Doug Hagerman

IPI Command Queuing   X3T9.2/91-212

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4 Logical interface characteristics

4.1 Operations

The Logical Interface uses a packet structure to transfer Commands from the master to the slave and Responses from the slave to the master. A Bus Exchange at the Physical Interface requires a Bus Control sequence and its associated Ending Status sequence to frame the Information Transfer of Commands, Responses, and data.

The Commands and Responses vary in length and only a single packet of data is transferred for each Information Transfer.

4.1.1 Commands

Commands are issued by the master to instruct the slave, facility, or both to perform an operation. The slave returns a Response when the command has been completed (unless inhibited by the "Inhibit Operation Response on Success" attribute set by the master).

4.1.1.1 Command types

The command types include:

- Control. The Control commands provide for control of the slave and facility or facilities.

- Position. The Position commands cause the positioning of the facility or facilities.

- Transfer. The Transfer commands may cause multiple blocks of data to be transferred between the master and the facility. Before data is actually transferred, the slave activates the Class 2 Interrupt to inform the master that it is ready to transfer data. The complete data transfer may be broken up into several Information Transfers. A slave with Command Queuing shall generate a Transfer Notification to inform the master of the identity of the command for which the transfer is pending.

- Combination. The Combination commands provide for operations between two facilities attached to the same slave, or between two facilities attached to different slaves if Slave-to-Slave Information Transfers are supported at the Physical Interface. In an operation between two different slaves, the master shall designate a dominant slave and a subservient slave. The dominant slave assumes the role of the master for the purpose of initiating Information Transfers to carry out slave-to-slave operations.

- Diagnostic. The Diagnostic commands provide for maintenance and diagnostic operations between a master and a slave or facility. These commands may be product specific, vendor specific, or both.

4.1.1.2 Command stacking

A slave that can accept more than one command is capable of command stacking. The number of commands that may be stacked is defined by the slave's attributes. When a master attempts to send more commands to a slave than can be accepted, rejection occurs at the Physical Interface. Commands that are stacked may be Individual or Queued.

4.1.1.2.1 Individual

The slave can accept only one operation for every facility under its control (i.e., a queue of one).

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4.1.1.2.2 Queued

The master can have more than one operation for every facility concurrently active under control of the slave, and slave is responsible to execute them. This permits the slave the freedom to optimize the sequence of command execution to enhance performance (e.g., seek ordering algorithms). The master has the ability to override slave optimization via Attributes.

4.1.1.3 Command execution order

The order in which commands are executed is controlled by the command modifier bits that are common to all commands. Commands that are identified as Chained, Sequential, or Ordered cannot be intermixed for a given addressee. The last command of a Chain, Sequence, or Order has no encoding of its identity in order to identify it as being the last one - the slave shall be capable of recognizing it as being the last one, rather than treating it as an Individual or Queued command. The execution scenarios possible are:

a) Individual/Queued Commands. Commands other than those labeled by modifier bits as Chained, Sequential, Ordered, or Priority are executed in a slave-dependent order or a facility-dependent order or both.

b) Chained Commands. Commands are executed in the order received by the slave (first in, first out (FIFO) order) (i.e., a sequence of commands (not necessarily stacked) to a single addressee). The addressee is implicitly reserved as long as any command of the Chain is being executed. If a command in the Chain is unsuccessful, the Chain shall be terminated and the remaining commands are not executed. The Chained modifier encoding is not set for the last command in a Chain. The slave may multiplex operations for other addressees during execution of the Chain.

c) Sequential Commands. Commands are executed in the order received by the slave (FIFO order). There may be more than one addressee in a Sequence and the slave may multiplex other operations during execution of the Sequence. If a command in the Sequence is unsuccessful, the Sequence shall be terminated and the remaining commands are not executed. The Sequential modifier encoding is not set for the last command in a Sequence. There is no implicit Reserve of the addressee beyond the command being executed.

d) Ordered Commands. Commands are executed in the order received by the slave (FIFO order). There may be more than one addressee in an Order, but the slave shall not multiplex other operations during execution of the Order. If a command in the Order is unsuccessful, the Order shall be terminated and the remaining commands are not executed. The Ordered modifier encoding is not set for the last command in an Order. There is no implicit Reserve of the addressee beyond the command being executed.

e) Priority Commands. Priority commands and Priority Chains/Sequences/Orders are indicated by the command modifier bits. Only the first command in a Chain/Sequence/Order shall be designated as Priority, but the Priority shall apply to the entire Chain/Sequence/Order. A Priority command causes the slave to change the order of execution of stacked commands and also causes changes in interpreting the Command packet transmission for each addressee.

When a Priority Command packet is received for an addressee, any Chain/Sequence/Order that was in the process of being received shall be ended (i.e., the last packet received is interpreted as the last of the Chain/Sequence/Order regardless of the command modifier settings in that packet. This ending applies regardless of whether the slave is operating in a queued or non-queued environment.

NOTE — This applies only to commands received over the same port.

Priority commands, whether Individual or part of a Chain/Sequence/Order, are executed before non-Priority commands. Priority commands are executed in Last In First Out (LIFO) order. With the exception of individual ABORT commands, the receipt of a Priority command does not affect the operation of any Individual command or commands in a Chain/Sequence/Order, except for the possible ending noted previously. When a Priority, Individual ABORT command is received, the slave shall suspend the command executing (if possible), and process the ABORT.

