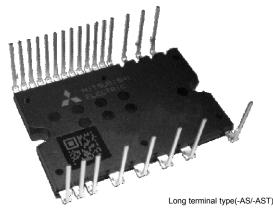


< Dual-In-Line Package Intelligent Power Module > PS219B2-S/-AS/-CS PS219B2-ST/-AST/-CST

TRANSFER MOLDING TYPE **INSULATED TYPE**

OUTLINE



MAIN FUNCTION AND RATINGS

- 3 phase DC/AC inverter
- 600V / 5A (CSTBT)
- N-side IGBT open emitter
- Built-in bootstrap diodes with current limiting resistor

APPLICATION

• AC 100~240Vrms(DC voltage:400V or below) class low power motor control

TYPE NAME

PS219B2-S/-AS/-CS	With temperature output function
PS219B2-ST/-AST/-CST	With OT protection function

INTEGRATED DRIVE, PROTECTION AND SYSTEM CONTROL FUNCTIONS

• For P-side : Drive circuit, High voltage high-speed level shifting, Control supply under-voltage (UV) protection

• For N-side : Drive circuit, Control supply under-voltage protection (UV), Short circuit protection (SC),

Over temperature protection (OT, -ST/-AST/-CST only)

• Fault signaling : Corresponding to SC fault (N-side IGBT), UV fault (N-side supply)

• Temperature output: Outputting LVIC temperature by analog signal (-S/-AS/-CS only)

• Input interface : 3, 5V line, Schmitt trigger receiver circuit (High Active)

• UL Recognized : UL1557 File E323585

INTERNAL CIRCUIT P(24) V_{UFB}(2) Di1 V_{VFB}(3) U(23) IGBT2 Di2 V_{WFB}(4) HVIC U_P(5) V(22) V_P(6) IGBT3 Di3 W_P(7) V_{P1}(8) W(21) V_{NC}(9) IGRT4 Di4 U_N(10) NU(20) V_N(11) IGRT5 W_N(12) V_{N1}(13) NV(19) LVIC F₀(14) IGBT6 Di6 CIN(15) V_{NC}(16) NW(18) V_{OT}(17) ·Built-in temperature output type: Vot (-S/-AS/-CS) ·Built-in OT type: NC (No Connection) (-ST/-AST/-CST)

TRANSFER MOLDING TYPE

INSULATED TYPE

MAXIMUM RATINGS (T_j = 25°C, unless otherwise noted)

INVERTER PART

Symbol	Parameter	Condition	Ratings	Unit
Vcc	Supply voltage	Applied between P-NU,NV,NW	450	V
V _{CC(surge)}	Supply voltage (surge)	Applied between P-NU,NV,NW	500	V
V _{CES}	Collector-emitter voltage		600	V
±lc	Each IGBT collector current	T _C = 25°C	5	Α
±I _{CP}	Each IGBT collector current (peak)	T _C = 25°C, less than 1ms	10	Α
Pc	Collector dissipation	T _C = 25°C, per 1 chip	21.3	W
Tj	Junction temperature	(Note 1)	-20~+150	°C

Note1: The maximum junction temperature rating of built-in power chips is 150°C(@Tc≤100°C). However, to ensure safe operation of DIPIPM, the average junction temperature should be limited to Tj(Ave)≤125°C (@Tc≤100°C).

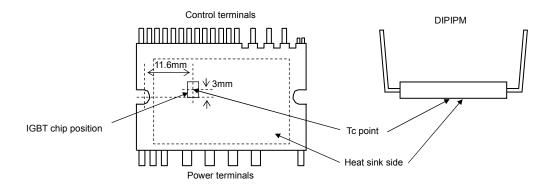
CONTROL (PROTECTION) PART

Symbol	Parameter	Condition	Ratings	Unit
V_D	Control supply voltage	Applied between V _{P1} -V _{PC} , V _{N1} -V _{NC}	20	V
V_{DB}	Control supply voltage	Applied between V _{UFB} -V _{UFS} , V _{VFB} -V _{VFS} , V _{WFB} -V _{WFS}	20	V
V_{IN}	Input voltage	Applied between U _P , V _P , W _P -V _{PC} , U _N , V _N , W _N -V _{NC}	-0.5~V _D +0.5	V
V_{FO}	Fault output supply voltage	Applied between F _O -V _{NC}	-0.5~V _D +0.5	V
I _{FO}	Fault output current	Sink current at Fo terminal	1	mA
V _{SC}	Current sensing input voltage	Applied between CIN-V _{NC}	-0.5~V _D +0.5	V

