L12P025D15

Application Manual

▌Overview

L12P025D15 comprises "built-in coil, built-in bus bar and onboard" current sensor of the open-loop type.

▌ Characteristics

- Elongated structure and compact
- Built-in coil-type flow of the current to be measured.
- Open-loop-type circuit configuration.
- Onboard type
- Simple structure

Uses

· General-purpose inverter

· Motor drive

· Generator

■Format

L12P 025 D 15

Power-supply voltage 15: 15V

Power-supply type D: Dual power supply

Rated current value 025: 25A

Series name　L12P

■ Block diagram (±15V Dual power-supply type)

L12P025D015

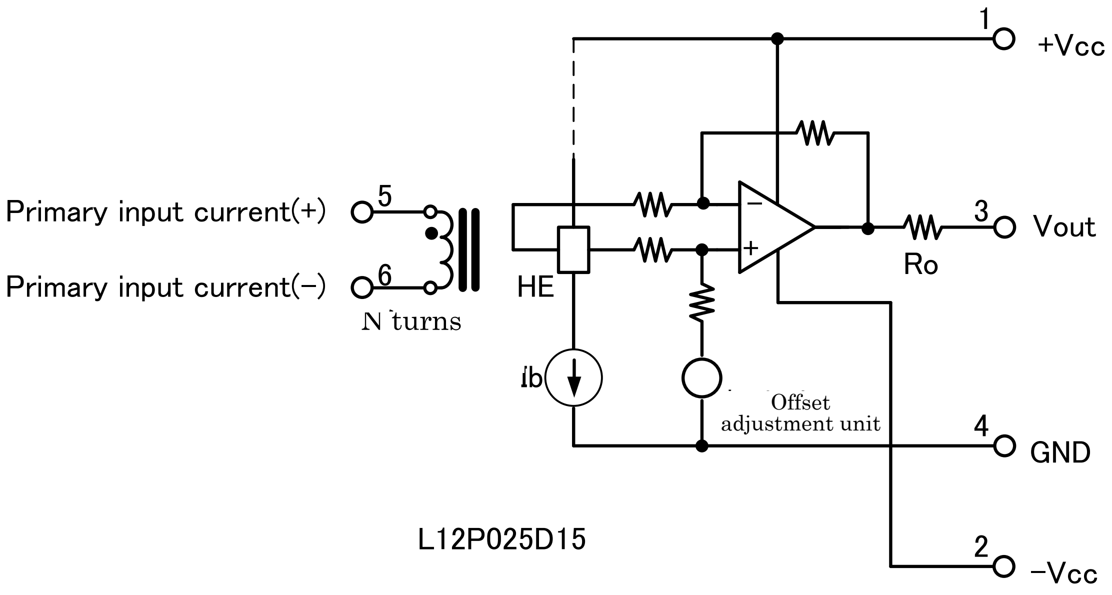


Fig. 1: L12P025D15 Internal block diagram

Table 1: L12P025D15 Description of terminals

Terminal number	Terminal name	Description	Remarks
1	+Vcc	Positive voltage terminal of power-supply voltage Apply +15V	
2	–Vcc	Negative voltage terminal of power-supply voltage Apply –15V	
3	Vout1	Output terminal	*
4	GND	GND terminal	
5	Primary current (+)	The plus terminal of the primary current (measured current) When the primary current flows through terminal (5) ⇒ (6), voltage with positive polarity is output to the output terminal (3).	
6	Primary current (–)	The minus terminal of the primary current (measured current)	

* The standard value of output voltage is

$Vout = G \times I + Vof$; $G \equiv \frac{4.0V}{If}$ If :Rated current Vof : Offset voltage

The standard value of the offset voltage is 0V.

L12P025D15 Description of operation

Current-detection unit

The current to be measured (primary input current) is passed through the built-in coil. The generated magnetic flux is focused by the core and applied to the magnetic-detection element (Hall element, HE).

The generated magnetic flux is proportional to the product (N×I) of the number of windings N of the built-in coil and the measured current I. The magnetic-detection element outputs a voltage proportional to the magnetic flux, i.e., provides an output voltage proportional to the current to the next-stage amplifier.

