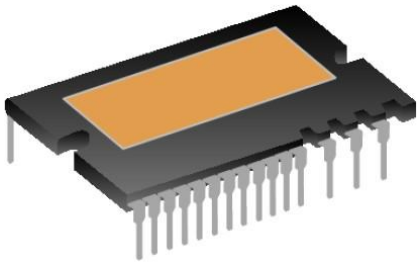
SYIM20G60BTB
Intelligent Power Module

Features

- Integrated 6 low-loss IGBTs(600V/20A)
- Integrated high voltage gate drive circuit(HVIC)
- Built-in under voltage protection and over temperature, over current protection and temperature output
- Built-in fast recovery bootstrap diode with current limiting resistor
- Insulation class 1500Vrms / min
- High reliability and thermal stability, good parameter consistency
- Built-in temperature output



DIP-24H

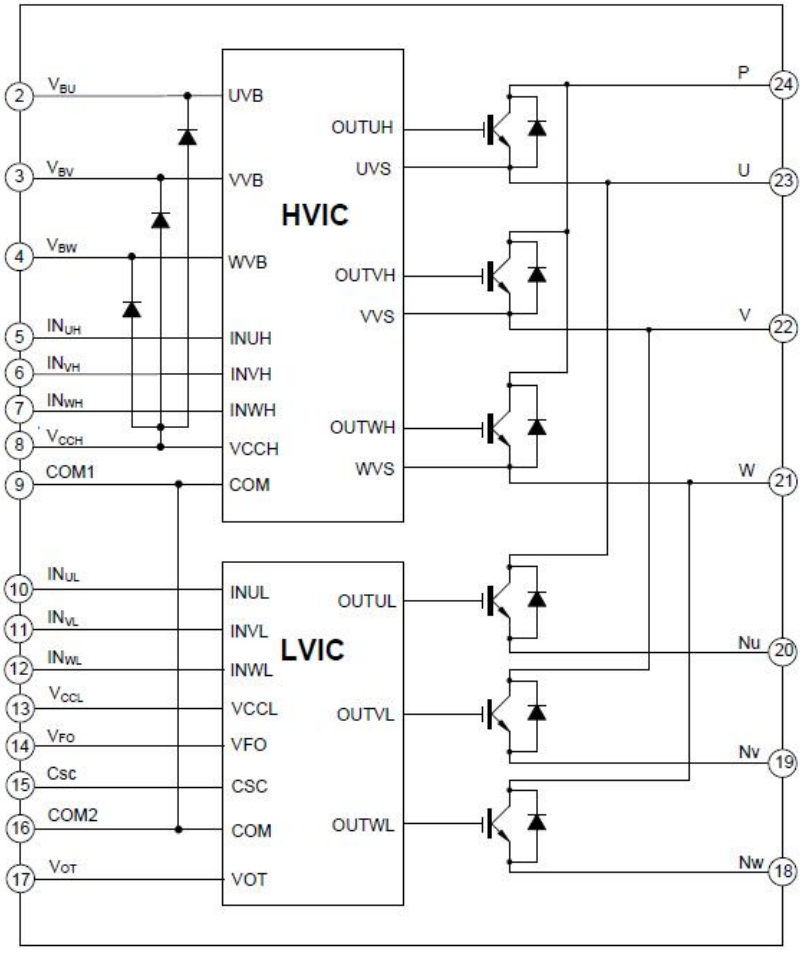
Applications

- Air conditioning compressor
- Refrigerator compressor
- Frequency converter
- Air cleaner

Ordering Information

Product Name	Marking	Package Type
SYIM20G60BTB	SYIM20G60BTB	DIP-24H

Internal Electrical Schematic



Absolute Maximum Ratings T_J = 25ºC, unless otherwise noted

Parameter	Symbol	Value	Unit
Inverter Section			
Supply Voltage	V_{PN}	450	V
Supply Voltage (surge)	$V_{PN\ (Surge)}$	500	V
Collector-Emitter voltage	Vce	600	V
Each IGBT Collector Current, T_C=25°C,$T_J \leq$ 150°C	I_C	20	A
Each IGBT Collector Current, (Peak)， T_C = 25°C, $T_J \leq$ 150°C	I_{CP}	40	A
Power dissipation per 1 chip T_C=25°C	P_D	53	W
Control section			
Control the supply voltage	V_{CC}	20	V
High-side control voltage	V_{BS}	20	V
Input signal voltage	V_{IN}	-0.3~VCC+0.3	V
Fault output supply voltage	V_{FO}	-0.3~VCC+0.3	V
Operating junction temperature range	T_J	-40 to 150	°C
Storage temperature range	T_{STG}	-40 to 125	°C
Single IGBT thermal resistance, junction-case	$R_{\theta JCB}$	1.89	°C/W
Single FRD thermal resistance, junction-case	$R_{\theta JCF}$	2.35	°C/W
Isolation test voltage (1min, RMS, f = 60Hz)	V_{ISO}	1500	Vrms

