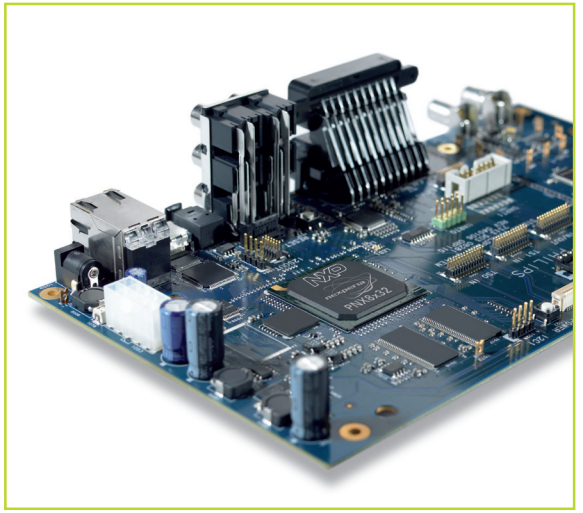


Application guide

Set-top boxes (STBs)

Contents

Introduction

Your partner for STBs

NXP Semiconductors offers a wide portfolio of advanced solutions for set-top-boxes (STBs). All are built on our deep understanding of what network operators and manufacturers need.

We can deliver application-specific solutions for reception, drawing on a complete range of silicon tuners that cover all the major standards for satellite, terrestrial, and cable reception. We also support peripheral functions, such as advanced audio and HDMI interfaces, and provide an extensive portfolio of standard products for STBs.

We use next-generation packaging to save space, lower costs, and improve AV content security, and we reduce energy consumption with low-power technologies that dramatically increase efficiency. We design for ruggedness, supplying devices that stand up to intensive use, and we deliver the high integration needed to simplify development, lower BOM and production costs, and reduce time-to-market.

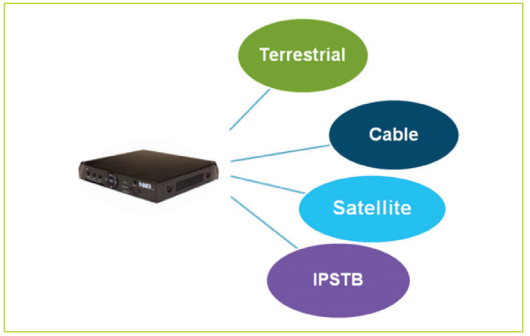
We are known for innovation and our ability to introduce new technologies that set the standard for performance, efficiency, and size. Our new chip-scale package (CSP) devices, for example, have an exceptionally compact footprint yet achieve a new benchmark in mechanical robustness.

We support our customers with a cost-efficient supply chain, and an enterprise-wide commitment to the highest standards of security, quality, and reliability. We also help our customers prepare for the future, by working with them to implement new features, such as 3D, that will drive growth. In short, our customers have the confidence that comes from working with a world-class partner.

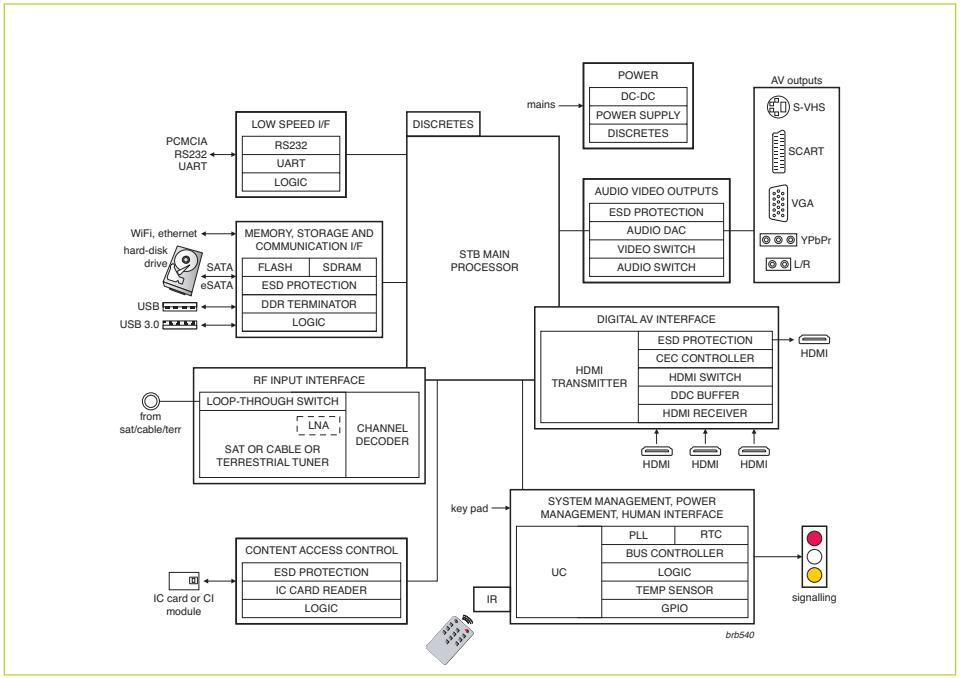
There's more.

This application guide provides an introduction to our STB portfolio. It highlights many of the forward-thinking solutions we have available, but it's only the beginning. To learn more, please visit our dedicated application page at www.nxp.com/applications/set_top_box/.

NXP supports all the existing STB standards



NXP improves performance throughout the system



1. Power solutions

We specialize in saving power, and build on decades of expertise in portable and battery-powered systems. Our GreenChip family, now in its third generation, delivers best-in-class efficiency for power supplies, and our broad portfolio of discretes help optimize power consumption throughout the system.

1.1 AC/DC controllers

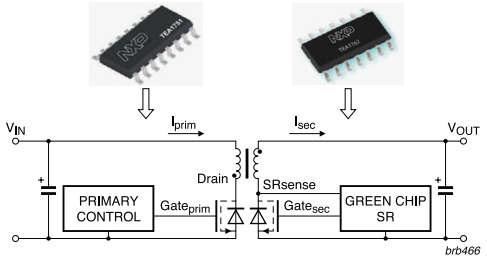
High-power GreenChip family TEA175x(L) and GreenChip SR family TEA176x & TEA179x

Designed for switched-mode power supplies (SMPS), NXP's extremely efficient and highly integrated GreenChip ICs enable simple, cost-effective power supplies with very few external components.

GreenChip III / SR: Flyback converters

TEA1571, TEA1752, TEA1761, TEA1762, TEA1791

- **GEN3 SMPS controller & SR IC delivers high efficiency at all power levels**
- **Energy STAR V 2.0** compliant (87% eff.)
- Allows **small adapter form factors**
- **High integration** reduces external component count, lowers overall cost
- **Reduced design-in time** with easy controlled start-up behavior and V_{cc} mngt
- **Special built-in green functions**, e.g. PFC switches off during stand-by, lowload
- **Standby power reduced by 100 mW** compared to conventional PFC solutions
- **Minimizes losses on secondary side** by as much much as 5 W (rectifying diode replaced by switch and smart controller IC)
- **High protection level**



Low-power STARplug family TEA152x

For simple STBs that use a power supply of less than 20 W (often called "zapper" STBs), our STARplug family of SMPS ICs is the best fit.

Type number	Package	R_{DSon}	Max output power on global mains	Application example
TEA1520T/N2	SO-14	48	2 - 5 W	Standby supply
TEA1520P/N2	DIP-8	48	2 - 5 W	Standby supply
TEA1521T/N2	SO-14	24	3 - 7 W	Standby supply
TEA1521P/N2	DIP-8	24	3 - 7 W	Standby supply
TEA1522T/N2	SO-14	12	7 - 9 W	Standby supply
TEA1522P/N2	DIP-8	12	7 - 9 W	Standby supply
TEA1523P/N2	DIP-8	6.5	9 - 12 W	Standby supply

>30 W SMPS IC TEA1733

Supporting power higher than 30 W, the TEA1733 is an ideal solution for high-end STBs with multiple options (such as HDD for recording), and high-end gateways that concentrate content reception at the home input.

Features

- SMPS controller IC enabling low-cost applications
- Large input voltage range (12 to 30 V)
- Very low supply current during start-up and restart (10 µA typ)
- Low supply current during normal operation (0.5 mA typ without load)
- Over-power or high/low line compensation
- Adjustable over-power time-out
- Adjustable over-power restart timer
- Fixed switching frequency with frequency jitter to reduce EMI
- Frequency reduction with fixed minimum peak current to maintain high-efficiency at low output power levels
- Slope compensation for CCM operation
- Low and adjustable over-current protection (OCP) trip level
- Adjustable soft-start operation
- Two protection inputs (e.g. for input UVP and OVP, OTP and output OVP)
- IC over-temperature protection

1. Power solutions

1.2 Discretes

The power consumption of STBs and other consumer appliances is progressively going down, because of new efficiency requirements and new power conservation regulations. This trend, among other factors, enables the usage of our new medium power Schottky diodes in the AC/DC 12 V rail.

- Our medium power Schottky diodes in SOD123W and SOD128 packages are used as freewheeling diodes on the secondary side, with an operating range of 30 to 60 V and 1 to 5 A. Recommended products include PMEG6030EP and PMEG4050EP.
  - Our TL431xxFDT series offer enhanced EMI ruggedness, an outstanding step response, and stability area for all SMPS applications.

Schottky diodes		Zener diodes		Analog ICs	
PMEG4030ER	SOD123W	BZX84J-SERIES	SOD323F		
PMEG4050EP	SOD128				
PMEG6030EP	SOD128	BZX84-SERIES	SOT23	TL431XXFDT	SOT23(SC74)

2. RF reception stage

2.1 Silicon tuners

Our portfolio covers digital STBs for cable, satellite, and terrestrial reception. We offer flexible platform development, whether the system is being optimized for low cost or high performance. The portfolio includes single and multiple tuners with optional loop-through circuitry (but without external splitters), as well as the possibility to use several tuners in parallel for multistream viewing/recording.

