

HIGH-VOLTAGE MONOLITHIC IC

ECN3035F/3036F

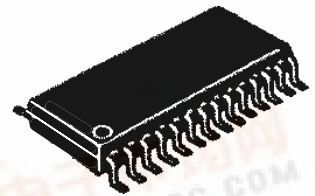
ECN3035F/3036F is a driver IC for a three-phase bridge inverter which has MOSFETs or IGBTs for the outputs. Especially, it is very suitable for controlling the speed of three-phase DC brushless motors to which converted AC200~230V power supplies are applied. The internal block diagram is shown in Fig. 1.

Functions

- * Integrated charge pump circuit
- * Integrated 3-phase distributor circuit
- * Integrated PWM circuit
- * Integrated over current protection circuit
- * Integrated rotating direction sense circuit
- * Integrated FG circuit

Package

FP-28DJ(JEDEC)



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.

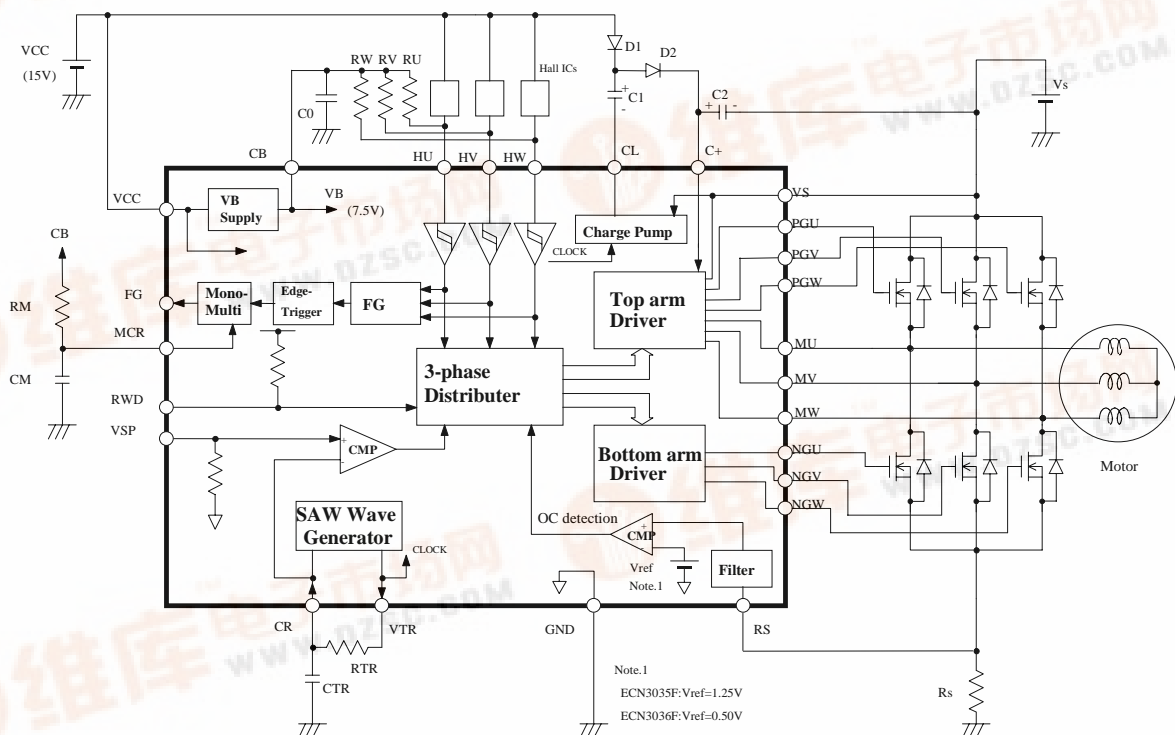


Fig.1 Block diagram

ECN3035F/3036F

1. General

- (1) Type ECN3035F, ECN3036F
- (2) Application 3-Phase DC Brushless Motor
- (3) Structure Monolithic IC
- (4) Package FP-28DJ(JEDEC)

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

| No. | Items | Symbols | Terminal | Ratings | Unit | Condition |
|-----|---------------------------------|---------|------------------------|---------------|------|-----------|
| 1 | Output Device Breakdown Voltage | VSM | VS MU,MV,MW | 500 | V | |
| 2 | Supply Voltage | VCC | VCC | 18 | V | |
| 3 | Input Voltage | VIN | VSP,RS,RWD HU,HV,HW | -0.5 ~ VB+0.5 | V | |
| 4 | Operating Junction Temperature | Tjop | | -20 ~ +125 | °C | Note 1 |
| 5 | Storage Temperature | Tstg | | -40 ~ +150 | °C | |

Note1. Thermal resistance (Rj-a) is approximately 100°C /W. (When ICs are installed on a print board.)
The value of this resistance is determined by the result of the trial product.

