
Chapter 2

Description of Terminal Symbols and Terminology

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1 Description of Terminal Symbols

Main terminals

Terminal Symbol	Description
P N	Main power source Vd input terminal for the inverter bridge. P: + side, N: – side
B	Brake output terminal: terminal to connect the resistor for regenerative operation declaration
U V W	3-phase inverter output terminal
N2	Main power source Vd "negative(-)" input terminal after rectification converter smoothing of the inverter unit (P617, 619)
N1	Terminal for external connection of resistance when the OC level is to be changed (P617, 619)

Control terminals

Terminal Symbol	P610, P611 P612	P617 P619	P621 P622	Description
GND U Vcc U	<1> <3>	<1> <3>	<1> <4>	Control power source Vcc input in the upper arm U phase Vcc U: + side, GND U: – side
Vin U	<2>	<2>	<3>	Control signal input in the upper arm U phase
ALM U	–	–	<2>	Upper arm U-phase alarm output when the protection circuits are operating
GND V Vcc V	<4> <6>	<4> <6>	<5> <8>	Control power source Vcc input in the upper arm V phase Vcc V: + side, GND V: – side
Vin V	<5>	<5>	<7>	Control signal input in the upper arm V phase
ALM V	–	–	<6>	Upper arm V-phase alarm output when the protection circuits are operating
GND W Vcc W	<7> <9>	<7> <9>	<9> <12>	Control power source Vcc input in the upper arm W phase Vcc W : + side, GND W: – side
Vin W	<8>	<8>	<11>	Control signal input in the upper arm W phase
ALM W	–	–	<10>	Upper arm W-phase alarm output when the protection circuits are operating
GND Vcc	<10> <11>	<10> <11>	<13> <14>	Control power source Vcc input in the lower arm common Vcc: + side, GND: – side
Vin X	<13>	<12>	<16>	Control signal input in the lower arm X phase
Vin Y	<14>	<13>	<17>	Control signal input in the lower arm Y phase
Vin Z	<15>	<14>	<18>	Control signal input in the lower arm Z phase
Vin DB	<12>	–	<15>	Control signal input in the lower arm brake phase
ALM	<16>	<15>	<19>	Lower arm alarm output when the protection circuits are operating

2 Description of Terminology

1. Absolute Maximum Ratings

Term	Symbol	Description	
Bus voltage	V_{DC}	DC voltage that can be applied between PN terminals	
DC Bus voltage (surge)	V_{DC} (surge)	Peak value of the surge voltage that can be applied between PN terminals in switching	
DC Bus voltage (short circuit)	V_{SC}	DC source voltage between PN terminals that can be protected from short circuits/overcurrent	
Collector-emitter Voltage	V_{CES}	Maximum collector-emitter voltage of the built-in IGBT chip and repeated peak reverse voltage of the FWD chip (only the IGBT for the brake)	
Reverse voltage	V_R	Repeated peak reverse voltage of the FWD chip in the brake section	
Collector current	I_C	Maximum DC collector current for the IGBT chip	
	I_{CP}	Maximum DC pulse collector current for the IGBT chip	
	$-I_C$	Maximum DC forward current for the FWD chip	
FRD forward Current	I_F	Maximum DC forward current for the FWD chip in the brake section	
Collector power Dissipation	P_C	Maximum power dissipation for one IGBT element Power dissipation for T_j to become 150°C at $T_c = 25^\circ\text{C}$ or power dissipated in collector so that T_j becomes 150°C at $T_c = 25^\circ\text{C}$	
Control power source voltage	V_{CC}	Voltage that can be applied between GND and each V_{cc} terminal	
Input voltage	V_{in}	Voltage that can be applied between GND and each V_{in} terminal	
Input current	I_{in}	Current that flows between GND and each V_{in} terminal	
Alarm signal voltage	V_{ALM}	Voltage that can be applied between GND and ALM terminal	
Alarm signal current	I_{ALM}	Current that flows between GND and ALM terminal	
Chip junction Temperature	T_j	Maximum junction temperature of the IGBT and FWD chips during continuous operation	
Operating case temperature	T_{opr}	Range of case temperature for electrical operation (Fig. 1 shows the measuring point of the case temperature T_c)	
Storage temperature	T_{stg}	Range of ambient temperature for storage or transportation, when there is no electrical load	
Isolating voltage	V_{iso}	Maximum effective value of the sine-wave voltage between the terminals and the heat sink, when all terminals are shorted simultaneously	
Screw torque	Terminal	–	Max. torque for connection of terminal and external wire with the specified screw
	Mounting	–	Max. torque when mounting the element to the heat sink with the specified screw

