USB Technology and Type-C Overview

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The Evolution of USB

1998
USB1.x
Low Speed
LS: 1.5Mbps
Full Speed
FS: 12Mbps

2000
USB2.0
High Speed
HS: 480Mbps
Full Speed
FS, LS

2001
USB OTG
Device can be
Both Master and Slave

2008
USB3.0
Super Speed
SS: 5Gbps

USB3.1 Gen 1
Super Speed+
SS+: 10Gbps

2013
USB3.1 Gen 2
Super Speed+
SS+: 10Gbps

TI Information – Selective Disclosure
The USB Signal Fundamentals

USB2.0 Signals
- D+
- D-
- Vbus
- GND

SuperSpeed(+) Signals
- SSTX+
- SSTX-
- SSRX+
- SSRX-

USB2.0 w wire bi-directional interface

Only one active for a peripheral and function

SuperSpeed(+) adds a dual-simplex data path with revised USB protocol
The USB Connectors

USB2.0
- Type-A
- Type-B
- Mini-B
- Micro-B

USB3.0
- Type-A
- Type-B
- Micro-B

One size for USB2.0, 3.0, 3.1

Type-C

- USB2.0
- USB3.1
- DisplayPort
- Power Delivery
USB Type-C Flippable Receptacle Interface

- High Speed Data, USB SS, SS+ TX or DP Alt Mode
- USB2 Data
- Sideband Use, not used for USB, AUX for DP
- High Speed Data USB SS, SS+ RX or DP Alt Mode

Configuration channel, for cable attach, orientation, role detection, and current mode. One becomes VCONN to supply power for cable or adaptor.
USB Type-C Operation Modes

- **Host Mode**
  - Downstream Facing Port (DFP)

- **Device Mode**
  - Upstream Facing Port (UFP)

- **Dual Role Mode**
  - Dual Role Port (DRP)

USB Controller:
- HD3SS460: SS, SS+, DP
- HD3SS3212: SS, SS+
- TUSB321: DFP/UFP/DRP, CC

- HD3SS2522: DFP, SS, SS+, CC

Texas Instruments

Auto or manually driven
Configure USB Type-C Orientation Using Switch/Mux

- USB Type-C switch can reduce pin out and complexity in USB controller
- Same switch required in both host and device
- Switch can be integrated with USB signal conditioner and CC functions
### USB-PD Over USB Type-C

<table>
<thead>
<tr>
<th>Precedence</th>
<th>Mode of Operation</th>
<th>Nominal Voltage</th>
<th>Maximum Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>USB PD</td>
<td>Up to 20 V</td>
<td>Up to 5 A</td>
</tr>
<tr>
<td></td>
<td>USB Type-C current @ 3A</td>
<td>5 V</td>
<td>3 A</td>
</tr>
<tr>
<td></td>
<td>USB Type-C current @ 1.5A</td>
<td>5 V</td>
<td>1.5 A</td>
</tr>
<tr>
<td></td>
<td>USB BC1.2</td>
<td>5 V</td>
<td>Up to 1.5 A</td>
</tr>
<tr>
<td>Lowest</td>
<td>USB 3.1</td>
<td>5 V</td>
<td>900 mA</td>
</tr>
<tr>
<td></td>
<td>USB 2.0</td>
<td>5 V</td>
<td>500 mA</td>
</tr>
</tbody>
</table>

#### Port Power Roles

USB PD over Type-C is negotiated through CC wire, port power roles are now defined separately from the port data roles.

- **Provider**: device can only provide power
- **Consumer**: device can only receive power
- **Consumer provider**: The device can act as either a consumer or provider. This is only possible for devices that support USB PD

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![USB Power Delivery diagram](image)
**Configuration Channel & VCONN**

*Enable the flexibility of USB Type-C*

**VCONN:**

When one of the CC pins is used for connecting between the DFP and UFP, the other CC pin can be used to supply power to an active cable. The name of this power-rail is VCONN. When the DFP CC detect the pull-down resistor, the CC pin will be switched from pull-up to VCONN. The VCONN will supply between 4.75-5.5v and output power of 1Watt.
USB Type-C Port Control using TUSB321

- TUSB321 is a USB Type-C CC Logic, Port Control and VCONN Switch for DFP, UPF, DRP mode
- GPIO or I2C enables host control on cable attach/detach, cable orientation and port role. It also configures the high speed switches for proper Type-C port connection
- TUSB321 advertises 3A for a charging of 15W.
USB Type-C Alternate Modes

- USB Type-C specification includes Alternate Mode that enables the multi-purposing of designated pins in the connector for alternate uses such as DisplayPort over Type-C cable while offering the same performance.
- The USB Power Delivery v2.0 specification designates how devices can enable Alternate Mode uses.
- Standard ID to be assigned for each Alternate Mode: DisplayPort, PCIe…
- Highly flexible with multiple communication buses and open Side Band Use (SBU) channel.

HD3SS460 makes it possible.
The HD3SS460 is a SuperSpeed bi-directional passive cross-point switch designed to support low- and high-speed signal switching required for Type C, with Alternate mode applications.
Alternate Mode Application: DP over Type-C

USB Host

USB2.0 D+/D-
SSTX
SSRX

DP Source

HD3SS460
DP0
DP1
DP2
DP3
AUXp
AUXn
PD Controller
HPD
Control

Source

USB Hub

USB2.0 D+/D-
SSTX
SSRX

HD3SS460
DP0
DP1
DP2
DP3
AUXp
AUXn
PD Controller
HPD
Control

Sink

TI Information – Selective Disclosure
Gigabit signals are subject to signal integrity degradation due to long trace, cross connectors, long cable and capacitance lines.

