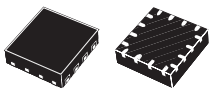
# STUSB03E

## USB Transceiver

## General features

- Compliant to USB V2.0 for full-speed (12Mb/s) and low-speed (1.5Mbps) operation
- HBM = ±14kV on D+, D– lines; ±5kV on VBUS
- ESD Compliant to IEC-61000-4.2 (level 3) on D+, D- lines
- Separate I/O supply with operation down to 1.6V
- Integrated 3.3V output LDO
- Very low power consumption to meet USB 'suspend' current requirements
- Small QFN16 lead free package 3x3 $mm^2$
- No power supply sequencing requirements
- Software controlled re-enumeration
- Integrated D+ pull-up resistor for FS operation



**QFN16 (3mm x 3mm)**

## Description

The STUSB03E is a single chip transceiver that complies with the physical layer specifications of the Universal Serial Bus (USB) v2.0 standard. It has an integrated 5V to 3.3V regulator which allows direct powering from the $V_{BUS}$. The transceiver has an integrated voltage detector to detect the presence of the $V_{BUS}$ voltage and features an internal D+ pull-up resistor implemented in accordance with the 27% resistor ECN.

The STUSB03E also supports Sharing mode when $V_{BUS}$ is not present, which allows the D+/D– lines to be shared with other serial protocols.

It supports both full-speed (12Mbps) and low-speed (1.5Mbps) operation. It is also designed to operate down to 1.6V so that it is compatible with lower system voltages of most portable systems, which include PDAs, MP3 Player and Cell phones.

## Order code

| Part number | Package | Packaging |
|---|---|---|
| STUSB03EQR | QFN16 (3mm x 3mm) | 3000 parts per reel |

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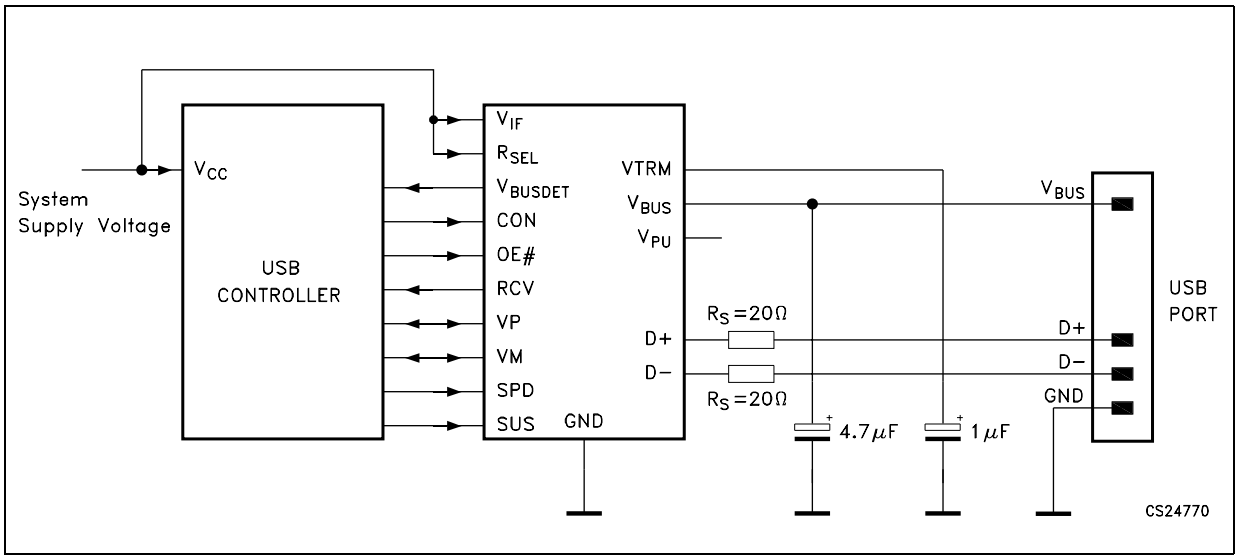
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# 1 Typical application

