

## 1. PCI Engineering Change Notice – Error Clarifications

<b>TITLE:</b>	Error Clarifications
<b>DATE:</b>	July 8, 2003
<b>AFFECTED DOCUMENT(S):</b>	PCI Express 1.0a
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### 1.1 Summary of the Functional Changes

Clarifies and removes inconsistencies in the description of error handling. Adds optional causes of Receiver Error and Malformed Packet Error. Redefines conditions under which Malformed packet errors withhold flow control credits.

### 1.2 Benefits

Clarifies description of error handling. Defines methods for handling additional error cases. Malformed packet change enables implementations to be more easily layered.

### 1.3 Assessment of the Impact

All changes are backward compatible with current specification.

### 1.4 Analysis of the Hardware Implications

Clarifies error handling. Eases layered hardware implementations.

### 1.5 Analysis of the Software Implications

None.

### 1.6 Additional Description and Rationale

#### Error Handline Proposal

##### **Introduction**

This proposal clarifies and removes inconsistencies in the PCI Express specification description of error handling. Additional optional causes of Receiver Error and Malformed Packet Error are defined. The conditions under which Malformed packet errors withhold flow control credits are redefined to allow cleaner layered hardware architectures.

#### Specification Document Changes

##### **Receiver Error**

##### **Section 4.2.4.4 Link Error Recovery**

- Link Errors are defined as 8b/10b decode errors, loss of Symbol lock, **Elasticity Buffer Overflow/Underflow**, or loss of Lane-to-Lane de-skew.
  - Note: 8b/10b decode errors **must be checked, and** trigger a Receiver Error (see Table 4-4), which is a reported error associated with the Port (see Section 6.2). **Triggering a Receiver Error on any or all of Framing Error, Loss of Symbol Lock, Lane Deskew Error, and Elasticity Buffer Overflow/Underflow is optional.**

##### **Section 4.2.6 Table 4-4 Row:L0 Column:Receiver Error**

Set on 8b/10b Error or optionally on Framing Error, **Loss of Symbol Lock, Lane Deskew Error, or Elasticity Buffer Overflow/Underflow**

**Table 6-2: Physical Layer Error List**

Error Name	Default Severity	Detecting Agent Action <sup>1</sup>
Receiver Error	Correctable	<i>Receiver <del>(if checking)</del>:</i> Send ERR_COR to Root Complex.
...		

**Table 7-27: Correctable Error Status Register**

Bit Location	Register Description	Attributes	Default Value
0	<b>Receiver Error Status</b> <del>(Optional)</del> [FOOTNOTE: For historical reasons, implementation of this bit is optional. If not implemented, this bit must be RsvdZ, and bit 0 of the Correctable Error Mask Register must also not be implemented. Note that some checking for Receiver Errors is required in all cases (see Sections 4.2.1.3, 4.2.4.4 and 4.2.6).]	RW1CS	0
...			

**Table 7-28: Correctable Error Mask Register**

Bit Location	Register Description	Attributes	Default Value
0	<b>Receiver Error Mask</b> <del>(Optional)</del> [FOOTNOTE: For historical reasons, implementation of this bit is optional. If not implemented, this bit must be RsvdP, and bit 0 of the Correctable Error Status Register must also not be implemented. Note that some checking for Receiver Errors is required in all cases (see Sections 4.2.1.3, 4.2.4.4 and 4.2.6).]	RWS	0

### Inconsistent Error Terminology

#### Section 3.5.2.1

- This is a ~~D~~Data Link Layer Protocol Error which is a reported error associated with the Port (see Section 6.2)

#### Section 3.5.2.1 Figure 3.17

Log ~~D~~Data Link Layer Protocol Error

<sup>1</sup> For these tables, detecting agent action is given as if all enable bits are set to “enable” and, for Advanced Error Handling, mask bits are disabled and severity bits are set to their default values. Actions must be modified according to the actual settings of these bits.

## Flow Control Initialization Errors

### Section 3.3.1

*FC initialization protocol errors cases are not defined. Remove reference.*

~~Violations of Flow Control initialization protocol are Data Link Layer Protocol Errors (DLLPE). Checking for such errors in FC initialization protocol is optional. If checking is implemented, any detected error is a reported error associated with the Port (see Section 6.2)~~

## Error Clarifications

### Section “Terms and Acronyms”

*Add the following definition:*

Completer Abort (CA) – 1. A status that applies to a posted or non-posted Request that the Completer is permanently unable to

complete successfully, due to a violation of the Completer's programming model or to a fatal error associated with the Completer.

2. A status indication returned with a Completion for a non-posted Request that suffered a Completer Abort at the Completer.

*Edit the following definition:*

Unsupported Request,

UR

~~space that is not~~

~~A Request Packet that specifies some action or access to some~~

~~supported by the Completer.~~

- ~~A status that applies to a posted or non-posted Request that specifies some action or access to some space that is not supported by the Completer.~~
- ~~2. A status indication returned with a Completion for a non-posted Request that suffered an Unsupported Request at the Completer.~~

### Section 3.5.3.1

- If the Physical Layer reports that the received TLP end framing Symbol was EDB, and the LCRC is the logical NOT of the calculated value, discard the TLP and free any storage allocated for the TLP. This is not considered an error.
  - If TLP end framing Symbol was EDB but the LCRC does not match the logical NOT of the calculated value, the TLP is corrupt - discard the TLP and free any storage allocated for the TLP.
    - If the NAK\_SCHEDULED flag is clear,
      - schedule a Nak DLLP for transmission
      - set the NAK\_SCHEDULED flag
- This is a reported error associated with the Port (see Section 6.2).

