

SECURE INTERFACES & POWER SOLUTIONS

SEPTEMBER 2019



SECURE CONNECTIONS
FOR A SMARTER WORLD

NXP Secure Interfaces & Power Solutions

Signal Integrity & Routing Solutions

- Signal Switches & Re-drivers
 - USB 3.1, USB Type-C
 - Thunderbolt
 - PCIe, SATA, SAS
 - DP, HDMI, VGA
 - Audio, Data
 - Memory Interface

Industry leader in high-speed switching.
Lowest-power consumption re-drivers

Load Switches

- Over Voltage Protection
- Over Current Protection
- Reverse Current Protection
- Under voltage Lockout
- Thermal Shutdown
- Low RON
- Low Quiescent Current

HV Load switching with 100V surge protection.

Interface Solutions

- DisplayPort Bridges
- UARTS
- Comparators
- I²C Bus Buffers
- I²C Bus Controllers
- I²C Muxes & Switches
- Voltage Level Translators

Industry's largest I²C Portfolio for Mobile, Computing and Industrial.

Wireless Connectivity & Smart Sensor Solutions

- NTAG Smart Sensors
- NFMI Radio
- Audio over BLE
- RF & IF Discrettes
 - Transceivers
 - LNA's
 - Mixers
 - Switches

Integrated temperature logging solutions.
Ultra low-power single-chip solution, providing robust wireless audio streaming.

Security & Authentication

- Anti-Counterfeit Solution

Industry's smallest package with lowest power.

Power Solutions

- USB Power Delivery
- AC-DC Controllers
- DC-DC Boost Converters
- Direct Charging (Rapid Battery Charging)
- Wireless Charging (Qi/A4WP)
- PMIC
- Powerline Communication Modem

High efficiency power conversion.
Support of multi-charging protocols (Direct, USB-PD, QC, BC1.2, and proprietary).

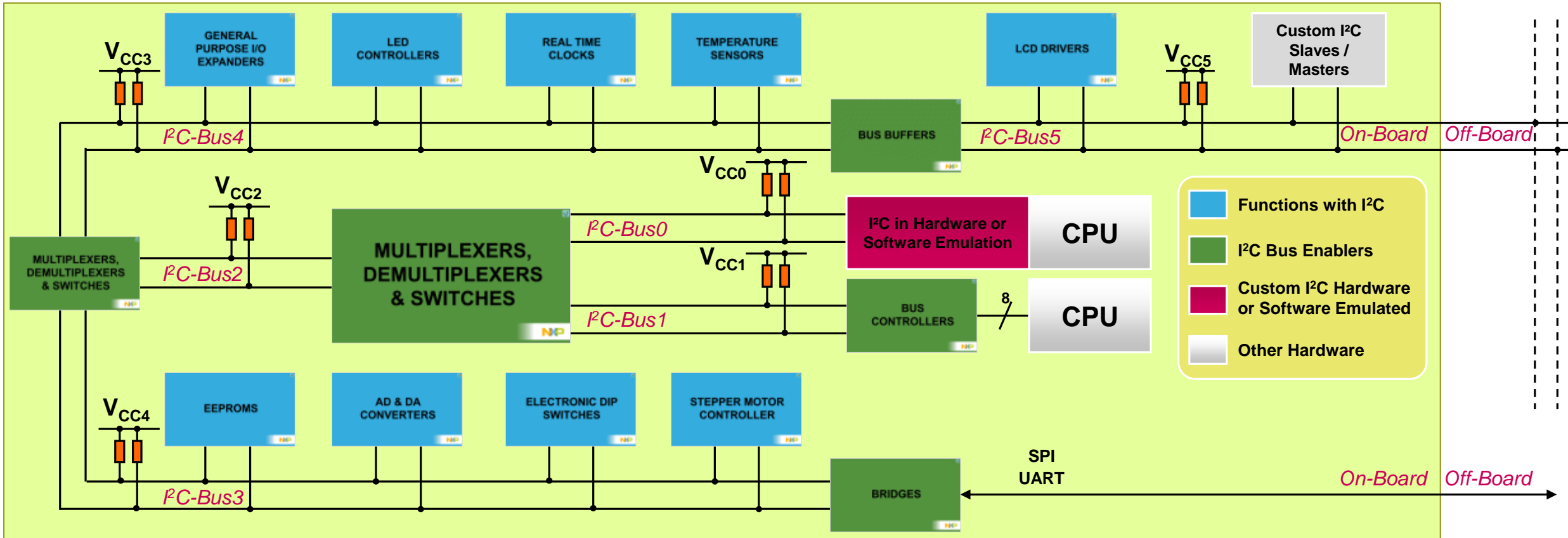
Bus Peripherals

- Real Time Clocks
- GPIO Expanders
- Temperature Sensors
- LCD Drivers
- LED Controllers
- Stepper Motor Controllers
- EEPROM
- Watch IC
- Data Converter
- DIP Switches

Ultra low-power RTC's.
Widest portfolio of GPIO Expanders.

Secure Interfaces & Power – Building Blocks

Click on any block to jump to the slide set! Click  to Return.



VOLTAGE LEVEL TRANSLATORS	NTAG SMART SENSOR	NFMI	AUDIO OVER BLE	AUDIO SWITCHES	GENERAL PURPOSE ANALOG SWITCHES	HIGH-SPEED SIGNAL SWITCHES	DISPLAY PORT SOLUTIONS	USB TYPE-C PD CONTROLLER & CC-LOGIC CONTROLLER	USB 3.0 RE-DRIVERS	COMPARATORS
UARTS	LOW-VOLTAGE DC/DC CONVERTERS	RAPID BATTERY (DIRECT) CHARGER	PMIC	WIRELESS POWER	AC/DC CONVERTERS	LOAD SWITCHES	PORT PROTECTION	POWER LINE MODEM	RF/IF	SUPPORT TOOLS





BUS CONTROLLERS





PCA9665 I²C-Bus Controller

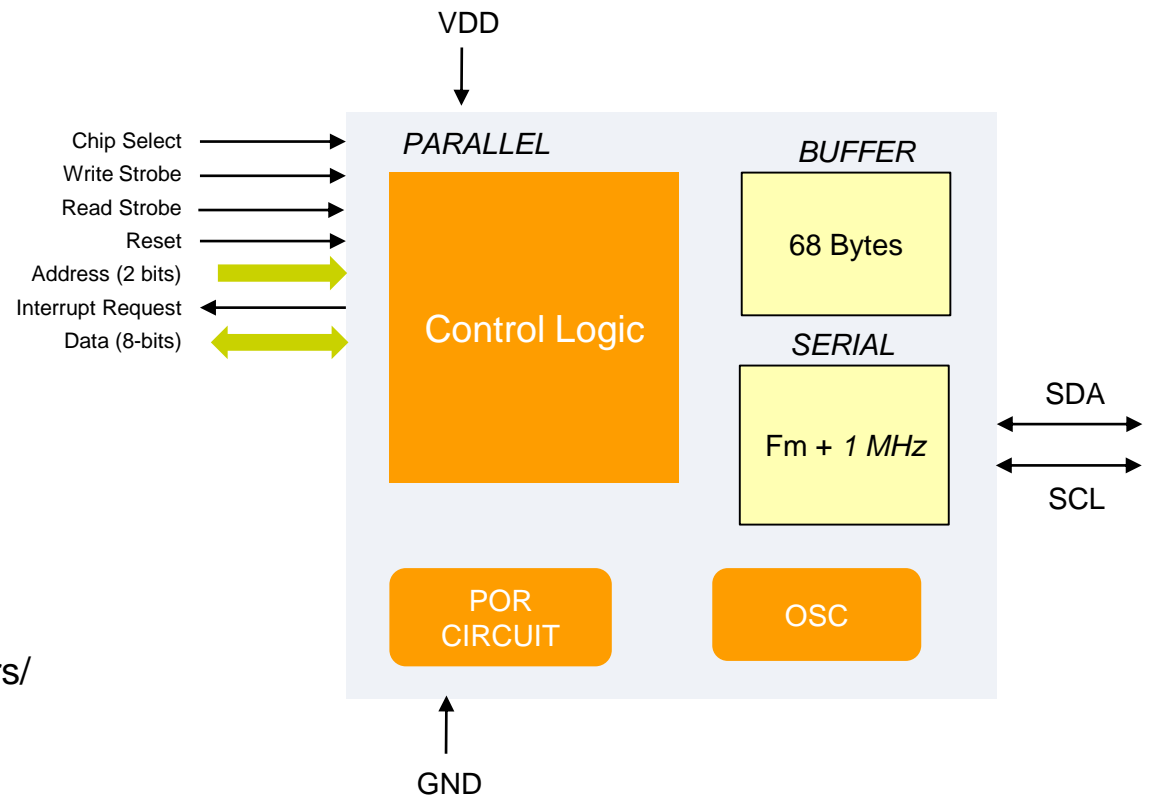
Parallel bus to Fm+ 1 MHz I²C-bus

FEATURES

- Converts parallel-bus to one Fm+ 1 MHz open-drain
- 68-byte buffer
- SW & HW reset
- Supply voltage: 3.0 V to 3.6 V
- 5V tolerant I²C-bus
- Multi-master capable
- Master and slave functions
- Up to 4000pF drive at reduced speeds

BENEFITS

- Serves as an interface between most standard parallel-bus microcontrollers/ microprocessors and the serial I²C-bus .
- Allows the parallel bus system to communicate with the I²C-bus

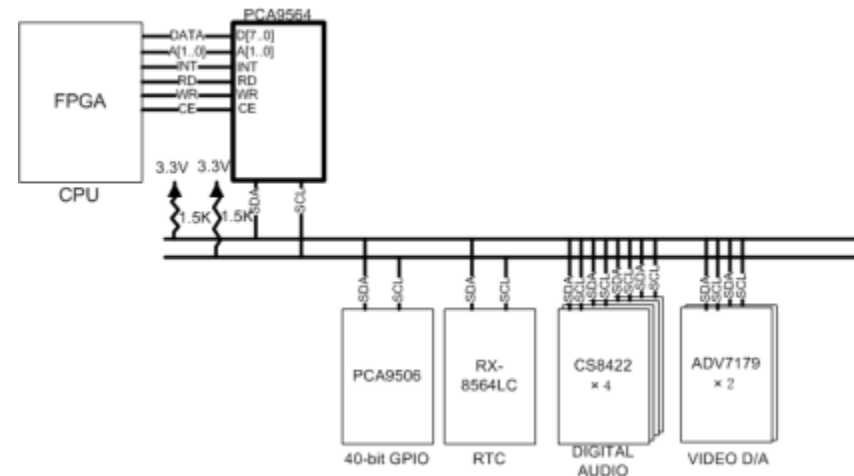
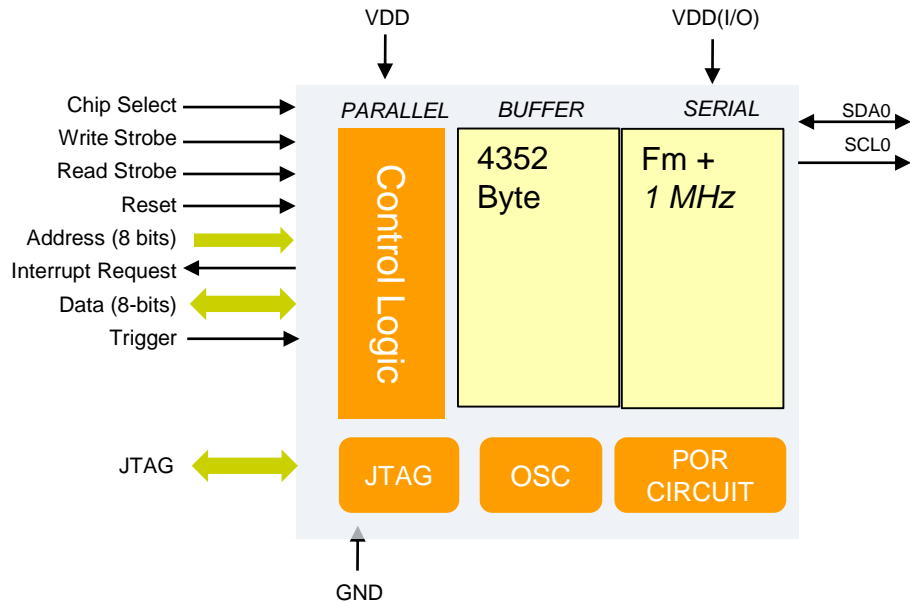


	Voltage range	Max I ² C freq	Clock source	Parallel interface
PCA9665 TSSOP20	2.3 - 3.6V w/5V tolerance	1 MHz	Trimmed Internal	50 MHz - Fast





PCA9661: 1-Channel Fast Mode+ Bus Controller



FEATURES

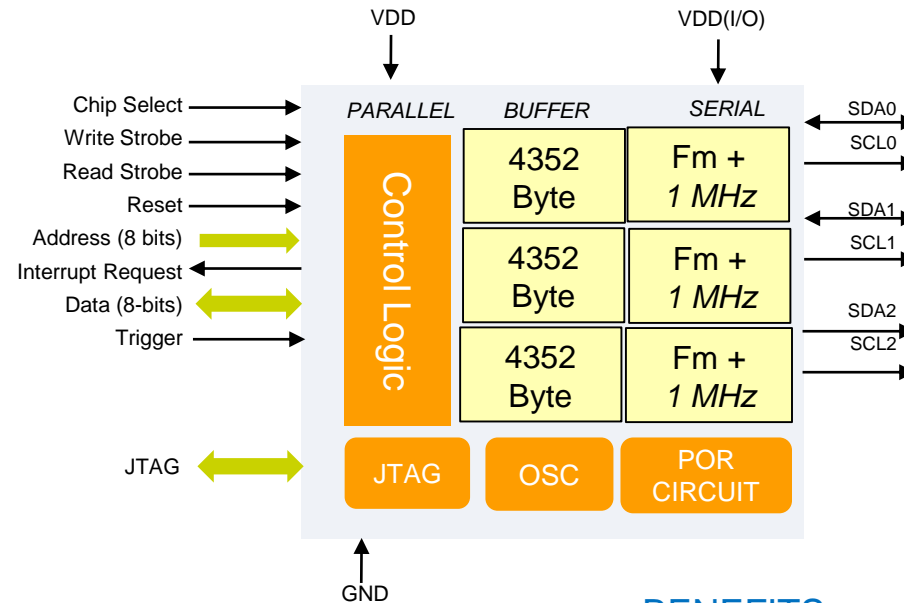
- Convert parallel-bus to 1 MHz I²C
 - 1 Mbps and up to 30 mA SCL/SDA IOL (Fm+) capability
- 4352 Bytes per channel data buffer
- Maskable interrupts
- Supply voltage: 3.0 V to 3.6 V with 5 V tolerant I²C-bus
- Buffer sequence looping with interval timer
- SW & HW reset
- LQFP48 package
- **For single master systems**

BENEFITS

- Offer 1 MHz Fm+ I²C-bus, maximizing throughput whereas read back/feedback is important
- Improve interrupts scheme from PCA9665 (no interrupt on START and SLA)
- Allow interrupts to be maskable to free CPU
- Off-load CPU with large data buffers
- Optimized register access with direct addressing



PCA9663: 3-Channel Fast Mode+ Bus Controller



FEATURES

- Convert parallel-bus to 1 MHz I²C
 - 3x1 Mbps and up to 30 mA SCL/SDA IOL (Fm+) capability
- 4352 Bytes per channel data buffer
- Maskable interrupts
- Supply voltage: 3.0 V to 3.6 V with 5 V tolerant I²C-bus
- Buffer sequence looping with interval timer
- SW & HW reset
- LQFP48 package
- **For single master systems**

BENEFITS

- Offer dual 1 MHz Fm+ I²C-bus, maximizing throughput whereas read back/feedback is important
- Improve interrupts scheme from PCA9665 (no interrupt on START and SLA)
- Allow interrupts to be maskable to free CPU
- Off-load CPU with large data buffers
- Optimized register access with direct addressing



PCU9669: 3-Channel Bus Controller

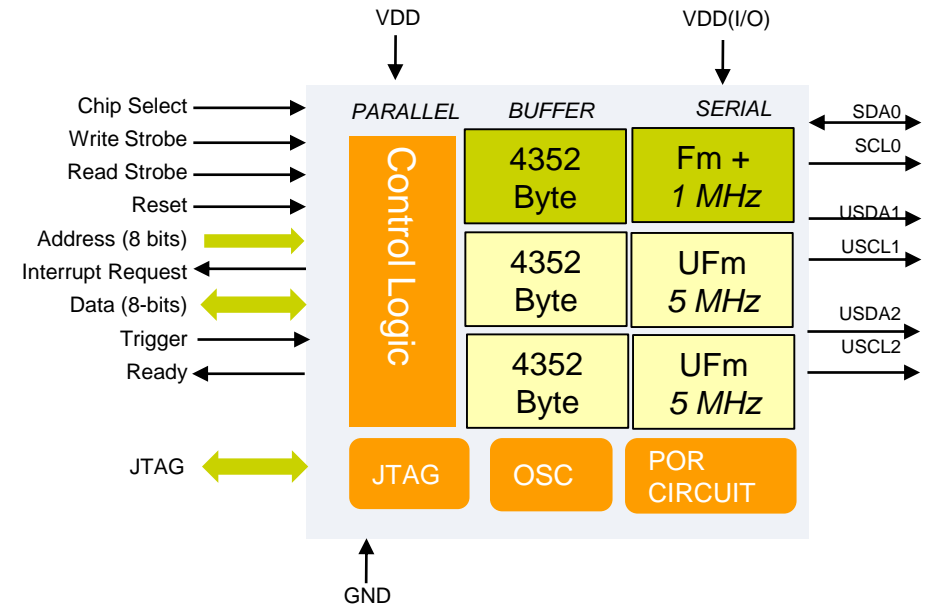
2x UFm 5 MHz, 1x Fm+ 1 MHz I²C-bus

FEATURES

- Convert parallel-bus to one Fm+ (Fast mode-Plus) 1 MHz open-drain I²C-bus and two UFm (Ultra Fast Mode) 5 MHz uni-directional push-pull serial bus
- Buffer size: 4352 bytes for each Fm+ or UFm channel
- Maskable interrupts
- Buffer sequence looping with interval timer
- SW & HW reset
- Supply voltage: 3.0 V to 3.6 V for logic, 3.0 V to 5.5 V for UFm
- LQFP48
- For Single Master Systems

BENEFITS

- Fm+ 1 MHz I²C-bus for fast stepper motor/feedback control
- UFm 5 MHz (no ACK) for fast LED and LED matrix control
- Deep buffer size, looping, and triggering ideal for complex lighting control, with minimum CPU bandwidth
- Improve interrupts scheme from PCA9665 (no interrupt on START and SLA) with maskable interrupts



Device	# channel	PCA	PCU
PCA/U9661	1-channel	1 Fm+	1 UFm
PCA9663	3-channel	3 Fm+	
PCU9668	3-channel		2 Fm+ 1 UFm
PCU9669	3-channel		1 Fm+ 2 UFm





BUS BUFFERS



I²C-Bus Buffer Family

Repeaters

PCA9509 Processor to SMBus	SO	PCA9515/15A/16A	SO
PCA9509A Processor to SMBus	SO	PCA9518A 5-Channel Hub Expander	SO
PCA9509P Processor to SMBus	SO	PCA9519 4 x PCA9509	SO
PCA9517A 0.9 – to 5.5V	SO	PCA9646 30-mA Drive; 1:4-Channel	NO
PCA9617A 0.8 to 5.5V	SO		
PCA9507 RTA for HDMI	SO		
PCA9527 PCA9507 + ½ PCA9517	SO		

Hot-Swap Buffers

PCA9508 Active Level Shifter	SO
PCA9510A No Accelerator	IO
PCA9511A 0.6-V Threshold	IO
PCA9512A Active Level Shifter	IO
PCA9513A 92-µA Current Source	IO
PCA9514A 0.8-V Threshold	IO

Extenders (Long Cable) (Long Cable Drivers)

P82B96 [1]	SO
P82B715 No Static Offset	AM
PCA9600/9601 1-MHz Speed	SO
PCA9614/15 2-CH Differential Driver	SO
PCA9616 3-CH Differential Driver	SO

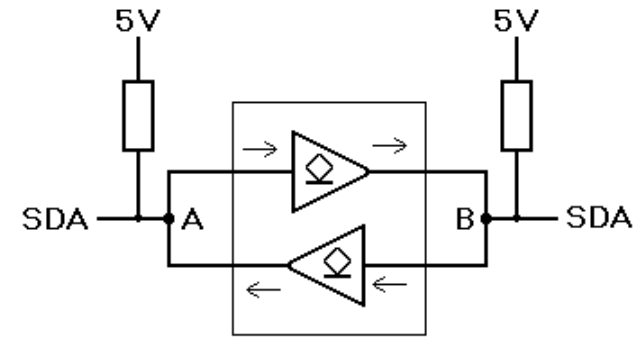
- NO** = No Offset
- SO** = Static Offset
- IO** = Incremental Offset
- AM** = Amplifier

[1] P82B96 is widely used for opto-isolation applications
Blue → 1 MHz system



The Need for Special Buffers on I²C-Bus

- The I²C-bus assumes the possibility of simultaneous bi-directional signal flows
 - Without any buffers, the bus wires are clearly bi-directional.
- Conventional buffers only handle signals traveling in one direction at any one time
 - There are logic buffers with a direction control pin, but at any one time they are uni-directional
- Buffers for use on an I²C-bus must not have any pull-up capability. They must have open-collector or open drain outputs
- If two conventional logic buffers are connected as shown then they will simply latch to the LOW state the first time either side goes LOW
 - The logic symbol represents a non-inverting, open drain, buffer

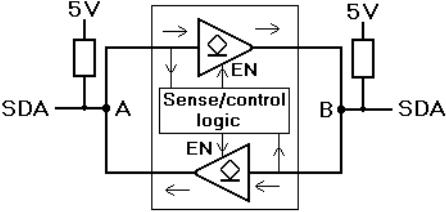
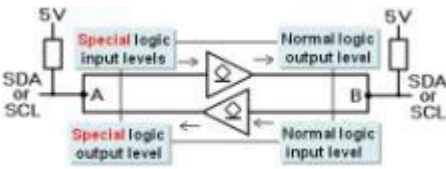
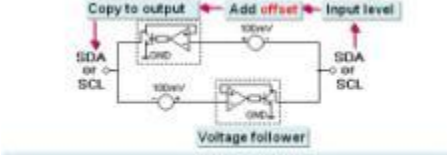
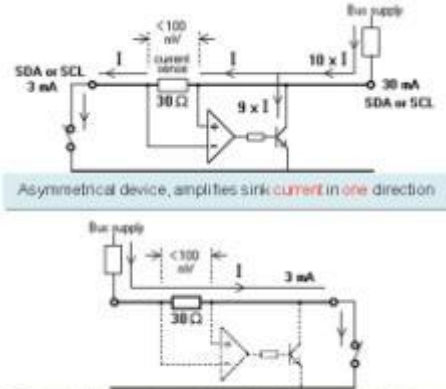


If side A is externally pulled LOW, then the upper open drain buffer pulls the bus at side B to the LOW level.

With this LOW now on side B, the lower buffer will pull side A LOW and even if the external drive at A is removed, the buses at A and B will simply remain latched LOW.

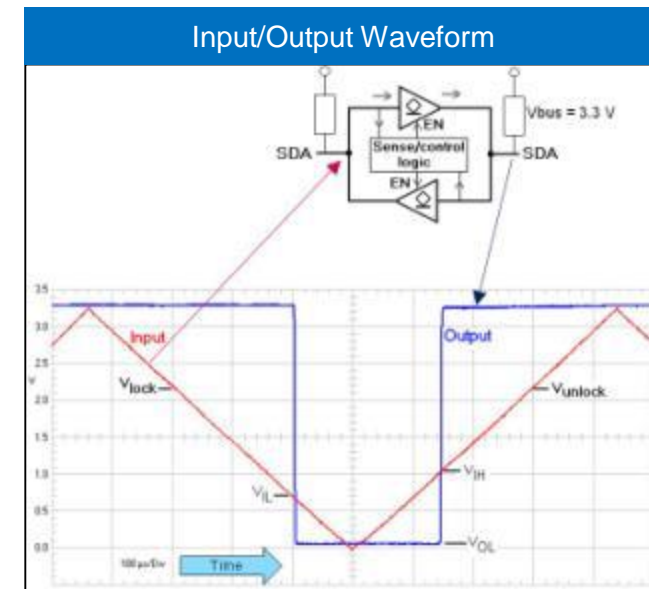
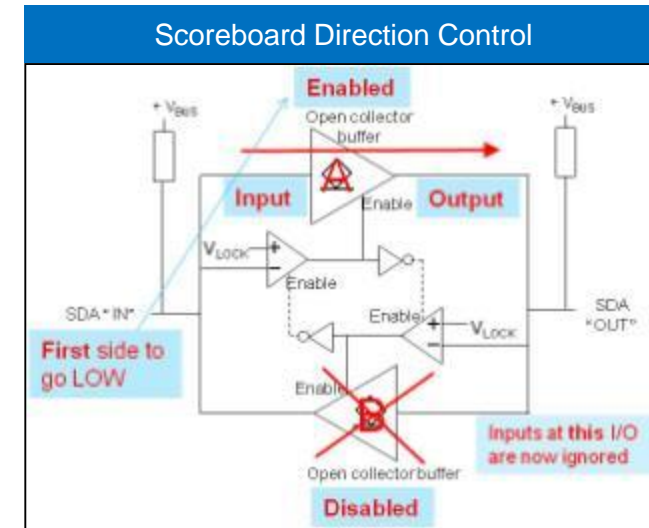
A special type of buffer is required for I²C-bus.

Understanding I²C-Bus Buffer Technologies

No Offset	Static Offset	Incremental Offset	Amplifier
		 <p style="text-align: center;">Symmetrical buffer using offsets applied to the input levels</p>	 <p style="text-align: center;">Behaves like a passive resistor when higher current side is pulled low</p>
<p>Characteristics:</p> <ul style="list-style-type: none"> • Buffer automatically changes direction in response to the applied drive signal • For use on SDA line <u>ONLY</u> • Buffer output has “no offset” and pulls its output down very close to 0V 	<p>Characteristics:</p> <ul style="list-style-type: none"> • A fixed third logic level is introduced on the special I/O side • The third logic level is higher (static offset) than 0.4V, but low enough to still be a low to the other devices on the bus 	<p>Characteristics:</p> <ul style="list-style-type: none"> • A dynamic third logic level is introduced by adding an incremental offset voltage to the input • Either bus will be driven (down), by a voltage follower, to a level 100mV higher than the voltage level of the other bus 	<p>Characteristics:</p> <ul style="list-style-type: none"> • The bus current is amplified, but in only one signal direction • Current gain enables a 3-mA driver on the input side to drive a bus with 30-mA pull-up on the other side

No Offset Buffer Characteristics

- Compatible (but not compliant) with I²C-bus or similar buses
 - Uni-directional clock
 - The first one to score (first input to go low) takes control of the bus and the other is disabled
 - When an input falls below V_{lock} , the buffer becomes enabled and the other buffer is disabled. When the controlling input signal rises above V_{unlock} , the buffer is disabled and the device is ready to process any side that goes low next or may be already low, but was unable to take control.
 - To prevent latching, Buffers A and B must never be enabled at the same time
 - Both buffers are able to drive their outputs fully low, near 0V.
 - Buffer creates glitches when it changes direction and so cannot be used on the SCL line. Therefore, clock stretching is not allowed and a true multi-master system cannot be implemented.
 - Devices with “No Offset” is PCA9646.



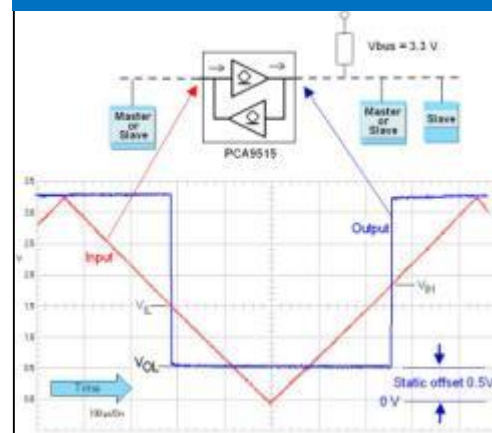


Static Offset Buffer Characteristics

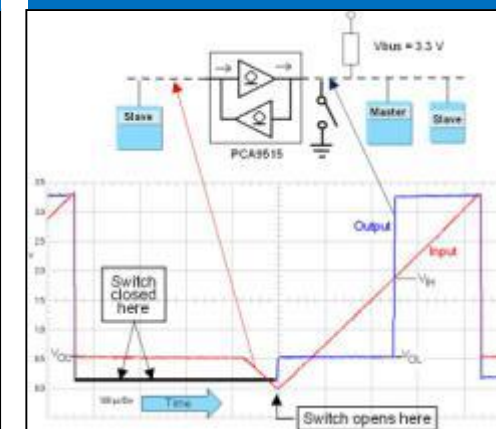
Compatible (but not compliant) with I²C-bus or similar buses

- Fully bi-directional
- Support multi-master operation, including clock stretching, and **do not generate any 'glitch'**
- Isolates the bus
 - The resistive and capacitive loadings connected on one side will have no loading effect on the other side of the bus
 - The rise times of buses connected at either side are determined only by the components of each bus
- Regenerates the input signal, but at a slightly higher output level on the **static offset side(s)**
 - Clean logic output LOW levels independent of their logic input LOW amplitude
 - **The special output LOW (VOL) is fixed at a level slightly higher level than the 0.4 V maximum requirement for driver devices**
 - For a bus operating above 3 V that complies with the I²C-bus requirement for a LOW to be $<0.25 \cdot V_{bus}$
- Devices with "Static Offset are PCA9507, PCA9508, PCA9509, PCA9515A, PCA9516A, PCA9517A, PCA9518A, PCA9519, PCA9614, PCA9615, PCA9616, PCA9527, PCA9600, PCA9601, P82B96

Special Input Levels (I/O Waveform)



V_{ILc} Requirement Met

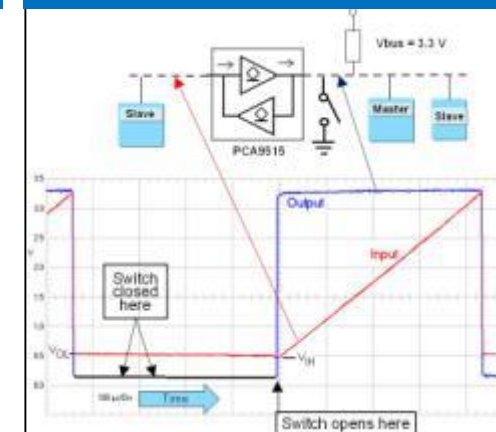


"Signature" Rising Edge Waveform



This 'step' is not a fault.
The 'step' is not a problem.
It's the characteristic 'signature'
of a static offset buffer.

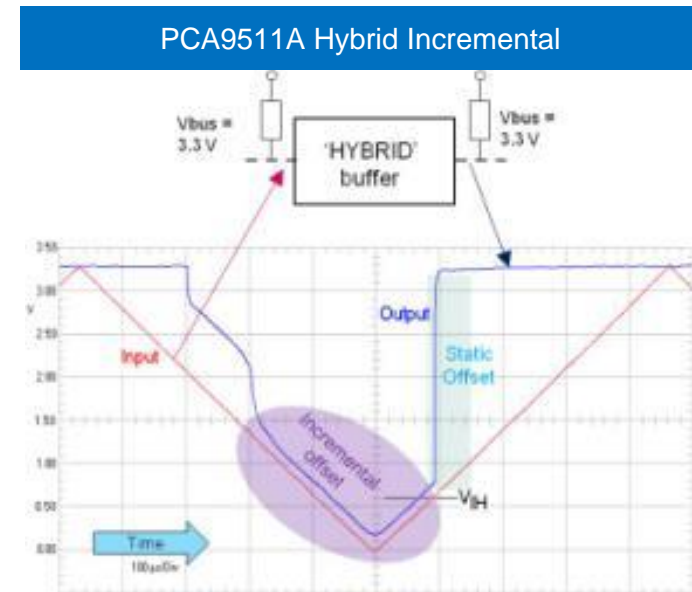
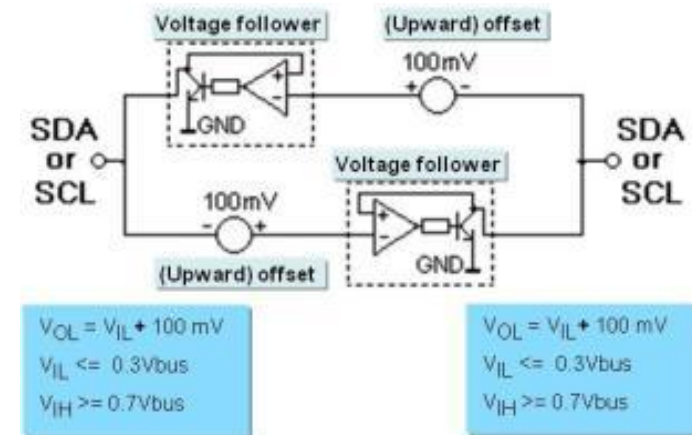
V_{ILc} Requirement not Met





Incremental Offset Buffer Characteristics

- Compatible with I²C-bus or similar buses
 - Fully bi-directional
 - The V_{IL} and V_{IH} levels are I²C-bus compliant
 - The V_{OL} level will also be I²C-bus compliant provided the V_{IL} level is designed to be just 100mV lower than the corresponding V_{OL} bus requirement ($\leq 0.3 \cdot V_{bus}$)
 - The concept and levels used in this type of buffer achieve the closest approximation to a “perfect” I²C-bus buffer
 - The V_{IH} level is chosen to be just slightly higher than V_{IL} because that remains I²C-bus compliant, yet enables this type of buffer to be applied in logic level shifting applications
 - The PCA9511A (and PCA9510A/12A/13A/14A) mixes some of the incremental offset characteristics and the static offset characteristics. During the falling edge, the buffer resembles an incremental offset type. If the input level falls below 0.5V, it changes its characteristics to a static offset type with V_{IH} of 0.6V.

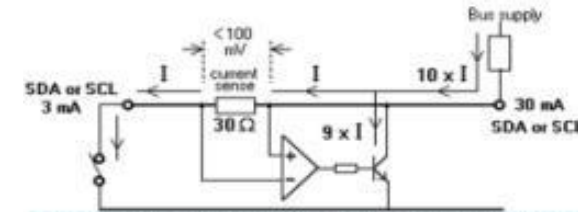




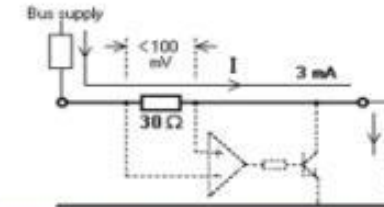
Amplifier Buffer Characteristics

- Compatible (and compliant) with I²C-bus or similar buses
 - Fully bi-directional
 - By amplifying the sink current of the I²C driver, a standard I²C device with normal sink current capabilities of 3mA can drive a bus with a low value pull-up resistor.
 - P82B715 has a current gain of 10x in one direction and allows connection of a bus with its pull-up resistor scaled for 30-mA sink current.
 - Because the two I/Os are joined internally by a 30Ω resistor, there can never be a voltage difference greater than 100mV between them. Typically, it's about 70mV. Logic voltage shifting is not possible for this part.
 - The inputs have no switching thresholds, so its input levels are always I²C compliant. Its output levels will be I²C compliant if the input levels are just slightly lower (100mV lower) than the requirement.
 - The current amplifier senses the current being sunk by its driver and internally sink to GND a current 9x larger than that drive. That gives the device a total sink current of 10x the driver sink current.
 - The driver therefore only “sees” 1/10th of the actual load on the 30-mA bus – but note that the load current is only “scaled”, it is not isolated as it is when using the other three device classes that we call “buffers” because they do isolate the loading.
 - Capacitive loading is also scaled. 4,000pF on the 30-mA bus is equivalent to 400-pF on the 3-mA bus

Asymmetrical, No Direction Control

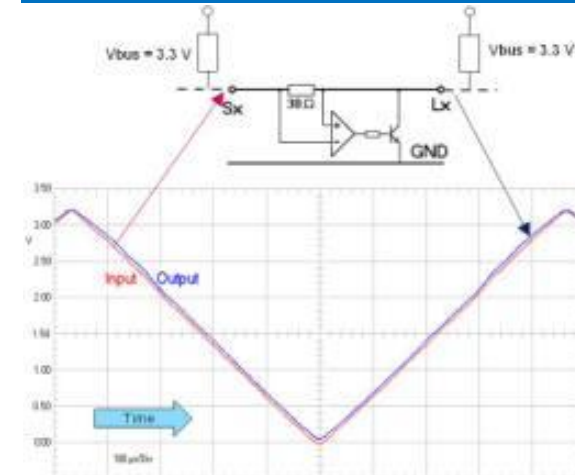


The driver for the bus at the left side only needs to sink 1/10 of the 30 mA current in the pull-up resistor of the bus on the right.



The driver for the bus at the right side needs to sink all of the 3 mA current in the pull-up resistor of the bus on the left.

P82B715 Input/Output Waveform





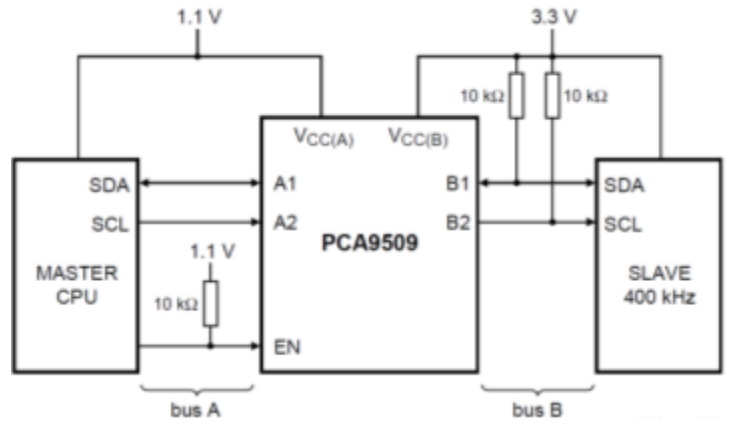
Pros & Cons of Different Types of Buffers

+	NO OFFSET
<ul style="list-style-type: none">• Both I/Os pull-down to zero volts for full level swing and best• Noise margin on output side• Both inputs interface with any slave and with most buffers	<ul style="list-style-type: none">• Only used on SDA due glitch during auto reversing• Only class that doesn't support clock stretch or multi-master because SCL buffer is unidirectional• User required to design Master's timing to accommodate buffer and any system delays
INCREMENTAL OFFSET	
<ul style="list-style-type: none">• Good V_{OL} as long as V_{IL} is low enough• Can be used in series or parallel• Supports logic level shifting• Only type where both I/Os can be fully I²C compliant	<ul style="list-style-type: none">• Offsets add up as parts are placed in series
HYBRID INCREMENTAL OFFSET	
<ul style="list-style-type: none">• Good V_{OL} as long as V_{IL} is low enough• Variety of parts available including parts with special features such as rising edge accelerators, pre-charge, and current source pull-up	<ul style="list-style-type: none">• Offsets add up as parts are placed in series• Can only be used for level shifting when part uses dual power supplies• V_{IL} requirement restricts the bus low voltage
STATIC OFFSET	
<ul style="list-style-type: none">• Strong drive down to V_{OL} (~0.6 V)• Wide range of single and hub parts with special features and options - offset voltage, drive strength, over-voltage tolerance, offset on only one side or all sides• Work with any slave when bus low voltage is acceptable	<ul style="list-style-type: none">• Forces a restrictive low bus voltage requirement on the static offset side• Side using offset generally cannot interface with other buffers
AMPLIFIER	
<ul style="list-style-type: none">• Allows driving high capacitance (~4,000 pF) with low value pull-up resistors• Strong drive (30mA)• No input level switch points	<ul style="list-style-type: none">• No enable• Not over-voltage tolerant• Input not isolated from output



I²C-Bus Repeaters

- 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 and speed of >3MHz (up to 30MHz) is required
- NXP Level Shifter Portfolio



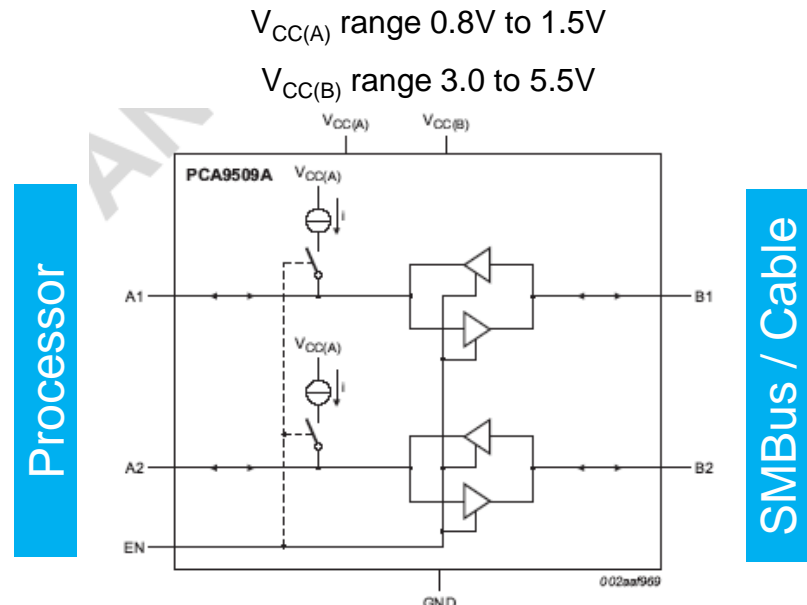
Device	Description	Normal I/O	Static Level Offset I/O	Idle Stop Detect for Hotswap	ESD (HBM)
PCA9508	0.9V-to-5.5V Level Shifter with Offset Free Hot-Swap	A Side	B Side	×	6KV
PCA9509	1.0V-to-5.5V Level Shifter	B Side	A Side		2KV
PCA9509A	0.8V-to-5.5V Level Shifter	B side	A Side		2KV
PCA9515A	3.3V / 5.0V I ² C-Bus Repeater		A & B Sides		2KV
PCA9516A	5-Channel I ² C Bus Hub		A & B Sides		2KV
PCA9517A	0.9V-to-5.5V Level Shifter	A Side	B Side		5KV
PCA9617A	0.8V-to-5.5V Level Shifter	A Side	B Side		5KV
PCA9518A	5-Channel I ² C Bus Hub Expander		A & B Sides		2KV
PCA9519	1.1V-to-5.5V Quad Level Shifter	B Side	A Side		2KV





PCA9509A 0.8 V to 3.3/5 V Translator

- Bidirectional Voltage translation between 0.8V -1.5V and 3.0 V – 5.5 V without directional pin
- Isolates bus capacitance
- ENABLE signal threshold controlled from 0.8 V side but is 5 V tolerant
- Ideal for 0.8 V master controlling 3.3/5 V slave or vice-versa
- No external pull-up required on the 0.8 V side due to internal current source. No additional components required.
- Lower current consumption
- TSSOP8 and XQFN8 packages
- Target Applications
 - Interfacing with very low voltage processors to support existing peripherals



A Side

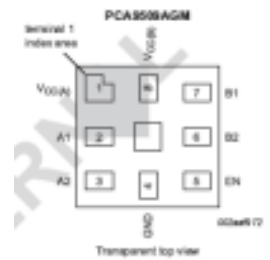
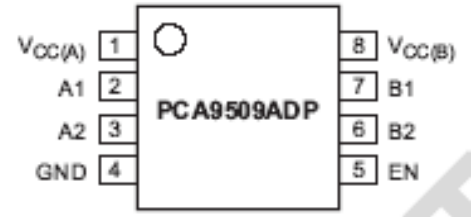
B Side

Static Offset

Normal I²C Levels

Low Voltage Side

SMBus/5V

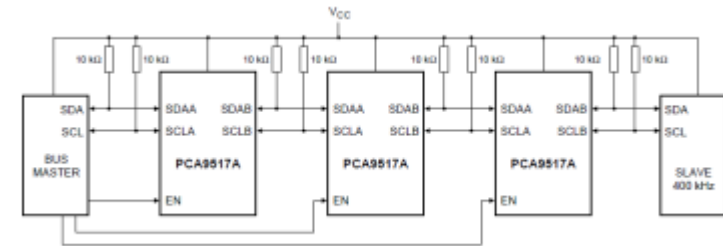
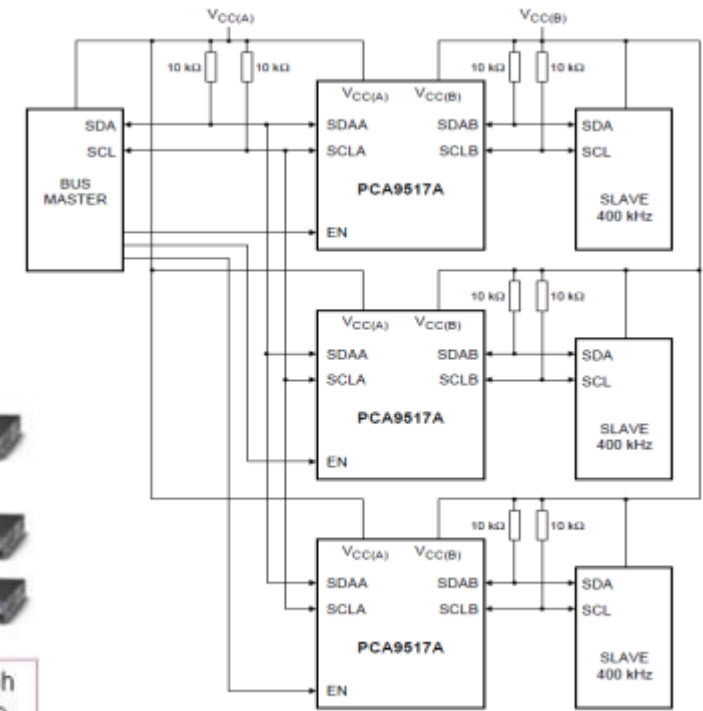
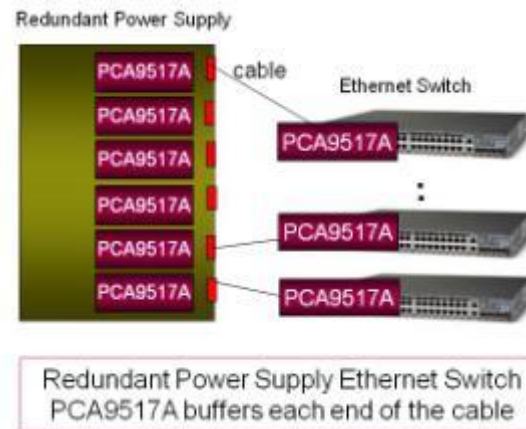




PCA9517A

Voltage-Level Translating Buffer for I²C-Bus

- Dual V_{CC} for level translation:
 - V_{CCA} : 0.9 V to 5.5 V (Low Side)
 - V_{CCB} : 2.7 V to 5.5 V
- Isolates capacitance and noise for cable application
 - Used to enable bus in star configuration
 - Used to for voltage translation in star configuration
 - Used to re-drive (repeater) in series configuration
- Incurs no voltage offset
 - A-side has normal drive levels
 - B-side has static offset levels
- I/O is high impedance when V_{CC} or EN is off
- 5.5kV HBM ESD Protection
- Packages: SO8 and TSSOP8



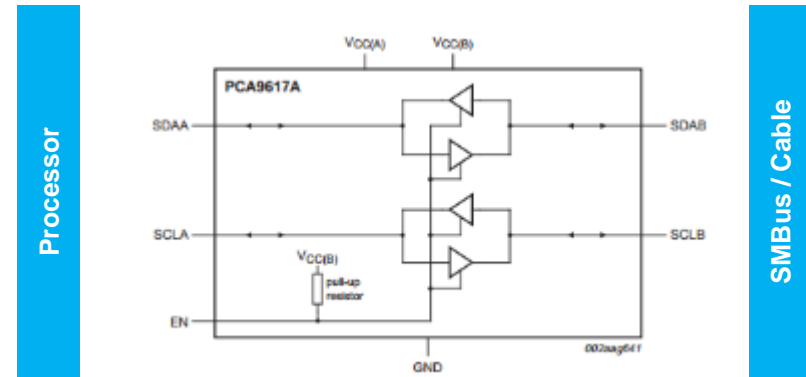


PCA9617A 0.80 V to 2.5/3.3/5V Translator

- Bidirectional Voltage translation between 0.80V – 5.5V and 2.2 – 5.5V without directional pin
- Isolate bus capacitance/level shift
- **Static offset 2.5/3.3/5V side**
- Supports **1 MHz system** operation for Grantley platforms
- ENABLE signal threshold controlled from 0.8 V side but is 5.5V tolerant
- Ideal for 0.8 V master controlling 2.5/3.3/5V slave or vice-versa
- **External pull-up required on both sides**

$V_{CC(A)}$ range 0.80V to 5.5V

$V_{CC(B)}$ range 2.2 to 5.5V



A Side

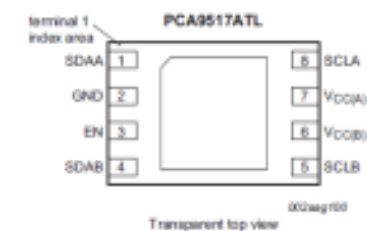
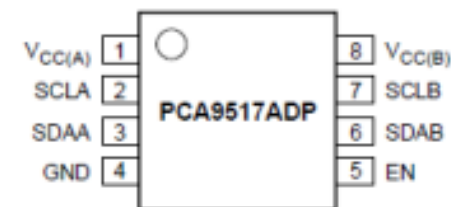
Normal I²C Levels

Low Voltage Side

B Side

Static Offset

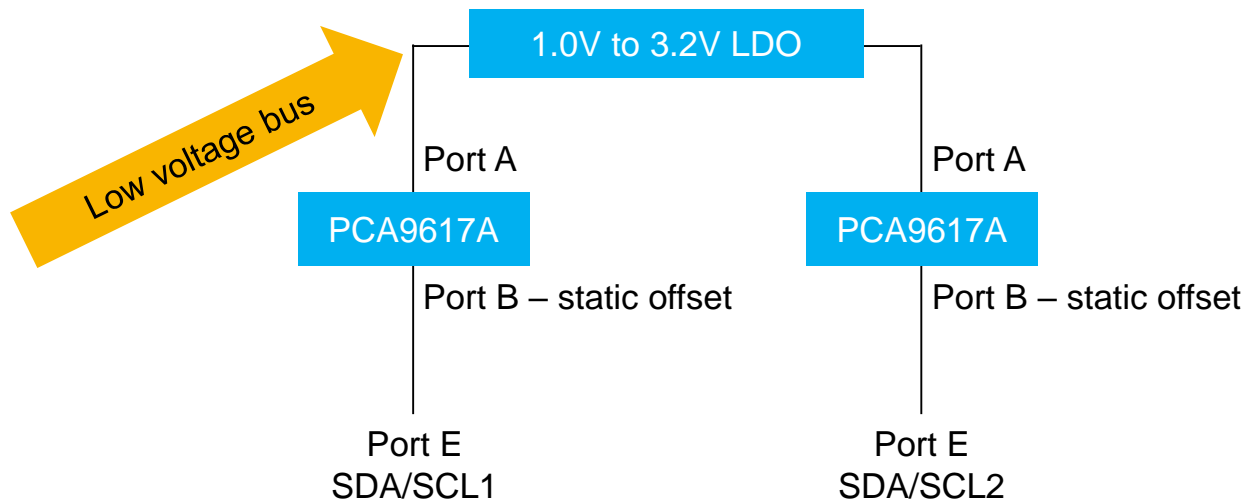
2.5/3.3V SMBus





OM13398: PCA9617A Bus Buffer Evaluation Board

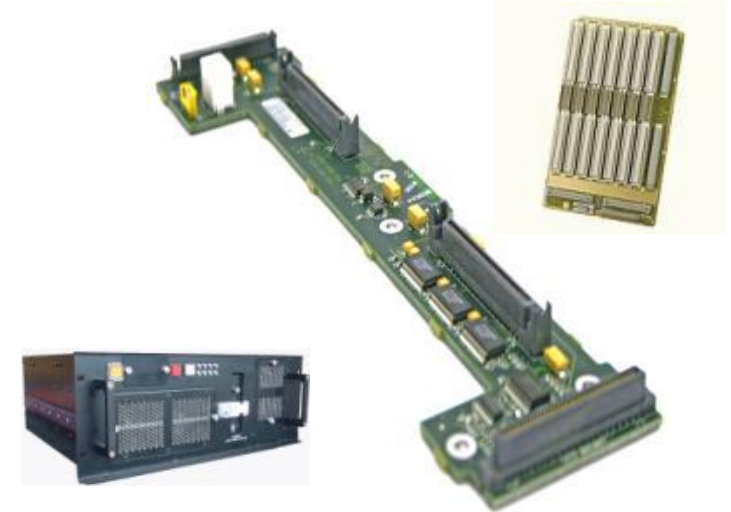
- Fm+ Bus buffer with PCA9617A (could also use PCA9517A @ 400 kHz)
- On board adjustable voltage supply for VCC(A) (1.0V – 3.2V)
- Fm+ supply for VCC(B) (3.3V or 5V)
- Twin buffer signal flow
- MSOP8 or HWSON8 footprints
- User select Pull-up values (A side)
- User select Capacitor loading





Hot-Swappable Buffers

- Why used?
 - During hot-swapping, glitches on the SCL and SDA lines may cause data corruption on the I²C-bus. The NXP hot-swappable buffers will prevent any data corruption in these applications.
- Where used?
 - Applications requiring I/O card insertion into a live system
 - Multipoint Backplanes Cards
 - VME
 - cPCI
 - AdvancedTCA Cards
- NXP Level Shifter Portfolio



Device	Accelerator	1-V Precharge	Ready OD Output and Low I _{CC} Disable	Dual-V _{CC} for Level Translation	92-μA Current Source	ESD (HBM)
PCA9508				x		6KV
PCA9510A		x (Input Side Only)	x			2KV
PCA9511A	0.6V	x	x			2KV
PCA9512A	0.6V (with Disable Pin)	x		x		2KV
PCA9513A	0.8V		x		x (Input Side Only)	2KV
PCA9514A	0.8V		x			2KV





Long-Distance Bus Buffers

- Why used?
 - Drives the I²C-bus signals over a long-distance cable and through inter-connects
 - Re-drive the SCL and SDA signals into loads exceeding the maximum specified 400-pF bus capacitance
- Where used?
 - Between card interconnects (does not support voltage level translation)
 - In noisy environment with compressors, pumps, relays, EMI, etc.
 - To eliminate the need for multiple costly bus controllers
 - AdvancedTCA
 - Opto-Couplers Interface
- NXP Long-Distance I²C-Bus Buffer Portfolio

Device	V _{CC}	F _{MAX}	Max Cable-Side Load	Cable Length	Capacitance Isolation	Interrupt	Signal Levels	ESD (HBM)
P82B715	3.0V – 12.5V	100kHz	3,000pF	50m			Single-ended	2.5KV
P82B96	2.0V – 15.0V	400kHz	4,000pF	20m	x		Single-ended	3.5KV
PCA9600/01	2.5V – 15.0V	1MHz	4,000pF	20m	x		Single-ended	4.5KV
PCA9614/15	3.0V – 5.5V	1MHz		100ft	x		Differential	4.0KV
PCA9616	3.0V – 5.5V	1MHz		100ft	x	x	Differential	4.0KV





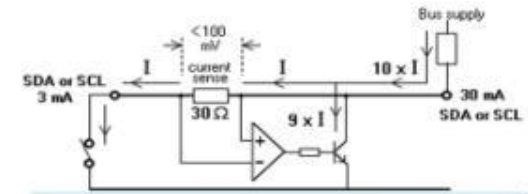
P82B715: I²C-Bus Extender

• Features

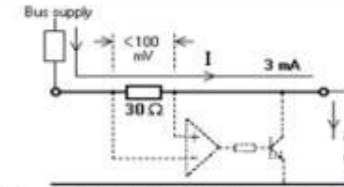
- Wide supply voltage range from 3V to 12V
- Amplifies the bus drive current in one direction
- Scales the current drive by 10x, but does not isolate the bus
- Scales the capacitive loading and is capable of driving 4000pF load
- Inputs have no switching level thresholds
- Compatible with I²C-bus, SMBus, and PMBus
- Does not do voltage level shifting

• Applications

- Driving a bus with low pull-up resistors
- Extending the communication distance of the I²C-bus over wire

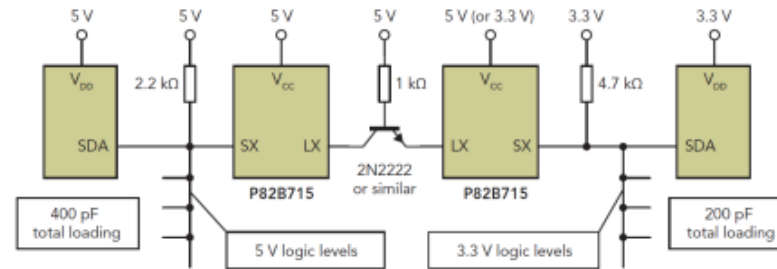


The driver for the bus at the left side only needs to sink 1/10 of the 30 mA current in the pull-up resistor of the bus on the right.

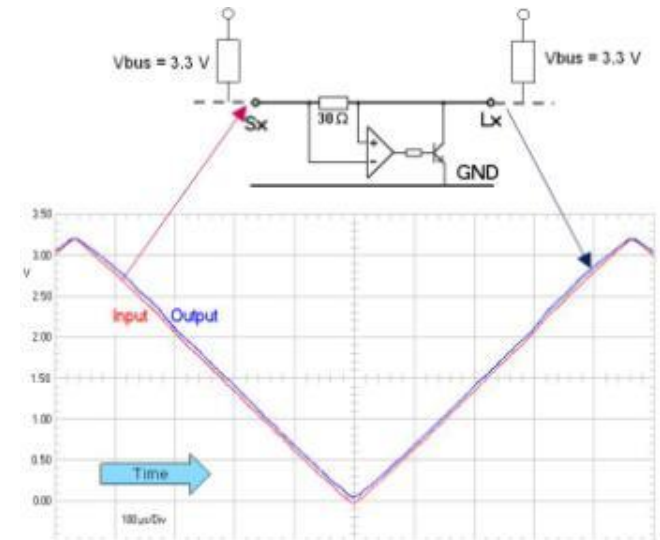


The driver for the bus at the right side needs to sink all of the 3 mA current in the pull-up resistor of the bus on the left.

Note how the two I/Os are internally connected by a 30 ohm resistor. For all input voltages, the voltage difference between I/Os never exceeds 100 mV.



Using simple discrete for logic level translation





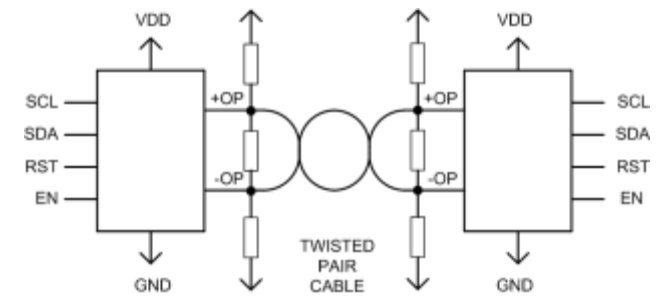
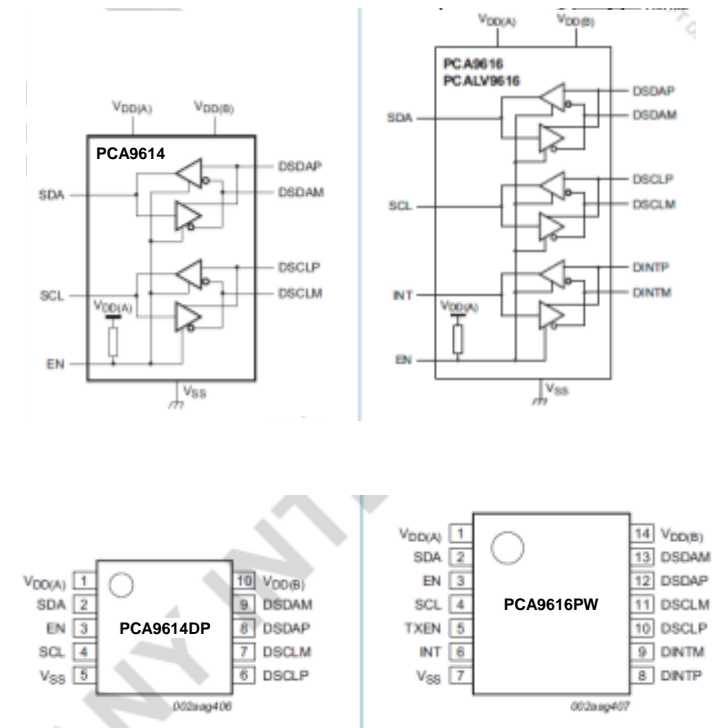
PCA9614/15/16 Differential I²C-Bus Drivers

• Features

- Multi-point differential I²C-bus buffers
- Communicate over long distances
- Supports normal I²C mode (100kHz), and fast mode (400kHz)
- Drive cable lengths up to 100 ft
- Differential signaling to reduce noise and ground offset
- Twisted pair cable (or PCB traces) must be terminated at both ends in the characteristic impedance of the cable (or PCB format)
- For the correct I²C-bus "idle" condition the terminations are biased to supply and ground

• Applications

- Ideally suited for rugged high-noise or long-cable applications:
- Temperature monitors and leak detectors on remote-board environment with interrupt back to master
- LED control
- Open or short detection
- Power supply control in high-noise environment
- Heating and cooling control



Only one of two pairs shown

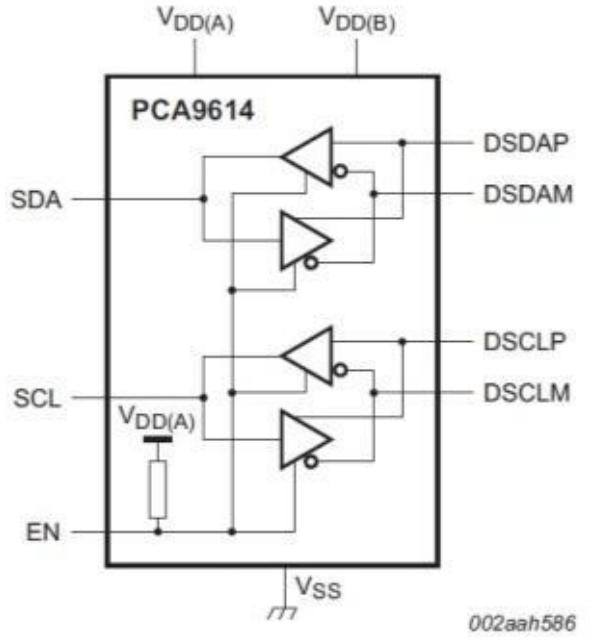




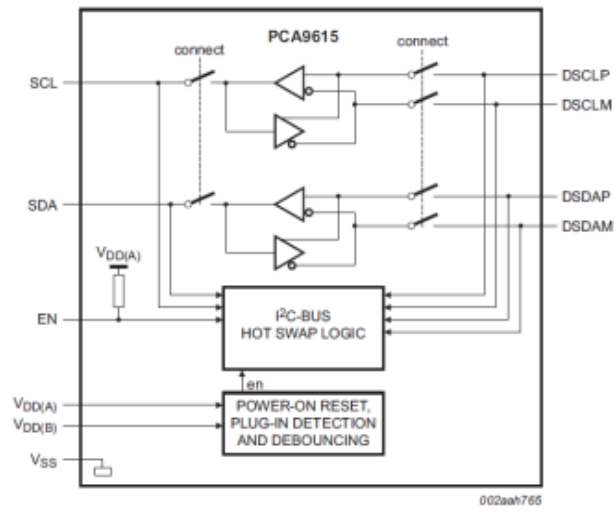
PCA9614/15/16 Differential I²C-Bus Drivers

Block Diagrams

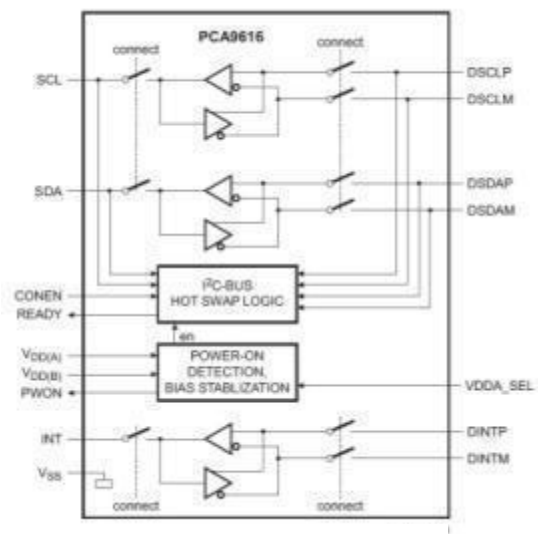
PCA9614



PCA9615



PCA9616



- Simple
- Physical layer translation

- With hot-swap capability
- Connects bus only when voltages on differential side are idle

- With additional channel for interrupt or any other control signal





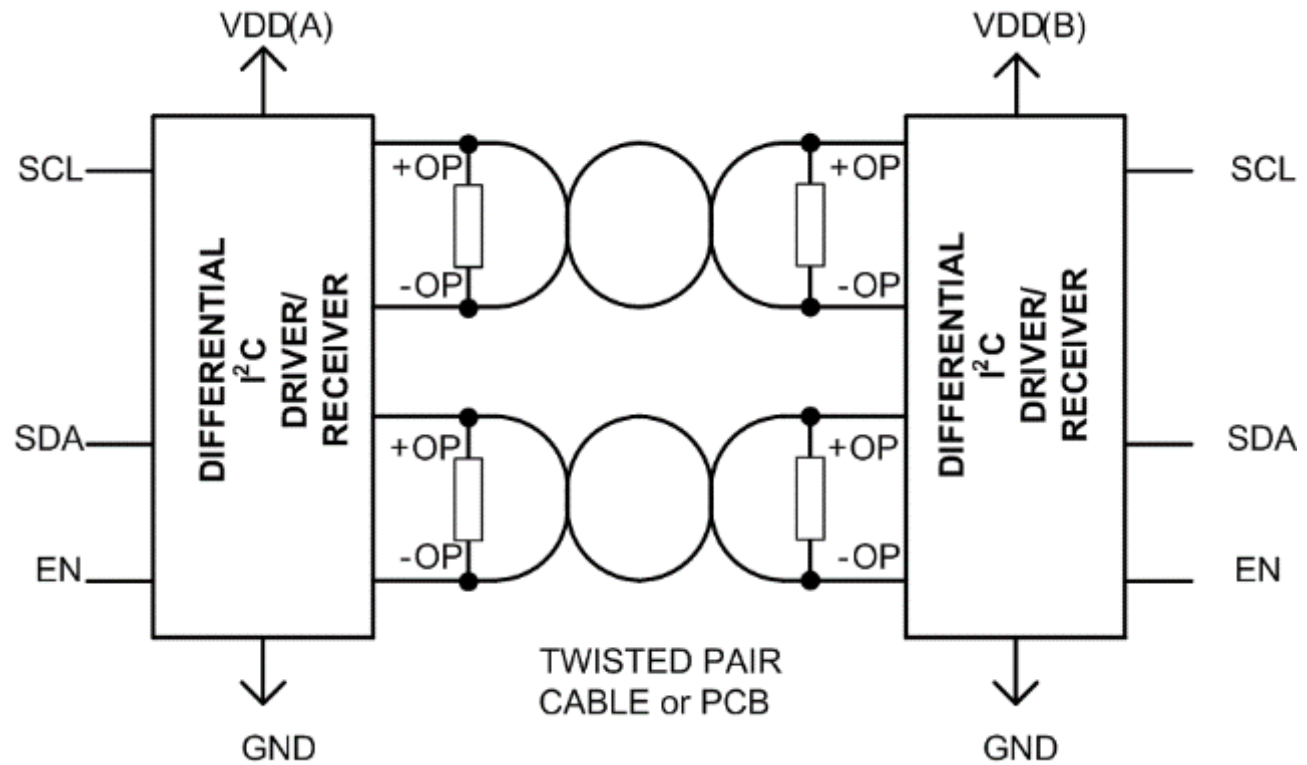
Solve Your I²C Noise Problem with Differential Signaling!

- The I²C bus has remained popular for a long time; it has the right features and cost to solve many diverse applications
- When applied to large systems I²C shows weak noise immunity
- NXP has developed a new technique to solve your noise problem



Full Differential I²C

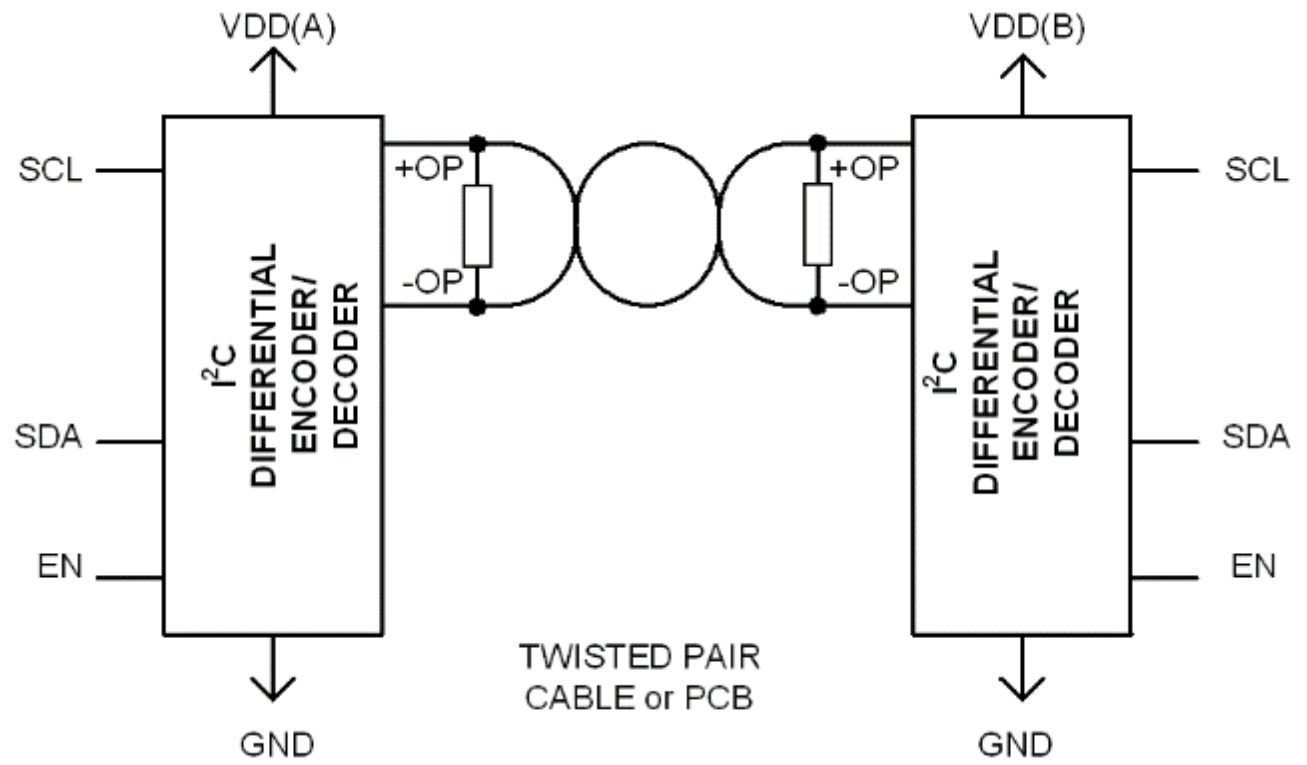
- For the most transparent I²C upgrade, use the full differential solution with two twisted pairs, one each for Clock and Data





Encoded Differential I²C

- If your design is pin count or wire count limited to just two nets, use the encoded differential I²C solution, which operates on existing wiring and delivers improved system performance





Differential Signaling Advantages

- Differential signaling is well known in the telephone industry to reduce cross-talk, (Patented in 1881). The same benefits apply today to differential I²C techniques

Noise Reduction and immunity

- Two identical signals of opposite polarity are sent over a terminated transmission line. Differential signaling results in cancellation of interfering noise. Correct termination at both ends of long runs removes detrimental overshoot and undershoot (found on the I²C bus)

Ground (Common-mode) Offset

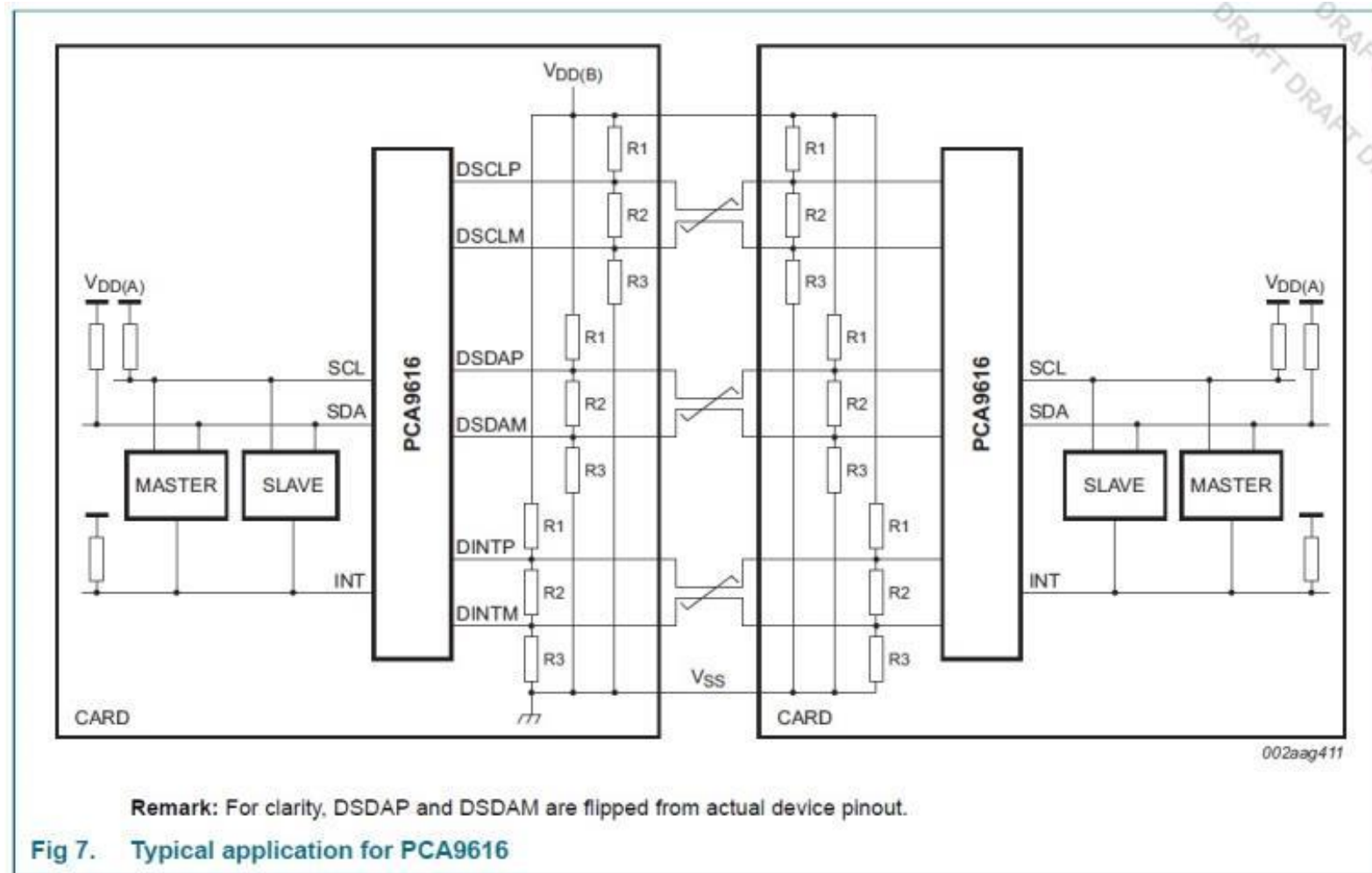
- An added advantage is that differential signaling doesn't require a dedicated ground connection, allowing differential I²C signal to pass unharmed between two locations that may not be at exactly the same ground potential



Encode – Decode Advantages

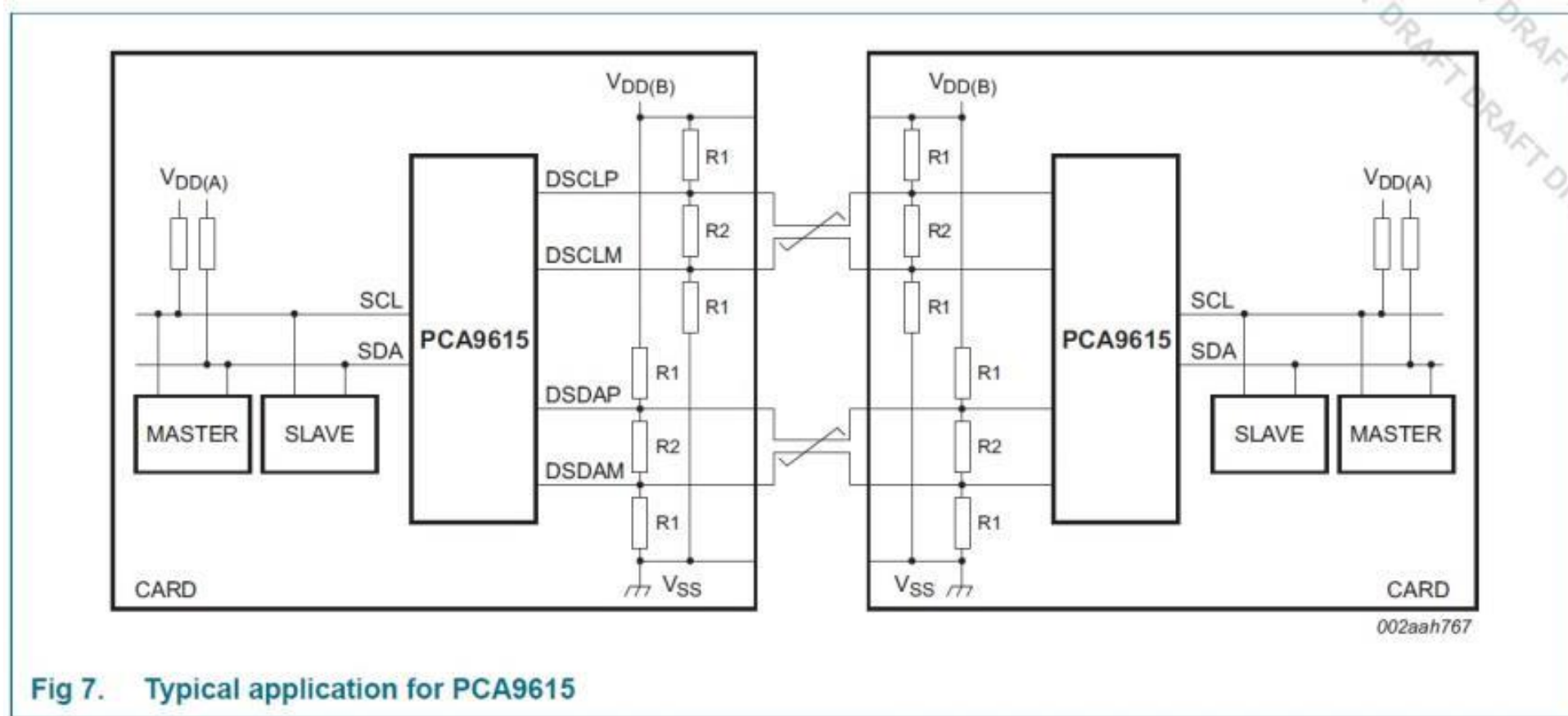
- While the differential I²C signals are superior to ordinary I²C, two pairs of wires (or PCB traces) are required. Doubling the number of circuit nets from two to four
- Application or retrofitting to systems with only two nets (the clock and data of I²C) is possible with Encoded Differential I²C, a brand new technique to combine the two signals onto existing nets

Application Circuit (3 channels, Hot Swap)





Application Circuit (2 channels, Hot Swap)



Application Circuit (2 channels)

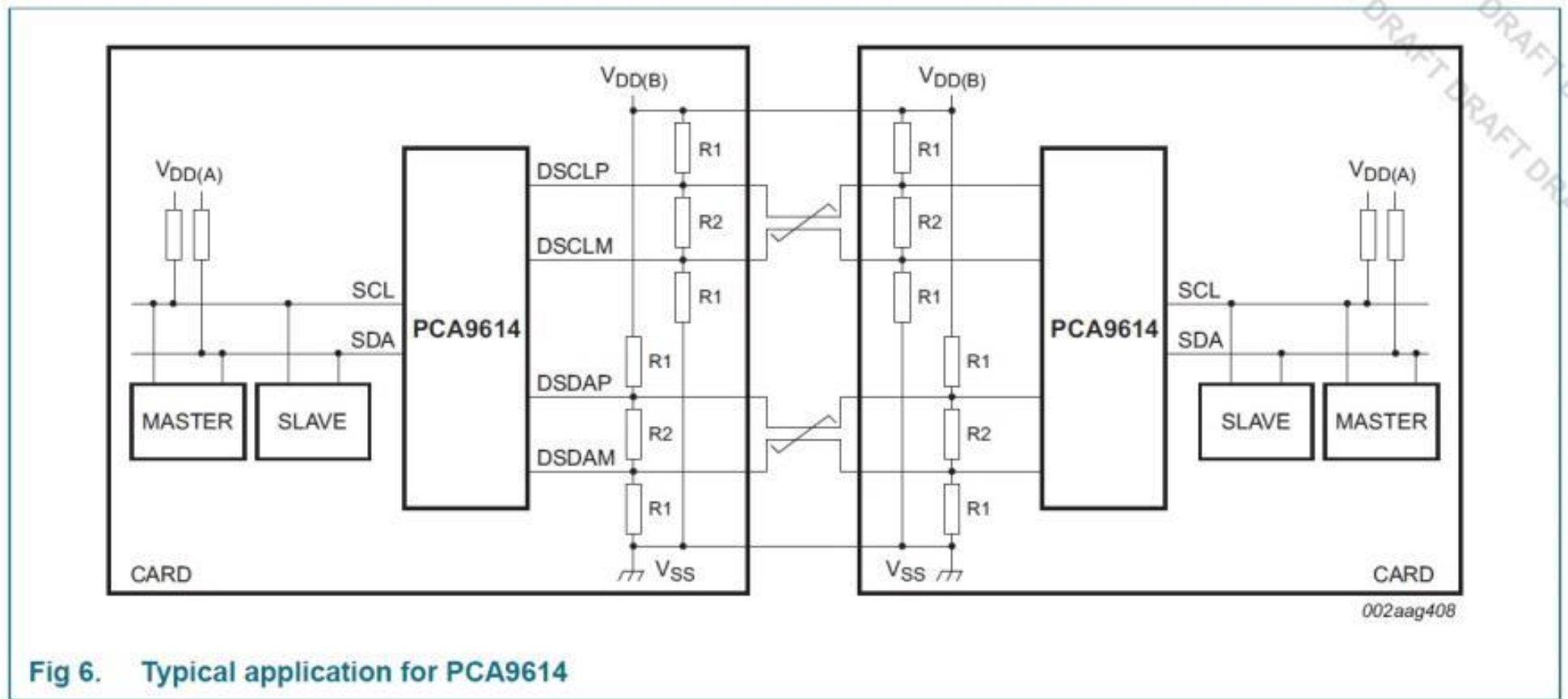


Fig 6. Typical application for PCA9614



MULTIPLEXERS, DEMULTIPLEXERS & SWITCHES

Multiplexers & Switches Value Proposition

- Why used?

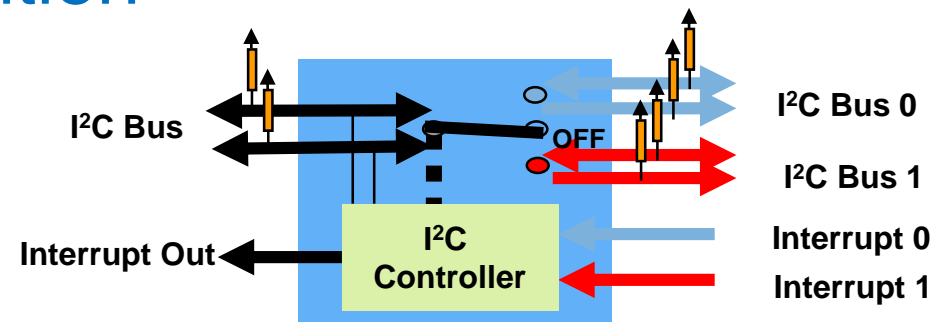
- Address conflict resolution if two devices with same address need to be on the same bus
- Voltage level translation to allow devices with different voltage supplies to operate on the same I²C-bus
- Broadcast communication to identically addressed slaves

- Where used?

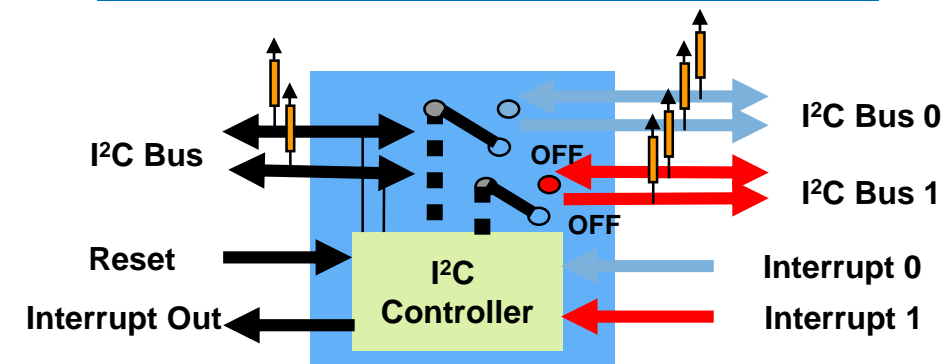
- Notebooks, desktop, server, telecom, power suppliers, and anywhere that requires the I²C-bus to be split

- Differences between Multiplexers & Switches?

- A mux can select only one channel at a time, while a switch can select one or more channels at a time.



Multiplexer
Can only select one downstream channel at a time

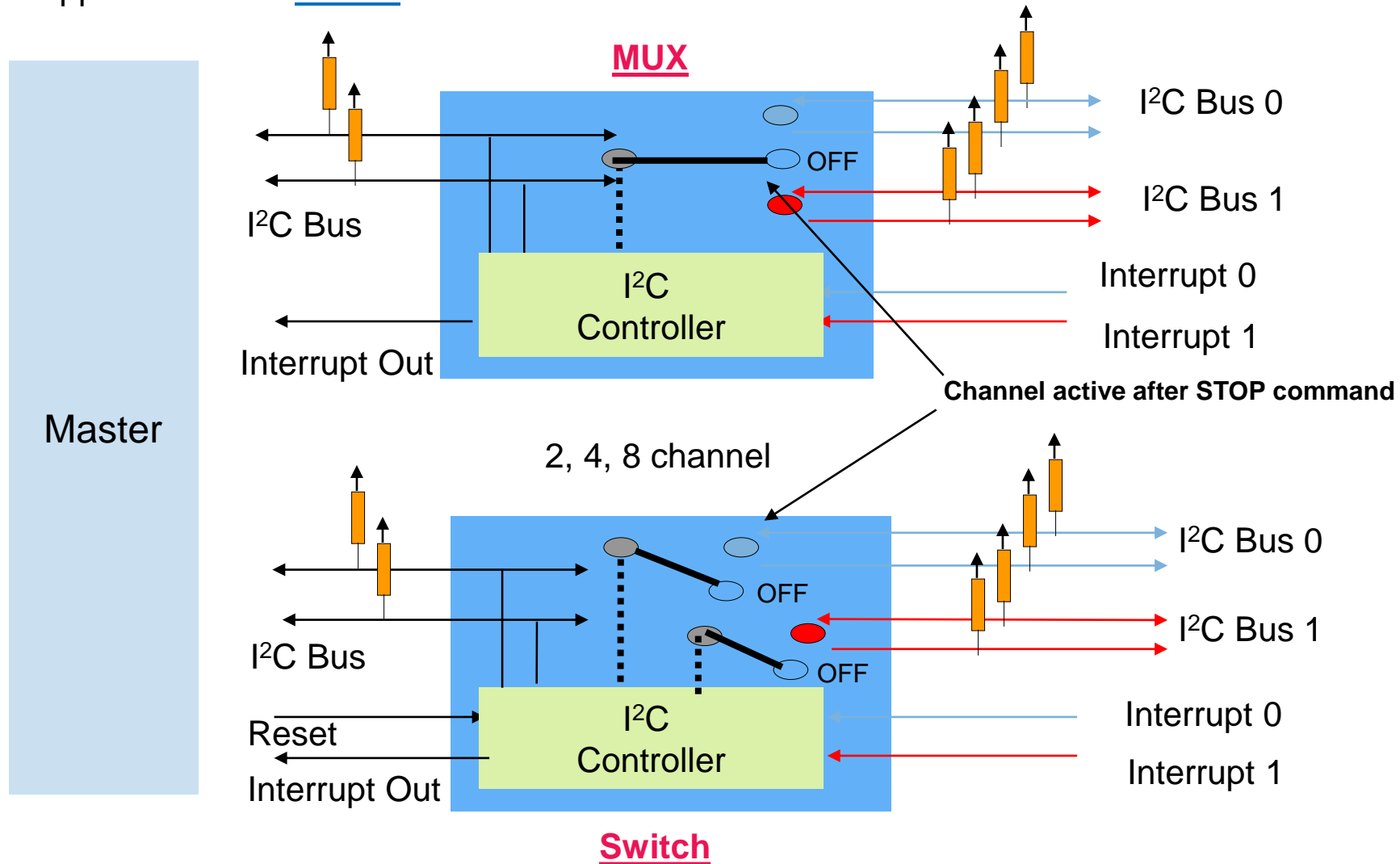


Switch
Can select one or more downstream channels at a time.
Multiple channels are selected in broadcast mode.



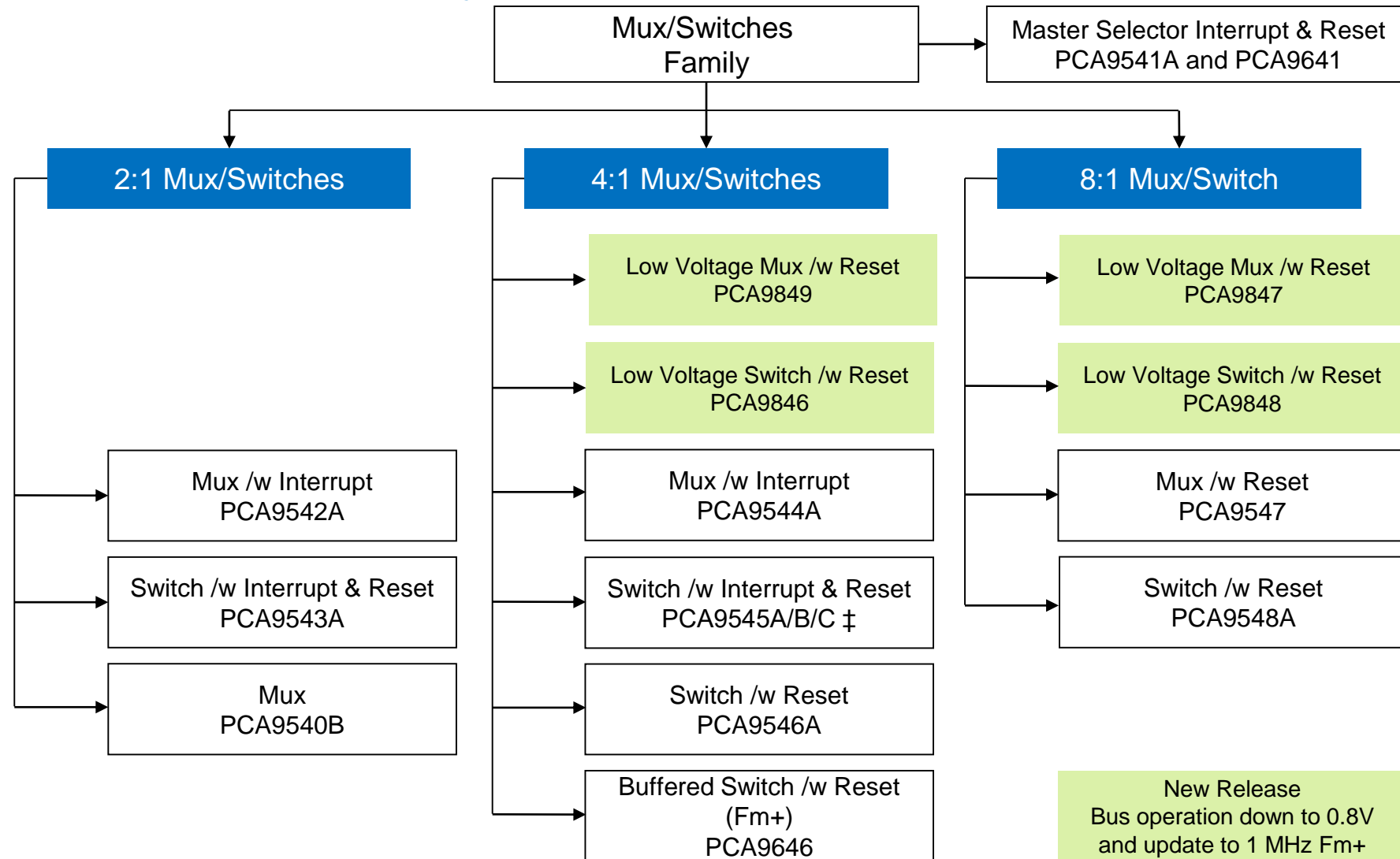
What Are Multiplexers and Switches

Application Note [AN262](#)



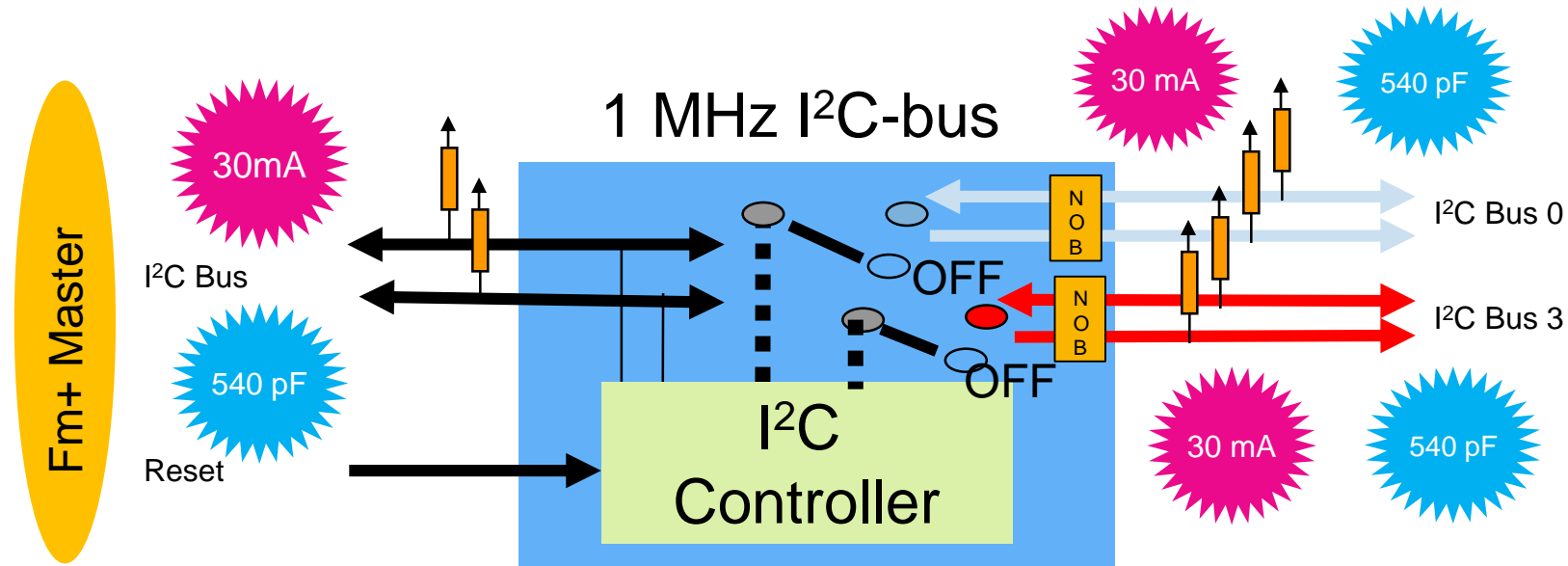


Multiplexer / Switch Family





PCA9646 Fm+ 4 Channel I²C Switch



- Fast-mode Plus (Fm+) version of PCA9546A (1 MHz I²C core and 30 mA SDA drive) that works in the Fm+ system to allow Fm+ masters to fan out to four Fm+ bus segments.
- Maximum speed and capacitance loading (1 MHz with 550 pF) is available on each channel due to no offset buffer integrated for each of the bus segments.
- No Offset bus buffers require no masters or clock stretching on the downstream bus segments and voltage level translation is not available.



PCA9848 8-ch Low Voltage I²C-Bus Switch /w Reset

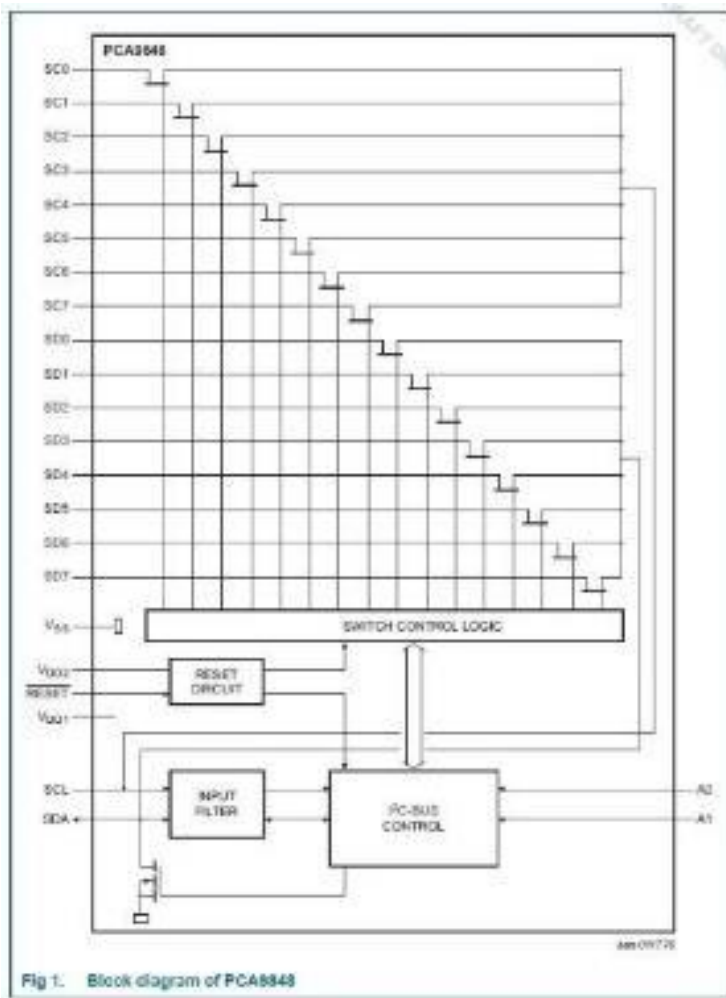
- Multichannel I²C Selector Switch for low voltage supplies and voltage level translation
- Bus Switches expand the I²C Bus and solve system design problems when reusing Slave Addresses, Isolating Bus sections for configuration, and to aid fault-finding. With ultra-low voltage operation and Fm+ bus speeds; this octal switch can directly connect I²C signals to next generation CPUs and SOCs.
- Closely matches pinout of PCA9548A:
 - 2nd power supply pin for B side = V_{DD2} (old A2 pin), existing V_{dd} pin connected to lowest bus voltage
- Lower voltage on the I²C master side: 0.8V to 3.6V
- I/O side (slave) voltage: 1.65V to 3.6V
- HVQFN and TSSOP packages

• Key Applications

- Any customer previously using the PCA9548A who needs lower voltage. (PCA9548A only goes down to 1.8V)
- Telecom/Datacom
- Computing
- Factory/Home Automation
- Any customer using multiple I²C-bus devices with address conflicts



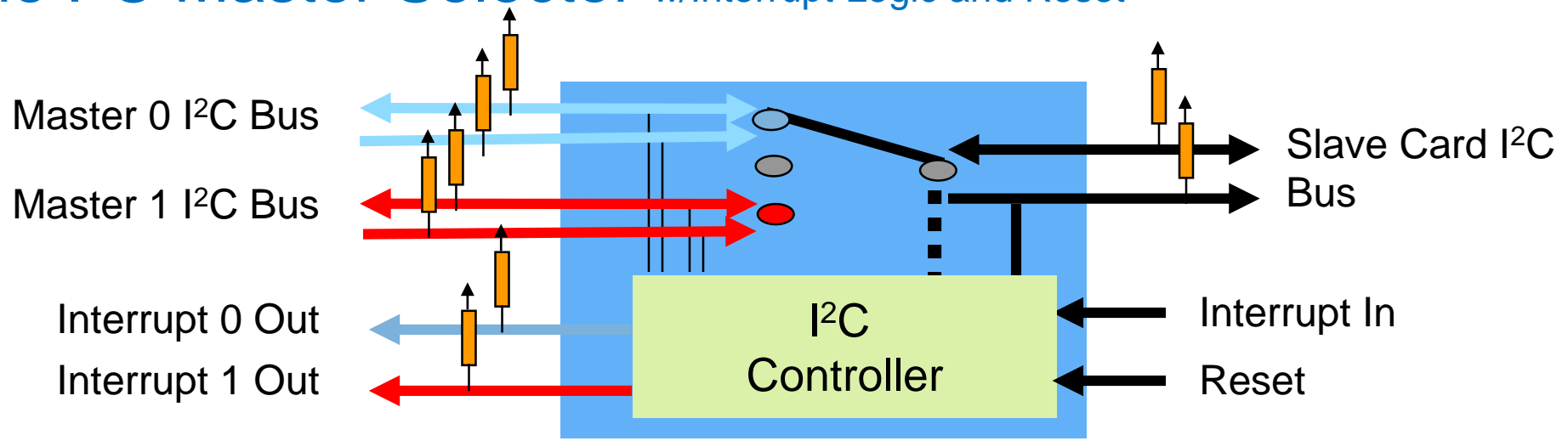
PCA9848: 8-Channel Ultra-Low Voltage Fm+ I²C Switch with Reset



Feature	Benefit
Select up to eight Bus Sections	Reuse Slave Address(es)
Disconnect I ² C down-stream Branches	Isolate Bus Sections to aid fault-finding and testing
Dynamically change I ² C bus paths	Allows system reconfiguration in the field
0.8 V to 3.3 V host side interface voltage support	Direct connection to latest host CPU/SOC ASICS
Expanded Device Address (using HIGH, LOW, SCL or SDA)	Allows eight devices to have unique I ² C Addresses using only two device pins
High Speed I ² C Signal and Control Path	Operates at Fm+ Clock speed (also STD and Fast-mode)
4mm x 4mm x 0.89mm HVQFN And TSSOP24	Small footprint



Two to One I²C Master Selector w/Interrupt Logic and Reset



FEATURES

- Select one of two I²C masters to a single channel
- I²C/SMBus commands used to select channel
- Reset or Power On Reset (POR) resets state machine
- Interrupt outputs also report demultiplexer status
- Sends 9 clock pulses and stop condition to clear slave card prior to transferring master

KEY POINTS

- Allows primary and backup master to communicate to one downstream slave card.
- Arbitration circuit between bus masters
- Doesn't isolate bus capacitance
- Allows voltage translation between 1.8 V, 2.5 V, 3.3 V and 5 V
- Idle detect for live insertion protection

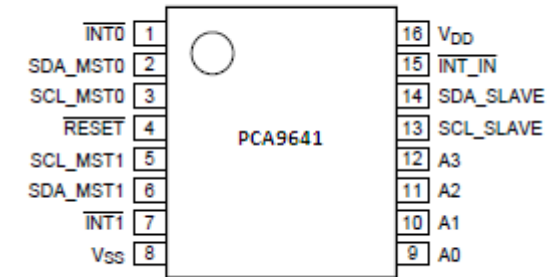
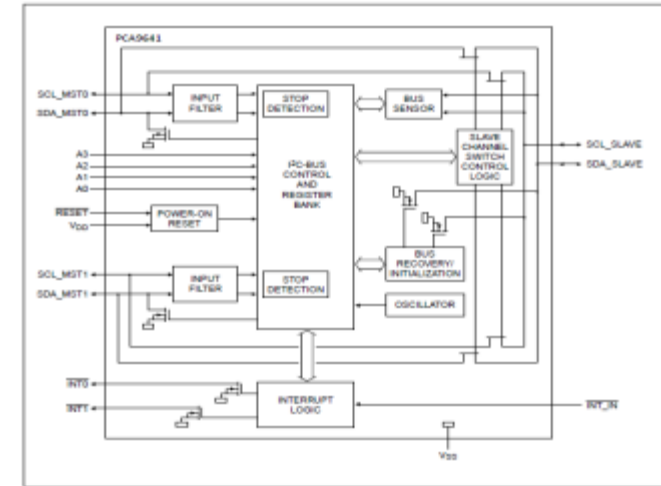
PCA9541A/01 - defaults to channel 0 on start-up/reset

PCA9541A/03 – defaults to off on start-up/reset, master commands channel



PCA9641: Two-to-One Demux with Arbitration

- Solves PCA9541A arbitration concerns
- Neither Master 0 or Master 1 selected at start up with two arbitration schemes:
 - At the same time
 - Master 0 and Master 1 receive control register ACK at the same time
 - Race condition
 - Master 1 starts writing to PCA9641 before Master 0 but Master 0 receives the control register ACK before Master 1
- Software or hardware reset will return the PCA9641 to start-up condition
- Drop in to PCA9541A footprint but with different control registers
- 2.3 – 3.6V supply with 3.6V tolerant I/O's
- A bus time-out function will release the masters from the bus, generate a stuck bus recovery sequence (9 SCL clocks to slaves), and return the PCA9641 to idle. Adjustable reset time (default > 2 seconds)
- BUSINIT function generates 9 clocks downstream before connecting bus.
- 128 possible addresses using V_{DD} , V_{SS} , SCL and SDA



Neither channel connected at start up

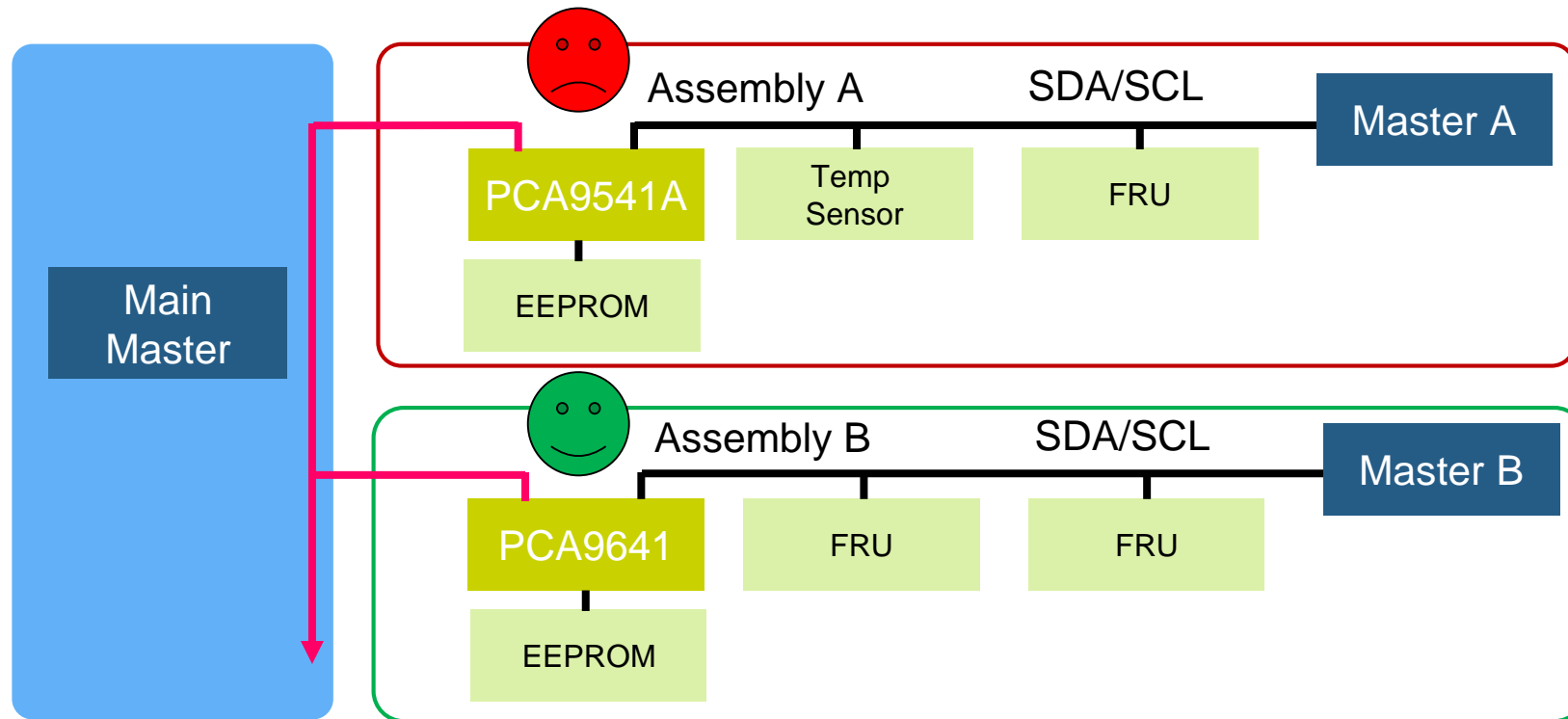
TSSOP	PCA9641PW
HVQFN	PCA9641BS





PCA9641 Master Selector for Fault Tolerant Application

- **Problem:** Masters may not be multi-master capable or can lock up the bus.
- **Solution:** PCA9541A, a master selector, is used to separate the masters and still allow shared access to slave devices but doesn't arbitrate.
- **Better solution:** PCA9641, new Fm+ arbitrating two to one demux





BRIDGES



What is a Bridge IC?

- Solutions for managing communication among various bus interfaces
- Allows one to overcome the limitations of the host bus interface to the peripherals

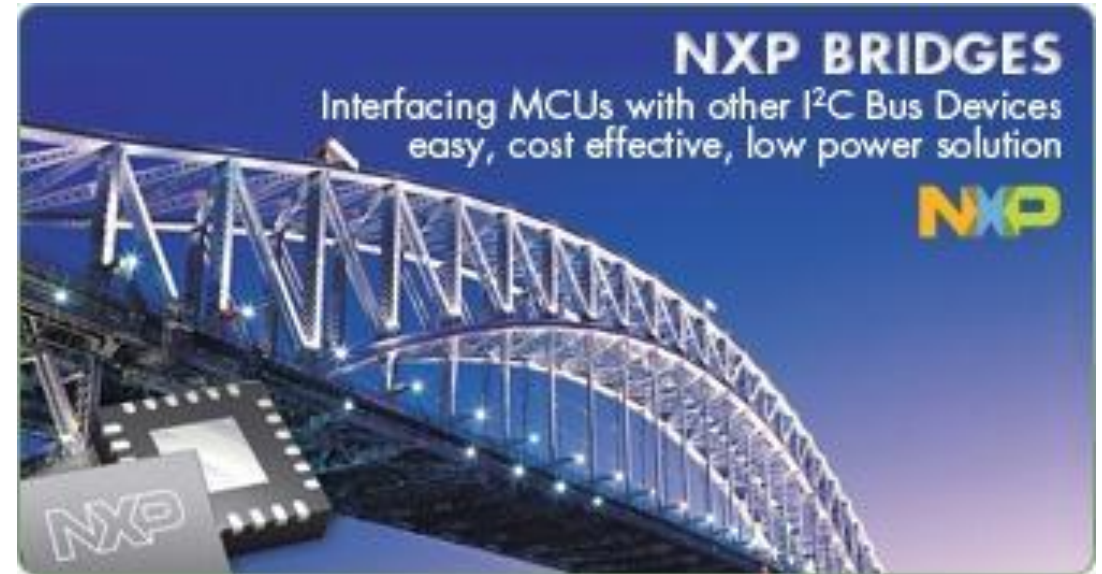


- Benefit :
 - Greater design flexibility
 - Ability to retain original design investment
 - Faster time to market
 - Link legacy and new systems and vice versa



NXP Bridges Value Proposition

- **Why used?**
 - Provide extra serial port, SPI or I²C controller.
 - Bridge between two different buses
 - Three to five wires host interface connection
- **Where used?**
 - Wireless modules
 - Industrial data communication
 - Industrial control Systems
 - Telecommunication network routers
 - Factory automation and process control
- **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

FROM \ TO	UART	I ² C	SPI
UART		SC18IM700/S8	
I ² C	SC16IS740 SC16IS75x SC16IS76x		SC18IS602B/S8
SPI		SC18IS600/S8	

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

UART-to-I²C Bridge

Part #	UART	I ² C	GPIO	CLK
SC18IM700/S8	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	I ² C	GPIO	CLK
SC18IS600/S8	1Mbps	400kHz	4	Int

I²C-to-SPI Bridges

Part #	SPI	I ² C	GPIO	CLK
SC18IS602B/S8	1.8Mbps	400kHz	4	Int



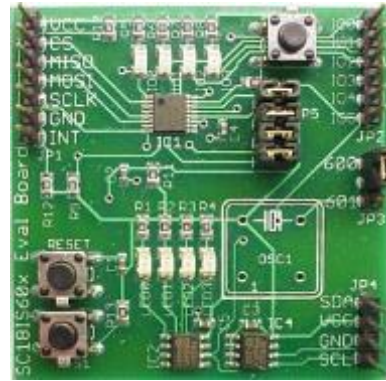


Demo Boards Support

UART-to-I ² C Bridge	SPI-to-I ² C Bridge	I ² C-to-SPI Bridge	SPI/I ² C-to-UART Bridge
<u>OM6272</u>	<u>OM6271</u>	<u>OM6274</u>	<u>OM6270 & 73</u>
SC18IM700	SC18IS600 / 600L	SC18IS602B	SC16IS750/60 & 52/62



- Features:**
- Demonstrates NXP's bridge solution for communication between a UART host and multiple I²C slave devices
 - Simple interface to a host's UART port
 - On-board NXP I²C slaves (EEPROM & LED Dimmer)
 - Board power provided through USB port



- Features:**
- Demonstrates NXP's bridge solution for communication between an SPI host and multiple I²C slave devices
 - Simple interface to an SPI master and external I²C slave devices via a header
 - On-board NXP I²C slaves (EEPROM & LED Dimmer)



- Features:**
- Demonstrates NXP's bridge solution for communication between an I²C host and multiple SPI slave devices
 - Simple interface to an external I²C master and SPI slave devices via a header
 - Selectable I²C slave device address



- Features:**
- Demonstrates NXP's bridge solution for communication between an I²C or SPI host and a UART interface
 - Selectable I²C or SPI-bus interface



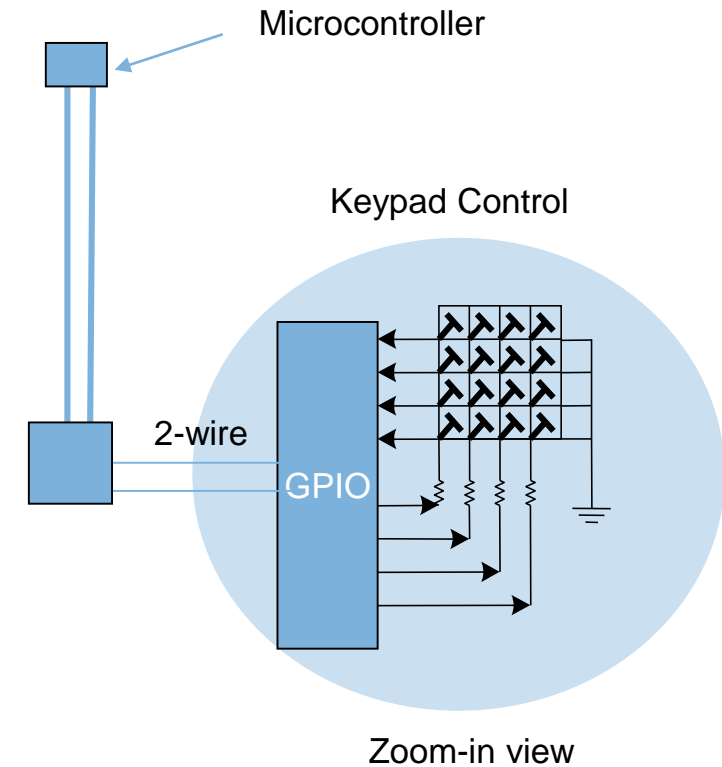


GENERAL PURPOSE I/O EXPANDERS



GPIO Expanders Value Proposition

- **Why used?**
 - Easily adds I/O via I²C-bus
 - Additional inputs for keypad, switch, signal monitoring and fan control
 - Additional outputs for LED control, ACPI power switch, relay, timers and sensor.
- **Where used?**
 - Computing (Servers, RAID Systems, etc.)
 - Industrial Controls
 - Medical Equipment
 - Cell Phones
 - Gaming Machines
 - Test and Measurement Instrumentations
- **Why NXP GPIOs?**
 - Largest selection of 4, 8, 16 and 40-bit GPIO in Quasi-bidirectional and Push-pull outputs with Interrupt and/or reset in a wide range of packages
 - Invented the I²C-bus. Continuously developing newer devices with added features to support different applications.





I/O Expanders with Flexible Output Structures

Quasi-Output Structure:

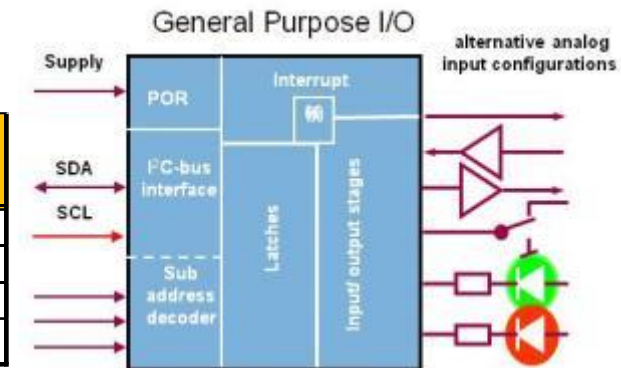
- Strong PMOS transistor is turned on only during the LH transition and turned off during static drive
- Weak pull-up current source (100µA) at the output
- Used in low-power applications where the 100-µA drive is sufficient to bias the inputs of CMOS devices
- May be reconfigured as an input or output 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

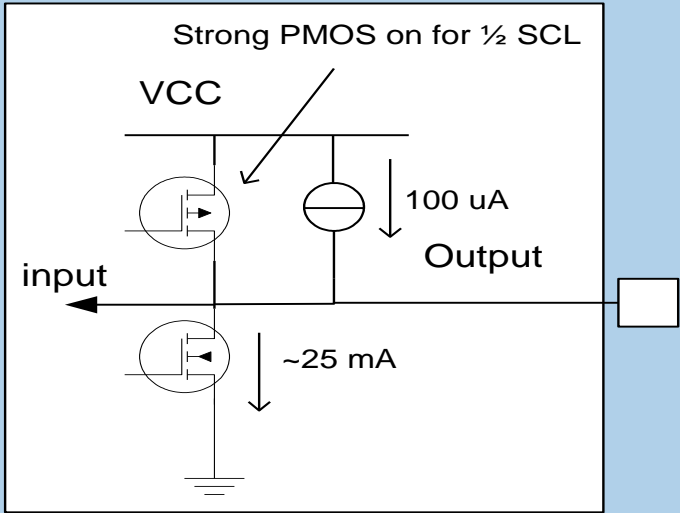
# of Outputs	None	Reset	Interrupt	Interrupt and Reset
4	PCA9536			PCA9537
8		PCA9557	PCA9534/54/54A	PCA9538, PCA9502, PCA9574
16	-	-	PCA9535/35C/55	PCA9539/39R, PCA9575
40	-	-		PCA9505/06, PCA9698





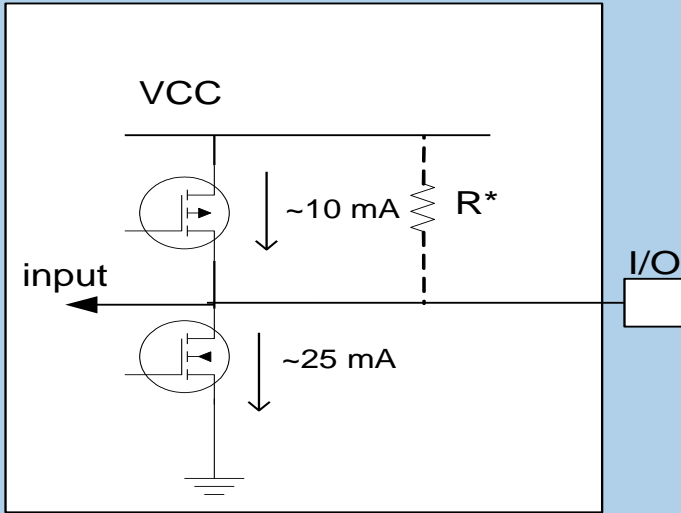
Flexible I/O (Output) Structures

Quasi Output



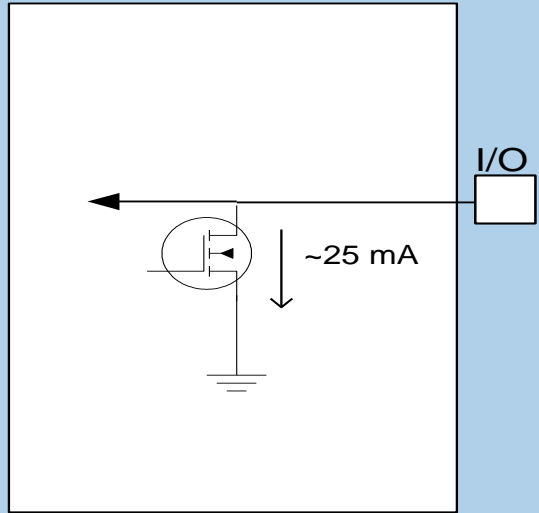
- Strong PMOS transistor is turned on only during the LH transition
- PMOS transistor is off during static drive
- Weak current source at the output

Totem-Pole Output



- Upper PMOS transistor is turned on during static high drive
- Some devices have weak pull-ups at the output

Open-Drain Output



- No upper PMOS transistor
- No pull-up resistor
- No weak current drive





I²C GPIOs

Totem-Pole Output Structure

BITS	V RANGE	BW	RESET	INT	I/O PULL-UP	NOTES	PART#
4	2.3 to 5.5V	400 kHz	NO	NO			PCA9536
			YES	YES			PCA9537
8	2.5 to 3.6V	400 kHz	YES	YES		SPI & I ² C	PCA9502
	2.3 to 5.5V			YES			PCA9534
	2.3 to 5.5V		YES	YES		Open Drain Interrupt output	PCA9538
	2.3 to 5.5V			YES	100 K Ω	Use PCA9554A for alternate I ² C address	PCA9554/A
	2.3 to 5.5V		YES				PCA9557
	1.1 to 3.6V		YES	maskable	prog. PU / PD or bus hold	low voltage, 2 supplies for level trans. selectable open drain	PCA9574
16	2.3 to 5.5V	400 kHz	NO	YES			PCA9535
	2.3 to 5.5V		YES	YES			PCA9539
	2.3 to 5.5V			YES	100 K Ω	"R" version resets I ² C-bus state machine	PCA9539R
	2.3 to 5.5V			YES			PCA9555
	1.1 to 3.6V		YES	maskable	prog. PU / PD or bus hold	Active low, low voltage, 3 supplies for level trans., selectable open drain	PCA9575
40	2.3 to 5.5V	400 kHz	YES	YES	100 K Ω	Output enable	PCA9505
			YES	YES		Output enable	PCA9506
	2.3 to 5.5V	1 MHz	YES	YES		Output enable, selectable open drain	PCA9698

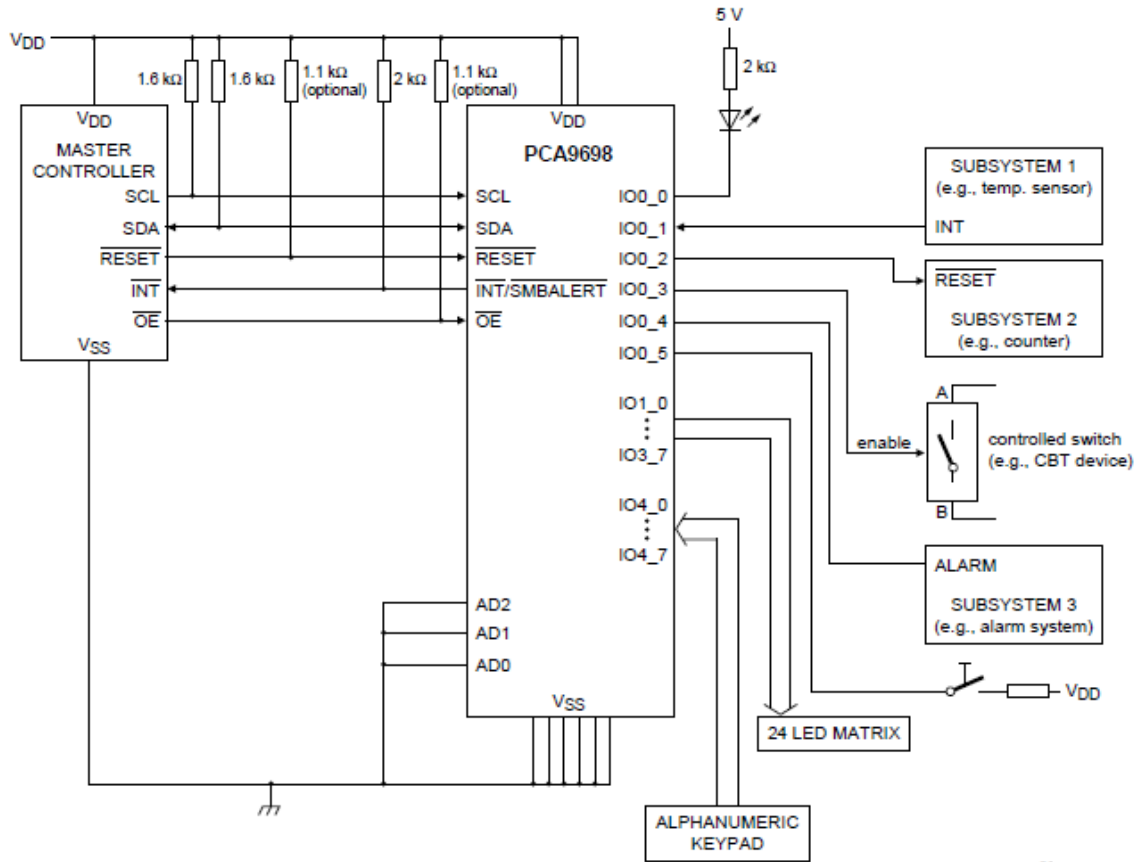
LOW VOLTAGE

8	1.65 to 5.5V	400 kHz	YES	YES		Low standby current: 1.5 μ A typ at 5V supply; 1.0 μ A typ at 3.3V supply	PCA9538A
				YES	100 K Ω	Use PCA9554C for alternate I ² C address	PCA9554B/C
			YES	YES		Standby current: 3 μ A max dual V _{CC}	PCA6408A
16	1.65 to 5.5V	400 kHz	NO	YES		Low standby current: 1.5 μ A typ at 5V supply; 1.0 μ A typ at 3.3V supply	PCA9535A
			YES	YES			PCA9539A
			YES	100 K Ω			PCA9555A
			YES	YES		Dual V _{CC} ; low standby current: 1.5 μ A typ at 5V supply; 1.0 μ A typ at 3.3V supply	PCA6416A





GPIO Expander Application Using the PCA9698



Device address configured as '0010 000x' for this example.
 IO0_0, IO0_2, IO0_3, IO1_0 to IO3_7 are configured as outputs.
 IO0_1, IO0_4, IO4_0 to IO4_7 are configured as inputs.

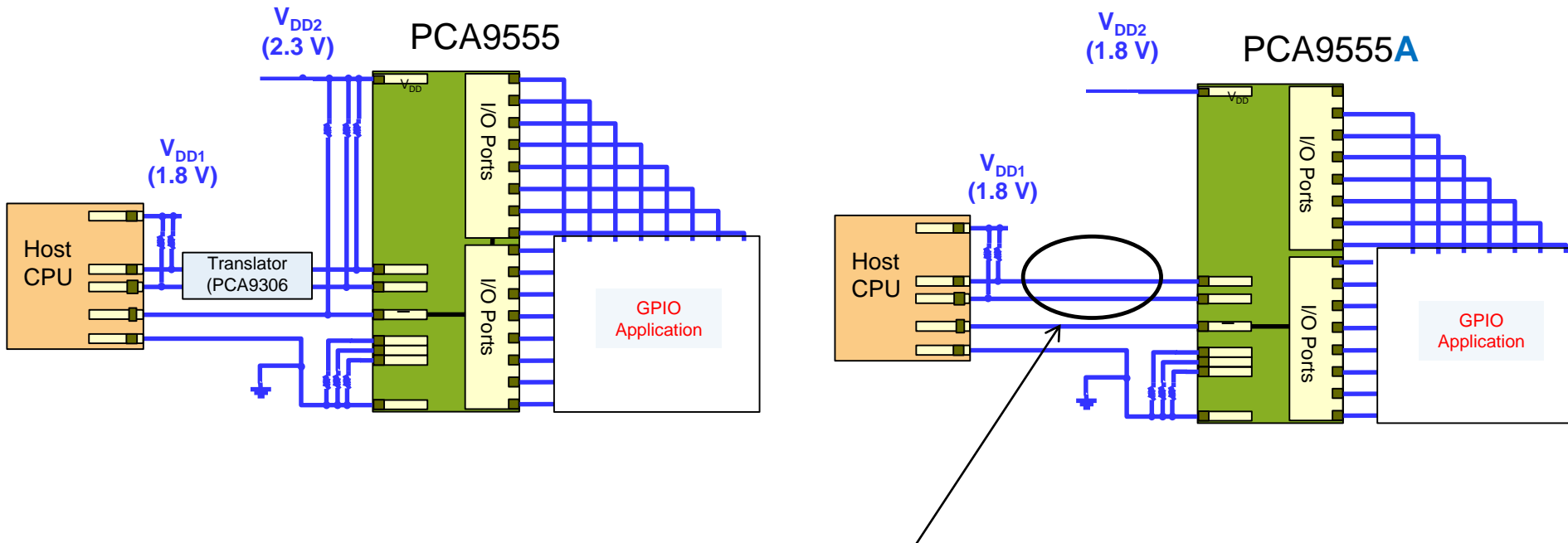
- I²C-bus Serial Interface
 - Fast-mode Plus (1MHz)
 - Supports up to 64 devices on same bus
- Control Inputs and Outputs
 - Reset
 - Interrupt (maskable)
 - OE
- Configurable Outputs
 - Push-pulls
 - Open-drain
- Wide Applications
 - Driving individual LEDs
 - Driving LED matrix
 - Reading from Keypad
 - Subsystem control signals
 - Subsystem status signals
 - Live Insertion (IOFF) Supports





PCA95xxA and PCA64xxA Low Voltage GPIO Families

Operate Down to 1.65V and Up to 5.5V



- Benefit
 - Lower VCC to 1.65V on GPIO supply eliminates the need for a voltage translator
- Easy migration
 - Drop-in replacement for existing PCA95XX GPIO family
 - Alternate source to Texas Instruments TCAxxxx family

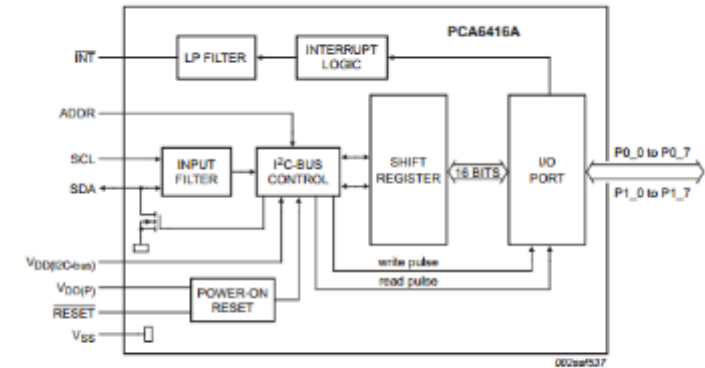


PCA6416A

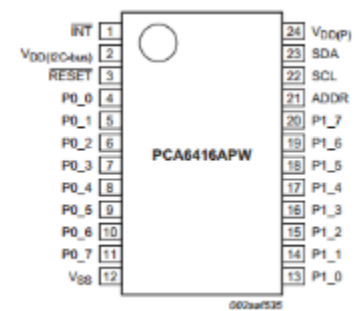
Dual- V_{CC} Low-Voltage, 16-Bit I²C-Bus I/O Expander with Interrupt, Reset, and Configuration Registers

Features

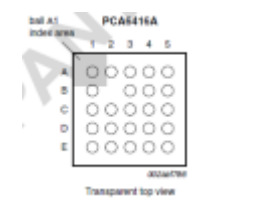
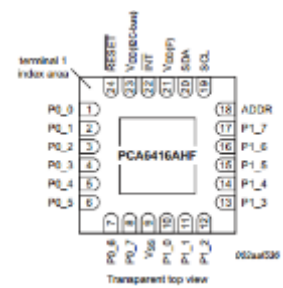
- Operating Power-Supply Voltage Range of 1.65 V to 5.5 V
- Low Standby Current Consumption of 3 uA Maximum
- Allows Bidirectional Voltage-Level Translation and GPIO Expansion Between 1.8, 2.5, 3.3 or 5 V SCL/SDA and 1.8, 2.5, 3.3, or 5 V Totem Pole configured I/O Port
- Schmitt-Trigger Hysteresis of 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)



All I/Os are set to inputs at reset.



