L37S Series

L03S Series

Application Manual

L37S□□□D15M
L37S□□□D15M-A

L37S□□□D15J

L03S□□□D15

L03S□□□D15WM
L03S□□□D15WM-

L03S□□□D15WJ

■ Overview

Both L03S series and L37S series are open-loop type and through type current sensors.
Their rated currents vary from 50A to 600A.
(L03S□□□D15WJ L03S□□□D15WM L03S□□□D15WM-A is 50A to 800A)
Both the L37S and L03S series can be classified into three types according to the connector specifications shown in Table 1. For the L37S series, L03S□□□D15WJ L03S□□□D15WM L03S□□□D15WM-A, the saturation current characteristics have been improved compared with the L03S series.

Table 1: Series model number and connector specification

Model number	Connecter specifications			Remarks
	Connecter manufacturer	Connector product number /(Old product number)	Connector terminal Plating specification	
L37S□□□D15J L03S□□□D15WJ	JST	B4B-XH-A-G	Gold	Recommended products: L37S series (L37S series is the successor model of L03S series)
L37S□□□D15M L03S□□□D15WM L03S□□□D15	Molex	22-04-1041 /（5045-04A）	Sn	
L37S□□□D15M-A L03S□□□D15WM-A L03S□□□D15-A	Molex	22-11-1041 /（5045-04AG）	Gold	

■ Characteristics

- Through-type supply system of the current to be measured.
- Open-loop-type circuit configuration.
- Connector-type input and output can be attached directly to a panel or to a bus bar.
- Simple structure

■ Uses

- General-purpose inverter
- Motor drive
- Generator
- Electronic breaker

Format

L37S □□□ D 15 □

Connector specifications (Table 2)
J
M
M-A

Power-supply voltage: 15: 15V

Power-supply type D: Dual power supply

Rated current value 050: 50A
100: 100A
200: 200A
300: 300A
400: 400A
500: 500A
600: 600A

Series name L37S

Table 2: L37S series Specifications of connector and terminal plating

Model number		Connecter specifications		
		Connecter manufacturer	Connector product number /(Old product number)	Connector terminal Plating specification
L37S□□□D15J	Standard	JST	B4B-XH-A-G	Gold
L37S□□□D15M	Standard	Molex	22-04-1041 /(5045-04A)	Sn
L37S□□□D15M-A	Build-to-order manufacturing	Molex	22-11-1041 /(5045-04AG)	Gold

L03S □□□ D 15 □

Connector specifications (Table 3)
No mark
-A

Power-supply voltage 15: 15V

Power-supply type D: Dual power supply

Rated current value 050: 50A
100: 100A
200: 200A
300: 300A
400: 400A
500: 500A
600: 600A

Series name L03S

Table 3: L03S series Specifications of connector and terminal plating

Model number		Connecter specifications		
		Connecter manufacturer	Connector product number /(Old product number)	Connector terminal Plating specification
L03S□□□D15	-	Molex	22-04-1041 /(5045-04A)	Sn
L03S□□□D15-A	Build-to-order manufacturing	Molex	22-11-1041 /(5045-04AG)	Gold

L03S □□□ D 15 W □

- □: Connector specifications (Table 4)
  - J
  - M
  - M-A
- W: Characteristics W: Product with improved saturation current
- 15: Power-supply voltage: 15: 15V
- D: Power-supply type D: Dual power supply
- □□□: Rated current value 050: 50A
  - 100: 100A
  - 200: 200A
  - 300: 300A
  - 400: 400A
  - 500: 500A
  - 600: 600A
  - 700: 700A
  - 800: 800A
- L03S: Series name L03S

Table 4: L03S series Specifications of connector and terminal plating

Model number		Connecter specifications		
		Connecter manufacturer	Connector product number /(Old product number)	Connector terminal Plating specification
L03S□□□D15WJ	-	JST	B4B-XH-A-G	Gold
L03S□□□D15WM	-	Molex	22-04-1041 /(5045-04A)	Sn
L03S□□□D15WM-A	Build-to-order manufacturing	Molex	22-11-1041 /(5045-04AG)	Gold

