Ultrastar 18XP/9LP Logical Interface Specification (Multimode SE/LVD Addendum) Release 6.0

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About This Addendum

This addendum is meant to be an extension of the Ultrastar 18XP/9LP SCSI Logical Interface Specification. It is intended for use by individuals who are operating multimode SE/LVD devices. This document includes function that is not included in the Ultrastar 18XP/9LP SCSI Logical Interface Specification along with differences in function between microcode developed for SE devices and multimode SE/LVD devices.

Revision History

03/28/98 OEM Version

Contents

1.0 Synchronous Data Transfer Request (01h,01h)

A pair of Synchronous Data Transfer Request messages are exchanged between an Initiator and a Target to establish the synchronous data transfer mode between the two devices. The message exchange establishes the permissible transfer period and REQ/ACK offset for a synchronous data transfer between the two devices. The Initiator may initiate a synchronous data transfer negotiation at any time after the LUN has been identified. The Target initiates a synchronous transfer negotiation if the Target has not negotiated with the Initiator since the last time the Target was Reset (Power-on Reset, SCSI Bus “hard” Reset, Bus Device Reset message, Self Initiated Reset, or Transceiver Mode changed).

Target-initiated synchronous negotiation normally occurs immediately following the wide data transfer negotiation. If a data transfer width agreement exists, the target-initiated synchronous negotiation occurs either immediately following the Command phase or immediately following the first reconnection.

The implied synchronous agreement remains in effect until the Target is Reset (Power-on Reset, SCSI Bus “hard” Reset, Bus Device Reset message, Self Initiated Reset, or Transceiver Mode changed), a new synchronous agreement is negotiated, or the Target receives a Wide Data Transfer Request message. If a Reset occurs or a Wide Data Transfer Request is negotiated, the Target goes to asynchronous mode.

1.1.1 Synchronous Data Transfer Request Message Definition

Table 1. Synchronous Data Transfer Request Message Definition

Byte	Value	Description
0	01h	Extended message
1	03h	Extended message length
2	01h	Synchronous Data Transfer Request code
3	M	Transfer Period Factor (See Table 2).
4	X	REQ/ACK offset.

Table 2. Synchronous Data Transfer Period Factor

Value	Description
0Ah	Transfer period equals 25 nSec
0Bh	Transfer period equals 30.3 nSec
0Ch	Transfer period equals 50 nSec
0Dh-FFh	Transfer period equals transfer period factor times 4 nSec

The transfer period (M above) is the minimum time between leading edges of successive REQ pulses and of successive ACK pulse to meet the device requirements for successful reception of data while using synchronous data transfers. The Drive supports transfer periods in the range 25 nSec to 375 nSec in 25 nSec increments. The Target uses the "fast-40 SCSI data transfer" timings if a synchronous agreement results in a target transfer period of less than 50 nSec. The Target uses the "fast-20 SCSI data transfer" timings if a synchronous agreement results in a target transfer period greater than or equal to 50 nSec and less than 100 nSec. The Target uses the "fast SCSI data transfer" timings if a synchronous agreement results in a target transfer period greater than or equal to 100 nSec and less than 200 nSec. The Drive does not support a target transfer period of 25 nSec with an established 8 bit transfer width.

The REQ/ACK offset (X above) is the maximum number of REQ pulses that can be outstanding before its corresponding ACK pulse is received at the Target. A REQ/ACK offset value of zero indicates asynchronous mode. The Drive supports REQ/ACK offset values in the range 0 through 15 for 16 bit data transfers and offset values in the range 0 through 30 for 8 bit data transfers. The Drive does not support REQ/ACK offset of 1 with a target transfer period of 25 nSec.

1.1.2 Synchronous Negotiation Started by the Initiator

If the Initiator recognizes that negotiation is required and sends a Synchronous Data Transfer Request message out, the Target responds by changing to the Message In phase and sending a Synchronous Data Transfer Request message in to the Initiator prior to transferring any additional message bytes (or any other Information phase bytes) from the Initiator. This provides an interlock during the synchronous negotiation.

