http://compliance.usb.org/

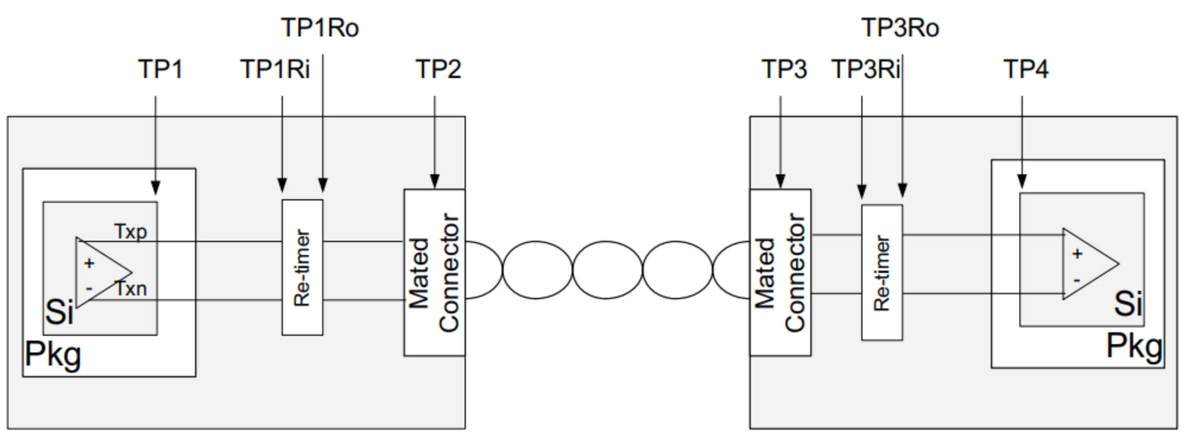
LFPS Tx Low Power

Mandate: Informational -> Required
Effective Date: Sep, 2019 -> May, 2020

USB3.2 Transmitter specification Rev1.0 (section 6.7.2) defines a **Low Power Transmitter operation.** In addition to the full swing transmitter specification, an optional low power swing transmitter is also specified for SuperSpeed applications. A low power swing transmitter is typically used in systems that are sensitive to power and noise interference, and have a relatively short channel. The requirement as to whether a transmitter needs to support full swing, low power swing, or both swings, is dependent on its usage model. All SuperSpeed transmitters **must support full swing**, while support for low power swing is optional. The method by which the output swing is selected is not defined in the specification, and is implementation specific. All metrics for **Table 6-18. Transmitter Normative Electrical Parameters** are defined at TP2 (Figure 6-6) unless otherwise specified.

Test Point	Description
TP1	Transmitter silicon pad
TP2	Transmitter port connector mid-point
TP3	Receiver port connector mid-point
TP4	Receiver silicon pad
TP1Ro, TP3Ro	Re-timer transmitter silicon pad
TP1Ri, TP3Ri	Re-timer receiver silicon pad

Figure 6-6. Electrical Test Points



$V_{TX-DIFF-PP}$	Differential p-p Tx voltage swing	0.8 (min) 1.2 (max)	0.8 (min) 1.2 (max)	V	Nominal is 1 V p-p
$V_{TX-DIFF-PP-LOW}$	Low-Power Differential p-p Tx voltage swing	0.4 (min) 1.2 (max)	0.4 (min) 1.2 (max)	V	Refer to Section 6.7.2. There is no de-emphasis requirement in this mode. De-emphasis is implementation specific for this mode.

