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Apr.	H. Yamamoto 21-Jun-'10	Apr.	H. Yamamoto 25-Oct-'10	

Applications : AC100V~240V three phase low power motor inverter drive.

Integrated Power Functions :

600V/15A low-loss IGBT inverter bridge for three phase DC-to-AC power conversion.
Built-in Bootstrap Di. Open Emitter type

Integrated drive, protection and system control functions :

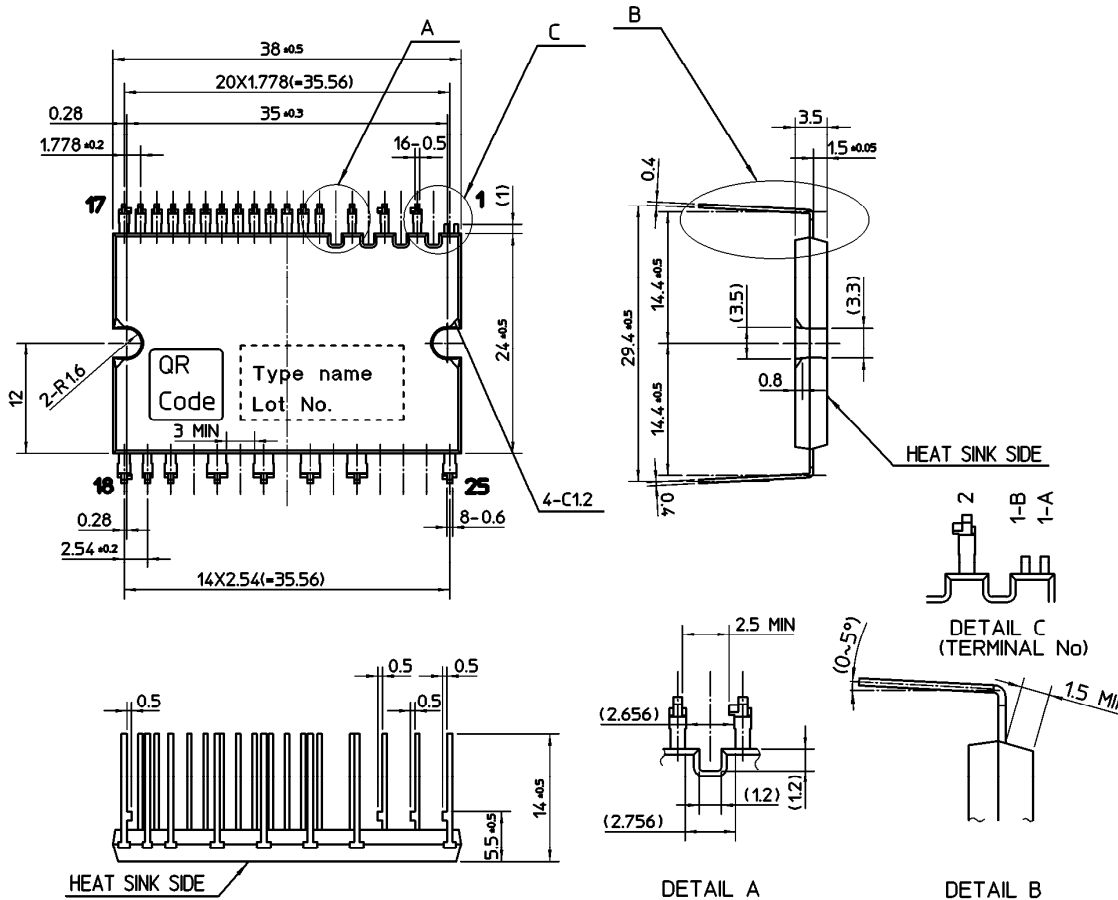
- For P-side : Drive circuit, High voltage high-speed level shifting, Control supply under-voltage (UV) protection.
- For N-side : Drive circuit, Control supply under-voltage protection (UV), Short circuit protection (SC), Over temperature protection (OT).
- Fault signaling : Corresponding to a SC fault (N-side IGBT), a UV fault (N-side supply) or OT fault (LVIC temperature)
- Input interface : 3~5V line (High Active).

