

PS21965-4/-4A/-4C/-4W

TRANSFER-MOLD TYPE
INSULATED TYPE

PS21965-4



INTEGRATED POWER FUNCTIONS

600V/20A low-loss CSTBT™ inverter bridge for three phase DC-to-AC power conversion

INTEGRATED DRIVE, PROTECTION AND SYSTEM CONTROL FUNCTIONS

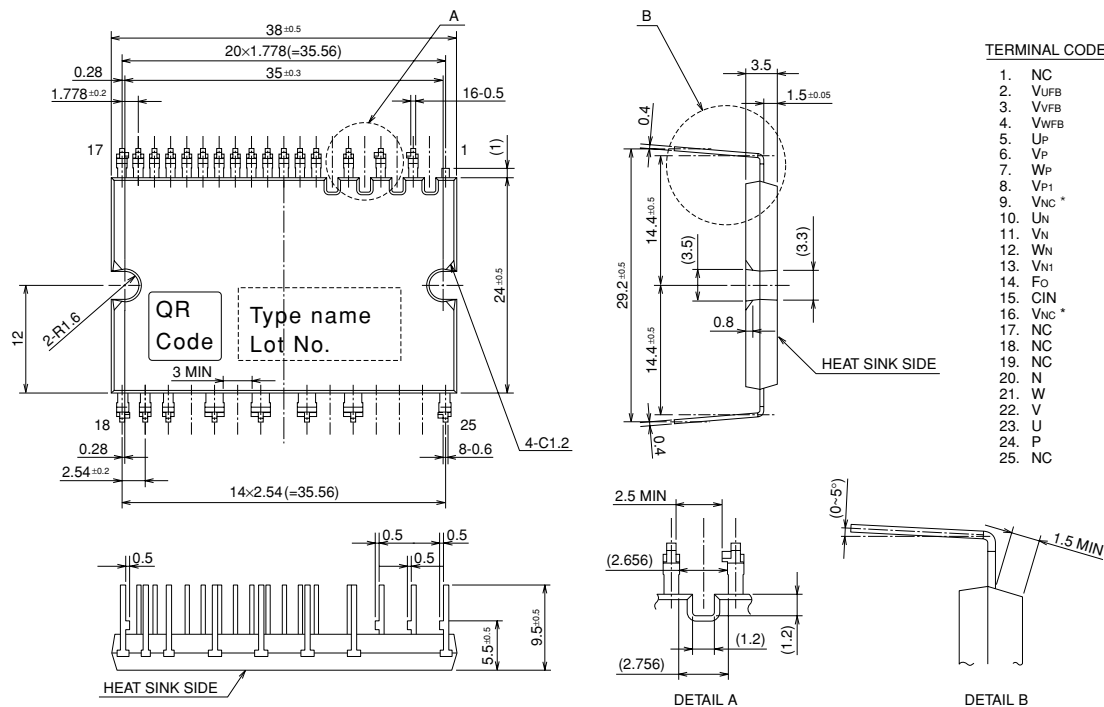
- For upper-leg IGBTs : Drive circuit, High voltage high-speed level shifting, Control supply under-voltage (UV) protection.
- For lower-leg IGBTs : Drive circuit, Control supply under-voltage protection (UV), Short circuit protection (SC).
- Fault signaling : Corresponding to an SC fault (Lower-leg IGBT) or a UV fault (Lower-side supply).
- Input interface : 3V, 5V line (High Active).
- UL Approved : Yellow Card No. E80276

APPLICATION

AC100V~200V three-phase inverter drive for small power motor control.

Fig. 1 PACKAGE OUTLINES (PS21965-4)

