

Pericom's Latest USB S&C

PI5USB2544, PI5USB2544A, PI5USB2546, PI5USB2546A

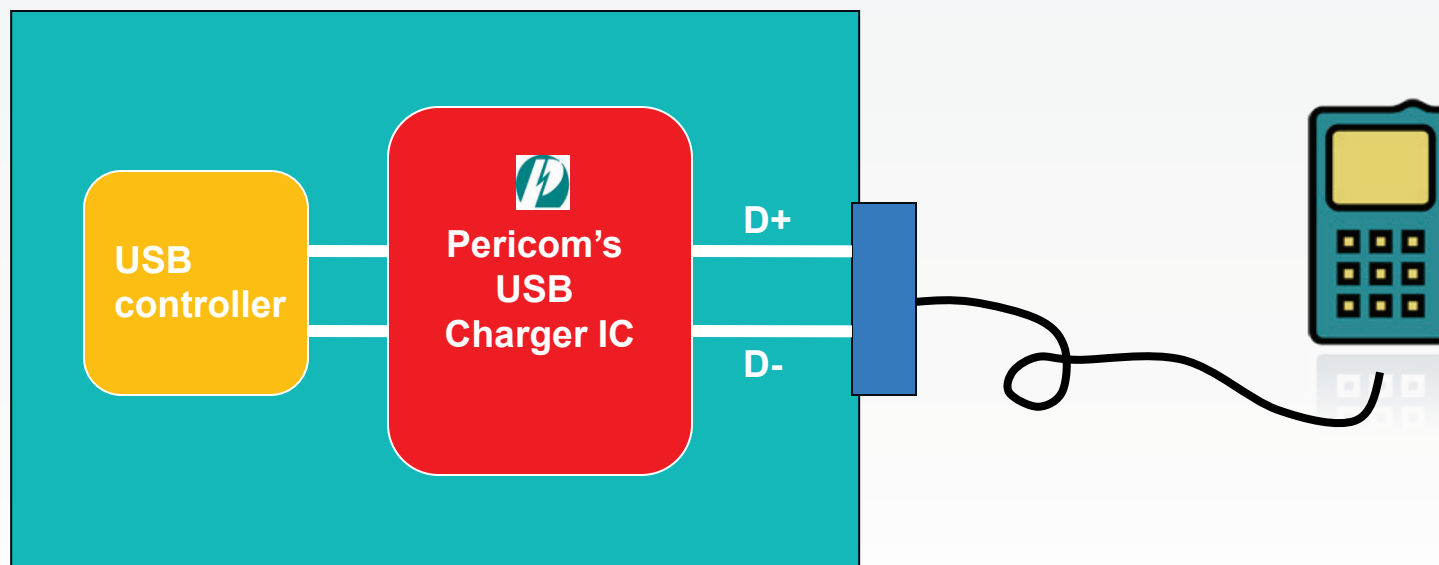
USB Charging Controller for PC

→ Provide charging function when OS is in any mode:

- S0 (on) /
- S3 (Standby mode)/
- S4 (Hibernate mode)/
- S5 (Shut down)

USB Charging Controller for PC

- S0: Standard port (500mA) or Charging port (CDP - 1.5A) per USB BC1.2
- S3/S4/S5: convert port from a dead port to a dedicated charging port per USB BC1.2, YD/T-1591-2009, and fulfill Samsung Galaxy charger or Apple charger requirements



S0 (Normal USB operation)

→ Standard Downstream Port - SDP

- If bus is not suspended and configured, maximum output current = 500mA (USB2.0)

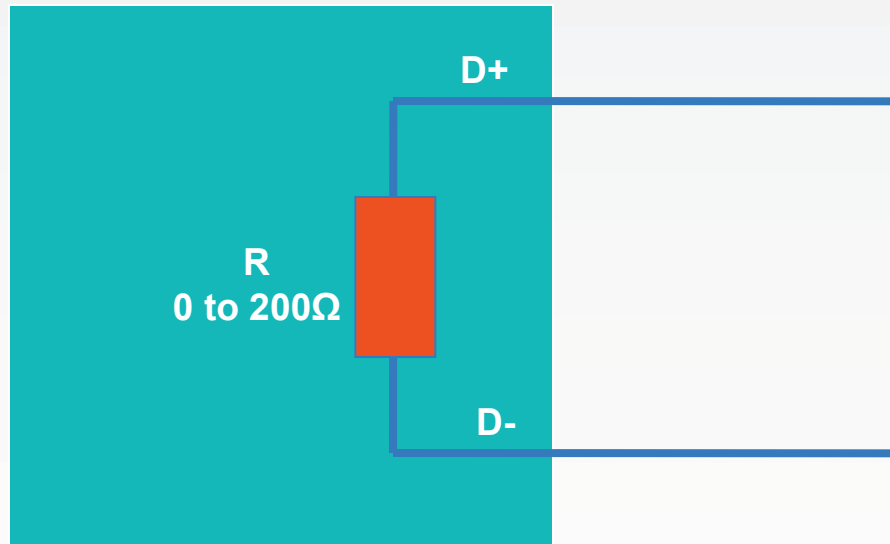
→ Charging Downstream Port – CDP

- supply a maximum of 1.5 A

S3/S4/S5 = Sleep and Charge

➔ Dedicate mode charger (DCP)

- ❑ USB charging specification 1.1/1.2
- ❑ Chinese Telecommunication Industry Standard YD/T1591-2009 charger specification
- ❑ Maximum current = 1.5 A at 5.25 V.



S3/S4/S5 = Sleep and Charge

→ Non BC 1.2 spec.

→ Apple different charger mode

- iPad charger (Max. charging current 2A and 2.4A)
- Other Apple device charger (Max. charging current up to 1A)

Output Voltage	Apple 1A	Apple 2A	Apple 2.4A
D+	2.0V	2.7V	2.7V
D-	2.7V	2.0V	2.7V

→ Samsung fast charger mode (for Galaxy Tab)

Output Voltage	Samsung Galaxy
D+	1.2V
D-	1.2V

Different Charging per BC1.2 - CDP/ SDP/ DCP

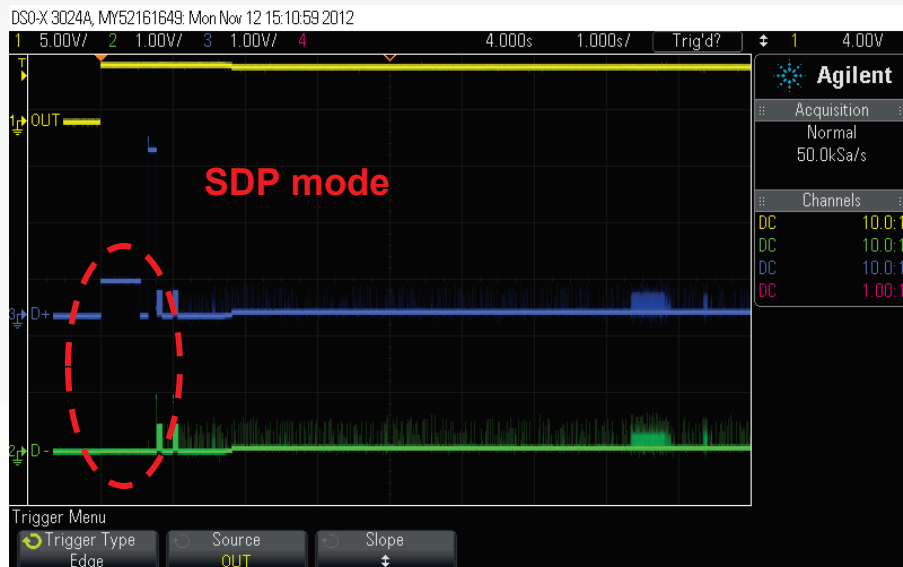
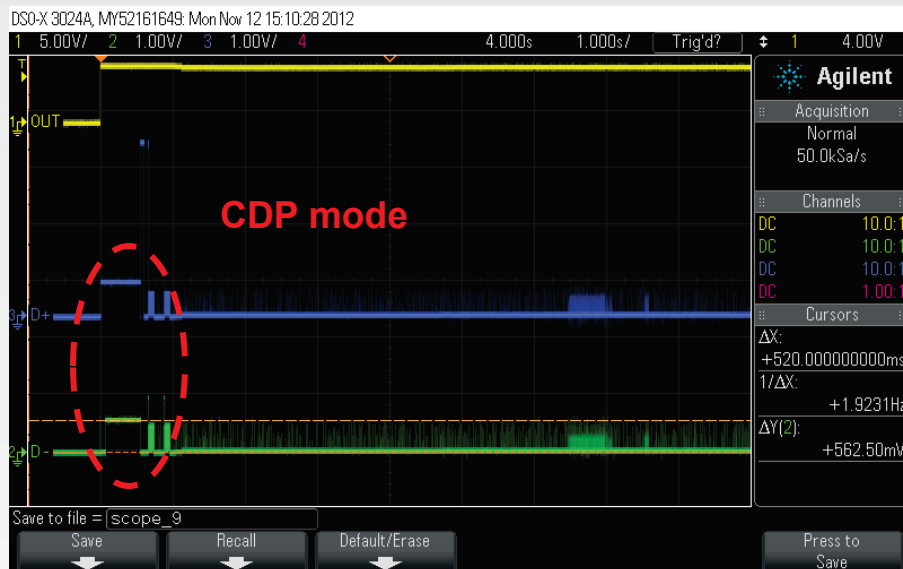
- CDP: Charging downstream port (1.5A), data transaction + charging
- SDP: Standard downstream port (USB2.0 = 500mA; USB3.0 = 900mA), data transaction + charging
- DCP: Dedicated charging port, (1.5A), charging only



