memorandum

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T10/03-380r0

To	From	Subject	Date
INCITS T10 Committee	Michael Banther, HP	ADT Baud Rate Fallback	29 October, 2003

Introduction

The present ADT revision (r08) does not include a mechanism for the receiver of an Initiate Recovery IU to fall back to the default baud rate if the recovery fails (see 4.7.2.3, Error recovery for other protocols and frame types). Consider:

a. A Data Transfer Device (DTD) that never initiates communication,

b. A link where both ports have negotiated to a baud rate greater than 9 600, and

c. An Automation Controller that falls back to 9 600 baud due to a failed link recovery attempt.

The subsequent Port Login attempts by the Automation Controller will result in multiple sampling of every bit by the DTD. The multiple sampling may show up as a series of framing errors or as valid, but incorrect, symbol pairs. For example, double clocking of an SOF character (5Bh) will result in the pair 19h, 7Fh at the receiver if the transmitter adds a one bit gap between the SOF and the first byte of the subsequent ADT Frame Header (see **Analysis**). In either case, the DTD will not acknowledge any of the communication as a frame (see 6.5.3.1, Acknowledgement information units introduction). This situation represents a deadlock.

Baud rate mismatch after link negotiation may lead to a similar deadlock. Fortunately a common enhancement can resolve all cases.

HP proposes that the receiver of a number of framing errors outside of a valid frame fall back to the default baud rate and initiate link negotiation. Regardless of the cause and regardless of the state of the other port, this strategy results in both ports returning to the default baud rate and attempting to reopen the link. Once one port has fallen back, the other port will begin to receive framing errors, and it will soon receive the requisite number to fall back also.

HP proposes that the receipt of four or more framing errors without a valid frame cause the receiver to fall back. A port operating at 19 200 baud receiving a Port Login IU transmitted at 9 600 baud will experience at least four framing errors.

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Analysis

Figure 1 shows the clock relationship between a transmitting and receiving port under normal operation.

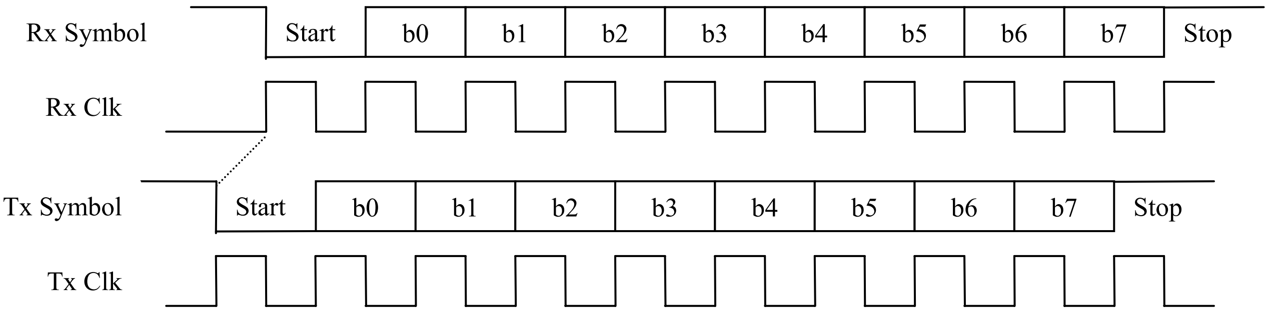

Figure 1

Figure 2 shows the clock relationship between a transmitting and receiving port when the receiving baud rate exceeds the transmitting baud rate by a factor of two.

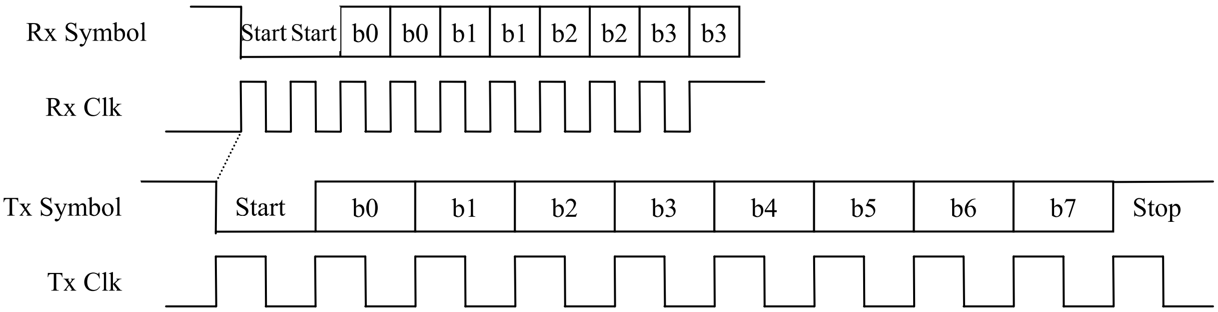

Figure 2

If the transmitter sends an SOF (5Bh) with a one bit gap before the next byte, the receiver running at twice the baud rate may receive 19h, 7Fh:

