



# USB Type-C，接口上的大统一？

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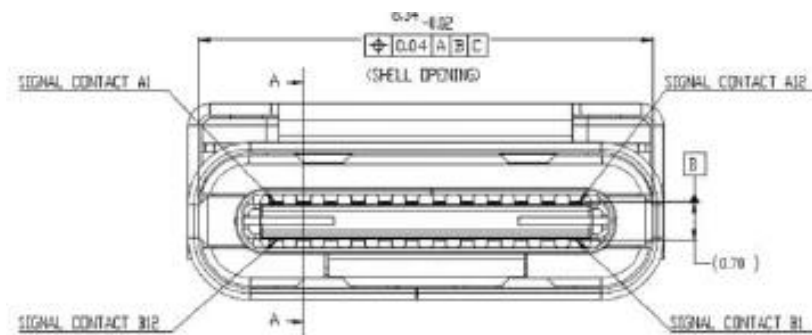
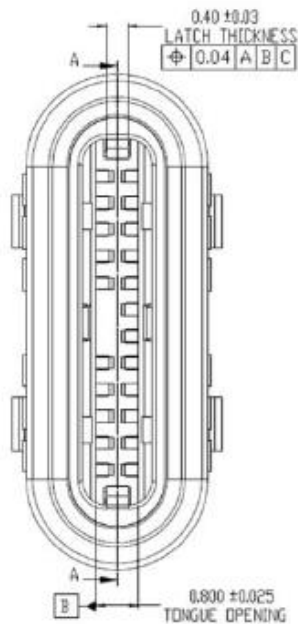
# USB 3.1 Type-C

USB Type-C，外观上最大特点在于其上下端完全一致。

USB Type-C接口尺寸为8.3×2.5毫米

至于电力传输规格，线材标准为3A，而连接器为5A。

Type-C由于不兼容现有的任何类型，因此需要额外设计转接装置。





# Type C Pin Define

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1-	Vbus	CC1	D+	D-	SBU1	Vbus	RX2-	RX2+	GND
GND	RX1+	RX1-	Vbus	SBU2	D-	D+	CC2	Vbus	TX2-	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

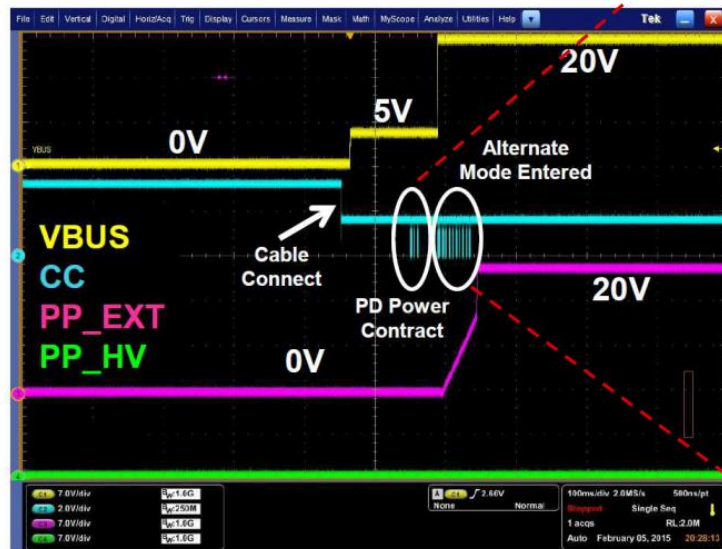
## CC Analog

- Detect attach, UFP/DFP role decide
- Cable Orientation Detection
- Type-C Current Mode (500/900mA, 1.5A, 3A)
- Configure VCONN
- Audio Accessory
- Debug Accessory

