specifications (cont'd)

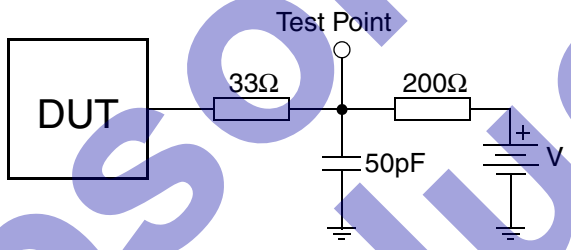
### Test Loads




Load for $V_P$ / $V_M$ and
RCV delay measurements




Load for D+ and D- delay measurements
(MAX and MIN Timing)




Load for ENABLE and DISABLE
delay measurements.

## Performance Information

**CM2400-02/03/04 Typical DC Characteristics (nominal conditions unless specified otherwise)**

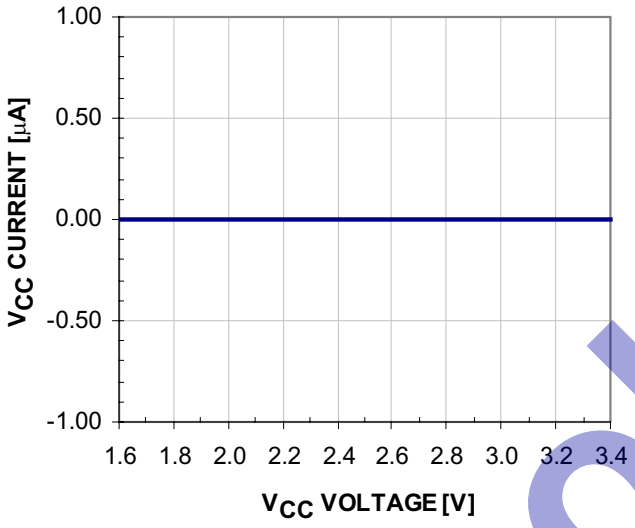



**Figure 1. $V_{CC}$ Current in Idle Mode (SPND=LOW)**

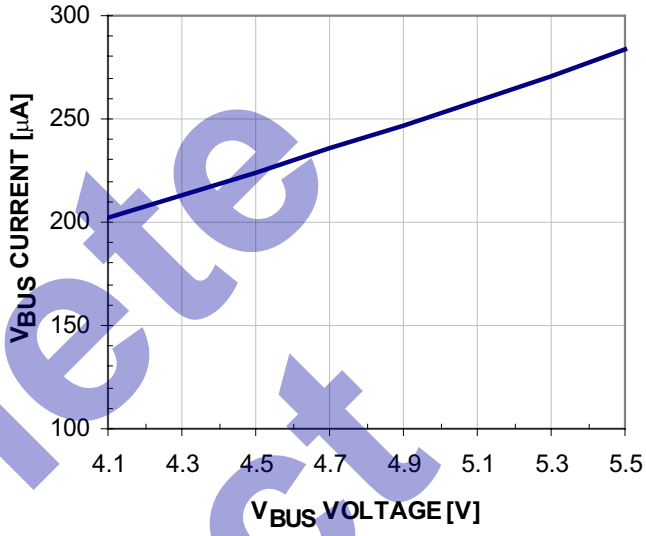



**Figure 3. $V_{BUS}$ Current in Idle Mode (SPND=LOW)**

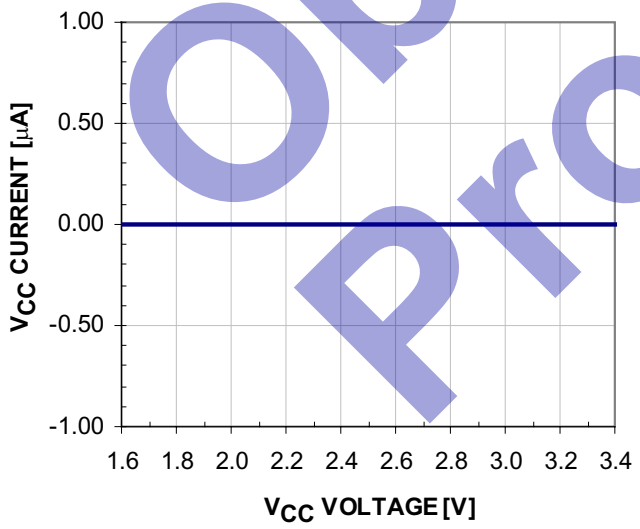



**Figure 2. $V_{CC}$ Current in Suspend Mode (SPND=HIGH)**

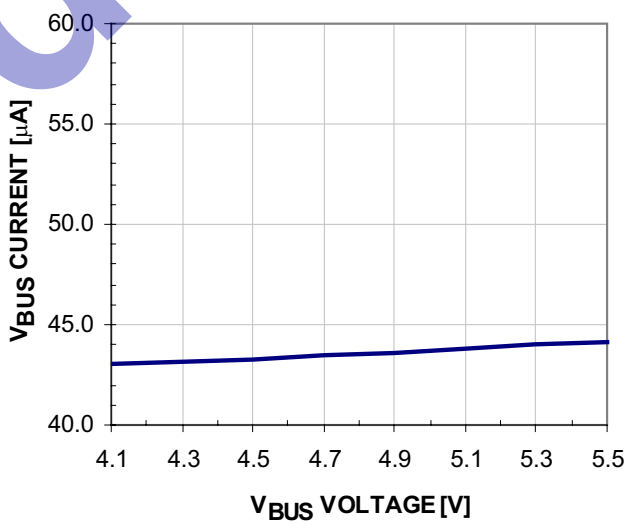



**Figure 4. $V_{BUS}$ Current in Suspend Mode (SPND=HIGH)**

## Performance Information (cont'd)

**CM2400-02/03/04 Typical AC Characteristics (nominal conditions unless specified otherwise)**

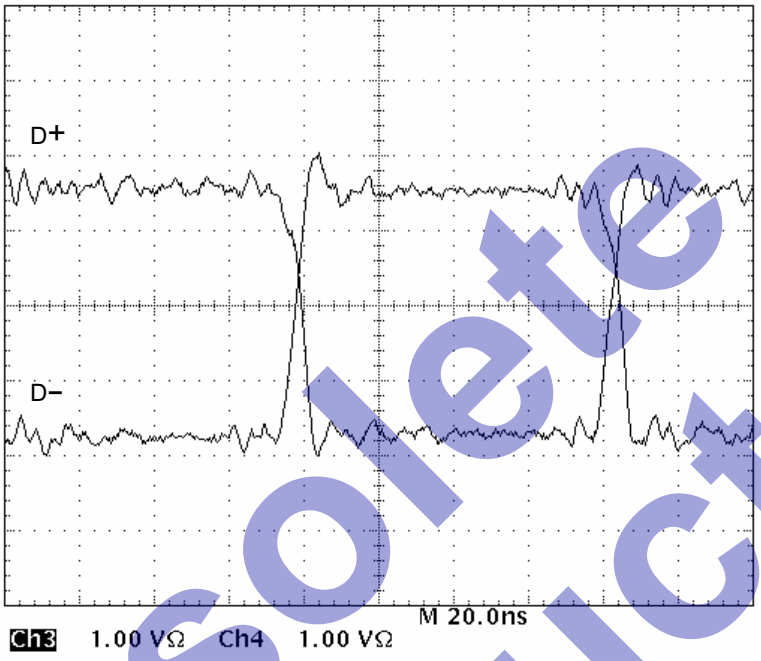



