BREA Technologies, Inc.
14902 Mesita Drive
Houston, TX 77083-3209
P: (281) 530-3063
F: (281) 988-0358
BillG@breatech.com

March 7, 1999

To: T10 Technical Committee
From: Bill Galloway
Subj: Synchronous ATN Timing

The setup time for ATN has been inadvertently changed from SPI-2 to SPI-3. This proposal moves the timing back closer to SPI-2 but not all of the way back. In SPI-2 the ATN setup time is at least two system deskew delays before the negation of ACK. In SPI-2 the system deskew delay varied with negotiated speed. In SPI-3 the system deskew delay remains constant.

The system deskew delay is used during Quick Arbitration, Selection, Reselection, Asynchronous Information Transfer, Bus turnaround, SCAM, Arbitration Fairness, and ATN Condition. Only the ATN Condition should vary by negotiated speed.

The existing SPI-3 definition for system deskew delay should remain the same. New times should be defined for the ATN Condition. These times should follow the new CRC times where appropriate. This table provides the old times for reference and proposes new numbers.

Old Times	Async	Fast-5	Fast-10	Fast-20	Fast-40	Fast-80
SPI-3 Transmit Setup Time (ST)	49ns	23ns	23ns	11,5ns	9,25ns	NA
SPI-3 Receive Setup Time (ST)	?	15ns	15ns	6,5ns	4,75ns	NA
SPI-3 Transmit Setup Time (DT)	NA	NA	37ns	18,5ns	9,25ns	4,8ns
SPI-3 Receive Setup Time (DT)	NA	NA	25ns	11,5ns	4,75ns	1,45ns
SPI-3 CRC Transmit Setup Time (DT)	NA	NA	47ns	28,5ns	19,25ns	14,8ns
SPI-3 CRC Receive Setup Time (DT)	NA	NA	35ns	21,5ns	14,75ns	11,45ns
SPI-2 ATN Setup	90ns	90ns	40ns	30ns	16ns	NA
SPI-3 ATN Setup	90ns	90ns	90ns	90ns	90ns	90ns
New Times						
New ATN Transmit Setup Time (ST)	90ns	33ns	33ns	21,5ns	19.25ns	NA
New ATN Receive Setup Time (ST)	?	17ns	17ns	8,5ns	6,75ns	NA
New ATN Transmit Setup Time (DT)	NA	NA	47ns	28,5ns	19,25ns	14,8ns
New ATN Receive Setup Time (DT)	NA	NA	27ns	13,5ns	6,75ns	3,45ns

Add new paragraphs to 9.1 Timing description

9.1.x ATN Transmit setup
The minimum time provided by the transmitter between the transition of the ATN signal and the negation of the ACK signal.

9.1.x ATN Receive setup
The minimum time required at the receiver between the transition of the ATN signal and the negation of the ACK signal to recognize the assertion or negation of an Attention Condition.

Editorial changes to clean up attention

11.1.1.1 Unexpected bus free

….
The target uses an unexpected bus free to inform the initiator of a protocol error. The target may switch to a BUS FREE phase at any time, except during an ARBITRATION phase, independent of ~~the state of the ATN signal~~ an attention condition.

11.1.2.2 Quick arbitration method protocol

…..
If an initiator receives a QA REQUEST message from a target that has not negotiated the use of quick arbitration, then the initiator shall ~~assert ATN before the ACK signal is released~~ create an attention condition for the QA REQUEST message, and shall report MESSAGE REJECT on the following MESSAGE OUT phase.

11.1.2.2.1 QUICK ARBITRATION phase

……
c) After detection of the last ACK signal being negated and if the ~~ATN signal is negated~~ attention condition is clear, the target shall release all SCSI signals except the BSY signal and the target shall negate the MSG, C/D, and I/O signals within two system deskew delay.

a) The SCSI device shall first wait for MESSAGE IN phase to occur with either a DISCONNECT/QA REQUEST (0455h) message sequence, COMMAND COMPLETE/QA REQUEST (0055h) message sequence, or a single QA REQUEST (55h) message. When the SCSI device detects the ACK signal being negated for the QA REQUEST message and the ~~ATN signal is negated~~ attention condition is clear, it shall begin the QUICK ARBITRATION phase if allowed under the fairness algorithm.

