BL Interface Products
Portable Consumer Electronics

BL Interface Products
2012 Q4

NXP solutions for portable devices

As a global market leader we excite customers through:

- innovative and application specific solution for peripheral functions

- innovative audio solutions

- a richer consumer experience with secure transactions services and software

- offering a one stop shop for the customer by offering one of the most comprehensive standard product portfolio

- a secure and cost effective supply chain

Our Application focus in Mobile Devices:

Mobile Transactions

- Near Field Communication
- Security

SW

- Audio & Voice & Multimedia software

Audio

- Energy efficient SMART amplifiers

RF LNAs

- GPS, LTE, FM RF LNAs

HDMI

- HDMI Transceiver
- HDMI Interface conditioning

Interface products

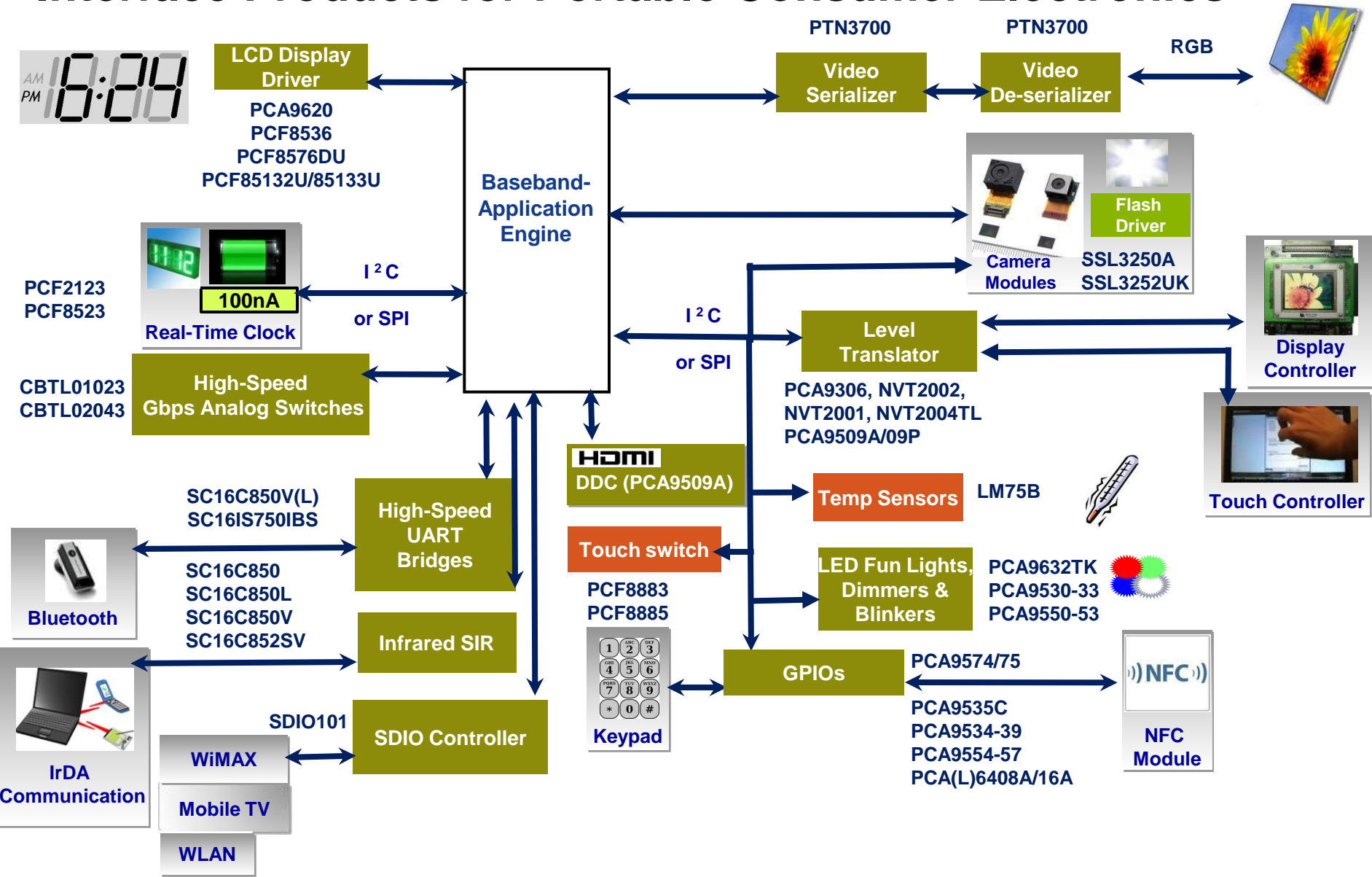- Flash, LED driver
- GPIO, I2C, UARTs
- Bridges, Switches

Logic

- Gates, Analog switches
- Voltage translators
- Load switches, Comperators

Discretes & Linear

- Discretes (D& T)
- EMI filters
- LDO & DCDC

Interface Products for Portable Consumer Electronics

LCD Display Driver

PCA9620
PCF8536
PCF8576DU
PCF85132U/85133U

PTN3700
Video Serializer

PTN3700
Video De-serializer

RGB

Baseband-Application Engine

Camera Modules

SSL3250A
SSL3252UK

Flash Driver

PCF2123
PCF8523
Real-Time Clock

100nA

I^2C or SPI

I^2C or SPI

Level Translator

PCA9306, NVT2002,
NVT2001, NVT2004TL
PCA9509A/09P

Display Controller

CBTL01023
CBTL02043
High-Speed Gbps Analog Switches

HDMI
DDC (PCA9509A)

Temp Sensors

LM75B

Touch Controller

SC16C850V(L)
SC16IS750IBS

SC16C850
SC16C850L
SC16C850V
SC16C852SV

High-Speed UART Bridges

Touch switch

PCF8883
PCF8885

LED Fun Lights, Dimmers & Blinkers

PCA9632TK
PCA9530-33
PCA9550-53

Bluetooth

Infrared SIR

Keypad

GPIOs

PCA9574/75

PCA9535C
PCA9534-39
PCA9554-57
PCA(L)6408A/16A

NFC Module

IrDA Communication

SDIO101

SDIO Controller

WiMAX

Mobile TV

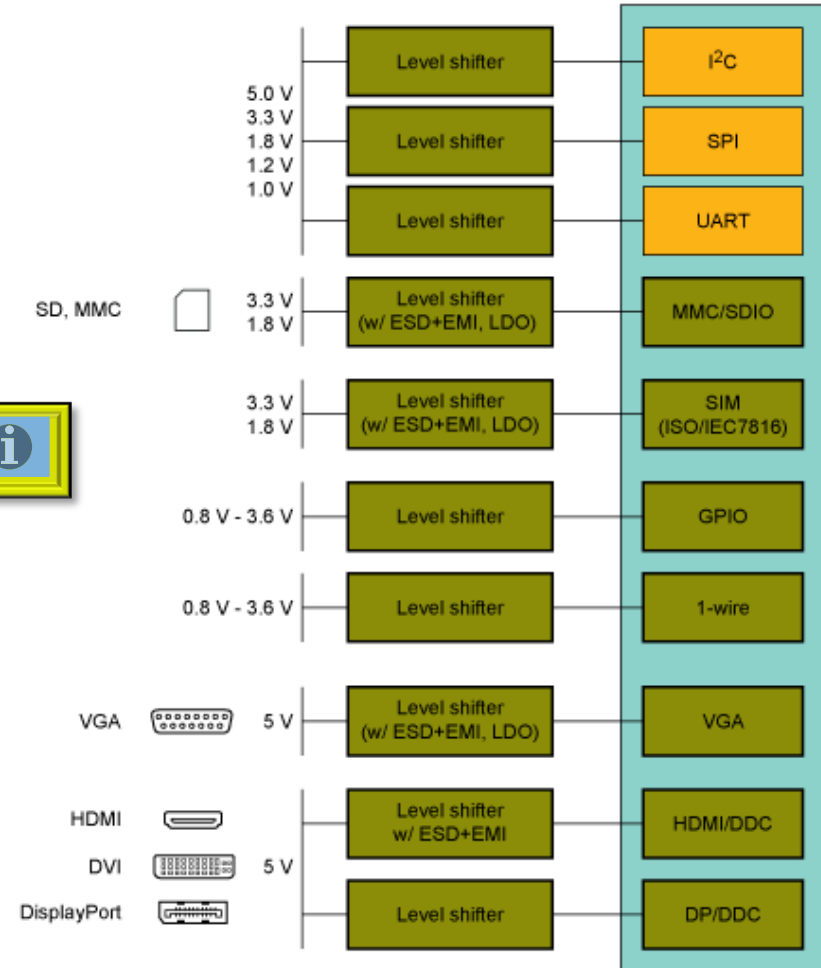**WLAN**

Sensors and Actuators   Power   Interface

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Level Shifters

Level/voltage translators

- We have a wide portfolio ranging from 1-wire up to multi wire auto sense

- Interface specific, optimized devices for popular interfaces available too!

On the web: ℹ️

Interface Products Level Shifters

NVT2001

1-bit Level Shifter for Clocks, Interrupt Lines

NVT2004 ⟷ Camera Module

4-bit Level Shifter for SPI

NVT2008 ⟷ Display

8-bit Level Shifter for RGB

I²C or SPI

1.8- 3.3V

I²C BUS

Display Subsystem

Haptic Vibrator	1.8\, 2.8V, 3.3V
Ambient Light Sens	1.8-3.3V
Touch Controller	1.8-3.3V
Display Driver	1.8-3.3V

HDMI 5V DDC
3.3V
5V

HDMI

HDMI level shifter

2-bit Level Shifter for I2C

Host Processor

I²C
2.4V or 1.8V

NVT2002 PCA9306 PCA9517A ⟵

I²C
3.3V or 5V

PCA9509A PCA9509P ⟵

I²C
0.8V

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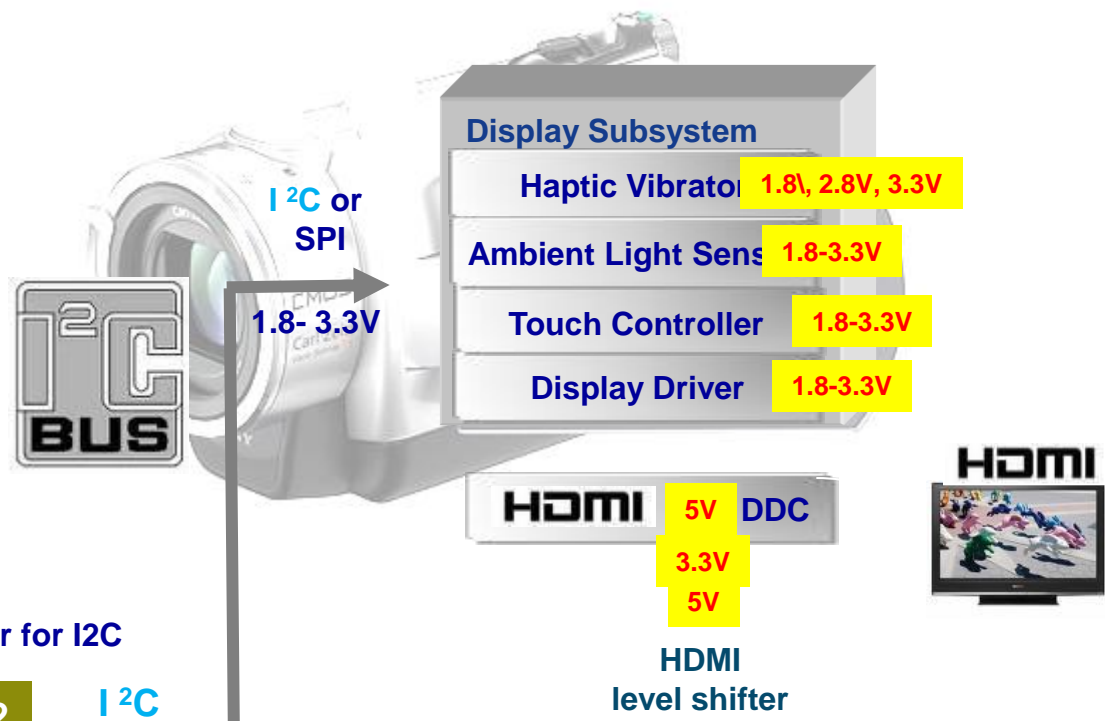
NXP's Level Shifters used in MHL Application
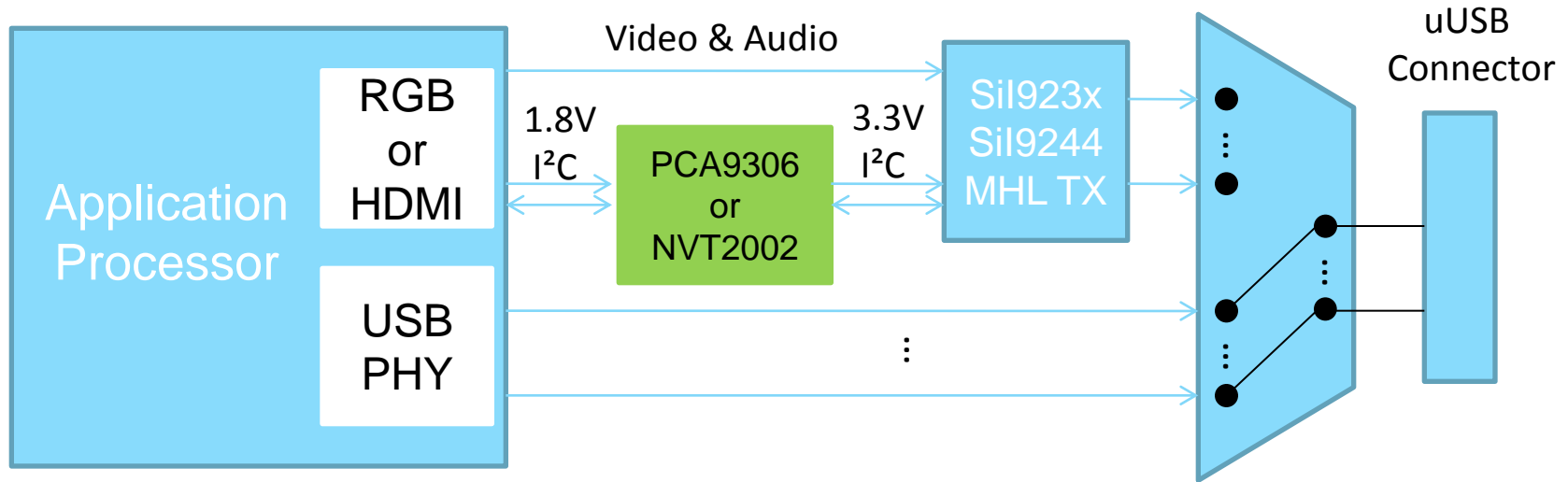
Why use NXP Level Shifters?

▸ Currently mobile phone and tablet PC platforms only provide 1.8V/2.6V or lower I2C-bus voltage level, but many touch panel controllers and display drivers are still at 3.3V bus level

▸ Support voltage level translation between 0.8V and 5.0V

▸ Bi-directional translator, no direction pin needed.

▸ Can support bus frequency from100 kHz up to 20MHz.

▸ Many mobile-friendly package choices including XQFN8 (1.6 x 1.6 x 0.5 mm) and XSON8U (1.35 x 1 x 0.5 mm)

▸ Simple schematics and peripheral devices

▸ Enable pin to control the connection and disconnection of the two sides

▸ Good performance with competitive price

NVT2002/PCA9306
Dual bidirectional I^{2}C-bus and SMBus voltage-level translator

▶ **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 I^{2}C-bus application: run two buses, one at 400 kHz other at 100 kHz operating frequency
- Excellent ESD performance

▶ **Applications**

- Voltage Level Translation
- Mixed-mode I^{2}C-Bus Applications
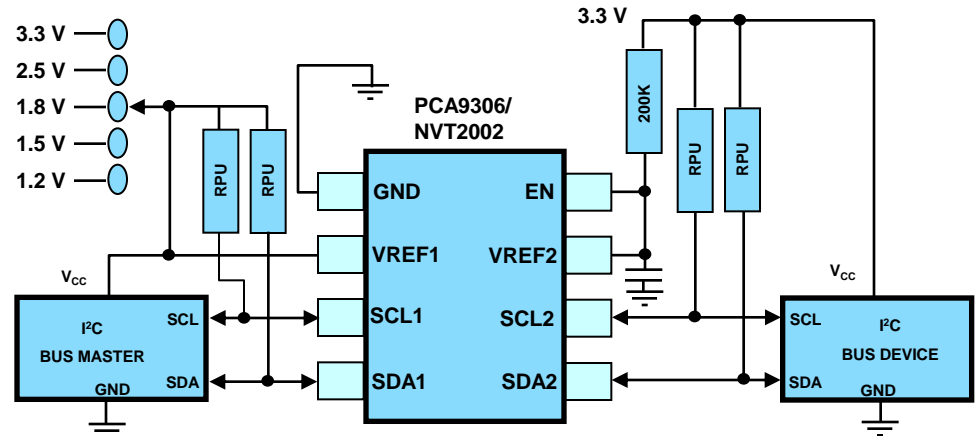
Difference between NVT2002 and PCA9306

- NVT2002 and PCA9306 have the same features and performance, except ESD performance:
  - ✓ NVT2002 is HBM 4KV, PCA9306 is HBM 2KV.

- Package availability:

	SO8	TSSOP8	TSSOP8	VSSOP8	VSSOP8	XSON8U	XSON8	XQFN8	HXSON8U
PCA9306	D	DP	DP1 [1]	DC	DC1 [2]	GD1[3]	GF[4]	GM	
NVT2002		DP				GD[3]	GF[4]	GM	TL
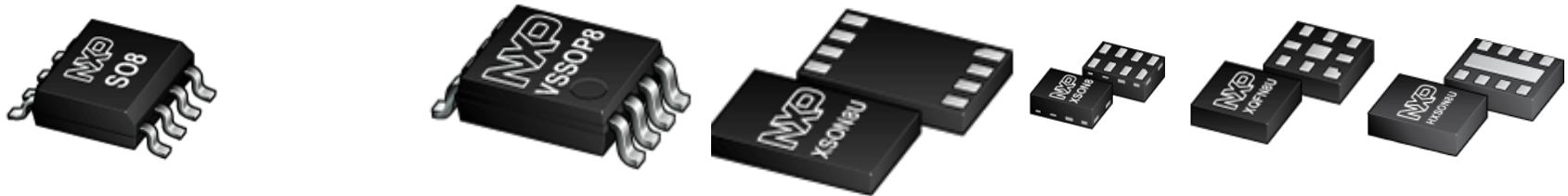
* D, DP, DP1, DC…are part number suffix.

