

# Series Electrical Connections for LED Light Bars

## Application Brief I-001

### Introduction

When designing LED light bars into a display system, three items should be considered:

1. Electrically connecting the LED chips in series/parallel circuit combinations to reduce power consumption.
2. Designing the layout of pc board traces between solder pads to reduce thermal stress on the light bars during soldering.
3. Using an alternating pin soldering sequence when hand soldering to reduce thermal stress.

### Series/Parallel Electrical Connections

Light bars are made with either 2, 4, or 8 LEDs per device, with each LED chip anode and cathode directly accessible through individual leads. The LEDs in a device could be electrically connected in parallel, with each LED having its own current limiting resistor. The amount of current required is the desired drive current per LED chip multiplied by the number of individual LEDs in the device.

A more effective approach is to connect the LEDs within a light

bar in a series/parallel circuit combination as shown in Figure 1. This reduces the needed LED drive current and the number of current limiting resistors by a factor of 2 for two and four chip light bars and by a factor of 4 for eight chip light bar devices. A 5 volt source has sufficient compli-

ance to drive light bars with two LED chips connected in series or series/parallel at 20 mA. A 9 volt source has sufficient compliance to drive light bars with four LEDs connected in either series or series/parallel at 20 mA. With a forward voltage drop across each LED chip of about 2 volts at 20 mA,

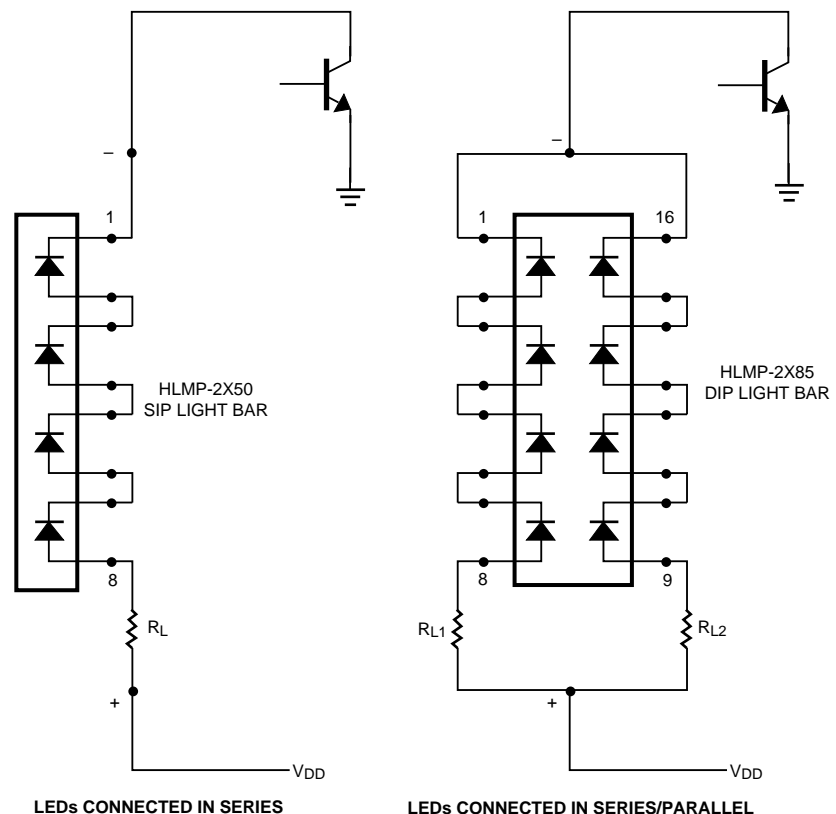


Figure 1. LED Light Bars Series, Series/Parallel Connections

a one volt drop is developed across the current limiter (assuming a negligible voltage drop across the switching transistor).

All LED chips in a series string share the same current limiting resistor, which is typically connected at the power supply side of the circuit. The switching transistor is typically connected between the LEDs and ground.

In Figure 1, the series circuit connection for an HLMP-2X50 four LED chip single in-line package (SIP) light bar device and the series/parallel circuit connection for an HLMP-2X85 eight LED chip dual in-line package (DIP) light bar device are shown. The cathode of an LED chip is connected to the anode of the adjacent LED chip to form the series connection. The SIP light bar device has all four LED chips connected into a single series circuit, sharing one current limiting resistor and one switching transistor. Each series string of the DIP light bar device has its own current limiter. The two series strings of the DIP device are connected in parallel to the voltage source and a single switching transistor.

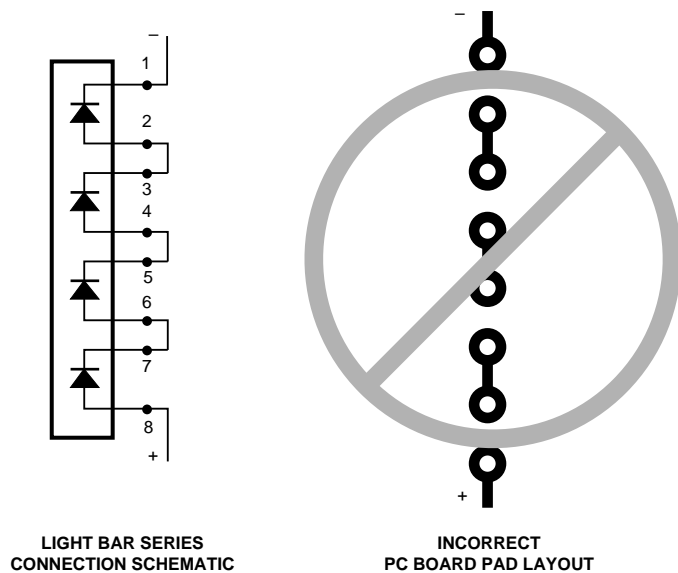
### Printed Circuit Board Trace Layout

It is important to have a special trace layout on the printed circuit (pc) board connecting adjacent anode and cathode pins to prevent excessive thermal stress during soldering. Using a short interconnecting trace between adjacent anode and cathode leads is not recommended. A short interconnecting trace, as shown in Figure 2 for a four chip SIP light bar device, has the effect of allowing adjacent LED chips to be heated simultaneously during soldering. This

