

3-Phase Motor Driver IC

ECN30624 Product Specification

Rev. 2

1. Product Description

1.1 Features

- (1) Maximum Ratings: 600VDC/3.0A, suitable for the system from 200VAC to 240VAC
- (2) PWM control of top and bottom arm IGBTs is possible with six control signals
- (3) Six IGBTs, six FWDs (Free-Wheeling Diodes), drivers for IGBTs, protection circuits, etc. integrated into a single chip, resulting in space reduction
- (4) Drives a motor using a high voltage DC power supply and a low voltage DC power supply (15V)
- (5) Motor under free run condition detected by built-in back electromotive force (hereinafter called "back EMF") detection circuit
- (6) A capacitor for top arm power supply is built in, so external capacitor is not required
- (7) Insulation distance for high voltage pins is ensured

1.2 Functions

- (1) Back EMF detection (Two phases)
- (2) Prevention function against simultaneous ON of top and bottom arm IGBTs
- (3) Over-current protection (detects at 0.8V)
- (4) Over temperature protection
- (5) Fault function (Over-current protection, over temperature protection, Vcc low-voltage detection, shutdown function)
- (6) Protection recovery time adjusting function (automatic recovery)
- (7) Vcc low-voltage detection
- (8) 5V power supply circuit
- (9) Shutdown function

1.3 Block Diagram of IC

FIGURE 1.3.1 shows block diagram.

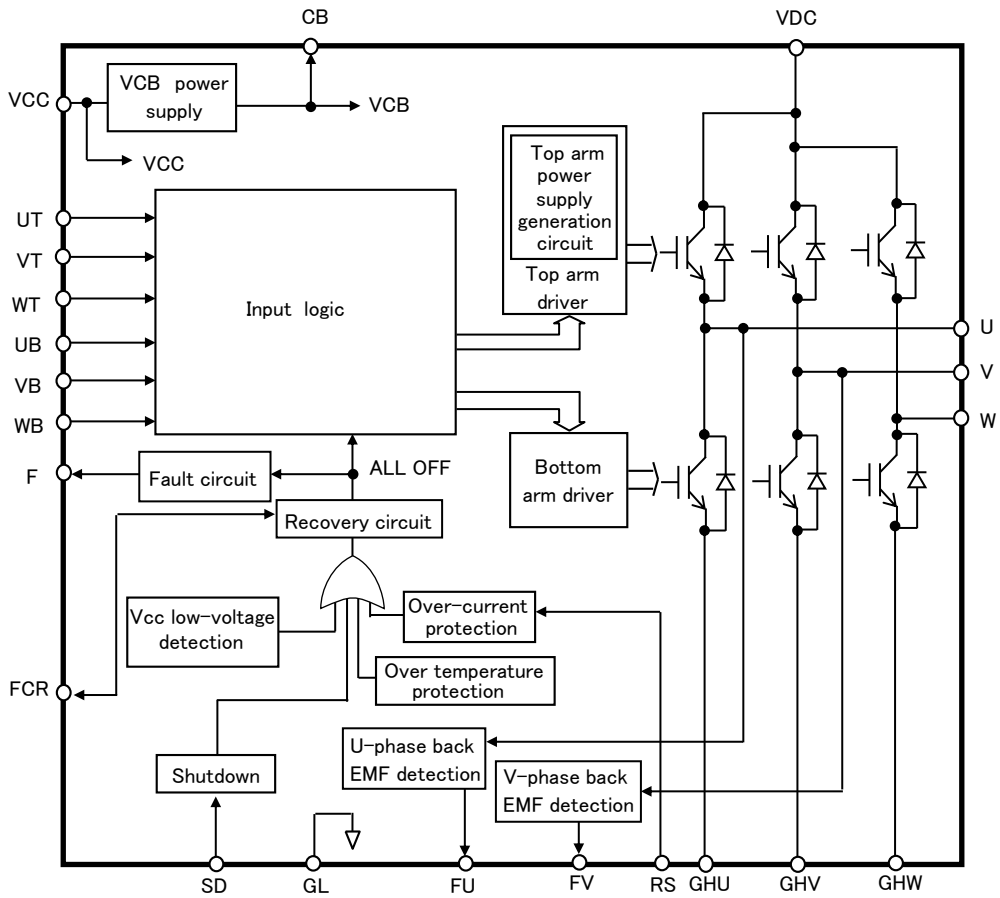
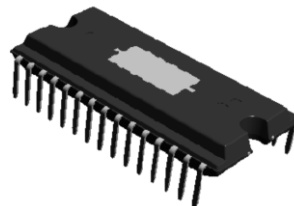


FIGURE 1.3.1 Block Diagram of IC

1.4 Package



ECN30624PN
(Package: DIP26N)

FIGURE 1.4.1 Package of ECN30624

2. Specification

2.1 Maximum Ratings

TABLE 2.1.1 Maximum Ratings

Condition: Ta=25°C

No.	Item	Symbol	Pin	Rating	Unit	Condition
1	Output device withstand voltage	VDCM	VDC U, V, W	600	V	
2	Vcc power supply voltage	VCC	VCC	18	V	
3	Input voltage	VIN	UT, VT, WT, UB, VB, WB, RS, SD, FCR	-0.5 to VCB+0.5	V	
4	Output current	Pulse	IP	U, V, W	A	Note 1
5		DC				
				2.0		
6	Fault output voltage	Vflt	F	-0.5 to Vcc+0.5	V	
7	FU, FV output voltage	VFU, VFV	FU, FV	-0.5 to VCB+0.5	V	
8	VCB supply output current	ICBMAX	CB	50	mA	
9	Junction operating temperature	Tjop	—	-40 to +135	°C	Note 2
10	Junction temperature	Tj	—	+150	°C	
11	Storage temperature	Tstg	—	-40 to +150	°C	

Note 1: Output IGBTs can handle this peak current.

Note 2: Thermal resistance

Between junction and case: Rjc = 3°C/W (Reference value)

2.2 Electrical Characteristics

TABLE 2.2.1 Electrical Characteristics (1/2) Suffix (T: Top arm, B: Bottom arm) Condition: Ta=25°C

