Display Solution
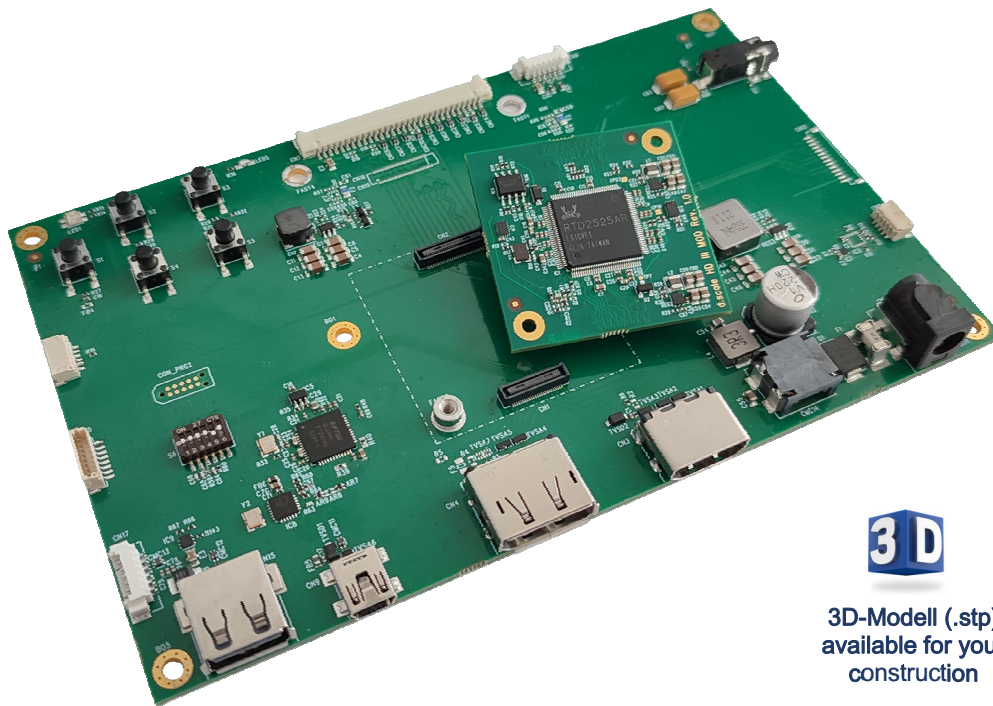### Competence in Digital Visualisation

d.scale-HDIII-Carrier

Datasheet

Carrier Board for
d.scale-HDIII-Module

3D

3D-Modell (.stp)
available for your
construction

Rev 1.2

November, 2023

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Revision History

Date	Rev	Description	Page
July, 2023	1.0	First draft	
October, 2023	1.1	3.23 Display & Backlight Control: VL_SW/Selected Voltage corrected	10
		3.2.5 Peripherals: Remark regarding FW-support added	13
		4.7 Power Supply / CN11: "Signal" & "Description" corrected, 12V only.	17
		5.1 Operating Values: Supply voltages adjusted	19
Nov.-02 2023	1.2	3.2.1 LVDS Data Channels: Add important note regarding termination of TXBCLK+/- in LVDS single-channel configurations	10

1   General Description

The d.scale-HDIII-CAR is a carrier board for the d.scale-HDIII-Module. With the help of this board all functions of the d.scale-HDIII module can be evaluated. An on-board programmer enables programming of the plugged-in module via USB. The integrated USB 2.0 high-speed hub controller also provides two downstream ports for connecting additional USB peripherals such as a touch controller.

2   Features

2.1 Video Input Interfaces

d.scale-HDIII-CAR provides the following two video-inputs:

- HDMI 19-pin connector
- DisplayPort 20-pin connector

2.2 LCD-TFT Output Interfaces

The d.scale-HDIII-CAR provides interfaces in order to support a wide range of LCD-TFT displays.

- LCD-TFT connection
    - Provides single/double pixel LVDS output
    - Support for 8 or 6-bit LVDS
    - LCD-Logic-supply +3.3V/+5V GPIO-controlled by the module

- Backlight supply/control connection
    - +12V power supply
    - Provides backlight-enable (+3.3V signal level)
    - PWM-signal (+3.3V signal level) output for brightness-control

2.3 Additional Interfaces and on-board peripherals

In order to evaluate further features the d.scale-HDII-module supports the following on-board options and interfaces are provided.

- OSD-control
    - Onboard keypad
    - Interface for an external keypad and dual status LED
- A dual on-board status LED
- 3.5mm audio jack for direct connection of a stereo-headphone
- On-board I2C sensors
    - 3-axis Gyro-sensor for Pivot-functionality
    - temperature sensor
- I^{2}C-interface for external connection

2.4 On-board Programmer

The d.scale-HDIII-Carrier Board has an integrated programmer, which allows the user to program the attached module directly via USB and thus enables a comprehensive evaluation of the entire system without additional equipment. The corresponding development and programming environment is also provided.

2.5 USB-Hub-functionality

The on-board USB 2.0 high-speed controller provides an additional internal and external USB downstream-port each. These USB ports can be used to connect additional system peripherals such as a touch controller to evaluate the entire application as easily and fully as possible

2.6 Power Supply

The d.scale-HDIII-CAR requires a single +12 supply, only. All further required voltages are generated on-board.

