# ECN3021

ECN3021 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

## 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.

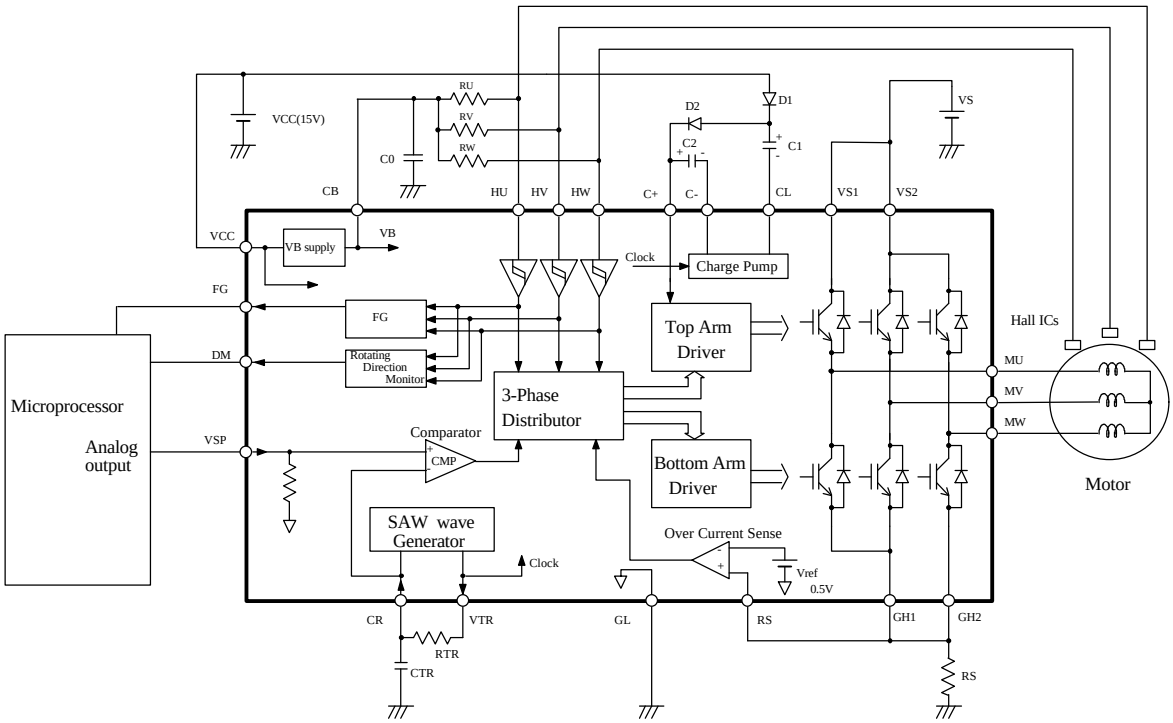



Fig. 1 Block diagram

# ECN3021

1. General
   (1) Type ECN3021
   (2) Application 3-phase DC Brushless Motor
   (3) Structure Monolithic IC
   (4) Package SP-23T

2. Maximum Allowable Ratings (Ta=25°C)

| No. | Items | Symbols | Terminal | Ratings | Unit | Condition |
|---|---|---|---|---|---|---|
| 1 | Output Device Breakdown Voltage | VSM | VS1,VS2 MU,MV,MW | 500 | V | |
| 2 | Supply Voltage | VCC | VCC | 18 | V | |
| 3 | Input Voltage | VIN | VSP,RS HU,HV,HW | -0.5 ~ VB+0.5 | V | |
| 4 | Output Current | IMDC | MU,MV,MW | 0.7 | A | |
| 5 | Peak Output Current | IMP | MU,MV,MW | 1.0 | A | Note 1 |
| 6 | Output Current in Start Up and Accelerating | IOM | MU,MV,MW | 1.0 | A | Note 1 |
| 7 | Operating Junction Temperature | Tjop | | -20 ~ +135 | °C | Note 2 |
| 8 | Storage Temperature | Tstg | | -40 ~ +150 | °C | |

