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# USB充电协议CDP/SDP/DCP

## 1、参照文档

USB\_Battery\_Charging\_1.2.pdf  
<http://blog.csdn.net/wlwl0071986/article/details/43307967>  
<https://www.maximintegrated.com/cn/app-notes/index.mvp/id/4803>

## 2、类型

BC1.1的内容超出了USB 2.0规定的电源分配，它定义了更多用于充电的电源。主要有三种不同类型的电源：

### 标准下行端口(SDP)

这与USB 2.0规范定义的端口相同，也是台式机和笔记本电脑常见的典型端口。挂起时，最大负载电流为2.5mA；连接且非挂起状态下为100mA，可以配置电流为500mA (最大)。设备可利用硬件识别SDP，USB数据线D+和D-分别通过15kΩ接地，但仍然需要枚举，以符合USB规范。尽管现在许多硬件不经枚举即消耗功率，但在USB 2.0规范中，从严格意义上并不合法，违反规范要求。

Standard Downstream Port (SDP) — USB 2.0 and USB 3.0  
An SDP is a traditional USB port that follows USB 2.0 and USB 3.0 protocol. An SDP supplies a minimum of 500 and 900-mA per port. USB 2.0 and USB 3.0 communications is supported, and the host controller must be active to allow charging.

### 充电下行端口(CDP)

BC1.1为PC、笔记本电脑及其它硬件规定了这种较大电流的新型USB口。现在，CDP可提供高达1.5A电流，由于可在枚举之前提供电流，所以有别于USB 2.0。插入CDP的装置可通过操纵和监测D+、D-线，从而利用硬件握手识别CDP (参见USB电池充电规范第3.2.3部分)。在将数据线转为USB收发之前进行硬件测试，这样就能够在枚举之前检测到CDP (以及开始充电)。

Charging Downstream Port (CDP)  
A CDP is a USB port that follows USB BC1.2 and supplies a minimum of 1.5 A per port. A CDP provides power and meets the USB-2.0 requirements for device enumeration. USB-2.0 communication is supported, and the host controller must be active to allow charging. The difference between CDP and SDP is the host-charge handshaking logic that identifies this port as a CDP. A CDP is identifiable by a compliant BC1.2 client device and allows for additional current draw by the client device.  
The CDP hand-shaking process occurs in two steps. During step one the portable equipment outputs a nominal 0.6-V output on the D+ line and reads the voltage input on the D– line. The portable device detects the connection to an SDP if the voltage is less than the nominal data detect voltage of 0.3 V. The portable device  
detects the connection to a CDP if the D– voltage is greater than the nominal data detect voltage of 0.3 V and optionally less than 0.8 V.

The second step is necessary for portable equipment to determine if the equipment is connected to a CDP or a DCP. The portable device outputs a nominal 0.6-V output on the D– line and reads the voltage input on the D+ line. The portable device concludes the equipment is connected to a CDP if the data line being read remains less than the nominal data detect voltage of 0.3 V. The portable device concludes it is connected to a DCP if the data line being read is greater than the nominal data detect voltage of 0.3 V.

### 专用充电端口(DCP)

BC1.1规定了不进行枚举的电源，例如墙上适配器电源和汽车适配器，不需要数字通信即可启动充电。DCP可提供高达1.5A电流，通过短路D+和D-进行识别，从而能够设计DCP“墙上适配器电源”，采用USB mini或微型插孔，而非圆形插头或自制连接器的固定安装线。这样的适配器可采用任意USB电缆(配备正确插头)进行充电。

Dedicated Charging Port (DCP)  
A DCP only provides power but does not support data connection to an upstream port. As shown in following sections, a DCP is identified by the electrical characteristics of its data lines.

## 3、判断是否是CDP

A method of performing enumeration (connection recognition) by performing a handshake using USB data lines (D + and D-).

It recognizes whether it is CDP or not in two steps.

