

Roku BrightSign HD2000 Hardware Guide

PCBA: Rev C
Version: 1.3



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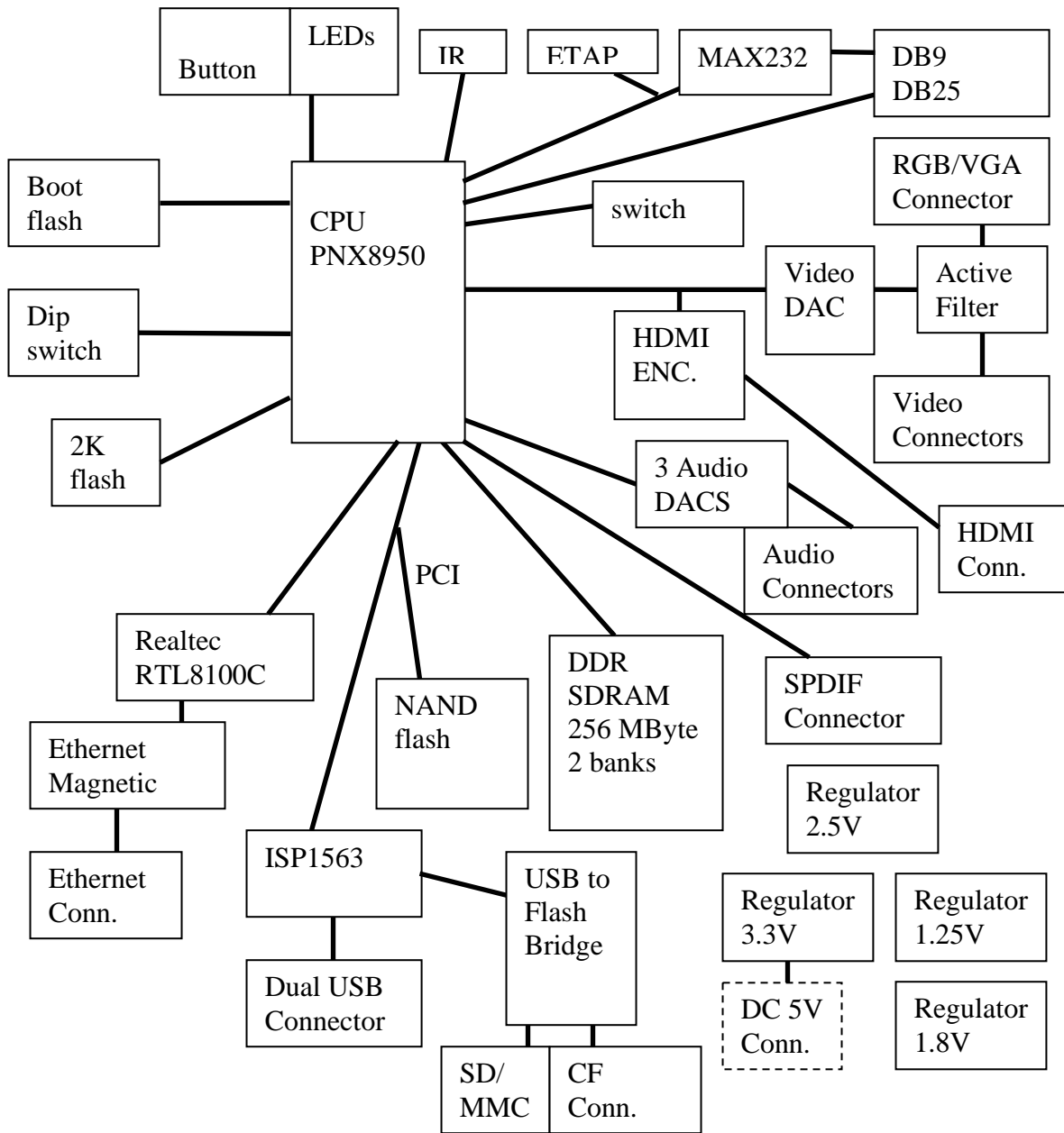
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Overview

This hardware reference manual specifies the hardware interfaces on the HD2000, as well as providing a guide to troubleshoot the hardware of the HD2000 for in-field service. This manual will not describe any software functions.

