Implementation Agreement (IA)

CMIS Versatile Control Set (CMIS-VCS)

Revision 1.0

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CMIS Versatile Control Set (CMIS-VCS)

Rev. 1.0

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ABSTRACT: CMIS Versatile Control Set (CMIS-VCS) generalizes and extends the current CMIS base Control Sets [1] to allow for support and control of advanced SI capabilities maintaining compatibility with hosts that use CMIS without VCS. The CMIS-VCS Implementation Agreement defines an extensible list of Signal Integrity (SI) parameters, including their characteristics and their representation, as well as an optional versatile allocation within the CMIS Control Set. A CMIS-VCS compliant module makes this module-specific list of SI parameters and their locations within the Control Sets available to the host.

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- Initial outline and scope.
- Abstract and Introduction content.
- Section layout.

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- Introduction content added.
- Background section content added.
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- Incorporate feedback received.

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- Added overview of CMIS-CSID Explicit Control per field feature to the background section.
- Detail section 7 content added.
- CDB Command section added.
- Appendix examples added.

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- Change title and definitions/acronyms (From CMIS-CSD to CMIS-FCS).
- Added definitions section.
- Added section for ApplicationMask Attribute.
- Added Signal Integrity Related Controls section content from CMIS 5.2 (Section 6.2.5).
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- Modified CDB section to have a single command for the entire VCS.
- Added details on VCSP TLV encoding.
- Updated Appendix with new VCS stream.

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- Updated captions and references.
- Updated table of contents, list of tables and list of figures.
- Updated wording on the abstract.
- Added definitions to the definitions section.
- Assigned overflow memory space (Pages 18h and 19h).
- Changed the AppSelMask Attribute to ApplicationMask.
- Changed the ExplicitControlperField Parameter to ExplicitControlperParam and identified it as a ‘pseudo’ VCSP.
- Added Editor’s notes for backwards compatibility questions.
- Expanded CDB command group IDs.
- Added custom VCS CDB command ID.

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- Draft prepared for PLL Management Q124 presentation.

- Name changed to Versatile Control Set (VCS) (From CMIS-FCS to CMIS-VCS).
- Updated backwards compatibility section. A module must be legacy compliant within CMIS 5.x.
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- Uprev for PLL straw ballot.

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REEV 1.0 – January 8, 2025

- Uprev and prepare for publication following OIF IA approval.

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1 CMIS-VCS Definitions

Table 1-1 CMIS-VCS Definitions

Acronym/Term	Definition
CMIS-VCS	CMIS Versatile Control Set – Control Set whose contents and register map structure are defined by the module and are advertised via a CDB query command.
VCS Parameter	Versatile Control Set Parameter – Signal Integrity (SI) parameter that can be part of the Versatile Control Set.
VCS Parameter ID	Versatile Control Set Parameter ID – Numerical identifier used to indicate a specific Versatile Control Set Parameter. Each Versatile Control Set Parameter is identified by a numerical ID defined in this document.
VCS Parameter Attribute	Versatile Control Set Parameter Attribute – Readable attribute describing some characteristics of a Versatile Control Set Parameter (For example, its range or resolution).
VCS Parameter Descriptor	Versatile Control Set Parameter Descriptor – Data structure describing the representation of the VCS Parameter.
VCS Descriptor	Versatile Control Set Descriptor – The sequence of VCS Parameter Descriptors. The VCS Descriptor is a Type-Length-Value (TLV) encoded byte array containing the list of VCS Parameter Descriptors.
VCS Space	Versatile Control Set Space – Management memory space containing the registers used to read and write to the VCS Parameter registers, as defined by the VCS Parameter Descriptors.

2 Acronyms and terminology

Adv.	Advertised (a register classification tag)
ACS	Active Control Set
Bool	1-bit Boolean value with encoding TRUE = 1 and FALSE =0
CDB	Command Data Block. See section 4.1
CDR	Clock and Data Recovery
CMIS	Common Management Interface Specification
CMIS base	The Implementation Agreement containing core and advanced management CMIS features [1]
Cnd.	Conditionally required (a register classification tag)
Comp.	Compute (a register classification tag)
Control Set	Set of parameters needed to setup a Data Path. See CMIS base [1]. In this document the subset of Signal Integrity (SI) parameters is of interest. See section 4.1
CTLE	Continuous Time Linear Equalizer
EC	Explicit Control (name of a control bit)
ENC.	Encoded
EPL	Externed Payload
IA	Implementation Agreement
ID	Identifier
LPL	Local Payload
LSB	Least Significant Bit (In a multiple bits context), Least Significant Byte (in a multi-byte context)
MSB	Most Significant Bit (In a multiple bits context), Most Significant Byte (in a multi-byte context)
OIF	Optical Interworking Forum
Opt.	Optional (register classification tag)
OTN	Optical Transport Network
RO	Read-Only
Rqd.	Required (Register classification tag)
RW	Readable and Writable
Rx	Receiver function of module, receive direction (media to host)
S8	8-bit signed integer (2's complement) with value range -127 to 127
SCS<k>	Staged Control Set k, where k is 0 or 1.

SI	Signal Integrity
SM	State Machine
TLV	Type Length Value – encoding scheme used to provide information in a consistent and standard manner.
Tx	Transmitter function of module, transmit direction (host to media)
Ux	x-bit unsigned integer. The variable x is determined via advertisement of the applicable register
U8	8-bit unsigned integer with value range 0 to 255, stored in a single byte
WO	Write-Only

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3 Introduction

The CMIS Versatile Control Set Implementation Agreement (CMIS-VCS IA) defines a standard method by which a module can advertise support for Signal Integrity (SI) features (such as the ones listed in Table 5-1) beyond those defined in CMIS base [1] (see “Tx and Rx signal integrity controls” section), to enable third-party vendor integration without requiring a pre-set memory space to use all available SI controls. To better understand this document, readers are encouraged to first read the "Data Path Configuration – Control Sets" section of CMIS base [1]. This document uses terms defined in CMIS base [1].

The Versatile Control Set (VCS) is defined within the same Staged Control Sets register space specified in CMIS base [1] and it provides a compatibility mode for use with VCS unaware hosts, as specified in section 4.4.

Modules supporting VCS advertise a set of Versatile Control Set Parameters (VCS Parameters), which are the group of SI parameters that can be part of the Versatile Control Set (VCS). The module shall support the CMIS base [1] Control Sets memory spaces in order to be compatible with hosts that do not support CMIS-VCS. Each VCS Parameter in this document is identified with a specific numerical ID (VCS Parameter ID) and is associated with unique attributes (VCS Parameter Attributes) that describe characteristics of that SI parameter. Hosts download the VCS from the module to learn the list of supported controls, their attributes, and their arrangement within the Control Set memory spaces prior to setting the module Control Sets. CMIS-VCS also provides support for read-only SI parameters intended for module advertisement to the host. These VCS Parameters appear only in the Active Control Set memory space, after all read-write VCS parameters, and cannot be modified by the host.

The cost of supporting VCS, namely the cost of module dependent register map segments (VCS space), is low when considering the advantages of the feature. VCS can provide savings in implementation and integration by employing a standardized technique to do SERDES optimization between any vendor VCS module and any VCS-aware host, versus implementing vendor-specific proprietary methods.

The purpose of this IA is to specify the method for a host to discover a module’s VCS Parameters, and their features, so it can make use of them. The end goal is a common approach so each module vendor can allow the host to control all SI capabilities in a consistent manner, and the user can take advantage of such capabilities to improve the performance and quality of electrical links regardless of vendor.

4 CMIS-VCS Overview

As observed with transport evolution, the capabilities and applications of modules, both optical and active copper, are continuously expanding. The market has increased significantly, offering a wide range of module vendors with a rich set of applications. As more modules are introduced in the market at faster rates, the range of their signal integrity controls and capabilities to satisfy the full solution space of applications continues to increase, which makes the current definition of Control Set contents quickly obsolete.

CMIS-VCS seeks to provide a solution for the large variety of SI capabilities by abstracting the CMIS base [1] Control Sets register space to provide module-specific capability advertisement that any system can implement, while providing an option to continue to support the current Control Sets for CMIS base [1] compatibility, where needed. The goal is to define a standard set of signal integrity controls (a menu of sorts). Implementers can select a subset of those controls to advertise and implement in the Control Set register space. Since the Control Set register space is now versatile (when VCS is implemented), the controls that are advertised and implemented can evolve from generation to generation as new controls are added and old controls are no longer needed.

4.1 CMIS base implementation of Control Sets

As outlined in the CMIS base Control Set Concept (See “Data Path Configuration – Control Sets” section in CMIS base [1]), a compliant module contains a group of registers with many of the settings required to set up a Data Path or lane(s) in a module and are known as Control Sets. There are two types of Control Sets, one Active, and two Staged Control Sets. The Active Control Set is read-only and reports the currently provisioned configuration settings that are used (or to be used) by the module to control its hardware. The Staged Control Sets are used by the host to define new configuration settings for future use, without immediate effect in the module, to be applied when triggered by the host. Support for one Staged Control Set is required. Support for a second Staged set is optional. The Staged Control Set register values are written prior to initialization or configuration according to the intended Application or Data Path.

The Control Sets contain Data Path-specific information to configure and describe the Application, and SI settings for the Data Path. This document applies only to the SI settings portion of the Control Sets. The register definitions of the SI portion of the Active and Staged Control Sets have the same format and register definitions in CMIS base [1]. VCS provides an ability to advertise read-only parameters that appear in the Active Control Set register space only, see section 4.4.

Within the SI portion, there are two options for ownership of the Stage Control Set register values: they can be controlled by the module, where the host selects the Application and the module configures the SI settings according to the requirements of that Application, or controlled by the host, where the host selects both the Application and all the SI settings. In CMIS base [1], the ownership of SI settings can be set per lane, but all the SI settings for that lane have the same ownership. To differentiate between the two methods, CMIS base specifies the ExplicitControl bit in the Data Path Configuration register. When the bit is set to 1, the host controls all of the SI Control Set registers for that lane. More details of the ExplicitControl mechanism can be found in the "Data Path Configuration – Control Sets" section of CMIS base [1]. VCS provides increased flexibility for Explicit Control of Data Path configuration settings.

Figure 4-1, which is a copy from the CMIS base “Data Path Configuration – Control Sets” section [1], shows how the Staged and Active Control Sets are used during initialization and configuration.

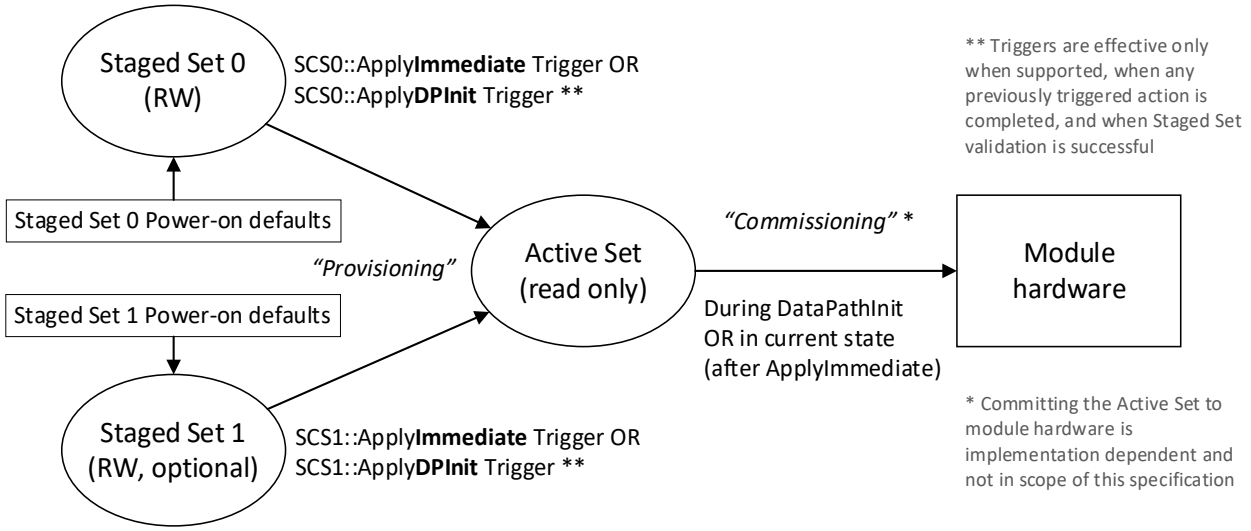

Figure 4-1 Control Set Data Flow Diagram

The "Tx and Rx Signal Integrity Controls" section in CMIS base [1] defines the bytes in Page 10h designated to signal integrity settings per lane. In CMIS base [1], the available SI controls are finite, and the capabilities and ranges of each control are as prescribed. Modules that have capabilities above and beyond what is in the space would require expansion of CMIS base or vendor-specific registers and host control software to implement.

