



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

Specifications

Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC\ max}$		33	V
LD pin voltage	V_{LD}		33	V
Allowable power dissipation	$P_{d\ max}$		425	mW
Operating temperature	T_{opr}		-20 to +85	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +125	$^\circ\text{C}$

Allowable Operating Ranges at $T_a = 25^\circ\text{C}$

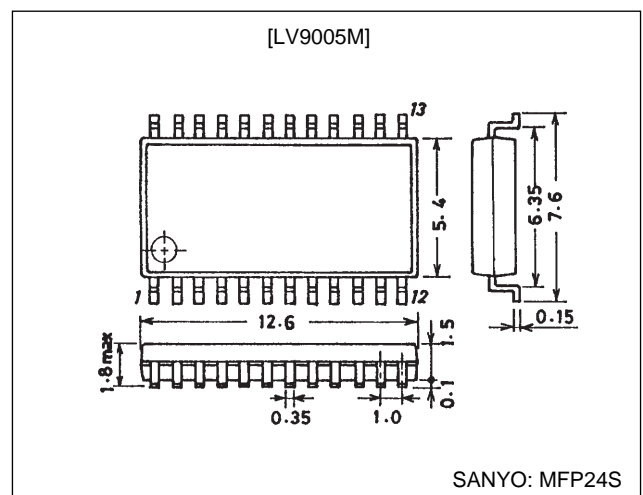
Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{CC}		4.5 to 30	V
LD pin voltage	V_{LD}	High breakdown voltage input pins	V_{CC} to 0	V

- Supports both reflection and through type applications, and supports both sense on light and sense on dark applications.
- 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

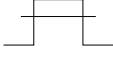
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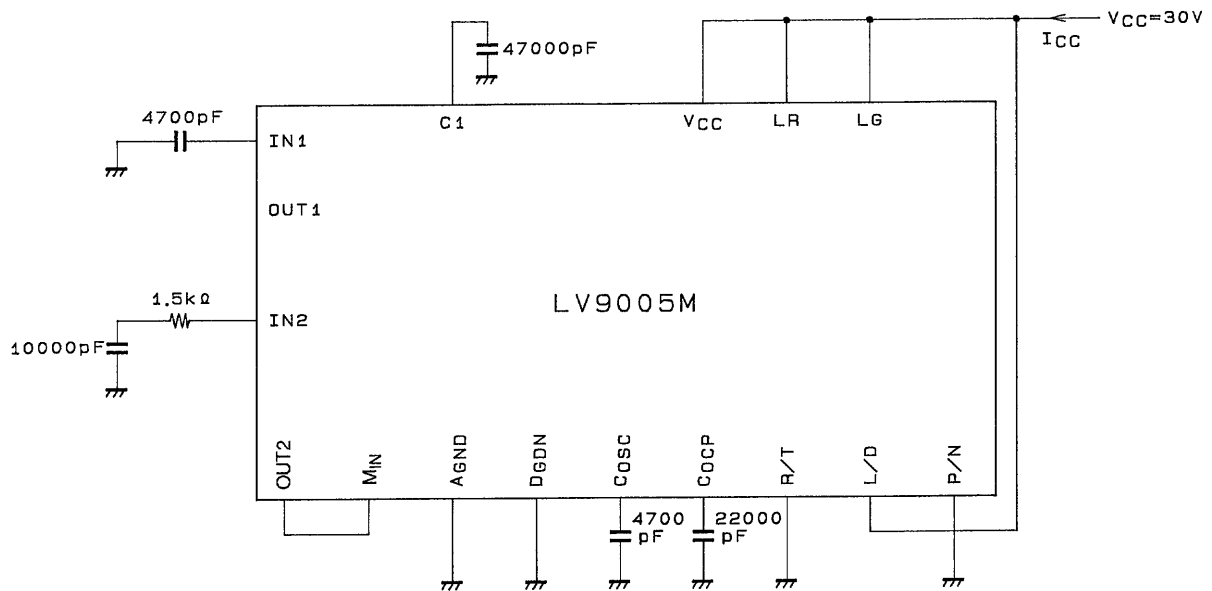
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Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC} = 12\text{ V}$ (unless otherwise specified)

