Figure 1-11. Before noise can be a problem, there must be a noise source, a receptor that is susceptible to the noise, and a coupling channel that transmits the noise to the receptor.

KEY CHARACTERISTICS OF THE NOISE SOURCE

1. VOLTAGE

"HIGH" VOLTAGE \( \rightarrow \) STRONG ELECTRIC FIELD \( \rightarrow \) CAPACITIVE COUPLING

2. CURRENT

"HIGH" CURRENT \( \rightarrow \) STRONG MAGNETIC FIELD \( \rightarrow \) INDUCTIVE COUPLING

3. FREQUENCY

"HIGH" FREQUENCY \( \rightarrow \) RADIATION \( \rightarrow \) RADIATIVE COUPLING

4. DISTANCE FROM VICTIM

DISTANCE = 0 \( \rightarrow \) DIRECT CONTACT \( \rightarrow \) CONDUCTIVE COUPLING

DISTANCE > WAVELENGTH \( \rightarrow \) PROBABLY RADIATIVE COUPLING

0 < DISTANCE < WAVELENGTH \( \rightarrow \) CAPACITIVE OR INDUCTIVE

WHAT IS THE MOST LIKELY COUPLING MECHANISM FOR:

- FLUORESCENT LIGHT NOISE
- ARC WELDING NOISE
- DIGITAL CLOCK NOISE
6-Pin DIP Optoisolators
Logic Output

The H1L1 and H1L2 have a gallium arsenide LED optically coupled to a high-speed integrated detector with Schottky trigger output. Designed for applications requiring electrical isolation, fast response, noise immunity and digital logic compatibility.

- Guaranteed Switching Times — t0, t00 < 4 µs
- Built-in On/Off Threshold Hysteresis
- High Data Rate, 1 MHz Typical (NRZ)
- Wide Supply Voltage Capability
- Microprocessor Compatible Drive

Applications
- Interfacing Computer Terminals to Peripherals Equipment
- Servo Machine Applications
- Digital Control of Power Supplies
- Logic to Logic Isolator
- Line Receiver — Eliminates Noise
- Logic Level Shifter — Couples TTL to CMOS

MAXIMUM RATINGS (TJ = 25°C unless otherwise noted)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT LED</td>
<td>VIL</td>
<td>0.05</td>
<td>mA</td>
</tr>
<tr>
<td>Reverse Leakage Current (IIL = 10 mA Max)</td>
<td>IIL</td>
<td>1</td>
<td>mA</td>
</tr>
<tr>
<td>Forward Voltage (IF = 10 mA)</td>
<td>VIF</td>
<td>0.75</td>
<td>Volt</td>
</tr>
<tr>
<td>Capacitance (Vcc = 0 V, f = 1 MHz)</td>
<td>C</td>
<td>20</td>
<td>pF</td>
</tr>
</tbody>
</table>

OUTPUT DETECTOR

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>VCC</td>
<td>3</td>
<td>—</td>
<td>15</td>
<td>Volt</td>
</tr>
<tr>
<td>Supply Current (Icc = 5 V)</td>
<td>ICC</td>
<td>1</td>
<td>5</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>Output Current, High (Ih)</td>
<td>0.1A</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>µA</td>
</tr>
</tbody>
</table>

COUPLING

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Current (Ih)</td>
<td>ION</td>
<td>1.6</td>
<td>5</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>Output Voltage, Low (RL = 270 Ω, VCC = 5 V)</td>
<td>VIL</td>
<td>0.2</td>
<td>0.4</td>
<td>—</td>
<td>Volt</td>
</tr>
<tr>
<td>Threshold Current, ON (RL = 270 Ω, VCC = 5 V)</td>
<td>ION</td>
<td>1</td>
<td>1.6</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>Threshold Current, OFF (RL = 270 Ω, VCC = 5 V)</td>
<td>IONOFF</td>
<td>0.3</td>
<td>0.75</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>Hysteresis Ratio (RL = 270 Ω, VCC = 5 V)</td>
<td>VILVCC</td>
<td>0.5</td>
<td>0.75</td>
<td>0.9</td>
<td>mA</td>
</tr>
</tbody>
</table>

