

# NXP USB Type-C End-End Solutions

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June 2018 | AMF-SMC-T3159



SECURE CONNECTIONS  
FOR A SMARTER WORLD

# Agenda

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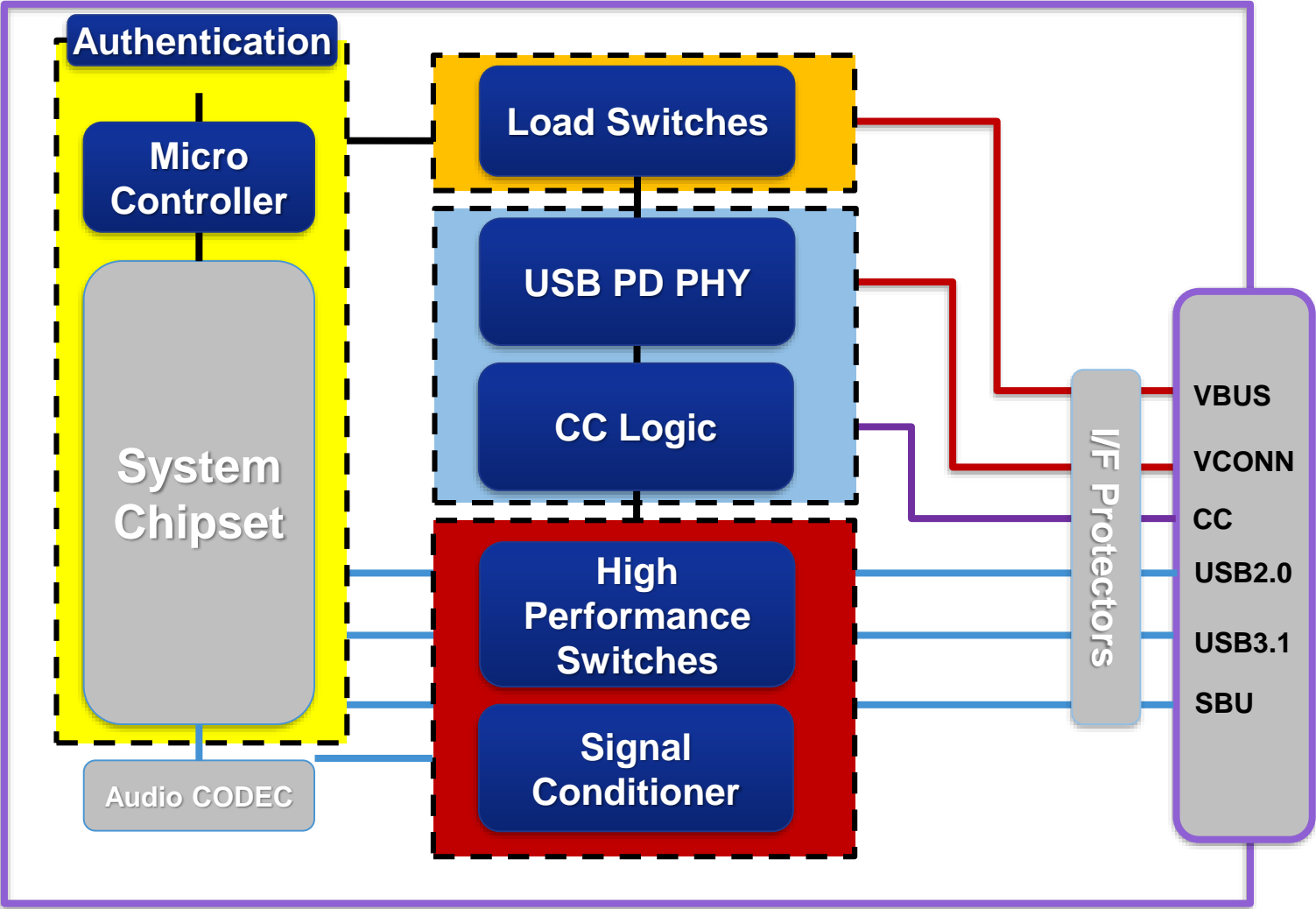
- NXP End to End Solution for USB Type-C
- NXP USB Type-C Shield Board & MCUXpresso
- Evolution and Advantage of TCPC Architecture
- NPI: PTN36502 USB & Display Port Combo Redriver
- Type-C power path management – Load switch solutions
- Type-C programmable charging solution

# End-End Type-C System Solution

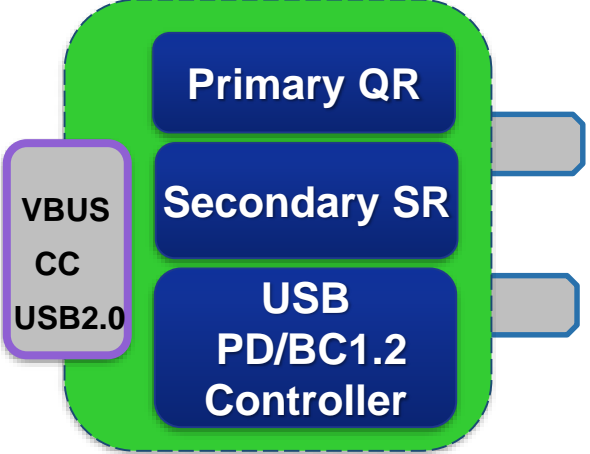


# NXP End-to-End Solution for USB Type-C Connector

## System Solution



## Power Solution

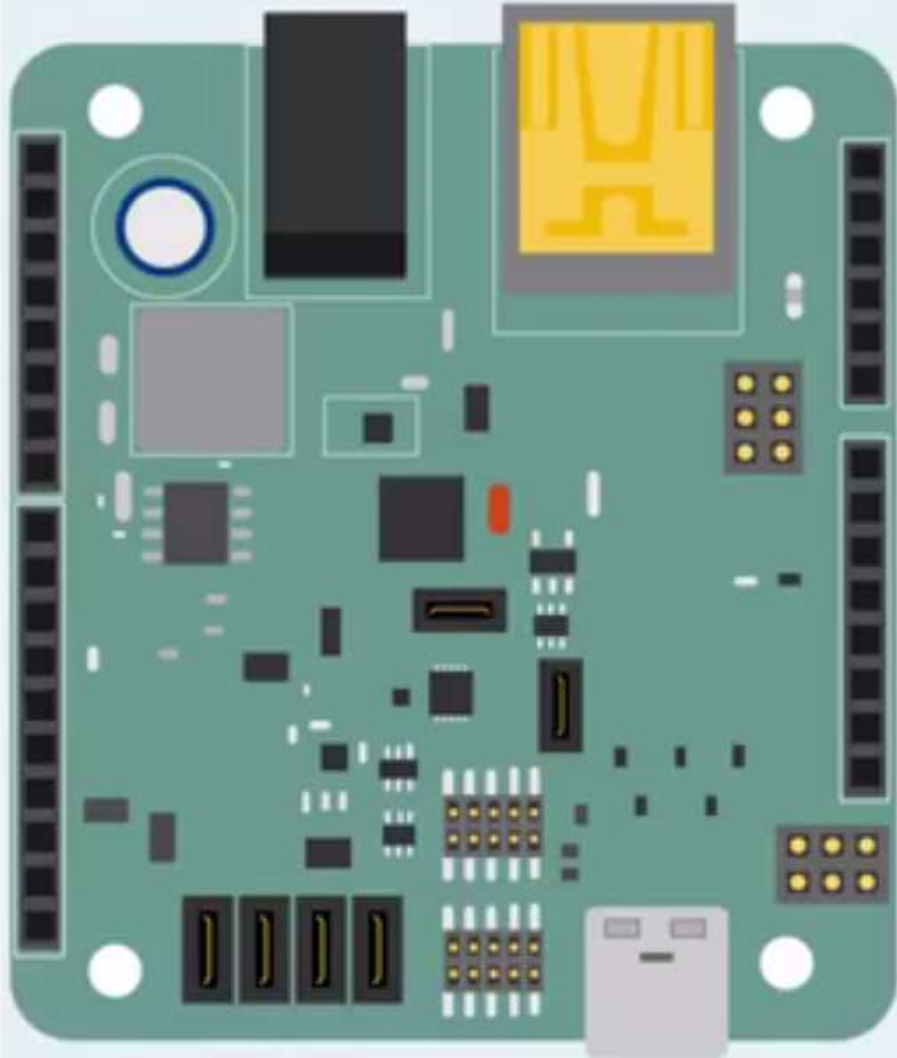


**Legendary**

- NXP Products**
- System Control** (Yellow dashed box)
- Fault Protection** (Orange dashed box)
- Detection and Communication** (Blue dashed box)
- Signal Routing and Integrity** (Red dashed box)
- AC/DC Power Solution** (Green dashed box)

