



# **BrightSign®** **HARDWARE MANUAL**

4K242, 4K1042, 4K1142

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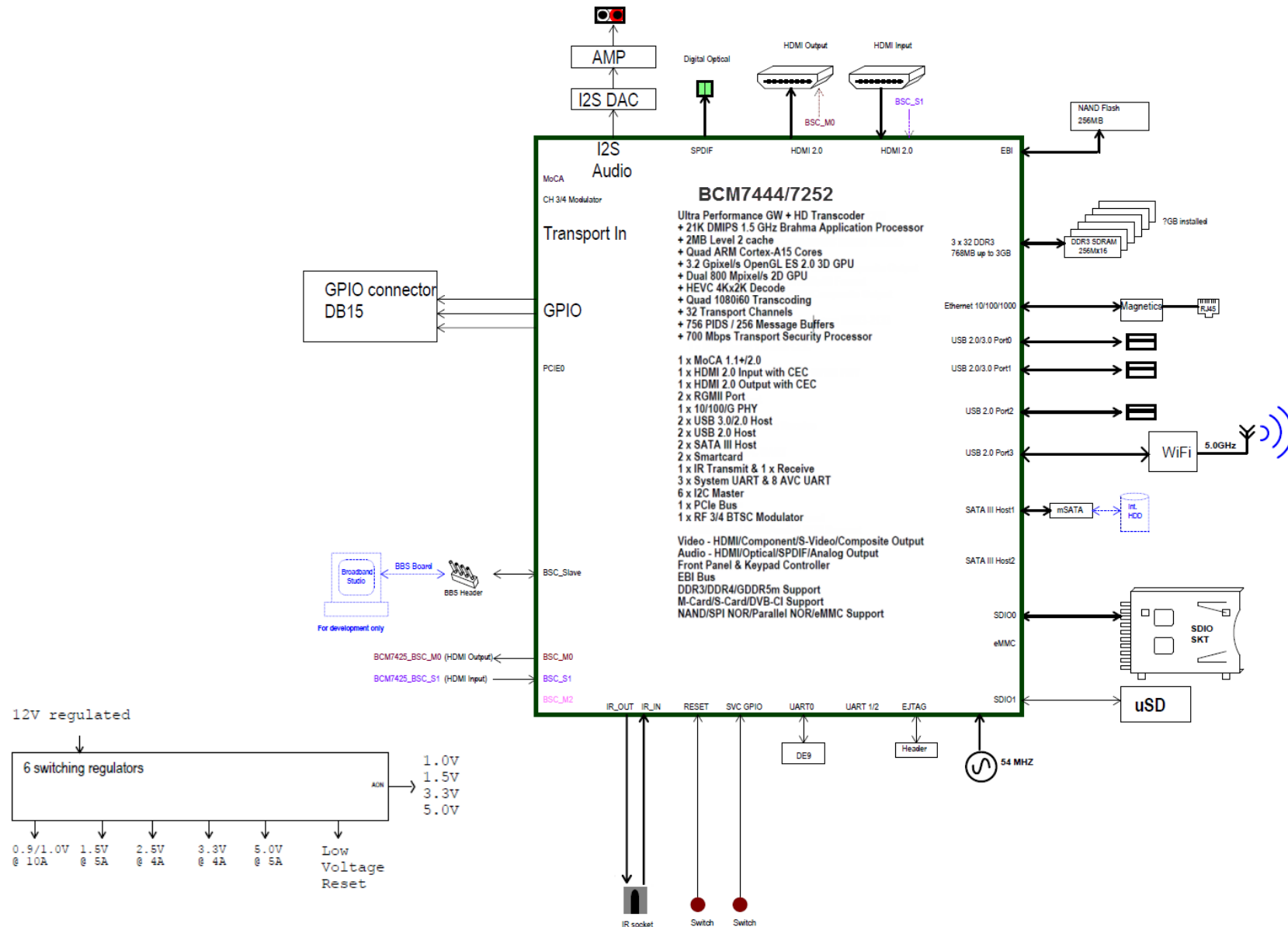


## OVERVIEW

The 4K series is a line of commercial-grade solid-state media players that can be used to decode images, audio, and video (up to 3840x2160x60p) for digital-signage and kiosk applications. In addition to driving audio/video devices, these players can be controlled with various networked and built-in interfaces.