One product can be used for several designs, including cable and terrestrial formats, and our software drivers simplify design work even further. All our tuners deliver excellent performance and are suitable for high-end analog/digital applications. Also, our products have been validated against major standards worldwide.

NXP silicon tuners

Worldwide coverage	• DVB-S, DVB-S2, DVB-C, DVB-C2, DVB-T, DVB-T2, ATSC A74, ISDB-T, DTMB, and more
Fully integrated	• LNA, RF & Filters, Loop Through circuitry, RF splitters, and more
High performance	• Noise figure, AGC, maximum input level, phase noise, image rejection, ACI, CSO, CTB, etc.
Validated reference designs	• ATSC A74, NorDig, CENELEC, DTG, and others
Robust technology	• More than 1 billion MOPLL and IF ICs sold • Rigorous lab and field testing • Customer test-case validation • System validation with partners

Recommended tuners for cable STBs

Part number	Europe	China	USA	1 GHz	MOCA Filter	Dual tuner	Multiple tuner out	Loop through
TDA18250	●	●						
TDA18252	●	●		●				●
TDA18253	●	●		●			●	●
TDA18254A	●	●	●	●	●		●	●
TDA18260	●	●	●	●	●	●	●	●

Recommended tuners for satellite STBs

Part number	DVB-S	DVB-S2	Single tuner	Dual tuner	Loop-through circuitry	LNA splitter & RF switch	FTA LNA
CX24113A	Yes	No	Yes	No	No	No	No
CX24118A	Yes	Yes	Yes	No	No	No	No
CX24132	Yes	Yes	No	Yes	No	No	No
TDA20136	Yes	Yes	No	Yes	Yes	Yes	No
TDA20142	Yes	Yes	Yes	No	Yes	No	Yes

Recommended tuners for terrestrial STBs

Part number	DVB-T	DVB-T2	ATSC	ISDB-T/DTMB	Cable compliant	2nd tuner output	Loop through
TDA18218	●	No					●
TDA18219	●	Ok		●	●		●
TDA18212	●	Best	●	●	●	●	●

2. RF reception stage

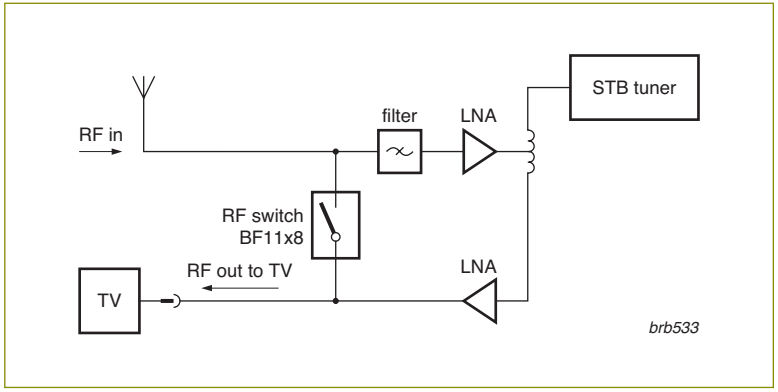
2.2 LNA and loop-through switches

LNA BGU703x

For applications that require sensitivity and noise figure beyond what's already integrated into NXP's high-performance silicon tuners, an external LNA from the BGU703x series can be used in front of the tuner.

BGU703x series

BGU7031	LNA with fixed gain
BGU7032	LNA with fixed gain and bypass mode
BGU7033	LNA with two gain levels and bypass mode



Silicon RF switch and MOSFET BF1108 and BF1118

NXP's silicon tuners offer built-in loop-through functionality in standby mode. Depending on the power requirements of the intended system, designers may choose to implement the loop-through function outside the tuner, using an external part. In this case, the BF1108/BF1118 is the recommended solution. It lets the TV connection operate, without quality loss, even when the STB is turned off. It is a depletion-type FET and a band-switching diode in a single SOT143B package. Low loss and high isolation provide excellent RF switching functions. The MOSFET gate can be isolated from ground with the diode, resulting in low losses. Integrated diodes between gate and source and between gate and drain protect against excessive input voltage surges. The BF1108 operates at 5 V while the BF1118 is for designs using 3.3 V supply.

Features

- Specially designed for low-loss RF switching up to 1 GHz
- Easy to design-in
- Power ON: high isolation (switch is open)
- Power OFF: low losses (switch is closed)
- ON or OFF, ZERO power consumption

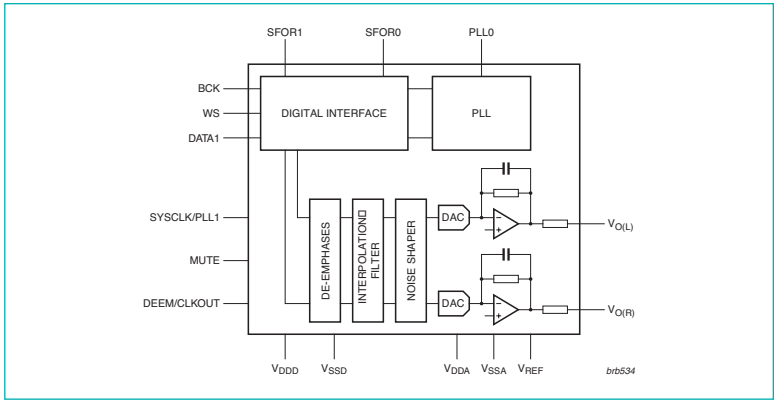
3. Analog audio and video interfaces

3.1 Audio digital-to-analog converters (DACs)

We offer a wide range of stereo DACs with serial inputs. The UDA133x series uses the I²S interface, the UDA1352TS supports SPDIF formats, and the UDA1355 is ideal for designs that require very complex audio I/O schemes.

Audio DAC series UDA133x

Type	Supply	PLL	Volume control	Control	Data formats	Package
UDA1330ATS	2.7 to 5.5 V		Digital logarithm	I²C / L3 / Static	I²S, LSB, or MSB justified; 16, 18, 20, 24 bit; 1 F_s	SSOP16
UDA1334ATS	2.4 to 3.6 V	•		Static	I²S, LSB justified; 16, 18, 20, 24 bit; 1 F_s	SSOP16
UDA1334BTS	2.4 to 3.6 V			Static		SSOP16
UDA1334BT	2.4 to 3.6 V			Static		SO16



Audio DAC UDA1352TS

Type	Output	Control	Noise shaper	Sys clock	PLL	PCM detect	SPDIF lock	AC-3/MPEG detect	Ch status	Vol control	DAC	DSP	Data formats	Package
UDA1352TS	Stereo	L3/I²C	5th	256 fs	•	•	•	•	40-bit	dB Lin	Anti-plop Auto mute	Bass boost, treble	IEC958 (SPDIF); 28 to 100 kHz	SSOP28

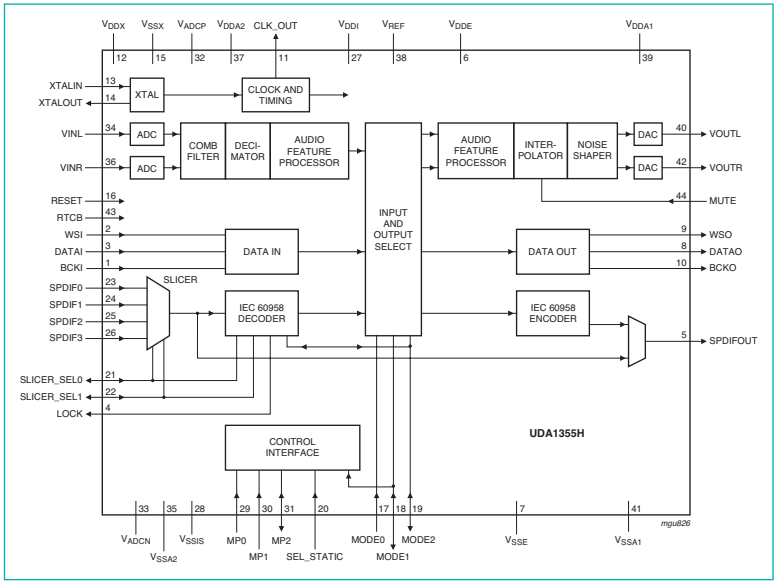
3. Analog audio and video interfaces

Audio codec UDA1355

An SPDIF codec for systems that require very complex audio I/O schemes.

Features

- 2.4 to 3.6 V supply voltage
- SPDIF I/O codec
  - 4 SPDIF inputs by select switch
  - 1 SPDIF output
  - Stereo analog I/O
- I^2C / L3 control and static mode of operation
- Mixing features for 2 data streams
- ADC with volume control -63.5 to 24 dB
- DAC with sound processing
  - Left/right volume control: -78 to 0 dB
  - Left/right bass boost and treble control
  - Optional resonant bass boost control
- Multiple operating modes
  - SPDIF to I^2C to SPDIF + analog
  - Analog to I^2C to SPDIF
  - SPDIF to analog



3. Analog audio and video interfaces

3.2 Audio and video switches

These switches support multiplexing and demultiplexing of analog audio and video signals (including HD and UXGA) without signal degradation.

Quad 5 V 2-1 video mux/demux NX5DV330

This single 5 V analog switch (4PCO/4PTT) supports a bandwidth of 300 MHz and offers 5 Ω on resistance. It is available in SO, SSOP, TSSOP, and DQFN packages.

Low-ohmic audio switches NX3LXXXX

These switches can be used to connect the STB's SoC to multiple selectable connectors on the back panel, such as SCART, Y/C, and YPbPr connections.