Signal Conditioners enables Type-C solution

- Improve signal quality, maintain signal integrity over long trace or cable
- Enable design flexibility and improve system performance, help pass compliance
- Enable broad range of interoperability
- Extend distance signal can travel across cable or trace

USB Controller

TUSB501
TUSB211
SN65LVPE512

USB Sig Con

Type-C Switch

HD3SS2522

CC1 / CC2

SS Tx/Rx

SS Tx/Rx

SS Tx/Rx 2

SS Tx/Rx 1
TI Solutions for USB Type-C

- **USB Host**
  - USB PHY
  - USB Redriver/Retimer
  - High Performance MUX
  - DP Redriver/Retimer
  - DP Source

- **USB Device**
  - USB PHY
  - USB Redriver/Retimer
  - High Performance MUX
  - DP Redriver/Retimer
  - DP Sink/Hub

- **USB HUB**
  - USB PHY
  - USB Redriver/Retimer

- **Power**
  - VBUS

- **USB TypeC**
  - CC Analog
  - USBPD
  - TUSB321
  - TUSB322
  - TPS65982/6

- **PCIe To USB**
  - HD3SS460
  - HD3SS2522

- **USB PD**
  - CC Analog
  - USB PHY

- **USB Redriver/Retimer**
  - TUSB7320
  - TUSB7340

- **USB Redriver/Retimer**
  - TUSB501
  - TUSB211

- **High Performance MUX**
  - HD3SS460
  - HD3SS3212

- **DP Source**
  - SN75DP130

- **DP Sink/Hub**
  - SN75DP130

- **Host**

- **Device**

- **TI Solutions**
USB Type-C & PD (Discrete Approach)

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USB Type-C and PD Ecosystem – TPS25810

• TPS25810 does not support USB PD or alternate modes.
• It can source only source 5V.
**TPS25810 USB Type-C Power Switch**

Implements all Type C DFP requirements w.o. USB PD

**Features**

- USB Type-C DFP Interface
  - Connector Attach/Detach Detection
  - STD/1.5A/3A Capability Advertisement on CC Line
  - Super Speed Lines Polarity Determination
  - $V_{BUS}$ Application
  - $V_{CONN}$ Application to Active Cable
  - Audio and Debug Accessory Identification
- <1.0 uA (typ) Operating Current with Nothing Attached
- Dedicated Supply for Charging, $V_{CONN}$ and Device Power
- Integrated 36 mΩ (typ) High-Side MOSFET
- Selectable 3.34 A/1.67 A OUT Current Limit with +/- 7.5% Accuracy
- Load Detection to Enable Port Power Management
- CC1 and CC2 +/-8 kV Contact and +/-15 kV Air Discharge ESD Rating (IEC 61000-4-2)
- Offered in 3x4, 20-pin QFN Package

**Benefits**

- **Passed latest Type C rev 1.1 compliance test**
- Highly integrated, industry’s first **single** chip solution to implement Type C Host Charging
- Ultra low Iddq (5uA) extends battery life in NB/Tablets
- Accurate limit (+/-7%) lowers BOM cost of DC-DC converter
- Optional low voltage (3.3V) chip supply lowers system power in system sleep state
- Built-in IEC 61000-4-2 protection on CC pin lowers BOM cost
- Load detect feature enables Port Power Management control in multi-port systems

**Applications**

- USB Port/Hubs
- Notebook/Desktop PCs, LCD Monitor
- USB Charger

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**Control Signals**

- Bus Power
- CC Power
- Auxiliary Power
- Type-C DFP Status Signals
- Power Switch
- VBUS

**Power Pad**

- 4.5V – 5.5V
- 2.9V – 5.5V
- 6 x 100 kΩ
Typical End-Applications for TPS25810 (up to 15W)

Notebook and AIO

AC-DC Adapters

Power Banks

Wall Chargers

Automotive Charging Ports
TPS25810 Type C Compliance Test Result
# TPS25810 Input Control Truth Table and Pin-Out

<table>
<thead>
<tr>
<th>CHG</th>
<th>CHG_HI</th>
<th>CC Capability Broadcast</th>
<th>Current Limit</th>
<th>Load Detect Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>STD</td>
<td>1.67 A</td>
<td>NA</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>STD</td>
<td>1.67 A</td>
<td>NA</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1.5 A</td>
<td>1.67 A</td>
<td>NA</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>3.0 A</td>
<td>3.34 A</td>
<td>1.77 A</td>
</tr>
</tbody>
</table>

![TPS25810 Pin-Out Diagram](image-url)
Two Port Type-C Implementation w.o. PD

Load Detect Benefits:
- Better user experience
- Lower BOM cost

DC-DC can be shutdown when no attachment detected
**TPS25810 vs Competition**

**TPS25810 Benefit List**

- Highly integrated
  - VCONN current limiting switch
  - 30mΩ Rds_On/3A power switch
  - IEC61000-4-2 rated ESD diode on CC1/CC2
  - **Total integration of $0.20**

- Internal fixed current limit for medium and high current mode and VCONN

- Current and thermal Fault output

- Wake detect

- Load detect for port power management implementation

- Integrated thermal shutdown protection

- Type C Rev 1.1 compliant

- Separate supply for device (3.3V) and charging (can be as high as 6.5V to handle IR drop)
# TPS25810 Feature List Compared to Competition

<table>
<thead>
<tr>
<th>Feature List</th>
<th>TPS25810</th>
<th>Competition</th>
<th>Discrete Solution</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance to Type C spec Rev 1.1</td>
<td>YES</td>
<td>NO (not mentioned in datasheet)</td>
<td>NO</td>
<td>External FET with discrete logic solution makes Type C compliance difficult to pass due to tight spec</td>
</tr>
<tr>
<td>Very High Integration (MOSFET/VCONN/ESD)</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>TPS25810 offers BOM cost savings of $0.2 compared to SLG7G814V</td>
</tr>
<tr>
<td>Automatic current limit setting based on current advertisement</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>Not possible to automatically change limit with external FET</td>
</tr>
<tr>
<td>VBUS/VCONN <strong>Discharge</strong> after cable is detached</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>VCONN must be discharged within 20 ms after removal of cable</td>
</tr>
<tr>
<td>Disconnect State Supply Current</td>
<td>0.7 uA</td>
<td>182uA</td>
<td>?mA</td>
<td>Longer run time when in battery mode</td>
</tr>
<tr>
<td>Board Space</td>
<td>3x4mm</td>
<td>1.6x2.0+3x3+1.5x1.5+1.5x1.5mm</td>
<td>&gt;&gt;&gt;&gt;&gt; 3x3mm</td>
<td>Smallest board space of any other solution</td>
</tr>
<tr>
<td>Thermal and current fault indicator</td>
<td>Built-in</td>
<td>External</td>
<td>External</td>
<td>More robust design to handle fault conditions</td>
</tr>
<tr>
<td>Advanced system power saving features</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
<td>TPS25810: Port power management, ability to automatically turn-off hi power DC-DC</td>
</tr>
</tbody>
</table>
TPS25810 Reference Design Under Development
PMP4488
Single port type c 15W car charger supporting BC1.2