11.1.3.1.1 Selection with ~~ATN~~ attention condition

The initiator shall set the DATA BUS to a value that is the OR of its SCSI ID bit, the target's SCSI ID bit, and the appropriate parity bit(s) (i.e., P_CRCA, and/or P1). If information unit transfers are disabled the initiator shall ~~assert the ATN signal~~ create an attention condition (indicating that a MESSAGE OUT phase is to follow the SELECTION phase). If information unit transfers are enabled the initiator may ~~assert the ATN signal~~ create an attention condition.

11.1.3.1.1.1 Selection with ~~ATN~~ attention condition time-out procedure

11.1.3.1.2 Selection without ~~ATN~~ attention condition

The initiator shall set the DATA BUS to a value that is the OR of its SCSI ID bit, the target's SCSI ID bit, and the appropriate parity bit(s) (i.e., P_CRCA, and/or P1) and it ~~shall negate the ATN signal~~ clear the attention condition (indicating that a INFORMATION UNIT OUT phase is to follow the SELECTION phase).

……
If an initiator, when selecting without ~~ATN~~ an attention condition, detects an unexpected COMMAND phase it should invalidate any prior PPR with the selected target. In this case, the initiator shall ~~assert the ATN signal~~ create an attention condition and on the corresponding MESSAGE OUT phase and shall issue an ABORT TASK message. On the next selection with the invalidated target the initiator should do a selection with ~~ATN~~ attention condition and negotiate to enable information unit transfers.

11.1.3.1.2.1 Selection without ~~ATN~~ attention condition time-out procedure

11.1.5 Information transfer phases

……

The C/D, I/O, and MSG signals are used to distinguish between the different information transfer phases (see table 33). The target drives these three signals and therefore controls all changes from one phase to another. The initiator requests a MESSAGE OUT phase ~~by asserting the ATN signal~~ creating an attention condition. The target causes the BUS FREE phase by releasing the MSG, C/D, I/O, and BSY signals.

11.1.5.2.2.2 CRC protected pad field and CRC field DT data transfer to initiator

……

If received CRC and computed CRC do not match (i.e., a CRC error is detected), or if an improperly formatted data group is transferred, then the initiator shall ~~establish an attention condition (see 11.2.1) by asserting the ATN signal before the ACK signal is negated for~~ create an attention condition on or before the last ~~bytes~~ transfer of the CRC field.

11.1.9.2 MESSAGE OUT phase

……

The target shall assert the C/D and MSG signals and negate the I/O signal during the REQ/ACK handshake(s) of this phase. The target shall handshake byte(s) in this phase until the ~~ATN signal is negated~~ attention condition is cleared, except when rejecting a message.

11.1.9.2.1 MESSAGE OUT phase exception condition handling

If the target detects one or more parity error(s) on the message byte(s) received, it may indicate its desire to retry the message(s) by asserting the REQ signal after detecting the ~~ATN signal has gone false~~ attention condition has been cleared and prior to changing to any other phase. The initiator, upon detecting this condition, shall resend all of the previous message byte(s) in the same order as previously sent during this phase. When resending more than one message byte, the initiator shall ~~assert the ATN signal at least two system deskew delays prior to asserting the ACK signal on the first byte and shall maintain the ATN signal asserted until the last byte is sent~~ re-establish the attention condition as described in 11.2.1.

…..

The target may act on messages as received as long as no parity error is detected and may ignore all remaining messages sent under one ~~ATN~~ attention condition after a parity error is detected. When a sequence of messages is resent by an initiator because of a target detected parity error, the target shall not act on any message which it acted on the first time received.

11.1.11.1 DT DATA IN phase information unit transfer exception condition handling

…..

If the initiator detects a parity error on any byte or a CRC error in any information unit it receives while in the DT DATA IN phase the initiator shall create an attention condition ~~by asserting the ATN signal before the ACK signal is released for the last byte of CRC~~ on or before the last CRC transfer. When the target switches to a MESSAGE OUT phase the initiator shall send an INITIATOR DETECTED ERROR message (see 11.6.2.5) to the target. This message notifies the target that data in the information unit was invalid.

Re-write of following section

11.2.1 Attention condition

The attention condition allows an initiator to inform a target that the initiator has a message ready. The target shall honor all valid attention conditions by performing a MESSAGE OUT phase.

The initiator may create an attention condition during the SELECTION phase and during all information transfer phases.

To create an attention condition during the SELECTION phase following normal arbitration, the initiator shall assert the ATN signal at least two system deskew delays before releasing the BSY signal. To clear an attention condition during the SELECTION phase following normal arbitration, the initiator shall negate the ATN signal at least two system deskew delays before releasing the BSY signal.

