## **Product Bulletin**

# Bus Switches: 3.3-V CBTLV and 5-V CBT Including LV-A, TVC

### Key Benefits

- Industry standard pin-outs
- LVTTL Compatible input and output levels
- Near-zero propagation delays (250 ps typ.)
- Isolation and Bus Exchange functions (several applications highlighted inside)
- Innovative Widebus<sup>™</sup> functions

## 3.3-V CBTLV

**Faster Switching, Faster Flow** More and more systems components are moving to low-voltage (3.3-V) supply currents. Chief benefits of this design practice are low power consumption and higher speed potentials. TI has always led the charge for lowvoltage logic solutions. In fact, there has never been a time when TI wasn't the #1 supplier of 3.3-V logic solutions worldwide. Now, TI introduces the world's first 3.3-V Bus Switch family --- CBTLV.



The world's first 3.3-V bus switch

With digital electronics running at ever higher speeds, every barrier to system performance must be removed. High-speed microprocessors, synchronous DRAMs, new bus architectures—all of these require supporting logic that keeps data moving fast.

To keep the data in your systems moving, Texas Instruments has developed a broad family of low-voltage bus switches (CBTLV). These highspeed bus connect devices bring greater system speed and reduced power consumption to designers of high-end workstations, portable computers, hard disk drives, industrial control systems and telecommunication equipment.

#### What Are CBTLV Switches?

A CBTLV switch consists of a simple n-channel MOS transistor in parallel with a p-channel MOS transistor. When the switch is open, it provides isolation (3-state) for its bus line. When the switch is closed, it imposes a near-zero propagation delay on the line.

### **Multiplexing Data**

In multiprocessor systems, CBTLV switches can be used for extremely fast bus connections, bus multiplexing, memory interleaving, bus byte-swapping and a variety of other switching functions.

Extremely low propagation delays (250 ps) make CBTLV

#### **CBTLV** Features

- Low ON resistance (R<sub>on</sub> = 4-6 Ω)
- Low input capacitance (C<sub>i</sub> = 6-8 pF)
- Near-zero propagation delay (t<sub>pd</sub> = 0.25 ns max.)
- Low power consumption  $(I_{cc} = 20 \ \mu A)$
- High current conduction per channel (I<sub>i</sub> = 64 mA)

## CBTLV 3245 Logic Diagram



switches an effective replacement for drivers and receivers in high-speed systems where signal buffering is not required.

In addition, low power consumption helps prolong battery life between charges in portable systems. Smallfootprint packages save board space in applications such as PC cards.

## A Broad Portfolio of CBTLV Products

The new family of SN74CBTLVxxx switches consists of 1-, 4-, 8-, 10-, 12-, 20- and 24-bit-wide bus switches, bus exchange switches, and decoder and multiplexer functions.

Current 8- to 56-pin

- packages include the following:
- Small-outline integrated (SOIC)
- Shrink small-outline package (SSOP)
- Thin shrink small-outline package (TSSOP)
- Very thin shrink small-outline package (TVSOP)

Packaging options are pincompatible with existing logic devices ('244/'245), making the migration to CBTLV easy. For space-critical applications like portable computers or PC cards, CBTLV switches come in TSSOPs and TVSOPs, the smallest available packages for logic devices in the industry.

Widebus<sup>™</sup> packages provide more than twice the I/O pin count and functionality of standard devices—without using additional board space. In addition, the Widebus flowthrough architecture simplifies printed circuit board layout and supports up to 64-bit-wide microprocessors.

The speed and flexibility of CBTLV switches support their use in a wide variety of applications. By consuming only 20 µA of static current, CBTLVs dissipate substantially less power than comparable bus interface devices, making them ideal for portable systems.

With propagation delays 16 times faster than standard CMOS or BiCMOS logic, CBTLVs can function as highspeed bus interfaces between computer system components, such as the CPU and memory. In many applications, CBTLV bus interfaces can eliminate system wait states by speeding up data throughput on the bus.

