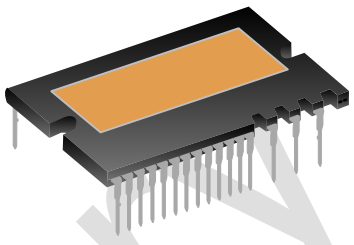
600V/10A 3-PHASE FULL-BRIDGE DRIVER (INTELLIGENT POWER MODULE)

DESCRIPTION

SDM10G60FB is a 3-phase brushless DC motor driver with high integration and high reliability for low power inverter driving such as air conditioner, refrigerator and dishwasher. It has embedded six low-loss IGBTs and three high-speed half-bridge gate drivers with high voltage.

The under voltage, short circuit and over temperature protections integrated make the circuit work safely in a wide range. The current of each phase can be detected separately because there is one independent negative DC terminal for each phase.

SDM10G60FB uses high-insulation design, compact package and carries heat easily, which makes it easy to use especially for compact installation applications.



DIP-24H

FEATURES

- Built-in six low-loss 600V/10A IGBT;
- Built-in high-voltage integrated circuit of gate driver;
- Built-in under voltage, over temperature and over current protections;
- Built-in bootstrap diode with current limiting resistor;
- Compatible with 3.3V, 5V MCU interface, active high;
- Three independent negative DC terminal for inverter current detection;
- Alarm signal: for low-side under voltage and short circuit protections;
- Package in Al_2O_3 DBC design with low thermal resistance;
- Insulation level: 1500Vrms/min

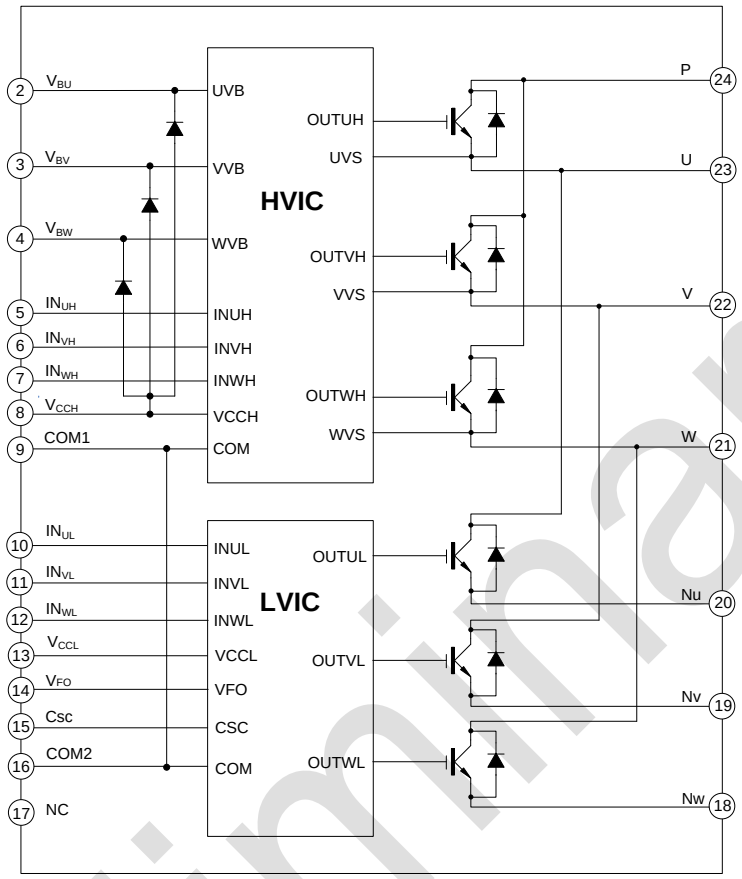
APPLICATIONS

- Air conditioner compressor
- Refrigerator compressor
- Low power inverter

ORDERING INFORMATION

Part No.	Package	Marking	Material	Packing
SDM10G60FB	DIP-24H	SDM10G60FB	Pb free	Tube