The BrightSign HD2000 is a device that can be used to drive a variety of HDTV and computer monitors for digital sign and kiosk applications. As well as driving the Video Display, the HD2000 has many different control interfaces built in to allow the sign to be controlled. The Brightsign HD2000 is differentiated from the HD2000 in that the HD2000 can decode MPEG2 HD video files and it has HDMI output, as well as additional IO interfaces.

HD2000 Block Diagram



Ports

On back of the unit:

- Power plug for 5V power input at 3A
- 3 stereo 1/8" mini plugs for audio output
- DB15 VGA video connector.
- Triple RCA jacks for Component Hi-Def output (Y-Pr-Pb). This port can also output composite video and S-Video.
- HDMI connector
- Two high speed USB host ports.
- 10/100 Ethernet jack
- DB25 Female for LED output and Switch input, as well as supplying 100mA of 3.3V power.
- DB9 Male RS232.
- 1/8" ETAP serial connector (0-5V serial)
- Optical SPDIF audio output.
- 8 position dip switch

On front of the unit:

- Power LED
- IR receiver for 38KHz IR reception.
- Front panel LEDs for status.
- Front panel Switch for user input (Typically used to switch screen resolutions)
- SD/MMC flash card slot
- Compact Flash slot for CF cards.

Power Connector

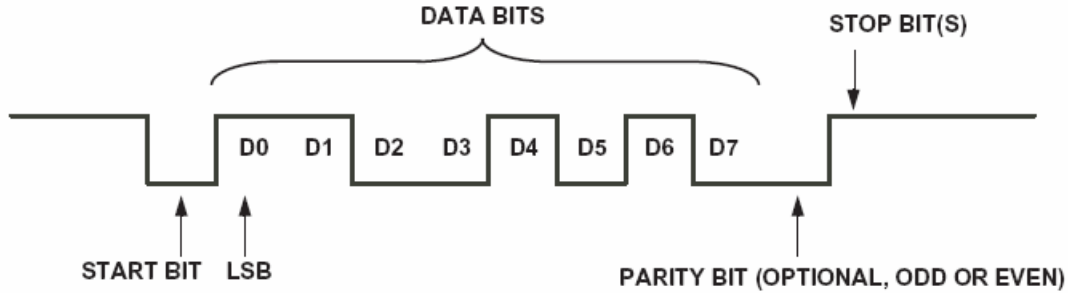
The power connector on our board is rated at 5V @ 3A. The plug to go into our connector is standard 5.5MM plug, center positive, with a 1.65MM center pin hole. The power is over voltage protected and reverse polarity protected with two 5W 5.6V zener diodes.

Optical SPDIF connector

This connector accepts a standard SPDIF optical cable.

DB9 RS232 connector

RS232 connector is a male DB9. The HD2000 is a DTE device (like a PC). The input to our chip accepts up to +25V and -25V, so it is compatible with standard +12 and -12 volt signaling. The output of our chip is rated at +5.4V and -5.4V typical which exceeds the voltage required by the RS232 specification. The chip we use for RS232 only enables the RS232 transmit function when a valid RS232 voltage level is detected on the receive line. This implies that the RS232 connector cannot be used for RS232 output only. The baud rate is 9600, No parity, 8 data bits, 1 stop bit. No hardware or software flow control. The TX and RX signal will look like this:



The pinout of the DB9 on the REVB HD2000 board is as follows (NC=No Connect):

pin	Description	pin	Description
1	NC	2	Receive data into HD2000
3	Transmit data out of HD2000	4	Available 5V @ 250mA
5	Ground	6	NC
7	RTS	8	CTS
9	NC		

