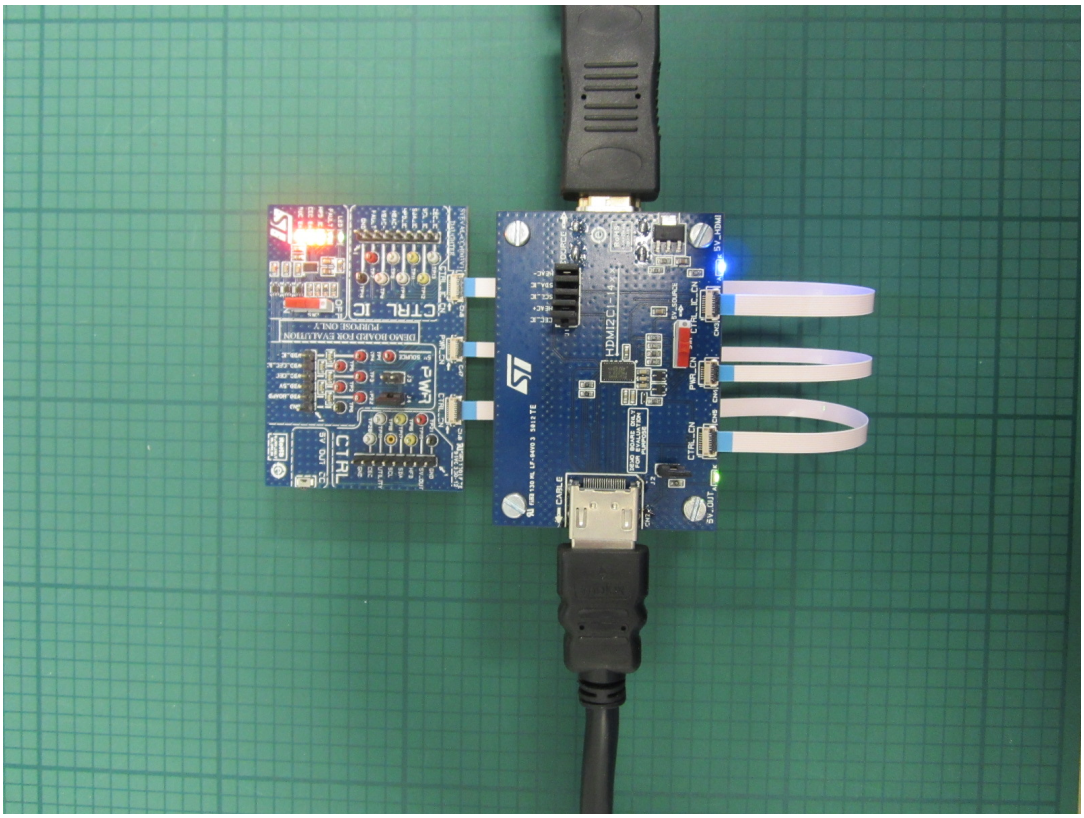
Using the STEVAL-CCH003V2 evaluation kit based on the HDMI2C1-14HD

Introduction

This application note provides an overview of the STEVAL-CCH003V2 evaluation kit which consists of a motherboard based on the HDMI2C1-14D device with an optional daughterboard. The HDMI2Cx-14HD series is a simple solution providing HDMI™ interface designers with an easy and fast way to reach full compliancy with the stringent HDMI™ 1.4 standard.

Figure 1. STEVAL-CCH003V2 evaluation kit



1 Electrical characteristics

Table 1. Main board - electrical characteristics

Parameter	Test conditions	Value			Unit
		Min.	Typ.	Max.	
Ambient operating temperature			25		°C
+5 V power supply		4.9	5.0	5.3	V
VDD_IC	Powered through HDMI connector		5.0		V
	Powered through PWR_CN connector (SW1 = 5 V_SOURCE)	1.62		3.63	
VDD_CEC	Powered through HDMI connector		3.3		V
	Powered through PWR_CN connector (SW1 = 5 V_SOURCE)	2.97	3.3	3.63	
VDD_CEC_IC	Powered through HDMI connector (internally generated)		3.3		V
	Powered through PWR_CN connector (SW1 = 5 V_SOURCE)	1.62		3.63	

Table 2. Daughterboard - electrical characteristics

Parameter	Test conditions	Value			Unit
		Min.	Typ.	Max.	
Ambient operating temperature			25		°C
5 V_BOARD		4.5	5.0	5.5	V
VDD_5V			5.0	5.3	V
VDD_IC		1.62		3.63	V
VDD_CEC		2.97	3.3	3.63	V
VDD_CEC_IC		1.62		3.63	V

2 Safety precautions

The evaluation boards must be used only by expert technicians. STMicroelectronics assumes no responsibility for any consequence which may result from the improper use of this evaluation kit.

3 Purpose

This evaluation board can be used to quickly and easily show the main features and benefits of the HDMI2Cx product family. The board has simply to be inserted between the HDMI Source device and the HDMI cable. Because the ASIC source signals are not accessible from the HDMI connector (power supplies and outputs of the ASIC), the operating conditions are not optimized.

The best way to maximize all the benefits of the board is to implement it directly in the application as close as possible to the main ASIC.

4 HDMI2Cx-14 product series description

The HDMI2Cx-14 is a fully integrated ESD-protection and signal conditioning device for control links and TMDS data video channels of an HDMI™ interface. Two versions are available: the first one is dedicated to HDMI™ source devices (HDMI2C1 series), the second one is dedicated to HDMI™ sink devices (HDMI2C2 series).