This manual specifies the hardware interfaces and operational theory of the 4K series.

## Block Diagram



## 4K242

### Front

- DA15 GPIO
- 3.5mm IR in/out
- 3.5mm audio out

### Left

- GPIO service button
- GPIO reset button

### Right

- SDHC/SDXC flash card slot
- Status/error LED (red)
- Update LED (yellow)
- Power LED (green)
- SD activity LED (green)
- MicroSD presence LED (green)
- Ethernet activity LED (green)
- WiFi activity LED (green)
- Server connection (green)

### Back

- 12V Molex power connector
- HDMI out
- RJ45 Ethernet (POE)

### Internal

- MicroSD slot

- SATA connector
- WiFi Module connector



## 4K1042

### Front

- DE9 RS232 serial (male)
- DA15 GPIO
- 3.5mm IR in/out
- 3.5mm audio out

### Left

- GPIO service button
- GPIO reset button

### Right

- SDHC/SDXC flash card slot
- Status/error LED (red)
- Update LED (yellow)
- Power LED (green)
- SD activity LED (green)
- MicroSD presence LED (green)
- Ethernet activity LED (green)
- WiFi activity LED (green)
- Server connection (green)

### Back

- 12V Molex power connector
- SPDIF out
- HDMI out
- USB 3.0

- RJ45 Ethernet (POE)

#### **Internal**

- MicroSD slot
- SATA connector
- WiFi Module connector

## 4K1142

### Front

- USB 2.0
- DE9 RS232 serial (male)
- 3.5mm IR in/out
- 3.5mm audio out

### Left

- GPIO service button
- GPIO reset button

### Right

- SDHC/SDXC flash card slot
- Status/error LED (red)
- Update LED (yellow)
- Power LED (green)
- SD activity LED (green)
- MicroSD presence LED (green)
- Ethernet activity LED (green)
- WiFi activity LED (green)
- Server connection (green)

### Back

- 12V Molex power connector
- SPDIF out
- HDMI out
- HDMI in

- (2x) USB 3.0
- RJ45 Ethernet (POE)

**Internal**

- MicroSD slot
- SATA connector
- WiFi Module connector

# HARDWARE INTERFACES

This section describes the characteristics and operation of all connectors on 4K models.

## Power Connector

The power connector for 4K players is rated for 12V @ 5A. The plug is a right-side positive, keyed and locking 4-pin connector.

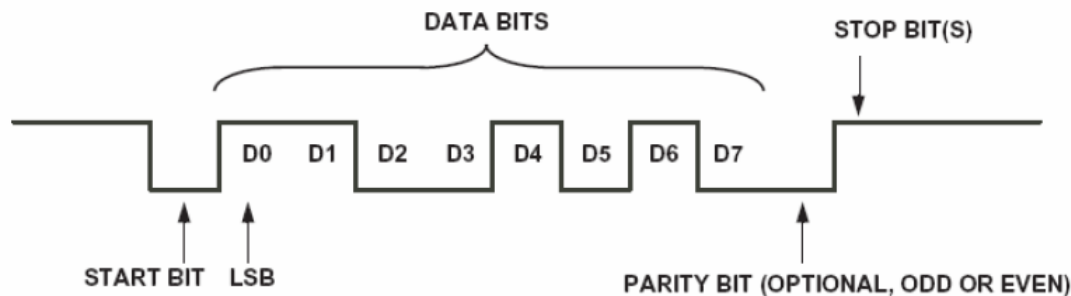
## DE9 RS-232 Serial

The RS-232 interface is a male DE9 connector. The BrightSign 4K player is a DTE device, similar to a PC. The input to the chip accepts a range between +25V and -25V, so it is compatible with +12V/-12V signaling.

The baud rate of the RS-232 interface (which is controlled by system software) is 115200, with no parity, 8 data bits, and 1 stop bit. The RS-232 interface supports RTS/CTS hardware flow control, but no software flow control. The maximum cable length is 50 meters, and the total cable capacitance is 2500pF.

