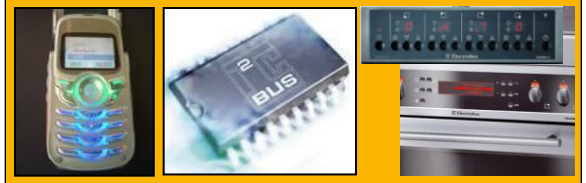
SSD Storage Application Presentation

Interface Products

3Q 2012 Rev 1.0

Interface Products Overview

System Management



- I²C-Bus Controllers
- I²C-Bus Buffers, Muxes & Switches
- GPIO Expanders
- LED Controllers
- Temperature Sensors
- Active & Passive Level Translation
- EEPROMs
- Electronic DIP Switches
- Stepper Motor Controllers
- Power Line Modem
- RF Transceivers

No. 1 in I²C-bus product

San Jose

High Speed Interface

- High Speed Buffers & Muxes
- SerDes
- Memory Interface
- UARTs
- Bridges
- SDIO Controller
- PCIe Phy
- Display Port Converters

Most integrated DisplayPort adapters
High speed switches up to 10 Gb/s

San Jose

Clocks, Watches & Graphic Drivers

- Real Time Clocks
- Display Drivers
- Proximity / Touch Switches
- Data Converters
- Watch Chips

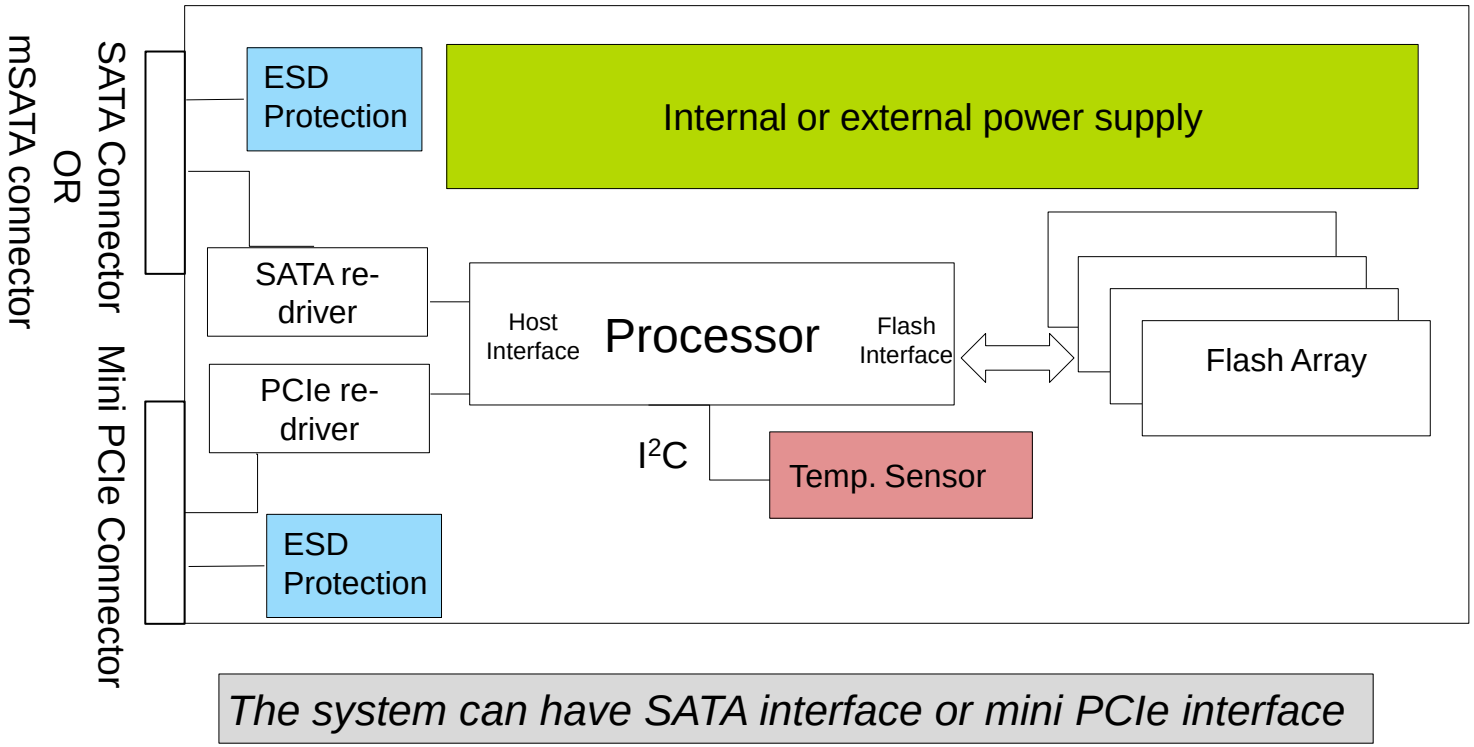
No. 1 in low power RTC's

Zurich

Focus on high-value, mixed-signal components
to support key processors in high-growth connected markets

General Block Diagram – Internal SSD Drive

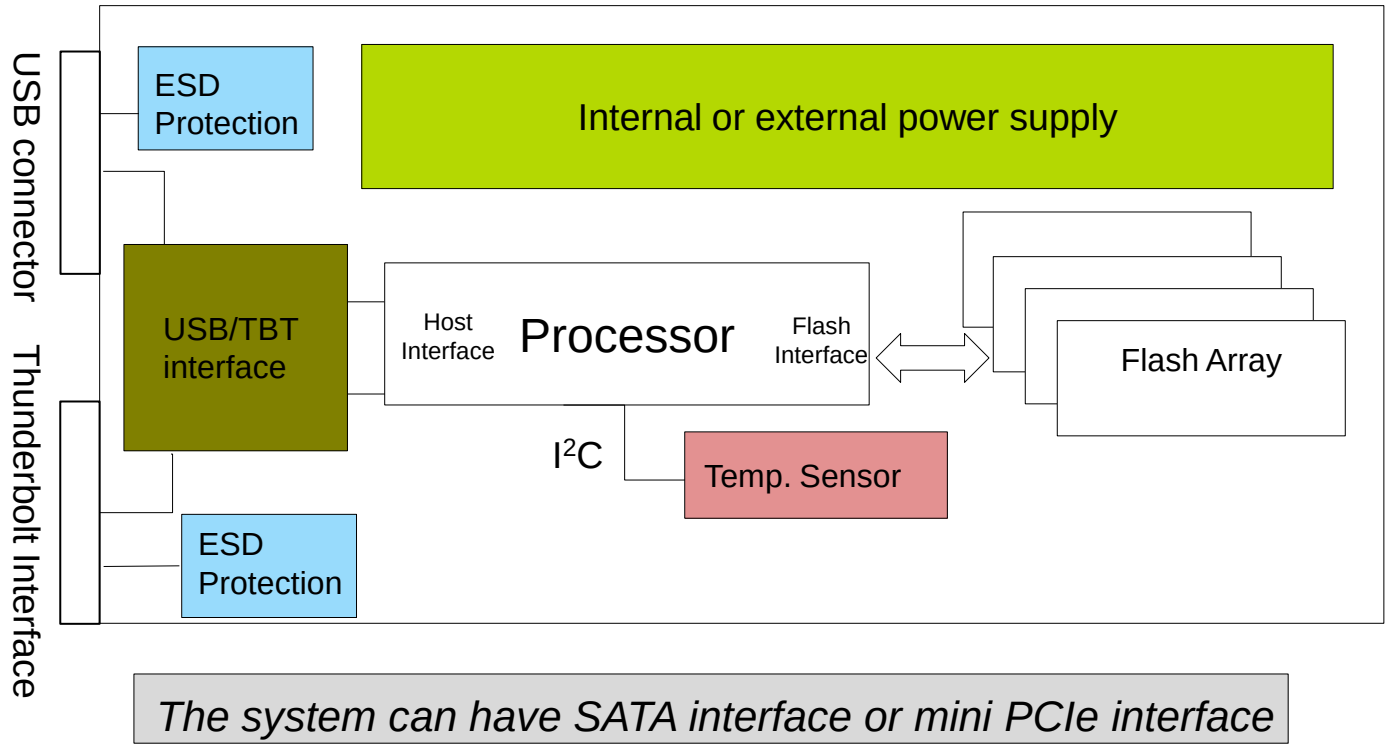
Internal SSD



Interface
Standard Products
Sensors and Actuators
Power
Processing

General Block Diagram – External SSD Drive

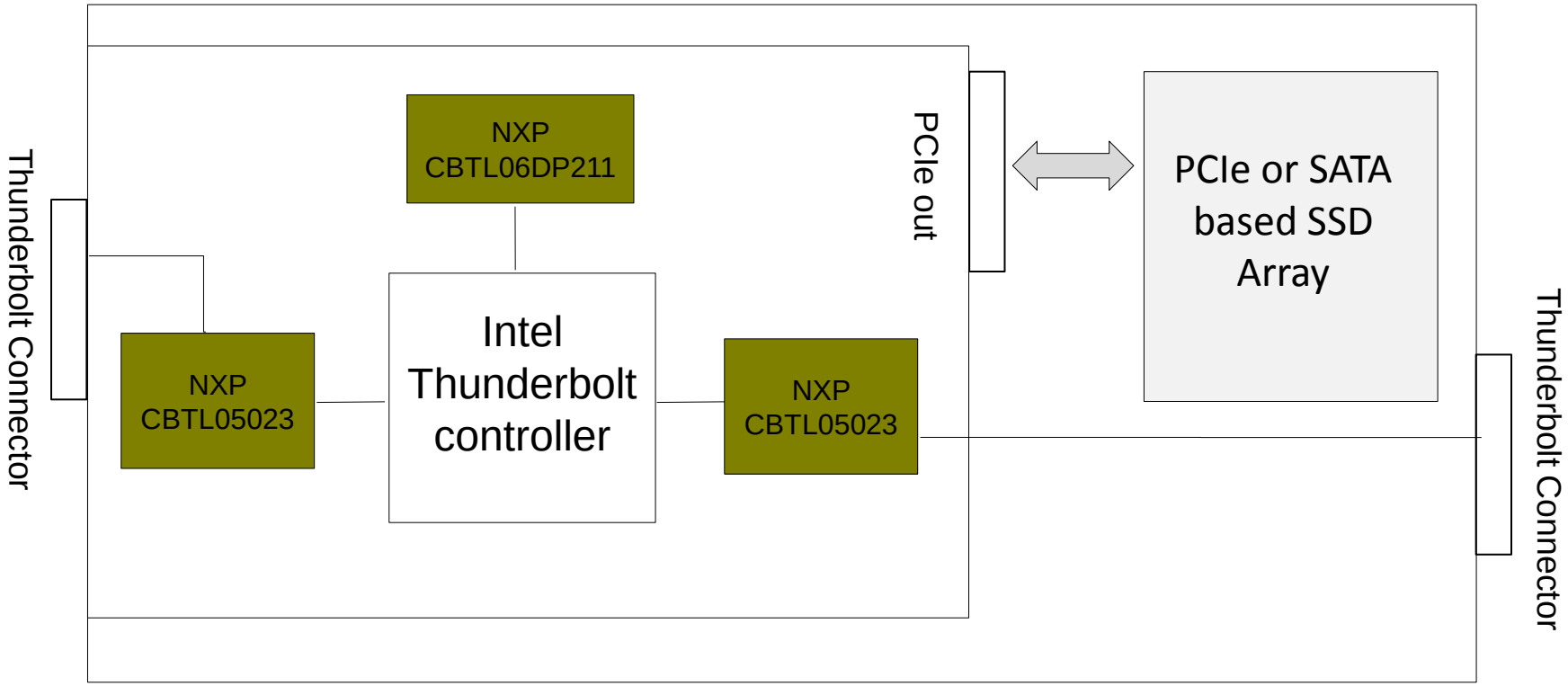
External SSD



Interface
Standard Products
Sensors and Actuators
Power
Processing

General Block Diagram – Thunderbolt based SSD Drive

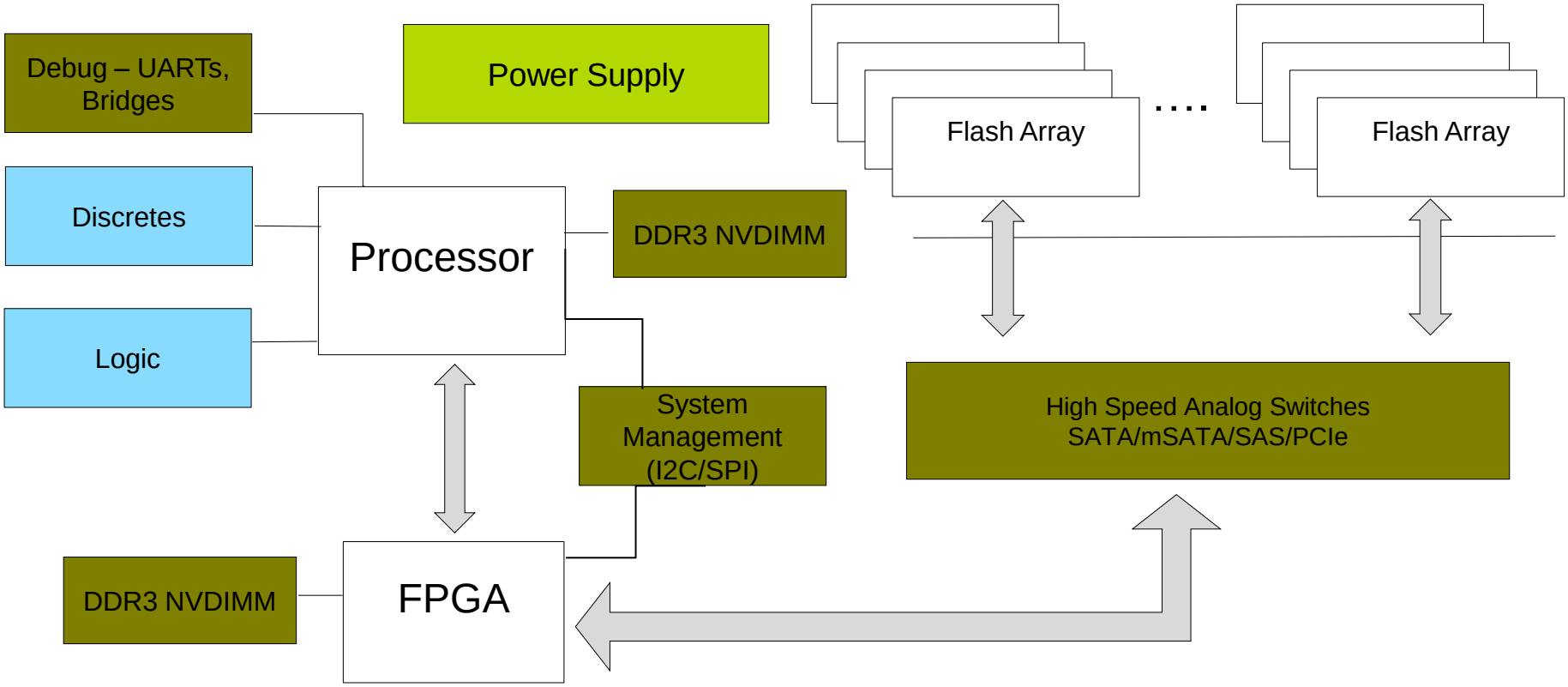
T-Bolt SSD



Interface
Standard Products
Sensors and Actuators
Power
Processing

General Block Diagram – SSD based storage system

Storage SSD



Interface
Standard Products
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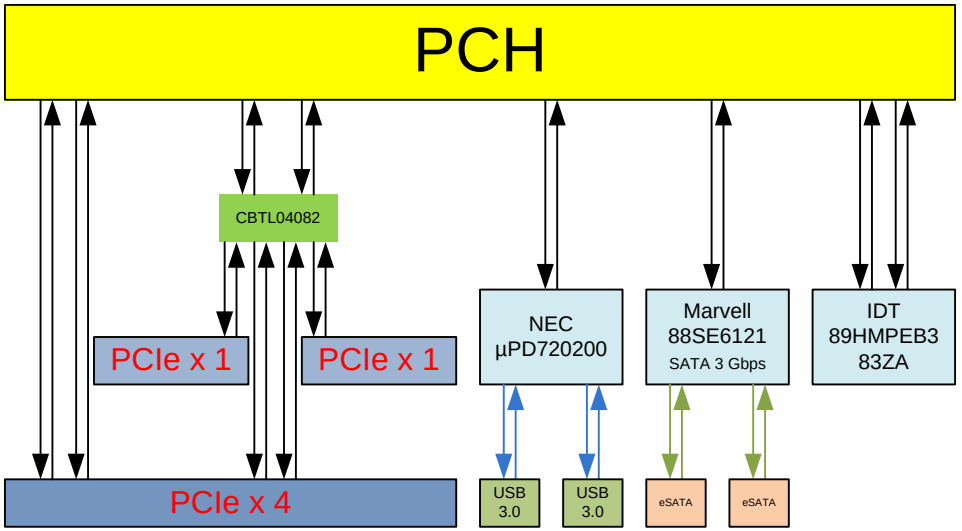
Processing