Features

- Low-ohmic, on resistance RON <1.0 Ω for minimal signal attenuation
- -90 dB isolation and crosstalk for superior signal integrity
- Low current consumption for higher power savings
- Low RON / CON combination adds performance and flexibility:
  - Digital data switching in portable applications
  - Analog functions in audio applications
  - Audio and data multiplexing around interface
- 7.5 kV ESD performance or better
- Built-in "translator/level shifter" function ("T" models only)
  - interfaces more easily with low voltage ASIC applications
  - reduces component count
- Smallest footprint: PicoGate and MicroPak packages with 0.35 mm pitch

3. Analog audio and video interfaces

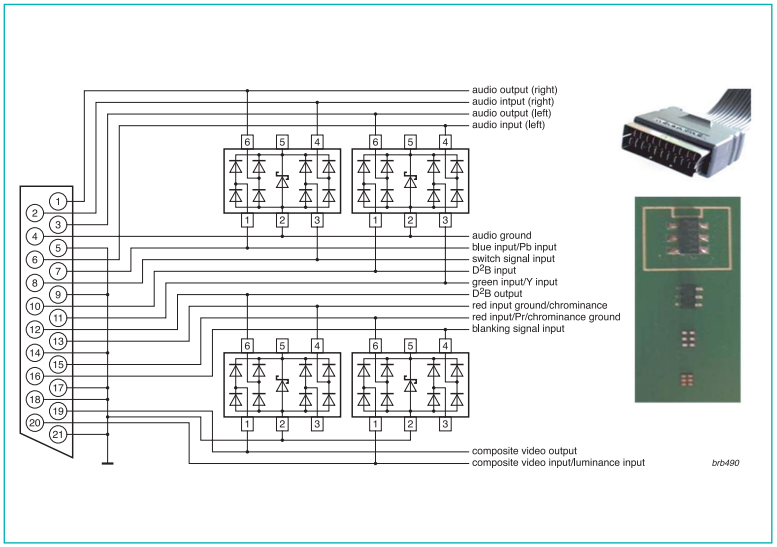
3.3 ESD protection for analog AV interfaces

We offer discrete and integrated ESD protection devices for all the audio and video interfaces commonly used by an STB, so it's easy to find the right configuration for a given application layout.

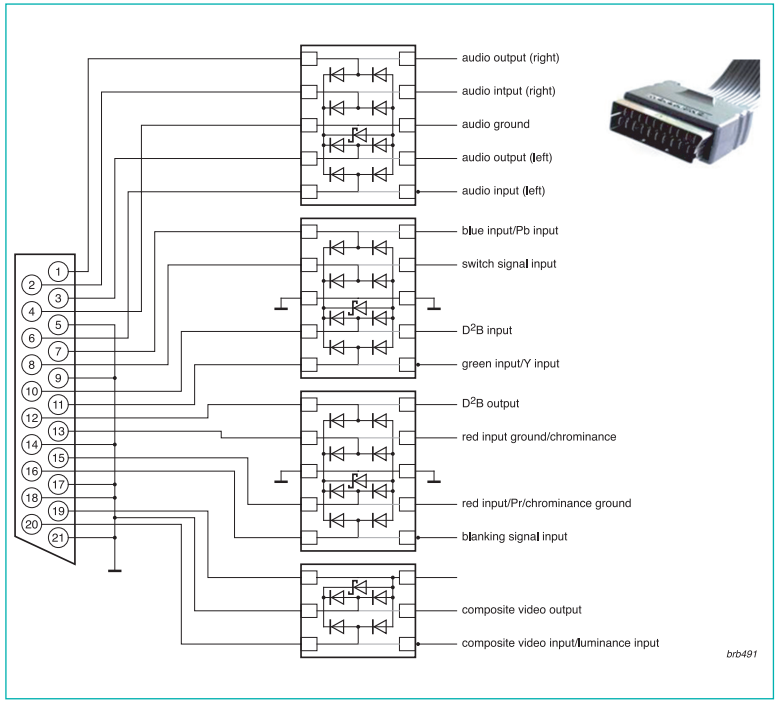
ESD protection for SCART

As shown in the diagrams, the IP4220CZ6 and the IP4221-S/XS can be used to protect SCART signals, as can the IP4283CZ10 and IP4282CZ6. Other configurations are also possible.

IP4220CZ6 and IP4221-S/XS configuration



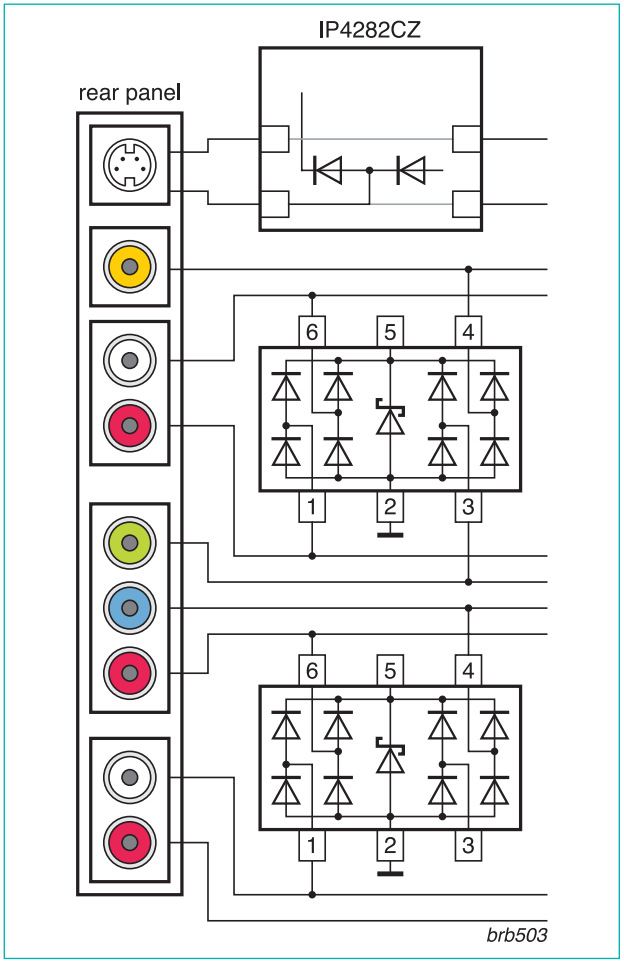
IP4283CZ10 and IP4282CZ6 configuration



ESD protection for YC, YPbPr, audio L/R, RGB, and other interfaces

For A/V interfaces, we recommend the integrated solutions IP4283, IP4282, IP4220 or IP4221-S/XS. For audio interfaces, use the PESD5V0S-1BB. For SVHS, use the PESD5V0S1UB, and for SCART/YPbPr interfaces, use either the PESD5V0S5UD or the PESD5V0L7BS.

3. Analog audio and video interfaces



ESD protection with level shifters/buffers for VGA interfaces

For designs that include a VGA output connector that connects to the VGA plug of a TV or PC monitor, we recommend the integrated solutions listed in the table. These devices combine ESD protection and sync signal buffering, along with DDC level shifting, in a single package.

Other options include the IP4283CZ10 and PRTR5V0U8S as well as the discrete solution PESD5V0S1UB, which is housed in an SOD523 package.

Part number	Features
IP4770/1/2CZ16 IP4770CZ16: Sync buffer Rout = 55 Ω IP4771CZ16: Sync buffer Rout = 65 Ω IP4772CZ16: Sync buffer Rout = 10 Ω	▸ IEC61000-4-2, level 4 ▸ DDC level shifting ▸ H-sync buffer ▸ V-sync buffer
IP4769CZ14	▸ IEC61000-4-2, level 4 ▸ DDC level shifting
IP4774CZ14 Sync buffer Rout = 10 Ω	▸ IEC61000-4-2, level 4 ▸ H-sync buffer

4. HDMI interface

Our support for the High Definition Multimedia Interface (HDMI) extends through a wide range of products, from transmitters and receivers to switches and ESD protection. Designers can leverage our extensive knowledge of system design, for fast development of high-definition applications.

Recommended devices for HDMI

	TDA9981	TDA9984	TDA19989	TDA19995	TDA19997	TDA19998
HDMI Tx	Yes	Yes	Yes	No	No	No
Key feature	Pass through	Upscaler 1080p	Low-power 1080p	–	–	–
HDMI switch	No	No	No	Yes	Yes	Yes
NB inputs	No	No	No	3:1	4:1	4:1
5th EDID	No	No	No	Yes	Yes	Yes
F3 technology	No	No	No	No	No	Yes
Availabliity	Full production	Full production	Full production	Full production	Full production	Full production

4.1 HDMI transmitters

HDMI 1.4a transmitter TDA9984 with upscaler

Optimized for use in HD consumer applications, this device makes it easy to add an HD output to any legacy STB platform. For example, in an STB based on a source decoder with a 16-bit SD YCbCr output, using the TDA9984 will enable the output of full HD 1080p with minimal effort. For STBs based on source decoders allowing only 720p or 1080i HDMI output, using the combination of a TDA19977 (HDMI receiver) and a TDA9984 (transmitter with integrated upscaler) makes it possible to upgrade the STB to 1080p output capability with minimal hardware and software development.

Features

- YUV/RGB video input with DDR mode and color space conversion
- I^2C/SPDIF audio input
- On-chip upscaler from 480i/576i or 480p/576p, 720p, 1080i to 1080p
- Enables HDMI-compliant applications, as verified by an HDMI Authorized Test Center.