**Figure 1. Application circuit**



# 2 Pin configuration

**Figure 2. Pin connections (Top View)**

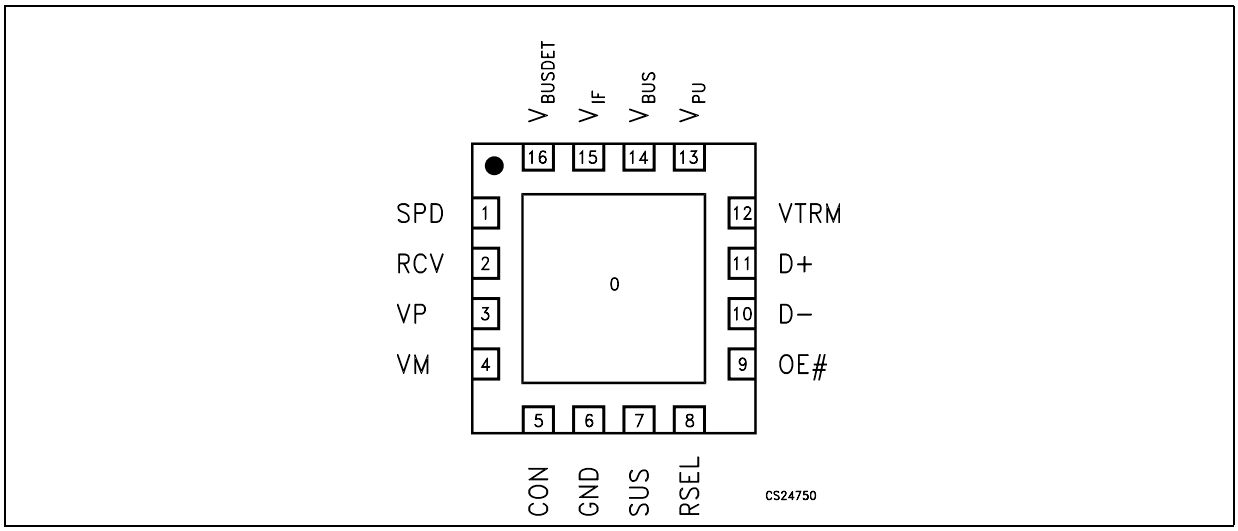



**Table 1. Pin description**

| Pln N° | Symbol | I/O | Name and function |
|---|---|---|---|
| 1 | SPD | I | Speed selection input. A logic HIGH operates at edge rates for “fullspeed” operation. A logic LOW operates edge rates for “lowspeed” operation. See also CON pin. |
| 2 | RCV | O | Receive Data. Output for USB differential data. (see *Table 2*) |
| 3 | VP | I/O | If OE# = H, VP = Receiver output (+)<br>If OE# = L, VP = Driver input (+) (see *Table 2*) |
| 4 | VM | I/O | If OE# = H, VM = Receiver output (-)<br>If OE# = L, VM = Driver input (-) (see *Table 2*) |
| 5 | CON | I | CONNECT (input). Connects the internal pull-up resistor to D+ if SPD and RSEL are logic high. Controls status of $V_{PU}$ pin if SPD or RSEL is logic low. |
| 6 | GND | | Ground reference |
| 7 | SUS | I | Suspend (active-high). Turns off internal circuits to reduce supply current. |
| 8 | RSEL | I | Full speed pull-up resistor selection input. If RSEL = 0 the internal pull-up resistor connected to D+ is disabled and an external resistor connected to $V_{PU}$ pin must be used. |
| 9 | OE# | I | Output Enable (active-low). Enables transceiver data transmission onto the bus. When not active, the transceiver is in the receive mode. (see *Table 2*) |
| 10, 11 | D-, D+ | I/O | Differential data lines that conform to the USB v2.0 standard. (see *Table 2*) |
| 12 | VTRM | O | 3.3V Reference Supply Output. Requires a 1.0µF decoupling capacitor for stability. |
| 13 | $V_{PU}$ | O | Pull-up Supply Voltage Output. Used to connect 1.5K pull-up speed detect resistor when RSEL or SPD is logic low. If CON = 0, $V_{PU}$ is high impedance. If CON = 1, $V_{PU}$ = 3.3V ±10% (see *Table 4.*). |
| 14 | $V_{BUS}$ | I | USB Bus Supply Voltage (4V to 5.5V). Supplies power to the USB transceiver and internal circuitry. |
| 15 | $V_{IF}$ | I | System Interface Supply Voltage (1.6V to 3.6V). Provides reference supply voltage for system I/O interface signals. |
| 16 | $V_{BUSDET}$ | O | $V_{BUS}$ indicator output. When $V_{BUS}$ > 4.0V, $V_{BUSDET}$ = High; when < 3.6V, $V_{BUSDET}$ = Low ($V_{IF}$ referred). |
| EXP | N.C. | | Not connected. |

# 3 Functional tables

**Table 2. Function selection**

| SUS | OE# | D+, D- | RCV | VP/VM | Function |
|---|---|---|---|---|---|
| L | L | Driving | Active | Active | Normal transmit mode |
| L | H | Receiving | Active | Active | Normal receive mode |
| H | L | Hi-Z | L | Not Active | Low power state |
| H | H | Hi-Z | L | Active | Receiving during suspend (low power state) (1) |

(1) During suspend VP and VM are active in order to detect out of band signalling conditions

**Table 3. Sharing mode pin configuration**

| Input/output | Status |
|---|---|
| $V_{BUS}$ | Floating or connected to GND |
| $V_{IF}$ | 1.6V to 3.6V input |
| D+, D-, | High impedance |
| VP, VM | High |
| RCV | Low |
| SPD | High impedance |
| $V_{BUSDET}$ | Low |
| $V_{PU}$ | High impedance |
| #OE, SUS, CON | High impedance inputs |

**Table 4. $V_{PU}$ Status**

| SPD | RSEL | CON | $V_{PU}$ |
|---|---|---|---|
| H | H | X | High impedance |
| H | L | L | High impedance |
| H | L | H | 3.3V ± 10% |
| L | X | L | High impedance |
| L | X | H | 3.3V ± 10% |

**Table 5. Truth table during normal Mode**

| **OE# = L** | | | | | |
|---|---|---|---|---|---|
| **Input** | | **Output** | | | **Result** |
| **VP** | **VM** | **D+** | **D-** | **RCV** | |
| L | L | L | L | X | SE0 |
| L | H | L | H | L | Logic Low |
| H | L | H | L | H | Logic High |
| H | H | X | X | X | Undefined |
| **OE# = H** | | | | | |
| **Input** | | **Output** | | | **RESULT** |
| **D+** | **D-** | **VP** | **VM** | **RCV** | |
| L | L | L | L | X | SE0 |
| L | H | L | H | L | Logic Low |
| H | L | H | L | H | Logic High |
| H | H | X | X | X | Undefined |

X = Undefined

# 4 Maximum ratings

**Table 6. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{BUS}$ | Supply Voltage | 6 | V |
| V+ | All other Inputs | -0.5 to 4.6 | V |
| $I_O$ | Output Current (D+, D-) | ±50 | mA |
| $I_O$ | Output Current (all others) | ±15 | mA |
| $I_I$ | Input Current | ±50 | mA |
| ESD | D+, D-, HBM (Note 3) | ±14 | kV |
| | $V_{BUS}$ (Note 3) | ±5 | |
| | All other pins (Note 3) | ±2 | |
| $T_{STG}$ | Storage Temperature Range | -65 to + 150 | °C |
| $T_{OPR}$ | Operating Temperature Range | -40 to + 85 | °C |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional Operation under these conditions is not implied.

Note 3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.

**Table 7. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJA}$ | Thermal Resistance Junction-Ambient | 59 | °C/W |

# 5 Electrical characteristics

**Table 8. DC electrical characteristics (system and USB interface)** ($V_{IF}$ = 3.6V, $V_{BUS}$ = 5V unless otherwise noted; $T_A$ = 25°C, specifications over temperature, -40 to 85°C)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{BUS}$ | USB Supply Voltage | | 4 | | 5.5 | V |
| $V_{IF}$ | System I/F Supply Voltage | | 1.6 | | 3.6 | V |
| $V_{IL}$ | Low Level Input Voltage (Note 4) | | | | $0.15V_{IF}$ | V |
| $V_{IH}$ | High Level Input Voltage (Note 4) | | $0.85V_{IF}$ | | | V |
| $V_{OL}$ | Low Level Output Voltage (Note 4) | $I_{OL}$ = 20µA | 0 | | 100 | mV |
| $V_{OH}$ | High Level Output Voltage (Note 4) | $I_{OH}$ = -20µA | $V_{IF}$-100 | | $V_{IF}$ | mV |
| $I_{IL}$ | Input Leakage Current (Note 4) | | -5 | | 5 | µA |
| $I_{IF}$ | $V_{IF}$ Supply Current (Note 7) | D+, D- are idle, SUS = 1 | | | 5 | µA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=1, f=6MHz, OE#=1 (Note 5) | | | 2 | mA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=0, f=750kHz, OE#=1 (Note5) | | | 220 | µA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=1, f=6MHz, OE#=0 (Note 5) | | | 0.8 | mA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=0, f=750kHz, OE#=0 (Note 5) | | | 120 | µA |
| $I_{BUS}$ | $V_{BUS}$ Supply Current | D+, D- are idle, $V_{BUS}$ = 5.25V Suspend Mode (SUS = 1), OE# = 1, SPD = 1 | | | 150 | µA |
| | | D+, D- are idle, $V_{BUS}$ = 5.25V SPD = 1, SUS = 0 | | | 5 | mA |
| | | D+, D- are idle, $V_{BUS}$ = 5.25V SPD = SUS = 0 | | | 3.5 | mA |
| | | D+, D- active, $V_{BUS}$ = 5.25V $C_{LOAD}$ = 50pF, SPD = 1, f = 6 MHz OE# = SUS = 0 (Note 5) | | | 8 | mA |
| | | D+, D- active, $V_{BUS}$ = 5.25V $C_{LOAD}$ = 50pF, f = 6 MHz, SUS = 0 OE# = SPD = 1 (Note 5) | | | 6 | |
| | | D+, D- active, $V_{BUS}$ = 5.25V $C_{LOAD}$ = 600pF, f = 750 KHz, SUS = SPD = 0 (Note 5) | | | 3.5 | |
| $I_{VPULEAK}$ | $V_{PU}$ Leakage Current | CON = 0, $V_{PU}$ = 0V | -5 | | 5 | µA |
| $I_{VIFLEAK}$ | $V_{IF}$ Leakage Current | $V_{IF}$ = 3.6V, $V_{BUS}$ = 0V | -5 | | 5 | µA |
| $V_{PU}$ | Pull-Up Output Voltage | $I_{TERM}$ = 200µA, $V_{BUS}$ = 4 to 5.25V | 3 | | 3.6 | V |
| $R_{SW}$ | $V_{PU}$ Internal Switch Resistance | $I_{TERM}$ = 10mA, $V_{BUS}$ = 4 to 5.25V | 6 | | 11 | Ω |
| $V_{BUSDET}$ | $V_{BUS}$ Comparator threshold | Supply present | 4 | | | V |
| | | Supply lost | | | 3.6 | |

