Chapter 2

Description of Terminal Symbols and Terminology

Contents Page

1. Description of Terminal Symbols

Table 2-1 and 2-2 show the description of terminal symbols and terminology respectively.

Table 2-1 Description of Terminal Symbols

Pin No.	Pin Name	Pin Description
3	VB(U)	High side bias voltage for U-phase IGBT driving
5	VB(V)	High side bias voltage for V-phase IGBT driving
7	VB(W)	High side bias voltage for W-phase IGBT driving
9	IN(HU)	Signal input for high side U-phase
10	IN(HV)	Signal input for high side V-phase
11	IN(HW)	Signal input for high side W-phase
12	V_{CCH}	High side control supply
13	COM	Common supply ground
14	IN(LU)	Signal input for low side U-phase
15	IN(LV)	Signal input for low side V-phase
16	IN(LW)	Signal input for low side W-phase
17	V_{CCL}	Low side control supply
18	VFO	Fault output
19	IS	Over current sensing voltage input
20	COM	Common supply ground
21	TEMP	Temperature sensor output
22	N(W)	Negative bus voltage input for W-phase
23	N(V)	Negative bus voltage input for V-phase
24	N(U)	Negative bus voltage input for U-phase
26	W	Motor W-phase output
28	V	Motor V-phase output
30	U	Motor U-phase output
32	P	Positive bus voltage input
36	NC	No Connection

2. Description of Terminology

Table 2-2 Description of Terminology

(1) Inverter block

Item	Symbol	Description
Zero gate Voltage Collector current	I_{CES}	Collector 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	$V_{CE(sat)}$	Collector-emitter voltage at a specified collector current when the input signal of only the element to be measured is H (= 5V) and the inputs of all other elements are L (=0V)
FWD forward voltage drop	V_F	Forward voltage at a specified forward current with all input signals L (=0V)
Turn-on time	ton	The time from the input signal rising above the threshold value until the collector current becomes 90% of the rating. See Fig. 2-1.
Turn-on delay	td(on)	The time from the input signal rising above the threshold value until the collector current decreases to 10% of the rating. See Fig. 2-1.
Turn-on rise time	tr	The time from the collector current becoming 10% at the time of IGBT turn-on until the collector current becomes 90%. See Fig. 2-1.
VCE-IC Cross time of turn-on	tc(on)	The time from the collector current becoming 10% at the time of IGBT turn on until the VCE voltage of IGBT dropping below 10% of the rating. See Fig. 2-1.
Turn-off time	toff	The time from the input signal dropping below the threshold value until the VCE voltage of IGBT becomes 90% of the rating. See Fig. 2-1.
Turn-off delay	td(off)	The time from the input signal dropping below the threshold value until the collector current decreases to 90%. See Fig. 2-1.
Turn-on fall time	tf	The time from the collector current becoming 90% at the time of IGBT turn-off until the collector current decreases to 10%. See Fig. 2-1.
VCE-IC Cross time of turn-off	tc(off)	The time from the VCE voltage becoming 10% at the time of IGBT turn ff until the collector current dropping below 10% of the rating. See Fig. 2-1.
FWD Reverse recovery time	trr	The time required for the reverse recovery current of the built-in diode to disappear. See Fig. 2-1.

(2) Control circuit block

Item	Symbol	Description
Circuit current of Low-side drive IC	I_{CCL}	Current flowing between control power supply V_{CCL} and COM
Circuit current of High-side drive IC	I_{CCH}	Current flowing between control power supply V_{CCH} and COM
Circuit current of Bootstrap circuit	I_{CCHB}	Current flowing between upper side IGBT bias voltage supply VB(U) and U,VB(V) and V or VB(W) and W on the P-side (per one unit)
Input Signal threshold voltage	Vth(on)	Control signal voltage when IGBT changes from OFF to ON
	Vth(off)	Control signal voltage when IGBT changes from ON to OFF
Input Signal threshold hysteresis voltage	Vth(hys)	The hysteresis voltage between Vth(on) and Vth(off).
Operational input pulse width	$t_{IN(on)}$	Control signal pulse width necessary to change IGBT from OFF to ON. Refer Chapter 3 section 4.
Operational input pulse width	$t_{IN(off)}$	Control signal pulse width necessary to change IGBT from ON to OFF. Refer Chapter 3 section 4.

