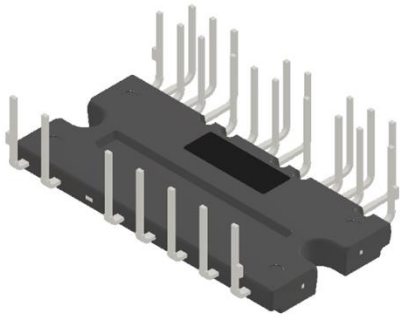
1. Descriptions

CIS06D60L2B2 is an insulated type three-phase Intelligent Power Modules (IPM), highly integrated in a compact package. With the embedded HVIC as the most compatible driver and protector for IGBTs, this Micro series IPM offers an efficient power inverter solution with outstanding performance for PMSM motors such as low power fan or pump for home appliances and Industrial Instruments.

Features

- 600V /6A three-phase DC/AC IGBT inverter
- HVIC for gate driving and protecting
- Built-in Control supply under-voltage protection (UV)
- Built-in Short circuit protection (SC)
- Built-in Over Temperature protection
- Separate Open−Emitter Pins from Low−Side IGBTs for Three−Phase Current Sensing
- Appropriate for 3.3v/5v logic high-active interface
- Bootstrap diode integrated
- Isolation 1500Vrms/min



3D Package Drawing

Applications

- Low Power Motors for Home Appliances and Industrial Instruments
- Air Conditioner Outside Fan
- Refrigerator Compressors
- Washing Machine

Type/Ordering Code	Package	Marking	Related Links
CIS06D60L2B2	Micro	CIS06D60L2B2 XXXXXXX*	see Appendix A

* MFG Number

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2. Maximum Ratings

at T_j = 25°C, unless otherwise specified

Table 1. Inverter part

Symbol	Parameter	Ratings	Unit	Test Condition
V_{PN}	Supply Voltage	450	V	Applied between P_{IN} -NU,NV,NW
$V_{PN(surge)}$	Supply Voltage (Surge)	500	V	Applied between P_{IN} -NU,NV,NW
V_{CES}	Collector-Emitter Voltage	600	V	-
$I_{C\ 25}$	Each IGBT collector current	6	A	TC=25℃，TJ≤150℃
I_{CP}	Each IGBT collector current (peak)	12	A	TC=25℃，TJ≤150℃，under 1ms pause width
P_C	Collector dissipation	16	W	T_C=25℃

Table 2. Control part

Symbol	Parameter	Ratings	Unit	Test Condition
V_{DD}	Control supply voltage	20	V	Applied between V_{DD} -COM
V_{BS}	High side control bias voltage	20	V	Applied between VB_U-VS_U, VB_V-VS_V, VB_W -VS_W
V_{IN}	Input signal voltage	-0.3~V_{DD}+0.3	V	Applied between IN_{UH}, IN_{VH}, IN_{WH}, IN_{UL}, IN_{VL}, IN_{WL}-COM
V_{FS}	Function Supply Voltage	-0.3~V_{DD}+0.3	V	Applied between FO/SD_W/OTP-COM
I_{FO}	Fault Output current	10	mA	Sink current at FO terminal
V_{SC}	Current Sensing Input Voltage	-0.3~V_{DD}+0.3	V	Applied between C_{SC}-COM

Table 3. Thermal resistance

Symbol	Parameter	Ratings	Unit	Test Condition
$R_{TH(JC)I}$	Thermal resistance from junction to case	7.50	℃/W	Inverter IGBT part, (per module)
$R_{TH(JC)F}$	Thermal resistance from junction to case	7.80	℃/W	Inverter FWD, (per module)

Table 4. Total system

Symbol	Parameter	Ratings	Unit	Test Condition
T_C	Operating case temperature	-20~125	℃	V_{GS}=0V
T_J	Operation junction temperature	-20~+150	℃	Continuous operation (Note 1)
T_{STG}	Storage temperature	-40~125	℃	-
V_{ISO}	Isolation Voltage Connect Pins to Heat Sink Plate	1500	V_{RMS}	60HZ, Sinusoidal, AC 1min, between Connected all pins and heatsink plate

Note 1: The maximum junction temperature rating of built-in power chips is 150°C(@Tc≤100°C), however, to ensure safe operation of IPM, the average junction temperature should be limited to Tj (Ave)≤125°C (@Tc≤100°C).

3. Pin Definition

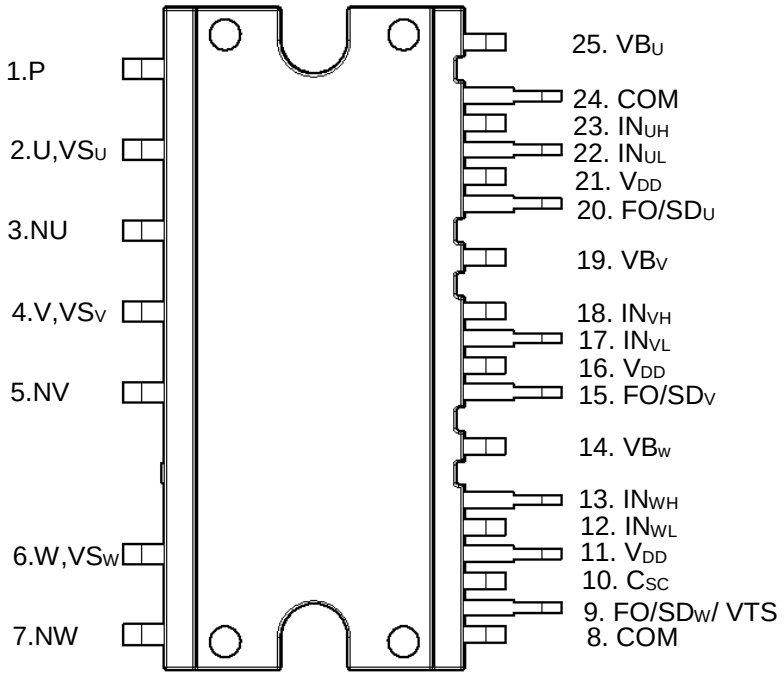


Figure1. Pin Definition (Top View)

