IPM, 600V/10A, Three-phase Full-Bridge Drive

Description:

SPB10CDG160SM is a highly integrated and highly reliable three-phase brushless DC motor drive circuit, mainly applied in low-power frequency conversion drives, such as Fan motor, Water pump, refrigerators, and Industrial motor, etc. It is equipped with a 3-phase full-bridge high-voltage gate driver circuit and 6 low-loss IGBTs. It integrates various protection functions such as under-voltage, short circuit, and over-temperature internally, providing excellent protection and a wide safe operating range.

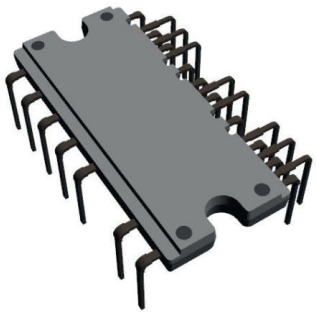
Features:

- Built-in 6 IGBTs and 3 half bridge gate drivers
- Built-in bootstrap diode
- Built-in under-voltage protection、 short circuit (overcurrent) protection、over temperature protection and temperature output
- Shut-Down input
- Temperature Detection: Negative temperature coefficient thermistor detection output
- Compatible with 3.3V & 5V input signal, effective at high level
- Insulation class 1500Vrms/min

Application:

- Fan motor
- Blender
- Water pump
- Refrigerator
- Industrial motor

Package



Order codes	Package	Marking
SPB10CDG160SM	SDIP25-FP	SPB10CDG160SM

Internal Block Diagram

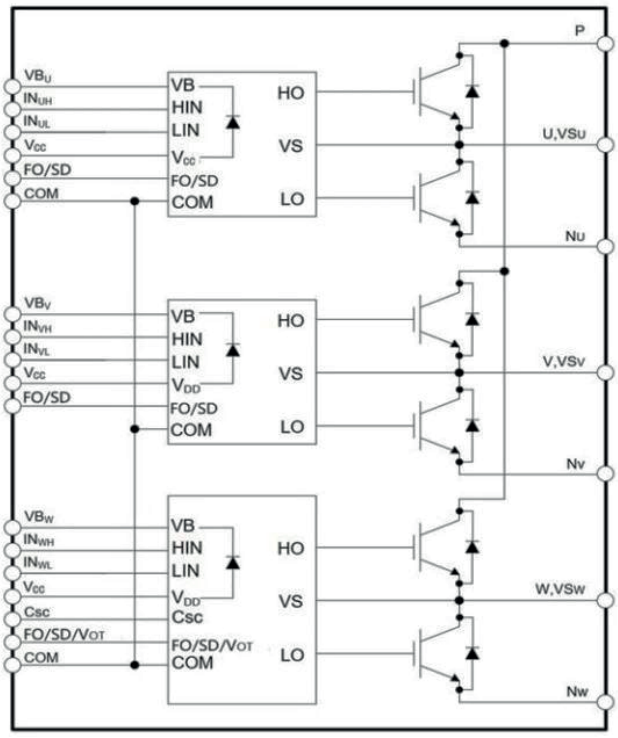


Fig 1：Internal Block Diagram

Pin configuration

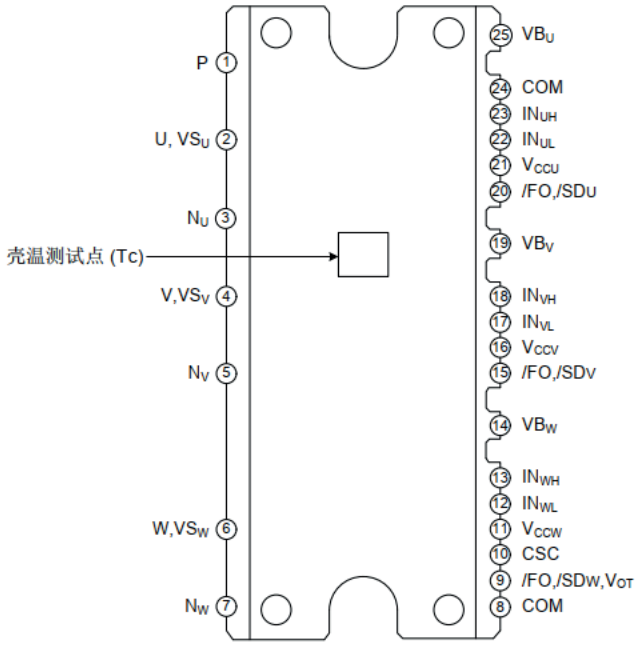


Fig 2：Pin Configuration

Pin Number	Pin Name	Pin Description
1	P	Dc input terminal of inverter
2	U, VS_U	Output for U-Phase & Bias Voltage Ground for U-phase High-Side Driving
3	N_U	U phase lower arm IGBT emitter terminal
4	V, VS_V	Output for V-Phase & Bias Voltage Ground for V-phase High-Side Driving
5	N_V	V phase lower arm IGBT emitter terminal
6	W, VS_W	Output for W-Phase & Bias Voltage Ground for W-phase High-Side Driving
7	N_W	W phase lower arm IGBT emitter terminal
8	COM	GND Common Supply Ground
9	/FO, $/SD_W$, V_{OT}	Fault Output, Shut−Down Input for W Phase, Temperature Output
10	C_{SC}	Shut Down Input for Over Current and Short Circuit Protection
11	V_{CCW}	Control power terminal
12	IN_{WL}	W phase lower arm control signal input terminal
13	IN_{WH}	W phase upper arm control signal input terminal
14	VB_W	W phase upper arm drive power terminal
15	/FO,$/SD_V$	Shut−Down Input for V Phase
16	V_{CCV}	Control power terminal
17	IN_{VL}	V phase lower arm control signal input terminal
18	IN_{VH}	V phase upper arm control signal input terminal
19	VB_V	V phase upper arm drive power terminal
20	/FO,$/SD_U$	Shut−Down Input for U Phase
21	V_{CCU}	Control power terminal
22	IN_{UL}	U-phase lower arm control signal input terminal
23	IN_{UH}	U-phase upper arm control signal input terminal
