

## LH2422 CRT Video Driver Amplifier

### General Description

The LH2422 CRT Video Driver is a wide bandwidth, large signal amplifier designed to swing large voltages of short duration. It works on a transimpedance principle, in that about  $\pm 6.5$  mA input current results in an output voltage of  $\pm 20$ V. The primary application for this very fast slewing amplifier is for driving High Resolution Monochrome or Color graphics monitors. These drivers can easily energize a 10 ns pixel. This makes the LH2422 very attractive for 1024 x 1024 displays. The LH2422 is DC coupled and can interface to National's LM1201 and LM1203 Preamplifiers.

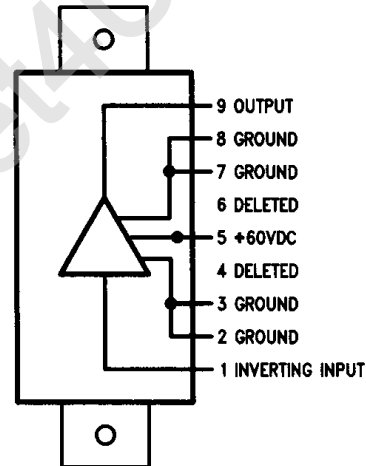
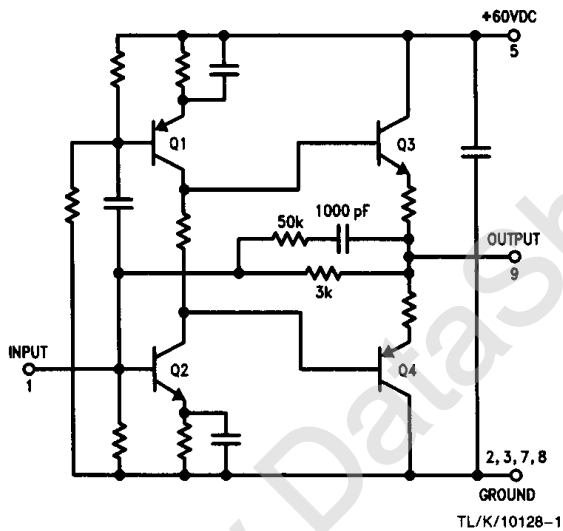
### Features

- 110 MHz bandwidth at 40V swings
- Rise/fall times of 3.3 ns
- Drives 8.5 pF capacitive load
- Pin compatible with CR2424
- DC coupled for output level adjust
- Output signal can swing 50V

### Applications

- CRT driver for color and monochrome monitors
- High voltage transimpedance amplifier

### Schematic and Connection Diagrams



Order Number LH2422J  
See NS Package Number HY09A

## Absolute Maximum Ratings

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

Supply Voltage,  $V_{CC}$  +70V  
Power Dissipation,  $P_d$  7W

Storage Temperature Range, TSTG -40°C to +125°C  
Operating Temperature Range,  $T_{case}$  -20°C to +80°C  
Lead Temperature (Soldering, <10 sec) 300°C  
ESD Tolerance TBD

**Electrical Characteristics**  $V_{CC} = +60V$ ,  $R_1 = 215\Omega$ ,  $C_1 = 60\text{ pF}$ ,  $C_{LOAD} = 8.5\text{ pF}$ ,  $40\text{ V}_{p-p}$  swing with  $30\text{ V}_{DC}$  offset. See Figure 1.  $T_{CASE} = 25^\circ\text{C}$  unless otherwise noted (Note 1).

