

# ECN3022

ECN3022 is a single chip three-phase bridge inverter IC which has 6 IGBTs in the circuit. Especially, it is very suitable for controlling the speed of 3-phase DC brushless motors to which converted AC200~230V power supplies are applied. Fig. 1 shows the internal block diagram.

## Functions

- \* Integrated charge pump circuit
- \* Integrated free wheel diodes
- \* Integrated PWM circuit
- \* Integrated FG circuit
- \* Integrated over current protection circuit
- \* Integrated rotating direction monitor circuit
- \* All output IGBTs shut off function

## Features

- \* Speed control for a 3-phase DC brushless motor is available with an external microprocessor.
- \* Bottom arm circuits can be operated in 20kHz chopping frequency of PWM.
- \* For converted AC200 to 230V power supplies.

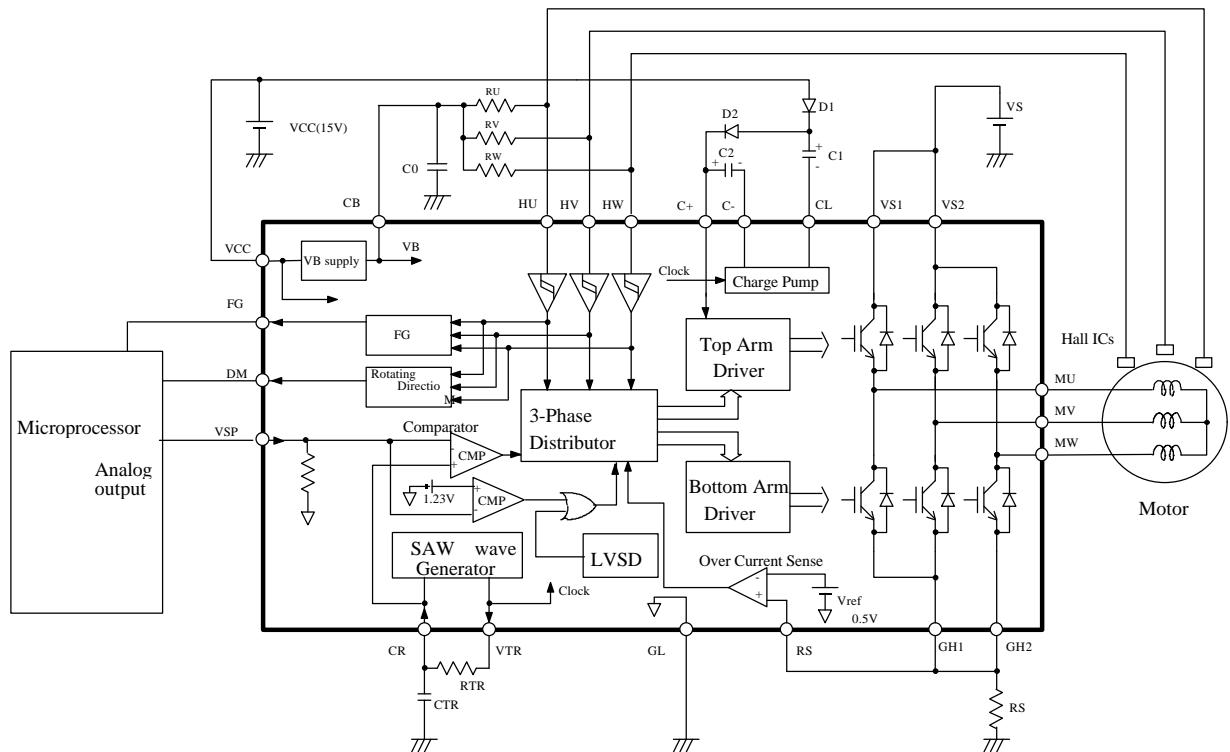


Fig. 1 Block diagram

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## 1. General

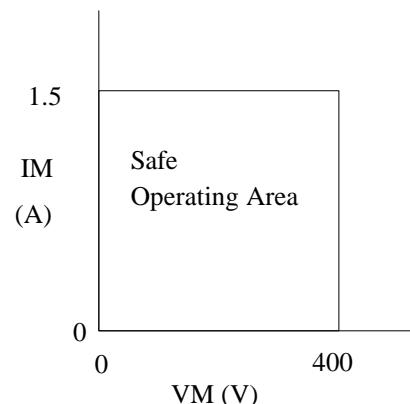
- (1) Type ECN3022SP, ECN3022SPV, ECN3022SPR
- (2) Application 3-phase DC Brushless Motor
- (3) Structure Monolithic IC
- (4) Package SP-23TA, SP-23TB, SP-23TR