The Drive responds to each Initiator requested transfer period as shown in the following table:

Table 3. Initiator Request/Target Response

Initiator Request	**Target Response**	**Target Transfer Period**	**Maximum Burst Rate**
0 <= Mi <= 10	Mt = 10	25 nSec	40.00 MT/s
11 <= Mi <= 12	Mt = 12	50 nSec	20.00 MT/s
13 <= Mi <= 18	Mt = Mi	75 nSec	13.34 MT/s
19 <= Mi <= 25	Mt = Mi	100 nSec	10.00 MT/s
26 <= Mi <= 31	Mt = Mi	125 nSec	8.00 MT/s
32 <= Mi <= 37	Mt = Mi	150 nSec	6.67 MT/s
38 <= Mi <= 43	Mt = Mi	175 nSec	5.71 MT/s
44 <= Mi <= 50	Mt = Mi	200 nSec	5.00 MT/s
51 <= Mi <= 56	Mt = Mi	225 nSec	4.44 MT/s
57 <= Mi <= 62	Mt = Mi	250 nSec	4.00 MT/s
63 <= Mi <= 68	Mt = Mi	275 nSec	3.64 MT/s
69 <= Mi <= 75	Mt = Mi	300 nSec	3.33 MT/s
76 <= Mi <= 81	Mt = Mi	325 nSec	3.08 MT/s
82 <= Mi <= 87	Mt = Mi	350 nSec	2.86 MT/s
88 <= Mi <= 93	Mt = Mi	375 nSec	2.67 MT/s
94 <= Mi <= 255	Mt = Mi	(Asynchronous mode)	N/A

Note: MT/s means Mega-Transfers per second. If the established data transfer width is 8 bits, the MB/s rate is the same as the MT/s rate. If the established data transfer width is 16 bits, the MB/s is two times the MT/s rate. For example, 40.00 MT/s on a 16 bit transfer width is an effective transfer rate of 80.00 MB/s.

The Drive responds to each Initiator requested REQ/ACK offset as follows:

If the Initiator requests a transfer period that is greater than 372 nSec (M > 93), the Target responds with the same period that the initiator requested but with a REQ/ACK offset of 0.

If the Initiator requests a transfer period in the acceptable range and requests a REQ/ACK offset value that is greater than 15 with an established 16 bit transfer width or greater than 30 with an established 8 bit transfer width, the Target responds with a REQ/ACK offset value of 15 or 30 respectively.

If the Initiator requests a transfer period equal to 25 nSec (M = 10) with a REQ/ACK offset value of 1, the Target responds with a transfer period of 50 nSec (M = 12) with a REQ/ACK offset of 1.

If the Initiator requests a transfer period equal to 25 nSec (M = 10), but has not established a 16 bit transfer width agreement, the Target responds with a transfer period of 50 nSec (M = 12).

If the Initiator is running in Single Ended mode and requests a transfer period equal to 25 nSec (M = 10), the Target responds with a transfer period of 50 nSec (M = 12).

If the Initiator requests a transfer period and an offset value in the acceptable range, the response is equal to the Initiator's requested value.

Note: If the REQ/ACK offset value is 0, this indicates asynchronous mode.

If following the Target's response above the Initiator asserts the ATN signal and the first message received is either a Message Parity Error or a Message Reject message, the Target negates the synchronous agreement and goes to asynchronous mode. For the Message Parity Error case, the implied synchronous agreement is reinstated if the Target successfully retransmits the Synchronous Data Transfer Request message to the Initiator. For any other message, the Target completes negotiation and goes to synchronous mode.

1.1.3 Synchronous Negotiation Started by the Target

If the Target recognizes that negotiation is required, the Target sends a Synchronous Data Transfer Request message to the Initiator. The transfer period is equal to 25 nSec (M = 10) when running LVD mode with an established 16 bit transfer width. The transfer period is equal to 50 nSec (M = 12) when running Single Ended mode or when running LVD mode with an established 8 bit transfer width. The REQ/ACK offset is equal to 15 (X = 15) for an established 16 bit transfer width or 30 (X = 30) for an established 8 bit transfer width. The Initiator must respond by asserting the ATN signal prior to its release of ACK for the REQ/ACK handshake of the last byte of the Synchronous Data Transfer Request message. This provides an interlock during the synchronous negotiation. If the Initiator does not assert the ATN signal, the Target goes to asynchronous mode. If the Initiator does assert the ATN signal, the Target changes to the Message Out phase and receives a message from the Initiator.