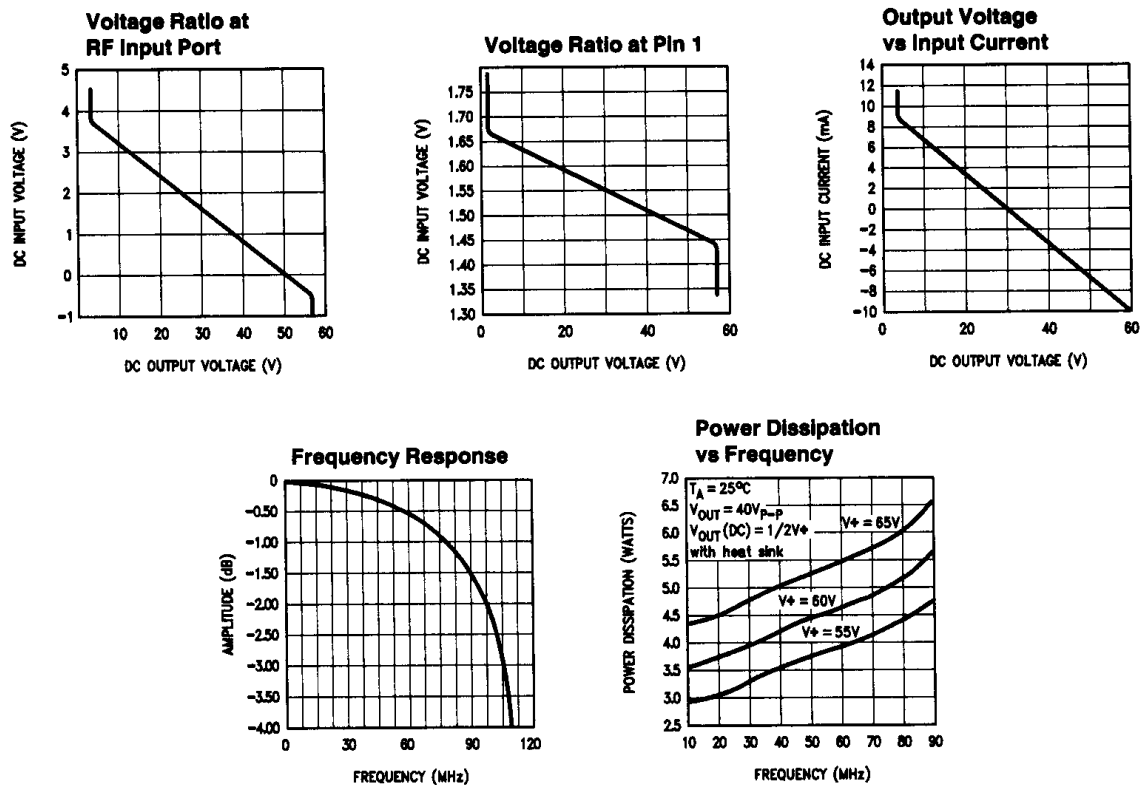
Symbol	Parameter	Conditions	Limits			Units (Max. Unless Otherwise Noted)
			Typical	Tested Limit (Note 2)	Design Limit (Note 3)	
$I_{CC}$	Supply Current	No Input or Output Load	43.5	47.5	<b>60</b>	mA
				39.5	<b>30</b>	mA (Min)
$V_{INDC}$	Input Offset Voltage	No Input or Output Load	1.55	1.7		V
				1.15		V (Min)
$V_{OUTDC}$	Output Offset Voltage		30	34		V
				26		V (Min)
$P_D$	Power Dissipation	50 MHz Square Wave	5.3	6		W
$t_r$	Rise Time	10% to 90%	3.3		4	ns
$t_f$	Fall Time	90% to 10%	3.3		4	ns
$V_{TILT}$	Low Frequency Tilt Voltage	1 kHz Square Wave	1.3			V
BW	Bandwidth	-3 dB	110	100		MHz (Min)
$V_{OS}$	Overshoot		10			%
VG	Insertion Gain	50 $\Omega$ Source Z	13	14.5		V/V
				11.5		V/V (Min)
	Linearity	$V_{OUT}$ from +5V to +55V	1	5	<b>8</b>	%

**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.

## Typical Performance Characteristics



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## Application Hints

### OUTPUT INFORMATION

The LH2422 is designed as a power amp for driving a Cathode Ray Tube (CRT). It can provide a 40V output swing and energize a 10 ns pixel. A CRT generally has a capacitance of 8.5 pF.

