ECN30671SP/SPV/SPR

The ECN30671 is a 3-Phase Permanent Magnet Synchronous Motor and Induction Motor driver. The chip integrates Top and Bottom arm drive circuits controlled by 6-CMOS inputs, six (6) 500V rated IGBTs. To reduce motor current losses, a PMSM can now be driven directly from rectified 220VAC (up to 450VDC) power lines, or from any DC power bus down to 15VDC.

Description

- Integrated 3-Phase 6-IGBT Motor Bridge with on chip Free-Wheeling diodes.
- Maximum Ratings 500VDC/3.0A
- Latch-Up free monolithic IC built with a high voltage Dielectrically Isolated (DI) process.
- Available in 3 package types with built-in heat sink (Tab).

Functions and Features

- PWM control of Top and Bottom arm IGBTs is possible with a Microprocessor.
- On-Chip 7.5VDC regulator (CB) with a guaranteed external Max load (25mA).
- Over-Current protection is set by an external Sense Resistor (RS).
- Under-Voltage protection for Top and Bottom IGBT Arms.
- Top and Bottom arm IGBTs can operate in 20kHz chopping frequency.
- 6 Logic inputs are compatible with 5V CMOS or LSTTL outputs.

ECN30671SP/SPV/SPR

Block Diagram

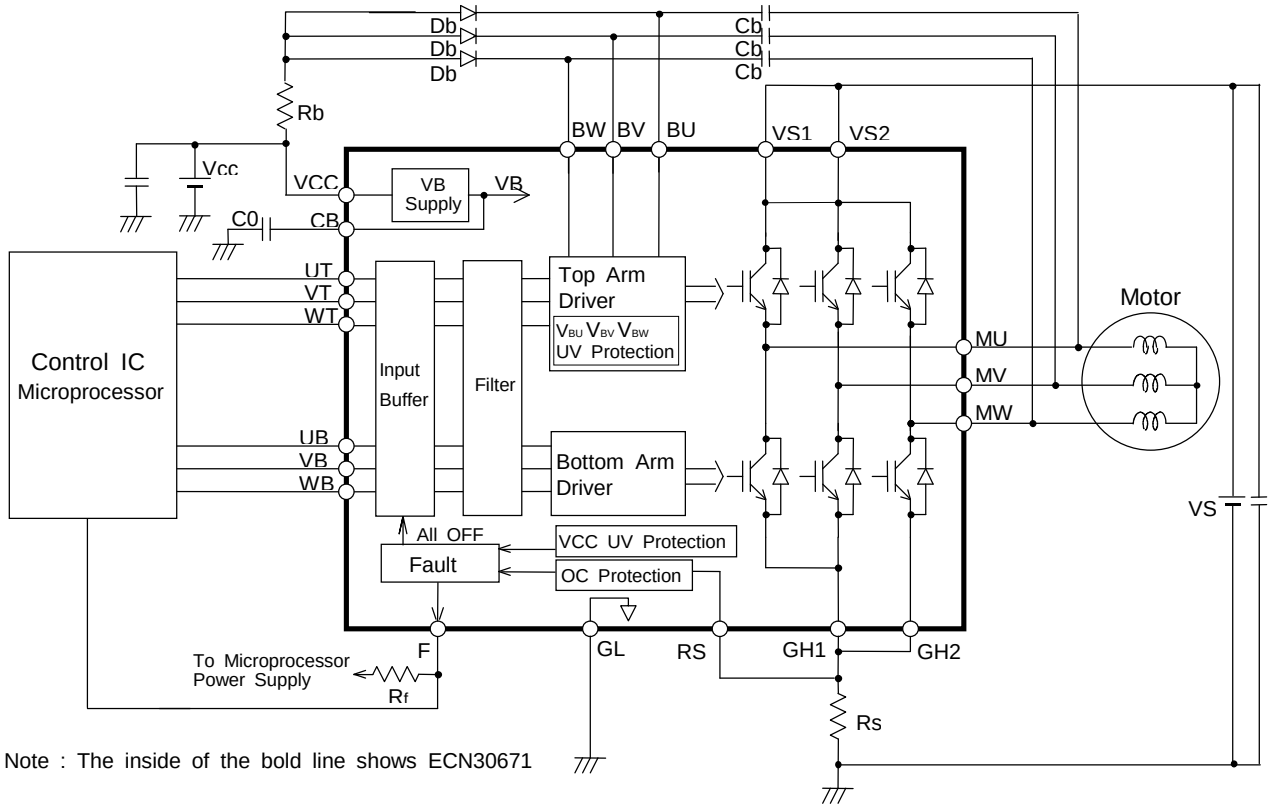
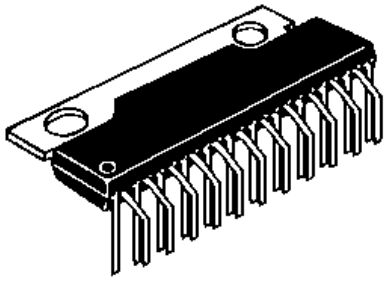
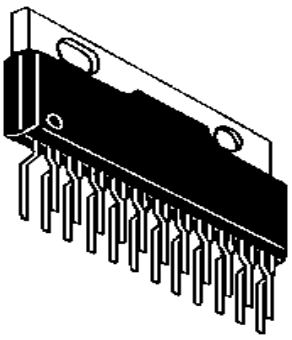