[1] DP1 is the same footprint and pin-out to competitor DCT.

[2] DC1 is the same footprint and pin-out to competitor DCU.

[3] GD1 is drop-in replacement for competitor DC1/DCU

[4] GF package dimension: 1.35 x 1 x 0.5 mm

Small and Tiny, Mobile Friendly Packages
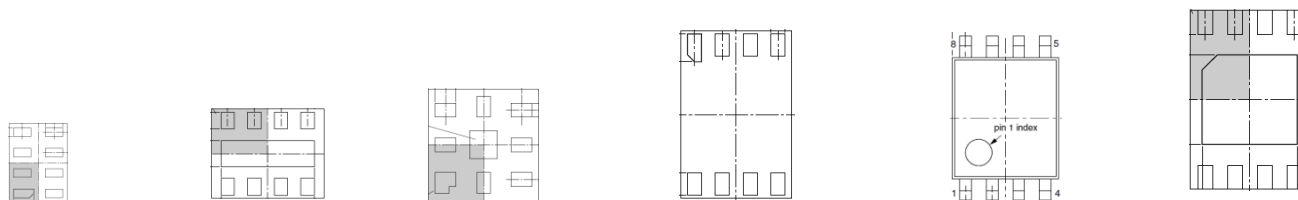
Package	XSON8	HXSON8U	XQFN8	XSON8U	VSSOP8	HWSON8
SOT	SOT1089	SOT983-1	SOT902-1	SOT996-2	SOT765-1	SOT1069-2
Suffix	GF	TL	GM	GD	DC	TP
Pitch (mm)	0.35	0.4	0.5	0.5	0.5	0.5
Width (mm)	1.35	1.7	1.6	3.0	2.3	3.0
Length (mm)	1.0	1.35	1.6	2.0	2.0	2.0
Height (mm)	0.5	0.5	0.5	0.5	1.0	0.8
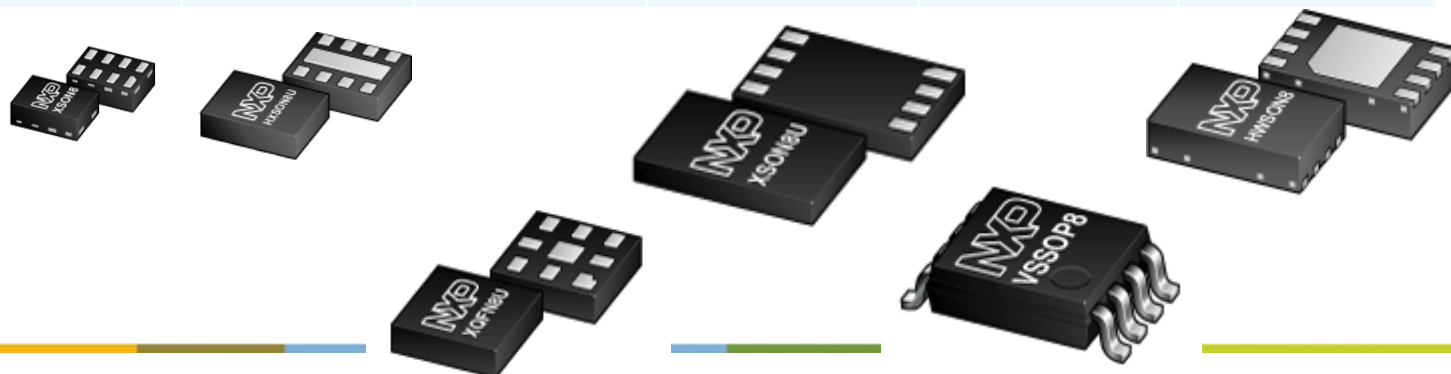
Comparison of NXP's I²C Level Shifters

▸ PCA9517A[2]: for standard I2C master to low voltage slave

▸ PCA9509A/09P[1]: for low voltage master to standard I2C voltage slave

▸ PCA9306 / NVT2002: for simple translation without capacitance isolation

FEATURES	PCA9517A	PCA9509A PCA9509P	PCA9306	NVT2002
Rise Time Accelerator	NO	NO	NO	NO
Idle/Stop Detect for Hot-swap	NO	NO	NO	NO
Noise/offset Isolation	YES	YES	NO	NO
Capacitance Isolation	YES	YES	NO	NO
VCCA or VCC supply range	0.9V – 5.5V	0.8V to 1.5V	N/A	N/A
VCCB or VCC2 supply range	2.7V – 5.5V	2.3V - 5.5V	N/A	N/A
ESD HBM	5kV	2 kV	2kV	4kV

[1] PCA9509P same as PCA9509A except for deletion of current source on low voltage A Port
[2] PCA9517A is the high ESD drop in replacement for PCA9517
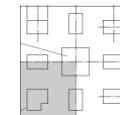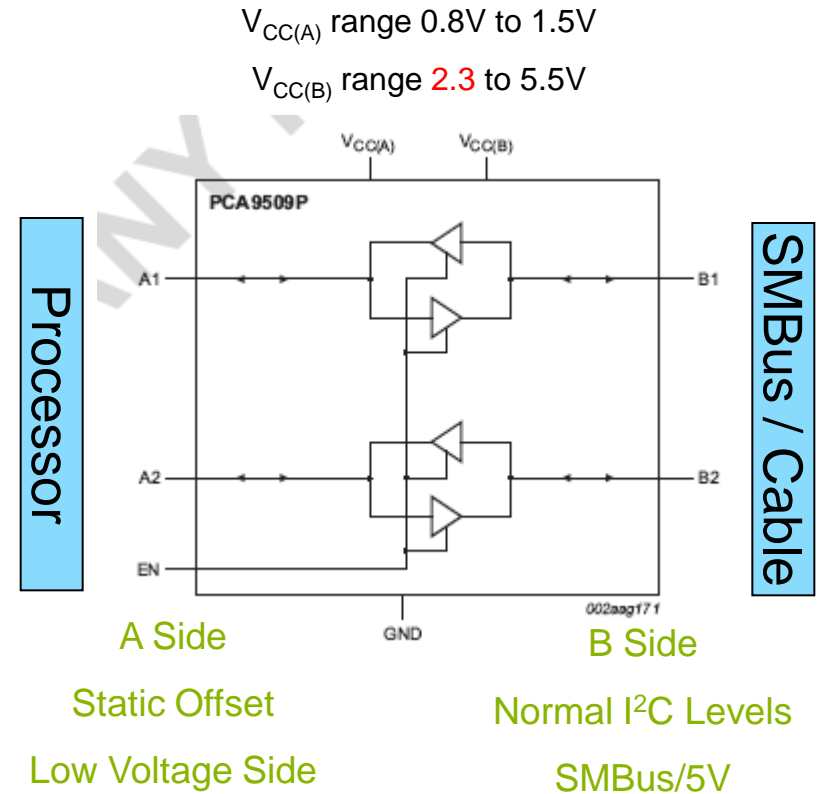
PCA9509A – 0.8 V to 2.5/3.3/5 V translator

- Bidirectional Voltage translation between 0.8 V – 1.5V and 2.3 – 5.5 V without directional pin

- Isolate bus capacitance

- ENABLE signal threshold controlled from 0.80 V side but is 5 V tolerant

- Ideal for 0.80 V master controlling 2.5/3.3/5 V slave or vice-versa

- No external pull-up required on the A-port due to internal current source. No additional components required.

- Much lower current consumption than PCA9509

- MSOP8 and XQFN8 package
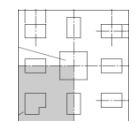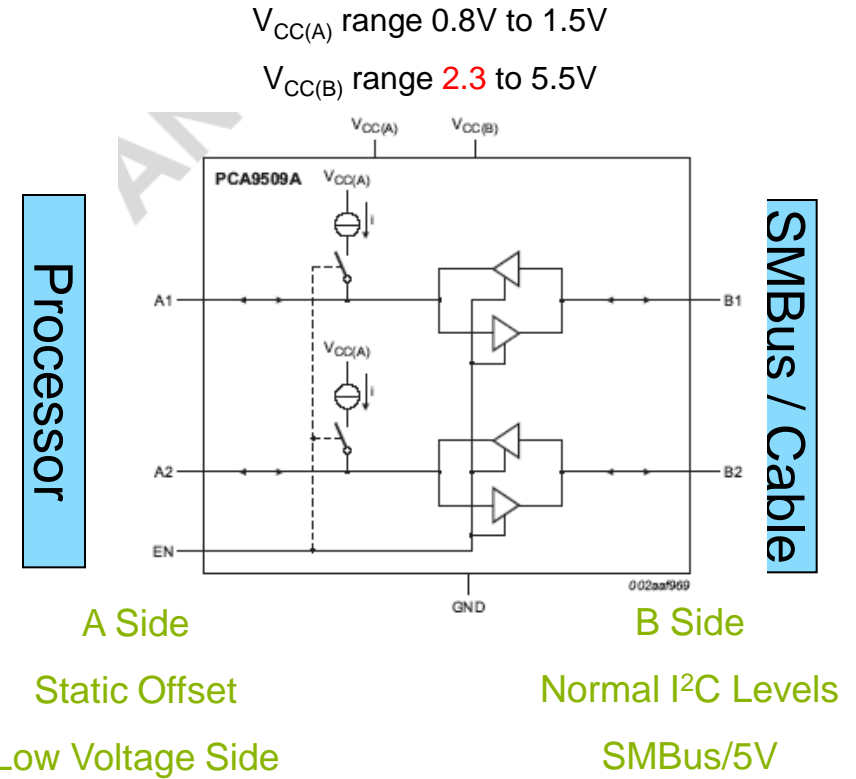
$V_{CC(A)}$ range 0.8V to 1.5V

$V_{CC(B)}$ range 2.3 to 5.5V

Processor

SMBus / Cable

PCA9509A

A1 — B1
A2 — B2
EN
GND

002aaf969

A Side   B Side

Static Offset   Normal I2C Levels

Low Voltage Side   SMBus/5V

Package	XQFN8
Pitch (mm)	0.5
Width (mm)	1.6
Length (mm)	1.6
Height (mm)	0.5

In Production

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PCA9509P – 0.8 V to 2.5/3.3/5 V translator

- ▶ Bidirectional Voltage translation between 0.8 V – 1.5V and 2.3 – 5.5 V without directional pin

- ▶ Isolate bus capacitance

- ▶ ENABLE signal threshold controlled from 0.80 V side but is 5 V tolerant

- ▶ Ideal for 0.80 V master controlling 2.5/3.3/5 V slave or vice-versa

- ▶ External pull-up required on the A-port due to no internal current source. Allows custom settings and lowest current consumption.

- ▶ Much lower current consumption than PCA9509A

- ▶ MSOP8 and XQFN8 package

$V_{CC(A)}$ range 0.8V to 1.5V

$V_{CC(B)}$ range 2.3 to 5.5V

A Side

Static Offset

Low Voltage Side

B Side

Normal I^{2}C Levels

SMBus/5V

Package	XQFN8
Pitch (mm)	0.5
Width (mm)	1.6
Length (mm)	1.6
Height (mm)	0.5

In Production

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PCA9509(A/P) – Comparison & Application

	PCA9509	PCA9509A	PCA9509P
A-Port - lowest voltage	0.95V with limitations	0.8V	0.8V
A-Port - current Source	Yes – 1 mA	Yes – 270 uA	No – external pull up
Operating current	< 6.1 mA	< 1.9 mA	< 0.95 mA
Standby current EN = low	< 2 mA	< 22 uA max	< 22 uA max
SO8 "D"	Yes	No	No
MSOP8 "DP"	Yes	Yes	Yes
XQFN "GM"	Yes	Yes	Yes

‣ The PCA9509A & P design has been changed to optimize current consumption and turn off the current mirrors when disabled, thereby substantially reducing the current drain

‣ **Use Recommendations** –

   ‣ The PCA9509A would be the recommended device for all applications.

   ‣ Use PCA9509P if an external A-Port pull up resistor is required to adjust current for noise margin considerations or to reduce operating current consumption even more.

   ‣ The PCA9509 should be used if instant on from disable is required and only if the processer is operating > 1.0V and standby current is not a concern.

GPIO

GPIO Expander Value Proposition

‣ **Why used?**
  – Easily **adds higher voltage I/O** via I²C-bus
  – Additional inputs for keypad and signal monitoring
  – Additional outputs for LED control and sensors.

‣ **Where used?**
  – Combats **"Feature Creep"** by expanding I/O port instead of new μC
  – Allows **seamless migration** to newer μC and still keeps the same peripherals
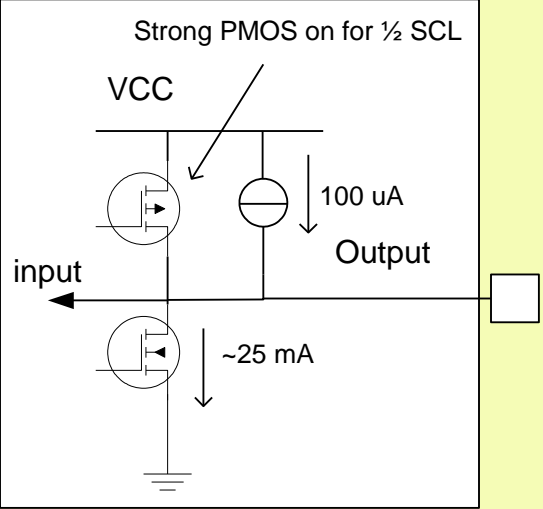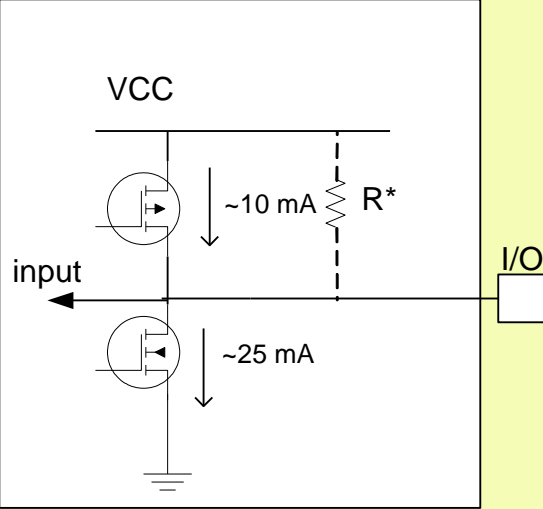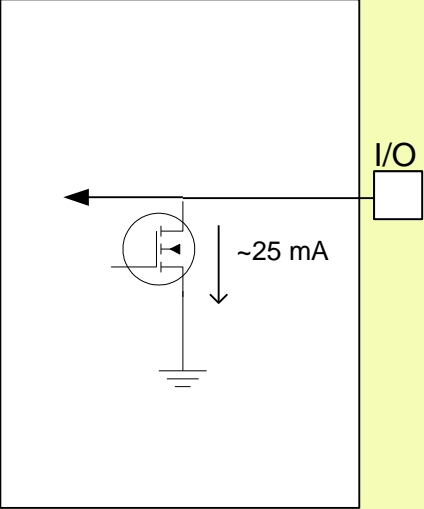 – **Eliminates costly congested PCB** since a trace or wire is not needed for each signal

‣ **Why NXP GPIO expanders?**
  – Largest selection of 4, 8, 16 and 40-bit GPIO in Quasi-bidirectional and Push-pull outputs with Interrupt and/or reset in small packages'
  – Wide selection of low power/low voltage (1.8V) GPIO expander portfolio suitable for mobile applications
 – Continuous innovation with new features

Microcontroller

**Keypad Control**

2-wire

Zoom-in view
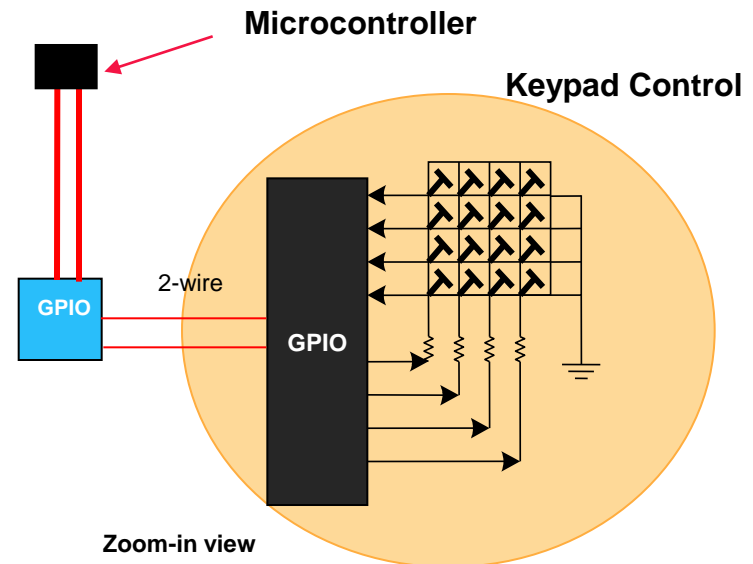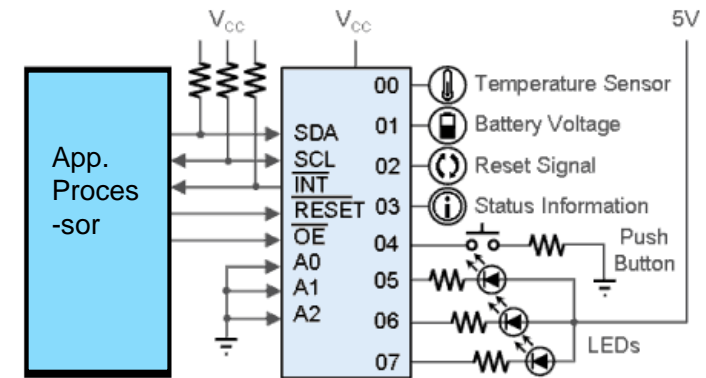
Flexible I/O (Output) Structures