DB25 Switch/LED connector

The Switch/Led connector is a DB25 Female. This connector is used to allow the HD2000 to control external LEDs or other devices requiring 15mA of current or less. Connect the LED outputs to the LED ANODE and connect LED CATHODE to ground. If you want to connect up some other device then the output is capable of sourcing or sinking up to 24mA at 3.3V, but we do have a series resistor of 100 Ohms in each line. This connector also allows connecting up external contact closures to ground. In order to connect a switch, connect one side of the switch to the switch input, and connect the other side of the switch to one of the ground pins on the DB25 connector. Finally the connector can also supply 3.3V at up to 100mA to an external device. The 3.3V output is polyfuse protected. The DB25 has the following pinout:

pin	Description	pin	Description
1	LED 5 output	2	Ground
3	LED 2 output	4	LED 0 output
5	Button 11 input	6	Button 9 input
7	Ground	8	Button 6 input
9	Button 5 input	10	Button 3 input
11	Ground	12	Button 1 input
13	+3.3V output @ 100mA	14	LED 4 output
15	LED 3 output	16	LED 1 output
17	Ground	18	Button 10 input

USB

The HD2000 has two high speed (400 mbit) USB host ports. The ports have the following pinout:

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

DB15 VGA connector

The VGA connector is able to output 1280 X 720 and 1024 X 768 computer RGB video. The connector has the following pinout (NOTE: This pinout is only accurate for REVC and later. REVB has a hardware bug on the pinout):

pin	Description	pin	Description
1	RED analog video output	2	GREEN analog video output
3	BLUE analog video output	4	NC
5	Digital ground	6	Analog ground
7	Analog ground	8	Analog ground
9	+5V DDC supply (REVC only)	10	Digital ground
11	NC	12	DDC SDA (REVC only)
13	HSYNC output	14	VSYNC output
15	DDC SCL (REVC only)		

Triple RCA Component HD video connector

The component triple RCA connector is able to output the following formats:

- 480P video: Y from Green jack, Pr from Red jack, and Pb from Blue jack.
- 720P video: Y from Green jack, Pr from Red jack, and Pb from Blue jack.
- 1080i video: Y from Green jack, Pr from Red jack, and Pb from Blue jack.

1/8" Audio connectors

The HD2000 has three 1/8" female audio connectors. Each connector has a stereo audio signal. The full scale voltage output of the audio is 3.06V PP, with no load. The minimum load resistance that should be connected to the audio output is 5 Ohms. The connectors are capable of driving headphones directly.

The connectors have the following pinout:

Tip: Left audio
Ring: Right audio
Base: Ground for audio signal

HDMI connector

The HDMI connector is used to send digital video and audio to HDMI enabled sink devices. This is 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)	20	Ground

ETAP connector

The HD2000 has a single 1/8" female connector for ETAP. This port is used to communicate with devices that require 0 and 5V serial signaling.

This connector has the following pinout:

Tip: Receive data
Ring: Transmit data
Base: Ground

Power usage

The power supply on the HD2000 is a 15W 5V @ 3A power supply. The HD2000 will use approximately 2.1A of power when playing a 720p or 1080i MPEG2 HD source file. This implies that there is 900mA of additional available power that can be used by peripherals connected to the HD2000. The user should not connect up any combination of peripherals that will exceed 900mA draw. If more than 900mA is drawn, then the external power supply will shut down due to overcurrent conditions. The unit will not be damaged, but it may cause the unit to reboot or to not operate properly until the overload is removed.

This 900mA can be shared any way you like on the following connectors.

