

# PS21963-4S

TRANSFER-MOLD TYPE  
INSULATED TYPE

## PS21963-4S



### INTEGRATED POWER FUNCTIONS

600V/10A low-loss 5<sup>th</sup> generation IGBT inverter bridge for three phase DC-to-AC power conversion.  
Open emitter type.

### INTEGRATED DRIVE, PROTECTION AND SYSTEM CONTROL FUNCTIONS

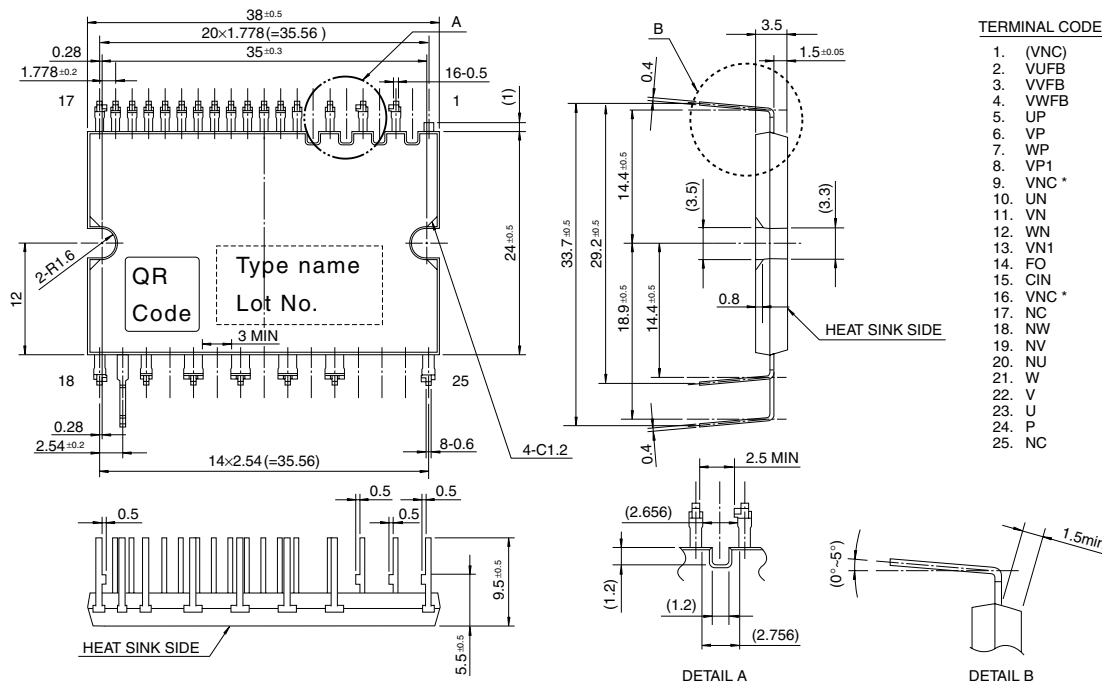
- For upper-leg IGBTs : Drive circuit, High voltage high-speed level shifting, Control supply under-voltage (UV) protection.
- For lower-leg IGBTs : Drive circuit, Control supply under-voltage protection (UV), Short circuit protection (SC).
- Fault signaling : Corresponding to an SC fault (Lower-leg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

## APPLICATION

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

Fig. 1 PACKAGE OUTLINES

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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**MAXIMUM RATINGS** ( $T_j = 25^\circ\text{C}$ , unless otherwise noted)

## INVERTER PART

Symbol	Parameter	Condition	Ratings	Unit
V <sub>CC</sub>	Supply voltage	Applied between P-NU, NV, NW	450	V
V <sub>CC(surge)</sub>	Supply voltage (surge)	Applied between P-NU, NV, NW	500	V
V <sub>CES</sub>	Collector-emitter voltage		600	V
±I <sub>C</sub>	Each IGBT collector current	T <sub>c</sub> = 25°C	10	A
±I <sub>CP</sub>	Each IGBT collector current (peak)	T <sub>c</sub> = 25°C, less than 1ms	20	A
P <sub>C</sub>	Collector dissipation	T <sub>c</sub> = 25°C, per 1 chip	27.0	W
T <sub>j</sub>	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 (@ T<sub>c</sub> ≤ 100°C). However, to ensure safe operation of the DIP-IPM, the average junction temperature should be limited to T<sub>j(ave)</sub> ≤ 125°C (@ T<sub>c</sub> ≤ 100°C).

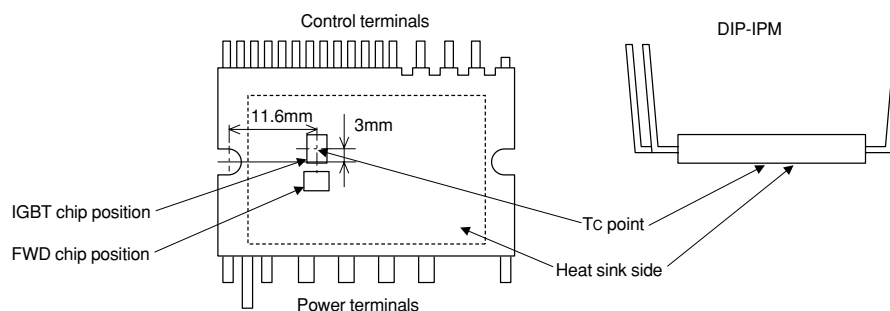
## CONTROL (PROTECTION) PART

Symbol	Parameter	Condition	Ratings	Unit
V <sub>D</sub>	Control supply voltage	Applied between VP1-VNC, VN1-VNC	20	V
V <sub>DB</sub>	Control supply voltage	Applied between VUFB-U, VVFB-V, VWFB-W	20	V
V <sub>IN</sub>	Input voltage	Applied between UP, VP, WP, UN, VN, WN-VNC	-0.5~V <sub>D</sub> +0.5	V
V <sub>FO</sub>	Fault output supply voltage	Applied between Fo-VNC	-0.5~V <sub>D</sub> +0.5	V
I <sub>FO</sub>	Fault output current	Sink current at Fo terminal	1	mA
V <sub>SC</sub>	Current sensing input voltage	Applied between CIN-VNC	-0.5~V <sub>D</sub> +0.5	V