TOTAL SYSTEM

Symbol	Parameter	Condition	Ratings	Unit
V _{CC(PROT)}	Self protection supply voltage limit (Short circuit protection capability)	V _D = 13.5~16.5V, Inverter Part T _i = 125°C, non-repetitive, less than 2μs	400	V
T _C	Module case operation temperature	Measurement point of Tc is provided in Fig.1	-20~+100	°C
T _{stg}	Storage temperature		-40~+125	°C
V _{iso}	Isolation voltage	60Hz, Sinusoidal, AC 1minute, between connected all pins and heat-sink plate	1500	V _{ms}

Fig. 1: T_C MEASUREMENT POINT



THERMAL RESISTANCE

Symbol	Parameter	Condition		Limits		
Symbol	i didilietei	Condition	Min.	Тур.	Max.	Unit
R _{th(j-c)Q}	Junction to case thermal	Inverter IGBT part (per 1/6 module)	-	-	4.7	K/W
$R_{th(j-c)F}$	resistance (Note 2)	Inverter FWDi part (per 1/6 module) -		-	5.4	K/W

Note 2: Grease with good thermal conductivity and long-term endurance should be applied evenly with about +100µm~+200µm on the contacting surface of DIPIPM and heat-sink. The contacting thermal resistance between DIPIPM case and heat sink Rth(c-f) is determined by the thickness and the thermal conductivity of the applied grease. For reference, Rth(c-f) is about 0.3K/W (per 1/6 module, grease thickness: 20µm, thermal conductivity: 1.0W/m•k).

TRANSFER MOLDING TYPE

INSULATED TYPE

ELECTRICAL CHARACTERISTICS ($T_j = 25^{\circ}C$, unless otherwise noted) **INVERTER PART**

Symbol	Parameter	Darameter	Condition		Limits		Unit
Syllibol	Farameter	Condition			Тур.	Max.	Offic
V	Collector-emitter saturation	$V_D = V_{DB} = 15V, V_{IN} = 5V, I_C = 5A$	T _j = 25°C	-	1.50	2.00	V
$V_{CE(sat)}$	voltage	V _D -V _{DB} - 15V, V _{IN} - 5V, I _C - 5A	T _j = 125°C	-	1.60	2.10	V
V _{EC}	FWDi forward voltage	V _{IN} = 0V, -I _C = 5A	$V_{IN} = 0V, -I_C = 5A$		1.70	2.20	V
ton				0.75	1.35	1.95	μs
t _{C(on)}		V _{CC} = 300V, V _D = V _{DB} = 15V		-	0.35	0.55	μs
t _{off}	Switching times	Switching times $I_C = 5A$, $T_j = 125^{\circ}C$, $V_{IN} = 0 \leftrightarrow 5V$	-	1.40	2.00	μs	
t _{C(off)}		Inductive Load (upper-lower arm)		-	0.30	0.60	μs
t _{rr}				-	0.30	-	μs
1	Collector-emitter cut-off	V _{CE} =V _{CES}	T _j = 25°C	-	-	1	mA
I _{CES}	current	V CE-V CES	T _i = 125°C	-	-	10	IIIA