4.2 CMIS-VCS implementation of Control Sets

The CMIS-VCS implementation is based on advertisement of SI capabilities unique to the module which may include new controls that are beyond what is in the CMIS base [1] definitions. The module uses the same memory space defined in the "Tx and Rx Signal Integrity Controls" section in CMIS base [1] for the Staged Control Set, and in the "Provisioned Tx and Rx Signal Integrity Settings" section of CMIS base [1] for the Active Control Set to configure and observe the SI settings for each lane in the module. The difference is that the mapping of SI controls to registers is no longer fixed by CMIS base. Instead, this mapping, including identifying which controls are supported and their characteristics, is advertised by the module using commands from a CDB Command Group (See section 6). The method for initialization and application of the Staged Control Sets registers does not change from the CMIS base [1] method, as shown in Figure 4-2.

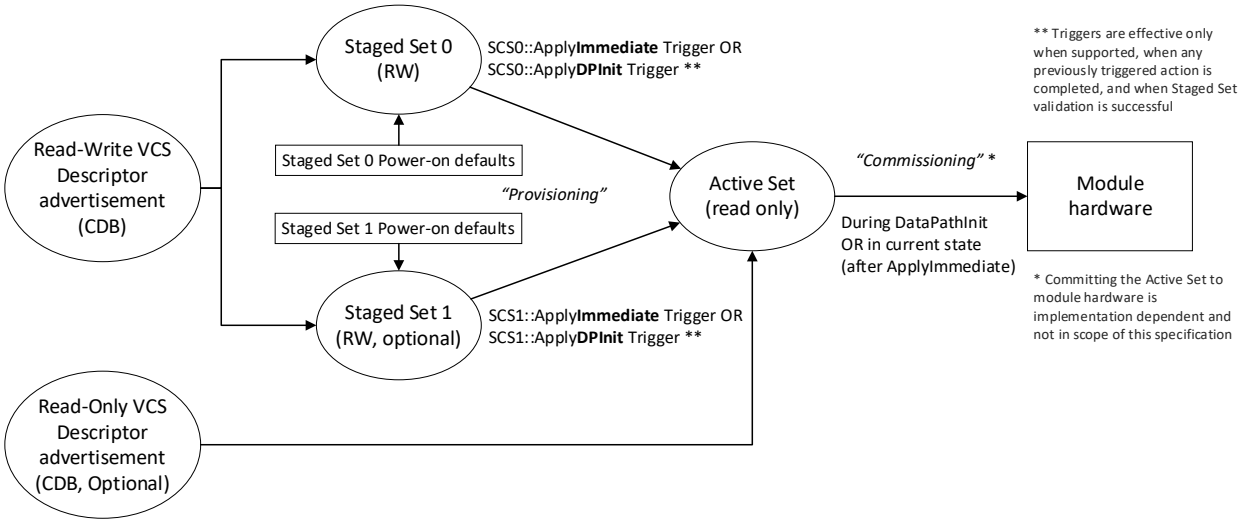

Figure 4-2 CMIS-VCS Control Set Data Flow Diagram

4.3 VCS Advertisement

Each module advertises its VCS Descriptor using CDB commands (See section 6). The advertisement contains the VCS Parameter IDs and applicable VCS Parameter Attributes for supported SI controls. VCS Parameters are defined in section 5. The host can query the module-supported VCS Parameters using CDB commands (see Section 6).

As defined in CMIS base [1], CDB is an optional feature for command-reply message exchange between host and module. Refer to the "Command Data Block (CDB) Message Communication" section in the CMIS base [1] for CDB messaging/reply protocol details. CMIS-VCS uses a specific command group ID in the range 4000h to 40FFh. In addition, a byte in the "CDB Feature and Capabilities Commands" in CMIS base [1] is used to indicate whether the module supports VCS, see section 6. See the CMIS base "CDB Command Group Summary" section [1] for a complete list of available CDB command groups.

If a module does not support a VCS Parameter but the module needs to be compatible with a predefined Control Set layout, such as for interoperability with 5.x CMIS base hosts, the VCS Parameter ID 0 is used. For details, see section 5.2.

The Attributes of each VCS Parameter, which include field type, access type, data type, size, units, length and AppSel dependency, are also defined in section 5.

4.4 Memory Map

The module advertises its mapping of VCS Parameters into the Control Set memory spaces defined in CMIS base [1] (See the "Tx and Rx Signal Integrity Controls" section), as shown in Table 4-1. The host queries the module VCS definition using CDB Messages Group IDs 4000h to 40FFh (see Section 6).

Table 4-1 CMIS base Control Set Memory Map

Function	Page	Bytes	Overflow Page	Overflow Page Bytes
Staged Control Set 0	10h	188-195	18h	144-199

Function	Page	Bytes	Overflow Page	Overflow Page Bytes
Staged Control Set 1	10h	196-210	18h	200-255
Active Control Set	11h	214-234	19h	152-207

If a module uses CMIS-VCS for SI control advertisement, the order of fields within the Control Set is the same as the order of VCS Parameters advertised in the VCS. The host can calculate the memory map offset for each field by calculating the accumulated lengths of previous fields advertised in the VCS, where the length is defined by the VCS Parameter.

In cases where the Staged Control Set Register space in pages 10h/11h is not big enough for the list of VCS Parameters, overflow pages 18h (bytes 144-255) and 19h (bytes 152-207) can be used, as shown in Table 4-1. The "Tx and Rx Signal Integrity Controls" register space in page 10h/11h [1] must be filled first before moving on to the overflow pages. An individual VCS Parameter must be fully contained within a page (includes all its Attributes). Fragmentation of VCS Parameters between pages is not allowed.

CMIS-VCS allows for advertisement of read-only VCS Parameters via the read-only CDB command as specified in section 6.4. The read-only VCS Parameters are used by the module to provide information to the host. The host cannot modify its contents. The read-only VCS Parameters are only populated in the Active Control Set memory space after all the read-write VCS Parameters have been allocated. Hence, the register offset for read-write VCS parameters is the same for all Control Sets (Staged and Active).

4.5 CMIS base compatibility

Over time, new modules are expected to implement the CMIS-VCS method for SI control advertisement. During the transition to this new methodology, and for CMIS base 5.x compliance, modules that support VCS are required to maintain compatibility with 5.x hosts, which are expecting the Control Set parameters to be ordered according to CMIS base 5.x [1].

In the future, a module that supports VCS may rearrange the Control Set memory space with supported VCS Parameters as desired via advertisement (as shown in Appendix B). However, for this version of CMIS-VCS, the module shall support the Control Sets space as defined in CMIS base [1]. To accomplish this, the module shall mark unused parameters using the "ReservedSpaceIndicator" parameter as described in section 5.2.

Modules should also continue to populate the page 01h SI advertisements in addition to the CDB VCS advertisements for CMIS base [1] compatibility.

4.6 CMIS-VCS Explicit Control per parameter feature

As mentioned in section 4.1, CMIS base [1] defines an ExplicitControl (EC) bit, which assigns ownership of all of the SI settings for a given lane to either the host or module. Since this ownership pertains to the entire set of SI registers for a lane, hosts wishing to customize only a subset of SI settings must first read all of the settings from the Active Set, then write the settings that did not require customization back into the Staged Control Set, adding complexity and time. CMIS-VCS allows the ownership of SI settings to be assigned per parameter and per lane. Thus, a host can control specific SI parameters while allowing the module to apply default values to other SI parameters in the same lane.

The feature is implemented via the ExplicitControlPerParam Parameter which is assigned the VCS Parameter ID 02h. Section 5.3 describes how the Parameter is used.

This VCS feature is not compatible with hosts that do not support CMIS-VCS functionality.

4.7 The ApplicationMask Attribute

As specified in CMIS base, “Control Set Content” section [1], the module advertises the Application Descriptors it supports, each of which is identified by a unique AppSel code.

CMIS-VCS allows SI Parameters (VCS Parameters) to be implemented, on a Parameter by Parameter basis, based on an Application. The module uses the ApplicationMask Attribute to advertise which parameters are supported per AppSel. When a value is programmed into the Staged VCS Parameter, the AppSel selected by the DPConfig register determines whether the value is used or ignored according to the ApplicationMask Attribute. A VCS Parameter always reserves its corresponding CMIS address space in the Staged Control Set memory region, independent of the values of AppSel and ApplicationMask. In other words, the layout of the CMIS memory map never depends on the AppSel codes but solely on the VCS Descriptor.

To this end, ApplicationMask is a VCS Parameter Attribute of every VCS Parameter. Thus, a module can enable usage of SI Parameters for some applications and mark them as unused or not supported for others, as applicable, on a Parameter basis.

The length of the ApplicationMask is dependent on the number of Application Descriptors the module advertises. The length is set by the count of AppSel codes supported, rounded up to the next byte. For example, if a module supports 4 AppSel codes, the ApplicationMask length is 1 byte.

The ApplicationMask Attribute is a bit mask where the Nth bit of the mask corresponds to the AppSel code. If a bit is set to 1, the corresponding VCS Parameter is supported for that AppSel code. For example, ApplicationMask value 1011b corresponds to the applicable Parameter being supported for AppSel codes 1, 2, and 4.

Further examples of the usage of the ApplicationMask Attribute can be found in Appendix A and Appendix B. *Note, ApplicationMask is used to identify an application where the parameter is supported, and ReservedSpaceIndicator (see section 5.2) is used when a module does not support a parameter for any application.*

5 CMIS-VCS Parameters

Table 5-1 shows the VCS Parameters that are specified in this CMIS-VCS revision.

The following subsections define the Descriptor format of the VCS Parameters and their Attributes, which are used when parsing the overall VCS as a sequence of VCS Parameters. Some of these parameters are defined in CMIS base [1] and have been directly copied into this document, they are identified with "CMIS base Parameter" in the Notes column of Table 5-1. Parameters that are unique to CMIS-VCS are identified with "VCS Parameter" in the Notes column of Table 5-1.

The "Type" column in Table 5-1 indicates whether the Parameters are read-write (appear in all Control Sets with the same register offset) or read-only (appear only in the Active Control Set after all read-write Parameters, in order of advertisement of the read-only VCS descriptor CDB command. Section 6.5).

Each VCS Parameter has a defined ID and length, which is also contained in each VCS Parameter as Attributes to allow parsing the entire VCS in one CDB command.

