High Efficiency Portable Media Player (PMP) Docking Station

National Semiconductor
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1.0 Design Specifications

Inputs	Output #1	Output #2	Output #3
VinMin=4.5V	Vout1=3.3V	Vout2=5V	Vout3=12V
VinMax=6V	Iout1=0.9A	Iout2=1.5A	Iout3=0.1A

2.0 Design Description

The High Efficiency Portable Media Player (PMP) Docking Station reference design showcases National Semiconductor's PowerWise® power converters, battery charging circuitry, audio drivers and display interface. The reference design saves more power by initiating a power-saving mode when the PMP is unplugged from the wall power, automatically reducing the maximum brightness of the display as well as the output power of the audio drivers. See Figure 1 which shows the power management and audio segments of the reference design.

The LM3658SD-A dual source, USB/AC Li chemistry charger IC receives a wall wart or USB input and converts either input into a source voltage, using the LM20124 synchronous buck regulator, powers the docking station as well as providing the charging current to an external Lithium-Ion back-up battery pack.

The LM20124 provides the source voltage which biases both the audio and DS90UR241/124 serializer/deserializer (SERDES) segments of the video transport sections of the system. The LM4674 stereo Class D audio amplifier drives two 2W speakers. The LM2735Y Boost and SEPIC DC-DC Regulator boosts the 3.3V $_{DC}$ output to 5V $_{DC}$, which supplies the bias voltage needed to charge the PMP device when docked in the docking station connector. Additionally, the wall wart also feeds an LM3478 Low-Side N-Channel Controller which boosts the voltage to 12V $_{DC}$ and provides power to the AVP-1280 video interface controller. The AVP-1280 converts the analog video output signal from the docking station into digital inputs for processing by the DS90UR241 serializer segment. Finally, the output of the DS90UR124 deserializer is taken and displayed by the Sharp LQ104S1DG21 TFT-LCD display, which is illuminated by an LED backlight with dimming capability.

3.0 Features

- 20W Wake-On-Load AC/DC Adapter provide source voltage to entire system.
- Wall wart adapter or USB charging capability to Lithium-Ion battery backup.
- Provides charging current for PMP device when docked in docking station connector.
- Detachable LCD Display can be removed at least 10 meters from base.
- Stereo Class D Audio Amplifier with logic selectable gain.
- Low profile, high efficiency power management design.
- Efficient LED Backlight Solution provides lighting to LCD Display.

4.0 Block Diagram

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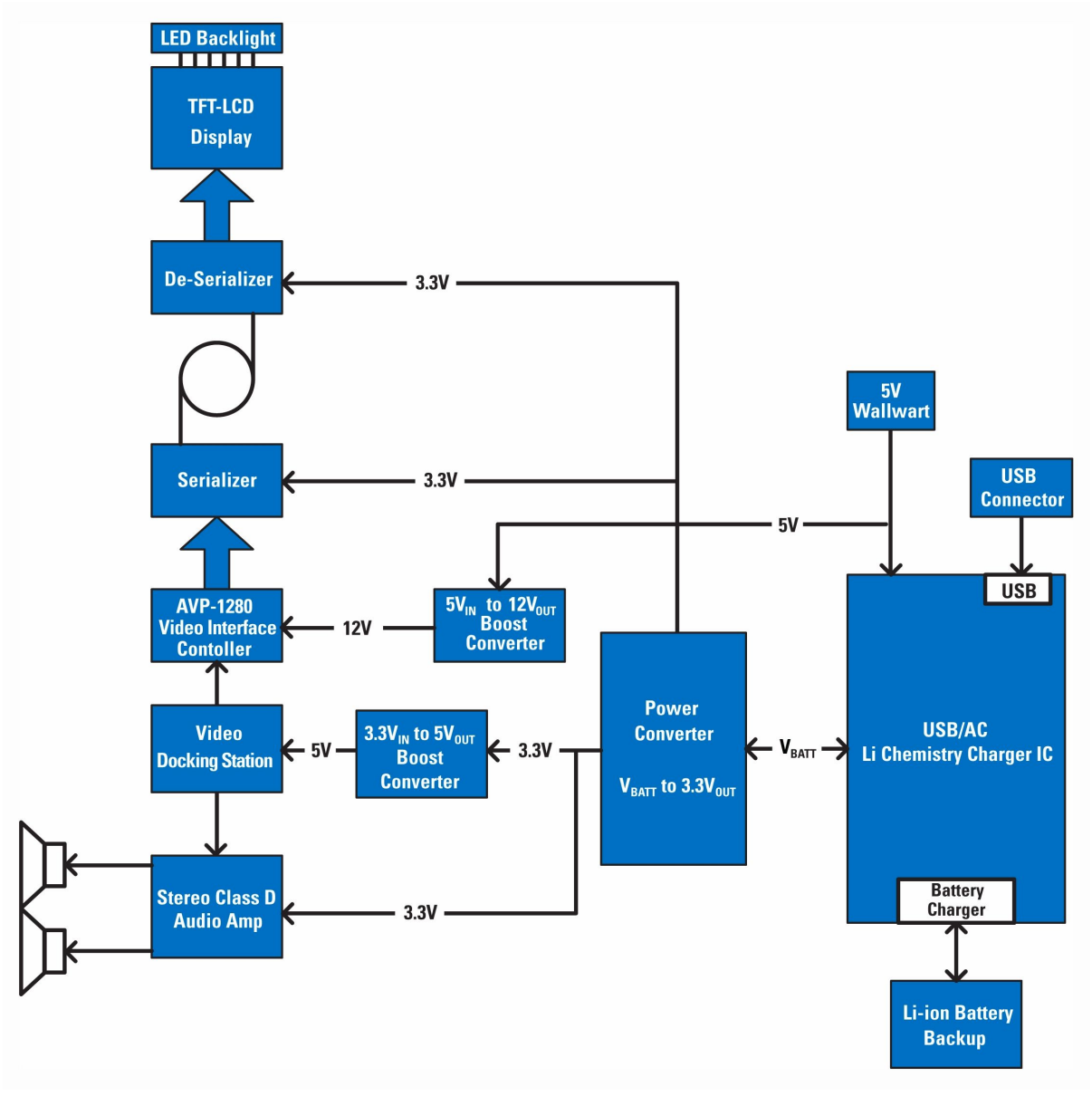


FIGURE 1. Portable Media Player (PMP) System Block Diagram

5.0 Schematic

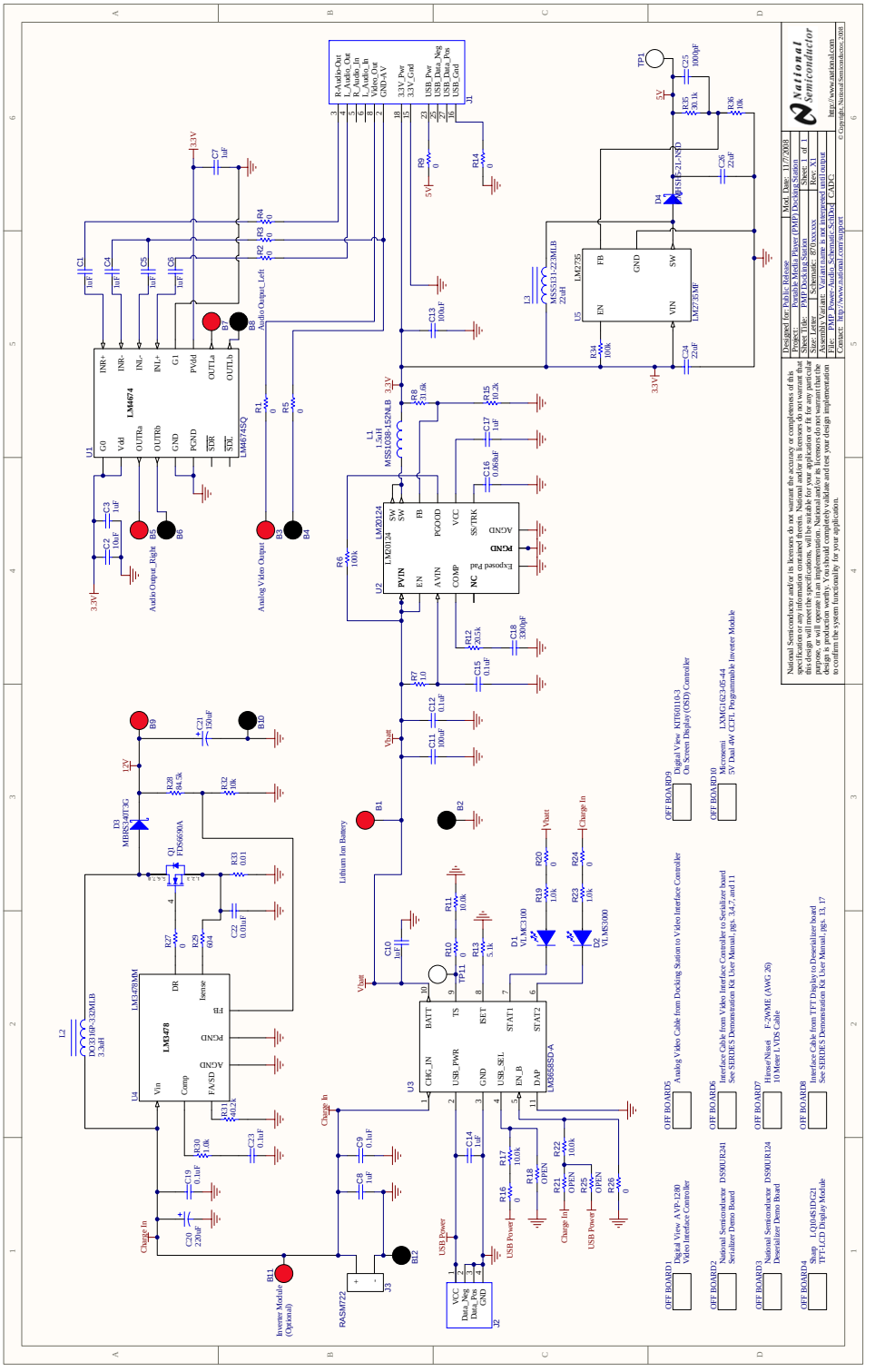


FIGURE 2. Portable Media Player (PMP) Power Management and Audio Schematic

6.0 Bill of Materials

Designator	Value	PackageReference	Characteristics	Manufacturer	PartNumber	RoHS
B1, B3, B5, B7, B9, B11	Red	Female - Panel Mount	Banana Plug Red	Johnson Components	108-0902-001	Y
B2, B4, B6, B8, B10, B12	Black	Female - Panel Mount	Banana Plug Black	Johnson Components	108-0903-001	Y
C1, C3, C4, C5, C6, C7, C8, C10, C14	1uF	0805	Ceramic, X7R, 10V, 10%	TDK	C2012X7R1A105K	Y
C2	10uF	1206	Ceramic, X5R, 6.3V, 10%	TDK	C3216X5R0J106K	Y
C9, C12, C15, C19, C23	0.1uF	0805	Ceramic, X7R, 25V, 10%	TDK	C2012X7R1E104K	Y
C11, C13	100uF	1210	Ceramic, X5R, 6.3V, 20%	TDK	C3225X5R0J107M	Y
C16	0.068uF	0805	Ceramic, X7R, 100V, 10%	AVX	08055C683KAT2A	Y
C17	1uF	0805	Ceramic, X7R, 25V, 10%	TDK	C2012X5R1E105K	Y
C18	3300pF	0805	Ceramic, X7R, 100V, 10%	AVX	08051C332KAT	Y
C20	220uF	D	TA, 10V, 10%, 0.13Ohm ESR	Vishay-Sprague	595D227X9010R2	Y
C21	150uF	D	TA, 16V, 20%, 0.14Ohm ESR	Vishay-Sprague	595D157X0016D2T	Y
C22	0.01uF	0805	Ceramic, X7R, 50V, 10%	TDK	C2012X7R1H103K	Y
C24, C26	22uF	0805	Ceramic, X5R, 6.3V, 20%	TDK	C2012X5R0J226M	Y
C25	1000pF	0805	Ceramic, X7R, 50V, 10%	TDK	C2012X7R1H102K	Y
D1	4V		Green SMT LED	Vishay	VLMC3100	
D2	3V		Red SMT LED	Vishay	VLMS3000	
D3	0.525V	SMC	Vr = 40V, Io = 3A, Vf = 0.525V	ON Semiconductor	MBRS340T3G	Y
D4	0.385V	SOD-123	Vr = 20V, Io = 500mA, Vf = 0.385V	Central Semiconductor	CMHSH5-2L-NSD	Y
J1	1A		30 pin PMP Device Connector	Kineteka Systems	PODDOCK-C-M-1	
J2	1x4	Series 48037	USB A Type Plug R/A Connector	Molex Incorporated	0480371000	Y
J3	RASM		Right Angle Miniature Power Jack	Switchcraft	RASM722	Y
L1	1.5uH	MSS1038	Shielded Drum Core, 8.3A, 0.0081 Ohm	Coilcraft Inc.	MSS1038-152NLB	Y
L2	3.3uH	DO3316	Unshielded Drum Core, 5.4A, 0.015 Ohm	Coilcraft Inc.	DO3316P-332MLB	Y
L3	22uH	MSS5131	Shielded Drum Core, 0.54A, 0.16 Ohm	Coilcraft Inc.	MSS5131-223MLB	Y
OFF BOARD1			Video Interface (LCD) Controller	Digital View	AVP-1280	Y

bom3

FIGURE 3. Bill of Materials (BOM) - Page 1 of 3

Designator	Value	PackageReference	Characteristics	Manufacturer	PartNumber	RoHS
OFF BOARD2			5-43MHz DC- Balanced 24-Bit LVDS Serializer	National Semiconductor	DS90UR241	Y
OFF BOARD3			5-43MHz DC- Balanced 24-Bit LVDS Deserializer	National Semiconductor	DS90UR124	Y
OFF BOARD4			TFT-LCD Display Panel Module	Sharp	LQ104S1DG21	Y
OFF BOARD5			Analog Video Cable from Docking Station to Video Interface Controller	NSC Lab	Cable 0001	
OFF BOARD6			Interface Cable from Video Interface Controller to Serializer board	NSC Lab	Cable 0002	
OFF BOARD7			10 Meter LVDS Cable	Hirose/Nissei	F-2WME (AWG 26)	N/A
OFF BOARD8			Interface Cable from TFT Display to Deserializer board	NSC Lab	Cable 0003	
OFF BOARD9			On Screen Display (OSD) Controller	Digital View	KIT60110-3	Y
OFF BOARD10			5V Dual 4W Programmable Inverter Module	Microsemi	LXMG1623-05-44	Y
Q1		SO8	30V N-Channel PowerTrench SyncFET	Fairchild	FDS6690A	Y
R1, R2, R3, R4, R5, R9, R10, R14, R16, R18, R20, R21, R24, R25, R26, R27	0, OPEN	0805	5%, 0.125W	Vishay-Dale	CRCW08050000Z0EA	Y
R6	100k	0805	1%, 0.125W	Vishay-Dale	CRCW0805100kFKEA	Y
R7	1.0	0805	5%, 0.125W	Vishay-Dale	CRCW08051R00JNEA	Y
R8	31.6k	0805	1%, 0.125W	Vishay-Dale	CRCW080531k6FKEA	Y
R11, R17, R22	10.0k	0805	1%, 0.125W	Vishay-Dale	CRCW080510k0FKEA	Y
R12	20.5k	0805	1%, 0.125W	Vishay-Dale	CRCW080520k5FKEA	Y
R13	5.1k	0805	5%, 0.125W	Vishay-Dale	CRCW08055k10JNEA	Y
R15	10.2k	0805	1%, 0.125W	Vishay-Dale	CRCW080510k2FKEA	Y
R19, R23, R30	1.0k	0805	5%, 0.125W	Vishay-Dale	CRCW08051k00JNEA	Y
R28	84.5k	0805	1%, 0.125W	Vishay-Dale	CRCW080584k5FKEA	Y
R29	604	0805	1%, 0.125W	Vishay-Dale	CRCW0805604RFKEA	Y
R31	40.2k	0805	1%, 0.125W	Vishay-Dale	CRCW080540k2FKEA	Y
R32, R36	10k	0805	5%, 0.125W	Vishay-Dale	CRCW080510k0JNEA	Y
R33	0.01	2010	1%, 1W	Vishay-Dale	WSL2010R0100FEA18	Y
R34	100k	0805	5%, 0.125W	Vishay-Dale	CRCW0805100kJNEA	Y

bom4

FIGURE 4. Bill of Materials (BOM) - Page 2 of 3

Designator	Value	PackageReference	Characteristics	Manufacturer	PartNumber	RoHS
R35	30.1k	0805	1%, 0.125W	Vishay-Dale	CRCW080530k1FKEA	Y
U1		SQA16A	Filterless 2.5 Stereo Class D Audio Power Amplifier	National Semiconductor	LM4674SQ	Y
U2		MXA16A	4A 1MHz Synchronous Buck Regulator	National Semiconductor	LM20124	Y
U3		L155B	Dual Source USB/AC Li Chemistry Charger IC for Portable Applications	National Semiconductor	LM3658SD-A	Y
U4		MSOP-8	Boost/Sepic Controller	National Semiconductor	LM3478MM	Y
U5		MF05A	520kHz/1.6MHz - Space-Efficient Boost and SEPIC DC-DC Regulator	National Semiconductor	LM2735YMF	Y

bom5

FIGURE 5. Bill of Materials (BOM) - Page 3 of 3

7.0 Other Operating Values

Operating Values

Description	Parameter	Value	Unit
Primary 3.3V Bus - Switching Frequency	Frequency	1	MHz
3.3V Output Ripple Voltage	Peak-to-peak	24.4	mVpp
Primary 3.3V Bus - Start-up	Tstart-up	8.68	ms
Primary 3.3V Bus - Shut-down	Tshut-down	548	ms
Docking Station Power Supply - Switching Frequency	Frequency	520	kHz
5V Output Ripple Voltage	Peak-to-peak	23.6	mVpp
Docking Station Power Supply - Start-up	Tstart-up	7.84	ms
Docking Station Power Supply - Shut-down	Tshut-down	352	ms
Video Interface Controller Power Supply - Switching Frequency	Frequency	400	kHz
12V Output Ripple Voltage	Peak-to-peak	120	mVpp
Video Interface Controller Power Supply - Start-up	Tstart-up	57.6	ms
Video Interface Controller Power Supply - Shut-down	Tshut-down	768	ms
Total Output Power	Output Power	11.45	W
Total System Efficiency	Efficiency	82	%

