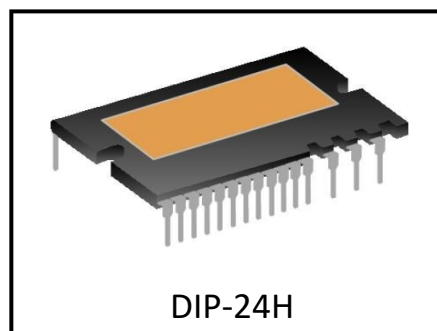


### Features

- Low-Loss, Short-Circuit Rated IGBTs
- Integrated high voltage gate drive circuit(HVIC)
- Integrated under voltage protection, over temperature, over current protection and temperature output
- Compatible with 3.3V&5V input signal, effective at high level
- Insulation class 1500Vrms /min
- Integrated bootstrap functionality
- High reliability and thermal stability, good parameter consistency

### Applications

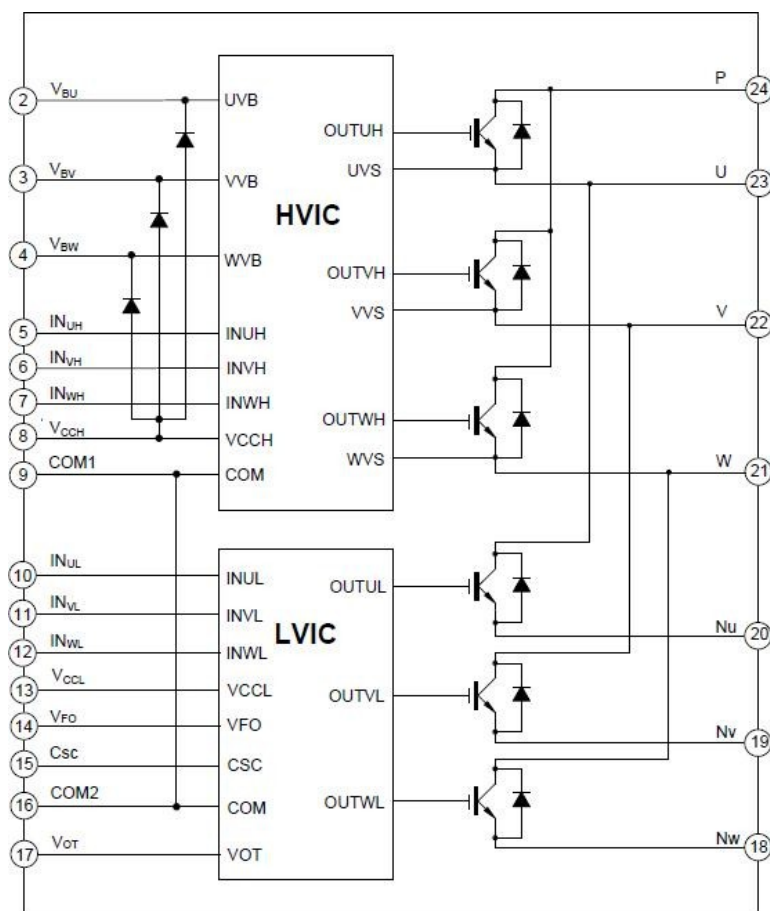
- Frequency converter
- Air Conditioning compressor
- Refrigerator compressor
- Air cleaner



