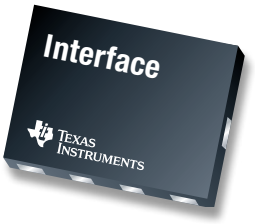
Interface Guide



Texas Instruments

1394
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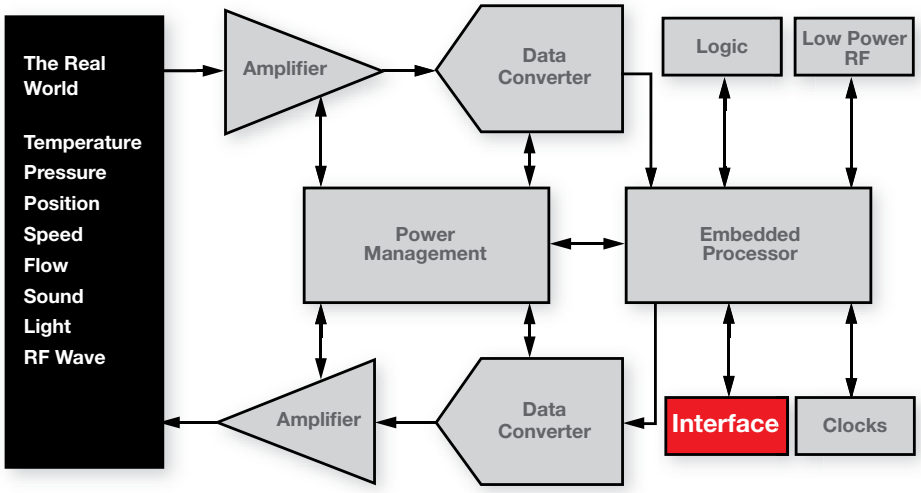


Table of Contents

Texas Instruments (TI) offers complete interface solutions with a full line of high-performance products. These products, which range from digital isolators to USB hub controllers, are tailored to meet your design challenges. And, TI makes designing easier by providing leading-edge support tools such as training, a broad selection of evaluation modules (EVMs), application notes, comprehensive technical documentation and more. TI also offers samples and small orders (shipped within 24 hours via TI authorized distributors) that will help you accelerate your time-to-market.

Included in this selection guide you will find featured products, design considerations, graphical representations of portfolios and parametric tables.

Texas Instruments (TI) provides complete interface solutions that empower you to differentiate your products and accelerate time-to-market.

Our expertise in high-speed, mixed-signal circuits, system-on-a-chip integration and advanced product development processes ensures you will receive the silicon, support tools, software and technical documentation to create and deliver the best products on time and at competitive prices. Included in this selection guide you will find design considerations, technical overviews, graphic representation of portfolios, parametric tables and resource information on the following families of devices:

LVDS: (p. 4) TIA/EIA-644A specification designed for differential transmission delivering signaling rates into the Gbps range and power in the mW range with low EMI to the telecommunication and consumer markets.

xECL: (p. 4) Emitter coupled logic (xECL), high-speed differential interface technology designed for low jitter and skew.

CML: (p. 4) Current-mode logic (CML), high-speed differential interface technology.

M-LVDS: (p. 8) TIA/EIA-899 specification with all the benefits of LVDS applicable to multipoint bus architecture in backplanes. Used often for clock distribution, e.g., AdvancedTCA.

Digital Isolators: (p. 10) The new ISO72x high-speed digital isolators use state-of-the-art integrated capacitive coupling and silicon-dioxide isolation barrier to provide up to 150-Mbps signaling rate with only 1-ns jitter, best-of-class noise immunity and high reliability.

Industrial Serializers: (p. 11) In combination with galvanic isolators these devices complete the interface between high voltage signals on the field-side and the low-voltage signals on the controller side.

RS-485/422: (p. 12) Robust TIA/EIA-485 and TIA/ EIA-422 specifications specially designed for harsh, industrial environments transmitting a differential signal up to 50 Mbps or 1.2 km.

RS-232: (p. 14) TIA/EIA-232 specification defining single-ended interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE).

UARTs: (p. 17) Universal Asynchronous Receiver/ Transmitters are the key logic component of serial communication utilizing RS232, RS485/422 or LVDS transceivers to transmit or receive between remote devices performing parallel to serial conversion in the transmit process and serial to parallel conversion in the receive process.

CAN: (p. 19) Controller Area Network (ISO11898) specification commonly used in automotive and industrial applications describes differential signaling at a rate up to 1 Mbps on a 40-meter bus with multipoint topology.

FlatLink™ 3G: (p. 20) A new family of serializers and deserializers designed for mobile phone displays.

SerDes: (p. 21) Serializers and deserializers in the gigabit range designed to bridge large numbers of data bits over a small number of data lines in telecommunication applications.

DVI/PanelBus™: (p. 23) The Digital Visual Interface Specification, DVI, is an industry standard developed by the Digital Display Working Group (DDWG) for high-speed digital connection to digital displays. DVI uses transition-minimized DC balanced (TMDS) data signaling.

TMDS: (p. 25) Transition minimized differential signaling is the electrical interface used by DVI and HDMI.

USB Hub Controllers and Peripheral Devices: (p. 26) The USB standard was established to make connecting PCs, peripherals and consumer electronics flexible and easy. The hub controller manages USB port connect/disconnect activities and a peripheral controller enables USB connectivity of a peripheral device to either a host or hub.

USB Power Managers: (p. 28) TI products, like TPS204xA and TPS205xA, are designed to meet all the USB 1.0 and 2.0 requirements for current-limiting and power switching to reliably control the power on the voltage bus.

PCI Express®: (p. 30) The PCI Express architecture is a robust, scalable, flexible, and cost-effective serial I/O interconnect, enabling dedicated point-to-point connectivity between peripherals.

PCI Bridges: (p. 33) A peripheral component interconnect (PCI) bridge provides a high-performance connection path between either two PCI buses or a PCI component and one or more DSP devices.

Power Distribution Switches: (pp. 34-35) The CardBus controller uses the card detect and voltage sense pins to determine a PC card's voltage requirements and then directs the PCMCIA power switch to enable the proper voltages. Standard PC cards require that V_{CC} be switched between ground, 3.3 V, and 5 V, while V_{PP} is switched between ground, 3.3 V, 5 V, and 12 V. CardBay sockets have the standard requirements for V_{CC}, but require ground, 3.3 V, and 5 V to V_{PP}, and ground, 1.8 V, or 3.3 V to V_{CORE}. Other PC card applications may simply not need 12 V or V_{PP} while still having the standard requirements for V_{CC}. Therefore, consider the voltage requirements of the application when selecting a PCMCIA power switch.

1394: (p. 36) IEEE 1394 (FireWire®) high-speed interconnection enables simple, low-cost, high-bandwidth, real-time data connectivity between computers, peripherals and consumer electronics.

ESD/EMI Protection: (p. 39) Transient voltage suppressors which protect multiple interfaces from ESD/EMI and electrical noise transients. The majority of devices comply with the IEC-61000-4-2 ESD protection specification.

I^2C : (p. 40) The I^2C bus is useful for many of today's microcontroller- and microprocessor-based systems or other systems linking many I/O devices.

Voltage-Level Translation : (p. 41) TI offers a full spectrum of products to achieve voltage-level translation, including dual-supply level translators; FET switches; and devices with over-voltage tolerance, TTL-compatible inputs and open-drain outputs.

Design Considerations

Signaling Rate — TI offers repeaters/translators and crosspoint switches with signaling rates up to 4.0 Gbps.

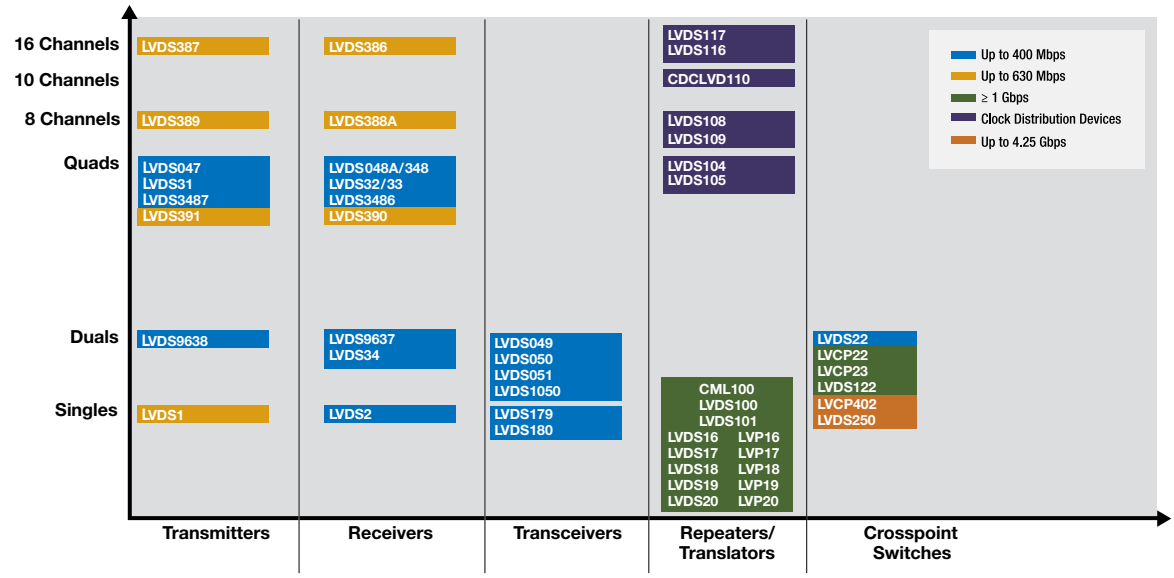
Jitter — Reducing jitter, the deviation of a signal timing event from its ideal position, has become a priority for ensuring reliability in high-speed data buses.

Skew — Excessive skew, the time delta between the actual and expected arrival time of a clock signal, can limit the maximum bandwidth performance and lead to data sampling errors. Low skew specifications make high-speed interconnect devices excellent for signal buffering.

Power Consumption — Low-voltage differential signaling (LVDS) offers a low-power alternative to ECL and PECL devices. Current-mode drivers in LVDS produce a constant current, which allows power consumption to be relatively independent of frequency. The constant current driver delivers about 3.5 mA to a 100-Ω load.

Technical Information

• LVDS is based on the TIA/EIA-644A standard conceived to provide a general-purpose electrical-layer specification for drivers and receivers connected in a point-to-point or multidrop interface.



Resources For a complete list of resources (evaluation modules, data sheets and application notes), visit interface.ti.com

Literature Number	Description
Application Notes	
SLLA014A	Low-Voltage Differential Signaling (LVDS) Design Notes (Rev. A)
SLLA030C	Reducing Electromagnetic Interference with LVDS (Rev. C)
SLLA031A	Using an LVDS Receiver with TIA/EIA-422 Data (Rev. A)
SLLA034A	Slew Rate Control of LVDS Circuits (Rev. A)
SLLA038B	Interface Circuits for TIA/EIA-644 (LVDS) (Rev. B)
SLLA053B	Performance of LVDS with Different Cables (Rev. B)
SLLA054A	LVDS Multidrop Connections (Rev. A)
SLLA065	A Comparison of LinBiCMOS and CMOS Process Technologies in LVDS ICs
SLLA082B	Active Fail-Safe in TI's LVDS Receivers (Rev. B)
SLLA100	Increase Current Drive Using LVDS
SLLA101	Interfacing Different Logic with LVDS Receivers
SLLA103	LVPECL and LVDS Power Comparison
SLLA104	Suggestions for LVDS Connections
SLLA105	DSP to DSP Link Using LVDS
SLLA107	Live Insertion with Differential Interface Products
SLLA147	Suitable LVDS Architectures

Literature Number	Description	
Application Notes		
SCAA059	AC-Coupling Between Differential LVPECL, LVDS, HSTL, and CML	
SCAA062	DC-Coupling Between Differential LVPECL, LVDS, HSTL, and CML	
Part Number	**Description**	**Price***
Evaluation Modules (EVM)		
SN65LVDS31-32EVM	Evaluation Module for LVDS31 and LVDS32	49.00
SN65LVDS31-32BEVM	Evaluation Module for LVDS31 and LVDS32B	49.00
SN65LVDS31-33EVM	Evaluation Module for LVDS31 and LVDS33	49.00
SN65LVDS386EVM	SN65LVDS386 Evaluation Module	49.00
SN65LVDS387EVM	SN65LVDS387 Evaluation Module	49.00
SN65LVDS100EVM	SN65LVDS100 Evaluation Module	49.00
SN65LVDS20EVM	SN65LVDS20 Evaluation Module	99.00
SN65CML20EVM	SN65CML20 Evaluation Module	49.00
SN65LVCP22-23EVM	SN65LVCP22 Evaluation Module	25.00
SN65LVDS122EVM	SN65LVDS122 Evaluation Module	49.00
SN65LVDS250EVM	SN65LVDS250 Evaluation Module	49.00

*Note: IBIS models are available at **interface.ti.com***
**Suggested resale price in U.S. dollars.*

PECL/ECL Buffers/Translators Selection Guide

Device	No of Rx	No of Tx	Input Signal	Output Signal	Frequency	Tpd typ (pS)	I_{CC} Max (mA)	ESD HDM (kV)	Supply Voltage (V)	Package(s)	Pinout	Price*
SN65EL11	2	1	ECL/PECL	ECL/PECL	1.25 GHz	265	32	3	5.0	8SOIC, 8TSSOP	MC10EL11, MC100EL11	Web
SN65EL16	1	1	ECL	TTL	2 GHz	250	23	3	5.0	8SOIC, 8TSSOP	MC10EL16, MC100EL16	Web
SN65ELT20	1	1	TTL	PECL	500 Hz	820	16	3	5.0	8SOIC, 8TSSOP	MC10ELT20, MC100ELT20	Web
SN65ELT21	1	1	TTL	PECL	150 Hz	3000	25	3	5.0	8SOIC, 8TSSOP	MC10ELT21, MC100ELT21	Web
SN65ELT22	2	2	TTL	PECL	500 Hz	1200	22	3	5.0	8SOIC, 8TSSOP	MC10ELT22, MC100ELT22	Web
SN65ELT23	2	2	TTL	PECL	150 Hz	3500	35	3	5.0	8SOIC, 8TSSOP	MC10EL23, MC100EL23	Web
SN65EPT22	2	2	LVTTL	LVPECL	1.25 GHz	420	56	3	3.3	8SOIC, 8TSSOP	MC10LVEL23, MC100LVEL23	Web
SN65LVEL11	2	1	ECL	ECL	1.5 GHz	265	26	3	2.5-3.3	8SOIC, 8TSSOP	MC10LVEL11, MC100LVEL11	Web
SN65LVELT22	2	2	LVTTL	LVPECL	400 Hz	350	29	3	3.3	8SOIC, 8TSSOP	MC10LVEL22, MC100LVEL22	Web
SN65LVELT23	2	2	LVPECL	LVTTL	100 Hz	3500	29	3	3.3	8SOIC, 8TSSOP	MC10LVELT23, MC100LVELT23	Web
SN65LVEP11	2	1	ECL/PECL	ECL/PECL	3 GHz	240	29	3	2.5-3.3	8SOIC, 8TSSOP	MC10LVEP11, MC100LVEP11	Web

LVDS/LVPECL/CML Repeaters/Translators and Crosspoints Selection Guide

Device[1]	Description	No. of Tx	No. of Rx	Input Signal	Output Signal	Signaling Rate (Mbps)	Jitter Max (ps)	Part-to-Part Skew Max	Tx tpd Typ (ns)	Rx typd Typ (ns)	I_{CC} Max (mA)	ESD HBM (kV)	Package(s)	Price*
Crosspoint Switch Family														
SN65LVCP22	2X2 Crosspoint Switch: LVDS Outputs	2	2	LVPECL, LVDS, CML	LVDS	1000	105	100	0.65	0.65	85	5	16SOIC, 16TSSOP	2.70
SN65LVCP23	2X2 Crosspoint Switch: LVPECL Outputs	2	2	LVPECL, LVDS, CML	LVPECL	1300	100	100	0.65	0.65	65	5	16SOIC, 16TSSOP	5.20
SN65LVCP40	Dual 1:2 Mux with Equalizer and Pre-Emphasis	6	6	LVPECL, LVDS, CML	CML	4000	30	500	1	1	254	4	48QFN	17.40
SN65LVCP402	2X2 Crosspoint Switch with Rx-Eq	2	2	CML	VML	4250	30	300	0.5	0.5	115	4	24QFN	7.15
SN65LVCP404	4X4 Crosspoint Switch with Rx-Eq	4	4	CML	VML	4250	30	300	0.5	0.5	220	4	48QFN	10.55
SN65LVDS122[2]	2X2 Crosspoint Switch: LVDS Output	2	2	LVPECL, LVDS, CML	LVDS	1500	65	150	0.9	0.9	100	4	16SOIC, 16TSSOP	4.75
SN65LVDS250[2]	4X4 Crosspoint Switch: LVDS Output	4	4	LVPECL, LVDS, CML	LVDS	2000	50	150	0.9	0.9	145	3	38TSSOP	8.30
Repeaters/Translators														
SN65CML100	LVDS/LVPECL/CML-to-CML Repeater/Translator	1	1	LVPECL, LVDS, CML	CML	1500	70	100	0.8	—	12	5	8SOIC, 8VSSOP	2.55
SN65LVDS100	LVDS/LVPECL/CML to LVDS Repeater/Translator	1	1	LVPECL, LVDS, CML	LVDS	2000	65	100	0.8	—	30	5	8SOIC, 8VSSOP	2.55
SN65LVDS101	LVDS/LVPECL/CML-to-LVPECL Repeater/Translator	1	1	LVPECL, LVDS, CML	LVPECL	2000	65	100	0.9	—	90	5	8SOIC, 8VSSOP	2.55
SN65LVDS16/17	2.5-V/3.3-V Oscillator Gain Stage/Buffer (single ended/diff inputs)	1	1	LVPECL	LVDS	2000	10	130	0.63	—	48	2	8QFN	2.55
SN65LVDS18/19	2.5-V/3.3-V Oscillator Gain Stage/Buffer (single ended/diff inputs)	1	1	LVPECL	LVDS	1000	10	130	0.63	—	36	2	8QFN	1.95
SN65LVDS20	2.5-V/3.3-V LVDS Repeater with Enable	1	1	LVPECL	LVDS	4000	45	130	0.63	—	45	3	8QFN	3.30
SN65LVP16/17	2.5-V/3.3-V Oscillator Gain Stage/Buffer (single ended/diff inputs)	1	—	LVPECL	LVPECL	2000	10	130	0.63	—	30	2	8QFN	2.55
SN65LVP18/19	2.5-V/3.3-V Oscillator Gain Stage/Buffer (single ended/diff inputs)	1	—	LVPECL	LVPECL	1000	10	130	0.63	—	20	2	8QFN	1.95
SN65LVP20	2.5-V/3.3-V LVPECL	1	1	LVPECL	LVPECL	4000	10	130	0.63	—	45	3	8QFN	4.40

[1]Supply voltage for all devices listed above is 3.3 V. [2]Integrated termination available (100-Ω) – SN65LVDTxxx.

*New products are listed in **bold red.***

**Suggested resale price in U.S. dollars in quantities of 1,000.*

LVDS Selection Guide

Device	Description	No. of Tx	No. of Rx	Input Signal	Output Signal	Signaling Rate (Mbps)	Part-to-Part Skew Max (ps)	Tx tpd Typ (ns)
Single Family								
SN65LVDS1	Driver	1	—	LVTTL	LVDS	630	—	1.7
SN65LVDS2	Receiver	—	1	LVDS	LVTTL	400	—	1.7
SN65LVDS179	Full-Duplex Transceiver, No Enables	1	1	LVDS, LVTTL	LVTTL, LVDS	400Tx/150Rx	—	1.7
SN65LVDS180	Full-Duplex Transceiver, with Enables	1	1	LVDS, LVTTL	LVTTL, LVDS	400Tx/150Rx	—	1.7
Dual Family								
SN65LVDS9638	Driver	2	—	LVTTL	LVDS	400	800	1.7
SN65LVDS9637	Receiver	—	2	LVDS	LVTTL	400Tx/150Rx	1000	—
SN65LVDS049	Transceiver, Driver and Receiver Enable	2	2	LVDS, LVTTL	LVTTL, LVDS	400	100	1.3
SN65LVDS050	Transceiver, Driver and Receiver Enable	2	2	LVDS, LVTTL	LVDS, LVTTL	400Tx/150Rx	—	1.7
SN65LVDS051	Transceiver, Driver Enable Only	2	2	LVDS, LVTTL	LVDS, LVTTL	400Tx/150Rx	—	1.7
SN65LVDS1050	Transceiver with 2.7-V Supply	2	2	LVDS, LVTTL	LVTTL, LVDS	400Tx/150Rx	—	1.7
SN65LVDS22	Multiplexed LVDS Repeater	2	2	LVDS	LVDS	250	—	4
Quad Family								
SN65LVDS047	Driver with Flow-Through Pinout	4	—	LVTTL	LVDS	400	1000	1.8
SN65LVDS31	Driver, AM26LS31 Footprint	4	—	LVTTL	LVDS	400	800	1.7
SN65LVDS3487	Driver, MC34987 Footprint	4	—	LVTTL	LVDS	400	800	1.7
SN65LVDS391	Driver with Flow-Through Pinout	4	—	LVTTL	LVDS	630	1500	1.7
SN65LVDS048A	Receiver with Flow-Through Pinout	—	4	LVDS	LVTTL	400	1000	—
SN65LVDS32	Receiver, AM26LS32 Footprint	—	4	LVDS	LVTTL	400Tx/150Rx	1000	—
SN65LVDS3486	Receiver, MC3486 Footprint	—	4	LVDS	LVTTL	400Tx/150Rx	1000	—
SN65LVDS390	Receiver with Flow-Through Pinout	—	4	LVDS	LVTTL	630	1000	—
8-Channel Family								
SN65LVDS389	Driver	8	—	LVTTL	LVDS	630	1500	1.7
SN65LVDS388A[1]	Receiver	—	8	LVDS	LVTTL	630	1000	
16-Channel Family								
SN65LVDS387	Driver	16	—	LVTTL	LVDS	630	1500	1.7
SN65LVDS386	Receiver	—	16	LVDS	LVTTL	630	1000	—

[1] *Integrated termination available (100-Ω) – SN65LVDTx.*

LVDS Selection Guide

Device	Rx tpd Typ (ns)	I_{CC} Max (mA)	ESD HBM (kV)	Supply Voltage (V)	Package(s)	Price*
Single Family						
SN65LVDS1	—	8	15	3.3	8SOIC, 5SOP	0.47
SN65LVDS2	2.6	7	15	3.3	8SOIC, 5SOP	0.47
SN65LVDS179	3.7	12	12	3.3	8SOIC, 8VSSOP	1.35
SN65LVDS180	3.7	12	12	3.3	14SOIC, 14TSSOP	1.35
Dual Family						
SN65LVDS9638	—	13	8	3.3	8HTSSOP, 8SOIC, 8VSSOP	1.15
SN65LVDS9637	2.1	10	8	3.3	8HTSSOP, 8SOIC, 8VSSOP	1.15
SN65LVDS049	1.9	35	10	3.3	16TSSOP	1.00
SN65LVDS050	3.7	20	12	3.3	16SOIC, 16TSSOP	2.00
SN65LVDS051	3.7	20	12	3.3	16SOIC, 16TSSOP	2.00
SN65LVDS1050	3.7	20	12	2.7	16TSSOP	2.00
SN65LVDS22	4	20	12	3.3	16SOIC, 16TSSOP	2.80
Quad Family						
SN65LVDS0 47	—	26	8	3.3	16SOIC, 16TSSOP	1.30
SN65LVDS31	—	35	8	3.3	16SOIC, 16TSSOP, 16SOP	1.50
SN65LVDS3487	—	35	8	3.3	16SOIC	1.50
SN65LVDS391	—	26	15	3.3	16SOIC, 16TSSOP	1.50
SN65LVDS048A	2.4	15	10	3.3	16SOIC, 16TSSOP	1.30
SN65LVDS32	2.1	18	8	3.3	16SOIC, 16TSSOP, 16SOP	1.50
SN65LVDS3486	2.1	18	8	3.3	16SOIC	1.50
SN65LVDS390	2.5	18	15	3.3	16SOIC, 16TSSOP	1.50
8-Channel Family						
SN65LVDS389	—	70	15	3.3	38TSSOP	2.90
SN65LVDS388A[1]	2.5	40	15	3.3	38TSSOP	2.90
16-Channel Family						
SN65LVDS387	—	95	15	3.3	64TSSOP	5.55
SN65LVDS386	2.5	70	15	3.3	64TSSOP	5.55

[1]Integrated termination available (100-Ω) – SN65LVDTx.
**Suggested resale price in U.S. dollars in quantities of 1,000.*

M-LVDS Features

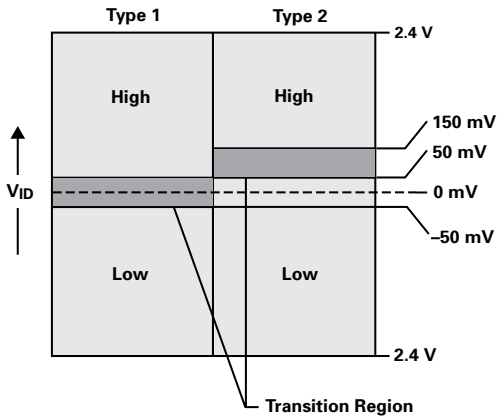
- TIA/EIA-899 standard
- Driver output current
  - 11.3 mA vs. 3.5 mA (LVDS)
- Receiver thresholds
  - 50 mV vs. 100 mV (LVDS)
- Driver edge rate control
  - 1 ns min allows ease-of-stub design
- Contention provisions
  - Driver short circuit limited to 43 mA
  - Drivers, receivers and disabled devices must limit their bus voltage from 0 to 2.4 V
  - Drivers are tested with 32 contending nodes

M-LVDS Devices from TI

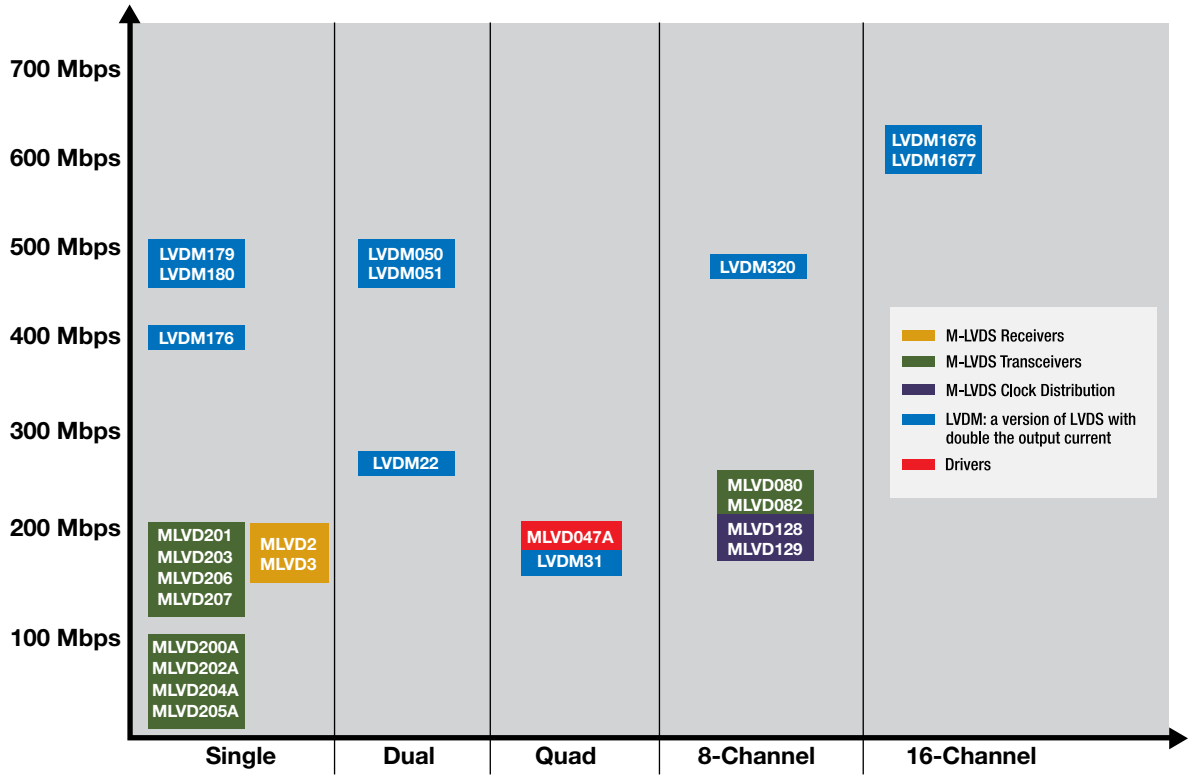
- TIA/EIA-899 standard compliant guarantees true multipoint
- Type 1 receivers: 25-mV hysteresis to prevent oscillation
- Type 2 receivers: internal failsafe (no external bias network)
- –1-V to 3.4-V common mode
- 3.3-V supply operation

M-LVDS for ATCA

- Synchronous ATCA clock signals (8 kHz, 19.22 MHz and user defined <100 MHz) use M-LVDS.