If the first message received is a Synchronous Data Transfer Request message, the Target establishes the new data transfer mode. The Drive interprets the Initiator corresponding transfer period as shown in the following table:

Table 4. Target Response to Initiator's Transfer Period

Initiator's Response	**Target Transfer Period**	**Maximum Burst Rate**
0 <= Mi <= 9	Send Message Reject (Asynchronous mode)	N/A
10 <= Mi <= 10	25 nSec	40.00 MT/s
11 <= Mi <= 12	50 nSec	20.00 MT/s
13 <= Mi <= 18	75 nSec	13.34 MT/s
19 <= Mi <= 25	100 nSec	10.00 MT/s
26 <= Mi <= 31	125 nSec	8.00 MT/s
32 <= Mi <= 37	150 nSec	6.67 MT/s
38 <= Mi <= 43	175 nSec	5.71 MT/s
44 <= Mi <= 50	200 nSec	5.00 MT/s
51 <= Mi <= 56	225 nSec	4.44 MT/s
57 <= Mi <= 62	250 nSec	4.00 MT/s
63 <= Mi <= 68	275 nSec	3.64 MT/s
69 <= Mi <= 75	300 nSec	3.33 MT/s
76 <= Mi <= 81	325 nSec	3.08 MT/s
82 <= Mi <= 87	350 nSec	2.86 MT/s
88 <= Mi <= 93	375 nSec	2.67 MT/s
94 <= Mi <= 255	Send Message Reject (Asynchronous mode)	N/A

Note: When operating in Single Ended mode, if the corresponding transfer period received from the Initiator indicates a transfer period that is less than 50 nSec (M < 12), the Target sends a Message Reject message to the Initiator to indicate asynchronous mode.

Note: If the corresponding transfer period received from the Initiator indicates a transfer period that is equal to 25 nSec (M = 10) and a REQ/ACK offset value of 1, the Target sends a Message Reject message to the Initiator to indicate asynchronous mode.

The Drive interprets each Initiator requested REQ/ACK offset as follows:

- If the Initiator requests a REQ/ACK offset value that is greater than 15 with an established 16 bit data transfer width or 30 with an established 8 bit data transfer width, the Target changes to the Message In phase, sends a Message Reject message to the Initiator, and goes to asynchronous mode.
- If the value is 0, the Target goes to asynchronous mode. For all other values, the Target interprets the REQ/ACK offset to be equal to the Initiator requested value.

If the first message received from the Initiator is either a Message Parity Error or a Message Reject message, the Target goes to asynchronous mode. For the Message Parity Error case, the synchronous negotiation is restarted if the Target successfully retransmits the Synchronous Data Transfer Request message to the Initiator.

If the first message received from the Initiator is any other message, the Target goes to asynchronous mode. The Target assumes that the Initiator does not support synchronous mode and does not attempt to renegotiate with this Initiator.

The implied agreement for synchronous operation is not considered to exist by the Target until the Target leaves the Message Out phase, implying that no parity error was detected. If the Target detects a parity error while attempting to receive the message from the Initiator, the Target goes to asynchronous mode. The Target will attempt to resume synchronous negotiation by retrying the Message Out phase.

Note: If during the Message In phase of negotiations, either Target or Initiator started, ATN is asserted prior to transmission of the last byte of the message and the message is not Message Parity or Message Reject, the Target goes to asynchronous mode. Message Reject and Message Parity Errors are handled as described in 1.1.2, "Synchronous Negotiation Started by the Initiator" on page 10 and 1.1.3, "Synchronous Negotiation Started by the Target" on page 11.

Note: Target initiated synchronous negotiation is selectable via the Option Jumper Block.

1.2 Wide Data Transfer Request (01h,03h)

A pair of Wide Data Transfer Request messages are exchanged between an Initiator and a Target to establish a data transfer width agreement between the two devices. The Initiator may initiate a wide data transfer negotiation at any time after the LUN has been identified. The Target initiates a wide data transfer negotiation if the Target has not negotiated with the Initiator since the last time the Target was Reset (Power-on Reset, SCSI Bus "hard" Reset, Bus Device Reset message, Self Initiated Reset, or Transceiver Mode changed),

Target-initiated negotiation occurs either immediately following the Command phase or immediately following the first reconnection. The Target will negotiate the data transfer width agreement prior to negotiating the synchronous data transfer agreement. If a synchronous data transfer agreement is in effect when a Wide Data Transfer Request message is received, the Target resets the synchronous agreement to asynchronous mode.