## CC Protocol

- PD – Power Delivery(100W)
- DP – Display Port
- TB – Thunderbolt
- MHL

# CC Protocol



- Default
  - DFP → PD Provider
  - UFP → PD Consumer
- Power Role Swap

TI Confidential – NDA Restrictions

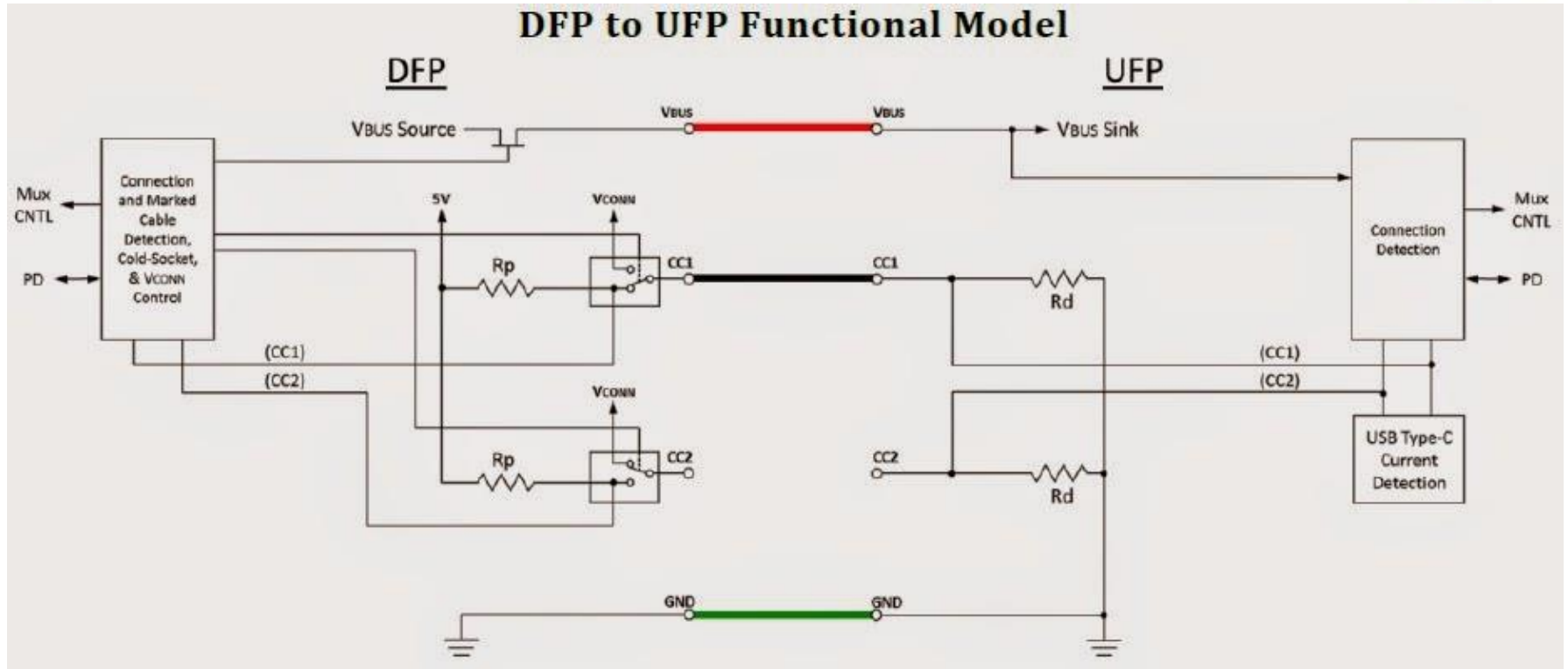
→ Source Capabilities packet (Fixed 5V 3A, Fixed 12V 3A, Fixed 20V 3A)	OUT
✓ GoodCrc packet	IN
⊞ Request (Object 3 = Fixed 20V 3A, Requested 3A, Maximum 3A) > Accepted	IN
⊞ Request (Object 3 = Fixed 20V 3A, Requested 3A, Maximum 3A)	IN
← Request packet (Object 3 = Fixed 20V 3A, Requested 3A, Maximum 3A)	IN
✓ GoodCrc packet	OUT
⊞ Accept	OUT
→ Accept packet	OUT
✓ GoodCrc packet	IN
⊞ PsRdy	OUT
→ PsRdy packet	OUT
✓ GoodCrc packet	IN
⊞ Discover Identity > Ack (Undefined)	OUT
⊞ Discover Identity	OUT
⊞ Discover Identity Ack (Undefined)	IN
⊞ Discover SVIDs > Ack (0x8086, 0xFF01)	OUT
⊞ Discover SVIDs	OUT
⊞ Discover SVIDs Ack (0x8086, 0xFF01)	IN
⊞ Discover Modes (SVID = 0x8086) > Ack (0x54425433)	OUT
⊞ Discover Modes (SVID = 0x8086)	OUT
→ Discover Modes (SVID = 0x8086) packet	OUT
✓ GoodCrc packet	IN
⊞ Discover Modes (SVID = 0x8086) Ack (0x54425433)	IN
← Discover Modes (SVID = 0x8086) Ack packet (0x54425433)	IN
✓ GoodCrc packet	OUT
⊞ Discover Modes (SVID = 0xFF01) > Ack (0x0000C05)	OUT
⊞ Discover Modes (SVID = 0xFF01)	OUT
→ Discover Modes (SVID = 0xFF01) packet	OUT
✓ GoodCrc packet	IN
⊞ Discover Modes (SVID = 0xFF01) Ack (0x0000C05)	IN
← Discover Modes (SVID = 0xFF01) Ack packet (0x0000C05)	IN
✓ GoodCrc packet	OUT
⊞ Enter Mode (SVID = 0x8086, Mode = 1) > Ack	OUT
⊞ Enter Mode (SVID = 0x8086, Mode = 1)	OUT
→ Enter Mode (SVID = 0x8086, Mode = 1) packet	OUT
✓ GoodCrc packet	IN
⊞ Enter Mode (SVID = 0x8086, Mode = 1) Ack	IN
← Enter Mode (SVID = 0x8086, Mode = 1) Ack packet	IN
✓ GoodCrc packet	OUT

# USB 供电



Mode of Operation	Nominal Voltage	Maximum Current	Notes
USB 2.0	5V	500 mA	基于基本规范中定义的默认电流
USB 3.1	5V	900 mA	
USB BC 1.2	5V	Up to 1.5 A	传统的充电
USB Type-C Current @ 1.5 A	5V	1.5 A	支持更高的功率的产品
USB Type-C Current @ 3.0 A	5V	3 A	支持更高的功率的产品
USB PD	5V, 12V, 20V	1.5A, 3A, 5A	可控制输出功率水平

