LM2427

LM2427 Triple 80 MHz CRT Driver

National *Semiconductor*

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Triple 80 MHz CRT Driver

General Description

The LM2427 is a high performance triple CRT driver for simplifying color monitor designs. The device contains three large signal transimpedance amplifiers, and provides direct cathode drive capability. A plastic power package and pin-to-pin compatibility make the LM2427 ideal for new designs or as a low cost replacement for designs using the LH2426 or CR5527.
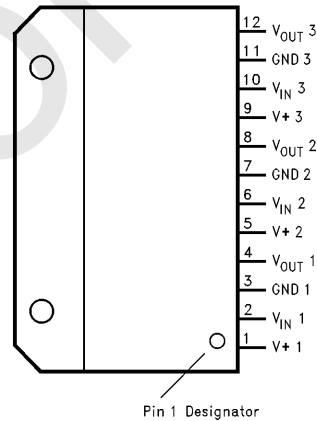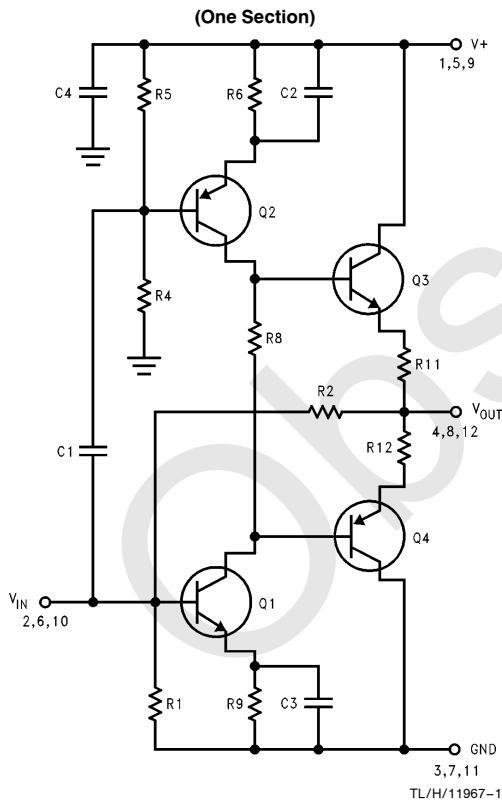
Features

■ Low-cost plastic power package
■ Typical rise/fall times of 3.5 ns
■ 80 MHz video bandwidth at 50 V_{PP} with 8 pF load
■ Operation from 80V power supply

Applications

■ CRT driver for color monitors
■ Drives CRT cathode directly
■ Pin-to-pin compatible with the LH2426 and CR5527 CRT drivers

Schematic and Connection Diagrams

(One Section)

TL/H/11967–1

Pin 1 Designator

TL/H/11967–2

Top View

Order Number LM2427T
See NS Package Number MKT-TA12A

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage, V+	+85V
Safe Operating Power Consumption	14W

Storage Temperature Range, T_{STG}	−25°C to +100°C
Operating Temperature Range, T_{CASE}	−20°C to +90°C
Lead Temperature (Soldering, 10 sec.)	300°C
ESD Tolerance	TBD

Electrical Characteristics

$V+ = 80V$, $R_G = 430\Omega$, $C1 = 47$ pF, $C_L = 8$ pF, 50 V_{PP} output swing with 40V DC offset. See *Figure 1*. $T_{CASE} = 25°C$ unless otherwise noted.

| Symbol	Parameter	Conditions	LM2427			Units
			Min	Typical	Max	
I_{CC}	Supply Current (per Amplifier)	No Input or Output Load		24	30	mA
V_{INDC}	Input Offset Voltage		1.4	1.6	1.8	V
V_{OUTDC}	Output Offset Voltage		34	40	46	V
t_R	Rise Time	10% to 90% (Note 1)		3.5		ns
t_F	Fall Time	90% to 10% (Note 1)		3.5		ns
A_V	Voltage Gain		−11	−13	−14	V/V
LE	Linearity Error	V_{OUT} from +10V to +70V (Note 2)		5		%
ΔA_V	Gain Matching	(Note 3)		0.2		dB

Note 1: Input signal: t_r, t_f < 1.5 ns, f_{in} = 1 MHz.