Note 1. Exceeding the absolute maximum rating may damage the device.
Note 2. The device is not guaranteed to function outside its operating rating.
Note 3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.
Note 4. Specification applies to the following pins: SUS, SPD, RCV, CON, VP, VM, OE#, VBUSDET.
Note 5. Characterized specification(s), but not production tested.
Note 6. All AC parameters guaranteed by design but not production tested.
Note 7. RCV NOT LOADED

**Table 9. DC electrical characteristics (system and USB interface)**
($V_{IF}$ = 3.6V, $V_{BUS}$ = 5V unless otherwise noted; $T_A$ = 25°C)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{BUS}$ | USB Supply Voltage | | 4 | | 5.5 | V |
| $V_{IF}$ | System I/F Supply Voltage | | 1.6 | | 3.6 | V |
| $V_{IL}$ | Low Level Input Voltage (Note 4) | | | | $0.15V_{IF}$ | V |
| $V_{IH}$ | High Level Input Voltage (Note 4) | | $0.85V_{IF}$ | | | V |
| $V_{OL}$ | Low Level Output Voltage (Note 4) | $I_{OL}$ = 20µA | | | 0.1 | V |
| $V_{OH}$ | High Level Output Voltage (Note 4) | $I_{OH}$ = 20µA | $0.9V_{IF}$ | | | V |
| $I_{IL}$ | Input Leakage Current (Note 4) | | -5 | | 5 | µA |
| $I_{IF}$ | $V_{IF}$ Supply Current (Note 7) | D+, D- are idle, SUS = 1 | | | 5 | µA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=1, f=6MHz, OE#=1 (Note 5) | | 1.3 | | mA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=0, f=750kHz, OE#=1 (Note5) | | 180 | | µA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=1, f=6MHz, OE#=0 (Note 5) | | 0.4 | | mA |
| | | D+, D- active, $C_{LOAD}$ = 25pF, SPD=0, f=750kHz, OE#=0 (Note 5) | | 67 | | µA |
| $I_{BUS}$ | $V_{BUS}$ Supply Current | D+, D- are idle, $V_{BUS}$ = 5.25V Suspend Mode (SUS = 1), OE# = 1, SPD = 1 | | 88 | 100 | µA |
| | | D+, D- are idle, $V_{BUS}$ = 5.25V SPD = 1, SUS = 0 | | 4.7 | | mA |
| | | D+, D- are idle, $V_{BUS}$ = 5.25V SPD = SUS = 0 | | 3 | | mA |
| | | D+, D- active, $V_{BUS}$ = 5.25V $C_{LOAD}$ = 50pF, SPD = 1, f = 6 MHz OE# = SUS = 0 (Note 5) | | 5.5 | | mA |
| | | D+, D- active, $V_{BUS}$ = 5.25V $C_{LOAD}$ = 50pF, f = 6 MHz, SUS = 0 OE# = SPD = 1 (Note 5) | | 5.2 | | |
| | | D+, D- active, $V_{BUS}$ = 5.25V $C_{LOAD}$ = 600pF, f = 750 KHz, SUS = SPD = 0 (Note 5) | | 3 | | |
| $I_{VPULEAK}$ | $V_{PU}$ Leakage Current | CON = 1, $V_{PU}$ = 0V | -5 | | 5 | µA |
| $I_{VIFLEAK}$ | $V_{IF}$ Leakage Current | $V_{IF}$ = 3.6V, $V_{BUS}$ = 0V | -5 | | 5 | µA |
| $V_{PU}$ | Pull-Up Output Voltage | $I_{TERM}$ = 200µA, $V_{BUS}$ = 4 to 5.25V | | 3.3 | | V |
| $R_{SW}$ | $V_{PU}$ Internal Switch Resistance | $I_{TERM}$ = 10mA, $V_{BUS}$ = 4 to 5.25V | | 9 | | Ω |
| $V_{BUSDET}$ | $V_{BUS}$ Comparator threshold | Supply present | 4 | | | V |
| | | Supply lost | | | 3.6 | |

Note 1. Exceeding the absolute maximum rating may damage the device.
Note 2. The device is not guaranteed to function outside its operating rating.
Note 3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.
Note 4. Specification applies to the following pins: SUS, SPD, RCV, CON, VP, VM, OE#, VBUSDET.
Note 5. Characterized specification(s), but not production tested.
Note 6. All AC parameters guaranteed by design but not production tested.
Note 7. RCV NOT LOADED

**Table 10. ESD performance**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| ESD | IEC-1000-4-2 (D+, D-) | Air Discharge (10 pulses) | | ±8 | | KV |
| | | Contact Discharge (10 pulses) | | ±6 | | |
| | IEC-1000-4-2 ($V_{BUS}$ only) | Air Discharge (10 pulses) | | ±5 | | |
| | | Contact Discharge (10 pulses) | | ±5 | | |

**Table 11. DC electrical characteristics (transceiver)**
($V_{IF}$ = 3.6V, $V_{BUS}$ = 5V unless otherwise noted; $T_A$ = 25°C, specifications over temperature, -40 to 85°C)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{LO}$ | Hi-Z State Data Line Leakage (Suspend Mode) | $V_I$ = 0 to 3.3 V, SUS = 1 | -10 | | 10 | µA |
| $V_{DI}$ | Differential Input Sensitivity | \|(D+) - (D-)\| | 0.2 | | | V |
| $V_{CM}$ | Differential Common Mode Range | Includes $V_{DI}$ range | 0.8 | | 2.5 | V |
| $V_{SE}$ | Single Ended Receiver Threshold | Low to high transition | 0.8 | 1.6 | 2.0 | V |
| | | High to low transition | 0.8 | 1.1 | 2.0 | V |
| $V_{RHYS}$ | Receiver Hysteresis | $V_{CM}$ = 0.8 V | | 100 | | mV |
| $V_{OL}$ | Static Output Low | $R_L$ = 1.5 KΩ at 3.6V (see test circuit) | 0 | | 0.3 | V |
| $V_{OH}$ | Static Output High | $R_L$ = 15 KΩ at GND (see test circuit) | 2.8 | | 3.6 | V |
| $C_I$ | Transceiver Capacitance | Pin to GND | | 25 | | pF |
| $Z_{DRV}$ | Driver Output Resistance | Steady state drive | 8 | | 24 | Ω |
| $R_{PU_D+}$ | D+ Data line pull-up resistance | BUS idle | 900 | | 1575 | Ω |
| | | Receive mode | 1425 | | 3090 | |

