USB 3.1 ENGINEERING CHANGE NOTICE

Title: HSEQ
Applied to: USB_3_1r1.0_07_31_2013

Brief description of the functional changes:
Addresses one extreme corner case in SSP operation where ambiguity of Header Sequence Number Advertisement may arise after entry to U0 from Recovery. In SSP operation, all header sequence numbers (0~7) are used. Header Sequence Number Advertisement is one and only one block acknowledgement in USB3 operation. There exist two scenarios that result in link going to Recovery. 1. All 8 HPs transmitted were corrupted and corrupted in a way that HPSTART OS are not recognizable and LBAD is impossible. This leads to entry to Recovery. The Header Sequence Number is LGOOD_4 (assuming the 1st header packet has HSEQ# of 5). 2. All 8 HPs transmitted were received successfully, but all 8 LGOOD_n are corrupted and corrupted in a way that SLCSTART OS are not recognizable. This will also lead to entry to Recovery. The same Header Sequence Number of LGOOD_4 is received. Although this is an extreme corner case, it does result in ambiguity where the port transmitting all 8 HPs needs to decide if all 8 HPs needs to be flushed or re-transmitted.

Benefits as a result of the changes:
Resolve behavioral uncertainty

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
No certified SSP product yet

An analysis of the hardware implications:
Minor change is needed. Header sequence number range increased by one bit.

An analysis of the software implications:
None

An analysis of the compliance testing implications:
Minor. Extend header sequence number range from 0~7 to 0~15.

Actual Change

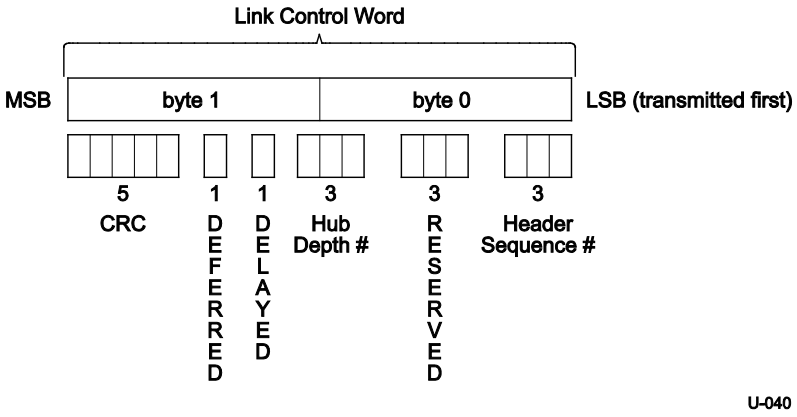
Section 7.2.1.1.3
From Text:

The Link Control Word shall contain a 3-bit Header Sequence Number, 3-bit Reserved, a 3-bit Hub Depth Index, a Delayed bit (DL), a Deferred bit (DF), and a 5-bit CRC-5.

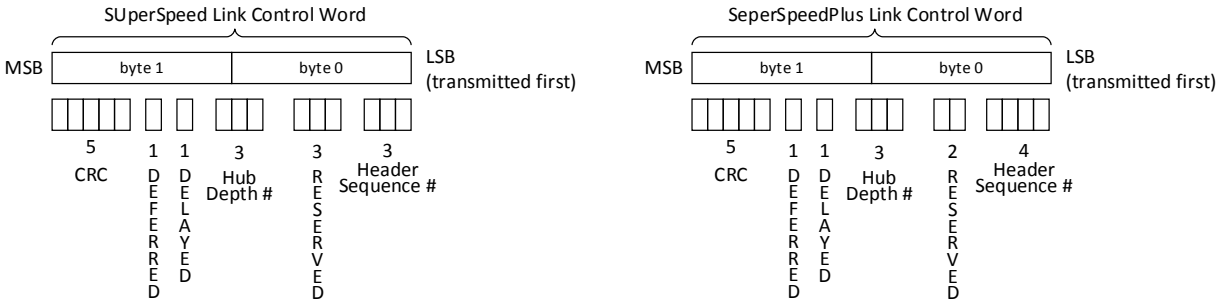
To Text:

In SuperSpeed operation, the Link Control Word shall contain a 3-bit Header Sequence Number, 3-bit Reserved, a 3-bit Hub Depth Index, a Delayed bit (DL), a Deferred bit (DF), and a 5-bit CRC-5. In SuperSpeedPlus operation, the Link Control Word shall contain a 4-bit Header Sequence Number, 2-bit Reserved, a 3-bit Hub Depth Index, a Delayed bit (DL), a Deferred bit (DF), and a 5-bit CRC-5.

