IPM, 600V/15A, Three-phase Full-Bridge Drive

Description:

XZ15GCA60C2FCF is a highly integrated and highly reliable three-phase brushless DC motor drive circuit, mainly applied in low-power frequency conversion drives, such as air conditioners, refrigerators, and washing machines, 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.

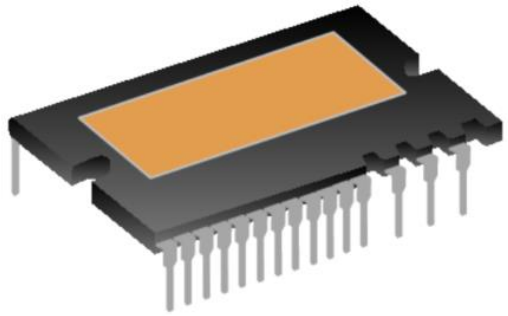
Features:

- Lower arm IGBT emitter output, built-in bootstrap diode;
- 600V/15A three-phase inverter with built-in low-loss trench gate-field stop IGBT;
- IGBT drive: high-speed 600V level conversion, power supply under-voltage protection, short circuit (overcurrent) protection, over temperature protection and temperature output;
- Fault signal: corresponds to short circuit (overcurrent)、over temperature and Low-side power under-voltage fault;
- Input interface: compatible with 3.3V&5V input signals, high level effective;

Application:

- Air-conditioning compressor;
- Refrigerator compressor;
- Low power inverter;
- Industrial sewing machine;

Package



Order codes	Package	Marking
XZ15GCA60C2FCF	DIP25-Cu	XZ15GCA60C2FCF

Internal Block Diagram

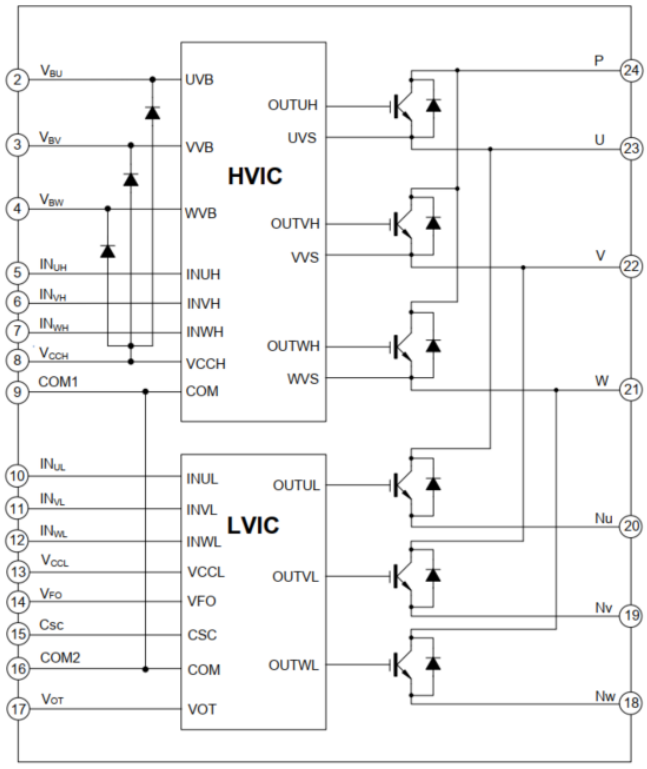


Fig 1: Internal Block Diagram

Pin configuration

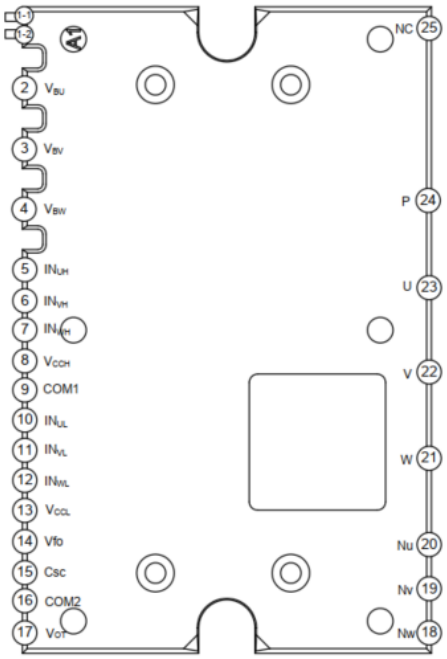


Fig 2：Pin Configuration(Top)