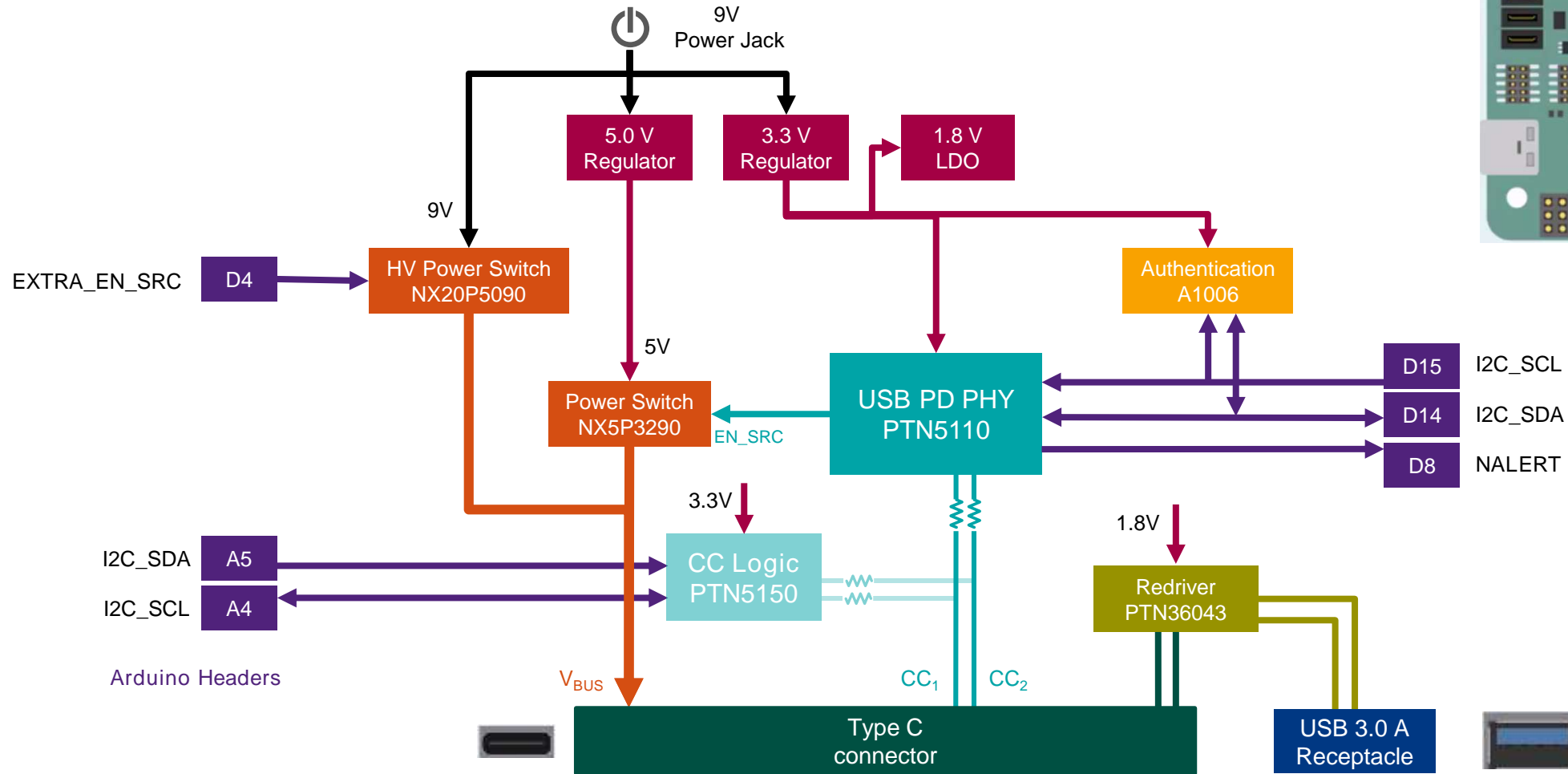
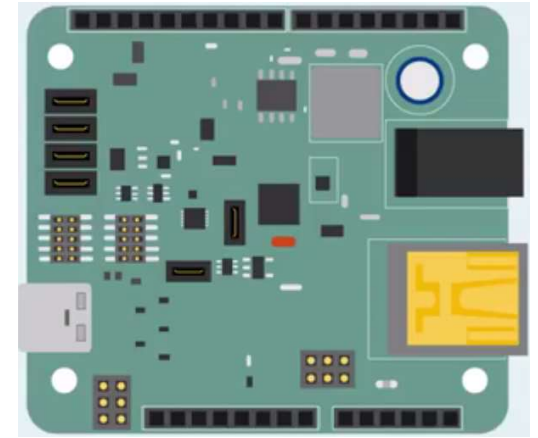


# USB PD Shield & MCUXpresso SDK

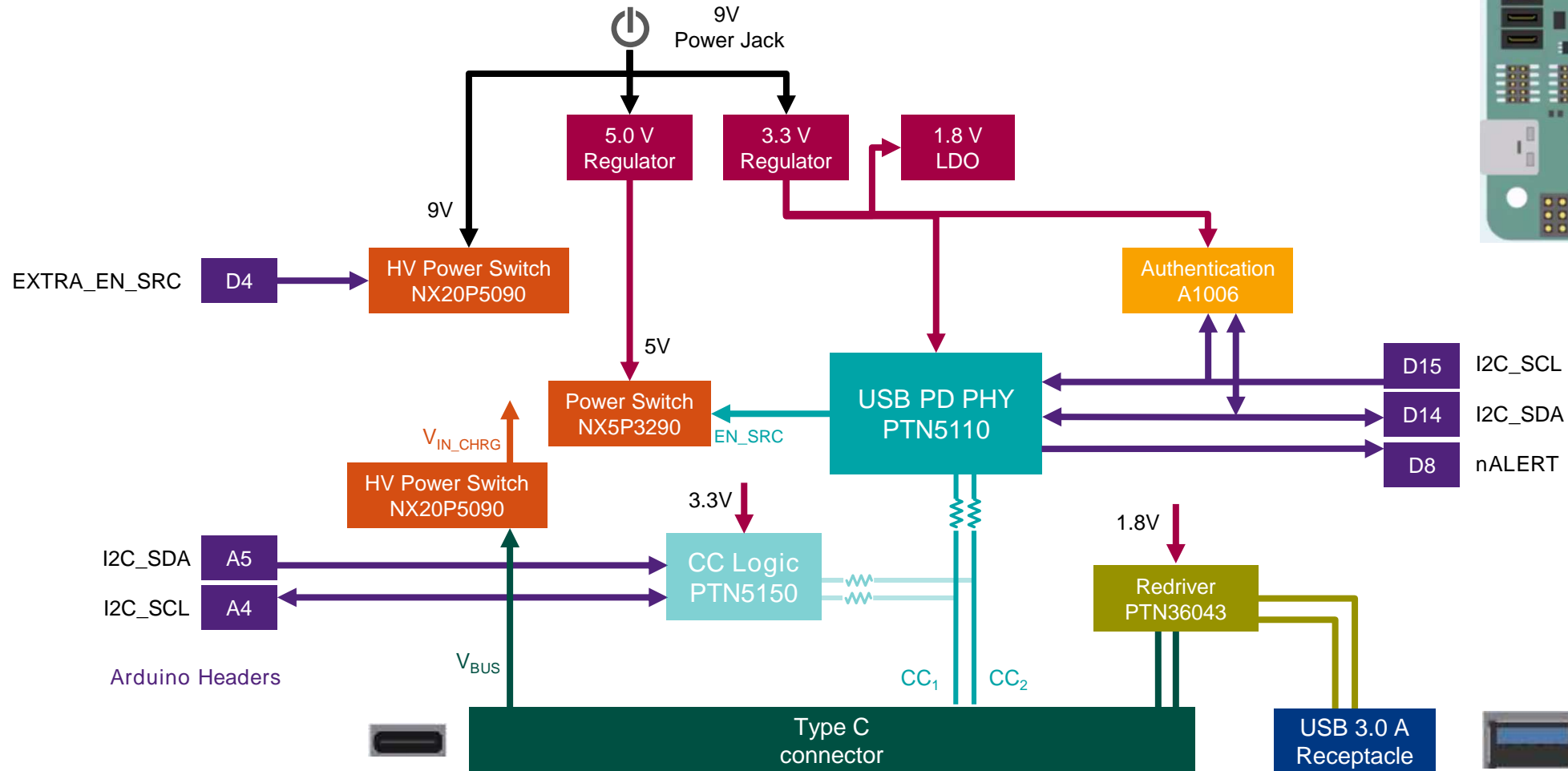
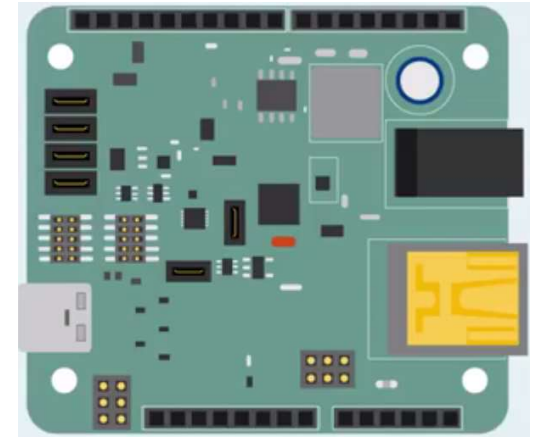


- USB Type-C Shield with TCPC PHY, Power Switch and USB 5Gbps signal condition.
- Arduino headers that is compatible with multiple NXP MCU development boards
- PD firmware source code available from MCUXpresso SDK builder. Including example code for power source and sink
- Enable customer to quickly add USB Type-C to Embedded or IoT hardware design