3. Recommended Operating Conditions

| No. | Items | Symbols | Terminal | MIN | TYP | MAX | Unit | Condition |
|-----|----------------|---------|----------|------|-----|------|------|---------------------------------|
| 1 | Supply Voltage | VS | VS | 50 | - | 380 | V | Within allowable rating at Tjop |
| 2 | | VCC | VCC | 13.5 | 15 | 16.5 | V | |

ECN3035F/3036F

4. Electrical Characteristics (Ta=25°C)

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

Suffix T; Top arm B; Bottom arm

Suffix *:U,V,W Phase

| No. | Items | Symbols | Terminal | MIN | TYP | MAX | Unit | Condition |
|-----|--|---------|-----------------|-----------------|--------|-----------------|------|--|
| 1 | Standby Current | IS | VS | - | 1.0 | 2.5 | mA | VSP<VSAWL |
| 2 | | ICC | VCC | - | 3.0 | 6.0 | mA | HU=L |
| 3 | Output Source Current | IO+T | PG* | 30 | 50 | 100 | mA | 20V between C+ and PG* |
| 4 | | IO+B | NG* | 100 | 200 | 300 | mA | 10V between VCC and NG* |
| 5 | Output Sink Current | IO-T | PG* | 100 | 200 | 300 | mA | 10V between PG* and M* |
| 6 | | IO-B | NG* | 100 | 200 | 300 | mA | 10V between NG* and GND |
| 7 | High Level Output Voltage | VOHT | C+,PG* | - | - | 0.2 | V | Between C+ and PG* Voltage |
| 8 | | VOHB | VCC,NG* | - | - | 0.2 | V | Between VCC and NG* Voltage |
| 9 | Low Level Output Voltage | VOLT | PG*,M* | - | - | 0.2 | V | Between PG* and M* Voltage |
| 10 | | VOLB | NG*,GND | - | - | 0.2 | V | Between NG* and GND Voltage |
| 11 | Output Resistance at VTR terminal | RVTR | VTR | - | 200 | 400 | Ω | IVTR=1mA |
| 12 | Amplitude 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.5 |
| 15 | Reference Voltage for Over Current detection | Vref | RS | 1.10 | 1.25 | 1.35 | V | only for ECN3035F |
| | | | | 0.45 | 0.50 | 0.55 | V | only for ECN3036F |
| 16 | Input Voltage | VIH | HU,HV,HW | 3.5 | - | - | V | |
| 17 | | VIL | RWD | - | - | 1.5 | V | |
| 18 | Input Current | IIH | VSP | - | - | 50 | uA | VSP=5.0V Note 1 Pull Down Resistance |
| 19 | | IIL | HU,HV,HW RWD | -100 | - | - | uA | HU,HV,HW,RWD=0V Note 1 Pull Up Resistance |
| 20 | VB Output Voltage | VB | CB | 6.8 | 7.5 | 8.2 | V | IB=0mA |
| 21 | VB Output Current | IB | CB | 25 | - | - | mA | delta VB≤0.2V |
| 22 | Output Resistance at FG terminal | RFG | FG | - | 250 | 400 | Ω | Note 3 IFG=1mA |
| 23 | Reference Voltage for FG pulse | Vref2 | MCR | VB×2/3 ×0.95 | VB×2/3 | VB×2/3 ×1.05 | V | Note 4 |
| 24 | Charge Pump Voltage | VCP | C+,VS | 13.3 | 14.5 | - | V | At stand-by Note 6 |

Note1.The pull up resistance and the pull down resistance are typically 200 kΩ.

Note2.Please see Note 2 in item 6 for determining the frequency of SAW wave.

Note3.The equivalent circuit at FG terminal is shown in Fig. 2

Note4.Please see Note 3 in item 6 for determining the FG output pulse width.

