**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)
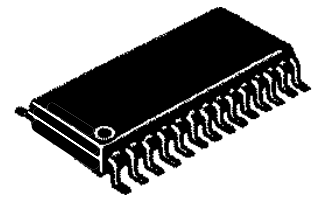
Features

* Speed control for a 3-phase DC brushless motor is available with an external microprocessor.
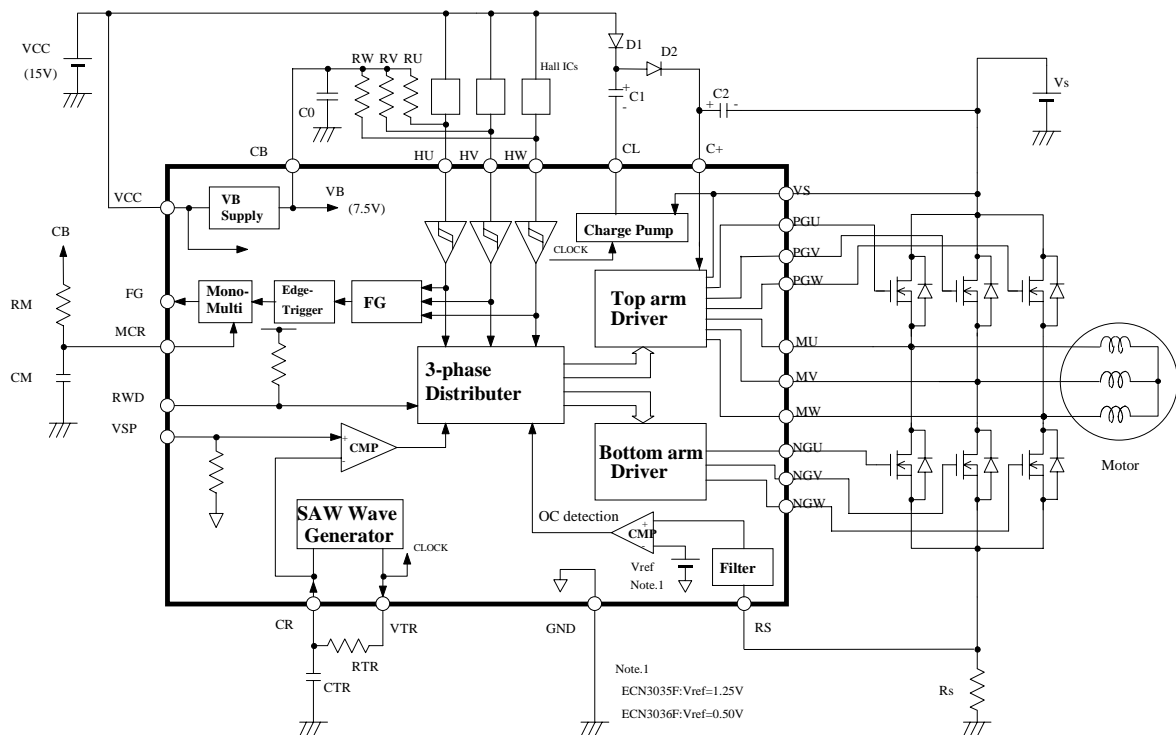* Bottom arm circuits can be operated in 20kHz chopping frequency of PWM.

Note.1
ECN3035F:Vref=1.25V
ECN3036F:Vref=0.50V

Fig.1   Block diagram

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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	$-0.5 \sim VB+0.5$	V	
4	Operating Junction Temperature	Tjop		$-20 \sim +125$	°C	Note 1
5	Storage Temperature	Tstg		$-40 \sim +150$	°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	

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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	IO=0A
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   (V)
Note6. The charge pump voltage (VCP) is determined by the voltage between C+ and VS.