Receiver types.



M-LVDS Selection Guide

Device[1]	No. of Tx	No. of Rx	Rx Type	Half/ Full Duplex	Input Signal	Output Signal	Signaling Rate (Mbps)	Part-to-Part Skew Max (ps)	Tx tpd Typ (ns)	Rx tpd Typ (ns)	I_{CC} Max (mA)	ESD HBM (kV)	Package(s)	TIA/ EIA-899 Standard Compliance	Price*
SN65MLVD2	—	1	1	—	M-LVDS	LVTTL	200	1000	—	—	25	9	8SON	✔	1.95
SN65MLVD3	—	1	2	—	M-LVDS	LVTTL	200	1000	—	—	25	9	8SON	✔	1.95
SN65MLVD200A	1	1	1	Half	LVTTL, M-LVDS	LVTTL, M-LVDS	100	1000	2.5	3.6	24	8	8SOIC	✔	1.55
SN65MLVD201	1	1	1	Half	LVTTL, M-LVDS	LVTTL, M-LVDS	200	1000	1.5	4	24	8	8SOIC	✔	1.85
SN65MLVD202A	1	1	1	Full	LVTTL, M-LVDS	LVTTL, M-LVDS	100	1000	2.5	3.6	24	8	14SOIC	✔	1.55
SN65MLVD203	1	1	1	Full	LVTTL, M-LVDS	LVTTL, M-LVDS	200	1000	1.5	4	24	8	14SOIC	✔	1.85
SN65MLVD204A	1	1	2	Half	LVTTL, M-LVDS	LVTTL, M-LVDS	100	1000	2.5	3.6	24	8	8SOIC	✔	1.55
SN65MLVD205A	1	1	2	Full	LVTTL, M-LVDS	LVTTL, M-LVDS	100	1000	2.5	3.6	24	8	14SOIC	✔	1.55
SN65MLVD206	1	1	2	Half	LVTTL, M-LVDS	LVTTL, M-LVDS	200	1000	1.5	4	24	8	8SOIC	✔	1.85
SN65MLVD207	1	1	2	Full	LVTTL, M-LVDS	LVTTL, M-LVDS	200	1000	1.5	4	24	8	14SOIC	✔	1.85
SN65MLVD047	4	0	—	Half	LVTTL	M-LVDS	200	1000	1.5	—	60	12	16SOIC, 16TSSOP	✔	1.45
SN65MLVD128	8	1	—	—	LVTTL	M-LVDS	200	800	1.5	1.5	140	8	48TSSOP	✔	3.80
SN65MLVD129	8	2	—	—	LVTTL	M-LVDS	200	800	1.5	1.5	140	8	48TSSOP	✔	3.80
SN65MLVD080	8	8	1	Half	LVTTL, LVDS	LVTTL, M-LVDS	250	1000	2.4	6	180	8	64TSSOP	✔	4.75
SN65MLVD082	8	8	2	Half	LVTTL, LVDS	LVTTL, M-LVDS	250	1000	2.4	6	180	8	64TSSOP	✔	4.75
SN65LVDM179	1	1	—	Full	LVTTL, LVDM	LVTTL, LVDM	500	1000	1.7	3.7	15	12	8SOIC, 8VSSOP	—	1.70
SN65LVDM050[2]	2	2	—	Full	LVTTL, LVDM	LVTTL, LVDM	500	1000	1.7	3.7	27	12	16SOIC, 16TSSOP	—	2.20
SN65LVDM22	2	2	—	—	LVDM	LVDM	250	—	4	4	27	12	16SOIC, 16TSSOP	—	2.50
SN65LVDM31	4	0	—	—	LVCMOS	LVDM	150	1000	2.3	—	40	12	16SOIC	—	1.55
SN65LVDM1676	16	16	—	Half	LVTTL, LVDM	LVTTL, LVDM	630	1000	2.5	3	175	15	64TSSOP	—	7.75

[1]Supply voltage for all devices listed above is 3.3 V and temperature range is –40 to 85°C.
[2]Automotive version available, temperature range of –40 to 125°C
**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red.***

Resources For a complete list of resources (evaluation modules, data sheets and application notes), visit interface.ti.com

Literature Number	Description
Application Notes	
SLLA106	TIA/EIA-485 and M-LVDS, Power and Speed Comparison
SLLA088A	Transmission at 200 Mbps in VME Card Cage Using LVDM (Rev. A)
SLLA108	Introduction to M-LVDS (TIA/EIA-899)
SLLA121	Interoperability of M-LVDS and BusLVDS
SLLA119	Wired-Logic Signaling with M-LVDS
SLLA127	M-LVDS Signaling Rate Versus Distance
SLLA067A	Comparing Bus Solutions

Part Number	Description	Price*
Evaluation Modules (EVMs)		
MLVD20xEVM	M-LVDS Evaluation Module	99.00
SN65LVDM31-32BEVM	SN65LVDM31-32EVM Evaluation Module	49.00

*Note: IBIS models are available at **interface.ti.com***
**Suggested resale price in U.S. dollars.*

Design Considerations

Reliability — Proven reliability of silicon-dioxide (SiO_2) insulation; stable over temperature and moisture; life span > 25 years.

Highest Noise Immunity— Only TI uses differential signals to cross the isolation barrier. Giving the highest immunity from external magnetic and electric fields to prevent data corruption.

Signaling Rate — TI offers digital isolators with the highest signaling rates of up to 200 Mbps. With the lowest skew and pulse distortion of only 1 ns.

Lowest Jitter — To ensure signal integrity, jitter reduction is a priority. ISO72xx products offer the lowest jitter with 1-ns jitter at 150-Mbps PRBS NRZ data input.

Key Features

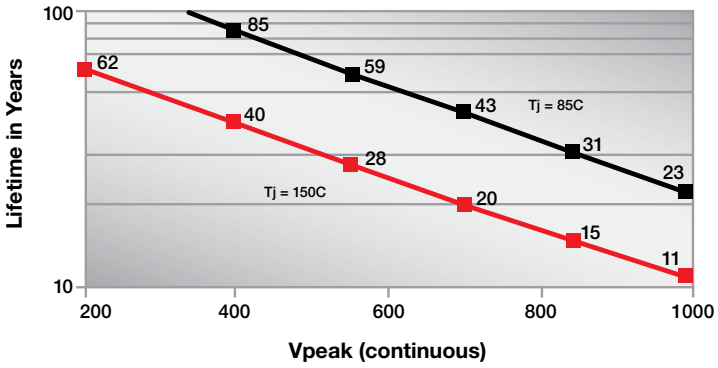
- 4000-V_{peak} isolation
  - UL 1577, IEC 60747-5-2 (VDE 0884, Rev. 2)
  - IEC 61010-1 and CSA approved
  - 50-kV/µs transient immunity
- Signaling rate: 0 Mbps to 200 Mbps
  - Passes DC single levels
  - Low pulse skew (pulse-width distortion)
- –40° to 125°C operation
- Low-input current requirement of 10 µA
- Fail-safe output

Technical Information

The ISO72xx is a family of digital isolators using the industry's first application of silicon-based digital capacitive isolation technology. Digital buffers capacitively couple data signals through a dual SiO_2 insulation barrier, which provides galvanic isolation of up to 4000 V. The device receives digital inputs and provides clean digital outputs while preventing noise currents and/or excessive voltages from entering the local ground.

TI produces the SiO_2 insulation in TI isolation devices in semiconductor fabrication process producing a near zero defect glass insulation layer. Then the input signal crosses this isolation barrier, as a differential signal to insure the highest immunity to external noise. All these features come together to make the longest lasting, most reliable isolation devices on the market.

TI ISO Life Expectancy vs. Voltage



Device	Description	Isolation Rating (UL, VDE, CSA)	Channel Direction	Data Rate (Max) Mbps	Transient Immunity (Min) (kV/µs)	Supply Voltage (V)	Price*
Digital Isolators							
ISO721/M	Single Channel (TTL)	4000 V	1/0	100/150	25	3.3, 5	1.40
ISO722/M	Single Channel, OUT EN	4000 V	1/0	100/150	25	3.3, 5	1.40
ISO150	Dual Channel Configurable	2400 V_{rms}	Config	80	1.6	5	8.10
ISO7220/A/B/C/M	Dual Channel	4000 V	2/0	1/5/25/150	25	3.3, 5	0.95
ISO7221/A/B/C/M	Dual Channel	4000 V	1/1	1/5/25/150	25	3.3, 5	0.95
ISO7230/A /C/M	Triple Channel	4000 V	3/0	1/25/150	25	3.3, 5	1.50
ISO7231/A/C/M	Triple Channel	4000 V	2/1	1/25/150	25	3.3, 5	1.50
ISO7240/A/C/M	Quad Channel	4000 V	4/0	1/25/150	25	3.3, 5	1.90
ISO7241/A/C/M	Quad Channel (TTL)	4000 V	3/1	1/25/150	25	3.3, 5	1.90
ISO7242/A/C/M	Quad Channel	4000 V	2/2	1/25/150	25	3.3, 5	1.90
ISO3082/ISO3088	Isolated Half Duplex RS-485	4000 V	2/1	0.2/20	25	5	3.25
ISO3080/ISO3086	Isolated Full Duplex RS-485	4000 V	2/1	0.2/20	25	5	3.25
ISO15/**ISO13**	Isolated Half Duplex RS-485	4000 V	2/1	1/20	25	3.3	3.00
ISO35/**ISO33**	Isolated Full Duplex RS-485	4000 V	2/1	1/20	25	3.3	3.00
ISO1176	Isolated PROFIBUS	4000 V	2/1	40 Mbps	25	5	3.35
ISO1050	Isolated CAN Transceiver	4000 V	1/1	1 Mbps	25	5	2.00
AMC1203	Isolated 2nd-Order ΔΣ Modulator	4000 V	N/A	10 Mbps	25	5	2.50

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*Preview products are listed in **bold blue**.*

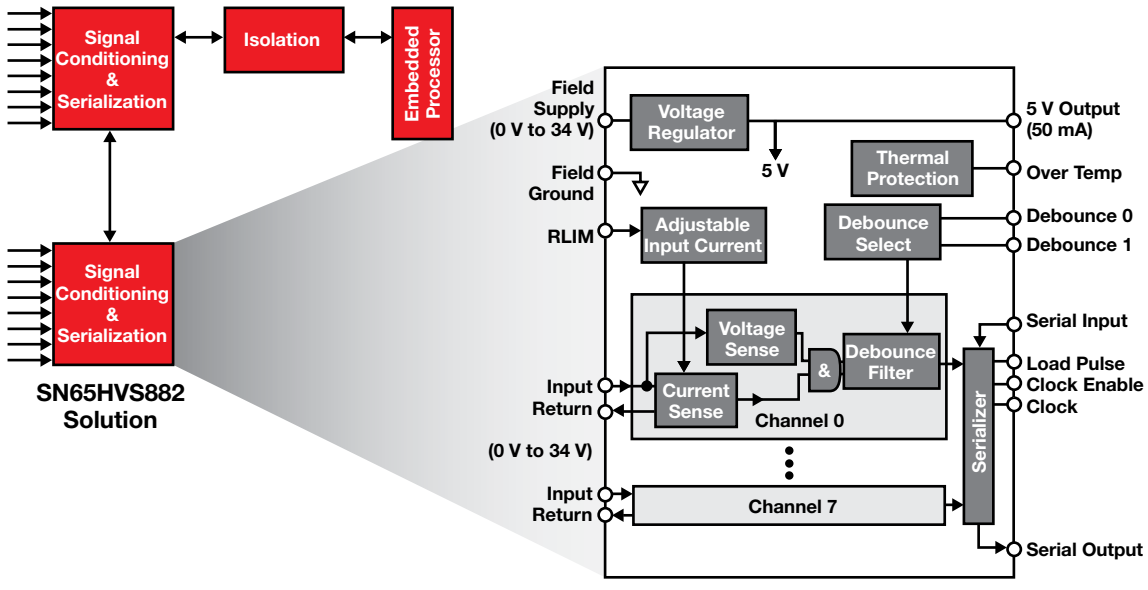
Industrial Serializers

The new industrial serializers convert eight digital inputs, ranging from 0 V to 34 V, into a single data stream on SPI interface, which simplifies the design and saves 60% overall board space for industrial automation and test and measurement equipment. The device's adjustable input current limit allows the use of a single resistor to set the maximum input current in the range of 200 µA to 5 mA, which reduces system-level power dissipation by more than 50% typical industrial applications. There are also other features like an integrated voltage regulator and adjustable debounce glitch filter to make your system design simpler and more cost effective. Devices can be cascaded together for systems with greater than 160 inputs.

Device	Description	Operating Voltage (V)	I/O Voltage (V)	Parity	Input Data Rate (Mbps)	Temperature Range Max	Low Voltage Detector	Price*
Industrial Eight-Channel Digital Serializes								
SN65HVS880	Nominal 24-V systems	18 to 30	0 to 30	No	1	–40 to 85	Yes – 15 V	2.75
SN65HVS882	10-V to 34-V digital-input	10 to 34	0 to 34	No	1	–40 to 125	No	3.00
SN65HVS884	0-V to 34-V serializer with parity	10 to 34	0 to 34	Yes	1	–40 to 125	No	3.10

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*Preview products are listed in **bold blue**.*



SN65HVS882, the industry's first eight-channel, 34-V digital-input serializer.

Design Considerations

Interoperability — In general, RS-485 is a superset of RS-422. Compliance with the TIA/EIA standard will ensure reliable data communication in a variety of networks, including Modbus, INTERBUS, PROFIBUS, BACnet and a variety of proprietary protocols.

Robustness — RS-485 is a robust interface standard for use in industrial environments. It features a wide common mode range of –7 V to 12 V. Parts from TI are available with ESD protection up to 30 kV.

Reliability — Integrated fail-safe circuitry protects the bus from interpreting noise as valid data when short-circuit, open-circuit or idle line fault conditions occur.

Speed and Distance — Low noise coupling of differential signaling with twisted-pair cabling and wide common-mode voltage range allows data exchange at signaling rates of up to 50 Mbps or to distances of several kilometers at lower rates.

Line Loading — RS-422 is capable of supporting one driver and up to 10 receivers on the bus line. Standard RS-485 is capable of supporting up to 32 unit loads or nodes on the bus line. However, there are reduced unit load devices available that can support up to 256 devices.

Termination — A multipoint bus architecture requires termination at both ends of the bus line. The termination resistors must be within 20 percent of the characteristic impedance of the cable and can vary from 90 W to 120 W.

Technical Information

- The main difference between RS-422 and RS-485 is the multidrop and multipoint bus architecture—that is, one driver to many receivers and many drivers to many receivers, respectively.
- Typical signaling rates and distances for these standards are up to 10 Mbps or up to 1.2 km. TI offers devices capable of reaching signaling rates of up to 50 Mbps.

Resources For a complete list of resources (evaluation modules, data sheets and application notes), visit interface.ti.com

Literature Number	Description
Application Notes	
SLLA036B	Interface Circuits for TIA/EIA-485 (RS-485)
SLLA070C	422 and 485 Standards Overview and System Configurations
SLLA112	RS-485 for E-Meter Applications
SLLA177	PROFIBUS Electrical-Layer Solutions
SLLA169	Use Receiver Equalization to Extend RS-485 Data Communications
SLLA143	RS-485 for Digital Motor Control Applications

Note: IBIS models are available at interface.ti.com

RS-422/485 Selection Guide

No. of Dr/Rx		Supply (V)	Device	Features	Signaling Rate (Mbps)	ESD (kV)	Receiver Fail-Safe	Nodes	Package(s)	Price*
1/1		3.3	HVD12/11/10	3.3-V Supply – Low/Mid High-Speed Slew-Rate Control	1 / 10 / 32	15	Short, Open, Idle	256	8-PDIP/SOIC	1.30
	Full		HVD32 /31 /30	3.3-V Supply, No Enables	25 / 5 / 1	15	Short, Open, Idle	256	8-SOIC	1.35
			HVD35 /34 /33	3.3-V Supply, with Enables	25 / 5 / 1	15	Short, Open, Idle	256	14-SOIC	1.35
		3 to 5	HVD08	Wide Supply Range: 3V to 5.5V	10	15	Short, Open, Idle	256	8-PDIP/SOIC	1.90
			HVD178x 0/1/2	±70-V Protected, Wide Supply Range: 3V to 5.5V	.115 / 1 / 10	16	Short, Open, Idle	320	8-PDIP/SOIC	1.85
		5	**HVD178x 5/6/7**	±70-V Protected, Wide –20V to +25V Common Mode	.115 / 1 / 10	16	Short, Open, Idle	256	8-PDIP/SOIC	1.85
			HVD1794	±70-V Protected, Bus-Pin Invert/Wide Common	.115 / 1 / 10	16	Short, Open, Idle	256	8-PDIP/SOIC	1.85
			HVD308x 2/5/8E	Ultra-Low Power, Optimized for Low & High Speeds	0.2 / 1 / 20	15	Short, Open, Idle	256	8-PDIP/SOIC/MSOP	0.90
			ISO308x 2/8	±4-kV Isolated RS-485 Optimized for Low & High Speeds	0.2 / 20	16	Short, Open, Idle	256	16-Wide SOIC	2.60
			HVD485E	Half Duplex Transceiver	10	15	Open	64	8-PDIP/SOIC/MSOP	0.70
			HVD1176	PROFIBUS Transceiver, EN 50170	40	10	Short, Open, Idle	160	8-SOIC	1.55
			HVD22/21/20	±27-V Protected and –20V to +25V Common Mode	0.5 / 5 / 25	16	Short, Open, Idle	256	8-PDIP/SOIC	1.40
			HVD24/23	Receiver Equalization Allows Faster to Go Further	3 / 25	16	Short, Open, Idle	256	8-PDIP/SOIC	1.80
			LBC176A	Low Power, Fast Signaling, ESD Protection	30	12	Open	32	8-PDIP/SOIC	1.20
			LBC184	ESD Protection IEC 4-2 Air, Contact & IEC 4-5 Surge	0.25	30	Open	128	8-PDIP/SOIC	1.30
			LBC182	ESD Protection HBM, IEC4-2 Air and Contact	0.25	15	Open	128	8-PDIP/SOIC	1.05
	Full		**HVD1791**	±70-V Protected, Wide –20V to +25V Common Mode	0.115	16	Short, Open, Idle	256	14-SOIC	1.90
			HVD308x 0/3/6E	Ultra-Low Power, Optimized for Low & High Speeds	0.2 / 1 / 20	15	Short, Open, Idle	256	14-SOIC	1.10
			ISO308x 0/6	±4-kV Isolated, Optimized for Low & High Speeds	0.2 / 20	16	Short, Open, Idle	256	16-Wide SOIC	2.60
			LBC180A	High Signaling Rate, w/Enables	30	12	Short, Open, Idle	32	14-PDIP/SOIC	1.35
4/0			LBC172A, 174A	Quad Drivers, High Signaling Rate	30	13	—	32	16-PDIP/SOIC	2.40
		3.3	AM26LV31E	Quad Drivers, High Signaling Rate, IEC4-2 ESD	64	15	—	10	16-SO/SOIC/ TSSOP/QFN	0.90
0/4		5	LBC173A, 175A	Quad Receivers, High Signaling Rate, Low Power	50	6	Short, Open, Idle	32	16-PDIP/SOIC	1.40
		3.3	AM26LV32E	Quad Receivers, High Signaling Rate, IEC4-2 ESD	64	15	Short, Open, Idle	—	16-SO/SOIC/ TSSOP/QFN	1.01
9/9		5	**HVD09**	9-Channel Parallel Bus Transceivers	20	12	Open	32	56-TSSOP	3.50

[1] *These devices use the temperature prefixes: SN55 = military (–55° C to 125° C); SN65 = industrial (–40° C to 85° C); SN75 = commercial (0° C to 70° C).*

*New products are listed in **bold red**.*

**Suggested resale price in U.S. dollars in quantities of 1,000.*

ControlNet™ Transceiver

Device	Description	Supply Voltage (V)	I_{CC} (max) (mA)	Operating Temp Range (°C)	Package
SN65HVD61	ControlNet™ Transceiver	5	65	–40 to 100	14 SOIC

RS232: IEC6100-4-2 (Level 4) ESD-Protected Devices

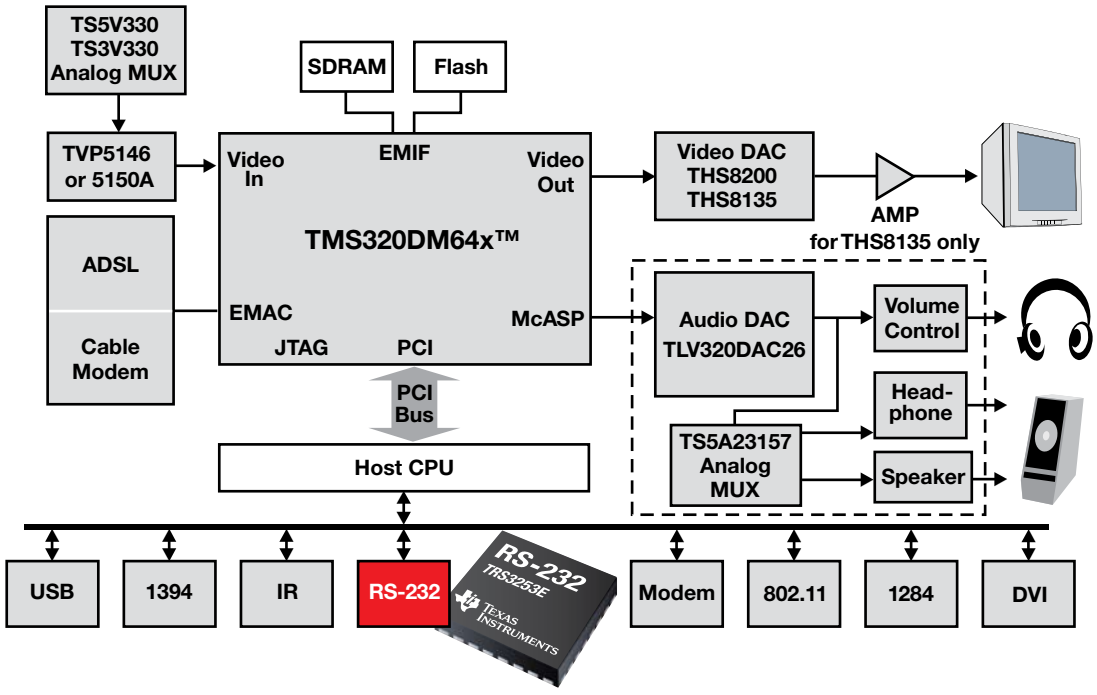
TI offers new RS-232 devices with system-level IEC61000-4-2 electrostatic discharge (ESD) protection. This protection makes the RS-232 interface immune to damage from ESD strikes that may occur while the system is up and running, such as when a connection to the RS-232 cable is made. These devices are drop-in replacements and are functionally identical to the existing industry-standard solutions, providing a seamless transition in the qualification process. These devices meet the requirements for low-power, high-speed applications such as portable/consumer, telecom and computing equipment.
TI offers these new devices in the NiPdAu Pb-Free finish, which eliminates tin whiskers that might compromise long-term system reliability. TI offers the space-saving QFN package on select devices in addition to its already extensive RS-232 portfolio.

