Ordering number : EN4908A

BiCMOS LSI

# LV9005M

## Optical Sensor Switch IC

## Overview

The LV9005M is an optical sensor switch IC that is fabricated in a medium breakdown voltage BiCMOS process. The LV9005M circuit structure includes a high-gain optical sensor amplifier, a comparator, an oscillator circuit, output drivers, LED drivers, and a synchronous detection and delay circuit. The use of this IC and a minimal number of external components allows the implementations of multifunction high-sensitivity applications that previously would have only been possible with a custom optical-switch IC.

## Applications

- Factory automation (detectors for many types of parts and products)
- Home security (doorway and window sensors)
- Office automation equipment

## Functions and Features

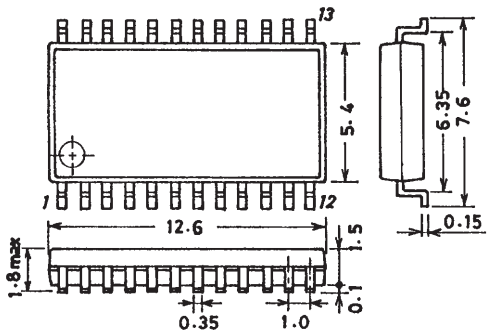
- Can be used with a wide range of supply voltages; from 5 to 30 V.
- Low power
- Outputs can be selected as PNP or NPN circuit types.
- Built-in high-gain amplifier
- Built-in stability and output display functions
- Supports both reflection and through type applications, and supports both sense on light and sense on dark applications. A separate illumination oscillator is used in transmission mode.
- Built-in OCP and power on reset functions
- Built-in three-level comparator
- Synchronous detection scheme adopted for robust performance in the presence of ambient and scattered light.
- External photodiode detection scheme allows the LV9005M to support a wide range of application areas.
- Miniature flat package supports high density printed circuit board mounting.

## Package Dimensions

unit: mm

**3112-MFP24S**

[LV9005M]




SANYO: MFP24S

## Specifications

### Absolute Maximum Ratings at Ta = 25°C

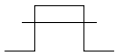
| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Maximum supply voltage | $V_{CC}$ max | | 33 | V |
| LD pin voltage | $V_{LD}$ | | 33 | V |
| Allowable power dissipation | Pd max | | 425 | mW |
| Operating temperature | Topr | | –20 to +85 | °C |
| Storage temperature | Tstg | | –40 to +125 | °C |

### Allowable Operating Ranges at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | 4.5 to 30 | V |
| LD pin voltage LD = Light ON / Dark ON | $V_{LD}$ | High breakdown voltage input pins | $V_{CC}$ to 0 | V |


SANYO Electric Co.,Ltd. Semiconductor Bussiness Headquarters
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

## Electrical Characteristics at Ta = 25°C, $V_{CC}$ = 12 V (unless otherwise specified)

| Parameter | Symbol | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| Preamplifier gain | $V_{G1}$ | With a 20 kΩ input series resistance, f = 200 kHz (sine wave) | 15 | 18 | 21 | dB |
| Main amplifier gain | $V_{G2}$ | f = 200 kHz (sine wave) | 45 | 48 | 51 | dB |
| Regulated power supply | $V_{REG}$ | $V_{CC}$ = 5 V, 5 mA DC load | 3.72 | 4.0 | 4.28 | V |
| Current drain | $I_{CC}$ | Measured in the specified circuit* | | 3.0 | 4.5 | mA |
| Input resistance | $Z_{IN}$ | | 8.5 | 10 | 11.5 | kΩ |
| [LED Output Block] | | | | | | |
| Pulse level | $V_{LEH}$ | With a 1 kΩ external resistor | 2.9 | 3.2 | 3.6 | V |
| Pulse period | $T_{LE}$ | $C_{OSC}$ = 4700 pF | 300 | 380 | 460 | µs |
| Pulse width | $T_{PW}$ |  50% | 4.2 | 5.2 | 6.2 | µs |
| [Overcurrent Detection Voltage] | | | | | | |
| PNP output (source) | OCP (P) | External transistor = PNP | $V_{CC}$ – 1.1 | $V_{CC}$ – 1.35 | $V_{CC}$ – 1.6 | V |
| NPN output (sink) | OCP (N) | External transistor = NPN | 1.10 | 1.35 | 1.75 | V |
| Comparator detection level (low) | $COMP_L$ | | 0.33 | 0.44 | 0.55 | V |
| Comparator detection level (middle) | $COMP_M$ | | 0.60 | 0.74 | 0.88 | V |
| Comparator detection level (high) | $COMP_H$ | | 1.03 | 1.16 | 1.30 | V |
| LG current | $I_{LG}$ | | 2.05 | 2.65 | 3.25 | mA |
| LR current | $I_{LR}$ | | 1.12 | 1.72 | 2.32 | mA |
| PNP drive current (source) | $I_{SRC}$ | | 1.80 | 2.85 | 3.80 | mA |
| NPN drive current (sink) | $I_{SNK}$ | | 1.90 | 2.95 | 3.90 | mA |
| Main amplifier output DC voltage | $V_{OUT2}$ | | 1.20 | 1.40 | 1.56 | V |
| RT input high voltage | $V_{IH}1$ | | 4.0 | | | V |
| RT input low voltage | $V_{IL}1$ | | | | 1.0 | V |
| LD input high voltage | $V_{IH}2$ | High breakdown voltage input pins | 4.0 | | | V |
| LD input low voltage | $V_{IL}2$ | High breakdown voltage input pins | | | 1.3 | V |
| P/N input high voltage | $V_{PNH3}$ | | 4.0 | | | V |
| P/N input low voltage | $V_{PNL3}$ | | | | 1.0 | V |