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATING

Characteristics	Symbol	Rating	Unit
Inverter section			
Voltage on the DC bus between PN	V_{PN}	450	V
Surge voltage on the DC bus between PN	$V_{PN(Surge)}$	500	V
Voltage between collector and emitter	V_{CES}	600	V
Continuous current of the single IGBT collector, T_C=25°C	I_C	10	A
Peak current of the single IGBT collector, T_C=25°C, Pulse width less than 1ms	I_{CP}	20	A
Max. power dissipation of the collector of each module, T_C=25°C	P_C	25	W
Control section			
Control supply voltage	V_{CC}	20	V
High-side control voltage	V_{BS}	20	V
Input signal voltage	V_{IN}	-0.5~ V_{CC}+0.5	V
Fault output supply voltage	V_{FO}	-0.5~V_{CC}+0.5	V

Characteristics	Symbol	Rating	Unit
Fault output current Sink current at V_{FO} pin	I_{FO}	1	mA
Input voltage at current detect pin	V_{SC}	-0.5~V_{CC}+0.5	V
Whole system			
Voltage limit of short circuit protection V_{CC}=V_{BS}=13.5~16.5V, T_J=150°C, single and less than 2μs	$V_{PN(PROT)}$	400	V
Operating temperature of module case Limit condition: -40°C≤T_J≤150°C	T_C	-20~100	°C
Storage temperature range	T_{STG}	-40~125	°C
Junction-to-case thermal resistance of each IGBT	$R_{\theta JCQ}$	4.0	°C/W
Junction-to-case thermal resistance of each FRD	$R_{\theta JCF}$	5.0	°C/W
Insulation voltage 60Hz, Sine, 1 minute Connect the pin to heatsink	V_{ISO}	1500	V_{rms}
Mounting torque Mounting screws: -M3, 0.62N.m recommended	T	0.5~0.8	N.m

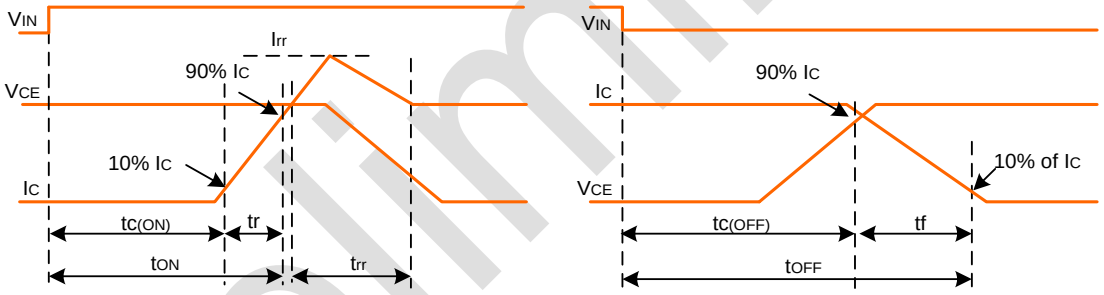
RECOMMENDED OPERATING CONDITIONS

Characteristics	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
Voltage on the bus between PN	V_{PN}	-	300	400	V
Control supply voltage	V_{CC}	13.5	15	16.5	V
High-side control voltage	V_{BS}	13.5	15	16.5	V
Control voltage variation	dVcc/dt dV_{BS}/dt	-1	-	1	V/μs
On threshold voltage	$V_{IN(ON)}$	3.0	-	V_{CC}	V
Off threshold voltage	$V_{IN(OFF)}$	0	-	0.6	V
Blanking time for preventing alrm-short V_{CC}=V_{BS}=13.5~16.5V, T_J⩽25°C	T_{dead}	1.5	-	-	μs
PWM input signal	f_{PWM}	-	-	20	KHz
COM variation (Between COM-Nu,Nv,Nw)	V_{COM}	-5	-	5	V

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, Tamb=25°C, VCC=VBS=15V)

Inverter

Characteristics		Symbol	Conditions	Min.	Typ.	Max.	Unit
Saturation voltage between collector and emitter		$V_{CE(SAT)}$	V_{CC}=V_{BS}=15V, V_{IN}=5V I_C=10A, T_J = 25°C	-	1.9	2.2	V
FRD forward voltage		V_F	V_{IN}=0V, I_F=10A, T_J = 25°C	-	1.7	2.2	V
Switching times	High side	t_{ON}	V_{PN} = 300V, V_{CC} = V_{BS} = 15V, I_C = 10A, V_{IN} = 0V←→ 5V, Inductive load Refer to fig. 1	-	0.60	-	μs
		$t_{C(ON)}$		-	0.20	-	μs
		t_{OFF}		-	0.60	-	μs
		$t_{C(OFF)}$		-	0.15	-	μs
		t_{rr}		-	0.06	-	μs
	Low side	t_{ON}		-	0.74	-	μs
		$t_{C(ON)}$		-	0.20	-	μs
		t_{OFF}		-	0.70	-	μs
		$t_{C(OFF)}$		-	0.15	-	μs
		t_{rr}		--	0.06	-	μs
Leakage current between collector and emitter		I_{CES}	V_{CE}=V_{CES}	-	-	1	mA



