

LM2485 220V Triple Bias Clamp with G1 Blank Amplifier

Check for Samples: [LM2485](#)

FEATURES

- V_{CC} Capable of up to 220V
- V_{BB} Selectable to 8V or 12V via Pin 12 Option
- Wide Bias Output Voltage Range of Over 100V
- Inverted Output Pulse Suitable for G1 Blanking, Selectable to 20V_{P-P} or 40V_{P-P} via Pin 13 Option

APPLICATIONS

- AC Coupled CRT Applications Using DTV Formats up to 1080i
- Well-Matched to the NSC LM12XX Family of Preamplifiers and LM242X/3X/5X Family of DTV CRT Drivers

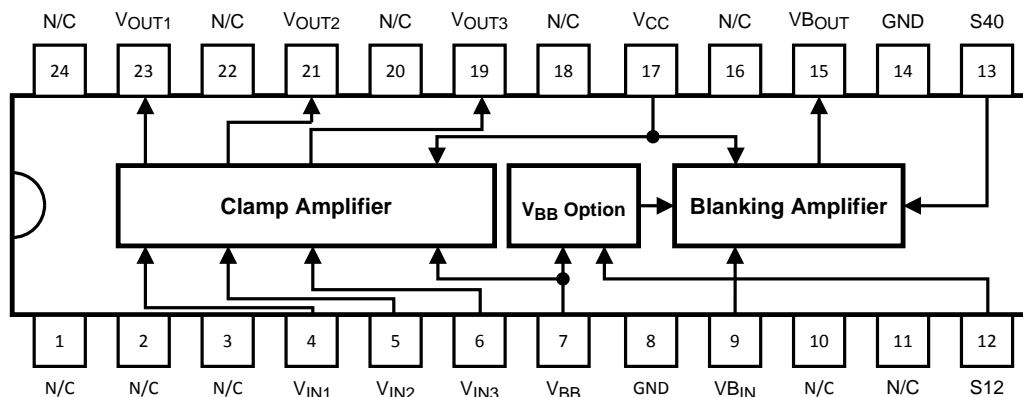
DESCRIPTION

The LM2485 is a triple channel clamp amplifier used to DC restore the AC coupled outputs of a DTV CRT driver and for cut-off adjustment. The LM2485 also has an integrated blanking amplifier that can be used to drive the G1 grid of a CRT negative for vertical retrace blanking. The blanking output has a selectable pulse amplitude of either 20V_{P-P} or 40V_{P-P} via the Pin 13 option. The blanking input pulse can be generated from a vertical flyback pulse or by a microcontroller.

The LM2485 can operate with a V_{CC} supply of up to 220V and a V_{BB} supply of either 8V or 12V. This V_{BB} option, selectable via the Pin 12 option, ensures the LM2485 is compatible with any TI DTV CRT driver sharing the same operating voltages in the application.

The IC is packaged in an industry standard 24-lead molded plastic dual-in-line package to meet high voltage spacing requirements.

Pinout and Internal Block Diagram



PDIP Package - Top View
See Package Number NAM



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾⁽²⁾⁽³⁾

Supply Voltage, V_{CC}		250V
Bias Voltage, V_{BB}		15V
Input Voltage, V_{IN}		-0.5V to +6.5V
Blanking Input Voltage, V_{BIN}		-0.5V to +6.5V
Storage Temperature Range, T_{STG}		-65°C to +150°C
Lead Temperature (Soldering, <10sec.)		300°C
ESD Tolerance	Human Body Model	2 kV
	Machine Model	200V
Max Junction Temperature		150°C
θ_{JA} (Max at 0 LFPM)		68°C/W

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.
(2) All voltages are measured with respect to GND, unless otherwise specified.
(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/ Distributors for availability and specifications.

