National Semiconductor

PRELIMINARY
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LH2440/LH2440A
CRT Preamplifier and Driver

General Description

The LH2440 is a wide band amplifier for high resolution CRT monitors. The device includes a low level amplifier with DC contrast/brightness control and circuitry for black level clamping to accomplish DC restoration. Also included is a high voltage output stage to directly drive a CRT's cathode. The LH2440 provides almost the entire circuitry needed in the video channel between the monitor input connection and the CRT cathode.

The LH2440 can swing 40 V_{PP} into an 8.5 pF load with 4 ns rise and fall times. The device requires minimum external components, thus, facilitating video amplifier design. Moreover, high frequency bypassing for the high voltage amplifier is internally provided for ease of use.

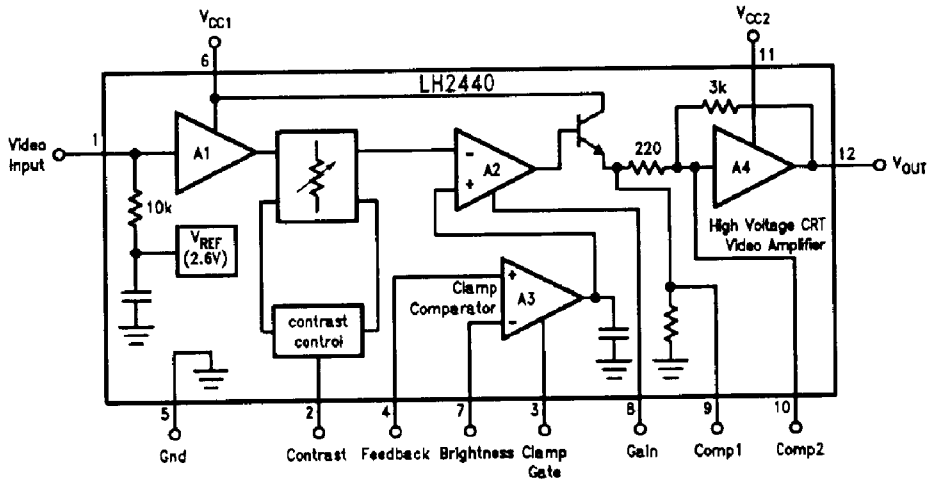
Features

- 90 MHz bandwidth at 40 V_{PP} swing
- Rise/fall times of 4 ns
- DC contrast and brightness controls
- Externally gated comparator for DC restoration of video signal
- Ease of use

Applications

- Video preamplifier and CRT driver for high resolution monitors.

Block and Connection Diagrams



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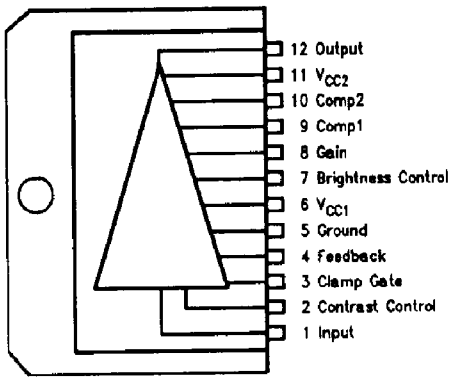

TL/K/10460-2

Order Number LH2440S or LH2440AS
See NS Package Number HY12A

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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_{CC1}	+13.5V
Supply Voltage, V_{CC2}	+70V
Power Dissipation, P_D	7W
Storage Temperature Range, T_{STG}	−40°C to +125°C
Operating Temperature Range, T_{case}	−20°C to +80°C
Lead Temperature (Soldering, < 10 Sec.)	300°C
ESD Tolerance	2 kV

Electrical Characteristics

V_{CC1} = 12V, V_{CC2} = 60V, C_{LOAD} = 8.5 pF, V_{OUT} = 40 V_{PP} Swing with 30 V_{DC} Offset Unless Otherwise Specified
T_{case} = 25°C Unless Otherwise Noted (Note 1).