Chapter 2 Description of Terminal Symbols and Terminology

2. Electrical Characteristics

2.1 Main Circuit

Term	Symbol	Description
Collector-emitter cutoff current	I_{CES}	Collector current when a specified voltage is applied between the collector and emitter of an IGBT with all input signals H (= Vz)
Collector-emitter saturation voltage	$V_{CE (sat)}$	Collector-emitter voltage at a specified collector current when the input signal of only the elements to be measured is L (= 0V) and the inputs of all other elements are H (= Vz)
Diode forward voltage	V_F	Forward voltage at a specified forward current with all input signals H (= Vz)
Turn-on time	t_{on}	The time from the input signal dropping below the threshold value until the collector current becomes 90% of the rating. See Fig. 2-3.
Turn-off time	t_{off}	The time from the input signal rising above the threshold value until the collector current becomes 10% of the rating. See Fig. 2-3.
Fall time	t_f	The time from the collector current becoming 90% at the time of IGBT turn-off until the tangent to the decreasing current becomes 10%. See Fig. 2-3.
Reverse recovery time	t_{rr}	The time required for the reverse recovery current of the built-in diode to disappear. See Fig. 2-3.

2.2 Control Circuits

Term	Symbol	Description
Control power source consumption current	I_{ccp}	Current flowing between control power source Vcc and GND on the P-side (upper arm side)
	I_{ccn}	Current flowing between control power source Vcc and GND on the N-side (lower arm side)
Input signal threshold voltage	$V_{inH (on)}$	Control signal voltage when IGBT changes from OFF to ON
	$V_{inH (off)}$	Control signal voltage when IGBT changes from ON to OFF
Input zenor voltage	V_z	Voltage clamped by zener diode connected between GND and each Vin when the control signal is OFF
Signal hold time	t_{ALM}	Period in which an alarm continues to be output (ALM) from the ALM terminal after the N-side protection function is actuated
Limiting resistor for alarm	R_{ALM}	Built-in resistance limiting the primary current of the photocoupler for ALM output
Current detection shunt resistance	R1	Resistance value of the IPM built-in shunt resistor (P617, P619)

2.3 Protection Circuits

Term	Symbol	Description
Overcurrent protective operation current	I_{OC}	IGBT collector current at which the overcurrent protection (OC) works
Overcurrent cut off time	t_{DOC}	Shown in Fig. 2-1
Short-circuit protection delay time	t_{sc}	Shown in Fig. 2-2
Chip overheating protection temperature	T_{jOH}	Tripping temperature at which the IGBT chip junction temperature Tj overheats and IGBT soft shutdown is performed
Chip overheating protection hysteresis	T_{jH}	Drop temperature required for output stop resetting after protection operation
Case overheating protection temperature	T_{cOH}	Tripping temperature at which the IGBT performs soft shutdown when the case temperature Tc shows overheating
Case overheating protection hysteresis	T_{cH}	Drop temperature required for output stop resetting after protection operation
Under voltage protection level	V_{UV}	Tripping voltage at which the IGBT performs soft shutdown when the control power source voltage Vcc drops
Control power source undervoltage protection hysteresis	V_H	Recovery voltage required for output stop resetting after protection operation

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3. Thermal Characteristics

Term	Symbol	Description
Chip-case thermal resistance	$R_{th(j-c)}$	Chip-case thermal resistance of IGBT or diode
Chip-fin thermal resistance	$R_{th(c-f)}$	Thermal resistance between the case and heat sink, when mounted on a heat sink at the recommended torque using the thermal compound
Case temperature	T_c	IPM case temperature (temperature of the copper plate directly under the IGBT or the diode)

4. Noise Tolerance

Term	Symbol	Description
Common mode noise	–	Common mode noise tolerance in our test circuit
Electric surge	–	Electric surge tolerance in our test circuit

5. Other

Term	Symbol	Description
Weight	W_t	Weight of IPM
Switching frequency	f_{sw}	Range of control signal frequencies for input to the control signal input terminal
Reverse recovery current	I_{rr}	Shown in Fig. 2-3
Reverse bias safe operation area	RBSOA	Area of the current and voltage in which IGBT can be cut off under specified conditions during turn-off
Switching loss	E_{on}	IGBT switching loss during turn-on
	E_{off}	IGBT switching loss during turn-off
	E_{rr}	FWD switching loss during reverse recovery