Table 2-2 Description of Terminology

(2) Control circuit block (Continued)

Item	Symbol	Description
Input current	I_{IN}	Current flowing between signal input IN(HU,HV,HW,LU,LV,LW) and COM.
Input pull-down resistance	R_{IN}	Input resistance of resister in input terminals IN(HU,HV,HW,LU,LV,LW). They are inserted between each input terminal and COM.
Fault output voltage	V_{FO}(H)	Output voltage level of VFO terminal under the normal operation (The lower side arm protection function is not actuated.) with pull-up resister 10kΩ.
	V_{FO}(L)	Output voltage level of VFO terminal after the lower side arm protection function is actuated.
Fault output pulse width	t_{FO}	Period in which an fault status continues to be output (VFO) from the VFO terminal after the lower side arm protection function is actuated. Refer chapter 3 section 6.
Over current protection voltage level	V_{IS}(ref)	Threshold voltage of IS terminal at the over current protection. Refer chapter 3 section 5.
Over Current Protection Trip delay time	$td_{(IS)}$	The time from the Over current protection triggered until the collector current becomes 50% of the rating. Refer chapter 3 section 5.
Output Voltage of temperature sensor	V(temp)	The output voltage of temp. It is applied to the temperature sensor output model. Refer chapter 3 section 7.
Overheating protection temperature	TOH	Tripping temperature of over heating. The temperature is observed by LVIC. All low side IGBTs are shut down when the LVIC temperature exceeds overheating threshold. See Fig.2-2 and refer chapter 3 section 8.
Overheating protection hysteresis	TOH(hys)	Hysteresis temperature required for output stop resetting after protection operation. See Fig.2-2 and refer chapter 3 section 8. TOH and TOH(hys) are applied to the overheating protection model.
Vcc Under voltage trip level of Low-side	$V_{CCL(OFF)}$	Tripping voltage in under voltage of the Low-side control IC power supply. All low side IGBTs are shut down when the voltage of V_{CCL} drops below this threshold. Refer chapter 3 section 1.
Vcc Under voltage reset level of Low-side	$V_{CCL(ON)}$	Resetting threshold voltage from under voltage trip status of V_{CCL}. Refer chapter 3 section 1.
Vcc Under voltage hysteresis of Low-side	$V_{CCL(hys)}$	Hysteresis voltage between $V_{CCL(OFF)}$ and $V_{CCL(ON)}$.
Vcc Under voltage trip level of High-side	$V_{CCH(OFF)}$	Tripping voltage in under voltage of High-side control IC power supply. The IGBTs of high-side are shut down when the voltage of V_{CCH} drops below this threshold. Refer chapter 3 section 1.
Vcc Under voltage reset level of High-side	$V_{CCH(ON)}$	Resetting threshold voltage from under voltage trip status of V_{CCH}. See Fig.3-3 Resetting voltage at which the IGBT performs shutdown when the High-side control power supply voltage V_{CCH} drops. Refer chapter 3 section 1.
Vcc Under voltage hysteresis of High-side	$V_{CCH(hys)}$	Hysteresis voltage between $V_{CCH(OFF)}$ and $V_{CCH(ON)}$.
VB Under voltage trip level	$V_{B(OFF)}$	Tripping voltage in under voltage of VB(*). The IGBTs of high-side are shut down when the voltage of VB(*) drops below this threshold. Refer chapter 3 section 2.
VB Under voltage reset level	$V_{B(ON)}$	Resetting voltage at which the IGBT performs shutdown when the upper side arm IGBT bias voltage VB(*) drops. Refer chapter 3 section 2.
VB Under voltage hysteresis	$V_{B(hys)}$	Hysteresis voltage between $V_{B(OFF)}$ and $V_{B(ON)}$.

Table 2-2 Description of Terminology

(3) BSD block

Item	Symbol	Description
Forward voltage of Bootstrap diode	$V_{F(BSD)}$	BSD Forward voltage at a specified forward current.

(4) Thermal Characteristics

Item	Symbol	Description
Junction to Case Thermal Resistance (per single IGBT)	Rth(j-c)_IGBT	Thermal resistance from the junction to the case of single IGBT.
Junction to Case Thermal Resistance (per single FWD)	Rth(j-c)_FWD	Thermal resistance from the junction to the case of single FWD.
Case to Heat sink Thermal Resistance	Rth(c-f)	Thermal resistance between the case and heat sink, when mounted on a heat sink at the recommended torque using the thermal compound

(5) Mechanical Characteristics

Item	Symbol	Description
Tighten torque	-	Screwing torque when mounting the IPM to a heat sink with a specified screw.
Heat-sink side flatness	-	Flatness of a heat sink side. See Fig.2-3.