The current detection unit outputs the result without saturation up to current three times as large as the rated current. However, the linearity is guaranteed only up to the rated current. (See also "amplifier unit" for the saturation current.)

Amplifier unit

This block amplifies the output voltage of the magnetic-detection element. Because the output of the magnetic-detection element is of a differential type, the amplifier unit adopts the configuration of a differential amplifier. It outputs the differential output of the magnetic-detection element as the voltage based on the GND. It adopts a circuit configuration that is negligibly affected by fluctuations in the power-supply voltage, and other in-phase signals and can ensure accurate output. The amplifier unit has the maximum output voltage limited by the power-supply voltage. Therefore, the amplifier unit may be saturated even when the current-detection unit of the preceding stage is not. When using the power-supply voltage at ±15V, it can be used without saturation up to three times the rated current. When using the power-supply voltage at ±12 V, the range up to 2.5 times the rated current can be used without saturation.

Because the output voltage of the magnetic-detection element is determined by factors such as the rated current value and the number of windings of the built-in coil, the gain in each product is precisely adjusted in the factory.

Offset adjustment unit

The offset voltage serves as a reference of the output voltage and is given by the output voltage when the current to be measured is 0A. The standard value of the offset voltage is 0V in the case of the current sensor with the dual power supply. Possible deviation in the plus or minus direction owing to an initial deviation and temperature variations should be considered. (Please refer to the specifications table.)

The main origin of the deviation of the offset voltage from the standard value lies in the fact that the Hall element, HE, which is a magnetic sensing element, has an offset voltage. The offset voltage of the Hall element refers to the voltage output from the Hall element, which is minute but nonzero even in the absence of applied magnetic flux. A certain deviation of the offset voltage can arise in the amplifier unit instead of the Hall element. The offset adjustment unit has already been controlled in the factory in such a way that these offsets are globally canceled and fall within a predetermined range of deviation.

Coil unit

In the built-in coil, the number of windings is increased corresponding to the rated current in such a way that accurate measurement can be made even for small current.

The electric wire of the coil consists of two ϕ1.4.

This unit generates heat due to copper loss (loss due to the coil resistance) and iron loss (loss of core) in the presence of current to be measured. Each loss varies depending on conditions such as magnitude, frequency, waveform, etc., of the current to be measured. The loss increases with the effective current value or with the dominant frequency component of the current to be measured.

In the case of direct current, continuous energization operation is possible up to the rated current value. For high-frequency driving, iron loss becomes serious when the frequency of the current to be measured exceeds 1 kHz. When the current contains high-frequency components other than those of the fundamental wave, the iron loss further increases. Therefore, confirmation using an actual current is necessary.