Note 2: Linearity error is defined as: The variation in small signal gain from +20V to +70V output with a 100 mVAC, 1 MHz, input signal.

Note 3: Calculated value from voltage gain test on each channel.

Typical Performance Characteristics

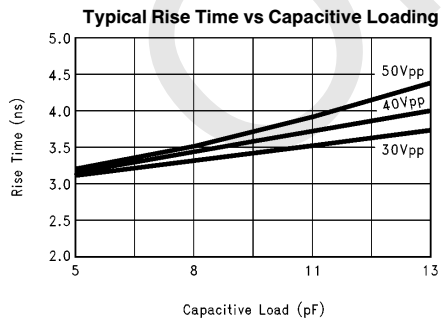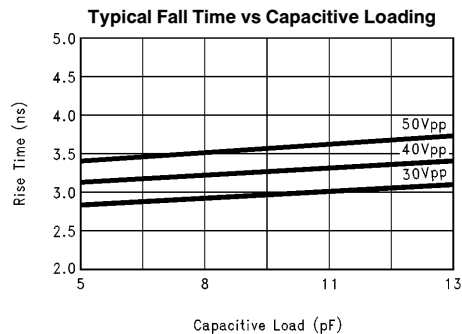## Typical Test Circuit (One Section)
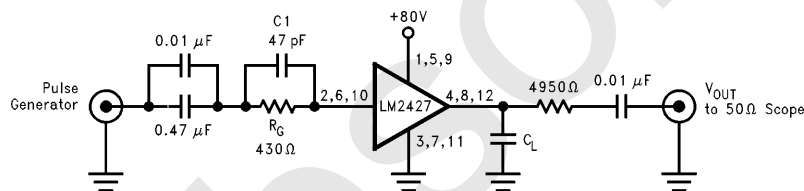
TL/H/11967−3

Note: C_L, total load capacitance, includes all parasitic capacitances.

FIGURE 1. Test Circuit (One Section)
This test circuit is used for both characteristic plots.

Typical Rise Time vs Capacitive Loading

TL/H/11967−10

Typical Fall Time vs Capacitive Loading

TL/H/11967−5

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Test Circuit

Figure 1 shows a typical test circuit for evaluation of the LM2427. This circuit is designed to allow testing of the LM2427 in a 50Ω environment, such as a pulse generator, oscilloscope or network analyzer. The 4950Ω resistor in series with the output of the LM2427 forms a 100:1 voltage divider when connected to a 50Ω-input oscilloscope or network analyzer. To calibrate pulse generator, set to 2.4 V_{PP} into 50Ω.

THEORY OF OPERATION

The LM2427 is a triple channel transimpedance amplifier for CRT's, suitable for SVGA, XGA, IBM and Macintosh display resolution monitors. The LM2427 is pin-to-pin compatible with the LH2426 and CR5527 CRT drivers. The device is packaged in the industry standard 12-lead SIP TO-220 molded plastic power package. The heat sink is electrically isolated and may be grounded for ease of manufacturing and RFI/EMI shielding.

Applying an input current to the LM2427 will result in an output voltage. An input current of about ±4.5 mA will provide a full output swing of ±25V. A resistor in series with the input converts the device into a voltage amplifier; with a resistor value of 430Ω the voltage gain becomes −13.

The LM2427 is a two stage amplifier configured in a push-pull configuration (see schematic on front page). Q2 is biased by resistors R4 and R5, Q1 gets its bias through a 5700Ω feedback resistor and the input biasing current. The bases of Q1 and Q2 are capacitively coupled and, therefore, Q2 will be actively driven.

The emitter resistors of Q1 and Q2 are bypassed with small capacitors. This increases the gain of the stage for high frequencies and increases the bandwidth of the amplifier.

Emitter followers Q3 and Q4 isolate the input stage from the output capacitance load, and minimizes the circuit sensitivity to load capacitance.