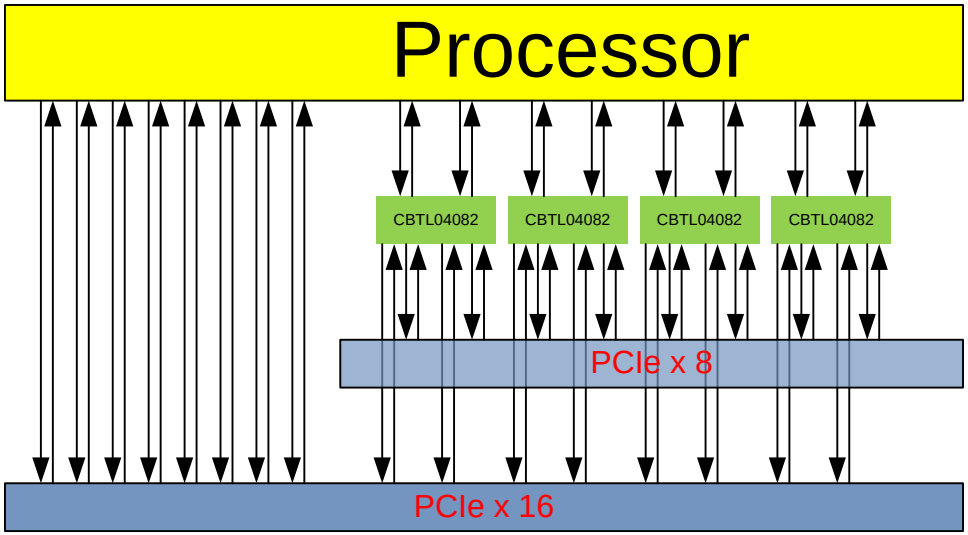
High Speed Analog Switching Solutions

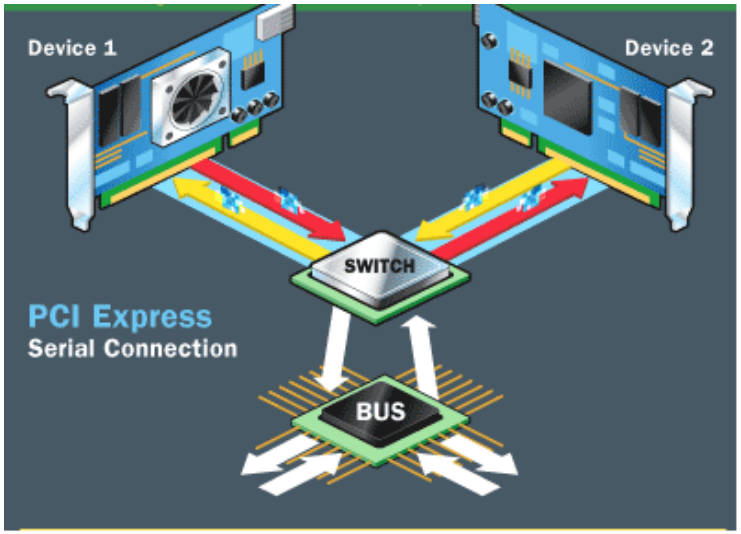
Uses Cases for PCIe

Storage SSD

- PCIe Slot Configuration
  - x16→x8→x4→x2→x1



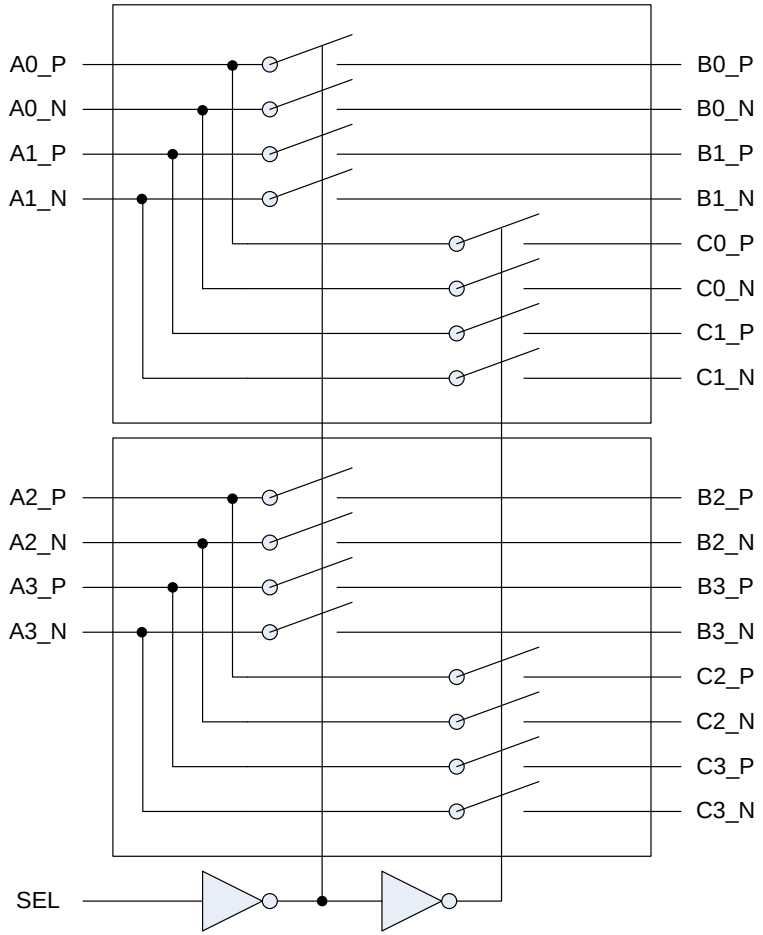




CBTU04082 5 Gbps Mux/De-mux/Switch

Storage SSD

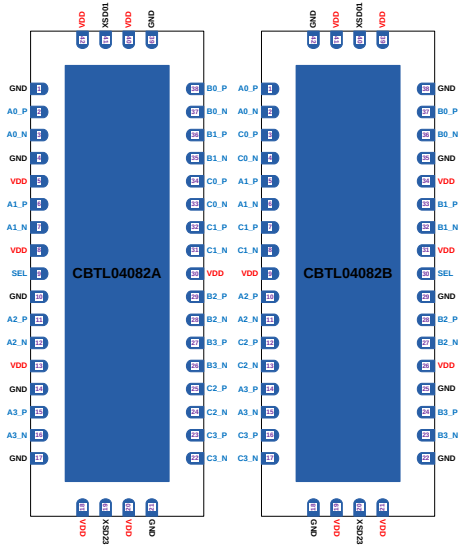
- 4 differential channel, 2 : 1 mux/demux
- Signaling Supported
  - PCIe Gen2, USB3.0, SATA @ 5Gbps
- Insertion loss: -2dB at 3 GHz
- Low crosstalk: −23 dB at 3 GHz
- Low off-isolation: −23 dB at 3 GHz
- VDD operating range: 1.65 V to 2.0 V
- ESD tolerance:
  - 6 kV HBM I/O
  - 1 kV CDM
- Low bit-to-bit skew: 10 ps max (between positive and negative bits)
- Low channel-to-channel skew: 35 ps max
- HVQFN42 package

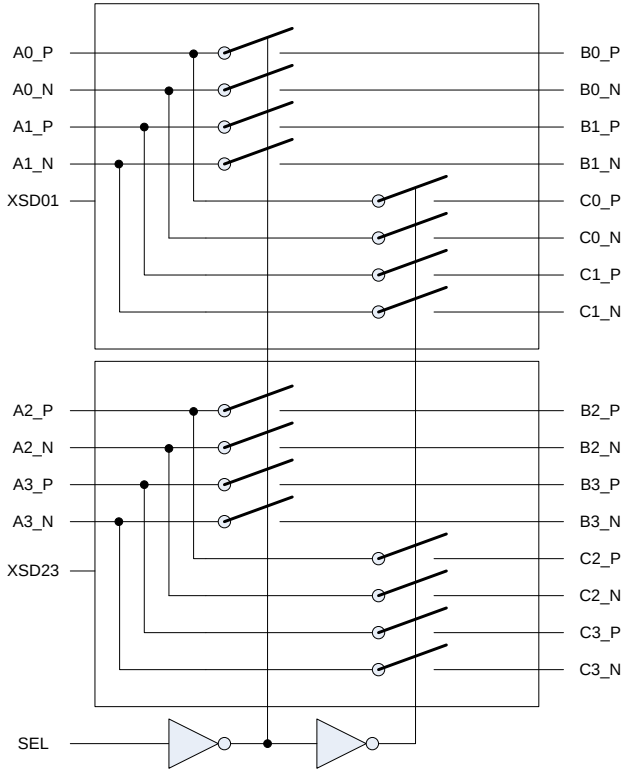


CBTL04082 5 Gbps Mux/De-mux/Switch

Storage SSD

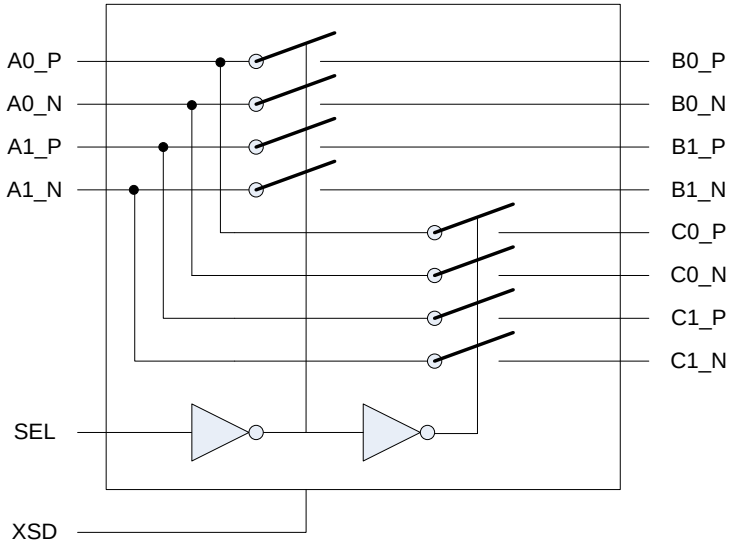
- 4 differential channel, 2:1 bi-directional mux/demux
- Signaling Supported
  - PCIe Gen2, USB3.0, SATA @ 5Gbps
- Insertion loss
  - -0.5dB at 100 MHz
  - -2.0dB at 2.5 GHz
  - -3.0dB at 4.3 GHz
- Low intra-pair skew: 5ps max
- Low inter-pair skew: 35ps max
- Low crosstalk: -30dB at 2.5GHz
- Off-isolation: -30dB at 2.5GHz
- 3.3 V supply voltage
- HVQFN42 package
- ESD 6kV HBM, 1kV CDM
- Two pin outs available for PCB layout optimization
- Standby current < 10 uA controlled by XSD pin

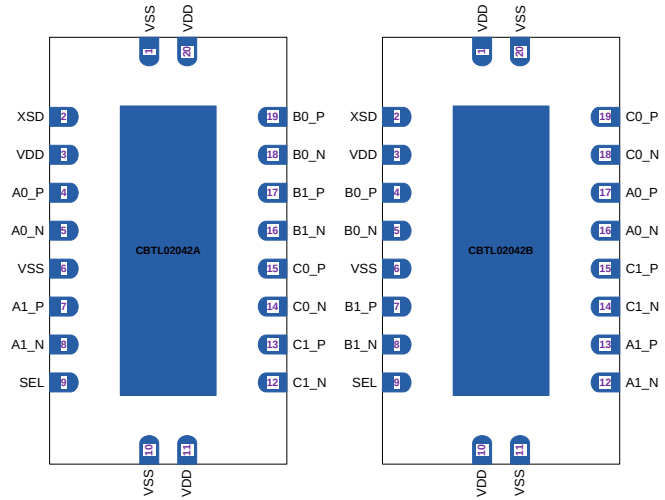




CBTL02042 5 Gbps Mux/De-mux/Switch

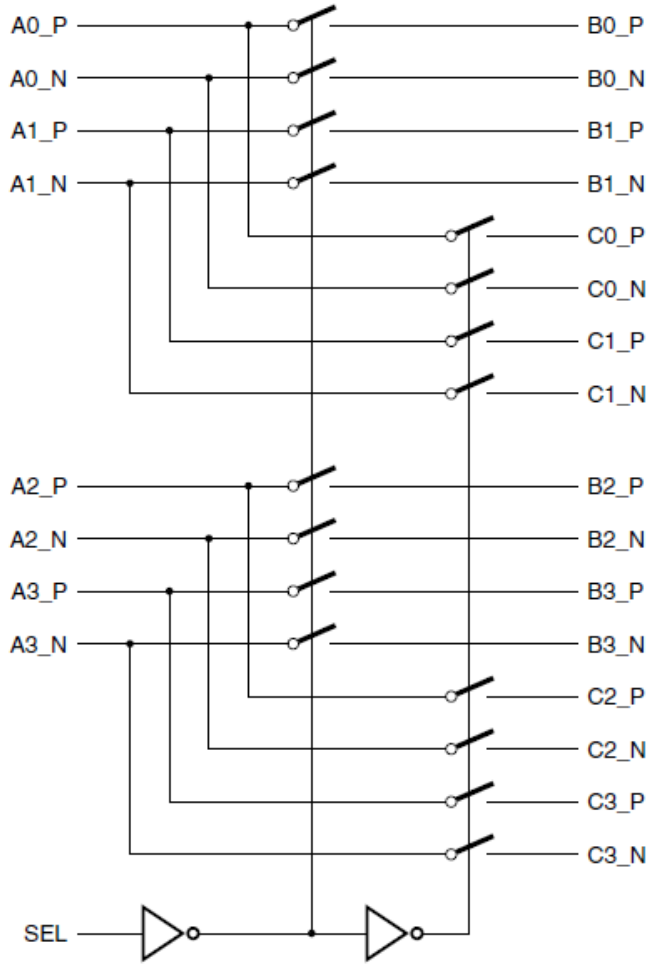
- 2 differential channel, 2:1 bi-directional mux/demux
- Signaling Supported
  - PCIe Gen1 @ 2.5Gbps
  - PCIe Gen2 @ 5Gbps
  - USB 3.0 @ 5.0Gbps
  - SATA Gen 2 @ 3.0Gbps
  - DisplayPort v1.1a @ 2.7Gbps
- -3dB bandwidth 4.3 GHz
- Low inter-pair skew: 5ps max
- Low crosstalk: -30dB at 5GHz
- Off-isolation: -30dB at 5GHz
- 3.3 V supply voltage
- DHVQFN 20, 2.5x4.5mm,0.5mm pitch
- ESD 6kV HBM, 1kV CDM
- Two pin-outs available
  - A pin-out optimized for outputs on the opposite side of input
  - B pin-out optimized for outputs on both sides of the package





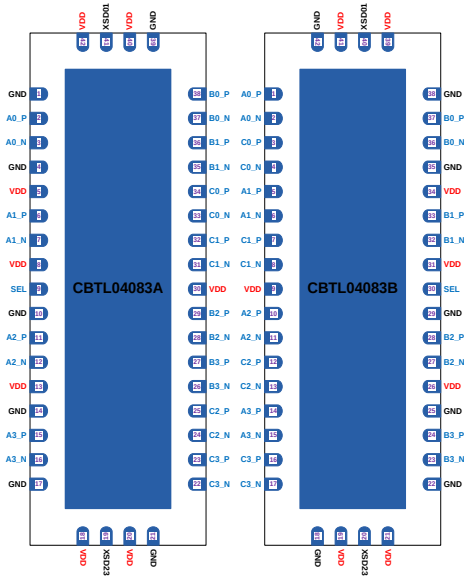
CBTU04083 8Gbps PCIe Gen3 Mux/De-mux/Switch

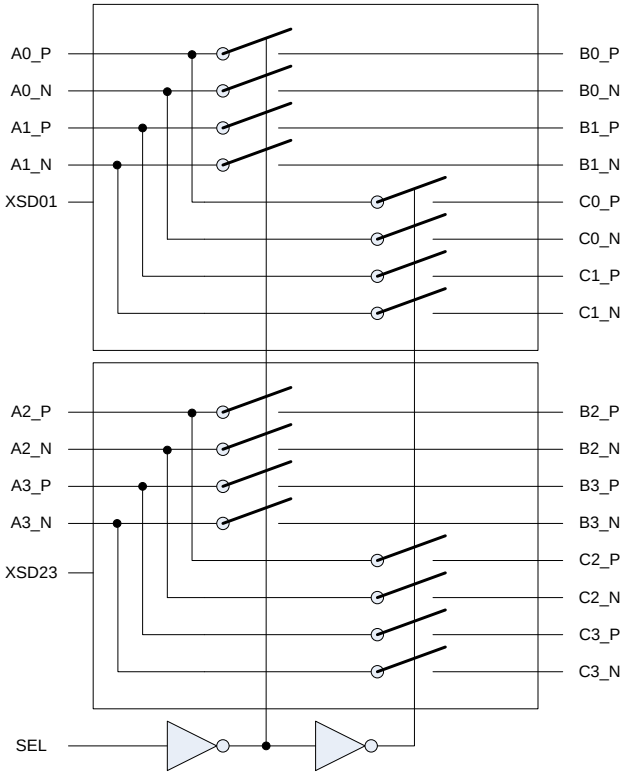
- 4 differential channel, 2 : 1 multiplexer/demultiplexer
- Signaling Supported
  - PCIe Gen3 @ 8 Gbps
  - SAS Gen2 @ 6 Gbps
- Insertion loss -2.8 dB at 4GHz
- Low crosstalk: −30 dB at 4 GHz
- Low off-isolation: −30 dB at 4 GHz
- VDD operating range: 1.65 V to 2.0 V
- ESD tolerance: 6kV HBM
- Low bit-to-bit skew: 10 ps max (between positive and negative bits)
- Low channel-to-channel skew: 35 ps max
- HVQFN42 package