(a)On period (b)Off period

Fig.1 Switching definition

Control section

Characteristics	Symbol	Conditions		Min.	Typ.	Max.	Unit
V_{CC} Quiescent current	I_{QCCN}	V_{CC}=15V, V_{IN}=5V	V_{CCH}-COM, V_{CCL}-COM	-	-	2.8	mA
	I_{QCCF}	V_{CC}=15V, V_{IN}=0V		-	-	2.8	mA
V_{BS} Quiescent current	I_{QBS}	V_{BS}=15V, V_{INH}=0V	V_{BU}-V_{SU},V_{BV}-V_{SV}, V_{BW}- V_{SW}	-	-	100	μA
Fault output voltage	V_{FOH}	V_{SC}=0V,V_{FO} pull up 10KΩ resistor to 5V		4.9	-	-	V
	V_{FOL}	V_{SC}=1V,IFo=1mA		-	-	0.95	V

Characteristics	Symbol	Conditions		Min.	Typ.	Max.	Unit
Fault output pulse width	t_{FO}	(note1)		20	-	-	us
Trip voltage of short circuit	$V_{SC(ref)}$	V_{CC}=15V	(note2)	0.43	0.48	0.53	V
Over-temperature protection	TSD	LVIC temperature		100	120	140	°C
Over-temperature protection hysteresis	ΔTSD	LVIC temperature		-	10	-	°C
Low-side under voltage protection(fig.4)	UV_{CCD}	V_{CC} detect voltage		10.3	11.2	12.5	V
	UV_{CCR}	V_{CC} reset voltage		10.8	11.7	13.0	V
High-side under voltage protection (fig.5)	UV_{BSD}	V_{BS} detect voltage		7.0	10.0	12.0	V
	UV_{BSR}	V_{BS} reset voltage		7.5	10.5	12.5	V
On threshold voltage	V_{IH}	Logic High	Between input and COM	-	2.1	2.6	V
Off threshold voltage	V_{IL}	Logic Low		0.8	1.3	-	V

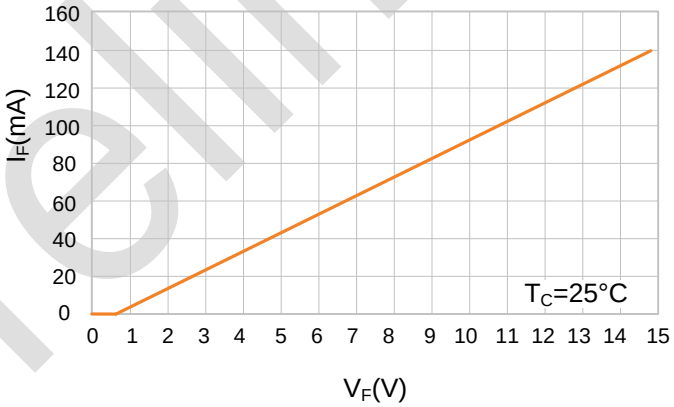
Note1: Fault signal FO outputs when SC or UV protection works. And FO pulse width is different for each protection modes. At SC failure, FO pulse width is a fixed width (=min.20us), but at UV failure, FO outputs continuously until recovering from UV state. (But minimum FO pulse width is 20us.)

Note2: Short circuit protection is functioning only at the low-sides.