OPERATING RANGES⁽¹⁾⁽²⁾

V_{CC}	170V to 230V
V_{BB} (Pin 12 floated)	7.5V to 8.5V
V_{BB} (Pin 12 grounded)	11.5V to 12.5V
V_{IN}	0V to 5V
V_{OUT}	105V to 215V
V_{BIN}	0V to 5V
V_{BOUT} ($V_{CC} = 220V$)	40V to 80V
V_{BOUT} ($V_{CC} = 180V$)	25V to 65V
Ambient Temperature Range, T_A	-20°C to T_{AMAX} ⁽³⁾

- (1) All voltages are measured with respect to GND, unless otherwise specified.
(2) Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and the test conditions, see the Electrical Characteristics. Datasheet min/max specification limits are ensured by design, test, or statistical analysis. The ensured specifications apply only for the test conditions listed. Some performance characteristics may change when the device is not operated under the listed test conditions.
(3) See [THERMAL CONSIDERATIONS](#) to calculate T_{AMAX} .

ELECTRICAL CHARACTERISTICS

(See [Figure 1](#) and [Figure 2](#) for Test Circuits)

Unless otherwise noted: $V_{CC} = 220V$, $V_{BB} = 8V$, $V_{IN} = 2.5V_{DC}$, $T_A = 20^\circ C$, Pin 12 floated, Pin 13 grounded.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{CC}	Supply Current	All channels, not including pull-up resistor currents		3.1	4.2	mA
I_{BB-8}	Bias Supply Current	All channels, $V_{BB} = 8V$		6.0	10.0	mA
I_{BB-12}	Bias Supply Current	All channels, Pin 12 grounded, $V_{BB} = 12V$		9.0	13.0	mA
V_{OUT}	Clamp Output Voltage		170	175	180	V_{DC}
$V_{OUT-Range}$	Clamp Output Voltage Range	$V_{IN-Range} = 1.5V$ to $4.5V$		75		V
A_V	Clamp Output DC Voltage Gain	$1.0V \leq V_{IN} \leq 5.0V$	-23	-25	-27	V/V
LE	Clamp Output Linearity Error	See ⁽¹⁾		5		%
$V_{BOUT-High}$	Blanking Output High Level	$V_{BIN} \leq 0.5V$		80		V_{DC}
$V_{BOUT-Low1}$	Blanking Output Low Level 1	$V_{BIN} \geq 4.5V$, Pin 13 floated		60		V_{DC}
$V_{BOUT-Low2}$	Blanking Output Low Level 2	$V_{BIN} \geq 4.5V$		40		V_{DC}
t_R	Blanking Output Rise Time	$V_{BIN} = 0V-5V$ Logic Pulse at 8.6% duty cycle (480p), $V_{BOUT} = 40V_{P-P}$ (40V-80V)		2.0		us
t_F	Blanking Output Fall Time	$V_{BIN} = 0V-5V$ Logic Pulse at 8.6% duty cycle (480p), $V_{BOUT} = 40V_{P-P}$ (40V-80V)		4.5		us

- (1) Linearity Error is the variation in DC gain from $V_{IN} = 1.0V$ to $5.0V$ measured at the points 1.0V, 1.5V, 4.5V, and 5.0V.