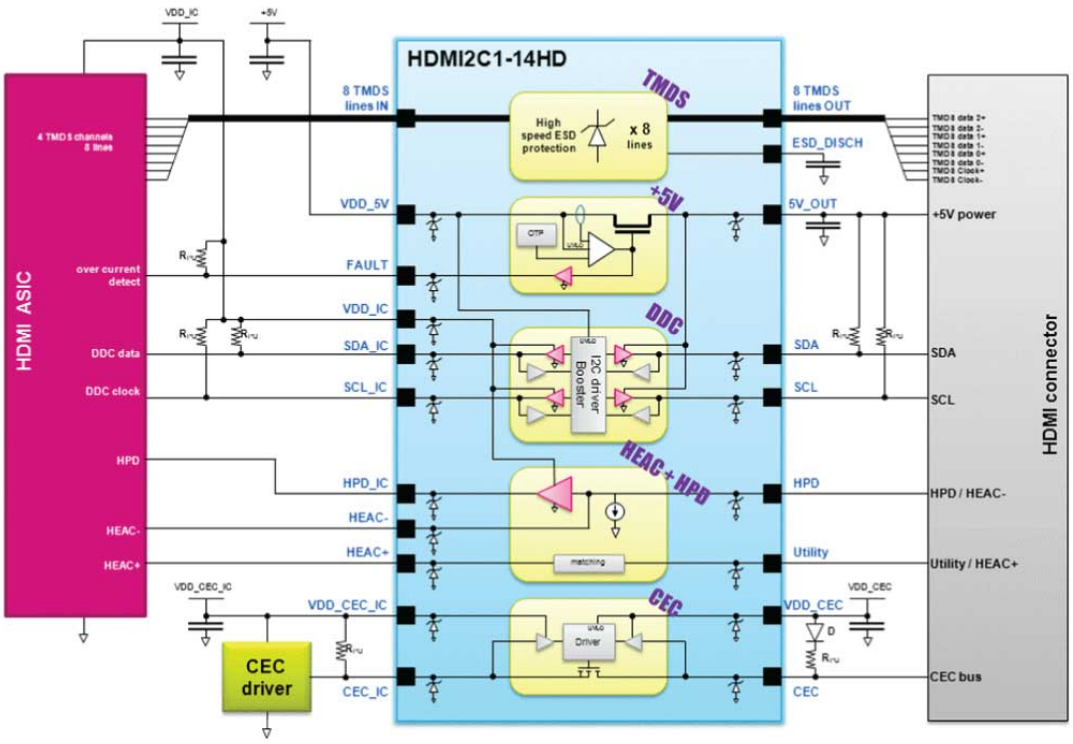
All the pins of the device are protected against ESD according to the HBM JESD22-A114D standard, level 2 (2 kV contact discharge). Furthermore, the pins connected to the HDMI connector provide an ESD protection compliant with the IEC 61000-4-2 standard, level 4 (up to 8 kV contact discharge).

The control stage of the device provides a bidirectional buffer, integrating signal conditioning and dynamic pull-up on the DDC bus for maximum system robustness and signal integrity.

The HEAC (HDMI ethernet and audio return channels) function is supported, making the component fully compliant with the HDMI™ 1.4 version. A bidirectional CEC signal conditioning block is integrated, able to wake up the application from low-power standby mode (all power supplies are off, except obviously the CEC power supply). The integrated ESD-protected TMDS data channels allow a video data rate up to the max specification of the HDMI1.4 standard (3.4 Gbps per channel). The +5 V supplied to the cable is protected against accidental surge current and short-circuit.

All these features are provided in a single 36-lead QFN package featuring natural PCB routing and space saving on the board. Figure 2 presents these different block diagrams.

Figure 2. Product functional diagram overview



The HDMI2Cx is a simple solution that provides HDMI designers with an easy and fast way to reach full compliancy with the stringent HDMI 1.4 CTS over a wide temperature range.

The product series offers an integrated solution for source and sink interfaces, as well as a trade-off concerning different speeds.

5 Evaluation board description - operating manual

5.1 General description of the boards

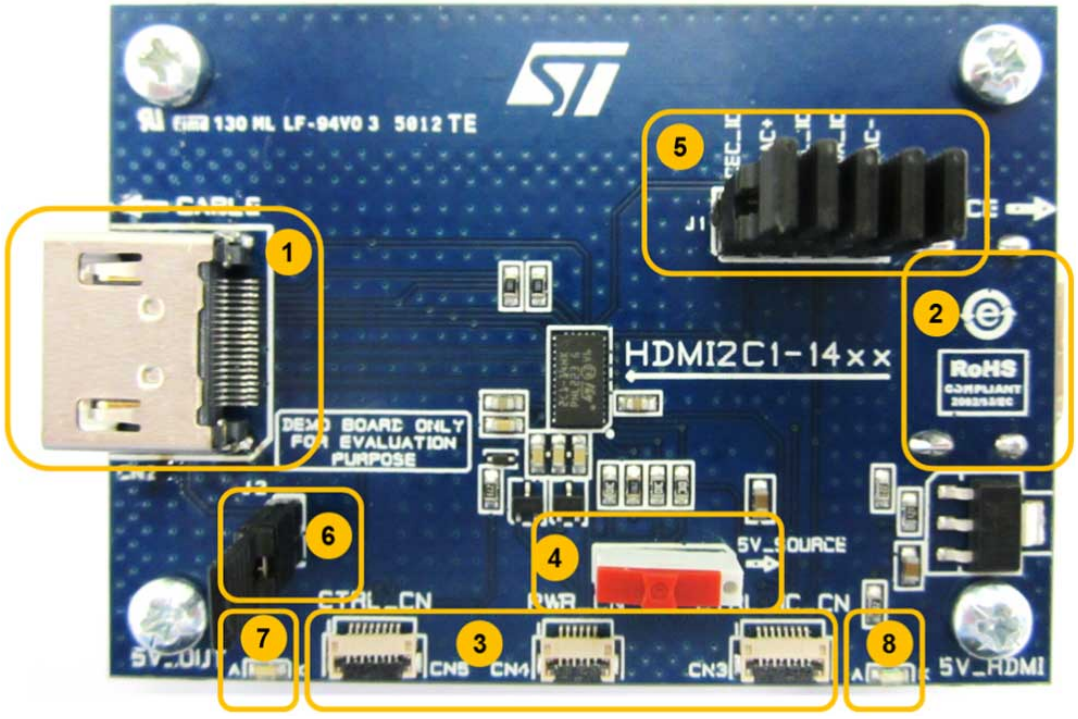
The STEVAL-CCH003V2 evaluation kit consists of two boards:

- The main “mother” board embedding the HDMI2C1-14HD device. It has been designed in order to be directly connected between any HDMI Source equipment (box) and any HDMI Sink (TV) through any HDMI cable
- The optional "daughter" board, can be connected to the main board through dedicated connectors. It gives easy access to all the HDMI control stage signals (DDC, CEC, HEAC, HPD), and to main board power supplies (+5 V of the DDC bus, +3.3 V of the CEC bus, V_{DD} of the HDMI ASIC)

5.1.1 Main board description

Figure 3. Main board

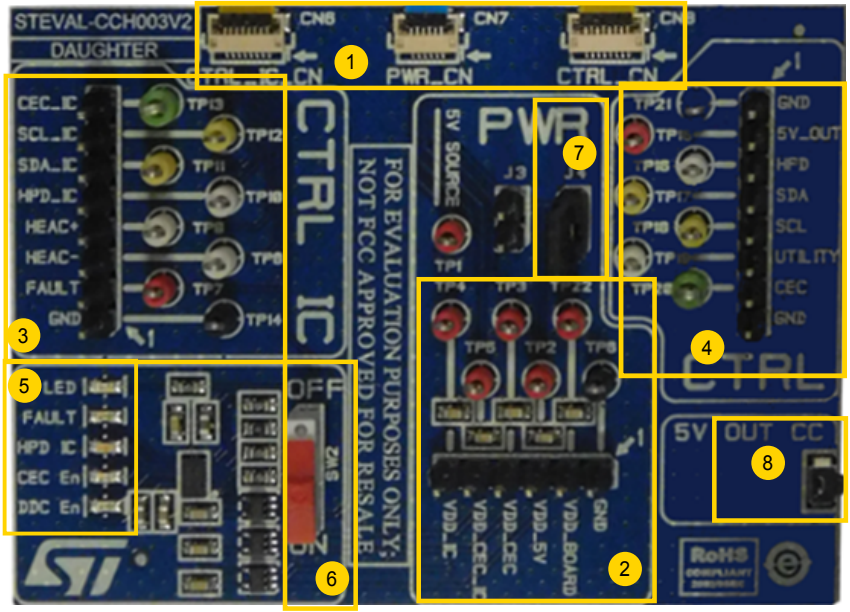
1. **HDMI type A receptacle connector**: to be connected to the HDMI sink equipment (TV) through any HDMI cable
2. **HDMI type A receptacle connector (bottom side)**: to be connected to the HDMI source equipment (box) through an HDMI male-to-male adapter
3. **Connectors to the daughterboard**: allow the user to access all HDMI control stage signals
   - **CN3**: access to the control stage signals coming from the HDMI source device (box)
   - **CN4**: access to the various power supplies
   - **CN5**: access to the control stage signals going to the HDMI sink device (TV)
4. **Switch SW1**: main +5 V power supply selector (internal or external)
5. **Jumpers J1**: connect/disconnect the DDC bus, CEC bus and HEAC bus to/from the HDMI source connector
6. **Jumper J2**: connects/disconnects the LED which indicates the presence of the +5 V_OUT power supply.
7. **5V_OUT LED**: ON when 5 V_OUT present and jumper J2 closed
8. **5V_HDMI LED**: ON when +5 V present on HDMI source connector



5.1.2 Daughterboard description

Figure 4. Daughterboard

1. **Connectors to the main board**: allow the user to control and measure all the HDMI control stage signals
   - **CN6**: gives access to the HDMI control stage signals coming from the HDMI Source device (box)
   - **CN7**: gives access to the various power supplies
   - **CN8**: gives access to the HDMI control stage signals going to the HDMI Sink device (TV) through the HDMI cable
2. **Connector CN9 and test points TP1 to TP6**: power supplies
3. **Connector CN10 and test points TP7 to TP14**: HDMI control stage signals on the HDMI IC side
4. **Connector CN11 and test points TP15 to TP21**: HDMI control stage signals on the cable side
5. **LED indicators**:
   - **LED**: light on when all the LED indicators are enabled
   - **FAULT**: light on when the fault signal goes low, ie. accidental short-circuit has been detected
   - **HPD_IC**: light on when HPD_IC goes high, ie. Sink connection detected
   - **CEC_EN**: light on when CEC bus is enabled, ie V_{DD_CEC} and $V_{DD\_CEC\_IC}$ powered on
   - **DDC_EN**: light on when DDC bus is enabled: ie V_{DD_IC} and V_{DD_5V} powered on
6. **Switch SW2**: Enables or disables LED indicators
7. **Jumper J4**: powers on (or not) the LED indicators circuitry with +5 V from the main board
8. **Switch SW3**: simulates a short-circuit on 5 V_OUT, ie. accidental short-circuit of the HDMI cable



5.2 How to use the main board in standalone mode

The main board can be used without the daughterboard as a "plug and play" evaluation board, showing that the interface is working properly. It can also be used to demonstrate the ability of the HDMI2C1-14HD to drive a cable presenting a high capacitance load (poor quality or long HDMI cable).

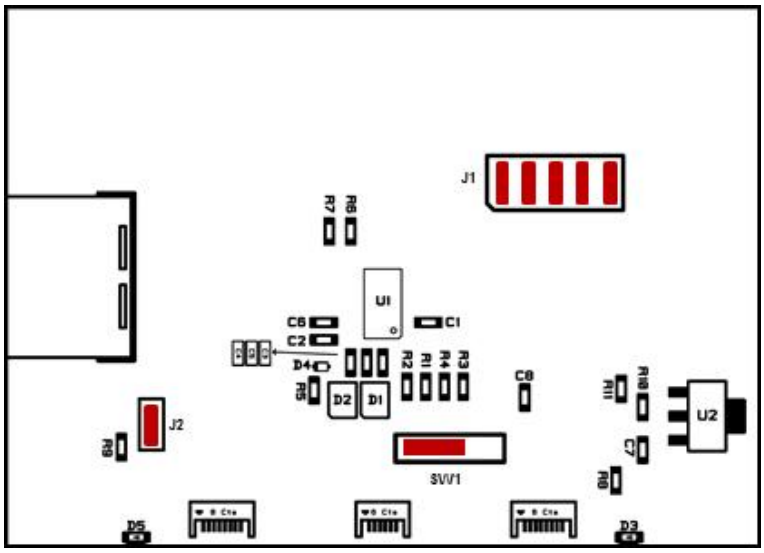
5.2.1 Main board configuration and connections

In order to use the main board in standalone (without the daughterboard), please set up the board as follows:

- **The SW1 switch must NOT be in the 5V_SOURCE position**. In this configuration, the +5 V is provided by the HDMI Source connector (box)
- **All the J1 jumpers must be CLOSED**. In this way, all the control signals coming from the Source connector (box) are connected to the HDMI2C1-14HD component (IC side).