Table 5-1 CMIS-VCS Descriptors

VCS Parameter ID	Parameter Name	Description	Type	Section	Notes
00h	ReservedSpaceIndicator	Used to reserve memory space for unused parameters.	RW	5.2	VCS Parameter
01h	ExplicitControlPerParam	Bit mask of VCS Parameter to explicitly control	RW	5.3	VCS Parameter
02h	AdaptiveInputEqEnableTx	Enable Tx adaptive input equalizer	RW	5.4	CMIS base Parameter
03h	AdaptiveInputEqRecallTx	Recall stored Tx equalizer adaptation settings	RW	5.5	CMIS base Parameter
04h	HostControlledInputEqTargetTx	Host Controlled Tx input equalizer	RW	5.6	CMIS base Parameter
05h	CDREnableTx	Tx CDR enable/bypass	RW	5.7	CMIS base Parameter
06h	CDREnableRx	Rx CDR enable/bypass	RW	5.8	CMIS base Parameter
07h	OutputEqPrePostCursorTargetRx	Rx output equalization pre/post-cursor target	RW	5.9	CMIS base Parameter

VCS Parameter ID	Parameter Name	Description	Type	Section	Notes
08h	OutputAmplitudeTargetRx	Rx output amplitude target	RW	5.10	CMIS base Parameter
09h	HostControlledInputEqTargetNumericTx	Host-controlled Tx Input equalization – Numeric.	RW	5.11	VCS Parameter
0Ah	OutputEqTargetNumericRx	Rx Output Equalization Target – Numeric.	RW	5.12	VCS Parameter
0Bh	OutputPrecodingEnableRx	Enable/disable precoding on Rx output	RW	5.13	VCS Parameter
0Ch	InputPrecodingEnableTx	Enable/disable precoding decoder on Tx input	RW	5.14	VCS Parameter
0Dh	OutputEqPrePostCursorCoeffRx	Rx output equalizer Pre/Post-cursor coefficient	RW	5.15	VCS Parameter
0Eh	OutputFineAmplitudeSettingRx	Rx output fine amplitude setting	RW	5.16	VCS Parameter
0Fh	HostChannelLossRx	Host Rx channel loss in dB	RW	5.17	VCS Parameter
10h	HostChannelLossTx	Host Tx channel loss in dB	RW	5.18	VCS Parameter
11h	NonLinearCompensationTx	Module Non-Linear Compensation	RO	5.19	VCS RO Parameter
12h	InputEqPrePostCursorCoeffTx	Tx Input Pre-Equalizer Pre/Post-Cursor Target	RO	5.20	VCS RO Parameter

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5.1 VCS Parameter Descriptors

Each module advertises the content and structure of the VCS Space, which is a list of VCS Parameter Descriptors. Sections 5.2 to 5.17 define the VCS Parameter Descriptor per VCS Parameter. The advertisement of VCS Parameter Descriptors applies to all lanes. Hosts may set the control per lane using the Staged VCS space registers.

Each of these sections, except for section 5.2 (Not used indicator VCS parameter), describes a VCS Parameter and contains two tables. The first table describes the VCS Parameter Descriptor (i.e. its VCS Parameter ID and Attributes, which are part of the VCS Descriptor contained in the reply to the VCS Descriptor CDB command). The second table describes how the control (or status) parameter is represented in the Control Set register(s), within the VCS Space.

The VCS Descriptor (i.e. the information about format and content of the VCS register space) is queried in two CDB commands (read-write and read-only VCS Descriptor CD commands). The VCS Descriptor is a Type-Length-Value (TLV) encoded byte array containing the list of VCS Parameter Descriptors. The type of each element in the VCS Descriptor is indicated by the VCS Parameter ID, and the total length of the VCS Parameter Descriptor in bytes (including the VCS Parameter ID and length bytes) is advertised in the VCS Parameter length field. The next VCS Parameter Descriptor follows directly after last the byte of the previous VCS Parameter Descriptor. See section 6.1 for details.

All read-write VCS Parameters supported by the module are parsed in the same CDB command, one after the other in TLV format, until the full set of VCS Parameters is included thus forming the VCS Descriptor. The same is done for the read-only VCS parameters in the read-only CDB command. Details of the CDB message are in Section 6.

5.2 Reserved Space Indicator VCS Parameter

This parameter is used to maintain compatibility with 5.x hosts, where the 5.x host is expecting a certain SI parameter in a specific memory offset (as defined by CMIS base [1]) but the module does not support it. In this case, the module may advertise the ReservedSpaceIndicator Parameter in place of the unsupported parameter with a ReservedLength attribute which corresponds to the unsupported parameter length. Thus, the corresponding bytes in the Control Set memory space will be reserved. Hosts that support VCS will know that the CMIS base [1] parameter in this location is not supported (by reading the VCS Parameter ID). Hosts that do not support VCS will see the expected CMIS base Control Set memory space [1] but writes to these bytes will have no effect.

The ReservedSpaceIndicator VCS Parameter has a VCS Parameter ID of 0. The ReservedLength Attribute corresponds to the length in bytes of the unused SI parameter's length. See Table 5-3 for the VCS Parameter Descriptor details. *Note, the actual value of the ApplicationMask has no effect on the VCS Parameter. The ApplicationMask attribute in the ReservedSpaceIndicator VCS Parameter is ignored.*

For example, if the module does not support the AdaptiveInputEqRecallTx (Bytes 154-155 of Page 10h as specified in CMIS base "Tx and Rx Signal Integrity Controls" [1]), it advertises VCS Parameter ID = 00h and ReservedLength = 02h in its place. This will reserve 2 bytes starting at location 154 (after the previous VCS parameter). See Figure 5-1 for a portion of the VCS Descriptor showing this example for a module that supports 4 AppSel codes.

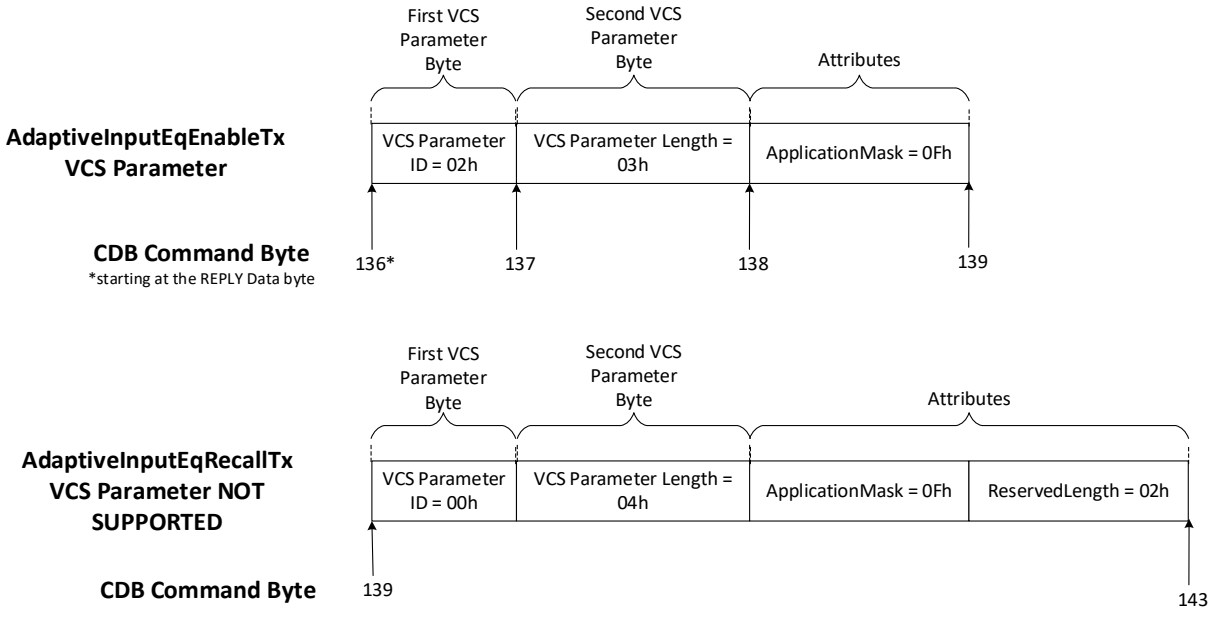

Figure 5-1 ReservedSpaceIndicator VCS Parameter - VCS Descriptor Example

Table 5-2 shows the resulting Control Set memory space for this example.

Table 5-2 ReservedSpaceIndicator VCS Parameter – Control Set Memory Space Example

Page 10h Byte	Parameter	Description
153	AdaptiveInputEqEnableTx<i>	**SCS0::AdaptiveInputEqEnableTx<i>** Adaptive input equalizer for host lane <i> 1b: Enable adaptive Tx input equalization 0b: Disable (use manual fixed equalizer)
154	**Not Supported**	**Reserved**
155	**Not Supported**	**Reserved**
156	HostControlledInputEqTargetTx<i>	**SCS0::FixedInputEqTargetTx<i>** Host-Controlled fixed Tx input equalizer control

See more usage examples in Appendix A. *Note, ApplicationMask (see section 4.7) is used to identify an application where the parameter is supported, and ReservedSpaceIndicator is used when a module does not support a parameter for any application.*

Table 5-3 ReservedSpaceIndicator VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
ReservedSpaceIndicator	VCS Parameter ID	U8	Versatile Control Set Parameter ID	00h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	ReservedLength	U8	Length to reserve in bytes (equivalent to the length of the unused parameter).	

5.3 Explicit Control per Parameter pseudo–VCS Parameter.

This pseudo–VCS Parameter is used to indicate which VCS Parameters are host controlled per lane. The value is of Boolean type. When a bit in this VCS Parameter is set to 1, the host is in control of the corresponding VCS parameter for that lane. When a bit in the VCS Parameter attribute mask is set to 0, the module is in control of the corresponding VCS parameter for that lane. The bit location in the ExplicitControlPerParam<i> VCS Parameter determines the corresponding VCS parameter, with the bit location correlating to the Nth VCS Parameter in the advertised VCS.

The length of the ExplicitControlPerParamMask is dependent on the number of VCS Parameters that the module advertises. The bit field corresponds to each VCS Parameter in the order that they appear in the VCS space. The size is rounded up to the next byte.

For example, if a VCS Descriptor contains 8 VCS Parameters, the length of ExplicitControlPerParamMask is 1 byte. Bit 0 corresponds to the 1st VCS Parameter advertised, and bit 7 will correspond to the 8th VCS Parameter advertised regardless of their associated IDs.

Table 5-4 Explicit Control per Parameter pseudo–VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
ExplicitControlPerParam	VCS Parameter ID	U8	Versatile Control Set Parameter ID	01h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	ExplicitControlPerParamMask	Ux	The size of this mask is determined by the number of VCS Parameter ID the module advertises, rounded up to the next byte.	

Table 5-5 Explicit Control per Parameter Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
ExplicitControlPerParam<i>	Bit mask of VCS Parameters to explicitly control. The Nth bit corresponds to the Nth VCS Parameter in the VCS. (Bit 0 = First VCS Parameter in the VCS Descriptor)	Property	RW	Bool	X (size is dependent on the advertised ExplicitControl PerParamMask length)

5.4 Tx Adaptive Input Equalizer Enable VCS Parameter

This Descriptor is used to enable the Tx adaptive input equalizer. This VCS Parameter is part of the CMIS base Tx Controls [1].

The controls for the Tx input equalization can be grouped by equalization type, as shown in Table 5-6.

Table 5-6 Tx Input Eq Control relationship to AdaptiveInputEqEnableTx

Equalization Type	Control	AdaptiveInputEqEnableTx
Adaptive	AdaptiveInputEqFreezeTx	1
	AdaptiveInputEqStoreTx	
	AdaptiveInputEqRecallTx	
Non-Adaptive	HostControlledInputEqTargetTx	0

The controls relevant for adaptive Tx input equalization are described in section 5.5

The controls relevant for non-adaptive Tx input equalization, when Tx input equalization settings are pre-determined or host provisioned, are described in section 5.6.

Note: The meaning of these input equalization values may be specified elsewhere, outside of this specification.

The module ignores control field values that are not relevant for the current AdaptiveInputEqEnableTx setting.

Table 5-7 Tx Adaptive Input Equalizer Enable VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
AdaptiveInputEqEnableTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	02h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-8 Tx Adaptive Input Equalizer Enable Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
AdaptiveInputEqEnableTx<i>	Adaptive input equalizer for host lane <i> 1b: Enable 0b: Disable (use host-controlled equalizer)	Property	RW	Bool	1

5.5 Tx Adaptive Input Equalizer Recall VCS Parameter

This VCS Parameter is used to advertise support for recalling the most recent stored adapted Tx input equalization settings. This VCS Parameter is part of the CMIS base Tx Controls [1].