No.	Item	Symbol	Pin	Min.	Typ.	Max.	Unit	Condition		
1	Standby current	IDCH	VDC	—	0	0.1	mA	UT,VT,WT,UB,VB,WB=0V VDC=325V, VCC=15V, ICB=0A		
2		ICC	VCC	—	5	10	mA			
3	IGBT collector-emitter	VONT	U, V, W	—	2.0	3.0	V	I=0.7A, VCC=15V		
4	saturation voltage	VONB		—	2.0	3.0	V			
5	Free-wheeling diode	VFDT	U, V, W	—	1.6	2.8	V	I=0.7A		
6	forward voltage	VFDB		—	1.6	2.8	V			
7	Output delay time	Turn ON	TdONT	U, V, W	—	0.7	1.1	μs	VDC=325V, VCC=15V I=0.7A, Resistance load	
8			TdONB		—	0.7	1.1	μs		
9		Turn OFF	TdOFFT		—	0.7	1.1	μs		
10			TdOFFB		—	0.7	1.1	μs		
11	Minimum pulse width	TMIN	U, V, W	0.5	—	—	μs	VCC=15V	Note 1	
12	RS input current	IILRS	RS	-100	—	—	μA	VCC=15V, RS=0V Note 2		
13	UT,VT,WT, UB,VB,WB, inputs	Voltage	VIH	UT, VT, WT, UB, VB, WB	2.5	—	—	V	VCC=15V	
14			VIL		—	—	1.0	V		
15		Current	IIH		—	—	100	μA	Input =4.5V VCC=15V	Pull-down resistor Note 3
16			IIL		-10	—	—	μA	Input =0V VCC=15V	
17	VCB supply output	Voltage	VCB	CB	4.5	5.0	5.5	V	VCC=15V, ICB=0A	
18		Current	ICB		—	—	45	mA	VCC=15V	
19	FU, FV output resistance	RONFU, RONFV	FU, FV	—	0.4	0.8	kΩ	IFU, IFV=1mA, VCC=15V Note 4		
20	Back EMF detection level	VIHE	U, V	5.5	—	—	V	VCC=15V,		
21		VILE		—	—	2.5	V	UT,VT,WT,UB,VB,WB=0V		
22	F output resistance	RONF	F	—	0.9	1.8	kΩ	IF=1mA, VCC=15V Note 5		
23	Over-current protection	Reference voltage	Vref1	RS, F, FCR	0.72	0.80	0.88	V	VCC=15V	
24		Delay time	Tref1		—	1.7	3.0	μs		
25	Over temperature protection	Operating temperature	TSDON	U, V, W, F, FCR	135	160	185	°C	VCC=15V	
26		Hysteresis	TSDHYS		—	25	—	°C		
27	Vcc low-voltage detection	Operating voltage	LVSDON	VCC, U, V, W, F	11.0	12.0	12.9	V		
28		Recovery voltage	LVSDOFF		11.1	12.5	13.0	V		

TABLE 2.2.1 Electrical Characteristics (2/2) Suffix (T: Top arm, B: Bottom arm) Condition: Ta=25°C

No.	Item	Symbol	Pin	Min.	Typ.	Max.	Unit	Condition
29	Shutdown function	Operating voltage	SD, F, FCR	1.15	1.23	1.31	V	VCC=15V
30		Recovery voltage		1.10	1.18	1.26	V	
31		Delay time		Tref2	—	2.5	5.0	
32	SD pin input current	I _{IHSD}	SD	—	—	2	μA	VCC=15V, SD=4.5V Note 6
33		I _{ILSD}		-2	—	—	μA	
34	FCR output resistance	R _{ONFCR}	FCR	—	0.4	0.8	kΩ	I _{FCR} =1mA, VCC=15V Note 7
35	Protection recovery time	Trs1	FCR	—	1.0	2.0	ms	When VCC=15V, C _{FCR} =1000pF is connected to GL, and R _{FCR} =1MΩ is connected to CB Note 8
36		Trs2		20	-	-	μs	

Note 1: The minimum pulse width to be able to turn on and off top and bottom arms.

Note 2: Internal pull-up resistor is typically 200kΩ. The equivalent circuit is shown in FIGURE 2.2.1.

Note 3: Internal pull-down resistor is typically 200kΩ. The equivalent circuit is shown in FIGURE 2.2.2.

Note 4: The equivalent circuit is shown in FIGURE 2.2.3.

Note 5: The equivalent circuit is shown in FIGURE 2.2.4.

Note 6: The equivalent circuit is shown in FIGURE 2.2.5.

Note 7: The equivalent circuit is shown in FIGURE 2.2.6.

Note 8: Typical value when the protection recovery time adjusting function is enabled. Details are shown in Section 2.4.6.

Note 9: Typical value when the protection recovery time adjusting function is disabled. Details are shown in Section 2.4.6.