### Texas Instruments CBTLV Portfolio

Device Number	Function	Availability
Single-gate		
SN74CBTLVG125	Low-Voltage Single FET Bus Switch	<b>v</b>
2 to 10 Bit		
SN74CBTLV3125	Low-Voltage Quandruple FET Bus Switch	<b>v</b>
SN74CBTLV3126	Low-Voltage Quandruple FET Bus Switch	<ul> <li>Image: A start of the start of</li></ul>
SN74CBTLV3245A	Low-Voltage Octal FET Bus Switch	<ul> <li>Image: A set of the set of the</li></ul>
SN74CBTLV3251	Low-Voltage 1-Of-8 FET Multiplexer/Demultiplexer	<b>v</b>
SN74CBTLV3253	Low-Voltage Dual 1-Of-4 FET Multiplexer/Demultiplexer	<b>v</b>
SN74CBTLV3257	Low-Voltage 4-Bit 1-Of-2 FET Multiplexer/Demultiplexer	✓
SN74CBTLV3383	Low-Voltage 10-Bit FET Bus-Exchange Switch	<b>v</b>
SN74CBTLV3384	Low-Voltage 10-Bit FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBTLV3857	Low-Voltage 10-Bit FET Bus Switch With Internal Pulldown Resistors	<ul> <li>Image: A set of the set of the</li></ul>
SN74CBTLV3861	Low-Voltage 10-Bit FET Bus Switch	<b>v</b>
Widebus		
SN74CBTLV16210	Low-Voltage 20-Bit FET Bus Switch	<b>v</b>
SN74CBTLV16211	Low-Voltage 24-Bit FET Bus Switch	<b>v</b>
SN74CBTLV16212	Low-Voltage 24-Bitl FET Bus-Exchange Switch	✓
SN74CBTLV16235	Low-Voltage 18-Bit 1-Of-2 FET Multiplexer/Demultiplexer	+
SN74CBTLV16292	Low-Voltage 12-Bit 1-Of-2 FET Multiplexer/Demultiplexer With Internal Pulldown Resistor	s 🖌
SN74CBTLVR16292	Low-Voltage 12-Bit 1-Of-2 FET Multiplexer/Demultiplexer With Internal Pulldown Resistor	s 🖌
SN74CBTLV16800	Low-Voltage 20-Bit FET Bus Switch With Precharged Outputs	<b>v</b>

✓ - Available + - Planned

#### **Advanced Packaging Examples**



Dimensions are in inches (millimeters). Area is in sq. inches (sq. millimeters).

## 5-V CBT

Texas Instruments also offers a broad line of 5-V Bus Switches. CBT, TI's original bus switch family, fast became an industry standard for many isolation, translation, and bus-exchange

needs. With over 30 functionalities available or planned in the industry's widest range of bus switch packaging options, CBT is the easy choice for designers' 5-V Bus Switch applications.

#### **CBT** Features

- Low ON resistance (R<sub>on</sub> = 4-6 Ω)
   Low input capacitance (C<sub>i</sub> = 6-8 pF)
- Near-zero propagation delay
- ( $t_{pd}$  = 0.25 ns max.) Low power consumption ( $I_{cc}$  = 50 µA)
- · High current conduction per channel  $(I_i = 64 \text{ mA})$
- Precharge for hot card insertion (CBT6800)