Fig. 1 Package Outlines PS219A4-ASTX

Dimensions in mm

TERMINAL CODE

- 1-A: NC(V_{NC})
- 1-B: NC(V_{PI})
- 2: V_{UFB}
- 3: V_{VFB}
- 4: V_{WFB}
- 5: U_P
- 6: V_P
- 7: W_P
- 8: V_{PI}
- 9: V_{NC*}
- 10: U_N
- 11: V_N
- 12: W_N
- 13: V_{NI}
- 14: Fo
- 15: CIN
- 16: V_{NC*}
- 17: NC
- 18: NW
- 19: NV
- 20: NU
- 21: W
- 22: V
- 23: U
- 24: P
- 25: NC



*) Please use either one only of the two VNC pins (No.9, 16) for the ground connection and leave another one open.
QR Code is registered trademark of DENSO WAVE INCORPORATED in JAPAN and other countries.

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DIIPM	DPH-7897e-A	
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PS219A4-ASTXTransfer-Mold Type
Insulated TypeMaximum Ratings (T_j=25°C, unless otherwise noted)

Inverter Part

Item	Symbol	Condition	Rating	Unit
Supply voltage	V _{CC}	Applied between P-NU,NV,NW	450	V
Supply voltage (surge)	V _{CC(surge)}	Applied between P-NU,NV,NW	500	V
Collector-emitter voltage	V _{CES}		600	V
Each IGBT collector current	±I _C	T _c =25°C	15	A
Each IGBT collector current (peak)	±I _{CP}	T _c =25°C, less than 1ms	30	A
Collector dissipation	P _C	T _c =25°C, per 1 chip	32.3	W
Junction temperature	T _j	(Note 1)	-20~+125	°C

(Note1)

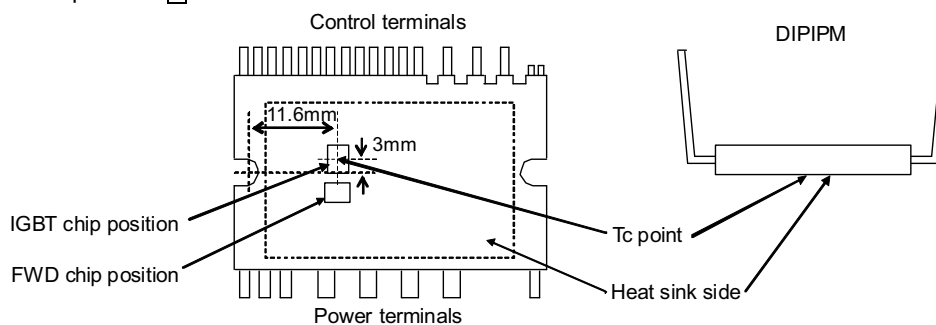
The maximum junction temperature rating of the power chips integrated within the DIPIPM is 150°C(@T_c≤100°C).However, to ensure safe operation of the DIPIPM, the average junction temperature should be limited to T_{j(ave)}≤125°C (@T_c≤100°C).

Control (Protection) Part

Item	Symbol	Condition	Rating	Unit
Control supply voltage	V _D	Applied between V _{P1} -V _{NC} , V _{N1} -V _{NC}	20	V
Control supply voltage	V _{DB}	Applied between V _{UFB-U} , V _{VFB-V} , V _{WFB-W}	20	V
Input voltage	V _{IN}	Applied between U _P , V _P , W _P -V _{NC} , U _N , V _N , W _N -V _{NC}	-0.5~V _D +0.5	V
Fault output supply voltage	V _{FO}	Applied between F _O -V _{NC}	-0.5~V _D +0.5	V
Fault output current	I _{FO}	F _O terminal sink current	1	mA
Current sensing input voltage	V _{SC}	Applied between C _{IN} -V _{NC}	-0.5~V _D +0.5	V

Total System

Item	Symbol	Condition	Rating	Unit
Supply voltage self protection limit (short circuit protection capability)	V _{CC(PROT)}	V _D =13.5~16.5V, Inverter part T _j =125°C, non-repetitive less than 2μs	400	V
Module case operation temperature	T _c	(Note 2)	-20~+100	°C
Storage temperature	T _{stg}		-40~+125	°C
Isolation voltage	V _{iso}	60Hz, Sinusoidal 1 minute, All connected pins to heat-sink plate	1500	V _{rms}

(Note 2) T_c measurement position A

Thermal Resistance

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Junction to case thermal resistance	R _{th(j-c)Q}	Inverter IGBT part (per 1/6 module)	-	-	3.1	°C/W
	R _{th(j-c)F}	Inverter FWD part (per 1/6 module)	-	-	4.5	

(Note 3) Grease with good thermal conductivity and long-term quality should be applied evenly with +100μm~+200μm on the contacting surface of DIPIPM and heat-sink. The contacting thermal resistance between DIPIPM case and heat sink (R_{th(c-f)}) is determined by the thickness and the thermal conductivity of the applied grease. For reference, R_{th(c-f)} (per 1/6 module) is about 0.3°C/W when the grease thickness is 20μm and the thermal conductivity is 1.0W/mk

DIPIPM	DPH-7897e-A
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PS219A4-ASTXTransfer-Mold Type
Insulated TypeElectrical Characteristics (T_j=25°C, unless otherwise noted.)