Figure 1. Block Diagram

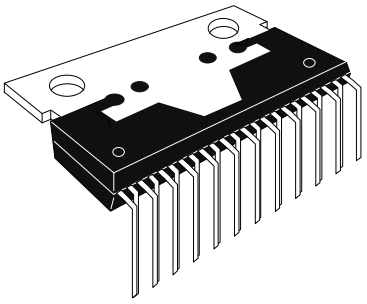
Types and Packages



ECN30671SP



ECN30671SPV



ECN30671SPR

ECN30671SP/SPV/SPR

1. Maximum Allowable Ratings

Ta = 25 °C

No.	Item		Symbol	Terminal	Rating	Unit	Condition
1	Output Device Breakdown Voltage		VSM	VS1,VS2 MU,MV,MW	500	V	
2	Analog Supply Voltage		VCC	VCC	18	V	
3	Input Voltage		VIN	UT,VT,WT UB,VB,WB	-0.5～VB+0.5	V	
4	Output Current	Pulse	IP	MU,MV,MW	3.0	A	Note 1
5		DC	IDC		1.5		
6	VB Supply Current		IBMAX	CB	50	mA	
7	Junction Operating Temperature		Tjop	-	-20～+135	°C	Note 2
8	Storage Temperature		Tstg	-	-40～+150	°C	

General Note: To determine appropriate deratings for these absolute maximum ratings, see page 13 (the Appendix) paragraphs 1.1 and 1.2.

Note 1: Output IGBTs can handle this peak motor current at up to 25 °C junction operating temperature.

Note 2: Thermal resistance

1) Between junction and IC case (Tab) : Rjc = 4 °C/W
2) Between junction and air : Rja = 40 °C/W

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2. Electrical characteristics

Suffix (T ; Top arm, B ; Bottom arm) Ta = 25 °C

No.	Item		Symbol	Terminal	MIN	TYP	MAX	Unit	Condition
1	Supply Voltage		Vsop	VS1,VS2	15	325	450	V	
2			VCCop	VCC	13.5	15	16.5	V	
3	Standby Current		IS	VS1,VS2	—	—	0.25	mA	UT,VT,WT,UB,VB,WB="H" VS=325V,VCC=15V
4			ISB	BU-MU, BV-MV, BW-MW	—	15	30	μA	BU-MU=BV-MV=BW-MW =15V
5			ICC	VCC	—	5	10	mA	UT,VT,WT,UB,VB,WB="H" VCC=15V,IB=0A
6	IGBT Forward Voltage		VONT	MU, MV, MW	—	2.5	3.5	V	I=1.5A,VCC=15V,PW<5ms
7	Drop		VONB		—	2.5	3.5	V	I=1.5A,VCC=15V,PW<5ms
8	Output Delay Time	Turn ON	TdONT	MU, MV, MW	0.5	1.5	2.5	μs	VS=325V,VCC=15V
9			TdONB		0.5	1.5	2.5	μs	I=1.5A
10		Turn OFF	TdOFFT		0.5	1.5	2.5	μs	Resistive Load
11			TdOFFB		0.5	1.5	2.5	μs	
12	Free Wheel Diode		VFDT	MU, MV, MW	—	2.5	3.5	V	I=1.5A,PW<5ms
13	Forward Voltage		VFDB	MU, MV, MW	—	2.5	3.5	V	
14	Reference Voltage		Vref	RS	0.45	0.5	0.55	V	VCC=15V
15	UT, VT, WT UB, VB, WB Input	Voltage	VIH	UT, VT, WT UB, VB, WB	3.5	—	—	V	VCC=15V
16			VIL		—	—	1.5	V	
17		Current	IIL		-100	—	—	μA	UT,VT,WT, UB,VB,WB =0V VCC=15V — Pull Up Resistor Note 1
18			IIH		-30	—	—	μA	UT,VT,WT, UB,VB,WB =5V VCC=15V — Pull Up Resistor Note 1
19	VB Supply Output	Voltage	VB	CB	6.8	7.5	8.2	V	VCC=15V,IB=0A
20		Current	IB		—	—	25	mA	VCC=15V
21	VCC Under Voltage	Detect Voltage	Vuvb	VCC	11.0	12.0	12.9	V	Note 2
22		Reset Hysteresis	Vrhb		0.1	0.4	0.9	V	
23	$V_{BU,BV,BW}$ Under Voltage	Detect Voltage	Vuvt	BU-MU, BV-MV, BW-MW	9.8	11.4	13.0	V	Note 2
		Reset Hysteresis	Vrht		0.1	0.4	0.9	V	
24	Fault Output		Ronf	F	—	300	400	Ω	I_{OL}=-10mA Note 3
25	Fault Reset Delay Time		tflrs	F	6.5	10	20	μs	
26	OC Shutdown Delay Time		toc	RS	—	3.0	4.0	μs	
27	RS Terminal Input Current		IILRS	RS	-100	—	—	μA	VCC=15V, RS=0V UT,VT,WT, UB,VB,WB="H"