USB1 – 500mA max

USB2 – 500mA max

DB9 5V – 250mA

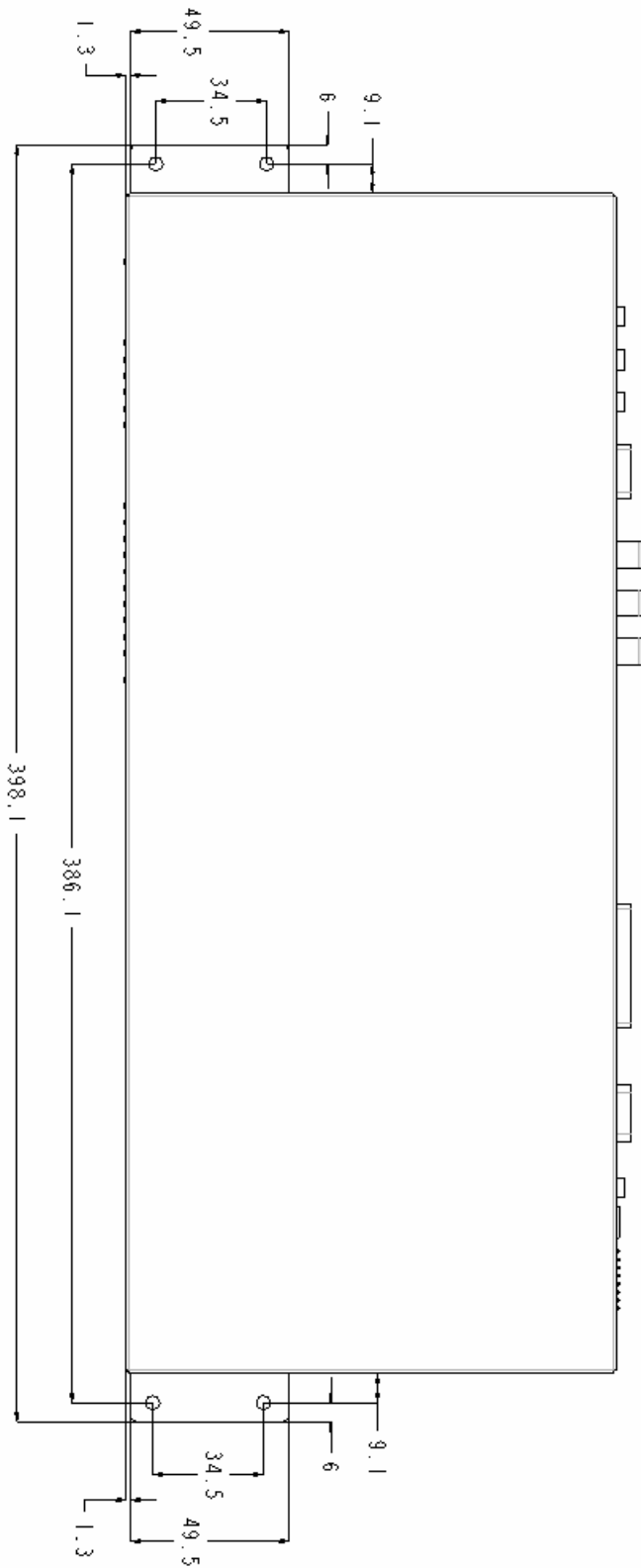
DB25 3.3V – 100mA

HDMI 5V – 55mA max

Each of 6 LED outputs on DB25 – up to 24mA each

Audio 1, 2, 3 – 200mA max (i.e. if you connect up 50ohm headphones, then each audio connector can output up to 200mA RMS)

Mechanical



Theory of operation

Power Supply

The HD2000 has a five voltages present. These are 5V, 3.3V, 2.5V, 1.8V and 1.2V. 5V comes in from the power connector and is used directly for USB, the video filter chip, the optical SPDIF chip, and the audio dacs. 3.3V is created from 5V by a AMC2596 switching regulator. Similar regulators are used to create 2.5V for the DDR SDRAM, 1.8V for the HDMI chip, and 1.2V for the PNX8950 core voltage.

Reset

The HD2000 has a Low Voltage Reset circuit made up of a ADM809SAKS. This circuit will hold the RESET_L signal low until a valid 3.3V power is present.

PNX8950 CPU

The HD2000 has a Philips PNX8950 Multimedia CPU in it. This CPU runs on 3.3V, 2.5V, and 1.2V. The PNX8950 runs from a 27MHz oscillator. The PNX8950 is reset by the signal RESET_L from the low voltage reset circuit going into the RESET_IN pin on the PNX8950. When the RESET_IN pin goes from low to high, then the PNX8950 will look at the bootstrap pins GPIO0-2, which are pulled low on the PNX8950. This forces the PNX8950 to boot from IIC serial boot flash.