Table 5. Pin Definition

Pin Number	Pin Name	Pin Description
1	P_{IN}	Positive DC-Link Input
2	U,VS_U	Output for U Phase
3	NU	Negative DC-Link Input for U Phase
4	V,VS_V	Output for V phase
5	NV	Negative DC-Link Input for V Phase
6	W,VS_W	Output for W phase
7	NW	Negative DC-Link Input for W phase
8	COM	Common Supply Ground
9	$FO/SD_W/VTS$	Fault Output/ Shut-Down Input for W Phase/Output for Temperature Sensing
10	C_{SC}	Shut Down Input for Over Current and Short Circuit Protection
11	V_{DD}	Common Bias Voltage for IC and IGBTs Driving
12	IN_{WL}	Signal Input for Low-Side W Phase
13	IN_{WH}	Signal Input for High-Side W Phase
14	VB_W	High-Side Bias Voltage for W-Phase IGBT Driving

15	FO/SD_V	Fault Output/Shut Down Input for V Phase
16	V_{DD}	Common Bias Voltage for IC and IGBTs Driving
17	IN_{VL}	Signal Input for Low-Side V Phase
18	IN_{VH}	Signal Input for High-Side V Phase
19	VB_V	High-Side Bias Voltage for V-Phase IGBT Driving
20	FO/SD_U	Fault Output/Shut Down Input for U Phase
21	V_{DD}	Common Bias Voltage for IC and IGBTs Driving
22	IN_{UL}	Signal Input for Low-Side V Phase
23	IN_{UH}	Signal Input for High-Side V Phase
24	COM	Common Supply Ground
25	VB_U	High-Side Bias Voltage for U-Phase IGBT Driving

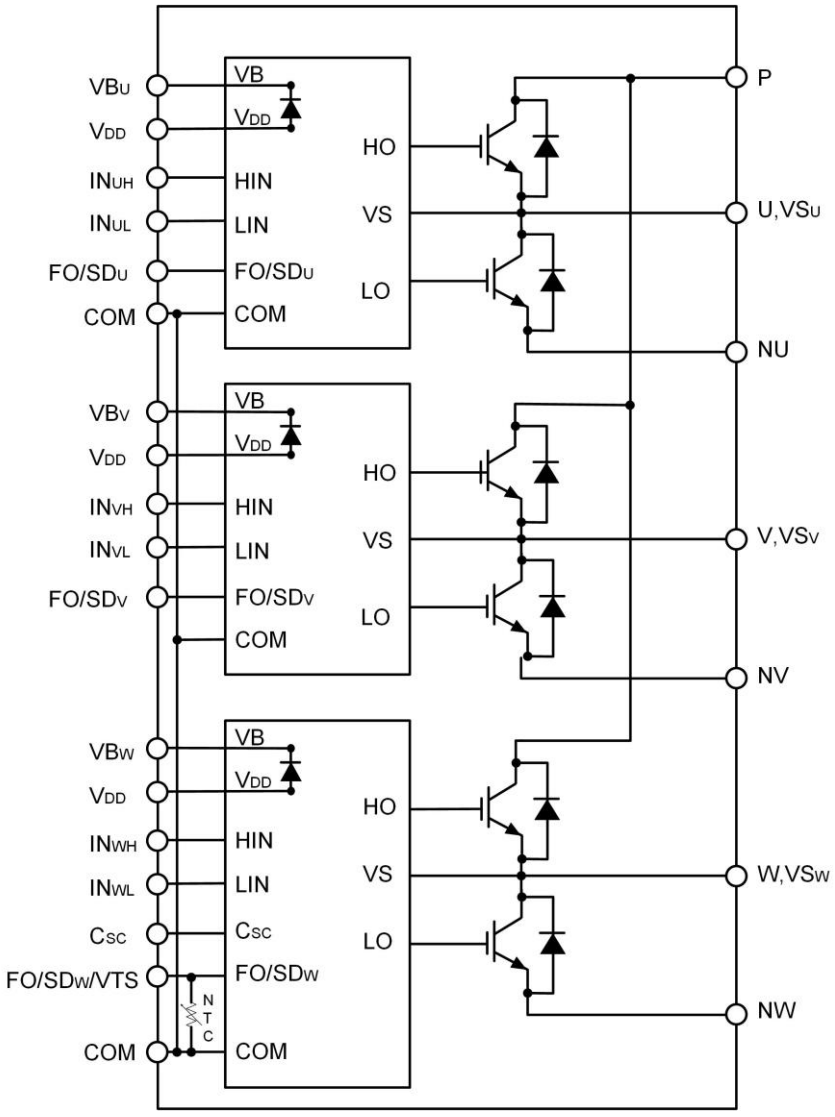


Figure2. Internal Block Diagram

4. Electrical Characteristics

at Tj = 25°C, unless otherwise specified

Table 5. Inverter Part

Symbol		Parameter	Values			Unit	Test Condition
			Min.	Typ.	Max.		
$V_{CE(SAT)}$		Collector-Emitter Saturation Voltage	-	1.70	2.4	V	V_{DD}=V_{BS}=15V,V_{IN}=5V,I_C=6A,T_J=25℃
V_F		FWD Forward Voltage	-	2.0	2.6	V	V_{DD}=V_{BS}=15V,V_{IN}=0V,I_C=-6A,T_J=25℃
HS	t_{ON}	Switching Times	-	550	-	ns	V_{PN}=400V,V_{DD}=V_{BS}=15V, V_{IN}=0~5V, I_C=6A, T_J=25℃
	$t_{C(ON)}$		-	220	-	ns	
	t_{OFF}		-	600	-	ns	
	$t_{C(OFF)}$		-	100	-	ns	
	t_{rr}		-	170	-	ns	
LS	t_{ON}		-	600	-	ns	
	$t_{C(ON)}$		-	260	-	ns	
	t_{OFF}		-	580	-	ns	
	$t_{C(OFF)}$		-	80	-	ns	
	t_{rr}		-	160	-	ns	
I_{CES}		Collector-emitter Leakage current	-	-	1	mA	V_{CE}=V_{CES}, V_{IN}=0V, T_J=25℃