Symbol	Parameter	Conditions	LH2440/LH2440A			Units (Max. Unless Otherwise Noted)
			Typical	Tested Limit (Note 2)	Design Limit (Note 3)	
I_{CC1}	Supply Current	No Output Load	80	90		mA
I_{CC2}			43	48		mA
V_{BIAS}	Video Input BIAS Voltage		2.6	2.4		Volts (Min)
				2.8		Volts
V_{CL}	Clamp Gate Low Input V	Clamp Comparator ON		0.8		V
V_{CH}	Clamp Gate High Input V	Clamp Comparator OFF		2.0		V(Min)
I_{CL}	Clamp Gate Low Input Current	V4 = 0V	−0.5	−5		μA
I_{CH}	Clamp Gate High Input Current	V4 = 12V	0.005	1		μA
V_{OS}	Comparator Input Offset Voltage	V5 − V7	±0.5	±50		mV
$V_{OUT(DC)}$	Output Offset Voltage		30	34		V
				26		V(Min)
OVR	Output Voltage Range	V7 = 0V to 10V	5 to 55	10 to 50		V
t_R	Rise Time	R_S = 50Ω, LH2440	4	6		ns
t_F	Fall Time	R_S = 50Ω, LH2440	4	6		ns
t_R	Rise Time	R_S = 50Ω, LH2440A	4	5		ns
t_F	Fall Time	R_S = 50Ω, LH2440A	4	5		ns
$A_{V(Max)}$	Gain	V3 = 12V @ 2 MHz	85	70		V/V(Min)
A_V 5V	Attenuation @ 5V	V3 = 5V	10			dB
A_V 2V	Attenuation @ 2V	V3 = 2V	45			dB
T_C (A_V)	Gain Drift	25°C ≤ T_C ≤ 80°C	0.1			% per °C
GS	Gain Stability	V_{CC1} = 10V to 13V V_{CC2} = 55V to 65V	4.3 0.4			% per V
t_S	Settling Time	to ±5%	18			ns
V_{Tilt}	Low Frequency Tilt Voltage	64 KHz Square Wave	2.2			V
BW	Bandwidth (−3 dB)		90			MHz
OS	Overshoot		10			%
THD	Distortion	@ 2 MHz	0.14			%

Note 1: Boldface limits are guaranteed over full temperature range.

Note 2: Tested limits are guaranteed and 100% production tested.

Note 3: Design limits are guaranteed (but not production tested) over the indicated temperature range. These limits are not used to calculate outgoing quality level.

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Applications Hints

OUTPUT INFORMATION

Precautions must be taken to prevent excessive overshoot and ringing caused by the inductance of the wire used to connect the LH2440's output to the CRT;s cathode. Since the wire's inductance and the capacitance at the cathode form an LC tank circuit when driven by the amplifier, at the resonant frequency the circuit may introduce overshoot and ringing. A damping resistor in series with the output of the LH2440 can critically damp the output ringing. The resistor value may be calculated from the following equation:

Damping Resistor, $R > 2\sqrt{L/C}$

where , L = Inductance of output wire
C = Capacitance at CRT cathode

Usually, a 50Ω–100Ω damping resistor is adequate. As an added advantage, the damping resistor also protects the amplifier's output against arcing by providing current limiting. Keep in mind that the damping resistor should not be too large; otherwise, the output signal's rise/fall time may be significantly affected due to the RC time constant formed by the damping resistor and the cathode's capacitance.

GROUND CONNECTION

LH2440's ground connection is internally connected to the package's metal tab. Thus, for proper operation, the tab should be connected to the power supply ground.

SHORT CIRCUIT PROTECTION

The LH2440 is designed to drive the capacitive load at the CRT's cathode and does not include short circuit protection. With no series current limiting resistor at the output, the LH2440 will be destroyed if the output is inadvertantly shorted to ground or V^+. When driving a resistive load, it is recommended that the load be greater than 600Ω.

THERMAL CONSIDERATIONS

The LH2440 requires that the package be heat sunk for proper operation under any condition. The worst case power dissipation occurs during full scale transitions i.e., when verticle lines of black and white stripes are displayed on the screen. The amplifier's power dissipation depends on the power supply voltage as well as operating frequency. For instance at V_{CC1} = 12V, V_{CC2} = 60V, and 50 MHz (10 ns pixel), the power dissipation is 5 watts. Such high power dissipation demands that proper care be exercised to ensure sufficient heat sinking.

LH2440's maximum ratings require that the device case temperature be limited to 80°C. Thus at 50°C ambient temperature and 5 watts power dissipation, the thermal resistance of the heat sink should be less than (80°C − 50°C) = 6°C/W. Several approaches to heat sinking may be taken. The simplest is a slug of aluminum with a volume of 3 cu. inches or a sheet of aluminum with an area of 30 sq. inches and a thickness of 0.1 inches. Alternatively, commercially available heat sinks may be used.