**Table 12. DC electrical characteristics (transceiver)**
($V_{IF}$ = 3.6V, $V_{BUS}$ = 5V unless otherwise noted; $T_A$ = 25°C)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{LO}$ | Hi-Z State Data Line Leakage (Suspend Mode) | $V_I$ = 0 to 3.3 V, SUS = 1 | -2 | | 2 | µA |
| $V_{DI}$ | Differential Input Sensitivity | \|(D+) - (D-)\| | 0.2 | | | V |
| $V_{CM}$ | Differential Common Mode Range | Includes $V_{DI}$ range | 0.8 | | 2.5 | V |
| $V_{SE}$ | Single Ended Receiver Threshold | Low to high transition | 0.8 | 1.6 | 2.0 | V |
| | | High to low transition | 0.8 | 1.1 | 2.0 | V |
| $V_{RHYS}$ | Receiver Hysteresis | $V_{CM}$ = 0.8 V | | 50 | | mV |
| $V_{OL}$ | Static Output Low | $R_L$ = 1.5 KΩ at 3.6V (see *Test circuits*) | | | 0.3 | V |
| $V_{OH}$ | Static Output High | $R_L$ = 15 KΩ at GND (see *Test circuits*) | 2.8 | | 3.6 | V |
| $C_I$ | Transceiver Capacitance (3) | Pin to GND | | 25 | | pF |
| $Z_{DRV}$ | Driver Output Resistance | Steady state drive | | 16 | | Ω |
| $R_{PU_D+}$ | D+ Data line pull-up resistance | BUS idle | | 1300 | | Ω |
| | | Receive mode | | 2200 | | |

(3) Pins D+, D-

**Table 13. AC electrical characteristics**

($V_{IF}$ = 3.6V, $V_{BUS}$ = 5V unless otherwise noted; $T_A$ = 25°C.) (Note 6)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $T_R$ | Transition Rise Time (LOW SPEED) | $C_L$ = 50pF (*Figure 5*) | 75 | | | ns |
| | | $C_L$ = 600pF | | | 300 | |
| $T_F$ | Transition Fall Time (LOW SPEED) | $C_L$ = 50pF (*Figure 5*) | 75 | | | ns |
| | | $C_L$ = 600pF | | | 300 | |
| $T_{RFM}$ | Rise/Fall Time Matching (LOW SPEED) | ($T_R$, $T_F$) | 80 | | 125 | % |
| $V_{CRS}$ | Output Signal Crossover Voltage (LOW SPEED) | | 1.3 | | 2 | V |
| $T_R$ | Transition Rise Time (FULL SPEED) | $C_L$ = 50pF (*Figure 5*) | 4 | | 20 | ns |
| $T_F$ | Transition Fall Time (FULL SPEED) | $C_L$ = 50pF (*Figure 5*) | 4 | | 20 | ns |
| $T_{RFM}$ | Rise/Fall Time Matching (FULL SPEED) | ($T_R$, $T_F$) | 90 | | 111.11 | % |
| $V_{CRS}$ | Output Signal Crossover Voltage (FULL SPEED) | | 1.3 | | 2 | V |
| $t_{TA_OI}$ | Output to input turnaround time | *Figure 4.* | 0 | | 5 | ns |
| $t_{TA_IO}$ | Output to input turnaround time | *Figure 4.* | 0 | | 5 | ns |
| $t_{PZH}$, $t_{PZL}$ | Driver enable delay | FS, *Figure 3.* | 50 | | | ns |
| $t_{PLZ}$, $t_{PHZ}$ | Driver disable delay | FS, *Figure 3.* | 50 | | | ns |
| $t_{PLH}$ $t_{PHL}$ | VP, VM to D+, D- Propagation Delay | FS, $C_L$ = 50pF | | | 55 | ns |
| | | LS, $C_L$ =600pF | | | 300 | ns |
| $t_{PLH}$ $t_{PHL}$ | D+, D- to RCV Propagation Delay | FS, input slope = 15 ns | | | 18 | ns |
| $t_{PLH}$ $t_{PHL}$ | D+, D- to VP, VM Propagation Delay | FS, input slope = 15 ns | | | 24 | ns |

Note 1. Exceeding the absolute maximum rating may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

Note 3. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.

Note 4. Specification applies to the following pins: SUS, SPD, RCV, CON, RCV, VP, VM, OE#.

Note 5. Characterized specification(s), but not production tested.

Note 6. All AC parameters guaranteed by design but not production tested.