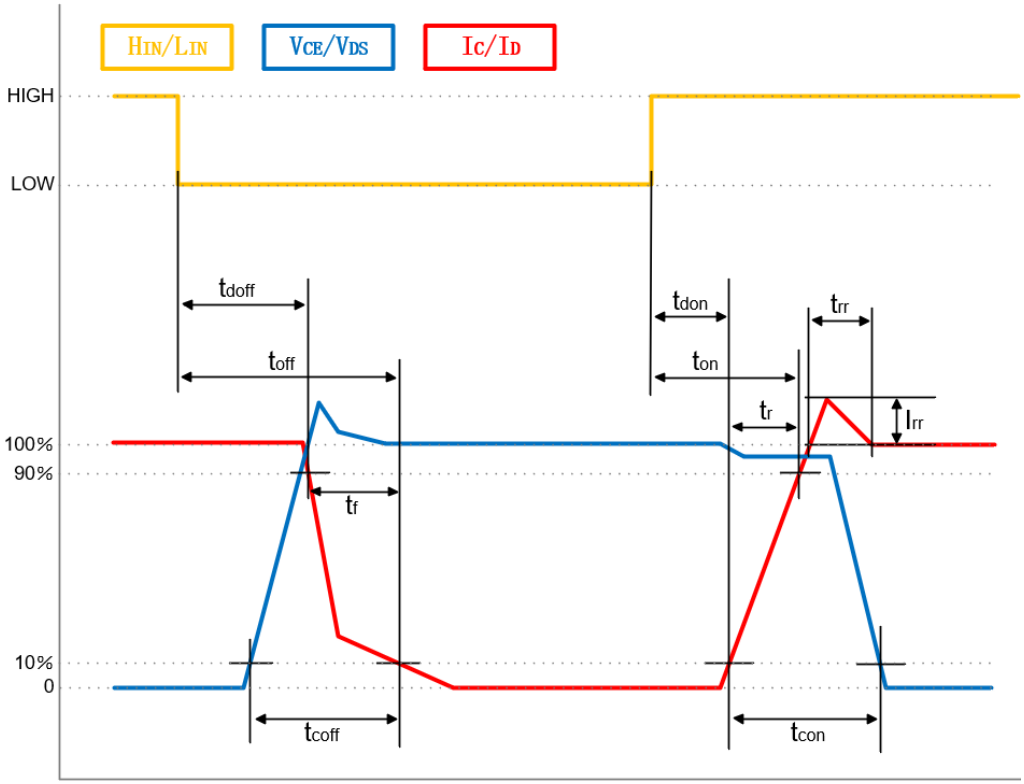


Figure3. Switching Time Chart

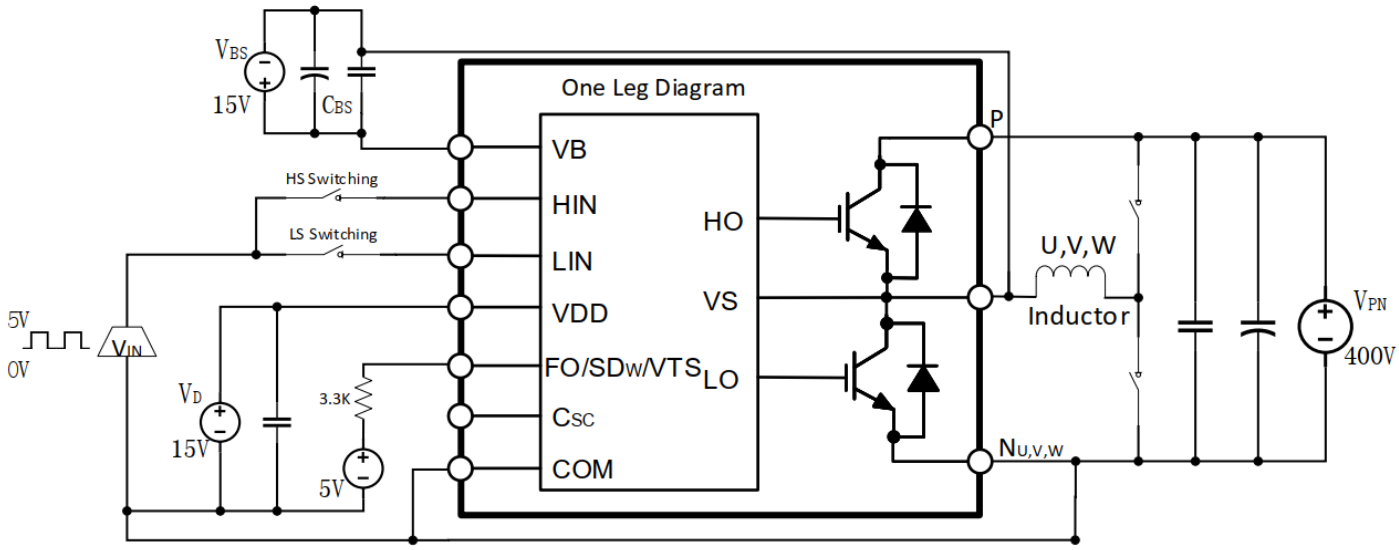


Figure4. Switching Test Circuit

Table 6. Control part

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
I_{QD}	Quiescent V_{DD} Supply Current	-	-	1.7	mA	V_{DD}=15V, V_{IN}=0V or 5V
I_{QB}	Quiescent V_{BS} Supply Current	-	-	100	μA	V_{DD}=15V, V_{IN}=0V
I_{FO_T}	Temperature output current	-	38	-	μA	Temperature sensing voltage, 25℃,1.5kohm to 3.3V pull-up
		-	480	-		Temperature sensing voltage, 100℃,1.5kohm to 3.3V pull-up
V_{FO_T}	Temperature output voltage	-	3.24	-	V	Temperature sensing voltage, 25℃,1.5kohm to 3.3V pull-up
		-	2.58	-		Temperature sensing voltage, 100℃,1.5kohm to 3.3V pull-up
V_{SC}	OCP positive going threshold	0.43	0.48	0.53	V	V_{DD}=15V
t_{FOT}	Fault-Out clear time	20	-	-	μs	-
UV_{DR}	Supply Circuit Under-Voltage Protection	10.5	11.5	12.5	V	Reset Level
UV_{DD}		9.5	10.5	11.5		Detection Level
UV_{BR}		10	11	12		Reset Level
UV_{BD}		9	10	11		Detection Level
V_{FSDR}	Shut Down Reset Level	-	-	2.5	V	Applied between FO-COM
V_{FSDD}	Shut Down Detection Level	0.8	-	-		
$V_{IN(ON)}$	ON Threshold Voltage	-	-	2.5	V	Applied between IN_{UH}, IN_{VH}, IN_{WH}, IN_{UL}, IN_{VL}, IN_{WL} -COM
$V_{IN(OFF)}$	OFF Threshold Voltage	0.8	-	-	V	
$I_{IN(ON)}$	ON Input Current	-	-	2000	μA	V_{IN}=5V
$I_{IN(OFF)}$	OFF Input Current	-	-	5		V_{IN}=0V

Table 7. BSD part

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
R_{BS}	Bootstrap Diode Resistance	-	90	-	Ω	
V_F	Bootstrap Diode Forward Voltage	-	1.5		V	I_F=10mA

