

To: T10 SAS Protocol Working Group Contact: Mark Evans Phone: 408-894-5310 Email: mark_evans@maxtor.com Date: 20 December 2002

Subject: SAS requests and confirmations between layers

Introduction

The following proposal is an attempt to reconcile all of the SAS requests and confirmations between layers. This proposal was developed by examining the tables in clause 4.3.3, each of the state machine figures and text for the phy, link, port, and transport layers in the SAS draft standard in order to check for correctness and consistency. Redundant and incorrect table entries have been deleted. Corrections and state references have been added. Other proposed modifications resulting from this review are included in 03-024r0 Port layer description modifications and the Maxtor SAS letter ballot comments document. The following proposal is "drop-in replacement text" for the 4.3.3 subclause based on SAS-r03.

4.3.3 Requests and confirmations between state machines

4.3.3.1 Requests and confirmations between the phy layer and other layers

Table a shows the requests from the management application layer to the phy layer.

Phy layer state machine(s)	<-Request (application to phy)	Application layer
SATA host emulation (SP22)	Enter Partial	Management
SATA host emulation (SP22)	Enter Slumber	Management
SATA host emulation (SP23)	Exit Partial	Management
SATA host emulation (SP23)	Exit Slumber	Management
OOB sequence (all)	Power-on Reset, Hard Reset, or Management	Management
	Reset	

Table a – Requests from management application layer to phy layer

Table b shows the confirmations from the phy layer to the link layer or the expander function.

Phy layer state machine(s)Confirmation-> (phy to expander)		Expander function
OOB sequence (SP1)	Broadcast Event Notify (Phy Not Ready)	expander function
OOB sequence (SP7)	Broadcast Event Notify (SATA Spinup Hold)	expander function

Table b – Confirmations from phy layer to expander function

Table c shows the confirmations from the phy layer to the link layer and from the link layer to the port layer.

Phy layer state machine(s)	Confirmation-> (phy to link)	Link layer state machine(s)	Confirmation-> (link to port)	Port layer state machine(s)
dword synchronization	Enable Disable Link Layer	link identification and hard reset (all)	Enable Disable Link Layer	overall control (all)
(SP_DWS0)	(Disable)	link (part 1, all)	(Disable)	phy manager (all)
dword synchronization (SP_DWS3)	Enable Disable Link Layer (SAS Enable)	link identification and hard reset (SL_IR_TIR1, SL_IR_RIF1, SL_IR_IRC1) link (part 1, SL0)	Enable Disable Link Layer (SAS Enable)	overall control (PL_OC1, PL_OC2)
dword synchronization (SP_DWS3)	Enable Disable Link Layer (SATA Enable)	link identification and hard reset (SL_IR_TIR1, SL_IR_RIF1, SL_IR_IRC1) link (part 1, SL0)	Enable Disable Link Layer (SATA Enable)	overall control (PL_OC1, PL_OC2)

Table c – Confirmations from phy layer to the link layer, and link layer to port layer

4.3.3.2 Requests from the management layer to the link layer and confirmations from the link layer to the port layer, expander function, and management layer

Table d shows the requests from the management application layer to the link layer.

Table d – Requests from management application layer to link layer

Link layer state machine(s)	<-Request (application to link)	Application layer
link identification and hard reset (SL_IR_TIR1)	Tx HARD_RESET	management
link identification and hard reset (SL_IR_TIR1)	Tx IDENTIFY Address Frame	management

Table e shows the confirmations from the link layer to the management application layer.

Table e – Confirmations from link layer to expander function and management application layer

Link layer state machine(s)	Confirmation-> (link to application)	Application layer
link identification and hard reset (SL_IR_IRC2)	Broadcast Event Notify	expander
	(Identification Sequence Complete)	function
link identification and hard reset (SL_IR_IRC1)	HARD_RESET Received	management
link identification and hard reset (SL_IR_TIR3)	HARD_RESET Transmitted	management
identification and hard reset (SL_IR_IRC2)	Phy Enabled	management
identification and hard reset (SL_IR_IRC1)	Phy Disabled	management
link identification and hard reset (SL_IR_IRC2)	Identify Sequence Complete	management
identification and hard reset (SL_IR_IRC2)	Identify Timeout	management
identification and hard reset (SL_IR_RIF1,	Address Frame Failed	management
_RIF2)		
link (part 1) (SL0, SL1)	Change Received	management

Table f shows the confirmations from the link layer to the port layer.