From Figure 7-7



To Figure 7-7



Section 7.2.4.1.1
From Text:

1. A port shall initiate the Header Sequence Number Advertisement by transmitting LGOOD_n with “n” equal to the Rx Header Sequence Number minus one.

   Note: The decrement is based on modulo-8 operation.

4. A port shall set its initial ACK Tx Header Sequence Number to the Sequence Number received during the Rx Header Sequence Number Advertisement plus one.

   Note: The increment is based on modulo-8 operation.

To Text:

3. A port shall initiate the Header Sequence Number Advertisement by transmitting LGOOD_n with "n" equal to the Rx Header Sequence Number minus one.

   Note: The decrement is based on modulo-8 operation in SuperSpeed operation, and modulo-16 in SuperSpeedPlus operation.

4. A port shall set its initial ACK Tx Header Sequence Number to the Sequence Number received during the Rx Header Sequence Number Advertisement plus one.

   Note: The increment is based on modulo-8 operation in SuperSpeed operation, and modulo-16 in SuperSpeedPlus operation.

Section 7.2.4.1.1
From Text:

b. If a port enters U0 from Recovery, it shall flush all the header packets in its Tx Header Buffers or Type 1/Type 2 Tx Header Buffers that have been sent before Recovery except for those with the Header Sequence Number greater than (modulo 8) the Header Sequence Number received in Header Sequence Number Advertisement.

   Note: If for example, the Header Sequence Number Advertisement of LGOOD_1 is received, a port shall flush the header packets in its Tx Header Buffers or Type 1/Type 2 Tx Header Buffers with Header Sequence Numbers of 1, 0, 7, 6.

To Text:

b. If a port enters U0 from Recovery, it shall flush all the header packets in its Tx Header Buffers or Type 1/Type 2 Tx Header Buffers that have been sent before Recovery except for those with the Header Sequence Number greater than (modulo 8 in SuperSpeed operation, and modulo-16 in SuperSpeedPlus operation) the Header Sequence Number received in Header Sequence Number Advertisement.

   Note: If for example in SuperSpeed operation, the Header Sequence Number Advertisement of LGOOD_1 is received, a port shall flush the header packets in its Tx Header Buffers or Type 1/Type 2 Tx Header Buffers with Header Sequence Numbers of 1, 0, 7, 6.

Section 7.2.4.1.2
From Text:

- Header packets shall be sent with the Header Sequence Number in the numerical order from 0 to 7, and back to 0. LGOOD_n received out of the numerical order is considered as missing of a link command, and the transition to Recovery shall be initiated.

To Text:

- Header packets in SuperSpeed operation shall be sent with the Header Sequence Number in the numerical order from 0 to 7, and back to 0. Header packets in SuperSpeedPlus operation shall be sent with the Header Sequence Number in the numerical order from 0 to 15, and back to 0. LGOOD_n received out of the numerical order is considered as missing of a link command, and the transition to Recovery shall be initiated.

Section 7.2.4.1.10
From Text:

- A port shall maintain every header packet transmitted within its Tx Header Buffer or Type 1/Type 2 Tx Header Buffer until it receives an LGOOD_n. Upon receiving LGOOD_n, a port shall do one of the following:

1. If LGOOD_n is the Header Sequence Number Advertisement and a port is entering U0 from Recovery, a port shall flush all the header packets retained in its Tx Header Buffers or Type 1/Type 2 Tx Header Buffers that have their Header Sequence Numbers equal to or less than the received Header Sequence Number, and initialize its ACK Tx Header Sequence Number to be the received Header Sequence Number plus one.