Note 1. Internal pull up resistors are typically 200 kΩ. The equivalent circuit is shown in Figure 2.
Note 2. Please see item 3.4.
Note 3. The equivalent circuit is shown in Figure 3.

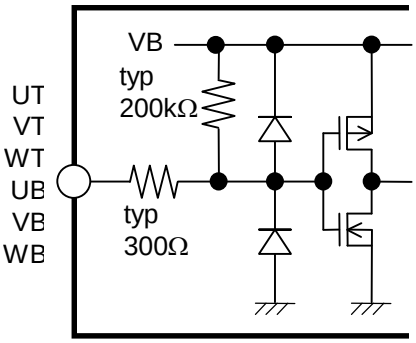

Figure 2. Equivalent circuit around UT,VT,WT,UB,VB,WB terminals

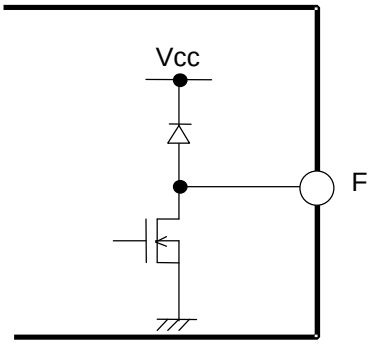

Figure 3. Equivalent circuit around F terminal

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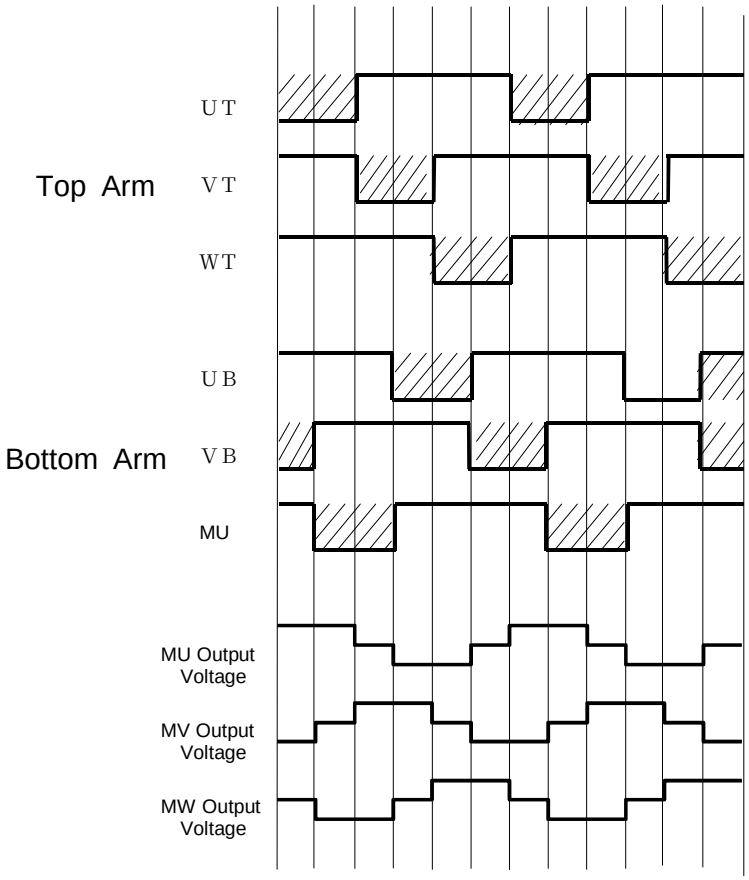
3. IGBT Motor Bridge Commutations and Logic Functions

3.1 Truth Table

Terminal	Input	Output
UT,VT,WT, UB,VB,WB	L	ON
	H	OFF
UT,UB	UT&UB=L	OFF
VT,VB	VT&VB=L	OFF
WT,WB	WT&WB=L	OFF

3.2 Timing Chart

Example of 120^{O} commutation mode.



3.3 Over Current Limit Operation

This IC detects over current by 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 all IGBTs and F terminal output becomes “L”. “H” inputs to all of six input terminals resets this state. In case of not using this function, please connect Rs terminal to GL terminal with less than 100Ω.