## 2. Maximum Allowable Ratings ( $T_a=25^{\circ}\text{C}$ )

| No. | Items                           | Symbols | Terminal            | Ratings       | Unit | Condition |
|-----|---------------------------------|---------|---------------------|---------------|------|-----------|
| 1   | Output Device Breakdown Voltage | VSM     | VS1,VS2<br>MU,MV,MW | 500           | V    |           |
| 2   | Supply Voltage                  | VCC     | VCC                 | 18            | V    |           |
| 3   | Input Voltage                   | VIN     | VSP,RS<br>HU,HV,HW  | -0.5 ~ VB+0.5 | V    |           |
| 4   | Output Current                  | IOM     | MU,MV,MW            | 1.5           | A    | Note 1    |
| 5   | Operating Junction Temperature  | Tjop    |                     | -20 ~ +135    | °C   | Note 2    |
| 6   | Storage Temperature             | Tstg    |                     | -40 ~ +150    | °C   |           |

Note 1. Recommended Safe Operating Area(SOA)

It is recommended that this IC should be used within the SOA as shown below, where IM and VM are the current and the voltage at the terminals connected to motor coils when the IGBT turn on and turn off.



Note 2. Thermal Resistance

$$R_{j-c} = 4 \text{ }^{\circ}\text{C/W}$$

$$R_{j-a} = 40 \text{ }^{\circ}\text{C/W}$$

## 3. Recommended Operating Conditions

| No. | Items          | Symbols | Terminal | MIN  | TYP  | MAX  | Unit | Condition |
|-----|----------------|---------|----------|------|------|------|------|-----------|
| 1   | Supply Voltage | VS      | VS1,VS2  | 50   | 325  | 400  | V    |           |
| 2   |                | VCC     | VCC      | 13.5 | 15   | 16.5 | V    |           |
| 3   | Supply Current | IS      | VS1,VS2  | -    | 0.25 | 0.7  | A    | Note.1    |

Note 1. Supply current means average supply current included at motor start and speed up current.

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## 4. Electrical Characteristics (Ta=25°C)