# USB PD Shield Hardware – Source Mode



# USB PD Shield Hardware – Sink Mode



# MCUXpresso Dev Board Supporting USB Type-C Shield



**FRDM-KL27**

64 kB Flash  
16 kB RAM



**FRDM-KL28**

512 kB Flash  
128 kB RAM



**FRDM-K22F**

512 kB Flash  
128 kB RAM



**FRDM-K64F**

1024 kB Flash  
256 kB RAM



**EVK i.MX RT1050**



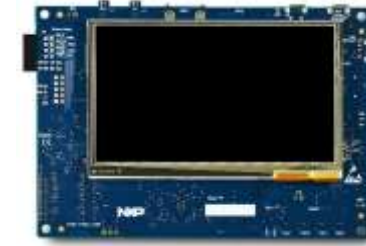
**LPCXpresso54114**

256 kB Flash  
192 kB RAM



**LPCXpresso54608**

512 kB Flash  
200 kB RAM



**LPCXpresso54018**



# Useful Links for USB Type-C Shield and MCUXpresso

## USB Type-C Shield OM13588

<https://www.nxp.com/products/analog/interfaces/usb-interfaces/usb-type-c-true-plugn-play/usb-type-c-shield-board-for-kinetis-freedom-board:OM13588>

## USB Type-C Shield OM13588 Getting Started

[https://www.nxp.com/products/analog/interfaces/usb-interfaces/usb-type-c-true-plugn-play/usb-type-c-shield-board-for-kinetis-freedom-board:OM13588?tab=In-Depth\\_Tab](https://www.nxp.com/products/analog/interfaces/usb-interfaces/usb-type-c-true-plugn-play/usb-type-c-shield-board-for-kinetis-freedom-board:OM13588?tab=In-Depth_Tab)

## USB Type-C Shield OM13588 Schematics

<https://www.nxp.com/downloads/en/schematics/sch-29705.pdf>

## MCUXpresso USB PD Migration Guide

<https://www.nxp.com/docs/en/user-guide/USBPDMUG.pdf?fsrch=1&sr=1&pageNum=1>

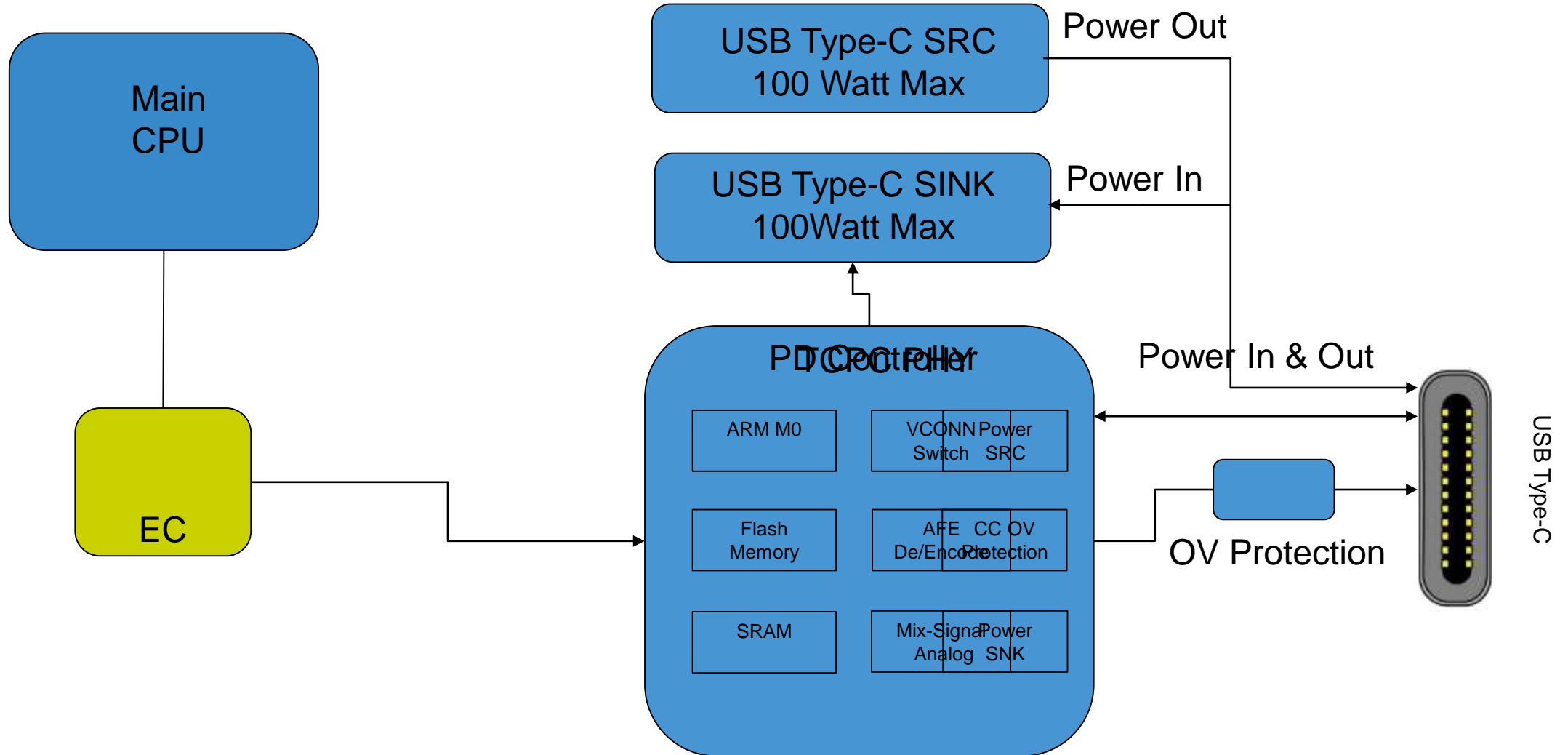
## i.MX RT1050 Combined demo of USB Type-C with GUI

<https://community.nxp.com/docs/DOC-340143>

# TCPC Advantage



# Evolution and Advantage of TCPC Architecture

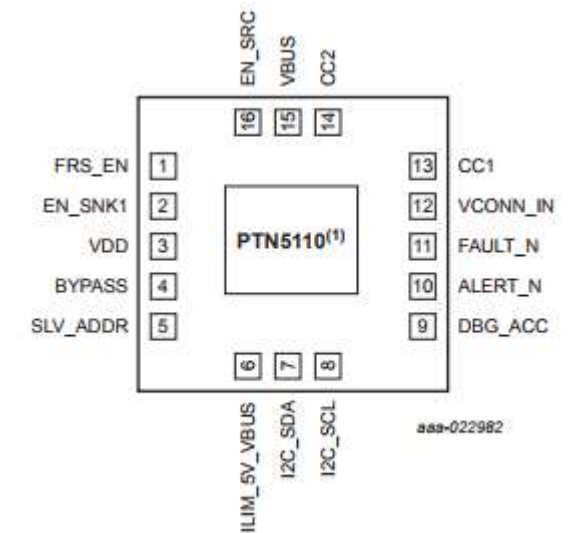
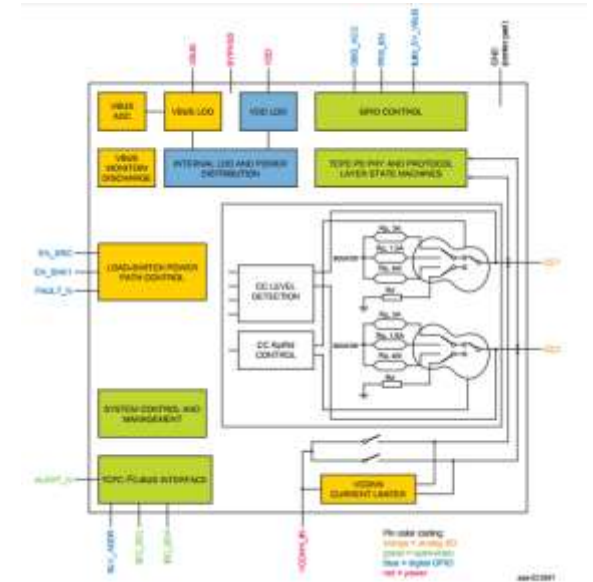


# TCPC Architecture Advantage Key Points

- Simplified BOM by eliminate the dedicated MCU to execute PD firmware stack.
- TCPC architecture allows PD firmware stack execute on main MCU (RTOS), application processor (Android) and CPU (Linux or MSFT OS).
- Standardize I2C interface that can be inter-change between different vendors.