Inverter Part

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	
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Collector-emitter saturation voltage	V _{CE(sat)}	V _D =V _{DB} =15V I _C =15A, V _{IN} =5V	T _j =25°C	-	1.60	2.10	V
			T _j =125°C	-	1.70	2.20	
FWD forward voltage	V _{EC}	-I _C =15A, V _{IN} =0V	-	1.90	2.40	V	
Switching times	A	V _{CC} =300V, V _D =V _{DB} =15V I _C =15A, T _j =125°C	t _{on}	-	0.85	1.25	μs
			t _{rr}	-	0.30	-	
			t _{c(on)}	-	0.40	0.60	
			t _{off}	-	1.10	1.50	
			t _{c(off)}	-	0.30	0.60	
Collector-emitter cut-off current	I _{CES}	V _{CE} =V _{CES}	T _j =25°C	-	-	1	mA
			T _j =125°C	-	-	10	

Control (Protection) Part

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	
Circuit current	I _D	V _D =V _{DB} =15V V _{IN} =5V	Total of V _{P1} -V _{NC} , V _{N1} -V _{NC}	-	-	2.80	mA
			V _{UFB} -U, V _{VFB} -V, V _{WFB} -W	-	-	0.10	
		V _D =V _{DB} =15V V _{IN} =0V	Total of V _{P1} -V _{NC} , V _{N1} -V _{NC}	-	-	2.80	
			V _{UFB} -U, V _{VFB} -V, V _{WFB} -W	-	-	0.10	
Fault output voltage	V _{FOH}	V _{SC} =0V, Fo terminal pull-up to 5V by 10kΩ	4.9	-	-	V	
	V _{FOL}	V _{SC} =1V, I _{FO} =1mA	-	-	0.95		
Input current	I _{IN}	V _{IN} =5V	0.70	1.00	1.50	mA	
Over temperature Protection (Note6)	OT _t	V _D =15V, Trip level	100	120	140	°C	
	OT _{rh}	At temperature of LVIC Trip/reset hysteresis	-	10	-		
Short circuit trip level	V _{SC(ref)}	V _D =15V (Note 4)	0.43	0.48	0.53	V	
Control supply under-voltage protection	UV _{DBt}	T _j ≤125°C	Trip level	7.0	10.0	12.0	V
	UV _{DBr}		Reset level	7.0	10.0	12.0	
	UV _{Dt}		Trip level	10.3	-	12.5	
	UV _{Dr}		Reset level	10.8	-	13.0	
Fault output pulse width	t _{FO}	(Note 5)	20	-	-	μs	
ON threshold voltage	V _{th(on)}	Applied between U _P , V _P , W _P , U _N , V _N , W _N -V _{NC}	-	2.1	2.6	V	
OFF threshold voltage	V _{th(off)}		0.8	1.3	-		
ON/OFF threshold hysteresis voltage	V _{th(hys)}		0.35	0.65	-		
Boot strap Di forward voltage (Note 7)	V _F	I _F =100mA	2.1	2.8	3.5	V	

(Note 4) Short circuit protection is functioning only for the lower-arms. Please select the external shunt resistance such that the SC trip-level is less than 1.7 times of the current rating.

(Note 5) Fault signal is asserted only corresponding to a SC or a UV failure at lower side, and the Fo pulse width is different for each failure modes. For SC failure, Fo output is with a fixed width of 20μs(min), but for UV failure, Fo output continuously during the whole UV period, however, the minimum Fo pulse width is 20μs(min) for very short UV period less than 20μs.

(Note 6) Over temperature protection(OT) outputs fault signal, when the LVIC temperature exceeds OT trip temperature level(OT_t). In that case if the heat sink comes off DIPIPM or fixed loosely, don't reuse that DIPIPM. (There is a possibility that junction temperature of power chips exceeded maximum T_j(150°C).

