PC928

Shortcircuit Protector Circuit Built-in OPIC Photocoupler Suitable for Inverter-Driving IGBT

❋ TÜV (VDE 0884) approved type is also available as an option.

■ Features

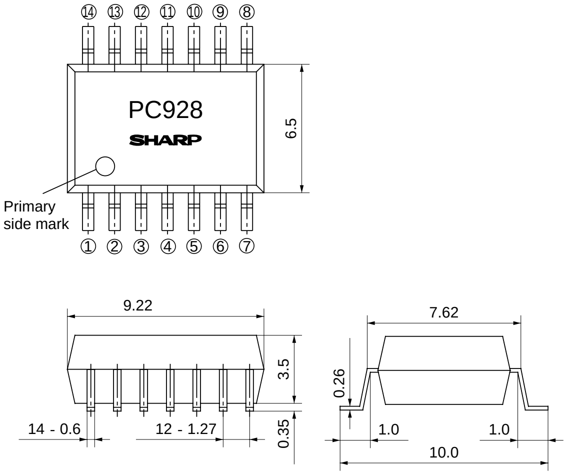
1. Built-in IGBT shortcircuit protector circuit
2. Built-in direct drive circuit for IGBT drive (Peak output current ... I_{O1P}, I_{O2P} : MAX. 0.4A)
3. High isolation voltage (V_{iso} : 4 000V_{rms})
4. Half lead pin pitch (p=1.27 mm) package type
5. Recognized by UL, file NO. E64380

■ Application

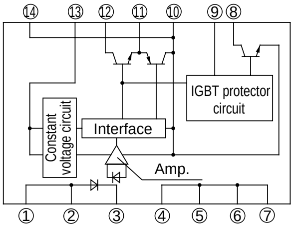
1. IGBT control for inverter drive

■ Outline Dimensions

(Unit : mm)



Internal connection diagram



①	Anode	⑧	FS
②	Anode	⑨	C
③	Cathode	⑩	GND
④	NC	⑪	O_2
⑤	NC	⑫	O_1
⑥	NC	⑬	V_{CC}
⑦	NC	⑭	GND

Terminals ④ to ⑦ : Shortcircuit in element

* "OPIC" (Optical IC) is a trademark of the SHARP Corporation. An OPIC consists of a light-detecting element and signal processing circuit integrated onto a single chip.

Operation truth table is shown on the next page.

■ Absolute Maximum Ratings

(Ta=Topr unless otherwise specified)

	Parameter	Symbol	Rating	Unit
Input	*1 Forward current	I_F	25	mA
	Reverse voltage	V_R	6 (T_a= 25˚C)	V
Output	Supply voltage	V_{CC}	35	V
	O_1 output current	I_{O1}	0.1	A
	*4 O_1 peak output current	I_{O1P}	0.4	A
	O_2 output current	I_{O2}	0.1	A
	*4 O_2 peak output current	I_{O2P}	0.4	A
	O_1 output voltage	V_{O1}	35	V
	*2 Power dissipation	P_O	500	mW
	Overcurrent detecting voltage	V_C	V_{CC}	V
	Overcurrent detecting current	I_C	30	mA
	Error signal output voltage	V_{FS}	V_{CC}	V
	Error signal output current	I_{FS}	20	mA
*3 Total power dissipation		P_{tot}	550	mW
*5 Isolation voltage		V_{iso}	4 000	Vrms
Operating temperature		T_{opr}	- 25 to + 80	˚C
Storage temperature		T_{stg}	- 55 to + 125	˚C
Soldering temperature		T_{sol}	260 (for 10 sec)	˚C

*1, 2, 3 Decrease in the ambient temperature range of the Absolute Max. Rating : Shown in Figs. 1 and 2.
*4 Pulse width<=0.15 µs, Duty ratio=0.01
*5 40 to 60% RH, AC for 1 minute, Ta=25˚C

■ Electro-optical Characteristics (1)

(Ta=Topr unless otherwise specified)