The implied data transfer width agreement remains in effect until the Target is Reset (Power-on Reset, SCSI Bus "hard" Reset, Bus Device Reset message, Self Initiated Reset, or Transceiver Mode changed), or a new data transfer width agreement is negotiated. If a Reset occurs, the Target goes to eight bit mode.

1.2.1 Wide Data Transfer Request Message Definition

Table 5. Wide Data Transfer Request Message Definition		
Byte	**Value**	**Description**
0	01h	Extended message
1	02h	Extended message length
2	03h	Wide Data Transfer Request code
3	E	Transfer Width Exponent

The data transfer width is two to the transfer width exponent bytes wide. Valid data transfer widths are 8 bits (E = 00h) and 16 bits (E = 01h). Values of E greater than 01h are reserved.

1.2.2 Transfer Width Negotiation Started by the Initiator

If the Initiator recognizes that negotiation is required and sends a Wide Data Transfer Request message out, the Target responds by changing to the Message In phase and sending a Wide Data Transfer Request message in to the Initiator prior to transferring any additional message bytes (or any other Information phase bytes) from the Initiator. This provides an interlock during the data transfer width negotiation.

The Drive responds to each Initiator requested transfer width exponent as shown in the following table:

Table 6. Initiator Request/Target Response		
Initiator Request	**Target Response**	**Target Data Transfer Width**
Ei = 0	Et = 0	8 Bit Data Transfers
Ei > 0	Et = 1	16 Bit Data Transfers

If following the Target's response above the Initiator asserts the ATN signal and the first message received is either a Message Parity Error or a Message Reject message, the Target negates the data transfer width agreement and goes to 8 bit mode. For the Message Parity Error case, the implied data transfer width agreement is reinstated if the Target successfully retransmits the Wide Data Transfer Request message to the Initiator. For any other message, the Target completes negotiation and goes to the negotiated data transfer width.

1.2.3 Transfer Width Negotiation Started by the Target

If the Target recognizes that negotiation is required, the Target sends a Wide Data Transfer Request message to the Initiator with the transfer width exponent equal to 1 (E = 1). The Initiator must respond by asserting the ATN signal prior to its release of ACK for the REQ/ACK handshake of the last byte of the Wide Data Transfer Request message. This provides an interlock during the wide data transfer negotiation. If the Initiator does not assert the ATN signal, the Target goes to 8 bit mode. If the Initiator does assert the ATN signal, the Target changes to the Message Out phase and receives a message from the Initiator.

If the first message received is a Wide Data Transfer Request message, the Target establishes the new data transfer mode. The Drive interprets the Initiator corresponding transfer width exponent as shown in the following table:

Table 7. Target Response to Initiator's Transfer Period	
Initiator's Response	**Target Data Transfer Width**
Ei = 0	8 Bit Data Transfers
Ei = 1	16 Bit Data Transfers
Ei > 1	Send Message Reject (8 Bit Data Transfers)

Note: If the corresponding transfer width exponent received from the Initiator indicates a data transfer width that is greater than 16 bits (E > 1) the Target sends a Message Reject message to the Initiator to indicate 8 bit data transfer mode.

If the first message received from the Initiator is either a Message Parity Error or a Message Reject message, the Target goes to 8 bit data transfer mode. For the Message Parity Error case, the wide data transfer negotiation is restarted if the Target successfully retransmits the Wide Data Transfer Request message to the Initiator.

If the first message received from the Initiator is any other message, the Target goes to 8 bit data transfer mode. The Target assumes that the Initiator does not support wide data transfers and does not attempt to renegotiate with this Initiator.

The implied agreement for wide data transfer operation is not considered to exist by the Target until the Target leaves the Message Out phase, implying that no parity error was detected. If the Target detects a parity error while attempting to receive the message from the Initiator, the Target goes to 8 bit data transfer mode. The Target will attempt to resume the wide data transfer negotiation by retrying the Message Out phase.