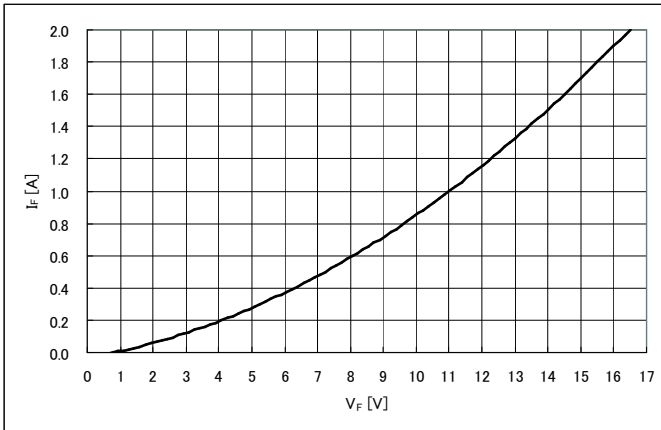
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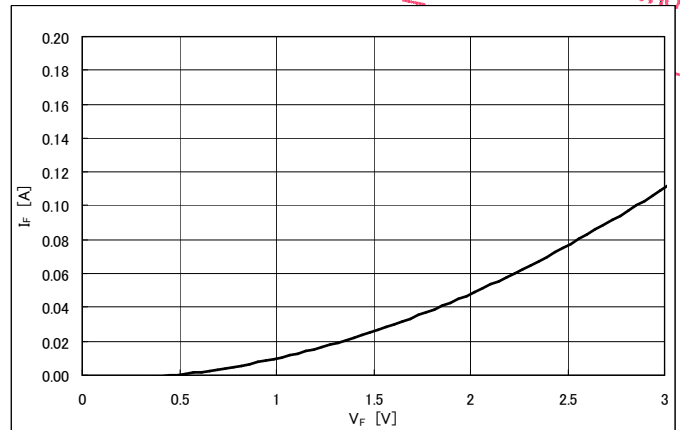
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(Note 7) It is recommended for the bootstrap capacitance to be 22 μ F or below. If it exceeds 22 μ F by the control condition, please refer the application note for this product (document No.DPH-7111e) that describes about the usage of built-in bootstrap diode or contact us. The characteristic of bootstrap Di is described below.



V_F-I_F curve for bootstrap

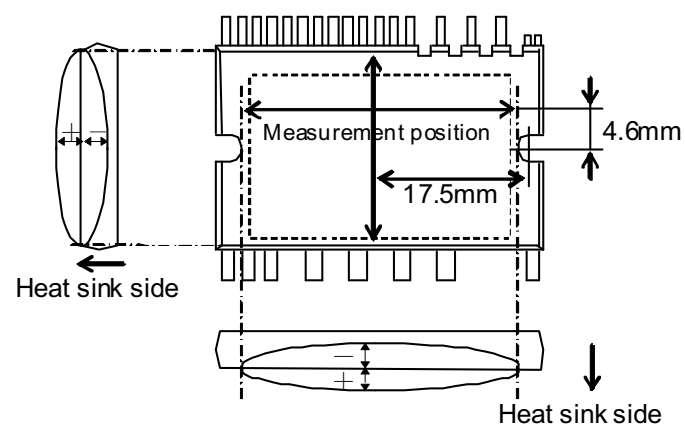


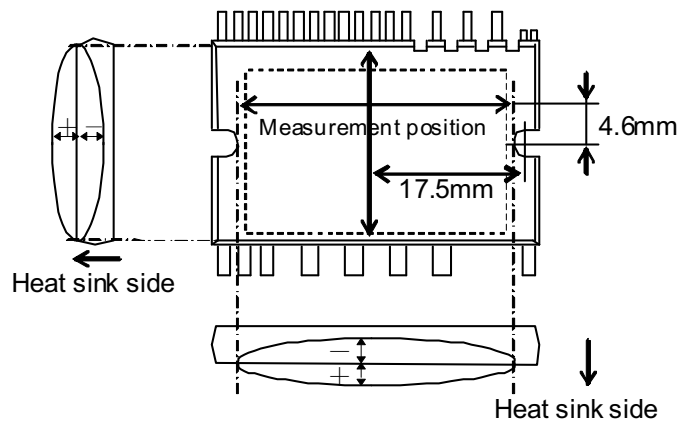
Di V_F-I_F curve for bootstrap Di (magnified view)

Mechanical Characteristics and Ratings

Item	Condition			Min.	Typ.	Max.	Unit
	Mounting screw: M3 (Note 8)	Recommended: 0.69N·m					
Mounting torque	Mounting screw: M3 (Note 8)	Recommended: 0.69N·m	-	0.59	-	0.78	N·m
Terminal pulling strength	Control terminal: Weight 4.9N Power terminal: Weight 9.8N		EIAJ-ED-4701	-	10	-	s
Terminal bending strength	Control terminal: Weight 2.45N Power terminal: Weight 4.9N 90deg. bend		EIAJ-ED-4701	-	2	-	times
Weight			-	-	10	-	g
Heat-sink flatness	(Note 9)		-	-50	-	+100	μ m

(Note 8) Plain washers (ISO 7089~7094) are recommended.