Device		A !! . !! !! ! .
Number	Function	Availability
Single-gate		
SN74CBT1G66	Single FET Bus Switch	+
SN74CBT1G125	Single FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBTD1G125	Single FET Bus Switch With Level Shifting	<u> </u>
SN74CBT1G384	Single FET Bus Switch	<u> </u>
SN74CBTD1G384	Single FET Bus Switch With Level Shifting	~
2 to 10 Bit		
SN74CBT3125	Quandruple FET Bus Switch	<b>v</b>
SN74CBT3126	Quandruple FET Bus Switch	
SN74CBT3244	Octal FET Bus Switch	<ul> <li></li> </ul>
SN74CBT3245A	Octal FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBT3251	1-Of-8 FET Multiplexer/Demultiplexer	<ul> <li>✓</li> </ul>
SN74CBT3253	Dual 1-Of-4 FET Multiplexer/Demultiplexer	<ul> <li>✓</li> </ul>
SN74CBT3257	4-Bit 1-Of-2 FET Multiplexer/Demultiplexer	<ul> <li>✓</li> </ul>
SN74CBT3306	Dual FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBTD3306	Dual FET Bus Switch With Level Shifting	<ul> <li>✓</li> </ul>
SN74CBTS3306	Dual FET Bus Switch With Schottky Diode Clamping	<b>v</b>
SN74CBT3345	8-Bit FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBT3383	10-Bit FET Bus-Exchange Switch	<u> </u>
SN74CBT3384A	10-Bit FET Bus Switch	
SN74CBTD3384	10-Bit FET Bus Switch With Level Shifting	<u> </u>
SN74CBTS3384	10-Bit FET Bus Switch With Schottky Diode Clamping	<ul> <li>✓</li> </ul>
SN74CBT3361	10-Bit FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBTLD3361	10-Bit FET Bus Switch With Level Shifting	<ul> <li></li> </ul>
SN74CBT6800A	10-Bit FET Bus Switch With Precharged Outputs For Live Insertion	<ul> <li>✓</li> </ul>
SN74CBTK6800	10-Bit FET Bus Switch With Precharged Outputs & Active-Clamp Undershoot-Protection Circuit	t 🖌
SN74CBTS6800	10-Bit FET Bus Switch With Precharged Outputs and Schottky Diode Clamping	<ul> <li>✓</li> </ul>
Widebus		
SN74CBT16209	18-Bit FET Bus-Exchange Switch	~
SN74CBT16210	20-Bit FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBTD16210	20-Bit FET Bus Switch With Level Shifting	<ul> <li>✓</li> </ul>
SN74CBT16211A	24-Bit FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBTD16211	24-Bit FET Bus Switch With Level Shifting	<ul> <li>✓</li> </ul>
SN74CBTS16211	24-Bit FET Bus Switch With Schottky Diode Clamping	<ul> <li>✓</li> </ul>
SN74CBT16212A	24-Bit FET Bus-Exchange Switch	<ul> <li>✓</li> </ul>
SN74CBTS16212	24-Bit FET Bus Switch With Schottky Diode Clamping	<ul> <li>✓</li> </ul>
SN74CBT16213	24-Bit FET Bus-Exchange Switch	<ul> <li>✓</li> </ul>
SN74CBTS16213	24-Bit FET Bus Switch With Schottky Diode Clamping	+
SN74CBT16214	12-Bit 1-Of-3 FET Multiplexer/Demultiplexer	<ul> <li>✓</li> </ul>
SN74CBT16232	Synchronous 16-Bit 1-Of-2 FET Multiplexer/Demultiplexer	<ul> <li>✓</li> </ul>
SN74CBT16233	16-Bit 1-Of-2 FET Multiplexer/Demultiplexer	<ul> <li>✓</li> </ul>
SN74CBT16244	16-Bit FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBT16245	16-Bit FET Bus Switch	+
SN74CBTK16245	16-Bit FET Bus Switch With Active-Clamp Undershoot-Protection Circuit	<b>v</b>
SN74CBT16292	16-Bit to 32-Bit FET Multiplexer/Demultiplexer	V
SN74CBT162292	16-Bit 1-Of-2 FET Multiplexer/Demultiplexer With Internal Pulldown Resistors	<ul> <li></li> </ul>
SN74CBT16390	16-Bit to 32-Bit FET Multiplexer/Demultiplexer Bus Switch	<ul> <li>✓</li> </ul>
SN74CBT16861	20-Bit FET Bus Switch	<ul> <li>✓</li> </ul>
SN74CBTD16861	20-Bit FET Bus Switch With Level Shifting	+
SN74CBTK16861	16-Bit FET Bus Switch With Level Shifting & Active-Clamp Undershoot-Protection Circuit	+
SN74CBT32245	32-Bit FET Bus Switch	V
SN74CBTK32245	32-Bit FET Bus Switch With Active-Clamp Undershoot-Protection Circuit	V
SN74CBT34X245	32-Bit FET Bus Switch	+

## Texas Instruments CBT Portfolio

## **Bus Switch Features**

## Level-Shifting Diode For Voltage Translation

CBT devices can also be used as near-zero delay translators between 5-V and 3.3-V components on the same system. For example, by adding an additional diode in the V<sub>cc</sub> path, the CBT3384 can bridge the voltage boundary between 3.3-V processors and any 5-V system components. Further, to eliminate the extra diode (and reclaim valuable board space), an integrated diode versions available with the CBTD3384. This internal diode plus the gate-source voltage drop of 1 V brings the 5-V signal automatically to approximately  $V_{out}$  of 3.3 V.



N-channel transistors damp CBT output voltage by approximately 1 V. As a result, CBTs with an external diode or CBTDs can also provide 5-V to 3.3-V translation with virtually no added propagation delay of directional control.

## Active-Clamp For Undershoot Protection

TI's new active-clamp undershoot protection feature, designated as K (ie: CBTK), integrates an activeclamp undershoot protection circuit on both ports. In the active-clamp

circuit, a BIAS generator sets a voltage slightly above ground, which allows the active-clamp pull-up voltage to turn on during an undershoot event. Features

- · Low power requirements
- Undershoot protection
- Bidirectional, both ports protected



### **Voltage From BIAS Generator**

## Series Damping Resistors on Both Inputs and Outputs

Series Damping Resistors (SDR) are included at all input and output ports of the device. Designated as "R", the

SDR limit the current thereby reducing noise from undershoot and overshoot. Additionally, SDR's help in line termination which improves signal quality by reducing ringing/line reflection.



