

# PC929

## Shortcircuit Protector Circuit Built-in Photocoupler Suitable for Inverter-Driving MOS-FET/IGBT

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

### ■ Features

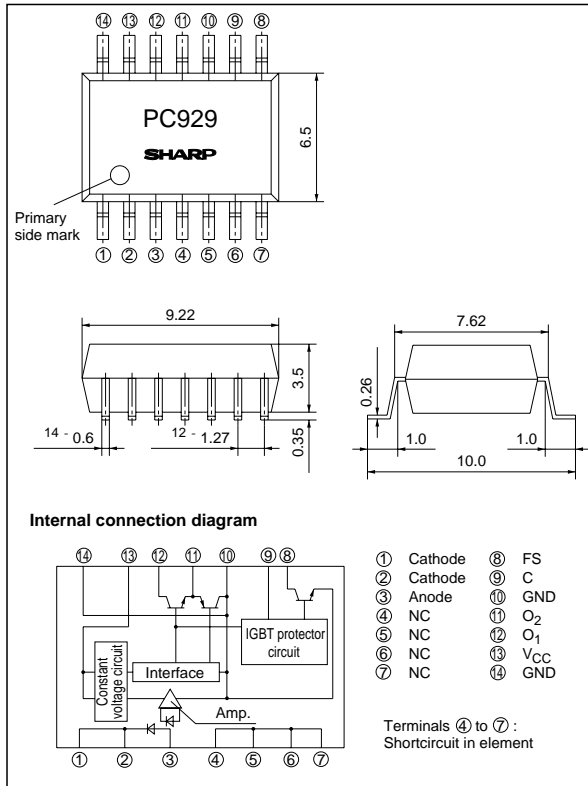
1. Built-in IGBT shortcircuit protector circuit
2. Built-in direct drive circuit for IGBT drive  
(Peak output current ...  $I_{O1P}$ ,  $I_{O2P}$  : MAX. 0.4A)
3. High speed response ( $t_{PLH}$ ,  $t_{PHL}$  : MAX. 0.5  $\mu$ s)
4. High isolation voltage ( $V_{iso}$  : 4000V<sub>rms</sub>)
5. Half lead pin pitch (p=1.27 mm) package type
6. Recognized by UL, file NO. E64380

### ■ Application

1. IGBT control for inverter drive

### ■ Outline Dimensions

(Unit : mm)



### ■ Absolute Maximum Ratings

(Ta=Topr unless otherwise specified)

|        | Parameter  | Symbol    | Rating           | Unit |
|--------|--|-----------|------------------|------|
| Input  | <sup>*1</sup> Forward current                    | $I_F$     | 20               | mA   |
|        | Reverse voltage                                  | $V_R$     | 6 (Ta = 25°C)    | V    |
|        | Supply voltage                                   | $V_{CC}$  | 35               | V    |
|        | O <sub>1</sub> output current                    | $I_{O1}$  | 0.1              | A    |
| Output | <sup>*4</sup> O <sub>1</sub> peak output current | $I_{O1P}$ | 0.4              | A    |
|        | O <sub>2</sub> output current                    | $I_{O2}$  | 0.1              | A    |
|        | <sup>*4</sup> O <sub>2</sub> peak output current | $I_{O2P}$ | 0.4              | A    |
|        | O <sub>1</sub> output voltage                    | $V_{O1}$  | 35               | V    |
|        | <sup>*2</sup> 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   |
|        | <sup>*3</sup> Total power dissipation            | $P_{tot}$ | 550              | mW   |
|        | <sup>*5</sup> 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   |

<sup>\*1</sup> 1, 2, 3 Decrease in the ambient temperature range of the Absolute Max. Rating : Shown in Figs 1 and 2.

<sup>\*4</sup> Pulse width  $\leq 0.15 \mu$ s, Duty ratio=0.01

<sup>\*5</sup> 40 to 60% RH, AC for 1 minute, Ta=25°C

\* "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.