HWQFN package is 4 x 4 x 0.8 mm with 0.5 mm pitch



BGA package is 3 x 3 x 1 mm with 0.5 mm pitch





PCA6424AHE: 24-Bit GPIO Expander

Key Features and Benefits

- Industry Leading GPIO
 - Simple solution for additional I/Os are needed for interfacing to sensors, push buttons, keypad, etc
 - Level translating 1.65 to 5.5V range
 - 400 kHz Fast-mode I²C-bus
 - Active LOW reset input (RESET)
 - Open-drain active LOW interrupt output (INT)
 - Input/Output Configuration register
 - Polarity Inversion register
- Very thin Quad Flat Package (5 x 5 mm)
 - Plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 x 5 x 0.56 mm
 - For applications that are on space constrained boards
- Four I²C addresses per device
 - The one ADDR pin support four addresses by connection to supply or GND and also SCL or SDA
- Drop in alternate source
 - TCA6424ARGJR

Part Number

PCA6424AHE

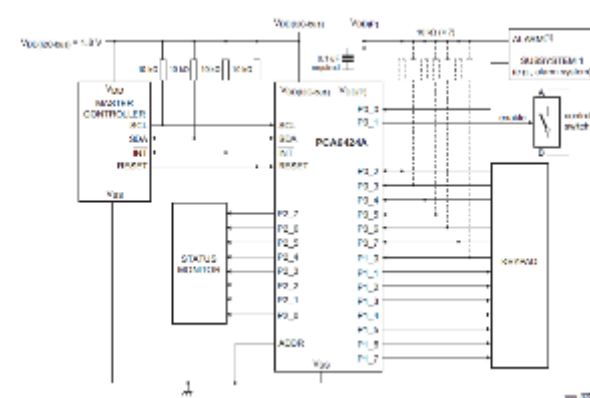
Package

HUQFN32

Key Applications

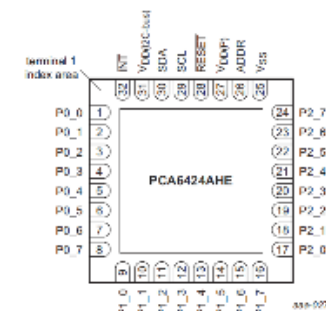
- Game Controllers
- Networking
- Smartphones
- Consumer

Application Diagram



Tools

OM13526UL PCAL6524 Fm+ I ² C 24-bit GPIO Demoboard	Use PCA6424A for electrical characteristics	Available now
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PCA6424AHE





PCALxxxx Agile I/O GPIO Features

- Input latch (bit-by-bit, default not latched): lock I/O pin changes on input until register read
- Output drive strength control (bit-by-bit, default 10 mA/25 mA)
 - User can program I/O drive strength: 25%, 50%, 75% and Full (default)
 - Can be used to control strength to better match line impedance
- Open drain control (bank-by-bank, default push pull)
 - Provide an optional open-drain output for each I/O pin
 - Also provides an additional wired-OR plane
 - PCAL6524 and PCAL6534 also have bit-by-bit push-pull or open-drain register selection
- Pull up or pull down (bit-by-bit, default no PU/PD): user programmable each I/O pin
- 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



PCALxxxx GPIO Family with Agile I/O

- Operates Down to 1.65V and Up to 5.5V
- Easy migration: drop in replacement for existing PCA95XX GPIOs
- Features input latch, /INT mask and other new Agile IO features

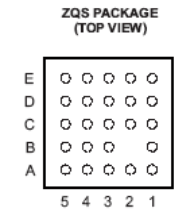
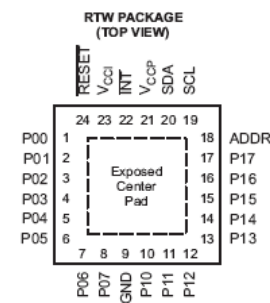
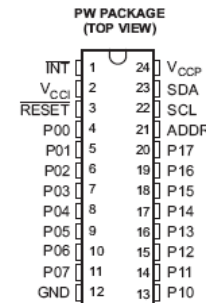
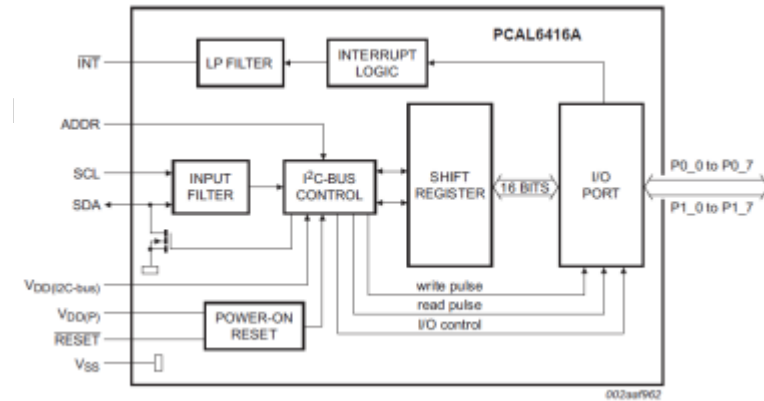
BITS	V RANGE	BW	RESET	INT	I/O PULL-UP	NOTES	PACKAGE	PART#
8	1.65 to 5.5V	400 kHz	YES	YES	programmable	single V _{CC}	HVQFN16, TSSOP16	PCAL9554B PCAL9554C
			YES	YES	programmable	single V _{CC}	HVQFN16, TSSOP16	PCAL9538A
			YES	YES	programmable	dual V _{CC}	HVQFN16, TSSOP16, XQFN16, XFBGA16	PCAL6408A
16	1.65 to 5.5V	400 kHz		YES	programmable	single V _{CC} & advanced IO	HWQFN24, TSSOP24	PCAL9555A
				YES	programmable	single V _{CC} & advanced IO	HWQFN24, TSSOP24	PCAL9535A
			YES	YES	programmable	single V _{CC} & advanced IO	HWQFN24, TSSOP24	PCAL9539A
			YES	YES	programmable	Voltage Level Translation	TSSOP24, HWQFN24, 24-pin BGA (XFBGA, VFBGA & UFBGA)	PCAL6416A
24	0.8 to 3.6V	1 MHz	YES	YES	programmable	Additional Agile I/O features	QFN32, TSSOP32, UFBGA32	PCAL6524
34	0.8 to 3.6V	1 MHz	YES	YES	programmable	Additional Agile I/O features	VFBGA42	PCAL6534



PCAL6416A: Dual- V_{CC} Low-Voltage, 16-Bit I²C-Bus Expander with /INT, Reset and Configuration Registers

Features:

- Operating Power-Supply Voltage Range of 1.65 V to 5.5 V
- Low Standby Current Consumption of 3 μ A (Max)
- Bidirectional Voltage-Level Translation between 1.8V to 5V SCL/SDA and 1.8V to 5V Totem
- Schmitt-Trigger Hysteresis; 10% of I²C-Bus Supply Voltage
- 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
- Output port configuration: bank selectable push-pull or open-drain output stages
- Interrupt status (read-only) register identifies interrupt source
- Bit-wise I/O programming for output drive strength, input latch, pull-up/pull-down enable, pull-up/pull-down selection, and interrupt mask
- High current Drive for Directly Driving LEDs
- 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)



The exposed center pad, if used, must be connected only as a secondary GND or must be left electrically open.





PCAL6524

Dual- V_{CC} Low-Voltage; 24-Bit I²C-Bus I/O Expander with Additional Agile I/O Features and Fm+

Features:

- 24-bit GPIO
- ~ 0.85 – 3.6V I²C-bus for interface to processor
- 1.65 – 5.5V I/O and core supply
- Fm+ (1MHz) interface
- Additional Agile I/O + features:
 - Enhanced input read & INT status functionality
 - Input hysteresis for noise immunity
 - Clock gating for lower power
 - Auto increment mode for ease of use
 - SMBus ARA, device ID, software reset I²C interface
 - Latched input - register for latched state and also actual current input state
- Logic transition level that will generate interrupt (high or low going)
- Read the interrupt flags to determine which inputs have an interrupt request
- Ability to clear individual interrupt flag
- 5 state per address pin
- Slew control (Port I/O)
- Packages: TSSOP32, QFN32, UFBGA32

PCAL6524 Demo Board (OM13526)



- [UM10868](#) User Manual



Low-Voltage GPIO Expanders – Comparison Table

Feature	PCA9574/75	PCA64XX	PCAL64XX	Comments
Number of I/O's	8 or 16	8 or 16	8 or 16	
Serial Interface – 400 kHz	I ² C-Bus	I ² C-Bus	I ² C-Bus	
Number of devices on bus	1, 2 or 16	2, 4 or 8	4, 5 or 8	One address pins provides two addresses except for the PCA9575 which has no address pins on the 24 pin version due to the separate supply per octal but the 28 pin version has four address pins allowing 16 devices on the bus.
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	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 before the register is read
Interrupt Mask - Programmable	Yes	No	Yes	Select which input 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 byte
Output Drive Current - Programmable	No	No	Yes	Selects reduced portion of output to control slew rate
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 if fault
Software Reset	Yes	No	No	User reset the device in software to quickly go to a know state
I _{standby} (V _{DD} = 3.6V)	0.25 μA (Typ.) 1 μA (Max.)	0.1μA (Typ.) 2 μA (Max.)	0.1μA (Typ.) 2 μA (Max.)	Lower standby current



I²C GPIOs

Quasi Output Structure

BITS	V RANGE	BW	RESET	INT	I/O PULL-UP [1]	NOTES	PART#
8	2.5 to 6.0V	100 kHz	NO	YES	weak PU		PCF8574/A
	2.3 to 5.5V	400 kHz	NO	YES	weak PU		PCA8574/A
	2.2 to 3.6V	400 kHz	NO	NO	weak PU	2 Kb EEPROM	PCA9500
		400 kHz	NO	YES	weak PU	2 Kb EEPROM	PCA9501
	2.3 to 5.5V	1 MHz	YES	NO	weak PU		PCA9670
		1 MHz	YES	YES	weak PU		PCA9672
		1 MHz	NO	YES	weak PU		PCA9674/A
16	4.5 to 5.5V	400 kHz	NO	YES	weak PU		PCF8575
	2.3 to 5.5V	400 kHz	NO	YES	weak PU		PCA8575
	2.3 to 5.5V	1 MHz	YES	NO	weak PU		PCA9671
		1 MHz	YES	YES	weak PU		PCA9673
		1 MHz	NO	YES	weak PU		PCA9675

Note [1]: The Quasi-outputs have a strong pull-up (transistor) to V_{DD} to allow fast rising edges into heavy loaded outputs. The devices with weak pull-ups have a 100- μ A current source to V_{DD} .

Open-Drain Output I²C I/O Expanders

- **Devices**

- The PCA9538 is an 8-bit and the PCF8575C and PCA9535C are 16-bit GPIO Expanders with open drain outputs.
- Some push-pull GPIO Expanders' outputs can be configured to turn off the upper PMOS transistor and used as open-drain devices
- The PCA9574 is an 8-bit GPIO Expander
- The PCA9575 is a 16-bit GPIO Expander
- The PCA9698 is a 40-bit GPIO Expander

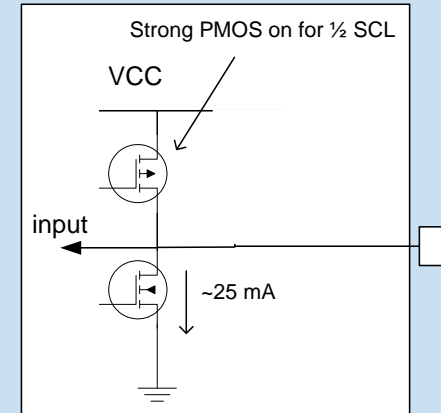
- **Features**

- The PCF8575C has a strong PMOS pull-up transistor to pull the signal from low to high, when the device is driving as an output.
- The PCA9535C has true open-drain output structure.
- Both devices have open-drain interrupt output.

- **Applications**

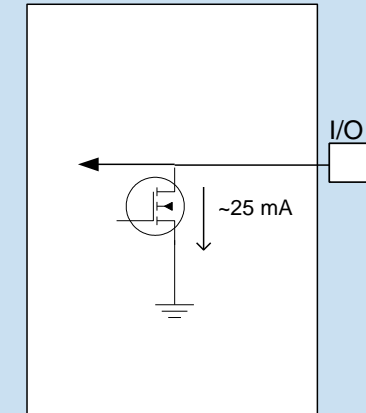
- The open-drain output GPIO Expanders are suited for applications requiring the expanders to put the I/O in high-impedance state and safe in power consumption.

PCF8575C Output Structure



- Strong PMOS transistor is turned on only during the LH transition
- PMOS transistor is off during static drive

PCA9535C Output Structure



- No upper PMOS transistor
- No pull-up resistor
- No weak current drive



I²C GPIOs

Open Drain Output

- No upper PMOS transistor
- Prevent current leakage through protection diode

BITS	V RANGE	BANDWIDTH	RESET	INTERRUPT	I/O Pull-Up	NOTES	PART(S)
8	3.0 to 3.6V	400 kHz	NO	NO	weak PU	2 Kb EEPROM, with 5-bit mux, 1-bit latch DIP SWITCH	PCA9558
16	2.3 to 5.5V	400 kHz	NO	YES			PCA9535C
	4.5 to 5.5V		NO	YES			PCF8575C

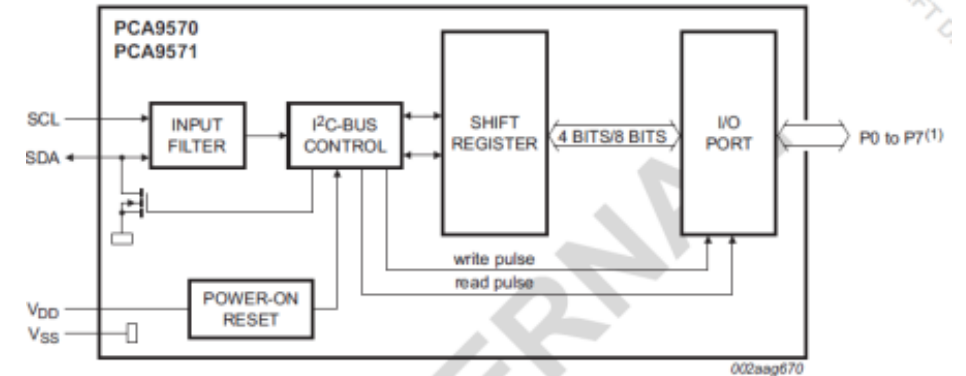


Small, Low-cost, Low Voltage GPO Expanders

PCA9570 / 71

FEATURES

- 1.1 V to 3.6 V operation with 4- or 8-bit, 4mA push-pull outputs
- 1 MHz I²C-bus interface with 6mA SDA sink capability for lightly loaded buses and improved power consumption
- Compliant with the I²C-bus Fast and Standard modes
- Readable device ID (manufacturer, device type, and revision)
- Software Reset and power-on reset
- Low standby current
- -40°C to +85°C operation
- ESD protection exceeds 2000 V HBM per
 - JESD22-A114 and 1000 V CDM per
 - JESD22-C101
- Latch-up testing is done to JEDEC standard
 - JESD78 which exceeds 100 mA
- Packages offered: XQFN8 and XQFN12



(1) P0 to P7 for PCA9571; P0 to P3 for PCA9570.



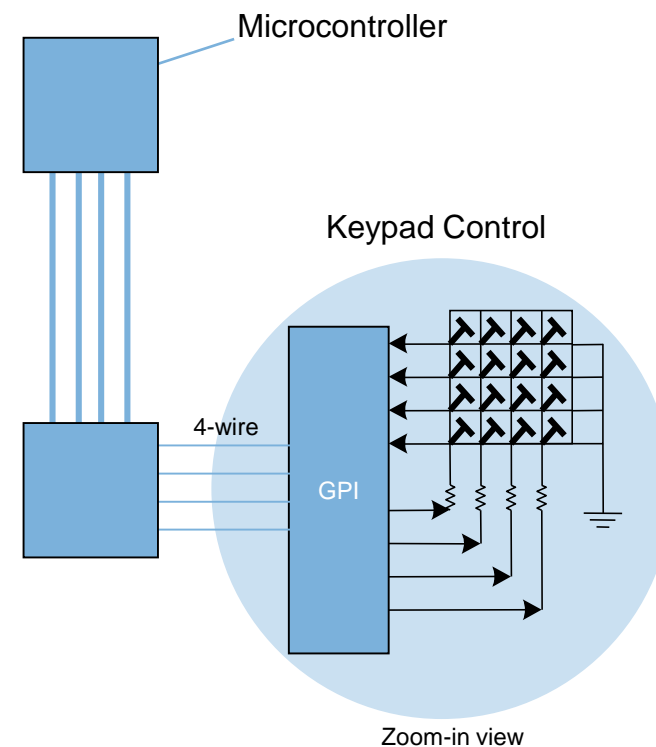
Part Number	Package Type	Package Description	Version
PCA9570GM4 (In Dev)	XQFN8	plastic, extremely thin quad flat package; no leads; 8 terminals; body 1.20 × 1.40 × 0.50 mm; 0.4mm pitch	SOT1309-1
PCA9570GM	XQFN8	plastic, extremely thin quad flat package; no leads; 8 terminals; body 1.6 × 1.6 × 0.5 mm; 0.5mm pitch	SOT902-2
PCA9571GU	XQFN12	plastic, extremely thin quad flat package; no leads; 12 terminals; body 1.70 × 2.00 × 0.50 mm; 0.4mm pitch	SOT1174-1



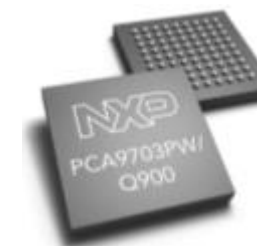


SPI-Bus GPI Expanders

- Why used?
 - Easily adds inputs via SPI-bus
 - Additional inputs for keypad, switch, signal monitoring and fan control
- Where used?
 - Automotive Applications (Body Control Modules)
 - Industrial Controls
 - Medical Equipment
 - Cell Phones
 - Gaming Machines
 - Test and Measurement Instrumentations



Part Number	Number of Inputs	Additional Feature
PCA9701	16	
PCA9702	8	
PCA9703	16	Individual input maskable interrupt
PCA9704	8	Individual input maskable interrupt



AEC-Q100 Compliant





GPIO Expanders Demo Boards Support

• Features

- Easy experimentation and training.
- I²C-bus I/O Ports for GPIO Expander daughter cards
- Use USB to Windows PC/Laptop GUI/power
- See details in User Manual ([UM10206](#))
- Order kits at www.demoboard.com or eTools



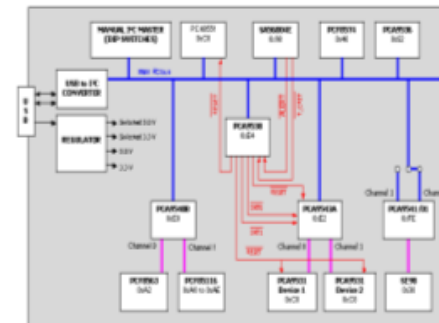
OM Number

Description (Device)

OM6281 †	40-Bit Totem-Pole Output GPIO Expander (PCA9698) ‡
OM13488 †	Universal 8-Bit GPIO Expander Daughter Card ‡
OM13489 †	Universal 16-Bit GPIO Expander Daughter Card ‡
OM13526	Universal 24-Bit GPIO Expander Daughter Card ‡

† Available on eDemoboard

‡ Requires an I²C-Bus master. User may already have a master or they can use the OM13320.





LED CONTROLLERS





LED Controllers Value Proposition

- Why used?
 - Offloads CPU from blinking operation
- Where used?
 - Equipment status indicator and control (Blinkers)
 - Keypad and LCD backlighting (Dimmers)
 - Color mixing and brightness control (Dimmers)
- Why NXP LED Controller?
 - Large selection of LED Controllers in a wide range of packages
 - Minimized supply voltage ripple with programmable LED outputs phase shifting
 - Thermally enhanced HTSSOP package



Mood Lighting

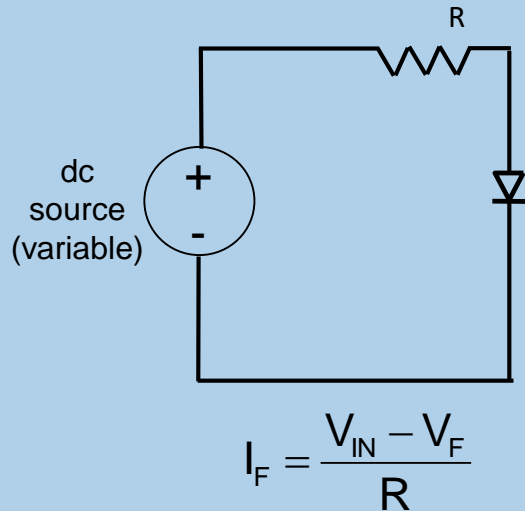


LCD Backlighting



Methods of Driving LEDs

Voltage Source + Resistor



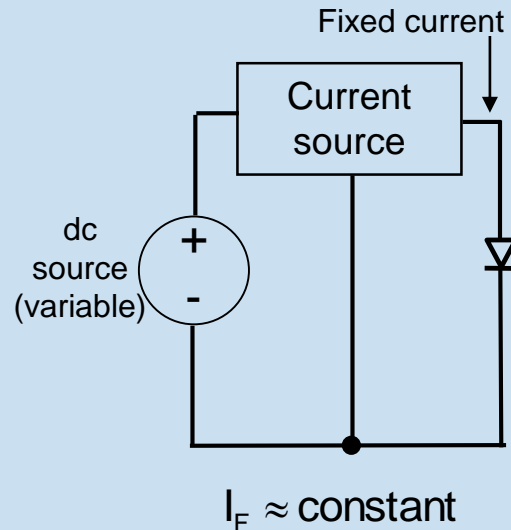
Pros:

- Heat is dissipated in the resistor
- Source is independent of heat dissipated
- Good for driving multiple LEDs in series, with different V_F

Cons:

- I_F changes with V_{IN}

Current Source



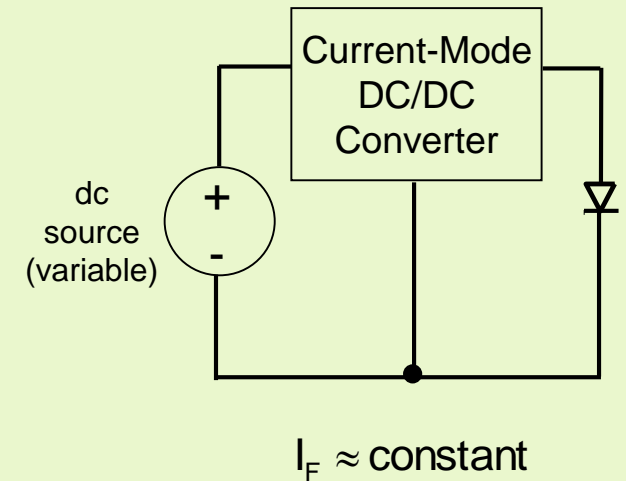
Pros:

- LED light remains constant with supply voltage fluctuations

Cons:

- Heat is dissipated at the current source
- Current source is sensitive to heat dissipation

Current-Mode DC/DC Converter



Pros:

- LED light remains constant with supply voltage fluctuations
- Ability to step-up or step-down LED supply voltage
- Good for directly driving LED when source and supply voltages are different.

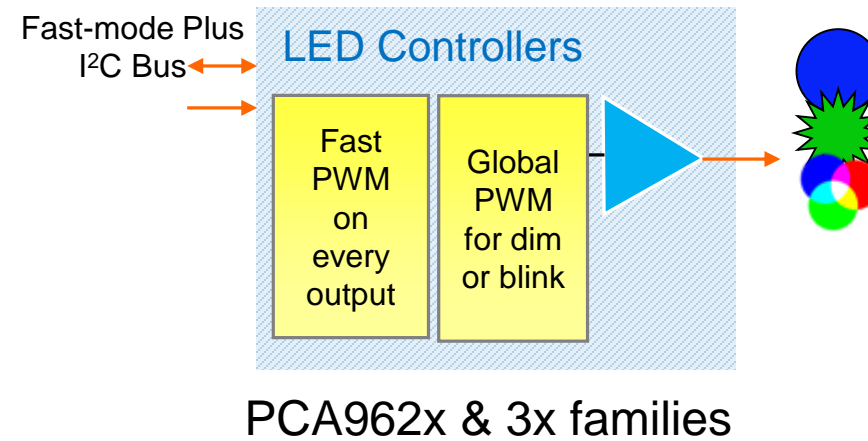
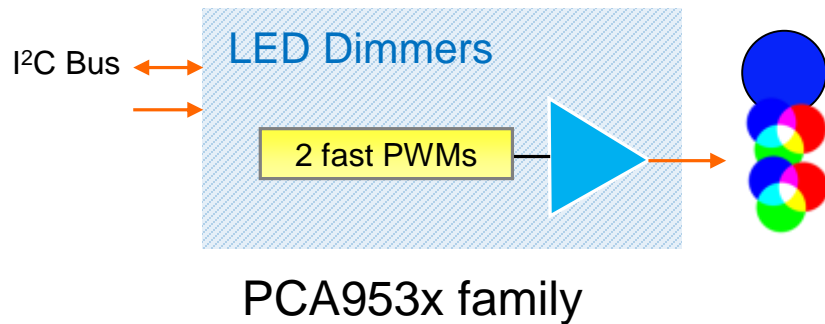
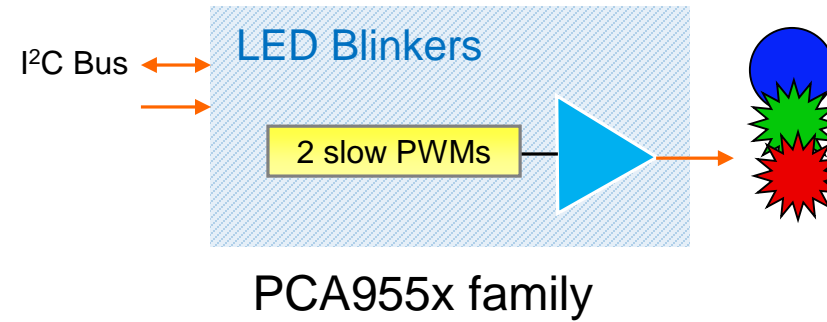
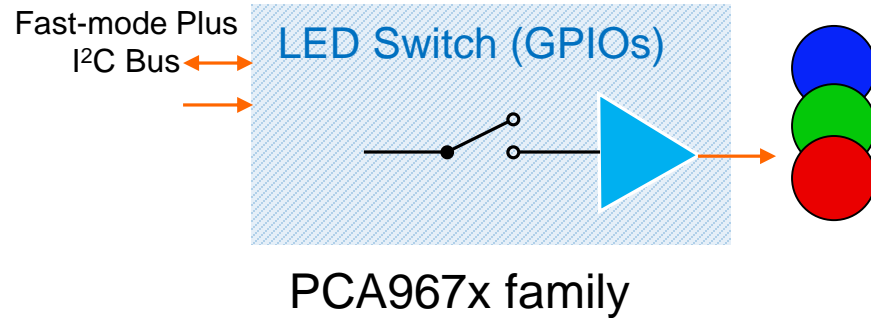
Cons:

- More expensive



I²C LED Switch, Blinkers, Dimmers and Controllers

Product overview





LED Controller Portfolio

Voltage-Source LED Controllers

Number of Outputs	LED Blinkers (25mA / 5V)	LED Dimmers (25mA / 5V)	Color Mixing LED Controllers (25mA / 5V)	Color Mixing LED Controllers (100mA / 40V)
2	PCA9550	PCA9530		
4	PCA9553	PCA9533	PCA9632 ^[1] PCA9633	
8	PCA9551	PCA9531	PCA9634	PCA9624
16	PCA9552	PCA9532	PCA9635 ^[3] PCA9685 ^{[2] [3]}	PCA9622
24				PCA9626

[1] Low power version of PCA9633

[2] The PCA9685 has 12-bit PWM while the PCA9635 has 8-bit PWM

[3] AEC-Q100 qualified

Current-Source LED Controllers

Device	# of Outputs	F _{osc}	Output Current	Active-Low /OE	Interface
PCA9952 ^[1]	16	8MHz	5mA ~ 57mA	Yes	Fm+ I ² C; 8 Addresses
PCA9955 ^[1]	16	8MHz	5mA ~ 57mA		Fm+ I ² C; 16 Addresses
PCA9955B ^[1]	16	8MHz	225µA ~ 57mA	Yes	Fm+ I ² C; 125 Addresses
PCA9745B ^[1]	16	8MHz	225µA ~ 57mA	Yes	Serial-Shift; No Address
PCA9755B ^[1]	16	8MHz	225µA ~ 57mA	Yes	SPI; 25 Addresses
PCA9956B	24	8MHz	225µA ~ 57mA	Yes	Fm+ I ² C; 125 Addresses
PCA9957	24				SPI; 10MHz

[1] AEC-Q100 Qualified



LED Controllers Applications: PCA962x LED Controller

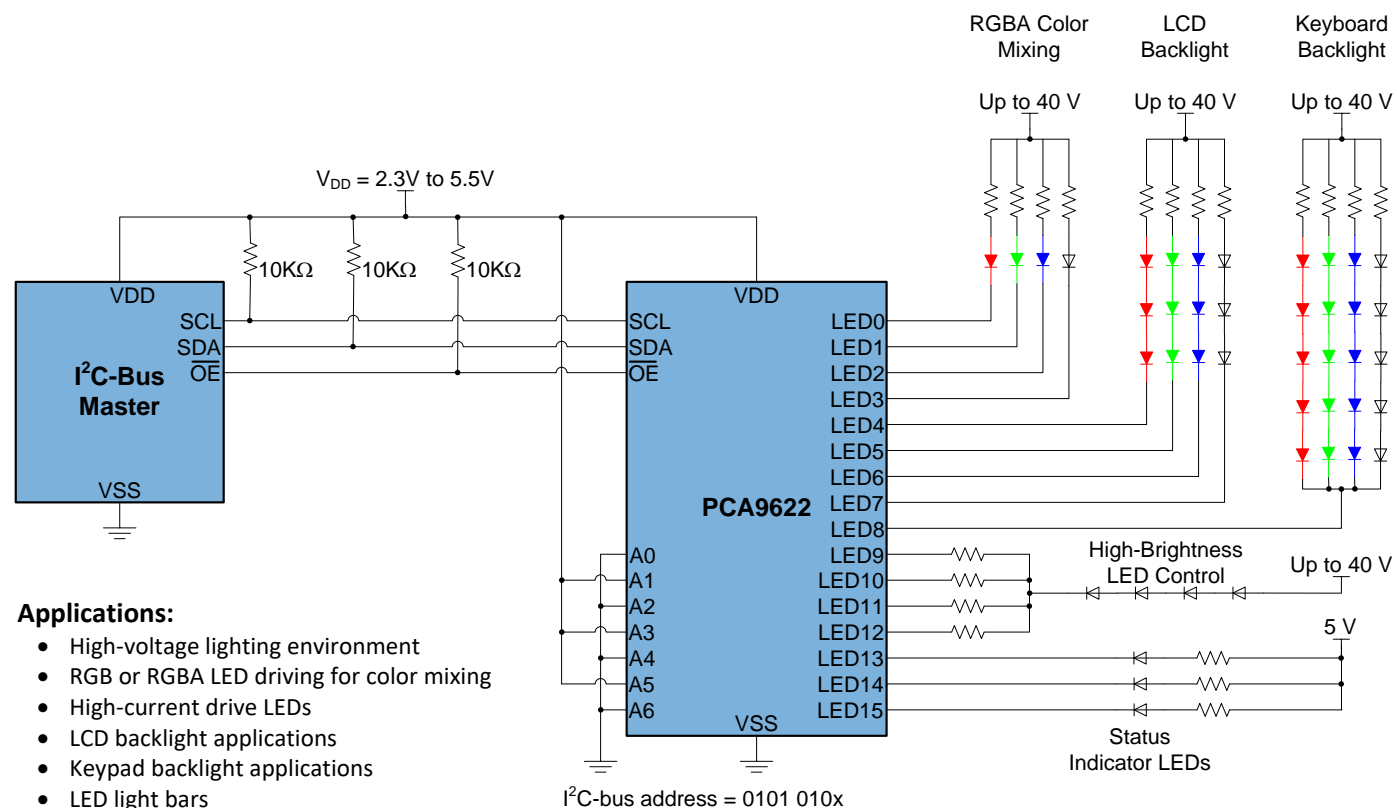
• Features:

- Programmable LED drivers
- Outputs drive up to 100-mA (per output)
- Open-drain outputs allow voltages up to 40V
- Individual LED dimming with 8-bit or 256 steps individual PWM
- Global LED dimming or blinking with 8-bit or 256 steps individual PWM
- 124 individual addresses with 4 programmable sub calls address groups
- Fast-mode Plus I²C interface (1MHz)

• Benefits:

- Same software as PCA963X
- Drive up to 100mA @ 40 V, with LEDs in series

PCA9624	8-Bit
PCA9622	16-Bit
PCA9626	24-Bit





PCA963x: 25-mA / 5V LED Controller

• Features:

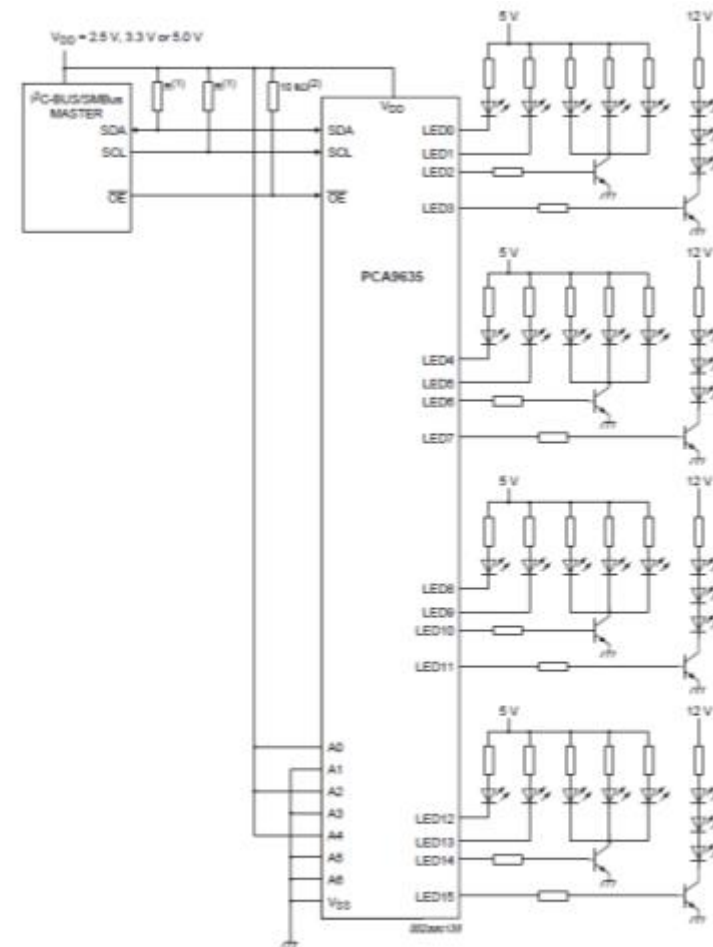
- LED drivers with totem-pole outputs to sink up to 25mA or source up to 10mA (per output)
- Individual LED dimming with 8-bit or 256 steps individual PWM
- Global LED dimming or blinking with 8-bit or 256 steps individual PWM
- Fast-mode Plus I²C interface (1MHz)
- 124 individual addresses with 4 programmable sub calls address groups

• Benefits:

- Same software as PCA962x
- Drive up to 25mA per output

• Applications:

- Industrial Lighting
- Emergency Warning Lights
- High-Voltage Lighting Environment



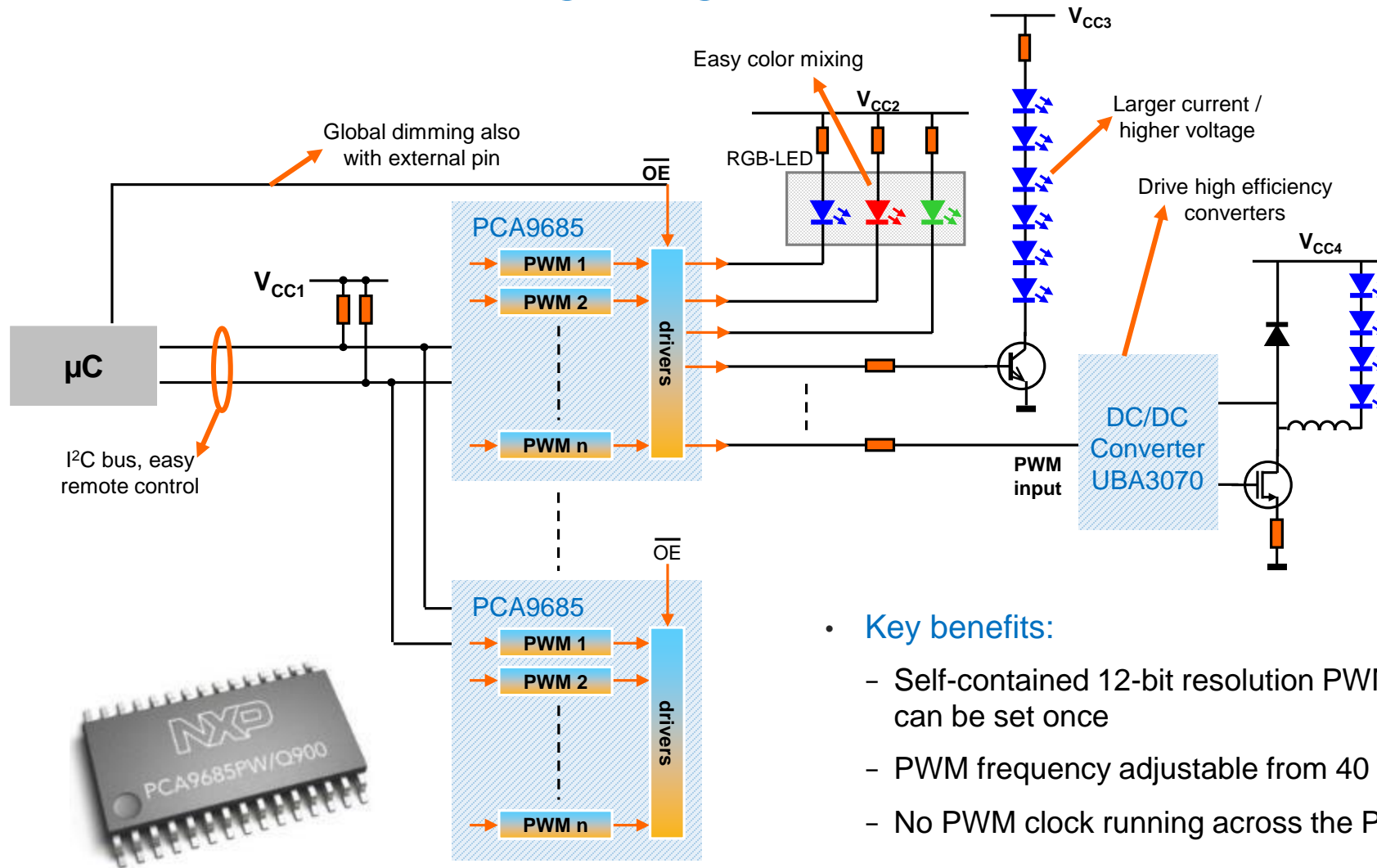
PCA9632	4-Bit
PCA9633	4-Bit
PCA9634	8-Bit
PCA9635	16-Bit

(1) R = 10 kΩ (typical) for SMBus, Standard-mode or Fast-mode I²C-bus. R = 1 kΩ (typical) for Fast-mode Plus I²C-bus.
 (2) OE requires pull-up resistor if control signal from the master is open-drain.
 I²C-bus address = 0010 101x.





PCA9685 Application (LED Lighting)





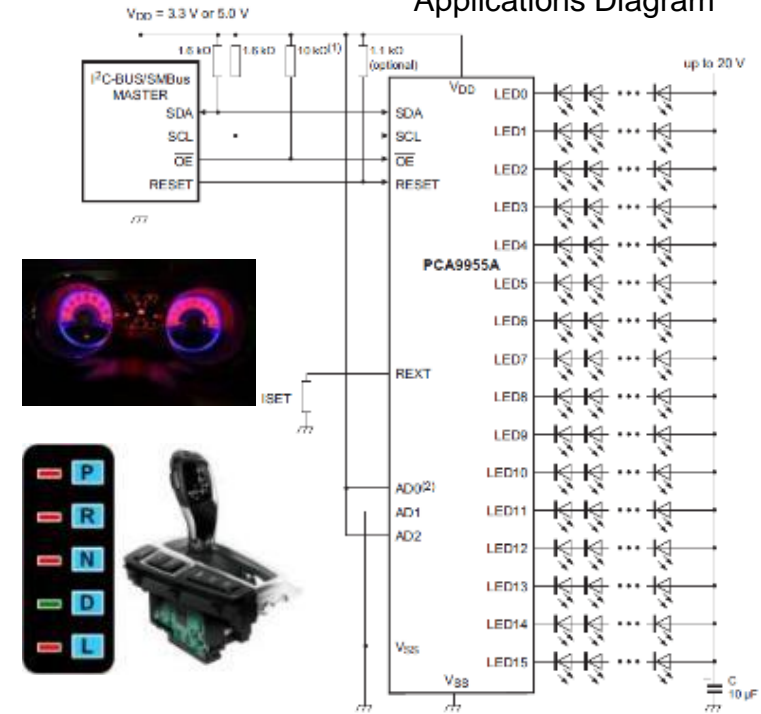
PCA9955B:

20V / 57mA 16-Channel Constant-Current LED Controller

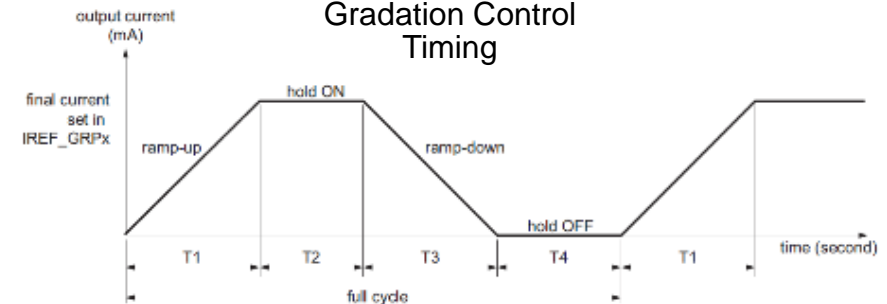
FEATURES

- $V_{CC} = 3.0\text{ V to } 5.5\text{ V}$
- Output
 - Constant current; Up to 57mA current drive/channel
 - 20V sustaining voltage
 - REXT sets ILED for all channels
 - $\pm 4\%$ channel-to-channel matching
 - $\pm 6\%$ IC-to-IC matching
 - 0.8V (typ) regulation voltage
 - 256:1 LED current peak adjustment
 - Gradation Control for all channels
 - Programmable step time from 0.5ms to 512ms
 - Programmable output current adjustment between linear and exponential curve
 - Real-time LED short or open detect
- Digital Interface
 - I²C (Fm+), 1 MHz (bi-directional)
 - Three quinary (five states) input address pins allow up to 125 devices to be connected on the same bus
 - Four software programmable I²C-bus addresses (one LED group call address and three LED sub call addresses)
- PWM Generator
 - 256:1 Individual PWM dimming range (31.25kHz)
 - 256:1 Global PWM dimming range (122Hz)
 - 256:1 Global blinking (0.05Hz to 15Hz)
 - Programmable phase shifting (125ns to 1.875us)
- Over-Temperature Protection (150 °C typ)
- -40 °C to +85 °C Operating Temperature
- HTSSOP28 Package with Thermal Relief Pad
- Compliant to ESD Standards (3kV HBM, 1kV CDM)

Simplified Applications Diagram



Gradation Control Timing



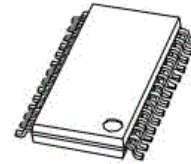


PCA9956B:

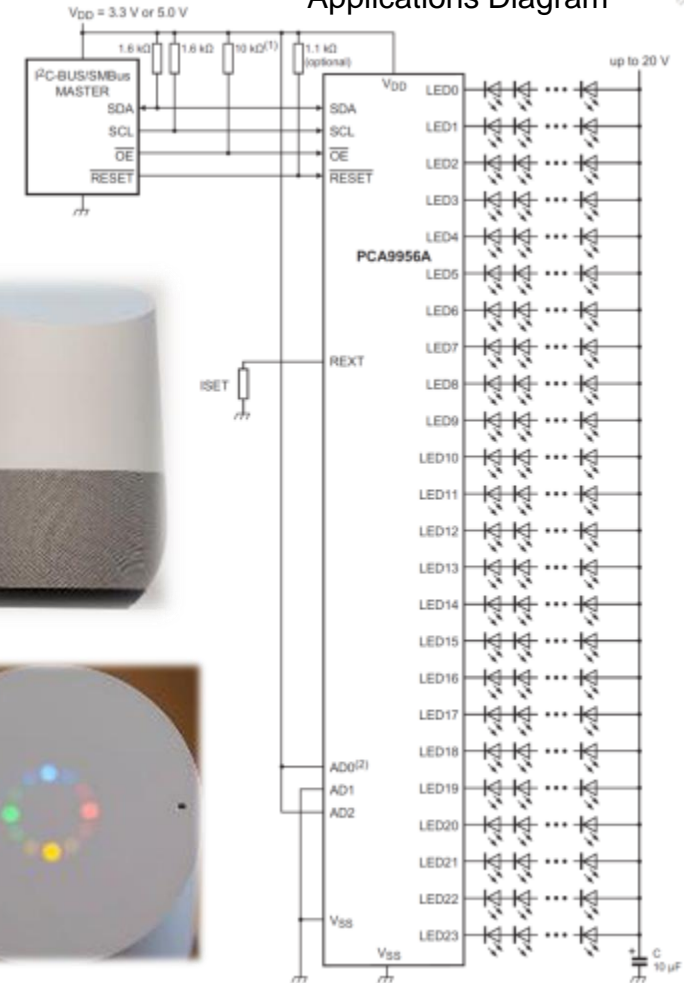
20V / 57mA 24-Channel Constant-Current LED Controller

FEATURES

- $V_{CC} = 3.0\text{ V to } 5.5\text{ V}$
- Output
 - Constant current; Up to 57mA current drive/channel
 - 20V sustaining voltage
 - REXT sets ILED for all channels
 - $\pm 4\%$ channel-to-channel matching
 - $\pm 6\%$ IC-to-IC matching
 - 0.8V (typ) regulation voltage
 - 256:1 LED current peak adjustment
 - Real-time LED short or open detect
- Digital Interface
 - I²C (Fm+), 1 MHz (bi-directional)
 - Three quinary (five states) input address pins allow up to 125 devices to be connected on the same bus
 - Four software programmable I²C-bus addresses (one LED group call address and three LED sub call addresses)
- PWM Generator
 - 256:1 Individual PWM dimming range (31.25kHz)
 - 256:1 Global PWM dimming range (122Hz)
 - 256:1 Global blinking (0.05Hz to 15Hz)
 - Programmable phase shifting (125ns to 1.875us)
- Over-Temperature Protection (150 °C typ)
- -40 °C to +85 °C Operating Temperature
- HTSSOP38 Package with Thermal Relief Pad

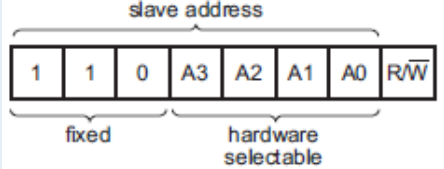
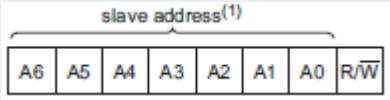


Simplified Applications Diagram





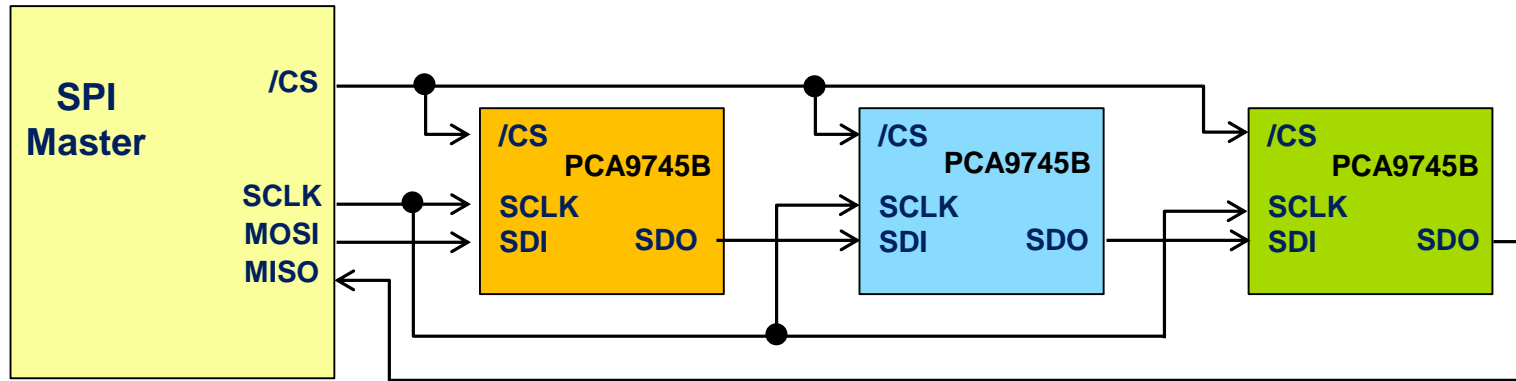
Comparison Between PCA9955 / 52 and PCA9955B / 56B

Feature	PCA9952 / PCA9955	PCA9955B (and PCA9956B)
Constant output current range	0 to 57 mA (255-step)	0 to 57 mA (255-step)
Maximum output voltage	40 V	20 V
Package	HTSSOP28 with thermal pad	HTSSOP28 with thermal pad HTSSOP38 with thermal pad (for PCA9956B)
Output enable (/OE)	No for PCA9955 (Yes for PCA9952)	Yes
Output current accuracy	± 6% between channels ± 8% between devices	± 4% between channels ± 6% between devices
Address scheme	Allow up to 16 devices in the same I ² C bus with 4 address select pins 	Allow up to 125 devices in the same I ² C bus with 3 address select pins 
PWM signal for individual LED brightness control (256-step)	31.25 KHz (duty cycle from 0% to 99.6%)	31.25 KHz (duty cycle from 0% to 100%)
LED Open/Short error detection method	Manual set the FAULTTEST bit to start fault test	Real time automatically detecting in ERROR status bit
Open/Short error flag bit	Single & shared bit to indicate either Open or Short in error flag register	Two bits to indicate Open or Short in error flag register
ESD (HBM/CDM)	2000V/750 V	3000V/1000 V



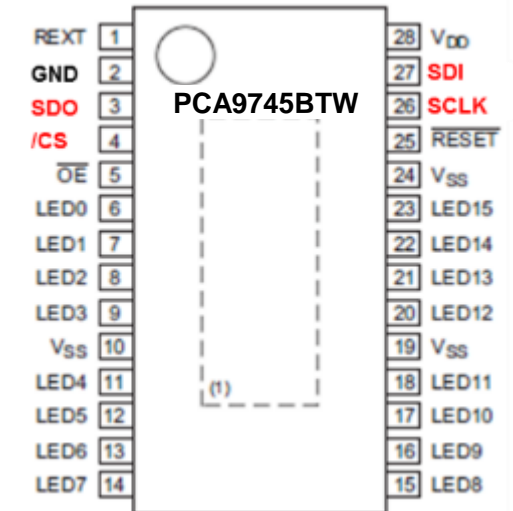


PCA9745B SPI Daisy Chain Connection



SPI Data Format

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Register Address					LSB	R / W	MSB	Data						LSB



- SPI Master send 16-bit (clocks with address and data) x 3 (number of slaves) to access all slave devices at the same time
- Only one byte data can be read/write from/to all slave devices
- No slave address required
- [AEC-Q100 automotive compliant version available](#)

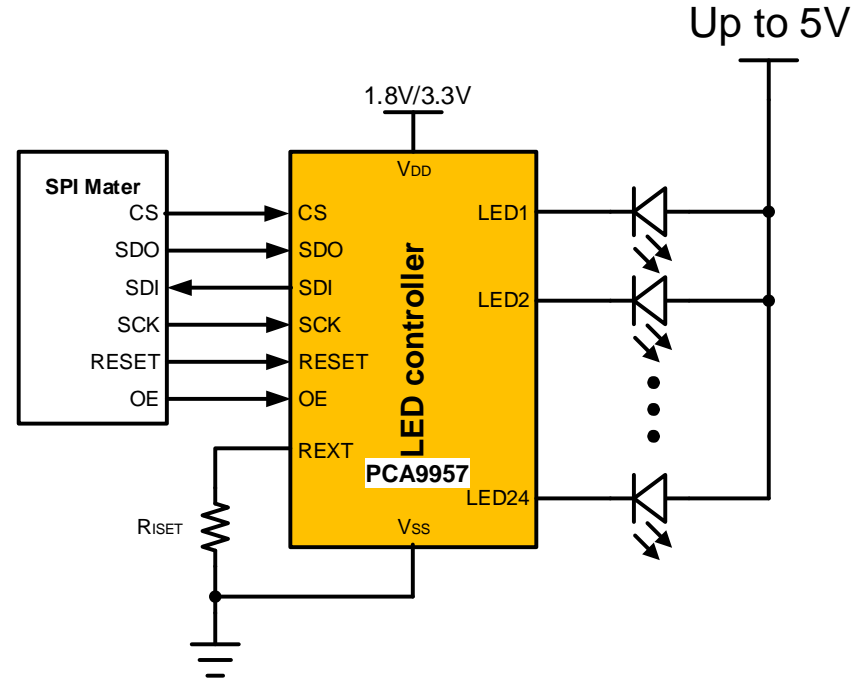




PCA9957: 32mA 24-CH Constant-Current LED Controller

Features

- 24 Channels constant current output
- VCC = 2.7V to 5.5V
- Output
 - Constant current; Up to 32mA current / channel
 - IREFx register to set current gain
 - Tolerant up to 5V
 - 0.4V (min) regulation voltage; drop at LED Output
 - Absolute accuracy: ±4% channel-to-channel matching
- Digital Interface
 - 4-Wire SPI-compatible serial-bus interface; up to 10MHz clock rate
 - Output Enable input pin allows for external hardware blinking and dimming of all LED's
- PWM Generator
 - 256-step group brightness and blinking control from 0% to 99.6%
- Hardware and Software Reset
- 8MHz internal oscillator requires no external component
- 140 °C Over-temperature protection
- Package: 40-Pin 5mm x 5mm QFN



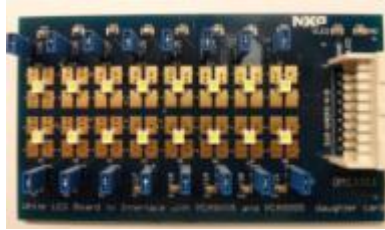
Samples Available





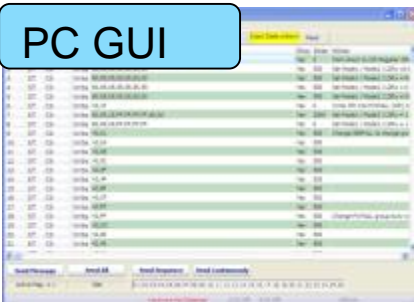
LED Controllers Demo Boards Support

16 White LED Board
(OM13311)



OR

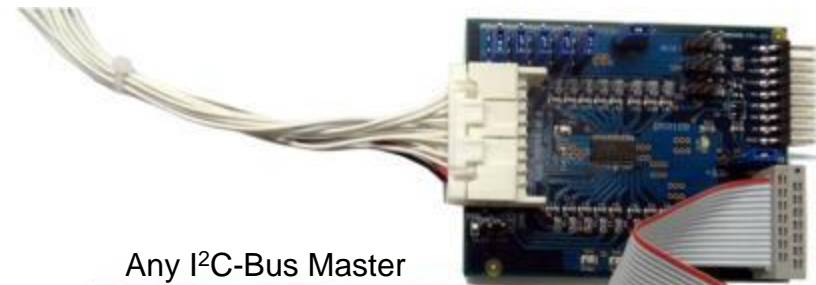
4 RGB + 4 White LED Board
(OM13310)



OM Number	Description (Device)
OM6282 †	4-Channel Fm+ Voltage Switch LED Controller Demo Board (PCA9633) ‡
OM6276 †	4-Channel Fm+ Voltage Switch LED Controller Demo Board (PCA9633) ‡
OM13269 †	4-Channel Fm+ Voltage Switch LED Controller Demo Board (PCA9632) ‡
OM13327 †	8-Channel Fm+ Voltage Switch LED Controller Demo Board (PCA9634) ‡
OM13528	16-Channel Voltage Switched LED Controller Demo Board (PCA9532) ‡
OM13331 †	16-Channel U _{Fm} Constant Current LED Controller Demo Board (PCU9955) ‡
OM13332 †	16-Channel Fm+ Voltage Switch LED Controller Demo Board (PCA9685) ‡
OM13333 †	16-Channel Fm+ Voltage Switch LED Controller Demo Board (PCA9635) ‡
OM13329	16-Channel Fm+ Constant Current LED Controller Demo Board (PCA9952) ‡
OM13309	16-Channel Fm+ Constant Current LED Controller Demo Board (PCA9955) ‡
OM13330 †	16-Channel Fm+ Constant Current LED Controller Demo Board (PCA9955) ‡
OM13483	16-Channel Fm+ Constant Current LED Controller Demo Board (PCA9955A) ‡
OM13524 †	16-Channel Fm+ Constant Current LED Controller Demo Board (PCA9745B) ‡
OM13321	24-Channel Fm+ Constant Current LED Controller Demo Board (PCA9956A) ‡

† Available on eDemoboard

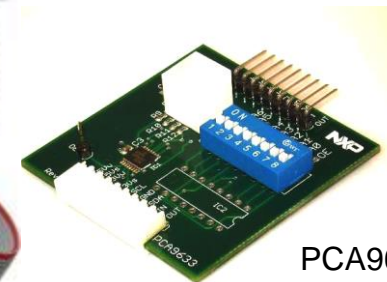
‡ Requires an I²C-Bus master. User may already have a master or they can use the OM13320.



PCA9955 Board
(OM13309)



PCA9633 Board
(OM6276)



PCA9633 Board
(OM6282)

Any I²C-Bus Master





REAL TIME CLOCKS



Standalone RTC Highlights

RTC Families:

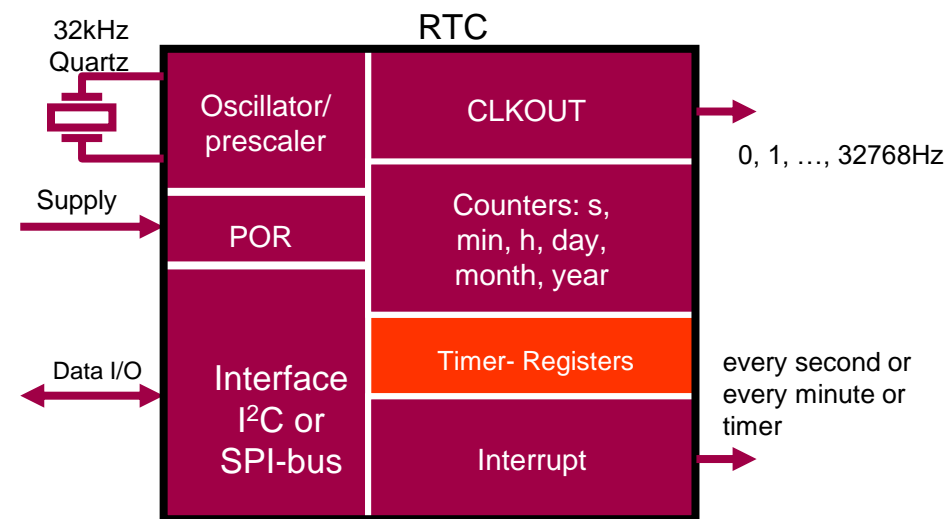
- | | | |
|----------------------------------|---------------------------------------|---|
| • Low Power RTC Family | PCF8523, PCF2123 | Ultra-low power, I ² C or SPI Interface |
| • Low Cost, Low Power RTC Family | PCF85063, PCF85063A, PCF85063B | Low power, I ² C or SPI Interface |
| | PCF85263A | Low power, time-stamp & battery switchover |
| | PCF85363A | Low power, 64-Byte RAM |
| • Accurate RTC Family | PCF2127(A)T/2, PCF2129(A)T/2 | Highly accurate RTC, I ² C and SPI Interface |
| • Automotive RTC Family | PCA8565, PCA21125, PCA85063A | High temp. up to 125°C, I ² C or SPI Interface |
| • Accurate/Automotive RTC Family | PCA2129T/Q900/2 | Highly accurate and AEC-Q100 compliant |

Key Features:

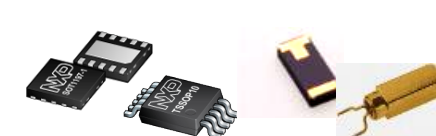
- Time keeping
- Low power; <100nA I_{CC} (PCF2123)
- Large voltage range; 1.5V to 5.5V
- Clock from seconds to 99 years
- Programmable Timer
- Frequency output
- Small packages (TSSOP8, HVSON10, etc)

Value Proposition:

- For highly accurate time-keeping, choose NXP RTCs with as low as **±3ppm** accuracy
- For long battery life, chose NXP RTCs with the industry's lowest current consumption of less than **100nA**
- For rugged environment applications, there is no way around NXP RTCs with extended temperature range up to **125°C** and **AEC-Q100 automotive compliant qualification**



Key RTC Products



	Type	Interface	Package	Status	Key features
	PCF8563	I ² C-Bus	SO8, TSSOP8, HVSON8	Production	Industry standard
Tiny	PCF85063 PCF85063A	I ² C-Bus	HWSON8, SO8 HXSON10	Production	Tiny footprint, best cost (<i>PCF85063A with alarm</i>)
	PCF85063B	SPI Bus	HXSON10	Production	Tiny footprint, best cost, alarm
Latest Generation	PCF85263A PCF85363A	I ² C-Bus	SO8, TSSOP8/10 HXSON10	Production	Two alarms, watchdog, electronic tuning, battery management, time stamp (<i>PCF85363A features also 64byte of RAM</i>)
	PCF85263B PCF85363B	SPI-Bus	SO8, TSSOP10, HXSON10	Development	Two alarms, watchdog, electronic tuning, battery management, time stamp (<i>PCF85363B features also 64byte of RAM</i>)
Lowest Power	PCF2123	SPI Bus	TSSOP14, HVQFN16	Production	Lowest power (100nA), electronic tuning
	PCF8523	I ² C-Bus	SO8, TSSOP14 HVSON8,	Production	Low power (100nA), electronic tuning Battery management
Precise	PCF2129A, PCF2127A	I ² C-Bus/ SPI Bus	SO20	Production	High accuracy ±3ppm, -25°...+65°C Battery management, Time stamp, metal can quartz (<i>PCF2127A features also 512byte RAM</i>)
	PCF2129 PCF2127	I ² C-Bus/ SPI Bus	SO16	Production	High accuracy ±3ppm, -40°..+85°C Battery management, Time stamp, ceramic quartz (<i>PCF2127 features also 512byte RAM</i>)
Automotive	PCA8565	I ² C-Bus	TSSOP8, HVSON10*	Production	Robustness: up to 125°C
	PCA21125	SPI Bus	TSSOP14	Production	Robustness: up to 125°C
	PCA2129	I ² C-Bus/ SPI Bus	SO16	Production	High accuracy ±3ppm, Battery management, Time stamp, ceramic quartz for automotive
	PCA85063A	I ² C-Bus	TSSOP8=TT	Production	Like PCF85063A, Tiny footprint, alarm, up to 105°C



RTC Selector Guide

RTC Portfolio	PCF8563	PCF85063A/B	PCF85263	PCF85363	PCF8523	PCF2123	PCF2127	PCF2129	PCA21125
Time	✓	✓	✓	✓	✓	✓	✓	✓	✓
Alarm	✓	✓	✓ 2x	✓ 2x	✓	✓	✓	✓	✓
Timer/ Watch dog	✓	✓	✓	✓	✓	✓	✓	✓	✓
Interrupt	✓	✓	✓ 2x	✓ 2x	✓ 2x	✓	✓	✓	✓
Stop Watch			✓	✓					
Time stamp			✓ 3x	✓ 3x			✓	✓	
Time stamp/ Tamper input			✓	✓			✓	✓	
Battery backup			✓	✓	✓		✓	✓	
Tuning register		✓	✓	✓	✓	✓	✓	✓	
Temperature compensation							✓	✓	
Factory calibration							✓	✓	
Quartz crystal							✓	✓	
RAM integrated				✓			✓		
High Temperature	PCA8565	PCA85063							✓
AEC-Q100 Automotive	PCA8565	PCA85063						PCA2129	✓
Interface									





PCF85063: Small Footprint Low-Power RTC

Available Versions:

- PCF85063TP: I²C-bus, Limited feature set, 8-pin package
- PCF85063A: I²C-bus, Full feature set, 8-pin package
- PCF85063B: SPI-bus, Full feature set + CLKOUT, 10-pin package
- PCA85063A: Automotive Qualified



Features

- Cost optimized
- Low-power consumption; At $V_{DD}=2.0V$, $T_{AMB}=25\text{ }^{\circ}C$, no bus activity and CLKOUT active, $I_{DD}=260\text{ nA (typ)}$
- Very small footprint packages
- HWSO8 (2 x 3 x 0.8mm)
- HXSON10 (2.6 x 2.6 x 0.5mm)
- SO8
- TSSOP8
- Two interfaces supported; I²C and SPI
- Two integrated programmable oscillator capacitors
- For 7-pF load
- For 12-pF load
- Electronic Tuning

Target Applications

- Printers
- Copy Machines
- Digital Still Cameras
- Digital Video Cameras

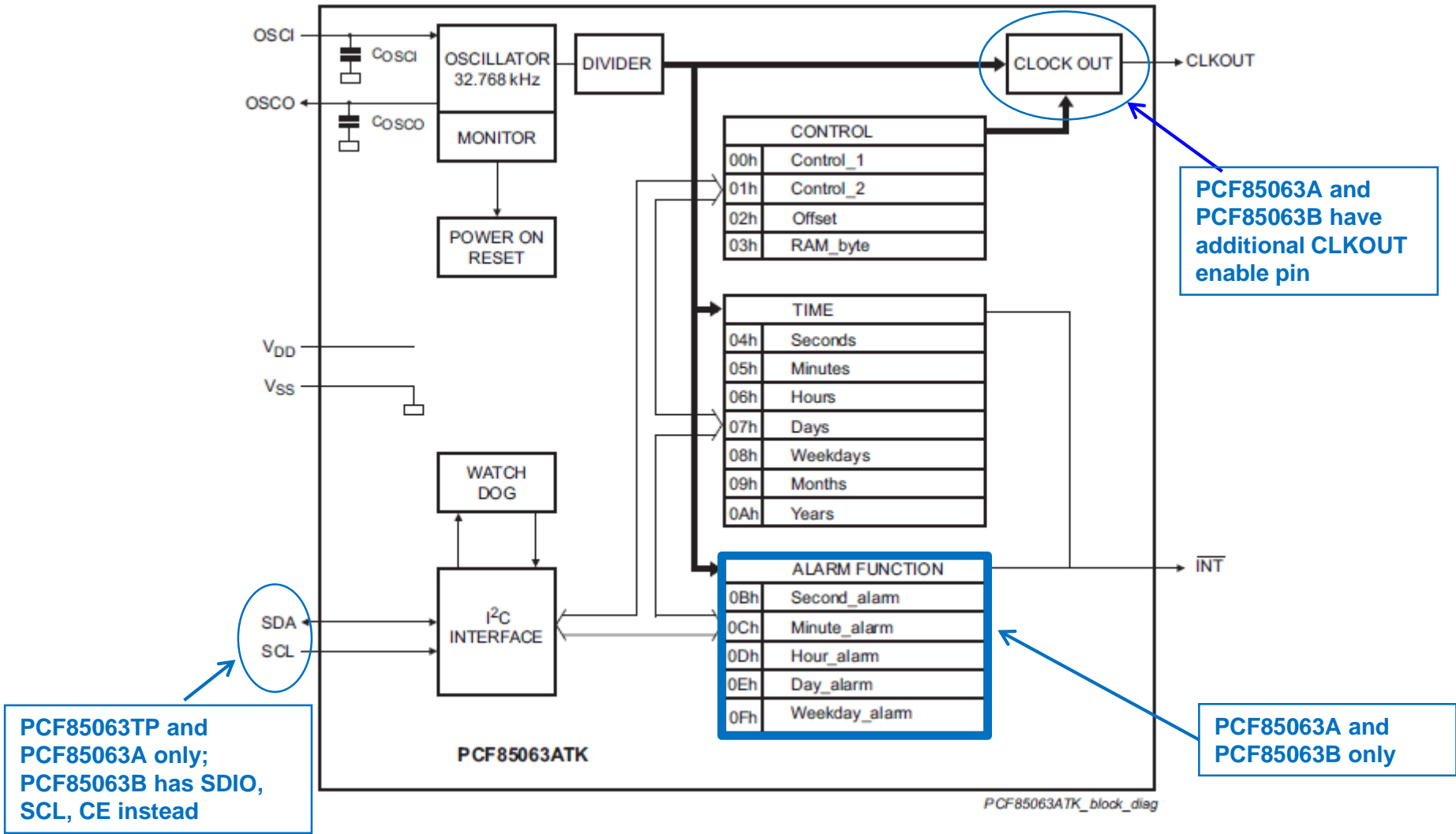
Function	PCF85063TP	PCF85063A	PCF85063B
Electronic tuning	Yes	Yes	Yes
I ² C-bus SPI interface	✓	✓	✓
1 min interrupt	No	Yes	Yes
Alarm facility	No	Yes	Yes
Timer	No	Yes	Yes
CLK out	Yes	Yes	Yes
CLK enable	No	Yes	Yes
Interrupt output	Yes	Yes	Yes
Package SOT number	HWSO8 ^[1] SOT1052	SO8, TSSOP8, HXSON-10 ^[1] SOT1052	HXSON-10 ^[1] SOT1197

[1] 0.5-mm pitch





PCF85063: Small Footprint Low-Power RTC





Comparison: PCF8563, PCF85063, PCF85063A, & PCF85063B

Parameter / Feature	PCF8563	PCF85063	PCF85063A	PCF85063B
Interface	I ² C-bus, 400kHz	I ² C-bus, 400kHz	I ² C-bus, 400kHz	SPI bus, 8MHz
Operating Supply Voltage	1.0V to 5.5V	0.9V to 5.5V	0.9V to 5.5V	0.9V to 5.5V
Interface Active Supply Voltage	1.8V to 5.5V	1.8V to 5.5V	1.8V to 5.5V	1.6V to 5.5V
CLKOUT Output	Open-drain	Push-pull	Push-pull (With CLKOE)	Push-pull (with CLKOE)
Programmable CLKOUT Frequency	32.768 kHz, 1.024 kHz, 32Hz , 1Hz, Off (CLKOUT=High-Z)	32.768 kHz, 16.3484kHz , 8.192kHz , 4.096kHz , 2.048kHz , 1.024 kHz, 1Hz, Off (CLKOUT=Low)	32.768 kHz, 16.3484kHz , 8.192kHz , 4.096kHz , 2.048kHz , 1.024 kHz, 1Hz, Off (CLKOUT=Low)	32.768 kHz, 16.3484kHz , 8.192kHz , 4.096kHz , 2.048kHz , 1.024 kHz, 1Hz, Off (CLKOUT=High-Z)
Alarm / Timer	Yes	No	Yes	Yes
Selectable Quartz C _L Tuning Capacitance	12pF (typical); 1 internal and 1 external	7pF or 12.5pF (Both Internal)	7pF or 12.5pF (Both Internal)	7pF or 12.5pF (Both Internal)
Automatic Interrupt (30 sec or 1 min)	No	Yes; Can also be disabled	Yes; Can also be disabled	Yes; Can also be disabled
Electronic Tuning	No	Programmable offset register for frequency adjustment	Programmable offset register for frequency adjustment	Programmable offset register for frequency adjustment
RAM	No	1 Byte	1 Byte	1 Byte
Packages	TSSOP8, SO8, DIP8, HVSON10	HWSON8	HXSON10, SO8, TSSOP8	HXSON10



PCF85263 & PCF85363: Tiny RTC Family



Available Versions:

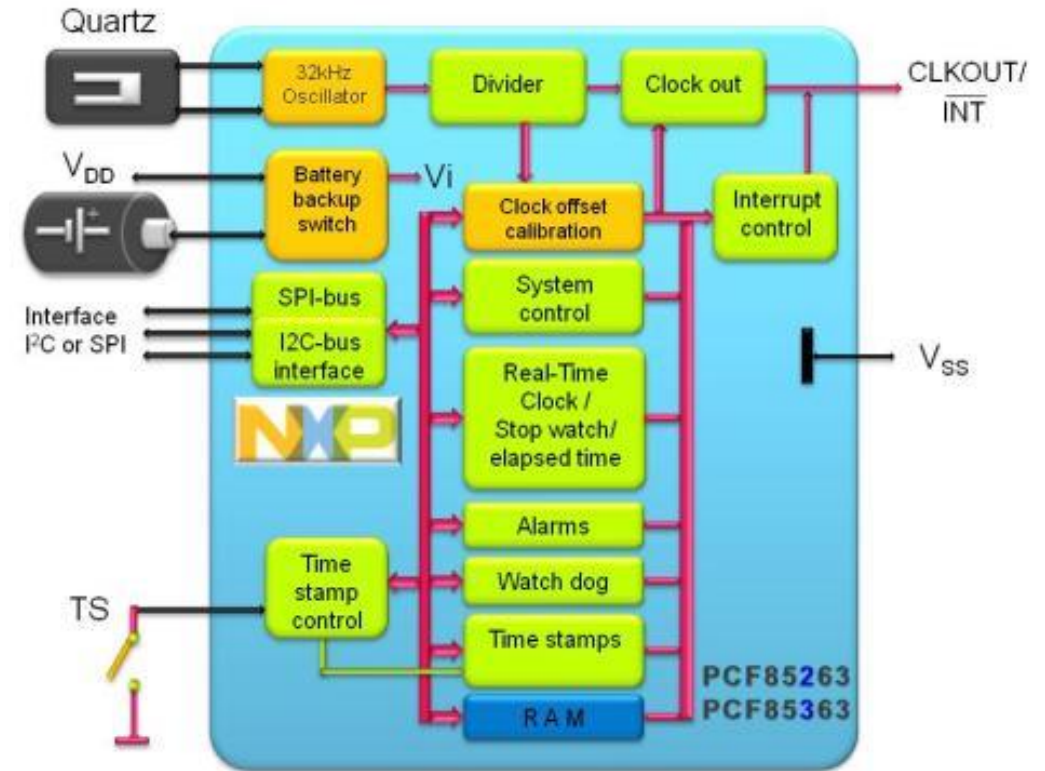
- PCF85263A: I²C-bus (1-Byte RAM)
- PCF85363A: I²C-bus + 64-Byte RAM

Features

- Low-power consumption; At VDD=3.0V, TAMB=25 °C, No bus activity and CLKOUT inactive, IDD<300nA (typ)
- Additional integrated features
- 1/100 s resolution RTC, stop-watch or elapsed time counter
- Battery backup input
- Time Stamps for tamper detection and battery switchover
- UL Recognized Component
- Watchdog
- Elapsed time counter
- Battery backed-up RAM (PCF85363)

Target Applications

- Telecom and Networking Equipment
- Servers
- Medical Equipment
- Power Supplies



Packages:

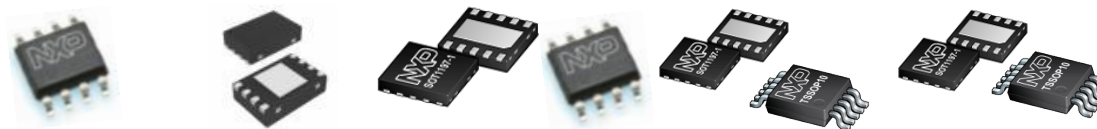
- Leadless Tiny Package: HXSON10
- Leaded Package: TSSOP8, TSSOP10
- Leaded Package: SO8 (PCF85x63A with I²C-bus)





The PCF85x63 Family Overview

Function \ Type	PCF8563 /5	PCF85063TP	PCF85063A PCF85063B	PCF85263A PCF85263B	PCF85363A PCF85363B
RTC, resolution Elapsed time counter	1s... years no	1s... years no	1s... years no	1/100s... years yes	1/100s... years yes
Alarm facility Timer, Watchdog	1 Alarm Timer, counter	No No	1 Alarm 1 Timer	2 Alarms Watch dog	2 Alarms Watch dog
Time Stamp	No	No	No	Yes 2	Yes 2
Battery backup input	No	No	No	Yes	Yes
RAM	No	1 Byte	1 Byte	1 Byte	64 Byte
Interrupts Interrupt pins	Universal 1	30 s, 1 min 1	30 s, 1 min, universal 1	universal 2, 1 in SO8	universal 2, 1 in SO8
I ² C-bus interface 400kHz SPI-bus interface 6.5MHz	Yes No	Yes No	A-version B-version	A-version B-version	A-version B-version
RTC electronic tuning Quartz, load capacity C _L =	No with external C	Yes 7pF / 12.5pF	Yes 7pF / 12.5pF	Yes 6pF / 7pF / 12.5pF	Yes 6pF / 7pF / 12.5pF
Package	SO8, TSSOP8, HVSON10	HVSON 8 2 x 3 x 0.8mm Tiny package	HXSON 10 2.6 x 2.6 x 0.5mm SO8, TSSOP8 (PCF85063A only)	HXSON 10 2.6 x 2.6 x 0.5mm SO8, TSSOP8, TSSOP10	TSSOP10, HXSON 10 2.6 x 2.6 x 0.5mm
Release Status	Released mass production	Released mass production	Released mass production	PCF85263A Released mass production PCF85263B In Development	PCF85363A Released mass production PCF85363B In Development



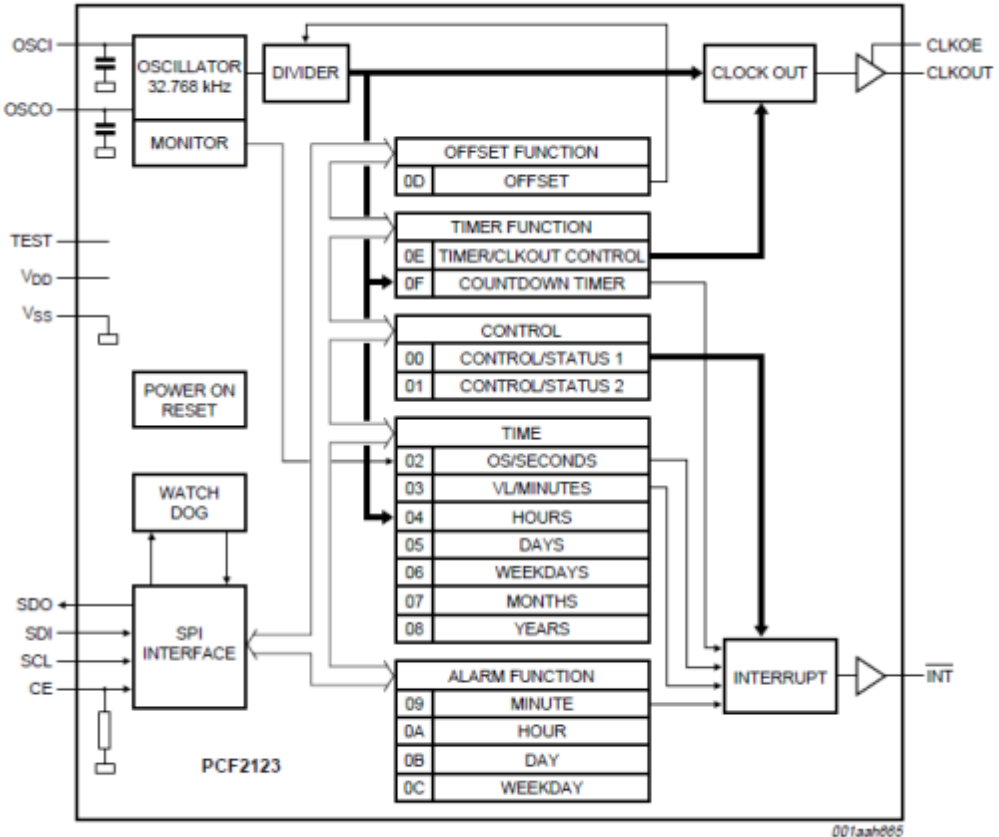


PCF2123: Ultra-low Power RTC with SPI Interface

Supply current as low as 100nA (typ.) at VDD = 2.0V and Tamb = 25 °C

Key Features:

- Ultra low power 100nA @ 2V (typ.)
- Large voltage range 1.5...5.5V
- SPI bus up to 6MHz
- Clock from seconds to 99 years
- Programmable Countdown Timer
- Programmable Output Clock Frequency with Output Enable pin
- [Electronic tuning](#)
- Small packages TSSOP14, HVQFN16 and U (die only)





PCF8523: Ultra-low Power RTC with I²C Interface

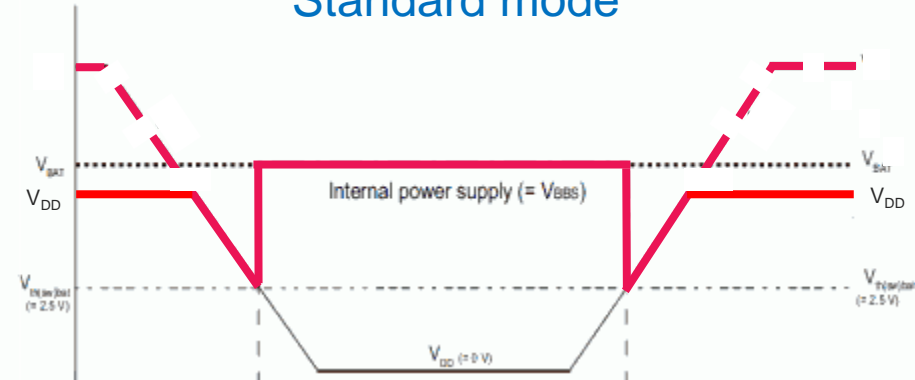


Supply current as low as 150nA (typ.) at VDD = 3.0V and T_{amb} = 25 °C

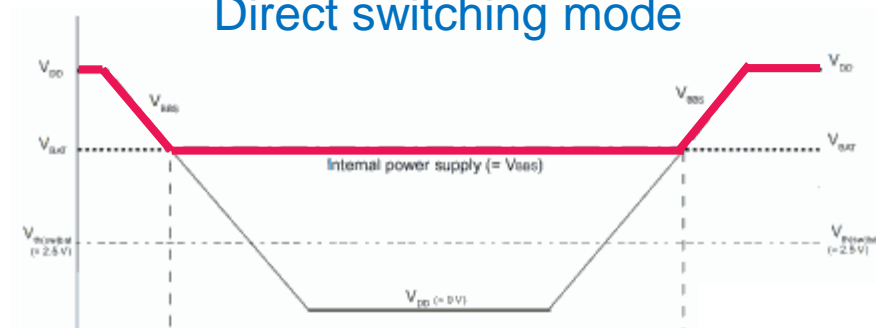
Key Features:

- Ultra low power **150nA @ 3V** (typ.)
- Large voltage range 1.6...5.5V
- 1MHz Fast-mode Plus (Fm+) I²C Interface
- Clock from seconds to 99 years
- Programmable Countdown Timer
- Programmable output clock
- Power Fail Detection Function
- Battery Switch-Over Function
- Battery Low Detection Function
- Electronic Tuning
- UL Recognized Component
- Packages: SO8, TSSOP14, HVSON8 & U

Standard mode



Direct switching mode

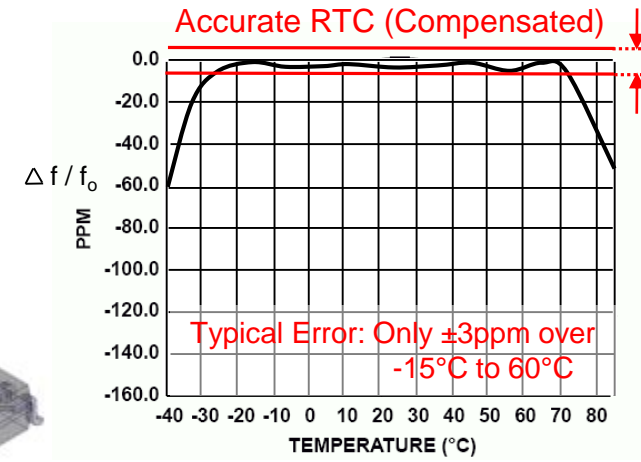
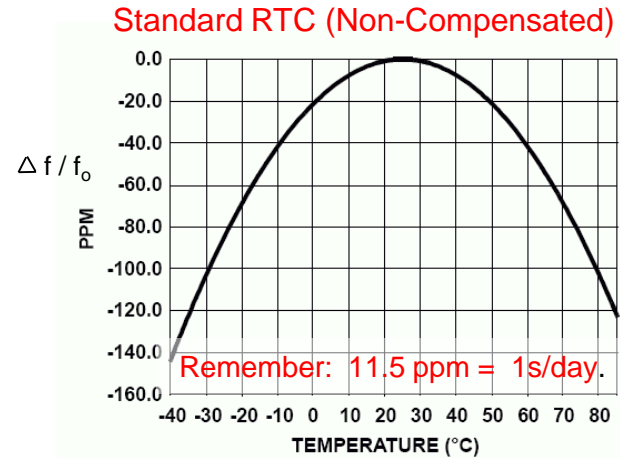
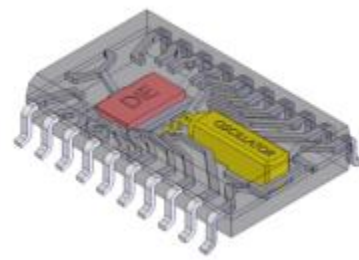




PCF2127A / 29A: Low-Power Accurate Real Time Clock (aRTC)

Features and Benefits

- High accuracy (**±3ppm**; typ.) for accurate time reference
- Ultra-low power consumption enables long battery life
 - ~500nA @ $V_{DD}=2.0V$ and $T_{amb}=25^{\circ}C$
- Integrated quartz crystal requires no external quartz
- Integrated TCXO with temperature compensation circuit requires no external temperature sensor and no temperature dependent tuning
- Battery backup and switchover functionality ensures reference timekeeping during power down
- Factory calibrated and ready at very first power up
- No external capacitors required and no re-calibration required to compensate for aging
- Integrated 512-byte RAM (PCF2127A) for retaining critical data during power down
- **UL Recognized Component**
- SPI and I²C Interface
- SO20 Package
- **AEC Q100 Compliant (PCA2129T/Q900)**





PCF2127A / 29A: Low-Power Accurate Real Time Clock (aRTC)

PCF2127A & PCF2129A Feature List

	PCF2127A	PCF2129A
Operating Temp. Range	-40°C, ..., +85°C	-40°C, ..., +85°C
Accuracy (typ)	±3 ppm; from -15°C to 60°C ±5 ppm; from -25°C to -15°C ±5 ppm; from +60°C to +65°C	±3 ppm; from -15°C to 60°C ±5 ppm; from -25°C to -15°C ±5 ppm; from +60°C to +65°C
Interface	I ² C and SPI	I ² C and SPI
RAM	512 Byte	-
Package	SO20	SO20
Supply Voltage Range VDD	1.8V – 4.2V	1.8V – 4.2V
Battery Supply Voltage Range VBat	1.8V – 4.2V	1.8V – 4.2V
Supply Current (typ.)	500nA @ 2.0V and T _{amb} =25°C	500nA @ 2.0V and T _{amb} =25°C
Battery Switch over function	Yes	Yes
Battery Low-Detection Function	Yes	Yes
Extra Power Fail Detection Function	Yes	No
Battery backed Output Voltage Pin	Yes	Yes
Reset Output Pin	Yes	No
Countdown timer and watch dog function	Yes	Watchdog only
Time Stamp Function	Yes	Yes





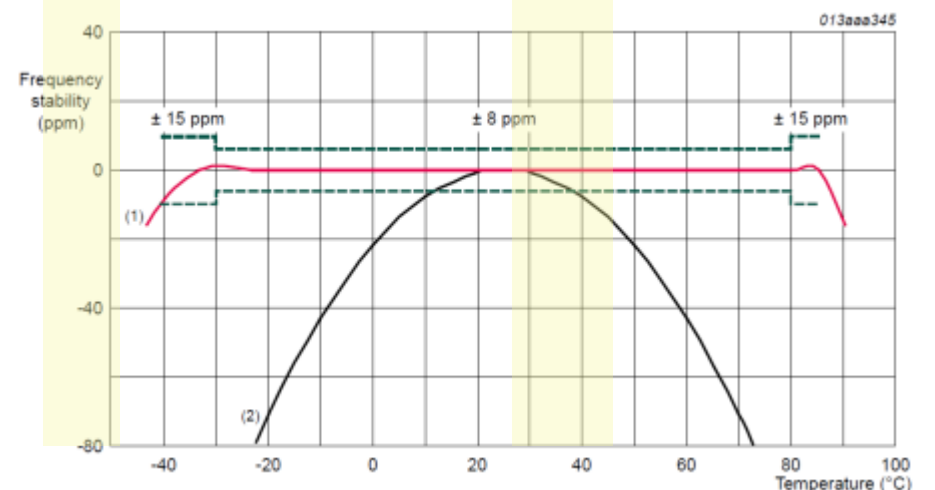
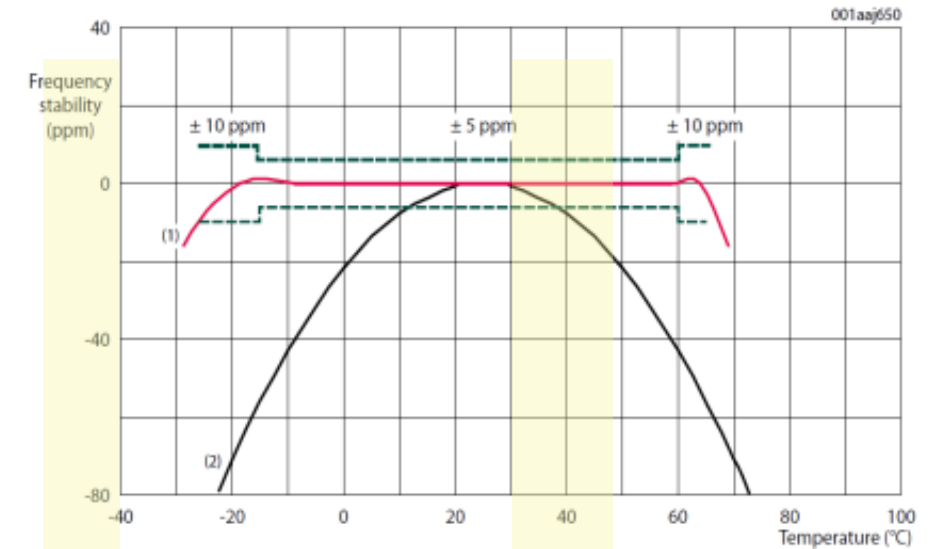
PCF2127(A) / 29(A): Differences in Accuracy

Key features:

The PCx2129 comprises a Real Time Clock (RTC) and a temperature compensated quartz oscillator (TCXO). The quartz crystal itself is integrated into the package.

There are 2 major version one in SO20, the other one in SO16. They feature different frequency response.

Type number	PCF2127AT, 2129AT	PC2127T/2, 2129T
Version	Industrial	Industrial
Grade	General Quality spec GQS	General Quality spec GQS
Frequency accuracy	+/- 5ppm -15°C...+60°C +/-10ppm -25...-15, 60..65°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C
Construction	Metal can quartz	Ceramic quartz
Silicon foundry	TSMC Taiwan	TSMC Taiwan
Assembly fab	APB Bangkok Thailand	APB Bangkok Thailand
Wafer and final test	APB Bangkok Thailand	APB Bangkok Thailand
Release status	Released , mass production	Release , mass production
Package	SO20	SO16 drop-in compliant to SO20
Quartz Type		





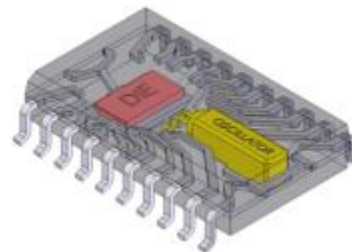
PCA2129: Automotive Qualified Accurate Real Time Clock (aRTC)

Features and Benefits:

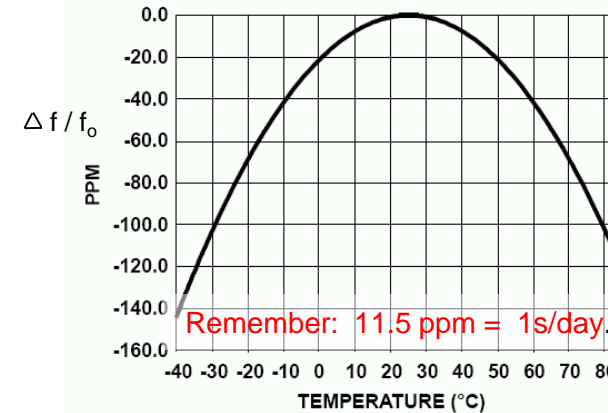
- High accuracy (**±3ppm**; typ.) for accurate time reference
 - ±3ppm accuracy -30°C to +80°C
 - ±5ppm -40°C to -30°C
 - ±5ppm +80°C to +85°C
- Temperature Range from -40°C to +85°C
- Voltage Supply from 1.8V to 4.2V
- Ultra-low power consumption enables long battery life
 - ~500nA @ $V_{DD}=2.0V$ and $T_{amb}=25^{\circ}C$
- Integrated quartz crystal requires no external quartz
- Integrated TCXO with temperature compensation circuit requires no external temperature sensor and no temperature dependent tuning
- Factory calibrated and ready at very first power up
- SPI and I²C Interface
- SO16 Package
- **AEC Q100 Compliant**

Target Applications:

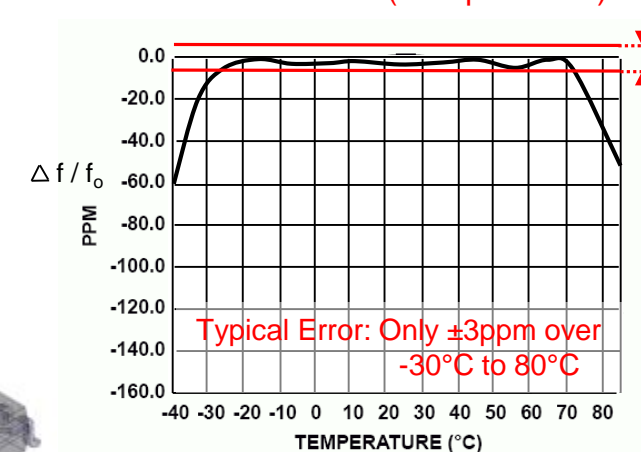
- Electric Car Battery Management
- Charging Stations
- Body Control Module



Standard RTC (Non-Compensated)



Accurate RTC (Compensated)






Comparison: NXP Accurate Real Time Clocks

Key Features:

- The aRTC comprises a Real Time Clock (RTC) and a temperature compensated quartz oscillator (TCXO).
- The quartz crystal is integrated in the package.
- No need for further tuning over time; Just set the clock time once.
- The type names are quite similar, but the differences are highlighted bold characters.

Type number	PCF2127AT/2	PCF2129AT/2	PCF2127T/2	PCF2129T/2	PCA2129T/Q900/2
Version	Industrial	Industrial	Industrial	Industrial	Automotive
Grade	General Quality spec GQS	General Quality spec GQS	General Quality spec GQS	General Quality spec GQS	AEC-Q100 Grade 3
Package	SO20	SO20	SO16 drop-in compliant to SO20	SO16 drop-in compliant to SO20	SO16
Frequency accuracy	+/- 5ppm -15°C...+60°C +/-10ppm -25..-15, 60..65°C	+/- 5ppm -15°C...+60°C +/-10ppm -25..-15, 60..65°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C	+/- 8ppm -30°C...+80°C +/-15ppm <-30°C, >80°C
Construction	Metal can quartz	Metal can quartz	Ceramic quartz	Ceramic quartz	Ceramic quartz
Silicon foundry Assembly fab Wafer and final test	TSMC Taiwan APB Bangkok Thailand APB Bangkok Thailand	TSMC Taiwan APB Bangkok Thailand APB Bangkok Thailand	TSMC Taiwan APB Bangkok Thailand APB Bangkok Thailand	TSMC Taiwan APB Bangkok Thailand APB Bangkok Thailand	TSMC Taiwan APB Bangkok Thailand APB Bangkok Thailand
Release status	Released mass production	Released mass production	Released mass production	Released mass production	Released mass production
	2129 + 512 Byte RAM count down timer reset output pin		2129 + 512 Byte RAM count down timer reset output pin		





Real Time Clock (RTC) Design Support

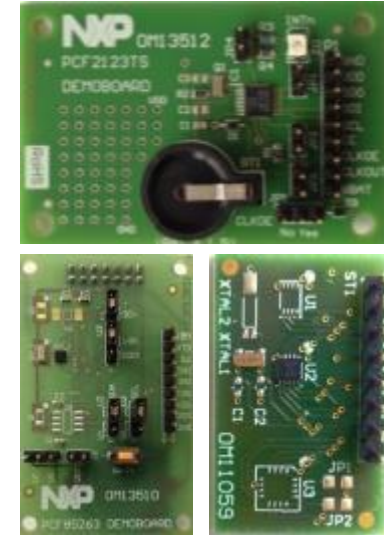
Key Features

- I²C or SPI bus interface
- Back-up battery installed
- Multiple package footprints for different package options. RTC Selectable by jumper.
- Demonstrates different features:
 - Timekeeping
 - Calendar
 - Two alarms with two configurable interrupt outputs
 - Clock Output
 - Counter
 - Stopwatch with 1/100 second resolution
 - Interrupt Feature
 - Timestamp
 - Low Power

USB-I²C-bus Dongle



RTC Evaluation Boards



RTC	Eval Board	User Manual
PCF2123	OM13512 †	UM10759
PCF8523	OM13511 †	UM10670
PCF2127, 29	OM13513 †	UM10762
PCF85063B	OM11059 †	UM10699
PCF85063A	OM11059A	UM10698
PCF85263A	OM13515 †	UM10788
PCF85363A	OM13510 †	UM10766
PCF85363A	OM13514 †	UM10787
USB-I ² C dongle	OM13518 †	UM10789

† Available on eDemoboard

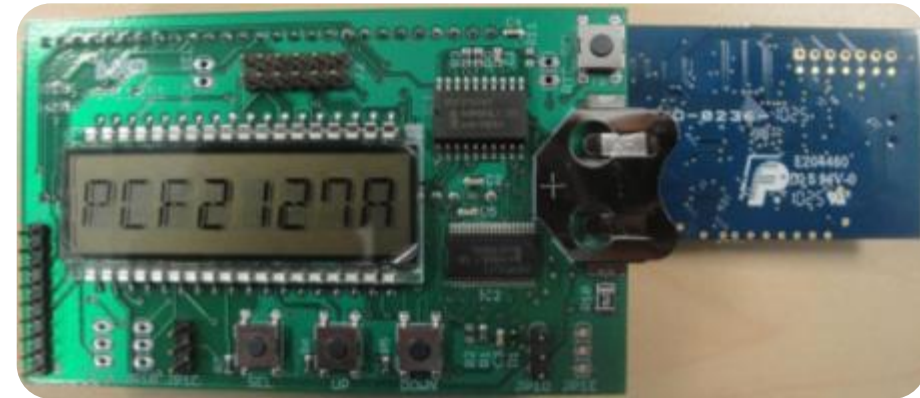




PCF2127A / PCF2129A Evaluation Kit (OM11051)

Key Features

- Demonstrates functions of the PCF2127A or the PCF2129A accurate Real Time Clock, together with software examples.
 - On power-up, the unit enters the clock mode and the LCD displays the time
 - Software examples showing how to program the RTC are included
- Based on the LPCXpresso (LPC1343 MCU)
- Demonstrates different features:
 - Clock
 - Calendar
 - Alarm
 - Counter
 - Interrupt Feature
 - Timestamp
 - Battery Backup
 - Low Power



OM11051 is available on eDemoboard



Application Notes

[AN10652](#): Improved Timekeeping Accuracy with PCF8563 Using External Temperature Sensor

[AN10857](#): Application and Soldering Information for PCF2127A and PCF2129A TCXO RTCs

[AN11120](#): Application and Soldering Information for PCA2129 Automotive TCXO RTC

[UM10301](#): User Manual for NXP Real Time Clocks PCF85x3, PCA8565 and PCF2123, PCA2125

[UM10698](#): User Manual for I²C-Bus RTC Demoboard OM11059A

[UM10699](#): User manual for SPI-bus RTC Demoboard OM11059



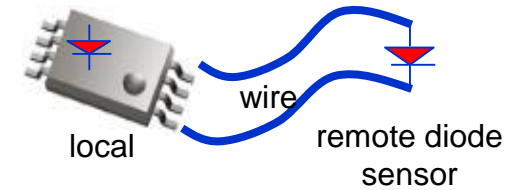
TEMPERATURE SENSORS





I²C Temperature Sensors

- Determine temperature and set window for interrupt, alarm, fan control, shutdown, etc.
- Applications
 - Industrial, medical, server, workstation and storage motherboards, enterprise SSD and hybrid drives power supplies, DIMM modules
- Large selection of commonly used local and local/remote thermal sensors
 - Wide range of packages
 - Continuous innovation with lower voltage, smaller package and higher accuracy





I²C Temperature Sensor Portfolio

V RANGE	ACCURACY (LOCAL)	ACCURACY (REMOTE)	SMBus TIMEOUT	TEMP RES.	ADC RES.	SUPPLY CURRENT	NOTES	PACKAGE	PART#
2.8 to 5.5V	±2 °C		YES	0.125	11-bit	operating: 300 µA standby: 1 µA	industry standard,	SO8, SSOP8, XSON8U, HWSO8 (metal pad)	LM75B
2.7 to 5.5V	±1 °C		YES	0.125	11-bit	operating: 200 µA standby: 1 µA		SO8, MSOP8, HWSO8, SOT23-6 (TSOP6)	PCT2075
1.7 to 3.6V		YES	0.125	11-bit	operating: 400 µA standby: 5 µA	low voltage	HWSO8	SE98A	
3.0 to 3.6V		YES	0.125	11-bit	operating: 400 µA standby: 3 µA	DDR3, 2K EEPROM	HWSO8	SE97B	
1.65 to 1.95V		±1.0°C typ. (-40 to +125 °C) ±0.5°C typ. (0 to +85 °C)	YES	0.0625	12-bit	operating: 30µA standby: 1 µA	TMP102 replacement, 1.8V	WLCSP6	PCT2202
3V to 5.5V	±2 °C	±3 °C †		1.0	8-bit	operating: 70 µA standby: 3 µA		QSOP16	NE1617A
3.0V to 3.6V	±2 °C	±1 °C †		0.125	11-bit	operating: 500 µA standby: 10 µA		SO8, TSSOP8, HWSO8	SA56004

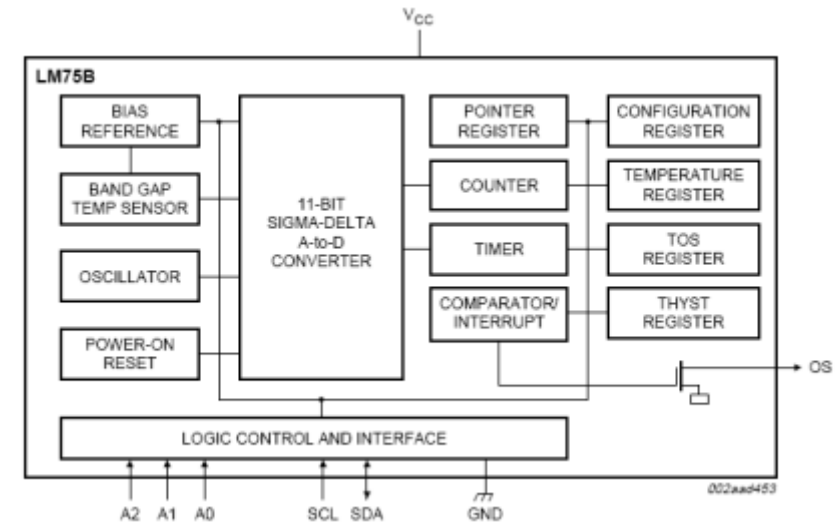
† The NE1617A and SA56004 can also be connected to an external diode for remote temperature sensing.



L75B: Local Digital Temp. Sensor & Thermal Watchdog

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 and TSSOP8



Type number	Topside mark	Package		Version
		Name	Description	
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





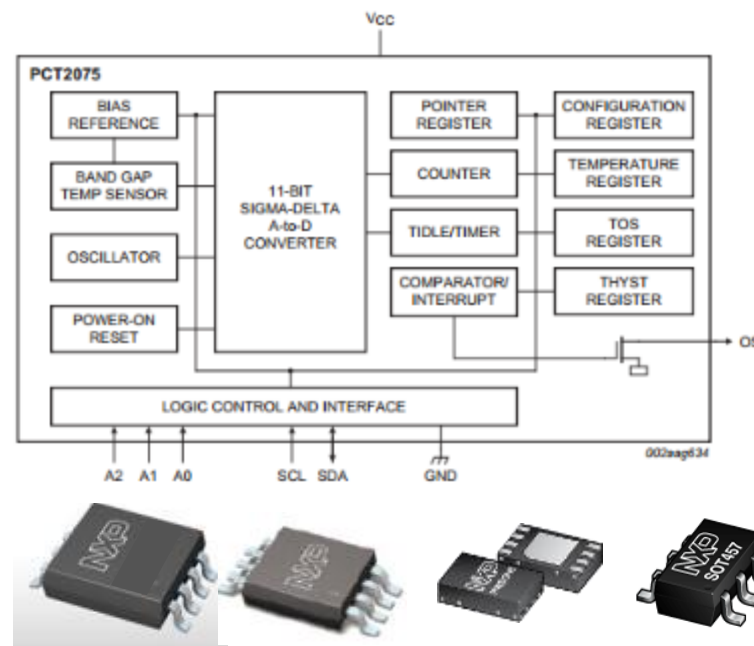
PCT2075: Digital Temp. Sensors & Thermal Watchdog

Features

- Fm+ I²C-bus (1MHz) with SMBus timeout
- Power supply range - 2.7 V to 5.5 V
- Temperatures range - -55 °C to +125 °C
- 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 I²C address range with 3 state pins (27 @ 8-pin and 3 @ 6-pin) address latched at power up
- 8-pin package types: SO8, TSSOP8, HWSON8
- 6-pin package types: SOT23-6 (TSOP6)

PCT2075: 11-Bit ADC

±1 °C (max.) from -25 °C to +100 °C
 ±2 °C (max.) from -55 °C to +125 °C



Package	SO8	TSSOP8	HWSON8	TSOP6 SOT23-6
SOT #	SOT96-1	SOT505-1	SOT1069-2	SOT457
Pitch (mm)	1.27	0.65	0.5	0.95
Width (mm)	3.90	3.0	2.0	3.0
Length (mm)	3.90	5.0	3.0	1.5
Height (mm)	1.75	1.1	0.8	1.1



PCT2202: Temp. Sensors for SSD and Portable

- 12-bit resolution with
 - $\pm 0.5^{\circ}\text{C}$ accuracy (0 to $+85^{\circ}\text{C}$)
 - $\pm 1.0^{\circ}\text{C}$ accuracy (-40 to $+125^{\circ}\text{C}$)
- Temperature Range from -40°C to $+125^{\circ}\text{C}$
- 1.65V to 1.95V operation
- High Speed Mode (HSM): 3.4 MHz operation
- High- and low-temperature set points and an alarm output
- One-shot mode to conserve power
- I²C state machine recognizes a General Call and MDA (Multiple Device Access)
- WLCSP6 (UK suffix, 0.69mm x 1.09mm) package

Frequency	1 MHz
ADC	12-bit
Current	30uA
Voltage	1.65 – 1.95V
Registers	4, Temp, Config, High, Low
One-shot	Yes
Prog Conv Rate	Yes, 1,4,8 conv/sec
Conv Time	25ms typ, 35ms max
Address	90h, 4 address, 1 pin
Bus	General Call, Hs-mode, Timeout, SMBus Alert
Package	WLCSP6
Similar to:	TMP102 ($\pm 1^{\circ}\text{C}$)

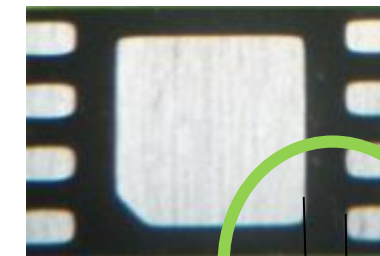
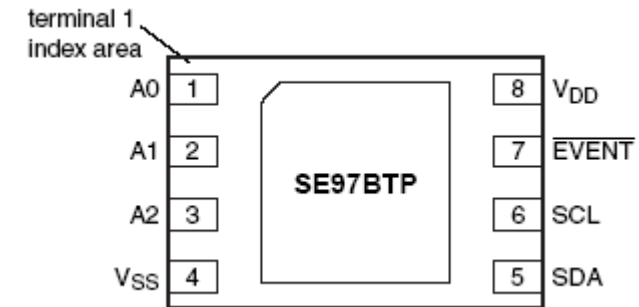




SE97B: Temperature Sensor with Integrated SPD

Features

- 2nd generation Temp Sensor with integrated new JEDEC compliant SPD (2-kbit EEPROM)
- JEDEC Grade B accuracy
 - $\pm 0.5\text{ }^{\circ}\text{C}/\pm 1\text{ }^{\circ}\text{C}$ (typ./max.) $+75\text{ }^{\circ}\text{C}$ to $+95\text{ }^{\circ}\text{C}$
 - $\pm 1.0\text{ }^{\circ}\text{C}/\pm 2\text{ }^{\circ}\text{C}$ (typ./max.) $+40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
 - $\pm 2.0\text{ }^{\circ}\text{C}/\pm 3\text{ }^{\circ}\text{C}$ (typ./max.) $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Temp sensor I²C address of 0011A2A1A0 and EEPROM I²C address of 1010A2A1A0 so master sees two different devices
- EEPROM is organized as a 256 x 8-bit with 10 years of data retention and 100,000 write/erase cycles
- Supports SMBus Time-out 25 – 35 mS (typical is 30.5 mS)
- Support /EVENT pin deasserted during TS shutdown
- Supports permanent and reversible software write protect
- Supports 0 – 16-byte write buffer
- TS and EEPROM operation range 3.0 to 3.6 V with Power Down Reset at 2.4V (up) and 2.0V (down) typical
- Maximum operating/shutdown current: 320 μA /10 μA max
- Operating temperature range from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- JEDEC compliant package from APB – SE97BTP,547



0.3 mm min vs 0.2 mm JEDEC
Reduces possibility of solder bridging



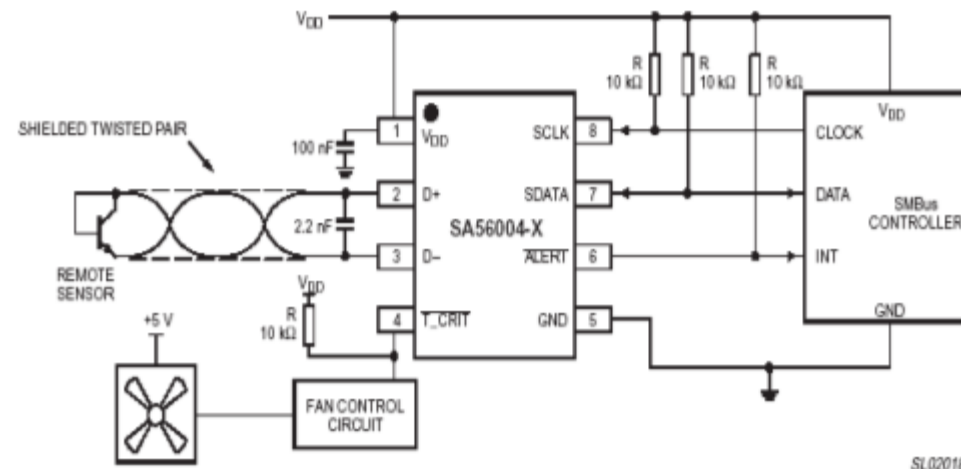
SA56004 Remote Thermal Sensor

- **Applications**

- System thermal management in ovens, ranges, refrigerators, dish washers, washers and dryers
- House-hold white-good products
- Electronic test equipment & instrumentation
- Industrial controllers and embedded systems

- **Features**

- On-chip local and remote microprocessor thermal diodes or diode connected transistors temperature sensing within ± 1 °C
- Offset registers available for adjusting the remote temperature accuracy
- Programmable under/over temperature alarms: ALERT and T_CRIT
- SMBus 2.0 compatible interface, supports TIMEOUT and 100/400 kHz I²C interface
- 11-bit, 0.125 °C resolution
- 8 different device addresses are available for server applications. The SA56004-ED/EDH with marking code ARW is address compatible with the National LM86, the MAX6657/8 and the ADM1032.



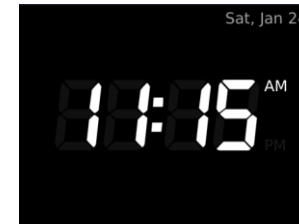


LCD DRIVERS



LCD Drivers Value Proposition

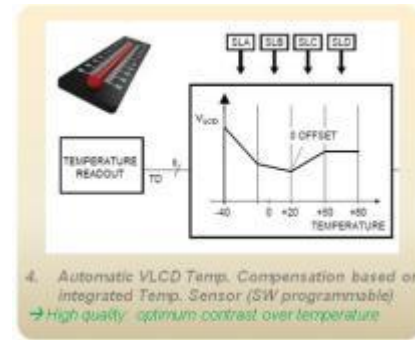
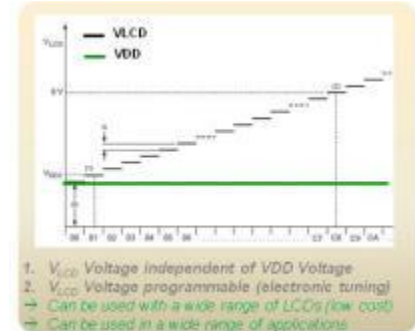
- **Where used?**
 - e-Metering
 - Automotive
 - White Goods
 - Consumer Electronics
 - Medical Equipment
 - Test & Measurement
 - POS Terminals
 - Telecom Equipment
- **Segment Drivers' Key Features**
 - Low power & driving up to 640 segments
 - Standalone – no need for external components
 - I²C and SPI interfaces available
 - AEC-Q100 options
 - Cascadable
- **Character Drivers' Key Features**
 - Combines low power segment display with sophisticated 2-line character display
 - Integrated generation of VLCD with temperature compensation
 - Very low power consumption (20 to 200mA)
 - Display shift or static display modes
- **Graphic Drivers' Key Features**
 - On-chip generation of LCD bias voltages
 - Low number of external components
 - Low power consumption



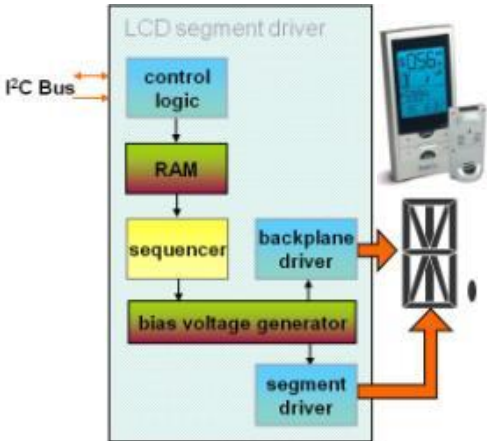
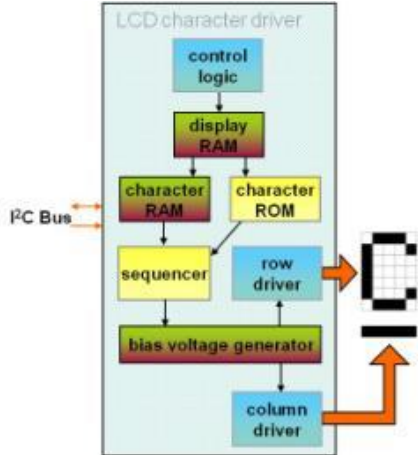
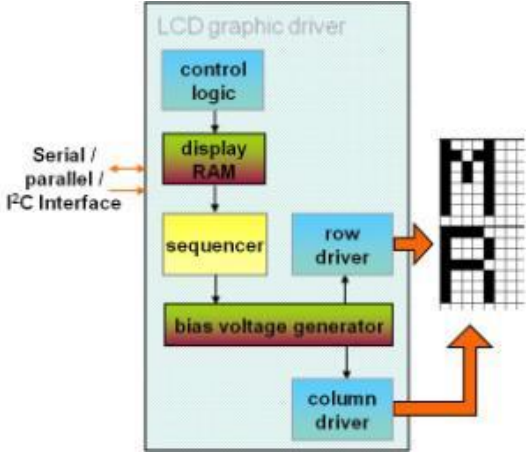


New LCD Driver Trends

- **Higher Frame Frequency**
 - Standard TN displays require frame frequency of 64Hz
 - High-contrast, true black background Vertical Alignment displays require frame frequency to be 2x to 3x higher
- **On-Chip Charge Pump**
 - Eliminate the need for external components
 - Ability to generate high VLCD voltage, even in systems with only 3.3V supply
 - In battery operated systems, the supply voltage may vary from 3.3V to 1.8V, but the charge pump allows the user to maintain a stable VLCD voltage
 - Ability to regulate VLCD internally and do temperature compensation
- **Higher VLCD Voltage**
 - For Vertical Alignment display applications (with true black background)
- **Integrated Temperature Sensor**
 - For temperature-compensated VLCD
 - With digital readout
- **Temperature Compensated VLCD**
 - Ability to adjust and maintain optimal contrast with varying liquid crystal viscosity due to temperature fluctuations
- **Improved Power-on Reset (POR) Circuitry**
 - Improved system ESD performance
 - Up to $\pm 15\text{kV}$ air discharge and $\pm 8\text{kV}$ contact discharge

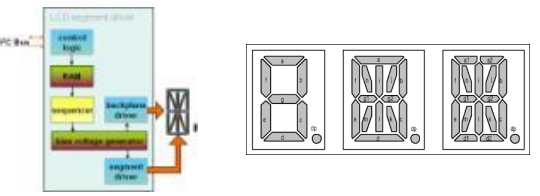

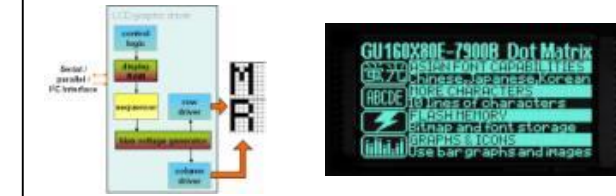


LCD Drivers: Differentiations

Segment Drivers	Character Drivers	Graphic (Dot Matrix) Drivers
		
<p>Features:</p> <ul style="list-style-type: none"> • Max multiplex rate 1:16 (generally 1:4) • Wide range of segment outputs • RAM and auto-incremental addressing • Low power consumption • No external component • Wide power supply range • Internal LCD bias voltage generation with voltage follower buffers • Internal oscillator, external clock also possible 	<p>Features:</p> <ul style="list-style-type: none"> • Multiplex rate up to 1:18 • On-chip character generator • 5x7 character + cursor; 5x8 for Kana (Japanese) & user-defined symbols • On-chip temperature compensation • On-chip character ROM and RAM • Low power consumption • Minimum external components • On-chip LCD bias voltage generation • Internal oscillator / external clock 	<p>Features:</p> <ul style="list-style-type: none"> • Wide range of mux rates to optimize power and display size (S/W selectable) • On-chip generation of LCD bias voltages • Low number of external components • Low power consumption • Temperature compensation



LCD Drivers: Key Products

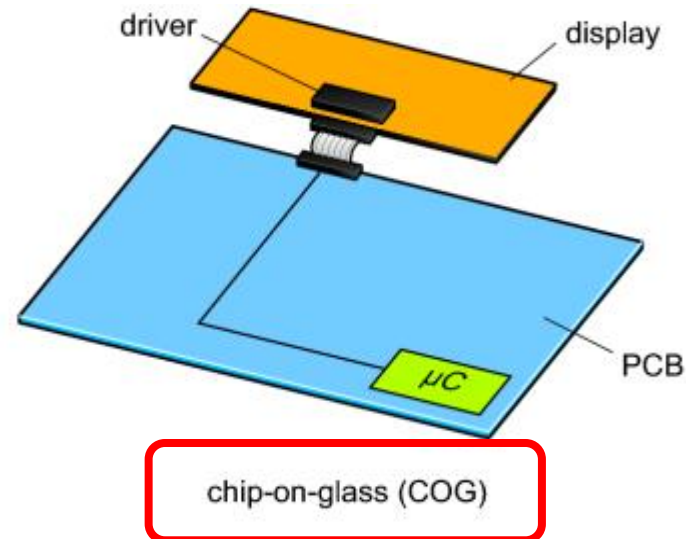
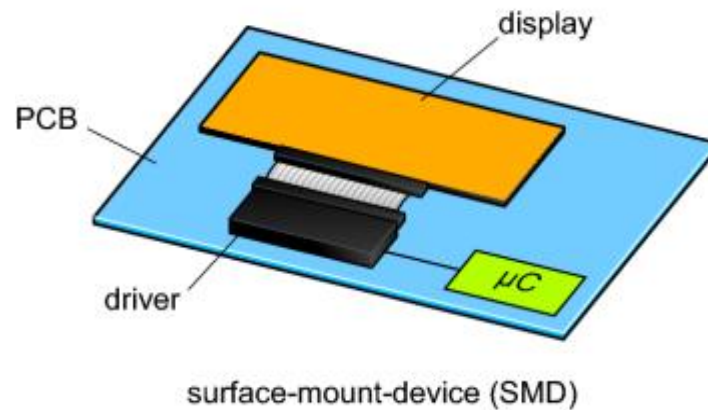
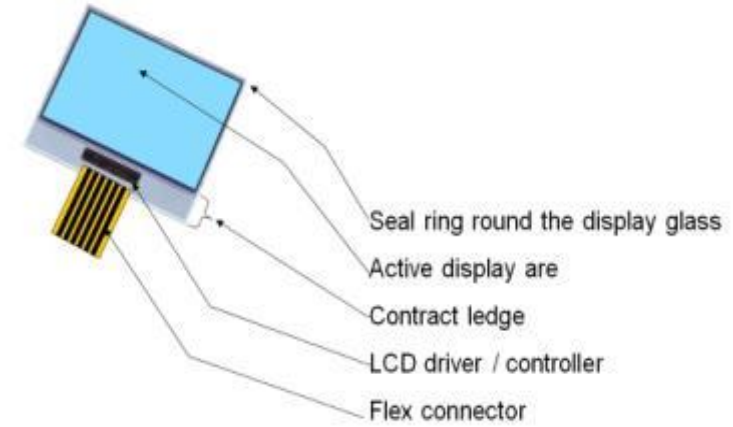
Segment Drivers		Character Drivers	Graphic (Dot Matrix) Drivers
			
<ul style="list-style-type: none"> • PCA8561 4 x 18 Segments • PCF8566 4 x 24 Segments • PCx85162 4 x 32 Segments • PCA85262 4 x 32 Segments • PCx8551 4 x 36 Segments • PCx85176 4 x 40 Segments • PCA85276 4 x 40 Segments • PCx8553 4 x 40 Segments • PCA8546 4 x 44 Segments • PCA8547 4 x 44 Segments • PCx85134 4 x 60 Segments • PCA8543 4 x 60 Segments • PCx8536 8 x 40 Segs + 6PWM • PCF8545 8 x 40 Segments • PCx8537 8 x 44 Segments • PCA9620 8 x 60 Segments 	Packaged	<ul style="list-style-type: none"> • PCF2119 2-Line x 16-Character Plus 160 icons COG • PCx2117 2-Line x 20-Character Plus 200 icons COG 	<ul style="list-style-type: none"> • PCA8539 18 x 100 (COG) Small Graphic Driver • PCF8531 34 x 128 (COG) Small 4-x-20 Text Characters Full Graphics • PCF8578 8 x 32 (stand-alone) Up to 40,960 dots when combined with 32 PCF8579 VSO56, TQFP64
<ul style="list-style-type: none"> • PCx8576D,E 4 x 40 Segments • PCA8576F 4 x 40 Segments • PCx85133 4 x 80 Segments • PCA85233 4 x 80 Segments • PCA8530 4x102 Segments • PCx85132 4 x 160 Segments • PCA85232 4 x 160 Segments • PCx8538 9 x 102 Segments 	COG	<p>x = A (Automotive) & F (Industrial)</p>	





What is Chip-on-Glass

- A cost-saving and easy way to design with LCD Drivers
- Advantages
 - 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

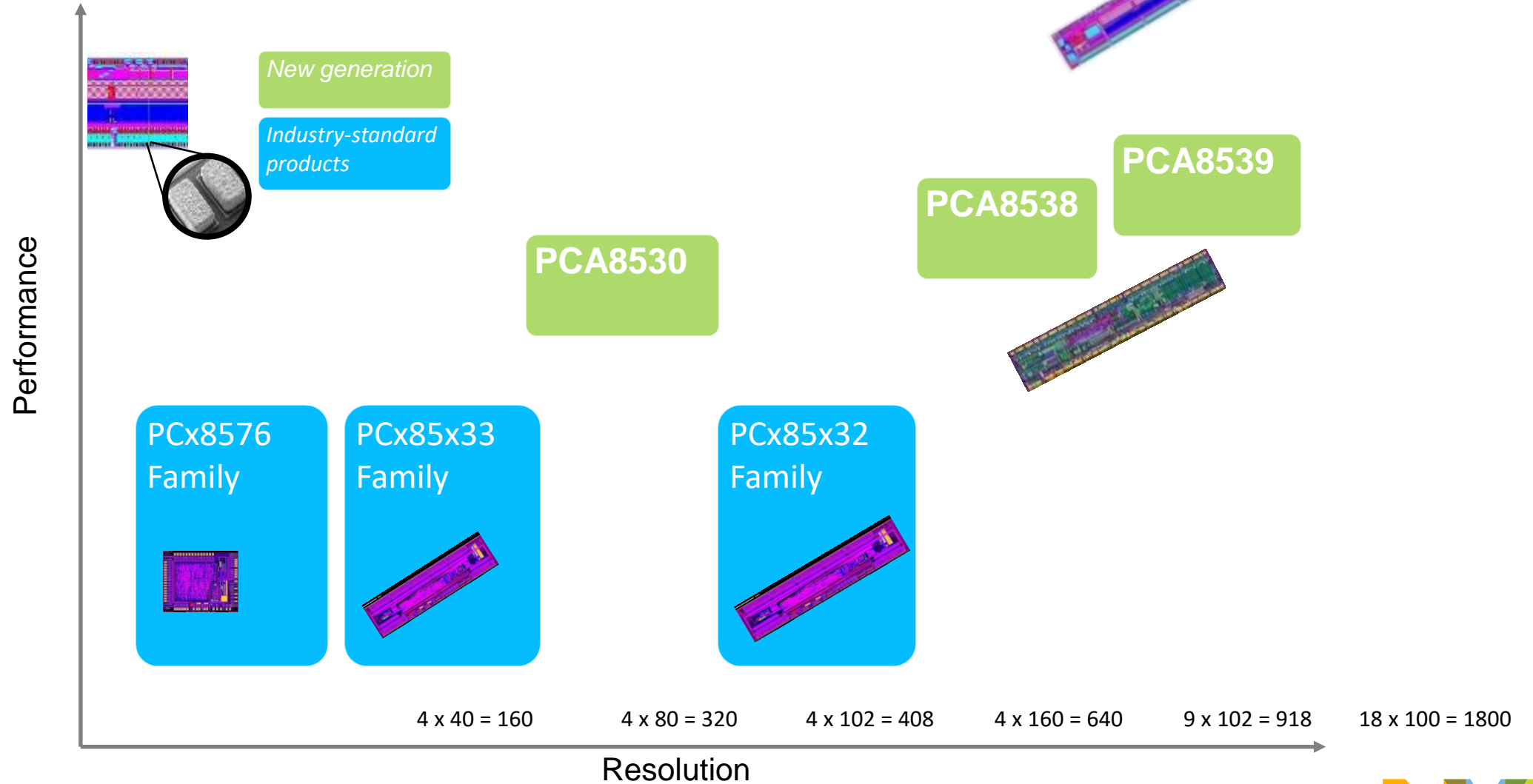


aaa-002681



COG LCD Segment Drivers

Portfolio Overview





PCA8576F: 4x40 COG† Segment Driver

PCA8576F: PCA8576D with removed POR and higher frame frequency

Main features	PCA8576D	PCA8576F
Resolution (max)	160	160
# BP x # SEG (max)	4 x 40	4 x 40
VLCD (ext.) (max)	6.5V	8.0V
Frame Freq. (typ.)	77Hz	200Hz
Frame Freq. Progr.	No	No
POR (Power On Reset)	Yes	No *)
Operating Temp Range	-40°C to +85°C	-40°C to +105°C
Package	Die with gold bumps for COG	Die with gold bumps for COG
Qualification	AEC-Q100	AEC-Q100
Compatibility		Drop In replacement for PCA8576D

† COG = Chip-on-Glass

*) increased ESD air discharge performance thanks to removal of POR

Value Proposition

- To drive high-contrast, true black background **Vertical Alignment displays** the frame frequency needs to be 2x to 3x higher than for standard TN cells which require a typ. Frame frequency of only 64Hz.



- By removing the Power On Reset (POR) the system level ESD performance can be improved considerably to ideally **15kV air discharge** and **8kV contact discharge**.
- Automotive dash board
- Instrument Clusters



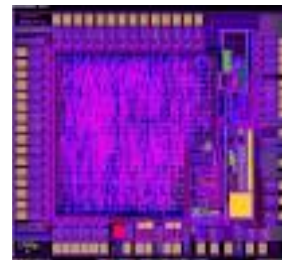


PCE85176: 4 x 40 COG Segment Driver

Targeted for cost-sensitive applications

- **Key Features**

- Maximum resolution: 4 x 40 (160 dots or segments)
- Independent supply voltages VDD and VLCD
- Wide VDD range: 1.8V ÷ 5.5V
- Wide VLCD range: 2.5V ÷ 5.5V
- Programmable Multiplex Rate: static, 1:2, 1:3, 1:4
- Programmable bias system: static, 1/2, 1/3
- Display line inversion mode (driving scheme A)
- Frame frequency 82 Hz (typ.)
- 400kHz I²C-bus interface
- ESD HBM ± 3500 V
- Enhanced EM compatibility (removed POR)
- Qualified for industrial application
- Delivery in tray



Parameters	PCE85176
Die Size	2.1 mm x 1.8 mm
IC thickness	380 μm
Bumps size	51 μm x 54 μm
Min bumps pitch	72 μm
Bumps height	15 μm

- **Ideal for low-cost reflective TN displays**
 - single-phases e-meters
 - wearables
 - consumer medical
 - white goods and small appliances



PCA85233: 4 x 80 COG† Segment Driver

PCA85233: PCA85133 with removed POR and higher frame frequency

Main features	PCA8576D	PCA8576 ^F
Resolution (max)	320	320
# BP x # SEG (max)	4 x 80	4 x 80
VLCD (ext.) (max)	8.0V	8.0V
Frame Freq. (typ.) <i>(selectable via HW pin)</i>	82Hz or 110Hz	150Hz or 220Hz
Frame Freq. programming	No	No
POR (Power On Reset)	Yes	No *)
Operating Temp Range	-40°C to +95°C	-40°C to +105°C
Package	Die with gold bumps for COG	Die with gold bumps for COG
Qualification	AEC-Q100	AEC-Q100
Compatibility		Drop In replacement for PCA85133

† COG = Chip-on-Glass

*) increased ESD air discharge performance thanks to removal of POR

Value Proposition

- To drive high-contrast, true black background Vertical Alignment displays the frame frequency needs to be 2x to 3x higher than for standard TN cells which require a typ. Frame frequency of only 64Hz.
- By removing the Power On Reset (POR) the system level ESD performance can be improved considerably to ideally 15kV air discharge and 8kV contact discharge.
- Automotive dash board
- Instrument Clusters

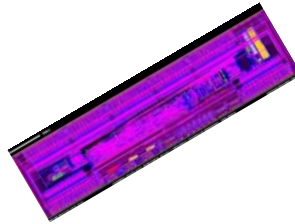


PCE85133: 4 x 80 COG Segment Driver

Targeted for cost-sensitive applications

- **Key Features**

- Maximum resolution: 4 x 80 (320 dots or segments)
- Independent supply voltages VDD and VLCD
- Wide VDD range: 2.5V ÷ 5.5V
- Wide VLCD range: 2.5V ÷ 5.5V
- Programmable Multiplex Rate: static, 1:2, 1:3, 1:4
- Programmable bias system: static, 1/2, 1/3
- Display line inversion mode (driving scheme A)
- Internal clock
- Frame frequency 150 Hz (typ.)
- 400kHz I²C-bus interface
- ESD HBM: ± 4.5kV; LAUP: 200mA max
- Enhanced EM compatibility (removed POR)
- Qualified for industrial applications
- Delivery in tray



Parameters	PCE85176
Die Size	4.6 mm x 1.07 mm
IC thickness	380 μm
Bumps size	33.8 μm x 90.0 μm
Min bumps pitch	54 μm
Bumps height	15 μm

Ideal for low-cost reflective TN displays

- three-phases e-meters
- wearables
- consumer medical
- white goods and small appliances





PCA8530: 4x102 COG Segment LCD Driver

Similar to the PCA8538 (with mux rate up to 1:9)

- **Key Features**

- 4 x 102 segment driver (409 dots or segments)
- Programmable Multiplex Rate (1:1, 1:2, 1:4)
- n-line inversion (includes line and frame inversion)
- On-chip Charge pump with integrated capacitors for the VLCD internal generation up to 12 V
- Temperature readout and device status readout for diagnostics
- Temperature compensated VLCD voltage (with programmable temperature regions and programmable slopes)
- Programmable frame frequency 45Hz to 300Hz
- I²C-bus and SPI-bus Interface
- Up to 4 chips can be cascaded with internal or external VLCD to drive bigger display
- Extended temperature range up to +105°C
- AEC-Q100 compliant



First driver in mux 1:4 with integrated charge pump and temperature sensor

PCA8538 Evaluation Board ([OM13501](#)) may be used with a PCA8530 glass



PCA85232: 4 x 160 COG† Segment Driver

PCA85232: PCA85132 with higher frame frequency

Main features	PCA8576D	PCA8576 ^F
Resolution (max)	640	640
# BP x # SEG (max)	4 x 160	4 x 160
VLCD (ext.) (max)	8.0V	8.0V
Frame Freq. (typ.) (software programmable)	60Hz, ..., 90Hz	117Hz, ... , 176Hz
Frame Freq. programming	Yes	Yes
POR (Power On Reset)	Yes	Yes
Operating Temp Range	-40°C to +95°C	-40°C to +95°C
Package	Die with gold bumps for COG	Die with gold bumps for COG
Qualification	AEC-Q100	AEC-Q100
Compatibility		Drop In replacement for PCA85132

† COG = Chip-on-Glass

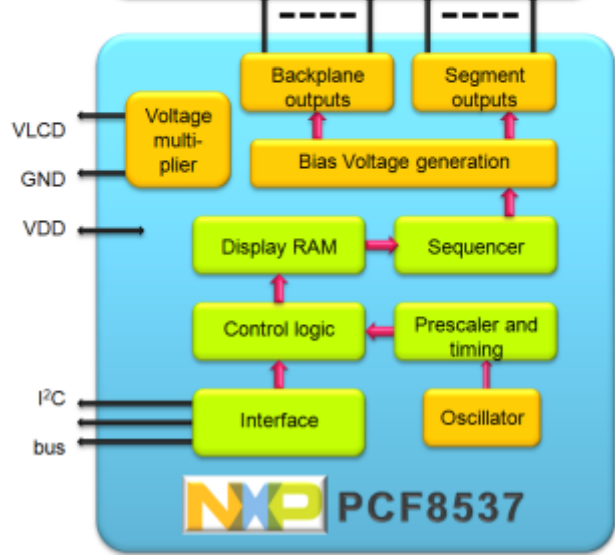
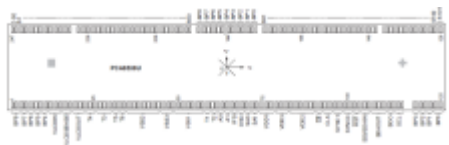
Value Proposition

- To drive high-contrast, true black background Vertical Alignment displays the frame frequency needs to be 2x to 3x higher than for standard TN cells which require a typ. Frame frequency of only 64Hz.
- Automotive dash board
- Instrument Clusters



PCA8538: 918 Dots or Segments LCD Driver

- **Key Features:**
 - Supports both I²C-bus and SPI-bus interfaces
 - Interfaces directly to the LCD cells; driving signals are internally generated
 - 102-Segment and 9-Backplane outputs for driving up to 918 Segments in a 1:9 multiplex rate
 - Supports mux rates of 1:1, 1:2, 1:4, 1:6, 1:8, and 1:9
 - Programmable Line Inversion or Frame Inversion
 - Programmable and calibrated Frame Frequency in the range of 45Hz to 300Hz in steps of 10Hz (typical)
 - Wide digital power supply range from 2.5V to 5.5V
 - Wide analog power supply range from 2.5V to 5.5V
 - Wide VLCD range from 4V to 12.0V
 - On-chip charge pump with integrated capacitors
 - Integrated temperature sensor (readout possible)
 - Temperature compensated VLCD voltage
 - Extended operating temperature range up to +85 °C (+105 °C)
 - AEC-Q100 automotive compliant qualification for high robustness and reliability
 - Available in COG
- **Benefits:**
 - Specifically Designed for high-contrast Vertical Alignment (VA) displays
- **Applications:**
 - Automotive Dashboards
 - Industrial Control
 - White Goods
 - Smart Meters
 - Medical Equipment





PCA8539: 1800 Dots or Segments LCD Driver

• Key Features:

- Supports both I²C-bus and SPI-bus interfaces
- Interfaces directly to the LCD cells; driving signals are internally generated
- 100-Segment and 18-Backplane outputs for driving up to 1800 Segments in a 1:18 multiplex rate
- Supports mux rates of 1:12 and 1:18
- Programmable Line Inversion or Frame Inversion
- Programmable and calibrated Frame Frequency in the range of 45Hz to 300Hz in steps of 10Hz (typical)
- Wide digital power supply range from 2.5V to 5.5V
- Wide analog power supply range from 2.5V to 5.5V
- **Wide VLCD range from 4V to 16.0V**
- **On-chip charge pump with integrated capacitors**
- **Integrated temperature sensor (readout possible)**
- **Temperature compensated VLCD voltage**
- Extended operating temperature range up to **+95 °C**
- **AEC-Q100 automotive compliant qualification for high robustness and reliability**
- Available in COG

• Benefits:

- Specifically Designed for high-contrast Vertical Alignment (VA) displays

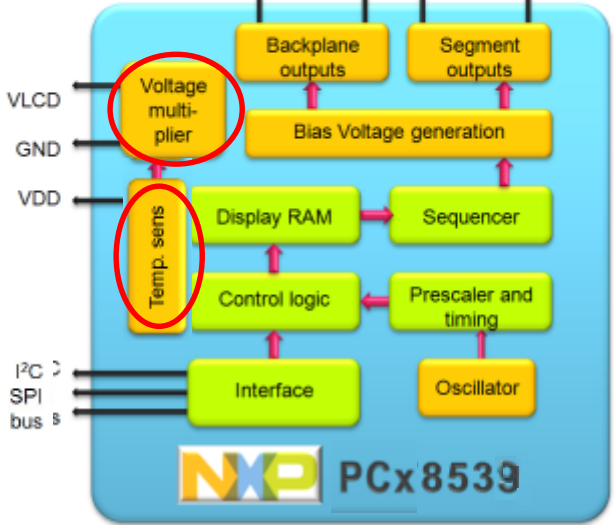
• Applications:

- Automotive Dashboards
- Industrial Control
- White Goods
- Smart Meters
- Medical Equipment

(i) 12 Backplanes x 100 Segments



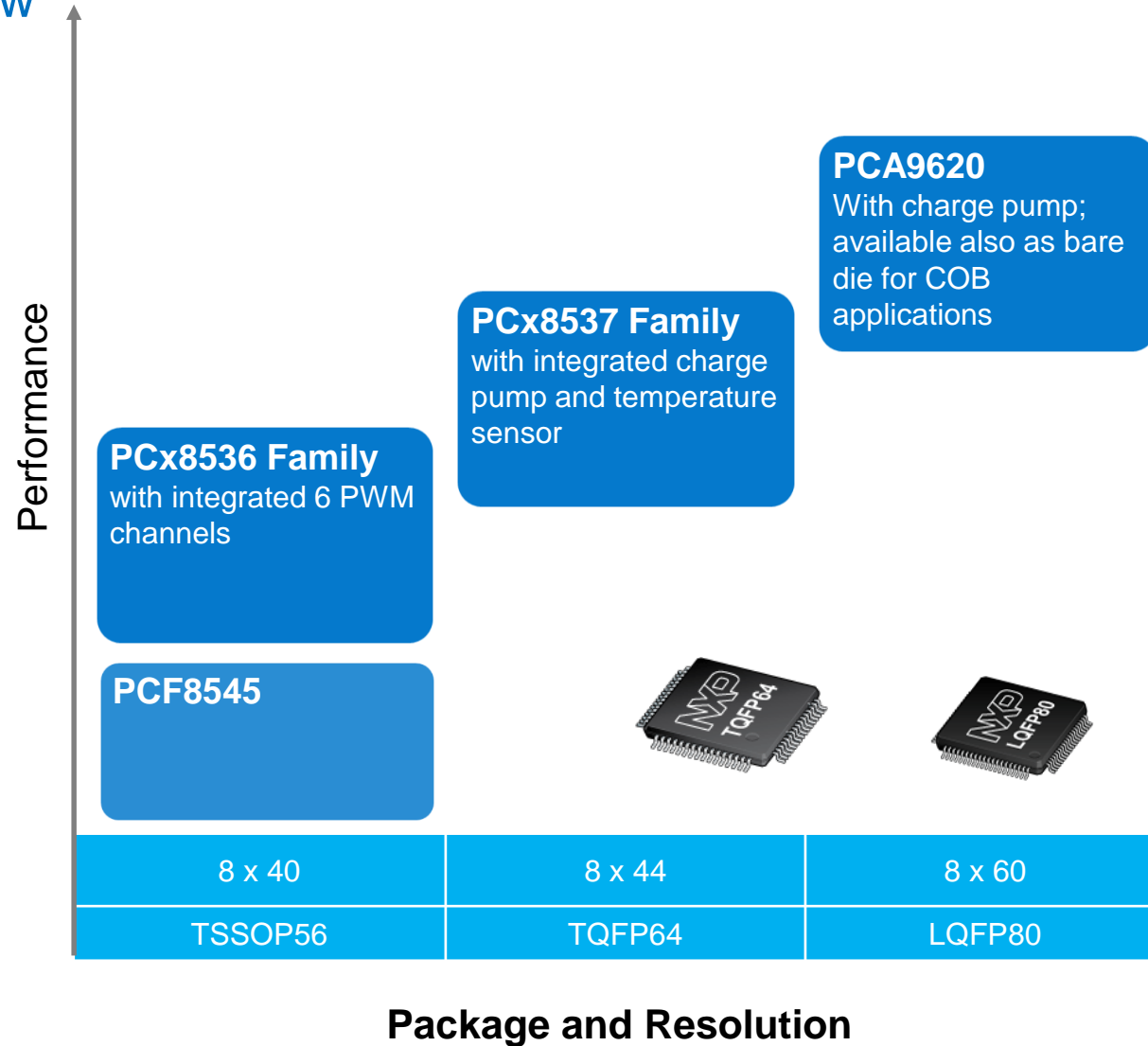
(ii) 18 Backplanes x 100 Segments





Packaged LCD Segment Drivers – Mux 1:8

Portfolio Overview





PCF8545: 8 x 40 Segment Driver

TSSOP56, 8 x 40 segment driver for cost sensitive applications

- **Key Features:**

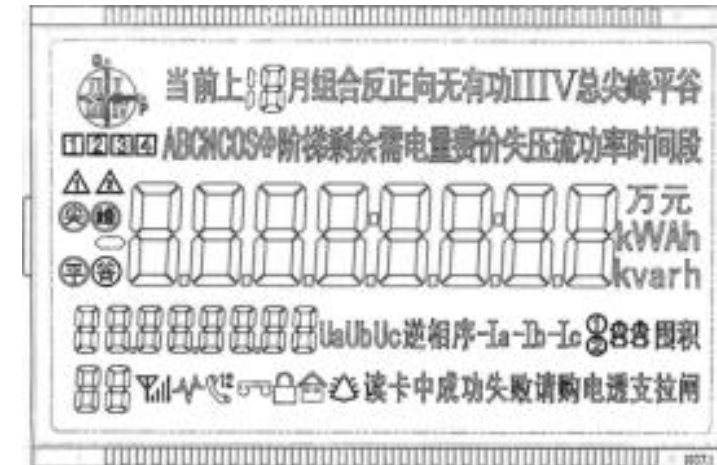
- 8 x 40 segment driver (320 dots or segments)
- I²C-bus (PCF8545ATT/A) and SPI-bus (PCF8545BTT/A) Interfaces
- Programmable Multiplex Rate (1:4, 1:6, 1:8)
- Line or frame inversion
- VDD range: 1.8V ÷ 5.5V
- VLCD range: 2.5V ÷ 5.5V
- Programmable Frame Frequency 60Hz to 300Hz
- Programmable position of the backplane outputs

- **Benefits:**

- Designed for cost sensitive applications

- **Applications:**

- Industrial Control
- White Goods
- Smart Meters
- Medical Equipment



Perfectly suitable for resolutions higher than 200 segments up to 320 segments, for very cost-sensitive applications, such as for example the e-metering industry.