Dimensions in mm



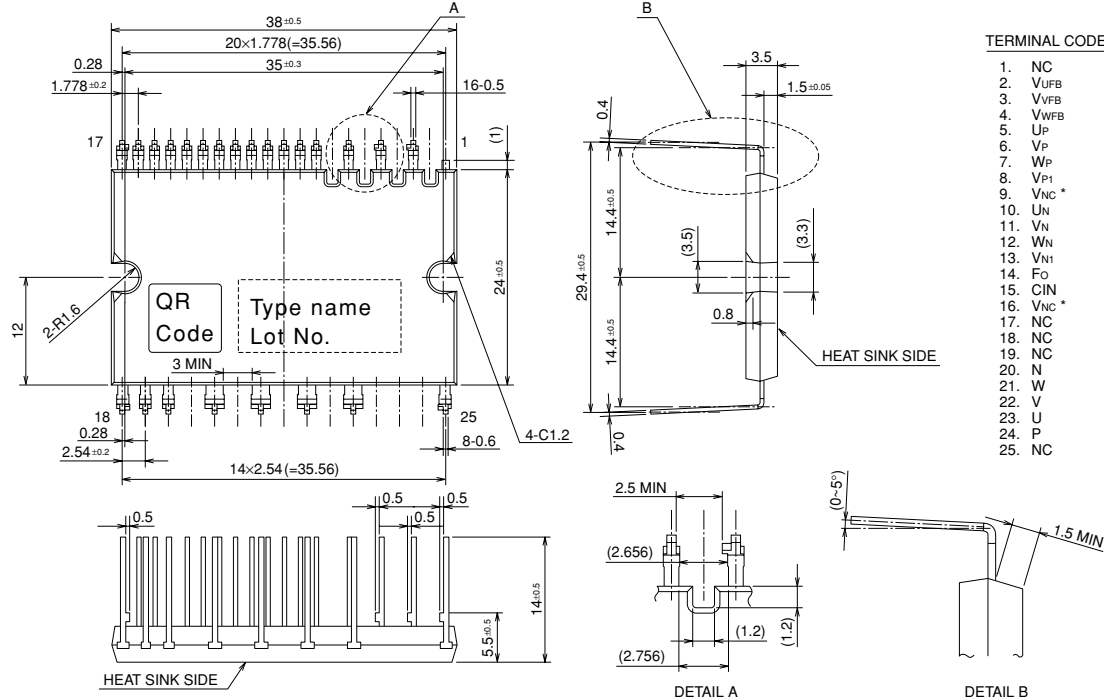
*) Two VNC terminals (9 & 16 pin) are connected inside DIP-IPM, please connect either one to the 15V power supply GND outside and leave another one open.

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Fig. 2 LONG TERMINAL TYPE PACKAGE OUTLINES (PS21965-4A)

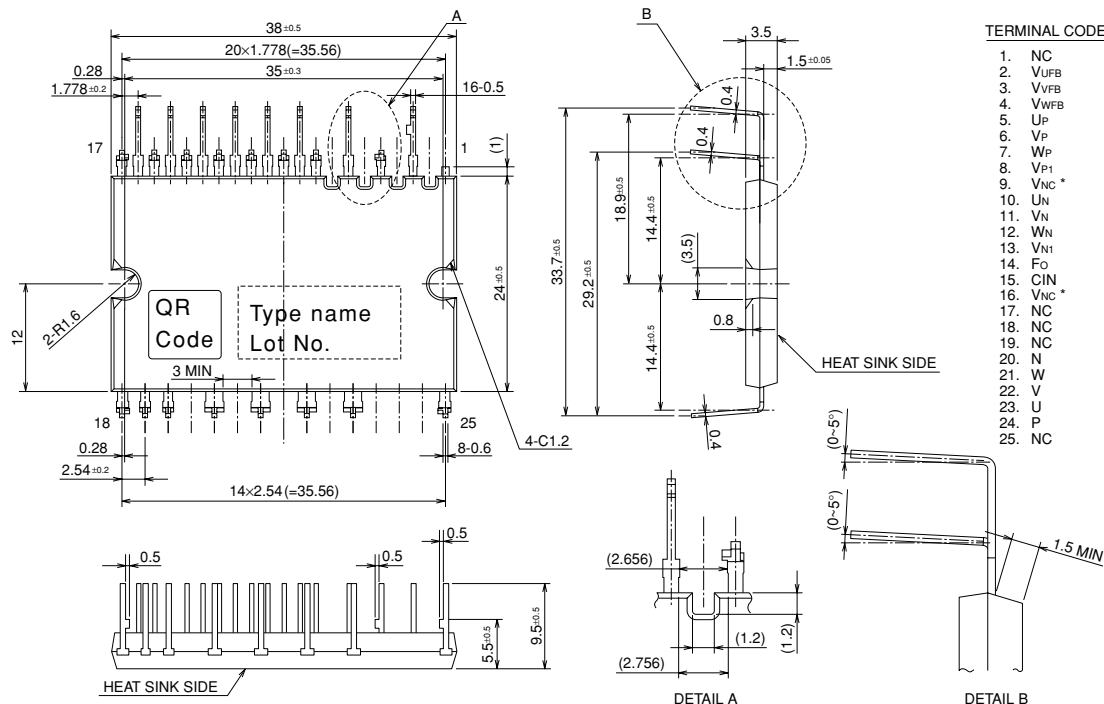
Dimensions in mm



*) Two VNC terminals (9 & 16 pin) are connected inside DIP-IPM, please connect either one to the 15V power supply GND outside and leave another one open.