Key Features

- No external ESD device needed with these system-level ESD ratings:
  - ±15-kV human-body model (HBM)
  - ±8-kV IEC61000-4-2, contact discharge
  - ±15-kV IEC61000-4-2, air-gap discharge
- Improved drop-in replacement of popular RS-232 devices
- Data rates meet or exceed today's high-speed-application requirements
- Flexible power-saving options enable longer battery life
- Wide portfolio permits selection of the right form, fit and functionality
- Industry-leading interface product space with assured source of supply
- NiPdAu Pb-Free solution provides whisker-free, reliable package options
- Space-saving QFN package options for portable applications

Applications

- The three-driver, five-receiver TRS3243E is most popular in applications like PCs, notebooks and servers.
- The TRS3238E/37E offer complementary five-driver, three-receiver solutions. These two devices are popular in PC peripheral applications like data cables, printers, modems, industrial control, etc.
- The TRS3227E/23E/22E/21E are popular in portable handheld applications due to their reduced bit count, package size and low power consumption.
- Higher-speed versions like the SNx5C3232E/23E/22E/21E meet today's higher throughput needs through the serial interface.
- The TRS232E and TRS213 provide a higher noise margin for more rugged environments such as industrial control.



Personal video recorder application block diagram.

RS-232 Selection Guide

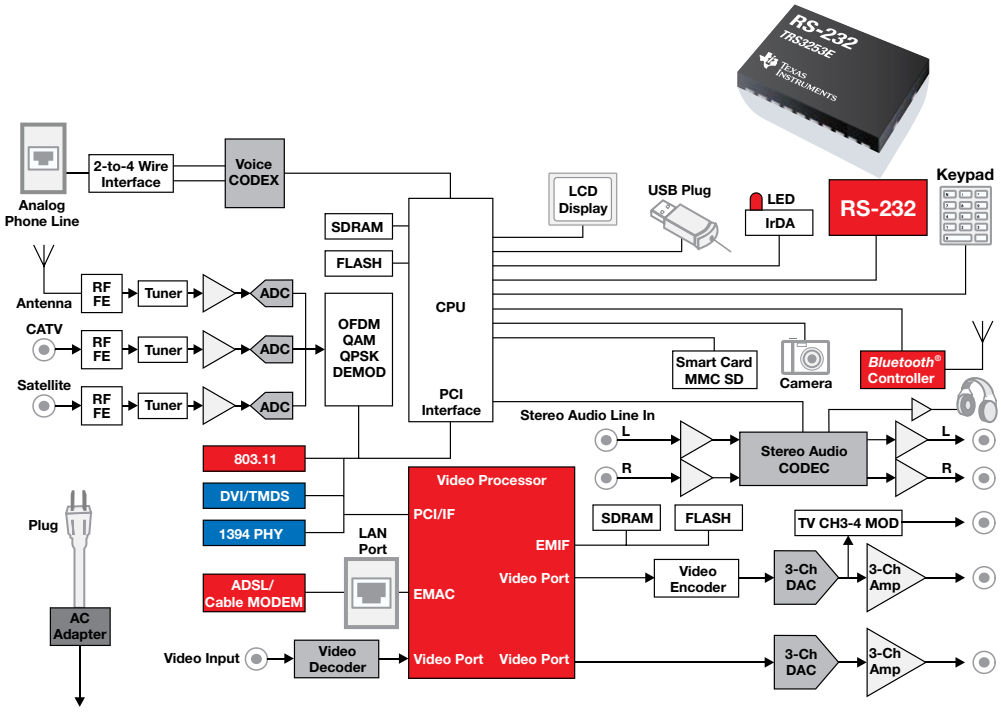
Device	Data Rate (kbps)	Drivers	Receivers	ESD HBM (kV)	Supply Voltage(s) (V)	I_{CC} (max) (mA)	Package(s)	Price*
TRS202E	120	2	2	IEC61000-4-2	5	15	16PDIP, 16SOIC, 16TSSOP	0.54
TRS207	120	5	3	±15	5	20	24SOIC, 24SSOP	1.08
TRS208	120	4	4	±15	5	20	24SOIC, 24SSOP	1.08
TRS211	120	4	5	±15	5	20	28SOIC, 28SSOP	1.08
TRS213	120	4	5	15	5	20	28SOIC, 28SSOP	1.08
TRS222	200	2	2	±15	5	10	18PDIP, 18SOIC	1.26
TRS232E	250	2	2	IEC61000-4-2	5	10	16PDIP, 16SOIC, 16TSSOP	0.58
TRS3221E	250	1	1	IEC61000-4-2	5	1	16SSOP, 16TSSOP	0.88
TRS3222E	250	2	2	IEC61000-4-2	5	1	20SOIC, 20SSOP, 20TSSOP	1.28
TRS3223E	250	3	3	IEC61000-4-2	5	1	20SOIC, 20SSOP, 20TSSOP	1.12
TRS3227E	1000	1	1	IEC61000-4-2	5	1	16SSOP	1.20
TRS3232E	250	2	2	IEC61000-4-2	5	0.3	16SOIC, 16SSOP, 16TSSOP	0.96
TRS3237E	1000	5	3	IEC61000-4-2	5	1	28SOIC, 28SSOP, 28TSSOP	1.33
TRS3238E	250	5	3	IEC61000-4-2	5	1	28SOIC, 28SSOP, 28TSSOP	1.20
TRS3243E	500	3	5	IEC61000-4-2	5	1	28SOIC, 28SSOP, 28TSSOP, 32QFN	0.88
TRS3253E	1000	3	5	IEC61000-4-2	3.3 or 5	1	32QFN	Web
TRS3318E	460	2	2	IEC61000-4-2	5	1	20SSOP, 20TSSOP	1.68
TRS3386E	250	3	2	IEC61000-4-2	5	1	20SOIC, 20TSSOP	1.92
TRSF23243	250	3	5	±15	5	1	48SSOP, 48TSSOP	3.42
TRSF3221E	1000	1	1	IEC61000-4-2	5	1	16SSOP, 16TSSOP	1.26
TRSF3222E	1000	2	2	IEC61000-4-2	5	1	20SOIC, 20SSOP, 20TSSOP	1.44
TRSF3223E	1000	2	2	IEC61000-4-2	5	1	20SOIC, 20SSOP, 20TSSOP	1.44
TRSF3232	1000	2	2	±15	5	1	16SOIC, 16SSOP, 16TSSOP	1.26
TRSF3238E	1000	5	3	IEC61000-4-2	5	2	28SOIC, 28SSOP	1.62
TRSF3243	1000	3	5	±15	5	1	28SOIC, 28SSOP, 28TSSOP	1.62
TRSF3253	1000	3	5	±15	5	1	28SOIC, 28SSOP, 28TSSOP	1.62
GD65232	120	3	5	—	±9, 5	38	20PDIP, 20SOIC, 20SSOP, 20TSSOP	0.29
GD75232	120	3	5	—	±9, 5	30	20PDIP, 20SOIC, 20SSOP, 20TSSOP	0.27
GD75323	120	5	3	—	±12, 5	32	20SOIC	0.41
LT1030	120	4	—	—	±5	1	14PDIP, 14SOIC	1.44
MC1488	120	4	—	—	±9	25	14PDIP	0.20
MC1489	120	—	4	—	5	26	14PDIP	0.25
MC1489A	120	—	4	—	5	26	14PDIP	0.29
SN65C1154	120	4	4	—	—	—	20PDIP	3.42
SN65C1406	120	3	3	—	±12, 5		16SOIC	1.80
SN75150	120	2	—	2	±12	22	8PDIP, 8SOIC	0.72
SN75154	120	4	4	—	5 or 12	35	16PDIP, 16SO, 16SOIC	0.72
SN75155	120	1	1	2	±12	14	8PDIP, 8SOIC	0.72
SN751701	120	1	1	—	±5, 9, 12	11.9	8SO	1.30
SN75185	120	3	5	10	±12, 5	30	20PDIP, 20SOIC, 20SSOP, 20TSSOP	0.45
SN75186	120	1	1	—	±12, 5		24SOIC	1.80
SN75188	120	4	—	2	±9	25	14PDIP, 14SO, 14SOIC	0.22
SN75189	120	—	4	—	5	26	14PDIP, 14SO, 14SOIC	0.22
SN75189A	120	—	4	—	5	26	14PDIP, 14SO, 14SOIC	0.22
SN75196	120	5	3	10	±12, 5	20	20PDIP, 20SOIC	0.68
SN752232	120	6	10	—	5	±50	48SSOP, 48TSSOP	0.90

**Suggested resale price in U.S. dollars in quantities of 1,000.*

RS-232 Selection Guide (Continued)

Device	Data Rate (kbps)	Drivers	Receivers	ESD HBM (kV)	Supply Voltage(s) (V)	I_{CC} (max) (mA)	Package(s)	Price*
SN75C1154	120	4	4	—	±12, 5	—	20PDIP, 20SO, 20SOIC	0.76
SN75C1406	120	3	3	2	±12, 5	0.45	16PDIP, 16SO, 16SOIC	0.86
SN75C185	120	3	5	2	±12, 5	0.75	20PDIP, 20SOIC	1.08
SN75C188	120	4	—	2	±12	0.16	14PDIP, 14SO, 14SOIC, 14SSOP	0.31
SN75C189	120	—	4	—	5	0.7	14PDIP, 14SO, 14SOIC	0.31
SN75C189A	120	—	4	—	5	0.7	14PDIP, 14SO, 14SOIC, 14SSOP	0.31
SN75C198	120	4	—	—	±12	0.32	14PDIP, 14SOIC	2.25
SN75C23243	250	6	10	15	3.3 or 5	0.02	48SSOP, 48TSSOP	3.42
SN75LBC187	120	3	5	—	5	30	28SSOP	3.60
SN75LBC241	100	4	5	—	5	8	28SOIC	2.16
SN75LP1185	256	3	5	15	5, ±12	1	20PDIP, 20SOIC, 20SSOP	1.78
SN75LP196	256	5	3	15	5, ±12	1	20PDIP, 20SOIC, 20SSOP, 20TSSOP	1.78
SN75LPE185	256	3	5	15	5, ±12	1	24PDIP, 24SOIC, 24SSOP, 24TSSOP	1.89
SN75LV4737A	128	3	5	4	3 or 5	20.7	28SSOP	2.61
TL145406	120	3	3	2	±12, 5	20	16PDIP, 16SOIC	0.94
UA9636A	120	2	—	—	±12	36	8PDIP, 8SOIC	0.36
UC5170C	120	—	—	—	—	—	28PLCC	3.15
UC5180C	120	—	8	—	4.75 to 5.25	35	28PLCC	3.00
UC5181C	120	—	8	—	4.75 to 5.25	35	28PLCC	3.15

**Suggested resale price in U.S. dollars in quantities of 1,000.*



PDA interface application block diagram.

Design Considerations

The UART is a key component of an asynchronous serial communications system. For example, all internal modems have their own UARTs. In this application, parallel data within the computer is converted by the UART to serial data before being transferred to the modem. In addition to PC/peripheral communication, UARTs can be used for chip-to-chip communications.

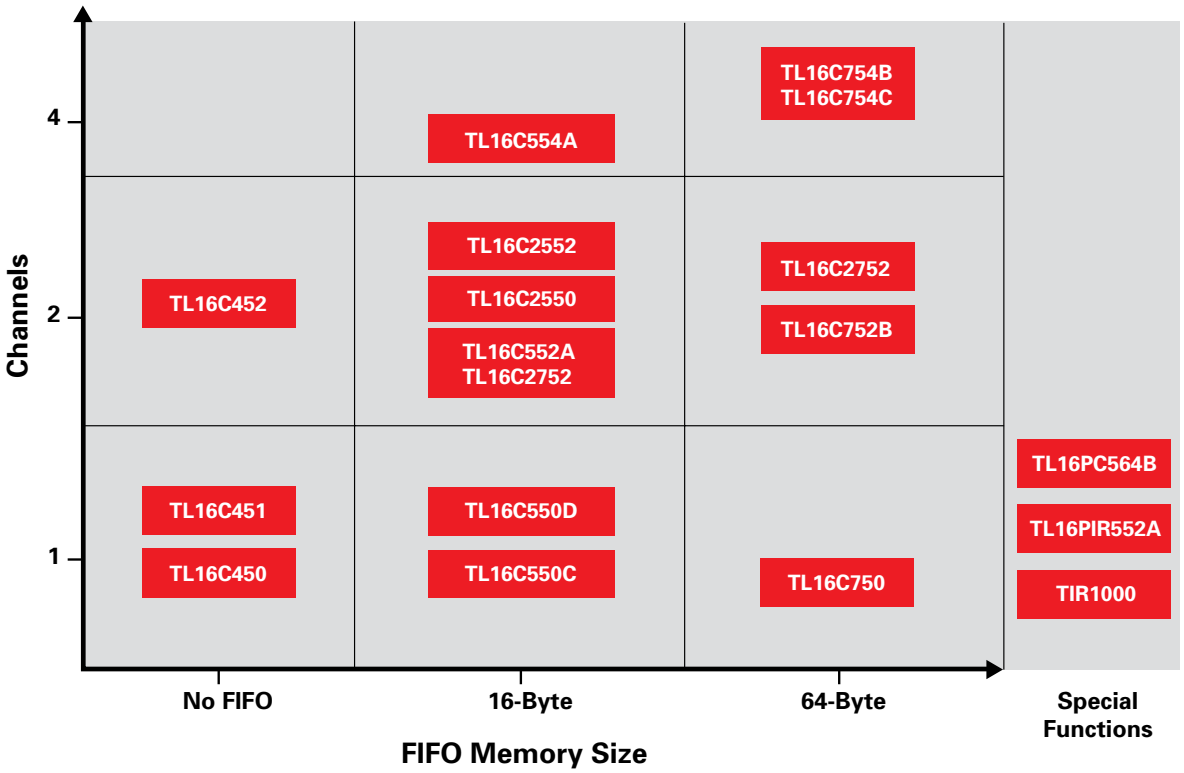
As data transfer speeds have increased to support applications such as telecommunication base stations, cell phones, PCs, fax servers and rack modems, the transmission rate of the UART has become critical to preventing system bottlenecks. When a fast external modem is used, designers should be sure the computer's UART can handle the modem's maximum transmission rate. For example, the TL16C550D UART contains a 16-byte buffer, enabling it to support higher sustained transmission rates than the older 8250 UART. To reduce software buffering and data overruns, TI has added its patented hardware autoflow control to all new designs and most existing UARTs. Most UARTs allow the divisor to be programmed from 1 to 65,535 and sometimes with an added predivisor factor of 1, 4, 16 or 64.

To accommodate the requirements of diverse applications, TI offers a wide portfolio of parallel-to-serial and serial-to-parallel UARTs in highly integrated, space-saving configurations that allow designers to increase system performance while decreasing space requirements.

As one of the world's leading high-volume semiconductor manufacturers, TI offers designers and OEMs the satisfaction of knowing they are backed by a supplier with the resources to meet their needs. These include a dedicated marketing and technical support team to assist with any issues.

Key Features

- Single-, dual- and quad-channel devices
- 16- and 64-byte FIFOs available
- 5-, 3.3-, 2.5- and 1.8-V supply
- Clock rates up to 24/20/16-MHz for 1.5/1.25/1.0-Mbps data transfer rates
- Hardware and software autoflow control
- Programmable sleep mode and low-power mode
- Industrial temperature characterization



UART family of products.

Device	Channel(s)	FIFOs	Voltage (V)	Characterized Temp. (°C)	Package(s)	Description	Price*
Universal Asynchronous Receiver/Transmitters (UARTs)							
TL16C2550	2	16-Byte	1.8/2.5/3.3/5	–40 to 85	32 QFN, 44 PLCC, 48 TQFP	Dual UART with Programmable Auto-RTS and Auto-CTS	2.80
TL16C2552	2	16-Byte	1.8/2.5/3.3/5	–40 to 85	32 QFN, 44 PLCC	Dual UART with Programmable Auto-RTS and Auto-CTS	3.00
TL16C2752	2	64-Byte	1.8/2.5/3.3/5	—	44 PLCC	Dual UART with Customizable Trigger Levels	Web
TL16C450	1	None	5	0 to 70	40 DIP, 44 PLCC	Single UART	1.50
TL16C451	1	None	5	0 to 70	68 PLCC	Single UART with Parallel Port	2.50
TL16C452	2	None	5	0 to 70	68 PLCC	Dual UART with Parallel Port	2.55
TL16C550C	1	16-Byte	3.3/5	–40 to 85	40 DIP, 44 PLCC, 48 LQFP, 48 TQFP	Single UART with Hardware Autoflow Control	1.75
TL16C550D	1	16-Byte	2.5/3.3/5	–40 to 85	32 QFN 48 LQFP, 48 TQFP	Single UART with Hardware Autoflow Control	1.75
TL16C552A	2	16-Byte	5	–40 to 85	68 PLCC, 80 TQFP	Dual UART with Parallel Port	3.85
TL16C554A	4	16-Byte	5	–40 to 85	68 PLCC, 80 LQFP	Quad UART with Hardware Autoflow Control	6.00
TL16C750	1	16/64-Byte	5	–40 to 85	44 PLCC, 64 LQFP	Single UART with Hardware Autoflow Control, Low-Power Modes	3.70
TL16C752B	2	64-Byte	3.3	–40 to 85	48 LQFP, 48 TQFP	Dual UART with Hardware Autoflow Control, Low-Power Modes	3.10
TL16C754B	4	64-Byte	3.3/5	–40 to 85	68 PLCC, 80 LQFP	Dual UART with Hardware Autoflow Control, Low-Power Modes	8.35
TL16C752C	2	64-Byte	1.8/2.5/3.3/5	–40 to 85	32 QFN, 48 TQFP	Dual UART with 64-Byte FIFO	7.50
TL16C754C	4	64-Byte	1.8/2.5/3.3/5	–40 to 85	64 LQFP	Quad UART with Hardware Autoflow Control, Low-Power Modes	6.75
TL16PC564B/BLV	1	16/64-Byte	3.3/5	0 to 70	100 BGA, 100 LQFP	Single UART with PCMCIA Interface	5.90/6.10
TL16PIR552	2	16-Byte	5	0 to 70	80 QFP	Dual UART with Selectable IR & 1284 Modes	6.10

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Asynchronous Communications Element
TL16C255x

Get samples, datasheets and app reports at: **www.ti.com/sc/device/TL16C2550**

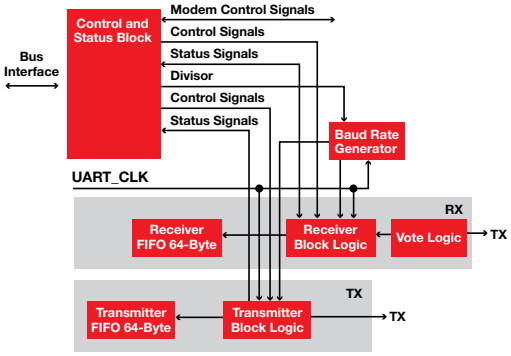
The TL16C255X family incorporates the functionality of two TL16C550D UARTs, each UART having its own register set and FIFOs. The two UARTs share only the data bus interface and clock source. Otherwise, they operate independently. Another name for the UART function is asynchronous communications element (ACE), and these terms will be used interchangeably.

Key Features

- Programmable auto-RTS and auto-CTS
- In auto-CTS mode, CTS controls transmitter
- In auto-RTS mode, RCV FIFO contents, and threshold control RTS
- Serial and modem control outputs drive an RJ11 cable directly when equipment is on the same power drop
- Capable of running with all existing TL16C450 software
- After reset, all registers are identical to the TL16C450 register set
- Up to 24-MHz clock rate for up to 1.5-Mbaud operation with V_{CC} = 5 V
- Up to 20-MHz clock rate for up to 1.25-Mbaud operation with V_{CC} = 3.3 V
- Up to 16-MHz clock rate for up to 1-Mbaud operation with V_{CC} = 2.5 V
- Up to 10-MHz clock rate for up to 625-kbaud operation with V_{CC} = 1.8 V
- In the TL16C450 mode, hold and shift registers eliminate the need for precise synchronization between the CPU and serial data
- Programmable baud rate generator allows division of any input reference clock by 1 to (2^{16}–1) and generates an internal 16x clock
- Standard asynchronous communication bits (start, stop, and parity) added to or deleted from the serial data stream
- 5-V, 3.3-V, 2.5-V, and 1.8-V operation
- Independent receiver clock input
- Transmit, receive, line status, and data set interrupts independently controlled

Applications

- Point-of-sale terminals
- Gaming terminals
- Portable applications
- Router control
- Cellular data
- Factory automation



TL16C754B, TI's high-performance, four-channel UART device.

Design Considerations

Bus Protection — Features such as short-circuit protection, thermal shutdown protection, glitch-free power-up and power-down protection, high-ESD protection, wide common-mode range that provides for common-mode noise rejection, and current-limiting circuitry to protect the transceivers and system from damage during a fault condition have been incorporated into these devices.

Electromagnetic Compatibility — An important requirement for products intended for networking applications is that they behave in a way that does not interfere with the operation of other nearby components or systems. TI offers specially designed and tested transceivers for EM compatibility without malfunction or degradation of performance in rugged EM environments. Compatibility in this definition means both immunity to external EM fields, and the limited strength of generated EM fields.

Supply Voltage — In addition to 5-V transceivers, TI offers 3.3-V transceivers that accomplish the same tasks with less than half the power and save on the cost of an additional voltage regulator in 3.3-V powered applications.

Technical Information

- ISO11898 specifies the physical-layer implementation of CAN.
- This specification describes a twisted wire pair bus with 120-W characteristic impedance (Zo) and differential signaling rate of up to 1 Mbps on a 40-meter bus with multi-drop topology.

CAN Transceiver Selection Guide

Supply Voltage	I/O Levels	Device	Description	Short-Circuit Protection (V)	ESD (kV)	Operating Temp Range (°C)	Price*
5 V	5-V CMOS	SN65HVD251	Improved PCA82C250 and PCA82C251	–27 to 40	±14	–40 to 125	0.90
	3.3-V TTL	**SN65HVD252**	Low Propagation Delay/DeviceNet Compliant, Highest IEC ESD CAN Device	–27 to 40	IEC	–40 to 125	0.75
	3.3-V TTL	**SN65HVD253**	Low Propagation Delay/DeviceNet Compliant, Highest IEC ESD, With Auto Baud Loop-Back	–27 to 40	IEC	–40 to 125	0.80
	5-V TTL	**SN65HVD1040**	Improved TJA1040 with Better ESD Bus Wake Up	–27 to 40	±14	–40 to 125	0.70
	5-V TTL	SN65HVD1050	Improved TJA1050 with Better ESD	–27 to 40	±8	–40 to 125	0.55
3.3 V	3.3-V TTL	SN65HVD230	Standby Mode	–4 to 16	±16	–40 to 85	1.45
	3.3-V TTL	SN65HVD231	Sleep Mode	–4 to 16	±16	–40 to 85	1.45
	3.3-V TTL	SN65HVD232	Cost Effective	–4 to 16	±16	–40 to 85	1.10
	3.3-V TTL	SN65HVD233	Standby Mode, Diagnostic Loop-Back	–36 to 36	±16	–40 to 125	1.50
	3.3-V TTL	SN65HVD234	Standby Mode, Sleep Mode	–36 to 36	±16	–40 to 125	1.45
	3.3-V TTL	SN65HVD235	Standby Mode, Autobaud Loop-Back	–36 to 36	±16	–40 to 125	1.50

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*
*Preview products are listed in **bold blue**.*

Standard Compliant Protocols

CAN is a serial communications bus for robust real-time control applications that is rapidly gaining the attention of industrial process, test, measurement and control engineers worldwide. It has excellent error detection and confinement capabilities, and has the flexibility to operate either as a primary backbone data communications network, as a secondary local embedded system, or as both. The engineering community is just now exploring the limits of what this bus can do when coupled with newly developed intelligent sensing technologies.

Besides CAN's high reliability, another of the main advantages of CAN when compared to alternative networks, is the availability of higher layer protocols (HLPs). There are many CAN-related system development packages prepared for these HLPs – hardware interface cards and easy-to-use software packages that provide system designers with a wide range of design and diagnostic tools. These components provide for the rapid development of complex control applications without building each node of a system network from scratch.