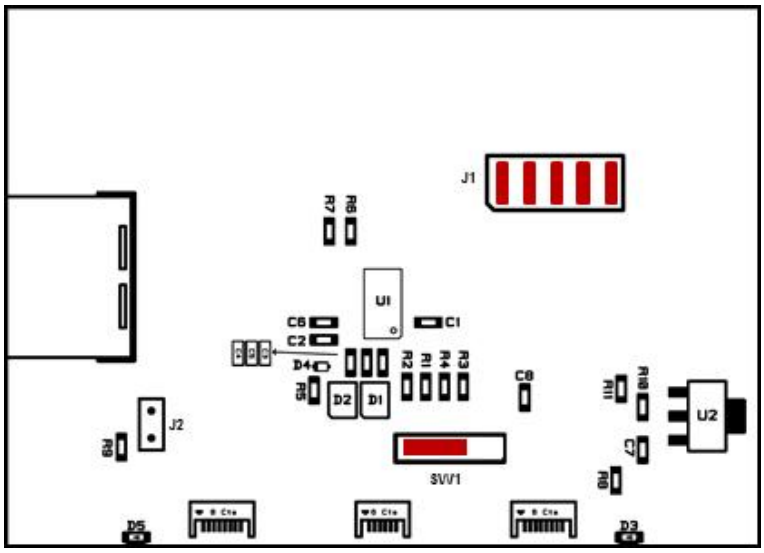
Figure 5. Main board configuration when used in standalone summarizes the key elements for proper usage of the main board in standalone mode.

Figure 5. Main board configuration when used in standalone



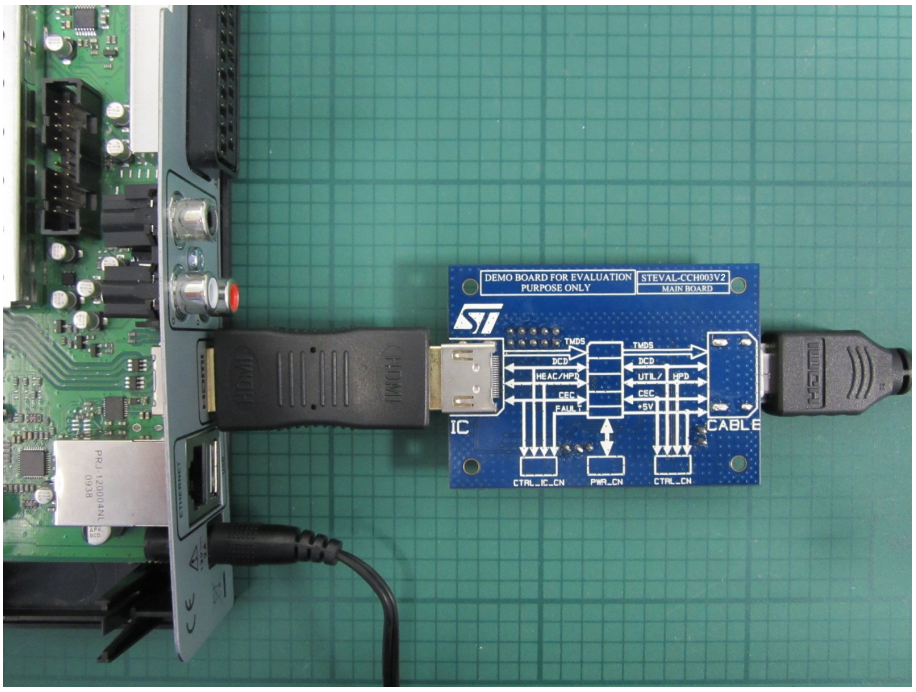
In order to reduce board power consumption, the J2 jumper can be left OPEN leading to disabling the 5 $V_{OUT\ LED}$ indicator. Figure 6. Main board configuration used in standalone and with LED indicator disabled illustrates this possible operating mode.

Figure 6. Main board configuration used in standalone and with LED indicator disabled



Connect the main board to the HDMI source device (box) with an HDMI male-to-male adapter on the SOURCE side. Connect the HDMI cable to the sink device (TV) on the CABLE side. Figure 7. Typical connection of the main board used in standalone mode illustrates the correct connection.

Figure 7. **Typical connection of the main board used in standalone mode**



5.2.2 Functional description in standalone

In the standalone mode configuration, the main board has no access either to the HDMI ASIC power supply (V_{DD_IC}) or to the standardized 3.3 V CEC power supply (V_{DD_CEC}). The main board has only access to the +5 V delivered by the Sink device (box) through the HDMI connector.

A voltage regulator is implemented on the main board in order to create the +3.3 V necessary to make the CEC bus functional.

The HDMI2C1-14HD is then used with the following power supply settings:

- V_{DD_5V} = +5 V (coming from the attached box)
- V_{DD_IC} = +5 V (coming from the attached box)
- V_{DD_CEC} = +3.3 V (coming from the on-board regulator)
- $V_{DD\_CEC\_IC}$ = +3.3 V (coming from the on-board regulator)

5.3 How to use the main board with the daughterboard

The daughterboard allows the user to perform various measurements of the HDMI control stage signals: DDC bus (SCL and SDA), CEC bus, HEAC lines, HPD line and optional FAULT line. The access is given to both sides of the HDMI2C1-14HD, i.e. the IC side and cable side. There are two types of accesses: test points for measurements, and micro connectors giving the possibility to act directly on the signals.

