Intel® High Definition Audio Specification
Document Change Notification

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Change Identification:	**DCN No: HDA040-A**
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Title: Multi-stream over Single Display Port

Brief description of the functional changes:

This DCN provides a set of addition and changes to the HD Audio specification that defines how the Display Port 1.2 Specification for multi-streaming over single DP port capability is exposed and control for the Display Port Audio Codec.

Definition Text Formatting:

xxx	Original text in existing specification or DCN released earlier.
yyy	New text inserted by this new DCN.
~~zzz~~	Deleted text introduced by this new DCN.

New Definitions:

7.3.3.10 Power State

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Table 86. Persisted Settings across Resets and power states

Setting	Action across Dx state transitions or clock stopped	Action with Link or Function Group reset	Codec, Function Group or Widgets that it applies to
Codec physical address (SDI)	Persist across Dx states, unless the link has been reset, in which case the	Persist across Single and double FG reset but Link Reset will initiate a Codec	Codec

Setting	Action across Dx state transitions or clock stopped	Action with Link or Function Group reset	Codec, Function Group or Widgets that it applies to
	codec shall initiate a Codec Initialization sequence to acquire an address when the link re-initializes. Note that unless the codec has been moved to a different SDI line the controller shall supply the same address.	Initialization to acquire an address from the controller.	
Converter Format; All bits [15:0] e.g. Type, Base, Mult, Div, Bits Chan fields	Persist across Dx states	Reset by POR, persist across Link & FG resets	Input & Output Converters, Digital Converter
Converter Stream & Channel settings, all bits [7:0] e.g. Stream number in bits [7:4] and Lowest Channel number in bits [3:0]	Reset to Default; must not assume same stream is in operation across Dx state transitions and could cause spurious audio to be played if not reset.	Reset to default by all resets and does not set PS-SettingsReset to one (1)	Input & Output Converter, Digital Converter
Digital Converter Controls 1 &2, all bits	Persist across Dx states	Reset by POR, persist across Link & FG resets	Digital Converter
Connection Select Index values, all bits [7:0]	Persist across Dx states	Reset by POR, persist across Link & FG resets	Input converter, Selector and Pin Complex
Device Select Index values, bits [5:0]	Persist across Dx states	Reset by POR, persist across Link & FG resets	Digital Display Pin Complex

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7.3.3.14.1 Intrinsic Unsolicited Responses

Intrinsic unsolicited responses are generated as a result of asynchronous hardware events such as presence detect and hot plug (represented by ELD valid) events. These responses have a predefined sub tag of 0 and are enabled by the Unsolicited Responses Control verb.

The Unsolicited response for intrinsic events is defined as:

31:26	25:21	20:15	14:3	2	1	0
Tag	Sub Tag	DE	*Reserved*	IA	ELDV	PD

Figure 70. Intrinsic Unsolicited Response Format

Data Structure:

Table 93. Intrinsic Unsolicited Response Fields

Sub Tag	This field has a predefined value of 0 for intrinsic messages.
PD	Presence Detect: This bit reflects the present state of the Pin Sense – Presence Detect bit when the unsolicited response is triggered. Software can optionally use the pin sense control verb to determine the latest pin sense data state. This bit implementation is only required for digital display pin widget. Non digital display pin widget is optional to implement this bit. For the case of multi stream capable Digital Display Pin Widget, this bit indicate the PD bit of the specific Device Entry.

ELDV	ELD Data valid: This bit reflects the present state of the Pin Sense – ELD Valid bit when the unsolicited response is triggered. Software can optionally use the pin sense control verb to determine the latest pin sense data state. This bit implementation is only required for digital display pin widget. For the case of multi stream capable Digital Display Pin Widget, this bit indicate the ELDV bit of the specific Device Entry.
IA	Inactive: This bit reflects the present state of the Pin Sense – IA bit when the unsolicited response is triggered. Software can optionally use the pin sense control verb to determine the latest pin sense data state. This bit implementation is only required for digital display pin widget. For the case of multi stream capable Digital Display Pin Widget, this bit indicate the IA bit of the specific Device Entry.
DE	Device Entry: Indicate the index of Device Entry (0 - 63) which the UR is generated for a multi stream capable Digital Display Pin Widget. Not valid for non Digital Display Pin Widget or Digital Display Pin Widget that is not multi stream capable.