# CC Analog: DFP to UFP



DFP (Downstream Facing Port)为Host端，UFP (Upstream Facing Port) 为device端

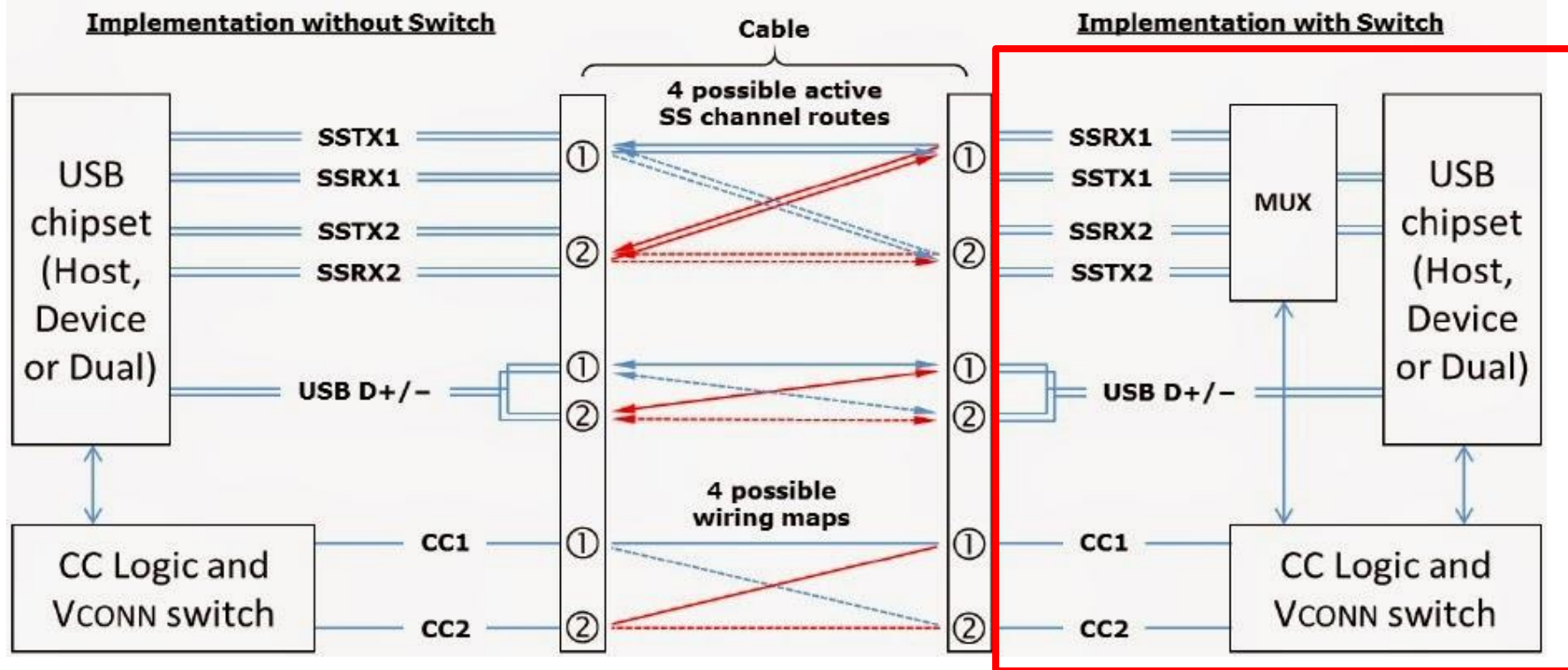
在DFP的CC pin会有上拉电阻Rp，在UFP会有下拉电阻Rd

在DFP与UFP未连接之前，DFP的VBUS是没有输出的

# CC Analog: Cable Plug

- Type-C是支援正反插，CC pin被用来侦测**正反插**，从DFP的角度来看，当CC1接到**下拉**就是正插，如果是CC2接到**下拉**就是反插。在侦测完正反插后，就会输出相对应的USB信号。
- 下图的右边整合了MUX，由于USB 3.1的data rate高达10 Gbps，为了避免PCB的走线出现交叉，所以正反插进来的讯号会由MUX来切换，正插时，切换到SSRX1&SSTX1，反插时，切换到SSRX2&SSTX2

Figure 4-3 Logical Model for Data Bus Routing across USB Type-C-based Ports



# USB 3.1 CC pin function



Discover and configure VBUS: USB Type-C Current modes

Type-C spec定义了DFP在不同模式下，在CC pin要供多大的电流或是要用多大的Rp阻值。

Figure 4-5 Pull-Up/Pull-Down CC Model

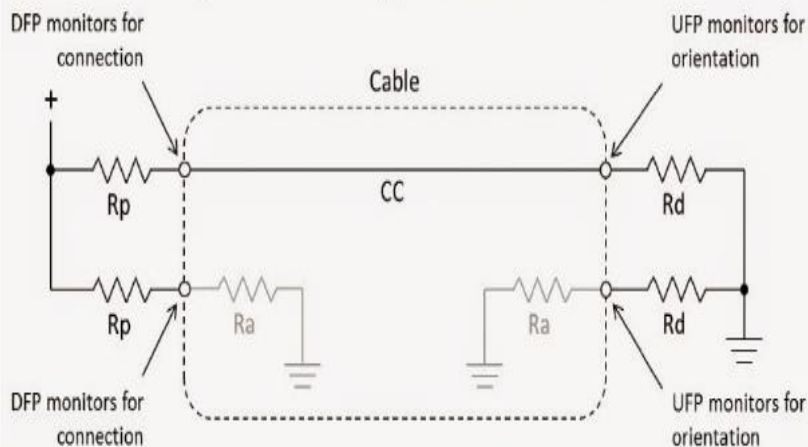


Figure 4-6 Current Source/Pull-Down CC Model

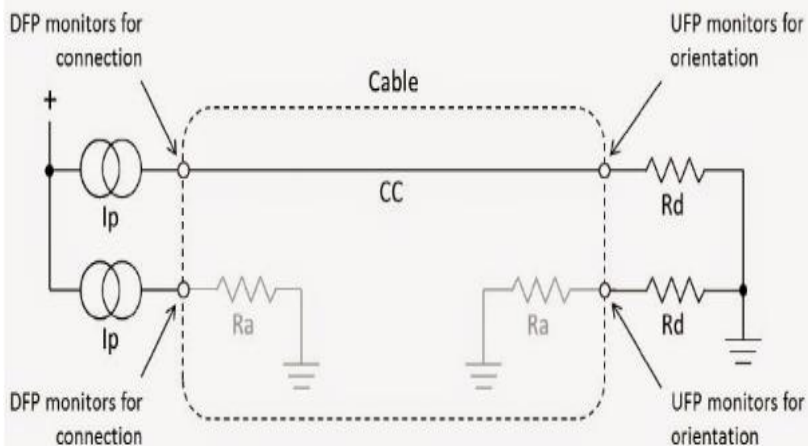


Table 4-10 DFP CC Termination (Rp) Requirements

DFP Advertisement	Current Source to 1.7 - 5.5 V	Resistor pull-up to 4.75 - 5.5 V	Resistor pull-up to 3.3 V ± 5%
Default USB Power	80 μA ± 20%	56 kΩ ± 20%	36 kΩ ± 20%
1.5 A @ 5 V	180 μA ± 8%	22 kΩ ± 5%	12 kΩ ± 5%
3.0 A @ 5 V	330 μA ± 8%	10 kΩ ± 5%	4.7 kΩ ± 5%