8.0 Quick Start

Recommended Equipment:

DC Power Supply or Wall Wart rated for 5V $_{DC}$ @ 4A

Multimeter

Oscilloscope with High Impedance Differential Probes

Portable Media Player Device (with Audio and Video Output capability)

The following instructions show how to connect Portable Media Player (PMP) System. Please use the ESD protection (ground cable) to prevent any unwanted damaging ESD events.

Connecting the input power supply to the Lithium-Ion battery charger circuit.

1. Connect a power supply (4.5V $_{DC}$ to 6.0V $_{DC}$) or 5V $_{DC}$ wall wart to the "Charge In" and the GND pins. The input power supply's negative terminal should be connected to GND and the positive terminal to "Charge In." Alternatively, power supply can be connected to the "USB Power" pin and the GND pin.

2. Connect a Lithium-Ion battery pack to "Vbatt" and GND pins to the B1 and B2 banana jack receptacles, respectively. The battery pack's negative terminal should be connected to GND and positive terminal to "Vbatt."

3. Check to make sure that R $_{26}$ is populated with 0Ω resistor and that R $_{21}$ and R $_{25}$ are OPEN.

4. Check to make sure that R $_{13}$ is a 5.11kΩ resistor connected to the "ISET" pin which will program the full-rate charge current to 500 mA. Adjusting the value of this resistor will increase or decrease the full-rate charge current (see LM3658SD-A datasheet for more details).

5. Check to make sure that R $_{10}$ is populated with 0Ω resistor to connect R $_{11}$ from the TS pin to GND.

6. Turn on the power supply and the charge cycle will begin if battery is not fully charged.

7. With a DVR or voltage measuring device, check to make sure the 3.3V $_{DC}$, 5V $_{DC}$, and 12V $_{DC}$ power rails are regulating at their correct voltage levels.

8. Disconnect the 5V $_{DC}$ wall wart of turn off the input power supply.

Connecting Main Power Board to External Components

1. With power removed, perform the following:

— Connect the right and left speakerOUTRa/OUTRb and OUTLa/OUTLb, respectively.

— Connect the 12V $_{DC}$ power rail to the PP1 or PP2/3 jack or Molex connector on the Digital View AVP-1280 Video Interface Controller Board.

— Connect the On Screen Display (OSD) Controller to the AVP-1280 using the OSD Interface Cable.

— Connect the Serializer Board (DS90UR241) to the AVP-1280 using the Serializer to AVP-1280 Interface Cable.

— Connect the Serializer Board (DS90UR241) to the Deserializer Board (DS90UR124) using the 10 meter LVDS Cable.

— Connect the Deserializer Board (DS90UR124) to the TFT-LCD Display Panel using the Deserializer to Display Interface Cable.

— If not using the LED Backlight for the LCD Display, connect the Microsemi LXMG1623-05-44 Inverter Module to the B $_{11}$ and B $_{12}$ banana jacks (V $_{IN1}$, and Enable connected to B $_{11}$; GND connected to B $_{12}$).

— Connect a PMP device with video capability (and pre-loaded video or audio file) to the docking station via docking station connector.

2. Turn on the power supply and recheck the 3.3V $_{DC}$, 5V $_{DC}$, and 12V $_{DC}$ power rails. With all the rail regulating at the

expected voltage, the PMP device should be in charge mode and the LCD Display should be ON.

3. Press and hold the ON/OFF button on the OSD controller for 2-3 seconds and the D_6 LED on the AVP-1280 should turn on.

4. Queue the PMP device and then press the "PLAY" button to see and hear the video (displayed on the LCD Display) and the sound coming from the speakers.

9.0 Hardware Description

The following references may be useful for the reader's deeper understanding of the operation of the system's blocks:

1. LM3658: Dual Source USB/AC Li Chemistry Charger IC for Portable Applications datasheet – National Semiconductor (http://www.national.com/ds/LM/LM3658.pdf)

2. LM20124: 4A, 1MHz PowerWise® Synchronous Buck Regulator datasheet – National Semiconductor (http://www.national.com/ds/LM/LM20124.pdf)

3. LM4674: Boomer, Filterless 2.5W Stereo Class D Audio Power Amplifier datasheet – National Semiconductor (http://www.national.com/ds/LM/LM4674.pdf)

4. DS90UR241/DS90UR124: 5-43 MHz DC-Balanced 24-Bit LVDS Serializer and Deserializer datasheet – National Semiconductor (http://www.national.com/ds/DS/DS90UR124.pdf)

5. Various LVDS application notes found at http://www.national.com/appinfo/lvds/ (http://www.national.com/appinfo/interface/files/national_SERDESUR-43USB_evalkit.pdf)

6. AVP-1280: Video Interface controller manual (Digital View) http://www.digitalview.com/manuals/avp1280-manual.pdf

7. LQ104S1DG21: TFT-LCD Module – Sharp (http://document.sharpsma.com/files/LQ104S1DG21_SP_092706.pdf)

8. LXMG1623-05-44: 5V Dual 4W CCFL Programmable Inverter Module – Microsemi (http://www.microsemi.com/datasheets/lxmg1623-05-44.pdf), Used for initial testing, replaced by LED Strips and LED Backlight Solution. See Appendix.

Figure 2 shows a block diagram of the entire Portable Media Player (PMP) Docking Station System. The following sections describe each circuit block in more detail and provides circuit design information regarding each section.

A. Input AC Power Adapter

This design utilizes a Wake-On-Load AC/DC adapter to drastically reduce the power losses when the docking station is unloaded. With the entire system power being sourced by the adapter input, the power supply must be able to provide at least 20W ($5V_{DC}$ @ 4A) in order to power the complete PMP system. See the LM5021 - Wake on Load AC/DC USB Power Adapter for more information.

B. Dual Source AC/USB Battery Charger and Power Sourcing Circuit

The LM3658 is capable of safely charging and maintaining a single cell Lithium-Ion battery from an AC wall adapter or a USB port. The input power source decision between the AC wall adapter and USB port is performed automatically within the IC. With both power sources present, the AC wall adapter power source has priority over the USB port. The charge current is programmed through an external resistor when operating from a wall AC adapter allowing charge currents from 50mA up to 1000mA. When the battery is charged using the USB power, charge currents are limited to 100mA or 500mA. The battery charge termination voltage (V_{TERM}) is controlled to within $4.2V_{DC}$ ± 0.35% (at 25°C and improves with increasing temperature). The LM3658 requires a few external components and utilizes thermally regulated, integrate Power MOSFETs to obtain the most efficient charging rate for a given ambient temperature, and reverse current protection, and current sensing to ensure maximum ratings are not exceeded. See Figure 18.

The LM3658 operates in five phases: pre-qualification mode, constant-current mode, constant-voltage mode, top-off mode and maintenance mode. The LM3658SD-B version charger IC operates as a linear regulator or as an "LDO mode" when the AC wall adapter is connected and no battery is present. Optimal battery management is obtained through the integration of thermal protection, battery temperature measurement and a multi-mode safety timer in this instance. However, since maximum battery life was desired for the reference design, the LM3658SD-B version charger IC was chosen because of its extended charge (T_{CHG}) and topoff (T_{TOPOFF}) timer options. Additionally, the LM3658 provides two open-drain outputs for LED status indication.

C. 3.3V $_{DC}$ Primary Bus Voltage

With an input voltage range of $2.95V_{DC}$ to $5.5V_{DC}$, the LM20124 Synchronous Buck Regulator is used to create the primary bus voltage for the docking station boost converter, as well as to the audio and video interface components. This section of the reference design accepts the output of the LM3658SD-A battery charger circuit (approximately $3.9V_{DC}$) and produces a regulated $3.3V_{DC}$ output that is capable of sourcing up to 4A of continuous output current. See Figure 19.

The 1MHz nominal switching frequency lends itself well to a design that can be balanced for optimal efficiency and space. In choosing components for this segment of the design, the maximum input RMS current was estimated to be 2A, so a100 µF X5R ceramic capacitor was selected to provide bulk capacitance and a small 1 µF ceramic capacitor was added in parallel to filter high frequency noise pulses on the input rail. To ensure that switching noise from the main supply rail did not adversely impact the functionality of the internal analog circuitry, a 1Ω resistor and 1 µF capacitor were used in a low-pass filter configuration to attenuate any noise spikes at the switching frequency.

Since continuous conduction mode was desired, a 1.5 µH output inductor was selected to minimize peak-to-peak ripple

while meeting circuit size, efficiency, and peak current carrying capabilities. Because the 3.3V $_{DC}$ rail sources power to a number of downstream circuits, a low ESR, high value output capacitor was needed to minimize the output voltage ripple. A 100 µF ceramic capacitor, with an inherently low ESR value, was chosen which provides excellent output ripple voltage (< 20mV) and contributes to good load transient performance.

The output voltage is established by R $_8$ = 31.6kΩ and R $_{15}$ = 10.2kΩ with an internal error amplifier reference voltage, V $_{REF}$ = 0.8V $_{DC}$. So that the 3.3V $_{DC}$ source would have adequate static and dynamic stability, the compensation components R $_{12}$ = 20kΩ and C $_{18}$ = 3.3nF were selected to provide sufficient bandwidth without compromising phase margin for excellent transient performance. Additionally, a 68nF was used as the soft-start capacitor for a monotonic start-up profile of approximately 10ms; and a 1 µF was used as the bypass capacitor for the internal regulator.

D. Docking Station Power Supply

The primary 3.3V $_{DC}$ bus voltage is fed into the LM2735Y and when attached to the docking station connector, the LM2735Y provides 5V $_{DC}$ to the USB Power (pin 23) to ensure the device's battery gets charged while in a docked mode. The LM2735Y is a Boost DC-DC Regulator that provides very good performance in a SOT23-5 package. The charge current for a charged device battery used for this reference design is in the sub 50mA range, while for a discharged battery, the charge current is approximately a factor of 10 greater. This directly affects the selection of the input inductor since the peak operating current should not exceed the saturation current of the inductor. For this design, a PMP device with a charged battery was used in all the testing so component selection a was based on a slightly lower charge current; however provisions are made in the design so that an inductor with the same size and lower value can be substituted. See Figure 20.

Again the higher switching frequency of the LM2735Y allows for a smaller, yet more efficient circuit to be realized. With a sub-maximum current of 200mA chosen as the battery charge current, a 39 µH inductor with adequate current rating and lower DCR was chosen to handle the peak inductor current. A 20V $_R$, 1A Schottky catch diode and 22 µF, X5R ceramic capacitor compose the remaining external power components, since the power MOSFET is integrate into the LM2735Y. The output voltage is established by R $_{35}$ = 30.1kΩ and R $_{36}$ = 10kΩ with an internal error amplifier reference voltage, V $_{REF}$ = 1.225V $_{DC}$. Although the LM2735Y is internally compensated, a capacitor C $_{25}$ = 1nF, is used to add a zero at a frequency slightly higher than the crossover frequency in order to boost the phase and provide adequate phase margin (> 50° Phase Margin).

E. Video Interface (LCD) Controller Power Supply

A video interface controller (Digital View, Model: AVP-1280) is used in order to convert the analog video output (Composite signal) of the PMP device into a digital format that is usable by the Sharp LQ104S1DG21 LCD display. The LCD display backlight is comprised of two (2) Cold Cathode Fluorescent Lamps (CCFL) that are driven by a Dual 4W CCFL Inverter Module (Microsemi: LXMG1623-05-44) that requires a 5V $_{DC}$ bias and less than 1.5A when it's in run mode. Additionally, the video interface controller has a host of other processing circuits that require biasing.

The inverter module was driven directly from the 5V $_{DC}$ input power supply to avoid dissipating power unnecessarily through the lower power upstream converters. Driving the CCFL inverter module directly from the input wall wart meant the 12V $_{DC}$, 4A rated AC/DC power supply accompanying the controller was no longer needed and that it could be powered using the LM3478 Low-Side N-Channel Controller configured as a boost converter (5V $_{DC}$ to 12V $_{DC}$). For CCM operation at 400kHz, the input inductor was selected to be 3.3 µH and subsequently, a 30V, 11A N-Channel device was chosen as the power MOSFET. The output voltage is established by R $_{28}$ = 84.5kΩ and R $_{32}$ = 10kΩ with an internal error amplifier reference voltage, V $_{REF}$ = 1.26V $_{DC}$.

The LM3478 is a current mode control part, and since the duty cycle was greater than 50%, slope compensation and filtering were added using R $_{29}$ = 604Ω and C $_{22}$ = 0.01 µF once the sense resistor, R $_{32}$ had been determined to be 0.01Ω. See Figure 21.

F. Stereo Class D Audio Power Amplifier

The LM4674 Filterless 2.5W Stereo Class D Audio Power Amplifier was setup in a Differential Input configuration to receive the left and right audio output signals from the PMP device docking station and drives two 8Ω, 2W speakers from the 3.3V $_{DC}$ input supply voltage. With this load, the efficiency at 1kHz is estimated to be greater than 85%.

The 12dB gain setting was chosen and it provided adequate power for driving both speakers. Additionally, 1 µF ceramic capacitors were used to AC couple the input audio signals, and block the DC voltage from the amplifier's input terminal. The 3.3V $_{DC}$ rail was decoupled by 1 µF ceramic capacitors and bypassed by 10 µF ceramic capacitors. See Figure 22.

G. AVP-1280 Video Interface Controller (Digital View)

This video interface controller is designed for LCD monitors and other flat panel display applications. The AVP-1280 controller provides an easy to use interface controller for : TFT (active matrix) LCD panels of 1366x768, 1280x1024, 1280x768, 1024x768, 800x600 and 640x480 resolutions display with composite-video as in the case of the LQ104S1DG21 use in this reference design; and S-Video video input. The analog video output from the PMP docking station is inputted into this board where it is prepared to be serialized by the DS90UR241 Serializer board.

— S-Video, two composite video input support
— Video signals of NTSC, PAL and SECAM standard.
— Volume control of audio (optional add-on board required)
— Digital View IR remote control support
— Full RS-232 OSD control interface support
— Supports Genlock – Synchronizes the output display refresh rate to the V-Sync of the input signal.
— Power indicator light on board

See Figure 23 for an overview of a typical LCD based display system utilizing this controller. Figure 24 shows the panel functions and setting for the OSD controller. Figure 25 shows the various connectors, pinouts, and jumpers associated with the AVP-1280 board. See Appendix for the complete design documents.