Built in Flash

The HD2000 contains four flash devices. One of the devices is denoted to be the IIC BOOT flash. This flash is write protected from the factory and it contains the MAC address for the 10/100 Ethernet chip, as well as the boot code and the SRB bytes. The boot code in the IIC serial flash instructs the PNX8950 to continue the boot process by reading additional code from the on board NAND flash. This flash can be updated in the field, either from on the flash slots or 10/100 Ethernet. Part of the NAND flash is also used to hold non-volatile parameters. The contents of the boot flash is copied into the SDRAM, then the PNX8950 jumps to the boot code. There is also a serial settings flash that can be used to contain non-volatile settings. The last flash is the Ethernet flash that is used to configure the Ethernet PHY chip.

SDRAM

The HD2000 contains four DDR SDRAM devices. When the PNX8950 boots, it will copy the code from the NAND flash device into SDRAM, and then execute the code from SDRAM. The SDRAM runs at clock rate 200MHz, with data rate 400MHz.

Serial Port

The HD2000 has a built in UART that that communicates with the RS232 level shifter. The MAX232 creates valid RS232 voltage levels for the transmit pin by using a capacitive voltage switcher.

Video Encoder and Filter

The PNX8950 streams decoded video out of the QVCP5L port using single data rate clock. The PNX8511 video encoder takes the QVCP5L data in and sends the data straight to the video DACs in HD mode. The PNX8511 also has an internal SYNC engine that is only used in HD mode to add video sync to the 3 component signals. In VGA mode, the sync signals from the PNX8950 and are passed through the PNX8511. The PNX8511 mode is controlled by IIC from the PNX8950. Analog video comes out of the PNX8511 and is connected to the Analog Devices ADA4412 video filter chip. This chip has a programmable cutoff frequency of either 8MHz, 16MHz or 32MHz. Since the video filter has a low impedance output, we can drive both VGA and COMPONENT 75Ohm terminated cables at the same time with no degradation (with the same signal).

HDMI encoder

The QVCP5L video is also sent over to the TDA9982B HDMI encoder chip, which drives the HDMI data out of the HD2000. The HDMI chip is also connected to I2S audio and SPDIF audio, so that audio will be driven out the HDMI connector.

Audio outputs

The HD2000 has three high quality audio DAC devices, which are Wolfson WM8729. These devices take in digital audio signals from the PNX8950 for I2S audio. The AUD_LRCIN signal is the framing signal for the audio, running at the frame rate of the audio source. The frame rate is usually either 44.1KHz or 48KHz. AUD_BITCLK signal is typically 64 times higher than AUD_LRCIN. The AUD_MCLK is usually 4 times faster than the AUD_BITCLK signal. The I2S audio is also routed to the HDMI chip.

The audio output from the Wolfson DAC is sent to TPA0211 high quality high power audio amplifiers. These amplifiers are capable of driving 5 Ohm headphones directly.

SPDIF output

The PNX8950 can generate the SPDIF audio signal internally. This signal, called SPDIF_OPT is connected to a OPTICAL SPDIF transmitter chip on the board. The SPDIF signal is also routed to the HDMI chip.

On Board LEDs

There are 18 on board LEDs. One of the LEDs is red in color and is designated to be the BUSY LED. Six of the LEDs are the resolution LEDs, intended to tell the user what resolution the HD2000 is currently outputting. The other LEDs are intended to tell the user which output connectors are active. All the LEDs are controlled by a set of 3 74HC574 latches. Data is latched into the latches under GPIO control. The far left green LED is the power LED. The far right RED LED is the flash activity LED, which flashes anytime the SD or CF is being accessed.

On Board Switch

The on board switch is connected to a GPIO32. There is a pullup on the button so that GPIO32 is high normally, and it is pulled low when the button is pressed.

IR Receiver

The IR receiver receives a 38KHz IR signal. The IR signal is filtered and demodulated and then sent into the PNX8950 on GPIO40. The signal is called IR_DAT on the schematic.