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Typical Application

The LH2440 provides a single chip solution for almost all the video signal processing and signal amplification requirements in a high resolution CRT monitor. The blanking function is not included in the LH2440. Blanking is usually done by applying a large negative pulse at the CRT's control grid (G1) during the blanking interval. The LH2440 includes a low voltage preamplifier with contrast and brightness control, and, black level clamping function for DC restoration of the video signal. Also, a wide bandwidth and high voltage amplifier is included to drive the CRT's cathode with a 40 V_{PP} signal. The device is simple to use and requires minimum external components.

Figure 1 shows how the LH2440 may be used to amplify and process the video signal and to drive the CRT's cathode. The video signal is ac coupled to the input of LH2440 through a blocking capacitor, C1, and is referenced to 2.6V by an internal bias voltage. Amplifiers A1 and A2 (see *Figure 1*) are low voltage amplifiers that amplify the 1 V_{PP} video input signal. In addition, A2 drives the high voltage CRT video amplifier, A4, with the proper DC bias.

The potentiometer R1 provides a variable voltage at the LH2440's contrast control pin (pin 2) which allows attenuation of the video output signal. A nearly linear 0 dB to 30 dB attenuation can be obtained by varying the contrast voltage. Contrast control adjustment thus allows the user to vary the video signal level by varying the gain of the amplifier. Maximum gain is achieved when the potential at pin 2 is the same as that of the low voltage power supply, V_{CC1}. With 0 dB attenuation, the gain from input to output is typically 100. Adjusting the potentiometer at the brightness control pin (pin 7) varies the DC offset of the output signal. This feature allows the user to vary the overall brightness or luminance of the picture displayed on the screen.

The LH2440 uses black level clamping at the back porch of the video signal to accomplish DC restoration. The clamping signal at the clamp gate (pin 3) enables the clamp comparator A3 during the black level reference period to provide a sample and hold function. DC feedback taken from the output during the black level reference period is compared with the voltage set by the brightness control potentiometer R3. Depending on the output voltage, an internal clamping capacitor is either charged or discharged so that the feedback loop consisting of amplifiers A2, A3 and A4 is stabilized and the output is restored to the black level. All this occurs during the horizontal retrace interval. During the video portion of the signal, A3 is disabled and the clamping capacitor holds the fixed black level reference voltage. Since the beginning of each line starts from a fixed reference voltage corresponding to the black level, the DC component of each line is restored. Adjusting the contrast control varies the amplitude of the video signal relative to the fixed black level. For the circuit of *Figure 1*, rise and fall times of 4 ns were measured at the cathode with a 40 V_{PP} output signal. This corresponds to a bandwidth of over 90 MHz.