Isolation Voltage (1) 50 Hz, AC Peak, 1 second, TA = 25°C

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn-On Time</td>
<td>RON</td>
<td>1.2</td>
</tr>
<tr>
<td>Turn-Off Time</td>
<td>ROFF</td>
<td>0.1</td>
</tr>
<tr>
<td>Rise Time</td>
<td>TR</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Figure 1. Switching Test Circuit

H1L1, H1L2

ELECTRICAL CHARACTERISTICS (TA = 0 to 70°C)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT LED</td>
<td>VIL</td>
<td>0.05</td>
<td>1.0</td>
<td>10</td>
<td>µA</td>
</tr>
<tr>
<td>Reverse Leakage Current (IIL = 10 mA Max)</td>
<td>IIL</td>
<td>1</td>
<td>1.5</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>Forward Voltage (IF = 10 mA)</td>
<td>VIF</td>
<td>0.75</td>
<td>0.75</td>
<td>—</td>
<td>Volt</td>
</tr>
<tr>
<td>Capacitance (Vcc = 0 V, f = 1 MHz)</td>
<td>C</td>
<td>20</td>
<td>—</td>
<td>pF</td>
<td></td>
</tr>
</tbody>
</table>

VCC = 5 Volt

(1) Isolation surge voltage is an internal device safety level breakdown rating.
For this test, Pins 1 and 2 are common, and Pins 3, 4 and 5 are common.
(2) Refer to Quality and Reliability Section for test information.
CONDUCTIVELY COUPLED NOISE

WHICH NOISE WAVEFORM MUST BE CONDUCTIVELY COUPLED? WHY?

NOISE VOLTAGE #1

NOISE VOLTAGE #2

TIME

CAPACITIVELY COUPLED NOISE

CAPACITIVE COUPLING - ELECTRIC FIELD COUPLING BETWEEN METAL SURFACES IN THE SIGNAL AND NOISE CIRCUITS

TYPICAL EXAMPLE

SIGNAL LINE

C

AC POWER LINE

SIMPSONIFIED EQUIVALENT CIRCUIT COUPLING CAPACITANCE

NOISE VOLTAGE SOURCE

V

C

Z

SIGNAL CIRCUIT IMPEDANCE
\[ V_N = \frac{j \omega [C_{12}/(C_{12} + C_{2G})]}{j \omega + 1/R(C_{12} + C_{2G})} V_1. \] (2-1)

6. REDUCING CAPACITIVELY COUPLED NOISE

CAPACITIVE SHIELDING

1. POSITION THE SHIELD TO INTERCEPT THE NOISE CURRENT.

2. CONNECT THE SHIELD TO RETURN THE NOISE CURRENT TO THE SOURCE.

HOW MANY CONNECTIONS TO THE SHIELD ARE REQUIRED?

CAPACITIVE SHIELD CAUSES THE NOISE CURRENT TO BYPASS THE CIRCUIT BEING PROTECTED.
SUMMARY OF CAPACITIVE NOISE REDUCTION TECHNIQUES

REDUCE CAPACITIVE NOISE COUPLING BY:
1. REDUCING COUPLING CAPACITANCE
2. REDUCING CIRCUIT IMPEDANCE
3. USING SHIELDING

CAPACITIVE SHIELDING REQUIRES:
1. PROPER SHIELD LOCATION
2. CORRECT SHIELD CONNECTION

LOCATE THE SHIELD BETWEEN THE TWO CAPACITIVELY COUPLED SURFACES.

CONNECT THE SHIELD AT ONE POINT SO THE CAPACITIVELY COUPLED NOISE CURRENTS INTERCEPTED BY THE SHIELD BYPASS THE SIGNAL CIRCUIT AS THEY RETURN TO THE NOISE SOURCE.

A SHIELD INCORRECTLY CONNECTED OR LEFT FLOATING IS WORSE THAN NO SHIELD.