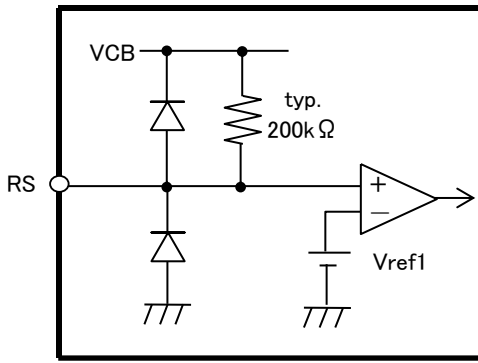


FIGURE 2.2.1 Equivalent Circuit Around RS Pin

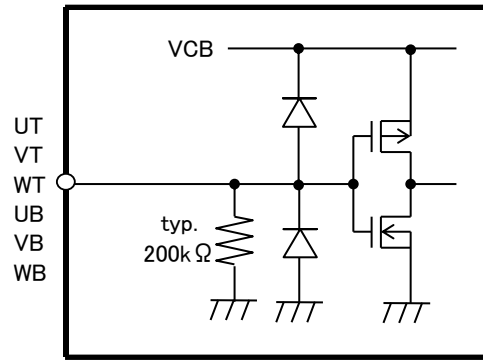


FIGURE 2.2.2 Equivalent Circuit Around UT, VT, WT, UB, VB, WB Pins

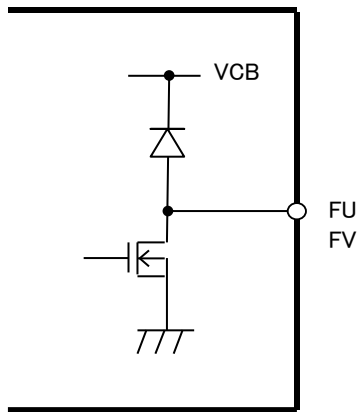


FIGURE 2.2.3 Equivalent Circuit Around FU, FV Pins

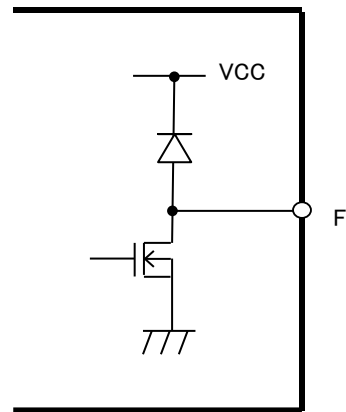


FIGURE 2.2.4 Equivalent Circuit Around F Pin

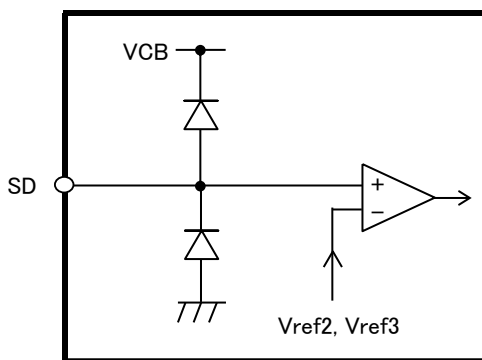


FIGURE 2.2.5 Equivalent Circuit Around SD Pin

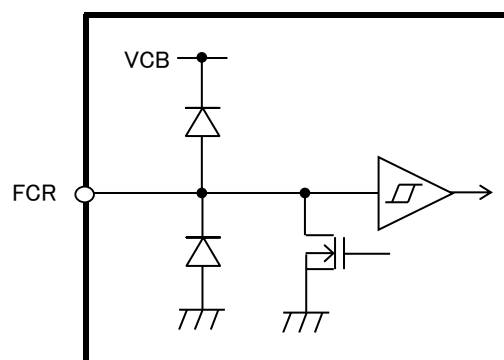


FIGURE 2.2.6 Equivalent Circuit Around FCR Pin

2.3 Operating Condition

TABLE 2.3.1 Operating Condition

No.	Item	Symbol	Pin	Min.	Typ.	Max.	Unit	Condition
1	Supply voltage	VDCop	VDC	100	325	450	V	
2		VCCop	VCC	13.5	15.0	16.5	V	
3	GH voltage	Vgh	GHU, GHV, GHW	-1.2	—	1.2	V	Based on GL pin
4	Dead time	Tdt	UT, VT, WT, UB, VB, WB	1.0	—	—	μs	
5	PWM frequency	fPWM	UT, VT, WT, UB, VB, WB	14	—	30	kHz	Note 1

Note 1. Depending on the usage conditions, this frequency may go in an audible band, generating noise.

2.4 Functions and Operations

2.4.1 Truth Table

TABLE 2.4.1.1 Truth Table

Input UT, VT, WT UB, VB, WB	IGBT operation
L	OFF
H Note 1	ON

Note 1: When the top input and bottom input in the same phase are “H” simultaneously, the top and bottom arm IGBTs in this phase are both off.

2.4.2 Over-current Protection

When the voltage at the RS pin reaches the over-current protection reference voltage (V_{ref1} , typ. 0.80V), the F output is “L”, and all IGBTs (top and bottom arms) are turned off. When the voltage at the RS pin drops below the over-current protection reference voltage (V_{ref1} , typ. 0.80V) and the over-current protection recovery time passes, the F output is “H”, and the IC automatically returns to a state in which the IGBTs operate depending on input signals. The protection recovery time is adjustable using FCR pin, and the adjustment method is shown in Section 2.4.6.

FIGURE 2.4.2.1 shows the timing chart for the over-current protection operation.

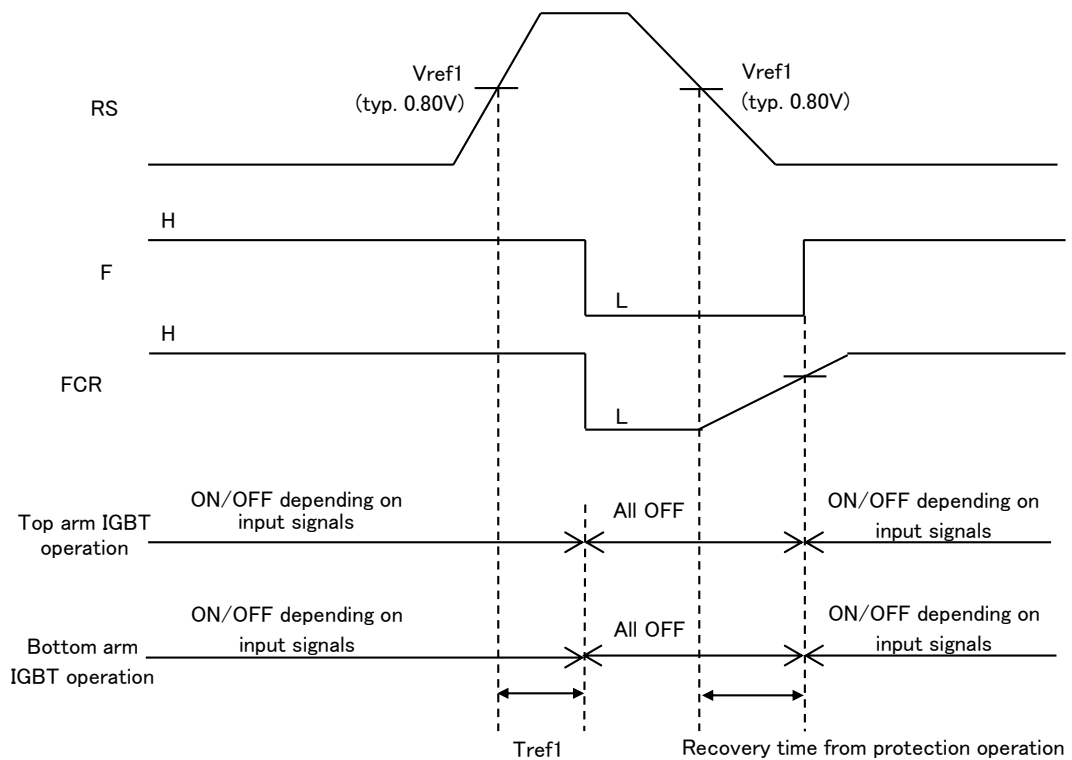


FIGURE 2.4.2.1 Timing Chart for Over-current Protection Operation

2.4.3 Vcc Low-voltage Detection

When the Vcc voltage drops below the operating voltage of the Vcc low-voltage detection (LVSDON, typ. 12.0V), the F output is "L", and all IGBTs (top and bottom arms) are turned off. When the Vcc voltage goes up above the recovery voltage of the Vcc low-voltage detection (LVSDOFF, typ. 12.5V) and the protection recovery time (Trs2) passes, the F output is "H", and the IC automatically returns to a state in which the IGBTs operate depending on input signals. The protection recovery time is fixed at Trs2.

FIGURE 2.4.3.1 shows the timing chart for the Vcc low-voltage detection operation.