Link layer state machine(s)	Confirmation-> (link to port)	Port layer state machine(s)		
identification and hard reset	Phy Enabled	overall control (PL_OC1)		
(SL_IR_IRC2)		phy manager (PL_PM1)		
identification and hard reset	Phy Disabled	overall control (PL_OC2),		
(SL_IR_IRC1)		phy manager (all states)		
SAS link (part 1) (SL1)	Open Failed (Retry)	phy manager (PL_PM2)		
SAS link (part 1) (SL1)	Open Failed (Port Layer Request)	phy manager (PL_PM2)		
SAS link (part 1) (SL1, SL2)	Connection Opened (SSP Source Opened)	overall control (PL_OC2),		
		phy manager		
		(PL_PM1, PL_LM2)		
SAS link (part 1) (SL1, SL2)	Connection Opened (STP Source Opened)	PL_OC2, PL_PM1, PL_PM2		
SAS link (part 1) (SL1, SL2)	Connection Opened (SMP Source Opened)	PL_OC2, PL_PM1, PL_PM2		
SAS link (part 1) (SL1, SL2)	Connection Opened (SSP Destination	PL_OC2, PL_PM1, PL_PM2		
	Opened)			
SAS link (part 1) (SL1, SL2)	Connection Opened (STP Destination	PL_OC2, PL_PM1, PL_PM2		
	Opened)			
SAS link (part 1) (SL1, SL2)	Connection Opened (SMP Destination	PL_OC2, PL_PM1, PL_PM2		
	Opened)			
frame transmission	DONE Transmitted	phy manager (PL_PM3)		
(SSP_TF4)				

Table f – Confirmations from link layer to port layer

4.3.3.3 Requests and confirmations between the link layer, port layer, and SSP transport layer

Table g shows the requests from the SSP transport layer to the port layer and from the port layer to the link layer.

Link layer state	<-Request	Port layer state	<-Request	Transport layer
machine(s)	(port to link)	machine(s)	(transport to port)	state machine(s)
SAS link (part 1)	Open Connection	phy manager		
(SL0)		(PL_PM2)		
		overall control	Cancel	SSP initiator device
		(PL_OC2)		(ST_ISF1),
				SSP target device
				(ST_TTS2)
SAS link (part 1)	Stop Arb	phy manager		
(SL1)		(PL_PM2)	(or
frame transmission	Close Connection	overall control		
(SSP_TF1)		(PL_OC2)		
SAS link (part 1)	Accept_Reject	overall control	Accept_Reject	SSP initiator device
(SL2)	Opens (Accept SSP)	(PL_OC2)	Opens (Accept	(ST_IFR1),
			SSP)	SSP target device
				(ST_TFR1)
SAS link (part 1)	Accept_Reject	overall control	Accept_Reject	ST_IFR1,
(SL2)	Opens (Reject SSP)	(PL_OC2)	Opens (Reject	ST_TFR1
			SSP)	
		overall control	Transmit Frame	SSP initiator device
		(PL_OC2,	(Interlocked)	(ST_ISF1),
		PL_OC1)		SSP target device
-				(ST_TTS2)
frame transmission	Tx Frame (Balance	phy manager		
(SSP_TF1)	Required)	(PL_PM3, part 2)		
		overall control	Transmit Frame	ST_ISF1,
		(PL_OC2,	(Non-interlocked)	ST_TTS2
		PL_OC1)		
frame transmission	Tx Frame (Balance	phy manager		
(SSP_TF1)	Not Required)	(PL_PM3, part 2)		

Table g – Requests from SSP transport layer to port layer, and port layer to SAS link layer

Table h shows the confirmations from the SAS link layer to the port layer and from the port layer to the SSP transport layer.