Table 4-20 Voltage on UFP CC pins (Multiple DFP Current Advertisements)

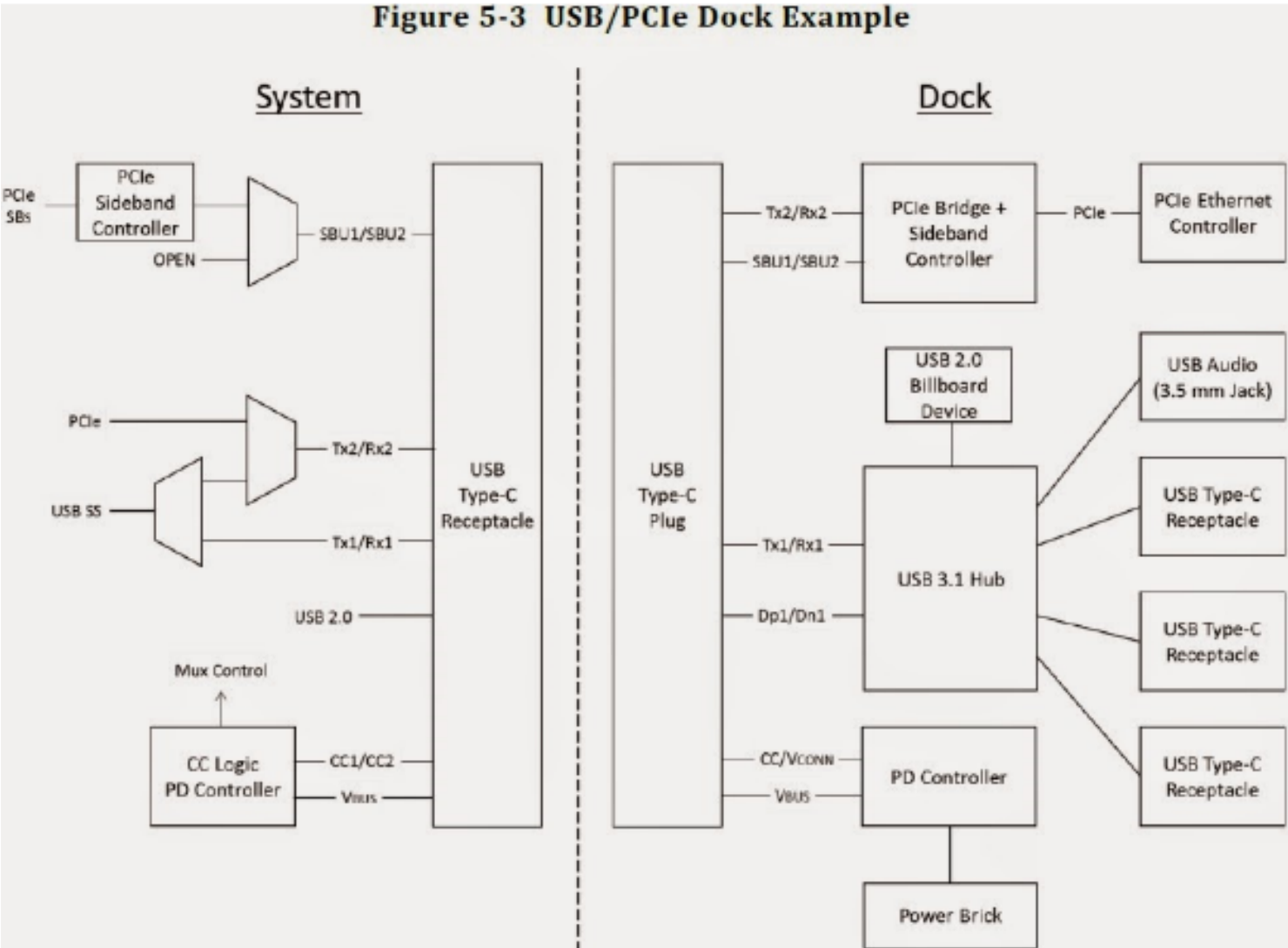
Detection	Min voltage	Max voltage	Threshold
vRd-USB	0.25 V	0.61 V	0.66 V
vRd-1.5	0.70 V	1.16 V	1.23 V
vRd-3.0	1.31 V	2.04 V	



# USB 3.1 CC pin function

Discover and configure optional Alternate and Accessory modes

## Alternate mode



# USB PD v2.0



PD 2.0 规范内允许定义多种替代模式（Alternate Modes），系统可以与装置进行交涉并且允许在不同模式间切换，而这些 Alternate Modes 可以透过 USB 3.1 Type C 中的 CC Pin 来沟通并定义 Structured Vendor Defined Messages（Structured VDMs，甚至可将内部的 PIN 重新定义挪作他用。

Figure 5-1 Pins Available for Reconfiguration over the Full-Featured Cable

A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	RX2+	RX2-	VBUS	SBU1	D-	D+	CC	VBUS	TX1-	TX1+	GND
GND	TX2+	TX2-	VBUS	VCONN			SBU2	VBUS	RX1-	RX1+	GND
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12