The codec adheres to the following rules for generating unsolicited responses triggered by intrinsic events:

- If a second UR is generated while the previous UR is still waiting to be sent then only the new UR is recommended to be sent, where the previous UR should be collapsed into the second UR. However, for multi stream capable Digital Display Pin Widget, the UR for different Device Entry should not be collapsed, but treated as independent UR generation source. Collapsing within each independent UR generation source is allowed.
- In the case of a monitor plug-in event, the ELD content is populated before the presence detect bit has been set. Setting of the ELD valid bit in this case is recommended ~~will~~ not to generate an (extra) UR, where UR generation should be ~~because~~ ~~it is~~ gated by PD or IA. In such cases when the PD bit or IA bit is also set, an Unsolicited Response is generated that contains both PD (or IA) and ELDV bits.

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7.3.3.15 Pin Sense

The **Pin Sense** control returns the Presence Detect status, EDID-Like Data (ELD) Valid, and the impedance measurement of the device attached to the pin.

Some codecs may require that the impedance measurement be triggered by software; in that case, sending the Execute command will cause the impedance measurement to begin. The "Presence Detect" bit will always be accurate if that functionality is supported by the widget.

Note that the Pin Complex Widget may support the generation of an Unsolicited Response to indicate that the Sense Measurement (either the Presence Detect or the Impedance) value has changed, the generation of which implies that the measurement is complete.

For the case of multi stream capable Digital Display Pin Widget, this verb can be used to read a specific Device Entry state as reported in Get Device List Entry verb.

Command Options:

Table 94. Pin Sense

	Verb ID	Payload (8 Bits)	Response (32 Bits)
Get	F09h	**For Analog pin widget or non multi-stream capable Digital pin widget:** 0	**For Analog pin widget:** Bit 31 is Presence Detect Bits 30:0 are Impedance Value
		For multi-stream capable Digital pin widget: Bits 7:6 are 0 Bits 5:0 are the Device Entry index value to be set	**For Digital pin widget:** Bit 31 is Presence Detect (PD) Bit 30 is ELD Valid (ELDV) Bits 29 is Inactive (IA) Bits 28:0 are 0
Execute	709h	**For Analog pin widget:** Right Chnl: bit 0 Rsvd: bits 1:7	0
		For Digital pin widget: Not Applicable	

Presence Detect is a bit indicating the state of the Presence Detect capability. A 1 indicates that there is "something" plugged into the jack associated with the Pin Complex. For Digital Display Pin Widget, the 1 also indicates that the pin widget audio capabilities have not been disabled under GFX driver control. This bit will only be valid if the widget has Presence Detect capability as indicated by the "Presence Detect Capable" bit of the Pin Capabilities parameter (see Section 7.3.4.9). For the case of multi stream capable Digital Display Pin Widget, this bit indicate the PD bit of the specific Device Entry.

EDID-Like Data (ELD) Valid is a bit indicating the state of the ELD memory. When the contents are valid ELD is set to 1 and cleared to zero when not valid. For the case of multi stream capable Digital Display Pin Widget, this bit indicate the ELDV bit of the specific Device Entry.

Inactive is only applicable for Digital Display Pin Widget. It is to supplement the Present Detect bit behavior for Digital Display Pin Widget. A 1 indicates that there is "something" plugged into the jack associated with the Pin Complex, but audio capabilities have been disabled under GFX driver control. This bit will only be valid if the widget has Presence Detect capability as indicated by the "Presence Detect Capable" bit of the Pin Capabilities parameter (see Section 7.3.4.9). For the case of multi stream capable Digital Display Pin Widget, this bit indicate the IA bit of the specific Device Entry. Note that ELDV may be 0 or 1 when IA = 1, depending on choice of audio codec implementation for exposing the ELD structure or not when the audio endpoint is inactive.