CONTROL (PROTECTION) PART

Symbol	Parameter	Condition		Limits			Unit
Gyiriboi	i alametei	Cond	illion	Min.	Тур.	Max.	Offic
1		Total of V V V	V _D =15V, V _{IN} =0V	-	2.80	2.80	
I _D	- Circuit current	Total of V _{P1} -V _{NC} , V _{N1} -V _{NC}	V _D =15V, V _{IN} =5V	-	-	2.80	mA
1	Circuit current	Each part of V _{UFB} -U,	$V_D=V_{DB}=15V, V_{IN}=0V$	-	-	0.10	IIIA
I _{DB}		V _{VFB} -V, V _{WFB} -W	$V_D = V_{DB} = 15V$, $V_{IN} = 5V$	-	-	0.10	
$V_{SC(ref)}$	Short circuit trip level	V _D = 15V	(Note 3)	0.43	0.48	0.53	V
UV _{DBt}	P-side Control supply		Trip level	7.0	10.0	12.0	V
UV_DBr	under-voltage protection(UV)	T <125°C	Reset level	7.0	10.0	12.0	V
UV _{Dt}	N-side Control supply	T _j ≤125°C	Trip level	10.3	-	12.5	V
UV_Dr	under-voltage protection(UV)		Reset level	10.8	-	13.0	V
V	Temperature Output (-S/-AS/-CS only)	Temperature Output Pull down R=5kΩ (Note 4)	LVIC Temperature=90°C	2.63	2.77	2.91	V
V_{OT}		Pull down R= $5k\Omega$ (Note 4)	LVIC Temperature=25°C	0.88	1.13	1.39	V
OTt	Overt temperature protection	V _D = 15V	Trip level	100	120	140	°C
OT _{rh}	(OT, -ST/-AST/-CST only) (Note5)	Detect LVIC temperature	Hysteresis of trip-reset	-	10	-	°C
V_{FOH}	Fault output voltage	V _{SC} = 0V, F _O terminal pulled u	p to 5V by 10kΩ	4.9	-	-	V
V _{FOL}	Fault output voltage	V _{SC} = 1V, I _{FO} = 1mA		-	-	0.95	V
t _{FO}	Fault output pulse width		(Note 6)	20	-	-	μs
I _{IN}	Input current	V _{IN} = 5V		0.70	1.00	1.50	mA
$V_{th(on)}$	ON threshold voltage	Applied between U _P , V _P , W _P , U _N , V _N , W _N -V _{NC}		-	2.10	2.60	
$V_{th(off)}$	OFF threshold voltage			0.80	1.30	-	V
$V_{\text{th(hys)}}$	ON/OFF threshold hysteresis voltage	7. April 20 20 20 20 20 20 20 20 20 20 20 20 20			0.65	-	
V_{F}	Bootstrap Di forward voltage	I _F =10mA including voltage drop b	by limiting resistor (Note 7)	1.1	1.7	2.3	V
R	Built-in limiting resistance	Included in bootstrap Di		80	100	120	Ω

Note 3 : SC protection works only for N-side IGBT. Please select the external shunt resistance such that the SC trip-level is less than 1.7 times of the current rating.

4 : DIPIPM don't shutdown IGBTs and output fault signal automatically when temperature rises excessively. When temperature exceeds the protective level that user defined, controller (MCU) should stop the DIPIPM. Temperature of LVIC vs. Vot output characteristics is described in Fig. 3.

user defined, controller (MCU) should stop the DIPIPM. Temperature of LVIC vs. V_{OT} output characteristics is described in Fig. 3.

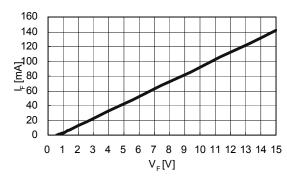
5: When the LVIC temperature exceeds OT trip temperature level(OT_t), OT protection works and Fo outputs. In that case if the heat sink dropped off or fixed loosely, don't reuse that DIPIPM. (There is a possibility that junction temperature of power chips exceeded maximum Tj(150°C).

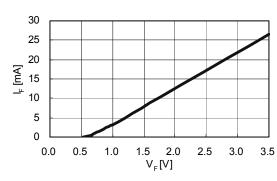
6: Fault signal Fo outputs when SC, UV or OT protection works. Fo pulse width is different for each protection modes. At SC failure, Fo pulse width is a fixed

6: Fault signal Fo outputs when SC, UV or OT protection works. Fo pulse width is different for each protection modes. At SC failure, Fo pulse width is a fixed width (=minimum 20µs), but at UV or OT failure, Fo outputs continuously until recovering from UV or OT state. (But minimum Fo pulse width is 20µs.)

7: The characteristics of bootstrap Di is described in Fig.2.