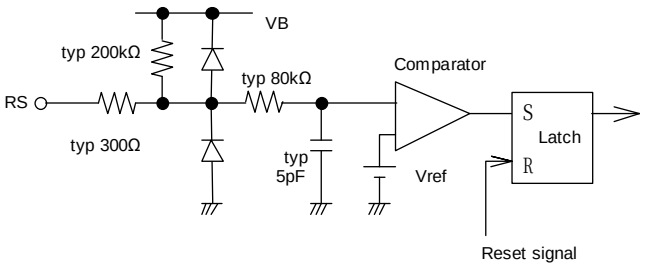


Figure 4. Equivalent circuit around RS terminal

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3.4 VCC Under Voltage Protection

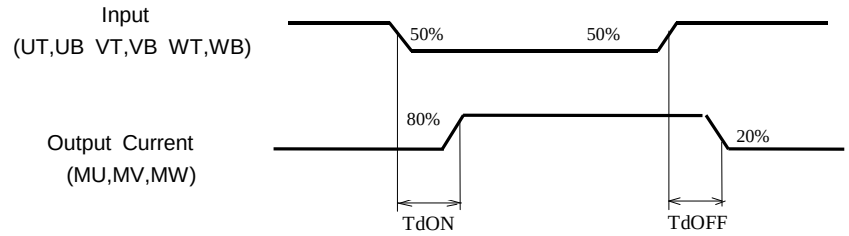
1) When VCC supply voltage drops below Vuvb (12V typ.), all IGBTs are shut down and F terminal output becomes “L”.

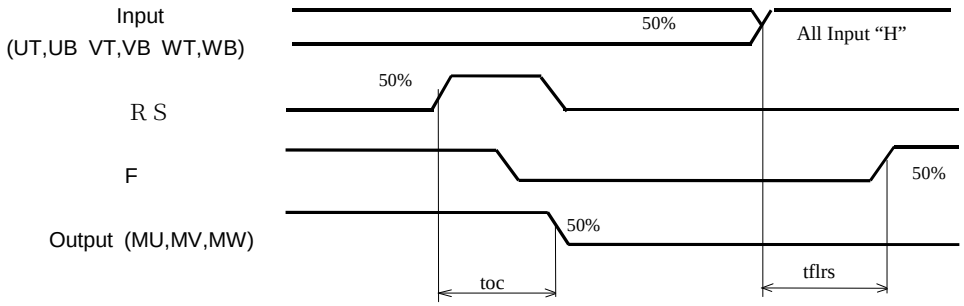
2) When BU-MU, BV-MV or BW-MW voltage drops below Vuvt (11.4V typ.), the IGBT of the phase where under voltage is detected is shut down. In this case, the output of F terminal is still “H”.

Note1. When VCC supply voltage becomes lower, driving capability of IGBT also becomes lower. Accordingly, power dissipation becomes higher and this causes temperature raise of IC. If junction temperature exceeds 135℃, IC may break.

Note2. When BU-MU, BV-MV or BW-MW voltage becomes lower, driving capability of IGBT also becomes lower. Accordingly, power dissipation becomes higher and this causes temperature raise of IC. BU-MU, BV-MV and BW-MW voltages must be kept more than 13V.

3.5 Definitions of Delay Time





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4. Standard applications

4.1 External components

Component	Standard value	Usage	Remark
Co	0.22 μF ± 20%	Filters the internal power supply (VB)	Stress voltage is VB (=8.2V)
Cb	3.3 μF ± 20%	For Boot Strap	Stress voltage is VCC
Db	Hitachi DFG1C6 (Glass mold type), DFM1F6 (Resin mold type) or equivalent	For Boot Strap	Breakdown Voltage:≧600V Current:≧1.0A trr: ≦200ns
Rs	Note 1	Sets Over-Current limit	
Rf	5～10kΩ	Load resistor for F terminal	
Rb	Note 2	Resistor for Boot Strap	

Note 1. The detection current (IO) for the Over-Current limit operation can be calculated as follows.

IO(A) = Vref(V) / Rs(Ω)

Where Vref is 0.55V and Rs is a minimum value.

(These are worst case values.)

To determine the Sense Resistor Rs, refer to the above comments and Appendix paragraphs 1.1 (Figure 6).

Note 2. Current limit resistance Rb should be set in order to prevent Over Current Limit Operation from operating by initial charge to Cb. Rb can be approximately by the following equation.

Rb > (VCC×Rs) / Vref × 2

(×2 means the margin.)