**Figure 5. Rise and Fall Time Matching for Full-Speed Mode**

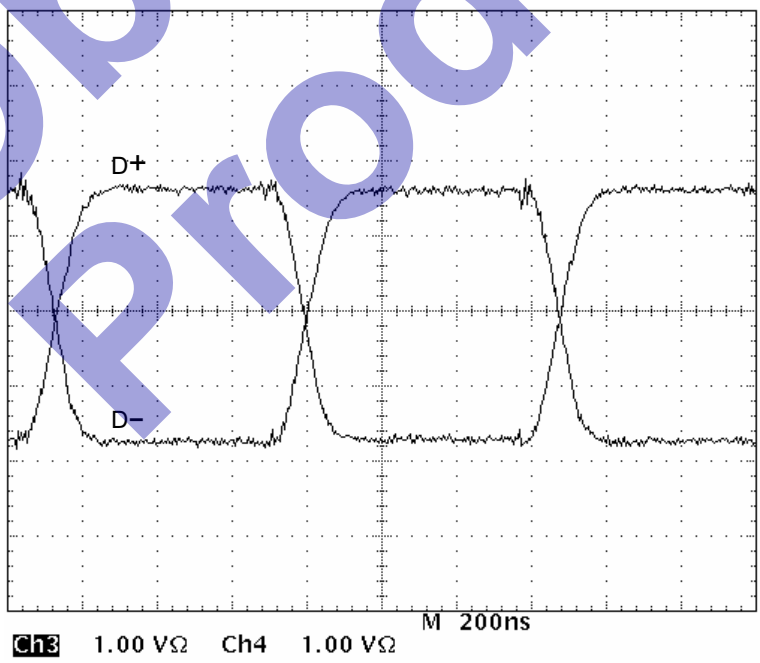



**Figure 6. Rise and Fall Time Matching for Low-Speed Mode**

## Performance Information (cont'd)

### CM2400 Timing Diagrams

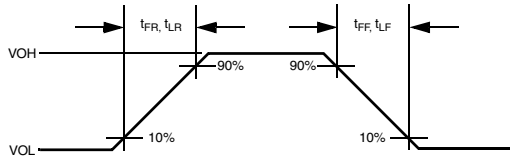



Figure 7. Rise and Fall Timing

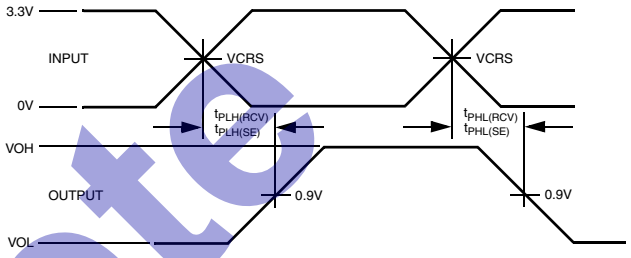



Figure 9. D+, D- to RCV, $V_P$ and $V_M$ Timing

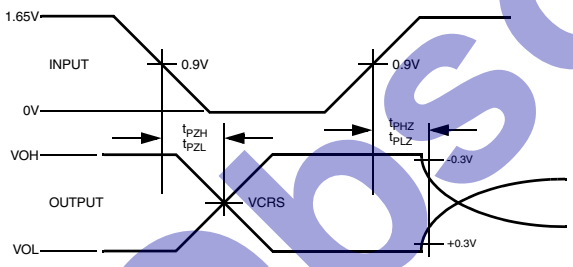



Figure 8. $\overline{OE}$ to D+, D- Timing

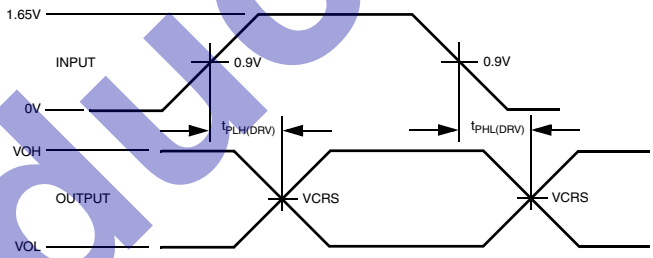



Figure 10. $V_O/V_{PO}$, $FSEO/V_{MO}$ to D+, D- Timing

## Functional Description

The CM2400-02/03/04 USB Transceiver supports 3 different power supply configurations, which can be configured dynamically. Table 1 details the various configurations. In Normal Mode the internal regulator produces 3.3V from $V_{BUS}$ to power the internal drivers and receivers associated with the USB protocol.

| $V_{BUS}$ | $V_{CC}$ | CONFIGURATION |
|---|---|---|
| Connected | Connected | Normal Mode |
| Connected | Not Connected | Disable Mode |
| Not Connected | Connected | Sharing Mode |

**Table 1: Power Supply Connections**

There are three power supply configurations for the CM2400-02/03/04: Normal mode, Disable mode and Sharing mode. These three modes can be changed dynamically.

Normal mode occurs when the $V_{CC}$ and $V_{BUS}$ inputs are both connected to a source. $V_{BUS}$ is tied to a 5V source for 5V operation. The internal regulator of the CM2400-02/03/04 provides 3.3V output on $V_{REG}$. The $V_{CC}$ input is connected to an independent source that can range from 1.65V to 3.6V.

When $V_{CC}$ is not connected and $V_{BUS}$ is connected, the device is in Disable mode. The D+ and D- pins are in tri-state and power consumption drops to a suspend state level.