PC_A8536: 320-Segment Driver with 6-CH PWM Generator

Key Features:

- I²C-bus (PCx8536AT) or SPI-bus (PCx8536BT) interface
- Interfaces directly to the LCD cells; driving signals are internally generated
- 40-Segment and 8-Backplane outputs for driving up to 320 Segments in a 1:8 multiplex rate
- Supports mux rates of 1:4, 1:6, and 1:8
- 7-Bit PWM outputs for controlling up to 6 LED's in conjunction with external transistors
- Configurable backplane outputs; either pinout in the centre of the segment outputs or at the edge of the device
- Programmable Line Inversion or Frame Inversion
- Programmable and calibrated Frame Frequency in the range of 60Hz to 300Hz in steps of 10Hz (typical)
- Wide digital power supply range from 1.8V to 5.5V
- Wide VLCD range from 2.5V to 6.5V (**9.0V**) when using an external supply
- Extended operating temperature range up to +85 °C (**+95 °C**)
- **AEC-Q100 automotive compliant qualification for high robustness and reliability**
- Available in TSSOP56 Package

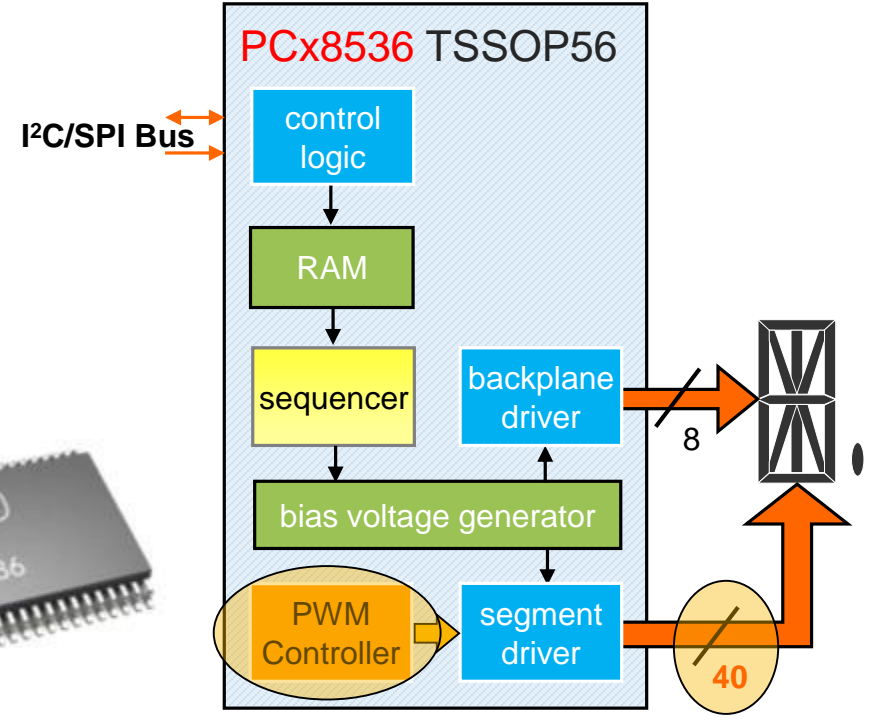
Benefits:

- Designed for horizontal or vertical mounting

Applications:

- Automotive Dashboards
- Industrial Control
- White Goods
- Smart Meters
- Medical Equipment

Mux	# Display Segments	
	w/o PWM	w/ 6x PWM
1:4	176	152
1:6	252	216
1:8	320	272





PC_A8537: 352 Segments or dots LCD Driver

Key Features:

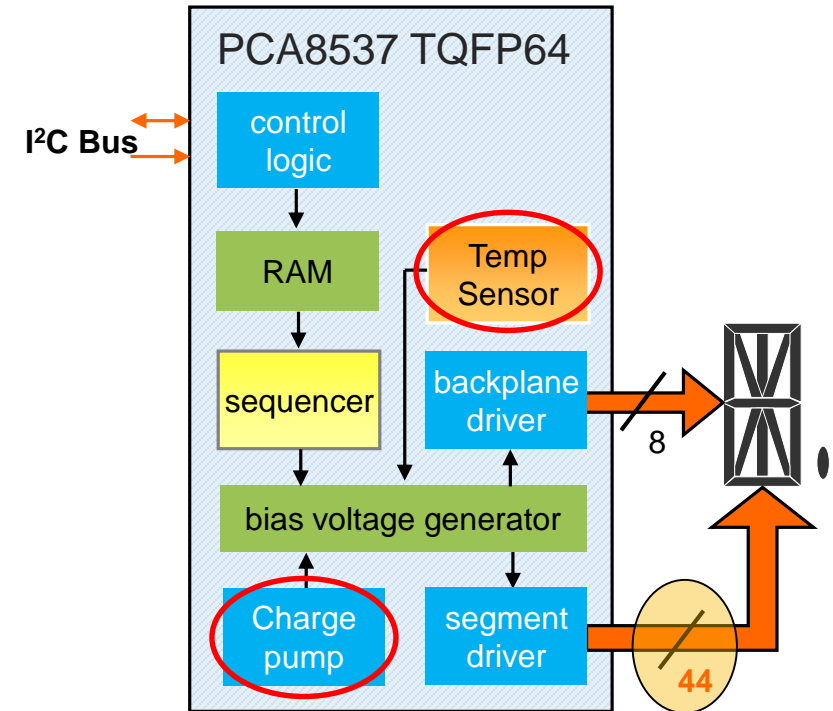
- I²C-bus (PCx8537AH) or SPI-bus (PCx8537BH) interface
- Interfaces directly to the LCD cells; driving signals are internally generated
- 44-Segment and 8-Backplane outputs for driving up to 352 Segments in a 1:8 multiplex rate
- Supports mux rates of 1:1, 1:2, 1:4, 1:6, and 1:8
- Programmable Line Inversion or Frame Inversion
- Programmable and calibrated Frame Frequency in the range of 60Hz to 300Hz in steps of 10Hz (typical)
- Wide digital power supply range from 1.8V to 5.5V
- Wide analog power supply range from 2.5V to 5.5V
- **Wide VLCD range from 2.5V to 9.0V when using an external supply**
- **On-chip charge pump with integrated capacitors**
- **Integrated temperature sensor (readout possible)**
- **Temperature compensated VLCD voltage**
- Extended operating temperature range up to +85 °C (**+95 °C**)
- **AEC-Q100 automotive compliant qualification for high robustness and reliability**
- Available in TQFP64 Package

Benefits:

- Specifically Designed for high-contrast Vertical Alignment (VA) displays

Applications:

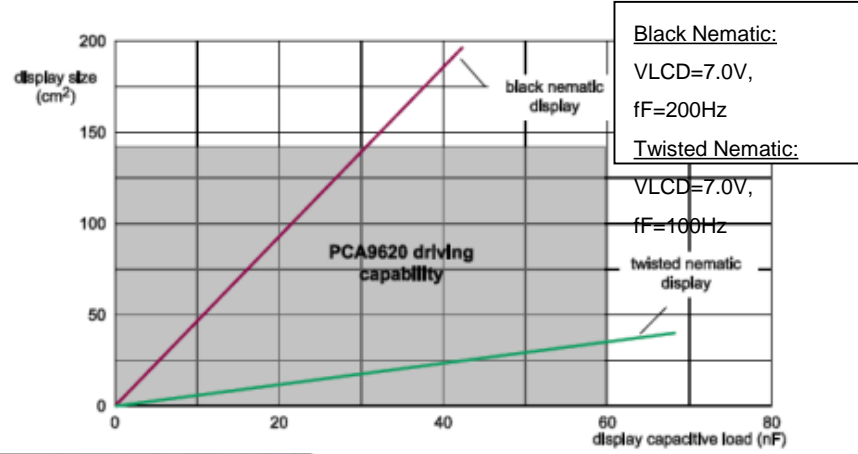
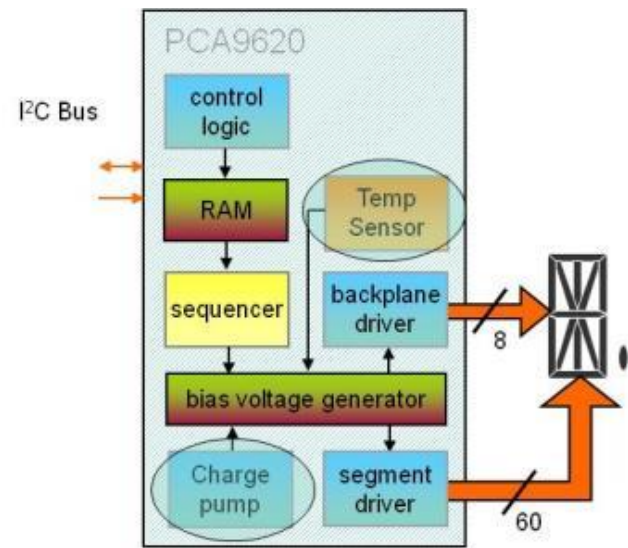
- Automotive Dashboards
- Industrial Control
- White Goods
- Smart Meters
- Medical Equipment





PCA9620: 8 x 60 LCD Driver with I²C-Bus Interface

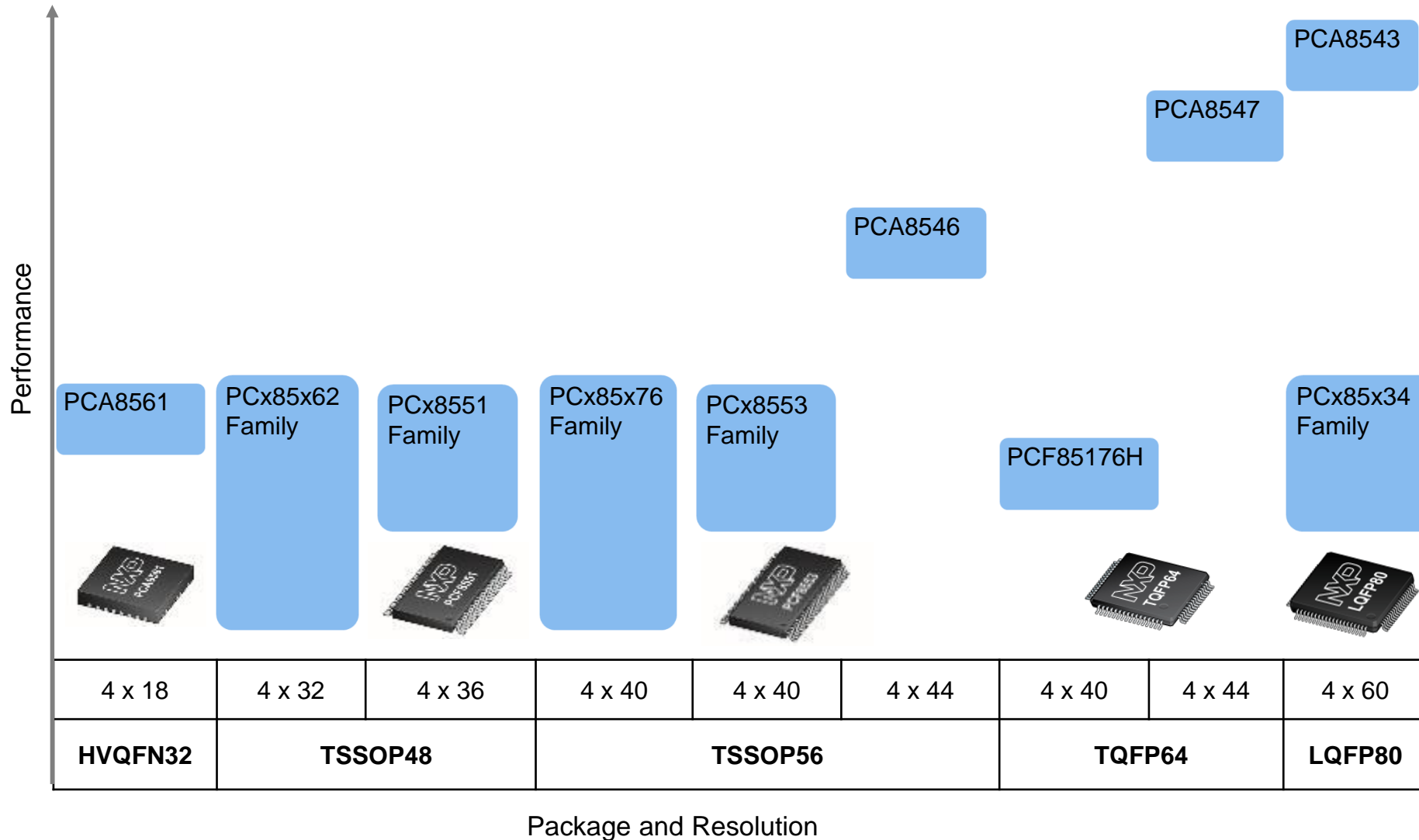
- **Key features and benefits**
 - 480 Segment Drive in Mux 1:8 Mode
 - I²C Interface
 - Integrated charge pump
 - Integrated temperature sensor
 - On-chip VLCD generation
 - Temperature compensated VLCD voltage
 - **Programmable and calibrated frame frequency**
 - Extended frame frequency from 60Hz up to 300Hz; in 10-Hz steps
 - Extended temperature range up to **+105°C**
 - **AEC-Q100 automotive compliant qualification for highest robustness and reliability**
- **Potential applications**
 - Dash boards
 - Climate control
 - Car radio
- **Product characteristics**
 - Wide digital and analog power supply ranges from 2.5V to 5.5V
 - Extended VLCD range from 2.5V to **9.0V**
 - Wide frame frequency range 60Hz to 300Hz
 - Wide operating temp range -40 to **+105°C**
 - 12 x 12 x 1.4 mm LQFP80 package





Packaged LCD Segment Drivers – Mux 1:4

Portfolio Overview





PCA8561: 4 x 18 Cased Segment Driver

Designed specifically for small displays

Main Features	PCA8561
Resolution (max)	4 x 18 = 72 segments
VDD range [V]	1.8V ÷ 5.5V
VLCD external (max)	1.8V ÷ 5.5V
Mux rates	1:1, 1:2, 1:3, 1:4
Bias configuration	static, 1/2, 1/3
Oscillator	Software selectable - internal / external (CLK pin)
Frame Freq.	32Hz, 64Hz (default), 96Hz, 128Hz, 192Hz, 256Hz
Frame Freq. calibration	Yes
Reset	Input reset pin (RST); software reset command; POR circuit with POR enable input pin (PORE)
Interface	PCA8561A: 2-line I ² C (A1 & A0 Address pins) PCA8561B: 3-line SPI
Operating Temp Range	-40°C to +105°C
Package	HVQFN32 (5mm x 5mm x 0.85mm; 0.5-mm pitch) With wettable flanks
ESD	4kV HBM
Qualification	AEC-Q100

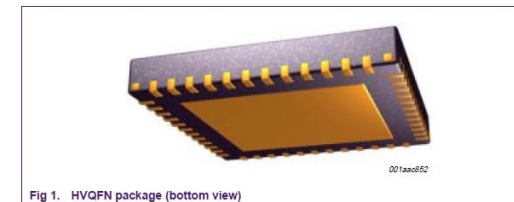
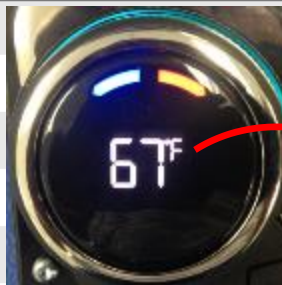


Fig 1. HVQFN package (bottom view)



Small passive displays in the clusters in combination with the big TFT display in the center. The MCU is advanced for TFT controller and does not encompass any LCD driver.





PCA85262: 4 x 32 Segment Driver

PCA85262: PCA85162 with removed POR and higher frame frequency

Main features	PCA85162T	PCA85262T
Resolution (max)	4 x 32 = 128 Segments	4 x 32 = 128 Segments
VLCD (ext.) (max)	8.0V	8.0V
Frame Freq. (typ.)	110Hz	200Hz
Frame Freq. Range	80Hz to 150Hz	146Hz to 260Hz
POR (Power On Reset)	Yes	No *)
Operating Temp Range	-40°C to +95°C	-40°C to +105°C
Package	TSSOP48 (SOT362)	TSSOP48 (SOT362)
Orderable Part Number	PCA85162T/Q900/1	PCA85 262 ATT/A
Qualification	AEC-Q100	AEC-Q100
Compatibility		Drop In replacement for PCA85162

Value Proposition

- To drive high-contrast, true black background Vertical Alignment displays the frame frequency needs to be 2x to 3x higher than for standard TN cells which require a typ. Frame frequency of only 64Hz.
- By removing the Power On Reset (POR) the system level ESD performance can be improved considerably to ideally 15kV air discharge and 8kV contact discharge.
- Automotive dash board
- Instrument Clusters

*) increased ESD air discharge performance thanks to removal of POR

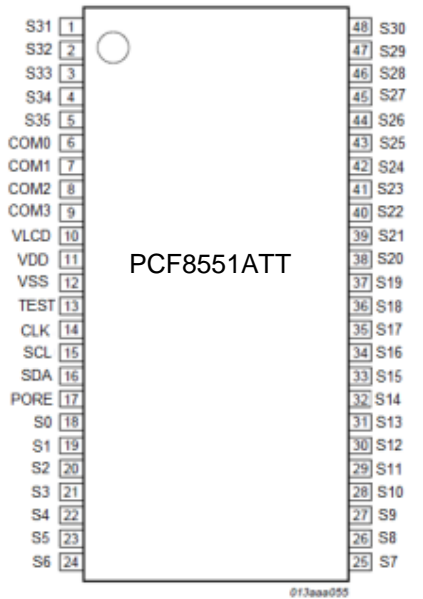




PCF8551: 4 x 36 TSSOP48 Segment Driver

Specifically designed for cost sensitive markets

Main features	PCF8551
Resolution (max)	4 x 36 = 144 segments
VDD range [V]	1.8V ÷ 5.5V
VLCD external [V]	1.8V ÷ 5.5V
Mux rates	1:1, 1:2, 1:3, 1:4 (def.)
Bias configuration	static, 1/2, 1/3 (def.)
Oscillator	Selectable Internal / external (CLK pin)
Frame Freq.	32 Hz ÷ 256 Hz (default: 64 Hz)
Reset	Input reset pin (RST); software reset command; POR circuit with POR enable input pin (PORE)
Interface	A version: 2-lines I ² C; B version: 3-lines SPI
Operating Temp Range	-40°C to +85°C
Package	TSSOP48
ESD	HBM 4kV
Qualification	NXP QRS (Standard for industrial and consumer)



Suitable for very cost sensitive markets, such as e-metering

*) increased ESD air discharge performance thanks to removal of POR





PC 8553: 4 x 40 TSSOP56 Segment Driver

New generation low-cost cased LCD Segment Driver

Main features	PCF8553
Resolution (max)	4 x 40 = 160 segments
VDD range [V]	1.8V ÷ 5.5V
VLCD external [V]	1.8V ÷ 5.5V
Mux rates	1:1, 1:2, 1:3, 1:4 (def.)
Bias configuration	static, 1/2, 1/3 (def.)
Oscillator	Selectable Internal / external (CLK pin)
Frame Freq.	32 Hz ÷ 128 Hz or 256 (default: 64 Hz)
Reset	Input reset pin (RST); software reset command; POR circuit with POR enable input pin (PORE)
Interface	Selectable I ² C and SPI through IFS pin
Operating Temp Range	-40°C to +85°C (+105°C)
Package	TSSOP48
ESD	HBM 4kV
Qualification	NXP QRS (Standard for industrial and consumer)



Suitable for very cost sensitive markets, such as e-metering, small appliances and consumer.





PCA85276: 4 x 40 Segment Driver

PCA85262: PCA85162 with removed POR and higher frame frequency

Main features	PCA85176	PCA85276
Resolution (max)	4 x 40 = 160 Segments	4 x 40 = 160 Segments
VDD range	1.8V to 5.5V	1.8V to 5.5V
VLCD range	2.5V to 6.5V (External)	2.5V to 8.0V (External)
Mux rate	Static, 1:2, 1:3, 1:4	Static, 1:2, 1:3, 1:4
Frame Freq. (typ.)	110Hz	200Hz
Frame Freq. Range	80Hz to 150 Hz	146Hz to 260Hz
Inversion Scheme	Line Inversion	Line Inversion or frame inversion
POR (Power On Reset)	Yes	No *)
Operating Temp Range	-40°C to +95°C	-40°C to +105°C
Package	TSSOP56	TSSOP56
Orderable Number	PCA85176T/Q900/1	PCA85 2 76ATT/A
Qualification	AEC-Q100	AEC-Q100

*) increased ESD air discharge performance thanks to removal of POR

Value Proposition

- To drive high-contrast, true black background Vertical Alignment displays the frame frequency needs to be 2x to 3x higher than for standard TN cells which require a typ. Frame frequency of only 64Hz.
- By removing the Power On Reset (POR) the system level ESD performance can be improved considerably to ideally 15kV air discharge and 8kV contact discharge.
- Automotive dash board
- Instrument Clusters



PCA8546 & PCA8547: 4 x 44 Segment Driver

PCA85262: PCA85162 with removed POR and higher frame frequency

Main features	PCA85176	PCA8546	PCA8547
Resolution (max)	4 x 40 = 160 segments	4 x 44 = 176 segments	4 x 44 = 176 segments
VDD range [V]	1.8V ÷ 5.5V	1.8V ÷ 5.5V	1.8V ÷ 5.5V
VLCD generation	Externally supplied	Externally supplied	Internal (charge pump) or external
VLCD range [V]	2.5V ÷ 6.5V for VDD<2.5V 2.5V ÷ 8.0V for VDD>2.5V	2.5V ÷ 9.0V	2.5V ÷ 9.0V
Temp. Sensor & Temp-Compensated VLCD	No	No	Yes
Mux rates	Static, 1:2, 1:3, 1:4	1:4	Static, 1:2, 1:3, 1:4
Oscillator	Internal or external	Internal or external	Internal or external
Frame Freq.	82 Hz, 110 Hz	60 Hz ÷ 300 Hz	60 Hz ÷ 300 Hz
Reset	POR	POR, RST pin, RST cmd	POR, RST pin, RST cmd
Interface	I ² C	A ver.: I ² C; B ver.: SPI	A ver.: I ² C; B ver.: SPI
Operating Temp range	-40°C ÷ 95°C	-40°C ÷ 95°C	-40°C ÷ 95°C
Package	TSSOP56 or TQFP64	TSSOP56	TQFP64
ESD HBM	± 2000 V	± 3500 V	± 4500 V
Cascadability	Up to 16 chips	No	No

PCA8546 & PCA8547 are both available in either I²C-bus or SPI-bus options





PCA8543: 4 x 60 Segment Driver

Upgrade to the PCA85134

Main features	PCA85134	PCA8543
Resolution (max)	4 x 60 = 240 Segments	4 x 60 = 240 Segments
VDD range	1.8V to 5.5V	2.5V to 5.5V
VLCD range	2.5V to 8.0V (External)	2.5V to 9V (Int. or Ext.)
Mux rate	Static, 1:2, 1:3, 1:4	Static, 1:2, 1:4
Oscillator	Internal or External	Internal or External
Frame Freq. (typ.)	82Hz	60Hz to 300Hz
Temp. Sensor & Temp. Compensation	No	Yes
Inversion Scheme	Line Inversion	Line Inversion or frame inversion
Reset	POR	POR and Reset Command
Operating Temp Range	-40°C to +95°C	-40°C to +105°C
Package	LQPF80	LQPF80
ESD HBM	±2.5kV	±4kV
Cascadability	Up to 16 devices	No
Qualification	AEC-Q100	AEC-Q100

Value Proposition

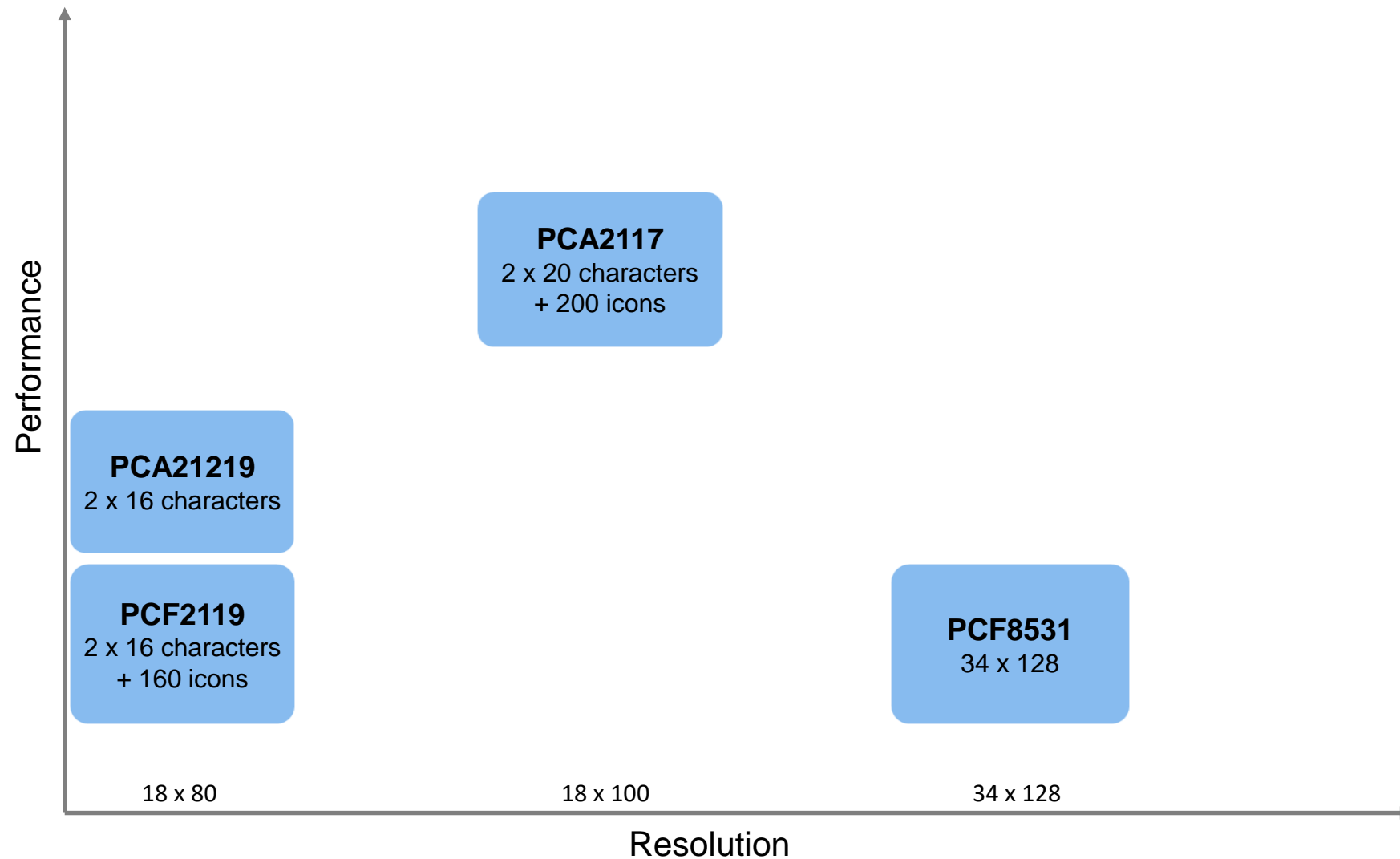
- To drive high-contrast, true black background Vertical Alignment displays the frame frequency needs to be 2x to 3x higher than for standard TN cells which require a typ. Frame frequency of only 64Hz.
- Automotive dash board
- Instrument Clusters

*) increased ESD air discharge performance thanks to removal of POR



COG LCD Character and Graphic Drivers

Portfolio Overview





PCF21219: 2-Line x 16-Character LCD Controller & Driver

Main features	PCF2119RU	PCF21219
Resolution (max)	2-lines by 16-characters plus 160 ions	2-lines by 16-characters plus 160 ions
Character Set	R	R
VLCD (max)	6.5V	6.5V
VLCD Generation	Internal Charge Pump or external supply	Internal Charge Pump or external supply
Frame Freq. (min/typ./max)	45 / 95 / 147Hz	150 / 225 / 300Hz
Frame Freq. programming	No	No
Operating Temp Range	-40°C to +85°C	-40°C to +85°C
Package	Die with gold bumps for COG	Die with gold bumps for COG
Qualification	NXP Quality & Reliability Specification	NXP Quality & Reliability Specification
Diffusion Fab	In transition from TSMC to Vanguard (PCN201303007A)	Vanguard
Delivery Form	Chip in Tray	Chip in Tray
Tray Size	In transition from 2-inch to 3-inch trays (PCN201302009F01)	3-inch trays
Compatibility		Drop In replacement for PCF2119RU *)

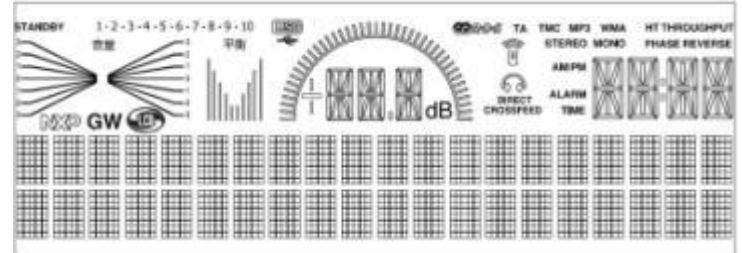
*) PCF21219 is Hardware and Software compatible to PCF2119; the only difference is the increased frame frequency



PCA2117: 2-Line x 20-Character LCD Controller & Driver

• Key Features:

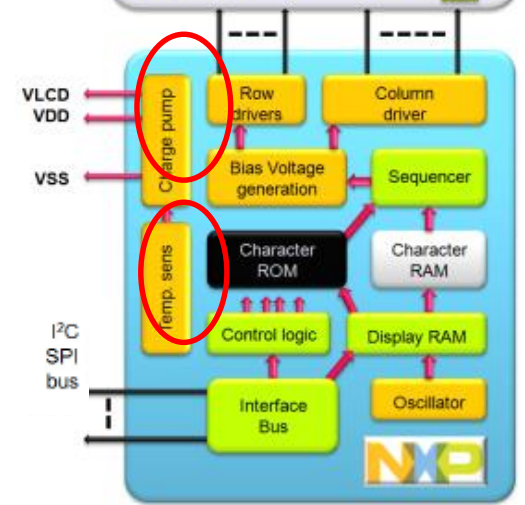
- Single-chip LCD controller/driver
- Supports both I²C-bus and SPI-bus interfaces
- 2-line display of up to 20 characters + 200 icons (48 Character RAM)
- Character “R” and “S”; other character sets upon request
- Icon blink function and Line feed function
- Programmable and calibrated Frame Frequency in the range of 45Hz to 360Hz in steps of 10Hz (typical)
- n-line inversion (includes line and frame inversion)
- Very low current consumption (20 µA to 200 µA):
 - Icon mode: < 25 µA (only icon mode active)
 - Power-down mode: < 2 µA
- **Wide digital power supply range from 2.5V to 5.5V**
- **Wide analog power supply range from 2.5V to 5.5V**
- **Wide VLCD range from 4V to 16.0V**
- **On-chip charge pump with integrated capacitors**
- **Integrated temperature sensor (readout possible)**
- **Temperature compensated VLCD voltage**
- A minimum of external components required
- Extended operating temperature range up to +85 °C (+105 °C)
- **AEC-Q100 automotive compliant qualification for high robustness and reliability**
- Available in COG
- Specifically Designed for high-contrast Vertical Alignment (VA) displays



200 icons + 2 line by 20 characters



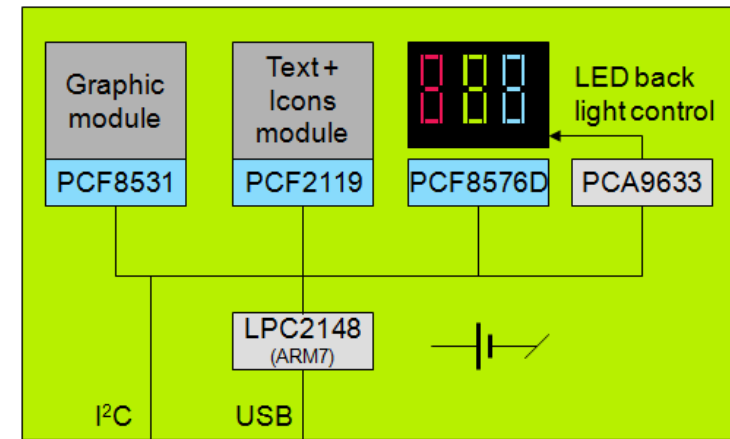
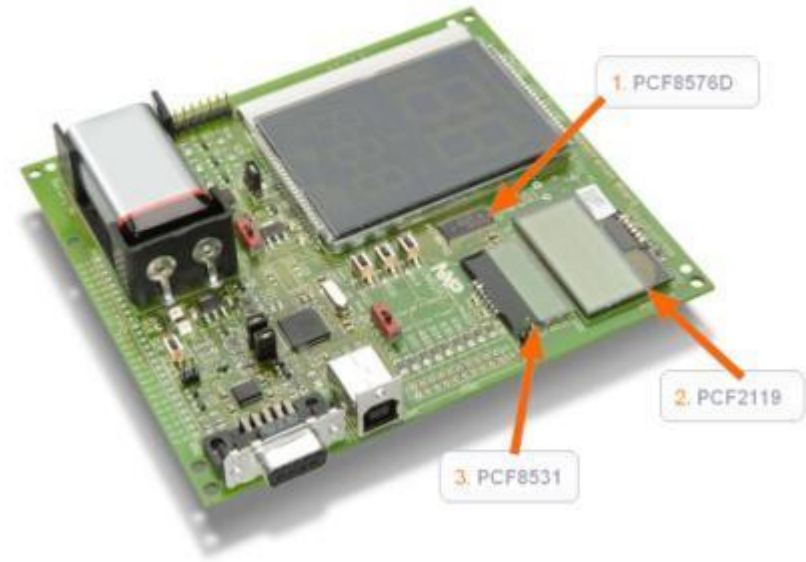
40 icons + 20 seven segment * + 2 line by 20 characters





LCD Drivers Demo Board (OM6290)

- Demonstrates NXP's LCD Driver features
- Includes three displays
 - Segment display driven by PCF8576D (4x40 segment driver)
 - Character display driven by PCF2119S (2-lines x 16-character driver)
 - Dot matrix display driven by PCF8531 (34x128 dot matrix driver)
- Uses the LPC2148 as an I²C-bus master to control the LCD drivers on board.
- Includes RGB backlights to the segment display. Backlights are driven by PCA9633 (4-Channel LED Controller).
- Support Documents:
 - [UM10300](#): User Manual for OM6290 LCD Demo Board





PCA8538 LCD Driver Demo Boards

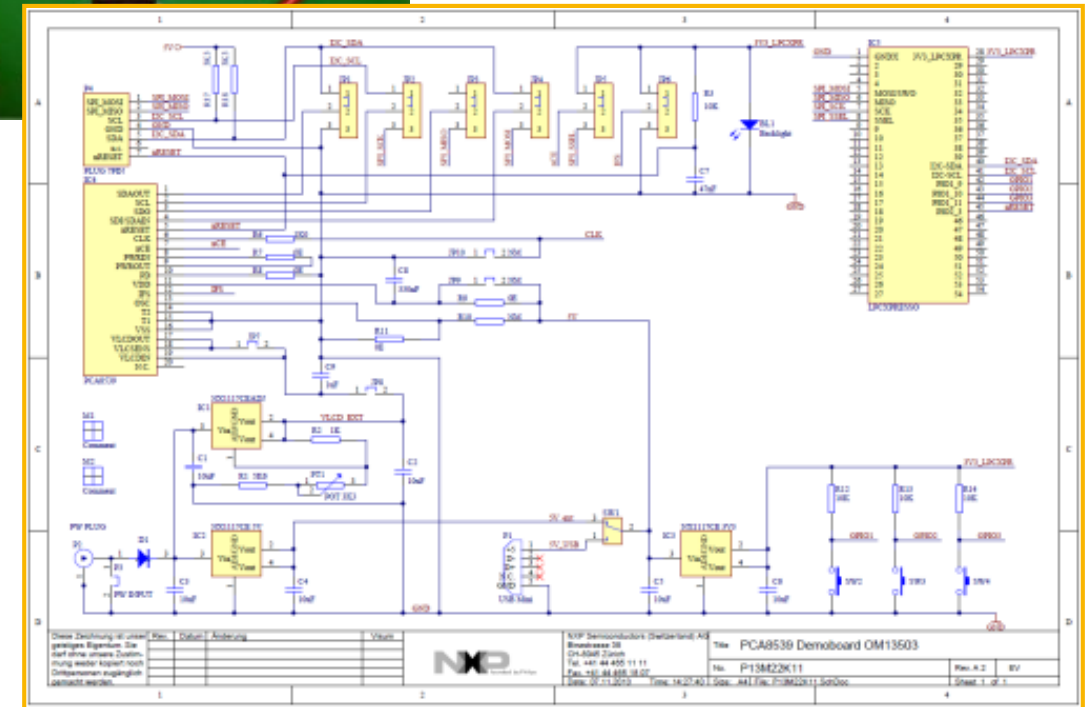
- **PCA8538 COG Demonstration Board (OM13501):**
 - Demonstrates the 102 x 9 Chip-on-Glass LCD segment driver for automotive and industrial applications
 - Features a vertical alignment (VA) COG display module with integrated backlight
 - Controlled by LPC1115 Cortex M0 MCU LPCXpresso (OM13035)
 - Powered by two AA batteries, USB or AC adapter
- **PCA8538 COG Evaluation Board (OM13501A):**
 - Provides a tool for evaluating the PCA8538 LCD Driver
 - Features a vertical alignment (VA) COG display module with integrated backlight
 - Includes jumpers for interface selection (I²C or SPI)
 - Includes a jumper for selecting internal or external oscillator
 - Includes connector pins for easy connection to external MCU or application board





PCA8539 LCD Driver Demo Board (OM13503)

- PCA8539 COG Demonstration Board (OM13503):
 - High quality and high performance dot matrix driver
 - Demonstrates the 18 x 100 Chip-on-Glass LCD dot matrix driver for automotive and industrial applications
 - Demonstration module includes a 7-inch VA graphic display with 18 x 100 dot matrix





PCA9620 & PCA8537 LCD Drivers Demo Boards

PCA9620 Demo board (OM13500):

60 x 8 LCD segment driver in LQFP80 pkg for automotive and industrial applications

PCA8537 Demo board (OM13500A):

44 x 8 LCD segment driver in TQFP64 pkg for automotive and industrial applications





EEPROMS



NxH5104 – Ultra-Low Power 4Mbit SPI EEPROM

Minimal footprint	4Mbit in 7.8mm² area (2.80mm by 2.74mm) WLCSP package with 13 bumps, 400um pitch Highly integrated: 1 external cap
Supply direct from battery	With integrated Power Management Unit to support ZnAir, NiMH and Silver-Zink batteries, offering direct operation from 1.0 .. 2.0V supply
Ultra low power	Designed for minimal average and peak currents: <ul style="list-style-type: none"> • Power-down < 5 uA • Average read current at .6 mA
Interfaces	128-byte and 256-byte page access via SPI <ul style="list-style-type: none"> • Speed up to 10MHz
Auxiliary supply	Auxiliary supply with current limiting allows supplying e.g. a LED <ul style="list-style-type: none"> • 2mA up to 3.2V
Reliable	Operating temperature -20 to 85 degrees >10 years data retention 500 000 program cycles



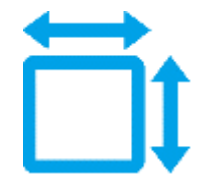
4MBit or 500kByte



Ave. Write Current of 0.7mA



Write protection

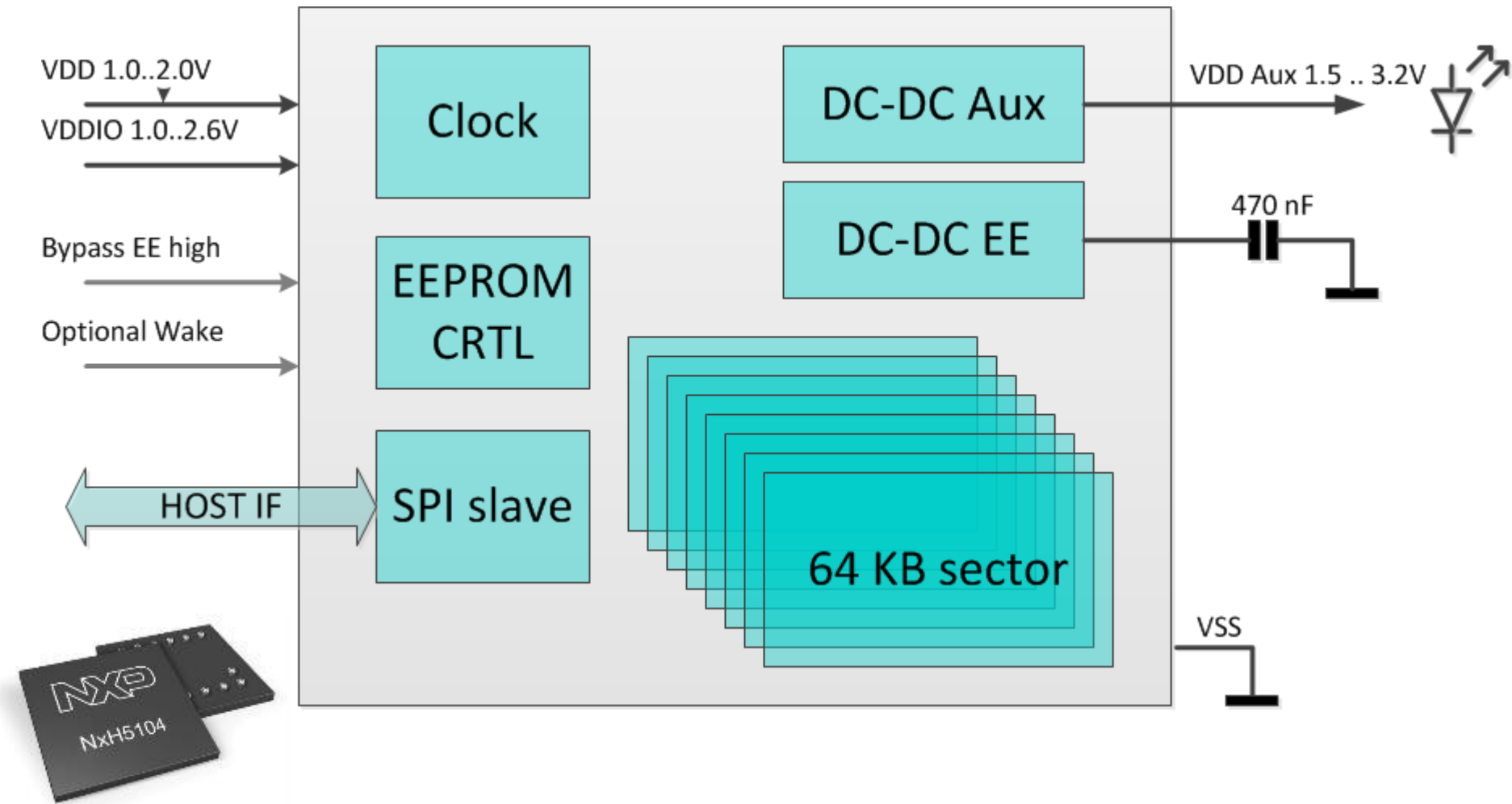


2.8mm by 2.7mm



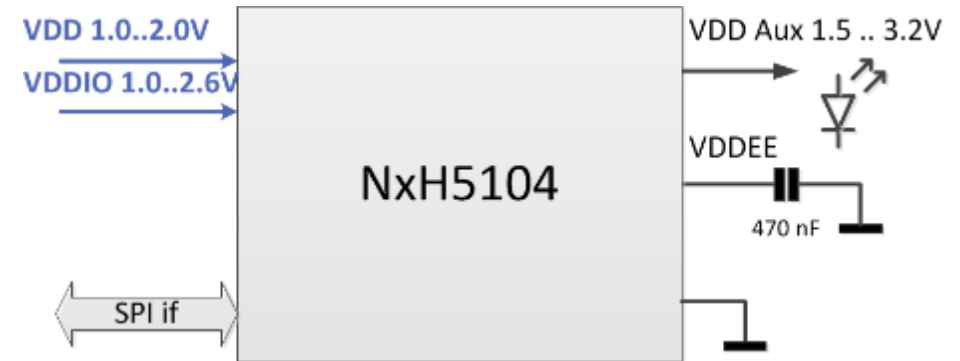
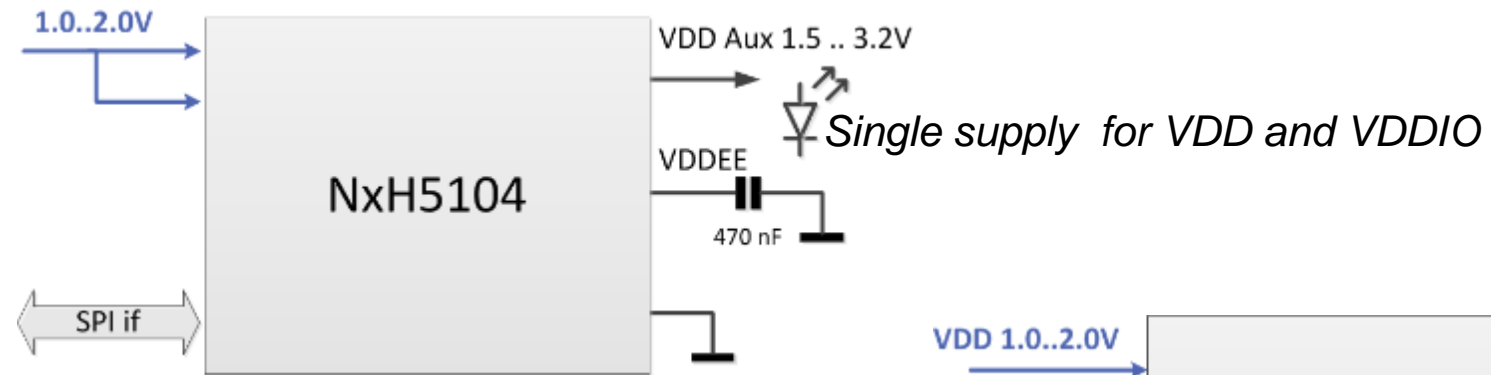


NxH5104 – Ultra-Low Power 4Mbit SPI EEPROM

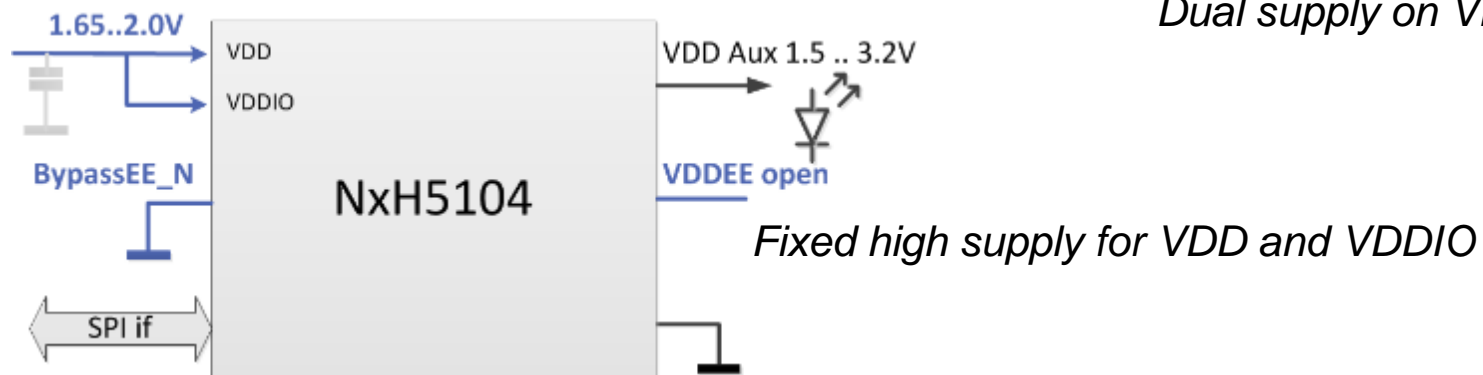




NxH5104 – Application Modes



Dual supply on VDD and VDDIO





NxH5104 – Competitor Benchmark

	ST M95M02-DR 2Mbit SPI EEPROM	NXP NxH5104 4Mbit SPI EEPROM	OnSemi CAT25M02 2Mbit SPI EEPROM	MicroChip SST26WF040B 4Mbit SPI Flash
Features	2Mbit SPI @ 5MHz	4Mbit SPI @ 10MHz	2Mbit SPI @ 5MHz	4Mbit SPI @ 40MHz
Supply	1.8V – 5.5V	0.9V – 2.0V	1.6V – 3.6V	1.65V – 1.95V
Current @1.8V	<ul style="list-style-type: none"> Standby <5µA Read 3mA Write 3mA 	<ul style="list-style-type: none"> Power down <5µA Read 0.6mA Program 1.5mA 	<ul style="list-style-type: none"> Standby <3µA Read >1.2mA Write <2mA 	<ul style="list-style-type: none"> Standby 2µA Read 10 mA Write 25 mA
Reliability	1 MCycles 200Yrs retention -40°C to +85°C	500 kCycles >10yrs retention -20°C to +85°C	1 MCycles 100yrs retention -40°C to +125°C	100 kCycles 100yrs retention -40°C to +85°C
Aux Supply / Drive LED	No	Yes	No	No
Footprint / Package	7.2mm ² WLCSP8 SO8	7.8mm ² WLCSP13	6.4mm ² WLCSP8 SO8	SO8 WSON8 – 30mm ²

- There is no other 4Mbit EEPROM device announced. Thus benchmark against existing 2Mbit EEPROM and 2Mbit Flash.
- Alternative recent technologies as MRAM and FRAM require higher supply levels (e.g. 3.3V or 2.5V) and are very expensive.



PCA24S08A

1024 x 8-Bit Security EEPROM with access protection

DESCRIPTION

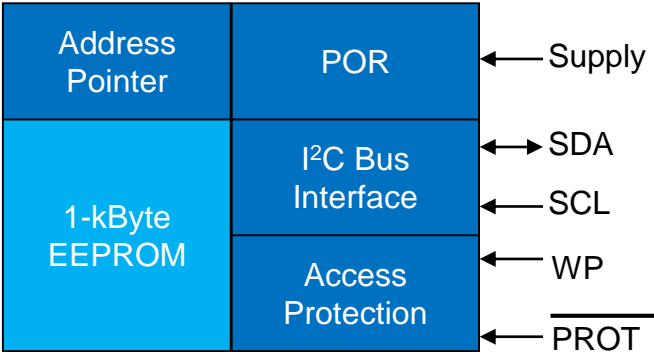
The PCA24S08A functions as a **dual access EEPROM** with a wired serial port used to access the memory. Access permissions are set from the serial interface side to **isolate blocks of memory from improper access.**

FEATURES

- Compatible with a 24C08 Serial EEPROM
- Programmable read/write protection
- Lock/unlock function
- 8 k bits organized as 8 blocks of 128 bytes
- 16-byte page write, 10 ms write time
- Operating temperature range - 40 to +85 ° C
- Operating supply voltage range of 2.5 V to 3.6 V
- Packages offered: SO8 and TSSOP8

Only 1 device allowed per bus

10101B₂B₁



APPLICATION

- Storing Operating Modes
- Storing Serial Number, Year of Manufacture, Firmware Version, etc.
- Storing Equipment Details (Site/Location, Communication, Security, etc.)
- Record Efficiency Information
- Record Diagnostic Information
- Storing Measured Data



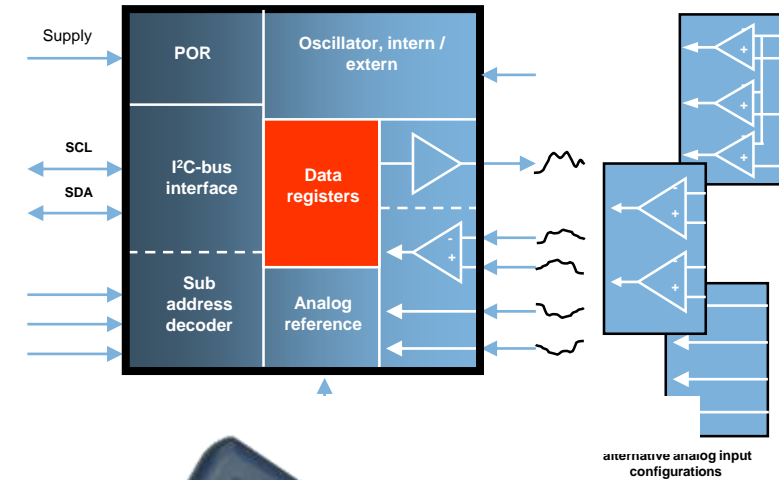


AD & DA CONVERTERS



AD/DA Converters Value Proposition

- Why Used?
 - Sampling analog values
 - Provides a link between analog and digital signals
 - Interfaces between a microcontroller and its periphery
 - 4 configurable input channels for sensing and measuring, and 1 output for extending digital outputs with analog function
- Where Used?
 - Sensors: Measuring bridges, humidity, flow, pressure, temperature, fluid levels, voltages, current, etc.
 - Controls: Analog output to drives, actuators, etc.
 - Management: Battery monitor, detectors, etc.
- Why NXP PCF8591?
 - Pioneered I²C-bus single-chip solution to interface the analog world. 8-Bit resolution with a sampling rate of 11ks/s



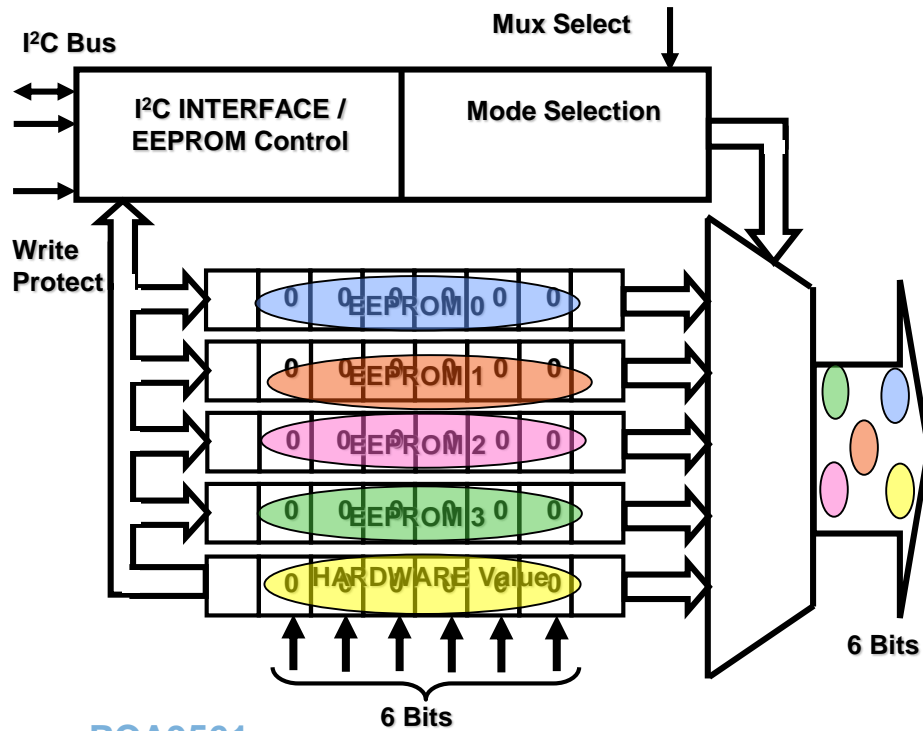


ELECTRONIC DIP SWITCHES



I²C DIP Switch Family

- 6 bit output value is dependant on the mux select pin position or command from I²C master
- EEPROM 0 is default output



PCA9561

	# of Pins	# of Non Volatile Registers	# of Register Bits	# of Hardware Input Pins	# of Muxed Outputs	Non-Muxed Output
PCA8550	16	1	5	4	4	YES
PCA9558	28	1	6	5	5	YES
PCA9559	20	1	6	5	5	YES
PCA9560	20	2	6	5	5	YES
PCA9561	20	4	6	6	6	NO

Application Note [AN250](#)



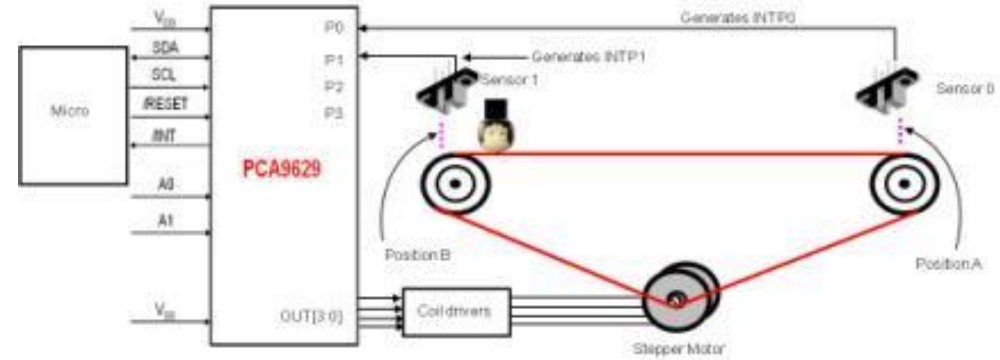


STEPPER MOTOR CONTROLLER



Stepper Motor Controller Value Proposition

- **Why used?**
 - Offload CPU/Microcontroller from driving control signals to the motor driver
- **Where used?**
 - HVAC Compressors and blowers
 - Industrial motors
 - Variable-speed fans and pumps
 - Premium e-bikes
 - Laundry machines
 - Medical pumps and blowers
 - Toys
- **Why NXP Stepper Motor Controller?**
 - Supports different commands (start, stop, ramp-up, ramp-down, direction control, etc.).
 - Interfaces with different stepper motors as drivers are external.
 - Easy integration in the system with I²C interface.

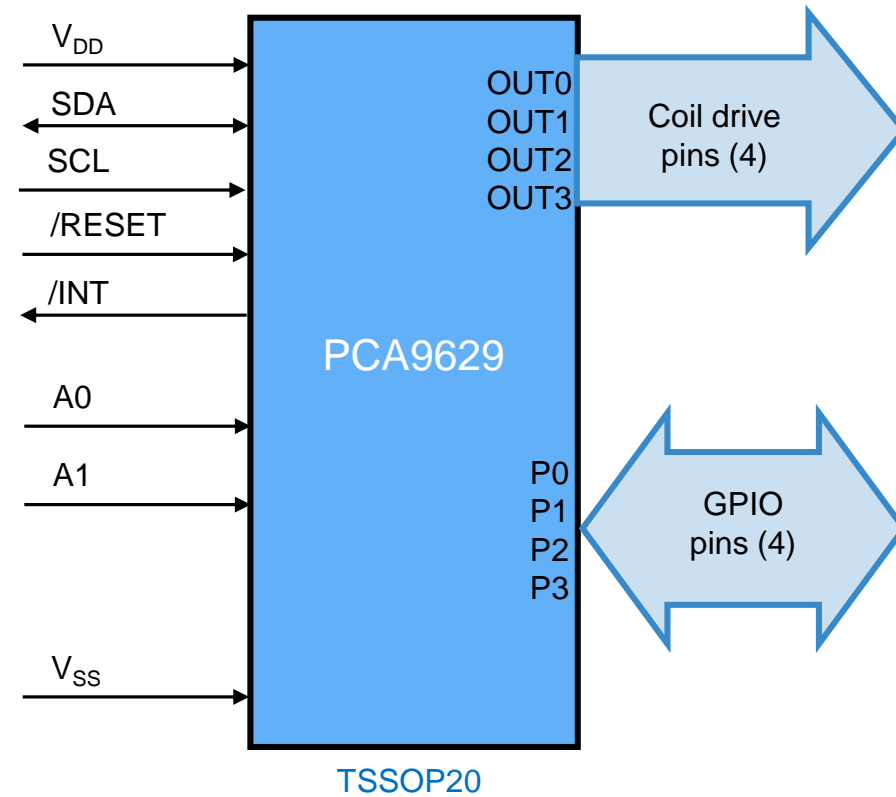




PCA9629 1-Channel Stepper Motor Controller

Features

- Provide drive signals for driving a single stepping motor:
 - One, Half and Two Phase Drive Control
 - Start, stop, ramp-up/ramp-down and direction control of stepper motors
 - Programmable steps per rotation allows use of many models of stepper motors
 - Programmable step pulse width to control speed of motor
 - Balanced push-pull outputs: Drives 1000 pF loads with 15 ns rise and fall times
- Interrupt linked extra steps, direction reversal and stop control
- Four GPIOs programmable as inputs or push-pull outputs (25 mA) to sense optical interrupter for motor home position or drive solenoid/LEDs, respectively
- Stand alone operation: Off loads microcontroller
- Hardware RESET to recover from bus stuck condition



Potential applications

- White Goods
- Robotics & Toys
- Gaming & Vending Machines
- Security & Surveillance Camera



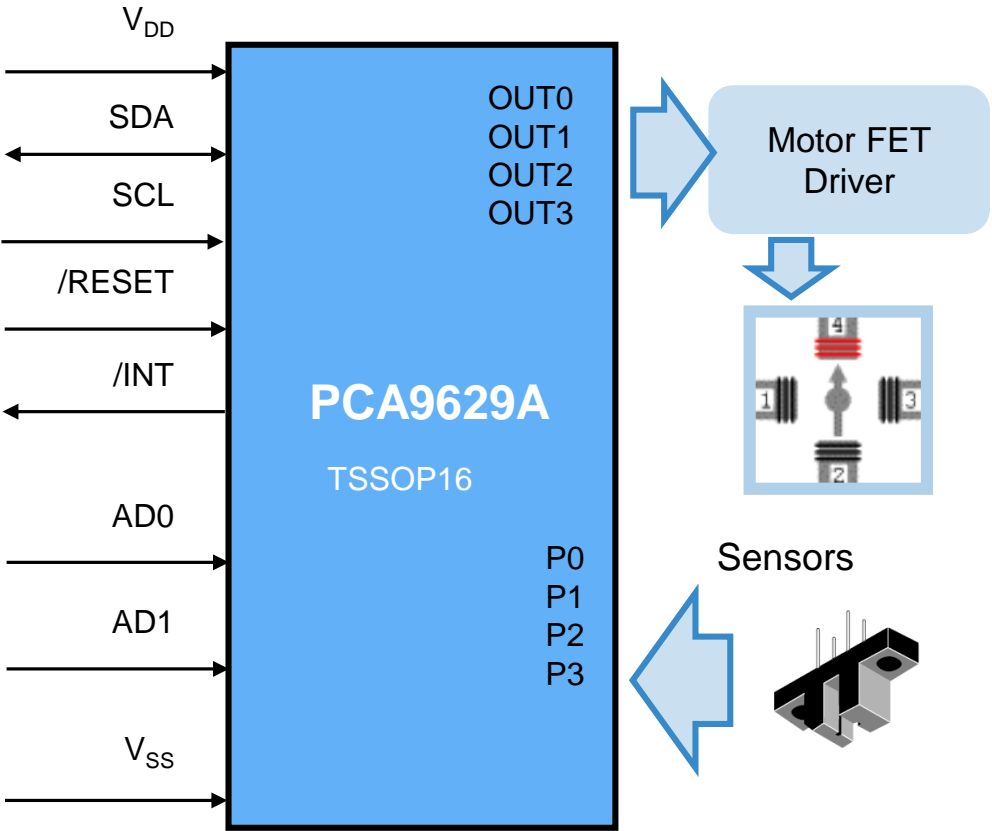


PCA9629A Improved Stepper Motor Controller

Improvement:

- Change PWM setting (rotational speed) while the stepper motor is running
- Countable loop feature to allow variable number of rotation (currently only one loop or continuous run is allowed)
- Faster ramp rate between stop and full run
- Support “pass-through” feature to allow brute force PWM
- Emergency Break to hold motor position
- Improve Interrupts functions including variable delays after sensor detected
- Allow use of unused I/O pins as inputs to monitor motor position
- Optimize order of registers
- Same 16-pin TSSOP16 package as that of PCA9629

Typical Application





PCA9629 Versus PCA9629A

#	Feature/Function	PCA9629	PCA9629A
1	Motor Speed Change	<ul style="list-style-type: none"> Motor speed change and ramp control only when motor STOP Symmetrical ramp up and down “Hard Stop” occurs only after ramp up/down sequence complete 	<ul style="list-style-type: none"> Motor speed change and ramp control any time Asymmetrical ramp up and down “Emergency Stop” stops motor immediately without waiting for ramp up/down completion
2	Motor Rotation Control	Rotate once or continuously	Rotate once up to 255 or continuously
3	Motor STOP interrupt	No interrupt generated when motor STOP	Interrupt (maskable) is generated when motor STOP
4	Motor Drive Outputs	Output PWM signals only	Output either PWM or GPO
5	Motor Home Position	None	Single command to bring motor to home-position without polling the P0 input
6	Motor Brake Function	Motor output pins to “0” or retaining the last state when motor STOP	Motor output pins to “0”, “1”, or retaining the last state when motor STOP with a programmable time-out timer (up to 1 sec) to reset all outputs to “0”
7	GPIO P0/P1 Input Pins	No filter, hence any noise events on P0/P1 inputs could prematurely trigger the interrupt	Programmable noise filter on P0/P1 to suppress noise to ensure the correct interrupt event is generated
8	Loop Delay Timer	One loop delay timer (range 1 sec up to 255 sec) for clockwise and counter-clockwise direction	Separate loop delay timer (4 msec up to 1.02 sec) for clockwise and counter-clockwise direction
9	Output Step Counter	None	32-bit step counter for monitoring motor position or counting number of rotations
10	Registers Map	<ul style="list-style-type: none"> Step per rotation, clockwise and counter-clockwise rotation count registers Sub/all call address registers are top of register map 39 registers 	<ul style="list-style-type: none"> No step per rotation, clockwise and counter-clockwise rotation count registers . Sub/all call address placed to the bottom of the register map for easy software control Reduced to 35 registers





PCA9629A Key Features and Benefits

	Features	Benefits
NEW	Re-start motor with new speed and operation	Allow to change the motor speed and operation on the fly without stopping motor
NEW	Re-enable ramp-up or ramp-down during current ramp operation	Allow to update ramp rate curve on the fly without stopping motor
NEW	Motor outputs can be configured as general purpose outputs	Support bypass mode
NEW	Generate an interrupt when motor stop	Off-load CPU bandwidth - no interrupt polling is necessary
NEW	Motor home position control from P0 input	Single command to bring motor in home position
NEW	32-bit step counter to count output step pulses	Host can find current motor position and number of rotations by reading step counter value
NEW	Programmable filter on P0 or P1 inputs	Avoid false interrupt trigger on P0 or P1 inputs
✓	Perform motor action settings from 1 to 255 or continuously	Allow to perform multiple of actions up to 255 or repeat without CPU re-program
✓	Motor brake/stop with time-out control to set output state: all "0", all "1" or hold last state	Flexible brake feature to protect motor from overheat
✓	Dual loop reversal mode timers	Allow asymmetrical delay in motor reverse operation
✓	± 2% output step pulse accuracy	Comparable with best in class accuracy

NEW

New design for PCA9629A



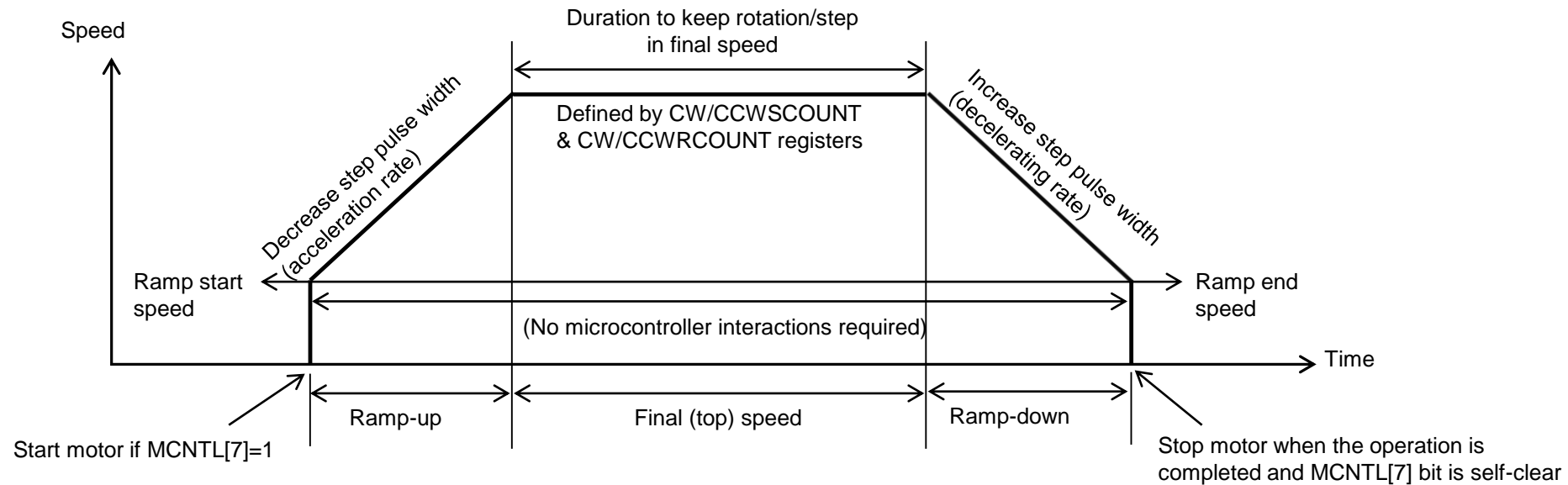
Improvement over PCA9629





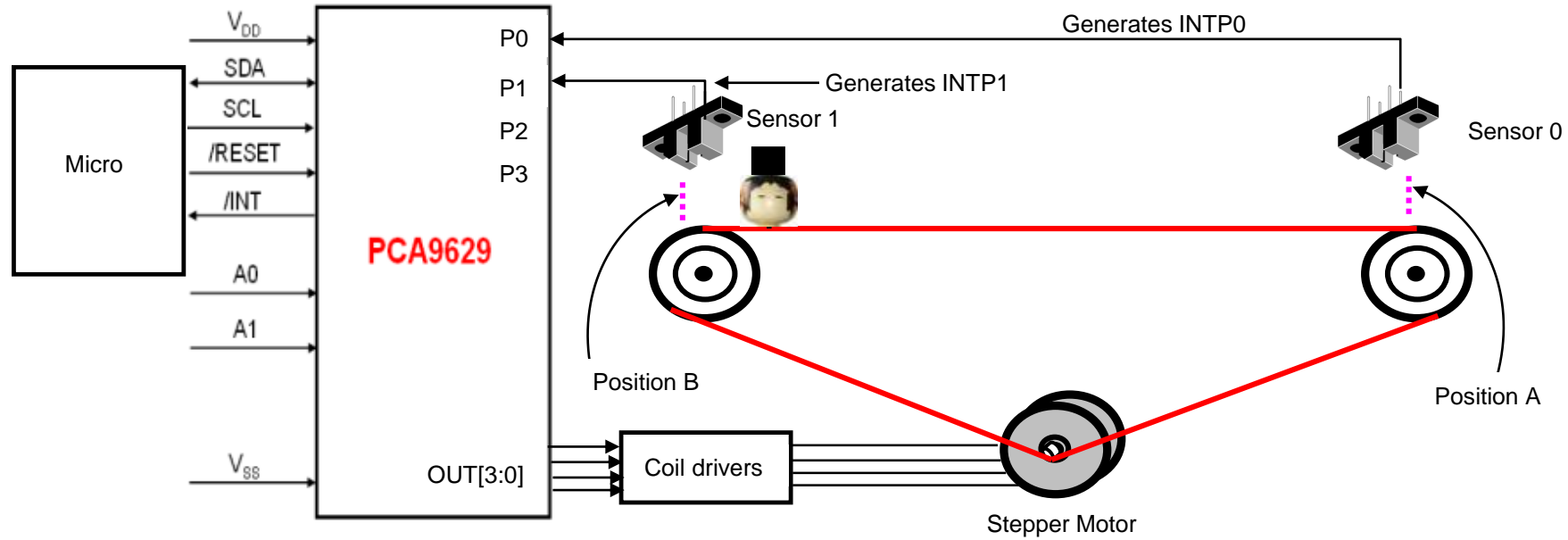
Ramp-up and Ramp-down Control

- The ramp start or ramp end speed is defined as the maximum value of the range given in Table 26/28 based on prescaler bit[15:13] in CWPWH/CCWPWH registers.
- The decrease/increase step pulse width is defined as the minimum value of the range given in Table 26/28 based on prescaler bit[15:13] in CWPWH/CCWPWH registers times the ramp step multiplication factor bit[3:0] in RMP_CNTL register.
- The ramp up final speed is defined as the minimum value of the range given in Table 26/28 based on prescaler bit[15:13] times the step pulse width value bit[12:0] plus 1 in CWPWH/L and CCWPWH/L registers

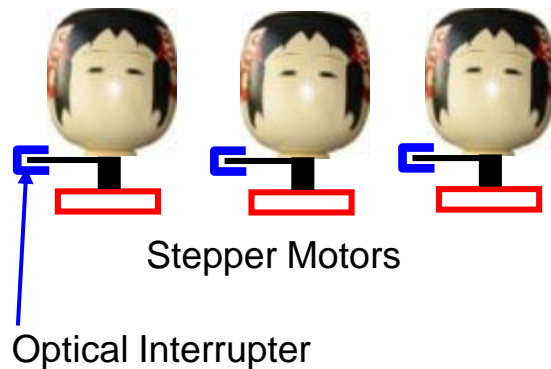




Stepper Motor Controller Typical Application



Doll Head Control



Wall-e-remote-control-robot



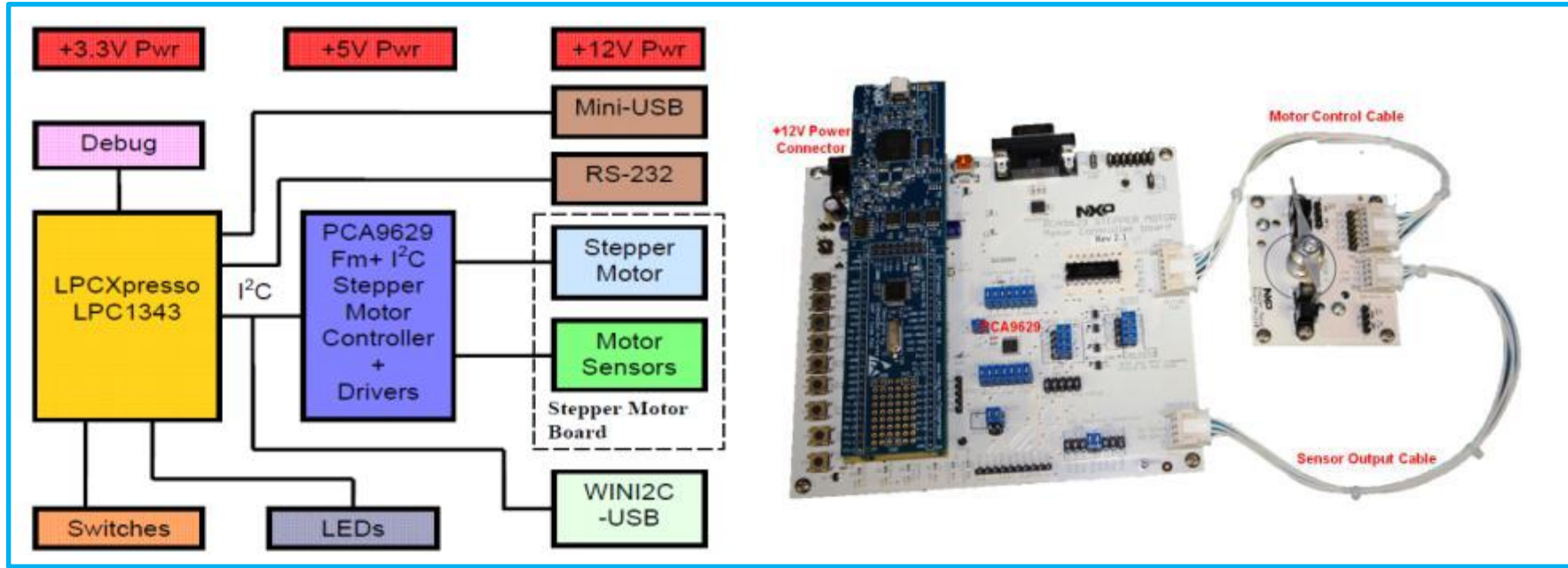
Open / Shut Doors





PCA9629: Evaluation Kit (OM13285)

PCA9629 Demo Board Block Diagram



LPC1343 (32-bit ARM Cortex-M3 Microcontroller)

Used to control the PCA9629 Stepper Motor Controller
LPC link can be plugged into the board
Software can be modified using LPCXpresso tools

The PCA9629 Stepper Motor Controller Demo Board only has Part Number OM13321



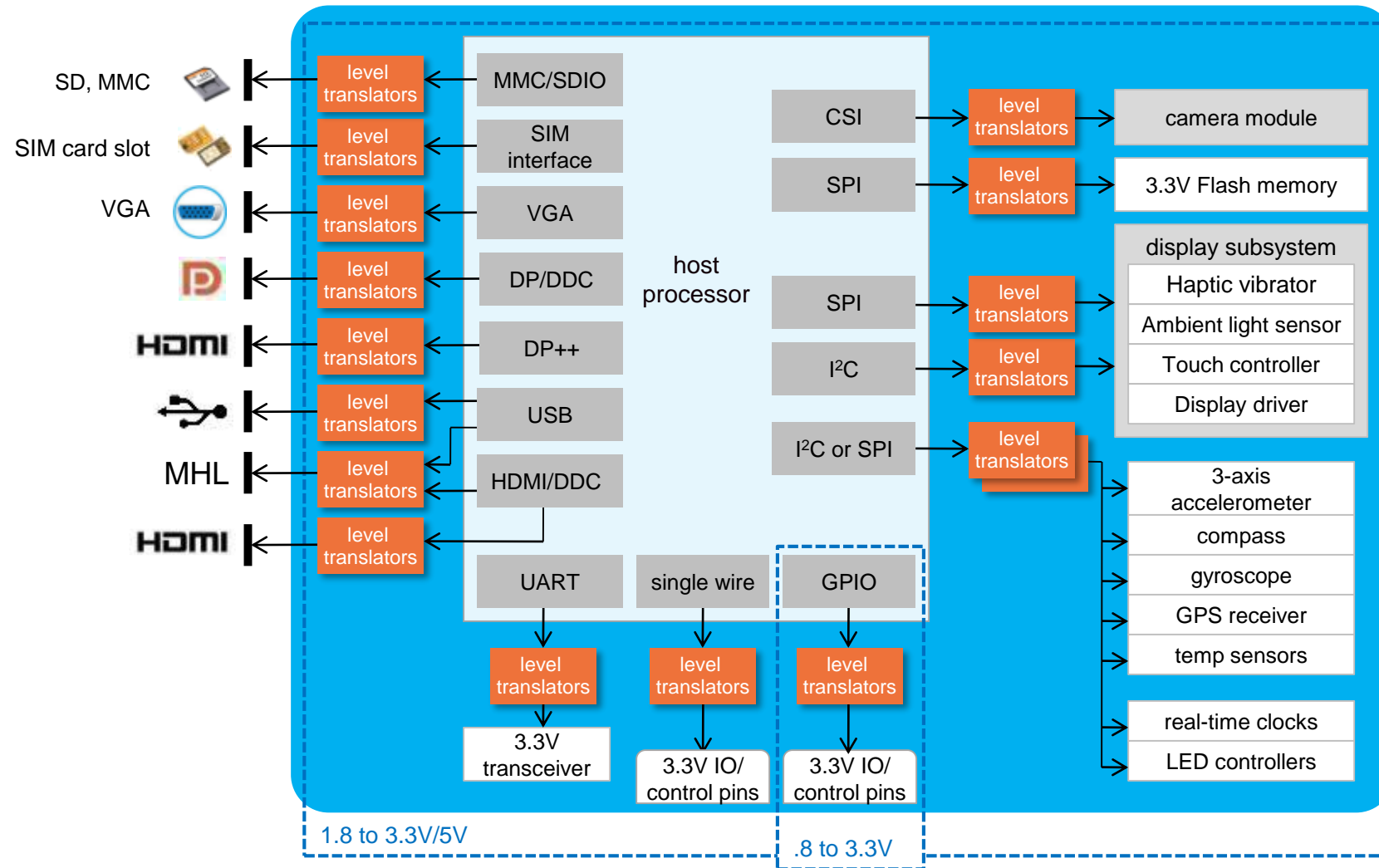


VOLTAGE LEVEL TRANSLATORS





Wide Selection of Voltage Level Translators For Different Applications





Voltage-Level Translator Overview

PCA Family

Features:

- Single and Dual supply
- Capacitive isolation
- High noise margin

Applications

- I²C buffering
- Long cable
- Hot-swap

NVT Family

Features:

- Dual supply
- Bidirectional
- Auto-sensing
- Passive
- External pull-ups required
- 1-10 bits wide

Applications

- Control interfaces

NTB Family

Features:

- Dual supply
- Auto-sensing
- Isolates capacitance
- Push-pull outputs
- Low output drive
- Operates down to 0.95V

Applications

- Control interfaces with active drive

GTL Family

Features:

- Supports 'GTL' logic
- Dual supply
- Auto sensing
- GTL to LVTTTL level translation

Applications

- Supports GTL levels on micro-processors

NTS/NTSX Family

Features:

- Dual supply
- Bidirectional
- Passive
- Open Drain
- Integrated Pull up resistors
- NTSX family has high sink current capability

Applications

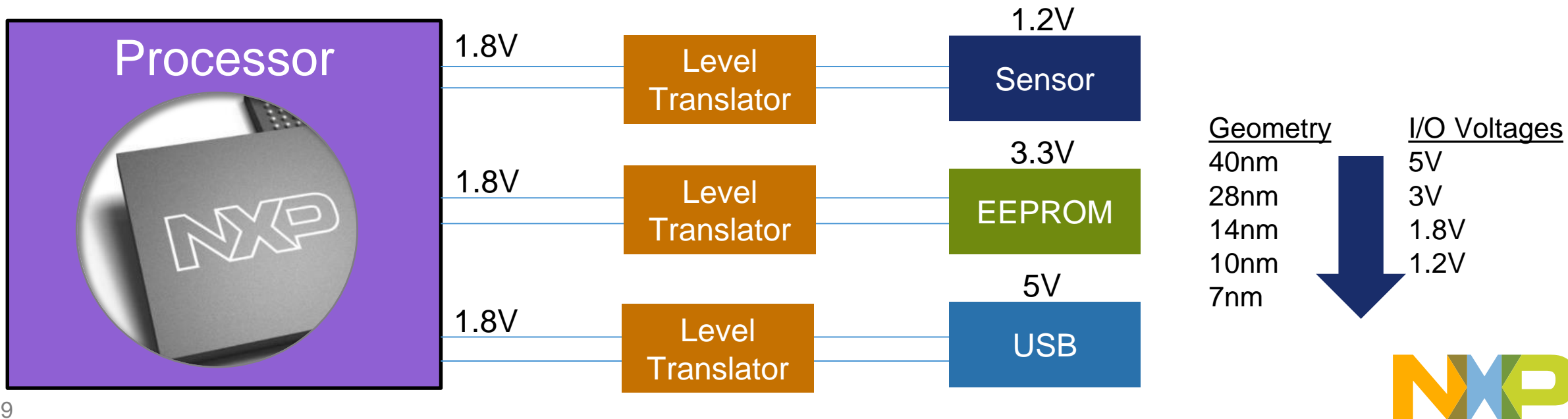
- Control Interfaces



Level Translators to Support Lower Voltages & Power

Opportunities for level translators as peripherals aren't changing quickly

- New designs/applications use lower supply voltage i.e. 3.0V or lower
- All the devices used in a design/application do not use same supply voltage
- A newly designed CPU, uses a lower voltage e.g. 1.8V but a proven old peripheral (e.g. memory, sensors, RF transceivers, etc.) uses higher supply voltage e.g. 3.3V.
- Voltage-Level Translator is used to prevent the current flow in mismatched voltage supplies





NTS030x: Level Translators Offer Wider Voltage Ranges

Maximum Data Rates – 20Mbps (Push Pull) / 10Mbps (Open Drain)

- Number of channels: 1, 2, 4, & 8-Bit Bi-directional level-shifting
- Supply voltage range
 - Number of channels: 1, 2, 4, & 8-Bit Bi-directional level-shifting
 - Supply voltage range:
 - A-Side Voltage: 0.95V to 3.6V
 - B-Side Voltage: 1.65V to 5.5V
 - $V_{CC(A)} \leq V_{CC(B)}$
- ESD: 8kV IEC61000-4-2, Class4, contact on the B-Side
- Smart one-shot with ~40 ns ($50ns_{max}$) pulse and slew-rate control for EMI reduction
- Compatible with most competitor footprints adding wider supply range and reducing EMI
- Packaging:
 - 8-channel: TSSOP20, VQFN20 and USON20
 - 4-channel: **TSSOP14†**, **WLCSP12†**, DHVQFN14, XQFN12
 - 2-channel: 8 Pin, TSSOP8, SSOP8, **X2SON8†**, XQFN8 and WLCSP8
 - 1-channel: 6-Pin, TSSOP6, SC-88

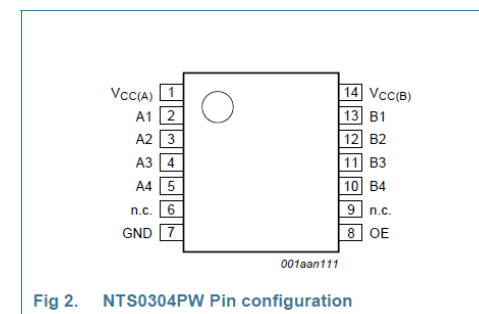
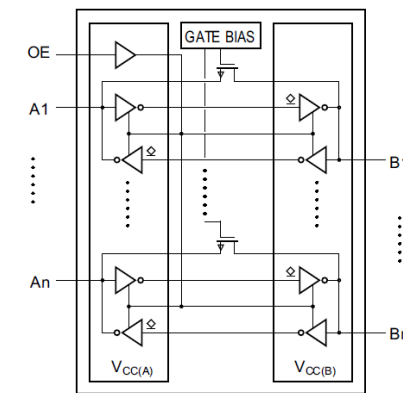
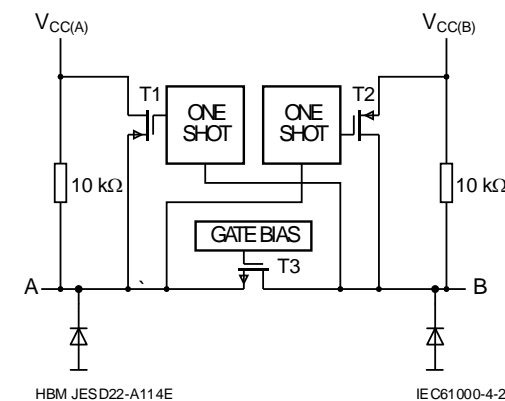


Fig 2. NTS0304PW Pin configuration

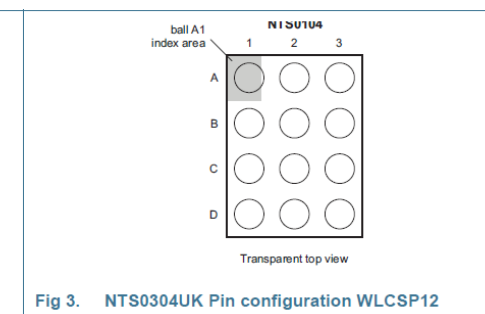


Fig 3. NTS0304UK Pin configuration WLCSP12

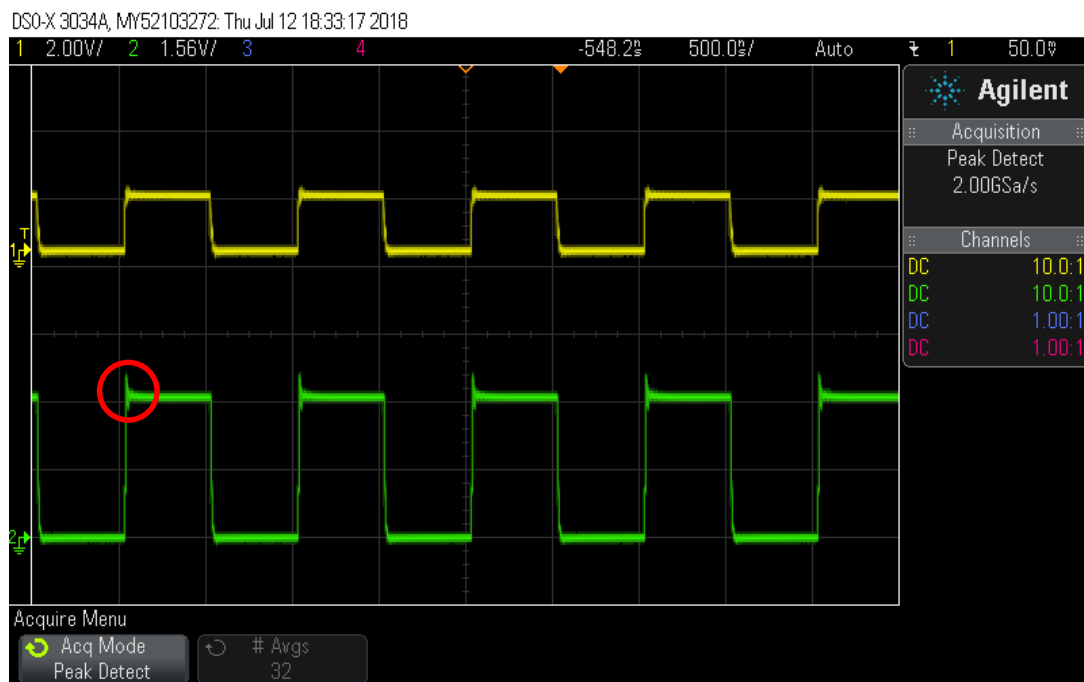
† Package options that are currently released



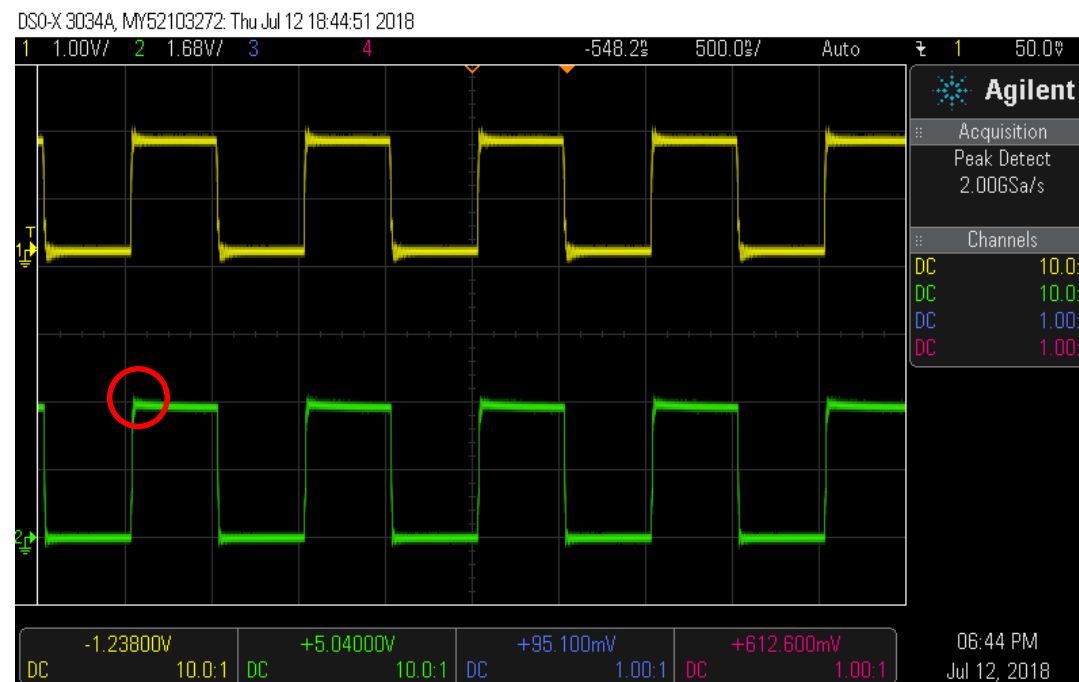


NTS0304 vs NTS0104: No Overshoot with Smart One Shot

Older generation: NTS0104



Newer generation: NTS0304



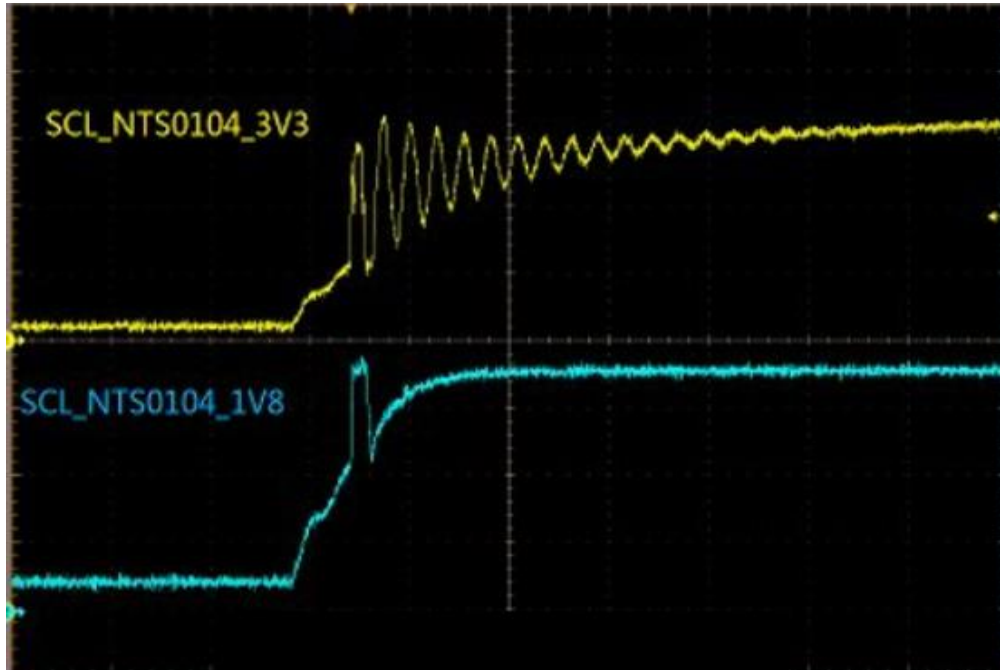
$V_{CCA} = 1.65V$ and $V_{CCB} = 3.3V$

NTS0104 shows visible overshoot with the same operating condition

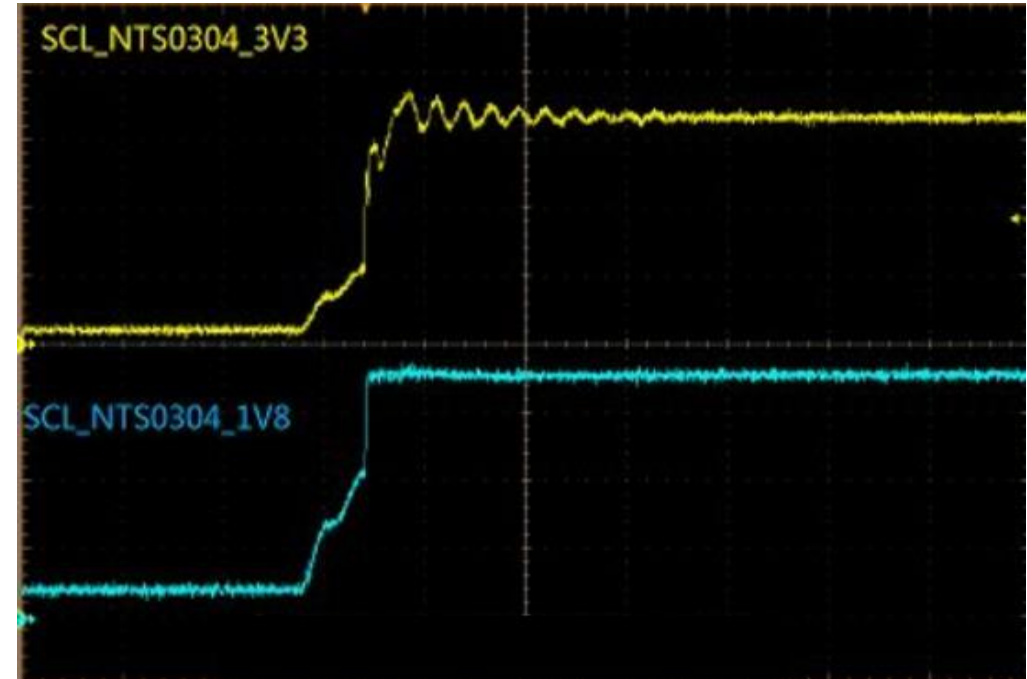


NTS0304 vs NTS0104: No Transition “Glitch” with 50-ns One-Shot

Older generation: NTS0104



Newer generation: NTS0304



$V_{CCA} = 1.8V$ and $V_{CCB} = 3.3V$

NTS0104 shows visible “glitch” with the same operating condition



Summary: NTS030x vs NTS010x vs Competition

	NXP: NTS030x	NXP: NTS010x	Competitor T
Type	Pass-through gate with one-shot accelerator for rising edge		
Typical IF	Open-drain <10Mbps	Open-drain <10Mbps, Push-pull with <=25Mbps	Open-drain < 2Mbps, Push-pull with <=100MHz
# Channels	1, 2, 4, 8	1, 2, 4	1, 2, 4, 8
V _{ccA} _{min}	0.9V	1.65V	1.65V (1.2V, '0108)
V _{ccB} _{min}	1.65V	2.3V	2.3V (1.65V, '0108)
ESD level on B-side	8kV IEC61000-4-2, class4	15kV HBM JESD22-A114E Class 3B	8kV IEC61000-4-2, class4 (4,8-ch)
Smart one-shot	Yes	No	No
One-shot duration	target 30ns, 50 ns max	~15 ns (spec <50 ns)	Measured to be ~30ns
Operating Temp.	-40 to +125 C	-40 to +125 C	-40 to +125 C





Level Translators with Capacitance Isolation (“Active”)

PCA Family

- 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 and speed of >3MHz (up to 30MHz) is required

SPEED	OUTPUT DRIVE	V RANGE	LEVEL TRANS	TECHNOLOGY	FUNCTION / USE	PACKAGE	PART#
Fm	A: 1 mA B: 6 mA 09A: 100 μA 09A: 6mA/30 mA	A: 1.0 to (V _{CCB} -1V) B: 3.0 to 5.5V	2 V _{dd} / 5V tolerant	A side (LV)	Works with any I ² C slave	SO8, TSSOP8, XQFN8	PCA9509
		A: 0.8 to 1.5V B: 2.3 to 5.5V				TSSOP8, XQFN8	PCA9509A PCA9509P
	6 mA	A: 1.0 to V _{CCB} -1.5V B: 3.0 to 5.5V	2 V _{dd} / 5V tolerant	static offset	Ideal for 1.0V master controlling 3.3V slave or vice-versa	TSSOP20, HVQFN24	PCA9519
	6 mA	2.3 to 3.6V	5V tolerant	offset on both sides	Extension of the I ² C-bus by buffering	SO8, TSSOP8 (MSOP8), HWSON8	PCA9515A
	6 mA (A&B)	A: 0.9 to 5.5V B: 2.7 to 5.5V	yes	B side (HV)	I ² C-bus buffering to I ² C device	S08, MSOP8 , HWSON	PCA9517A
Fm+	13 mA (A&B)	A: 0.8 to 5.5V B: 2.2 to 5.5V	yes	B side (HV)	I ² C-bus buffering to I ² C device	TSSOP8, HWSON8	PCA9617A





Passive Level Translators

NVT Family

- **NVT family: lowest standby current (5 μ A)**
 - Bidirectional, no directional pin required
 - Widest supply range: from 1 to 5V
 - Fast propagation delay
 - I²C and DDC compliant
 - Lock-up-free operation for isolation when EN=LOW
 - No offset
 - Voltage translation with supplies from different domains
- **Extremely thin, small pkgs available**

BIT(S)	SPEED	OUTPUT DRIVE	V RANGE	FUNCTION	BUS/USE	PACKAGE	PART#	
1	< 33 MHz	open-drain with 50pF capacitance & 197- Ω pull-up	1.0 to 5.0V		general purpose, I ² C, SMBus, I ² S, SPI, digital RGB	TSSOP8, XSON8U, XSON6	NVT2001	
2				alt source PCA9306			NVT2002	
3				<1.5 nsec max propagation delay			NVT2003	
6							TSSOP10/16, DHVQFN16, HVQFN16	NVT2006
8							alt source GTL2003, control signals	NVT2008
10							DHVQFN20/24, TSSOP20/24, HVQFN24	NVT2010
2	6 mA (A&B)	A: 0.9 to 5.5V B: 2.7 to 5.5V	B side (HV)	I ² C, I ² S, SMBus		SO8, TSSOP8, VSSOP8, XQFN8, XSON8, XSON8U	PCA9306	





PCA9306

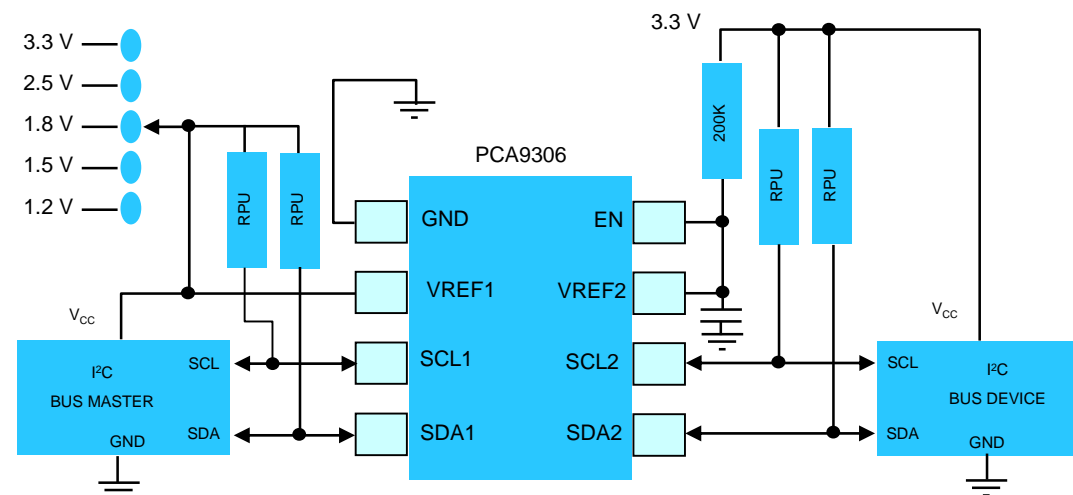
Bidirectional I²C-Bus & SMBus Level Translator

- 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 I²C-bus application: run two buses, one at 400 kHz other at 100 kHz operating frequency
- Excellent ESD performance

- Applications

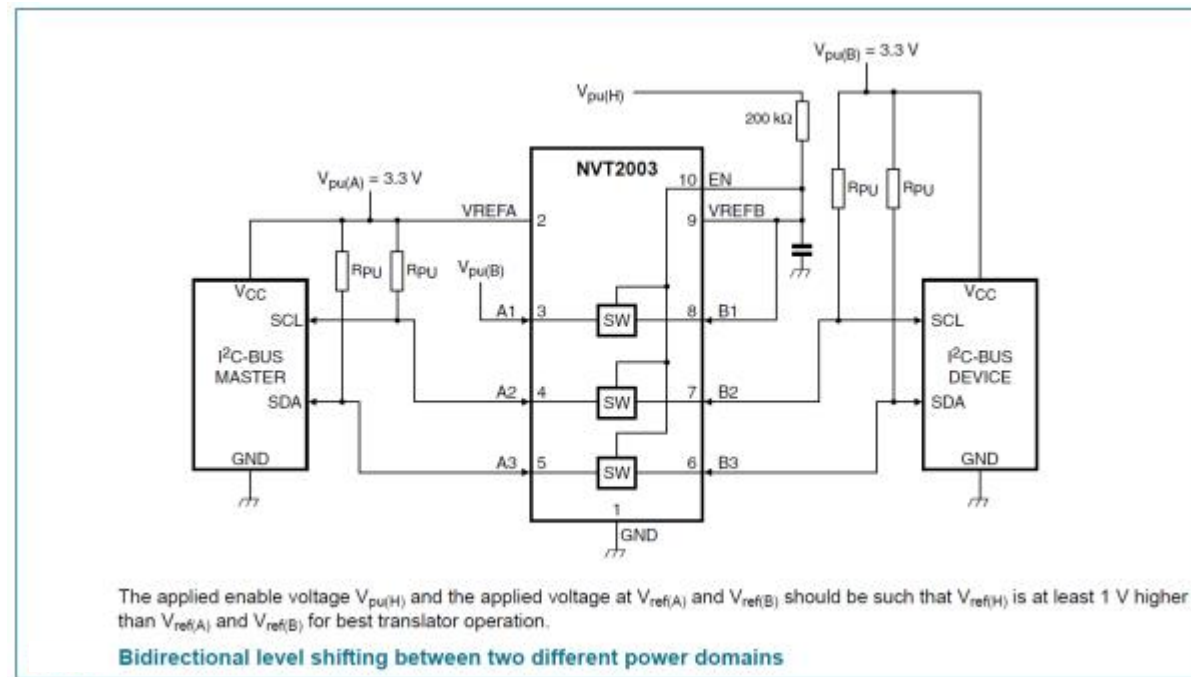
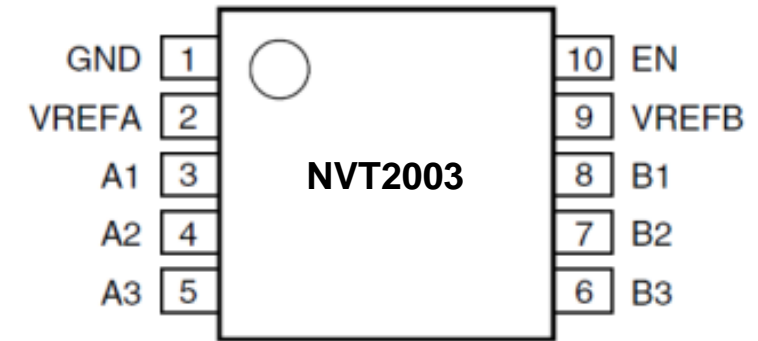
- Voltage Level Translation
 - Mixed-mode I²C-bus Applications





NVT2003 Level Translator

- **Where used?**
 - Small Level Translations
 - Two power supplies for same line
- **Why used?**
 - Prevent “fighting” between redundant power supplies
 - Bi-directional without direction pin





Comparison:

I²C Unbuffered & Buffered Level Translators

- I²C level translators (unbuffered): PCA9306 / NVT2002
- I²C level translators with bus buffers: PCA9509/09A/09P, PCA9517A/9617A

	PCA9509	PCA9509A PCA9509P	PCA9517A	PCA9617A	PCA9306	NVT2002
		low voltage master to standard I ² C voltage slave	standard I ² C master to low voltage slave		simple translation without capacitance isolation	
Rise-time accelerator	NO	NO	NO	NO	NO	NO
Idle/Stop detect for hot-swap	NO	NO	NO	NO	NO	NO
Noise/offset isolation	YES	YES	YES	YES	NO	NO
Capacitance isolation	YES	YES	YES	YES	NO	NO
V _{CCA} or V _{CC} supply range	1V to (V _{CCB} -1V)	0.8 to 1.5V	0.8 to 5.5V	0.9 to 5.5V	N/A	N/A
V _{CCB} or V _{CC2} supply range	3.0 to 5.5V	2.3 to 5.5V	2.7 to 5.5V	2.7 to 5.5V	N/A	N/A
ESD HBM	2KV	2 kV	5kV	5kV	2kV	4kV



Level Translators – NTB Family

3-State and Auto-Direction Sensing

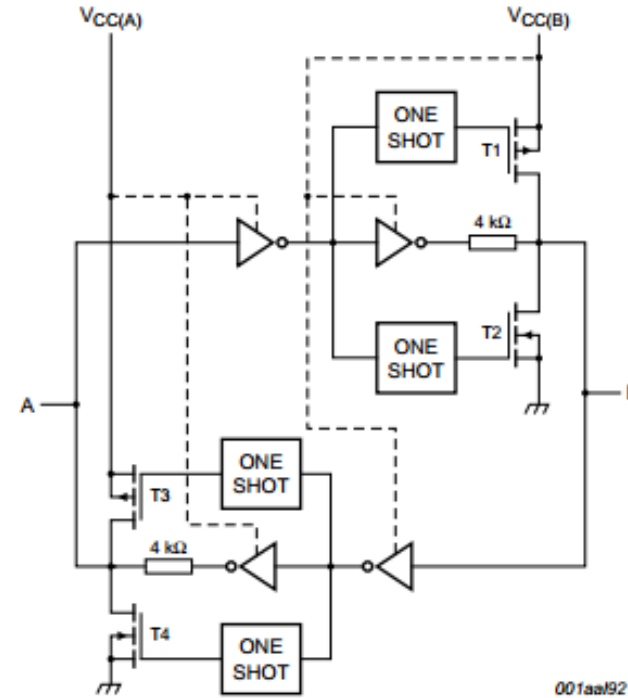
- Auto-direction sensing
- Wide operating voltage range
- Dual-supply, translating transceiver
- Suitable for 3-state and push-pull applications
- Capacitance isolation
- Not recommended for open-drain applications (use NTS family instead)

CH	V RANGE	OUTPUT DRIVE	BW	DESCRIPTION	OUTPUT ENABLE	PACKAGE	PART#
1	1.2V - 3.6V to 1.65 - 5.5V	-20 μ A	25 MHz	3-state or push pull	Active High	SC-88, X2SON6, XSON6	NTB0101
1					Active Low	SC-88	NTB0101A
2					Active High	TSSOP8, XSON8, XQFN10	NTB0102
4					Active High	XQFN12, DHVQFN14, WCSP12	NTB0104

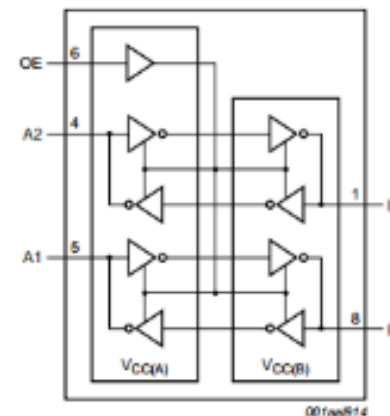
NTB0102 Level Translator

Auto-Direction Sensing, 3-state

- Features
 - 2-bit, dual supply, bi-directional
 - Auto direction sensing
 - Two 2-bit data I/O ports, 1 output enable, 2 supply pins
 - Translation: any voltage from 1.2 to 5.5V
 - Supply voltage
 - VccA: 1.2 to 3.6V
 - VccB: 1.65 to 5.5V
 - Partial power-down mode
 - High impedance OFF-state
 - ESD
 - 2.5kV / 15 kV HBM (JESD22-A114)
 - 200V MM (JESD22-A115)
 - 1.5kV CDM (JESD22-C101)
- Replaces: NLSX5012, FXLA102, TXB0102



NTB0102 3 States

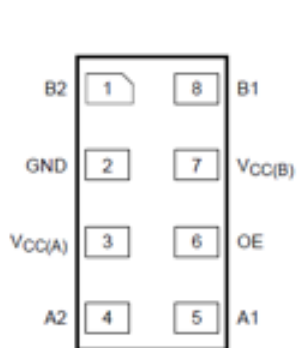




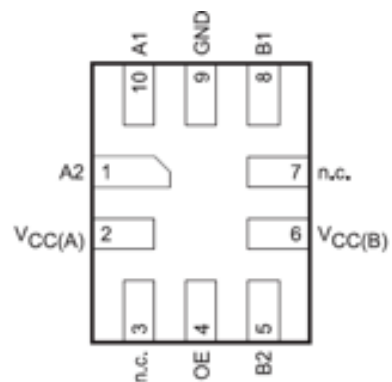
NTB0102 Level Translator

Auto-Direction Sensing, 3-state

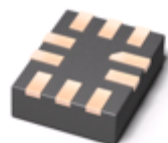
- Packaging: TSSOP8, XSON8, XSON8U, XQFN10





SOT833-1 (XSON8)
 1.0 x 1.95, 0.5 mm pitch
 SOT1089 (XSON8)
 1.35 x 1.0, 0.35 mm pitch



SOT1160 (XQFN10)
 1.4 x 1.8, 0.4 mm pitch



Suffix	GD	GM	GT
	 SOT996	 SOT902	SOT833
	8-pin	8-pin	8-pin
Width (mm)	3.00	1.60	1.00
Length (mm)	2.00	1.60	1.95
Pitch (mm)	0.50	0.50	0.50



NTB0104 Level Translator

Auto-Direction Sensing, 3-state

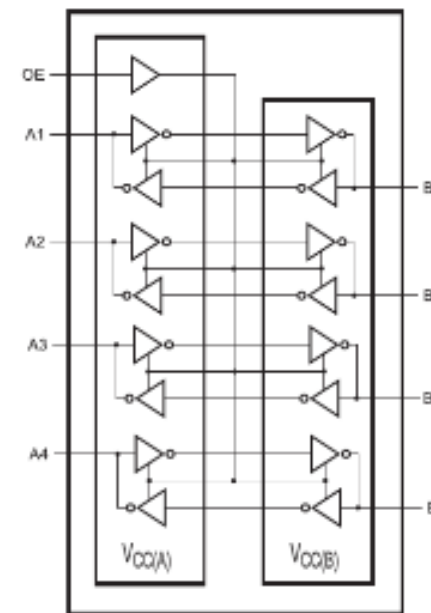
- Features

- 4-bit, dual-supply bidirectional translating transceiver
- Auto-direction sensing
- Two 4-bit data I/O ports, 1 output enable, 2 supply pins
- Translates between any low voltage nodes: 1.2V, 1.5V, 1.8V, 2.5V, 3.3V and 5.0V
- Supply voltage
 - VccA: 1.2 to 3.6V
 - VccB: 1.65 to 5.5V
- Partial power-down mode
- High impedance OFF-state
- ESD: 2.5 kV / 15 kV HBM

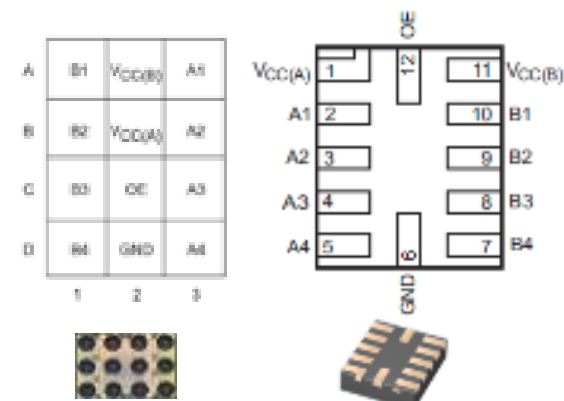
- Packages

- XQFN12: 1.7 x 2.0 x 0.5, 0.4 mm pitch
- DHVQFN14: 2.5 x 3.0 x 0.85, 0.4 mm pitch
- WCSP12: 1.2 x 1.6 x 0.56, 0.4 mm pitch

- Replaces: NLSX4014, FXLA104, TXB0104



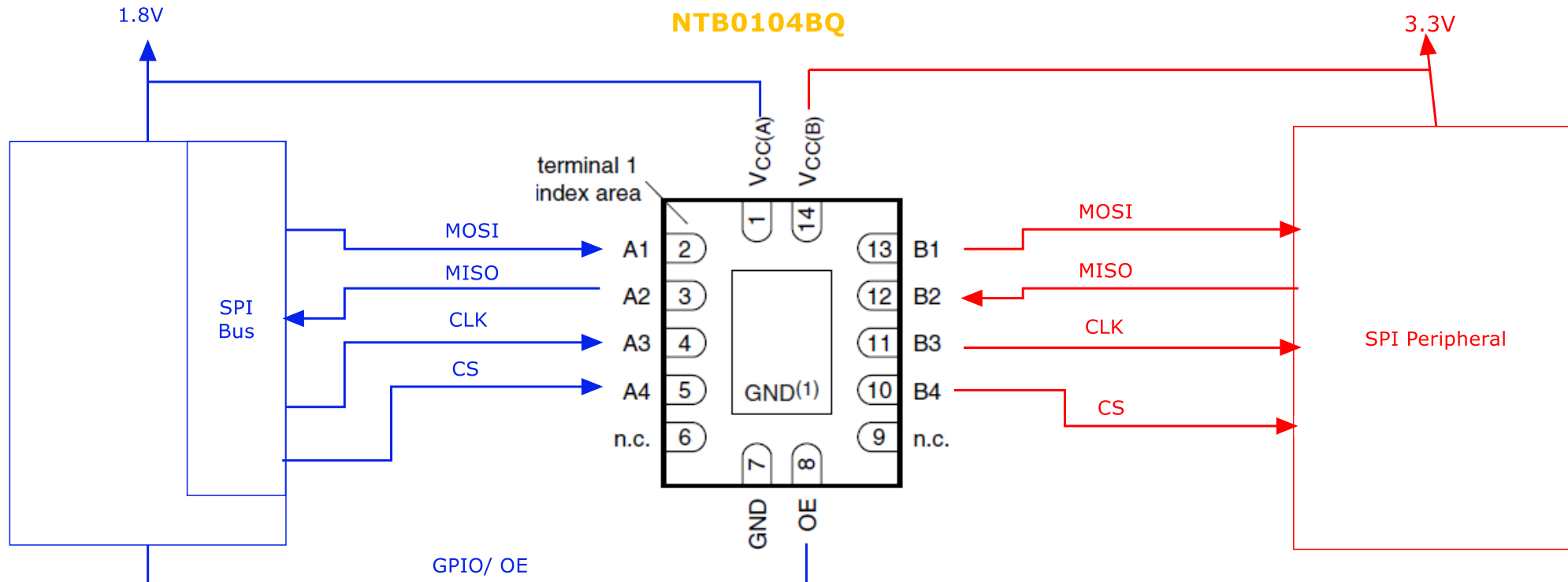
NTB0104 3 States





NTB0104

SPI-bus Application Example



* No external pull up resistors are required for SPI signal lines



Level Translators – NTS Family

Open Drain and Auto Direction Sensing

• Features

- Operating voltage range: 1.65 - 3.6V to 2.3 - 5.5V
- Low power consumption: 30 μ A max ICC
- Uni or bi-directional, auto-sensing
- 1-, 2- and 4-bit in multiple small packages
- Push pull and open drain drivers: UART, GPIO, I²C, SMBus, etc.
- No external components required
- Suspend mode; partial power down with IOFF
- Standby mode
- Operating temp range: -40 to 125°C

BITS	V RANGE	OUTPUT DRIVE	BW	DESCRIPTION	PACKAGE	PART#
1	1.65 – 3.6V to 2.3 – 5.5V	-20 μ A/1 mA	25 MHz	Open Drain	XSON6 (1 x 1 x 0.35mm), SC-88, TSOP6	NTS0101
2					TSSOP8, XSON8 (1 x 1.35 x 0.5mm), XQFN8, XQFN10	NTS0102
3					XQFN10 (1.4 x 1.8 x 0.5mm)	NTS0103
4	0.95 – 5.5V to 1.65 – 5.5V	-20 μ A/1 mA	20 MHz	Open Drain	WLCSP12 (1.2 x 1.6 x 0.56mm), TSSOP14, XQFN12	NTS0104
2	1.65 – 5.5V	-20 μ A/6 mA	25 MHz	Open Drain	XQFN8 (1.4 x 1.2 x 0.5mm), XSON8	NTSX2102



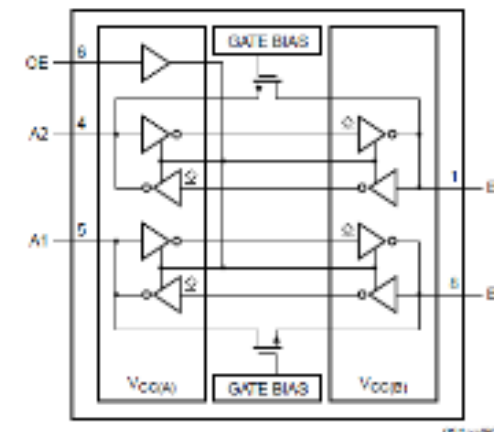
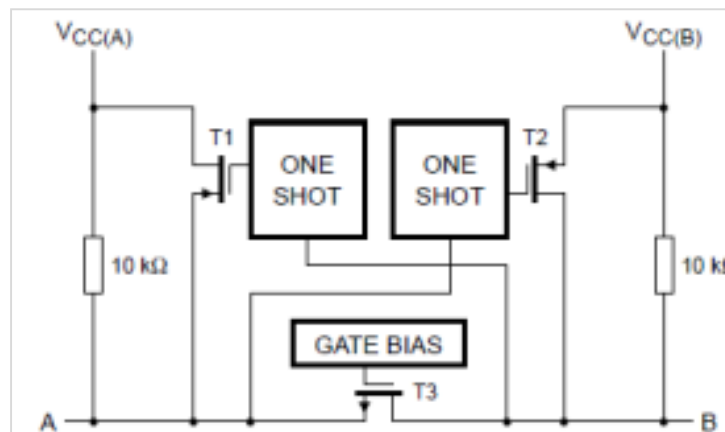
NTS0102 Level Translator

Auto-Direction Sensing, Open Drain

- 2-bit, dual supply, bi-directional
- Features
 - Auto direction sensing
 - Two 2-bit data I/O ports, 1 output enable, 2 supply pins
 - Translation: any voltage from 1.65 to 5.5V
 - Maximum data rates:
 - Push-pull: 50 Mbps
 - Supply voltage
 - VccA: 1.65 to 3.6V
 - VccB: 2.3 to 5.5V
 - Partial power-down mode
 - High impedance OFF-state
 - ESD
 - 2.5kV / 8 kV HBM (JESD22-A114)
 - 200V MM (JESD22-A115)
 - 1.5kV CDM (JESD22-C101)
- Replaces: NLSX4373, TXS0102

- No external components required
 - One shot used to short (remove) the pull-up resistor during rising edges
 - Edge acceleration eliminates external pull-up resistors, lowering total power dissipation in open-drain applications such as I²C and SMBus

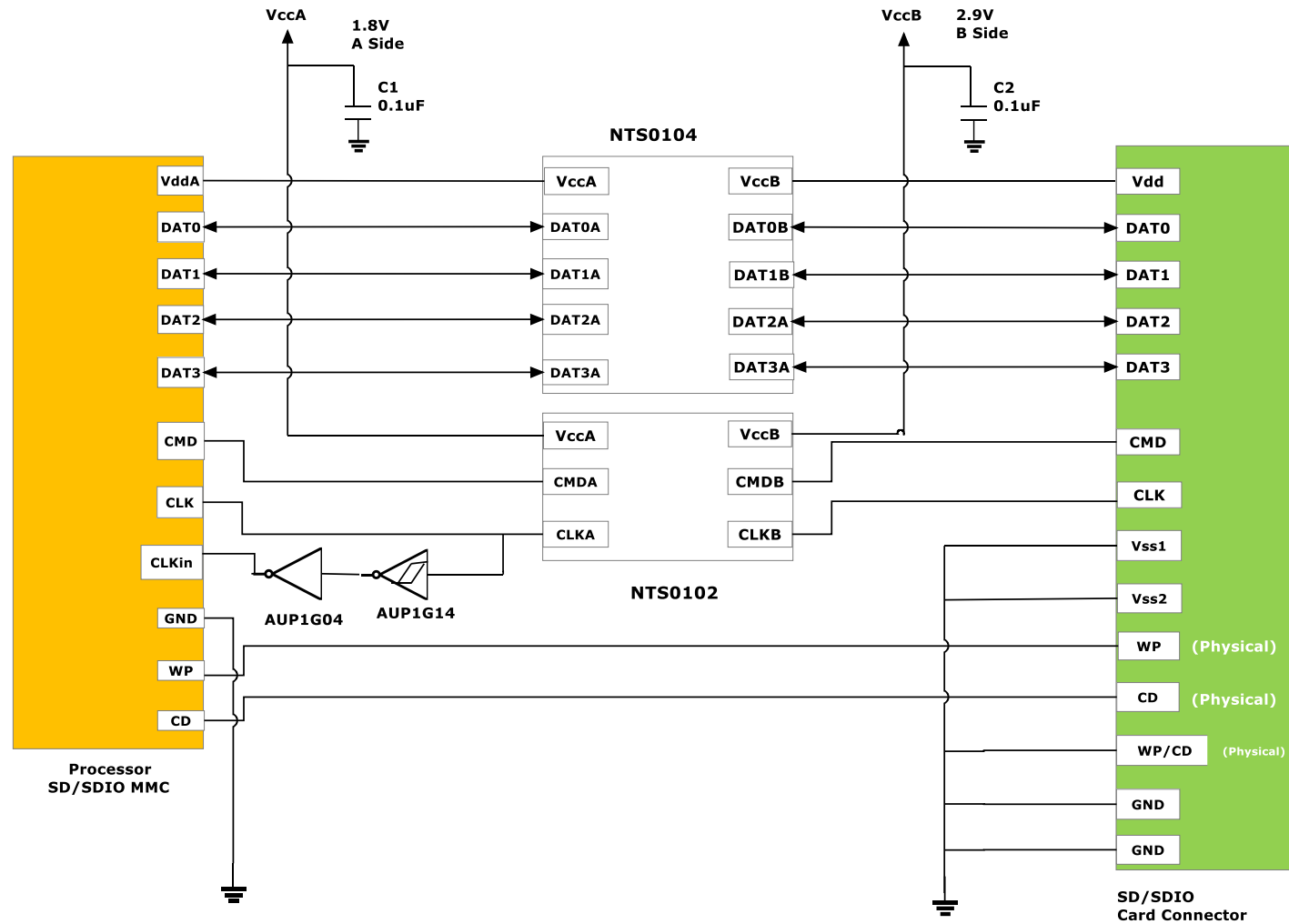
NTS0102 Open Drain





NTS0102/0104 Level Translators Application

SD Card Reference Design





NTS0104 Level Translator

Auto-Direction Sensing, Open Drain

• Features

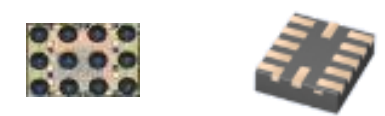
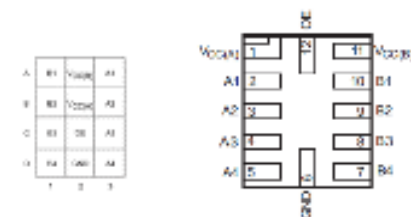
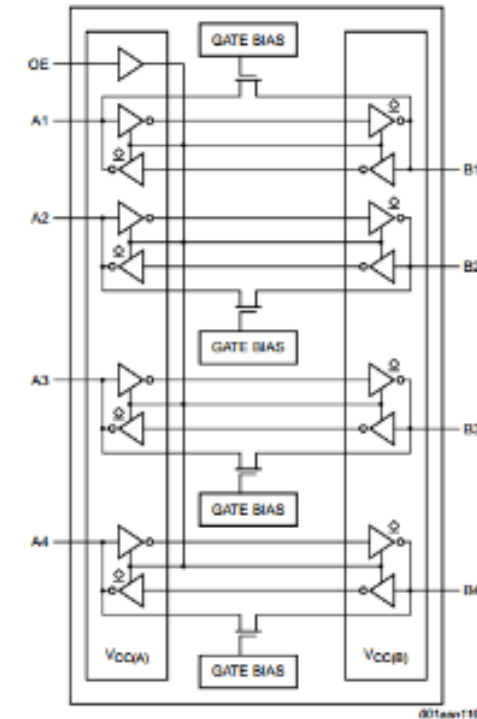
- 4-bit, dual-supply bidirectional translating transceiver
- Auto-direction sensing
- Two 4-bit data I/O ports, 1 output enable, 2 supply pins
- Translation: any voltage from 1.65 to 5.5V
- Supply voltage
 - VccA: 1.65 to 3.6V
 - VccB: 2.3 to 5.5V
- Partial power-down mode
- High impedance OFF-state
- ESD: 2.5 kV / 8 kV HBM