Benefits

- Enables high-quality upscaling to 1080p
- Minimal software development thanks to availability of software drivers

4. HDMI interface

HDMI 1.4a transmitter TDA19989 with CEC support

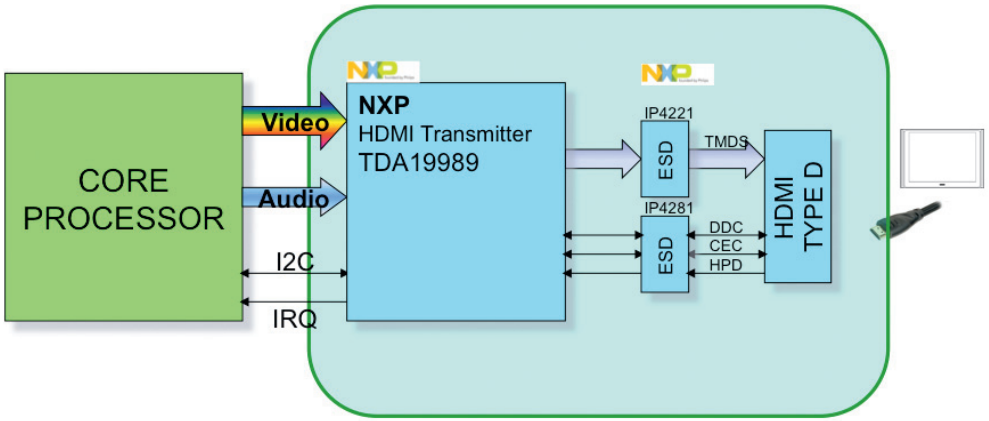
Optimized for use in mobile applications, this low-power device delivers 1080p performance, integrates HDCP keys, has embedded CEC, and is housed in a 0.5 mm pitch BGA that measures only 4.5 x 4.5 mm.

Features

- YUV/RGB video input with DDR mode and color space conversion
- I²C/SPDIF audio input
- Low power consumption (55 mW in 720p, 120 mW in 1080p)
- Optimized for use with the standard Type A connector and Type D micro connector
- Enables HDMI- and CEC-compliant applications, as verified in an HDMI Authorized Test Center.

Benefits

- Enables 1080p output on mobile devices, including DSCs, DVCs, and mobile phones
- Enables easy CEC implementation
- BGA package offers additional signal protection against snooping



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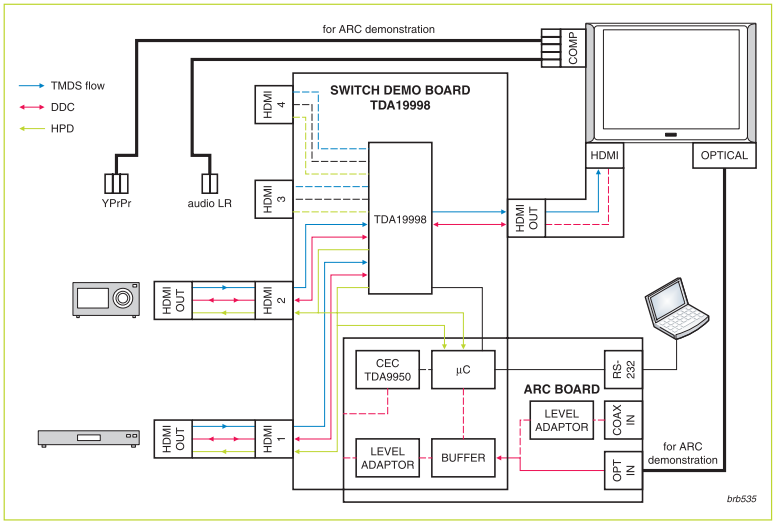
4. HDMI interface

4.2 HDMI Switch

HDMI 1.4a switch TDA19998

This advanced 4:1 switch accepts a bit rate of 2.25 giga-samples per second on each input, which enables it to support full HD formats such as 1080p at 60 Hz, in the 12-bit Deep Color mode as defined in the HDMI1.3a standard. It supports color depth processing at 24, 30, and 36 bits (3 x 12-bit), offers automatic power management, and, along with the four EDIDs needed for HDMI input, embeds a fifth EDID for an additional VGA input. It includes ESD protection on its inputs, as well as DDC buffers. It enables HDMI source compliance, thus allowing manufacturers to use it as the output stage of their STB and adding switch-box functionality to the original design with minimal effort.



Features

- Fast switch
- Built on NXP HDMI standards expertise
- HDMI 1.4 compatible (HEC voltage, ARC)
- Reference design compliance verified
- Respect of HDCP rule (encrypted output)
- Enables design of HDMI source compliant products

Benefits

- Fast switching performance
- Low power consumption
- Adding the functionality of a switch box to a standard set-top-box for optimized cost
- Pass-through for HDCP-encrypted streams

4. HDMI interface

4.3 CEC controller

CEC controller TDA9950

This device offers a simple way to add CEC function to a design. It translates CEC messages to I^2C and vice-versa, and manages all the timing and error-control aspects of CEC. All designers need to do is modify the main system software to support creation and reception/interpretation of messages in I^2C format.

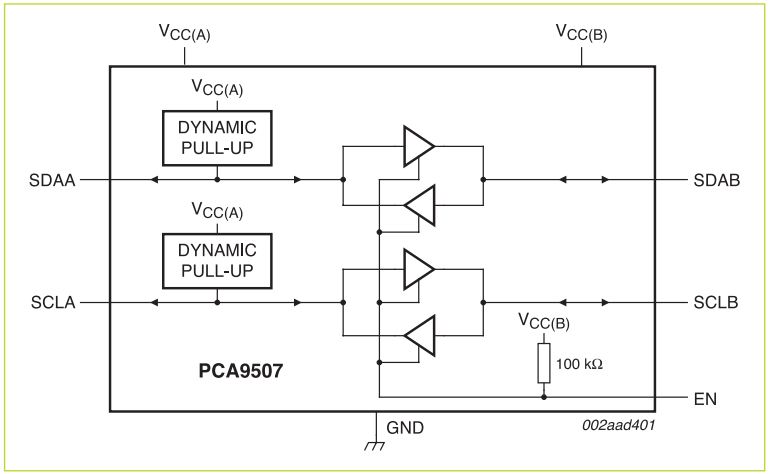
4.4 DDC and CEC buffers

HDMI DDC buffer with rise time accelerator PCA9507

This two-wire, bidirectional DDC buffer has 3.3 and 5 V supply rails and integrates a rise time accelerator. It is recommended for designs that don't have the function built into the transmitter, switch, or receiver ICs. It is also well suited for use in systems that have HDMI functions built into the main system ICs and use low-power supplies. It delivers normal I/O voltage swing with high drive on the A side. ESD protection is 5 kV HBM, and it is available in a TSSOP8 (3.0 x 3.0 x 1.0 mm) or SO8 (4.0 x 5.0 x 1.75 mm) package.

Features

- Bidirectional bus buffer, to isolate capacitance and noise on DDC line
- 3.3 and 5 V dual supplies to permit DDC level shift
- Rise time accelerator on A side, for extending cable length beyond 18 m
- Normal A-side driver, for compatibility with all types of source/sink devices
- Integrated ESD protection (5 kV HBM) so there's no need for external discrete components



4. HDMI interface

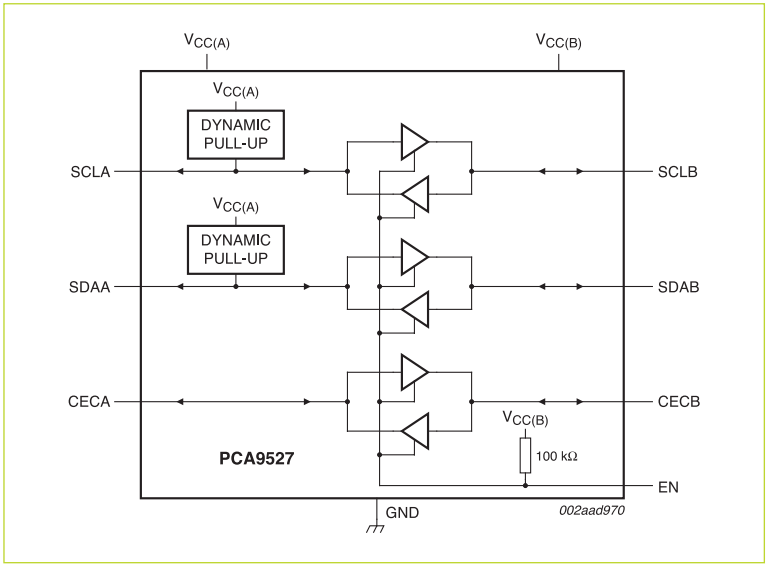
3-channel DDC/CEC voltage translating buffer PCA9527

This is a 3.3 and 5 V dual V_{CC} level translating buffer. It is recommended for designs that don't have the function built into the transmitter, switch, or receiver ICs. It is also well suited for use in systems that have HDMI functions built into the main system ICs and use low-power supplies. It has a rise-time accelerator for the DDC clock and data lines only. the CEC line is 3.3 V and remains active when the 5 V line is powered down. The B side has static-level offset. It features high-impedance I/O when the power is off and low power when V_{CCA} is off (< 100 µA). It is available in a TSSOP10 package.

Features

- Bidirectional bus buffer, to isolate capacitance and noise on DDC line
- 3.3 and 5 V dual supplies, for DDC level shift
- Rise time accelerator on A side, for extending cable length beyond 18 m
- Normal A-side driver, for compatibility with all types of source/sink devices
- Integrated ESD protection (8 kV HBM), so there's no need for external discrete components

Part number	Features
IP4776CZ38	8kV ESD IEC DDC level shifting Hot Plug back drive CEC back drive
IP4777CZ38	8kV ESD IEC DDC buffer Hot Plug module CEC termination and back drive



4.5 ESD protection

The IP4776CZ38 and IP4777CZ38 protect HDMI and DVI signals, and offer varying levels of integration to reduce component count. Depending on layout constraints, the IP4280CZ10, IP4283CZ10, IP4282CZ6, IP4221CZ6, or PRTR5V0U4D are also available, as is the PESD5V0F1BL in SOD882. The IP4776CZ38 and IP4777CZ38 integrated ESD protection circuits also include buffer capabilities.