### Ordering Information

Type NO.	Marking	Package Code
SYIM10G60BTB	SYIM10G60BTB	DIP-24H

### Internal Electrical Schematic



## Absolute Maximum Ratings: $T_J = 25^{\circ}\text{C}$ , unless otherwise noted

Parameter	Symbol	Value	Unit
<b>Inverter Part</b>			
Supply Voltage	$V_{PN}$	450	V
Supply Voltage (surge)	$V_{PN(surge)}$	500	V
Collector – Emitter Voltage	$V_{ce}$	600	V
Each IGBT Collector Current, $T_C = 25^{\circ}\text{C}$ , $T_J \leq 150^{\circ}\text{C}$	$I_C$	10	A
Each IGBT Collector Current (Peak), $T_C = 25^{\circ}\text{C}$ , $T_J \leq 150^{\circ}\text{C}$	$I_{CP}$	20	
Power dissipation per 1 chip $T_C=25^{\circ}\text{C}$	$P_D$	25	W
<b>Control Part</b>			
Control Supply Voltage	$V_{CC}$	20	V
High-Side Control Bias Voltage	$V_{BS}$	20	V
Input Signal Voltage	$V_{IN}$	-0.3~ $V_{CC}+0.3$	V
Fault Output Supply Voltage	$V_{FO}$	-0.3~ $V_{CC}+0.3$	V
Operating junction temperature	$T_J$	-40 to 150	$^{\circ}\text{C}$
Storage temperature range	$T_{STG}$	-40 to 125	$^{\circ}\text{C}$
Single IGBT thermal resistance, junction-case	$R_{\theta JCB}$	4.0	$^{\circ}\text{C}/\text{W}$
Single FRD thermal resistance, junction-case	$R_{\theta JCF}$	5.0	$^{\circ}\text{C}/\text{W}$
Isolation test voltage (1min, RMS, $f = 60\text{Hz}$ )	$V_{ISO}$	1500	Vrms

Note: The maximum junction temperature of the power chips is  $150^{\circ}\text{C}$ . To ensure the safe operation of DIIPIM, it is recommended that the average junction temperature should be limited to  $T_J \leq 125^{\circ}\text{C}$  (@ $T_C \leq 100^{\circ}\text{C}$ )

## Recommended Operation Conditions: $T_J = 25^{\circ}\text{C}$ , unless otherwise noted

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

## Electrical Characteristics (unless otherwise noted, $T_j=25^{\circ}\text{C}$ , $V_{CC}=V_{BS}=15\text{V}$ )

### Inverter Part

Parameter	Symbol	Condition	Value			Unit
			Min.	Typ.	Max.	
Collector – Emitter Saturation Voltage	$V_{CE(SAT)}$	$V_{CC}=V_{BS}=15\text{V}$ , $V_{IN}=5\text{V}$ $I_C=10\text{A}$	-	1.8	2.3	V
FRD Forward Voltage	$V_F$	$V_{IN}=0\text{V}$ , $I_F=10\text{A}$		1.8	2.4	V
High Side	$t_{on}$	$V_{PN} = 300\text{V}$ , $V_{CC} = V_{BS} = 15\text{V}$ , $I_C = 20\text{A}$ , $V_{IN} = 0\text{V} \leftarrow \rightarrow 5\text{V}$ , Inductive load	-	671	-	ns
	$t_r$		-	38	-	ns
	$t_{off}$		-	561	-	ns
	$t_f$		-	79	-	ns
	$t_{rr}$		-	73	-	ns
Low Side	$t_{on}$		-	779	-	ns
	$t_r$		-	76	-	ns
	$t_{off}$		-	591	-	ns
	$t_f$		-	71	-	ns
	$t_{rr}$		-	150	-	ns
Collector – Emitter Leakage Current	$I_{CES}$	$V_{CE}=600\text{V}$	-	-	250	$\mu\text{A}$