   Note: The comparison and increment are based on modulo-8 operation.
2. If a port receives an LGOOD_n and this LGOOD_n is not Header Sequence Number Advertisement, it shall flush the header packet in its Tx Header Buffer or Type 1/Type 2 Tx Header Buffer with its Header Sequence Number matching the received Header Sequence Number and increment the ACK Tx Header Sequence Number by one based on modulo-8 operation.

To Text:

- A port shall maintain every header packet transmitted within its Tx Header Buffer or Type 1/Type 2 Tx Header Buffer until it receives an LGOOD_n. Upon receiving LGOOD_n, a port shall do one of the following:
  1. If LGOOD_n is the Header Sequence Number Advertisement and a port is entering U0 from Recovery, a port shall flush all the header packets retained in its Tx Header Buffers or Type 1/Type 2 Tx Header Buffers that have their Header Sequence Numbers equal to or less than the received Header Sequence Number, and initialize its ACK Tx Header Sequence Number to be the received Header Sequence Number plus one.

     Note: The comparison and increment are based on modulo-8 operation in SuperSpeed operation, and modulo-16 in SuperSpeedPlus operation.
  2. If a port receives an LGOOD_n and this LGOOD_n is not Header Sequence Number Advertisement, it shall flush the header packet in its Tx Header Buffer or Type 1/Type 2 Tx Header Buffer with its Header Sequence Number matching the received Header Sequence Number and increment the ACK Tx Header Sequence Number by one based on modulo-8 operation in SuperSpeed operation, and modulo-16 in SuperSpeedPlus operation.

Section 7.2.2.2
From Table 7-4:

Table 7-1. Link Command Bit Definitions

Class		Type	b6~4	Sub-Type
b10~9	**Link Command**	**b8~7**		**b3~0**
00	LGOOD_n LRTY LBAD LCRD_x LCRD1_x LCRD2_x	00: LGOOD_n	Reserved (000)	b3: Reserved b2~0: HP Sequence Number 000: LGOOD_0 001: LGOOD_1 010: LGOOD_2 011: LGOOD_3 100: LGOOD_4 101: LGOOD_5 110: LGOOD_6 111: LGOOD_7
		01: LCRD_x LCRD1_x LCRD2_x		b3: Reserved b2: Credit series 0: LCRD_x or LCRD1_x 1: LCRD2_x b1~0: Rx Header Buffer Credit 00: LCRD_A/LCRD1_A/LCRD2_A 01: LCRD_B/LCRD1_B/LCRD2_B 10: LCRD_C/LCRD1_C/LCRD2_C 11: LCRD_D/LCRD1_D/LCRD2_D
		10: LRTY 11: LBAD		Reserved (0000)
01	LGO_Ux LAU LXU LPMA	00: LGO_Ux		0001: LGO_U1 0010: LGO_U2 0011: LGO_U3 Others: Reserved
		01: LAU 10: LXU 11: LPMA		Reserved (0000)
10	LDN LUP	00: LUP 11: LDN Others: Reserved		Reserved (0000)
11: Reserved	Reserved	Reserved (0000)		Reserved (0000)

To Table 7-4:

Table 7-2. Link Command Bit Definitions

Class		Type	b6~4	Sub-Type
b10~9	**Link Command**	**b8~7**		**b3~0**
00	LGOOD_n LRTY LBAD LCRD_x LCRD1_x LCRD2_x	00: LGOOD_n	Reserved (000)	SuperSpeed operation: b3: Reserved; b2~0: HP Sequence Number 000: LGOOD_0, 001: LGOOD_1, …111: LGOOD_7 SuperSpeedPlus operation: b3~0: HP Sequence Number 0000: LGOOD_0, 0001: LGOOD_1, ... 1111: LGOOD_15
		01: LCRD_x LCRD1_x LCRD2_x		b3: Reserved b2: Credit series 0: LCRD_x or LCRD1_x 1: LCRD2_x b1~0: Rx Header Buffer Credit 00: LCRD_A/LCRD1_A/LCRD2_A 01: LCRD_B/LCRD1_B/LCRD2_B 10: LCRD_C/LCRD1_C/LCRD2_C 11: LCRD_D/LCRD1_D/LCRD2_D
		10: LRTY 11: LBAD		Reserved (0000)
01	LGO_Ux LAU LXU LPMA	00: LGO_Ux		0001: LGO_U1 0010: LGO_U2 0011: LGO_U3 Others: Reserved
		01: LAU 10: LXU 11: LPMA		Reserved (0000)
10	LDN LUP	00: LUP 11: LDN Others: Reserved		Reserved (0000)
11: Reserved	Reserved	Reserved (0000)		Reserved (0000)