TD.1.1 LFPS Tx Goal:

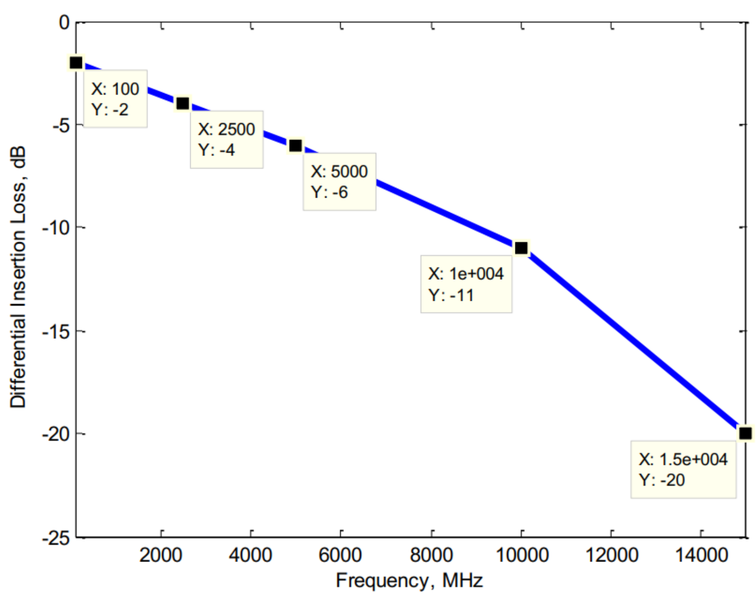
This test verifies that the low frequency periodic signal transmitter meets the timing requirements when measured at the compliance test port.

Overview of Test Steps

1. The test performs the following steps. Connect the DUT to a simple breakout test fixture. Disconnect bus power if the DUT is a bus powered device.
2. Power on the device under test (connect bus powered if DUT is a bus powered device) and let it pass through the Rx.Detect state to the Polling.LFPS substate.
3. Trigger on the initial LFPS burst sent by the DUT and capture the first five bursts for analysis..
4. Measure the following LFPS parameters and compare against the USB 3.2 specification requirements: tburst, trepeat, tperiod, tRiseFall2080, Duty cycle, $V_{CM-AC-LFPS}$,$V_{TX-DIFF-PP-LFPS}$ and $V_{TX-DIFF-PP-LFPS-LP}$. For these measurements the start of an LFPS burst is defined as starting when the absolute value of the differential voltage has exceeded 100 mV and the end of an LFPS burst is defined as when the absolute value of the differential voltage has been below 100 mV for 50 ns. tperiod, tRiseFall2080, Duty cycle, $V_{CM-AC-LFPS}$,$V_{TX-DIFF-PP-LFPS}$ and $V_{TX-DIFF-PP-LFPS-LP}$ are only measured during the period from 100 nanoseconds after the burst start to 100 nanoseconds before the burst stop.

In case of **captive cable devices** it is considered that the captive cable shall comply with USB Type-C Specification section 3.7.2.1.1

Figure 3-34 Recommended Differential Insertion Loss Requirement



LFPS Max. Frequency as defined below is 50MHz thus the expected IL is -1dB

Table 6-29. Normative LFPS Electrical Specification

Symbol	Minimum	Typical	Maximum	Units	Comments
tPeriod	20		100	ns	
tPeriod for SuperSpeedPlus	20		80	ns	
$V_{CM-AC-LFPS}$			$V_{TX-CM-AC-PP-ACTIVE}$	mV	See Table 6-19
$V_{CM-LFPS-Active}$			10	mV	
$V_{TX-DIFF-PP-LFPS}$	800		1200	mV	Peak-peak differential amplitude
$V_{TX-DIFF-PP-LFPS-LP}$	400		600	mV	Low power peak-peak differential amplitude
tRiseFall2080			4	ns	Measured at TP2, as shown in Figure 6-20.
Duty cycle	40		60	%	Measured at compliance TP2, as shown in Figure 6-20.

Low power transmitter at TP2 is not accessible thus effective TP3 shall comply with the following limit:

Table 1.1-1

$V_{TX-DIFF-PP-LOW}$	Low-Power Differential p-p Tx voltage swing	0.352(Min.)	V	Refer to Section 6.7.2. There is no de-emphasis requirement in this mode. De-emphasis is implementation specific for this mode.