TEST CIRCUITS

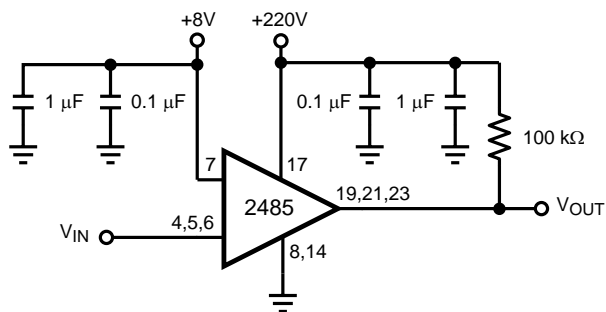


Figure 1. Clamp Amplifier Test Circuit

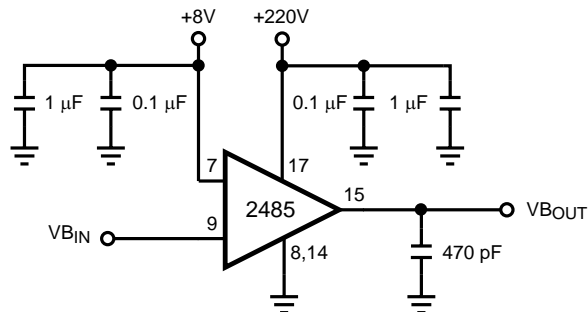
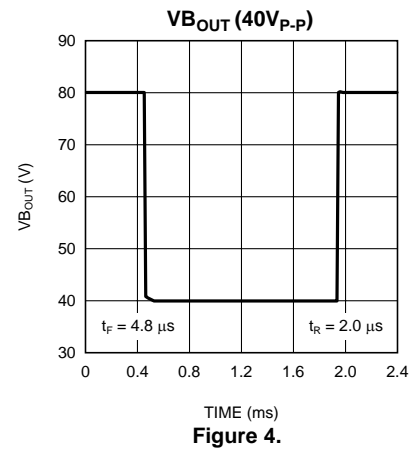
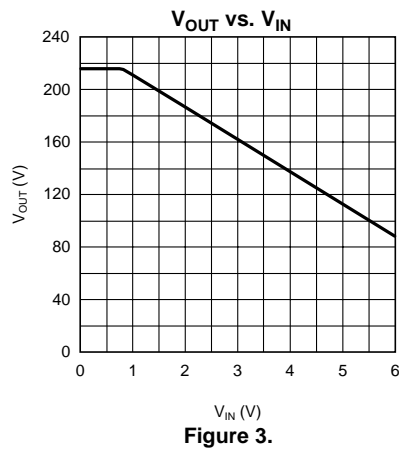


Figure 2. Blanking Amplifier Test Circuit

Figure 1 shows the test circuit used to evaluate the LM2485 clamp amplifier. A high impedance voltmeter (>10MΩ) is used to measure the DC voltages at the V_{OUT} output pins. Figure 2 shows the test circuit used to evaluate the LM2485 blanking amplifier. An oscilloscope and a scope probe are used to measure the pulse amplitude at the V_{BOUT} output pin.

TYPICAL PERFORMANCE CHARACTERISTICS

($V_{CC} = 220V$, $V_{BB} = 8V$, $V_{B_{IN}} = 0V-5V$ Logic Pulse at 8.6% duty cycle, Pin 12 floated, Pin 13 grounded, Test Circuits - Figure 1 and Figure 2)



THEORY OF OPERATION

The pinout and internal block diagram of the LM2485 is shown in .

The LM2485 is a triple channel bias clamp amplifier used to DC restore the AC coupled outputs of a DTV CRT driver and for cut-off adjustment. The clamp circuit amplifies the DC inputs, V_{IN} , by the internally fixed gain of -25 . Each DC clamp output, V_{OUT} , will require a pull-up resistor to V_{CC} . The clamp DC transfer function is shown in [Figure 3](#).

The LM2485 also has an integrated blanking amplifier that takes a positive-going 5V input pulse, $V_{B_{IN}}$, and outputs a negative-going pulse, $V_{B_{OUT}}$, with a selectable amplitude of either $20V_{P-P}$ or $40V_{P-P}$ via the Pin 13 (S40) option. If Pin 13 is floated, the $V_{B_{OUT}}$ pulse amplitude is $20V_{P-P}$; if Pin 13 is grounded, the amplitude is $40V_{P-P}$ (see [Figure 4](#)). With a simple clamp circuit, this inverted pulse can be used to drive the G1 grid of a CRT negative to blank the horizontal retrace lines during the vertical flyback period. The input pulse can be generated from a vertical flyback pulse or by a microcontroller.

The LM2485 can operate with a V_{CC} supply of up to 220V and a selectable V_{BB} supply of either 8V or 12V via the Pin 12 (S12) option. If Pin 12 is floated, then 8V is expected at the V_{BB} pin; if Pin 12 is grounded, then 12V is expected. This V_{BB} option ensures the LM2485 is compatible with any TI DTV CRT driver sharing the same operating voltages in the application. Note that using a V_{BB} supply of 12V will increase the input offset of the clamp circuit, which would have the effect of shifting the DC transfer function slightly to the right. Also, if the V_{BB} option is incorrectly matched to the actual V_{BB} supply voltage, an incorrect $V_{B_{OUT}}$ amplitude will be produced. Therefore, it is important to ensure that the appropriate V_{BB} option is used and the V_{BB} supply is within the range stated in the [Operating Ranges](#).