To create an attention condition during an information transfer phase, the initiator shall assert the ATN signal at least an attention setup time before negating the ACK signal. To re-establish an attention condition during a multi-byte MESSAGE OUT retry, the initiator shall assert the ATN signal two system deskew delays before asserting the ACK signal on the first message byte. To clear an attention condition during an information transfer phase, the initiator shall negate the ATN signal at least two system deskew delays before asserting the ACK signal. The initiator shall not negate the ATN signal while the ACK signal is asserted during a MESSAGE OUT phase.

If the initiator creates the attention condition on or before the last information transfer in a bus phase or information unit, the target shall honor the attention condition before transitioning to a new bus phase or information unit. If the initiator does not meet the attention condition setup time, the target may not honor the attention condition until a later bus phase. The initiator shall keep the ATN signal asserted until the target honors the attention condition.

Once the target has responded to the attention condition by going to MESSAGE OUT phase, the initiator shall keep the keep the attention condition set if more than one message byte is to be transferred. The initiator shall clear the attention condition on the last message byte to be sent. The initiator shall clear the attention condition while transferring the last byte of the messages indicated with a Yes in tables 46, 60, and 65. If the target detects that the initiator failed to meet this requirement, then the target shall go to BUS FREE phase (see 11.1.1).

A target shall respond to an attention condition with MESSAGE OUT phase as follows:

a) If an attention condition is created during a COMMAND phase, the target shall enter MESSAGE OUT phase after transferring part or all of the command descriptor block bytes.
b) If an attention condition is created during a DATA phase, the target shall enter MESSAGE OUT phase at the target's earliest convenience (often, but not necessarily on a logical block boundary). The initiator shall continue REQ/ACK handshakes until it detects the phase change.
c) If an attention condition is created during a STATUS phase, the target shall enter MESSAGE OUT phase after the status byte has been acknowledged by the initiator.
d) If an attention condition is created during a MESSAGE IN phase, the target shall enter MESSAGE OUT phase before it sends another message. This permits a MESSAGE PARITY ERROR message from the initiator to be associated with the appropriate message.
e) If an attention condition is created during a SELECTION phase and information unit transfers are disabled, the target shall enter MESSAGE OUT phase immediately after that SELECTION phase.
f) If an attention condition is created during a SELECTION phase and information unit transfers are enabled, the target shall enter BUS FREE phase immediately after that SELECTION phase.

g) If an attention condition is created during a RESELECTION phase, the target shall ignore it until after the first information transfer phase.
h) If the attention condition is created during an information unit transfer, the target shall enter MESSAGE OUT phase at the completion of the current SPI information unit.

NOTE 35 - The initiator should only create an attention condition during a RESELECTION phase to transmit an ABORT TASK SET, ABORT TASK, TARGET RESET, CLEAR TASK SET, DISCONNECT, NO OPERATION, or CONTINUE TASK message. Other uses may result in ambiguities concerning the nexus.

11.3.1 Phase sequences for reselection and selection with ~~ATN~~ attention condition and information unit transfers dis-abled

Change all references to “with ATN” to “with attention condition”

11.3.2 Phase sequences for selection without ~~ATN~~ attention condition and information unit transfers disabled

Change all references to “without ATN” to “without attention condition”

11.4.1 SPI information unit sequences

…..
NOTE 37 - An initiator may request a BUS FREE phase by ~~asserting the ATN signal~~ creating an attention condition and sending a DISCONNECT message on the corresponding MESSAGE OUT phase. This allows an initiator to request the target break up a long sequence of SPI L_Q information unit/SPI data information unit pairs into smaller sequences.
…..
During a read operation the initiator should ~~assert the ATN signal~~ create an attention condition on a parity error or CRC error and not move the data pointers. This allows a target to do a RESTORE POINTERS message and retry the last SPI information unit.

11.4.5 SPI status information unit

The SPI status information unit (see table 41) contains the completion status of the task indicated by the preceding SPI L_Q information unit. The target shall consider the SPI status information unit transmission to be successful when ~~it detects the negation of ACK for the last byte of the information unit with the ATN signal false~~ there is no attention condition on the last transfer of the information unit.

11.6.1.1 Message protocol rules

If information unit transfers are disabled, the first message sent by the initiator after a successful SELECTION phase with ~~the ATN signal asserted~~ an attention condition shall be an IDENTIFY, ABORT TASK SET (see 11.6.4.2), or TARGET RESET message. If a target receives any other message it shall switch to a BUS FREE phase (see 11.1.1.1).