Since a wire of some length is usually needed between the LH2422 and the tube, a resonant circuit is generated by the wire's inductance and the tube's capacitance. Objectionable ringing and overshoot can be avoided by using a damping resistor in series with the output and load. This resistance can be calculated by using:

$$R = 2\sqrt{L/C}$$

The output resistor is also recommended for protection against tube arcing. Typical resistor values are 50Ω to 100Ω. Sometimes the lead inductance may be artificially increased to obtain peaking if desired. Typically 0.2 μH will do

the job. Cables of 75Ω and 93Ω or 300Ω twin-lead, terminated by capacitance, will exhibit inductance. A damping resistor should be used here.

### SHORT CIRCUIT PROTECTION

The LH2422 does not have output short circuit protection. It is recommended that an output series resistance of at least 600Ω be used for protection to ground or  $V^+$ .

### INPUT INFORMATION

The "Output Voltage vs Input Current" graph shows that a ±20V swing (from a 30V output DC bias) can be achieved with an input current swing of only ±6.5 mA. The "Voltage Ratio at RF Input Port" graph relates the input voltage as measured at RF input port to the voltage at the output; note that the amplifier is phase-inverting. A 13.5 ratio is achieved. The above values are used to calculate a low frequency input impedance of 230Ω at the RF input port.

## Application Hints (Continued)

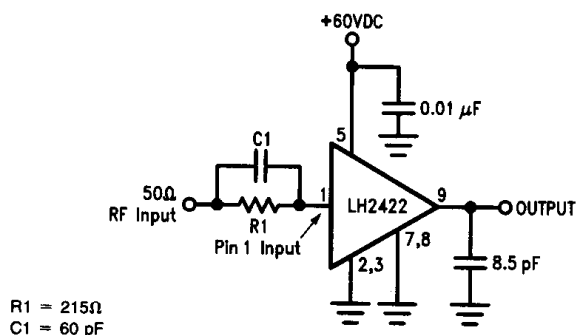


FIGURE 1. Typical AC Test Circuit

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The "Voltage Ratio at Port 1" is measured at the input pin (pin 1) to the output with a ratio of 240. The calculated low-frequency impedance is about  $13\Omega$ . This impedance does not deviate much throughout the range from DC to 110 MHz. With no voltage at the input the DC level sits at about 1.55V and the output voltage is half the supply voltage.

### GAIN CIRCUIT

The LH2422 can be thought of as a transimpedance circuit because of the internal  $3\text{ k}\Omega$  feedback resistor shown in the schematic diagram. The input current through this feedback resistor results in a corresponding output voltage.

Generally speaking,  $\pm 2\text{V}$  (referenced to 1.55V DC) across an input resistor of  $300\Omega$  results in an input current of  $\pm 6.67\text{ mA}$ . This current through the  $3\text{ k}\Omega$  resistor produces a  $\pm 20\text{V}$  swing at the output.

### TYPICAL TEST CIRCUIT

The test circuit in *Figure 1* is driven from a fast pulse generator with a  $50\Omega$  output impedance. The cable between the generator and DUT should be of minimum length. The generator's DC level should be about 1.55V. Use a FET probe with X100 attenuation when using an oscilloscope. Total load capacitance (including probe capacitance) should be limited to  $8.5\text{ pF}$ .

The input circuit RC network is tuned to produce peaking when driven from a  $50\Omega$  source.