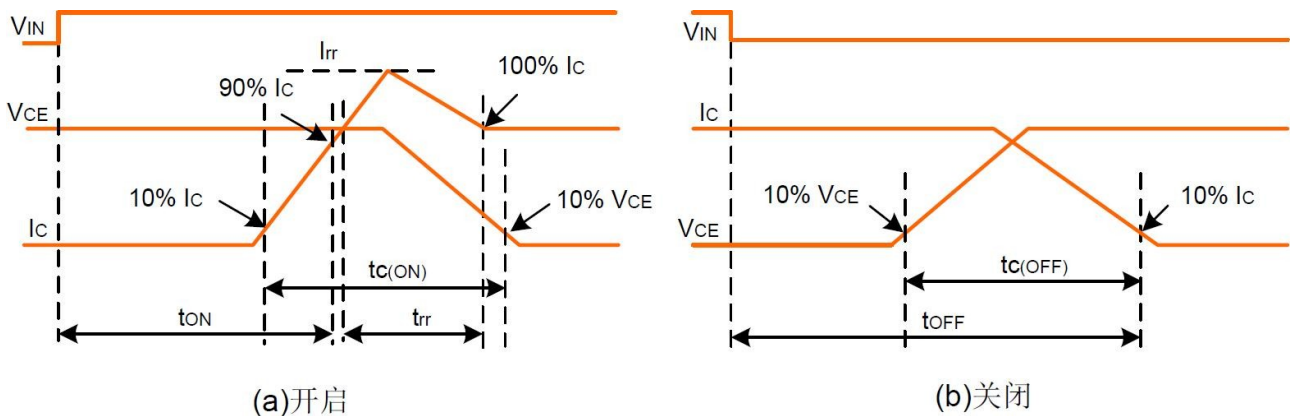


Figure 1. Switching Time Definition

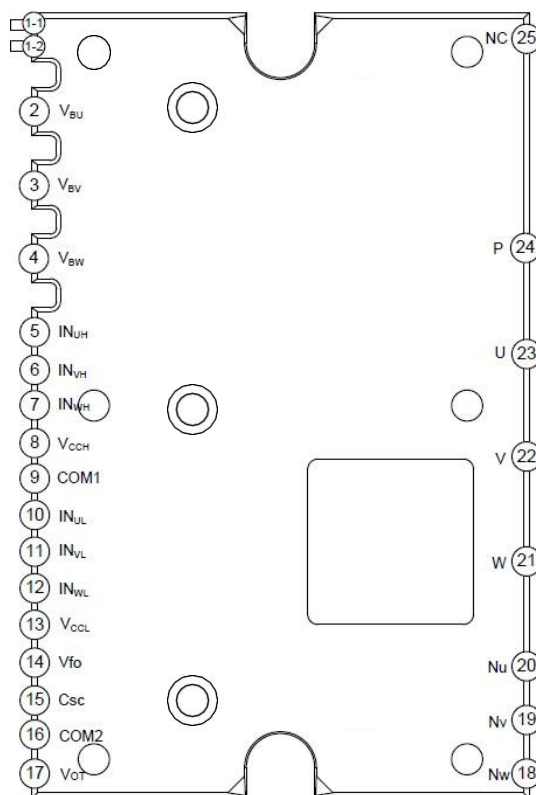
## Control Part

Parameter	Symbol	Condition		Value			Unit
				Min.	Typ.	Max.	
Quiescent V <sub>CC</sub> supply current	I <sub>QCC</sub>	V <sub>CC</sub> =15V, V <sub>IN</sub> =0V		-	-	3.5	mA
Quiescent V <sub>BS</sub> supply current	I <sub>QBS</sub>	V <sub>BS</sub> =0V, V <sub>IN</sub> =0V		-	75	-	uA
Fault Output Voltage	V <sub>FOH</sub>	V <sub>SC</sub> = 0 V, V <sub>F</sub> Circuit: 10kΩ to 5V Pull-up		4.9	-	-	V
	V <sub>FOL</sub>	V <sub>SC</sub> =1V, I <sub>FO</sub> =1mA		-	-	0.9	V
Fault-Out Pulse Width	t <sub>FO</sub>	Fault duration		40	-	-	us
Short-Circuit Trip Level	V <sub>SC</sub> (ref)	V <sub>CC</sub> =15V		0.42	0.46	0.51	V
Over temperature protection	OT <sub>t</sub>	LVIC temperature		100	120	140	°C
Over temperature protection hysteresis	OT <sub>rh</sub>	LVIC Temperature Hysteresis		-	10	-	°C
Temperature Output	VOT	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 <sub>Dt</sub>	Detection level		10	11	12	V
	UV <sub>Dr</sub>	Reset level		9	10	11	V
High side undervoltage protection Figure 6	UV <sub>DBt</sub>	Detection level		10	11	12	V
	UV <sub>DBr</sub>	Reset level		9	10	11	V
ON Threshold Voltage	V <sub>IH</sub>	Logic high level	Between input and COM	-	-	2.5	V
OFF Threshold Voltage	V <sub>IL</sub>	Logic low level		0.8	-	-	V