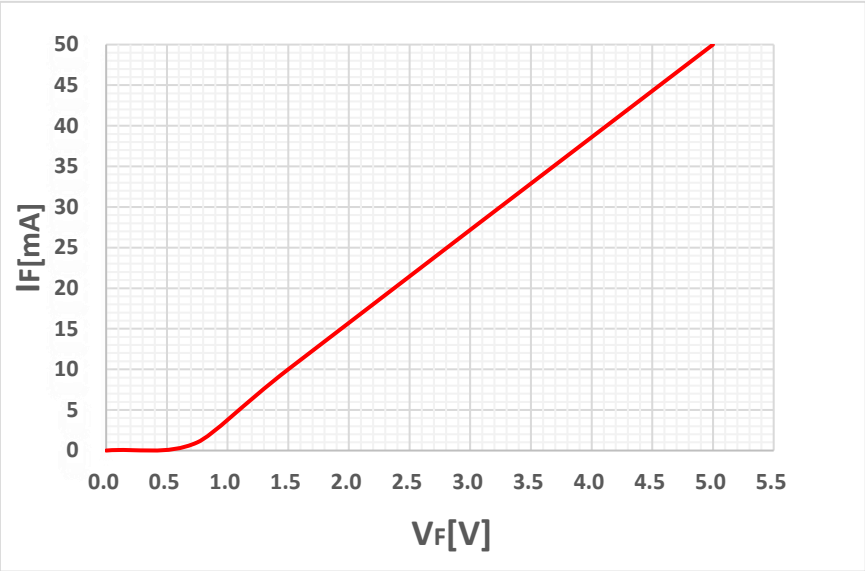


Figure5. Bootstrap Diode Characteristic

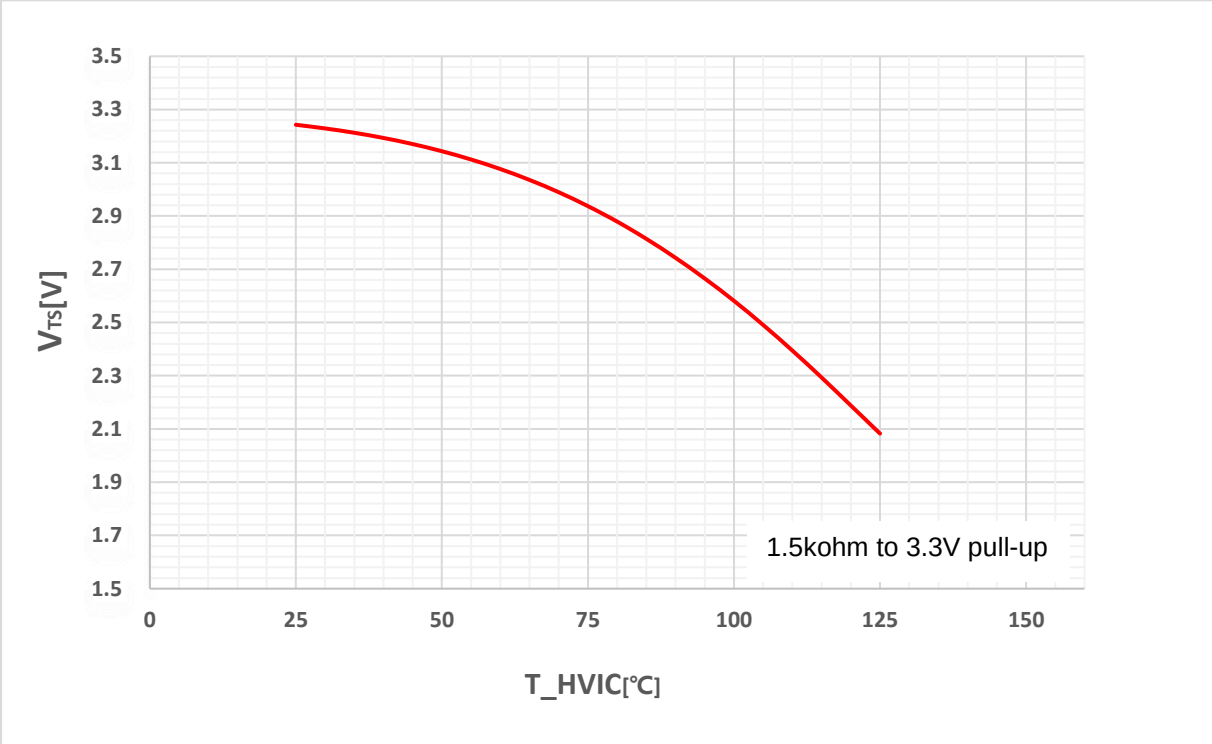


Figure6. Temperature Output of IC

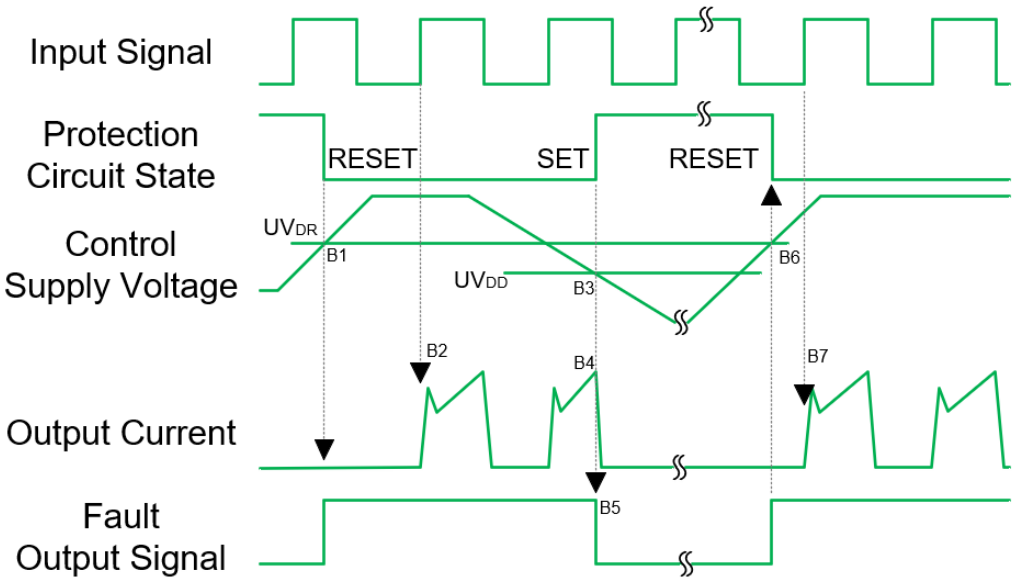


Figure7. Under−Voltage Protection

Figure7 NOTES:

B1: Control supply voltage rises: after the voltage rises UVDR, the circuits start to operate when next input is applied.
B2: Normal operation: IGBT ON and carrying current.
B3: Under−voltage detection ($UV_{DD/BD}$).
B4: IGBT OFF in spite of control input condition.