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

L37S□□□D15J
L37S□□□D15M
L37S□□□D15M-A
L03S□□□D15WJ
L03S□□□D15WM
L03S□□□D15WM-A

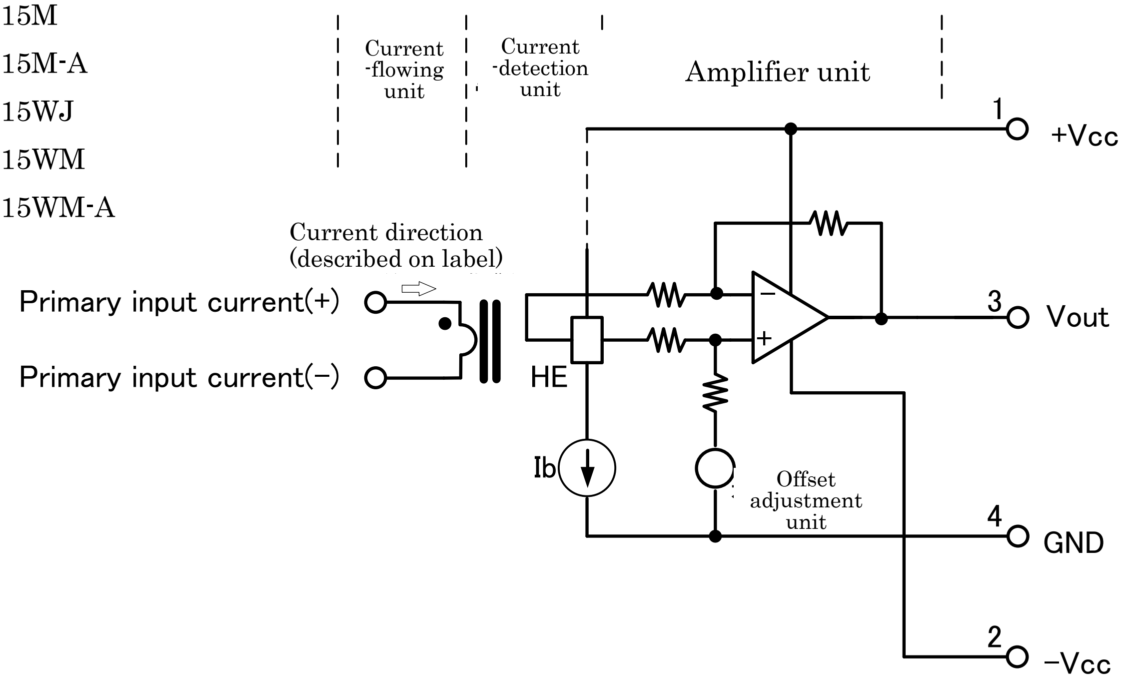


Fig. 1: L37S　L03S series　　Internal block diagram
(Excluding L03S□□□D15 and L03S□□□D15-A)

Table 5: Description of terminals of Fig. 1

Terminal number	Terminal name	Description	Remarks
1	+Vcc	Positive voltage terminal of power-supply voltage Apply +12V or + 15V.	
2	-Vcc	Negative voltage terminal of power-supply voltage Apply −12V or −15V.	
3	Vout	Output terminal	*
4	GND	GND terminal	
	Primary current (+)	The plus side of the primary current (measured current). When the primary current flows in the direction of the arrow (⇒) on the label, the output voltage is output with positive	

		polarity to the output terminal (3).	
	Primary current (-)	The minus terminal of the primary current (measured current)	

* The standard value of output voltage is

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

The standard value of the offset voltage is 0V.