Figure 5-2 Pins Available for Reconfiguration for Direct Connect Applications

A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1
GND	RX2+	RX2-	VBUS	SBU1	D-	D+	CC	VBUS	TX1-	TX1+	GND
GND	TX2+	TX2-	VBUS	VCONN			SBU2	VBUS	RX1-	RX1+	GND
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12



# TYPE-C 测试要点

# TYPE-C 测试要点



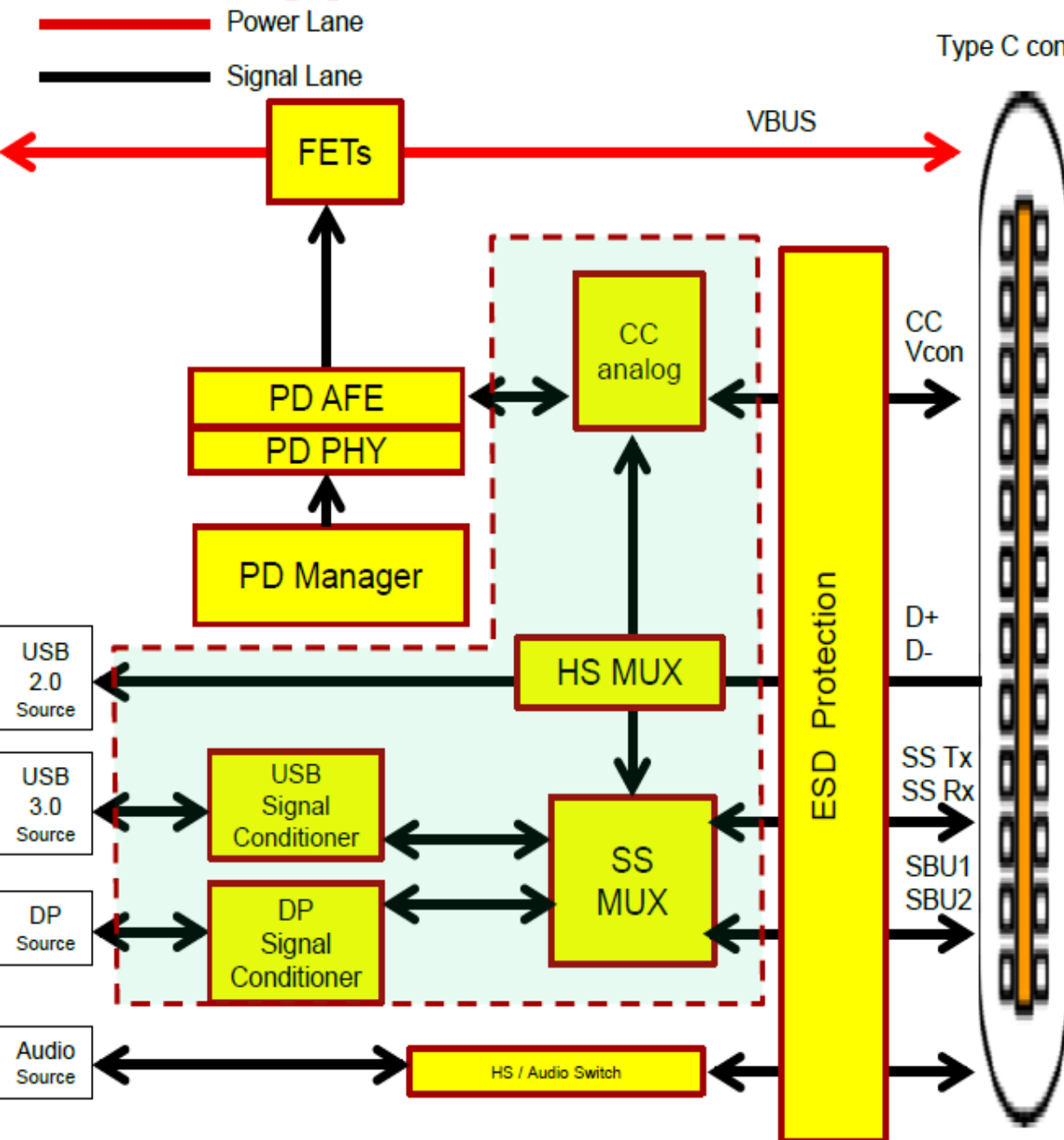
1. 结构测试：
  - 插拔10,000次的高寿命
2. 电器测试：
  - 低阶额定电阻 (LLCR) 的测试上也有改变，初始值从原本的30mΩ变成40mΩ
  - 电流温升测试，在Vbus端子给予5A的电流，且在Vconn端子给予1.25A的电流，温度的变化量不能超过30°C
3. 环境测试：
  - 与USB 3.0要求相同，遵照EIA 364-1000.01规范运行环境测试
4. 电镀要求：
  - 与USB 3.0要求相同
5. 高频测试：
  - Type-C板端连接器与标准Type-C线缆高频测试要求如右

	Type-C 板端连接器		标准 Type-C 线缆	
	测试要求	标准值	测试要求	标准值
Impedance	Rise Time: 40 ps (20-80%)	85±9 ohms	与板端连接器相同	
Insertion Loss	100 MHz	-0.25 dB	100 MHz	-2 dB
	2.5 GHz	-0.35 dB	2.5 GHz	-4 dB
	5 GHz	-0.45 dB	5 GHz	-6 dB
	10 GHz	-0.75 dB	10 GHz	-11 dB
	15 GHz	-1.85 dB	15 GHz	-20 dB
Return Loss	100 MHz	-20 dB	100 MHz	-18 dB
	5 GHz	-20 dB	5 GHz	-18 dB
	10 GHz	-13 dB	10 GHz	-12 dB
	15 GHz	-6 dB	15 GHz	-5 dB
Near-end & Far-end Crosstalk	100 MHz	-40 dB	100 MHz	-37 dB
	5 GHz	-40 dB	5 GHz	-37 dB
	10 GHz	-36 dB	10 GHz	-32 dB
	15 GHz	-30 dB	15 GHz	-25 dB
Near-end & Far-end Crosstalk with D+/D-	100 MHz	-40 dB	100 MHz	-35 dB
	5 GHz	-40 dB	5 GHz	-35 dB
	7.5 GHz	-36 dB	10 GHz	-30 dB
Differential to Common Mode Conversion	100 MHz	-30 dB	100 MHz	-20 dB
	6 GHz	-30 dB	10 GHz	-20 dB
	10 GHz	-25 dB		