• Packages

- TSSOP14
- XQFN12: 1.7 x 2.0 x 0.5, 0.4 mm pitch
- DHVQFN14: 2.5 x 3.0 x 0.85, 0.4 mm pitch
- WCSP12: 1.2 x 1.6 x 0.56, 0.4 mm pitch

• Replaces: TXS0104

NTS0104 Open Drain



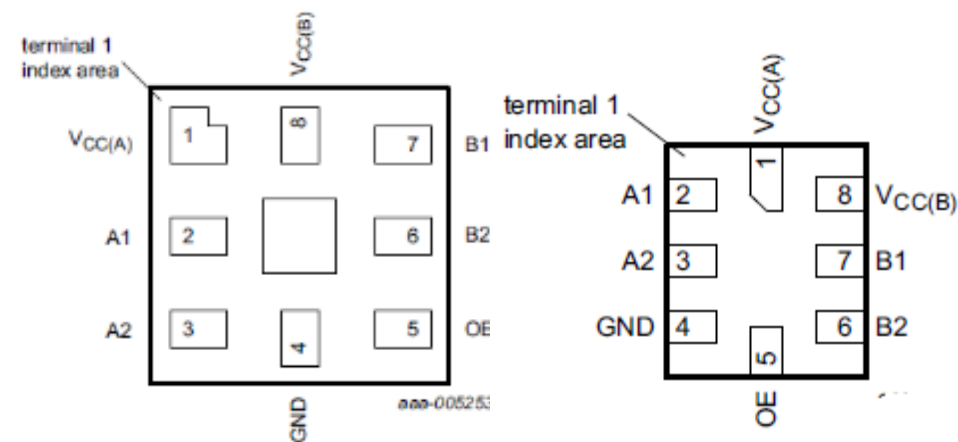
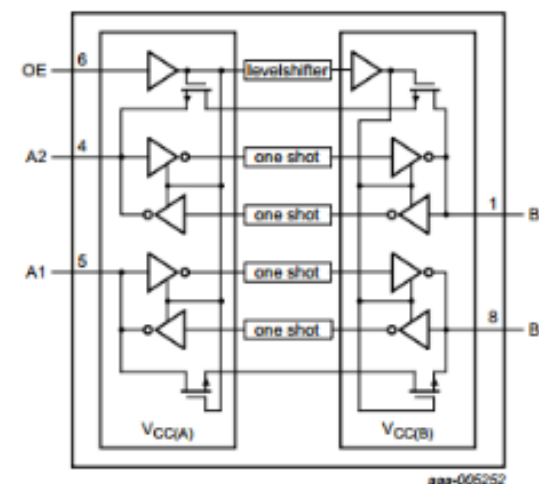
NTSX2102 Level Translator

Auto-Direction Sensing, Open Drain

- **Features**

- 2-bit, dual supply translating transceiver
- Auto-direction sensing
- Bidirectional voltage level translation
- Two 2-bit data I/O ports, one output enable, two supply pins
- Output edge-rate accelerator that detects and accelerates rising and falling edges on the I/O pins
- Translates between any low voltage nodes: 1.2V, 1.5V, 1.8V, 2.5V, 3.3V and 5.0V
- Operates at
 - $V_{CC(A)} = 1.65$ to 5.5V supply
 - $V_{CC(B)} = 1.65$ to 5.5V supply
- Inputs up to 5.5V
- Partial power-down mode
- High impedance OFF-state

NTSX2102 Open Drain



SOT902 (XQFN8)
1.6 x 1.6, 0.4 mm pitch

SOT1309 (XQFN8)
1.4 x 1.2, 0.4 mm pitch



NTS & NTB Voltage Level Translators Crosses

NTS family = TI's TXS family

- Suitable for push-pull and open drain applications: I²C, UART, GPIO, SMBus, etc.
- Bi-directional w/ auto-direction sensing
- No external components required

NTB family = TI's TXB family

- Suitable for tri-state and push-pull applications
- Bi-directional w/ auto-direction sensing
- **Not** recommended for open-drain applications (e.g. I²C and 1-wire) (use NTS family instead)

	TI	NXP
1-bit	TXS0101DCK	NTS0101GW
	TXS0101DBV, TXS0101DRL, TXS0101YZP	
2-bit	TXS0102DCT	NTS0102DP
	TXS0102DCU, TXS0102DQE, TXS0102DQM, TXS0102YZP	
		NTS0102GT, NTS0102GD, NTS0102GF
3-bit	No 3-bit version	NTS0103GU10
4-bit	TXS0104EPW	NTS0104PW
	TXS0104ED, TXS0104ERGY, TXS0104EYZT	
		NTS0104GU12, NTS0104BQ, NTS0104UK
8-bit	TXS0108xxxxx	No 8-bit version

	TI	NXP
1-bit	TXB0101DCK	NTB0101GW
	TXB0101DBV, TXB0101DRL, TXB0101YZP	
2-bit		NTB0101GM, NTB0101GS1
	TXB0102DCU, TXB0102YZP	
		NTB0102DP, NTB0102GF, NTB0102GT
4-bit	TXB0104D, TXB0104PWR, TXB0104RGY, TXB0104YZT, TXB0104RUT, TXB0104ZXU	
		NTB0104GU12, NTB0104BQ, NTB0104UK
8-bit	TXB0108xxxxx	No 8-bit version

Both TI and NXP have **automotive versions** of some of the above devices





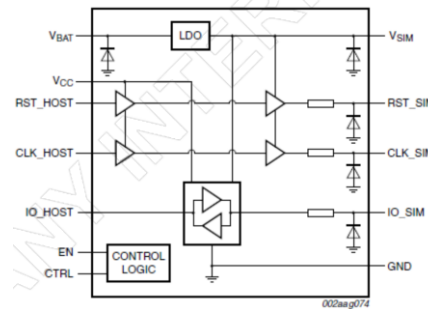
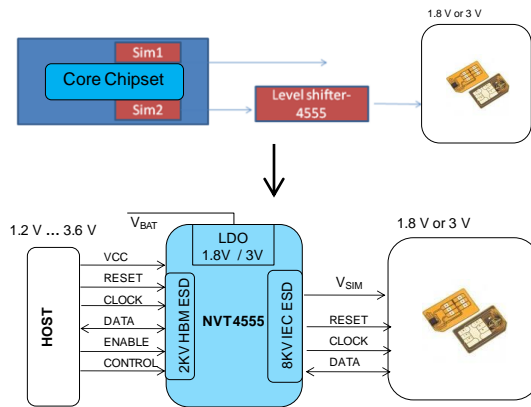
NVT4555: SIM Card Level Shifter With LDO

Features:

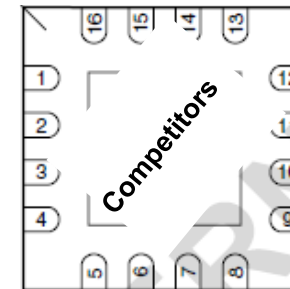
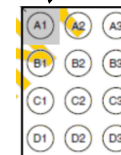
- SIM card level shift between 1.2V ...3.6V and 1.8V or 3V
- Built-in **automatic direction control** without pass gate transistor
- Integrate ESD protection to IEC61000-4-2 8 kV contact
- ISO/IEC 7816 compliant voltage translator (CLASS B - C)
- Integrate 1.8 V or 3 V selectable 50 mA LDO
- V_{BAT} supply ranges from 2.5 V to 5.25 V
- Low power (< 20uA) with built-in internal pull-up resistors for Data I/O, in addition to capacitance isolation
- Integrate biasing pull-up resistors
- Industry's smallest solution footprint size, 12-pin WLCSP

Benefits

- Support wide range of interface voltages
- Simplify design & host control
- Protect Host with low BOM cost
- Plug & play with all SIM Card standard
- Plug & play with 1.8 V or 3 V SIM Cards
- Support a wide range of battery voltages
- Low power consumption & Low BOM cost
- **Ultra small** 12-pin WLCSP



1.16 x 1.56 mm² x 0.50 mm_{max.}, 0.4 mm pitch





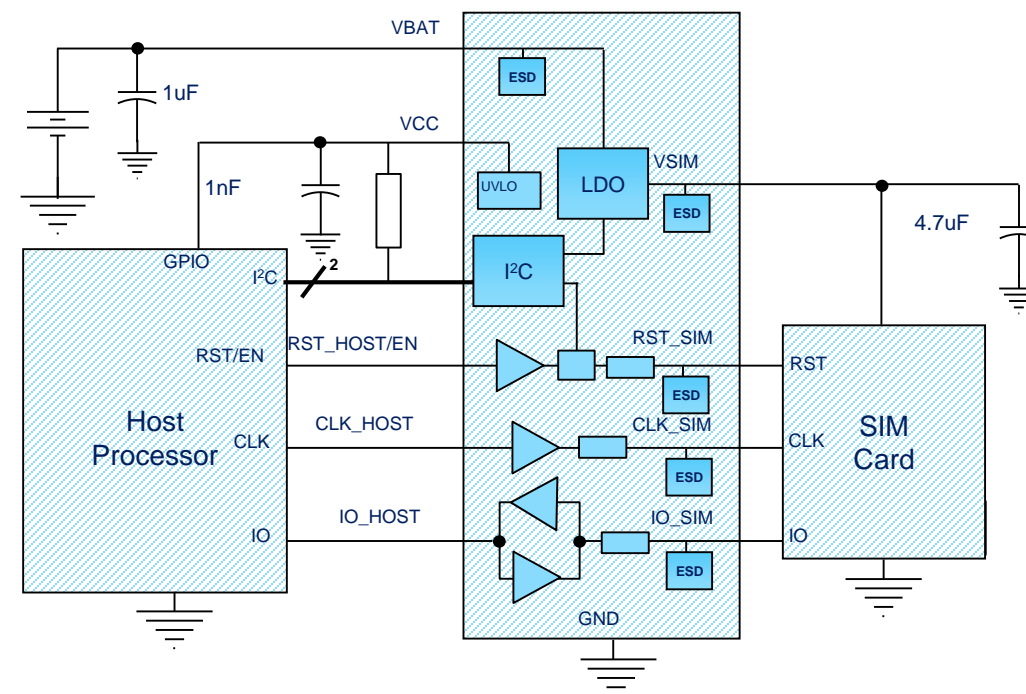
NVT4556: I²C-Controlled SIM Card Level Shifter

Includes LDO and IEC61000-4-2 ESD Protection

Features:

- Vbat from 2.5V to 5.25V; V_{CC} range from 1.55V to 3.6V
- **I²C controls:** Enable, LDO voltage, RST_HOST/EN selection
- Multiple devices can be added to form a MUX providing Dual/Triple SIM card support (three different I²C slave addresses)
- **Supports Clock stop** by Host latching inputs
- Low host supply power consumption 200uA: Source-able through GPIO (1.8V Host)
- Host supply pin (V_{CC}) doubles as a logic level input pin to enable and disable the device : UVLO set to 1.2V
- **Automatic direction control** on the data line **without pass-gate** transistor (**capacitive isolation** and superior low level adjustment)
- clock speed support > 5 MHz
- Internal pull-up/down resistors for Data I/O, and RST
- **IEC 61000-4-2 contact 8kV; (15kV with proper layout) & EMI filtering**
- Industry's **smallest solution** footprint size, **12-pin WLCSP**, ~1.2x1.6 mm², 0.4 mm pitch

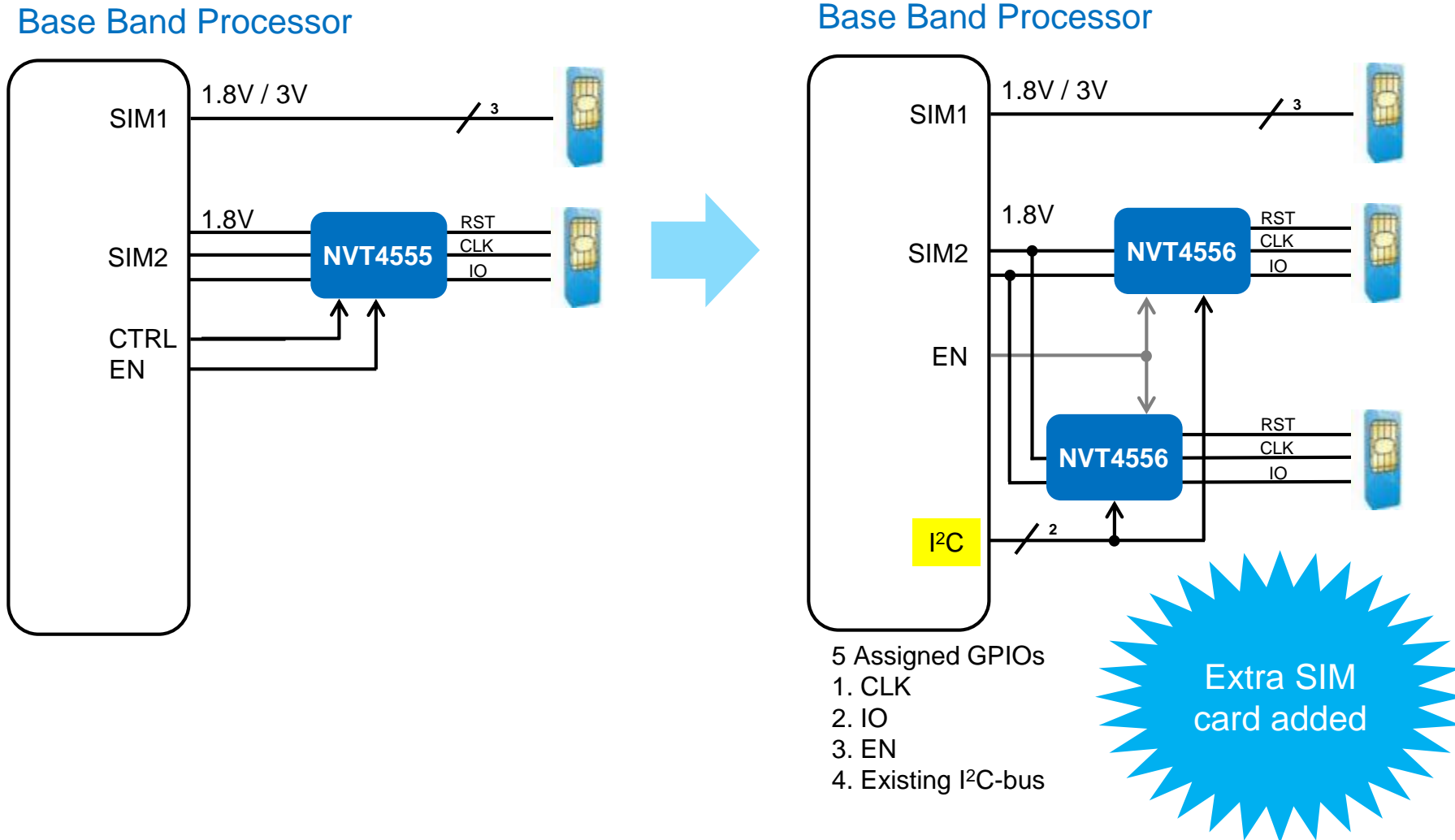
Block Diagram:





NVT4556's I²C Advantage

Dual Multiplexer for GPIO Constrained Systems



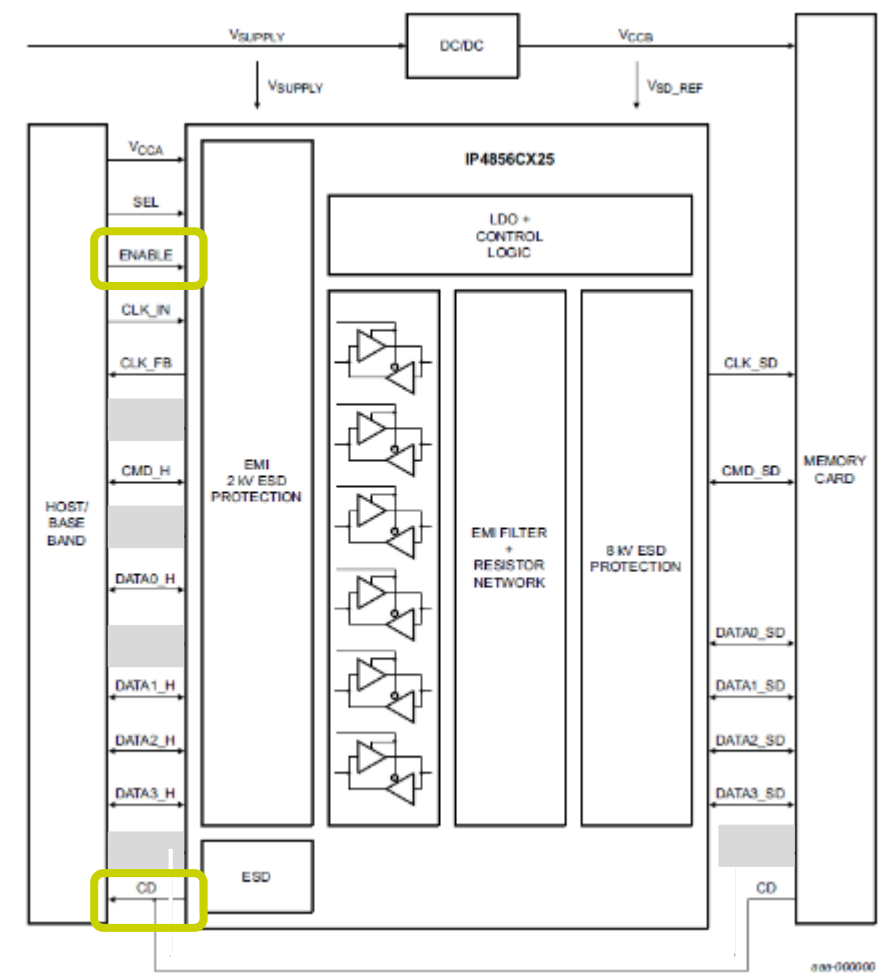


NVT4857: SDR104 compliant Auto Direction Control

SD3.0 Auto Direction Control

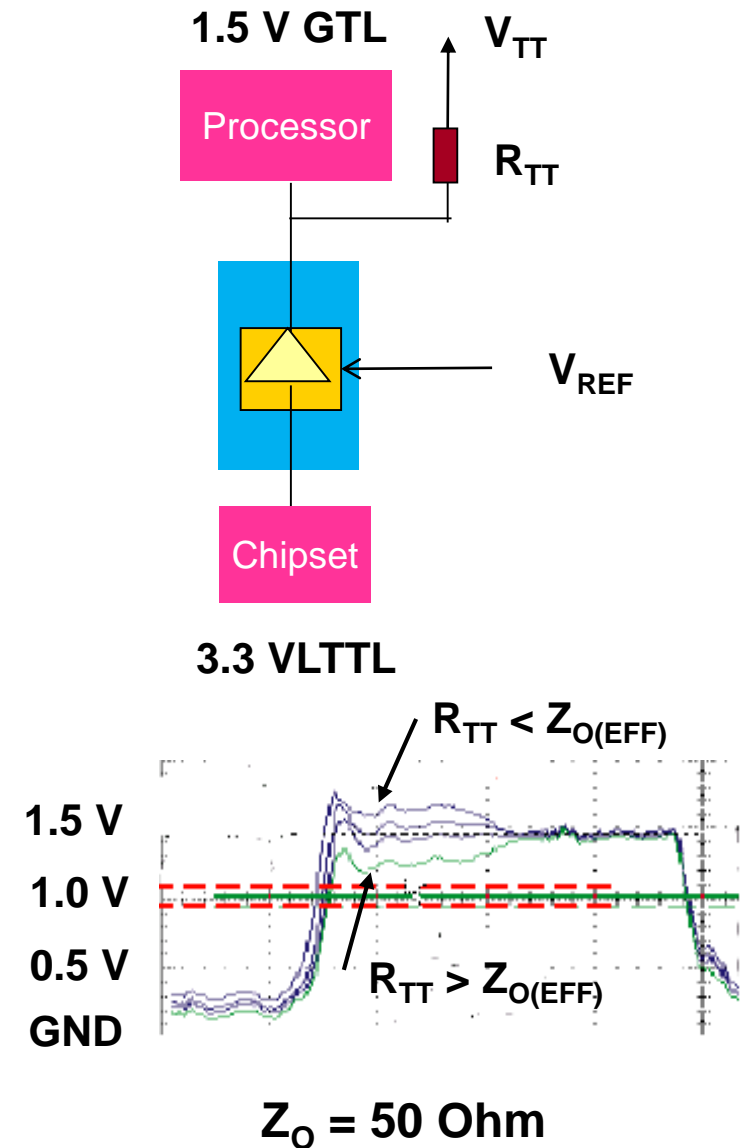
Specification outline:

- External supply with > **2.8 V** to **3.6 V**
- **SD card Interfaces voltage 2.9 V** or **1.8 V** generated by **internal LDO**
- 1.2 V and 1.8 V host side support
- No capacitive through pass from card side to host side
- Clock speed up to **208MHz** in SDR104 mode
- **IEC61000-4-2** ESD-protection > 8 kV contact
- Biasing resistors included
- **~ 1.6 x 2 mm²** chip scale package with 4x5 grid 0.4mm pitch



GTL Value Proposition

- Where used?
 - Signal voltage conversion between low voltage processor and LVTTL device
- Why **G**unning **I**nsceiver **L**ogic (**GTL**)?
 - Largest selection of GTL devices available
 - Provide level transition between GTL I/O and LVTTL I/O
 - Low voltage open drain interface with externally supplied V_{REF} threshold voltage with $\pm 0.05V$ VIL & VIH range and R_{TT} sized to match trace impedance to minimize reflections.
- Why Dedicated GTL Processor to Chipset Interface?
 - Work with Intel on new device functionality that is required with their processors
 - Integrated control logic using GTL and LVTTL input line levels
 - Enable pin to disable signals
 - Saves board space and component count

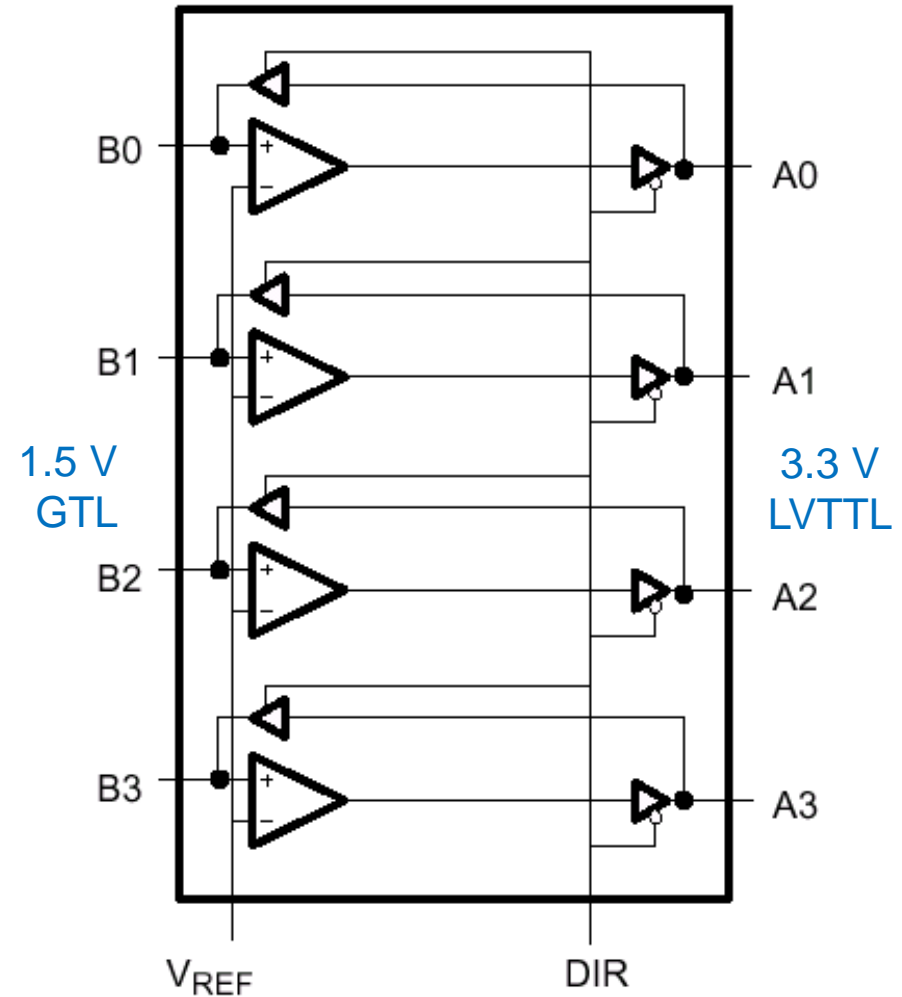




GTL2005

4 bit GTL to LVTTTL Bus Transceiver

- **Application**
 - Intel Server Architecture
- **Features**
 - 4-bit LVTTTL to GTL translation
 - 3.3V VCC with 5 V tolerance
 - ± 12 mA A-Port
 - Medium Drive (40 mA) B-Port
 - Supports Hot Insertion
 - 175 MHz Operation
 - 14 pin TSSOP package
- **Similar Devices**
 - 2-bit GTL2012
 - 4-bit GTL2014 - Alt source GTL2005
 - 8-bit GTL2018
 - 4-bit GTL2034 - GTL to GTL buffer





GTL Active Translation Device Status

Device	Function
GTL2005	4-bit GTL to LVTTL
GTL2006	13-bit Xeon translator
GTL2007	12-bit Xeon translator with power good
GTL2008	12-bit Xeon translator with power good & Hi Z outputs
GTL2012	2-bit GTL to LVTTL
GTL2014	4-bit GTL to LVTTL
GTL2018	8-bit GTL to LVTTL
GTL2034	4-bit GTL to GTL
GTL2107	12-bit Xeon translator with power good & Hi Z outputs





GTL Active Translation Device Status

CH	V RANGE	OUTPUT DRIVE	DESCRIPTION	VREF	PACKAGE	PART#
2	3.0V - 3.6 V operation. TTL input 5V tolerant	16 mA on TTL 40mA on GTL	Bi-directional LVTTTL to GTL-/ GTL / GTL+ transceivers with direction pin and VREF	0.5V to VCC/2	TSSOP8, VSSOP8	GTL2012
4				0.5V to VCC/2	TSSOP14	GTL2014
8				0.5V to VCC/2	TSSOP24	GTL2018
N/A	3.0 to 3.6V operation	16 mA I _{OL} on TTL 15 mA I _{OL} on GTL	Specialty server level translator with custom logic	0.5V to VCC/2	TSSOP28	GTL2107
4	3.0 to 3.6V operation	40 mA I _{OL}	4 bit GTL-/GTL /GTL+ to GTL-/ GTL/GTL+ bus buffer	0.5V to VCC/2	TSSOP14	GTL2034

- Bi-directional LVTTTL to GTL transceivers
- With direction pin and VREF (GTL2012, GTL2014, GTL2018)
- LVTTTL to GTL level translation

Note:

FET based level translators without DIR pin GTL2000, GTL2002, GTL2003, GTL2010 are also available, but NVT family is recommended for new designs



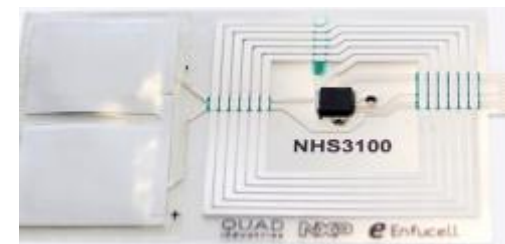
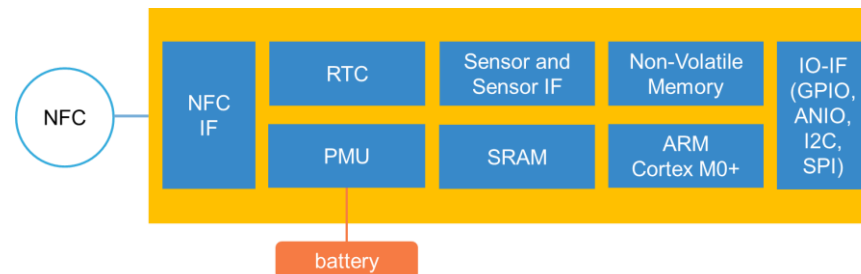
NTAG SMART SENSOR





NTAG Smart Sensor (Temperature Logger)

- Single-chip solution for creating a semi-passive sensing NFC Solution (tags)
 - Periodic sensing
 - Battery powered
 - Passive communication over NFC
- Flexible and autonomous – Open ARM Cortex M0+
- PMU – Powered via battery or passive over NFC
- External power supply voltage range from 1.72V to 3.6V
- SDK based on LPCXpresso IDE
- Calibrated accurate temperature sensor; Accuracy of $\pm 0.3\text{ }^{\circ}\text{C}$ between $0\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$; Accuracy of $\pm 0.5\text{ }^{\circ}\text{C}$ from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$
- Clock Generation:
 - 8MHz internal RC oscillator trimmed to 2% accuracy
 - 32.678kHz timer oscillator linked to RTC timer unit
- ISO14443 Type A NFC/RFID Interface
- NFC Interface for configuration and data readout
- Large non-volatile memory to log more than 14,000 points
 - 32kByte on-chip Flash programming memory
 - 4kByte on-chip EEPROM
 - 8kByte SRAM



- Passive communication over NFC Extendable via I/O interfaces (GPIO, I²C, SPI, ANIO, SWD)
- Option to add visual indicator, sensor or radio
- Easy to apply; just add a battery and an NFC Antenna

	Sensors					Packages		
	digital IO	Temp	ADC	DAC	Current	HVQFN24	WLCSP25	BumpedDie
NHS3100	✓	✓				✓	✓	✓
NHS3152	✓	✓	✓	✓	✓	✓	✓	





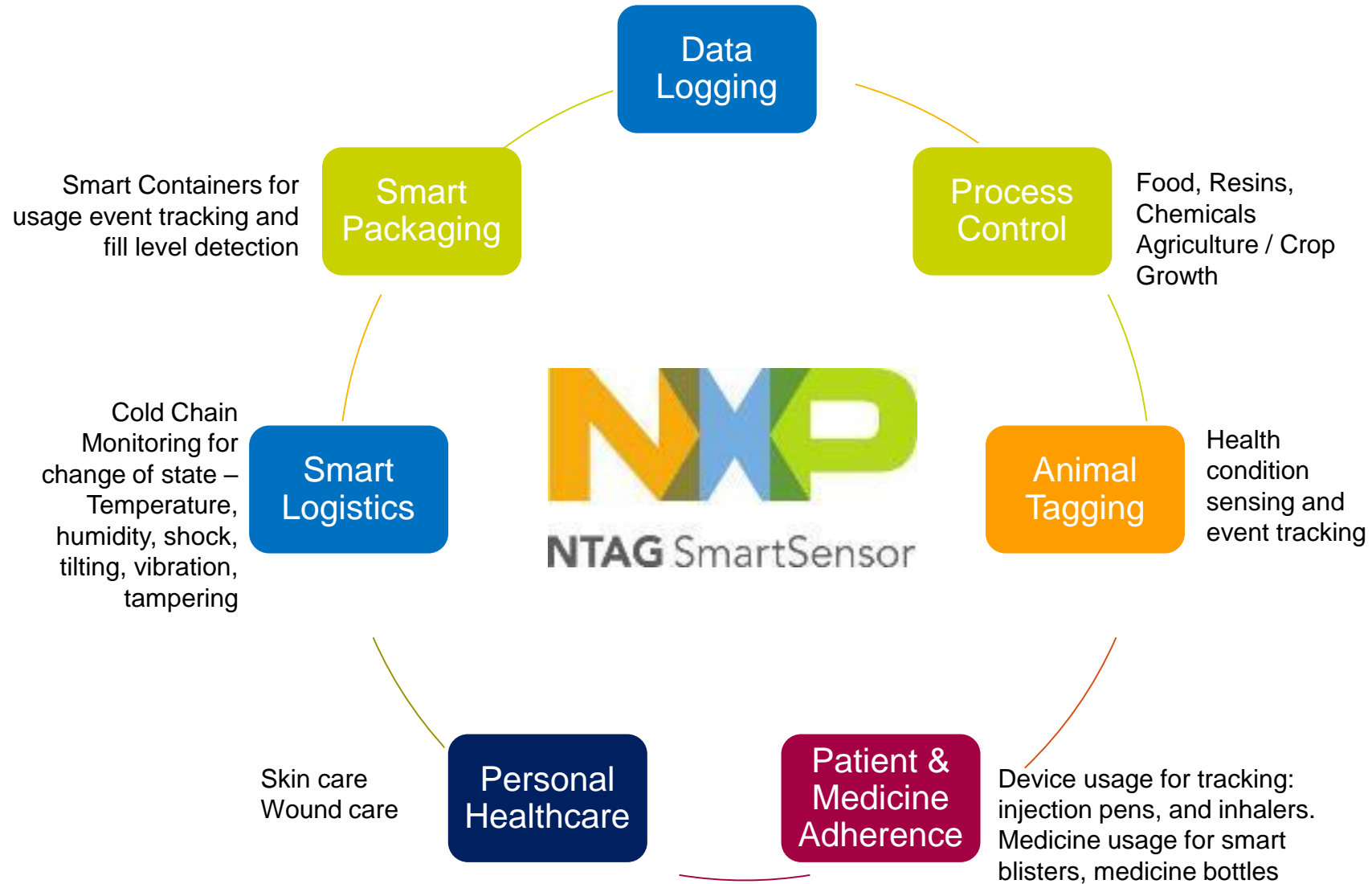
NTAG Smart Sensor – Competitive Overview

	AMS	AMS	Delta	Melexis	TI	NXP
	SL13A	AS39513	Thor	MLX90129	RF430FRL15xH	NHS31XX
General						
Single chip	yes	yes	yes	yes	dual die	yes
Flexibility	fsm	fsm	Open MSP430	fsm	MSP430	M0+
NFC Forum compatible	type 5	type 5	type 2 / type 5	type 5	type 5	type-2
NFC ISO standard	ISO15693	ISO15693	ISO14443 / ISO15693	ISO15693	ISO15693	ISO14443
EEPROM/Flash	1 kB	9kBit	32kB	0.44 kB	2 kB FRAM	32 + 4 kB
Alarms	?	?	Multiple	?	?	Multiple
Maximum logging points	756	841	11000			>18000
Battery	single/two cell	single/two cell	two cell	two cell	single cell	two cell
Vmin	1,2	1,2	2,7	2,7	1,45	1,72
Vmax	3,3	3,6	5,5	5,5	1,65	3,6
Compatible printed battery	yes	yes	no	no	no	yes
Activation via NFC	yes	yes	yes	yes	yes	yes
Temp accuracy	0,5	1	0.5	2,5	external/ internal poor	0,3
User calibration needed	yes	?	yes	?	?	no
User calibration possible	yes	yes	yes	?	?	yes
Time accuracy (ppm)	3%	3%	crystal	150000	20000	0,2%
Current consumption (uA)						
not activated	0,1	0,5	0,1	0,5	0,02	0,01
deep power down	3	2	1	1,5	12	2,5
active	100	150	?	700	330	280

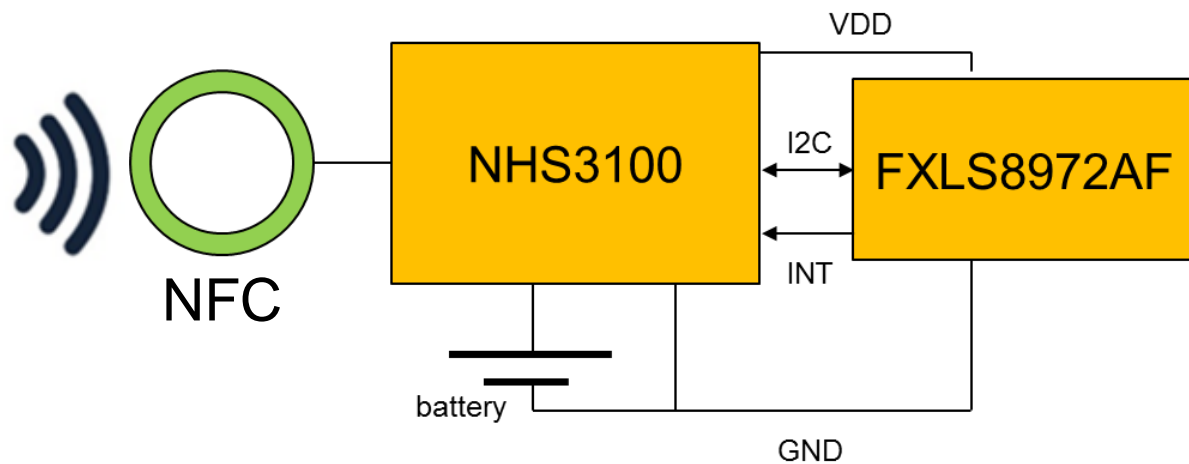
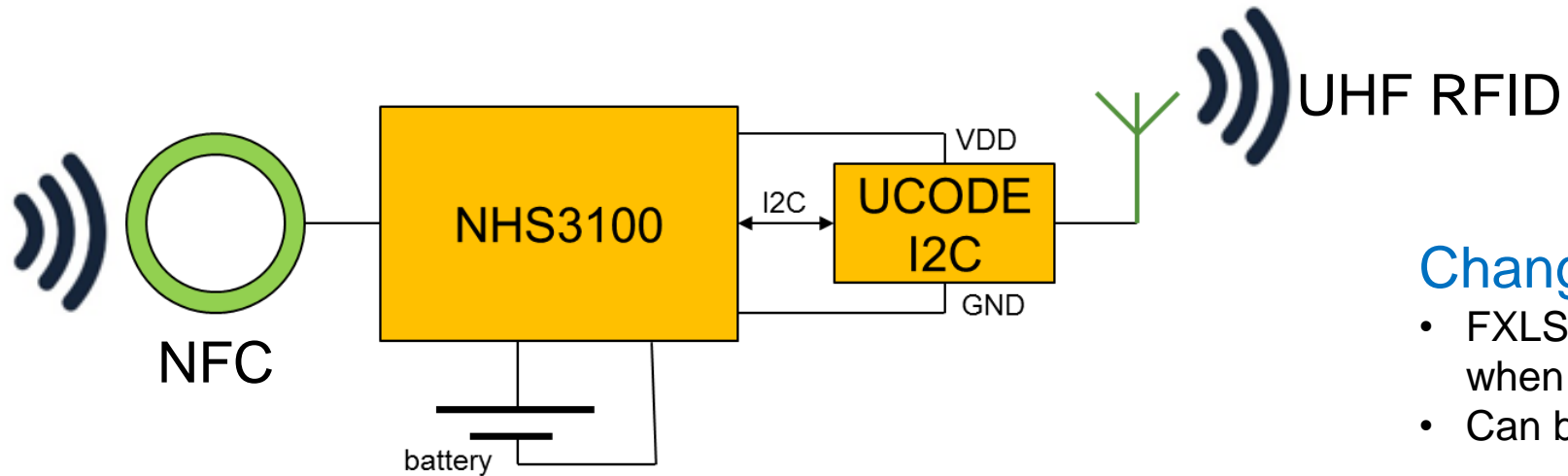




NTAG Smart Sensor – Application Domains



NTAG Smart Sensor – Solution Concepts

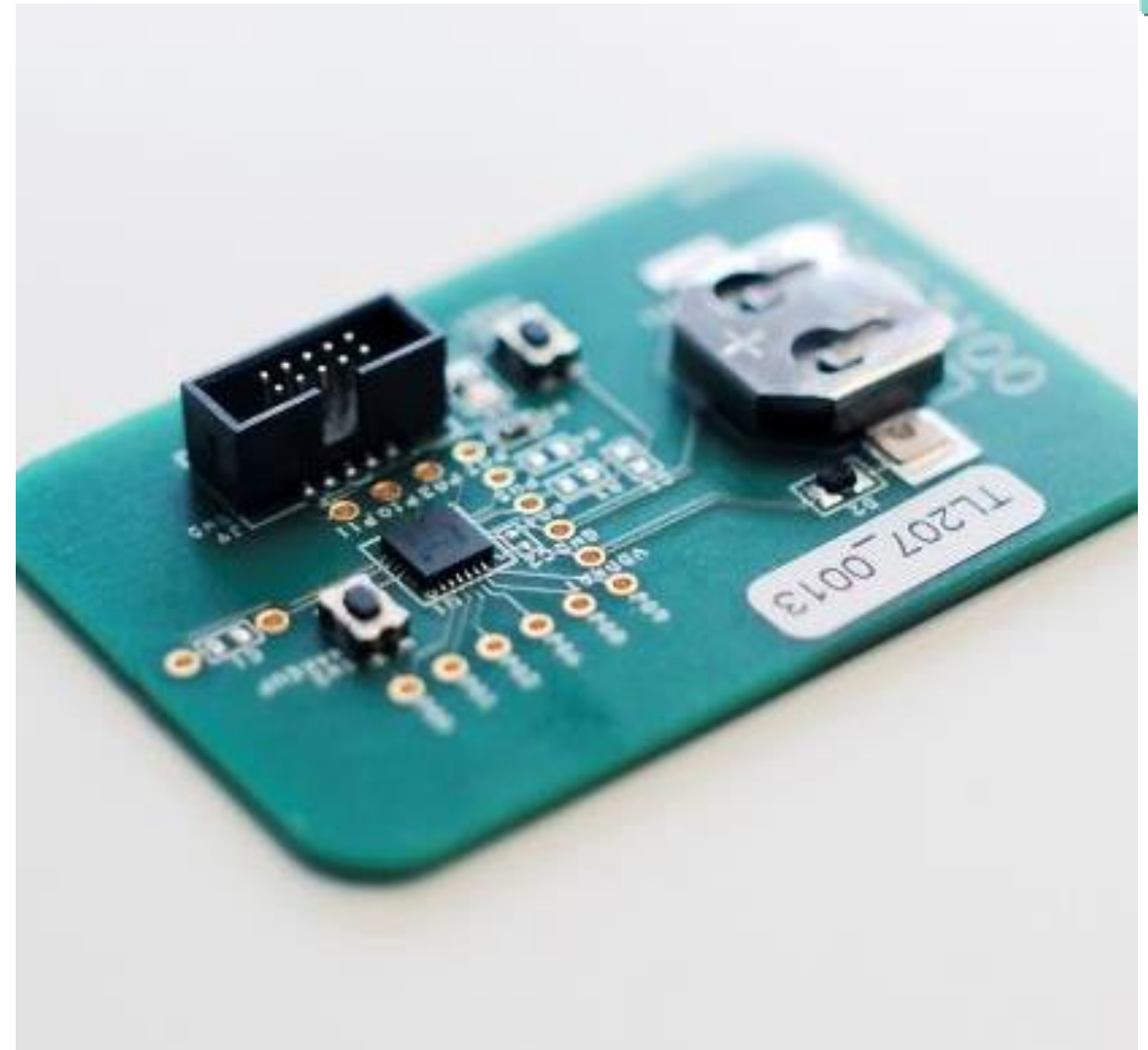


Change-of-State Monitoring

- FXLS8972AF Is set up by the NHS3100 when temperature monitoring is started
- Can be configured to signal exceptional
 - Shocks
 - Vibrations
 - Tilting
- Parametrized sensitivity
- Other important parameters for goods:
 - Atmospheric pressure
 - Humidity
 - Light
 - Tampering

NHS3100 Demo Board

- Ready to use demonstrator
- Includes:
 - NHS3100 HVQFN24 IC
 - A 3V coin cell battery
 - An LED, Wake-Up and Reset button
 - Probe/connection points towards GPIO, I²C, SPI pins
- Available:
 - 12NC: 9353 086 25598
(NHS3100TEMODB)





NFMI





Hearable Use Cases



Headphone

- Audio playback
- Calling
- Augmented Hearing

Mp3 Player

- Store and playback locally embedded music
- Go swimming, cycling, running, ... without your cellphone!

Fitness Monitor

- Heart rate
- Breathing rate
- Step counter
- Activity monitor
- Measure directly in the ear
- No need for additional wearable device

Universal Translator

- Real-time translation between any 2 languages
- Enjoy a natural conversation with locals while traveling

Personal Sound Amplifier

- Reduce background noise
- Control sound exposure level
- Enhance natural conversation in loud places (e.g. restaurant)

Stand-Alone Operation

- Embedded LTE modem
- Reduces dependence on smart phone
- "Spotify-in-the-ear"
- GPS in the ear

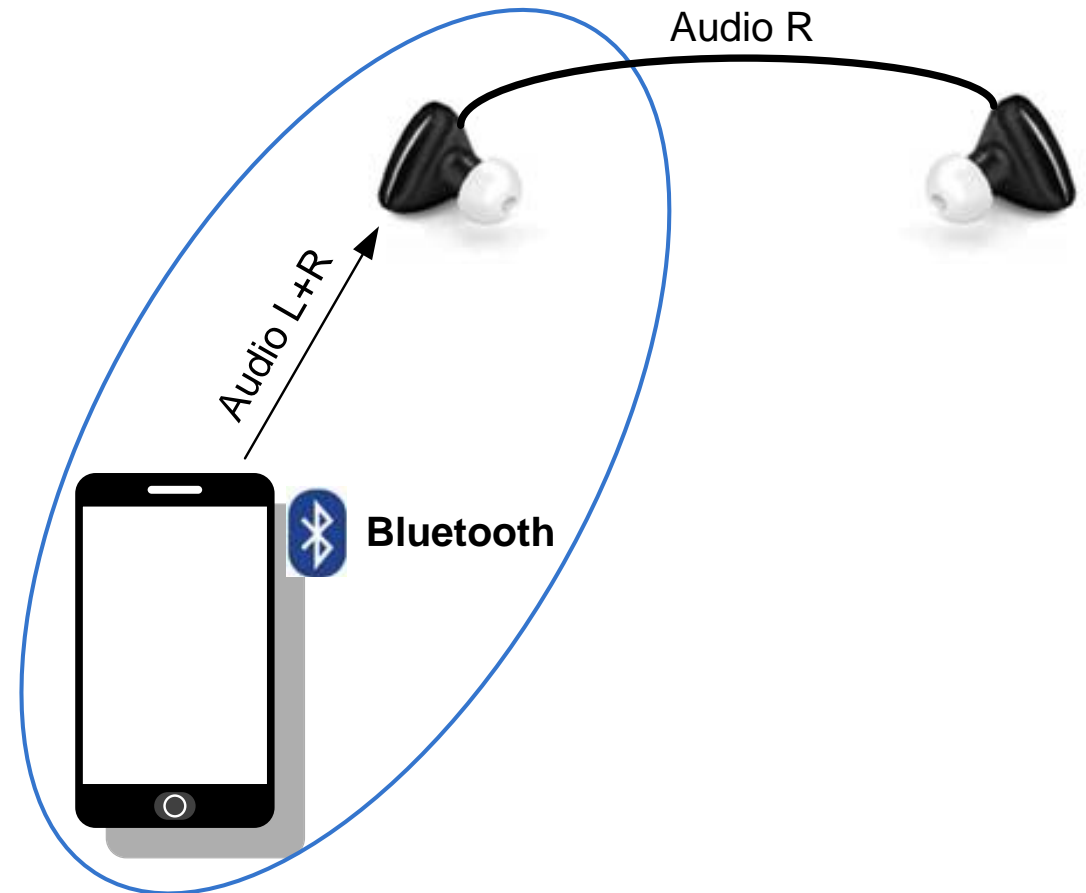
Customer Value





Existing RF Solution is Almost Good Enough

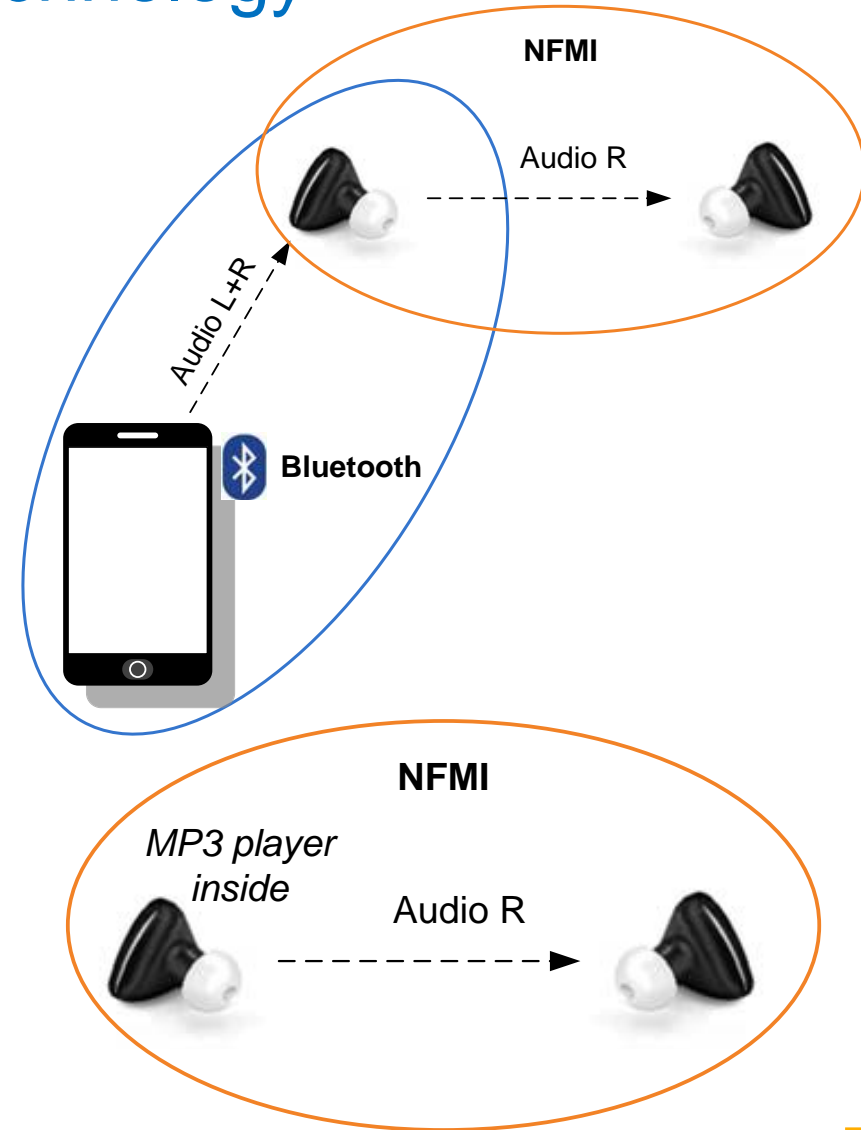
- **Existing** earbuds on the market still have a **wired connection** between earbuds.
- Sending a stereo audio stream to two distinct earbuds is not possible using standard **Bluetooth A2DP profile**: it is a **point-to-point solution**.
- **Forwarding** a quality audio stream from **ear to ear** is notoriously **difficult** using existing **2.4 GHz RF** solutions. Most of the signal is **absorbed** by human body tissue.





NXP Near Field Magnetic Induction Technology Enabling True Wireless Earbuds

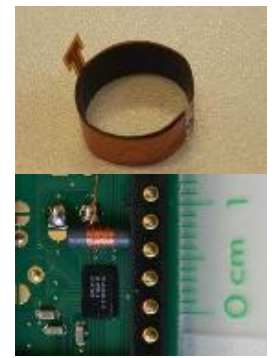
- **NFMI** is the **best** technology to be used for a **wireless** audio and data connection **between earbuds**.
- Works **reliable** close to the **human body**.
- **Lowest power** consumption to stream audio and data over small distances. (<1m)



NXP Hearables Product Offerings

Main drivers:

- Increasing audio quality to the level of existing Bluetooth A2DP headsets
- Standard package offering for CE products
- Area and cost of integration



Key delta features / benefits

Parameter	NxH2280 Released Q3-16	NxH2281 Released Q1-17	NxH2261 Released Q2-17	NxH2265 Released Q2-18
Increased audio quality				
• Codec	G.722	SBC+G.722	SBC+G.722	SBC+G.722
• Audio bandwidth	16 kHz	21 kHz	21 kHz	21 kHz
• THD+N	-40 dB	-67 dB	-67 dB	-67 dB
• SNR	-81 dB	-93 dB	-93 dB	-93 dB
• Power [mW] *unidirectional streaming	2.5 mW	3.6 mW*	3.6 mW*	3.6mW*
Net data throughput [kbps]	220	220	220	350
Free CortexM0 programming memory	10 kB	15 kB	15 kB	5kB
Non-volatile memory [kbit]	512	512	512	0
Package				
• Pin compatible with NxH2280	Yes	Yes	No	No
• Bump diameter [um]	130	130	250	250
• UBM [um]	100	100	240	240
• Back side coating	No	No	Yes	Yes
• Underfill required	Yes	Yes	No	No
• Size [mm ²]	10.4	10.4	10.4	7.5

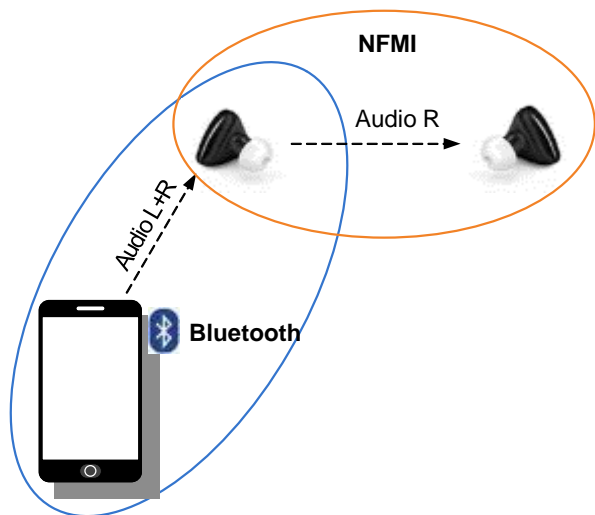
Remarks:

- * audio streaming using G.722, fs=48 kHz still supported



NXP Hearables Roadmap

Gen 1: Standard BT Classic + NFMI



2015-2018

NxH2280/NxH2281

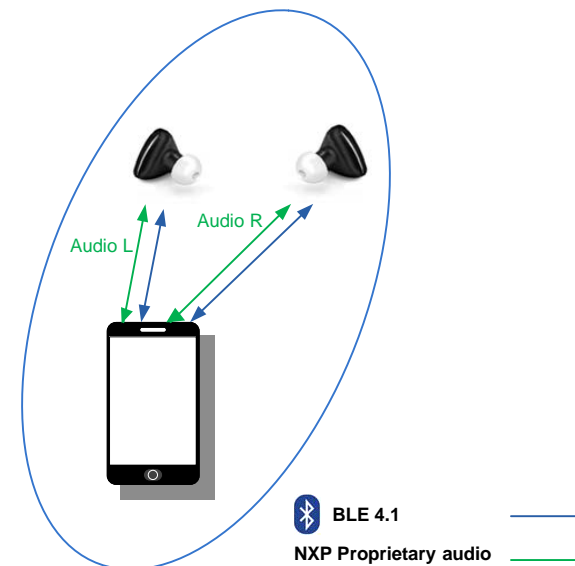
NxH2261/NxH2265

NFMI Audio Transceiver

Perfect Sound

5-Hour Play Time

Gen 2: BLE 4.1 + proprietary NXP audio streaming



2019

NxH3670

2.4GHz Audio Transceiver

LifeVibes voice & audio SW

Disruptive Battery Life

20-Hour Play Time





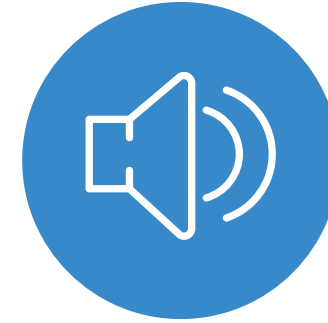
Hearables – What Matters for Consumers



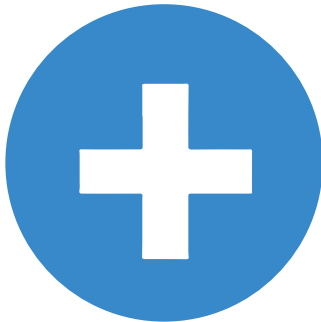
Battery Life



User Comfort



Sound Quality



Health



Retail Price



Features

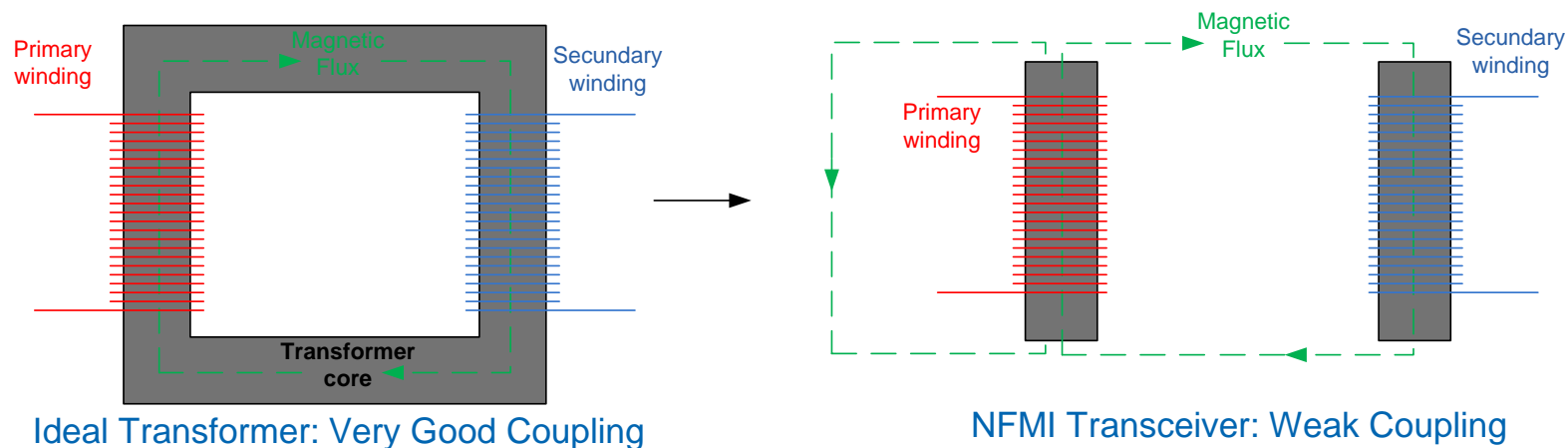
What is NFMI and What are the Differences with RF?

RF

- Antenna transmits propagated electromagnetic wave
- All transmitted energy designed to radiate into free space
- This is called “far-field” transmission

Near Field Magnetic Induction (NFMI)

- Coupling a low power, non-propagating field between devices
- This is called near-field communication
- Can be modelled by weakly coupled transformer
- AC current in primary induces AC voltage in secondary winding





NFMI Antenna and Range

NFMI performance dependencies

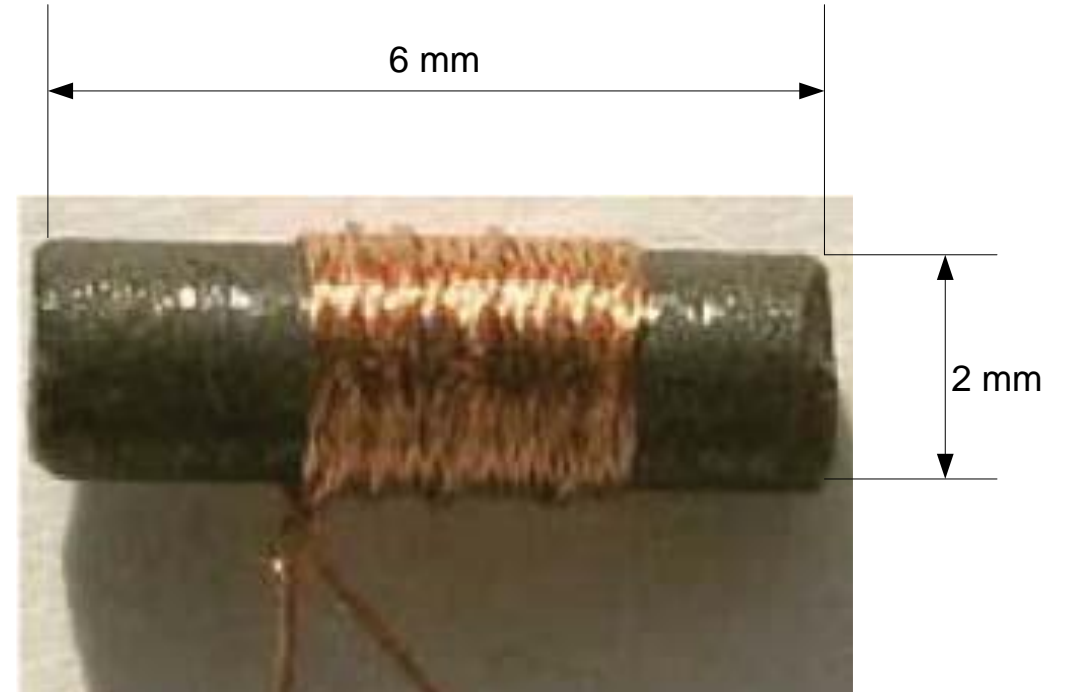
- Material properties: ferrite core
- Form factor TX and RX antenna
- Transmit power: configurable on-chip
- Integration: noise of the PCB

Typical antenna size for earbuds

- See picture: $D=2\text{mm}$, $L=6\text{mm}$
- Making antenna bigger: increased communication range
- Communication range: 20 ... 25 cm

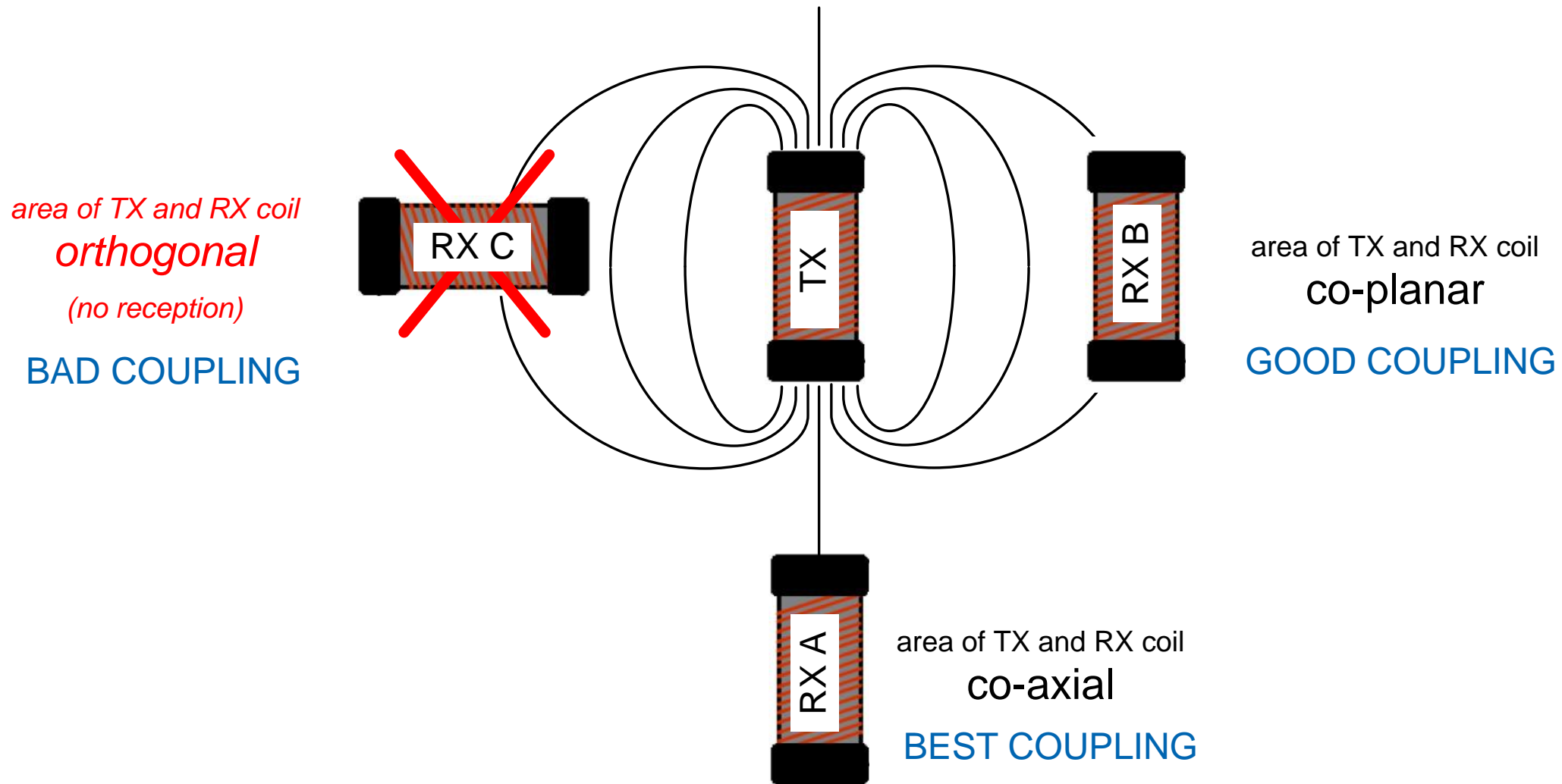
Antenna design

- Most of the time it is custom
- Few standard types available: see www.sonion.com
- No Surface Mount Devices available





Influence of Antenna Alignment





NFMI Radio versus NFC

NFC	NFMI Radio
Proximity (< 10 cm)	Arm Length (up to 1 m)
Passive Tag and Active Reader	Active transceiver (TX & RX)
Point to Point communication	Enables Networks up to 15 devices
NFC reader is not low power	Low Power transmitter
Short data packets	Data packets & audio Streaming
Standard using ISM band	Proprietary solution
Frequency = 13.56MHz	Frequency = 10.6MHz





Key Benefits of NFMI Technology

1

POWER EFFICIENT

NFMI is more power efficient than RF on short distance. Distance is depending on antenna size. Typical distance for headsets: 20 ... 25 cm.

2

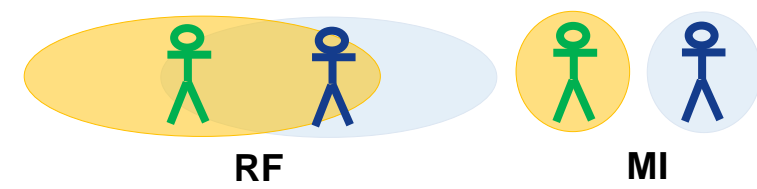
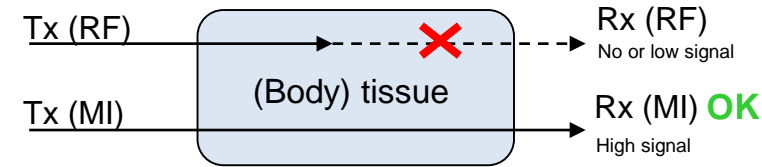
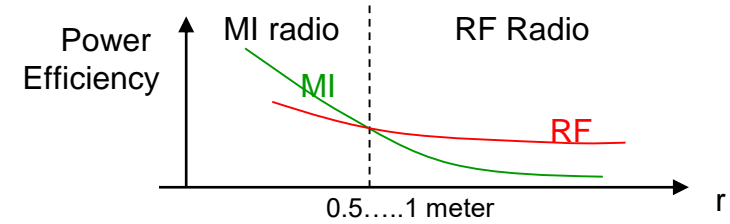
HUMAN BODY FRIENDLY

NFMI goes through (body) tissue with low degradation of signal strength, whereas RF doesn't. The Specific Absorption Rate is 10000 times less than for Bluetooth. This technology is already being used for more than a decade in medical devices such as hearing aids.

3

RELIABLE AND PRIVATE

Steep degradation of MI signal strength as function of distance **reduces interference** level, therefore increases robustness. It also increases privacy. It also allows to reuse the carrier frequency for multiple headsets in a same room.





Key Benefits of NFMI Technology

No Wires, Great Workout!

- During **sports and fitness** activities, an audio solution should be **hassle-free** and **safe**.
- A **truly wireless earbud** solution enables enjoying listening to your favourite music while doing your **workout**.
- When combined with continuous monitoring of **vital signs**, you can get feedback on your performance to **optimize** your workout.





NFMI Applications

Ear-to-Ear
Communication



Hearing Aids

IoT

NFMI enables a secure and reliable **Wireless Personal Area Network** that represents the link from the person to IoT.



Wireless
Earbuds

Automotive

NFMI can create a wireless bubble inside the car to connect 'you' with the car in a reliable way!

NFMI

Critical Audio
Communication

Access
Control

Critical communication without the security and reliability problems associated with RF technologies. For use in hazardous and/or high noise environments or under water.



NFMI creates a wireless bubble around you! Easy pairing by proximity.



In/On Body
Sensors

Sensors in
Metal Box

Sensors on the body (wireless body area network)
Pill cams in the body.

Only small opening is required

Smart fridge (communicate with sensors inside the fridge)



Food/drug monitoring (sensors inside the containers)

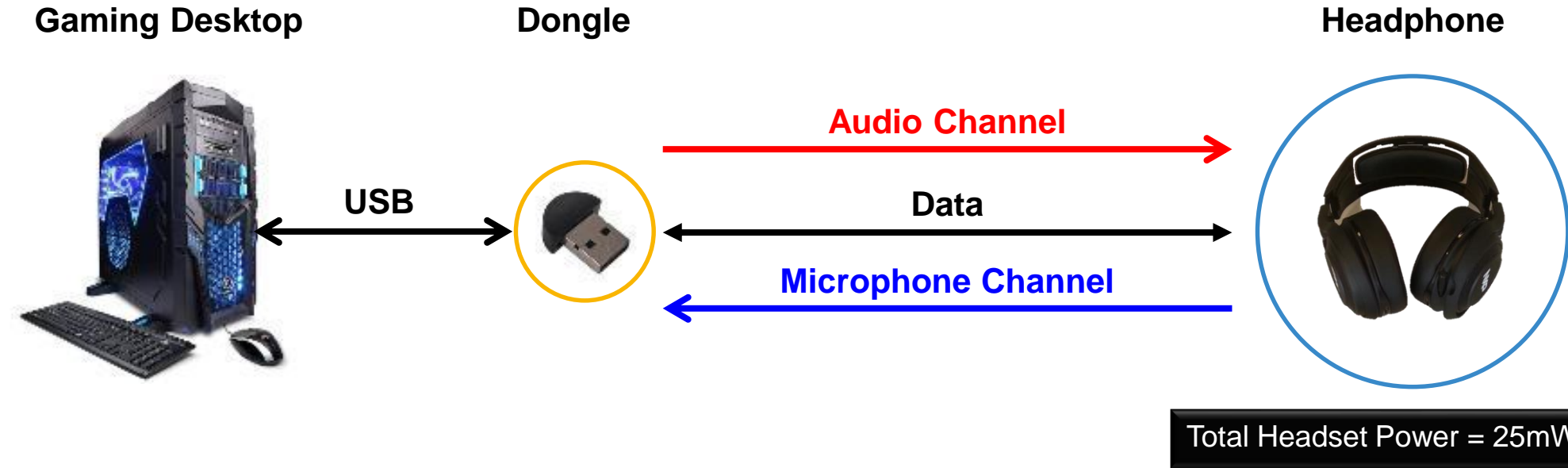




AUDIO OVER BLE



NxH3670 Wireless Headset Use Case



Forward Audio Channel

- Stereo audio
- SBC HQ audio codec
- 48kHz, 16 bit
- Latency < 20ms

Data Channel

- HCI interface
- ~4kbps

Microphone Channel

- Mono audio
- G.722 audio codec
- 16kHz, 16 bit



NxH3670 Value Proposition

Applications	Wireless gaming / communication headsets: small form factor communication and consumer gaming headsets with long battery life
Power efficient	Lowest active energy consumption in the market Average power consumption of <8.5mW for 48kHz audio
Highly integrated	Low external component count enabling miniaturized devices
HiFi Audio	Optimized architecture with DSP and hardware support for robust, high quality audio streaming at <20ms latency
Flexible	Bluetooth Low Energy 4.2 certified. Proprietary low latency audio streaming support





NxH3670 Overview

Fully integrated 2.4GHz RF Transceiver

- PHY + MAC + Higher network layers
- Supports BLE 1 & 2Mbps mode
- TX output power of -10dBm to +4dBm
- RX sensitivity of
 - -94 dBm in BLE 1Mbps mode
 - -90 dBm in BLE 2Mbps mode
- Supports 16MHz and 32MHz XTAL

Multi-standard Link Layer

- Bluetooth Low Energy 4.2 certified
- Proprietary isochronous audio streaming protocol

Industry-lowest Power RF Transceiver

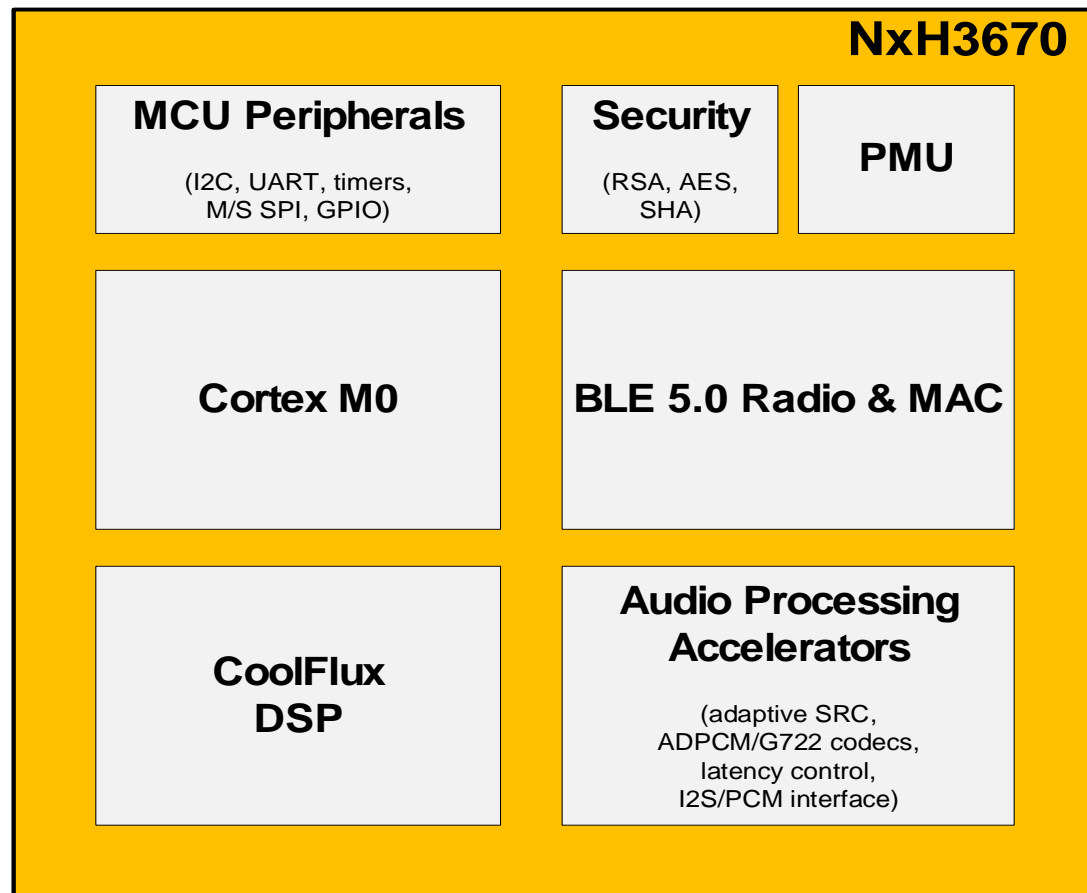
- Continuous RX 4mA @ 1.2V
- Continuous TX (0dBm) 8mA @ 1.2V

Cortex M0 MCU

- Runs BLE higher layers and audio profiles
- Peripherals: Master/slave SPI, I²C master, UART, SWD

Flexible Audio Path

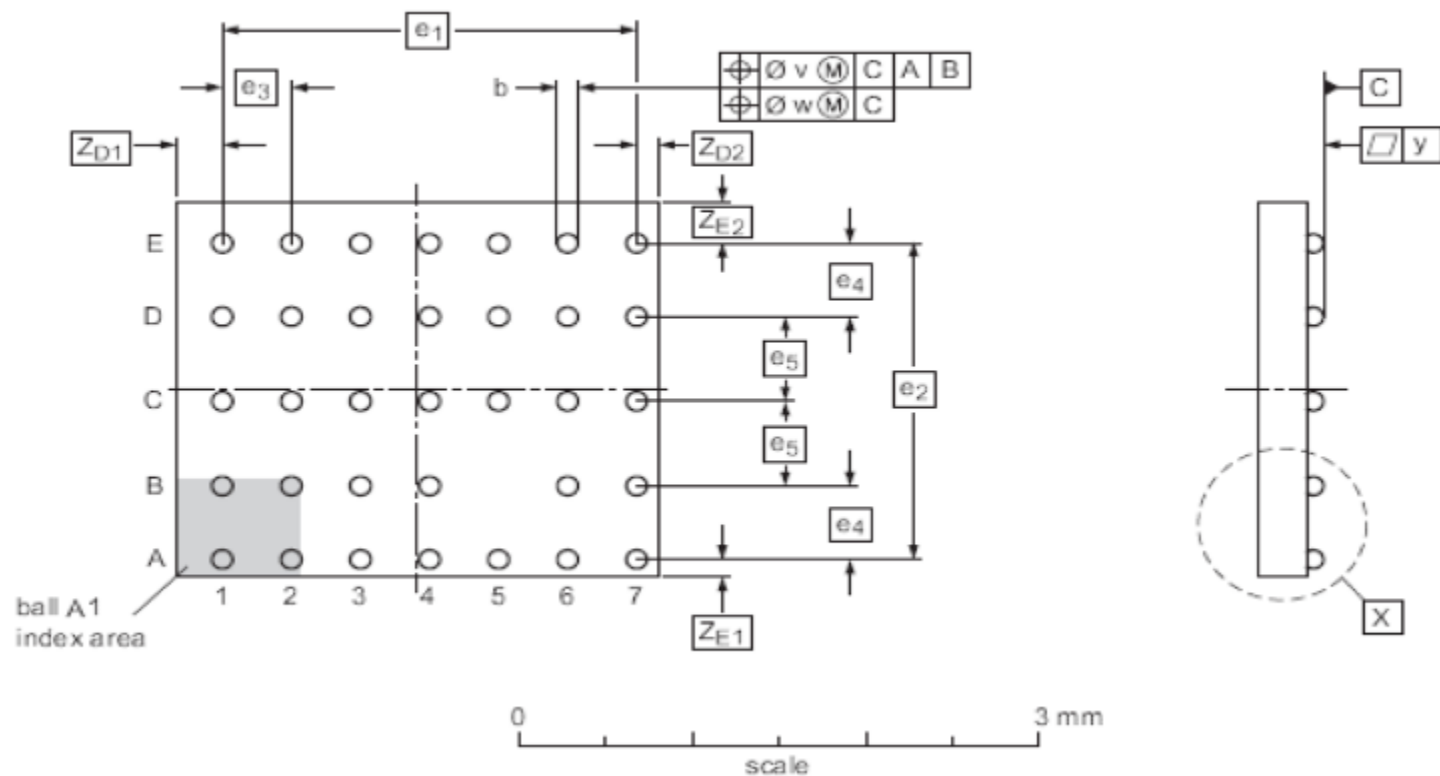
- Optimized HW-accelerated audio datapath
- CoolFlux DSP
- G722/SBC audio compression codec
- I2S or PCM interface to Host and codecs





NxH3670 Package

- Limited external components
- Configurable IO voltage up to 2.6V
- Bump pitch of 400 um with ball diameter 130um
- 34 bump package: 7 by 5 bump grid
- WLCSP ~ 7.25 mm²





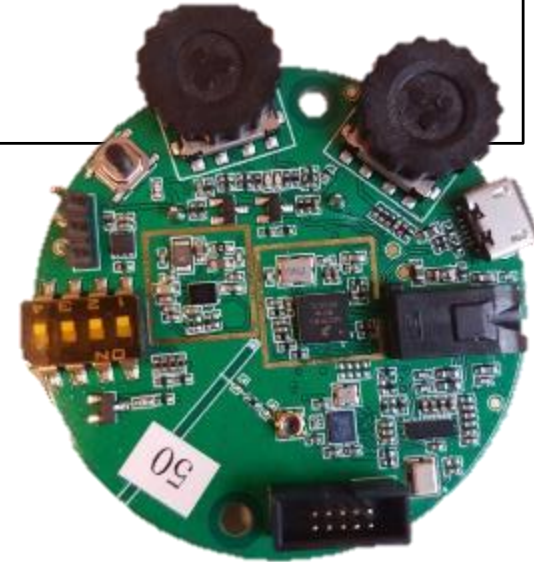
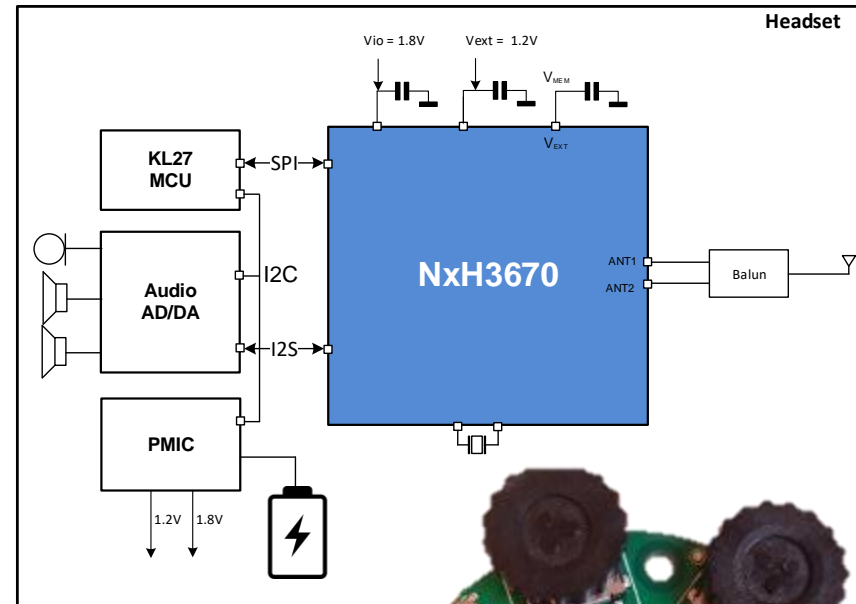
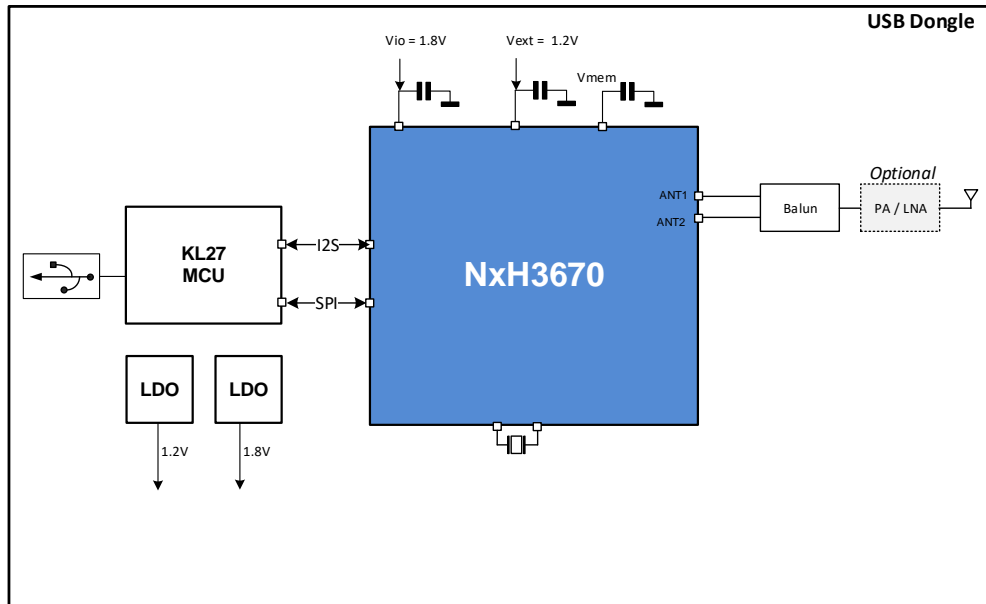
NxH3670 SDK Board

- NxH3670 development board
 - Flexible board intended for SW and system development, debug and bring-up
 - Contains
 - NxH3670
 - Black box with simple HAPI
 - KL27 Microcontroller
 - SW source code available
 - MCUXpresso programming suite
 - Audio codec
 - Power management
 - Battery
 - Full signal observability
- Available in SampleStore





NxH3670 Reference Design – Gaming Headset





NxH3670 ADK Reference Design

- NxH3670 application development board
 - Contains both dongle as well as headset reference design
 - Form factor reference showing real-life performance of the complete NxH3670 gaming solution
- Dongle
 - NxH3670
 - KL27 MCU
 - Integrated PCB antenna
- Headset
 - NxH3670
 - KL27 MCU
 - Dialog codec
 - Integrated omni-directional PCB antenna
- Programmer's model
 - NxH3670 – Black box with simple HAPI
 - KL27 MCU – MCUXpresso with full SW source code
- Available in SampleStore





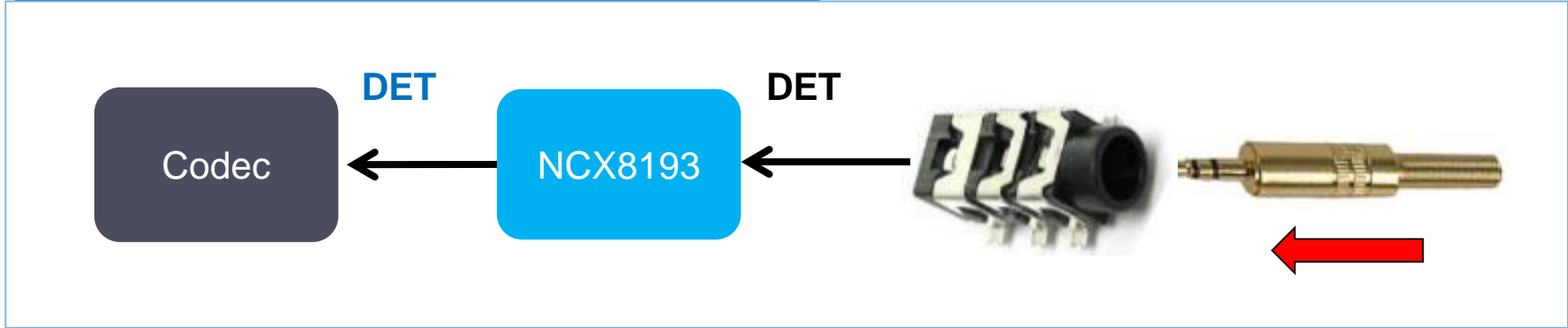
AUDIO SWITCHES



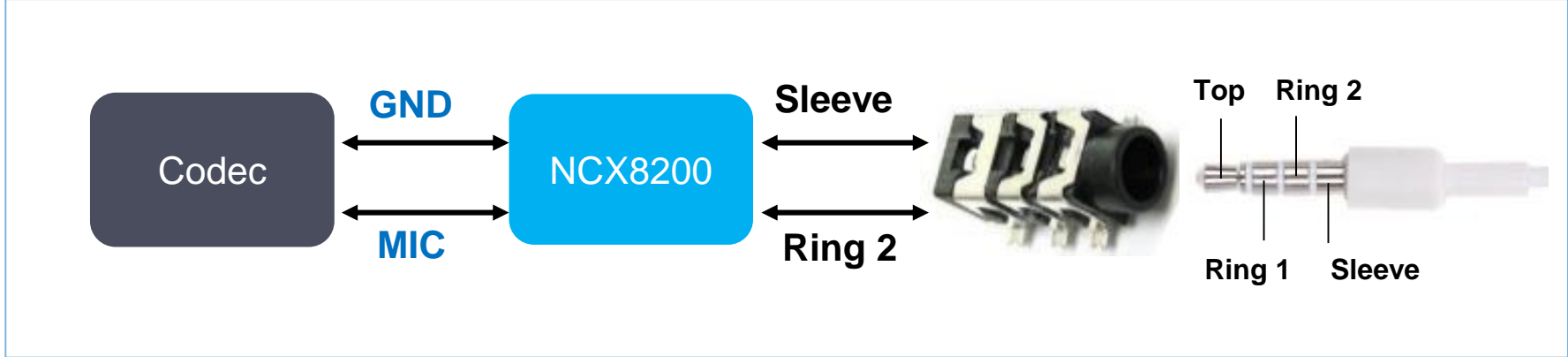


Application for Audio Jack Switches

Insertion Detection – NCX8193



GND/MIC Switching – NCX8200





Benefits of Audio Jack Switches

Reliable Insert Detection





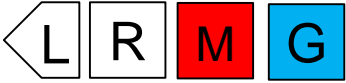
Moisture false detection Prevention

Multi Standard Support

Supports 3 pole, 4 pole AHJ & OMTP headphone

Simply Design
Better Performance

Low Crosstalk by Low Ron & common voltage feedback
No insertion noise with built in MIC switch

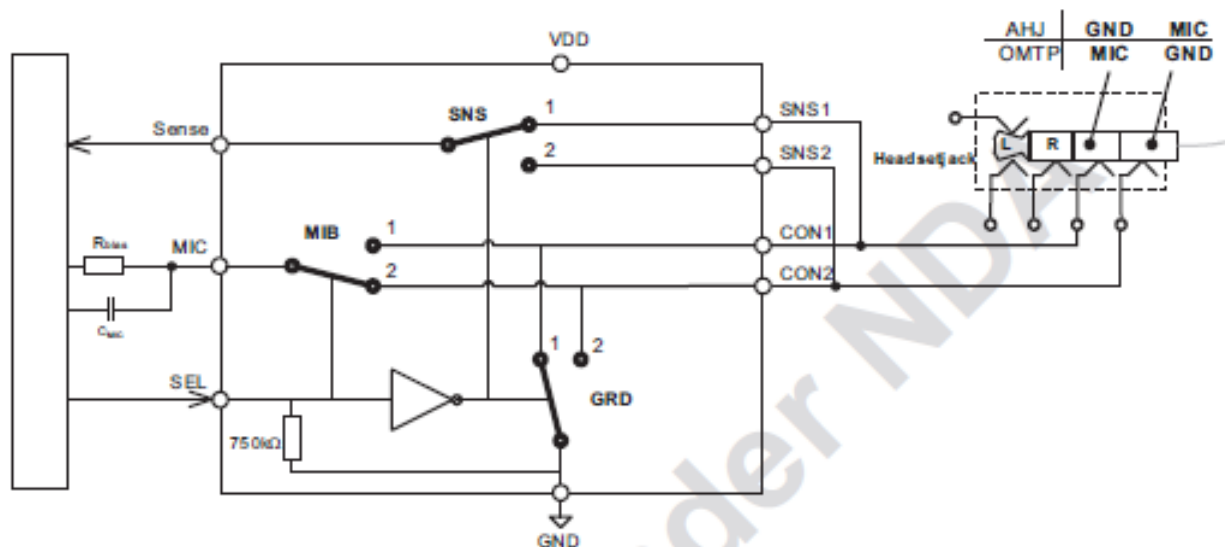
	3 Pole Stereo	
 3.5 mm Headset	4 Pole AHJ (American Headset Jack)	
	4 Pole OMTP (Open Mobile Terminal Platform)	

NCX8200UK: Audio Jack Configuration Switch Matrix

- **Description:**

- The NXP-NCX8200 is an advanced audio jack configuration switch matrix device.
- It supports 3- and 4-pole connectors and allows re-configuration of the GND and microphone-bias contact to comply with the American Headset Jack (AHJ) and the Open Mobile terminal Platform (OMTP) pinout. Furthermore, a GND sense path is automatically connected to the GND path chosen to support quasi-differential amplifier architectures..

- Available in: WCSP 9pin 1.22X1.22mm 0.4mm pitch



(1) Default configuration with SEL = L is AHJ compliant in this example.

Applications

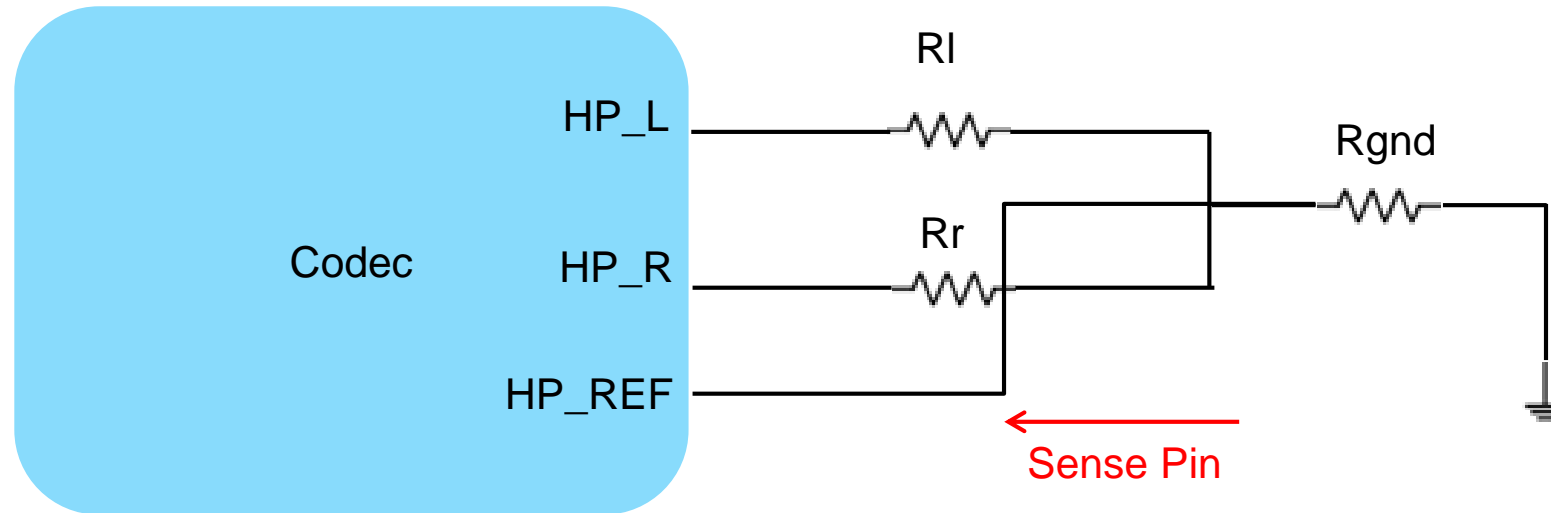
- Notebook and tablet PC
- Cellular handsets
- Portable media players
- Navigation devices

Features

- Low power standby.
- Click free switching.
- Extra Low resistance GND FET, 60mΩ typ.
- Sensing pin for Codec compensation.
- 8kV HBM ESD protection.



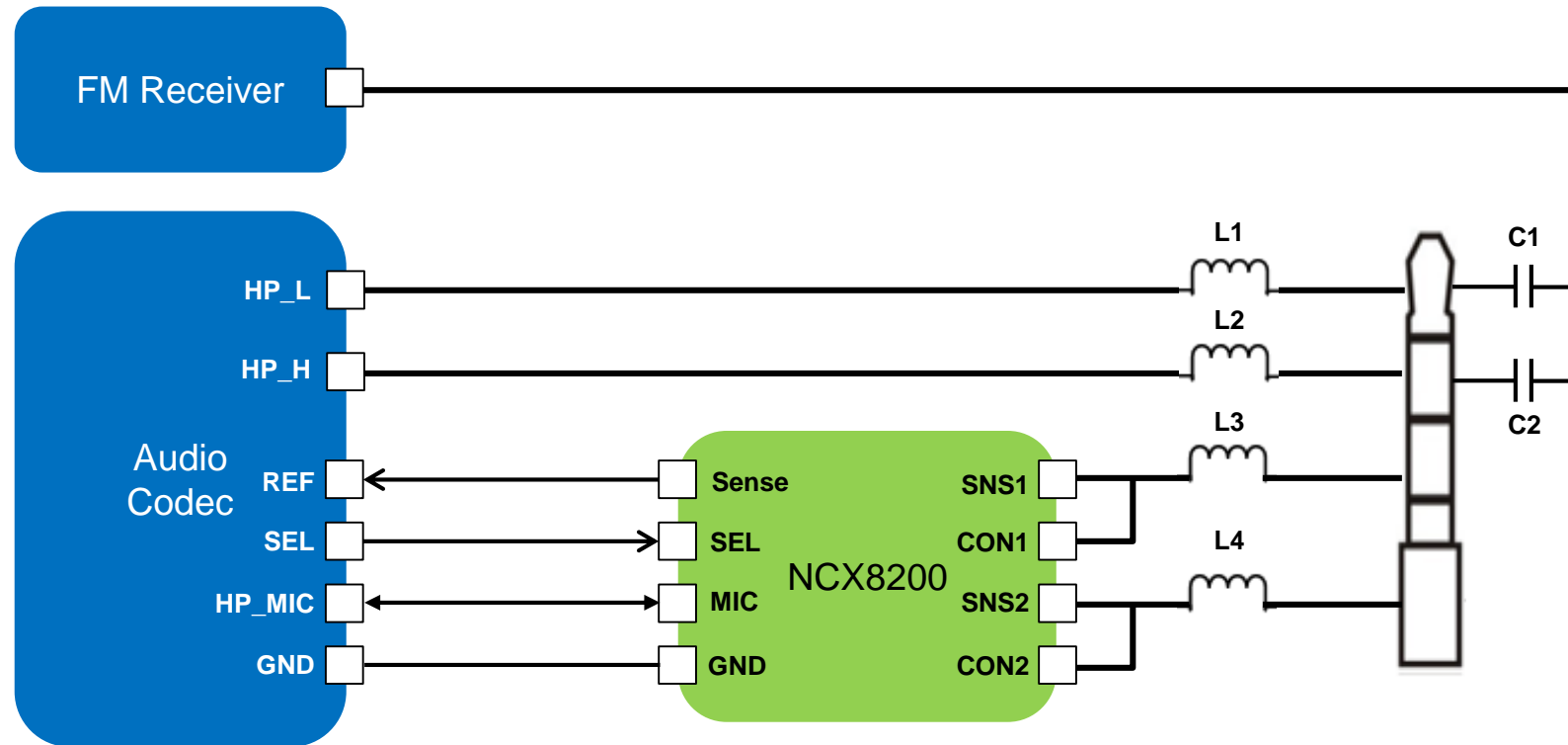
NCX8200UK: Audio Jack Configuration Switch Matrix



Sense and feedback the voltage on the common GND of L/R Channel will help on the crosstalk performance and EMI noise.



NCX8200UK: With FM Receiver





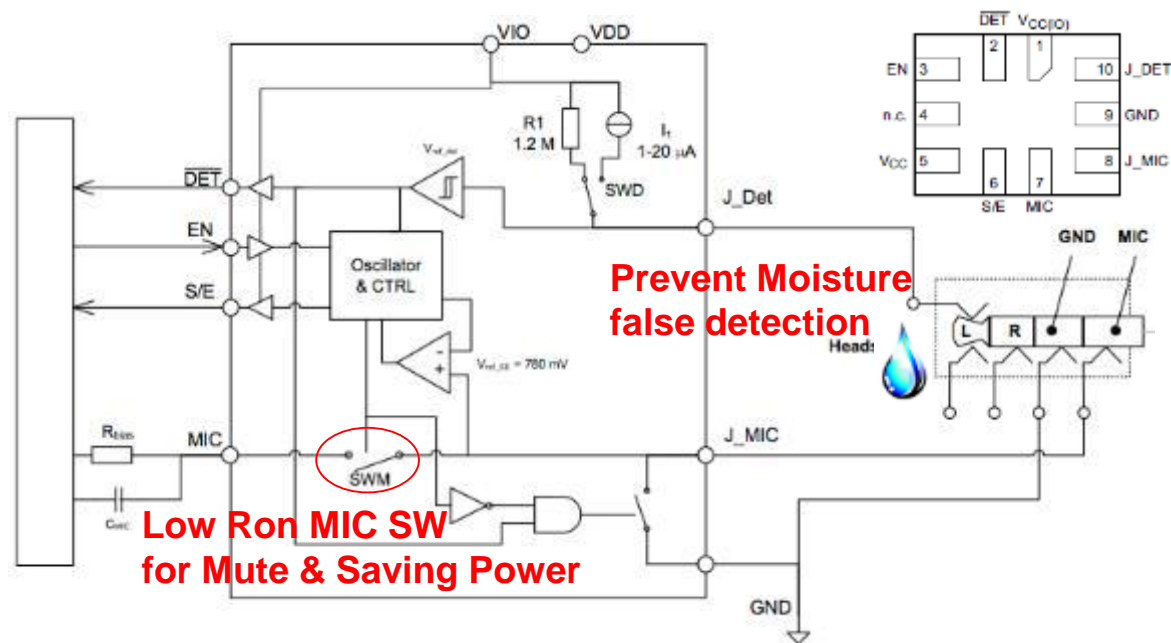
NCX8193GU: Headset Insertion Detection with Moisture Detection

- **Description:**

- Advanced audio jack accessory detector and controller. Supports 3- and 4-pole connectors. An internal microphone bias line switch allows the codec or application processor to control the audio jack configuration to after-market headphones of various configurations.

- Available in: SOT1160 (10 lead QFN) 1.4 x 1.8, 0.5 mm pitch;

- Replaces: FSA8039A



Applications

- Notebook and tablet PC
- Cellular handsets
- Portable media players
- Navigation devices

Features

- low power standby.
- Prevent Moisture false detect
- Click free switching.
- Low ON resistance, 1.8Ω typ.
- 8kV HBM ESD protection.

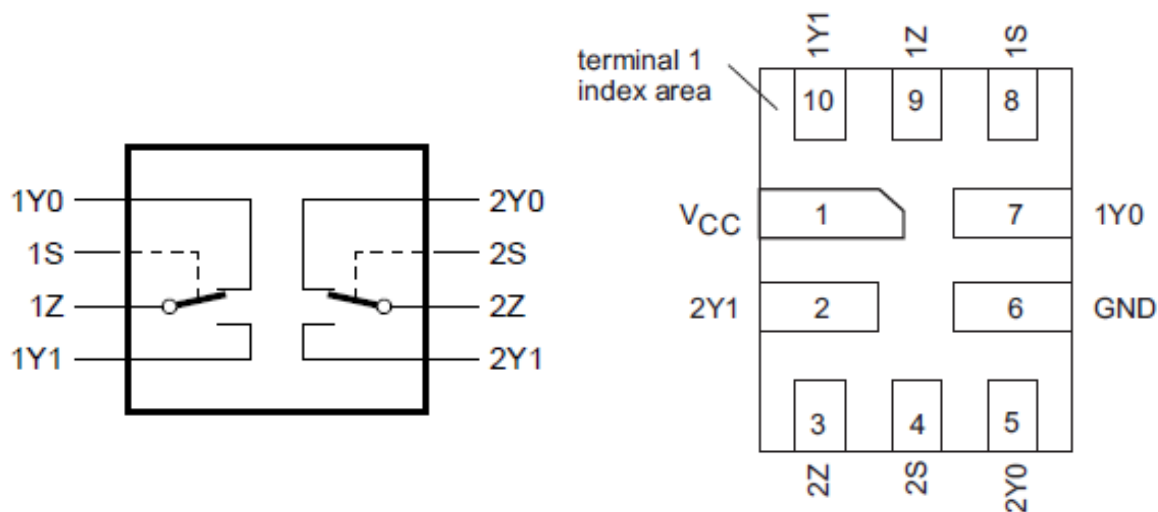


NX5L2750C: Negative Swing Audio signal Switch

- **Description:**

- The NX5L2750 is a dual low-ohmic single-pole double-throw analog switch suitable for use as an analog or digital 2:1 multiplexer/ demultiplexer. Each switch has a digital select input (nS), two independent inputs/outputs (nY0 and nY1) and a common input/output (nZ).
- The NX5L2750 is capable of switching audio signals with negative swing without the need of a coupling capacitor.

- **Available in:** FSA3157, DG2750



Applications

- Notebook and tablet PC
- Cellular handsets
- Portable media players
- Set top boxes
- Navigation devices

Features

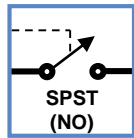
- Operates at 1.8 – 5.0 V supply.
- Switch voltage: -2.5V to V_{CC}
- Supply current I_{CC} < 2uA.
- On resistance R_{ON} = 0.6 W typ.
- Typical C_{S(ON)} = 75 pF
- High Bandwidth f_(-3dB) = 35 MHz



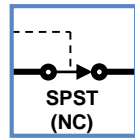
GENERAL PURPOSE ANALOG SWITCHES



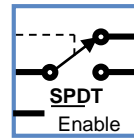
General Purpose Analog Switches Configuration & Nomenclatures



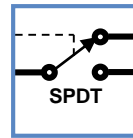
1G66



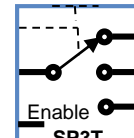
1G384



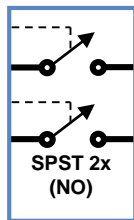
1G53



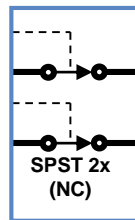
1G3157



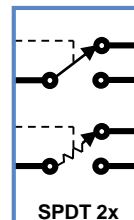
4357



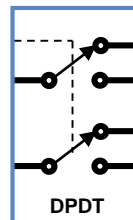
2G66



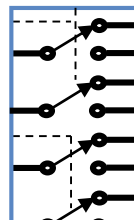
2G384



4684
2267



221
42



2467
2567
3899

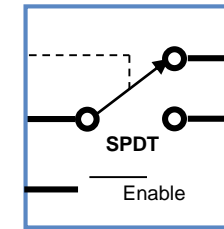
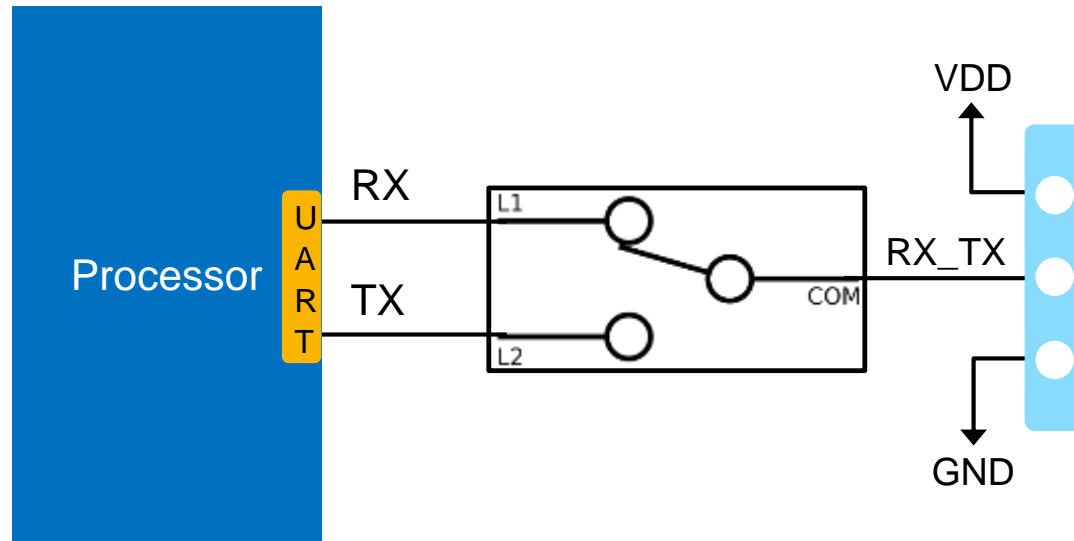
Config	Device type	R _{ON} (Ω)	f _{-3dB} (MHz)	THD (%)	X-talk (dB)
1x SPST	NX3L1G66	0.75	60	0.024	-90
	NX3VT384	0.45	25	0.01	-90
2x SPST	NX3L2G66	0.75	60	0.024	-90
	NX3VT384	0.45	25	0.01	-90
1x SPDT	NX3L1G3157GW-Q100	0.75	60	0.024	-90
	NX3L1T3157	0.75	60	0.024	-90
	NX3L1G53	0.75	60	0.024	-90
	NX3L1T53	0.75	60	0.024	-90
2x SPDT	NX3L4684	0.8	60	0.01	-90
		0.5	25		
	NX3L2267GU-Q100	0.75	60	0.024	-90
2x DPDT or 4PDT	NX3L2467	0.75	60	0.02	-90
	NX3DV2567HR-Q100	9.5	330	-	-60
	NX3DV3899	4.5	200	0.01	-90
1x SPTT	NX3L4357	0.75	30	0.02	-90
1x SP8T	NX3L4051HR-Q100	0.75	15	0.02	-90
	NX3L4051PW-Q100				
3x SPDT	NX3L4053HR-Q100	0.8	60	0.02	-90
	NX3L4053PW-Q100				

Devices listed in Blue are AEC-Q100 Qualified

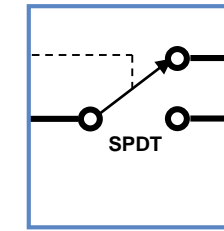




Analog Switch in Pin Multiplexing Application



NX3L1G53



NX3L1G3157

DESCRIPTION	BW	CH	R_{ON}	THD	XTALK	PART#
1x SPDT	60 MHz	1	0.75 Ω	0.024	-90 dB	NX3L1G3157
						NX3L1T3157
						NX3L1G53
						NX3L1T53



NXP Signal Switches for USB 2.0 Applications

- High-bandwidth, low-power, DPDT USB 2.0 muxes/demuxes
- Features
 - Supply voltage
 - 1.65V to 4.3V (NX3DV42)
 - 2.3V to 3.6V (NX3DV221)
 - I/O swing voltage
 - -.5V to 5.5V (NX3DV221)
 - 0 to V_{CC} (NX3DV42)
 - Bandwidth: Up to 1 GHz
 - Low R_{ON} and C_{S(ON)}
 - Low power consumption
 - ESD HBM to 4kV on all pins; >12kV on power-On

BANDWIDTH	CHANNELS	CROSSTALK	OFF-ISOLATION	DESCRIPTION	PART#
950 MHz	2	-30 dB	-30dB	Differential SPDT switch	NX3DV42
1 GHz	2	-40 dB	-38dB	Differential SPDT switch with charge pump, bidirectional	NX3DV221



NX3DV42 – Dual USB2.0 Switch

Description

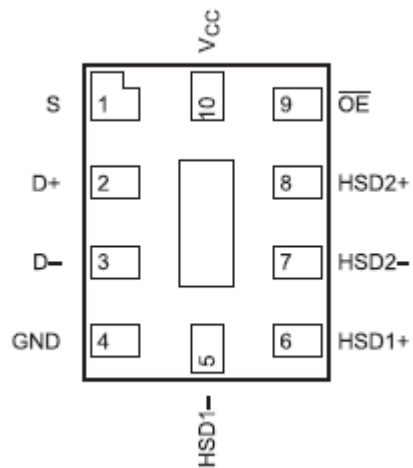
DPDT analog switch designed for switching USB 2.0 high speed (480 Mbps) signals in applications with limited USB I/Os. The wide bandwidth allows to pass signals with minimum edge & phase distortion. Designed for low bit-to-bit skew and high channel-to-channel noise isolation, it is perfect for any high bandwidth application.

Available in: XQFN10U (SOT1049) 1.55 x 2.0 x 0.5 mm, 0.5 mm pitch
XQFN10 (SOT1160) 1.40 x 1.8 x 0.5 mm, 0.4 mm pitch
XQFN10 (SOT1337-1) 1.3 x 1.6 x 0.5 mm, 0.4mm pitch

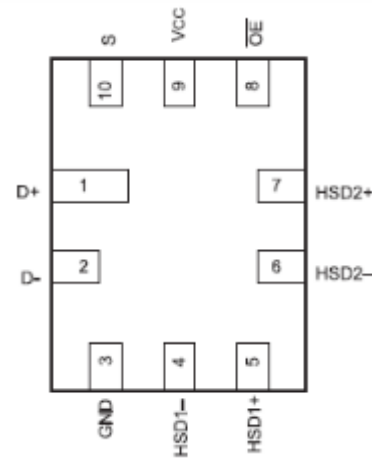
Replaces: FSUSB42/6, MAX4983/4, NLAS7222, NLAS7242, PI3USB102/3, TS3USB30, DG2722DN.

Applications

- Notebook and tablet PC
- Cellular handsets
- Portable media players
- Set top boxes
- Navigation devices
- Lcd displays



SOT1049
1.55 x 2.0 mm



SOT1160
1.4 x 1.8 mm

Features

- Operates at 1.65 – 4.3 V supply.
- On resistance $R_{ON} < 4.0 \Omega$
- Typical $C_{S(ON)} = 6.0 \text{ pF}$
- High Bandwidth $f_{(-3dB)} = 950 \text{ MHz}$
- ESD HBM to 4kV on all pins
- ESD HBM >12kV on power-GND.





NX3DV42 – USB2.0 Compliant Switches

Part Number	NX3DV42	FSUSB42	NLAS7222	TS3USB30	TS3USB30E	DG2722DN	PI3USB102
Vendor	NXP	Fairchild	ON Semi	TI	TI	Vishay	Pericom
# of switches	1x	1x	1x	1x	1x	1x	1x
Config	DPDT	DPDT	DPDT	DPDT	DPDT	DPDT	DPDT
Vcc Range (V)	1.65 - 4.3	3.0 - 4.3	1.65 - 4.5	3.0 - 4.3	3.0 - 4.3	2.7 - 4.3	2.7 – 4.2
Ron typ. (ohm)	3.9	3.9	8.0	6.0	n.a.	7.0	4.0
Ron max (ohm)	6.5	6.5	N/A	10	10	9	5.0
f3dB (MHz)	950	720	700	950	900	900	810
C _{S(ON)} max (pF)	7.3 typ	3.7 typ	8.0 typ	7.0 typ	7.5 typ	5.8 typ	7.0
Icc (on) (uA)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Package (W x H, pitch mm)	UQFN10 (1.4x1.8, 0.4p) (1.3x1.6, 0.4p)	UMLP10 (1.4x1.8,0.4p)	UQFN10 (1.4x1.8, 0.4p)	TQFN (1.4x1.8,0.4p)	TQFN10 (1.4x1.8,0.4p)	miniQFN10 (1.4x1.8, 0.4p)	UQFN-10 (1.4x1.8,0.4p), TQFN-10 (1.3x1.6, 0.4p)
ESD (IO to Gnd)	>12 kV	8 kV	8 kV	6 kV	> 12kV	8 kV	8 kV

NXP NX3DV42 outperforms in 4 out of 7 technical specifications





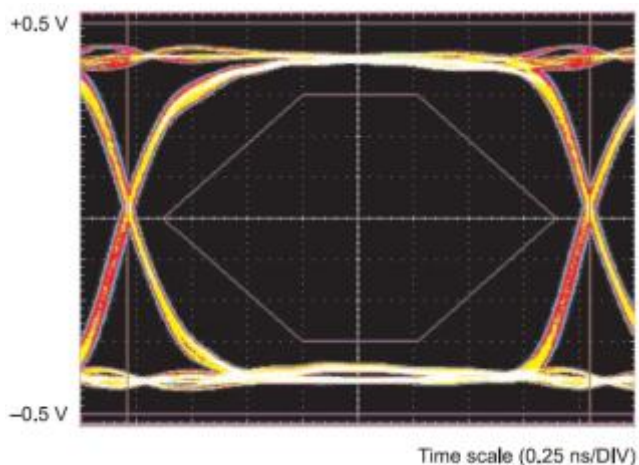
NX3DV221 – USB2.0 Switch with Charge Pump

Description

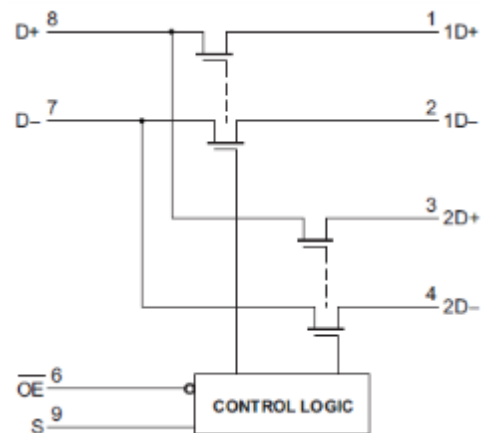
Dual SPDT analog switch designed for switching USB 2.0 high speed (480 Mbps) signals in applications with limited USB I/Os. The wide bandwidth (1.0 GHz) allows to pass signals with minimum edge & phase distortion. The switch is bidirectional & offers little or no attenuation at the outputs. Designed for low bit-to-bit skew and high channel-to-channel noise isolation, it is perfect for any high bandwidth application.

Available in: XQFN10U (SOT1049) 1.55 x 2.0 x 0.5 mm, 0.5 mm pitch

Replaces: TS3USB221, PI3USB221, FSUSB30L10X, FSA221L10X



Eye pattern 480 Mbps USB Signal of NX3DV221 switch



Applications

- Notebook and tablet PC
- Cellular handsets
- Portable media players
- Set top boxes
- Navigation devices
- Lcd displays

Features

- Operates at 2.3 - 3.6 V supply.
- Switch inputs up to 5.5 V.
- Supply current $I_{CC} < 2\mu A$ in low power mode.
- On resistance $R_{ON} < 6.0 \Omega$
- Typical $C_{S(ON)} = 6.0 \text{ pF}$
- High Bandwidth $f_{(-3dB)} = 1.0 \text{ GHz}$
- Evaluation Board Available



NX3DV221 – USB2.0 Compliant Switch with Charge Pump

Specifications Comparison

Part Number	NX3DV221	FSA221	FSA321	FSUSB30	TS3USB221	TS3USB221A	Comment
Vendor	NXP	Fairchild	Fairchild	Fairchild	TI	TI	N/A
Config	DPDT	DPDT	DPDT	DPDT	DPDT	DPDT	N/A
Vcc Range (V)	2.7 - 3.6	3.0 - 4.3	1.8 - 4.3	3.0 - 3.4	2.3 - 3.6	2.3 - 3.6	Wider is better
Ron typ. (ohm)	3.5	3	2 - 8	6.5	n.a.	n.a.	Lower is better
Ron max (ohm)	6.0	6.0 est.	10 est.	10	6.0	6.0	Lower is better
f3dB (MHz)	1000	720	720	720	1100	900	Higher is better
C _{S(ON)} max (pF)	7.5	4.5 typ	5.0 typ	3.7 typ	6	7.5	Lower is better
Icc (on) (uA)	45	10	25	1.0	30	30	Lower is better
Package	XQFN10U (1.55x2.0,0.5p)	Micropak10 (1.6x2.1)	UMLP10 (1.4x1.8,0.4p)	Micropak10 (1.6x2.1,0.5p)	UQFN10 (1.5x2.0,0.5p)	UQFN10 (1.5x2.0,0.5p)	Smaller is better
ESD	12kV	8kV	8kV tbc	8kV	2kV	12kV	Higher is better

Warning:

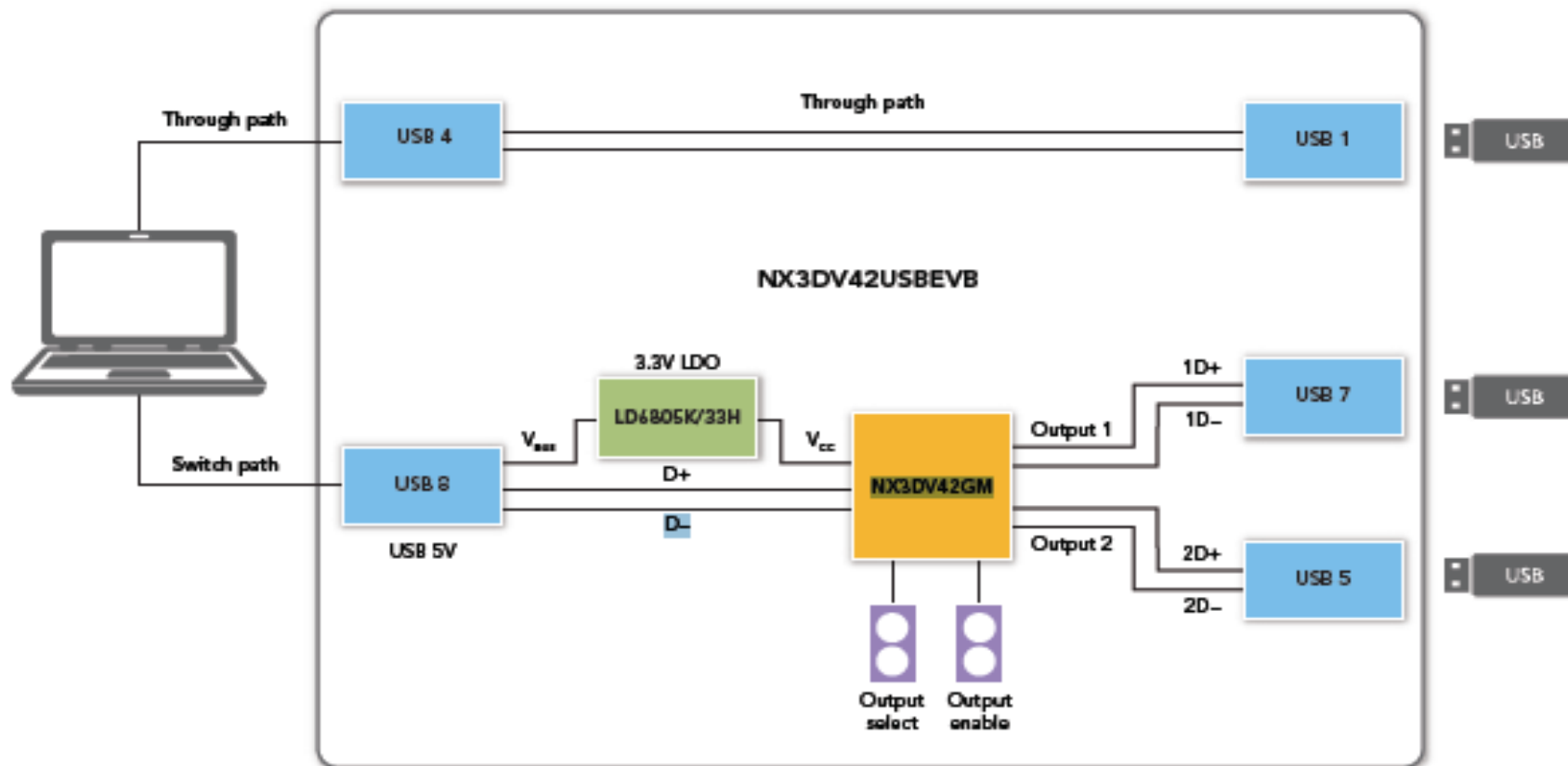
FSA221 & 321 only have one channel meeting USB 2.0, 720 MHz requirement. The second Channel is for audio signals only.

NX3DV221, FSUSB30, TS3USB221, both channels are USB 2.0 , 720MHz compliant.



USB Charge: Data and Power Switching

- High Bandwidth Analog Switch to divert the data path
- 1A OVP switch with IEC ESD diode protection
- Low power consumption LDO





NXP Signal Switches for VGA Video Applications

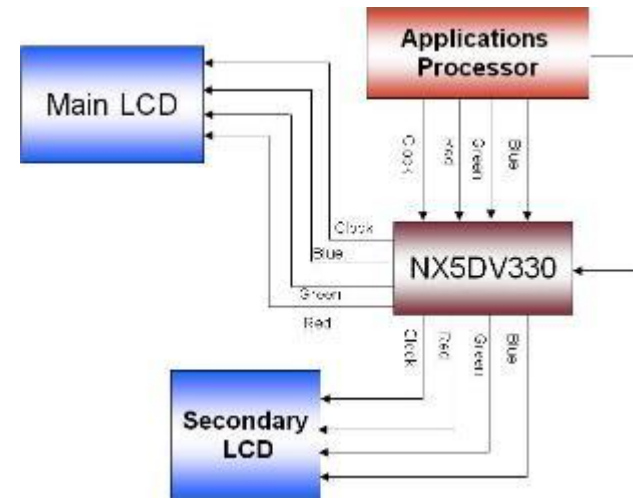
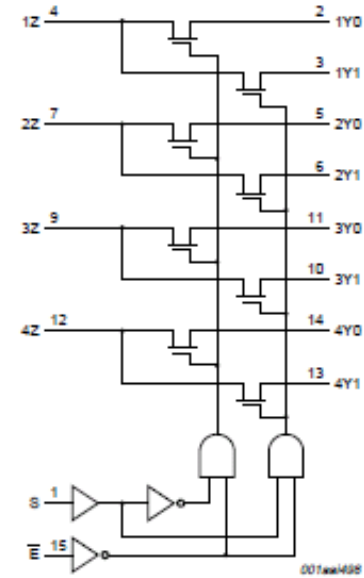
NX5DVxxx Family

DESCRIPTION	CHANNELS	R _{ON}	BANDWIDTH	XTALK		PART#
1:2, TTL-compatible	4	< 5.0 Ω	300 MHz	-63 dB	SSOP	NX5DV330
Dual-supply 1:2 VGA Switch	7	4/9 Ω	600 MHz	-40 dB	QFN32	NX5DV715



NX5DV330 VGA Switch

- Quad 1:2 high-speed TTL-compatible
 - ▶ Low R_{ON} ($< 5.0 \Omega$) minimizes propagation delay & generation of ground bounce noise
- Schmitt-trigger action at enable and select inputs makes the circuit tolerant to slow input signals.
- Features
 - Supply voltage: 4.0 - 4.5V
 - High isolation (-60 dB)
 - Typical $C_{S(ON)}$: 14 pF
 - High bandwidth $f_{(-3dB)}$: 300 MHz
- Ideal for S-video, composite, or VGA
- Packages: SSOP
- Replaces: TS5V3320, FSAV330, PI5V330



digital RGB component video switching between main and secondary LCDs



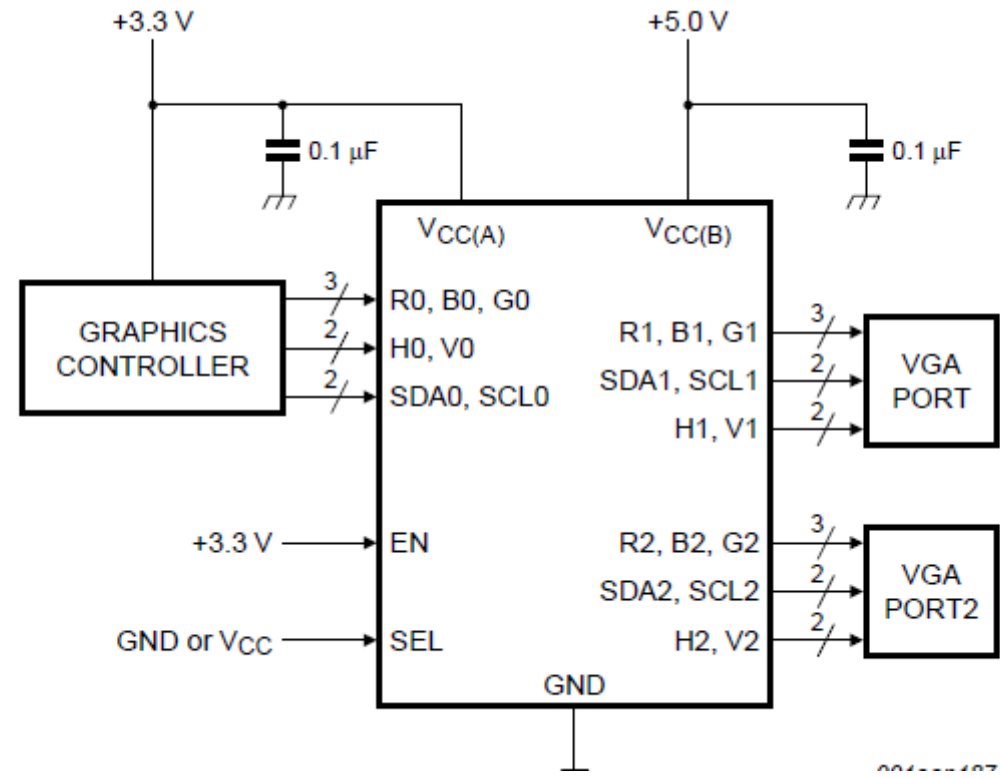


VGA Signal Switching

- Switch VGA signals from a video source to either of two external port,
- ESD protection, 4kV HBM JESD22-A114E Class 3A on VGA ports, 4kV contact IEC61000-4-2 on I/Os.
- Integrates all the required blocks of VGA interface.

NXP Switches Integrate:

- Level shifting of VGA signals down.
- Internal buffers drive HSYNC and VSYNC signals to VGA standard TTL levels.





NX5DV715 – High Speed VGA Video Switch

Description

Dual-Supply 1-to-2 VGA Switch with integrated high-bandwidth level-translating SPDT switches for RGB, H-sync, V-sync and DDC signals to either of two output channels.

It is guaranteed to operate from -40 to 85 °C.

Low ON resistance minimizes propagation delay & ground bounce noise.

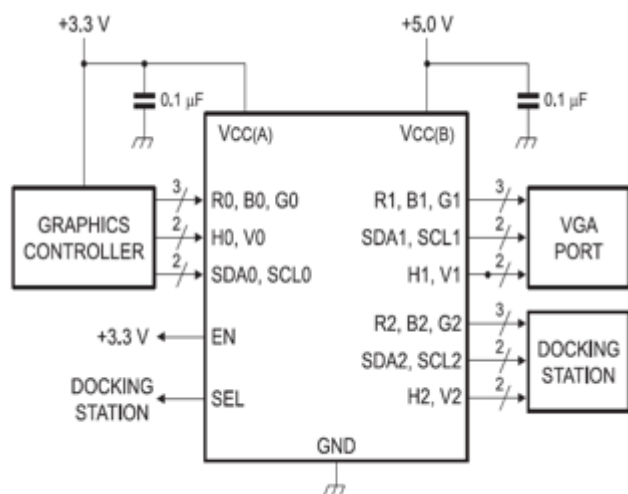
Schmitt-trigger action at enable & select inputs makes the circuit tolerant to slow input signals.

Available in: QFN32 Package

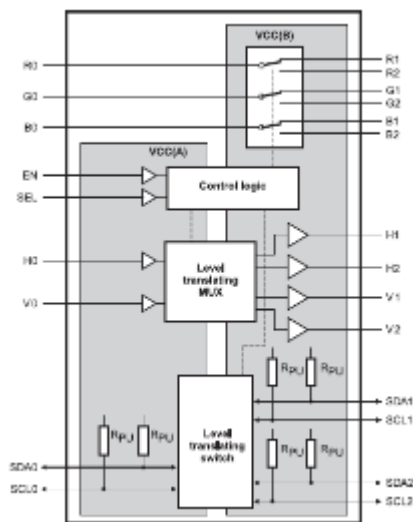
Replaces: PI3V713ZLE, TS3V712ERTGR, PI3V712/A, MAX4885

Applications

- Notebook and tablet PC
- Net books
- Server PCs
- Set top boxes
- Lcd displays
- HD Televisions



VGA graphics switching between main LCD & external monitor via docking station.



Features

- Operates at 2V-5.5V supply.
- Complete 7 Ch-VGA Signal Switch
- Low Insertion Loss of 0.6dB
- R_{ON} of 4.0 Ω for RGB Signals
- Typical $C_{S(ON)} = 10$ pF
- High Bandwidth $f_{(-3dB)} = 600$ MHz
- Meets VESA 1920x1440



Analog Switches for MIPI CSI/DSI Applications

BW	CH	R _{ON}	XTALK	OFF-ISOLATION	DESCRIPTION	PACKAGE(S)	PART#
950 MHz	6	7.5 Ω	-30 dB	-30dB	Differential TPDT switch	XQFN24U	NX3DV642
950 MHz	2	5.8 Ω	-30 dB	-30dB	Differential SPDT switch	XQFN10U, XQFN10	NX3DV42
1 GHz	2	3.6 Ω	-40 dB	-38dB	Differential SPDT switch with charge pump, bidirectional	XQFN10U (SOT1049)	NX3DV221

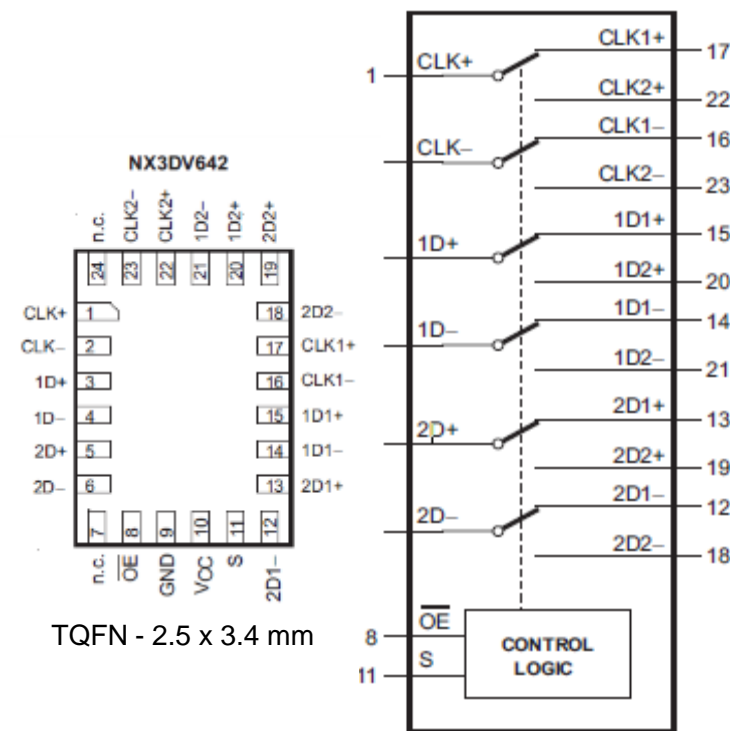


NX3DV642 – Analog Switch

3-Lane MIPI*-CSI Switch

- High-speed TPDT differential signal switch
 - optimized for switching between two MIPI* devices, such as cameras or LCD displays, and on-board multimedia application processors
 - compatible with MIPI* requirements
 - low capacitance designs allows switching signals in excess of 500-MHz frequency
- Key features
 - Operates at 2.65 to 4.3V supply
 - R_{ON} : 5.8 Ω
 - Typical $C_{S(ON)}$: 8.4 pF
 - High bandwidth $f(-3dB) > 950MHz$
 - ESD HBM to 4kV on all pins
 - ESD HBM >12kV on power-GND
- Package:
 - XQFN24U 2.5 x 3.4 x 0.5 mm, 0.4 mm pitch
- Replaces: FSUSB642

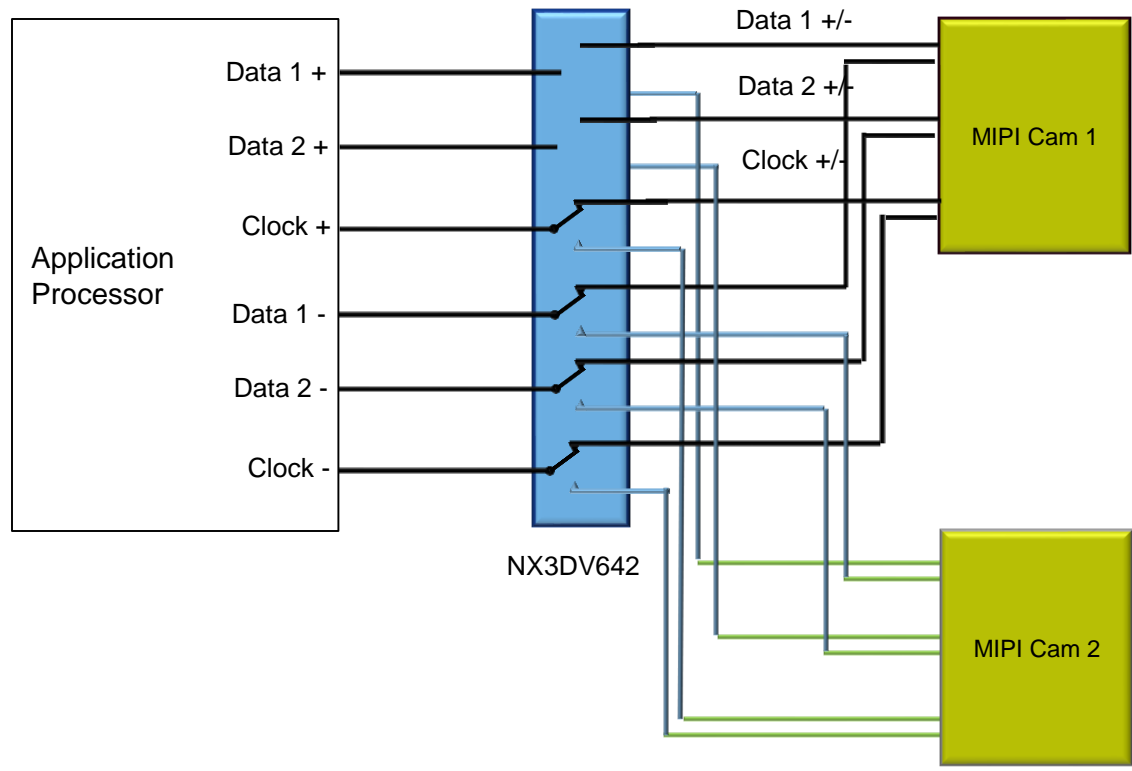
* Mobile Industry Processor Interface





NX3DV642 Application Example

MIPI Camera – Dual Signal Switching



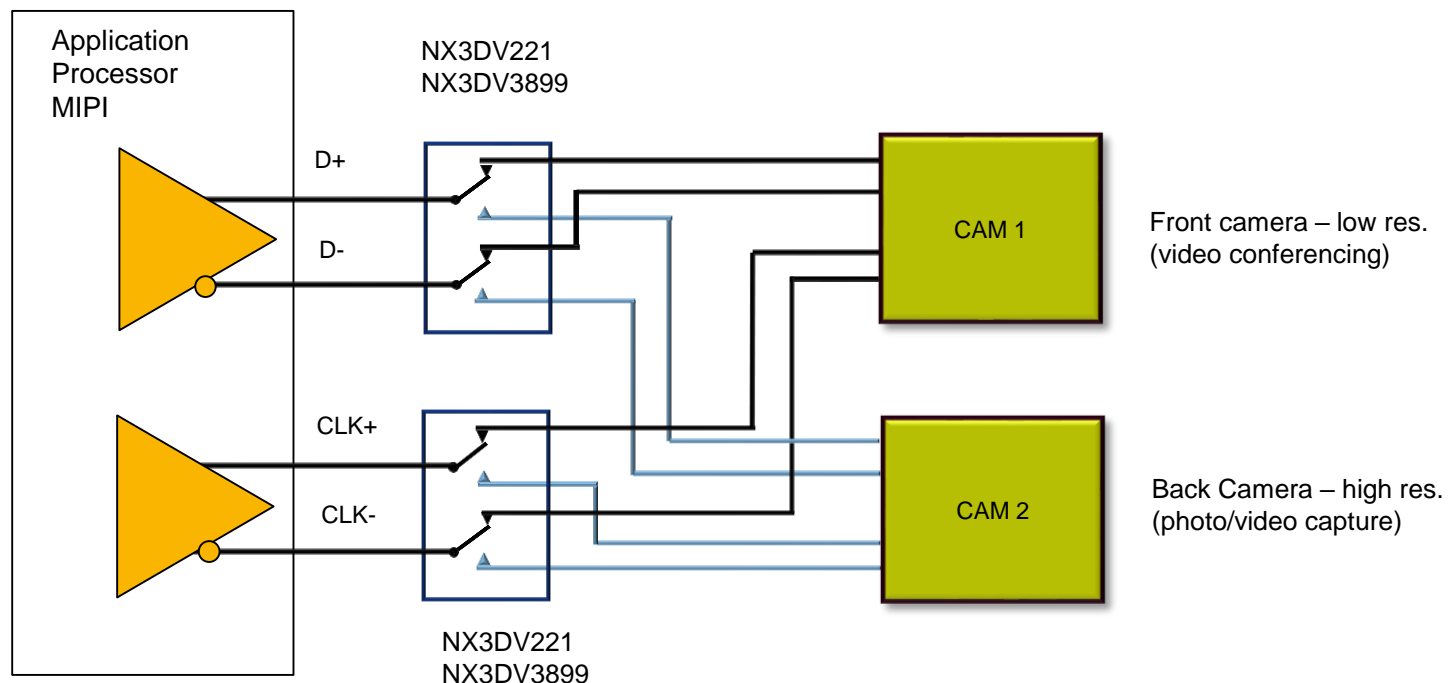
Supports cameras requiring 4 MIPI data lanes and 2 clock lanes





Camera Display Interface – Dual Swing Switching

NX3DV221 / 3899



- Use NX3DV221 & NX3DV3899 to toggle video signals between 2 cameras when high bandwidth is needed.
- NX3DV221 supports up to 1.0 GHz, NX3DV3899 support up to 200 MHz.



