National Semiconductor

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LH2426
Triple 80 MHz CRT Driver

General Description

The LH2426 contains three wide bandwidth, large signal amplifiers designed for large voltage swings at high frequencies. The amplifiers work on a transimpedance principal i.e., an input current swing of ±4.38 mA results in an output voltage swing of ±25V. The device is intended for use in color CRT monitors and is a low cost solution to designs conforming to the IBM® 8514 graphics standard.

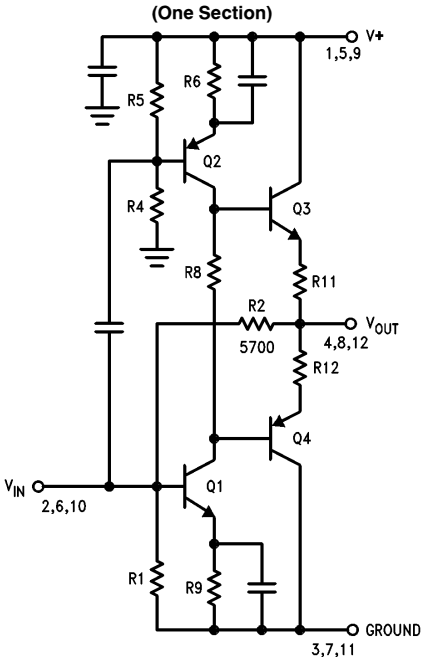
Features

- Operation from 80V power supply
- 80 MHz bandwidth at 50 V_{PP} swings
- Rise/fall time less than 4 ns
- Output signal can swing 70V
- Drives CRT directly

Applications

- CRT driver for RGB monitors
- High voltage transimpedance amplifiers

Schematic and Connection Diagrams



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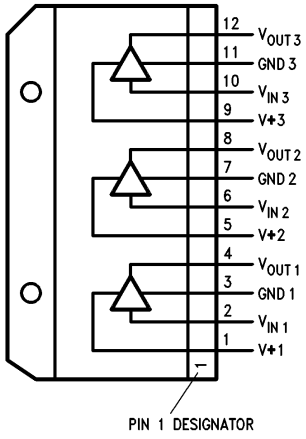

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Top View
Order Number LH2426S
See NS Package Number HY12B

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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
Power Dissipation, P_D	10W
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

DC Electrical Characteristics

$V_+ = 80V$, R1 = 430Ω, C1 = 82 pF, C_L = 8 pF, 50 V_{PP} output swing with 40V DC offset. See *Figure 1*. T_{CASE} = 25°C unless otherwise noted.

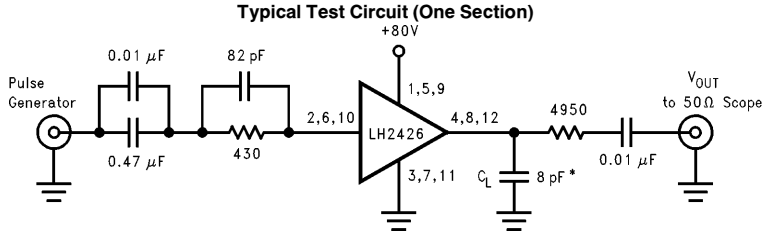
Symbol	Parameter	Conditions	LH2426			Units
			Min	Typical	Max	
V^+	Supply Current (per Amplifier)	No Input or Output Load		24	30	mA
V_{INDC}	Input Offset Voltage		1.4	1.6	1.8	V
V_{OUTDC}	Output Offset Voltage		34	40	46	V
t_R	Rise Time	10% to 90%		3.5	5	ns
t_F	Fall Time	90% to 10%		3.5	5	ns
BW	Bandwidth	−3 dB		100		MHz
Av	Voltage Gain		11	13	14	V/V
OS	Overshoot			10		%
LE	Linearity Error	V_{OUT} from +10V to +70V Note 1		5		%
Δ Av	Gain Matching	Note 2		0.2		dB

Note 1: Linearity error is defined as: The variation in small signal gain from +10V to +70V output with a 100 mVAC, 1 MHz, input signal.