….

Remove paragraph… duplicate

~~The initiator is required to end the MESSAGE OUT phase (by negating ATN) when it sends certain messages identified in tables 46, 60, and 65. These messages are identified by a "Yes" entry in the column headed "Negate ATN before last ACK".~~

Table 46:

Change "Negate ATN before last ACK" to Clear attention condition".

Change "Yes=Initiator shall negate ATN before last ACK of message." to
"Yes=Initiator shall clear attention condition on last byte of message."

11.6.2.1 CONTINUE TASK

……..

An initiator that gets rejected should ~~assert the ATN signal~~ create an attention condition and send an ABORT TAG message on the resulting MESSAGE OUT phase. Otherwise, the target may treat the reconnection as an incorrect initiator connection (see 11.7.2).

11.6.2.2 DISCONNECT

The DISCONNECT message is sent from a target to inform an initiator that the target plans to disconnect by releasing the BSY signal, and that a later reconnect will be required in order to complete the current task. This message shall not cause the initiator to save the data pointer. The target shall consider the message transmission to be successful when ~~it detects the negation of the ACK signal for the DISCONNECT message with the ATN signal false~~ there is no attention condition on the DISCONNECT message.

11.6.2.3 IDENTIFY

Identification is considered successful during a target reconnect when ~~the ATN signal is not asserted during the transfer of~~ there is no attention condition on either the IDENTIFY message or the SIMPLE message for an I_T_L_Q nexus in the MESSAGE IN phase immediately following the RESELECTION phase. See the 11.6.3 for the ordering of the IDENTIFY and task attribute messages. See 11.2.1, item d), for handling target detected errors during the MESSAGE IN phase.

11.6.2.6 MESSAGE PARITY ERROR

…….

In order to indicate its intentions of sending this message, the initiator shall ~~assert the ATN signal prior to its release of the ACK signal for the REQ/ACK handshake of~~ create an attention condition on the message byte that has the parity error. This provides an interlock so that the target is able to determine which message byte has the parity error. If the target receives this message under any other circumstance, it shall signal a catastrophic error condition by going to a BUS FREE without any further information transfer attempt (see 11.1.1).

11.6.2.7 MESSAGE REJECT

…….
In order to indicate its intentions of sending this message, the initiator shall ~~assert the ATN signal prior to its release of the ACK signal for the REQ/ACK handshake of~~ create an attention condition on the message byte that is to be rejected. If the target receives this message under any other circumstance, it shall reject this message.
…….
After a target sends a MESSAGE REJECT message and if the ~~ATN signal is still asserted~~ attention condition is still set, then it shall return to the MESSAGE OUT phase. The subsequent MESSAGE OUT phase shall begin with the first byte of a message.

11.6.2.10.1 Target initiated PARALLEL PROTOCOL REQUEST negotiation

…..
~~Prior to releasing the ACK signal~~ The initiator shall create an attention condition on the last byte of the PARALLEL PROTOCOL REQUEST message from the target~~, the initiator~~ and shall ~~assert the ATN signal and~~ respond with its PARALLEL PROTOCOL REQUEST message, MESSAGE PARITY ERROR message, or with a MESSAGE REJECT message.

11.6.2.10.2 Initiator initiated PARALLEL PROTOCOL REQUEST negotiation

If the initiator recognizes that PARALLEL PROTOCOL REQUEST negotiation is required, it ~~asserts the ATN signal~~ creates an attention condition and sends a PARALLEL PROTOCOL REQUEST message to begin the negotiating process.
……
b) the target does not detect an ~~assertion of the ATN signal before the ACK signal is released~~ attention condition on the last byte of the PARALLEL PROTOCOL REQUEST message.

If the initiator does not support the target's responding PARALLEL PROTOCOL REQUEST message's values the initiator shall ~~assert ATN~~ create an attention condition and the first message shall be a MESSAGE REJECT message.

If during the PARALLEL PROTOCOL REQUEST message the initiator ~~asserts the ATN signal~~ creates an attention condition and the first message of the MESSAGE OUT phase is either a MESSAGE PARITY ERROR or MESSAGE REJECT message the data transfers shall be considered to be negated by both SCSI devices.

11.6.2.14.1 Target initiated SDTR negotiation

…
~~Prior to releasing the ACK signal~~ The initiator shall create an attention condition on the last byte of the SDTR message from the target~~, the initiator~~ and shall ~~assert the ATN signal and~~ respond with its SDTR message, MESSAGE PARITY ERROR message, or with a MESSAGE REJECT message.