Note 1: The maximum junction temperature of the power chip is 150°C, in order to ensure that IPM can work safely, it is recommended that the average junction temperature Tj≤125°C (@Tc≤100°C)

Recommended Operation Conditions: T_J = 25ºC, unless otherwise noted

Control section

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	V_{PN}	-	300	400	V
Control the supply voltage	V_{CC}	13.2	-	20	V
High side control voltage	V_{BS}	13.0	-	20	V
High-side gate output voltage	V_{HO}	VS	-	VB	V
Low-side gate output voltage	V_{LO}	VSS	-	VCC	V

Electrical Characteristics: T_J = 25ºC, unless otherwise noted

Inverter Section

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Collector-emitter saturation voltage	$V_{CE(SAT)}$	V_{CC}=V_{BS}=15V, V_{IN}=5V I_C=20A, T_J = 25°C	-	1.7	2.2	V
FRD forward voltage	V_F	V_{IN}=0V, I_F=20A, T_J = 25°C	-	1.6	2.2	V
Switching time (high side)	t_{on}	V_{PN} = 300V, V_{CC} = V_{BS} = 15V, I_C = 20A, V_{IN} = 0V⟷ 5V, The inductive load is detailed in Figure 1	-	709	-	ns
	t_r		-	39	-	ns
	t_{off}		-	669	-	ns
	t_f		-	57	-	ns
	t_{rr}		-	170	-	ns
Switching time (low side)	t_{on}		-	843	-	ns
	t_r		-	114	-	ns
	t_{off}		-	697	-	ns
	t_f		-	44	-	ns
	t_{rr}		-	192	-	ns
Collector-Emitter Leakage current	I_{CES}	V_{CE}=600V	-	-	250	uA