To be available on Aug. 30.2015

<table>
<thead>
<tr>
<th>TI Parts</th>
<th>$V_{in}$</th>
<th>Po</th>
<th>Vo/Io</th>
<th>Topology</th>
<th>Avg. Eff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM14030 or TPS54340/TPS2514/TPS25810</td>
<td>7-36Vin</td>
<td>15W</td>
<td>5V/3A</td>
<td>Buck</td>
<td>TBD</td>
</tr>
</tbody>
</table>

**Features**
- 7~42Vin wide input range
- Type C DFP only+BC1.2
- LMR14030/TPS54340 compliant design ease evaluation
- Compact size with 2layer design

**Application**
- Car charger
PMP4403:
SSR 15W Type-C Adapter supporting BC1.2

To be available on Aug. 15, 2015

<table>
<thead>
<tr>
<th>TI Parts</th>
<th>$V_{in}$</th>
<th>$P_o$</th>
<th>$V_o/I_o$</th>
<th>Topology</th>
<th>Avg. Eff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCC28740, UCC24632, CSD18509, TPS25810, TPS2514</td>
<td>85~265 V</td>
<td>15W</td>
<td>5V/3A</td>
<td>S.R Flyback with PSR</td>
<td>85.8%@115Vac</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>84.8%@230Vac</td>
</tr>
</tbody>
</table>

**Features**
- S.R QR Flyback with secondary side regulation
- <30mW standby power
- 15W Type-C + BC1.2
- DOE-6/COCV5
- Fully tested and passes CE/RE
- Size 47mm(L)×45mm(W)×15mm(H)

**Advantage**
- Good regulation and fast dynamic response
- Above Energy Star 6.0 standard
- Support type C fast charger while compliant with BC1.2 equipment
- High efficiency over load range
- Reduce design & test cycle
- Small size adapter

PMP4403 design files
PMP4445: <10mW no-load power 15W Type-C Adapter supporting BC1.2

<table>
<thead>
<tr>
<th>TI Parts</th>
<th>$V_{in}$</th>
<th>$P_o$</th>
<th>$V_o/I_o$</th>
<th>Topology</th>
<th>Avg. Eff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCC28730, UCC24631, CSD18509, TPS25810, TPS2514</td>
<td>85~265 V</td>
<td>15W</td>
<td>5V/3A</td>
<td>S.R Flyback with PSR</td>
<td>86.3%@115Vac</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>85.7%@230Vac</td>
</tr>
</tbody>
</table>

**Features**
- S.R QR Flyback with wake up
- <10mW standby power
- 15W Type-C + BC1.2
- DOE-6/COCV5
- Fully tested and passes CE/RE
- Size 47mm(L)x45mm(W)x15mm(H)

**Advantage**
- Fast dynamic response from no load to heavy load
- Above Energy Star 6.0 standard
- Support type C fast charger while compliant with BC1.2 equipment
- High efficiency over load range
- Reduce design & test cycle
- PSR control eliminating opto-coupler

To be available on Aug. 15, 2015
PMP4424, PMP4451
USB Type C Power Bank Reference Design

**PMP4424**
- **Input:** USB Micro-B, 5V~12V
- **Output:** 2 Ports:
  - Type C w/o PD 5V/3A, Type A 5V/2A
  - Support all adapters and Compatible QC2.0/MTK/Maxcharge
  - Support USB-C output and USB-A with BC1.2

<table>
<thead>
<tr>
<th>Function</th>
<th>Battery Charger</th>
<th>Battery Protection</th>
<th>USB Type-C</th>
<th>USB-A BC1.2</th>
<th>MCU</th>
<th>LDO</th>
<th>Booster(1PCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI P/N</td>
<td>BQ25895</td>
<td>BQ29703</td>
<td>TPS25810</td>
<td>TPS2514A</td>
<td>MSP430G2332</td>
<td>TLV70028</td>
<td>TPS61236(5V/3A)</td>
</tr>
</tbody>
</table>

**PMP4451**
- **Input:** USB Micro-B, 5V~12V
- **Output:** 2 Ports:
  - Type C w/o PD 5V/3A, Type A with fast charging 5/9V2A or 12V1.2A
  - Support all adapters and Compatible QC2.0/MTK/Maxcharge
  - Support USB-C output and USB-A with Fast Charging

<table>
<thead>
<tr>
<th>Function</th>
<th>Battery Charger</th>
<th>Battery Protection</th>
<th>USB Type-C</th>
<th>USB-A BC1.2</th>
<th>MCU</th>
<th>LDO</th>
<th>Booster(2PCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI P/N</td>
<td>BQ25895</td>
<td>BQ29703</td>
<td>TPS25810</td>
<td>TPS2514A</td>
<td>MSP430G2332</td>
<td>TLV70028</td>
<td>TPS61236(5V/3A)</td>
</tr>
</tbody>
</table>

**Key Selling Points**
- Total verified solution shorten customer design cycle
- Support different kinds of input compatible with QC2.0/PE+/Maxcharge
- Support different kinds of output USB Type-C, USB-A with BC1.2 and USB-A Fast Charging
- Efficiency optimized with high performance battery charger and booster
- Supports two ports output but can be easy copied and pasted as single port output as well

Final version available by end Aug.
TI USB Type-C and PD Solutions (DFP-only, Provider-Only)
TPS25740 does not communicate with the cable. So it can only provide 3A unless the cable is tethered to the provider.
Typical End-Applications for TPS25740 (up to 100W)

Automotive Rear Seat Charging Ports

AC-DC Adapters

Power Banks

Wall Chargers
TPS25740/A USB PD Type C DFP Controller
Implements Complete USB PD 2.0 Stack for a Stand-alone DFP Solution