5. Smart-card reader interface

Selection guide for smart-card reader ICs

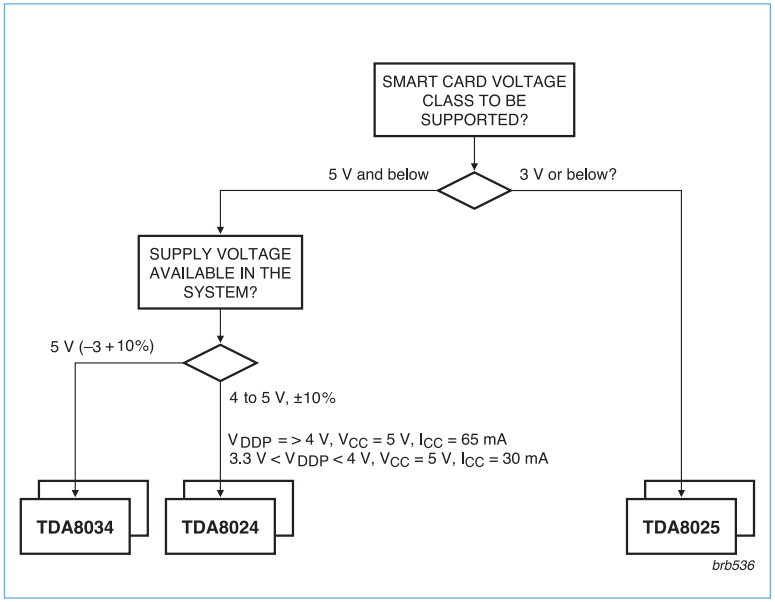
	Analog interface				CPU+UART+analog
Product features	**TDA8024**	**TDA8020**	**TDA8025**	**TDA8034**	**TDA8029**
Number of card slots	1	2	1	1	1
ISO7816 UART	no	no	no	no	yes
ISO7816 timers	no	no	no	no	yes
µC core					80C51RB+
ROM [kbyte] / RAM [byte]					16/768
Flexible sequencer programming	no	no	no	no	no
Host interface	IO	I^2C	IO	IO	serial or I^2C
ESD protection on ISO contacts (kV)	6	6	6	6	6
Auxiliary protected lines for C4 & C8 lines	2	0	2	2 (on 24 pins package)	0
V_{CC} card (V)	3, 5	3, 5	1.2, 1.8, 3	1.8, 3, 5	1.8, 3, 5
Card supply current at V_{cc}= 5 V (mA)	80	2x55		65	65
Card supply current at V_{cc}= 3 V (mA)	65	2x50	65	65	50
Card supply current at V_{cc}= 1.8 V (mA)	-	-	65	65	30
Card supply current at V_{cc}= 1.2 V (mA)	-	-	30	-	
Card clock frequency max (MHz)	26	20	26	26	20
Card activation time max (µs)	225	135	220	3500	225
Card deactivation time max (µs)	100	110	100	90	100
Protocol support					
Synchronous card management	yes	-	yes	yes	yes
Asynchronous cards (T=0 1 , T=1)	yes	yes	yes	yes	yes
Security features					
Voltage supervisor and over-current detection	yes	yes	yes	yes	yes
Current protection on V_{cc}, IO, RST, CLK	yes	yes	yes	yes	yes
Additional product information					
Power supply interface V_{DDI} (V)	-	-	1.6 - 3.6	1.6 - 3.6	
Power supply (V)	2.7 - 6.5	2.5 - 6.5	2.7 - 5.5	2.7 - 5.5	2.7 - 6.0
Power down current max (µA)	-	150	100	12	20
Temperature range (°C)	-40 / +85	-25 / +85	-25 / +85	-25 / +85	-25 / +85
Package	SO28, TSSOP28	LQFP32	HVQFN32	HVQFN24, SO16	LQFP32
Software libraries (EMV 4.2)					yes
NDS compliance	yes		yes	yes	yes
EMV compliance	EMV 4.2	EMV 4.2		EMV 4.2	EMV 4.2

5. Smart-card reader interface

Smart-card reader ICs TDA8024, TDA8025, and TDA8034

These are complete, cost-efficient analog interfaces for asynchronous smart cards. They provide all the supply, protection, and control functions between a smart card and the microcontroller. The TDA8025 is for use in smart cards operating at 1.8 or 3 V, while the TDA8024 is for cards operating at 3 or 5 V. The TDA8034 is the same as the TDA8024, but without a DC/DC converter. All are available with demo kits.

Selection tree for TDA8024, TDA8025 and TDA8034



TDA8034

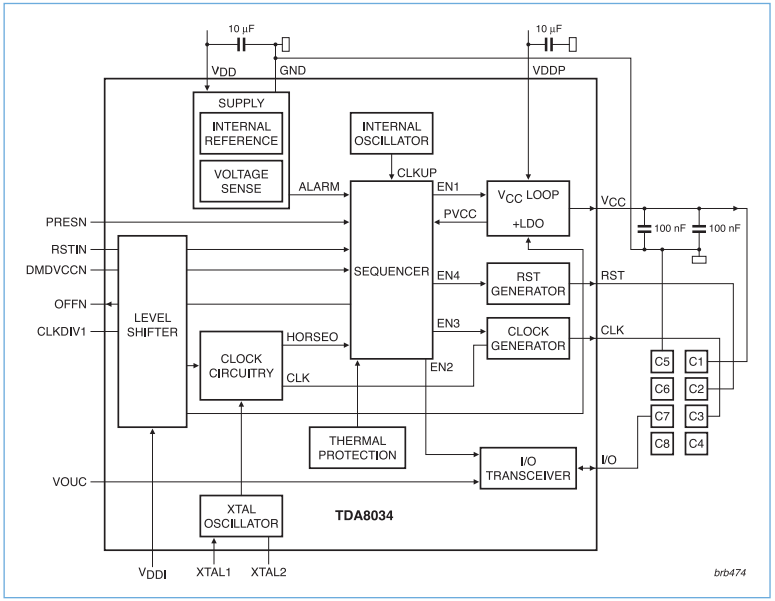
The TDA8024 and TDA8034 are both NDS and EMV 4.2 compliant, and they both can supply a V_{CC} of 5 V to the smart card. The system supply voltage influences device selection. Use the TDA8034 when the system supply voltage is 5 V ± 3%. This will ensure that the card V_{CC} value is a minimum of 4.75 V with a current load of 65 mA. In systems that can only supply a voltage of 5 V ± 10%, the TDA8024 is a better choice, because it can guarantee a proper value on V_{CC} = 5 V.

The TDA8034 is available in a 24-pin HVQFN or, to meet low-cost requirements, can be housed in a 16-pin SO package. The TDA8034 is not pin-compatible with the TDA8024, which has 28 pins.

5. Smart-card reader interface

Smart-card reader interface TDA8034

- TDA8024 without DC/DC
- Smaller package HVQFN24 & SO16
- NDS compliant (depending on package option)
- EMV compliant
- BCAS compliant
- 1.8, 3, and 5 V cards supported (on 24-pin version)
- 3 full-duplex I/O lines
- Synchronous clock division supported 8/4/2/1
- Interface voltage V_{DDI} down to 1.6 V
- LDO instead of DC/DC means that V_{DDP} should be >4.85 V to guarantee V_{CC} = 4.75 V min with 65 mA load
- On board oscillator or possibility to use external clock source on XTAL1
- Shutdown mode on both packages
- Deep shutdown on HVQFN24 (<10 µa)



5. Smart-card reader interface

Comparison of TDA8024 and TDA8034

Feature	Condition	TDA8024T or TDA8024TT	TDA8034HN	TDA8034T	TDA8034AT
Package		SO28 or TSSOP28	HVQFN24	SO16	SO16
Smart-card supply voltage		3, 5 V	1.8, 3, 5 V	3, 5 V	3, 5 V
Power block type		DC/DC	LDO	LDO	LDO
Supply voltage (power) V_{DDP}	V_{cc}= 5 V, ± 5%, I_{cc}= 80 mA	4 to 6.5 V	4.85 to 5.5 V	4.85 to 5.5 V	4.85 to 5.5 V
	V_{cc}= 5 V, ± 5%, I_{cc}= 30 mA	3.3 to 6.5 V	4.85 to 5.5 V	4.85 to 5.5 V	4.85 to 5.5 V
Supply voltage (interface V_{DDI})		2.7 to 6.5 V	1.6 to 3.6 V	1.6 to 3.6 V	1.6 to 3.6 V
Supply voltage (interface & or digital) V_{DD}		2.7 to 6.5 V	2.7 to 3.6 V	2.7 to 3.6 V	2.7 to 3.6 V
Supervision of supplies		V_{DD}	V_{DDI} & V_{DD}	V_{DDI} & V_{DD}	V_{DDI} & V_{DD}
Number of bidirectional IO lines		3	3	1	1
Number of presence detection pins		2 (PRES & PRESN)	1 (PRESN)	1 (PRESN)	1 (PRESN)
Clock source		XTAL or external	XTAL or external	XTAL or external	XTAL or external
Clock division ratio		1/2/4/8	1/2/4/8	2/4	1/2
Automatic shutdown mode		no	yes	yes	yes
RST enabled in the activation sequence	activation sequence, t5	220 µs max	3.4 ms (wake-up time)	3.4 ms (wake-up time)	3.4 ms (wake-up time)
PORadj pin		yes	yes	no	no
NDS certification		yes	yes	no	no
EMV 4.2 compliance		yes with filter on I/O line	yes	yes	yes

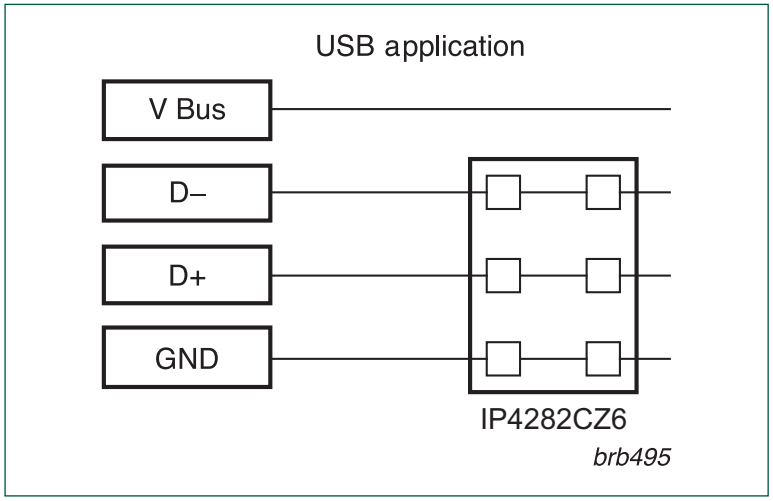
6. Data transfer interfaces: ESD protection

6.1 ESD protection for USB

For designs that use a USB interface – to connect permanent data storage devices using flash memory, for example – we offer a range of protection devices. In addition to the IP4282 and IP4234, listed below, the PESD5V0X1BL, PRTR5V0U2D, PRTR5V0U2AX, PRTR5V0U4D, PRTR5V0U2F can also be used. Other options for USB, such as alternative packaging (including CSP), flow-through routing, different capacitance ratings, and support for On-The-Go (OTG) are also available.