Fig. 3 ZIGZAG TERMINAL TYPE PACKAGE OUTLINES (PS21965-4C)

Dimensions in mm



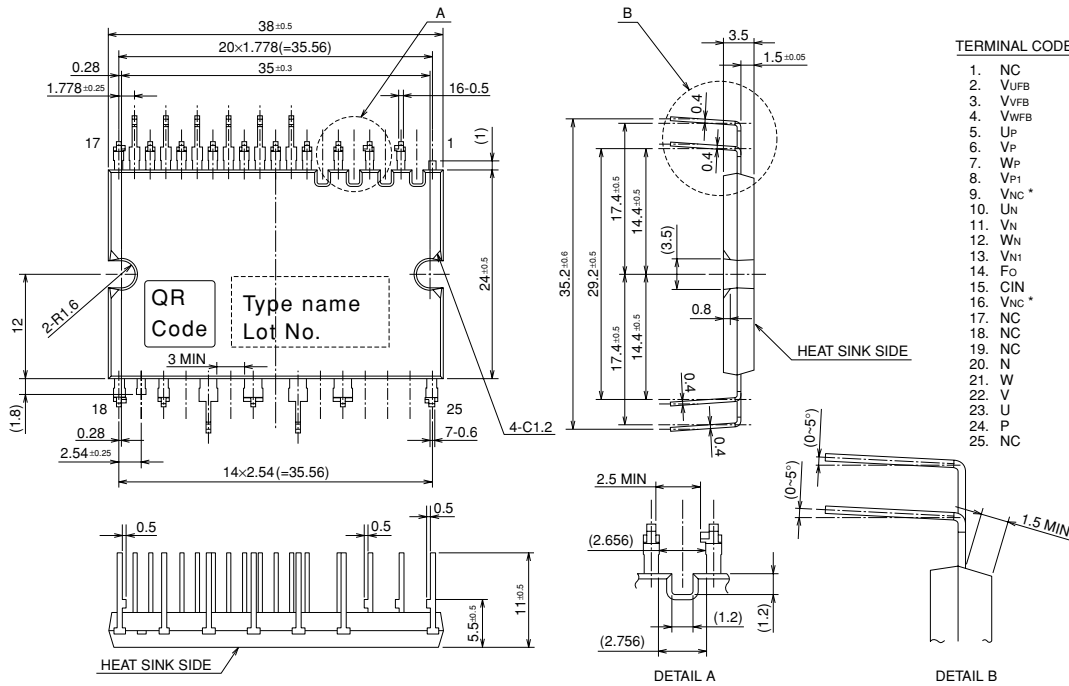
*) Two VNC terminals (9 & 16 pin) are connected inside DIP-IPM, please connect either one to the 15V power supply GND outside and leave another one open.