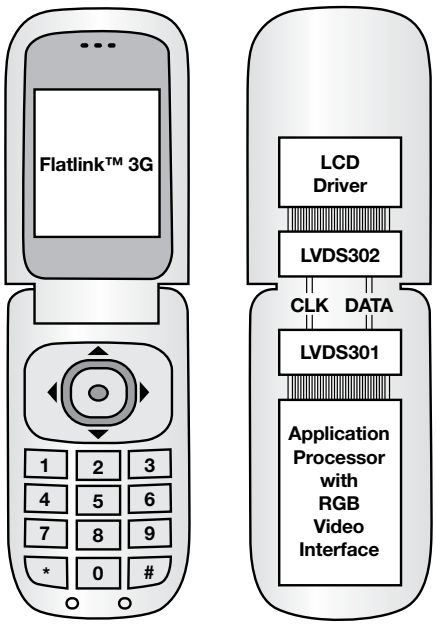
The HLP relieves a developer from the burden of dealing with CAN-specific details such as bit-timing and implementation functions. It provides standardized communication objects for real-time data with Process Data Objects (PDOs) and Service Data Objects (SDOs), and provides special functions such as a time stamp, a sync message, and emergency shut-down procedures as well as network management, boot-up commands, and error management.

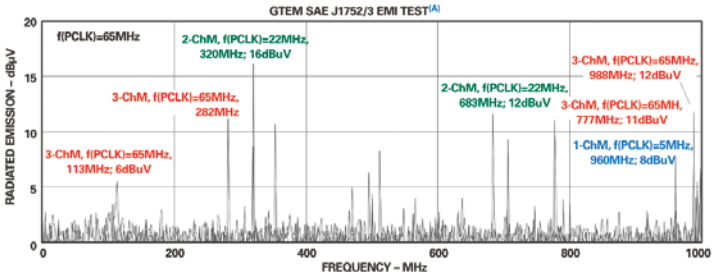
Among the most popular HLPs are CANopen, CANkingdom and DeviceNet with applications ranging from medical equipment to process control and assembly line coordination.

FlatLink™ 3G – Display SerDes for Mobile Phones

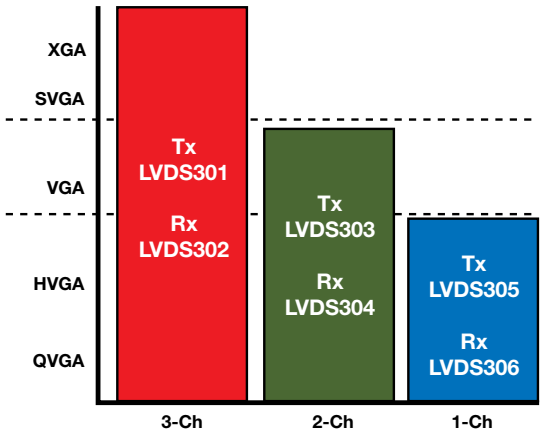
FlatLink 3G uses low EMI subLVDS to carry 24-bit color RGB data from applications processors, such as OMAP™ from TI, to the LCD driver. It caters to screen resolutions from QVGA to XGA.

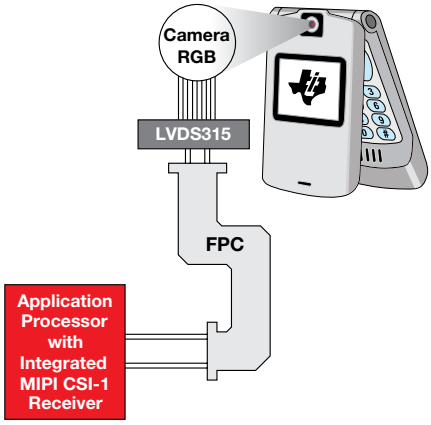
FPC cabling typically interconnects the serializer transmitter with the display. Compared to parallel signaling, FlatLink 3G outputs significantly reducing the EMI of the interconnect by over 20 dB. The electromagnetic emission of the device itself is very low and meets the SAE J1752/3 'M'-specification.





Resolution (W x H)		
QVGA	240	320
	640	200
CIF+	352	416
	352	440
HVGA	320	480
	800	250
	640	320
VGA	480	640
	1024	320
WVGA	480	800
SVGA	800	600
XGA	1024	768





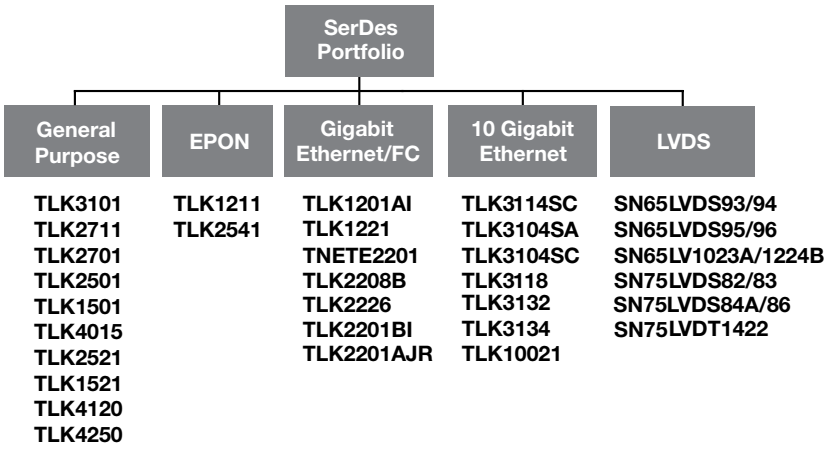
FlatLink™ 3G Selection Guide

Device	Description	Number of Parallel Outputs	Number of Parallel Inputs	Data Throughout (MB/s)	PLL Frequency (MHz)	Serial Data Receiver Channels	Serial Data Transmitter Channels	Price*
SN65LVDS301	QVGA-XGA Serializer Transmitter	—	27	1755	4 to 65	—	3	1.90
SN65LVDS302	QVGA-XGA Deserializer Receiver	27	—	1755	4 to 65	3	—	1.90
SN65LVDS303	QVGA-VGA Serializer Transmitter	—	27	810	4 to 30	—	2	1.70
SN65LVDS304	QVGA-VGA Deserializer Receiver	27	—	810	4 to 30	2	—	1.70
SN65LVDS305	QVGA-HVGA Serializer Transmitter	—	27	405	4 to 15	—	1	1.55
SN65LVDS306	QVGA-HVGA Deserializer Receiver	27	—	405	4 to 15	1	—	1.55
SN65LVDS315	Camera CSI-1 Converter	8	—	208	3.5 to 26	—	1	2.10

**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*

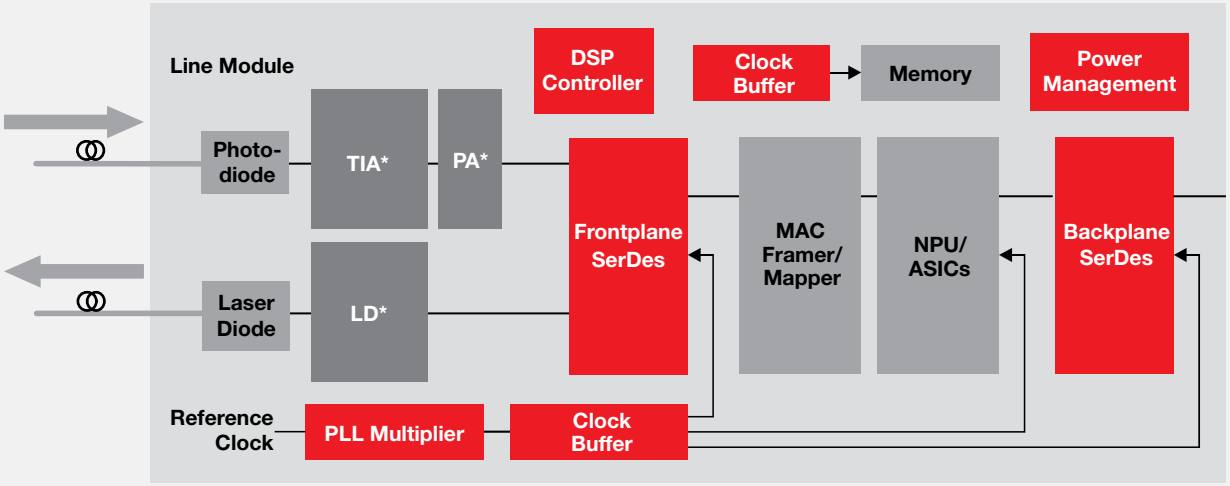
The serial gigabit transceiver family of devices from TI provides low power dissipation while enabling multigigabit transmission over copper backplanes, cable and optical links. The transceivers can be used in a variety of applications, including Gigabit Ethernet, 10 Gigabit Ethernet modules, synchronous optical network (SONET) OC-48 and OC-192 based equipment, wireless infrastructure backplanes and general-purpose backplane applications.



SerDes Solutions – Frontplane/Backplane

TLK1201AI/TLK2226/TLK2208B
Low-Power 1-GbE Transceiver
1 to 1.6 Gbps

(Backplane/Frontplane)



*TIA, PA and LD are in development and not currrently available.

TLK3134	—	10-Gigabit Ethernet Backplane Device XAUI (4 x 3.125 Gbps)
TLK2208B	—	8-Channel Gigabit Ethernet Xcvr (8 x 1 to 1.3 Gbps)
TLK2226	—	6-Channel Gigabit Ethernet Xcvr (6 x 1 to 1.3 Gbps)
TLK1201AI	—	1- to 1.6-Gbps Gigabit Ethernet-Compliant SerDes
TLK3101/TLK2501/TLK1501	—	600-Mbps to 3.2-Gbps General-Purpose Backplane SerDes
SN65LV1023A/1224B	—	100 to 660 Mbps – 10:1 LVDS SerDes

SerDes (Serial Gigabit Transceivers) Selection Guide

Device	Function	Data Rate	Serial I/F[1]	Parallel I/F	Power	Special Features	Price*
General Purpose							
TLK1501	Single-Ch. 16:1 SerDes	0.6-1.5 Gbps	1 CML	16 LVTTL	200 mW	Built-In Testability	8.40
TLK2501	Single-Ch. 16:1 SerDes	1.6-2.5 Gbps	1 CML	16 LVTTL	300 mW	Built-In Testability	12.60
TLK2701	Single-Ch. 16:1 SerDes	1.6-2.5 Gbps	1 CML	16 LVTTL	300 mW	Built-In Testability and K Character Control	12.60
TLK2711	Single-Ch. 16:1 SerDes	1.6-2.5 Gbps	1 VML	16 LVTTL	350 mW	MicroStar Junior™ BGA Packaging	10.50
TLK3101	Single-Ch. 16:1 SerDes	2.5-3.125 Gbps	1 VML	16 LVTTL	350 mW	Built-In Testability	16.85
TLK2521	Single-Ch. 18:1 SerDes	1.0-2.5 Gbps	1 VML	18 LVTTL	<550 mW	Low Power and Built-In Equalization	12.60
TLK1521	Single-Ch. 18:1 SerDes	0.6-1.3 Gbps	1 VML	18 LVTTL	<350 mW	Low Power and Built-In Equalization	10.50
TLK4120	Four-Ch. 18:1 Serdes	0.5-1.3 Gbps	4 VML	18 LVTTL	<350 mW	Four-Channel Version of TLK1521	24.00
TLK4250	Four-Ch. 18:1 Serdes	1.0-2.5 Gbps	4 VML	18 LVTTL	<550 mW	Four-Channel Version of TLK2521	32.00
TLK4015	Four-Ch. of 16:1 Xcvr	0.6-1.5 Gbps/Ch.	4X CML	16 LVTTL/Ch.	1 W	Four-Channel Version of TLK1501	29.40
EPON							
TLK1211	Single-Ch. 10:1 Gigabit Ethernet	0.6-1.3 Gbps	1 LVPECL	10 LVTTL	200 mW	Fast Relock for PON	Web
TLK2541	Single-Ch. 20:1 Txcr	1.0-2.6 Gbps	1 LVPECL	20 LVTTL	625 mW	Supports Independent 1 and 2.5-Gbps Tx/Rx EPON OLT Channels	Web
Gigabit Ethernet/FibreChannel							
TLK1201AI	Single-Ch. 10:1 Gigabit Ethernet Xcvr Gbps	0.6-1.3	1 LVPECL	10 LVTTL	200 mW	Industrial Temperature	4.85
TLK2201BI	Single-Ch. 10:1 Gigabit Ethernet Xcvr	1.2-1.6 Gbps	1 LVPECL	10 LVTTL	200 mW	JTAG; 5-Bit DDR Mode, Industrial Temperature Qualified	4.65
TLK2201AJR	Single-Ch.10:1 Gigabit Ethernet Xcvr	1.0-1.6 Gbps	1 LVPECL	10 LVTTL	200 mW	MicroStar Junior 5 mm x 5 mm LGA	4.25
TLK2208B	Eight-Ch. of 10:1 Gigabit Ethernet Xcvr	1.0-1.3 Gbps	8 VML	4/5-Bit/Ch. (Nibble DDR Mode), 8/10-Bit/Ch. (Multiplex Ch. Mode)	1 W	JTAG, MDIO Supported	31.50
TLK2226	Six-Ch. 16:1 Gigabit Ethernet Xcvr	1.0-1.3 Gbps	6 VML	4/5-Bit RTBI or RGMII	<1.5 W	MDIO Supported 100-FX Mode Support	19.65
10 Gigabit (XAUI) Ethernet							
TLK3104SA	Four-Ch. of 10/8:1 Xcvr	2.5-3.125 Gbps	4X 3.125 Gbps LVPECL (XAUI)	4X 10/8-Bit SSTL/HSTL	700 mW/Ch.	JTAG; Programmable Pre-Emphasis and XAUI I/F	69.30
TLK3104SC	Four-Ch. of 4.1: Xcvr	3.0-3.125 Gbps	4X LVPECL	20X622 LVDS Lines	700 mW/Ch.	JTAG, 8b/10b On/Off	126.00
TLK3114SC	Four-Ch. of 10/8:1: Xcvr	2.5-3.125 Gbps	4X 3.125 Gbps LVPECL (XAUI)	4X 10/8-Bit SSTL/HSTL (XGMII)	600 mW/Ch.	IEEE 802.3ae Backplane Transceiver Compliant	57.75
TLK3118	Four-Ch. 10/8:1 Xcvr w/ (XAUI) Full Redundancy	2.5-3.125 Gbps/Ch.	4X 3.125 Gbps LVPECL (XAUI)	8/10 HSTLx4 (XGMII)	<2 W	Full Redundancy for Four Channels (XAUI)	80.00
TLK3134	Four-Ch. Multi-Rate Xcvr	0.6-3.75 Gbps	4X 3.125 Gbps CML (XAUI)	8/10 HSTLx4 (XGMII)	400 mW/Ch.	Built-In Ref. Clock Jitter Cleaner	35.00
TLK3132	Two-Ch. Multi-Rate Xcvr	0.6-3.75 Gbps	2X 3.125 CML	8/10 HSTLx2	400 mW/Ch.	Built-In Ref. Clock Jitter Cleaner	Web
TLK10021	Four XAUI to XFI	10 Gbps	1 XFI	4 XAUI	800 mW	Built-In Testability	Web
LVDS Serdes							
SN65LVDS93/94	Four-Ch. 28:4 TX/RX Chipset	140-455 Mbps/Ch.	5 LVDS	28 LVTTL	250 mW/Chip	Supports Up to 1.82 Gbps Throughout	3.45
SN65LVDS95/96	Three-Ch. 21:3 TX/RX Chipset	140-455 Mbps/Ch.	4 LVDS	28 LVTTL	250 mW/Chip	Supports Up to 1.82 Gbps Throughout	3.45
SN65LV1023A/1224B	Single-Ch. 10:1 TX/RX Chipset	100-660 Mbps	1 LVDS	10 LVTTL	<400 mW	Low Power Solution	4.60
SN75LVDT1422	14:1 Xcvr SerDes	140 Mbps-1.4 Gbps	1 LVDS	14-Bit LVTTL	<300 mW	Supports Spread Spectrum Clocking	3.70
SN75LVDS82/83	Four-Ch. 28:4 TX/RX Chipset	0.651 to 1.428 Gbps	4 LVDS	28 LVTTL	250 mW/Chip	Commercial Temp	2.25
SN75LVDS84A/86	Three-Ch. 21:3 TX/RX Chipset	0.42 to 1.428 Gbps	3 LVDS	21 LVTTL	250 mW/Chip	Commercial Temp	2.10

[1] *CML = Current Mode Logic; VML = Voltage Mode Logic.*
**Suggested resale price in U.S. dollars in quantities of 1,000.*

*New products are listed in **bold red**.*
*Preview products are listed in **bold blue**.*

Design Considerations

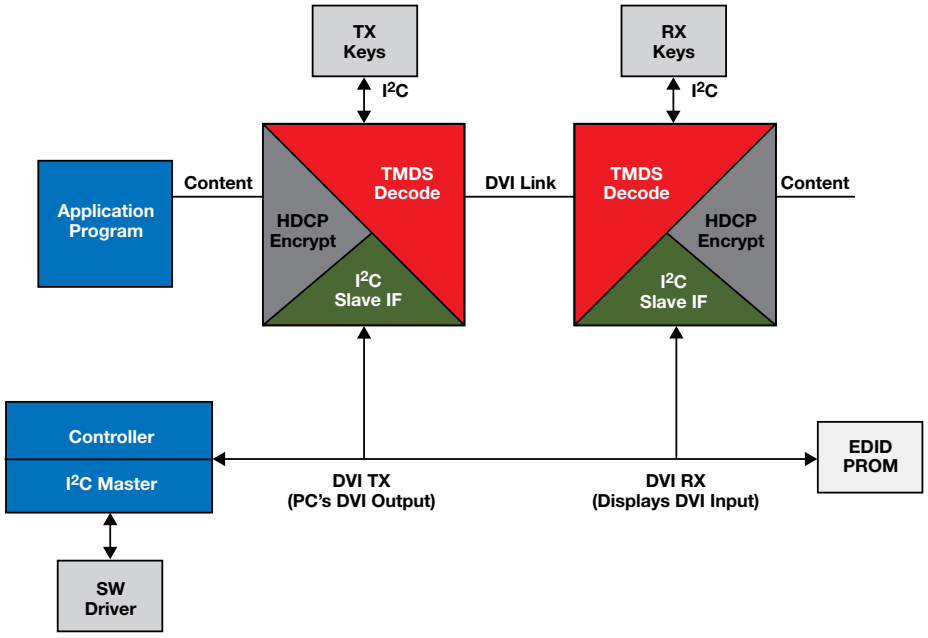
The Digital Visual Interface (DVI) Specification, is an industry standard developed by the Digital Display Working Group (DDWG) for high-speed digital connection to digital displays. DVI uses transition-minimized DC balanced data signaling. Single link supports up to 165 Mpixels/s – UXGA FPDs, SXGA DCRTs, 720p and 1080i HDTVs.

High Bandwidth Digital Content Protection (HDCP)

- Content protection for video sent over DVI
- Implementation of HDCP requires a license from the Digital Content Protection Licensing, L.L.C. *(www.digital-cp.com)*

HDCP Elements

- Authentication is a process for verifying that a device is authorized (e.g. licensed) to handle protected content.
- Encryption prevents eavesdropping of protected content.
- Renewability enables revocation of compromised devices.



DVI/HDCP implementation.

PanelBus™ (DVI) Transmitters and Receivers

Device	Voltage (V)	Recvr./Trans. Channels	Parallel Outputs	Data Speed (Mbps)	I_{CC} (mA)	Package	Description	Price*
TFP401	3.3	3	48	495	400	100 HTQFP	DVI Receiver, 165 MHz	4.00
TFP401A	3.3	3	48	495	400	100 HTQFP	DVI Receiver, 165 MHz, HSYNC Jitter Immunity	4.00
TFP403	3.3	3	48	495	400	100 HTQFP	DVI Receiver	5.45
TFP410	3.3	3	6	495	250	64 HTQFP	DVI Transmitter, 165 MHz	3.00
TFP501	3.3	3	48	495	400	100 HTQFP	DVI Receiver, 165 MHz Plus HDCP	Web
TFP510	3.3	3	6	495	250	64 HTQFP	DVI Transmitter, 165 MHz Plus HDCP	Web

**Suggested resale price in U.S. dollars in quantities of 1,000.*

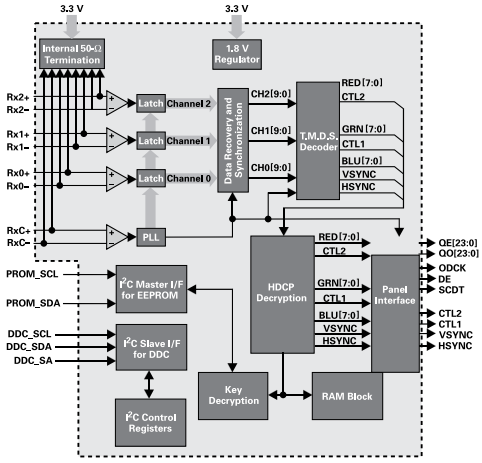
PanelBus™ HDCP Digital Receiver
TFP501

Get samples, datasheets and app reports at: **www.ti.com/sc/device/TFP501**

The TFP501 is a TI PanelBus flat panel display product, part of a comprehensive family of end-to-end DVI 1.0-compliant solutions. The TFP501 supports display resolutions up to UXGA, including the standard HDTV formats, in 24-bit true-color pixel format. The TFP501 offers design flexibility to drive one or two pixels per clock, support TFT or DSTN panels and provide an option for time-staggered pixel outputs for reduced ground-bounce.

Key Features
- Supports UXGA resolution (output pixel rates up to 165 MHz)
- Digital visual interface (DVI) and high-bandwidth digital content protection (HDCP) specification compliant
- Encrypted external HDCP device key storage for exceptional security and ease of implementation
- True color, 24 bits/pixel, 48-bit dual-pixel output mode; 16.7/M colors at one or two pixels per clock
- 4x oversampling for reduced bit-error rates and better performance over longer cables
- Supports hot-plug detection
- Packaging: 100-pin TQFP PowerPAD™

Applications
- Desktop LCD monitors
- DLP® and LCD projectors
- Digital TVs



TFP501 block diagram.

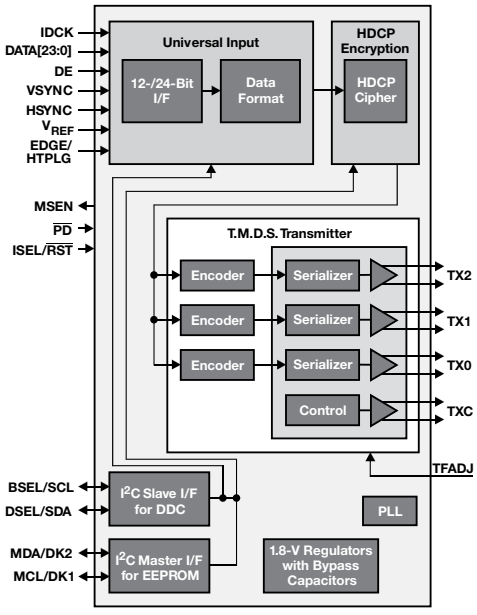
TI PanelBus™ Digital Transmitters
TFP510

Get samples, datasheets and app reports at: **www.ti.com/sc/device/TFP510**

The TFP510 provides a universal interface allowing a glueless connection to most commonly available graphics controllers. Some of the advantages of this universal interface include selectable bus widths, adjustable signal levels and differential and single-ended clocking. The DVI interface supports flat panel display resolutions up to UXGA at 165 MHz in 24-bit true color pixel format.

Key Features
- Digital visual interface (DVI) compliant
- Supports resolutions from VGA to UXGA (25-MHz to 165-MHz pixel rates)
- Universal graphics controller interface
- 12-bit, dual-edge and 24-bit, single-edge input modes
- Adjustable 1.1-V to 1.8-V and standard 3.3-V CMOS input signal levels
- Fully differential and single-ended input clocking modes
- Standard Intel® 12-bit digital video port compatible as on Intel 81x chipsets
- Programmable using I²C serial interface
- Monitor detection through hot-plug and receiver detection
- Packaging: 64-pin TQFP PowerPAD™

Applications
- Set-top boxes
- DVD recorders/players



TFP510 block diagram.

TMDS (for HDMI and DVI)

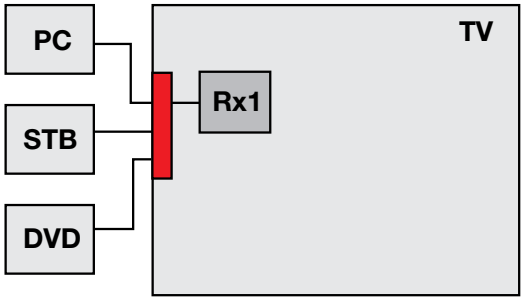
Transition Minimized Differential Signaling (TMDS) is the electrical level standard used to transmit Digital Visual Interface (DVI) and High-Definition Multimedia Interface (HDMI) data.

Design Considerations

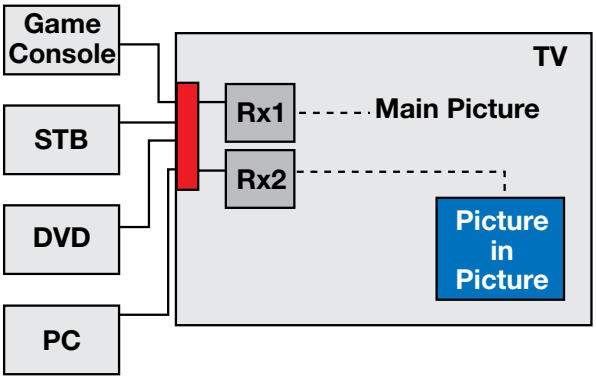
Intra-Pair Skew – The time difference between the true and complementary signals of a given differential pair should be kept as small as possible.