**Note:** A lower capacitance cable allows you to use cable lengths beyond 50 meters.

The following diagram illustrates the behavior of the TX and RX signal:



The following table illustrates the pinout of the DE9 serial connector on 4K players:

pin	Description	pin	Description
1	NC	2	Receive data into the device
3	Transmit data out of the device	4	Available 5V@500mA
5	Ground	6	NC
7	RTS	8	CTS
9	NC	--	--

## DA15 GPIO

The GPIO switch/ILED connector is a DA15 female. This connector is used to allow the player to control external LEDs or other devices requiring 24mA of current or less.

Connect the LED outputs to the LED ANODE and connect the LED CATHODE to the ground. If you want to connect another device, then the output is capable of sourcing or sinking up to 3.3V at 24mA, but there is a series resistor of 100Ω in each line.

The connector also allows the connecting of external contact closures to the ground. In order to connect a switch, connect one side of the switch to the switch input, and connect the other side to one of the ground pins on the DA15 connector. The connector can also supply 3.3V at up to 500mA to an external device. The 3.3V output is polyfuse-protected and can source up to 500mA.

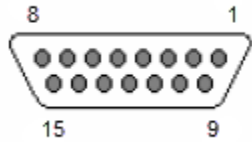
If one BrightSign player is driving the inputs on another BrightSign player, then you can drive at most three inputs from one output. The following calculations explain this limitation:

**Note:** The GPIO outputs have 100Ω series resistors; the GPIO inputs have 1K pullup resistors to 3.3V; and the input threshold on the 541 chips is 2V high and .8V low. The high voltage is not problematic, but the low voltage can be if there are too many inputs connected to one output.

1 out driving 1 in	$V=3.3*100/(100+1,000)=0.3$
1 out driving 2 in	$V=3.3*100/(100+500)=0.55$
1 out driving 3 in	$V=3.3*100/(100+333.3)=0.76$
1 out driving 4 in	$V=3.3*100/(100+250)=.94$ (This is too high, so 1 output driving 3 inputs is the maximum)

The following table illustrates the pinout of the DA15 on the 4K series of players:

pin	Description	pin	Description
1	IR blaster input	2	Ground
3	Button 6 I/O	4	Button 5 I/O
5	Button 3 I/O	6	Ground
7	Button 1 I/O	8	+3.3V output at 500mA
9	Ground	10	Button 7 I/O
11	Ground	12	Button 4 I/O
13	Button 2 I/O	14	Ground
15	Button 0 I/O	--	--



Here is the DA15 female as viewed from the front of a BrightSign 4K player:

A button/LED/IR board can be used to demonstrate the GPIO and IR functions on a BrightSign player. This board is built by a third-party manufacturer and can be purchased upon request.

## RJ45 Ethernet

The 4K series has an RJ45 connector for Gigabit (10/100/1000) base-T Ethernet, as well as Power over Ethernet (PoE) capabilities. The maximum Ethernet-cable length is 91 meters for PoE applications and 100 meters for non-PoE applications. To operate using PoE, 4K players require type-2 PoE supplying a minimum of 25W.

**Important:** *The equipment should be connected only to PoE networks without routing to the outside plant.*

The following table illustrates the pinout of the RJ45:

pin	Description	pin	Description
1	TX+	2	TX-
3	RX+	4	BI+
5	BI-	6	RX-
7	BI+	8	BI-



## USB

The 4K1042 has a single USB 2.0 port, and the 4K1142 has two USB 3.0 ports and a single USB 2.0 port. All ports are capable of transfer speeds up to 480 Mbit/s. The maximum length for a USB cable is 5 meters. The following tables illustrate the pinout of the USB 2.0/3.0 host ports:

### USB 2.0

pin	Description	pin	Description
1	VBUS	2	D-
3	D+	4	Ground

### USB 3.0

pin	Description	pin	Description
1	VBUS	2	D-
3	D+	4	Ground
5	StdA_SSTX-	6	StdA_SSTX+
7	Ground	8	StdA_SSRX-
9	StdA_SSRX+		

## 3.5mm Audio Connector

All 4K models have a single 3.5mm female audio connector, which transmits an analog stereo signal. The full-scale voltage output of the audio is 2V RMS. The minimum load impedance of the audio connector is 32Ω.