Bootstrap Diode Part(Each Bootstrap diode, Unless Otherwise Specified)

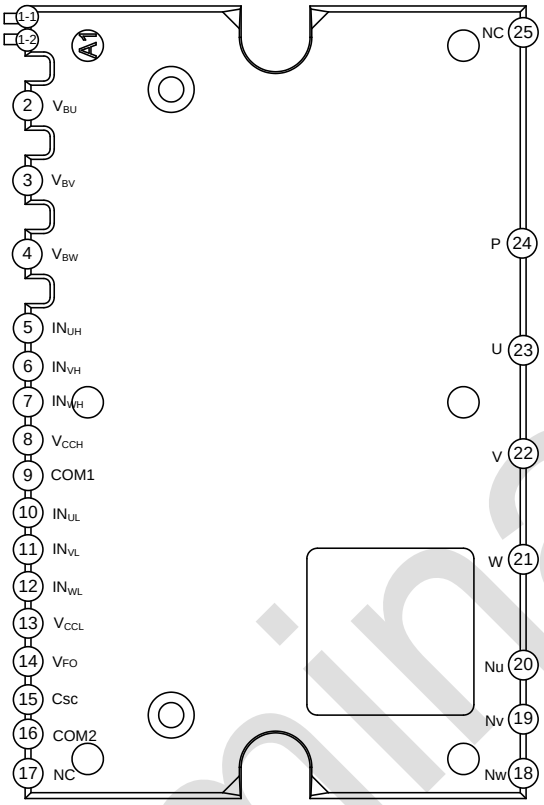
Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Forward Voltage	V_F	I_F=0.1A, T_C=25°C	-	10.7	-	V
Reverse Recovery Time	t_{rr}	I_F=0.1A, T_C=25°C	-	80	-	ns

Built in Bootstrap Diode V_F-I_F Characteristic



Note: Resistive characteristic: equivalent resistor: ~100Ω.

PIN CONFIGURATION

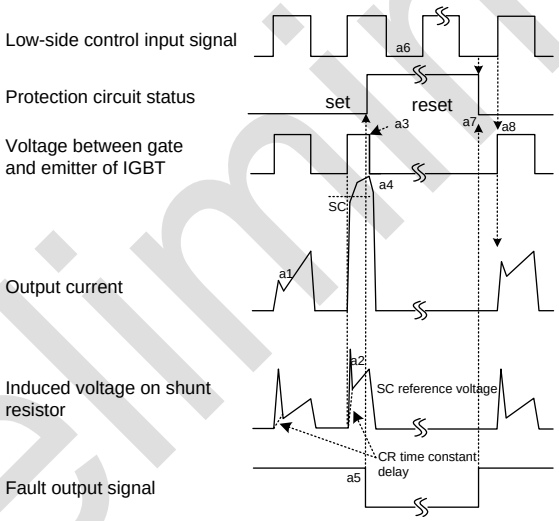


PIN DESCRIPTION

Pin No.	Pin Name	I/O	Pin Descriptions
1-1	(Com)	NC	Inner used terminal, it has control GND potential, should be left no connection
1-2	(Vcc)	NC	Inner used terminal, it has control supply potential, should be left no connection
2	V_{BU}	I/O	Floating supply voltage for U-phase high-side IGBT driving
3	V_{BV}	I/O	Floating supply voltage for V-phase high-side IGBT driving
4	V_{BW}	I/O	Floating supply voltage for W-phase high-side IGBT driving
5	IN_{UH}	I	U-phase high-side signal input
6	IN_{VH}	I	V-phase high-side signal input
7	IN_{WH}	I	W-phase high-side signal input
8	V_{CCH}	I/O	Supply voltage for high-side gate driver
9	Com1	I/O	Common ground for the module
10	IN_{UL}	I	U-phase low-side signal input
11	IN_{VL}	I	V-phase low-side signal input
12	IN_{WL}	I	W-phase low-side signal input
13	V_{CCL}	I/O	Supply voltage for low-side gate driver
14	V_{FO}	O	Fault output

Pin No.	Pin Name	I/O	Pin Descriptions
15	Csc	I/O	Connect to the capacitor for short circuit current detection input and low-pass filter
16	Com2	I/O	Common ground for the module
17	NC	NC	No connection
18	N_W	I/O	W-phase DC negative terminal
19	N_V	I/O	V-phase DC negative terminal
20	N_U	I/O	U-phase DC negative terminal
21	W	O	W-phase output
22	V	O	V-phase output
23	U	O	U-phase output
24	P	I/O	DC positive terminal
25	NC	NC	No connection

CONTROL TIMING SEQUENCE DESCRIPTION



(Including the external shunt resistor and CR connection)

a1: Normal working: IGBT is on and current is delivered to the load.

a2: Short circuit current detect(SC trigger) .

a3: All low-side IGBT gate hard interrupt.

a4: All low-side IGBT is off.