Note: Equalizer adaptation can be time-consuming. In some applications, the available time for a speed change (which incurs selecting a new Application and hence a Data Path reconfiguration) does not include equalizer adaptation time. To better support such applications, an optional host-controlled Store and Recall mechanism is specified for storing adapted equalizer settings for later recall and use.

Note: Only modules supporting applications that require fast application change (e.g. for speed negotiation) with critical time budgets are expected to support this mechanism.

The TxInputEqRecallBuffersSupported field (see CMIS base [1]) advertises support of the adaptive Tx input equalizer store and recall mechanism by advertising the number of recall buffers supported by the module.

Recall buffers are numbered and used independently of Staged Control Set instances.

The module provides enough storage in each recall buffer to store adapted equalizer settings for each lane of the module. The storage mechanism is implementation specific and not defined in this specification.

The AdaptiveInputEqStoreTx trigger field is described in CMIS base [1]. To store the most recent adapted Tx input equalizer settings for lane <i>, the host writes the desired target recall buffer number into AdaptiveInputEqStoreTx<i>. Equalizer adaptation is then stopped until the settings have been stored and continues afterwards, unless adaptation is frozen (i.e. unless AdaptiveInputEqFreezeTx<i> is set).

Host requests to store equalizer settings while adaptation is disabled (i.e. AdaptiveInputEqEnableTx<i> is cleared for lane <i>) are ignored by the module.

The host may trigger storage by writing to AdaptiveInputEqStoreTx<i> at any time while the Data Path state is DPInitialized or DPActivated, and a requested storage occurs then immediately.

The AdaptiveInputEqRecallTx control field is described in CMIS base [1] for Staged Control Set 0 and for Staged Control Set 1.

The Active Control Set provides a read-only indication of the current AdaptiveInputEqRecalledTx status for each lane (see CMIS base [1]).

To recall a stored Tx input equalizer adaptation setting into a Staged Control Set, the host writes the storage buffer number to be recalled to the applicable AdaptiveInputEqRecallTx lane controls.

Note: These settings are not recalled into the active equalizer until the host has triggered ApplyDPInit or ApplyImmediate for that Staged Control Set.

The AdaptiveInputEqRecallTx field is used independent of the ExplicitControl field settings for that lane.

If AdaptiveInputEqFreezeTx is cleared, the recalled Tx input Eq adaptation setting is used as the starting point for continuous adaptation for the applicable lanes. Otherwise, if AdaptiveInputEqFreezeTx is set, the recalled Tx Input Eq Adaptation is used as the frozen Tx Input Eq value for the applicable lanes.

Table 5-9 Tx Adaptive Input Equalizer Recall VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
AdaptiveInputEqRecallTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	03h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-10 Tx Adaptive Input Equalizer Recall Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
AdaptiveInputEqRecallTx<i>	Recall stored Tx input equalizer adaptation settings for host lane <i> when Staged Control Set is copied to Active Control Set. 00b: do not recall 01b: recall from recall buffer 1 10b: recall from recall buffer 2 11b: reserved	Method	RW	Enc.	2

5.6 Tx Host-controlled Input Equalizer target VCS Parameter

This Descriptor is used to set a target value for the equalizer. This VCS Parameter is part of the CMIS base Tx Controls [1].

Tx input equalization values in dB are based on a reference CTLE and may not directly apply to the equalizer implemented in the module. See the appropriate analog specification for the meaning of the input equalization values.

SCS<k>::HostControlledInputEqTargetTx<i> is a four-bit control field for lane <i> and encoded as shown in Table 5-11. This field allows the host to specify a non-adaptive Tx input equalization target and is ignored by the module if AdaptiveInputEqEnableTx<i> is set for that lane.

In addition to including this parameter in the VCS Descriptor, the module advertises support non-adaptive Tx input equalization control in Page 01h byte 161 as described in CMIS base, “Supported Configuration and Signal Integrity Controls Advertisement” section [1].

The module also advertises the maximum supported non-adaptive Tx input equalization in Page 01h byte 153 as described in CMIS base, “Module Characteristics Advertisement” section [1].

Table 5-11 Tx Host-controlled Input Equalization Codes

Code Value	Bit Pattern	Input Equalization
0	0000b	No Equalization
1	0001b	1 dB
2	0010b	2 dB
3-8	0011b … 1000b	3 dB … 8 dB
9	1001b	9 dB
10	1010b	10 dB
11	1011b	11 dB
12	1100b	12 dB
13-15		Custom

Table 5-12 Tx Host-controlled Input Equalizer Target VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
HostControlledInputEqTargetTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	04h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	

Parameter Name	Attribute	Type	Definition	Value
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	CodeValueMask	U16	Code Values supported per Table 5-11. Each bit corresponds to the code value. Bit = 1 indicates the value is supported.	

1 **Table 5-13 Tx Host-controlled Input Equalizer Target Register Format**

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
HostControlledInputEqTargetTx<i>	Host-controlled Tx input equalizer control for host lane <i>. Code Values as described in Table 5-11.	Property	RW	U4	4

2

5.7 Tx CDR Enable VCS Parameter

This VCS Parameter is used to enable the Tx CDR. When the value is 0, the CDR is in bypass mode. This VCS Parameter is part of the CMIS base Tx Controls [1].

In addition to including this parameter in the VCS Descriptor, the module advertises support for Tx CDR bypass in Page 01h byte 161 as described in CMIS base, "Supported Configuration and Signal Integrity Controls Advertisement" section [1].

Table 5-14 Tx CDR Enable VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
CDREnableTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	05h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-15 Tx CDR Enable Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
CDREnableTx<i>	1b: CDR enabled 0b: CDR bypassed	Property	RW	Bool	1

5.8 Rx CDR Enable VCS Parameter

This VCS Parameter is used to enable the Rx CDR. When the value is 0, the CDR is in bypass mode. This VCS Parameter is part of the CMIS base Rx Controls [1].

In addition to including this parameter in the VCS Descriptor, the module advertises support for Rx CDR bypass in Page 01h byte 162 as described in CMIS base, "Supported Configuration and Signal Integrity Controls Advertisement" section [1].

Table 5-16 Rx CDR Enable VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
CDREnableRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	06h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-17 Rx CDR Enable Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
CDREnableRx<i>	1b: CDR enabled 0b: CDR bypassed	Property	RW	Bool	1

5.9 Rx Output Equalization Pre/Post-Cursor Target VCS Parameter

This VCS Parameter sets the values for the Rx output equalizer pre/post-cursor target, in dB. This VCS Parameter is part of the CMIS base Rx Controls [1].

Rx output equalization is defined at an appropriate test point defined by the relevant standard.

SCS<k>::OutputEqPreCursorTargetRx<i> and SCS<k>::OutputEqPostCursorTargetRx<i> are four-bit control fields for lane <i> and encoded as shown in Table 5-18.

In addition to including this parameter in the VCS Descriptor, the module advertises support of Rx output equalization control in Page 01h byte 162 as described in CMIS base, “Supported Configuration and Signal Integrity Controls Advertisement” section [1].

The module also advertises the maximum supported Rx output equalization values in Page 01h byte 154 as described in CMIS base, “Module Characteristics Advertisement” section [1].

Modules may advertise that they support only a single output emphasis setting (Pre-Cursor only or Post-Cursor only).

In both cases and despite the apparent name mismatch in the Pre-Cursor only case, the SCS<k>::OutputEqPostCursorTargetRx<i> fields are used to control the single emphasis settings (they offer a larger dB range), and modules ignore the SCS<k>::OutputEqPreCursorTargetRx<i> fields.

Table 5-18 Rx Output Equalization Codes

Code Value	Bit Pattern	Post-Cursor Equalization	Pre-Cursor Equalization
0	0000b	No Equalization	No Equalization
1	0001b	1 dB	0.5 dB
2	0010b	2 dB	1.0 dB
3	0011b	3 dB	1.5 dB
4	0100b	4 dB	2.0 dB
5	0101b	5 dB	2.5 dB
6	0110b	6 dB	3.0 dB
7	0111b	7 dB	3.5 dB
8-10	1000b-1010b	Reserved	Reserved
11-15	1011b-1111b	Custom	Custom

Note: The pre-cursor equalizer settings in dB approximates to Equation 5-1.

$$Pre\ EQ\ (dB) = -20\log_{10}\left(\frac{1 - C_{-1}}{(C_{-1} + C_0 + C_1)}\right)$$

Equation 5-1 Pre-cursor equalizer equation

The post-cursor equalizer settings in dB approximates to Equation 5-2

$$Post\ EQ\ (dB) = -20\log_{10}\left(\frac{1 - C_1}{(C_{-1} + C_0 + C_1)}\right)$$

Equation 5-2 Post-cursor equalizer equation

Equalizer coefficients Cn are pre-cursor for n<0 and post-cursor when n>0.

Table 5-19 Rx Output Equalizer Pre/Post-Cursor Target VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
OutputEqPrePostCursorTargetRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	07h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	PrePostCursorIndex	S8	Indicates the coefficient for which the settings apply. C(value)	
	CodeValueMask	U16	Code Values supported per Table 5-18. Each bit corresponds to the code value. Bit = 1 indicates the value is supported.	

Table 5-20 Rx Output Equalizer Pre/Post-Cursor Target Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
OutputEqPreCursorTargetRx<i>	Rx output Pre-Cursor equalization code value. See Table 5-18	Property	RW	Enc.	4
OutputEqPostCursorTargetRx<i>	Rx output Post-Cursor equalization code value. See Table 5-18	Property	RW	Enc.	4

5.10 Rx Output Amplitude Target VCS Parameter

This VCS Parameter is used to advertise the Rx Output Amplitude Target field. This VCS Parameter is part of the CMIS base Rx Controls [1].

The Rx output amplitude is measured without Rx output equalization and defined at an appropriate test point defined by the relevant standard.

SCS<k>::OutputAmplitudeTargetRx<i> is a four-bit field for lane <i> to specify the Rx output signal level being in a particular amplitude range, with amplitude range encoding as described in Table 5-21.

In addition to including this parameter in the VCS Descriptor, the module advertises support of Rx output amplitude control in Page 01h byte 162 as specified in CMIS base, "Supported Configuration and Signal Integrity Controls Advertisement" section [1].

The module also advertises the maximum supported Rx output equalization values in Page 01h byte 153 as described in CMIS base, "Module Characteristics Advertisement" section [1].

Table 5-21 Rx Output Amplitude Codes

Code Value	Bit Pattern	Output Amplitude
0	0000b	100-400 mV (P-P)
1	0001b	300-600 mV (P-P)
2	0010b	400-800 mV (P-P)
3	0011b	600-1200 mV (P-P)
4-14	0100b-1110b	Reserved
15	1111b	Custom

Table 5-22 Rx Output Amplitude Target VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
OutputAmplitudeTargetRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	08h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Parameter Name	Attribute	Type	Definition	Value
	CodeValueMask	U16	Code Values supported per Table 5-21. Each bit corresponds to the code value. Bit = 1 indicates the value is supported.	

Table 5-23 Rx Output Amplitude Target Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
OutputAmplitudeTargetRx<i>	Rx output amplitude encoding See Table 5-21	Property	RW	Enc.	4

5.11 Tx Host-controlled Numeric Input Equalization VCS Parameter

This VCS Parameter is used to set a host-controlled target value for the Tx input equalizer.

This VCS Parameter allows for advertisement of all supported values by the module. This register value is numeric, which provides more flexibility than the CMIS base parameter in section 5.6.

SCS<k>::HostControlledInputEqTargetNumericTx<i> is a S8 control field for lane <i>. This field allows the host to specify a non-adaptive Tx input equalization target. See the appropriate analog specification for the meaning of the input equalization values.