CBTL04083 8 Gbps PCIe Gen3 Mux/De-mux/Switch

- 4 differential channel, 2:1 bi-directional mux/demux
- Signaling Supported
  - PCIe Gen3 @ 8 Gbps
  - SAS Gen2 @ 6 Gbps
- Insertion loss, equivalent to about 2” of FR4 PCB trace
  - -0.5dB at 100 MHz
  - -1.0dB at 4 GHz
  - -3.0dB at 8 GHz
- Low intra-pair skew: 5ps max
- Low inter-pair skew: 20ps max
- Low crosstalk: -25dB at 4GHz
- Off-isolation: -10dB at 4GHz
- 3.3 V supply voltage
- HVQFN42 package
- ESD 2kV HBM, 500V CDM
- Two pin outs available for PCB layout optimization
- Standby current < 10 uA controlled by XSD pin

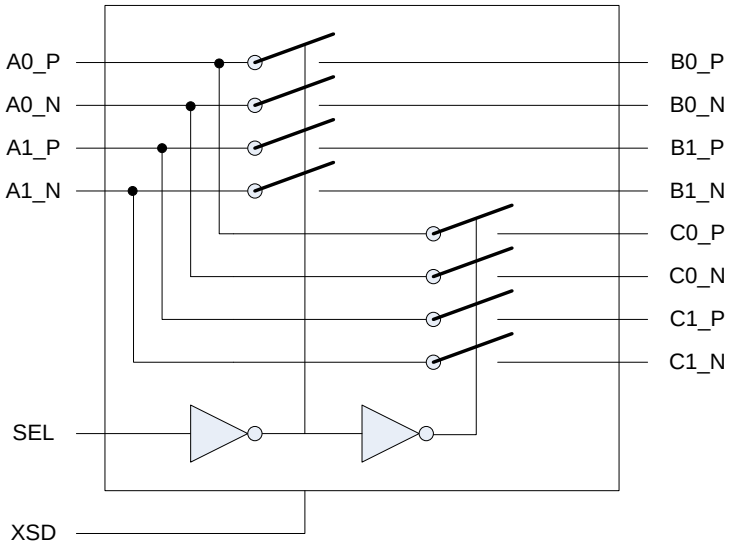




CBTL02043 10 Gbps Mux/De-mux/Switch

Storage SSD

- 2 differential channel, 2:1 bi-directional mux/demux
- Signaling Supported
  - PCIe Gen1 @ 2.5 Gbps
  - PCIe Gen2 @ 5 Gbps
  - PCIe Gen3 @ 8 Gbps
  - USB 3.0 @ 5.0Gbps
  - SATA Gen 2 @ 3.0 Gbps
  - DisplayPort v1.1a @ 2.7 Gbps
  - DisplayPort v1.2 @ 5.4 Gbps
- **-3dB bandwidth 10 GHz**
- Low inter-pair skew: 5ps max
- Low crosstalk: -30dB at 5GHz
- Off-isolation: -30dB at 5GHz
- 3.3 V supply voltage
- DHVQFN 20, 2.5x4.5mm,0.5mm pitch
- ESD 6kV HBM, 1kV CDM
- Two pin-outs available
  - A pin-out optimized for outputs on the opposite side of input
  - B pin-out optimized for outputs on both sides of the package



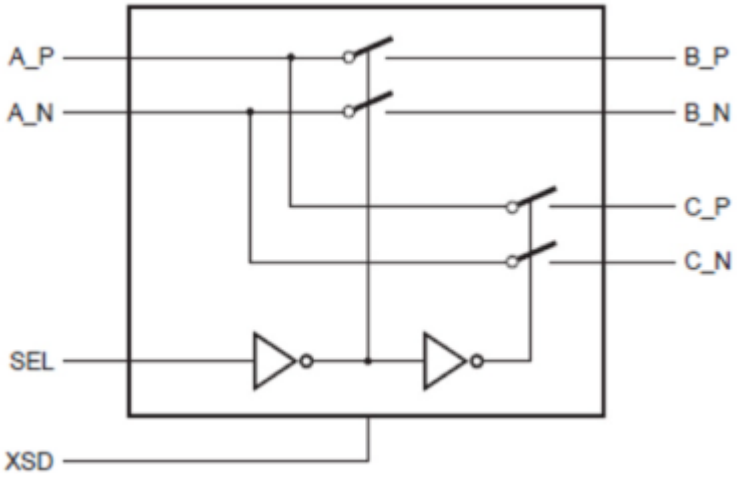
Applications:

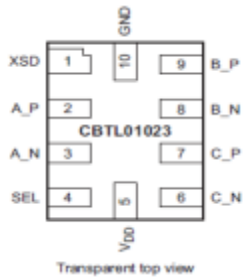
- ✓ Computing – Enterprise and Storage
- ✓ Base-station
- ✓ Network infrastructure

CBTL01023 10 Gbps Mux/De-mux/Switch

Storage SSD

- Single bidirectional differential channel, 2:1 mux/demux switch
- High bandwidth: 9 GHz at −3 dB
- Low insertion loss:
  - −0.5 dB at 100 MHz
  - −1.3 dB at 4.0 GHz
- Low return loss: −20 dB at 4 GHz
- Low crosstalk: −35 dB at 4 GHz
- Low off-state isolation: −20 dB at 4 GHz
- Low intra-pair skew: 5 ps typical
- VDD operating range: 3.3 V
  - Standby current less than 1 µA
- XQFN10 package





NXP High Speed Switches Portfolio

Storage SSD

PCIe Gen 2, USB 3.0, mSATA, LVDS, SATA 2.0, SAS 1.0

Product	Function	Samples	Production
CBTU04082B	5 Gbps PCIe Gen 2 Mux/De-mux/Switch (4 differential channels)	NOW	NOW
CBTL04082A CBTL04082B	5 Gbps PCIe Gen 2 Mux/De-mux/Switch A and B pin outs optimized for PCB layouts (4 differential channels)	NOW	NOW
CBTL02042A CBTL02042B	5 Gbps PCIe Gen 2 Mux/De-mux/Switch A and B pin outs optimized for PCB layouts (2 differential channels)	NOW	NOW

NXP High Speed Switches Portfolio

Storage SSD

PCIe Gen 3, SAS 2.0, SATA 3.0, USB 3.0

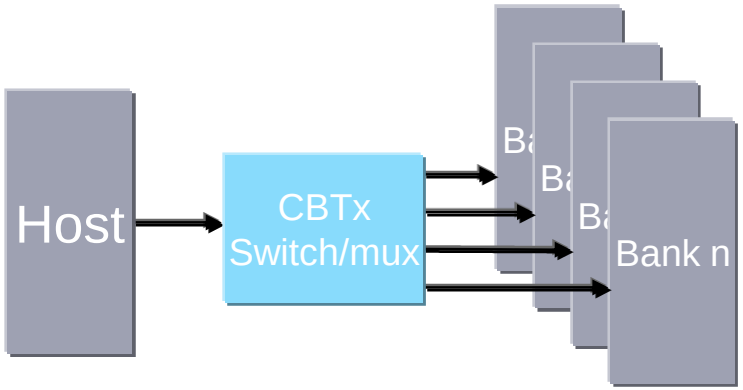
Product	Function	Samples	Production
CBTU04083B	8 Gbps PCIe Gen3 Mux/De-mux/Switch (4 differential channels)	NOW	NOW
CBTL04083A CBTL04083B	8 Gbps PCIe Gen3 Mux/De-mux/Switch A and B pin outs optimized for PCB layouts (4 differential channels)	NOW	NOW
CBTL02043A CBTL02043B	10 Gbps Mux/De-mux/Switch A and B pin outs optimized for PCB layouts (2 differential channels)	NOW	NOW
CBTL01023	10 Gbps Mux/De-mux/Switch (1 differential channel)	NOW	NOW

DDR3 switching solution

CBTU/W Bus Switch Value Proposition

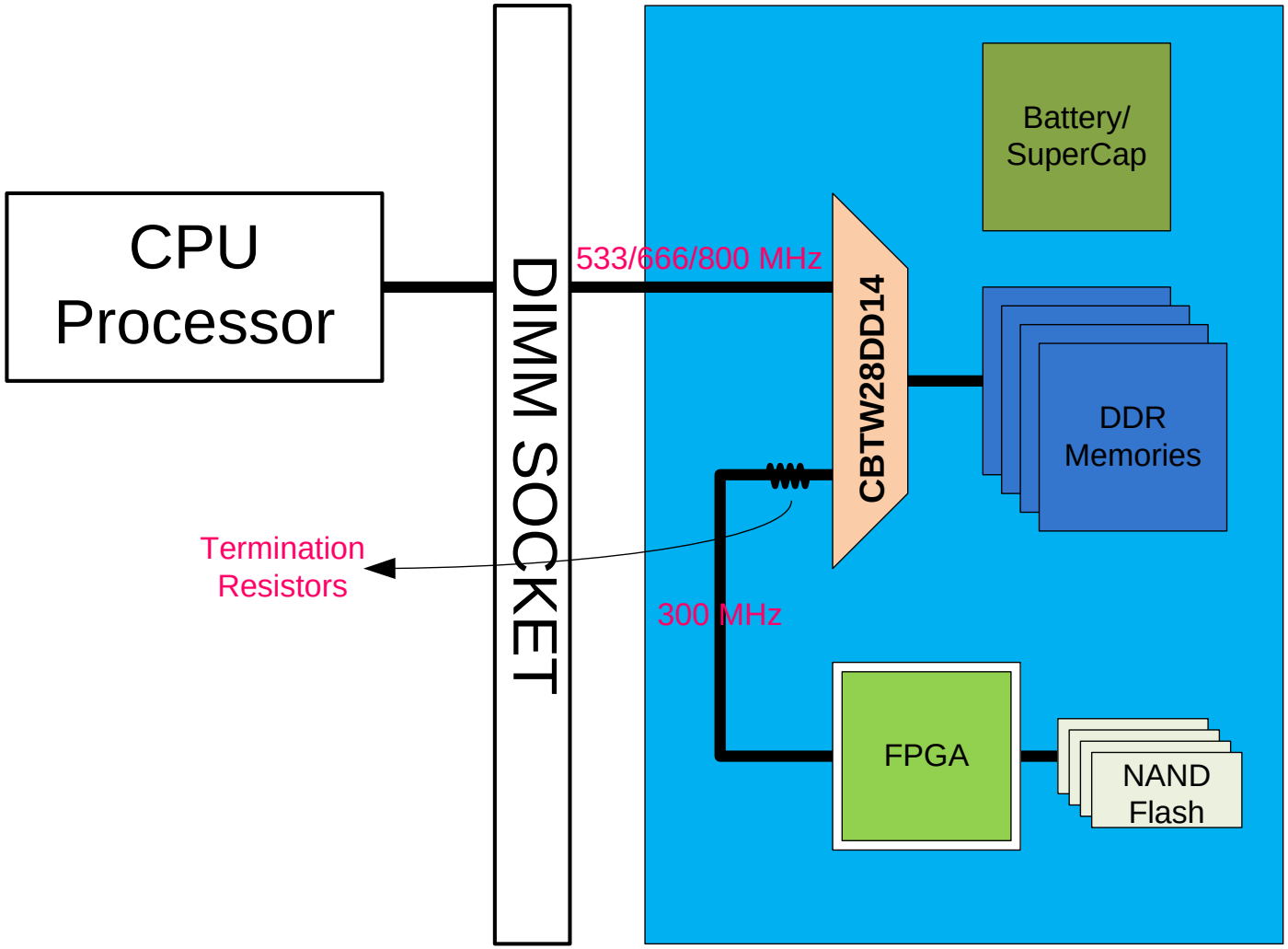
Storage SSD

- **Where used?**
  - Custom memory bus architectures for server or enterprise storage applications
  - General purpose bus switching or multiplexing
  - Base station and server applications
- **Why used?**
  - Route one bus to one of several destinations depending on system configuration
  - Maintain high signal integrity at high speed
  - Can be used for failover purposes in servers/base-stations and Flash based memory support in high end servers
- **Why use NXP?**
  - Unique portfolio of bus switches
  - High speed and high signal integrity (800 Mbps)



Memory Mux Application Diagram

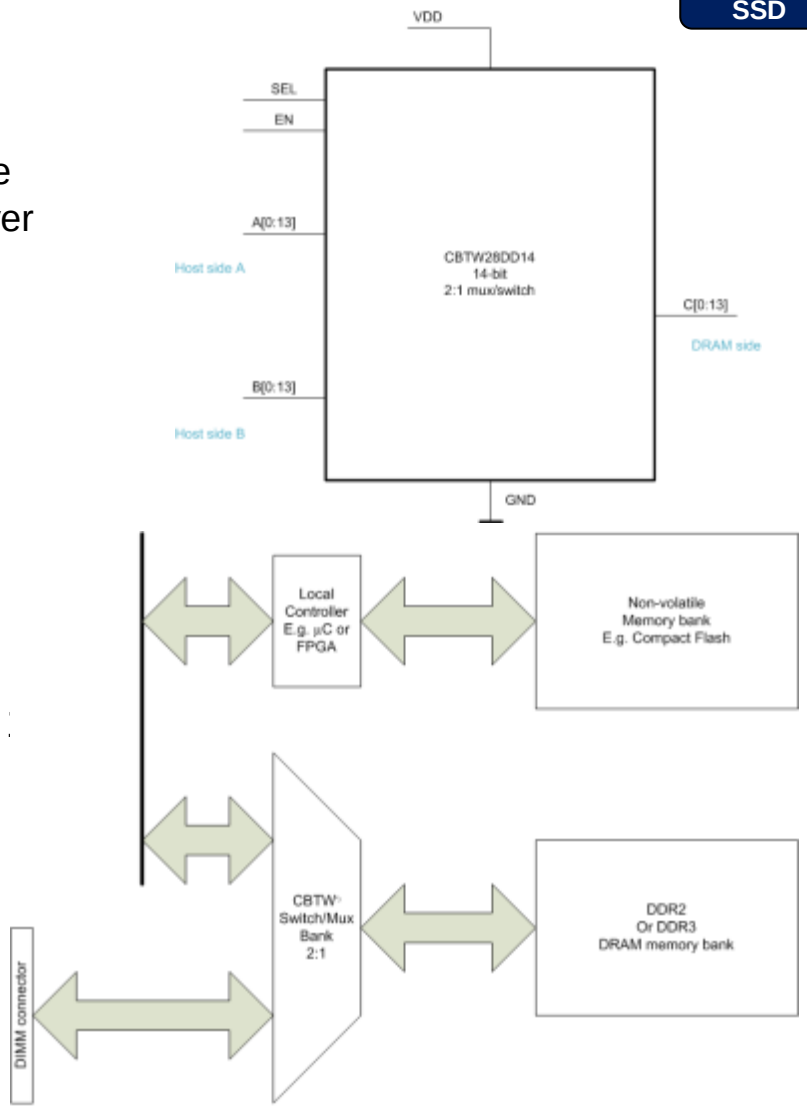
Storage SSD



CBTW28DD14 DDR3 Mux

Storage SSD

- Channel width: 14 bits
  - Optimal to fit one data lane each as well as divide address & command bus and auxiliary signals over remaining muxes
- SSTL_15 and SSTL_18 signaling
- 1.5 V or 1.8 V supply voltage
- Bandwidth > 3 GHz
- Supports 1.6 Gbps throughput per lane
- Bidirectional ports
- CMOS select signals compatible with 1.5 V and V signaling
- Switch/mux topology: 1:2
- ESD 4kV HBM, 1kV CDM
- TFBGA48 package, 4.5 x 4.5mm, 0.5 mm pitch



*CBTW denotes a new family of CBT muxes suitable for 1.2 V and higher power supply operation