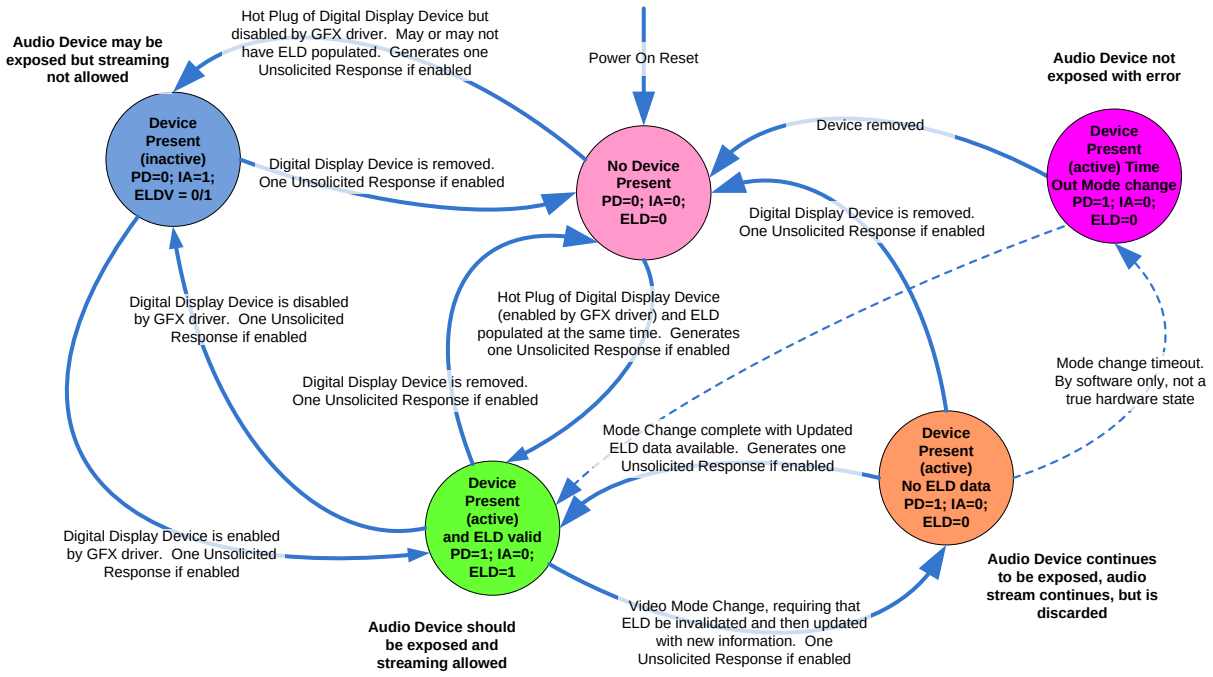

Figure 73. PD, IA and ELDV unsolicited responses flow for digital display codecs

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7.3.3.34.1 ELD Memory Structure

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CEA_SADs indicates up to 15 entries of 3-byte CEA-861 Short Audio Descriptor reported by the sink device. This field is a "canned" field that would be populated through implementation specific mean of default programming before the graphic driver is loaded, typically with only one LPCM SAD entry to indicate the basic LPCM audio support. The bytes orientation is little endian, i.e. the lowest significant byte is located at the lower byte offset of the ELD memory structure and most significant byte is located at the higher byte offset of the ELD memory structure. Note that the field is not valid for the case of inactive audio endpoint (IA = 1, PD = 0) even though ELDV = 1, as this field may be massaged by graphic driver depending on the active video mode when the audio endpoint become active (IA = 0, PD = 1) later.

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7.3.3.42 Device Select

For Digital Display Pin Widget that is multi stream capable, the Device Select control determines which Device Entry is currently selected and accessible by the Pin Widget verbs which are controlling the sink device operations. This control verb is only required if it is a Digital Display Pin Widget and multi stream capable.

The index is in relation to the Device List associated with the widget. The index is a zero-based offset into the Device List. Once the Device Entry is selected by the Set index, all subsequent Pin Widget verbs controlling the sink device operations will be directed to the selected Device Entry, until the Device Select verb get updated with a new value. These Pin Widget verbs include:

- Connection Select
- Get Connection List Entry
- Amplifier Gain/Mute
- Power State
- Pin Widget Control
- ELD Data
- DIP-Size
- DIP-Index
- DIP-Data
- DIP-XmitCtrl
- Content Protection Control
- ASP Channel Mapping

If the Device List Length value is 0, the Pin Widget is not multi stream capable since there is only one sink device connection possible, therefore, there is no Device Select control, and the verb for this control is not operable on that widget.

If an attempt is made to Set an index value greater than the number of list entries (index is equal to or greater than the Device List Length property for the widget) the behavior is not predictable.

Note that the Sink Device ID returned in the Device Select Control response is used by the codec hardware to forward audio stream to the correct sink device on the DP multi-stream connection hierarchy. To software, this Sink Device ID is only for status information.

Command Options:

Table 139. Device Select Control

	Verb ID	Payload (8 bits)	Response (32 bits)
Get	F35h	0	Bits 31:12 are 0 Bits 11:6 are the Sink Device ID in the multi stream topology of the DP hierarchy. Bits 5:0 are the Device Entry index currently set
Set	735h	Bits 7:6 are 0 Bits 5:0 are the Device Entry index value to be set	0

Applies to:

Digital Display Pin Complex (multi stream capable)

7.3.3.43 Get Device List Entry

Returns the Device List Entries at the index supplied. This command provides a way for the software to query the complete sink device status list for a widget multiple entries at a time. This control verb is only required if it is a Digital Display Pin Widget and multi stream capable.