**Note:** *The BrightSign expansion module allows you to drive up to three sets of 5Ω headphones directly.*

The audio connector has the following pinout:

- **Tip:** Left audio

- **Ring:** Right audio
- **Sleeve:** Ground for audio signal

## HDMI Output

The HDMI-out connector is used to send digital video and audio to HDMI-enabled sink devices. This connector is compatible with HDMI 2.0 devices, capable of outputting a maximum video resolution of 3840x2160x60p.

The following table illustrates the pinout of the HDMI connector:

pin	Description	pin	Description
1	TX2p	2	Ground
3	TX2n	4	TX1p
5	Ground	6	TX1n
7	TX0p	8	Ground
9	TX0n	10	TXCp
11	Ground	12	TXCn
13	CEC	14	NC
15	DDC SCL	16	DDC SDA
17	Ground	18	+5V DDC
19	HPD (Hot Plug Detect)	--	

## HDMI Input

The HDMI-in connector is used to receive digital video and audio from HDMI-enabled source devices. This connector is compatible with HDMI 2.0 devices, capable of accepting a maximum video resolution of 3840x2160x60p. The signaling also conforms with DVI 1.0, HDMI 1.4, and HDCP 2.2 standards.

The HDMI signaling has CEC (but no ARC or HEC) functionality. The CEC channel is electrically coupled to the corresponding signal on the HDMI output, and the CEC commands will pass through the player even when it does not have power.

### 3.5mm IR Input/Output

The IR blaster generates or receives a space-encoded NEC or Pronto Hex signal. The two transported bit values of the signal (0 and 1) are encoded using differing lengths of low-time IR pulses.

The 3.5mm IR in/out port has the following pinout:

- **Tip:** 3.3V
- **Ring:** IR Input
- **Sleeve:** IR Output

**Note:** *The sleeve is used as a ground during input operations.*

### SPDIF Out

The SPDIF\_OPT signal is generated within the BCM7444 CPU, which is connected directly to the SPDIF output.

### Wireless

BrightSign 4K players feature a six-pin connector on top of the printed circuit board (PCB) within the case. This connector allows installation of a peripheral wireless module that supports 802.11 a/b/g/n WiFi protocols.

## ENVIRONMENTAL AND POWER USAGE

BrightSign 4K players are designed to be used between 0°C and 40°C, at 90% maximum relative humidity, non-condensing.

The power supply for 4K players is 60W and 12V at 5A. The device will use approximately 1A of power when playing a 3840x2160x60p H.265 (HEVC) source file.

**Important:** *This product is intended to be supplied by power from a Listed Power Adapter, rated +12Vdc at 5A minimum.*

An additional 4A of power is available for peripherals connected to a 4K player. The user should not connect any combination of peripherals that will exceed 4A draw. If more than 4A is drawn, the external power supply may shut down due to over-current conditions. The unit will not be damaged, but it may reboot or not operate properly until the overload is removed.

If the device is being powered by the power supply, the 4A can be shared in any way among the following connectors:

Connector	Maximum Power Usage
Ethernet	Approx. 180mA (when transferring data)
USB 2.0/3.0	500mA (on each connector)
DE9 5V	500mA
DA15 3.3V	500mA
HDMI 5V	500mA
IR blaster output	300mA

If the device is being powered by PoE, only 1A is available for all connectors (or possibly less if the device is running a resource-intensive presentation). It can be shared in any way among the following connectors:

Connector	Maximum Power Usage
Ethernet	Approx. 180mA (when transferring data)
USB 2.0/3.0	500mA (on each connector)
DE9 5V	100mA
HDMI 5V	500mA
IR input/output	300mA

# THEORY OF OPERATION

This section describes how specific components operate on BrightSign 4K players.

## Power Supply

There are several voltage levels present in BrightSign 4K players.

## Reset

BrightSign 4K players have a Low Voltage Reset circuit. This circuit will hold the RESET\_L signal low until a valid 3.3V power source is present.

## BCM7444/7252 CPU

The 4K242 and 4K1042 utilize a BCM7252 CPU, while the 4K1142 utilizes a BCM7444 CPU. The CPU is reset by the RESET\_L signal from the low voltage reset circuit going into the RESET\_IN pin on the CPU. When the RESET\_IN pin goes from low to high, the CPU will boot from the NAND flash.