L03S□□□D15
L03S□□□D15-A

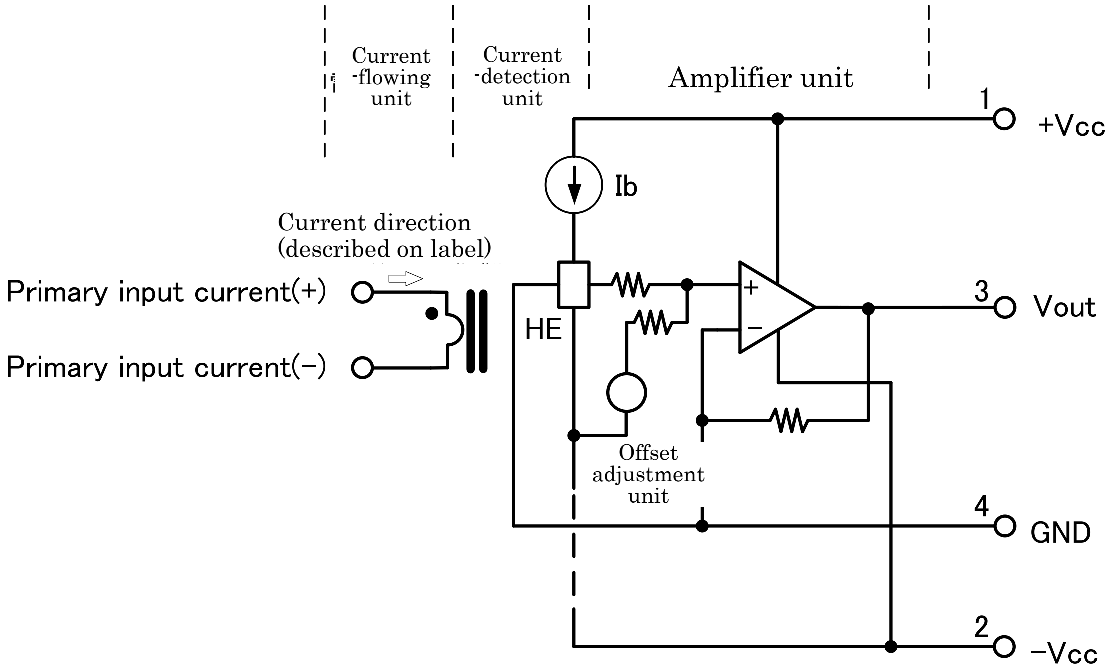


Fig. 2: L03S□□□D15　L03S□□□D15-A　　Internal block diagram

Table 6: L03S□□□D15　L03S□□□D15-A　 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	Vout 1	Output terminal	*
4	GND	GND terminal	
	Primary current (+)	The plus side of the primary current (measured current). When the primary current flows in the direction of the arrow (⇒) on the label, the output voltage is output with positive polarity to the output terminal (3).	
	Primary current (-)	The minus terminal of the primary current (measured current)	

L37S L03S Description of operation

Current-detection unit

The current to be measured (primary input current) passes through the through-hole. The generated magnetic flux is focused by a core and applied to the magnetic-detection element (Hall element, HE).

The generated magnetic flux is proportional to 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 detector outputs a voltage up to the limit fixed by the rated current without saturation (refer to each catalog value). However, the linearity is guaranteed only up to the rated current value. (See also "amplifier unit" for the saturation current.)

Amplifier unit

This block amplifies the output voltage of the magnetic-detection element. 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. The range that can be used without saturation for power-supply voltage ±15 V is different from that for ±12V.

Because the output voltage of the magnetic-detection element is determined by factors such as the rated current value, etc., 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 for the current sensor of 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.

Current-flowing unit

The current-flowing part is used by passing a bus bar or electric wire through the through-hole in the main body. The current to be measured is supplied to the bus bar or the electric wire passing through the through-hole. The bus bar or electric wire generates heat owing to its own resistance component (copper loss). Choose either a bus bar or electric wire in such a way that the temperature of the sensor does not exceed the specified value even when the ambient temperature is the allowable maximum value.

In addition to the copper loss caused by the penetrated bus bar and electric wire, heat is generated owing to iron loss (core loss) of the core built in the sensor. Each loss varies depending on conditions such as the 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. When the current contains high-frequency components other than those of the fundamental wave, iron loss further increases. Therefore, confirmation using an actual current is necessary.