Residual Jitter – The difference in the amount of measured jitter between the test point and the signal source. It is the allowable maximum residual jitter equivalent to the minimum jitter budget between transmitter and receiver.

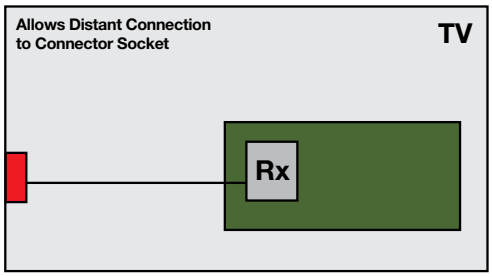
ESD – External connectors being exposed to the outside world are especially susceptible to electrostatic discharge. A higher ESD rating provides improved protection.



TMDS361 3-to-1 Mux.



TMDS442 4-to-2 Mux.



TMDS141 HDMI Hider.

Device	Description	No. of Inputs	No. of Outputs	Intra-Pair (ps) Skew (max)	Inter-Pair Skew (max) (ps)	I_{CC} (max) (mA)	ESD HBM (kV)	Package(s)	Price*
TMDS141	HDMI Hider	1	1	50	100	150	5	40QFN	1.75
TMDS361	3-to-1 DVI/HDMI Switch	3	1	40	100	215	12	64TQFP	Web
TMDS442	4-to-2 DVI/HDMI Switch	4	2	50	100	550	5	128TQFP	3.45
TS3DV416	2-to-1 Switch for HDMI/DVI	2	1	—	—	0.6	2	48TSSOP, 48TVSOP	0.90
TS3DV520E	2-to-1 Switch for HDMI/DVI	2	1	—	—	0.6	14	56QFN, 42QFN	1.05

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Universal Serial Bus (USB)

The USB standard defines a bus product that requires a host controller and enables plug-and-play connectivity. The most recently released final specification, USB 2.0, defines high speed and allows complete backward compatibility with USB 1.1.

USB products fall into three categories: hubs, host controllers and peripherals. USB 1.1 supported speeds of up to 12 Mbps and cables up to 5 meters long for these devices. USB 2.0 extends the connection speed to 480 Mbps to support next-generation peripherals of higher-performance PCs and applications. USB 2.0 officially defines three speeds: low (1.5 Mbps), full (12 Mbps) and high (480 Mbps). The lowest speed is ideal for human interface devices such as a mouse, game pad or keyboard; while full speed is well suited for "data dumps" to the PC via digital still cameras, PDA cradles and flash-card readers. Modems, printers, scanners and storage drives are just a few of the items that can take advantage of USB's highest speed specification.

The USB On-The-Go (OTG) supplement to USB 2.0 specifies a new class of devices aimed at the portable market. USB OTG defines devices that can operate as standard USB peripherals when connected to a standard USB host controller.

However, these same devices can operate as reduced-function host controllers to support selected USB OTG peripheral devices. End-equipment manufacturers can specify what type of peripherals their devices will support when in OTG host mode. This new specification allows easy sharing of contact information between USB OTG PDAs and cell phones or printing of photographs directly from an OTG-enabled digital still camera without a PC.

Technical Information

Speed

- The USB 2.0 standard defines three speeds: low speed (LS) 1.5 Mbps, full speed (FS) 12 Mbps and high speed (HS) 480 Mbps. It requires full backward and forward compatibility for devices and cables. All three modes offer both asynchronous and isochronous (real-time) data transmission over a simple and inexpensive 4-wire cable to meet requirements of peripherals including keyboards, mice, printers, speakers, scanners, external storage devices and digital still cameras.

Transfer Type

- USB 2.0 defines four types of transfers: bulk, control, interrupt and isochronous. Bulk transfer is intended for applications such as printers, scanners and mass storage, where latency isn't critical but accuracy is. All devices must include control transfers for configuration. Interrupt transfer is for devices such as mice, keyboards and game pads that must receive the host's or device's attention periodically. Isochronous transfer offers guaranteed delivery time but no error-checking or automatic retransmission of data received with errors, making it the better choice for audio or video applications.

RS232/IrDA Serial-to-USB Converter
TUSB3410

Get samples, datasheets, evaluation modules and app reports at: **www.ti.com/sc/device/TUSB3410**

USB-to-Serial Bridge

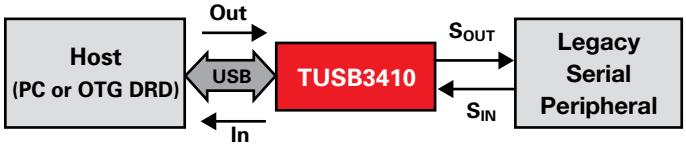
The TUSB3410 provides an easy way to move a serial-based legacy device to a fast, flexible USB interface by bridging between a USB port and an enhanced UART serial port. The TUSB3410 contains all the necessary logic to communicate with the host computer using the USB bus.

Key Features

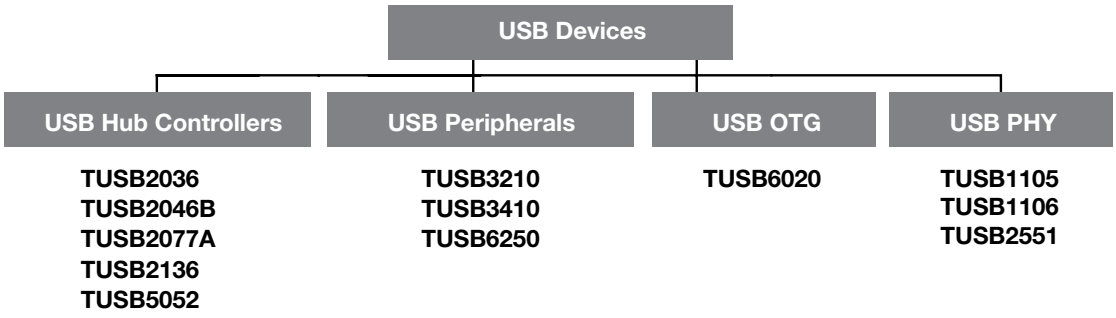
- USB full-speed compliant: data rate of 12 Mbps
- 8052 microcontroller with 16 Kbytes of RAM that can be loaded from the host or from external onboard memory via an I²C bus
- Integrated, enhanced UART features including:
  - Programmable software/hardware flow control
  - Automatic RS-485 bus transceiver control, with and without echo
  - Software-selectable baud rate from 50 to 921.6 kbaud
  - Built-in, two-channel DMA controller for USB/UART bulk I/O
- Evaluation module to jump-start USB development or for use as a complete USB-to-RS232 converter

Applications

- Handheld meters
- Health metrics/monitors
- Any legacy serial device that needs to be upgraded to USB



TUSB3410 data flow.



USB family of products.

USB Selection Guide

Device	Speed	Ports	I²C	Voltage (V)	Package	Description	Price*
USB Hub Controllers							
TUSB2036	Full (1.1)	2/3	No	3.3	32 LQFP	2/3-Port Hub for USB with Optional Serial EEPROM Interface	1.15
TUSB2046B	Full (1.1)	4	No	3.3	32 LQFP	4-Port Hub for USB with Optional Serial EEPROM Interface	1.20
TUSB2077A	Full (1.1)	7	No	3.3	48 LQFP	7-Port USB Hub with Optional Serial EEPROM Interface	1.95
TUSB2136	Full (1.1)	1/2	Yes	3.3	64 LQFP	2-Port Hub with Integrated General-Purpose Function Controller	3.25
TUSB5052	Full (1.1)	1-5	Yes	3.3	100 LQFP	5-Port Hub with Integrated Bridge to Two Serial Ports	5.10

Device	Speed	Voltage (V)	Remote Wakeup	Package	Description	Price*
USB Peripherals						
TUSB3210	Full	3.3	Yes	64 LQFP	USB Full-Speed General-Purpose Device Controller	2.50
TUSB3410	Full	3.3	Yes	32 LQFP	USB-to-Serial Converter (RS-232, RS-485)	2.25
TUSB6015	High	1.5, 1.8, 3.3	Yes	80 BGA	USB 2.0 High-Speed to Muxed NOR Flash Bridge Controller	
TUSB6250	Full, High	3.3	Yes	80 TQFP	USB 2.0 High-Speed, Low-Power ATA/ATAPI Bridge Solution	2.80

Device	Speed	Voltage (V)	Package(s)	Local Bus Interface	Description	Price*
USB On-The-Go (OTG)						
TUSB6020	High	1.5, 1.8, 3.3	80 QFP	VLYNQ™	USB 2.0 High-Speed On-The-Go to Local Bus Interface Controller	Web

Device	Speed	Voltage (V)	Package(s)	Single ended Input	Description	Price*
USB Transceivers						
TUSB1105	Full, Low	1.6, 3.6	16RTZ, 16RGT	Yes	USB Transceivers	Web
TUSB1106	Full, Low	1.6, 3.6	16RTZ, 16PW	No	USB Transceivers	Web
TUSB2551	Full, Low	1.6, 3.6	14PW, 16RGT	No	USB Transceivers	Web

**Suggested resale price in U.S. dollars in quantities of 1,000.*

USB Port Protection – Transient voltage suppressor protects USB 1.1 devices from ESD and electrical noise transients.

Device	Description	Temp Range (°C)	Price*
USB Port Protection			
SN65220	Single Suppressor	–40 to 85	0.33
SN65240	Dual Suppressor	–40 to 85	0.41
SN75240	Dual Suppressor	0 to 70	0.38

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Resources For a complete list of resources (evaluation modules, data sheets and application notes), visit interface.ti.com

Literature Number	Description
Application Notes	
SLLA122	Selection and Specification of Crystals for Texas Instruments USB 2.0 Devices
SLLA154	VIDs, PIDs and Firmware: Design Decisions When Using TI USB Device Controllers
SLLU043	TUSB3410 UART Evaluation Board
SLLA170B	USB/Serial Applications Using TUSB3410/5052 and the VCP Software
SLLAA276	MSP430 USB Connectivity Using TUSB3410

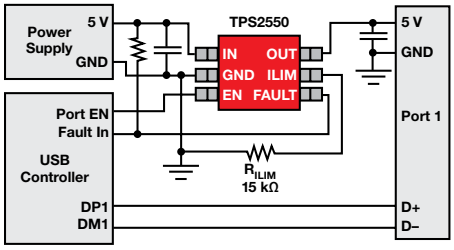
Design Considerations

USB High-Power Peripheral Switch with Dual Current Limit + LDO

TPS2140/41/50/51 – The TPS2140/41/50/51 target high-power USB peripherals such as ADSL modems. The devices contain a power switch and an LDO. The dual-current-limiting switch allows the use of high-value capacitance to stabilize the voltage from the USB bus.

Dual Power Switch + LDO for USB Bus-Powered Peripherals and Hubs

TPS2148/49 – TPS2148 is a complete power management solution for USB bus-powered peripherals such as zip drives, while TPS2149 is for USB bus-powered hubs, such as keyboards with integrated hubs. TPS2148/9 each combine a 3.3-V LDO and dual power switch in a single MSOP package. The TPS2148 switch configuration allows power and board capacitance segmentation to meet USB system current requirements. The TPS2149 switches manage two independent or four ganged USB ports.



Typical application diagram.

4-Port USB Hub Power Controllers

TPS207x – The TPS207x family provides the complete power solution for 4-port self-powered, bus-powered or hybrid USB hubs by incorporating current-limited switches for four ports, a 3.3-V 100-mA LDO, a 5-V LDO controller for self power (TPS2070, TPS2071) and a DP0 line control to signal an attach to the host.

USB Current-Limiting Power Switches

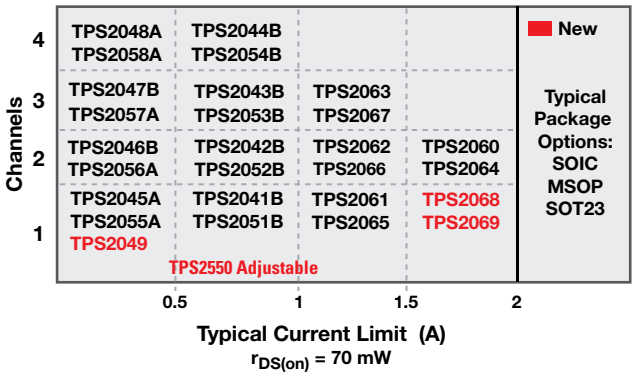
Power switches are used to intelligently turn power on/off and provide fault protection. They are ideal for power sequencing or segmentation and when controlled allocation of power is needed to circuit blocks, modules, add-in cards or cabled connections.

Universal serial bus (USB) ports are great examples of where this intelligent protection is vital for protecting your power supply and achieving regulatory compliance. TI's family of low-cost power switches are ideal for USB port designs.

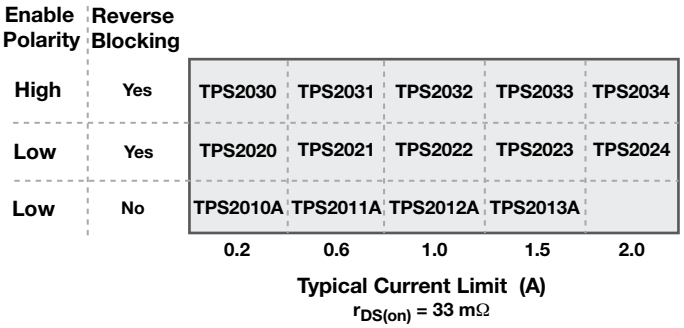
To minimize voltage drop, select devices with the lowest $r_{DS(on)}$ or Drain-to-Source on-resistance.

Power Distribution Switches

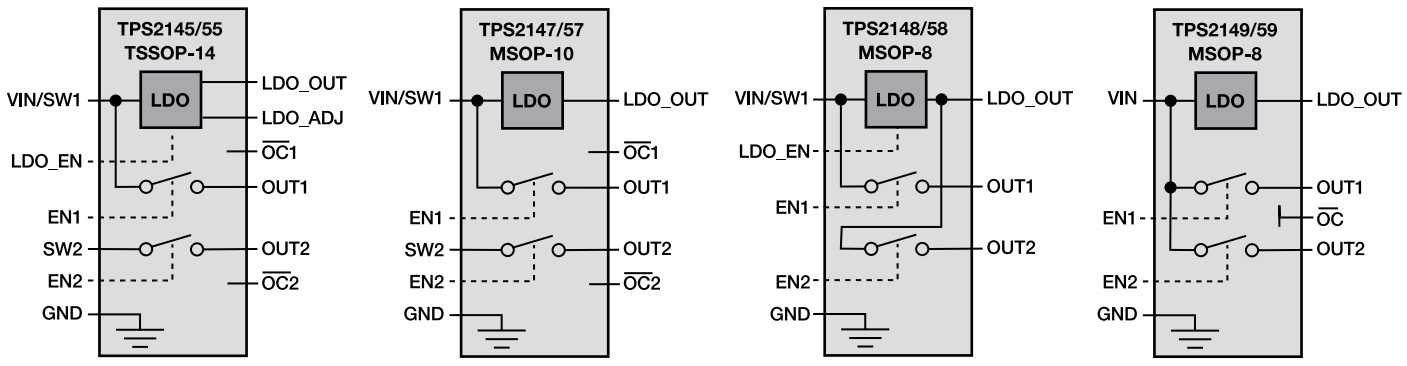
The low-cost and low $r_{DS(on)}$ current-limiting power switch families meet all the USB power management requirements for controlling downstream ports, and include additional features to improve the design reliability.



Low-cost power switch matrix.



Low $r_{DS(on)}$ power switch roadmap.



Dual power switch + LDO for USB bus-powered peripherals and hubs.

USB Power Switch Selection Guide

Device	Number of FETs	I_{OS} (min) (A)	$r_{DS(on)}$ (mW)	V_{IN} Range (V)	Supply Current (µA)	OC Logic Output	OT Logic Output	Enable	Predecessor	Price*
USB Power Distribution Switches										
TPS2010A	1	0.22	30	2.7 to 5.5	73	No	No	L	TPS2010	0.75
TPS2011A	1	0.66	30	2.7 to 5.5	73	No	No	L	TPS2011	0.75
TPS2012A	1	1.1	30	2.7 to 5.5	73	No	No	L	TPS2012	0.75
TPS2013A	1	1.65	30	2.7 to 5.5	73	No	No	L	TPS2013	0.75
TPS2020/30	1	0.22	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2021/31	1	0.66	33	2.7 to 5.5	73	Yes	Yes	L/H	TPS2014	1.05
TPS2022/32	1	1.1	33	2.7 to 5.5	73	Yes	Yes	L/H	TPS2015	1.05
TPS2023/33	1	1.65	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2024/34	1	2.2	33	2.7 to 5.5	73	Yes	Yes	L/H	—	1.05
TPS2041B/51B	1	0.7	70	2.7 to 5.5	43	Yes	Yes	L/H	TPS2041/51/41A/51A	0.50
TPS2042B/52B	2	0.7 ea	70	2.7 to 5.5	50	Yes	Yes	L/H	TPS2042/52/42A/52A	0.70
TPS2043B/53B	3	0.7 ea	70	2.7 to 5.5	65	Yes	Yes	L/H	TPS2043/53/43A/53A	0.90
TPS2044B/54B	4	0.7 ea	70	2.7 to 5.5	75	Yes	Yes	L/H	TPS2044/54/44A/54A	1.00
TPS2045A/55A	1	0.3	80	2.7 to 5.5	80	Yes	Yes	L/H	TPS2045/55	0.60
TPS2046B/56A	2	0.3 ea	80	2.7 to 5.5	80	Yes	Yes	L/H	TPS2046/46A/56	0.65
TPS2047B/57A	3	0.3 ea	80	2.7 to 5.5	160	Yes	Yes	L/H	TPS2047/47A/57	0.90
TPS2048A/58A	4	0.3 ea	80	2.7 to 5.5	160	Yes	Yes	L/H	TPS2048/58	1.20
TPS2049	1	0.1	400	2.7 to 5.5	43	Yes	Yes	L	TPS2041/51/41A/51A	0.50
TPS2550/51	1	0.1 to 1.1	85	2.5 to 6.5	130	Yes	Yes	L/H	—	0.70
TPS2060/4	2	1.5 ea	70	2.7 to 5.5	50	Yes	Yes	L/H	—	1.20
TPS2061/5	1	1.1	70	2.7 to 5.5	43	Yes	Yes	L/H	—	0.60
TPS2062A/6	2	1.1 ea	70	2.7 to 5.5	50	Yes	Yes	L/H	TPS2062	0.75
TPS2063/7	3	1.1 ea	70	2.7 to 5.5	65	Yes	Yes	L/H	—	0.90
TPS2068/9	1	1.5	70	2.7 to 5.5	43	Yes	Yes	L/H	—	0.60
TPS2080/1/21	2	0.7 ea	80	2.7 to 5.5	85	Yes	Yes	2H, 1L/1H, 2L	—	0.65
TPS2085/6/71	4	0.7 ea	80	2.7 to 5.5	85	Yes	Yes	4H, 2L/2H, 4L	—	1.05
TPS2090/1/21	2	0.3 ea	80	2.7 to 5.5	85	Yes	Yes	2H, 1L/1H, 2L	—	0.65
TPS2095/6/71	4	0.3 ea	80	2.7 to 5.5	85	Yes	Yes	4H, 2L/2H, 4L	—	1.05

[1] *Can be configured as power MUX ICs.*

*New products are listed in **bold red**.*

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Device	Application	Number of FETs	Switch Enable	Bus Power Indicator (BPMODE)	V_{IN} (min) (V)	V_{IN} (max) (V)	Bus Powered $r_{DS(on)}$ per FET (typ) (mW)	Bus Powered Current Limit (min) (A)	Self Powered $r_{DS(on)}$ per FET (typ) (mW)	Self Powered Current Limit (min) (A)	LDO Controller (A)	LDO	Price*
USB Power Controllers													
TPS2070	USB 4-Port Hub	8	L	1L	4.5	5.5	560	0.12	107	0.6	5 V, 3 A	3.3 V, 100 mA	2.55
TPS2071	USB 4-Port Hub	8	L	1H	4.5	5.5	560	0.12	107	0.6	5 V, 3 A	3.3 V, 100 mA	2.55
TPS2074	USB 4-Port Hub	8	L	1L	4.5	5.5	500	0.12	100	0.6	—	3.3 V, 100 mA	2.55
TPS2075	USB 4-Port Hub	8	L	1H	4.5	5.5	500	0.12	100	0.6	—	3.3 V, 100 mA	2.55
TPS2140	USB Peripheral	1	L	—	2.7	5.5	70	0.1 & 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2141	USB Peripheral	1	L	—	4	5.5	70	0.1 & 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2150	USB Peripheral	1	H	—	2.7	5.5	70	0.1 & 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2151	USB Peripheral	1	H	—	4	5.5	70	0.1 & 1.2	—	—	—	Adj. 0.9 to 3.3 V, 250 mA	1.10
TPS2145	DSP, PDA	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.15
TPS2147	DSP, PDA	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.10
TPS2148	USB Peripheral	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.99
TPS2149	USB 2-Port Hub	2	L	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.95
TPS2155	DSP, PDA	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.15
TPS2157	DSP, PDA	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	1.10
TPS2158	USB Peripheral	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.99
TPS2159	USB 2-Port Hub	2	H	—	2.9	5.5	340	0.2	—	—	—	3.3 V, 200 mA	0.95

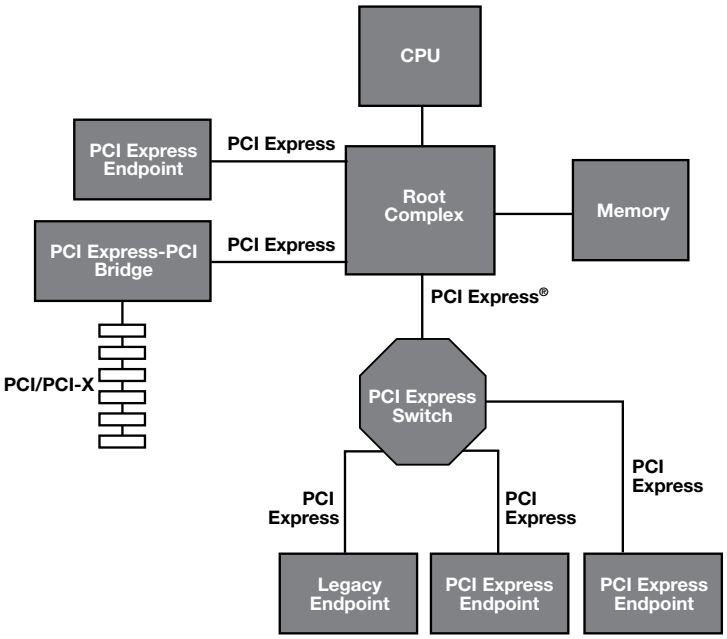
**Suggested resale price in U.S. dollars in quantities of 1,000.*

Design Considerations

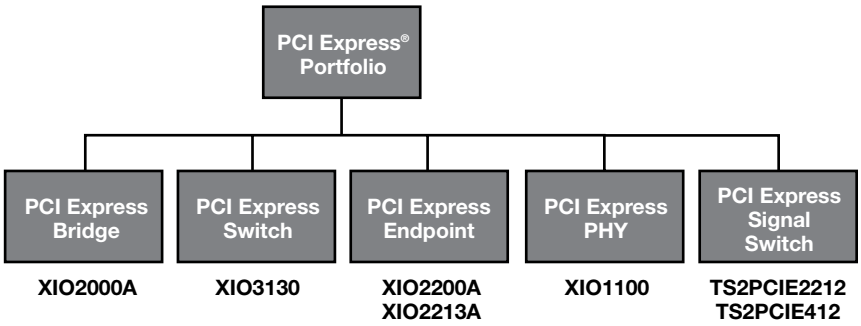
PCI Express® (PCIe) takes the best features and ideas behind PCI and combines them with more than 10 years of industry "lessons learned." The result is a robust, scalable, flexible, cost-effective I/O interconnect that will serve the industry for many years to come.

Key Features

- PCIe architecture is an industry standard high-performance, general-purpose serial I/O interconnect designed for use in enterprise, desktop, mobile, communications and embedded platforms.
- It is PCI-compatible by using the established PCI software programming models. PCIe facilitates a smooth transition to new hardware and allows software to evolve and leverage the advantages of PCIe features.
- Gen I has a scalable bandwidth of 8 GBps at its initial signaling rate of 2.5 GHz. With the release of Gen II, higher transfer rates are achieved using higher frequency signaling technologies.
- Supports multiple interconnect widths via x1, x2, x4, x8, x12, x16 and x32 lane configurations aggregated to match application bandwidth needs.
- Serves new and innovative, hot-plug/hot-swap add-in card and module devices.
- Delivers unique, advanced features such as power management, quality of service and other native functions not available in other I/O architectures.



PCI Express® topology.



Current TI PCI Express® portfolio.

4-Lane, 4-Port PCIe Switch
XIO3130

Get samples, datasheets, evaluation modules and app reports at:
www.ti.com/sc/device/XIO3130

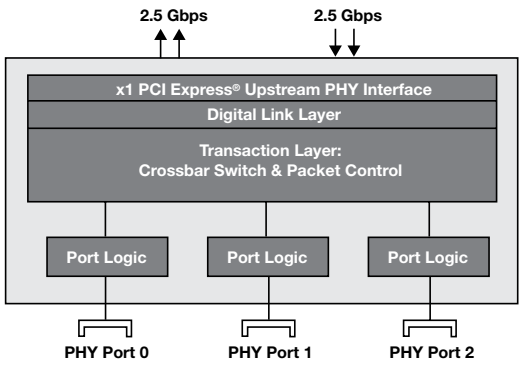
TI's XIO3130 is an integrated PCIe fan-out switch solution with one upstream x1 port and three downstream x1 ports. This high-performance, integrated solution provides the latest in PCIe switch technology. It features cut-through architecture and integrated reference clock buffers for downstream ports. The XIO3130 is fully-compliant with the PCI Express Base Specification Rev. 1.1. It supports Advanced Error Reporting as defined in the PCIe base specifications and is backwards compatible with the PCI Local Bus Specification, Rev. 2.3.