Какой жиапазон частот разрешен для несущей?

OCP = OverCurrent Protection

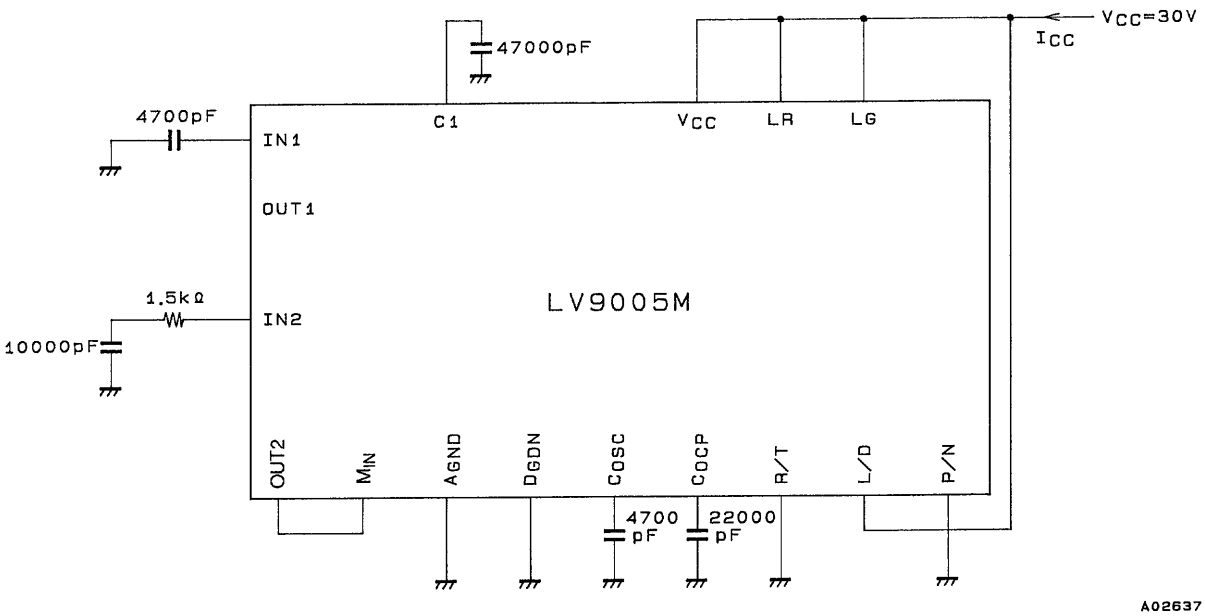
LG = Light Green
LR = Light Red

to Comp-r Middle IN
Why DC?

