

Chapter 2 Description of Terminal Symbols and Terminology

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1. Description of Terminal Symbols

Table 2-1 and Table 2-2 describe the terminal symbols and terminology, respectively.

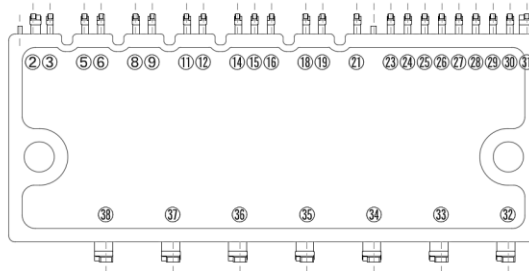


Fig. 2-1 Terminals number

Table 2-1 Description of terminal symbols

Terminal No.	Terminal Name	Terminal Description	Terminal No.	Terminal Name	Terminal Description
2	IN(HU)	Signal Input for High-side U-phase	24	COM	Low-side Control Power Supply GND
3	VCCH(U)	High-side Control Power Supply for U-phase	25	TEMP	Temperature Sensor Output
5	VB(U)	High-side Bias Voltage for U-phase	26	IS	Overcurrent Sensing Voltage Input
6	VS(U)	High-side Bias Voltage for U-phase GND	27	CFO	Fault Output Pulse Width Setting
8	IN(HV)	Signal Input for High-side V-phase	28	VFO	Fault Output
9	VCCH(V)	High-side Control Power Supply for V-phase	29	IN(LU)	Signal Input for Low-side U-phase
11	VB(V)	High-side Bias Voltage for V-phase	30	IN(LV)	Signal Input for Low-side V-phase
12	VS(V)	High-side Bias Voltage for V-phase GND	31	IN(LW)	Signal Input for Low-side W-phase
14	IN(HW)	Signal Input for High-side W-phase	32	N(W)	Negative Bus Voltage Input for W-phase
15	VCCH(W)	High-side Control Power Supply for W-phase	33	N(V)	Negative Bus Voltage Input for V-phase
16	COM	High-side Control Power Supply GND	34	N(U)	Negative Bus Voltage Input for U-phase
18	VB(W)	High-side Bias Voltage for W-phase	35	W	W-phase Output
19	VS(W)	High-side Bias Voltage for W-phase GND	36	V	V-phase Output
21	VSC	Low-side Sense Current Detection	37	U	U-phase Output
23	VCCL	Low-side Control Power Supply	38	P	Positive Bus Voltage Input

2. Description of Terminology

Table 2-2 Description of terminology

(1) Inverter Block

Item	Symbol	Description
Zero Gate Voltage Collector Current	I_{CE}	Leakage current when a specified voltage is applied between the collector and emitter of an IGBT with all input signals L (= 0V).
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$ (terminal)	Collector-emitter voltage at a specified collector current when only the input signal of the element under measurement is H (= 5V) and the inputs of all other elements are L (= 0V).
Forward Voltage	V_F	Forward voltage at a specified forward current with all input signals L (= 0V).
Turn-on Time	t_{on}	The time from when the input signal voltage level exceeds the threshold value until the collector current rises to 90% of rating. See Fig. 2-2 for details.
Turn-on Delay Time	$t_{d(on)}$	The time from when the input signal voltage level exceeds the threshold value until the collector current rises to 10% of rating. See Fig. 2-2 for details.
Turn-on Rise Time	t_r	The time for the collector current to rise from 10% of rating to 90% of rating when the IGBT is turned on. See Fig. 2-2 for details.
V_{CE} - I_C Cross Time of Turn-on	$t_{c(on)}$	The time from when the collector current reaches 10% of rating until the V_{CE} voltage fall to 10% of rating when the IGBT is turned on. See Fig. 2-2 for details.
Turn-off Time	t_{off}	The time from when the input signal voltage level falls below the threshold value until the collector current falls to 10% of rating. See Fig. 2-2 for details.
Turn-off Delay Time	$t_{d(off)}$	The time from when the input signal voltage level falls below the threshold value until the collector current falls to 90% of rating. See Fig. 2-2 for details.
Turn-off Fall Time	t_f	The time for the collector current to fall from 90% of rating to 10% of rating when the IGBT is turned off. See Fig. 2-2 for details.
V_{CE} - I_C Cross Time of Turn-off	$t_{c(off)}$	The time from when the V_{CE} voltage reaches 10% of rating until the collector current fall to 10% of rating when the IGBT is turned off. See Fig. 2-2 for details.
Reverse Recovery Time	t_{rr}	Time required to reduce the reverse recovery current of FWD to zero. See Fig. 2-2 for details.