# **Electro-optical Characteristics (1)**

(Ta=Topr unless otherwise specified)

| Parameter                |   | Symbol                            | Conditions  | MIN.                 | TYP.                 | MAX. | Unit | Measuring circuit |
|--------------------------|---|-----------------------------------|---|----------------------|----------------------|------|------|-------------------|
| Input                    | Forward voltage   | V <sub>F1</sub>                   | T <sub>a</sub> = 25°C, I <sub>F</sub> = 10mA  | -                    | 1.6                  | 1.75 | V    | -                 |
|                          |   | V <sub>F2</sub>                   | T <sub>a</sub> = 25°C, I <sub>F</sub> = 0.2mA   | 1.2                  | 1.5                  | -    | V    | -                 |
|                          | Reverse current   | I <sub>R</sub>                    | T <sub>a</sub> = 25°C, V <sub>R</sub> = 5V  | -                    | -                    | 10   | μA   | -                 |
|                          | Terminal capacitance  | C <sub>t</sub>                    | T <sub>a</sub> = 25°C, V = 0, f = 1kHz  | -                    | 30                   | 250  | pF   | -                 |
| Output                   | Operating supply voltage  | V <sub>CC</sub>                   | T <sub>a</sub> = -10 to 60°C  | 15                   | -                    | 30   | V    | -                 |
|                          |   |                                   | -   | 15                   | -                    | 24   | V    |                   |
|                          | O <sub>1</sub> low level output voltage                           | V <sub>O1L</sub>                  | V <sub>CC1</sub> = 12V, V <sub>CC2</sub> = -12V<br>I <sub>O1</sub> = 0.1A, I <sub>F</sub> = 5mA *8  | -                    | 0.2                  | 0.4  | V    | (1)               |
|                          | O <sub>2</sub> high level output voltage                          | V <sub>O2H</sub>                  | V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>O2</sub> = -0.1A<br>I <sub>F</sub> = 5mA *8   | 20                   | 22                   | -    | V    | (2)               |
|                          | O <sub>2</sub> low level output voltage                           | V <sub>O2L</sub>                  | V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>O2</sub> = 0.1A, I <sub>F</sub> = 0mA *8  | -                    | 1.2                  | 2.0  | V    | (3)               |
|                          | O leak current  | V <sub>O1L</sub>                  | T <sub>a</sub> = 25°C, V <sub>CC</sub> = V <sub>O1</sub> = 35V, I <sub>F</sub> = 0mA *8   | -                    | -                    | 500  | μA   | (4)               |
|                          | High level supply current   | I <sub>CCH</sub>                  | T <sub>a</sub> = 25°C, V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 5mA *8   | -                    | 10                   | 17   | mA   | (6)               |
|                          |   |                                   | V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 5mA *8  | -                    | -                    | 19   | mA   |                   |
|                          | Low level supply current  | I <sub>CCL</sub>                  | T <sub>a</sub> = 25°C, V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 0mA *8   | -                    | 11                   | 18   | mA   |                   |
|                          |   |                                   | V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 0mA *8  | -                    | -                    | 20   | mA   |                   |
| Transfer characteristics | *7 "Low→High" threshold input current                             | I <sub>FLH</sub>                  | T <sub>a</sub> = 25°C, V <sub>CC</sub> = V <sub>O1</sub> = 24V *8   | 0.3                  | 1.5                  | 3.0  | mA   | (5)               |
|                          |   |                                   | V <sub>CC</sub> = V <sub>O1</sub> = 24V *8  | 0.2                  | -                    | 5.0  | mA   |                   |
|                          | Isolation resistance  | R <sub>ISO</sub>                  | T <sub>a</sub> = 25°C, DC500V, 40 to 60% RH   | 5 × 10 <sup>10</sup> | 1 × 10 <sup>11</sup> | -    | Ω    | -                 |
|                          | Response time   | "Low→High" propagation delay time | T <sub>a</sub> = 25°C, V <sub>CC</sub> = V <sub>O1</sub> = 24V<br>R <sub>G</sub> = 47Ω, C <sub>G</sub> = 3 000pF, I <sub>F</sub> = 5mA *8         | -                    | 0.3                  | 0.5  | μs   | (8)               |
|                          |   | "High→Low" propagation delay time |   | -                    | 0.3                  | 0.5  | μs   |                   |
|                          |   | Rise time                         |   | -                    | 0.2                  | 0.5  | μs   |                   |
|                          |   | Fall time                         |   | -                    | 0.2                  | 0.5  | μs   |                   |
|                          | Instantaneous common mode rejection voltage "Output : High level" | CM <sub>H</sub>                   | T <sub>a</sub> = 25°C, V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 5mA<br>V <sub>CM</sub> = 600V(peak), ΔV <sub>O2H</sub> = 2.0V *8 | - 1 500              | -                    | -    | V/μs | (7)               |
|                          | Instantaneous common mode rejection voltage "Output : Low level"  | CM <sub>L</sub>                   | T <sub>a</sub> = 25°C, V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 0mA<br>V <sub>CM</sub> = 600V(peak), ΔV <sub>O2L</sub> = 2.0V *8 | 1 500                | -                    | -    | V/μs |                   |

