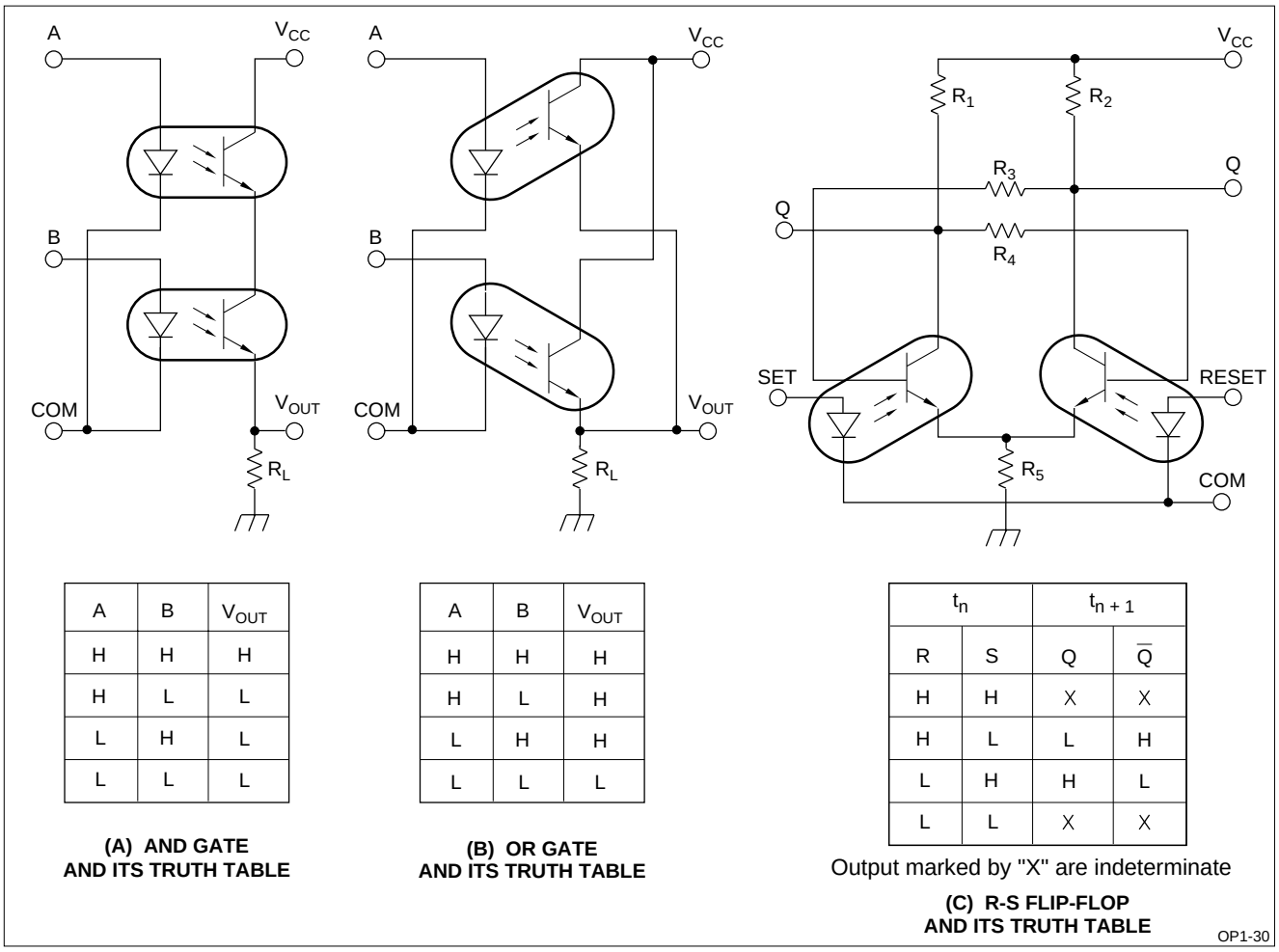
Photocoupler, Photothyristor Coupler, and Phototriac Coupler Application Circuits

INTRODUCTION

For the effective use of photocouplers, the usage utilizing the features and fundamental circuits using photocouplers are described below.

LOGIC GATE CIRCUIT USING PHOTOCOUPLERS

Figure 1 shows logic gates using photocouplers and their associated truth tables. The circuit of Figure 1 (A) forms an AND gate while the circuit of Figure 1 (B) forms an OR gate. These circuits are converted to a NAND gate and NOR gate, respectively, when the R_L load resistor is connected to the collector.