H. DC Balanced 24-Bit LVDS Serializer and Deserializer

The LCD display for the PMPdeveice docking station needed to be truly mobile. If the display were connected directly to the LCD controller, then it would have limited performance as the signal would need to be carried over a relatively long distance in order to have mobile display. Figure 26 shows the connection diagram for the SERDES components along with the video interface controller and LCD Display

The AVP-1280 outputs the processed video signal and the DS90UR241/124 chipset translates that 24-bit parallel bus output into a fully transparent data/control LVDS serial stream with embedded clock information. The Serializer/Deserializer (SERDES) accomplished this by sending 24 bits of parallel LVCMOS data over a serial LVDS link up to 1.03 Gbps. Serialization of the input data signal is performed using an on-board PLL at the Serializer which embeds a clock signal with the data into a single differential pair over frequency ranges of 5-43MHz. The true embedded clock consists of a unique architecture that embeds the clock in the serialized data stream and doesn't require an external oscillator at the receiver. See Figure 27 for a top side view of the DS90UR241 Serializer board.

This embedded clock solution saves board space, reduces cost, and eliminates the extra design effort needed to match transmitter and receiver oscillator frequencies especially beneficial in applications where the transmitter oscillator frequency may change dynamically. The Deserializer extracts the clock/control information from the incoming data stream and deserializes the data. The Deserializer monitors the incoming clock information to determine lock status and will indicate lock by asserting the LOCK output high. The output of the DS90UR124 is 24-bits of parallel LVCMOS data that feeds the LCD display with the deserialized video signal.

The DS90UR241 contains a pre-emphasis feature that boosts data signals over longer distances and will extend the transmission distance up to 10 meters. The programmable pre-emphasis is used to optimize signal integrity for different cable/connector setups. The DS90UR124 features @Speed BIST (Built-In Self Test), which is a self test that provides a simple means by which the integrity of the data link can be validated. See Figure 31 for a top side view of the DS90UR124 Deserializer board.

Additionally, 3.3V $_{DC}$ from the LM20124 powers the DS90UR241 and that voltage is bussed through the serial LVDS interface to provide the bias voltage needed to power the DS90UR124.

Because the bandwidth is greater than 1Gbps, EMI reduction is very important. The DS90UR241/124 chipset include EMI reduction features of: Frequency Spread PTO (progressive turn on), GTO (gradual turn-on) on the receiver outputs, SS-CG input capability at the transmitter, programmable pre-emphasis, and selectable drive strength for the transmitter and receiver outputs.

I. TFT-LCD Module (Sharp) and Backlighting

This module is a color active matrix LCD display incorporating amorphous silicon Thin Film Transistor (TFT) technology. It is composed of a color TFT-LCD panel, driver ICs, a controller circuit, power supply, and a dual backlight unit. Graphics and text can be displayed on an 800 x 3 x 600 dots panel with 262,144 colors by supplying an 18-bit data signal (6bit/color), four timing signals, 3.3V $_{DC}$ or 5V $_{DC}$ supply voltage for the TFT-LCD driving panel and supply voltage for the backlight.

The TFT-LCD panel used for this module is a low-reflection and higher color saturation type. Therefore, this module is suitable for multimedia use. Optimum viewing angle is at 6 o'clock.

NOTE: There is a trend to replace CCFL lamps with LEDs for LCD Display Backlighting. This greatly reduces the EMI and high voltage concerns when using CCFL Inverter Modules, without compromising the performance of the display panel. See the LM3431 Two Channel 60mA Backlight LED Driver for CCFL Replacement reference design for more information on an alternative backlight powering method.

Additionally, in Portable Media Player (PMP) devices, the LCD Display brightness may require a controlled adjustment depending on the ambient lighting conditions. See LM3423 Adaptive LED Driver with Automatic Ambient Light Brightness Compensation for more information on this automatic adaptive backlighting control feature.