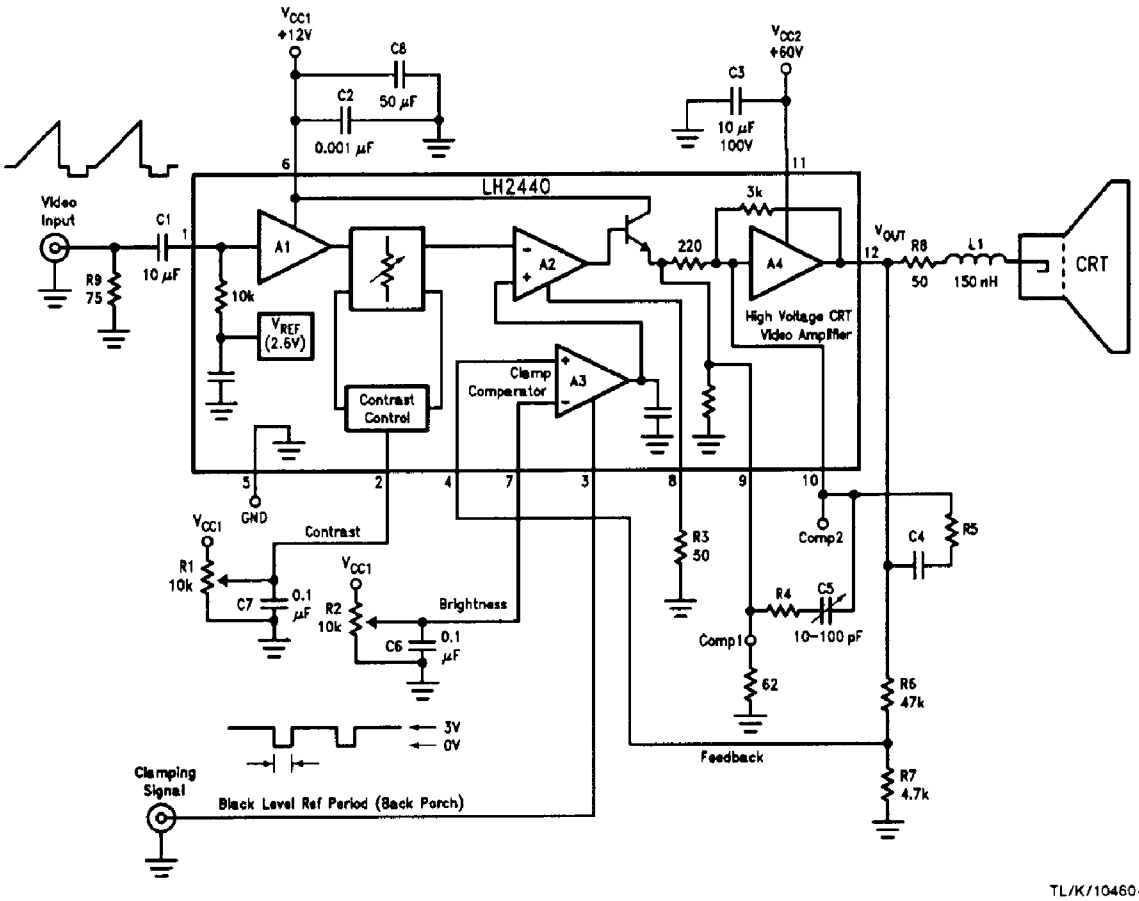

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FIGURE 1. Circuit shows how the LH2440 may be used in a high resolution monitor. LH2440 also provides brightness/contrast control and black level clamping.

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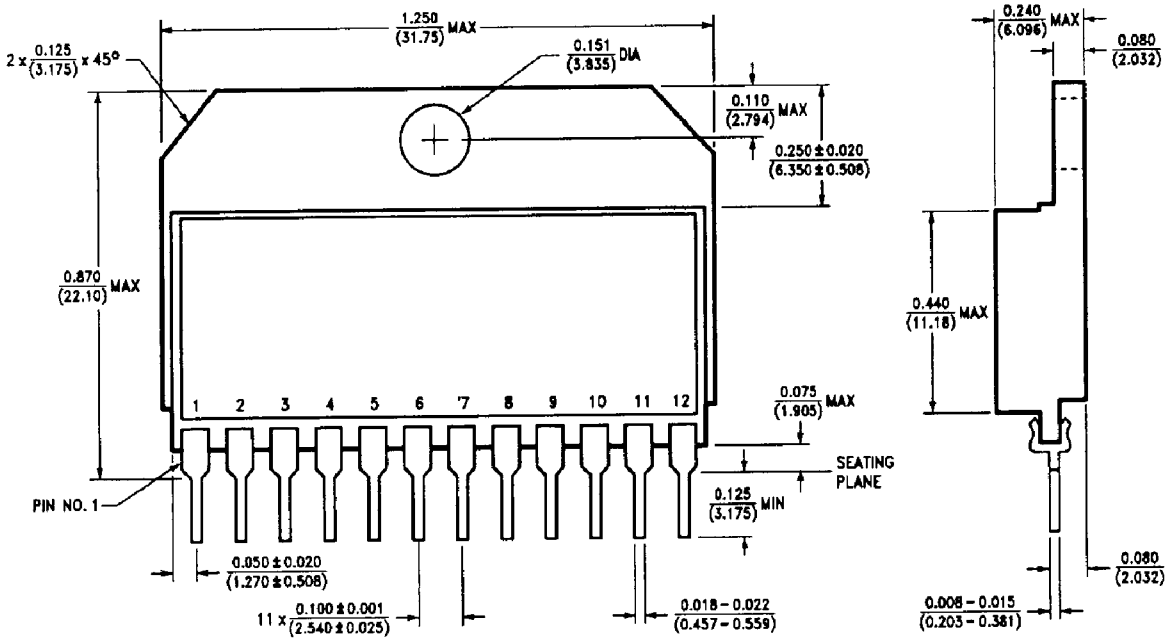
Physical Dimensions inches (millimeters)



12-Lead Single-In-Line Package (J)
Order Number LH2440S
NS Package Number HY12A

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