Unless otherwise specified, VCC=15V, VS=325V

Suffix T; Top arm B; Bottom arm

| No. | Items                        | Symbols | Terminal         | MIN  | TYP  | MAX  | Unit | Condition                                   |
|-----|------------------------------|---------|------------------|------|------|------|------|---|
| 1   | Standby Current              | IS      | VS1,VS2          | -    | 0.5  | 1.5  | mA   | VSP=0V                                      |
| 2   |                              | ICC     | VCC              | -    | 10   | 20   | mA   |   |
| 3   | Output device FVD            | VFT     | MU,MV,MW         | -    | 2.2  | 3.0  | V    | I=0.35A                                     |
| 4   |                              | VFB     | MU,MV,MW         | -    | 2.2  | 3.0  | V    |   |
| 5   | Turn On                      | TdONT   | MU,MV,MW         | -    | 1.0  | 2.0  | us   | I=0.35A<br>Resistance Load                  |
| 6   | Delay Time                   | TdONB   | MU,MV,MW         | -    | 1.0  | 2.0  | us   |   |
| 7   | Turn Off                     | TdOFFT  | MU,MV,MW         | -    | 1.0  | 2.0  | us   |   |
| 8   | Delay Time                   | TdOFFB  | MU,MV,MW         | -    | 1.0  | 2.0  | us   |   |
| 9   | Free Wheel                   | VFDT    | MU,MV,MW         | -    | 2.2  | 2.8  | V    | I=0.35A                                     |
| 10  | Diode FVD                    | VFDB    | MU,MV,MW         | -    | 2.4  | 3.0  | V    |   |
| 11  | Output Resistance            | RVTR    | VTR              | -    | 200  | 400  | Ω    |   |
| 12  | H or L Level of SAW wave     | VSAWH   | CR               | 4.9  | 5.4  | 6.1  | V    | Note 2                                      |
| 13  |                              | VSAWL   | CR               | 1.7  | 2.1  | 2.5  | V    |   |
| 14  | Amplitude of SAW wave        | VSAWW   | CR               | 2.8  | 3.3  | 3.8  | V    | Note 3                                      |
| 15  | Reference Voltage            | Vref    | RS               | 0.45 | 0.5  | 0.55 | V    |   |
| 16  | Hall signal                  | VIH     | HU,HV,HW         | 3.5  | -    | -    | V    |   |
| 17  |                              | VIL     | HU,HV,HW         | -    | -    | 1.5  | V    |   |
| 18  | Hall signal<br>Input Current | IIL     | HU,HV,HW         | -100 | -    | -    | μA   | HU,HV,HW=0V<br>Note 1<br>Pull Up Resistance |
| 19  | VSP Input Current            | IVSPH   | VSP              | -    | -    | 100  | μA   | VSP=5.0V Note 1<br>Pull Down Resistance     |
| 20  | VSP Offset Voltage           | SPCOMOF | VSP              | -40  | 10   | 60   | mV   | Refer to CR Terminal                        |
| 21  | VB Output Voltage            | VB      | CB               | 6.8  | 7.5  | 8.2  | V    |   |
| 22  | VB Output Current            | IB      | CB               | 25   | -    | -    | mA   | deltaVLOAD=0.1V                             |
| 23  | FG,DM<br>Output Voltage      | VOL     | FG,DM            | -    | 1.0  | -    | V    | IOL=-5mA                                    |
| 24  | FG,DM<br>Output Resistance   | ROL     | FG,DM            | -    | 200  | 400  | Ω    | IOL=-10mA                                   |
| 25  | VSP all off operation        | Voff    | VSP              | 0.85 | 1.23 | 1.6  | V    |   |
| 26  | LVSD Output Voltage          | LVSDON  | VCC,MU,<br>MV,MW | 10.0 | 11.5 | 12.9 | V    | Note.5                                      |
| 27  | LVSD recover Voltage         | LVSDOFF |                  | 10.1 | 12.0 | 13.0 | V    |   |
| 28  | LVSD reset hysteresis        | Vrh     |                  | 0.1  | 0.5  | 0.9  | V    |   |

Note 1. Pull Up Resistance and Pull Down Resistance are typically 200 kΩ.

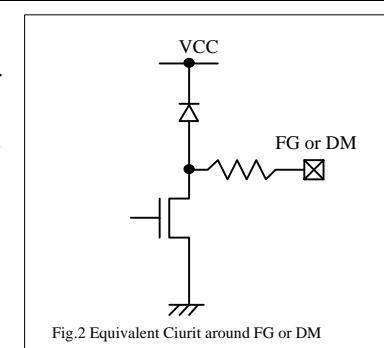
Note 2. Please see Note 2 in item 6 for determining the frequency of SAW wave.