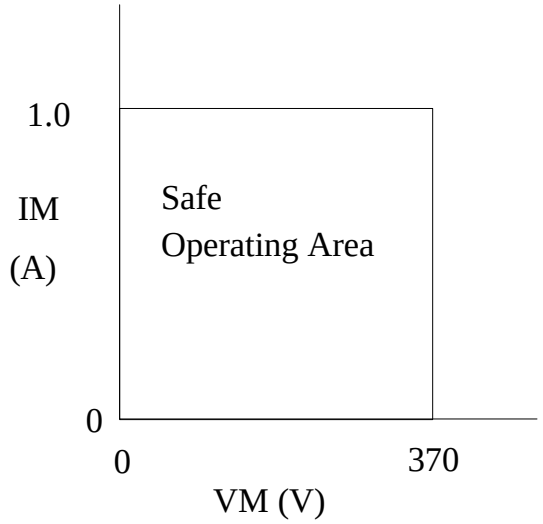
Note 1. Please note that acumulated duty of a period exceeding 0.7A has to be less than 5% of total current flowing period.

Note 2. Thermal Resistance
Rj-c = 4°C/W
Rj-a = 40°C/W

3. Recommended Operating Conditions

| No. | Items | Symbols | Terminal | MIN | TYP | MAX | Unit | Condition |
|---|---|---|---|---|---|---|---|---|
| 1 | Supply Voltage | VS | VS1,2 | 50 | 325 | 370 | V | |
| 2 | | VCC | VCC | 13.5 | 15 | 16.5 | V | |

Note. 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 phase is changed (turned off).



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 | VS1,2 | - | 2.5 | 5.0 | mA | VSP=0V |
| 2 | | ICC | VCC | - | 10 | 20 | mA | |
| 3 | Output device FVD | VFT | MU,MV,MW | - | 4.0 | 6.0 | V | I=0.35A |
| 4 | | VFB | MU,MV,MW | - | 4.0 | 6.0 | V | I=0.35A |
| 5 | Turn On | TdONT | MU,MV,MW | - | 0.5 | 3.0 | μs | |
| 6 | Delay Time | TdONB | MU,MV,MW | - | 0.5 | 3.0 | μs | I=0.35A |
| 7 | Turn Off | TdOFFT | MU,MV,MW | - | 3.0 | 6.0 | μs | Resistance Load |
| 8 | Delay Time | TdOFFB | MU,MV,MW | - | 1.0 | 3.0 | μs | |
| 9 | Free Wheel | VFDT | MU,MV,MW | - | 4.0 | 6.0 | V | I=0.35A |
| 10 | Diode FVD | VFDB | MU,MV,MW | - | 4.0 | 6.0 | V | |
| 11 | Output Resistance | RVTR | VTR | - | 200 | 400 | Ω | |
| 12 | H or L Level of | VSAWH | CR | 4.9 | 5.4 | 6.1 | V | Note 2 |
| 13 | SAW wave | 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 | Input Voltage | VIL | HU,HV,HW | - | - | 1.5 | V | |
| 18 | Hall signal Input Current | IIL | HU,HV,HW | -100 | - | - | μA | HU,HV,HW=0V Note 1 Pull Up Resistance |
| 19 | VSP Input Current | IVSPH | VSP | - | - | 100 | μA | VSP=5.0V Note 1 Pull Down Resistance |
| 20 | VB Output Voltage | VB | CB | 6.8 | 7.5 | 8.2 | V | |
| 21 | VB Output Current | IB | CB | 25 | - | - | mA | delta Vload=0.1V |
| 22 | FG,DM Output Voltage | VOL | FG,DM | - | 1.0 | - | V | IOL=-5mA Note 4 |
| 23 | FG,DM Output Resistance | ROL | FG,DM | - | 200 | 400 | Ω | |
| 24 | LVSD Output Voltage | LVSDON | Vcc,MU, MV,MW | 10.0 | 11.5 | 12.9 | V | Note.5 |
| 25 | LVSD recover Voltage | LVSDOFF | | 10.1 | 12.0 | 13.0 | V | |
| 26 | LVSD reset hysterisis | 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 (V)