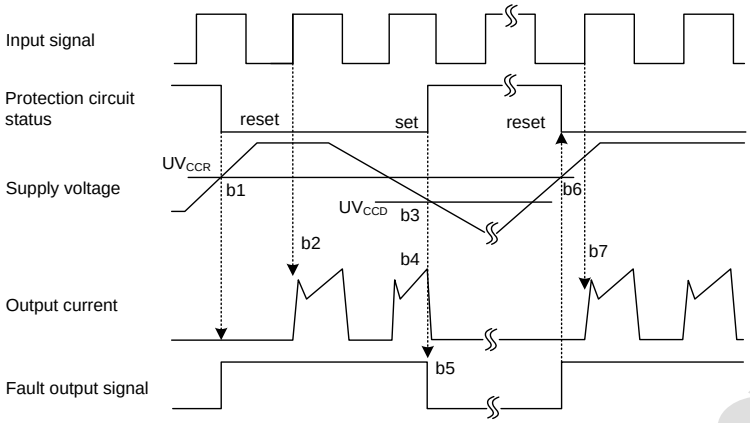
a5: Fault output timer starts working for t_{FO}=minimum 20uS.

a6: Input "L": IGBT is off.

a7: Input "H": IGBT is on, while during the period when fault output is active, IGBT is not conductive.

a8: Normal working: IGBT is on and current is delivered to the load.

Fig. 2 Short circuit current protection(only for low-side)



b1: Supply voltage rises to UV_{CCR}, the circuit begins when next input waveform arrives.

b2: Normal working: IGBT is on and current is delivered to the load.

b3: Under voltage detect point (UV_{CCD}).

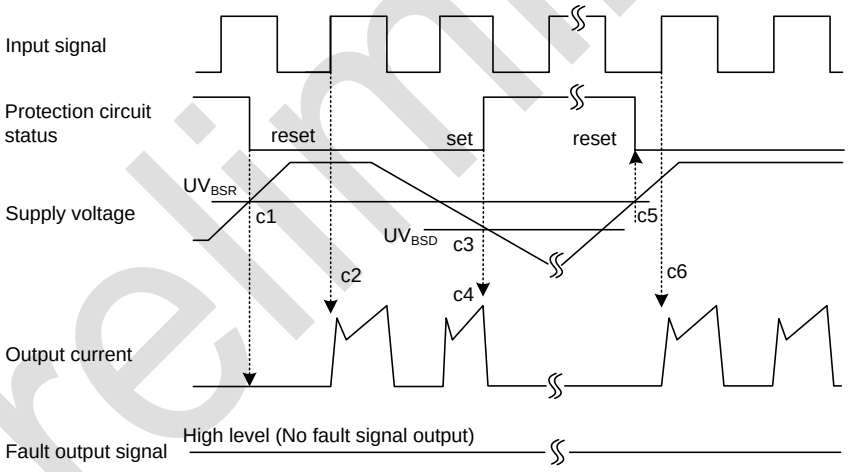
b4: All low-side IGBT is off no matter what signal is input.

b5: Begin to output fault indicating signal for t_{FO}=minimum 20uS.

b6: Under voltage reset (UV_{CCR}).

b7: Normal working: IGBT is on and current is delivered to the load.

Fig.3 Under voltage protection(low-side)



c1: Supply voltage rises to UVBSR, the circuit begins when next input signal arrives.

c2: Normal working: IGBT is on and current is delivered to the load.

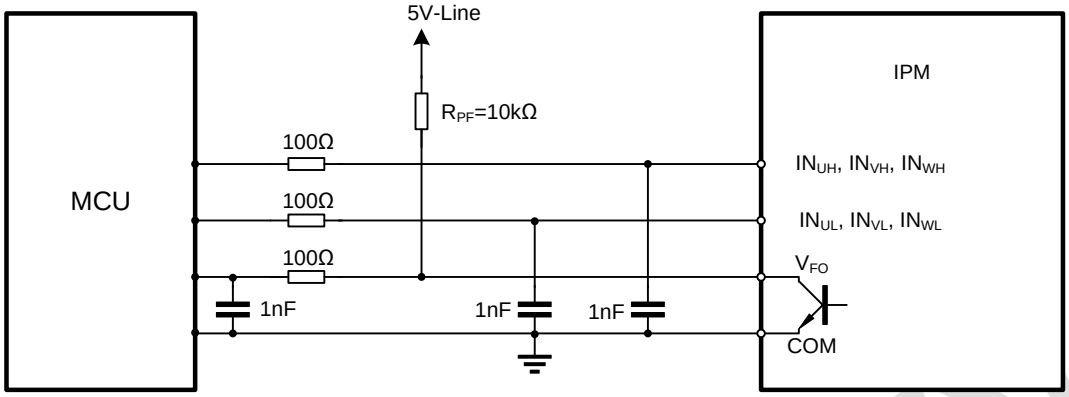
c3: Under voltage detect (UVBSD).