3　d.scale-HDIII-Module Interface

The d.scale-HDIII-CAR provides 2 connectors (CN1 & CN2) for interfacing d.scale-HDIII-MOD

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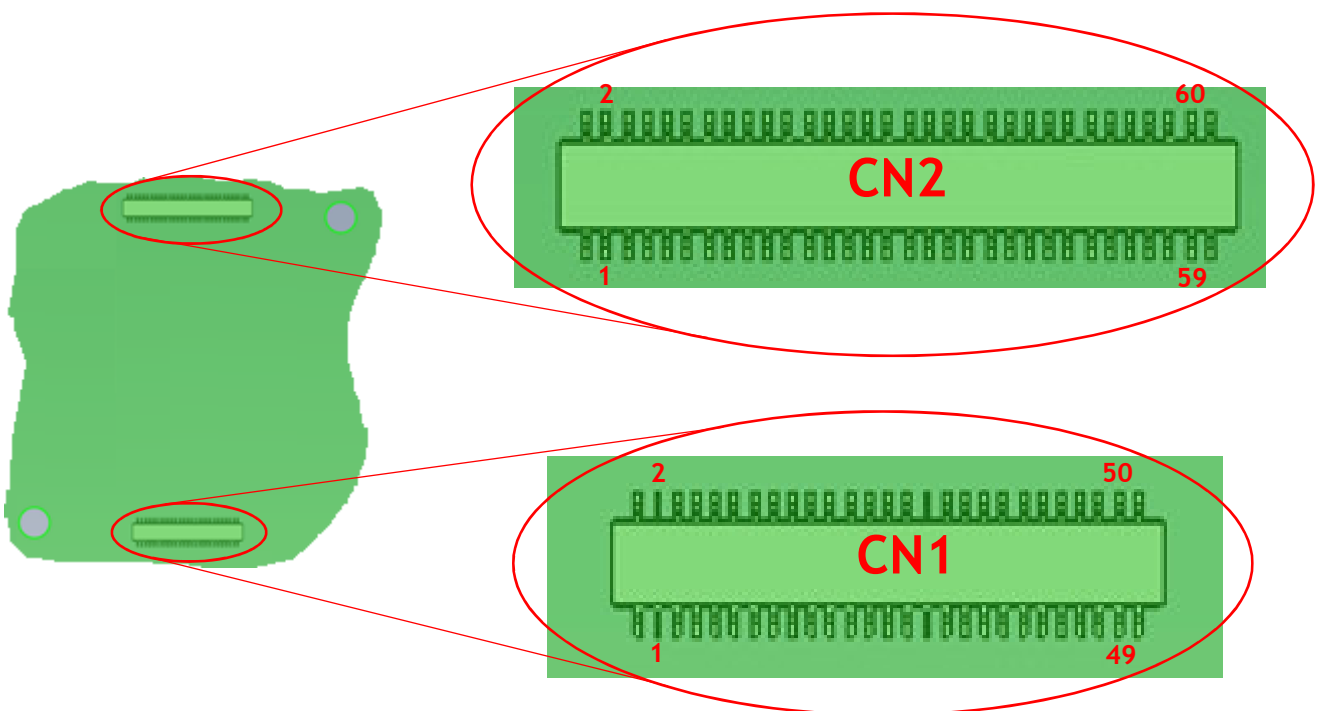
3.1 Output Interface to d.scale-HDIII-MOD - Connector CN1

Pin	Signal	Description	Pin	Signal	Description
1	GND	Ground	26	FLASH_WP	
2	GND	Ground	27	HDMI_RXC-	Differential TMDS Clock-
3	DP_D0+	Lane 0 (positive)	28	3.3V_PRG	+3.3V supply for programming
4	DP_AUX-	Auxiliary channel (negative)	29	HDMI_RXC+	Differential TMDS Clock+
5	DP_D0-	Lane 0 (negative)	30	GND	Ground
6	DP_AUX+	Auxiliary channel (positive)	31	GND	Ground
7	GND	Ground	32	HDMI_HPD	Hot Plug Detect
8	GND	Ground	33	HDMI_RX0-	Differential TMDS Data 0-
9	DP_D1+	Lane 1 (positive)	34	HDMI_+5V	+5V/50mA (by graphics card)
10	DP_CAB_DET	DP Cable detect *1	35	HDMI_RX0+	Differential TMDS Data 0+
11	DP_D1-	Lane 1 (negative)	36	HDMI_CAB_DET	HDMI Cable detect *1
12	DP_HPD	Hot plug detect	37	GND	Ground
13	GND	Ground	38	HDMI_DDC_SDA	DDC EDID data
14	GND	Ground	39	HDMI_RX1-	Differential TMDS data 1-
15	DP_D2+	Lane 2 (positive)	40	HDMI_DDC_SCL	DDC EDID clock
16	SPI_SW_RT	Pull to +3.3V for programming	41	HDMI_RX1+	Differential TMDS data 1+
17	DP_D2-	Lane 2 (negative)	42	FITP	For internal test purpose *2
18	SCLK_PRG	Serial clock	43	GND	Ground
19	GND	Ground	44	RFU	Reserved for future use *2
20	SDIN_PRG	Serial input	45	HDMI_RX2-	Differential TMDS data 2-
21	DP_D3+	Lane 3 (positive)	46	+5.0V	Module power supply
22	SDOUT_PRG	Serial output	47	HDMI_RX2+	Differential TMDS data 2+
23	DP_D3-	Lane 3 (negative)	48	+5.0V	Module power supply
24	SCE_PRG	Chip select	49	GND	Ground
25	GND	Ground	50	+5.0V	Module power supply

*1 Can be connected to one of the cable GND-pins to detect cable-connection. If not used please connect to GND
*2 Do not connect.