Parameter		Symbol	Conditions	MIN.	TYP.	MAX.	Unit	Test circuit
Input	Forward voltage	V_{F1}	T_a = 25˚C, I_F = 20mA	-	1.2	1.4	V	-
		V_{F2}	T_a = 25˚C, I_F = 0.2mA	0.6	0.9	-	V	-
	Reverse current	I_R	T_a = 25˚C, V_R = 4V	-	-	10	μ A	-
	Terminal capacitance	C_t	T_a = 25˚C, V = 0, f = 1kHz	-	30	250	pF	-
Output	Operating supply voltage	V_{CC}	T_a = - 10 to 60˚C	15	-	30	V	-
			-	15	-	24	V	
	O_1 low level output voltage	V_{O1L}	V_{CC1} = 12V, V_{CC2} = - 12V I_{O1} = 0.1A, I_F = 10mA *8	-	0.2	0.4	V	(1)
	O_2 high level output voltage	V_{O2H}	V_{CC} = V_{O1} = 24V, I_{O2} = - 0.1A I_F = 10mA *8	20	22	-	V	(2)
	O_2 low level output voltage	V_{O2L}	V_{CC} = V_{O1} = 24V, I_{O2} = 0.1A, I_F = 0mA *8	-	1.2	2.0	V	(3)
	O_1 leak current	I_{O1L}	T_a = 25˚C, V_{CC} = V_{O1} = 35V, I_F = 0mA *8	-	-	500	μ A	(4)
	High level supply current	I_{CCH}	T_a = 25˚C, V_{CC} = V_{O1} = 24V, I_F = 10mA *8	-	10	17	mA	(6)
			V_{CC} = V_{O1} = 24V, I_F = 10mA *8	-	-	19	mA	
	Low level supply current	I_{CCL}	T_a = 25˚C, V_{CC} = V_{O1} = 24V, I_F = 0mA *8	-	11	18	mA	
			V_{CC} = V_{O1} = 24V, I_F = 0mA *8	-	-	20	mA	
Transfer characteristics	*7 "Low→High" threshold input current	I_{FLH}	T_a = 25˚C, V_{CC} = V_{O1} = 24V *8	1.0	4.0	7.0	mA	(5)
			V_{CC} = V_{O1} = 24V *8	0.6	-	10	mA	
	Isolation resistance	R_{ISO}	T_a = 25˚C, DC500V, 40 to 60% RH	5×10^{10}	1×10^{11}	-	Ω	-
	Response time: "Low→High" propagation delay time	t_{PLH}	T_a = 25˚C, V_{CC} = V_{O1} = 24V R_G = 47Ω , C_G = 3 000pF, I_F = 10mA *8	-	1.0	2.0	μ s	(8)
	Response time: "High→Low" propagation delay time	t_{PHL}		-	1.0	2.0	μ s	
	Response time: Rise time	t_r		-	0.2	0.5	μ s	
	Response time: Fall time	t_f		-	0.2	0.5	μ s	
	Instantaneous common mode rejection voltage "Output : High level"	CM_H	T_a = 25˚C, V_{CC} = V_{O1} = 24V, I_F = 10mA V_{CM} = 600V(peak), Δ V_{O2H} = 2.0V *8	- 1 500	-	-	V/ μ s	(7)
	Instantaneous common mode rejection voltage "Output : Low level"	CM_L	T_a = 25˚C, V_{CC} = V_{O1} = 24V, I_F = 0mA V_{CM} = 600V(peak), Δ V_{O2L} = 2.0V *8	1 500	-	-	V/ μ s	

*6 When measuring output and transfer characteristics, connect a bypass capacitor (0.01 μ F or more) between Vcc 13 and GND 14 near the device.
*7 I_{FLH} represents forward current when O_2 output goes from "Low" to "High".
*8 FS=OPEN, V_C =0V

■ Truth Table

Input	C Input/output	O_2 Output	FS Output	
ON	Low level	High level	High level	
	High level	Low level	Low level	For protective operation
OFF	Low level	Low level	High level	
	High level	Low level	High level	

■ Electro-optical Characteristics (2)

(Ta=Topr unless otherwise specified)

	Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit	Test circuit
*9 Overcurrent detection	*10 Overcurrent detecting voltage	V_{CTH}	T_a = 25˚C, I_F = 10mA, V_{CC} = V_{O1} = 24V, R_G = 47Ω, C_G = 3 000pF, FS = OPEN	V_{CC} - 6.5	V_{CC} - 6.0	V_{CC} - 5.5	V	(9)
	Overcurrent detecting voltage hysteresis width	V_{CHIS}		1	2	3	V	
*9 Protective output	O_2 "High→Low" delay time at protection from overcurrent	t_{PCOHL}	T_a = 25˚C, V_{CC} = V_{O1} = 24V, I_F = 10mA, C_G = 3 000pF, R_G = 47Ω, C_P = 1 000pF, R_C = 1kΩ, FS = OPEN	-	4	10	μs	(13)
	O_2 fall time at protection from overcurrent	t_{PCOtf}		2	5	-	μs	
	O_2 output voltage at protection from overcurrent	V_{OE}		-	-	2	V	(10)
*9 Error signal output	Low level error signal voltage	V_{FSL}	T_a = 25˚C, I_F = 10mA, I_{FS} = 10mA, V_{CC} = V_{O1} = 24V, R_G = 47Ω, C_G = 3 000pF, C = OPEN	-	0.2	0.4	V	(11)
	High level error signal current	I_{FSH}	T_a = 25˚C, I_F = 10mA, V_{FS} = 24V, V_{CC} = V_{O1} = 24V, R_G = 47Ω, C_G = 3 000pF, V_C = 0V	-	-	100	μA	(12)
	Error signal "High→Low" delay time	t_{PCFHL}	T_a = 25˚C, R_{FS} = 1.8kΩ, V_{CC} = V_{O1} = 24V, I_F = 10mA, C_G = 3 000pF, R_G = 47Ω, C_P = 1 000pF, R_C = 1kΩ	-	1	5	μs	(14)
	Error signal output pulse width	Δt_{FS}		20	35	-	μs	

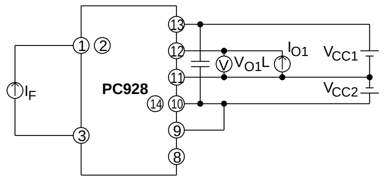
*9 When measuring overcurrent, protective output and error signal output characteristics, connect a bypass capacitor (0.01μF or more) between V_{CC} (13) and GND (14) near the device.
*10 V_{CTH} represents C-terminal voltage when O_2 output goes from "High" to "Low".