### Thermal Considerations

The LH2422 requires that the package be heatsunk for proper operation under any condition. Maximum ratings require that the device case temperature be limited to  $80^\circ\text{C}$  maximum. Thus at  $50^\circ\text{C}$  maximum ambient temperature and  $5\text{W}$  maximum power dissipation, the thermal resistance of the heat sink should be less than  $(80-50)^\circ\text{C}/5\text{W} = 6^\circ\text{C}/\text{W}$ . Several approaches to heat sinking may be taken. The simplest is a sheet of aluminum with a volume of 4 cubic inches or an area of 32 sq. inches and a thickness of 0.125 inches.

Commercially available heatsinks such as Thermalloy 15509 extrusion would result in size reduction. *Figures 2* and *3* show the two approaches for proper heat sinking. Note that an aluminum spacer must be placed between the package and the heatsink block so as to prevent the device output from being shorted to ground. In the absence of a series current limiting resistor at the output, the LH2422 will be destroyed if the output is inadvertently shorted to ground or  $V_+$ .

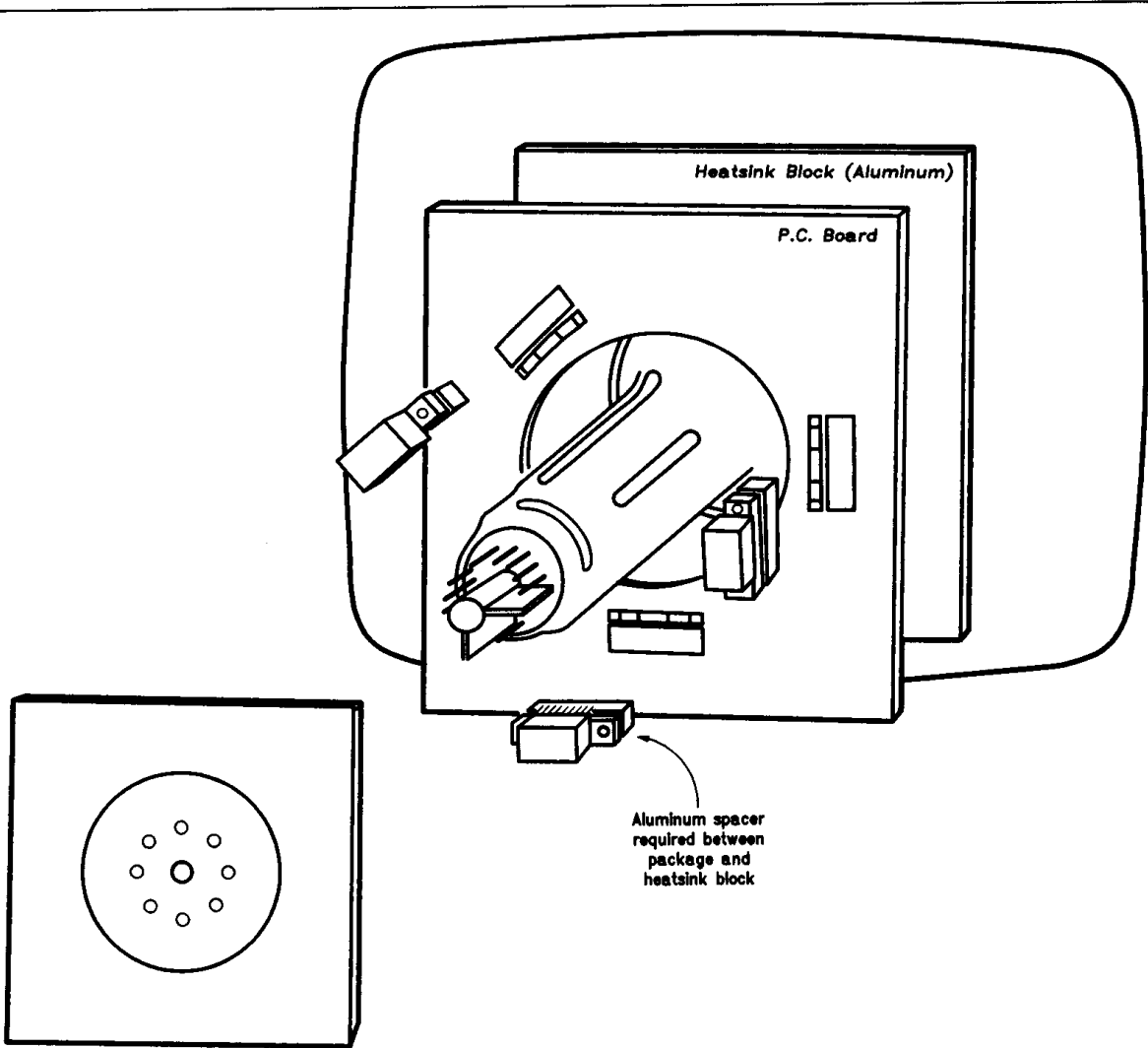


FIGURE 2. Heat Sinking with an Aluminum Block

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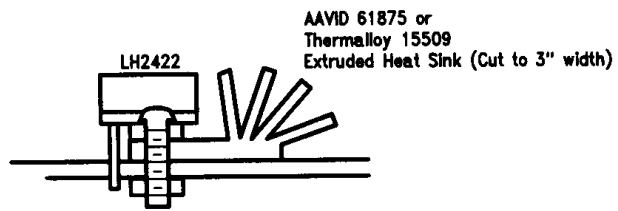