Pin Number	Pin Name	Pin Description
1-1	NC	connectionless
1-2	NC	connectionless
2	V_{BU}	U-phase upper arm drive power terminal
3	V_{BV}	V-phase upper arm drive power terminal
4	V_{BW}	W-phase upper arm drive power terminal
5	IN_{UH}	U-phase upper arm control signal input terminal
6	IN_{VH}	V-phase upper arm control signal input terminal
7	IN_{WH}	W-phase upper arm control signal input terminal
8	V_{CCH}	Control power terminal
9	Com1	Control power GND terminal
10	IN_{UL}	U-phase lower arm control signal input terminal
11	IN_{VL}	V-phase lower arm control signal input terminal
12	IN_{WL}	W-phase lower arm control signal input terminal
13	V_{CCL}	Control power terminal
14	V_{FO}	Fault output terminal
15	C_{SC}	Shortcircuitprotectiontriggervoltagedetectionterminal
16	Com2	Control power GND terminal
17	V_{OT}	Temperature detection output terminal
18	N_W	W phase lower arm IGBT emitter terminal
19	N_V	V phase lower arm IGBT emitter terminal
20	N_U	U phase lower arm IGBT emitter terminal
21	W	W phase output terminal
22	V	V phase output terminal
23	U	U phase output terminal
24	P	Dc input terminal of inverter
25	NC	Connectionless

Fig 3：Pin function

Absolute Maximum Ratings(TJ= 25°C, Unless Otherwise Specified)

Symbol	Parameter	Condition	Ratings	Unit
Inverter Part				
V_P	Supply Voltage	Applied between P- NU, NV, NW	450	V
$V_{P(Surge)}$	Supply Voltage (Surge)	Applied between P- NU, NV, NW	500	V
V_{CES}	Collector-emitter Voltage		600	V
I_C	Each IGBT Collector Current	T_C=25°C	15	A
I_{CM}	Each IGBT Collector Current (Peak)	T_C=25°C, less than 1ms	30	A
P_C	Collector Dissipation	T_C=25°C, Per One Chip	39	W
T_j	Operating Junction Temperature	(NOTE 1)	-40~+150	°C
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	-0.5~V_{CC}+0.5	V
V_{FO}	Fault output voltage	Applied between FO-VNC	-0.5~V_{CC}+0.5	V
I_{FO}	Fault output Current	FO terminal sink current value	1	mA
V_{SC}	Input voltage of current detection terminal	Applied between CIN-VNC	-0.5~V_{CC}+0.5	A
T_j	Operating Junction Temperature		-40~+150	°C
Total System				
T_C	Module Case Operating Temperature		-20~100	℃
T_{STG}	Storage Temperature	Tc = 25°C	-40~150	℃
V_{ISO}	Isolation Voltage	60Hz, Sinusoidal, AC 1 min, between Pins and Heat-sink	1500	V
$R_{\theta JC}$	Thermal Resistance, junction to Case for IGBT		3.1	℃/W
$R_{\theta JC}$	Thermal Resistance, junction to Case for FRD		3.9	℃/W

NOTE1: To insure safe operation of the IPM, the average junction temperature should be limited to TJ ≤ 150°C (@Tc ≤ 125°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=15A	-	1.7	2.0	V
V_F	FRD Forward Voltage	V_{IN}=0V,I_F=15A	-	1.5	1.9	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=15A, V_{IN}=0V~5V, Inductive load	-	647	-	ns
$T_{C(ON)}$			-	186	-	ns
Toff			-	869	-	ns
$T_{C(OFF)}$			-	100	-	ns
Trr			-	144	-	ns
E_{on}			-	849	-	uJ
E_{off}			-	410	-	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_D	VD Quiescent Current	V_{CC} = 15V V_{IN} = 5V	VP1-VNC	-	-	1	mA
I_{DB}	VDB Quiescent Current	V_{DB} = 15V V_{IN} = 5V	UFB - U, VFB - V, WFB - W	-	-	550	uA
V_{FOH}	Fault output voltage	Vsc = 0V, FO pin is pulled up to 5V through 10K resistor		4.6	5.0	-	V
V_{FOL}		Vsc =1V, IFO=1.5mA		-	0.1	0.2	V
Vsc,TH+	Short circuit forward trigger threshold	VBS Under-Voltage Protection Detection Level		0.45	0.46	0.55	V
UV_{DD}	Power undervoltage protection contro	Trigger level(L)		9.5	10.0	11.0	V
UV_{DR}		Reset level(L)		10.0	10.5	12.0	
UV_{DBD}		Trigger level(H)		8.0	9.5	11.0	
UV_{DBR}		Reset level(H)		9.0	10.0	11.0	
T_{FD}	Fault output pulse width	/		-	65	-	uS
$V_{IN(ON)}$	Turn on threshold voltage	Applied between UP, VP, WP, UN, VN, WN and VNC		-	2.4	2.7	V
$V_{IN(OFF)}$	Turn-off threshold voltage			1	1.35	-	
V_{OT}	Temperature output, Note 3	Tc=90℃		2.6	2.8	3.0	V
		Tc=25℃		0.96	1.16	1.36	
OTt	Over temperature protection	LVIC temperature		120	130	140	℃
OTrh	Over temperature protection hysteresis	LVIC Hysteresis temperature		-	10	-	℃
R_{BSD}	Built-in limiting resistance	/		75	90	105	ohm