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

Note 5. LVSD: Low Voltage Shut Down

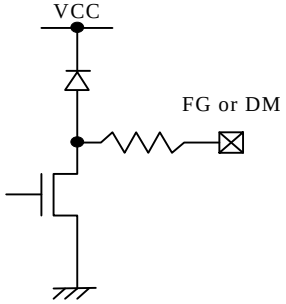


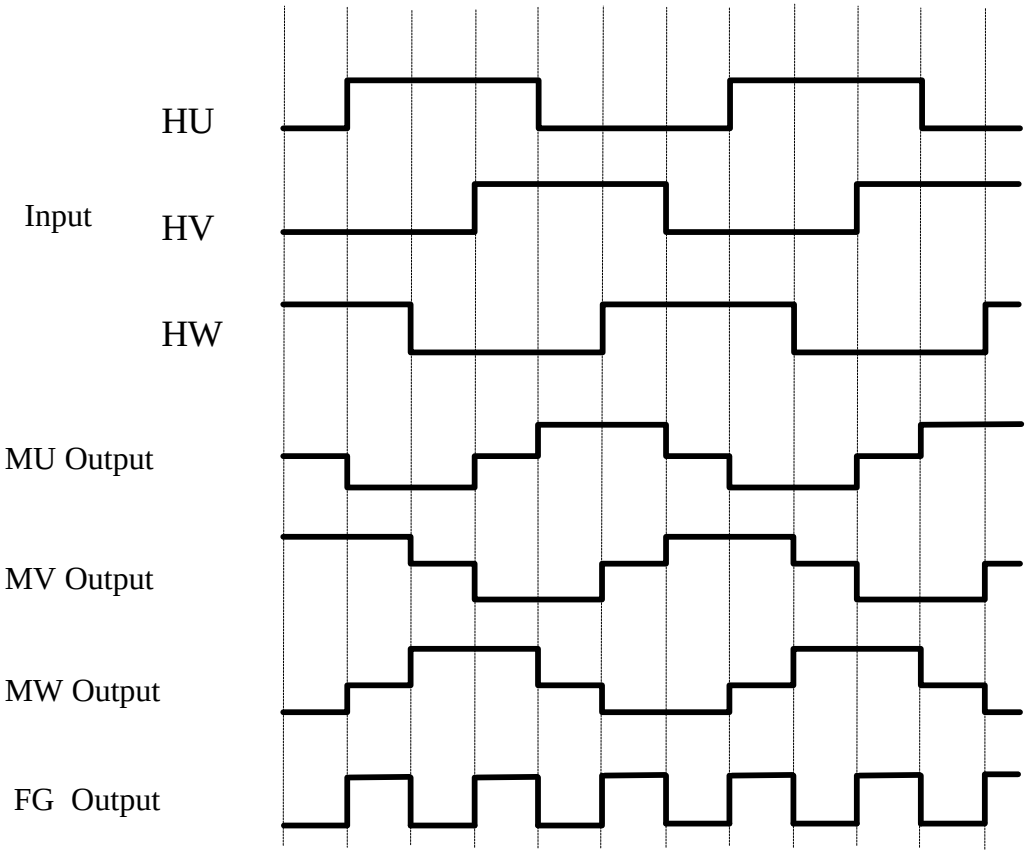

Fig.2 Equivalent circuit around FG or DM

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



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 inner clock signal (VTR terminal).

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 voltrage 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).

6. Standard Application

| Component | Recommended Value | Usage | Remark |
|---|---|---|---|
| C0 | More than 0.22 μF | for inner power supply(VB). | stress voltage is VB |
| C1,C2 | 0.5 μF ± 20% | for charge pump | stress voltage is VCC |
| D1,D2 | Hitachi DFG1C6(glass mold)<br>Hitachi DFM1F6(resin mold)<br>or equivalent parts | for charge pump | 600V/1.0A<br>trr≤100ns |
| Rs | Note 1. | for current limiting | |
| CTR | 1800 pF ± 5% | for PWM | Note 2. |
| RTR | 22 kΩ ± 5% | for PWM | Note 2. |

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

IO = Vref / Rs (A)

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

fPWM = -1 / (2C*R*Ln(1-3.5/5.5)) ; Ln is natural logarithm

= 0.494 / (C*R) (Hz)

Note 3. It is recommended that RU,RV,RW should be 5.6 kΩ ± 5%.