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3.1.1   Reference Pin-Assignments

**DisplayPort
CN4**
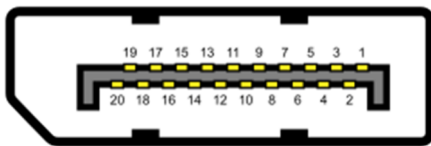
Pin	Signal	Description
1	DP_D0+	Lane 0 (positive)
2	GND	Lane 0 Shield - Ground
3	DP_D0-	Lane 0 (negative)
4	DP_D1+	Lane 1 (positive)
5	GND	Lane 1 Shield - Ground
6	DP_D1-	Lane 1 (negative)
7	DP_D2+	Lane 2 (positive)
8	GND	Lane 2 Shield - Ground
9	DP_D2-	Lane 2 (negative)
10	DP_D3+	Lane 3 (positive)
11	GND	Lane 3 Shield - Ground
12	DP_D3-	Lane 3 (negative)
13	Config1	Connected to GND
14	Config2	Connected to GND
15	DP_AUX+	Auxiliary Channel (positive)
16	GND	Aux Shield - Ground
17	DP_AUX-	Auxiliary Channel (negative)
18	DP_HPD	Hot Plug Detect
19	Return (GND)	Return for Power
20	DP_PWR	Power for Connector (3.3V/500mA)

**HDMI
CN3**
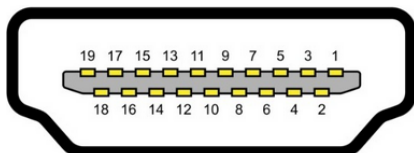
Pin	Signal	Description
1	TMDS2+	Differential TMDS Data 2+
2	GND	TMDS Data2 Shield - Ground
3	TMDS2-	Differential TMDS Data 2-
4	TMDS1+	Differential TMDS Data 1+
5	GND	TMDS Data1 Shield
6	TMDS1-	Differential TMDS Data 1-
7	TMDS0+	Differential TMDS Data 0+
8	GND	TMDS Data0 Shield
9	TMDS0-	Differential TMDS Data 0-
10	TMDSCLK-	Differential TMDS Clock-
11	GND	TMDS Clock Shield
12	TMDSCLK+	Differential TMDS Clock+
13	RSV	Reserved
14	RSV	Reserved
15	SCL	DDC EDID clock
16	SDA	DDC EDID data
17	DDC/CEC GND	Ground
18	+5V	+5V/50mA (by graphics card)
19	HPD	HotPlug Detect

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Programming Interface

As reference the table below shows the connection of the programming signals to the firmware SPI-flash
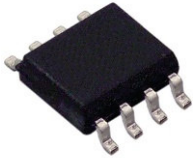
IC Pin	Signal	Description
1	SCE_PRG	Chip select
2	SDO_PRG	Serial output
3	FLASH_WP	Write protect (is pulled high)
4	GND	Ground
5	SDI_PRG	Serial input
6	SCLK_PRG	Serial clock
7	Hold#	Hold (is pulled high)
8	VDD	Device power supply

SPI_SW_RT

This pin has to be pull to +3.3V to connect the SPI-Flash device of the d.scale-HDIII-MOD to the programming interface of CN1

3.3V_PRG

If an external CHIP-programmer is used, usually the SPI-Flash chip supply can be connected to this pin. This pin does not have to be powered, if the d.scale-HDIII-module is powered up via CN1 pins 46, 48, 50.

3.1.2 Power Supply

On pins 48, 49 and 50 a 5.0V supply voltage has to be provided to power up the d.scale-HDIII-MOD. Please see the "Electrical Characteristics" for power consumption and tolerances.