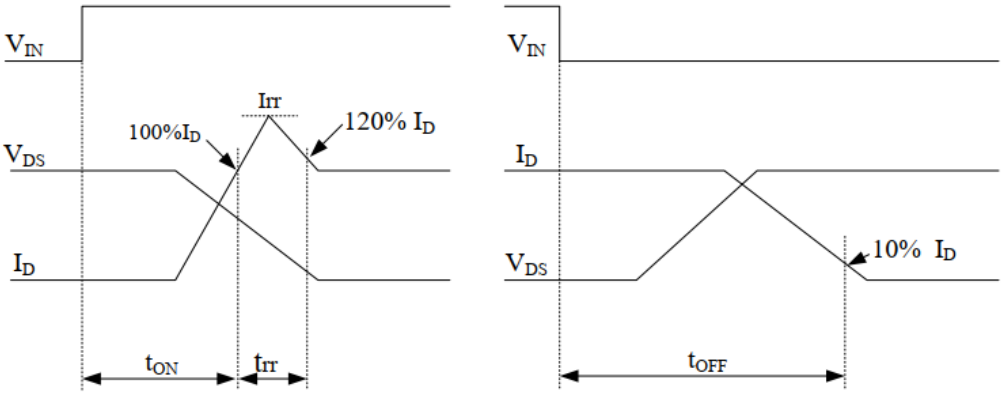
NOTE 3: Please refer to Figure 7 for the VOT output characteristic curve of IPM.

Bootstrap diode Part

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_F	Forward Voltage	I_F=15A, Tc = 25°C	-	1.57	-	V
t_{rr}	Reverse Recovery Time	I_F=15A, Tc = 25°C	-	116	-	ns

Recommended Operating Conditions

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{PN}	Supply Voltage	Applied between P- NU, NV, NW	-	400	500	V
V_{CC}	Control Supply Voltage	Applied between VCC and COM	-	15.0	-	V
V_{BS}	High-side Bias Voltage	Applied between VB and VS	-	15.0	-	V
$V_{IN(ON)}$	Input On-state Threshold Voltage	Applied between VIN and COM	2.5	-	V_{CC}	V
$V_{IN(OFF)}$	Input Off-state Threshold Voltage	Applied between VIN and COM	0	-	0.8	V
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