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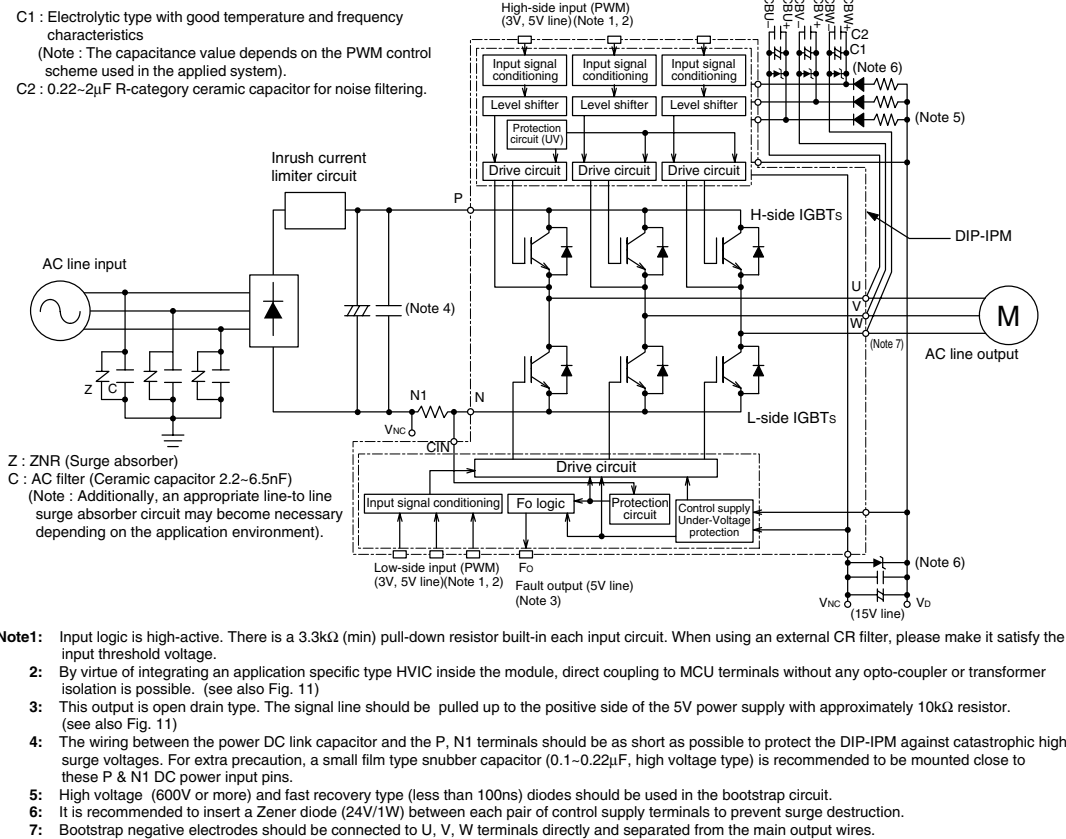
Fig. 4 BOTH SIDES ZIGZAG TERMINAL TYPE PACKAGE OUTLINES (PS21965-4W)

Dimensions in mm



*) Two V_{NC} terminals (9 & 16 pin) are connected inside DIP-IPM, please connect either one to the 15V power supply GND outside and leave another one open.

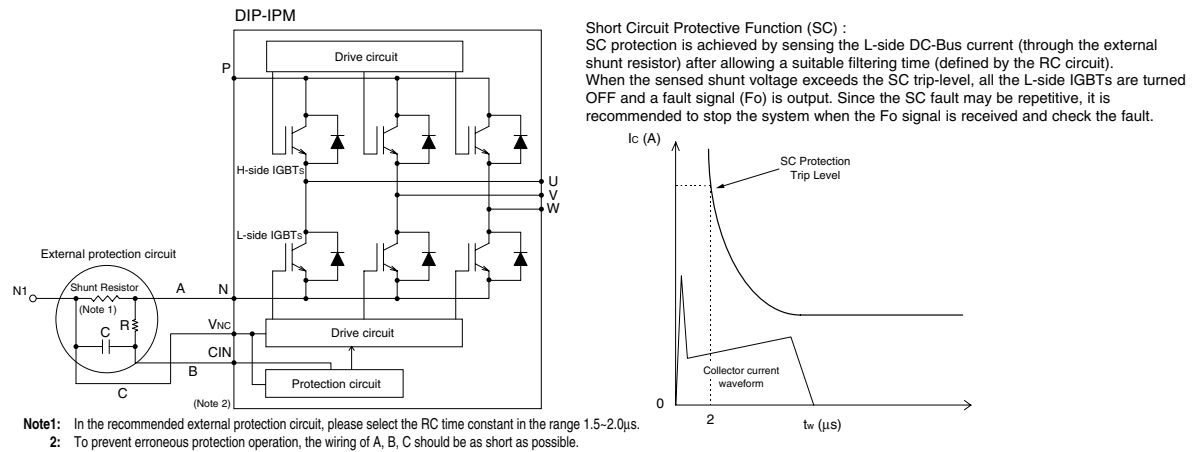
Fig. 5 INTERNAL FUNCTIONS BLOCK DIAGRAM (TYPICAL APPLICATION EXAMPLE)



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Fig. 6 EXTERNAL PART OF THE DIP-IPM PROTECTION CIRCUIT



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

INVERTER PART

Symbol	Parameter	Condition	Ratings	Unit
VCC	Supply voltage	Applied between P-N	450	V
VCC(surge)	Supply voltage (surge)	Applied between P-N	500	V
VCEs	Collector-emitter voltage		600	V
±Ic	Each IGBT collector current	Tc = 25°C	20	A
±ICP	Each IGBT collector current (peak)	Tc = 25°C, less than 1ms	40	A
Pc	Collector dissipation	Tc = 25°C, per 1 chip	35.7	W
Tj	Junction temperature	(Note 1)	-20~+125	°C