B5: Fault output operation starts.
B6: Under−voltage reset ($UV_{DR/BR}$).
B7: Normal operation: IGBT ON and carrying current.

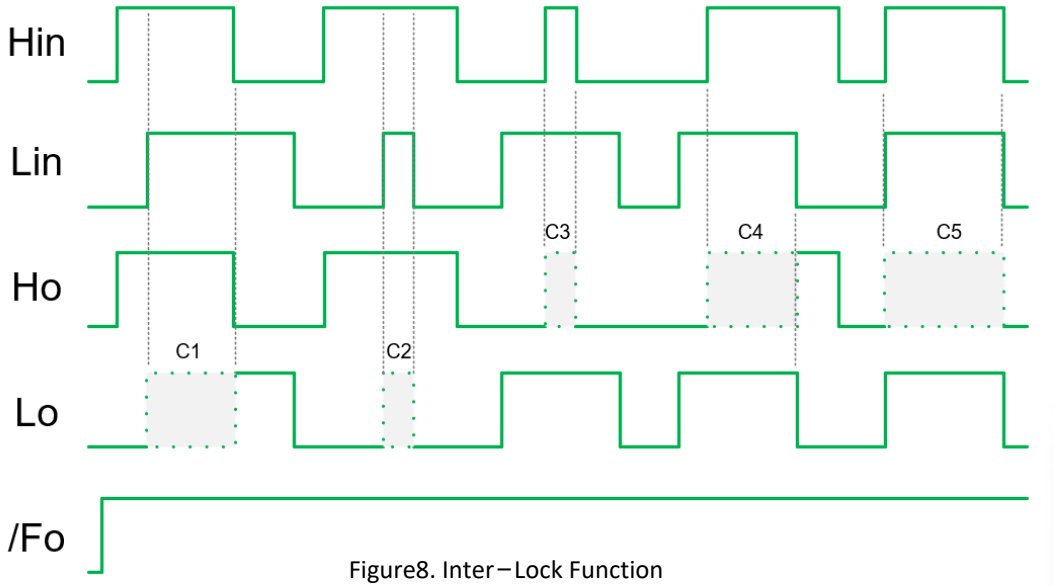


Figure8. Inter−Lock Function

Figure8 NOTES:

Hin: High−side Input Signal
Lin: Low−side Input Signal
Ho: High−side IGBT Gate Voltage
Lo: Low−side IGBT Gate Voltage
/Fo: Fault Output

C1: High Side First−Input−First−Output Mode
C2: Low Side Noise Mode: No LO
C3: High Side Noise Mode: No HO
C4: Low Side First−Input First−Output Mode
C5: IN−Phase Mode: No HO