NX3DV2567 – Dual SIM Card Data Switch

Description

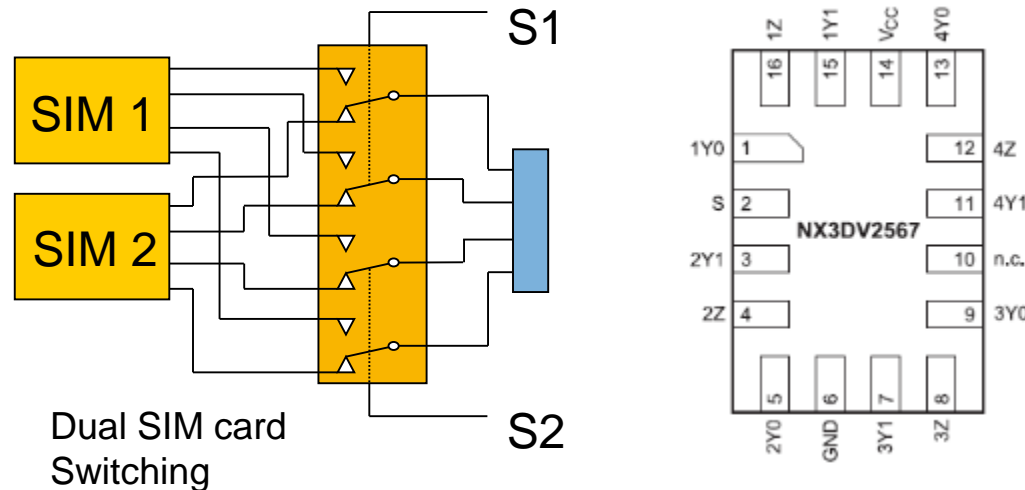
Dual low-ohmic DPDT switch designed for analog or digital multiplexer/demultiplexer. Optimized for switching WLAN-SIM data and control signals, it features low on capacitance of 10 pF to ensure high-speed data transfer. The supply switch path has a low ON resistance to ensure minimal voltage drop as well.

This device is a perfect fit for dual SIM card switching applications.

Available in: XQFN16 (SOT1161) 1.8 x 2.6 x 0.5 mm, 0.4 mm pitch.

HXQFN16U (SOT1039) 3.0 x 3.0 x 0.5 mm, 0.5 mm pitch.

Replaces: FSA2567.



Applications

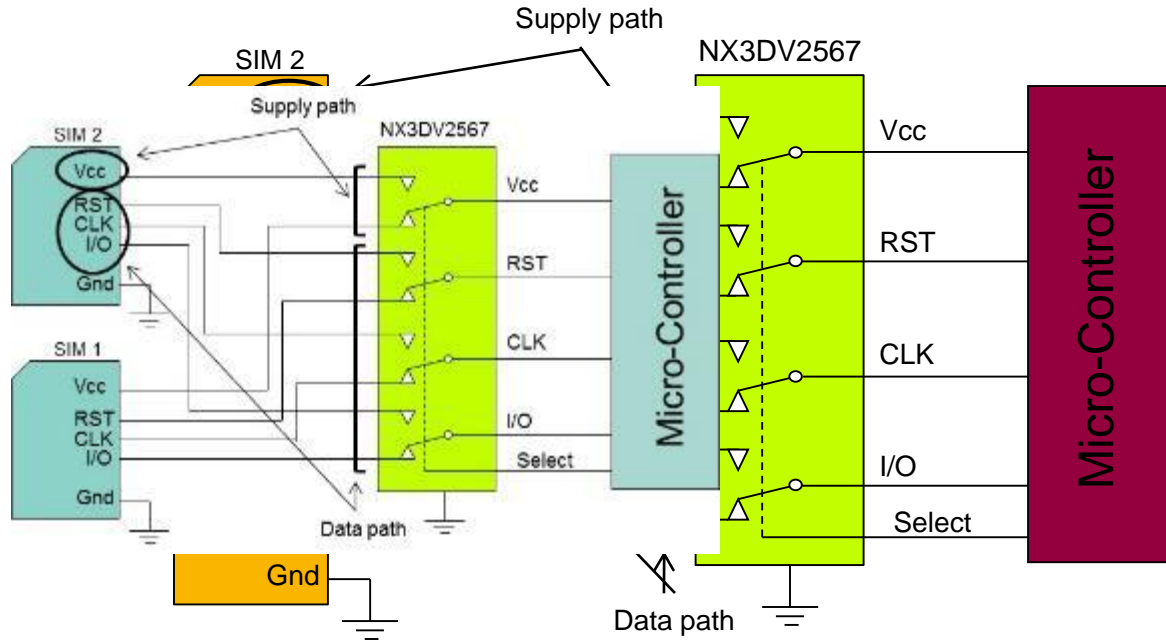
- Notebook and tablet PC
- Cellular handsets
- Portable media players
- Set top boxes

Features

- Operates at 1.4 – 4.3 V supply.
- Control inputs up to 4.3 V
- Dedicated supply source switch
- High Off isolation of -60dB
- On resistance $R_{ON} < 1.0 \Omega$
- Typical $C_{S(ON)}$ for data path = 16 pF
- High Bandwidth $f_{(-3dB)} = 330 \text{ MHz}$
- Low Cross Talk = -60dB



Dual SIM Card Switching w/ NX3DV2567



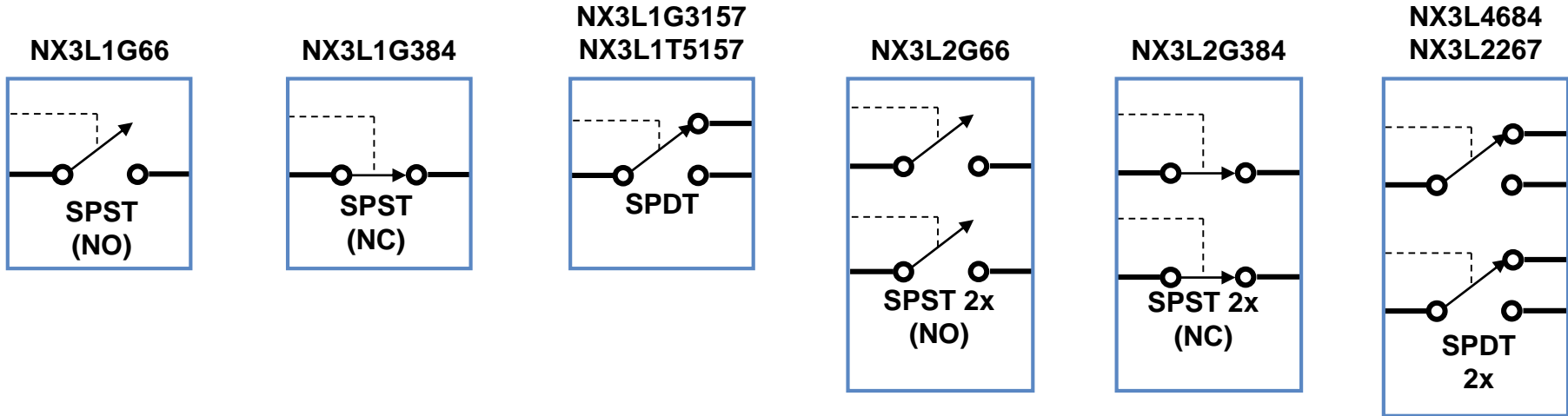
Supply path switch portion
 $R_{on} = 0.5 \text{ ohm}$
 $f_{3dB} = 160 \text{ MHz}$
 $C_{S(ON)} = 130 \text{ pF}$
 → Optimized for low power loss

Data path switch portion
 $R_{on} = 6 \text{ ohm}$
 $f_{3dB} = 330 \text{ MHz}$
 $C_{S(ON)} = 10 \text{ pF}$
 → Optimized for fast data transfer

NX3DV2567 can switch from one SIM card to another without powering down the phone



NX3L Switch Competition



- Fairchild**
- FSA2156
 - FSA1156
 - FSA66
- ON Semi**
- NLAS4501
- TI**
- TS12A4514
 - TS12A4515
 - TS12A4516
 - TS12A4517
- Pericom**
- PI5A121

- Fairchild**
- FSA1157
- TI**
- TS5A3167
 - TS5A4597
- Pericom**
- PI5A124

- Fairchild**
- FSA5157
 - FSA4157
 - NC7SBU3157
- ON Semi**
- NLASB3157
 - NLAS4157
- Pericom**
- PI5A3157
 - PI3A3159

- Fairchild**
- FSA1256A
 - FSA266
 - FNC7WB66
- ON Semi**
- NLAS323
- TI**
- TS5A23166
 - TS5A2066
 - TS3A4741

- Fairchild**
- FSA1257/A
- TI**
- TS5A23167

- Fairchild**
- FSA2267/A
 - FSA2257
 - FSA2268/T
- ON Semi**
- NLAS5223
 - NLAS4684
 - NLAS4717
- Pericom**
- PI5A3158

= Drop-in equivalent
 All others are electrical equivalent





HIGH-SPEED SIGNAL SWITCHES





NXP High Speed Analog Switches

General Purpose

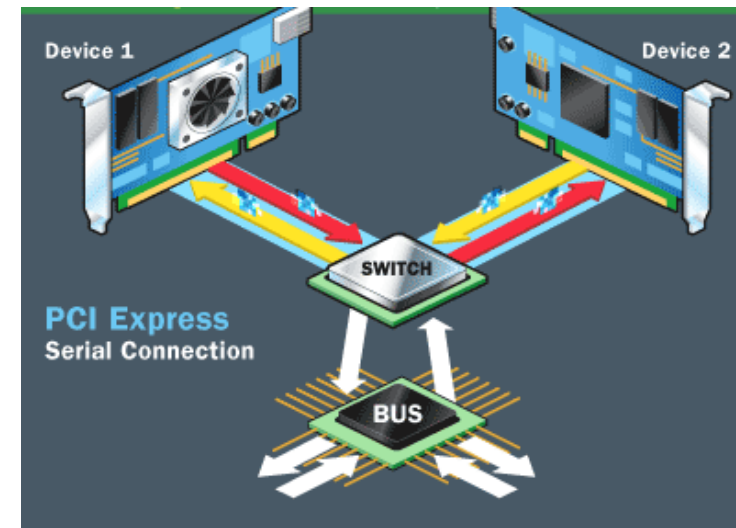
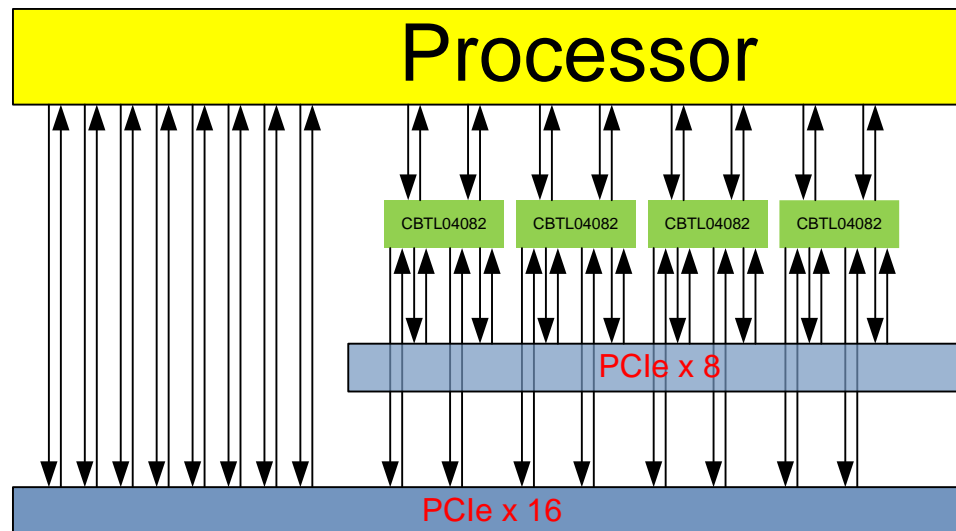
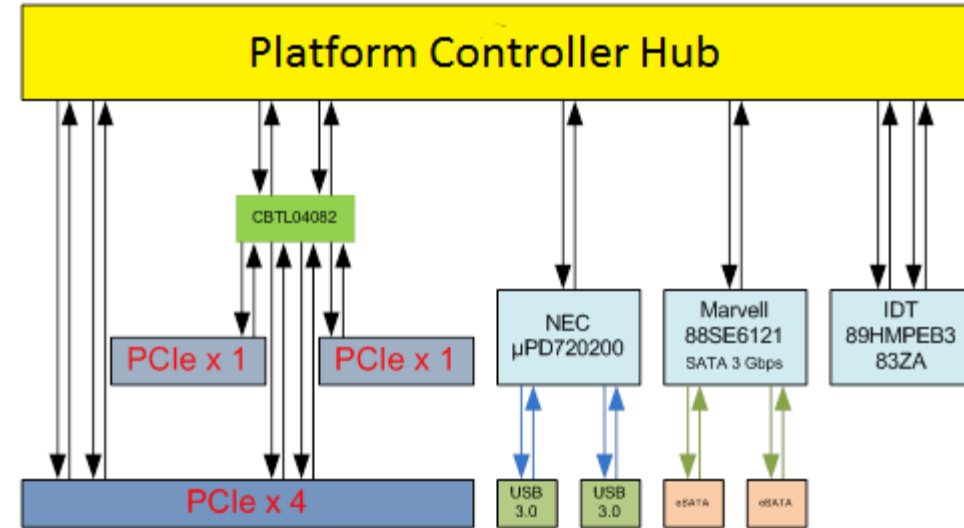
	BANDWIDTH	CHANNELS	SUPPLY VOLTAGE	INSERTION LOSS	CROSSTALK	OFF-ISOLATION	PART#
Gen 2	5 Gbps	2	3.3V	-0.9dB at 2.5GHz	-30dB at 2.5GHz	-25dB at 2.5GHz	CBTL02042A/B
	5Gbps	4	3.3V	-1.5dB at 2.5GHz	-35dB at 2.5GHz	-16dB at 2.5GHz	CBTL02GP023
Gen 3	8 Gbps	4	3.3V	-1.3dB at 4GHz	-29dB at 4GHz	-20dB at 4GHz	CBTL04083A/B
	8 Gbps	2	3.3V	-1.3dB at 4GHz	-35dB at 4GHz	-20dB at 4GHz	CBTL02043A/B
	10 Gbps	1	3.3V	-1.3dB at 4GHz	-35dB at 4GHz	-20dB at 4GHz	CBTL01023
	12Gbps	2	1.8V / 3.3V	-1.4dB at 5GHz	-37dB at 5GHz	-20dB at 5GHz	CBTU02043



Computing/server/networking Use Case

PCIe lane reconfiguration

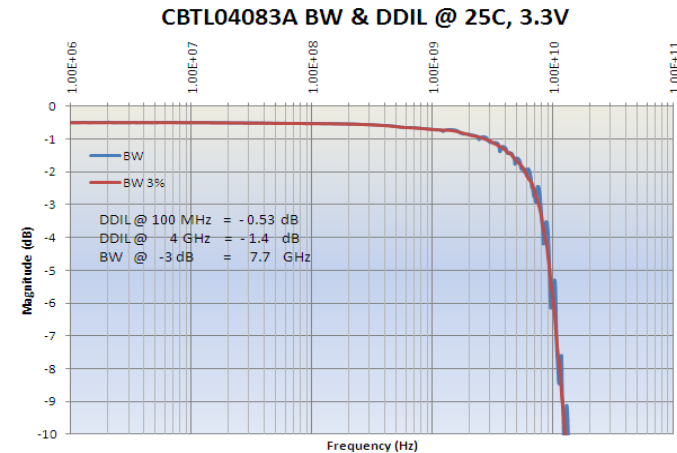
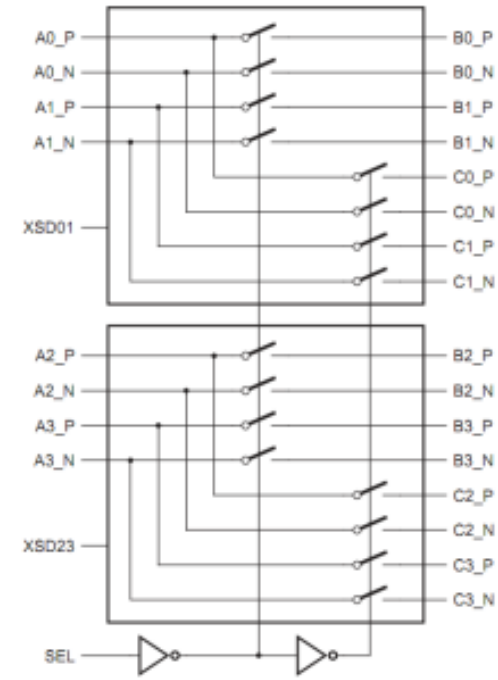
- PCIe Slot Configuration
 - x16 → x8 → x4 → x2 → x1





CBTL04083 Mux/DeMux/Switch

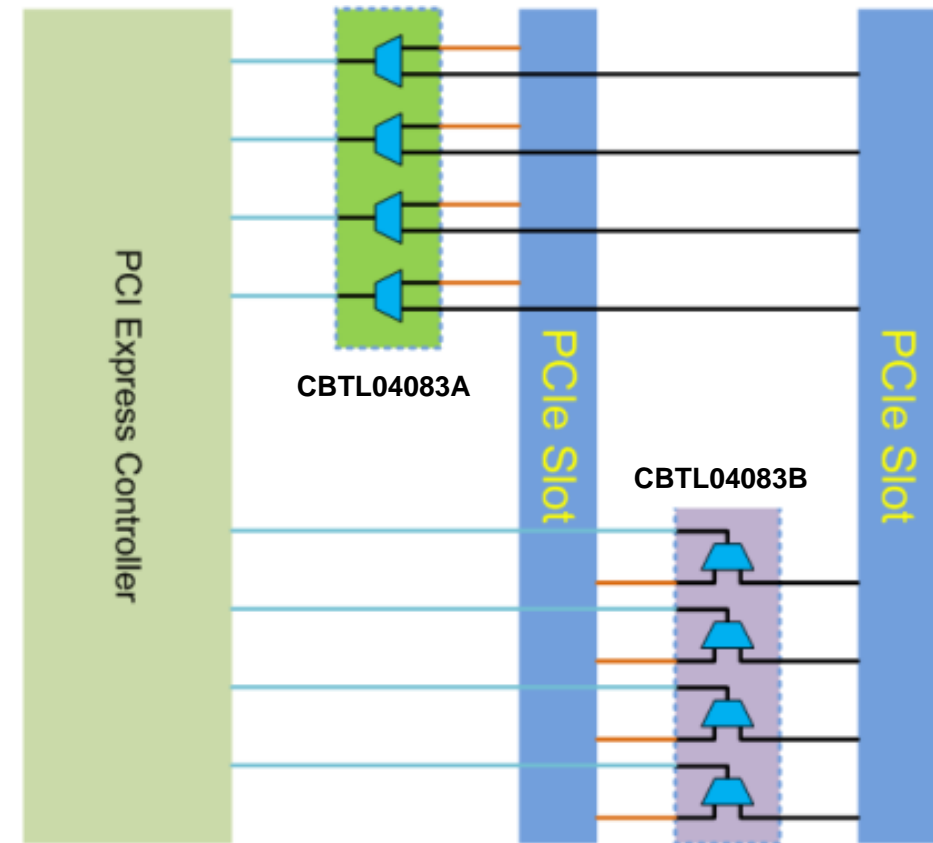
- 8-Gbps high-speed signal switch for:
 - PCI Express Gen 3
 - USB 3.0
 - SATA 2 or mSATA
- Features
 - 4 differential channel, 2:1
 - Insertion loss
 - -0.5 dB at 100 MHz
 - -1.4 dB at 4 GHz
 - -3.0 dB at 7.8 GHz
 - Low intra-pair skew: 5 ps max
 - Low inter-pair skew: 20 ps max
 - Low crosstalk: -30 dB @ 4 GHz
 - Low off-state isolation: -25 dB @ 4 GHz
 - Low return loss: -10 dB @ 4GHz
 - Dual shutdown pins for power-saving mode
 - Standby current <10 μ A
 - 3.3V supply voltage
 - ESD: 2kV HBM, 500V CDM
 - Package: HVQFN42





Gen3 PCIe Switch Pinout Arrangement & Layout Differences

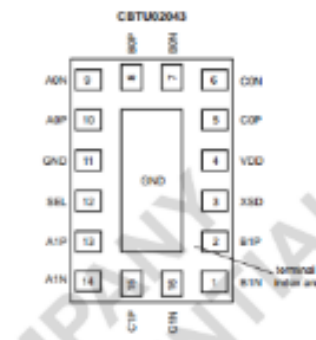
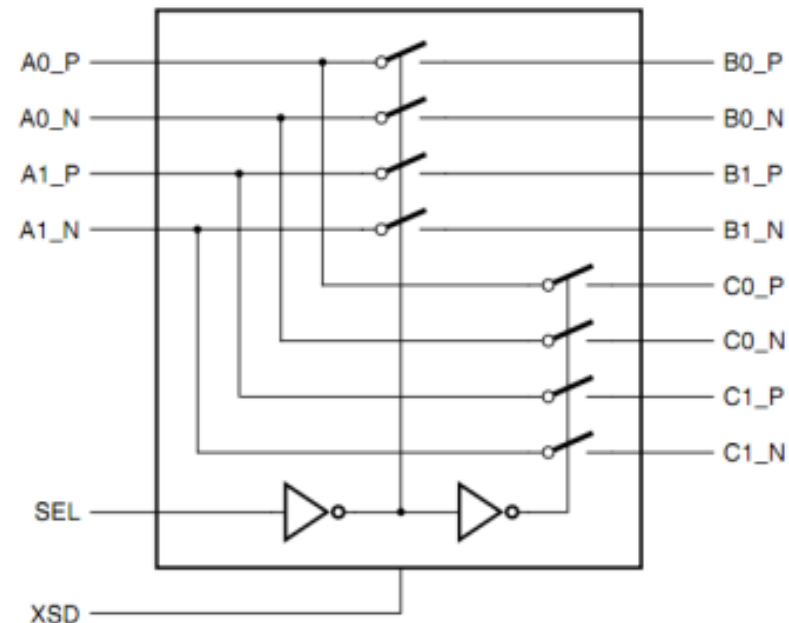
- **CBTL04083A** (Flow Through Pinout)
 - Trace layout is easy but the signal propagation delay is unbalanced
- **CBTL04083B** (Loop-back Pinout)
 - Placed between 2 PCIe connectors, the loop-back pin arrangement gives balanced trace length





CBTU02043 Mux/DeMux/Switch

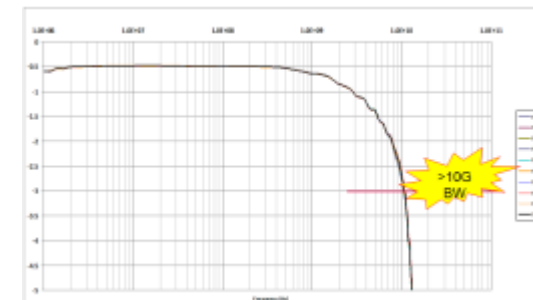
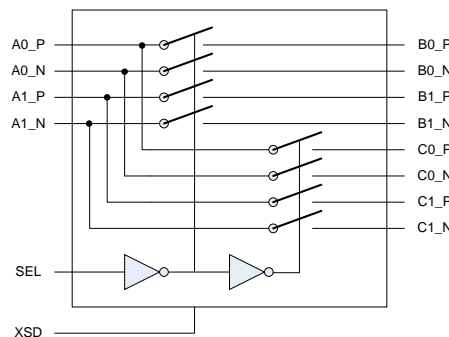
- 2 differential channel (or 4 single-ended) 2:1 bi-directional mux/demux
- Signaling supported
 - 10 Gbps USB3.1 Gen2, PCIe-Gen 3 signals
 - DDR signals
- **Supply voltage: 1.8V - 3.3V**
- **Differential BW: 12 GHz**
- Differential Return Loss: < -12dB @ 5GHz
- Low crosstalk: <-37dB at 5GHz
- Low Off-isolation: -20dB at 5GHz
- Low differential intra-pair skew: 6ps typical
- IDD: 200 μ A (active) and 3 μ A (powerdown)
- CMOS select signals
- Switch/mux topology: 1:2
- ESD 2.5kV HBM, 1kV CDM
- **HUQFN16 package: 2.4 x 1.6 X0.5 mm package with 0.4mm pitch**





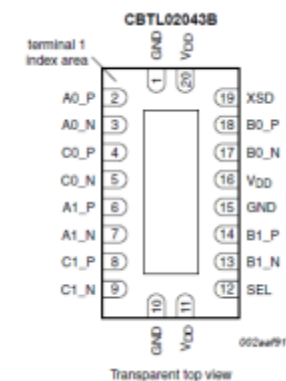
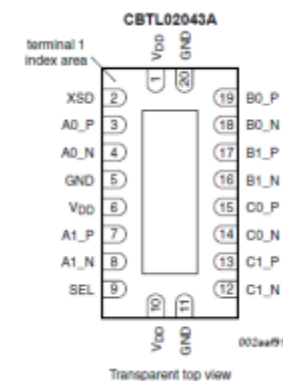
CBTL02043 Mux/DeMux/Switch

- 2 differential channel, 2:1 bi-directional mux/demux
- Signaling Supported
 - PCIe Gen3 @ 8Gbps
- Insertion loss
 - -0.5dB at 100 MHz
 - -1.2dB at 4 GHz
 - -3.0dB at 10 GHz
- **Supply voltage: 3.3V - 3.6V**
- **Differential BW: 10 GHz**
- Low Return-Loss -19.4dB at 4GHz
- Low crosstalk: -28dB at 4GHz
- Low Off-isolation: -23dB at 4GHz
- Low intra-pair skew: 5ps typical
- Low inter-pair skew: 35ps max
- 3.3 V supply voltage
- **DHVQFN20 package**
- ESD 2kV HBM, 1kV CDM
- Two pin outs available for PCB layout optimization
- Standby current < 1 μ A controlled by XSD pin



• Applications:

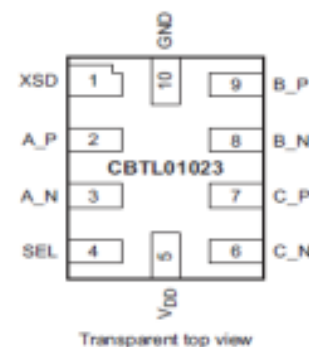
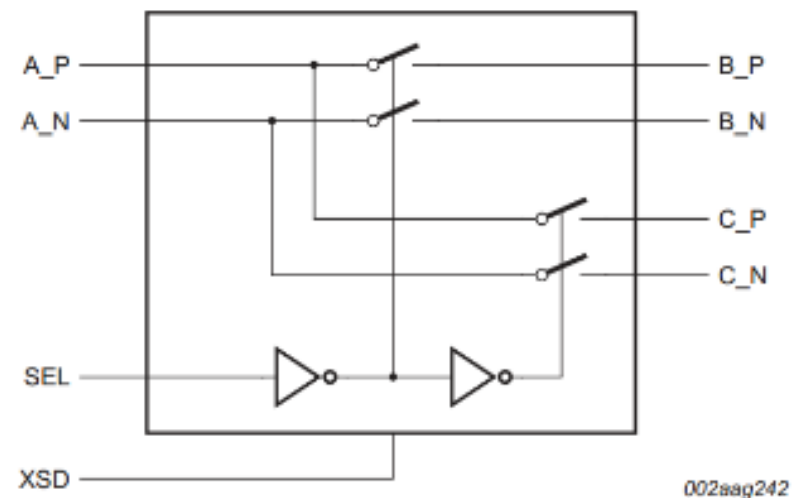
- Type-C connector
- PCIe Gen 3
- DisplayPort V1.2
- USB 3.0
- SATA Gen 3





CBTL01023 Mux/DeMux/Switch

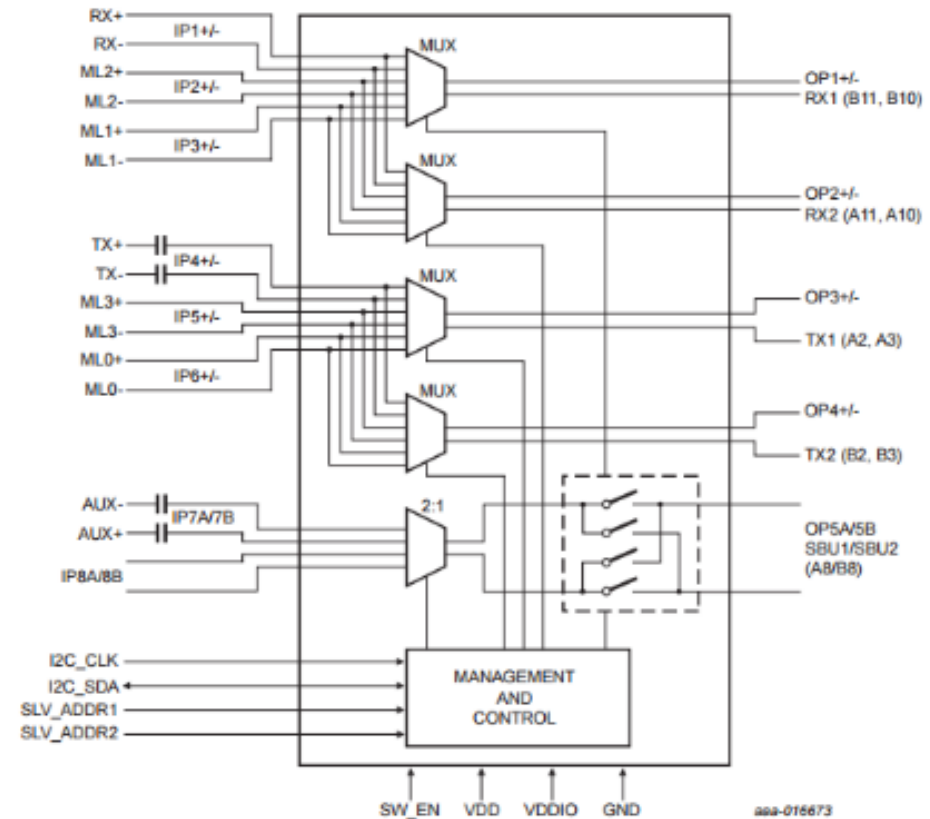
- 10-Gbps bandwidth signaling supporting:
 - 10G Ethernet
 - PCIe Gen 3
 - SATA 3, mSATA, SAS 2
 - USB 3.0
- Bidirectional differential channel, 2:1
- High bandwidth: 9 GHz at -3 dB
- Low insertion loss: -0.5 dB at 100 MHz / -1.3 dB at 4.0 GHz
- Low return loss: -20 dB at 4 GHz
- Low crosstalk: -35 dB at 4 GHz
- High off-state isolation: 20 dB at 4 GHz
- Low intra-pair skew: 5 ps typical
- VDD operating range: 3.3V
 - Standby current less than 1 μ A
- Tiny XQFN10 package: 1 x 1.55 x 0.5 mm, 0.5 mm pitch





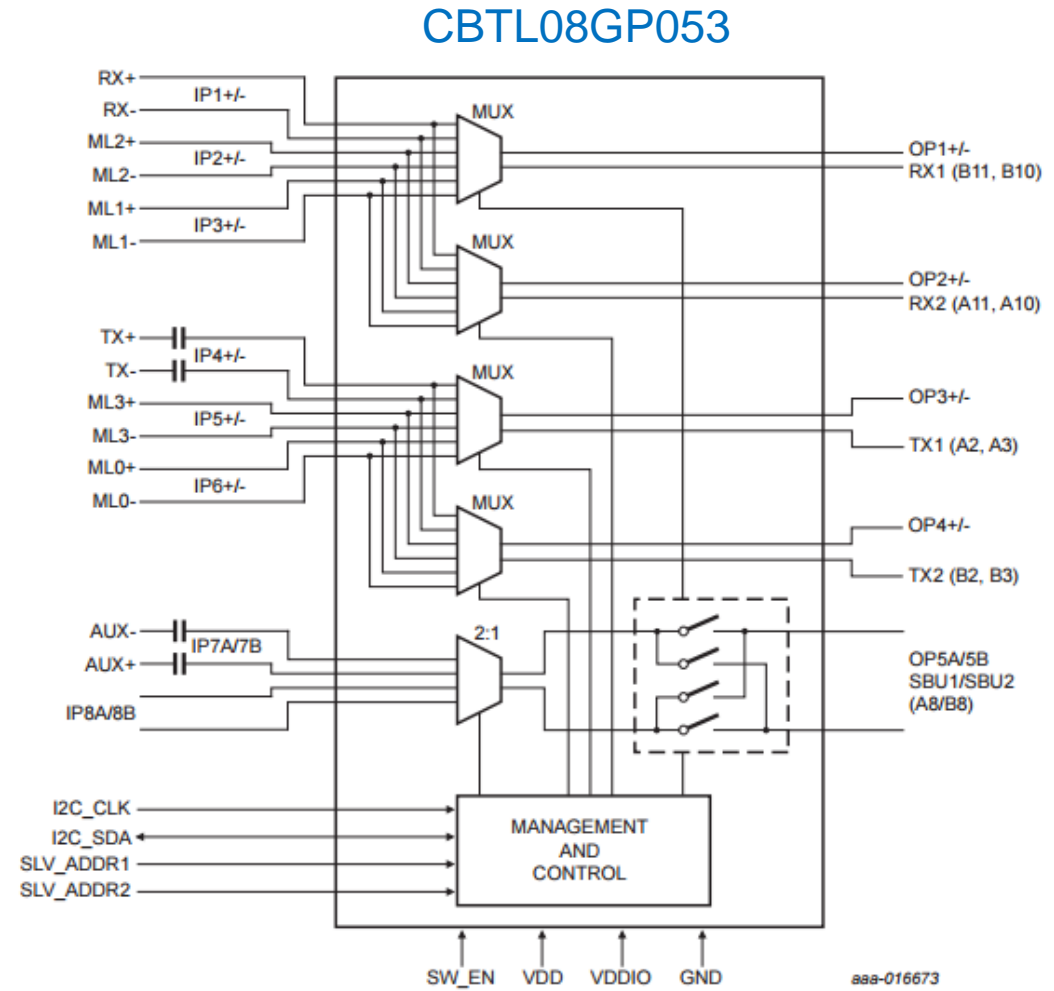
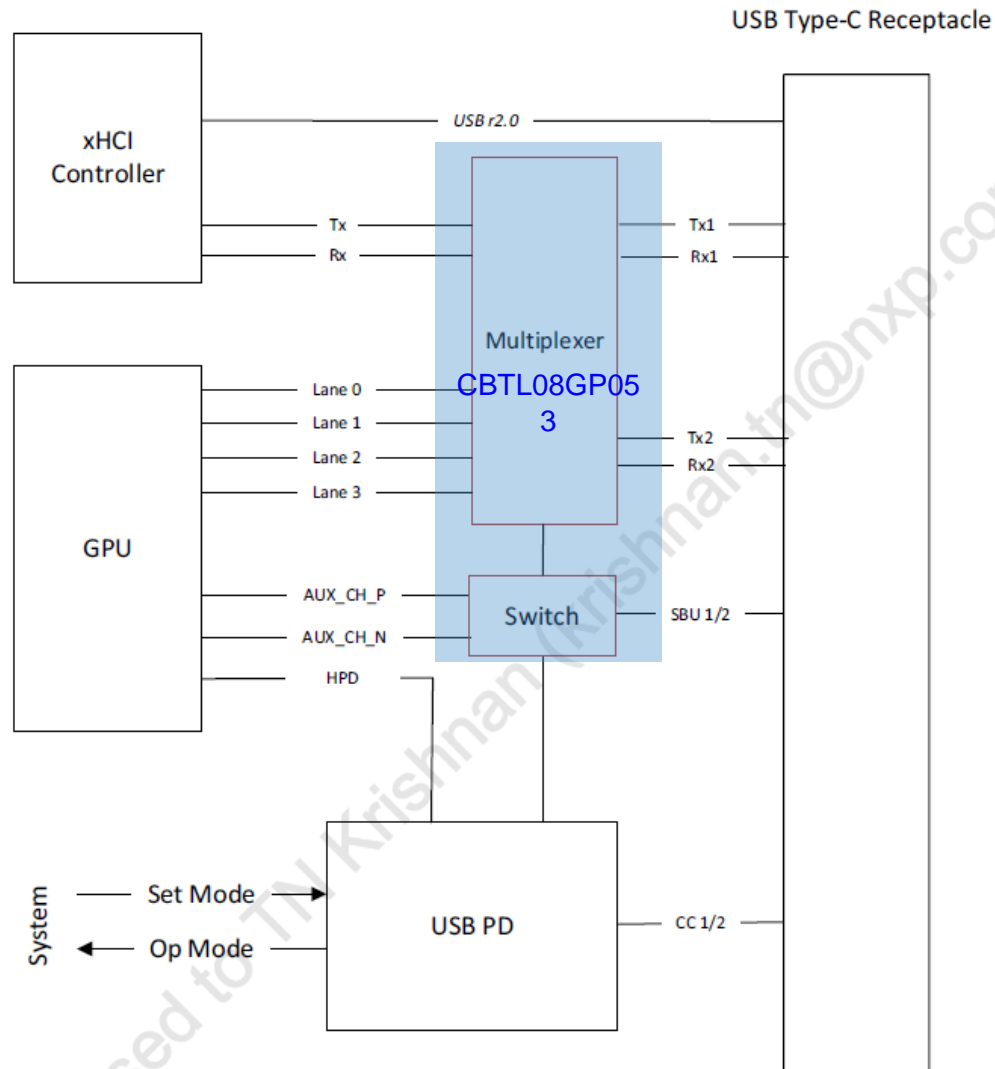
CBTL08GP053 – USB Type-C Combo Switch

- Applications in platforms supporting Alternate Modes to transport multiple high speed signals over USB Type-C connector
- Supports data rates up to 5.4 Gbps
- Supports several use cases
 - USB3
 - USB3, DP 1/2/4-lanes
 - USB3, PCIe (1-lane)
- High Speed Mux target specs
 - Bi-directional usage support (mux or switch)
 - -3dB BW: >5 GHz
 - Insertion loss: 1.3 dB @ 2.7 GHz
 - Isolation: 25 dB @ 2.7 GHz
 - Return loss: 18 dB @ 2.7 GHz
 - Cross talk: 35dB @ 2.7 GHz
- High speed and Side band Mux support (controlled via I²C)
- Back current protection on control pins
- Side band muxes can handle up to 5V (rail to rail signaling)
- Single 3.3V supply
- Active Current consumption ~500 uA
- ESD 2kV HBM, 500V CDM
- 36-ball BGA, 0.4 mm pitch



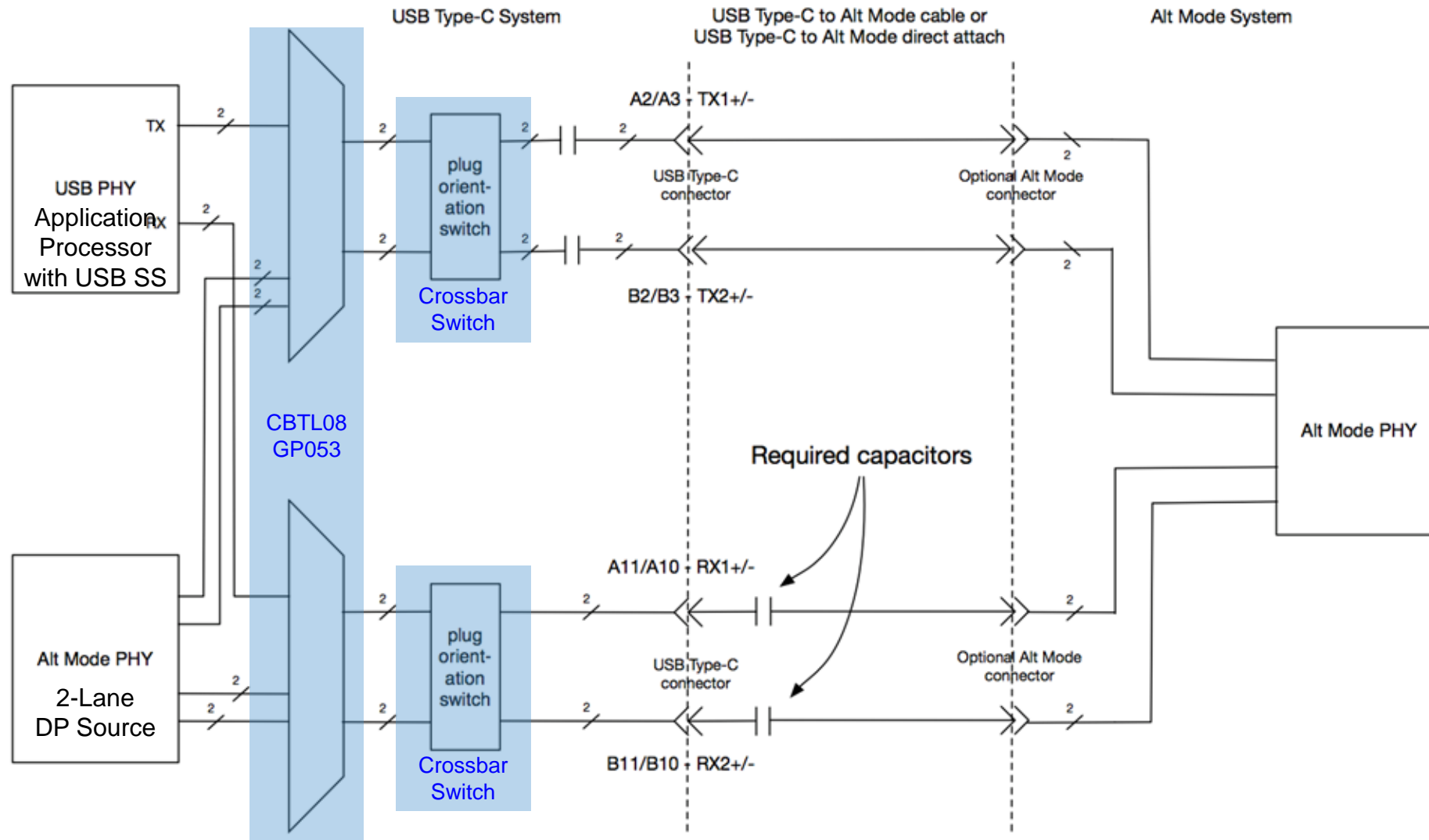


CBTL08GP053 – Application in DP ALT Mode (Host System)





CBTL08GP053 – Application in DP ALT Mode





NXP High Speed Analog Switches

Application Specific

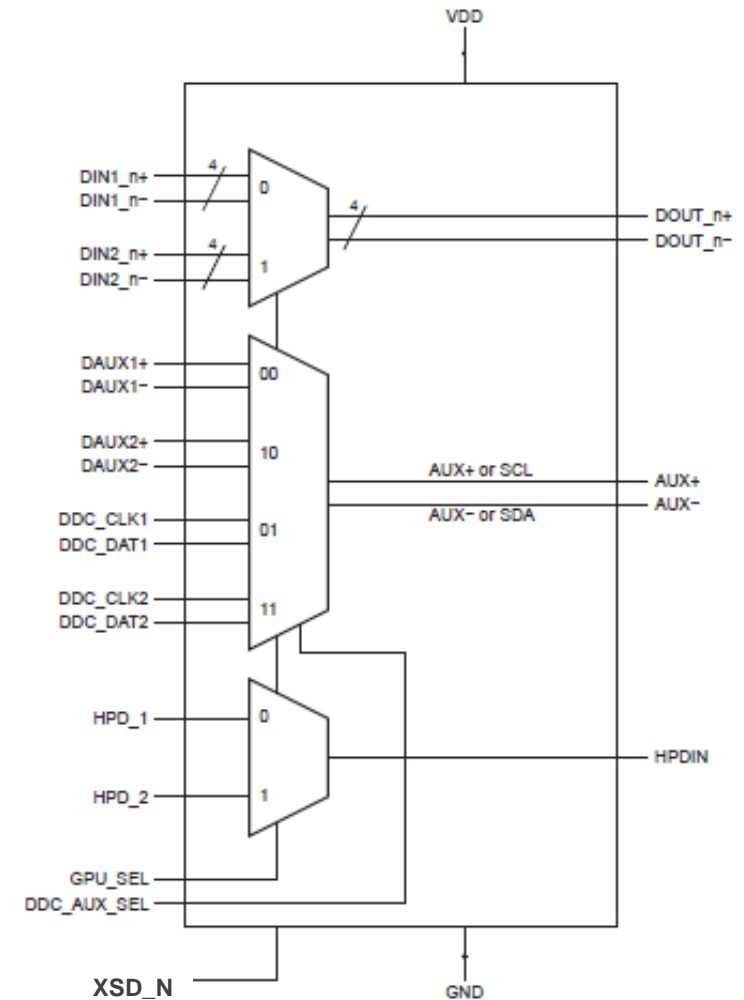
	BANDWIDTH	CHANNELS	INSERTION LOSS	CROSSTALK	OFF-ISOLATION	PART#
DisplayPort	11.1 GHz	6	-1.3dB @2.7GHz	-35dB @2.7GHz	-30dB @2.7GHz	CBTL06DP213
Thunderbolt	5.0 GHz	N/A	-0.5db @5MHz	-40db @5MHz	-75dB @5MHz	CBTL05023
	10.0 GHz	N/A				CBTL05024
HDMI	9.5GHz	6	-1.3dB @2.7GHz	-32dB @2.7GHz	-23dB @2.7GHz	CBTL06GP213
Memory	2.5GHz, DDR3	14				CBTW28DD14
	DDR4	12				CBTV24DD12



CBTL06DP213

High performance DPv1.2 Mux/De-mux/Switch

- Very High Performance Bi-directional Switch for DPv1.2 (5.4 Gb/s) applications
- Supports
 - 2:1 Multiplexing /Switching of 4 High Speed lanes of DP Main Link
 - 4:1 Multiplexing/Switching of DP AUX channels / DDC signals
 - 2:1 Multiplexing/Switching of DP HPD signal
 - 2 Selection pins and 1 shutdown pin
- Excellent Signal Integrity Performance
 - RON 14Ω
 - -3dB BW: 11 GHz
 - Diff. Return loss: -20 dB @ 100 MHz, -17 dB @ 1.35 GHz, -13 dB @ 2.7 GHz
 - Diff. Insertion loss: -0.9 dB @ 100 MHz, -1 dB @ 1.35 GHz, -1.3 dB @ 2.7 GHz
- 3.3 V supply voltage; Active Current consumption 2 mA typical, Shutdown current 10 uA
- ESD 2kV HBM, 500V CDM
- TFBGA48, 5x5mm,0.5mm ball pitch

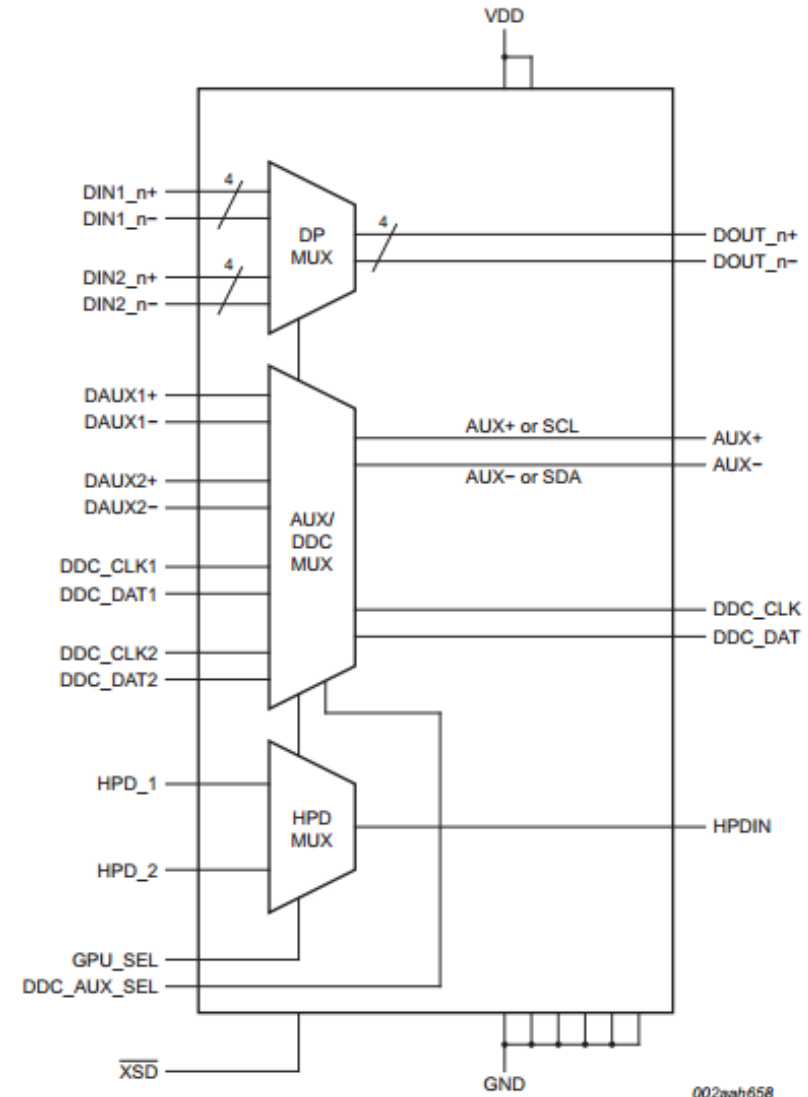




CBTL06GP213

General purpose HDMI Switch

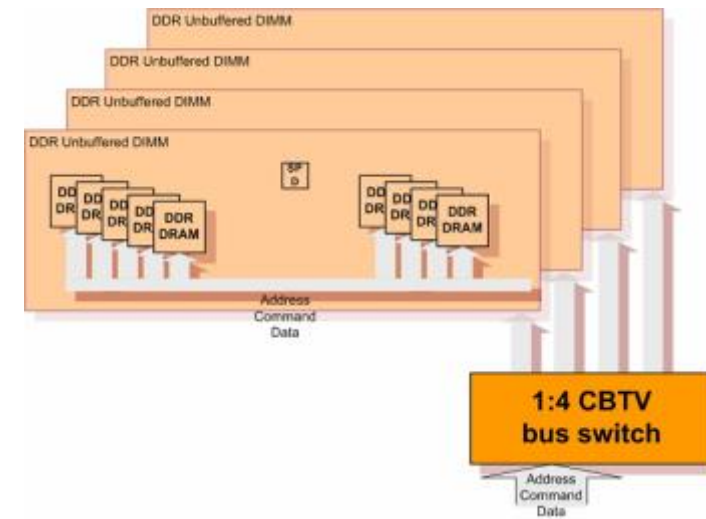
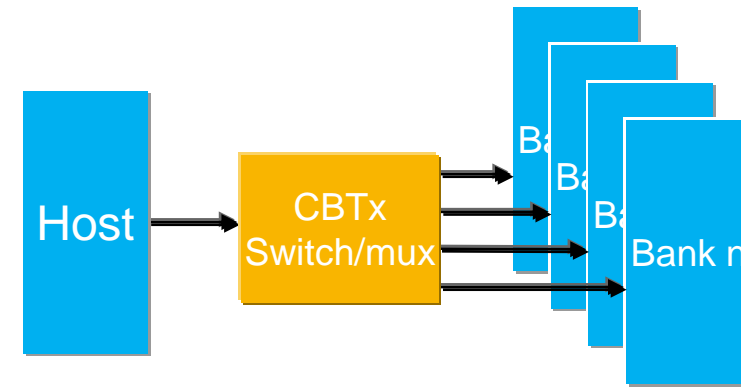
- 6-channel multiplexing
 - 4 high-speed differential channels 2:1 muxing
 - DisplayPort v1.2 @ 5.4Gbps
 - PCIe Gen2 @ 5.0Gbps
 - HDMI 1.4 @ 3.4Gbps
 - 1 channel 4:2 muxing for AUX and DDC
 - 1 channel 2:1 muxing for HPD
- Low intra-pair differential skew (5 ps typical)
- Low inter-pair skew (< 80 ps)
- Single 3.3 V supply voltage; shutdown pin
- Current consumption
 - Operation: 0.5 mA typical
 - Shutdown: < 10 μ A
- Input voltage: 4V max
- ESD 2kV HBM, 500V CDM
- Package: TFBGA50, 5mm x 5mm, 0.5mm pitch
 - Two additional balls at J3 and J7





CBTx Bus Switch Value Proposition

- **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)

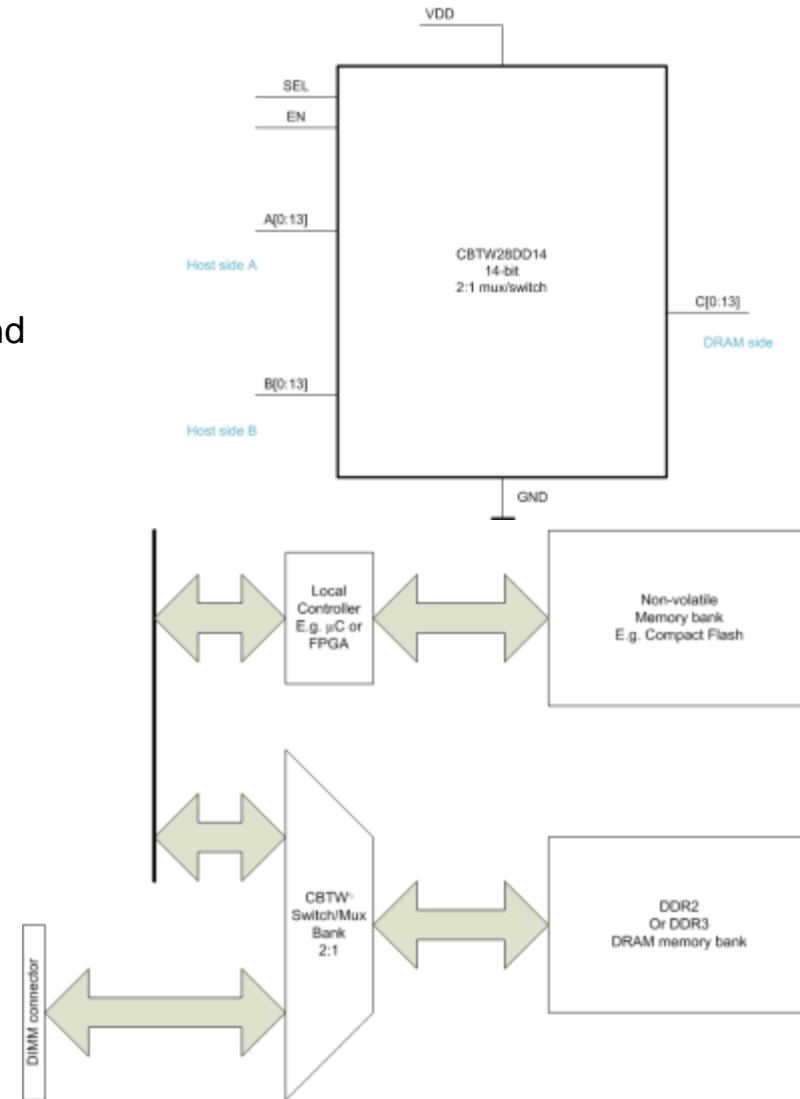




CBTW28DD14

DDR3 Mux

- 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 1.8 V signaling
- Switch/mux topology: 1:2
- ESD 4kV HBM, 1kV CDM
- TFBGA48 package, 4.5 x 4.5mm, 0.5 mm pitch



¹CBTW denotes a new family of CBT muxes suitable for 1.2 V and higher power supply operation

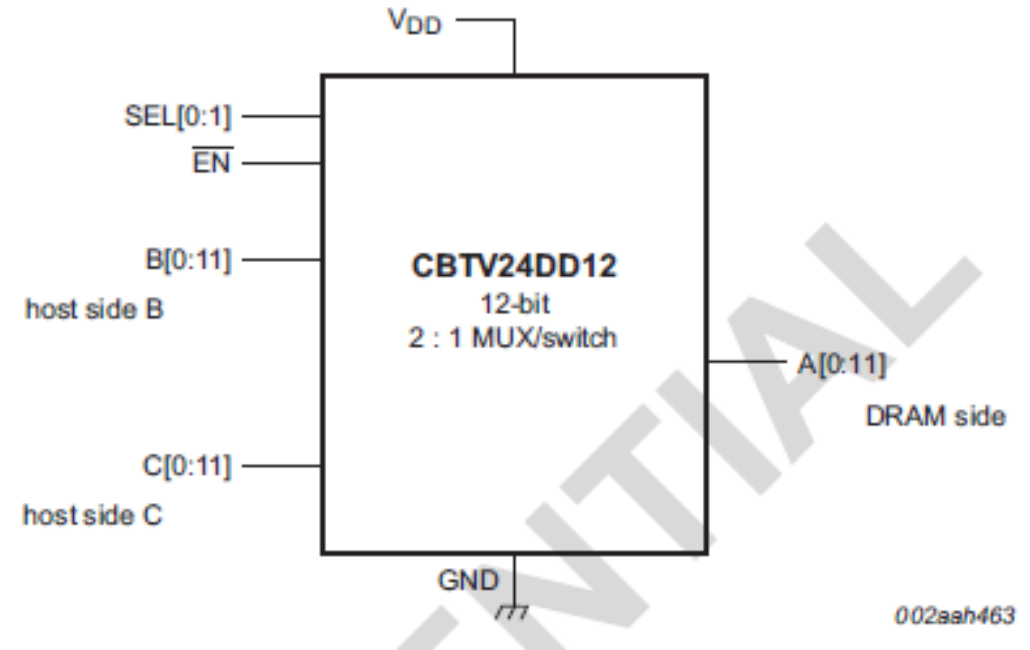




CBTV24DD12

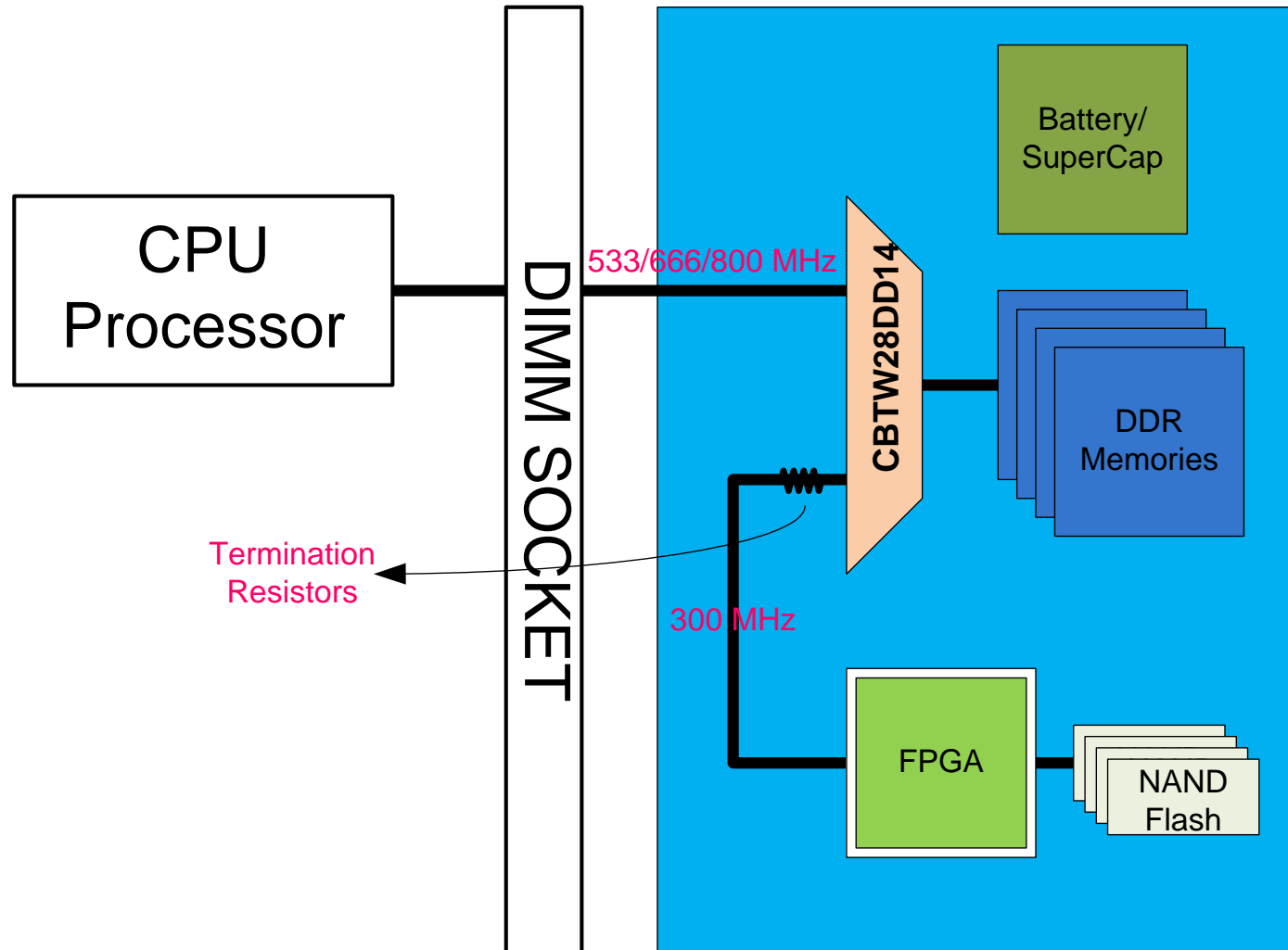
DDR3/DDR4 Mux

- Channel width: 12 bits
 - Optimal to fit one data lane each as well as divide address & command bus and auxiliary signals over remaining muxes
- Supply Voltage: 1.8V-3.3V
- Bandwidth: 8 GHz
- Input Return Loss: -16dB @ 4GHz
- Skew < 6ps (3 ps typical)
- R_{ON} : 8 ohms; ΔR_{ON} < 1 ohm
- Supports 3.2 GT/s throughput per lane
- Bidirectional ports
- CMOS select signals
- Switch/mux topology: 1:2
- ESD 2kV HBM, 1kV CDM
- VFBGA48 package, 3.0 x 8.0 x 1 mm, 0.65 mm pitch





Memory Mux Application Diagram



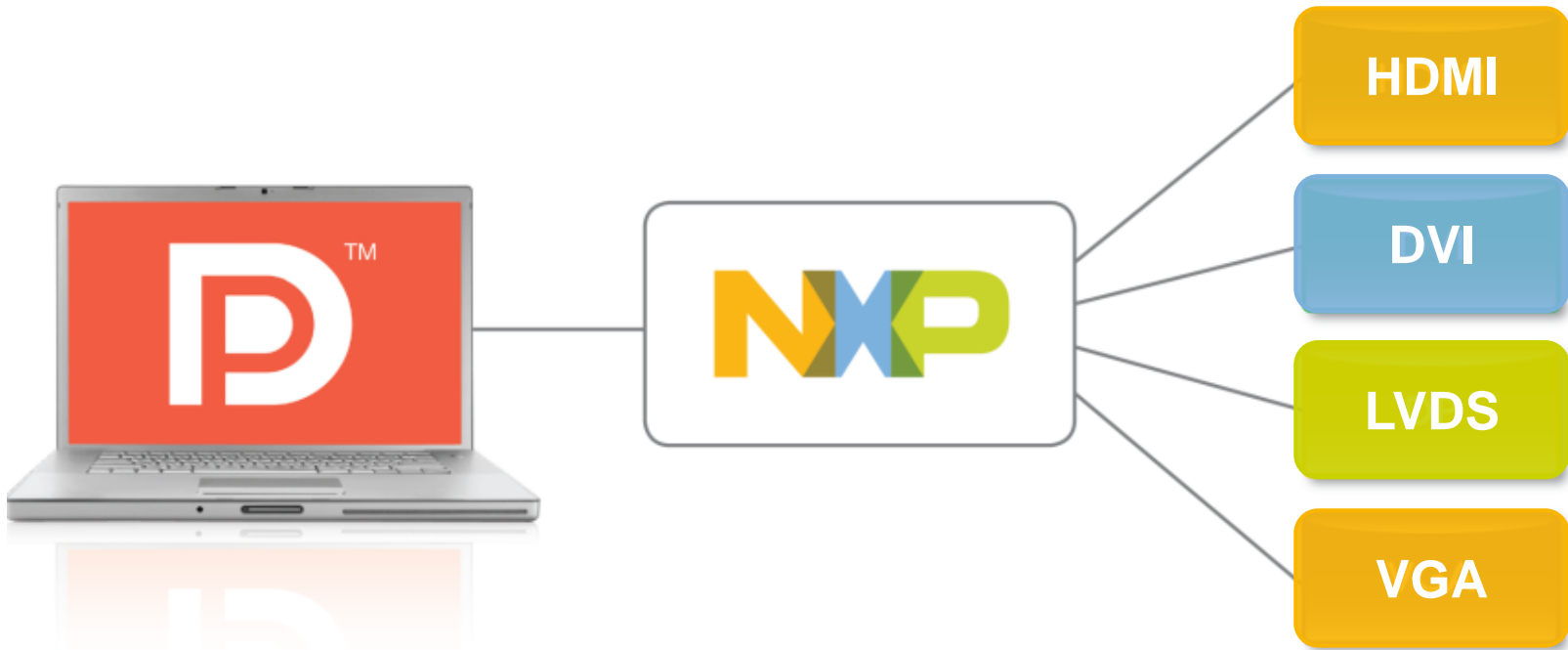


DISPLAY PORT SOLUTIONS















NXP enables DisplayPort





NXP DisplayPort Adapter Products

Part Number & Description	
PTN3363 Low power HDMI/DVI level shifter with active DDC buffer, supporting 3.4 Gbit/s operation DVI v1.0 and HDMI v1.4b compliant	 HDMI™
PTN3381B/D Enhanced DisplayPort-DVI/HDMI Level Shifters w/ DDC buffer and 5V voltage regulator, cost and feature optimized for dongle application	 HDMI™
PTN3360D Enhanced DisplayPort-HDMI Level Shifter with Deep Color Support for HDMI on Motherboard	 HDMI™
PTN3392 2-lane DisplayPort-to-VGA Adapter IC, cost and feature optimized for VGA dongle	 
PTN3355 2-lane DisplayPort-to-VGA Adapter IC, low power, small package optimized for motherboards (with Flash)	 
PTN3356 2-lane DisplayPort-to-VGA Adapter IC, low power, small package optimized for motherboards (with ROM)	 
PTN3460 DP-LVDS Adapter	 LVDS

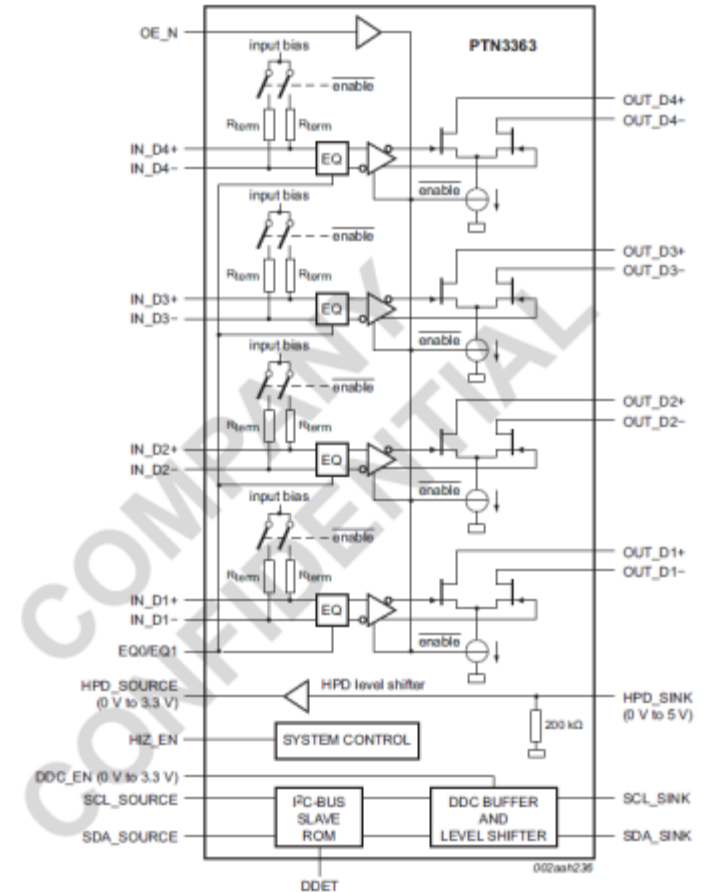




PTN3363 Low-Power DP to HDMI Level Translator

Active DDC buffer, 3.4 Gbps Operation

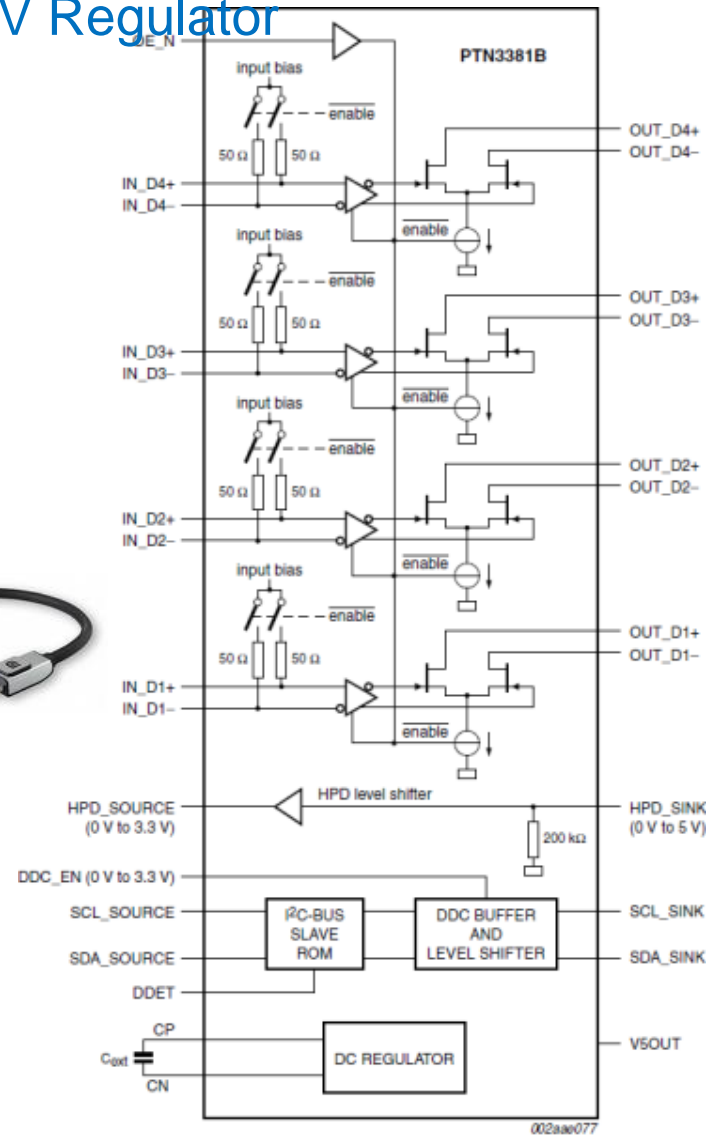
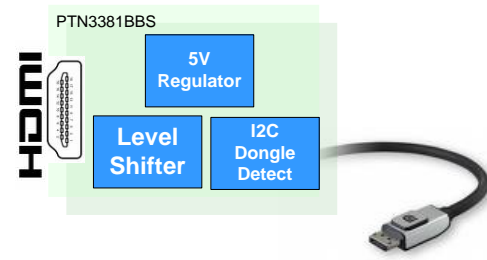
- Inputs
 - 4 pairs of low-swing AC-coupled differential for TX from display source to sink with integrated 50-Ω termination and bias voltage
 - Active DDC buffer
 - Non-inverting level-shifting HPD inverter
- Outputs
 - 4 pairs of TMDS outputs, up to 3.4 Gbps per lane
 - Back-current safe outputs to disallow current when device power off and monitor on
 - Supports HDMI Deep Color at 12 bits/color
 - 1 pair for DDC level translator/buffer
- Selectable Rx equalizer (0/2/4/6 dB)
- Data rate: 3.4 Gbps, supports 4K x 2K 3 Gbps and 3D video fmts
- On-board I²C-bus slave ROM
 - Detect presence of HDMI dongle through DDC channel
 - Up to 400 kHz I²C-bus clock frequency
- Supply voltage: 2.8 to 3.6V
- Operating temp: -40 to +105 °C
- ESD 8kV HBM
- Package: HVQFN 32-pin, 5x5 mm





PTN3381B HDMI Level Shifter w/ DDC Buffer & 3.3V/5V Regulator

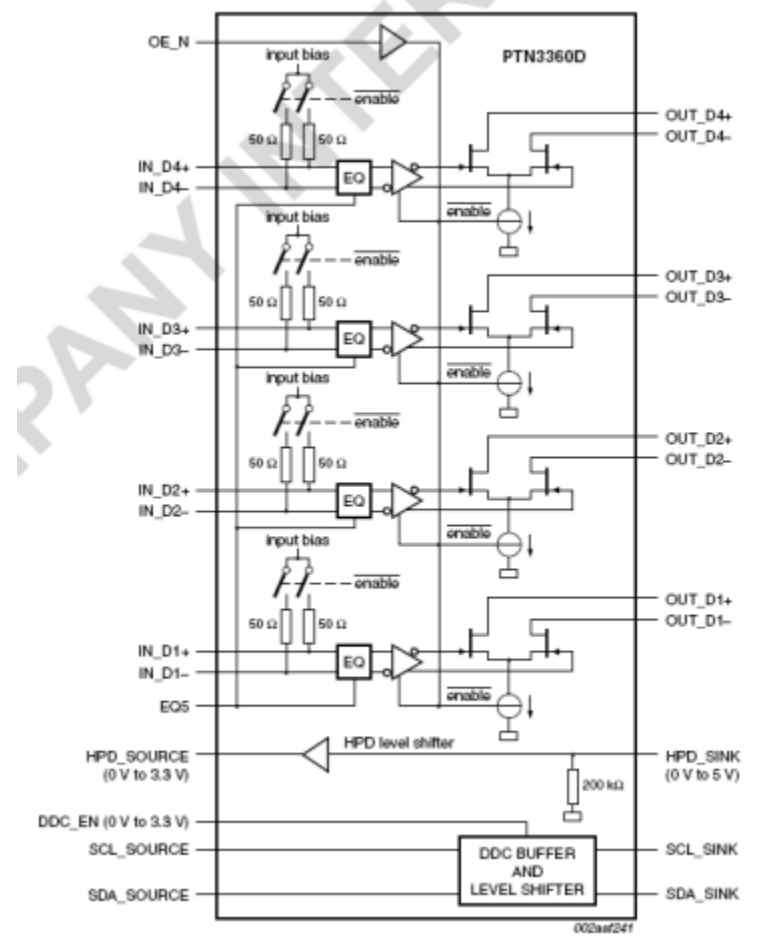
- Inputs
 - 4 pairs of low-swing AC-coupled differential for TX from display source to sink with integrated 50-ohm termination resistors and bias voltage
 - 1 HPD from display HPD_Sink to GMCH HPD_Source
 - 1 pair for DDC (I²C SCL and SDA)
- Outputs
 - 4 pairs of TMDS outputs - Up to 1.65Gb/s per lane
 - 1 pair for DDC level shifter
 - Optional I²C-based HDMI dongle detect
- Respond to HDMI dongle detect via I²C (option pin)
 - **Mandatory feature for DisplayPort-HDMI dongle**
- 3.3V ± 10% power supply
- Active current 30mA typical
- -40 to +85 °C
- ESD 4kV HBM
- PTN3381BBS: HVQFN-48, 7x7 mm
- PTN3381B = PTN3361B + Integrated 3.3V to 5V Voltage Regulator
 - **Integrated solution for Low-cost DP-HDMI Dongle**
 - 3.3V to 5V voltage regulator (55mA)





PTN3360D AC-Coupled to DVI/HDMI Level Shifter

- Inputs
 - 4 pairs of low-swing AC-coupled differential for TX from display source to sink with integrated 50-ohm termination resistors and bias voltage
 - 1 HPD from display HPD_Sink to GMCH HPD_Source
 - 1 pair for DDC (I²C SCL and SDA)
- Outputs
 - 4 pairs of TMDS outputs - up to 2.5Gb/s per lane
 - Supports HDMI Deep Color at 12bits/color
 - 1 pair for DDC level shifter / buffer
- Programmable equalizer
- Non-inverting level-shifting HPD inverter
- 3.3V ± 10% power supply
- Active current 70mA typical
- -40 to +85 °C
- ESD 6kV HBM
- HVQFN 48-pin package, 7x7 mm





DP-DVI Reference Design

NXP DP-DVI dongle with PTN3361B or PTN3381B

- Availability: NOW
- Hardware:
 - Hardware ready for both PTN3361B and PTN3381B (stuff option)
 - Form factor optimized as a production-ready dongle
 - Reflects best practices in schematics and layout
 - Reflects best-in-class BOM cost
 - Constitutes a **reference design** of PTN3361B, PTN3381B



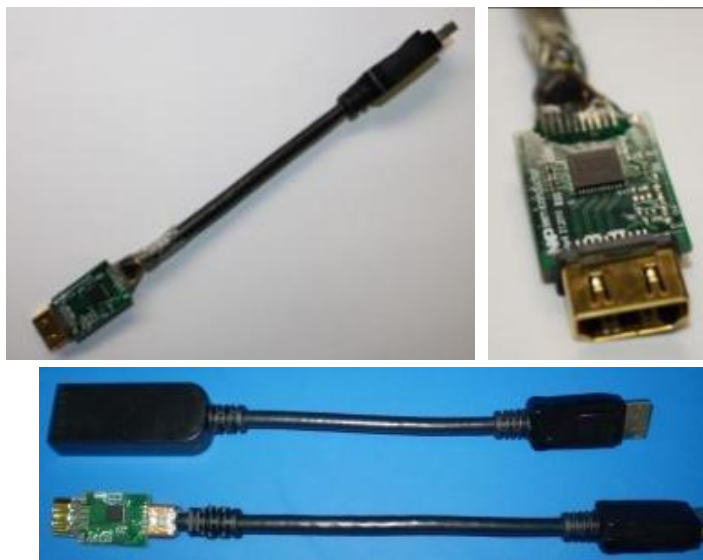
- Contents
 - Full schematic and layout
 - Bill of Materials
 - Design and layout guidelines for optimal performance and EMC
- Purposes
 1. Customer reference design
 2. PTN3361B/3381B interop testing
 3. Trade show demos



DP-HDMI Reference Design

NXP DP-HDMI dongle with PTN3361B or PTN3381B or PTN3381D

- Hardware:
 - Hardware ready for both PTN3361B and PTN3381B/81D (stuff option)
 - Form factor optimized as a production-ready dongle
 - Reflects best practices in schematics and layout
 - Reflects best-in-class BOM cost
 - Constitutes a reference design of PTN3361B, PTN3381B and PTN3381D

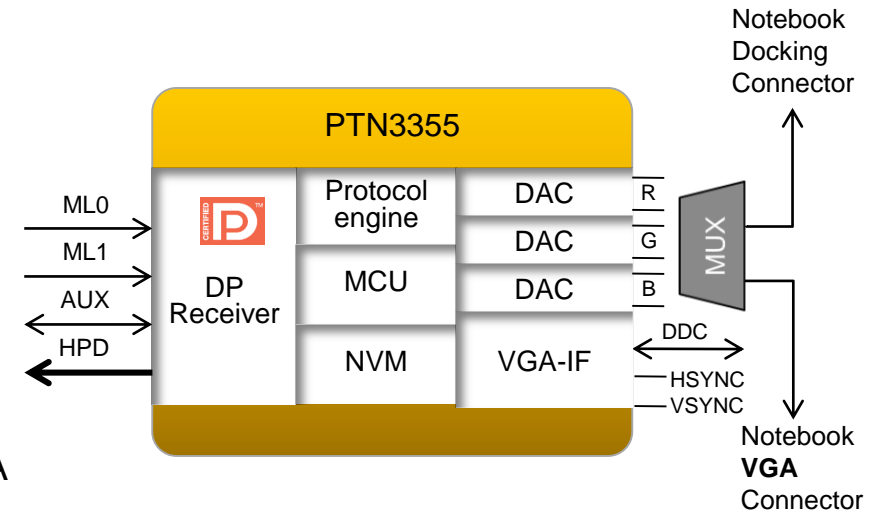


- Contents
 - Full schematic and layout
 - Bill of Materials
 - Design and layout guidelines for optimal performance and EMC
- Purposes
 1. Customer reference design
 2. PTN3361/3381 interop testing
 3. Trade show demos



PTN3355 – DisplayPort to VGA Bridge with VGA Mux

- DisplayPort receiver (eDP v1.3/DP1.2a)
 - 1-lane / 2-lane 2.7 Gbps / 1.62 Gbps
 - AUX channel, HPD support
- 2 VGA output ports
 - Analog RGB, up to 240 MHz, 8-bit color
 - 3.3V HSYNC, VSYNC outputs
 - DDC, AUX channel to I²C DDC channel bridge
- Resolutions: QWXGA, QXGA, WUXGA, UXGA, SXGA (CRT), SXGA, XGA, VGA
- Supply voltage: 2.8 to 3.3V
- Operating temp: 0 to 70 °C
- No support for HDCP or audio
- Support fast link training, full link training
- eDP Content Protection mechanisms
 - Supports alternate framing
 - Supports alternate scrambler reset
- HVQFN40, 6x6mm, 0.5mm pitch, 1 mm height (max)
- ESD HBM 8kV



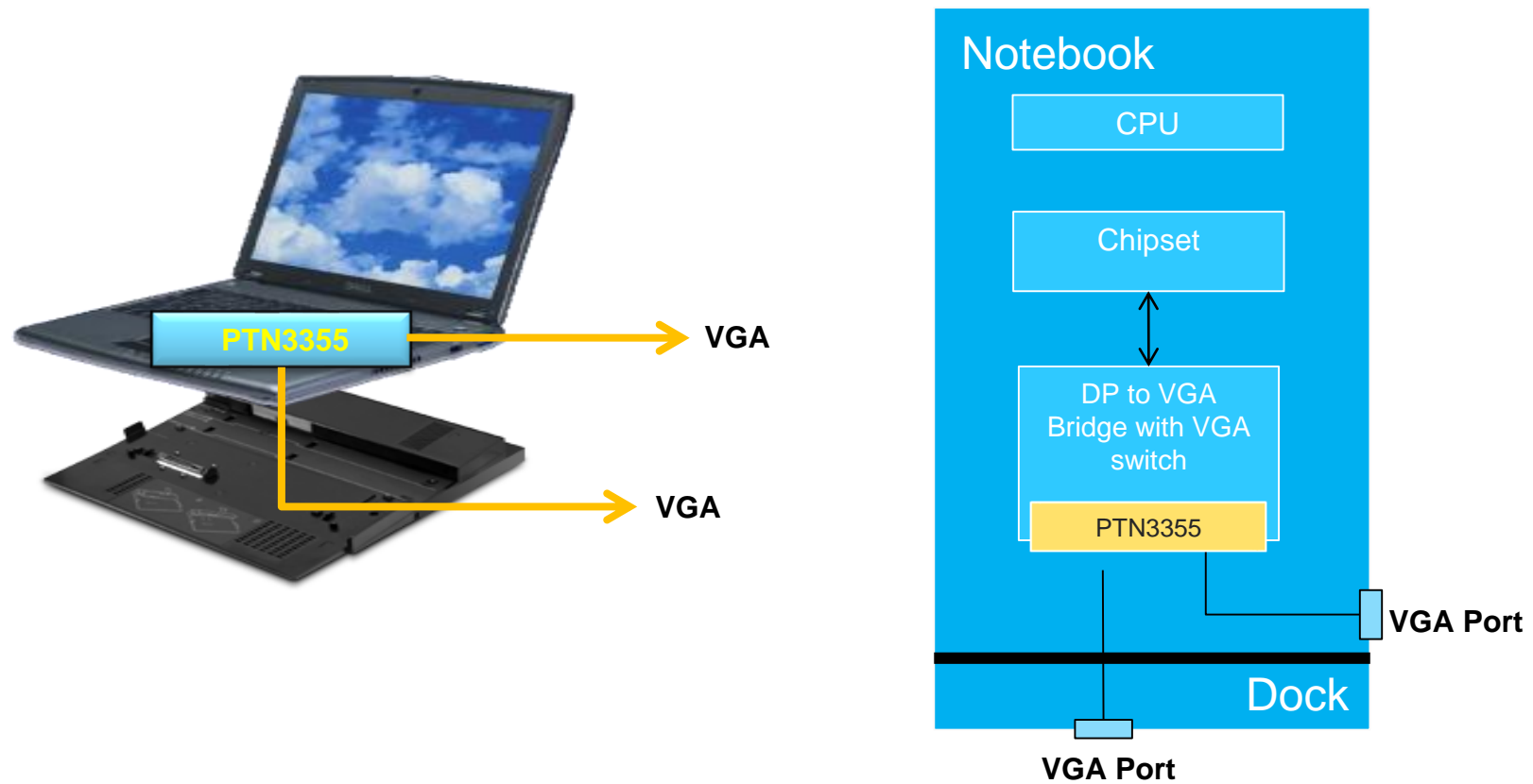
	RESOLUTIONS	PIXEL CLOCK
QXGA	2048 x 1536 @ 50 Hz	173 MHz, 18bpp
QWXGA	2048 x 1152 @ 60 Hz	156 MHz, 24 bpp
WUXGA	1920x1200 @ 60Hz	154 MHz, 24 bpp
UXGA	1600 x1200 @ 60Hz	162 MHz, 24 bpp
SXGA (CRT)	1280x1024 @ 80Hz	135 MHz, 24 bpp
SXGA	1280x1024 @ 60Hz	108 MHz, 24 bpp
XGA	1024x768 @ 60Hz	65 MHz, 24 bpp
VGA	640x480 @ 60Hz	25 MHz, 24 bpp





DP-to-VGA Bridge for OEM Platform – Use Case

PTN3355 with integrated VGA port switching on Notebook main board

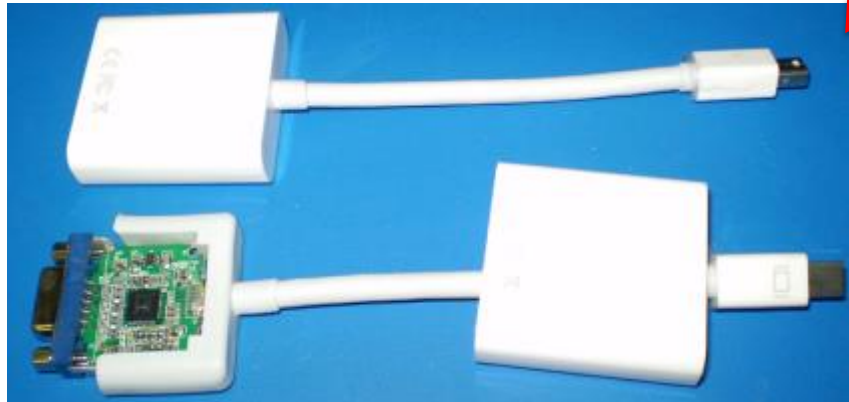




DPVGA4M and mDPVGA4M

NXP DP-VGA reference design dongle with PTN3392

Complete with plastic encasing



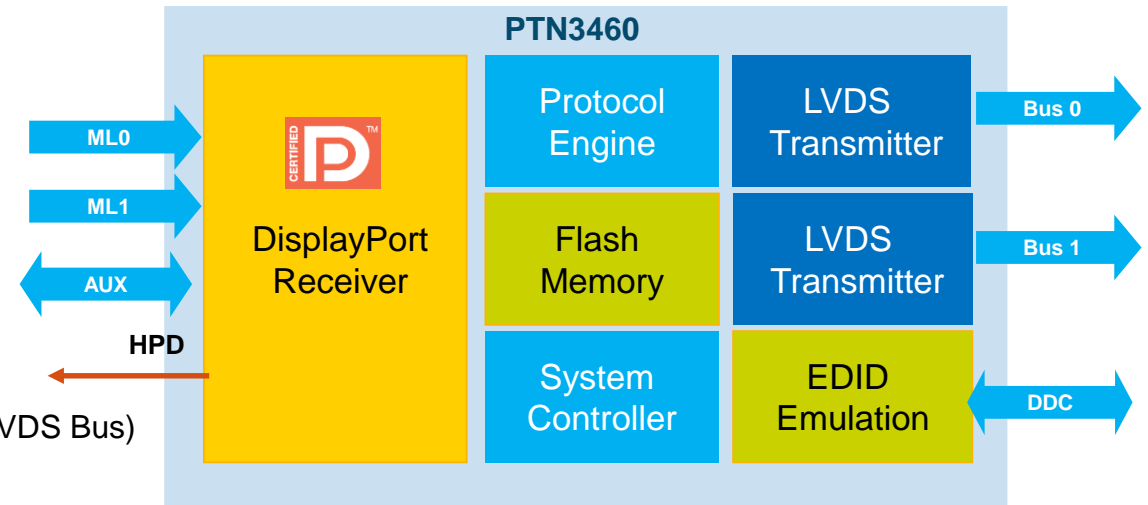
- Availability: NOW
- Reference Dongle Design w/
 - regular DP connector and
 - mini DP connector
- Uses PTN3392
- Production-ready form factor
- Reflects best practices in schematics & layout
- Reflects best-in-class BOM cost
- Optimized for EMI
- Optimized for VSIS performance
- Purity of signals, reference planes
- Final PTN3392 ref design schematic / BOM
- Minimized size
- Optimized component cost / quality
- No external ESD protection needed for passing IEC ESD tests





PTN3460 and PTN3460I: eDP-to-LVDS Adapter

- Embedded DisplayPort (eDP) Receiver
 - 1-lane/2-lane, 1.62/2.7Gbps
 - 1 Mbps AUX channel, HPD support
 - Support of Full Link Training and Fast link training with auto equalization
- LVDS Transmitter
 - Single or Dual Buses. Color depths – 18/24 bpp
 - Supports up to 1920 x 1200, 60 Hz, 24 bpp
 - Pixel clock 112 MHz (max).
 - Pixel Data Rate max.112 Mpixels/s (Single LVDS Bus) and 224 Mpixels/s(Dual LVDS Bus)
 - EDID support via AUX to I²C DDC bridge
- EMI Reduction Support
 - Down spreading support on DisplayPort interface
 - Center spreading support on LVDS interface
- eDP Content Protection mechanisms
 - Support Alternate Framing and Alternate Scrambler Seed Reset
- EDID ROM Emulation up to 8 EDID Data
- Power supply – 3.3V, 3.3V/1.8V
- Industrial temp version: PTN3460I
- ESD 7KV HBM
- HVQFN56 Pkg (7mm x 7mm x 0.85mm, 0.4mm pitch)



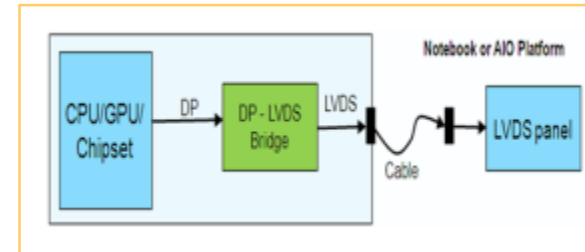
Mode	Resolution	LVDS Channel	Pixel Clock
WUXGA	1920x1200 @ 60Hz	Dual	96.5MHz
UXGA	1600 x1200 @ 60Hz	Dual	81MHz
SXGA	1280x1024 @ 60Hz	Dual	108MHz
XGA	1024x768 @ 60Hz	Single	65MHz
VGA	640x480 @ 60Hz	Single	25MHz



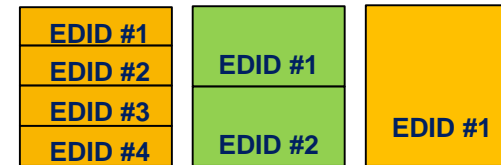


PTN3460 Value Proposition

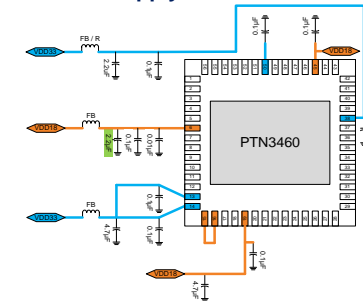
- Display Port Link Control Functions
 - Auto DP Equalizer
 - Equalization gain up to 15 dB
 - Optimal link performance thru DP link
 - Host power saving
 - Extended Control over DP AUX
 - Pulse Width Modulation through DP AUX (eDP v1.2 spec)
 - Backlight Mode set register
 - Max. of 16 bits for Backlight brightness control
- Automatic Power Sequence Control
- Embedded Flash memory for BoM saving
 - No EEPROM for device configuration
 - No EEPROM for EDID Emulation. On chip memory size up to 1K bytes.
- ▶ Single 3.3v power supply operation or dual 3.3v/1.8v power supply operation for further power reduction
- ▶ Integrated LDO regulator without voltage regulation Inductor coil
- ▶ Selectable Configurability & Feature Rich Settings



Example EDID Block Configurations

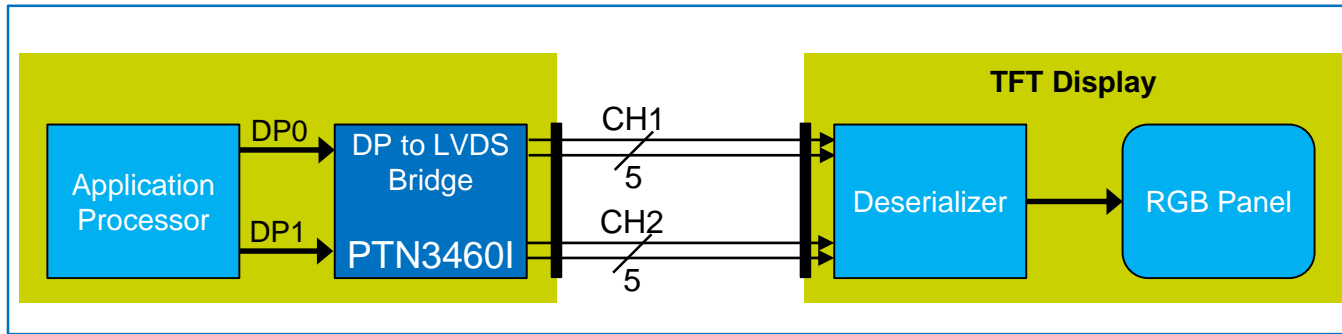


Power Supply Connections





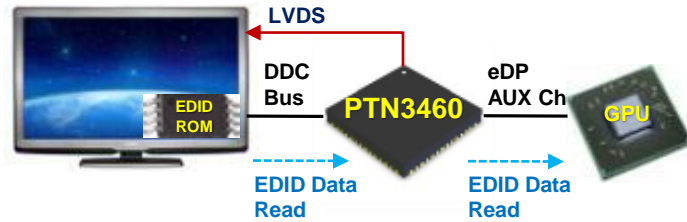
PTN3460I DP-LVDS Adapter



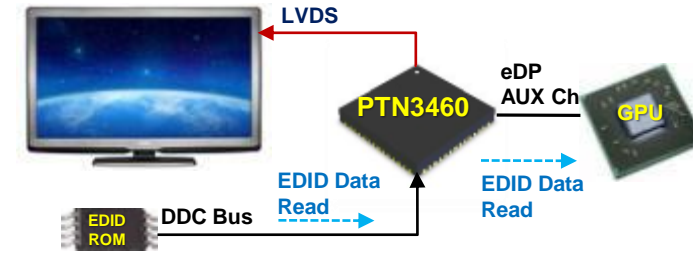
- New generation processors (Intel, AMD, Nvidia, Marvell, and TI) which only support DisplayPort will need a way to interface with LVDS/RGB panels.
- NXP bridge converts DP or eDP signals to LVDS to enable new processors to interface with standard TFT displays.
- Two High-Speed DisplayPort Inputs:
 - Compliant with DP v1.1a, DP v1.2, eDP v1.1, and eDP v1.2
 - Supports link rates of 1.62 Gbits/s and 2.7 Gbits/s
 - Supports 1-lane and 2-lane data transfer
- Two LVDS Output Buses:
 - Supports single bus and dual bus
 - Supports color depth of 18 bits/pixel and 24 bits/pixel
 - Supports RGB data packing as per VESA and JEIDA R data formats



Flexible EDID Data Read Support



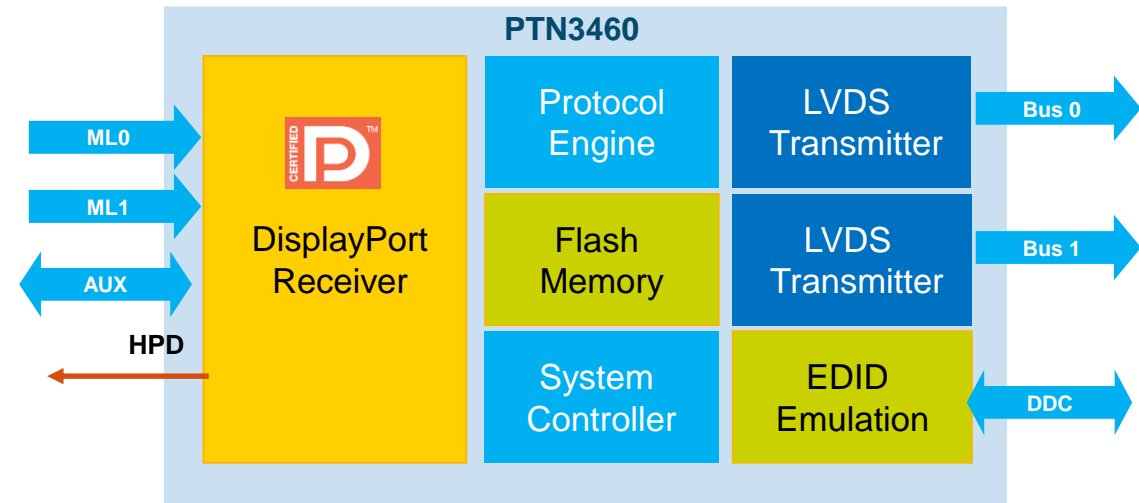
1. PTN3460 reads the EDID data from display panel via DDC bus
2. GPU sends EDID Read command (I²C-Over-Aux) to PTN3460
3. PTN3460 forwards the EDID data to GPU via eDP AUX channel



1. PTN3460 reads the EDID data from standalone E2PROM
2. GPU sends EDID Read command (I²C-Over-Aux) to PTN3460
3. PTN3460 forwards the EDID data to GPU via eDP AUX channel

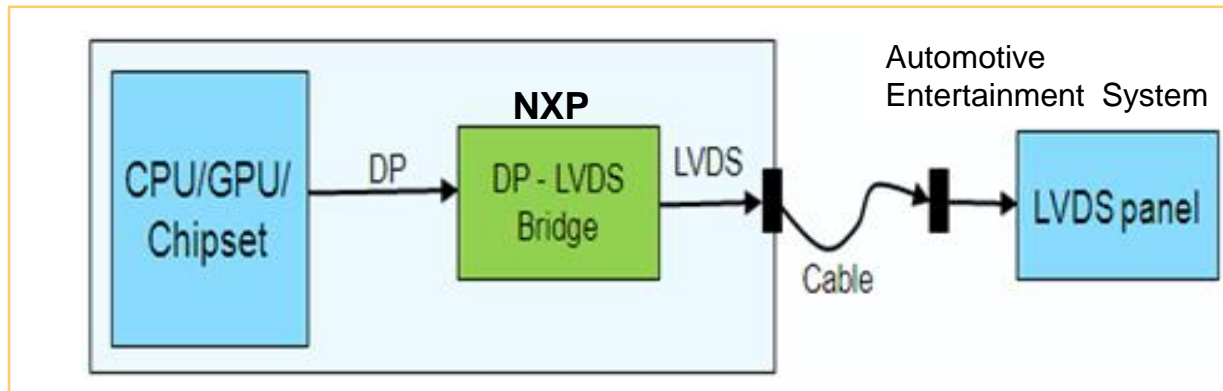


1. PTN3460 stores the EDID data in the embedded flash RAM
 2. GPU sends EDID Read command (I²C-Over-Aux) to PTN3460
 3. PTN3460 forwards the EDID data to GPU via eDP AUX channel
- * Value proposition – Save the cost of using external memory chip





OM11064: PTN3460 eDP-to-LVDS Demo





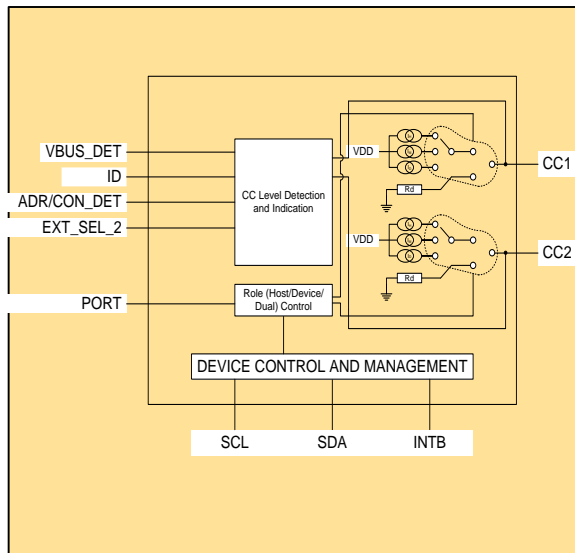
USB TYPE-C PD CONTROLLER & CC-LOGIC CONTROLLER



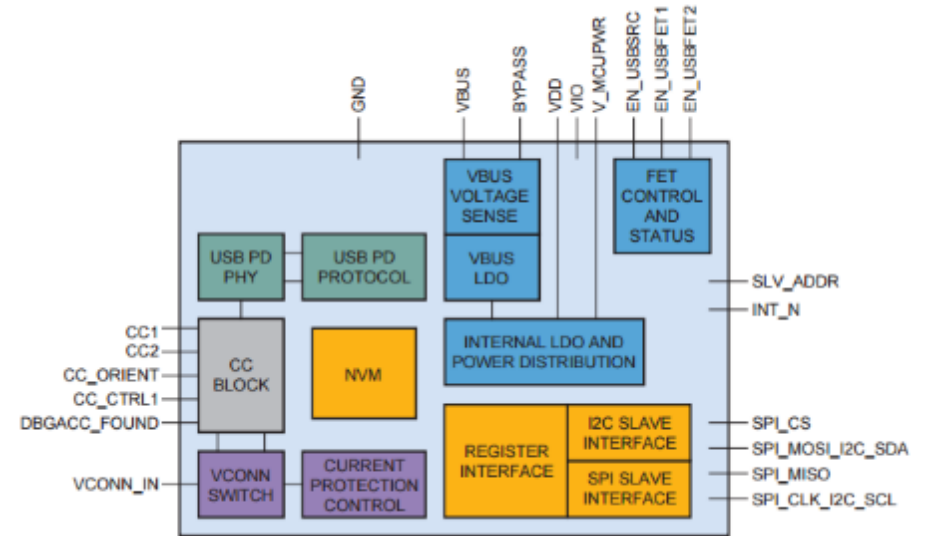
USB Type-C PD PHY and CC Logic Controller

PTN5150
CC Logic

PTN5110
PD PHY



Type-C CC logic,
Legacy USB, OTG



USB TCPC PHY

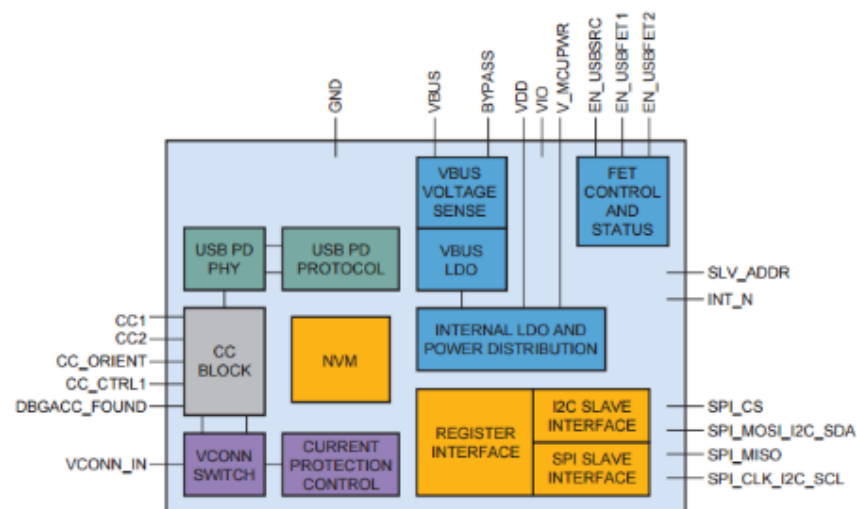




PTN5110 – USB Type-C Port Controller (TCPC) PD PHY

Description

- Target compliance to PD3.0, Type-C 1.2 and TCPC Version 1.0, Rev. 1.2
- Implements TCPC PHY with register interface towards TPCM along with vendor defined extensions to support PD3.0
- VDD range from 2.7V to 5.5V
- Integrated VCONN with over current limiting, short-to-GND and temperature protection
- VBUS discharge (Force and Bleed) support
- VBUS dead battery power supply (4.0V to 25V, 28V Max Tolerance)
- VBUS voltage monitor with 10-bit ADC
- I2C based host interface (up to 1Mbps). Provides up to 4 slave addresses, enabling PHY user for multiple ports.
- Provides GPIO for debugging accessory indication, fast role swap for “arming” 5V load switch, and 5V load switch ILIM selection control
- Provides VBUS source and sink power path control signal
- [Available in:](#) X2QFN16 2.6 x 2.6 mm, 0.4 mm pitch



Applications	Part Number	Power-Up Mode	Interface	Use Case
Notebook	PTN5110	DRP	I ² C	Notebook, Ultrabook
Desktop	PTN5110T	DFP	I ² C	Desktop, AIO
Dongle Docking	PTN5110D	UFP	I ² C	Docking and Dongle
Enables the Embedded Controller (EC) to act as a PD Controller				

OM13585UL - PTN5110 Host Board

OM13586UL - PTN5110 Dock Board

OM13587JP - PTN5110 Type-C Demo Kit

OM13588xx - Shield Board for i.MX/Kinetis (xx [TBD] will be either UL or JP)



PTN5150/PTN5150A – USB Type-C CC Logic Controller

- **Features:**

- Complies to USB Type-C Rev 1.1
- Can work autonomously or can connect to a controller through I2C-bus interface
- PTN5150A: Pin 11 = EXT_SEL output to control USB data switch, e.g. PTN36043 (USB 3.0 Active Switch)
- PTN5150: Pin 11 = ENB (Enable input pin, active low)

- **DFP/DRP/UFP Advertisement**

- DFP Rp = 80/180/330μA
- UFP Rd = 5.1KΩ

- **Supports:**

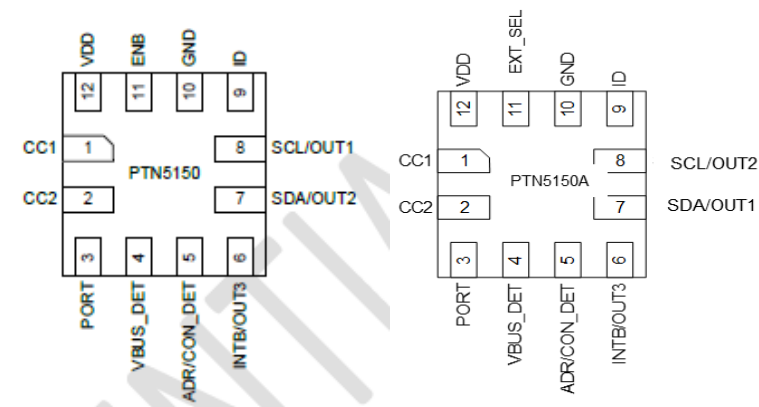
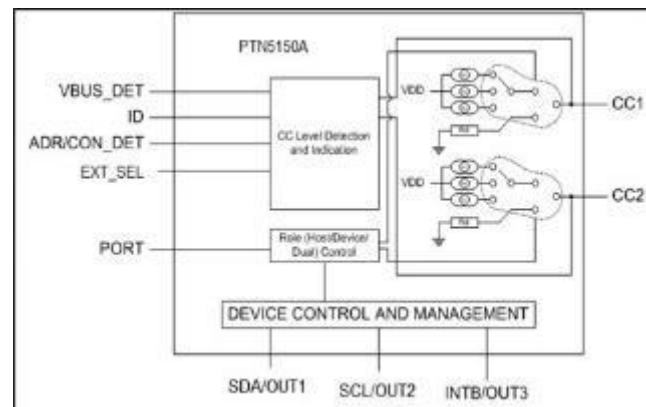
- Cable/plug insertion / removal detection
- Orientation detection
- Role and charging current detection

- **Dead battery mode**

- **Current consumption:**

- Standby in dual-role mode: 50μA
- Standby in host mode: 40μA
- Standby in device mode : 40μA

- **Package: 12-pin HVQFN (1.6mm x 1.6mm)**



Applications

Part Number

Interface

Use Case

Applications	Part Number	Interface	Use Case
Smartphone, Computing and Accessories	PTN5150A	Pin 11 = EXT_SEL	EXT_SEL directly controls PTN36043 or CBTL02043. Save one GPIO pin from PMIC to USB 3.0 Switch
Smartphone, Computing and Accessories	PTN5150	Pin 11 = ENB Active Low	Pin-to-pin compatible with competitors (TI & Pericom). When PMIC use active low to enable CC logic chip.

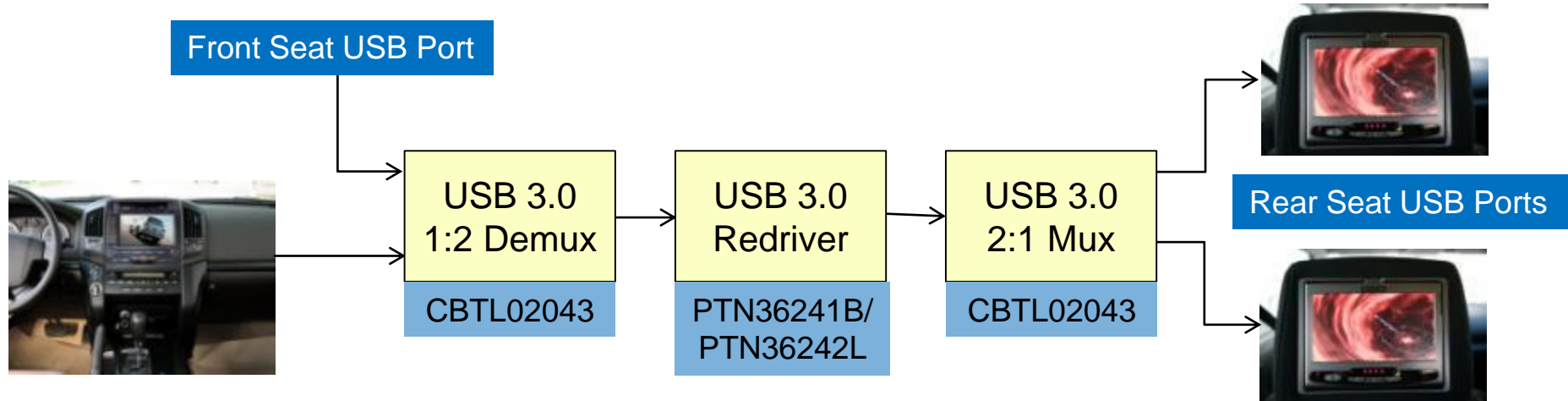


USB 3.0 RE-DRIVERS





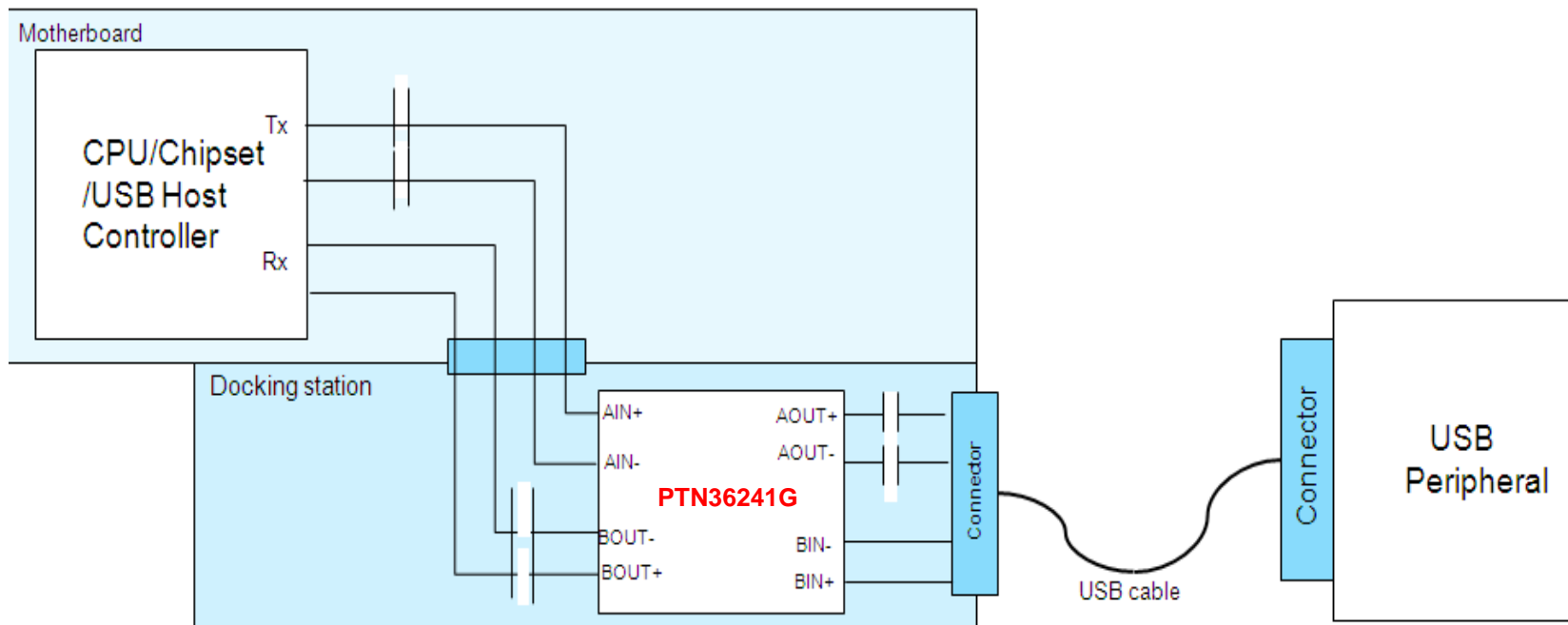
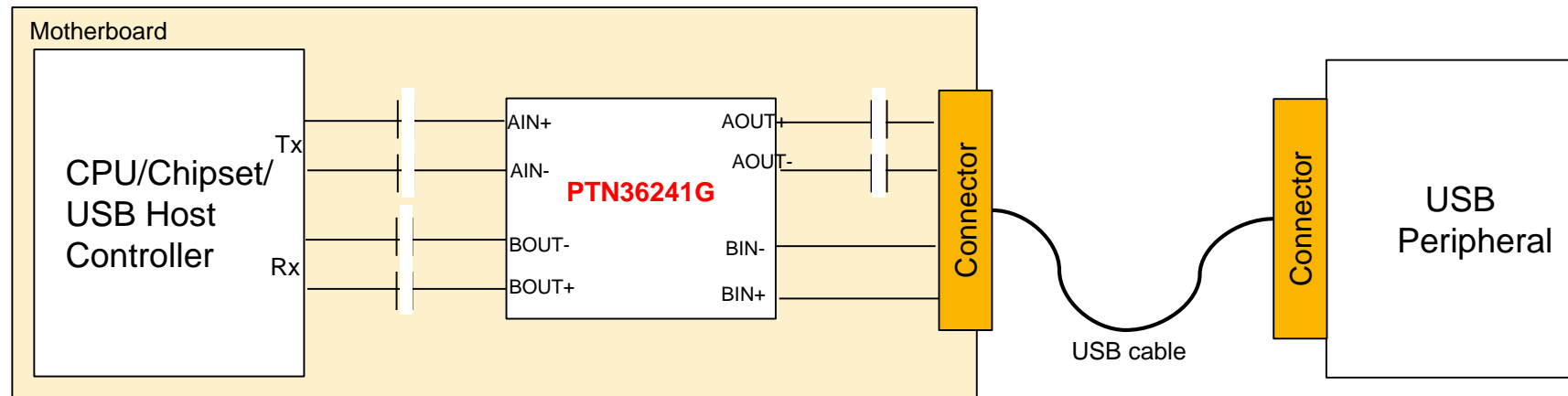
Applications for USB3.0 Interface Products



- USB 3.0 Redriver
 - Improve system reliability and compliance to USB 3.0 specifications
 - Flexibility of placement of USB 3.0 controller and PHY (e.g. driving the USB 3.0 signals from Infotainment Processor in front panel to the back seat)
- USB 3.0 Muxes and Switches
 - Demultiplexing the signals from an internal hard drive and external USB 3.0 connector
 - Multiplexing the USB 3.0 interface to two interfaces in rear seat



USB3.0 Re-drivers Example Usage Models





USB3.0 Re-drivers and Active Switch Overview

- Single and dual-port options
- 5-Gbps bandwidth

DESCRIPTION	BANDWIDTH	SETTINGS	POWER SAVING	PART#
USB 3.0 Single Port	5 Gbps	5-state quinary pins OS, EQ, DE	53 mW @ U2/U3 20 mW @ No Connect 10 mW @ Sleep mode	PTN36241B
USB 3.0 Dual Port	5 Gbps	binary pins OS, EQ, DE	66 mW @ U2/U3 26 mW @ No Connect 0.5 mW @ Sleep mode	PTN36242L
USB 3.0 Half Port (Single Channel)	5 Gbps	adjustable RX equalization, TX de-emphasis & output swing	active: 97 mW (54mA) deep power saving: 18 μ W (10 μ A)	PTN36221A
USB 3.0 Single Port	5 Gbps	adjustable RX equalization both channels, TX de-emphasis & output swing		PTN36241G PTN36001
USB3.0 Single Port Active SW	5 Gbps	adjustable RX equalization both channels, TX de-emphasis & output swing		PTN36043
USB3.0 + DP1.2 Combo Re-driver	USB3: 5Gbps DP: 1.62Gbps, 2.7Gbps, 5.4 Gbps	I2C or GPIO		PTN36502
USB 3.0 Dual Port	5 Gbps	adjustable RX equalization both channels, TX de-emphasis & output swing	VDD=1.8V	PTN36002





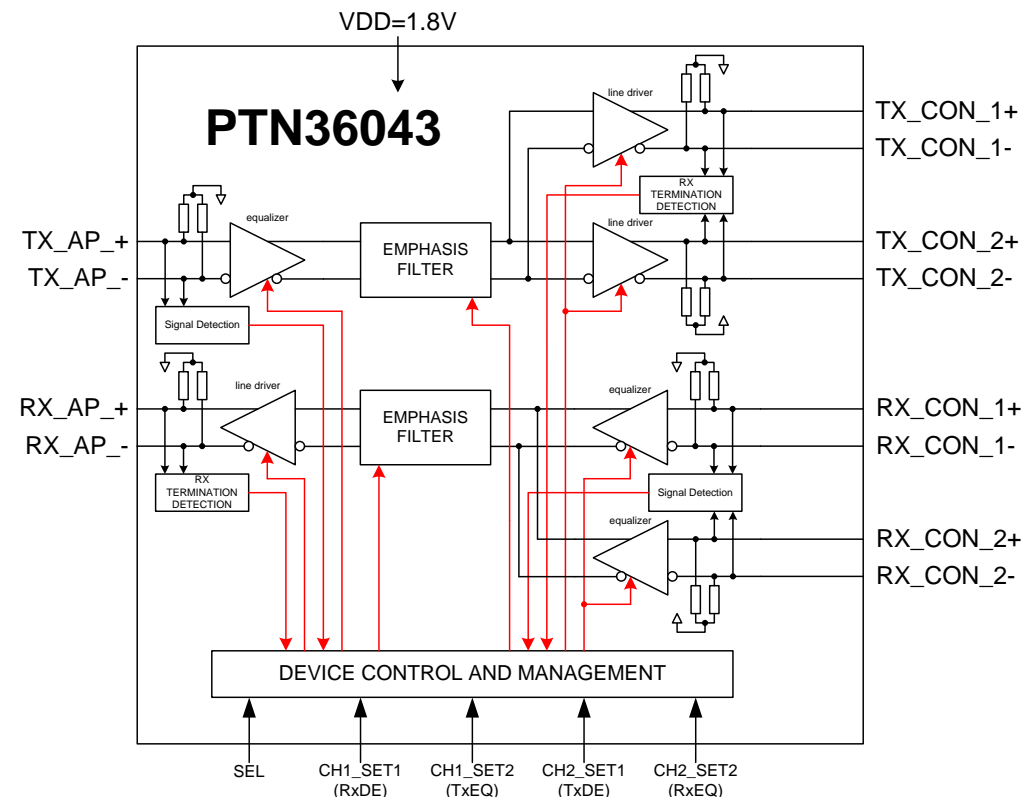
USB3.0 Re-drivers and Active Switch Overview

	New PTN38003	New PTN3814	PTN36502	PTN36043	PTN36241G	PTN36001
Features	Combo USB 10Gbps DP 1.4	DP1.4 Redriver	Combo USB 5Gbps DP 1.2	USB 5Gbps	USB 5Gbps	USB 5Gbps
Port Configuration	4 x 4	4 x 4	4 x 4	1 x 2	Single	Single
Power Supply	1.8V	1.8V	1.8V	1.8v	1.8v	1.8v
Rx Equalizer TX De-Emphasis Control	I2C & GPIO	I2C & GPIO	I2C & GPIO	GPIO	GPIO	GPIO
Power Consumption* Active Disable mode	450mW 18uW	450mW 18uW	207mW 5.4uW	189mW -	189mW 3.6uW	200mW 11uW
Package	HWFLGA36 (2.1 mm x 6.0 mm x 0.6mm, 0.4mm pitch)	HWFLGA36 (2.1 mm x 6.0 mm x 0.6mm, 0.4mm pitch)	DHXQFN24 2.4x3.2 x0.35mm, 0.4 mm pitch	DHXQFN18 2.4x2.0x0.35 mm, 0.4 mm pitch	X2QFN12 1.25x2.1x 0.35mm, 0.4 mm pitch	X2QFN12 1.25x2.1x 0.35mm, 0.4 mm pitch
Target Application	Mobile	Computing	Mobile	Mobile	Mobile	Computing
Availability	ES	ES	Production	Production	Production	Production



PTN36043 – USB Type-C Super Speed Redriver Switch

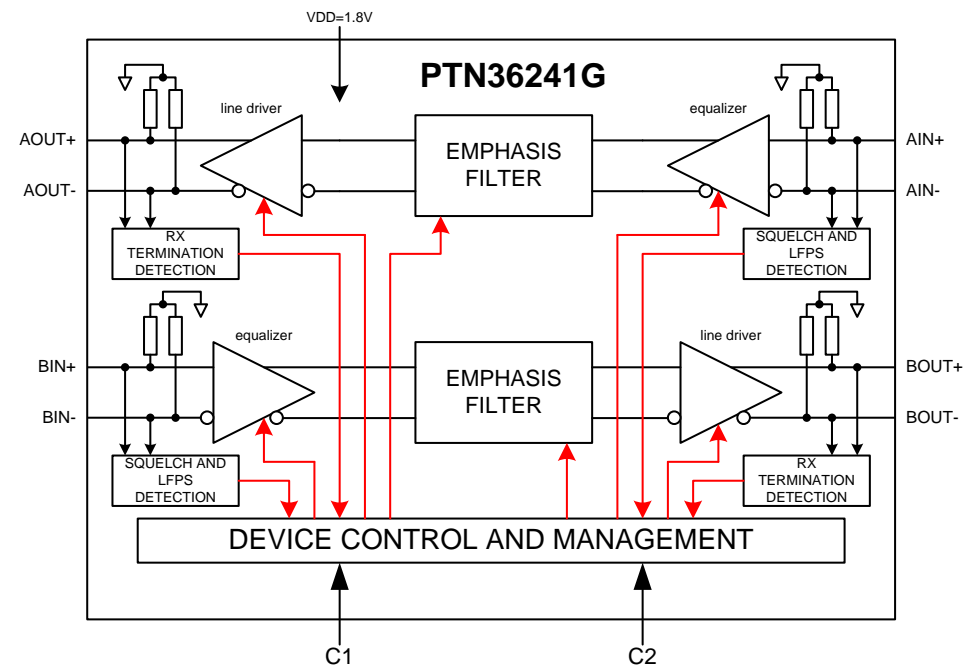
- 5Gbps USB3.0 one port redriver switch
- Compliant to SuperSpeed USB standard
- Optimized data flow for Type-C connector
- Adjustable Receive equalization, Transmit de-emphasis, and output swing functions
- Low crosstalk and excellent differential and common return loss performance
- Low power management scheme
 - 189 mW (105mA) active power
 - 2.16 mW (1.2mA) in U2/U3 state
 - 0.9 mW (0.5mA) with no connection
- Power supply: VDD=1.8V±5%
- ESD 8kV HBM; 1kV CDM
- Operating Temperature Range: -40°C to 85°C
- Very small thin DHXQFN18 package 2.4 mm x 2.0 mm x 0.35mm, 0.4 mm pitch





PTN36241G –USB3 Redriver

- 1 port (2 channels) USB3.0 redriver
- Compliant to SuperSpeed USB standard.
- Optimized data flow for high performance and optimized PCB layout
- Adjustable Receive equalization, Transmit de-emphasis, and output swing functions
- Ultra Low power management scheme
- Power supply: $VDD=1.8V\pm 5\%$
- ESD 8kV HBM; 1kV CDM
- Operating Temperature Range: -40°C to 85°C
- Very small thin X2QFN12 package 1.25 mm x 2.1 mm x 0.35mm, 0.4 mm pitch



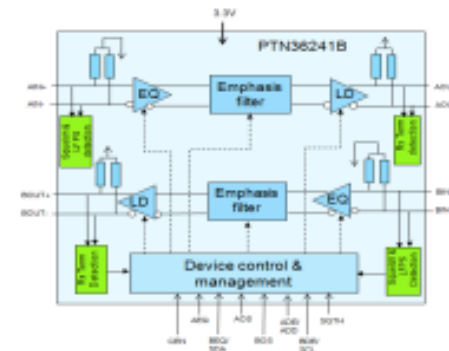
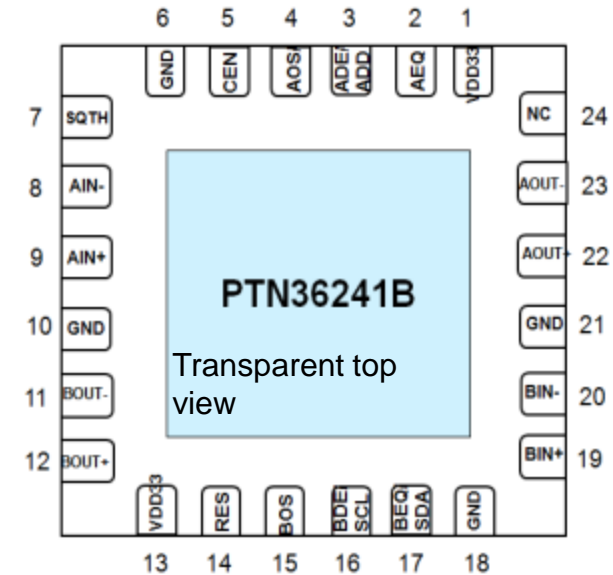


PTN36241B USB3.0 (Super speed) Re-driver

- Supports USB3.0 Super Speed at 5Gbps
- Intelligent I²C-bus multiplexing 5-level logic configuration options (with patent-pending quinary pins) delivering ultimate flexibility
- Link budget enhancement – Compensates for High Frequency losses/inter-symbol interference
- Selectable Output swing, Transmit Emphasis and Receive Equalization & input signal threshold
- Rx Termination Indication & Detection
- LFPS detection and forwarding
- Intelligent Power management with Multiple power modes
- Hot Plug capable
- ESD HBM 6kV, CDM 1.25kV
- Power supply: 3.3V
- HVQFN24 package (4 mm x 4 mm, 0.5 mm pitch)

Target Applications

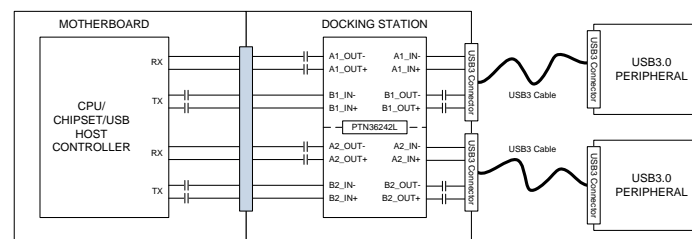
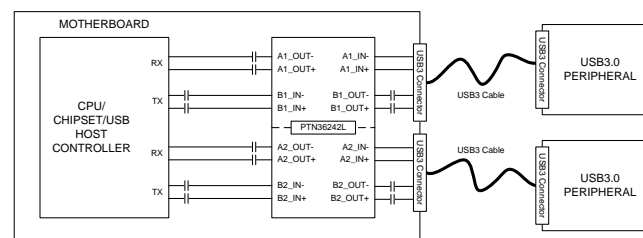
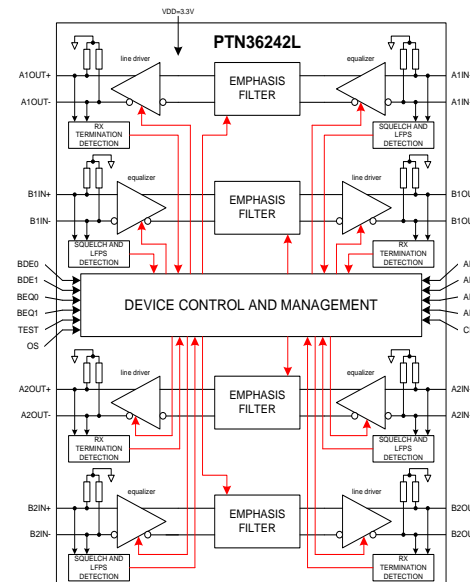
- Systems with USB3.0 interface requiring long-distance cables
 - Multi-media servers
 - Infotainment systems
 - Networking equipment
 - Computers/Notebooks
 - Docking stations
- Active USB3.0 cables





PTN36242L Dual Port USB3.0 Re-driver

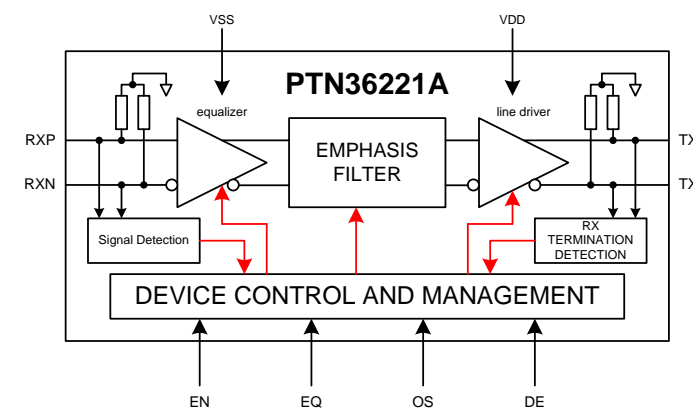
- Support 2 USB3.0 ports
- Selectable RX Equalization
- Selectable TX De-emphasis
- Programmable output swing
- 3.3V Power supply
- Low active power: 775mW
- Low Power-Saving mode
 - 80 mW in U2/U3 states
- Small HVQFN32 package
 - 3X6X0.85mm with 0.4mm pitch