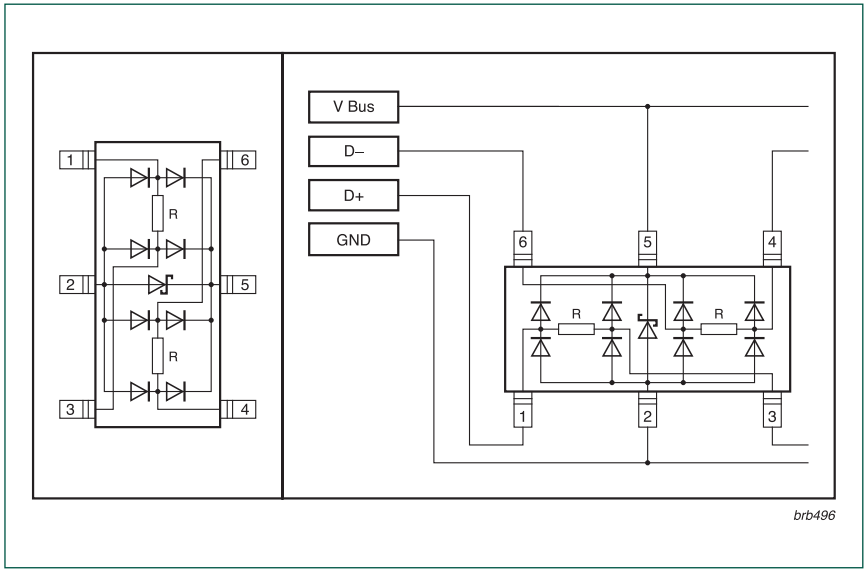
ESD protection device IP4282 with pass-thru routing

Simply place this UTLP device on top of the signal lines to provide ESD protection. No additional PCB space is consumed, and there's no need for special routing. The extremely short distance between the ESD diodes and the signal lines ensures very fast reaction times.



ESD protection device IP4234 with pi-filter concept

This device delivers excellent clamping performance and extremely high robustness against ESD pulses (15KV IEC 61000-4-2 contact).



6. Data transfer interfaces: ESD protection

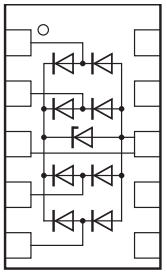
6.2 ESD protection for USB 3.0

ESD protection device IP4284CZ10

Use this device, which has an extremely low capacitive load, to create an impedance design that protects the high transfer speeds (up to 5 Gpbs) of USB 3.0.

Features

- 4 channels
- Straight-through routing
- Only 0.5 pF
- Very small footprint with SOT1059 (XSON10)
- Leaded TSSLP10 package also available
- Excellent signal integrity
  - 0.05 pF line-to-line matching
  - -70 dB differential crosstalk at 2.5 GHz
- ESD protection of ±8 kV according to IEC61000-4-2, level 4



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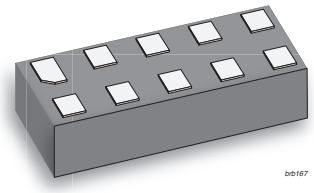

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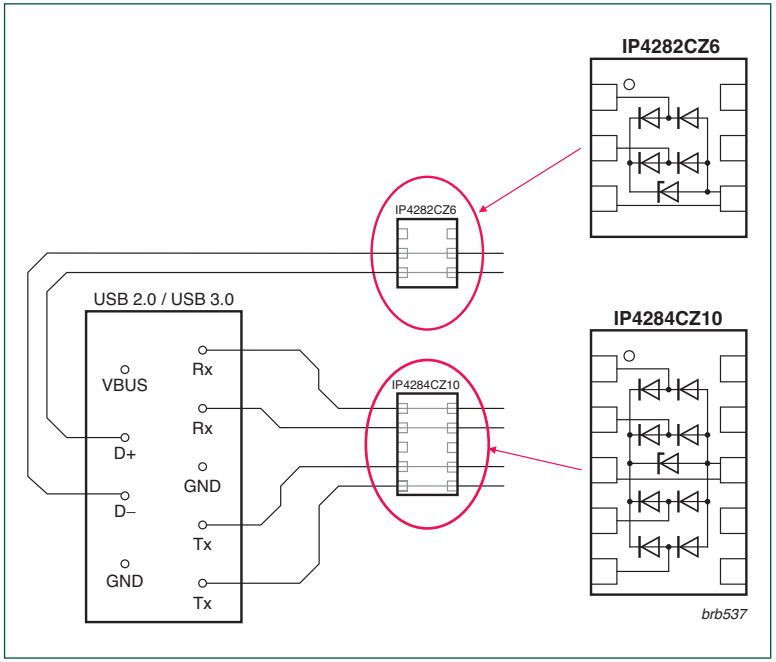
For designs that use a combi-connector (USB 2.0 + 3.0), the IP4282CZ6 can be used in combination with the IP4284CZ10.



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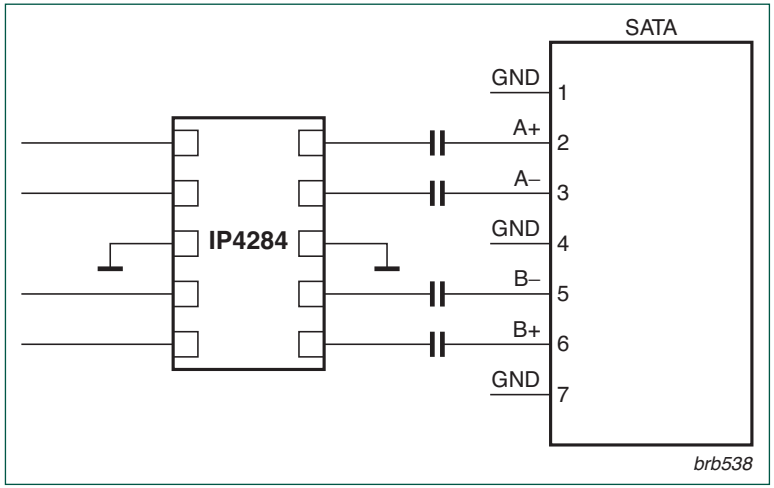
6. Data transfer interfaces: ESD protection

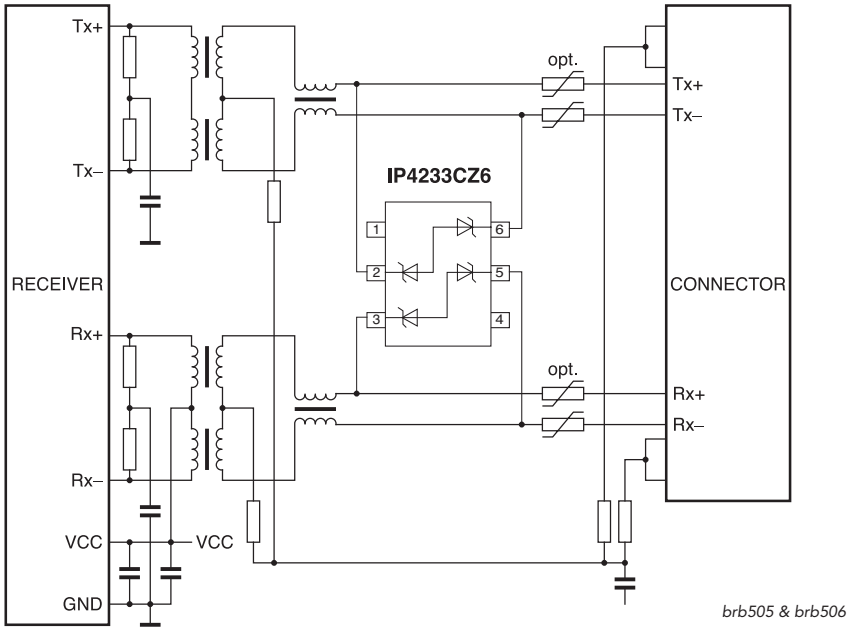
6.3 ESD protection for SATA, eSATA

In designs that use a hard disk drive equipped with a SATA or eSATA interface, we recommend the IP4284CZ10.



6.4 ESD protection for Ethernet

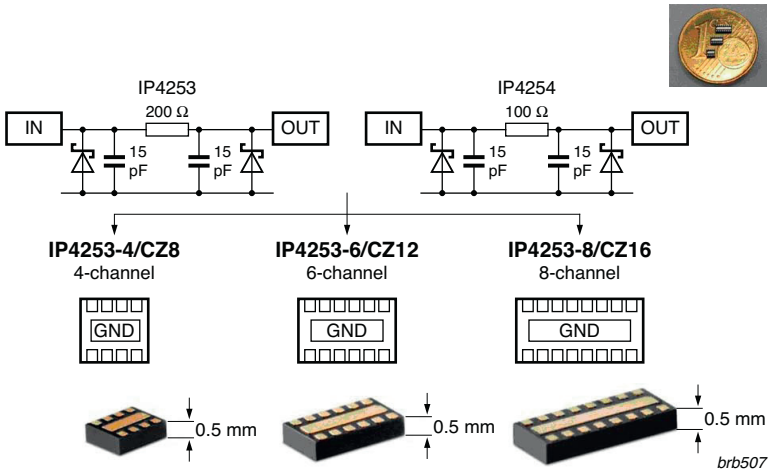
For designs that include an Ethernet interface, we recommend the IP4233CZ6. Alternatively, the IP4280 or the IP4220/3 can be used. To protect high-speed Gigabit Ethernet, use the PRTR5V0U4D.