Key Features

- PCIe fan-out switch with x1 upstream port and three x1 downstream ports
- Fully compliant with PCIe Base Specification, Rev. 1.1
- Cut-through architecture
- Built-in adaptive equalizer in each of the four ports
- Wake-event and beacon support
- Support for D1, D2, $D3_{hot}$, and $D3_{cold}$
- Active State Power Management (ASPM)
- Uses both L0s and L1
- Low-power PCIe transmitter mode (pre-emphasis disabled)
- Integrated AUX power switch drains VAUX power only when main power is "off"
- Integrated hot-plug support
- Integrated REFCLK buffers for switch downstream ports
- Advanced error Reporting to assist with system debug tools
- 3.3-V Multifunction I/O pins (e.g., for hot-plug status-and-control, or general-purpose I/Os)
- Listed in PCI-SIG compliance list

Target Market

The primary purpose of the XIO3130 as a fan-out device is efficiently expanding the chipset's computing resources to multiple I/O ports and enhancing system functionality and flexibility. Target applications for the XIO3130 include PCs, servers, storage, industrial control and backplane.



PCIe Hot-Swap Manager
TPS2363

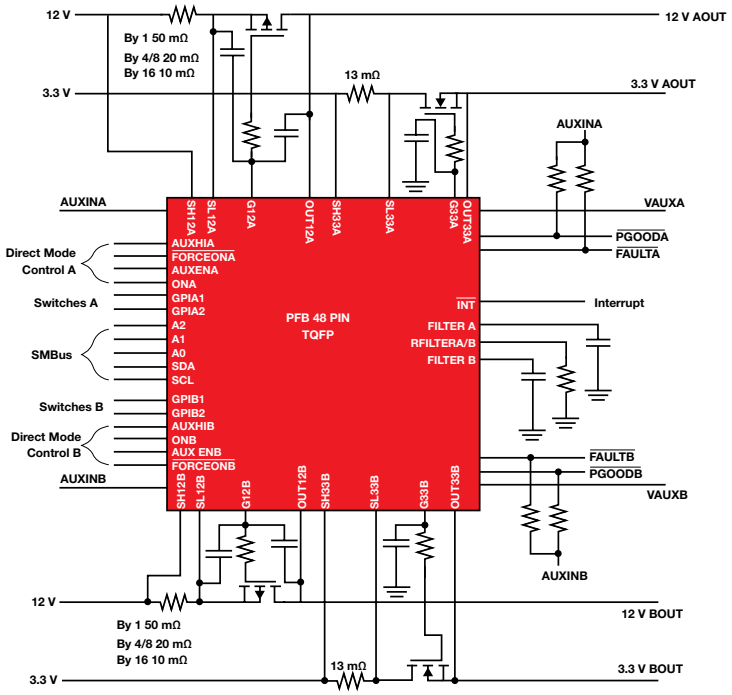
Get samples and datasheets at:
www.ti.com/sc/device/TPS2363

In complex, high-reliability systems, it may be necessary to allow for insertion and removal of PCIe peripherals while the bus voltage is active. A hot-swap power-management solution is required in these designs to ensure inserting and removing these does not damage the bus or the card – or cause the system or other peripherals to reset as a result of bus voltage droops or spikes.

The TPS2363 is a host-side, dual-slot PCIe hot-swap controller that provides this functionality. The TPS2363 has an onboard SMBus interface for control and monitoring functions and sense resistor programmable current limits for the 3.3-V and 12-V supplies.

Key Features

- Meets PCIe hot-plug requirements
- Programmable 12-V current limit
- Inrush current limiting
- SMBus interface and direct mode available
- VAUX internal FET
- General-purpose inputs
- Available in a 48-pin TQFP package; fits between the PCIe connectors



Typical application diagram.

PCIe Signal Switch
TS2PCIE412

PREVIEW*

Get samples and datasheets at: **www.ti.com/sc/device/TS2PCIE412**

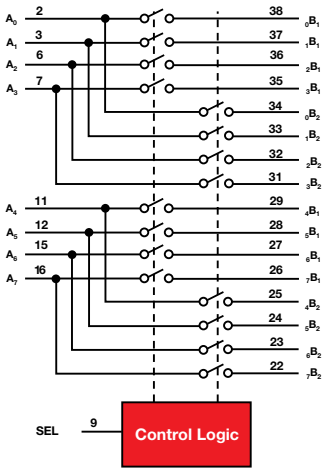
The PCIE412 is a x1 4-channel PCIe 2:1 Multiplexer/Demultiplexer passive FET switch that can be used to either route one PCIe data lane between two possible destinations or two PCIe data lanes to one destination. Each representing differential pairs of receive (RX) and transmit (TX) signals can be routed through a single PCB skew and operates at a signal-processing bandwidth speed of 2.5 Gbps. The device is controlled with one select input pin which controls the data path of the mux/demux and can be connected to any GPIO in the system, using an external voltage divider system.

Key Features

- Compatible with PCIe Gen-1 Standard
- Low R_{ON} and C_{ON} assuring maximum signal transfer while maintaining low distortion
- Low Crosstalk of –40 dB minimizing transmission noise
- Low channel-to-channel and bit-to-bit skew optimizing synchronization on the signal path
- 42-pin QFN package

Target markets

Target applications include computing (desktop and notebook), servers and telecom or where PCIe is used.



TS2PCIE412 functional diagram.
Expected release date, March 2009.

PCI Express Selection Guide

Device	Supply Voltage (V)	PCIe	Parallel Bus Width	Speed (max) (Gbps)	MicroStar BGA™ Packaging	Package	Description	Price*
PCI Express PHY								
XIO1100	3.3, 1.8, 1.5	x1	8, 16	2.5	Yes	100 BGA	x1 PCI Express PHY, Compliant with the PCI Express Base Specification Revision 1.1	7.00

Device	Supply Voltage (V)	PCIe	PCI Bus Masters	Wake/Beacon Support	MicroStar BGA™ Packaging	Package	Description	Price*
PCI Express Bridge								
XIO2000A	3.3, 1.5	x1	6	Yes	Yes	175 BGA 201 BGA	x1 PCI Express to PCI Bus Translation Bridge	10.50

Device	Supply Voltage (V)	PCIe	FIFO (KB)	Speed (max) (Mbps)	MicroStar BGA™ Packaging	Package	Description	Price*
PCI Express Endpoints								
XIO2200A	3.3, 1.5	x1	9	400	Yes	175 BGA 176 BGA	PCI Express to PCI Bus Translation Bridge with 1394a OHCI and Two-Ports	7.75
XIO2213A	3.3, 1.95, 1.5	x1	8	800	No	167 BGA	PCI Express to 1394b OHCI with Three-Port PHY	8.70

Device	Supply Voltage (V)	PCIe	Downstream PCIe Ports	Wake/Beacon Support	MicroStar BGA™ Packaging	Package	Description	Price*
PCI Express Packet Switch								
XIO3130	3.3, 1.5	x1	3	Yes	Yes	196 BGA	x1 PCI Express 4-Port Fanout Packet Switch	Call

Device	No. of Inputs	No. of Outputs	Supply Voltage Range (V)	r_{ON} (typ) (Ω)	tpd (typ) (ns)	MicroStar BGA™ Packaging	Package	Description	Price*
PCI Express Signal Switches**									
TS2PCIE2212	2	1	1.7 - 1.9	10	0.25	No	48 BGA	2-Channel PCIe 2:1 Multiplexer/Demultiplexer Passive FET Switch	1.61
TS2PCIE412	2	1	1.5 - 2.1	12.5	0.25	No	42 QFN	4-Channel PCIe 2:1 Multiplexer/Demultiplexer Passive FET Switch	Preview

**Suggested resale price in U.S. dollars in quantities of 1,000.*
***For additional TI switches, visit www.ti.com/switches*

*Preview products are listed in **bold blue**.*

Design Considerations

Peripheral Component Interconnect (PCI) is an interconnection system between a microprocessor and attached devices in which expansion slots are spaced closely for high-speed operation. A PCI-to-PCI bridge is a high-performance connection path between two PCI buses that allows bridge transactions to occur concurrently on both buses. Burst-mode transfers maximize data throughput while the two bus traffic paths through the bridge act independently. In future systems, many PCI bus structures will be replaced by the new serial PCI Express architecture. TI is actively developing a portfolio of PCI Express products to address this market.

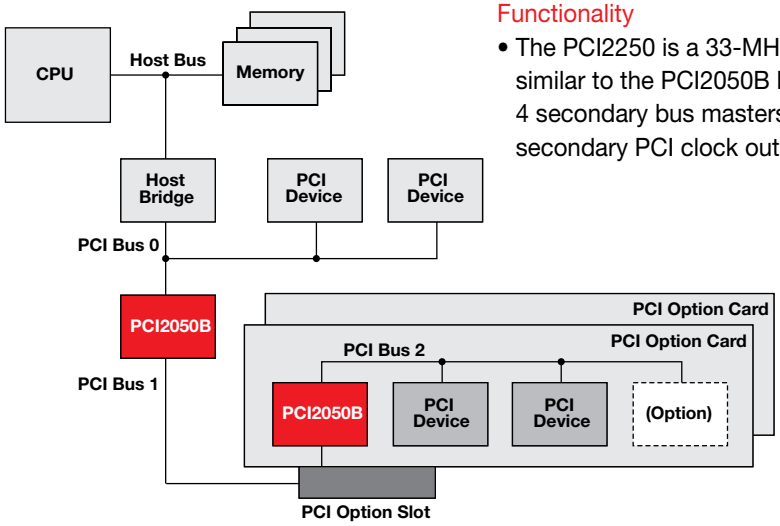
PCI Bridges

PCI2050B
PCI2250
PCI2060

PCI bridge family of products.

Key Features

- Two 32-bit, 33- or 66-MHz buses
- Configurable for PCI power-management interface specification
- CompactPCI hot-swap functionality
- 3.3-V core logic with 3.3- to 5-V PCI signaling compatibility
- Intel® bridge compatibility
- Transparent bridging



Typical PCI-to-PCI bridge system application.

Technical Information

Capabilities

- TI's PCI2050B is a 32-bit, 66-MHz bridge with internal two-tier arbitration for up to 9 secondary bus masters and support for an external secondary bus. There are independent read/write buffers for each direction and 10 secondary PCI clock outputs.

Functionality

- The PCI2250 is a 33-MHz bridge similar to the PCI2050B but supports 4 secondary bus masters and 5 secondary PCI clock outputs.

PCI Bridges Selection Guide

Device	Intel-Compatible Part No.	Speed (MHz)	Expansion Interface (Bits)	Hot Swap	MicroStar BGA™ Packaging	Voltage (V)	Package(s)	Description	Price*
PCI Bridges									
PCI2050B	21150bc	66	32	Yes	Yes	3.3, 5	208 LQFP, 208 QFP, 257 BGA	32-Bit, 66-MHz, 9-Master PCI-to-PCI Bridge	9.50
PCI2250	21152ab	33	32	Friendly	No	3.3, 5	176 LQFP, 160 QFP	32-Bit, 33-MHz PCI-to-PCI Bridge, Compact PCI Hot-Swap Friendly, 4-Master	6.10
PCI2060	—	66	32	Yes	Yes	3.3, 5	257 BGA	32-Bit, 66-MHz, 9-Master, Asynchronous PCI-to-PCI Bridge	9.50

**Suggested resale price in U.S. dollars in quantities of 1,000.*

Resources For a complete list of resources (evaluation modules, data sheets and application notes), visit interface.ti.com

Application Notes

Literature Number	Description
SCPA029A	Adding Debounce Logic to /HSSwitch Terminal
SLLA067	Comparing Bus Solutions
SCPA027	Connecting ENUM Terminal to an External Open-Drain Buffer

Application Notes

Literature Number	Description
SCPA030	Interfacing the PCI2040 to the TMS320VC5420 DSP
SPRA679	Texas Instruments TMS320VC5409/5421 DSP to PCI Bus

Design Considerations

ExpressCard Power Switches

The TPS2231 and TPS2236 ExpressCard power interface switches provide the total power management solution required by the ExpressCard specification. The TPS2231 and TPS2236 ExpressCard power interface switches distribute 3.3 V, AUX and 1.5 V to the ExpressCard socket. Each voltage rail is protected with integrated current-limiting circuitry. The TPS2231 supports systems with single-slot ExpressCard/34 or ExpressCard/54 sockets. The TPS2236 supports systems with dual-slot ExpressCard sockets.

PCMCIA/CardBus Power Switches

Standard PC cards require that V_{CC} be switched between ground, 3.3 V and 5 V, while V_{PP} is switched between ground, 3.3 V, 5 V and 12 V. CardBay sockets have the standard requirements for V_{CC}, but require ground, 3.3 V and 5 V to V_{CC}, and ground, 1.8 V or 3.3 V to V_{CORE}. Other PC card applications may simply not need 12 V or V_{PP} while still having the standard requirements for V_{CC}. Therefore, consider the voltage requirements of the application when selecting a PCMCIA power switch.

Power MUX ICs

Power MUX ICs are designed to transition from a main power supply to an auxiliary source when the main supply shuts down (e.g., switching from battery operation to a wall adapter).

For more information on these and other switches, please see the USB current-limiting power switches on page 28.

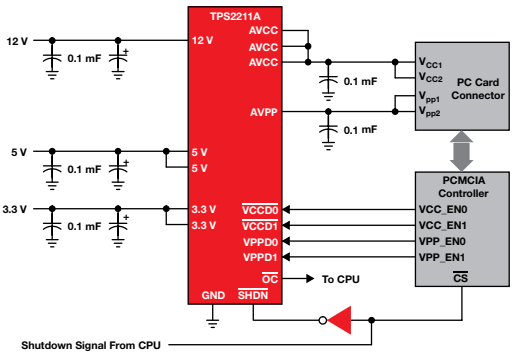
Current-Limiting Power Switches

Power switches are used to intelligently turn power on and off, while providing fault protection. They are useful anywhere controlled allocation of power is needed to circuit blocks, modules, add-in cards or cabled connections. They are ideal for power sequencing or segmentation.

To minimize voltage drop, select devices with the lowest $r_{DS(on)}$ or Drain-to-Source on-resistance.

TPS2211A

- Fully integrated V_{CC} and V_{PP} switching for single-slot PC card interface
- Low $r_{DS(on)}$
- 3.3-V low-voltage mode
- Short-circuit and thermal protection
- Compatible with 3.3-V, 5-V and 12-V PC cards



Typical PC card power-distribution application.

ExpressCard Power Switch ICs

Device	Ports	3-V $r_{DS(on)}$ (mΩ)	Interface	Current Limit (Min) (A)
TPS2231	1	45	Parallel	2.5
TPS2236	2	45	Parallel	2.5

PCMCIA/CardBus Power Switch Matrix ICs

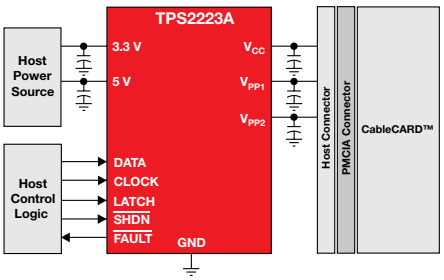
	Current Limit (min) (A)			
	0.3	0.7	1.0	2.5
3.3 V, 5 V, 12 V, V_{PP}				
Dual	—	—	TPS2224(A), TPS2226(A), TPS2204A, TPS2206A, TPS2205	—
Single	TPS2212	—	TPS2204A, TPS2210A, TPS2211(A), TPS2220A, TPS2220B	TPS2231
12 V, 5 V, 12 V, V_{PP}				
Dual	—	—	TPS2223A	TPS2236
Single	—	TPS2044B/54B	—	—
No V_{PP}				
Dual	—	TPS2044B/54B	—	—

Power MUX ICs

Configuration	Device	I_{OUT} (mA)	Transition	Comments
IN1 IN2	TPS2100/1	IN1: 500, IN2: 10	Manual	SOT-23, 0 to 70°C
	TPS2102/3	IN1: 500, IN2: 100	Manual	SOT-23, 0 to 70°C
	TPS2104/5	IN1: 500, IN2: 100	Manual	SOT-23, –40 to 85°C
	TPS2110A	Adj. 310 to 750	Auto/Manual	TSSOP
	TPS2111A	Adj. 630 to 1250	Auto/Manual	TSSOP
	TPS2112A	Adj. 310 to 750	Auto	TSSOP, Status Pin
	TPS2113A	Adj. 630 to 1250	Auto	TSSOP, Status Pin
	TPS2114A	Adj. 310 to 750	Auto/Manual	TSSOP, Status Pin
	TPS2115A	Adj. 630 to 1250	Auto/Manual	TSSOP, Status Pin

CableCARD™ Power Requirements

Many consumer set-top boxes today require the implementation of CableCARD compliant slots, similar to PCMCIA Type II cards. These CableCARD-compliant slots enable third-party equipment to be used with telecommunications service provider networks. TI's TPS2223A, TPS2221 and other switches are ideal to provide the various power requirements for many CableCARD applications.



Typical CableCARD application.

Device	Interface	Number of Ports	3.3-V $r_{DS(on)}$ I_{OS} (typ) (mW)	5.0-V $r_{DS(on)}$ (typ) (mW)	I_{OS} (min) (A)	Predecessor	Price*
PCMCIA/CardBus Switch Matrix ICs							
TPS2210A	3-Line Serial	1	85	95	1	—	0.85
TPS2204A	3-Line Serial	2	85	95	1	TPS2214/14A	1.95
TPS2220B	3-Line Serial	1	85	95	1	TPS2220A	0.85
TPS2223A	3-Line Serial	2	85	95	1	—	1.80
TPS2224A	3-Line Serial	2	85	95	1	TPS2214/14A	1.95
TPS2226A	3-Line Serial	2	85	95	1	TPS2206, TPS2216/16A	2.10
TPS2206A	3-Line Serial	2	85	95	1	TPS2206, TPS2216/16A	2.10
TPS2205	8-Line Parallel	2	70	100	1	TPS2201	2.90
TPS2211A	4-Line Parallel	1	70	57	1	TPS2211	0.75
TPS2212	4-Line Parallel	1	160	160	0.3	—	1.45
TPS2231	4-Line Parallel	1	68	—	2.5	—	1.00
TPS2044B or 54B	Parallel	1 or 2	80	80	0.7	TPS2044/44A, TPS2054/54A	1.00
TPS2221	Interface Parallel	1	72	97	1	—	1.85
TPS2228	Interface Serial	2	72	97	1	—	3.10

Device	Number of Inputs	IN1 $r_{ds(on)}$ (mΩ)	IN2 $r_{ds(on)}$ (mΩ)	IN1 Output Current (mA)	IN2 Output Current (mA)	IN1 Supply Current (µA)	IN2 Supply Current (µA)	Input Voltage Range (V)	Transition Time		Transition	Price*
									IN1 to IN2 (µs)	IN2 to IN1 (µs)		
Power MUX ICs												
TPPM0301/2	3	—	—	400	400	2500	250	3 to 5.5	—	—	Autoswitch	1.60
TPPM0303	3	—	—	250	250	2500	250	3 to 5.5	—	—	Autoswitch	1.07
TPS2100/1	2	250	1300	500	10	10	0.75	2.7 to 4.0	4	900	L/H enable	0.59
TPS2102/3	2	250	1300	500	100	14	0.75	2.7 to 4.0	3	700	L/H enable	0.69
TPS2104/5	2	250	1300	500	100	18	0.75	2.7 to 5.5	3	700	L/H enable	0.85
TPS2110A/2A/4A	2	120	120	312 to 750	312 to 750	85	85	2.8 to 5.5	40	40	Autoswitch	0.70
TPS2111A/3A/5A	2	84	84	625 to 1250	625 to 1250	85	85	2.8 to 5.5	40	40	Autoswitch	0.70

Suggested resale price in U.S. dollars in quantities of 1,000.

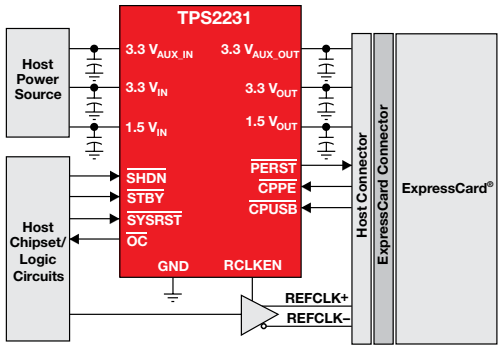
*New products are listed in **bold red**.*

Integrated ExpressCard® Power Interface Switch
TPS2231

Get samples, datasheets, evaluation modules and app reports at: **www.ti.com/sc/device/TPS2231**

Key Features

- Meets PC card standard for ExpressCard technology
- TTL-logic compatible inputs
- Short-circuit and thermal protection
- 50-µA (typ) quiescent current on 3.3-V auxiliary input (single)



Typical ExpressCard® power-distribution application.

Overview

IEEE 1394 high-speed interconnection enables simple, low-cost, high-bandwidth real-time data connectivity between many types of electronic equipment. As a multimedia network standard, 1394 is ideally suited for consumer electronics, computers and peripherals. It is also ideal for situations that benefit from true peer-to-peer operation and maximum flexibility. 1394 is self-configuring, has strong power management/distribution capabilities and robust error-detection that make it a leading choice in control applications, especially those that also need to accommodate streaming multimedia.

The new 1394b technology enables higher performance (STP, UTP, POF, GOF and Coax), longer distance (STP, UTP, POF, GOF and Coax) and a variety of cable media to fit any application (STP, UTP, POF, GOF and Coax), making it ideal for home networking and high-speed data transfer applications. For example, 1394b is capable of 400 Mbps over coax or unshielded twisted pair Category 5 cable (called CAT5 or UTP5). For high-speed applications, TI offers a 1394b chip set that enable speeds up to 800 Mbps for applications such as video-on-demand or backing up a RAID array. TI 1394b is backward compatible to 1394a.

Design Considerations

Physical-Layer Selection Issues

- The 1394 PHY layer should support the minimum number of nodes or ports required by the end product. Having two ports permits spanning to other devices on the bus through daisy-chaining. Three or more nodes enable branching or hub capabilities.

- Will the end product need DC isolation at the 1394 interface? The cable doesn't provide a DC-isolated path from node to node. In cases where there's a possibility for the various equipment connected across 1394 to be at different ground potentials or different power domains, the grounds may need to be isolated from each other to prevent excessive currents and noise. However, the ground signal on the 1394 cable must not be DC-isolated from the PHY power-distribution ground plane. Thus when DC isolation between units is required at the 1394 interface, it is frequently performed at the PHY- and link-layer interfaces—often through the use of special I/O cells that allow for capacitive coupling of the PHY-link signals.

- While the EIA-775 specification requires a minimum speed of 200 Mbps at the 1394 interface, using 400-Mbps PHYs is recommended. Slower nodes present on the bus can be a source of speed traps. Almost all 1394 silicon available today is already 400-Mbps capable.

- The suspend/resume feature of the PHY layer lets two currently inactive ports achieve low-power states while maintaining their connection status. It also permits them to quickly resume operation as soon as they detect an applied port bias voltage.

Link-Layer Selection Issues

- What kind of data needs to be transferred? Some link controllers are designed to implement specific data protocols over 1394, such as the serial bus protocol 2 (SBP-2) for mass storage or IEC 61883-4 for MPEG-2 transport, and some are designed as general purpose.

- What is being interfaced to 1394? If the system has PCI, consider one of the PCI/OHCI links. Applications involving streaming compressed audio/video most likely need a link from the iceLynx family. Other TI links have interfaces for external processors/memory or are dedicated for a peripheral function (camera/storage).

- For audio/visual (A/V) applications, different types of A/V data require different formatting and transmission methods on 1394. Specifically identifying which types of A/V to be supported is fundamental to choosing the right 1394 chip set for the digital set-top box (DSTB) or digital TV (DTV) design. Standards define how to carry MPEG-2 transport streams in both digital video broadcasting (DVB) format and in DirecTV format, which have different packetization schemes.

- Another aspect of the link layer that should be considered is the amount of data-buffer memory supported. Typically, the more bandwidth an application requires, or the more simultaneous isochronous/asynchronous traffic that needs to be supported, the larger the buffer memories must be.

- As the number of simultaneous isochronous channels present goes up, or the bit rate of an individual stream increases, the receive buffer needs to be larger.

Technical Information

- 1394-1995 is an IEEE designation for a high-performance serial bus. A revision to this standard has been published as IEEE 1394a-2000, and clarifies and adds to portions of the IEEE 1394-1995 standard. The 1394b standard increases the speed of 1394 to 800, 1600 and 3200 Mbps, as well as providing new connection options such as plastic optical fiber (POF), glass optical fiber (GOF) and UTP-5. This serial bus defines both a backplane (for example, VME, FB+) physical layer and a point-to-point, cable-connected virtual bus. The backplane version operates at 12.5, 25 or 50 Mbps, whereas the cable version supports data rates of 100, 200, 400, 800 and 1,600 Mbps across the cable medium supported in the current standard. Both versions are totally compatible at the link layer and above. The interface standard defines transmission method, media and protocol.