In Sharing mode, $V_{CC}$ is connected while $V_{BUS}$ is below 3.6V. The D+ and D- pins are in tri-state and the CM2400-02/03/04 allows external signals (≤3.6V) to share these two lines. The CM2400-02/03/04 is designed to draw almost zero current from the D+ and D- lines while in sharing mode. In this mode, $V_P$ and $V_M$ are driven high while RCV and USB_DET are driven low.

In Disable and Sharing Mode, all input/output pins follow the states defined in Table 2.

| PIN | Sharing Mode State | Disable Mode State |
|---|---|---|
| $V_{BUS}$ | $V_{BUS}$ < 3.6V | 4.1V to 5.5V |
| $V_{REG}$ | Pulled Down | 3.3V Out |
| $V_{CC}$ | Present | Not Present |
| $V_{PU}$ | High-Z (off) | High-Z (off) |
| D+, D- | High-Z | High-Z |
| $V_P$ , $V_M$ | H | Invalid |
| RCV | L | Invalid |
| USB_DET | L | Invalid |
| Inputs | High-Z | High-Z |

**Table 2: Pin States in Disable or Sharing Mode**

Table 3 lists the functions of the modes associated with suspend and $\overline{OE}$ pins. When Suspend is low and $\overline{OE}$ is high, signal levels on D+ and D- are determined by other USB devices and pull-up/down resistors. In Suspend Mode (SPND = HIGH) the differential receiver is inactive and output RCV is always LOW. Out of suspend signaling is detected via the single-ended receivers $V_P$ and $V_M$. During suspend and while the output is still enabled ($\overline{OE}$ = LOW), D+ and D- lines are driven to their intended states.

| SUSPEND | $\overline{OE}$ | D+ / D- | RCV | $V_P/V_M$ | Function |
|---|---|---|---|---|---|
| L | L | Driver & Receiver Active | Active | Active | Normal driving mode. Differential receiver active |
| L | H | Receiving | Active | Active | Driver Tri-stated. Differential receiver active. |
| H | L | Driving | Inactive RCV=L | Active | Driving during 'suspend'. Differential receiver inactive. |
| H | H | High-Z | Inactive RCV=L | Active | Low-power state. |

**Table 3: Function Selection.**

## Functional Description (cont'd)

Detailed in Table 4 and Table 5 are the operating modes for the CM2400-02/03/04. The CM2400-02 features a fixed, single-ended input operating mode which is summarized in Table 4. The CM2400-03 features a differential-pair input operating mode which is summarized in Table 5. The CM2400-04 input mode is selectable via the MODE input. Table 4 and Table 5 summarize both operating modes for the CM2400-04.

On the CM2400-02, the two driver inputs function as $V_O$ and FSE0 inputs. On the CM2400-03, the driver inputs function as $V_{PO}$ and $V_{MO}$. On the CM2400-04, when the MODE input is HIGH, differential-pair input mode is selected and the two driver inputs function as $V_{PO}$ and $V_{MO}$. When MODE is LOW, the single-ended input data interface mode is selected and the two driver inputs function as $V_O$ and FSE0.

| MODE | $V_O$ ($V_{PO}$) | FSE0 ($V_{MO}$) | Result |
|---|---|---|---|
| L (single-ended) | L | L | Logic '0' |
| | L | H | SE0 |
| | H | L | Logic '1' |
| | H | H | SE0 |

**Table 4: Single-ended Input Operating Mode, CM2400-02 and CM2400-04 in Single-ended Input Mode ($\overline{OE}$ = L)**

| MODE | $V_O$ ($V_{PO}$) | FSE0 ($V_{MO}$) | Result |
|---|---|---|---|
| H (differential) | L | L | SE0 |
| | L | H | Logic '0' |
| | H | L | Logic '1' |
| | H | H | Undefined |

**Table 5: Differential-pair Input Operating Mode, CM2400-03 and CM2400-04 in Differential-pair Input Mode ($\overline{OE}$ = L)**

Table 6 details the receiving function when $\overline{OE}$ is HIGH (driver disabled). RCV denotes the signal level on the output RCV just before an SE0 state occurs. This level is stable during the SE0 period.

| D+/D- | RCV | $V_P$ | $V_M$ |
|---|---|---|---|
| Differential Logic '0' | L | L | H |
| Differential Logic '1' | H | H | L |
| SE0 | RCV* | L | L |

* Denotes RCV is stable in last state before SE0 condition.