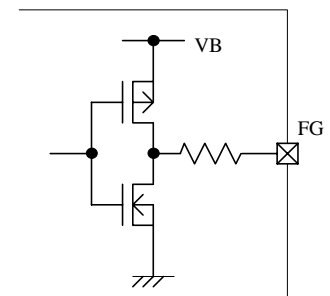Fig. 2   Equivalent
          around FG

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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)
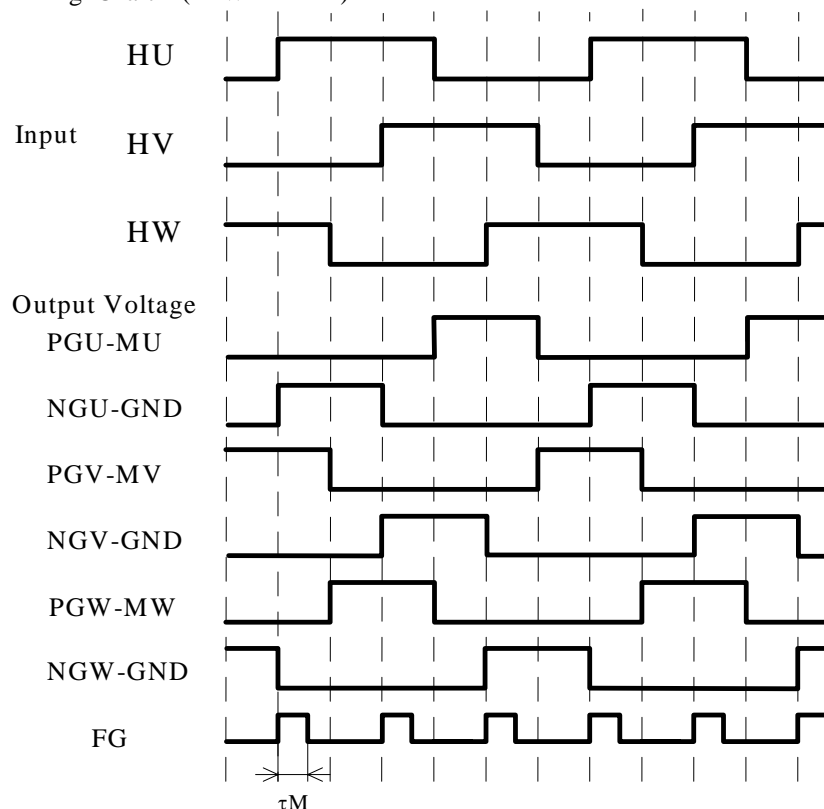
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5.3 PWM Operation

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 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.
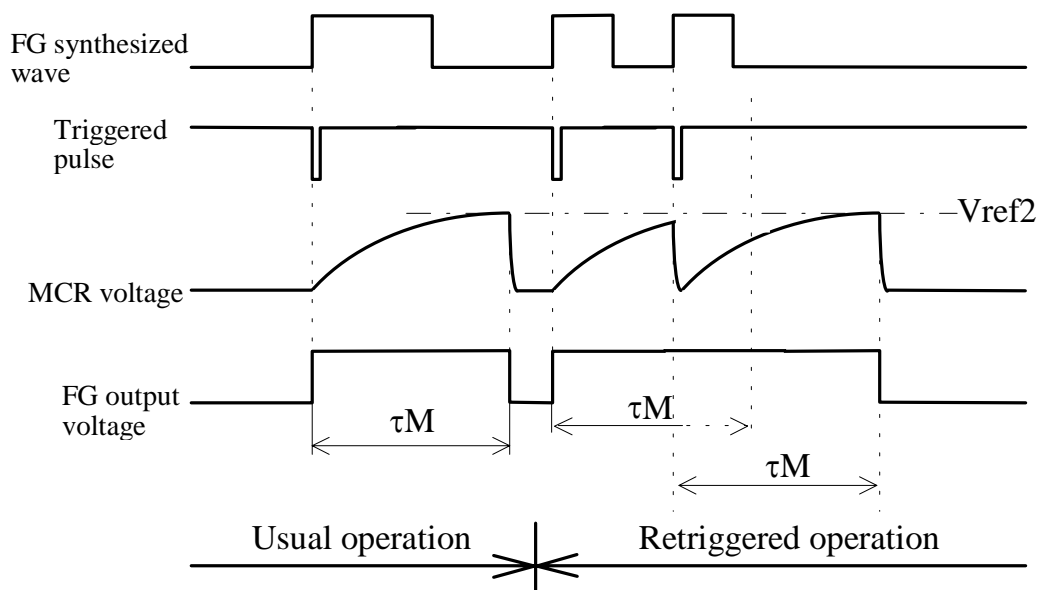
5.6 VCC Under Voltage Detection Operation

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 hysterisis 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.
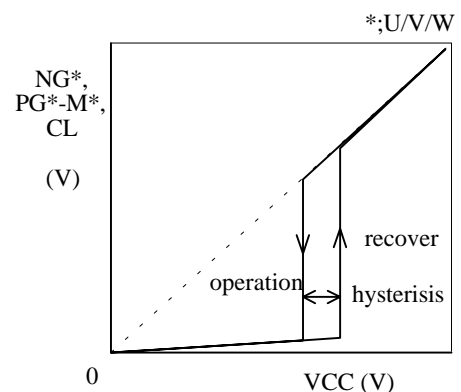