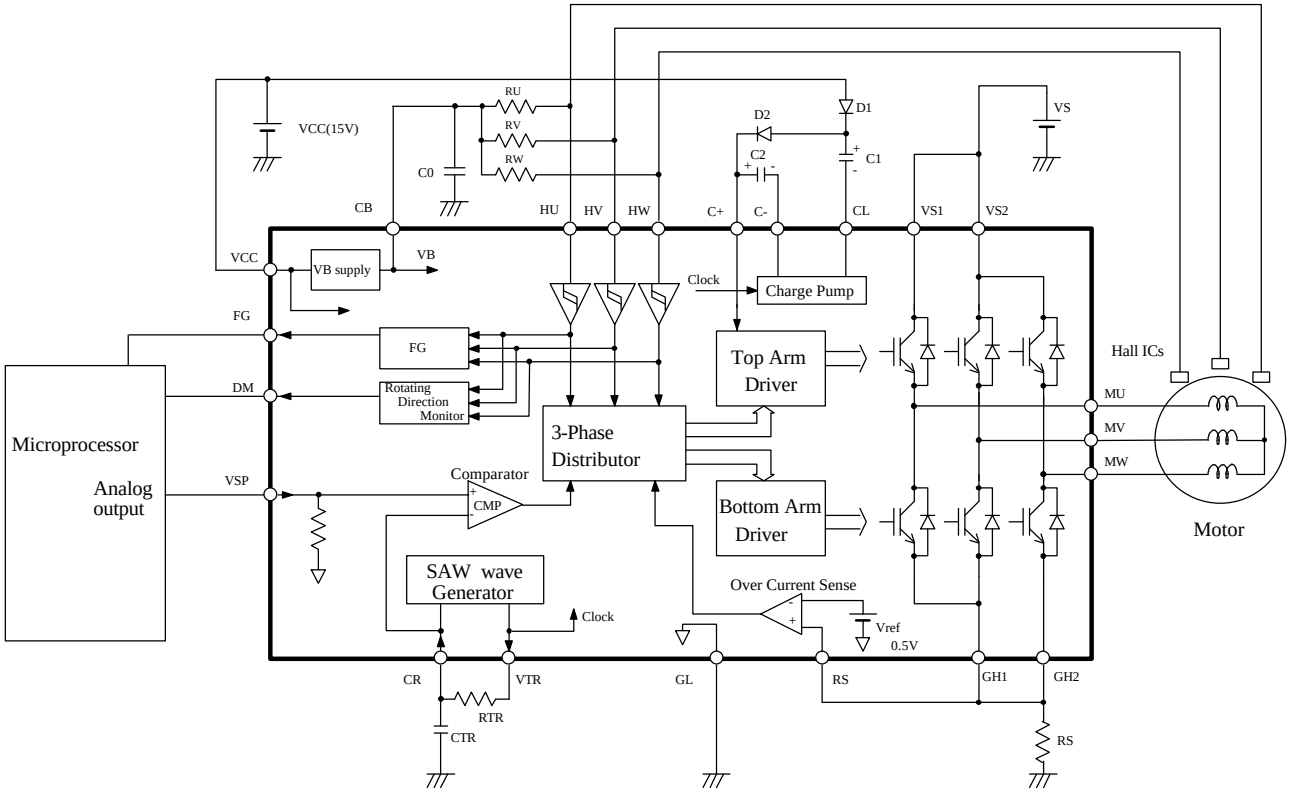
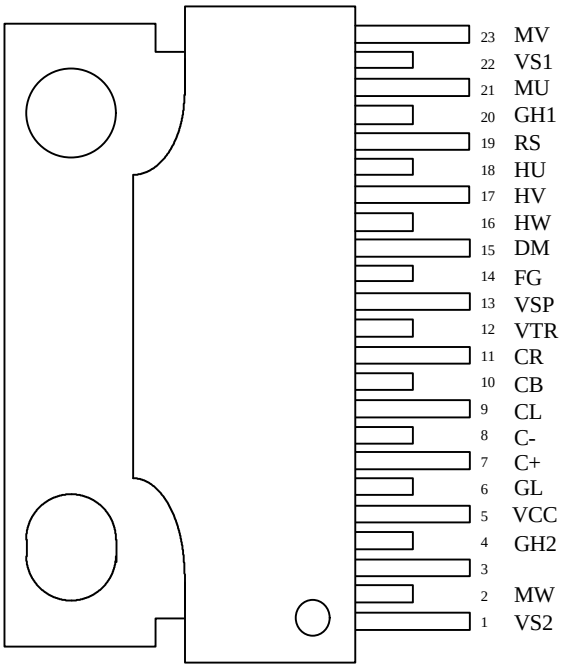