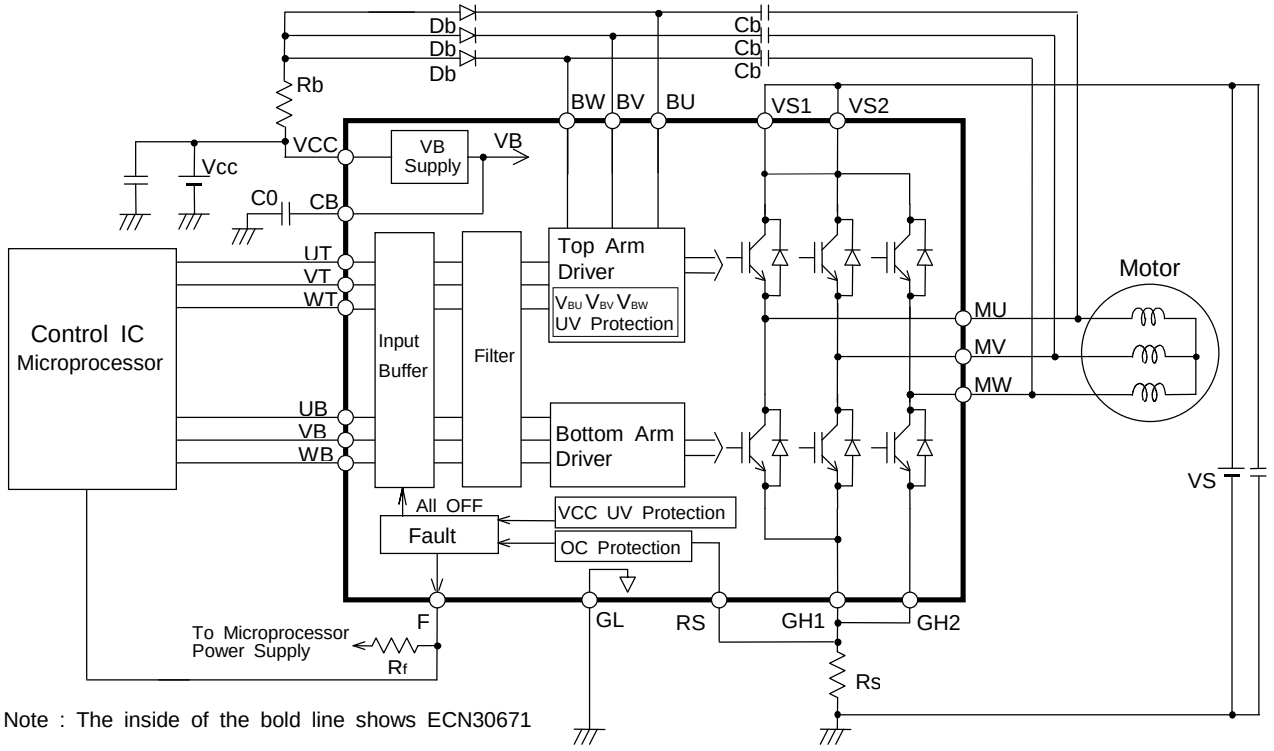

Figure 5. Block Diagram(example for boot strap)

4.2 Input Pins（UB,VB,WB,UT,VT,WT）

In some applications, input pins may be noise sensitive due to their high impedance. This can be minimized with the use of external capacitance as follows:

- A 500pF±20% ceramic capacitor to ground (the GL pin).

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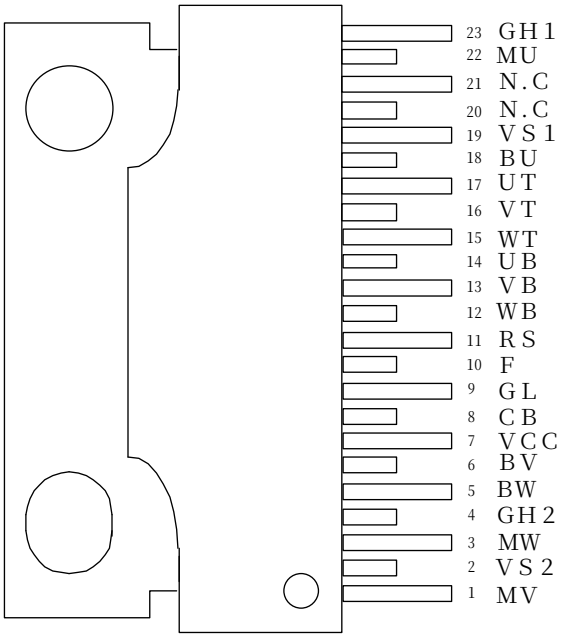
5. Pinout



(Marking side)

6. Terminal definitions

Terminal No.	Symbol	Definition	Remark
1	MV	V phase output (to motor coil V)	Note1
2	VS2	Power supply for top IGBT of phases V and W	Note1,Note2
3	MW	W phase output (to motor coil W)	Note1
4	GH2	W phase emitter of IGBT and anode of FWD. Connect RS.	Note3
5	BW	Power supply for top arm of phase W	Note1
6	BV	Power supply for top arm of phase V	Note1
7	VCC	Analog/Logic power supply	
8	CB	Internal regulated (VB) power supply output	
9	GL	Analog/Logic ground	
10	F	Fault signal output	
11	RS	RS voltage detect input for the on-chip Over Current limit detection	
12	WB	Input control signal for bottom arm of phase W	
13	VB	Input control signal for bottom arm of phase V	
14	UB	Input control signal for bottom arm of phase U	
15	WT	Input control signal for top arm of phase W	
16	VT	Input control signal for top arm of phase V	
17	UT	Input control signal for top arm of phase U	
18	BU	Power supply for top arm of phase W	Note1
19	VS1	Power supply for top IGBT of phase U	Note1,Note2
20	NC	No Connection	Note4
21	NC	No Connection	Note4
22	MU	U phase output (to motor coil U)	Note1
23	GH1	U and V phase emitters of IGBTs and anodes of FWDs Connect RS.	Note3

Note1 This is high voltage pin.