Quasi Output	Totem-Pole Output	Open-Drain Output
Strong PMOS on for ½ SCL VCC input → 100 uA Output ~25 mA	VCC input → ~10 mA R* I/O ~25 mA	I/O ~25 mA
• **Strong PMOS transistor is turned on only during the LH transition** • **PMOS transistor is off during static drive** • **Weak current source at the output** • **Simple I2C command sequence**	• **Upper PMOS transistor is turned on during static high drive** • **Some devices have weak pull-ups at the output** • **Provide both high and low drive** • **Configure either as input or output**	• **No upper PMOS transistor** • **No pull-up resistor** • **No weak current drive** • **Prevent current leakage through protection diode**

Example Usage - GPIO in Phones and Tablets
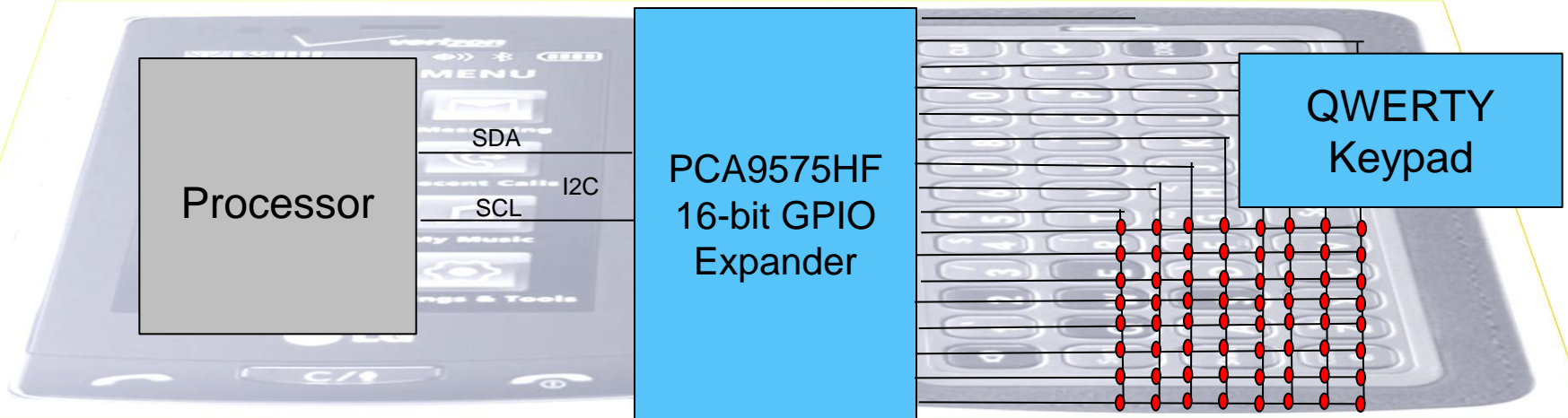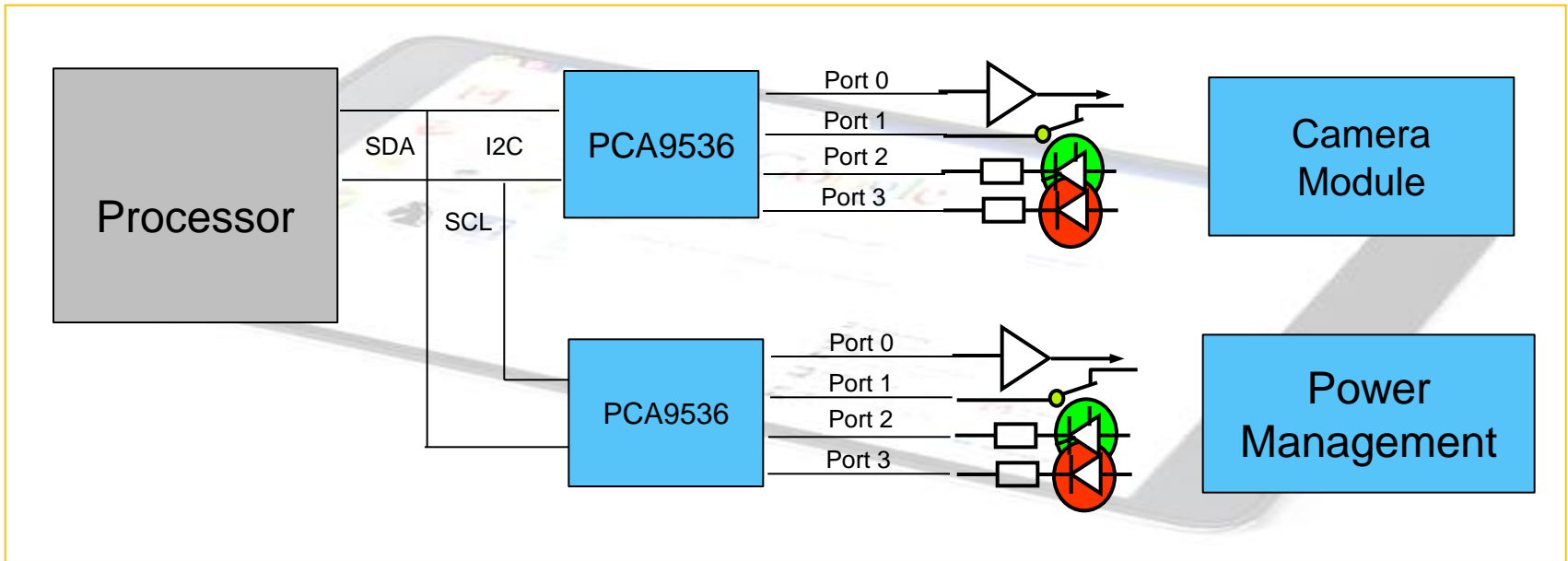
GPIO for Tablet Docking Solution

Processor — I2C — PCA9536

Port 0
Port 1
Port 2
Port 3
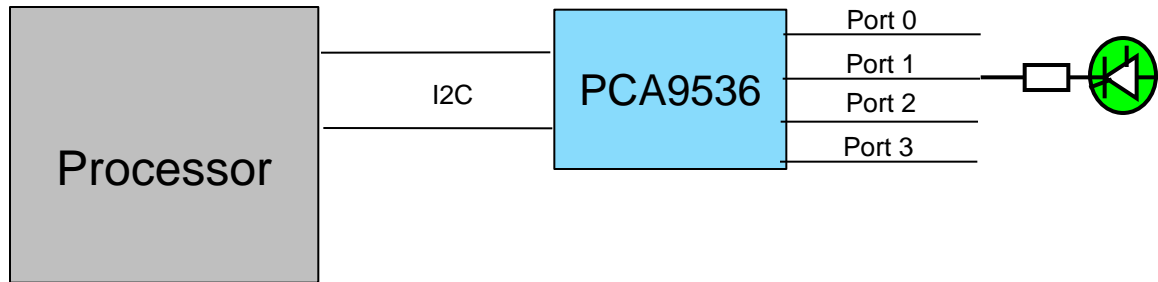
LAN Isolate
LAN Link Status
Audio Line Out

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 mobile 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

General Purpose I/O
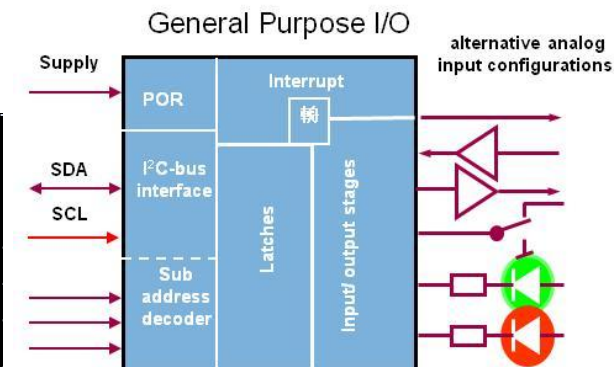
New Low Voltage GPIO Family

Lower voltage GPIO that operates down to 1.65V but still operate up to 5.5V
- New "L" in part number for input latch, /INT mask and other new IO features (green letters)
- Easy migration - Drop in replacement for existing PCA95XX GPIO

PCA Name	Single Vcc			Single Vcc Advanced IO			Two Vcc	Two Vcc Advanced IO
Feature	INT & PU	INT	INT & RST	INT & PU	INT	INT & RST	INT & RST	INT & RST
8 bit	PCA9554B PCA9554C		PCA9538A	PCAL9554B PCAL9554C		PCAL9538A	PCA6408A	PCAL6408A
16 bit	PCA9555A	PCA9535A	PCA9539A	PCAL9555A	PCAL9535A	PCAL9539A	PCA6416A	PCAL6416A

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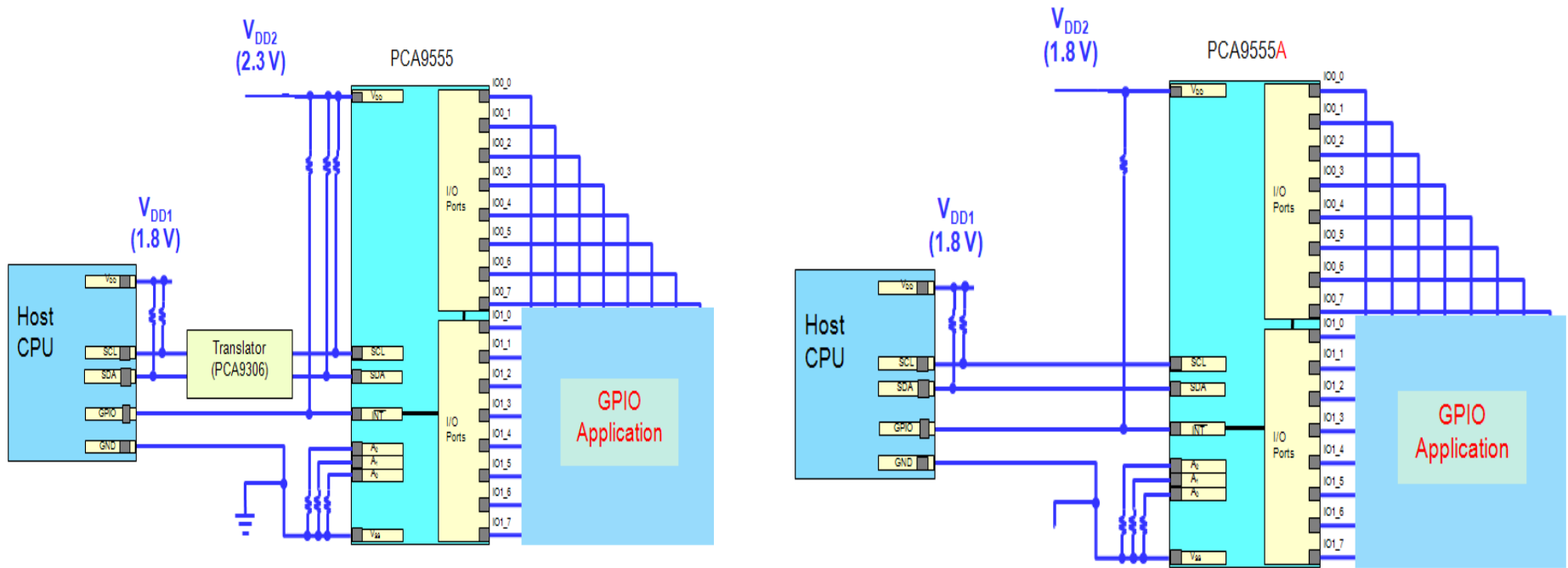
Lower V_{CC} to 1.65V on GPIO supply eliminates the need for a voltage translator like the PCA9306!

PCA6408A
Two Vcc, Low-voltage, 8-bit I2C-bus I/O expander with interrupt output, reset, and configuration registers

- Voltage range of **1.65V** to 5.5V
- Low Standby Current Consumption of 3 uA Max
- 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
- Fast Mode I2C Bus freq of up to 400-kHz
- 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
- Package – 16 pin TSSOP, HWQFN, XQFN and HLA BGA
- ESD Protection Exceeds JESD 22
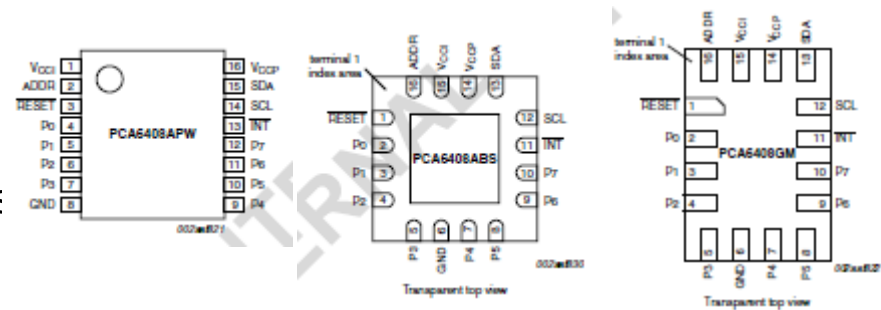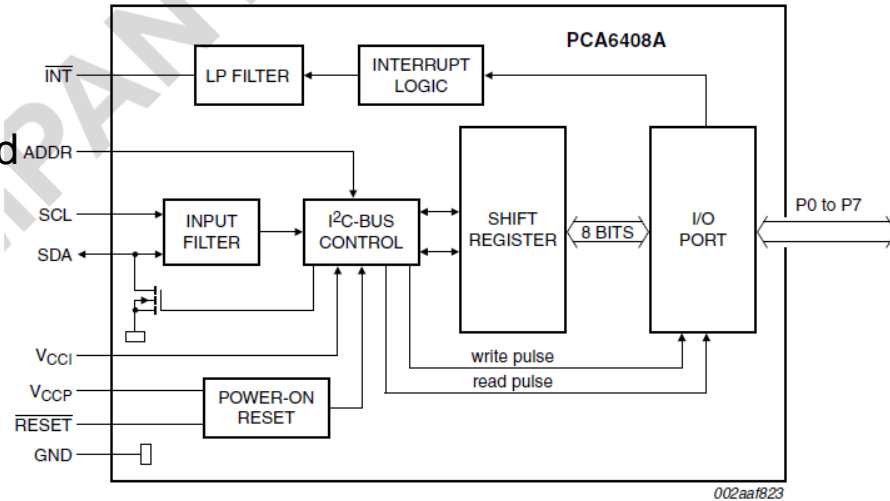
HLA16 fan-out BGA package planned, either 2 x 2 mm 0.5 mm pitch or 1.6 x 1.6 mm 0.4 mm pitch
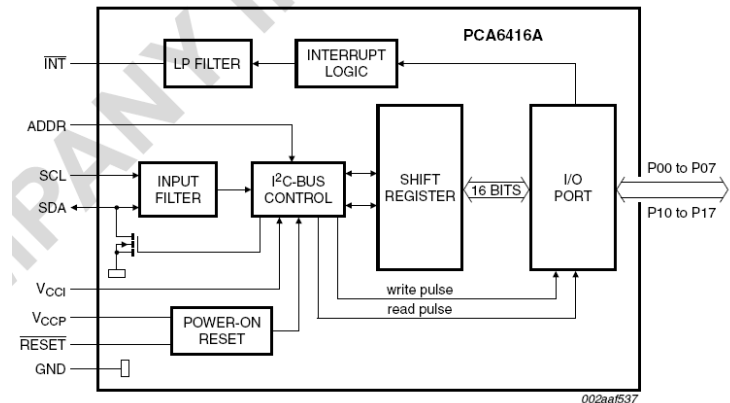
In Production

PCA6416A
Two Vcc Low-voltage, 16-bit I2C-bus I/O expander with interrupt output, reset, and configuration registers

• Voltage Range of 1.65 V to 5.5 V

• Low Standby Current Consumption of 3 uA Max

• 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

•Fast Mode I2C Bus Freq of up to 400-kHz

•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

• Package – 24 pin TSSOP, HWQFN, VFBGA and HLA BGA

• ESD Protection Exceeds JESD 22
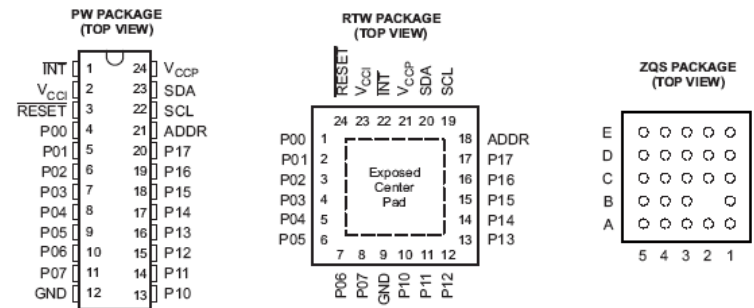
HLA24 fan-out BGA package in development with 2 x 2 mm 0.4 mm pitch (mechanical sample available)

In Production

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Features of the Agile IO Expanders

- 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):
    - User can program I/O drive strength 2 mA, 4 mA, 8 mA or 10 mA.
    - 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

Comparison Table

Feature	PCA9574/75	PCA64XX	PCAL64XX	Comments
Number of I/O's	8 or 16	8 or 16	8 or 16	
Number of devices on bus	1, 2 or 16	2	2 or 5	One address pins provides two addresses. Other PCA95xx GPIO have 2 or 3 address pins (4-8 addresses) . PCAL6424A has one pin with 5 input states (quinary address pin).
Supply Voltage Range at Vcc core and Vcc I/O	1.1 V to 3.6V	1.65 V to 5.5 V	1.65 V to 5.5 V	Supports lower supply voltages with supply per octal for the PCA9574/75 and supply per total I/O for PCA(L)64XX.
Input & Output, Polarity Inversion and Configuration Command Byte	Yes	Yes	Yes	Basic registers used by all I/O expanders to control/configure I/O pins
Bus-Hold - Programmable	Yes	No	No	Very small current source maintains undriven line high or low, doesn't cause continuous current drain when line is at opposite signal level.
Pull-up / Pull-down - Programmable	Yes	No	Yes	100-kΩ pull-up or pull-down at the I/O's. Provides a valid logic level when the I/O is not actively driven.
Input Latch - Programmable	No	No	Yes	Select which input changes "latch" in interrupt if input changes back to initial logic state before the input register is read
Interrupt Mask - Programmable	Yes	No	Yes	Select which input bit changes would not generate an interrupt to reduce spurious interrupts.
Interrupt Status - Register	Yes	No	Yes	User may read this register to identify the source of an interrupt directly without having to remember the previous state of the input
Open Drain Output - Programmable	No	No	Yes	Select I/O from push pull to open drain per bank (8-bits)
Output Drive Current - Programmable	No	No	Yes	Selects reduced output drive strength
Input Current Limiter	No	No	Yes	Reduces current through the input when input voltage is above the supply voltage
Hardware Reset	Yes	Yes	Yes	External pin resets the state machine and I/O to default
Software Reset	Yes	No	No	User reset the device in software to quickly go to a known state
$I_{standby}$ (V_{DD} = 3.6V)	0.25 µA (Typ.) 1 µA (Max.)	1µA (Typ.) 3.2 µA (Max.)	1µA (Typ.) 3.2 µA (Max.)	Low standby current for extended battery life (estimates for 24 bit LV 0.1uA (typ) 2uA (max)