Furthermore, the daughterboard also gives access to the various power supplies needed to implement an HDMI interface. As for the control stage signals, the board embeds test points and micro connectors in order to perform various measurements and to act on each voltage value.

5.3.1 Daughterboard configuration

The daughterboard must be connected to the main board through three independent flat flexible cables (FFC). Then, connect the main board to the HDMI source device (box) with an HDMI male-to-male adapter on the SOURCE side. Connect the HDMI cable to the sink device (TV) on the CABLE side.

There are two possibilities to power the demonstration kit. Either use the +5 V provided by the source device at the source connector side (in this case, the daughterboard is powered by the main board), or use an external independent +5 V power supply (in this case, the main board is powered by the daughterboard).

5.3.2 Daughterboard powered by the main board

The evaluation kit (main board + daughterboard) could be used without any external power supply but the +5 V provided by the HDMI Source device (box). In this case, both boards are powered by the +5 V pin of the HDMI source connector. The configuration is described in Figure 8. Main board configuration and Figure 9. Daughterboard configuration, summarized as follows:

- The SW1 switch on the main board must be NOT in the “5 V_SOURCE” position
- The J2 jumper on the main board can be left OPEN to disable 5 V_OUT LED in order to reduce the power consumption
- The J4 jumper on the daughterboard must be closed to supply the LED indicator

Figure 8. Main board configuration

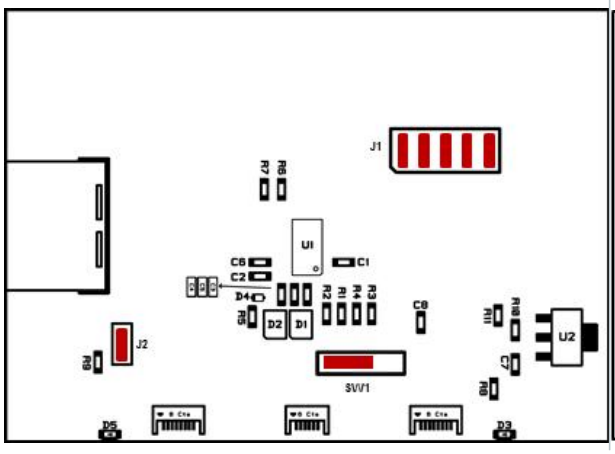
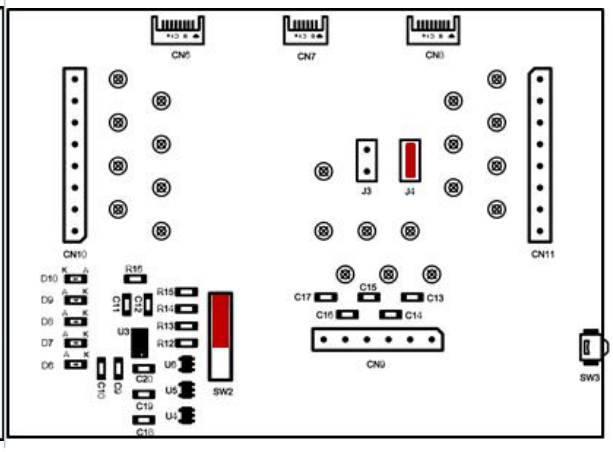


Figure 9. Daughterboard configuration



5.3.3 Main board powered by the daughterboard

The evaluation kit (main board + daughterboard) can be powered with a +5 V external power supply instead of the +5 V provided by the HDMI Source device (box). In this case, the +5 V external supply has to be connected to the daughterboard, and the daughterboard will power the main board. The configuration is described in Figure 10. Main board configuration (5V) and Figure 11. Daughterboard configuration (5V), summarized as follows:

- The SW1 switch on the main board MUST be set to the "5 V_{SOURCE}" position
- The J4 jumper on the daughterboard must be left OPEN, all the external power supplies are connected to the PWR connector (CN9)

Figure 10. Main board configuration (5V)

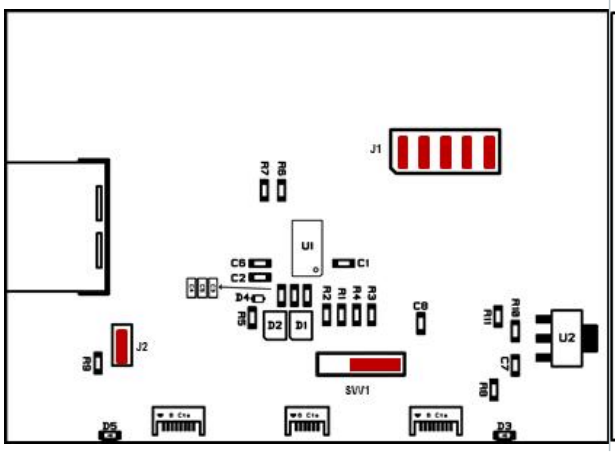
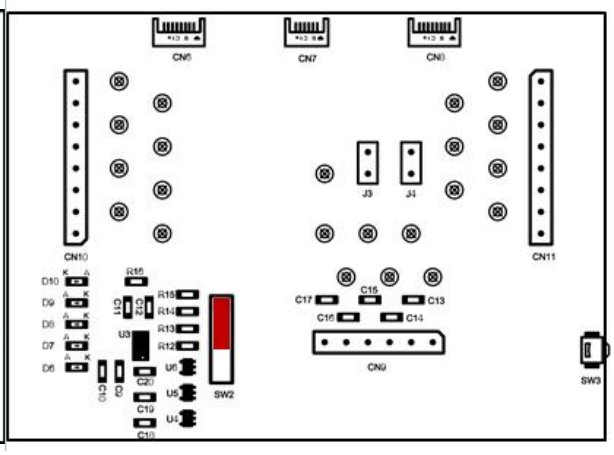


Figure 11. Daughterboard configuration (5V)



5.4 Electrical characteristics evaluation

The following sections explain the configuration and use of the board + daughterboard in order to evaluate the electrical characteristics and the features offered by the HDMI2C1-14HD.