Fig 3. Protection operation for VCC under voltage

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6. Standard Application

6.1 External Parts

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

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

$$IO = Vref / Rs \quad (A)$$

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%.

$$fPWM = -1 / (2C \times R \times Ln(1-3.5/5.5)) \quad ; Ln \text{ is natural logarithm}$$
$$= 0.494 / (C \times R) \quad (Hz)$$

Note3. The FG output pulse width is determined approximately by the following equation. $\tau M \geq 10\mu s$ should be necessary.

$$\tau M = -(CM \times RM \times Ln(1-VB \times 2/3/VB))$$
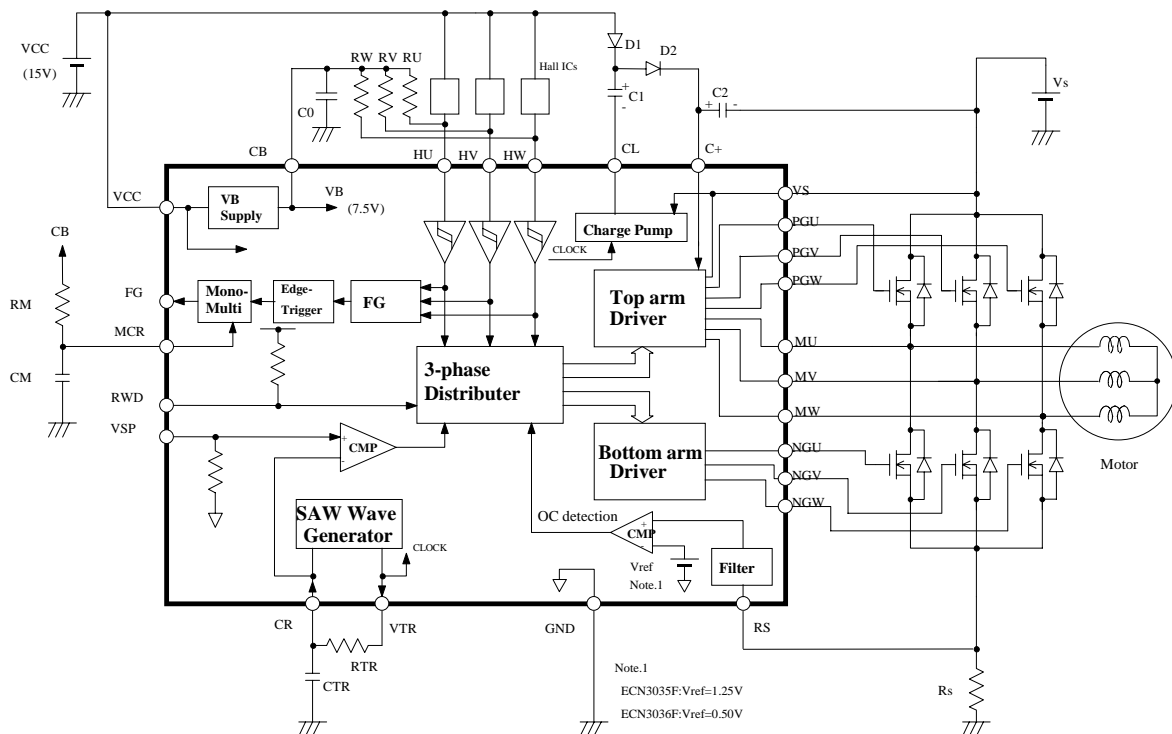$$= 1.1 \times CM \times RM \quad (s)$$

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.

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7. Terminal

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       ○
  1  FG          MU   28
  2  MCR         PGU  27
  3  CR          N.C  26
  4  VTR         MV   25
  5  HU          PGV  24
  6  HV          N.C  23
  7  HW          MW   22
  8  VSP         PGW  21
  9  RWD         N.C  20
 10  RS          C+   19
 11  CB          VS   18
 12  NGU         CL   17
 13  NGV         VCC  16
 14  NGW         GND  15
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(Marking side)

Fig. 5   Pin connection

8. Package Dimensions

18.13MAX

28

15

7.52±0.10

10.31±0.20

1

14

1.27 ±0.10

0.41 +0.10 −0.05

0.22±0.05

2.59MAX

0.15 +0.05 −0.10

0.15

0.53±0.20

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