Table 2-2 Description of terminology

(2) Control Circuit Block

Item	Symbol	Description
Circuit Current of Low-side	I_{CCL}	Consumption current between VCCL and COM.
Circuit Current of High-side	I_{CCH}	Consumption current between VCCH(U, V, W) and COM (for each phase).
Circuit current of Bootstrap circuit	I_{CCHB}	Consumption current between VB(U)-VS(U), VB(V)-VS(V), and VB(W)-VS(W) (for each phase).
Input Signal Threshold Voltage	$V_{th(on)}$	Input signal threshold voltage that turns on the IGBT. ^{*1}
	$V_{th(off)}$	Input signal threshold voltage that turns off the IGBT. ^{*1}
Input Signal Threshold Hysteresis Voltage	$V_{th(hys)}$	Hysteresis voltage between $V_{th(on)}$ and $V_{th(off)}$. ^{*1}
Operational Input Pulse Width of Turn-on	$t_{IN(on)}$	Control signal pulse width required to turn-on the IGBT. Refer to Chapter 3.4 for details.
Operational Input Pulse Width of Turn-off	$t_{IN(off)}$	Control signal pulse width required to turn-off the IGBT. Refer to Chapter 3.4 for details.
Input Current	I_{IN}	Current flowing between IN(HU,HV,HW,LU,LV,LW) and COM.
Input Pull-down Resistance	R_{IN}	Resistance of built-in resistor between IN(HU,HV,HW,LU,LV,LW) and COM. (for each phase).
Fault Output Voltage	$V_{FO(H)}$	VFO output voltage during normal operation (low-side protection function is not activated). External pull-up resistor = 10kΩ.
	$V_{FO(L)}$	VFO output voltage when low-side protection function is activated.
Fault Output Pulse Width	t_{FO}	The period during which VFO continues to output after low-side protection function is activated. Refer to Chapter 3.6 for details.
Overcurrent Protection Voltage Level	$V_{IS(ref)}$	Overcurrent protection threshold voltage of IS. Refer to Chapter 3.5 for details.
Overcurrent Protection Delay Time	$t_d (IS)$	The time from overcurrent condition is detected until the collector current falls below 50% of rating. Refer to Chapter 3.5 for details.
Overcurrent Trip Level	I_{oc}	The current value that can be detected when a specified sense resistor Rsc is connected between VSC and COM without connecting external shunt resistors to N(U), N(V), and N(W).
Output Voltage of Temperature Sensor	$V_{(temp)}$	TEMP output voltage. Applied to temperature sensor output model. Refer to Fig. 2-3 and Chapter 3.7 for details.
Pull down Resistance of TEMP terminal	$R_{(temp)}$	Resistance value at which the temperature characteristic of TEMP output voltage becomes linear below room temperature.
Overheating Protection Temperature	T_{OH}	Tripping temperature of overheating protection by LVIC. All low-side IGBTs are shut down when the temperature exceeds this threshold. Refer to Figure 2-3 and Chapter 3.8 for details.
T_{OH} Hysteresis	$T_{OH(hys)}$	Hysteresis temperature that does not reset the protection status during overheating protection. Refer to Figure 2-3 and Chapter 3.8 for details. T_{OH} and $T_{OH(hys)}$ are applied to overheating protection model.

^{*1} If the pulse width of the input signal is less than $t_{IN(on)}$ or $t_{IN(off)}$, the IPM might make incorrect response.