5.4.1 Evaluation of the level shifter performance

Features

The HDMI2Cx-14HD provide signal conditioning circuitry on the DDC bus and CEC bus, allowing the voltage to be adapted from the external environment (+5 V or +3.3 V, defined by the HDMI standard) to the main ASIC power supply voltage (that can be as low as 1.8 V).

Test setup

The main board must be connected to and powered by the daughterboard. This test setup is described in the Section 5.3.3 Main board powered by the daughterboard. In this way, the input voltages on ASIC side can be set to the desired value.

An oscilloscope probe is used in order to measure the input and output signals on the DDC bus and on the CEC bus by using the test points on the daughterboard.

Typical test results

Figure 12. Typical waveform on DDC bus when V_{DD_IC} and $V_{DD\_CEC\_IC}$ are set to 3.3 V (communication from sink to source) and Figure 13. Typical waveform on DDC bus when V_{DD_IC} and $V_{DD\_CEC\_IC}$ are set to 1.8 V (communication from Sink to Source) illustrate the wide power supply voltage range that can be applied to the ASIC. The component properly shifts this ASIC low voltage to the standardized cable voltages (+5 V for the DDC bus, +3.3 V for the CEC bus).

Figure 12. Typical waveform on DDC bus when V_{DD_IC} and $V_{DD\_CEC\_IC}$ are set to 3.3 V (communication from sink to source)

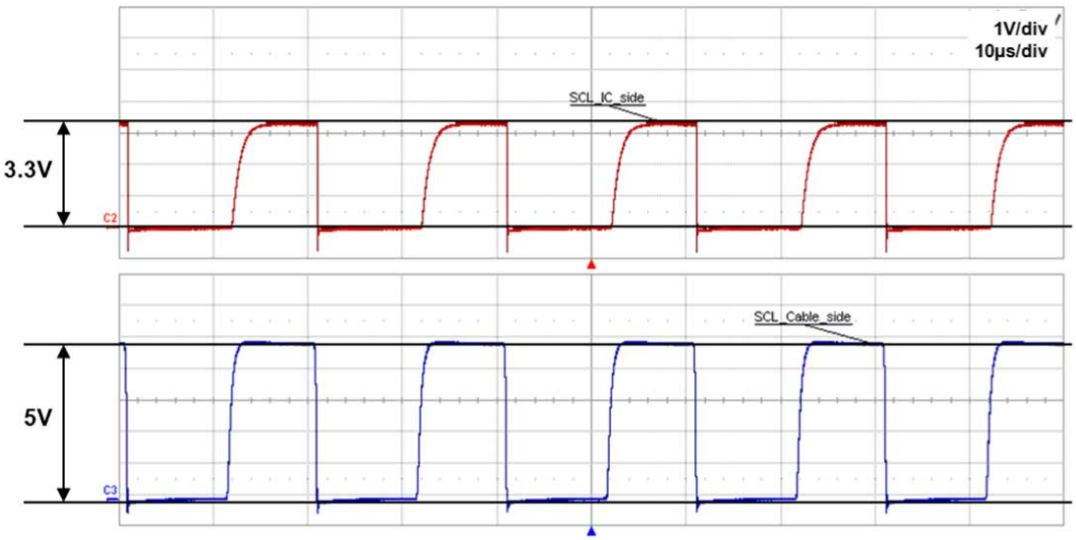
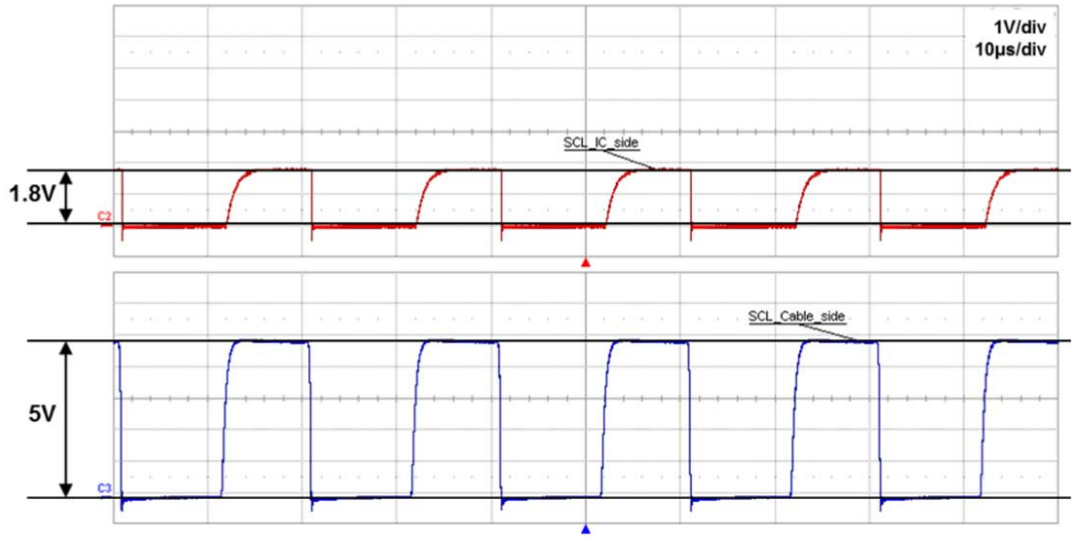


Figure 13. **Typical waveform on DDC bus when V_{DD_IC} and $V_{DD\_CEC\_IC}$ are set to 1.8 V (communication from Sink to Source)**



Conclusion

The HDMI2C1-14HD provides high flexibility to the HDMI interface designer, as any chipset technology (any power supply voltage as low as 1.8 V) can be used.