Note: If during the Message In phase of negotiations, either Target or Initiator started, ATN is asserted prior to transmission of the last byte of the message and the message is not Message Parity or Message Reject, the Target goes to 8 bit data transfer mode. Message Reject and Message Parity Errors are handled as described in 1.2.2, "Transfer Width Negotiation Started by the Initiator" on page 13 and 1.2.3, "Transfer Width Negotiation Started by the Target" on page 13.

Note: Target initiated negotiation of wide transfers is selectable via the Option Jumper Block.

1.3 Unit Attention Condition

The Target generates a Unit Attention condition when one of the following occurs:

- Target has been reset

  This includes Power-On reset, SCSI Bus reset, Bus Device Reset message, Self Initiated reset, or Transceiver Mode changed. In all of these cases, a Unit Attention condition is generated for each Initiator. For Power-On reset, SCSI Bus reset, Bus Device Reset message, and Self Initiated reset, the Additional Sense Code and Additional Sense Code Qualifier reported is ***Power On, Reset, or Bus Device Reset occurred***. For Transceiver Mode changed the Additional Sense Code and Additional Sense Code Qualifier reported is ***Transceiver Changed to SE*** or ***Transceiver Changed to LVD***

- Mode Select command has been executed

  In this case, a Unit Attention condition is generated for all Initiators except the one that issued the Mode Select command. The Additional Sense Code and Additional Sense Code Qualifier reported is ***Mode Parameters Changed***. The Unit Attention condition is generated if any of the current page parameters are set by the Mode Select command. The Target does not check to see that the old parameters are different from the new parameters. For example: If the Initiator issues a Mode Sense command with a page code to report the current values followed by a Mode Select command with the same parameter list, a Unit Attention condition is generated despite the fact that the current parameters were not changed from their previous value. However, if the Target detects an illegal parameter or error condition prior to modifying the current parameters, a Unit Attention condition is not generated since the parameters were not set. The Unit Attention condition is also not generated if the Mode Select command parameter list does not include any pages and only the header or header/block descriptor is present.

- Format Unit command has been executed

  In this case, a Unit Attention condition is generated for all Initiators except the one that issued the Format Unit command. The Additional Sense Code and Additional Sense Code Qualifier reported is ***Not Ready To Ready Transition, (Medium may have changed)***. This indicates that the block descriptor parameters from the last Mode Select command have been used and are now considered current values.

- Write Buffer command to download microcode has been executed

  In this case, a Unit Attention condition is generated for all Initiators except the one that issued the Write Buffer command. The Additional Sense Code and Additional Sense Code Qualifier reported is ***Microcode has been changed***.

- Commands Cleared by a Clear Queue Message

  This Unit Attention condition is generated after an Initiator sends a Clear Queue Message. The Unit Attention condition is generated for all other Initiators with I/O processes that were either active or queued for the logical unit. The Additional Sense Code and Additional Sense Code Qualifier reported is ***Commands Cleared by Another Initiator***.

The Unit Attention condition persists for each Initiator until that Initiator clears the condition from the logical unit as described below. Several commands are handled as special cases during a Unit Attention condition. These cases are also discussed below.

If the Target receives a command from an Initiator before reporting a *Check Condition Status* for a pending Unit Attention condition for that Initiator, the Target's response varies with the command as follows:

Inquiry Execute the command, return *Good Status*, and preserve the Unit Attention condition.

Request Sense Execute the command, return any pending sense data, return *Good Status*, and preserve the Unit Attention condition. If there is not any pending sense data, the sense data associated with the highest priority Unit Attention condition is returned and the highest priority Unit Attention condition is cleared for this Initiator.

All Others Do not execute the command, return a *Check Condition Status*, and clear the highest priority Unit Attention condition for this Initiator. If the following command from this Initiator is Request Sense, then the sense data associated with the highest priority Unit Attention condition is returned. Otherwise, it is lost.

The Target's response to the next command received from an Initiator after reporting a *Check Condition Status* for a pending Unit Attention condition for that Initiator, varies with the command as follows:

Inquiry Execute the command, return *Good Status*, and preserve any lower priority Unit Attention condition(s) for that Initiator (sense data for the highest priority Unit Attention condition is lost).

Request Sense Execute the command, return a Sense key of ***Unit Attention*** and Additional Sense Code and Qualifier that corresponds to the highest priority Unit Attention condition, return *Good Status*, and preserve any lower priority Unit Attention condition(s).