Note 3. The amplitude of SAW(VSAWW) is determined by the following equation,

$$VSAWW = VSAWH - VSAWL \quad (V)$$

Note 4. The equivalent circuit around FG and DM terminal is shown in Fig. 2

Note 5. LVSD: Low Voltage Shut Down



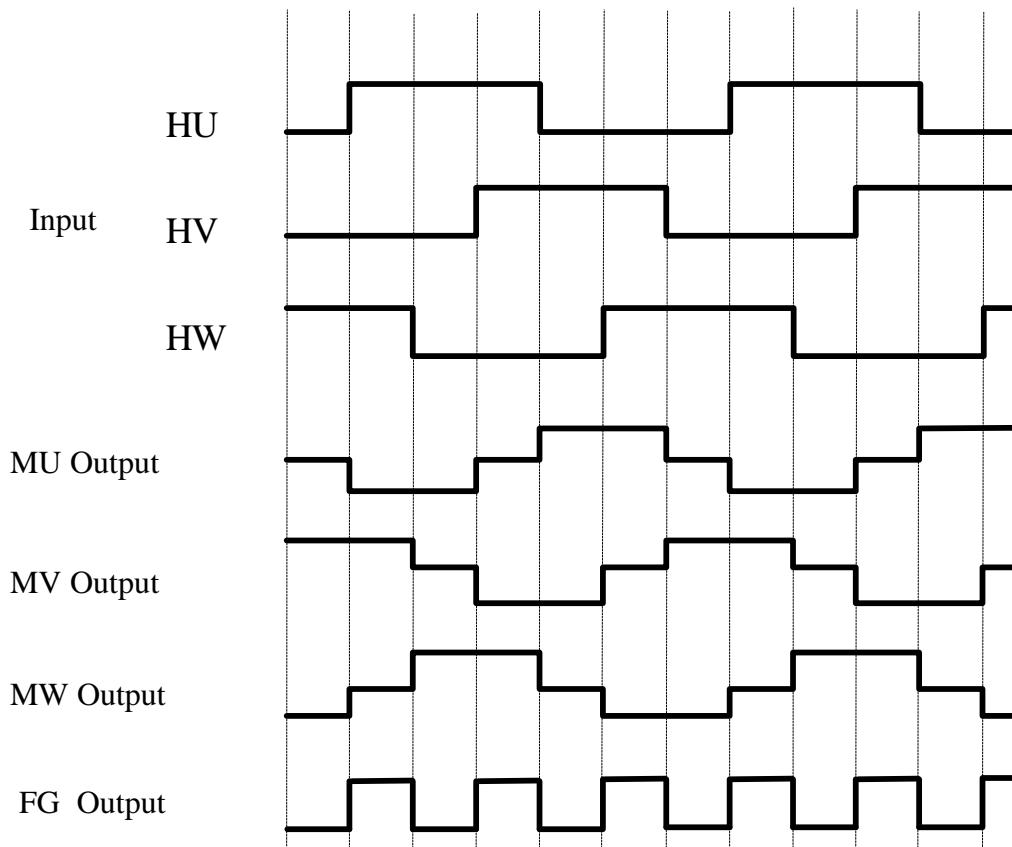
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## 5. Function

### 5.1 Truth Table

| Input |    |    | MU  |        | MV  |        | MW  |        |
|-------|----|----|-----|--------|-----|--------|-----|--------|
| HU    | HV | HW | Top | Bottom | Top | Bottom | Top | Bottom |
| H     | L  | H  | OFF | ON     | ON  | OFF    | OFF | OFF    |
| H     | L  | L  | OFF | ON     | OFF | OFF    | ON  | OFF    |
| H     | H  | L  | OFF | OFF    | OFF | ON     | ON  | OFF    |
| L     | H  | L  | ON  | OFF    | OFF | ON     | OFF | OFF    |
| L     | H  | H  | ON  | OFF    | OFF | OFF    | OFF | ON     |
| L     | L  | H  | OFF | OFF    | ON  | OFF    | OFF | ON     |
| L     | L  | L  | OFF | OFF    | OFF | OFF    | OFF | OFF    |
| H     | H  | H  | OFF | OFF    | OFF | OFF    | OFF | OFF    |

### 5.2 Timing Chart



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## 5.3 PWM Operation

The PWM signal is produced by comparing the input voltage at VSP terminal with the voltage from the internal SAW wave. The duty of the PWM signal can be changed by the triangular wave amplitude level, from the minimum point of VSAWL to the maximum point of VSAWH, and when the level is under VSAWL, the duty becomes 0%, and when the level is over VSAWH, the duty becomes 100%. In addition, chopping with the PWM signal is operated in the bottom arm circuit.

## 5.4 Over Current Limiting Operation

This IC detects over current by checking the voltage drop at the external resistance RS. When the input voltage at RS terminal exceeds the internal reference voltage(Vref), this IC turns off the output of the bottom arm circuit. After over current detection, reset operation is done at every period of the PWM signal.

## 5.5 Rotating Direction Sense Operation

The rotation direction of the motor is detected by the signal at DM terminal. Table 1 shows the output signal for the rotation direction.