5.4.2 Evaluation of the DDC dynamic pull-up effect

Features

The DDC bus corresponds to an I2C bus. The HDMI cable presents a parasitic capacitance depending on its construction and on its length. The I²C standard specifies a maximum rise time of the signal in order to be sure that the Transmitter and Receiver are able to communicate properly.

An active pull-up resistor is implemented in the HDMI2Cx-14HD component on the cable side. When a source-to-sink communication is detected, the dynamic pull-up switches on during a brief moment in order to boost the charging time of the natural cable capacitance.

Test setup

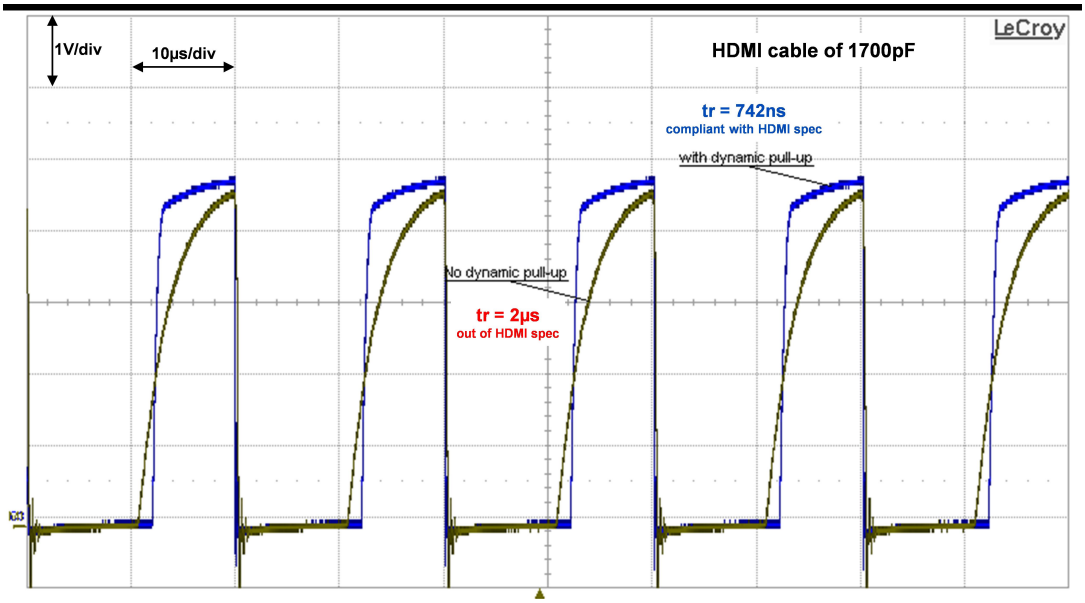
The main board must be connected to the daughterboard. The main board could be either powered by the +5 V pin of the HDMI source connector (please refer to Section 5.3.2 Daughterboard powered by the main board), or by the daughterboard connected to an independent power supply (please refer to Section 5.3.3 Main board powered by the daughterboard

Whatever the configuration selected, we start a communication process on the DDC bus. An oscilloscope probe has to be connected on the SCL and SDA lines, on the cable side, in order to measure the rise time of the signals with various cable types and sizes.

Typical test results

Figure below illustrates the behavior of the dynamic pull-up and the value of the rise time according to different cable characteristics.

Figure 14. **Typical waveform on SCL and SDA lines with a 1.7 nF HDMI cable**



Conclusion

Regarding the DDC electrical characteristics, the HDMI standard refers to the I²C specification. The maximum rise time is specified to be lower than 1 µs with a global load capacitance of 750 pF. The HDMI2Cx-14HD allows the application to be compliant with the maximum rise time, even with a higher specified capacitance value. The system is then presenting a high interoperability level, and is able to work properly with poor quality and long HDMI cables.

5.4.3 Evaluation of the short-circuit protection

Features

The HDMI standard specifies that the transmitter must provide a +5 V power supply voltage to the HDMI cable that must be protected against accidental short-circuit. The HDMI2C1-14HD embeds a current limiter that is able to limit accidental overcurrent and even open the +5 V supply in case of accidental short-circuit. A feedback signal is even proposed in order to inform the ASIC that a failure has been detected.

Test setup

The main board must be connected to the daughterboard. The main board could be powered by the +5 V pin of the HDMI source connector (please refer to Section 5.3.2 Daughterboard powered by the main board) or by the daughter board connected to an external power supply source (please refer to Section 5.3.3 Main board powered by the daughterboard).

The evaluation board allows the user to simulate an accidental short-circuit in two different ways:

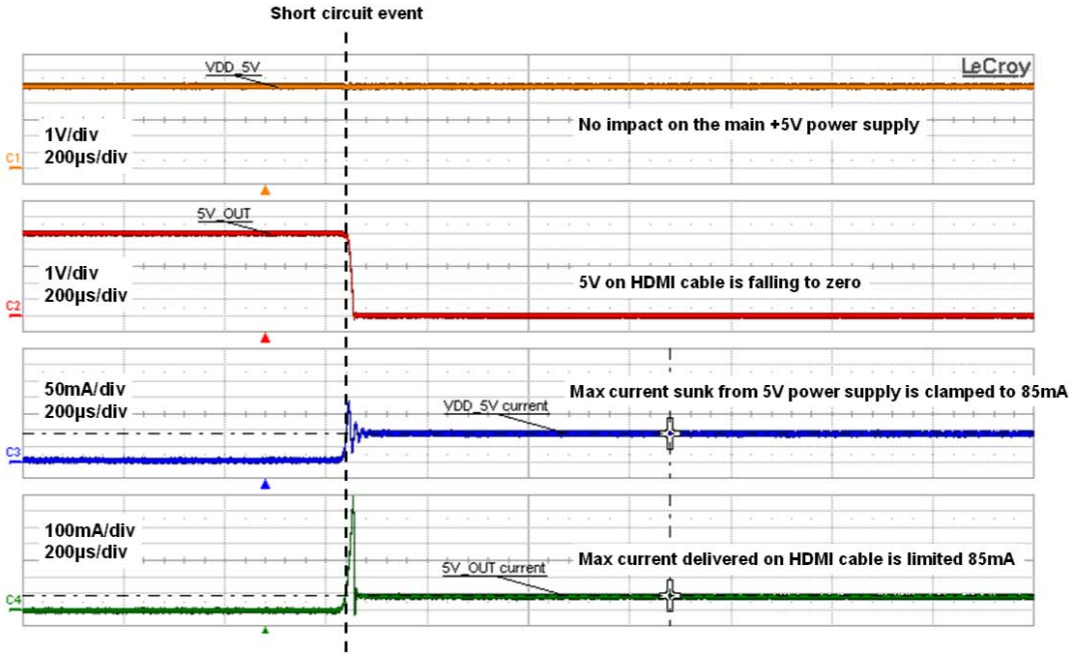
- For a temporary short-circuit: push on the 5 V_OUT_CC switch on the daughterboard
- For a permanent short-circuit: connect the 5 V_OUT pin to GND pin to the daughterboard's CRTL connector