# TI TYPE-C SOLUTION

# USB Type C Full function Block Diagram



Block	Function	Comment
CC analog	Cable orientation detection Type-C current mode detection	Required
SS Mux	SuperSpeed switching for flippable connector orientation Depending on device, may allow for DP	Required for USB 3.0
HS Mux	Support alternate mode D+ D- or SBU 1 / 2	Required for alternative mode
HS/ Audio Switch	Multiplexes analog to audio codec	USB3.1 Required for audio accessory mode
Sig Con	Redriver / Retimer for better signal	Optional
PD manager	PD power negotiation Manages alternate modes	Required for USB PD and alternate mode
PD PHY / AFE	PD PHY processes commands from PD manager and detects AFE to drive FETs	Required for USB PD
FETs	Provides power path on VBUS	Required for USB PD
ESD Protection	Protects all data path connections from ESD damage	Optional

# TI Product Line for USB Type-C / PD



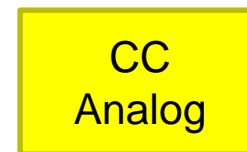
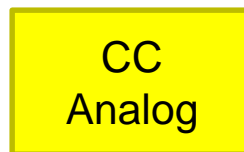
HD3SS3212



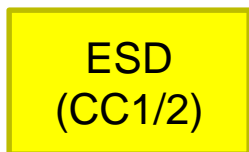
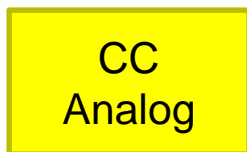
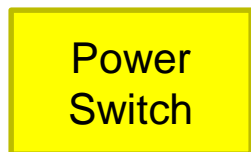
HD3SS460



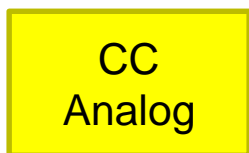
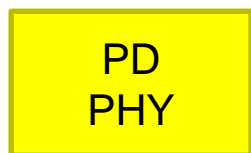
HD3SS3220(DRP)  
HD3SS2522(DFP)



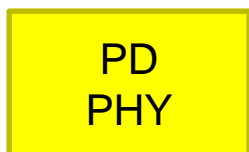
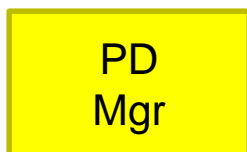
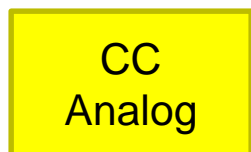
TUSB320  
TUSB321(Vconn)



TPS25810(0.5A to 3.0A)  
TPS25820(0.5A to 1.5A)



TPS25740(带PD管理功能, 独立的DFP Host设备+外部Mos Driver)