(Note 9) Flatness measurement position: 



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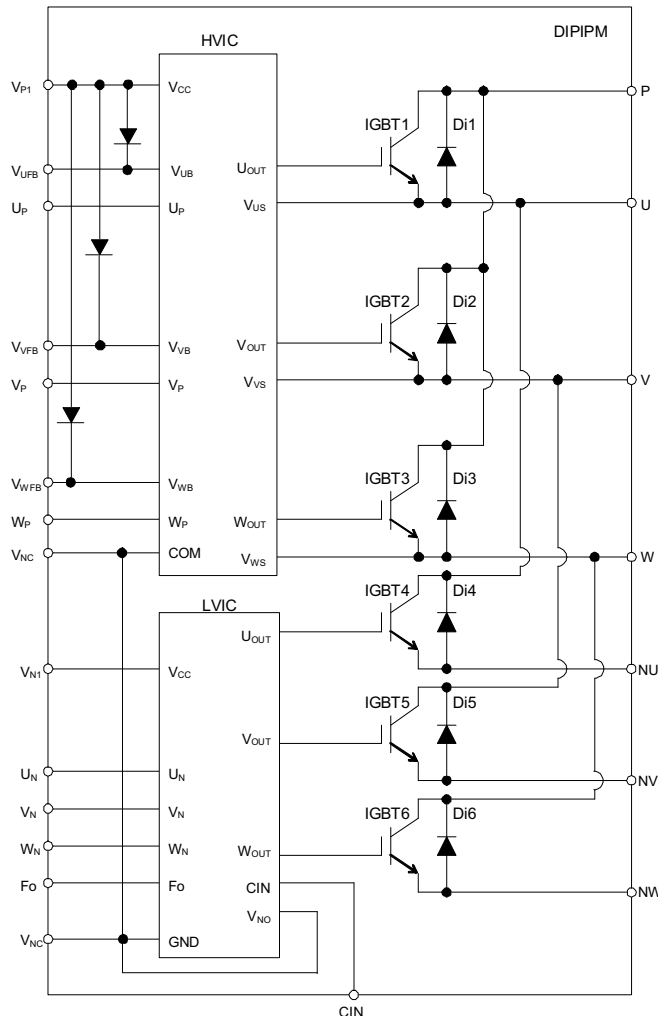
Recommended Operation Conditions

Item	Symbol	Condition	Recommended			Unit	
			Min.	Typ.	Max.		
Supply voltage	V_{CC}	Applied between P-NU, NV, NW	0	300	400	V	
Control supply voltage	V_D	Applied between V_{P1} - V_{NC} , V_{N1} - V_{NC}	13.5	15.0	16.5	V	
Control supply voltage	V_{DB}	Applied between V_{UFB-U} , V_{VFB-V} , V_{WFB-W}	13.0	15.0	18.5	V	
Control supply variation	$\Delta V_D, \Delta V_{DB}$		-1	-	1	V/ μ s	
Arm-shoot-through blocking time	t_{dead}	For each input signal, $T_c \leq 100^\circ\text{C}$	1.0	-	-	μ s	
Allowable r.m.s. current A	I_o	$V_{CC}=300\text{V}$, $V_D=V_{DB}=15\text{V}$, P.F=0.8, sinusoidal PWM, $T_j \leq 125^\circ\text{C}$, $T_c \leq 100^\circ\text{C}$ (Note10)	$f_{PWM}=5\text{kHz}$	-	-	7.5	Arms
			$f_{PWM}=15\text{kHz}$	-	-	4.5	
Allowable minimum input pulse width	$PWIN(\text{on})$	(Note 11)	0.5	-	-	μ s	
	$PWIN(\text{off})$		0.5	-	-		
V_{NC} variation	V_{NC}	Between V_{NC} - NU, NV, NW (including surge)	-5.0	-	5.0	V	
Junction temperature	T_j		-20	-	125	$^\circ\text{C}$	

(Note 10) The allowable r.m.s. current also depends on the actual application conditons.