Section 7.2.2.2
From Text:

Successful header packet transactions between the two link partners require proper header packet acknowledgement. Rx Header Buffer Credit exchange facilitates link flow control. Header packet acknowledgement and Rx Header Buffer Credit exchange are realized using different link commands. LGOOD_n (n = 0 to 7) and LBAD are used to

acknowledge whether a header packet has been received properly or not. LRTY is used to signal that a header packet is re-sent.

To Text:

Successful header packet transactions between the two link partners require proper header packet acknowledgement. Rx Header Buffer Credit exchange facilitates link flow control. Header packet acknowledgement and Rx Header Buffer Credit exchange are realized using different link commands. LGOOD_n and LBAD are used to acknowledge whether a header packet has been received properly or not. LRTY is used to signal that a header packet is re-sent.

Section 7.2.2.2
From Table 7-5:

Link Command	Definition – See Sections 7.2.4.1, 7.2.4.2, and 7.5.6 for detailed use and requirements.
LGOOD_n	n (0, 1, 2, ...7): Header Sequence Number. Sent by a port receiving a header packet when all of the following conditions are true: • The header packet has a valid structure and can be recognized by the receiver. • CRC-5 and CRC-16 are valid. • Header Sequence Number in the received header packet matches the expected Rx Header Sequence Number. • An Rx Header Buffer in the receiver is available for storing the received header packet. Mismatch between a Header Sequence Number in the received header packet and the expected Rx Header Sequence Number will result in a port transitioning to Recovery. Received by a port sending a header packet. This is an acknowledgement from a link partner that a header packet with the Header Sequence Number of "n" is received properly. Receipt of LGOOD_n mismatching the expected ACK Tx Header Sequence Number will result in a port transitioning to Recovery. Also sent by a port upon entry to U0 as the Header Sequence Number Advertisement to initialize the ACK Tx Header Sequence Number of the two ports. Refer to Section 7.2.4.1 for details.

To Table 7-5:

Link Command	Definition – See Sections 7.2.4.1, 7.2.4.2, and 7.5.6 for detailed use and requirements.
LGOOD_n	n: Header Sequence Number. Sent by a port receiving a header packet when all of the following conditions are true: • The header packet has a valid structure and can be recognized by the receiver. • CRC-5 and CRC-16 are valid. • Header Sequence Number in the received header packet matches the expected Rx Header Sequence Number. • An Rx Header Buffer in the receiver is available for storing the received header packet. Mismatch between a Header Sequence Number in the received header packet and the expected Rx Header Sequence Number will result in a port transitioning to Recovery. Received by a port sending a header packet. This is an acknowledgement from a link partner that a header packet with the Header Sequence Number of "n" is received properly. Receipt of LGOOD_n mismatching the expected ACK Tx Header Sequence Number will result in a port transitioning to Recovery. Also sent by a port upon entry to U0 as the Header Sequence Number Advertisement to initialize the ACK Tx Header Sequence Number of the two ports. Refer to Section 7.2.4.1 for details.

Section 7.2.4.1.2

From Text:

- Header packets shall be sent with the Header Sequence Number in the numerical order from 0 to 7, and back to 0. LGOOD_n received out of the numerical order is considered as missing of a link command, and the transition to Recovery shall be initiated.

To Text:

- Header packets shall be sent with the Header Sequence Number in the numerical order from 0 to its maximum value, and back to 0. LGOOD_n received out of the numerical order is considered as missing of a link command, and the transition to Recovery shall be initiated.