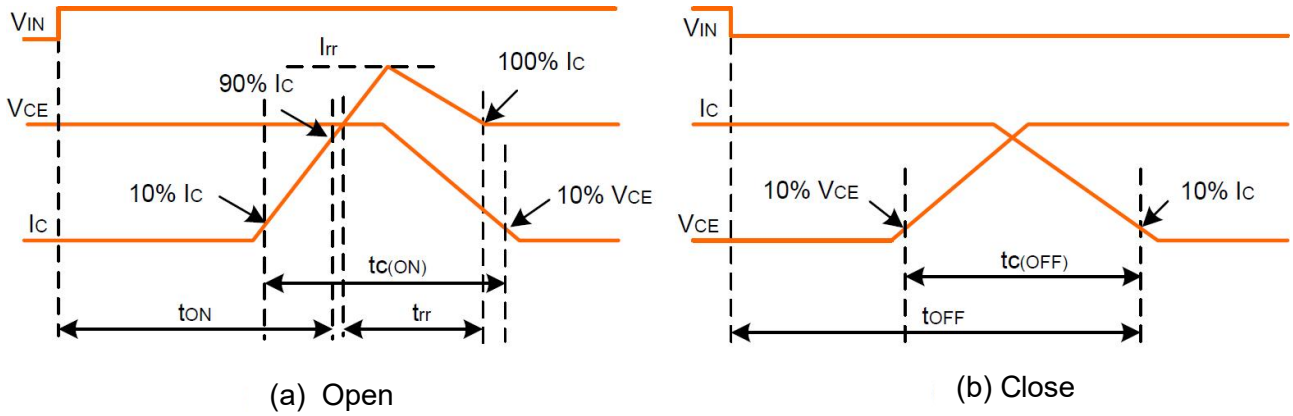


Figure 1. Definition of switching time

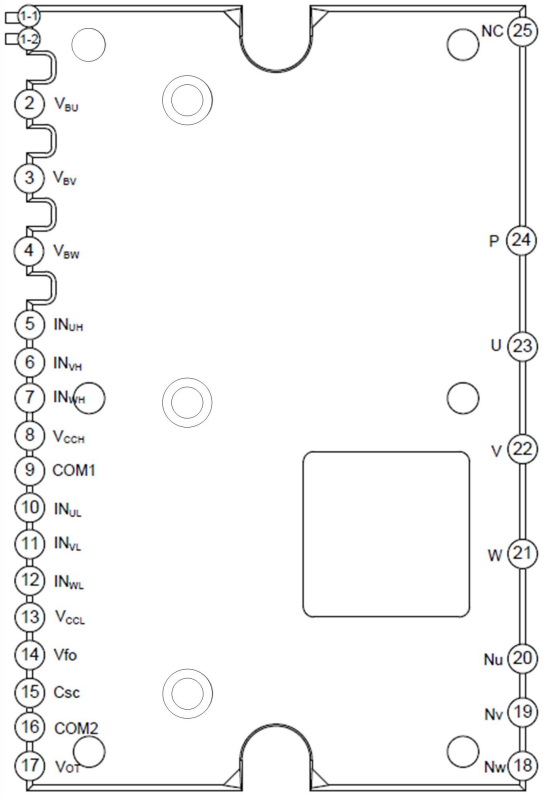
Control section

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Quiescent V_{CC} supply current	I_{QCC}	V_{CC}=15V, V_{IN}=0V	-	-	3.5	mA
Quiescent V_{BS} supply current	I_{QBS}	V_{BS}=15V, V_{IN}=0V	-	75	-	uA
Fault output voltage	V_{FOH}	V_{SC}=0V, V_F Circuit: 10kΩ to 5V Pull−up	4.9	-	-	V
	V_{FOL}	V_{SC}=1V, I_{Fo}=1mA	-	-	0.9	V
Fault output pulse width	t_{FO}	Fault duration	40	-	-	us
Short-circuit protection trigger voltage	$V_{SC(ref)}$	V_{CC}=15V	0.42	0.46	0.51	V
Over temperature protection	OT_t	LVIC temperature	100	120	140	°C
Over temperature protection hysteresis	OT_{rh}	LVIC temperature Hysteresis	-	10	-	°C
Temperature output (Figure 2)	V_{OT}	LVIC Temperature=25°C	0.88	1.13	1.39	V
		LVIC Temperature=90°C	2.63	2.77	2.91	V
Low-side undervoltage protection (Figure 5)	UV_{Dt}	V_{CC} senses the voltage	10	11	12	V
	UV_{Dr}	V_{CC} reset voltage	9	10	11	V
High-side undervoltage protection (Figure 6)	UV_{DBt}	V_{BS} senses voltage	10	11	12	V
	UV_{DBr}	V_{BS} reset voltage	9	10	11	V
On-threshold voltage	V_{IH}	Logic high	-	-	2.5	V
Shutdown threshold voltage	V_{IL}	Logic low	0.8	-	-	V

Bootstrap diode section

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward voltage	V_F	I_F=10mA, T_C=25°C	-	2.5	4.0	V
Reverse recovery time	t_{rr}	I_F=10mA, T_C=25°C	-	50	-	ns

Pin Assignment



Pin Description

Pin Number	Pin Name	Pin Description
1-1	COM	Internal common ground terminal
1-2	V_{CC}	Internal power terminal, No Connection
2	V_{BU}	U-phase high side floating IC supply voltage
3	V_{BV}	V-phase high side floating IC supply voltage
4	V_{BW}	W-phase high side floating IC supply voltage
5	IN_{UH}	U-phase high side gate driver input
6	IN_{VH}	V-phase high side gate driver input
7	IN_{WH}	W-phase high side gate driver input
8	V_{CCH}	High side gate drive supply voltage
9	COM1	Module common ground
10	IN_{UL}	U-phase low side gate driver input
11	IN_{VL}	V-phase low side gate driver input
12	IN_{WL}	W-phase low side gate driver input
13	V_{CCL}	Low side gate drive supply voltage
14	V_{FO}	Fault Output
15	Csc	External capacitor, used for short-circuit current detection input and low-pass filtering
16	COM2	Module common ground
17	V_{OT}	Temperature output terminal

Pin Number	Pin Name	Pin Description
18	N_W	W-phase DC negative terminal
19	N_V	V-phase DC negative terminal
20	N_U	U-phase DC negative terminal
21	W	Output for W Phase
22	V	Output for V Phase
23	U	Output for U Phase
24	P	Positive DC−Link Input
25	NC	No Connection