24	COM	GND Common Supply Ground
25	VB_U	U-phase upper arm drive power terminal

Fig 3：Pin function

Absolute Maximum Ratings (Tj= 25℃, Unless Otherwise Specified)

Symbol	Parameter	Condition	Ratings	Units
Inverter Part				
V_{CES}	Collector to emitter voltage	/	600	V
I_C	Collector current	Tc = 25°C	10	A
I_{CP}	Collector current (peak)	Tc = 25°C, pulse width is less than 1ms	20	A
V_{CC}	Supply voltage	Applied between p-NU, NV, NW	450	V
P_C	Collector power consumption	TC = 25°C, single chip	25	W
$V_{CC(Surge)}$	Supply voltage (including surge)	Applied between p-NU, NV, NW	500	V
Tj	Junction temperature	(Note 1)	-40~+150	℃
Control Part				
V_{CC}	Control Supply Voltage	Applied between V_{CC} and COM	20	V
V_{BS}	High-side Bias Voltage	Applied between VB and VS	20	V
V_{IN}	Input Signal Voltage	Applied between V_{IN} and COM	-0.3~V_{CC}+0.3	V
Total System				
$V_{CC(PROT)}$	Power supply voltage Self-protection range (short circuit)	Tj = 125°C, no repetition, time is less than 2us	400	V
T_C	Module working temperature	-20℃≤Tj ≤150°C	-20 ~ +100	℃
Tstg	Storage temperature	/	-40 ~ +125	℃
Viso	Isolation Voltage	60Hz, Sinusoidal，AC 1 min，between pins and heat-sink plate	1500	Vrms
Thermal Resistance				
Rth(j-c)Q	Junction to Case Thermal resistance	Single IGBT element	4.6	℃/W
Rth(j-c)F		Single FRD element	5.7	℃/W

NOTE1：The maximum rated junction temperature of the IPM power chip is 150°C (@surface temperature TC≤ 100°C). However, to ensure safe operation of the IPM, the junction temperature should be limited to Tj(av) ≤ 125°C (@surface temperature Tc ≤ 100°C).