# 6 Timing diagram

**Figure 3. Driver enable and disable delay**

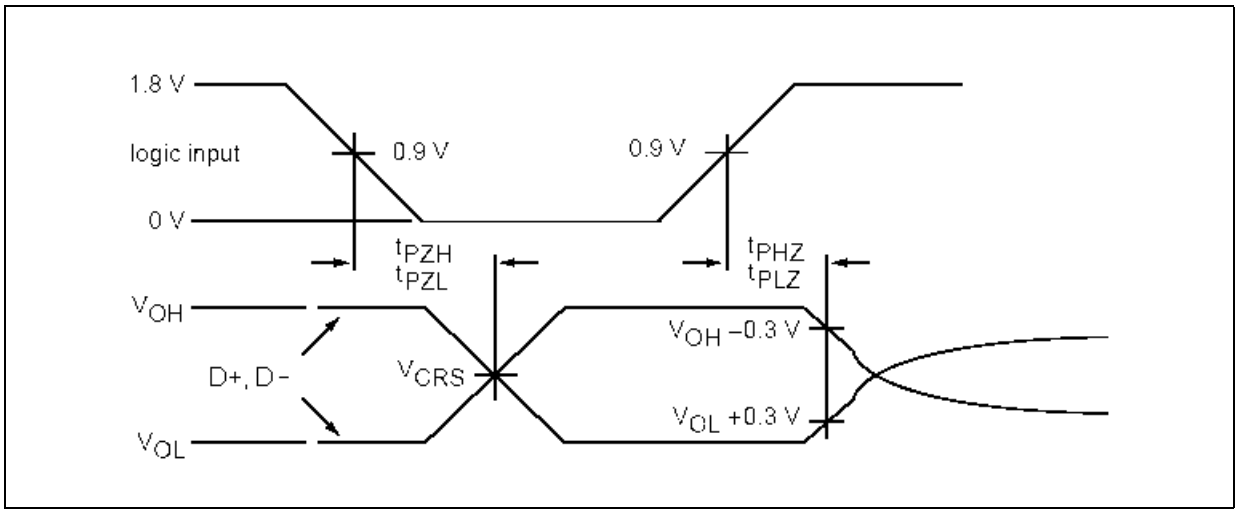



**Figure 4. Turnaround time**

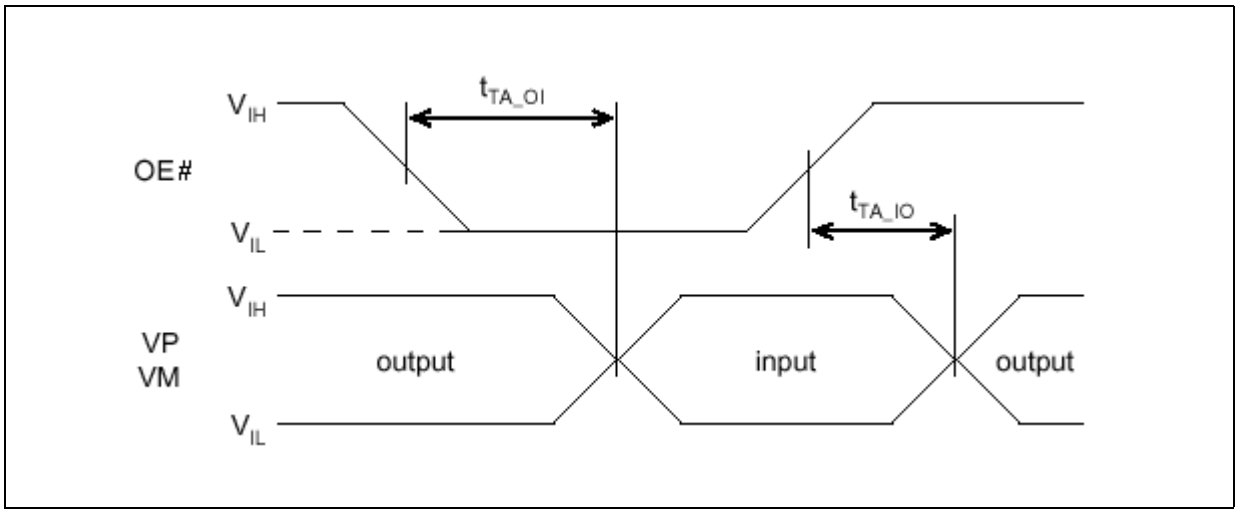