■Standard circuit

L12P025D15

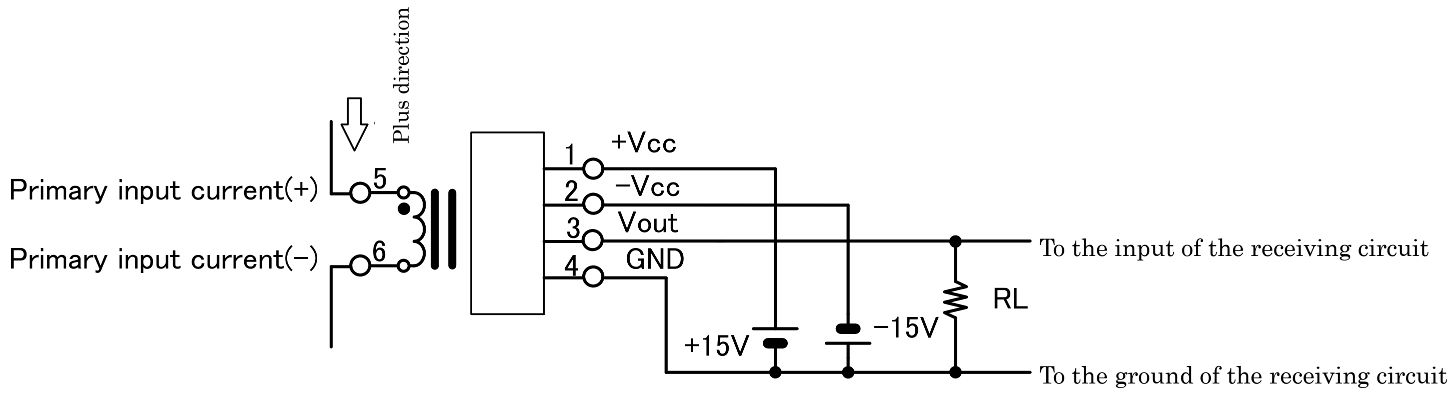


Fig. 2: L12P025D15　　Standard circuit

□Description of Fig. 2

Basic operation

This current sensor converts a measured current into a voltage. The output voltage Vout (3) in Fig. 2 is output on the basis of the GND potential. When the current to be measured is 0, Vout (3) = 0V. When the current to be measured is in the plus direction ((5) ⇒ (6)), Vout (3) becomes + (voltage converted from the measured current). When the current to be measured is in the minus direction ((6) ⇒ (5)), Vout (3) becomes – (voltage converted from the measured current).

The standard value of the output voltage $Vout$ corresponding to the current Iin to be measured is expressed by the following equation.

$Vout = G \times Iin + Vof$; $G \equiv \frac{4.0V}{If}$　If : Rated current　Vof Offset voltage　Standard value is 0V

RL = 10 kΩ in Fig. 2 is the equivalent resistance of the receiving circuit of the current sensor output Vout (3). The load resistance between the Vout terminal (3) and the GND potential (4) is standard 10 kΩ.

Effect of offset voltage

The offset voltage Vof is 0 ± 40mV at maximum under the condition of Ta = 25°C. When measuring the rated current, an error within ±1% occurs. The influence of the offset voltage decreases to 1/3 for measured current three times as large as the rated current and the error can be compressed within ±0.34%. On the other hand, when measuring a current of a half of the rated current, the output voltage is 2.0V and the error of the offset voltage ±40mV is within ±2%.

In order to minimize the error, it is necessary to select a sensor with a rated current suitable for the measured current.

If a sensor with a higher rated current than necessary is selected, the measurement error due to the offset voltage increases. In selecting the rated current, it is necessary to consider the capability of covering the peak value of the measured current, heat generated by the coil and the core, etc., as well as the above conditions.

■Application Circuit: Conversion circuit with reference voltage of 2.5V

L12P025D15

– Can be converted to CPU reference voltage (2.5 V) with accuracy being maintained. –