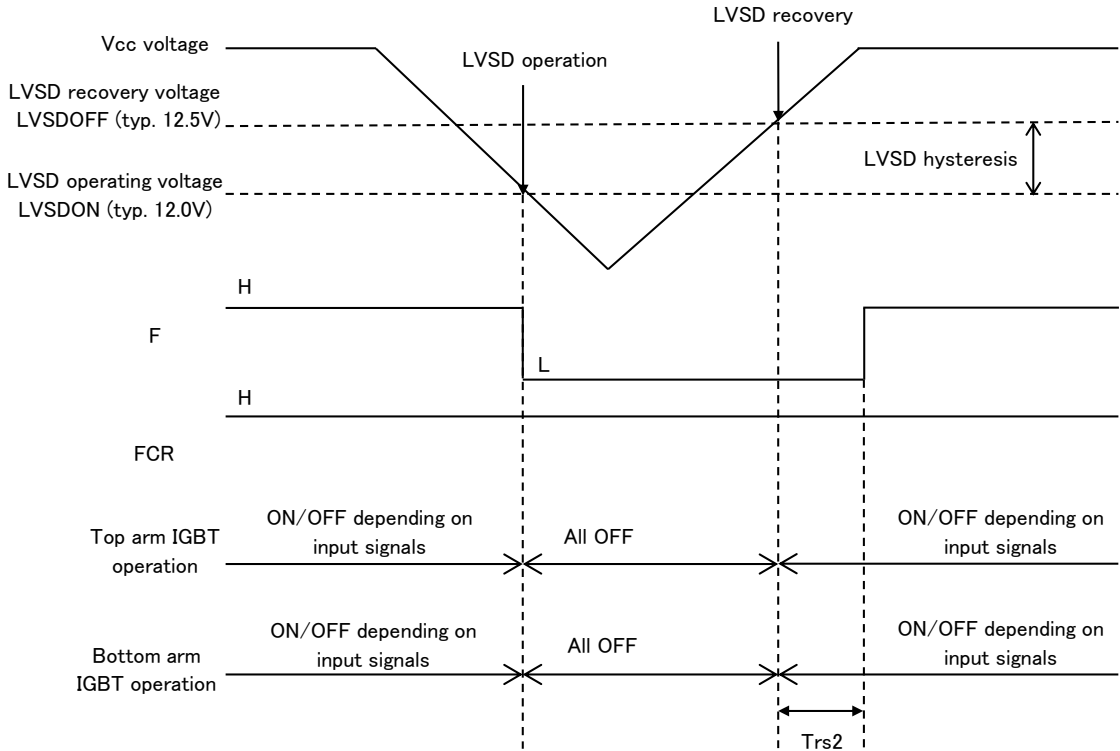


FIGURE 2.4.3.1 Timing Chart for Vcc Low-voltage Detection Operation (LVSD Operation)

2.4.4 Over Temperature Protection

When the IC temperature exceeds the operating temperature of over temperature protection (TSDON, typ. 160°C), the F output is “L”, and all IGBTs (top and bottom arms) are turned off. When the IC temperature goes down the hysteresis (TSDHYS, typ. 25°C) from the operating temperature of over temperature protection (TSDON, typ. 160°C) and protection recovery time passes, the F output is “H”, and the IC automatically returns to a state in which the IGBTs operate depending on input signals. The protection recovery time is adjustable using FCR pin, and the adjustment method is shown in Section 2.4.6.

FIGURE 2.4.4.1 shows the timing chart for the over temperature protection operation.

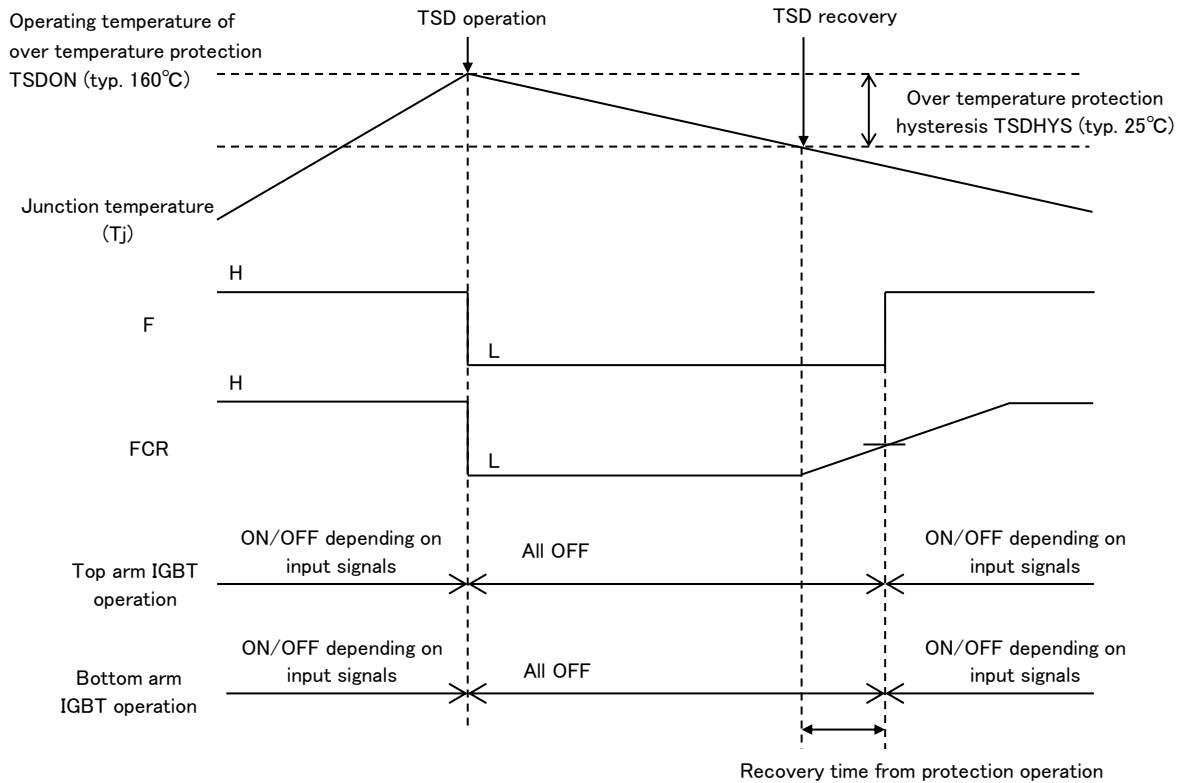


FIGURE 2.4.4.1 Timing Chart for Over Temperature Protection Operation

2.4.5 Shutdown Function

When the voltage at the SD pin reaches the shutdown operating voltage (Vref2, typ. 1.23V), the F output is “L”, and all IGBTs (top and bottom arms) are turned off. After that, when the voltage at the SD pin falls below the shutdown recovery voltage (Vref3, typ. 1.18V) and protection recovery time passes, the F output is “H”, and the IC automatically returns to a state in which the IGBTs operate depending on input signals. The protection recovery time is adjustable using the FCR pin, and the adjustment method is shown in Section 2.4.6.

This function can be used as an over-voltage protection when over-voltage is applied on the VDC pin. The operating voltage and recovery voltage of the over-voltage protection are adjustable by the resistance values of external resistors ROVP1 and ROVP2 which are connected between the VDC pin and GL pin. These voltages can be calculated using the following equations:

$$\text{Over-voltage protection operating voltage: } OV_{PON}(V) = \frac{ROVP1(\Omega) + ROVP2(\Omega)}{ROVP2(\Omega)} \times V_{ref2}(V)$$

$$\text{Over-voltage protection recovery voltage: } OV_{POFF}(V) = \frac{ROVP1(\Omega) + ROVP2(\Omega)}{ROVP2(\Omega)} \times V_{ref3}(V)$$

When this function is not used, connect the SD pin to the GL pin. FIGURE 2.4.5.1 shows the timing chart for shutdown function operation.