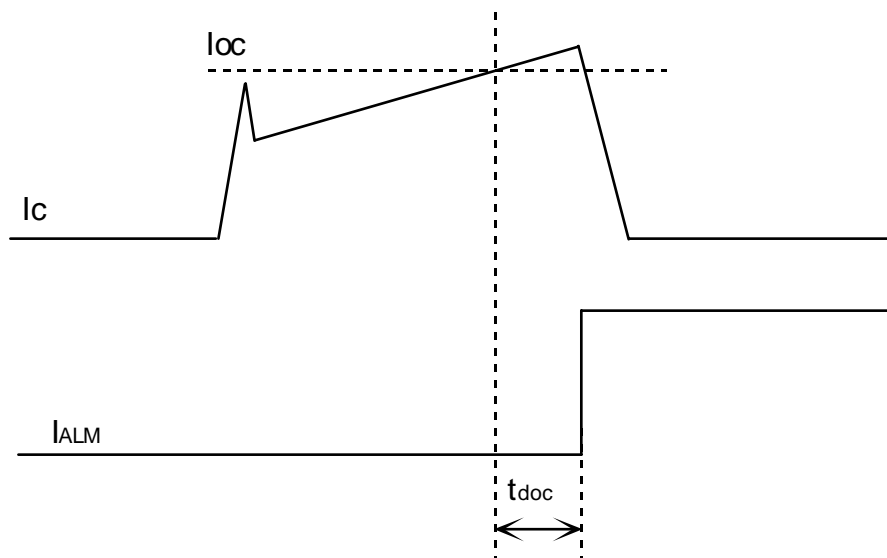


Fig. 2-1 Overcurrent Protection Delay Time (t_{doc})

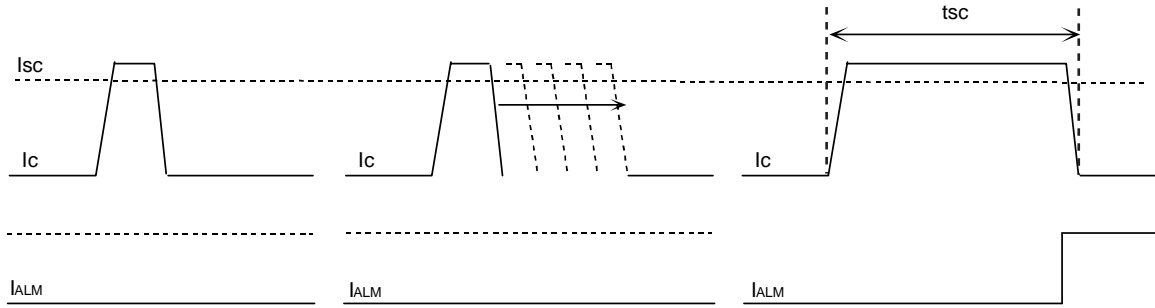


Fig. 2-2 Short-circuit Protection Delay Time (t_{sc})

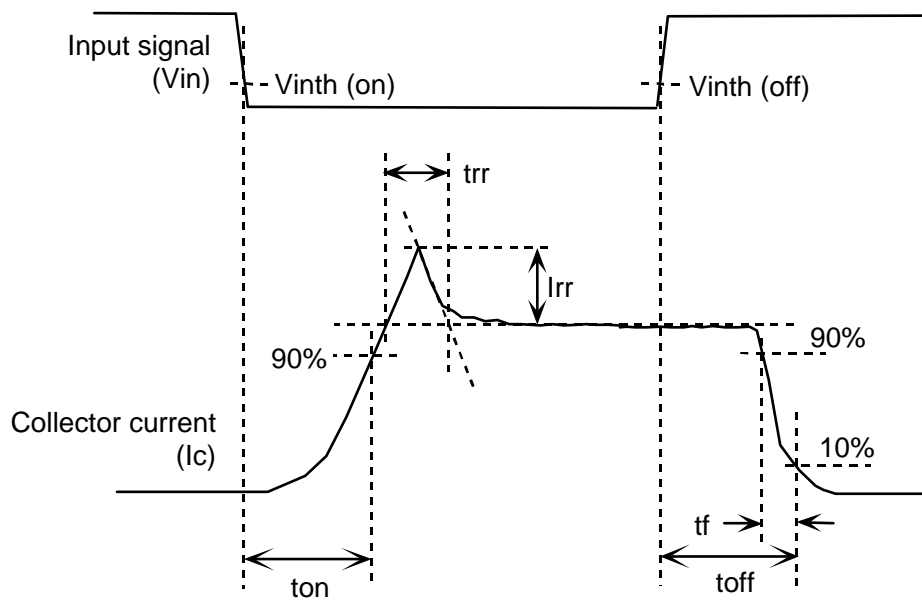


Fig. 2-3 Switching Time

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