Link layer state	Confirmation->	Port layer state	er, and port layer toConfirmation->	Transport layer
machine(s)	(link to port)	machine(s)	(port to transport)	state machine(s)
identification and	HARD RESET	overall control	· · ·	
hard reset	Received	(all)		
(SL_IR_IRC2)		phy manager (all)		
		overall control	HARD_RESET	SSP initiator device
		(PL_OC1)	Received	(ST_IFR1),
				SSP target device
	Osman astisma Olassad	a concelle a sectoral		(ST_TFR1)
SAS link (part 1) (SL3, SL4, SL5)	Connection Closed (Break Received),	overall control (PL_OC2)	Cancel Acknowledge (after receiving a	SSP initiator device
(313, 314, 315)	Close Timeout),	(FL_002)	Cancel request only)	(ST_ISF1), SSP target device
	(Link Broken), or		Calleer request only)	(ST TTS2)
	(Normal)			(01_1102)
SAS link (part 1)	Connection Closed	overall control	Connection Failed	SSP initiator device
(SL3, SL4, SL5)	(Break Received),	(PL_OC2)	(before receiving a	(ST_ISF1),
	Close Timeout),		Frame Transmitted	SSP target device
	(Link Broken), or		confirmation only)	(ST_TTS2)
	(Normal)		-	OT /07/
		overall control	Transmission Status	ST_ISF1,
CAC link (part 1)	Open Failed (Red	(PL_OC1)	(No Phys In Port)	ST_TTS2
SAS link (part 1) (SL1)	Open Failed (Bad Destination)	phy manager (PL PM2)	PL_PM2 to Unable To	
(31)	Destination	overall control	Transmission Status	ST ISF1,
		(PL OC2)	(Open Failed – Bad	ST TTS2
		(· _ _ · · =)	Destination)	
SAS link (part 1)	Open Failed (Break	phy manager	,	
(SL1)	Received)	(PL_PM2)		
		overall control	Transmission Status	ST_ISF1,
		(PL_OC2)	(Open Failed – Break	ST_TTS2
CAC link (nort 1)	Onen Feiled		Received)	
SAS link (part 1) (SL1)	Open Failed (Connection Rate	phy manager (PL PM2)		
(311)	Not Supported)	(FL_FWZ)		
	Not Supported)	overall control	Transmission Status	ST ISF1,
		(PL_OC2)	(Open Failed –	ST_TTS2
			Connection Rate Not	
			Supported)	
SAS link (part 1)	Open Failed (No	phy manager		
(SL1)	Destination)	(PL_PM2)		
		overall control	Transmission Status	ST_ISF1,
		(PL_OC2)	(Open Failed – No Destination)	ST_TTS2
SAS link (part 1)	Open Failed (Open	phy manager		
(SL1)	Timeout Occurred)	(PL_PM2)		
(0=1)	. inteedt ooddrod)	overall control	Transmission Status	ST_ISF1,
		(PL_OC2)	(Open Failed - Open	ST TTS2
		· /	Timeout Occurred)	
SAS link (part 1)	Open Failed	phy manager	,	
(SL1)	(Pathway Blocked)	(PL_PM2)		
		overall control	Transmission Status	ST_ISF1,
		(PL_OC2)	(Open Failed –	ST_TTS2
	Onen Felled		Pathway Blocked)	
SAS link (part 1)	Open Failed	phy manager		
(SL1)	(Protocol Not Supported)	(PL_PM2)		
<u> </u>	Supported)			

Table h – Confirmations from SAS link layer to port layer, and port layer to SSP transport layer

		overall control (PL_OC2)	Transmission Status (Open Failed – Protocol Not Supported)	ST_ISF1, ST_TTS2
SAS link (part 1)	Open Failed (STP	phy manager		
(SL1)	Resources Busy)	(PL_PM2)		
		overall control	Transmission Status	ST_ISF1,
		(PL_OC2)	(Open Failed – STP	ST_TTS2
			Resources Busy)	_
SAS link (part 1)	Open Failed (Wrong	phy manager		
(SL1)	Destination)	(PL_PM2)		
		overall control	Transmission Status	ST_ISF1,
		(PL_OC2)	(Open Failed –	ST_TTS2
			Wrong Destination)	

Table i shows the confirmations from the SSP link layer to the port layer and from the port layer to the SSP transport layer.