A	B	V_{OUT}
H	H	H
H	L	L
L	H	L
L	L	L

(A) AND GATE AND ITS TRUTH TABLE

A	B	V_{OUT}
H	H	H
H	L	H
L	H	H
L	L	L

(B) OR GATE AND ITS TRUTH TABLE

t_n		t_{n+1}	
R	S	Q	$\overline{Q}$
H	H	X	X
H	L	L	H
L	H	H	L
L	L	X	X

Output marked by "X" are indeterminate

(C) R-S FLIP-FLOP AND ITS TRUTH TABLE

OP1-30

Figure 1. Logic Gate Circuits using Photocouplers

ISOLATION AMPLIFIER

Figure 2 shows a non-modulated isolation amplifier operable with low-frequency signals. In the arrangement, the photocoupler input is biased by DC forward current which is superimposed by a low-frequency signal. This gives the operating region of the good linearity of photocoupler. The DC bias current is adjusted by VR_1.

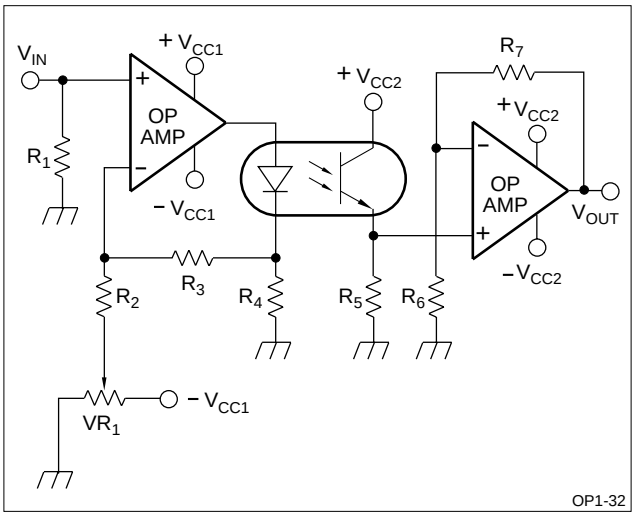


Figure 2. Isolation Amplifier

LEVEL CONVERSION CIRCUIT

Figure 3 shows simple level converters using a photocoupler. The circuit simple level converters using a photocoupler. The circuit shown in Figure 3 (A) converts the MOS level to the TTL level. Because of the small output current from the MOS IC, a photocoupler with a high current transfer ratio (CTR) at low input is required.

The circuit shown in Figure 3 (B) is a Schmitt trigger arranged using a photocoupler and transistor and a convert signal into an arbitrary level.