Reflection/Through

Light ON / Dark ON

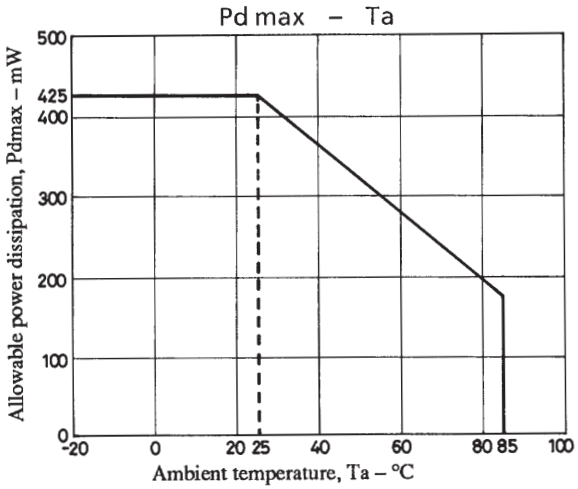
PNP/NPN

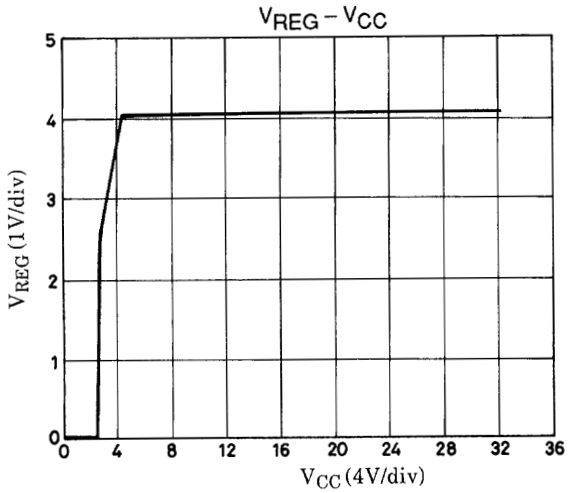



Note: * Current drain test circuit

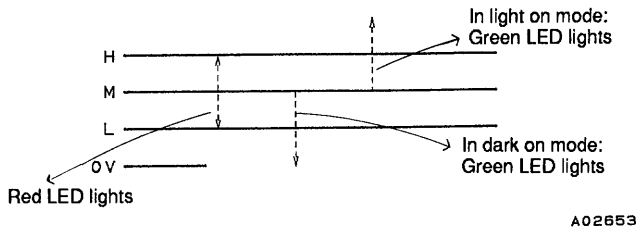
## Design Specifications

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Synchronization pull-in range | PIR | $T_{EL}$ = LED pulse period, transmission mode | 0.55 $T_{LE}$ to 1.45 $T_{LE}$ | µs |
| Power on reset | $T_{POR}$ | | 13.5 | ms |
| Response time | $T_D$ | Oscillator external capacitor $C_{OCP}$ = 4700 pF | 2 $T_{LE}$ | µs |
| Oscillator period | $T_{OSC}$ | Oscillator external capacitor $C_{OCP}$ = 4700 pF | 380 | µs |
| Hysteresis | $V_H$ | | $0.7^{+0.2}_{-0.15}$ | Vp-p |
| [OCP Pulse] | | | | |
| Pulse period | $T_{OCP\ (N)}$ | $C_{OCP}$ = 22000 pF | 7.0 | ms |
| Pulse width | $T_{OCPW\ (N)}$ | | 55 | µs |
| Pulse period | $T_{OCP\ (P)}$ | | 7.0 | ms |
| Pulse width | $T_{OCPW\ (P)}$ | | 55 | µs |

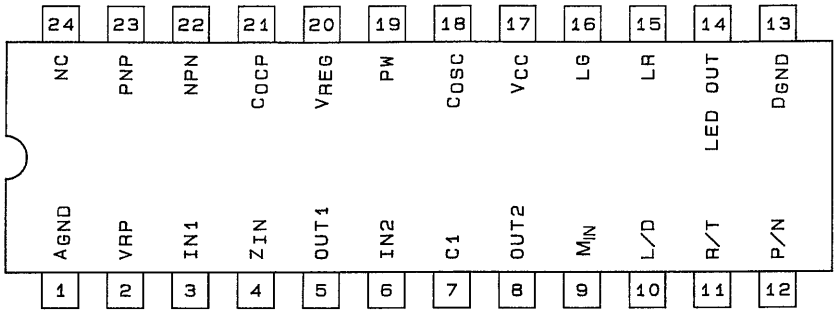



## Functional Description

| Item | Symbol | Description |
|---|---|---|
| R/T SW | R/T | Reflection/through switching. *: A separate illumination oscillator is used in transmission mode. |
| Reflect | R | Input voltage = high ($V_{REG}$) or open |
| Through | T | Input voltage = low (GND) |
| L/D SW | L/D | Light/dark switching |
| Light | L | Input voltage = high ($V_{CC}$) or open |
| Dark | D | Input voltage = low (GND) |
| P/N SW | P/N | Output PNP/NPN switching |
| PNP mode | PNP | Input voltage = high ($V_{REG}$) or open |
| NPN mode | NPN | Input voltage = low (GND) |
| Output protection | | Built-in overcurrent (load short) protection circuit |
| Comparator and display ranges | |  |
| Output type | | NPN, PNP, two outputs |
| Mode relationship | | Light on mode → Light detected: output on, dark detected: output off |
| | | Dark on mode → Light detected: output off, dark detected: output on |