APPLICATION INFORMATION

INTRODUCTION

Texas Instruments is committed to provide application information that assists our customers in obtaining the best performance possible from our products. The following information is provided in order to support this commitment. The reader should be aware that the optimization of performance was done using a specific printed circuit board designed at TI. Variations in performance can be realized due to physical changes in the printed circuit board and the application. Therefore, the designer should know that component value changes may be required in order to optimize performance in a given application. The values shown in this document can be used as a starting point for evaluation purposes.

POWER SUPPLY BYPASS

The LM2485 should have proper power supply bypassing for optimal arc protection and performance. A 0.1 μF capacitor should be connected from each of the supply pins, V_{CC} and V_{BB} , to ground, as close to the supply and ground pins as possible. Additionally, a 1 μF electrolytic capacitor should be connected from each supply to the LM2485 ground and placed reasonably close to both supply pins.

ARC PROTECTION

During normal CRT operation, internal arcing may occasionally occur. To protect the LM2485 against arcing, it is important that the recommended applications circuit is used and good layout practices are followed. Please refer to the [TI Demonstration Board](#) for a detailed example on arc protection and PCB layout considerations.

THERMAL CONSIDERATIONS

Determining Maximum Power Dissipation and Ambient Temperature

Power dissipation within an integrated circuit package is a very important parameter. An incorrect maximum power dissipation calculation may result in excessive thermal stress to the device, affecting its reliability and performance. To estimate the maximum power dissipation of the LM2485, the following system parameters should be determined first.

- Maximum V_{CC} and V_{BB} supply voltages
- Average CRT cut-off voltages
- Maximum average beam currents
- Highest duty cycle

Once these parameters are known, the system designer can then calculate the maximum ambient temperature surrounding the LM2485 without a heat sink. A small, low-cost heat sink may be used if the calculated maximum ambient temperature does not satisfy the worst-case operating temperature inside the TV.

The following example shows how to determine the maximum power dissipation and maximum ambient temperature and assumes the recommended application circuit is used (see [Figure 5](#)).

Example

The LM2485 uses 1.0W of static power from the 220V and 8V supplies, assuming the worst-case supply currents. If the average CRT cut-off voltage of all channels is 180V and each LM2485 output sinks a maximum average beam current of 1.0 mA at 77% duty cycle (480p format) at the highest brightness setting, the LM2485 will dissipate:

$$P_{\text{DISS}} = P_{\text{STATIC}} + 3 \times (V_{\text{CUT-OFF}} \times I_{\text{AVGMAX}}) \times \delta, \text{ or} \quad (1)$$

$$P_{\text{DISS}} = 1.0\text{W} + 3 \times (180\text{V} \times 1.0 \text{ mA}) \times 0.77 = 1.42\text{W}. \quad (2)$$

The maximum thermal resistance from junction-to-air, θ_{JA} , and maximum junction temperature, T_{JMAX} , are stated in the [Absolute Maximum Ratings](#). Therefore, the maximum ambient temperature surrounding the LM2485 can be calculated:

$$T_{\text{AMAX}} = T_{\text{JMAX}} - (P_{\text{DISS}} \times \theta_{\text{JA}}), \text{ or} \quad (3)$$

$$T_{\text{AMAX}} = 150^{\circ}\text{C} - (1.42\text{W} \times 68^{\circ}\text{C/W}) = 53^{\circ}\text{C}. \quad (4)$$

TYPICAL APPLICATION

Used in conjunction with NSC's LM12XX Preamplifier and LM24XX CRT Driver, a complete analog video solution from the preamplifier input to the CRT cathode can be achieved. The LM2485 can support any AC coupled DTV application using formats up to 1080i with proper selection of a preamplifier and CRT drivers.

TI Demonstration Board

Figure 5 shows the recommended application schematic for the TI Demonstration Board that can be used to evaluate the LM2423/LM2485 AC coupled solution in a Direct-View CRT Digital TV application. Figure 6 shows the routing and component placement on the TI LM2423/LM2485 Demonstration Board. This board provides a good example of a PCB layout that was designed for robust arc protection and optimal video performance.