Table 1. Output signal for the rotation direction

| Rotating Direction | Output (DM terminal) |
|--------------------|----------------------|
| U-V-W              | L                    |
| U-W-V              | H                    |

## 5.6 Vcc under voltage Detection

When Vcc supply voltage becomes below LVSDON(11.5V typ), all of the IGBTs shut off.

This condition is recovered when Vcc supply voltage becomes greater than LVSDOFF(12.0V typ).

## 5.7 All output IGBTs shut off function

When voltage of VSP terminal becomes below 1.23V(typical), all of the IGBTs shut off.

If this mode occurs, at motor rotating state, motor will stop and Vs voltage could rise.

Please note that this voltage not to exceed 500V.

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## 6. Standard Application

| Component | Recommended Value  | Usage                       | Remark                        |
|-----------|--|-----------------------------|-------------------------------|
| C0        | More than 0.22 $\mu$ F   | for inner power supply(VB). | stress voltage is VB          |
| C1,C2     | 1.0 $\mu$ F $\pm$ 20%  | for charge pump             | stress voltage is VCC         |
| D1,D2     | Hitachi DFG1C6(Glass mold type),DFM1D6 (Resin mold type) or considerable parts | for charge pump             | 600V/1.0A<br>trr $\leq$ 100ns |
| Rs        | Note 1.  | for current limiting        |                               |
| CTR       | 1800 pF $\pm$ 5%   | for PWM                     | Note 2.                       |
| RTR       | 22 k $\Omega$ $\pm$ 5%   | for PWM                     | Note 2.                       |

Note 1. Start up current is limited by the following equation.

$$IO = V_{ref} / Rs \quad (A)$$

Note 2. PWM frequency is approximately determined by the following equation.

$$f_{PWM} = -1 / (2C * R * \ln(1-3.5/5.5)) \quad ; \text{Ln is natural logarithm}$$

$$= 0.494 / (C * R) \quad (\text{Hz})$$

Note 3. It is recommended that RU,RV,RW should be 5.6 k $\Omega$   $\pm$  5%.