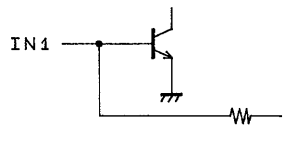
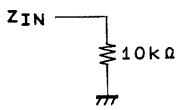
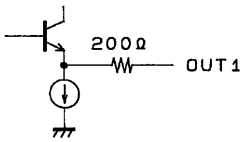
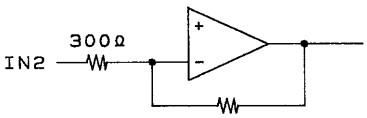
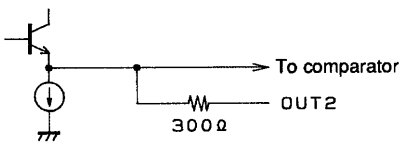
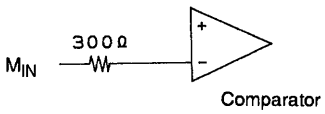
## Pin Assignment




Note: The NC pin must not be used.

A02638

## Pin Functions

| Pin No. | Symbol | I/O circuit type | Notes |
|---|---|---|---|
| 3 | IN1 |  A02639 | Amplifier first stage input<br>(Capacitor coupled to the external circuit.) |
| 4 | $Z_{IN}$ |  A02640 | Photodiode series (load) resistance<br>(Used when not used with an external resistor.) |
| 5 | OUT1 |  A02641 | Amplifier first stage output |
| 6 | IN2 |  A02642 | Output amplifier input |
| 8 | OUT2 |  A02643 | Output amplifier output |
| 9 | $M_{IN}$ |  A02644 | Comparator middle input (This pin sets the hysteresis. The hysteresis is maximum when this pin is open, and minimum when this pin is shorted to pin 8.) |
| 10 | L/D | Light on mode → $V_{CC}$<br>Dark on mode → 0 V | Light/dark mode switching<br>This pin has a built-in noise filter (delay time: $2T_{LE}$) |
| 11 | R/T | Reflect mode → 4 V ($V_{REG}$) or open<br>Through mode → 0 V | Reflect/through mode switching |

Continued on next page.