Camera LED Flash Drivers

Key benefits of SSL325x

- ▸ Capable of driving single, dual, or even triple LEDs in series, allowing one design to be duplicated across multiple platforms

- ▸ Dual LED offers more than 3x light output compared with a single LED

- ▸ Dual LED always puts the driver in boost mode – resulting in higher efficiency (> 85 %) than single LED – reducing battery recharge interval

Single LED

Charge Pump Driver can only drive 1 LED

Dual LED in series

SSL325x

Triple LED in series *
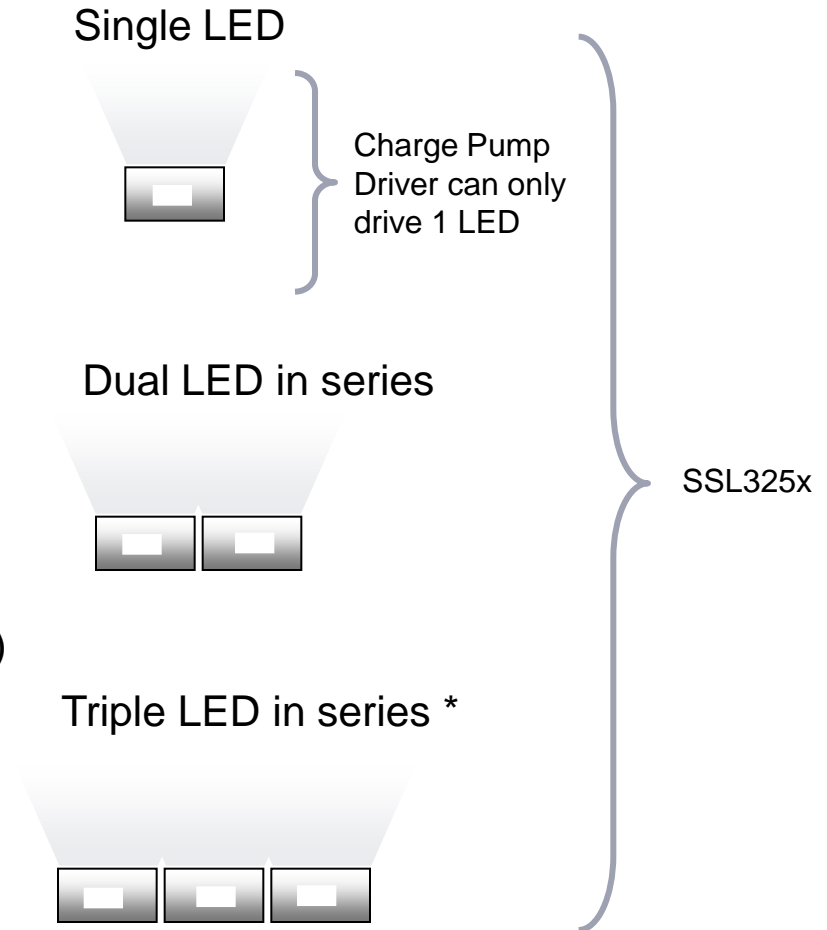
* For reduced output current (or lower LED forward voltage VF), SSL325x may power up to 3 LEDs in series

30

SSL3250A for Camera Phones

Single LED Phone

- Status:
  - Shipped over 30 Mu for single and dual LED camera phone applications
  - Received zero customer complaint

- Successful factors:
  - Drive single or dual LED to allow one design and PCB layout for a low-end or high-end platform

Dual LED Phone

500mA dual LED Flash

SSL3250A – 500 mA Async Boost Dual LED Flash Driver (16-pin QFN)

- Output up to 500mA per LED for two LED in series in flash (200mA torch) mode with 20mA current source for video-on indication

- Low-side drive asynchronous boost architecture

- Greater than 85% efficiency

- Low standby current (< 1uA)

- Optional external resistors to set the flash, torch, and indicator current levels without a microcontroller

- High switching frequency at 1.2MHz for small size inductor

- TXMASK to reduce current output for push application

- Wide input voltage range (2.7V to 5.5V)

- Programmable via hardware pins or I²C-bus

- Strobe signal to avoid I²C-bus latency

- Built-in 820ms flash time-out

- LED open, short, over-temperature shutdown, and output over-voltage protection

- Direct drop in replacement for ADP1653

- 3x3x0.8 [Typ mm] HVQFN-16 package
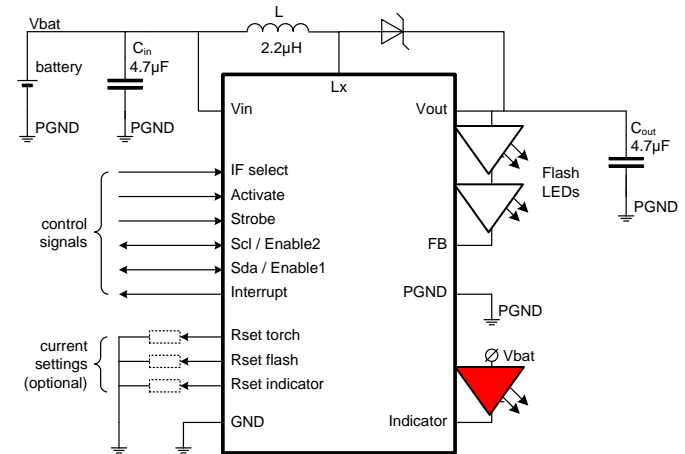
Direct Drop in Replacement for ADI ADP1653

7 mm

7 mm

In Production
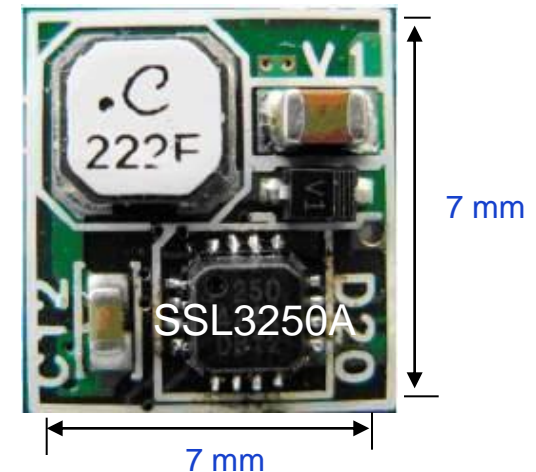
SSL3250A – Designed in Tablets / Camcorders

▸ SSL3250A designed in multiple tablet reference

designs, phones & camcorders

- – Built-in flash feature for still camera mode
- – Integrated LED indicator for video indication
- – 30% higher efficiency than competing charge pump solution
- – Output power 50% lower than competitive solution

Tablet Reference Designs

Camcorders

Host Processors E.g. Tegra T20 MTK MT6573

I2C
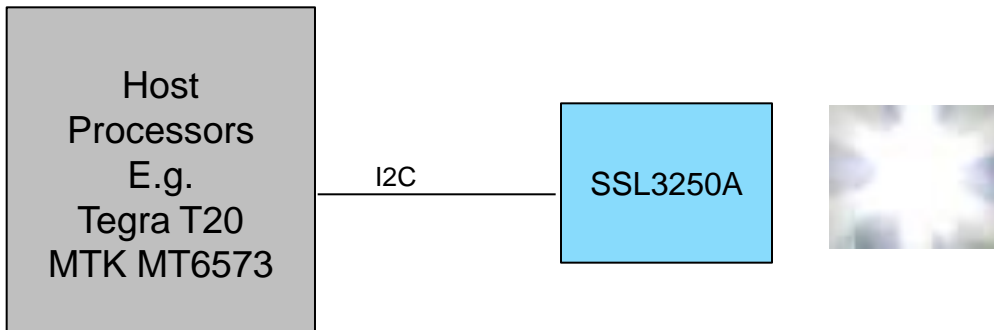
SSL3250A

SSL3252 – 400 mA Sync Boost Dual LED Flash Driver

- Output up to 400mA [1] per LED for two LED in series in flash (160mA in torch) mode with10mA output for LED/video-on indicator

- High-side drive that is based on synchronous boost design (integrate diode)

- Greater than 85% efficiency

- Low standby current (< 1uA)

- High switching frequency at 2MHz and integrating rectifying diode for compact PCB layout

- Wide input voltage range (2.5V to 5.5V)

- Strobe signal to avoid I^2C-bus latency

- Direct hardware control or 400kHz I^2C-bus interface

- Built-in protection 850ms flash time-out

- LED open, short, over-temperature shutdown, and output over-voltage protection

- Ability to detect broken-coil during manufacturing test

- Direct drop in replacement for LM3555

- 1.5x2.0x0.6 [Typ mm] WLCSP-12 package

[1] 400mA for dual LED, and 500mA for single LED
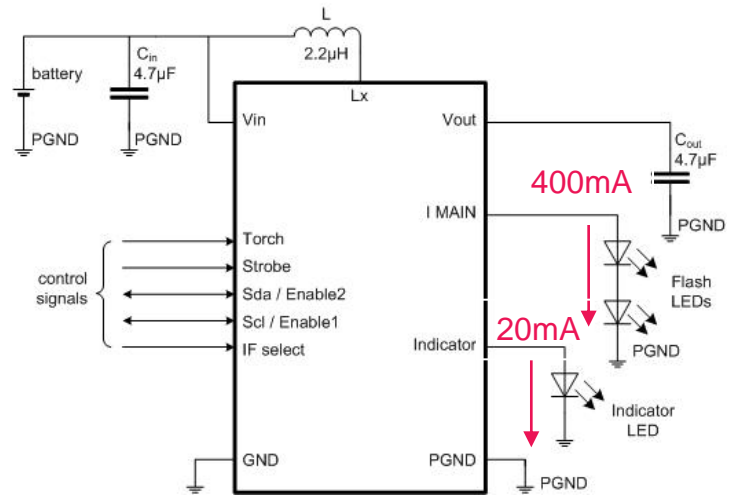
Direct Drop in Replacement for National LM3555/ADP1655/AS3645

Total PCB Area = 23.75 mm^2

3.8 mm

6.25 mm

In Production
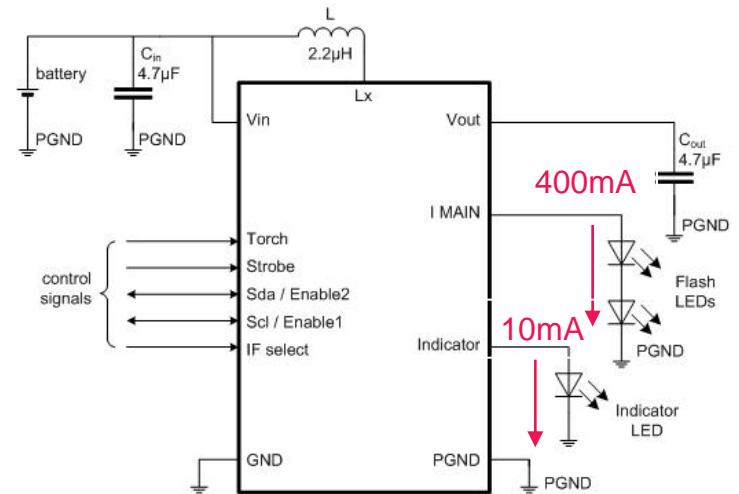
34
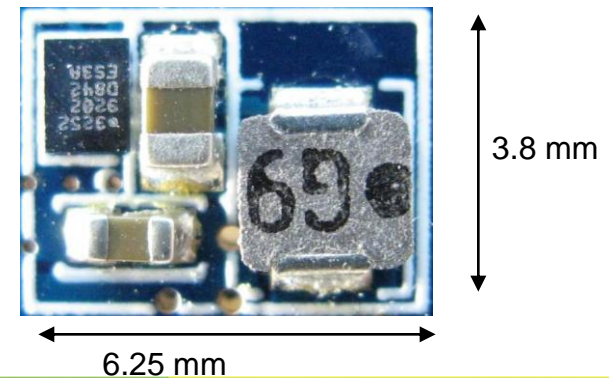
SSL3250A vs SSL3252 dual series flash LED

- Asynchronous boost, low-side drive, 500mA flash, 200mA torch, 20mA indicator
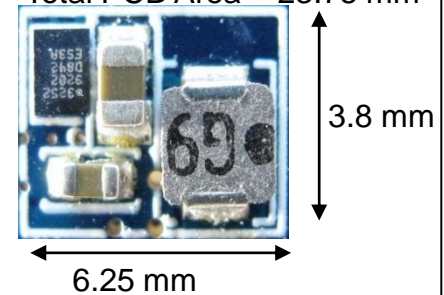
- 3x3x1 mm HVQFN-16

SSL3250A

7 mm

7 mm
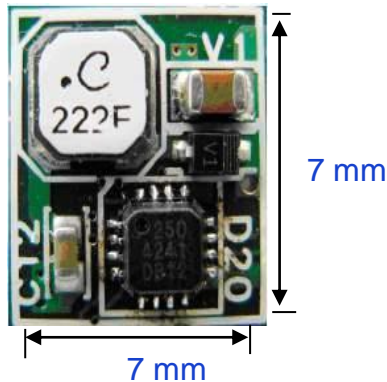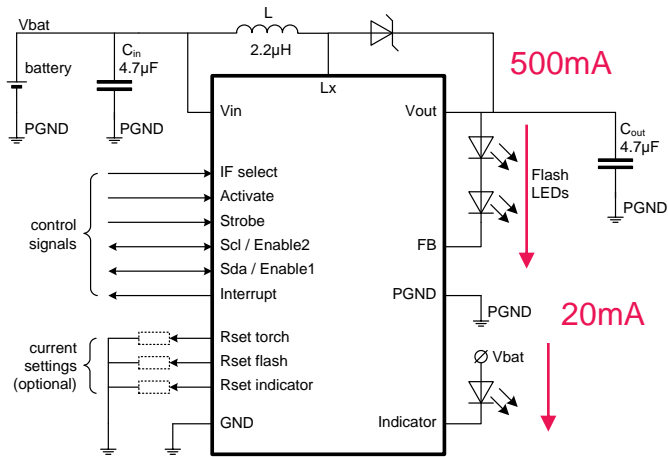
- Synchronous boost, high-side drive, 400mA flash, 160mA torch, 10mA indicator

- 1.5x2.0x0.6 mm WLCSP-12

SSL3252

Total PCB Area = 23.75 mm^2

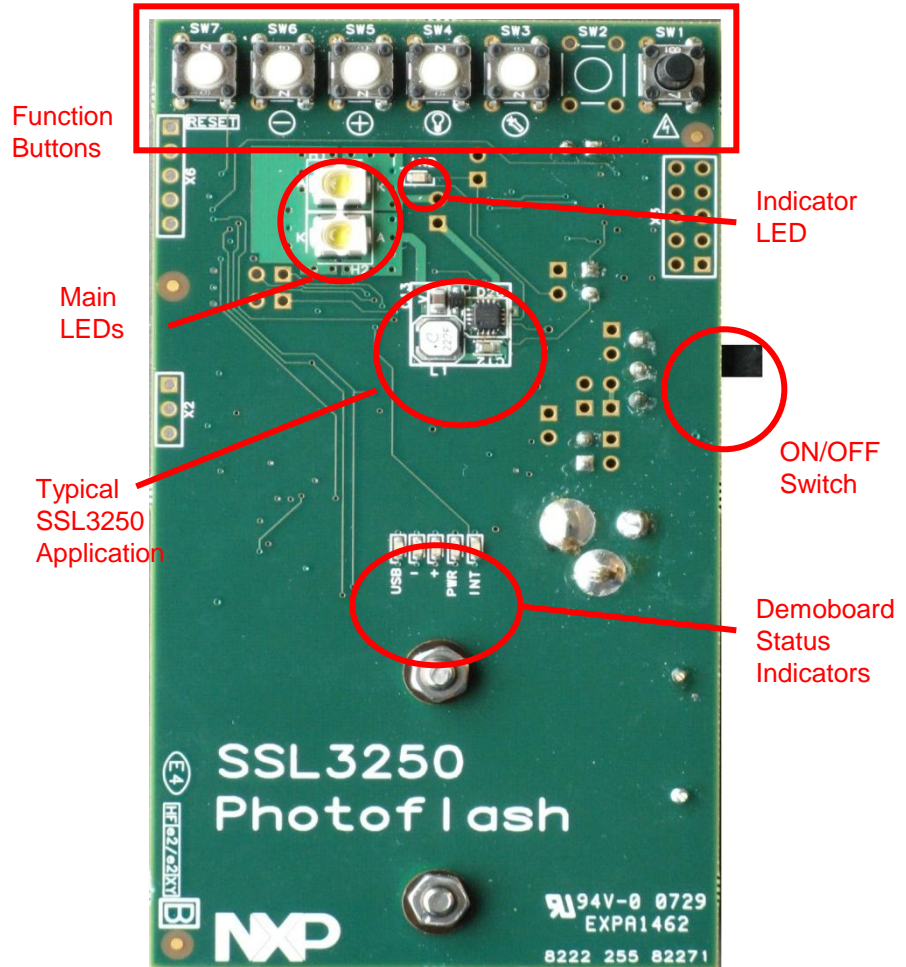3.8 mm

6.25 mm

SSL3250A versus SSL3252

FEATURE	SSL3250A	SSL3252
Total PCB area	7 mm x 7mm (**49 mm²**)	6.25 mm x 3.8 mm (**23.75 mm²**)
Peak efficiency	85%	85%
Programmable flash / torch / indicator current	500mA / 200mA / 20mA	400 mA / 160 mA / 10mA
LED output voltage	Up to 9.5 V	Up to 8.5 V
Programmable assist light	Not supported	Up to 160 mA
LED output driver	Low side drive – LED cathode to chip with little heat dissipation	High side drive – LED cathode to PCB ground with excellent heat dissipation to PCB ground
Low noise fixed switching frequency	1.2 MHz	2 MHz
External resistor for flash/torch level	YES	NO
Integrate rectifying diode	NO	YES
Support direct or I2C-bus interface	YES	YES
Input voltage range	2.7V to 5.5V	2.5V to 5.5V
Inductor broken coil detect	NO	YES
Package	3 x 3 x 0.8 [mm]; HVQFN-16	1.5 x 2 x 0.6 [mm]; WLCSP-12
Availability	In production	In Production