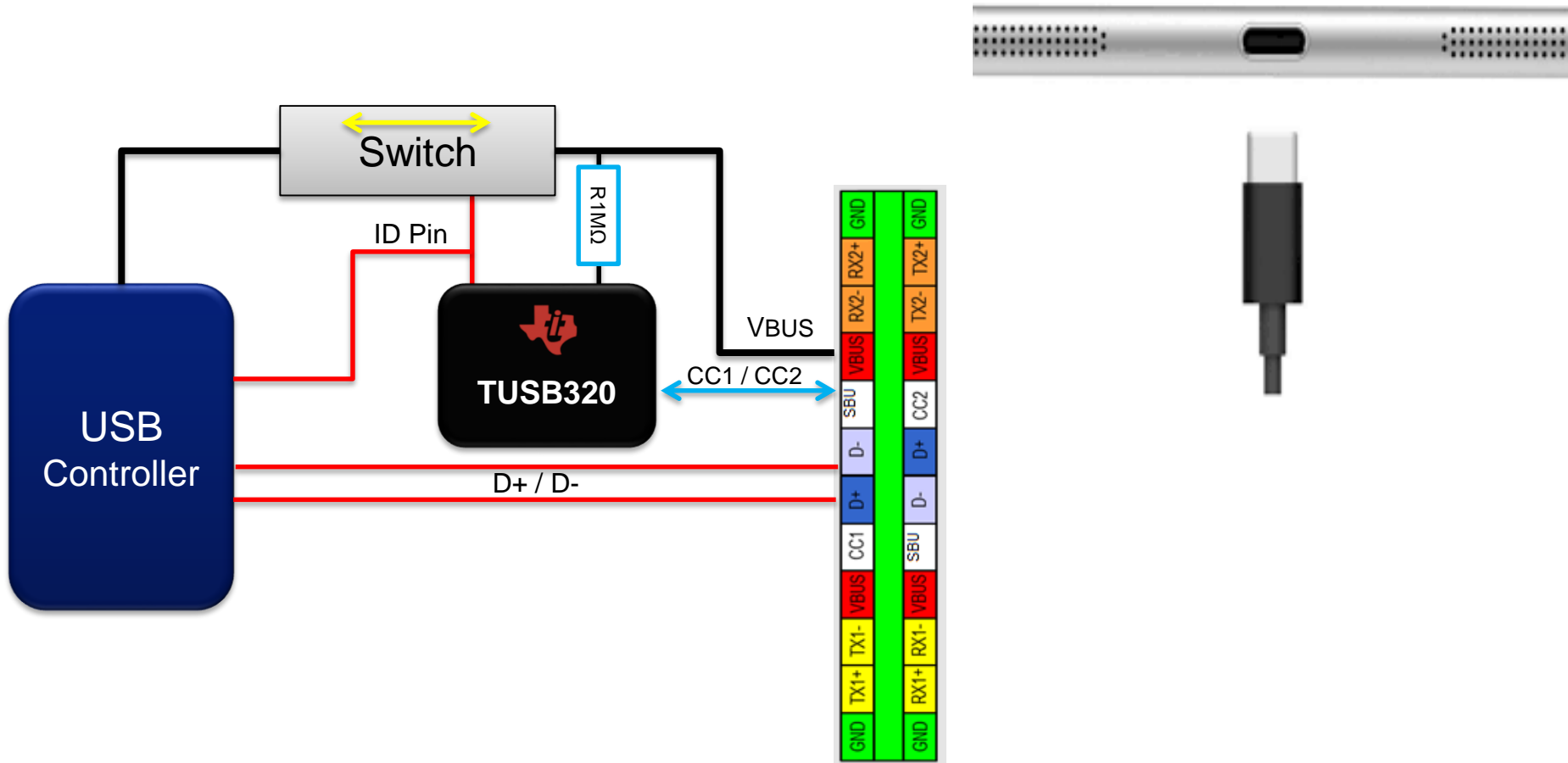
TPS65982

# Type C USB 2.0 smartphone



## TUSB320 DRP CC Controller

Upgrade your USB 2.0 OTG cellphone easily with TUSB320

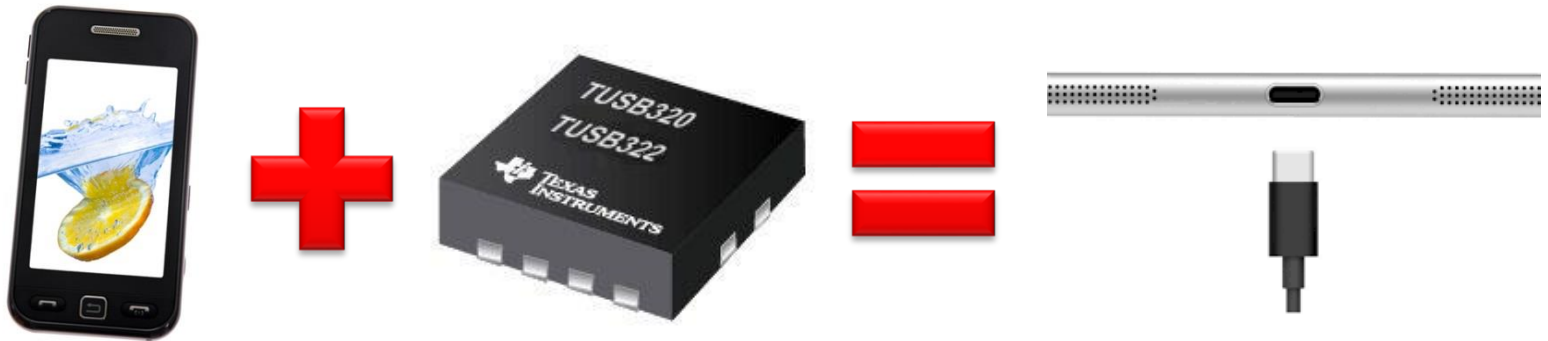




# Type C USB 3.0 smartphone

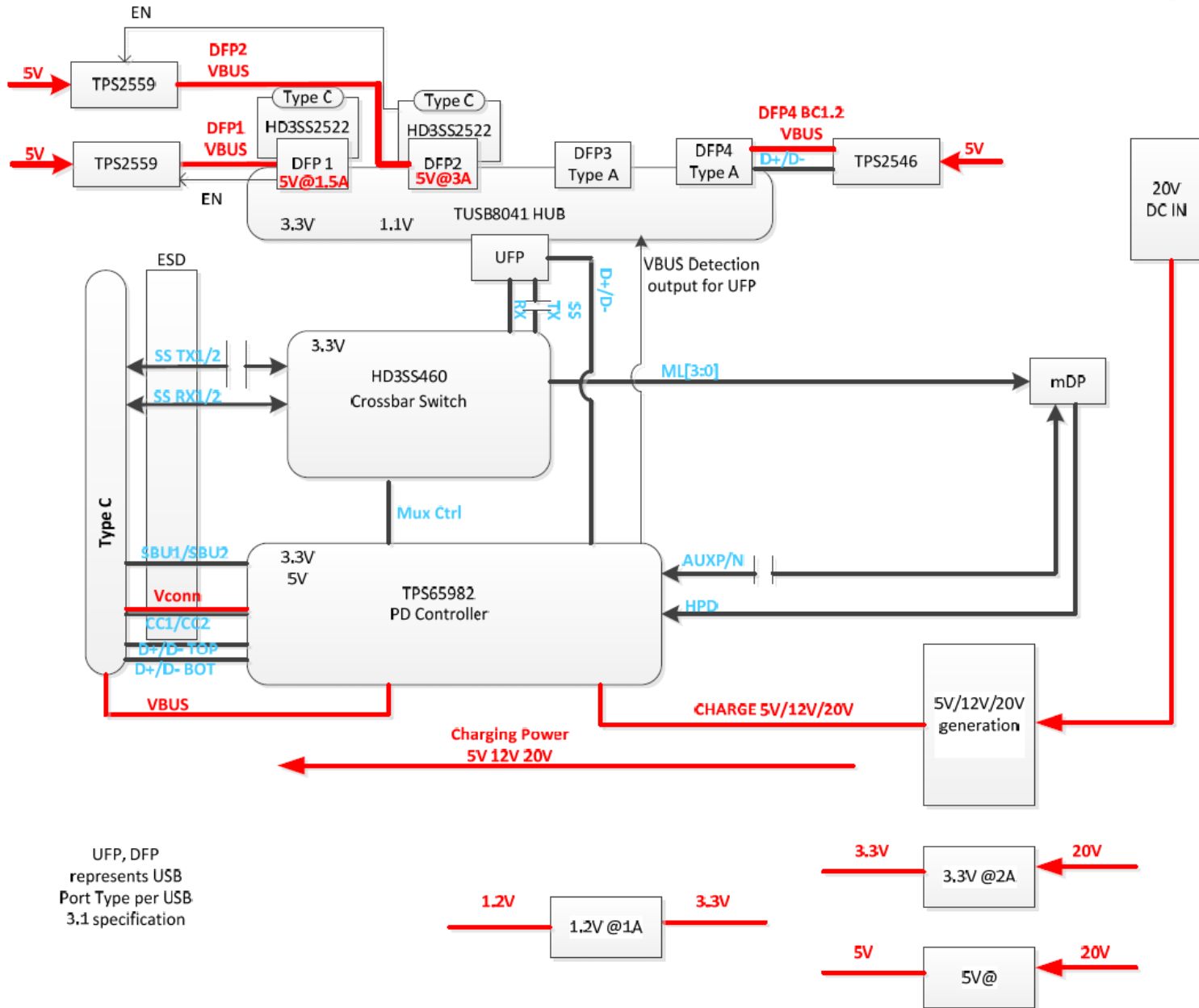


- **DRP CC Controller options**
  - TUSB320
