

# USB ENGINEERING CHANGE NOTICE

**Title: USB 2.0 Connect Timing Update**

**Applies to: Universal Serial Bus Specification, Revision 2.0**

## Summary of ECN Update

Many portable devices use their USB port as their primary charging port. It is difficult for these portable devices to be compliant with the original USB2.0 spec for the case where the portable device had a weak battery. The original USB2.0 spec only allowed a peripheral to draw 100mA for 100ms after attach before the peripheral was required to connect. Most portable devices with dead batteries are not able to power up and be ready to enumerate with this little time or current.

To address this issue, the Connect Timing ECN included a provision whereby a portable device with a weak battery could draw 100mA for up to 45min, in order to trickle charge its battery before being required to connect. Although this allowed a way for portable devices to remain compliant with USB2.0, it resulted in an unacceptable user experience. Users were not willing to wait for extended periods of time while the battery trickle charged, before being able to use the portable device. As a result, most portable devices with dead batteries do not comply with the Connect Timing ECN, and simply draw 500mA as soon as they are attached to a PC. These devices will typically power up and enumerate within a short time, at which point they are again in compliance with USB2.0. It is only for this short time after attach that they are not compliant.

This short time of non-compliance has not resulted in any apparent issues with PCs or other host ports. Portable devices can benefit greatly from being a part of the USB-IF compliance program. However, some portable devices are not being submitted for compliance because they are not compliant with the Connect Timing ECN.

The purpose of the Connecting Timing ECN Update is to define a provision that allows portable devices with dead batteries to draw up to 500mA from a PC for a short time after attach, so that they can power up immediately, and yet still be compliant with USB2.0. This will enable and encourage more portable devices to be submitted for USB-IF compliance testing.

The text of the original Connect Timing ECN is preserved below, with the changes shown as redlines.

## Definition of Terms

The following terms are defined in the USB-IF Battery Charging Specification, Revision 1.2 (BC1.2), and are copied here for convenience.

### **Attach**

A downstream device is considered to be attached to an upstream port when there is a physical cable between the two.

### **Connect**

A downstream device is considered to be connected to an upstream port when it is attached to the upstream port, and when the downstream device has pulled either the D+ or D- data line high through a 1.5 kΩ resistor, in order to enter Low-Speed, Full-Speed or High-Speed signaling.

### **Dead Battery Threshold**

The Dead Battery Threshold is defined as the maximum charge level of a battery such that below this threshold, a device is assured of not being able to power up successfully.

### **Weak Battery Threshold**

The Weak Battery Threshold is defined as the minimum charge level of a battery such that above this threshold, a device is assured of being able to power up successfully.

## **Summary of ECN**

This ECN addresses the following three issues:

- dead battery pre-connect current
- post-connect current timing
- VBUS valid to connect timing

### **Dead battery pre-connect current**

The Battery Charging spec contains the Dead Battery Provision, which allows devices with weak or dead batteries to draw up to 100mA for the time required to power the device up, and bring it to a state where it can connect.

The USB 2.0 spec currently allows devices to draw 100mA for only 100ms before connecting. This time is not sufficient for most portable devices with dead batteries to power up.

The USB 2.0 spec would be modified such that a device with a dead battery could draw 100mA for the time required to power up the device, and bring it to a state where it can connect.

### **Post-connect current timing**

The Battery Charging spec allows devices to draw 100mA for 1 second after the connect event, regardless of what is happening on the bus.

The USB 2.0 spec currently requires devices to drop down to suspend current within 10ms of no bus activity, during both the attach debounce time (TATTDB) and during the reset time (TDRST). In practice, no devices do this. During USB compliance testing, suspend current is not tested until several seconds after the connect event.

The USB 2.0 spec would be modified such that a device is not required to drop down to the suspend current during the 1 second immediately following the connect event.

### **VBUS session valid to connect time**

During compliance testing, a device that is already powered up must connect within 1 second of VBUS valid. The reason for this test is to provide a user experience where something happens within a short time of a device being attached to a host.

The USB 2.0 spec is not explicit in this issue. Figure 7-29 can be interpreted to imply a VBUS valid to connect time of 100ms. But Figure 7-29 does not distinguish between the VBUS valid event and the time at which the device draws current.

The USB spec would be modified such that the VBUS valid to connect time is explicitly called out. As well, the USB spec would differentiate between the VBUS valid event and the time at which the device starts to draw current from VBUS.

## **Reasons for ECN**

The benefits of this ECN are outlined below.

### **Dead battery pre-connect current**

The USB 2.0 spec will align with the Dead Battery Provision, which allows a device with a dead battery to power up when attached to a USB host.

### **Post-connect current timing**

The USB 2.0 spec will align with the fact that devices don't drop to suspend current during the attach debounce time, TATTDB. The spec will also align with the USB compliance program which doesn't check for suspend current until at least one second after the connect event.

### **VBUS session valid to connect time**

The USB 2.0 spec will align with the USB compliance program, which requires a powered on device to connect within 1 second of VBUS valid.

## **Impact on Existing Peripherals and Systems:**

### **Hardware Implications:**

No change is required of existing peripheral hardware.