Precautions for Operation

1. It is recommended that a capacitor of about 1000pF is added between C-terminal and GND in order to prevent malfunction of C-terminal due to noise. In the case of capacitor added, rise of the detecting voltage is delayed. Thus, use together a resistance of about 1kΩ set between V_{CC} and C-terminal.
   The C-terminal rise time varies with the time constant of CR added. Make it clear before use.
2. The light-detecting element used for this product is provided with a parasitic diode between each terminal and GND. When a terminal happens to reach electric potential lower than GND potential even in a moment, malfunction or rupture may result. Design the circuit so that each terminal will be kept at electric potential lower than the GND potential at all times.

■ Test Circuit Diagram

(1)



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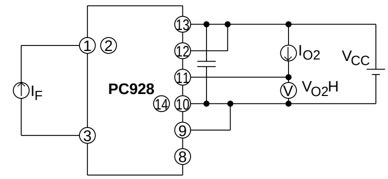

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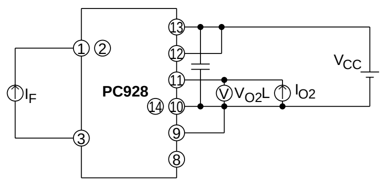

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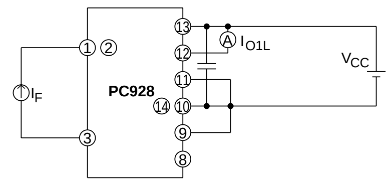

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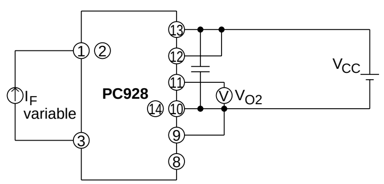

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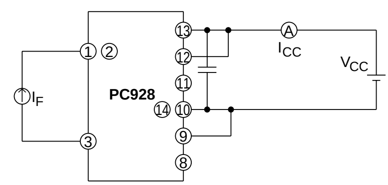

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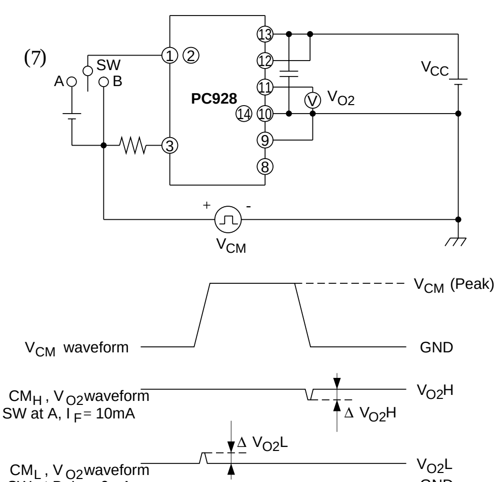

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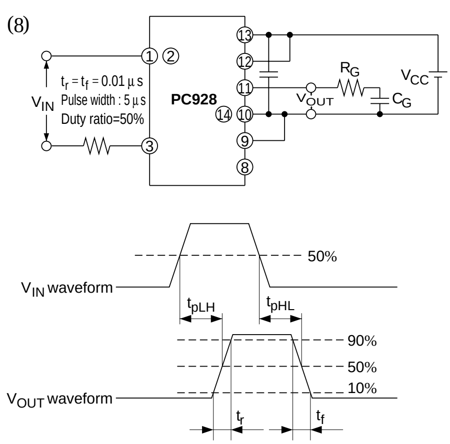

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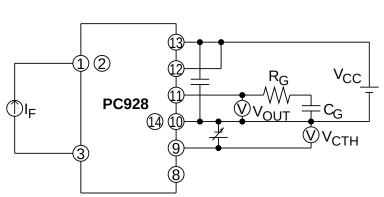

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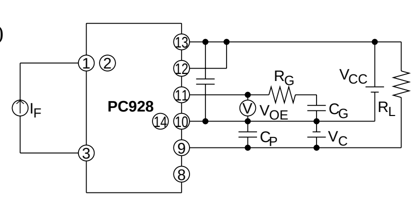
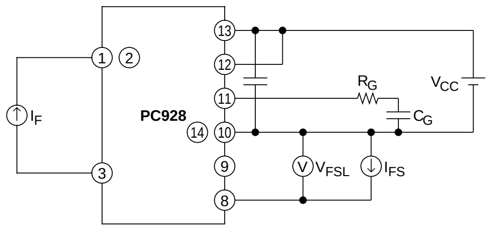


■ Test Circuit Diagram

(11)



