

Date: May 13, 1998

To: T10 Committee (SCSI)

From: George Penokie (IBM)

Subject: Parallel Protocol Request

0.0.1 transition period: The time between transition changes (i.e., assert to deassert or deassert to assert). The transition period is normally half the period.

0.0.1.1 PARALLEL PROTOCOL REQUEST

PARALLEL PROTOCOL REQUEST messages (see table 1) are used to negotiate a synchronous data transfer agreement, a wide data transfer agreement, and protocol options usage between two SCSI devices.

Table 1 - PARALLEL PROTOCOL message format

| Bit Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-------------|---------------------------------|---|---|---|------------------|---|---|---|
| 0 | EXTENDED MESSAGE (01h) | | | | | | | |
| 1 | EXTENDED MESSAGE LENGTH (06h) | | | | | | | |
| 2 | PARALLEL PROTOCOL REQUEST (04h) | | | | | | | |
| 3 | RESERVED | | | | | | | |
| 4 | PERIOD FACTOR | | | | | | | |
| 5 | REQ/ACK OFFSET | | | | | | | |
| 6 | TRANSFER WIDTH EXPONENT (m) | | | | | | | |
| 7 | RESERVED | | | | PROTOCOL OPTIONS | | | |

The PERIOD FACTOR field is defined in table 2.

Table 2 - PERIOD FACTOR field

| Code | Description |
|--|--|
| 00h-09h | Reserved (note 1) |
| 0Ah | period equals 25ns (note 2, note 6) |
| 0Bh | period equals 30,3ns (note 2, note 6) |
| 0Ch | period equals 50ns (note 3, note 7) |
| 0Dh-18h | period equals the period factor x 4 (note 3, note 7) |
| 19h-31h | period equals the period factor x 4 (note 4, note 8) |
| 32h-FFh | period equals the period factor x 4 (note 5, note 9) |
| <p>note:</p> <p>1 - Faster timings may be allowed by future SCSI parallel interface standards.</p> <p>2 - Fast-40ST data transfer rates that have a period equal 25ns or 30,3ns.</p> <p>3 - Fast-20ST data transfer rates that have a period of less than or equal 96ns and greater than or equal to 50ns.</p> <p>4 - Fast-10ST data transfer rates that have a period of less than or equal 196ns and greater than or equal 100ns.</p> <p>5 - Fast-5ST data transfer rates that have a period of less than or equal 1020ns and greater than or equal to 200ns.</p> <p>6 - <u>Fast-80DT data transfer rates that have a transitions period equal 12,5ns or 15,15.</u></p> <p>7 - <u>Fast-40DT data transfer rates that have a transitions period of less than or equal 96ns and greater than or equal to 50ns.</u></p> <p>8 - <u>Fast-20DT data transfer rates that have a transitions period of less than or equal 196ns and greater than or equal 100ns.</u></p> <p>9 - <u>Fast-10DT data transfer rates that have a transitions period of less than or equal 1020ns and greater than or equal to 200ns.</u></p> | |

For single-edge clocked synchronous data transfer the REQ/ACK OFFSET is the maximum number of REQ assertions allowed to be outstanding before a corresponding ACK assertion is received at the target. The size of a data transfer may be 1, 2, or 4 bytes depending on the values in the TRANSFER WIDTH EXPONENT field.

For double-edge clocked synchronous data transfer the REQ/ACK OFFSET is the maximum number of paired REQ transitions allowed to be outstanding before a corresponding pair of ACK transitions is received at the target. The size of a data transfer may be 2 or 4 bytes depending on the values in the TRANSFER WIDTH EXPONENT field.

The REQ/ACK OFFSET value is chosen to prevent overflow conditions in the device's reception buffer and offset counter. A REQ/ACK OFFSET value of zero shall indicate asynchronous data transfer mode and that the PERIOD FACTOR field and PROTOCOL OPTIONS field shall be ignored; a value of FFh shall indicate unlimited REQ/ACK offset.

The TRANSFER WIDTH EXPONENT field defines the transfer width to be used during SINGLE TRANSITION DATA IN phases, SINGLE TRANSITION DATA OUT phases. The transfer width that is established applies to all logical units on both SCSI devices. Valid transfer widths are 8 bits (m=00h), 16 bits (m=01h), and 32

bits (m=02h) if the PROTOCOL OPTIONS field is zero. Valid transfer widths are 16 bits (m=01h) and 32 bits (m=02h) if the PROTOCOL OPTIONS field is a non-zero value.

The protocol options field is defined in table 3.