 $Fig.\ 2\ Characteristics\ of\ bootstrap\ Di\ V_F-I_F\ curve\ (@Ta=25^{\circ}C)\ including\ voltage\ drop\ by\ limiting\ resistor\ (Right\ chart\ is\ enlarged\ chart.)$





TRANSFER MOLDING TYPE INSULATED TYPE

Fig. 3 Temperature of LVIC vs. V_{OT} output characteristics

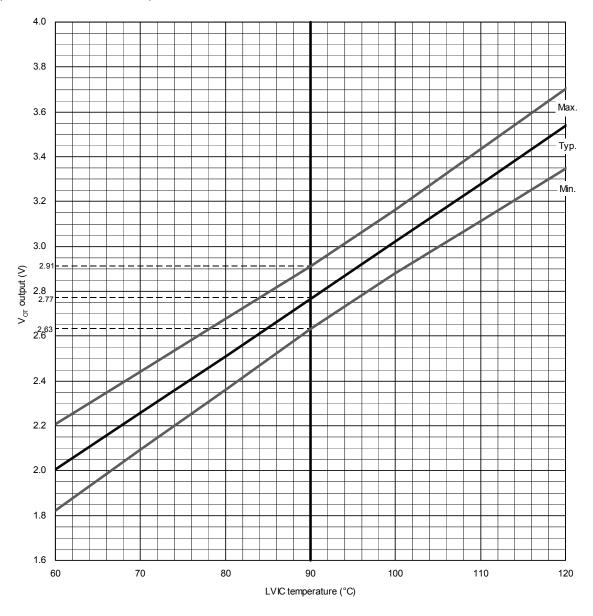
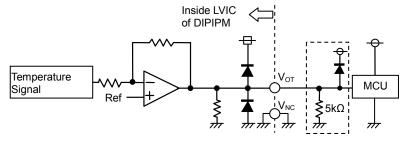


Fig. 4 V_{OT} output circuit



- (1) It is recommended to insert 5kΩ or more (5.1kΩ is recommended) pull down resistor for getting linear output characteristics at low temperature below room temperature. When the pull down resistor is inserted between V_{OT} and V_{NC}(control GND), the extra circuit current, which is calculated approximately by V_{OT} output voltage divided by pull down resistance, flows as LVIC circuit current continuously. In the case of using V_{OT} for detecting high temperature over room temperature only, it is unnecessary to insert the pull down resistor.
- (2) In the case of using V_{OT} with low voltage controller like 3.3V MCU, V_{OT} output might exceed control supply voltage 3.3V when temperature rises excessively. If system uses low voltage controller, it is recommended to insert a clamp Di between control supply of the controller and V_{OT} output for preventing over voltage destruction.
- (3) In the case of not using V_{OT}, leave V_{OT} output NC (No Connection).

Refer the application note for Super Mini DIPIPM Ver.5 series about the usage of V_{OT} .

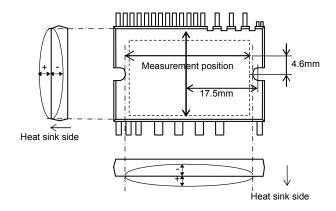
TRANSFER MOLDING TYPE

INSULATED TYPE

MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Condition			Limits		
1 drameter	Cond	Min.	Тур.	Max.	Unit	
Mounting torque	Mounting screw : M3 (Note 8)	Recommended 0.69N·m	0.59	0.69	0.78	N∙m
Terminal pulling strength	Control terminal: Load 4.9N Power terminal: Load 9.8N	EIAJ-ED-4701	10	-	-	s
Terminal bending strength	Control terminal: Load 2.45N Power terminal: Load 4.9N 90deg. bend	EIAJ-ED-4701	2	-	1	times
Weight			-	8.5	-	g
Heat-sink flatness	(Note 9) -50			-	100	μm

Note 8: Plain washers (ISO 7089~7094) are recommended. Note 9: Measurement point of heat sink flatness