10.0 Waveforms

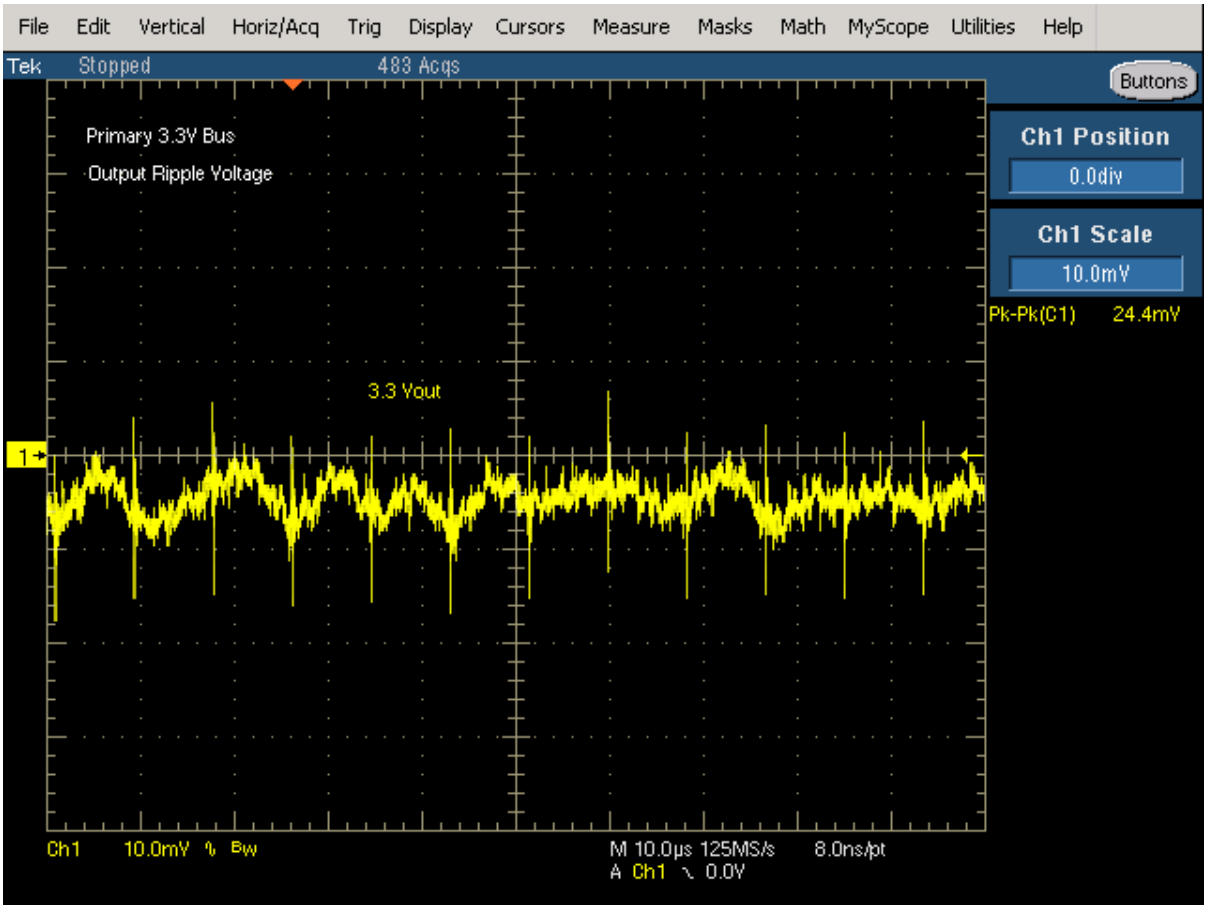


FIGURE 6. Primary 3.3V Bus - Output Ripple Voltage

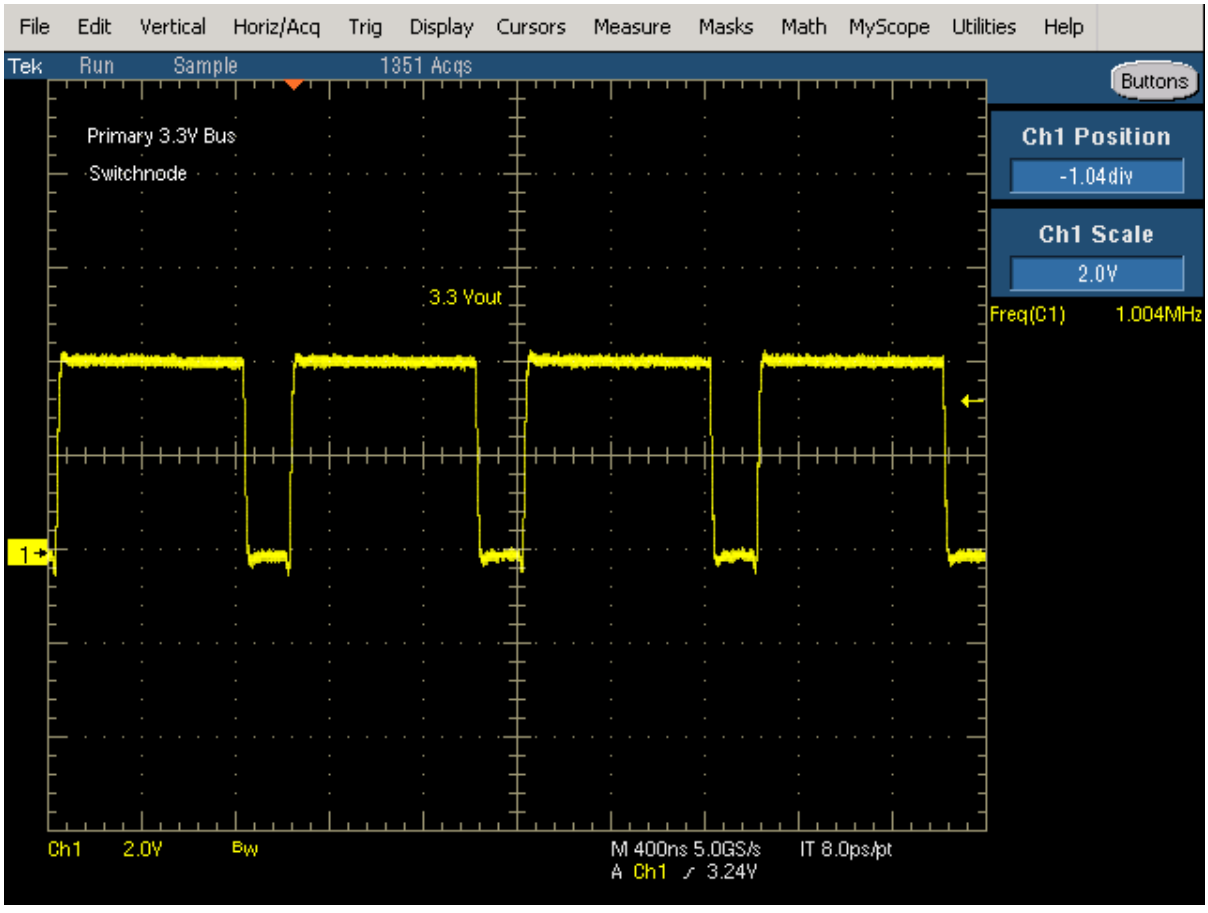


FIGURE 7. Primary 3.3V Bus - Switchnode Voltage

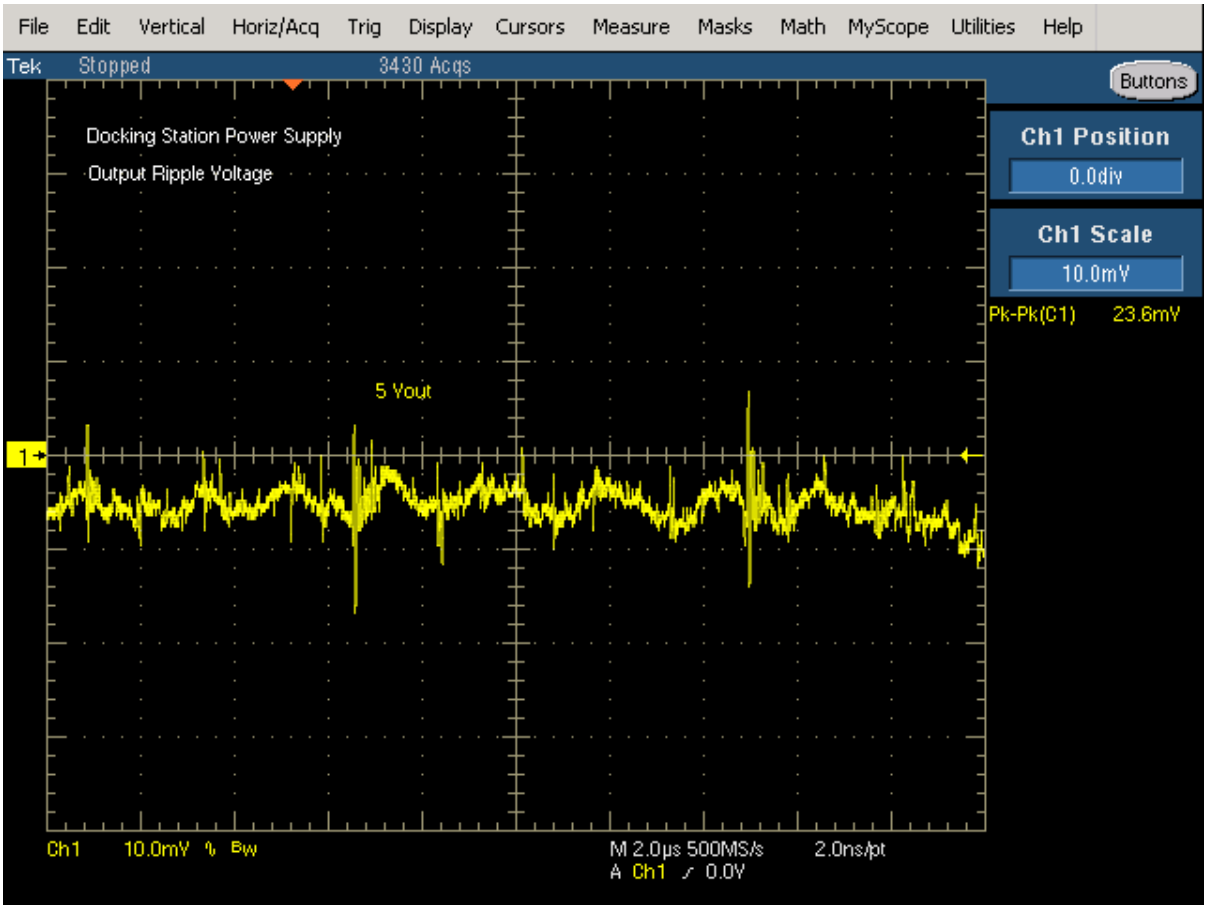


FIGURE 8. Docking Station Power Supply - Output Ripple Voltage

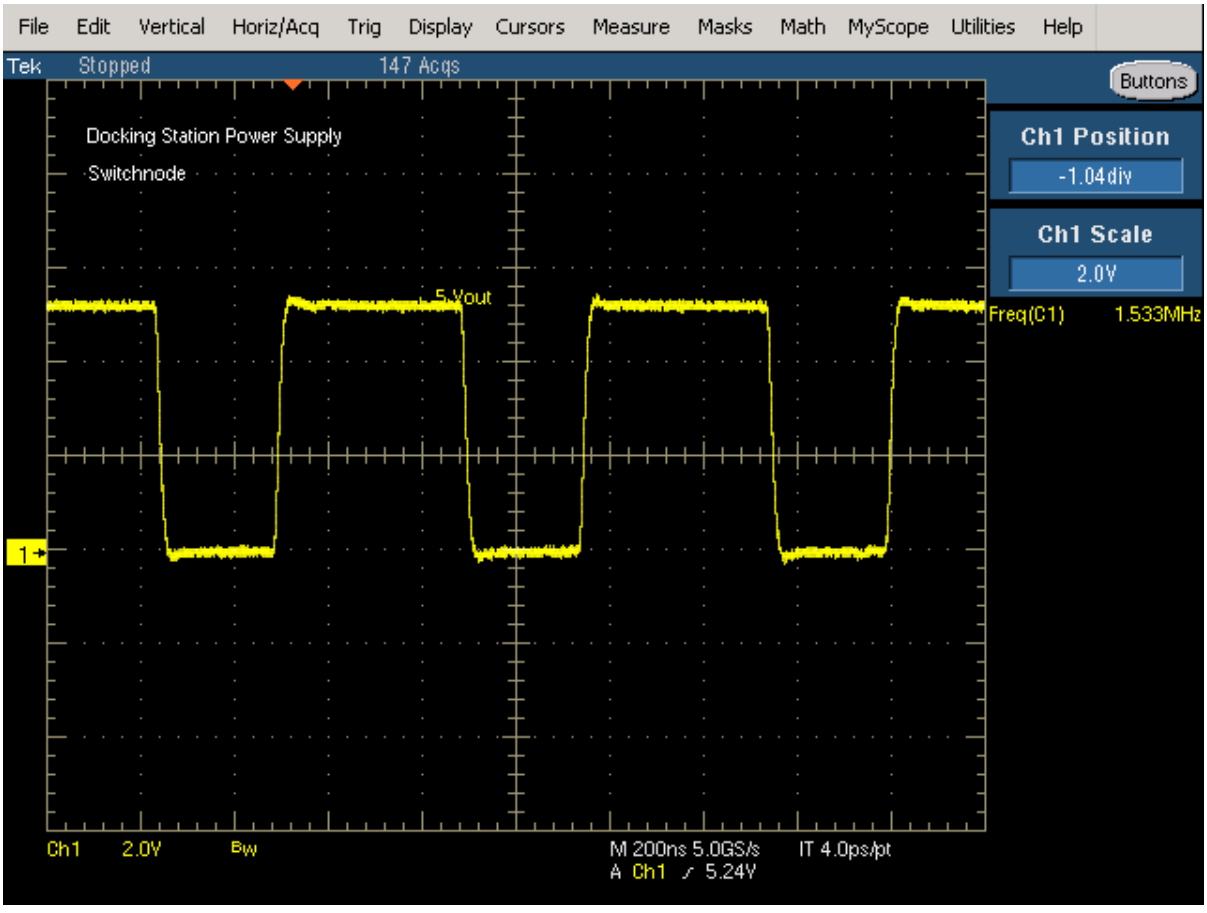


FIGURE 9. Docking Station Power Supply - Switchnode Voltage

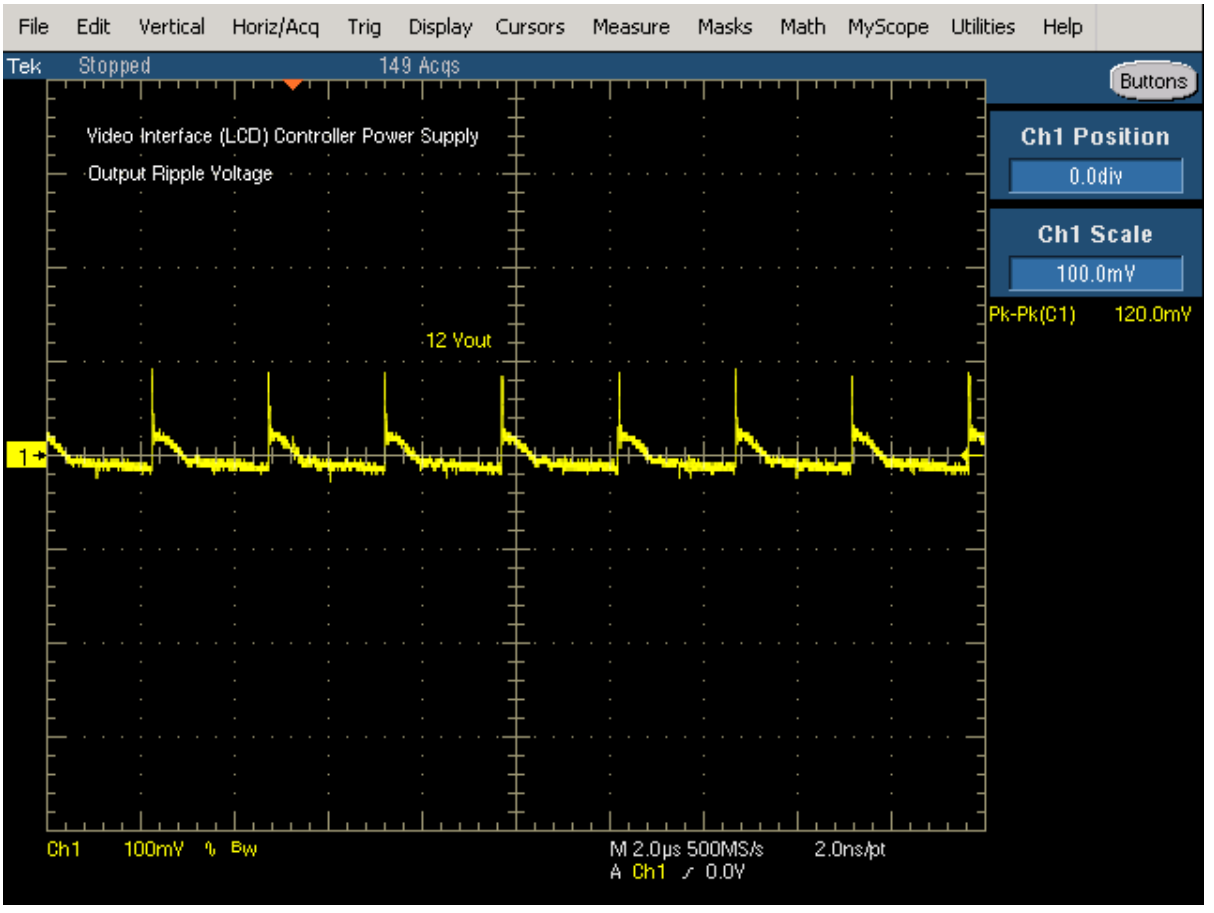


FIGURE 10. Video Interface Controller Power Supply - Output Ripple Voltage

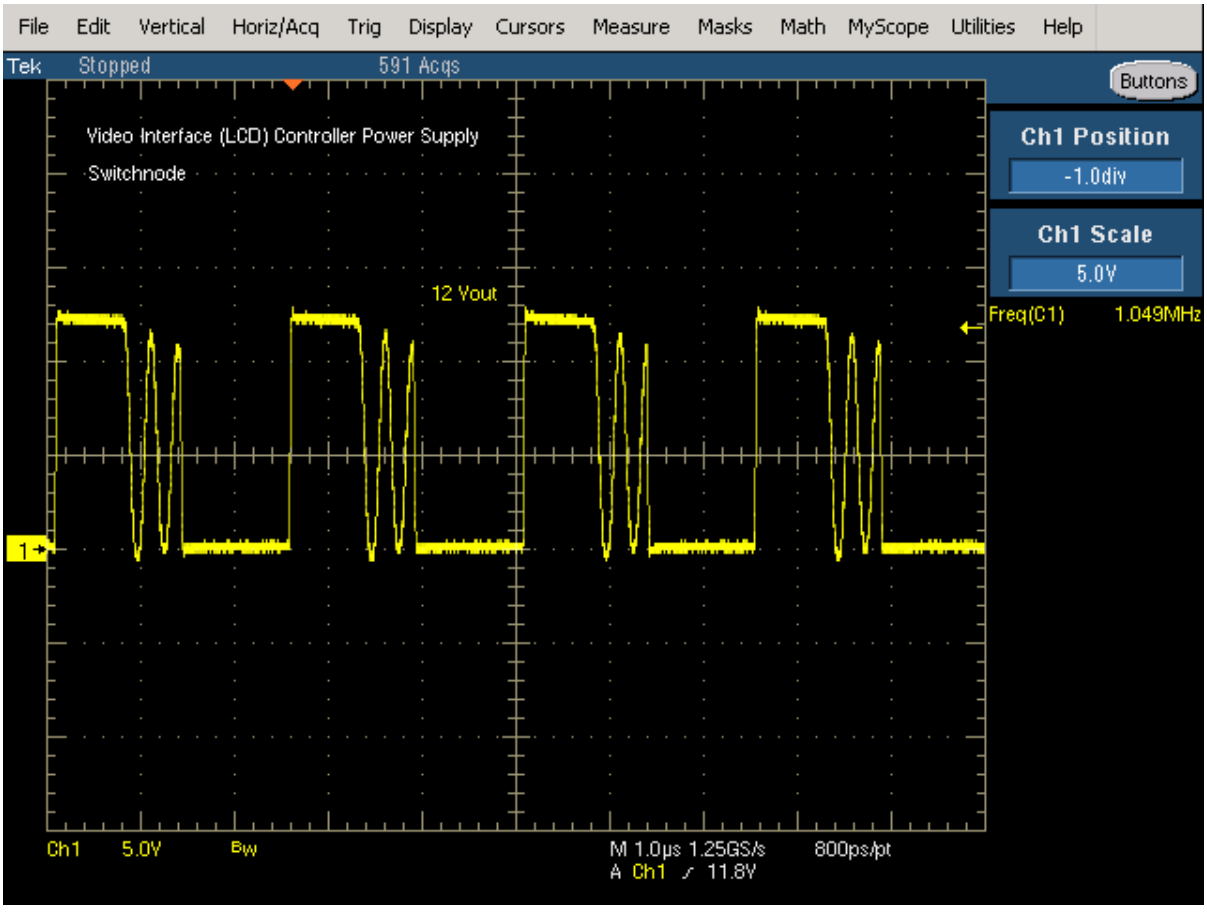


FIGURE 11. Video Interface Controller Power Supply - Switchnode Voltage

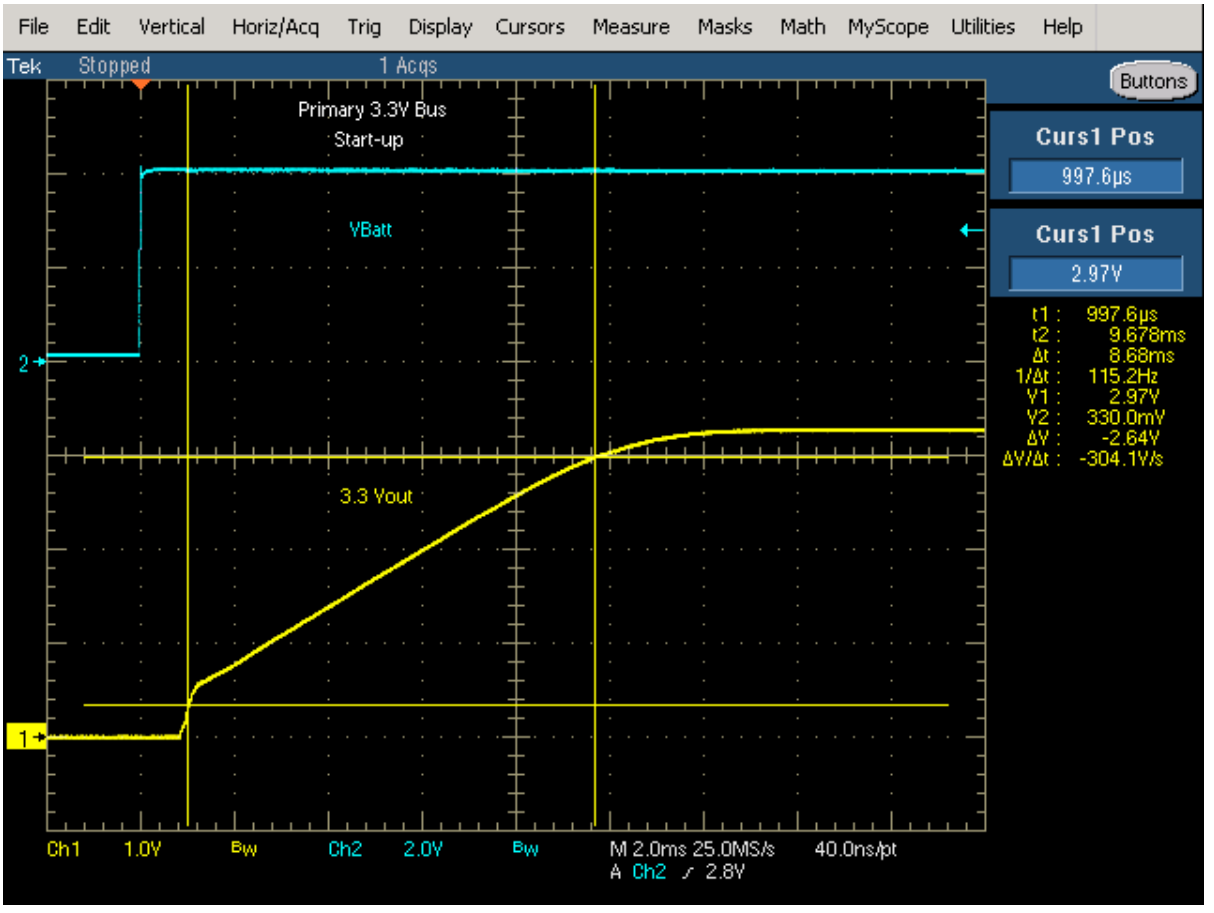


FIGURE 12. Primary 3.3V Bus - Start-up Waveform