### Section 2.7.1

- For TLPs including a TLP Digest field used for an ECRC value, Receivers which support end-to-end data integrity checking, check the ECRC value in the TLP Digest field by:
  - applying the same algorithm used for ECRC calculation (above) to the received TLP, not including the 32-bit TLP Digest field of the received TLP
  - comparing the calculated result with the value in the TLP Digest field of the received TLP

- Receivers which support end-to-end data integrity checks report violations as an ECRC Error. This reported error is associated with the receiving port (see Section 6.2).

How the Receiver makes use of the end-to-end data integrity check provided through the ECRC is beyond the scope of this document.

### Section 6.2.6

Add a column to tables 6-2, 6-3 and 6-4 labeled “References” contain section references for each error type:

- Receiver Error
  - Section 4.2.1.3
  - Section 4.2.2.1
  - Section 4.2.4.4
  - Section 4.2.6
- Bad TLP
  - Section 3.5.3.1
- Bad DLLP
  - Section 3.5.2.1
- Replay Timeout
  - Section 3.5.2.1
- Replay Num Rollover
  - Section 3.5.2.1
- Data Link Layer Protocol Error
  - Section 3.5.2.1
- Poisoned TLP Received
  - Section 2.7.2.2
- ECRC Check
  - Section 2.7.1
- Unsupported Request
  - Section 2.2.8.6
  - Section 2.3.1.
  - Section 2.3.2
  - Section 2.7.2.2
  - Section 2.9.1
  - Section 5.3.1
  - Section 6.2.3.1
  - Section 6.2.6
  - Section 6.2.7.1
  - Section 6.5.7
  - Section 7.3.1
  - Section 7.3.3
  - Section 7.5.1.1
  - Section 7.5.1.2
- Completion Timeout
  - Section 2.8.
- Completer Abort
  - Section 2.3.1.
- Unexpected Completion
  - Section 2.3.2.
- Receiver Overflow
  - Section 2.6.1.2.
- Flow Control Protocol Error
  - Section 2.6.1
- Malformed TLP
  - Section 2.2.2
  - Section 2.2.3

- Section 2.2.5
- Section 2.2.7
- Section 2.2.8.1
- Section 2.2.8.2
- Section 2.2.8.3
- Section 2.2.8.4
- Section 2.2.8.5
- Section 2.2.9
- Section 2.3
- Section 2.3.1
- Section 2.3.1.1
- Section 2.3.2
- Section 2.5
- Section 2.5.3
- Section 2.6.1
- Section 2.6.1.2
- Section 6.3.2
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## Malformed Packet Errors

### Section 2.2.7

- I/O Requests have the following restrictions:
  - TC[2:0] must be 000b
  - Attr[1:0] must be 00b
  - Length[9:0] must be 00 0000 0001b
  - Last DW BE[3:0] must be 0000b

Receivers may optionally check for violations of these rules. If a Receiver implementing these checks determines that a TLP violates these rules, the TLP is a Malformed TLP.

- Configuration Requests have the following restrictions:
  - TC[2:0] must be 000b
  - Attr[1:0] must be 00b
  - Length[9:0] must be 00 0000 0001b
  - Last DW BE[3:0] must be 0000b

Receivers may optionally check for violations of these rules. If a Receiver implementing these checks determines that a TLP violates these rules, the TLP is a Malformed TLP.

### Section 2.6.1.2

- Updated as shown:
 
$$\text{CREDITS\_RECEIVED} := (\text{CREDITS\_RECEIVED} + \text{Increment}) \bmod 2^{\lceil \text{Field Size} \rceil}$$
 (Where Increment corresponds to the credits made available, and [Field Size] is 8 for PH, NPH and CPLH and 12 for PD, NPD, and CPLD)
 

for each Received TLP, provided that TLP:

  - passes the Data Link Layer integrity checks
  - is not malformed or (optionally) is malformed and is not ambiguous with respect to which buffer to release and is mapped to an initialized virtual channel.
  - does not consume more credits than have been allocated (see following rule)

### Section 2.3

- ~~All Received TLPs which fail the required (and implemented optional) checks of TLP formation rules described in this chapter, or which use undefined Type field values, are Malformed TLPs (MP) and must be discarded without updating Receiver Flow Control information~~
  - ~~This is a reported error associated with the Receiving Port (see Section 6.2)~~
- All Received TLPs which use undefined Type field values are Malformed TLPs.

- This is a reported error associated with the Receiving Port (see Section 6.2)
- All Received Malformed TLPs must be discarded.
  - Received Malformed TLPs that are ambiguous with respect to which buffer to release or are mapped to an uninitialized virtual channel must be discarded without updating Receiver Flow Control information.
  - All other Received Malformed TLPs must be discarded, optionally not updating Receiver Flow Control information.