SSL3250A Demo Board

- ▸ Feature SSL3250A solution with total PCB area of 49mm^2

- ▸ SSL3250A drives two Luxeon LEDs, LXCL-PWF-1

- ▸ Passed EMI compliant test

- ▸ On/off switch

- ▸ Push button for flash, torch, increase/decrease torch level, and a reset

- ▸ Powered by 3AAA Li-Ion battery or by power adapter

- ▸ Quick start user guide

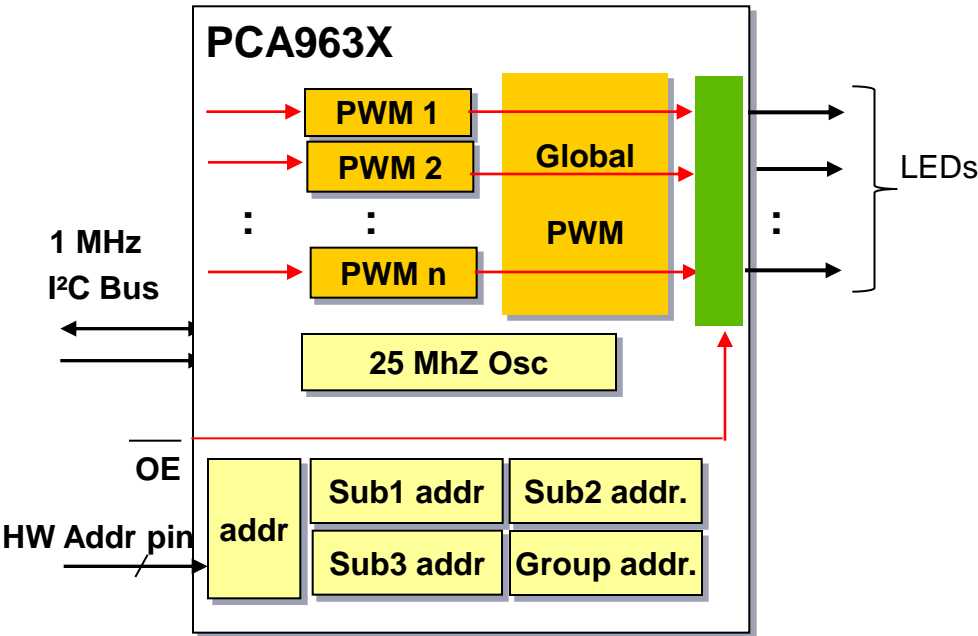- ▸ USB port to control SSL3250A with software GUI

Function Buttons

Indicator LED

Main LEDs

ON/OFF Switch

Typical SSL3250 Application

Demoboard Status Indicators

LED Dimmers / Blinkers

I²C LED Controller – Voltage Switching Source

RGBA Dimmer/Blinker – PCA9633/4/5

PCA963X

PWM 1
PWM 2
Global
PWM
:
PWM n

1 MHz
I²C Bus

LEDs

25 MhZ Osc

OE

HW Addr pin

addr

Sub1 addr
Sub2 addr.
Sub3 addr
Group addr.

•PCA9633TK (QFN8)= Normal Power

•PCA9632TK (QFN8)= Low Power

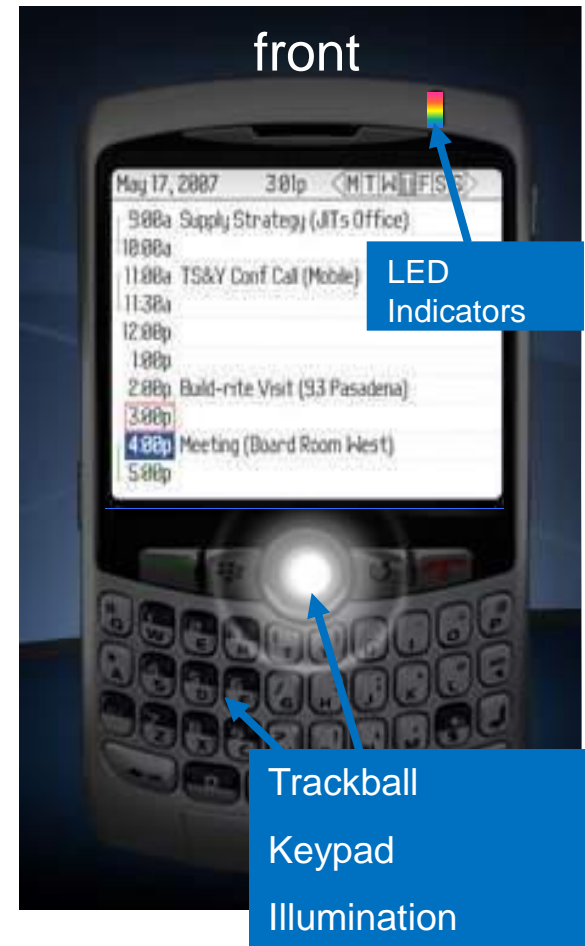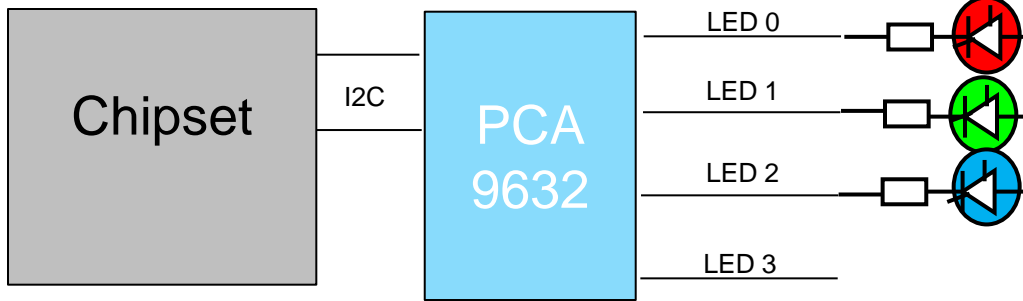PCA9632TK is capable of interfacing with 1.8V I2C-bus, 2.8V VCC

Dimmer – PCA9531/2/3

PCA953X

400 kHz
I²C Bus

PWM 1
PWM 2
:

HW Addr pin

160 Hz Osc

Blinker – PCA9551/2/3

PCA955X

400 kHz
I²C Bus

PWM 1
PWM 2
:

HW Addr pin

40 Hz Osc
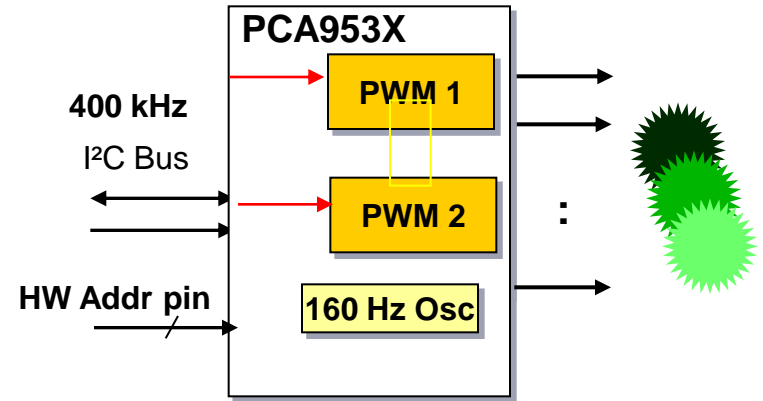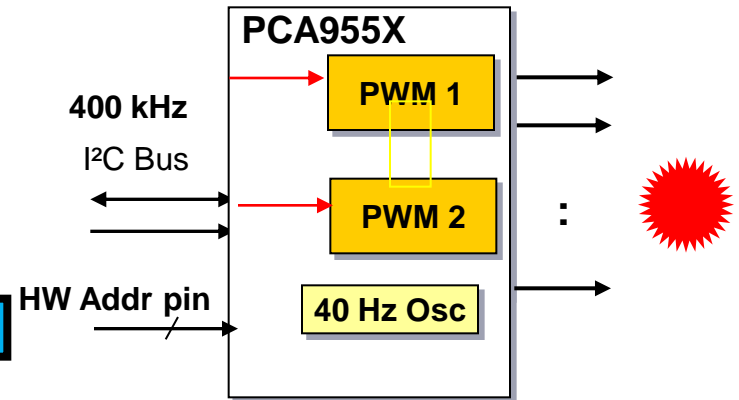
In Production

LED Control for Status Indicator – Use Case Example

Chipset — I2C — PCA 9632

LED 0
LED 1
LED 2
LED 3

front

LED Indicators

Trackball
Keypad
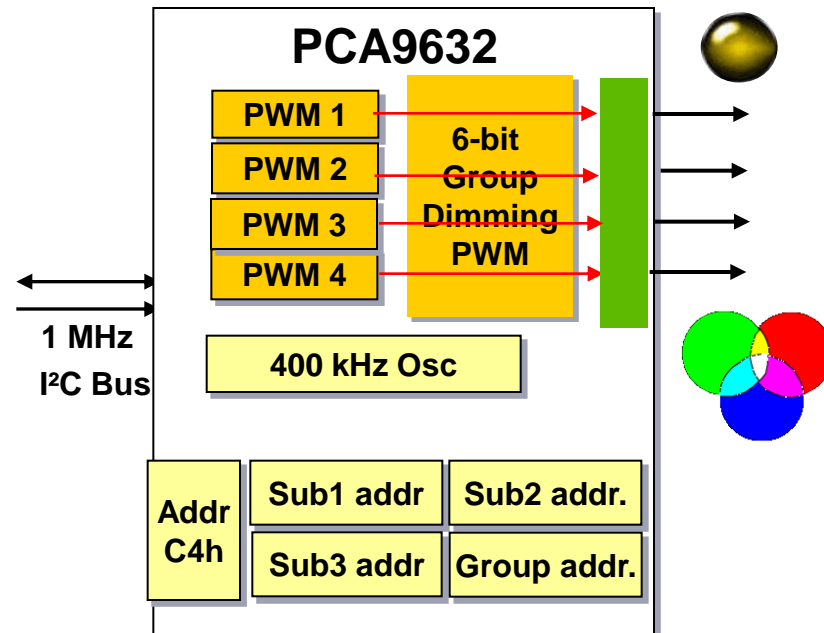Illumination

For message indicator,
and lighting around button

- RGB color mixing
- <1uA standby current
- Offloads CPU from blinking operation
- (Program once, LED ON, OFF, Blink Once, continuously)

In Production

NXP PCA9632

4 channel I²C LED controller for Mobile

Features

- 4 Push-Pull output driver, 25mA sink, 10mA source with I²C-bus interface

- Low stand-by current (1µA to 15 uA)

- LED On/Off, Bright/Dim, Blinking controls

- Blink rate: 40ms to 10.73 seconds

- Individual 8-bit PWM for LED intensity control

- Global 6-bit PWM for color dimming control

- Support 1.8V I/O / 2.3V to 5.5V VCC

- ALLCALL, SUBCALL for zone dimming

- Glue less connection to external FETs for higher LED drive

- Drop-in low power upgrade for PCA9633

- HVSON8 (TK) 3x3x 0.8 package

PCA9632

| PWM 1 |
| PWM 2 | 6-bit Group Dimming PWM |
| PWM 3 |
| PWM 4 |

1 MHz I²C Bus

400 kHz Osc

| Addr C4h | Sub1 addr | Sub2 addr. |
| | Sub3 addr | Group addr. |

In Production

41
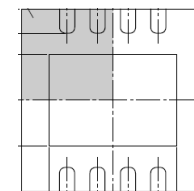
Temperature Sensors

Temperature Sensor Value Proposition

▶ **Where used?**

- Tablets, Mobile, E-Book

▶ **Why used?**

- Determine the temperature
- Set window for Interrupt, 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
- Continuous innovation with new low price LM75B local sensor in small 2 x 3 mm package

Part #	Accuracy	SMBus Timeout
LM75B	± 2 °C	A = No; B = Yes
PCT2075	± 1 °C	Yes
PCT1075	± 0.5 °C	Yes

local

local   wire   Remote Diode Sensor
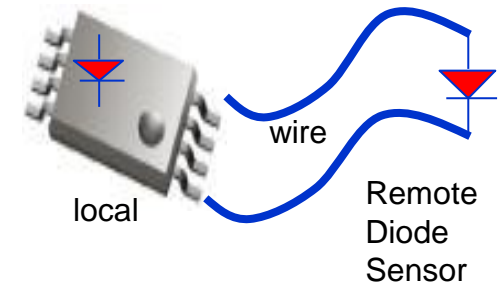
Part #	Local Sensor Accuracy	Remote Sensor Accuracy
NE1617A	± 2 °C	± 3 °C
NE1619*	± 3 °C	± 5 °C
SA56004	± 2 °C	± 1 °C

Note:* With voltage monitors

NXP Temp Sensor Selection Table

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, die
NE1617A	1	1	±2°C	±3°C	1.0/8	3.0-5.5	70	3.0	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
PCT1075 PCT2075	1		±0.5°C, ±0.3°C typ. ±1°C, ±0.5°C typ.		0.0625/12 0.125/11	2.7-5.5	200	1	SO8, TSSOP8, HWSON8

LM75B - Local Digital Temp. Sensor & Thermal Watchdog

Features

- Pin-for-pin replacement for industry standard LM75 and LM75A
- I^{2}C-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 type: XSON8U & HWSON8 (metal pad)
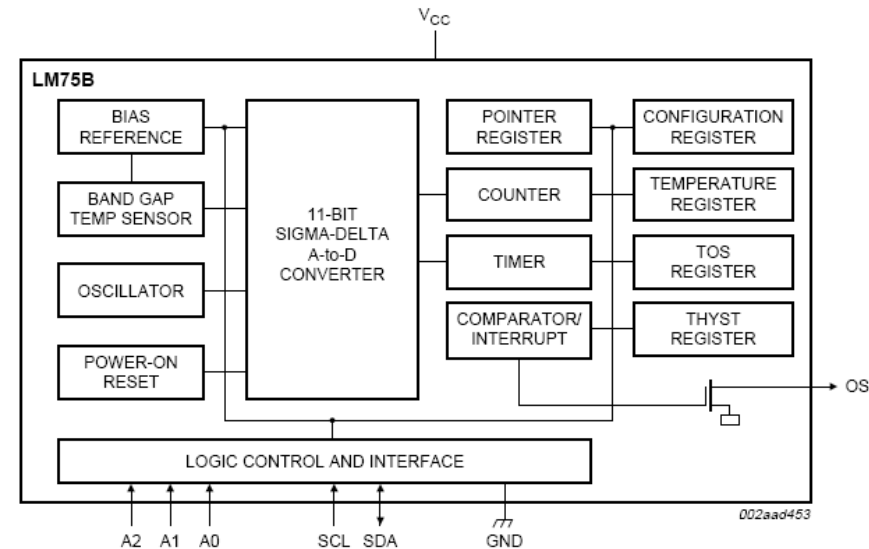
Type number	Topside mark	Package		
		Name	Description	Version
LM75BD	LM75BD	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
LM75BDP	LM75B	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm	SOT505-1
LM75BGD	75B	XSON8U	plastic extremely thin small outline package; no leads; 8 terminals; UTLP based; body 3 x 2 x 0.5 mm	SOT996-2
LM75BTP	M75	HWSON8	plastic thermal enhanced very very thin small outline package; no leads; 8 terminals, 2 x 3 x 0.8 mm	SOT1069-2

In **Production**

PCTx075 - Digital temperature sensor and thermal watchdog

FEATURES

- Fm+ I^{2}C-bus (1MHz) with SMBus timeout
- Power supply range - 2.7 V to 5.5 V
- Temperatures range - -55 ° C to +125 ° C
- 11-bit ADC - accuracy ± 1° C min/max
- 12-bit ADC - accuracy ± 0.5° C min/max
- Programmable temperature threshold and hysteresis set points allows customer-defined default Tos & Thyst set points
- Tidle programmable adjustment for temperature sampling. Allows reduction in power consumption
- Stand-alone operation as thermostat at power-up
- Expanded I^{2}C address range with 3 state pins (27 @ 8-pin and 3 @ 6-pin) address latched at power up
- 8-pin package types: SO8, MSOP8, HWSON8

002aad453

	11-bit ADC ± 1°C min/max	PCT2075
	12-bit ADC ± 0.5°C min/max	PCT1075

PCTabcd – Fm+ thermal sensor
a = accuracy +/- ° C min/max over range of interest
b = modifier to base device
cd = base device
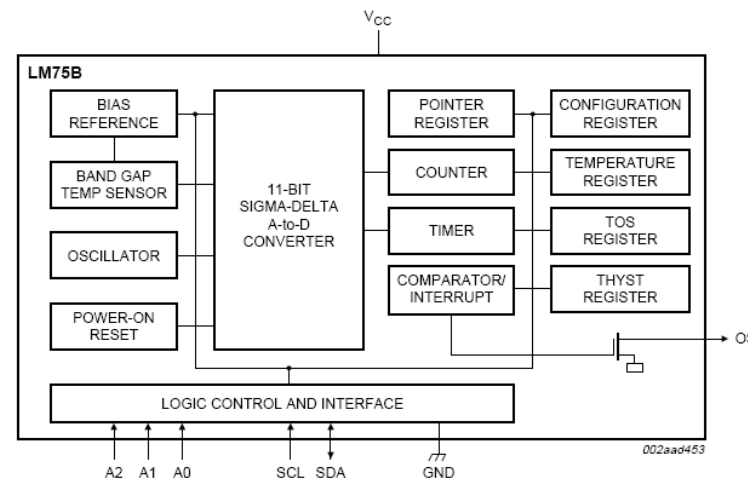
Package	SO8	MSOP8	HWSON8
SOT #	SOT96-1	SOT505-1	SOT1069-2
Pitch (mm)	1.27	0.65	0.5
Width (mm)	3.90	3.0	2.0
Length (mm)	3.90	5.0	3.0
Height (mm)	1.75	1.1	0.8