PCB LAYOUT CONSIDERATIONS

Note that the TI Demonstration Board complies with the layout guidelines outlined below. For convenience, the component names are shown in parenthesis to cross-reference with the schematic and layout images provided.

Power Supplies and Grounds

- 0.1 μ F bypass capacitors (C3 and C6) should be placed very close to V_{BB} and V_{CC} of the LM2485. These capacitors should have a short, direct return to the LM2485 ground.
- 1 μ F electrolytic capacitors (C1 and C2) should also be placed reasonably close to both supply pins.
- GND Pins 8 and 14 should connect to a solid ground plane under the LM2485. The LM2485 ground plane should connect directly to the CRT Driver ground at one point (above C21). Do not connect the LM2485 ground plane directly to CRT ground to protect the LM2485 from arcing.

Inputs

- The LM2485 input traces should be routed away from all output traces of the CRT Driver. This will help protect the video preamplifier and LM2485 from high frequency, large amplitude video coupling and potential damage from arcing at the cathodes.
- If the LM2485 inputs are coming from the main board, 0.1 μ F capacitors (C4, C5, C7) should be placed at the V_{IN} pins of the input connector. If a LM12XX preamplifier is placed on the neck board, these 0.1 μ F capacitors should be placed very close to its DAC output pins to protect it during arcing. In both cases, these capacitors should be connected to the LM2485 ground and should not be connected directly to CRT ground.
- 1k Ω series resistors (R1, R3, R4) should be placed close to the V_{IN} pins and a small resistor may also be placed close to the VB_{IN} pin. These resistors will protect the preamplifier in the event that the LM2485 fails.

Outputs

- 1.5k Ω resistors (R6, R7, R8) and 0.1 μ F capacitors (C21, C24, C25) should be placed near the V_{OUT} pins to limit the current and voltage surges on the outputs during an arc event. These bypass capacitors should have a short, direct return to the LM2485 ground.
- Because the clamp outputs carry DC, the clamp output traces routed to each AC coupled video output can be long. Avoid cutting a ground trace(s) simply to route clamp output traces and use wire jumpers, if necessary.
- Clamp diodes (D3, D5, D6) and pull-up resistors (R20, R23, R24) should be placed closest to the video output traces to minimize the size of the video nodes and reduce parasitic capacitance on the video outputs. The clamp diodes must be 1SS83 or equivalent diodes; do not use 1N4148 type diodes. These diodes must have a fast transient response, low shunt capacitance, low series impedance, and a high peak current rating to clamp the video output voltage to the V_{CC} supply during an arc event.
- 0.1 μ F bypass capacitors (C46, C48, C9) should be placed very close to the 1SS83 type arc protection diodes (D1/D2, D4/D7, D8/D9) between V_{CC} and ground. The ground connection should have a short, direct path to CRT ground. Therefore, arc currents shunted by the protection diodes can return to the CRT DAG (J6).
- 300V spark gaps (S1, S2, S3, S4) are strongly recommended and should be placed very close to the cathode and G1 pins and grounded directly to the CRT ground plane, so arc current can return to the nearby CRT DAG. Spark gaps help to minimize voltage stress on the CRT Driver and LM2485.
- If the G1 blanking feature is used, all G1 circuit components should be placed as close as possible to the G1 pin of the CRT connector, with the exception of a small resistor (R2) placed close to the VB_{OUT} pin to limit any current toward the LM2485. The sequence of circuit components from the VB_{OUT} pin to the G1 pin is recommended to protect the LM2485 against arcing. All these components must be grounded directly to the

CRT ground plane. Therefore, arc currents can easily return to the CRT DAG. Do not omit any of the components in the G1 circuit as they are required to protect the LM2485 against arcing and for correct G1 blank operation.

- If the G1 blanking feature is not used, simply place a 470pF capacitor from the $V_{B_{OUT}}$ pin to LM2485 ground and do not connect the output to the G1 circuitry.