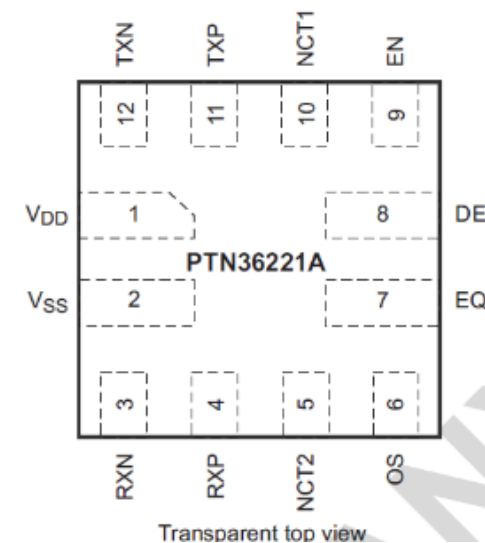


PTN36221A Single Channel USB3.0 Re-driver

- SuperSpeed USB 3.0 compliant
- Adjustable receive equalization, transmit de-emphasis, and output swing functions
- Low power management scheme ($V_{DD}=1.8V$)
 - Active power: 97 mW (54 mA)
 - U2/U3 state: 5 mW (2.8 mA)
 - No connection: 1 mW (0.55 mA)
 - Deep power saving: 18 μ W (10 μ A)
- Hot plug capable
- Supply voltage (V_{DD}): 1.8V \pm 5%
- ESD 8kV HBM; 1kV CDM
- Operating temperature range: -40 to 85 $^{\circ}$ C
- Package: small, thin X2QFN12, 1.6 mm x 1.6 mm x 0.35mm, 0.4 mm pitch



Top View



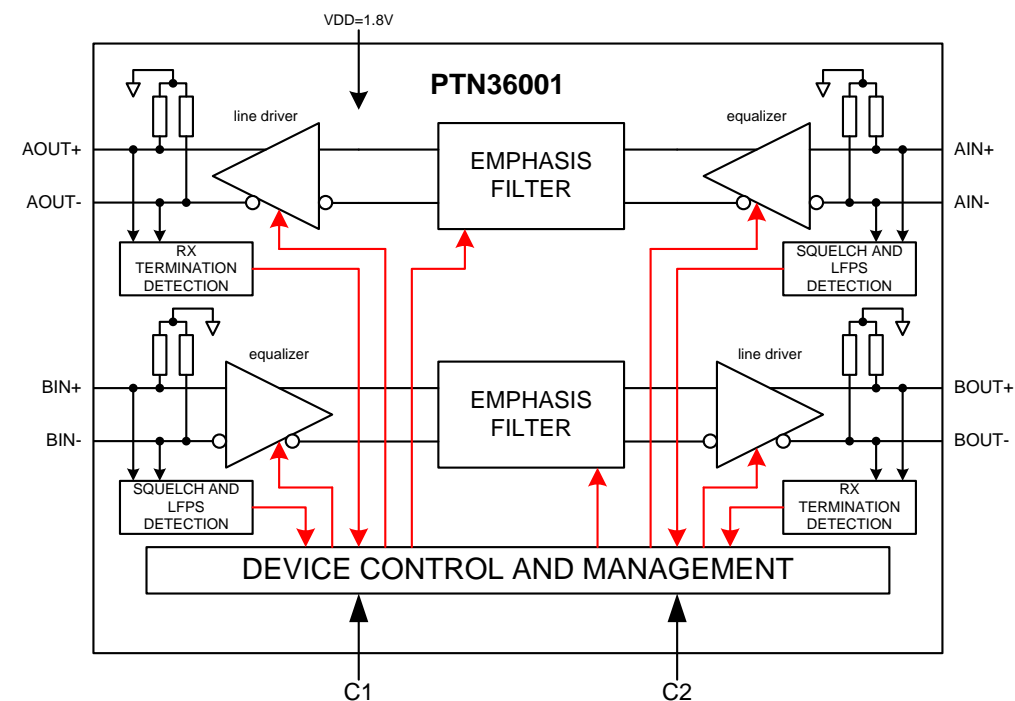
Transparent top view





PTN36001 Single Port USB3 Re-Driver

- 1 port (2 channels) USB3.0 re-driver
- Compliant to SuperSpeed USB standard.
- Optimized data flow for high performance and optimized PCB layout
- Adjustable Receive equalization, Transmit de-emphasis, and output swing functions
- Low power management scheme
 - 200 mW active power
 - 5.4 mW (1mA) in U2/U3 state
 - 3.6 mW (0.5mA) with no connection
 - 11 μ W in deep power saving
- Power supply: VDD=1.8V \pm 5%
- ESD 4kV HBM; 500V CDM
- Operating Temperature Range: 0°C to 85°C
- Very small thin X2QFN12 package 1.25 mm x 2.1 mm x 0.35mm, 0.4 mm pitch



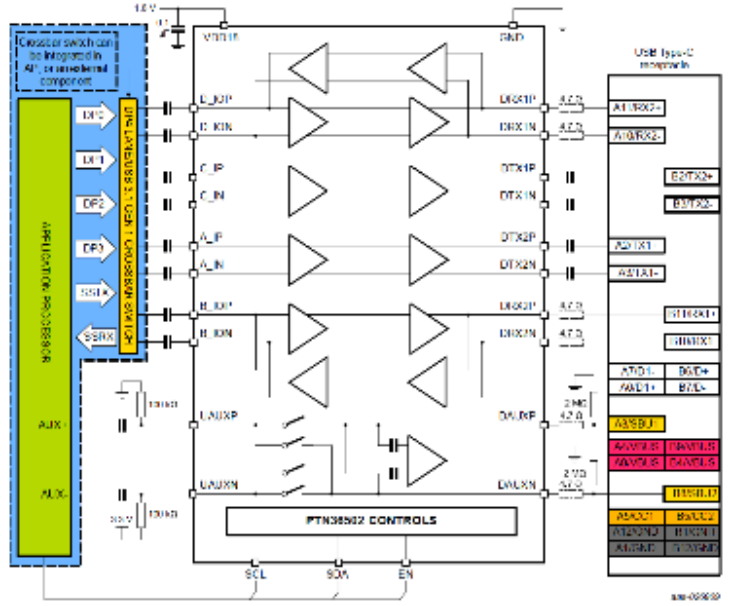
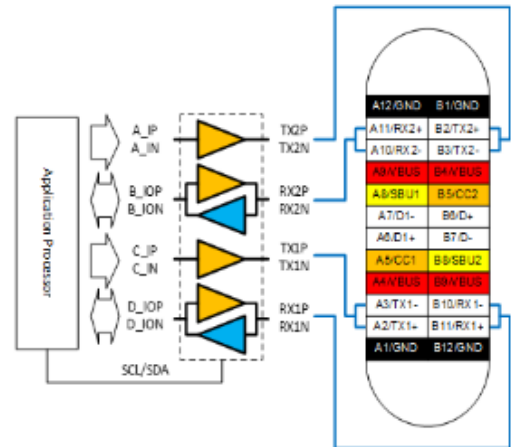
Target Applications





PTN36502: 5Gb DP/USB Combo Re-Driver

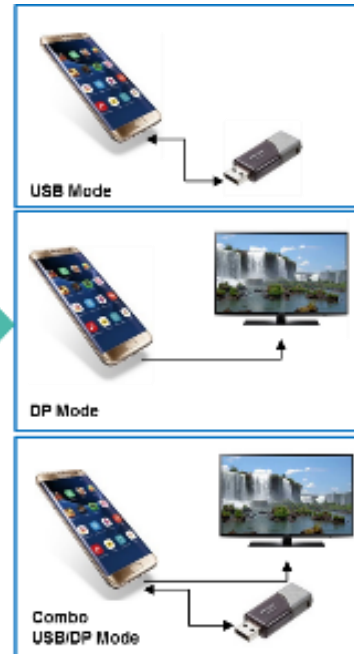
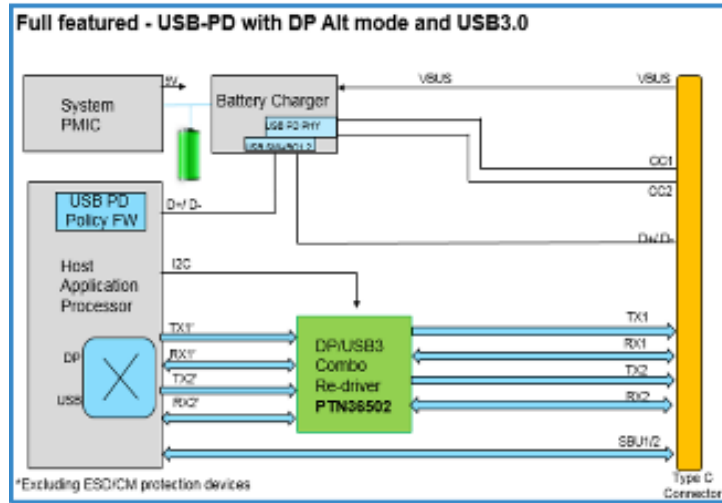
- Combo USB and DisplayPort Redriver function
 - USB3.0 and 4-lane DP1.2 (HBR2) operation
 - Works with Host processor that integrates DP/USB Crossbar Switch
 - Complies with USB3.0 and DP1.2 specifications
 - Integrated AUX xbar switch with USB-C Safe State support
 - Automatic Output driver adjustment for DP path through AUX channel
 - Good signal integrity with minimum near end crosstalk
 - Low power design with very low power saving modes
 - Support both I2C slave and GPIO control mode for programmability
 - Configurable Receive equalization, Transmit de-emphasis and output swing capability
- Single Power supply: VDD=1.8V±10%
- Robust protection - ESD 8kV HBM; 1kV CDM
- Wide operating Temperature Range: -40oC to 85oC
- Optimized pinout and package for Type-C applications
 - Very small thin package DHX2QFN24
 - 2.4mm X 3.2mm x 0.35mm with 0.4mm pitch
 - Part Number options (PTN36502HQX & PTN36502AHQX) for I2C address variant



Mode	Usage
Standard USB Type-C mode	USB3 signaling only
DP Alt mode & USB3	USB3 & 2-lane DP signaling
DP Alt mode only	4-lane DP signaling with USB2 only

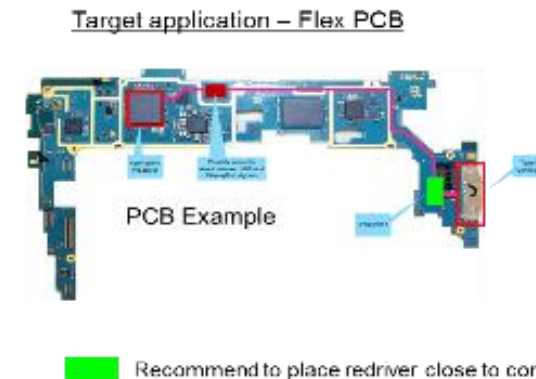


PTN36502: Application Use Cases



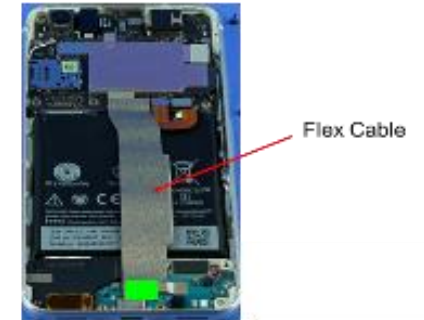
- To compensate signal loss between an application processor or a chipset to to Type-C connector

Applications
 Smartphone
 Personal Computer
 VR/AR Goggles
 Accessory/Docking
 LCD Monitor



Recommend to place redriver close to connector

Target application – Flex Cable





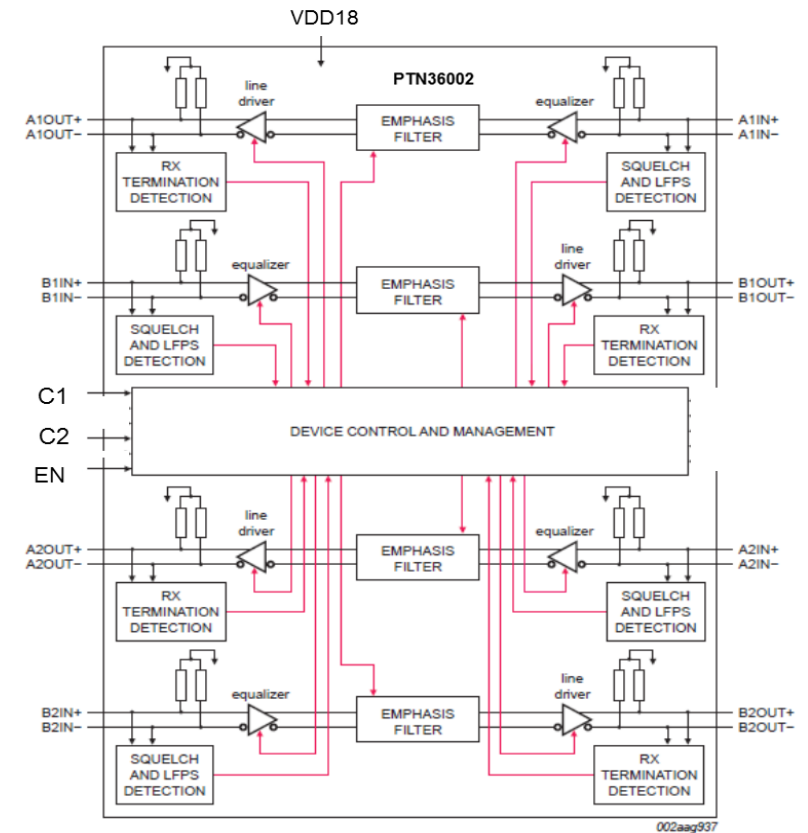
PTN36002: 10Gb USB Type-C/DP Combo Linear Re-Driver

Product Features

- Supports USB 3.1 Gen 1 data rate (aka. USB3.0) of 5Gbps
- Support USB type A/B/C connector through either I2C slave interface or ternary GPIO pins
- Support RX equalizers on all inputs to compensate receiver side channel attenuation
- Support TX De-emphasis and Output swing on all outputs to compensate transmitter side channel loss
- Low power design with very low power saving modes
- Small thin package DHX2QFN24 2.4mm X3.2mm x 0.35mm

Product Benefits

- **Lowest power consumption**
 - Active power: 1.8v (NXP) vs 3.3v (Competitor) Vdd power supply
 - Standby power (U2/U3 mode): 1.8mW
- **Good signal integrity** for full USB compliance.
- **Enhanced surge protection** at Rx pins: ~14v surge capability (Tx pins are covered by the required coupling cap per USB spec.)
- **Support both I2C and GPIO mode.** I2C mode has more programmability (Ex. Threshold voltages, EQ, De-emphasis, amplitude, etc.)
- **Higher HBM ESD:** 8kV vs 6kV (Competitor)
- **Better system level ESD** protection: 8kV contact (target)
- **Smaller package**



Applications

- Smartphone
- Personal Computer
- Accessory/Docking
- LCD Monitor





PTN36002: Dual-Port USB Re-Driver Competition Landscape

	PTN36002	Parade PS8720B
Repeater Architecture	5G Dual Port Limiting Redriver	5G Dual Port Limiting Redriver
Package size	HX2QFN24 2.4x3.2x0.4 mm (Dimension: 7.68mm ² . Max height: 0.4mm)	TQFN32 3x6x0.4 mm (Dimension: 18mm ² . Max height: 0.75mm)
Rx CTLE Gain	EQ: 9dB (Tx DE: -5.3dB)	EQ: 13dB (Tx DE: -5dB)
VDD	1.8V	3.3V
USB	USB3.1 Gen1 (5Gbps)	USB3.1 Gen1 (5Gbps)
Power consumption	@ 1.8V supply	@ 3.3v
USB only	207mW	861mW
Standby (U2/U3)	2mW	70mW
Shutdown	0.027mW (15uA)	1mW
Configuration	I ² C or GPIO	GPIO



COMPARATORS



Voltage Comparators

- Low-power, rail-to-rail I/O
- No phase inversion with overdriven input signals.
- Excellent noise rejection for high signal integrity
- **Very low supply current ($I_{cc} < 6 \mu A$)**
- **Low start up voltage: 1.3 to 5.5 V**
- Leading MicroPak and PicoGate packages

Applications

- Portable media players
- Consumer/wearable devices
- Set top boxes
- Navigation devices
- LCD displays
- Notebook and tablet PC
- Cellular handsets

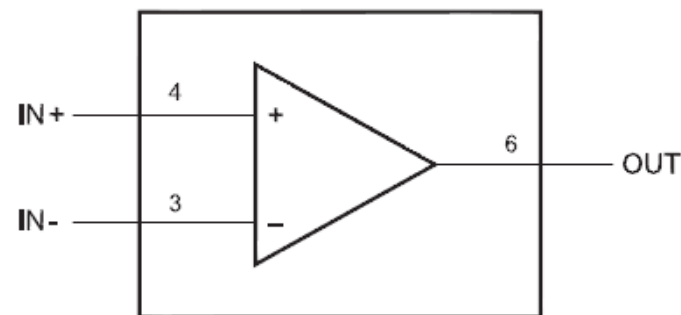
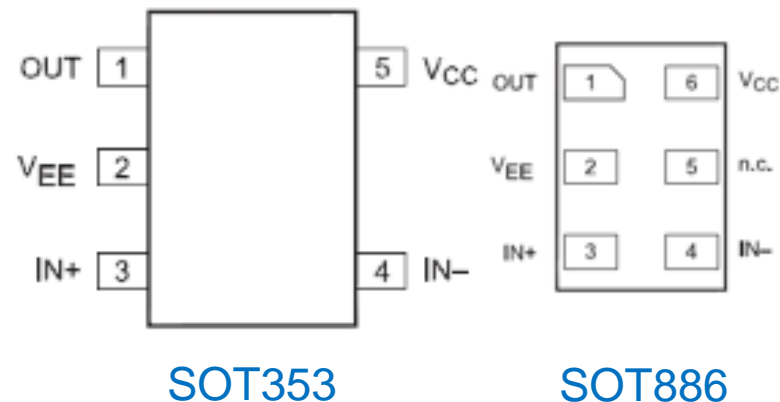
V_{CC} (min – max)	CURRENT (TYP)	PROP DELAY	INPUT OFFSET V	OPERATING TEMP	OUTPUT	# COMPARATORS	PACKAGE	PART#
1.3 to 5.5V	drive: 68 mA supply: 5 μA	0.5 ms	0.5 mV	-40 to 85°C	push pull	2	XSOP6, X2SON6, UMT5	NCX2220
					open drain			NCX2222
	drive: 68 mA supply: 6 μA				push pull	1	TSSOP8, XQFN8(U), HXSON8	NCX2200
					open drain			NCX2202



NCX2200/2202 Comparators

Low-Power Rail-to-Rail

- Low voltage, low power comparator
- Convenient for use in 1.8, 3.0, and 5.0V systems
- Features
 - Supply voltage: 1.3 to 5.5V
 - Rail-to-rail I/O
 - Very low supply current: 6 μ A per comparator
 - No phase inversion w/ overdriven input
 - Excellent noise rejection
 - Push-pull output (NCX2200)
 - Open drain output (NCX2202)
- Packaging
 - NCX2200GM:SOT886 1.0 x 1.45, 0.5 mm pitch
 - NCX2200GW: SOT353, 2.0 x 2.0, 0.65 mm pitch
 - NCX2200GF: SOT891, 1.0X 1.0, 0.35 mm pitch
 - NCX2202GM: SOT886 1.0 x 1.45, 0.5 mm pitch, open drain
- Replaces: ON Semi NCS2200A

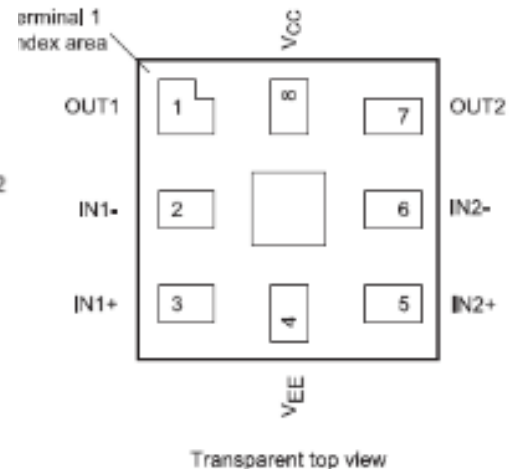
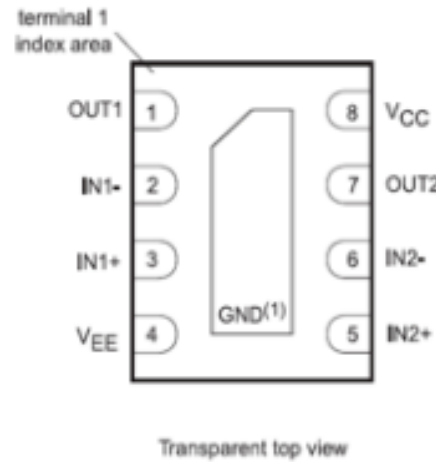
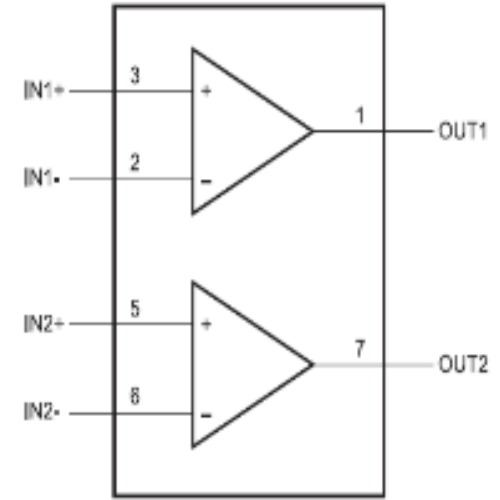




NCX2220/2222 Comparators

Low-Power Rail-to-Rail

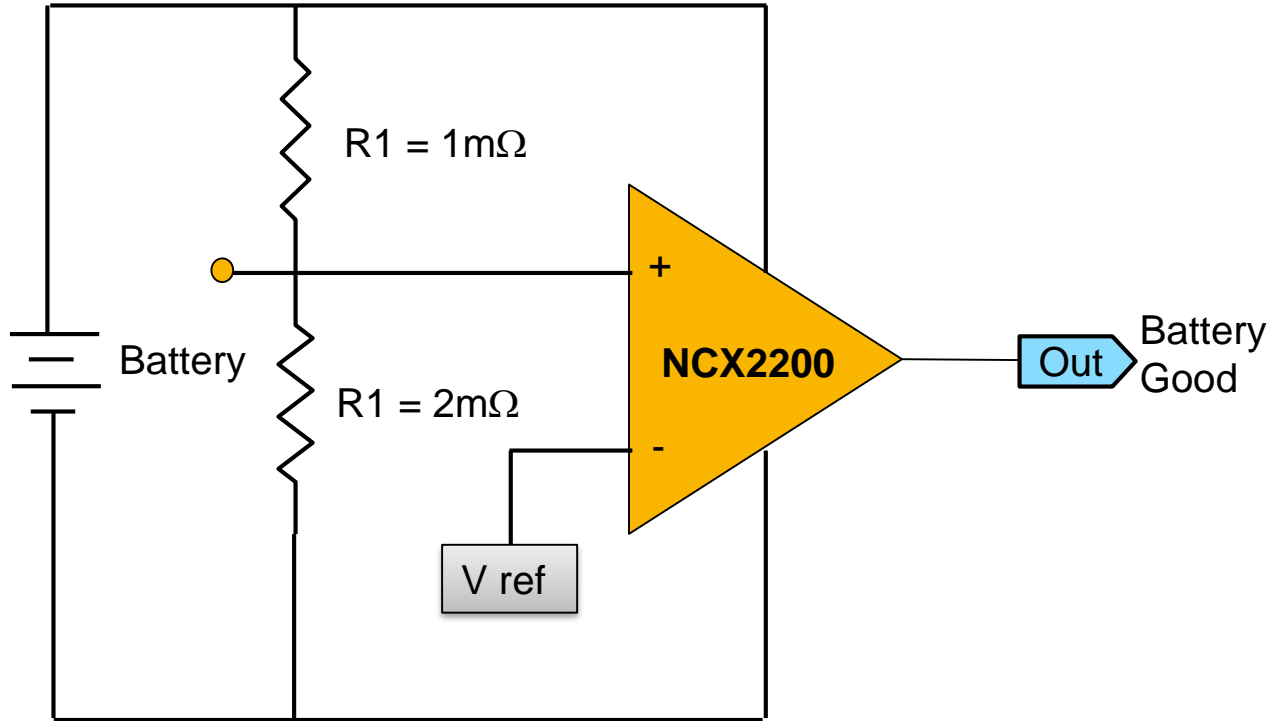
- Two comparators in one package
 - Very low supply current: $I_{CC} < 5 \mu A$
 - Supply voltage: 1.3 to 5.5 V
 - Rail to rail input/output
 - No phase inversion with overdriven input signals
 - Excellent noise rejection
 - Push-pull output (NCX2220)
 - Open drain output (NCX2222)
- Convenient for use in 3.0V & 5.0V systems
- Perfect fit for audio & accessory plug-in detection
- Packages
 - HXSON8 (SOT972) 1.3 x 1.7 x 0.5 mm, 0.4 mm pitch
 - Micro-Pak (SOT902) 1.6X1.6 X 0.5mm, 0.5mm pitch
- Replaces: ON Semi NCS2220A





Common Comparator Application Circuit

Voltage Level Detection Application



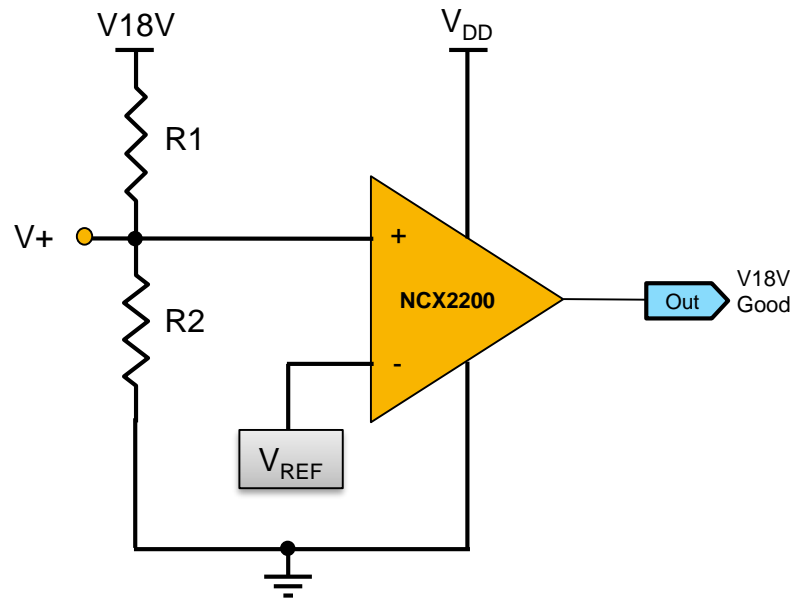
How Comparator works;
Battery Voltage - Trip Voltage
 $= V_{\text{ref}} \times ((R1+R2)/R2)$

Example:
 $V_{\text{cc}} = 3\text{V}$ and $V_{\text{ref}} = 1.2\text{V}$
Battery voltage goes below 1.8V the NCX2200 will turn Low



Common Comparator Application Circuit

Voltage Level Detection Application



- NCX2200 can operate with V_{DD} from 1.3V to 5.5V. V_{+(max)} should be less than or equal to the supply voltage.

- The reference voltage connected to V₋ should be less than V_{+(max)}.

- V_{th} is the threshold voltage that needs to be detected.

- From the simultaneous equations:

$$V_{+(max)} = \left(\frac{R2}{R1+R2} \right) 18V \leq V_{DD}$$

$$V_{REF} = \left(\frac{R2}{R1+R2} \right) V_{th}$$

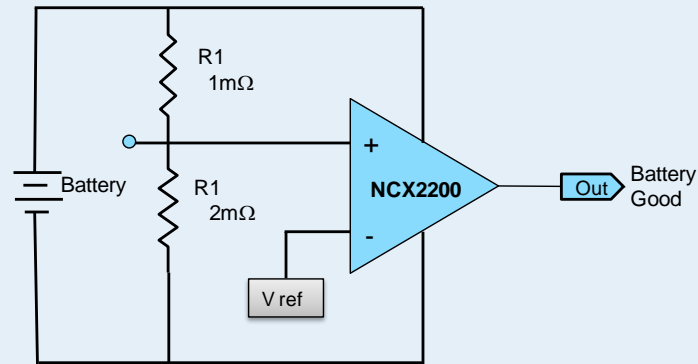
- The user can calculate the values for R1 and R2.



Comparator Applications

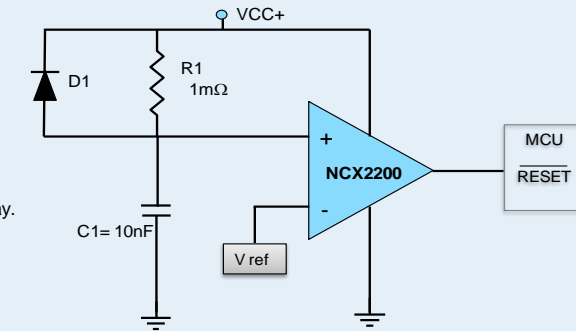


Battery Level Detection



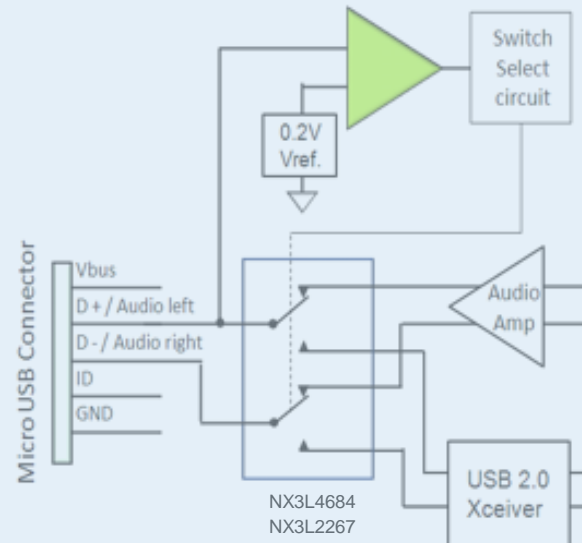
If V_{bat} goes below $V_{ref} \times ((R1+R2)/R2)$ the NCX2200 will turn Low

RESET command to MCU



RC circuit provides a power up delay. When Power is ON, the output comparator is low, holding the processor in the reset

Audio Line Plug-in Detection

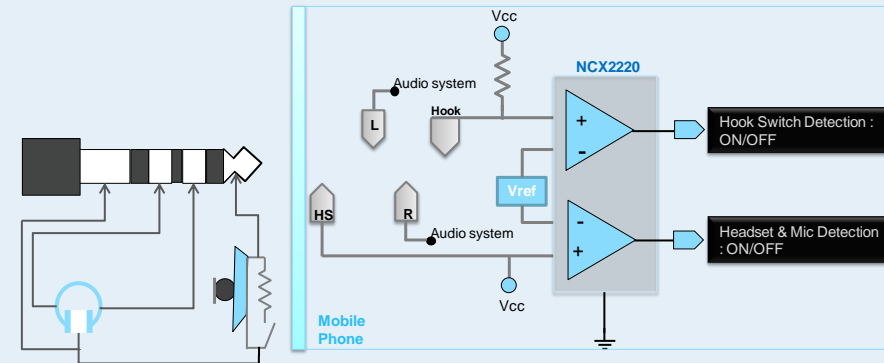


When audio signal is detected on D+, the comparator output drives the select pin of the switch to route signal from USB to Audio lines

Similar scheme can be used in combination with a hook switch:

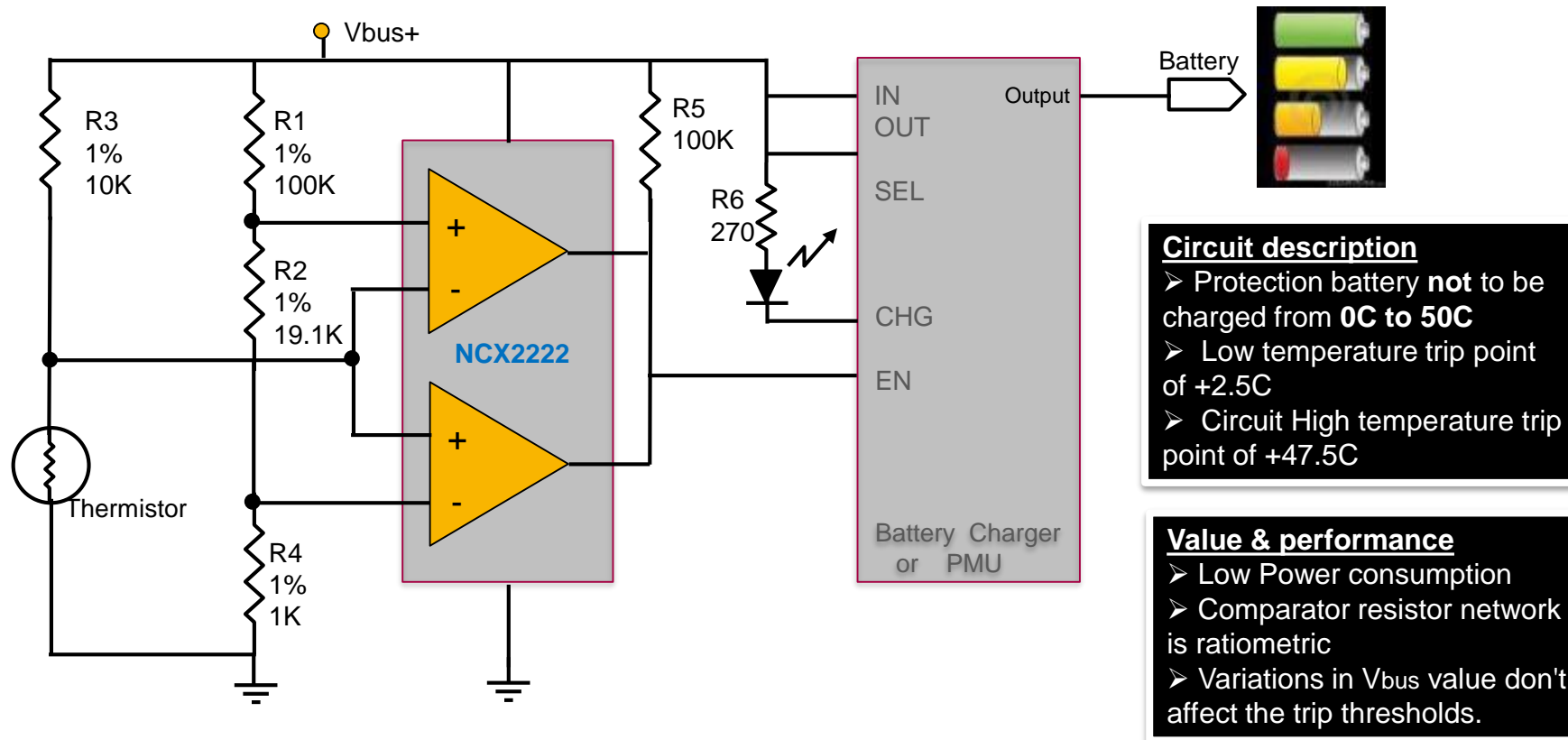
- To acknowledge muting of microphone
- To receive/end phone calls with headset

Portable Headset detection



Portable Battery Thermal Protection Application

NCX2222 Comparators in thermal protection circuit for Battery charging



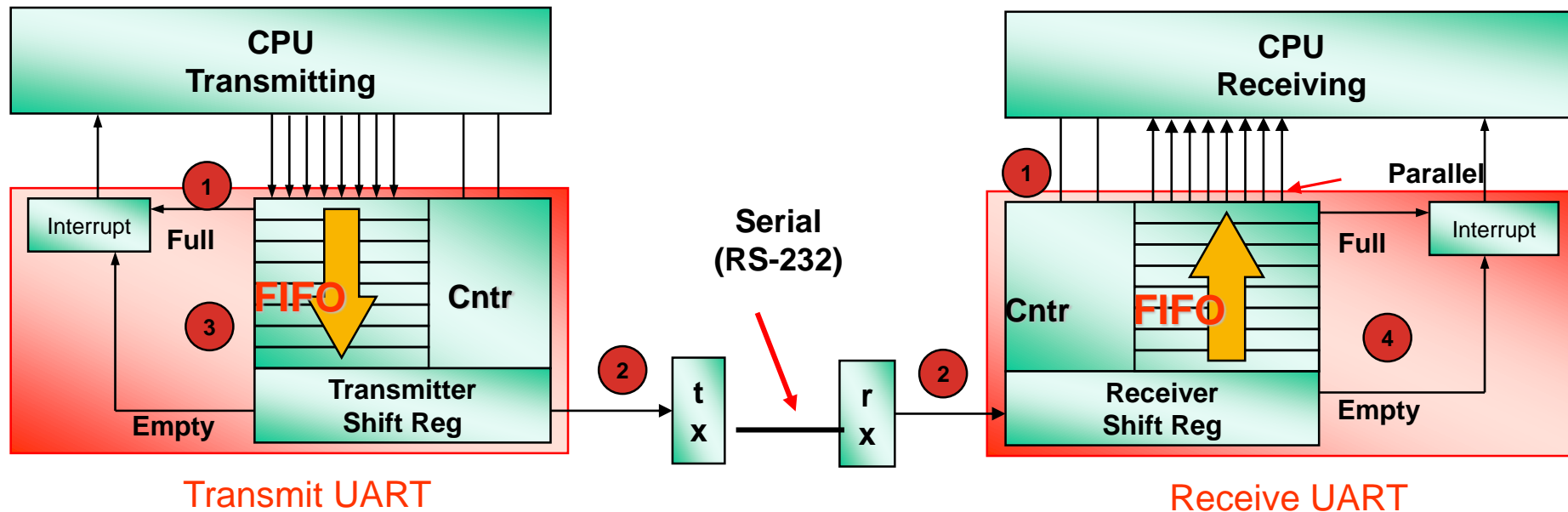


UARTS



UARTs Value Proposition

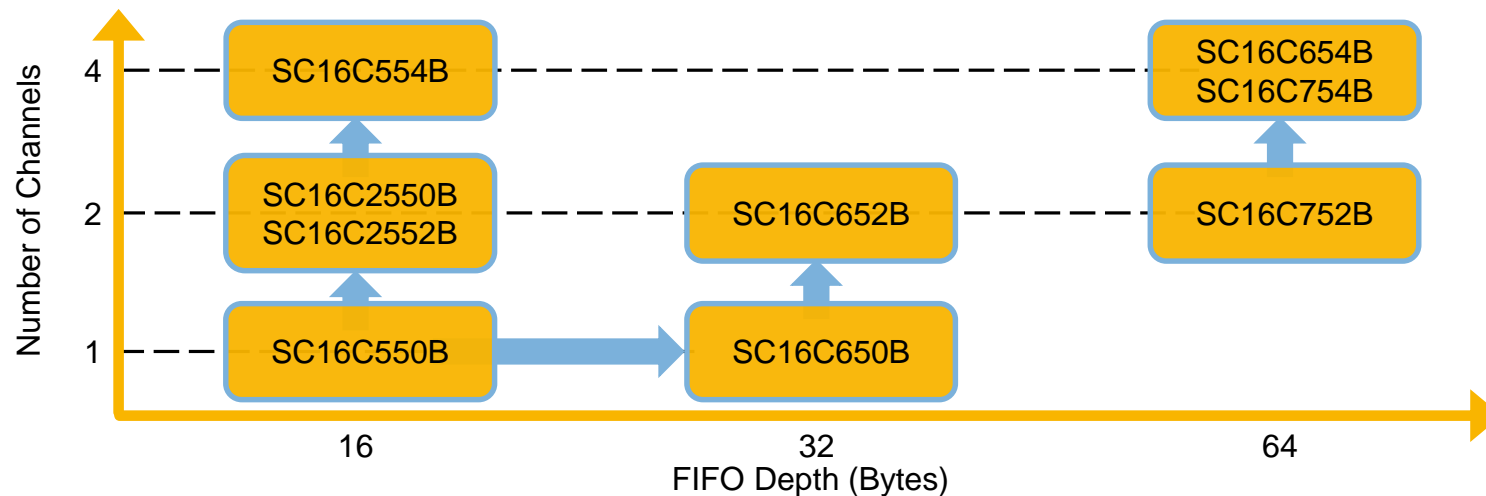
- Why used?
 - Transmits and receives data transfer between processor and communication channel
 - Checks communication error and relieves processor from the task of managing communication errors
- Where used?
 - Communication channels
- Why NXP UARTs?
 - Established committed long-term supplier
 - Broad portfolio in the industry
 - Number #1 supplier for Industrial UARTs





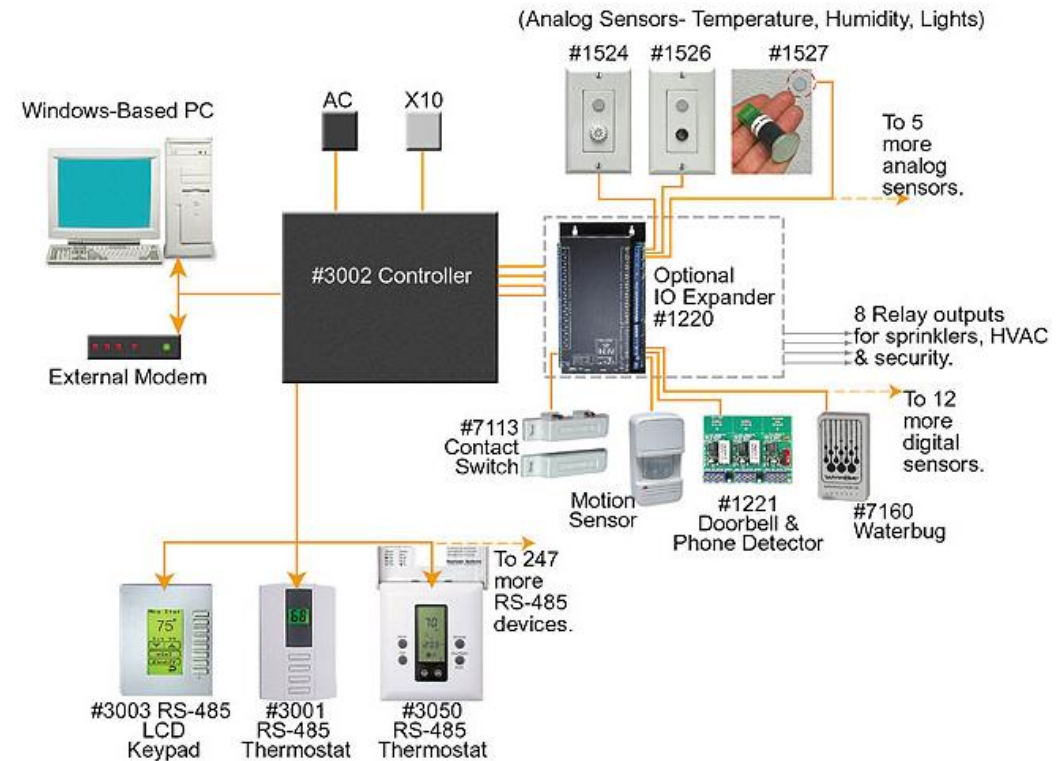
Commercial 16CxxxB UART Family

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



SC16C850/852 1.8V – 3.3V UARTs

- 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

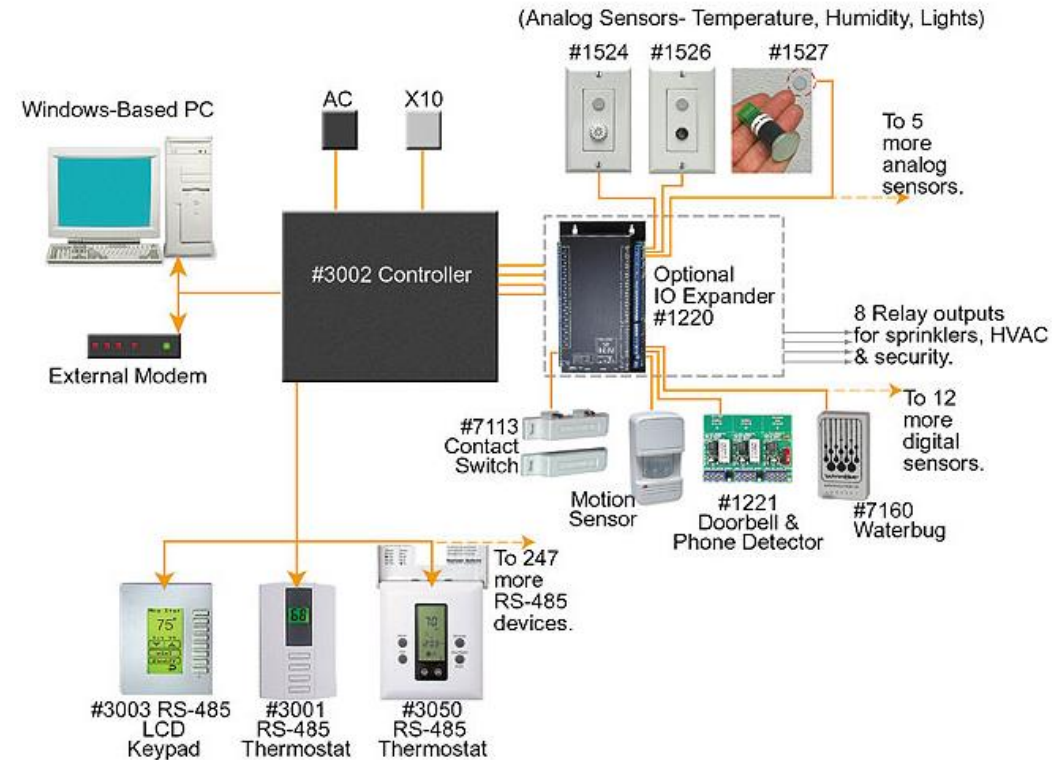


SC16C850IBS/Q900

- UART with 16-mode or 68-mode parallel bus interface; -40°C to +85°C; HVQFN32; AEC-Q100 compliant automotive qualification

SC16C85xSV 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, HVQFN



Part Number	CH	Host Interface	V _{CC}	TFBGA (3.5x3.5)	HVQFN (5x5)
SC16C850SV	1	VLIO	1.8 V	No	✓
SC16C852SV	2	VLIO	1.8 V	✓	No



LOW-VOLTAGE DC/DC CONVERTERS





Mobile DC/DC Converter Requirements

- **Application and requirements**

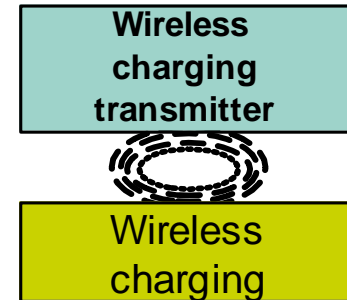
- Today's mobile devices require multiple levels of power conversion between the available battery voltage and interface drivers
 - Wireless interfaces, e.g NFC, Wifi, Bluetooth require higher drive voltages than the battery voltage.
 - Each application has unique power efficiency and control constraints

- **Existing solutions**

- Provide generic DC/DC conversion not optimized for a specific application
- Consume too much active and standby power.
- Can not support high switching frequencies

- **NXP DC/DC Converter Solutions:**

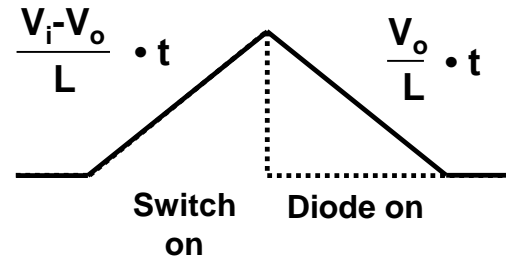
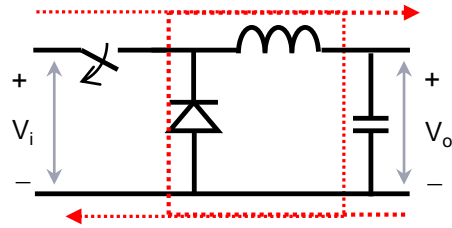
- Use application optimized process technology to provide the most cost-effective, space efficient DC/DC Converter products
- Integrates elements of available power sources such as USB, wireless charging receivers in the DC/DC Conversion control to deliver
 - Optimum efficiency
 - Lower cost





DC/DC Converter Basics

Down- or buck converter

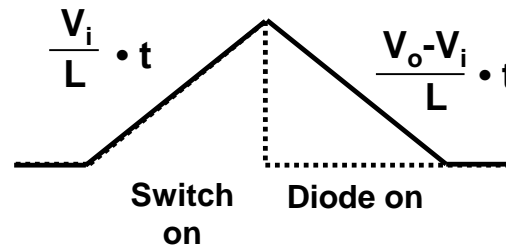
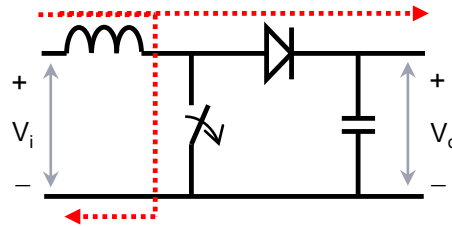


$$V_o/V_i = D \text{ or } V_o = D \times V_i$$

$$V_{\text{switch}} = V_i + V_{\text{diode}}$$

$$V_{\text{diode}} = V_i$$

Up- or boost converter

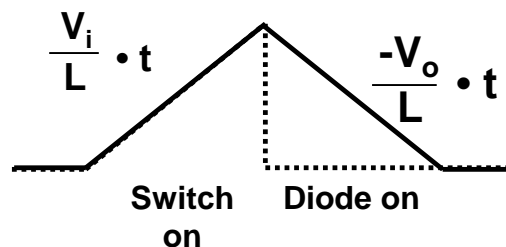
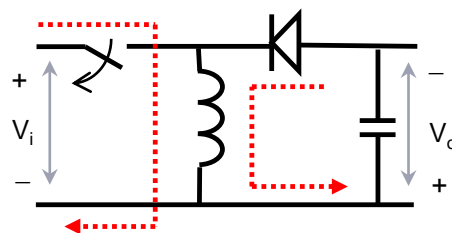


$$V_o/V_i = 1/(1 - D)$$

$$V_{\text{switch}} = V_o + V_{\text{diode}}$$

$$V_{\text{diode}} = V_o$$

Up/down- or buck/boost converter



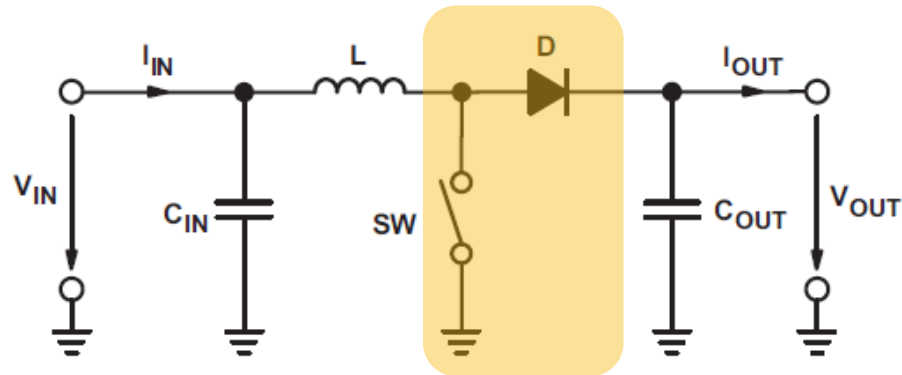
$$V_o/V_i = -D/(1 - D)$$

$$V_{\text{switch}} = V_i + V_o + V_{\text{diode}}$$

$$V_{\text{diode}} = V_o + V_i$$



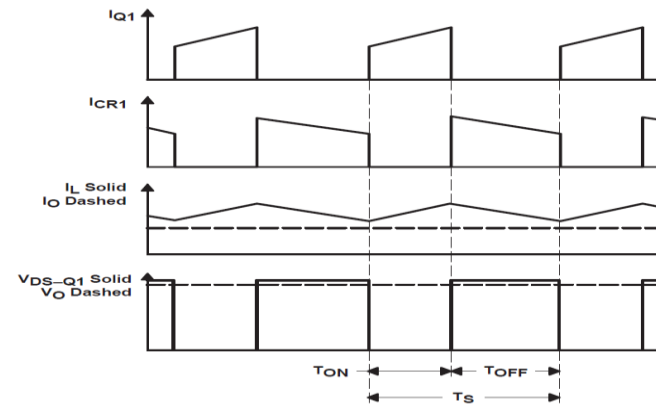
DC/DC Boost Converter Basics



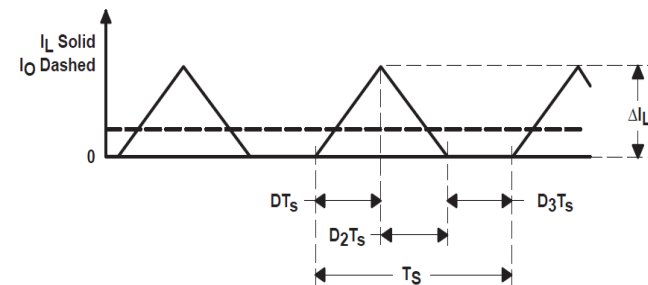
Topology

$$D = 1 - \frac{V_{in(min)} \times \eta}{V_{out}}$$

- D: Duty cycle
- $V_{IN(Min)}$: Minimum input voltage
- V_{OUT} : Output voltage
- η : Efficiency



Continuous current mode



Discontinuous current mode

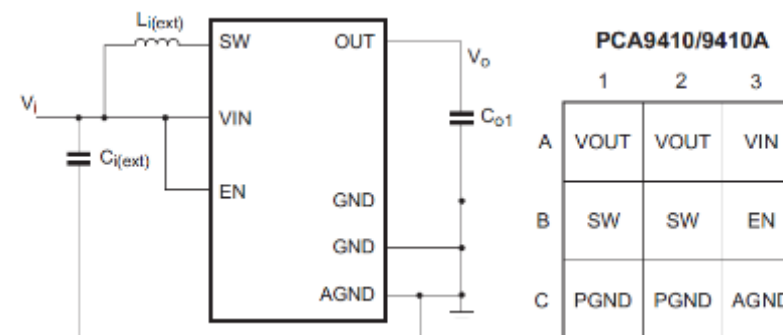
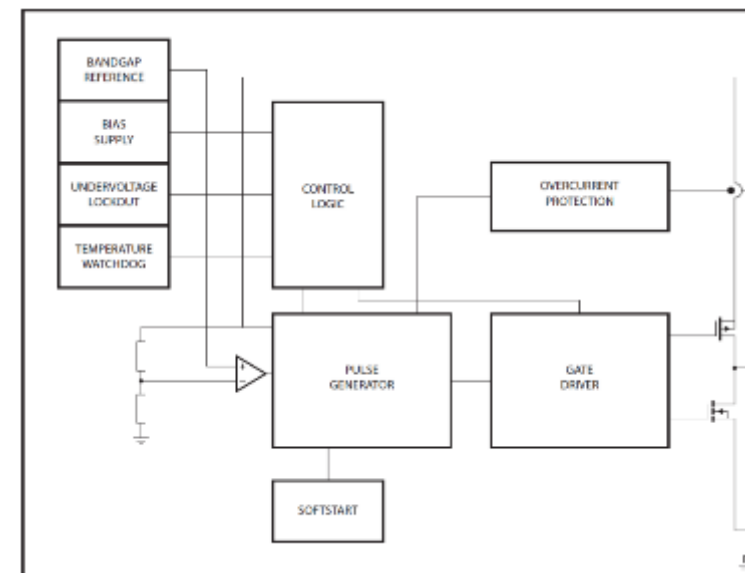




PCA941xUK / PCA941xAUK: Boost Converter

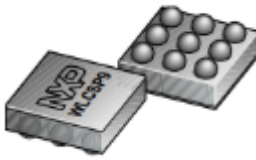
• Features

- Step-up DC-DC Converter with 500mA output current
- Operating switching frequency of 3.0 MHz
- Input voltage from 2.3V to 5.25V
- Fixed output voltage of 5.0V (PCA9410A)
- Fixed output voltage of 5.25V (PCA9411/9411A)
- Fixed output voltage of 5.4V (PCA9412A)
- High Efficiency up to 94%
- 2% VOUT accuracy at nominal and static conditions
- 3% VOUT accuracy over full current, voltage and temperature range
- PCA9410 & PCA9412 supports disconnect mode; Output disconnected from the input when EN is low
- PCA9410A & PCA9412A supports pass-through mode; VOUT equals VIN when EN is low
- Current-mode controller
- Soft start function for limiting inrush current with true load disconnect
- Reverse current, over-current and over-temperature protection
- WLCSP with 0.4 mm pitch
- Development boards available now



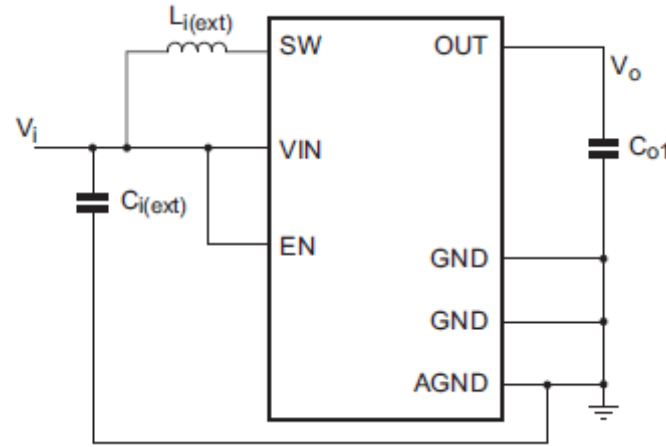


DC/DC Boost Converter Portfolio



Features:

- V_{IN} : 2.5V to 5.25V
- V_{OUT} : 5.0V, 5.25V or 5.4V
- Efficiency > 92%
- Designed to increase system performance even for very low battery levels
- $V_{IN} > V_{OUT}$ Pass-Through Mode operation (A version)
- Load/Frequency response designed to limit RF noise
- Soft start function for limiting inrush current with true load disconnect
- Reverse current, overcurrent and over-temperature protection
- **Small WLCSP9 package, 1.2mm x 1.2mm x 0.6mm**



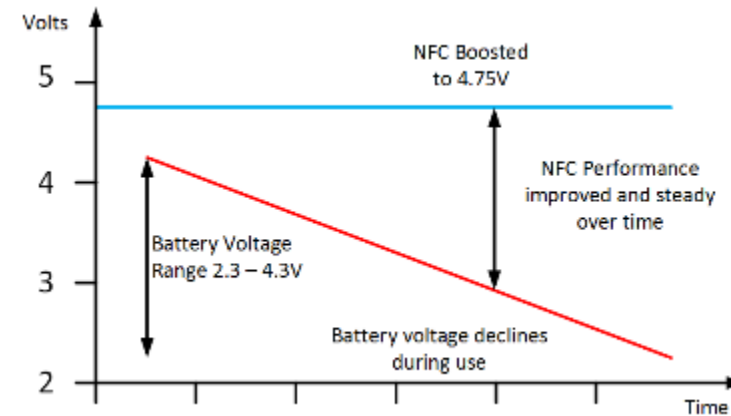
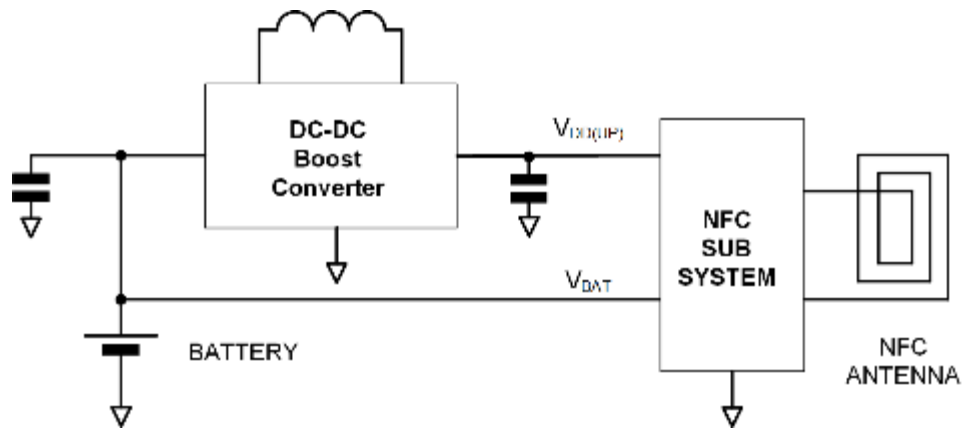
Product	V_{IN} Range	V_{OUT}	I_{OUT} (Max)	Pass-Through	F_{OUT} (Typ)
PCA9410AUK	2.5 – 5.25 V	5.00 V	500 mA	Disconnect / Pass-Through	3 MHz
PCA9411UK	2.5 – 5.25 V	5.25 V	500 mA	Disconnect	3 MHz
PCA9411AUK	2.5 – 5.25 V	5.25 V	500 mA	Disconnect / Pass-Through	3 MHz
PCA9412AUK	2.5 – 5.25 V	5.40 V	300 mA	Disconnect / Pass-Through	3 MHz





Need for DC/DC Boost in NFC Applications

- Boosting the battery voltage has three benefits for NFC:
 1. **Consistent RF signal strength**, over any battery charge state
 2. **Stronger RF signal** due to higher TX operating voltage
 3. **Improved User Experience** (ease of use, trust in the technology, convenience)

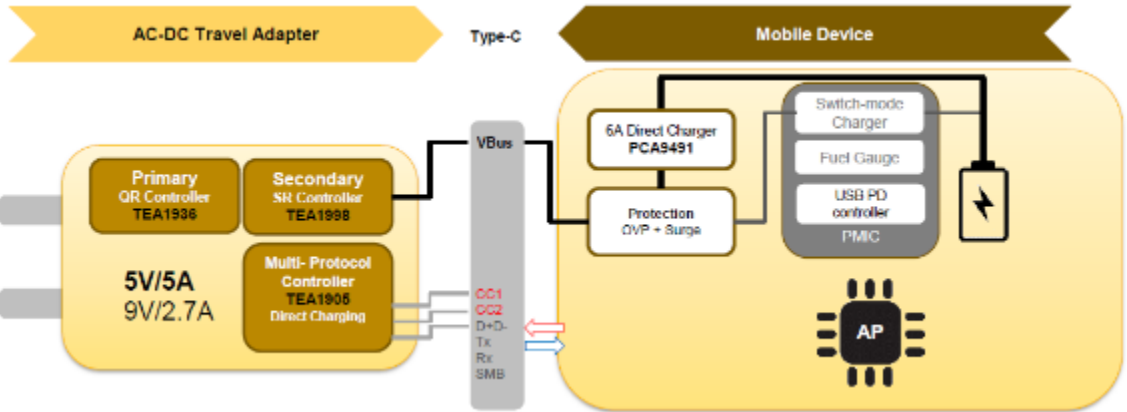
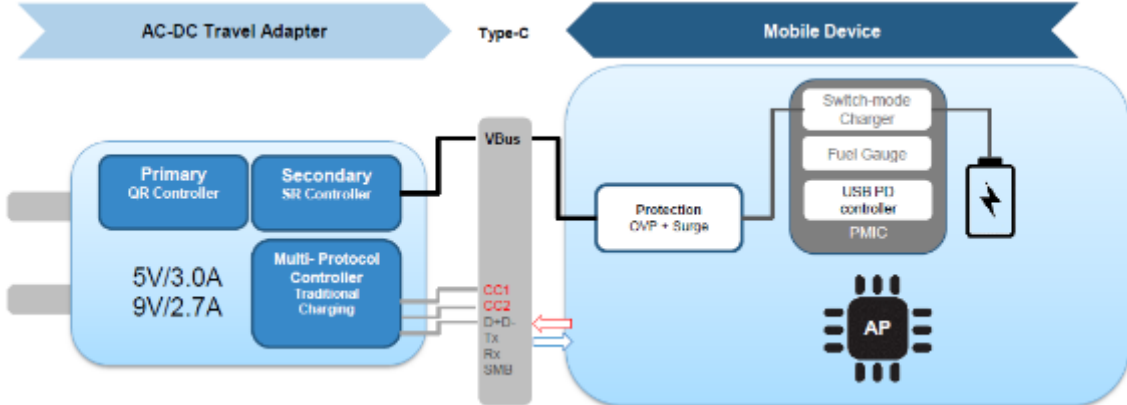




RAPID BATTERY (DIRECT) CHARGER



Direct Charging Solution



- **Traditional Charging**
 - 15W Delivery to Mobile Device
 - Using traditional SW charging
 - Switch-Mode Charger includes buck converter and regulation which leads to more losses in the mobile device
 - Not efficient for >3A to the battery which is needed for fast charging

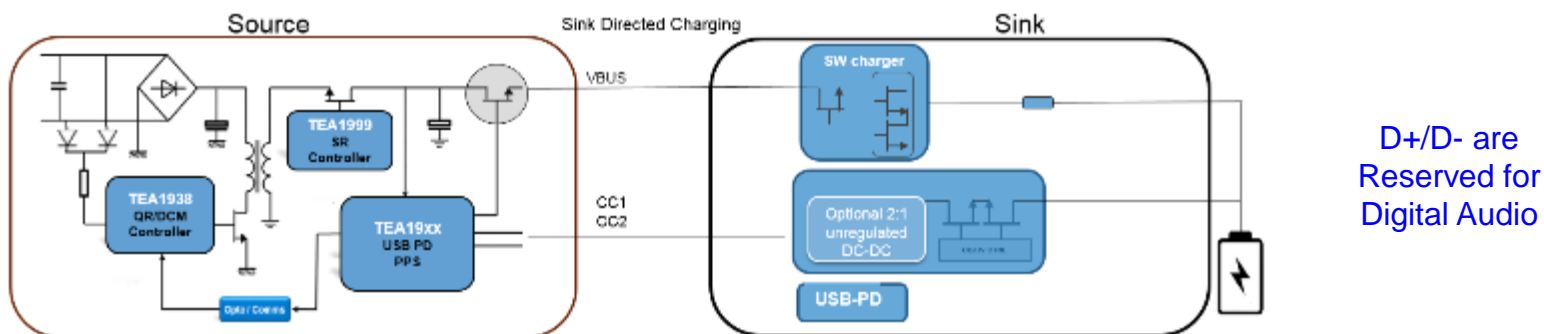
- **E2E Charging Solution with 6A Direct Charger**
 - Higher Efficiency 25W Adapter Solution
 - Supports DC, USB PD, QC
 - Efficiency >91% at peak current during direct charging mode
 - Precise voltage (min 5mV) and current (10mA) ramp control
 - **Higher Integrated Direct Charger**
 - 6A Charging with lowest RON = 13mΩ
 - Integrated protection and regulation
 - NTC interface for battery and connector
 - With the Direct Charger, only the regulation is done in the mobile device.





Programmable Power Supply (PPS) – Overview

- PPS enables sink directed charging using thinner wires, optionally using “divide by two” charge pump converter
- USB-PD Specification Rev. 3.0 V1.1 includes support for PPS. Maximum current on VBUS is 5A.



PPS Nominal Voltages

	Fixed Nominal Voltage			
	5V Prog	9V Prog	15V Prog	20V Prog
PPS Max Voltage	6V	11V	16V	21V
PPS Min Voltage	3V	3V	3V	3V

PPS Power Rules

PDP (W)	5V fixed	9V fixed	15V fixed	20V fixed	5V prog	9V prog	15V prog	20V prog
$x \leq 15W$	PDP/5	-	-	-	PDP/5	-	-	-
$15 < x \leq 27W$	3A	PDP/9	-	-	3A or PDP/5 ²	PDP/9	-	-
$27 < x \leq 45W$	3A	3A	PDP/15	-	PDP/5 ¹	3A or PDP/9 ²	PDP/15	-
$45 < x \leq 100W$	3A	3A	3A	PDP/20	-	PDP/9 ¹	3A or PDP/15 ²	PDP/20

Notes:

1. This PPS PDO is *Optional*.
2. The PPS may offer more than 3A when a 5A cable is present.





Normal PPS Voltage Ranges

Table 10-8 Programmable Power Supply Voltage Ranges

	Fixed Nominal Voltage			
	5V Prog	9V Prog	15V Prog	20V Prog
Maximum Voltage	5.9V	11V	16V	21V
Minimum Voltage	3V	3V	3V	3V

- Sink can request voltages between Minimum and Maximum in 20mV steps and current in 50mA steps
- Source advertises Maximum Voltage and Minimum Voltage limits using 100mV per bit
- Additional APDO's can be used if needed (might be useful for 2S batteries with 2:1...?)
- Select a charger wattage to determine fixed and programmable PDO that are mandatory
- PPS must also support fixed voltage PDO's
- Note that a 27W PPS charger that supports 9V Prog must also support 5V Prog PDO:
 - A Charger that works with a phone with 2:1 divider must also work with a phone without 2:1 divider
 - A phone without 2:1 divider needs 3V charging voltage
 - This is why support for 3V minimum is needed
 - If PPS interoperation is removed, PD specification becomes irrelevant. Therefore, interoperation is very important.

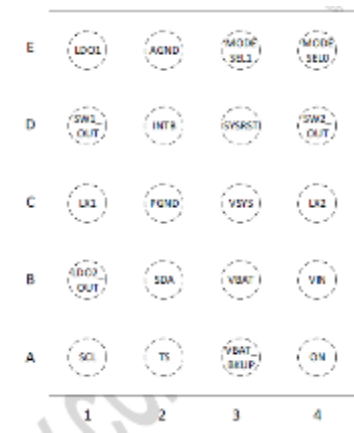
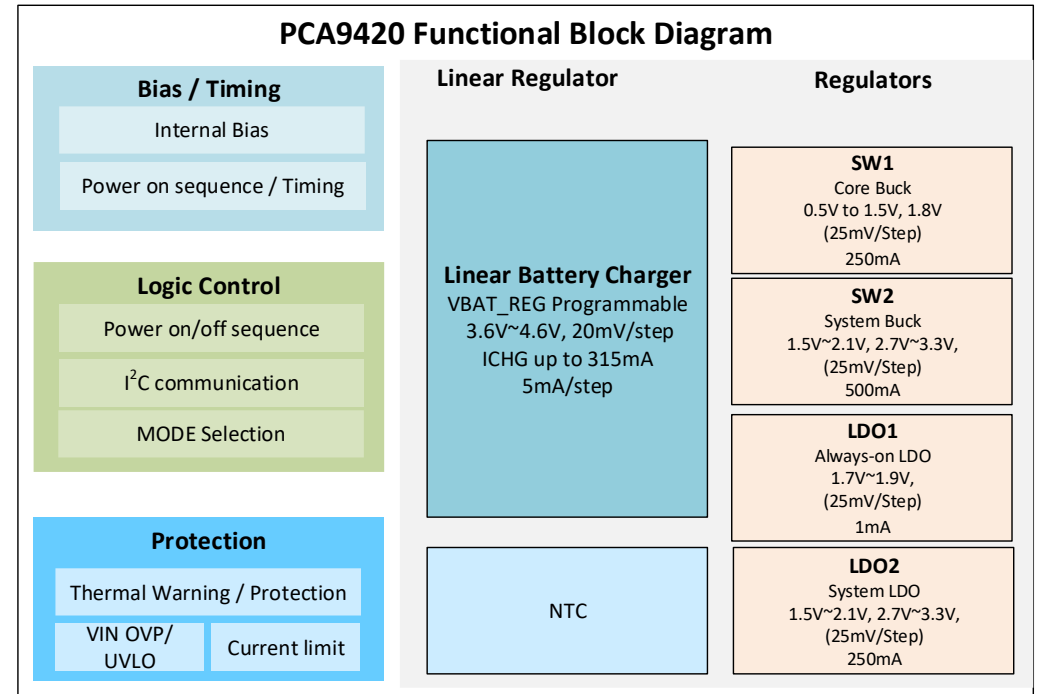


PMIC



PCA9420 – μ PMIC Key Features

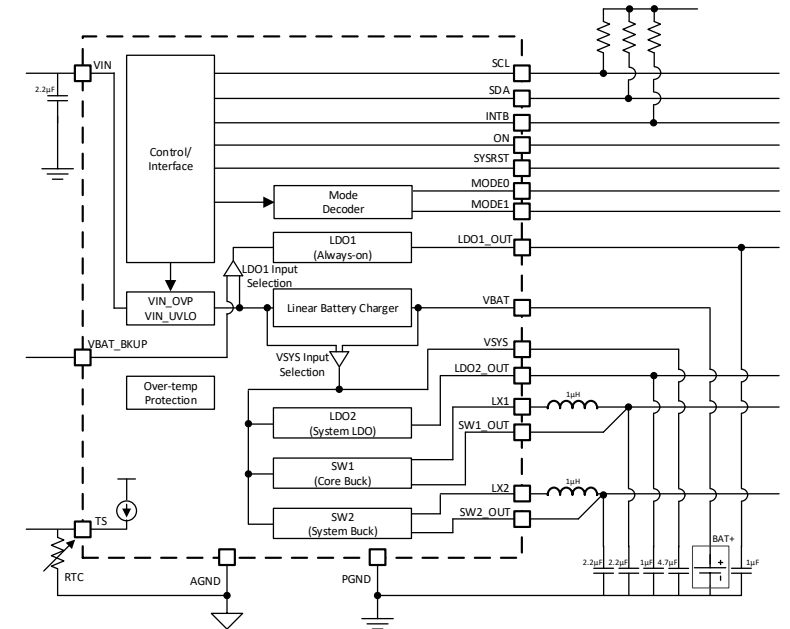
- Micro-PMIC for Kinetis and LPCNext Low-Power processors, typically used in Wearable/IoT applications
- **Micro-PMIC**
 - Optimized efficiency for low current levels (100's of μ A range)
 - Low quiescent current (100's nA range)
 - Includes a battery charger
 - Programmable outputs in 25 mV steps.
 - Outputs can be enabled/disabled independently
 - 20V DC Tolerance on V_{IN} with programmable OVP
 - I²C interface for communications
 - Packages: QFN and WLCSP
 - WLCSP: 2mm x 1.7mm, 20 balls
 - QFN: 3mm x 3mm, 24 pin
 - Board area for passives is $\sim 10 \text{ mm}^2$ (if all outputs are used)





PCA9420 – μ PMIC Key Features

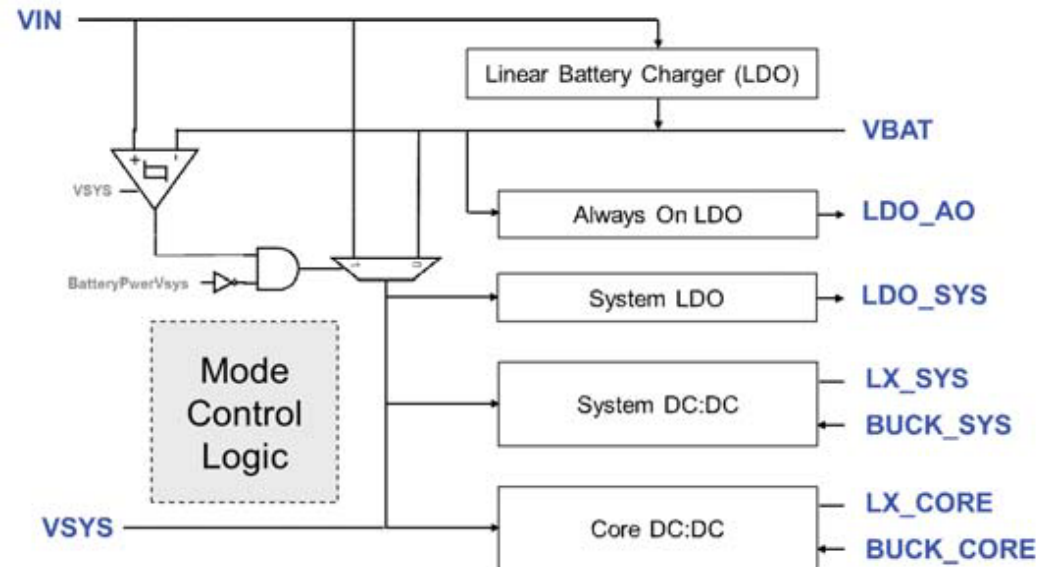
- V_{IN} Over Voltage Protection
 - Programmable (5.5V or 6V) with 20V tolerance
- Over Temperature Protection
 - Thermal Shutdown at 150 °C
- Battery Charging Safety Features
 - Reverse Current protection, triggered when $V_{IN} < V_{Bat} + 100\text{mV}$ typical
 - Programmable Charge Current Limit
 - V_{Bat} short circuit protection (0.8V)
 - Programmable pre-charge current as % of max charge current
 - Thermal Regulation when junction temperature > 125 °C
- Over Current Protection
- Watchdog Timer 16s – 64s, 15% accuracy
- Charger Safety Timer 7hr – 13hr, 15% accuracy





PCA9420 – Functional Block Summary

	Linear Battery Charger	SW1 (Core Buck)	SW2 (System Buck)	LDO1 (AO-LDO)	LDO2 (System LDO)
V_{OUT} Range	3.6V ~ 4.6V (CV Regulation) 0.5% Accuracy @25 °C	0.5V ~ 1.5V	1.5V~2.1V 2.7V-3.3V	1.7V~1.9V	1.5V~2.1V 2.7V-3.3V
V_{OUT} Adj. Res.	20mV/step	25mV/step	25mV/step	25mV/step	25mV/step
I_{OUT} Range	Up to 315mA (5mA~10mA/step)	Up to 250mA	Up to 500mA	Up to 1mA	Up to 250mA
V_{IN} (DC Rating)	Up to 20V	N/A	N/A	N/A	N/A



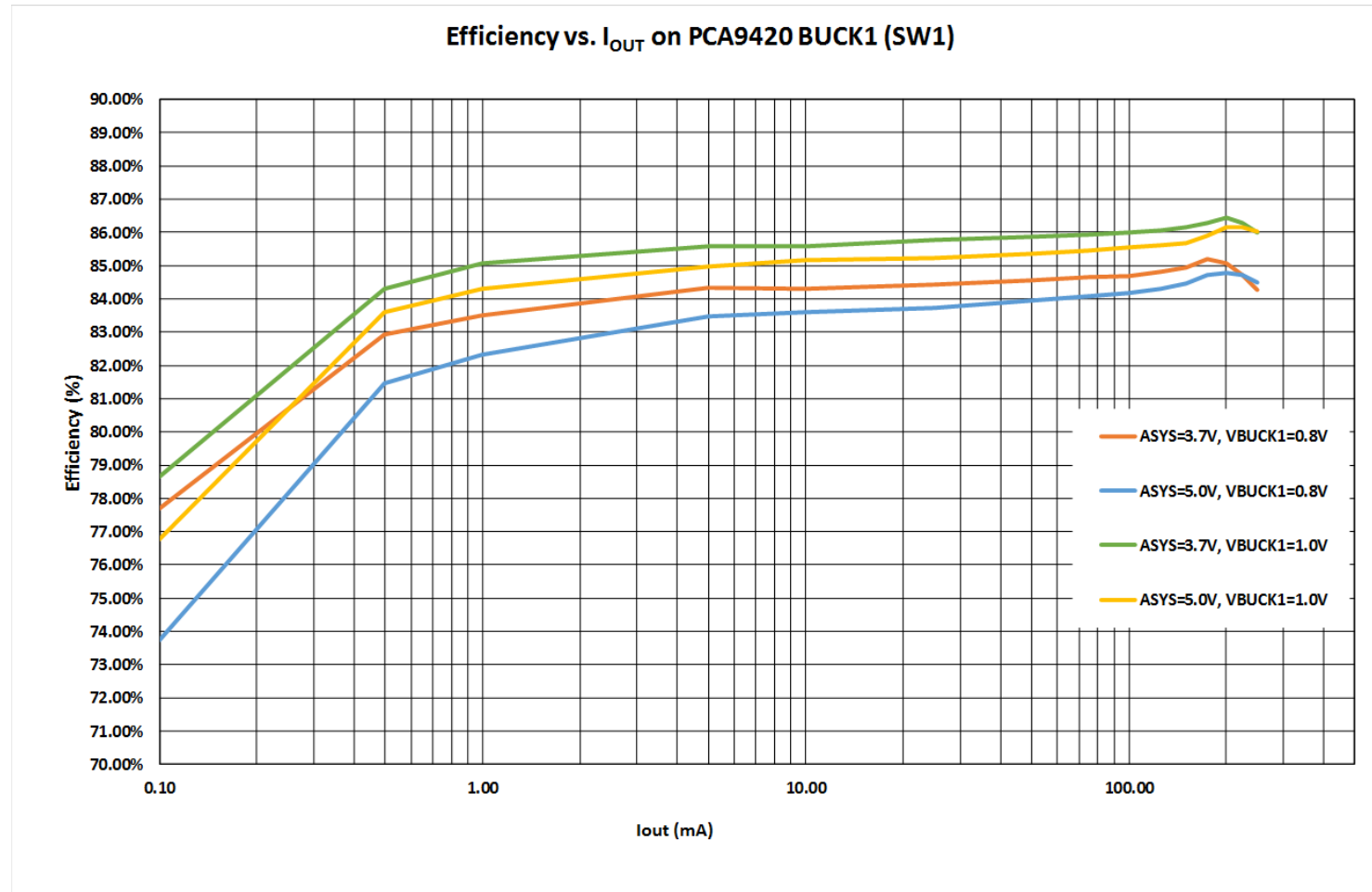


PCA9420 – Programmable VSYS Selection

- Programmable through I²C
- VSYS input source can be programmed to select:
 - Either VBAT or Vin, whichever is greater (default setting);
 - From VBAT only;
 - From VSYS only;
 - Disconnect from VBAT or VIN (for testing purpose only).

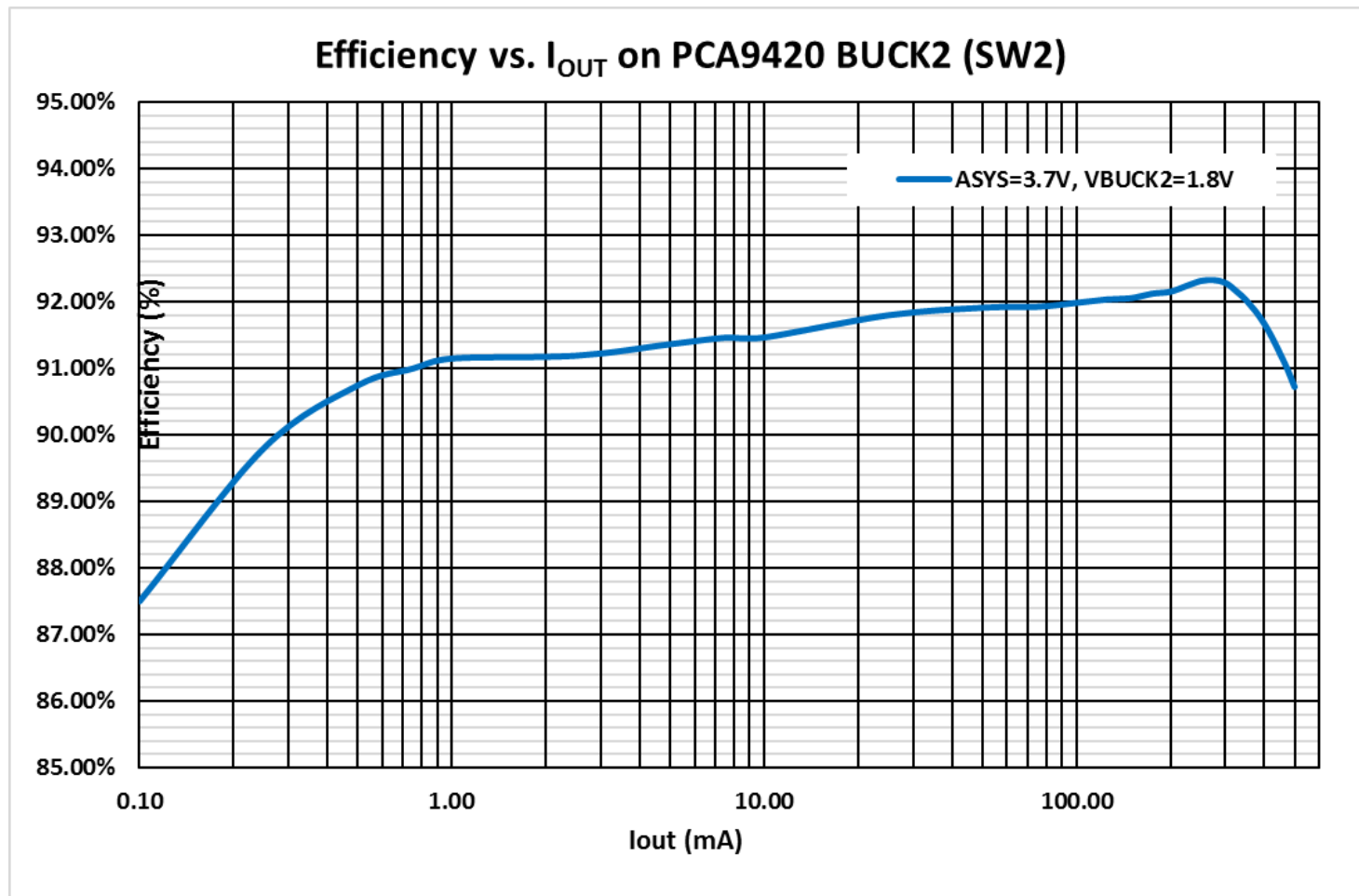


PCA9420 – Buck1 (Core Buck) Efficiency vs. Load Current





PCA9420 – Buck2 (SYS Buck) Efficiency vs. Load Current



Test Condition: VASYS=3.7V, VBUCK2=1.8V, IBUCK2=0mA to 500mA



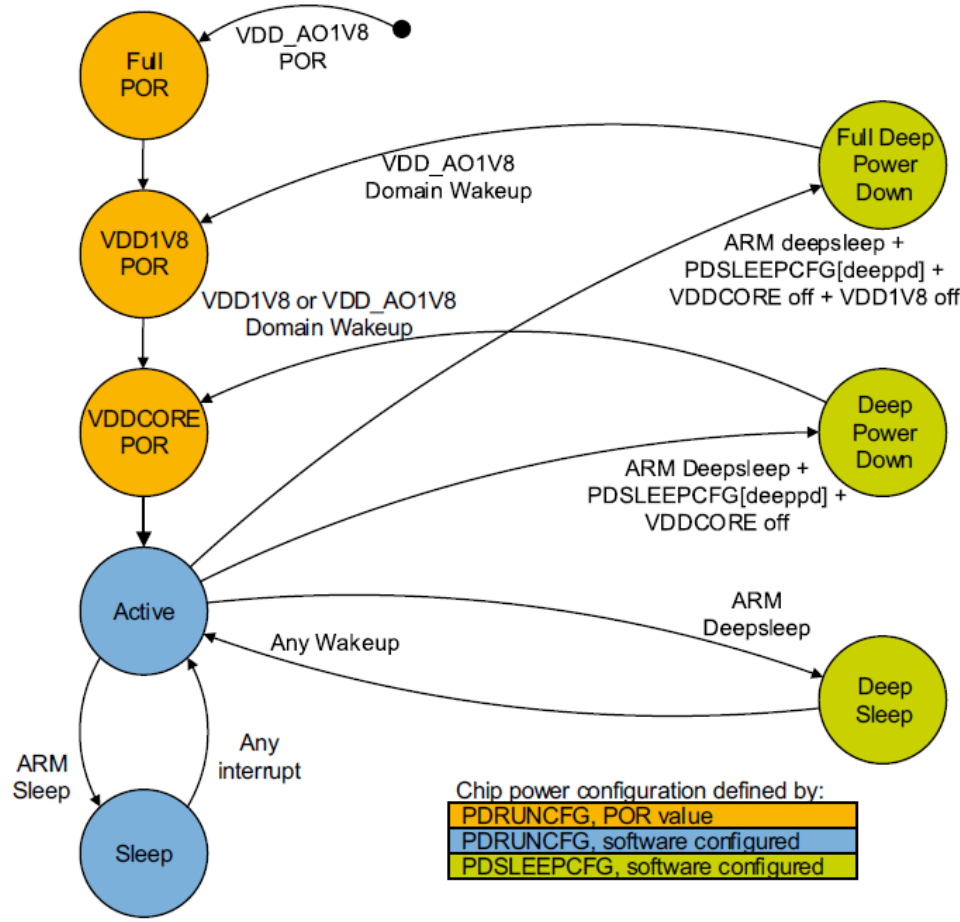
PCA9420 – Mode Control

- Mode Pins control fast entry into pre-define power settings
- Two different configurations can be programmed
 - Two-pin 4-state operation

MODE1 pin voltage level	MODE0 pin voltage level	Output Voltage Setting
LOW (0)	LOW (0)	Setting Group A
LOW (0)	HIGH (1)	Setting Group B
HIGH (1)	LOW (0)	Setting Group C
HIGH (1)	HIGH (1)	Setting Group D

- Single-pin 3-state operation

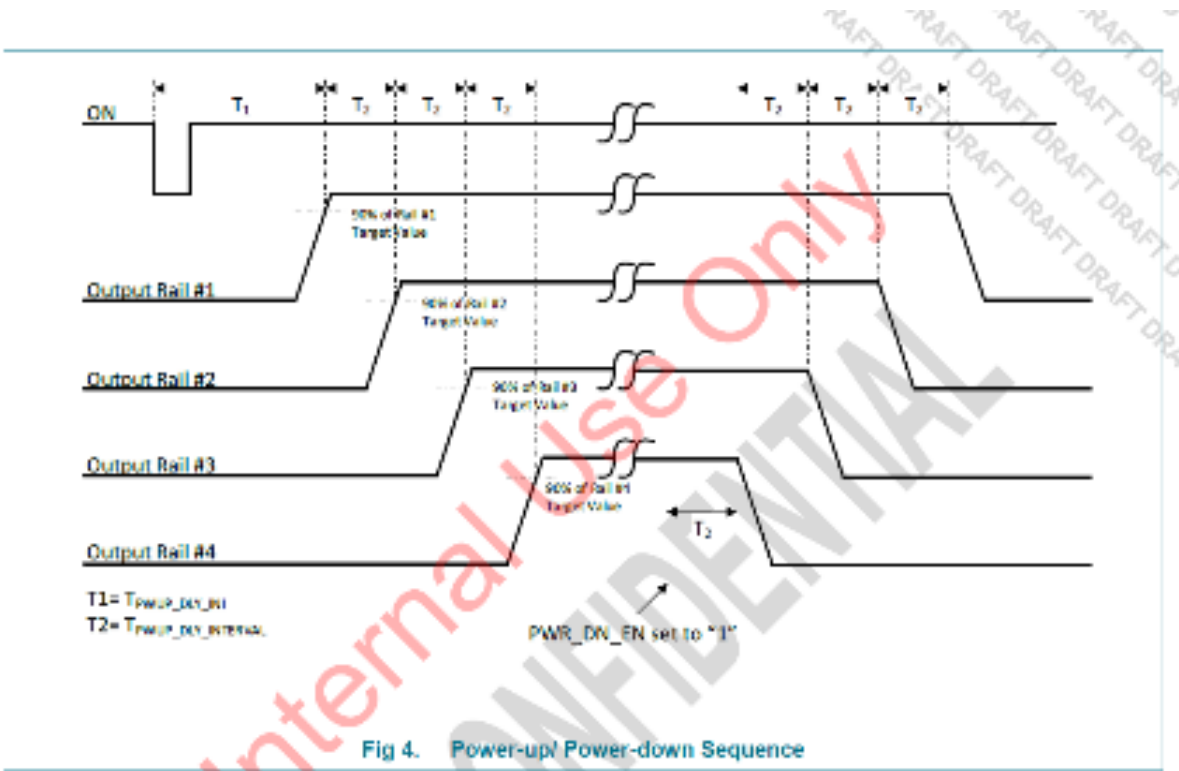
MODE1 pin voltage level	MODE0 pin voltage level	Output Voltage Setting
NA	LOW (0)	Setting Group A
NA	HIGH (1)	Setting Group B
NA	Hi-Z (z)	Setting Group C
NA	NA	NA





PCA9420 – Timing Sequence

- Startup sequence can be in any order (programmed by MTP)
 - Including no-start
- Typical $T_{PUWP_DLY_INI}$ is 2 ms
- Typical $T_{PWUP_DLY_INTERVAL}$ is 1 ms





PCA9420 – Ship Mode

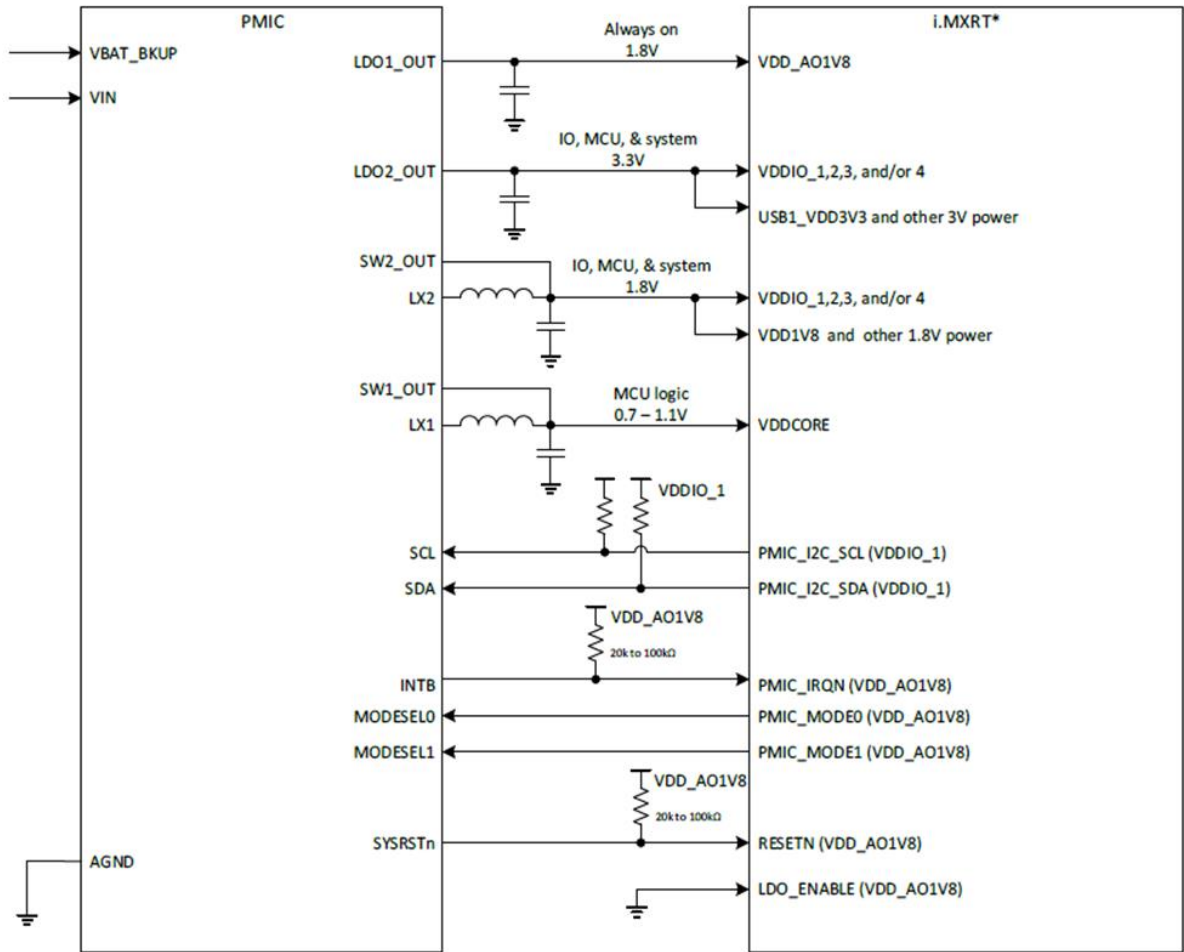
- Ship Mode provides the lowest current consumption
 - Entry through I²C command
 - All I²C registers are set to their default
 - Exiting Ship Mode
 - Falling edge detection at ON pin
 - Valid Vin plug-in

Target Current Consumption – I _{DD} (@25 °C)	
Ship Mode	125nA
Active Mode with no Load	2.5µA





PCA9420 with RT600/500



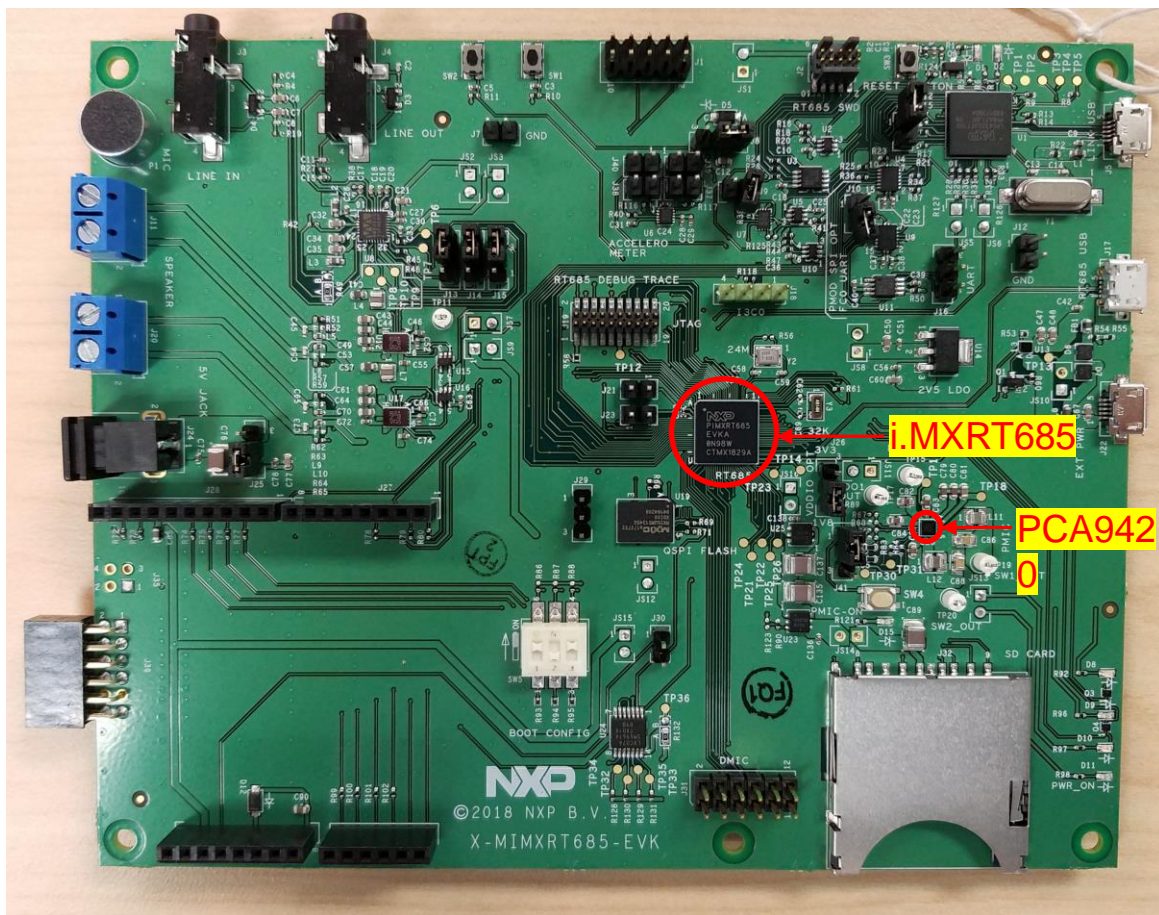
(1) Power-up Sequence

(2) Mode Setting

- Mode 0 – Run Mode
- Mode 1 – Deep Sleep
- Mode 2 – Deep Power Down
- Mode 3 – Full Deep Power Down



i.MXRT685 Standard EVK



PCA9420 Feature List

- Suitable for Low-power processors in wearable & IoT applications
- 100nA (typ) Quiescent Current Consumption During Ship-Mode
- Flexible Mode Setting Capability (via GPIO or I²C) Accommodating Fast MCU Operation Mode Switch
- Integrated Single-cell Linear Li-ion Battery Charger (up to 315mA)
- 2x DC/DC, 2x LDO
- Programmable outputs in 25 mV steps
- Output can be enabled/disabled independently
- 20V DC Tolerance on Vin with programmable OVP
- I²C interface for communications
- Packages : QFN and WLCSP
- WLCSP 25-bump, 2.09mm x 2.09mm, 0.4mm pitch
- QFN 3mmx3mm, 24 pin



PCA9420 – Key Features Comparison

Feature	PCA9420	BQ25120
Battery Charger	3.6V – 4.6V Accuracy of 0.5% @ 25 °C 20 mV/step 315mA (5mA/step – 10mA/step)	3.6V – 4.65V Accuracy of 0.5% @ 25 °C 10mV/step 300mA
SW1 (Core Buck)	0.5V – 1.5V 25mV/step 250mA	N/A
SW2 (System Buck)	1.5V – 2.1V 2.7V – 3.3V 25mV/step 500mA	1.1V – 3.3V 100mV/step 300mA
LDO1 (A0-LDO)	1.7V – 1.9V 25mV/step 1mA	N/A
LDO2 (System LDO)	1.5V – 2.1V 2.7V – 3.3V 25mV/step 250mA	0.8V – 3.3V 100mV/step 100mA
VIN Voltage Range	20V	20V
Size	WLCSP 3.4 mm ²	BGA 6.25 mm ²



PCA9420 – Key Features Comparison

	PCA9420	Bx2512xA
Key Function Summary	1x Linear Battery Charger 2x DC/DC: 500mA/ 250mA 2x LDO: 250mA/ 1mA	1x Linear Battery Charger 1x DC/DC: 300mA 1x LDO(Load Switch): 100mA
Package	WLCSP (5x5 bump array): 2.09mm x 2.09mm = 4.37sqmm QFN (24-pin): 3mm x 3mm = 9sqmm	DSBGA 2.5mm x 2.5mm = 6.25sqmm 6 X 6 Bump Array
Battery Charger	Linear	Linear
Charger CC Current Range	5mA~315mA, 5mA/step (I ² C programmable)	5mA~300mA (set by external resistor)
Charger CV Voltage Range	3.6V~4.6V, 20mV/step (I ² C programmable)	3.6V~4.65V, 10mV/step (I ² C programmable)
Number of Buck Converter	2	1
Buck Converter	Buck #1: 500mA output 1.5~2.1V/2.7~3.3V, 25mV/step Buck #2: 250mA output 0.5~1.5V/1.8V, 25mV/step	Buck#1: 300mA output 1.1~3.3V, 100mV/step
Number of LDO	2	1
LDO	LDO #1: 1mA output 1.7~1.9V, 25mV/step LDO #2: 250mA output 1.5~2.1V/2.7~3.3V, 25mV/step	LDO#1: 100mA output 0.8~3.3V, 100mV/step
NTC Sensing	Yes	Yes

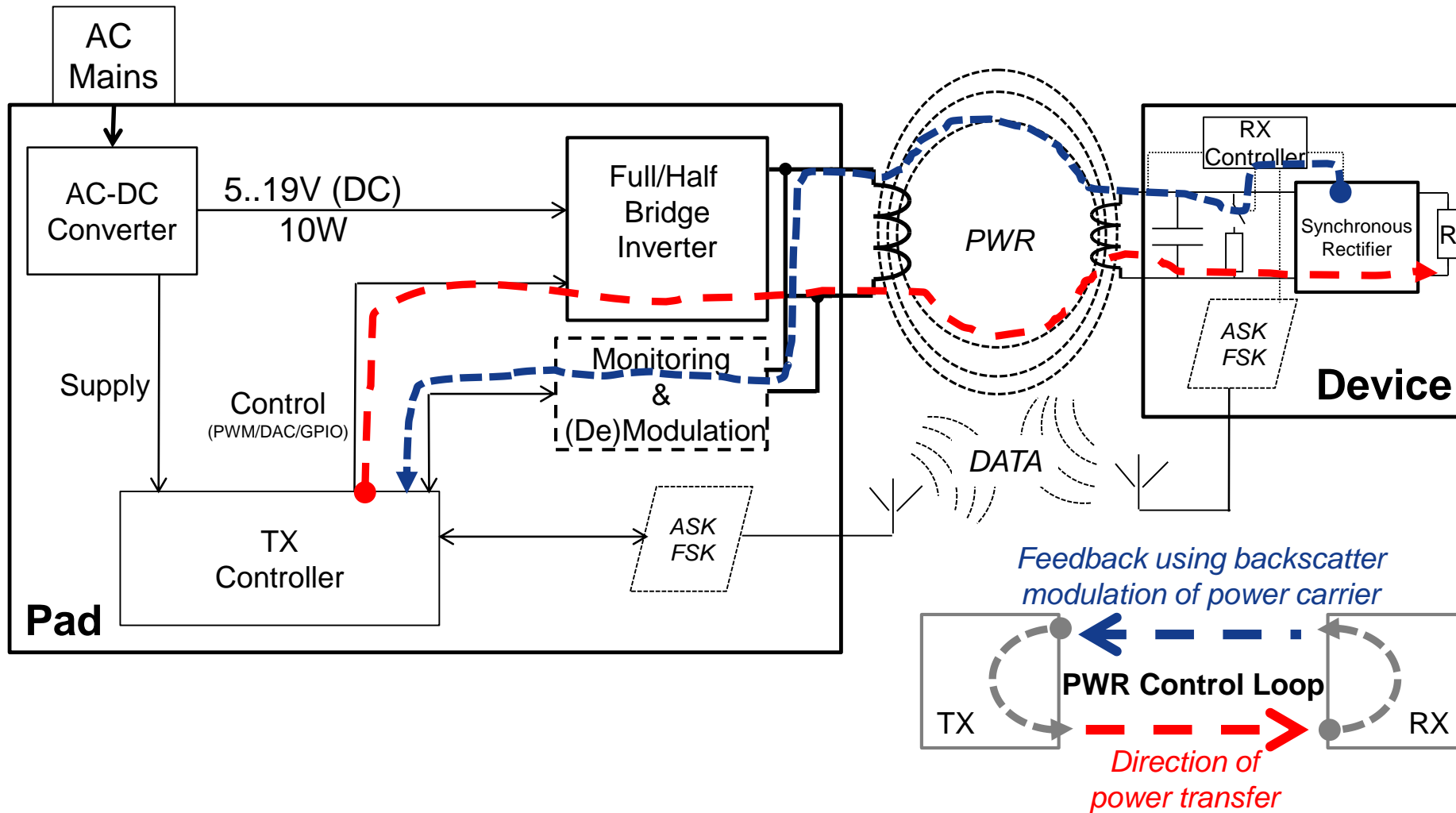


WIRELESS POWER





Qi Wireless Charging System Overview





QI WIRELESS CHARGING TRANSMITTER SOLUTIONS





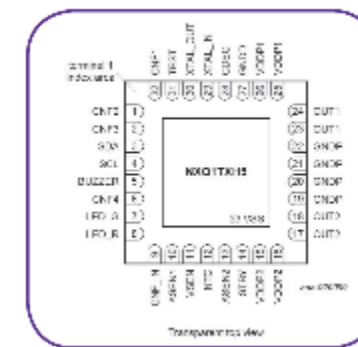
NXQ1TXH5 & NXQ1TXL5: Low-Power Qi Transmitter

- Features:

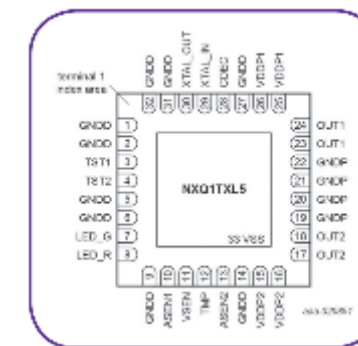
- Integrates A5, A11, A12, & A16 WPC Qi V1.2 analog and digital functions for 5W System Specification
- Average output power up to 6W
- **The NXQ1TXL5 is a lower-cost option for applications that do not require FOD**
- Easy FOD Control
- Internal voltage and current measurement circuits
- On-chip analog and digital filters for robust ASK detection
- No external OpAmp, filter, or biasing circuit needed
- **Less than 10 external passive components required**
- Low cost 32.768kHz external crystal for low power oscillator to **achieve standby current of 15µA (typical); System Standby Power of 10mW (typ)**
- DSP wakeup by special device detect function
- Operates supply from 3.5V to 5.25V
- Small 5mm x 5mm HVQFN32 package
- **Qi Certified**



NXQ1TXH5 Pinning



NXQ1TXL5 Pinning



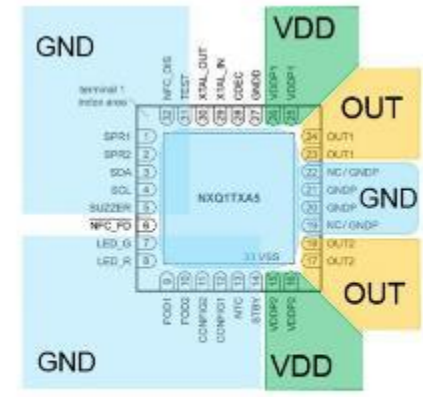
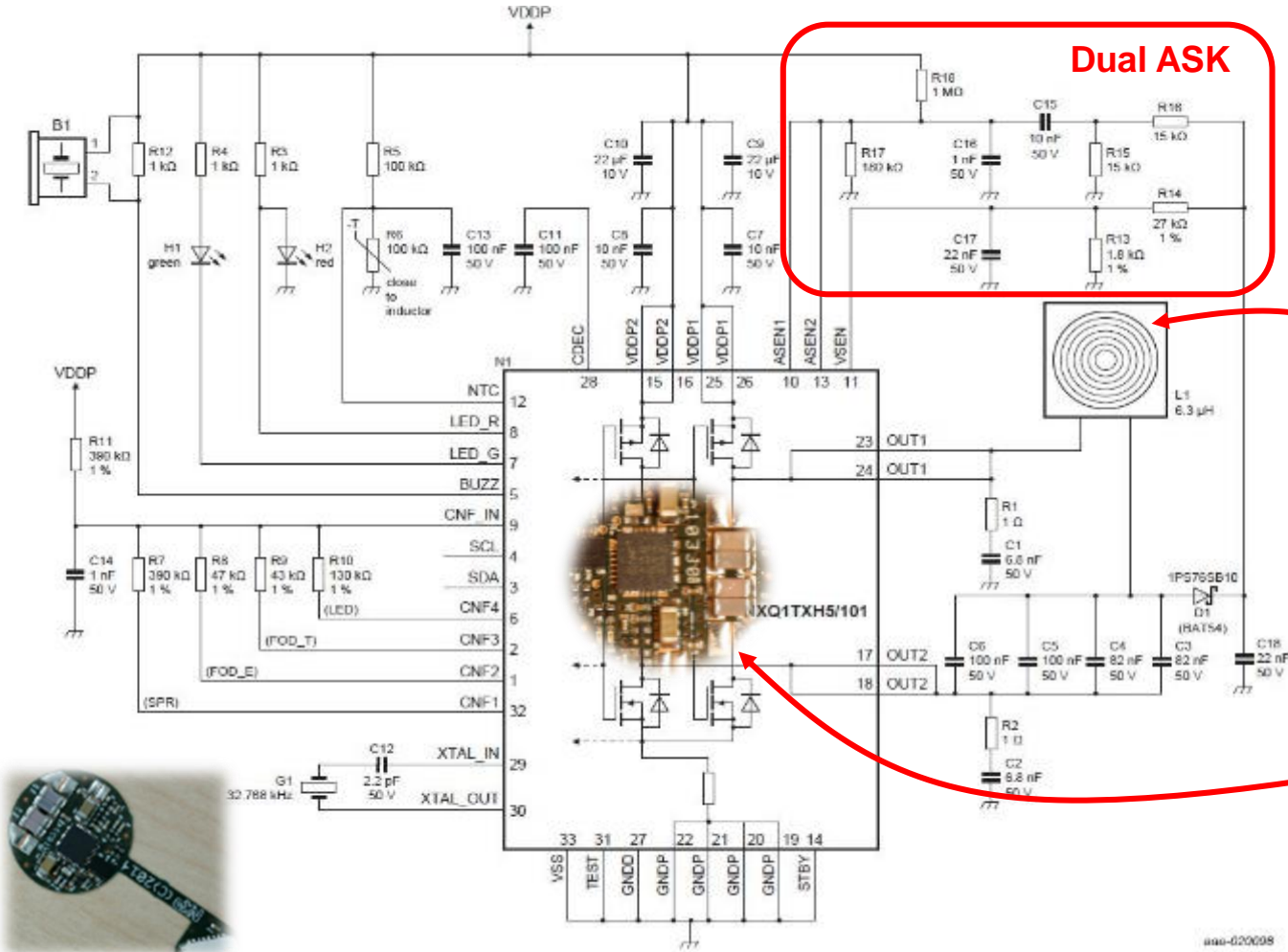
- Applications:

- Wearable Charger
- Mobile Charger
- Applications requiring USB power, low cost and low standby power

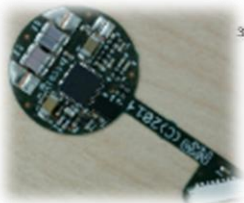




NXQ1TXH5/101: New Design with Dual ASK



PCB Top Layer Copper Layout (colors are for clarification only)

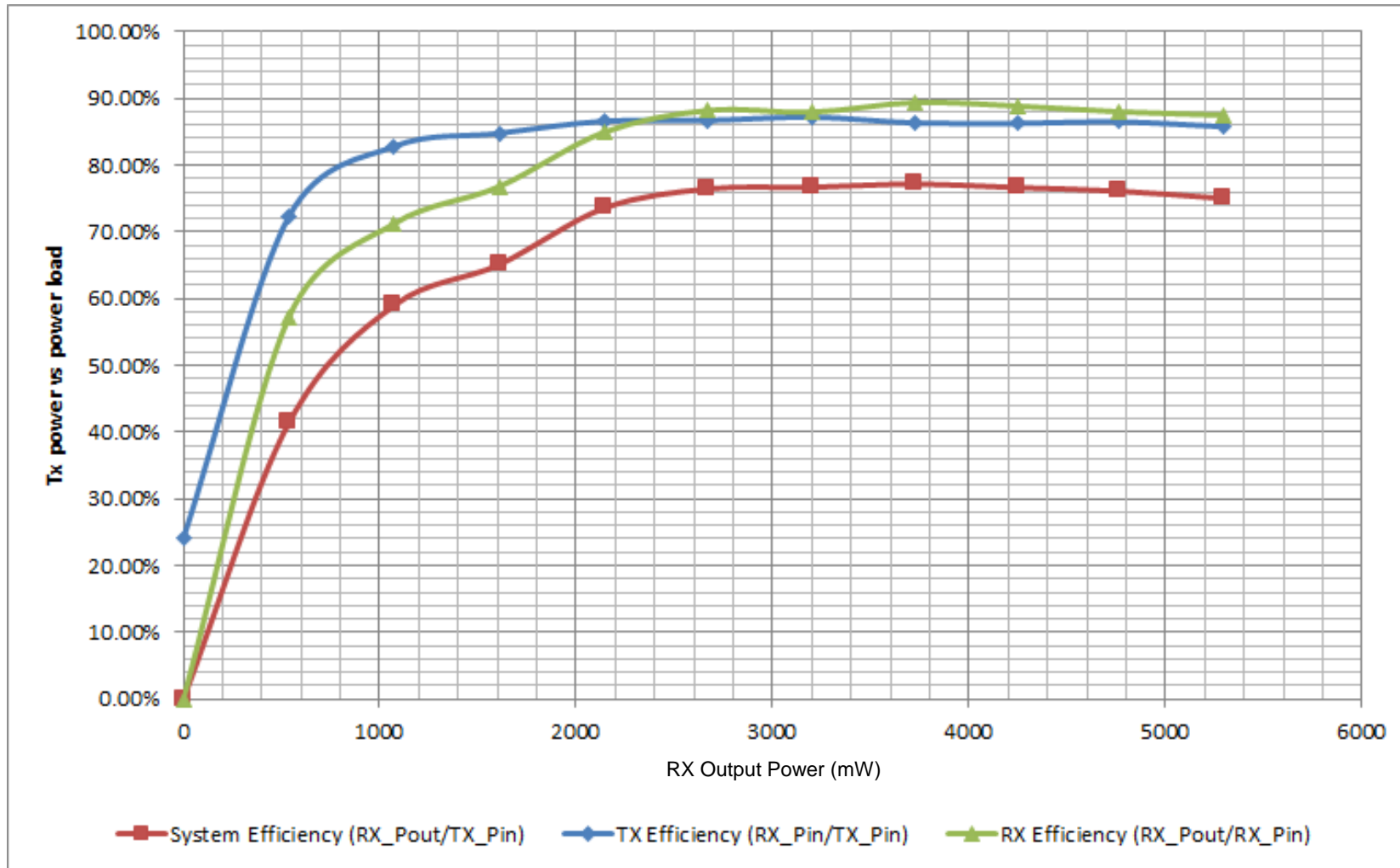


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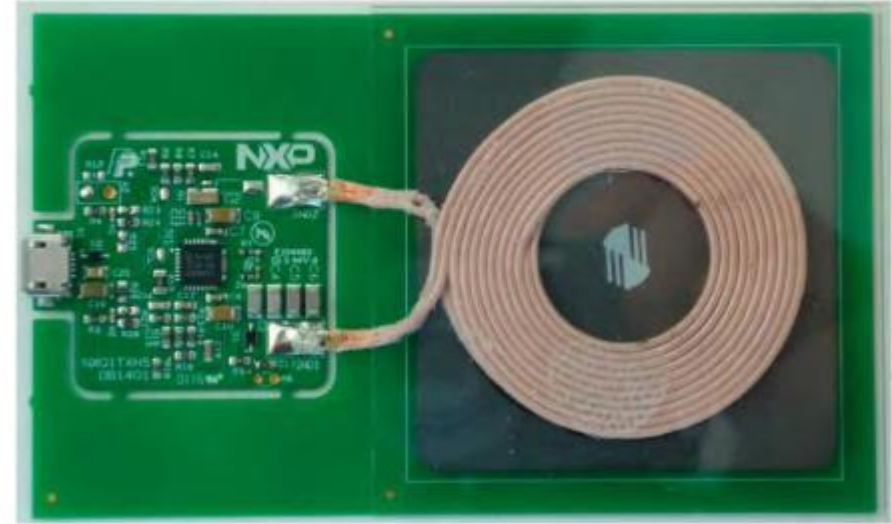
NXQ1TXH5: Measured System Efficiency





NXQ1TXH5DB1401 Evaluation Board

- Design includes a micro-USB connector for powering the board with standard USB charger with rating of 1,500mA or more
- Design includes an A11 Qi Transmitter coil
- Connection for optional NTC to measure coil temperature
- Resistors for setting configurations (FOD, LED mode, SPR/SPL)
- Optional buzzer connection

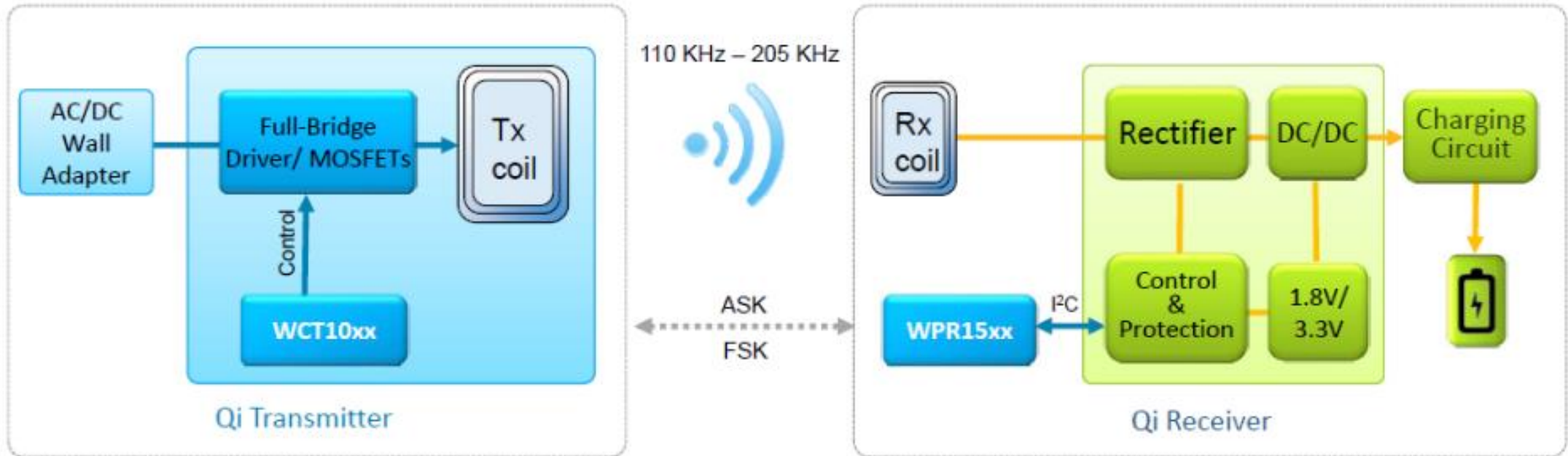


Reference Documents

- Application Note: [AN11775](#)
User Manual: [UM10943](#)
Board Layout Files: [Click Here](#)



Qi System Solution

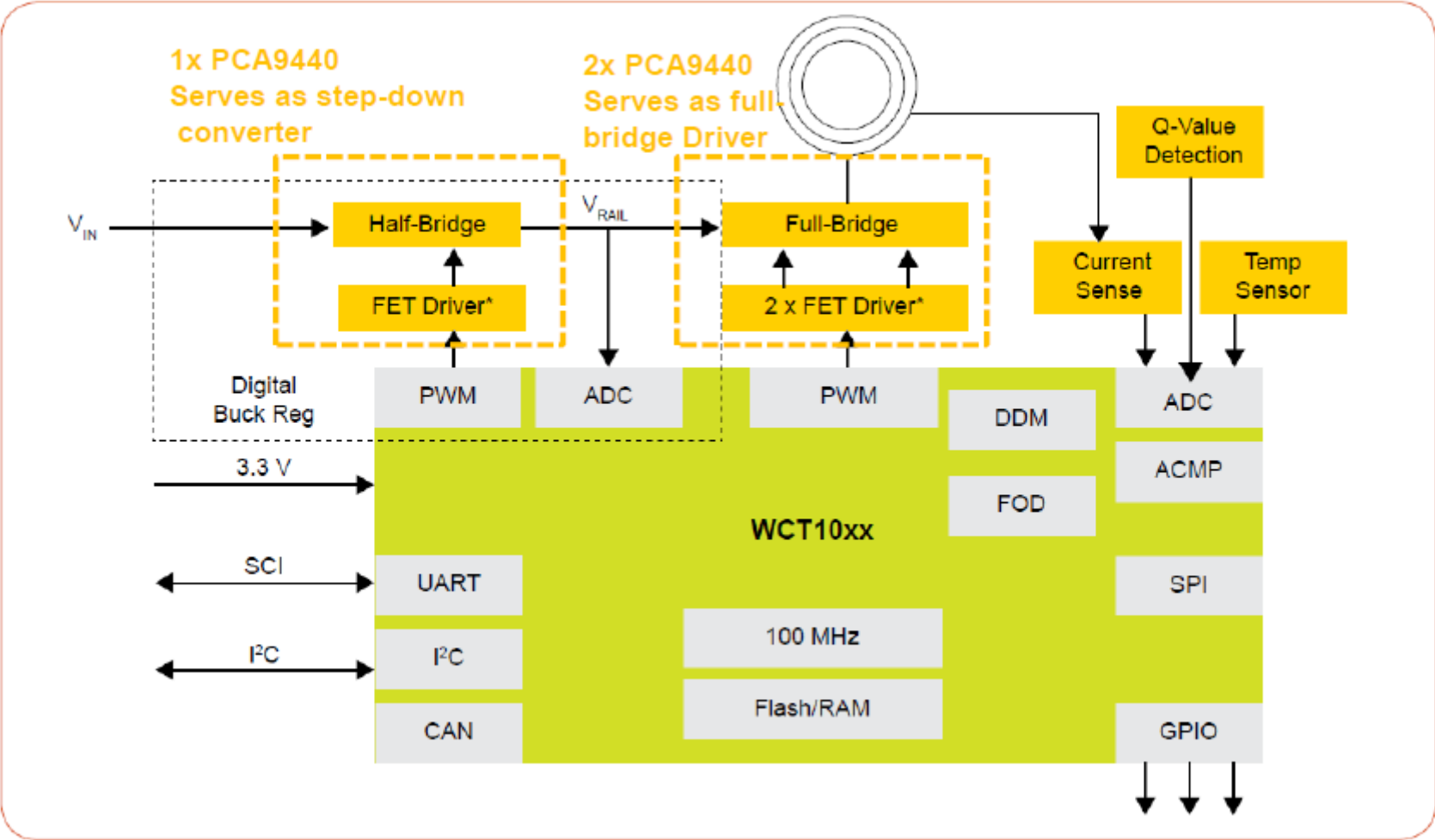


- WCT-15W1COILTX: 15W Single Coil TX Ref. Design (Variable Frequency)
- WCT-15WTX1COILFF: Up to 15W Single Coil Fixed TX

- WPR1500-LDO: 15W RX Ref. Design with LDO Architecture
- WPR-1500-Buck: 15W RX Ref. Design with Buck Architecture
- WPR-1500-LITE



15W Qi-Compliant Transmitter Block Diagram









AC/DC CONVERTERS



Introduction to NXP GreenChip

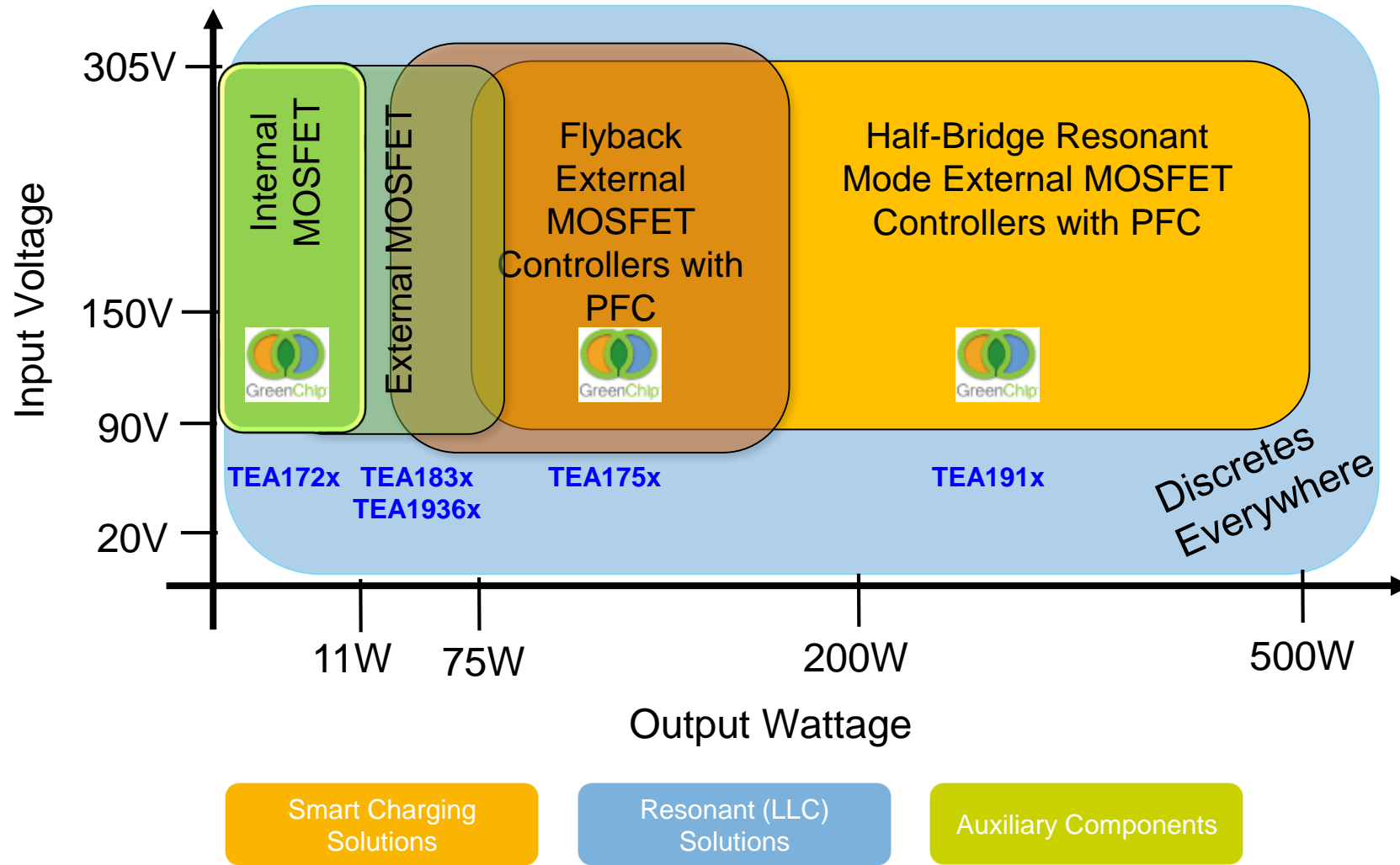
Switch-Mode Power Supply (SMPS) Controller Portfolio

Power Range	PFC Control	Primary Control	Secondary Control	Aux. Control
Resonant >90W 		TEA171x (TEA1713, TEA1716) TEA1916	TEA1791A TEA1792A TEA1795 TEA1892A TEA1995	Parallel Supply TEA173x Active X-cap Discharge TEA1708
Flyback >75W 		TEA175x (TEA1750/51/52/53/ TEA1755) (GreenChip III)	TEA1761 TEA1762 TEA1791 TEA1792	Standby Control TEA1703
Flyback <75W 	N/A	TEA153x (TEA1530/32/33) TEA173x (TEA1731/33/38) TEA183x (TEA1832/33/36) TEA1936x (TEA19361/2/3)	TEA1892 TEA1993 TEA1999	Active X-cap Discharge TEA1708
Flyback <12W 	N/A	TEA152x, TEA162x (StarPlug) TEA1721, TEA1723 (GreenChip SP)	N/A	Integrated in Primary IC



Introduction to NXP GreenChip

Power Range Selection Guide



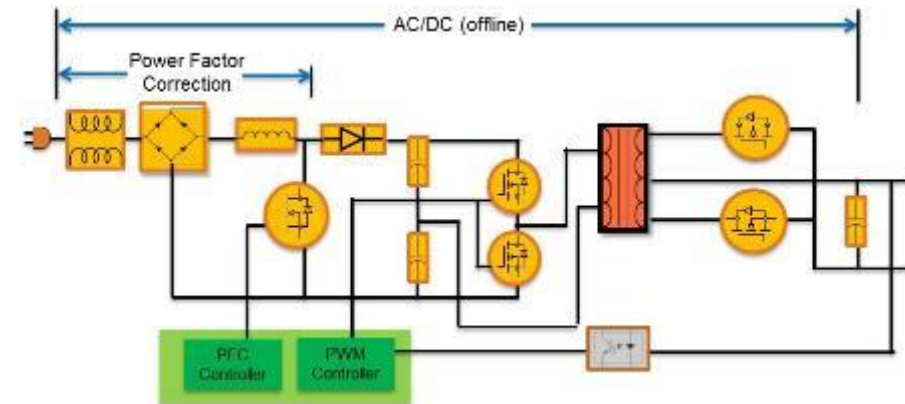
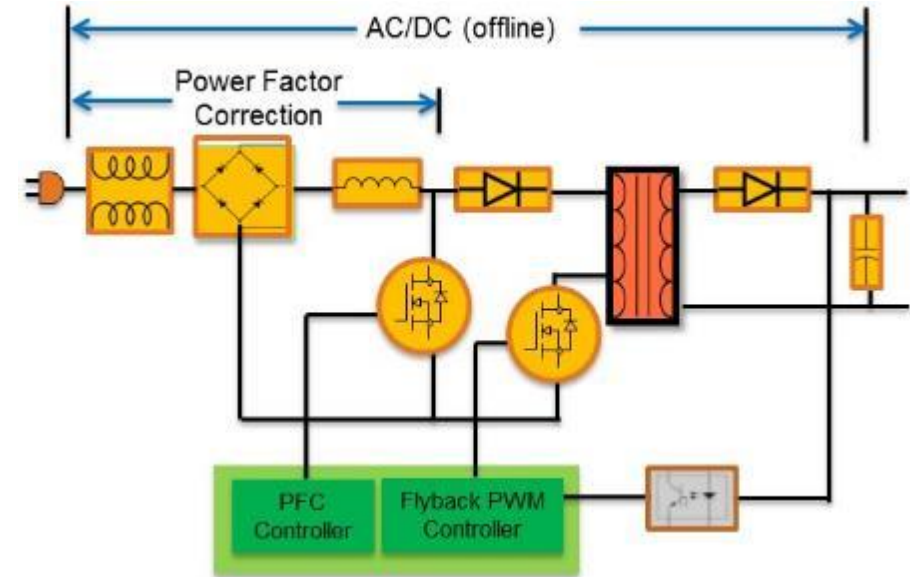


Introduction to NXP GreenChip

SMPS Topologies

- Flyback Topology:
 - Excellent input voltage range and decent efficiency
 - Power Factor Correction (PFC) circuit required for high wattage (>70W) power supplies
 - Fewer components (1 MOSFET in Primary, 1 Diode in Secondary)

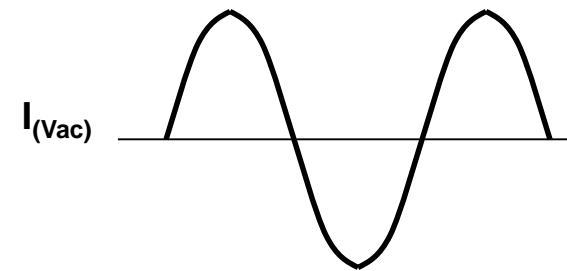
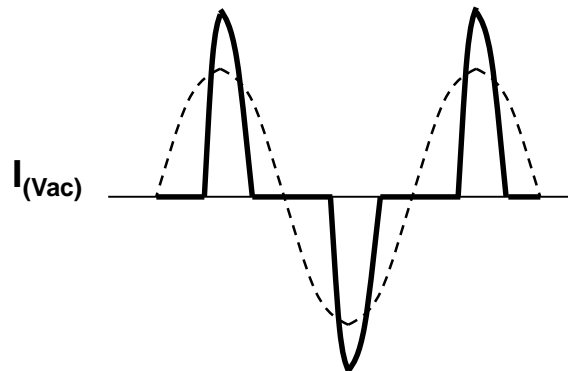
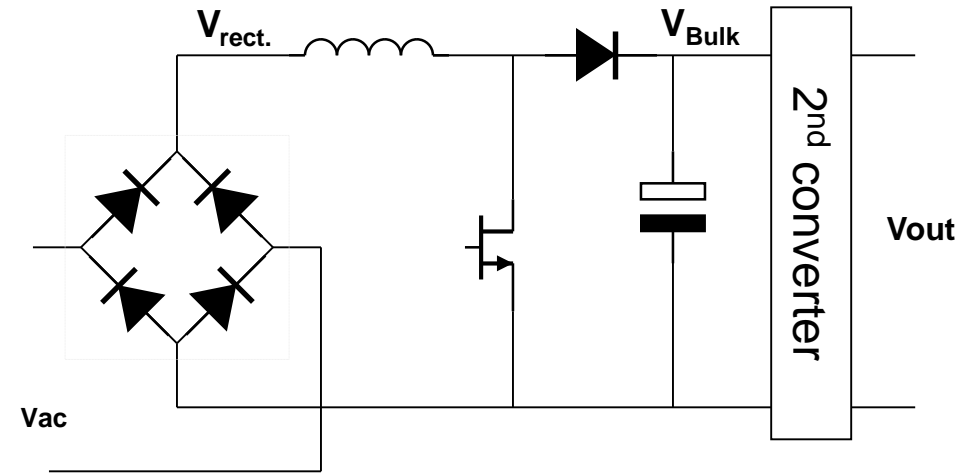
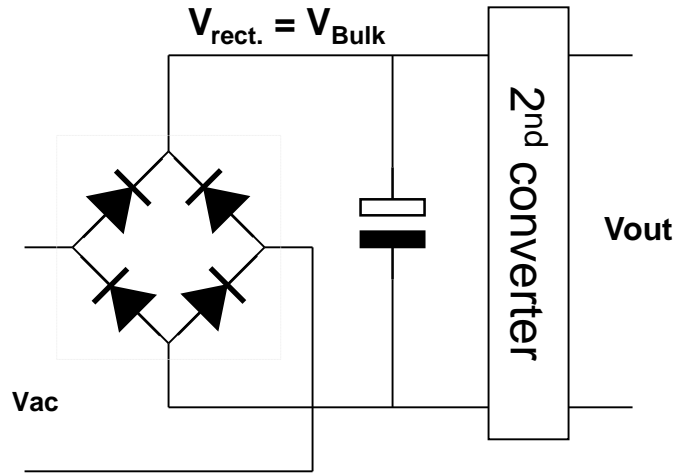
- Resonant Half-Bridge Topology:
 - Improved performance and efficiency
 - Optimized for 100W to 300W Output Power
 - Requires a different PFC for >300W
 - More switches (2 MOSFET's in Primary, 2 Diodes in Secondary)





Introduction to NXP GreenChip

Power Factor Correction (PFC)

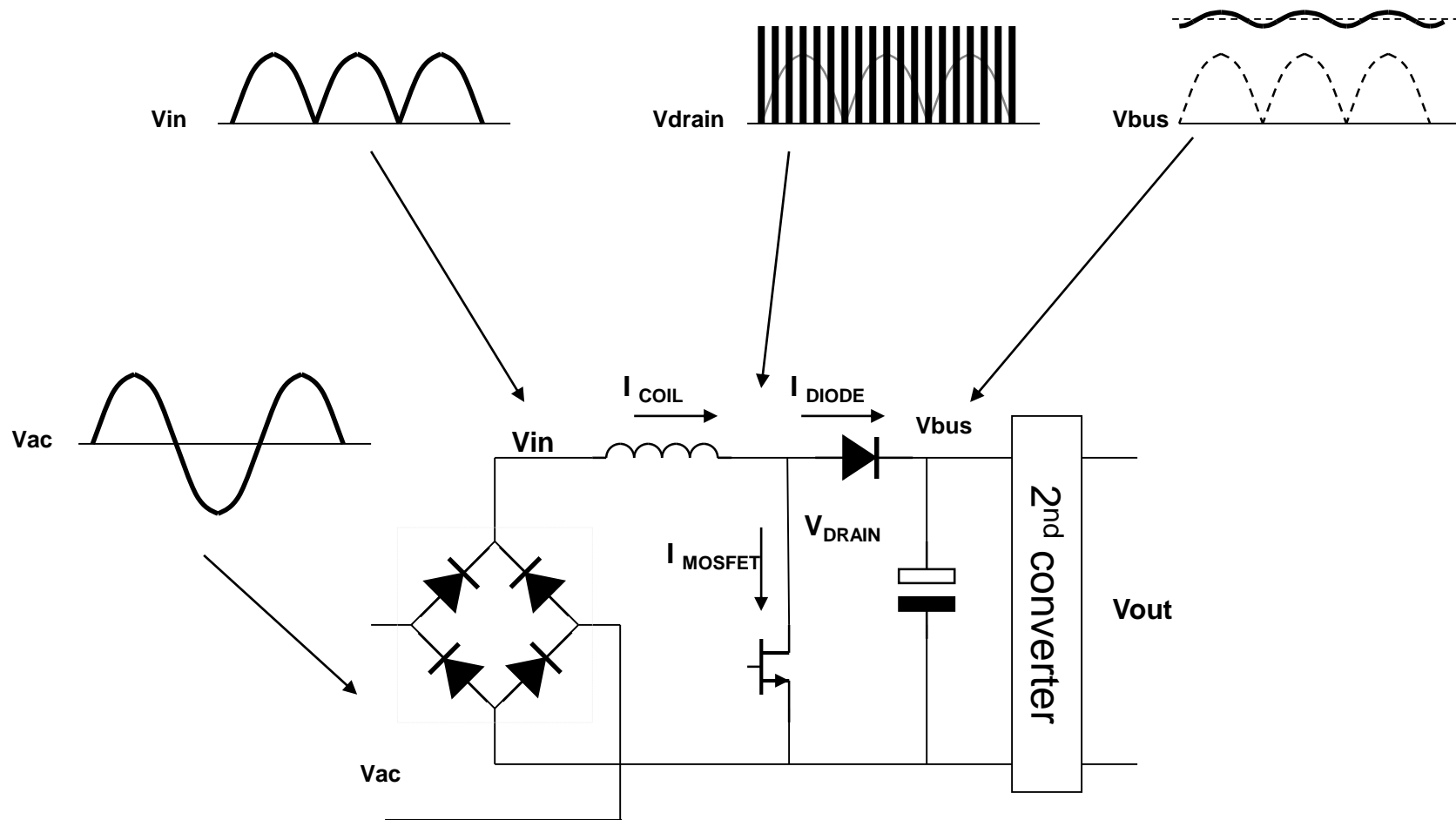


- Reduce mains RMS current by a sine-wave shaped input current
- Reduce mains harmonic currents (MHR)



Introduction to NXP GreenChip

Power Factor Correction (PFC)

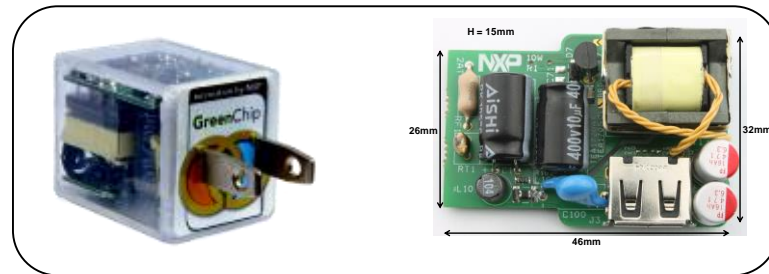




Key Products & Applications (1 of 6)

Flyback Solutions with Integrated MOSFET for <15W Applications

- TEA172x (1721, 1723) Flyback Controllers for Compact (<1.5 inch³) Cost-Effective Chargers
 - Primary sensing eliminates opto-coupler and reduces total BoM cost
 - Low no-load standby <20mW @ 10W
 - High efficiency >82% on average
 - Integrated HV start-up current source
 - Small output capacitors save cost and PCB footprint





TEA1721/TEA1723: Key Feature Set

Key Differentiators

- Enables **low no-load power consumption below 10mW**
- **Low component count** for cost-effective system design
- Advanced control modes creating **high efficiency**



SO-7 package:

- Low cost due to high volume production
- Small package enabling compact designs
- HV spacer included

Customer Collateral

- Housed in a SO7 package with high voltage spacing
- RoHS and Halogen free compliant package
- Available Demo and Promotion Material:
 - Charger demo boards with <10mW no-load power
 - White Goods and Metering/Industrial demo boards
 - Datasheets and Application Notes
 - Online Calculation Tools

Key features

- SMPS controller with **integrated power switch** up to 11W
- **700V high voltage MOSFET for universal mains operation**
- **Primary sensed control eliminates opto-coupler**
- Variable switching frequency up to 51.5kHz
- Avoids audible noise in all operation modes (min. fsw>22kHz)
- Compensation of cable impedance included
- Jitter function for reduced EMI
- USB Battery Charging (CC/CV) and Energy Star 2.0 compliant

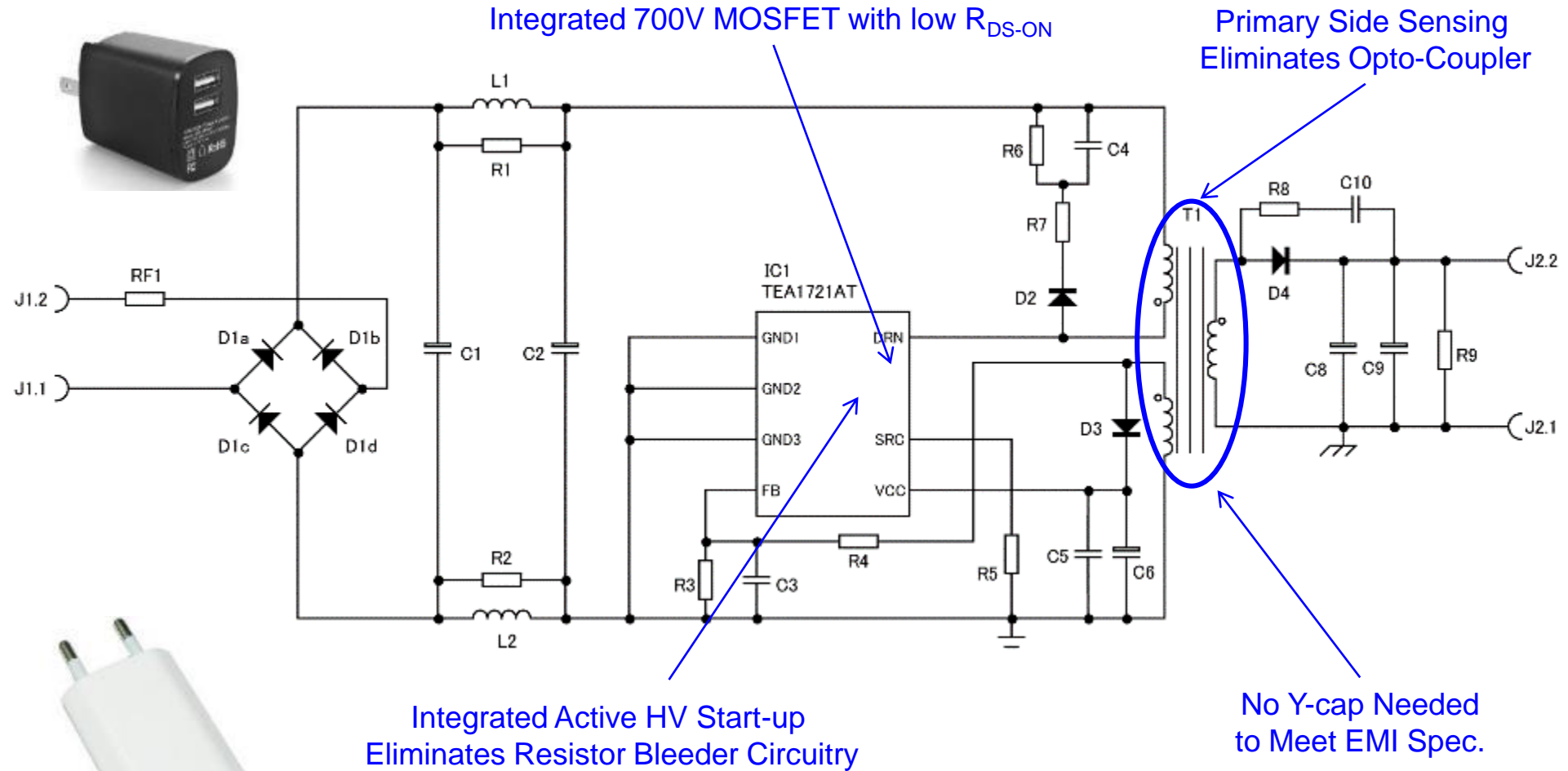
Protections

- Safe restart mode for system fault conditions
- Over voltage protection (OVP) with auto-restart function
- Under voltage lockout (UVLO) and clamp protection
- Over temperature protection (OTP)
- Soft start by reduced peak current for zero & low Vout
- Demagnetization protection for guaranteed DCM mode
- Open and short-circuit protection of the FB pin





TEA1721/TEA1723: Application Diagram



BOM Count: <30 Components





TEA172x – Target Applications

Mobile Communication

- Mobile Phone Chargers
- Smart Phone Chargers
- Tablet Chargers



Major Home Appliances

- Washing Machines & Dryers
- Refrigerators & Freezers
- Dish washers
- Induction Cookers
- Room Air Conditioners



Computing & Consumer

- E-readers
- Portable Audio/Video
- Set-Top Boxes
- PC Peripherals



Industrial & Residential

- Smart Metering
- (Smart) Lighting
- Home & Building Automation
- HVAC
- Industrial Automation & Contrc





Key Products & Applications (2 of 6)

Flyback Solutions with External MOSFET for <75W Applications

- TEA173x (1731, 1732, 1733, 1738)
Fixed Frequency Flyback Controllers

- High efficiency ~ 90%
- Very low supply currents during start-up and normal operation
- Frequency reduction at low power operation to maintain high efficiency
- Enables low no-load power consumption
 - Less than 100mW typically
 - Less than 40mW is possible in combination with NXP's Standby Controller (TEA1703)
- Operates under overpower situations for an adjustable limited time (OPP)



- TEA183x (1832, 1833, 1836) Primary Controllers

- Enables < 30mW NLP dissipation with output high (output in full regulation)
- Auto burst-mode prevents audible noise and enables high efficiency at low loads
- Integrated active X-cap discharge & Brown out protection
- TEA1836 + TEA1892 efficiency exceeds 93% allowing the components inside to be well within thermal limits despite the small form factor.