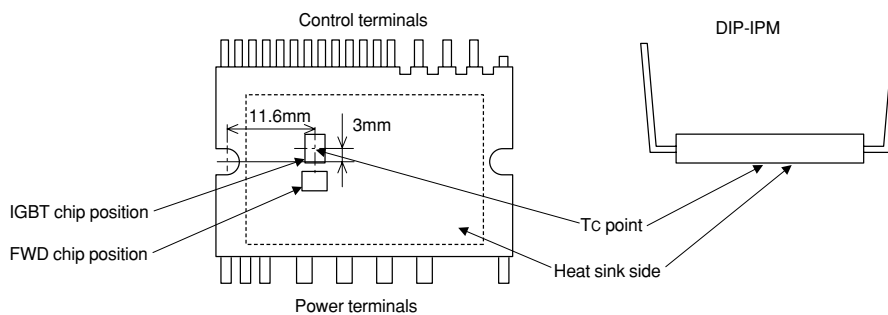
Note 1: The maximum junction temperature rating of the power chips integrated within the DIP-IPM is 150°C (@ Tc ≤ 100°C). However, to ensure safe operation of the DIP-IPM, the average junction temperature should be limited to Tj(ave) ≤ 125°C (@ Tc ≤ 100°C).

CONTROL (PROTECTION) PART

Symbol	Parameter	Condition	Ratings	Unit
VD	Control supply voltage	Applied between VP1-VNC, VN1-VNC	20	V
VDB	Control supply voltage	Applied between VUFB-U, VVFB-V, VWFB-W	20	V
VIN	Input voltage	Applied between UP, VP, WP, UN, VN, WN-VNC	-0.5~VD+0.5	V
VFO	Fault output supply voltage	Applied between Fo-VNC	-0.5~VD+0.5	V
Ifo	Fault output current	Sink current at Fo terminal	1	mA
VSC	Current sensing input voltage	Applied between CIN-VNC	-0.5~VD+0.5	V

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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 _j = 125°C, non-repetitive, less than 2μs	400	V
T _C	Module case operation temperature	(Note 2)	-20~+100	°C
T _{stg}	Storage temperature		-40~+125	°C
V _{iso}	Isolation voltage	60Hz, Sinusoidal, 1 minute, Between pins and heat-sink plate	1500	V _{rms}

Note 2: T_C measurement point**THERMAL RESISTANCE**

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
R _{th(j-c)Q}	Junction to case thermal resistance (Note 3)	Inverter IGBT part (per 1/6 module)	—	—	2.8	°C/W
R _{th(j-c)F}		Inverter FWD part (per 1/6 module)	—	—	3.9	°C/W

Note 3: Grease with good thermal conductivity should be applied evenly with about +100μm~+200μm on the contacting surface of DIP-IPM and heat-sink.

The contacting thermal resistance between DIP-IPM 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/m·K.

ELECTRICAL CHARACTERISTICS (T_j = 25°C, unless otherwise noted)**INVERTER PART**

Symbol	Parameter	Condition		Limits			Unit
				Min.	Typ.	Max.	
V _{CE(sat)}	Collector-emitter saturation voltage	V _D = V _{DB} = 15V	I _C = 20A, T _j = 25°C	—	1.70	2.20	V
		V _{IN} = 5V	I _C = 20A, T _j = 125°C	—	1.80	2.30	
V _{EC}	FWD forward voltage	T _j = 25°C, -I _C = 20A, V _{IN} = 0V		—	1.90	2.40	V
t _{on}	Switching times	V _{CC} = 300V, V _D = V _{DB} = 15V		0.70	1.30	1.90	μs
t _{rr}		I _C = 20A, T _j = 125°C, V _{IN} = 0 ↔ 5V		—	0.30	—	μs
t _{c(on)}		Inductive load (upper-lower arm)		—	0.50	0.75	μs
t _{off}				—	1.60	2.20	μs
t _{c(off)}				—	0.40	0.75	μs
I _{CES}	Collector-emitter cut-off current	V _{CE} = V _{CES}	T _j = 25°C	—	—	1	mA
			T _j = 125°C	—	—	10	