Link layer state	Confirmation->	Port layer state	Confirmation->	Transport layer
machine(s)	(link to port)	machine(s)	(port to transport)	state machine(s)
frame transmission	Frame Transmitted	phy manager	Transmission Status	SSP initiator device
(SSP_TF3)		(PL_PM3, part 2)	(Frame Transmitted)	(ST_ISF1),
				SSP target device
				(ST_TTS2)
frame transmission	ACK/NAK Timeout	phy manager	Transmission Status	ST_ISF1,
(SSP_TIM1)		(PL_PM3, part 2)	(ACK/NAK Timeout)	ST_TTS2
frame transmission	Credit Timeout	phy manager	Transmission Status	ST_ISF1,
(SSP_TF2)		(PL_PM3, part 2)	(Credit Timeout)	ST_TTS2
frame transmission	ACK Received	phy manager	ACK Received	ST_ISF1,
(SSP_TIM1)		(PL_PM3, part 2)		ST_TTS2
frame transmission	NAK Received	phy manager	NAK Received	ST_ISF1,
(SSP_TIM1)		(PL_PM3, part 2)	.	ST_TTS2
frame transmission	Done Received	phy manager	Transmission Status	ST_ISF1,
(SSP_D1)	(Clos e Connection)	(PL_PM3)	(Done Received	ST_TTS2
	Dana Daasiyad		Close Connection)	
frame transmission	Done Received	phy manager	Transmission Status	ST_ISF1,
(SSP_D1)	(ACK/NAK Timeout)	(PL_PM3)	(Done Received	ST_TTS2
france transmission	Dana Dagaiyad		ACK/NAK Timeout)	
frame transmission	Done Received	phy manager	Transmission Status	ST_ISF1,
(SSP_D1)	(Credit Timeout)	(PL_PM3)	(Done Received	ST_TTS2
frame transmission	Done Timeout	nhy managar	Credit Timeout) Transmission Status	ST ISF1,
(SSP D1)	Done Timeout	phy manager (PL PM3)	(Done Timeout)	ST_ISF1, ST_TTS2
frame reception	Frame Received	phy manager	Frame Received	SSP initiator device
(SSP RF1)	(ACK/NAK Balanced)	(PL PM3, part 2)	(ACK/NAK Balanced)	(ST IFR1),
	(ACIVINAN Balanced)	$(\Gamma L_1 M 3, part 2)$	(ACIVINAN Balanced)	SSP target device
				(ST TFR1)
frame reception	Frame Received	phy manager	Frame Received	ST IFR1,
(SSP RF1)	(ACK/NAK	(PL PM3, part 2)	(ACK/NAK	ST TFR1
	Unbalanced)	(1 - 1 mo, part 2)	Unbalanced)	<u> </u>
frame reception	ACK Transmitted	phy manager	ACK Transmitted	SSP initiator device
(SSP_TAN1)		(PL PM3, part 2)		(ST ISF1),
		(SSP target device
				(ST TTS2)
		1		(0

Table i – Confirmations from SSP link layer to port layer, and port layer to SSP transport layer

4.3.3.4 Requests and confirmations between the link layer, port layer, and SMP transport layer

Table j shows the requests from the SMP transport layer to the port layer and from the port layer to the SAS and SMP link layers.

able j – Requests from SMP transport layer to port layer, and port layer to SAS/SMP link layer				
Link layer state machine(s)	<-Request (port to link)	Port layer state machine(s)	<-Request (transport to port)	Transport layer state machine(s)
SAS link (part 1) (SL0)	Open Connection	phy manager (PL_PM2)		
SAS link (part 1) (SL1)	Stop Arb	phy manager (PL_PM2)		
SAS link (part 1) (SL2)	Accept_Reject Opens (Accept SMP)	overall control (PL_OC2)	Accept_Reject Opens (Accept SMP)	SMP target device (MT_TD1)
SAS link (part 1) (SL2)	Accept_Reject Opens (Reject SMP)	overall control (PL_OC2)	Accept_Reject Opens (Reject SMP)	SMP target device (MT_TD1)
		overall control (PL_OC2), (PL_OC1)	Transmit Frame (SMP)	SMP initiator device (MT_ID2), SMP target device (MT_TD2)
SMP initiator device (SMP_IL1) SMP target device (SMP_TL2)	Tx Frame (SMP)	phy manager (PL_PM3, part 2)		
SMP initiator device (SMP_IL3)	SMP Transmit Break	overall control (PL_OC2)	SMP Transmit Break	SMP initiator device (MT_ID3)