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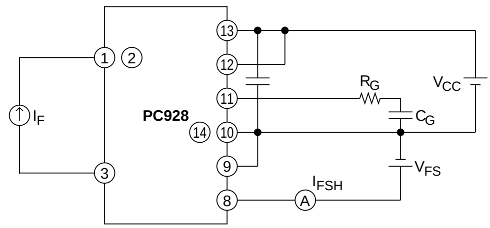

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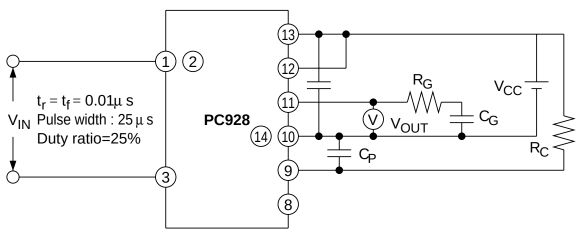

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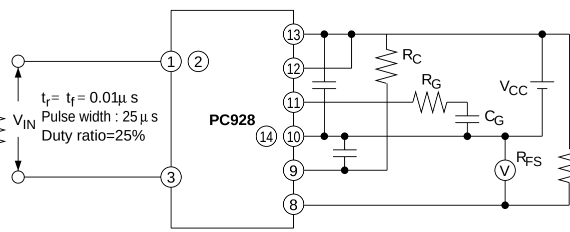