# **Applications**

### Memory Interleaving

TI's CBT and CBTLV Bus Switches have devices designed for memory interleaving applications. The CBT16292 and CBTLV16292, when utilized as seen below, can effectively reduce a memory controller's loading by 50%. The 3.3-V CBTLV16292 is especially useful in low-voltage applications, because it allows designers to keep the FET switch, memory controller, and memory modules in the same powerplane. In a memory interleaving application such as this one, the speed of the data transfer is determined by the  $t_{\rm en}$  and  $t_{\rm dis}$  of the bus switches.

At a  $t_{en}$  of 5.7 ns and a  $t_{dis}$  of 5.4 ns, the CBT16292 boasts one of the fastest enable/disable times in the industry.

#### Features

- Super-fast enable/disable times
- Reduces memory controller loading by half



### **5-V Bus Switch Application**





CBT switches provide a safe, effective method of converting device interfaces using older technologies into interfaces capable of hot card insertion. This feature is particularly important in fault-tolerant computing, telecommunications switching and VME bus boards.

The CBT6800 is designed specifically for hot card insertion. It has a built-in p-channel pull-up tied to bias voltage. Theis pull-up ensures that the buses are not connected at power up. It also ensures a highimpedance state during power up or power down.

## **Noise Filtering**



CBTs reduce switching noise from voltage spikes and overshooting generated by line reflections, crosstalk or simulataneous switching.

## 5-V Bus Switch Application





- Flow-through pinout for simpler board layouts
- Precharged outputs for live insertion

Bus switches are commonly utilized in the docking hardware of notebook computers. TI's bus switch portfolio provides bus switch solutions for this application in both the 5-V CBT family and 3.3-V CBTLV family. The CBTD16210 and the CBTLV16210 both provide a 5  $\Omega$  switch connection between two ports. The '16210 bus switches provide 20 bits of high-speed bus switching. The low on-state resistance of the switch allows connections to be made with minimal propagation delay. The devices are organized as dual10-bit bus switches with seperate ouput-enable (OE) inputs and can be used as two 10-bit bus switches or one 20-bit bus switch. When OE is low, the associated 10-bit bus switch is on and port A is connected to port B. When OE is high, the switch is open, and the high-impedance state exists between the two ports.

• Flow-through pinout configuration for optimized board layout

• Flow-through pinout configuration for optimized board layout



TI's CBT and CBTLV bus switches feature flow-through pinout architecture. Flowthrough pinout (see illustration at right) allows for simplified routing of the input signals and output signals of the bus switch. Flow-through pinouts make signal trace crisscrossing a thing of the past for designers.







These switches are designed to handle both analog and digital signals. Each switch permitts signals with amplitudes up to 5.5-V (peak) to be transmitted in either direction. Applications include signal gating, chopping, modulation or demodulation (modem), and signal multiplexing for analog-to-digital and digital-to-analog conversion systems.

#### Features

- 2-V to 5.5-V operation
- Support mixed-mode voltage operation on all ports
- High on-off output-voltage ratio

## Texas Instruments LV-A Portfolio

Device Number	Function	Availability
SN74LV4051A	8-Channel Analog Multiplexer/Demultiplexer	<b>v</b>
SN74LV4052A	Dual 4-Channel Analog Multiplexer/Demultiplexer	✓
SN74LV4053A	Triple 2-Channel Analog Multiplexer/Demultiplexer	<ul> <li>✓</li> </ul>
SN74LV4066A	Quadruple Bilateral Analog Switch	<ul> <li>✓</li> </ul>

- Available + - Planned

## TVC

The Translation Voltage Clamp (TVC) family of devices offer flexibility in designs, protection of circuits that are sensitive to high-state voltage-level overshoots, and cost efficiency. TI offers the TVC in a 20-bit and 10-bit device.

#### Features

- Designed to be used in voltagelimiting applications
- 6.5-Ω on-state connection betweem ports A and B
- Flow-through pinout for ease of printed circuit board trace routing

## Texas Instruments TVC Portfolio

Device Number	Function	Availability
SN74TVC16222A	22-Bit Voltage Clamp	$\checkmark$
SN74TVC3010	10-Bit Voltage Clamp	<ul> <li>✓</li> </ul>

✓ - Available + - Planned

## For More Information

To receive additional information about Texas Instruments 3.3-V CBTLV or 5-VCBT Bus Switches, please call 1-800-477-8924 or visit the Texas Instruments Logic Home Page:

http://www.ti.com/sc/logic

For military product infroamtion and availability, please contact your local TI Sales Representative of you local Texas Instruments Authorized Distributor. Information is also available on the Miltary Semiconductor Home Page: http://www.ti.com/sc/docs/ military

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