Note 2: Calculated value from voltage gain test on each channel.

Typical Performance Characteristics

Typical Test Circuit (One Section)



TL/H/10739–3

FIGURE 1. Test Circuit (One Section)

*Note: 8 pF is total load capacitance. It includes all parasitic capacitances.

Figure 1 shows a typical test circuit for evaluation of the LH2426. This circuit is designed to allow testing of the LH2426 in a 50Ω environment such as a pulse generator, oscillosope or network analyzer. To calibrate pulse generator, set to 2.4 V_{PP} into 50Ω.

Application Hints

The LH2426 is designed as a triple power amplifier for delivering red, blue and green video signals to a cathode ray tube (CRT). It can provide 50V output swing and energize a 12 ns pixel. The input capacitance of a CRT grid is typically 8 pF.

THEORY OF OPERATION

The LH2426 is a two stage amplifier (see schematic on front page). Both stages are in push pull configuration. Q_2 is biased with two resistors, Q_1 gets its bias through the 5700Ω feedback resistor and the input biasing current. The bases of Q_1 and Q_2 are capacitively coupled and therefore Q_2 is also actively driven.

The LH2426 is a transimpedance amplifier: an input current is translated into an output voltage. An input current of about ±4.5 mA will provide full output swing of ±25V. A resistor in series with the input converts the LH2426 into a voltage amplifier, with 430Ω the voltage gain becomes −13.

Application Hints (Continued)

The emitter resistors of Q_1 and Q_2 are bypassed with small capacitors. This increases the gain to the stage for high frequencies and increases the bandwidth of the amplifier.

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

INPUT NETWORKS

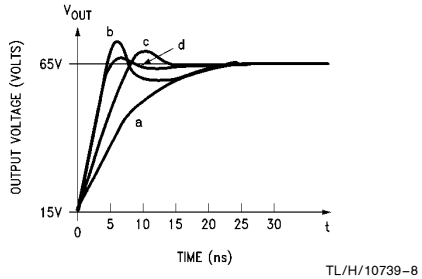
The voltage gain and the response of the amplifiers can be set by adding an R–C to the input.

A 430Ω resistor in series, will set the voltage gain to 13. This will increase the rise and fall times of the system. (See *Figure 2a*) Bypassing the resistor with a capacitor of about 50 pF will restore the rise/fall times but will result in some overshoot. *(Figure 2b)*

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

The addition of a second capacitor will restore the rise and fall times without significant 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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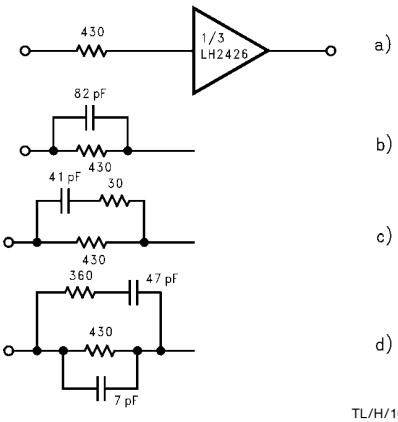

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FIGURE 2. Influence of Input Networks on Switching Performance

Figure 2 compares different input networks and their influence on the switching waveform.

DROOP COMPENSATION

When low frequency square waves are amplified, some droop will occur due to the large change in the thermal dissipation in the input transistors. If this causes a problem, it can be compensated with R-C feedback. Figure 3 illustrates the circuit and recommended component values.