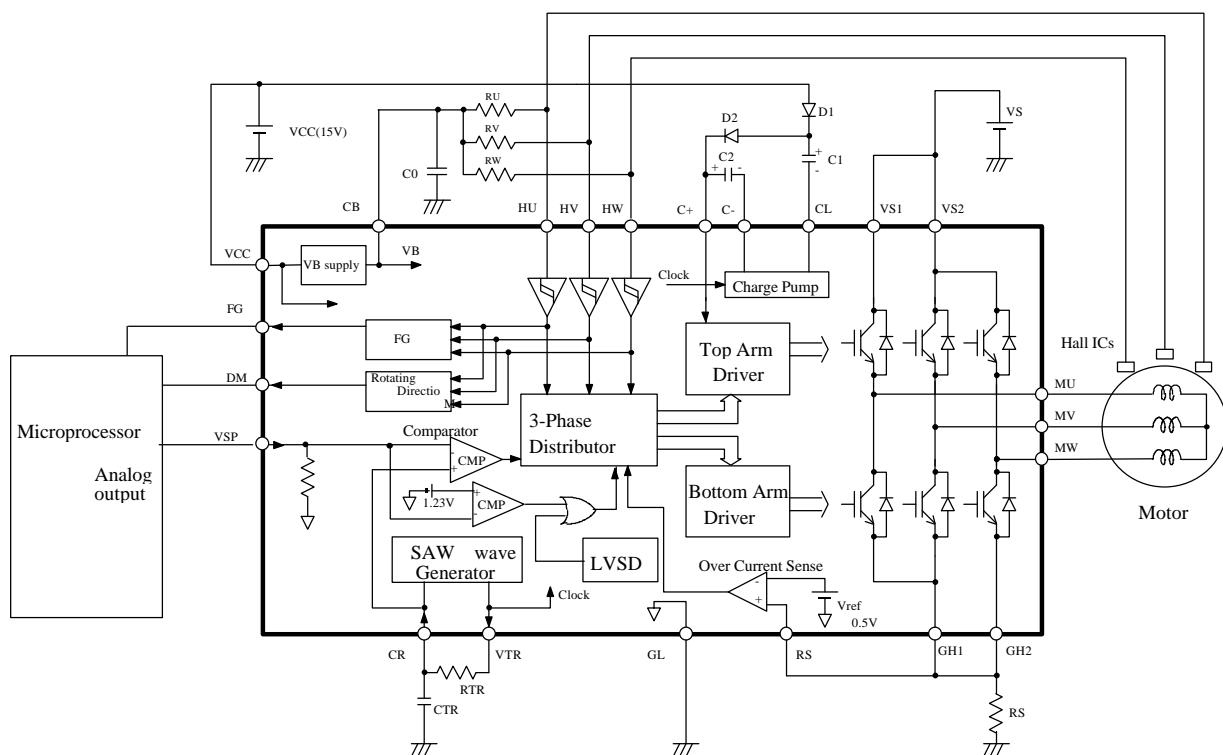
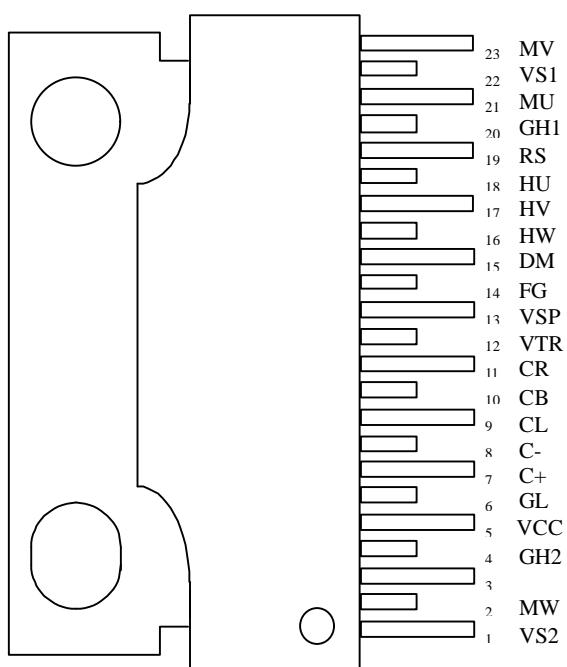


Fig. 3 Block diagram and external elements

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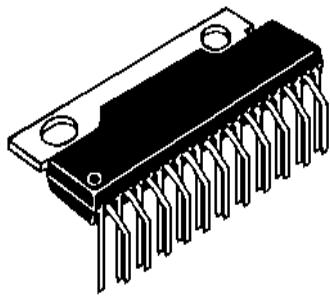
## 7. Terminal



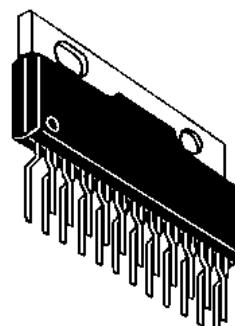
(Marking side)

Fig.4 Pin Connection

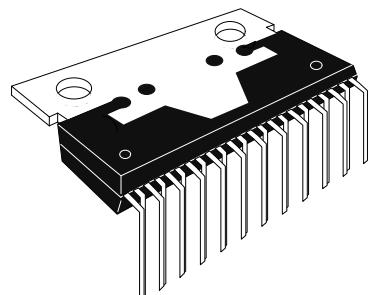
## 8. Package Outline



ECN3022 SP  
(SP-23TA)



ECN3022 SPV  
(SP-23TB)