## Built-in Flash

The boot code in the BCM7252/BCM7444 instructs it to continue the boot process by reading additional code from the onboard NAND flash, which can be updated in the field, either from a SDHC/SDXC flash card or a USB mass-storage device. Part of the NAND flash is also used to hold non-volatile parameters. The contents of the boot flash are copied into the SDRAM. The CPU then jumps to the boot code.

## SDRAM

The 4K1142 contains six banks of DDR SDRAM (two 4GB banks and four 2GB banks), while the 4K242 and 4K1042 each contain four banks of DDR SDRAM (two 2GB banks and two 4GB banks). When the CPU boots, it will copy the code

from the NAND flash device into the SDRAM and then execute the code from the SDRAM. The SDRAM runs at a clock rate of 1067MHz, with a data rate of 2133MT/s.

## Serial Port

The 4K1042 and 4K1142 have a built-in UART that communicates with the RS-232 level shifter. The MAX232 uses a capacitive voltage switcher to create valid RS-232 voltage levels for the transmit pin.

## Audio Outputs

BrightSign 4K players each have a single high quality audio DAC device, which takes in digital audio signals from the CPU in an I2S audio format. The AUD\_LRCIN is the framing signal for the audio and runs at the frame rate of the audio source (usually either 44.1KHz or 48KHz). The AUD\_BITCLK signal is typically 32 times higher than the AUD\_LRCIN.

The audio output is fed through an amplifier and sent directly to the audio output jack. It can drive a 32 $\Omega$  load with a 2V RMS signal.

## On-Board LEDs

There are eight on-board LEDs that indicate the following:

LED	Indication
Green power ( <b>Pwr</b> )	Displays when the board is powered up and not in reset mode.
Green file-system activity ( <b>Bsy</b> )	Flashes any time there is file-system activity (on any storage device)
Green MicroSD activity ( <b><math>\mu</math>SD</b> )	Displays when a MicroSD card is present.
Green network activity ( <b>Svr</b> )	Displays when the player is connected to the BrightSign Network.
Green Ethernet activity ( <b>Eth</b> )	Flashes when the player is connecting to the network. Displays when connected.
Green WiFi activity	Flashes when the player is connecting to the wireless network. Displays when connected.

Yellow update ( <b>Upd</b> )	Flashes when the board is being upgraded.	
Red status ( <b>Err</b> )	Flashes a certain number of times to indicate which error is occurring. The flash codes are described below.	
	2	Unspecified error
	3	Network recovery script is preparing to run on a device configured for network recovery.
	4	No upgrade file found
	5	Failed to load kernel module
	6	Board is not capable of running the current firmware version.
	7	A piece of on-board hardware is not working.
	8	Problem related to the storage device (either the USB drive or SD card)
	9	Problem related to the registry/NAND
	10	The autorun script encountered a load/run error.
	11	WiFi-related error (mainly, WiFi not found on USB)
	12	Unable to find a bootable image

## On-Board Switch

The on-board switch is connected to the GPIO02. The GPIO02 is pulled low when the service (SVC) button is pressed. Conversely, a pull-up on the button normally sets the GPIO02 to be pulled high.

## Reset Switch/GPIO Button

The on-board switch is connected to the reset circuit. Pressing down the reset button will cause the GPIO07 to go low. Holding the reset button low for approximately 10 seconds will cause a hard reset. When the board goes into reset mode, the power LED will be dark until the reset button is released.



## SDHC/SDXC and MicroSD Slots

The 4K series has one SDHC/SDXC and one internal MicroSD card slot, both capable of transferring a 25 Mbit/sec video stream, one 5.1 AC3 stream (pass-through), and three stereo PCM tracks simultaneously. There is no inherent limit on the storage capacity of SD cards used for 4K series players.

## NAND Flash

BrightSign players have a built-in NAND flash. All the code for the player is stored on the NAND flash. It may also be possible to store some content on the NAND flash, which is connected directly to the CPU.