Electrical Characteristics (TJ= 25°C, Unless Otherwise Specified)

Inverter Part

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{CESAT}	Collector−Emitter Saturation Voltage	V_{CC}=V_{BS}=15V,V_{IN}=5V I_C=10A	-	1.5	1.9	V
V_F	FRD Forward Voltage	V_{IN}=0V,I_F=10A	-	1.7	2.1	V
I_{CES}	Collector−Emitter Leakage Current	V_{CE}=600V	-	-	50	uA
Ton	Switching Time and Loss (NOTE 2) (Figure 4)	V_{PN}=300V, V_{CC}=V_{BS}=15V, I_C=10A, V_{IN}=0V~5V, Inductive load	-	560	-	ns
$T_{C(ON)}$			-	180	-	ns
Toff			-	670	-	ns
$T_{C(OFF)}$			-	105	-	ns
Trr			-	135	-	ns
E_{on}			-	1200	-	uJ
E_{off}			-	820	-	uJ

NOTE2：Ton and Toff Includes HVIC internal transmission delay. $T_{C(ON)}$ and $T_{C(OFF)}$ is the switching time of the IGBT.

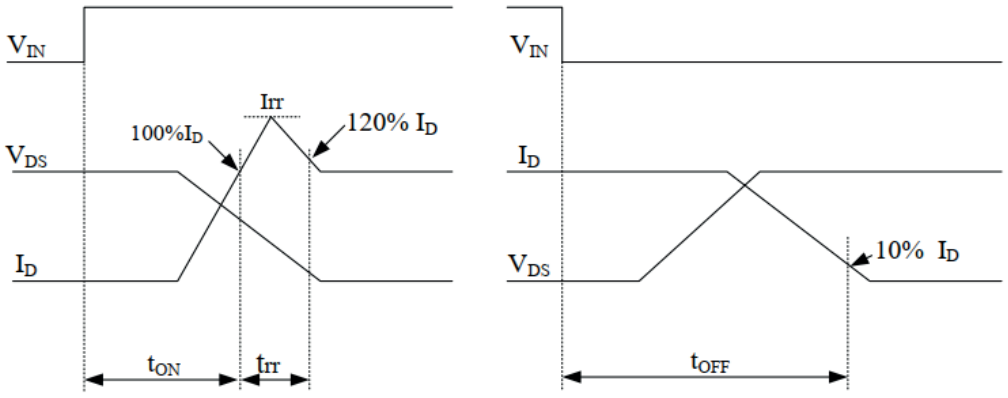
Control Part

Symbol	Parameter	Condition		Min	Typ	Max	Unit
I_{QCC}	Quiescent VCC Supply Current	V_{CC} = 15V	Applied between VCC and COM	-	320	400	uA
I_{QB}	Quiescent VBS Supply Current	V_{DB} = 15V	Applied between VB(U) - U,VB(V) - V,VB(W) -W	-	35	100	uA
V_{FOH}	Fault Output Voltage	Vsc=0V, FO terminal pulled up to 5V by 6.8 kΩ		4.1	-	-	V
V_{FOL}		Vsc=1V, FO terminal pulled up to 5V by 6.8 kΩ		-	-	0.5	V
$V_{SC(ref)}$	Short-Circuit Trip Level	Vcc=15V		0.40	0.45	0.50	V
UV_{CCD}	Low-Side Under-Voltage Protection (Figure 5)	VCC Under-Voltage Protection Detect Level		8.4	8.9	9.5	V
UV_{CCR}		VCC Under-Voltage Protection Reset Level		9.5	10.1	10.7	V
UV_{BSD}	High-Side Under-Voltage Protection (Figure 6)	VBS Under-Voltage Protection Detect Level		7.7	8.6	9.1	V
UV_{BSR}		VBS Under-Voltage Protection Reset Level		8.3	9.2	9.7	V

Symbol	Parameter	Condition		Min	Typ	Max	Unit
T_{FO}	Fault-out Pulse Width			20	-	-	us
V_{OT}	Temperature Sensing Voltage Output (Figure 7)	Tc=90℃, Pull down R=6.8kΩ, C_{SC}=0V		-	3.4	-	V
		Tc=25℃, Pull down R=6.8kΩ, C_{SC}=0V		-	4.3	-	V
T_{OTP}	Over temperature protection threshold			-	138	-	℃
V_{FSDR}	Shut-down Reset level	SD_X-COM		3	-	-	V
V_{FSDD}	Shut-down Detection level	SD_X-COM		-	-	0.8	V
V_{IH}	ON threshold Voltage	Logic high level	Applied between Vin-COM	2.6	-	-	V
V_{IL}	OFF threshold Voltage	Logic low level		-	-	1	V