## Bootstrap diode section

Parameter	Symbol	Condition	Value			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$I_F=10mA$ $T_c=25^\circ C$	-	2.5	4.0	V
Reverse recovery time	$t_{rr}$	$I_F=10mA$ $T_c=25^\circ C$	-	50	-	ns

## Pin Assignment



## Pin Description

Pin Number	Pin name	Pin Description
1-1	COM	Internal common ground terminal
1-2	V <sub>CC</sub>	Internal power terminal, No Connection
2	V <sub>BU</sub>	U-phase high side floating IC supply voltage
3	V <sub>BV</sub>	V-phase high side floating IC supply voltage
4	V <sub>BW</sub>	W-phase high side floating IC supply voltage
5	I <sub>NUH</sub>	U-phase high side gate driver input
6	I <sub>NVH</sub>	V-phase high side gate driver input
7	I <sub>NWH</sub>	W-phase high side gate driver input
8	V <sub>CCH</sub>	High side gate drive supply voltage
9	COM1	Module common ground
10	I <sub>NUL</sub>	U-phase low side gate driver input
11	I <sub>NVL</sub>	V-phase low side gate driver input
12	I <sub>NWL</sub>	W-phase low side gate driver input
13	V <sub>CCL</sub>	low side gate drive supply voltage
14	V <sub>FO</sub>	Fault Output
15	C <sub>sc</sub>	External capacitor, used for short-circuit current detection input and low-pass filtering
16	COM2	Module common ground
17	V <sub>OT</sub>	Temperature output terminal

18	NW	W-phase DC negative terminal
19	NV	V-phase DC negative terminal
20	NU	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