**Table 6: Receiving Function (SPND = L)**

A regulator bypass option can be utilized by shorting VBUS to VREG and connecting to a 3.3v supply.

## Mechanical Details

The CM2400-02/03/04 family is available in a 16-lead HBCC and 16-lead TSSOP packages.The mechanical details for these packages are presented below.

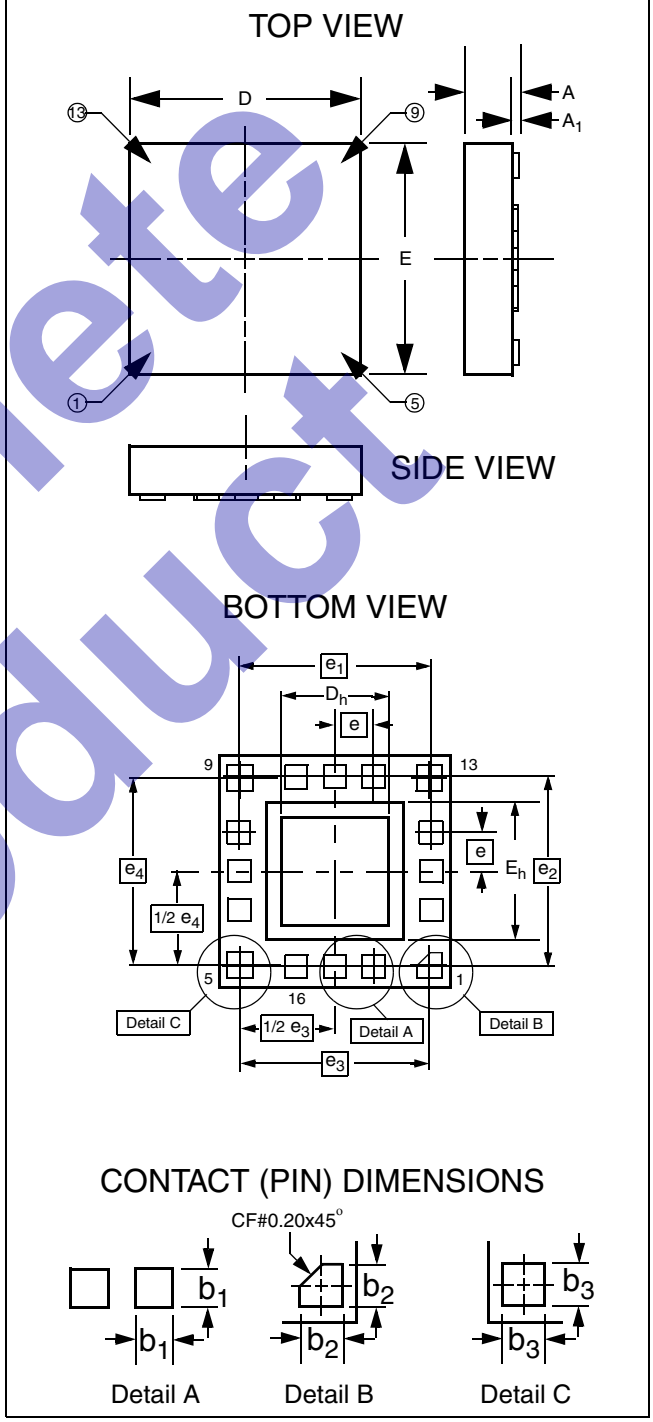
### HBCC-16 Mechanical Specifications

Dimensions for the CM2400-02HB, CM2400-03HB and CM2400-04HB devices packaged in 16-pin HBCC packages are presented below.

| PACKAGE DIMENSIONS | | | | |
|---|---|---|---|---|
| **Package** | HBCC-16 | | | |
| **Pins** | 16 | | | |
| **Dimensions** | **Millimeters** | | **Inches** | |
| | **Min** | **Max** | **Min** | **Max** |
| **A** | - | 0.80 | | 0.0315 |
| **$A_1$** | 0.05 | 0.10 | | 0.0039 |
| **$b_1$** | 0.25 | 0.35 | | 0.0138 |
| **$b_2$** | 0.30 | 0.40 | | 0.0157 |
| **$b_3$** | 0.30 | 0.40 | | 0.0157 |
| **D** | 2.90 | 3.10 | | 0.1220 |
| **$D_h$** | 1.45 | 1.55 | | 0.0610 |
| **E** | 2.90 | 3.10 | | 0.1220 |
| **$E_h$** | 1.75 | 1.85 | | 0.0728 |
| **e** | 0.50 TYP. | | 0.0197 TYP. | |
| **$e_1$** | 2.50 TYP. | | 0.0984 TYP. | |
| **$e_2$** | 2.50 TYP. | | 0.0984 TYP. | |
| **$e_3$** | 2.45 TYP. | | 0.0965 TYP. | |
| **$e_4$** | 2.45 TYP | | 0.0965 TYP. | |
| **# per tube** | 120 pieces* | | | |
| **# per tape and reel** | 2500 pieces | | | |
| Controlling dimension: millimeters | | | | |