(Note 11) DIPIPM might not make response or work properly if the input signal pulse width is less than $PWIN(\text{on})$, $PWIN(\text{off})$. And if such a short ON signal pulse is input, it might cause excessive negative surge between output (U,V,W) and GND (V_{NC}), or fluctuation of control supply voltage 15V. It is recommend that the total parastic inductance of shunt resistor and wiring between N terminal (N-side IGBT emitter) - GND(V_{NC}) is 10nH or less and the ceramic capacitors with good temperature, frequency and DC bias characteristics are located nearby the control supply terminals (between V_{N1} , V_{P1} and V_{NC}).

Fig.2 DIPIPM Internal Circuit:



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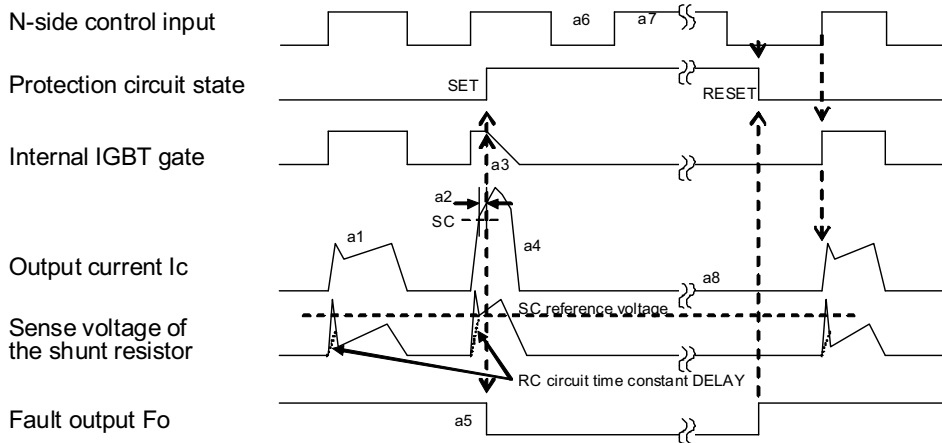
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Fig.3 Timing Chart of the DIIPM Protective Functions

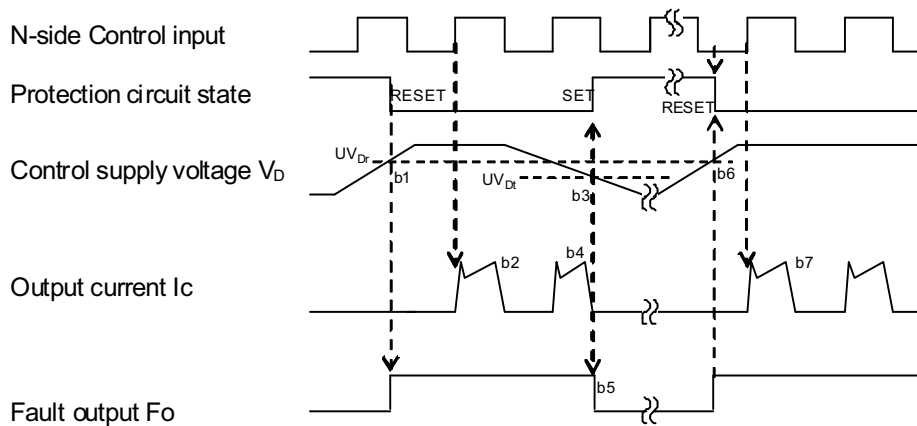
[A] Short-Circuit Protection (N-side only with the external shunt resistor and RC filter)

- a1. Normal operation: IGBT ON and carrying current.
- a2. Short circuit detection (SC trigger).
- a3. All N-side IGBT gate hard interruption.
- a4. All N-side IGBTs turn OFF.
- a5. Fo outputs with a fixed pulse width of ($t_{FO(min)}=20\mu s$).
- a6. Input = "L". IGBT OFF.
- a7. Input = "H".
- a8. IGBT OFF in spite of "H" input.



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

- b1. Control supply voltage rising: After the voltage level reaches UV_{Dr} , the circuits start to operate when next input is applied.
- b2. Normal operation : IGBT ON and carrying current.
- b3. Under voltage trip (UV_{Dt}).
- b4. All N-side IGBTs OFF in spite of control input condition.
- b5. Fo outputs ($t_{FO} \geq 20\mu s$ and Fo outputs continuously during under voltage UV period., however, the minimum pulse width is $20\mu s$.)
- b6. Under voltage reset (UV_{Dr}).
- b7. Normal operation : IGBT ON and carrying current.