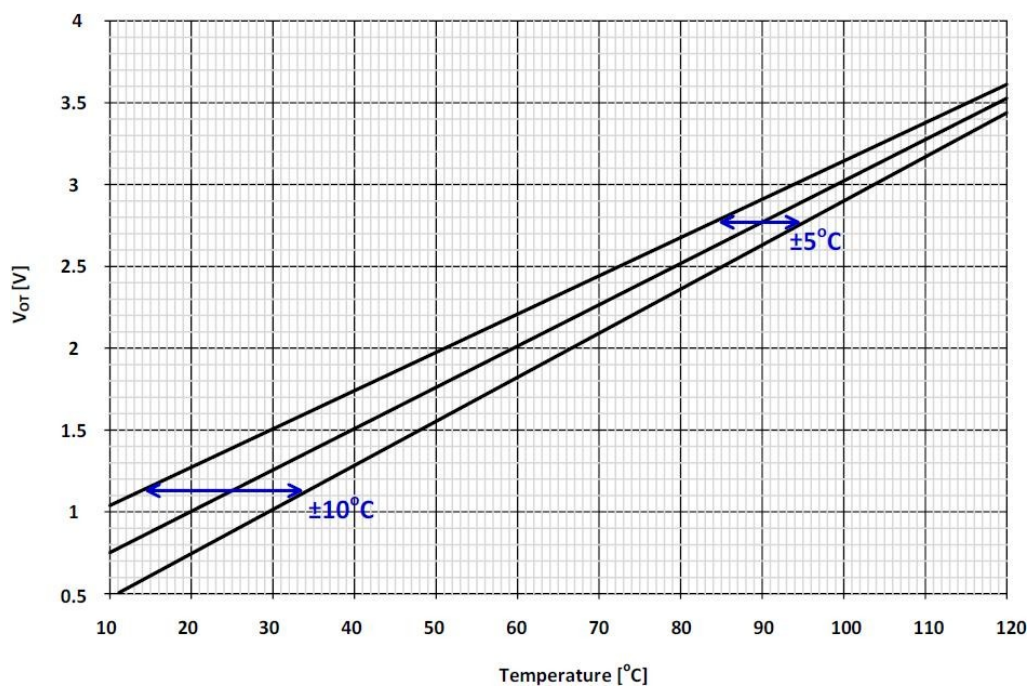


Figure 2. LVIC Temperature - VOT Temperature Characteristics

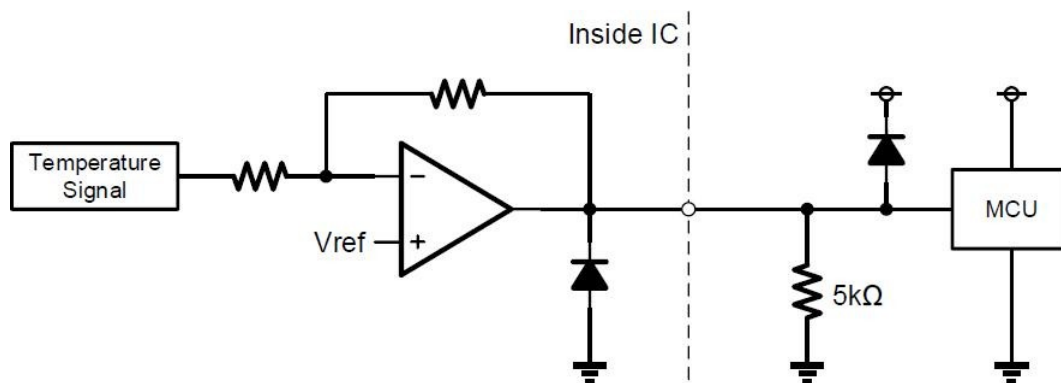
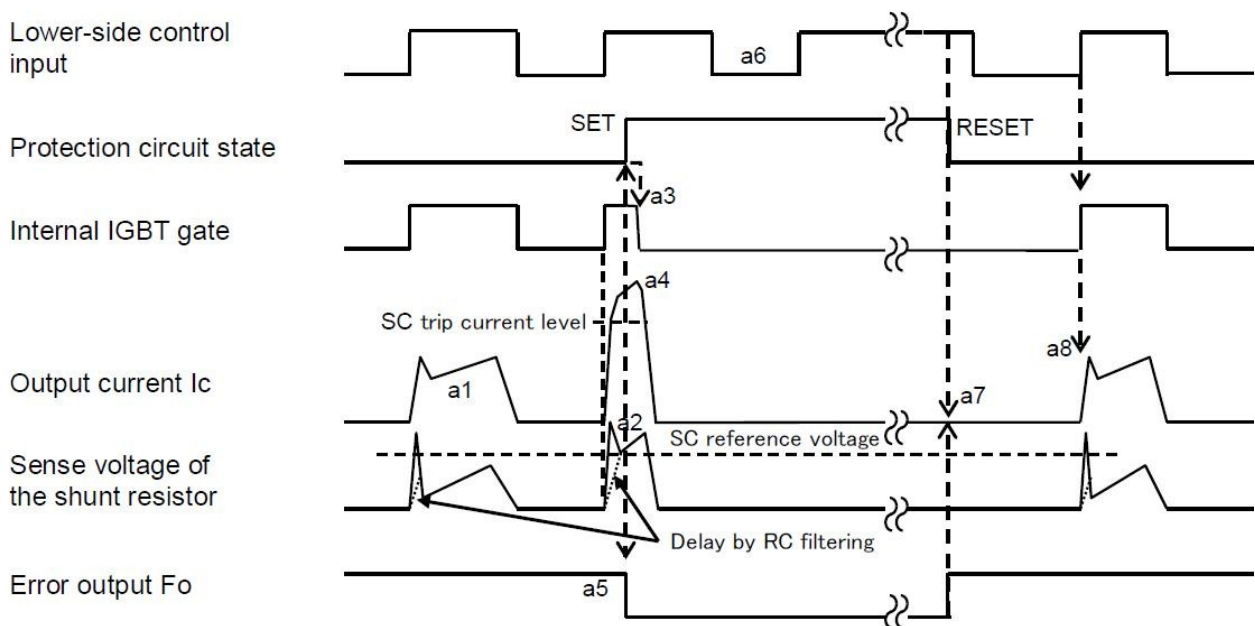