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CONTROL (PROTECTION) PART

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
I _D	Circuit current	V _D = V _{DB} = 15V V _{IN} = 5V	Total of V _{P1} -V _{N1} , V _{N1} -V _{N2}		2.80	mA
			V _{UFB} -U, V _{VFB} -V, V _{WFB} -W		0.55	mA
		V _D = V _{DB} = 15V V _{IN} = 0V	Total of V _{P1} -V _{N1} , V _{N1} -V _{N2}		2.80	mA
			V _{UFB} -U, V _{VFB} -V, V _{WFB} -W		0.55	mA
V _{FOH}	Fault output voltage	V _{SC} = 0V, F _O terminal pull-up to 5V by 10kΩ	4.9	—	—	V
V _{FOL}		V _{SC} = 1V, I _{FO} = 1mA	—	—	0.95	V
V _{SC(ref)}	Short circuit trip level	T _j = 25°C, V _D = 15V (Note 4)	0.43	0.48	0.53	V
I _{IN}	Input current	V _{IN} = 5V	0.70	1.00	1.50	mA
UV _{DBt}	Control supply under-voltage protection	T _j ≤ 125°C	Trip level		10.0	V
UV _{DBr}			Reset level		10.5	V
UV _{Dt}			Trip level		10.3	V
UV _{Dr}			Reset level		10.8	V
t _{FO}	Fault output pulse width	(Note 5)	20	—	—	μs
V _{th(on)}	ON threshold voltage	Applied between U _P , V _P , W _P , U _N , V _N , W _N -V _{N2}	—	2.1	2.6	V
V _{th(off)}	OFF threshold voltage		0.8	1.3	—	V
V _{th(hys)}	ON/OFF threshold hysteresis voltage		0.35	0.65	—	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.

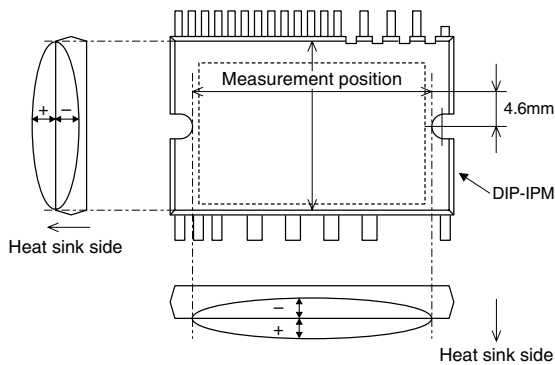
5 : Fault signal is asserted corresponding to a short circuit or lower side control supply under-voltage failure.

MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Condition	Limits			Unit
		Min.	Typ.	Max.	
Mounting torque	Mounting screw : M3 (Note 6) Recommended : 0.69 N·m	0.59	—	0.78	N·m
Weight		—	10	—	g
Heat-sink flatness	(Note 7)	-50	—	100	μm

Note 6 : Plain washers (ISO 7089~7094) are recommended.

Note 7 : Flatness measurement position



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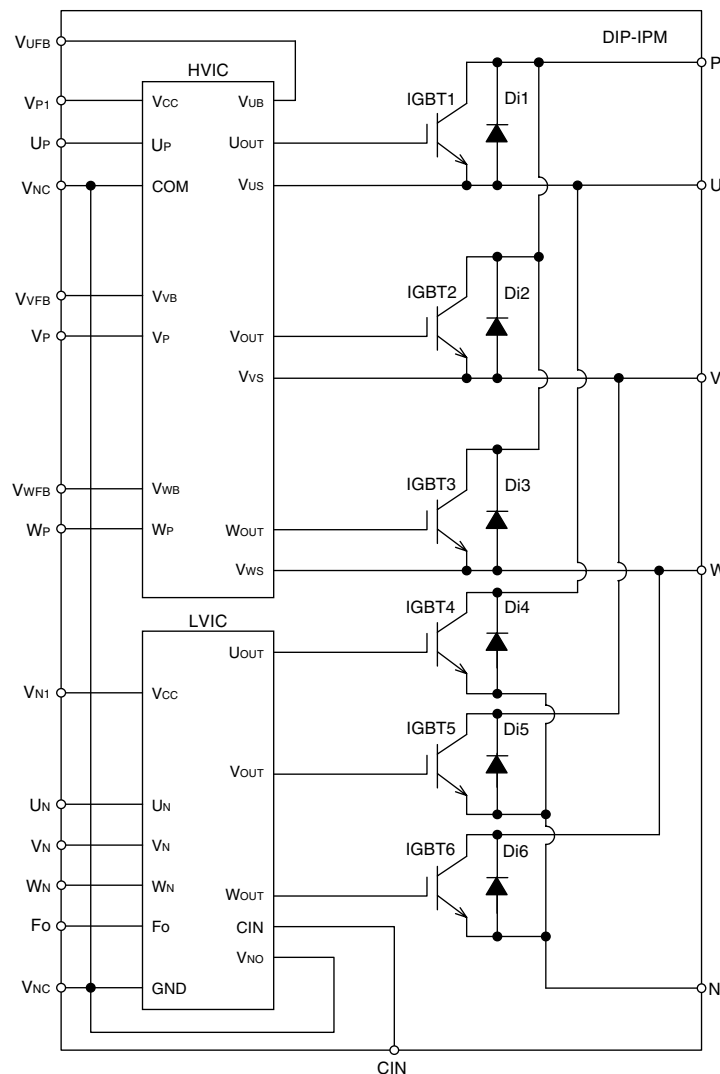
RECOMMENDED OPERATION CONDITIONS