All Others Execute the command unless prevented by another higher priority status or another lower priority Unit Attention Condition, and return the appropriate status for the command. (Sense data for the highest priority Unit Attention condition is lost).

More than one Unit Attention condition may be generated for an Initiator before that Initiator clears the Unit Attention condition. Each Unit Attention condition is reported one at a time until they all have been reported and cleared. The highest priority Unit Attention condition is reported first. The order in which the Target checks for each Unit Attention condition determines their priority (highest priority first) as follows:

1. Reset (Target has been reset)
2. Mode Select Parameters Changed (Mode Select command has been executed.)
3. Not Ready To Ready Transition (Medium May Have Changed) (Format Unit command has been executed.)
4. Microcode Has Been Changed (Write Buffer command to download microcode has been executed.)
5. Commands Cleared By Another Initiator (Commands Cleared by a Clear Queue Message)

1.4 Reset

The Reset condition is used to clear all SCSI devices from the bus. This condition takes precedence over all other phases and conditions. After a reset condition is detected and the reset actions completed, the target returns to a 'SCSI bus enabled' state that allows the target to accept SCSI commands.

This device uses the Hard reset option as defined in the SCSI-2 standard.

1.4.1 Reset Sources

There are four sources of resets detected by the target:

Reset Name	**Reset Source**
Power-On reset	This is the signal generated by the hardware at initial power-on.
Self-Initiated reset	This is a software-generated reset that occurs when a catastrophic error is detected by the microcode (for example, microcode sanity error).
SCSI Bus reset	This is a reset generated when the SCSI bus control line RST goes active.
SCSI Bus Device Reset message	This is the reset generated by the SCSI Bus Device Reset Message (0Ch).
Transceiver Mode changed	This is a reset generated when the Differential Sense line changes state.

1.4.2 Reset Actions

The action taken by the Drive following a reset is dependent on the source of the reset.

1.4.2.1 Power-On reset and Self-Initiated reset

These two reset conditions cause the following to be performed in the order shown.

1. A power-up sequence
2. A start-up sequence is necessary to put the Drive in a ready state

1.4.2.2 SCSI Bus reset, SCSI Bus Device Reset message, and Transceiver Mode changed

These three reset conditions cause the following to be performed.

- If reset goes active while the power-up sequence is in progress, the power-up sequence is started over.
- If the Auto Start pin is grounded and a start-up sequence has not yet completed, a start-up sequence will be re-attempted from the beginning.

  Note: The power-up sequence, having already completed, is not rerun.

- If reset occurs while a physical sector is being written, the write operation is disabled after the current physical sector is written. Data is not lost as long as power stays valid until the physical sector being written is completed.

1.5 LVD Sense Data Format

The Target generates a Unit Attention condition (see 1.3, “Unit Attention Condition” on page 15) in response to a Transceiver Mode changed reset event. Table 8 shows the additional Sense Code Qualifier for the LVD Unit Attentions.

Table 8. Valid Sense Key, Code, Qualifier Combinations used by the drive.

Key	Code	Qual	Description	Intitiator Recovery
6	29	05	***Transceiver Changed to SE*** **(01 4A)** Unit Attention - Transceiver Changed to SE.	1.4, “Reset” on page 17
6	29	06	***Transceiver Changed to LVD*** **(01 4B)** Unit Attention - Transceiver Changed to LVD.	1.4, “Reset” on page 17

For a complete list of Additional Sense Code Qualifiers and a description of the SCSI Sense Data Format, see Appendix A in the Ultrastar 18XP/9LP/9ZX SCSI Logical Interface Specification.

1.6 LVD Unit Error Codes

The following is a list of Unit Error Codes and associated descriptions for the LVD Unit Attentions. The Unit Error Codes are returned by the target in sense data bytes 20-21 in response to the Request Sense command.

Table 9. Unit Error Codes with Descriptions.

Unit Error Code	**Description**
01 4A	Unit Attention - Transceiver Changed to SE.
01 4B	Unit Attention - Transceiver Changed to LVD.

For a complete list of Unit Error Codes and descriptions, see Appendix D in the Ultrastar 18XP/9LP SCSI Logical Interface Specification.