Application Notes

Using Consumer Electronic Control (CEC) in the Lightware Devices
1. Introduction

This document gives an overview about the CEC support of the Lightware devices.

- WHAT IS CEC?
- ELECTRICAL CONNECTIONS OF CEC
- BENEFITS OF COLLABORATION LIGHTWARE AND CEC
- CEC COMPATIBILITY IN LIGHTWARE DEVICES
- ABOUT CEC COMMANDS
- TYPICAL APPLICATION 1. - TRANSPARENT CEC SUPPORT
- SUMMARY OF USING ADVANCED CEC FUNCTIONS IN LIGHTWARE DEVICES
- TYPICAL APPLICATION 2. - ADVANCED CEC SUPPORT

1.1. What is CEC?
Consumer Electronic Control (CEC) is a bi-directional communication, defined in the HDMI standard. This feature is for remote control of the source and sink devices in the A/V system.

CEC standard is based on the AV-link protocol of the SCART connector, this is the reason of the limited bandwidth (about 400bit/sec).

The structure of the CEC communication is a tree topology data bus, where every unit can communicate with every unit. The standard supports only one sink, so Lightware devices are designed to have independent CEC bus for each port (e.g. units which are connected to the matrix cannot detect each other directly).

This document aims to give a general description of CEC services.

1.2. Electrical Connections of CEC
- CEC has a dedicated pin in the HDMI connector.
- DVI connector does not contain this pin, so the CEC transmission brakes when HDMI-DVI connector or adapter is in the signal route.
- DisplayPort supports CEC, it has no dedicated pin but embeds the CEC data.

1.3. Benefits of Collaboration Lightware and CEC
- It makes the Lightware devices compatible with third-party units via standard CEC commands.
- No extra cabling required, it uses HDMI cable, that is always available.
- The Lightware devices support standard and vendor specific command sending, it makes the system universal and easily adaptable.
- User-friendly text format commands, customizable hexadecimal format command sending.
- The Lightware devices can receive CEC messages which makes possible to request system information from the third-party devices (e.g. Device ID, the status of the sink or the source etc.).
- CEC is integrated into the Event Manager and it supports the synchronization of the different units of the A/V system.

1.4. CEC Compatibility in Lightware Devices

CEC-transparent devices
- HDMI20-OPT-J-TX90 and HDMI20-OPT-J-RX90 extender pair is transparent for CEC (just like a cable).
- HDMI-TPS-TX95 and HDMI-TPS-RX35 extender pair is transparent when connected with each other.
- HDMI-TPS-TX97 and HDMI-TPS-RX97 extender pair is transparent when connected with each other.
- In DA2HDMI-4K-PLUS-A, DA2HDMI-4K-PLUS distribution amplifiers the HDMI In and HDMI Out 2 ports are CEC-transparent.

Lightware devices with advanced CEC-support
These below devices are able to send and recognize CEC commands in text and hex format. This feature is for remote control of the source or sink device.

Matrix switches
- MX2-4x4-HDMI20-CA; MX2-8x4-HDMI20-CA; MX2-8x8-HDMI20-L; MX2-8x8-HDMI20-CA; MX2-8x8-HDMI20-Audio; MX2-8x8-HDMI20-Audio-L; MX2-8x8-DH-4DPi-A; MX2-8x8-DH-8DPi-A; MX2-16x16-HDMI20; MX2-16x16-HDMI20-8; MX2-16x16-HDMI20-Audio; MX2-16x16-HDMI20-Audio-R; MX2-24x24-HDMI20-12DPi-A-R; MX2-32x32-HDMI20-A-R; MX2-32x32-DH-16DPi-A-R; MX2-48x48-HDMI20-A-R;
- UMX-HDMI-140-Plus
- UMX-TPS-TX140-Plus
- WP-UMX-TPS-TX130-US-Plus Black, White
- HDMI-TPS-RX110AY-Plus
- SW4-TPS-TX240-Plus
- MMX4x2-HDMI, MMX4x2-HT200 (only with LW3 protocol commands)
- MMX8x4-HT420M, MMX8x4-HT400MC, MMX8x8-HDMI-4K-A
1. Introduction

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1.5. About CEC Commands

Standard CEC Commands

Standard CEC commands support querying basic information and they have control functions for the sources and sinks.