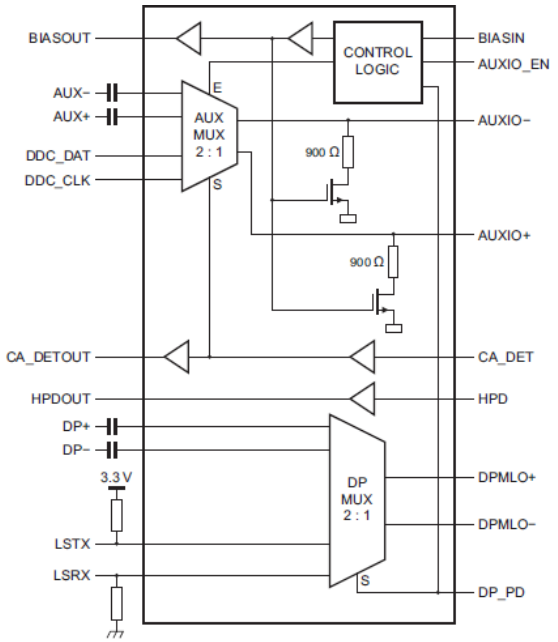
External SSD

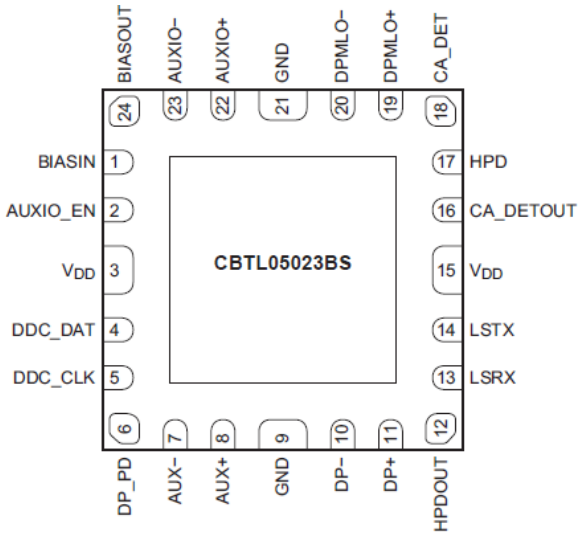
T-Bolt SSD

DisplayPort/Thunderbolt switches

CBTL05023 Thunderbolt Mux

- **CBTL05023 is optimized to interface TBT/miniDP connector for TBT applications**
- Excellent Signal Integrity to support 5.4Gbps DP1.2 HBR2 data rate
  - -15dB DDRL @ 2.5GHz for DP MUX
  - -2dB DDIL @ 2.5GHz for DP MUX
  - 7GHz bandwidth with 3.3V common mode input voltage
    - Pass rail-to-rail LS signal swing without clipping
- Optimized Integration to work with external PIN diodes for 10Gbps+AUX/DDC MUX
  - BIASOUT buffer supports bias current up to 6 PIN diodes
  - Integrated bias R for PIN diode path
- HPD input buffer with 5V tolerant
- Small 3 mm X3 mm HVQFN24 package with 0.4mm pitch



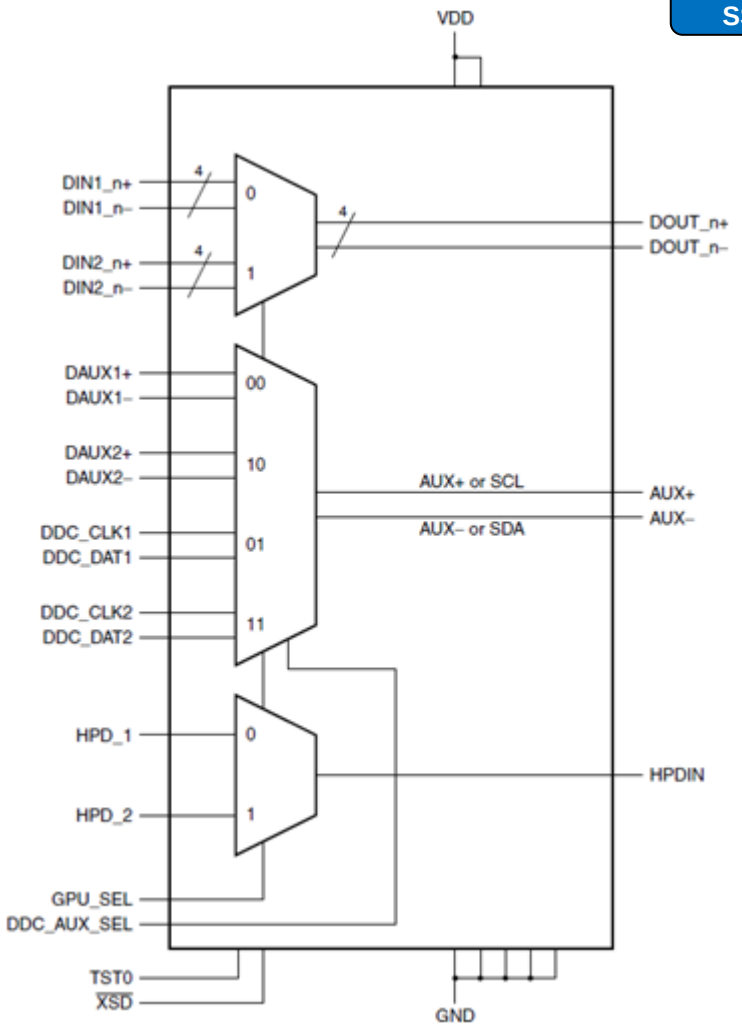


CBTL06DP211 DPv1.1a Mux/De-mux/Switch

External SSD

T-Bolt SSD

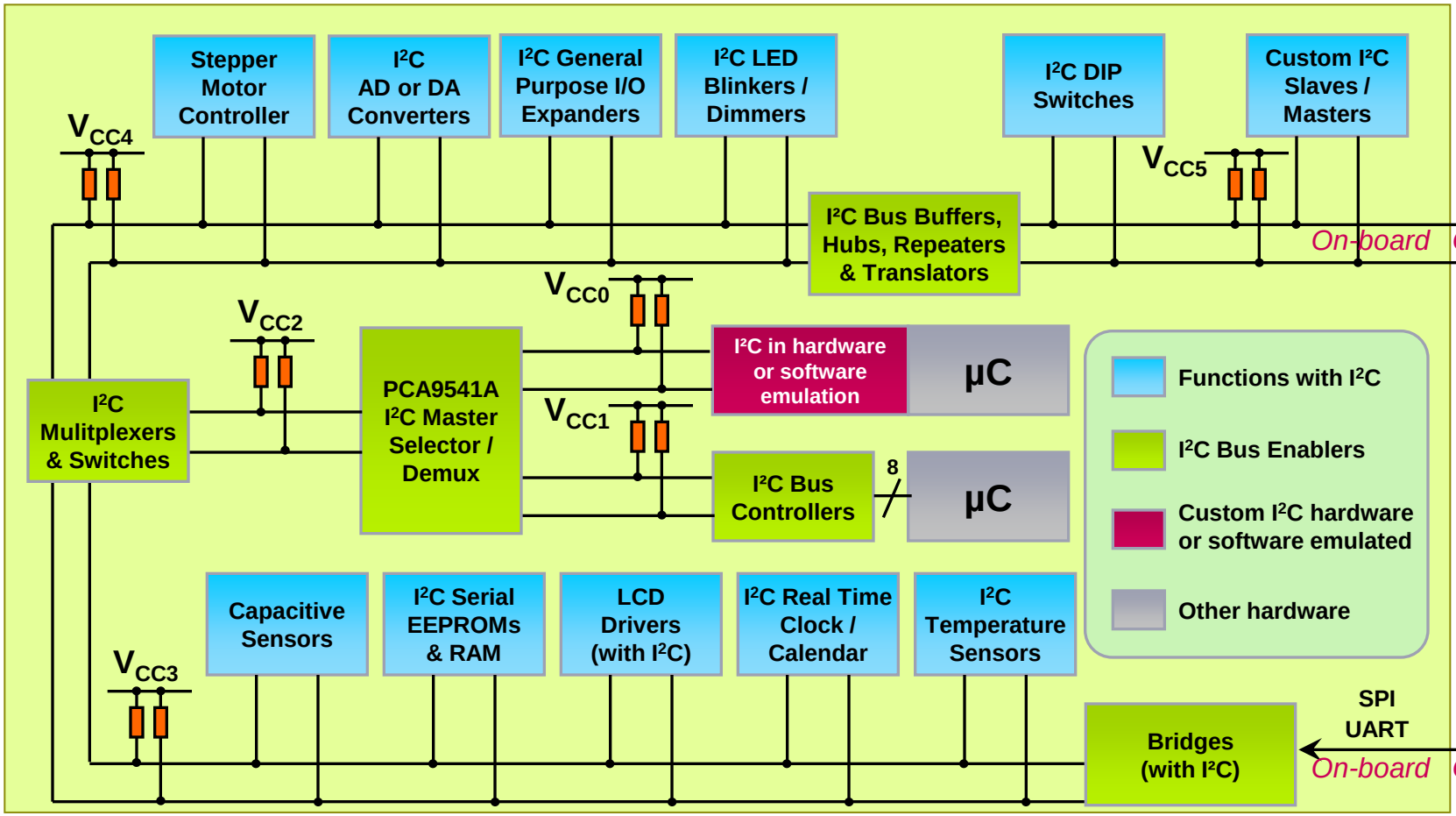
- 1 : 2 multiplexing
  - DisplayPort (v1.1 - 2.7 Gbit/s) or
  - PCIe Gen1 (2.5 Gbps)
  - 4 high-speed differential channels
  - 1 channel 4:1 muxing for AUX differential signals or DDC clock and data
  - 1 channel 2:1 muxing for HPD
- Low intra-pair differential skew (< 5 ps)
- Low inter-pair skew (< 180 ps)
- Current Consumption
  - Operation 0.2 A
  - Shutdown < 10 mA
- DDC and AUX ports tolerant to being pulled to +5 V via 2.2 kΩ resistor
  - Supports HDMI/DVI incorrect dongle connection



Standard I²C building blocks

Overview of all standalone peripherals

Storage SSD



Demo Boards & Support

I²C Fast Mode+ Products Click Here

UART

NXP I²C Fast Mode Plus Devices – PCA96xx

- Bus speed DC to 1 MHz fully compatible with existing I²C and SMBus
  - Higher bandwidth allows more devices on the bus and more complicated patterns w/o addition of buffers
- Bus drive strength 10x normal I²C I/O drive w/o addition of buffers
  - Drive heavier capacitive load or longer cable lengths
  - Low cost alternative to USB, Ethernet, wireless
- New practical features
  - Software reset of I/O ports (via I²C bus)
  - Hardware reset pin
  - Hardware address pins connecting to V_{CC}, GND, SCL, SDA allow up to 64 addresses vs the normal 8 using only three pins
- New NXP Cortex™ microcontrollers support Fast-mode plus
- Target applications: amusement/gaming, lighting, remote user interface applications (e.g. POS, security, kiosk, etc)
- I²C-bus Specification UM10204 at www.nxp.com/i2c

NXP Fast-mode Plus Product Offerings

I²C | Storage SSD

Bus Controller	Bus Buffer	LED Controller					GPIO		
Device	Device	Device	CHAN	TYPE (OD = Open Drain; TP = Totem Pole)	OUTPUT		Device	# I/O	RESET
					(mA)	(V)			
PCA9661 PCA9663 PCA9665	PCA9600 PCA9601 PCA9605 PCA9646	PCA9622	16	OD	100	40	PCA9672	8	YES
							PCA9621	8	NO
		PCA9624	8	OD	100	40	PCA9673	16	YES
		PCA9626	24	OD	100	40	PCA9674/74A	8	NO
		PCA9632	4	OD/TP	25/10	5	PCA9670	8	YES
		PCA9633	4	OD/TP	25/10	5	PCA9675	16	NO
		PCA9634	8	OD/TP	25/10	5	PCA9671	16	YES
		PCA9635	16	OD/TP	25/10	5	PCA9698	40	YES
		PCA9685	16	OD/TP	25/10	5			
		PCA9955	16	Constant Current	57	40			

General Purpose I/O Expanders

I/O Expanders with Flexible Output Structures

Quasi-Output Structure:

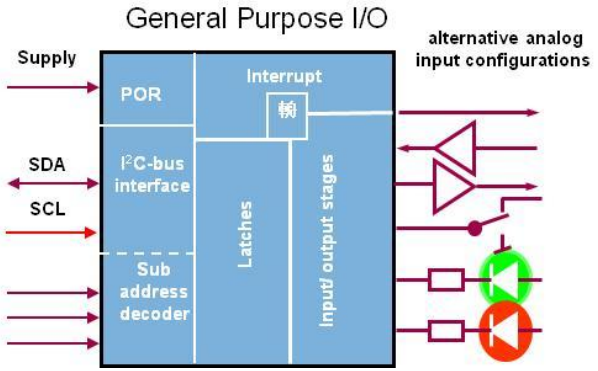
- Strong PMOS transistor is turned on only during the LH transition and turned off during static drive
- Weak pull-up current source (100µA) at the output
- Used in low-power applications where the 100-µA drive is sufficient to bias the inputs of CMOS devices
- May be reconfigured as an input or output without the need of a port configuration register

# of Outputs	Interrupt	Reset	Interrupt & Reset	2Kbit EEPROM	Interrupt and 2Kbit EEPROM
8	PCF8574/74A, PCA8574/74A, PCA9674/74A	PCA9670	PCA9672	PCA9500/58	PCA9501
16	PCF8575/75C, PCA9675	PCA9671	PCA9673	-	-

Totem-Pole Output Structure:

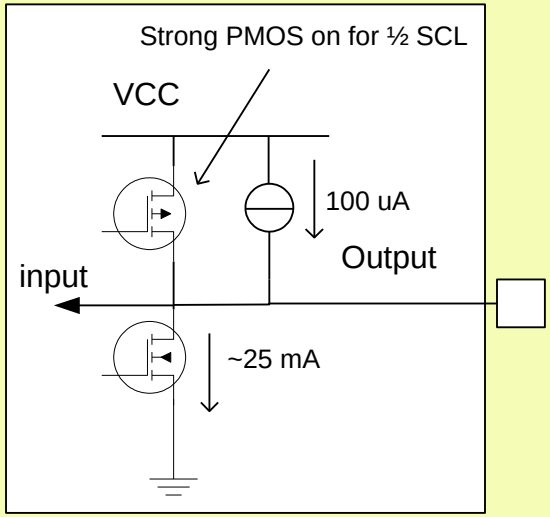
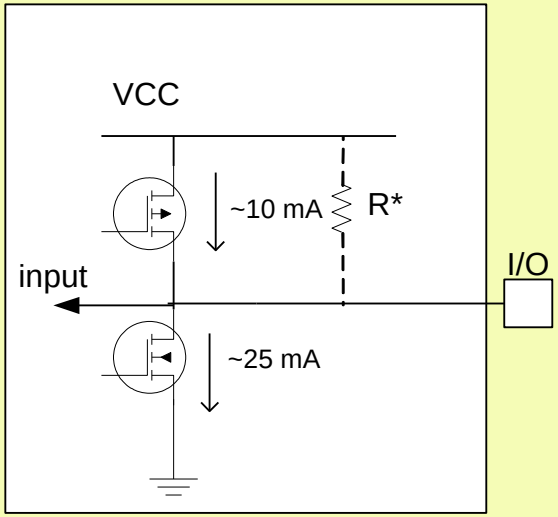
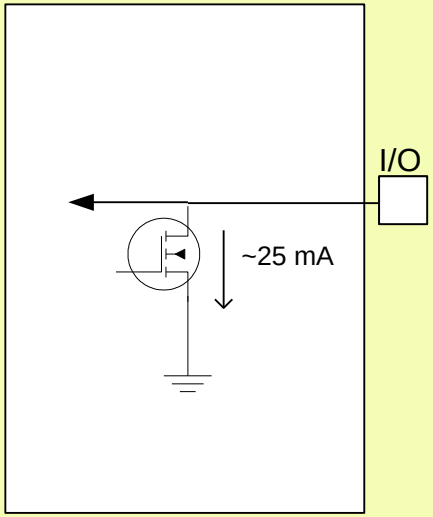
- Upper PMOS transistor is turned on during LH transition and static high drive. Up to 10mA (or 25mA) of high drive
- Some devices have weak pull-up resistors at the output
- Used in applications requiring high drive for heavy loads
- Extra command byte needed to switch an I/O pin between input and output

# of Outputs	None	Reset	Interrupt	Interrupt and Reset
4	PCA9536			PCA9537
8		PCA9557	PCA9534/54/54A	PCA9538, PCA9502, PCA9574
16	-	-	PCA9535/35C/55	PCA9539/39R, PCA9575
40	-	-		PCA9505/06, PCA9698



Flexible I/O (Output) Structures

I²C | Storage SSD

Quasi Output	Totem-Pole Output	Open-Drain Output
		
• Strong PMOS transistor is turned on only during the LH transition • PMOS transistor is off during static drive • Weak current source at the output	• Upper PMOS transistor is turned on during static high drive • Some devices have weak pull-ups at the output	• No upper PMOS transistor • No pull-up resistor • No weak current drive