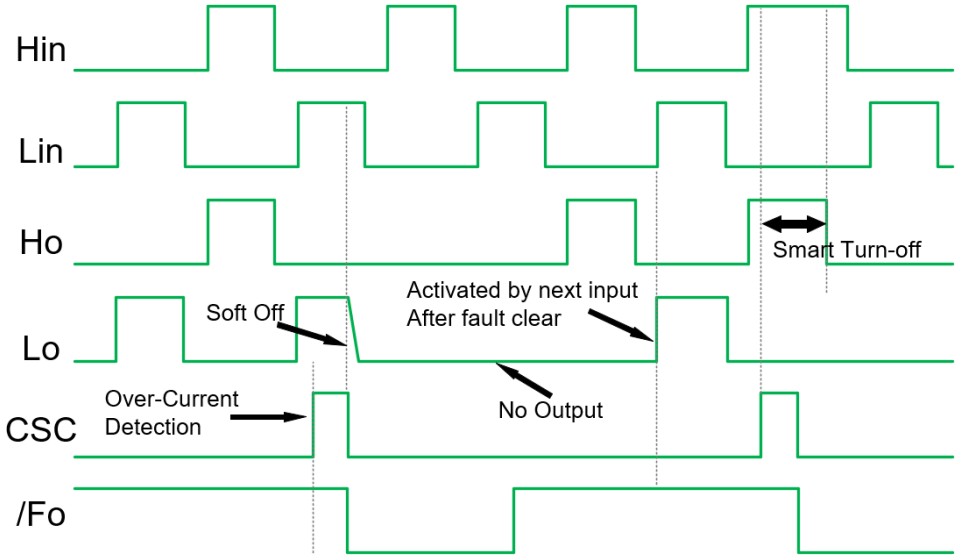


Figure9. Fault−Out Function by Over Current

Figure9 NOTES:

HIN: High−side Input Signal
LIN: Low−side Input Signal
HO: High−Side Output Signal
LO: Low−Side Output Signal
CSC: Over Current Detection Input
/FO: Fault Out Function

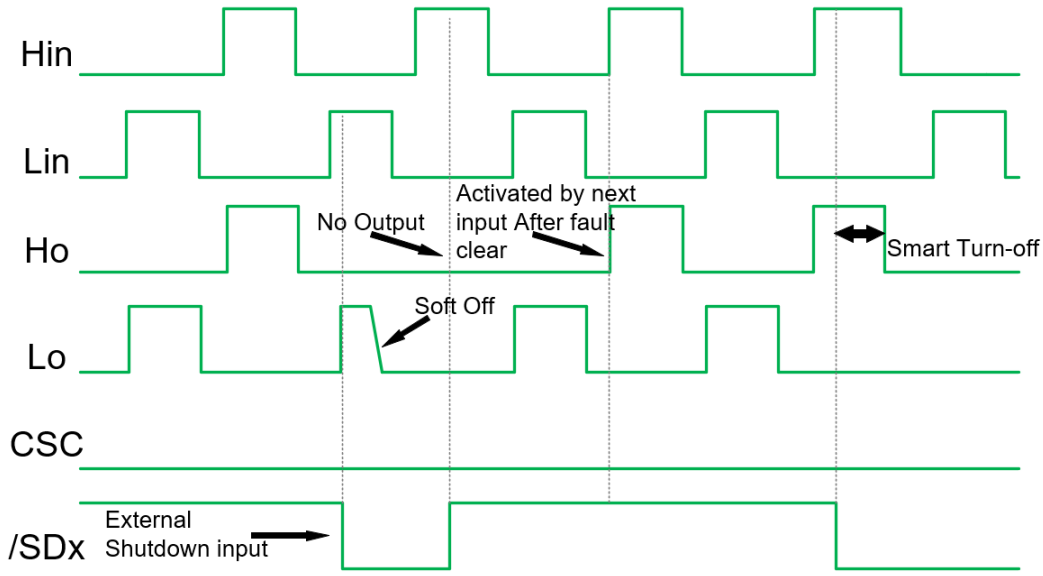


Figure10. Shutdown Input Function by External Command Protection

Figure10 NOTES:

HIN: High−side Input Signal
LIN: Low−side Input Signal
HO: High−Side Output Signal
LO: Low−Side Output Signal
CSC: Over Current Detection Input
/SDx: Shutdown Input Function