Sampling

Temperature Sensor – Package comparison

"HWSON8"
SOT1069-2
2.0 x 3.0 x 0.8

LM75BTP
PCT2075TP
PCT1075TP

"TSOP6"
SOT457
2.9 x 1.5 x 1.0

"SOT23-6 – LM73CIMK"

"TSOP6"
SOT666
1.6 x 1.2 x 0.55

"SOT563 - TMP102DRL"

"HXSON4"
SOT1194
1 x 1 x 0.55

PCTxxxxGX

"WLCSP5"
SOT -TBD
0.83 x 0.83 x 0.5

PCT2202UK

LCD Drivers

PCA9620 60 x 8 LCD Driver with I2C Interface

‣ **Features and benefits**
- 480 segment drive in Mux 1:8 Mode; can also be programmed for use in lower multiplex rates to enhance optical performance, e.g.:
  - In multiplex 1:4 mode with up to 240 segments
  - In multiplex 1:2 mode with up to 120 segments
- Integrated Charge Pump for on-chip VLCD generation
  - Wide analog power supply range 2.5V to 5.5V
  - Wide VLCD output range 2.5V to 9.0V
- Integrated temperature sensor for on-chip VLCD temperature compensation to enhance optical performance and ease of use
- Programmable and calibrated frame frequency for enhanced optical performance
  - 60Hz to 300Hz
- High drive capability to drive large displays
- Extended temperature range from -40°C to +105°C and AEC-Q100 automotive compliant qualification for highest robustness and reliability

PCA9620

I²C Bus — control logic — RAM — Temp Sensor — sequencer — backplane driver (8) — bias voltage generator — Charge pump — segment driver (60)
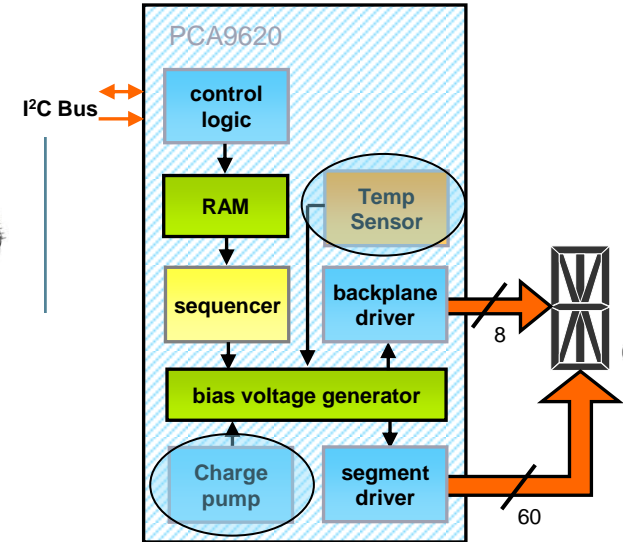
‣ **Applications and Use Cases**
- SmartCards
- Digital Camera
- Video Cameras
- Medical Portable devices

Display

Example:
Maximum display size for a Black Nematic display in relation to a standard sized credit card (VLCD=7.0V, fF=200Hz)
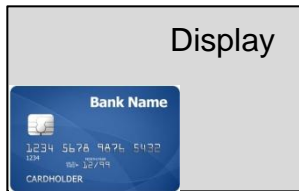
PCF8536 Mux 1:8 320-Segment Driver and PWM

▸ LCD Segment Driver

– Including 6 PWM Channels

• For LED Backlighting

• For LED Button Lighting

▸ PWM resolution

– Each channel will have a 7bit PWM generator to allow for dimming

– This could be used to generate 777RGB = 2 million colours.

– Alternatively, this gives 128 steps if white LEDs are used
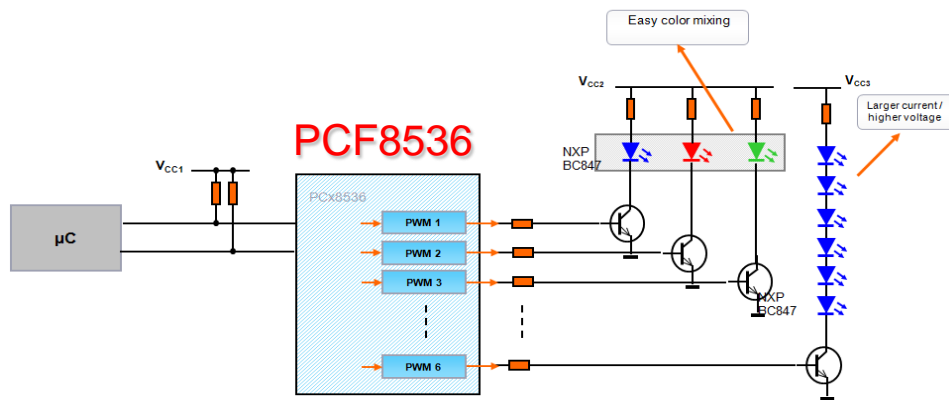
Chip On Glass – A cost saving and easy way of design

▸ Chip On Glass (COG) Segment Driver
  – The driver is directly placed on the glass
  – No package is needed (cost saving)
  – Easier PCB design
  – Less board space needed on the PCB
  – Driver is handled by the module maker

▸ **Drivers**

▸ PCF8576DU (160 segments)

▸ PCF85133U (320 segments)

▸ PCF85132U (640 segments)

display

PCB

driver

μC

surface-mount-device (SMD)

driver

display

μC

PCB

chip-on-glass (COG)
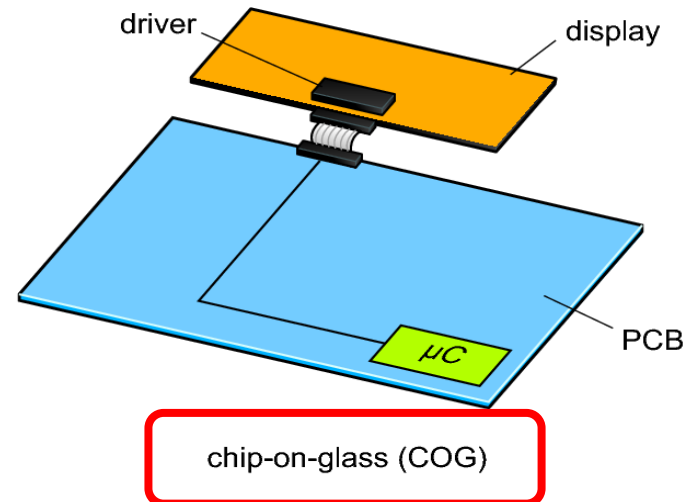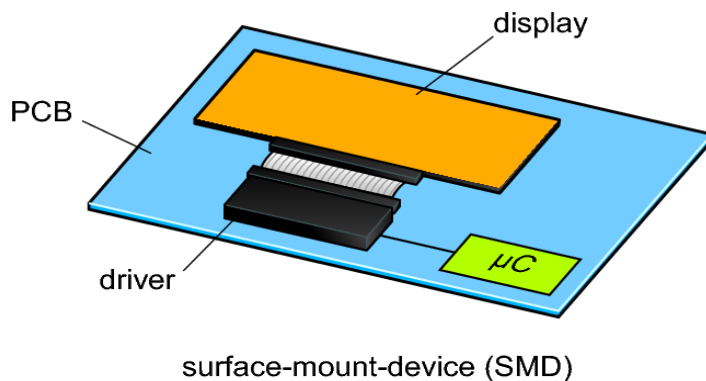
aaa-002681

Low-Power and accurate
Real-Time Clocks

RTC centric architecture
RTC is key to save system stand-by power

Real Time Clock centric applications
– power saving has high priority, RTC controls timing most of the time
– Sub-uA active power consumption compares well with integrated RTC (on processor) in advanced IC process node (high leakage current for IC process nodes beyond 45nm)
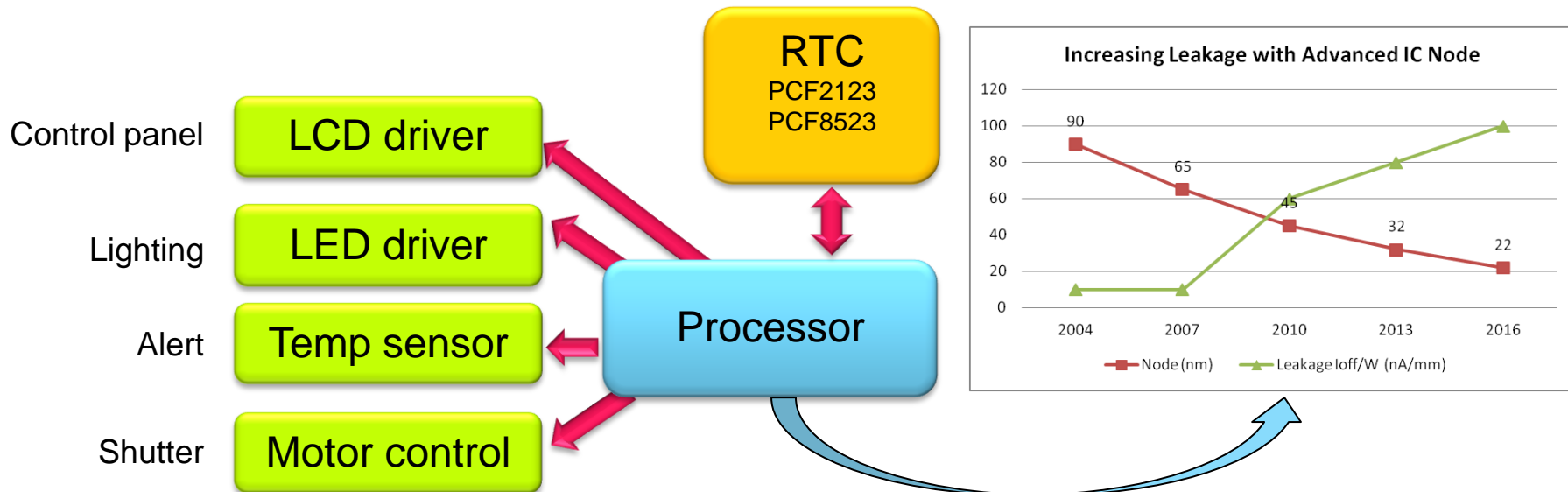
NXP RTC Portfolio Overview (Packaged)

	Type	Inter-face	Package	Key features
Lowest Power	PCF2123	SPI Bus	TSSOP14, HVQFN16	Lowest power (100nA), electronic tuning
	PCF8523	I²C-Bus	SO8, TSSOP14 HVSON8,	Lowest power (100nA), electronic tuning Battery management
!!	PCF8563 /5	I²C-Bus	SO8, TSSOP8, HVSON8	Industry standard
Precise	PCF2129, PCF2127	I²C-Bus/ SPI-Bus	SO20	High accuracy +/-3ppm, Battery management, Time stamp: (PCF2127 features also 512byte RAM)
Automotive	PCA8565	I²C-Bus	TSSOP8, HVSON10	Robustness: up to 125°C
	PCA21125	SPI-Bus	TSSOP14	Robustness: up to 125°C
	PCA2129	I²C-Bus/ SPI-Bus	SO16	High accuracy +/-3ppm, Battery management, Time stamp: ceramic quartz for automotive

NXP Low Power Real Time Clocks

- Clock operating voltage: 1.0 V to 5.5 V
- Integrated tuning Capacitance C_{Load} of 12.5 and 7.0pF
- Tiny leadless packages: 2 * 3mm or 2.6 * 2.6mm
- Frequency adjustment via programmable offset register (electronic tuning)
- General purpose RAM byte
- 400 kHz I2C-bus interface or 6MHz SPI
- Interrupt output with 4 options: every 30s, every 60s, programmable alarm, off
- Operating temperature range: - 40°C …+ 85°C

Quartz

32kHz Oscillator — Divider — Clock out — CLKOUT

V_{DD}

Power-on reset

Clock calibration offset

CLKenable

SPI-bus
I2C-bus interface

System control

Real-Time Clock

Interrupt control — INTerupt

Communication to and from

Alarm control

V_{SS}

PCF85063

IDD2 Current Consumption (f_{SCL} = 0; T_{amb} = 25°C; Vdd = 3V)

1μA

100nA

DIP 8
SO 8
TSSOP8
HVSON10
HWSON8
HXSON10
CSP 9 bumps

PCA2125
PCF85063
PCF8563
PCF2123
PCF8523

Foot print / mm²

year 1988   year 2008   year 2010   year 2012

World's Lowest Powered RTC

NXP RTC Portfolio Overview (CSP)

Type	Interface	Package	Key features
PCF2123	SPI Bus	Bare die Gold bumps,	Lowest power (100nA), electronic tuning 150µm and 200µm die thickness
PCF8523	I^{2}C-Bus	Gold bumps	Lowest power (100nA), electronic tuning Battery management
PCA8802	I^{2}C-Bus	Gold bumps Solder bumps	Lowest power (100nA), 24 bit counter
PCF8564A	I^{2}C-Bus	Bare die Solder bumps	Integrated capacitors, clock enable

Solder bumps = wafer level chip scale package (WLCSP), lead free

Bare die for wire bonding (gold ball bond or alu wedge)

Gold bumps, 15um height

Touch and proximity switches

Capacitive Sensor Portfolio

Single Channel

PCF8883 *(released)*
- single channel **proximity switch**
- automatic calibration
- low power consumption (< 3uA)
- SOIC8 package

Dual Channel

PCA8886 *(released)*
- two channels
- large supply voltage range (3V to 9V)
- low power consumption (< 6uA)
- automotive qualification, TSSOOP16

Multi-Channel

PCF8885, *(released)*
- eight channel device
- up to 28 sensors
- Up to 64 in cascading
- low power consumption (< 10uA)
- Ideal for key pads

- Patented (EDISEN) digital method to detect a change in capacitance on a remote sensing plate
- Changes in the static capacitance (as opposed to dynamic capacitance changes) are automatically compensated using continuous auto-calibration
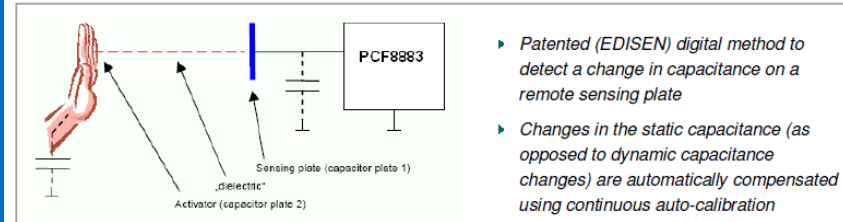
Proximity detection:
- Phone at the ear
- Camera at the eye
- Approaching hand for wake up.

Capacitive touch switch
- Key matrix
- Function keys
- Menu selection ...

Multi channel touch sensor PCF8885

- Key pads, up to 28 key (single chip)
- Functional keys
- Program selections
- Low power consumption 10uA
- Ideal for sealed surfaces
- Insensitive to contamination & environmental changes