Figure 3. VOT Output Circuit

- (1) If the temperature monitoring function is used, 5k $\Omega$  is connected to the VOT pin, the internal OTP function is ignored. If the internal over temperature shut-down function is used, keep the VOT pin open (no connection).
- (2) When the IPM is used for low-voltage control (for example, the working voltage of MCU is 3.3V), the VOT output voltage may be 3.3V higher than the control power supply voltage when the temperature rises sharply. 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 (including 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 gates are hard interrupted.

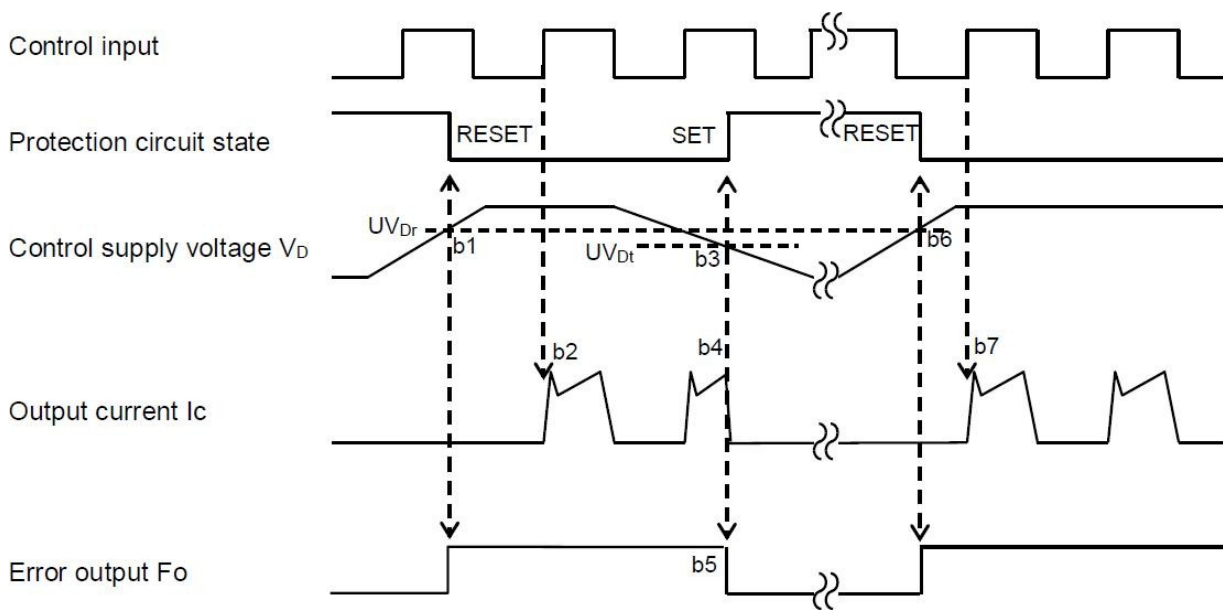
a4: All low side IGBTs are turned off.

a5: Fault output pin outputs a fixed pulse width signal ( $t_{FO} \geq 40\mu s$ ).