# PTN5110 (TCPC-PHY) Key Features

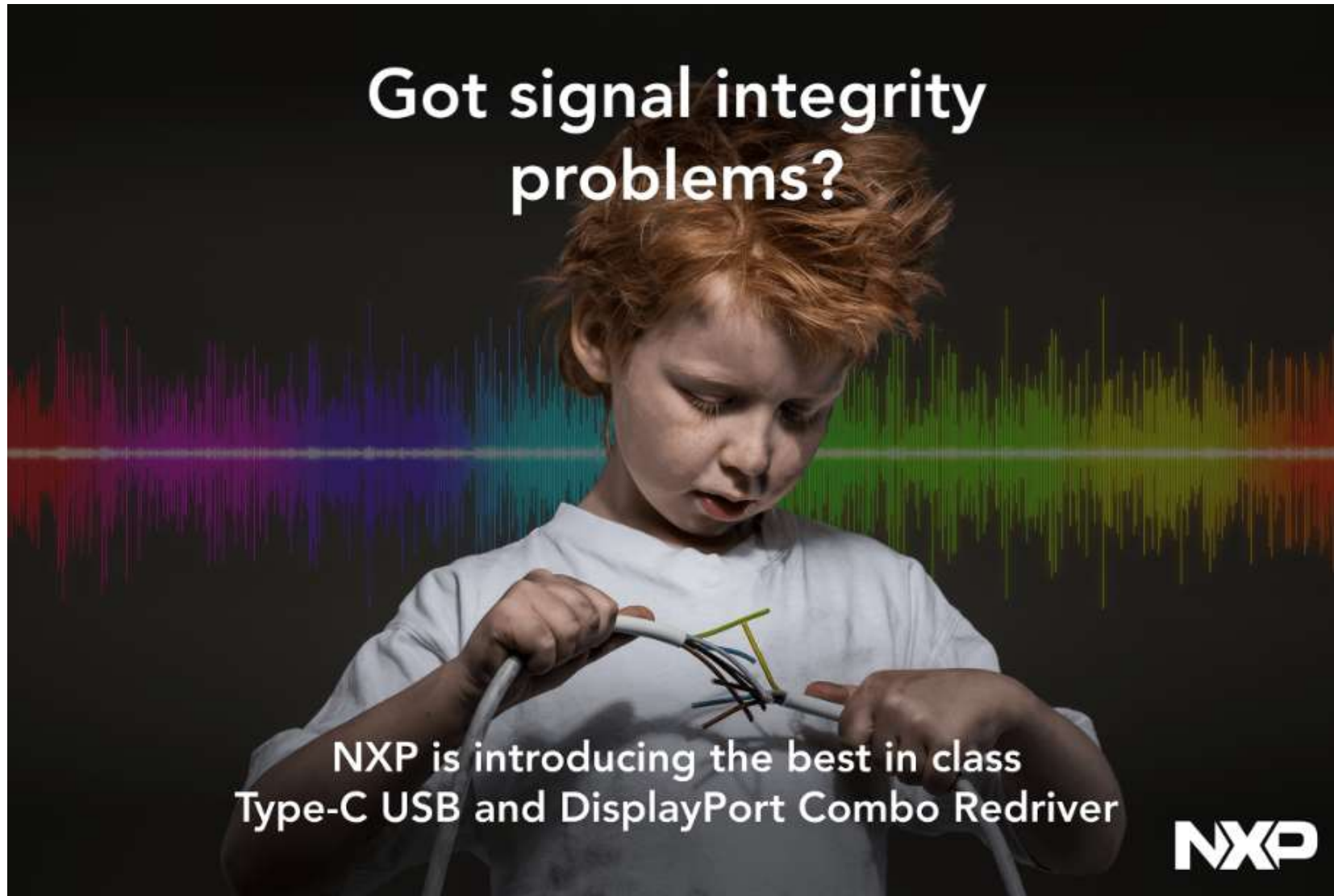
- Compliance to **PD2.0, Type-C 1.2 and TCPC Rev 1.0 / Version 1.1**
  - Target compliance to PD 3.0 pending on USB official release of PD3.0 test suite
- Supports wider VDD range (2.7V-5.5V)
- Integrated VCONN with Over Current Limiting, Short-to-GND and Temperature protection
- VBUS Discharge (Force and Bleed) support
- VBUS dead battery power supply (Nom operating range): 4.0V to 25V
- VBUS absolute max tolerance 28V Max
- VBUS voltage monitoring with 10 bit ADC
- I2C based Host interface (up to 1 Mbps)
- Provides up to 4 slave address options enabling PHY use for multiple ports
- Provides GPIOs for
  - Debug accessory indication
  - Autonomous Fast Role Swap control to load switch
  - 5V Load switch ILIM selection control
- Provides VBUS Source and Sink power path control signals
- Small footprint – X2QFN16 (2.6 x 2.6 mm, 0.4 mm pitch)



# Signal Conditioning




# PTN36502 Type-C 5G USB/DP Combo Redriver

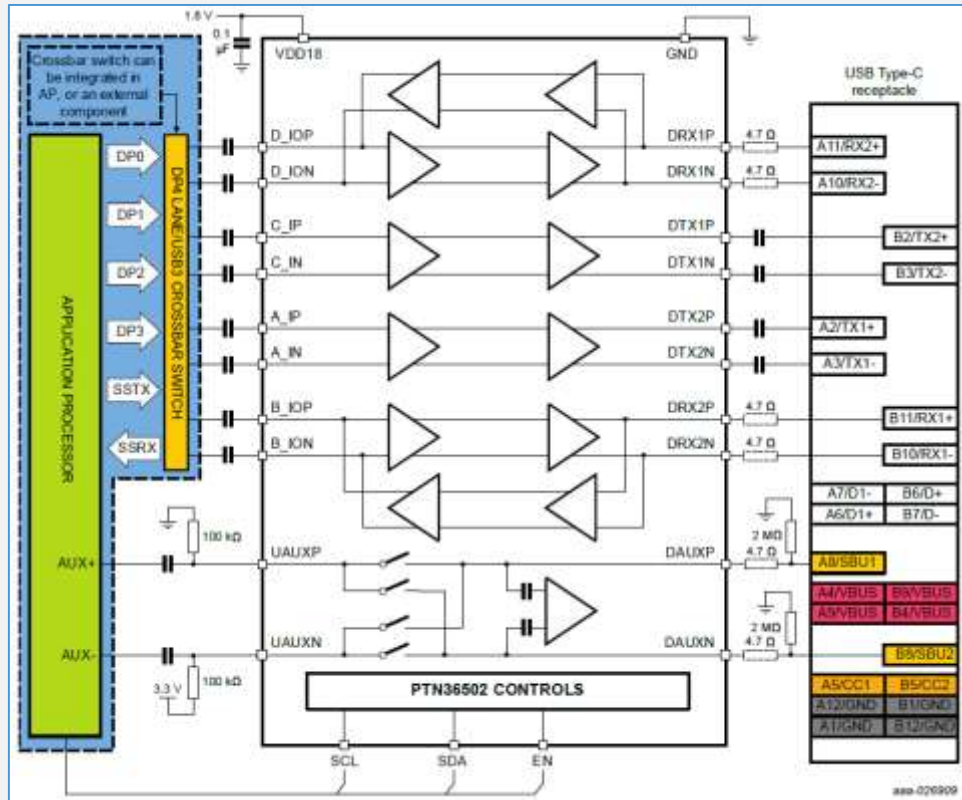


Got signal integrity problems?

NXP is introducing the best in class Type-C USB and DisplayPort Combo Redriver



PTN36502



# PTN36502 Type-C 5G USB/DP Combo Redriver

## • Product Features

- Works with Host processor that integrates DP/USB Crossbar Switch
- USB3.0 and 4-lane DP1.2 (HBR2) operation
- Support DP Aux Snoop function for automatic link rate, lane count and DP signal swing adjustment
- Integrated Aux xbar switch with USB-C Safe State support
  - Standby power (U2/U3 mode): 1.8mW vs 8mW
- Low power design with very low power saving modes
  - Active power: 190mW @ 1.8v
- Support both I2C and GPIO control mode for programmability
  - USB and Displayport EQ, Emphasis and amplitude setting
- Small thin package DHX2QFN24 2.4mm X3.2mm x 0.35mm

## • Application

- Smartphone
- Personal Computer
- VR/AR Goggles
- Accessory/Docking



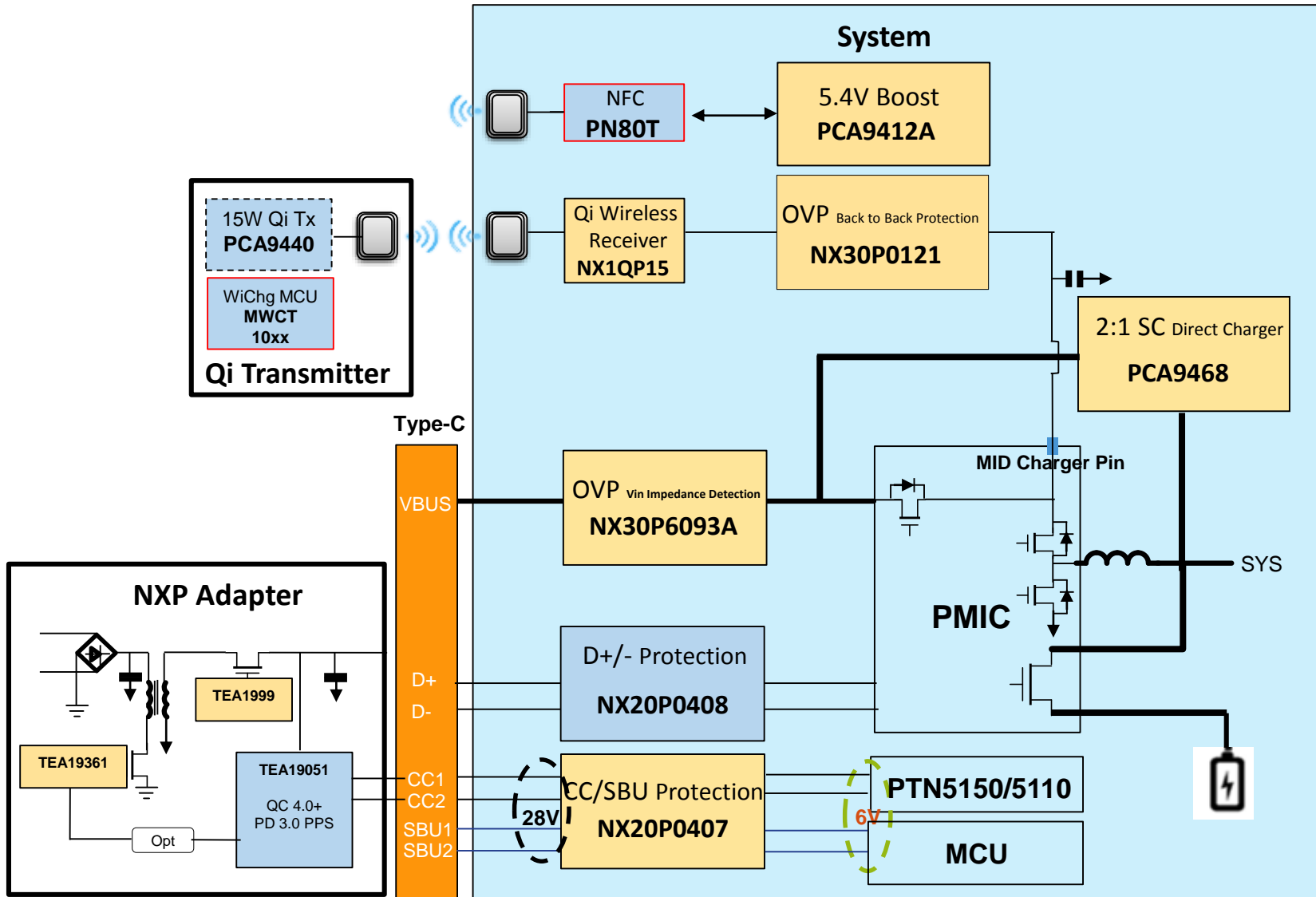
# PTN36502 Type-C 5G USB/DP Combo Redriver