c4: IGBT is off no matter what signal is input, but there is no fault signal output.

c5: Under voltage reset (UVBSR).

c6: Normal working: IGBT is on and current is delivered to the load.

Fig.4 Under voltage protection(high-side)

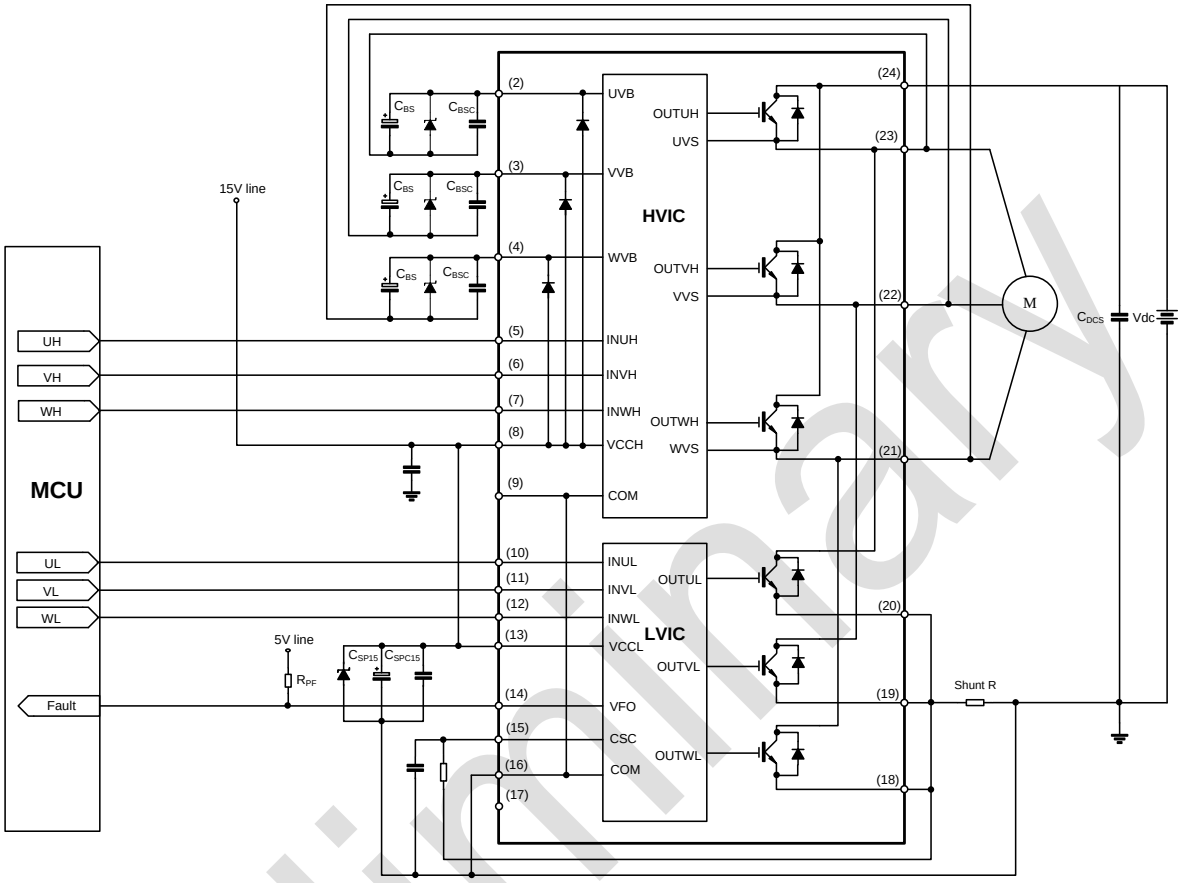


Note:

The RC coupling of each input should change following the PWM control solution and the PCB connection impedance. There is a 5K pull-down resistor integrated in IPM input signal section, so, should pay attention on the voltage drop at input terminal when using an external filter resistor.