Pin Options and No Connects

- Depending on the pin options required, Pin 12 and Pin 13 can be connected to ground via a ground plane, trace, or jumper wire. See the [THEORY OF OPERATION](#) to determine the appropriate pin option for the application.
- The “No Connect” or N/C pins (pins 16, 18, 20, 22, 24) are not connected to the die internally in order to achieve larger spacing between the high voltage V_{CC} and V_{OUT} pins. These N/C pins should not be used to route other traces through.

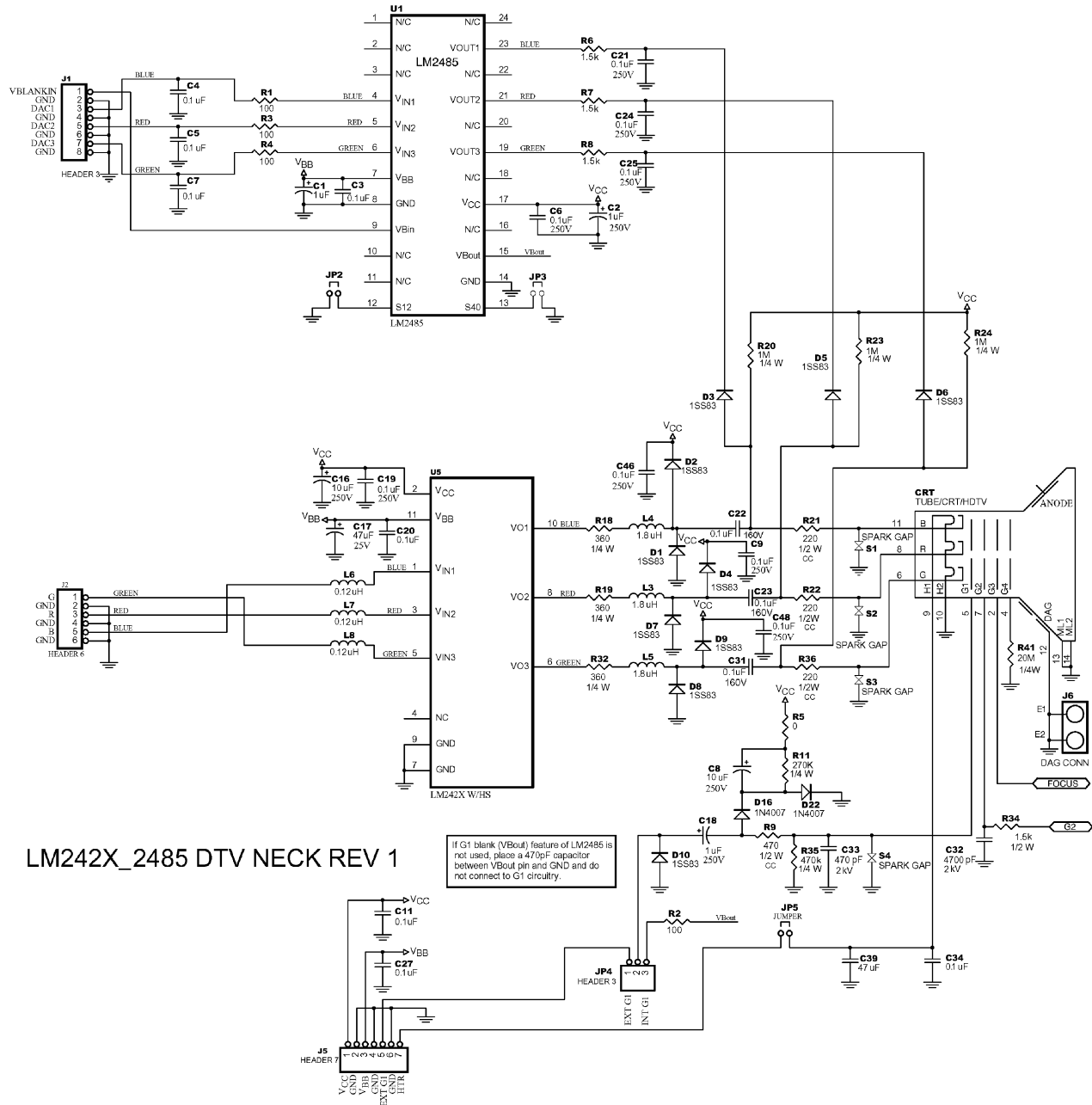


Figure 5. TI Demonstration Board — Recommended Application Schematic

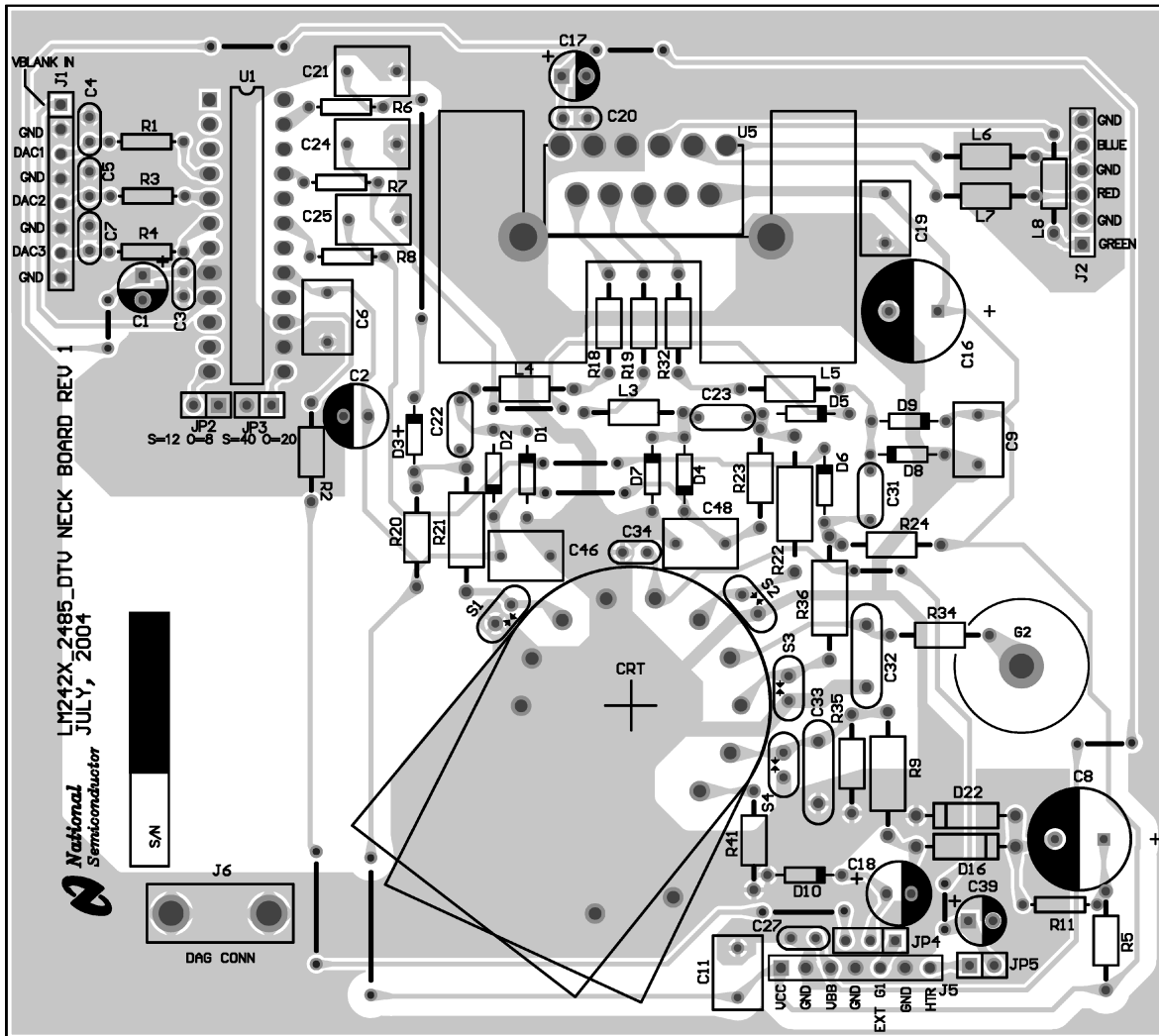


Figure 6. TI Demonstration Board — PCB Layout

REVISION HISTORY

Changes from Revision A (April 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format	10

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com