Note5.The amplitude of SAW(VSAWW) is determined by the following equation,

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

Note6.The charge pump voltage (VCP) is determined by the voltage between C+ and VS.

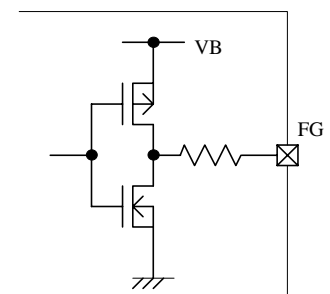


Fig. 2 Equivalent circuit around FG

ECN3035F/3036F

5. Function

5.1 Truth Table

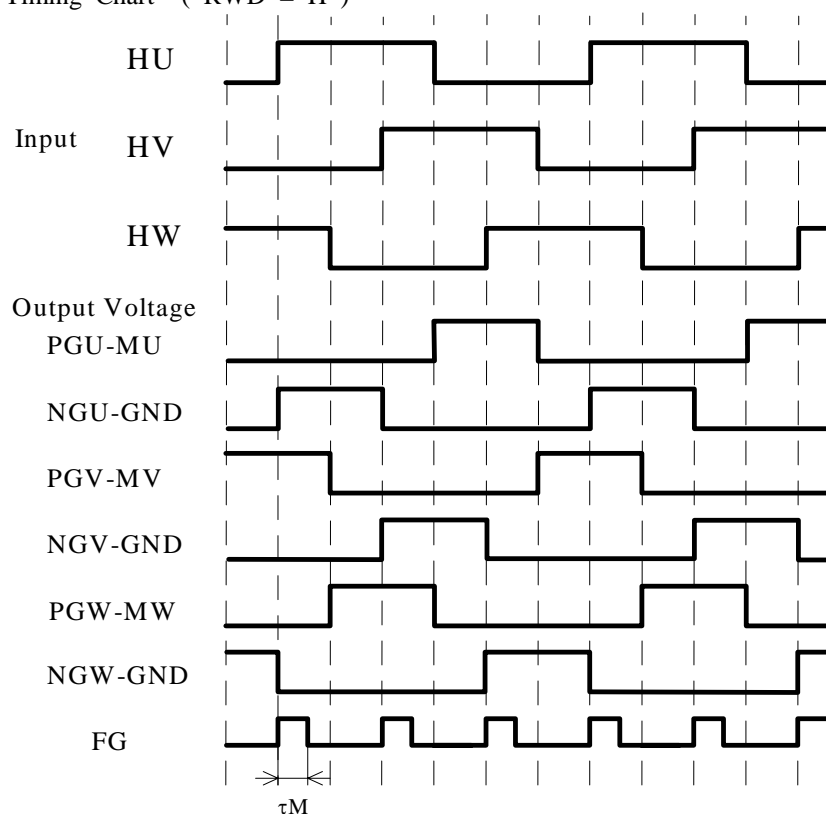
| Input | | | | U Phase | | V Phase | | W Phase | |
|-------|----|----|----|---------|--------|---------|--------|---------|--------|
| RWD | HU | HV | HW | Top | Bottom | Top | Bottom | Top | Bottom |
| H | H | L | H | L | H | H | L | L | L |
| H | H | L | L | L | H | L | L | H | L |
| H | H | H | L | L | L | L | H | H | L |
| H | L | H | L | H | L | L | H | L | L |
| H | L | H | H | H | L | L | L | L | H |
| H | L | L | H | L | L | H | L | L | H |
| L | H | H | L | L | L | H | L | L | H |
| L | H | L | L | H | L | L | L | L | H |
| L | H | L | H | H | L | L | H | L | L |
| L | L | L | H | L | L | L | H | H | L |
| L | L | H | H | L | H | L | L | H | L |
| L | L | H | L | L | H | H | L | L | L |
| - | L | L | L | L | L | L | L | L | L |
| - | H | H | H | L | L | L | L | L | L |

Note1. Top arm : Output voltage for between PG* and M*.

Bottom arm : Output voltage for between NG* and GND.

Note2. It is possible to change the rotation direction of the motor by putting a signal into RWD terminal.
A method of using is shown in item 5.7.