Features
- Implements PD 2.0 physical layer, protocol layer, policy engine and device policy manager
  - Programmable to deliver up to 3A or 5A in tethered cable applications
- Type-C rev 1.1 and USB PD2.0 rev 1.1 compliant
- Built-in over-current, over-voltage
- Two output pins for external power supply control
- Single pin safety shut-down
- Ultra-low Iddq (<10uA) when port is un-attached
- Port attachment indicator
- Outputs a 1.8V@30mA regulated supply
- Available in 24-pin 4x4 QFN

Applications
- USB PD AC-DC adapter
- Data-less power hubs and USB PD charging ports

Benefits
- Highly integrated power and control feature enables low BOM cost USB PD DFP data less solution
  - Integrated HV Discharge (30V ABS MAX)
  - Direct HV NFET drive (30V ABS MAX)
  - IEC 61000-4-2 tolerant on CC1 and CC2
  - No need for external uC or FW
  - 4V-25V input supply remove need for chip LDO in Adapter implementation

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Voltage control (e.g., secondary voltage in fly-back topology)
A/C Adaptor Conceptual Schematic

Configure Capabilities

TI Information – Selective Disclosure
# PMP11250
60W Type-C/PD Wall Charger

**To be available on Dec. 2015**

<table>
<thead>
<tr>
<th>TI Parts</th>
<th>$V_{in}$</th>
<th>$P_{o}$</th>
<th>$V_{o}/I_{o}$</th>
<th>Topology</th>
<th>Avg. Eff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCC27714D, UCC24636DBVR, UCC28740DR, TPS54061DRBR, TPS25740RGE, CSD17578Q3A</td>
<td>85~265 V</td>
<td>60W</td>
<td>5V/12V/20V @3A</td>
<td>S.R Flyback with PSR</td>
<td>TBD</td>
</tr>
</tbody>
</table>

![Voltage fly-back regulator](image1.png) ![Image of 60W Type-C/PD Wall Charger](image2.png)

**Test result TBD**

## Features
- PMP4490 5V/12V/20V 60W adapter
- USB type C/PD protocol
- SSR controller + V.S balancing S.R controller

## Application
- Type C PD adapter
USB Type-C & PD (Complete Solution)
USB Type-C and PD Ecosystem – TPS65982

Provider

USB Signal Conditioner

DP Signal Conditioner

SS Mux

HS Mux

CC Analog

PD Manager

AFE

PHY

Type-C Cable

USB Signal Conditioner

DP Signal Conditioner

SS Mux

HS Mux

CC Analog

PD Manager

AFE

PHY

Consumer

USB Signal Conditioner

DP Signal Conditioner

SS Mux

HS Mux

CC Analog

PD Manager

AFE

PHY

TI Information – Selective Disclosure
**Features**

- **USB Power Delivery (PD) Controller**
  - Mode Configuration for Source (Host), Sink (Device), or Source-Sink
- **USB Type-C Specification Compliant**
  - Cable Orientation and Role Detection
- **Port Power Switch**
  - Supports 100W (20V, 5A), 60W (20V, 3A), and 15W (5V, 3A) of power
  - Meets USB Type-C Slew Rate Control, Hard Reset Support requirements
  - Integrated VCONN
  - Overcurrent, overvoltage, reverse current, and thermal protection
- **Port Data Multiplexer**
  - Sideband Use Data for Alternate Mode Support
  - DisplayPort, Thunderbolt™, etc.
- **Power Management**
  - 3.3V LDO Output for Dead Battery Support
  - Supports 100W (20V, 5A) External Power Path
- **UL 2367 and IEC 60950 Certified**
- **6x6mm, 96 Pin BGA MicroStar Junior Package**

**Applications**

- Notebook / Desktop Computers
- Dock / Camera / Storage / Tablet / TV/ Monitor
- Power Management System

**Benefits**

- **Fully Integrated USB Type-C and PD Solution**
  - No additional discrete components needed for full CC Function
  - No additional components needed for Power Paths up to 20V @ 3A
- **Compliant to the USB Type-C 1.1 and USB PD 2.0 Specifications**
- **Configurable as either a Downward Facing Port, Upward Facing Port or Dual Role Port**
- **Integrated USB Endpoint**
- **Industry’s smallest solution size**

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**TPS65982 USB Type-C Port Power Switch with USB-PD Controller & HS Mux**

![Diagram](image-url)
The TPS65982 Power Paths and their features:

- 100W (20V, 5A) Provider/Consumer High Voltage External Power Path
- 60W (20V, 3A) Provider/Consumer High Voltage Internal Power Path
- 15W (5V, 3A) Provider Internal Power Path
- 3W (5V, 600mA) Internal VCONN Path
- Overcurrent, Overvoltage and Thermal Protection
- Certified through the following standards:
  - UL 2367 Standard for Solid State Overcurrent Protectors Ed. 1
USB Type-C and PD Ecosystem – TPS65986

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**Provider**

- AFE
- PHY
- PD Manager
- USB Signal Conditioner
- DP Signal Conditioner
- SS Mux
- TX/RX1
- TX/RX2

**Type-C Cable**

- CC Analog
- ESD
- VBUS
- VCONN
- SBU
- CC
- CC
- CC

**Consumer**

- AFE
- PHY
- PD Manager
- USB Signal Conditioner
- DP Signal Conditioner
- SS Mux
- TX/RX1
- TX/RX2

---

**Specifications**

- Supply, Battery: 5-20 V
- Power Mux: Programmable DC
- DC: 20 V, 3 A
- VCONN: IEC/UL
- Thermal: 5 V, 3 A
- LDO: Dead Battery
- Slew Rate Control: 20 V, 5 A
- RCP, OCP, OVP: Programmable

---

**Additional Information**

- USB 2.0
- USB 3.x
- Alternate Mode
**Features**

- **USB Power Delivery (PD) Controller**
  - Mode Configuration for Source (Host), Sink (Device), or Source-Sink
- **USB Type-C Specification Compliant**
  - Cable Orientation and Role Detection
- **Port Power Switch**
  - Supports 60W (20V, 3A), and 15W (5V, 3A) of power
  - Slew Rate Control
  - Overcurrent, overvoltage, reverse current, and thermal protection
  - Hard Reset Support
- **Port Data Multiplexer**
  - Sideband Use Data for Alternate Mode Support
    - DisplayPort, etc.
- **Power Management**
  - 3.3V LDO Output for Dead Battery Support
- **UL 2367 and IEC 60950 Certified**
- **6x6mm, 96 Pin BGA MicroStar Junior Package**