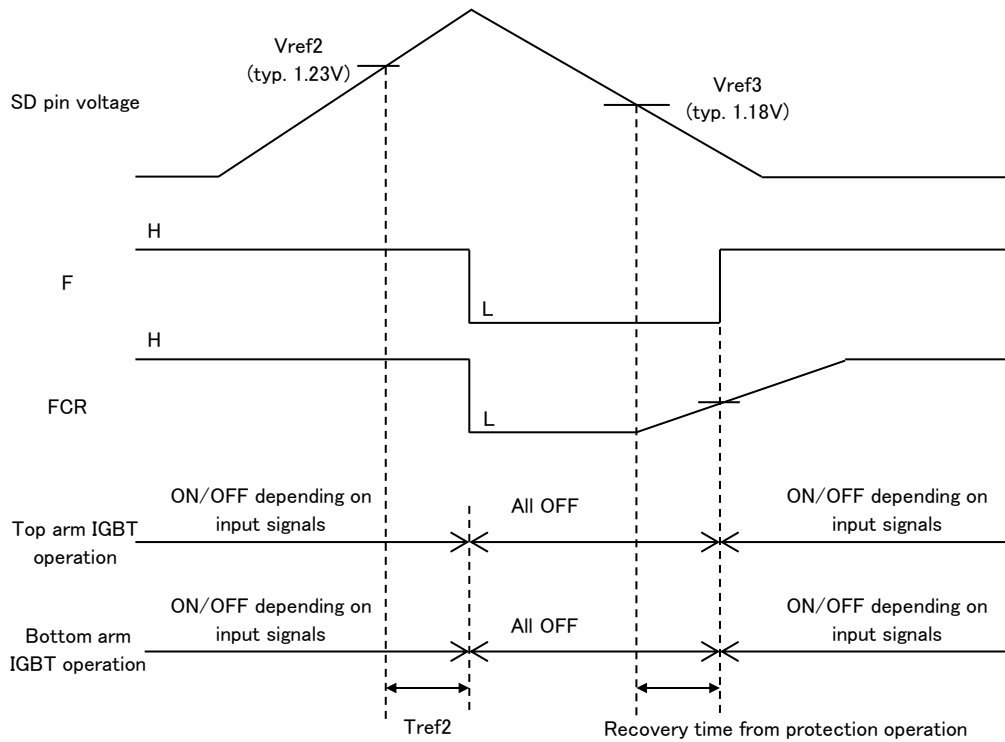


FIGURE 2.4.5.1 Timing Chart for Shutdown Function Operation

2.4.6 Protection Recovery Time Adjusting Function

The FCR pin is used for adjusting the protection recovery time. Connect the RFCR and CFCR between the CB pin and GL pin. Then, connect the midpoint of the CB pin and GL pin to the FCR pin. See the connection example in FIGURE3.1.1. When any of the protection functions (over-current, over temperature, or shutdown) operates, the voltage at the FCR pin is “L”. After that, when the protection recovery conditions are satisfied and protection recovery time (Trs) determined by RFCR and CFCR passes, the F output is “H”, and the IC returns to a state in which the IGBTs operate depending on input signals. On the other hand, when RFCR=10kΩ is connected between the CB pin and FCR pin with the CFCR unconnected, after the protection recovery conditions are satisfied and protection recovery time (Trs2) determined by the internal circuit passes, the F output is “H”, and the IC returns to a state in which the IGBTs operate depending on input signals. When the Vcc low-voltage detection operates, the protection recovery time is Trs2 regardless of RFCR and CFCR values.

Trs can be calculated as follows.

$$Trs(ms) = Trs1 (ms) * \times \frac{RFCR(M\Omega) \times CFCR(pF)}{1(M\Omega) \times 1000(pF)}$$

* Trs1 (typ. 1ms)

Please set RFCR to 500kΩ to 2MΩ and CFCR to 1000pF to 5000pF as a guide.

TABLE 2.4.6 shows the relationship between each protection function and protection recovery time.

FIGURE 2.4.6.1 shows the timing chart in case of FCR pin connected to RFCR and CFCR. FIGURE 2.4.6.2 shows the timing chart in case of RFCR=10kΩ connected to FCR pin with CFCR unconnected.

TABLE 2.4.6 Relationship Between Protection and Protection Recovery Time

Protection function	Protection recovery time	
	When protection recovery time adjusting function is enabled (When RFCR, CFCR are connected to FCR pin)	When protection recovery time adjusting function is disabled (When RFCR=10kΩ is connected to FCR pin with CFCR unconnected)
Vcc low-voltage detection	Trs2	Trs2
Over-current protection	Trs	
Over temperature protection		
Shutdown function		

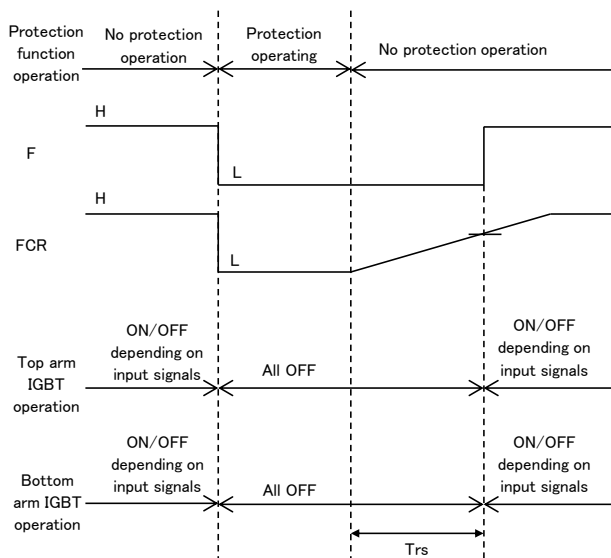


FIGURE 2.4.6.1 Timing Chart in Case of Protection Recovery Time Adjusting Function Enabled (Except for Vcc low-voltage detection)

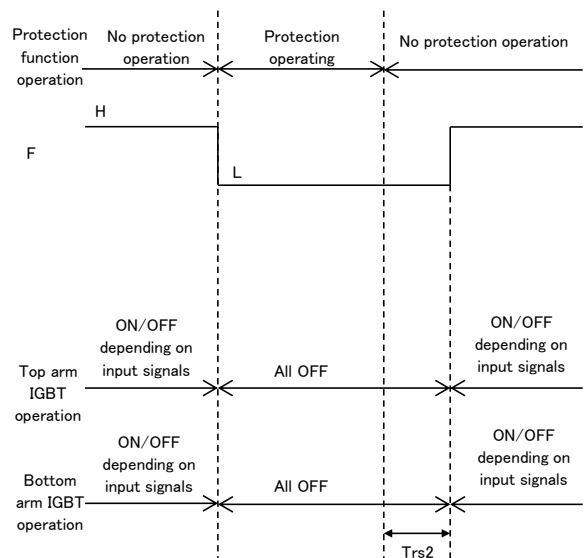


FIGURE 2.4.6.2 Timing Chart in Case of Protection Recovery Time Adjusting Function Disabled

3. Standard Applications

3.1 External Components

TABLE 3.1.1 External Components

Component	Standard value	Usage	Remarks
C0	1μF±10%, 25V	Smooths the internal power supply (VCB)	
CV1	1μF±10%, 25V	Smooths the Vcc power supply	Note 1
CV2	33nF±10%, 630V	Smooths the Vdc power supply	Note 1
Rs	1Ω±1%, 1W	Sets over-current protection	Note 2 for how to set Rs.
RFU,RFV	10kΩ±5%	For pull up	
CF	0.01μF±10%, 25V	Eliminates output noise of Fault signal	
RF	10kΩ±10%	For pull up	
CFCR	1000pF±10%, 25V	Sets protection recovery time	When the protection recovery time adjusting function is enabled, connect RFCR and CFCR to FCR pin.
RFCR	1MΩ±10%		
CFCR	-	-	When the protection recovery time adjusting function is disabled, connect RFCR to FCR pin and do not connect CFCR to FCR pin.
RFCR	10kΩ±10%	For pull up	
ROVP1	-	Sets over-voltage protection operating voltage/recovery voltage	Note 3
ROVP2	-	Sets over-voltage protection operating voltage/recovery voltage	Note 3
COVP	0.1μF±10%, 25V	Eliminates input noise of SD signal	Note 4