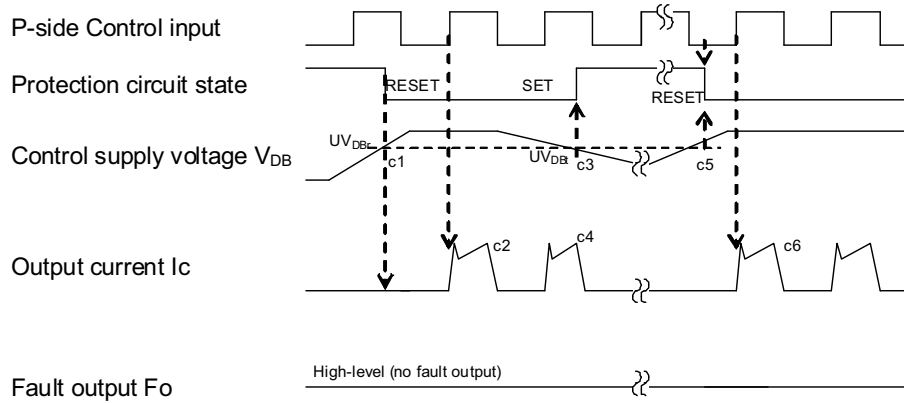
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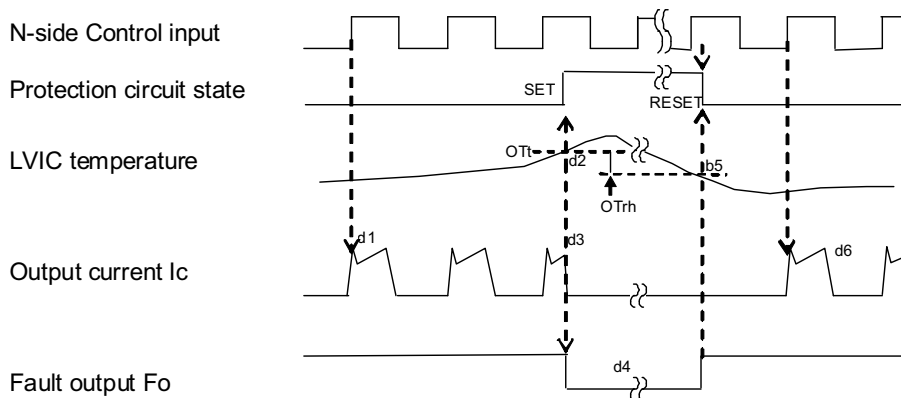
[C] Under Voltage Protection (P-side, UV_{DB})

- c1. Control supply voltage rises: After the voltage reaches UV_{DBr} , the circuits start to operate when next input is applied.
- c2. Normal operation : IGBT ON and carrying current.
- c3. Under voltage trip (UV_{DBt}).
- c4. P-side IGBT turns OFF in spite of control input signal level, but there is no Fo signal outputs.
- c5. Under voltage reset (UV_{DBr}).
- c6. Normal operation : IGBT ON and carrying current.



[D] Over Temperature Protection (N-side, OT)

- d1. Normal operation: IGBT ON and carrying 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. F_o outputs during over temperature period, however, the minimum pulse width is $20\mu s$.
- d5. LVIC temperature becomes under over temperature reset level.
- d6. Circuits start to operate normally when next input is applied.