**Figure 5. Rise and fall times**

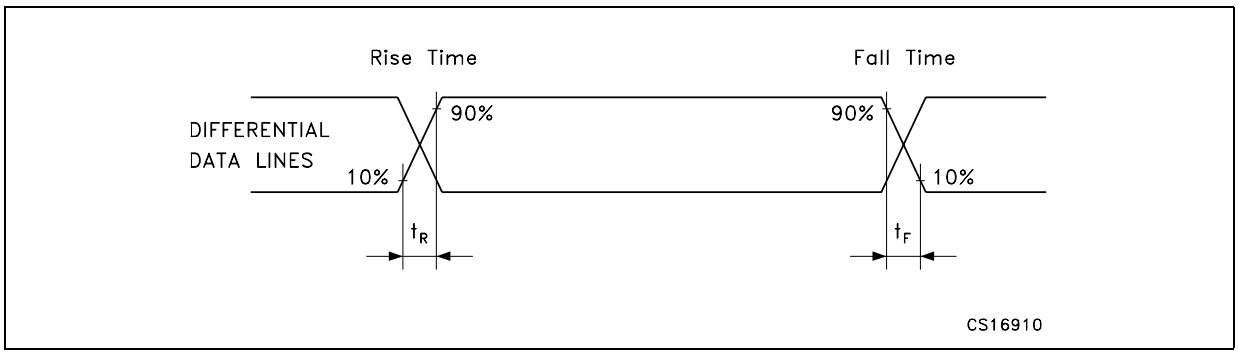


**Figure 6. Receiver propagation delay**

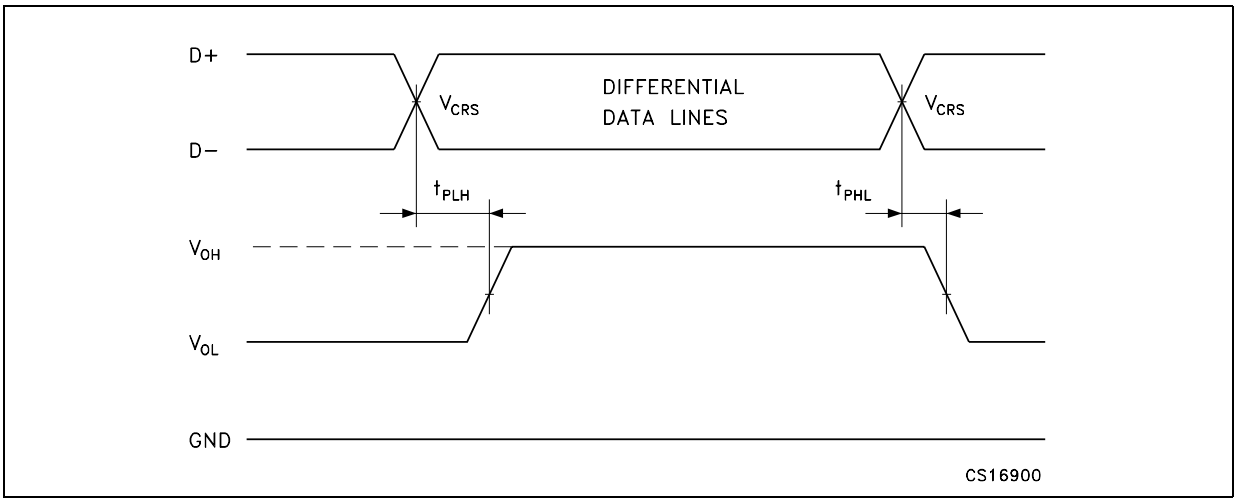
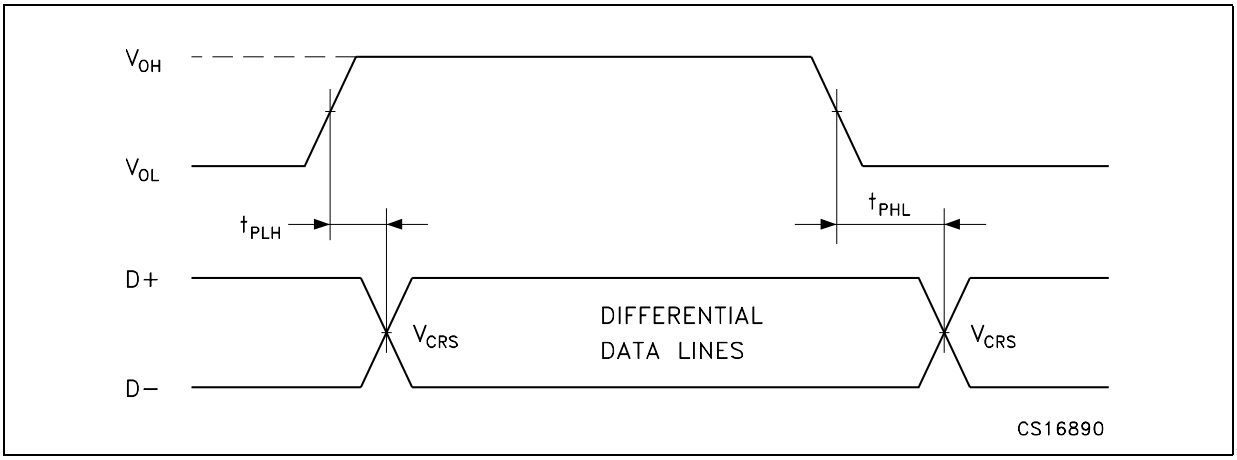
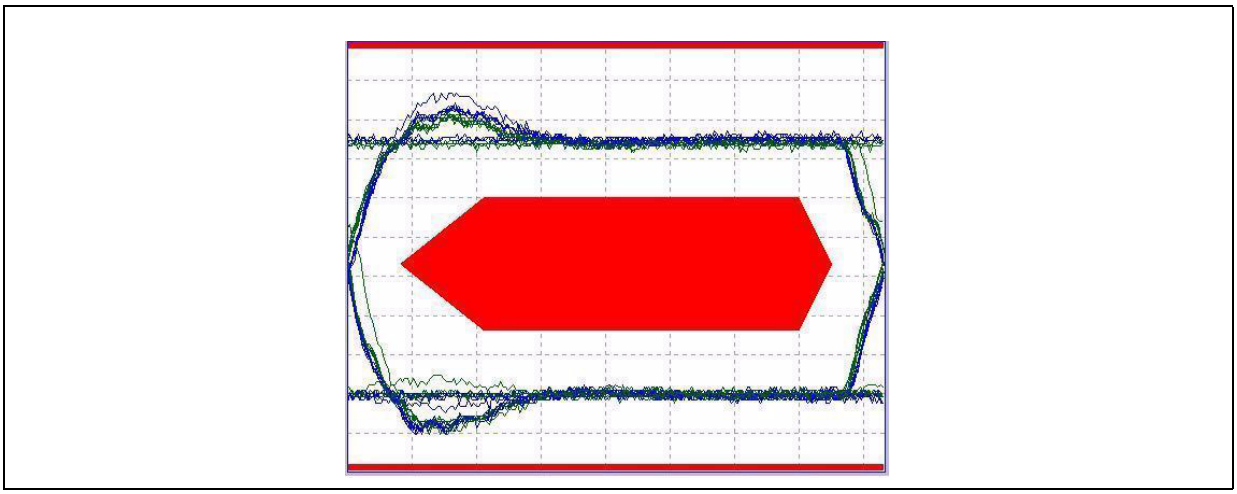