The power supply pin is internally bypassed. If low frequencies are present in the power supply line, an electrolytic capacitor is recommended.

Application Hints

The LM2427 is designed as a triple power amplifier for delivering red, green, and blue video signals to a cathode ray tube (CRT). It can provide a 50V output swing and energize a 12 ns pixel at a CRT cathode with 8 pF of capacitance.

As with any CRT driver, when designing a video amplifier board with the LM2427, careful attention should be paid at reducing stray capacitance along the entire video signal path. This is especially important in the path between the output of the CRT driver and the cathodes, because any additional capacitance load will increase rise and fall times and will result in reduced picture quality.

INPUT NETWORKS

The voltage gain and the response of the amplifiers can be set by adding an R-C network to the input.

A 430Ω resistor in series with the input will set the voltage gain to −13, but this will increase the rise and fall times of the system (see *Figure 2a*).

Bypassing the resistor with a capacitor of about 47 pF will restore the rise and fall times but will result in some overshoot. *(Figure 2b)*

Adding a resistor in series with the 47 pF capacitor will reduce the overshoot but also increases the rise and fall times. *(Figure 2c)*

The addition of a second capacitor offers a compromise between the above networks by improving the rise and fall times at the expense of some overshoot. *(Figure 2d)*

Suggested values for the resistors and capacitors are shown, however, optimum values may differ depending upon the stray inductances and capacitances present in different board layouts.
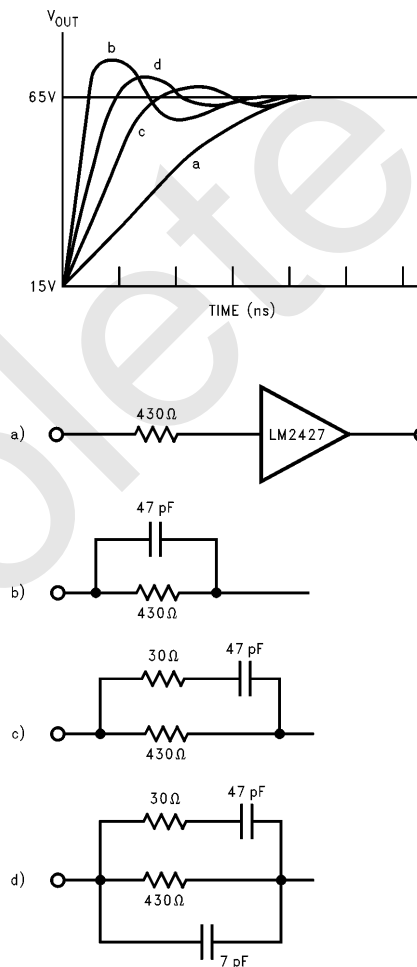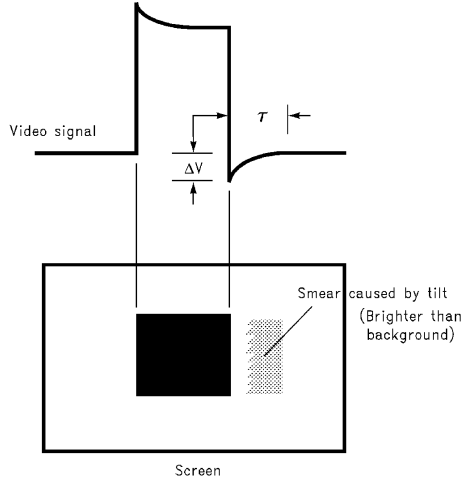

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FIGURE 2. Influence of Input Networks on Switching Performance

Application Hints (Continued)

### TILT AND OVERSHOOT COMPENSATION

When a low frequency square is displayed on a monitor screen, some tilt may appear on the video signal due to the large power and thermal dissipation changes in the input transistors. This problem is illustrated in *Figure 3*.