  - TUSB321
- **Mux options**
  - HD3SS3212
  - TUSB542 active re-driver mux

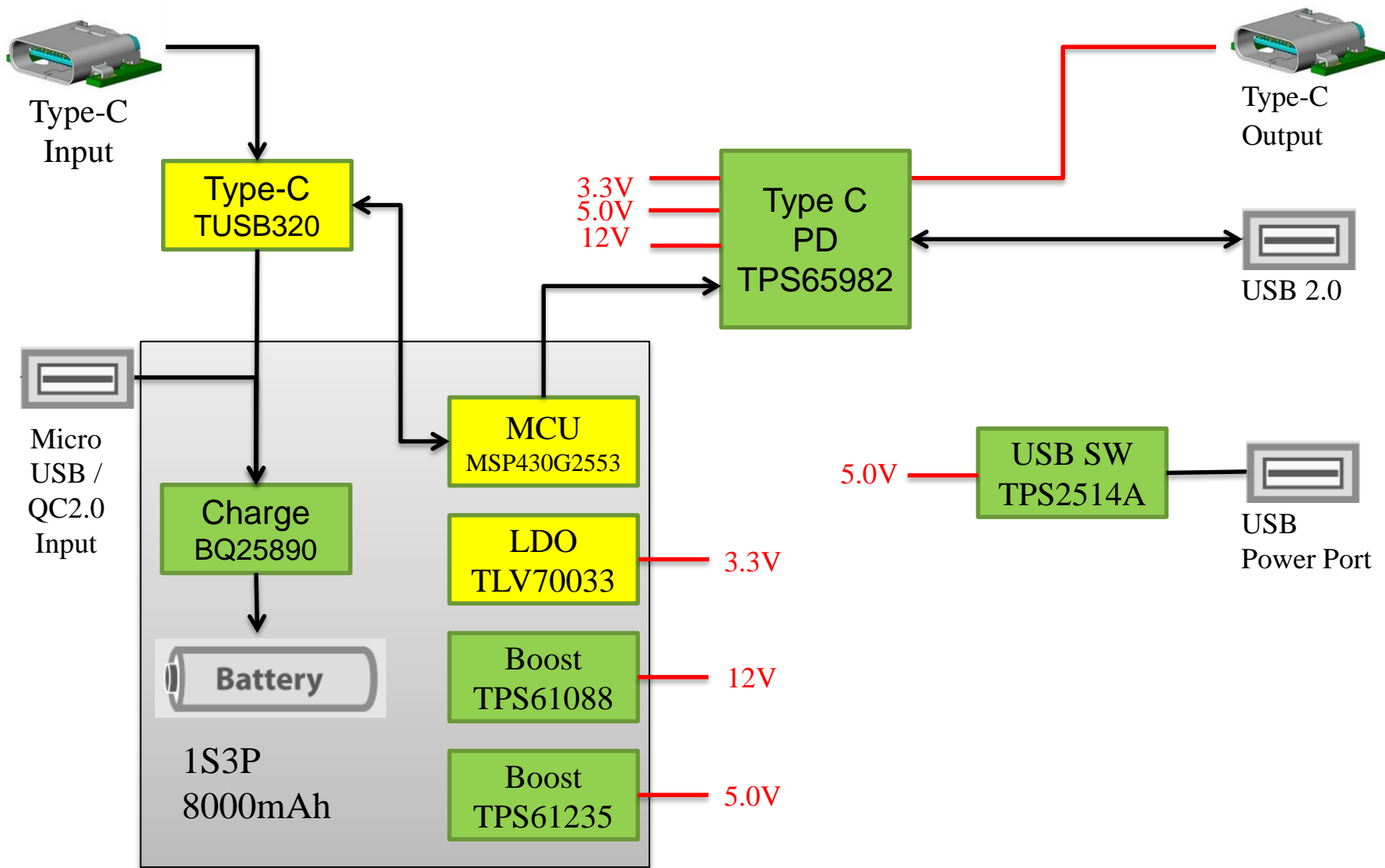


Upgrade your USB 3.0 OTG cellphone easily with TUSB320 or TUSB321

# Type C USB3.0 Docking Solution Block



# Type-C Power Bank Solution





*Thank you*

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