**Figure 7. Driver propagation delay ($C_L$ = 50pF)**




Minimum Timing LS and maximum timing FS

**Figure 8. FS eye diagram**



# 7 Test circuits

**Figure 9. Load for VP, VM, RCV**

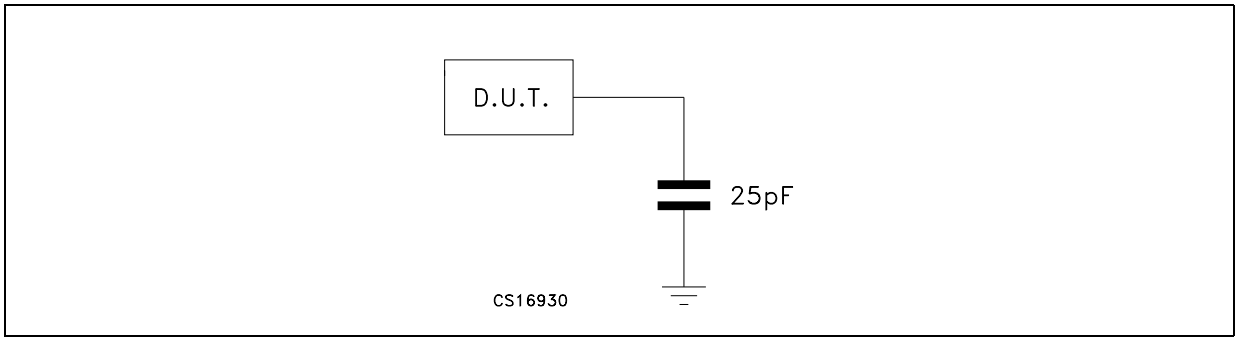



**Figure 10. Load for D+, D-**

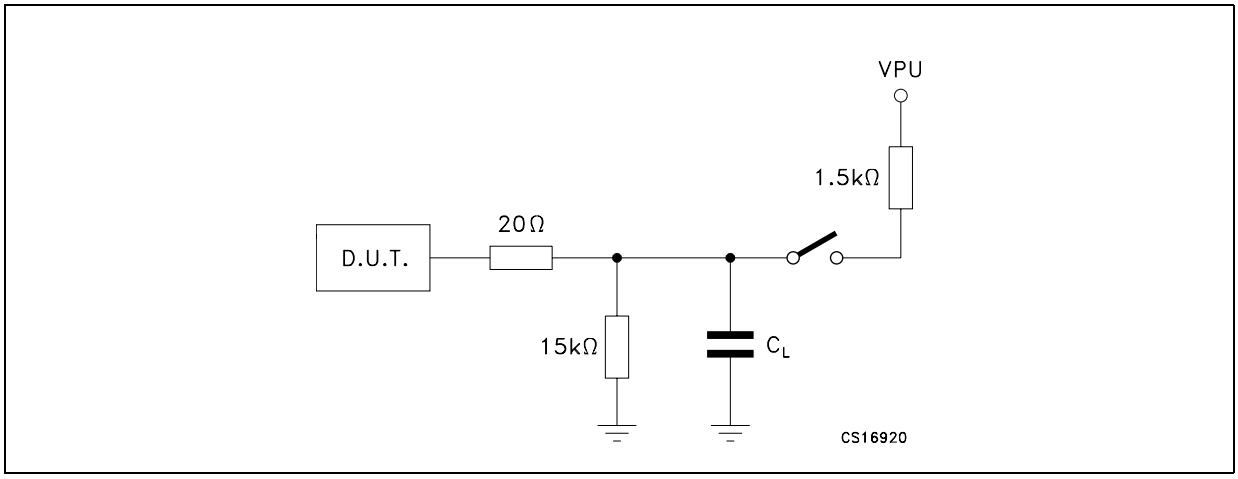
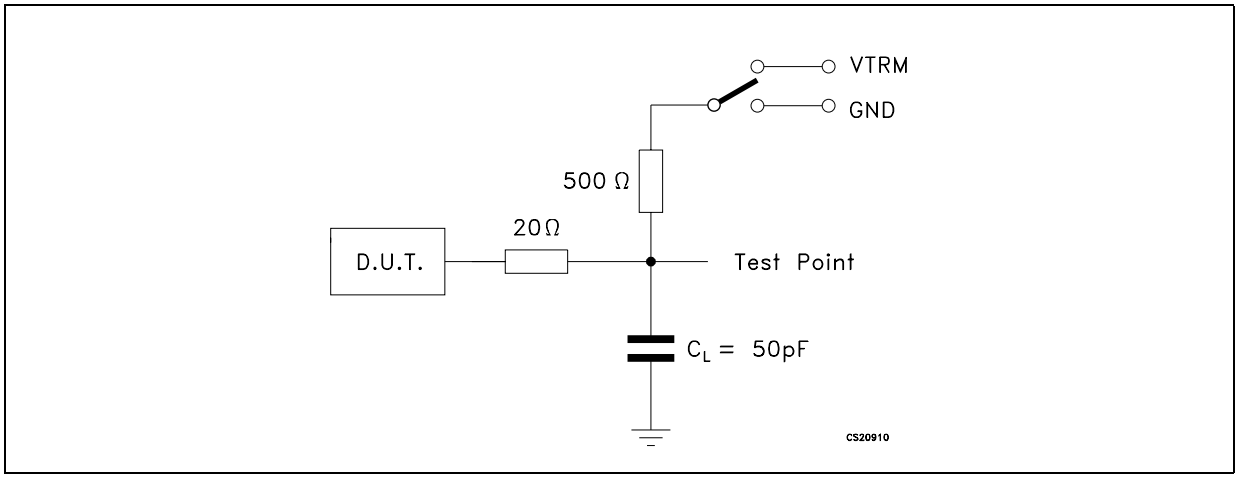
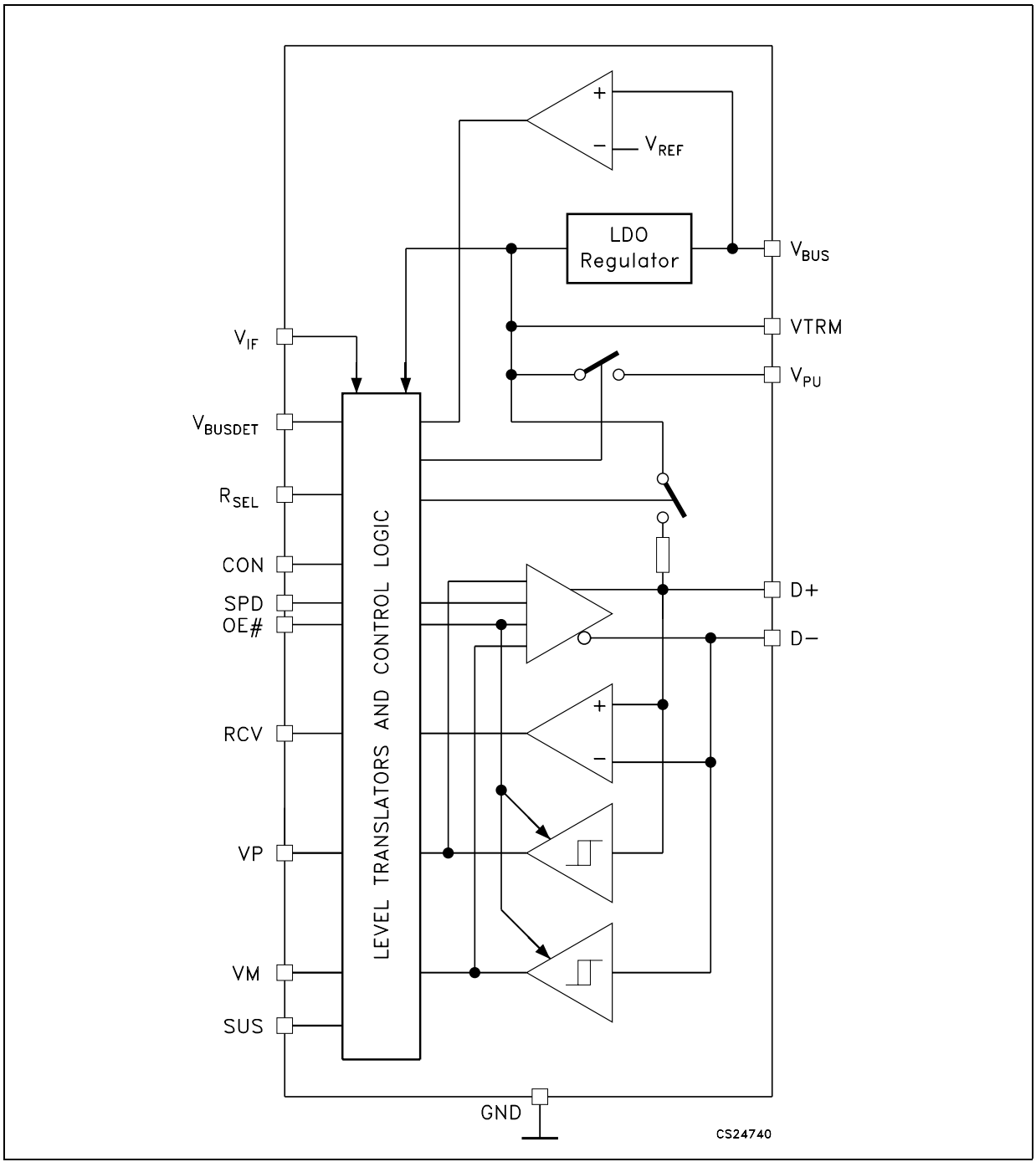



**Figure 11. Enable and disable time circuit**




Switch = GND for $t_{PZH}$ and $t_{PHZ}$; V = VTRM for $t_{PZL}$ and $t_{PLZ}$

**Figure 12. Functional diagram**



# 8 Functional description

The STUSB03E is designed to provide USB connectivity in mobile systems where available system supply voltages are not able to satisfy USB requirements. The STUSB03E can operate down to supply voltages of 1.6V and still meet USB physical layer specifications. As shown in the circuit above, the STUSB03E takes advantage of the USB supply voltage, $V_{BUS}$, to operate the transceiver. The system voltage, $V_{IF}$, is used to set the reference voltage used by the digital I/O lines interfacing to the system controller. Internal circuitry provides translation between the USB and system voltage domains. $V_{IF}$ will typically be the main supply voltage rail for the controller.

In addition, a 3.3V, 10% termination supply voltage, $V_{PU}$, is provided to support speed selection. $V_{PU}$ can be disabled or enabled under software control via the CON input. This allows for software-controlled connect or disconnect states. A 1.5K resistor is required to be connected between this pin and the D- line when operating in low speed mode. In full speed mode either an internal pull-up resistor or an external one connected between $V_{PU}$ pin and D+ line can be used; the desired configuration is chosen by tying $R_{SEL}$ pin to $V_{IF}$ or GND.