\*6 When measuring output and transfer characteristics, connect a bypass capacitor (0.01 μF or more) between V<sub>CC</sub> (13) and GND (14) near the device.\*7 I<sub>FLH</sub> represents forward current when output goes from "Low" to "High".\*8 FS=OPEN, V<sub>C</sub>=0V

# **Truth Table**

| Input | C Input/Output | O <sub>2</sub> Output | FS Output  |                          |
|-------|----------------|-----------------------|------------|--------------------------|
| ON    | Low level      | High level            | High level | For protective operation |
|       | High level     | Low level             | Low level  |                          |
| 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                                   | *10 Overcurrent detecting voltage                                   | V <sub>CTH</sub>   | T <sub>a</sub> = 25°C, I <sub>F</sub> = 5mA<br>V <sub>CC</sub> = V <sub>O1</sub> = 24V, R <sub>G</sub> = 47Ω<br>C <sub>G</sub> = 3 000pF, FS = OPEN   | V <sub>CC</sub> - | V <sub>CC</sub> - | V <sub>CC</sub> - | V    | (9)          |
|                                      | Overcurrent detecting voltage hysteresis width                      | V <sub>CHIS</sub>  |   | 6.5               | 6.0               | 5.5               | V    |              |
| *9                                   | O <sub>2</sub> "High→Low" delay time at protection from overcurrent | t <sub>PCOHL</sub> | T <sub>a</sub> = 25°C<br>V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 5mA<br>C <sub>G</sub> = 3 000pF, R <sub>G</sub> = 47Ω<br>C <sub>P</sub> = 1 000pF, R <sub>C</sub> = 1kΩ<br>FS = OPEN             | -                 | 4                 | 10                | μ s  | (13)         |
|                                      | O <sub>2</sub> fall time at protection from overcurrent             | t <sub>PCOf</sub>  |   | 2                 | 5                 | -                 | μ s  |              |
|                                      | O <sub>2</sub> output voltage at protection from overcurrent        | V <sub>OE</sub>    |   | -                 | -                 | 2                 | V    | (10)         |
| *9                                   | Low level error signal voltage                                      | V <sub>FSL</sub>   | T <sub>a</sub> = 25°C, I <sub>F</sub> = 5mA, I <sub>FS</sub> = 10mA<br>V <sub>CC</sub> = V <sub>O1</sub> = 24V, R <sub>G</sub> = 47Ω, C <sub>G</sub> = 3 000pF, C = OPEN  | -                 | 0.2               | 0.4               | V    | (11)         |
|                                      | High level error signal current                                     | I <sub>FSH</sub>   | T <sub>a</sub> = 25°C, I <sub>F</sub> = 5mA, V <sub>FS</sub> = 24V<br>V <sub>CC</sub> = V <sub>O1</sub> = 24V, R <sub>G</sub> = 47Ω, C <sub>G</sub> = 3 000pF, V <sub>C</sub> = 0V                                  | -                 | -                 | 100               | μ A  | (12)         |
|                                      | Error signal "High→Low" delay time                                  | t <sub>PCFHL</sub> | T <sub>a</sub> = 25°C, R <sub>FS</sub> = 1.8kΩ<br>V <sub>CC</sub> = V <sub>O1</sub> = 24V, I <sub>F</sub> = 5mA<br>C <sub>G</sub> = 3 000pF, R <sub>G</sub> = 47Ω<br>C <sub>P</sub> = 1 000pF, R <sub>C</sub> = 1kΩ | -                 | 1                 | 5                 | μ s  | (14)         |
|                                      | Error signal output pulse width                                     | Δ t <sub>FS</sub>  |   | 20                | 35                | -                 | μ s  |              |