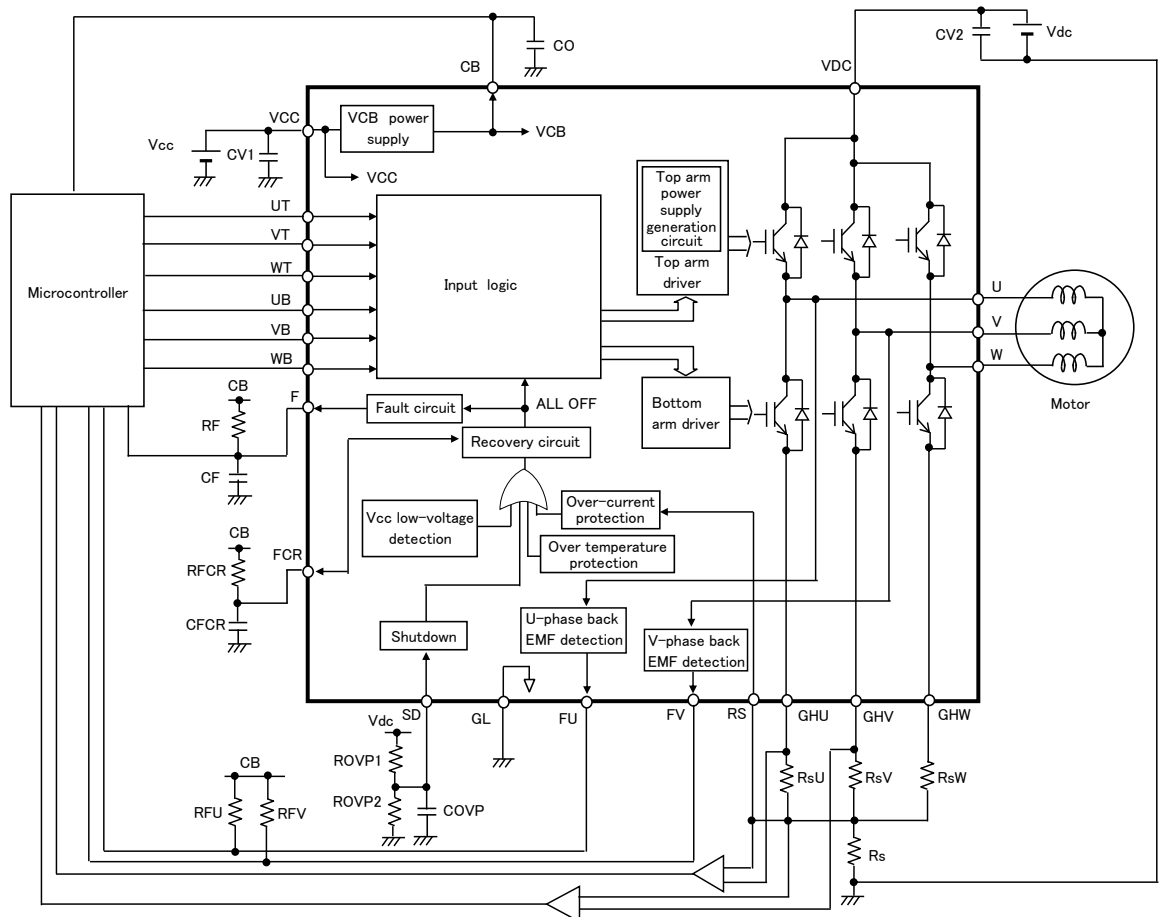


FIGURE 3.1.1 Block Diagram and External Components of IC

Note 1. Caution for smoothing capacitor

As necessary, increase the capacitance and add a zener diode in consideration of noise immunity. Mount each of the components close to the pins of the IC.

Note 2. Caution for Rs resistance setting

The over-current protection set value (IO) can be calculated as follows.

$$IO = Vref1/Rs$$

Vref1: Over current protection reference voltage

Rs: Shunt resistance value

Delay time to turn output IGBT off (Tref1) and variability of Vref1, Rs need to be considered. Observe the output currents of the IC (the coil currents of the motor) and confirm a design margin.

When shunt resistance value is set, GHU, GHV, and GHW voltages are not allowed to exceed the range of GH voltage (Vgh) shown in the Product Specification.

Note 3. Section 2.4.5 shows how to set the resistance values.

Note 4. When influence of noise or others is large, adjust the capacitance of the capacitor as necessary.

3.2 Input Pins (UT, VT, WT, UB, VB, WB)

In some applications, input pins may be sensitive to noise due to high impedance. If noise is detected at an input pin, the following resistor and/or capacitor should be added.

- Resistor : 5.6kΩ ± 5% pull-down resistor between the GL pin and input pins
- Capacitor : 470pF ± 20% ceramic capacitor close to the input pin

4. Safe Operation Area (SOA) and Derating

4.1 Safe Operation Area (SOA)

The current and voltage at output pins must not be outside the SOA shown in FIGURE 4.1.1.

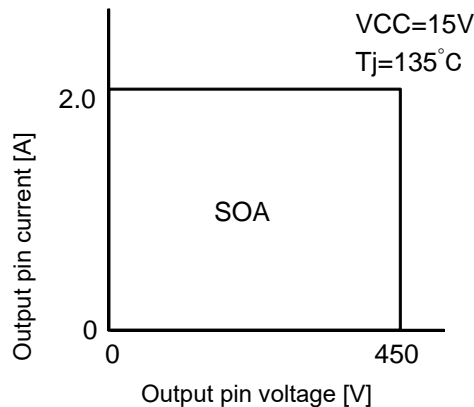


FIGURE 4.1.1 SOA

4.2 Shunt Resistor (Rs) Setting

Delay time to turn output IGBT off (Tref1) and variability of Vref1, Rs need to be considered, and the current must be below the curve of FIGURE 4.1.1.

4.3 General Design Derating Standards

(a) Temperature - Junction operating temperature must be kept under 110°C.

Junction operating temperature depends on various parameters such as power supply voltages, ambient temperature, load, heat dissipation routes, and output ON duty. Test it sufficiently by using actual systems.