Table 5-24 Tx Host-controlled Numeric Input Equalization VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
HostControlledInputEqTargetNumericTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	09h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	Min	S8	Minimum supported equalization target	
	Max	S8	Maximum supported equalization target	

Parameter Name	Attribute	Type	Definition	Value
	StepSize	Enc. 8 bits	Step size in dB: 00h: Reserved 01h: 0.25dB 02h: 0.5dB 03h: 1dB 04h: 2dB 05h-FFh: Reserved	

Table 5-25 Tx Host-controlled Numeric Input Equalization Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
HostControlledInputEqTargetNumericTx<i>	host-controlled input equalization target	Property	RW	S8	8

5.12 Rx Output Numeric Equalization Control VCS Parameter

This VCS Parameter is used to set the Rx output equalization.

This VCS Parameter allows for advertisement of a single Rx output equalization value unlike CMIS base parameter in section 5.9, for modules that do not provide independent control of pre/post-cursors.

SCS<k>::OutputEqTargetNumericRx<i> is a S8 control field for lane <i>. This field allows the host to specify the values for the Rx output equalizer target, in dB. See the appropriate analog specification for definition of a test point and the meaning of the output equalization values.

Table 5-26 Rx Output Equalization Target Numeric VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
OutputEqTargetNumericRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	0Ah
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	Min	S8	Minimum supported equalization target	
	Max	S8	Maximum supported equalization target	
	StepSize	Enc. 8 bits	Step size in dB: 00h: Reserved 01h: 0.25dB 02h: 0.5dB 03h: 1dB 04h: 2dB 05h-FFh: Reserved	

Table 5-27 Rx Output Equalization Target Numeric Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
OutputEqTargetNumericRx<i>	Host-controlled output equalization target	Property	RW	S8	8

5.13 Rx Output Precoding Enable VCS Parameter

This VCS Parameter is used to enable Rx output precoding per lane.

Table 5-28 Rx Output Precoding Enable VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
OutputPrecodingEnableRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	0Bh
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-29 Rx Output Precoding Enable Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
OutputPrecodingEnableRx<i>	When value =1, the Output precoding encoder is enabled.	Property	RW	Bool	1

5.14 Tx Input Precoding Enable VCS Parameter

This VCS Parameter is used to enable the Tx input precoding decoder.

Table 5-30 Tx Input Precoding Enable VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
InputPrecodingEnableTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	0Ch
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-31 Tx Input Precoding Enable Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
InputPrecodingEnableTx<i>	When value = 1, the input precoding decoder is enabled.	Property	RW	Bool	1

5.15 Rx Output Equalizer Pre/Post-Cursor VCS Parameter

This VCS Parameter sets the values for the Rx output equalizer pre/post-cursor (and main), in dB.

This VCS Parameter allows for advertisement of all supported pre/post-cursor values by the module. This register value is numeric, which provides more flexibility than the CMIS base parameter in section 5.9.

The output FIR taps are written in S8 notation and use the StepSize attribute advertised by the module to obtain the tap weight value. The supported pre/post-cursor range is -128 * StepSize to +127 * StepSize (for example -1.28 to +1.27 for StepSize = 0.01), as shown in Table 5-32. The output FIR taps are normalized to a sum of magnitude equal to 1 when the Staged VCS is applied, and the results are then reflected in the Active VCS. See the appropriate analog specification for definition of a test point and the meaning of the output equalization coefficients.

The example in Table 5-32 illustrates the output FIR taps calculation using S8 for the following tap values [C(-3), C(-2), C(-1), C(0), C(1)] = [-0.02, 0.06, -0.14, 0.75, 0.03].

Table 5-32 Rx Output FIR tap weight calculation example

FIR tap	OutputEqPrePostCursorCoeffRx<i>	StepSize	Tap weight = S8 Value * StepSize
$C_{(-3)}$	1111 1110b	0.01	-0.02
$C_{(-2)}$	0000 0110b	0.01	0.06
$C_{(-1)}$	1111 0010b	0.01	-0.14
$C_{(0)}$	0100 1011b	0.01	0.75
$C_{(1)}$	0000 0011b	0.01	0.03

Table 5-33 Rx Output Equalizer Pre/Post-Cursor Target VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
OutputEqPrePostCursorCoeffRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	0Dh
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	

Parameter Name	Attribute	Type	Definition	Value
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	PrePostCursorIndex	S8	Indicates the coefficient for which the settings apply. C(value)	
	Max	S8	Max pre/post-cursor value	
	Min	S8	Min pre/post-cursor value	
	StepSize	Enc. 8 bits	Step size: 00h: 0.01 01h: 0.02 02h: 0.025 03h: 0.04 04h-FFh: Reserved	

Table 5-34 Rx Output Equalizer Pre/Post-Cursor Target Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
OutputEqPrePostCursorCoeffRx<i>	Pre/Post-Cursor Tap value in S8. Actual tap weight to be calculated as shown in Table 5-32.	Property	RW	S8	8

5.16 Rx Output Fine Amplitude Setting VCS Parameter

This VCS Parameter sets the values for the Rx output amplitude setting.

This VCS Parameter has a finer resolution than the CMIS base [1] Parameter described in section 5.10.

The Rx output amplitude is measured without Rx output equalization and defined at an appropriate test point defined by the relevant standard.

SCS<k>::OutputAmplitudeTargetRx<i> is a four-bit field for lane <i> that indicates that the Rx output signal level should target a particular amplitude range encoding as described in Table 5-35. See the appropriate analog specification for definition of a test point and the meaning of output amplitude and P-P.

The module also advertises support of Rx output amplitude control and maximum supported Rx output amplitudes in Page 01h byte 153 as specified in CMIS base [1].

Table 5-35 Rx Output Fine Amplitude Codes

Code Value	Bit Pattern	Output Amplitude
0	0000b	250 mV (P-P)
1	0001b	300 mV (P-P)
2	0010b	350 mV (P-P)
3	0011b	400 mV (P-P)
4	0100b	450 mV (P-P)
5	0101b	500 mV (P-P)
6	0110b	550 mV (P-P)
7	0111b	600 mV (P-P)
8	1000b	650 mV (P-P)
9	1001b	700 mV (P-P)
10	1010b	750 mV (P-P)
11	1011b	800 mV (P-P)
12	1100b	850 mV (P-P)
13	1101b	900 mV (P-P)
14	1110b	950 mV (P-P)
15	1111b	1000 mV (P-P)

Table 5-36 Rx Output Fine Amplitude Setting VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
OutputAmplitudeSettingRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	0Eh
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	CodeValueMask	U16	Code Values supported per Table 5-35. Each bit corresponds to the code value. Bit = 1 indicates that the value is supported.	

Table 5-37 Rx Output Fine Amplitude Setting Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
OutputAmplitudeSettingRx<i>	Rx output amplitude encoding See Table 5-35	Property	RW	U8	4

5.17 Rx Host Channel Loss VCS Parameter

This VCS Parameter allows the host to provide the module with channel loss information between the module electrical output and the destination.

This HostChannelLossRx<i> value is used by the module to set its Rx electrical output equalization values when ExplicitControl of the corresponding VCS Parameter is clear (module ownership). If Explicit control is set on its Rx electrical output equalization VCS Parameters (host ownership), this HostChannelLossRx<i> value is ignored by the module. See sections 5.9, 5.10, 5.12, 5.15, and 5.16 for applicable VCS parameters.

Table 5-38 Rx Host Channel Loss Value VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
HostChannelLossRx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	0Fh
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-39 Rx Host Channel Loss Value Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
HostChannelLossRx<i>	Host provides channels loss value in dB. A value of 0 indicates the module should ignore this parameter.	Property	RW	U8	8

5.18 Tx Host Channel Loss VCS Parameter

This VCS Parameter enables the host to provide the module with channel loss information of the host electrical channel.

This HostChannelLossTx<i> value is used by the module to set its Tx electrical input equalization values when ExplicitControl of the corresponding VCS Parameter is clear (module ownership). If Explicit control is set on its Tx electrical input equalization VCS Parameters (host ownership), this HostChannelLossRx<i> value is ignored by the module. (See section 5.6 for the applicable VCS parameter).

Table 5-40 Tx Host Channel Loss Value VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
HostChannelLossTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	10h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-41 Tx Host Channel Loss Value Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
HostChannelLossTx<i>	Host provides channels loss value in dB. A value of 0 indicates the module should ignore this parameter.	Property	RW	U8	8

5.19 Tx Non-Linear Compensation (Read-Only)

This VCS Parameter allows the module to specify a fixed (non-adaptive) Tx Non-Linear Compensation (NLC) target to be used by the host. This value is ignored by the host if NLC is not implemented. This NLC VCS Parameter value is set by the module and the host cannot modify it. Thus, it is a Read-Only VCS Parameter and must appear in the Active Control Set memory space only (not in the Staged Control Set memory space), after all the read-write Parameters.

The VCS Parameter Descriptor is used by the module to advertise support for Tx NLC, as shown in Table 5-42. The VCS Parameter contains two bytes per lane for the module's upper eye compensation, NLCupp (%), and lower eye compensation, NLClow (%), respectively, where the percentages can be both negative and positive to allow for eye compression and expansion with respect to the center eye, as shown in Table 5-43. A positive percentage in either NLCupp or NLClow represents an eye expansion (bigger eye). A negative percentage in either NLCupp or NLClow represents an eye compression (smaller eye).

Figure 5-2 shows an example of a neutral case with no NLC compensation. Figure 5-3 shows an example with module requested NLC compensation (outer eye expansion), which a host may act upon if it has the capability, and Figure 5-4 show an example with lower eye expansion and upper eye compression as requested by the modem.