\*9 When measuring overcurrent, protective output and error signal output characteristics, connect a bypass capacitor (0.01 μ F or more) between V<sub>CC</sub> (13) and GND (14) near the device.

\*10 V<sub>CTH</sub> represents C-terminal voltage when O<sub>2</sub> output goes from "High" to "Low".

Fig. 1 Forward Current vs. Ambient Temperature

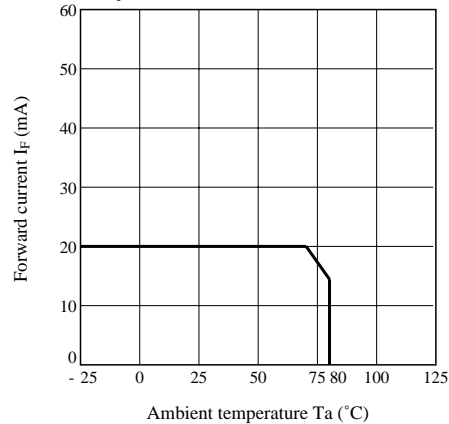
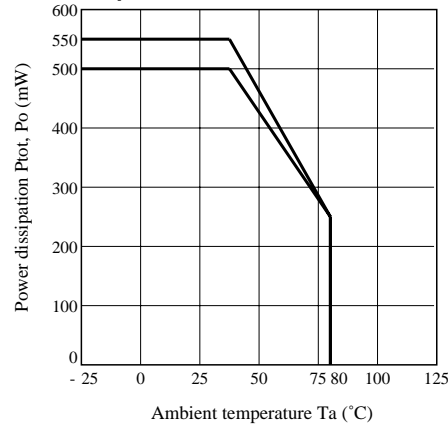
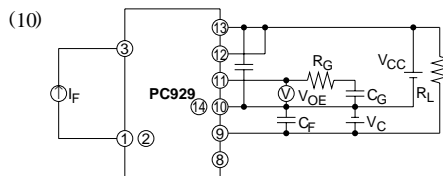