Note2 The VS1 and VS2 pins are connected within the IC, but VS1 and VS2 must be connected by external wiring.

Note3 GH1 and GH2 are not connected within the IC and must be connected by external wiring.

Note4 Not connected to the internal IC chip.

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7. Inspection

Hundred percent inspections shall be conducted on electric characteristics at room temperature.

8. Cautions

8.1 Tightening torque at 0.39 to 0.78 N-m should be applied for device to attach to heat sink.

8.2 Tab should not be soldered.

8.3 Customers are advised to follow the below cautions to protect semiconductor from electrical static discharge (ESD).

a) IC needs to be dealt with caution to protect from damage by ESD. Material of container or any device to carry semiconductor devices should be free from ESD which may be caused by vibration while transportation. To use electric-conductive container or aluminum sheet is recommended as an effective countermeasure.

b) What touch semiconductor devices such as work platform, machine and measuring and test equipment should be grounded.

c) Workers should be grounded connecting with high impedance around 100k to 1M while dealing with semiconductor to avoid damaging IC by electric static discharge.

d) Friction with other materials such as a high polymer should not be caused.

e) Attention is needed so that electric potential will be kept on the same level by short circuit terminals when PC board with mounted IC is carried and that vibration or friction might not occur.

f) Air conditioning is needed so that humidity should not drop.

8.4 Applying molding or resin coating is recommended for below mentioned pin-to-pin insulation;
(1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 17-18, 18-19, 22-23)

8.5 Protective function against short circuit (ex. load short, line-to-ground short or top/bottom arm short) is not built in this IC. External protection needs to prevent IC breakdown.

8.6 Bootstrap capacitors (Cb) should be charged by the on-state of bottom arm IGBT, before motor starts. Moreover, if boot strap capacitors are not charged for a long time (e.g. low carrier frequency), the boot strap capacitor voltage drops gradually.

8.7 Refer to “Precautions for Use of High-Voltage Monolithic ICs” for the other precautions and instructions on how to deal with products.

8.8 Regardless of changes in external conditions during use, “absolute maximum ratings” should never be exceeded in designing electronic circuits that employ products. In a case absolute maximum ratings are exceeded, products may be damaged or destroyed. In no event shall Hitachi be liable for any failure in products or any secondary damage resulting from use at a value exceeding the absolute maximum ratings.

8.9 Products may experience failures due to accident or unexpected surge voltages. Accordingly, adopt safe design features, such as redundancy or prevention of erroneous action, to avoid extensive damage in the event of a failure.

8.10 Products are not designed, manufactured, or warranted to be suitable for use where extremely high reliability is required (such as use in nuclear power control, aerospace and aviation, traffic equipment, life-support-related medical equipment, fuel control equipment and various kinds of safety equipment).

Inclusion of products in such application shall be fully at the risk of customers. Hitachi, Ltd. assumes no liability for applications assistance, customer product design, or performance. In such cases it is advised customers ensure circuit and/or product safety by using semiconductor devices that assures high reliability or by means of user’s fail-safe precautions or other arrangement.

(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.)

8.11 Lead (Pb)-free solder is used for coating pins and the tab of this IC. In case of flow soldering*, the IC can withstand peak temperature 260oC for less than 10 seconds in liquid solder.

*Only pins are in liquid solder. The package body and the tab must not be in it.

9. Important Notice

9.1 Hitachi warrants performance of its power semiconductor products (hereinafter called “products”) to the specifications applicable at the time of sale in accordance with the Product Specification. Testing and other quality control techniques are utilized to the extent Hitachi needs to meet specifications described in the Product Specification. Specific testing of all parameters of each device is not necessarily performed, except those mandated by related laws and/or regulations.

9.2 Should any claim be made within one month of product delivery about products’ failure to meet performance described in the Product Specification, all the products in relevant lot(s) shall be retested and re-delivered. Products delivered more than one month before of such claim shall not be counted for such response.

9.3 Hitachi assumes no obligation or any way of compensation should any fault about customer’s goods using products be found in marketplace. Only in such a case fault of Hitachi is evident and products concerned do not meet the Product Specification, compensation shall be conducted if claimed within one year of product delivery up to in the way of product replacement or payment of equivalent amount.

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9.5 In no event shall Hitachi be liable for any damage that may result from an accident or any other cause during operation of the user’s units according to this Product Specification. Hitachi assumes no responsibility for any intellectual property claims or any other problems that may result from applications of information, products or circuits described in this Product Specification.