1. The transmitter encodes 5Bh as 0 0101 1011 11b,
2. By double sampling, the receiver detects 00 0011 0011 1100 1111 1111b,
3. The receiver decodes this string as:
   1) 0 0001 1001 1b,
   2) 11b (additional stop/idle bits),
   3) 0 0111 1111 1b.

Note that if the transmitter did not leave a one bit gap, the receiver will still receive 19h, but it will detect a framing error in place of the 7Fh because the Stop bit for that symbol will have the value zero.

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What's the minimum number of framing errors that a port will receive if it operates at a higher baud rate and the transmitter operates at 9 600 baud? The analysis below seeks to provide an answer. It assumes the receiver operates at 19 200 since a higher baud rates provide more opportunities for framing errors to arise. It also assumes favourable gaps between symbols to minimize the number of framing errors.

A port initiating Link Negotiation after a fallback sends a Port Login IU frame: SOF, ADT Frame Header, Port Login IU, Checksum, and EOF. The Port Login IU and Checksum may vary widely from one device to another. However the SOF and ADT Frame Header contain an almost static set of values (X indicates a nibble that may vary in value):

1. 5Bh,
2. 02h, X0h, 00h, 08h,

Provided the initiator sets the EXCHANGE ID to zero, only the X_ORIGIN bit will vary depending on which port initiates the negotiation.

The transmitter encodes the bytes to (| indicates byte boundaries; idle gaps appear in italics between vertical bars):

0 0101 1011 1| *1*| 0 0000 0010 1| 0 X000 0000 1| 0 0000 0000 1| 0 0000 1000 1.

The receiver, by double sampling, detects (| represents transmitter byte boundaries):

00 0011 0011 1100 1111 11| *11*| 00 0000 0000 0000 1100 11| 00 XX00 0000 0000 0000 11|
00 0000 0000 0000 0000 11| 00 0000 0000 1100 0000 11

The receiver decodes (| now represents byte boundaries decoded by the receiver; idle gaps, as seen by the receiver, appear in italics between vertical bars):

0 0001 1001 1| *11*| 0 0111 1111 1| 0 0000 0000 0| 0 0001 1001 1| 0 0XX0 0000 0| 0 0000 0001 1|
0 0000 0000 0| 0 0000 0001 1| 0 0000 0000 0| *11*| 0 0000 011X X

Hence the frame containing the Port Login IU generates at least four framing errors in the receiver. I've verified that the number of framing errors increases if the transmitter doesn't include the gap between the first and second bytes. I didn't finish the analysis to calculate the total number of framing errors.

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Proposed Text

3.1.31 Symbol framing error: An error that occurs when the receiver an asynchronously transmitted symbol detects a Start or Stop bit with an incorrect value.

Subsequent sub-clause numbers in clause 3 adjusted upwards.

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4.7.1.3 Error detection by the frame receiver

The port that receives a frame shall detect and report the following link level errors:

a. Checksum, over-length, under-length, or improperly formatted frames.
b. Unsupported PROTOCOL or FRAME TYPE values.
c. Frames with protocol other than link service when logged out.
d. Frames with a frame number that does not match the Expected Frame Number counter (see 4.6.3)

When a port detects an error on a frame it receives it shall send a NAK IU to the other port with appropriate status so that the port that sent the frame in error can initiate recovery steps. The FRAME NUMBER field of the NAK IU shall be set to the Expected Frame Number counter value (see 4.6.3) when the error was detected. The Expected Frame Number counter shall not be adjusted.

The port shall also detect symbol framing errors received outside of a frame.

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4.7.2.4 Error recovery for symbol framing errors

After detecting four or more symbol framing errors without the receipt of a frame, a port shall abort all exchanges, set the operating parameters of the interface to default settings, and initiate a Port Login exchange with the AOE bit set to one.