 Output 0.6 V to the D + line and measure the voltage of the D - line  
When the voltage of the D - line is less than 0.3 V, it is judged that it is connected to SDP；  
When the voltage of the D - line is 0.3 V or more and less than 0.8 V, it is judged that it is connected to CDP or DCP  
 Output 0.6 V to the D - line and measure the voltage of the D + line  
When the voltage of the D + line is less than 0.3 V, it is judged that it is connected to the CDP；  
When the voltage of the D + line is 0.3 V or more and less than 0.8 V, it is determined that it is connected to DCP；

# USB 2.0 IP with Link Power Management Extension(LPM)

Michael Liu, Corporate Applications Engineer

## What is it?

USB 2.0 Link Power Management Addendum is officially released as an Engineering Change Notice (ECN) to apply to USB specification Revision 2.0. In this ECN, it defines a power management feature for USB called Link Power Management (LPM). This feature is similar to the existing USB 2.0 suspend/resume, however, it has transitional latencies of tens of microseconds between defined power states. This is a much finer granularity as compared to the USB 2.0.s suspend/resume, whose transitional latencies are in tens of milliseconds.

In the ECN, it introduces a formal terminology for bus line-states in terms of power states. The fast transition of a root port from an enabled state (called L0 state) to a new Sleep state (called L1 state) is also defined. The ECN has also defined the corresponding L1 state to L0 state transition. Further, the ECN defines the method for extending the existing USB 2.0 protocol to accommodate the newly introduced explicit L1 entry.

Using a newly defined USB transaction, a USB host would actively initiate a L0 to L1 transition. This would allow a device to detect the host.s intent and respond immediately. This feature is favorably compared to the existing suspend method in USB 2.0, which requires 3 orders of magnitude more transitional time on USB wires. Similarly, the L1 to L0 transition is compared to USB 2.0 resume. Both the host and device can initiate the resume. However, the duration of resume signaling has been redefined to be 3 orders of magnitude faster in LPM.

## Why is there a LPM?

The ECN intends to make USB 2.0 a relevant technology for today.s mobile platforms, upon which many hand-held devices have been designed and marketed. The focus of LPM is to provide a more favorable power management method for mobile product development. The existing USB 2.0 power management feature is simply not suitable for many of the mobile products being developed nowadays. Preliminary lab testing has shown that the LPM feature allows for power consumption optimization across both the USB 2.0 host and devices. A direct impact on the hand-held device application in terms of its power consumption reduction is that the effective battery life cycles will be extended by 15-20%.

## LPM Power States

In ECN, it formally defines 4 power management states for USB as follows:

* L0 (On)
* L1 (Sleep): New & finer granularity
* L2 (Suspend)
* L3 (Off)

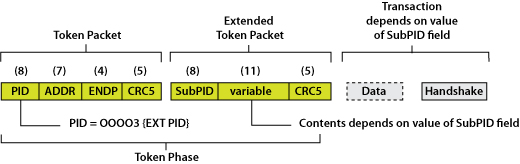
Please note that the L0, L2 and L3 states are formal names for conditions already defined in USB 2.0 specification. The link in this context is intended to encapsulate the downstream facing port of a host or hub, the upstream facing port of a device and the data lines connecting the ports.

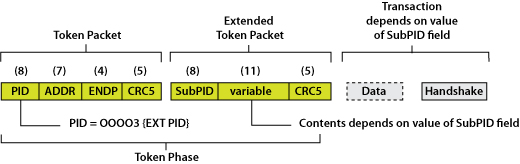
The L1 Sleep state is a newly introduced link power state. It differs from the L2 Suspend in 2 ways: the transitional latencies are much shorter and there are no explicit power draw requirements. The comparison of the 2 states is provided in the following table:

|  |  |  |
| --- | --- | --- |
|  | **L1 (Sleep)** | **L2 (Suspend)** |
| Entry | Explicitly entered via LPM extended transaction | Implicitly entered via 3ms of link inactivity |
| Exit | Device or host-initiated via resume signaling;  Remote-wake can be (optionally) enabled/disabled via the LPM transaction. | Device- or host-initiated via resume signaling;  Device-initiated resumes can be (optionally) enabled/disabled by software |
| Latencies | Entry: ~10us  Exit: ~70 us to 1ms (host-specific) | Entry: ~3ms  Exit: >0ms (OS-dependent) |
| Device Power Consumption | Device power consumption level is application and implementation specific | Device power consumption is limited to: ≤500 uA or ≤2.5mA |

The explicit port commands are used to control a particular USB link.s L0 and L1 state transitions.