3.2 Input Interface from d.scale-HDIII-MOD - Connector CN2

Pin	Signal	Description	Pin	Signal	Description
1	FITP	For internal test purpose *1	31	ENBKL	Enable display backlight
2	GND	Ground	32	GND	Ground
3	KEY_REF	Keypad reference voltage *2	33	GND	Ground
4	TXA0-	LVDS / Channel-1 / Data-Pair-0	34	TXB0-	LVDS / Channel-2 / Data-Pair-0
5	RFU	Reserved for future use *1	35	RFU	Reserved for future use *1
6	TXA0+	LVDS / Channel-1 / Data-Pair-0	36	TXB0+	LVDS / Channel-2 / Data-Pair-0
7	RFU	Reserved for future use *1	37	PERI_SCL	I^2C-clock for Peripherals
8	GND	Ground	38	GND	Ground
9	RFU	Reserved for future use *1	39	PERI_SDA	I^2C-data for Peripherals
10	TXA1-	LVDS / Channel-1 / Data-Pair-0	40	TXB1-	LVDS / Channel-2 / Data-Pair-1
11	GND	Ground	41	GND	Ground
12	TXA1+	LVDS / Channel-1 / Data-Pair-0	42	TXB1+	LVDS / Channel-2 / Data-Pair-1
13	KEY	OSD Keypad Input	43	RFU	Reserved for future use *1
14	GND	Ground	44	GND	Ground
15	LED1	Status-LED 1	45	RFU	Reserved for future use *1
16	TXA2-	LVDS / Channel-1 / Data-Pair-0	46	TXB2-	LVDS / Channel-2 / Data-Pair-2
17	LED2	Status-LED 2	47	RFU	Reserved for future use *1
18	TXA2+	LVDS / Channel-1 / Data-Pair-0	48	TXB2+	LVDS / Channel-2 / Data-Pair-2
19	RFU	Reserved for future use *1	49	RFU	Reserved for future use *1
20	GND	Ground	50	GND	Ground
21	RFU	Reserved for future use *1	51	GND	Ground
22	TXACLK-	LVDS / Channel-1 / Clock-Pair	52	TXBCLK-	LVDS / Channel-2 / Clock-Pair
23	GND	Ground	53	AUDIO_HOUTL	Headphone-output, left
24	TXACLK+	LVDS / Channel-1 / Clock-Pair	54	TXBCLK+	LVDS / Channel-2 / Clock-Pair
25	ENVCC	Enable display logic supply	55	AUDIO_HOUTR	Headphone-output, right
26	GND	Ground	56	GND	Ground
27	VL_SW	Display logic supply select	57	RFU	Reserved for future use *1
28	TXA3-	LVDS / Channel-1 / Data-Pair-3	58	TXB3-	LVDS / Channel-2 / Data-Pair-3
29	BRC_PWM	Brightness-control PWM-signal	59	GND	Ground
30	TXA3+	LVDS / Channel-1 / Data-Pair-3	60	TXB3+	LVDS / Channel-2 / Data-Pair-3

*1 Do not connect

*1 This pin is a +3.3V output which can be used as keypad reference voltage. Maximum output is 25mA

3.2.1 LVDS-Data Channels

The d.scale-HDIII-MOD provides one or two LVDS data channels and supports 6-bit and 8-bit (per colour) displays.

Single channel
Usually LCD-TFT displays with resolutions from VGA (640x480) up to XGA (1024x768) / WXGA (1366x768) are equipped with a single channel LVDS interface whereas with each clock-cycle the data for one pixel is transmitted

These displays have to be connected to the **TXA...- Channel**

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> **NOTE:**
> If a LCD-TFT display with single-channel LVDS is connected it is essential to ensure that the TXBCLK+/- differential pair is terminated with a 100 Ohm resistor.
> • If only single channel LVDS is used in the design, please place the terminating resistor close to CN2
> • If single and dual channel LVDS is used in the design, please place the terminating resistor close to the design's output connector.
>
> On the d.scale-HDIII-Carrier board the termination resistor is R22
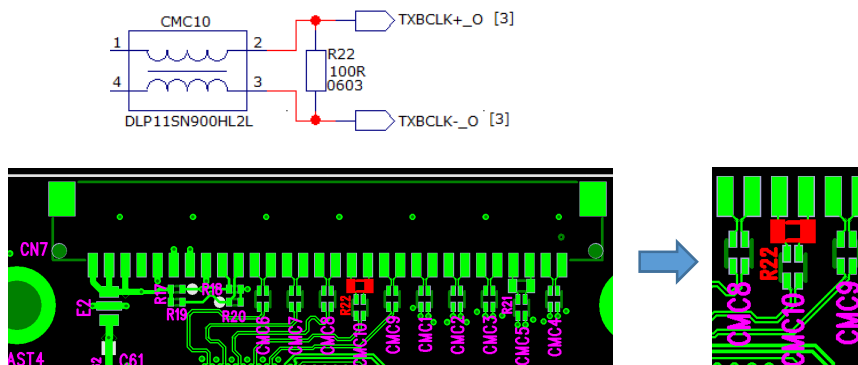
Dual channel

LCD-TFT displays with resolutions from SXGA (1280x1024) up to FHD (1280x1080) / WUXGA (1920x1200) are equipped with a dual channel LVDS interface, whereas with each clock-cycle the data for two pixels is transmitted

These displays have to be connected to the **TXA...- Channel** & **TXB…- Channel**

NOTE
TXA...- Channel
This channel provides the data for the 1. / 3. / 5. / … pixel

TXB…- Channel
This channel provides the data for the 2. / 4. / 6. / … pixel

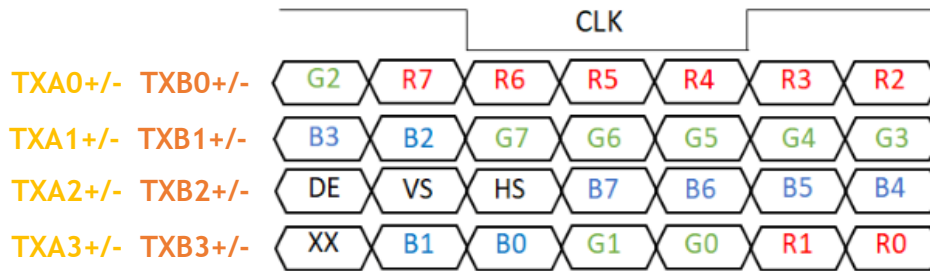## 3.2.2 LVDS Data Mapping

Historically, 2 LVDS data mappings have been established, known by different names

Data-Mapping-1 **known as:**
  • Conventional data-mapping
  • Open-LDI data-mapping
  • JEIDA data-mapping