New Low Voltage GPIO Family

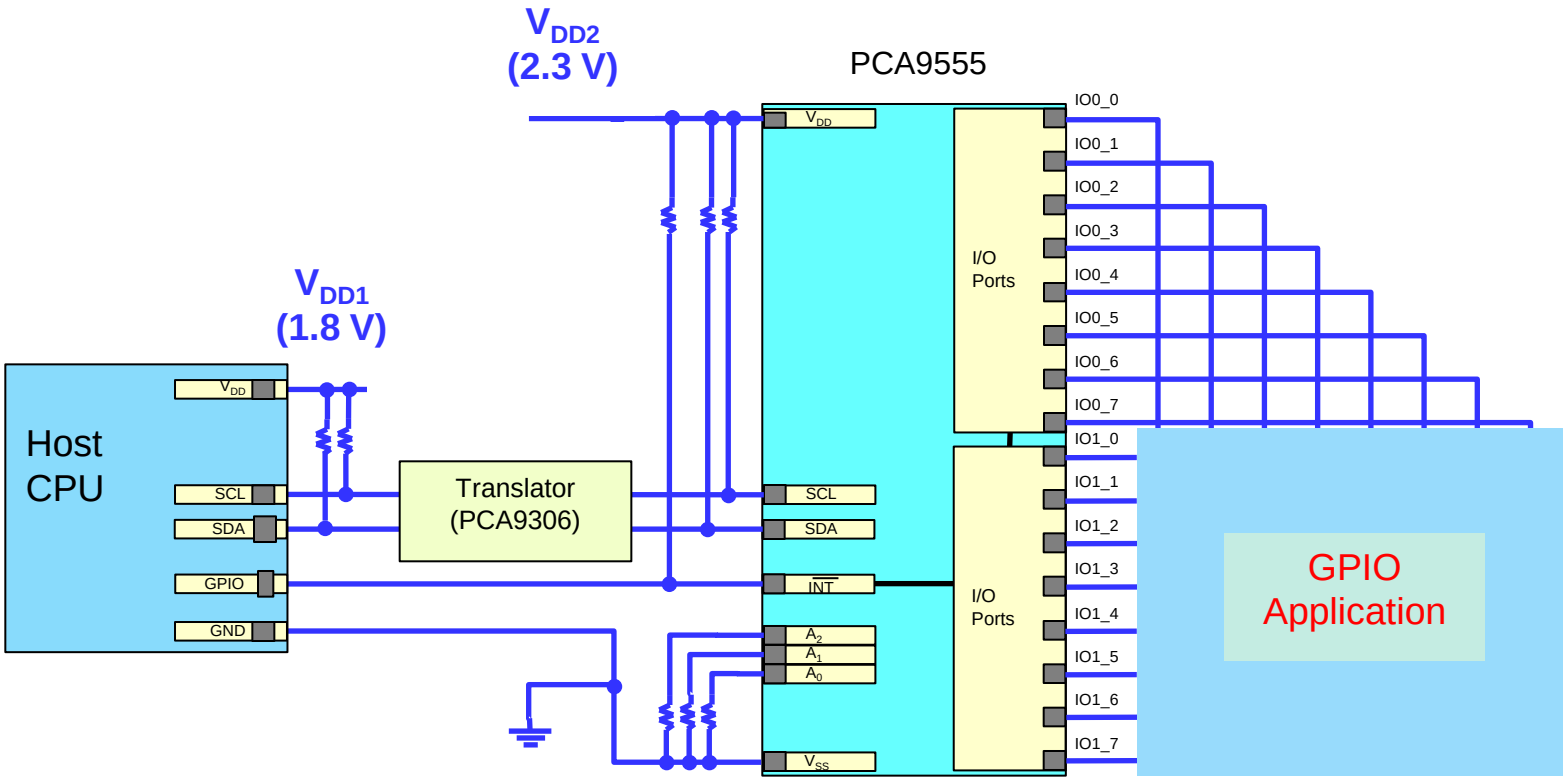
I²C | Storage SSD

Purpose

- Offer lower voltage GPIO that operate down to 1.65V but still operate up to 5.5V
- Offer new input latch and other new Agile IO features with “L” in part number
- Easy migration - Drop in replacement for existing PCA95XX GPIO

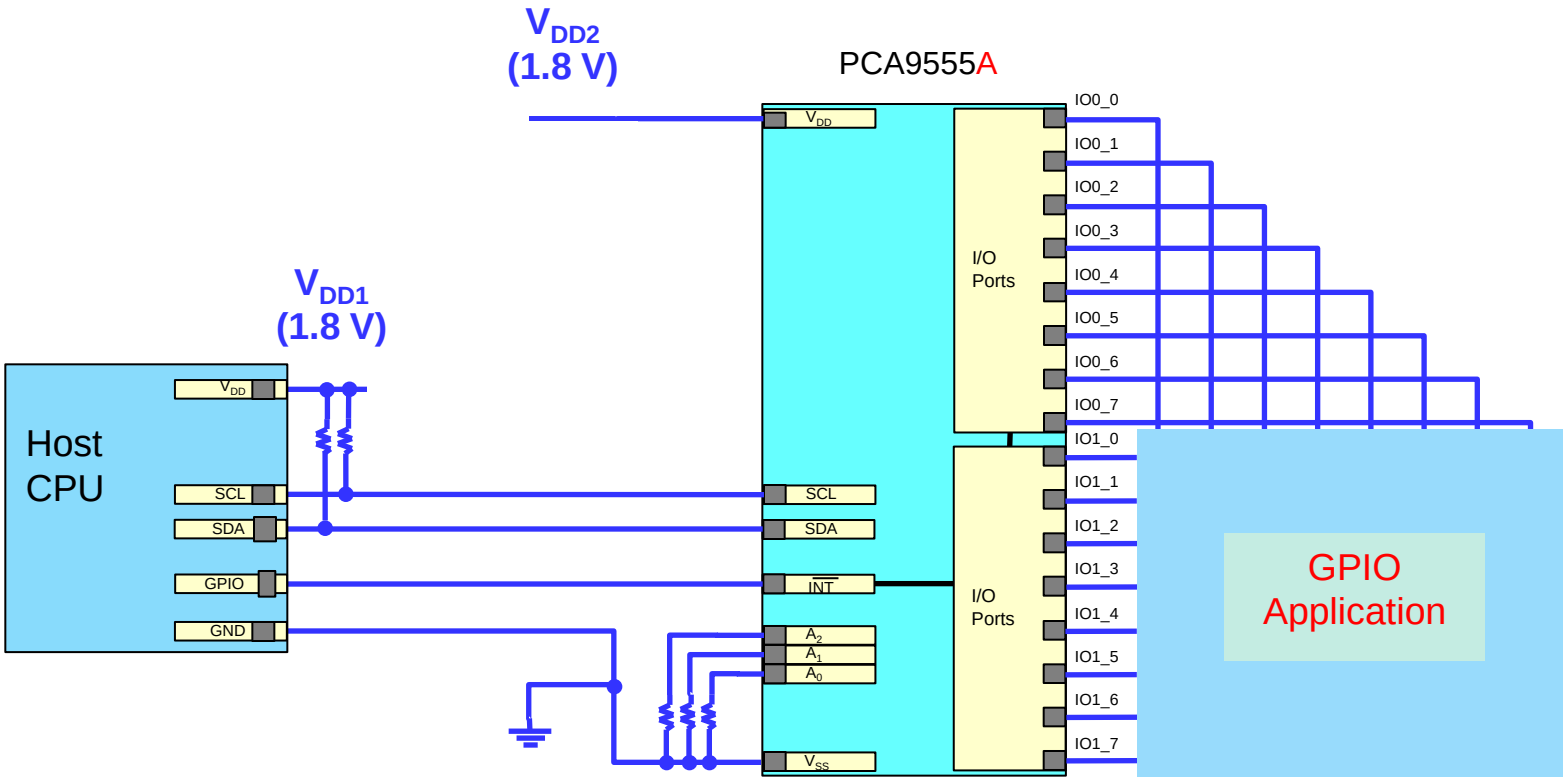
PCA Name	**Single Vcc**						**Two Vcc**	
Feature	INT & PU	INT	INT & RST	**INT & PU**	**INT**	**INT & RST**	INT & RST	**INT & RST**
				Input Latch	**Input Latch**	**Input Latch**		**Input Latch**
16 bit	PCA9555A	PCA9535A	PCA9539A	**PCAL9555A**	**PCAL9535A**	**PCAL9539A**	PCA6416A	**PCAL6416A**

Benefit of Lower V_{CC} and Wider V_{CC} Range



Lower V_{CC} to 1.65V on GPIO supply eliminates the need for a voltage translator like the PCA9306!

Benefit of Lower V_{CC} and Wider V_{CC} Range



Lower V_{CC} to 1.65V on GPIO supply eliminates the need for a voltage translator like the PCA9306 and second set of pull ups!

Features of the PCAL64xx IO Expanders

I²C | Storage SSD

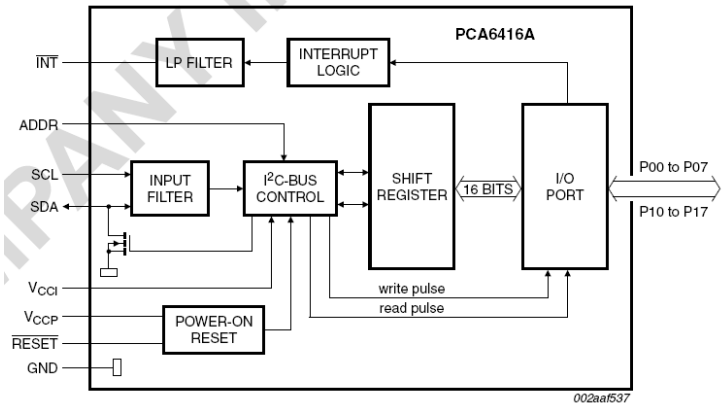
- GPIO are backwards compatible to existing GPIOs with new superset of registers to control the configurable features. The PCA64xxA and PCA95xxA devices will be drop in replacements while the PCAL64xxA and PCAL95xxA will offer these desirable features:
- GPIO input latch (bit by bit – default not latched):
  - Lock I/O pin changes on input until the register is read.
- GPIO output drive strength control (bit by bit – default 10 mA push and 25 mA pull):
  - User can program I/O drive strength 25%, 50%, 75% or 100%
  - This output can be used to control the brightness of LEDs.
- GPIO open drain control (24-bit bit by bit and 8 and 16-bit bank by bank – default push pull):
  - Provide an optional open-drain output for each I/O pin.
  - This output can also provide an additional wired-OR plane.
- GPIO pull up or pull down (bit by bit – default no PU/PD):
  - User can turn on/off an internal pull-up or pull down on each I/O pin.
- GPIO interrupt mask and interrupt status (bit by bit – default not masked):
  - User can enable or disable interrupts of each I/O pin.
  - Identifies the source of interrupts of each I/O pin.
- 5 state address pins to allow more devices on the bus (24 bit only)

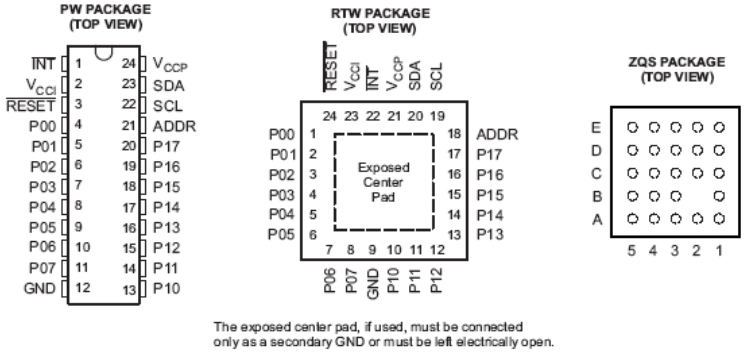
PCA6416A

Two Vcc Low-voltage, 16-bit I2C-bus I/O expander with interrupt output, reset, and configuration registers

Features

- Operating Power-Supply Voltage Range of 1.65 V to 5.5 V
- Low Standby Current Consumption of 3 uA Maximum
- Allows Bidirectional Voltage-Level Translation and GPIO Expansion Between 1.8, 2.5, 3.3 or 5 V SCL/SDA and 1.8, 2.5, 3.3, or 5 V Totem Pole configured I/O Port
- Schmitt-Trigger Hysteresis of 10% of SCL/SDA Supply Voltage
- Noise Filter on SCL/SDA Inputs
- Fast Mode I2C Bus Operating Frequency of up to 400-kHz
- Active-Low Reset Input
- Open-Drain Active-Low Interrupt Output
- 5-V Tolerant I/O Ports
- High current Drive for Directly Driving LEDs
- Input/Output Configuration Register
- Polarity Inversion Register
- Internal Power-On Reset
- Power-Up With All Channels Configured as Inputs
- No Glitch On Power-Up
- Package – 24 pin TSSOP, HWQFN and CSP
- Latch-Up Performance Exceeds 100 mA per JESD 78, Class II
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 1000-V Charged-Device Model (C101)

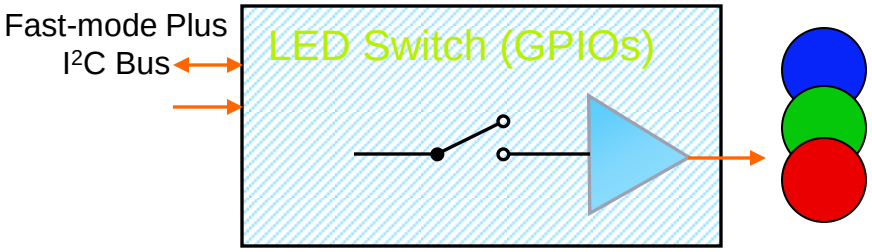




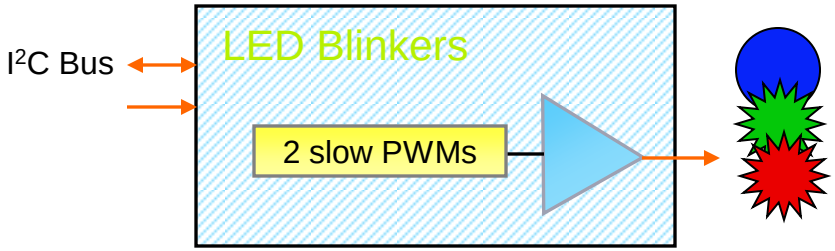
LED Controllers

I²C LED Switch, Blinkers, Dimmers, and Controllers

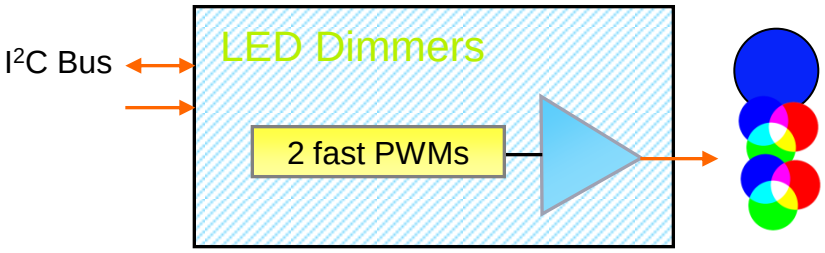
Product overview



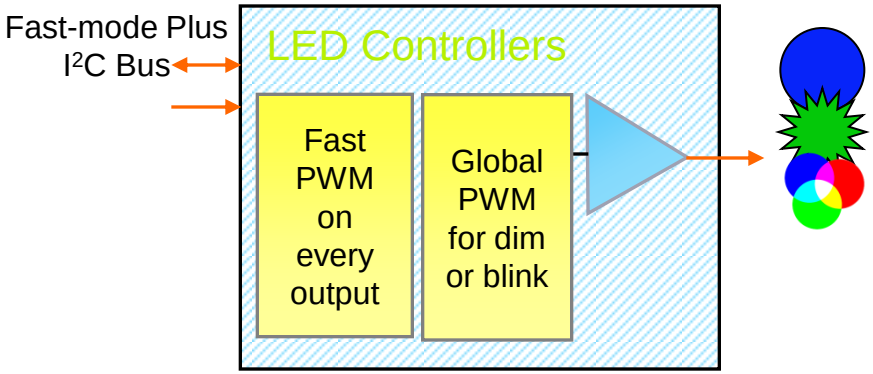
PCA967x family



PCA955x family

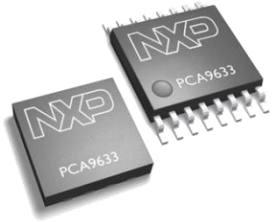


PCA953x family



PCA962x & 3x families

LED Controller Portfolio



I²C | Storage SSD

Part #	OUTPUT					FUNCTION		
	#of channel	VS	CC	VDD	IDD	Control I/F	PWM	Function
PCA9901	1		●	5 V	20mA	1-Wire	12 bit indiv	Blinker
PCA9922	8		●	5 V	60mA	Serial in/out	12-bit indiv	Blinker
PCA9550,3,1,2	2,4,8,16	●	-	5 V	25mA	400kHz Fm	8-bit Indiv	Blinker
PCA9530,3,1,2	2,4,8,16	●	-	5 V	25mA	400kHz Fm	8-bit Indiv	Dimmer
PCA9633,4,5*	4,8,16	●	-	5 V	25mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCA9632	4 (low power)	●	-	5 V	25mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCA9624,2,6	8,16,24	●	-	40V	100mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCA9685*	16	●	-	5 V	25mA	1 MHZ Fm+	12 bit indiv	Dimmer
PCA9952,5**	16	-	●	40V	57mA	1 MHZ Fm+	8-bit Indiv/global	Dimmer
PCU9654,5,6	8,16,24	●	-	40V	100mA	5 MHZ UFM	8-bit Indiv/global	Dimmer
PCU9955	16	-	●	40V	57mA	5 MHZ UFM	8-bit Indiv/global	Dimmer