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6.3.4.7 Parameters 64-65

Table 35 — Attributes parameters 64-65

a	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	15	64				PHYSICAL INTERFACE ATTRIBUTES PARAMETER
			01-04			SDE (ns)
			05-08			IRT (ns)
			09-0C			CCD (ns)
			0D-10			SDR (µs)
			11-14			SYD (µs)
S	n+1	65				ADDRESSEE CONFIGURATION PARAMETER
			01-04			Data Buffer Size
			05-08			Command buffer size
			09-0A			Max No of octets in Command packet
			0B-0C			Max No of octets in Response packet
			0D			Max No of Access Permit Extents
			0E			Min No of Queued Commands
			0F			Max No of Queued Commands
			10			Size of Command Stack

6.3.4.7.1 Physical Interface Attributes parameter

See clause 5 of ISO/IEC 9318-1 for the definition of these fields, which must be supplied at Power On.

6.3.4.7.2 Addressee Configuration parameter

This parameter is typically relevant only to the slave. However, a slave may have facilities attached that contain their own buffers and capabilities, or the slave may have allocated its own buffering on a dedicated basis among the facilities. A simple example would be facilities with integral data buffers for error correction (in which case only the first parameter field is required).

This parameter is intended to provide the master with information that would allow it to maximize performance. If this parameter is relevant to facilities as well as the slave, it is noted in the Slave Configuration parameter (see Facility Configuration Information in 6.3.4.8).

This parameter is made up of the following parameters:

a) Data Buffer Size. This value specifies the size (in octets) of the data buffer associated with the addressee.

b) Command Buffer Size. This value specifies the size (in octets) of the command buffer associated with the addressee.

c) Maximum Number of Octets in Command packet. This value specifies the maximum number of octets the addressee can accept in a Command packet.

d) Maximum Number of Octets in Response packet. This value specifies the maximum number of octets the addressee can provide in a Response packet.

e) Maximum Number of Access Permit Extents per Addressee. This value specifies the maximum number of Access Permits Extents allowed per addressee.

f) Minimum Number of Queued Commands. Any value greater than 0 indicated the minimum number that shall be guaranteed to queue per facility. A value of zero means the slave cannot guarantee any commands for the facility.

g) Maximum Number of Queued Commands. A value of 0 means that the queue may contain more than the minimum but only as many as the size of the command buffer permits. A value of 1 means that there is no Command Queuing and commands are Individual. Any other value shall be greater than or equal to t' minimum.

h) Size of Command Stack. This value specifies the minimum number of commands that the slave is capable of stacking (e.g., a slave with addressability to 8 facilities and a minimum queue size of 4 per facility may stack 32). If this is an absolute limitation, the value of 32 shall be specified. However, in some implementations, the stack may be as large as command buffering and the queuing algorithm permit, and may exceed 32 if the commands are small in length. If the size of the stack is variable, depending on the sum of command sizes, and it can exceed the calculable maximum, this field shall be set to x'FF'.

NOTE — A large number of factors influence the exact degree of stacking and queuing actually available in a slave (e.g., a slave capable of addressing 8 facilities but only 3 are physically attached and operational). If Individual commands are issued, then no more than 3 commands can be stacked. If Queued commands are issued, and there may be up to 4 per facility, the command stack would be 32. However, since only 3 facilities are operational, the effective queue per facility would average above 10 commands. The minimum parameters are what the slave guarantees, and are not intended to be an upper limit.

Another consideration is that commands are variable in length, but the size of the command buffer is typically fixed. In a configuration of 8 facilities with a minimum command queue of 4 and a maximum command size of 256, the command stack would be 32 and the command buffer size would have to be 8192 octets (32 x 56). However, if only one command of maximum size can be accepted by the slave (e.g., a COPY), and the others are typically less than 64 octets, then the command buffer size need be only 2240 octets (256+(31 x 64)). Refer to vendor documentation to determine the methods of buffer management used to maximize performance.

6.3.4.8 Parameter 66 - Slave Configuration (bit significant)

Table 36 — Attributes parameter 66

a	LTH	ID	OCTET	X/b	DEF	ATTRIBUTES PARAMETERS
S	n+1	66				SLAVE CONFIGURATION (BIT SIGNIFICANT)
			01	7		Facilities may be of Different Classes
				6		Facility-Facility Transfers
				5		Synonym Addressing
				4		Alias Addressing
				3		Odd Octet Transfers
				2		Master Termination of Commands Required
				1		Extended Substatus
				0		Multiplexed Data Transfers
			02	7		Transfer Notification packets
				6		Imbedded Data Responses
				5		Master-Definable Maintenance Partitions
				4		Facility Configuration Information
				3		Master Throttling of Data Streaming
				2		Multiple Command Extents Accepted
				1		Data Streaming Data Transfers
				0		Interlock Data Transfers
			03	7-0		reserved
			04			Logical Interface
				7		Level 2
				6		Level 3
				5-0		reserved

There are a large number of features that the slave may be able to support, and the following list provides a summary of its capabilities.

a) The Facilities May Be of Different Classes bit. This bit shall be set by the slave if it can support more than one class of facility. This bit is set even if both classes are not currently attached.

b) Facility-Facility Transfer Capability bit. This bit shall be set by the slave to indicate that it has the capability to transfer data between facilities attached to it without master intervention.

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