CF flash slot

The CF flash slot is connected up to the SMSC USB2777 USB flash controller chip. The USB2777 is connected to the ISP1563BM PCI to USB bridge chip. The USB2777 won't attempt to access the CF slot unless it first detects that a CF card is present. The signal CF_CD1 and CF_CD2 go low when a CF card is inserted. Power to the CF slot is controlled by a MOSFET, and it is not turned on until the USB2777 detects that a CF card has been inserted into the CF slot.

SD/MMC Flash Slot

The SD/MMC flash slot supports 2 different formats of flash cards: SD & MMC. Power to the SD/MMC slot is controlled by the USB2777 directly with a built in MOSFET, and it is not turned on until the USB2777 detects that one of the SD/MMC cards has been inserted into the slot.

NAND flash

The HD2000 has a built in NAND flash. All the code for the unit is stored on the NAND flash, and it may also be possible to store some content on the NAND flash. The NAND flash is connected to the PCI/XIO bus on the PNX8950.

Ethernet

10/100 Base T Ethernet is implemented on the HD2000 by a Realtec RTL8100C PHY controller. This device takes the PNX8950 Ethernet signals and converts them to the differential Ethernet signals. The PHY chip is also connected to an on-board Ethernet magnetic and a RJ45 for cable termination. The DM9161 chip is able to signal to the PNX8950 that its state has changed by toggling the INT_ETH line, which is connected to GPIO11.

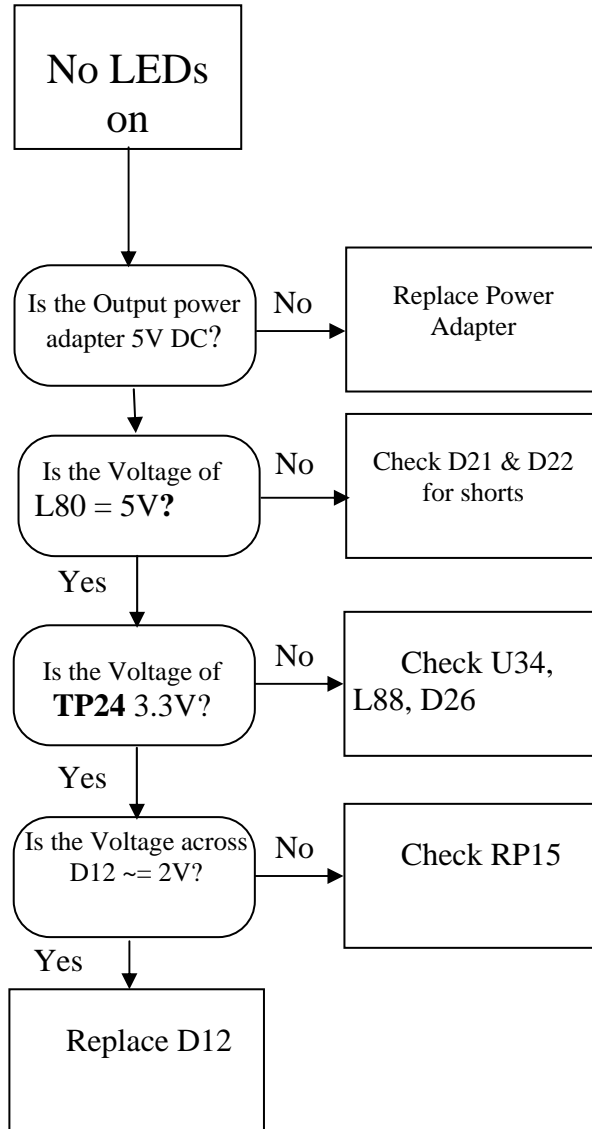
USB

USB is implemented by a PCI ISP1563 USB dual host controller chip. There is also a dual over-current protected switch TPS2042BD device, which is used to turn on and off power to the USB device, and to detect over-current situations.