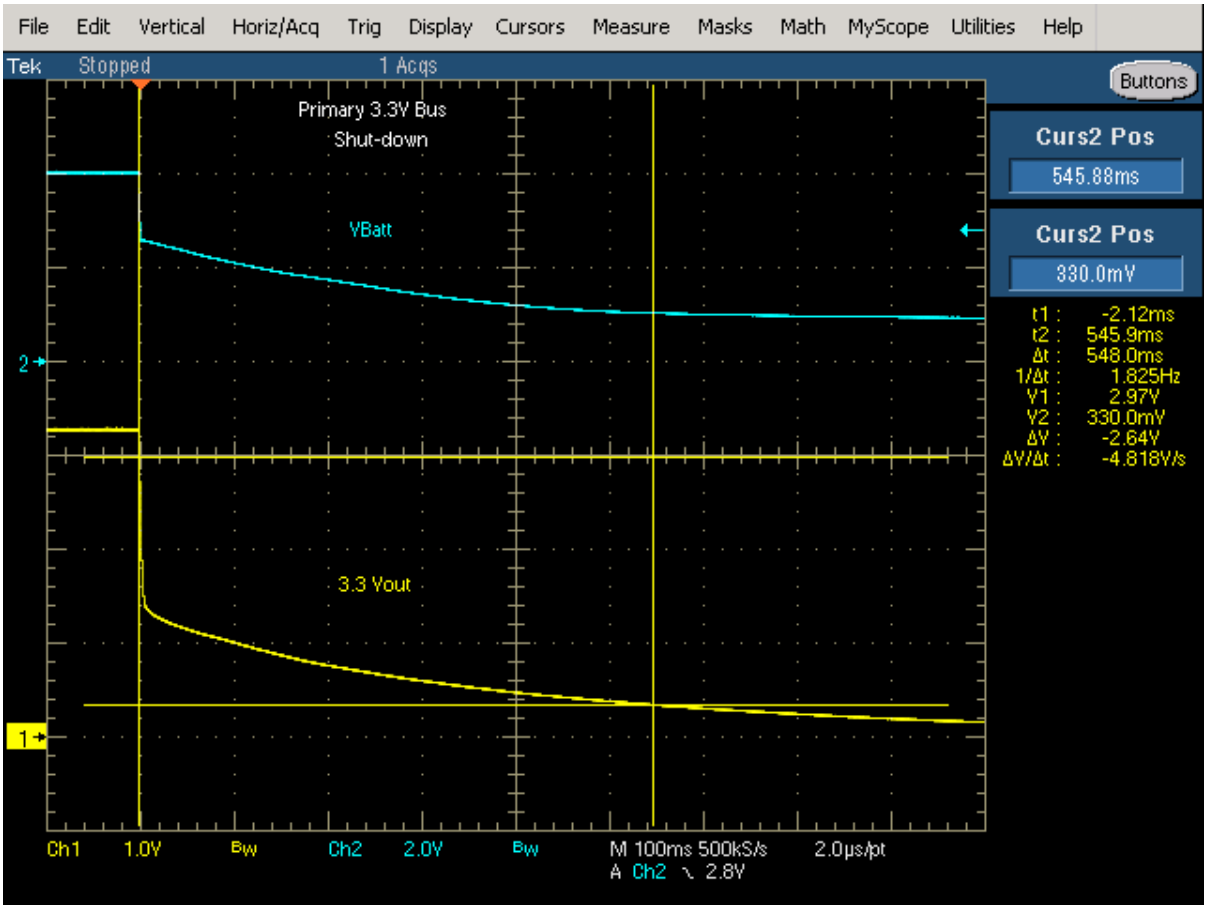


FIGURE 13. Primary 3.3V Bus - Shut-down Waveform

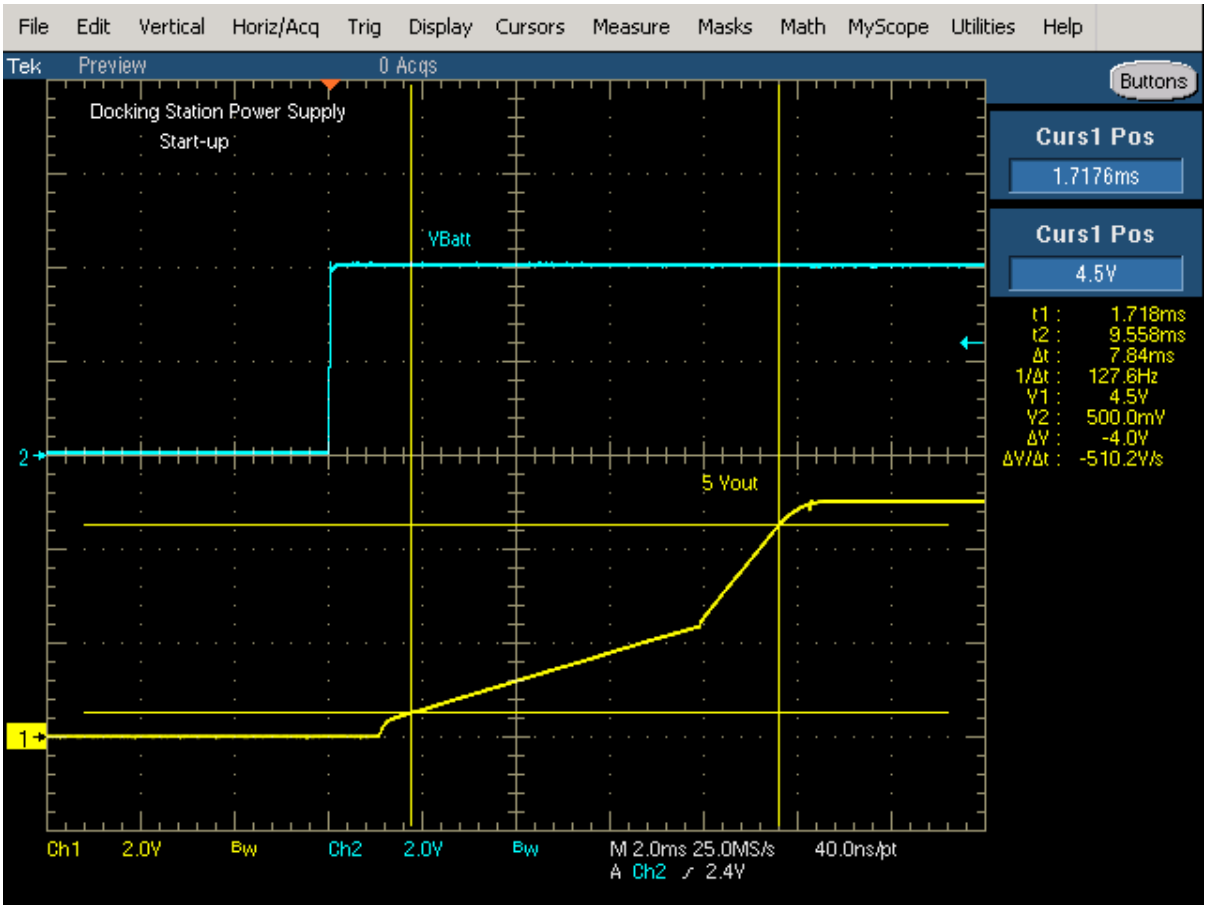


FIGURE 14. Docking Station Power Supply - Start-up Waveform

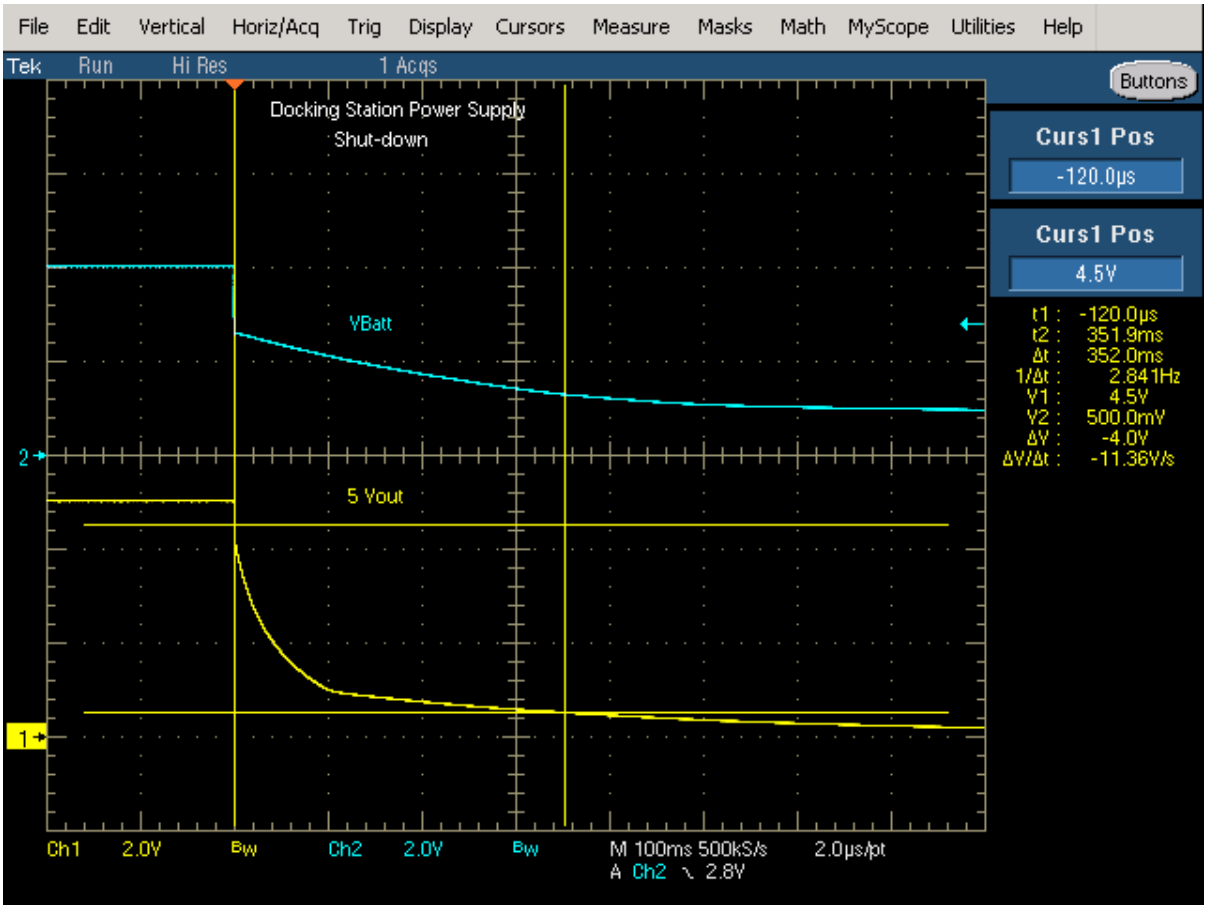


FIGURE 15. Docking Station Power Supply - Shut-down Waveform

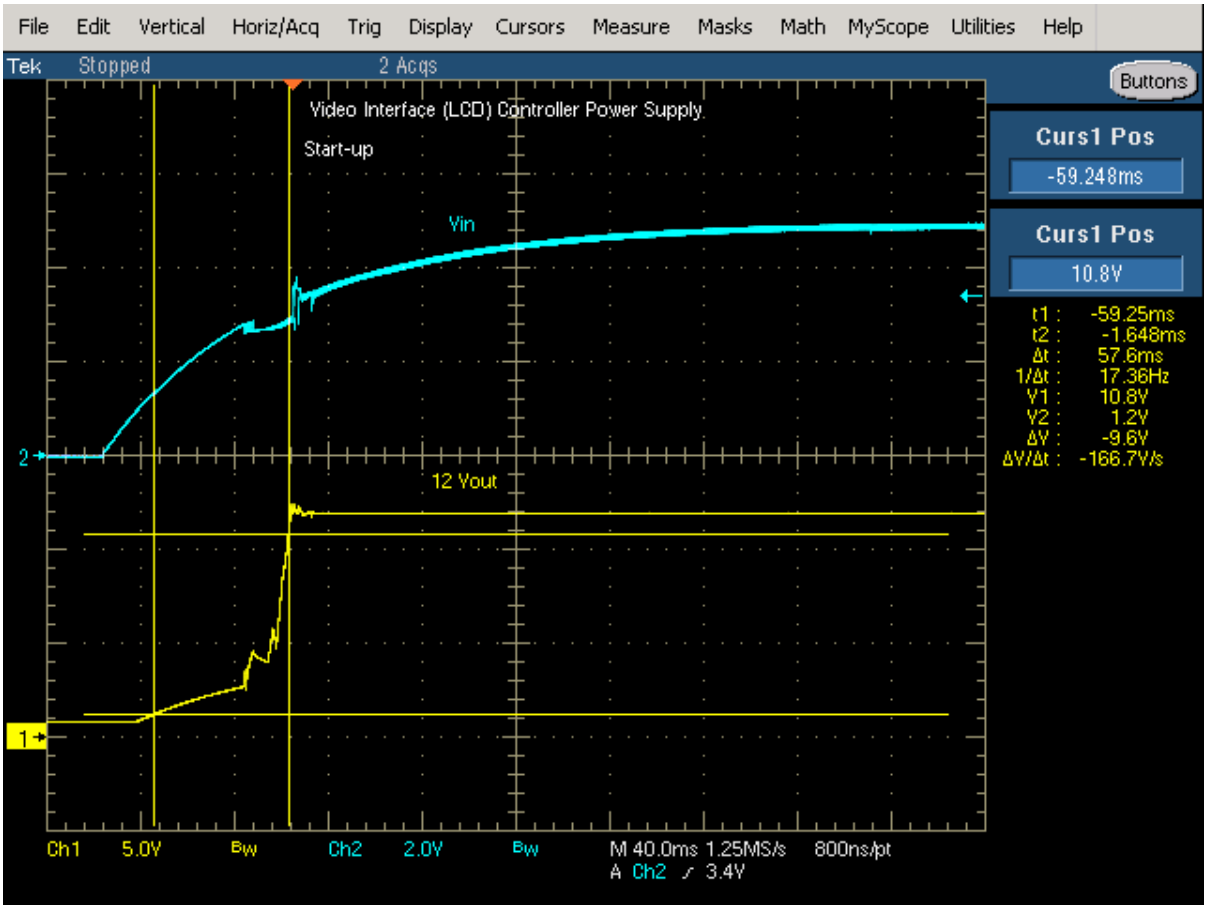
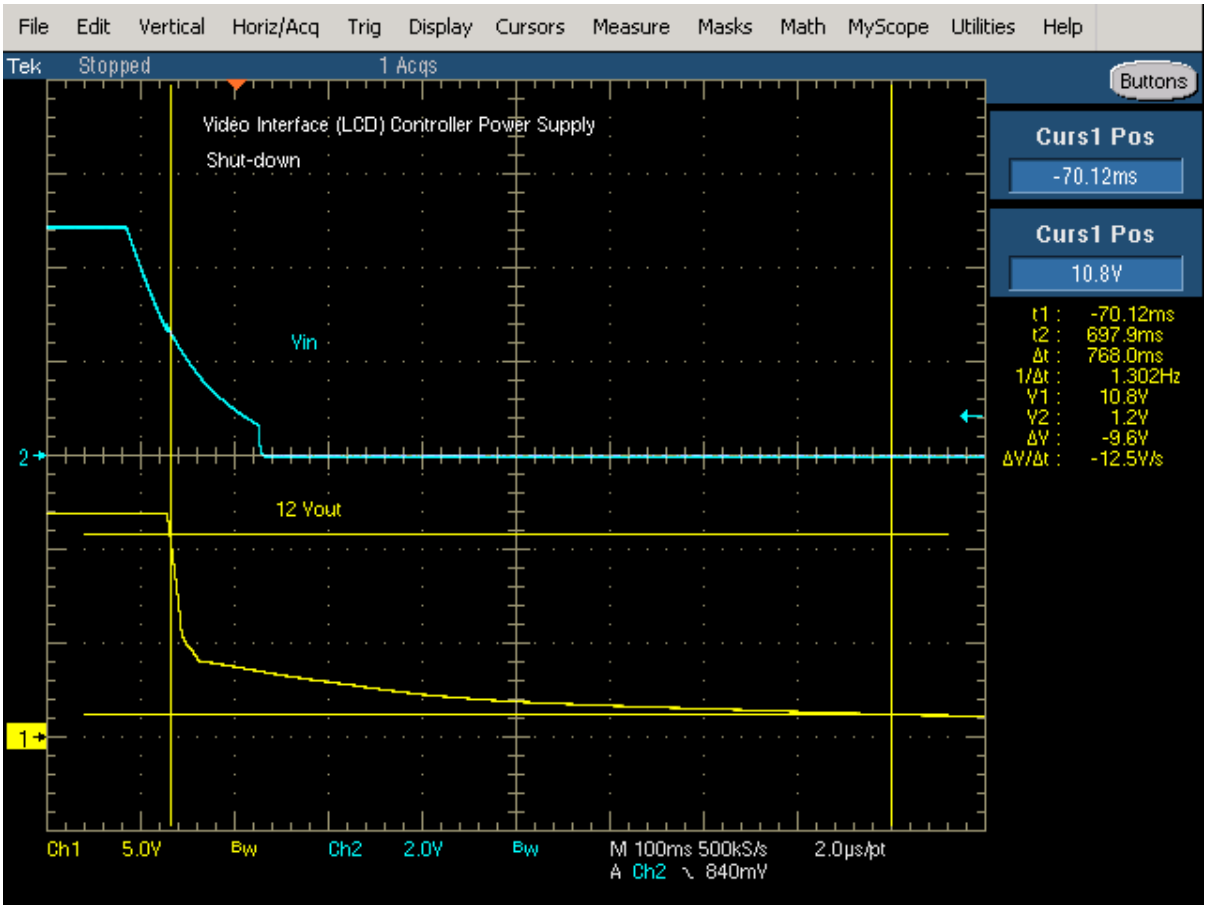


FIGURE 16. Video Interface Controller Power Supply - Start-up Waveform



other9

FIGURE 17. Video Interface Controller Power Supply - Shut-down Waveform

11.0 Appendix

Section 1

Power Management and Audio Segments

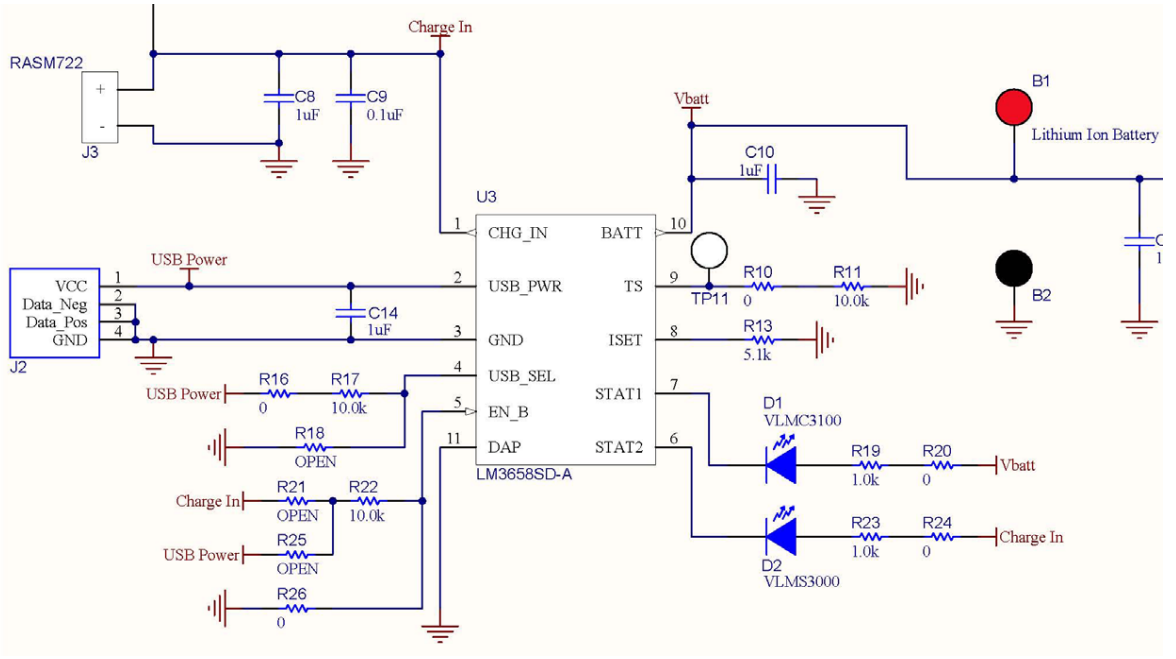


image8

FIGURE 18. Dual Source AC/USB Battery Charger and Power Sourcing Circuit Schematic