How Portable device distinguish the SDP, CDP, DCP

- Two Detection stage according to Battery Charging Specification
- Primary detection - distinguish whether the USB port is SDP or CDP and DCP
 - PD send out a 0.5-0.7V pulse from D+ and check whether the USB port reply a 0.5-0.7V pulse from D-
 - SDP - No reply on D-
 - CDP/DCP – reply on D-
- Secondary detection - distinguish whether the USB port is CDP or DCP (BC1.2 only)
 - PD send out a 0.5-0.7V pulse from D- and check whether the USB port reply anything on D+
 - CDP - No reply on D+
 - DCP – receive a signal from D+ (As D+/D- short together)

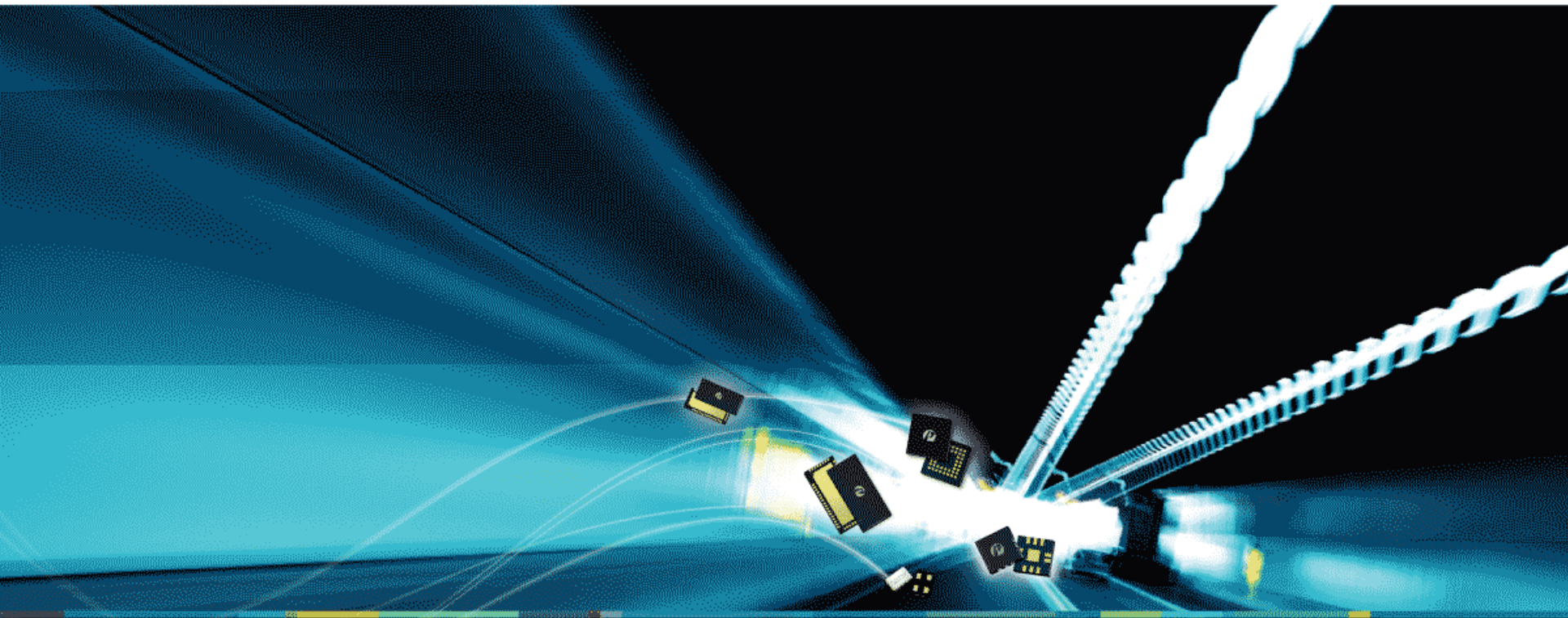
Waveform of CDP and SDP



➤ A CDP requested PD plugged into a CDP port and a SDP port

➤ Waveform index:

- Yellow = Vbus
- Green = D-
- Blue = D+



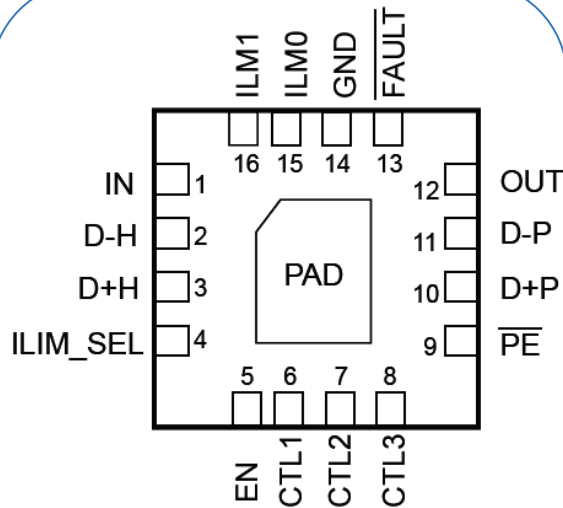
Pericom's latest USB S&C IC – PI5USB2544, PI5USB2544A, PI5USB2546, PI5USB2546A

PI5USB2543 vs 2546/A vs 2544/A

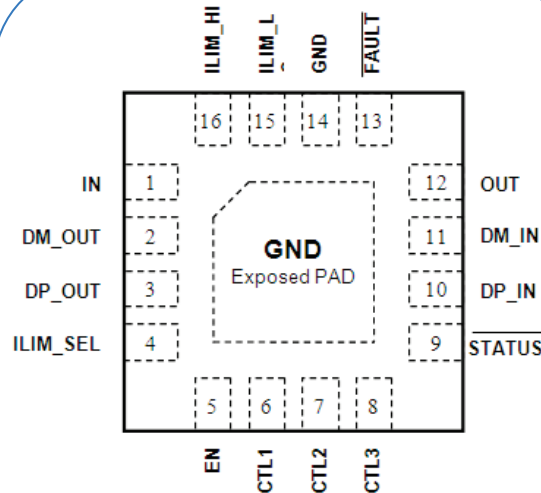
Features	PI5USB2543	PI5USB2546 = TPS2546	PI5USB2546A	PI5USB2544 = TPS2544	PI5USB2544A
Port power control (PPC)	No	Yes	Yes	No	No
Automatic CDP/SDP switching for devices that do not connect to CDP port	No	Yes	Yes	Yes	Yes
LS KB/mouse wake-up when S0 \leftrightarrow S3	Yes	Yes	Yes	Yes	Yes
FS KB/mouse wake-up when S0 \leftrightarrow S3	No	Yes	Yes	Yes	Yes
OCP, OTP, OVP	Yes	Yes	Yes	Yes	Yes
OCP Precision	+/-20%	+/-7% (trim)	+/-7% (trim)	+/-7% (trim)	+/-7% (trim)
Power wake (plug-in detection in S3, S4 and S5)	Yes	Yes	Yes	Yes	Yes
YD/T 1591-2009 charging (D+/- shorted and charging)	Yes	Yes	Yes	Yes	Yes
BC 1.2: DCP, SDP, CDP	Yes	Yes	Yes	Yes	Yes
Power MOSFET RON	100m Ω	73m Ω	73m Ω	73m Ω	73m Ω
Non-BC 1.2 charging: •Apple 1A, 2A (Divider-1A, -2A) charging	Yes	Yes	Yes	Yes	Yes
Non-BC 1.2 charging: •Samsung 1.2V fast charging (DCP-1.2V)	No	Yes	Yes	Yes	Yes
Non-BC 1.2 charging: •Apple 2.4A charging, (Divider-2.4A)	No	No	Yes	No	Yes
Reverse leakage protection	No	Yes	Yes	Yes	Yes

PI5USB254x Pin assignment

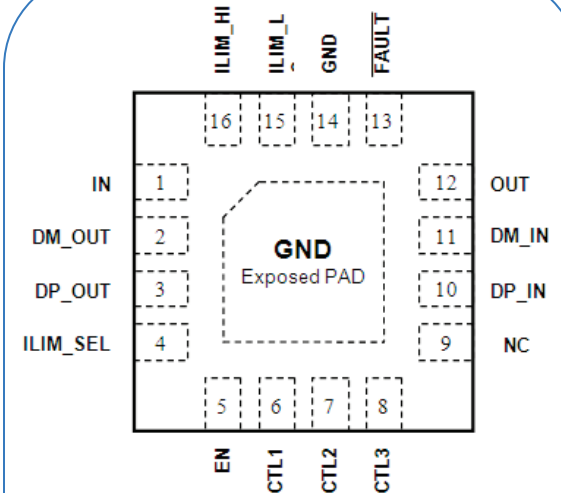
- All part are in the same package – TQFN 16 pin
- Same package of PI5USB2543