**Applications**

- Notebook / Desktop Computers / Phones / Tablets
- Dock / Camera / Storage / Tablet / TV/ Monitor
- Power Management System

**Benefits**

- **Fully Integrated USB Type-C and PD Solution**
  - No additional discrete components needed for full CC Function
  - No additional components needed for Power Paths up to 20V @ 3A
- **Compliant to the USB Type-C 1.1 and USB PD 2.0 Specifications**
- **Configurable as either a Downward Facing Port, Upward Facing Port or Dual Role Port**
- **Integrated USB Endpoint**
- **Industry’s smallest solution size**

---

*Preliminary*
# USB-C/PD Family Comparison (DRP)

<table>
<thead>
<tr>
<th>Part Number</th>
<th>TPS65982</th>
<th>TPS65986</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy Manager</strong></td>
<td>• Integrated</td>
<td>• Integrated</td>
</tr>
<tr>
<td><strong>Port Role</strong></td>
<td>• DRP</td>
<td>• DRP</td>
</tr>
</tbody>
</table>
| **Internal Power Paths** | • VCONN  
  • 5V @ 3A provider  
  • 20V @ 3A consumer/provider | • VCONN  
  • 5V @ 3A provider  
  • 20V @ 3A consumer/provider |
| **External Power Paths (NFET)** | • 20 @ 5A NFET drive consumer/provider  
• Programmable OCP  
• Programmable OVP | • GPIO |
| **OCP & OVP** | • Programmable | • Programmable |
| **USB 2.0 Endpoint** | • Integrated | • Integrated |
| **HS Mux** | From Type-C  
• USB2.0 D+/D- Top & Bottom  
• SBU1/SBU2 | • External |
| **Alternate Mode Support** | • Yes | • Yes |
TPS65986 USB Type C – Notebook – 3A, 2 Power Paths

- **Battery Charger**
- **System Control (I2C Master)**
- **TPS65986 USB Type C – Notebook – 3A, 2 Power Paths**

- **VBUS**
- **VCON**
- **SBU**
- **D-**
- **D+**
- **TX1/RX1**
- **TX2/RX2**

- **ESD**
- **SS MUX**
- **CC Analog**
- **AFE PD PHY**
- **Power Manager**
- **USB EP**

- **5.0V**
- **3.3V**
- **~ 20V Input**
- **3A**

- **Alternate Mode Display Port**

- **USB3.1**

- **HD3SS460**

- **TI Information – Selective Disclosure**

- **Texas Instruments**
TPS65982 USB Type C – Notebook – 5A, 3 Power Paths

- Battery Charger BQ
- System Control I2C Master
- TPS65982 USB Type C – Notebook – 5A, 3 Power Paths
- Optional ~ 20V
- 12V
- 5A
- 3A
- 5.0V
- 3.3V
- 3A
- USB3.1
- Display Port
- GPIO
- AMSEL
- POL
- EN
- TX1/RX1
- TX2/RX1
- TX2/RX2
- SS MUX
- HD3SS460
- Alternate Mode Display Port
- USB3.1
- PD PHY
- AFE
- Power Manager
- CC Analog
- CC
- SBU
- VBUS
- VCON
- D-
TPS65982 USB Type C – Dock System

TI Information – Selective Disclosure

DC/DC convertor

20V → 5V

5.0V

20V → 3.3V

20V → 5.0V

3.3V

5A

~ 20V Input

5A

VBUS

D+/D-

TX1/RX1

TX2/RX2

SS MUX

HD3SS460

DC/DC convertor

20V → 15V/12V/5V

3A

12V

5.0V

3.3V

AUX+

AUX-

HPD

PD PHY

CC Analog

AFE

Power Manager

HS MUX

USB EP

Alternate Mode Display Port

DP 1:2 Switch Re-driver

USB HUB

DC/DC convertor

20V → 3.3V

5.0V

TPS65982

TI Information – Selective Disclosure
TPS65982 USB Type C Monitor – DP, USB3.1 & Charger

- VBUS
- D+/D-
- CC
- SBU
- TX1/RX1
- TX2/RX2

---

**DC/DC convertor**

- 5V → 20V → 3.3V
- 5V → 20V → 5V

---

**Alternate Mode Display Port**

- Display Port: 4Ln/2Ln
- TX/RX
- 5.0V
- D+/D-
TPS65986 USB Type C Monitor – DP, USB3.1 & Charger

- **VBUS**
  - 3A
  - ~ 20V Input

- **VCON**
  - 3A

- **CC**
  - 3.3V

- **SBU**
  - 3.3V

- **D-**
  - TX/RX1

- **D+**
  - TX2/RX2

- **TX1/RX1**
  - D+/D-

- **SS MUX**
  - TX/RX
  - TX1/RX1
  - TX2/RX2

- **HD3SS460**

- **AFE**
  - PD PHY

- **Power Manager**

- **CC Analog**

- **USB EP**

- **DC/DC converter**
  - 5V – 20V → 3.3V
  - 5V – 20V → 5V

- **Alternate Mode Display Port**

- **USB3.1**
  - 5.0V
  - D+/D-

- **USB multiplexer** (SS MUX)
  - TX1/RX1
  - TX2/RX2

- **Display Port**
  - DP: 2Ln/4 Ln

- **AUX+**
  - DP: 2Ln/4 Ln

- **AUX-**

- **HPD**

- **5V**
  - USB EP

- **Analog Power Manager**

- **PD PHY**

- **AFE**

- **DC/DC converter**
  - 3.3V

- **USB multiplexer** (SS MUX)

- **USB multiplexer** (SS MUX)

- **Add Another USB-C/PD Port w TPS65986**

TI Information – Selective Disclosure
TPS65986 USB Type C Dongle – DP, USB3.1 & Charger

Add Another USB-C/PD Port w TPS65986

TI Information – Selective Disclosure
Features:

- USB Type-C™ testing and verification
- USB Power Delivery testing and verification
- Application Emulation (Notebook, Dock, Tablet, Dongle, Charger)
- Powered from single supply and bus-powered capable