Host and hub hardware must now be able to provide a unit load current for at least 1 sec (TCON\_ISUSP) after a peripheral connects.

Previously, peripherals would have to drop down to suspend current several seconds after the connect event if a host suspended the bus. This several second time came from compliance testing and not from the USB 2.0 spec. The USB 2.0 spec was more even constraining, and required a peripheral to drop down to suspend current immediately after the connect event, and before start of reset. However, this was not realistic for connect to reset times of 100ms or less, and was universally ignored.

### **Software Implications:**

There are no software changes required for either the host or peripheral. The host is still allowed to suspend the bus anytime after connect.

### **Compliance Testing Implications:**

Existing compliance tests are not affected for self powered devices or devices with good batteries. Devices with weak or dead batteries should also be tested against the Portable Device Compliance Tests associated with the Battery Charging 1.1 specification.

## **Specification Changes**

**INSTRUCTIONS:** In this section of the ECR, any paragraph starting with the word "INSTRUCTIONS" contains instructions for modifying the text of the USB specification. Any other paragraphs contain new text that should be inserted in the USB specification.

**INSTRUCTIONS:** In Section 7.1.7.3, replace Figure 7-29 as well as the previous one paragraph and following six paragraphs with the following.

Figure 7-29 shows the timing associated with a peripheral connecting to a host or hub port.

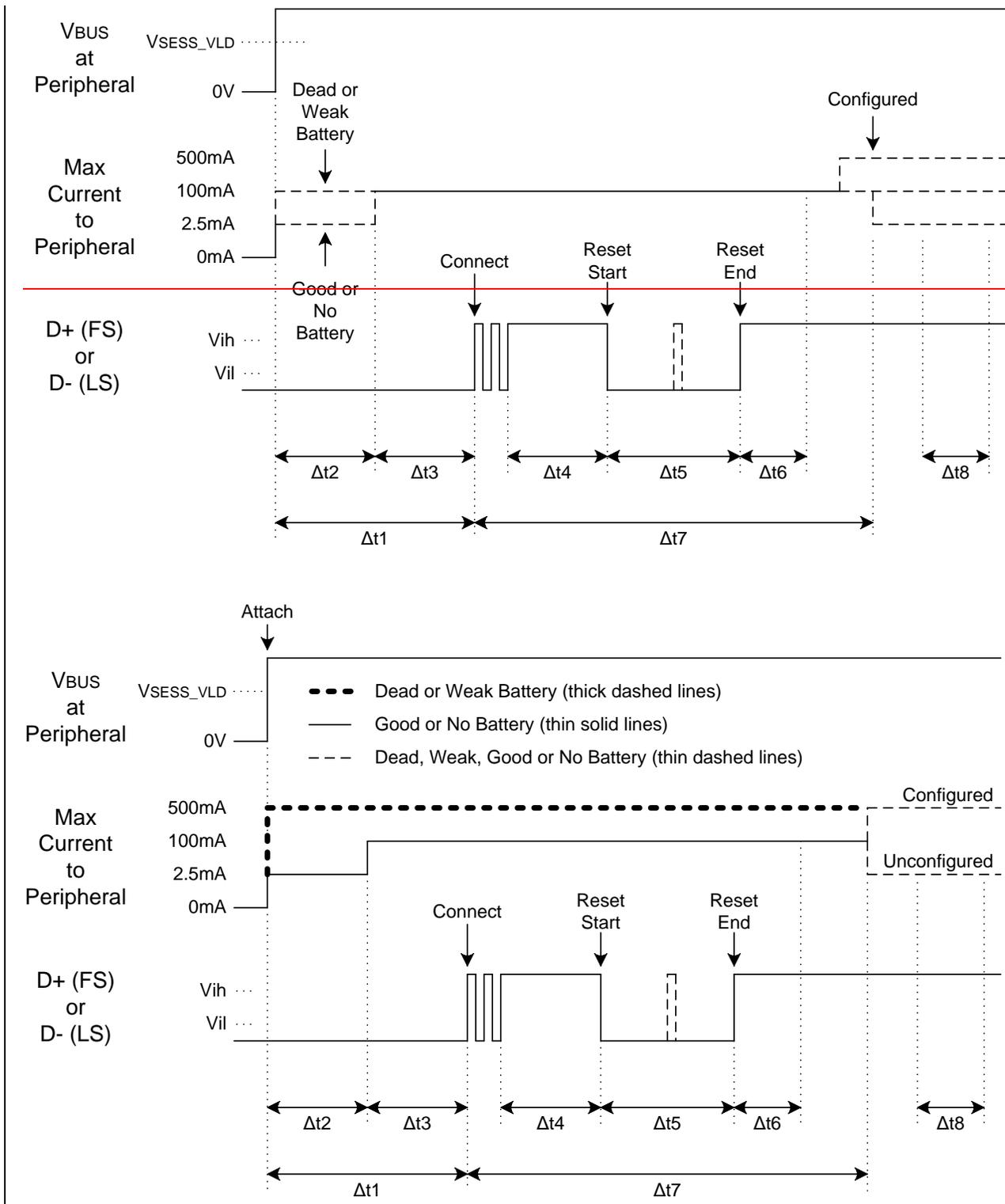


Figure 7-29 Connect Event Timing

$\Delta t_1$  (TSVLD\_CON\_PWD, TSVLD\_CON\_WKB) This is the maximum time from when VBUS crosses  $V_{SESS\_VLD}$  to when the peripheral is required to connect (pull D+ or D- high) and be ready for enumeration. For bus powered peripherals and peripherals that are already powered up, this time