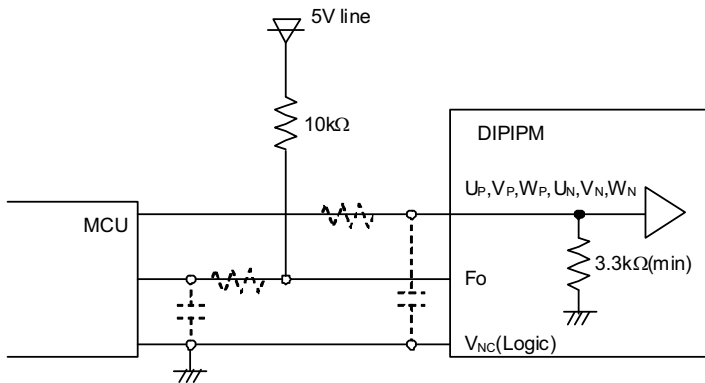


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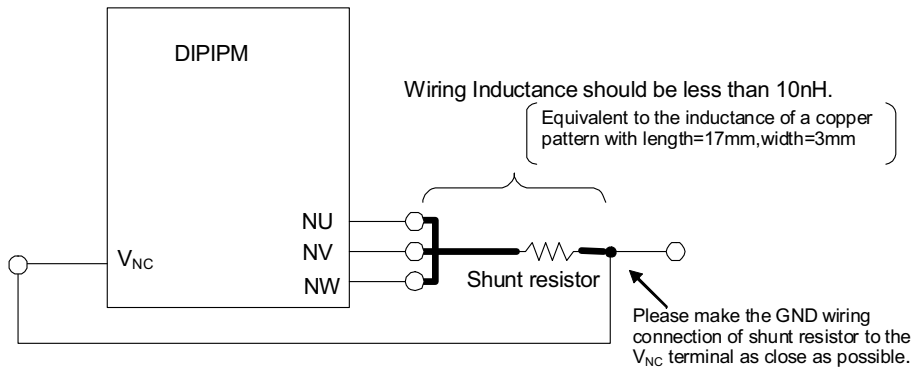
Fig.4 A Instance of Interface Circuit



Note:

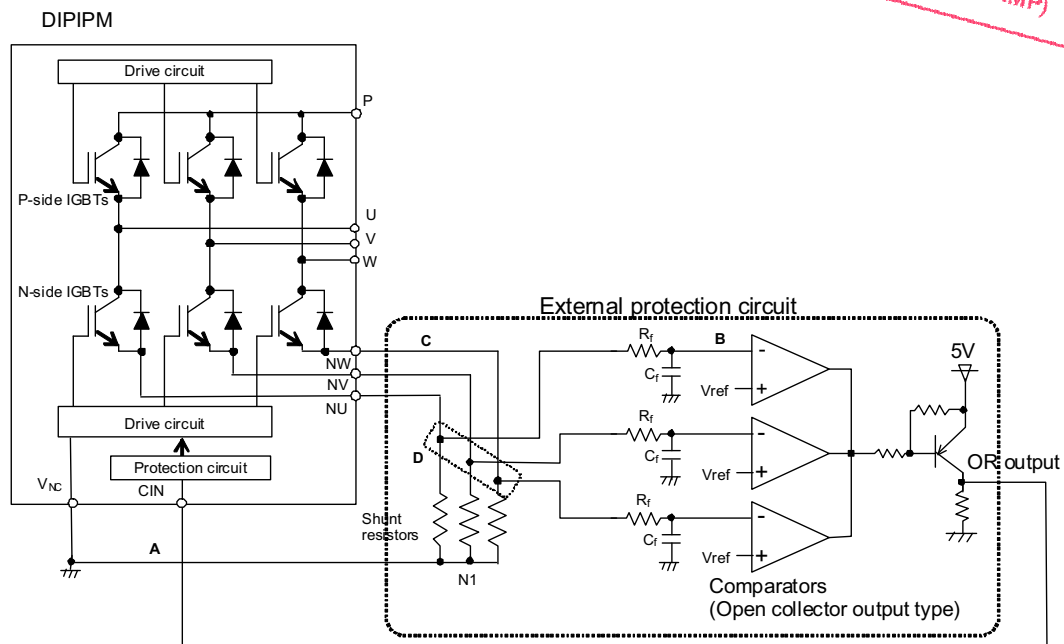
1. The setting of RC coupling at each input (parts shown dotted) depends on the PWM control scheme and the wiring impedance of the printed circuit board.
2. The DIPIPM input section integrates a 3.3kΩ(min) pull-down resistor. Therefore, when using an external filtering resistor, pay attention to the turn-on threshold voltage.

Fig.5 Pattern Wiring Around the Shunt Resistor



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PS219A4-ASTXTransfer-Mold Type
Insulated Type**Fig.7 External SC Protection Circuit with Using Three Shunt Resistors****Note:**

- (1) It is necessary to set the time constant $R_f C_f$ of external comparator input so that IGBT stop within $2\mu s$ when short circuit occurs. SC interrupting time might vary with the wiring pattern, comparator speed and so on.
- (2) The threshold voltage V_{ref} should be set up the same rating of short circuit trip level ($V_{sc(ref)}$ typ. 0.48V).
- (3) Select the external shunt resistance so that SC trip-level is less than specified value.
- (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 near the terminal of shunt resistor.
- (6) OR output high level should be over 0.53V (=maximum $V_{sc(ref)}$).

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