Sensor inputs 1 8

PCF8885

Oscillator → Timing control

Timing reference

System Control

Channel 1

Sense

Multi plex

I2C-bus Interface

Channel 8

Voltage Regulator

VDD
VSS
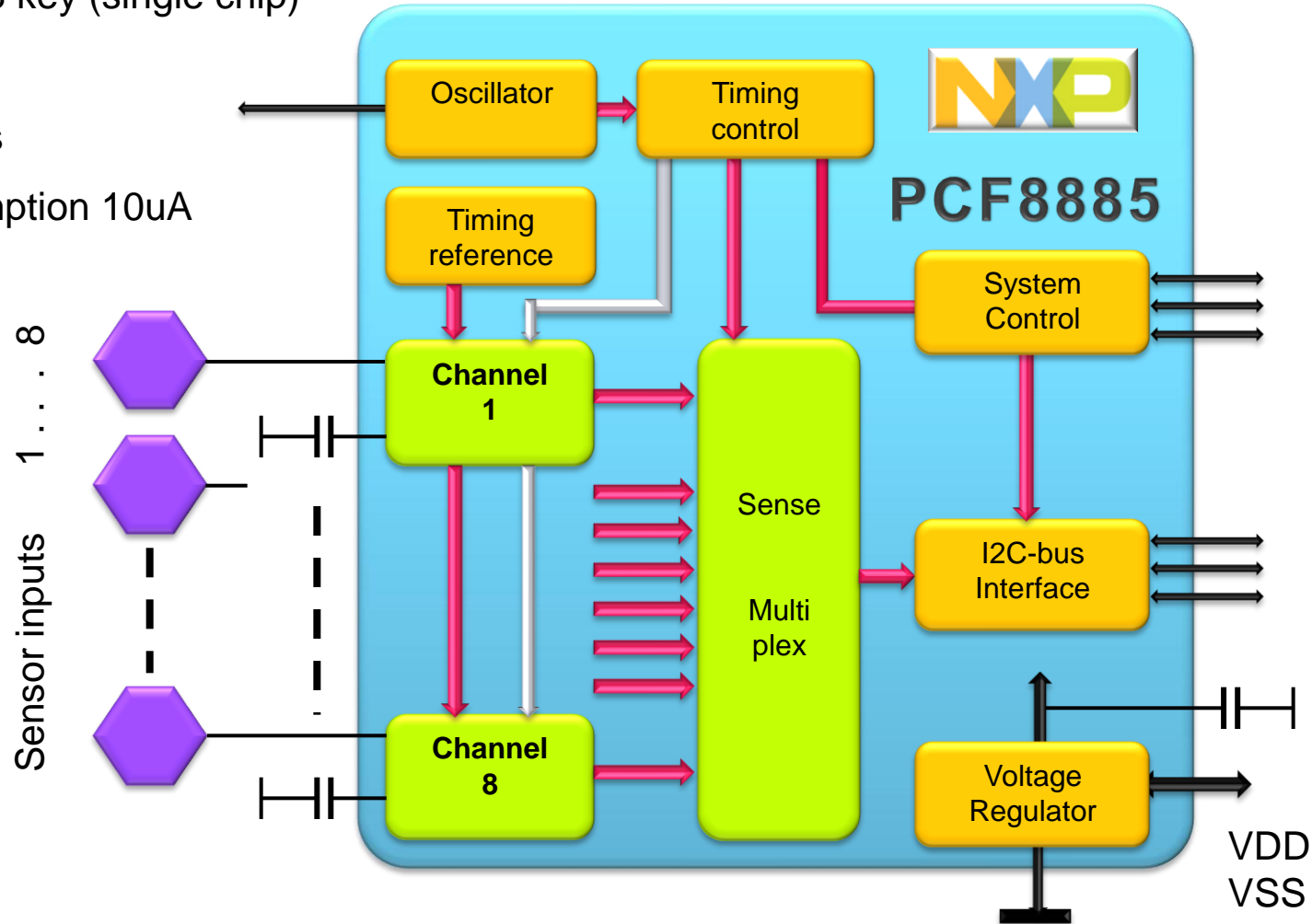
UART

Commercial 16CxxxB UART Family

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
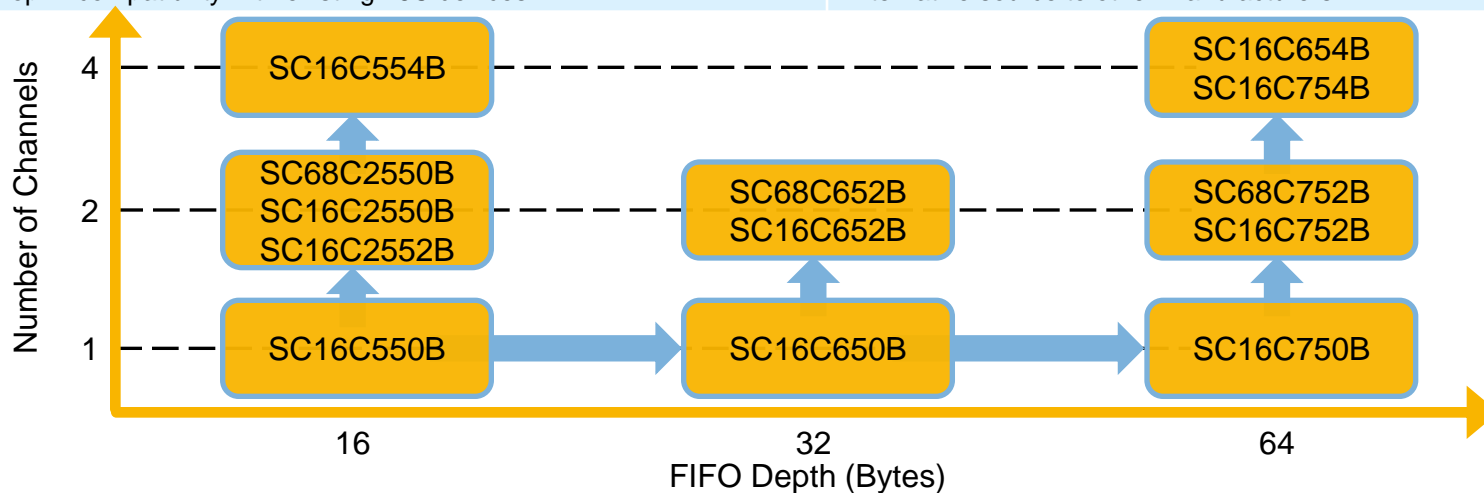
SC16C85xx: New 1.8V – 3.3V UARTs

- Single- and dual-channel UART

- Intel/Motorola and VLIO interface

- Sleep Mode / Low Power mode

- up to 5Mbps

- 128 bytes Tx / Rx FIFOs

- Automatic RS485

- IrDA version 1.0

- Independent UART Tx and Rx enable/disable

- Ultra small: TFBGA

SC16C850IBS/Q900

- UART with 16-mode or 68-mode parallel bus interface; -40°C to +85°C; HVQFN32; AEC-Q100 compliant automotive qualification
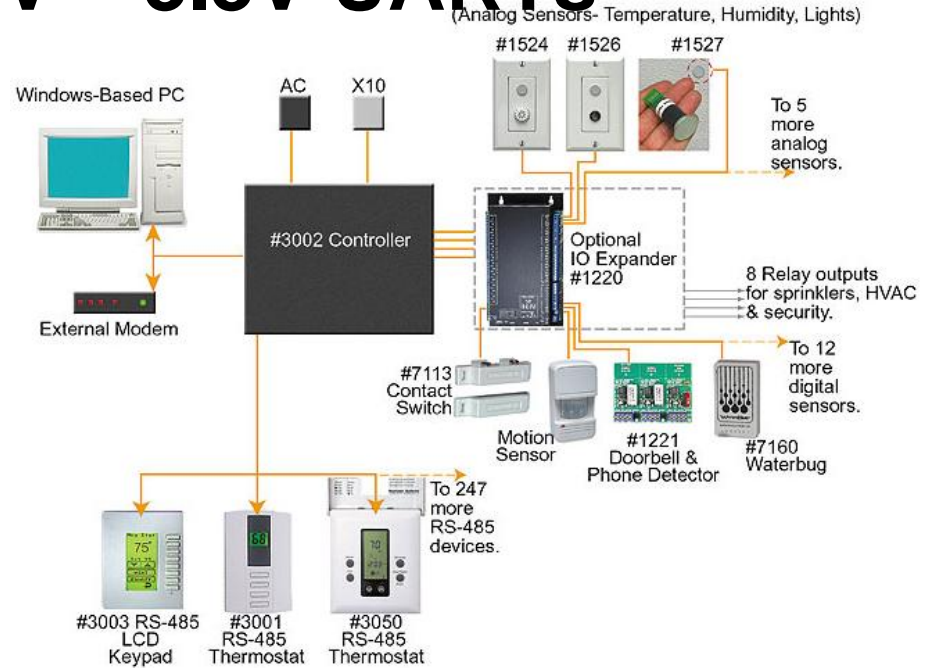
Part Number	CH	Host Interface	V_{CC}	TFBGA (3.5x3.5)	HVQFN (5x5)	LQFP (7X7)
SC16C850L	1	Intel / Motorola	1.8 V	√	√	TBD
SC16C850V	1	VLIO	1.8 V	TBD	√	
SC16C852L	2	Intel / Motorola	1.8 V	TBD	√	√
SC16C852V	2	VLIO	1.8 V	√	√	TBD

SC16C85xx**S**: New 1.8V – 3.3V UARTs

- Single- and dual-channel UART

- Intel/Motorola and VLIO interface

- Sleep Mode / Low Power mode

- Programmable Sampling Rates up to 20Mbps

- 128 bytes Tx / Rx FIFOs

- Automatic RS485

- IrDA version 1.0

- Independent UART Tx and Rx enable/disable

- Ultra small: TFBGA
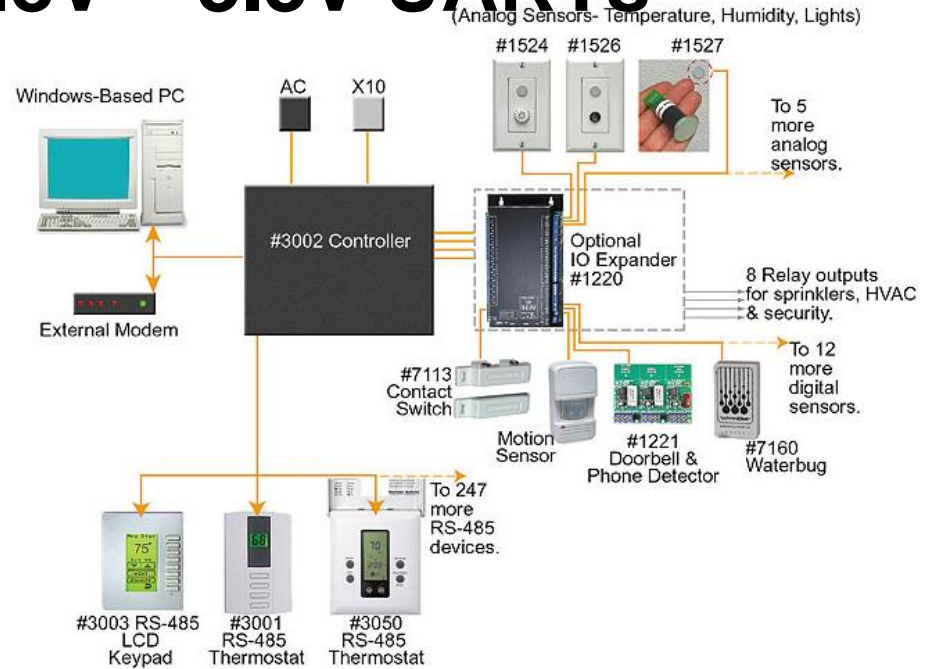
Part Number	CH	Host Interface	V_{CC}	TFBGA (3.5x3.5)	HVQFN (5x5)	LQFP (7X7)
SC16C850**S**L	1	Intel / Motorola	1.8 V	√	√	TBD
SC16C850**S**V	1	VLIO	1.8 V	TBD	√	
SC16C852**S**L	2	Intel / Motorola	1.8 V	√	√	√
SC16C852**S**V	2	VLIO	1.8 V	√	√	TBD

Video SERDES

Mobile Video SERDES

- Why Video SERDES?

  - Greatly reduces wire density across hinge

  - Reduces flexible printed circuit width

  - Minimizes EMI

  - Increases reliability

  - Saves space and system cost

- Why PTN3700?

  - Supports wide range of display modes QVGA to XVGA

  - Simplifies inventory with user-configurable TX or RX

  - Voltage, Power & Package for the mobile application

  - Low active transmit and standby mode

  - Small footprint; Thin package

PTN3700

PTN3700

PTN3700 as TX

PTN3700 as RX
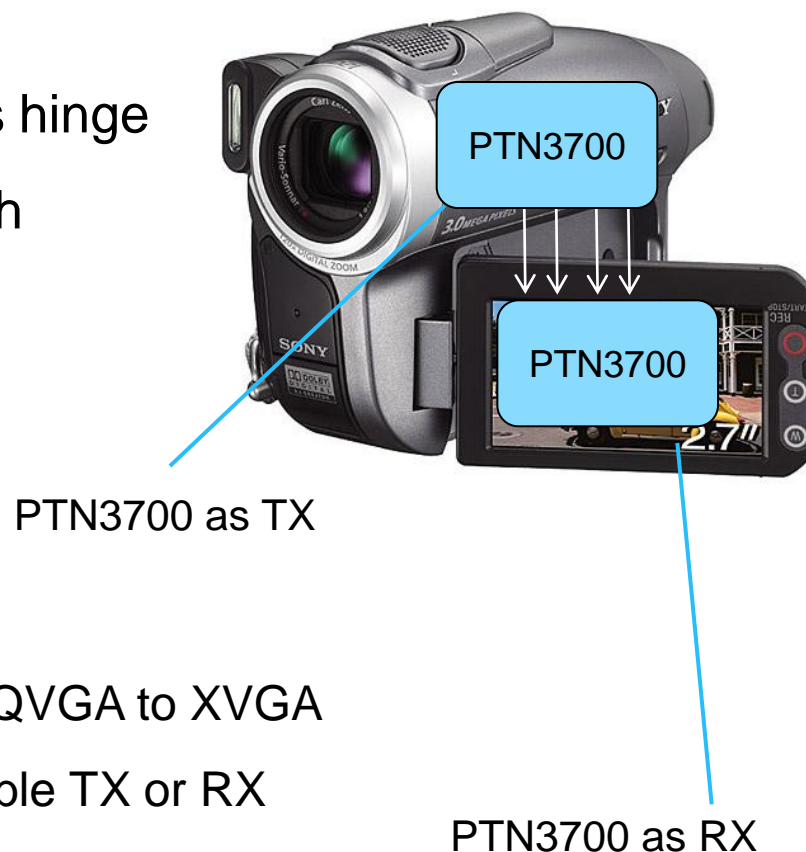
PTN3700 Mobile Video SERDES

▸Advanced Frame Mixing

  ▸Increases quality of display resolution

  ▸Enables 24 bit color on 18 bit display

▸Configurable 3 lane performance to handle a wide range of display modes

  ▸QVGA to XVGA

  ▸Data transfer > 1.9Gbps

▸User configurable as TX or RX

▸1.8v operation

▸18mW active transmit mode

▸ 4uA standby power mode (Typ)

▸ Small footprint < 4mm2 & <18mm2 in the thinnest package
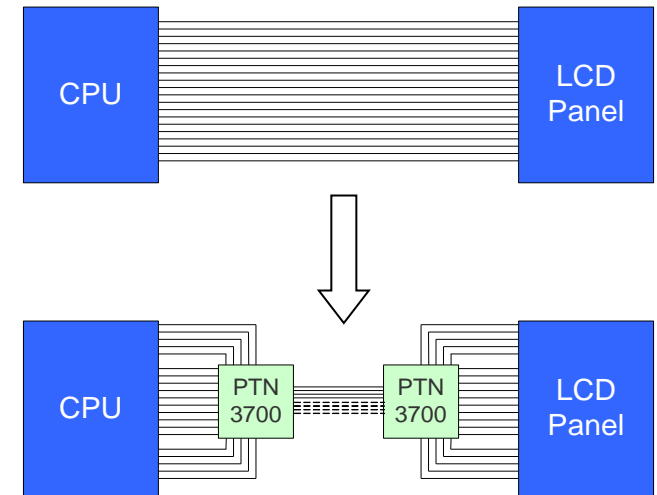
Reduces 30 wires to only 4 – 8 wires, depending on the bandwidth needed

In Production

PTN3700 Applications

▶ Video displays on portable devices

▶ Personal Audio or Video Players
  – DVD or HD-based

▶ All-in-one function printers
  – LCD Displays

▶ Stand-alone GPS/Navigation

PTN3700 as Transmitter   PTN3700 as Receiver
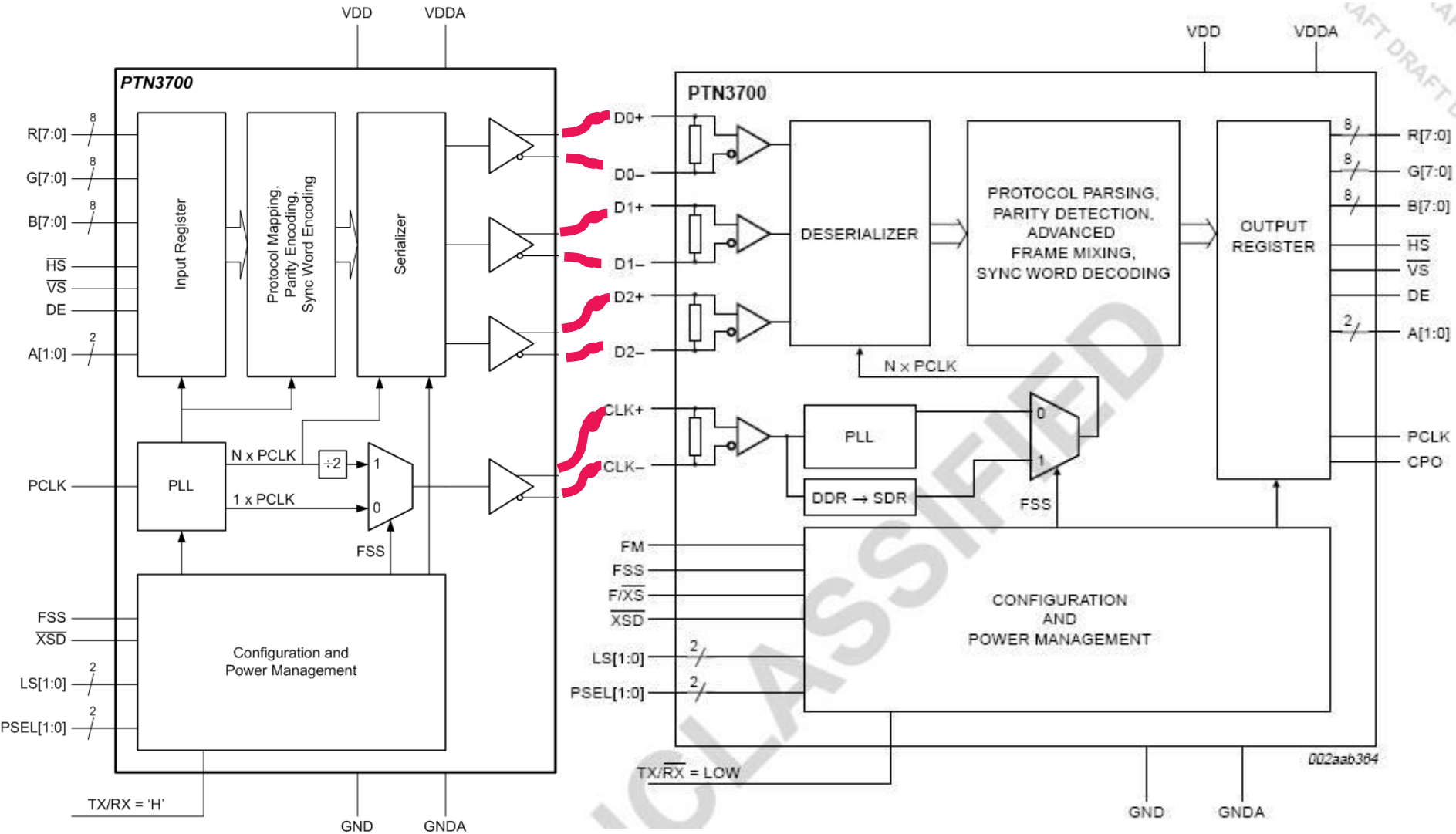
PTN3700 Competitive Advantages

- Competitive pricing $$$

- PTN3700EV - One of industry's tiniest and thinnest package!
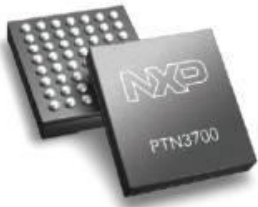
- Easy part inventory
  - PTN3700 used as TX and RX

- Support wide range of high-quality portable displays
  - Resolution from QVGA to XGA

  - 18- or 24-bit color

PTN3700 Active-Mode Current
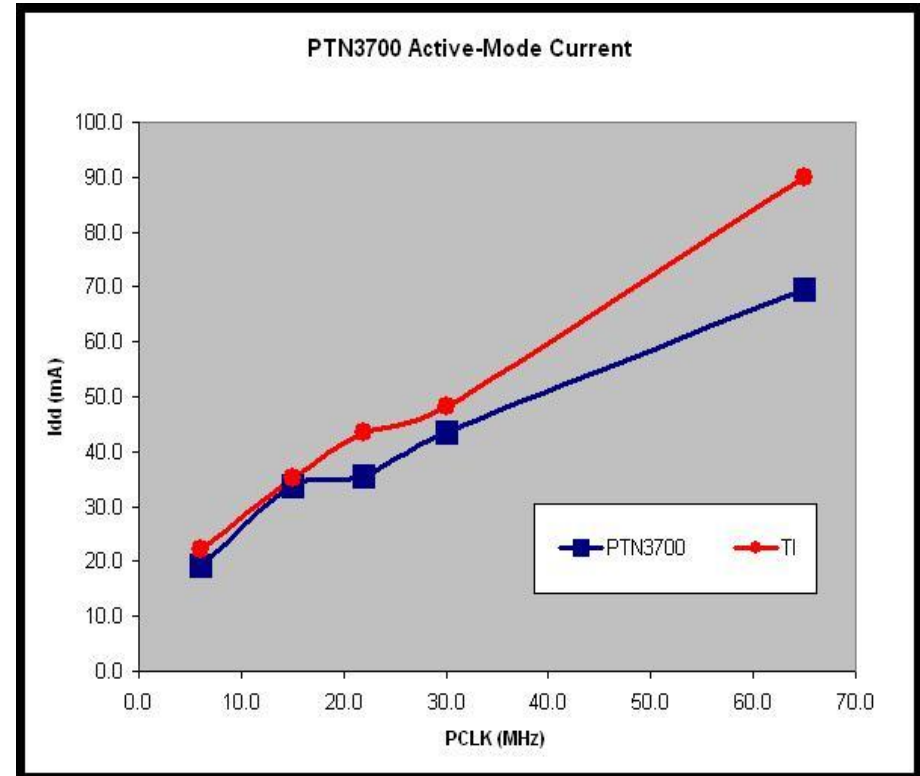
- Lower active-mode power than competitor!
  - Key parameter for portable devices!