The requested index *n* is zero based. *n* must be a multiple of 8 and 8 Device List Entries will be returned. Therefore, requesting index 0 will return the values at offset 0 – 7, requesting index 8 will return the values at offset 8 – 15, etc.

If the number of Device List Entries is not multiple of 8, the number of entries beyond the end of the list would be reported as 0's for the verb response of last valid index. For example, if the Device List Length parameter is read as 0001h, indicating that there are two Device List Entries in the list, requesting the Device List Entry with *n* equal to 0 will return List Entry 0 in bits 3:0, List Entry 1 in bits 7:4, and 0's for the other list entries.

If an index value of greater than the number of list entries (*n* is equal to or greater than the Device List Length property for the widget) the behavior is not predictable.

Command Options:

Table 140. Get Device List Entry Control

	Verb ID	Payload (8 Bits)	Response (32 Bits)
Get	F36h	Bits 7:6 are 0 Bits 5:0 are offset index n, where bits 2:0 must be 0	See response format below

Get Response:

31:28	...	11:8	7:4	3:0
Device List Entry n+7	...	Device List Entry n+2	Device List Entry n+1	Device List Entry n

Figure 82. Get Device List Entry Response Format

Each of the Device List Entry contains 4 bits as defined in Table 141 below. An UR will be generated for each of the Device Entry PD, ELDV, and IA fields through the Intrinsic Unsolicited Response if enabled, with the conditions as defined in the section 0. The UR response format will have the DE field indicating which Device Entry is causing the UR.

Table 141. Device List Entry Definition

Bits	Field	Definition
0	PD	**Presence Detect:** This bit reflects the Device Entry present state of the Pin Sense – Presence Detect bit.
1	ELDV	**ELD Valid:** This bit reflects the Device Entry present state of the Pin Sense – ELD Valid bit.
2	IA	**IA:** This bit reflects the Device Entry present state of the Pin Sense – IA bit.
3		*Reserved.*

Applies to:

Digital Display Pin Complex (multi stream capable)

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7.3.4.16 Device List Length

The Device List Length parameter returns the number of sink device that can be connected to this Pin Widget. This parameter is only required if it is a Digital Display Pin Widget.

Parameter ID: 15h

Response Format:

31:6	5:0
Reserved	Device List Length

Figure 99. Device List Length Response Format

Device List Length is a 0 based integer value indicating the number of sink device that a multi stream capable Digital Display Pin Widget can support. If Device List Length is value is 0, there is only one sink device connection possible indicating the Pin Widget is not multi stream capable, and there is no Device Select control (see Section 7.3.3.42). If the Device List Length value is 1 – 63, it indicates the Pin Widget is multi stream capable, and 2 – 64 Device Entries are supported in the Pin Widget.

Applies to:

Digital Display Pin Complex

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7.3.6 Required Parameter and Control Support

Table 145 specifies which parameters are required (R) for each specification-defined node. It also indicates optional (o) parameters which are used to declare the presence of optional features in the associated node. A shaded square in the table indicates that the subject parameter is not applicable to the subject node type. The squares marked with (a) indicate an alternative; the parameter is required in either the Audio Function Group (AFG), to be used as a default, or else in all of the indicated widgets. If these parameters are present in the AFG, they are only needed in the individual widgets that have non-default capabilities. Some parameters are marked with an asterisk (*) for the "Vendor_Specific_Audio_Widget indicating they are not required by the specification since a vendor specific node may largely define its own parameters. If, however, the vendor specific node implements features that can be defined by an existing parameter, then using the standard parameter is preferable to defining a new one.

Table 145. Required Support for Parameters

Required Parameter Support	Parameter ID	Root Node	Audio Function Group	Modem Function Group	Vendor Defined Function Group	Audio Output Converter	Audio Input Converter	Pin Complex Widget (non Digital Display)	Pin Complex Widget (Digital Display)	Mixer (SumAmp)	Selector (Mux)	Power Widget	Volume Knob	Beep Generator	Vendor Defined Wdiget

Vendor ID	00	R													
Revision ID	02	R													
Subordinate Node Count	04	R	R	R	R										
Function Group Type	05		R	R	R										
Audio Function Group Capabilities	08		o												
Audio Widget Capabilities	09					R	R	R	R	R	R	R	R	R	R
Sample Size, Rate CAPs	0A		A			A	a								*
Stream Formats	0B		A			A	a								*
Pin Capabilities	0C							R	R						*
Input Amp Capabilities	0D		A				a	a		a	a				*
Output Amp Capabilities	12		A			a		a	a	a	a				*
Connection List Length	0E						R	R	R	R	R	R			*
Supported Power States	0F		R	R	o	o	o	o	o	o	o	R			*
Processing Capabilities	10					o	o	o	o		o				*
GPI/O Count	11		o	o	o										
Volume Knob Capabilities	13												R		
HDMI LPCM CAD (Obsolete)	20												R		
Device List Length	15								o						