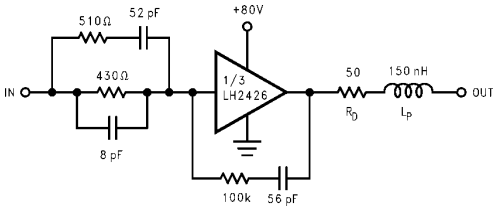
PROTECTING AMPLIFIER OUTPUT FROM TUBE ARCING

During normal CRT operation, internal arcing may occasionally occur. Spark gap protectors do limit the maximum voltage, but to a value that is much higher than allowable on the LH2426. This fast, high voltage, high current pulse can damage the LH2426 output. The addition of a current limiting resistor of 50Ω to 100Ω will provide protection but will slow down response. Adding a series peaking inductor of 100 nH to 150 nH will restore the bandwidth and provide additional protection. (See *Figure 3*)

The value of the inductor can be calculated from:

$$L_P = \left[\frac{(R_0 + R_D)^2}{2.4}\right] C$$

where C is the total load and R_0 is the intrinsic high frequency output resistance of the amplifier, generally 160Ω.



TL/H/10739–7

FIGURE 3. One Section of the LH2426 with Damping Resistor R_D and Peaking Inductance L_P in the Output

SUPPLY BYPASSING

Although the LH2426 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 near the supply pins.

CAPACITIVE LOADS

The LH2426 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.

SHORT CIRCUIT PROTECTION

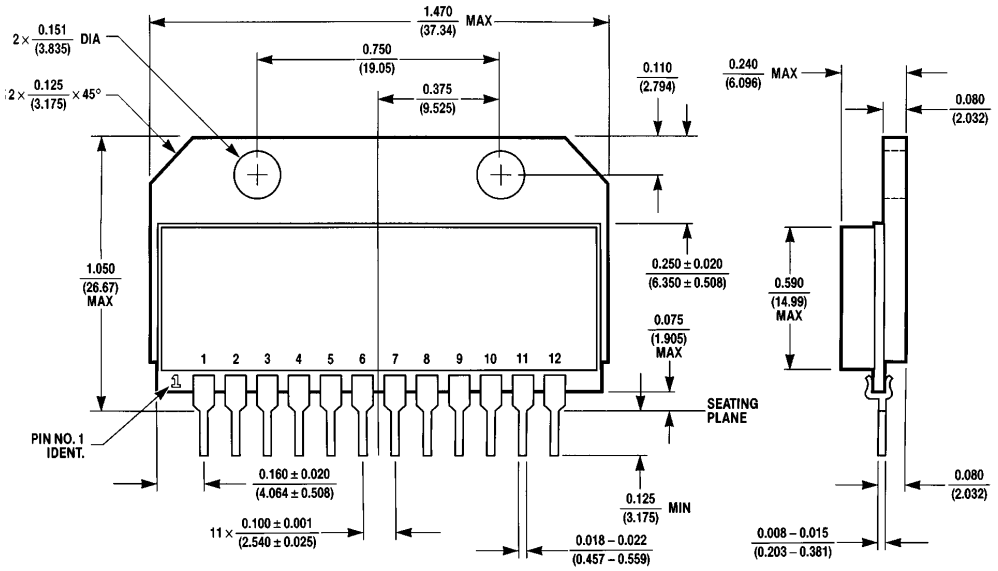
Warning! To provide maximum output speed, the LH2426 does not have short circuit protection. Shorting the output can destroy the device. The lowest value load the LH2426 is designed to drive is 600Ω. If the device is used in an application where the output may be shorted, 600Ω should be placed in series with the output.

HEAT SINKING

As the LH2426 will dissipate up to 10W, an external heatsink is always required. The maximum allowed case temperature is 90°C. To calculate maximum heatsink thermal resistance, use the following formula:

$$R_{th} = (90°C - \text{Max Ambient})/10$$

Physical Dimensions inches (millimeters)



Note 1: Substrate: 96% alumina.

Note 2: Lid seal: epoxy.

Note 3: Leads: phos. bronze alloy or equiv. with 95 Sn/5 Ag solder DIP.

Note 4: Four radius bumps on corners of lid are optional. Not shown on drawing.

Order Number LH2426S
NS Package Number HY12B

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National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

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