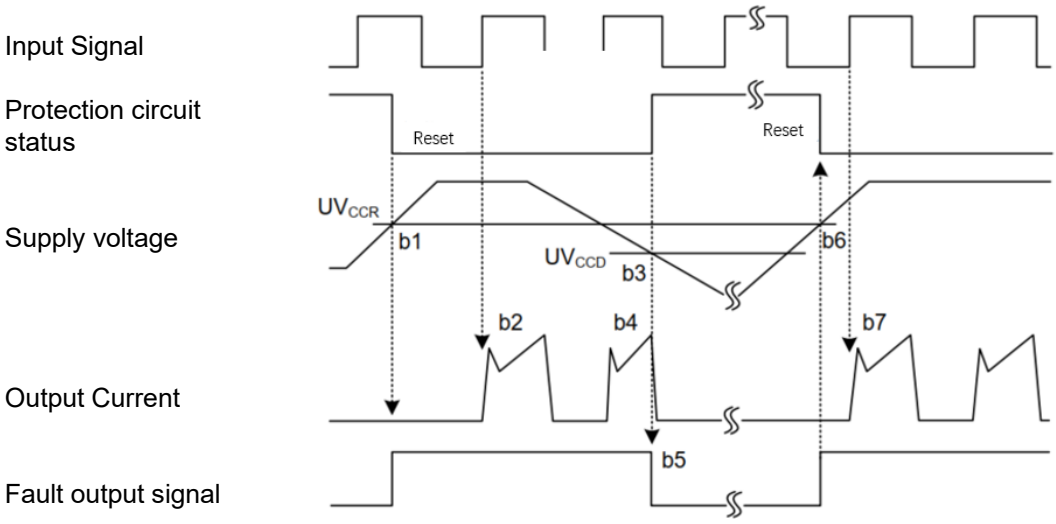


Fig 5: Under-voltage protection sequence diagram (low side)

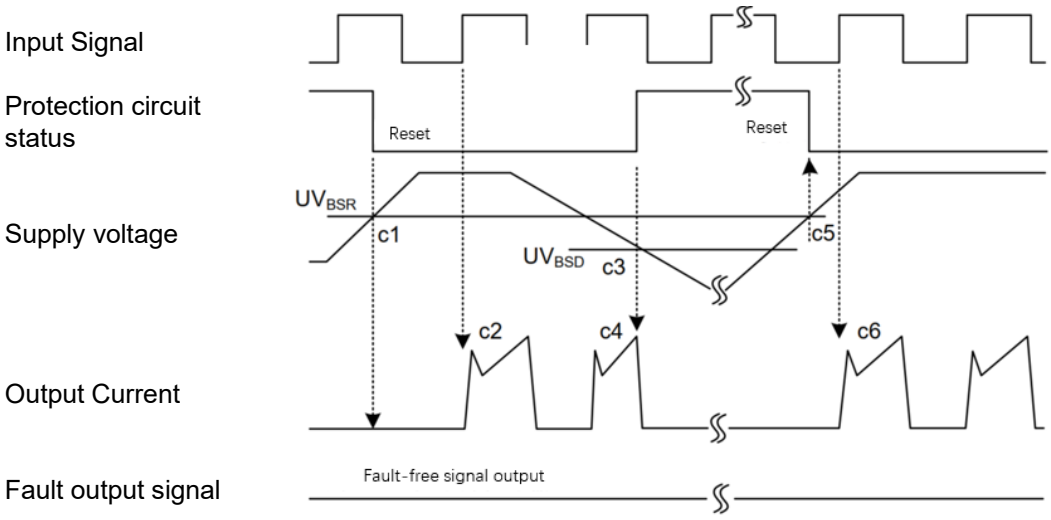


Fig 6: Under-voltage protection sequence diagram (High side)