Note that the Audio Function Group Capabilities parameter provides a default delay for the entire AFG to be used in lieu of adding specific delays listed for each widget in the Audio Widget Capabilities parameter. This is required if one or more widgets in the AFG opts to not report a correct delay in its Audio Widget Capabilities parameter; if all widgets do report an accurate delay number, the Audio Function Group Capabilities parameter is not required.

Table 146 specifies which verbs and controls are required (R) for each specification-defined node. It also indicates conditional (c) verbs which are required only if the respective optional capability is declared to be available. Another conditional verb (X) is required when the codec supports multiple **SDI** signals. A shaded square in the table indicates that the subject verb is not applicable to the subject node type. Some parameters are marked with an asterisk (*) for the "Vendor_Specific_Audio_Widget" indicating they are not required by the specification since a vendor specific node may largely define its own verbs. If, however, the vendor specific node implements controls that can be accessed with an existing verb, then using the standard verb is preferable to defining a new one.

Table 146. Required Support for Verbs

Required Verb Support	Get Code	Set Code	Root Node	Audio Function Group	Modem Function Group	Vendor Defined Function Group	Audio Output Converter	Audio Input Converter	Pin Complex Widget (non Digital Display)	Pin Complex Widget (Digital Display)	Mixer (SumAmp)	Selector (Mux)	Power Widget	Volume Knob	Beep Generator	Vendor Defined Wdiget
Get Parameter	F00		R	R	R	R	R	R	R	R	R	R	R	R	R	R
Connection Select	F01	701						c	c	c		c				*
Get Connection List Entry	F02							R	R	R	R	R	R	R		*
Processing State	F03	##					c	c	c	c		c				*
Coefficient Index	D- -	5- -					c	c	c	c		c				*
Processing Coefficient	C- -	4- -					c	c	c	c		c				*
Amplifier Gain/Mute	B- -	3- -					c	c	c	c	c	c			c	*
Stream Format	A- -	2- -					R	R								*
Digital Converter 1	F0D	70D					c	c								*
Digital Converter 2	F0D	70E					c	c								*
Power State	F05	705		R	R	c	c	c	c	c	c	c	R			c
Channel/Stream ID	F06	706					R	R								*
SDI Select	F04	704					X	X								*
Pin Widget Control	F07	707							R	R						*
Unsolicited Enable	F08	708					c	c	c	c	c	c	c	c		*
Pin Sense	F09	709							c	c						*
EAPD/BTL Enable	F0C	70C							c							*
All GPI Controls	F10 thru F1A	710 thru 71A		c	c											
Beep Generation Control	F0A	70A													R	
Volume Knob Control	F0F	70F												R		
Implementation ID, Byte 0	F20	720		R	R	R										
Implementation ID, Byte 1	F20	721		R	R	R										
Implementation ID, Byte 2	F20	722		R	R	R										
Implementation ID, Byte 3	F20	723		R	R	R										
Config Default, Byte 0	F1C	71C							R	R						
Config Default, Byte 1	F1C	71D							R	R						

Required Verb Support	Get Code	Set Code	Root Node	Audio Function Group	Modem Function Group	Vendor Defined Function Group	Audio Output Converter	Audio Input Converter	Pin Complex Widget (non Digital Display)	Pin Complex Widget (Digital Display) Mixer (SumAmp)	Selector (Mux)	Power Widget	Volume Knob	Beep Generator	Vendor Defined Wdiget
Config Default, Byte 2	F1C	71E							R	R					
Config Default, Byte 3	F1C	71F							R	R					
Stripe Control	F24	724					c								
Converter Channel Count	F2D	72D					c								
DIP-Size	F2E									R					
ELD Data	F2F									R					
DIP-Index	F30	730								R					
DIP-Data	F31	731								R					
DIP-XmitCtrl	F32	732								R					
Content Protection Control	F33	733								c					
ASP Channel Mapping	F34	734								R					
Device Select	F35	735								c					
Get Device List Entry	F36									c					
RESET		7FF		R	R	R									

Note that the Connection Select control is not required when the Connection List Length Register value is 1 for this node. In that case, there is no Connection Select control. Similarly, the Device Select control is not required when the Device List Length parameter value is 0 for this node.