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**FIGURE 3. Tilt on a Low Frequency
Signal and Its Effects**

The tilt can be compensated by adding an external RC feedback network as shown in *Figure 4*. The RC feedback helps by reducing the gain of the amplifier during the edge transition for a duration corresponding to τ. The values of R and C should be selected so that the gain is reduced ($\Delta V = 0$) for the duration of the tilt (τ).
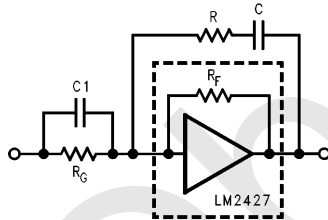
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FIGURE 4. RC Feedback Network for Tilt Compensation

To find the value of resistor R, the following formula can be used:

$$R = \frac{(100 - x\%)}{x\%} R_F$$

where x% is the percentage value of ΔV to the peak-to-peak output swing (V_{PP}). R_F is internally fixed to 5700Ω. The value of capacitor C is determined by:

$$C = \tau/R$$

where τ is the duration of the tilt.

For optimum results in a specific application, the values for R and C may need to be tested and adjusted in the given application board.

PROTECTING AMPLIFIER OUTPUT FROM TUBE ARCING

During normal CRT operation, internal arcing may occasionally occur. Spark gap protectors will limit the maximum voltage, but to a value that is much higher than allowable on the LM2427. This fast, high voltage, high energy pulse can damage the LM2427 output stage. The addition of two current limiting resistors of 50Ω to 100Ω total, and clamping diodes D1 and D2, will provide protection but will slow down the response. The diodes should have a fast transient response, high peak current rating, low series impedance and low shunt capacitance. FDH400 or equivalent diodes are recommended. Adding a series peaking inductor of 100 nH to 150 nH will restore the bandwidth and provide additional protection. (See *Figure 5*)

The value of the inductor can be calculated from:

$$Lp = \frac{(R_O + R_1 + R_2)^2}{2.4} C_L$$

where C_L is the total load and R_O is the intrinsic high frequency output resistance of the amplifier, generally 160Ω.
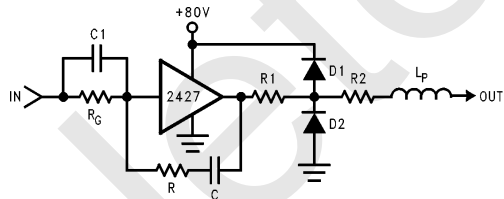
TL/H/11967–9

**FIGURE 5. One Section of the LM2427
with Tilt Compensation, Arc Protection
and Peaking Inductance L_P in the Output**

SHORT CIRCUIT PROTECTION
WARNING!

To provide maximum output speed, the LM2427 does not have short circuit protection. Shorting the output can destroy the device.

SUPPLY BYPASSING

Although the LM2427 has internal supply bypassing, some values of supply line inductance can cause ringing in the supply lines. If this occurs, an additional bypass capacitor or a low-pass filter should be placed as close as possible to the supply (V+) pins of the LM2427.

CAPACITIVE LOADS

The LM2427 is designed to drive capacitive loads, however, the very high output slew rate of about 13,700 V/μs can result in charging currents of over 200 mA into a 20 pF load. These very high currents can damage the output transistors.

HEAT SINKING

Power consumption by the LM2427 will depend on the supply voltage used, the output loading, the peak-to-peak output swing and the operating frequency. Since the LM2427 will dissipate up to 14W, an external heatsink is always required. The maximum allowed case temperature is 90°C. To calculate maximum heatsink thermal resistance, use the following formula:

$$R_{th} = \frac{(90°C - \text{Max Ambient})}{14}.$$

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PC BOARD LAYOUT CONSIDERATIONS