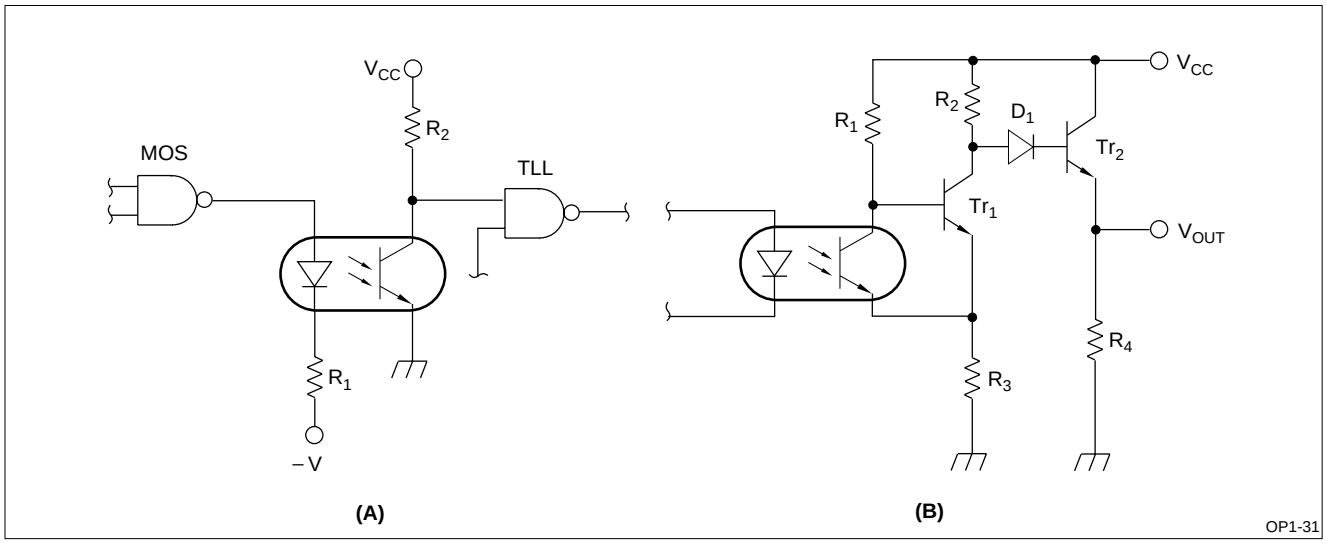


Figure 3. Level Conversion Circuit

NOISE PROTECTION

Figure 4 shows some noise protection examples. The example shown in Figure 4 (A) includes the parallel connection of a capacitor (C_1) and resistor (R_1) across the input of the photocoupler where relatively long signal lines are connected for example where a computer and a terminal unit. The larger the capacitance of C_1, the greater the effect is expected, although signal propagation time is sacrificed.

The examples in Figure 4 (B) and (C) use a photocoupler with a base terminal. Example (B) is effective against noise, but only in exchange for the response time, while example (C) tends to have low current transfer ratio (CTR).

However, when the photocoupler is operated in the switching mode, the base terminal tends to be affected by noise. Therefore, the use of photocouplers without a base terminal is recommended.

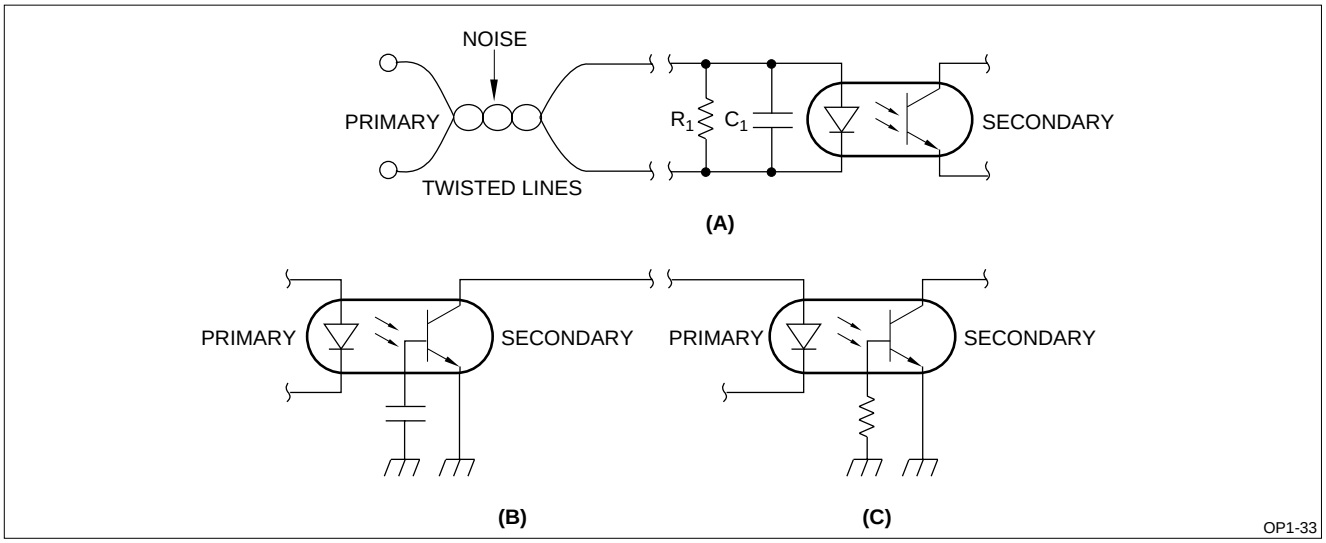


Figure 4. Noise Protection Example

LAMP DRIVING CIRCUIT AND RELAY DRIVING CIRCUIT

Figures 5 and 6 show circuits for driving a lamp and relay, respectively, directly at the output of the photocoupler.

For this purpose, a suitable photocoupler includes a Darlington transistor providing a high CTR. The circuit shown in Figure 5 includes an R_2 resistor for supplying a preheating current to the lamp so as to prevent a rush current in lighting the lamp. The circuit in Figure 6 includes a diode D_1 for suppressing a counter-electromotive voltage produced when the relay is in the OFF-state.

CURRENT MONITORING CIRCUIT

The current monitoring circuit shown in Figure 7 is designed to detect and indicate leak current in a circuit using a photocoupler. The LED indicator lights off if the leak current exceeds the V_F/R_1 value.

PHOTOCOUPLER APPLICATION FIELDS

Table 1 summarizes the industrial applications of the photocoupler.