Temperature output function description

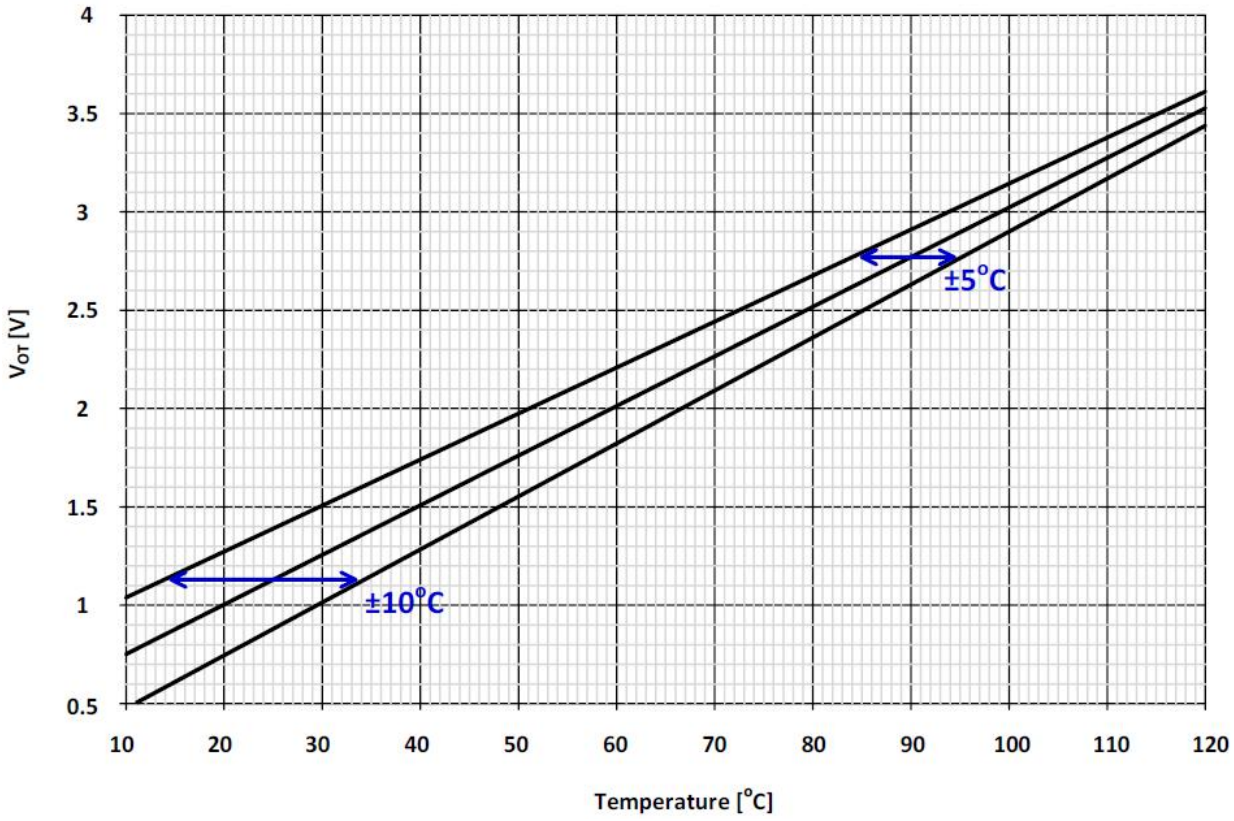


Figure 2. LVIC temperature VOT temperature characteristics

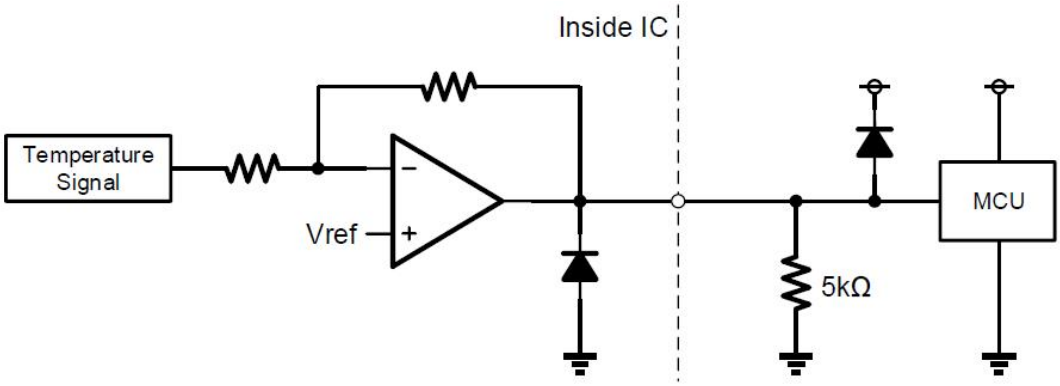


Figure 3. VOT output circuit

（1） If the temperature monitoring function is used, connect 5kΩ to the VOT pin, and ignore the internal OTP function. If the internal over temperature shutdown function is used, keep the VOT pin on (no connection).

（2） When IPM is applied in low-voltage control (such as MCU working voltage of 3.3V), the output voltage of VOT may be greater than the control supply voltage of 3.3V in the case of a sharp rise in temperature, if the system is used for low-voltage control, it is recommended to connect a clamping diode between the control power supply and the VOT output signal to prevent overvoltage damage.