- TEA1892 Secondary Controller and Synchronous Rectifier

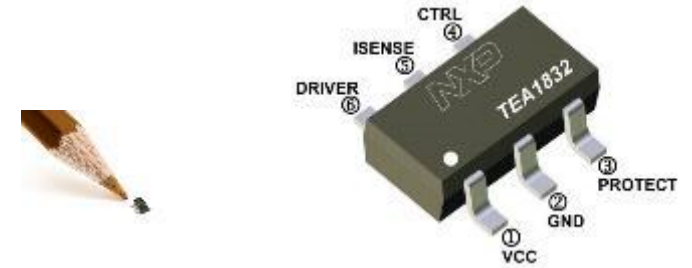
- Enables the use of low Rdson MOSFET with the TEA1836 DCM Controller



TEA1832(L) / 1833(L): Fixed Frequency Flyback Controller

- SMPS Controller IC enabling high-performance, low-cost applications
- Wide VCC range up to ~40V, Lowered UVLO ~11V (allowing using a smaller VCC cap)
- $P_{IN} < 55mW$ @ no load
- Delivers 200% Peak Power (Supporting Intel processor series)
- Very low supply current during start-up and restart (typically ~10 μ A)
- Low supply current during normal operation (typically 0.58mA, without load)
- $F_{max} = 130kHz$ (peak power performance) with Peak Current run-away protection
- Burst mode by VCC_rescure (keeps VCC above UVLO during load change, allowing lower value VCC capacitor)
- Increased maximum duty cycle of ~89%
- Soft start integrated (~3.5msec)

- Differences between TEA1833 and TEA1832
 - ✓ Higher efficiency at 25% load because of reduced switching frequency
 - ✓ Improved slope compensation
 - ✓ Maximum frequency limitation at high mains



TEA1832TS: Safe restart protection
TEA1832LTS: Latched protection version

TEA1833TS: Safe restart protection
TEA1833LTS: Latched protection version





TEA1832(L): Versions

Function	TEA1832TS TEA1833TS (Safe Restart)	TEA1832LTS TEA1833LTS (Latched)	TEA1832CTS (All safe restart) * Considered part
OPP time-out	30 ms	180 ms	30 ms
OPP	Slow restart ¹	Latch	Slow restart ¹
UVLO	Restart	Latch	Restart
OVP (via ISENSE & VCC)	Latch	Latch	Restart
External OTP	Latch	Latch	Restart
Internal OTP	Latch	Latch	Latch
Brown-out	Restart	Restart	Restart
Max duty cycle	Restart	Restart	Restart

¹Slow restart = 3 cycles discharge/charge VCC capacitor





Measurement Results from 45W TEA1832TS / LTS Board

High load efficiency

Measured directly at PCB, see UM10862 section 4.1.1 for how to calculate efficiency at end of cable

Condition	Efficiency at specified load					
	10 % 4.5 W	25 % 11.25 W	50 % 22.5 W	75 % 33.75 W	100 % 45 W	4 point average
115 V (AC); 60 Hz	88.74	90.24	90.70	90.01	89.23	90.05
230 V (AC); 50 Hz	87.52	88.64	90.33	90.65	90.46	90.02

Low load efficiency

Measured directly at PCB

Condition	Efficiency at specified load				
	0.1 W 0.22 %	0.2 W 0.44 %	0.5 W 1.11 %	1 W 2.22%	2 W 4.44 %
115 V (AC); 60 Hz	69.36	78.35	85.65	87.77	88.89
230 V (AC); 50 Hz	56.52	69.12	80.34	84.02	86.02

Efficiency standards

Standard	10% load	4 point average (25, 50, 75 and 100 %)
COC 2014	78.43 %	88.43 %
COC 2016	78.85 %	88.85 %
DoE 2008	-	84.26 %
DoE 2016	-	87.73 %
Energy Star 2.0	-	86.03 %

No-load power measurements

Input condition	No load power
90 V (AC); 60Hz	24.8 mW
115 V (AC); 60Hz	27.4 mW
230 V (AC); 50Hz	48.8 mW
264 V (AC); 50Hz	58.7 mW

No-load power requirements

Standard	No-load power
COC 2014	150 mW
COC 2016	75 mW
DoE 2008	300 mW
DoE 2016	100 mW
Energy Star 2.0	300 mW

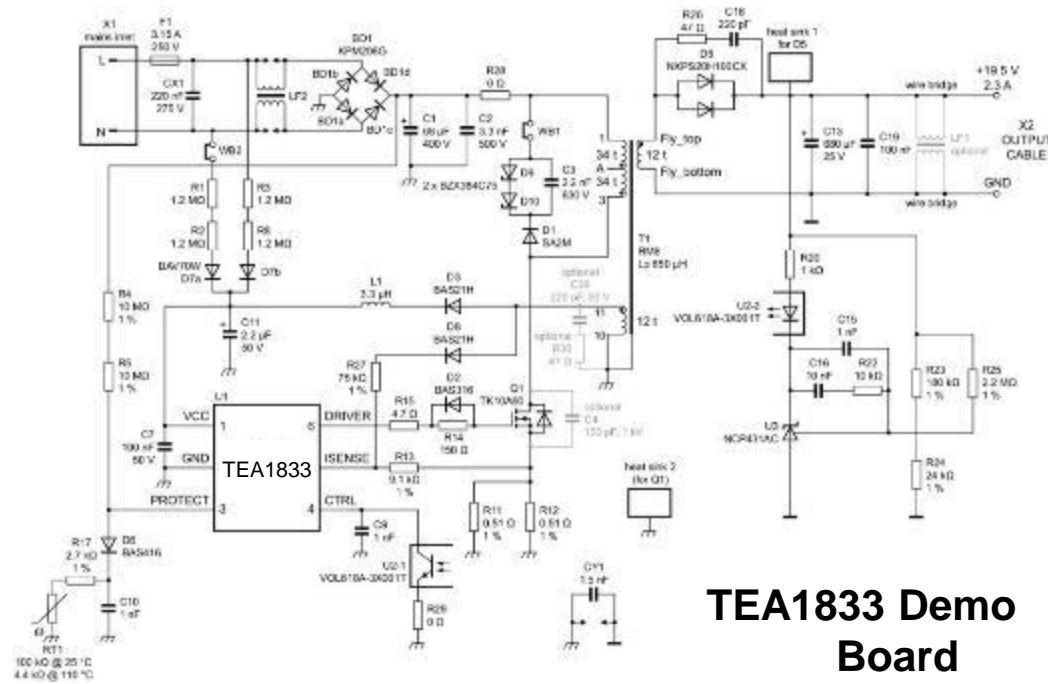




Measurement Results from 45W TEA1833TS / LTS Board



606-013245



TEA1833 Demo Board

Input condition	No-load power
90 V (ac) / 60 Hz	25.7 mW
115 V (ac) / 60 Hz	28.5 mW
230 V (ac) / 50 Hz	51.3 mW
264 V (ac) / 50 Hz	62.0 mW

Input condition	Efficiency at specified load					
	10 %; 4.5 W	25 %; 11.25 W	50 %; 22.5 W	75 %; 33.75 W	100 %; 45 W	4-point average
115 V (ac) / 60 Hz	89.21 %	90.61 %	90.36 %	90.01 %	89.21 %	90.05 %
230 V (ac) / 50 Hz	88.44 %	90.61 %	90.57 %	90.70 %	90.64 %	90.63 %

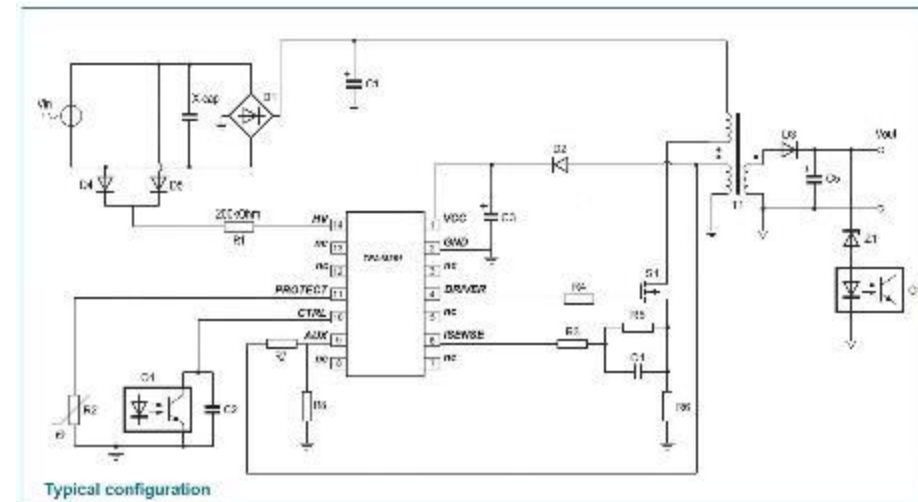
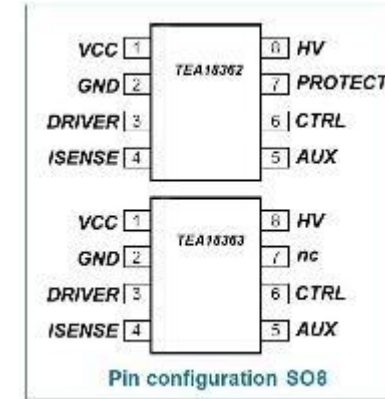
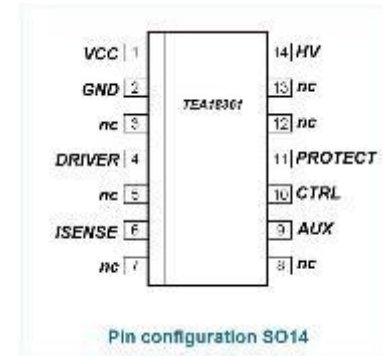
Input condition	Efficiency at specified load			
	0.2 W; 0.44 %	0.5 W; 1.11 %	1 W; 2.22 %	2 W; 4.44 %
115 V (ac) / 60 Hz	78.44 %	86.00 %	88.30 %	89.48 %
230 V (ac) / 50 Hz	70.21 %	81.31 %	84.93 %	86.91 %





TEA1836(L): Primary-Side QR Flyback Controller

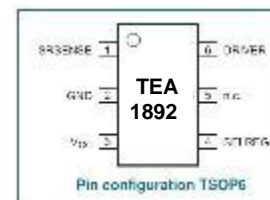
- Quasi Resonant controller with NXP patented true valley switching for high efficiency
- <30mW no-load standby power dissipation with output in full regulation
- High Voltage startup current source
- Integrated active X-cap discharge & Brown out protection
- Powerdown function, lowering no-load power to <20mW or even lower
- Peak power capability up to 150% (new) and integrated OP timer
- Integrated mains independent OPP, Demag protection, accurate OVP & OTP
- Robust MOSFET driver stage, driver maximum on-time protection
- Nemko and UL certified





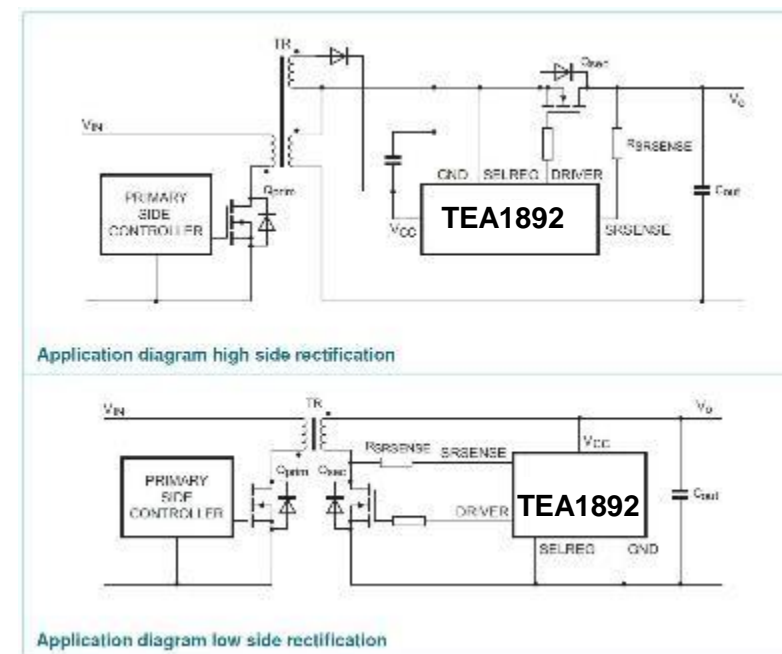
TEA1892(A): Secondary Side Controller

- Strong drive capability
- High driver-output voltage (10 V), for compatibility with NXP Semiconductors and all other MOSFETs
- Discrimination between primary stroke and ringing at low mains
- Wide VCC range (8.5V to 38V)
- Low current consumption
- High-side drive possible (EMI friendly)
- The TEA1892(A) enables the use of low R_{dson} MOSFET's
 - A clear efficiency improvement can be seen of 1% - 2% at low loads for e.g. a 90W adapter
- Small TSOP6 package
- The difference between the TEA1892 and the TEA1892A is only the “minimum synchronous rectification active time”, the $t_{act(sr)(min)}$



Pin description

Symbol	Pin	Description
SRSENSE	1	synchronous timing input
GND	2	ground
V _{CC}	8	supply voltage
SELREG	4	selection input for driver regulation level
n.c.	5	not connected
DRIVER	6	driver output for SR MOSFET





TEA1791/1792(A)/N1 versus TEA1892(A)/N1

Parameter	TEA1791	TEA1791A	TEA1792	TEA1792A	TEA1892	TEA1892A
Package	SO8	SO8	TSOP6 / SO8	TSOP6 / SO8	TSOP6	TSOP6
Mosfet drive	Single Mosfet drive	Single Mosfet drive	Single Mosfet drive	Single Mosfet drive	Single Mosfet drive	Single Mosfet drive
Minimum synchronous rectification active time	Short: 2 μ sec Long: 2.2 μ sec	Short: 0.93 μ sec Long: 0.99 μ sec	Short: 1.8 μ sec Long: 2.1 μ sec	Short: 0.75 μ sec Long: 0.95 μ sec	1.5 μ sec	0.8 μ sec
Driver output disabled at short secondary conducting times (low load)	✓	✓	✓	✓	Not disabled	Not disabled
Driver activation voltage	-310mV	-310mV	-220mV	-220mV	-220mV	-220mV
Driver regulation voltage	-55mV	-55mV	-30mV / -42mV	-30mV / -42mV	-30mV / -42mV	-30mV / -42mV
Driver deactivation voltage	-12mV	-12mV	-12mV	-12mV	-12mV	-12mV
Driver activation delay time	125nsec	125nsec	75nsec	75nsec	75nsec	75nsec
Driver source current	-250mA	-250mA	-400mA	-400mA	-400mA	-400mA
Driver sink current	2.7A	2.7A	2.7A	2.7A	2.7A	2.7A

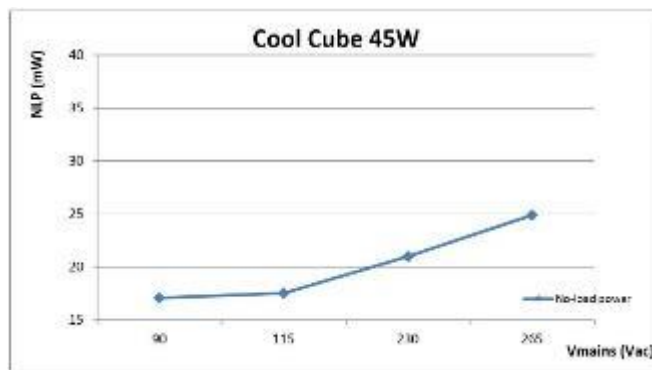
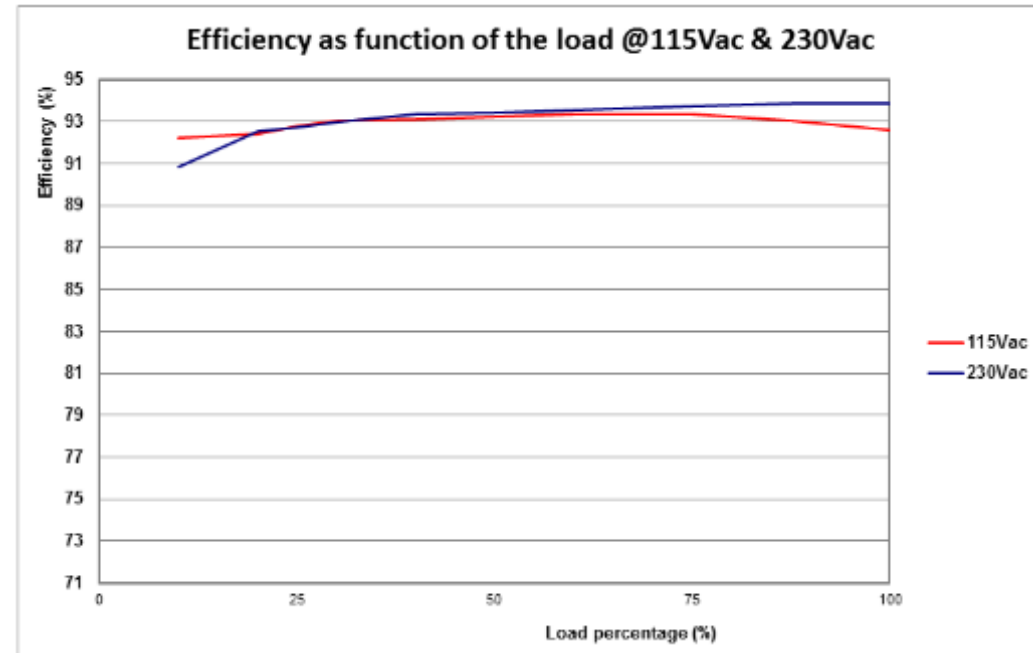


TEA1836 + TEA1892: 45W “CoolCube” Adapter

Efficiency Results



No-Load Standby Power with Output High!
 ~26mW @ 230Vac
 No-Load Standby Power with Power Supply in Full Regulation
 ~21mW @ 115Vac



115Vac, 60Hz

Load (% of full load)	100	75	50	25.00		10.00		Average efficiency
Efficiency (%)	92.61	93.33	93.24	92.77		92.24		92.99

230Vac, 50Hz

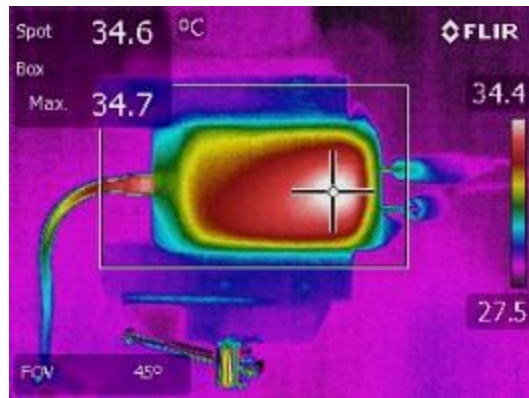
Load (% of full load)	100	75	50	25		10		Average efficiency
Efficiency (%)	93.85	93.71	93.45	92.74		90.82		93.44





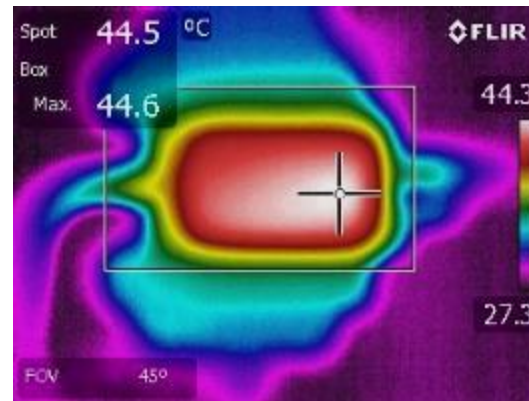
TEA1836+TEA1892: Thermal Result from 45W Adapter

Vmains=115Vac, Tambient=26.9°C



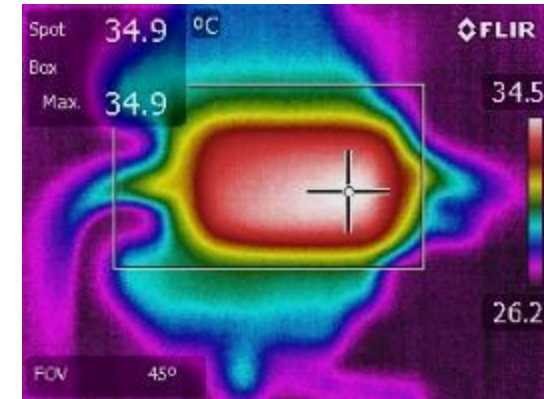
Casing temperature @ T0 (cold start)

Vmains=115Vac, Tambient=26.9°C

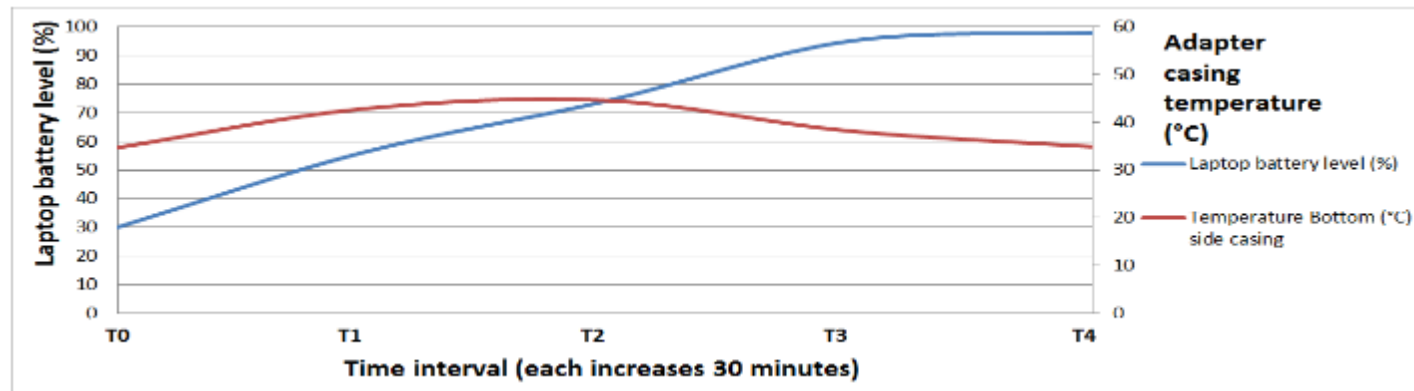


Casing temperature @ T2 (T0 + 1hr)

Vmains=115Vac, Tambient=26.9°C



Casing temperature @ T4 (T0 + 2hrs)





Target Applications for 15W – 45W

Tablets & Computing

- Smart Phone Chargers
- Tablet & eReader Chargers
- E-Readers



Home Appliance

- Washing Machines & Dryers
- Refrigerators & Freezers
- Dish Washers
- Vacuum Cleaners
- Induction Cookers
- Room Air Conditioners



Consumer

- Set-top Boxes
- PC Peripherals
- Digital Camera & Camcorders
- Gaming Consoles



Industrial & Residential

- Smart Metering
- (Smart) Lighting
- Home & Building Automation
- HVAC
- Industrial Automation & Control





Target Applications for 45W – 75W

Computing

- Ultrabooks
- Laptops
- All-in-one PC



Computing Peripheral

- Printers
- Cable Modems
- Gateways & Routers



Consumer

- Set-top Boxes
- DVD & BluRay Players
- Portable Media Players
- Gaming Consoles



Medical & Industrial

- IP Video Surveillance Cameras
- Power Tools
- PoE
- Industrial Chargers/Adapters
- Medical Chargers Adapters



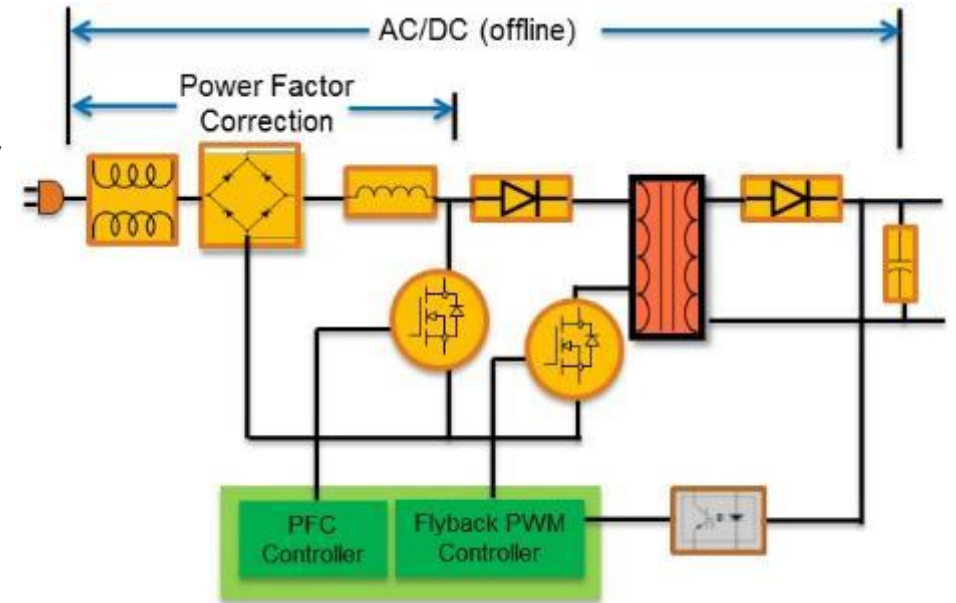


Key Products & Applications (3 of 6)

DCM Flyback + PFC Solutions for >75W Applications

NEW!

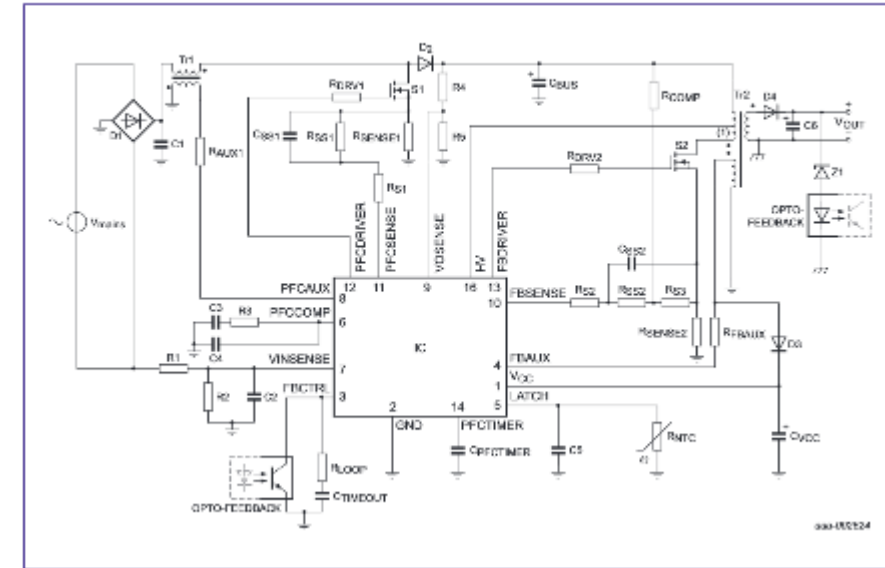
- TEA1755 DCM Flyback Controller with Integrated PFC
 - Integrates Power Factor Correction (PFC) and Flyback controller
 - On-chip HV startup current source
 - QR operation at higher power levels; QR & valley skipping at medium power levels; highly efficient, audible noise-free burst mode at low power operation
 - Dual Boost PFC with accurate maximum output voltage
 - Enables no-load power consumption <100mW (<30mW with TEA1703)
- TEA179x (1791, 1792) Secondary Controller and Synchronous Rectifier
 - SR with integrated feedback for output voltage and current regulation
 - TEA1791T SR with high-side MOSFET drive
 - TEA1792T Lower driver activation and reg. voltages



TEA1755: PFC + Flyback Combo Controller

- PFC + Flyback combo controller for compact size Notebook adapter >75W
- Higher efficiency at low loads (e.g. $P_{in} < 400\text{mW}$ @ $P_{out} = 250\text{mW}$)
- Significant reduction in audible noise thanks to new burst mode
- New accurate and predictable PFC ON/OFF control to reduce production spread and support easy calculation for customers
- Low no-load standby power
 - ✓ <100mW without additional sec. side controller
 - ✓ <30mW using TEA1703 standby controller

A typical configuration of the TEA1755





TEA1755: No-Load Power & Efficiency Results

Result for 90W GreenChip Solution (TEA1755L+TEA1792+TEA1703)

Power consumption: no-load

Condition	ENERGY STAR 2.0 requirement (mW)	No-load power consumption (mW)	
		Configuration A	Configuration B
90 V; 60 Hz	≤300 mW	4	69
100 V; 50 Hz	≤300 mW	5	70
115 V; 60 Hz	≤300 mW	6	72
230 V; 50 Hz	≤300 mW	21	97
264 V; 50 Hz	≤300 mW	27	112



There are two versions of this demo board:

- APBADC068(A)-with TEA1703TS
- APBADC068(B)-without TEA1703TS

[Also See UM10514](#)

Efficiency results

Condition	ENERGY STAR 2.0 Efficiency requirement (%)	Efficiency (%)							
		Average	100% load	75% load	50% load	25% load	500mW load	250mW load	100mW load
90 V; 60 Hz	>87	90.5	89.87	90.74	90.79	90.63	81.41	72.99	54.61
100 V; 50 Hz	>87	90.9	90.41	91.14	91.11	90.94	81.49	72.88	54.13
115 V; 60 Hz	>87	91.4	90.98	91.60	91.47	91.53	81.29	72.41	53.34
230 V; 50 Hz	>87	91.1	91.72	91.37	90.01	91.33	77.11	66.12	45.27
264 V; 50 Hz	>87	91.0	91.92	91.53	89.96	90.76	75.27	63.71	42.78





Target Applications for 75W – 120W

Computing

- » Desktop and AIO PC
- » Servers
- » Notebook Adapters
- » Networking Equipment



Displays

- » Ultra-HD 4K/8K TV
- » Flat Panel TV
- » LCD Monitors



Gaming

- » Gaming Consoles



Medical & Industrial

- » Hospital Equipment
- » Factory Equipment





Key Products & Applications (4 of 6)

Resonant Controller for >90W Applications

NEW!

TEA1716 Primary Controller with PFC

TEA1916 Primary Controller with PFC

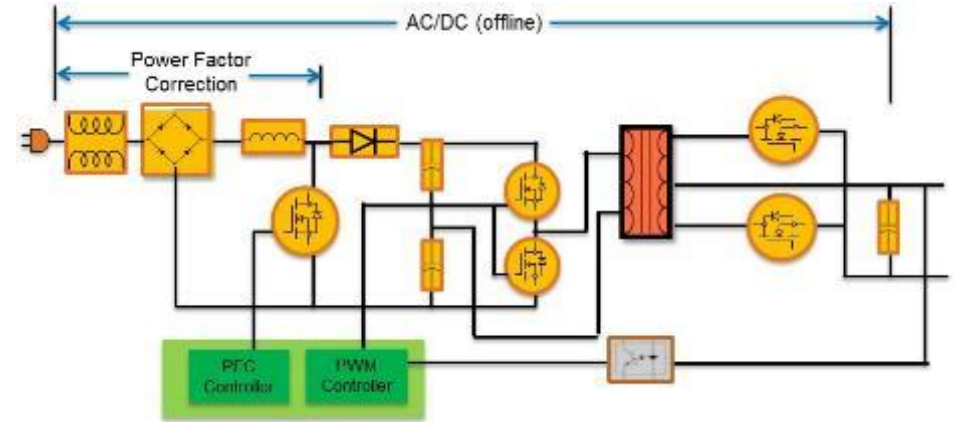
- Resonant topology, TEA1716 integrates the HBC & PFC in one package
- Small form factor, high efficiency >90%
- Capacitive mode protection thus highly robust
- Adaptive non-overlap timing control
- On-chip high voltage startup source
- Fully integrated burst mode circuitry; low no-load power consumption (EuP lot6 compliancy)

TEA1795 Secondary Controller & SR

TEA1995 Secondary Controller & SR

NEW!

- Low-side SR with double MOSFET drive
- TEA1995 operates with 5V supply
- TEA1995 has improved off-time with driver deactivation delay time



Efficiency Improvement Using Synchronous Rectifier			
AC Input	Load	With No SynchRec	With SynchRec
115V AC	25%	86.7%	87.5%
	50%	90.2%	91.7%
	75%	90.9%	92.6%
	100%	91.0%	92.9%
230V AC	25%	87.3%	88.0%
	50%	91.2%	92.7%
	75%	92.1%	93.8%
	100%	92.4%	94.2%



TEA1716: Key Feature Set



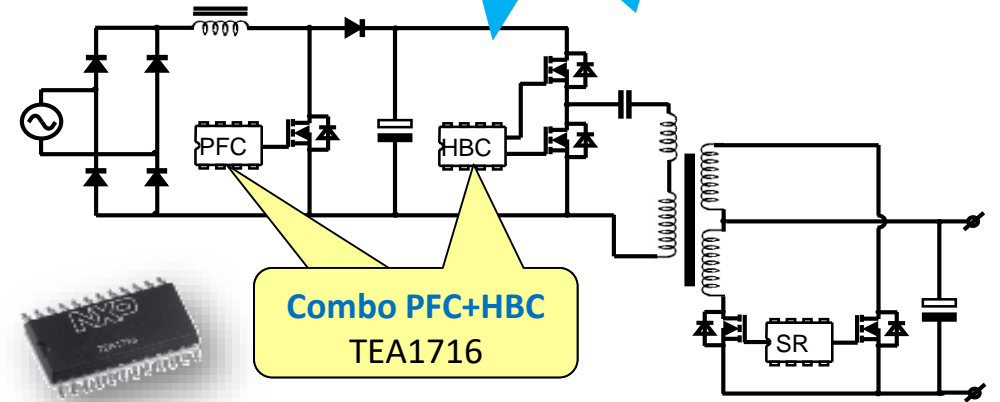
Key Differentiators

- PFC + Resonant/LLC combo controller up to 500W
- EuP lot6 compliant (Standby: $P_{IN} < 0.5W$ @ $P_{OUT} = 0.25W$)
- Adaptive non-overlap and capacitive mode protection

Key features

- On-chip high-voltage start-up source
- Stand-alone operation or from external DC supply
- Extended wide supply voltage range (up to 36V)
- Boundary Condition Mode operation with on-time control
- Valley/zero voltage switching for min. switching losses
- Frequency limitation to reduce switching losses
- PFC Burst mode switching with soft-start and soft-stop
- Adaptive non-overlap timing (cycle-by-cycle)
- Integrated Burst mode to reduce low-load consumption
- Integrated high-voltage level shifter
- Adjustable min and max frequency (up to 500kHz)

Applications



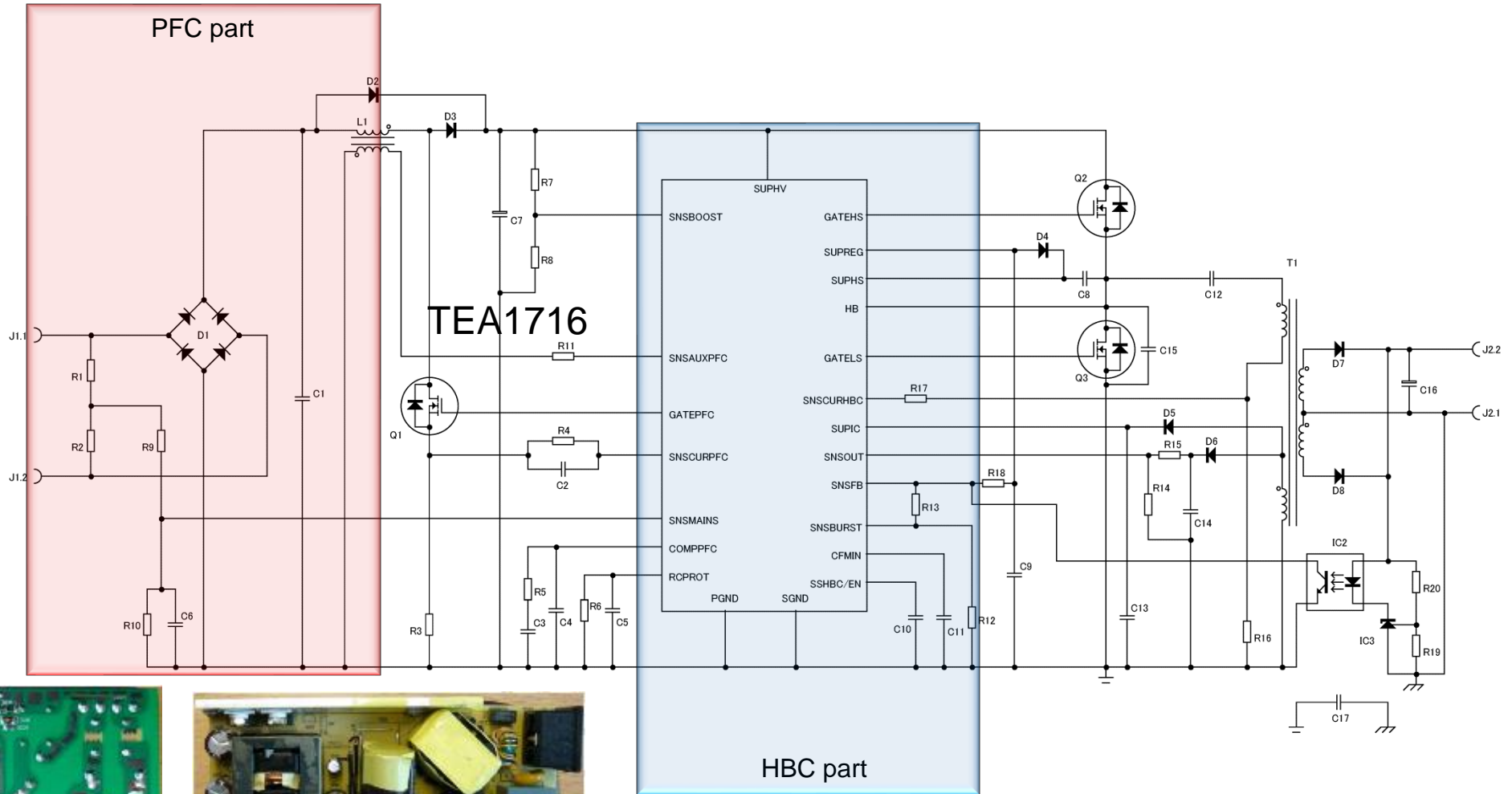
Protections

- Safe restart mode for system fault conditions
- General latched protection input for output over-voltage protection or external temperature protection.
- Over-temperature protection (OTP)
- Soft (re)start for both converters
- Protection timer for time-out and restart
- Under-voltage protection for Mains, Boost and IC supply
- Over-current regulation/protection for both converters (OCP)
- Accurate over-voltage protection for boost voltage (OVP)
- Capacitive mode protection (cycle-by-cycle)





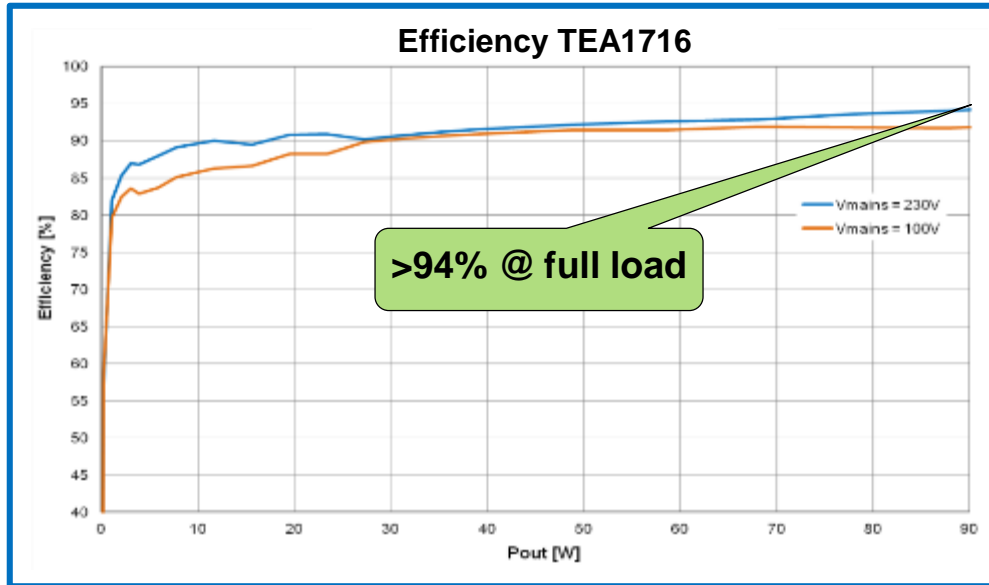
TEA1716: 90W Demo Board



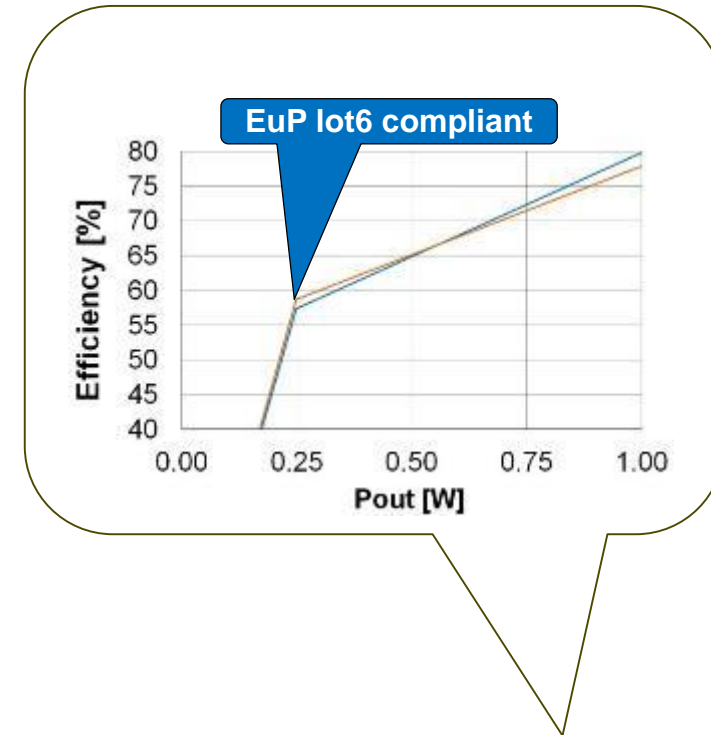


TEA1716: 90W Demo Board

Efficiency Results



Condition	Energy star 2.0 efficiency requirement (%)	Efficiency (%)				
		Average	25% load	50% load	75% load	100%
100 V, 60 Hz	>87	90.8	88.2	91.4	91.9	91.9
230 V, 50 Hz	>87	92.5	90.9	92.1	92.9	94.1



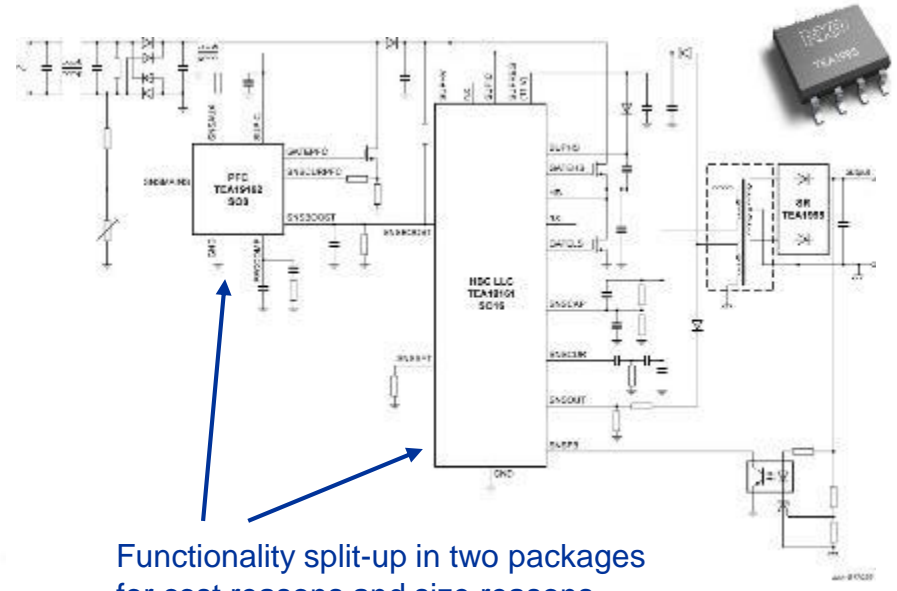
Condition	Output power (mW)	Output voltage (V)	Power consumption (mW)
100 V, 60 Hz	250 mW	19.5	395
230 V, 50 Hz	250 mW	19.5	415





TEA1916: Primary-Side PFC + LLC Controller

- Space-saving Two-Chip Combo
 - TEA19161: LLC Controller
 - TEA19162: PFC Controller
- Different conversion modes over the load range ensure highest possible efficiency (High Power, Low Power, & Burst Mode)
- Low no-load power (<75mW)
- Reduces BOM cost as auxiliary supply can be eliminated
- Meets EuP lot 6 easily
- Little Burst Mode spread
- Ease of design by settings
- Fast load-step response
- Boost voltage compensated operation
- Adaptive non-overlap switching LLC
- Integrated active X-cap discharge
- Extensive protection (OVP, OCP, OPP, SWP, UVP, OTP)



Functionality split-up in two packages for cost reasons and size reasons (PCB area used)

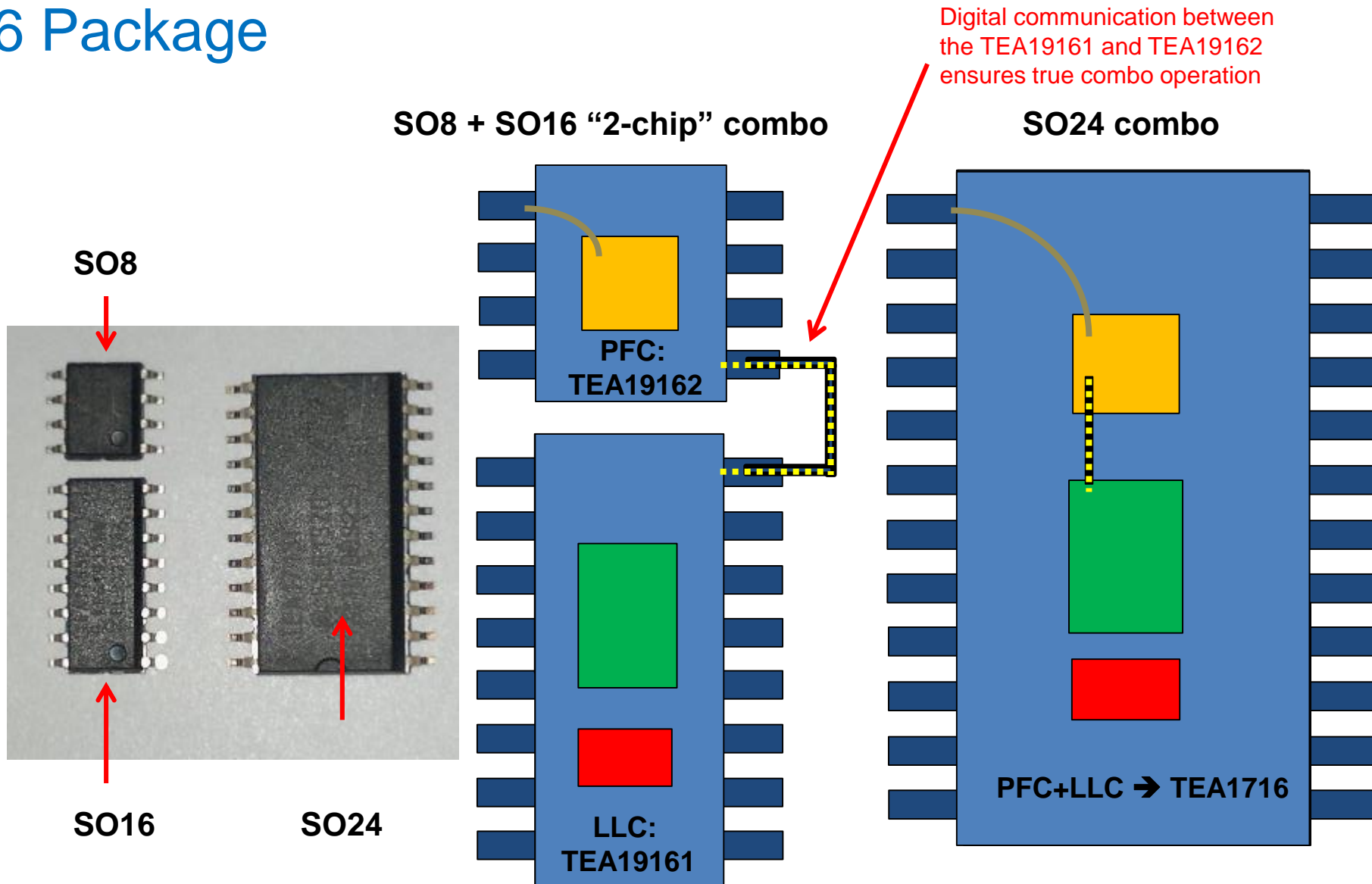
Functional the TEA1916 is a one-package combo (like e.g. TEA1716 or TEA175x)

Dual package but one functional combo!



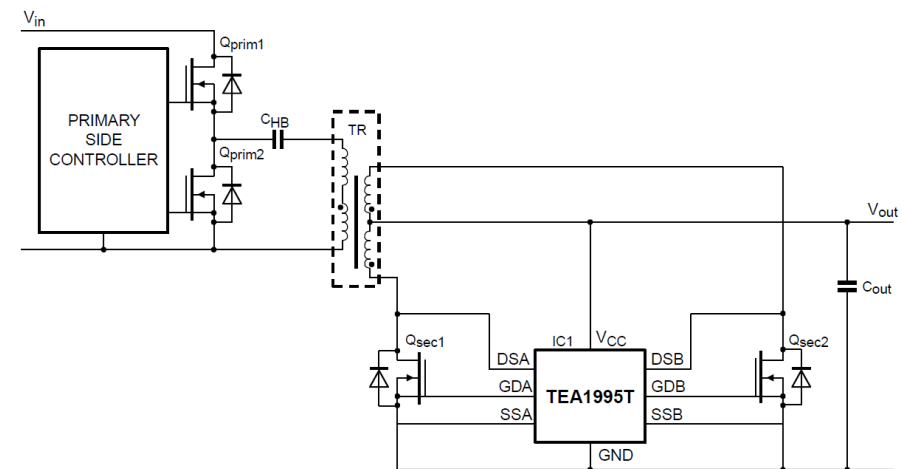
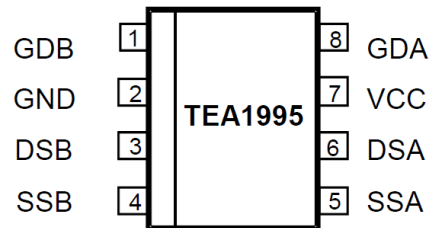
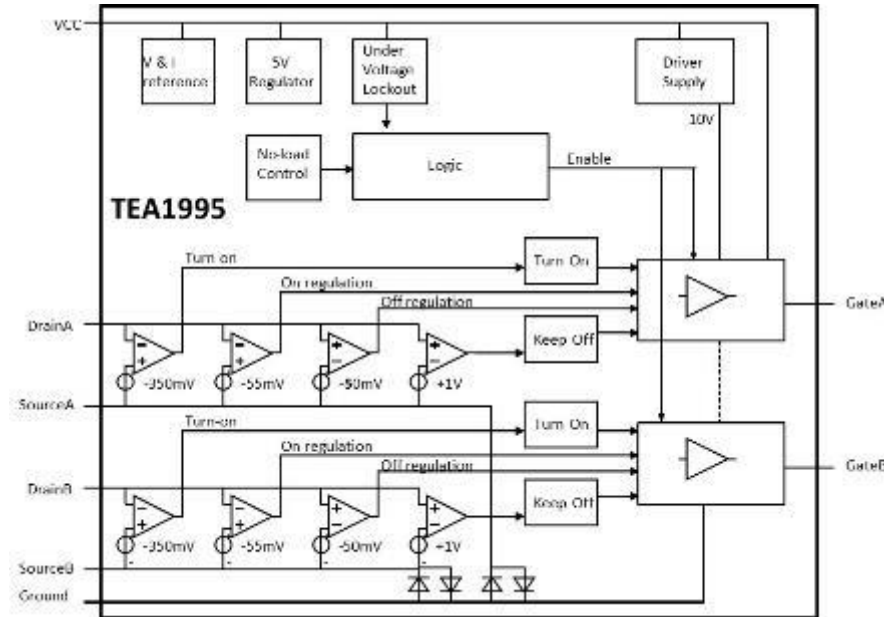


TEA1916 Package



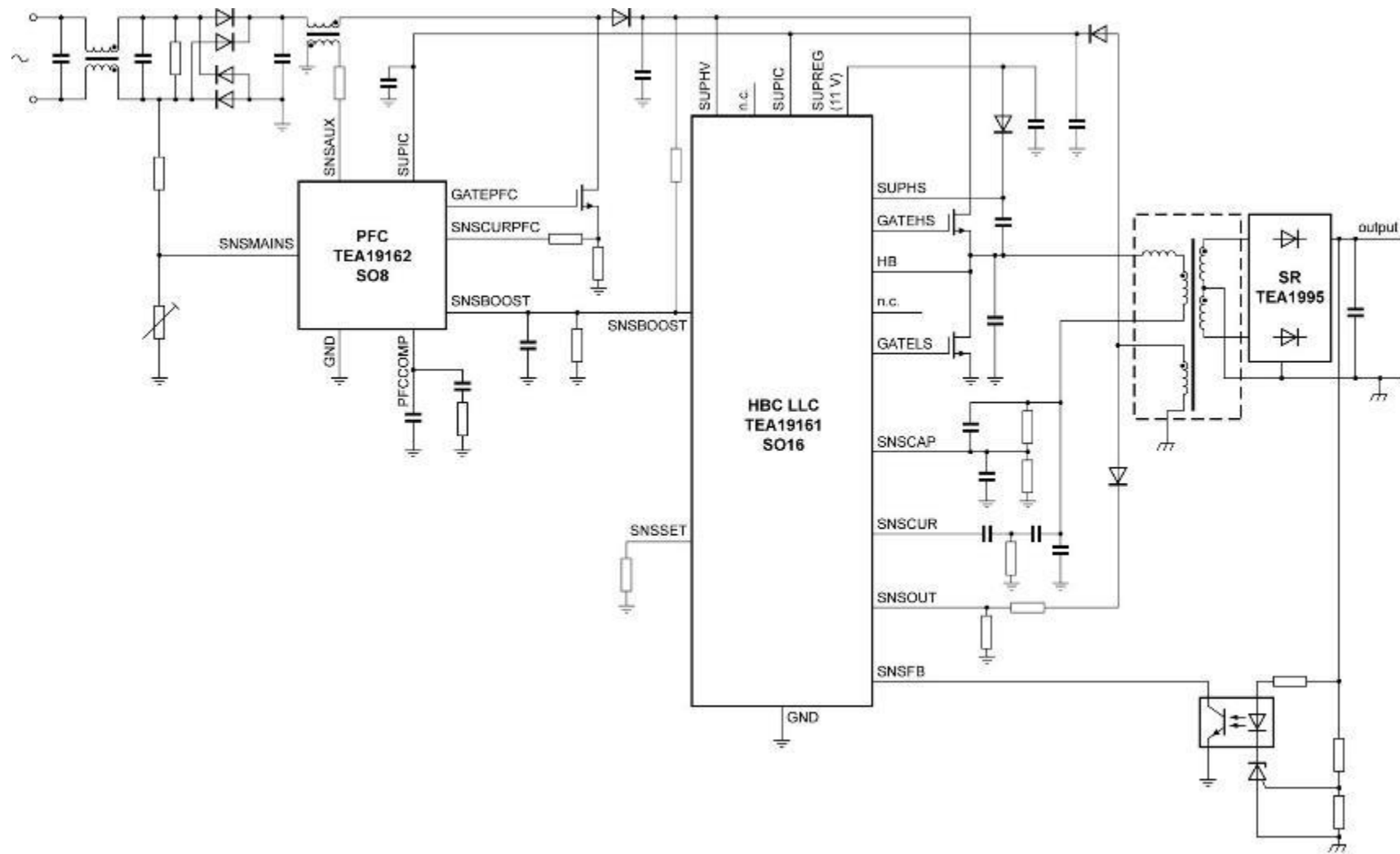
TEA1995: Secondary-Side SR Controller

- Adaptive gate driver
- No-load supply current <math><200\mu\text{A}</math>
- Wide supply voltage range from 4.5V to 40V
- Switching frequency up to 500kHz
- No minimum on-time
- No reverse current
- Adaptive gate drive for fast turn-off at end of conduction
- SO8 package





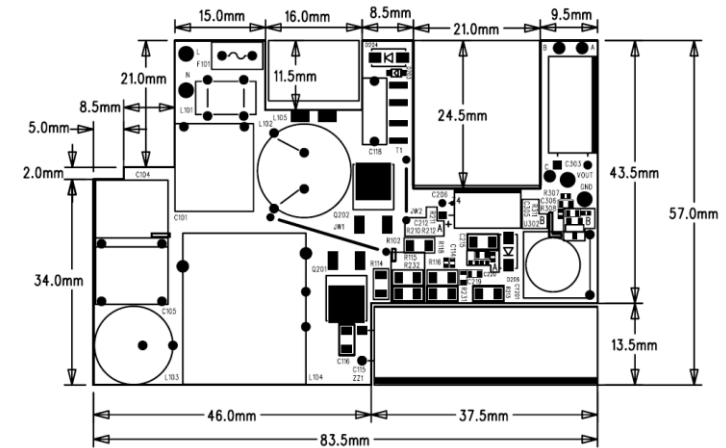
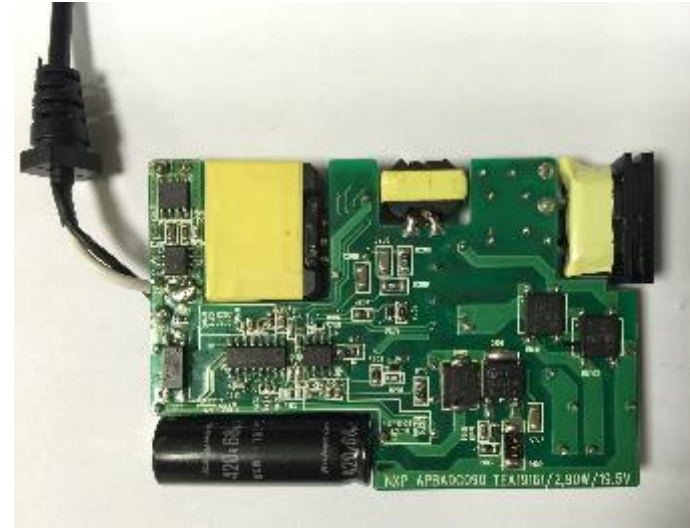
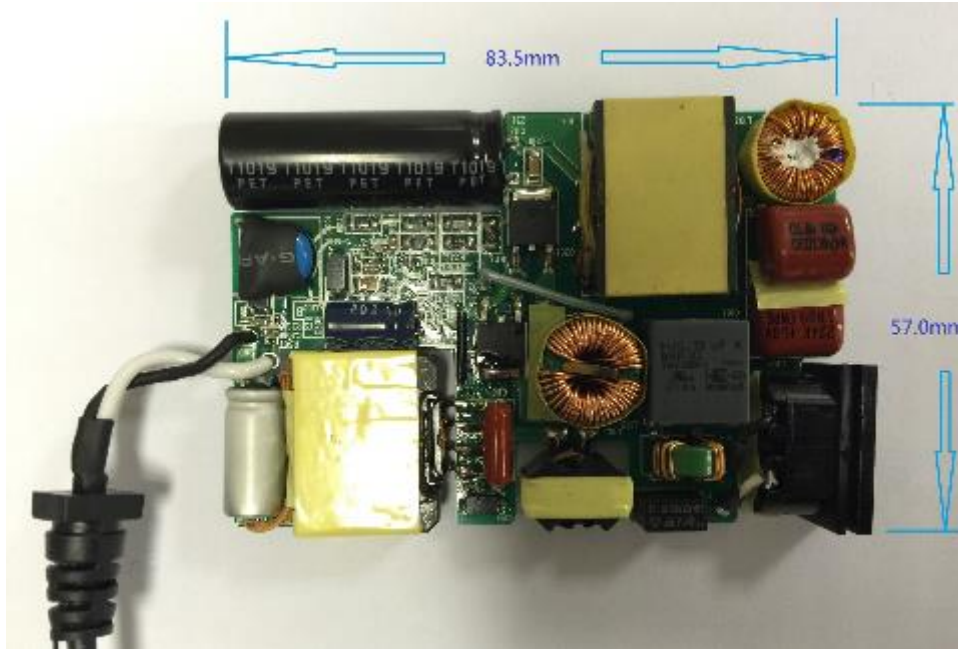
TEA19162+TEA19161+TEA1995: Application Circuit





90W Slim Size Adapter Demo Board

TEA19162+TEA19161+TEA1995 (PFC+LLC+SR) Notebook Slim Design





90W Slim Size Adapter Demo Board

Measurement Results with VOUT=19.5V

Average efficiency @ PCB board end:

	25% (1.15A)	50% (2.3A)	75% (3.46A)	100% (4.62A)	Average
115Vac	88.58	92.3	93.3	93.73	91.98%
230Vac	88.75	93.05	94.38	94.92	92.78%

90Vac/47Hz 100% load Efficiency = 92.90% @ PCB board end.

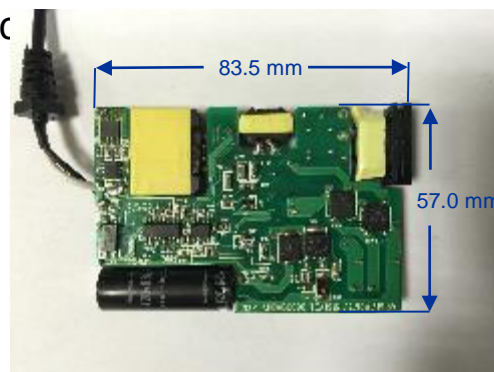
Average efficiency @ cable end (1.8M/18AWG):

	25% (1.15A)	50% (2.3A)	75% (3.46A)	100% (4.62A)	Average
115Vac	88.03	91.46	91.92	91.88	90.82%
230Vac	88.23	92.17	92.99	93.08	91.62%

90Vac/47Hz 100% load Efficiency = 91.06% @ cable end.

No Load Stand-by Power & Low-Load Efficiency

Load	0W (Pi<0.15W)
115Vac	65mW
230Vac	67mW
Load	0.25W (Eff.>50%)
115Vac	52.5%
230Vac	52.61%



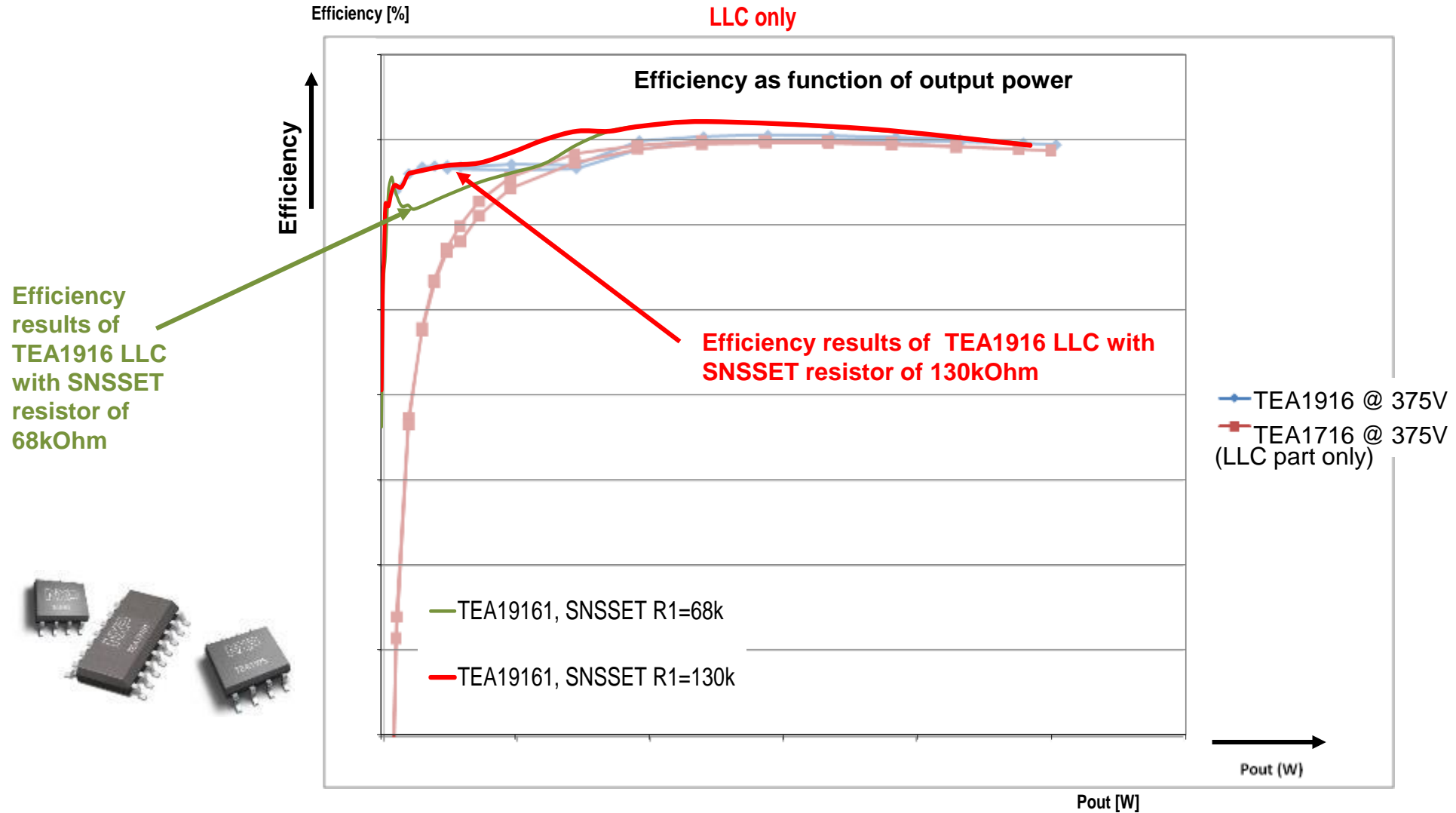
17W/inch³





TEA19161 (LLC) Efficiency Result

Power Consumption Measurement for Different Ripple Settings





Target Applications for >100W

Computing

- Desktop and AIO PC
- Servers
- Notebook Adapters
- Networking Equipment



Displays

- Ultra-HD 4K/8K TV
- Flat Panel TV
- LCD Monitors



Gaming

- Gaming Consoles



Medical & Industrial

- Hospital Equipment
- Factory Equipment

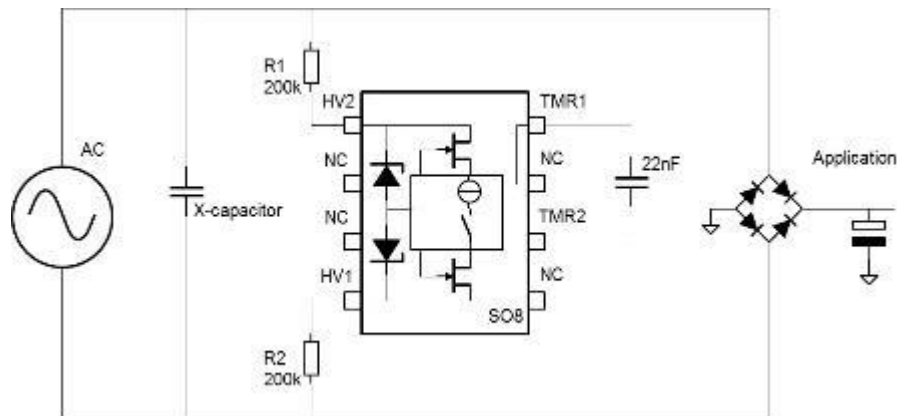


Key Products & Applications (5 of 6)

Auxiliary Components

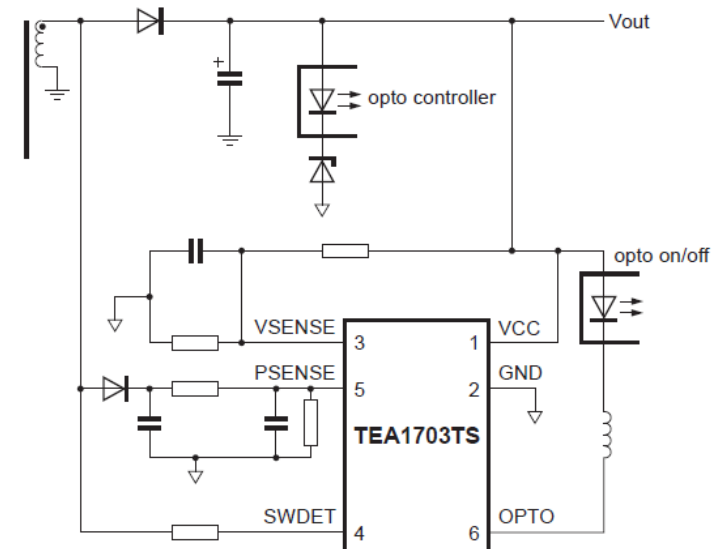
• TEA1708 X-cap Discharge Solution

- Automatically discharges the X capacitor when input voltage is switched off
- High voltage zener diode (500V) to protect against mains surges
- Withstands >6kV surges
- Adjustable AC removal detection time (one external low voltage capacitor)
- Supply current of 4 μ A (~1mW @230VAC)
- Discharge current internally limited to 2.3mA



• TEA1703 Standby Controller

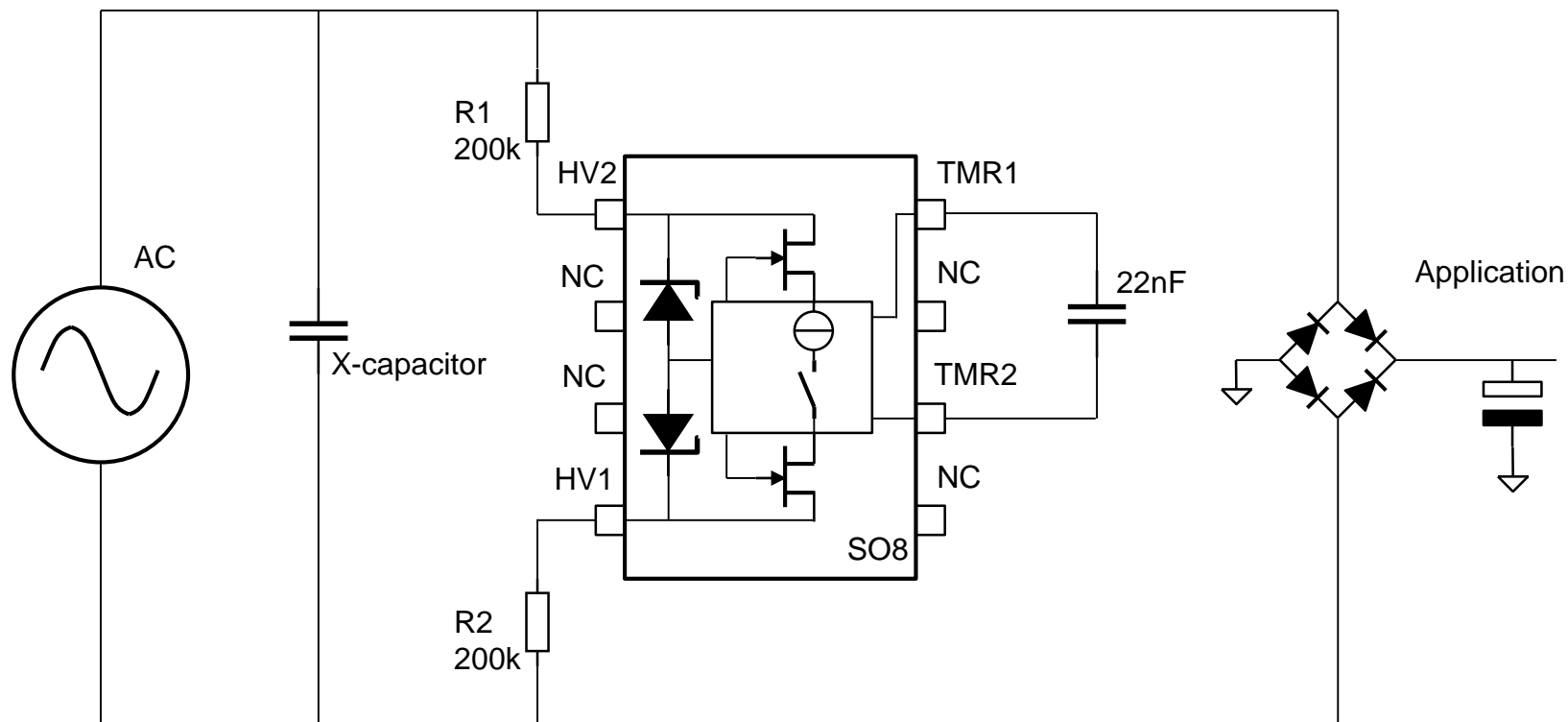
- Low power standby controller for use in applications with low no-load standby power
- Monitors the output voltage and power and enables the optocoupler to driven with high peak current while keeping the power low
- Typical current consumption <30 μ A; Power consumption <0.5mW





TEA1708: X-cap Discharge Solution

Block Diagram



- High voltage zener diode (500V) to protect against mains surges
 - Withstands >6kV surges with R1=R2=200kΩ easily
- Adjustable AC removal detection time (one external low voltage capacitor)
- Supply current of 4μA (~1mW @230VAC)
- Discharge current internally limited to 2.3mA






TEA1708: X-cap Discharge Solution

Customer Benefits

- ~1mW power consumption
- Very Robust on surge tests (>6 kV). No additional MOV needed to protect the X-cap discharge (integrated) circuit (TEA1708 IC)
- No HV diodes needed
- Nemko certified

 1 of 1

NXP Semiconductors
Gorstweg 2
6534 AE Nijmegen
Netherlands

Oslo, 2017-11-06
Our ref.: Ole Morten Aaslund
Order No.: 245640
Your ref.: Gerwin Folmer

I

Statement of Conformity

Nemko AS herby confirms that the product mentioned below complies with the standards listed.


Product: IC including capacitor discharge function (IGX)

Model(s): TEA1708T/N1

Trade mark: GreenChip


Ratings: 85-265V AC, 47-63Hz, Overvoltage Category II

Standard: IEC 60850-1:2005 (Second Edition) + Am 1:2008 with CTL Decision, DSH 1080

Best regards,

Ole Morten Aaslund
Senior Engineer
Project Responsible, Safety Laboratory

Nemko AS, Gaustadaløen 30, 0314 Oslo, Norway

TEL: +47 22 96 05 05
MCR: +47 809 54 803
FAX: +47 22 96 05 50
EMAIL: ole.morten.aaslund@nemko.com

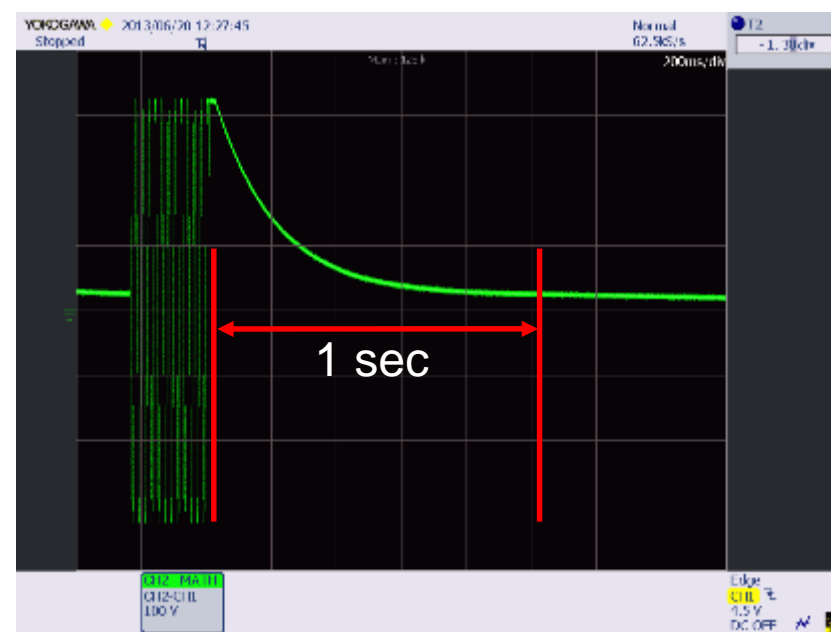
 ONE-STOPPED = OUR APPROVAL

Nemko Group
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tel: +47 22 86 83 88 fax: +47 22 96 05 50 email: info@nemko.com
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TEA1708: Demo Boards Measurement Results

Mains disconnect test with 10nF timer capacitor, 470nF X-cap, VAC=230V



X-capacitor value	R-discharge (R1+R2)	T-discharge (135V)	T-discharge (60V)
470nF	400k Ω	210ms	420ms
1000nF	400k Ω	420ms	870ms
2000nF	400k Ω	810ms	1700ms



Key Products & Applications (6 of 6)

TEA1936x DCM Flyback Controller

- Flyback QR Controller with true valley switching
- Adaptive dual-supply for highest efficiency
- [Active Xcap discharge integrated](#)
- High efficiency at low loads
- [No load stand by power dissipation < 30mW](#)
- [Low ripple ±1% at any output voltage](#)
- Switching frequency up to 140kHz (QR with true valley switching)

TEA1993 Secondary Controller and SR

- Adaptive gate driver for maximum efficiency
- Supply current in “no load” operation <250μA
- Self-supporting for high-side rectification without the use of an auxiliary winding
- Operates with standard logic level SR MOSFETs
- Optimized for fast charger applications, like USB BC 1.2, USB-PD, QC2.0/3.0 and any other proprietary protocol application



Smart AC-DC Power Product Portfolio

Product		Package	Rating (V)	Type-C	PD 2.0	PD3.0/ PPS	QC2.0	QC3.0	QC4.0+	27 W	45 W	65 W	Comments
AC/DC Controller	TEA1936x	SO-10		+	+	+	+	+	+	+	+	+	Low power burst-mode, X-cap discharge & fixed frequency option
Sync Rec Controller	TEA1993	TSOP-6	20	+	+	+	+	+	+	+	+	+	Optimized for 150 kHz
	TEA1999	HVSON-8	20	+	+	+	+	+	+	+			150 kHz & 300 kHz option

Product	Operating Mode	Switching Freq	Active X-Cap Discharge	Low-Power Mode	Protection	Main Application
TEA19361T	QR/DCM	130 kHz Max	No	Burst	Safe Restart	Mobile market, highest efficiency, audible noise optimized, meets IEC 62684 Common Mode Noise spec
TEA19362T	DCM	70 kHz Fixed	No	Burst	Safe Restart	Mobile market, improved touchscreen compatibility
TEA19363T	QR/DCM	130 kHz Max	Yes	Burst	Safe Restart	Computing market, for non-touchscreen devices
TEA19363LT	QR/DCM	130 kHz Max	Yes	Burst	OVP & OTP Latched Rest Safe Restart	Computing market, for non-touchscreen devices



TEA1936x: Primary Side Controller

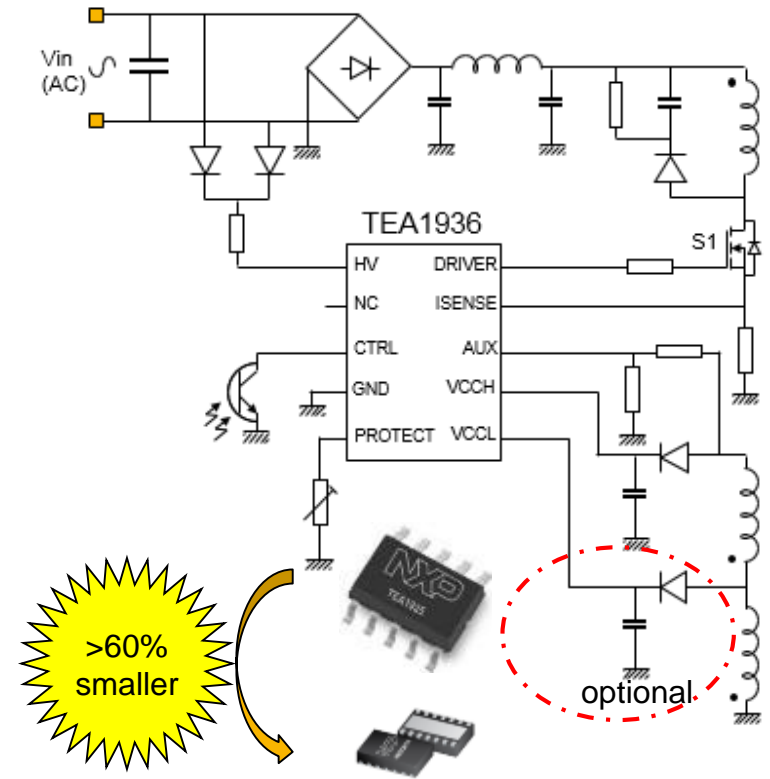
- Flyback QR Controller with true valley switching
- Adaptive dual-supply for highest efficiency at entire output voltage range
 - From 5V to 20V in CV mode
 - From 3V to 20V in CC mode
 - From 3V to 6V in Direct Charging mode
- HV Start-up and active Xcap discharge integrated (TEA19363)
- Advanced burst mode enabling high efficiency at low loads while keeping the output in full regulation
- No load stand by power dissipation < 30mW; with output high (VOUT=5V & output in full regulation)
- Low ripple $\pm 1\%$ at any output voltage over the entire load range
- Fast transient response (VOUT $\pm 5\%$) from 0 up to full load
- Switching frequency up to 140kHz (QR with true valley switching)
- Integrated slope control and brown-in / brown-out protection
- Integrated mains independent OPP, Demag protection, accurate OVP & OTP
- Housed in a small SO10 package

TEA19361T Mobile Version
Without active X-cap discharge, safe restart, [130kHz max \(QR/DCM\)](#)

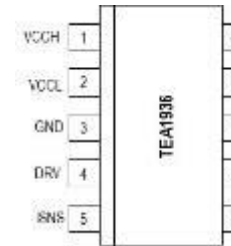
TEA19362T Mobile Version
Without active X-cap discharge, safe restart, [70kHz fixed \(DCM\)](#)

TEA19363T/LT Computing Version
[With active X-cap discharge](#), safe restart (T) or latched (LT), [130kHz max \(QR/DCM\)](#)

- HVSON package considered for smallest size



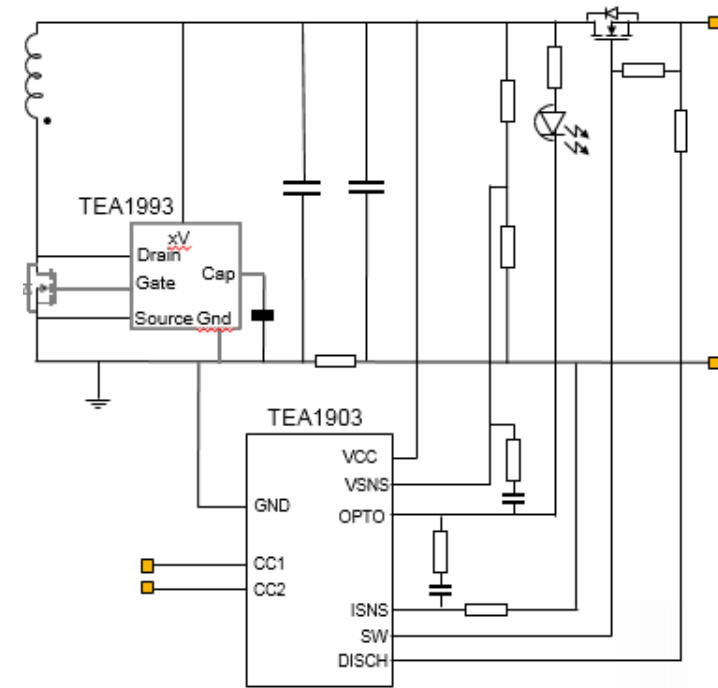
Symbol	Pin	Description
VCCH	1	Supply voltage high
VCCL	2	Supply voltage low
GND	3	Ground
DRV	4	Gate driver output
ISENSE	5	Current sense input
AUX	6	Auxiliary winding input for demagnetization timing
CTRL	7	Control input
PROT	8	General purpose protection pin
n.c.	9	High voltage safety spacer, not connected
HV	10	High voltage start up, active X cap discharge





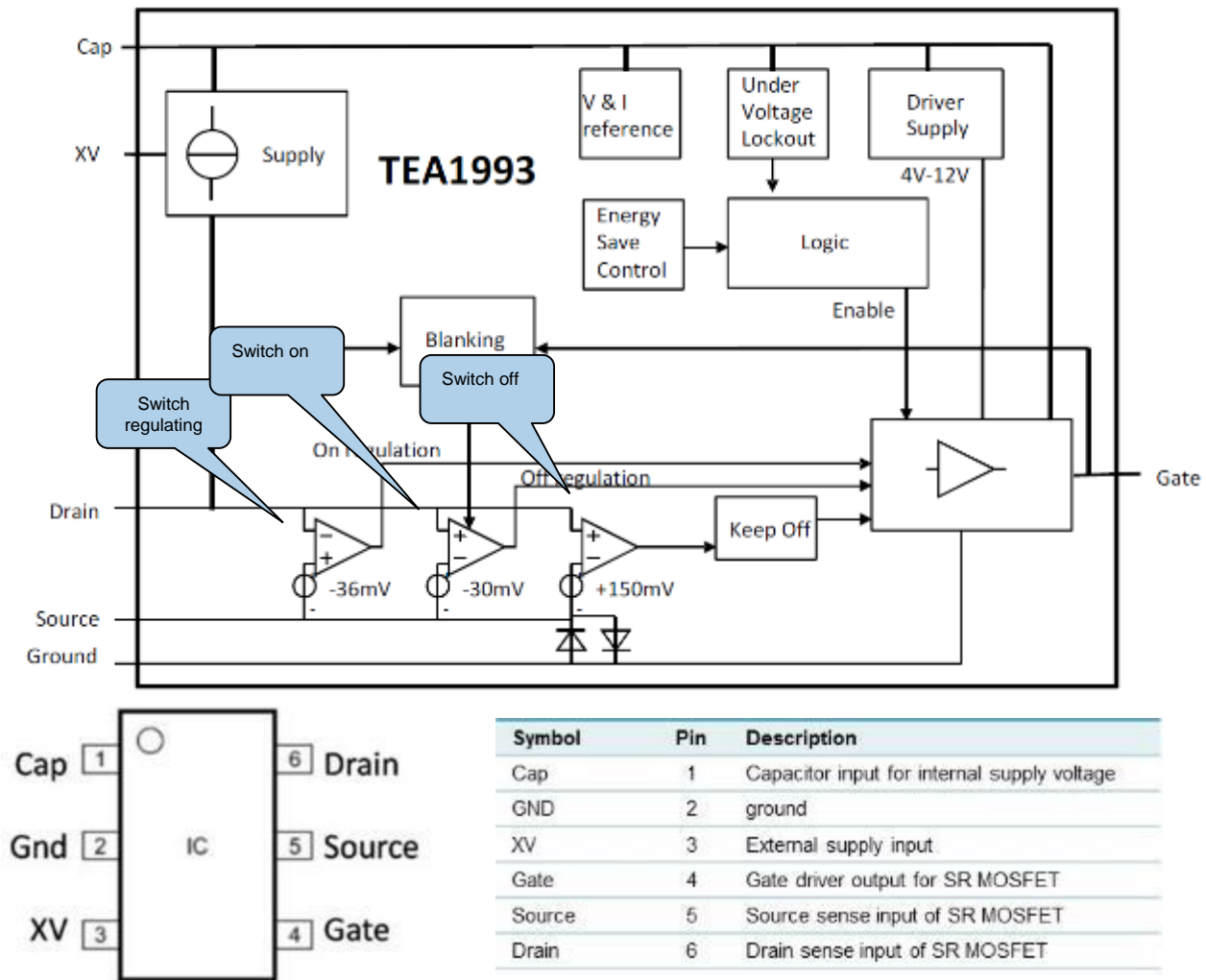
TEA1993: SR Controller

- Adaptive gate driver for maximum efficiency at any load
- Supply current in “no load” operation below 200µA
- Self-supporting for high-side rectification without the use of an auxiliary winding
- Application Features:
 - Operates in a wide output voltage range down to 0 V
 - Self-supplying for operation with low output voltage
 - Self-supplying for high-side rectification without the use of an auxiliary winding
 - Operates with standard and logic level SR MOSFETs
 - Supports USB BC, USB PD, and QuickCharge applications
- Drain sense pin capable of handling input voltage up to 120V
 - Operates “as is” in an output voltage range from 2V to 15V
 - For 20V output voltage, one external small signal transistor needed (for robustness in case of mains surge and spikes)
- Adaptive gate drive for fast turn-off at the end of conduction
- Under-Voltage Lock-Out (UVLO) with active gate pull-down
- Blanking input for low and high switching frequency
- Small TSOP6 package



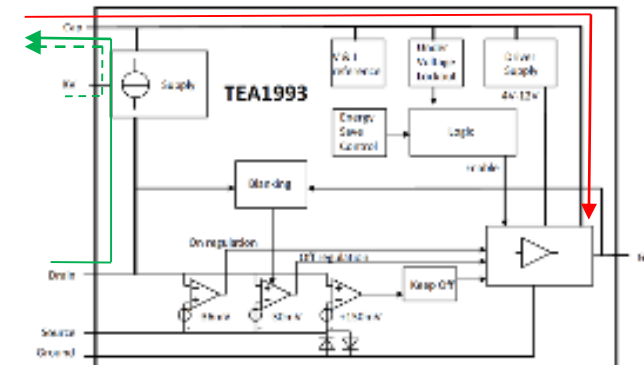
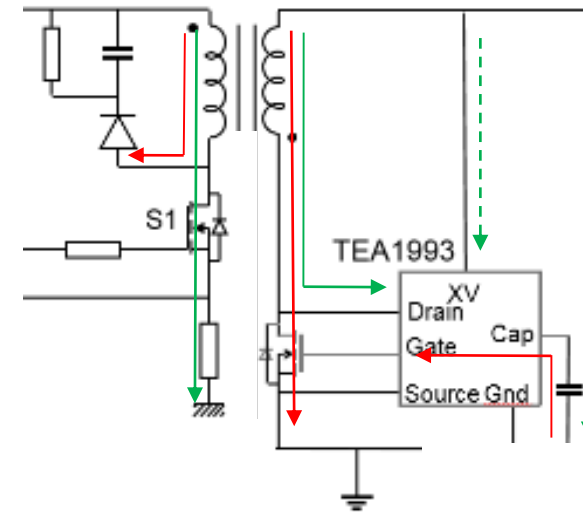
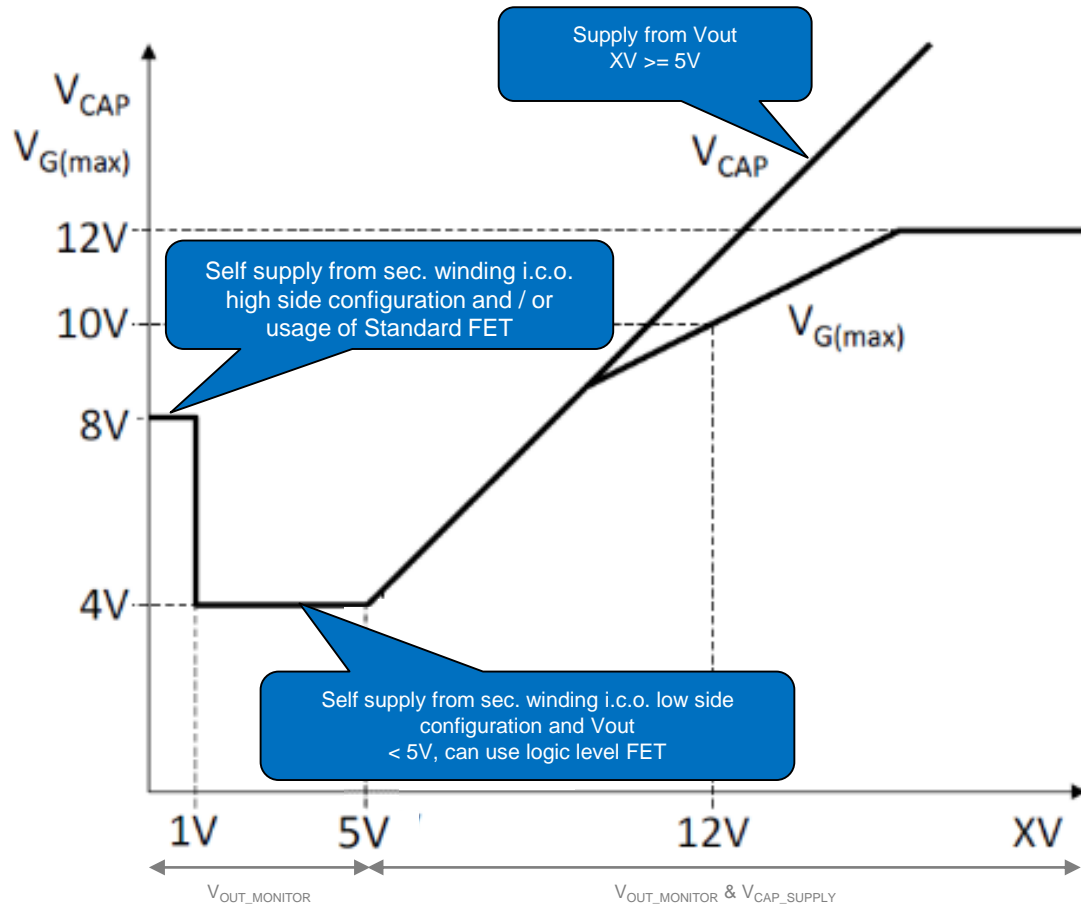


TEA1993: SR Controller – Block Diagram





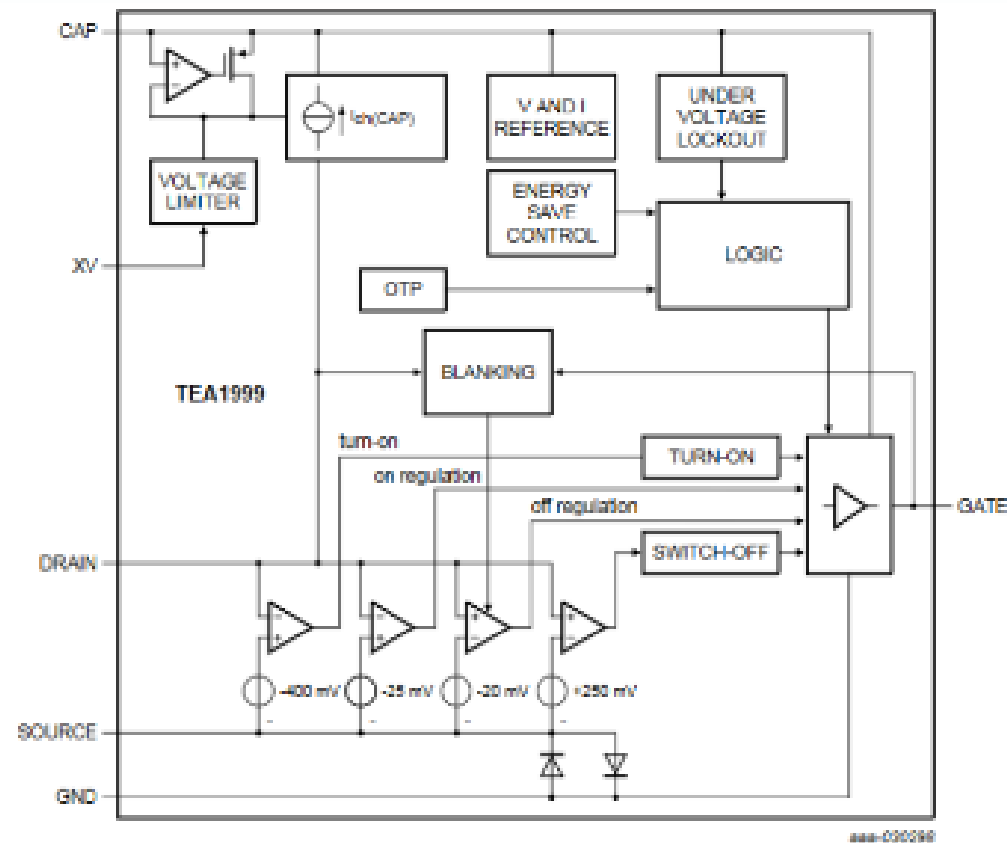
TEA1993: SR Controller – Supply Mechanism





TEA1999: SR Controller

- Adaptive gate driver for maximum efficiency at any load
- Supply current in “no load” operation below 250 μ A
- Self-supporting for high-side rectification without the use of an auxiliary winding
- Application Features:
 - Operates in a wide output voltage range between 26V and 0V
 - Self-supplying for operation with low output voltage
 - Self-supplying for high-side rectification without the use of an auxiliary winding
 - Operates with standard and logic level SR MOSFETs
 - Supports USB BC, USB PD, and QuickCharge applications
- Drain sense pin capable of handling input voltage up to 120V
 - Operates “as is” in an output voltage range from 2V to 15V
 - For 20V output voltage, one external small signal transistor needed (for robustness in case of mains surge and spikes)
- Adaptive gate drive for fast turn-off at the end of conduction
- Under-Voltage Lock-Out (UVLO) with active gate pull-down
- Blanking input for low and high switching frequency
- Enable input for CCM operation and for disabling at start-up or shorted output
- Small HVSON8 package





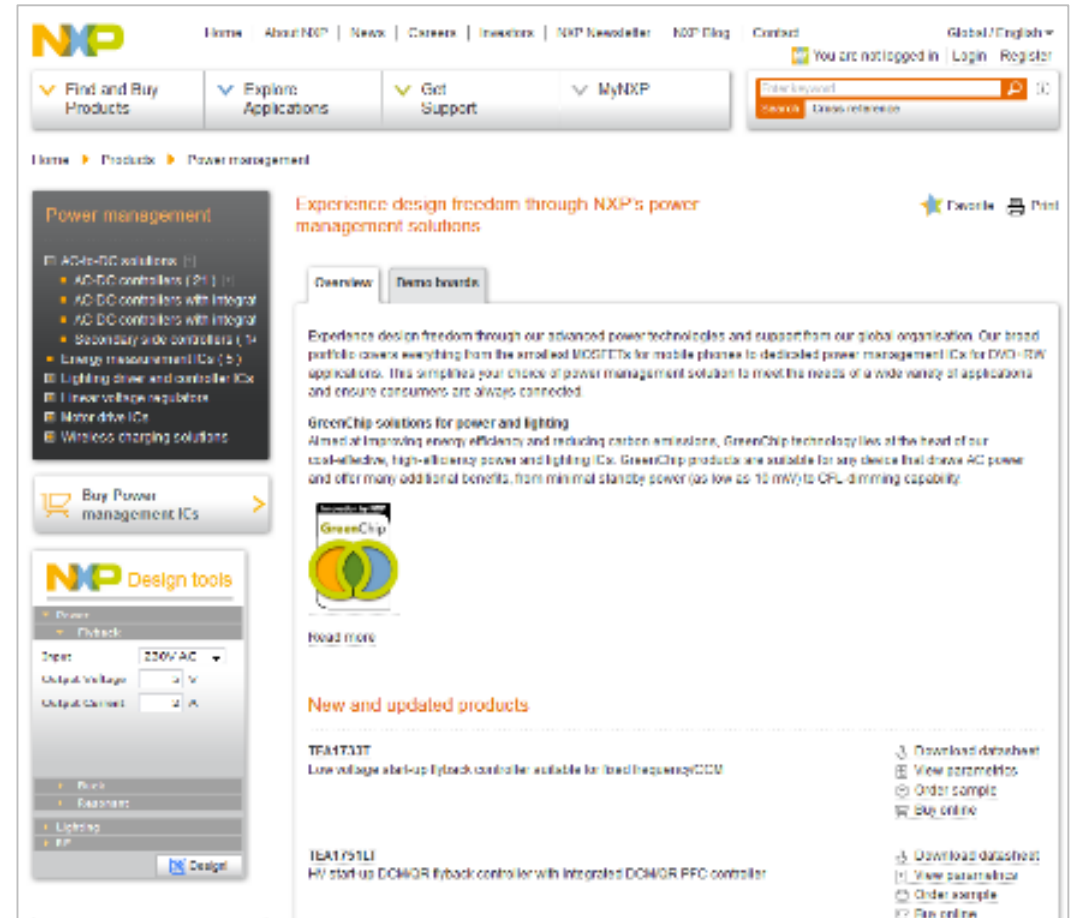
Support Tools & Collaterals

Demo Boards, User Manual, Application Notes, Design Tools, etc.

Interested in learning more about NXP GreenChip Power Solutions?

A full set of Collateral is available

- Product Information Page
 - Product Leaflets and Datasheets
 - Application Notes
 - Qualification Data
 - Free Samples of all Product Versions
- Demo Board Information Page
 - Demo Boards
 - User Manuals
 - Online Design Tools
- GreenChip Power Product Selection Guide
- Online Calculation Design Tool



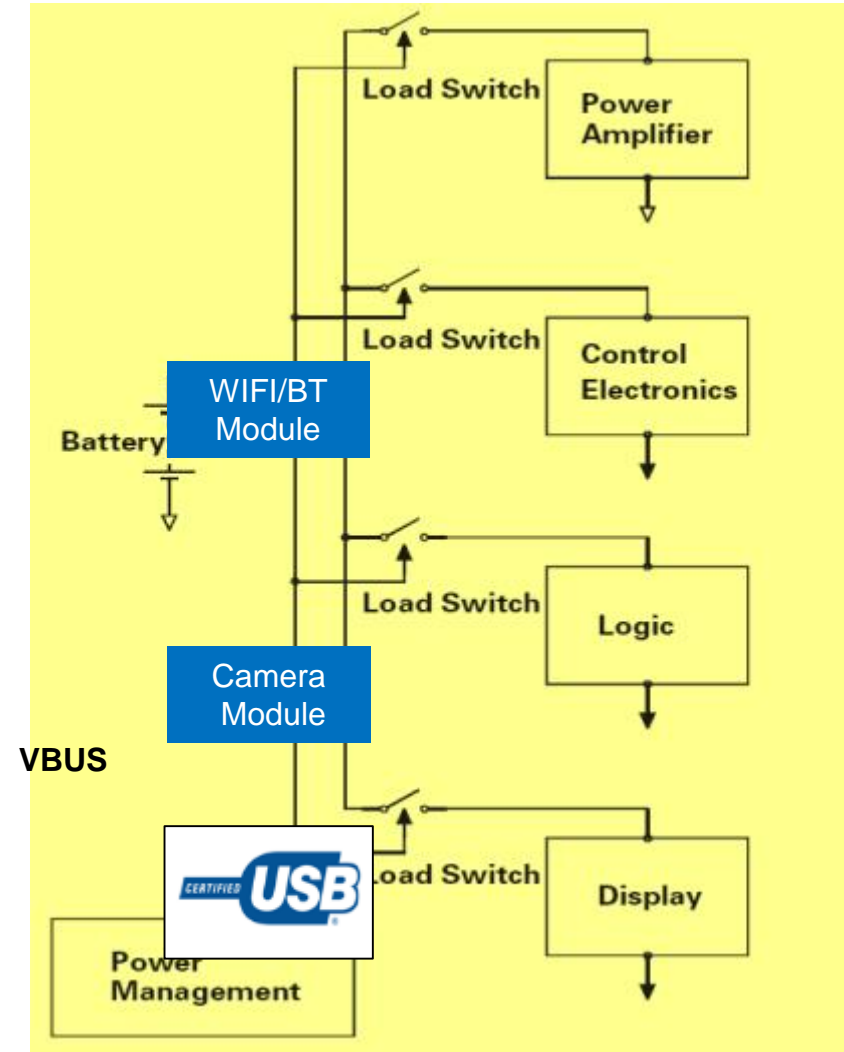


LOAD SWITCHES



Load Switches Power Distribution Applications

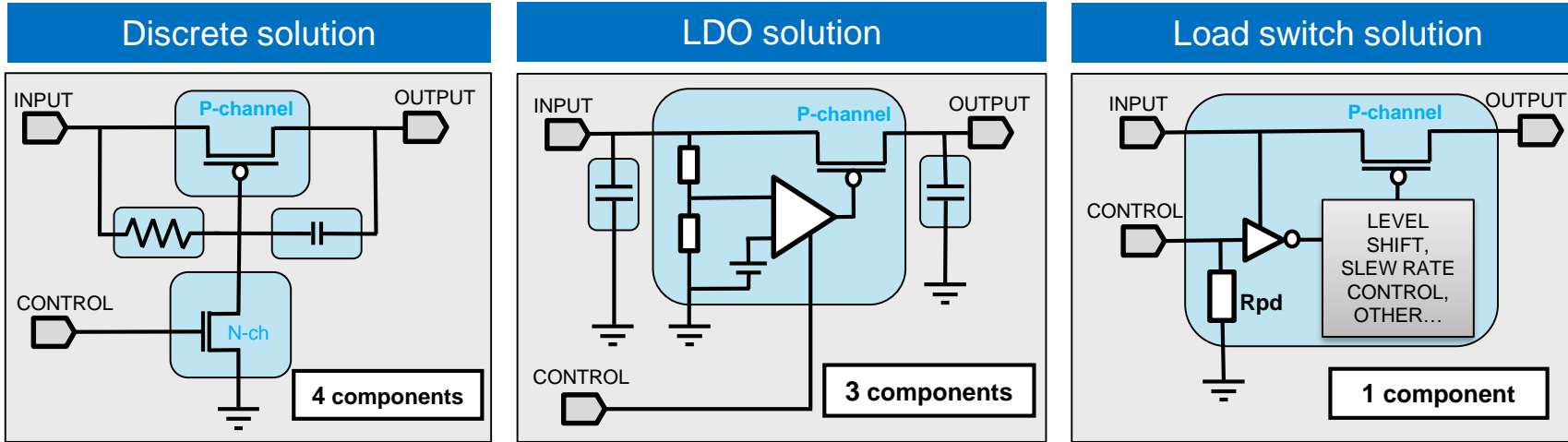
- **Usage:**
 - Power distribution to subsystem blocks
 - Connect/disconnect loads to power supply rails
- **Benefits:**
 - Extend battery life:
 - Low voltage drop across switch, compare to LDO
 - Very low current consumption and leakage current
 - Minimize load drawn from battery by disconnecting unused blocks
- **Lower costs**
 - Varies power rating and Low Ron for better efficiency
 - Reduces overall part count
 - Reduces PCB space
- **Why NXP?**
 - Large manufacturing capacity
 - Variety of package options
 - Low power CMOS processes
 - Excellent balance of price and features





Load Switches

Three Alternatives for High-Side Switching



	Discrete	LDO	Load switch
Footprint (external components)	Largest	Mid	most compact
Cost	Lowest	Lower	Low
Efficiency	Med	Lowest	Best
Regulated voltage	No	Yes	No
Logic level control	No	Possible	Yes
FEATURES			Yes**
Current limit, OCP	No*	No	Yes**
Thermal shutdown	No*	No	Yes**
Load discharge	No*	No	Yes**
Short circuit protection	No*	No	Yes**
In-rush protection	No*	No	Yes**
Reverse voltage protection	No*	No	Yes**
UVLO	No*	No	Yes**

* Feature can be implemented discretely with additional components

** Feature is integrated in the silicon. Specific feature set will vary by part number



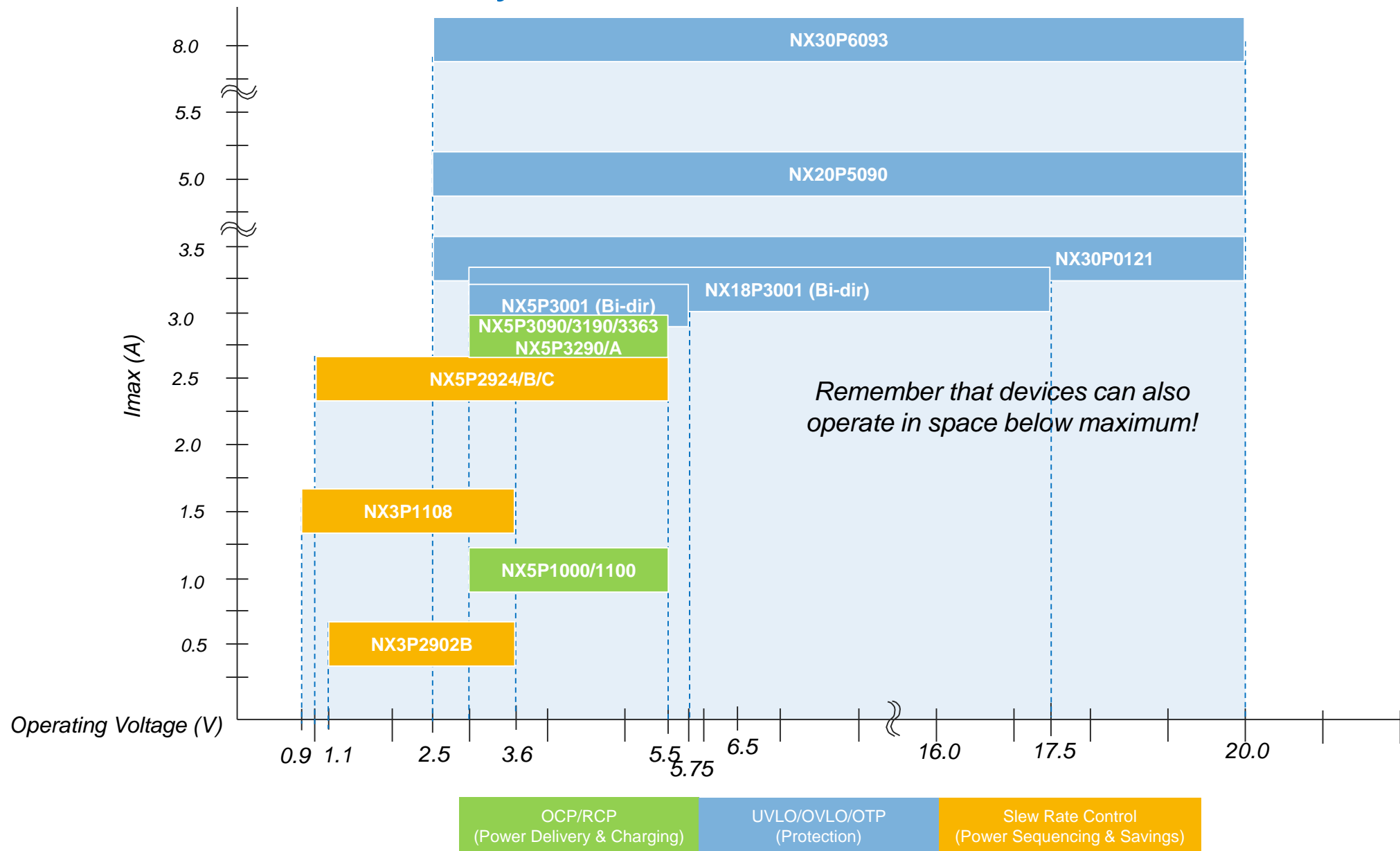


Safety Features with Load Switches

Feature	Description
Slew rate control (SR)	Also called in-rush current protection or soft start. Limits the initial current ramp when switch is first turned on. High capacitive load can create a high current spike with damaging potential if not controlled. Slew rate is typically fixed internally, but could also be programmed externally with an RC network.
Constant current limit (CC limit)	Limits the maximum current through the switch at all times to a specific value. Value can be either fixed internally by design, or programmed externally with a resistor.
Short circuit protection	Turns off the switch when a short circuit situation is detected. The protection can include an auto-reset circuit, which allows the switch to resume normal operation once the short circuit is removed, or include a latch-off mode, which locks the switch in the off position until the fault is removed and the power re-cycled.
Reverse voltage protection	Prevents current from flowing in the reverse direction from output to input of the switch in situations where the output voltage is higher than the input voltage.
Over temperature protection (OTP)	Turns off the switch when the device internal temperature increases above a certain set level to prevent internal damages. The threshold can be either fixed internally, or programmed externally.
Under voltage lockout (UVLO)	Turns off the switch, or prevent the switch from turning on, while the input voltage is below a certain level. This limits the risk of pulling excessive current from the source while the input voltage is still too low for normal operation.
Brown out protection	Sag in the input voltage can create malfunction or damages. Brownout protection (related to UVLO) prevents
Over voltage protection (OVP)	Turns off the switch when the input voltage rises above a certain level. This prevents voltage overshoot from propagating through the switch and damaging the load. The threshold level can be fixed internally, or programmed externally.
Load discharge circuit	Removes any capacitive charge from the load by shorting it directly to ground to provide a clean reset. The discharge rate can be adjusted with a resistor internally or externally.
Fault indicator	Outputs a DC signal to indicate an error has been detected (short circuit, over temperature...) and trigger a reset.



NXP Load Switch Family





Load Switches Portfolio

For Power Sequencing, Power Savings, Power Delivery, Protection & Control

- Ultra-low current consumption
- Low and flat on-resistance (R_{ON})
- Wide Supply Voltage Range

Power Sequencing & Savings
Protection (OVP)
Power Delivery & Charging (OCP)

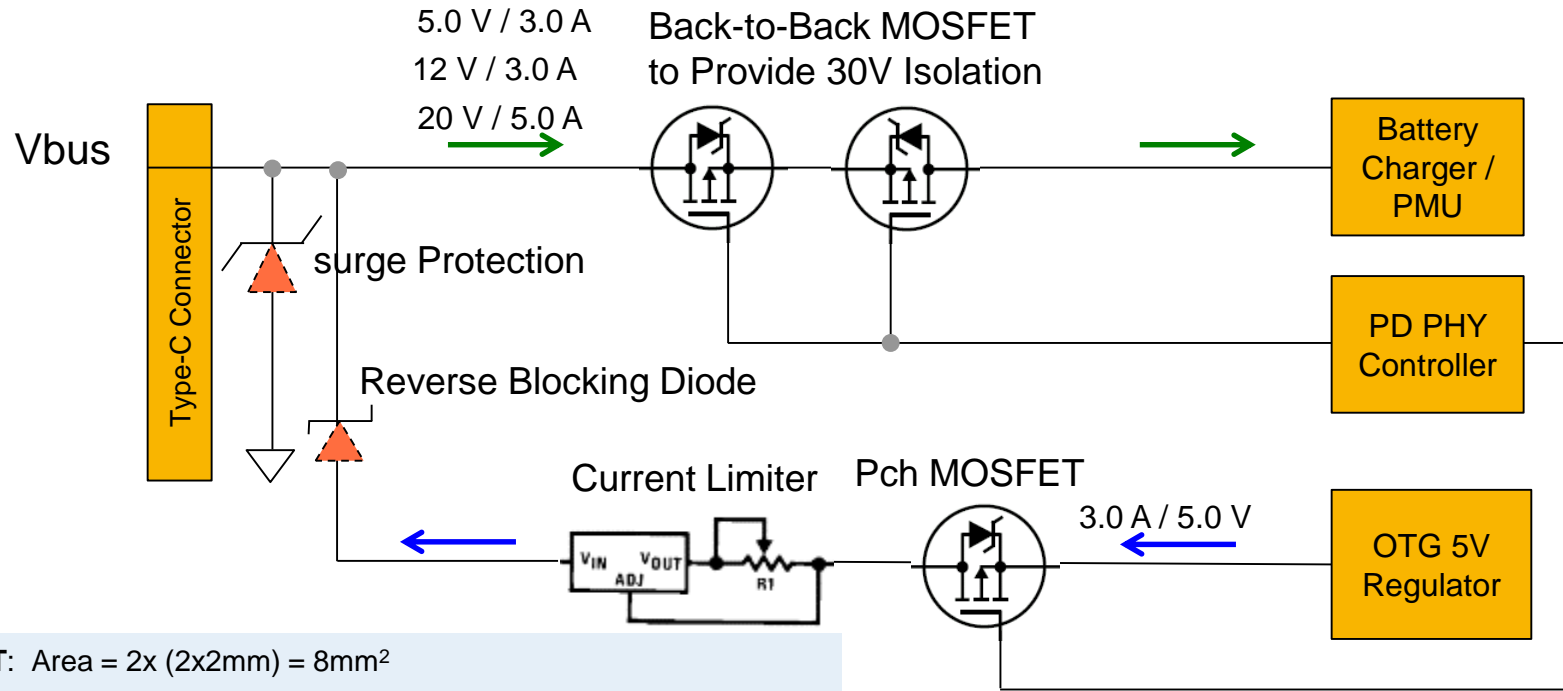
Device	V_{IN} (V)	R_{ON} TYP (m Ω)	$I_{QUIESCENT}$ TYP (nA)	I_{OUTPUT} MAX (A)	Slew Rate	R_{dch}	UVLO	OVP	OTP	OCP	RCP	Package
NX3P2902B	1.1 – 3.6	65	10	0.5	Y	Y						WLCSP4
NX3P1108	0.9 – 3.6	35	100	1.5	Y	Y						WLCSP4
NX5P2924	0.9 – 5.5	14	500	2.5	Y	Y						WLCSP6
NX5P1000 †	3.0 – 5.5	60	200	1.0 (adj)	Y		Y	Y	Y	Y	Y	WLCSP12
NX5P1100 †‡	3.0 – 5.5	60	200	1.0 (adj)	Y		Y	Y	Y	Y	Y	WLCSP12
NX5P3090 †	2.5 – 5.5	30	1,000	3.0 (adj)	Y	Y	Y		Y	Y	Y	WLCSP12
NX5P3290	4.0 – 5.5	35	3,000	3.0 (adj)	Y		Y		Y	Y	Y	WLCSP16
NX5P3363	4.0 – 5.5	TBD	TBD	3.0 (adj)	Y		Y		Y	Y	Y	WLCSP16
NX5P3190	4.0 – 5.5	20	TBD	3.3 (adj)	Y	Y	Y		Y	Y		WLCSP12
NX5P3001 †	3.0 - 5.75	65	100	3.0	Y		Y	Y	Y			WLCSP12
NX18P3001 †	3.0 - 17.5	65	100	3.0	Y		Y	Y	Y			WLCSP12
NX20P5090 †	2.5 – 20	30	1,000	5.0	Y		Y	Y	Y		Y	WLCSP15
NX30P6093 †	2.8 – 20	9	2,000	8.0	Y		Y	Y (adj)	Y		Y	WLCSP20
NX20P3481					Y	Y	Y	Y	Y	Y	Y	WLCSP28

† 30V Tolerant for USB OTG 3.0
‡ 8ms OCP trigger delay





USB Type-C / USB-PD Discrete Solutions



2x 30V Pch MOSFET: Area = 2x (2x2mm) = 8mm²

$R_{ds(on)}$ (at 100 degC) = 2x35mΩ = 70 mΩ

Reverse current protection

→ Add 30V/3A Schottky diode (Area = 2.5x4.8mm = 12mm²)

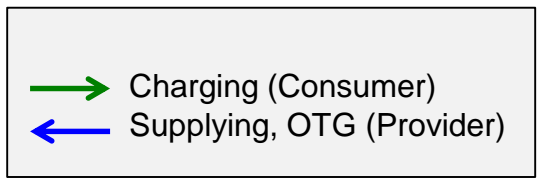
Over-voltage protection, No surge protection

→ Add 100V tolerant diode (Area = 5.3x4.2mm = 22mm²)

→ **Total area = 42 mm²** + PCB spacing of components

Surge & Reverse Blocking Diodes (orange) are integrated and not needed

Power Delivery Path



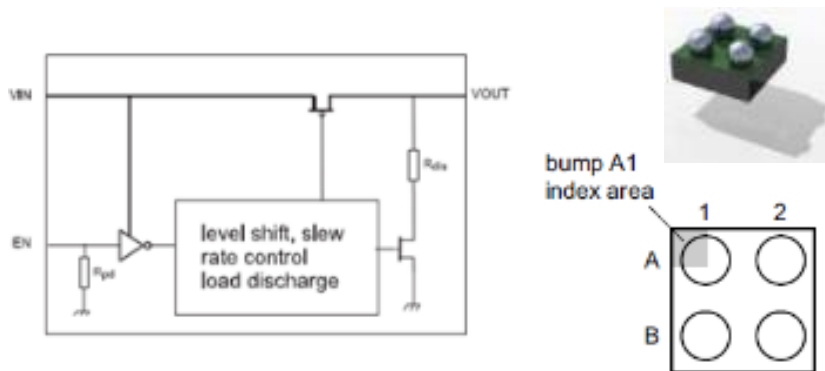
A Load Switch Integrates all the Discretes!



NX3P2902B – 0.5A High-Side Load Switch

- **Description**

- Low ON resistance P-channel MOSFET supporting 500 mA of continuous current
 - Operates from 1.1V to 3.6V
 - Used in power domain isolation to reduce power consumption & extend battery life
 - Enable pin includes level translation making the device compatible with low voltage processors
 - Include slew rate control to limit inrush current
- Available in: [WLCSP-4: 0.76 x 0.76 x 0.61 mm, 0.4 mm pitch](#)
 - Pin to Pin with: [TI TPS22901/902/902B](#)



NX3P2902B Transparent Top View Pinout

Features

- Operates from 1.1 to 3.6 V.
- Low $R_{ON} = 65 \text{ m}\Omega$ typ.
- Low power mode with EN = low.
- **Continuous current of 500 mA.**
- Leakage current with 0.1 μA
- Slew rate control 40 μSec @3.6V.