■Standard circuit

L37S□□□D15J
L37S□□□D15M
L37S□□□D15M-A

L03S□□□D15WJ
L03S□□□D15WM
L03S□□□D15WM-A
L03S□□□D15
L03S□□□D15-A

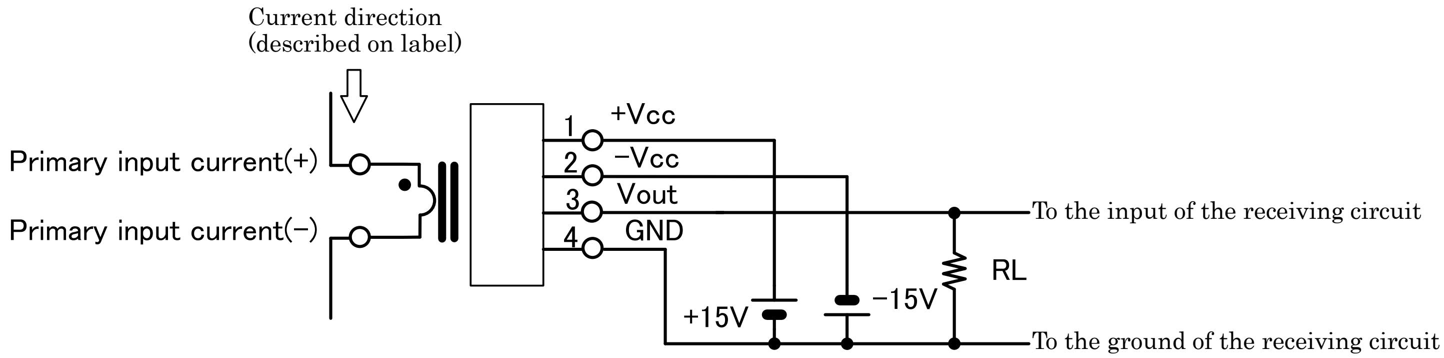


Fig. 3: L37S　L03S　　Standard circuit

☐Description of Fig. 3

Basic operation

This current sensor converts a measured current into a voltage. The output voltage Vout (3) in Fig. 3 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 (direction ⇒ of the label), Vout (3) becomes 0V + (voltage converted from the measured current). When the current to be measured is in the minus direction (direction opposite to ⇒ of the label), Vout (3) becomes 0V – (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.

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

RL = 10 kΩ in Fig. 3 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 ± 30mV at maximum in the case of L37S050D15J under the condition of Ta = 25°C. An error within ±0.75% occurs when measuring the rated current. When measured current is three times the rated current, the influence of the offset voltage decreases to 1/3 and the error is compressed to within ±0.25%. On the other hand, when the measured current is half the rated current, the error of the offset voltage ±30mV is within ±1.5% because the output voltage is 2.0V.

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 bus bar, and the core built in the sensor, etc. as well as the above conditions.