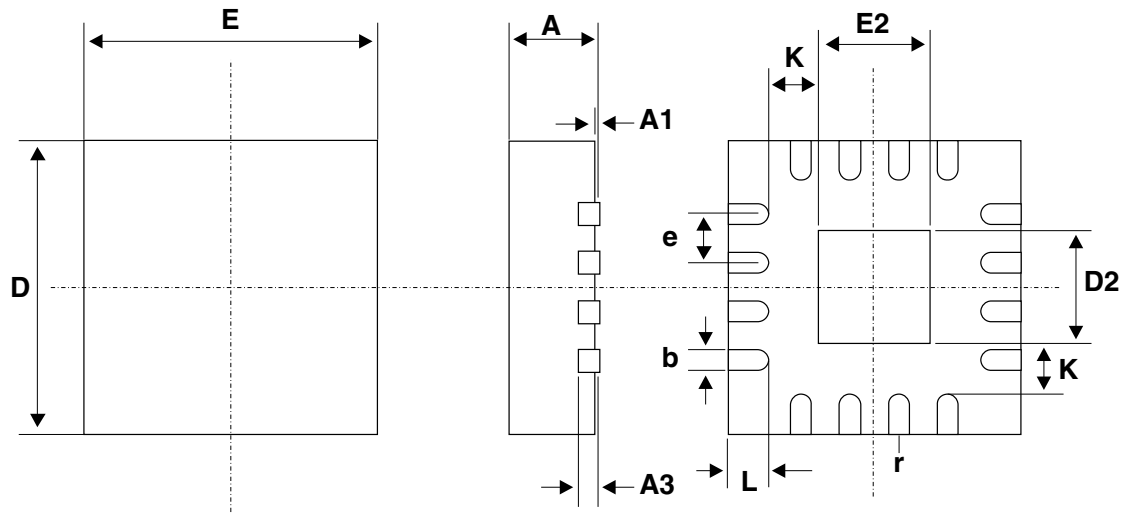
The use of ESD transient protection devices is not required for operation, but is recommended.

# 9 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

## QFN16 (3mmx3mm) MECHANICAL DATA

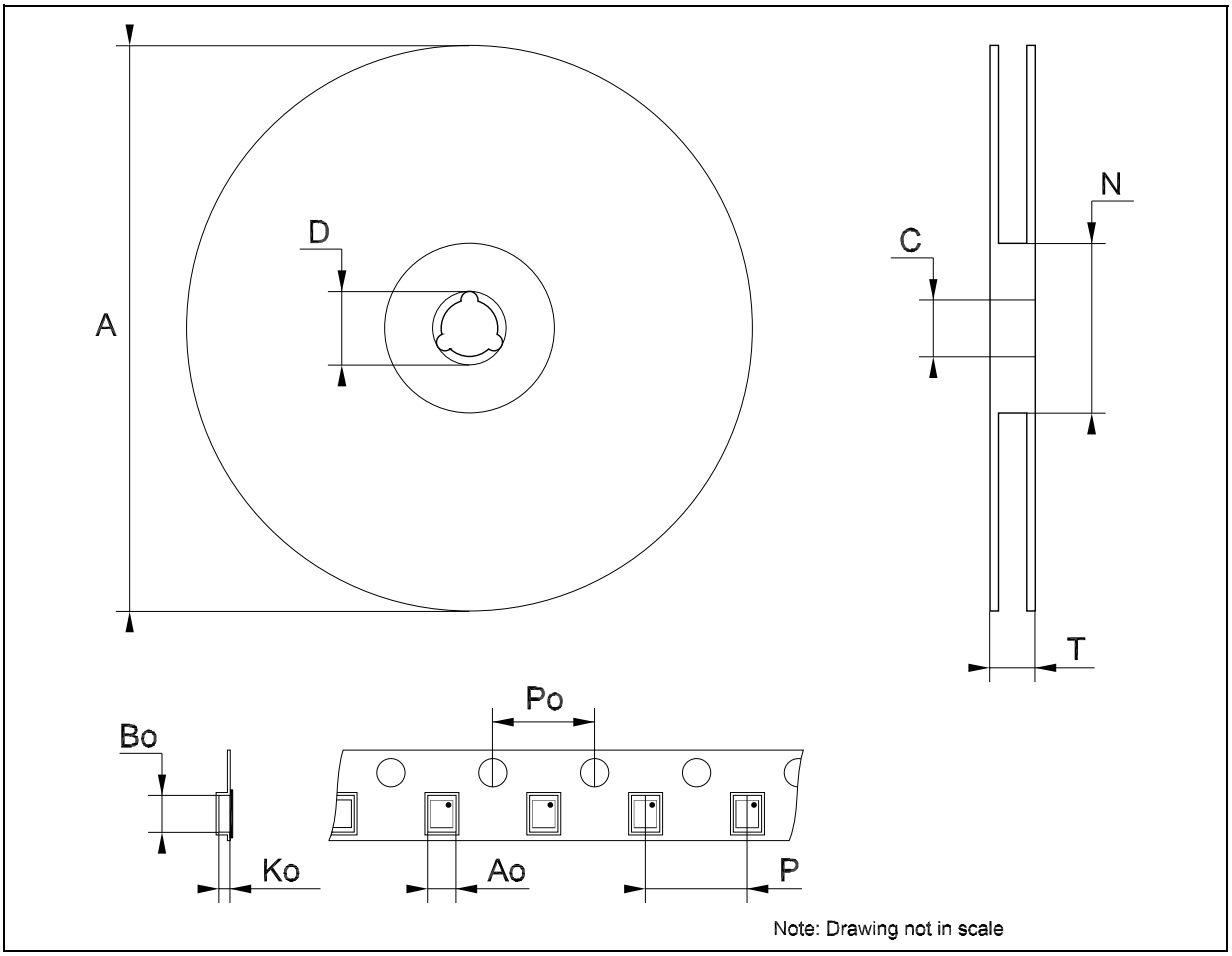
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 0.80 | 0.90 | 1.00 | 0.032 | 0.035 | 0.039 |
| A1 | | 0.02 | 0.05 | | 0.001 | 0.002 |
| A3 | | 0.20 | | | 0.008 | |
| b | 0.18 | 0.25 | 0.30 | 0.007 | 0.010 | 0.012 |
| D | | 3.00 | | | 0.118 | |
| D2 | 1.55 | 1.70 | 1.80 | 0.061 | 0.067 | 0.071 |
| E | | 3.00 | | | 0.118 | |
| E2 | 1.55 | 1.70 | 1.80 | 0.061 | 0.067 | 0.071 |
| e | | 0.50 | | | 0.020 | |
| K | | 0.20 | | | 0.008 | |
| L | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |
| r | 0.09 | | | 0.006 | | |




This drawing is not to scale

## Tape & Reel QFNxx/DFNxx (3x3) MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 330 | | | 12.992 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 18.4 | | | 0.724 |
| Ao | | 3.3 | | | 0.130 | |
| Bo | | 3.3 | | | 0.130 | |
| Ko | | 1.1 | | | 0.043 | |
| Po | | 4 | | | 0.157 | |
| P | | 8 | | | 0.315 | |




Note: Drawing not in scale

# 10 Revision history

**Table 14. Revision history**

| Date | Revision | Changes |
|---|---|---|
| 31-Oct-2006 | 1 | First Release. |
| 14-Mar-2007 | 2 | Update tape & reel. |

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