0.5A Load Switches Specification Comparison

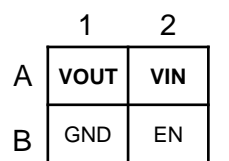
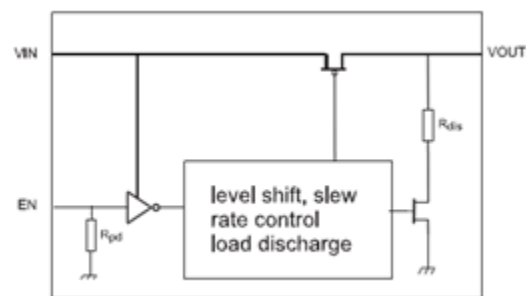
	ADP190	NX3P2902B	TPS22901	TPS22902B
Input voltage (V)	1.1 to 3.6	0.9 to 3.6V	1.0 to 3.6	1.0 to 3.6
R _{ON} @ 1.8V (mΩ)	105	✓ 95	109	109
R _{ON} @ 3.6V (mΩ)	80	✓ 65	78	78
Quiescent Current with EN=GND (nA)	100	✓ 10	137	137
Output t _{EN} @ 1.8V (μs)	-	310	72	335
Output t _{EN} @ 3.6V (μs)	50	135	39	183
Output t _{RISE} @ 1.8V (μs)	-	265	45	220
Output t _{RISE} @ 3.6V (μs)	1.5	150	28	146
Quick discharge	No	Yes	No	Yes
Max output current (A)	0.5	0.5	0.5	0.5
Package	WCSP4 0.8X0.8mm	WCSP4 0.8X0.8mm	WCSP4 0.8X0.8mm	WCSP4 0.8X0.8mm

- NXP has 10% Lower RDson
- NXP also provides best in class supply chain and is cost competitive

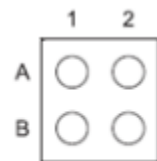


NX3P1108UK – 1.5A High-Side Load Switch

- **Description**
 - Low ON resistance P-channel MOSFET supporting 1.5 A of continuous current
 - Operates from 0.9V to 3.6V
 - Used in power domain isolation to reduce power consumption & extend battery life
 - Enable pin includes level translation making the device compatible with low voltage processors
 - Include slew rate control to limit inrush current
 - NX3P1108 also includes active pull down to discharge any residual output charge
- Available in: [WLCSP-4: 0.96 x 0.96 mm, 0.5 mm pitch](#)
- Pin to Pin with: [Fairchild FPF1107/1108](#), [TI TPS22902/22907](#)



Pin-out top view



Transparent top view

Features

- Operates from 0.9 to 3.6 V
- Low $R_{ON} = 32 \text{ m}\Omega$ typ at 3.3 V
- $= 50 \text{ m}\Omega$ typ at 1.8 V
- Low power mode with EN = low
- **Supplies 1.5 A of continuous current**, Highest industry rating / area
- Slew rate control
- **Load discharge circuit for NX3P1108UK**



1.5A Load Switches

Competitive Comparison

- Lower operating voltage: 0.9V
- Highest current rating of 1.5A
- Lowest R_{ON}

	NX3P1108	TPS22906	TPS22907	FPF1107	FPF1108	Comments
Input voltage	0.9 to 3.6	1.0 to 3.6	1.0 to 3.6	1.2 to 4.0	1.2 to 4.0	NXP has lower voltage
R_{ON} @ 3.3V (m Ω)	35	78	44	35	35	> NXP 10% lower $R_{DS(ON)}$
Slew rate control	Yes	Yes	Yes	Yes	Yes	
Quick discharge	Yes	Yes	No	No	Yes	
Max output current (A)	1.5	1.0	0.5	1.2	1.2	
Package (mm)	WCSP4 (0.96 x 0.96)					
Pitch (mm)	0.5					





NX5P2924/B/C – 2.5A, Low RON High-Side Load Switch

Description

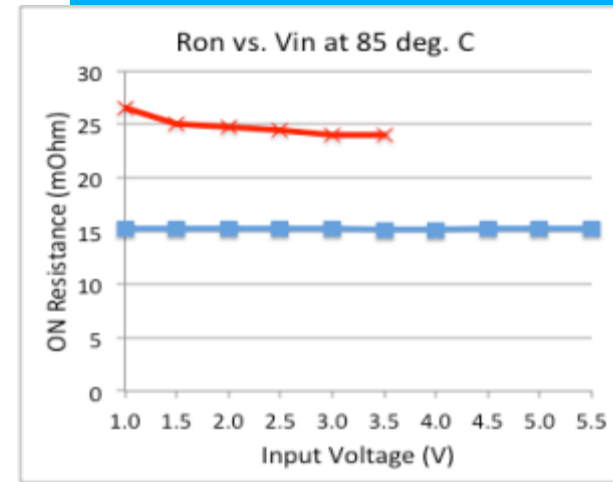
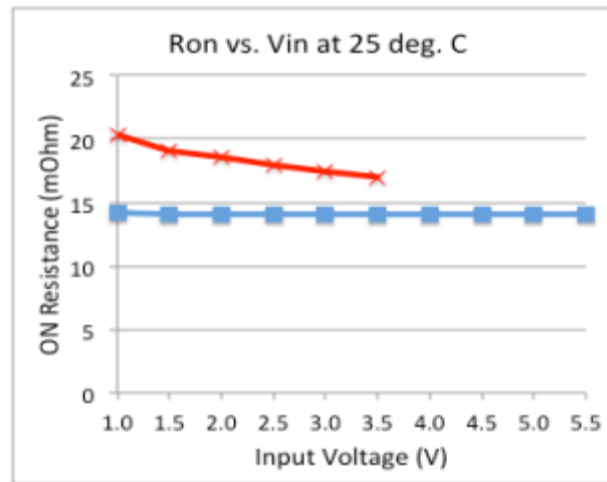
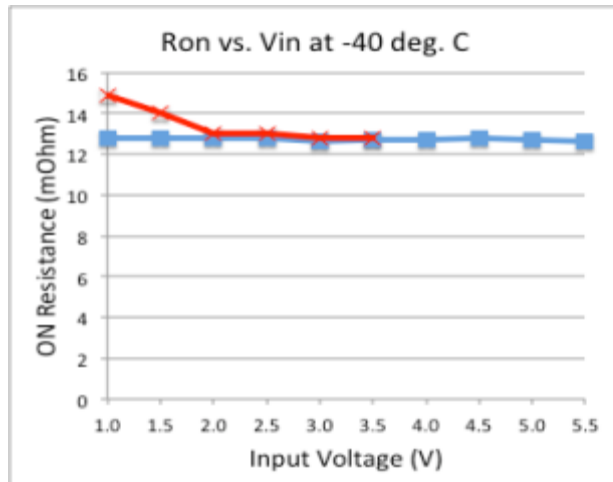
- Low ON-resistance across all Vin and temperature (-40 to 85°C).
 - Switch controlled by 1.2V logic enable pin, optional internal pull-down resistor to prevent false triggering.
 - Internal output shunt resistor/MOSFET quickly discharges residual load when power switch is turned off.
 - Slew rate control limits device rise time to prevent inrush current
 - NX5P2924 has pull-down resistor on EN pin; NX5P2924B/C have no pull-down resistor on EN pin
 - Difference between the NX5P2924B/C is the output slew rates (B=100us, C=8ms)
- Pin-to-pin with: TI TPS22924(B)YZPR



6-ball WLCSP Package
1.4 mm x 0.9 mm x 0.5mm;
0.5 mm pitch

Features

- Operates from 0.9 V to 5.5V
- Low RON = 14 mΩ typ. at 1.8V
- Low power mode with EN = low
- High continuous current of 2.5A
- Switch leakage current of 0.5 uA
- Off-state supply current of 0.1 uA
- Slew rate control, 100us
- Load discharge circuit
- On-chip Enable pull-down resistor



NX5P2924 Blue TPS22924 RED





Load Switch Specification Comparison

Key inputs	NX5P2924	NX5P2924B	TPS22924B	Comments
Operating voltage	0.8 to 5.5V	0.8 to 5.5V	0.75 to 3.6V	Wider operating range
Max continuous current	2.5A	2.5A	2.0A	Higher current
EN pin: Pull-down resistor	integrated pull-down resistor	no pull-down resistor	no pull-down resistor	
R _{ON} (typ/max)	14 / 18 mW	14 / 18 mW	20 / 28 mW	NXP R _{ON} better
Package and size	WCSP6 (1.4 x 0.9 mm)			Pin-to-pin compatible

NXP offers very low, flat R_{ON} over operating voltage range.



NX5P1000 / NX5P1100 – Uni-directional OVP/OCP IC

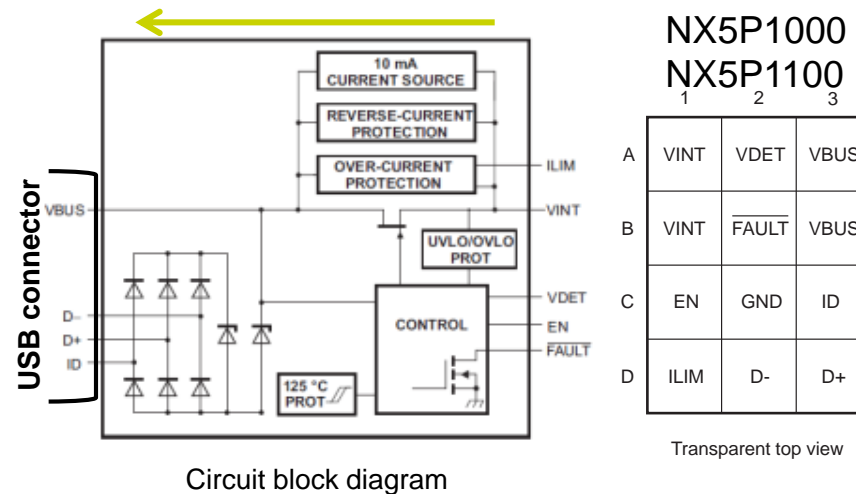
With ESD Protection Diodes for Data Lines

• Description

- Uni-directional power switch and ESD protection device for **USB OTG** supply.
- Operates from 3.0 to 5.5V. Protect the inside circuitry from external voltages up to 30V.
- Designed to isolate a VBUS OTG voltage source from an interface pin during over-current or over-temperature events.
- Features an externally adjustable current limit; an output voltage detect, OVP, OTP, and a fault indicator.
- Available in: NX5P1000: WCSP12 1.4 x 1.7, 0.4 mm pitch
- **Competes with: TI TPD4S214**

Features

- Isolates/protects up to 30V on VBUS
- Operates from 3.0 - 5.5V
- Adjustable current limit: 200mA – 1.0A
- Low ON resistance: RON 60 mΩ
- Soft start turn-on, slew rate controlled
- Over-/under-voltage protection
- Over-temperature protection @125C
- Reverse bias current protection
- ESD IEC contact to 8kV

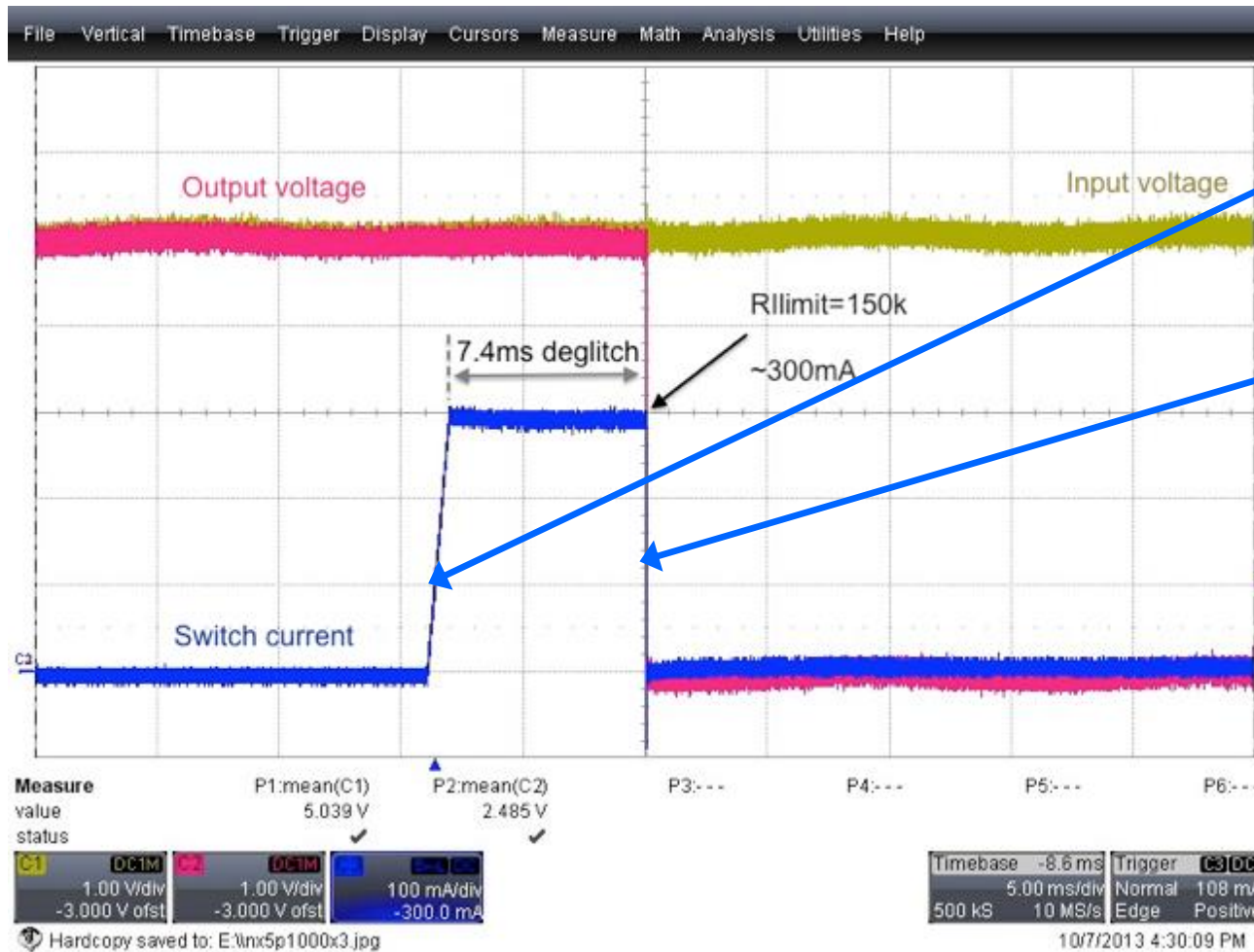


The NX5P1000 is very similar to the NX5P1100 with the addition of an 8ms OCP trigger delay in the NX5P1100



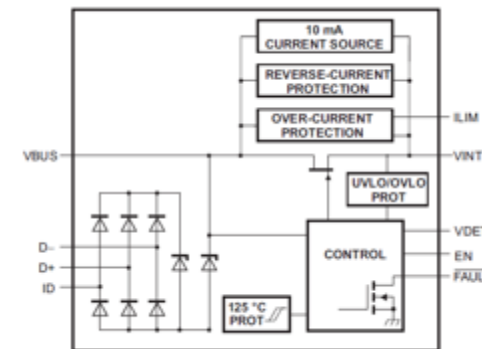


NX5P1100 – Screen Shot During Power-up



Current limit set to 300mA
5V input voltage
Switch current step from: 0 to 500mA

After switch current = I_{limit} for 7.4ms, switch opens, isolating V_{in} from V_{bus}

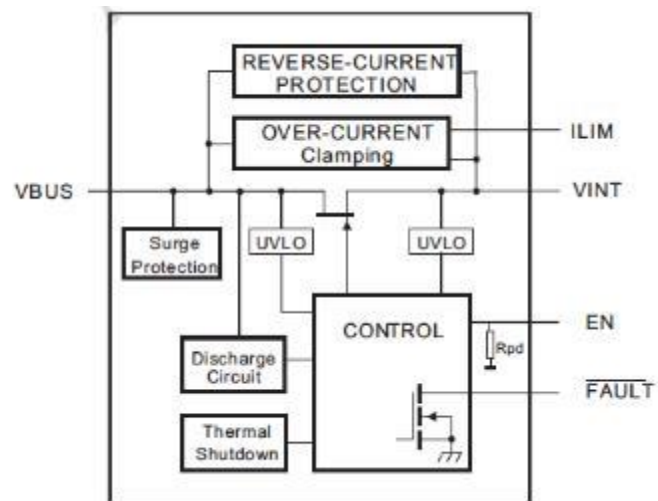




NX5P3090 – 5V/3A Adjustable Current Limit Load Switch

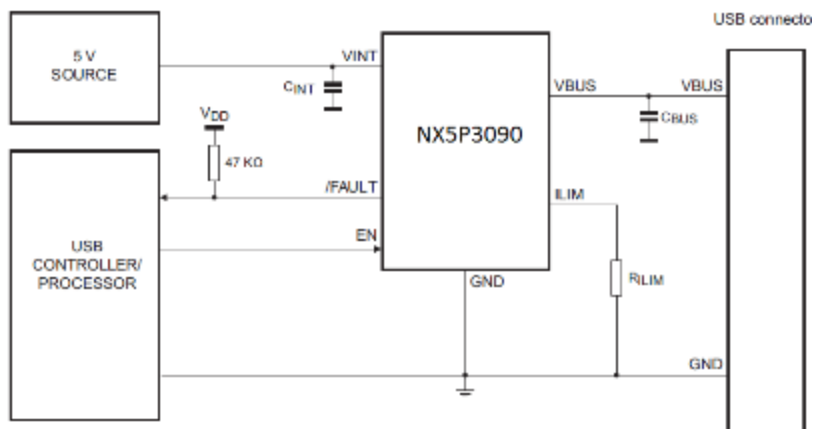
Description

- High-side Load Switch with low ON resistance P-channel MOSFET
- 29 V tolerance on VBUS and EN pin
- Active-HIGH EN pin with internal pull-down resistor
- Adjustable current limit from 400 mA to 3.3 A
- Clamped current output in over-current condition
- Very low ON resistance: 34 mΩ (typical)
- Protections: OCP, RCP, OTP
- Surge protection: IEC61000-4-5 exceeds ±80 V on VBUS
- Safety approvals
 - UL 62368-1, 2nd Edition, File no. 20160526-E470128
 - IEC 62368-1 (ed.2), File no. DK-54536-UL



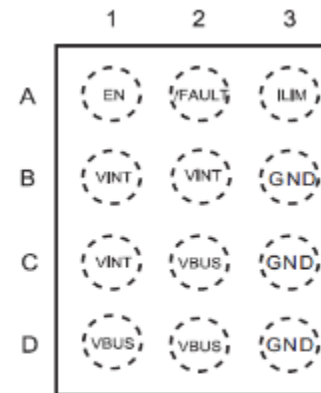
Available in: WLCSP12 (1.4mm x 1.7mm, 0.4-mm pitch)

block diagram



Applications

- Notebook and tablet PC
- Cellular handsets
- Portable media players



Transparent Top View



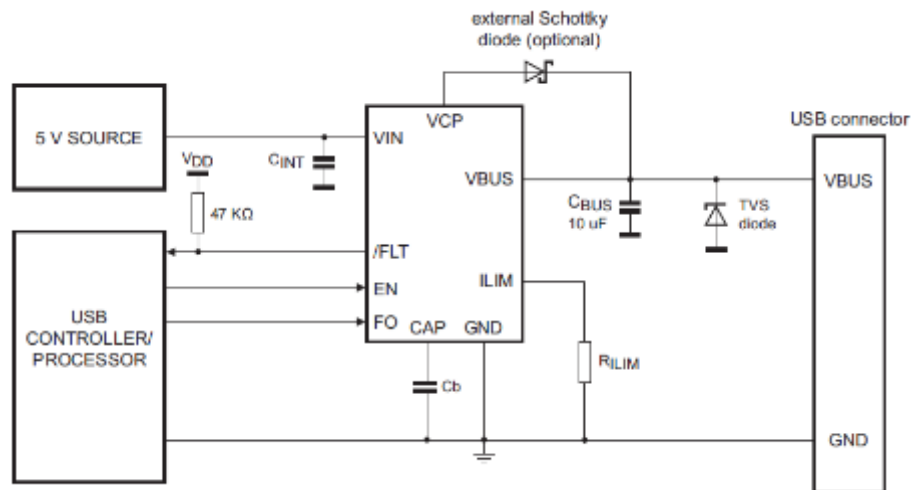


NX5P3290 – OCP Load Switch with Fast RCP Recovery

Description

- VIN supply voltage range from 4.0 V to 5.5 V
- All time reverse current protection with ultra fast RCP recovery
- Adjustable current limit from 400 mA to 3.3 A
- Clamped current output in over-current condition
- 29 V high voltage tolerance on VBUS pin
- Low ON resistance of the power FETs: 35 m Ω (typical) in total
- Over temperature protection
- Safety approvals
 - UL 62368-1, 2nd edition, file no. 20161017-E470128
 - IEC 62368-1, 2nd edition, file no. DK-57975-UL

- Fast RCP recovery circuit added to the switch to prevent any reverse current flowing back to power source at all time.
- When existing from RCP state, the power MOSFET will be turn on within 50 μ s.



- Over current protection of VBUS for USB PD and Type C application
- Adjustable OCP from 400mA to 3.3A
- Support USB PD 3.0 fast role swap
- Support 24V hot plug-in

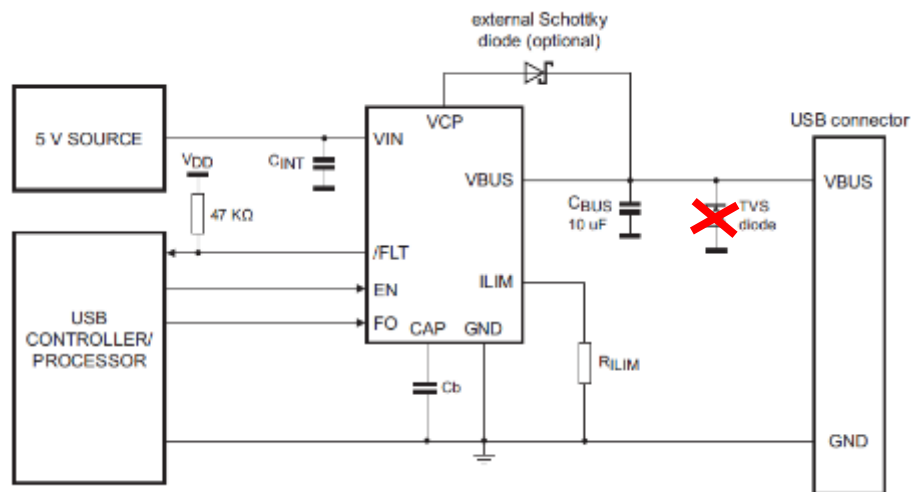


NX5P3363 – OCP Load Switch with Fast RCP Recovery

Description

- VIN supply voltage range from 4.0 V to 5.5 V
- All time reverse current protection with ultra fast RCP recovery
- Adjustable current limit from 400 mA to 3.3 A
- Clamped current output in over-current condition
- 29 V high voltage tolerance on VBUS pin
- Low ON resistance of the power FETs: 35 m Ω (typical) in total
- Over temperature protection
- Safety approvals
 - UL 62368-1, 2nd edition, file no. 20161017-E470128
 - IEC 62368-1, 2nd edition, file no. DK-57975-UL
- Surge protection: IEC61000-4-5 exceeds ± 80 V on VBUS

- Fast RCP recovery circuit added to the switch to prevent any reverse current flowing back to power source at all time.
- When existing from RCP state, the power MOSFET will be turn on within 50 μ s.

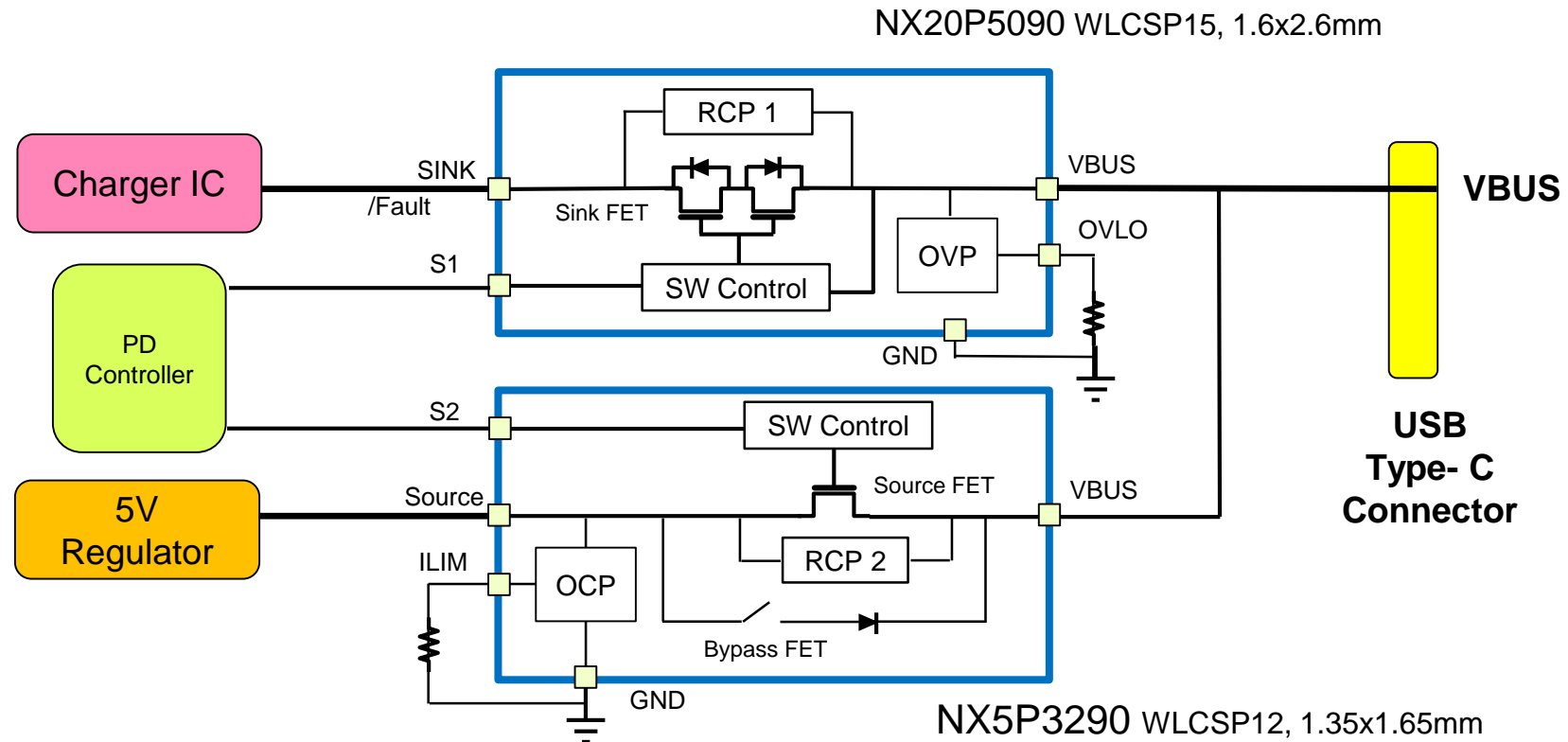


Over current protection of VBUS

- for USB PD and Type C application
- Adjustable OCP from 400mA to 3.3A
- Support USB PD 3.0 fast role swap
- Support 24V hot plug-in
- **+80V Surge protection**



NX5P3290/3363 – Load Switch with Fast RCP Recovery



1. Sink Path supports 20V/5A with over-voltage protection.
2. 5V Source path supports 5V/3A with current limit.
3. Programmable current limit and OVP by external resistor
4. Bypass FET for fast Vbus support during transitions
5. RCP protection, 30V isolation on Vbus.

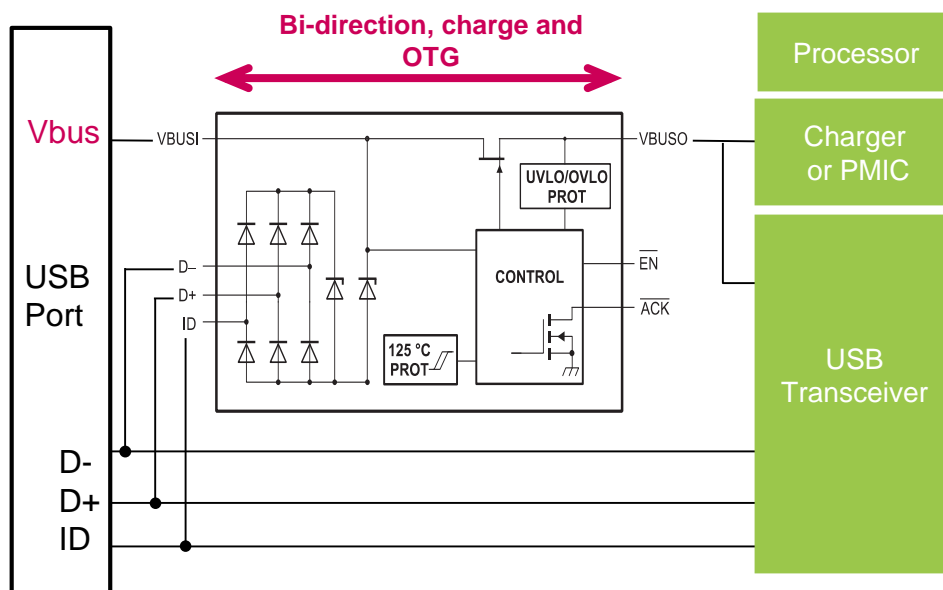


NX5P3001/NX18P3001 Bi-directional OVP Load Switch for USB OTG & Charge

Description

- Bi-directional power switch w/ ESD-protection for USB-OTG charger port applications
- Under & over voltage lockout protection to automatically isolate the power switch terminals during fault conditions
- Slew-rate control to protect from inrush currents
- Low capacitance TVS are built-in on D+ and D- lines

Available in: WCSP12 1.2 x 1.6 x 0.5, 0.4 mm pitch



Features

- Isolates/protects up to 30V on VBUSi
- Operates from 3.0 - 5.75V (NX5P...)
- Operates from 3.0 – 17.5V (NX18P...)
- Switch continuous current: 3 A max
- Low ON resistance: R_{ON} 65 m Ω .
- Soft start (slew rate control)
- Over voltage protection
- Under voltage protection
- Over-temperature protection
- ESD IEC contact to 8kV, HBM of 2kV

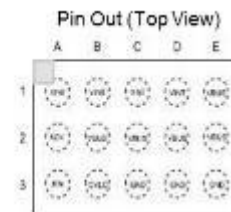
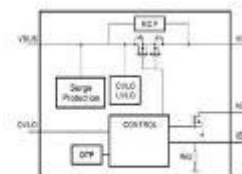
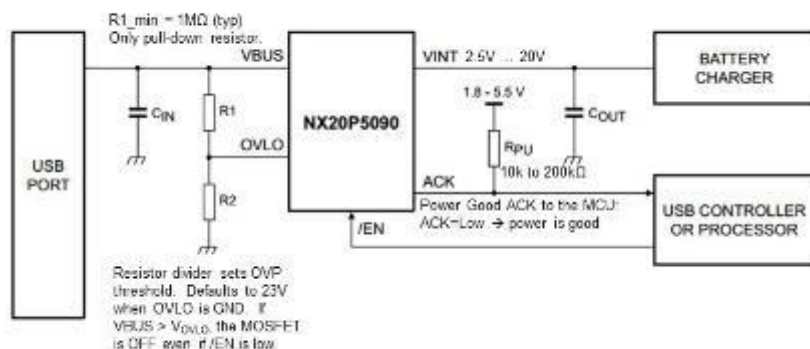


NX20P5090 – 5A Programmable OVP Power Switch

Description

- 5.0A capable power switch with programmable over-voltage protection. OVLO is programmed via pull-down resistor.
- Includes under-voltage protection, reverse-current protection, and over-temperature protection. During fault condition, device opens to protect the load.
- Supports USB-PD Type C and power domain isolation applications with high supply current
- Slew rate control with 15ms debounce time before the switch turns on
- Enable input integrates voltage level translation, making device compatible with low voltage processors

Available in: WLCSP15 1.6 x 2.6mm; 0.5mm pitch



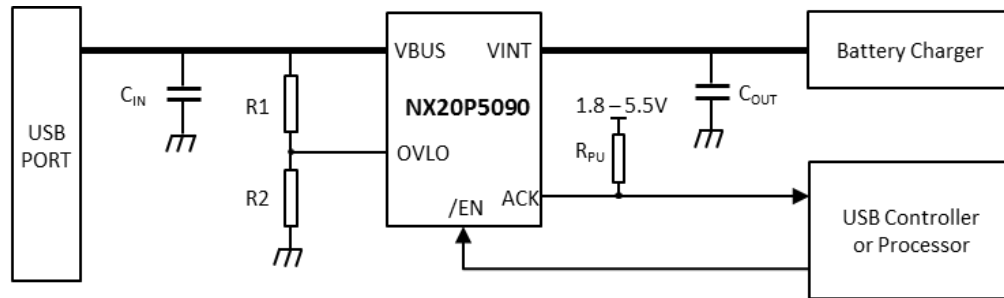
Features

- Operates from 2.5 to 20 V.
- Low ON resistance: Ron typ 30 mΩ
- 29V tolerant VINT/VBUS pins
- Reverse current protection
- Programmable over-voltage protection
- Under voltage protection (2V)
- Over-temperature protection @125C
- 1.8V control Logic to enable/disable
- IEC61000-4-5 90V Surge Protection on Vbus
- Slew rate control with 15ms debounce

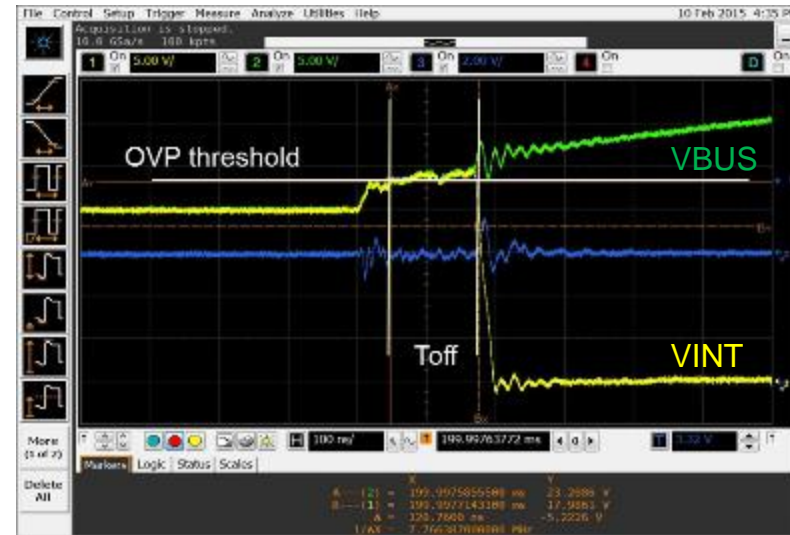
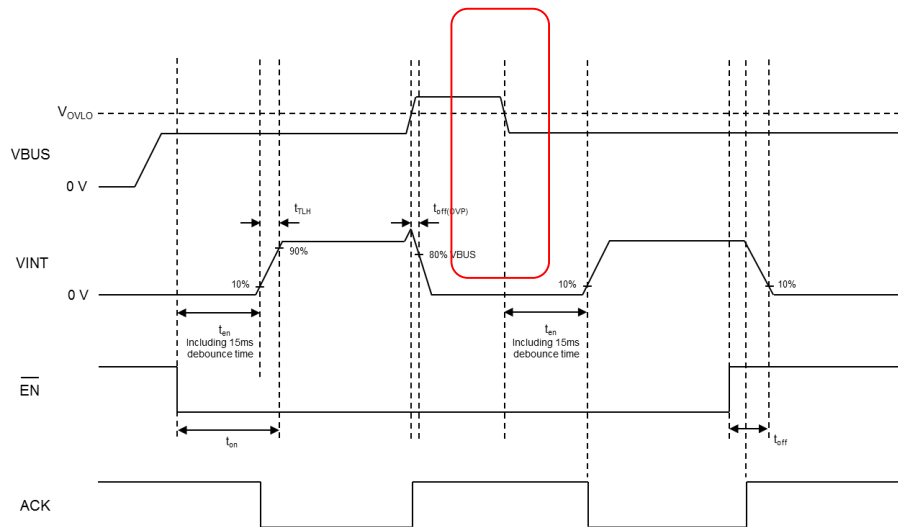


NX20P5090 – 5A Programmable OVP Power Switch

Configurable and Fast Over Voltage Protection



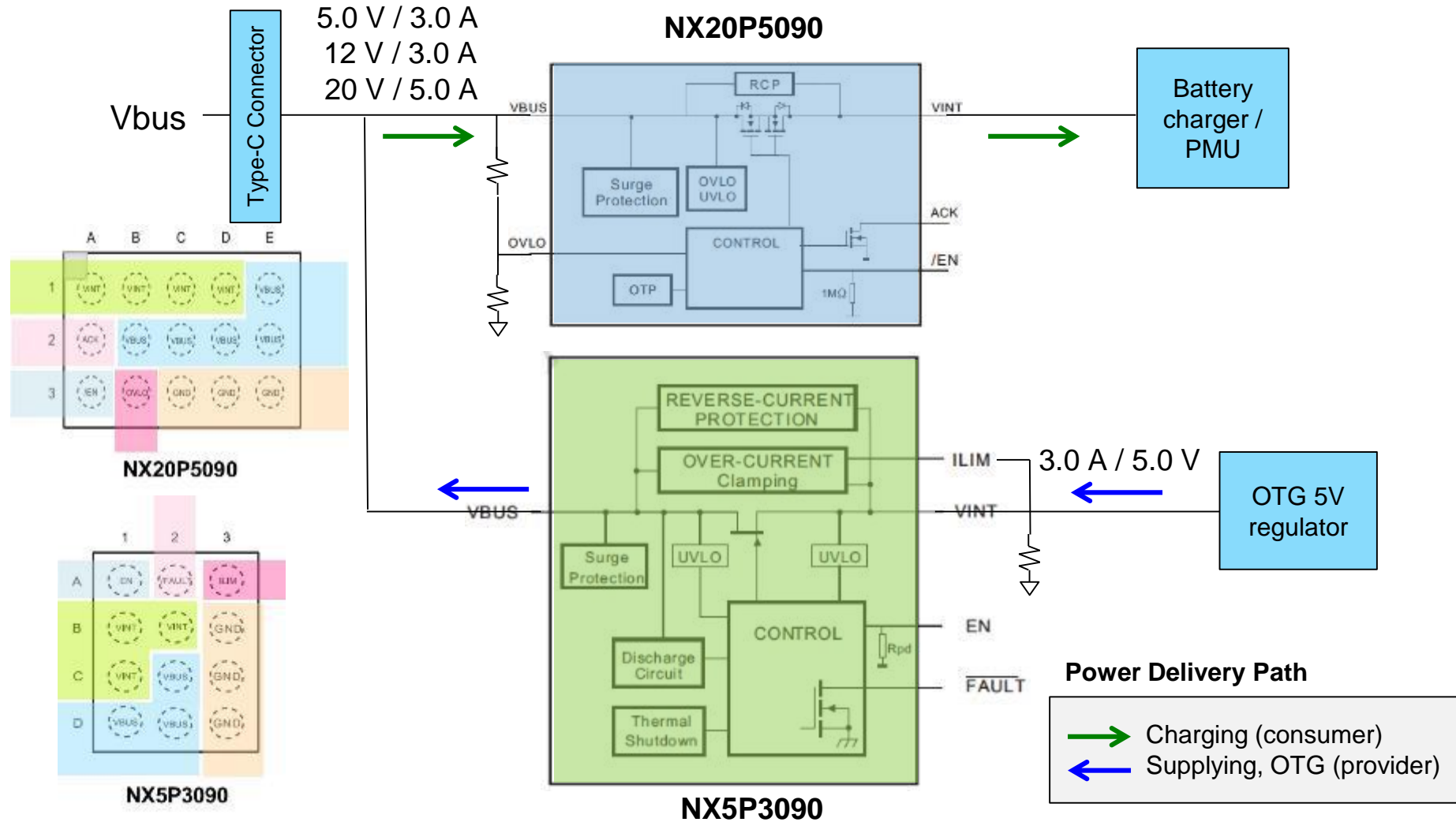
$$V_{ovlo} = V_{th(ovlo)} \times (R1 + R2) / (R2)$$



When $V_{BUS} > V_{OVLO}$, $T_{off} \approx 130\text{ns}$



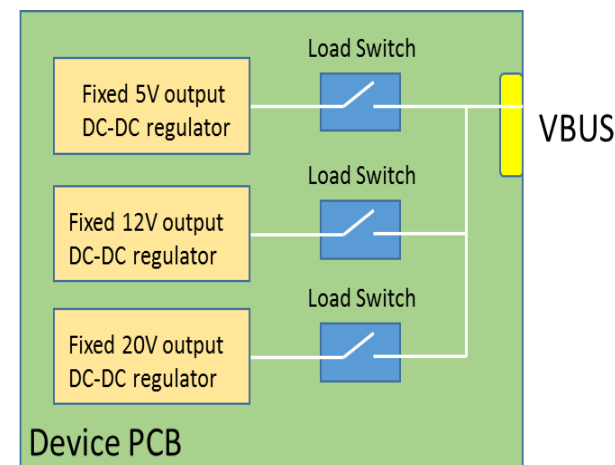
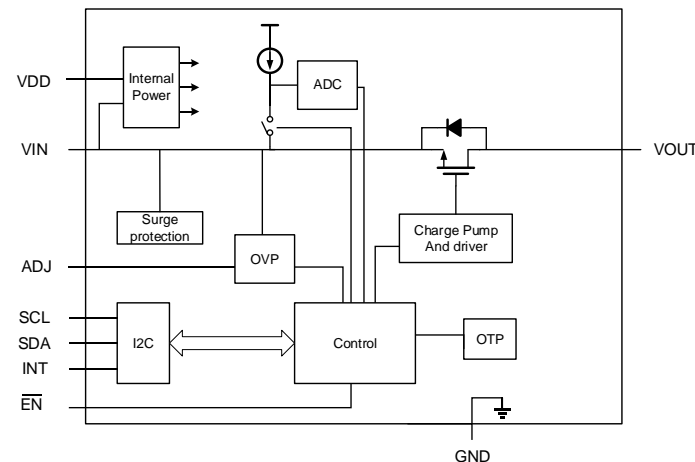
NX20P5090 & NX5P3090 – USB Type-C Power Path





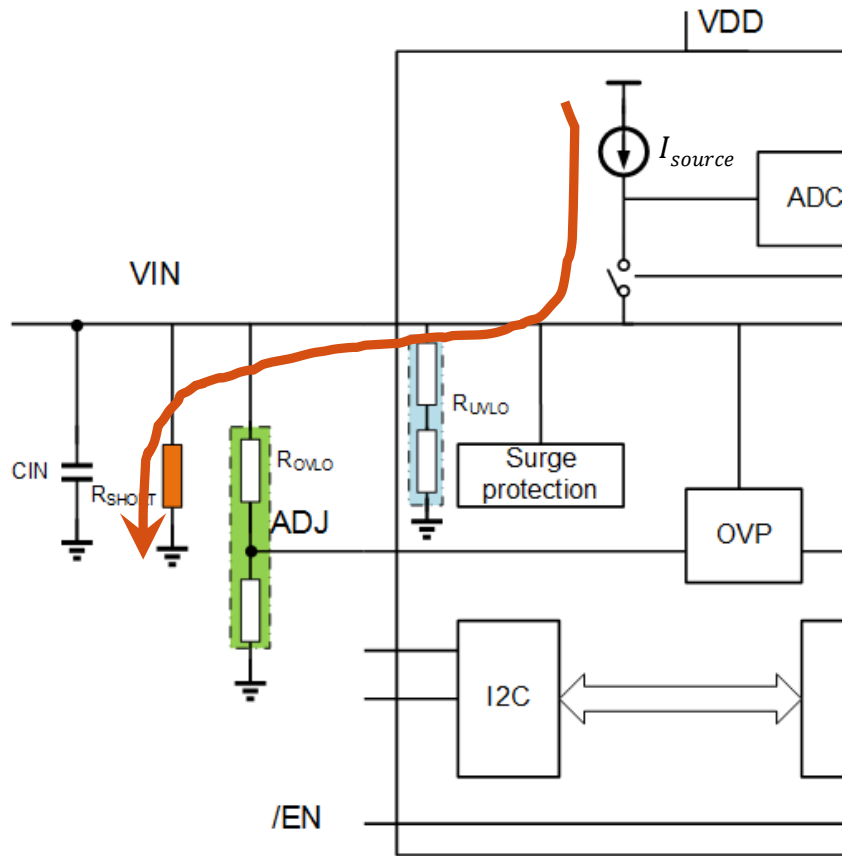
NX30P6093 – 30V / 8A Programmable Load Switch

- Uni-direction Load Switch (Sink Path)
- Over voltage protection up to 29V on VIN
- Adjustable OVP by I²C (6V, 10V, 11.5V, 14V, 17V, 23V)
- Maximum switch continuous current 8A
- Integrated current source for VIN pin resistance detection
- Ultra-low RDS(ON) = 8.95mΩ (Typ) for high current operation
- Short circuit protection from VIN to VOUT
- Slew rate control for inrush current limit
- Input discharge path for USB PD specification
- I²C control and programmability for OVP threshold, timing control, pin resistance current source value, interrupt flag, etc.
- Surge protection: IEC61000-4-5 exceeds ±100 V on VIN without capacitor
- Protection circuitry
 - Over-Temperature Protection, Over-Voltage Protection, Under-Voltage Lockout
- ESD
 - IEC61000-4-2 contact discharge exceeds 8 kV on VIN
 - IEC61000-4-2 air discharge exceeds 15 kV on VIN
 - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 3 kV on all pins





NX30P6093 – V_{IN} Impedance Detection



The detected resistance,

$$R_{DETECT} = R_{SHORT} // R_{OVLO} // R_{UVLO}$$

The stable V_{IN} voltage after charging by current source,

$$V_{IN} = I_{source} * R_{DETECT}$$

However, due to C_{IN} capacitance, the voltage would be,

$$V_{IN} = I_{source} * R_{DETECT} * (1 - e^{-\frac{t_{det}}{t_{rc}}})$$

$$\text{Where, } t_{rc} = R_{DETECT} * C_{IN}$$

Smartphone OS notification to your end user,

1. Plug out any of the accessory on USB connector
2. Clear the USB connector to **remove possible moisture or dusty etc @ Type-C connector**

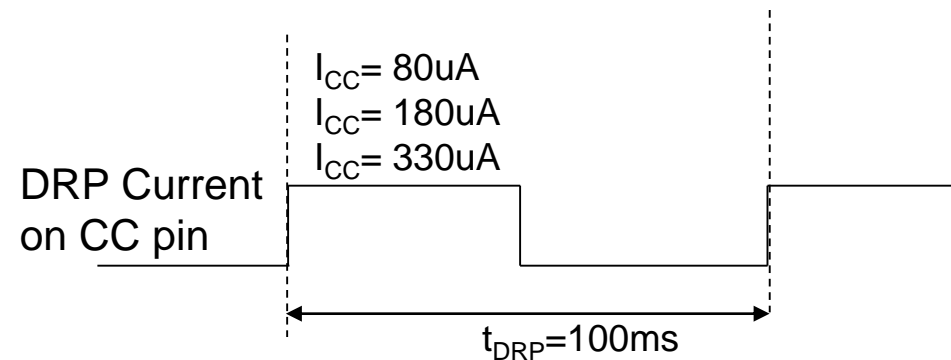


Type-C Connector Moisture Testing

Moisture Type	Full Liquid in Connector ¹⁾	Little Liquid in Connector ²⁾
Drink Water	78kΩ	260kΩ
Coffee	65kΩ	252kΩ
Sugar Water	72kΩ	255kΩ
Salt (Sea) Water	28kΩ	212kΩ
Coca Cola	38kΩ	255kΩ

1. Inject the liquid in Type C connector and make the liquid full in the connector
2. A small drop liquid in connector

- The DRP CC pins have periodically current according to Type-C specification as shown in the diagram
- With the moisture, the chemical-electronic effect will corrode the metal and damage the pins and connector as shown in the following tested impedance on CC pin to ground



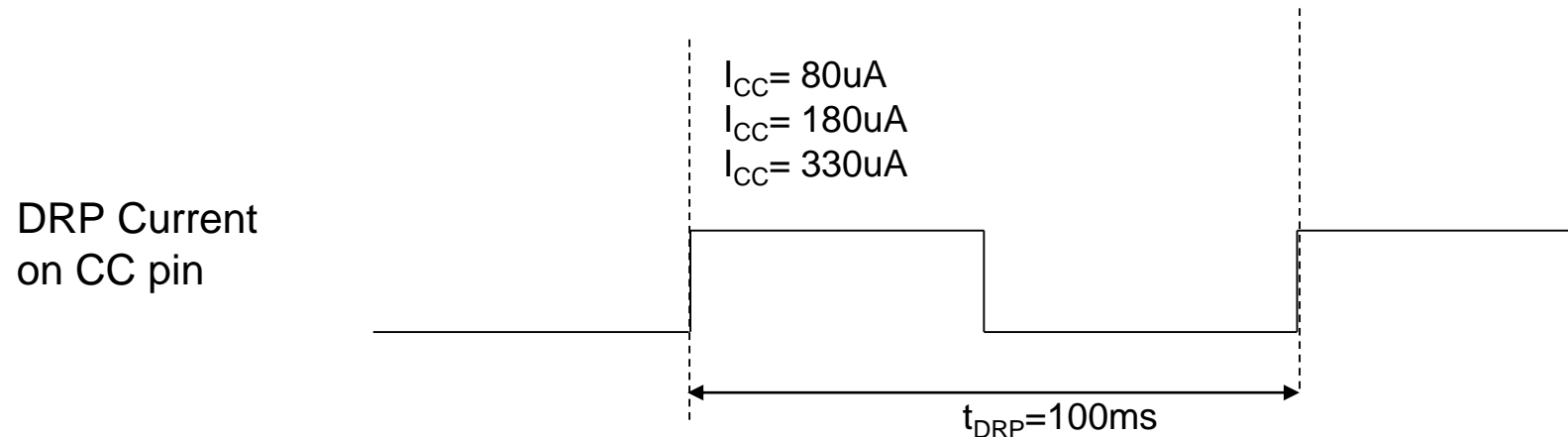
DRP CC current	Liquid in Connector	1 hour @ DRP CC current	2 hour @ DRP CC current	5 hour @ DRP CC current
$I_{CC} = 80\mu A$	78kΩ	20kΩ	1.7kΩ	0.4kΩ





Type-C Moisture Detection and Corrosion Protection with NX30P6090

- Run moisture detection by NX30P6093 periodically
 - Such as, detect the VBUS impedance every 6s by set $T_{duty}=6s$.
- When the abnormal impedance detected (detected $V_{IN} < V_{TAG}$)
 - Notify the end user in OS
 - Turn off CC logic or set CC logic to UFP mode to avoid CC pin corrosion issue
- When the connector is cleaned or fixed and detected impedance is good
 - Turn on CC logic again or set CC logic back to DRP mode





NX30P6093 – Comparison with FPF2281

	NX30P6093	FPF2281
Pin/Package	20WLCSP	12WLCSP
	1.70 x 2.16mm	1.29 x 1.99mm
Rds(on)	8.95mΩ	32mΩ
VIN Impedance Detection	Yes	No
I ² C Control	Yes	No
Short Circuit Protection	Yes	No
Max Continuous Current	8A	4.5A
Slew Rate Control for Inrush Current	Yes	No
OVP Response Time(TYP)	30ns	0.1uS
Surge Immunity	Over 100V	100V
OVP Trip Level	5.95V to 23V	5.95V/9.98V
I _Q	65μA	70μA
Input OVP	28V	28V
IEC 61000-4-2 Contact	±8kV	±8kV
IEC 61000-4-2 Air-Gap	±15kV	±15kV



NX30P6093 – Comparison with FPF2283

	NX30P6093	FPF2283	Notes
Package size	WLCSP20 1.70 x 2.16mm	WLCSP20 1.80 x 2.20mm	NX30P6093 has smaller die size and Both are P2P
Surge Protection	Yes +102V	No	Key feature for OVP and FPF2283 does not have
OVP Response time	30ns	70ns	Key feature. NX30P6093 has industry fastest OVP response time
RDSON	8.95mΩ @TYP	8mΩ @TYP	FPF2283 has a little better RDSON. Both parts are good enough for 6A operations and NX30P6093 supports up to 8A
VIN Impedance detection	Yes	Yes	According to customer, FPF2283 has ADC accuracy issue when VIN impedance detection
VIN pin discharge	Yes	?	
Slew Rate adjustable	Yes From 0.85ms to 11ms	?	NX30P6093 has turn on slew rate adjust feature for system level flexibility



NX30P6093 – Comparison with NX20P5090 & TPS25942

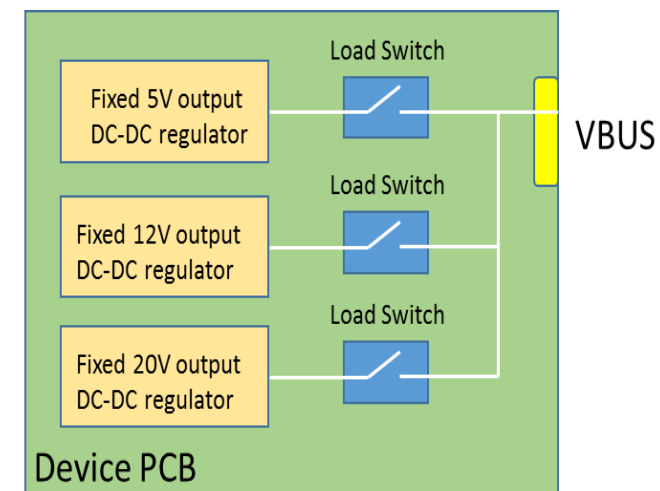
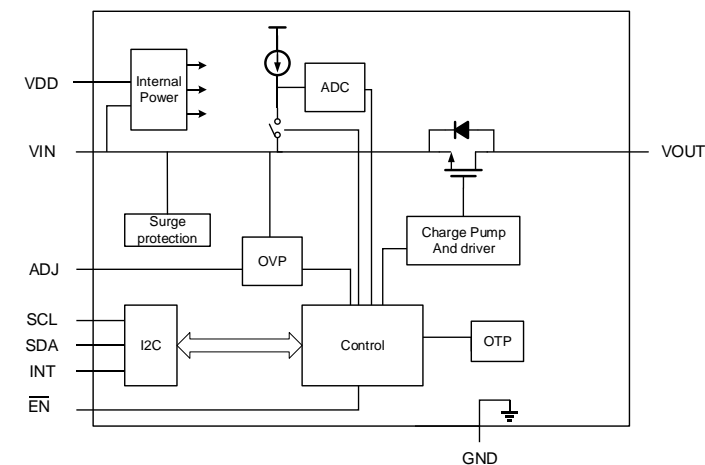
Parameter	NX30P6093	NX20P5090	TPS25942	Note
Package	WLCSP20 1.70 x 2.16mm, 0.4mm pitch	WLCSP15 1.54 x .56mm, 0.5mm pitch	WQFN20 3.00 x 4:00mm	NXP's package size is much smaller than TI
RON	9mΩ	30mΩ	42mΩ	Lower RON → better thermals
Surge Protection	Yes	Yes	NO	Need to add an external 100V PTVS diode (\$0.05).
VIN, VOUT High Voltage Tolerance	29V	29V	20V	20V can't protect downstream IC due to overvoltage tolerance.
Actual Clamping Voltage @ PTVS24VS1UTR	Below 28V	Below 28V	Over 38V	Competitor device will be damaged when surge happen due to VOUT Abs max 20V
Current Capability	8A	5A	5A	
RCP	No	Yes 40mV	Yes ??mV	
Support Multi Type-C port	No	Yes	Yes	NX30P6093 is suitable only for one Type-C connect application





NX30P6093A – Overvoltage Protection Load Switch

- Over voltage protection up to 29V on VIN
- Adjustable OVP by I²C (6V, 10V, 11.5V, 14V, 17V, 23V)
- Bi-direction and supports OTG up to 1.5A (Source Path)
- Maximum switch continuous current 6A (Sink Path)
- Integrated current source for VIN pin resistance detection
- Ultra-low RDS(ON) = 17mΩ (Typ) for high current operation
- Short circuit protection from VIN to VOUT
- Slew rate control for inrush current limit
- Input discharge path for USB PD specification
- I²C control and programmability for OVP threshold, timing control, pin resistance current source value, interrupt flag, etc.
- Surge protection: IEC61000-4-5 exceeds ±100 V on VIN without capacitor
- Protection circuitry
 - Over-Temperature Protection, Over-Voltage Protection, Under-Voltage Lockout
- ESD
 - IEC61000-4-2 contact discharge exceeds 8 kV on VIN
 - IEC61000-4-2 air discharge exceeds 15 kV on VIN
 - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 3 kV on all pins

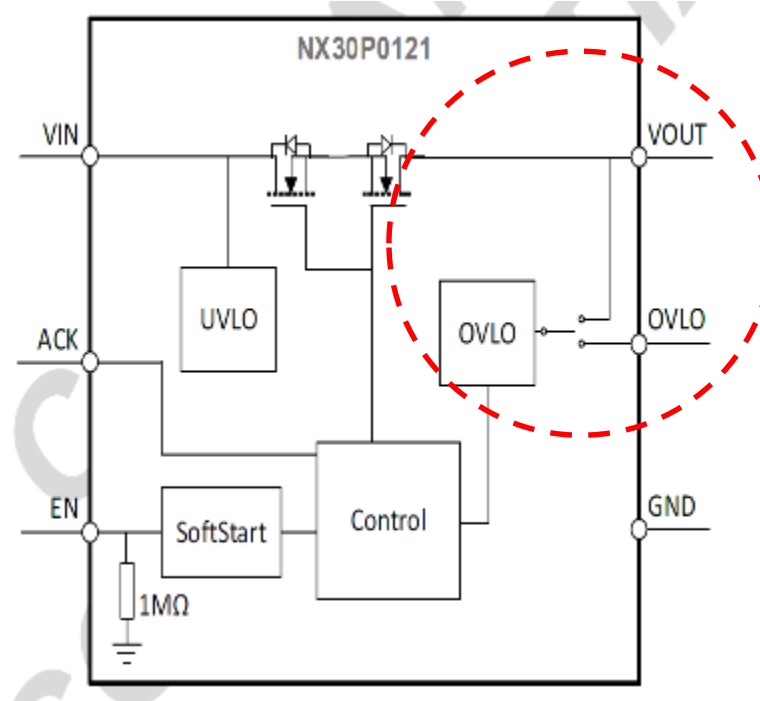




NX30P0121 – 3A Back-to-Back OVP Load Switch

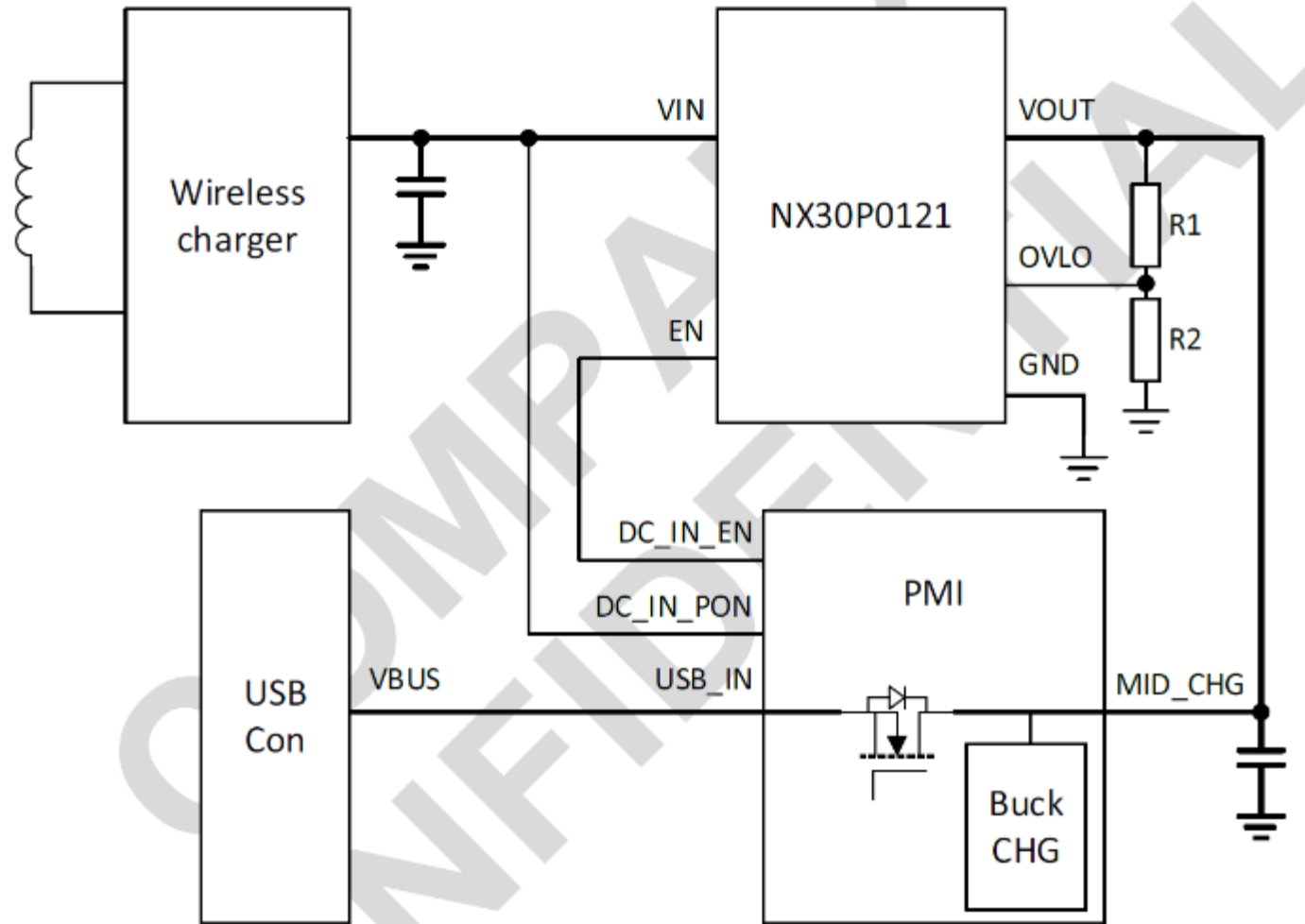
Features and Benefits:

- Wide operation voltage from 2.8V to 29V for VOUT
- 29V tolerance on both VIN and VOUT pins, break down voltage up to 35V
- **Adjustable VOUT overvoltage protection**
- On-chip back-to-back MOSFET with low RDSON <math>< 50\text{m}\Omega</math> (Typical)
- Built in slew rate control for inrush current limit
- 5ms deglitch time for VOUT pin
- FAULT condition notification to system
- Maximum switch current 3A
- Protection circuitry
 - Over-Temperature Protection
 - Under-Voltage Lockout
- ESD
 - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV on all pins





NX30P0121 – Application Use Case





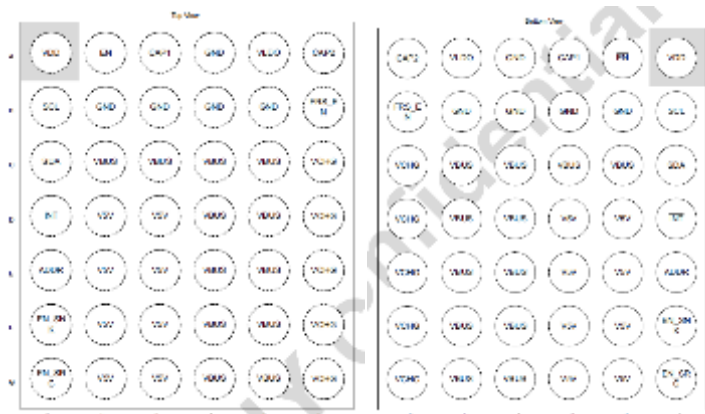
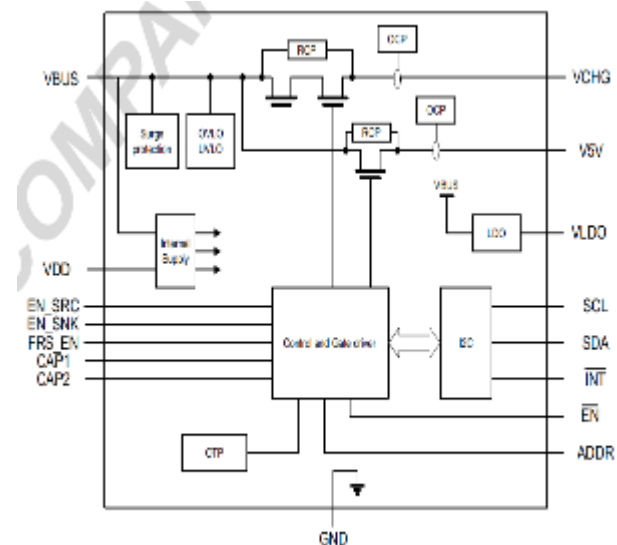
NX30P0121 Comparison

	NX30P0121	FPF2495
Package	3x4 WLCSP 1.25x1.65mm	3x3 WLCSP 1.21x1.21mm
VIN (Max)	20V	5.5V
VBUS abs max	29V	6.0V
VBUS abs max	29V	28V
Rdson	50mΩ	70mΩ
SW current	3A	2A
RCP	Yes	Yes
Current Limit	No	Yes
EN Control	Yes	Yes



NX20P3483 – Sink/Source Integrated OVP Combo Switch

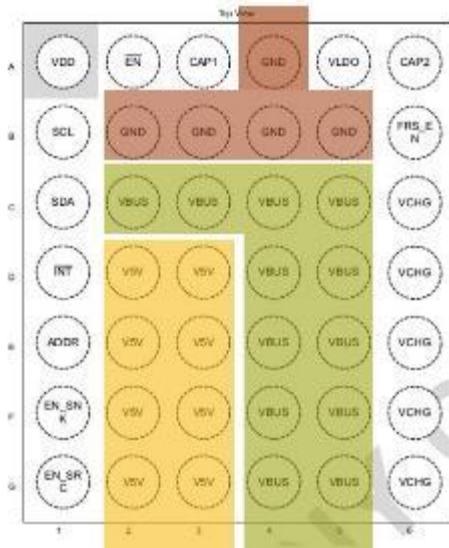
- Features & Benefits:
- Adjustable over voltage protection (OVP) on VBUS via I²C interface (6V, 10.5V, 13.9V, 17.0V, 23V)
- On-chip ultra-low RDSON
 - 18mΩ for VBUS-to-VCHG path
 - 33mΩ for V5V-to-VBUS path
- Bi-directional Operation
 - I²C-configurable current limit; From 400mA to 3.3A for V5V-to-VBUS path
 - Maximum switch current of 6A for VBUS-to-VCHG path
 - Maximum switch current of 3.3A for V5V-to-VBUS path
- 29-V Tolerance on VBUS, VCHG and CCx pins; breakdown voltage up to 35V
- Slew rate control for inrush current limit
- Supports 4 different I²C addresses on ADDR pin
- Support fast role swap and dead battery conditions
- Fast Role Swap is enabled when FRS_EN=High
- Integrated always-on LDO to supply EC or TCPM for dead battery operation
- Protection circuitry for OTP, OVP, UVLO, and RCP
- Surge protection: IEC61000-4-5 exceeds ±100 V on VBUS
- ESD Performance:
 - IEC61000-4-2 contact discharge exceeds 8 kV on VBUS
 - IEC61000-4-2 air discharge exceeds 15kV on VBUS
 - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV on all pins
- Available in WLCSP42 (2.51 x 2.91 x 0.525 mm), 0.4-mm pitch



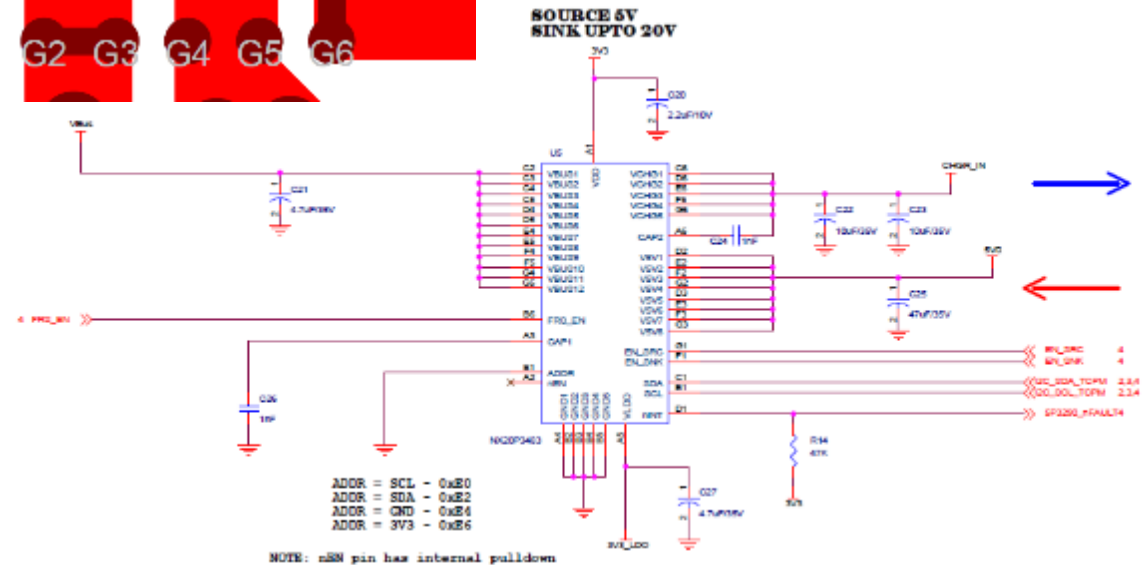


NX20P3483 – Recommended Layout for Non-HDI PCB

Layout Guideline

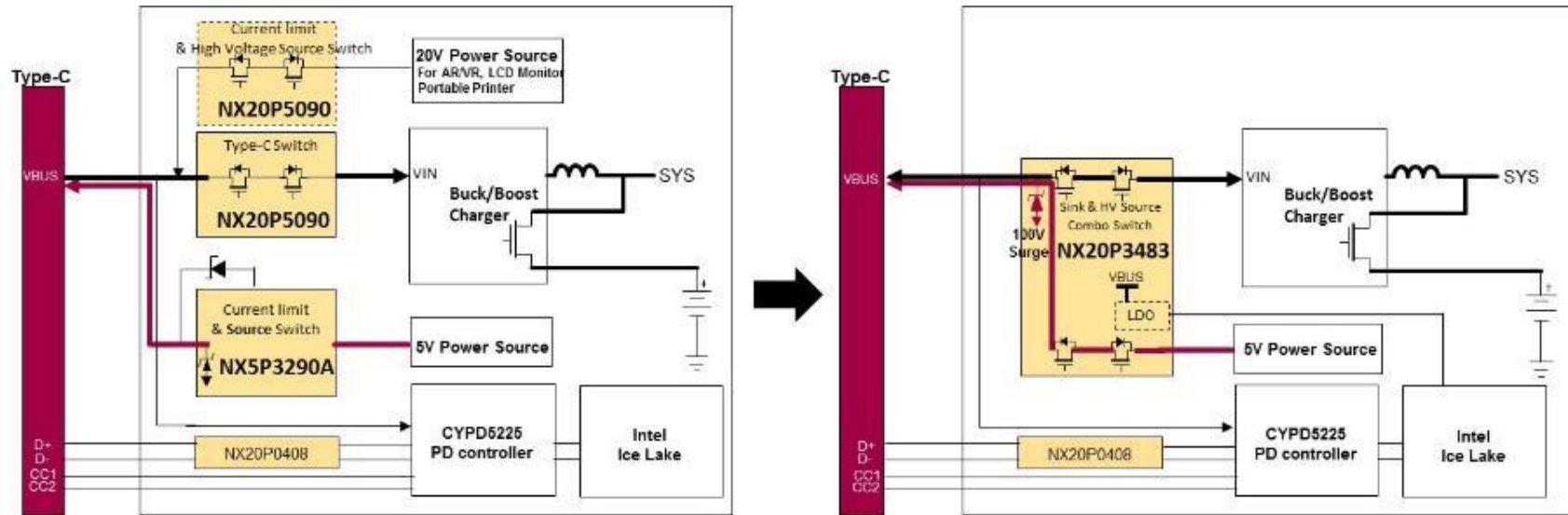


PCB Layout





USB Type-C Discrete Versus Combo Switch Comparison



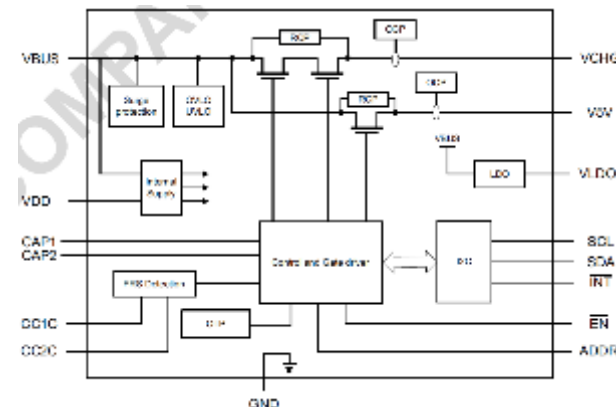
Parameter	NX20P5090 + NX5P3363	NX20P3483	NX20P3483 Advantages
IC Size	3.95 mm ² + 4.85 mm ² = 8.80 mm²	7.30 mm²	~20% Smaller Size than Discrete
Surge Protection	Yes (80V)	Yes (100V)	Higher Surge Protection
External Components	11 pcs	6 pcs	Save 5 pcs External Components
Path between VBUS and Charger VIN	Sink Path No Source Path	Sink & Source Bi-direction Path 5~20V Source Path	High Voltage Source Power w Current limit
Dead Battery Operation Mode	No	Yes	VLDO
Cost	NX20P5090 + NX5P3363 + Discrete = ~\$0.70	Over 20% lower price	~22% lower than Discrete Solution



NX20P3481 – Type-C Combo Power Switch

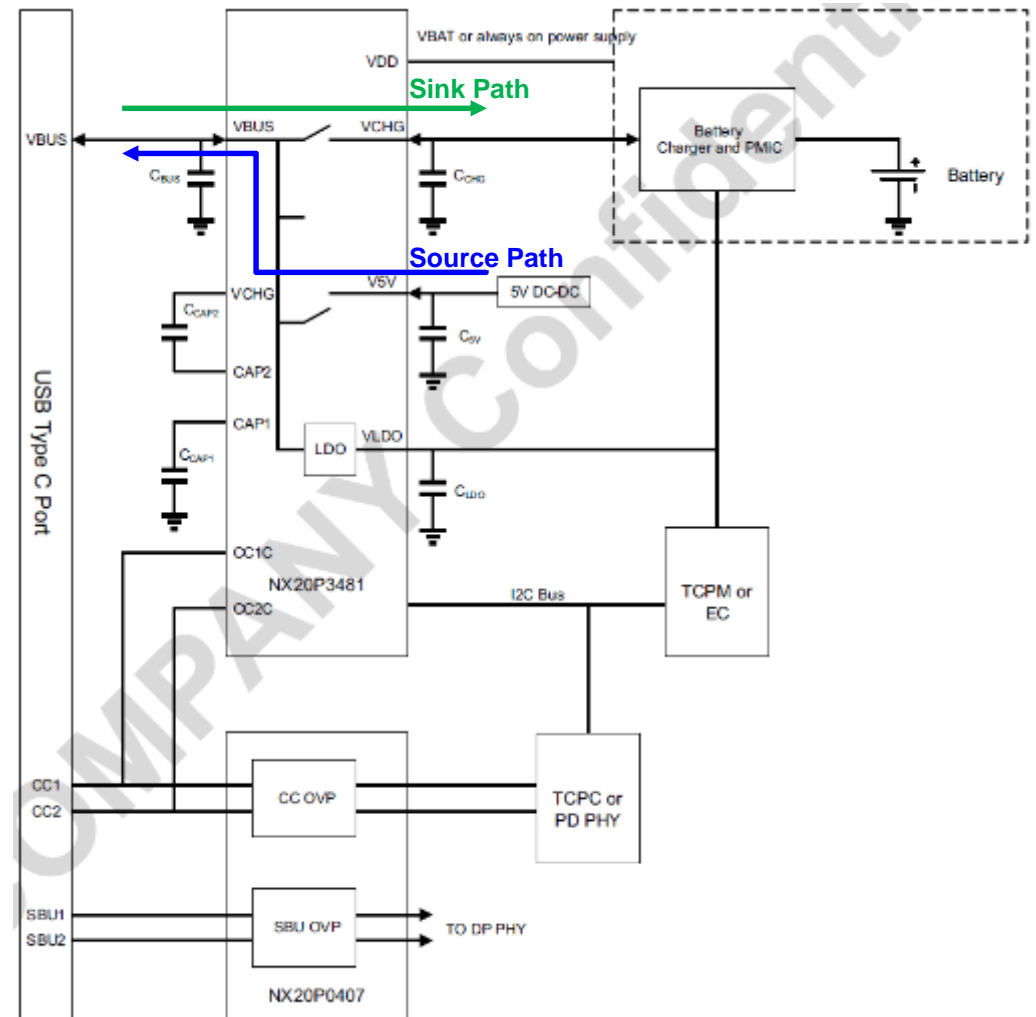
Description

- Adjustable over voltage protection (OVP) on VBUS via I²C interface (6V, 6.8V, 10V, 11.5V, 14V, 17V, 23V)
- On-chip ultra-low RDSON
 - 28mΩ for VBUS-to-VCHG path
 - 35mΩ for V5V-to-VBUS path
- Bi-directional Operation
 - I²C-Configurable current limit; From 400mA to 3.4A for V5V-to-VBUS path
 - Maximum switch current of 5A for VBUS-to-VCHG path
- 29-V Tolerance on VBUS, VCHG and CCxC pins
- Slew rate control for inrush current limit
- Supports 4 different I²C addresses on ADDR pin
- Support fast role swap and dead battery conditions
- Fast Role Swap is detected by the CC1C & CC2C pins according to the USB PD Fast Role Swap specification
- Integrated always-on LDO to supply EC or TCCPM for dead battery operation
- Protection circuitry for OTP, OVP, UVLO, and RCP
- Surge protection: IEC61000-4-5 exceeds ±100 V on VBUS
- ESD Performance:
 - IEC61000-4-2 contact discharge exceeds 8 kV on VBUS and CCxC pins
 - IEC61000-4-2 air discharge exceeds 15kV on VBUS and CCxC pins
 - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV on all pins
- Available in WLCSP42 (2.51 x 2.91 x 0.525 mm), 0.4-mm pitch



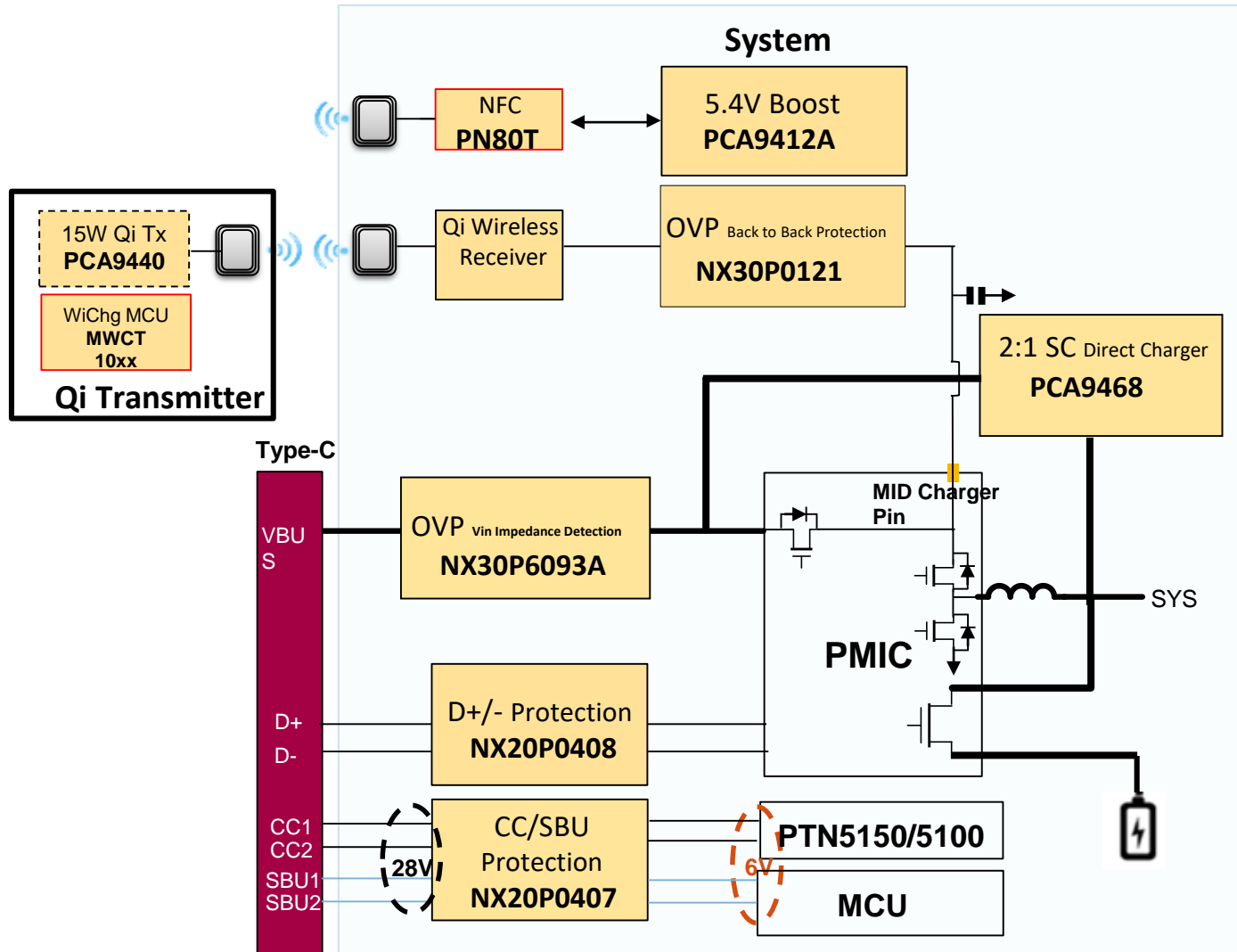
NX20P3481 – Application Block Diagram

- Dead Battery Operation
 - Regardless of the status of /EN pin, if VDD is not present, device is forced to be in dead battery operation mode.
 - In Dead Battery Mode, device closes HV Sink path to charge battery.
 - VBUS OVLO in Dead Battery Mode is fixed to 6.8V.
 - Device will only exit from Dead Battery Mode when DB_EXIT=1 (Host writes to REG 0x0B) and VDD > 2.7V.
- Fast Role Swap Mode





Application Block Diagram – Smartphone, Tablet, etc.



System

- PCA9412A
 - 5.4V DC-DC Boost for NXP NFC IC
- NX30P0121
 - 28V Back to Back OVP
 - Samples available now
- PCA9468
 - 2:1 Switched Cap Direct Charger
- NX30P6093/6093A(OTG support)
 - 28V OVP with Moisture & Dust Detection
- NX20P0407/0408(Only D+/- protection)
 - CC & SBU or CC & D+/- Protection

Qi Transmitter

- PCA9440
 - 15W Qi (Half-Bridge) Transmitter
 - Samples available now



PORT PROTECTION



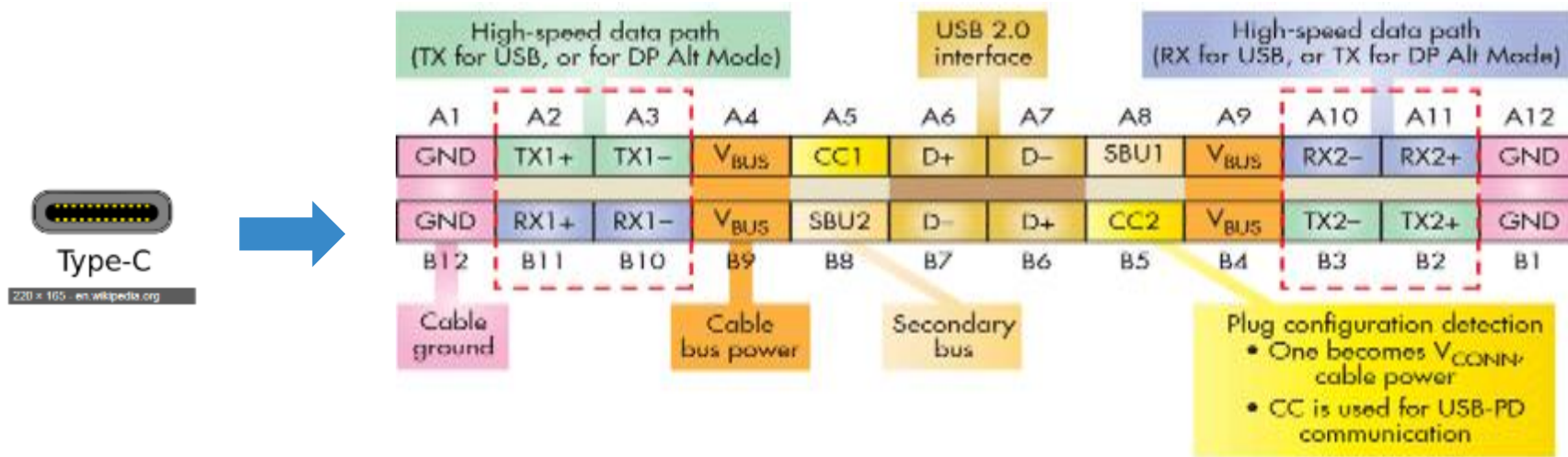
NX20P0407 Introduction

• Description

- USB Type-C CC&SBU or CC&D+/- Protector
- Short-to-VBUS (28 VDC) Overvoltage Tolerant and IEC ESD Protection

• Justification

- Since the release of the USB Type-C connector, many products and accessories for USB Type-C have been released which do not meet the USB Type-C specification.
- One example is the mechanical twisting and sliding of the connector that could short pins due to the close proximity in the small connector. This can cause 20-VBUS to be shorted to the CC and SBU pins in the Type-C connector.
- Further, there is a heightened concern that debris and moisture will cause the 20V VBUS pin to be shorted to the CC and SBU pins.
- NX20P0407 will protect downstream components for high voltage damage.

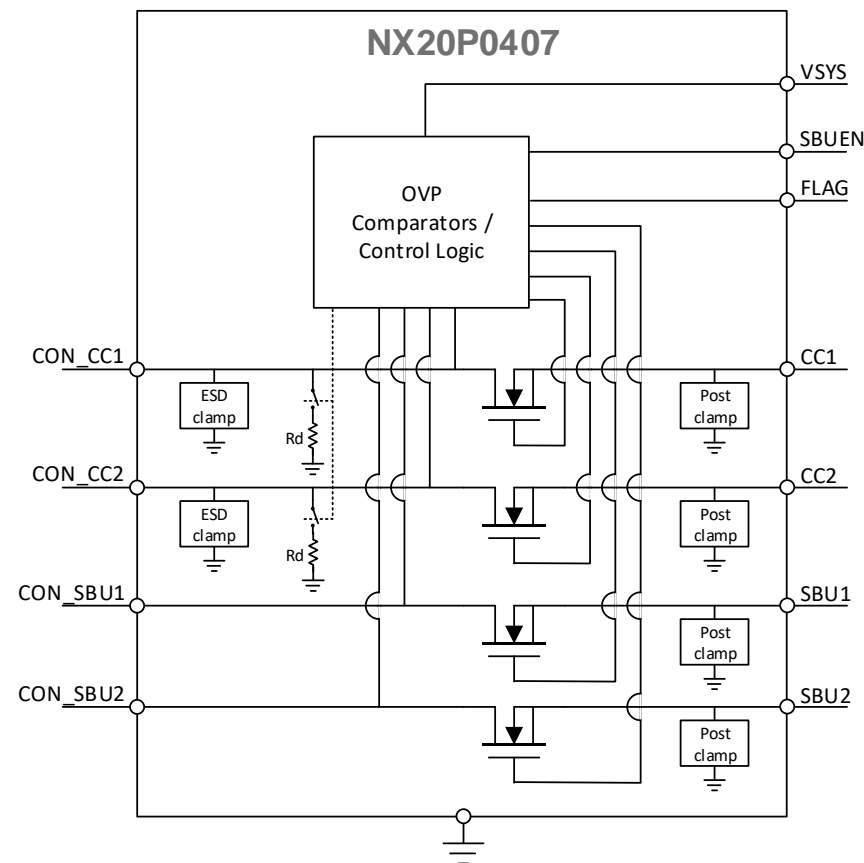




NX20P0407 – CC/SBU or CC/D+/D- Protection in Type-C

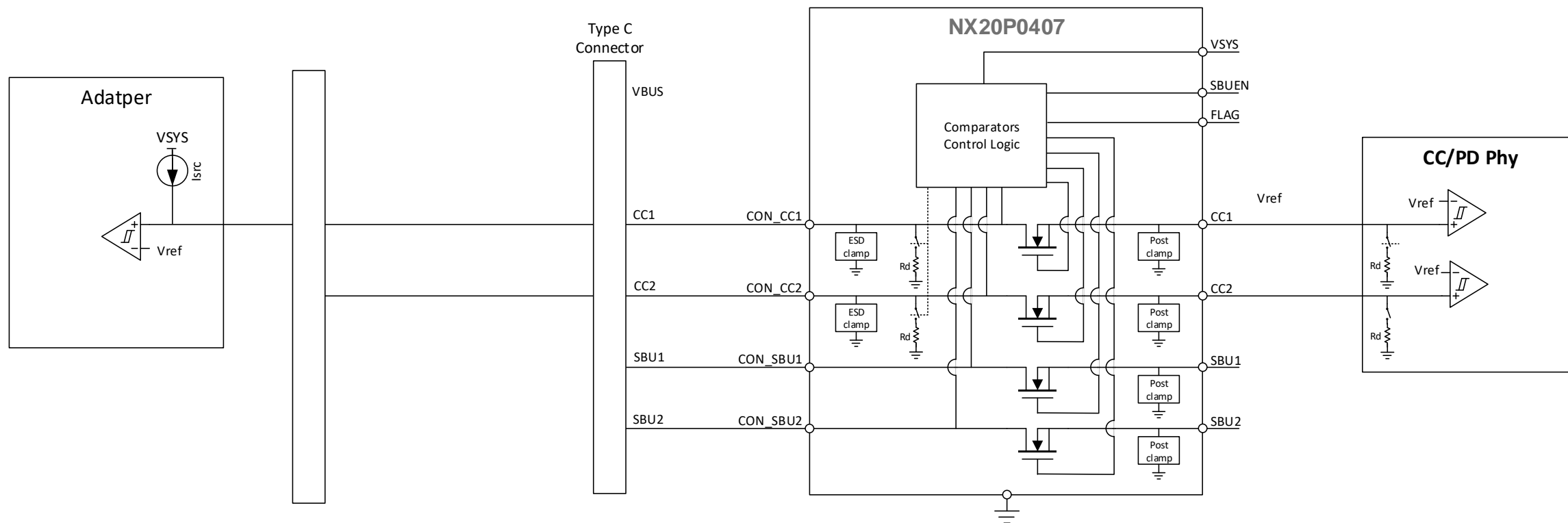
Features and Benefits

- USB Type-C CC and SBU (or D+/-) short protection to VBUS
 - CON_CC1 / CON_CC2 : +28VDC
 - CON_SBU1 / CON_SBU2 : +28VDC
- Rd circuit in CON_CC1/CON_CC2 for dead battery
- Low R_{dson} switch
 - CC switch : 170mΩ
 - SBU switch : 4Ω
- Robust ESD immunity for CON_CC1/2
 - IEC 61000-4-2 Contact discharge: 8KV
 - IEC 61000-4-2 Air discharge: 15KV
- ±34V surge protection on CON_CC1/2
- High speed Bandwidth of SBU switch: 1GHz (capable of USB HS signals)
- Low battery leakage current: 20μA
- CC1/2 leakage current: < 1μA
- Fast OVP turn-off time: 60ns for CC, 45ns for SBU
- 1.27 x 1.67 mm 12 WLCSP with 0.4 mm pitch



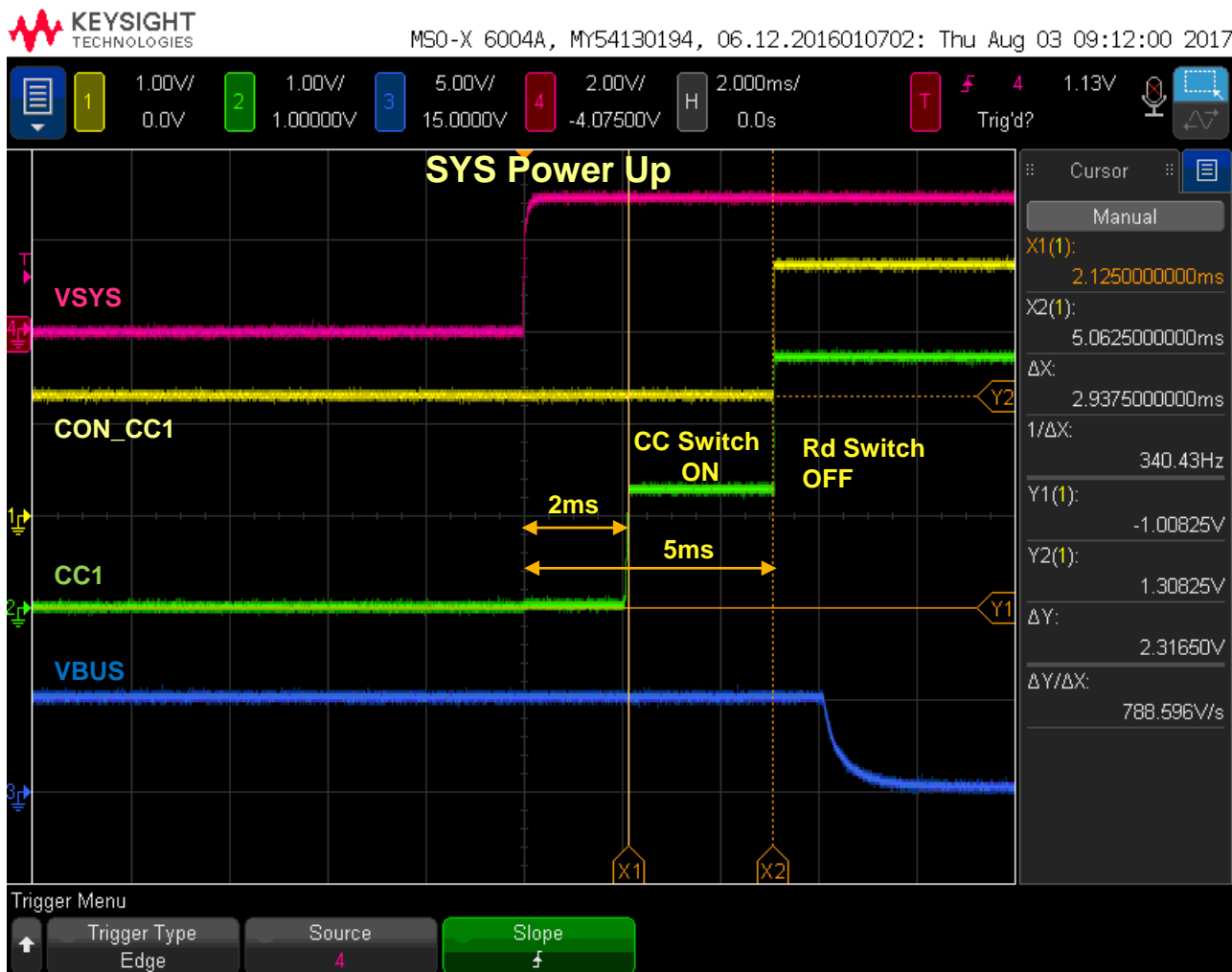


System Diagram





NX20P0407 Dead Battery Behaviour (Stand-Alone)



NX20P0407 Test without CC/PD PHY

1. Rd is connected when VSYS < UVLO (Dead Battery condition)
2. CC switch is turned ON in 2ms after VSYS exceed UVLO
3. Rd switch is disconnected in 3ms after CC switch is ON

→ There is 3ms overlap time between Rd and CC switch ON to secure Rd connection.



NX20P0407 Dead Battery Behaviour (In System)



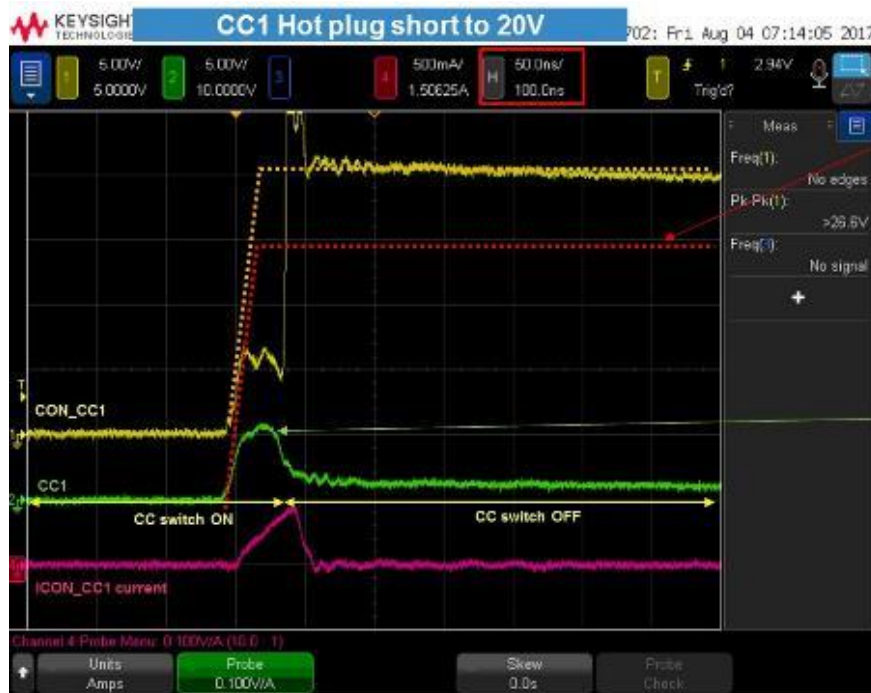


NX20P0407 – Comparison Table

		NX20P0407UK	FUSB252UMX	TPD6S300	Comments
Package		4x3 WLCSP	16-pin UMLP	20-pin QFN	
Size		1.67 x 1.27 mm	2.6 x 1.8 mm	3.0 x 3.0 mm	Smallest package size
SW Config		4CH (CC & D+/- or SBU)	2CH CC / Dual SPDT	4CH (CC & D+/- or SBU)	
CC	ABS max	28V	24V	24V	Higher Rating voltage
	Ron	250mΩ	350mΩ	392mΩ	
	IVCONN	1.20A	1.25A	600mA	
	OVP res	60ns	500ns	70ns	Competitor has slow response. High VBUS can be passed without post clamp.
	Post Clamp	Yes	No	Yes	
	Rd	Yes	Yes	Yes	
	ESD	IEC (15KV / 8KV)	IEC (15KV / 8KV)	IEC (15KV / 8KV)	
SBU / USB SW	ABS max	28V	16V	24V	16V is not suitable to protect VBUS 20V
	OVP res	45ns	500ns	70ns	Competitor has slow response. High VBUS can be passed without post clamp.
	Post Clamp	Yes	No	Yes	
	Ron/Con	4Ω / 6pF	5Ω / 4pF	4Ω / 6pF	Ron/Con combination limit bandwidth
	BW	1.5GHz	1.4GHz	1GHz	



NX20P0407 Benefits – CC/SBU OVP Behaviour



Competitor

: OVP response time = 0.5us typ
No post-clamp circuit.

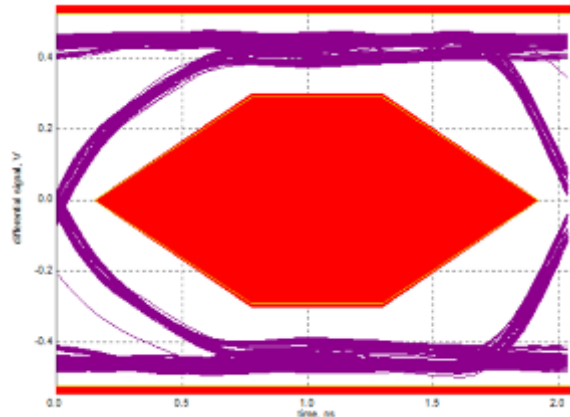
The VBUS voltage can be passed for 0.5us, it cause CC/PD IC damage.

NX20P0407

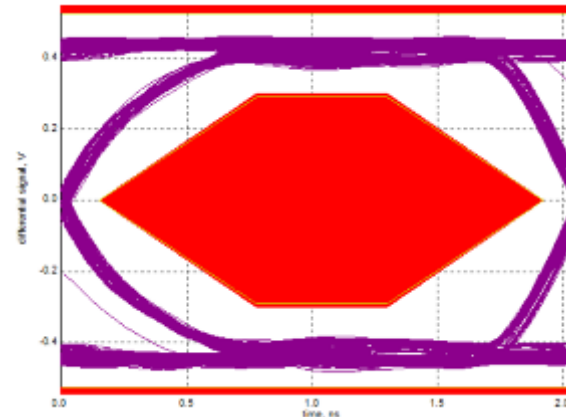
: OVP response time = 50ns typ.
CC Clamp at 6.1 due to Post-clamp

VBUS is clamped by post clamp circuit, SW is turned off in 50ns. CC/PD IC is well protected

Eye Diagram Without NX20P0407



Eye Diagram With NX20P0407



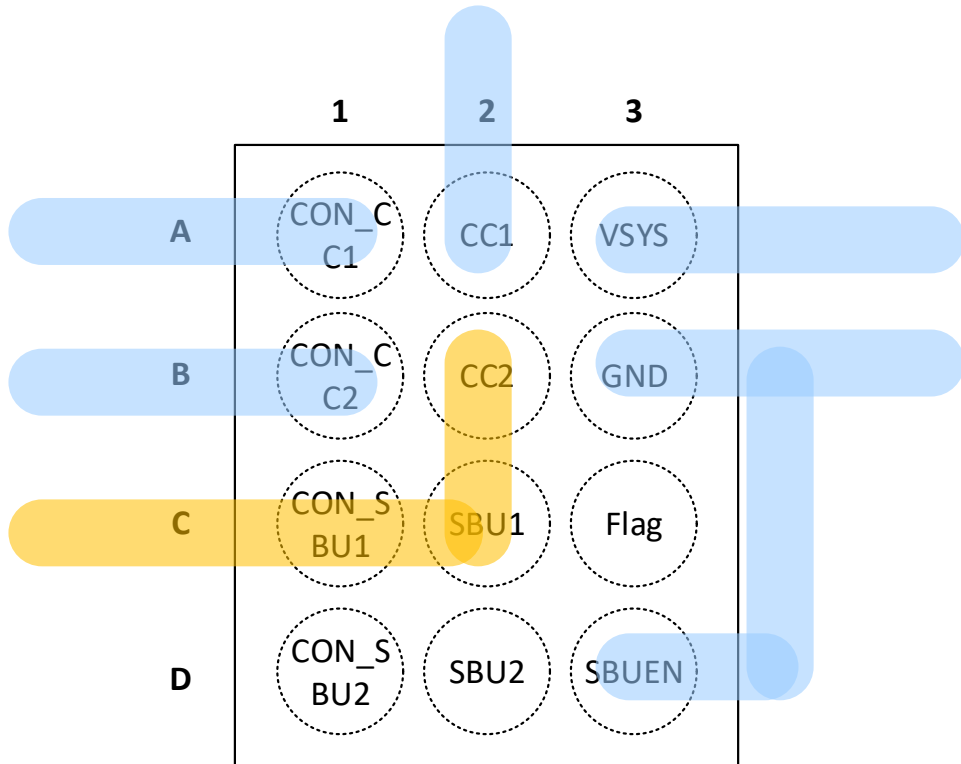


Competitor's Dead Battery Behaviour Without Make-Before-Break Switching Action

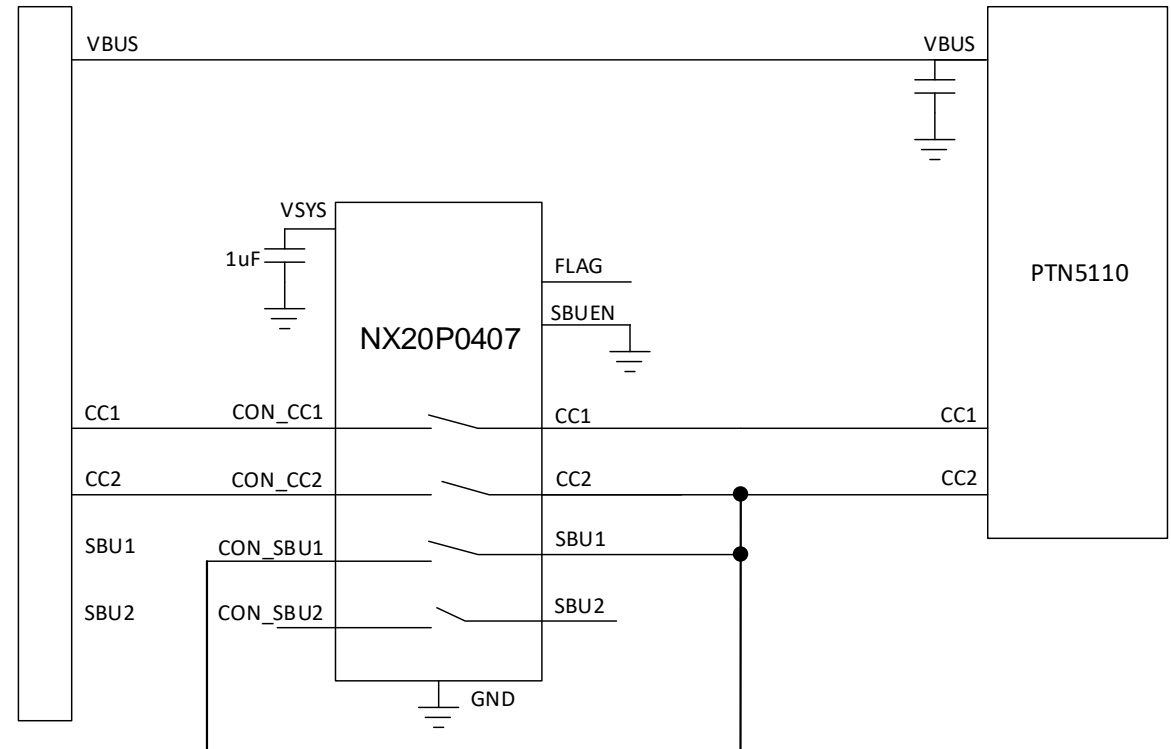




NX20P0407: Layout for Non-HDI PCB



Type C Connector

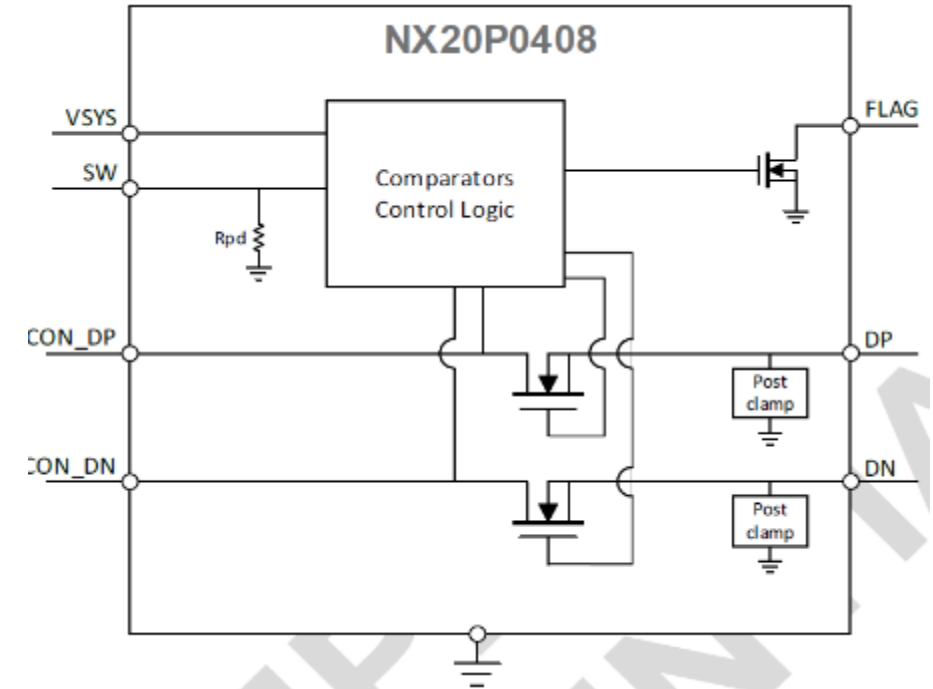




NX20P0408 – USB Type-C D+/D- Protection

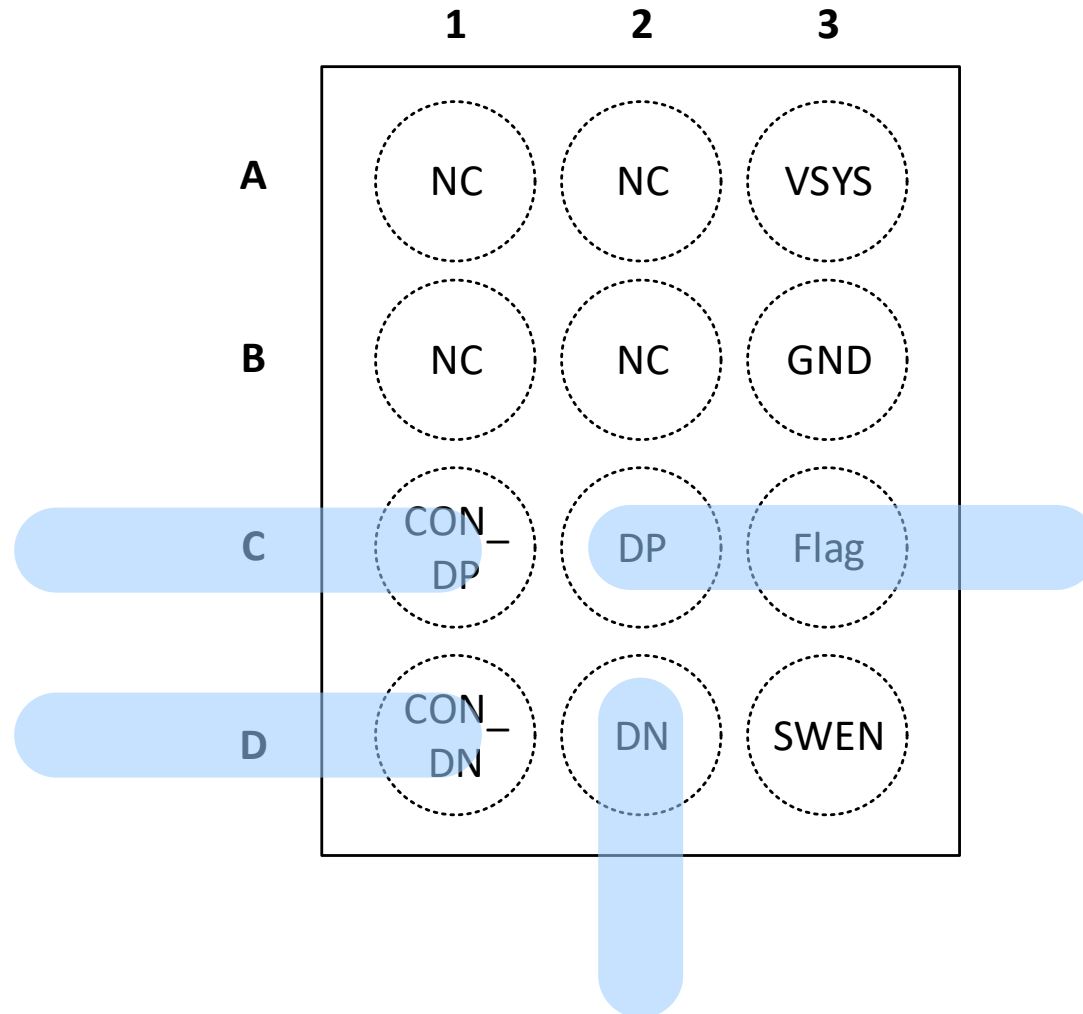
Features and Benefits

- USB Type-C DP & DN short protection to VBUS
 - CON_DP / CON_DN: +28VDC
- High speed Bandwidth: 1.5GHz (capable of USB HS signals)
- Low Rdson switch
 - DP & DN Switch: 4Ω
- 35V Surge protection on CON_DP / CON_DN
- Fast OVP turn-off time: 60ns
- 1.27 x 1.67 mm 12 WLCSP with 0.4 mm pitch





NX20P0408 – Recommended Routing for Non-HDI PCB





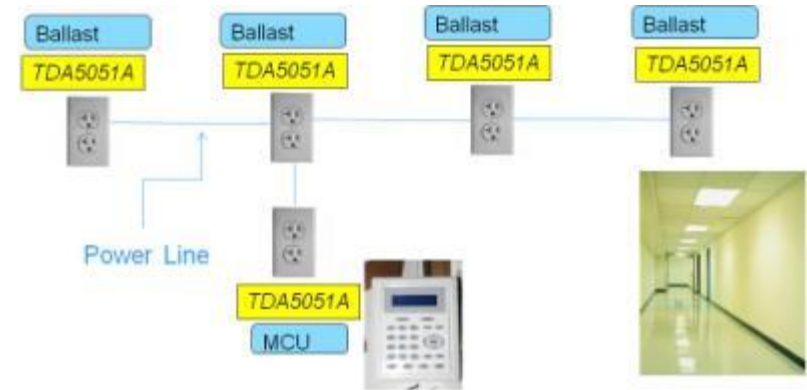
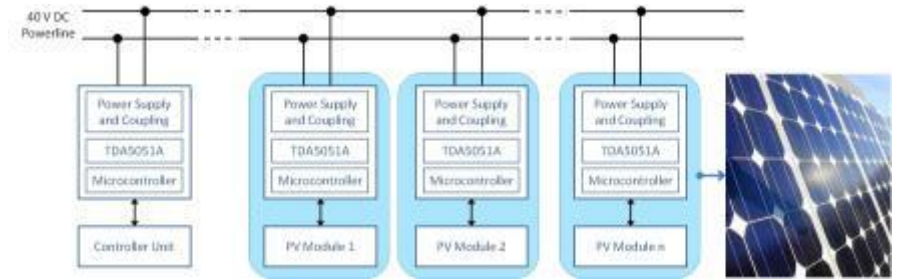
POWER LINE MODEM





Power Line Modem Value Proposition

- **Why used?**
 - Enables two-way communication between smart meters and appliances, for building automation
 - Allow smart meters to track utilization by individual components
- **Where used?**
 - Smart Energy Systems
 - Solar Panel Systems
 - Remote Diagnostics & Control
 - Building Automation
 - HVAC Systems
 - Home appliance control (air conditioning, shutters, lighting, alarms, etc.)
 - Building security systems
 - Intelligent power receptacles
 - Energy (heating and cooling) control
- **Why NXP PLC Modem?**
 - Design requires few external components for low cost applications
 - NXP software support (LPC1114 M0 Cortex MCU)
 - Robust solution with zero-crossing detection and redundancy protocol



<http://www.theenergydetective.com/>





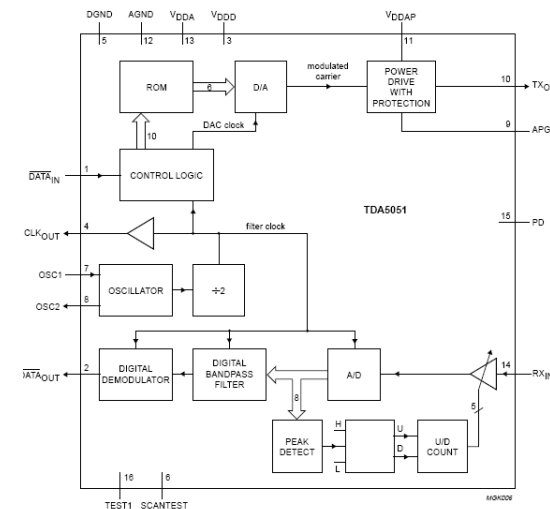
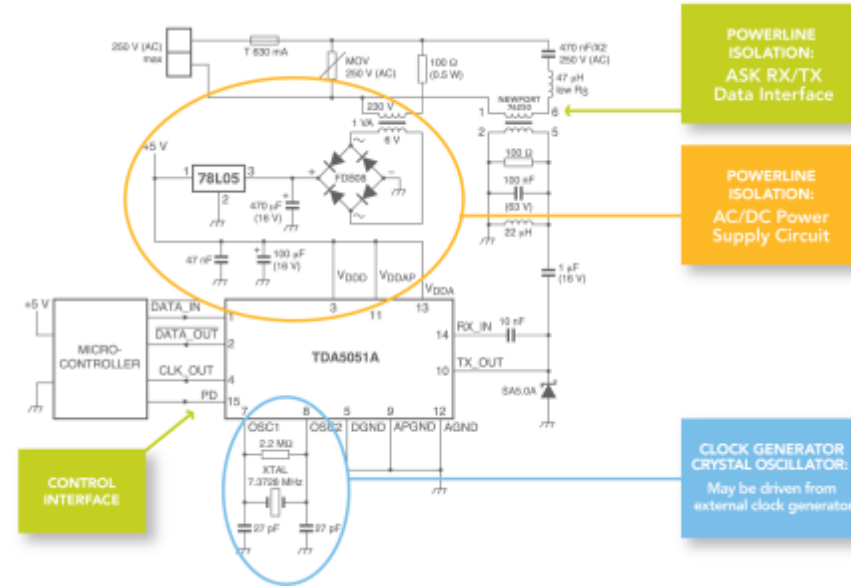
TDA5051A: PLC Modem Application

• Features

- Full digital carrier generation and shaping
- Modulation/demodulation frequency set by clock adjustment, from microcontroller or on-chip oscillator
- High clock rate of 6-bit D/A converter for rejection of aliasing components
- Fully integrated output power stage with overload protection
- Automatic gain control at receiver input
- 8-bit A/D and narrow digital filtering
- Digital demodulation delivering baseband data
- Easy compliance with EN50065-1 with simple coupling network
- Few external components for low cost applications
- SO16 plastic package
- Application Note (AN10903) available

• Applications

- ASK (Amplitude Shift Keying) data transmission using existing power network (up to 3,000 feet)
- May be used with a galvanic isolated power transformer (but not through a multi-phase transformer)
- May be used to transmit data over an AC or DC power line



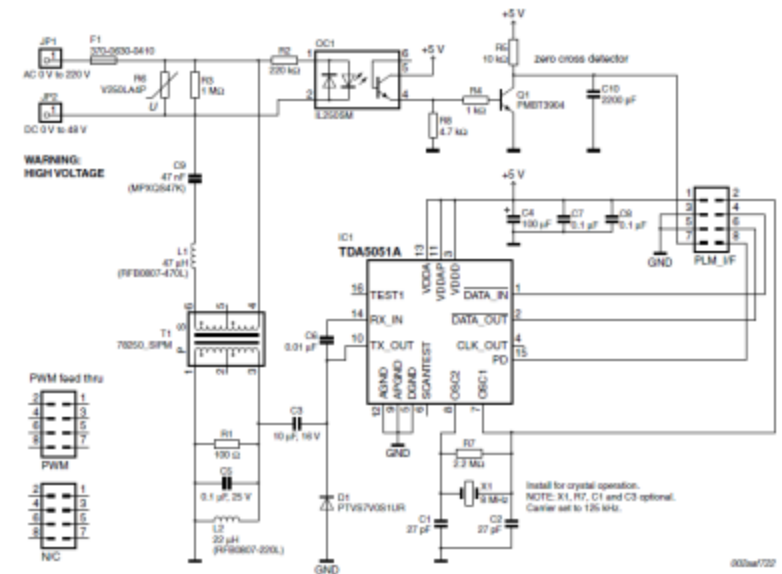
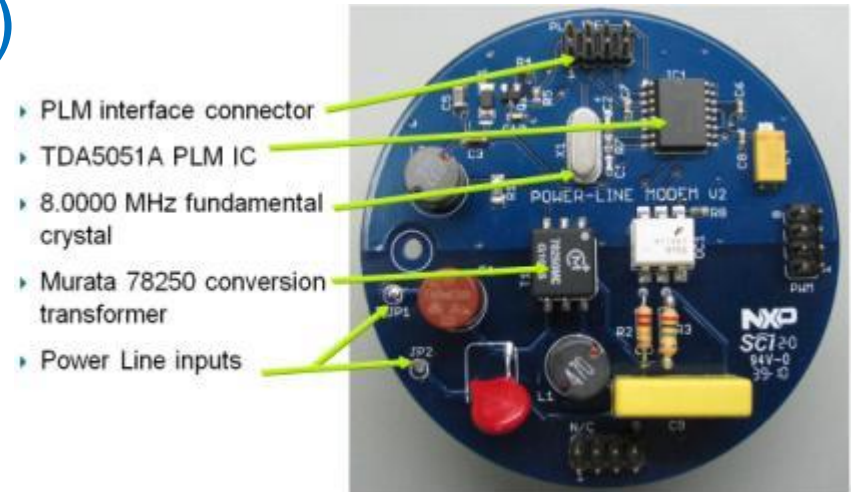
NRND





TDA5051A: Demonstration Kit (OM13313)

- A demo kit consists of two demo boards with AC power cords attached
- Evaluation board can be used for a 230-V (AC 50 Hz), a 120 V (AC 60 Hz), or a 0-V to 48-V DC mains power line
- If a galvanic isolated power transformer is used, it should be placed between the AC power line and the PLM evaluation board
- Select a power line plug/cable depending on power line supply voltage and safety enclosure used in test bench setup
- A user manual [UM10422](#) is provided



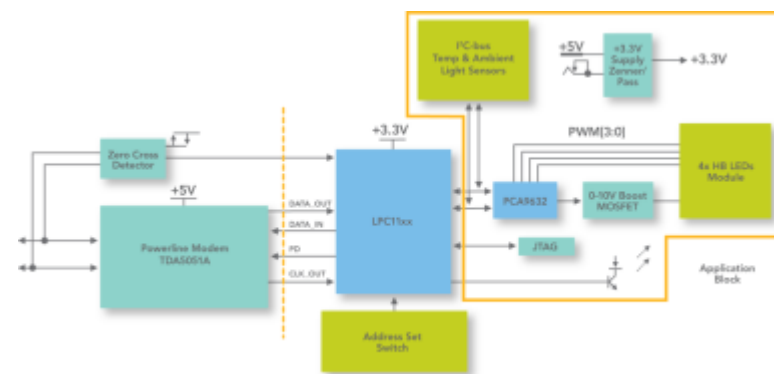
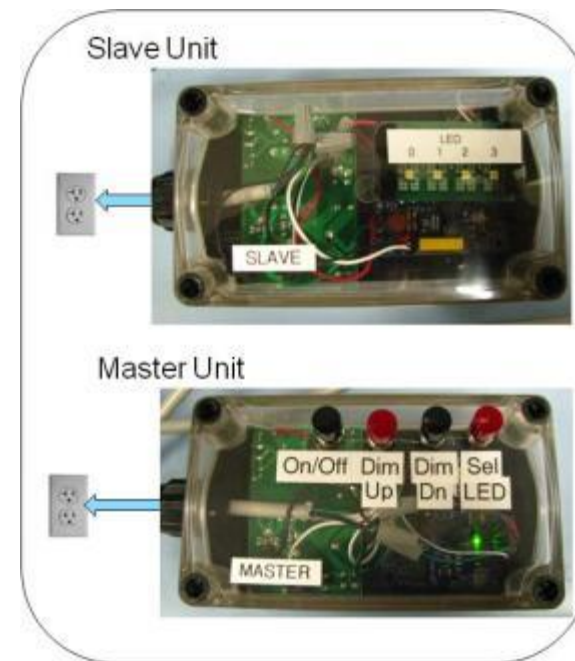
Available on eDemoboard





TDA5051A: Master/Slave Lighting Demo Kit (OM13314)

- A demo kit consists of two demonstration units with AC power cords attached
 - Master unit has 4 switches to select all four LEDs or individual LED on the slave unit, and to turn on/off or adjust brightness of selected LED(s)
 - Slave unit that drives LEDs
- Evaluation board can be used for a 230-V (AC 50 Hz), a 120 V (AC 60 Hz), or a 0-V to 48-V DC mains power line
- If a galvanic isolated power transformer is used, it should be placed between the AC power line and the PLM evaluation board
- Select a power line plug/cable depending on power line supply voltage and safety enclosure used in test bench setup
- A user manual [UM10495](#) is provided
- Sample software will be included



Available on eDemoboard

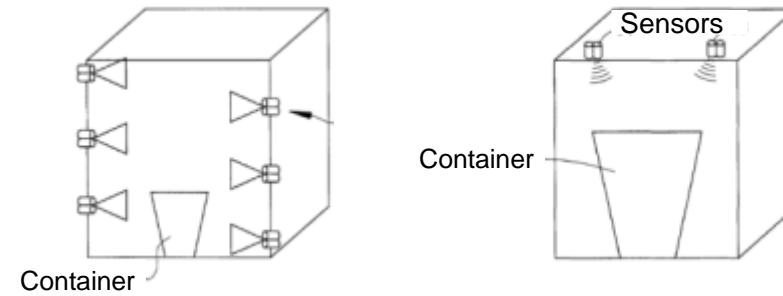


RF/IF

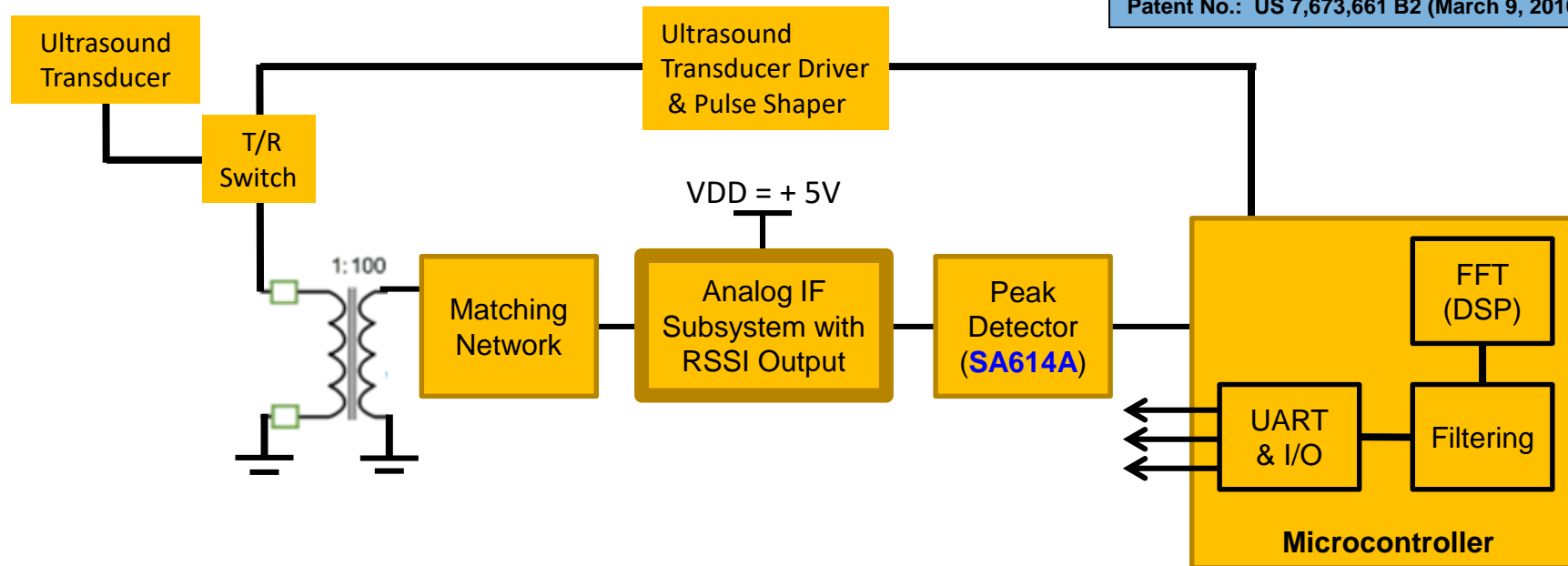


RF Solution for Detecting Water Level

- Auto-refill water dispenser consists of ultrasound transducer, peak detector and microcontroller
- The system is switched between transducer transmit and receiver mode with a T/R Switch
- The Analog IF Subsystem consists of high gain limiting IF amplifiers and a high dynamic range RSSI amplifier that drives the peak detector



Patent No.: US 7,673,661 B2 (March 9, 2010)

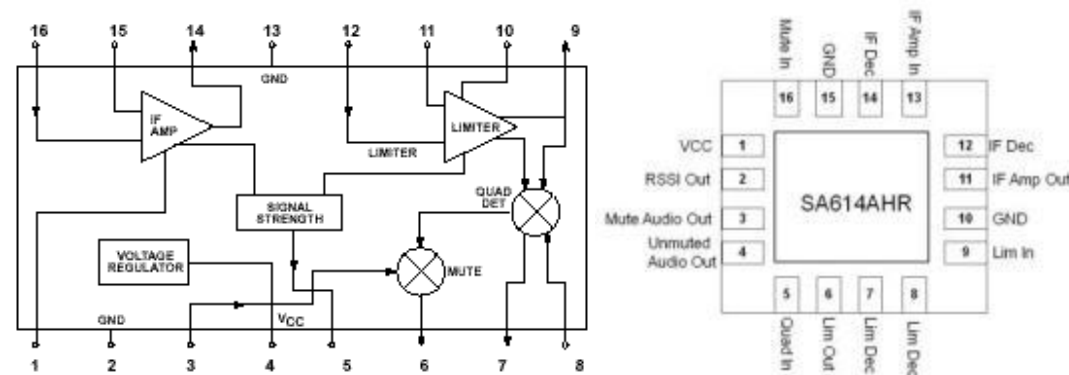




SA614A: Low-Voltage FM Subsystem

- IF amp, Limiter amp, RSSI and Quadrature Detector, and muted and unmuted audio output
- Supply voltage range from 4.5V to 8.0V
- Supply current of 3.3mA (typical)
- IF BW = 28 MHz
- SO16 Package
- SA614AHR is SA614AD die in 3mm x 3mm x 0.5mm 16-pin HXQFN package
- Support documents:
 - AN199: Designing with SA604A
 - AN1993: High Sensitivity Applications of Low-Power RF/IF Integrated Circuits
 - AN1991: Audio Decibel Level Detector with Meter Driver

Parameter	Min	Typ	Max
AM Rejection (dB)	25	33	
THD (dB)		-30	-42
S/N (dB)		68	
RSSI @ IF in = -118dBm	0mV	160mV	800mV
-68dBm	1.7V	2.5V	3.3V
-18dBm	3.6V	4.8V	5.8V
RSSI Range (dB)		80	
RSSI Accuracy (dB)		±2.0	





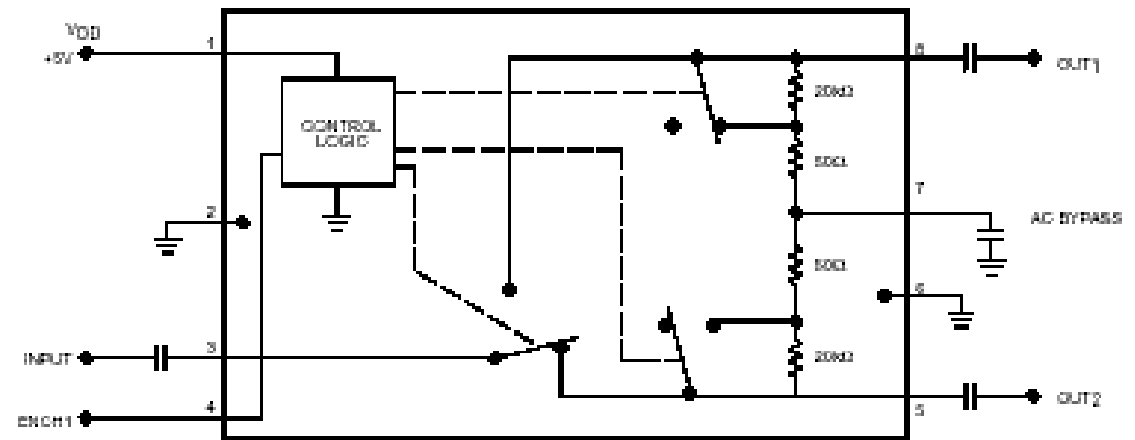
Low-Voltage Single-Pole Double-Throw (SPDT) Switch

- **Features:**

- SA630D/01 is available in SO8 and CSP8 Packages
- Wideband (DC to 1GHz)
- Low Through-loss (1 dB typ at 200MHz)
- Excellent Overload Capability (+18dBm at 300MHz)
- Low DC Power (170mA at 5V)
- Fast Switching (20ns typ)
- Good Isolation (off channel isolation 60dB at 100MHz)
- Low Distortion (IP3 intercept +33dBm)
- Good 50 ohm match (18dB return loss at 400MHz)
- Bidirectional Operational

- **Applications:**

- Digital transceiver front-end switch
- Antenna switch
- Filter selector
- Video switch
- FSK transmitter





SUPPORT TOOLS





I²C Fm+ Development Kit ([OM13320](#))

Fm+ Development Board Kit OM13320



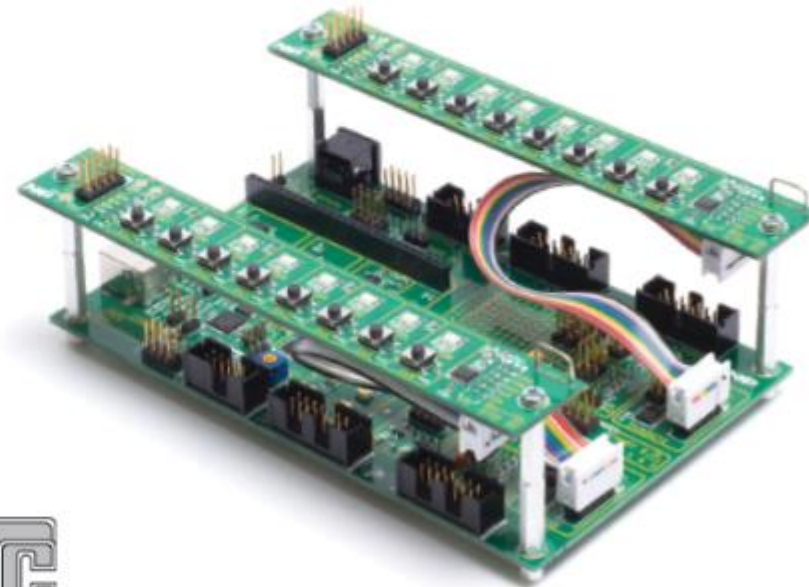
- Explore the I2C-Bus
- Run demonstrations of NXP's I2C Fm+ Slaves and Bus Controllers
- Develop I2C Hardware
- Expand this kit with add-on I2C Daughter Cards

BOX CONTENTS:

OM13260 Fm+ Development Board

Plus

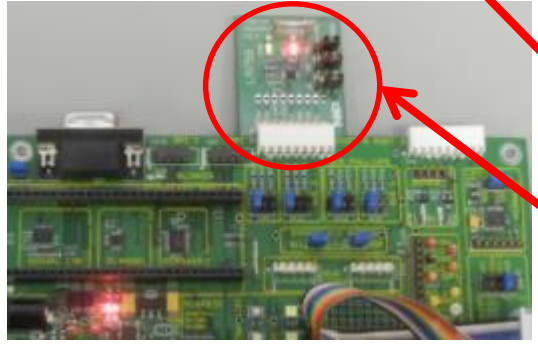
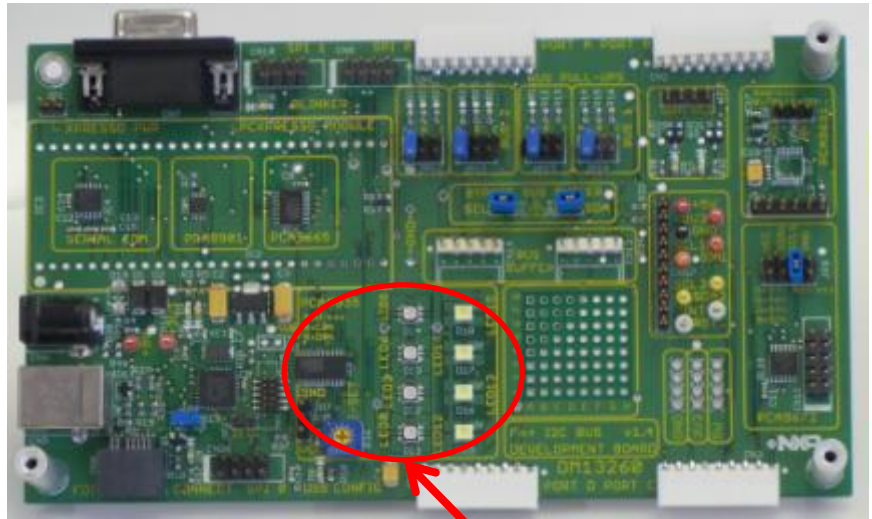
- OM13303 GPIO Target BRD (x2)
- OM13398 PCA9617A Bus Buffer Demo Board
- OM13399 Bridge Board
- Cables and Mounting Hardware





I²C Fm+ Development Kit (OM13320)

- Modular evaluation board for I²C-bus Fast-mode plus (Fm+) devices
- Easy experimentation and training board
- Used to develop software and evaluate device performance
 - GPIO Expander
 - LED Controller
 - Bus Buffer
 - Bus Controller
 - Temperature Sensor
 - Stepper Motor Controller
- USB connection for direct control of peripheral devices with GUI
- Standalone processor for developing code to control peripheral devices
- Used in conjunction with associated daughter cards for GPIO Expanders, LED Controllers, Temperature Sensors, Bus Buffers, etc.



PCA9955 Circuitry

Example Daughter Card





**SECURE CONNECTIONS
FOR A SMARTER WORLD**