Order now on [TI.com](https://www.ti.com) or build your own with these [design files](https://www.ti.com)!
Features:

- Powered by a 20V DC IN Barrel Jack Adapter or the DRP USB-C
- Includes a USB3 hub TUSB8041 for USB port expansion purposes
  - 2 USB Type-A DFPs
  - 2 USB-C DFPs
- Mini DP source connector for connecting to a DisplayPort sink, a protocol converter or a hub
- Pre-packaged software, easily configurable and updateable for GUI-based configuration tool
- Alternate Mode Support:
  - DisplayPort - PDIO
  - Quick Swap
TPS65982 Configuration Tool

- Allows engineer to configure the application binary to meet their specific use case needs
  - 6 preconfigured profiles

- Supports:
  - DFP, UFP, DRP profiles
  - Up to 7 Source PDOs
  - Up to 6 Sink PDOs
  - GPIO Mapping
  - Alternate Modes including DisplayPort and Thunderbolt™
TPS65982 Host Interface Utilities Package

- A set of python scripts used to interact with the TPS65982 USB Type-C and PD controller using the device’s Host Interface and an external Windows-based computer. This interface provides a rich variety of functions for both controlling the TPS65982 and for acquiring status information.

Check Source Capabilities by reading “Transmit Source Capabilities” register.
Q&A

• Thank you for your time!
• For more information visit the following links:
  – USB Type-C Overview
  – USB Power Delivery Overview
  – If you have any questions or need any further assistance choosing the right USB-C and PD device for your system please visit the USB E2E Forum
Backup

USB Portfolio
USB Type-C Switch and Controller
# TUSB321
**USB Type-C CC Logic, Port Control and VCONN Switch**

## Features

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>• Optimized for Mobile Applications and Compatible to USB Type-C Specification 1.0</strong></td>
<td></td>
</tr>
<tr>
<td><strong>• Mode configuration (DFP, UFP, DRP)</strong></td>
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<td></td>
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</tr>
</tbody>
</table>
|   |   | **Host Only,**
|   |   | **Device Only,**
|   |   | **Dual Role Port**
|   |   | **I2C and GPIO for Configuration**
| **• Channel Configuration (CC)** |   |
|   |   | **Attach of USB Port Detection**
|   |   | **Cable Orientation Detection**
|   |   | **Role Detection**
|   |   | **Type-C Current Mode (Default, Mid, High)**
| **• ID Emulation and VBUS detection** |   |
| **• VCONN support** |   |
| **• Supply Voltage 4.5-5.5V** |   |
| **• Low Active Standby Current Consumption** |   |
| **• Industrial Temperature Range** |   |
| **• 1.6x1.6mm QFN package** |   |

## Benefits

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>• Low Power, small form factor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>• USB Type-C implementations with USB 3.1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>• Enable type-C operation, using GPIO to communicate with the host on cable attach/detach, cable orientation and port role. It also configures the High Speed switches for proper Type-C port connection</strong></td>
<td></td>
</tr>
</tbody>
</table>

## Applications

Mobile applications implementing USB TypeC
- Cellphones, Tablets
- Notebooks, Desktops, All In Ones
- Peripherals
HD3SS3212
USB 3.1 SS, SS+ High Performance Differential Switch

Features
• Provides MUX/DEMUX solution for USB Type-C ecosystem for USB3 and USB3.1 Gen2, up to 10Gbps
• 2mW active and 20uW shutdown power
• Wide –3dB BW of over 10GHz
• Excellent Dynamic Characteristics (at 5GHz)
  – Crosstalk = –35dB
  – Off Isolation = –19dB
  – Insertion Loss = –1.5dB
  – Return Loss = –11dB
• Single Supply VCC of 3.3V ±10%
• Dynamic Common Mode Tracking
• 2.5mmx4.5mm QFN Package (p2p with industry)
• Commercial Temperature Range of 0 to 70°C
• Industrial Temperature Range of -40°C to 85°C

Benefits
• Provides MUXing solution for USB Type-C ecosystem for USB3.0 and USB3.1
• Supports latest Gen USB interface common in today’s computing applications
• Low I/O capacitance minimizes loading & signal distortion
• Low power consumption

Applications
• USB Type-C Ecosystem
• Desktop and Notebook PCs
• Server/Storage Area Networks
• PCI Express Backplanes
• Shared I/O Ports
# HD3SS2522
**USB Type C Super Speed MUX with DFP Controller**

## Features
- Compliant to USB Type C Specification 1.1
- Provides Configurable Channel Logic
  - Attach USB Port Detection
  - Cable Orientation Detection
  - Type-C Current Mode (Default, Mid, High)
- Supports Data Rates up to 10Gbps with Wide -3dB BW of 8GHz
- Excellent Dynamic Characteristics at 2.5GHz
  - Crosstalk = -39dB
  - Off Isolation = -22dB
  - Insertion Loss = -1.2dB
  - Return Loss = -12dB
- Low Active (2mW) and Standby Power (50μW) Consumption

## Benefits
- Provides automatic determination and configuration of USB SS mux for cable orientation
- Flexibility for many different applications
- Provides IOs to support 5V VCONN sourcing

## Applications
### USB Type C DFP Applications
- Notebooks
- Motherboards
- Desktop
- Docking Stations
- Tablets
- Smart Phones

## Diagram
![Diagram of HD3SS2522 USB Type C Super Speed MUX with DFP Controller](image-url)
**TDI Information – Selective Disclosure**

- Compatible to USB TypeC Specifications 1.0
- X-point mux for USB Type-C with alternate modes
  - Switching between 2 Ln DP + USBSS or 4 Ln DP
  - Switching for SBU pins
- Ron 8Ω typ
- Low power consumption
- 2mW active, 20uW shutdown
- Operates up to 5.4Gbps with Wide –3dB BW of over 5GHz
- Excellent dynamic characteristics (at 2.5GHz)
  - Off isolation = –25dB
  - Insertion loss = –1.6dB
  - Return loss = –11dB
- Single supply VCC of 3.3V ±10%
- Industrial temp range of -40 to 85°C
- 28 pin QFN RHR
  - 0.5mm pitch
  - 3.5x5.5mm