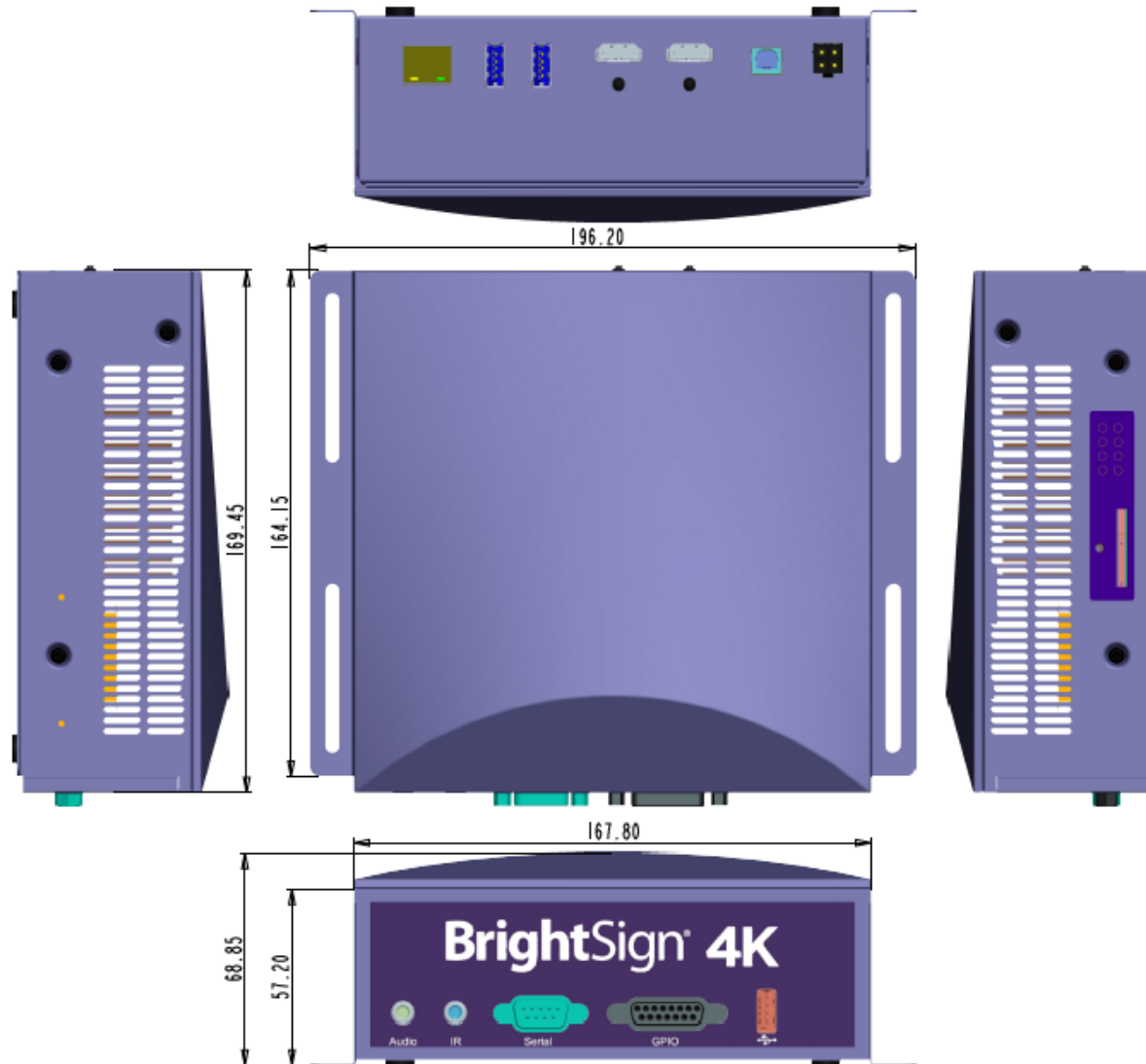
## Ethernet

The 10/100/1000 Base-T Ethernet is implemented on 4K players by directly interfacing with the BCM7252/BCM7444. The player has on-board Ethernet magnetics and termination for the RJ-45 cable.

## USB 2.0/3.0

The USB 2.0/3.0 high-speed host controller is implemented internally on the BCM7252/BCM7444 SOC. The board utilizes over-current protected switches that can be used to turn the power to USB devices on or off or to detect over-current situations.

## DIMENSIONS



## MOUNTING PROCEDURE

BrightSign 4K players can be mounted on a wall using the brackets attached to each side. It is recommended that you mount the device using four screws (one for each bracket slot). The screws should have a major diameter between 3.5mm and 4.2mm.

**Important:** *Nails should not be used to mount the device.*