Table 3 - PROTOCOL OPTIONS field

| Code | Description |
|------|---|
| 0h | Use SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases to transfer data |
| 1h | Use SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases with information units to transfer data |
| 2h | Use DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC to transfer data |
| 3h | Use DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units to transfer data |
| 4h | Use DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC and QAS to transfer data |
| 5h | Use DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units and QAS to transfer data |

Editors Note 1 - GOP: There are two other possible protocol options. double with pack/crc, and double with pack/crc/qas.

An PARALLEL PROTOCOL REQUEST agreement applies to all logical units of the two SCSI devices that negotiated agreement. That is, if SCSI device A, acting as an initiator negotiates a data transfer agreement with SCSI device B (a target), then the same data transfer agreement applies to SCSI devices A and B even if SCSI device B changes to an initiator.

A data transfer agreement only applies to the two SCSI devices that negotiate the agreement. Separate data transfer agreements are negotiated for each pair of SCSI devices. The data transfer agreement only applies to data phases and information unit phases.

An PARALLEL PROTOCOL REQUEST message exchange shall be initiated by an SCSI device whenever a previously arranged parallel protocol agreement may have become invalid. The agreement becomes invalid after any condition which may leave the parallel protocol agreement in an indeterminate state such as:

- a) after a hard reset;
- b) after a TARGET RESET message; and
- c) after a power cycle;
- d) after a change in the transceiver mode (e.g., LVD mode to SE mode).

Any condition that leaves the data transfer agreement in an indeterminate state shall cause the SCSI device to enter an asynchronous, eight-bit wide data transfer mode and the PROTOCOL OPTIONS field set to

zero.

An SCSI device may initiate an PARALLEL PROTOCOL REQUEST message exchange whenever it is appropriate to negotiate a data transfer agreement. SCSI devices that are capable of supporting any of the PARALLEL PROTOCOL REQUEST options shall not respond to an PARALLEL PROTOCOL REQUEST message with a MESSAGE REJECT message.

Renegotiation after every selection is not recommended, since a significant performance impact is likely.

The PARALLEL PROTOCOL REQUEST message exchange establishes an agreement between the two SCSI devices;

- a) on the permissible periods and the REQ/ACK offsets for all logical units on the two SCSI devices. This agreement only applies to SINGLE TRANSITION DATA IN phases, SINGLE TRANSITION DATA OUT phases, DOUBLE TRANSITION DATA IN phases, and DOUBLE TRANSITION DATA OUT phases. All other phases shall use asynchronous transfers;
- b) on the width of the data path to be used for data phase transfers between two SCSI devices. This agreement only applies to SINGLE TRANSITION DATA IN phases, SINGLE TRANSITION DATA OUT phases, DOUBLE TRANSITION DATA IN phases, and DOUBLE TRANSITION DATA OUT phases. All other information transfer phases shall use an eight-bit data path; and
- c) on which protocol option is to be used.

The originating SCSI device (the SCSI device that sends the first of the pair of PARALLEL PROTOCOL REQUEST messages) sets its values according to the rules above to permit it to receive data successfully. If the responding SCSI device can also receive data successfully with these values (or smaller periods or larger REQ/ACK offsets or both), it returns the same values in its PARALLEL PROTOCOL REQUEST message. If it requires a larger period, a smaller REQ/ACK offset, a smaller transfer width, or does not support the selected protocol option in order to receive data successfully, it substitutes values in its PARALLEL PROTOCOL REQUEST message as required, returning unchanged any value not required to be changed (see table 4 for valid substitutions for the protocol options). Each SCSI device when transmitting data shall respect the limits set by the other's PARALLEL PROTOCOL REQUEST message, but it is permitted to transfer data with larger periods, smaller REQ/ACK offsets, or both than specified in the other's PARALLEL PROTOCOL REQUEST message. The completion of an exchange of PARALLEL PROTOCOL REQUEST messages implies an agreement as shown in table 5.

Table 4 - Valid substitutions for protocol options

| Request | Valid Responses |
|--|--|
| DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC | a) DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC b) SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases |
| DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units | a) DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units b) SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases |
| DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC and QAS | a) DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC and QAS a) DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC b) SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases |
| DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units and QAS | a) DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units and QAS b) DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units c) SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases |
| SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases with information units | a) SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases with information units b) SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases |

Table 5 - PARALLEL PROTOCOL REQUEST messages implied agreements

| Responding agent PARALLEL PROTOCOL REQUEST response | Implied agreement |
|---|---|
| Non-zero REQ/ACK offset | Synchronous transfer (i.e., Each SCSI device transmits data with a period equal to or greater than and a REQ/ACK offset equal to or less than the values received in the other device's SDTR message). |
| REQ/ACK offset equal to zero | Asynchronous transfer |
| Non-zero TRANSFER WIDTH EXPONENT | Wide transfer (i.e., the initiator and the target transmit data with a transfer width equal to the responding device's transfer width). If the initiating SCSI device does not support the responding SCSI device's TRANSFER WIDTH EXPONENT then the initiating SCSI device shall MESSAGE REJECT the PARALLEL PROTOCOL REQUEST message (see 0.0.1.1.1 and 0.0.1.1.2). |
| TRANSFER WIDTH equal to zero | Eight-bit data |
| protocol options equal to 0h | SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases to transfer data |
| protocol options equal to 1h | DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC to transfer data |
| protocol options equal to 2h | DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units to transfer data |
| protocol options equal to 3h | DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with CRC and QAS to transfer data |
| protocol options equal to 4h | DOUBLE TRANSITION DATA IN and DOUBLE TRANSITION DATA OUT phases with information units and QAS to transfer data |
| protocol options equal to 5h | SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases with information units to transfer data |
| MESSAGE REJECT message | Any prior data transfer agreement shall remain intact |
| Parity error (on responding message) | Eight-bit/asynchronous data transfer with information unit phases disabled |
| Unexpected bus free (as a result of the responding message) | Eight-bit/asynchronous data transfer with information unit phases disabled |
| No response | Any prior data transfer agreement shall remain intact |

If there is an unrecoverable parity error on the initial PARALLEL PROTOCOL REQUEST message (see xxx and xxx) the initiating SCSI device shall retain its previous data transfer mode and protocol options. If there is an unexpected bus free on the initial PARALLEL PROTOCOL REQUEST message the initiating SCSI device shall retain its previous data transfer mode and protocol options.

0.0.1.1.1 Target initiated PARALLEL PROTOCOL REQUEST negotiation

If the target recognizes that PARALLEL PROTOCOL REQUEST negotiation is required, it sends an PARALLEL PROTOCOL REQUEST message to the initiator.

Prior to releasing the ACK signal on the last byte of the PARALLEL PROTOCOL REQUEST message from

the target, the initiator shall assert the ATN signal and respond with its PARALLEL PROTOCOL REQUEST message, MESSAGE PARITY ERROR message, or with a MESSAGE REJECT message.

If an abnormal condition prevents the initiator from responding with an PARALLEL PROTOCOL REQUEST message with a MESSAGE REJECT message then both SCSI devices shall use the eight-bit/asynchronous data transfer mode with the protocol options set to SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases between the two SCSI devices.

Following an initiator's responding PARALLEL PROTOCOL REQUEST message, an implied agreement for data transfers operation shall not be considered to exist until the target leaves the MESSAGE OUT phase, indicating that the target has accepted the negotiation.

If the target does not support any of the initiator's responding PARALLEL PROTOCOL REQUEST message's values the target shall switch to a MESSAGE IN phase and the first message shall be a MESSAGE REJECT message. In this case the implied agreement shall be considered to be negated and both SCSI devices shall use the eight-bit/asynchronous data transfer mode with protocol options set to SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases for data transfers between the two SCSI devices.

If a parity error occurs, the implied agreement shall be reinstated if a retransmission of a subsequent pair of messages is successfully accomplished. After a vendor-specific number of retry attempts (greater than zero), if the target continues to receive parity errors, it shall terminate the retry activity. This is done by the target causing an unexpected bus free. The initiator shall accept such action as aborting the PARALLEL PROTOCOL REQUEST negotiation, and both SCSI devices shall use the eight-bit/asynchronous data transfer mode with protocol options set to SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases for data transfers between the two SCSI devices.

0.0.1.1.2 Initiator initiated PARALLEL PROTOCOL REQUEST negotiation

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

If an abnormal condition prevents the target from responding with an PARALLEL PROTOCOL REQUEST message or with a MESSAGE REJECT message then both SCSI devices shall use the eight-bit/asynchronous data transfer mode with protocol options set to SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases between the two SCSI devices.

Following a target 's responding PARALLEL PROTOCOL REQUEST message, an implied agreement for data transfers shall not be considered to exist until;

- a) the initiator receives the last byte of the PARALLEL PROTOCOL REQUEST message and parity is valid; and
- b) the target does not detect an assertion of the ATN signal before the ACK signal is released 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 and the first message shall be a MESSAGE REJECT message.

If during the PARALLEL PROTOCOL REQUEST message the initiator asserts the ATN signal 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. In this case, both SCSI devices shall use the go to eight-bit/asynchronous data transfer mode with protocol options set to SINGLE TRANSITION DATA IN and SINGLE TRANSITION DATA OUT phases for data transfers between the two devices.