CEC-compatible Lightware devices are able to send and recognize CEC messages in user-friendly text format, or hex format.

INFO: The first 2x2 bytes of the CEC commands contain identification data of the source and destination address. When the port is input, it is always 04 (from TV to Playback device 1.), when the port is output, it is always 40 (from Playback device 1. to TV). Broadcast addressing is also possible (in this case it is 0F or 4F).

The example below shows a CEC message structure that is sent from the input port towards the source:

<table>
<thead>
<tr>
<th>Logical Address</th>
<th>Command ID</th>
<th>Parameter 1. (fix)</th>
<th>Parameter 2. (fix)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Destination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV</td>
<td>Playback</td>
<td>Set OSD String</td>
<td>Display until</td>
</tr>
<tr>
<td>device 1.</td>
<td></td>
<td></td>
<td>cleared LWR</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>64</td>
<td>40</td>
</tr>
<tr>
<td>4C5752</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INFO: The number of the parameters depends on the command, some commands do not need any parameter.

Vendor-Specific CEC Commands

The manufacturers designed their A/V products CEC-compatible and use vendor-specific commands for a fluent cooperation of their own units in the system. Certain companies make these commands public and available for third-party users.

Lightware gives a platform for managing vendor specific CEC commands in hex format. For more information, see Custom command textbox section or Sending CEC Commands section.

The example below shows a CEC message that is sent from the output port towards the sink:

<table>
<thead>
<tr>
<th>Logical Address</th>
<th>Command ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Destination</td>
</tr>
<tr>
<td>Playback device 1.</td>
<td>TV</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>A080046001800020090</td>
<td></td>
</tr>
</tbody>
</table>

1.6. Typical Application 1. - Transparent CEC Support

For the list of CEC-transparent units, see CEC-transparent devices section.

The configuration below shows an application, where Lightware devices (an HDMI-OPTJ extender pair) let the CEC message traffic from the TV to the Blue-ray player without any modification. It makes possible, that both the TV and the Blu-ray player can be controlled by the remote controller.

The TV receives the IR signal from the remote control. The remote control commands can control the TV or transmitted as a CEC command towards the Blue-ray player to control it.

1.7. Summary of Using Advanced CEC functions in Lightware Devices

In Lightware Device Controller (LDC) Software - Port Properties Window

In the port properties window, CEC has a user-friendly interface, where pre-defined commands or custom commands in hex format can be sent. A CEC command terminal box gives an immediate feedback about the sent and the received commands.

For more details, see CEC Layout in the Lightware Device Controller section.

In Lightware Device Controller (LDC) Software - Event Manager

The Event Manager offers an easy and quick configurable platform to set a Condition and an Action in the Event.

- Wizard mode for sending CEC messages can be set as an Action triggered by any Condition.
- In the Advanced mode - LastReceivedMessage property can be set as a Condition connecting with any Action.

For more details, see the CEC Support in the Event Manager section.

With LW3 Protocol Commands

CEC commands can be also sent by LW3 protocol. For more details, see CEC Management with LW3 Protocol Commands section.
1.8. Typical Application 2. - Advanced CEC Support

The configuration below shows a typical arrangement of the video conference system, which turns on and off automatically after setting the Events in Event Manager in MMX8x4-HT420M matrix switcher.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received CEC message: Wake up signal</td>
<td>When the Video Conference Codec becomes active by the Touch panel, it sends an automatic status report via CEC (wake up signal) to the I7 port of the matrix.</td>
<td>Send CEC message: Wake up signal</td>
<td>The matrix switcher sends a CEC command to the monitor to wake up.</td>
</tr>
<tr>
<td>Send TCP message: PWR on</td>
<td>The matrix switcher sends a TCP message to turn on the projector via Ethernet.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more details about setting the events see Create or Modify an Event section.
2. Sending CEC commands with Lightware Device Controller (LDC) software

This feature is the part of the Lightware 3 protocol, therefore all settings can be arranged in the protocol tree or set by sending LW3 commands. To provide a user-friendly method for setting the necessary parameters, the feature is implemented in the Lightware Device Controller software.