**Applications**

X-Point MUX for Systems Supporting USB TypeC with Alternate Modes such as DP
- Cellphones, Tablets
- Notebooks, Desktops, All In Ones
- Docking stations

**Benefits**

- Provides cross point switching to implement flexible data and video schemes within TypeC eco-system
- Provides cross point switching for SBU pins
- Can be used as part of host/source and device/sink systems

---

**Features**

- 4 to 6 Channels USB Type-C MUX (USB + DP)

---

**Diagram**

![Diagram of HD3SS460](image-url)
USB Signal Conditioner
# TUSB501

**SuperSpeed USB Single Channel Redriver**

## Features
- Single channel USB SuperSpeed Redriver
- Option to power from 3.3VDC or 5VDC Power rail
- 2mm x 2mm package for space constrained applications
- Selectable Equalization, De-emphasis and Output Swing Control
- U2/U3 Mode Detection will selectively turn-off internal circuitry to save on power
- Low active power consumption
- Supports USB 3.0 LFPS Protocol Compliance test

## Benefits
- Enables the broadest interoperability with various host implementations
- Provides customer with optimized power vs. performance settings for their system implementation
- Typical power saving is about 75% lower than normal operating mode
- Expected to save approximately 40% active power versus the competition
- 5V DC Power Rail options allows powering from VBUS
- EQ/DE settings provide better performance flexibility

## Applications
- Low Power, Small Footprint
  - PC Motherboards
  - PC Docking Stations
  - PC Add–in Cards
  - Backplane & Cabled applications

---

TI Information – Selective Disclosure
## SN65LVPE512

*SuperSpeed Dual Channel USB Redriver*

### Features
- Dual Channel USB 3.0 Equalizer, Redriver
- Selectable Equalization, De-emphasis and Output Swing Control
- Hot-Plug Capable
- U2/U3 Mode Detection will selectively turn-off internal circuitry to save on power
- Low active power consumption
- Supports USB 3.0 LFPS Protocol Compliance test
- SN65LVPE502B allows alternate pinout for drop-in replacement to Parade device
- 3x3mm & 4x4mm 24pin QFN packages
- Operating temperature: -40°C to 85°C

### Benefits
- Enables the broadest interoperability with various host implementations
- Provides customer with optimized power vs. performance settings for their system implementation
- Typical power saving is about 75% lower than normal operating mode
- Expected to save approximately 40% active power versus the competition
- Allows customers to pass all certification testing and utilize SuperSpeed USB logo
- Alternate pin-out allows board layout flexibility

### Applications

**Low Power, Small Footprint**
- PC Motherboards
- PC Docking Stations
- PC Add-in Cards
- Backplane & Cabled applications

---

![Diagram](image-url)
### Features
- Drives bi-directional USB 2.0 signals
- Compatible with USB 2.0, OTG 2.0 & BC 1.2
- Does NOT break DP, DM trace
- Eliminates overshoot (ringing) and dynamically adjusts to trade off EMI while compensating for line loss
- Flexible cascade capability
- USB logo planned
- Automotive Qualified

### Benefits
- Eliminates cable and silicon costs - obsoletes hubs for redriving saving up to 40% active power
- Provides customer with optimized power vs. performance settings for their system design
- Offsets signal integrity impairments caused by external switches, connectors and ESD solutions to pass USB certification
- Designed onto PCB without populating the device for easy modifications

### Applications
**Low Power, Small Footprint**
- Automotive Infotainment
- Server and Communication Infrastructure
- Handsets
- Mobile Docking
- Medical docking
- Industrial Computing

---

TI Information – Selective Disclosure
USB Hubs and Switches
TUSB8041
4 Port USB3.0 Hub Controller

**Features**

- Third Generation USB3.0 Certified Hub Controller TID #330000056
- Customer programmable OTP eFuse flexibility
- Improved Battery Charging Support
  - USB Battery Charging 1.2 CDP and DCP modes
  - Chinese Telecom industry standard YD/T 1591-2009 support
  - Divider mode charging
- Per Port or Ganged Power Switching and Over-Current Notification Inputs
- Driver FREE operation (no driver needed)
- Small 64 pin QFN or QFP package
- Automotive version Q100 available

**Applications**

- Automotive Infotainment
- Discrete Hub Boxes
- Hub in Monitors
- Embedded USB Ports
- Hub on Motherboard/Front-panel for Desktop/Notebook PCs

**Benefits**

- Increases the number of available USB SS Ports
- Fully backward compatible between USB SS and HS
- USB 2 Hub Logic fully supports legacy FS/LS Devices
- Rx sensitivity is twice as good as required by the USB 3.0 specification enabling longer etch runs or cable lengths to be used.
- Lowers BOM cost by integrating per port charging functions
**TUSB8020B**

2 Port USB3.0 Hub Controller

### Features
- Third Generation USB3.0 Compliant Hub Controller (Certified by the USB-IF: TID#330000057)
- Customer programmable OTP efuse flexibility
- Improved Battery Charging Support
  - USB Battery Charging 1.2 CDP and DCP modes
  - Chinese Telecom industry standard YD/T 1591-2009 support
  - Divider mode charging
- Per Port or Ganged Power Switching and Over-Current Notification Inputs
- Driver FREE operation (no driver needed)
- Small 48 pin QFP package; Q100 available

### Applications
- Automotive Infotainment
- Discrete Hub Boxes
- Hub in Monitors
- Embedded USB Ports
- Hub on Motherboard/Front-panel for Desktop/Notebook PCs

### Benefits
- Increases the number of available USB SS Ports
- Fully backward compatible between USB SS and HS
- USB 2 Hub Logic fully supports legacy FS/LS Devices
- Rx sensitivity is twice as good as required by the USB 3.0 specification enabling longer etch runs or cable lengths to be used.
- Lowers BOM cost by integrating per port charging functions
**HD3SS6126**