Parameter	Symbol	Conditions	min	typ	max	Unit
Preamplifier gain	V_{G1}	With a 20 k Ω input series resistance, $f = 200\text{ kHz}$ (sine wave)	15	18	21	dB
Main amplifier gain	V_{G2}	$f = 200\text{ kHz}$ (sine wave)	45	48	51	dB
Regulated power supply	V_{REG}	$V_{CC} = 5\text{ V}$, 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	k Ω
[LED Output Block]						
Pulse level	V_{LEH}	With a 1 k Ω external resistor	2.9	3.2	3.6	V
Pulse period	T_{LE}	$C_{OSC} = 4700\text{ pF}$	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_{IH1}		4.0			V
RT input low voltage	V_{IL1}				1.0	V
LD input high voltage	V_{IH2}	High breakdown voltage input pins	4.0			V
LD input low voltage	V_{IL2}	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



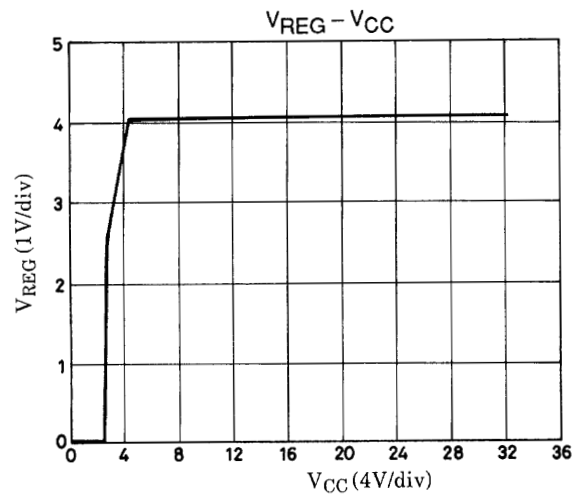
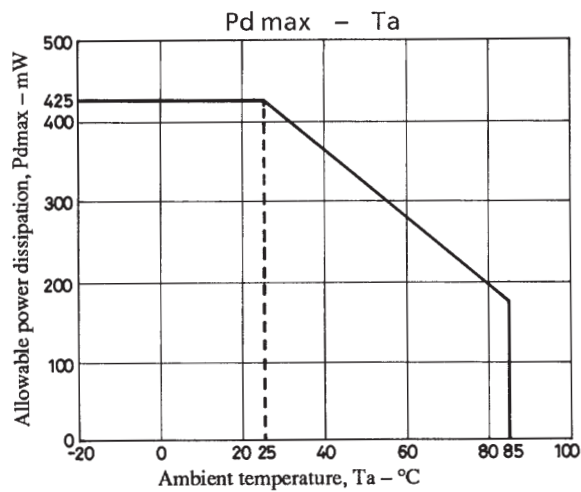
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Note: * Current drain test circuit

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Design Specifications

Parameter	Symbol	Conditions	Ratings	Unit
Synchronization pull-in range	PIR	T_{EL} = LED pulse period, transmission mode	$0.55 T_{LE}$ to $1.45 T_{LE}$	μ s
Power on reset	T_{POR}		13.5	ms
Response time	T_D	Oscillator external capacitor $C_{OCP} = 4700$ pF	$2 T_{LE}$	μ s
Oscillator period	T_{OSC}	Oscillator external capacitor $C_{OCP} = 4700$ pF	380	μ s
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	μ s
Pulse period	$T_{OCP(P)}$		7.0	ms
Pulse width	$T_{OCPW(P)}$		55	μ s