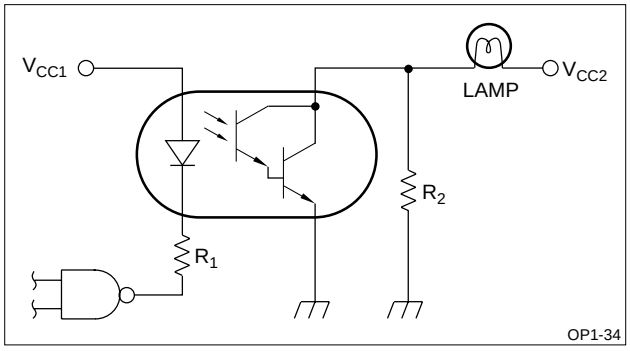


Figure 5. Lamp Driving Circuit

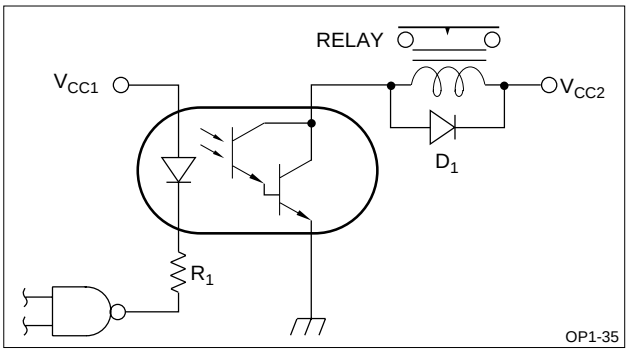


Figure 6. Relay Driving Circuit

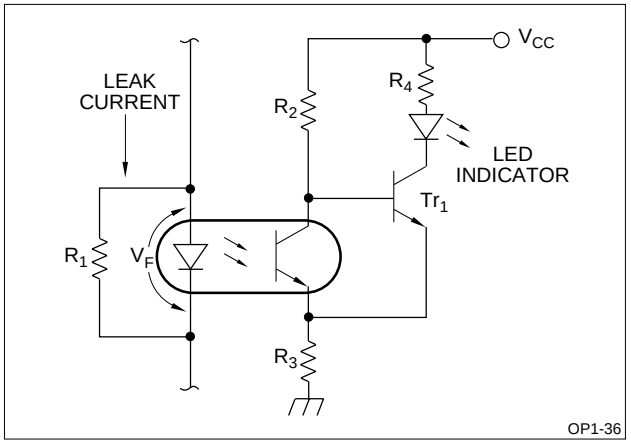


Figure 7. Current Monitoring Circuit

Table 1. Photocoupler Application Fields

FIELD	EQUIPMENT	APPLICATIONS
Computer Peripheral	Computer peripherals and I/O units	Interface circuit between computer and peripheral
		Battery backup circuit
Control equipment	Programmable controllers, numerical control machines	Isolation circuit in input unit
		Contact input circuit for small signal
		Isolation of signal transmission system
		Servo motor control circuit
	Power control, distribution card	Current monitoring circuit
		Contact input circuit
		Noise protection circuit
		AC power line monitoring circuit
		Ground isolation
	Elevator, auto-door	Isolation of signal transmission system
		Auto-door control circuit
	Others	Self-hold switch circuit
		Lamp and relay driving system
Instrument	Measuring, testing instruments	Isolation of signal transmission system (line driver, line receiver)
		I/O isolation of isolation amplifier
		Inductive noise protection circuit
		Level conversion circuit
Office equipment	Copiers, facsimiles	Ground isolation
		Power circuit (primary-secondary isolation)
	Printers	High voltage control circuit of electrostatic printer
		Printer drive circuit
		I/O interface
Automatic vendors		I/O interface
		Commodity/ticket selection circuit
Home appliances	Television sets	Audio multiplexing circuit isolation
		R-G-B signal interface
		Power circuit
	Electronic sewing machines	Motor control circuit
	Microwave oven, room heaters	Ground isolation
		I/O interface
	Air conditioners	Inverter control base amplifier circuit
		Over-current detection circuit
Audio equipment	Players, cassette tape recorders	Power circuit (primary-secondary isolation)
		Isolation of signal transmission system
Telephone system	Telephone sets	Dial pulse monitoring circuit
		Ring signal counter circuit
		Chiming circuit
		Modem switching circuit
	Exchangers	Subscriber line/control system separation
Power supply unit	Switching regulators	Pulse width modulation circuit
		Feedback circuit
		Isolation between primary and secondary

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