FIGURE 3. Heat Sinking with the Thermalloy 15509 Extrusion

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### Application Circuit

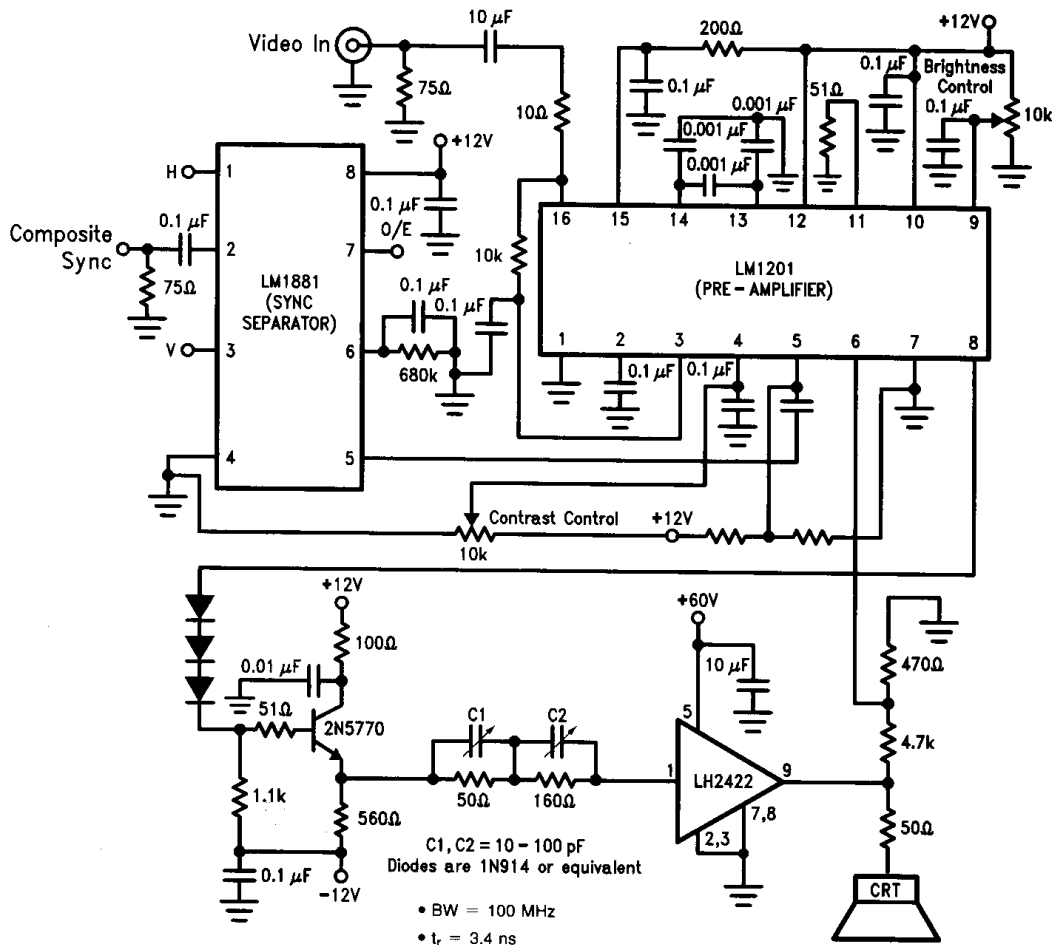


FIGURE 4. CRT Monitor Application

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### Evaluation Board

The evaluation board is intended to demonstrate the capabilities of the LH2422 CRT Driver Amplifier. The board may be used to interface the driver to a CRT display or evaluate the frequency response or pulse response in a 50Ω system.

Figure 5 shows the schematic of the LH2422 evaluation board.

R1 sets the overall gain of the fixture. The test circuit used 220Ω to provide a gain of 12.5. C1 sets the "midband" peaking in the 30 MHz to 60 MHz range. A typical value for this capacitor is 40 pF.

A large bypass capacitor, C2, is needed to reduce lower frequency ringing caused by the power supply wires.

The input is designed to be fed from a 50Ω generator, however, the input impedance at  $V_{IN}$  is not well matched to 50Ω and if a long cable is used between the generator and the input, reflections will occur giving unpredictable responses. Two things can be done to get around this problem:

1. Use a very short connector (less than 2 inches) between the generator and the input.

2. Use a 6 dB pad between the cable and the input. This will reduce reflections and provide a 50Ω source to the circuit board.