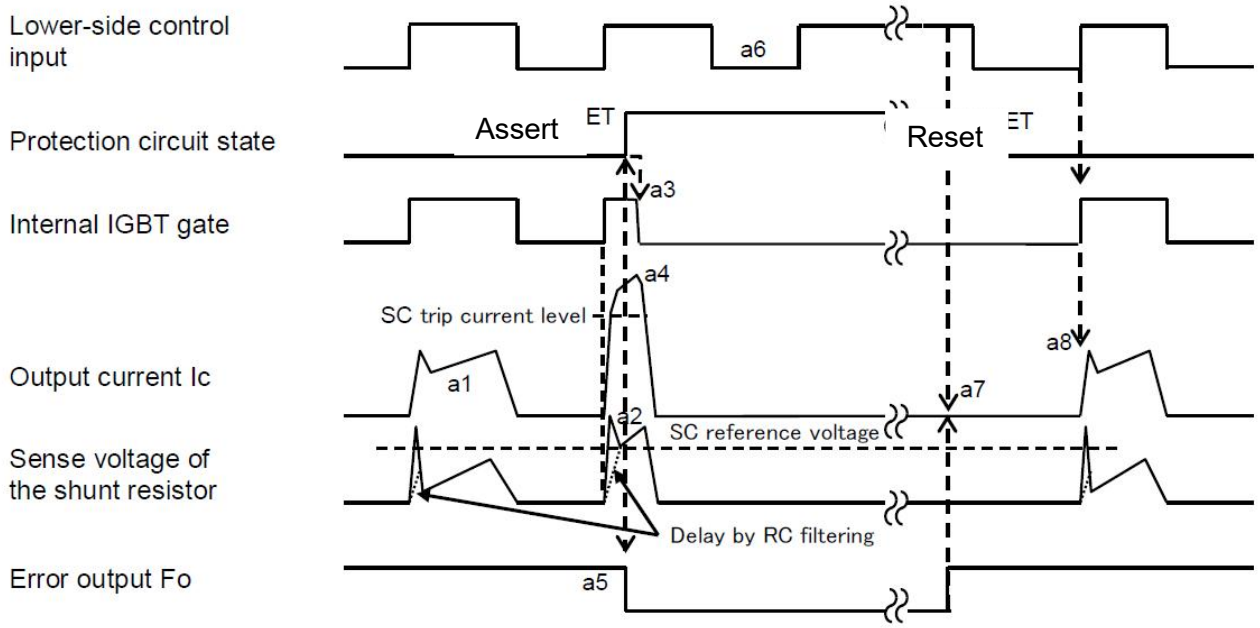


Figure 4. Short-circuit current protection (low side only)

Short circuit protection(Includes external shunt resistor and RC filter).
a1: Normal operation:IGBT ON and outputs current.
a2: Short-circuit current detection (short-circuit triggering).
a3: All low-side IGBT's gate hard interrupts.
a4: All low-side IGBT's are turned off.
a5: The fault output pin outputs a fixed pulse width signal (t_{FO}≥ 40us).
a6: Input is "L": IGBT shutdown state.
a7: Input is "H": Although the input is "H", the IGBT is still in the off state during this time if there is a fault output signal.
a8: Normal operation: IGBT is ON, current is supplied to the load.