5.2 Timing Chart (RWD = H)



ECN3035F/3036F

5.3 PWM Operation

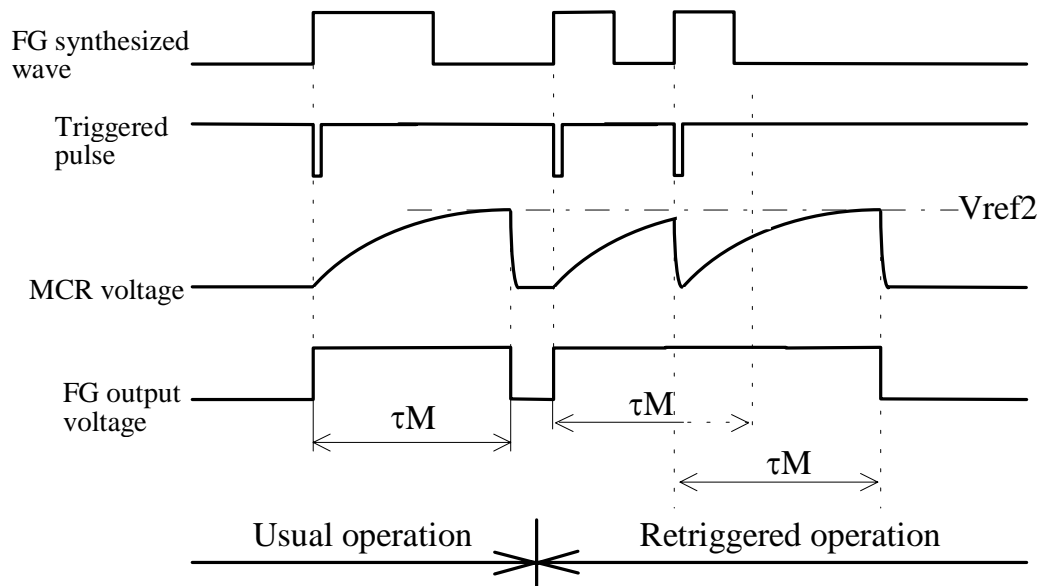
The PWM signal is produced by comparing the input voltage at VSP terminal with the voltage from the internal SAW wave. The duty of the PWM signal can be changed linearly by the triangular wave amplitude level, from the minimum point of VSAWL to the maximum point of VSAWH, and when the level is under 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 FG operation

One shot pulse is put out at this terminal synchronized with the rising edge of the synthesized signal of the hole signal HU, HV, HW. The pulse width τM is decided by the constant number which is determined by R and C at MCR terminal(See No.6 Standard Application.). One shot pulse is produced in a mono-multi circuit. This circuit has a retrigger feature which keeps the output signal high when a trigger is input during high signal of FG output.



5.6 VCC Under Voltage Detection Operation

When VCC becomes lower than the determined voltage, all arms operation and the charge pump operation are forced to stop. The detection voltage is typically 11.5V, and it also has a hysteresis of 0.5V. However, there may be a case when the operation is canceled under 2V of VCC.

5.7 Rotating Direction of the Motor

The rotating direction of the motor can be changed by inputting "H" or "L" signal to RWD terminal. Please do not change this signal at operation. This may cause short through of the output Device. However, it is OK if the VSP input voltage is below VSAWL(1.7V typ.) before RWD input voltage change so that the short through is avoided.

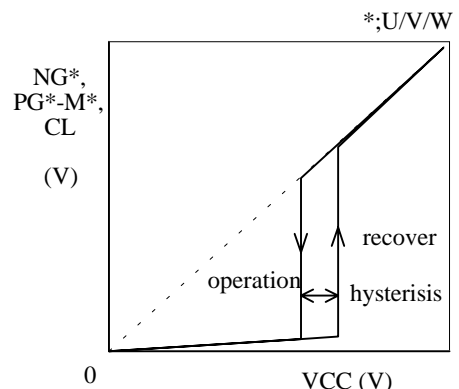


Fig 3. Protection operation for VCC under voltage

ECN3035F/3036F

6. Standard Application

6.1 External Parts

| Component | Recommended Value | Usage | Remark |
|-----------|--|--|-----------------------------------|
| C0 | More than 0.22 μ F | for smoothing Internal Power Supply(VB). | stress voltage is VB |
| C1,C2 | 1.0 μ F \pm 20% | for charge pump | stress voltage is VCC |
| D1,D2 | Hitachi DFG1C6(glass mold) or equivalent parts | for charge pump | 600V/1.0A $t_{rr} \leq 100$ ns |
| Rs | Note 1 | for current limiting | |
| CTR | 1800 pF \pm 5% | for PWM | Note 2 |
| RTR | 22 k Ω \pm 5% | | |
| RU,RV,RW | 5.6k Ω \pm 5% | pull up resistance | |
| CM | More than 1000pF | for Output Pulse width at FG terminal | Note 3 |
| RM | More than 10k Ω | | |