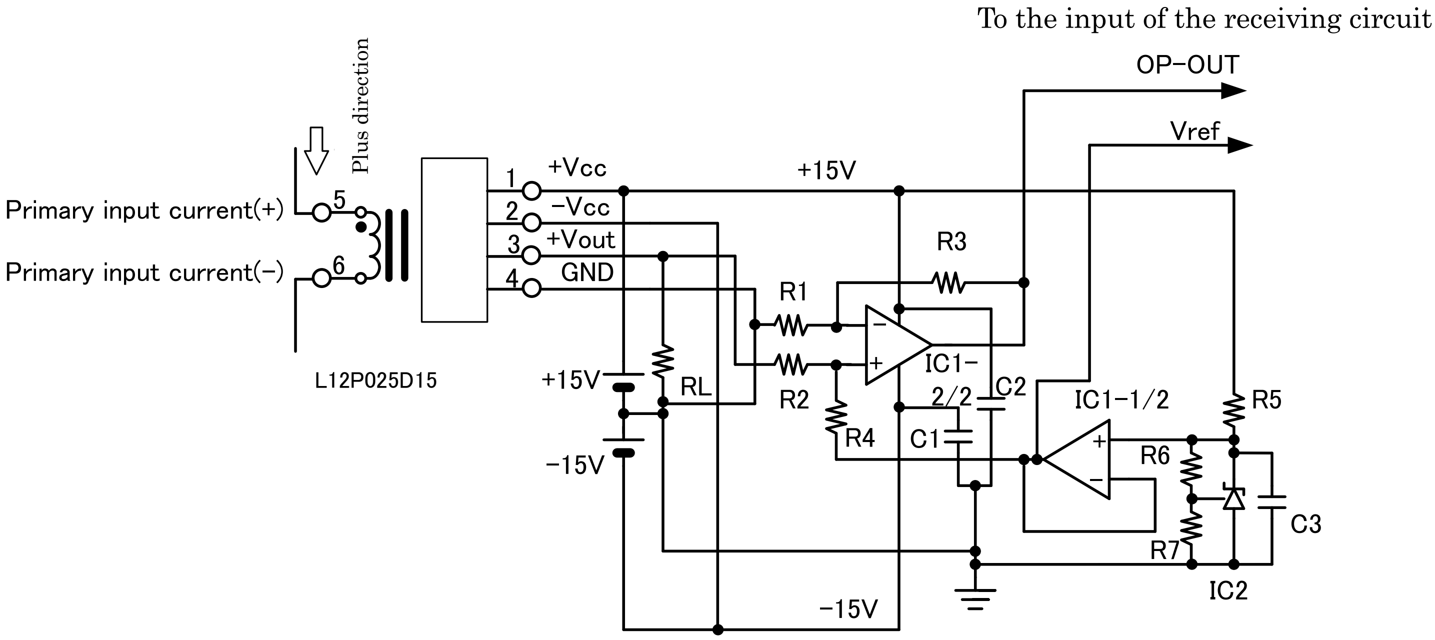


Fig. 3: L12P025D15 Conversion circuit with reference voltage of 2.5V

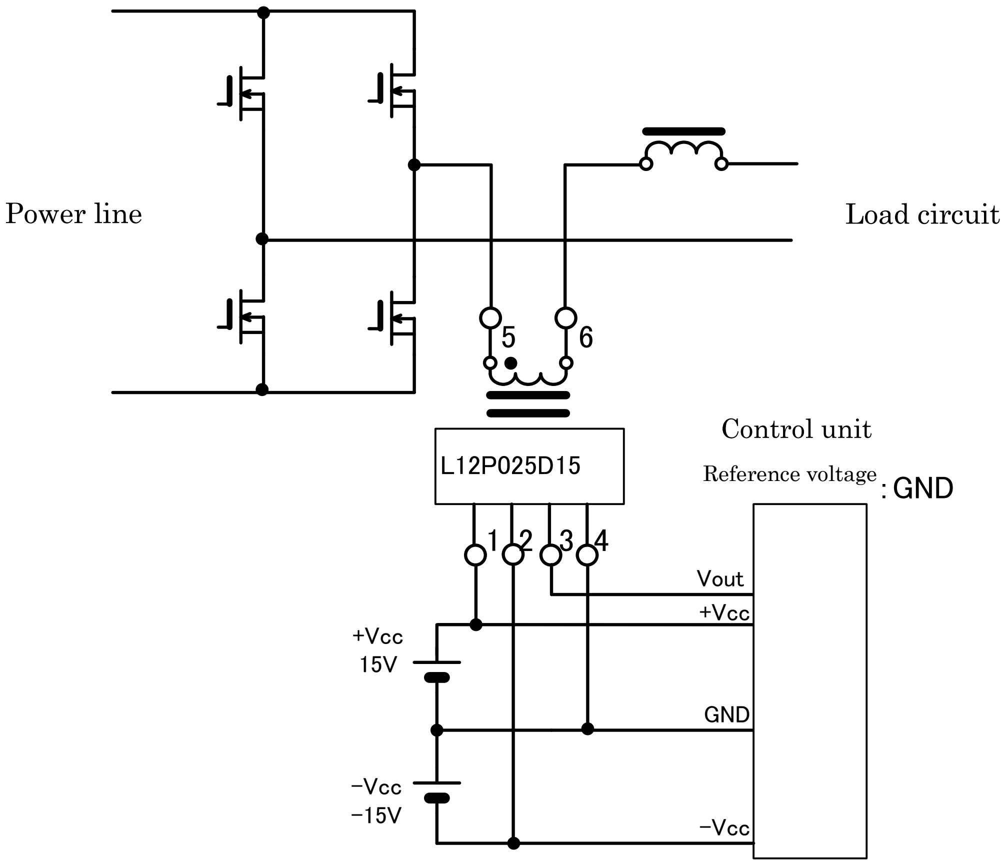
Table 3: Conversion circuit with reference voltage of 2.5V