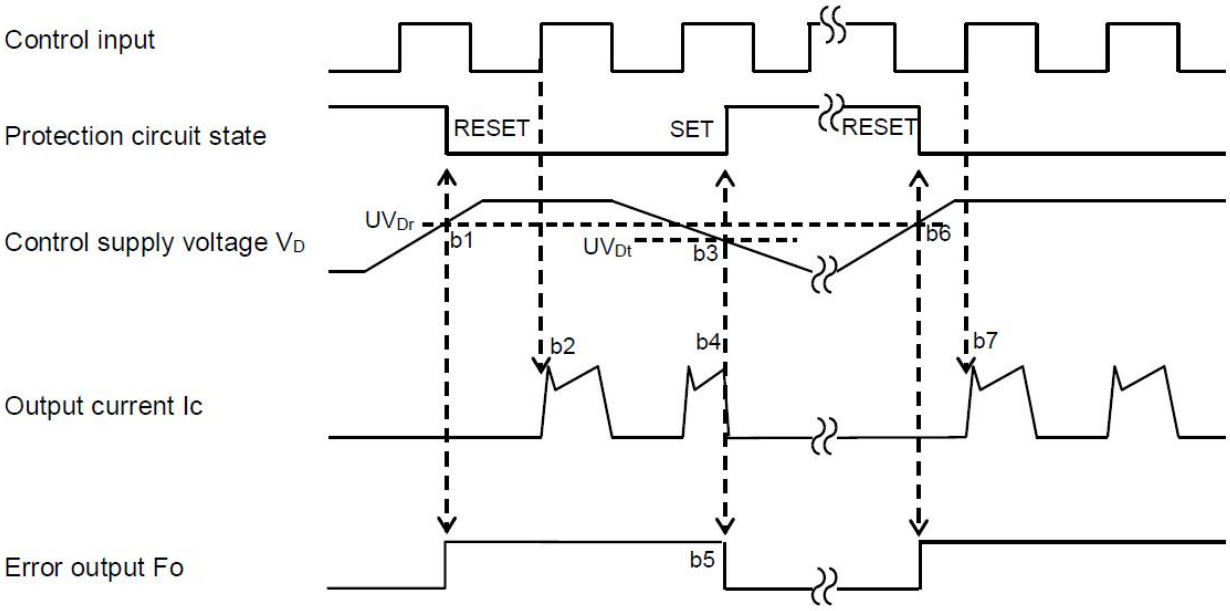


Figure 5. Undervoltage Protection (Low Side)

b1: Control supply voltage VD exceeds under voltage reset level UV_{Dr}, and the circuit starts to work when the next input waveform arrives.
b2: Normal operation: IGBT ON and outputs current.
b3: VD level drops under voltage trip level (UV_{Dt}).
b4: All low side IGBTs turn off in spite of control input condition.
b5: FO pin outputs fault signal (t_{FO} ≥ 40us, and continuously outputs fault signal during under voltage).
b6: VD level reaches UV_{Dr}.
b7: Normal operation: IGBT ON and outputs current.

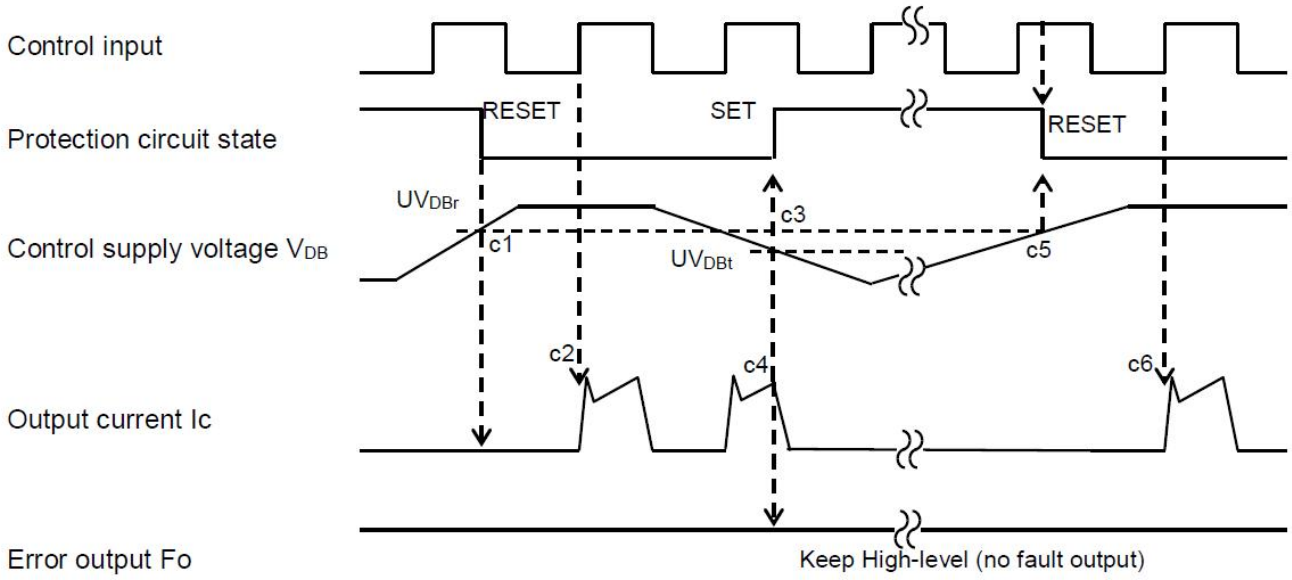


Figure 6. Undervoltage Protection (High Side)

c1: Control supply voltage V_{DB} rises to UV_{DBR}, and the circuit starts to work when the next input signal arrives.
c2: Normal operation: IGBT ON and outputs current.
c3: VDB level drops to under voltage trip level (UV_{DBt}).
c4: No matter what signal input, IGBT is turned off, but there is no fault signal output.
c5: VDB level reaches UV_{DBr}.
c6: Normal operation: IGBT ON and outputs current.