- CEC Layout in the Lightware Device Controller
- Advanced View
- CEC Support in the Event Manager
- Typical Application - Detailed Settings in the Event Manager

2.1. CEC Layout in the Lightware Device Controller

**ATTENTION!** This layout is available in the advanced CEC-supported devices. For the list of these units, see Lightware devices with advanced CEC-support section.

*Where can it be found?*

Navigate the Crosspoint menu, Input or Output Port Properties Window to reach the CEC layout in the LDC.

*Drop-down command list*

This list contains the basic CEC commands, most of them are displayed on the graphical interface, too (on the left side). Click on the Send button to execute sending the command.

*Custom command textbox*

The text field is for sending hexadecimal commands to the source. The maximum length of the message could be 30 characters (15 bytes). Click on the Send button to execute sending the command.

*OSD string textbox*

A max. 14 character-long text can be shown on the sink device. The send OSD (On-screen display) command textbox is the input field of the string. Alphanumeric characters, glyphs and space are accepted. Click on the Send button to execute the command.

*CEC Command terminal box*

Displays all the sent (in red) CEC commands and the received answers (in blue) with a timestamp.

**Legend of the received message:**

- `<[10:33:17] ACK`
  Answer for the acknowledged command.
- `<[10:35:01] NACK`
  Answer for the not acknowledged command.
- `<[10:33:17] IN PROGRESS`
  The command is in progress at the moment.
- `<[10:33:17] FAILED`
  Answer for other failure.
- `<[10:35:40] feature_abort_<*>`
  This is the most common answer from the third-party devices when the command is delivered, but the execution is refused. The cause of the refuse stands after 'feature_abort' expression.

*Clear button*

Click on the Clear button to erase the content of the terminal window.

*CEC command button panel*

This panel provides the quick and easy management of CEC commands. These buttons are pre-programmed with basic functions and sends commands towards the sink. The communication is displayed in the Received Command box. For the list of the commands see Send CEC Command in Text Format section. Both the layout and functionality are similar to the design of a remote control.

2. Sending CEC commands with Lightware Device Controller (LDC) software

It can occur that the third-party device can receive, but not execute the command because it is not supported by the product. Check the accepted commands in the documentation of the device.

**ATTENTION!** Make sure that the controlled unit is CEC-compatible and this function is enabled. Certain vendors gives different trade names for CEC.
2. Sending CEC commands with Lightware Device Controller (LDC) software

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2.2. Advanced View

Advanced view is the surface for displaying the LW3 protocol tree. Commands and specific parameters (which are not available on the graphical user interface of the LDC) can be run and set by the controlling tools.

1. LW3 Protocol Help
   Short description about the command types and LW3 Protocol.

2. Terminal Window
   Commands and responses. Sent command starts with ‘>’ character, received response starts with ‘<’ character. The content of the window can be emptied by the Clear button. If the Autoscroll option is ticked, the list is scrolled automatically when a new line is added. Place the mouse cursor on a line to display the date and time stamp in a Hint field.

3. Protocol Tree
   LW3 protocol tree; select an item to see its content.

4. Edit Mode
   The default appearance is the Edit mode. If the option is unticked the values or parameters cannot be changed.

5. Node List
   Parameters and nodes of the selected item are shown.

6. Warn Option
   The LDC can be set to warn the user before enable the Edit mode.

7. Command Line
   Type the desired command and execute it by the Send button.

INFO: The CEC-related properties can be found in /MEDIA/CEC/<port> node for each port.
2.3. CEC Support in the Event Manager

The Event Manager is a built-in feature of Lightware Device Controller software. It reacts to internal status changes or user interactions without any external control system. The detected event is called Condition, the response is called Action.

CEC feature is integrated in Event Manager, so incoming CEC message can be set as Condition which triggers a pre-defined Action. CEC command sending can be set as an Action, and it can be triggered by any Condition.

INFO: For more details about using the Event Manager see the Event Manager Application notes on www.lightware.com website or the LDC chapter of device's own User's Manual.

Where can it be found?
The location of the Event manager is the same in all cases in the software: navigate to the Control submenu and select the Events tab.

2.3.1. The Events Tab

1. Event Lines
   Each line means an Event: a Condition and an Action. The green line means the Event is enabled and both the Condition and the Action are set properly.