* This is an approximate number which may vary.

**Mechanical Package Diagrams**




**Dimensions for HBCC-16 Package**

## Mechanical Details (cont'd)

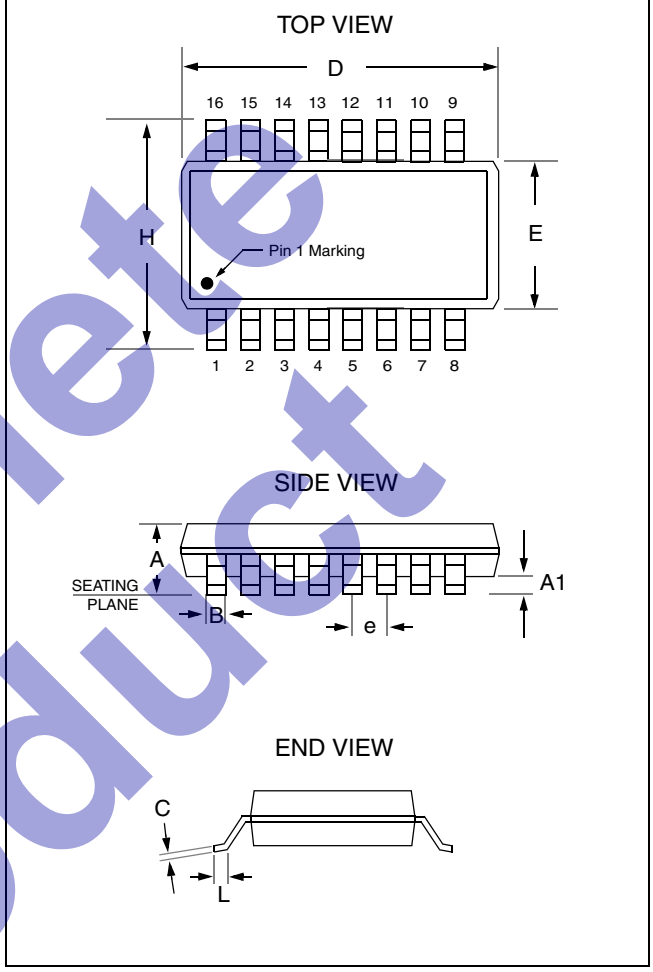
### TSSOP-16 Mechanical Specifications

Dimensions for the CM2400-02TS and CM2400-03TS devices packages are presented below.

For complete information on the TSSOP-16 package, see the California Micro Devices TSSOP Package Information document.

| PACKAGE DIMENSIONS | | | | |
|---|---|---|---|---|
| **Package** | TSSOP | | | |
| **Pins** | 16 | | | |
| **Dimensions** | **Millimeters** | | **Inches** | |
| | **Min** | **Max** | **Min** | **Max** |
| **A** | — | 1.10 | — | 0.0433 |
| **A1** | 0.05 | 0.15 | 0.002 | 0.006 |
| **B** | 0.19 | 0.30 | 0.0075 | 0.0118 |
| **C** | 0.09 | 0.20 | 0.0035 | 0.0079 |
| **D** | 4.90 | 5.10 | 0.193 | 0.201 |
| **E** | 4.30 | 4.50 | 0.169 | 0.177 |
| **e** | 0.65 BSC | | 0.0256 BSC | |
| **H** | 6.25 | 6.50 | 0.246 | 0.256 |
| **L** | 0.50 | 0.70 | 0.020 | 0.028 |
| **# per tube** | Consult Factory | | | |
| **# per tape and reel** | 2500 pcs | | | |
| Controlling dimension: millimeters | | | | |

**Mechanical Package Diagrams**




**Dimensions for the TSSOP-16 Package**