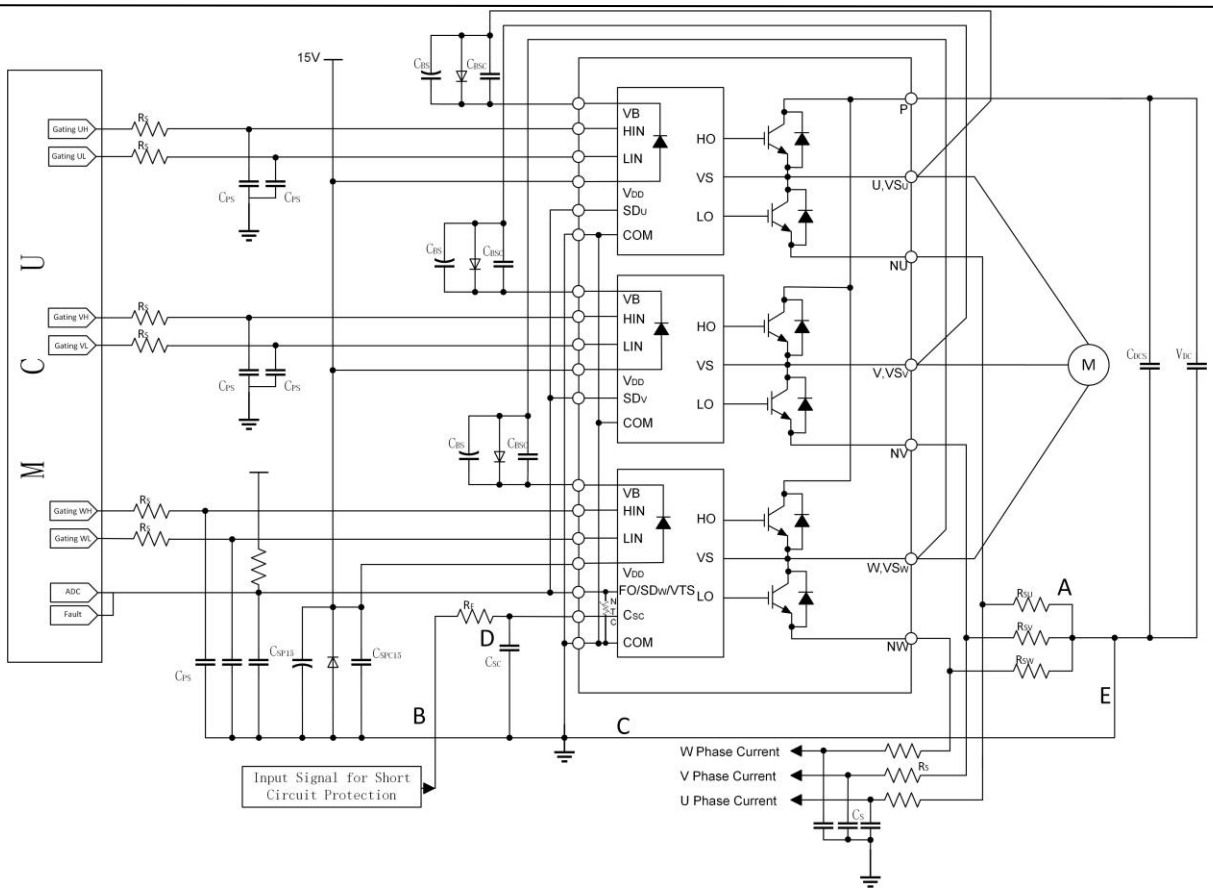


Figure11. Example of Application Circuit

Figure11 NOTES:

1. To avoid malfunction, the wiring of each input should be as short as possible (Less than 2 ~ 3 cm).
2. When using the module's temperature sense output function, PIN9 needs to be connected to the MCU's ADC and fault detection terminals; Since the PIN9 pin is an open-drain type, it must be pulled up to 3.3V through the pull-up resistor, which is recommended to be 1.5KΩ.
3. C_{SP15} of around seven times larger than bootstrap capacitor C_{BS} is recommended.
4. Input signal is active−HIGH type. There is a 5 KΩ resistor inside the IC to pull down each input signal line to GND. RC coupling circuits are recommended for the prevention of input signal oscillation. $R_S C_{PS}$ time constant should be selected in the range 50 ~ 150 ns (Recommended R_S = 100Ω, C_{PS} = 1 nF).
5. Each wiring pattern inductance of A point should be minimized (Recommend less than 10nH). Use the shunt resistor $R_{S(U/V/W)}$ of surface mounted (SMD) type to reduce wiring inductance. To prevent malfunction, wiring of point E should be connected to the terminal of the shunt resistor $R_{S(U/V/W)}$ as close as possible.
6. To prevent errors of the protection function, the wiring of B, C, and D point should be as short as possible.
7. In the short−circuit current protection circuit, please select the $R_F C_{SC}$ time constant in the range 1.5 ~ 2 μs. Do enough evaluation on the real system because short−circuit protection time may vary wiring pattern layout and value of the R_F and C_{SC} time constant.
8. The connection between control GND line and power GND line which includes the NU, NV, NW must be connected to only one point. Please do not connect the control GND to the power GND by the broad pattern. Also, the wiring distance between control GND and power GND should be as short as possible.
9. Each capacitor should be mounted as close to the pins of the Motion product as possible.
10. To prevent surge destruction, the wiring between the smoothing capacitor and the P and GND pins should be as short as possible. The use of a high frequency non−inductive capacitor of around 0.1 ~ 0.22 μF between the P and GND pins is recommended.
11. Relays are used in almost every system of electrical equipment of home appliances. In these cases, there should be sufficient distance between the CPU and the relays.
12. The zener diode or transient voltage suppressor should be adapted for the protection of ICs from the surge destruction between each pair of control supply terminals (Recommended Zener diode is 22 V / 1 W, which has the lower zener impedance characteristic than about 15Ω).
13. Please choose the electrolytic capacitor with good temperature characteristic in C_{BS}. Also, choose 0.1 ~ 0.2 μF R−category ceramic capacitors with good temperature and frequency characteristics in C_{BSC}.
14. For the detailed information, please refer to the application notes.
15. FO and $SD_{U/V/W}$ must be connected as short as possible.

5. Recommended operation condition

Table 8.

Symbol	Parameter	Values			Unit	Test Condition
		Min.	Typ.	Max.		
V_{PN}	Supply Voltage	-	300	400	V	Applied between PIN -NU, NV, NW
V_{DD}	Control Supply Voltage	14.0	15.0	16.5	V	Applied between VDD-COM
V_{BS}	High-side Bias Voltage	13.0	15.0	18.5	V	Applied between VBU-U, VBV-V, VBW -W
dV_D/dt, dV_B/dt	Control Supply Variation	-1	-	1	V/μs	-
t_{dead}	Arm shoot-through blocking time	1	-	-	μs	For each Input Signal
f_{PWM}	PWM Input frequency	-	-	20	kHZ	TC≤100℃,TJ≤125℃
V_{SEN}	COM variation	-4	-	4	V	Applied between NU, NV, NW -COM (including surge voltage)
$P_{WIN(ON)}$	Minimum Input Pulse Width	0.7	-	-	μs	VDD=VBS=15V,IC ≤ 10A,wiring inductance between NU,NV,NW and DC Link N<10nH
$P_{WIN(OFF)}$		0.7	-	-	μs	

6. Mechanical Characteristics

Table 9.