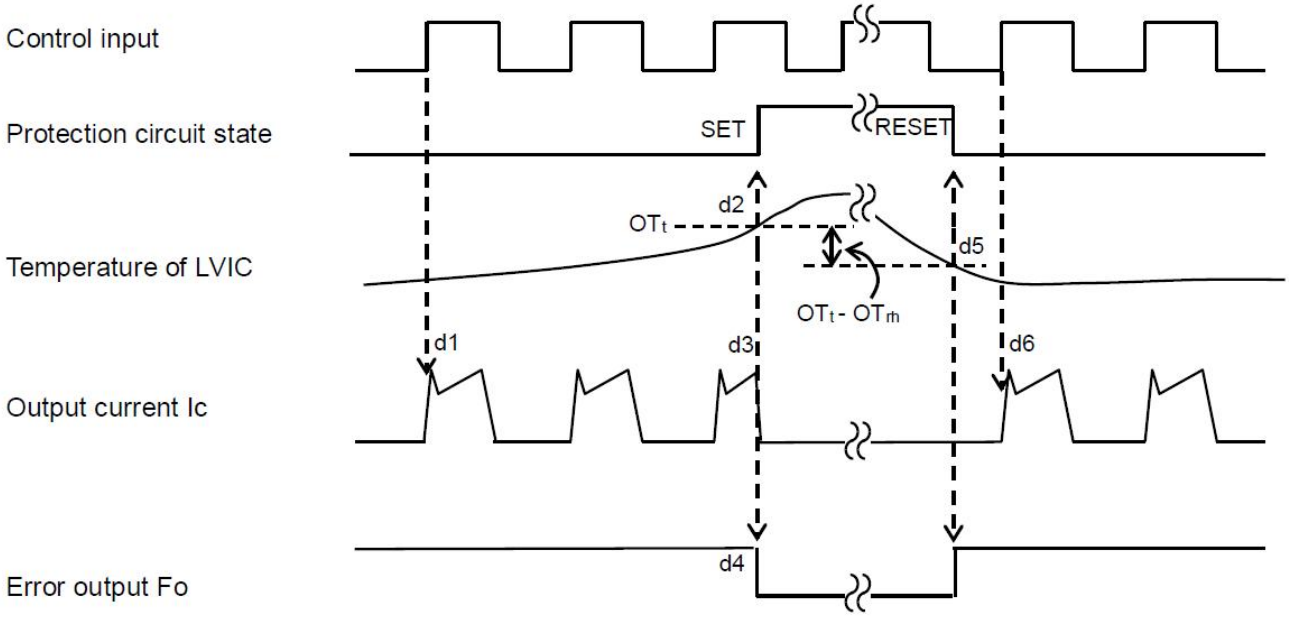


Figure 7. Overtemperature protection (low side only)