9.6 No license is granted by this Product Specification under any patents or other rights of any third party or Hitachi, Ltd.

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9.8 The products (technologies) described in this Product Specification are not to be provided to any party whose purpose in their application will hinder maintenance of international peace and safety nor are they to be applied to that purpose by their direct purchasers or any third party. When exporting these products (technologies), the necessary procedures are to be taken in accordance with related laws and regulations.

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◆Appendix - Supplementary Data

Refer to the derating information below when designing with the ECN30671.

1. Safe Operation Area (SOA) and Derating Standards

1.1 SOA

The ECN30671 must not be used outside the SOA shown below in Figure 6, where the current and voltage are at the MU, MV and MW pins (motor coils).

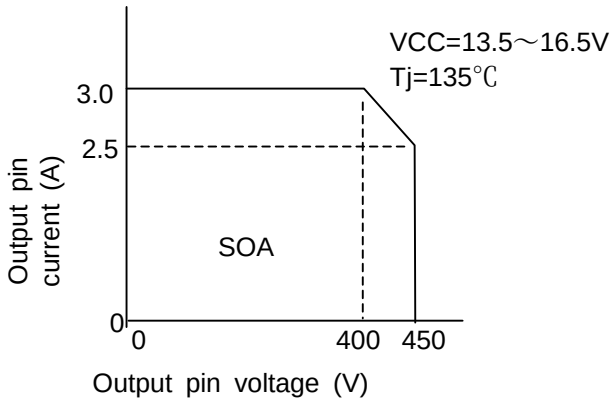

Figure 6. SOA

1.2 General Design Derating Standards

a) Temperature - Junction Operating Temperature must be kept under 110 °C.

b) Supply Voltage - VS power supply voltage must be kept under 450 V.

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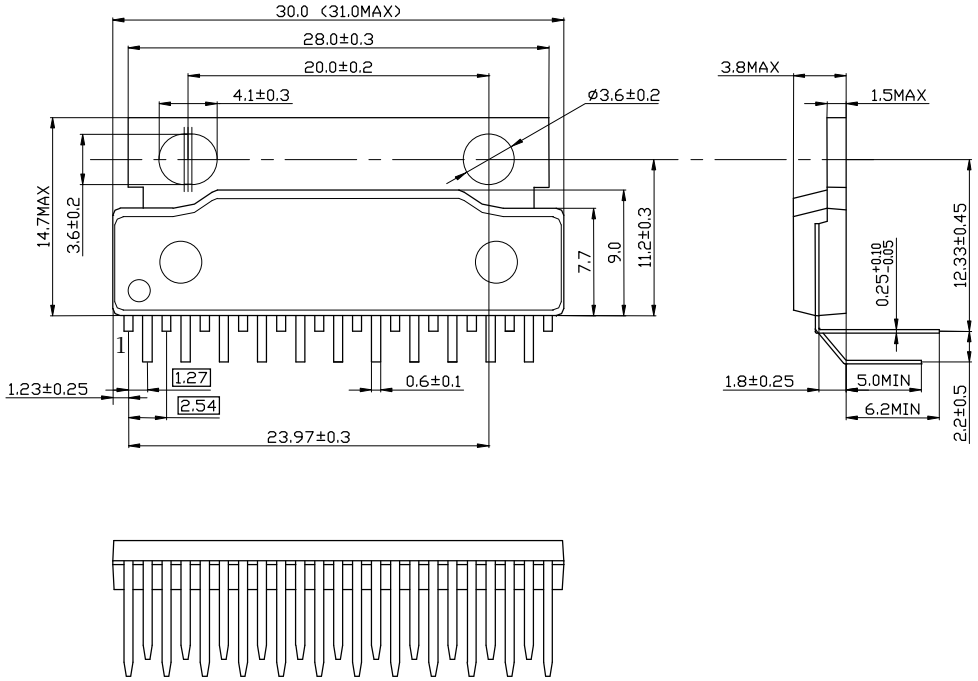
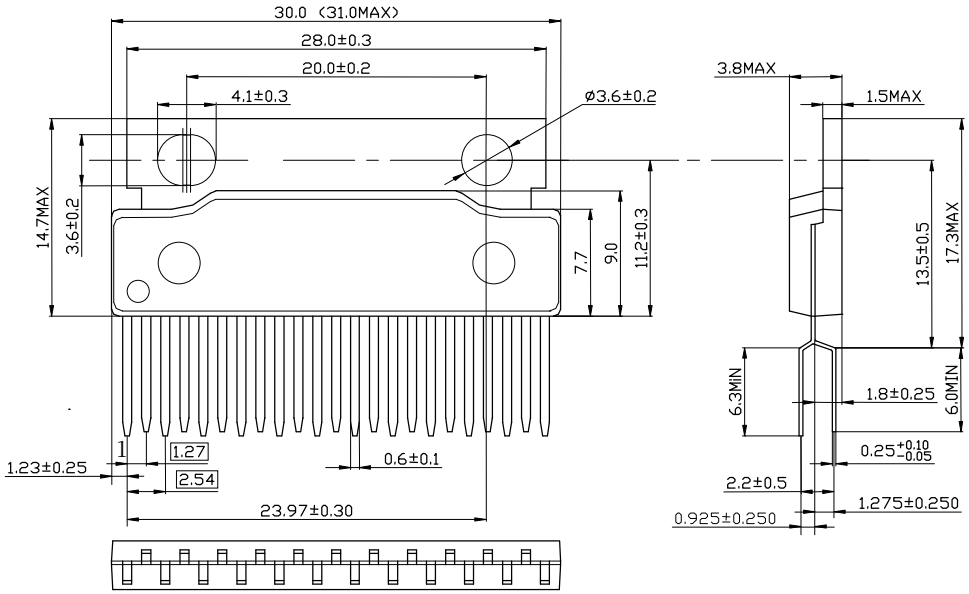
2. Package Dimensions (Unit: mm)