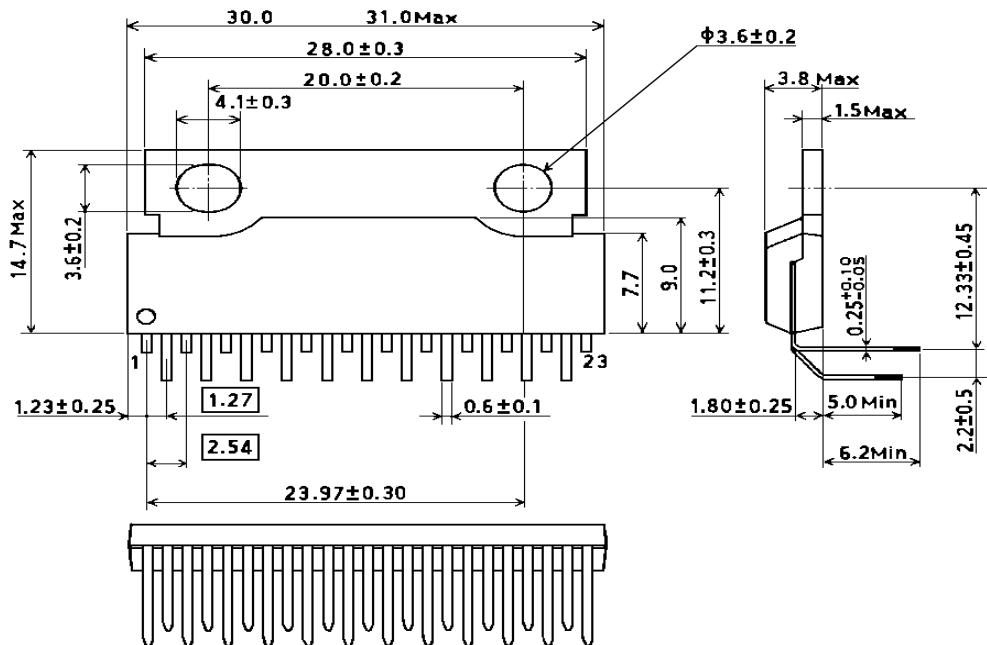
ECN3022 SPR  
(SP-23TR)

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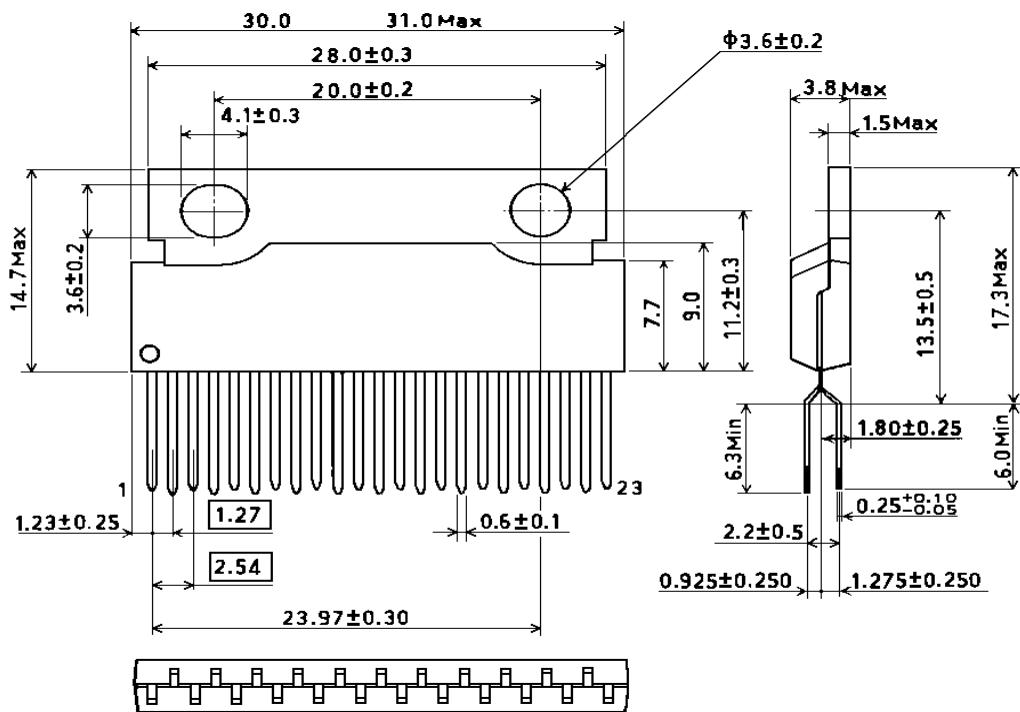
## 9. Package Dimensions

(1) ECN3022SP (SP-23TA)

(Unit:mm)



(2) ECN3022SPV (SP-23TB)



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(3) ECN3022SPR (SP-23TR)