Technical Information (Continued)

- Applications of the cable version are the integration of I/O connectivity of personal computers, peripherals, and consumer electronics using a low-cost, scalable, high-speed serial interface. The 1394 standard provides services such as real-time I/O and live connect/disconnect capability for devices including storage (HDD, CD-ROM, CDRW, MO, ZIP, RAID, SAN, etc.), printers, scanners, cameras, set-top boxes, HDTVs and camcorders.

Key Features

- Real-time streaming of audio and video
- High-speed: up to 400 Mbps with IEEE 1394-1995 and 1394a-2000, up to 1, 2 and 4 Gbps with 1394b
- Plug-and-play hot pluggable
- Peer-to-peer communication
- Small, durable and flexible cable and connectors
- Memory-mapped architecture
- Seamless I/O interconnect 1394b Advantages
- Faster: speeds from 800 Mbps to 3200 Mbps
- Longer distances: 100 meters with GOF and Cat5; 50 meters with POF
- TI 1394b is bi-lingual: communicates in 1394a and 1394b modes
- More cabling options: STP, Cat5, POF, GOF
- More efficient: BOSS arbitration
- More user-friendly: loop-free build allows any topology and redundancy

1394b Advantages

- Faster: speeds from 800 Mbps to 3200 Mbps
- Longer distances: 100 meters with GOF and CAT5; 50 meters with POF
- TI 1394b is bi-lingual: communicates in 1394a and 1394b modes
- More cabling options: STP, CAT5, POF, GOF
- More efficient: BOSS arbitration
- More user-friendly: loop-free build allows any topology and redundancy

1394 Selection Guide

Device	Ports	Voltage (V)	Data Rate (Mbps)	Package(s)	Description	Price*
1394 Physical Layer Controllers						
TSB41AB1	1	3.3	Up to 400	48/64 HTQFP	IEEE 1394a 1-Port Cable Transceiver/Arbiter	1.50
TSB41AB2	2	3.3	Up to 400	64 HTQFP	IEEE 1394a 2-Port Cable Transceiver/Arbiter	1.85
TSB41AB3	3	3.3	Up to 400	80 HTQFP	IEEE 1394a 3-Port Cable Transceiver/Arbiter	3.00
TSB41BA3B	3	3.3	Up to 400	80 TQFP	1394b-2002 3-Port Physical Layer Device	6.50
TSB41LV04A	4	3.3	Up to 400	80 HTQFP	IEEE 1394a 4-Port Cable Transceiver/Arbiter	6.50
TSB41LV06A	6	3.3	Up to 400	100 HTQFP	IEEE 1394a 6-Port Cable Transceiver/Arbiter	6.40
TSB81BA3D	3	1.8, 3.3	Up to 800	80 HTQFP	High-Performance 1394b s800 3-Port Cable Transceiver/Arbiter	5.55
TSB43AB21A	1	3.3	Up to 400	128 TQFP	PCI-Based 1394a OHCI Link Layer with Integrated 1394a Phy	3.60
TSB43AB22A	2	3.3	Up to 400	128 TQFP	PCI-Based 1394a OHCI Link Layer with Integrated 1394a Phy	3.80
TSB43AB23	3	3.3	Up to 400	128 TQFP	PCI-Based 1394a OHCI Link Layer with Integrated 1394a Phy	4.25
TSB83AA22C	2	1.95, 3.3	Up to 800	168 BGA	PCI-Based 1394b OHCI Link Layer with Integrated 1394b Phy	8.50
TSB83AA23	3	1.95, 3.3	Up to 800	167 BGA	PCI-Based 1394b OHCI Link Layer with Integrated 1394b Phy	9.00
XIO2200A	2	1.8, 3.3	Up to 400	176 BGA	PCIe-Based 1394a OHCI Link Layer with Integrated 1394a Phy	7.50
XIO2213A	3	1.95, 3.3	Up to 800	176 BGA	PCIe-Based 1394b OHCI Link Layer with Integrated 1394b Phy	8.70

**Suggested resale price in U.S. dollars in quantities of 1,000.*

IEEE 1394b 3-Port Cable Transceiver/Arbiter

TSB81BA3D

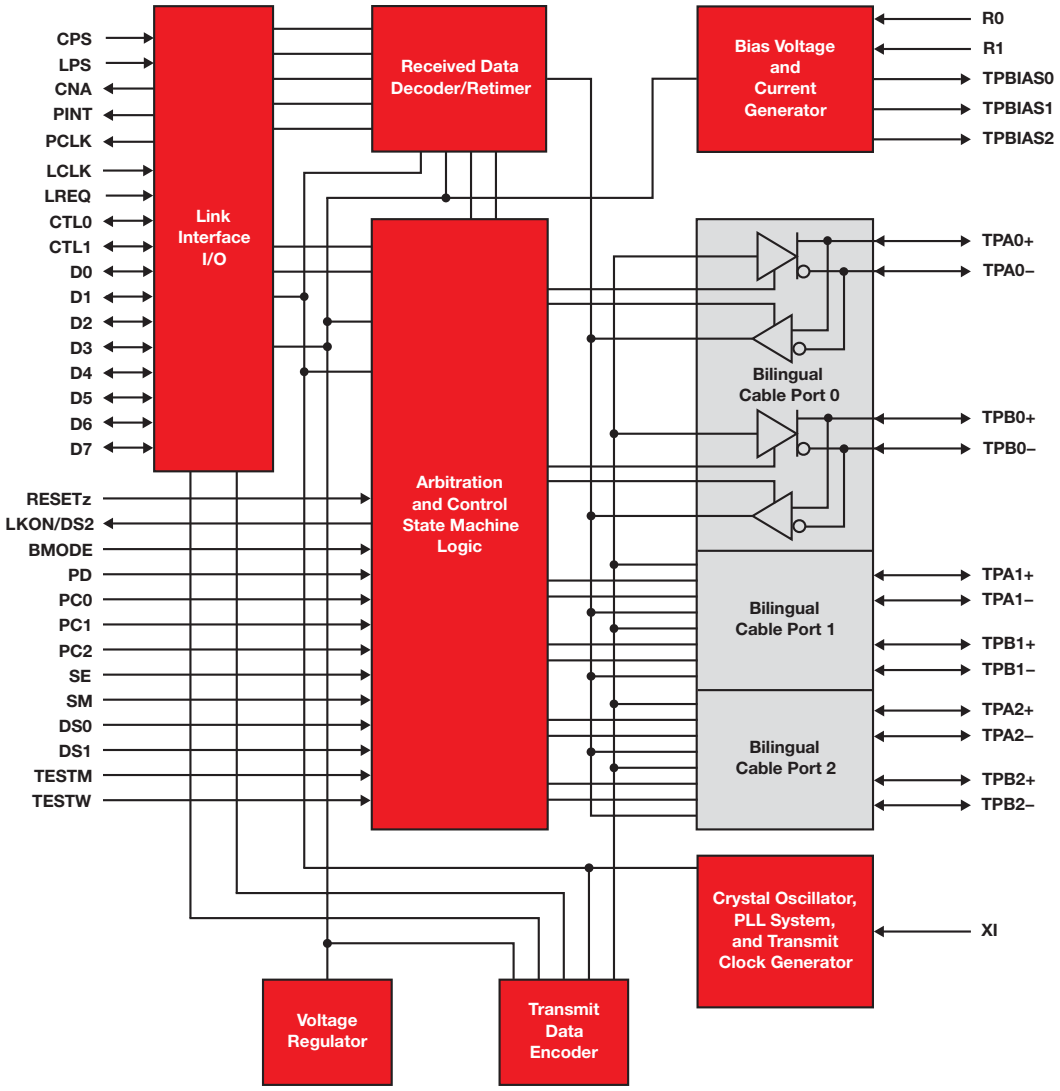
Get samples, datasheets, evaluation modules and app reports at: **www.ti.com/sc/device/TSB81BA3D**

Key Features

- Compliant with IEEE 1394b-2002, IEEE 1394a-2000 and 1394-1995 standards
- Three bilingual 1394 ports
  - 1394b (Beta) Mode at s400 and s800
  - 1394a (Data Strobe -DS) Mode at s100, s200 and s400
- Interoperable with link-layer controllers using 3.3-V supplies and other 1394 PHYs using 1.8-V, 3.3-V and 5-V supplies

Applications

- Storage devices
- Consumer electronics
- 1394b PC ports



TSB81BA3D block diagram.

Design Considerations

I/O Pin Capacitance – The allowable bandwidth through an ESD protection device is directly correlated to the I/O Pin Capacitance of the protection device. TI's portfolio offers a wide range of ESD/EMI protection devices that cover a multitude of end applications and protected ports. I/O capacitance of our devices range from 35 pF for lower speed applications down to <1 pF for high speed applications.

Breakdown Voltage – The breakdown voltage of an ESD protection device is defined as the maximum voltage allowed to pass across the internal diodes of the monolithic circuit, prior to it breaking down and dissipating the energy safely to ground. Different applications require certain breakdown voltages, and TI's portfolio addresses this with our broad product offering.

Layout Features – Many of the ESD protection devices offered by TI include unique package and pin layouts to make board routing easier for designers. There are a number of products which, in addition to providing popular pitch options, offer flow-through routing features and layout option to only populate the ESD chip if the system requires additional system-level protection.

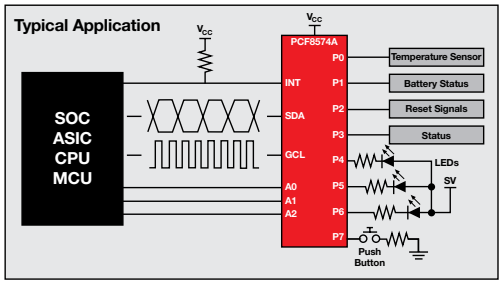
ESD/EMI Selection Guide

Device	# Channels	I/O Capaciance (pF)	V_{BR} (min) (V)	Package(s)	Description
SN65220	2	35	7	DSBGA-4 SOT23-6	USB 2.0 FS
SN65240	4	35	7	PDIP-8 TSSOP-8	USB 2.0 FS
SN75240	4	35	7	PDIP-8 TSSOP-8	USB 2.0 FS
TPD4E002	4	11	6	SOT-5	USB 2.0 HS
TPD2E001	2	1.5	11	SOT-5 SON-6	USB 2.0 HS
TPD3E001	3	1.5	11	SOT-5 SON-6	USB 2.0 HS, USB 2.0 OTG
TPD4E001	4	1.5	11	SOT-6 SON-6	USB 2.0 HS, Ethernet, FireWire, eSATA
TPD6E001	6	1.5	11	QFN-10 QFN-12	USB 2.0 HS, Ethernet, FireWire, eSATA
TPD4E004	4	1.6	6	SOT-6 SON-6	USB 2.0 HS, Ethernet, FireWire, eSATA
TPD6E004	6	1.6	6	QFN-8	USB 2.0 HS, Ethernet, FireWire, eSATA
TPD4S009	4	0.9	9	SOT23-6 SC70-6 SON-6	eSATA, LVDS Signaling
TPD8S009	8	0.9	9	SON-15	HDMI, DisplayPort
TPD12S520	12	0.9	9	TSSOP-38	HDMI
TPD12S521	12	0.9	9	TSSOP-38	HDMI

Design Considerations

Why use I²C I/O expanders?

- Advantages:
  - Easy board routing
  - Board-space savings
  - Pin savings
  - Low cost
  - Industry standard
- Applications:
  - Useful with processors with few I/Os
  - Increase feature set without going to larger processor
  - Keypad control



Buffer/Repeaters

Device	No. of Outputs	f_{SCLK} (max) (kHz)	Package(s)	Description
P82B715	2	400	8PDIP, 8SOIC	I²C Bus Extender
P82B96	2	400	8MSOP, 8PDIP, 8SOIC, 8TSSOP	Dual Bidirectional Bus Buffer
PCA9515A	2	400	8MSOP, 8PDIP, 8SOIC, 8SON, 8TSSOP	Dual Bidirectional I²C Bus and SMBus Repeater
PCA9517	2	400	8MSOP, 8SOIC	Level-Translating I²C Bus Repeater
PCA9518	5	400	20SOIC, 20SSOP, 20SSOP/QSOP, 20TSSOP	Expandable Five-Channel I²C Hub

I/O Expanders

Device	I/O Bits	f_{SCLK} (max) (kHz)	Package(s)	Description
PCA6107	8	400	18SOIC	Remote 8-Bit I²C and SMBus Low-Power I/O Expander with Interrupt Output, Reset, and Configuration Registers
PCA9534	8	400	16QFN, 16SOIC, 16SSOP, 16TSSOP, 16TVSOP	Remote 8-Bit I²C and Low-Power I/O Expander with Interrupt Output and Configuration Registers
PCA9534A	8	400	16QFN, 16SOIC, 16SSOP, 16SSOP/QSOP, 16TSSOP, 16TVSOP	Remote 8-Bit I²C and Low-Power I/O Expander with Interrupt Output and Configuration Registers
PCA9535	16	400	24QFN, 24SOIC, 24SSOP, 24SSOP/QSOP, 24TSSOP, 24TVSOP, 24VQFN	Remote 16-Bit I²C and SMBus, Low-Power I/O Expander with Interrupt Output and Configuration Registers
PCA9536	4	400	8DSBGA, 8MSOP, 8SOIC	Remote 4-Bit I²C and SMBus I/O Expander with Configuration Registers
PCA9538	8	400	16SOIC, 16SSOP, 16TSSOP, 16TVSOP	Remote 8-Bit I²C and SMBus Low-Power I/O Expander with Interrupt Output, Reset, and Configuration Registers
PCA9539	16	400	24QFN, 24SOIC, 24SSOP, 24SSOP/QSOP, 24TSSOP, 24TVSOP, 24VQFN	Remote 16-Bit I²C and SMBus, Low-Power I/O Expander with Interrupt Output, Reset and Configuration Registers
PCA9554A	8	400	16QFN, 16SOIC, 16SSOP, 16SSOP/QSOP, 16TSSOP, 16TVSOP	Remote 8-Bit I²C and SMBus I/O Expander with Interrupt Output and Configuration Registers
PCA9555	16	400	24QFN, 24SOIC, 24SSOP, 24SSOP/QSOP, 24TSSOP, 24TVSOP, 24VQFN	Remote 16-Bit I²C And SMBus I/O Expander with Interrupt Output and Configuration Registers
PCA9557	8	400	16QFN, 16SOIC, 16SSOP, 16TSSOP, 16TVSOP	Remote 8-Bit I²C and SMBus Low-Power I/O Expander with Reset and Configuration Registers
PCF8574	8	400	16PDIP, 16QFN, 16SOIC, 20QFN, 20TSSOP, 20TVSOP	Remote 8-Bit I/O Expander for I²C-Bus
PCF8574A	8	400	16PDIP, 16SOIC, 20QFN, 20TSSOP, 20TVSOP	Remote 8-Bit I/O Expander for I²C-Bus
PCF8575	16	400	24QFN, 24SOIC, 24SSOP, 24SSOP/QSOP, 24TSSOP, 24TVSOP, 24VQFN	Remote 16-Bit I²C and SMBus I/O Expander with Interrupt Output
PCF8575C	16	400	24SOIC, 24SSOP, 24SSOP/QSOP, 24TSSOP, 24TVSOP, 24VQFN	Remote 16-Bit I²C and SMBus I/O Expander with Interrupt Output
TCA6408	8	400	16QFN, 16TSSOP, 20BGA Microstar Junior™	Low-Voltage 8-Bit I²C and SMBus I/O Expander with Interrupt Output, Reset, and Configuration Register
TCA6416	16	400	24BGA Microstar Junior, 24QFN, 24TSSOP	Low-Voltage 16-Bit I²C and SMBus I/O Expander with Interrupt Output, Reset, and Configuration Registers
TCA6424	24	400	32QFN	Low-Voltage 24-Bit I²C and SMBus I/O Expander with Interrupt Output Reset and Configuration Registers
TCA6507	7	400	12BGA Microstar Junior, 12QFN, 14TSSOP	Low-Voltage 7-Bit I²C and SMBus LED Driver with Intensity Control and Shutdown

Switches/Multiplexers

Device	tpd (max) (ns)	f_{SCLK} (max) (kHz)	Package(s)	Description
PCA9543A	0.3, 1	400	14SOIC, 14TSSOP	Two-Channel I²C Bus Switch with Interrupt Logic and Reset
PCA9544A	0.3, 1	400	20BGA Microstar Junior, 20QFN, 20SOIC, 20TSSOP, 20TVSOP	4-Channel I²C and SMBus Multiplexer with Interrupt Logic
PCA9545A	0.3, 1	400	20BGA Microstar Junior, 20QFN, 20SOIC, 20TSSOP, 20TVSOP	4-Channel I²C and SMBus Multiplexer with Interrupt Logic and Reset Functions
PCA9546A	0.3, 1	400	16QFN, 16SOIC, 16TSSOP, 16TVSOP, 20BGA Microstar Junior, 20TVSOP	4-Channel I²C and SMBus Multiplexer with Reset Functions
PCA9548A	0.3, 1	400	24SOIC, 24SSOP, 24TSSOP, 24TVSOP, 24VQFN	8-Channel I²C Switch with Reset

Translator

PCA9306	1.5	400	8SM8, 8US8	Dual Bidirectional I²C Bus and SMBus Voltage-Level Translator

Design Considerations

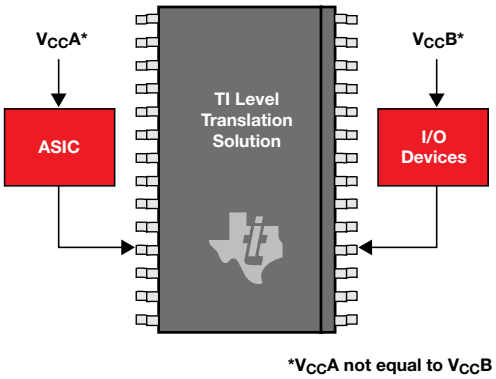
Supply voltages continue to migrate to lower nodes to support today's low-power, high-performance applications. While some devices are capable of running at lower supply nodes, others might not have this capability. To have switching capability between these devices, the output of each driver must be compliant with the input of the receiver that it is driving.

Why use a voltage-level translator?

- Easily interface between subsystems operating with different supply voltages
- Provide migration paths from old architectures to new architectures

For two devices to have switching capability:

- V_{OH} of the driver must be greater than the V_{IH} of the receiver
- V_{OL} of the driver must be less than the V_{IL} of the receiver
- The output voltage from the driver must not exceed the I/O voltage tolerance of the receiver



Typical situation in which a level translator is needed.

Single Supply Translators

Device	Bits	Trans Low (V)	Trans High (V)	V_{CC} (V)	DIR Pins	Bus Hold	OE Pins	t_{pd} (max) (ns)
SN74AUP1T57	3	2.5	3.3	2.3 - 3.6	No	No	No	6.2
SN74AUP1T58	3	2.5	3.3	2.3 - 3.6	No	No	No	6.2
SN74AUP1T97	3	2.5	3.3	2.3 - 3.6	No	No	No	6.2
SN74AUP1T98	3	2.5	3.3	2.3 - 3.6	No	No	No	6.2

Dual Supply Translators

Device	Bits	Trans Low (V)	Trans High (V)	V_{CC}A (V)	V_{CC}B (V)	DIR Pins	Bus Hold	OE Pins	t_{pd} (max) (ns)
TXB0101	1	1.2	5	1.2 to 3.6	1.65 to 5.5	Auto	No	1	4.5
TXB0102	2	1.2	5	1.2 to 3.6	1.65 to 5.5	Auto	No	1	4.5
TXB0104	4	1.2	5	1.2 to 3.6	1.65 to 5.5	Auto	No	1	4
TXB0104-Q1	4	1.2	5	1.2 to 3.6	1.65 to 5.5	Auto	No	1	7
TXB0106	6	1.2	5	1.2 to 3.6	1.65 to 5.5	Auto	No	1	4
TXB0108	8	1.2	5	1.2 to 3.6	1.65 to 5.5	Auto	No	1	4
TXS0101	1	1.8	5	1.65 to 3.6	2.3 to 5.5	Auto	No	1	7.5
TXS0102	2	1.8	5	1.65 to 3.6	2.3 to 5.5	Auto	No	1	4.6
TXS0104E	4	1.8	5	1.65 to 3.6	2.3 to 5.5	Auto	No	1	4.6
TXS0108E	8	1.2	5	1.2 to 3.6	1.65 to 5.5	Auto	No	1	4.8
SN74AVC1T45	1	1.2	3.3	1.2 to 3.6	1.2 to 3.6	1	No	No	2.8
SN74AVC2T45	2	1.2	3.3	1.2 to 3.6	1.2 to 3.6	1	No	No	2.4
SN74AVCH1T45	1	1.2	3.3	1.2 to 3.6	1.2 to 3.6	1	Yes	No	2.8
SN74AVCH2T45	2	1.2	3.3	1.2 to 3.6	1.2 to 3.6	1	Yes	No	2.4
SN74AVC2T245	2	1.2	3.3	1.2 to 3.6	1.2 to 3.6	2	No	1	2.4
SN74AVC4T245	4	1.2	3.3	1.2 to 3.6	1.2 to 3.6	2	No	2	2.9
SN74AVC8T245	8	1.2	3.3	1.2 to 3.6	1.2 to 3.6	1	No	1	2.5
SN74AVC16T245	16	1.2	3.3	1.2 to 3.6	1.2 to 3.6	2	No	2	2.7
SN74AVC20T245	20	1.2	3.3	1.2 to 3.6	1.2 to 3.6	2	No	2	2.9
SN74AVC24T245	24	1.2	3.3	1.2 to 3.6	1.2 to 3.6	6	No	6	2.7
SN74AVC32T245	32	1.2	3.3	1.2 to 3.6	1.2 to 3.6	4	No	4	2.7
SN74AVCH4T245	4	1.2	3.3	1.2 to 3.6	1.2 to 3.6	2	Yes	2	2.9
SN74AVCH8T245	8	1.2	3.3	1.2 to 3.6	1.2 to 3.6	1	Yes	1	2.5
SN74AVCH16T245	16	1.2	3.3	1.2 to 3.6	1.2 to 3.6	2	Yes	2	2.7
SN74AVCH20T245	20	1.2	3.3	1.2 to 3.6	1.2 to 3.6	2	Yes	2	2.9
SN74AVCH24T245	24	1.2	3.3	1.2 to 3.6	1.2 to 3.6	6	Yes	6	2.7
SN74AVCH32T245	32	1.2	3.3	1.2 to 3.6	1.2 to 3.6	4	Yes	4	2.7
SN74AVC4T774	4	1.2	3.3	1.2 to 3.6	1.2 to 3.6	4	No	1	2.4
SN74LVC1T45	1	1.8	5	1.65 to 5.5	1.65 to 5.5	1	No	No	3.9
SN74LVC2T45	2	1.8	5	1.65 to 5.5	1.65 to 5.5	1	No	No	3.9
SN74LVC8T245	8	1.8	5	1.65 to 5.5	1.65 to 5.5	1	No	1	4.2
SN74LVCH8T245	8	1.8	5	1.65 to 5.5	1.65 to 5.5	1	Yes	1	4.2
SN74LVC16T245	16	1.8	5	1.65 to 5.5	1.65 to 5.5	2	No	2	4.2
SN74LVCH16T245	16	1.8	5	1.65 to 5.5	1.65 to 5.5	2	Yes	2	4.2

High-Speed Optoelectronics Devices and Equalizers

Physical-media-dependent (PMD) electronics from Texas Instruments (TI) provide optical component and systems developers with key building blocks such as laser diode drivers, transimpedance amplifiers, post amplifiers, and equalizers. TI solutions provide wide data rate range support while minimizing power, PCB real estate, and implementation cost.

Laser Drivers

- Data rates ranging from 155 Mbps up to 11.3 Gbps.
- Automatic power control (APC), temperature compensation of modulation and bias currents
- Fault detection and current monitors

Transimpedance Amplifiers

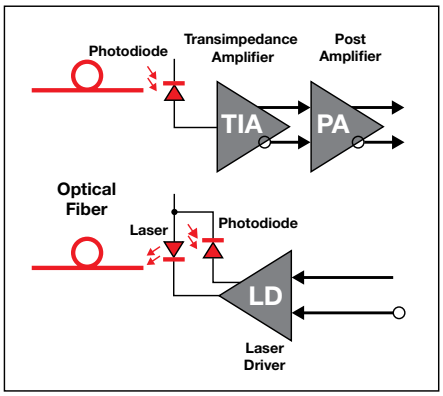
- Data rates of up to 11.3 Gbps
- Low input-referred noise
- Transimpedance between 2.6 and 7 kΩ with low power dissipation

Post Amplifiers

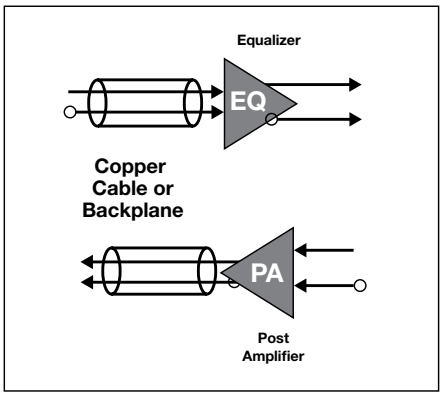
- Data rates of up to 11.3 Gbps
- Loss-of signal (LOS) detection
- Received-signal-strength indicator (RSSI)

Equalizers

- Data rates up to 11.3 Gbps
- Devices compensate for channel loss of active cables and printed circuit board traces up to 30 dB at the receive side
- Loss-of-signal (LOS) detection



Optical network signal chain.



Copper network signal chain.