RECOMMENDED OPERATION CONDITIONS

Symbol	Parameter	Condition			Limits		Unit
Syllibol	Farameter	Condition		Min.	Тур.	Max.	Offic
Vcc	Supply voltage	Applied between P-NU, NV, NW		0	300	400	V
V_D	Control supply voltage	Applied between V _{P1} -V _{PC} , V _{N1} -V _{NC}		13.5	15.0	16.5	V
V_{DB}	Control supply voltage	Applied between V_{UFB} - V_{UFS} , V_{VFB} - V_{VFS} , V_{V}	_{WFB} -V _{WFS}	13.0	15.0	18.5	V
ΔV_D , ΔV_{DB}	Control supply variation			-1	-	+1	V/µs
t _{dead}	Arm shoot-through blocking time	For each input signal	For each input signal			-	μs
f_{PWM}	PWM input frequency	T _C ≤ 100°C, T _j ≤ 125°C		-	-	20	kHz
I-	Allowable r.m.s. current		f _{PWM} = 5kHz	ı	-	2.5	Arms
I _O	Allowable I.III.S. current		f _{PWM} = 15kHz	-	-	1.5	Aiiis
PWIN(on)	Minimum input pulse width		(Note 11)	0.7	-	-	110
PWIN(off)	Williman input puise width	(Note 11)		0.7	-	-	μs
V_{NC}	V _{NC} variation	Between V _{NC} -NU, NV, NW (including surge)			-	+5.0	V
Tj	Junction temperature			-20	-	+125	°C

Note 10: Allowable r.m.s. current depends on the actual application conditions.

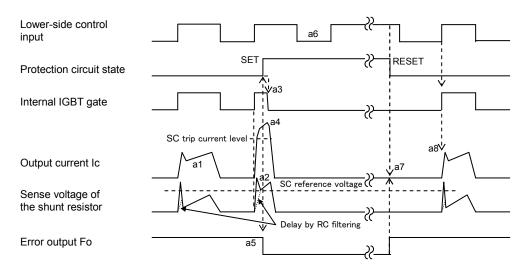
^{11:} DIPIPM might not make response if the input signal pulse width is less than PWIN(on), PWIN(off).

TRANSFER MOLDING TYPE INSULATED TYPE

Fig. 5 Timing Charts of The DIPIPM Protective Functions

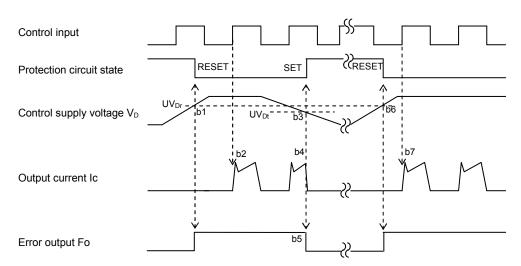
[A] Short-Circuit Protection (N-side only with the external shunt resistor and RC filter)

- a1. Normal operation: IGBT ON and outputs current.
- a2. Short circuit current detection (SC trigger)
 - (It is recommended to set RC time constant 1.5~2.0µs so that IGBT shut down within 2.0µs when SC.)
- a3. All N-side IGBT's gates are hard interrupted.
- a4. All N-side IGBTs turn OFF.
- a5. F_O outputs for t_{Fo} =minimum 20 μ s.
- a6. Input = "L": IGBT OFF
- a7. Fo finishes output, but IGBTs don't turn on until inputting next ON signal (L→H). (IGBT of each phase can return to normal state by inputting ON signal to each phase.)
- a8. Normal operation: IGBT ON and outputs current.



[B] Under-Voltage Protection (N-side, UV_D)

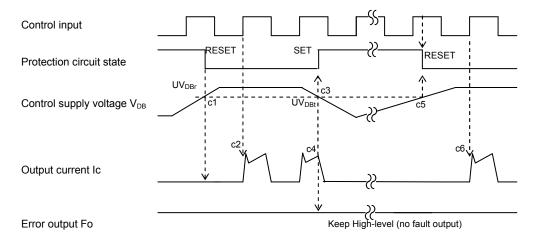
- b1. Control supply voltage V_D exceeds under voltage reset level (UV_{Dr}), but IGBT turns ON by next ON signal ($L\rightarrow H$). (IGBT of each phase can return to normal state by inputting ON signal to each phase.)
- b2. Normal operation: IGBT ON and outputs current.
- b3. V_D level drops to under voltage trip level. (UV $_{Dt}$).
- b4. All N-side IGBTs turn OFF in spite of control input condition.
- b5. Fo outputs for t_{Fo} =minimum 20 μ s, but output is extended during V_D keeps below UV_{Dr} .
- b6. V_D level reaches UV_{Dr} .
- b7. Normal operation: IGBT ON and outputs current.