▌Application Circuit: Conversion circuit with reference voltage 2.5V

L37S□□□D15J

L37S□□□D15M

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

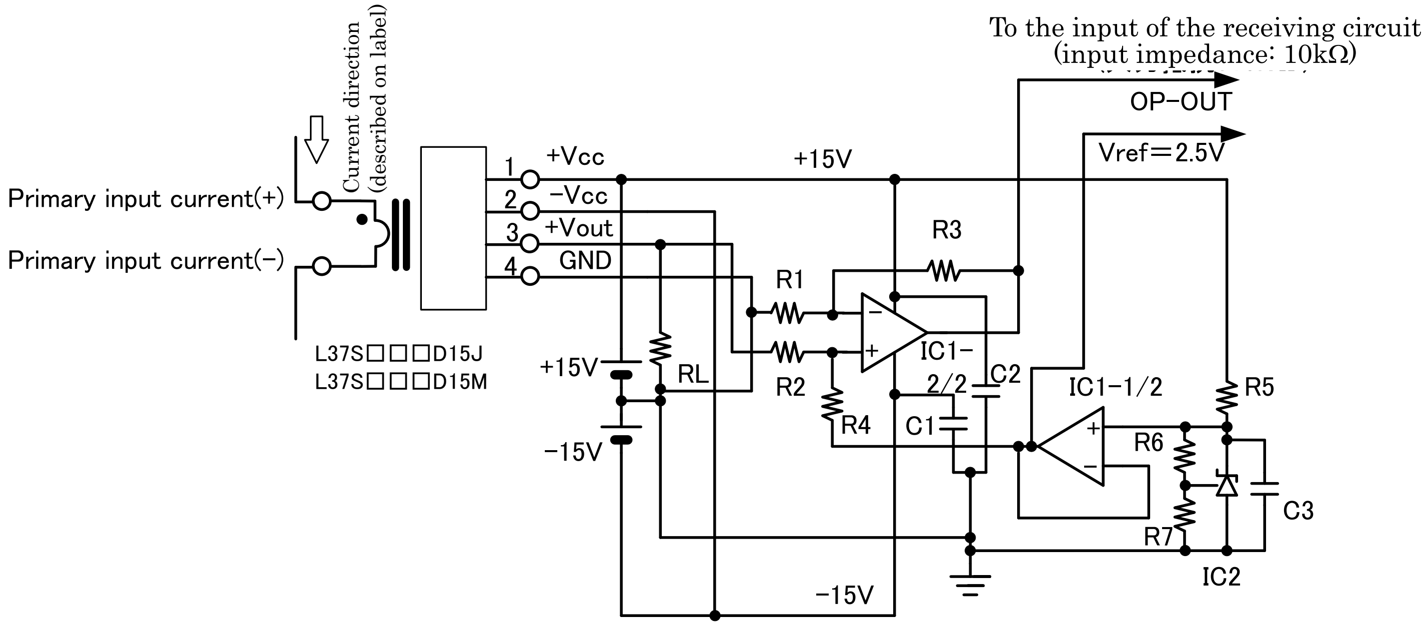


Fig. 4: Conversion circuit with reference voltage 2.5V

Table 9: Conversion circuit with reference voltage 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		

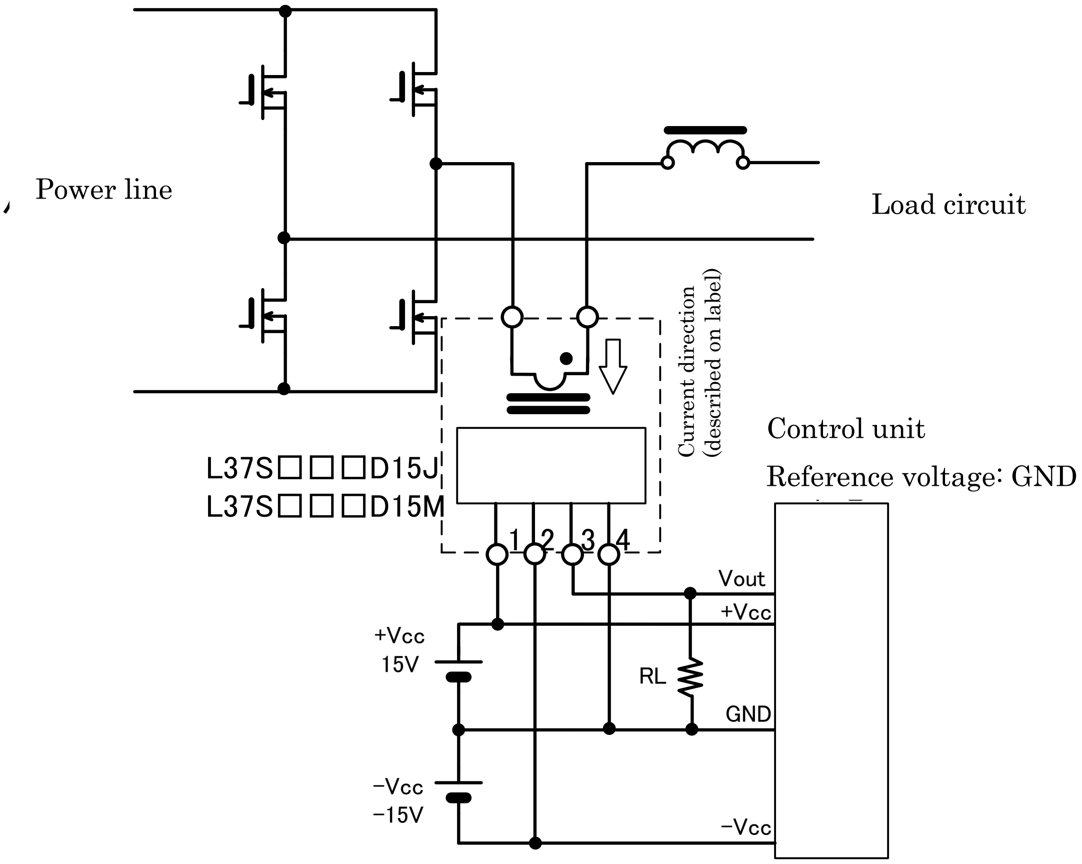
The output voltage $Vout$ corresponding to the current Iin to be measured, as shown in Fig. 4, is expressed by the following equation.