Recommended Operating Conditions

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{PN}	Supply Voltage	Applied between P- NU, NV, NW	-	300	400	V
V_{CC}	Control Supply Voltage	Applied between VCC and COM	13.5	15.0	16.5	V
V_{BS}	High-side Bias Voltage	Applied between VB and VS	13.5	15.0	16.5	V
d_{VCC}/d_t, d_{VBS}/d_t	Control Power Fluctuation		-1	-	1	V/us
T_{DEAD}	Deadtime is Shoot Through Prevention	VCC=VBS=13.5~16.5V, T_J≤150°C	1.0	-	-	us
F_{PWM}	PWM Switching Frequency	T_J≤150°C	-	-	20	KHz



(a) Turn-on (b) Turn-off

Fig 4: Switching Time Waveform Definitions

Time Charts of Function

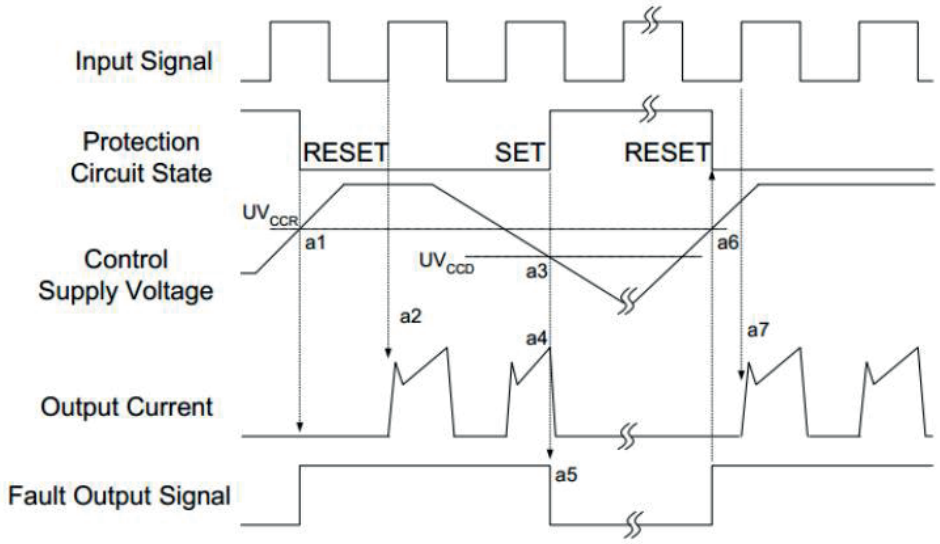


Fig 5: Under-voltage protection sequence diagram (low side)

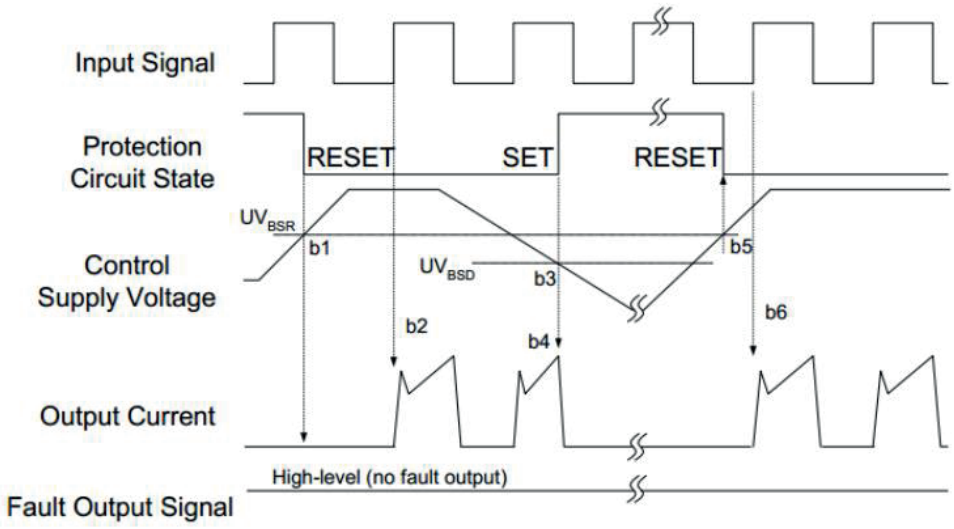


Fig 6: Under-voltage protection sequence diagram (High side)