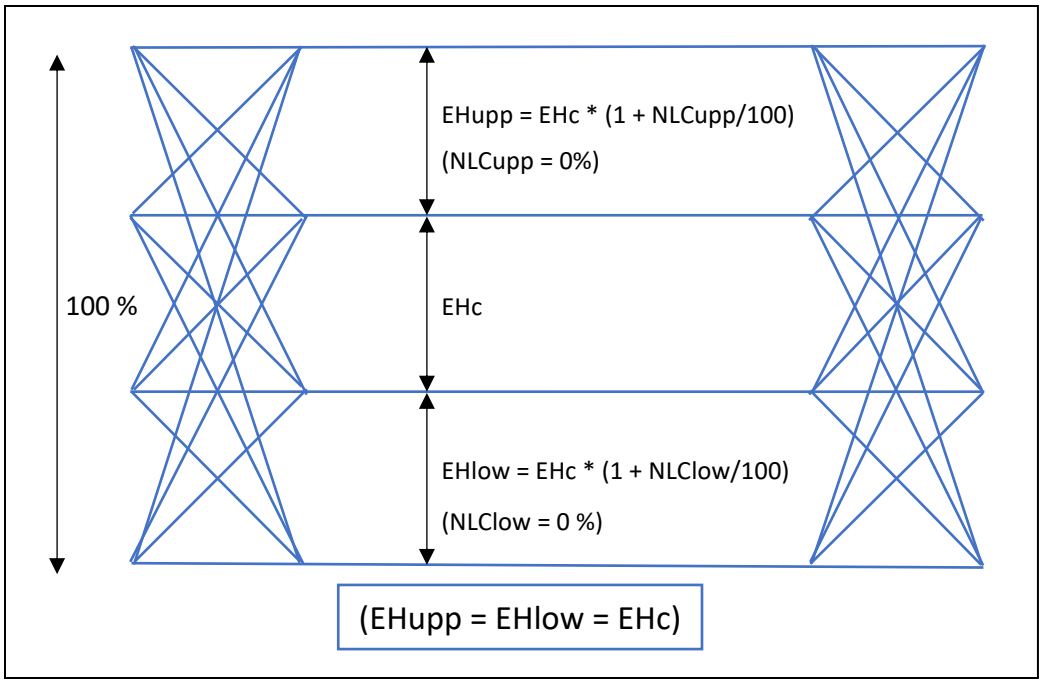

Figure 5-2 Example of No NCL compensation requested by the module

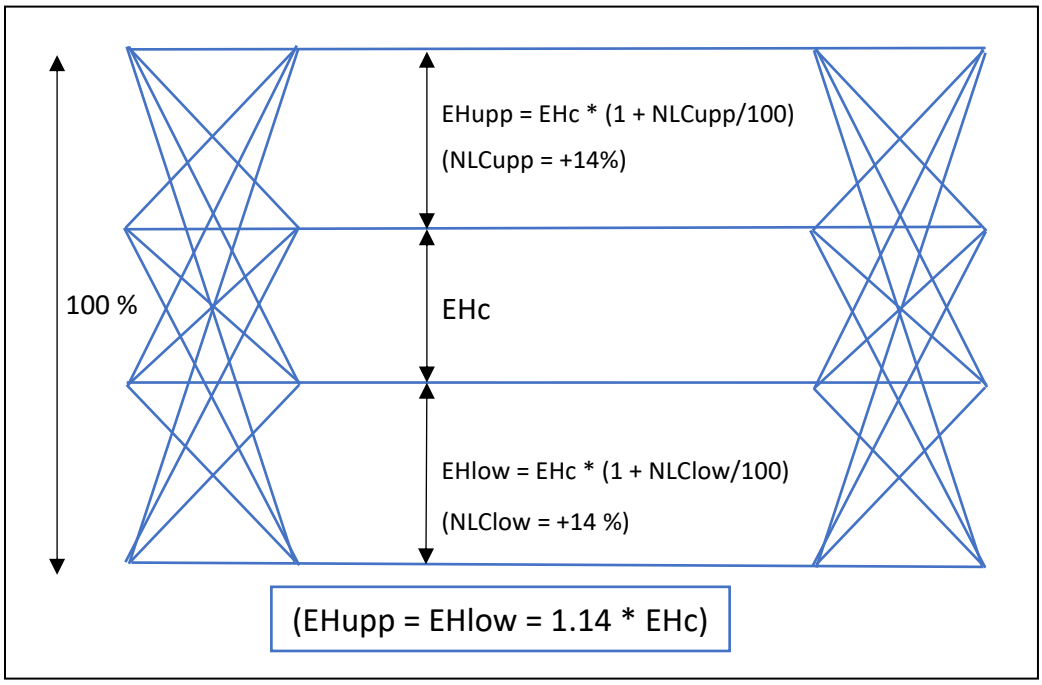

Figure 5-3 Example of outer eye expansion of 14% as requested by the module

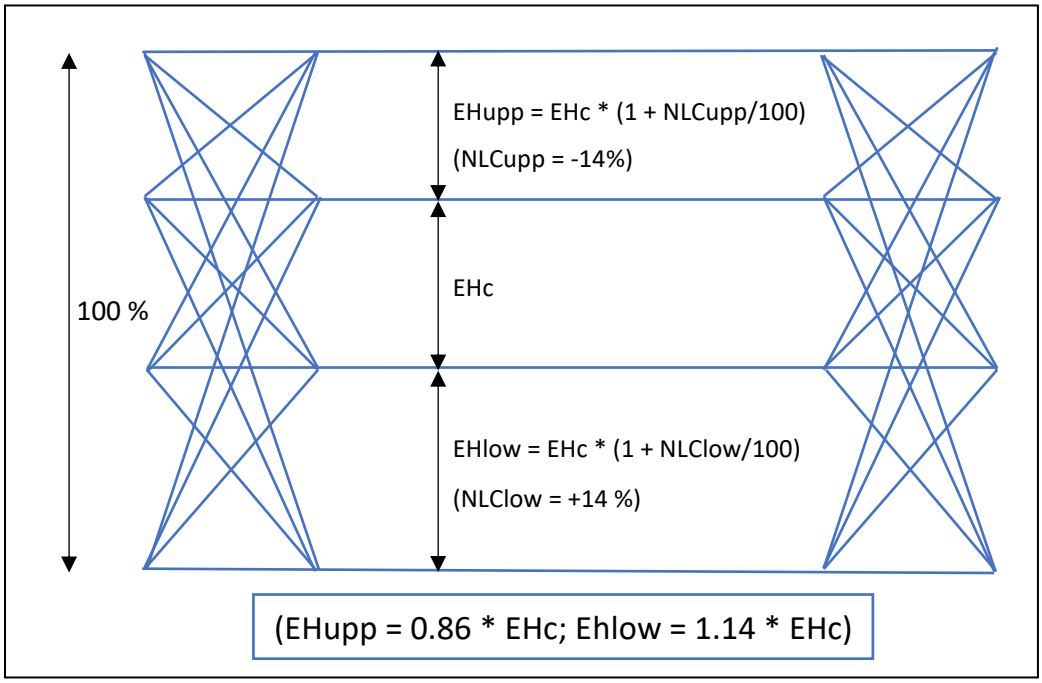

Figure 5-4 Example of Upper eye compression by 14% and lower eye expansion by 14%

ACS::FixedNLCuppTargetTx<i> and ACS::FixedNLClowTargetTx<i> is an S8 control field per lane indicating the percentage of adjustment (either expansion or compression) requested by the module for the outer eyes (See Table 5-43). A host that supports NLC may have a range of adjustment that is less than the module requests, if the module requests for a stronger setting than the host can support, it is expected that the host will use its nearest setting.

It is expected that in typical CEI-112G-Linear applications, the module transmitter NLCupp and NLClow values will be static and provided to the host as a non-changing parameter. However, dynamically changing values provided by the module, perhaps as a function of temperature, are not explicitly excluded but outside the scope of this document.

Table 5-42 Tx Non-Linear Compensation VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
NonLinearCompensationTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	11h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	

Table 5-43 Tx Non-Linear Compensation Register Format

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
FixedNLCuppTargetTx<i>	The module requested NLC upper eye compensation value in %	Property	RO	S8	8
FixedNLClowTargetTx<i>	The module requested NLC lower eye compensation value in %.	Property	RO	S8	8

5.20 Tx Input Pre-Equalizer Pre/Post-Cursor VCS Parameter (Read-Only)

This VCS Parameter advertises the target values for the Tx input pre-equalizer pre/post-cursor (and main), in dB. This Pre-Equalizer Pre/Post-Cursor VCS Parameter value is set by the module and the host cannot modify it. Thus, it is a Read-Only VCS Parameter and must appear in the Active Control Set memory space only (not in the Staged Control Set memory space), after all the Read-Write Parameters.

This VCS Parameter allows for advertisement of target pre/post-cursor values to the host for optimal pre-equalization of the module's forward channel (TP1 to TP2) electro-optical impairments. These values can be combined by the host with its own output channel (TP0 to TP1) pre-equalization targets. This VCS parameter can be used by the host independently, or in conjunction with other advertised VCS Parameters. See the appropriate analog specification for definition of test points and the meaning of the equalization coefficients.

The pre-equalizer FIR taps are written in S8 notation and use the StepSize attribute advertised by the module to obtain the tap weight value. The supported pre/post-cursor range is -128 * StepSize to +127 * StepSize (for example -1.28 to +1.27 for StepSize = 0.01), as shown in Table 5-44. The output FIR taps are normalized to a sum of magnitude equal to 1 when the Staged VCS is applied, and the results are then reflected in the Active VCS.

The example in Table 5-44 illustrates the pre-equalizer FIR taps calculation using S8 for the following tap values [C(-3), C(-2), C(-1), C(0), C(1)] = [-0.02, 0.06, -0.14, 0.75, 0.03].

Table 5-44 Tx Input Pre-Equalizer FIR tap weight calculation example

FIR tap	InputEqPrePostCursorCoeffTx<i>	StepSize	Tap weight = S8 Value * StepSize
$C_{(-3)}$	1111 1110b	0.01	-0.02
$C_{(-2)}$	0000 0110b	0.01	0.06
$C_{(-1)}$	1111 0010b	0.01	-0.14
$C_{(0)}$	0100 1011b	0.01	0.75
$C_{(1)}$	0000 0011b	0.01	0.03

Table 5-45 Tx Input Pre-Equalizer Pre/Post-Cursor Target VCS Parameter Descriptor

Parameter Name	Attribute	Type	Definition	Value
InputEqPrePostCursorCoeffTx	VCS Parameter ID	U8	Versatile Control Set Parameter ID	12h
	VCS Parameter Length	U8	Length in bytes of this VCS Parameter Descriptor, including the VCS Parameter ID field, this VCS Parameter Length field, and all other attributes.	

Parameter Name	Attribute	Type	Definition	Value
	ApplicationMask	Ux	Each bit of ApplicationMask corresponds to the Nth AppSel (bit 0 = AppSel 1) Size is rounded up to the next byte.	
	MemoryLength	U8	Length in bytes that this VCS parameter will occupy in the Control Set memory space.	
	PrePostCursorIndex	S8	Indicates the coefficient for which the settings apply. C(value)	
	StepSize	Enc. 8 bits	Step size in dB: 00h: 0.01 01h: 0.02 02h: 0.025 03h: 0.04 04h-FFh: Reserved	

1 **Table 5-46 Tx Input Pre-Equalizer Pre/Post-Cursor Target Register Format**

Parameter Name	Description	Field Type	Access	Data Type	Size (bits per lane)
InputEqPrePostCursorCoeffTx<i>	Pre/Post-Cursor Tap value in S8. Actual tap weight to be calculated as shown in Table 5-44.	Property	RO	S8	8

2

6 CDB Commands for CMIS-VCS

The VCS is a sequence of VCS Parameters and is queried via CDB messaging. As defined in CMIS base [1], CDB is an optional feature for command-reply message exchange between host and module. Refer to the "Command Data Block (CDB) Message Communication" section in the CMIS base [1] for CDB messaging/reply protocol details.

In CMIS 5.3 [1], a new CMD ID has been added to the CDB Features and Capabilities Inquiry Commands space to indicate that the module supports VCS (see Table 6-1)

Table 6-1 CDB Features and Capabilities Inquiry Commands

ID	Command Title	Description	Type	Section
0045h	Externally Defined Features	Identify which CMIS supplement specifications that define CDB messages in a dedicated part of the restricted CMD ID space from 4000h to 40FFh are supported	Adv.	6.2

Table 6-2 shows the supported VCS CDB command group, which the host can use to query the VCS Descriptors. CMIS-VCS uses a specific command group ID in the range 4000h to 40FFh. See the CMIS base "CDB Command Group Summary" section [1] for a complete list of available CDB command groups.

The first CDB command is used to query the overview of the VCS Descriptor (CMD ID 4000h). This command includes the VCS version, the length of the ApplicationMask, CMIS base [1] compatibility and overflow page indicators. For details of this command see section 6.3.

The CDB Command (CMD ID 4001h) consists of the read-write VCS Descriptor as a sequence of VCS Parameters Descriptors. These parameters populate the Stage and Active Control Set memory space with the same register offsets in all Control Sets. For details of this command. See section 6.4.

The CDB Command (CMD ID 4002h) consists of the read-only VCS Descriptor as a sequence of VCS Parameters Descriptors. These parameters only populate the Active Control Set memory space and appear after the read-write parameters in the memory space. For details of this command. See section 6.4.

The CMD ID 4003h is reserved for custom, vendor-defined VCS Descriptors. For details of this command see section 6.5.

The remaining CMD IDs in the VCS command group are reserved for future use. *Note, the LPL space in the VCS Descriptor Commands in this version is sufficient to support the VCS parameters defined in this revision of the document. If the number of parameters grows in a way that could require more advertisement space in the future, the changes to accommodate the space will be made in future specification versions.*

Table 6-2 VCS CDB Command Overview

ID	Command Title	Description	Type	Section
4000h	VCS Descriptor overview	Returns details of the VCS Descriptor	Rqd.	6.3

ID	Command Title	Description	Type	Section
4001h	Read-Write VCS Descriptor Command	VCS Descriptor consisting of a sequence of Read-Write VCS Parameter Descriptors (TLV encoded) – These parameters populate the Stage and Active Control Set memory space.	Adv.	6.4
4002h	Read-Only VCS Descriptor Command	VCS Descriptor consisting of a sequence of VCS Parameter Descriptors (TLV encoded) - These parameters will populate the Active Control Set memory space only and appear after the Read-write parameters in the memory space.	Adv.	6.5
4003h	Custom VCS Descriptor	Reserved for custom vendor-specific VCS Descriptors	Adv.	6.6
4004h-40FFh	-	**Reserved**		

1
2

6.1 CMIS-VCS CDB command VCS Parameter TLV Encoding

The CMIS-VCS CDB command contains the Parameter ID, Length and Attributes of each VCS Parameter in a TLV encoded stream. By decoding the TLV stream, implementers can use one CDB command to construct the entire VCS space. The VCS Parameter TLV encoding is depicted in Figure 6-1.