11.6.2.14.2 Initiator initiated SDTR negotiation

If the initiator recognizes that SDTR negotiation is required, it ~~asserts the ATN signal~~ creates an attention condition and sends a SDTR message to begin the negotiating process. After successfully completing the MESSAGE OUT phase, the target shall respond with the SDTR message or a MESSAGE REJECT message.

…..

b) the target does not detect an ~~assertion of the ATN signal before the ACK signal is released~~ attention condition on the last byte of the SDTR message.

If the initiator does not support the target's responding SDTR message's values the initiator shall ~~assert ATN~~ create an attention condition and the first message shall be a MESSAGE REJECT message.

If during the SDTR message the initiator ~~asserts the ATN signal~~ creates an attention condition and the first message out is either MESSAGE PARITY ERROR or MESSAGE REJECT the synchronous operation shall be considered to be negated by both the initiator and the target.

11.6.2.15 TARGET TRANSFER DISABLE

This message shall be sent as the last message of the series of consecutive messages of an initial connection. In the case where the initiator initiates a PPR, SDTR and/or a WDTR the initiator shall ~~assert ATN~~ create an attention condition during the last SDTR or WDTR negotiation within the same initial connection and send the target transfer disable message in response to the corresponding MESSAGE OUT phase. The target may continue the task, including any DATA OUT phases on the initial connection, until the target would normally disconnect, but the target shall not reconnect to transfer data.

11.6.2.16 TASK COMPLETE

The TASK COMPLETE message is sent from a target to an initiator to indicate that a task has completed and that valid status has been sent to the initiator. After successfully sending this message, if normal arbitration is enabled the target shall go to the BUS FREE phase by releasing the BSY signal. The target shall consider the message transmission to be successful when ~~it detects the negation of ACK for the TASK COMPLETE message with the ATN signal false~~ there is no attention condition on the TASK COMPLETE message.

11.6.2.17.1 Target initiated WDTR negotiation

….

~~Prior to releasing the ACK signal~~ The initiator shall create an attention condition on the last byte of the WDTR message from the target~~, the initiator~~ and shall ~~assert the ATN signal and~~ respond with its WDTR message, MESSAGE PARITY ERROR message, or with a MESSAGE REJECT message.

11.6.2.17.2 Initiator initiated WDTR negotiation

If the initiator recognizes that WDTR negotiation is required, it ~~asserts the ATN signal~~ creates an attention condition and sends a WDTR message to begin the negotiating process. After successfully completing the MESSAGE OUT phase, the target shall respond with a WDTR message or a MESSAGE REJECT message.

…..

b) the target does not detect an assertion of the ATN signal before the ACK signal is released on the last byte of the WDTR message.

If the initiator does not support the target's responding TRANSFER WIDTH EXPONENT the initiator shall ~~assert ATN~~ create an attention condition and the first message shall be a MESSAGE REJECT message.

If during the WDTR message the initiator ~~asserts the ATN signal~~ creates an attention condition and the first message of the MESSAGE OUT phase is either a MESSAGE PARITY ERROR or MESSAGE REJECT message the wide data transfers shall be considered to be negated by both SCSI devices. In this case, both SCSI devices shall use the eight-bit data transfer mode for data transfers between the two devices.

11.6.3 Task attribute messages

……

If a target attempts to reconnect using an invalid tag, then the initiator ~~should assert the ATN signal~~ create an attention condition. After the corresponding MESSAGE OUT phase the initiator shall respond with an ABORT TASK message.

Table 60 and 65:

Change "Negate ATN before last ACK" to Clear attention condition".

Change "Yes=Initiator shall negate ATN before last ACK of message." to "Yes=Initiator shall clear attention condition on last byte of message."

11.6.4.1 ABORT TASK

…….

NOTE 37 - A nexus may not be fully identified on a reconnection if ~~the ATN signal is asserted~~ an attention condition is created during or prior to the IDENTIFY message and the target has any tagged tasks for that initiator on that logical unit.

11.7.2 Incorrect initiator connection

An incorrect initiator connection occurs on a reselection if an initiator ~~asserts the ATN signal~~ creates an attention condition during the MESSAGE IN phase that follows the RESELECTION phase and does not send an ABORT TASK SET, ABORT TASK, TARGET RESET, CLEAR TASK SET, DISCONNECT, LOGICAL UNIT RESET, or CONTINUE TASK message as one of the messages within the corresponding MESSAGE OUT phase.