- Lowest power consumption
  - Active power: 1.8v (NXP) vs 3.3v (Competitor) Vdd power supply
  - Standby power (U2/U3 mode): 1.8mW vs 8mW
- Good signal integrity for full USB/DP compliance.
- Enhanced surge protection at Rx and SBU pins: Supports IEC61000-4-5 8/20 us  $\pm 16$  V Surge test performance with external 4.7  $\Omega$  series resistors on the DRX1P/N, DRX2P/N and DAUXP/N pins
- Support both I2C and GPIO mode. I2C mode has more programmability (Ex. Threshold voltages, EQ, Pre-emphasis, amplitude, etc.)
- Higher HBM ESD: 8kV vs 6kV (Competitor)
- Smaller package: DHX2QFN24 (2.4mm X3.2mm) vs Competitor VQFN (4mm x 4mm)/WQFN24 (3mm x 3mm)
- For more information, please visit [PTN36502 product page \(click\)](#)

# Power Path Management



# E2E (wall-to-battery) USB & Wireless Charging Solution



## System

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

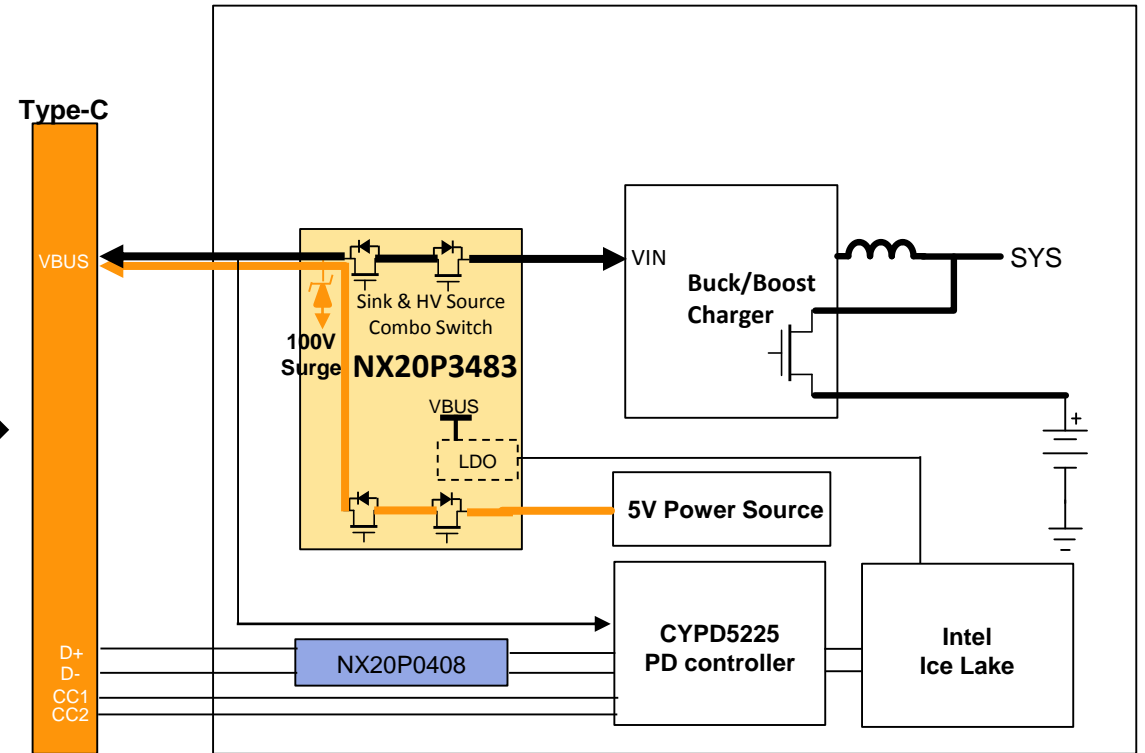
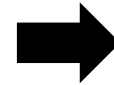
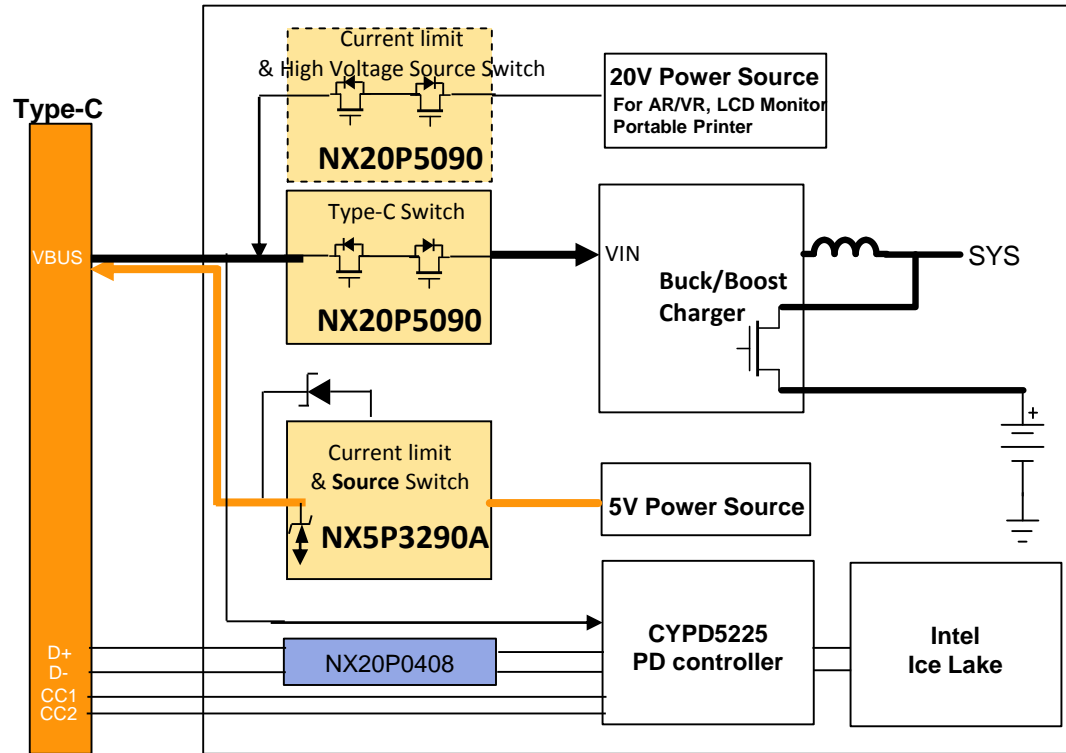
## Qi Transmitter

- PCA9440
  - 15W Qi (Half-Bridge) Transmitter
  - Samples available now
  - **MP in Q4 '18**