PI5USB2543



PI5USB2546
PI5USB2546A

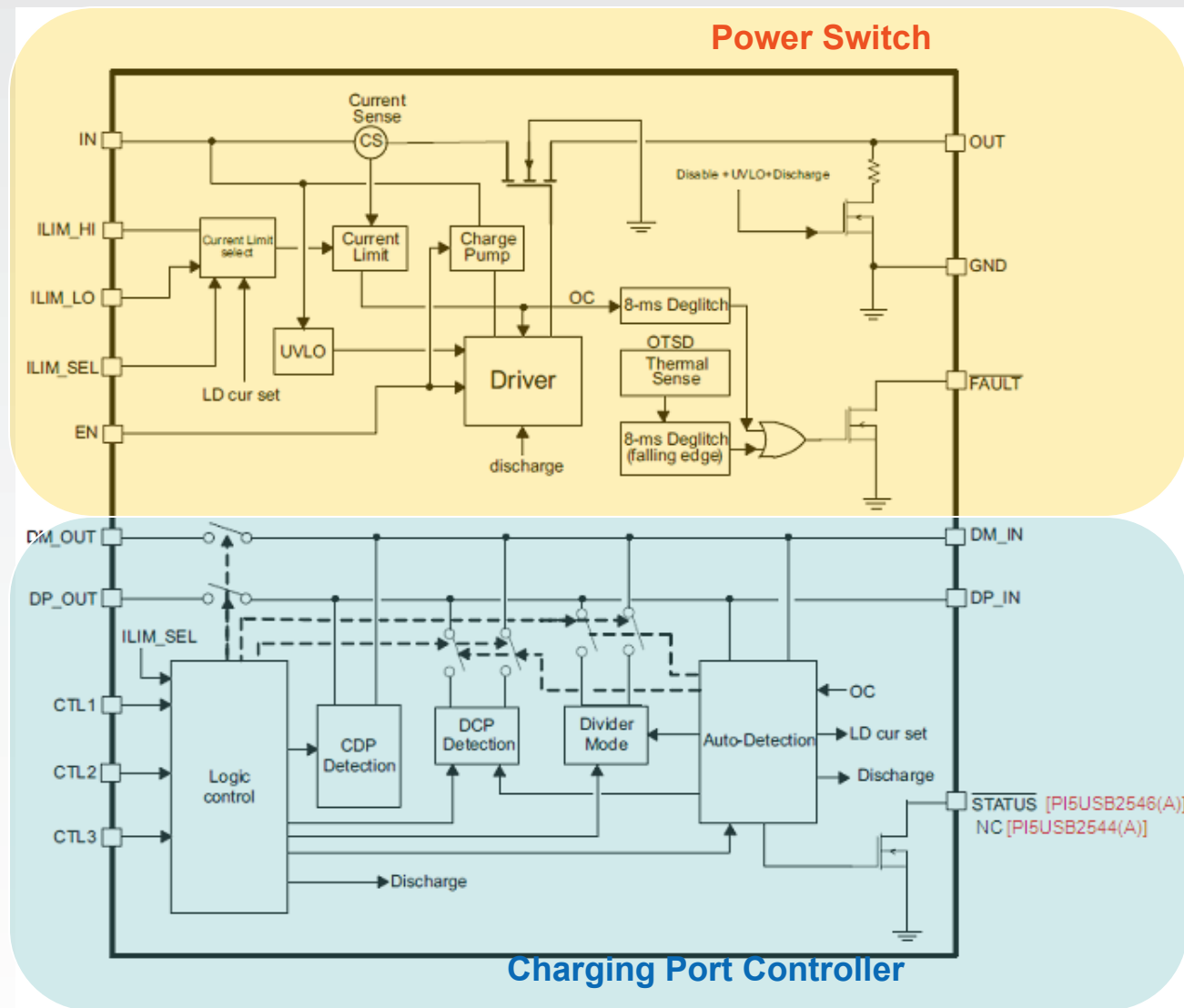


PI5USB2544
PI5USB2544A

PI5USB2544/A / PI5USB2546/A Block Diagram

Features

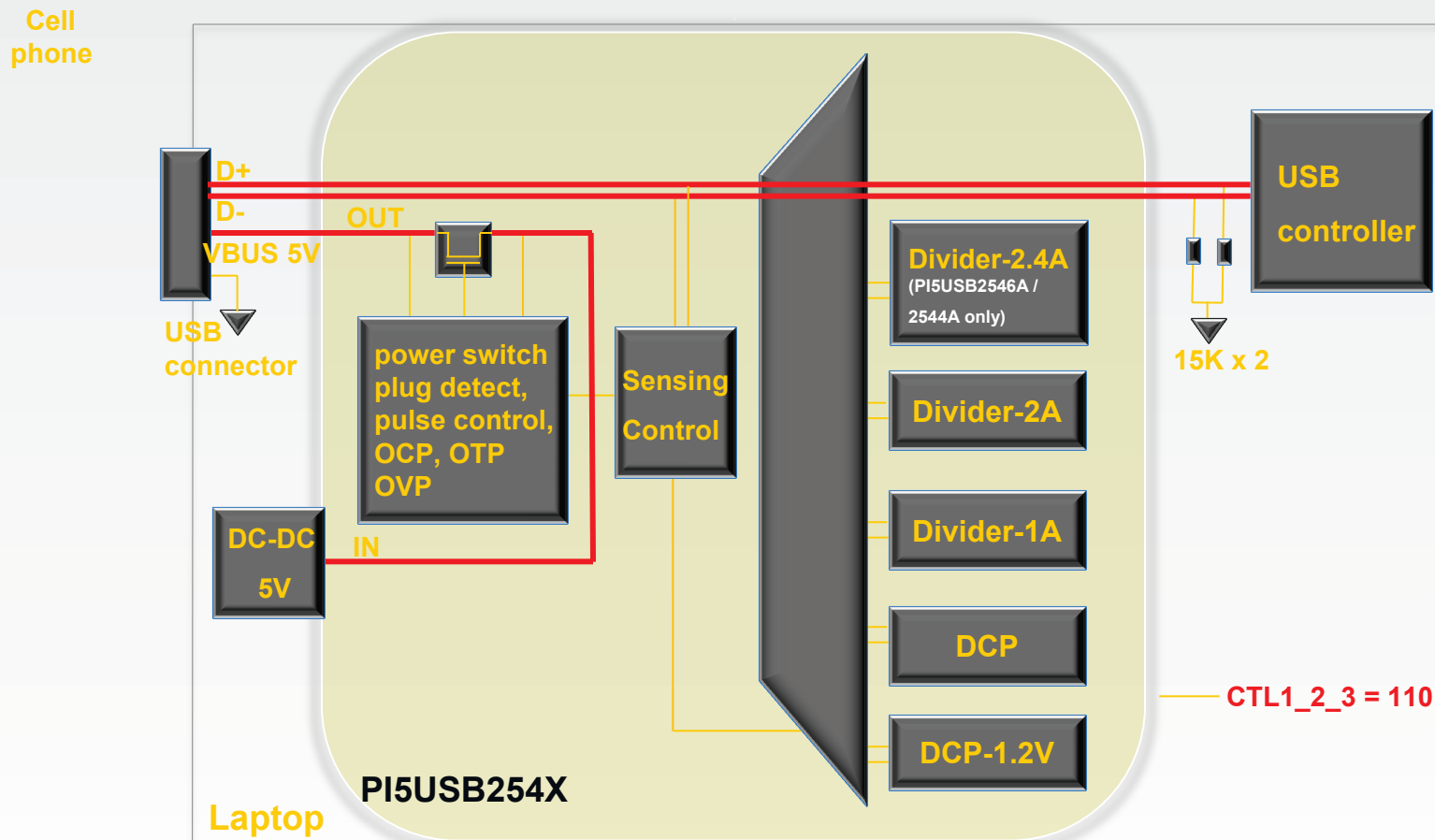
- Two separate current limiting channels
- Supports D+/D- CDP/DCP Modes per USB Battery Charging Specification 1.2
- Supports D+/D- Shorted Mode per Chinese Telecommunication Industry Standard YD/T1591-2009
- Supports non-BC1.2 Charging Modes by Automatic Selection
 - D+/D- Divider Modes 2.0/2.7V, 2.7/2.0V and 2.7/2.7V
 - D+/D- 1.2V Mode
- Supports Sleep-Mode Charging and Mouse/Keyboard Wake up
- Automatic SDP/CDP Switching for Devices that do not Connect to CDP Ports
- Load Detection for Power Supply Control in S4/S5 Charging and Port Power Management in all Charge Modes
- Compatible with USB 2.0/3.0 Power Switch requirements
- Integrated 73-mΩ (Typ.) High-Side MOSFET
- Adjustable Current-Limit up to 3A (Typ.)
- Operating Range: 4.5V to 5.5V
- Max Device Current
 - 2μA at Device Disabled
 - 270μA at Device Enabled



Back

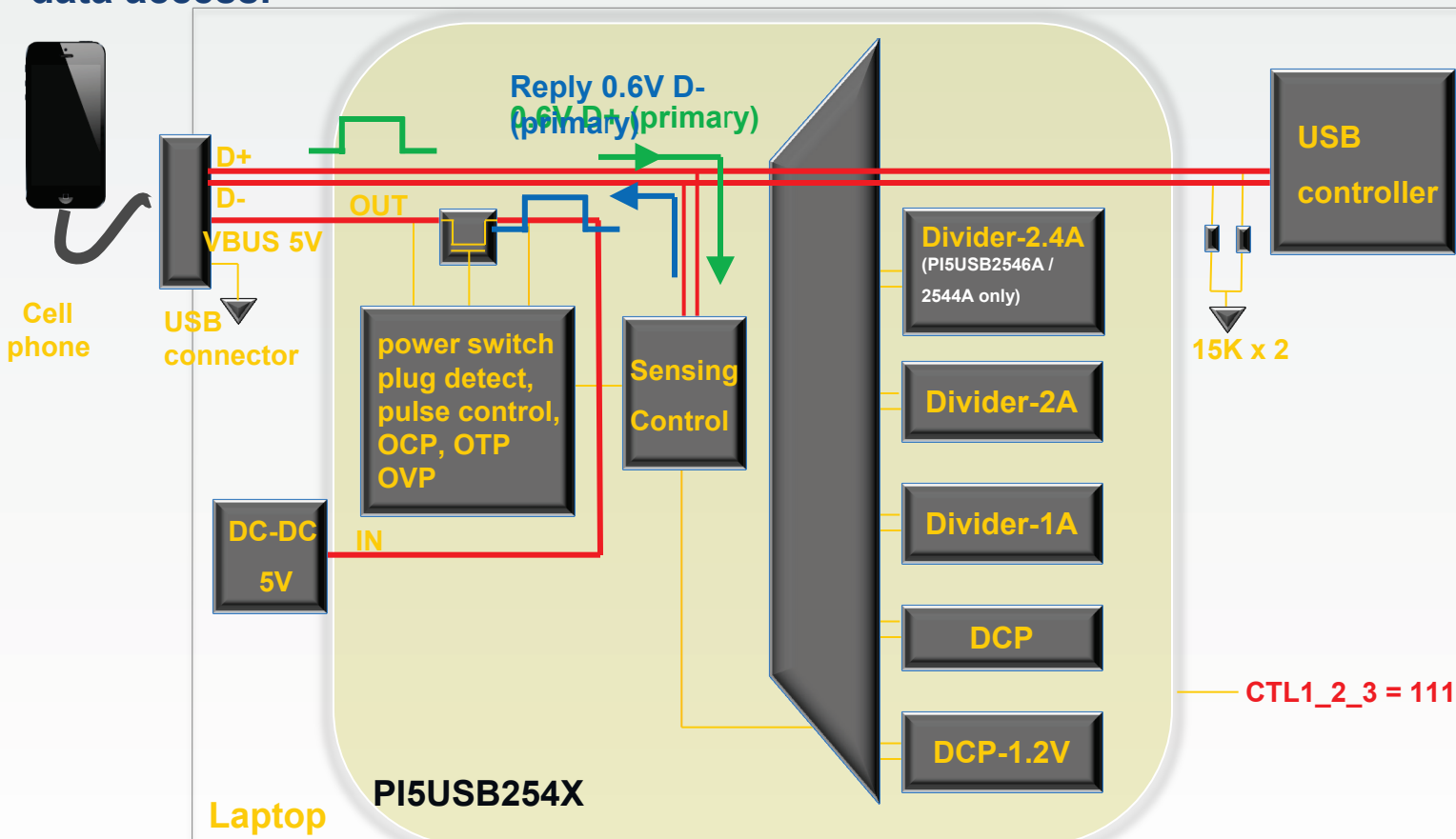
PI5USB25XX in SDP mode

- BC 1.2, SDP - same as a normal USB port in USB 2.0.
- In Windows, PI5USB254X will simply connect (lines in red) the cell-phone to the USB controller only.