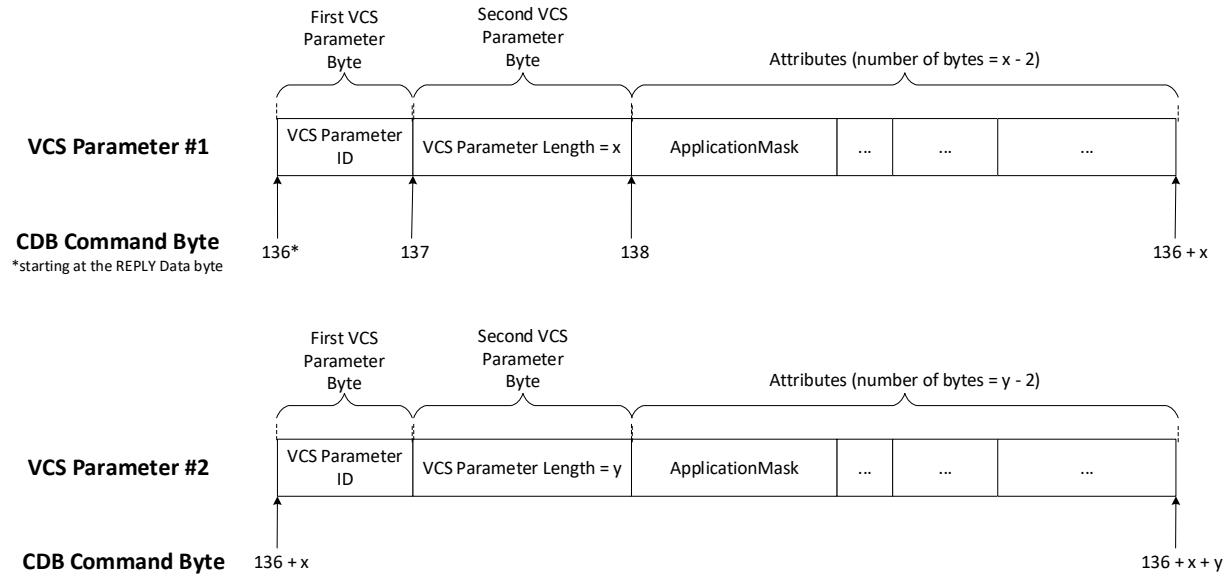

Figure 6-1 VCS Parameter TLV Encoding

6.2 CMD 0045h: Externally Defined Features Command

Table 6-3 CDB Command 0045h: Externally Defined Features Command

Page	Byte	Field Name	Description	Value
CMD Header Fields				
9Fh	128-129	CMDID	Externally Defined Features CMD ID	0045h
9Fh	130-131	EPLLength	EPL is not used	0000h
9Fh	132	LPLLength	LPL is not used	00h
9Fh	133	CdbChkCode	Check Code over 9Fh:128-132 and LPL. (see CMIS base [1] CDB command message header)	
9Fh	134	RPLLength	Note: Initiator may fill those reply fields, to later verify field updates by the target in the reply. (see CMIS base [1] CDB command message header)	Undef.
9Fh	135	RPLChkCode		Undef
CMD Data (LPL)				
9fh	136-255	-	Reserved	
REPLY Status				
00h	8.6 or 8.7	CdbCmdCompleteFlag	Set by module when the CDB command in complete	1
00h	37 or 38	CdbStatus	**On Success** 00 000001b: Success **On Failure** 01 000000b: Failed, no specific failure 01 000101b: CdbChkCode error	
REPLY Header and Data (LPL)				
9Fh	134	RPLLength	see CMIS base [1] CDB command message header	1
9Fh	135	RPLChkCode	See CMIS base [1] CDB command message header	Comp.
9Fh	136.0	VCS Support (CMDs 4000h-40FFh supported)	Value of 1 indicates the module supports VCS. Value of 0 indicates VCS is not supported.	
9Fh	137-255	-	Content not specified	

6.3 CMD 4000h: VCS Overview Command

Table 6-4 CDB Command 4000h: VCS Overview Command

Page	Byte	Field Name	Description	Value
CMD Header Fields				
9Fh	128-129	CMDID	VCS Overview CMD ID	4000h
9Fh	130-131	EPLLength	EPL is not used	0000h
9Fh	132	LPLLength	LPL is not used	00h
9Fh	133	CdbChkCode	Check Code over 9Fh:128-132 and LPL. (see CMIS base [1] CDB command message header)	
9Fh	134	RPLLength	Note: Initiator may fill those reply fields, to later verify field updates by the target in the reply. (see CMIS base [1] CDB command message header)	Undef.
9Fh	135	RPLChkCode		Undef
CMD Data (LPL)				
9fh	136-255	-	Reserved	
REPLY Status				
00h	8.6 or 8.7	CdbCmdCompleteFlag	Set by module when the CDB command in complete	1
00h	37 or 38	CdbStatus	**On Success** 00 000001b: Success **On Failure** 01 000000b: Failed, no specific failure 01 000101b: CdbChkCode error	
REPLY Header and Data (LPL)				
9Fh	134	RPLLength	See CMIS base [1] CDB command message header	4
9Fh	135	RPLChkCode	See CMIS base [1] CDB command message header	Comp.
9Fh	136	VCS version	The upper nibble (bits 7-4) is the integer part (major number). The lower nibble (bits 3-0) is the decimal part (minor number). Example: 01h indicates version 0.1, 21h indicates version 2.1.	
9Fh	137	ApplicationMask Length	U8 – ApplicationMask length in bytes (number of supported AppSel rounded up to the next byte)	

Page	Byte	Field Name	Description	Value
9Fh	138.0	CMIS base [1] compatible	0b = Not CMIS base compatible. (Staged and Active VCS spaces will not match CMIS base [1] Staged and Active Control Set register space) 1b = module is CMIS base compatible (SI settings not supported are marked as not used)	
9Fh	139.0	Overflow page support	Indicates whether CS overflow pages are required. See section 4.4. 1b = Indicates overflow pages are required.	
9Fh	140.0	Read-only VCS Parameter support	Indicates whether the module supports read-only VCS Parameters (use CMD ID 4002h to obtain the read-only VCS Descriptor. See 6.5). 1b = Indicates read-only VCS Parameters are supported.	
9Fh	141-255	-	Content not specified	

1

6.4 CMD 4001h: Read-Write VCS Descriptor Command

Table 6-5 CDB Command 4001h: Read-Write VCS Descriptor Command

Page	Byte	Field Name	Description	Value
CMD Header Fields				
9Fh	128-129	CMDID	Get VCS Descriptor (List of VCS Parameter Descriptors) CMD ID	4001h
9Fh	130-131	EPLLength	EPL is not used	0000h
9Fh	132	LPLLength	LPL is not used	00h
9Fh	133	CdbChkCode	Check Code over 9Fh:128-132 and LPL. (see CMIS base [1] CDB command message header)	
9Fh	134	RPLLength	Note: Initiator may fill those reply fields, to later verify field updates by the target in the reply. (see CMIS base [1] CDB command message header)	Undef.
9Fh	135	RPLChkCode		Undef
CMD Data (LPL)				
9fh	136-255	-	Reserved	
REPLY Status				
00h	8.6 or 8.7	CdbCmdCompleteFlag	Set by module when the CDB command in complete	1
00h	37 or 38	CdbStatus	**On Success** 00 000001b: Success **On Failure** 01 000000b: Failed, no specific failure 01 000101b: CdbChkCode error	
REPLY Header and Data (LPL)				
9Fh	134	RPLLength	See CMIS base [1] CDB command message header	Comp.
9Fh	135	RPLChkCode	See CMIS base [1] CDB command message header	Comp.
9Fh	136-255	VCS content	Sequence of VCS Parameters as TLV encoded streams. See section 6.1	

6.5 CMD 4002h: Read-Only VCS Descriptor Command

Table 6-6 CDB Command 4002h: Read-Only VCS Descriptor Command

Page	Byte	Field Name	Description	Value
CMD Header Fields				
9Fh	128-129	CMDID	Get VCS Descriptor (List of VCS Parameter Descriptors) CMD ID	4002h
9Fh	130-131	EPLLength	EPL is not used	0000h
9Fh	132	LPLLength	LPL is not used	00h
9Fh	133	CdbChkCode	Check Code over 9Fh:128-132 and LPL. (see CMIS base [1] CDB command message header)	
9Fh	134	RPLLength	Note: Initiator may fill those reply fields, to later verify field updates by the target in the reply. (see CMIS base [1] CDB command message header)	Undef.
9Fh	135	RPLChkCode		Undef
CMD Data (LPL)				
9fh	136-255	-	Reserved	
REPLY Status				
00h	8.6 or 8.7	CdbCmdCompleteFlag	Set by module when the CDB command in complete	1
00h	37 or 38	CdbStatus	**On Success** 00 000001b: Success **On Failure** 01 000000b: Failed, no specific failure 01 000101b: CdbChkCode error	
REPLY Header and Data (LPL)				
9Fh	134	RPLLength	See CMIS base [1] CDB command message header	Comp.
9Fh	135	RPLChkCode	See CMIS base [1] CDB command message header	Comp.
9Fh	136-255	VCS content	Sequence of VCS Parameters as TLV encoded streams. See section 6.1	

6.6 CMD 4003h: Custom VCS Descriptor Command

Table 6-7 CDB Command 4003h: Custom VCS Descriptor Command

Page	Byte	Field Name	Description	Value
CMD Header Fields				
9Fh	128-129	CMDID	Custom VCS Descriptor CMD ID	4003h
9Fh	130-131	EPLLength	EPL is not used	0000h
9Fh	132	LPLLength	LPL is not used	00h
9Fh	133	CdbChkCode	Check Code over 9Fh:128-132 and LPL. (see CMIS base [1] CDB command message header)	
9Fh	134	RPLLength	Note: Initiator may fill those reply fields, to later verify field updates by the target in the reply. (see CMIS base [1] CDB command message header)	Undef.
9Fh	135	RPLChkCode		Undef
CMD Data (LPL)				
9fh	136-255	-	Reserved	
REPLY Status				
00h	8.6 or 8.7	CdbCmdCompleteFlag	Set by module when the CDB command in complete	1
00h	37 or 38	CdbStatus	**On Success** 00 000001b: Success **On Failure** 01 000000b: Failed, no specific failure 01 000101b: CdbChkCode error	
REPLY Header and Data (LPL)				
9Fh	134	RPLLength	See CMIS base [1] CDB command message header	Comp.
9Fh	135	RPLChkCode	See CMIS base [1] CDB command message header	Comp.
9Fh	136-255	VCS content	Sequence of VCS Parameters as TLV encoded streams. See Section 6.1	

7 References

7.1 Sources

[1] Common Management Interface Specification (CMIS) Rev 5.3 (OIF-CMIS-05.3 2024)

Appendix A Example CMIS base compatible VCS space

This example is a QSFPDD Ethernet module. Not shown here, the advertisement of AppSel returned 4. The AppSel1= 400GAUI-2-S, AppSel2 = 400GAUI-2-L, AppSel3 = 200GAUI-4, AppSel4 = CAUI-4. Also not shown here, the VCS Overview CDB Command (Section 6.3) returned an ApplicationMask Length of 1 byte (4 bits needed for 4 AppSel codes).