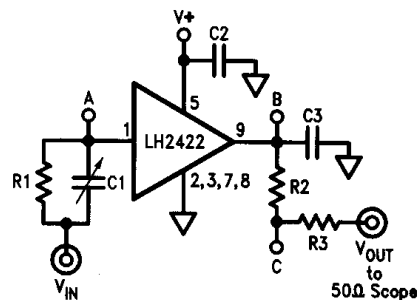


FIGURE 5. Schematic of LH2422 Evaluation Circuit

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## Evaluation Board (Continued)

The output of the CRT driver can drive the CRT cathode directly from point B, while R2 and R3 are used as a 100 to 1 (40 dB) attenuator to a 50Ω scope or network analyzer input. Two resistors are used in series to reduce capacitance and attempt to compensate the frequency response. The layout of the board (*Figure 6*) includes a trace at point C to connect R2 and R3; unfortunately, the capacitance to ground at this point is about 0.6 pF, enough to cause a 20% bandwidth reduction in the response of the attenuator resistors. The resistors should be wired "floating" above the board.

Capacitor C3 is used to simulate the input capacitance at the CRT cathode. The board exhibits about 4.5 pF at the output node of the LH2422. A capacitor of 4 pF will increase it to the specified value of 8.5 pF.

## PARTS LIST

### RESISTORS:

- R1 220Ω, 1/4W, 5%
- R2 2.2 kΩ, 1/4W, 5%
- R3 2.7 kΩ, 1/4W, 5%

### CAPACITORS:

- C1 10 pF – 120 pF (muRata ERIE P/N TZ03R121E)
- C2 10 μF, 100V, 10%
- C3 4 pF, 50V, 10%

### HARDWARE:

- BNC CONNECTORS (KINGS P/N KC-79-237-MO6)
- BANANA JACKS (JOHNSON P/N 108-09XX-001)
- HOLTITE SOCKET (AUGAT P/N 8134-HC-5P2)