Note1. The start up current is limited by the following equation.

$$I_O = V_{ref} / R_s \quad (A)$$

Note2. The PWM frequency is approximately determined by the following equation. At the recommended Value of CR, the error factor of IC is about 10%.

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

$$= 0.494 / (C \times R) \quad (Hz)$$

Note3. The FG output pulse width is determined approximately by the following equation.

$\tau_M \geq 10 \mu s$ should be necessary.

$$\tau_M = -(CM \times RM \times \ln(1 - VB \times 2/3 / VB))$$

$$= 1.1 \times CM \times RM \quad (s)$$

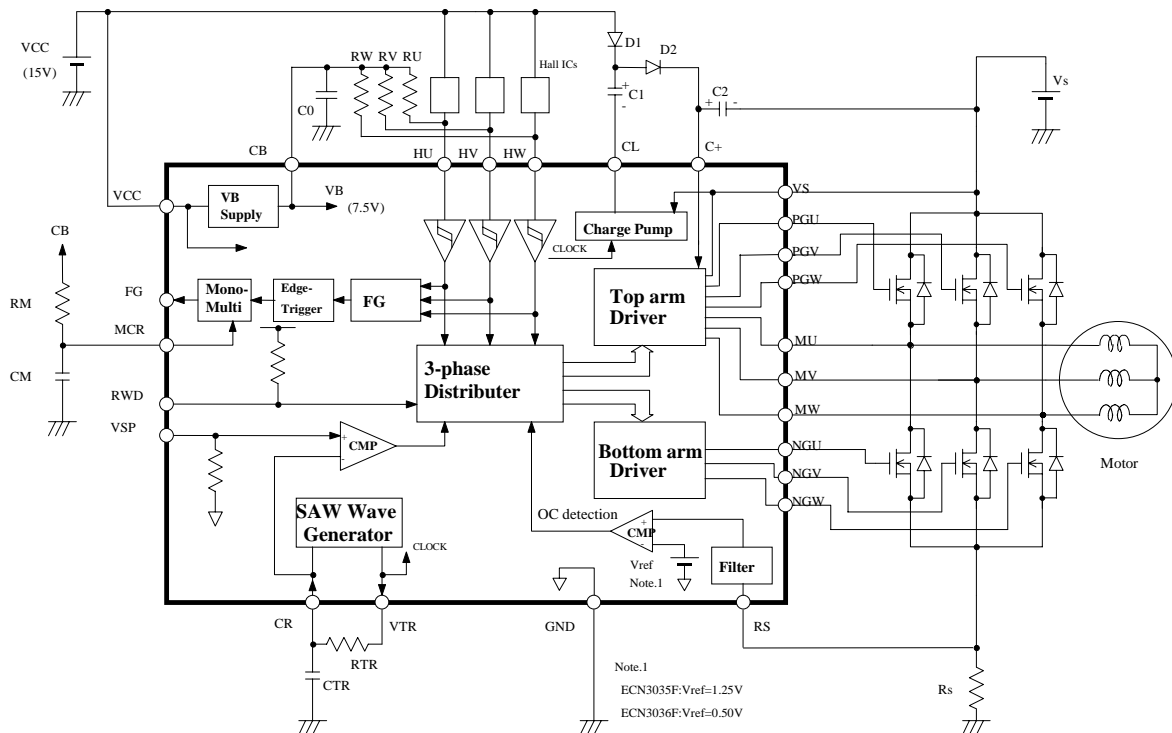


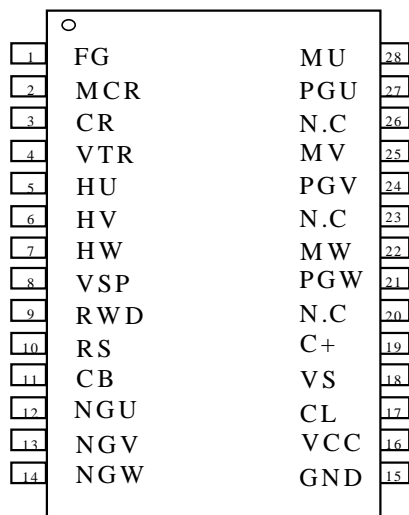
Fig.4 Block diagram with external parts

6.2 Supply Voltage Sequence

The order for turning on power supplies should be (1)Vcc, VS (2)VSP. The order for turning off should be (1)VSP (2)VS, Vcc. When the order is mistaken, there may be a case when the external bridge circuit is broken.

ECN3035F/3036F

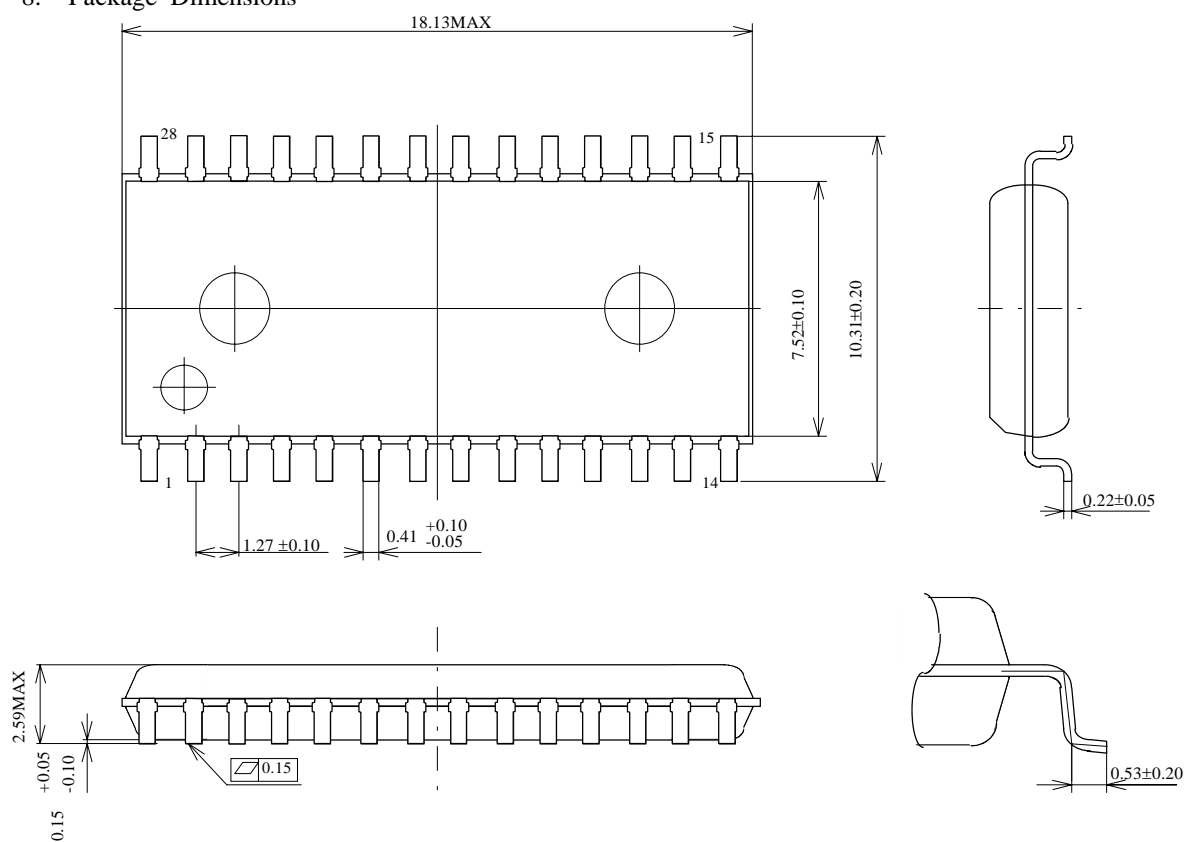
7. Terminal



(Marking side)

Fig. 5 Pin connection

8. Package Dimensions



HITACHI POWER SEMICONDUCTORS

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