TRANSFER MOLDING TYPE INSULATED TYPE

[C] Under-Voltage Protection (P-side, UV_{DB})

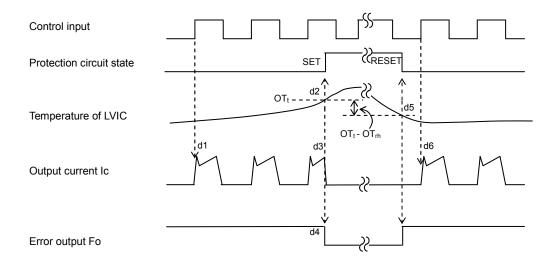
- c1. Control supply voltage V_{DB} rises. After the voltage reaches under voltage reset level UV_{DBr} , IGBT turns on by next ON signal (L \rightarrow H).
- c2. Normal operation: IGBT ON and outputs current.
- c3. V_{DB} level drops to under voltage trip level (UV_{DBt}).
- c4. IGBT of the correspond phase only turns OFF in spite of control input signal level, but there is no Fo signal output.
- c5. V_{DB} level reaches UV_{DBr} .
- c6. Normal operation: IGBT ON and outputs current.



[D] Over Temperature Protection (N-side, Detecting LVIC temperature)

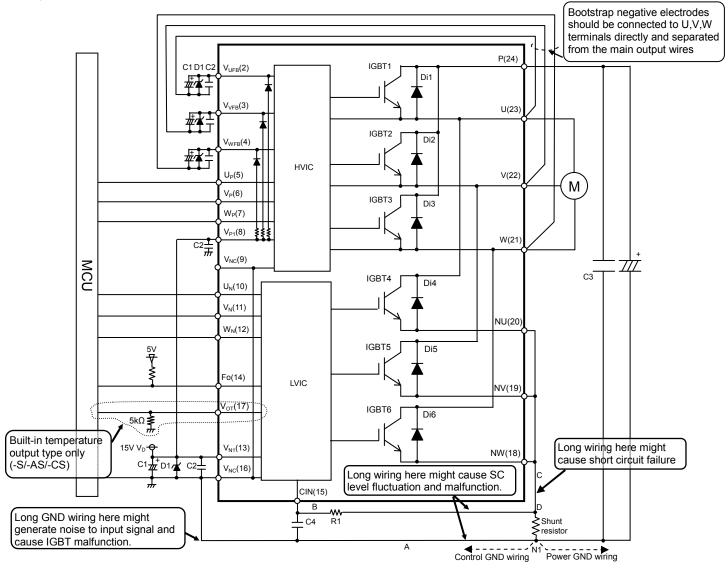
- d1. Normal operation: IGBT ON and outputs current.
- d2. LVIC temperature exceeds over temperature trip level(OT_t).
- d3. All N-side IGBTs turn OFF in spite of control input condition.
- d4. Fo outputs for t_{Fo} =minimum 20 μ s, but output is extended during LVIC temperature keeps over OT_t .
- d5. LVIC temperature drops to over temperature reset level.
- d6. Normal operation: IGBT turns on by next ON signal ($L\rightarrow H$).

(IGBT of each phase can return to normal state by inputting ON signal to each phase.)