Fig. 5 MCU input/output connection circuit recommended

TYPICAL APPLICATION CIRCUIT



Note:

(1) The routing of each input pin should be as short as possible to avoid the possible error action;

(2) Input signal is high active and there is a 5KΩ pull-down resistor connected to the ground at input of each channel in the HVIC; In addition, RC filter circuit can be added to the input, which will prevent the surge noise caused by the incorrect input.

(3) To avoid the surge damage, a flat high-frequency non-inductive capacitor between 0.1μF and 0.22μF should be connected between PN and the routing must be as short as possible;

(4) The routing between current detect resistor and IPM should be as short as possible to avoid the damage caused by the big surge voltage bringing from the connection inductance.

(5) A filter capacitor at least 7 times by bootstrap capacitor CBS (CBS is recommended to be more than1μF) is better to be added at the 15V power supply input;

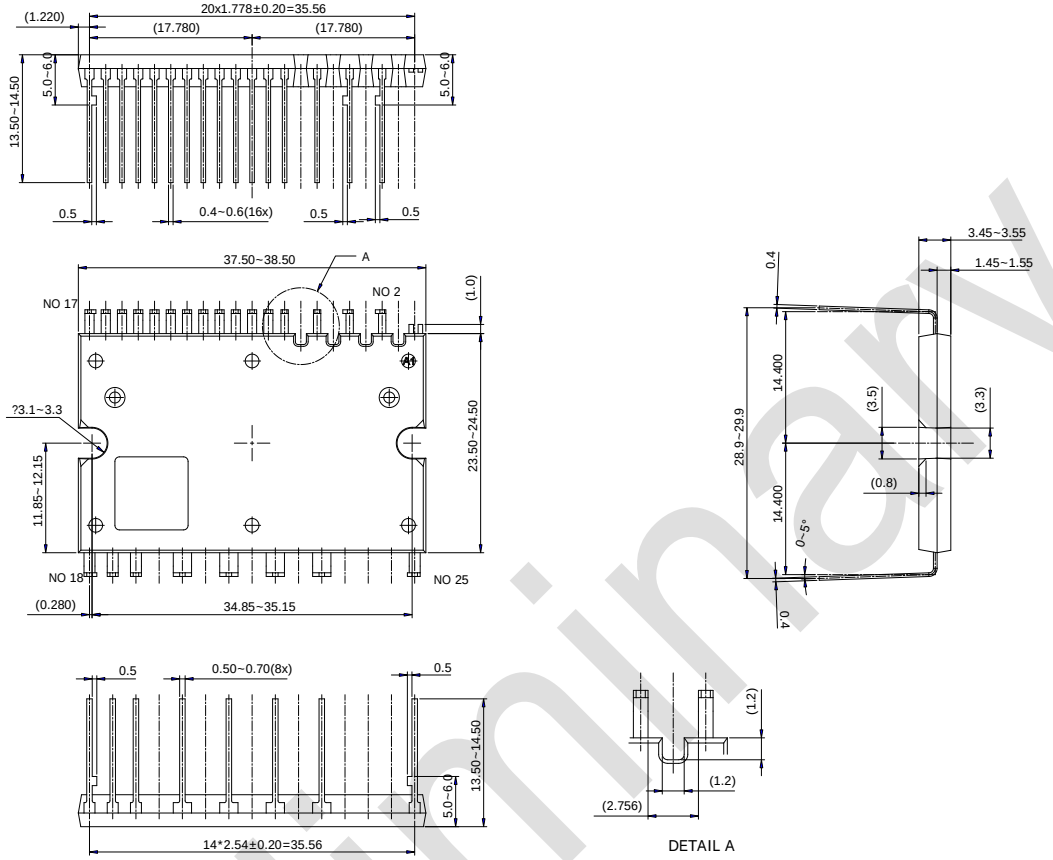
(6) Each external capacitor must be connected to the pins of IPM as close as possible;

(7) V_{FO} output is open,it should be pulled up to a 5V supply with a resistor that make Ifo up to 1mA

(8) In short circuit protection circuit, please select the time constant of RF and CSC between 1.5~2μs, at the same time, the routing around the RF and CSC should be as short as possible. The wiring of Rf should be near the terminal of shunt resistor.

PACKAGE OUTLINE

DIP-24H **UNIT: mm**



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