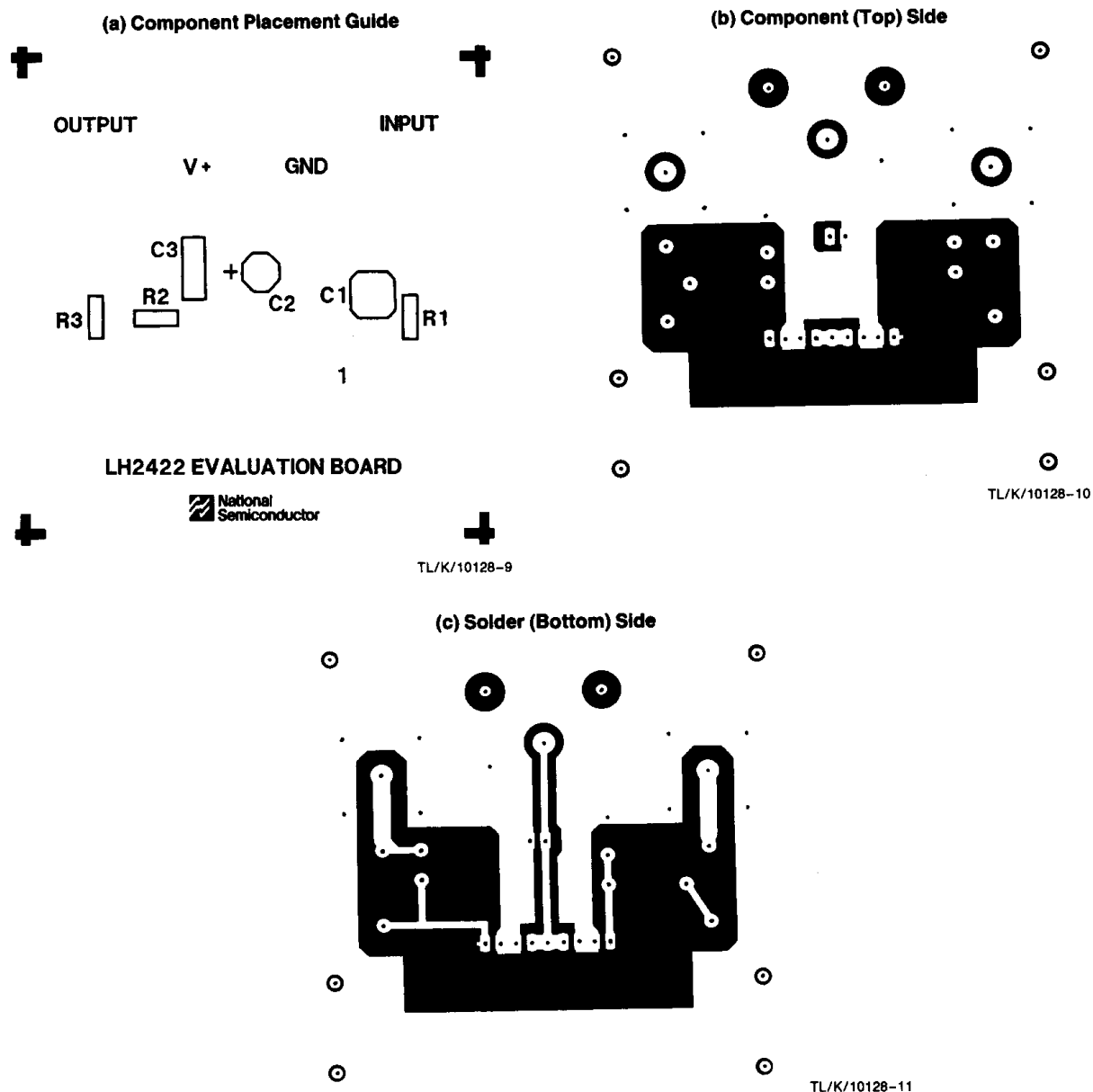


FIGURE 6. PC Board Layout and Component Placement Guide