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
V _{CC}	Supply voltage	Applied between P-N	0	300	400	V
V _D	Control supply voltage	Applied between V _{P1} -V _{NC} , V _{N1} -V _{NC}	13.5	15.0	16.5	V
V _{DB}	Control supply voltage	Applied between V _{UFB} -U, V _{VFB} -V, V _{WFB} -W	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, T _c ≤ 100°C	1.5	—	—	μs
f _{PWM}	PWM input frequency	T _c ≤ 100°C, T _j ≤ 125°C	—	—	20	kHz
I _O	Allowable r.m.s. current	V _{CC} = 300V, V _D = V _{DB} = 15V, P.F = 0.8, sinusoidal PWM, T _j ≤ 125°C, T _c ≤ 100°C (Note 8)	—	—	10.0	Arms
		f _{PWM} = 5kHz f _{PWM} = 15kHz	—	—	6.0	
PWIN(on)	Allowable minimum input pulse width	(Note 9)	0.5	—	—	μs
PWIN(off)			0.5	—	—	
V _{NC}	V _{NC} variation	Between V _{NC} -N (including surge)	-5.0	—	5.0	V

Note 8 : The allowable r.m.s. current value depends on the actual application conditions.

9 : IPM might not make response if the input signal pulse width is less than the recommended minimum value.

Fig. 7 THE DIP-IPM INTERNAL CIRCUIT



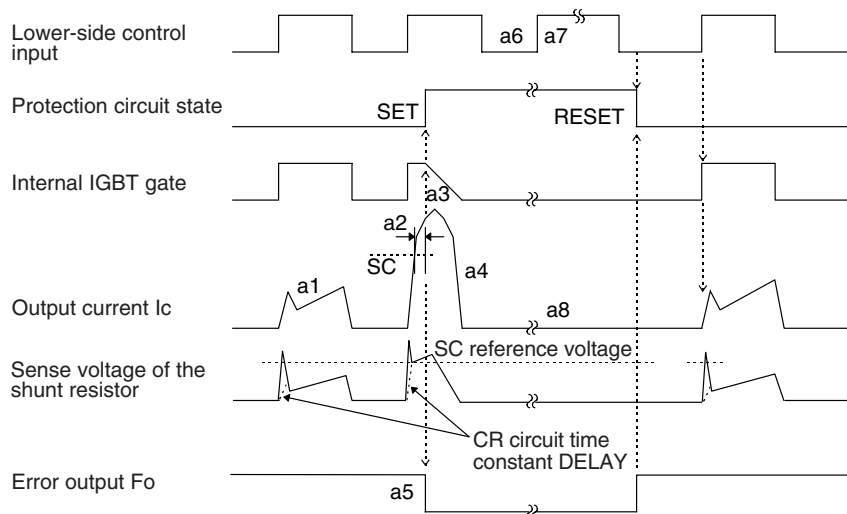
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Fig. 8 TIMING CHART OF THE DIP-IPM PROTECTIVE FUNCTIONS