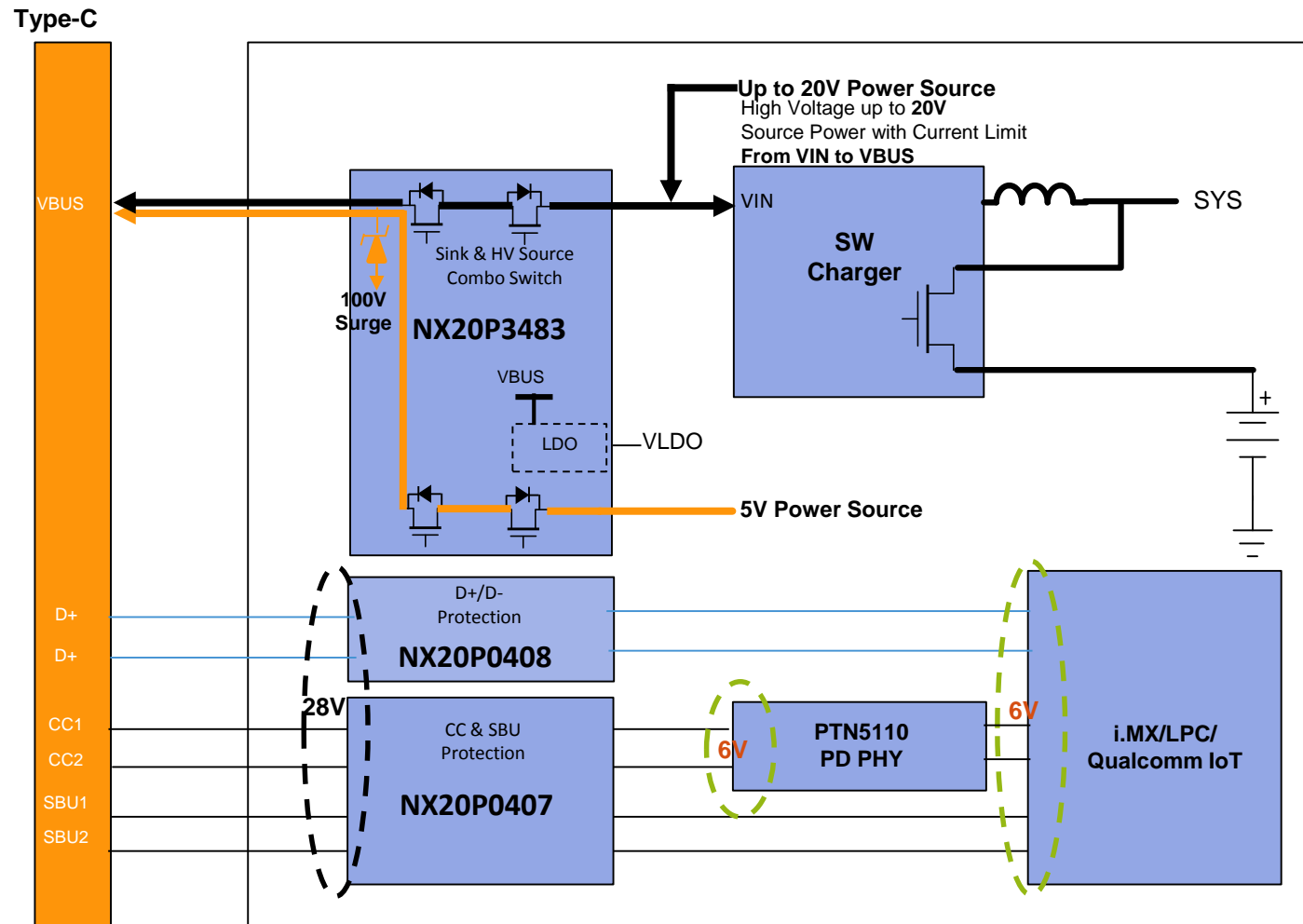
## Adaptor

- TEA19361
  - Primary Controller
  - MP now
- TEA1999
  - Secondary Controller
  - MP now
- TEA19051
  - QC 4.0+, USB PD 3.0 PPS Protocol
  - MP now

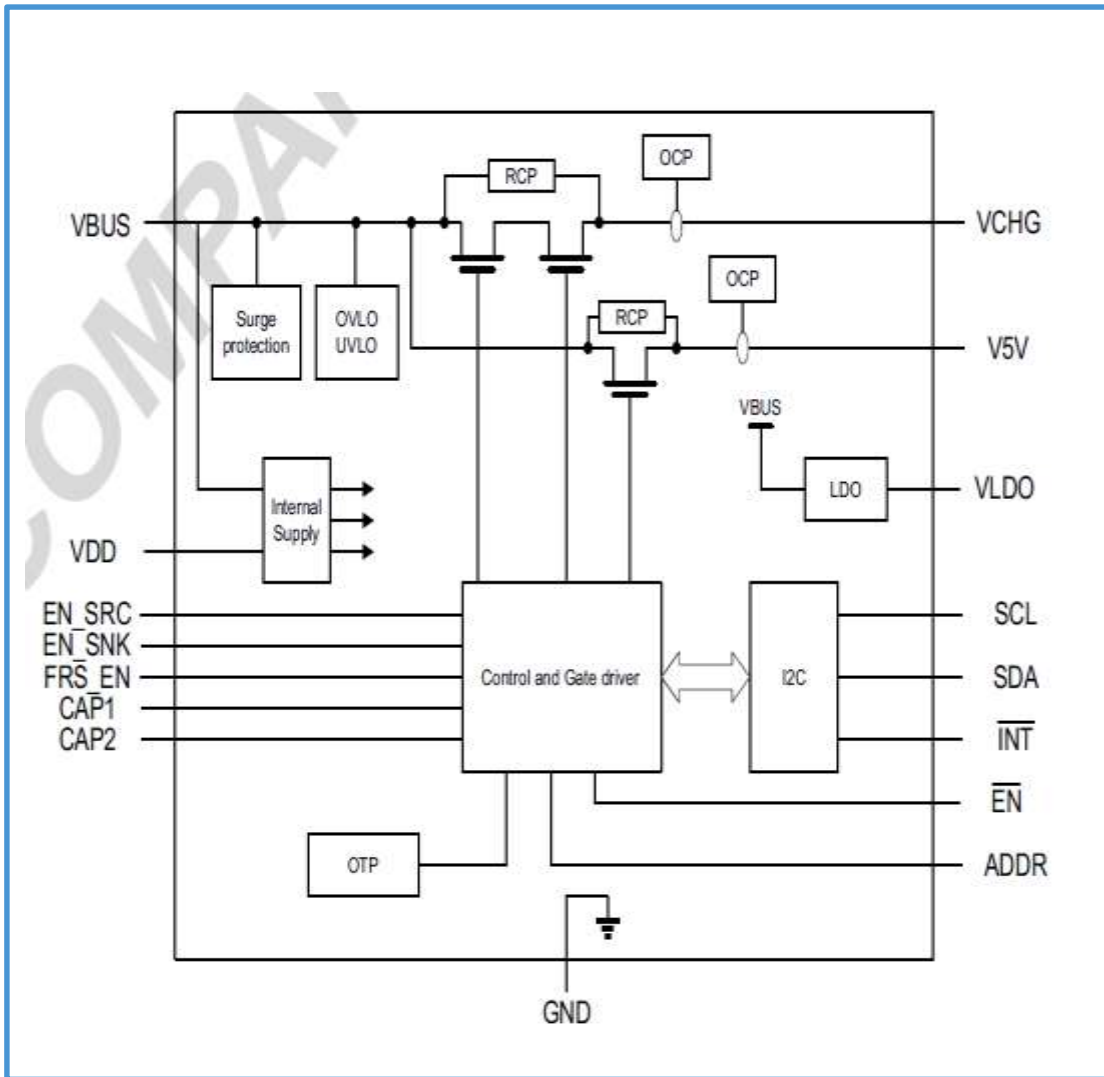
# NXP USB Type C Solution Intel Kaby/Whiskey/Lake field Platform