Input pins 2, 6 and 10 are amplifier summing junctions. All connections to these points should be as short as possible and should be separated from other signals. The components connected to these pins should be located close to the LM2427, and the total conductor length connected to these points should be no more than one inch.
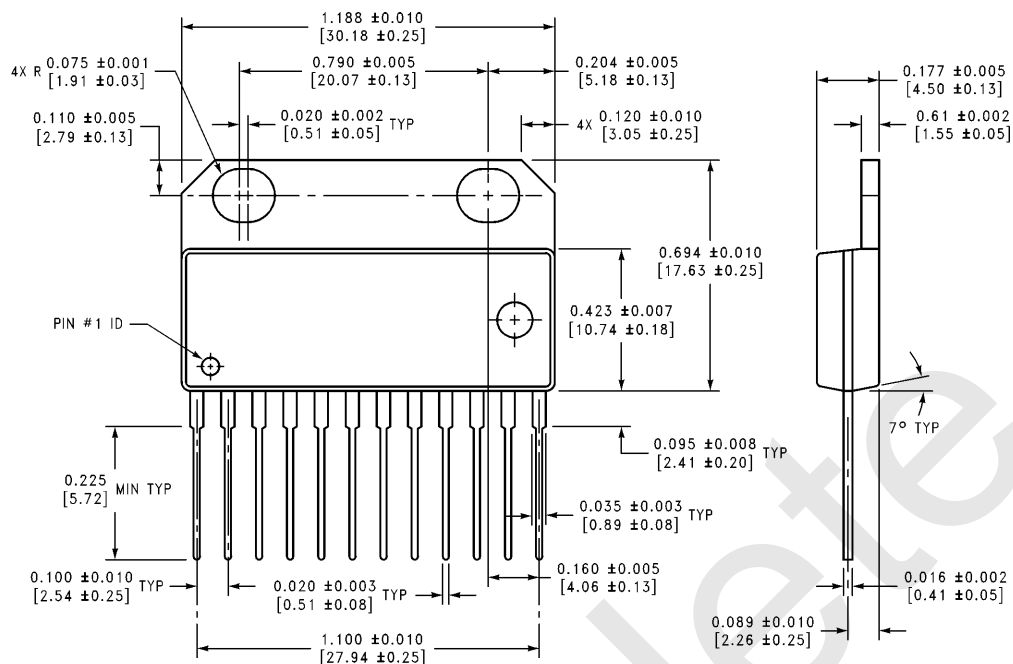
For optimum performance, an adequate ground plane, isolation between channels, good supply bypassing and minimizing unwanted feedback are necessary. Also, the length of the signal traces from the preamplifier to the LM2427 and from the LM2427 to the CRT cathode should be as short as possible. The following references are recommended:

Ott, Henry W., *"Noise Reduction Techniques in Electronic Systems",* John Wiley & Sons, New York, 1976.

"Guide to CRT Video Design", National Semiconductor Application Note 861.

Physical Dimensions inches [millimeters]

1.188 ±0.010
[30.18 ±0.25]

4X R 0.075 ±0.001
[1.91 ±0.03]

0.790 ±0.005
[20.07 ±0.13]

0.204 ±0.005
[5.18 ±0.13]

0.177 ±0.005
[4.50 ±0.13]

0.110 ±0.005
[2.79 ±0.13]

0.020 ±0.002
[0.51 ±0.05] TYP

4X 0.120 ±0.010
[3.05 ±0.25]

0.61 ±0.002
[1.55 ±0.05]

0.694 ±0.010
[17.63 ±0.25]

0.423 ±0.007
[10.74 ±0.18]

PIN #1 ID

7° TYP

0.095 ±0.008
[2.41 ±0.20] TYP

0.225
[5.72] MIN TYP

0.035 ±0.003
[0.89 ±0.08] TYP

0.100 ±0.010
[2.54 ±0.25] TYP

0.020 ±0.003
[0.51 ±0.08] TYP

0.160 ±0.005
[4.06 ±0.13]

0.016 ±0.002
[0.41 ±0.05]

0.089 ±0.010
[2.26 ±0.25]

1.100 ±0.010
[27.94 ±0.25]

TA12A (REV B)

Note 1: Unless otherwise specified. Standard Lead Finish: 200 microinches/5.08 micrometers minimum. Lead/Tin (Solder) on Olin 194 or equivalent.

Note 2: No JEDEC Registration as of 09-01-93.

Order Number LM2427T
NS Package Number MKT-TA12A

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