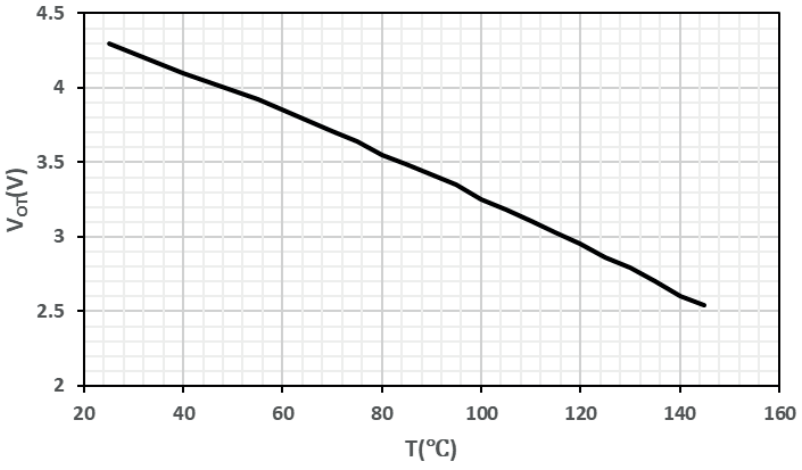


Fig 7: Temperature curve of V_{OT}

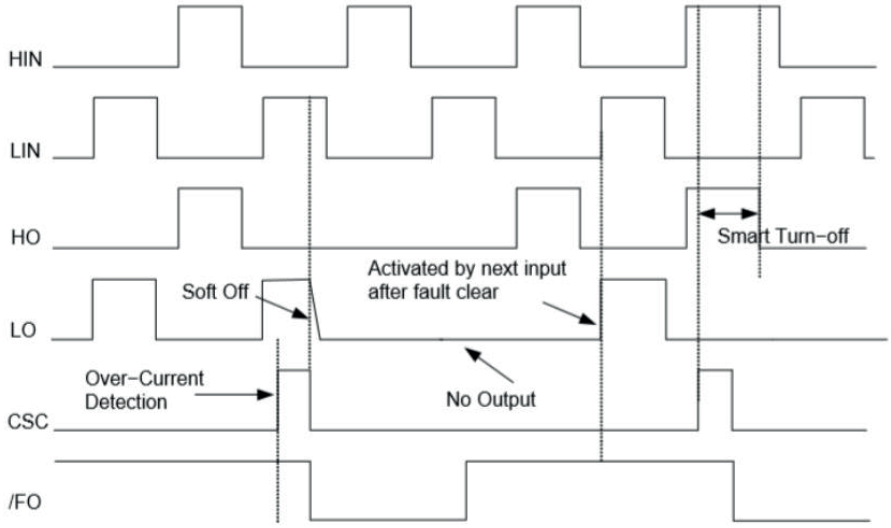


Fig 8: Fault-out Function by Over Current Protection

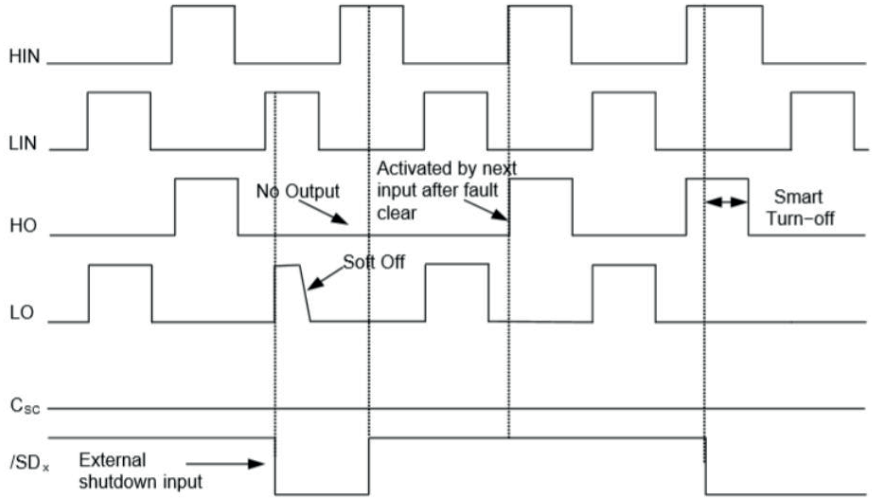


Fig 9: Shot-down Input Function by External Command

Recommended Application Circuit

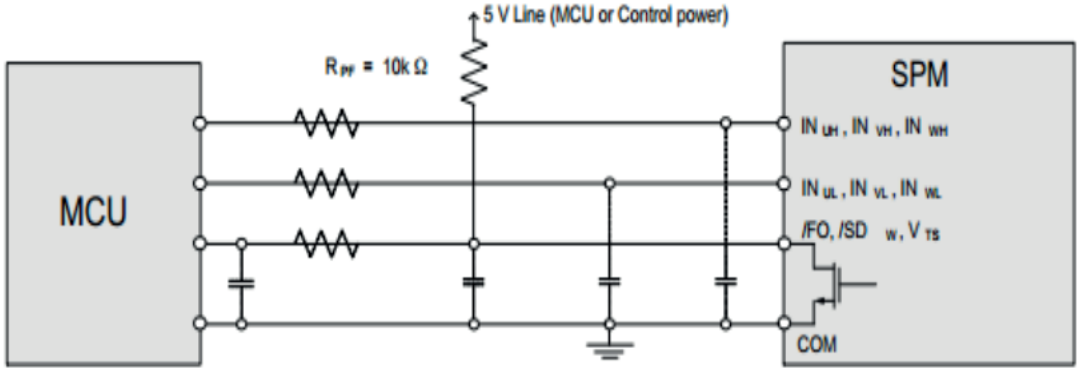


Fig 10: Recommended MCU input and output interface circuit

NOTE3: Due to the PWM control method and the impedance of the actual application circuit and the impedance of the circuit board, RC decoupling may change.