5. Pin Locations

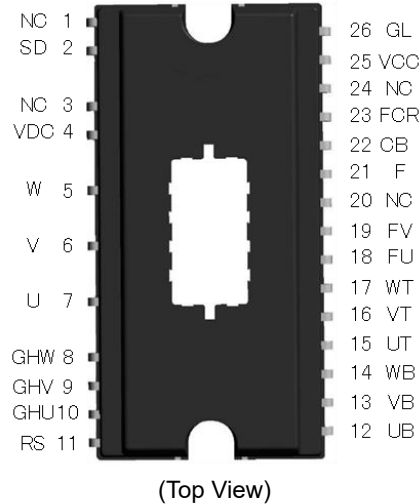


FIGURE 5.1 Pin Locations

6. Pin Assignments

TABLE 6.1 Pin Assignments

Pin No.	Symbol	Pin functions	Remarks
1, 3, 20, 24	NC	No connection	Note 2
2	SD	For shutdown function	
4	VDC	High voltage power supply	Note 1
5	W	W-phase output	Note 1
6	V	V-phase output	Note 1
7	U	U-phase output	Note 1
8	GHW	Emitter of W-phase bottom arm IGBT and anode of W-phase bottom arm FWD	
9	GHV	Emitter of V-phase bottom arm IGBT and anode of V-phase bottom arm FWD	
10	GHU	Emitter of U-phase bottom arm IGBT and anode of U-phase bottom arm FWD	
11	RS	Input for over-current protection	
12	UB	Input control signal for U-phase bottom arm	
13	VB	Input control signal for V-phase bottom arm	
14	WB	Input control signal for W-phase bottom arm	
15	UT	Input control signal for U-phase top arm	
16	VT	Input control signal for V-phase top arm	
17	WT	Input control signal for W-phase top arm	
18	FU	U-phase back EMF signal output	
19	FV	V-phase back EMF signal output	
21	F	Fault signal output	
22	CB	VCB power supply output	
23	FCR	For adjusting protection recovery time	
25	VCC	Control power supply	
26	GL	Ground	

Note 1. High voltage pin.

Note 2. Not connected to the chip in the IC.

Note 3. The tab potential is the same as that of the GL pin. Set the tab potential to open or the same as that of GND. If the tab is mounted on the external cabinet of the motor for heat radiation purposes, the IC will not be able to withstand an insulation withstand voltage test in which a high voltage is applied between the external cabinet and the GND. Please insert an insulation sheet or something similar between the IC tab and the external cabinet.

7. Inspection

Hundred percent inspection shall be conducted on electric characteristics at room temperature. For the operating temperature and hysteresis of the over temperature protection, equivalent inspections are conducted at room temperature.

8. Precautions for Use

8.1 Countermeasures against Electrostatic Discharge (ESD)

- (a) Customers need to take precautions to protect ICs from electrostatic discharge (ESD). The material of the container or any other device used to carry ICs should be free from ESD, which can be caused by vibration during transportation. Use of electrically conductive containers is recommended as an effective countermeasure.
- (b) Everything that touches ICs, such as the work platform, machine, measuring equipment, and test equipment, should be grounded.
- (c) Workers should be high-impedance grounded (100kΩ to 1MΩ) while working with ICs, to avoid damaging the ICs by ESD.
- (d) Friction with other materials, such as high polymers, should be avoided.
- (e) When carrying a PCB with a mounted IC, ensure that the electric potential is maintained at a constant level using the short-circuit terminals and that there is no vibration or friction.
- (f) The humidity at an assembly line where ICs are mounted on circuit boards should be kept around 45 to 75 percent using humidifiers or such. If the humidity cannot be controlled effectively, using ionized air blowers (ionizers) is effective.

8.2 Output Short-circuit Protection

This IC (the product of Hitachi Power Semiconductor Device, hereinafter called "HPSD's IC") could break by a short circuit (ex. load short). Therefore, external protection is needed.

8.3 Maximum Ratings

Regardless of changes in external conditions during use of HPSD's IC, the "maximum ratings" described in this document should never be exceeded when designing electronic circuits that employ HPSD's IC. If maximum ratings are exceeded, HPSD's IC may be damaged or destroyed. In no event shall Hitachi Power Semiconductor Device (hereinafter called "HPSD") be liable for any failure in HPSD's IC or any secondary damage resulting from use at a value exceeding the maximum ratings.

8.4 Derating Design

Continuous high-load operation (high temperatures, high voltages, large currents) should be avoided and derating design should be applied, even within the ranges of the maximum ratings, to ensure reliability.

8.5 Safe Design

The HPSD's IC may fail due to accidents or unexpected surge voltages. Accordingly, adopt safe design features, such as redundancy and measures to prevent misuse, in order to avoid extensive damage in the event of a failure.

8.6 Application

If HPSD's IC is applied to the following uses where high reliability is required, obtain the document of permission from HPSD in advance.

- Automobile, Train, Vessel, etc.

Do not apply HPSD's IC to the following uses where extremely high reliability is required.

- Nuclear power control system, Aerospace instrument, Life-support-related medical equipment, etc.

8.7 Soldering

(1) Soldering Condition

The peak temperature of flow soldering* must be less than 260°C, and the dip time must be less than 10 seconds. High stress by mounting, such as long time thermal stress by preheating, mechanical stress, etc., can lead to degradation or destruction. Make sure that your mounting method does not cause problem as a system.

* Flow soldering: Only pins enter a solder bath, while the resin or tab does not.

(2) Reliability of Solder Connection

The reliability of solder connection depends on soldering condition, materials of circuit boards, footprint, etc. Test it sufficiently by heat cycle test, heat shock test, and so on after mounting ICs on circuit boards.

8.8 Others

See "Instructions for Use of Hitachi High-Voltage Monolithic ICs" and "Application Note" for other precautions and instructions on how to deal with these kinds of products.

9. Usage

- (1) HPSD warrants that the HPSD products have the specified performance according to the respective specifications at the time of its sale. Testing and other quality control techniques of the HPSD products by HPSD are utilized to the extent HPSD needs to meet the specifications described in this document. Not every device of the HPSD products is specifically tested on all parameters, except those mandated by relevant laws and/or regulations.
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◆Appendix - Supplementary Data