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

■Application circuit: Inverter current-detection circuit

L37S□□□D15J

L37S□□□D15M



RL: The resistance value is chosen such that the total resistance becomes 10 kΩ when being combined with the input resistance of control unit.

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

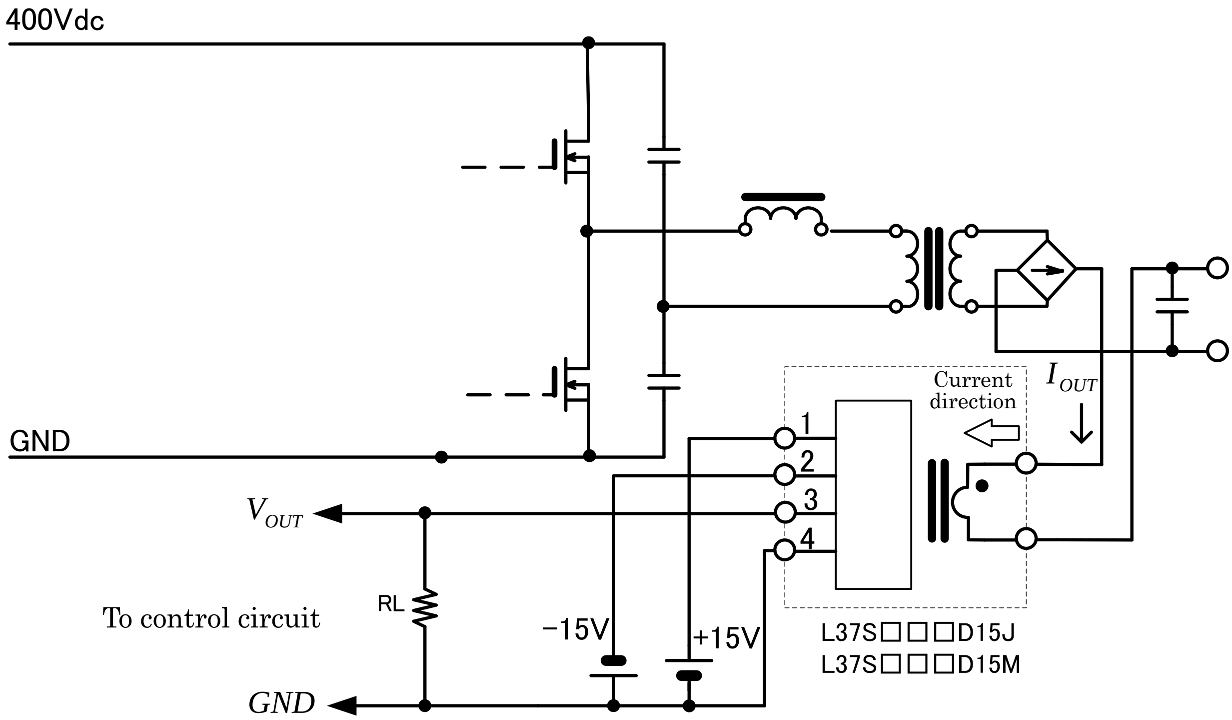
$Vout = G \times Iin + Vof$; $G \equiv \frac{4.0}{If}$ If : Rated current Vof : Offset voltage Standard value is $0V$

Fig. 5: Inverter current-detection circuit

■Application Circuit: Overcurrent-detection circuit

L37S□□□D15J

L37S□□□D15M



RL: The resistance value is chosen such that the total resistance becomes 10 kΩ when being combined with the input resistance of control circuit.

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

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

Fig. 6: Overcurrent-detection circuit