# NXP USB Type C I.MX/LPC/Kinetic Solution



# NX20P3483 Sink & Source Integrated OVP Combo Switch

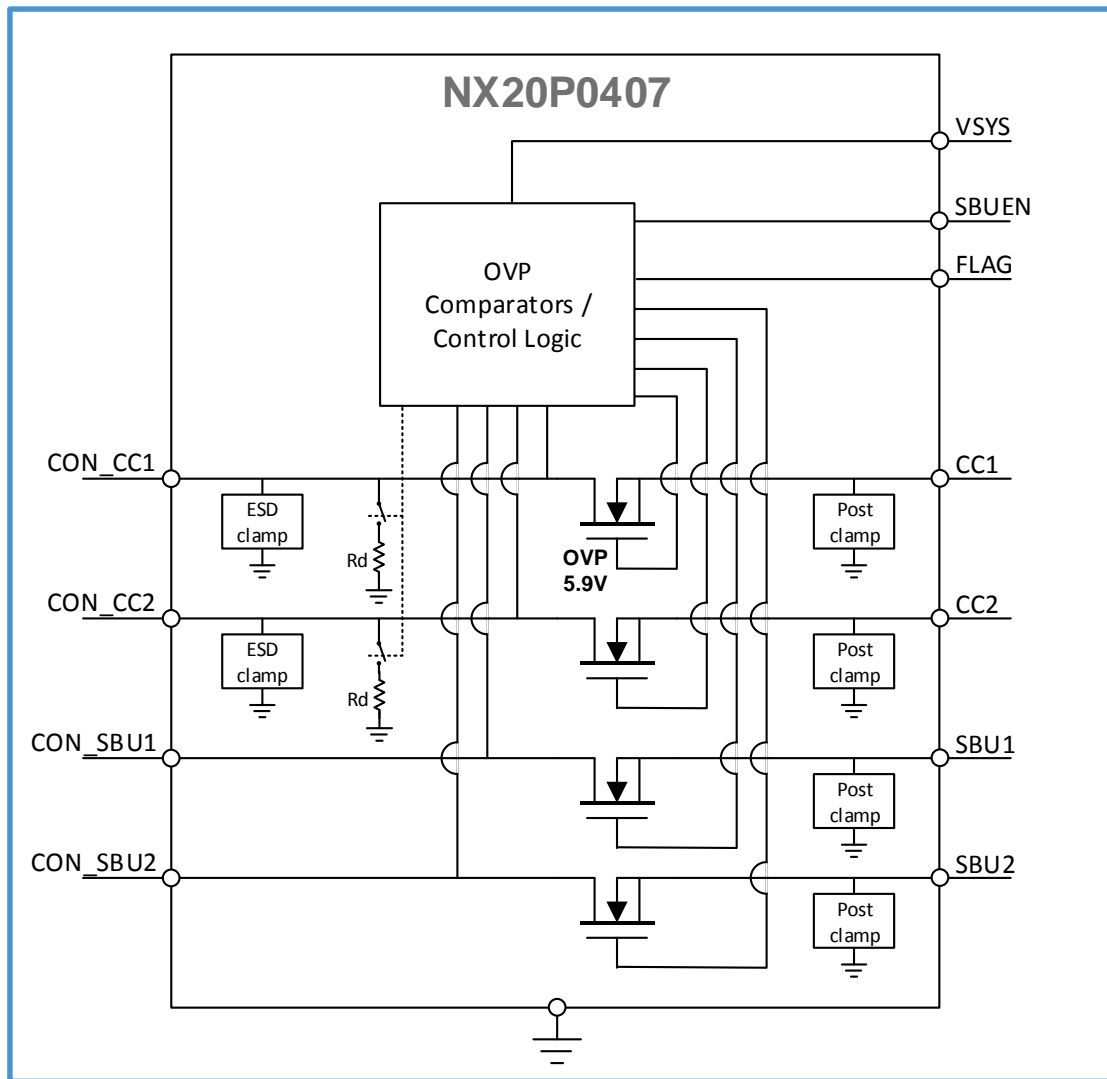


## Features and Benefits

- VBUS Over voltage protection up to 28V, adjustable OVP by I2C (6V, 10.5V, 13.9V, 17.0V, 23V)
- On-chip ultra low RDSON,
  - **18mohm** for VBUS to VCHG path
  - 33mohm for V5V to VBUS path
- **High voltage power source up to 20V from VCHG to VBUS**
- Slew rate control for inrush current limit
- Current limit protection 400mA to 3.3A for V5V to VBUS path
- I2C control and programmable for OVP threshold, timing control
- Surge protection: IEC61000-4-5 exceeds  $\pm 100$  V on VIN without capacitor
- Maximum switch current
  - 6A for VBUS to VCHG path
  - 3.3A for V5V to VBUS patch
- Protection circuitry
  - Over-Temperature Protection, Over-Voltage Protection, Under-Voltage Lockout, reverse current protection
- 2.51 x 2.91mm, 42pin WLCSP package.

MP now

# NX20P0407 – CC&SBU or CC&D+/- protection

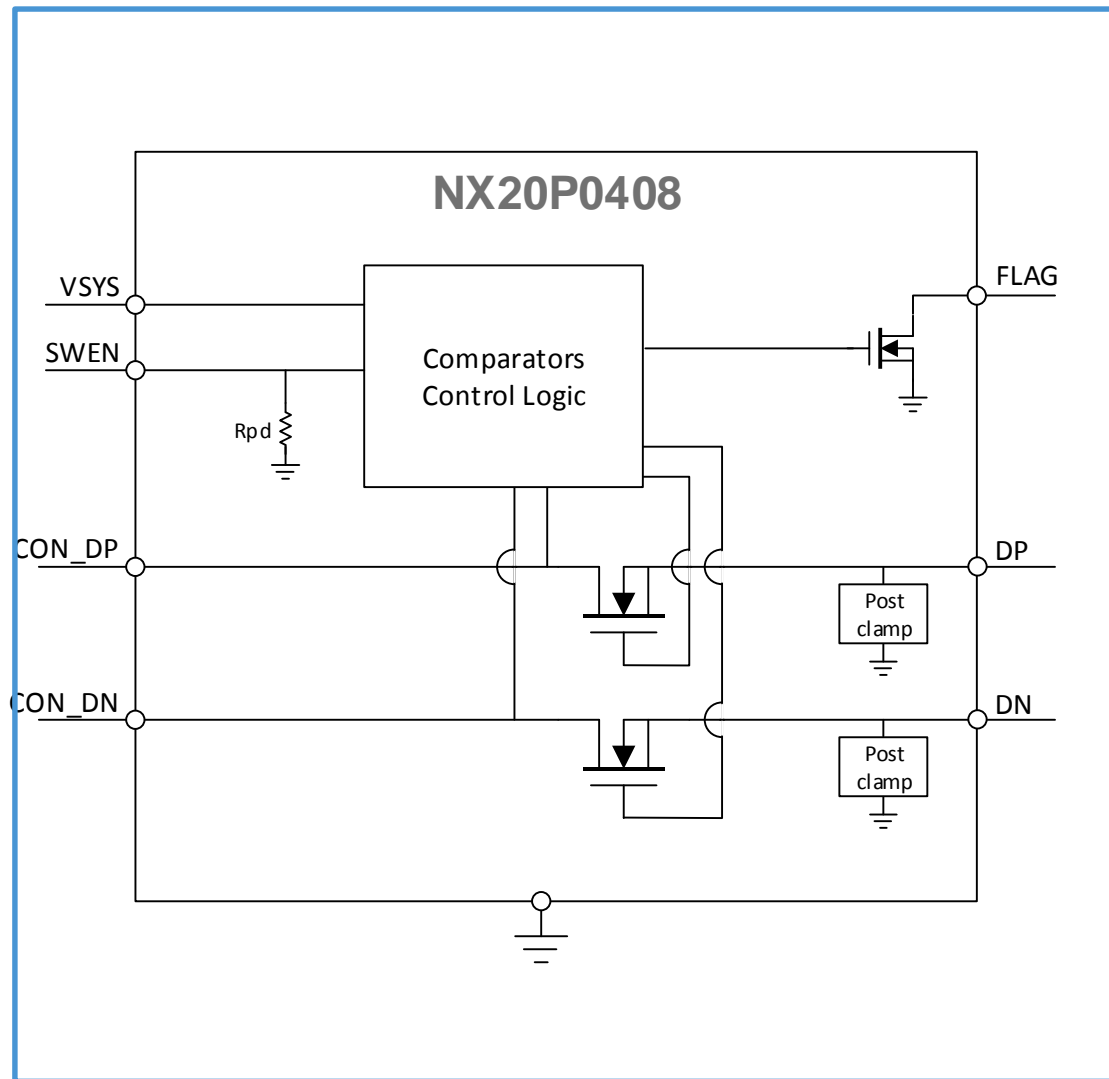


## Features and Benefits

- USB Type C CC1/2 and SBU1/2 short protection to VBUS
  - CON\_CC1 / CON\_CC2 : +28VDC
  - CON\_SBU1 / CON\_SBU2 : +28VDC
- **Rd circuit in CON\_CC1/CON\_CC2 in dead battery**
- Low R<sub>dson</sub> switch
  - CC switch : 160mΩ
  - SBU switch : 3.6Ω
- Robust ESD immunity for CON\_CC1/2
  - IEC 61000-4-2 Contact discharge: 8KV
  - IEC 61000-4-2 Air discharge: 15KV
- +/-40V surge protection on CON\_CC1/2
- +/-35V surge protection on CON\_SBU1/2
- **SBU SW is capable of USB HS Signal : BW = >1.5GHz**
- **Fast OVP turn-off time** : 60ns for CC and SBU
- 1.27 x 1.67 mm 12 WLCSP with 0.4 mm pitch

MP now

# NX20P0408 – D+/D- protection in Type C



MP now

## Features and Benefits

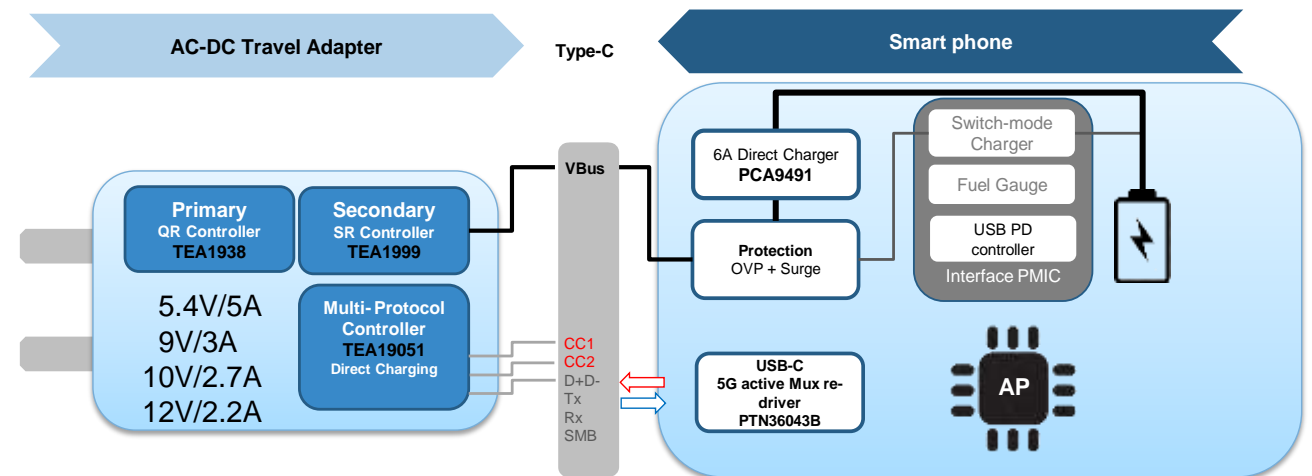
- USB Type C DP&DN short protection to VBUS
  - CON\_DP / CON\_DN : 28VDC
- High switch bandwidth: 1.5GHz
- Low R<sub>dson</sub> switch
  - DP&DN switch : 3.6Ω
- +/-35V surge protection on CON\_DP/CON\_DN
- Fast OVP turn off time : ~60ns
- 1.27 x 1.67 mm 12 WLCSP with 0.4 mm pitch