Bus Buffers & Level Shifters

I²C Bus Buffer Portfolio

I²C | Storage SSD

Repeaters

- PCA9527 — PCA9507 + ½ PCA9517 — SO
- PCA9509 — Processor to SMBus — SO
- PCA9509A — Processor to SMBus — SO
- PCA9509P — Processor to SMBus — SO
- PCA9517A — 0.9 – to 5.5V — SO
- PCA9507 — RTA for HDMI — SO
- PCA9519 — 4 x PCA9509 — SO
- PCA9515/15A — SO
- PCA9518A — 5-Channel Hub Expander — SO
- PCA9525 — 3-mA Drive — NO
- PCA9605 — 30-mA Drive — NO
- PCA9646 — 30-mA Drive; 1:4-Channel — NO

Hot-Swap Buffers

- PCA9522[1] — IO
- PCA9508 — Active Level Shifter — SO
- PCA9512A/12B — Active Level Shifter — IO
- PCA9511A — 0.6-V Threshold — IO
- PCA9514A — 0.8-V Threshold — IO
- PCA9513A — 92-µA Current Source — IO
- PCA9510A — No Accelerator — IO

Extenders (Long Cable)
(Long Cable Drivers)

- P82B96 [2] — SO
- P82B715 — No Static Offset — AM
- PCA9600/9601 — 1-MHz Speed — SO

NO = No Offset
SO = Static Offset
IO = Incremental Offset
AM = Amplifier

[1] PCA9522 is compliant for ATCA applications
[2] P82B96 is widely used for opto-isolation applications
Red part = 1 MHz system

Level Translators Portfolio

I²C | Storage SSD

Active Level Shifter
- input & Output dual supply
- Capacitance Isolation
- High Noise Margins

PCA9527 SO
PCA9507 + ½ PCA9517

PCA9509/A/P SO
Processor to SMBus

PCA9517A SO
0.9 – to 5.5V

PCA9507 SO
RTA for HDMI

PCA9519 SO
4 x PCA9509

PCA9508 SO
Active Level Shifter

PCA9512A/12B IO
Active Level Shifter

Active level Shifter
- Single Supply
- Capacitance Isolation

P82B96 SO
2.2 – 15V

PCA9518A AM
2.3 – 5.5V

PCA9600/9601 SO
2.2 – 15V

PCA9522 IO
1.8 -10V w/HS

PCA9516A SO
2.3 – 5.5V

Passive Level Shifter
- No capacitance Isolation
- Low Power & Low Cost

PCA9306 NO
1 – 5.5V

GTL2002/03/10/00 NO
1 – 5.5V

NVT20xx NO
1 – 5.5V w low Ron

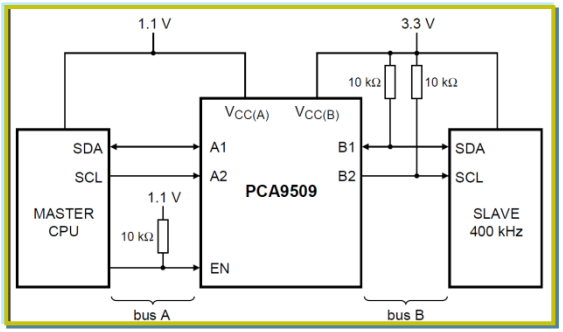
NO = No Offset
SO = Static Offset
IO = Incremental Offset
AM = Amplifier

Red text = 1 MHz system

Active Level-Shifter Value Proposition

I²C | Storage SSD

- **Why used?**
  - Voltage level shifting between host processor's I²C-bus and peripheral devices when there is a mismatch of supply voltages
  - Used when additional drive is needed or to isolate two sections of the bus loading
- **Where used?**
  - Digital logic level translation between host processor and slave device where **capacitance isolation is required**
- **Why NXP Level-Shifter?**
  - Largest selection of active and passive level shifters
  - Continuous innovation with new NXP voltage follower and zero-offset active buffers



Device	Description	Normal I/O	Static Level Offset I/O	Accelerator	Idle Stop Detect for Hotswap	Interrupt	ESD (HBM)
PCA9507	2.7V-to-5.5V Level Shifter	A Side	B Side	× (A-Side)			5KV
PCA9508	0.9V-to-5.5V Level Shifter with Offset Free Hot-Swap	A Side	B Side		×		6KV
PCA9509	1.0V-to-5.5V Level Shifter	B Side	A Side				2KV
PCA9515A	3.3V / 5.0V I²C-Bus Repeater		A & B Sides				2KV
PCA9516A	5-Channel I²C Bus Hub		A & B Sides				2KV
PCA9517A	0.9V-to-5.5V Level Shifter	A Side	B Side				5KV
PCA9518A	5-Channel I²C Bus Hub Expander		A & B Sides				2KV
PCA9519	1.1V-to-5.5V Quad Level Shifter	B Side	A Side				2KV
PCA9527	3.0V-to-5.5V Level Shifter	A Side	B Side	× (A-Side)		×	8KV
PCA9617	0.8V-to-5.5V Level Shifter	A Side	B Side				5KV

PCA9509 0.95V-to-3.3V/5V Level Shifting Buffer

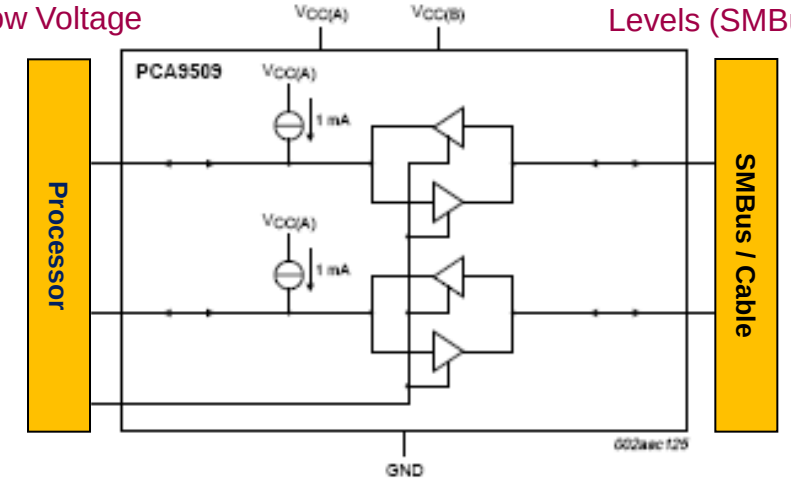
I²C | Storage SSD

Features

- Bidirectional level shift between 0.95V and 3.3V/5V without directional control pin
- Isolates noise and bus capacitance
- Support dual Vcc(A) and Vcc(B)
  - Vcc(A) ranges from 0.95V to Vcc(B)-1V
  - Vcc(B) ranges from 3V to 5.5V
- Low static level offset (200mV) on A side
- No external pull-up required on A side due to internal current source
- MSOP8 and 1.6 x 1.6 “GM” package
- ESD
  - 2000 V HBM per JESD22-A114
  - 200 V MM perJESD22-A115
  - 1000 V CDM per JESD22-C101

A-Side Static Offset Low Voltage

B-Side Normal I²C Levels (SMBus/5V)



Ideal for 1.0 V ± 5% master controlling 3.3V/5V slave or vice-versa

Passive Level-Shifter Value Proposition

I²C | Storage SSD

- **Why used?**
  - Voltage level shifting between host processor's I²C-bus peripheral devices when there is a mismatch of supply voltages
  - Used when additional drive is not needed and capacitive loading is not an issue
- **Where used?**
  - Digital logic level translation between host processor and slave device; **no direction control and no capacitance isolation are required**
  - Applications requiring open-drain bidirectional or unidirectional voltage translation (down to 1V) without a direction pin
- **Why NXP Passive Level-Shifter?**
  - Largest selection of active and passive level shifters
  - Continuous innovation with new NXP Voltage Translation family (NVT20xx) in widths of **1, 2, 3, 4, 6, 8 and 10 bits**
- **NXP Passive Level-Shifter Portfolio**

Device	Description	R_{ON}	Process	ESD (HBM)
PCA9306	2-Bit Bidirectional Voltage-Level Translator	3.5 Ω	CMOS	2kV
GTL2002	2-Bit Bidirectional Voltage-Level Translator	6.5 Ω	BiCMOS	>2kV
GTL2003	8-Bit Bidirectional Voltage-Level Translator	6.5 Ω	BiCMOS	>2kV
GTL2010	10-Bit Bidirectional Voltage-Level Translator	6.5 Ω	BiCMOS	>2kV
GTL2000	22-Bit Bidirectional Voltage-Level Translator	6.5 Ω	BiCMOS	>2kV
NVT2001/02/03/04/ 06/08/10	x-Bit Bidirectional Voltage-Level Translator	3.5 Ω	BiCMOS	>4kV

PCA9306

Bidirectional I²C-Bus & SMBus Level Translator

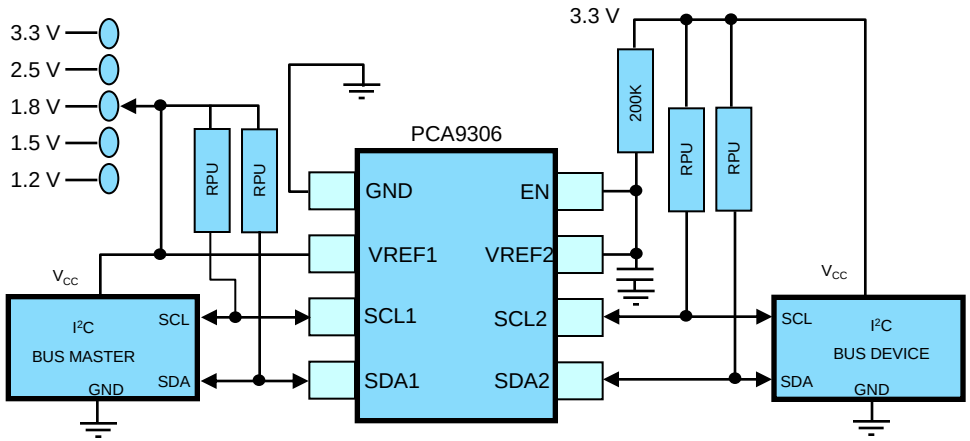
I²C | Storage SSD

Features

- Bi-directional without need for direction pin
- Voltage translation between any voltage from 1.0 V to 5.5 V
- Lock-up free operation for isolation when EN = LOW
- Mixed-mode I²C-bus application: run two buses, one at 400 kHz other at 100 kHz operating frequency
- Excellent ESD performance

Applications

- Voltage Level Translation
  - Mixed-mode I²C-Bus Applications

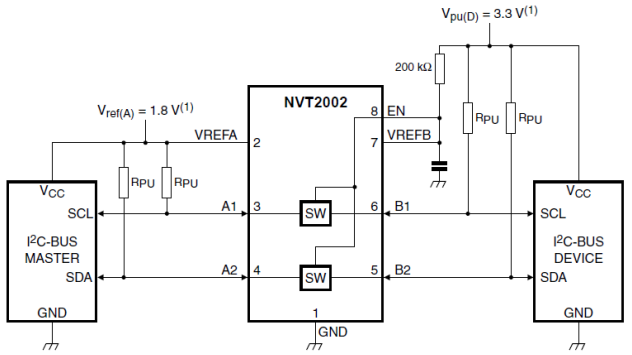


NVT20xx: Level Translator Family

I²C | Storage SSD

- **Where used?**
  - Digital Logic level translation
  - TI's PCA9306 is drop-in replacement for NXP GTL2002 and PCA9306
- **Why used?**
  - Voltage level shifting in range of 1V and 5V
  - Bi-directional without direction pin
- **Why NXP NVT 20xx Level Shifter?**
  - More consistent device naming - NVT means "NXP Voltage Translator"
    - NVT2001 – 1-bit
    - NVT2002 – 2-bit (alt source GTL2002)
    - NVT2003 - 3-bit
    - NVT2004 – 4-bit
    - NVT2006 – 6-bit
    - NVT2008 – 8-bit (alt source GTL2003)
    - NVT2010 – 10-bit (alt source GTL2010)
  - In TSSOP and smaller packages
  - Can be used as FET replacement
  - Continuous innovation from NXP

# CH	New	OLD	Usage
1	NVT2001	--	Clock
2	NVT2002 PCA9306	GTL2002	I²C
3	NVT2003	--	I²C, server
4	NVT2004	--	SPI
6	NVT2006	--	
8	NVT2008	GTL2003	Digital RGB
10	NVT2010	GTL2010	Data Bus
22	--	GTL2000	



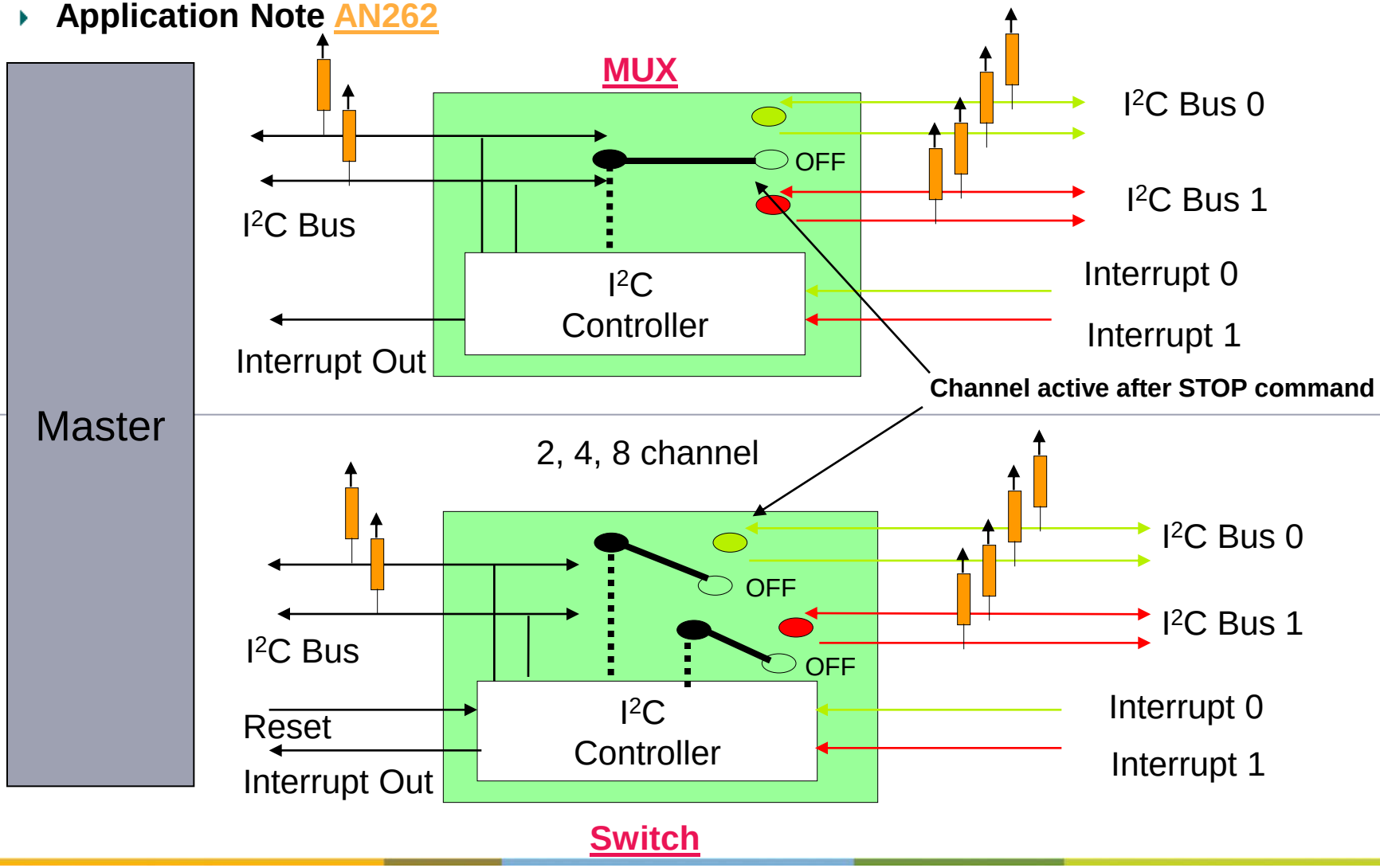
(1) The applied voltages at $V_{ref(A)}$ and $V_{pu(D)}$ should be such that $V_{ref(B)}$ is at least 1 V higher than $V_{ref(A)}$ for best translator operation.