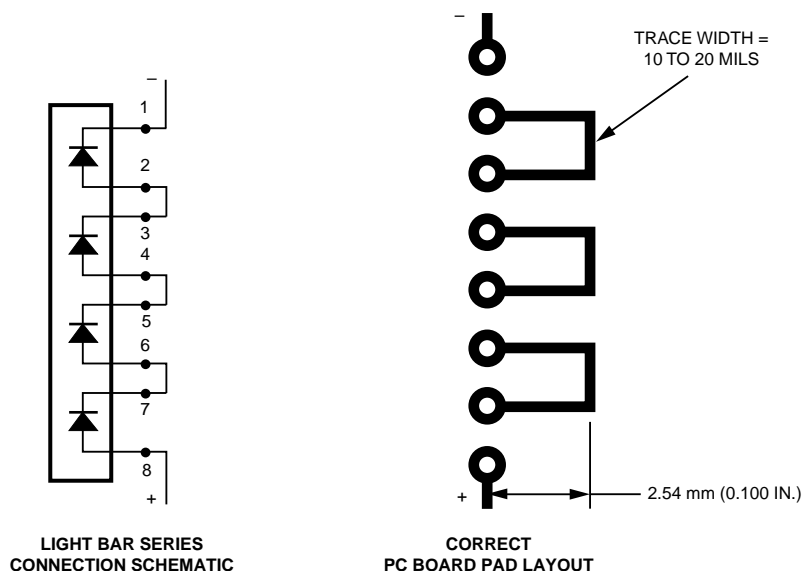
simultaneous heating can cause excessive thermal stress on the LED chips, resulting in broken wire bonds and lifted die attach.

A special extended interconnecting trace, as shown in Figure 3, should be used on the pc board between adjacent anode and cathode leads. The longer trace

provides the needed thermal isolation between adjacent LED chips within the light bar device. This interconnecting trace need be only 10 to 20 mils wide to carry the electrical current, and should extend at least 2.54 mm (0.100 in.) out from the pc board plated through holes.



**Figure 2. Trace Layout Contributes to Thermal Overstress of LEDs During Soldering**



**Figure 3. Trace Layout Reduces Thermal Stress on LEDs During Soldering**

## Alternating Pin Sequence Technique for Hand Soldering

If hand soldering is to be used, an alternating pin sequence technique significantly reduces the possibility of thermal overstress on the LED chips. This concept is illustrated in Figure 4 for a four chip SIP light bar device. The idea is to allow sufficient time for cooling between the soldering of the cathode and

anode leads of each LED chip. This is accomplished by first soldering the cathode lead of an LED chip then the anode lead of a non-adjacent LED chip. Figure 4 shows this procedure.

## Summary

Hewlett-Packard LED light bars provide a high performance solution to many annunciator needs. Performance and reliability can be increased by taking the steps outlined in this brief:

1. Using series/parallel connections.
2. Providing thermal relief with extended pc board traces.
3. Alternating pins when hand soldering.

For further related information, consult Application Note 1027, *Soldering LED Components*.

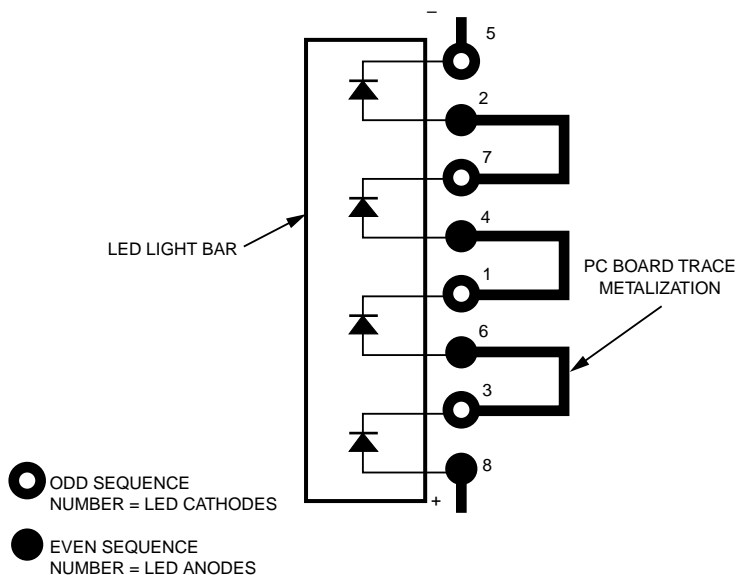


Figure 4. Alternating Pin Sequence Reduces Thermal Stress on LEDs During Hand Soldering



For technical assistance or the location of your nearest Hewlett-Packard sales office, distributor or representative call:

**Americas/Canada:** 1-800-235-0312 or (408) 654-8675

**Far East/Australasia:** Call your local HP sales office.

**Japan:** (81 3) 3335-8152

**Europe:** Call your local HP sales office.

Data Subject to Change

Copyright © 1997 Hewlett-Packard Co.

Printed in U.S.A. 5965-6074E (1/97)