# Introduction

- NXP is focusing on complete Wall-to-Battery USB Type-C charging solutions
- Extensive portfolio for smartphone, tablets & notebooks applications
- USB-C applications
  - 27W for Smartphones & Tablets
  - 45W for Ultrabook and Laptop
  - 60W for Notebook and others
- NXP solution provides advantages
  - Best in class Peak efficiency
  - Enable small form factor designs
  - Highest safety features
  - Security
- NXP solution supports USB-PD, BC1.2 and Leader in QC4.0+
- Certified for USB-PD and QC4.0+
- Custom Protocol support

## 27W Multi protocol adapter solution with 6A Direct charger



- High efficiency 27W adapter solution
- Supports multi protocol (DC, USB PD, QC)
  - Best in class thermal management
  - Hard and soft short protection

- Highly integrated Direct charger
- 6A charging with lowest Ron@13mOhm
  - Integrated protection and regulation
  - NTC interface for Battery and Connector

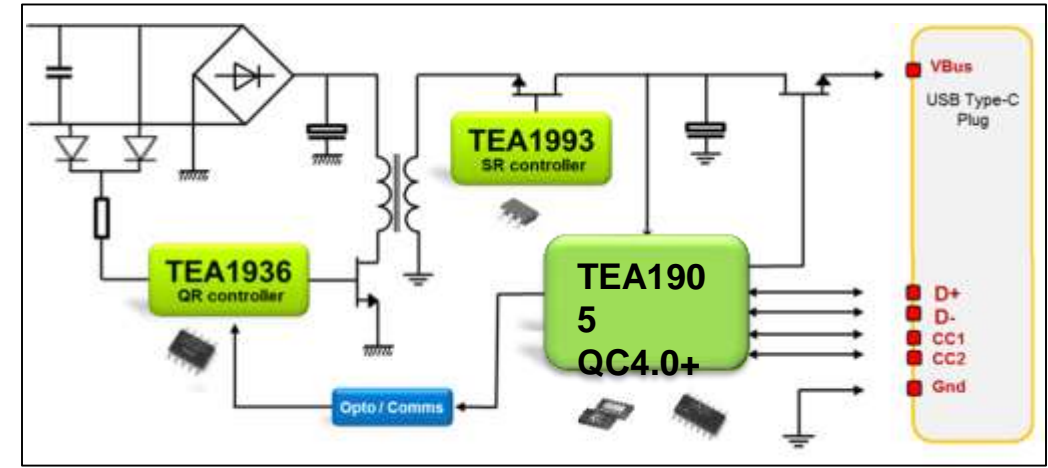
4 EXTERNAL USE

# Smart Charging Solution



# NXP AC-DC USB Type-C Solution

NXP provides total USB Type-C AC-DC solutions with higher Power density, security and safety with leading technologies that enables time to market, solving application challenges and complying to key global Power regulations.



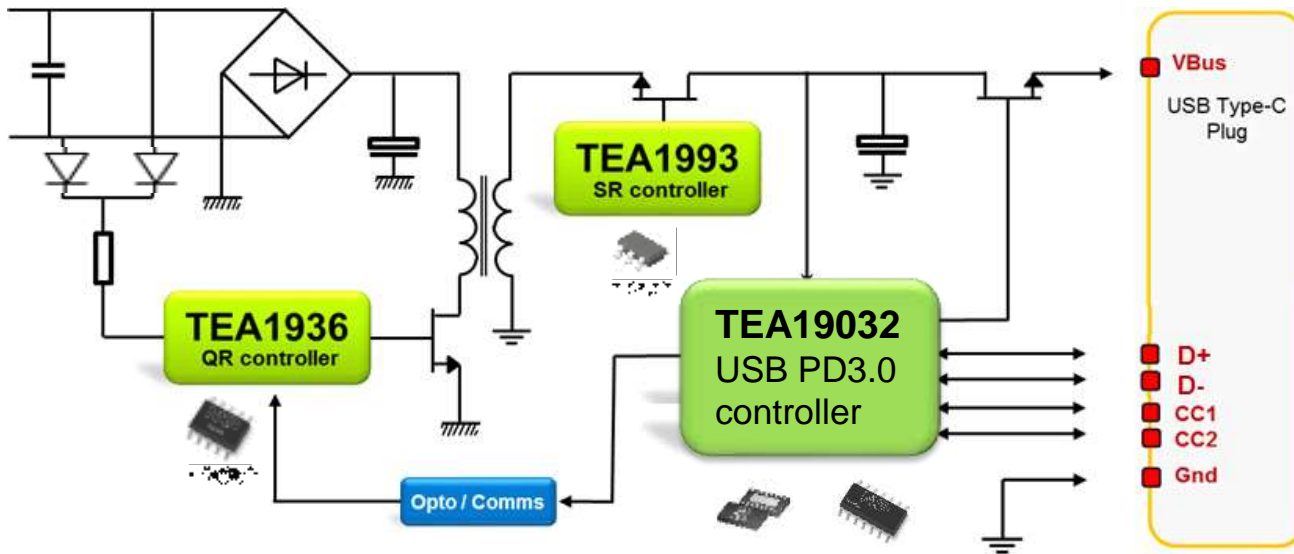
Product	Package	Rating (V)	Type-C	USB PD			Quick charge			Platform			Comments	
				PD 2.0	PD3.0/PPS		QC2.0	QC3.0	QC4.0+	27W	45W	65W		
ACDC controller	TEA1936x	SO-10	+	+	+	+	+	+	+	+	+	+	Low power burst-mode, X-cap discharge & fixed frequency option	
	TEA1938	SO-10	+	+	+	+	+	+	+	+	+	+	Low power VCO mode	
SyncRec controller	TEA1993	TSOP-6	20	+	+	+	+	+	+	+	+	+	Optimized for 150KHz	
	TEA1999	HVSON-8	20	+	+	+	+	+	+	+	+	+	150 & 300KHz option	
	TEA1998	TSOP-6	7	+									Type-C and Direct Charging	
Protocol controller	TEA19031A	SO-10	20	+	+						+	+	+	USB PD 2.0 application
	TEA19031B	SO-10	20	+	+						+	+	+	USB PD2.0 application
	TEA19032	SO-10	20	+	+	+					+	+	+	USB PD3.0/PPS application
	TEA19051B	HVSON-16 SO-14	20	+	+	+	+	+	+	+	+	+	+	QC4.0+ certified

# TEA1936/38 Primary side Flyback QR/DCM controller

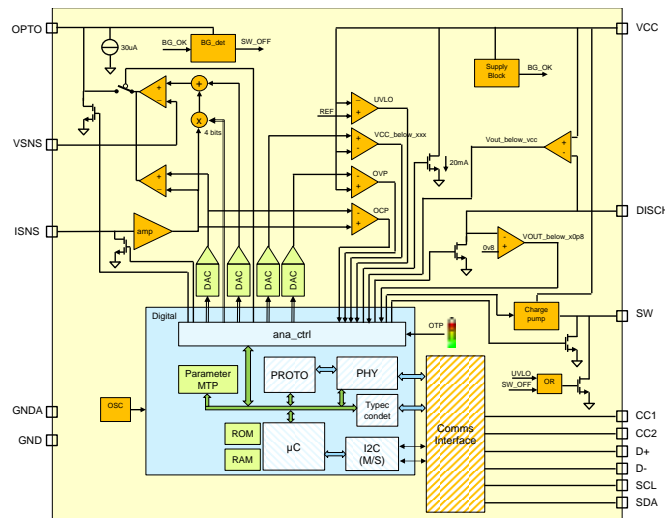
- Family of flyback QR/DCM or fixed frequency DCM-only controllers enabling synchronous rectification for highest charger efficiency
- Four versions optimized for computing market and mobile market with additional common mode noise requirements for touchscreen compatibility
- All small SO10 package, all pin compatible

Product	Operating mode	Switching frequency	Active X-cap discharge	Low power mode	Protections	Main Application
TEA19361T	QR/DCM	130kHz max	no	burst	safe restart	Mobile market, highest efficiency, audible noise optimized, meets IEC 62684 Common Mode Noise spec
TEA19362T	DCM	70kHz fixed	no	burst	safe restart	Mobile market, improved touchscreen compatibility
TEA19363T	QR/DCM	130kHz max	yes	burst	safe restart	Computing market, for non-touchscreen devices
TEA19363LT	QR/DCM	130kHz max	yes	burst	OVP & OTP latched, rest safe restart	Computing market, for non-touchscreen devices
TEA1938T	QR/DCM	130kHz max	no	VCO	safe restart	Mobile market, highest efficiency, low output ripple optimized, meets IEC 62684 CMN spec

# NXP Type-C USB PD and QC4.0+ solutions



- 3 platforms: Demo boards/eval kits
  - 27W: QC4.0+ and USB PD3.0
  - 45W: USB PD3.0/PPS
  - 60W: USB PD3.0/PPS
- Key features and differentiation
  - Peak Power Density >10W/inch<sup>3</sup>
  - Peak efficiency >92.8% @20V
  - Thermal
  - Extra protections: Cable detach, Soft short & data pins
- Certification & Compliance
  - TEA1905x QC4.0+ certified
  - TEA1903x is USB-PD/PPS certified



**TEA1905 USB PD3.0 type C, BC1.2 and QC2.0/3.0 /4.0+ smart charging controller**



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