During the short-circuit event, the FAULT pin goes from high to low level. If the LED indicator is enabled (SW2 switch on daughterboard set to ON), the FAULT LED is lit ON. Furthermore, the HPD LED is switched OFF, because the +5 V provided to the cable is shorted. The communication between the source and the sink is then stopped. Once the short-circuit disappears, the communication can restart and the application (Source device, but also sink device) has been protected.

Typical test results

Figure below illustrates the operating mode of the HDMI2C1-14HD in case of accidental shortcircuit detection.

Figure 15. **Protection against accidental short-circuit**



The +5 V provided to the cable falls to zero (accidental short-circuit on the cable), and the HPD signal at the source side is then pulled down, leading to stop the communication protocol. Furthermore, the FAULT line is pulled down, informing the ASIC that an abnormal situation has been detected.

During the short-circuit, the current flowing through the cable (and sunk from the power supply) is limited to a typical value of 85 mA, in line with the HDMI specification.

Conclusion

The HDMI2C1-14HD makes the application compliant with the HDMI specification (current limited in any case). The HDMI interface is rendered robust, protecting the whole application against external stresses. Furthermore, the optional FAULT pin gives the opportunity to enhance communication through the user interface.

5.4.4 Standby mode: low-power consumption and wake-up via CEC

Features

The final user keeps control of the video chain in set-top box applications with the smart remote control (using the CEC bus), and at the same time limits the power consumption (which may even be mandated by law) as low as possible.

In HDMI standby mode, the CEC driver has to be powered in low-power mode (monitor request from the final user to wake up the application), while all other functions such as DDC bus, +5 V, V_{DD_IC}, MPEG ASIC, etc. have to be switched off.

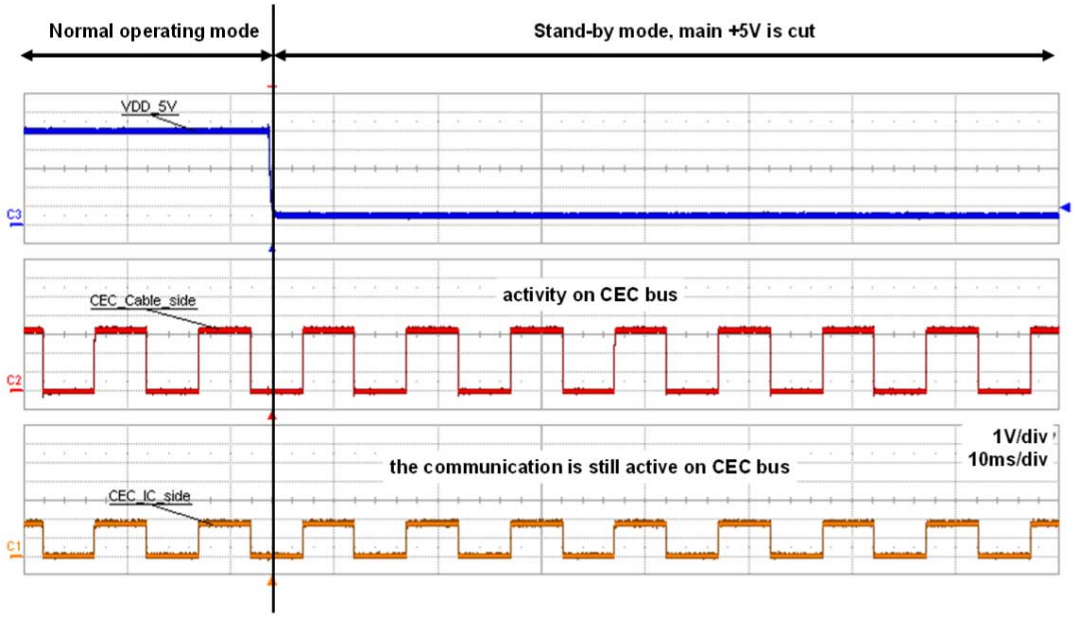
Test setup

The main board must be powered by the daughterboard connected to external power supplies (please refer to Section 5.3.3 Main board powered by the daughterboard). The main +5 V and VDD_IC power supplies have to be set to zero. V_{DD_CEC} has to be set to 3.3V, and $V_{DD\_CEC\_IC}$ has to be set to a value as low as 1.8 V.

Typical test result

Figure below illustrates the fact that, even if +5 V and VDD_IC are switched down to zero (shown by the fact that the 5 V and VDD_IC LEDs are off), the CEC bus is working properly. The CEC level shifter block integrated in the HDMI2Cx-14HD component is totally independent of the other functional blocks.

Figure 16. **Communication on the CEC bus is still maintained even in standby mode**



Conclusion

The HDMI2C1-14HD allows the designer to implement a smart standby wake-up of the application, and at the same time allows a drastic reduction of the power consumption in standby. Therefore, the application can be compliant with the most stringent ecofriendly standard in the world, without any sacrifice to the user's experience.

Revision history

Table 3. **Document revision history**

Date	Version	Changes
06-Jun-2013	1	Initial release.
08-May-2019	2	Replace STEVAL-CCH003V1 with STEVAL-CCH003V2

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