2. Condition
   Displays the expression shown in Wizard mode or the exact LW3 path and node.

3. Switch
   The Event can be enabled or disabled.

4. Edit Button
   Press the button to open the Event Editor and set all the parameters.

5. Clear Button
   Delete the settings of the given Event.

6. Delay Settings
   The Action can be scheduled to follow the Condition after the set time value.

7. Action
   Displays the expression shown in Wizard mode or the exact LW3 path and node.

2.3.2. Adding an Event – the Event Editor

Press the Edit button in the desired Event line to open the Event Editor window.

1. Event header
   The name of the Event is displayed. Type the desired name and press the Set name button. The Event can be cleared by the Clear button. Use the tick mark to enable/disable the Event.

2. Condition header
   If the condition is set, the description (white colored text) and the exact LW3 protocol expression (yellow colored text) can be seen. If the advanced mode was used the description is Custom condition.

3. Condition panel
   The Wizard, the Advanced or the Link tool is available to set the condition. The parameters and settings are displayed below the buttons.

4. Delay settings
   The action can be scheduled to follow the condition after the set time value.

5. Action header
   If the action is set, the description (white colored text) and the exact LW3 protocol expression (yellow colored text) can be seen. If the advanced mode was used the description is Custom action.

6. Action panel
   The Wizard, the Advanced or the Link tool is available to set the action. The parameters and settings are displayed below the buttons.
2.3.3. Create or Modify an Event

**Wizard Mode**

The wizard mode lists the most common conditions and actions, so the user does not have to look for LW3 nodes and properties.

**Step 1.** Click on the Edit button of the desired Event; the Event editor is displayed.

**Step 2.** The wizard mode is displayed as default. Select the desired Category first (e.g. Audio or Video).

**Step 3.** Select the desired Expression from the drop-down menu. If any other parameter is necessary to set, it is going to be displayed.

**Step 4.** Press the Apply button to store the settings of the Condition.

**Advanced Mode**

The goal of this mode is the same as of the wizard: set the properties and methods for conditions and actions. The difference is the number of the available and usable properties and methods of the LW3 protocol. Advanced mode allows almost all of it.

**Step 1.** Click on the Edit button of the desired Event; the Event editor is displayed.

**Step 2.** The wizard mode is the default, press the Advanced button. The LW3 protocol tree is displayed showing the list of the properties in the drop-down menu. Navigate to the desired node.

**Step 3.** Select the desired Property from the menu. The manual of the property is displayed below to help to select the necessary property and to set the value.

**Step 4.** Set the desired value and operator, then press the Apply button to store settings.

**TIPS AND TRICKS:** When the conditions (or the actions) are the same in the events, use the Link Tool.
2.4. Typical Application - Detailed Settings in the Event Manager

The Events in the Typical Application 2. - Advanced CEC Support example can be set with the following parameters:

### Waking up the System

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Event</strong></td>
<td><strong>Trigger</strong></td>
</tr>
<tr>
<td>E1</td>
<td>Received CEC message: Wake up signal</td>
</tr>
<tr>
<td>E2</td>
<td>Received CEC message: Wake up signal</td>
</tr>
</tbody>
</table>

*TCP control message is replaceable according to the documentation of the projector.

### Start Playing the Content

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Event</strong></td>
<td><strong>Trigger</strong></td>
</tr>
<tr>
<td>E3</td>
<td>Received CEC message: Start playing content</td>
</tr>
</tbody>
</table>

### Standby the System

<table>
<thead>
<tr>
<th>Condition</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Event</strong></td>
<td><strong>Trigger</strong></td>
</tr>
<tr>
<td>E4</td>
<td>Received CEC message: Standby status</td>
</tr>
<tr>
<td>E5</td>
<td>Received CEC message: Standby status</td>
</tr>
</tbody>
</table>

*TCP control message is replaceable according to the documentation of the projector. IP address and the port number is related to network settings of the projector.

For more details about setting the events see Create or Modify an Event section.

INFO: The connected device sends an automatic message when its status turns to Standby. LastMessage property can store the one CEC message in hex or text format.

3. CEC Management with LW3 Protocol Commands

The CEC-related controlling and messaging features provided by Lightware Protocol #3 (LW3) is introduced in this section. Controlling Lightware devices or third-party devices remotely is described by the detailed examples in the coming chapter.