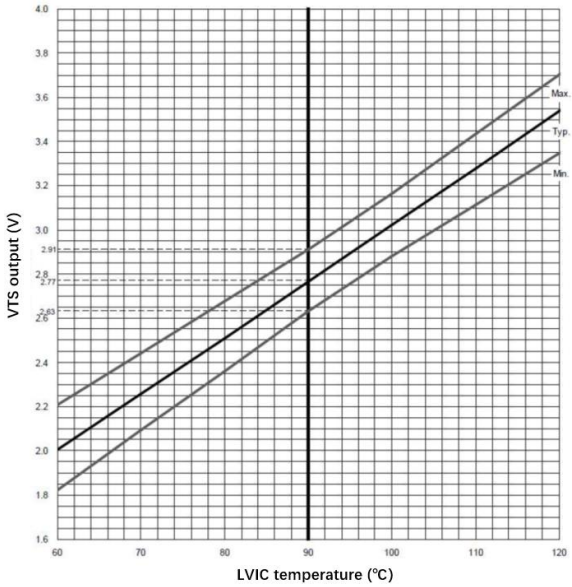


Fig 7: Temperature curve of VTS

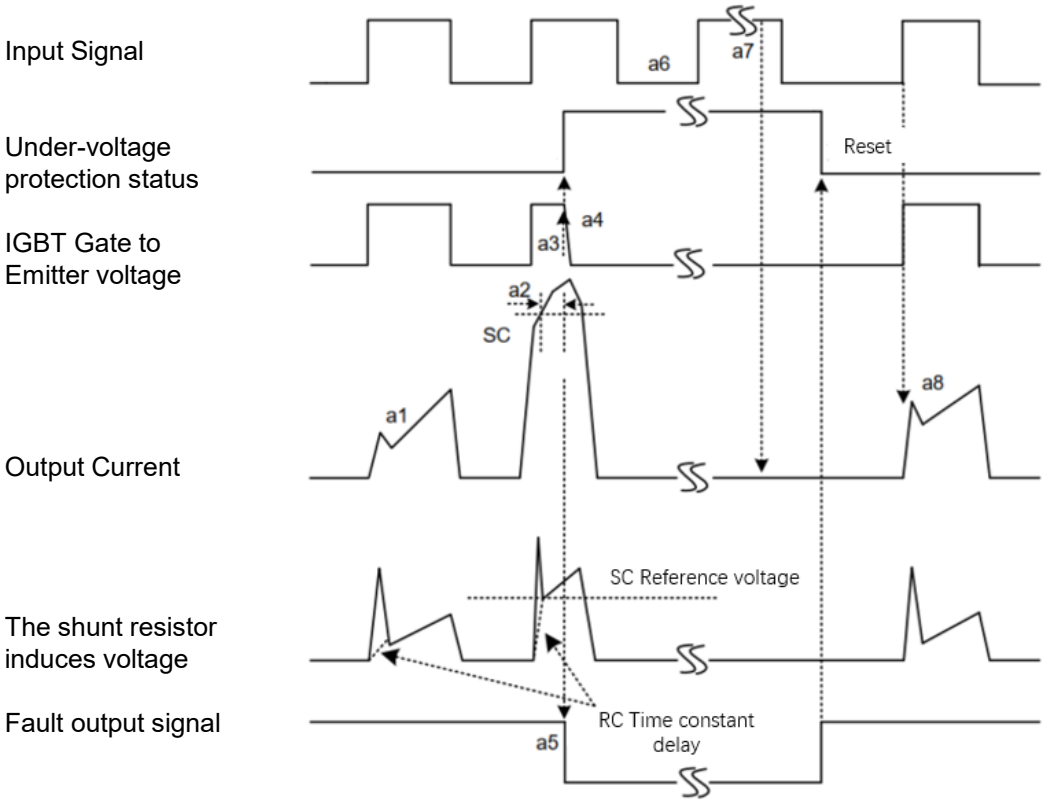


Fig 8： Short-circuit current protection(low side)