Characteristics
The LVDS data-pairs TXA3+/- & TXB3+/- transmits the LSBits of each color namely Red-0/Red-1, Green-0/Green-1, Blue-0/Blue-1
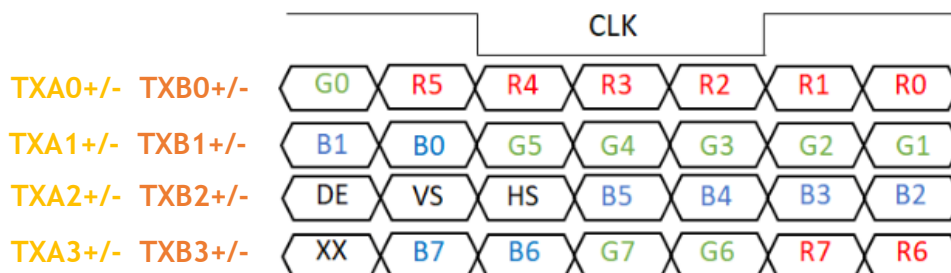
Color-Depth
- Displays with 18-bit color-depth (262K colors) requires TX..0+/- to TX..2+/-
- Displays with 24-bit color-depth (16Mio colors) requires TX..0+/- to TX..3+/-

***Data-Mapping-2* known as:**
- Non-Conventional data-mapping
- VESA data-mapping

Characteristics
The LVDS data-pairs TXA3+/- & TXB3+/- transmits the MSBits of each color namely Red-6/Red-7, Green-6/Green-7, Blue-6/Blue-7

Color-Depth
This data-mappings supports 24-bit color depth (16Mio colors), ONLY.

3.2.3 Display & Backlight Control

In order control the LCD-TFT display and the according backlight the following signals are provided. The power-on/off sequence is controlled by firmware and can be adjusted by the user.

ENVCC
ENVCC is used to enable the supply voltage of the display logic and features the following characteristics:
- Active high
- Push/pull
- +3.3V signal level

VL_SW

VL_SW can be used to ensure by an user configurable firmware setting, that the correct logic-supply voltage is provided to the connected display. Usually it is used to adjust the voltage either to +3.3V or +5.0V.

VL_SW	Selected Voltage
High	+5.0V
Low	+3.3V

VL_SW has the following characteristics:
- Push/pull
- +3.3V signal level

ENBKL

ENBKL is used to enable the backlight inverter circuitry and has the following characteristics:
- Active high
- Push/pull
- +3.3V signal level

BRC_PWM

BRC_PWM is a pulse-width-modulated signal which is used to control the panel's backlight brightness. The PWM-characteristics (e.g. frequency, min/max, etc.) can be adjusted by the user via firmware settings. The signal features the following characteristics:
- Positive PWM
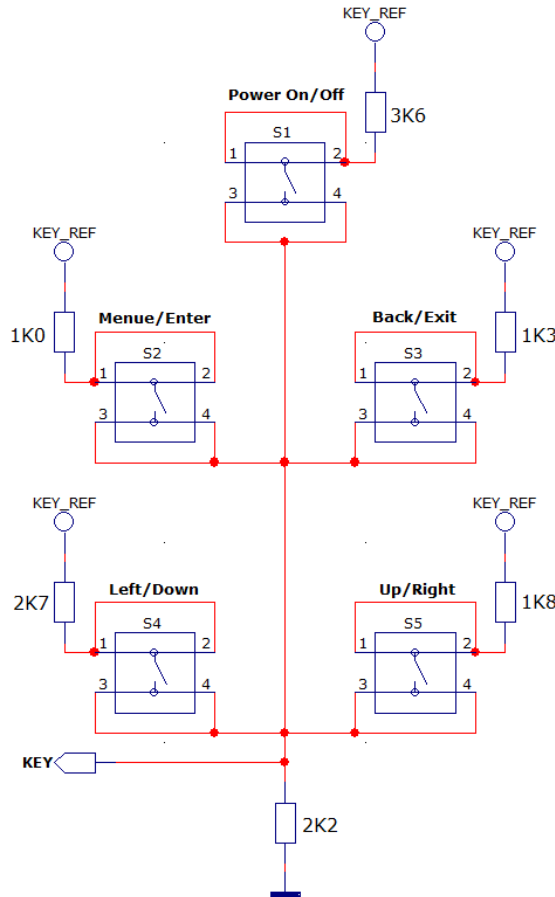- Push/pull
- +3.3V signal level

3.2.4 Scaler Control & Status

Keypad

The d.scale-HDIII-MOD supports an external keypad to control the OSD-menu. It supports the following buttons:

- Button S1 for power on/off the scaler,

- Button S2 to enter the menu respectively confirm selection
- Button S3 to exit the menu respectively to go one step back
- Button S4 to move left/down respectively decrease the selected value depending on the selected menu status
- Button S5 to move right/up respectively increase the selected value depending on the selected menu status

Depending on the key pressed, the voltage value returned via KEY is evaluated. Below the required resistor values are shown. The reference voltage KEY_REF is +3.3V and can be drawn from the KEY_REF pin.