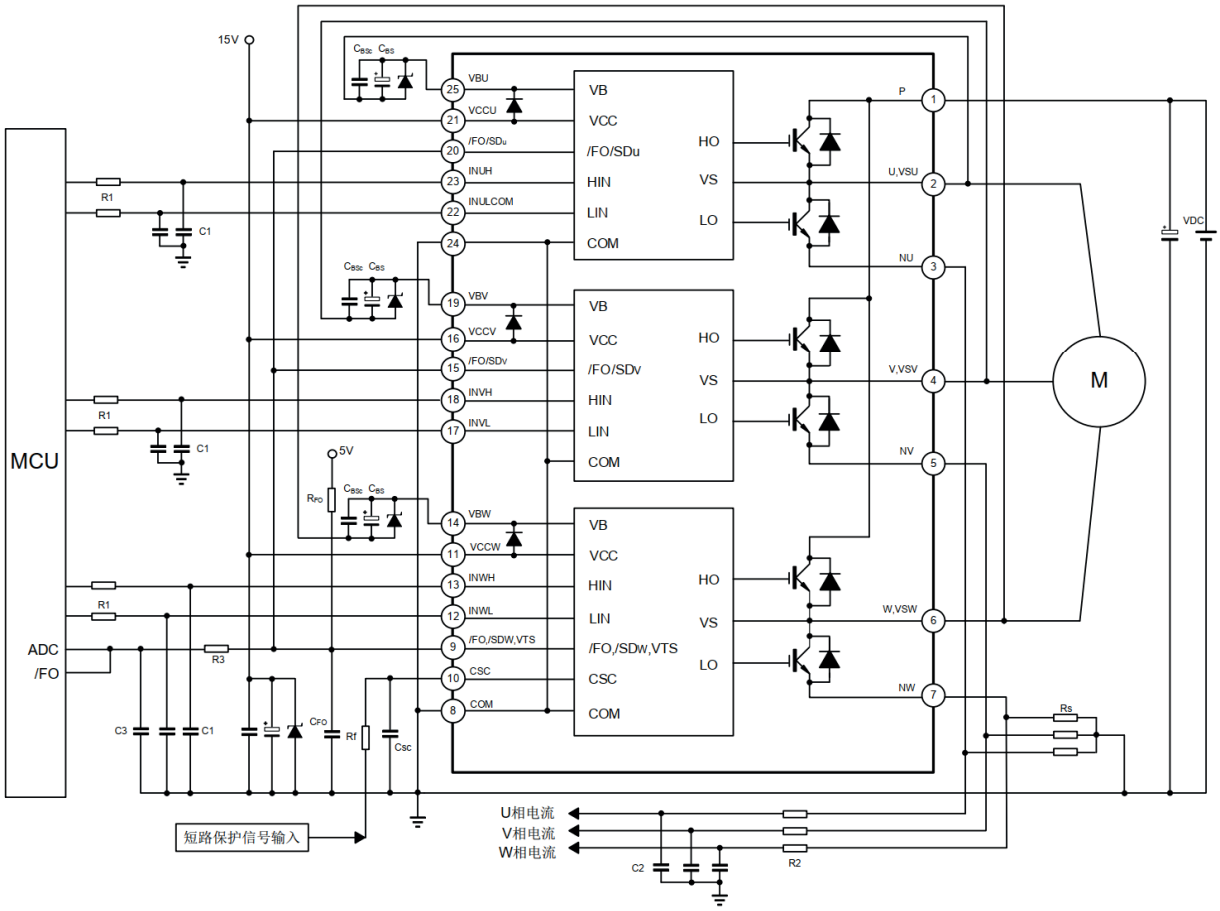


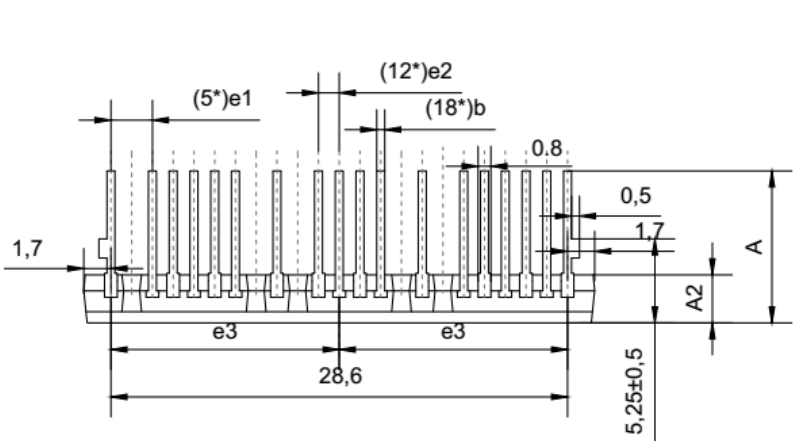
Fig 11：Typical application circuit

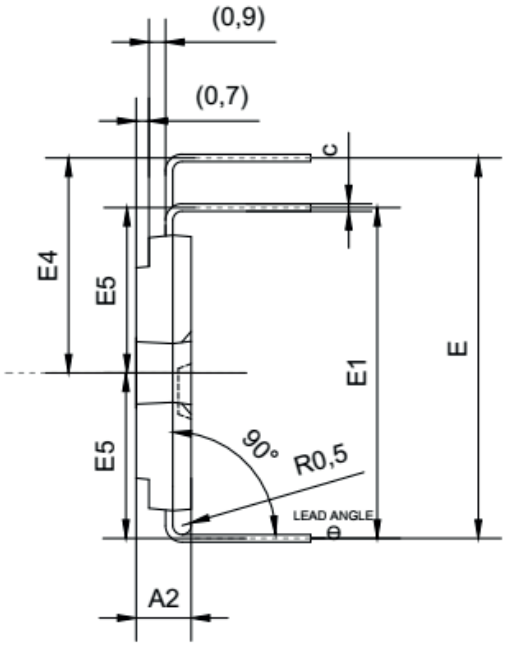
NOTE4：

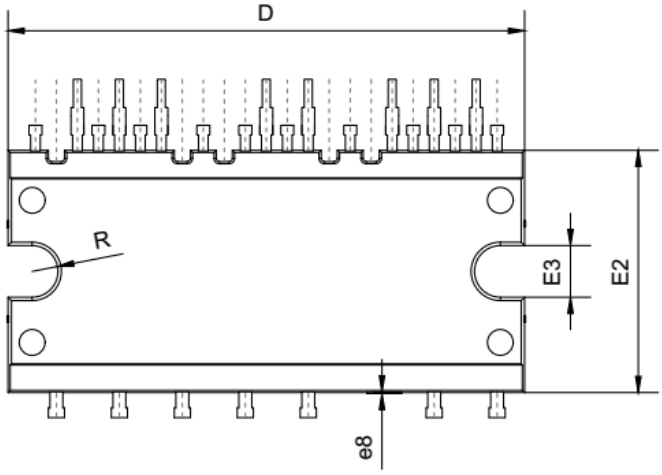
1. The position of the pins can refer to Figure 1.
2. To avoid malfunction, the wiring of each input should be as short as possible.
3. To prevent surge destruction, it is recommended to add a high-frequency non inductive smoothing capacitor (0.1μF~0.22μF) between PN, and the wiring of the capacitor should be as short as possible.
4. The high level of the input signal is effective, and a pull-down resistor is connected to the ground at the input terminals of each channel of HVIC; It is suggested to add RC filter circuit at the input terminals to prevent input signal oscillation.
5. Position all capacitors as close to IPM as possible.
6. The control ground wire and power ground wire shall be connected at one point, and the wiring shall be as short as possible;