Application Circuit

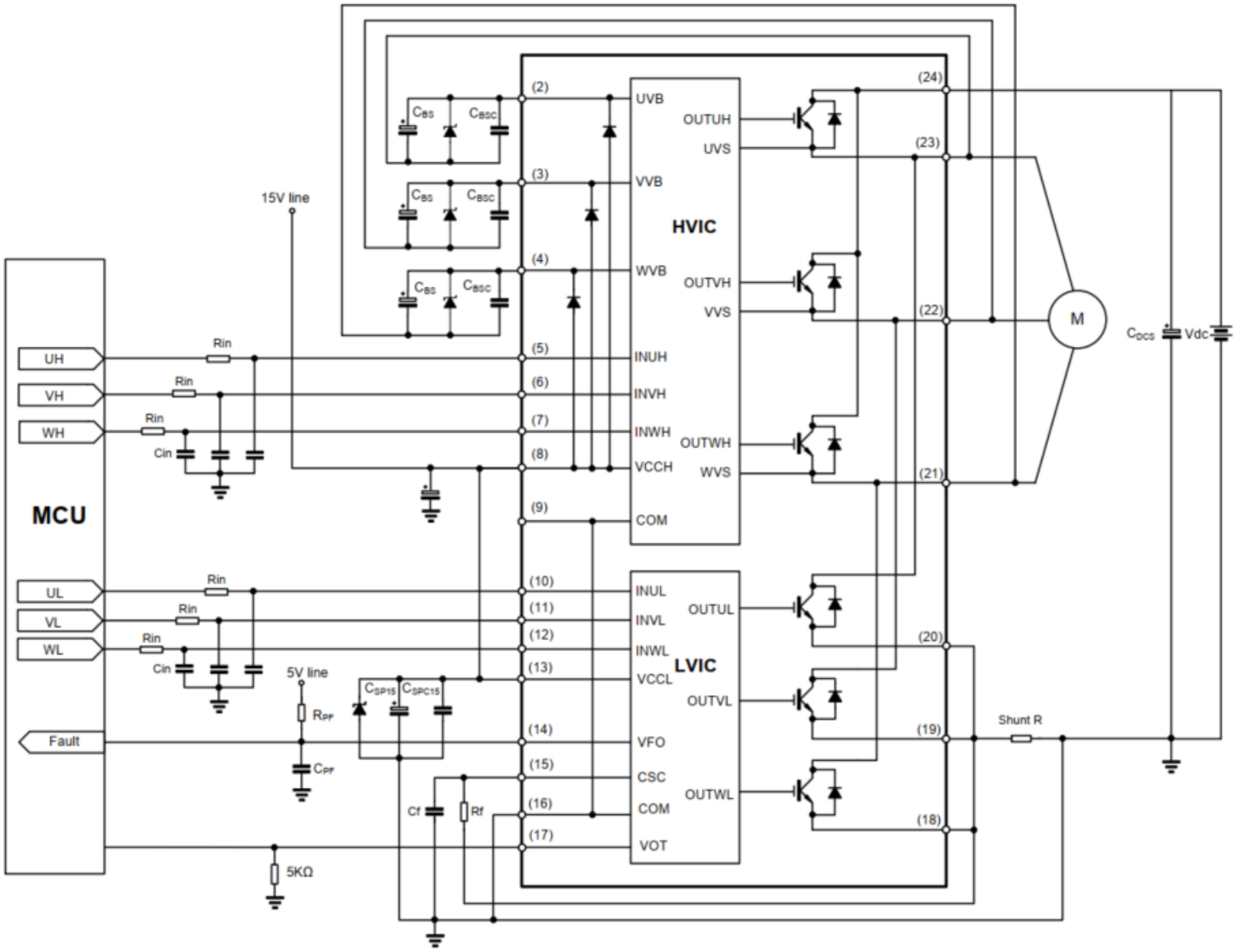


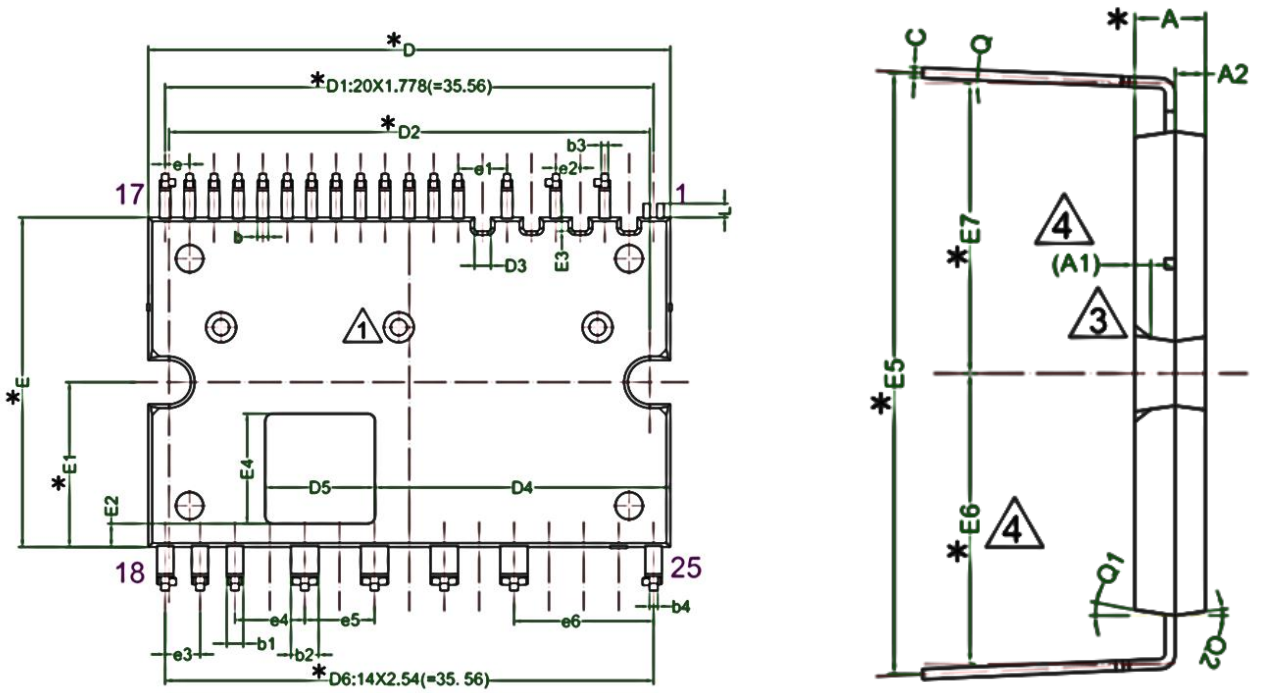
Fig 10: Typical application circuit

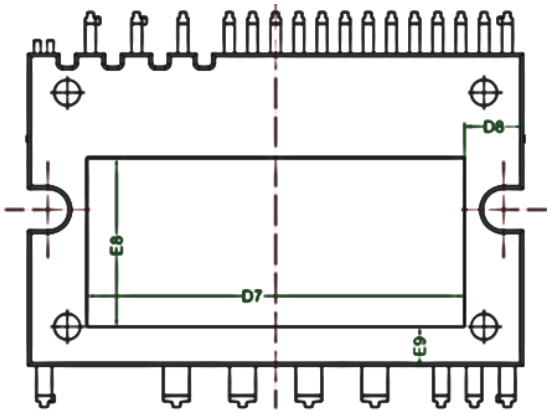
NOTE:

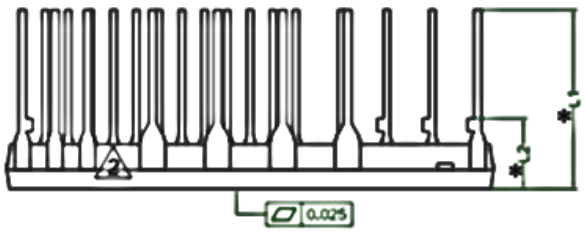
1. Keep the connections to each input pin as short as possible; otherwise, it may cause incorrect operation.
2. The input signal is valid when it is at a high level. At the input terminal of each channel of the HVIC, there is a 5KΩ pull-down resistor connected to ground. Additionally, an RC filter circuit can be added at the input terminal to prevent surge noise caused by incorrect input.
3. To prevent surge damage, it is recommended to add a high-frequency non-inductive smoothing capacitor (0.1μF to 0.22μF) between PN. The connection lines of the capacitor should be as short as possible.
4. The connection between the current detection resistor and the IPM should be as short as possible; otherwise, the large surge voltage generated by the connection inductor may cause damage
5. It is recommended that the filter capacitor at the 15V power input terminal be at least 7 times the bootster capacitor CBS
6. Each external capacitor should be placed as close as possible to the IPM pin