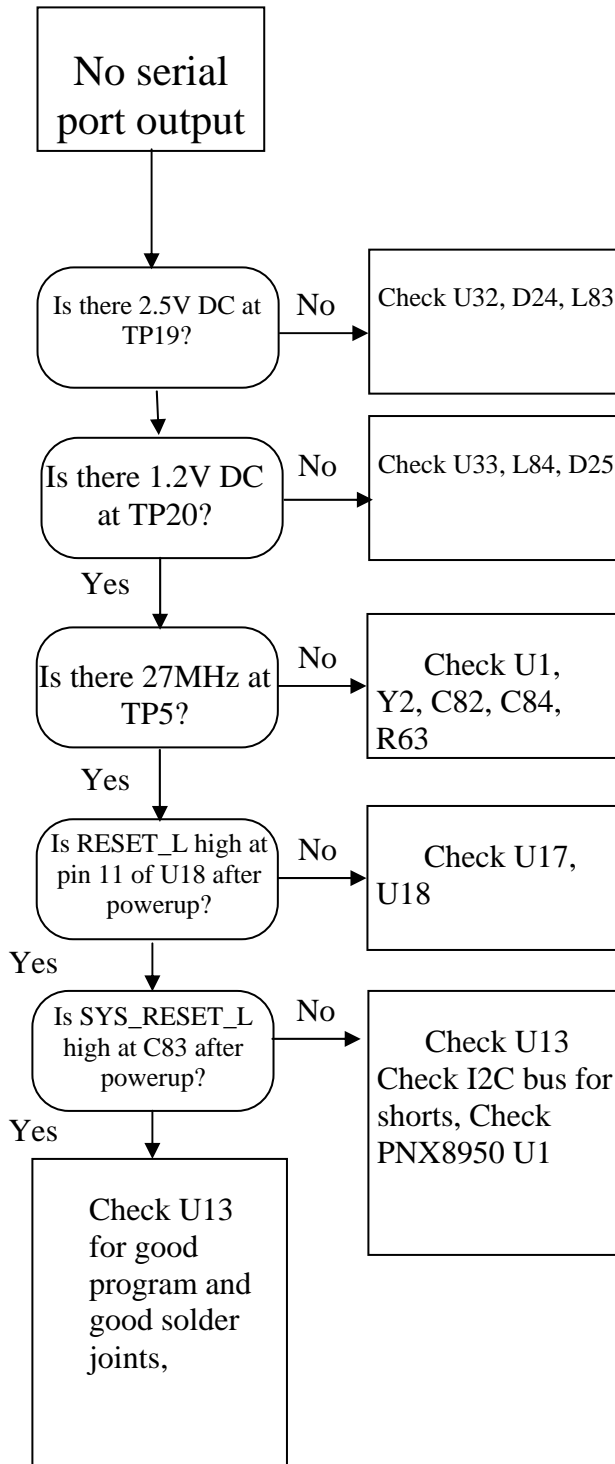
Appendix A

Flow Chart: (for Repair Center Use)

(1) Power Start



(2) Power LED comes on, no serial port output



(3) Power LED comes on, 1 or more green LEDs come on in sequence from left to right, and then go out.

Red LED stays out. Serial port tests are in order. Connect a PC to the HD2000 using a null modem cable (Wire up 2-3, 3-2, 5-5). Set the terminal program to 38,400 N,8,1.

- A) If the serial port is not working, then check U12 and P4.
- B) Use the “dir” command to test reading the CF flash card. Use the “dir SD:” command to read from the SD card. Use “dir USB1:” and “dir USB2:” command to test reading from external USB mass storage devices. If the CF or SD card fails to read, check U50, Q4 and the CF socket, and associated resistor packs. If the USB mass storage reads fail, check U40, U42, and P14.
- C) Use the “videoplay” command to test the video and audio outputs, for example “videoplay test.mp3” or “videoplay test.mpg”. If the analog audio fails to work, check U6, U8, U10. Check for the audio master clock on R10, should be 11.288MHz or 12.288MHz. Check for audio bit clock R9, should be ¼ of the MCLK. Check for AUD_LRCIN on R11, should be 44.1KHz or 48KHz. Check for audio data on R12, R13, R14. Check passives on outputs of U6, U8, U10. The voltage output of the audio during this test (fullscale) is 3.06V PP, with no load. Check the audio amplifiers U2, U3, U5, U7, U9, U11 and associated passives. Check the 5V_ANA power supply. If the audio fails to come out of the SPDIF output, then check U1 & U4.