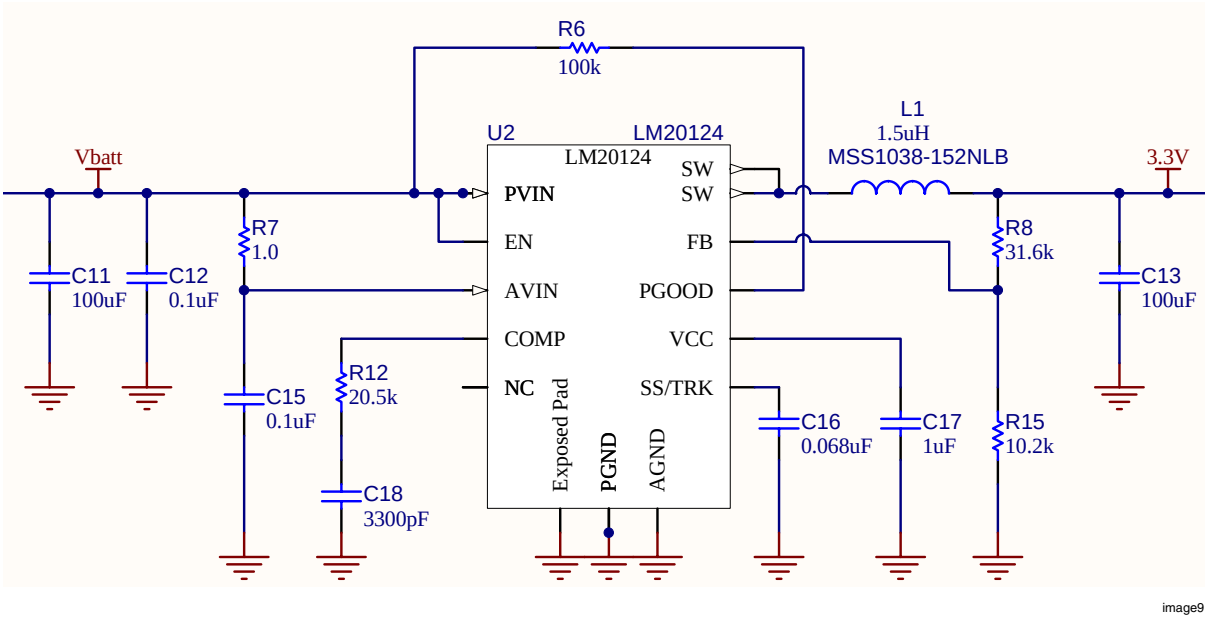


FIGURE 19. Primary 3.3V Power Supply Schematic

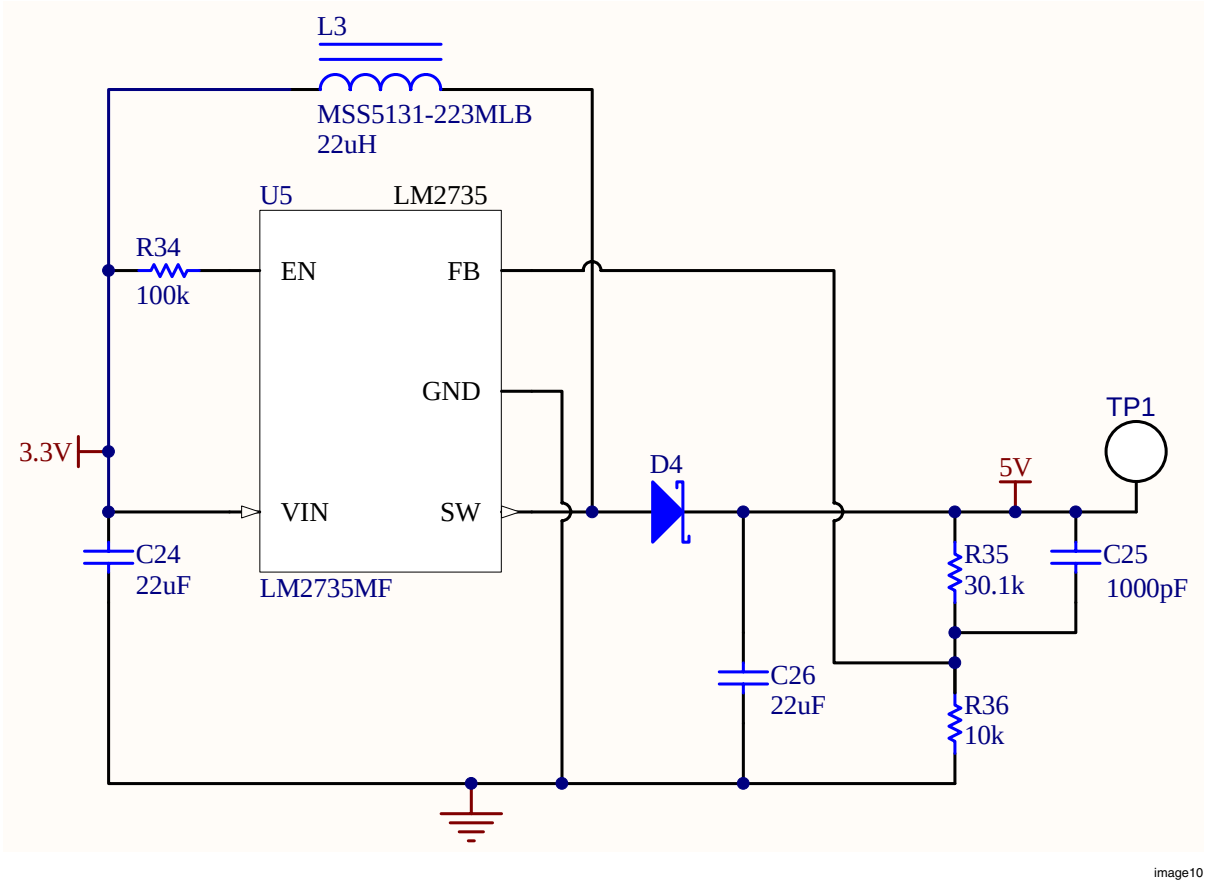


FIGURE 20. Docking Station Power Supply Schematic

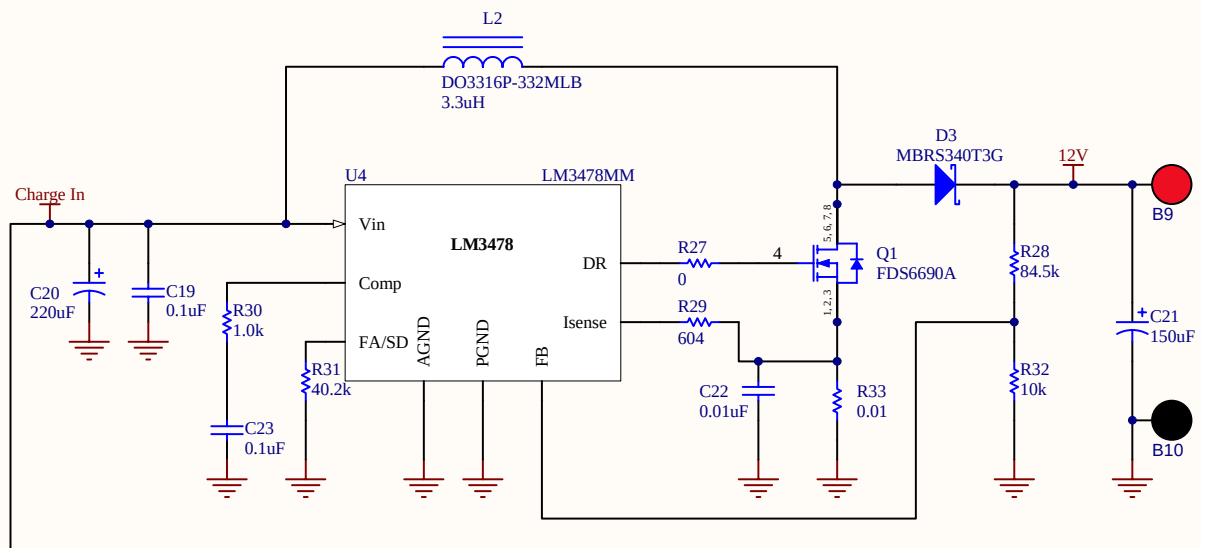


FIGURE 21. Video Interface (LCD) Controller Power Supply Schematic

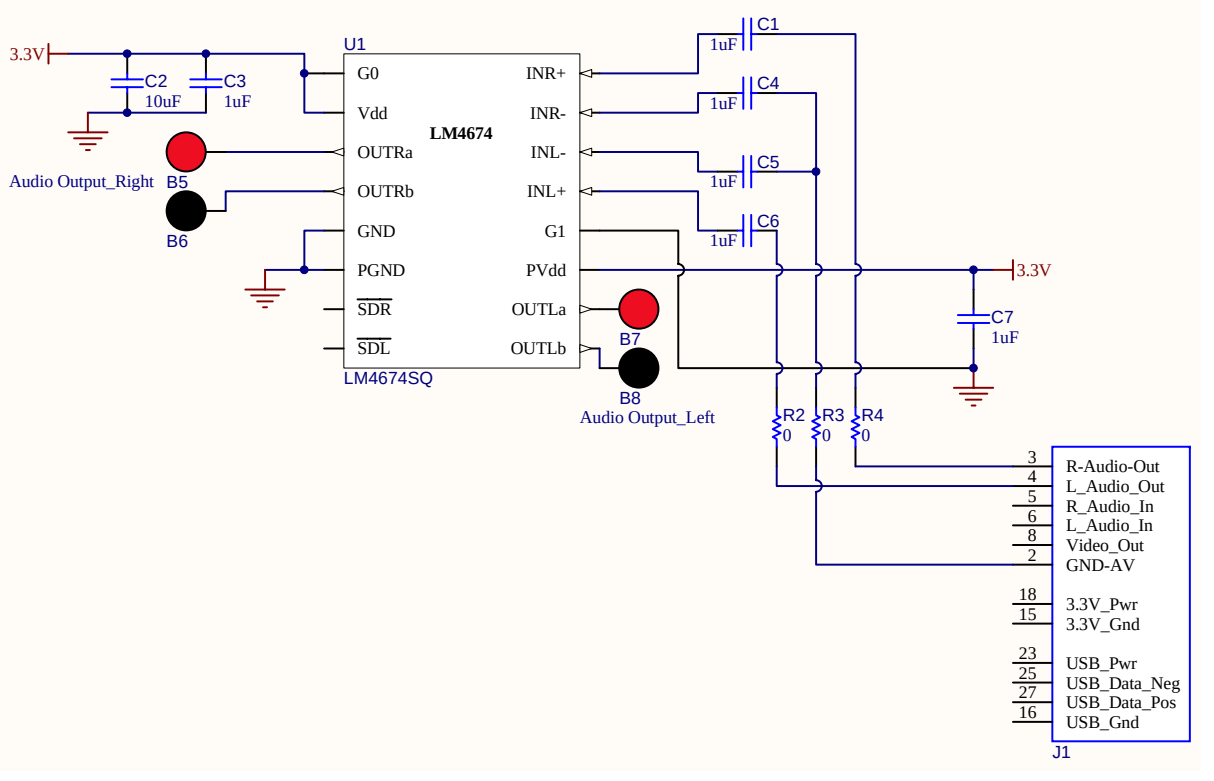
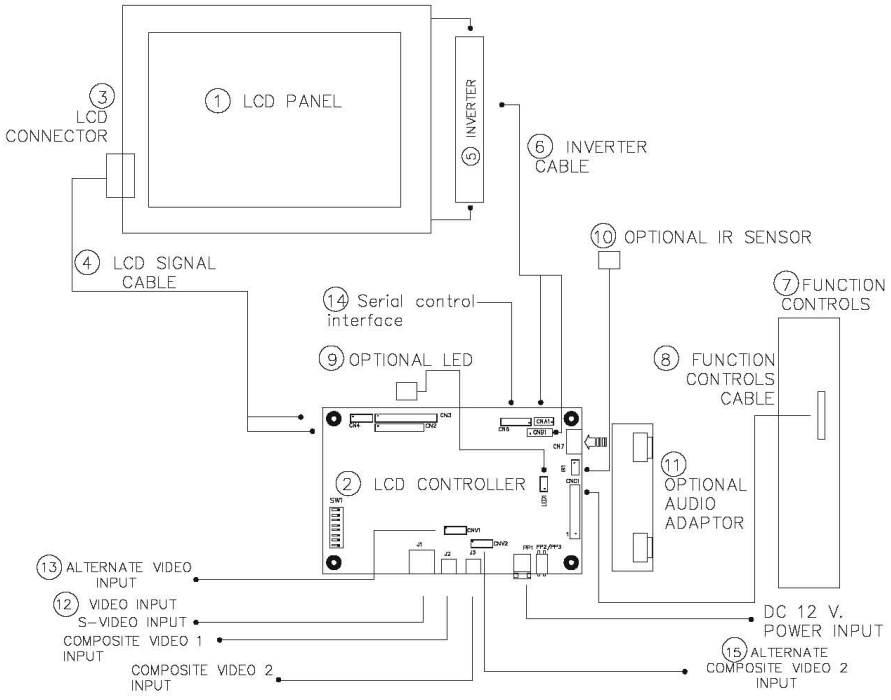


FIGURE 22. Stereo Class D Audio Amplifier Schematic

Section 2

Video Interface (LCD) Controller



Summary:

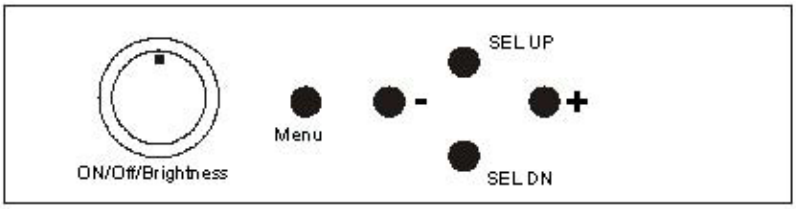
1. LCD panel
2. LCD controller card, AVP-1280
3. LCD panel connector board for LCD signal cable (if necessary)
4. LCD signal cables
5. Inverter for backlight (if not built into LCD)
6. Inverter cable
7. Function controls
8. Function controls cable
9. Status LED (optional)
10. IR sensor (optional)
11. Audio add-on board (optional)
12. AV cables (J1: S-video, J2: Composite video 1, J3: Composite video 2)
13. Alternate S-video or Composite video 1 input
14. Serial control interface
15. Alternate Composite video 2 input

- Power supply
- Enclosure or Mounting (not shown)

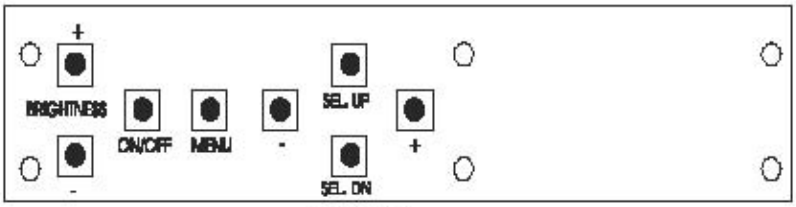
other6

FIGURE 23. Typical LCD Based Display System Diagram

Controls	Analog VR type	Digital type
On/Off – turns controller board power on	VR toggle switch	On/Off button
Brightness – controls backlight brightness	Rotary VR	Brightness +/- buttons
Menu – turns OSD menu On or Off (it will auto time off)	Menu button	Menu button
Select down – moves the selector to the next function (down)	SEL DN	SEL DN
Select up – moves the selector to the previous function (up)	SEL UP	SEL UP
+ – increase the setting/confirm the select	+	+
- – decrease setting	-	-