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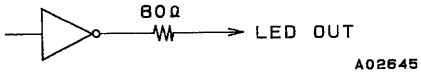
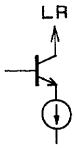
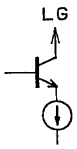
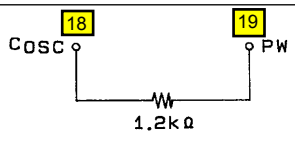
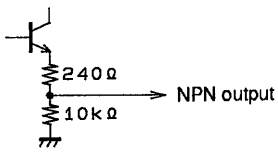
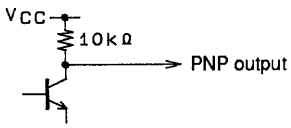
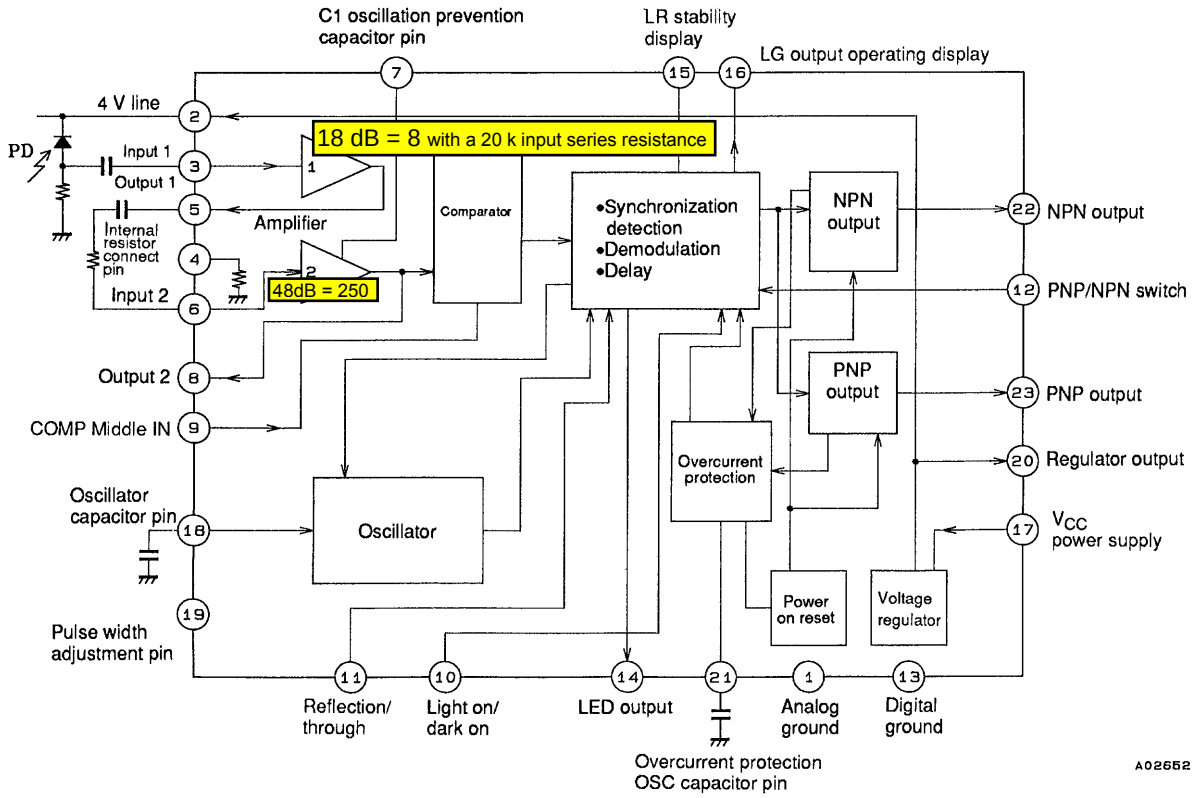
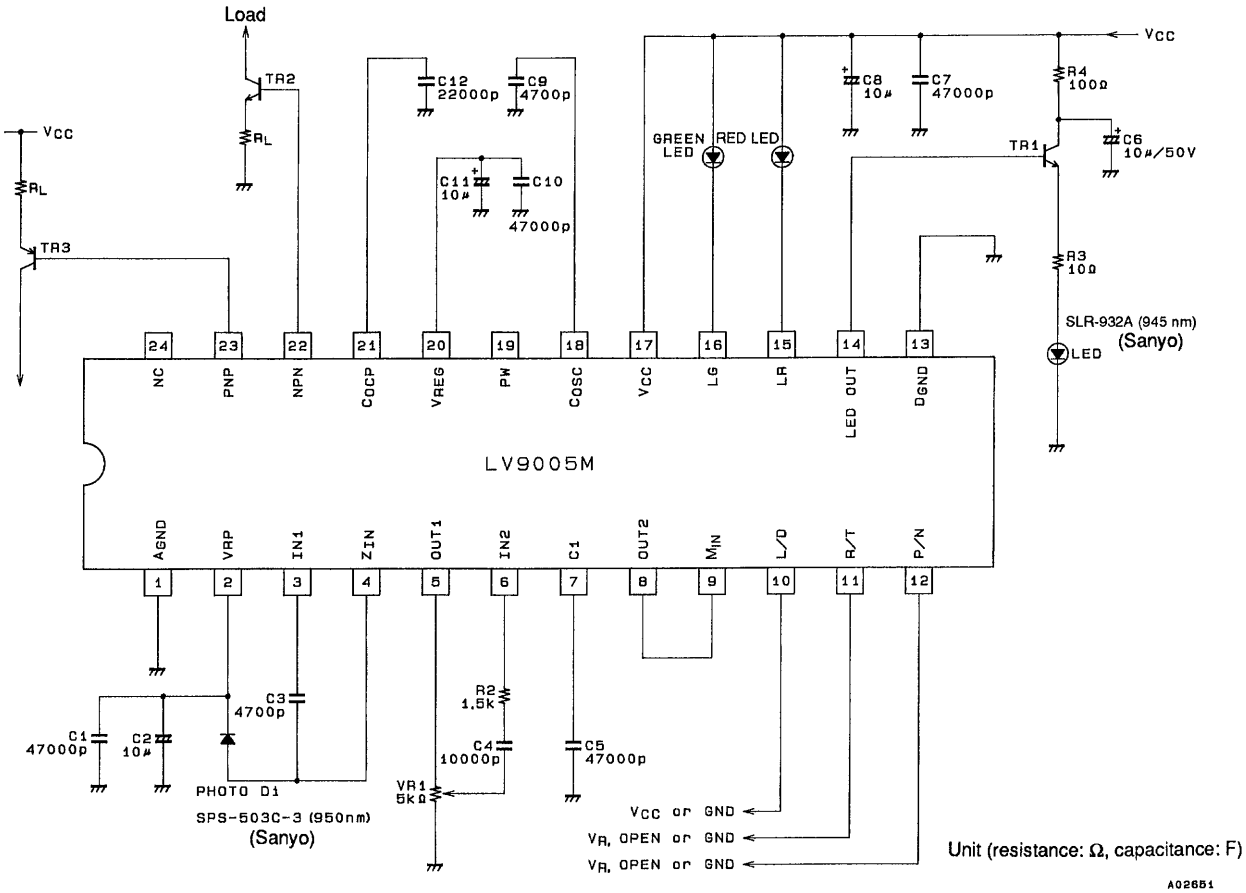
| Pin No. | Function | I/O circuit type | Notes |
|---|---|---|---|
| 12 | P/N | PNP mode → 4 V ($V_{REG}$) or open<br>NPN mode → 0 V | PNP/NPN switching |
| 14 | LED OUT |  | Light source LED drive output |
| 15 | LR<br>LED Red |  | Red LED (display) connection |
| 16 | LG<br>LED Green |  | Green LED (display) connection |
| 18 | $C_{OSC}$ | | Oscillator capacitor connection |
| 19 | PW<br>pulse width |  | О! Дл-ть импульса на св-диод разрешается подстраивать! Правда, только уменьшать. В каких пределах?!<br>Light source LED pulse width adjustment<br>(Connect pins 18 and 19 through an external resistor to narrow the pulse width from the illumination LED.) |
| 20 | $V_{REG}$ | $V_{REG}$ = $V_{RP}$ (Pin 2)= 4 V | Regulator output |
| 21 | $C_{OCP}$ | | OCP pulse oscillator capacitor connection |
| 22 | NPN |  | NPN transistor connection output |
| 23 | PNP |  | PNP transistor connection output |