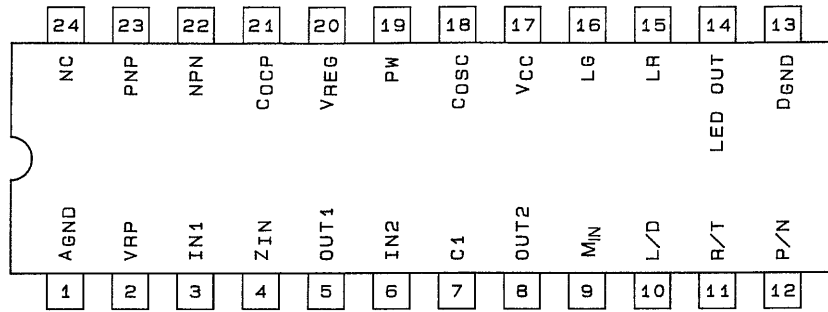


Functional Description

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		<p style="text-align: right;">A02653</p>
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

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Pin Assignment



Top view

Note: The NC pin must not be used.

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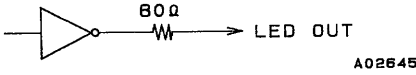
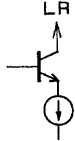
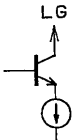
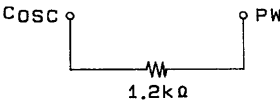
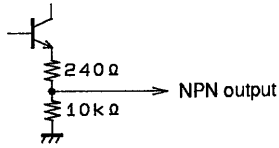
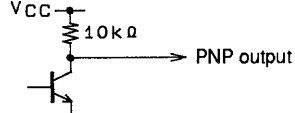
Pin Functions

Pin No.	Symbol	I/O circuit type	Notes
3	IN1	<p>A02639</p>	Amplifier first stage input (Capacitor coupled to the external circuit.)
4	Z _{IN}	<p>A02640</p>	Photodiode series (load) resistance (Used when not used with an external resistor.)
5	OUT1	<p>A02641</p>	Amplifier first stage output
6	IN2	<p>A02642</p>	Output amplifier input
8	OUT2	<p>A02643</p>	Output amplifier output
9	M _{IN}	<p>A02644</p>	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} Dark on mode → 0 V	Light/dark mode switching This pin has a built-in noise filter (delay time: 2T _{LE})
11	R/T	Reflect mode → 4 V (V _{REG}) or open Through mode → 0 V	Reflect/through mode switching

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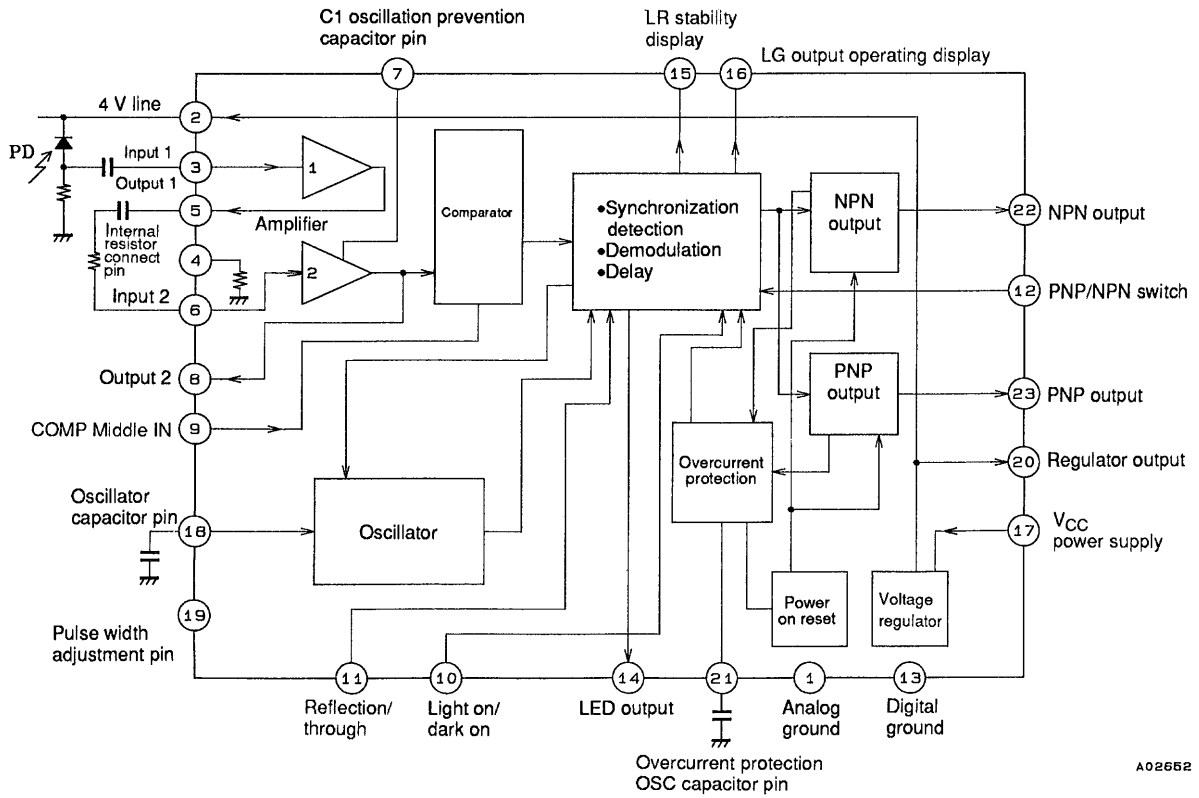
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Pin No.	Function	I/O circuit type	Notes
12	P/N	PNP mode → 4 V (V_{REG}) or open NPN mode → 0 V	PNP/NPN switching
14	LED OUT	 A02645	Light source LED drive output
15	LR	 A02646	Red LED (display) connection
16	LG	 A02647	Green LED (display) connection
18	C _{OSC}		Oscillator capacitor connection
19	PW	 A02648	Light source LED pulse width adjustment (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	 A02649	NPN transistor connection output
23	PNP	 A02650	PNP transistor connection output