TRANSFER MOLDING TYPE INSULATED TYPE

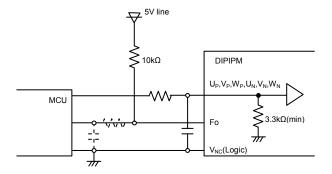
Fig. 6 Example of Application Circuit



- (1) If control GND is connected with power GND by common broad pattern, it may cause malfunction by power GND fluctuation. It is recommended to connect control GND and power GND at only a point N1 (near the terminal of shunt resistor).
- (2) It is recommended to insert a Zener diode D1(24V/1W) between each pair of control supply terminals to prevent surge destruction.
- (3) To prevent surge destruction, the wiring between the smoothing capacitor and the P, N1 terminals should be as short as possible. Generally a 0.1-0.22µF snubber capacitor C3 between the P-N1 terminals is recommended.
- (4) R1, C4 of RC filter for preventing protection circuit malfunction is recommended to select tight tolerance, temp-compensated type. The time constant R1C4 should be set so that SC current is shut down within 2µs. (1.5µs~2µs is general value.) SC interrupting time might vary with the wiring pattern, so the enough evaluation on the real system is necessary.
- (5) To prevent malfunction, the wiring of A, B, C should be as short as possible.
- (6) The point D at which the wiring to CIN filter is divided should be near the terminal of shunt resistor. NU, NV, NW terminals should be connected at near NU, NV, NW terminals.
- (7) All capacitors should be mounted as close to the terminals as possible. (C1: good temperature, frequency characteristic electrolytic type and C2:0.22μ-2μF, good temperature, frequency and DC bias characteristic ceramic type are recommended.)
- (8) Input drive is High-active type. There is a minimum 3.3kΩ pull-down resistor in the input circuit of IC. To prevent malfunction, the wiring of each input should be as short as possible. When using RC coupling circuit, make sure the input signal level meet the turn-on and turn-off threshold voltage.
- (9) Fo output is open drain type. It should be pulled up to MCU or control power supply (e.g. 5V,15V) by a resistor that makes I_{FO} up to 1mA. (I_{FO} is estimated roughly by the formula of control power supply voltage divided by pull-up resistance. In the case of pulled up to 5V, 10kΩ (5kΩ or more) is recommended.)
- (10) Thanks to built-in HVIC, direct coupling to MCU without any opto-coupler or transformer isolation is possible.
- (11) Two V_{NC} terminals (9 & 16 pin) are connected inside DIPIPM, please connect either one to the 15V power supply GND outside and leave another one open.
- (12) If high frequency noise superimposed to the control supply line, IC malfunction might happen and cause DIPIPM erroneous operation. To avoid such problem, line ripple voltage should meet dV/dt ≤+/-1V/µs, Vripple≤2Vp-p.
- (13) For DIPIPM, it isn't recommended to drive same load by parallel connection with other phase IGBT or other DIPIPM.

TRANSFER MOLDING TYPE INSULATED TYPE

Fig. 7 MCU I/O Interface Circuit

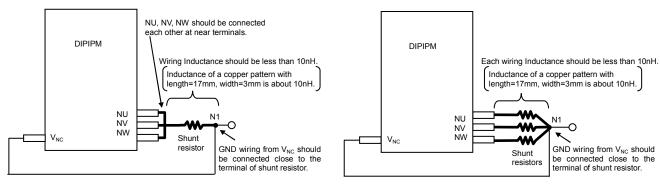


Note)

Design for input RC filter depends on PWM control scheme used in the application and wiring impedance of the printed circuit board. DIPIPM input signal interface integrates a minimum $3.3 k\Omega$ pull-down resistor. Therefore, when inserting RC filter, it is necessary to satisfy turn-on threshold voltage requirement.

Fo output is open drain type. It should be pulled up to control power supply (e.g. 5V, 15V) with a resistor that makes Fo sink current I_{Fo} 1mA or less. In the case of pulled up to 5V supply, $10k\Omega$ ($5k\Omega$ or more) is recommended.

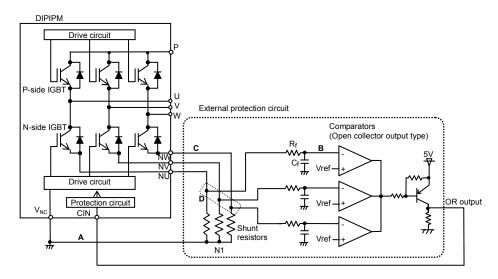
Fig. 8 Pattern Wiring Around the Shunt Resistor



Low inductance shunt resistor like surface mounted (SMD) type is recommended.

Fig. 9 Pattern Wiring Around the Shunt Resistor (for the case of open emitter)

When DIPIPM is operated with three shunt resistors, voltage of each shunt resistor cannot be input to CIN terminal directly. In that case, it is necessary to use the external protection circuit as below.