**USB3.0 & USB2.0 Differential 1:2/2:1 Mux/Demux**

**Features**

- Independently switch USB2.0 signals (HS/FS/LS)
- Independently switch USB3.0 signals (SS)
- 3-Bidirectional Differential Pair Channel MUX/DEMUX Switch
- Support Data rate up to 10 Gbps
- VCC Operating range 3.3V ± 10%
- USB 3.0 I/O with common mode voltage of 0V to 2.2V
- USB 2.0 I/O accept signal to 3.6V
- Wide -3dB Differential BW of over 10 GHz
- Excellent Dynamic Characteristics (at 2.5GHz)
  - Crosstalk = -35dB
  - Isolation = -23dB
  - Insertion Loss = -1.1dB
  - Return Loss = -11 dB
  - Max Bit-Bit Skew = 4 ps
- Small 3.5mm x 9mm, 42-Pin TQFN Package

**Applications**

- Notebook / Desktop / Tablet / Dock /
- HDTV/STB
- Telecommunication

**Benefits**

- Supports flexible mode configurations
- Designed to handle Super/Low/Full/High speed signals
- Low I/O capacitance minimizes loading & signal distortion
- Ideal for re-routing USB3.0/2.0 lanes in DTV/STB applications
- Low cost alternative to USB 3.0 hub/host in NB docks
USB Controllers and Bridges
# TUSB9261

## SuperSpeed USB 3.0 to SATA 2.0 Bridge

### Features

- Integrated ARM Cortex M3 Core
- Serial Peripheral Interface (SPI) Up to 50MHz
- Best in Class Adaptive Equalizer
- Performance enabled by TI’s Leading SuperSpeed USB Analog PHY Technology with Rx sensitivity of less than 50mV differential peak-to-peak.
- Supports Firmware Update Via USB
- Integrated Transceiver Supports SS/HS/FS Signaling
- Attached SCSI Protocol Compliant (UASP)
- Mass Storage Class Bulk-Only Transport compliant
- Up to 12 GPIOs with PWM functionality for LED control on 2 GPIOs
- Fully RoHS Compliant Package 64 Pin HTQFP

### Applications

- External Storage:
  - SSDs
  - HDDs
  - Optical Drives
  - Memory Readers

### Benefits

- Proven Performance
  - ≥ $0.10 BoM savings eliminating one VREG
  - Enables functionality without of spec host controller implementations
- Rx sensitivity is twice as good as required by the USB 3.0 specification enabling longer etch runs or cable lengths to be used.
- Ultra Fast Sync-and-Go User Experience
- Enables customer defined end-user configuration

---

![Diagram of TUSB9261](image)
# TUSB3410

**USB 2.0 to UART/RS232/RS485/IrDA**

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fully compliant with USB 2.0 full speed specifications: TID #40340262.</td>
<td>• Certified compliance and inter-operability</td>
</tr>
<tr>
<td>• Integrated 8052 microcontroller</td>
<td>• Flexible Architecture</td>
</tr>
<tr>
<td>- Four GPIO terminals from 8052</td>
<td>• Vendor ID &amp; Product ID can be modified.</td>
</tr>
<tr>
<td>- Master I2C controller for EEPROM device access</td>
<td>• Firmware can be customized.</td>
</tr>
<tr>
<td>• Built-in two-channel DMA controller for USB/UART bulk I/O</td>
<td>• Supports Self and Bus powered mode)</td>
</tr>
<tr>
<td>• Selectable IrDA mode (up to 115.2 Kbps transfer)</td>
<td></td>
</tr>
</tbody>
</table>

## Applications

- USB-to-RS-232 Dongles
- Point-of-Sale Terminal Interface
- Mobile phone data cable
- Serial-based MCU interface
- Industrial control interface
USB PHYs
# TUSB1211

## Standalone USB 2.0 PHY Transceiver

### Features
- Interface with a USB controller via a ULPI interface.
- Universal Serial Bus Specification Rev.2.0 TID# 100000036
- Complete HS-USB Physical Front-End
- Supports High Speed, Full Speed and Low Speed
- Impedance Programmability for External Component Compensation
- On-The-Go Supplement to the USB 2.0 Spec. Rev. 1.3/2.0
- UTMI+ Low Pin Interface (ULPI) Specification Rev. 1.1
- ULPI CLOCK Pin (60 MHz) Supports Both Input and Output Clock Configurations.
- Flexible System Integration
- USB Battery Charging Specification Rev. 1.1
- External Vbus power switch control & indicator
- Accessory Charger Adapter (ACA) detection.
- Available in a 36-Pin ZRQ Package

### Benefits
- Optimized for Portable Devices or System ASICs with Built-in USB OTG Device
- Very low current consumption: 9.8µA (Off mode), 272µA (Suspend mode), 47.7mA (HS USB), 32.7mA (FS USB)
- Can be disabled or configured in low power mode for energy saving.
- Flexible to work with either battery operated systems or pure 3.3 V supplied systems.
- Integrates a high-performance low-jitter 480 MHz PLL

### Applications
- Consumer electronics.
  - Mobile phones
  - Tablet devices
  - Desktop computers
  - Portable computers
  - Video games

---

![LINK Controller](image)

ULPI Interface

![TUSB1211](image)
TUSB1210
USB 2.0 ULPI PHY Transceiver

**Features**
- Interface with a USB controller via a ULPI interface.
- Universal Serial Bus Specification Rev. 2.0 TID# 100000037
- Complete HS-USB Physical Front-End
- Supports High Speed, Full Speed and Low Speed
- Impedance Programmability for External Component Compensation
- On-The-Go Supplement to the USB 2.0 Spec. Rev. 1.3
- UTMI+ Low Pin Interface (ULPI) Specification Rev. 1.1
- ULPI CLOCK Pin (60 MHz) Supports Both Input and Output Clock Configurations.
- Internal Power-On Reset (POR) Circuit
- External Vbus power switch control
- Flexible System Integration and very low current consumption, optimized for portable devices.
- Available in a 32-Pin QFN Package Automotive Q1 version

**Applications**
- Consumer electronics.
  - Mobile phones
  - Tablet devices
  - Desktop computers
  - Portable computers
  - Video games

**Benefits**
- Optimized for Portable Devices or System ASICs with Built-in USB OTG Device
- Very low current consumption: 16µA (Off mode), 210µA (Suspend mode), 48mA (HS USB), 31.7mA (FS USB)
- Can be disabled or configured in low power mode for energy saving.
- Flexible to work with either battery operated systems or pure 3.3 V supplied systems.
- Integrates a high-performance low-jitter 480 MHz PLL