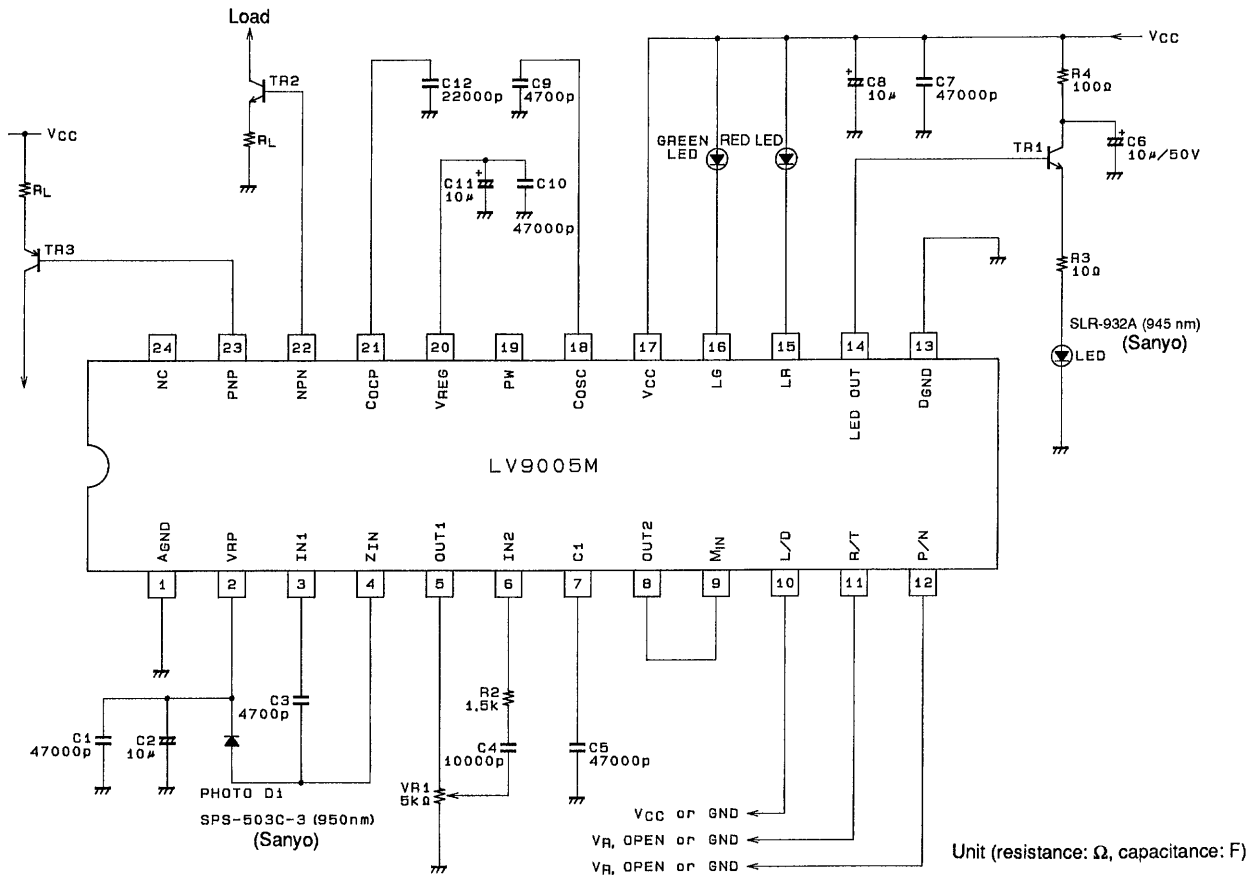
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Equivalent Circuit Block Diagram