Table j – Requests from SMP transport layer to port layer, and port layer to SAS/SMP link layers

Table k shows the confirmations from the link layer to the port layer and from the port layer to the SMP transport layer.

Link layer state	Confirmation->	Port layer state	Confirmation->	Transport layer
machine(s)	(link to port)	machine(s)	(port to transport)	state machine(s)
identification and	HARD RESET	overall control	(porto a anoport)	
hard reset	Received	(all)		
(SL IR IRC1)	Received	phy manager (all)		
		overall control	HARD RESET	SMP initiator device
		(PL OC1)	Received	(all),
		(1 2_001)	Received	SMP target device
				(all)
SMP initiator	Frame Transmitted	phy manager		()
device (SMP_IL2)		(PL PM2)		
SMP target device		()		
(SMP_TL2)				
		overall control	Transmission Status	SMP initiator device
		(PL OC)	(Frame Transmitted)	(MT ID2),
			· · · · · · · · · · · · · · · · · · ·	SMP target device
				(MT TD2)
SMP initiator	Frame Received	phy manager	Frame Received	SMP initiator device
device (SMP_IL3)	(SMP)	(PL_PM3, part 2)	(SMP)	(MT_ID3),
SMP target device				SMP target device
(SMP_TL1)				(MT_TD1)
(SMP_IL3)	Frame Received	phy manager	Frame Received (SMP	MT_ID3,
(SMP_TL1)	(SMP Failure)	(PL_PM3, part 2)	Failure)	MT_TD1
SAS link (part 1)	Connection Closed	overall control	Connection Closed	SMP initiator device
(SL3, SL4)	(Break Received)	(PL_OC2)	(Break Received)	(MT_ID2),
				SMP target device
				(MT_TD2)
SAS link (part 1)	Connection Closed	overall control	Connection Closed	MT_ID2,
(SL4)	(Close Timeout)	(PL_OC2)	(Close Timeout)	MT_TD2
SAS link (part 1)	Connection Closed	overall control	Connection Closed	MT_ID2,
(SL5)	(Link Broken)	(PL_OC2)	(Link Broken)	MT_TD2

SAS link (part 1)	Connection Closed	overall control	Connection Closed	MT_ID2, MT_TD2
(SL4) SAS link (part 1)	(Normal) Open Failed (Bad	(PL_OC2) phy manager	(Normal) PL_PM2 to	
(SL1)	Destination)	(PL_PM2)	Unable To (
(021)	Destination	overall control	Transmission Status	MT ID2,
		(PL_OC2)	(Open Failed – Bad	MT_TD2
			Destination)	-
SAS link (part 1)	Open Failed (Break	phy manager		
(SL1)	Received)	(PL_PMŽ)		
		overall control	Transmission Status	MT_ID2,
		(PL_OC2)	(Open Failed – Break	MT_TD2
			Received)	
SAS link (part 1)	Open Failed	phy manager		
(SL1)	(Connection Rate	(PL_PM2)		
	Not Supported)	overall control	Transmission Status	MT ID2,
		(PL_OC2)	(Open Failed –	MT_ID2, MT_TD2
		(1 2_002)	Connection Rate Not	
			Supported)	
SAS link (part 1)	Open Failed (No	phy manager		
(SL1)	Destination)	(PL_PM2)		
		overall control	Transmission Status	MT_ID2,
		(PL_OC2)	(Open Failed – No	MT_TD2
			Destination)	
SAS link (part 1)	Open Failed (Open	phy manager		
(SL1)	Timeout Occurred)	(PL_PM2) overall control	Transmission Status	MT ID2,
		(PL_OC2)	(Open Failed - Open	MT_TD2, MT_TD2
		(1 L_002)	Timeout Occurred)	
SAS link (part 1)	Open Failed	phy manager		
(SL1)	(Pathway Blocked)	(PL_PM2)		
	, ,	overall control	Transmission Status	MT ID2,
		(PL_OC2)	(Open Failed –	MT_TD2
			Pathway Blocked)	
SAS link (part 1)	Open Failed	phy manager		
(SL1)	(Protocol Not	(PL_PM2)		
	Supported)		Transmission Of the	MT IDO
		overall control	Transmission Status	MT_ID2,
		(PL_OC2)	(Open Failed – Protocol Not	MT_TD2
			Supported)	
SAS link (part 1)	Open Failed (STP	phy manager	oupported)	
(SL1)	Resources Busy)	(PL_PM2)		
(0=1)	. (coodi coo Buoy)	overall control	Transmission Status	MT ID2,
		(PL_OC2)	(Open Failed – STP	MT_TD2
			Resources Busy)	-
SAS link (part 1)	Open Failed (Wrong	phy manager		
(SL1)	Destination)	(PL_PM2)		
		overall control	Transmission Status	MT_ID2,
		(PL_OC2)	(Open Failed – Wrong	MT_TD2
			Destination)	