(1) ECN30671SP

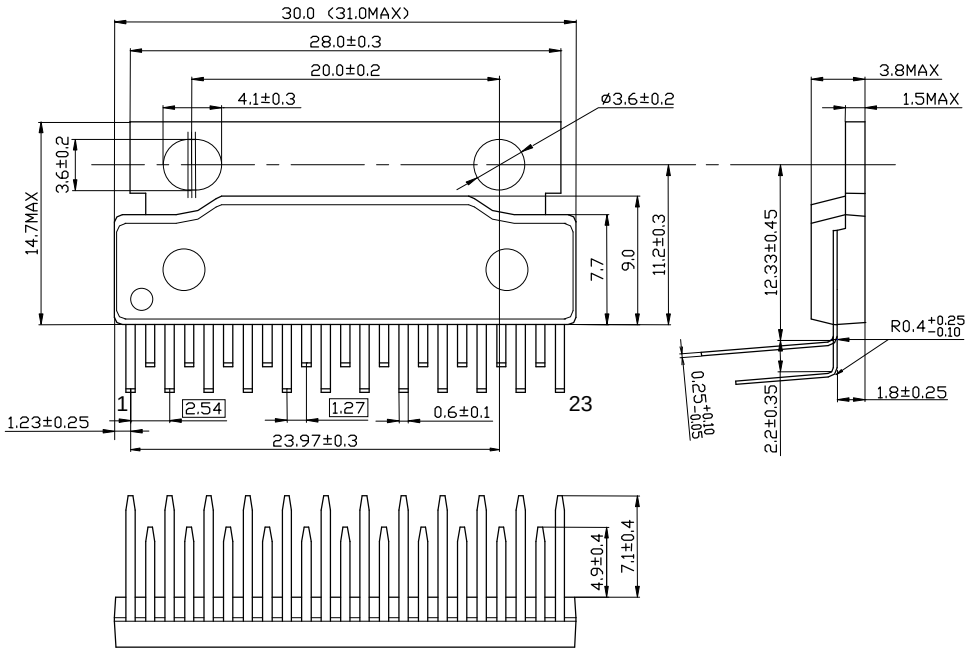


(2) ECN30671SPV



ECN30671SP/SPV/SPR

(3) ECN30671SPR



Precautions for Safe Use and Notices

If semiconductor devices are handled inappropriate manner, failures may result. For this reason, be sure to read “Precaution for Use” before use.

⚠	This mark indicates an item about which caution is required.
⚠ 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 “absolute maximum ratings” should never be exceed in designing electronic circuits that employ semiconductors. In the case of pulse use, furthermore,″safe operating area (SOA)”precautions should be observed.

(2)Semiconductor devices may experience failures due to accident or unexpected surge voltages. Accordingly, adopt safe design features, such as redundancy or prevention of erroneous action, to avoid extensive damage in the event of a failure.

(3)In cases where extremely high reliability is required (such as use in nuclear power control, aerospace and aviation, traffic equipment, life-support-related medical equipment, fuel control equipment and various kinds of safety equipment), safety should be ensured by using semiconductor devices that feature assured safety or by means of user's fail-safe precautions or other arrangement. Or consult Hitachi's sales department staff.

(If a semiconductor devices 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 (in figures and tables), dimensions and handling notes concerning power semiconductor products (hereinafter called “products”) to aid in the selection of suitable products.

2. The specifications and dimensions, etc. stated in this Data Sheet are subject to change without prior notice to improve products characteristics. Before ordering, purchasers are advised to contact Hitachi’s sales department for the latest version of this Data Sheet and specifications.

3. In no event shall Hitachi be liable for any damage that may result from an accident or any other cause during operation of the user’s units according to this Data Sheet. Hitachi assumes to responsibility for any intellectual property claims or any other problems that may result from applications of information, products or circuits described in this Data Sheet.

4. In no event shall Hitachi be liable for any failure in a semiconductor device or any secondary damage resulting from use at a value exceeding the absolute maximum rating.

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