This is an example of a CMIS base [1] compatible VCS space as received in the module's Read-Write VCS Descriptor CDB command reply (Section 6.4). In this example, the module has advertised 8 VCS Parameters as mandated by CMIS-VCS (to keep compliance with CMIS base Control Set memory map [1]).

This VCS space produces a memory map that is compatible with CMIS base [1], as seen in Table A-2.

The fields that are not supported by the module in this example are advertised with VCS Parameter ID = 00h (ReservedSpaceIndicator VCS Parameter per section 5.2).

Table A-1 Example VCS Descriptor with 8 VCS Parameters (CMIS base compatible)

Read-Write VCS Descriptor CDB Command reply	Attribute	Value	Comment
VCS Parameter #1	ID	02h	AdaptiveInputEqEnableTx VCS Parameter
	Length	03h	
	ApplicationMask	0Fh	Applies to all AppSels
	MemoryLength	01h	One byte in the Control Set memory Space
VCS Parameter #2	ID	00h	AdaptiveInputEqRecallTx field, not supported. Using ReservedSpaceIndicator VCS Parameter
	Length	04h	
	ApplicationMask	xxh	This attribute is ignored. Value is don't care.
	ReservedLength	02h	AdaptiveInputEqRecallTx would have consumed 2 bytes
VCS Parameter #3	ID	04h	HostControlledInputEqTargetTx VCS Parameter
	Length	05h	
	ApplicationMask	08h	Applies to CAUI-4 AppSel only
	MemoryLength	04h	Four bytes in the Control Set memory Space
	CodeValueMask	0004h	3rd bit of the mask indicates Code Value = 3 (3dB)
VCS Parameter #4	ID	00h	CDREnableTx field, not supported. Using ReservedSpacedIndicator VCS Parameter
	Length	04h	

Read-Write VCS Descriptor CDB Command reply	Attribute	Value	Comment
	ApplicationMask	xxh	This attribute is ignored. Value is don't care.
	ReservedLength	01h	CDREnableTx would have consumed 1 byte
VCS Parameter #5	ID	00h	CDREnableRx field, not supported. Using ReservedSpacedIndicator VCS Parameter
	Length	04h	
	ApplicationMask	xxh	This attribute is ignored. Value is don't care.
	ReservedLength	01h	CDREnableRx would have consumed 1 byte
VCS Parameter #6	ID	07h	OutputEqPrePostCursorTargetRx VCS Parameter
	Length	06h	
	ApplicationMask	0Fh	Applies to all AppSels
	MemoryLength	04h	Four bytes in the Control Set memory Space
	PrePostCursorIndex	FFh	Pre-cursor C-1
	CodeValueMask	0002h	2nd bit of the mask indicates Code Value = 2 (2dB)
VCS Parameter #7	ID	07h	OutputEqPrePostCursorTargetRx VCS Parameter
	Length	06h	
	ApplicationMask	0Fh	Applies to all AppSels
	MemoryLength	04h	Four bytes in the Control Set memory Space
	PrePostCursorIndex	01h	Post-cursor C+1
	CodeValueMask	0004h	3rd bit of the mask indicates Code Value = 3 (3dB)
VCS Parameter #8	ID	08h	OutputAmplitudeTargetRx VCS Parameter
	Length	05h	
	ApplicationMask	0Fh	Applies to all AppSels
	MemoryLength	04h	Four bytes in the Control Set memory Space
	CodeValueMask	0007h	Supports Code Values 0, 1, and 2 but not 3

Table A-2 Resulting Staged Control Set memory space (CMIS base compatible)

Staged Control Set (Page 10h) Byte	Register Description
153	AdaptiveInputEqEnableTx<i>
154	**Reserved**
155	**Reserved**
156	HostControlledInputEqTargetTx<i>
157	
158	
159	
160	**Reserved**
161	**Reserved**
162	OutputEqPreCursorTargetRx<i>
163	
164	
165	
166	OutputEqPostCursorTargetRx<i>
167	
168	
169	
170	OutputAmplitudeTargetRx<i>
171	
172	
173	

Appendix B Example VCS space (not CMIS base compatible)

This is an example of a CMIS-VCS compliant module that is not CMIS base [1] compatible. It advertises only the VCS Parameters it needs and uses the VCS Explicit Control per Field Pseudo-VCS Parameter. The values are mapped to the Staged Control Set memory map in order of advertisement.

In this example, there is only one AppSel for a Linear Active module (AppSel = 1). Not shown here, the VCS Overview CDB Command (Section 6.3) returned an ApplicationMask Length of 1 byte (1 bit needed for 1 AppSel code).

In this example, the module's read-write VCS Descriptor CDB command reply (Section 6.4) has advertised 3 VCS Parameters, and the module's read-only VCS Descriptor CDB command reply (Section 6.5) has advertised 2 VCS read-only parameters.

This VCS space produces a memory map as seen in Table B-3, Table B-4, and Table B-5.

Table B-1 Example read-write VCS Descriptor with 3 read-write VCS Parameters (NOT CMIS base compatible)

Read-write VCS Descriptor CDB Command reply	Attribute	Value	Comment
VCS Parameter #1	ID	01h	ExplicitControlPerParam VCS Parameter
	Length	04h	
	ApplicationMask	01h	Applies to the only AppSel
	MemoryLength	01h	One byte in the Control Set memory Space
	ExplicitControlPerParamMask	01h	1 byte for explicit control field. EC only for the first VCS Parameter (VCS Parameter ID 04h)
VCS Parameter #2	VCS Parameter.ID	04h	HostControlledInputEqTargetTx VCS Parameter
	Length	05h	
	ApplicationMask	01h	Applies to the only AppSel
	MemoryLength	04h	Four bytes in the Control Set memory Space
	CodeValueMask	0002h	2nd bit of the mask indicates Code Value = 2 (2dB)
VCS Parameter #3	ID	09h	HostControlledInputEqTargetNumericTx VCS Parameter
	Length	04h	

Read-write VCS Descriptor CDB Command reply	Attribute	Value	Comment
	ApplicationMask	01h	Applies to the only AppSel
	MemoryLength	04h	Four bytes in the Control Set memory Space
	CodeValueMask	0002h	Code Value 2 = 2dB

Table B-2 Example Read-only VCS Descriptor with 2 read-only VCS Parameters (NOT CMIS base compatible)

Read-only VCS Descriptor CDB Command reply	Attribute	Value	Comment
VCS Parameter #1	ID	11h	NonLinearCompensationTx VCS Parameter
	Length	03h	
	ApplicationMask	01h	Applies to the only AppSel
	MemoryLength	10h	Sixteen bytes in the Control Set memory Space
VCS Parameter #2	ID	12h	InputEqPrePostCursorCoeffTx VCS Parameter
	Length	05h	
	ApplicationMask	01h	Applies to the only AppSel
	MemoryLength	08h	Eight bytes in the Control Set memory Space
	PrePostCursorIndex	FFh	Pre-cursor C-1
	StepSize	00h	StepSize=0.01dB

Table B-3 Resulting Staged Control Set memory space (NOT CMIS base compatible)

Staged Control Set (Page 10h) Byte	Register Description
153	ExplicitControlPerParam<i>
154	HostControlledInputEqTargetTx<i>
155	
156	
157	
158	HostControlledInputEqTargetNumericTx<i>
159	
160	

Staged Control Set (Page 10h) Byte	Register Description
161	

Table B-4 Resulting Active Control Set memory space (NOT CMIS base compatible)

Active Control Set (Page 11h) Byte	Register Description
214	ExplicitControlPerParam<i>
215	HostControlledInputEqTargetTx<i>
216	
217	
218	
219	HostControlledInputEqTargetNumericTx<i>
220	
221	
222	
223	FixedNLCuppTargetTx<i>
224	
225	
226	
227	
228	
229	
230	

Note: The defined Active Control Set memory location in CMIS base page 10h (See "Provisioned Tx and Rx Signal Integrity Settings") [1] is too small for the advertised read-only VCS parameters. 4 Bytes remain free. However, the next VCS parameter requires 8 bytes which means it must start in the overflow page to not cause VCS Parameter fragmentation (See section 4.4). Since the overflow pages are needed, this must be indicated by the module in the VCS Overview Command CDB reply (See section 6.3)

Table B-5 Resulting Overflow Active Control Set memory space (NOT CMIS base compatible)

Active Overflow Control Set (Page 19h) Byte	Register Description
152	FixedNLClowTargetTx<i>
153	
154	

Active Overflow Control Set (Page 19h) Byte	Register Description
155	
156	
157	
158	
159	
160	InputEqPrePostCursorCoeffTx<i>
161	
162	
163	
164	
165	
166	
167	

1
2

Appendix C OIF member companies at time of approval

Accelight Technologies, Inc.
Accton Technology Corporation
Adtran Networks SE
Advanced Fiber Resources (AFR)
Advanced Micro Devices, Inc.
AIO Core Co., Ltd
Alibaba
Alphawave Semi
Amazon
Amphenol Corp.
Anritsu
Applied Optoelectronics, Inc.
Arista Networks
Astera Labs
ATOP Corporation
BitifEye Digital Test Solutions GmbH
BizLink Technology, Inc.
Broadcom Inc.
Cadence Design Systems
Casela Technologies USA
Celestica
China Telecom
CICT
Ciena Corporation
Cisco Systems
Coherent
ColorChip LTD
Cornelis
Corning
Dai Nippon Printing Co., Ltd.
Dell, Inc.
Dexerials Corporation
DustPhotonics
EFFECT Photonics B.V.
Eoptolink Technology
Epson Electronics America, Inc.
Ericsson
EXFO
Foxconn Interconnect Technology Ltd
Fujikura
Fujitsu
Furukawa Electric Co., Ltd.
Global Foundries
Google
H3C Technologies Co., Ltd.
Hakusan Inc
Hewlett Packard Enterprise (HPE)
HGGenuine Optics Tech Company
Hirose Electric Co. Ltd.
Hisense Broadband Multimedia Technologies Co., LTD
Huawei Technologies Co., Ltd.
Infinera Corporation
InfiniLink
Integrated Device Technology
Intel
Juniper Networks
Kandou Bus
KDDI Research, Inc.
Keysight Technologies, Inc.
KYOCERA Corporation

Lessengers Inc.

Lightmatter

Linktel Technologies Co., Ltd.

Lumentum

Lumiphase AG

LUXIC Technology Co

Luxshare Technologies International, Inc.

MACOM Technology Solutions

Marvell Semiconductor, Inc.

MaxLinear Inc.

MediaTek

Meta Platforms

Microchip Technology Incorporated

Microsoft Corporation

Mitsubishi Electric US, Inc.

Molex

Multilane Inc.

NEC Corporation

Nokia

NTT Corporation

Nubis Communications, Inc.

NVIDIA

O-Net Technologies (Shenzhen) Group Co., Limited

Omattrix Ltd Co

Omniva LLC

Optomind Inc.

Orange

PETRA

Point2 Technology

Precision Optical Technologies

Quantifi Photonics USA Inc.

Quintessent Inc.

Ranovus

Retym

Rosenberger Hochfrequenztechnik GmbH & Co. KG

Ruijie Networks Co., Ltd.

Samsung Electronics Co. Ltd.

Samtec Inc.

SCINTIL Photonics

Semtech Canada Corporation

Senko Advanced Components

SeriaLink Systems Ltd.

Sicoya GmbH

SiFotonics Technologies Inc.

Silith Technology

Socionext Inc.

Source Photonics, Inc.

Spirent Communications

Sumitomo Electric Industries, Ltd.

Sumitomo Osaka Cement

Synopsys, Inc.

TE Connectivity

Tektronix

Telefonica S.A.

TELUS Communications, Inc.

TeraHop US

Teramount

TeraSignal, LLC.

US Conec

Viavi Solutions Deutschland GmbH

Wilder Technologies, LLC

Wistron Corporation

Xphor Ltd.

ZTE Corporation

Yamaichi Electronics Ltd.

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