1. Dimensions

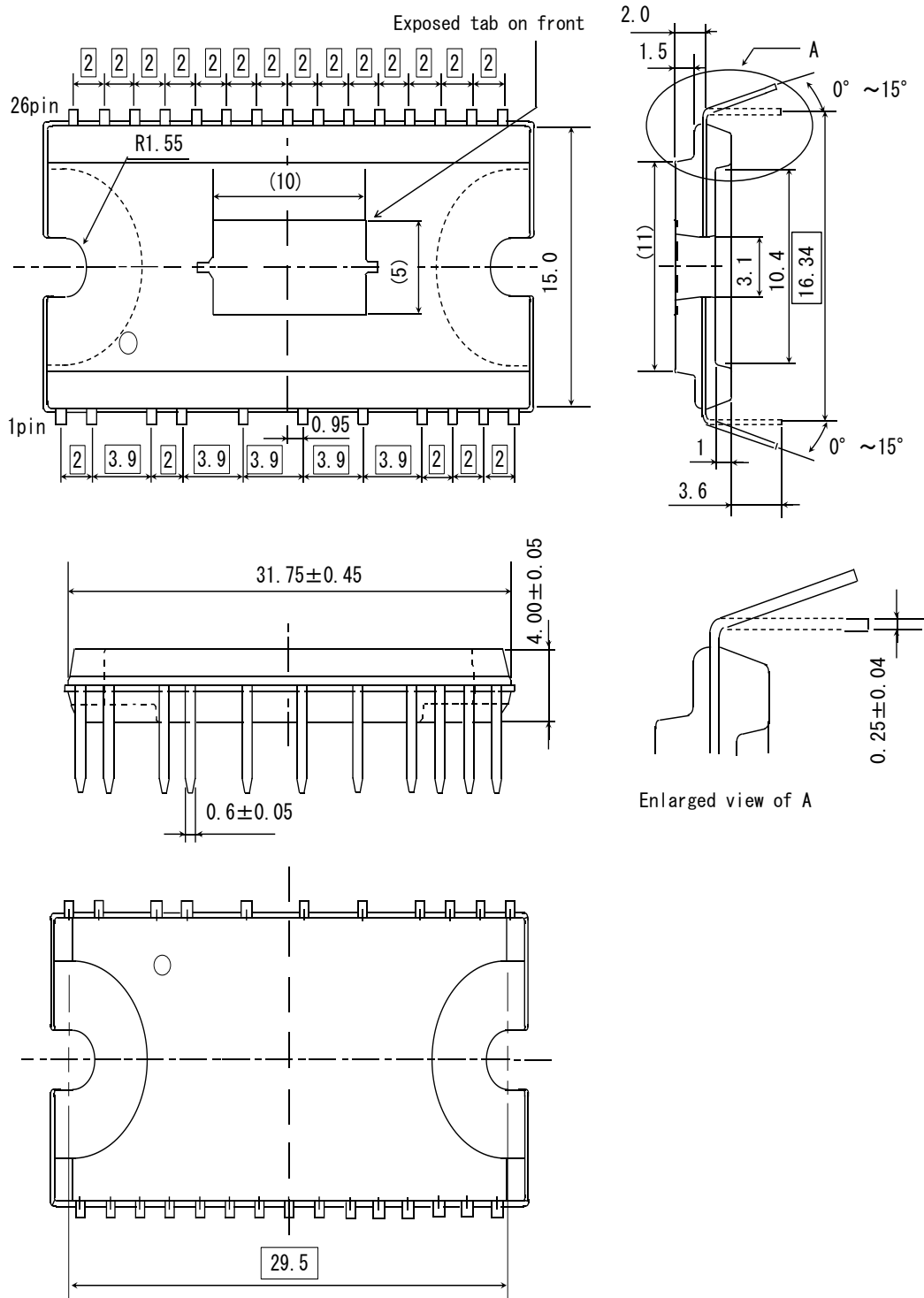


FIGURE A : Dimensions of DIP26N

Unit: mm

Note: Unless otherwise specified, the tolerance is ±0.1.

2. External Packaging

FIGURE B shows the external packaging. The order quantity is basically the following.
- ECN30624PN : 1,620 pcs or its multiple

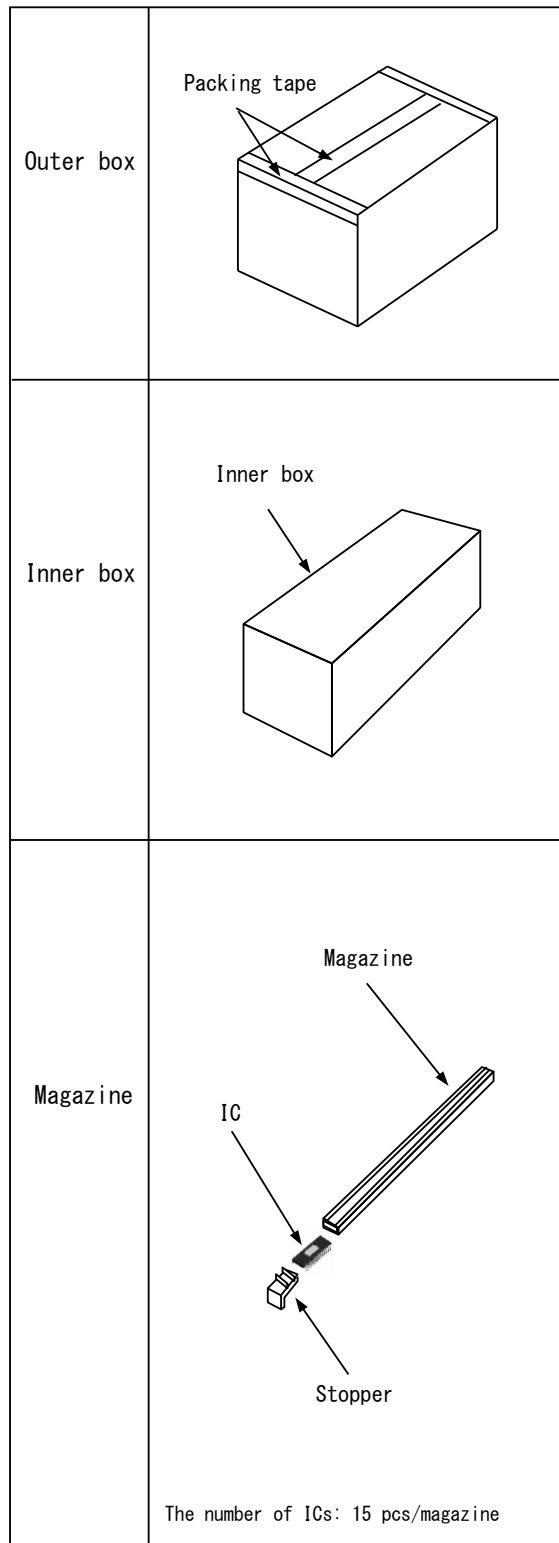


FIGURE B: External Packaging

Precautions for Safe Use and Notices

If semiconductor devices are handled in an inappropriate manner, failures may result. For this reason, be sure to read the latest version of "Instructions for Use of Hitachi High-Voltage Monolithic ICs" before use.



This mark indicates an item requiring caution.



CAUTION

This mark indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and damage to property.



CAUTION

- (1) Regardless of changes in external conditions during use of semiconductor devices, the "maximum ratings" and "safe operating area(SOA)" should never be exceeded when designing electronic circuits that employ semiconductor devices.
- (2) Semiconductor devices may fail due to accidents or unexpected surge voltages. Accordingly, adopt safe design features, such as redundancy and measures to prevent misuse, in order to avoid extensive damage in the event of a failure.
- (3) If semiconductor devices are applied to uses where high reliability is required, obtain the document of permission from HPSD in advance (Automobile, Train, Vessel, etc.). Do not apply semiconductor devices to uses where extremely high reliability is required (Nuclear power control system, Aerospace instrument, Life-support-related medical equipment, etc.).
(If a semiconductor device fails, there may be cases in which the semiconductor device, wiring or wiring pattern will emit smoke or cause a fire or in which the semiconductor device will burst.)

NOTICES

1. This Data Sheet contains the specifications, characteristics, etc. concerning power semiconductor products (hereinafter called "products").
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Refer to the following website for the latest information. Contact a HPSD sales office if you have any questions.

<http://www.hitachi-power-semiconductor-device.co.jp/en/>