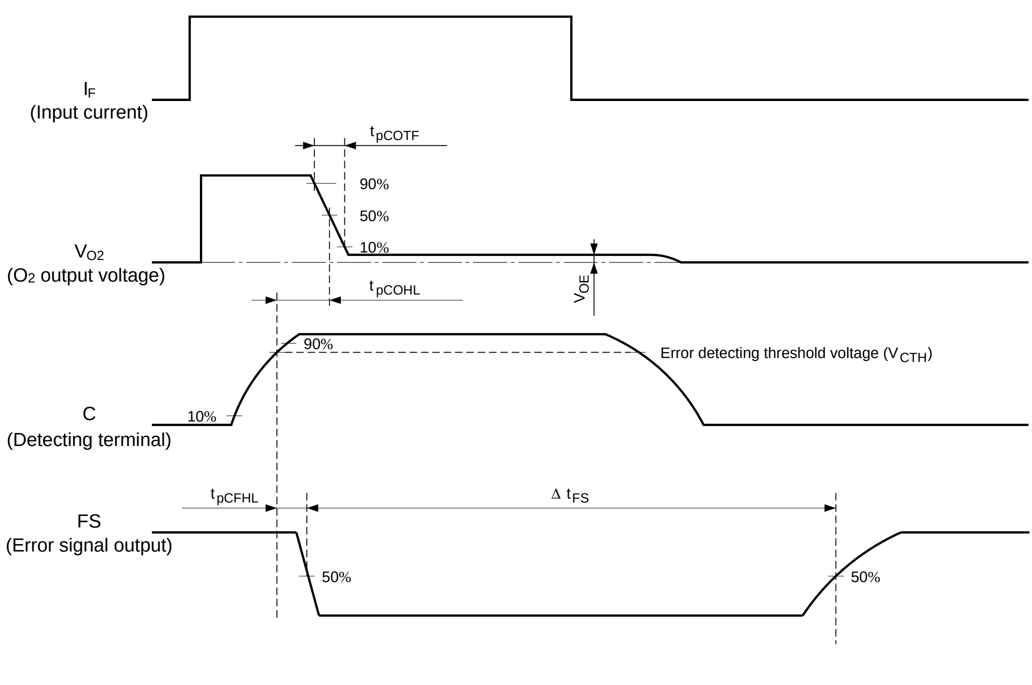


Fig. 1 Forward Current vs. Ambient Temperature

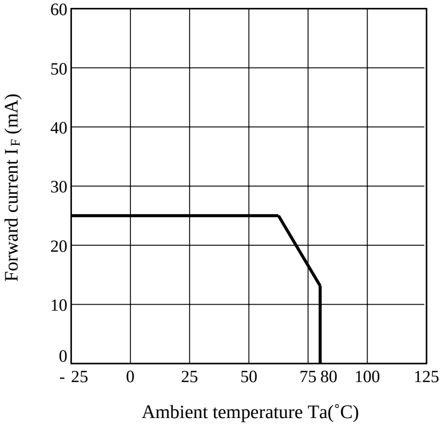


Fig. 2 Power Dissipation vs. Ambient Temperature

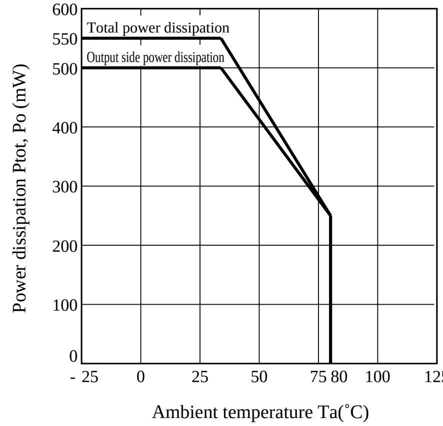


Fig. 3 Forward Current vs. Forward Voltage

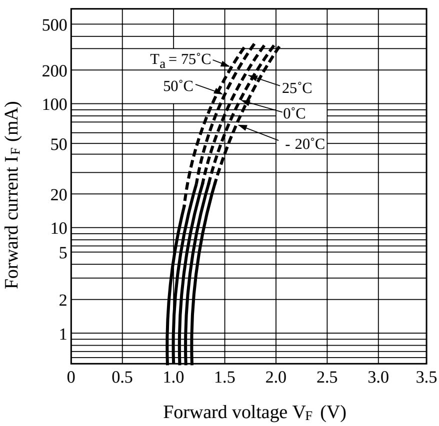


Fig. 4 "L-H" Relative Threshold Input Current vs. Supply Voltage

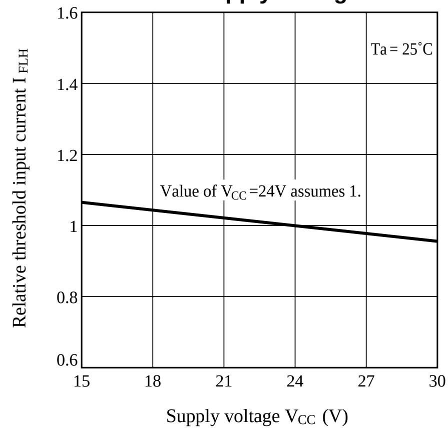


Fig. 5 "L-H" Relative Threshold Input Current vs. Ambient Temperature

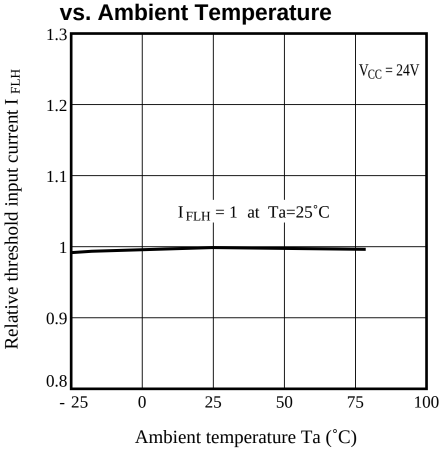


Fig. 6 O_1 Low Level Output Voltage vs. O_1 Output Current

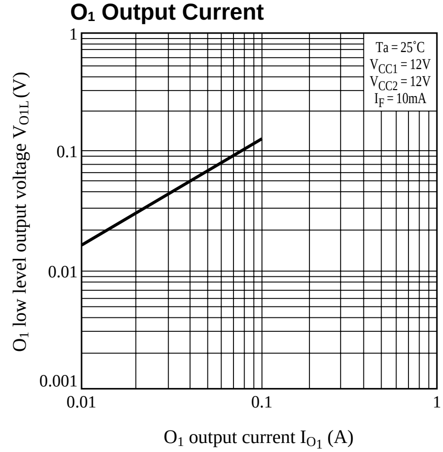


Fig. 7 O_1 Low Level Output Voltage vs. Ambient Temperature