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Application Circuit

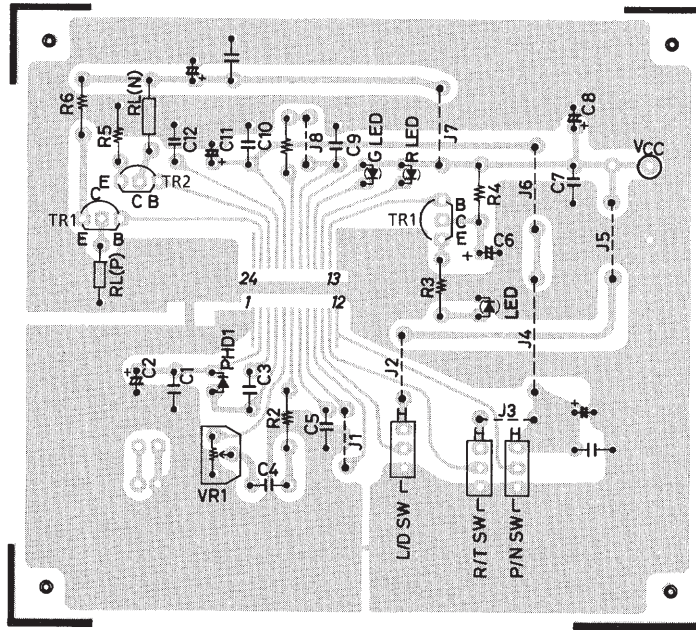


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- Note:
1. AGND and DGND are connected within the IC.
 2. The photodiode and LEDs specified here are examples only. The devices actually used should be chosen based on the particular application.
 3. The OCP detection level is determined by the voltage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

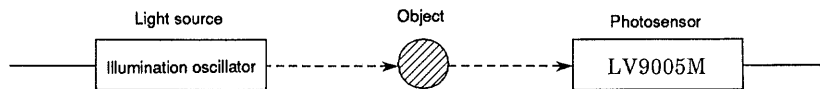
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Sample Printed Circuit Board Pattern (copper side)

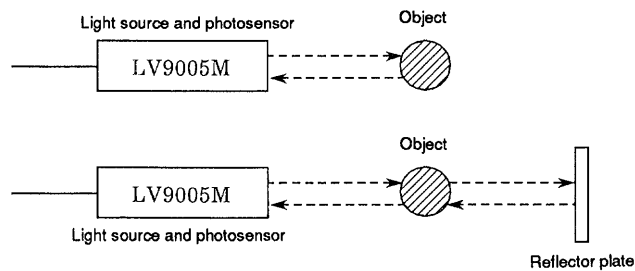


Sample LV9005M Applications

Through type optoelectronic switch



Reflection type optoelectronic switch



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