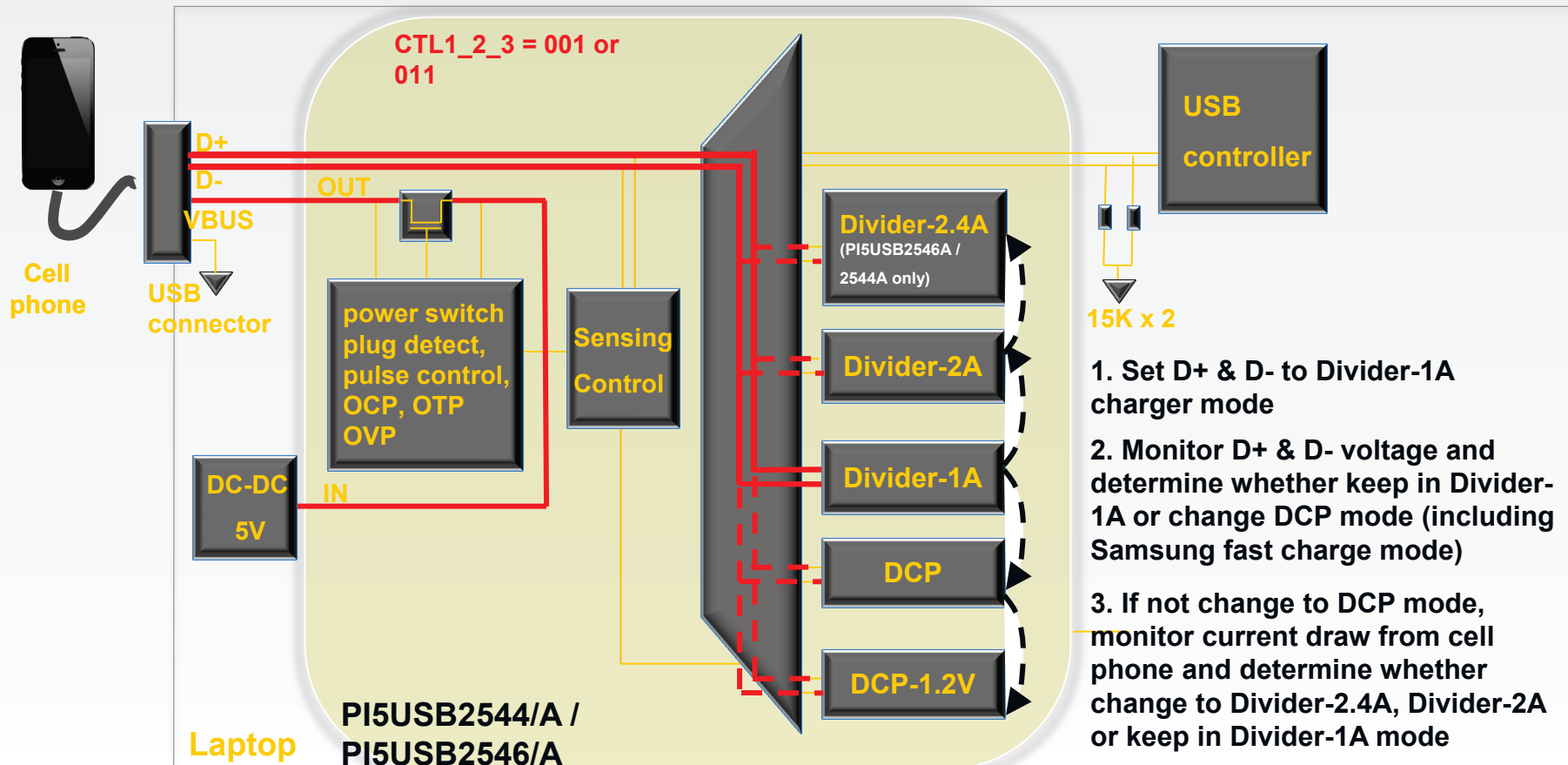
PI5USB254X – CDP mode

- ➔ CDP request cell-phone plugged and seen 5V Vbus, the cell phone will apply a 0.6V on D+ (primary detection) and PI5USB254x will reply a 0.6V on D- (see the connections in red).
- ➔ cell-phone will apply 0.6V on D- (secondary detection) and PI5USB254x will not reply.
- ➔ cell-phone will start to charge maximum 1.5A and will also enumerate to Windows for data access.



PI5USB254X – Auto DCP mode

- ➔ **PI5USB2544/A, PI5USB2546/A enter Divider-1A mode after CTL1/2/3 = 001 or 011**
- ➔ **2 detection method:**
 - **Detect D+/D- voltage for charging to DCP mode**
 - **Detect the current for Divider-2.4A (PI5USB2544A/PI5USB2546A only), Divider-2A or Divider-1A mode**