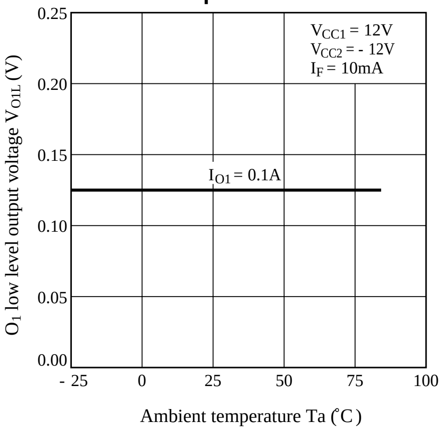


Fig. 8 O_1 Leak Current vs. Ambient Temperature

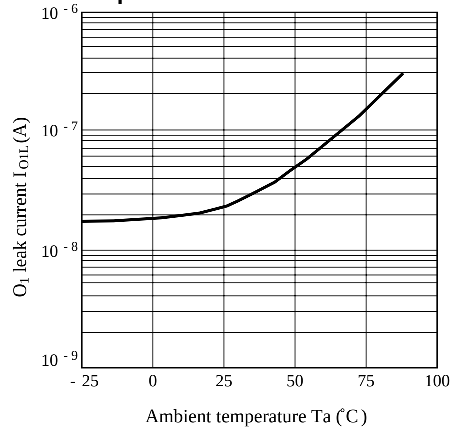


Fig. 9 O_2 High Level Output Voltage vs. Supply Voltage

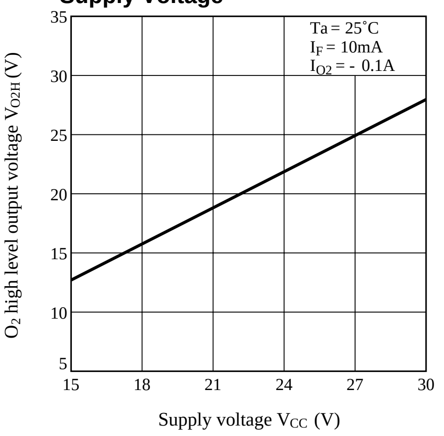


Fig. 10 O_2 High Level Output Voltage vs. Ambient Temperature

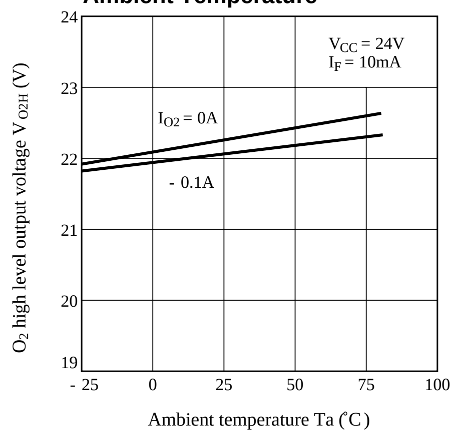


Fig. 11 O_2 Low Level Output Voltage vs. Output Current

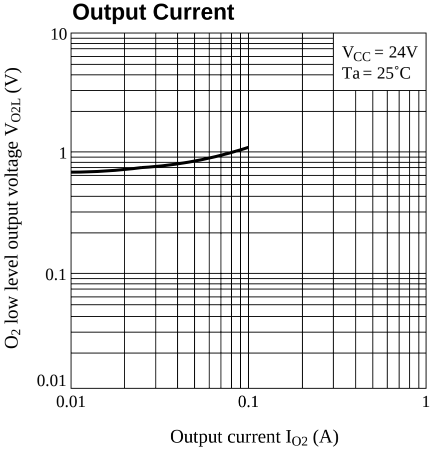


Fig. 12 O_2 Low Level Output Voltage vs. Ambient Temperature

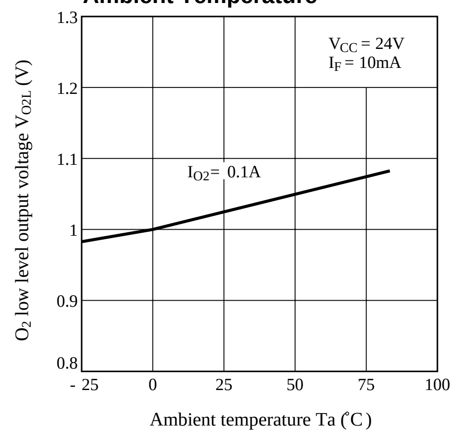


Fig. 13 High Level Supply Current vs. Supply Voltage

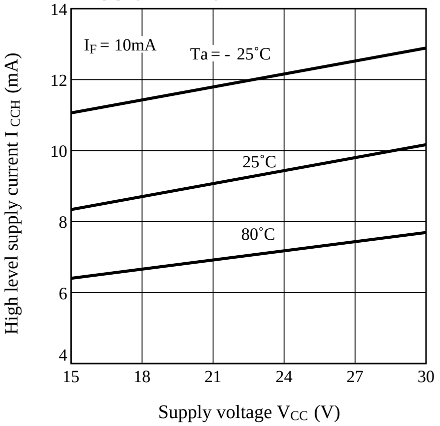


Fig. 14 Low Level Supply Current vs. Supply Voltage