5. For **captive cable devices** Repeat steps **1 to 4** and compare tburst, trepeat, tperiod, tRiseFall2080, Duty cycle, VCM-AC-LFPS. VTX-DIFF-PP-LFPS-LP is compared against specified limit in Table 1.1-1. A **Captive device** will pass if in compliance to this step.

LFPS Rx Detect Threshold

Mandate: Informational -> Required

Effective Date: Sep, 2019 -> May, 2020

USB3.2 Transmitter specification Rev1.0 (section 6.7.2) defines a **Low Power Transmitter operation.** In addition to the full swing transmitter specification, an optional low power swing transmitter is also specified for SuperSpeed applications. A low power swing transmitter is typically used in systems that are sensitive to power and noise interference, and have a relatively short channel. The requirement as to whether a transmitter needs to support full swing, low power swing, or both swings, is dependent on its usage model. All SuperSpeed transmitters **must support full swing**, while support for low power swing is optional. The method by which the output swing is selected is not defined in the specification, and is implementation specific. All metrics for **Table 6-18. Transmitter Normative Electrical Parameters** are defined at TP2 (Figure 6-6) unless otherwise specified.

Test Point	Description
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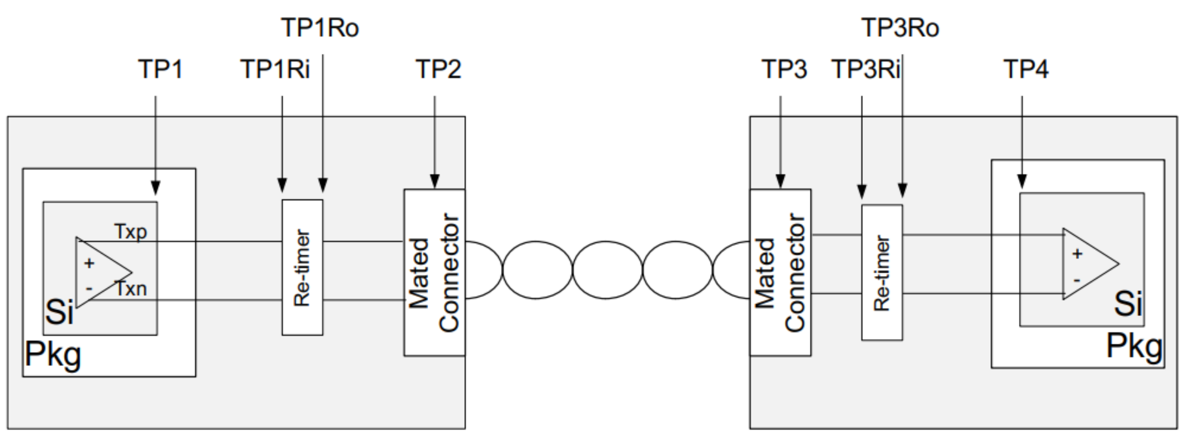
Figure 6-6. Electrical Test Points



$V_{TX\text{-}DIFF\text{-}PP}$	Differential p-p Tx voltage swing	0.8 (min) 1.2 (max)	0.8 (min) 1.2 (max)	V	Nominal is 1 V p-p
$V_{TX\text{-}DIFF\text{-}PP\text{-}LOW}$	Low-Power Differential p-p Tx voltage swing	0.4 (min) 1.2 (max)	0.4 (min) 1.2 (max)	V	Refer to Section 6.7.2. There is no de-emphasis requirement in this mode. De-emphasis is implementation specific for this mode.

While two different transmitters are specified, only a single receiver specification is defined. This implies that receiver margins (as specified in Table 6-22) shall be met if a low power transmitter is used.

$V_{RX-LFPS-DET-DIFFp-p}$	LFPS Detect Threshold	100 (min) 300 (max)	100 (min) 300 (max)	mV	Below the minimum is noise. Must wake up above the maximum.