Run the following script to test the LEDs. If any LED fails to come on, then check U25, U26, U27 and the resistors on the outputs of these. The DB25 LEDS are controlled by U24 and U26.

```
port = CreateObject("roMessagePort")
gpio = CreateObject("roGpioControlPort")
gpio.SetPort(port)

led = 0
ls = 0

loop:
  msg = wait(100, port)

  else if type(msg)="roGpioButton" then
    if msg.GetInt() = 12 then end
  endif

  gpio.SetOutputState(led,ls)
  led = led+1
  if led > 22 then toggle_led
  goto loop

toggle_led:
  led = 0
  if ls = 0 then ls = 1 else ls = 0
  goto loop
```

- D) Run the following script to test the buttons. Press each button and a led should light for each button pressed. If any switch fails to read, or is stuck on, then check U22, U23 and the resistors and beads on the inputs to U22 and U23. This script will test the front panel switch as well as the switches connected to the DB25.

```
p = CreateObject("roMessagePort")      'create a MessagePort to receive button
events
sw = CreateObject("roGpioControlPort")  'switch/led control port
sw.SetPort(p)

clear:
for led=0 TO 11
    sw.SetOutputState(led+11,0)
next

loop:
msg=wait(0, p) ' Wait forever for a message
if type(msg)="roGpioButton" then      ' Is it a GPIO button press?
    if msg.GetInt() = 12 then goto clear ' Front Panel button was pressed, clear
    leds.
    led = msg.GetInt() + 11
    sw.SetOutputState(led,1)
endif
goto loop
```

- E) Connect a Ethernet cable to a switch, and type “ifconfig eth0 192.168.1.21” (Use an unused address on your network). The switch should show link on, and you should be able to ping the unit and ping other things on your network. If this does not work, check U21, T1, P9 and associated passives.

Appendix B

Boot Progress

During booting the HD2000 uses the LEDs immediately to the right of the front panel LED to indicate progress. The LEDs are displayed at the following times:

LED	Description
LED1	I2C ROM executing
LED2	Bootloader executing
LED3	Kernel executing (actually set quite far through kernel startup)
LED4	User space started
LED5	DENC drivers loaded
LED6	Trimedia code loaded
LED7	Frambuffer driver loaded
LED8	udev has settled
LED9	BrightSign application is just about to start looking for the autorun.

[\[edit\]](#)

Errors

When the HD2000 discovers a problem during bootup it displays a flash code on the video mode LEDs (the group of six). These codes are intended to be used to help resolve the problem although connecting serial is always a good way to see better information.

Here are a few useful ones.

All unspecified LEDs remain off.

LEDs	Description
LED11	RAM test failed
LED12	No boot targets (found neither safe mode nor run mode).
LED13	ROMFS script failed (try booting again forcing safe mode).
LED11, 12	Modprobe failure (highly unlikely)
LED11, 13	Module load failure (a non-specific module failed to load, see serial).
LED11, 14	Error loading SAA8510 module (probably not found on I2C)
LED11, 15	Error loading TDA9983 module (probably not found on I2C)
LED11, 12, 13	Ethernet not found on PCI bus or other Ethernet problem
LED11, 12, 14	USB not found on PCI bus or other USB problem.
LED11, 12, 13, 14	STB Root App not running
LED12, 13, 14, 15, 16	Unspecified error

BrightSign HD2000

LED16 No upgrade found in safe mode

LED11, 13, 14, 16 No ship indicator has been set

Note that all LEDS11-16 is not defined on this list since it has been used to indicate completion of the updater.