## Equivalent Circuit Block Diagram

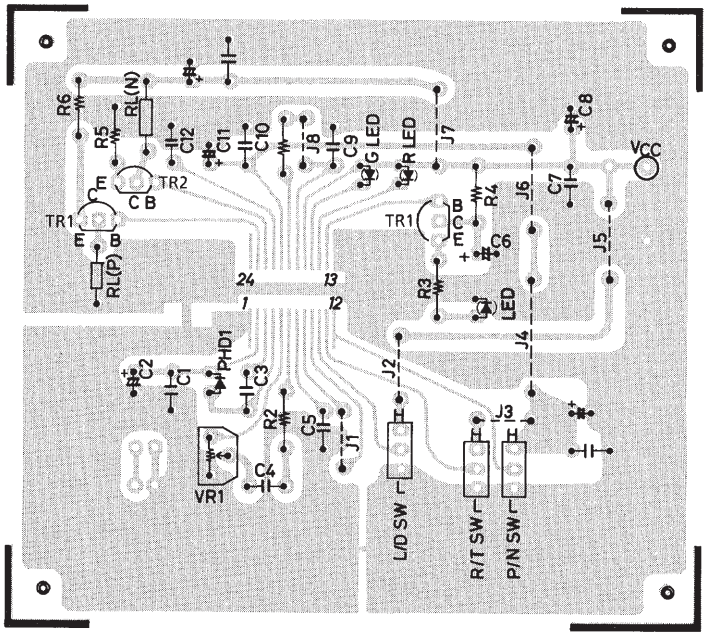



## Application Circuit



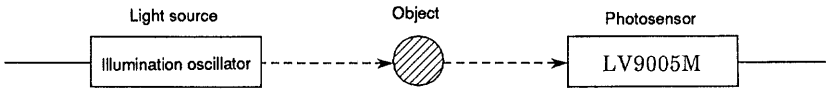

Note: 1. $A_{GND}$ and $D_{GND}$ are connected within the IC.
2. The photodiode and LEDs specified here are examples only. The devices actually used should be chosen based on the particular application.
3. The OCP detection level is determined by the voltage across RL plus the Tr2 (or TR1) VBE voltage.

## Sample Printed Circuit Board Pattern (copper side)




## Sample LV9005M Applications

Through type optoelectronic switch




Reflection type optoelectronic switch