Present **TD.1.2 LFPS Rx test** address only $\mathbf{V_{TX-DIFF-PP-LFPS}}$ parameter and not $\mathbf{V_{TX-DIFF-PP-LFPS-LP}}$ as described in Table 6-29.

Table 6-29. Normative LFPS Electrical Specification

Symbol	Minimum	Typical	Maximum	Units	Comments
tPeriod	20		100	ns	
tPeriod for SuperSpeedPlus	20		80	ns	
$V_{CM-AC-LFPS}$			$V_{TX-CM-AC-PP-ACTIVE}$	mV	See Table 6-19
$V_{CM-LFPS-Active}$			10	mV	
$V_{TX-DIFF-PP-LFPS}$	800		1200	mV	Peak-peak differential amplitude
$V_{TX-DIFF-PP-LFPS-LP}$	400		600	mV	Low power peak-peak differential amplitude
tRiseFall2080			4	ns	Measured at TP2, as shown in Figure 6-20.
Duty cycle	40		60	%	Measured at compliance TP2, as shown in Figure 6-20.

TD.1.2 LFPS Rx Goal:

This test verifies that the DUT low frequency periodic signal receiver recognizes LFPS signaling with voltage swings and duty cycles that are at the limits of what the specification allows. The link test specification includes test that vary additional LFPS parameters to test the LFPS receiver.

Overview of Test Steps

The test performs the following steps.

1. Connect the DUT to a simple breakout test fixture. Disconnect bus power if the DUT is a bus powered device.
2. Power on the device under test (connect bus powered if DUT is a bus powered device) and let it pass through the Rx.Detect state to the Polling.LFPS substate.
3. Trigger on the initial LFPS burst sent by the DUT and send LFPS signals to the DUT with the following parameters:
   a. tPeriod 50 ns.
   b. $V_{TX-DIFF-PP-LFPS}$ 800 mV.
   c. Duty Cycle 50%
4. The test passes if the device recognizes the LFPS and starts sending the TXEQ sequence following initial LFPS without reverting to Electrical Idle and new LFPS cycle.
5. The test is repeated with the following parameters:
   a. tPeriod 50 ns, $V_{TX-DIFF-PP-LFPS}$ 1200 mV, Duty Cycle 50%.

b. tPeriod 50 ns, $V_{TX-DIFF-PP-LFPS}$ 1000 mV, Duty Cycle 40%.

c. tPeriod 50 ns, $V_{TX-DIFF-PP-LFPS}$ 1000 mV, Duty Cycle 60%.

6. To verify Rx LFPS Detect Threshold ($V_{RX-LFPS-DET-DIFFp-p}$) (as specified in Table 6-22) the following test is performed:

   a. If the DUT reacts to voltages below “Min Spec” or does not react to voltages above “Max Spec” it would produce a result of fail.

$V_{RX-LFPS-DET-DIFFp-p}$	LFPS Detect Threshold	100 (min) 300 (max)	100 (min) 300 (max)	mV	Below the minimum is noise. Must wake up above the maximum.

7. Repeat steps 1 and 2 above

8. Trigger on the initial LFPS burst sent by the DUT and send LFPS signals to the DUT with the following parameters and register DUT response on scope:

   a. tPeriod 50 ns, $V_{RX-LFPS-DET-DIFFp-p}$ 100 mV, Duty Cycle 50%. **Normative**

   b. tPeriod 50 ns, $V_{RX-LFPS-DET-DIFFp-p}$ 200 mV, Duty Cycle 50%. (**Characterization - Informative**)

   c. tPeriod 50 ns, $V_{RX-LFPS-DET-DIFFp-p}$ 300 mV, Duty Cycle 50%. **Normative**

   d. tPeriod 50 ns, $V_{RX-LFPS-DET-DIFFp-p}$ 90 mV, Duty Cycle 50%. (**Characterization - Informative**)