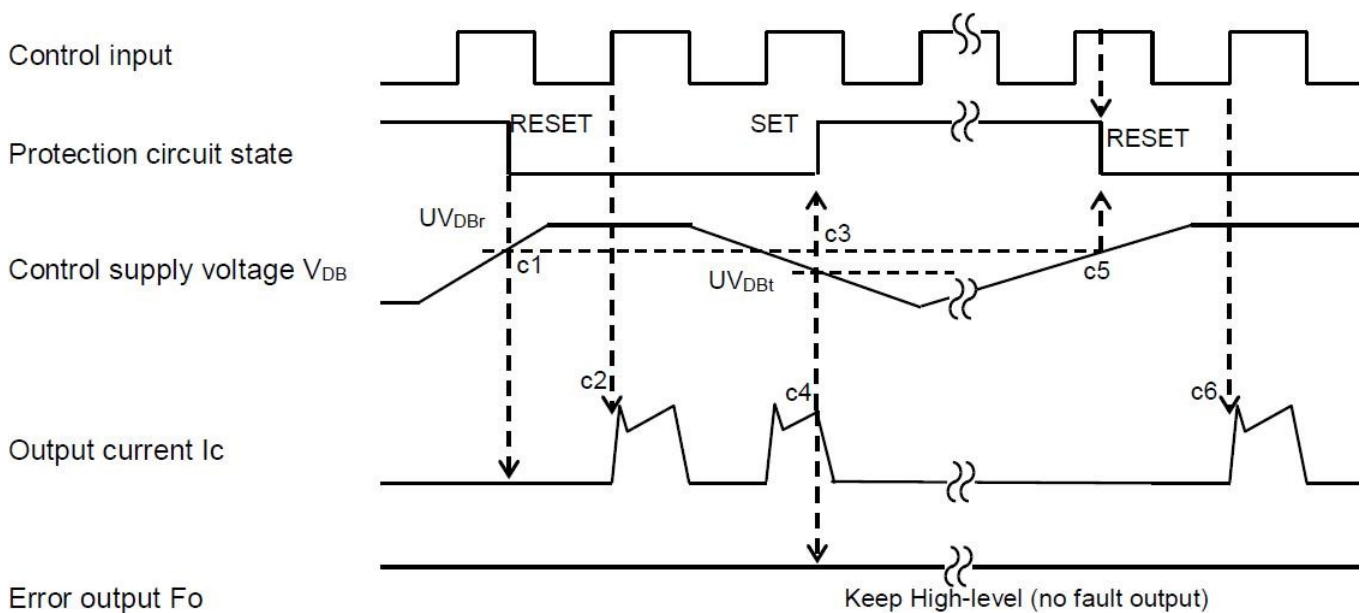
a6: Input is "L": IGBT off state.

a7: Input is "H": although the input is "H", there is a fault output signal during this period, and IGBT is still in the off state.

a8: Normal operation: IGBT ON and outputs current.