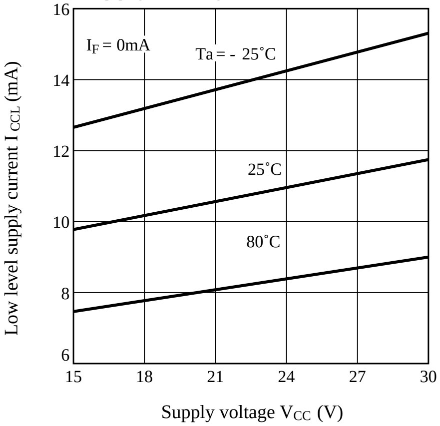


Fig. 15 Propagation Delay Time vs. Forward Current

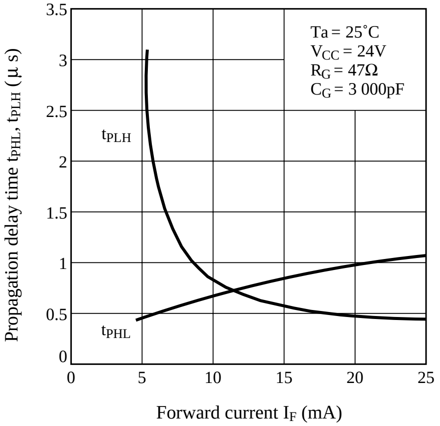


Fig. 16 Propagation Delay Time vs. Ambient Temperature

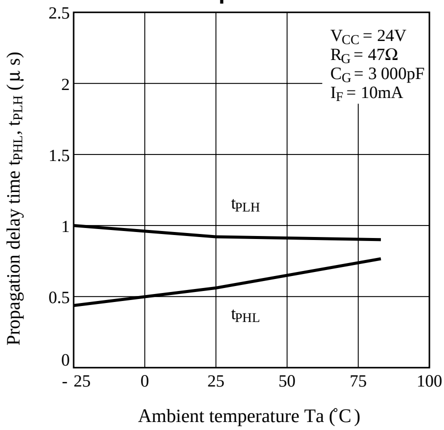


Fig. 17 Overcurrent Detecting Voltage vs. Ambient Temperature

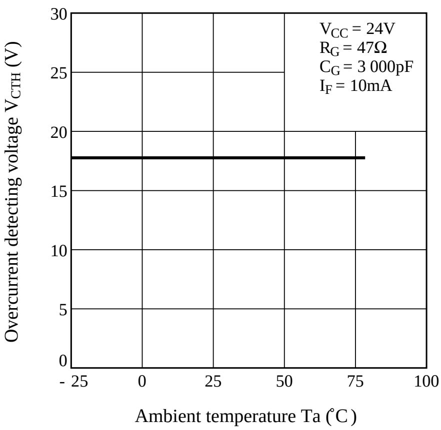


Fig. 18 O_2 Output Fall Time at Protection from Overcurrent/O_2 "H-L" Delay Time at Protection from Overcurrent vs. Ambient temperature

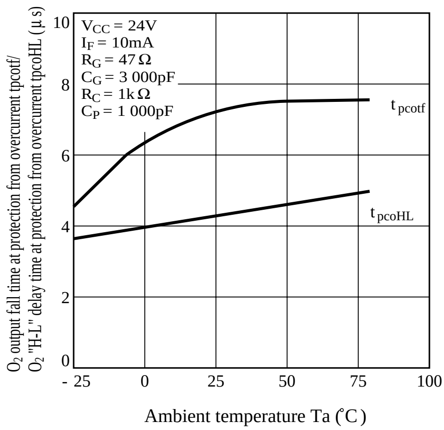


Fig. 19 Error Signal "H-L" Delay Time vs. Ambient Temperature

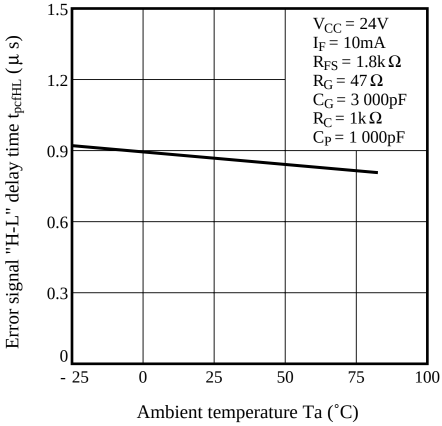


Fig. 20 O_2 Output Voltage at Protection from Overcurrent vs. Ambient Temperature