Table 2-2 Description of terminology

(2) Control Circuit Block (continued)

Item	Symbol	Description
V_{CC} Under Voltage Trip Level of Low-side	$V_{CCL(OFF)}$	Tripping voltage of under voltage protection of low-side control power supply. When V_{CCL} falls below the threshold voltage, all low-side IGBTs are shut down. Refer to Chapter 3.1 for details.
V_{CC} Under Voltage Reset Level of Low-side	$V_{CCL(ON)}$	Reset voltage that resets the under voltage protection of low-side control power supply. Refer to Chapter 3.1 for details.
V_{CC} Under Voltage Hysteresis of Low-side	$V_{CCL(hys)}$	Hysteresis voltage between $V_{CCL(OFF)}$ and $V_{CCL(ON)}$.
V_{CC} Under Voltage Trip Level of High-side	$V_{CCH(OFF)}$	Tripping voltage of under voltage protection of high-side control power supply. When $V_{CCH(U)}$, $V_{CCH(V)}$ or $V_{CCH(W)}$ falls below the threshold voltage, the corresponding high-side IGBTs are shut down. Refer to Chapter 3.1 for details.
V_{CC} Under Voltage Reset Level of High-side	$V_{CCH(ON)}$	Reset voltage that resets the under voltage protection of high-side control power supply. Refer to Chapter 3.1 for details.
V_{CC} Under Voltage Hysteresis of High-side	$V_{CCH(hys)}$	Hysteresis voltage between $V_{CCH(OFF)}$ and $V_{CCH(ON)}$.
V_B Under Voltage Trip Level	$V_{B(OFF)}$	Tripping voltage of under voltage protection of high-side bias voltage. When $V_{B(U)}$, $V_{B(V)}$, $V_{B(W)}$ falls below the threshold voltage, the corresponding high-side IGBT is shut down. Refer to Chapter 3.2 for details.
V_B Under Voltage Reset Level	$V_{B(ON)}$	Reset voltage that resets the under voltage protection of high-side bias voltage. Refer to Chapter 3.2 for details.
V_B Under Voltage Hysteresis	$V_{B(hys)}$	Hysteresis voltage between $V_{B(OFF)}$ and $V_{B(ON)}$.
Forward Voltage of Bootstrap Diode	$V_{F(BSD)}$	Forward voltage when a specified forward current flows through BSD.
Built-in Limiting Resistance	$R_{(BSD)}$	Built-in current limiting resistor resistance value of bootstrap circuit.

Table 2-2 Description of terminology

(3) Thermal Characteristics

Item	Symbol	Description
Junction to Case Thermal Resistance (per single IGBT)	$R_{th(j-c)}_{IGBT}$	Thermal resistance from junction to case of a single IGBT.
Junction to Case Thermal Resistance (per single Diode)	$R_{th(j-c)}_{FWD}$	Thermal resistance from junction to case of a single FWD.

(4) Mechanical Characteristics

Item	Symbol	Description
Mounting Torque of Screws	M_S	Maximum screwing torque when mounting the IPM to a cooling body with specified screws.
Heat-sink Side Flatness	-	Flatness of the IMS's aluminum surface. Refer to Fig. 2-4.
Weight	-	Weight of a single IPM.
Resistance to Soldering Heat	-	Number of times of solder heat resistance under specified conditions.