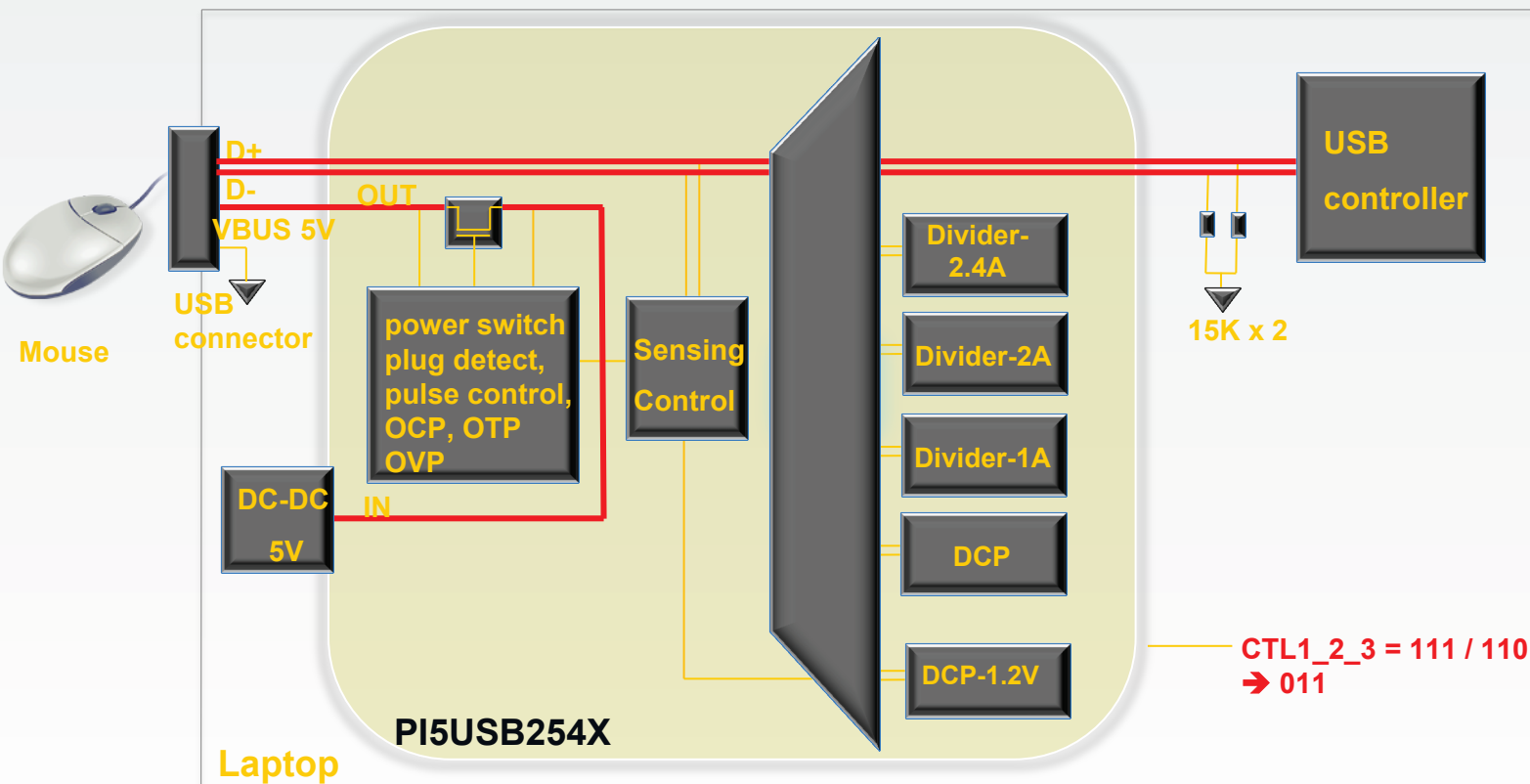


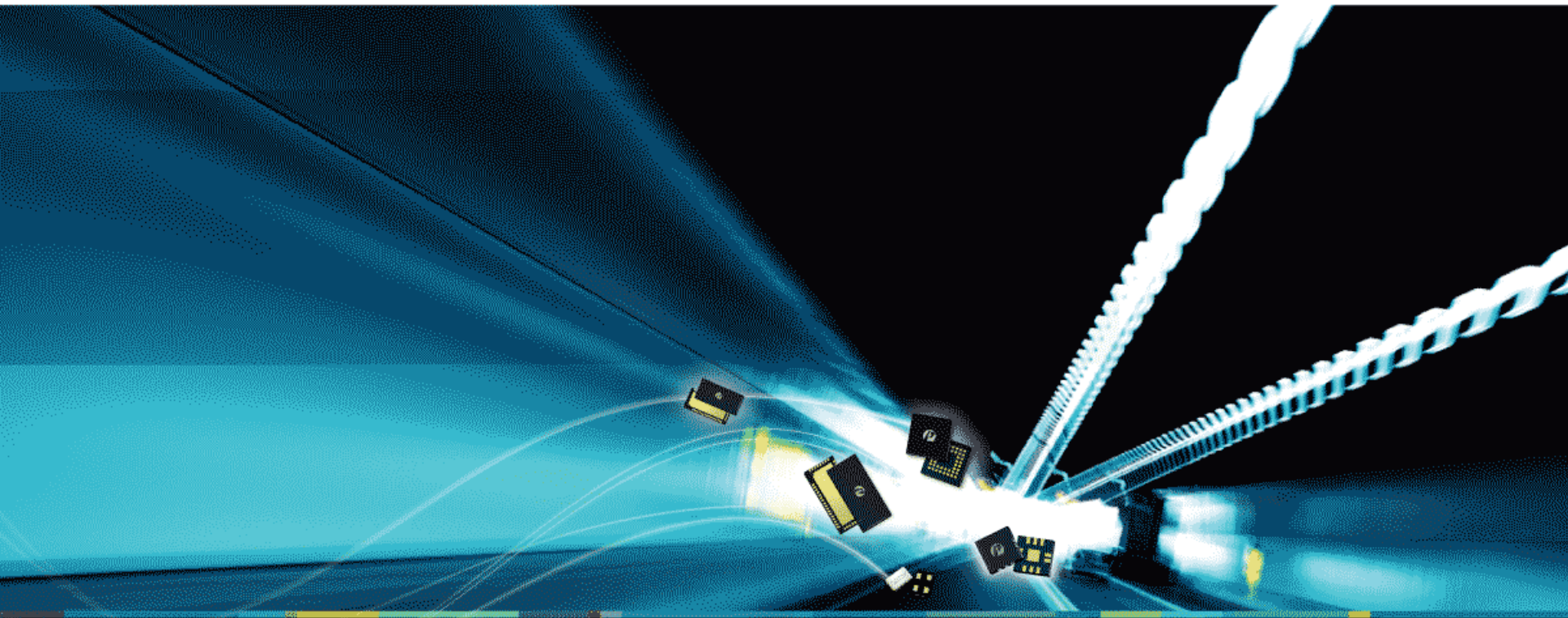
PI5USB254X– Keyboard, mouse pass through

→ USB charging port is keep the connection of the low speed (LS) or full speed (FS) keyboard-mouse to USB controller, rather than change to charging mode, when switching from Windows to sleep.

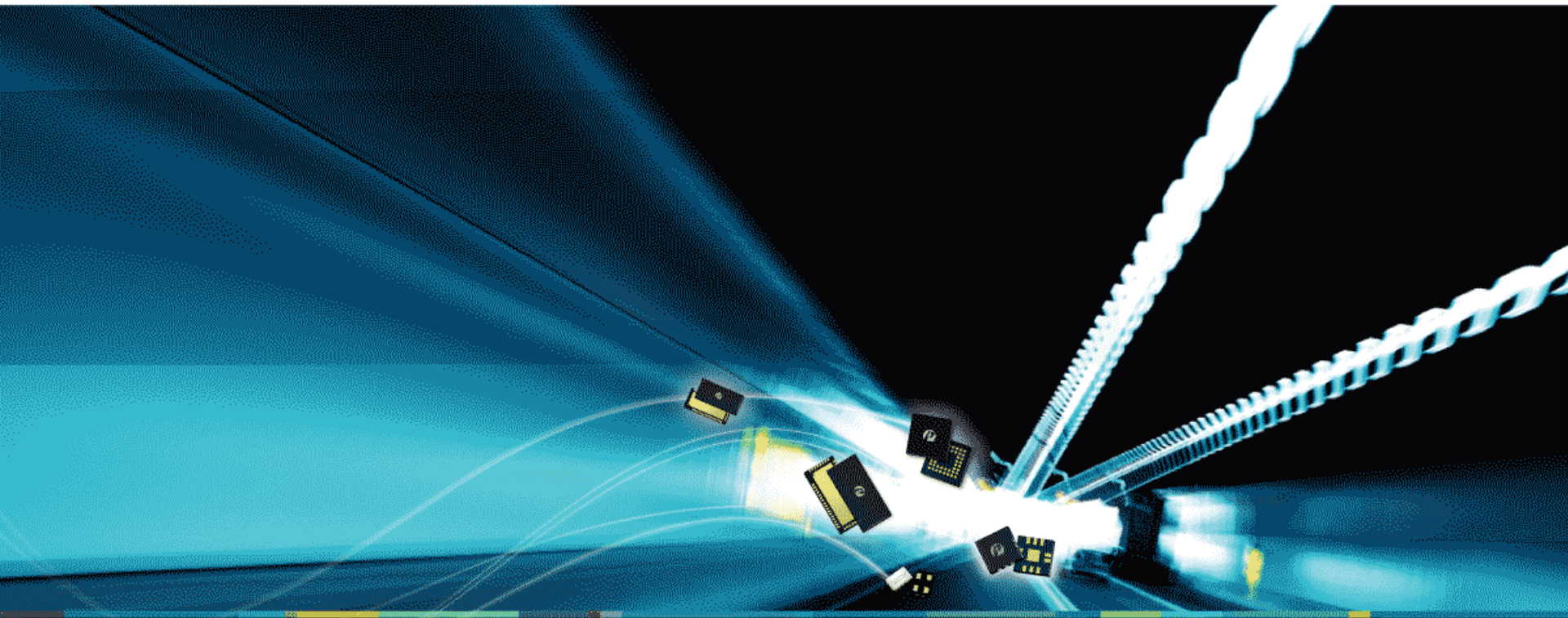
→ Under sleeping mode, PI5USB254X will stay in USB switch mode to keep the connection between LS / FS keyboard-mouse and USB controller (lines in red).

Remark: PI5USB2543 detect LS device only





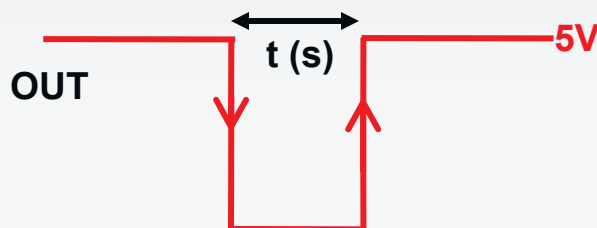
Other information



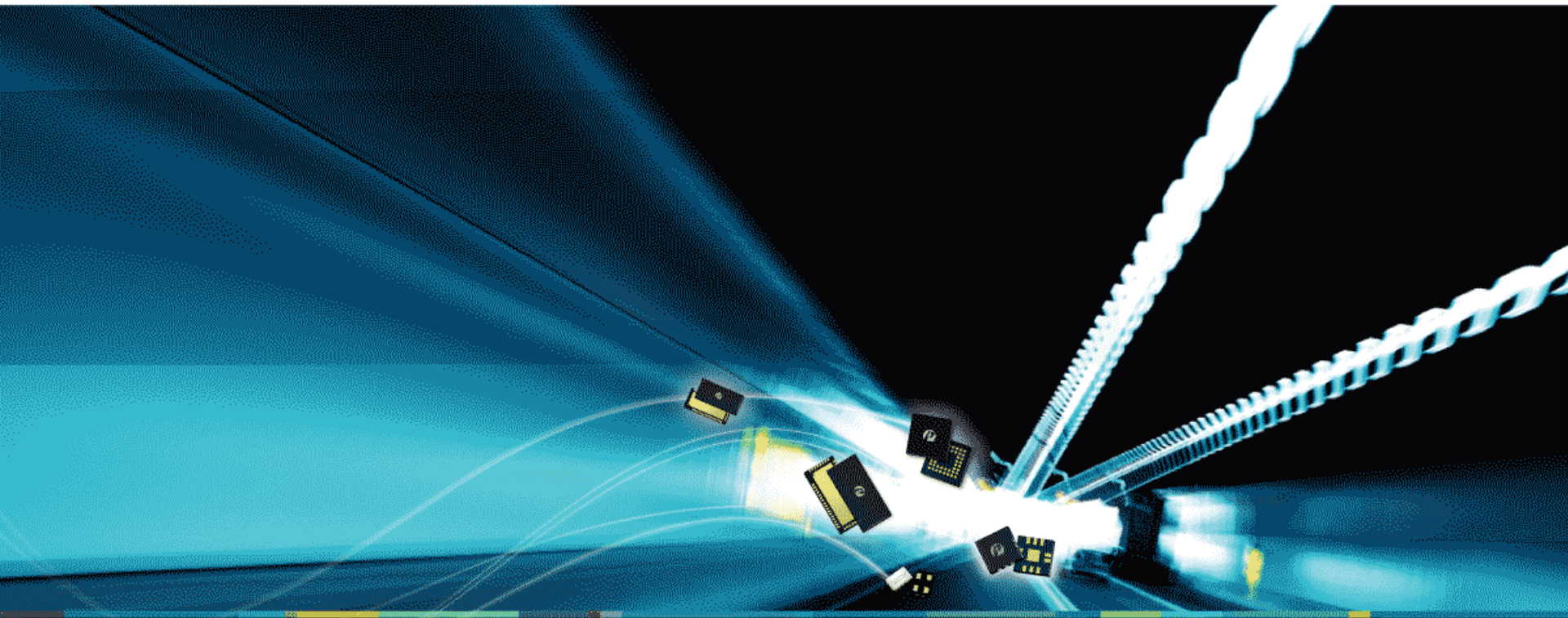
1. Vbus Off pulse

Vbus Off Pulses

- ➔ A chargeable device will detect the mode (SDP, DCP, CDP, Apple, etc.) of a USB charging port **one-time** only, when it detect the rising-edge of Vbus 5V. It need another 5V Vbus rising-edge to re-detect the USB port again (BC 1.2 requests Vbus pulse when changing between SDP, CDP and DCP).
- ➔ There are two ways that can reset a chargeable device:
 - re-plug,
 - generate a Vbus pulse to mimic a re-plug.
- ➔ PI5USB254X will generate Vbus pulses when switching between various charging mode and USB modes to assure proper charging and working



Part Number	Vbus off timing for each device – t(s)
PI5USB2543	500ms
PI5USB2544/A	(a) 2s
PI5USB2546/A	(b) 400ms (change back to CDP or SDP mode)



2. Power Wake

Power wake : PI5USB2543 vs PI5USB2546/A

→ PI5USB2543

- Didn't support Power wake feature
- Will detect Vbus current >0.1mA as for plugged-in
- Will detect certain D+/- voltage as plugged-out.