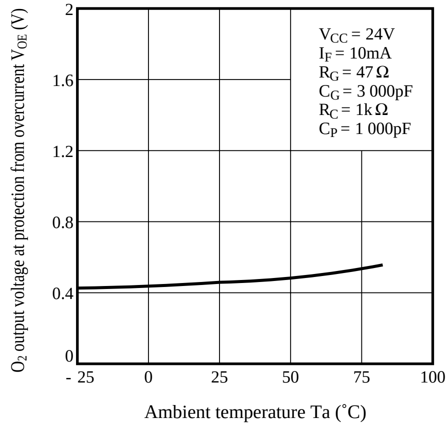


Fig. 21 Low Level Error Signal Voltage vs. Ambient Temperature

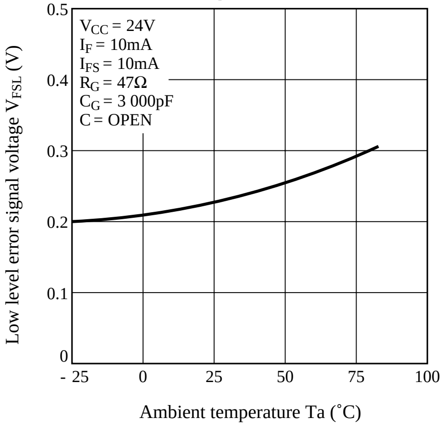


Fig. 22 High Level Error Signal Current vs. Ambient Temperature

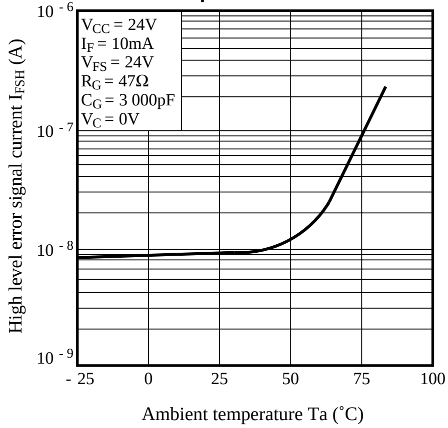


Fig. 23 Error Signal Output Pulse Width vs. Ambient Temperature

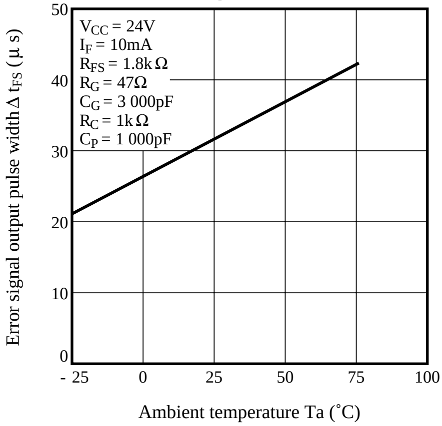
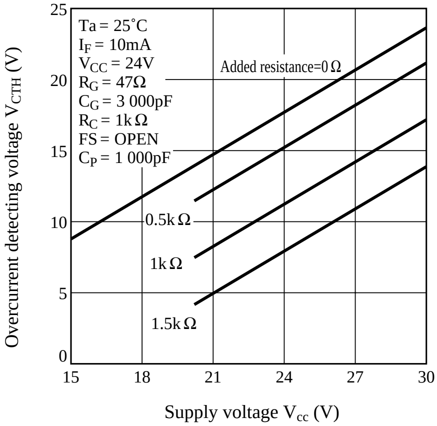
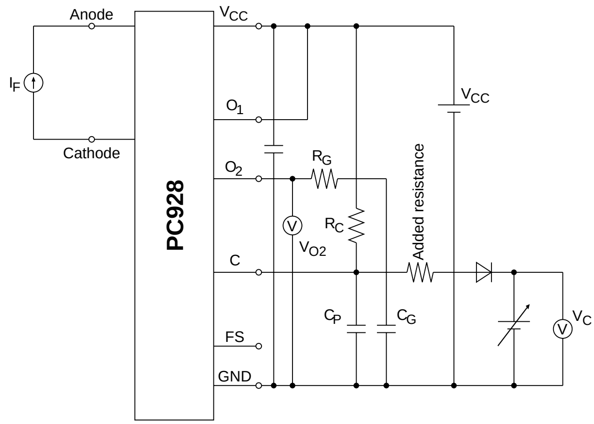


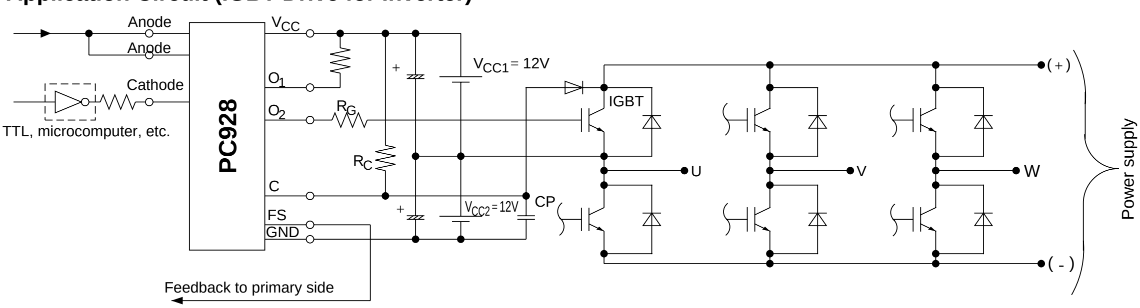
Fig. 24 Overcurrent Detecting Voltage vs. Supply Voltage



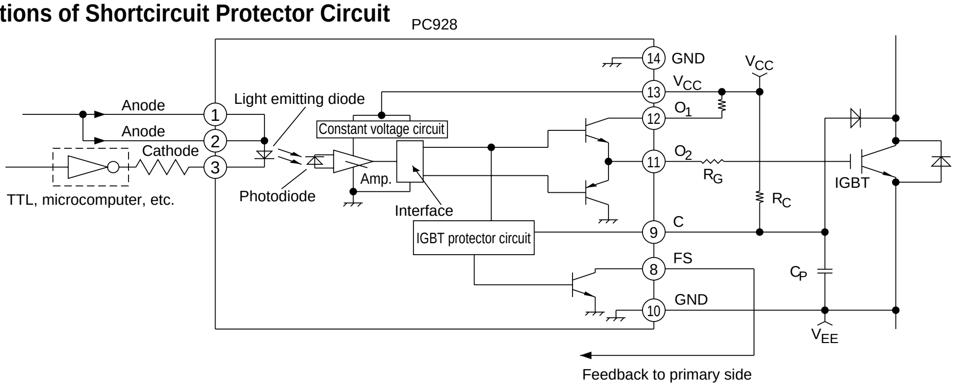
Overcurrent Detecting Voltage - Supply Voltage Characteristics Test Circuit



Application Circuit (IGBT Drive for Inverter)



■ Operations of Shortcircuit Protector Circuit



1. Detection of increase in $V_{CE(sat)}$ of IGBT due to overcurrent by means of C-terminal (9 terminal)
2. Reduction of the IGBT gate voltage, and suppression of the collector current
3. Simultaneous issue of signals to indicate the shortcircuit condition (FS signal) from FS terminal to the microcomputer
4. Judgement and processing by the microcomputer → In the case of instantaneous shortcircuit, run continues.
   → At fault, input to the photocoupler is cut off, and IGBT is turned OFF.