Typical application circuit (switch always enabled)

Multiplexers, Demultiplexers & Switches

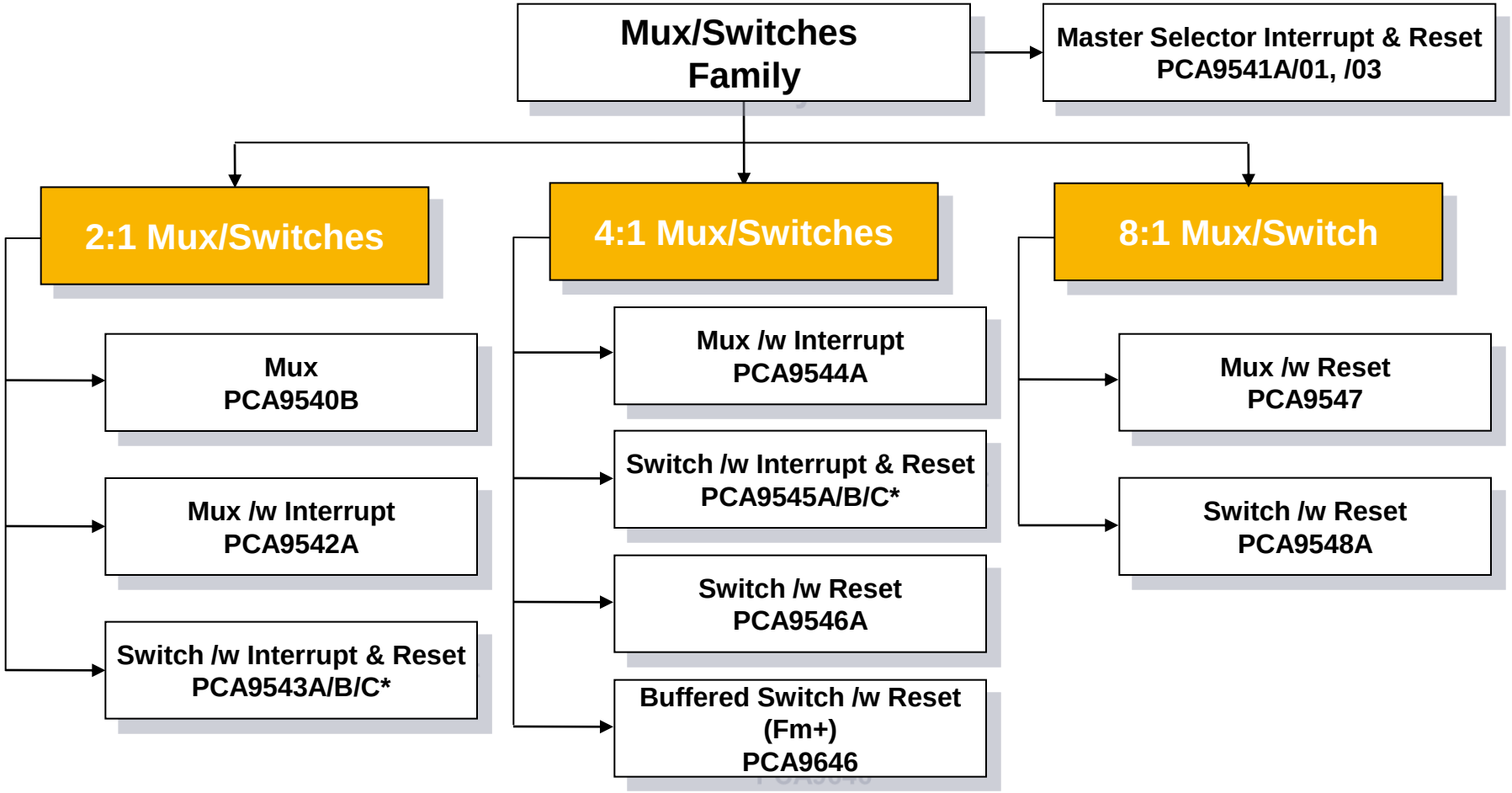
What are Multiplexers and Switches

- **Application Note AN262**

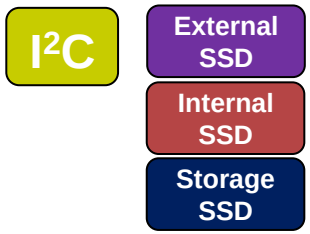


Multiplexer / Switch Family

I²C | Storage SSD



* Note: A, B, and C have different I²C fixed address



Temperature Sensors

Temperature Sensors Value Proposition

I²C

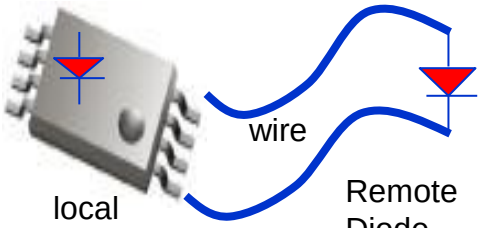
External SSD

Internal SSD

Storage SSD

- **Where used?**
  - Networking platforms, Backplanes, Notebook and Tablets
- **Why used?**
  - Determine the temperature
  - Set window for Interrupt, alarm, fan control, shutdown, etc.
- **Why NXP Thermal Sensor?**
  - Large selection of commonly used local sensor and local/remote sensor thermal sensors in a wide range of packages
  - Invented the I²C-bus. Continuously developing newer devices with added features to support different applications.
  - Continuous innovation with new low price LM75B local sensor in small 2 x 3 mm package

Part #	Accuracy	SMBus Timeout
LM75A / 75B	±2 ˚C	A = No; B = Yes
SE95	±1 ˚C	No
SE98A	±1 ˚C	Yes
SE97B*	±1 ˚C	Yes



Part #	Local Sensor Accuracy	Remote Sensor Accuracy
NE1617A	±2 ˚C	±3 ˚C
NE1619**	±3 ˚C	±5 ˚C
SA56004	±2 ˚C	±1 ˚C

Note: * With 2Kbit EEPROM; ** With voltage monitors

Temp Sensor in SSD Applications

I²C

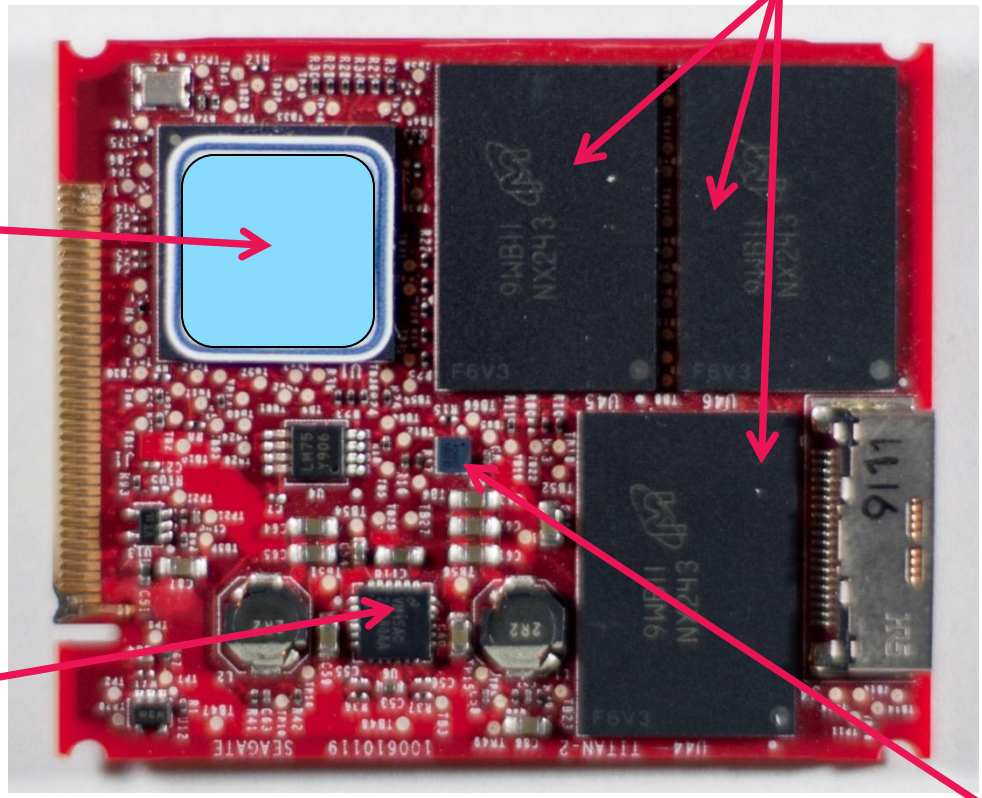
External SSD

Internal SSD

Storage SSD

High Density
Memory Array (Flash)

Power-hungry
Controller



High current
Switched-mode
Power Supply

Temp Sensor for thermal management

Thermal Sensor Portfolio

I²C

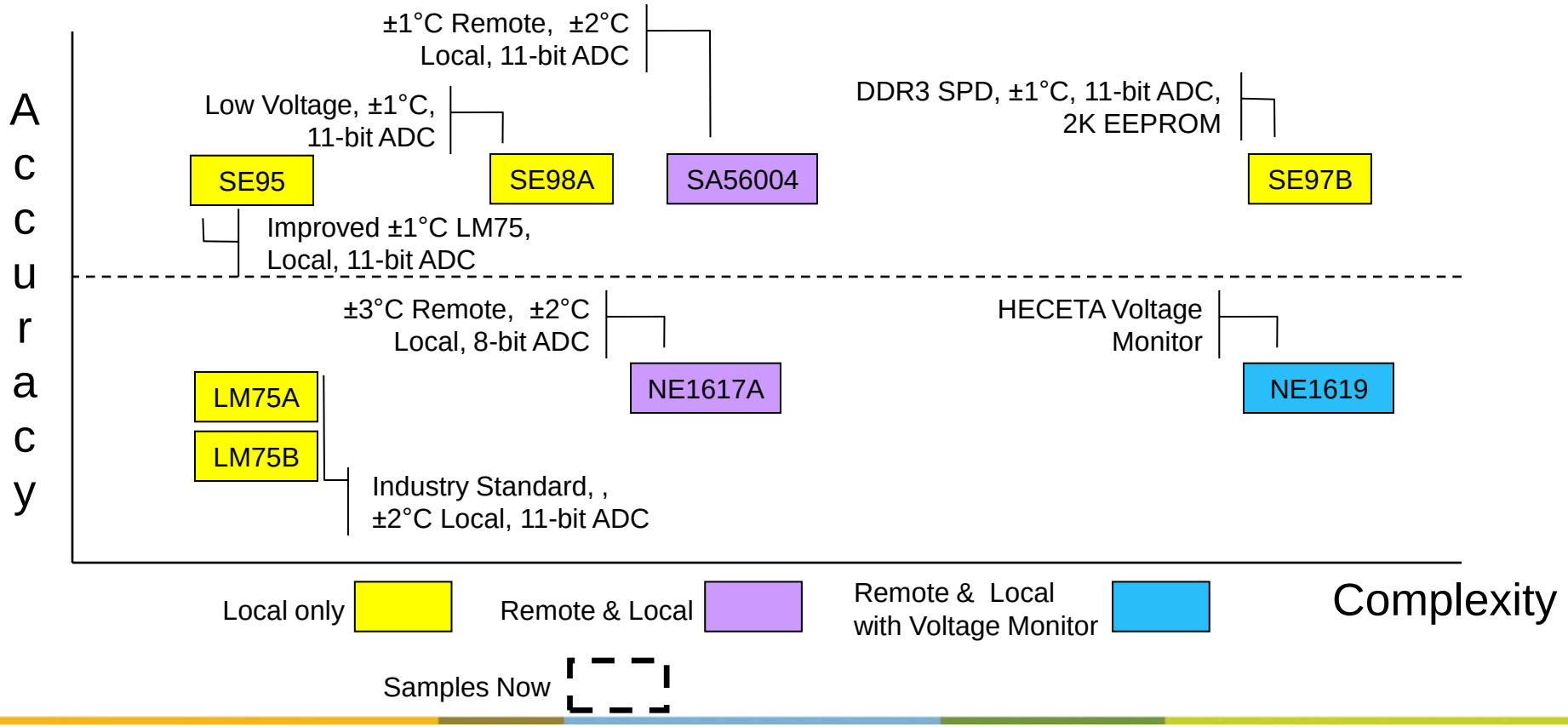
External SSD

Internal SSD

Storage SSD







NXP Temp Sensor Selection Table

I²C | External SSD | Internal SSD | Storage SSD

Part Number	Local Channels	Remote Channels	Accuracy Local (max)	Accuracy Remote (max)	Temp Resolution / A/D Resolution Bits	Power Supply Voltage Range	Supply Current Operating uA	Supply Current Standby uA	Package Option
LM75A	1		±2°C		0.125/11	2.8-5.5	1000	3.5	SO8 TSSOP8
LM75B	1		±2°C		0.125/11	2.8-5.5	300	1	SO8, TSSOP8 XSON8, HWSON8
SE95	1		±1°C		0.125/11	2.8-5.5			SO8, TSSOP8
NE1617A	1	1	±2°C	±3°C	1.0/8	3.0-5.5	70	3.0	QSOP16
NE1619	1	1*	±3°C	±5°C	1.0/8	2.8-5.5	500	100	QSOP16
SA56004	1	1	±2°C	±1°C	0.125/11	3.0-5.5	500	10	SO8, TSSOP8, HVSON8
SE97B	1		±1°C		0.125/11	3.0-3.6	400	3	HWSON8
SE98A	1		±1°C		0.125/11	1.7-3.6	400	5	TSSOP8, HWSON8

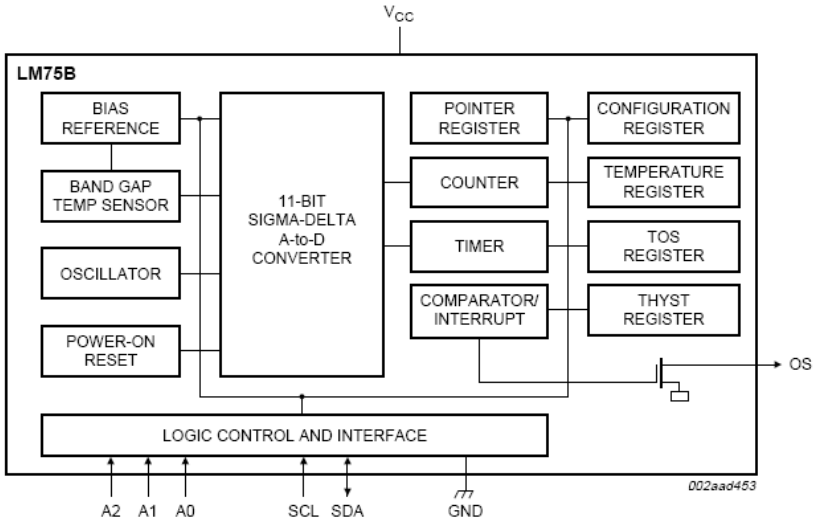
*** NE1619 monitor different power supplies: 12 V, 5 V, 3.3 V, 2.5 V, VCCP, VDD**

LM75B
Local Digital Temp. Sensor & Thermal Watchdog

I²C | External SSD | Internal SSD | Storage SSD

Features

- Pin-for-pin replacement for industry standard LM75 and LM75A
- I²C-bus interface - 8 devices on the same bus
- Power supply range from 2.8 V to 5.5 V
- Temperatures range from -55 °C to +125 °C
- Frequency range 20 Hz to 400 kHz with bus fault time-out to prevent hanging up the bus
- 11-bit ADC - temperature resolution of 0.125 °C
- Temperature accuracy of:
  - ±2 °C from -25 °C to +100 °C
  - ±3 °C from -55 °C to +125 °C
- Programmable temperature threshold and hysteresis set points
- Max supply current of 1.0 µA in shutdown mode
- Stand-alone 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, XSON8, & HWSON8



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 × 2 × 0.5 mm	SOT996-2
LM75BTP	M75	HWSON8	plastic thermal enhanced very very thin small outline package; no leads; 8 terminals, 2 × 3 × 0.8 mm	SOT1069-2

Bridges

What is a Bridge IC?