Symbol	Product name	Model number / Rating	Manufacturer	Remarks
C1, C2, C3	Ceramic capacitor	/0.1uF		
IC1	Integrated circuit	TL082	TI	
IC2	〃	TL431	TI	
R1, R2	Fixed resistor	14.08kΩ		
R3、R4	〃	2.2kΩ		
R5	〃	10kΩ		
R6	〃	22Ω		
R7	〃	10kΩ		
RL	Fixed resistor	33kΩ		

The output voltage *Vout* corresponding to the current *Iin* to be measured, as shown in Fig. 3, is expressed by the following equation.

$$Vout = G \times Iin + Vof \quad ; \; G \equiv \frac{0.625V}{If} \qquad If: \text{Rated current} \qquad Vof: \text{Offset voltage Standard value is } 2.5V$$

■Application circuit: Inverter current-detection circuit



The output voltage $Vout$ corresponding to the current Iin to be measured is given by the following equation.

$$Vout = G \times Iin + Vof \quad ; \; G \equiv \frac{4.0}{If} \qquad If: \text{Rated current} \qquad Vof: \text{Offset voltage Standard value is 0V}$$

Fig. 4: L12P025D15 Inverter current-detection circuit

Application Circuit: Overcurrent-detection circuit

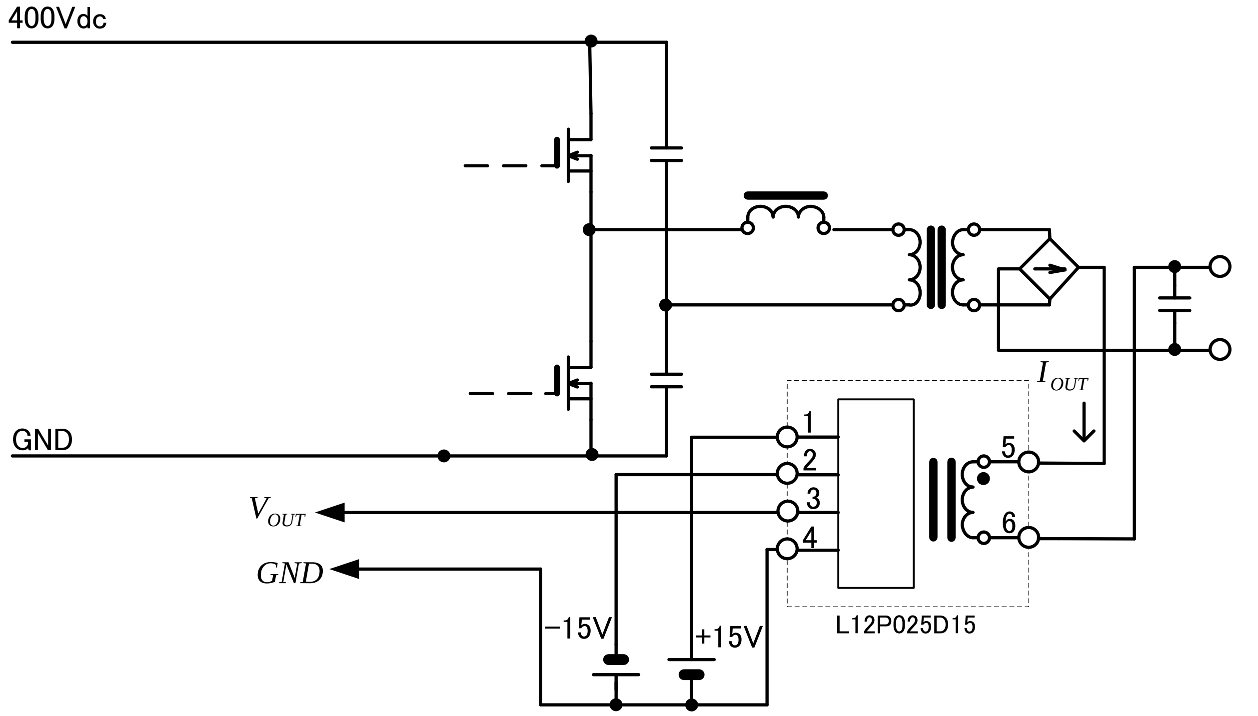


Fig. 5: L12P025D15 Overcurrent-detection circuit