6. Data transfer interfaces: ESD protection

6.5 ESD protection and EMI filtering for SD Card and other low/medium-speed interfaces

Our integrated ESD protection devices, which include EMI filtering, are well suited for use with multi-channel interfaces such as SD/SDHC, medium-speed interfaces such as LCD displays, and low-speed interfaces such as keyboards. To protect an SD card connector, for example, use the IP4253, which is available with 4, 6, or 8 channels, or the IP4254. For memory-card interfaces, we recommend the PESD5V0L4UG or the PESD5V0V4UW.



7. Interfaces and control

7.1 Microcontrollers

8/16/32-bit microcontrollers

We offer highly-integrated and cost-effective products, from the smallest 8-bit to the highest performing 32-bit ARM microcontrollers.

The LPC111x family, based on Cortex-M0, is an excellent choice for standby microcontroller tasks. It can be used for power management, system and human interface monitoring (including remote control and keypad), signaling, LEDs, and more. The family delivers the outstanding performance of a 32-bit architecture, with best-in-class power consumption, and the optimized code footprint enables memory cost reduction.

The NXP approach lets designers work with a single ARM development environment to cover all their processing needs, from ARM7 and ARM9 to Cortex-M. Our portfolio also includes an industry-leading selection of enhanced 80C51.

Read more

Web page
www.ics.nxp.com/microcontrollers

Selection guide
www.ics.nxp.com/literature/other/microcontrollers/pdf/line.card.pdf

7.2 I²C GPIO expanders

Our GPIO expanders make it easy to increase the number of I/O using the I²C-bus. Add inputs for a keypad, a switch, signal monitoring, or fan control, or add outputs for LED control, an ACPI power switch, a relay, timers, or sensors.

Combat "feature creep" by increasing the number of I/O ports instead of adding a new microcontroller. Or, enable seamless migration to a newer microcontroller and still keep the same peripherals. Using expanders eliminates costly, congested PCBs, since a trace or wire isn't needed for each signal.

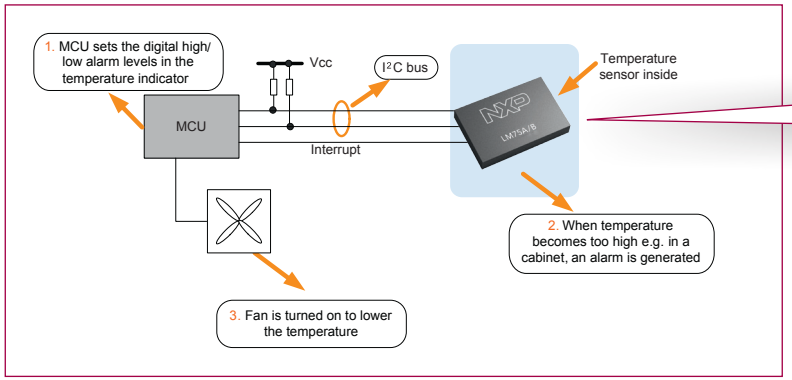
NXP offers an extremely wide selection. We have 4-, 8-, 16-, and 40-bit formats, support quasi-directional and push-pull outputs, and offer options with interrupts and/or resets — all in a wide range of packages.

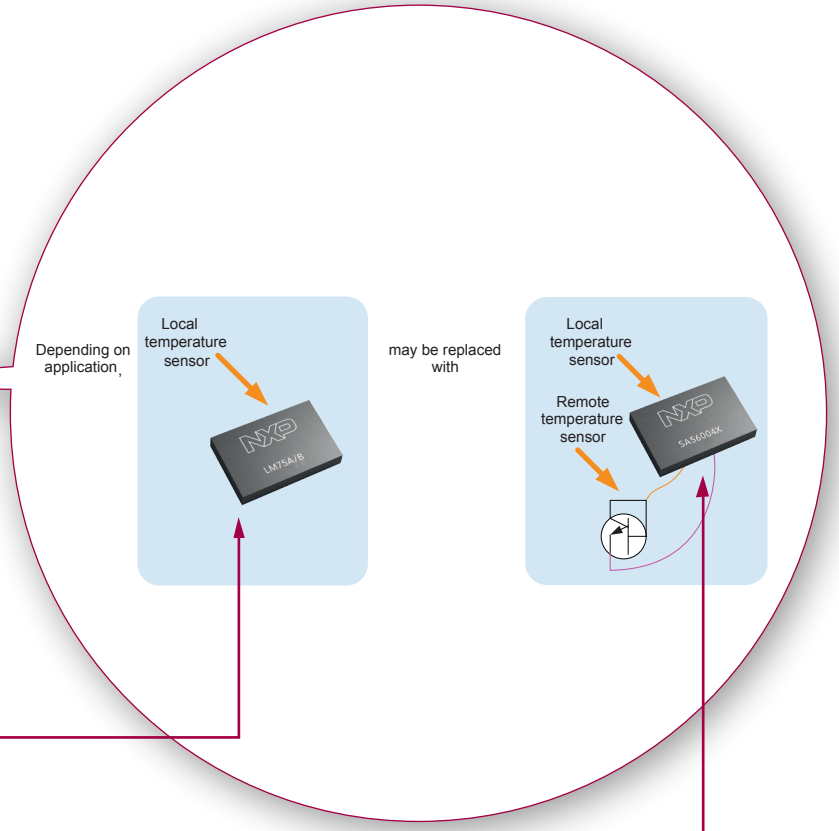
# of Outputs	Interrupt	Reset	Interrupt & reset	2 kbit EEPROM	Interrupt & 2 kbit EEPROM
Quasi ouput (25 ma sink and 100 uA source)					
8	PCF8574/74A, PCA8574/74A, PCA9674/74A	PCA9670	PCA9672	PCA9500/58	PCA9501
16	PCF8575/75C, PCA9675	PCA9671	PCA9673	-	-

7. Interfaces and control

7.3 I²C temperature sensors

These devices can be used in power supplies, STBs, and home gateways, to determine the temperature or define the window for an action, such as an interrupt, an alarm, fan control, or shutdown. We offer a large selection of commonly used sensors, in a wide array of package types.





Local sensor	
LM75A/B	±2 °C local (thermal Watchdog, -55 to +125 °C)
SE95	±1 °C local (thermal Watchdog, -55 to +125 °C)
SE97	±1 °C local (thermal Watchdog, 2 kbit EEPROM, -20 to +125 *C)

Local & Remote Sensor	
NE1617A	±2 to ±3 °C (0 to +125 °C)
NE1619	±2 to ±3 °C (voltage monitor, 0 to +125 °C)
SA56004X	±2 to ±1 °C (alarms, -40 to +125 °C)

7. Interfaces and control

Local digital temperature sensor and thermal Watchdog timer LM75B

This highly integrated device provides advanced performance in a cost-effective format and is available in a package that measures only 2 x 3 mm.

Features

- Pin-for-pin replacement for industry-standard LM75 and LM75A
- I²C-bus interface: up to 8 devices on the same bus
- Power supply range from 2.8 to 5.5 V
- Temperatures range from -55 to +125 °C
- Frequency range from 20 Hz to 400 kHz with bus fault time-out to prevent hanging up the bus
- 11-bit ADC with temperature resolution of 0.125 °C
- Temperature accuracy of
  - ±2 °C from -25 to +100 °C
  - ±3 °C from -55 to +125 °C
- Programmable temperature threshold and hysteresis set points
- Max supply current of 1.0 µA in shutdown mode
- Standalone operation as thermostat at power-up
- ESD protection exceeds 4500 V HBM per JESD22-A114, 450 V MM per JESD22-A115 and 2000 V CDM per JESD22-C101
- Small 8-pin package types: SO8, TSSOP8 and XSON8 (2 x 3 x 0.8 mm)

Type number	Topside mark	Package		
		Name	Description	Version
LM75BD	LM75BD	SO8	Plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
LM75BDP	LM75B	TSSOP8	Plastic thin shrink small outline package; 8 leads; body width 3 mm	SOT505-1
LM75BGD	75B	XSON8U	Plastic extremely thin small outline package; no leads; 8 terminals; UTLP based; body 3 x 2 x 0.5 mm	SOT996-2

7. Interfaces and control

7.4 I²C level shifters

These devices provide digital logic level translation between a host processor and a slave device. This is an important part of voltage level shifting, since the host processor's I²C voltage continues to go down while the voltages used by the peripheral devices remain unchanged. We offer a very large selection of active and passive level shifters, and have evolved our NVT20xx family to include widths of 1, 2, 3, 4, 6, 8, and 10 bits.