4.3.3.5 Requests and confirmations between the SSP transport layer and the SCSI application layer

Table I shows the requests from the SCSI application layer to the SSP transport layer.

Transport layer state machine(s)	<-Request (application to transport)	Application layer
initiator device (ST_ISF1)	Send SCSI Command	initiator device
initiator device (ST_ISF1)	Send Task Management Request	initiator device
initiator device (ST_IFR1)	Accept_Reject Opens (Accept)	initiator device
initiator device (ST_IFR1)	Accept_Reject Opens (Reject)	initiator device
target device (ST_TTS1)	Send SCSI Command Complete	target device
target device (ST_TTS1)	Task Management Function Executed	target device
target device (ST_TTS1)	Send Data-In	target device
target device (ST_TTS1)	Receive Data-Out	target device
target device (ST_TFR1)	Accept_Reject Opens (Accept)	target device
target device (ST_TFR1)	Accept_Reject Opens (Reject)	target device

Table I – Requests from the SCSI application layer to the SSP transport layer

Table m shows the confirmations from the SSP transport layer to the SCSI application layer.

Transport layer state machine(s)	Confirmation-> (transport to application)	Application layer
initiator device (ST_IPR1)	Command Complete Received	initiator device
initiator device (ST_IPR1)	Received Task Management Function Executed	initiator device
target device (ST_TFR1)	SCSI Command Received	target device
target device (ST_TFR1)	Task Management Request Received	target device
target device (ST_TTS2)	Data-In Delivered	target device
target device (ST_TTS4)	Data-Out Received	target device
target device (ST_TTS2)	Nexus Lost	target device

4.3.3.6 Requests and confirmations between the SMP transport layer and the management application layer

Table n shows the requests from the management application layer to the SMP transport layer.

Table n – Requests from the management application layer to the SMP transport layer

Transport layer state machine(s)	<-Request (application to transport)	Application layer
initiator device (MT_ID1)	Send/Receive Frame Pair	initiator device
target device (MT_TD2)	Tx SMP Frame	target device
target device (MT_TD1)	Accept_Reject Opens (Accept SMP)	target device
target device (MT_TD1)	Accept_Reject Opens (Reject SMP)	target device

Table o shows the confirmations from the SMP transport layer to the management application layer.

Table o – Confirmations from the SMP transport layer to the management application layer

Transport layer state machine(s)	Confirmation-> (transport to application)	Application layer
initiator device (MT_ID2)	Open Failed	initiator device
initiator device (MT_ID3)	SMP Frame Receive Time-out	initiator device
initiator device (MT_ID3)	SMP Frame Tx/Rcv Failure	initiator device
initiator device (MT_ID3)	SMP Frame Pair Sent/Received	initiator device
target device (MT_TD1)	SMP Frame Received	target device
target device (MT_TD1)	SMP Connection Closed	target device