7. In the short−circuit current protection circuit, please select the RF CSC time constant in the range 1.5～2us, At the same time, the wiring around RF and CSC shall be as short as possible, and RF wiring shall be close to shunt resistance;
8. /FO and /SD must be connected as short as possible.

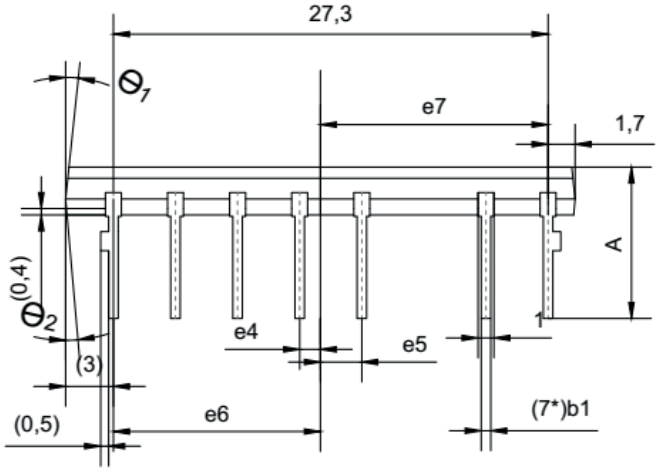
Detailed Package Outline Drawings

SDIP25-FP POD









SYMBOL	COMMON Dimensions millimeter			SYMBOL	COMMON Dimensions millimeter		
	Min	Nom	Max		Min	Nom	Max
A	9.00	9.50	10.00	e1	2.30	2.60	2.90
A2	2.80	3.00	3.20	e2	1.00	1.30	1.60
b	0.40	0.50	0.60	e3	14.00	14.30	14.60
b1	0.50	0.60	0.70	e4	1.00	1.30	1.60
c	0.35	0.40	0.50	e5	2.30	2.60	2.90
D	31.70	32.00	32.30	e6	12.70	13.00	13.30
E	20.20	20.70	21.20	e7	14.00	14.30	14.60
E1	17.50	18.00	18.50	e8	0.00	--	0.10
E2	14.70	15.00	15.30	R	1.50	1.60	1.70
E3	3.00	3.20	3.40	θ	0°	--	3°
E4	11.40	11.70	12.00	θ1	6° REF		
E5	8.70	9.00	9.30	θ2	5° REF		

(unit: mm)