Laser Drivers

Device	Data Rate (typ) (Gbps)	V_{CC} (V) (typ)	Modulation Current (mA)	Bias (mA)	Rise and Fall Time (typ) (µs)	DJ (typ) (ps)	Package
ONET1101L	Up to 11.3	3.3	85	100	25	5	24VQFN
ONET1191V	Up to 11.3	3.3	45	20	25	4	20QFN
ONET4201LD	0.155 to 4.25	3.3	85	100	55	15	24VQFN
ONET4211LD	0.155 to 4.25	3.3	85	100	35	15	24VQFN
ONET4291VA	1 to 4.25	3.3	11.5	11	35	7	20QFN
ONET8501V	Up to 11.3	3.3	24	20	24	4	20QFN

Post Amplifiers

Device	Data Rate (typ) (Gbps)	V_{CC} (V) (typ)	V_{IN} (min) (typ) (mV_{PP})	I_{VCC} (typ) (mA)	DJ (typ) (ps)	Power (typ) (mW)	Package
ONET1191P	Up to 11.3	3.3	2.5	33	4	110	16QFN
ONET4201PA	0.155 to 4.25	3.3	3	35	3	115	16QFN
ONET4251PA	1 to 4.25	3.3	50	35	6	115	16QFN
ONET4291PA	1 to 4.25	3.3	2	46	8	152	16QFN
ONET8501P	2 to 11.3	3.3	6	48	4	160	16QFN
ONET8501PB	2 to 11.3	3.3	5	50	3	165	16QFN

Transimpedance Amplifiers

Device	Data Rate (typ) (Gbps)	V_{CC} (V) (typ)	Transimpedance (kΩ)	Input Referred Noise (typ) (nArms)	I_{VCC} (typ) (mA)	DJ (typ) (ps)	Power (typ) (mW)	Package(s)
ONET2511TA	2.5	3.3	4	470	25	25	83	DIE
ONET2591TA	Up to 2.5	3.3	2.6	280	14	8.5	46	DIE, WAFER
ONET4291TA	Up to 4.25	3.3	3.2	465	17	10	56	DIE, WAFER
ONET8501T	Up to 12.5	3.3	7	900	28	6	93	DIE
ONET8511T	Up to 11.3	3.3	5.5	1000	46	8	151	DIE
ONET8531T	Up to 12.5	3.3	4.5	900	28	6	93	DIE

Equalizers

Part Number	Data Rate (typ) (Gbps)	V_{CC} (V) (typ)	V_{IN} (max) (mV_{PP})	V_{OD} (typ) (mV_{PP})	I_{VCC} (max) (mA)	DJ (typ) (ps)	RJ (typ) (ps)	Package
TLK1101E	Up to 11.3	3.3	1600	300/600/900	110	12 (with 27-dB loss @ 5 GHz)	1 (with 27-dB loss @ 5 GHz)	20QFN
TLK6201EA	Up to 6.25	3.3	2000	800/1200	67	12 (with 18-dB loss @ 3 GHz)	1 (with 18-dB loss @ 3 GHz)	16QFN

The following products have similar functionality:

Part Number	TI Replacement
AGERE	
BDG1A	TB5D1M
BDG1A	TB5D2H
BDGLA	TB5D2H
BPNGA	TB5D1M
BRF1A	TB5R1
BRF2A	TB5R1
BRS2A	TB5R2
BRS2B	TB5R2
BTF1A	TB5T1
AGILENT	
HDMP1636/1646	TNETE2201B
ALLEGRO	
A2525	TPS2051A
A2526	TPS2052A
A2535	TPS2041A
A2536	TPS2042A
ANALOG DEVICES (ADI)	
ADM1485	SN75LBC176A*
ADM1486	SN65HVD1176*
ADM3485E	SN75HVD10*
ADM483E	SN65HVD3082E
ADM483E	SN75LBC176A*
ADM485	SN65HVD3085E*
ADM485	SN65HVD485E*
ADM485	SN75LBC176A*
ADM485	SN75176B*
ADM488	SN75LBC179A*
ADM489	SN75LBC180A*
CMP	
CMPWR025	TPS210x
CYPRESS	
AN-213x	TUSB3410
EUREKA	
EP600	TL16C550C
EXAR	
ST16C2450	TL16C452
ST16C2550	TL16C552A
ST16C2550	TL16C752B*
ST16C2552	TL16C552A*
ST16C450	TL16C450*
ST16C452	TL16C452*
ST16C550	TL16C550B
ST16C550	TL16C550C
ST16C552	TL16C552
ST16C552	TL16C552A
ST16C552A	TL16C552
ST16C552A	TL16C552A
ST16C554	TL16C554A
ST16C554D	TL16C554
ST16C554D	TL16C554A
ST16C580	TL16C550C
ST16C654	TL16C754B
ST16C654D	TL16C754B

Part Number	TI Replacement
EXAR (cont.)	
ST68C554	TL16C554A
XR16L2750	TL16C752B
XR16L2751	TL16C752B
XR16L2752	TL16C752B
XR16L651	TL16C750
XR16L784	TL16C754B
FAIRCHILD SEMICONDUCTOR	
FIN1001	SN65LVDS1*
FIN1002	SN65LVDS2*
FIN1017	SN65LVDS1*
FIN1018	SN65LVDS2*
FIN1019	SN65LVDS180
FIN1022	SN65LVCP22*
FIN1025	SN65LVDS9638
FIN1026	SN65LVDS9637
FIN1027	SN65LVDS9638*
FIN1028	SN65LVDS9637*
FIN1031	SN65LVDS31*
FIN1032	SN65LVDS32*
FIN1047	SN65LVDS047*
FIN1048	SN65LVDS048A*
FIN1049	SN65LVDS049
FIN1101	SN65LVDS100
FIN1102	SN65LVCP22
FIN1104	SN65LVDS125
GTLP1616	SN74GTLPH1616
GTLP16612	SN74GTLPH1612
GTLP16612	SN74GTLPH16612
GTLP16T1655	SN74GTLPH1655
GTLP18T612	SN74GTLPH16912
GTLP6C817	SN74GTLP817
GTLP8T306	SN74GTLPH306
FTDI	
FT232BM	TUSB3410
GOLDSTAR	
GM16C550	TL16C550B*
GM16C550	TL16C550C*
HYNIX (LG)	
GD75232	GD75232*
IMP	
Ei16C450	TL16C450
Ei16C550	TL16C550C
Ei16C552	TL16C552
Ei16C552	TL16C552A
Ei16C554	TL16C554
Ei16C554	TL16C554A
IMPX	
IMP2525	TPS2051A
IMP2525A	TPS2051A
IMP2526	TPS2052A
INFINEON	
TLE6250	SN65HVD251
TLE6250	SN65HVD1050

Part Number	TI Replacement
INTEL	
21150AB/AC	PCI2050*
21150BC	PCI2050B*
21152	PCI2250*
INTERSIL	
HIN211	SN75LBC241
HIN211E	SN75LBC241
HIN232	TRS232*
HIN232E	TRS232E*
HIN241	SN75LBC241
HIN241E	SN75LBC241
ICL232	TRS232*
ICL3221	TRS3221*
ICL3221E	TRS3221E*
ICL3222	TRS3222*
ICL3222E	TRS3222E*
ICL3223	TRS3223*
ICL3223E	TRS3223E*
ICL3232	TRS3232*
ICL3232E	TRS3232E*
ICL3238	TRS3238*
ICL3238E	TRS3238E*
ICL3243	TRS3243*
ICL3243E	TRS3243E*
ISL1483	SN65HVD3082E*
ISL1483	SN65LBC184*
ISL1487	SN65HVD06*
ISL1487	SN65HVD21*
ISL1487E	SN65HVD06*
ISL1487E	SN65HVD21*
ISL1487L	SN65HVD3082E*
ISL1487L	SN65LBC184*
ISL8483	SN65HVD3082E*
ISL8485	SN65HVD06*
ISL8485	SN65HVD21*
ISL8488	SN65LBC179A*
ISL8489	SN65LBC180A*
ISL8490	SN65LBC179A*
ISL8491	SN65LBC180A*
LINEAR TECHNOLOGY CORP. (LTC)	
LT1030	LT1030
LT1081	TRS232
LT1181A	TRS232
LT1381	TRS232
LT1785	SN75LBC184*
LTC1472	TPS2211A
LTC1480	SN75HVD11*
LTC1481	SN75LBC176A*
LTC1482	SN75LBC176A*
LTC1483	SN75LBC176A*
LTC1484	SN75LBC176A*
LTC1485	SN65LBC176A*
LTC1487	SN65HVD3082E*

**Drop-in, pin-compatible devices*

The following products have similar functionality:

Part Number	TI Replacement
LINEAR TECHNOLOGY CORP. (LTC) (cont.)	
LTC1487	SN75HVD07*
LTC1518	SN75LBC173A*
LTC1519	SN75LBC175A*
LTC1685	SN65HVD1176*
LTC1686	SN75LBC179A*
LTC1687	SN75LBC180A*
LTC1688	SN75LBC172A*
LTC1689	SN75LBC174A*
LTC1690	SN75LBC179A*
LTC1796	SN65HVD251*
LTC485	SN65HVD3085E*
LTC485	SN65HVD485E*
LTC485	SN75LBC176A*
LTC485	SN75176B*
LTC486	SN75172*
LTC486	SN75ALS172A*
LTC486	SN75LBC172A*
LTC487	SN75174*
LTC487	SN75ALS174A*
LTC487	SN75LBC174A*
LTC488	SN75173*
LTC488	SN75ALS173*
LTC488	SN75LBC173A*
LTC489	SN75175*
LTC489	SN75ALS175*
LTC489	SN75LBC175A*
LTC490	SN75LBC179A*
LTC491	SN75LBC180A*
MAXIM	
MAX1487	SN65HVD3082E*
MAX1487	SN75HVD06*
MAX1487E	SN65HVD3082E*
MAX1487E	SN75HVD06*
MAX1600/MAX1603	TPS2205
MAX1601/MAX1604	TPS2205
MAX1602	TPS2211A
MAX1607	TPS2041A
MAX202	TRS202*
MAX211	TRS211*
MAX232	TRS232*
MAX241	SN75LBC241
MAX3040	SN75LBC174A*
MAX3041	SN75LBC174A*
MAX3042B	SN75LBC174A*
MAX3043	SN75LBC172A*
MAX3044	SN75LBC172A*
MAX3045B	SN75LBC172A*
MAX3050	SN65HVD251*
MAX3053	SN65HVD251
MAX3053	SN65HVD251*
MAX3057	SN65HVD251*
MAX3082	SN65HVD3082E*
MAX3082E	SN65HVD3082E*

Part Number	TI Replacement
MAXIM (cont.)	
MAX3085	SN65HVD3085E*
MAX3085E	SN65HVD3085E*
MAX3088	SN65HVD3088E*
MAX3088E	SN65HVD3088E*
MAX3093E	SN75LBC173A*
MAX3095E	SN75LBC175A*
MAX3221	TRS3221*
MAX3221E	TRS3221E*
MAX3222	TRS3222*
MAX3222E	TRS3222E*
MAX3223	TRS3223*
MAX3223E	TRS3223E*
MAX3232	TRS3232*
MAX3232E	TRS3232E*
MAX3238	TRS3238*
MAX3238E	TRS3238E*
MAX3243	TRS3243*
MAX3243E	TRS3243E*
MAX3362	SN75HVD10*
MAX3443E	SN75LBC184*
MAX3463	SN65HVD1176*
MAX3464	SN65HVD3082E*
MAX3464	SN75HVD05*
MAX3483	SN75HVD12*
MAX3483E	SN75HVD12*
MAX3485	SN75HVD11*
MAX3485E	SN75HVD11*
MAX3486	SN75HVD12*
MAX3486E	SN75HVD12*
MAX481/E	SN65HVD3088E*
MAX481	SN75LBC176*
MAX481E	SN75LBC176A*
MAX483/E	SN65HVD3082E*
MAX483	SN75LBC176*
MAX483E	SN75LBC176A*
MAX485/E	SN65HVD3085E*
MAX485	SN75LBC176*
MAX485E	SN75LBC176A*
MAX487	SN75HVD07*
MAX487	SN75LBC182*
MAX487E	SN65HVD3082E*
MAX488	SN75LBC179*
MAX488E	SN75LBC179A*
MAX489	SN75LBC180*
MAX489E	SN75LBC180A*
MAX490	SN75LBC179*
MAX490E	SN75LBC179A*
MAX491	SN75LBC180*
MAX491E	SN75LBC180A*
MAX625	TPS2044A/54A
MAX780	TPS2205
MAX869L	TPS2024/34
MAX890L	TPS2022/32

Part Number	TI Replacement
MAXIM (cont.)	
MAX9110	SN65LVDS1*
MAX9111	SN65LVDS2*
MAX9112	SN65LVDS9638*
MAX9113	SN65LVDS9637*
MAX9115	SN65LVDS2
MAX9121	SN65LVDS048A*
MAX9122	SN65LVDT048A*
MAX9123	SN65LVDS047*
MAX9124	SN65LVDS31*
MAX9125	SN65LVDS32*
MAX9126	SN65LVDT32*
MAX9130	SN65LVDS2
MAX9152	SN65LVCP22
MAX9155	SN65LVDS100
MAX9156	SN65LVDS100
MAX9159	SN65LVDS9637*
MAX9163	SN65MLVD201
MAX9164	SN65LVDS180
MAX9169	SN65LVDS104*
MAX9170	SN65LVDS105*
MAX9171	SN65LVDS2*
MAX9172	SN65LVDS9637
MAX9173	SN65LVDS048A
MAX9174	SN65LVDS122
MAX9175	SN65LVDS122
MAX9177	SN65LVCP22
MAX9178	SN65LVDS047*
MAX9179	SN65LVDS348*
MAX9180	SN65LVDS100
MAX9181	SN65LVDS100
MAX9205	SN65LV1023*
MAX9206	SN65LV1021*
MAX9207	SN65LV1224*
MAX9208	SN65LV1212*
MAX9320	SN65LVCP23
MAX9320A	NS65LVCP23
MAX9321B	SN65LVDS101
MAX9374	SN65LVDS100
MAX9374A	SN65LVDS100
MAX9375	SN65LVDS101
MICROCHIP	
MCP2551	SN65HVD251*
MCP2120	TIR1000
MICREL	
MIC2505	TPS2024/34
MIC2506	TPS2042A/52A
MIC2507	TPS2044A/54A
MIC2514	TPS210x
MIC2524	TPS2044A/54A
MIC2525	TPS2041A/51A
MIC2526	TPS2042A/52A
MIC2527	TPS2044A/54A

**Drop-in, pin-compatible devices*

The following products have similar functionality:

Part Number	TI Replacement
MICREL (cont.)	
MIC2564A	TPS2216A
NATIONAL SEMICONDUCTOR	
DS14185	SN75185*
DS14196	SN75196
DS1487	SN75HVD06*
DS1488	SN75188
DS1489	SN75189
DS14C232	TRS232
DS14C88	SN75C188
DS14C89A	SN75C189A
DS25CP102	SN65LVCP402
DS25CP104	SN65LVCP404
DS25MB200	SN65LVCP40*
DS36276	SN75HVD05*
DS3695	SN65HVD3088E*
DS3695	SN75LBC176A*
DS3695	SN75ALS176*
DS3695	SN75176B*
DS3697	SN75179*
DS3697	SN75ALS179*
DS3697	SN75LBC179*
DS36C278	SN75HVD06*
DS36C279	SN75HVD06*
DS36C280	SN75HVD06*
DS36F95	SN75LBC176*
DS40MB200	SN65LVCP40*
DS42MB200	SN65LVCP40*
DS485	SN65HVD3088E*
DS485	SN75LBC176A*
DS485	SN75ALS176*
DS485	SN75176B*
DS75176B	SN75LBC176A*
DS75176B	SN75ALS176*
DS75176B	SN75176B*
DS90CP04	SN65LVDS125
DS90CP22	SN65LVCP22*
DS90CR215	SN65LVDS95*
DS90CR216	SN65LVDS96*
DS90CR283	SN65LVDS93*
DS90CR284	SN65LVDS94*
DS90LT012A	SN65LVDS3*
DS90LV001	SN65LVDS100*
DS90LV0101A	SN65MLVD201
DS90LV011A	SN65LVDS1*
DS90LV012A	SN65LVDS2*
DS90LV017	SN65LVDS1*
DS90LV017A	SN65LVDS1*
DS90LV018A	SN65LVDS2*
DS90LV018A	SN65LVDT2*
DS90LV019	SN65LVDS179
DS90LV027A	SN65LVDS9638*
DS90LV028A	SN65LVDS9637*
DS90LV031	SN65LVDM31*

Part Number	TI Replacement
NATIONAL SEMICONDUCTOR (cont.)	
DS90LV031	SN65LVDS31*
DS90LV031A	SN65LVDM31*
DS90LV031A	SN65LVDS31*
DS90LV031B	SN65LVDM31*
DS90LV031B	SN65LVDS31*
DS90LV032	SN65LVDS32*
DS90LV032A	SN65LVDS32*
DS90LV047	SN65LVDS047*
DS90LV047A	SN65LVDS047*
DS90LV048	SN65LVDS048A*
DS90LV048A	SN65LVDS048A*
DS90LV049	SN65LVDS049*
DS90LV1021	SN65LV1021*
DS90LV1023	SN65LV1023*
DS90LV1023	SN65LV1023A*
DS90LV1212A	SN65LV1212*
DS90LV1224	SN65LV1224A*
DS92LV010A	SN65MLVD200*
DS92LV010A	SN65MLVD201*
DS92LV010A	SN65MLVD204*
DS92LV010A	SN65MLVD206*
DS92LV090	SN65LVDM976
DS92LV090	SN65LVDM977
DS92LV090A	SN65LVDM976
DS92LV090A	SN65LVDM977
DS92LV1010	SN65MLVD201
DS92LV1021	SN65LV1021*
DS92LV1021	SN65LV1023A*
DS92LV1021	SN65LVDS151
DS92LV1023	SN65LV1023A*
DS92LV1212A	SN65LV1212*
DS92LV1224	SN65LV1224B*
DS92LV16	TLK2521
DS92LV18	TLK2521
DS92LV222	SN65LVCP22
DS92LV222	SN65LVDM22
DS92LV222A	SN65LVCP22
DS92LV222A	SN65LVDM22
DS96173	SN75173*
DS96173	SN75ALS173*
DS96173	SN75LBC173A*
DS96174	SN75174*
DS96174	SN75ALS174A*
DS96174	SN75LBC174A*
DS96175	SN75LBC175A*
DS96175	SN75ALS175*
DS96175	SN75175*
DS96176	SN65HVD3088E*
DS96176	SN75LBC176A*
DS96176	SN75ALS176*
DS96176	SN75176B*
DS9636	DS9636
DS96F174C	SN75174*

Part Number	TI Replacement
NATIONAL SEMICONDUCTOR (cont.)	
DS96F174C	SN75ALS174A*
DS96F174C	SN75LBC174A*
DS96F175C	SN75175*
DS96F175C	SN75ALS175*
DS96F175C	SN75LBC175A*
PC16550D	TL16C550B
PC16550D	TL16C550C*
PC16552D	TL16C552A
SC28L194	TL16C554A*
SC28L92	TL16C552A*
SC68C562C1A	TL16C552A*
ON SEMI	
MC100EL11	SN65EL11*
MC100EL16	SN65EL16*
MC100ELT20	SN65ELT20*
MC100ELT21	SN65ELT21*
MC100ELT22	SN65ELT22*
MC100ELT23	SN65ELT23*
MC100ELT23	SN65EPT22*
MC100LVEL11	SN65LVEL11*
MC1488	SN75188*
MC1489	SN75189*
MC1489A	SN75189A*
MC14C89AB	SN75C189A
MC3488A	UA9636A
OXFORD	
OXCF950	TL16PC564B
PERICOM	
PI7C8150A	PCI2050*
PI7C8150A	PCI2050B*
PI7C8152A	PCI2250*
PI90LV001	SN65LVDS1*
PI90LV019	SN65LVDS180
PI90LV02	SN65LVDS2*
PI190LV03	SN65LVDS100
PI90LV051	SN65LVDS051*
PI90LV179	SN65LVDS179*
PI90LV180	SN65LVDS180*
PI90LV3486	SN65LVDS3486*
PI90LV3487	SN65LVDS3487
PI90LV3487	SN65LVDS3487*
PI90LV9637	SN65LVDS9637*
PI90LV9638	SN65LVDS9638*
PI90LVB001	SN65LVDS1
PI90LVB010	SN65MLVD201
PI90LVB03	SN65LVDS100
PI90LVB047A	SN65LVDS047
PI90LVB180	SN65LVDM180*
PI90LVB387	SN65LVDS387
PI90LVB9638	SN65LVDS9638
PI90LVT02	SN65LVDS2*
PI90LVT02	SN65LVDT2*

**Drop-in, pin-compatible devices*

The following products have similar functionality:

Part Number	TI Replacement
PERICOM (cont.)	
PI90LVT048A	SN65LVDT348
PI90LVT3486	SN65LVDT3486*
PI90LVT3486	SN65LVDT3486B*
PI90LVT386	SN65LVDT386*
PI90LVT9637	SN65LVDT9637*
PI90LVT9637	SN65LVDT9637B*
PI90LV017A	SN65LVDS1*
PI90LV018A	SN65LVDS2*
PI90LV019	SN65MLVD200*
PI90LV019	SN65MLVD201*
PI90LV019	SN65MLVD204*
PI90LV019	SN65MLVD206*
PI90LV022	SN65LVCP22
PI90LV022	SN65LVDS122
PI90LV027A	SN65LVDS9638*
PI90LV028A	SN65LVDS9637*
PI90LV031A	SN65LVDS31*
PI90LV032A	SN65LVDS32*
PI90LV047A	SN65LVDS047*
PI90LV048A	SN65LVDS048*
PI90LV050	SN65LVDS050*
PI90LV386	SN65LVDS386*
PI90LV387	SN65LVDS387*
PI90LVB022	SN65LVDM22
PI90LVB047A	SN65LVDM31
PI90LVB050	SN65LVDM050*
PI90LVB051	SN65LVDM051*
PI90LVB179	SN65LVDM179*
PI90LVB180	SN65MLVD202*
PI90LVB180	SN65MLVD203*
PI90LVB180	SN65MLVD205*
PI90LVB180	SN65MLVD207*
PHILIPS	
PCA82C250	SN65HVD251*
PCA82C251	SN65HVD251*
SC16C550	TL16C55C*
SC16C554	TL16C554*
SC16C554	TL16C554A*
SC16C650A	TL16C550
SC16C652	TL16C752
SC16C654	TL16C754
SC16C752	TL16C752B*
SC16C2550	TL16C752B
SC16C2552	TL16C752B
SC28L194	TL16C554A
SC28L91	TL16C550C

Part Number	TI Replacement
PHILIPS (cont.)	
SC28L92	TL16C552A
SC68C562C1A	TL16C552A
SCC2691	TL16C450
SCC2692	TL16C452*
SCC68692	TL16C452*
SCN2681	TL16C452*
TJA1040	SN65HVD1040*
TJA1050	SN65HVD1050*
PLX	
PCI6150	PCI2050*
PCI6150	PCI12050B*
PCI6140	PCI2250*
PROLIFIC	
PL-2303	TUSB3410
SEMTECH	
SC5825	TPS2041A/51A
SC5826	TPS2041A/52A
SILICON LABORATORIES	
CP2101	TUSB3410
CP2102	TUSB3410
SILICON/VISHAY	
Si9711	TPS2211A
Si9712	TPS2211A
SILICON SYSTEM	
73M550	TL16C550C*
SIPEX	
SP211	SN75LBC241
SP232A	TRS232
SP3222E	TRS3222
SP3222EB	TRS3222
SP3222EU	SNx5C3222
SP3223E	TRS3223
SP3223EB	TRS3223
SP3223EU	SNx5C3223
SP3232E	TRS3232
SP3232EB	TRS3232
SP3232EU	SNx5C3232
SP3238E	TRS3238
SP3243E	TRS3243
SP3243EB	TRS3243
SP3243EU	SNx5C3243
SP3481	SN75HVD11*
SP3483	SN75HVD12*
SP3485	SN75HVD11*
SP3494	SN75HVD10*

Part Number	TI Replacement
SIPEX (cont.)	
SP481	SN65HVD3088E*
SP481	SN75LBC176*
SP481	SN75ALS176*
SP481	SN75176B*
SP481E	SN65HVD3088E*
SP481E	SN75LBC176A*
SP481R	SN65HVD3088E*
SP483	SN65HVD3082E*
SP483	SN75LBC176*
SP483	SN75ALS176*
SP483	SN75176B*
SP483E	SN65HVD3088E*
SP483E	SN75LBC176A*
SP485	SN65HVD3088E*
SP485	SN75LBC176*
SP485	SN75ALS176*
SP485	SN75176B*
SP485E	SN65HVD3088E*
SP485E	SN75LBC176A*
SP486E	SN75LBC172A*
SP487	SN75LBC174*
SP487E	SN75LBC174A*
SP488	SN75LBC173*
SP488A	SN75LBC173A*
SP488E	SN75LBC173A*
SP489	SN75LBC175*
SP489A	SN75LBC175A*
SP489E	SN75LBC175A*
SP490	SN75LBC179*
SP490E	SN75LBC179A*
SP491	SN75LBC180*
SP491E	SN75LBC180A*
STM	
ST232	TRS232*
ST3222	TRS3222*
ST3222E	TRS3222E*
ST3232	TRS3232*
ST3232E	TRS3232E*
ST3243	TRS3243*
ST3243E	TRS3243E*
ST75185	SN75185
ST75C185	SN75C185*
VITESSE	
VSC7123	TLK2201
VSC7132-01	SN65LVCP15

**Drop-in, pin-compatible devices*

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Email	tiasia@ti.com or ti-china@ti.com
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