→ PI5USB2546/A

- With current sensing and behavior same as TPS2546
- Will detect Vbus current >55mA as for plugged-in
- Will detect Vbus current <45mA as plugged-out.

(please refer to P.23 to P27 for details)

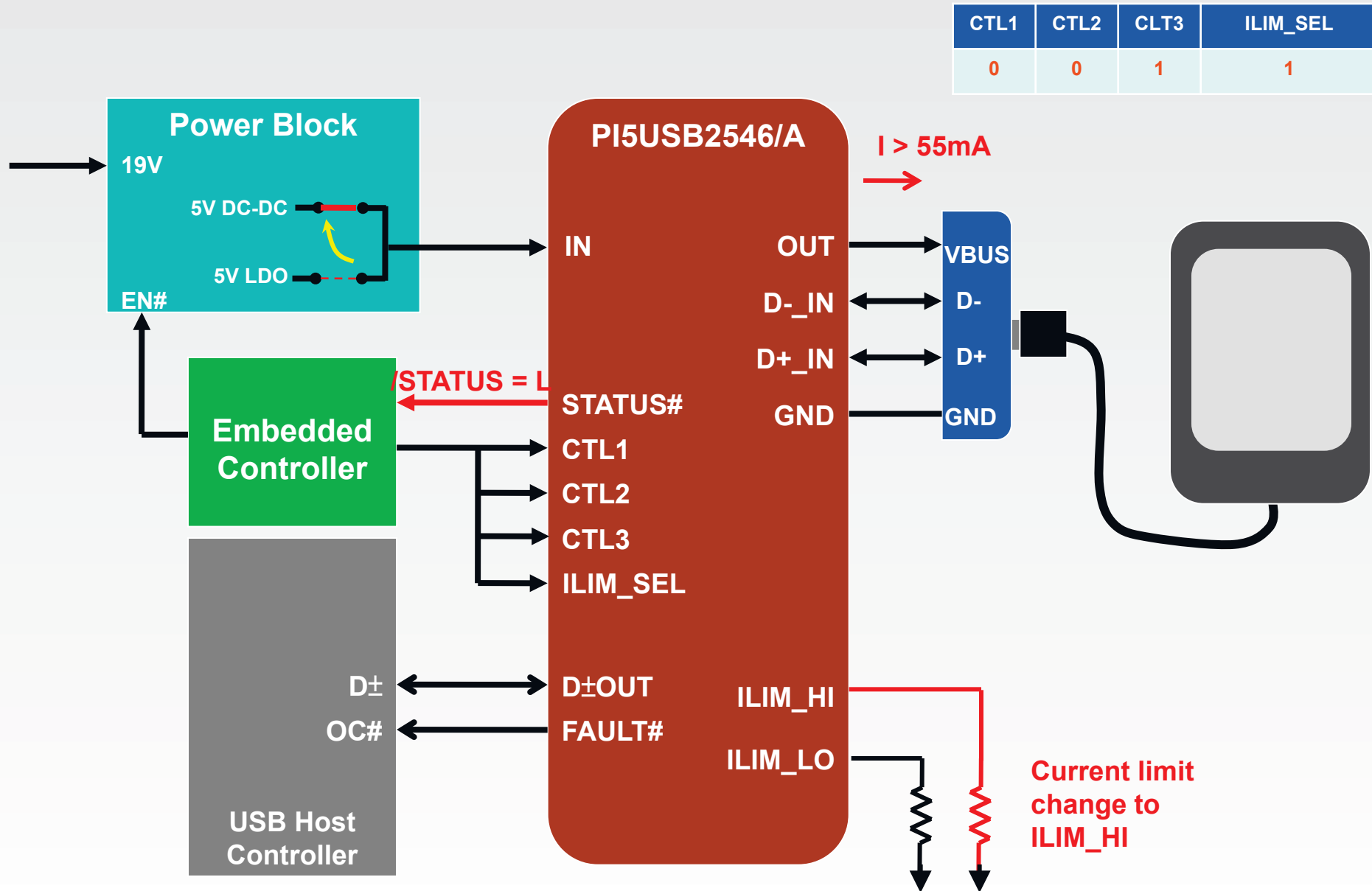
PI5USB2546/A Power Wake in Notebook

- Power wake is activated in S4 / S5 mode of the system
- CTL1/2/3 & ILIM_SEL = 0011
- Select between high power DC-DC converter or low power LDO based on charging requirements

PI5USB2546/A Power Wake in notebook

- When device is connected to the charging port and provide charging current $> 55\text{mA}$ (typ),
- STATUS# will pull “**LOW**” => the power supplier of the charging port will be switched out from LDO and to DC-DC converter
- VBUS turn off for 2s
- Current limit auto switch to ILIM_HI => (depends on the RILIM_HI - Pin 16 of PI5USB2546/A)