d1: Normal operation: IGBT ON and outputs current.
d2: LVIC temperature exceeds the over temperature protection trigger level(OT_t).
d3: All low side IGBTs are turned off in spite of control input condition.
d4:Continuously output fault signal during overtemperature, and the minimum pulse width is 40us.
d5: The LVIC will reset when the temperature is lower than the over temperature protection level.
d6: IGBT turns on when the next input signal control signal comes.
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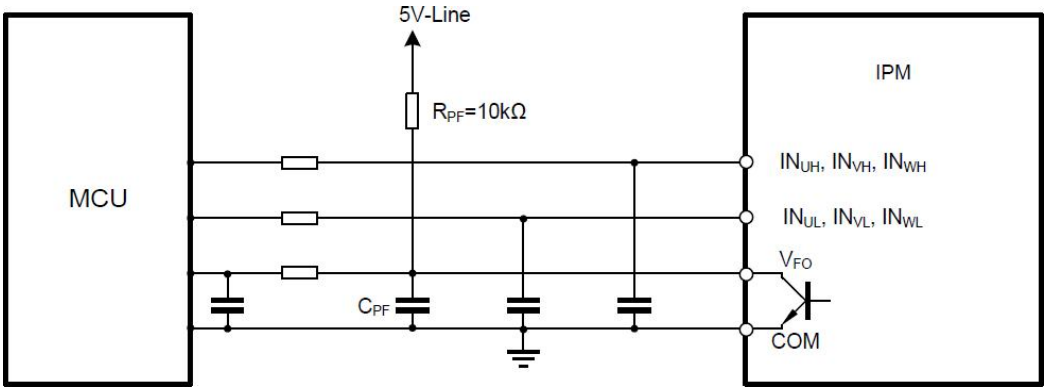
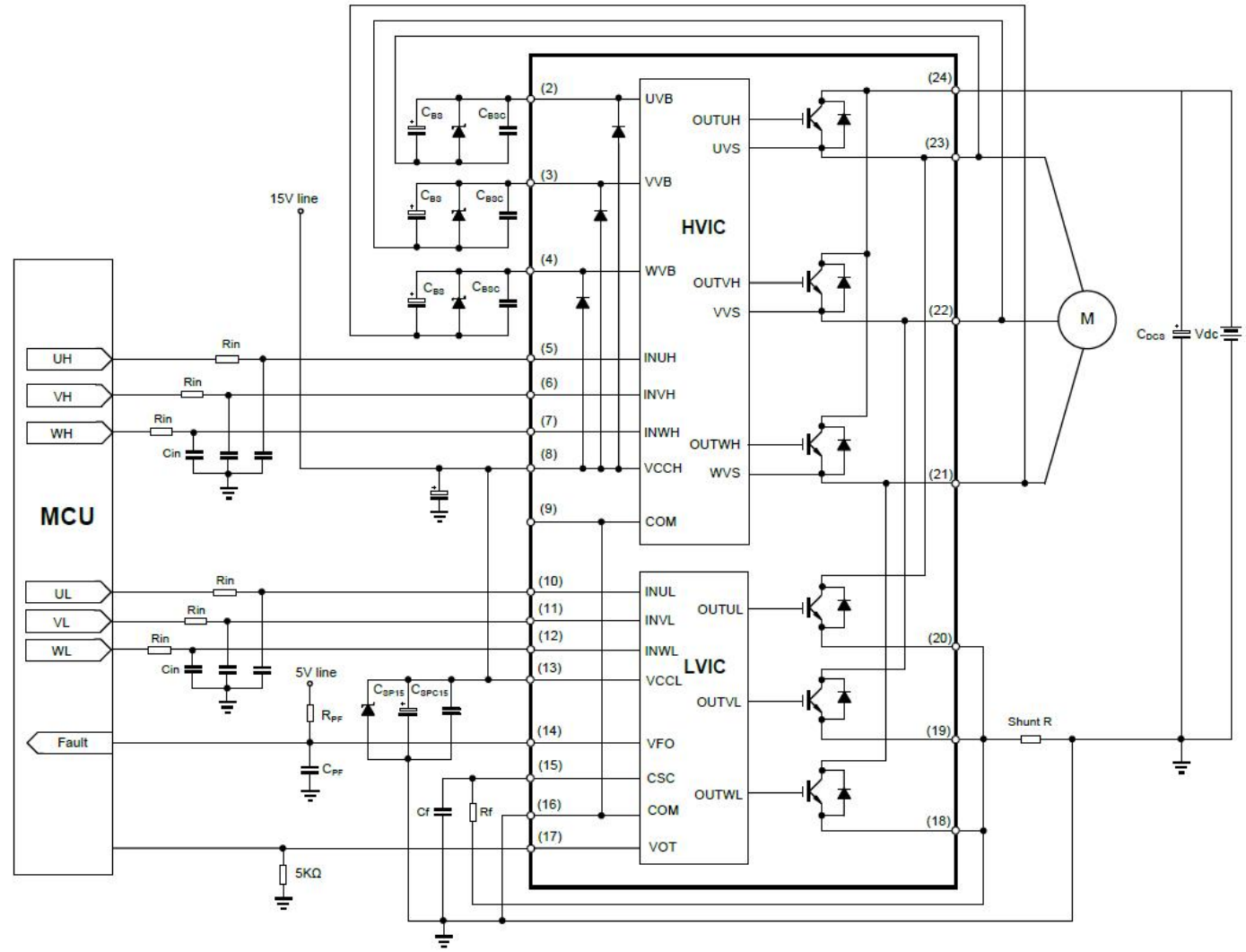


Figure 8. MCU input/output connection circuit (recommended)

Note: The RC coupling at each input should be adapted to the PWM control scheme and PCB layout. A 5K pull-down resistor is built into the IPM input signal section, so pay attention to the voltage drop at the input when using an external filter circuit.

Typical Application Schematic:



Remark:

(1) The connection of each input pin should be as short as possible, otherwise it may cause misoperation;

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

(3) In order to prevent surge damage, it is recommended to add a high-frequency non-inductive flat capacitor (0.1μF ~ 0.22μF) between PNs, and the connection of the capacitor should be made Keep it as short as possible;

(4) The connection between the current sense resistor and the IPM should be as short as possible, otherwise the large surge voltage generated by the connection inductor may cause damage;

(5) The filter capacitor at the input of the 15V power supply is recommended to be at least 7 times that of the bootstrap capacitor CBS;

(6) Each external capacitor should be placed as close as possible to the IPM pin;

(7) The VFO output is open and should be pulled up to the 5V supply through the resistor so that the Ifo is 1mA;

(8) In the short-circuit protection circuit, please select RF and CSC with time constants in the range of 1.5~2 μs, and the wiring around RF and CSC should be as short as possible. The RF wiring should be close to the shunt resistor.

Package Outline DIP-24H