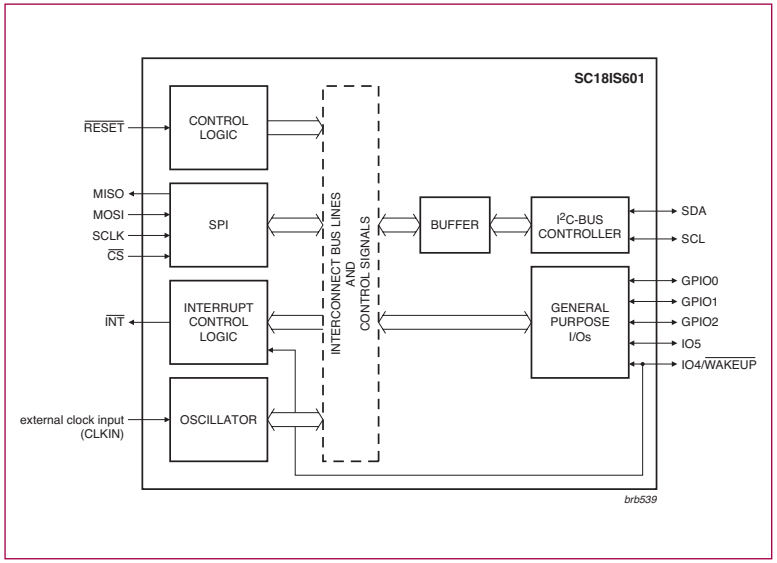
Device	Description	Normal I/O	Static level offset I/O	Accelerator	Idle stop detect for hot swap	Interrupt	ESD (HBM)
PCA9507	2.7 to 5.5 V level shifter	A side	B side	• (A side)			5 kV
PCA9508	0.9 to 5.5 V level shifter with offset free hot-swap	A side	B side		•		6 kV
PCA9509	1.0 to 5.5 V level shifter	B side	A side				2 kV
PCA9517A	0.9 to 5.5 V level shifter	A side	B side				5 kV
PCA9519	1.1 to 5.5 V quad level shifter	B side	A side				2 kV
PCA9527	3.0 to 5.5 V level shifter	A side	B side	• (A side)		•	8 kV

7. Interfaces and control

7.5 I²C bridges (SPI, UART) and 16C-compatible UARTs

SPI-to-I²C bridge SC18IS600/601

Control multiple I²C devices using a source decoder equipped with an SPI interface, or use its I²C interface for other purposes. The SC18IS600 has a maximum SPI clock rate of 1 Mbps and uses an internal oscillator. The SC18IS601 has a maximum SPI clock rate of 3 Mbps and uses an external oscillator.



Features

- SPI host interface
- I²C bus controller
- Multi-master capability
- 5 configurable I/O ports
- High-speed I²C: 400 Kbps
- 96-byte Rx and Tx FIFOs
- Operating range: 2.4 to 3.6 V
- Power-down mode with wakeup pin
- Small, 16-pin TSSOP package

7. Interfaces and control

UART-to-I²C bridge SC18IM700

Use this device to add an RS-232 interface to the design, or when implementing development, on-site debug, service, or maintenance functions.

Features

- UART host interface
- I²C master bus controller
- High-speed RS-232 with baud rate up to 460.8 Kbps
- Fast-mode I²C with speed up to 400 kbps
- 16-byte Rx and Tx FIFO
- 8 programmable I/O pins
- Programmable baud rate generator
- Operating range: 2.3 to 3.6 V
- Input pins tolerant to 5 V
- Sleep mode (power down)
- I²C-like RS-232 Protocol in ASCII format
- Master, multi-master capability
- Fixed 8N1 RS-232 format (1 start, 8 data, 1 stop, no parity bit)
- Supports hardware reset
- After reset, the baud rate is 9600 bps (can then be changed via Baud Rate Generator)
- Wakeup pin
- Very small 16-pin TSSOP package

16C-compatible UARTs

Our UARTs, available with 1, 2, or 4 channels, deliver low-power operation with data rates up to 5 Mbps. They support 2.5, 3.3, and 5 V operation, and include IrDA for wireless links.

Channel	FIFO byte	HVQFN-32	HVQFN-48	LFBGA-64	LQFP64
		5 x 5 x 0.85	6 x 6 x 0.85	6 x 6 x 1.05	7 x 7 x 1.4
1	16	16C550BIBS			
1	32	16C650BIBS			
1	64	16C750BIBS			
2	16	16C2550BIBS			
2	32	16C652BIBS			
2	64	16C752BIBS			
4	16		16C554BIBS		16C554BIBM
4	64		16C654BIBS	16C654BIEC	16C654BIBM
4	64				16C754BIBM

7. Interfaces and control

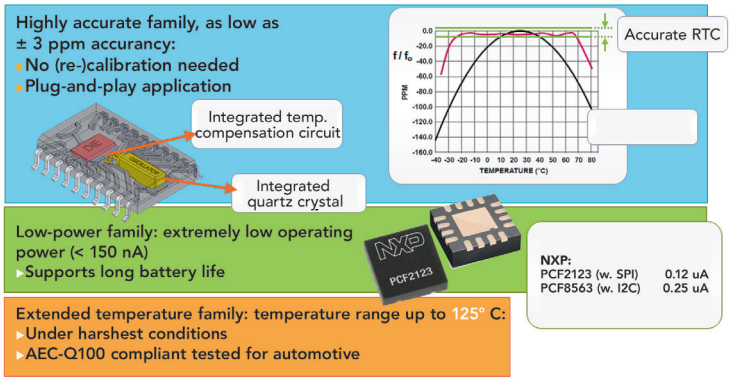
7.6 I²C real-time clocks (RTCs)

Our I²C portfolio includes high-accuracy RTCs that need no calibration, low-power RTCs that use less than 150 nA, and an extended temperature range for reliable performance in the harshest conditions.

Accurate RTCs	
PCF2127A	±3ppm (typ) over -20 to +70 °C, calibrated at V_{dd} = 3.3 V, I²C & SPI, RAM
PCF2129A	±3ppm (typ) over -20 to +70 °C, calibrated at V_{dd} = 3.3 V, I²C & SPI, cost-optimized

Low-power RTCs	
PCF8593	Low power, 1/100 s resolution
PCF8583	Low power, 240 scratch-pad RAM
PCF8563	Very low power (250 nA)
PCF2123	Extremely low power (as low as 100 nA), SPI, electronic frequency tuning register

RTCs with extended temperature range	
PCA8565	Low power, extended temp range to 125 °C, I²C
PCA2125	Extended temp range to 125 °C, SPI



7. Interfaces and control

7.7 I²C design tools and tech support

As a leading provider of I²C solutions, we have one of the largest portfolios in the industry, with hundreds of options for all kinds of applications. We support all our I²C product families with an extensive array of development tools, application notes, sample designs, and discussion forums.

I²C demo board I2C2005-1
This kit is an easy-to-use tool for experimentation and training. It includes I²C-bus I/O ports, temperature sensors, LED drivers, and real-time clocks. It employs a USB interface to connect to a Windows PC or laptop and for power. To place an order, go to www.demoboard.com or visit eTools.

7.8 Logic functions

We offer a wide range of logic functions in state-of-the-art packages. Our portfolio includes the industry-leading HC/T and LVC families, our new AUP family, plus translator and bus functions.

Packages include the ultra-compact DQFN, HVQFN, MicroPak XSON, and PicoGate. The PicoGate format is especially useful for adding source decoder functions with minimal PCB rework or expansion. There are two versions of DQFN: one with accessible pads, for easy signal probes during system validation, test, and production, and one without access to signals, to prevent probes, for use in applications with higher security requirements.

7.9 Memory termination regulator

DDR memory termination regulator NE578xx
Designed for STBs using DDR-type SDRAM, these devices include a standby mode and deliver enhanced efficiency.

Features
- Fast transient response time
- Over-temperature and over-current protection
- High bandwidth drivers minimize requirement for output hold-up filter capacitors
- Internal divider maintains termination voltage at 1/2 memory supply voltage

8. Discrete components for the main processing board

8.1 Power solutions

Since integrated circuits typically use a lower core supply voltage than interfaces and memory devices, most boards require a number of different supply voltages. Our power solutions include a variety of devices, including medium-power Schottky diodes, bipolar transistors, and MOSFETs, to help create efficient, cost-effective linear regulators and DC/DC converters.

- The PBSS4041PZ can be used as a linear PNP regulator to generate 2.5 and 1.5 V analog supplies. It delivers excellent gain up to 15 A ICM while supporting 5.7 A of continuous current.
- Supporting 1.2 or 1.8 V or the LNB supply, the PMEG2005EH, PMEG4010EH, and PMEG4030ER are excellent options for the freewheeling Schottky diodes commonly used in DC/DC conversion.
- The BSP030, a 10 A, N-channel MOSFET in an SOT233 package, can be used as an external MOSFET for synchronous rectification.
- The TL431xxSDT series of shunt regulators, along with the BC847, a general-purpose transistor, are recommended for low-power, discrete linear voltage regulators.

Schottky diodes		Protection diodes		MOSFETs		BJTs		Analog ICs	
PMEG2005EH	SOD123F	PTVS12VS1UR	SOT123W	BSP030	SOT223	PBSS306P2	SOT223	TL431xxSDT	SOT23
PMEG4010EH	SOD123F					PBSS4041PZ	SOT223		
PMEG4030ER	SOD123W								

8. Discrete components for the main processing board

8.2 Special functions and general-purpose devices

To complement function-specific solutions, such as modem, USB, and audio interface devices, we offer general-purpose discrete devices that are well suited for use on the main processing board.

- The high-voltage switching diode BAS101S is recommended for use as a bridge rectifier on the Tip and Ring wires. In this configuration, it can be used for current steering, to maintain DAA operation, or for connection to AC-coupled Tip and Ring ports.

- For Tip and Ring control, as well as off-hook functionality, the high-voltage transistors MMBTA42 or PBHV8540T are recommended.

- For audio muting, there is the low-noise low VCEsat (BISS) transistor PBSS2515E, which is housed in an ultra-small SOT416 package, and the PBSS4140T, housed in the cost-efficient, high-volume SOT23 package.

Discrete PESD5V0xx protection diodes are also available for USB, memory, audio, video, and HDMI interfaces. Please refer to the specific chapters in this guide for details.

Additional resources

The listed web pages provide access to additional information about NXP and its product lines.

Application notes
www.nxp.com/all_appnotes

Datasheets (all released products and product families)
www.nxp.com/all_datasheets

Interactive selection guides
www.nxp.com/selectionguides/all-selectionguides.html

Sales literature (product leaflets, brochures)
www.nxp.com/all_literature

X-reference tool (search tool for NXP website, for use offline)
www.nxp.com/search/advanced

NXP Chinese website (simplified characters)
www.cn.nxp.com

NXP Chinese website (traditional characters)
www.tw.nxp.com

www.nxp.com

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