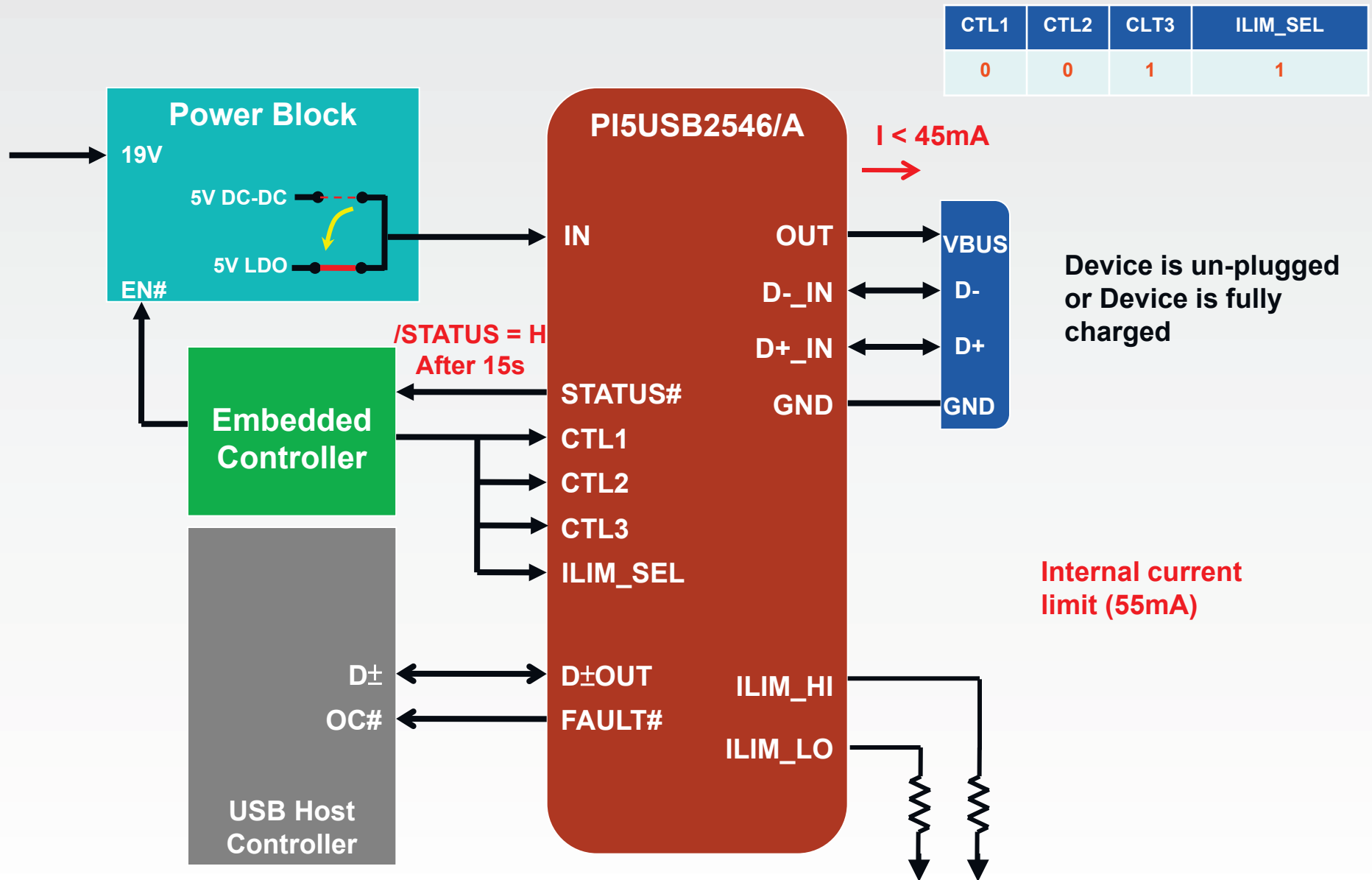
PI5USB2546/A Power Wake in notebook

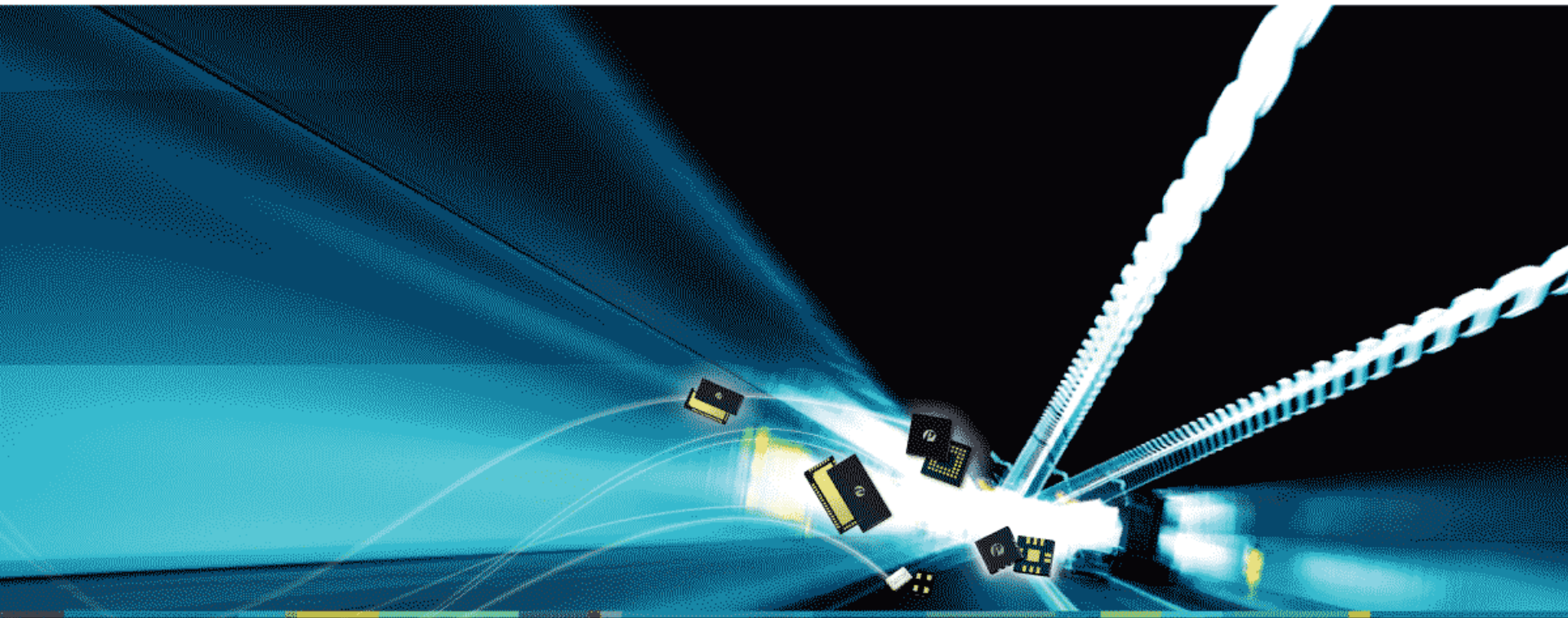


PI5USB2546/A Power Wake in Notebook

- When device is unplugged or device is fully charge and current is drop to $< 45\text{mA}$ (typ),
- STATUS# of PI5USB2546 will pull “HIGH” after 15s => control the low power LDO supplies the standby power of the charging port.
- Current limit set to internally => 55mA for LDO

Power Wake in notebook



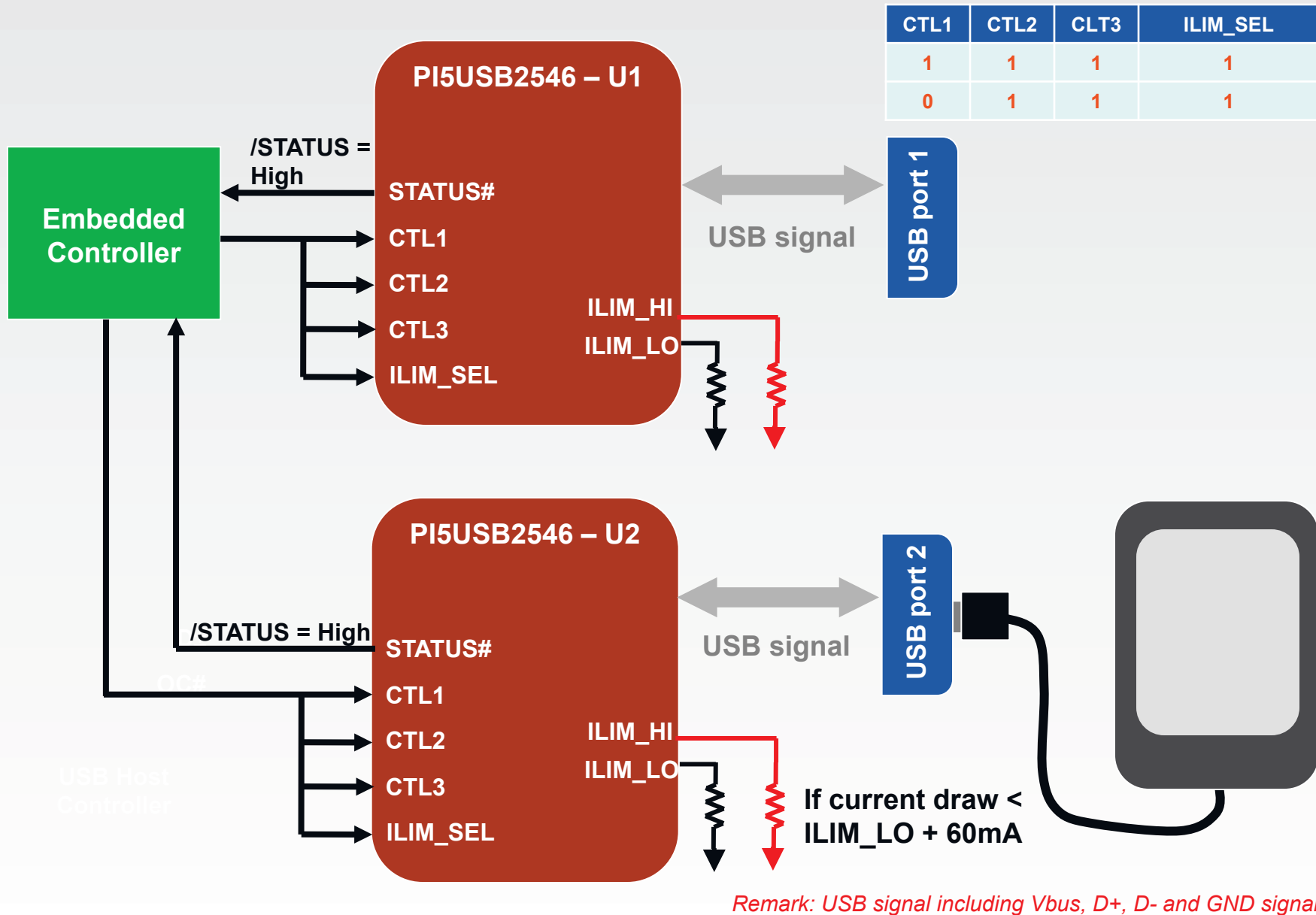


3. Port Power Management

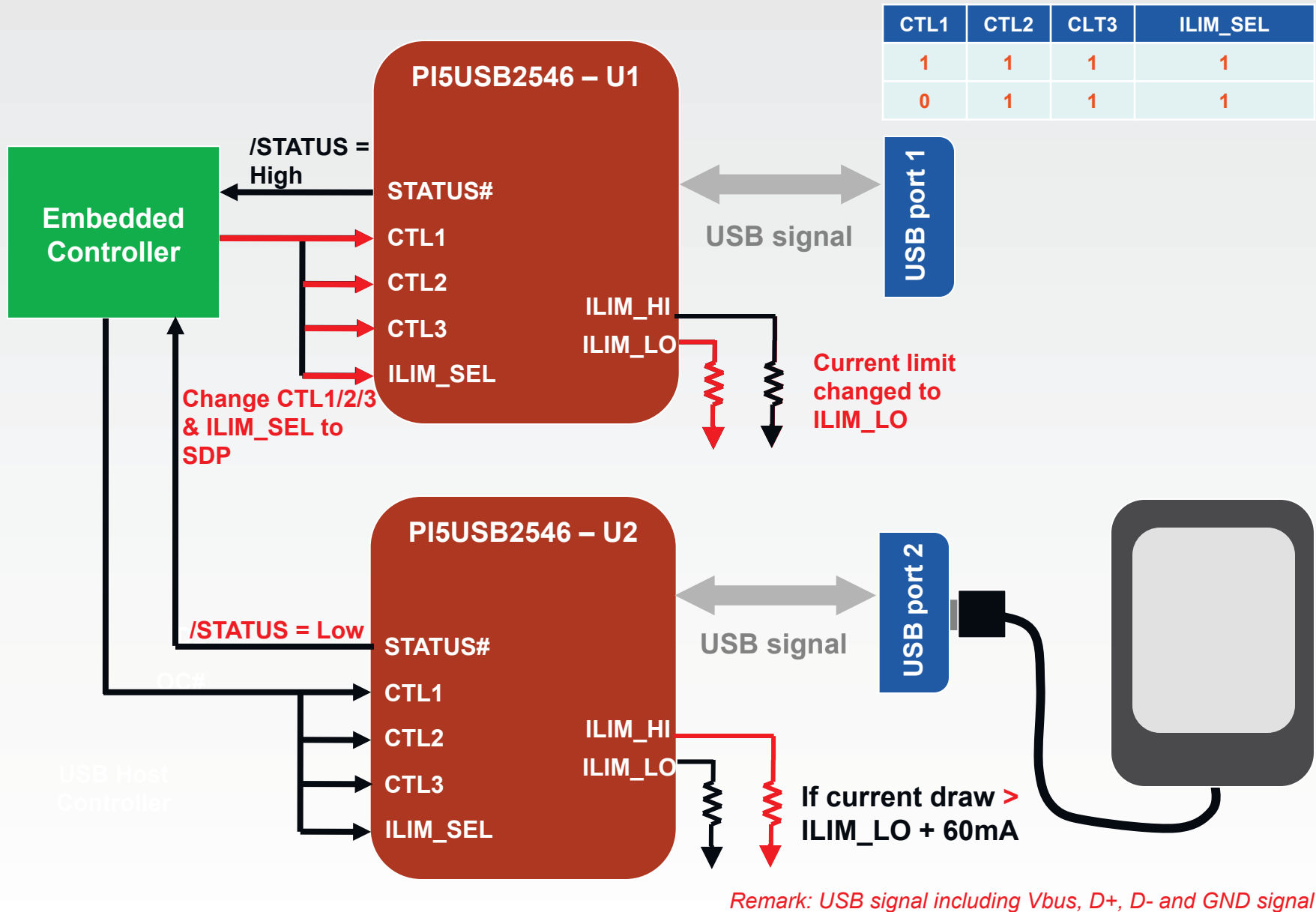
PI5USB2546/A Port Power Management (PPM)