Analog VR type

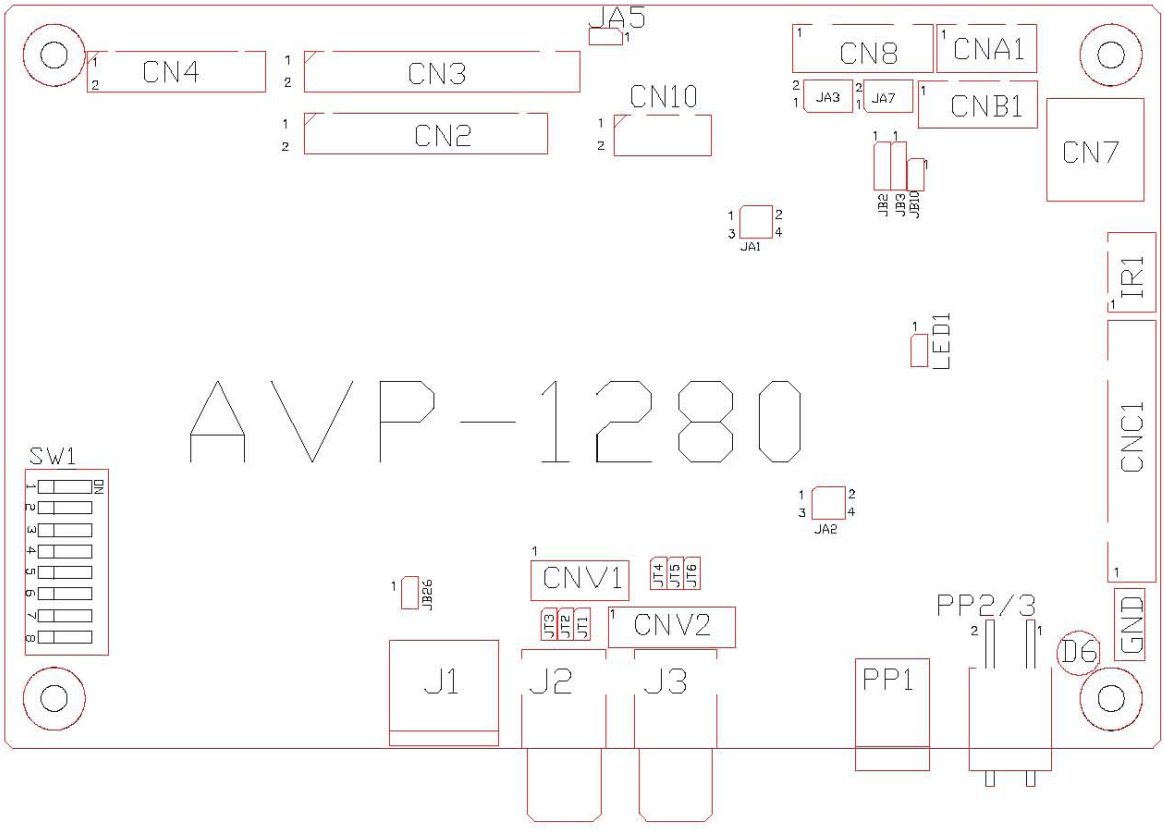


Digital type

To turn on the OSD menu:	Press the MENU button
Move to next icon:	Press the MENU button
Select options within icon menu:	Use SEL UP/SEL DN buttons, the selected option is in yellow
Increase/decrease setting:	Use +/- buttons
Move selection left/right:	Use +/- buttons, the selected option is in green
To confirm the selection:	Use + button

diagram1

FIGURE 24. On Screen Display (OSD) Controller Diagram



Summary: Connectors

Ref	Purpose	Description	
CN2	Panel signal	Hirose 28-pin, DF11-28DP-2DSA	(Matching type : DF11-28DS-2C)
CN3	Panel signal	Hirose 32-pin, DF11-32DP-2DSA	(Matching type : DF11-32DS-2C)
CN4	Panel signal	Hirose 20-pin, DF11-20DP-2DSA	(Matching type : DF11-20DS-2C)
CN7	Audio board connector	DIL socket header 5x2 right angle	
CN8	RS-232 serial control	JST 6-way, B6B-XH-A	(Matching type : XHP-6)
CN10	Panel signal	Hirose 10-pin, DF11-10DP-2DSA	(Matching type : DF11-10DS-2C)
CNA1	Auxiliary power output	JST 4-way, B4B-XH-A	(Matching type : XHP-4)
CNB1	Backlight inverter	JST 5-way, B5B-XH-A	(Matching type : XHP-5)
CNC1	OSD controls	JST 12-way, B12B-XH-A	(Matching type : XHP-12)
CNV1	Alternate video in	JST 5-way, B5B-PH-K	(Matching type : PHR-5)
CNV2	Alternate composite video in	JST 6-way, B6B-PH-K	(Matching type : PHR-6)
J1	S-video in	Mini din 4-way	
J2	Composite video 1 in	RCA jack (yellow)	
J3	Composite video 2 in	RCA jack (yellow)	
IR1	Infra-Red sensor connector	JST 3-way, B3B-XH-A	(Matching type : XHP-3)
LED1	Dual color LED connector	Header pin 3x1	
PP1	Main power input	DC power jack, 2.5mm contact pin diameter	
PP2/3	Power input (alternative)	DC power Molex 2 pin 0.156" pitch	
SW1	Panel selection	8-positions DIP Switch	

image2

FIGURE 25. Video Interface Controller connectors, pinouts, and jumpers

Section 3

SERDES
Serializer/Deserializer

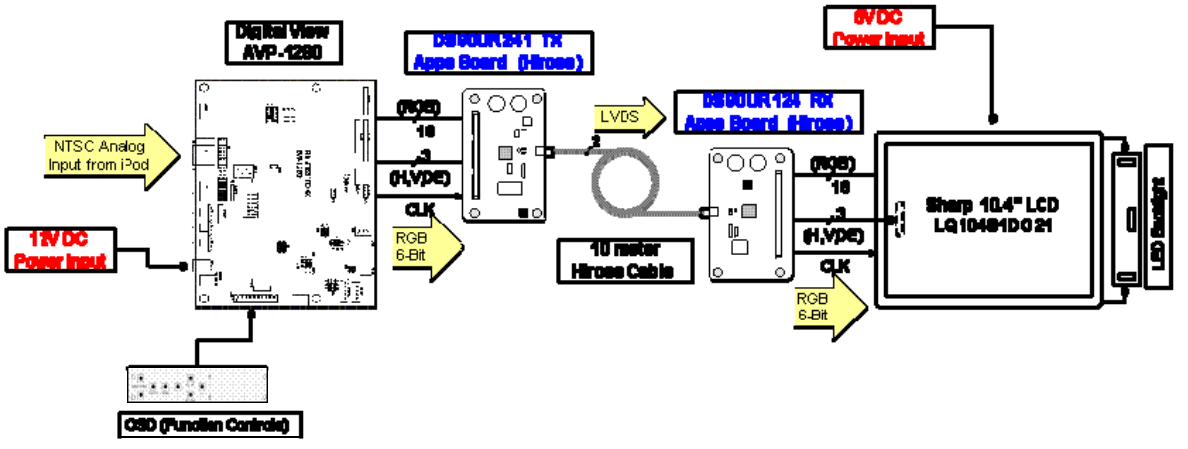


FIGURE 26. SERDES System Block Diagram with Video Interface Controller and LCD Display