Parameter	Values			Unit	Test Condition
	Min.	Typ.	Max.		
Device Flatness	-50	-	+100	μm	See Figure 12
Mounting Torque	0.6	0.7	0.8	N • m	Mounting Screw: M3 (See Figure 13) Recommended 0.62N•m
Weight	3.0	4.0	5.0	g	-

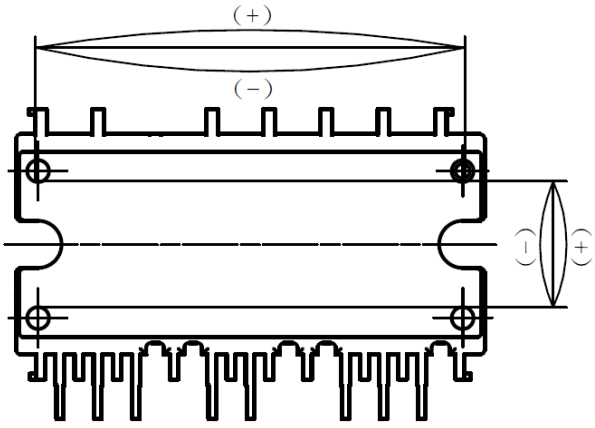


Figure12. Flatness Measurement Position

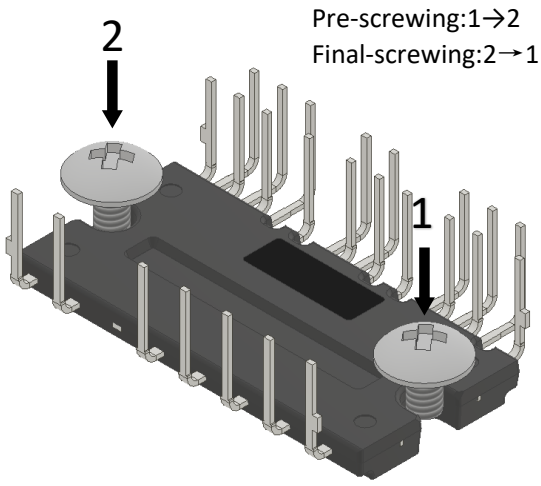
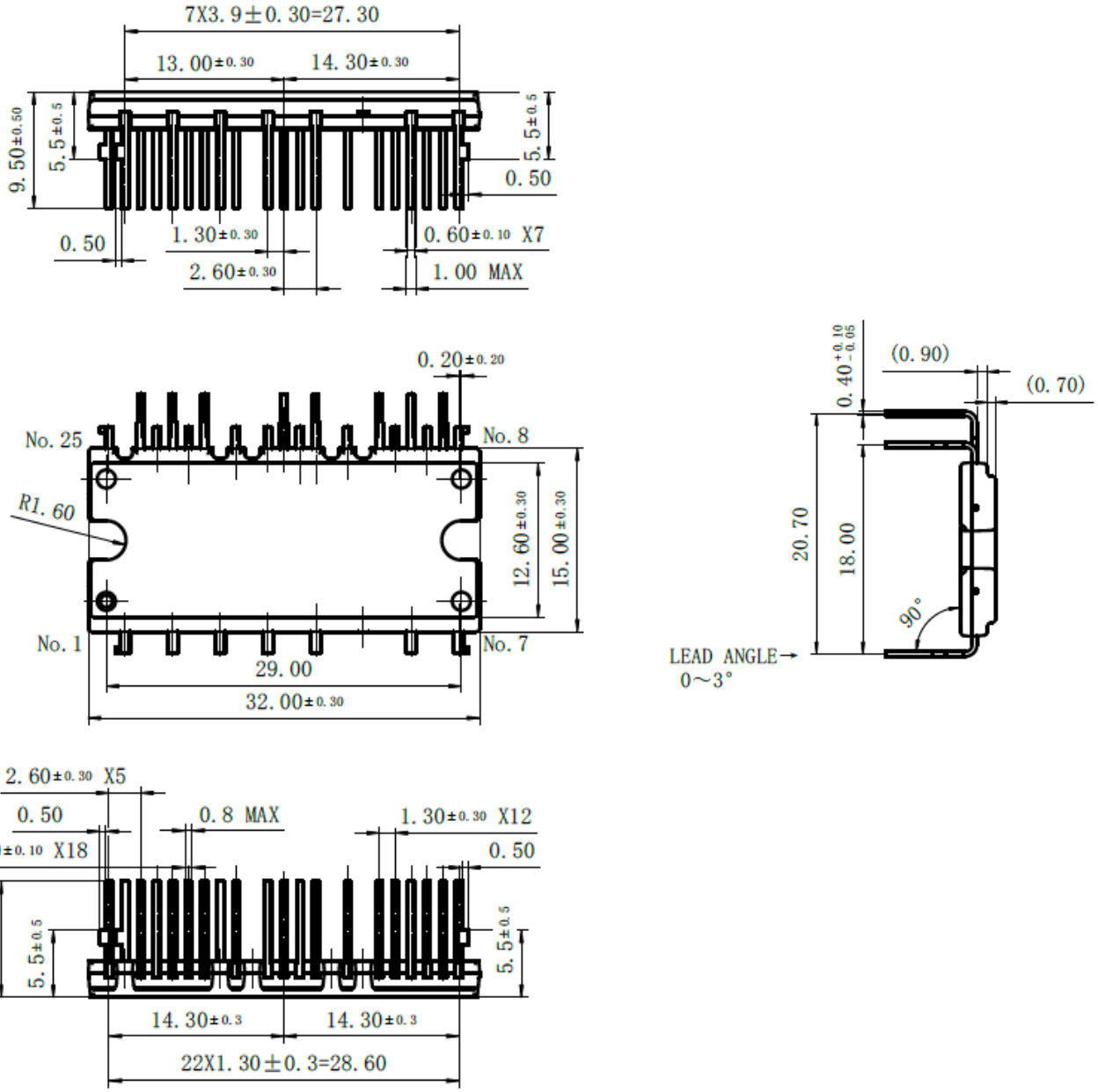


Figure13. Screwing Order

7. Outline Drawing

Dimensions in mm (DIP25-B)



8. Appendix

CoolSemi Webpage: www.coolsemi.com.