7. In short-circuit protection circuits, please select RF and CSC with time constants within the range of 1.5 to 2μs. Meanwhile, the wiring around RF and CSC should be as short as possible. The RF wiring should be close to the shunt resistor

Detailed Package Outline Drawings

DIP25







(unit: mm)

SYMBOL	COMMON Dimensions millimeter			SYMBOL	COMMON Dimensions millimeter		
	Min	Nom	Max		Min	Nom	Max
A	3.40	3.50	3.60	(E3)	0.90	1.00	1.10
(A1)	0.40	0.50	0.60	E4	7.80	8.00	8.20
A2	1.48	1.50	1.52	E5	28.90	29.40	29.90
b	0.75	0.80	0.85	E6	13.90	14.40	14.90
b1	1.15	1.20	1.25	E7	13.90	14.40	14.90
b2	1.95	2.00	2.05	E8	12.80	13.00	13.20
b3	0.45	0.50	0.55	E9	2.60	3.00	3.40
b4	0.55	0.60	0.65	e	1.728	1.778	1.828
C	0.45	0.50	0.55	e1	3.506	3.556	3.606
D	37.80	38.00	38.20	e2	1.728	1.778	1.828
(D1)	35.51	35.56	35.61	e3	2.490	2.540	2.590
(D2)	34.90	35.00	35.1	e4	5.030	5.080	5.130
D3	1.10	1.20	1.30	e5	5.030	5.080	5.130
D4	21.30	21.50	21.70	e6	10.11	10.16	10.21
D5	7.80	8.00	8.20	L	0.90	1.00	1.10
D6	35.51	35.56	35.61	L1	13.70	14.00	14.30
D7	28.80	29.00	29.20	L2	5.20	5.50	5.80
D8	4.10	4.50	4.90	(Q)	0°	2.5°	5°
E	23.80	24.00	24.20	Q1	7°	8°	9°
E1	11.90	12.00	12.10	Q2	7°	8°	9°
E2	1.50	1.70	1.90				