METAL SHOULD NOT BE LEFT ELECTRICALLY FLOATING.
REVIEW OF INDUCTIVE COUPLING CONCEPTS

BASIC CIRCUIT FOR INDUCTIVE COUPLING

IDENTIFYING CHARACTERISTICS:

EXCESSIVE WIRING INDUCTANCE AS INDICATED BY
1. UNNECESSARY LOOP AREAS.
2. LC = CONSTANT.

HIGH NOISE CURRENT AND/OR FREQUENCY
UNAFFECTED BY NON-CONDUCTING, NON-MAGNETIC MATERIALS.
EFFECTIVENESS OF SHIELDING MATERIAL NOT CHANGED BY GROUNDING.
ESSENTIALLY NO SHIELDING BY CONDUCTIVE, NON-MAGNETIC MATERIALS BELOW 1KHz.
DETECTABLE BY MAGNETIC (LOOP) SENSOR.

SOLUTION POSSIBILITIES:
REDUCE THE NOISE CURRENT SOURCE
REDUCE THE NOISE FREQUENCY
REDUCE THE MUTUAL INDUCTANCE
INCREASE THE SIGNAL CIRCUIT IMPEDANCE
FILTER THE NOISE AT THE SIGNAL CIRCUIT
USE MAGNETIC SHIELDING
6-Pin DIP Optoisolators
Transistor Output

These devices consist of a gallium arsenide infrared emitting diode optically coupled to a monolithic silicon phototransistor detector.
- Convenient Plastic Dual-in-Line Package
- Economical
- High Input-Output Isolation Guaranteed — 7500 Volts Peak
- UL Recognized. File Number E54915
- VDE approved per standard 0883/6.80 (Certificate number 41853), with additional approval to DIN IEC380/VDE0806, IEC435/VDE0805, IEC65/VDE0860, VDE110b, covering all other standards with equal or less stringent requirements, including IEC294, VDE0113, VDE0160, VDE0832, VDE0833, etc.
- Special lead form available (add suffix "T" to part number) which satisfies VDE0883/6.80 requirement for 8 mm minimum creepage distance between input and output solder pads.
- Various lead form options available. Consult "Optoisolator Lead Form Options" data sheet for details.

MAXIMUM RATINGS \( (T_A = 25^\circ\text{C} \text{ unless otherwise noted}) \)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT LED</td>
<td>Reverse Voltage</td>
<td>( V_R )</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Forward Current — Continuous</td>
<td>( I_F )</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>LED Power Dissipation ( (\alpha \ T_A = 25^\circ\text{C}) ) with Negligible Power in Output Detector</td>
<td>( P_D )</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Derate above 25°C</td>
<td></td>
<td>1.41</td>
</tr>
<tr>
<td>OUTPUT TRANSISTOR</td>
<td>Collector-Emitter Voltage</td>
<td>( V_{CEO} )</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Emitter-Collector Voltage</td>
<td>( V_{ECO} )</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Collector-Base Voltage</td>
<td>( V_{CBO} )</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Collector Current — Continuous</td>
<td>( I_C )</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Detector Power Dissipation ( (\alpha \ T_A = 25^\circ\text{C}) ) with Negligible Power in Input LED</td>
<td>( P_D )</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Derate above 25°C</td>
<td></td>
<td>1.76</td>
</tr>
</tbody>
</table>

TOTAL DEVICE

| Isoalation Surge Voltage \((1)\) (Peak ac Voltage, 60 Hz, 1 sec Duration) | \( V_{ISO} \) | 7500 | Vac |
| Total Device Power Dissipation \( (\alpha \ T_A = 25^\circ\text{C}) \) Derate above 25°C | \( P_D \) | 250 | mW |
| Ambient Operating Temperature Range | \( T_A \) | -55 to +100 | °C |
| Storage Temperature Range | \( T_{STG} \) | -55 to +150 | °C |
| Soldering Temperature \((10 \text{ sec, } 1/16" \text{ from case})\) | \( T_{SOL} \) | 260 | °C |

(1) Isolation surge voltage is an internal device dielectric breakdown rating. For this test, Pins 1 and 2 are common, and Pins 4, 5 and 6 are common.