- PPM is activated in S0 (CDP) or S3 - S5 (DCP_Auto) mode of the system
- CTL1/2/3 & ILIM_SEL = 1111 or 0111
- Prevents overloading of the system's power supply
- Limiting the total power of USB port
- System monitors /STATUS pin for different USB port
- Once # of USB port assert /STATUS, system will toggle the reminding port to a SDP
- If the charging current drop to $< ILIM_LO + 60mA$, /STATUS pin will de-assert and system resume the charging feature for all USB ports.

PPM in notebook



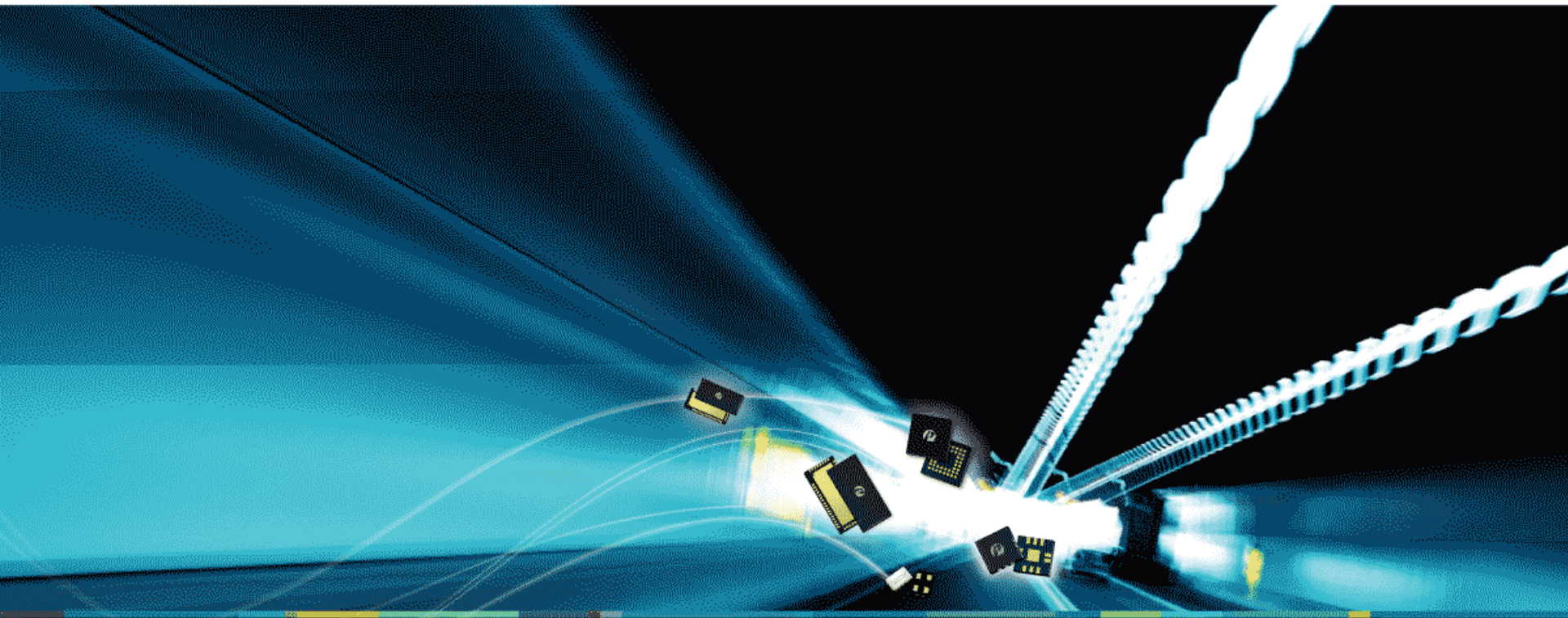
PPM in notebook





The End

Thank You



Appendix: Difference between PI5USB2546 vs TPS2546

Difference between PI5USB2546 and TPS2546

- Major feature and behaviors are the same between PI5USB2546 and TPS2546
- Difference only found on specially condition, eg. Charging current drop suddenly when IC just enter Divider-2A mode



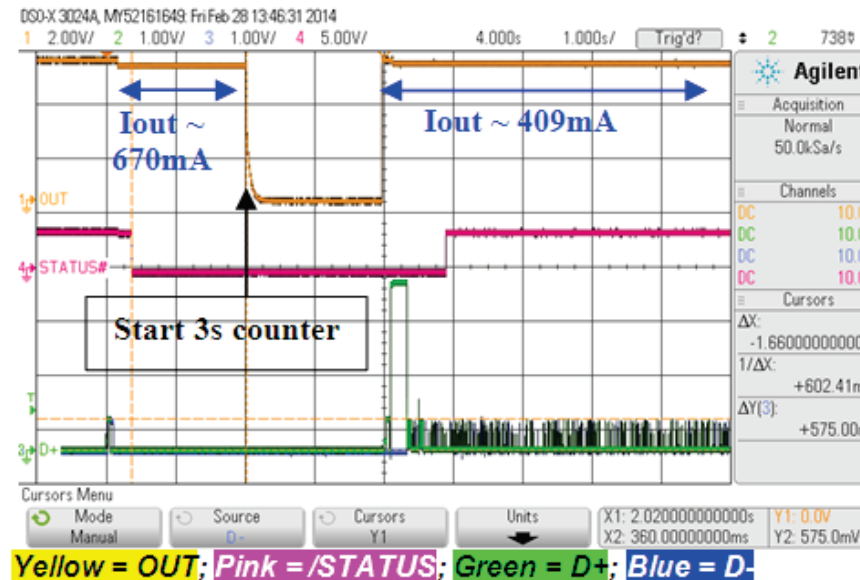
Difference between PI5USB2546 and TPS2546

→ /STATUS disable time (CTL1/2/3 & ILIM_SEL = 0111 or 1111)

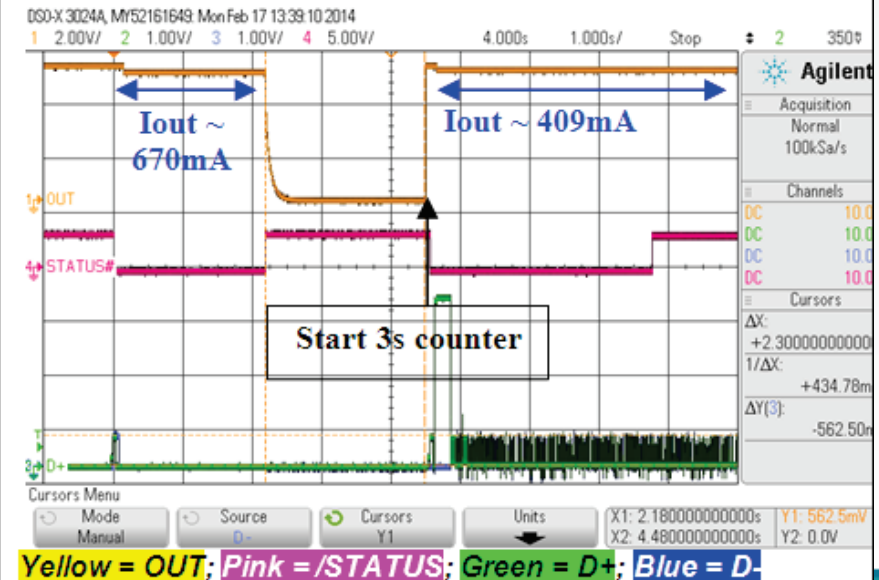
- When $I_{out} < I_{LIM_LO} + 50\text{mA}$, /STATUS will be resumed after 3s.
- The counter starting time between PI5USB2546 and TPS2546 is slightly difference.
- /STATUS resume faster than TPS2546

Example for Samsung Galaxy S2 plugged into CDP mode (Samsung Galaxy S2 is non-CDP device)

PI5USB2546

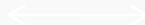


TPS2546



Difference between PI5USB2546 and TPS2546

- Detection time from Divider-2A back to Divider-1A (or Divider-2.4A to Divider-2A)
- Only when current will drop $< 100\text{mA}$ when D+/D- JUST enter Divider-2A (or 2.4A)
- trigger OUT drop (2s) before resume to Divider-1A
- This difference solve the looping issue on HTC butterfly and Sony Xperia Z under dead battery case



Difference between PI5USB2546 and TPS2546

- When current drop to $< 100\text{mA}$ when D+/D- enter Divider-2A / 2.4A within $t(\text{sec})$, 2sec OUT drop before resume to Divider-1A
- Detection time (t) = 15s for PI5USB2546; 3s for TPS2546
 - OUT drop found @ ~17s for PI5USB2546 after enter Divider-2A/2.4A mode; @4s for TPS2546