## LPM Protocol Extension

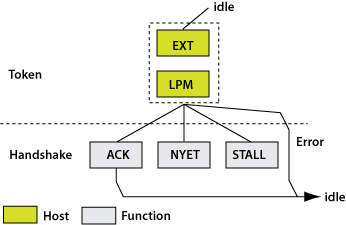
The LPM ECN uses the existing USB 2.0 reserved PID value 0000B and defines this PID value the EXT PID. Further, the ECN defines an extended token phase used to extend the USB 2.0 transaction protocol. Now the token phase has 2 token packets as illustrated below: 



Please note that the first token packet is a standard token packet with its newly defined EXT PID. The second token is the extended token packet with a SubPID that is specific to the LPM extension. When its value is LPM, then the 11-bit content would contain definitions that are related to the LPM. In that content definition, it would further describe link states, resume capability and timing duration.

## LPM Transactions

A host would use LPM transactions to transition a host to device link to a specific link power state. An LPM transaction is a two phase extended USB transaction as shown below, consisting of an extended token phase and a handshake phase.



When a host is ready to transition a port from L0 to L1 state, it issues a port command that will result in an LPM transaction being initiated on the affected port. The attached device of the port would send ACK if it is ready to make such a transition or a NYET handshake if it is currently not able to do so. The device must send a STALL if it does not support the requested link state. If the device detects errors or it does not understand the protocol extension transaction, then it sends no handshake.

## LPM Impacts

LPM is backward compatible with USB 2.0 systems. A USB 2.0 host would continue to work with properly with a device that supports LPM. Similarly, a USB 2.0 device would work properly with a host that supports LPM. The only time when LPM is used is when both host and device support such a feature.

LPM enhancement requires changes on both host and device platforms to really take advantage of this feature. There will be implications on hardware, software and compliance testing,

For hardware implications, there are no changes to the physical analog layer. The L1 state is identical to USB 2.0 suspend in terms of line-state. There are no changes to resume signaling levels, end of resume signaling event and subsequent line states. However, new state machines are required at both host and device to accommodate the shorter event times. Further, a device must be able to decode the new extended protocol to recognize an LPM transaction.

For software implications, the host controller design would need to allow software to exert control on LPM feature management. This is host controller implementation specific. Minimally, a host controller needs to provide the software a means of control to expose the compliance testing of L1 and new resume timings.

For compliance testing, it is easy to test the LPM feature since L1 is an explicit transaction, it is easily captured via the bus analyzer. Similarly, the resume signaling is also easily captured and measured using existing procedures.

## When is it available?

General availability for the DesignWare USB 2.0 IP with LPM is scheduled for Q4 2008. Please [contact Synopsys](https://www.synopsys.com/cgi-bin/designware/contact/req1.cgi?p=DWTB+USB+LPM) for more details about the DesignWare USB 2.0 IP solutions.

# USB transaction translator (TT)

Any USB hub that supports a higher standard than USB 1.1 (12 Mbit/s) will translate between the lower standard and the higher standard using what is called a **transaction translator** (TT). For example, if a USB 1.1 device is connected to a port on a USB 2.0 hub, then the TT would automatically recognize and translate the USB 1.1 signals to USB 2.0on the uplink. However, the default design is that all lower standard devices share the same transaction translator and thus create a bottleneck, a configuration known as the **single transaction translator**. Consequently, **multitransitional translators** (Multi-TT) were created, which provide more transaction translators such that bottlenecks are avoided.

A USB hub consists of a Hub Repeater section, a Hub Controller section, and a Transaction Translator (TT) section.

The Hub Repeater is responsible for managing connectivity between upstream and downstream facing ports which are operating at the same speed. The Hub Repeater supports full-/low-speed connectivity and high-speed connectivity.

The Hub Controller provides status and control and permits host access to the hub.

The Transaction Translator (TT) takes high-speed split transactions and translates them to full-/low-speed transactions when the hub is operating at high-speed and has full-/low-speed devices attached. If a low or full speed device is connected to the hub operating at high speed, the data transfer route includes the Transaction Translator (TT). If a high-speed device is connected to this high-speed hub the route only includes the Hub Repeater and no Transaction Translator (TT).

For more information, please review the chapter11.14 Transaction Translator of USB 2.0 specification.