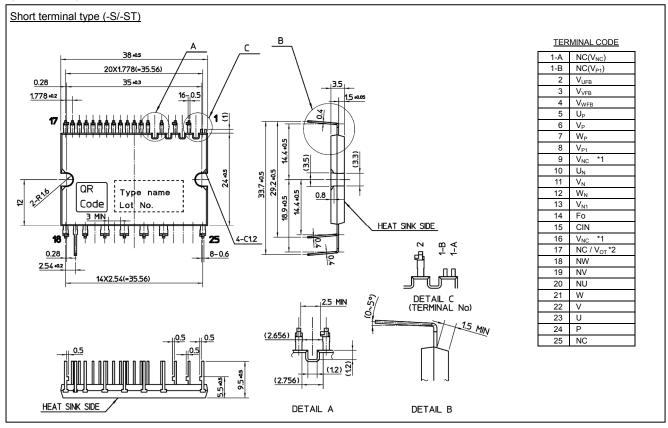


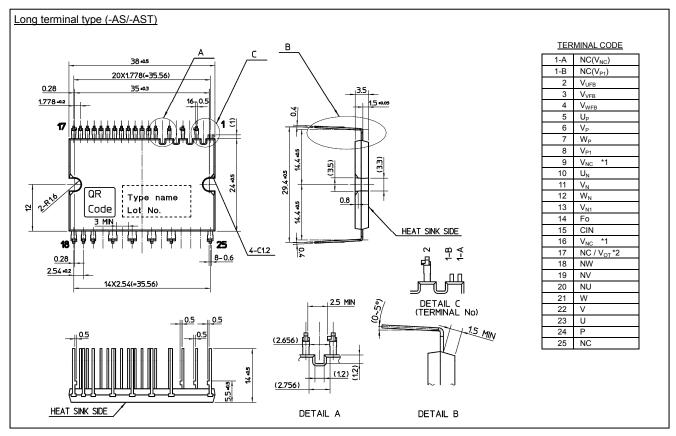
- It is necessary to set the time constant R_fC_f of external comparator input so that IGBT stops within 2μs when short circuit occurs.
 SC interrupting time might vary with the wiring pattern, comparator speed and so on.
- (2) It is recommended for the threshold voltage Vref to set to the same rating of short circuit trip level (Vsc(ref): typ. 0.48V).
- (3) Select the external shunt resistance so that SC trip-level is less than specified value (=1.7 times of rating current).
- (4) To avoid malfunction, the wiring A, B, C should be as short as possible.
- (5) The point D at which the wiring to comparator is divided should be close to the terminal of shunt resistor.
- (6) OR output high level when protection works should be over 0.53V (=maximum Vsc(ref) rating).

TRANSFER MOLDING TYPE INSULATED TYPE

Fig. 10 Package Outlines

Dimensions in mm



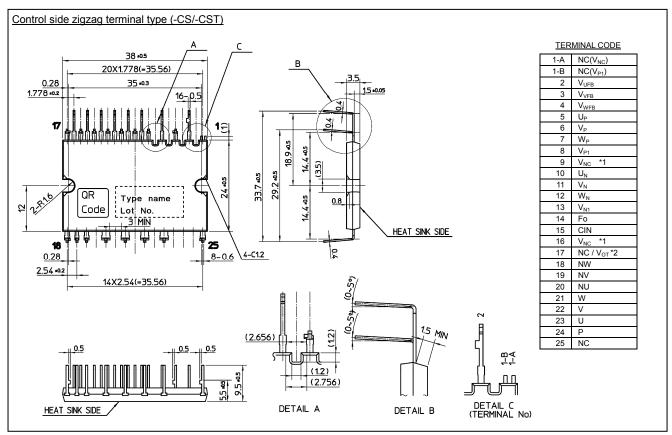


1) 9 & 16 pins (V_{NC}) are connected inside DIPIPM, please connect either one to the control power supply GND outside and leave another one open. 2) No.17 is V_{OT} for built-in temperature output function type (-S/-AS/-CS) and NC (No Connection) for built-in OT protection function type (-ST/-AST).

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TRANSFER MOLDING TYPE

INSULATED TYPE



1) 9 & 16 pins (V_{NC}) are connected inside DIPIPM, please connect either one to the control power supply GND outside and leave another one open. 2) No.17 is V_{OT} for built-in temperature output function type (-S/-AS/-CS) and NC (No Connection) for built-in OT protection function type (-ST/-AST).

< Dual-In-Line Package Intelligent Power Module >

PS219B2-S/-AS/-CS/-ST/-AST/-CST

TRANSFER MOLDING TYPE INSULATED TYPE

Revision Record

Rev.	Date	Page	Revised contents
1	11/15/2011	-	New

TRANSFER MOLDING TYPE INSULATED TYPE

Keep safety first in your circuit designs!

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