Fig 3. Block diagram and external elements

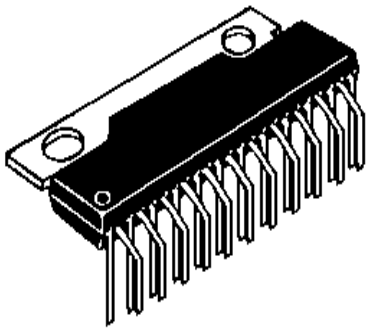
7. Terminal



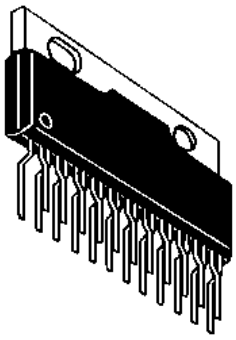

(Marking side)

Fig.4 Pin Connection

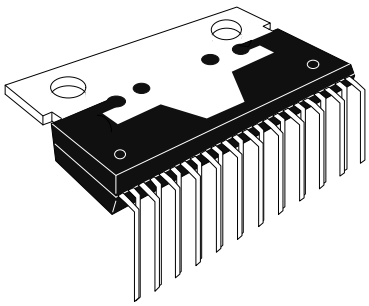
8. Package Outline



ECN3021SP



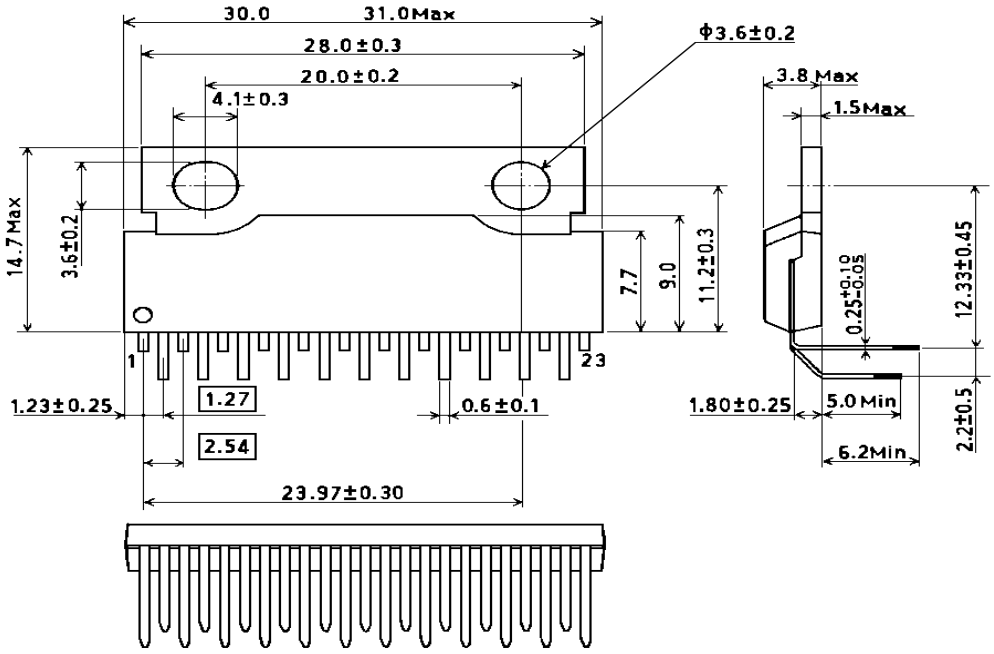
ECN3021SPV



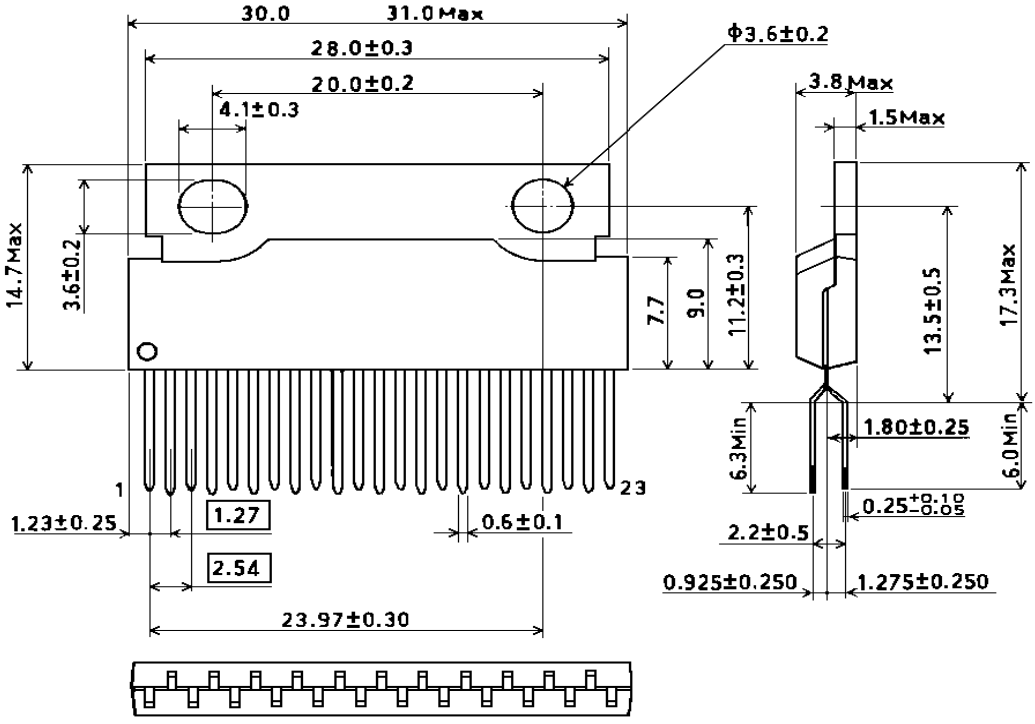
ECN3021SPR

8. Package Dimensions

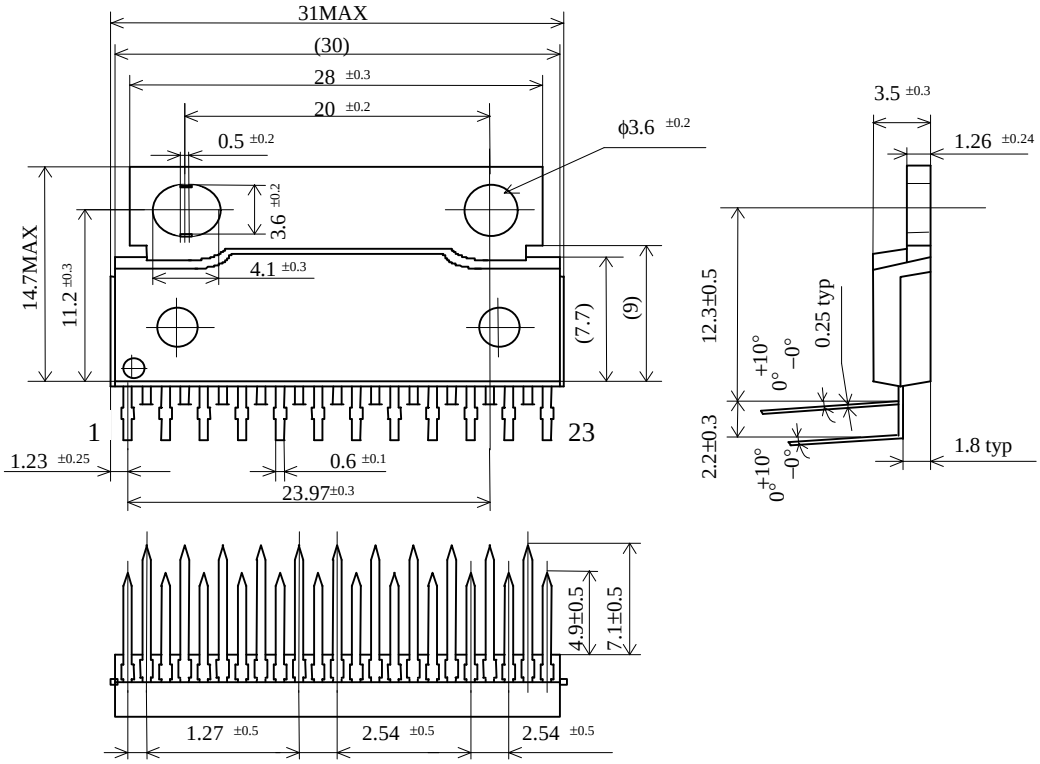
(1) ECN3021SP




(2) ECN3021SPV



(3) ECN3021SPR



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