is TSVLD\_CON\_PWD. For portable devices with dead or weak batteries, this time is TSVLD\_CON\_WKB. During TSVLD\_CON\_WKB, a portable device with a dead or weak battery ~~that is drawing up to IUNIT is required to signal the upstream port by driving D+ to VDP\_SRC. If a portable device with a dead or weak battery cannot connect and be enumerated after drawing IUNIT for TSVLD\_CON\_WKB, then it shall reduce its current draw to ISUSP.~~ is allowed to draw up to five times IUNIT.

- Δt2 (TSVLD\_UNIT) This time starts when VBUS crosses the VSESS\_VLD threshold, and ends ~~400ms\_TUNIT\_CON~~ before the connect event. During this time, portable devices with ~~dead or weak batteries are allowed to draw up to IUNIT from VBUS. All other peripherals are only allowed to draw up to ISUSP during this time~~ good batteries are allowed to draw up to ISUSP.
- Δt3 (TUNIT\_CON) This is the maximum time that a bus powered peripheral or a portable device with a good battery can draw up to IUNIT from VBUS before connecting.
- Δt4 (TCON\_RST) This is a debounce interval with a minimum duration of 100 ms that is provided by USB System Software. It ensures that the electrical and mechanical connection is stable before software attempts to reset the attached device. The interval starts when the USB System Software is notified of a connect event (D+ or D- pulled high). The interval restarts if there is a disconnect event. The debounce interval ensures that power is stable at the device for at least 100 ms before resetting the peripheral.
- Δt5 (TDRST) This is the period of time hubs drive reset to a peripheral. Refer to Section 7.1.7.5 and Section 11.5.1.5 for details.
- Δt6 (TRSTRCY) The USB System Software guarantees a minimum of 10 ms for reset recovery. Peripheral response to any bus transactions addressed to the default device address during the reset recovery time is undefined.
- Δt7 (TCON\_ISUSP) After connecting, a peripheral with a good battery is allowed to draw up to ~~one unit load current~~ IUNIT, and a peripheral with a dead or weak battery is allowed to draw up to five times IUNIT, for a time of TCON\_ISUSP. If a peripheral is not configured after TCON\_ISUSP, then it is required to reduce its current draw to ISSUSP., before having to obey the rules of dropping down to suspend current. If, during this time, a peripheral becomes configured, it is then allowed to draw its configured current.
- Δt8 (T2SUSP) After a time of TCON\_ISUSP from the connect event, a peripheral must obey the rules of going into suspend (see Section 7.1.7.6).

Figure 7-29 shows the connect event timing from the perspective of peripheral. From a hub perspective, there is delay between the time that the hub is requested to switch on a port, to the time that the hub outputs a valid voltage on VBUS. This delay is a function of the type of hub port switch. Hubs report this time in the hub descriptor (see Section 11.15.2.1), which can be read via a request to the Hub Controller (see Section 11.16.2.4).

INSTRUCTIONS: Globally replace ICCS with ISUSP.

INSTRUCTIONS: In Table 7-7 below the row for Low-power port, add a row for the parameter VSESS\_VLD. In the Parameter box, add the text “Peripheral session valid threshold”. The min and max values are 0.8V and 4.0V respectively.

INSTRUCTIONS: In Table 7-14, replace TATTDB with TCON\_RST. In the Parameter box, replace the existing text with “Debounce interval provided by USB System Software after peripheral connects.”

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INSTRUCTIONS: In Table 7-14, replace TSIGATT with TSVLD\_CON\_PWD. In the Parameter box, replace the existing text with “Time from VBUS crossing VSESS\_VLD to a powered up peripheral connecting (pull D+ or D- above VIH).” Replace the max value of 100ms with 1sec.

INSTRUCTIONS: In Table 7-14, add the parameter TSVLD\_CON\_WKB, with a maximum value of 2 minutes. In the Conditions box put “Section 7.1.7.3”. In the Parameter box put “Time from VBUS crossing VSESS\_VLD to a peripheral with a dead or weak battery connecting and being ready to enumerate.”

INSTRUCTIONS: In Table 7-14, add the parameter TUNIT\_CON, with a maximum value of 100 msec. In the Conditions box put “Section 7.1.7.3”. In the Parameter box put “Time a peripheral can draw unit load from VBUS before connecting.”

INSTRUCTIONS: In Table 7-14, add the parameter TCON\_ISUSP, with a maximum value of 1 sec. In the Conditions box put “Section 7.1.7.3”. In the parameter box put “Time after connect when peripheral must obey rules of suspend.”