SDIO Controller

SDIO101 Host Controller

▸ Features:
  – One Port SDIO Controller
  – Host Clock Rate from 0 to 52MHz
  – Supports One SDIO Slot
  – Data Throughput up to 200Mbps (Using 4-bit Data Mode) or 416Mbps (Using 8-bit Data Mode for MMC)
  – 2K Double Data Buffer (1K Block Size), Reduces Latency

▸ Compliance
  – Meets SD Host Controller Version 2.0
  – Meets SDIO Card Specification Version 1.20
  – Meets SD Memory Card Security Version 1.10
  – Meets MMC Version 3.31 and 4.0
  – Supports CE-ATA (CMD60 / CMD61)
  – WinCE Driver Supported
  – Linux 2.4 Driver Supported

▸ Host Interface
  – Synchronous / Asynchronous μP Interfaces
  – Supports 16-bit Data Bus
  – OMAP SRAM Interface

▸ Glueless Interface
  – SRAM Interface: 16-bit Data Bus, 8-bit Address Bus, Interrupt, DMA
  – 2.5-V and 3.3-V Interface
  – 13-MHz Clock/Crystal Input
  – SDIO Clock from DC to 52MHz

V_{CC} & CRYSTAL OSC.

HOST BUS

SDIO CONTROLLER

HOST BUS

SD SDIO MMC CE-ATA

Port1

INTERRUPT DMA

CARD POWER
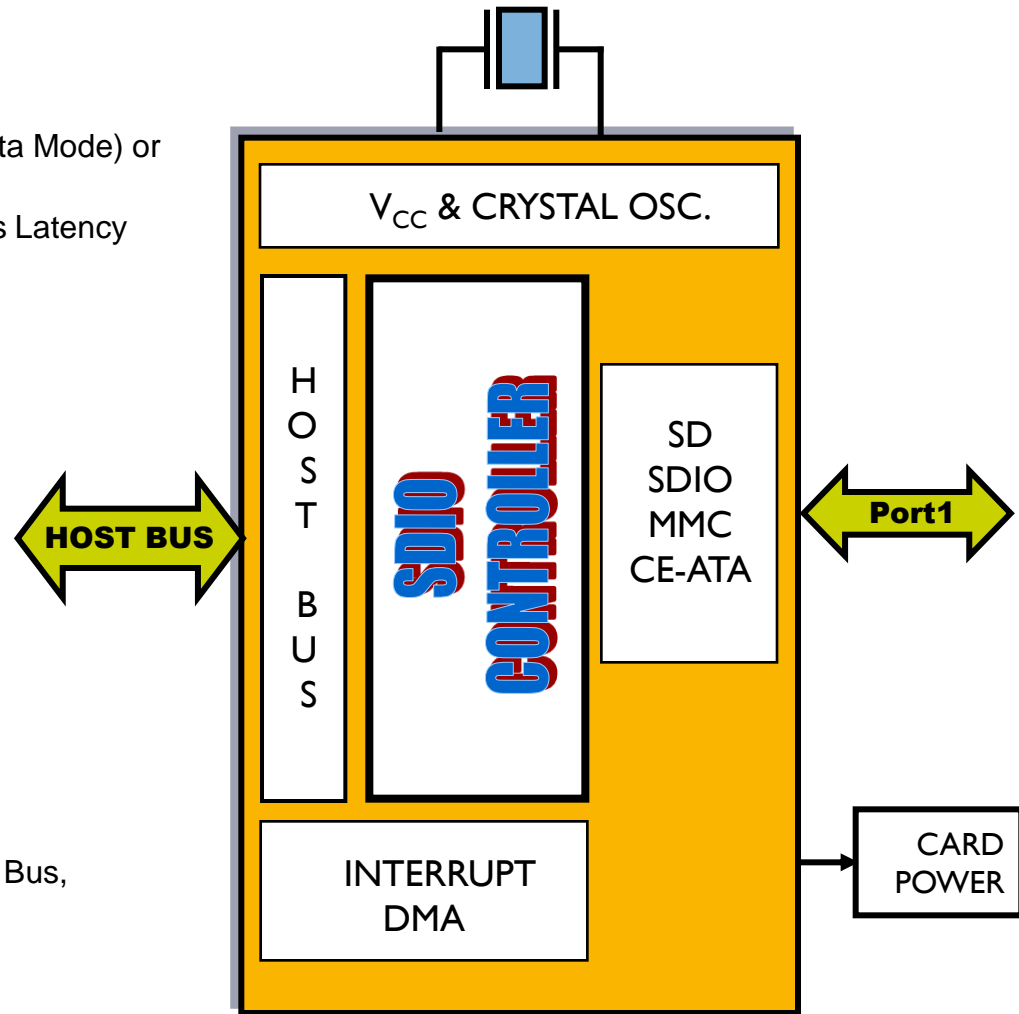
SDIO101 Application Block Diagram
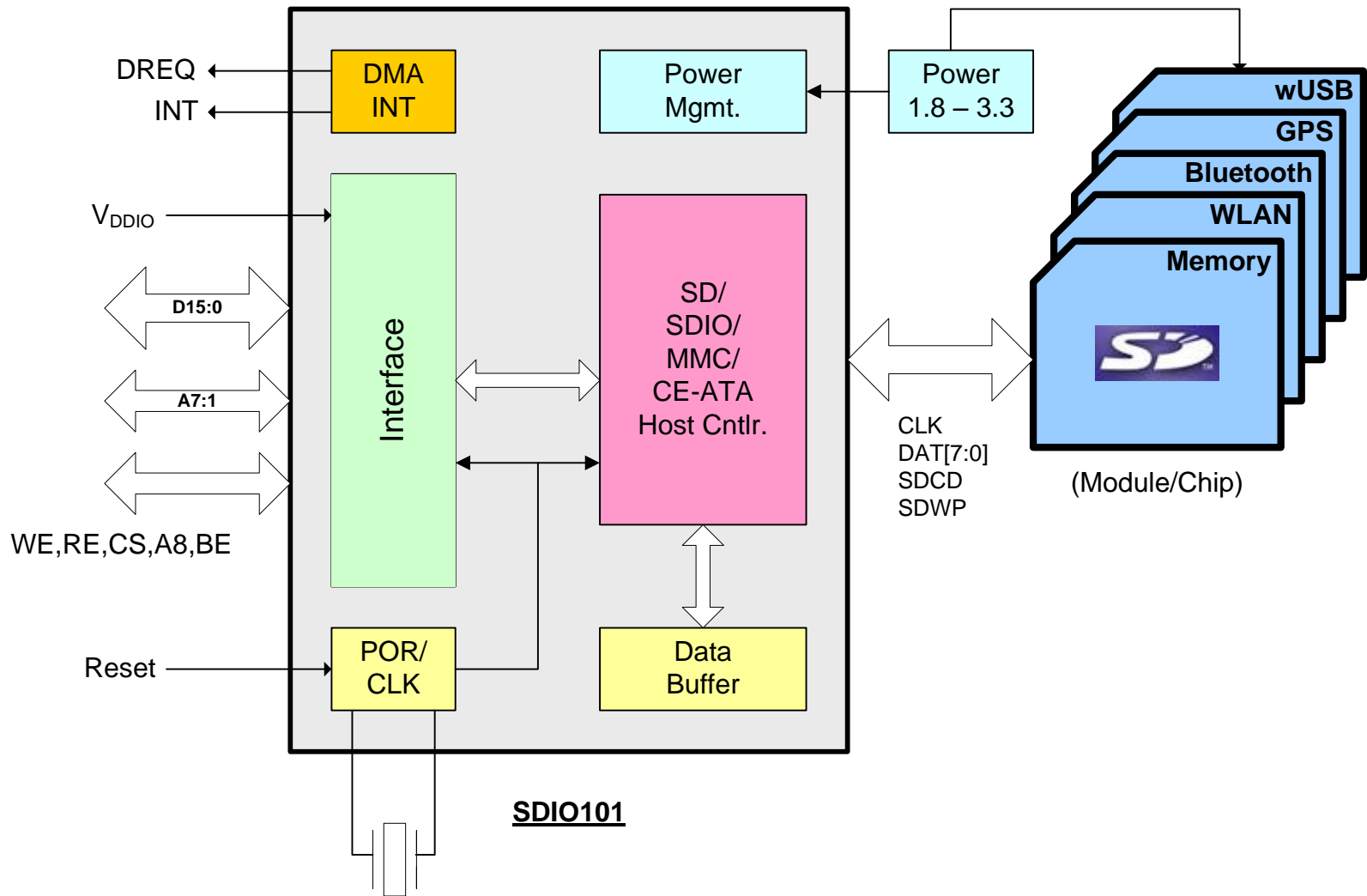
SDIO101 Application Schematic
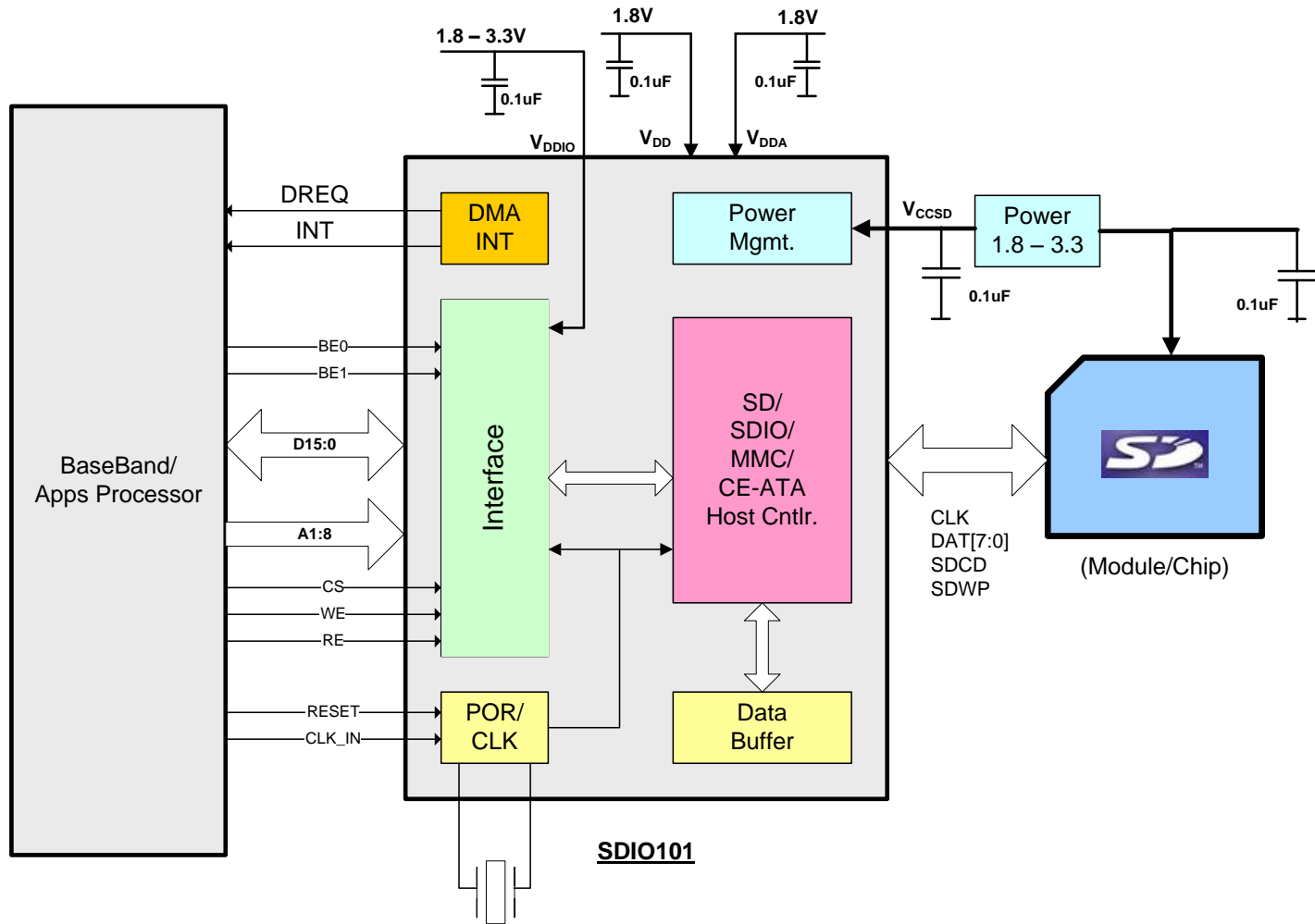
High-Speed Switches

CBTL01023   10Gbps Mux/De-mux/Switch

- ▸ 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

- ▸ High 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

- ▸ Tiny XQFN10 package
  1 x 1.55 x 0.5 mm, 0.5 mm pitch

Transparent top view

In Production
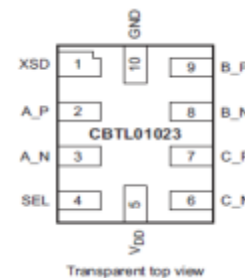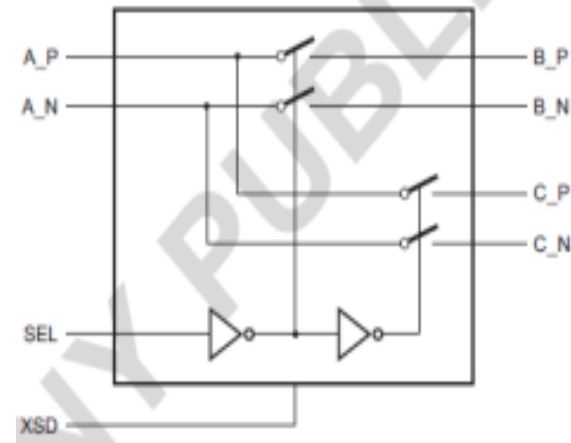
CBTL02043 10Gbps Mux/De-mux/Switch

- 2 differential channel, 2:1 bi-directional mux/demux

- Signaling Supported
  - PCIe Gen1 @ 2.5 Gbps
  - DisplayPort up to v1.2 @ 5.4 Gbps
  - PCIe Gen1 to Gen3 @ 8 Gbps
  - USB 3.0 @ 5.0Gbps
  - SATA 3.0 @ 6.0 Gbps
  - SAS 2.0 @ 6.0 Gbps

- **-3dB bandwidth 10 GHz**

- Low inter-pair skew: 5ps max

- Low crosstalk: -30dB at 5GHz

- High Off-isolation: 30dB at 5GHz

- 3.3 V supply voltage

- DHVQFN 20, 2.5 x 4.5x 1.0 mm, 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
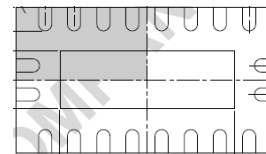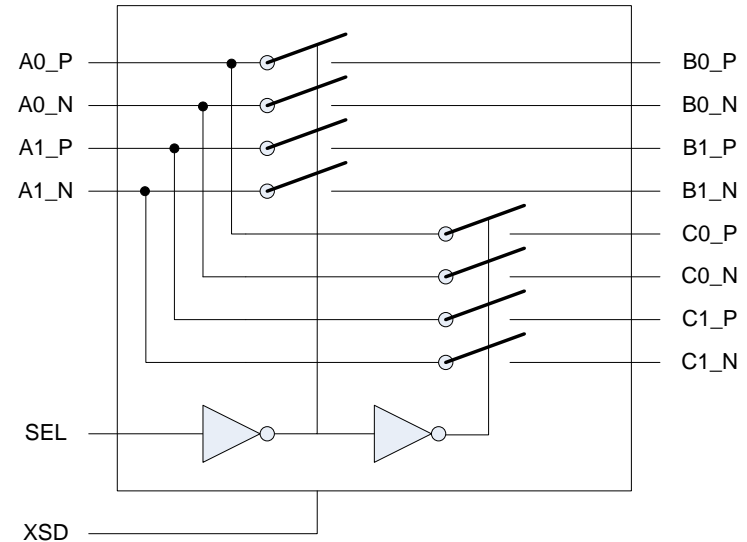
In Production

Support

- Product Information: www.nxp.com/interface/

- NXP Technical Support: www.nxp.com/support/

- Second-Level Support:
  - BL-Interface Products: interface.support@nxp.com
  - I^2C Specific: i2c.support@nxp.com

NXP Internet application pages

Device Pages

▸ Cellular / mobile phone solution

▸ Digital still camera

▸ E-book

▸ MP3 player

▸ Mobile internet device / tablet

Interface pages

▸ Audio interface

▸ Charging interface

▸ HDMI interface

▸ Memory card interface

▸ Mobile platform RF front-end

▸ SIM card interface

▸ Load switch

▸ Voltage translators