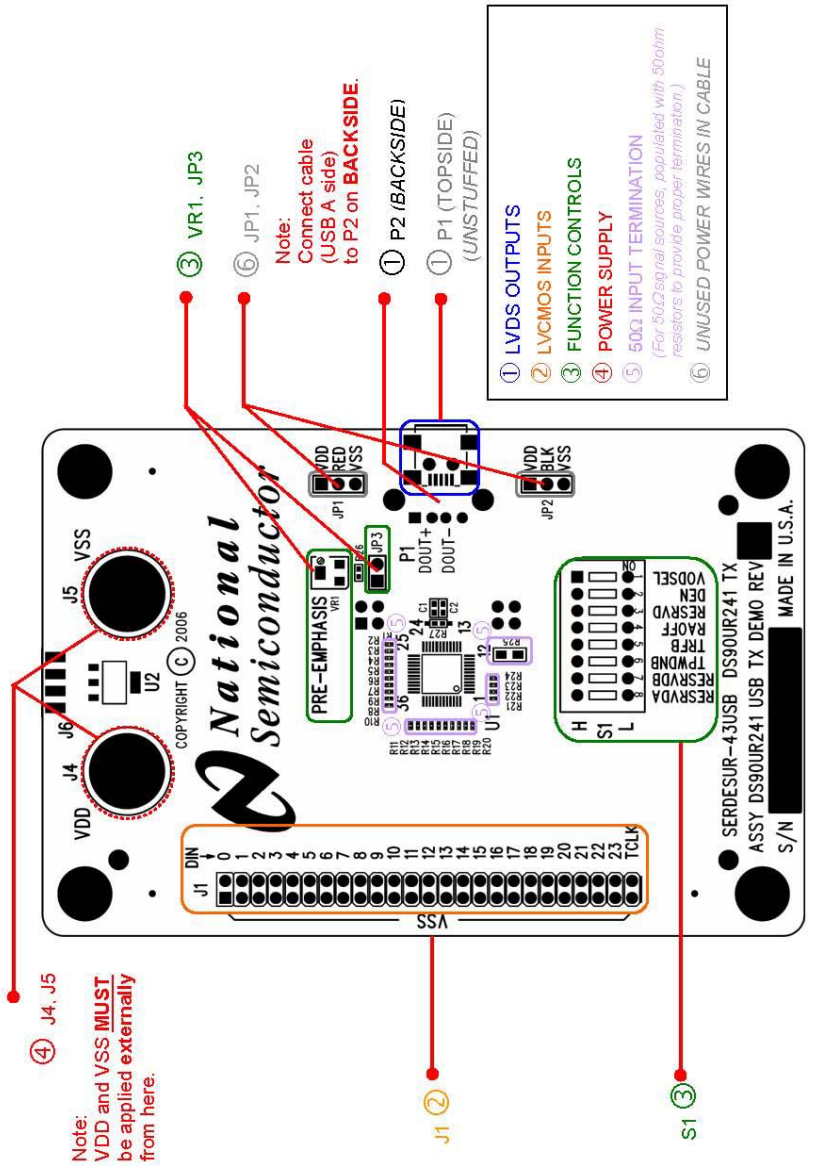


image31

FIGURE 27. Serializer Board_DS90UR241.pdf

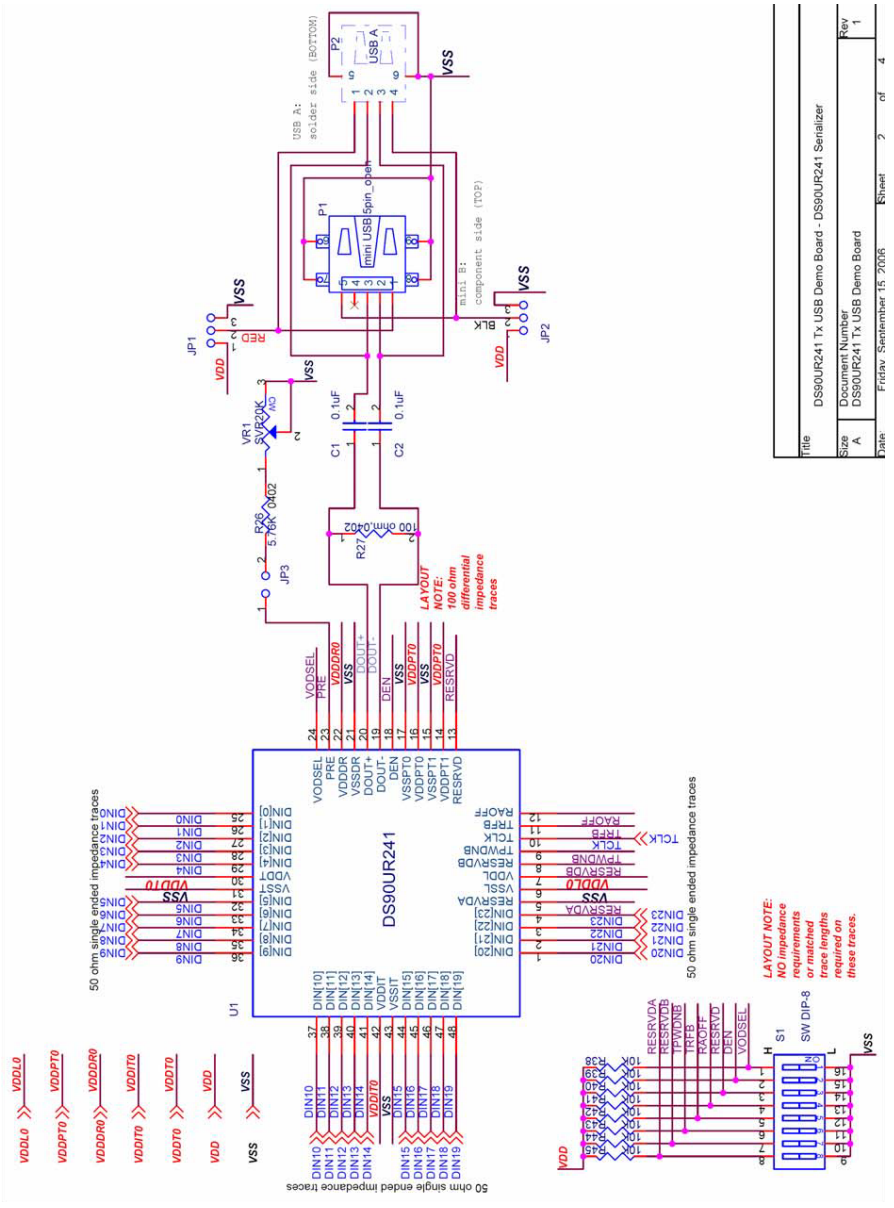


image32

FIGURE 28. DS90UR241 Serializer

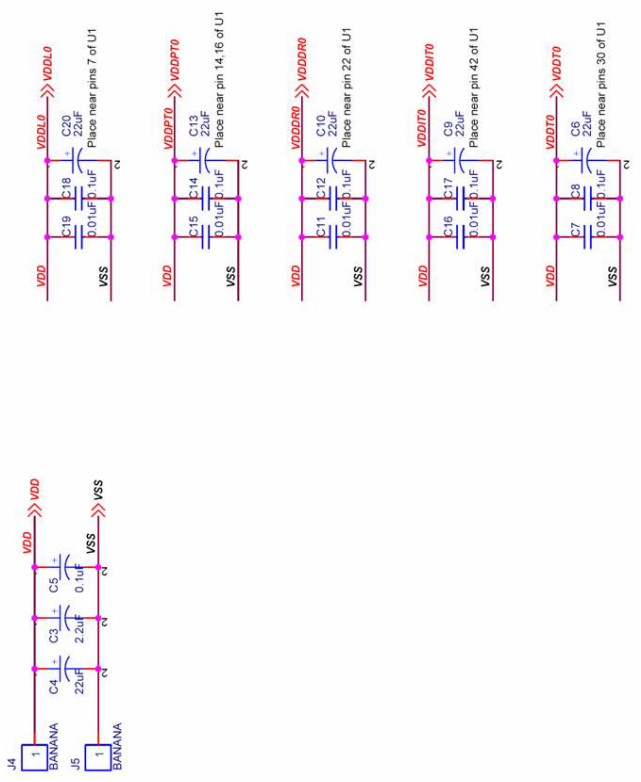


image33

FIGURE 29. DS90UR241 Power and Decoupling

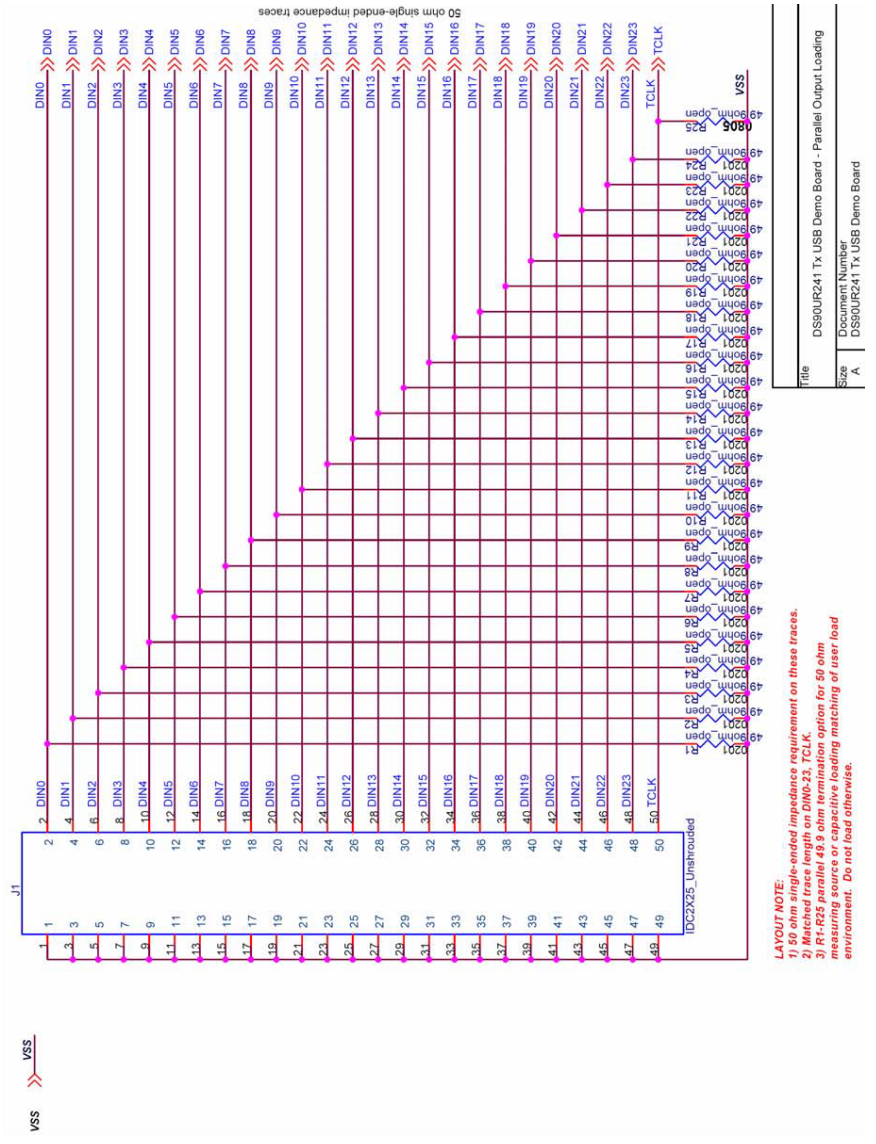


image34

FIGURE 30. DS90UR241 Parallel Output Loading

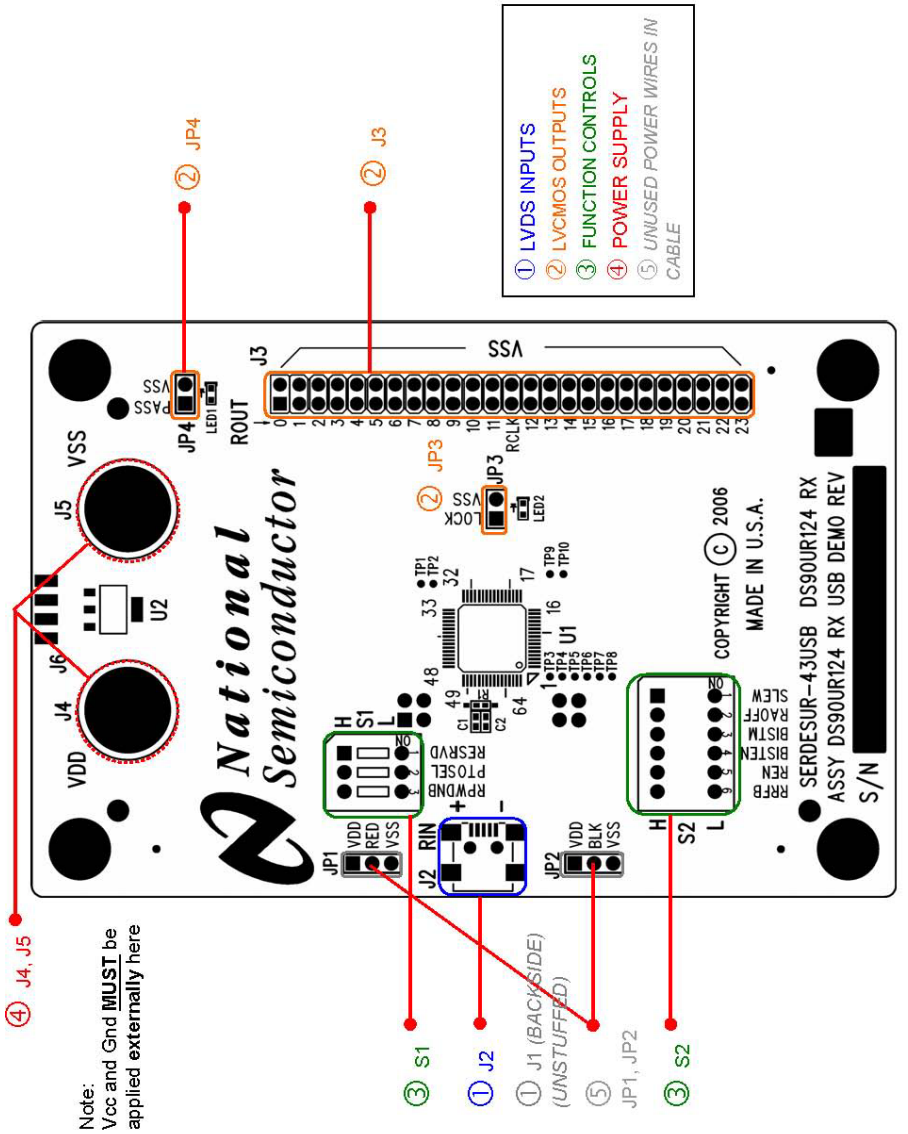


image35

FIGURE 31. DS90UR124 Deserializer Board

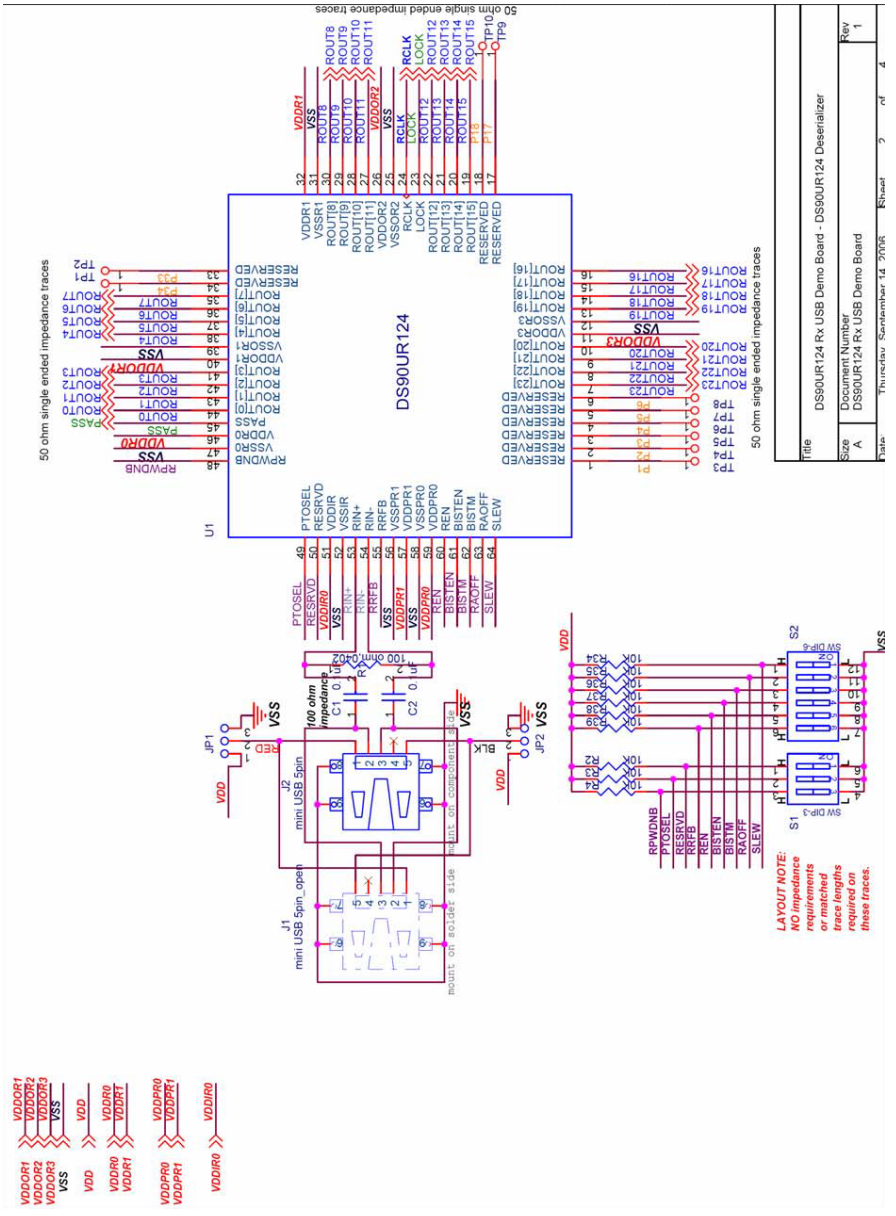


image36

FIGURE 32. DS90UR124 Deserializer

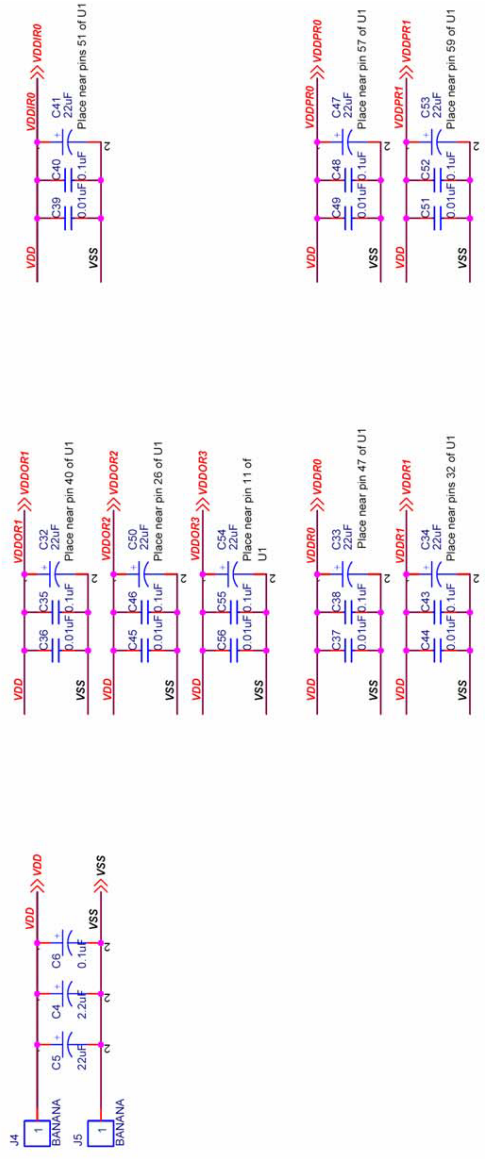


image37

FIGURE 33. DS90UR124 Power and Decoupling

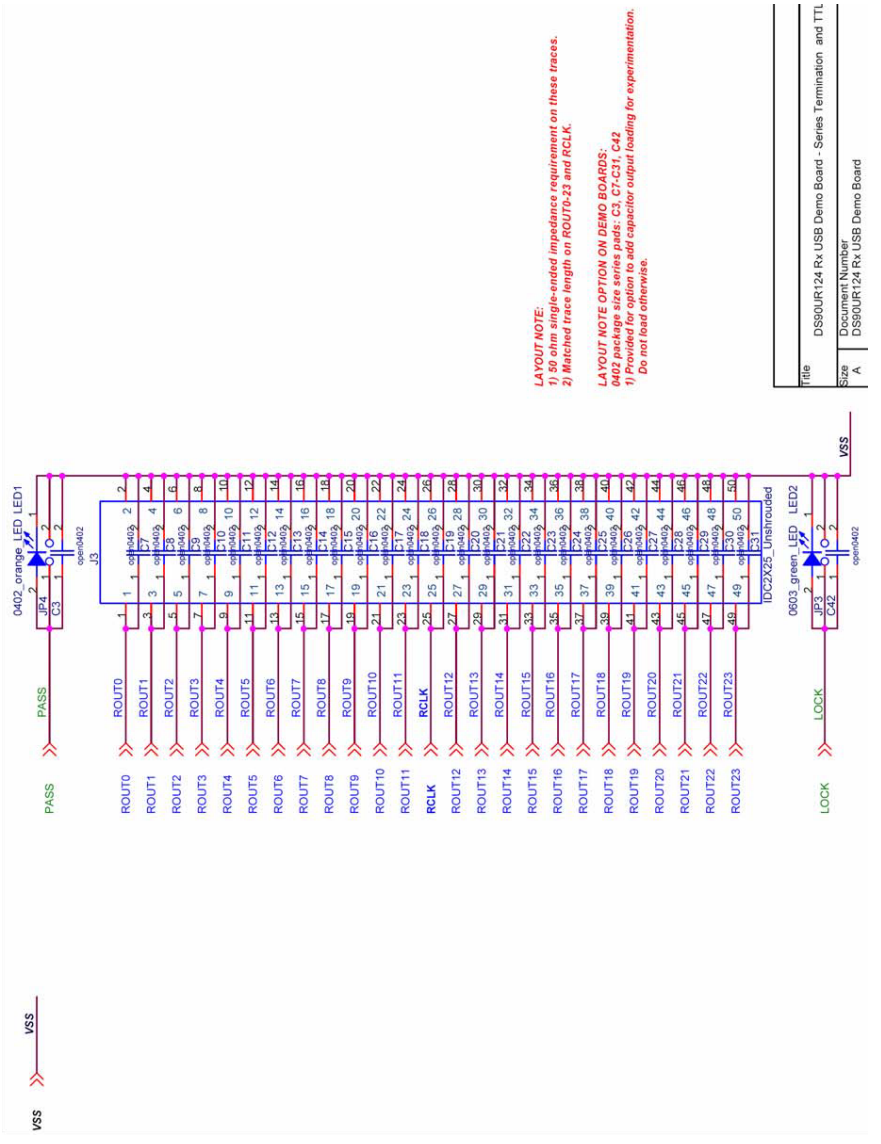
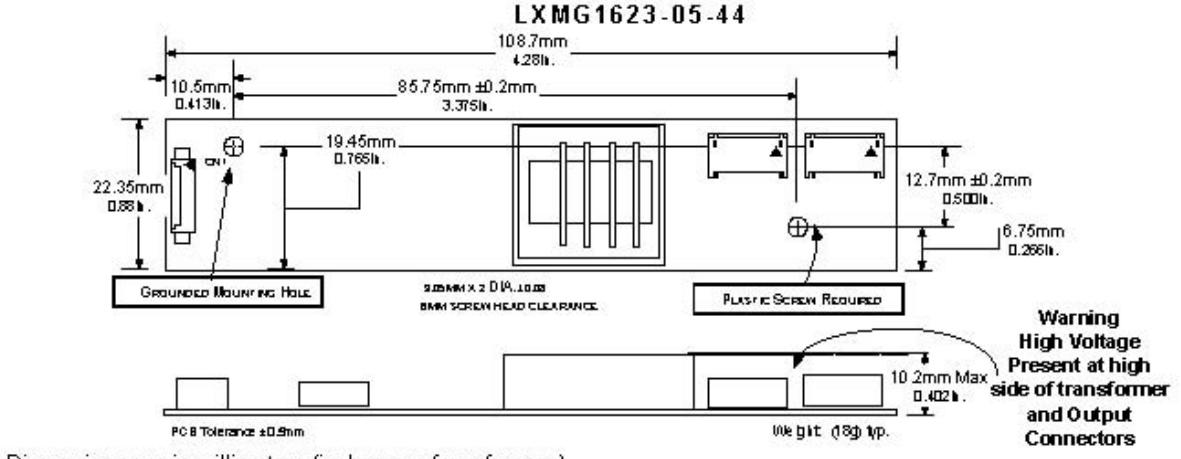


image38

FIGURE 34. DS90UR124 Series Termination and TTL Loading

Section 4

TFT-LCD Panel Display Module



Dimensions are in millimeters (inches are for reference)

image39

FIGURE 35. 5V Dual 4W Programmable Inverter Module

Notes

Notes

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