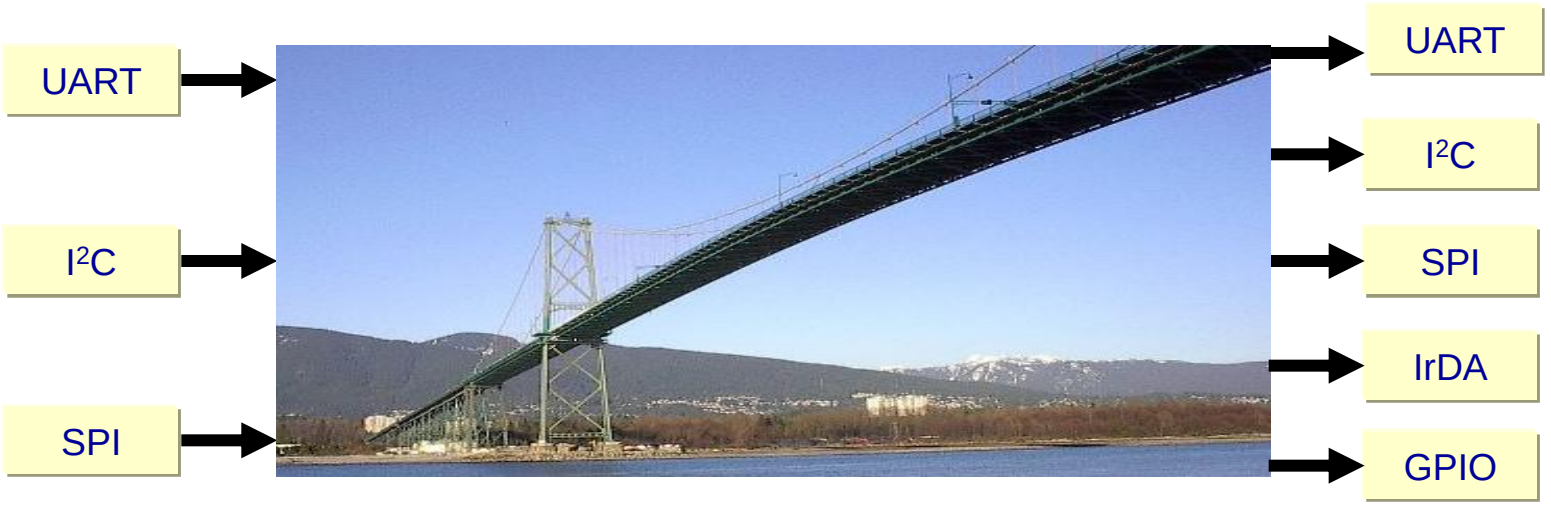
- New generation of interface solutions for managing communication among various bus interfaces
- The purpose is to overcome the limitations of the host bus interface to the peripherals

- Benefit :
  - Greater design flexibility
  - Ability to retain original design investment
  - Faster time to market
  - Link legacy and new systems and vice versa

NXP Bridges Value Proposition

I²C | Storage SSD

- **Why used?**
  - To provide an extra serial port, a SPI or I²C controller.
  - To bridge between two different buses: SPI to I²C, I²C to SPI, etc.
  - Three to five wires host interface connection
- **Where used?**
  - Telecommunication network routers, Servers, Blades
- **Why NXP Bridges?**
  - Low cost, advanced low profile packages and easy to use solutions
  - Sample demo boards and sample software code or drivers are available
  - NXP offers extensive application support including on-line technical support: Interface.Support@NXP.com



Selecting a Bridge IC

I²C | Storage SSD

FROM \ TO	UART	I²C	SPI
UART		SC18IM700	
I²C	SC16IS740 SC16IS75x SC16IS76x SC16IS850L		SC18IS602B
SPI		SC18IS600	

I²C/SPI-to-UART Bridges

Part #	UART	FIFO	SPI	GPIO
SC16IS740	1	64	4Mbps	–
SC16IS750	1	64	4Mbps	8
SC16IS752	2	64	4Mbps	8
SC16IS760	1	64	15Mbps	8
SC16IS762	2	64	15Mbps	8
SC16IS850L	1	128	15Mbps	–

UART-to-I²C Bridge

Part #	UART	I²C	GPIO	CLK
SC18IM700	460.8kbps	400kHz	8	Int

SC16IS740IPW/Q900

- Fully featured standalone UART (IrDA) with I²C/SPI interface and 64byte FIFOs; -40°C to +85°C; TSSOP24; AEC-Q100 compliant automotive qualification

SPI-to-I²C Bridges

Part #	SPI	I²C	GPIO	CLK
SC18IS600	1Mbps	400kHz	4	Int

I²C-to-SPI Bridges

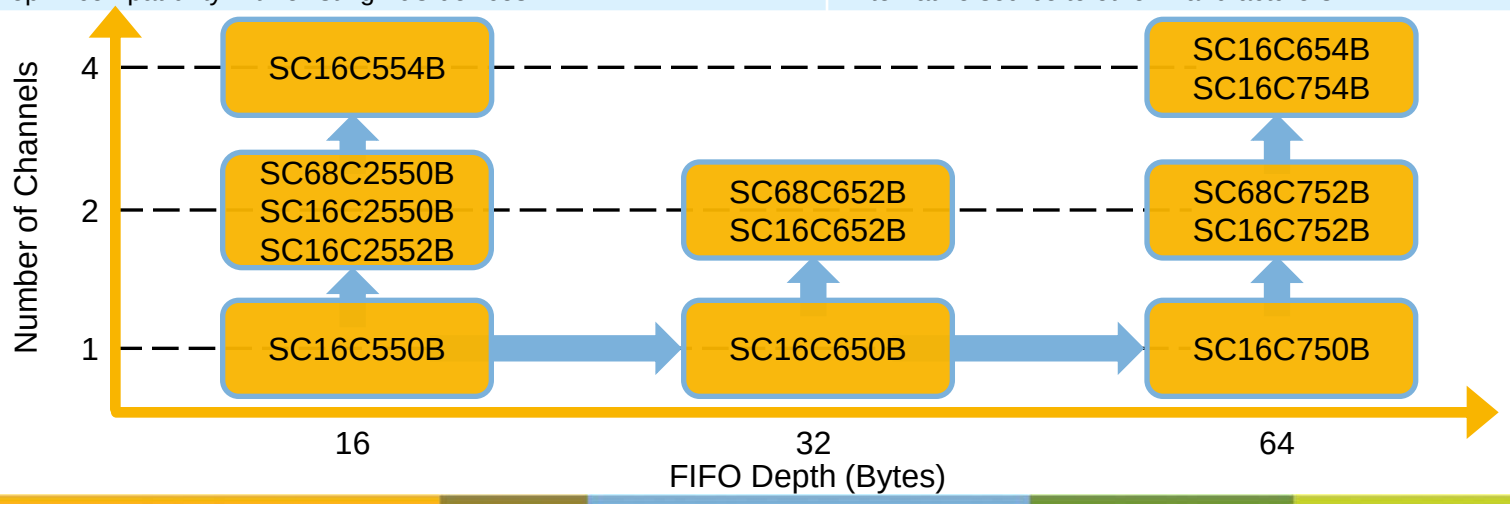
Part #	SPI	I²C	GPIO	CLK
SC18IS602B	1.8Mbps	400kHz	4	Int

UARTs

Commercial 16CxxxB UART Family

I²C | Storage SSD

Features	Benefits
Broad line of single to quad channel UARTs	One-stop shopping
Widest supply range (2.5V, 3.3V, 5V) at industrial temperature range (-40˚C to 85˚C) without price premium	Single part can be used for multiple systems and multiple operating environments. Lower overall cost of ownership – can replace up to four competitor parts.
Fastest device on the market with over 20% faster bus cycle times and baud rates up to 5Mbps	Compatible with high-speed processors
Power-down mode	Ideal for battery-operated systems
HVQFN and BGA package options	Ideal for small, portable systems
Windows and Linux OS-compatible	Simplifies software development
Infrared (IrDA) interface	Enables wireless, short-range applications
Software readily available	Shortens design cycle
Automatic software and hardware flow control	Reduces CPU overhead and data loss
DMA mode and wide variety of FIFO depths	Increases system throughput
Drop-in compatibility with existing 16C devices	Alternative source to other manufacturers

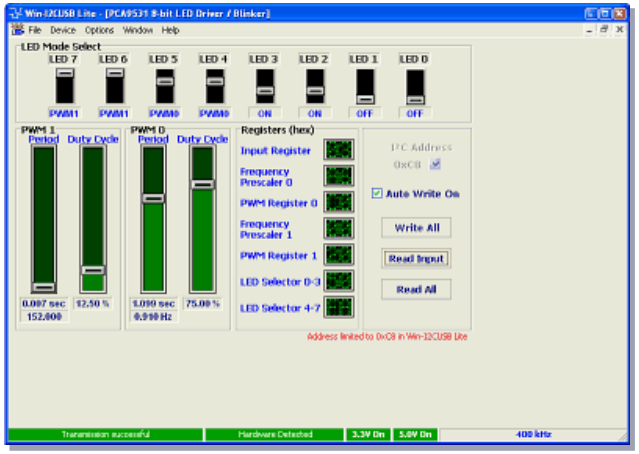


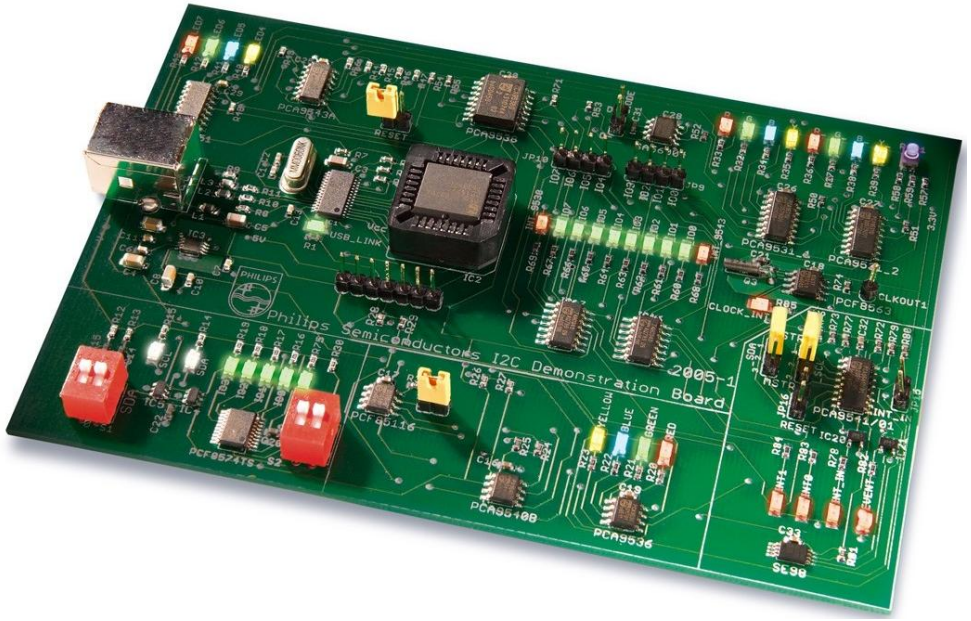
Support Tools

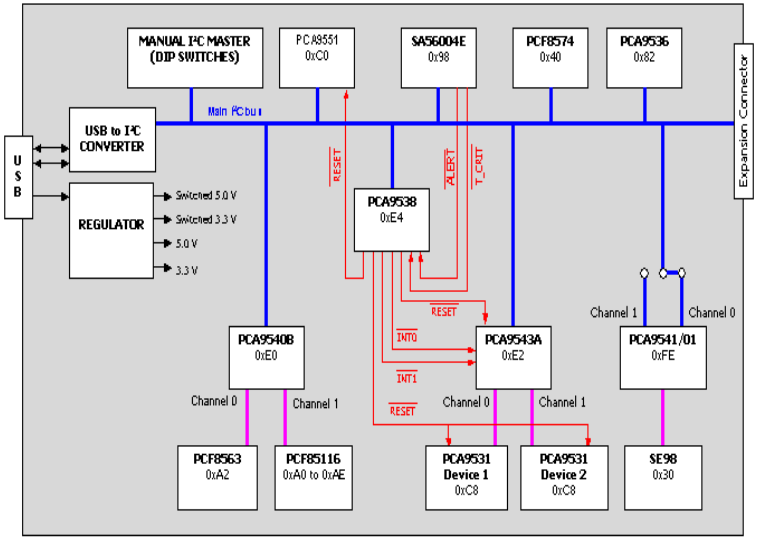
I2C2005-1 Demonstration Board Kit

Features

- Easy experimentation and training.
- I²C-bus I/O Ports, Temperature Sensors, LED Drivers, Real-time Clock daughter cards
- Use USB to Windows PC/Laptop GUI/power
- See details in User Manual
- Order kits at www.demoboard.com or eTools





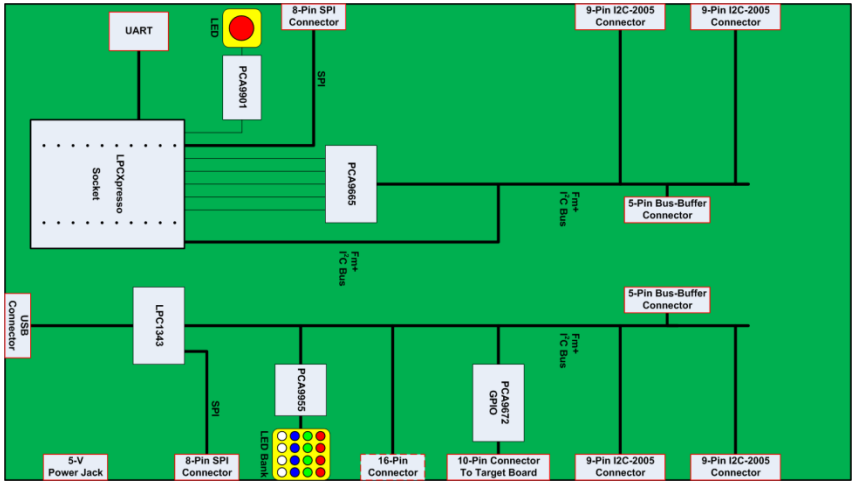


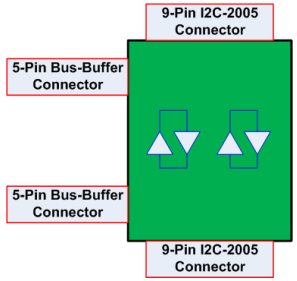
I²C Fm+ Development Kit

I²C

Features

- Modular evaluation board for Fast-mode Plus (Fm+) devices
- Easy experimentation and training board
- Used to develop software and evaluate device performance
- USB connections for direct control of device with GUI
- Standalone processor for developing code to control device
- Used in conjunction with associated daughter cards for GPIO Expanders, LED Controllers, Temperature Sensors, Bus Buffers, etc.
- Board in development



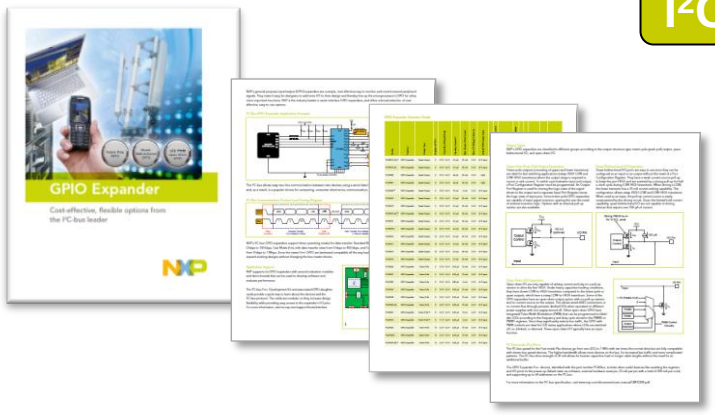


OM13224	PCF8574 8-bit GPIO Expander Daughter Card
OM13225	PCF8574A 8-bit GPIO Expander Daughter Card
OM13226	PCA8574 8-bit GPIO Expander Daughter Card
OM13227	PCA8574A 8-bit GPIO Expander Daughter Card
OM13228	PCA9500 8-bit GPIO Expander Daughter Card
OM13229	PCA9501 8-bit GPIO Expander Daughter Card
OM13230	PCA9536 4-bit GPIO Expander Daughter Card
OM13231	PCA9537 4-bit GP Expander Daughter Card
OM13232	PCA9534 8-bit G Expander Daughter Card
OM13233	PCA9538 8-bit Expander Daughter Card
OM13234	PCA9554 8-bit Expander Daughter Card
OM13235	PCA9554A 8 Expander Daughter Card
OM13239	Card
OM13240	Daughter Card
OM13241	Daughter Card
OM13242	Daughter Card
OM13243	Daughter Card
OM13244	Card
OM13245	Card
OM13246	Card
OM13247	PCF8575 16-bit GPIO Expander Daughter Card
OM13248	PCF8575C 16-bit GPIO Expander Daughter Card
	LM75B Temperature Sensor Daughter Card
	SA56004 Temperature Sensor Daughter Card
	SE97B Temperature Sensor Daughter Card
	SE98 Temperature Sensor Daughter Card
	PCA9531 8-bit Blinker/Dimmer Daughter Card
	PCA9551 8-bit Blinker Daughter Card
	PCA9552 16-bit Blinker Daughter Card

Daughter Cards may also be used with I2C-2005 Board

Sales Collateral

- I²C-bus device tri-fold
- I²C GPIO tri-fold
- High speed switches tri-fold
- LED controller tri-fold



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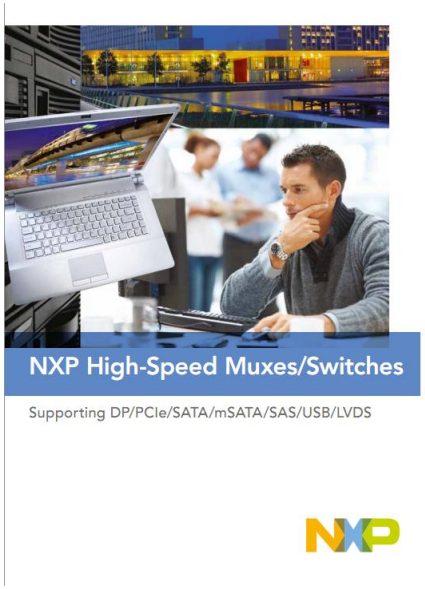

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Doc. # 9397 750 16950

Technical Contact

- Product Information: www.ics.nxp.com
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- E-mail: i2c.support@nxp.com