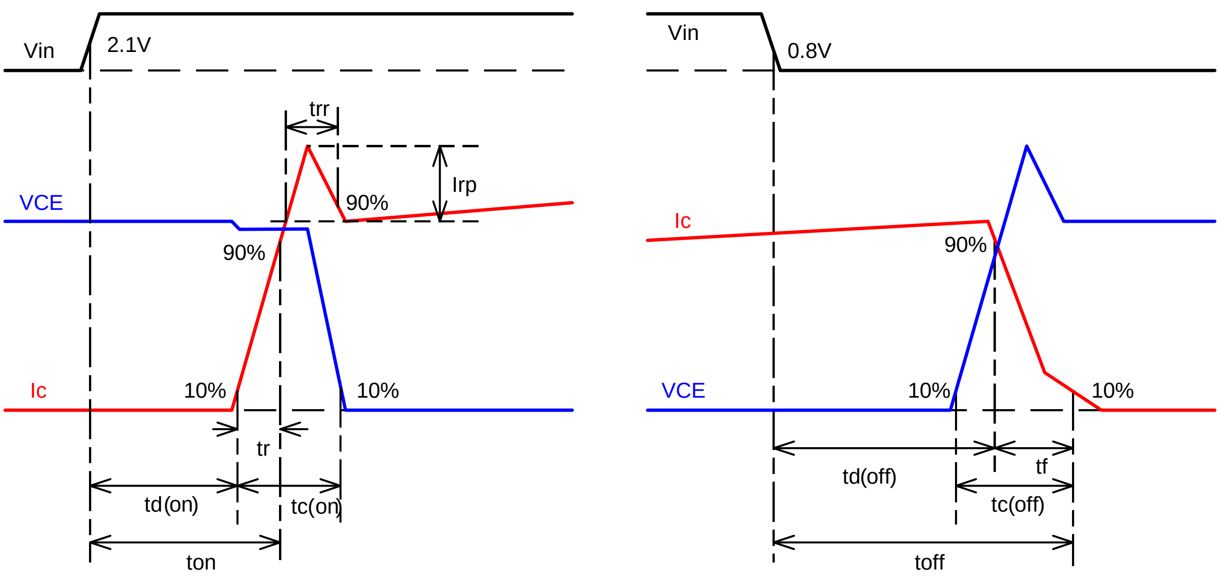

Fig.2-1 Switching waveforms

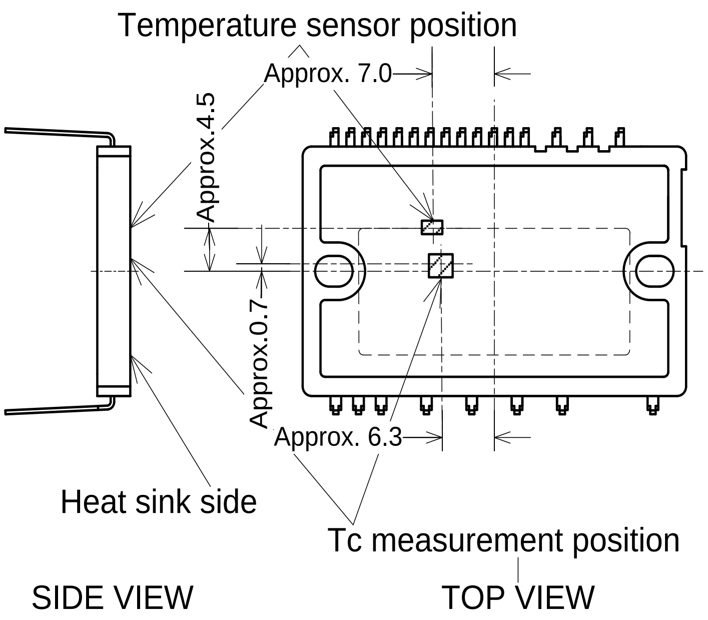

Fig.2-2 The measurement position of temperature sensor and Tc.

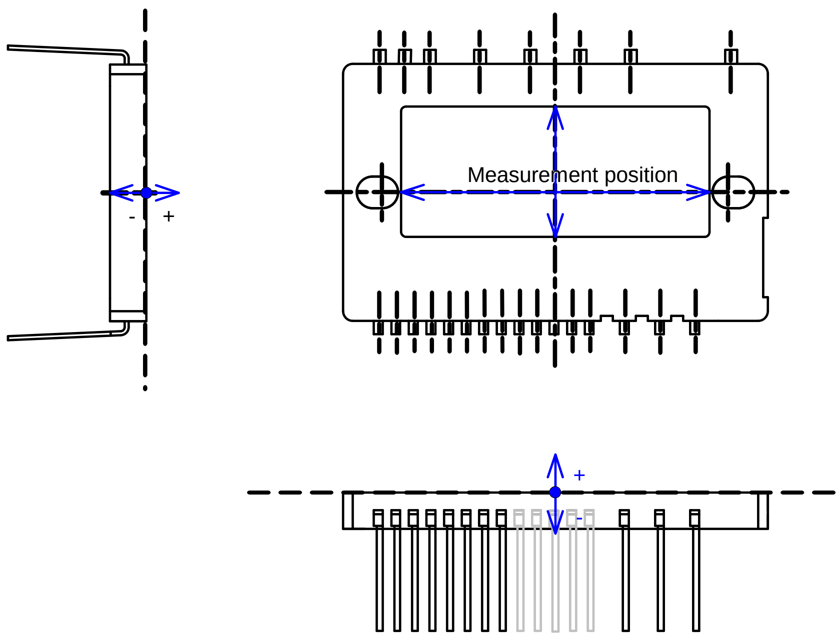

Fig.2-3 The measurement point of heat-sink side flatness.