Status LEDs

In order to show different system states two GPIOs (push-pull, max.10mA) are available. These GPIOs are provided on CN2 on pins LED1 and LED2. The table below shows the states.
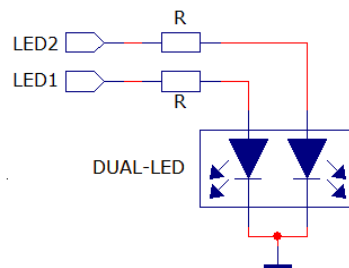
Description	LED1	LED2
Power-off / Standby	Off	Off
Power-on / System start-up, splash-screen is displayed Power-on / No valid video input detected	Off	On
Power-on / Valid video input detected	On	Off
Power-on / no valid video input detected / go to sleep	On	On

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3.2.5 Peripherals

I²C-Interface

The d.scale-HDIII-MOD provides an I²C-Interface for connection of useful peripheral devices. The devices can be controlled via the DDC/CI (MCCS) which is a standardized channel by VESA. As physical interface the DDC (HDMI) or the AUX-channel (DisplayPort) is used, which means, that no additional connection like USB or UART is required. The user can select and configure the devices in the firmware configuration tool.

Currently the following devices are supported:

- STMIcro / LIS3DH
  3-axis Gyro-sensor for Pivot-functionality
- Texas Instruments / TMP102
  Temperature sensor
- Texas Instruments / OPT3001
  ambient-light sensor

Analog Audio output

Via the two pins AUDIO_HOUTL and AUDIO_HOUTR an analog stereo headphone signal is provided.

Remark: I2C peripherals and analog audio output will be supported with firmware Release 2.0!

4　Connectors

4.1　Video Input

CN3　HDMI

Pin CN23	Signal	Description
1	TMDS2+	Differential TMDS Data 2+
2	TMDS2_SHLD	TMDS Data2 Shield
3	TMDS2-	Differential TMDS Data 2-
4	TMDS1+	Differential TMDS Data 1+
5	TMDS1_SHLD	TMDS Data1 Shield
6	TMDS1-	Differential TMDS Data 1-
7	TMDS0+	Differential TMDS Data 0+
8	TMDS0_SHLD	TMDS Data0 Shield
9	TMDS0-	Differential TMDS Data 0-
10	TMDSCLK-	Differential TMDS Clock-
11	TMDSCLK_SHLD	TMDS Clock Shield
12	TMDSCLK+	Differential TMDS Clock+
13	RSV	Reserved
14	RSV	Reserved
15	SCL	DDC EDID data clock
16	SDA	DDC EDID data
17	DDC/CEC GND	Ground
18	+5V	+5V / 50mA (sink, for HPD & DDC/EDID)
19	HPD	HotPlug Detect
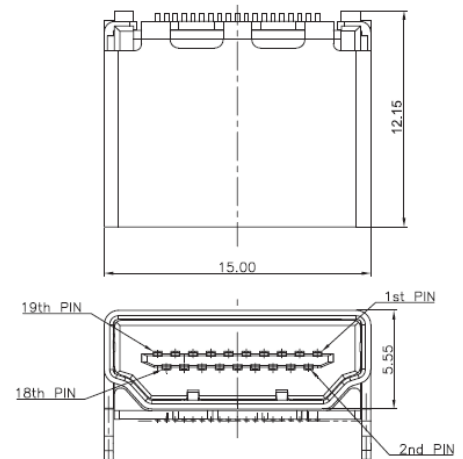
CN4　DisplayPort

Pin CN12	Signal	Description
1	ML_Lane 0 (p)	Lane 0 (positive)
2	GND	Ground
3	ML_Lane 0 (n)	Lane 0 (negative)
4	ML_Lane 1 (p)	Lane 1 (positive)
5	GND	Ground
6	ML_Lane 1 (n)	Lane 1 (negative)
7	ML_Lane 2 (p)	Lane 2 (positive)
8	GND	Ground
9	ML_Lane 2 (n)	Lane 2 (negative)
10	ML_Lane 3 (p)	Lane 3 (positive)
11	GND	Ground
12	ML_Lane 3 (n)	Lane 3 (negative)
13	Config1	Connected to GND
14	Config2	Connected to GND
15	AUX CH (p)	Auxiliary Channel (positive)
16	GND	Ground
17	AUX CH (n)	Auxiliary Channel (negative)
18	Hot Plug	Hot Plug Detect
19	Return	Return for Power
20	DP_PWR	Power for Connector (3.3V/500mA)
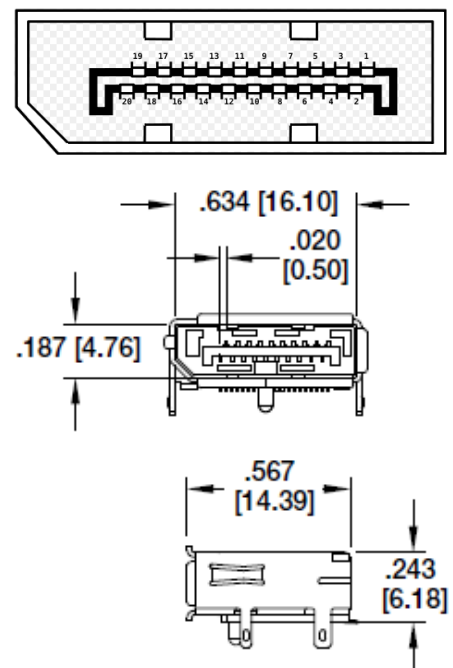
4.2 Video Output