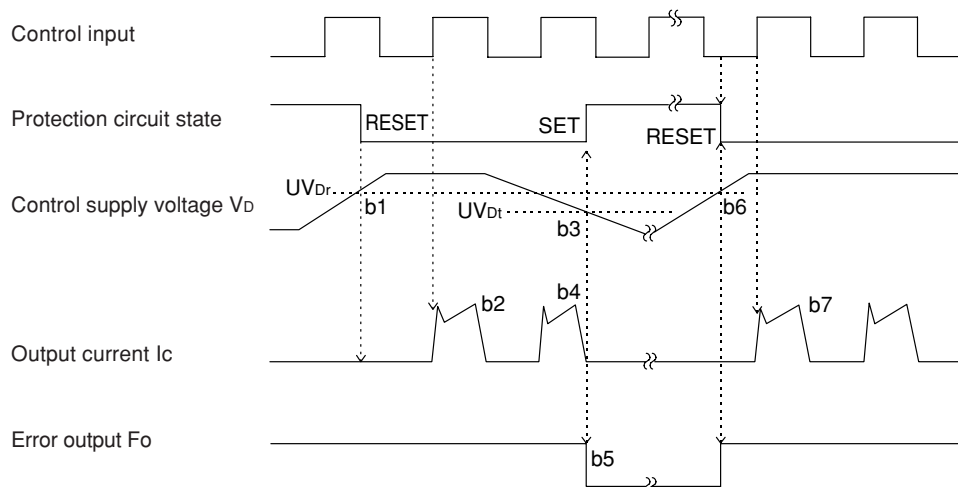
[A] Short-Circuit Protection (Lower-side only with the external shunt resistor and CR filter)

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



[B] Under-Voltage Protection (Lower-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. IGBT OFF in spite of control input condition.
- b5. Fo outputs ($t_{FO} \geq 20\mu s$ and Fo outputs continuously during UV period).
- b6. Under voltage reset (UV_{Dr}).
- b7. Normal operation : IGBT ON and carrying current.



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

- c1. Control supply voltage rising : After the voltage level 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. IGBT 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.

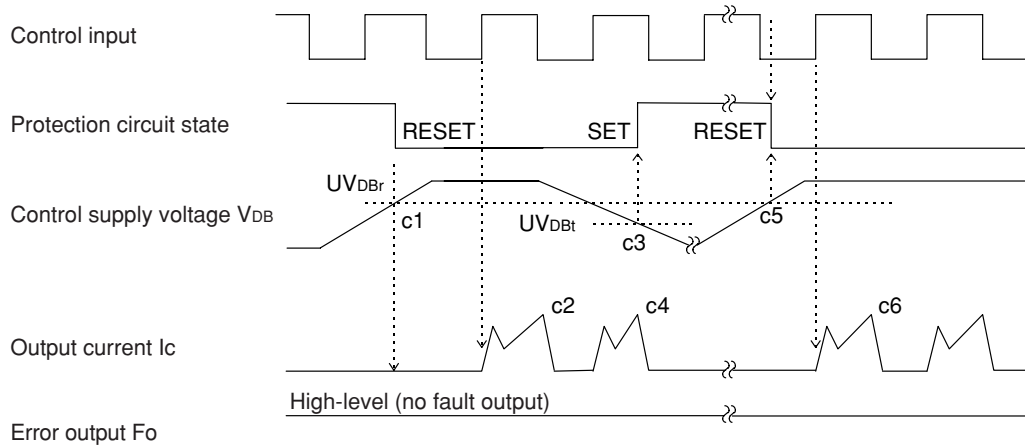
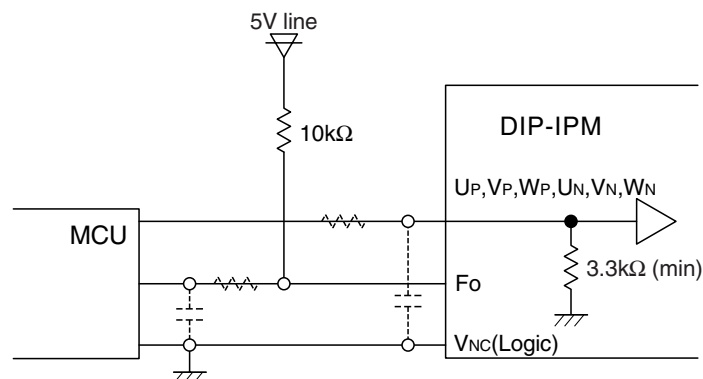


Fig. 9 RECOMMENDED MCU I/O INTERFACE CIRCUIT



Note : 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.
The DIP-IPM 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. 10 WIRING CONNECTION OF SHUNT RESISTOR