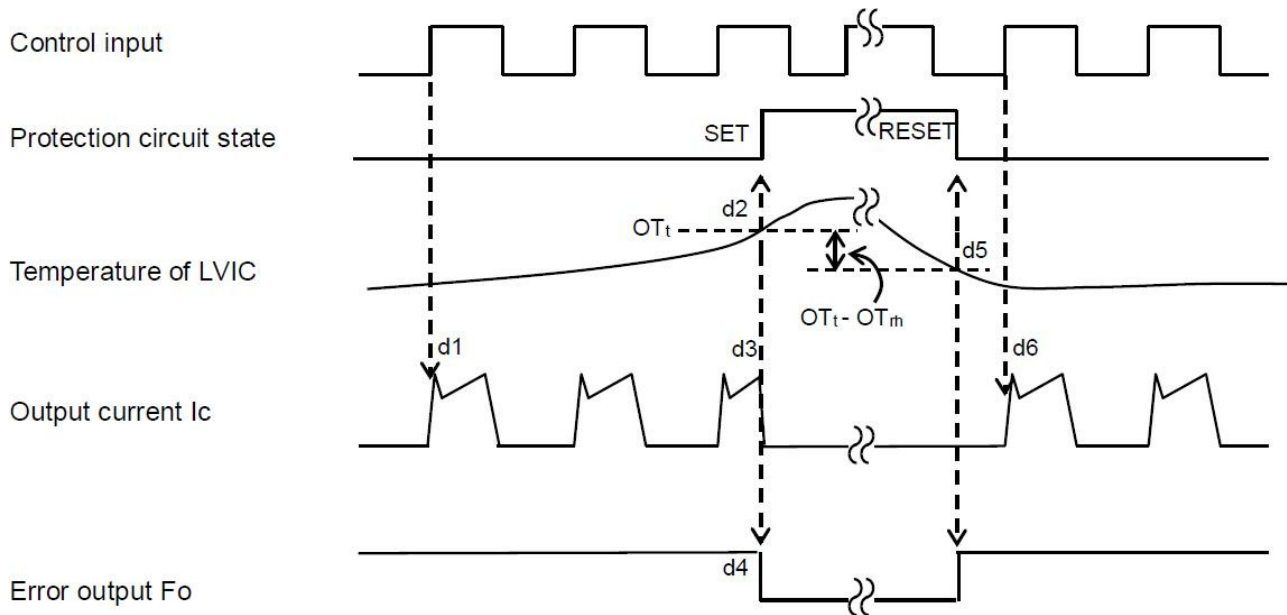

**Figure 5. Under voltage protection (low side)**

- b1: Control supply voltage  $V_D$  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:  $V_D$  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 ( $t_{FO} \geq 40\mu s$ , and continuously outputs fault signal during under voltage).
- b6:  $V_D$  level reaches  $UV_{Dr}$ .
- b7: Normal operation: IGBT ON and outputs current.


**Figure 6. Under voltage 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:  $V_{DB}$  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:  $V_{DB}$  level reaches  $UV_{DBr}$ .
- c6: Normal operation: IGBT ON and outputs current.



**Figure 7. Over Temperature 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.

- (1) The wiring of each input pin shall be as short as possible, otherwise it may cause mis operation;
- (2) The input signal is active at high level, and a 5KΩ pull-down resistor is connected to the ground at the input end of each channel of HVIC; In addition, RC filter circuit can be added at the input end 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~0.22μF) between P and N, the connecting wire of capacitor shall 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 connecting the inductor may cause damage;
- (5) It is recommended that the filter capacitance at the input end of 15V power supply be at least 7 times the bootstrap capacitance CBS;
- (6) Each external capacitor shall be placed as close to the IPM pin as possible;
- (7) If the  $V_{FO}$  output is open circuit, it should be pulled up to the 5V power supply through resistance to make  $I_{fo}$  1mA;
- (8) In the short-circuit protection circuit, please select a time constant of 1.5~2μs and the wiring around the RF and CSC should be as short as possible. RF wiring shall be close to shunt resistor.

Technical drawing of a PCB assembly showing top, side, and bottom views with dimensions.

**Top View:** Overall dimensions are 38.00±0.1 (width) and 24.00±0.1 (height). The drawing includes numerous component footprints with specific dimensions such as 1.778±0.05, 0.50±0.05, 3.556±0.05, 0.80±0.05, 1.778±0.05, 1.20±0.1, 1.00±0.1, 1.50±0.1, 2-φ3.20, 2.54±0.05, 1.20±0.05, 5.08±0.05, 0.60±0.05, 10.16±0.05, and 2.00±0.05. A central rectangular cutout is shown.

**Side View:** Shows the profile of the assembly with dimensions 29.4±0.5 (total height), 14.00±0.2 (height of the main body), and 5.50±0.1 (height of the base). It also shows a 90° angle and a 0.400±0.05 dimension.

**Bottom View:** Shows the underside of the assembly with dimensions 29.0±0.4 (width) and 13.0±0.4 (height). It includes a central rectangular cutout and dimensions for mounting holes: 2-φ3.20.

**Revision History:**

Revision	Date	Subjects (major changes since last revision)
1.0	2023-03	Initial version

**Disclaimer:**

Operating conditions may differ from simulation assumptions in several aspects like level of DC-link voltage, applied gate-voltage and gate-resistor, case and junction temperatures as well as the power circuit stray-inductance. Therefore, deviations of parameters and assumptions used for the simulation and the real application may exist.

For these reasons we cannot take any responsibility or liability for the exactness or validity of the form's results. The form cannot replace a detailed reflection of the customer's application with all of its operating conditions.

Accurate results depend on huge data, so with the measured data increasing, we should be updated in real time and send it to the corresponding engineer so that he can know it in real time.