CN7 LVDS Output

Pin	Signal	Description	Pin	Signal	Description
1	TXA3+	LVDS data 1st pixel	16	TXB2-	LVDS data 2nd pixel
2	TXA3-	LVDS data 1st pixel	17	TXB1+	LVDS data 2nd pixel
3	TXACL+	LVDS clock 1st pixel	18	TXB1-	LVDS data 2nd pixel
4	TXACL-	LVDS clock 1st pixel	19	TXVB0+	LVDS data 2nd pixel
5	TXA2+	LVDS data 1st pixel	20	TXVB0-	LVDS data 2nd pixel
6	TXA2-	LVDS data 1st pixel	21		
7	TXA1+	LVDS data 1st pixel	22	SCD_1	Scan Direction
8	TXA1-	LVDS data 1st pixel	23		
9	TXA0+	LVDS data 1st pixel	24	GND	Ground
10	TXA0-	LVDS data 1st pixel	25		
11	TXB3+	LVDS data 2nd pixel	26		
12	TXB3-	LVDS data 2nd pixel	27		Switched panel power supply +3,3V/ +5V/ +12V (fused)
13	TXBCL+	LVDS clock 2nd pixel	28	SVCC	
14	TXBCL-	LVDS clock 2nd pixel	29		
15	TXB2+	LVDS data 2nd pixel	30		

A = 42,45 mm
B = 36,25 mm
C = 41,45 mm
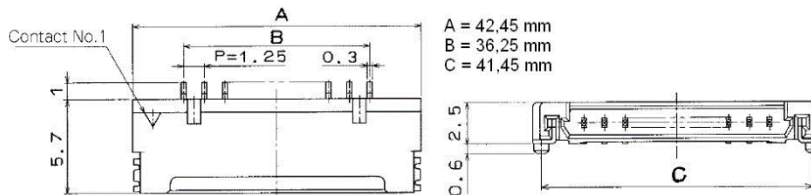
4.3 Backlight

CN8   Backlight Power Supply & Control

Pin	Signal	Description
1	BPS	Backlight power supply
2	BPS	Backlight power supply
3	EBKL	Enabel backlight signal
4	BRCTRL	Brightness Control
5	GND	Ground
6	GND	Ground
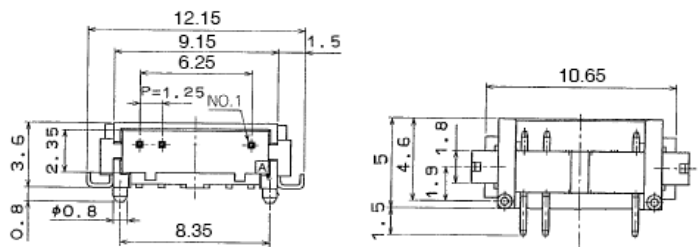
4.4 Board Control

CN5   Keypad Control

Pin	Signal	Description
1	KP_DRV	Reference Voltage for Voltage Devider - ONLY
2	LED_1	Red Status LED
3	LED_2	Green Status LED
4	Key	Voltage Divider Feedback
5	+3.3V	3.3V Low Power Supply
6	GND	Ground
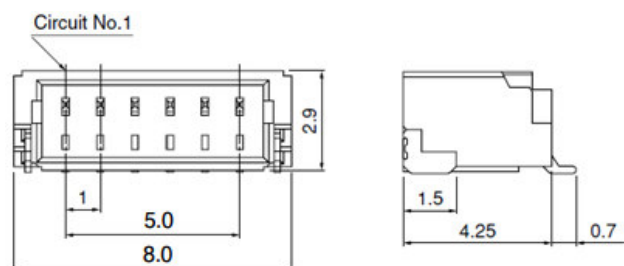
4.5 Peripherals

CN6   I2C-Interface

Pin	Signal	Description
1	+3.3V	3.3V Low power supply
2	Peri_SDA	I^{2}C data
3	PERI_SCL	I^{2}C clock
4	I2C_S_INT	Reserved for future use
5	GND	Ground
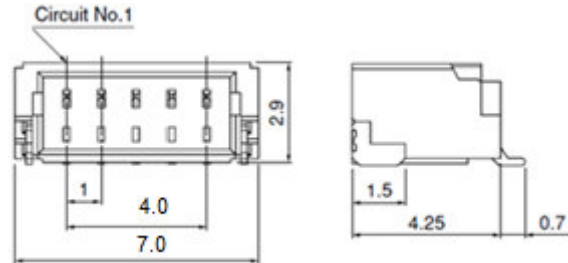
CN12   Audio / Headphone Output

Pin	Signal	Description
1	GND	Ground
2	HOUT_L	Headphone output left
3	HOUT_R	Headphone output right
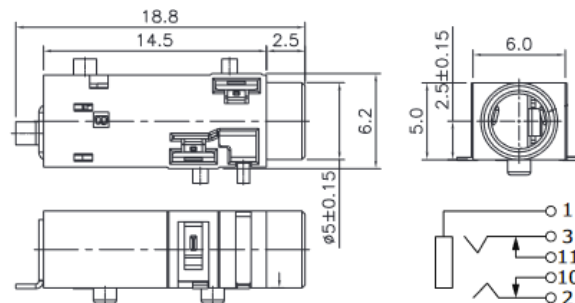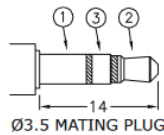
CN10   ISP-Interface