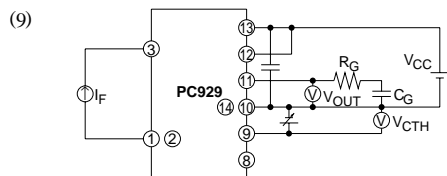
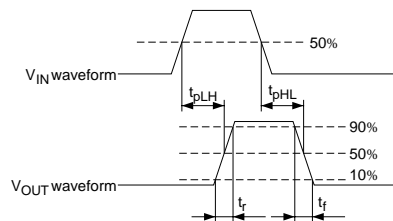
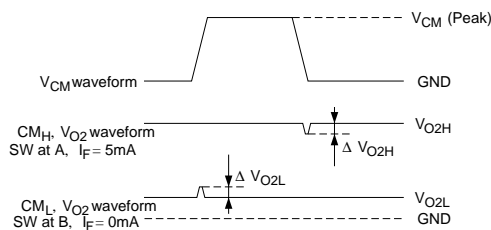
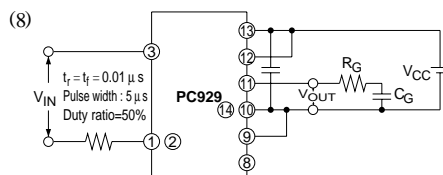
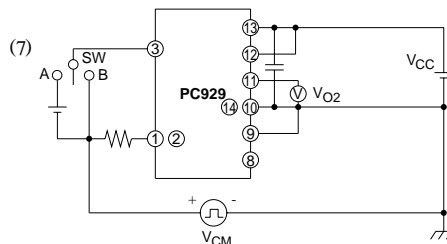
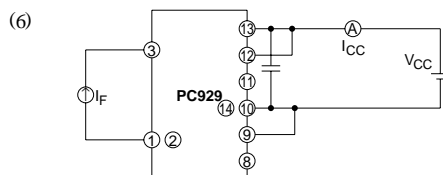
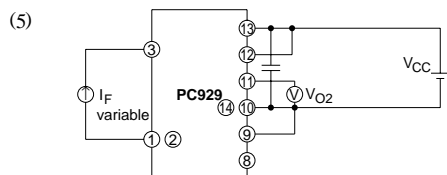
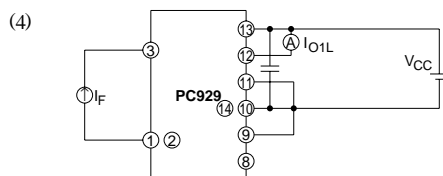
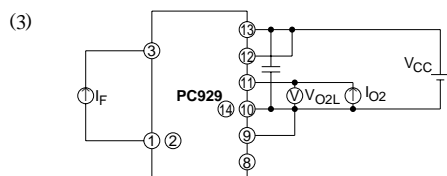
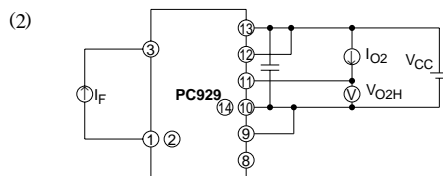
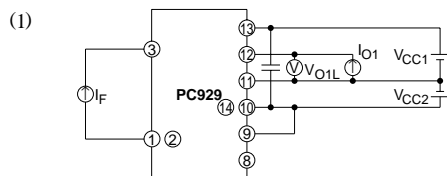