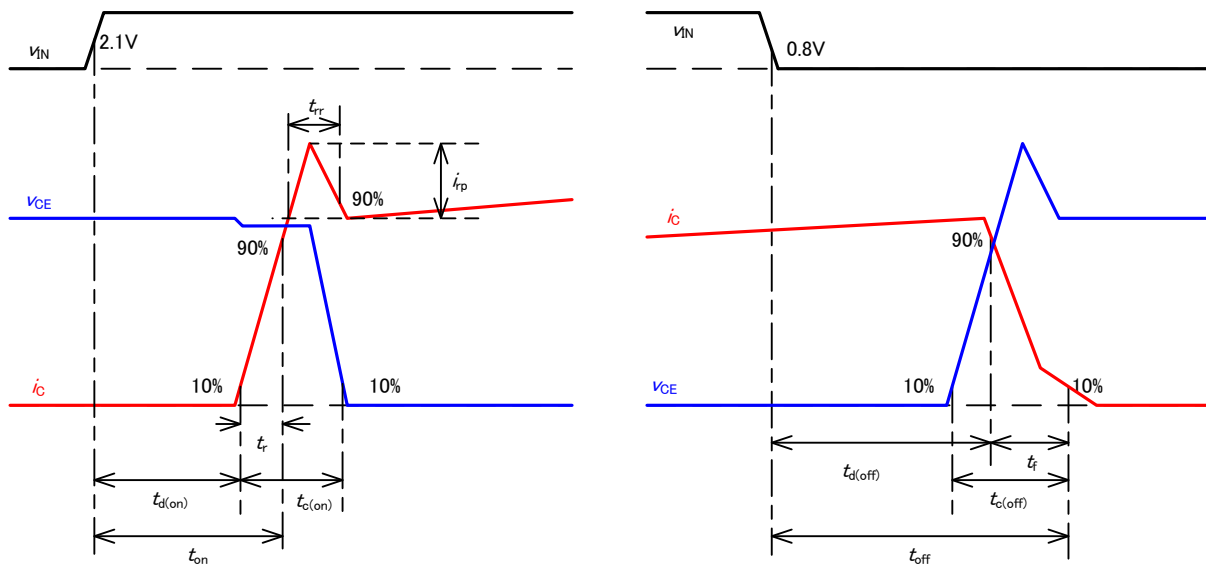


Fig. 2-2 Switching waveforms

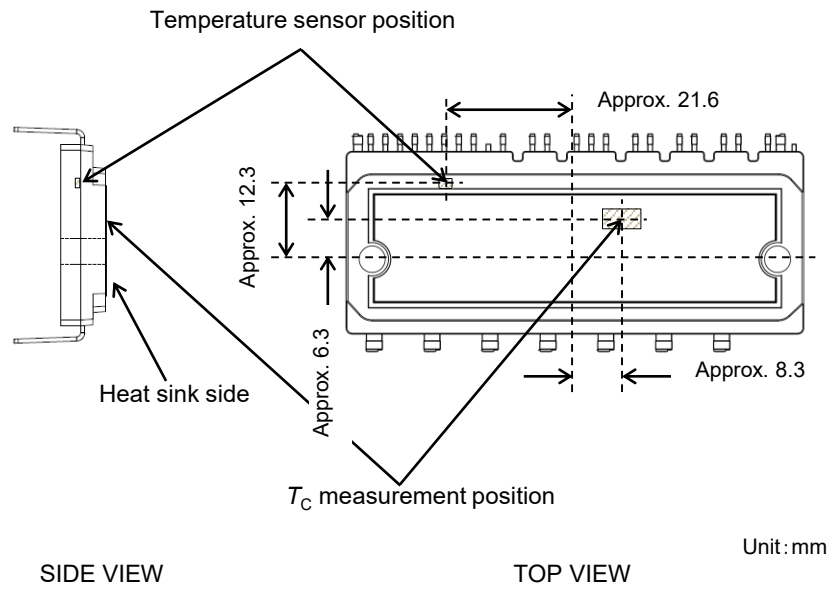


Fig. 2-3 Temperature sensor position and T_c measurement position

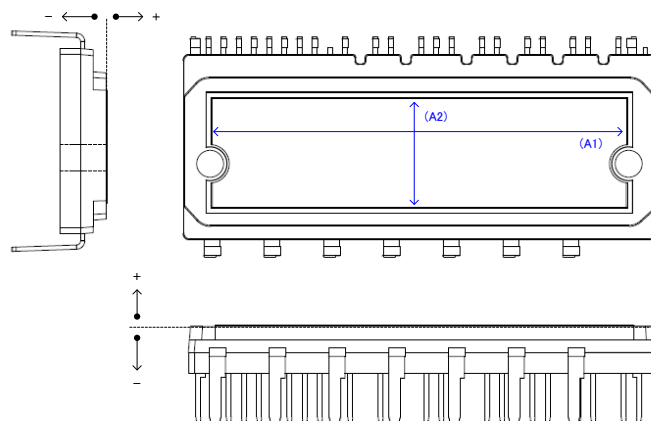


Fig. 2-4 Measurement point of heat sink surface flatness