### Sending CEC Commands

#### Send CEC Command in Text Format

#### Send CEC Command in Hexadecimal Format

#### Query the Received CEC Commands

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**3.1. Sending CEC Commands**

INFO: The first 2x2 bytes of the CEC commands contains identification data of the source and destination address, that is added to the command automatically. When the port is input, it is always 04 (from TV to Playback device 1.), when the port is output, it is always 40 (from Playback device 1. to TV). Broadcast addressing is also possible (in this case it is 0F or 4F).

#### 3.1.1. Sending OSD String

Sending the OSD string consists of two steps. First, set the CEC.OsdString property with the desired text, after that, call the CEC.send(set_osd) method.

**Step 1.** Set the CEC.OsdString property.

- `SET /MEDIA/CEC/<port>.OsdString=<text>`
- `pw /MEDIA/CEC/<port>.OsdString=<text>`

**Step 2.** Call the CEC.send(set_osd) method.

- `CALL /MEDIA/CEC/<port>:send(set_osd)`
- `mO /MEDIA/CEC/<port>:send`

**Parameters**

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Parameter description</th>
<th>Parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;port&gt;</td>
<td>Port identifier</td>
<td>I4: Source port number. O4: Destination port number.</td>
</tr>
<tr>
<td>&lt;text&gt;</td>
<td>On-screen displayed text</td>
<td>The following characters are allowed in the text: Letters (A-Z) and (a-z), hyphen (-), underscore (_), numbers (0-9), and dot (.). Max length: 14 characters.</td>
</tr>
</tbody>
</table>

**Example**

- `SET /MEDIA/CEC/I1.OsdString=Lightware`
- `pw /MEDIA/CEC/I1.OsdString=Lightware`
- `CALL /MEDIA/CEC/I1:send(set_osd)`
- `mO /MEDIA/CEC/I1:send`
### 3.2. Send CEC Command in Text Format

- **CALL /MEDIA/CEC/<port>:send(<command>)**
- **mo /MEDIA/CEC/<port>:send**

**Parameters**

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Parameter description</th>
<th>Parameter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;port&gt;</td>
<td>Port identifier</td>
<td>I1-I5: Source port number. O1-O9: Destination port number</td>
</tr>
<tr>
<td>&lt;command&gt;</td>
<td>CEC command</td>
<td>image_view_on, standby, ok, back, up, down, left, right, root_menu, setup_menu, contents_menu, favorite_menu, media_top_menu, media_context_menu, number_0-9, number_10-16, number_17-18, channel_down, sound_select, input_select, display_info, power_legacy, page_up, page_down, volume_up, mute_toggel, mute, unmute, play, stop, pause, record, play, fast_forward, skip_backward, 3d_mode, stop_record, pause_record, play_forward, play_reverse, select_next_media, select_media_1, select_media_2, select_media_3, select_media_4, select_media_5, power_toggle, power_on, power_off, stop_function, f1, f2, f3, f4</td>
</tr>
</tbody>
</table>

**Example**

- **CALL /MEDIA/CEC/I5:send(play)**
- **mo /MEDIA/CEC/I5:send**

### 3.3. Send CEC Command in Hexadecimal Format

- **CALL /MEDIA/CEC/<port>:sendHex(<hex_code>)**
- **mo /MEDIA/CEC/<port>:sendHex**

**Parameters**

- **<hex_code>** Accepted command is max. 30 character long (15 byte) in hexadecimal format.

**Example**

- **CALL /MEDIA/CEC/I6:sendHex(83)**
- **mo /MEDIA/CEC/I6:sendHex**

This command requests the physical address of the device that is connected to the I6 port.

### 3.4. Query the Received CEC Commands

- **.LastReceivedMessage** property stores the last received command of the chosen port. This is a read-only parameter, what is designed mainly for trigger actions in the Event Manager.

- **GET /MEDIA/CEC/<port>:LastReceivedMessage**
- **pr /MEDIA/CEC/<port>:LastReceivedMessage=<cec_code>**

**Parameters**

- **<cec_code>** Received command is max. 30 character long (15 byte) in text or hexadecimal format.

**Example**

- **GET /MEDIA/CEC/I6.LastReceivedMessage**
- **pr /MEDIA/CEC/I6.LastReceivedMessage=standby**

The current power status of the device that is connected to the I6 port is Standby.