Fig. 2 Power Dissipation vs. Ambient Temperature

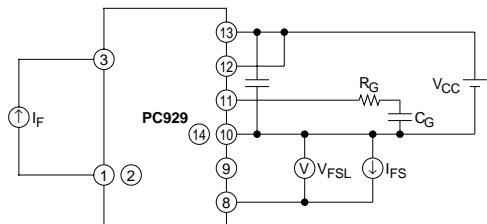


### ■ Test Circuit Diagram

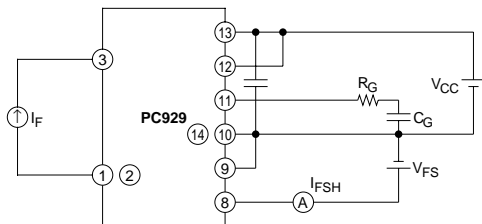


# Test Circuit Diagram

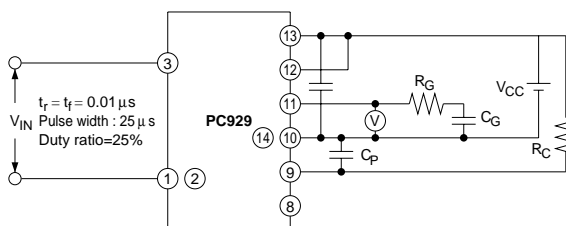
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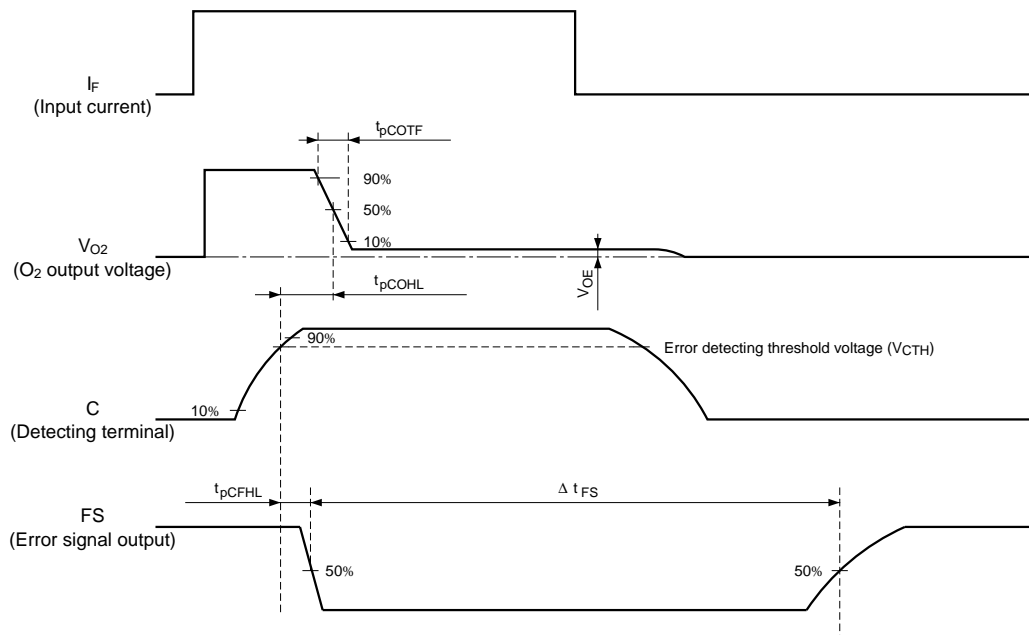
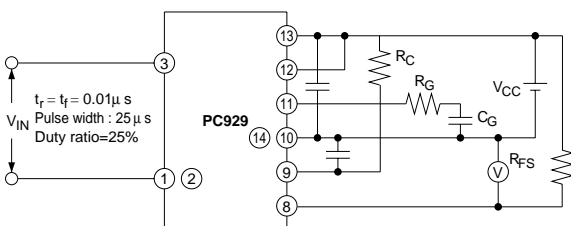
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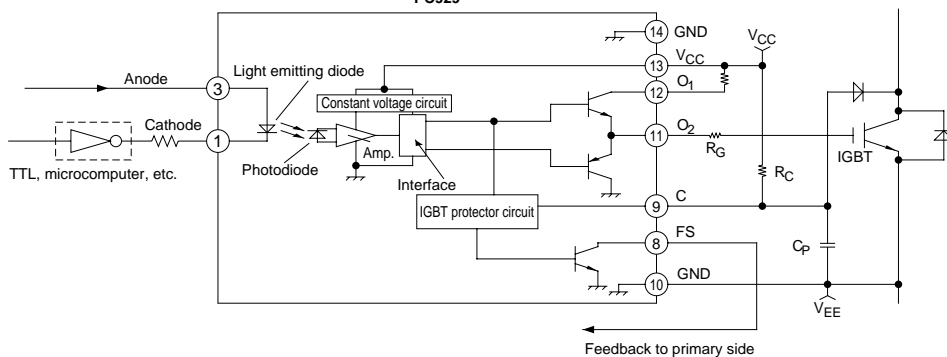
(13)

 $V_{OUT}$ 

(14)



PC929



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 output 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.

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<sub>CC</sub> and C-terminal.  
The C-terminal rise time varies with the time constant of CR added. Check sufficiently 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.

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