Pin	Signal	Description
1	3.3V_PRG	3.3V programming supply
2	SCLK_PRG	Serial clock
3	MOSI_PRG	Master-out/slave-in data
4	MISO_PRG	Master-in/slave-out data
5	SCE_PRG	Chip-select
6	FLASH_WP	Write protect
7	SPI_SW_RT	Enable programming, active high
8	GND	Ground
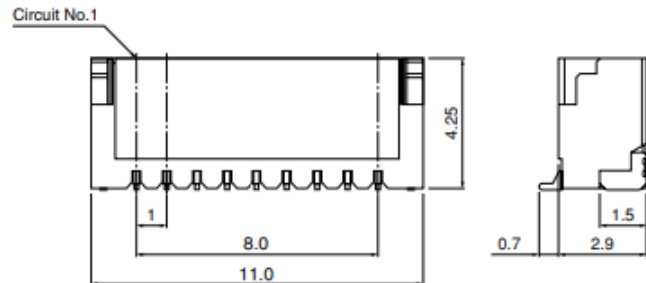
CON_PRG2   ISP-Interface

Pin	Signal	Description
1	3.3V_PRG	3.3V programming supply
2	SCLK_PRG	Serial clock
3	MISO_PRG	Master-in/slave-out data
4	NC	Not conneted
5	SPI_SW_RT	Enable programming, active high
6	SCE_PRG	Chip-select
7	GND	Ground
8	FLASH_WP	Write protect
9	MOSI_PRG	Master-out/slave-in data
10	NC	Not conneted
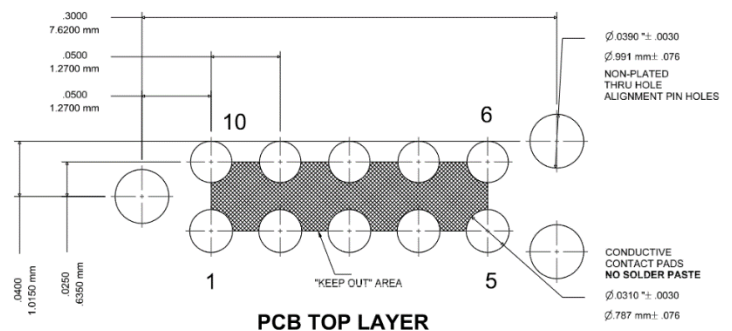
Matching connector/prog-cable:
Tag-connect / TC2050-IDC-NLFP

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4.6 USB-Interface

CN9　USB-Upstream Connector

Pin	Signal	Description
1	VBUS	+5V /max 500mA
2	D-	Differential Signal -
3	D+	Differential Signal +
4	ID	
5	GND	Ground
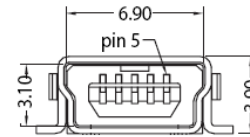
CN15　USB-A Downstream (External)

Pin	Signal	Description
1	VBUS	+5V /max 500mA (fused)
2	D-	Differential Signal -
3	D+	Differential Signal +
4	ID	
5	GND	Ground
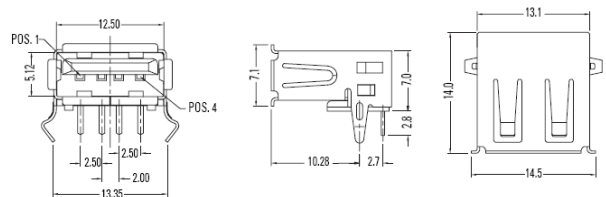
CN17　USB-A Downstream (Internal)

Pin	Signal	Description
1	VBUS	+5V /max 500mA (fused)
2	D-	Differential Signal -
3	D+	Differential Signal +
4	GND	Ground
5	SHLD_GND	Shielding Ground
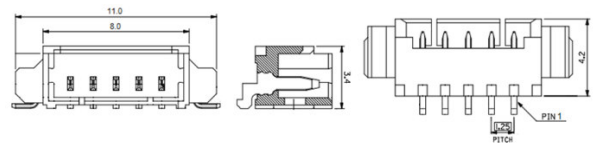
4.7 Power Supply

CN11　Power Supply Connector (external)

Pin	Signal	Description
Center	+12V	12V Power supply (max 3A)
Outer Shield	GND	Ground

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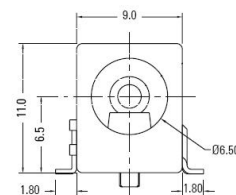
4.8 Connector Overview

CN	Description	Type	Manufacturer
CN3	HDMI /In	e.g. 685119134923	Würth
CN4	DP /Out	e.g. Adam-Tech	DPC-F-S-RA-SMT
CN5	Keypad Control	SM06B-SRSS-TB	JST
CN6	I2C-Interface	SM05B-SRSS-TB	JST
CN7	LCD-TFT Interface: LVDS	DF14-30P-1.25	Hirose
CN8	Backlight Supply	53261-0671	Molex
CN9	USB-Upstream	651 005 161 21	Würth
CN10	ISP-Interface	BM08B-SRSS-TB	JST
CN11	Power supply	KLDX-SMT2-0202-A	Kycon
CN12	Headphone Jack	SJ2-3593D-SMT	CUI
CN15	USB-Downstream external	629 004 160 21	Würth
CN17	USB-Downstream Internal	53261-0571	Molex

5   Specifications

5.1 Electrical Characteristics

Operating Values

Table below shows typical operating values:

Item	Condition	MIN.	TYP.	MAX.	Unit	Note
Supply Voltage			12.0		VDC	
Current Input					A	

5.2 Temperature & Humidity

Item	MIN.	TYP.	MAX.	Unit	Note
Operating Temperature	0/TBD	-	+70	°C	
Storage Temperature	10/TBD	-	+85	°C	
Humidity	5	-	90	%RHmax	

6   Outline Dimensions