## TOTAL SYSTEM

Symbol	Parameter	Condition	Ratings	Unit
V <sub>CC(prot)</sub>	Self protection supply voltage limit (short circuit protection capability)	V <sub>D</sub> = 13.5~16.5V, Inverter part T <sub>j</sub> = 125°C, non-repetitive, less than 2μs	400	V
T <sub>C</sub>	Module case operation temperature	(Note 2)	-20~+100	°C
T <sub>stg</sub>	Storage temperature		-40~+125	°C
V <sub>iso</sub>	Isolation voltage	60Hz, Sinusoidal, 1 minute, Between pins and heat-sink plate	1500	V <sub>rms</sub>

**Note 2:** T<sub>C</sub> measurement point



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## 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)	—	—	3.7	°C/W
$R_{th(j-c)F}$		Inverter FWD part (per 1/6 module)	—	—	4.5	°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 ( $T_j = 25^\circ\text{C}$ , unless otherwise noted)

### INVERTER PART

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_D = V_{DB} = 15\text{V}$ $V_{IN} = 5\text{V}$	—	1.70	2.20	V
		$I_C = 10\text{A}, T_j = 25^\circ\text{C}$ $I_C = 10\text{A}, T_j = 125^\circ\text{C}$	—	1.80	2.30	
$V_{EC}$	FWD forward voltage	$T_j = 25^\circ\text{C}, -I_C = 10\text{A}, V_{IN} = 0\text{V}$	—	1.70	2.20	V
$t_{on}$	Switching times	$V_{CC} = 300\text{V}, V_D = V_{DB} = 15\text{V}$ $I_C = 10\text{A}, T_j = 125^\circ\text{C}, V_{IN} = 0 \leftrightarrow 5\text{V}$ Inductive load (upper-lower arm)	0.60	1.10	1.70	μs
$t_{rr}$			—	0.30	—	μs
$t_{c(on)}$			—	0.40	0.60	μs
$t_{off}$			—	1.50	2.10	μs
$t_{c(off)}$			—	0.50	0.80	μs
$I_{CES}$	Collector-emitter cut-off current	$V_{CE} = V_{CES}$	—	—	1	mA
		$T_j = 125^\circ\text{C}$	—	—	10	

### CONTROL (PROTECTION) PART

Symbol	Parameter	Condition		Limits			Unit
				Min.	Typ.	Max.	
ID	Circuit current	VD = VDB = 15V	Total of VP1-VNC, VN1-VNC	—	—	2.80	mA
		VIN = 5V	VUFB-U, VVFB-V, VWFB-W	—	—	0.55	
		VD = VDB = 15V	Total of VP1-VNC, VN1-VNC	—	—	2.80	
		VIN = 0V	VUFB-U, VVFB-V, VWFB-W	—	—	0.55	
VFOH	Fault output voltage	VSC = 0V, FO terminal pull-up to 5V by 10kΩ		4.9	—	—	V
VFOL		VSC = 1V, IFO = 1mA		—	—	0.95	V
VSC(ref)	Short circuit trip level	Tj = 25°C, VD = 15V (Note 4)		0.43	0.48	0.53	V
IIN	Input current	VIN = 5V		0.70	1.00	1.50	mA
UVDBt	Control supply under-voltage protection	Tj ≤ 125°C	Trip level	10.0	—	12.0	V
UVDBr			Reset level	10.5	—	12.5	V
UVDt			Trip level	10.3	—	12.5	V
UVDr			Reset level	10.8	—	13.0	V
tFO	Fault output pulse width	(Note 5)		20	—	—	μs
Vth(on)	ON threshold voltage	Applied between UP, VP, WP, UN, VN, WN-VNC		—	2.1	2.6	V
Vth(off)	OFF threshold voltage			0.8	1.3	—	V
Vth(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.

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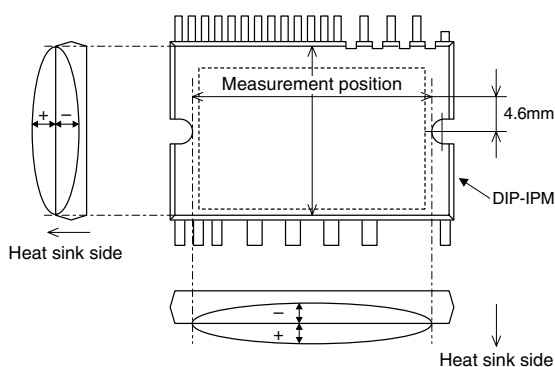
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## MECHANICAL CHARACTERISTICS AND RATINGS

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



## RECOMMENDED OPERATION CONDITIONS

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
V <sub>CC</sub>	Supply voltage	Applied between P-NU, NV, NW	0	300	400	V
V <sub>D</sub>	Control supply voltage	Applied between VP1-VNC, VN1-VNC	13.5	15.0	16.5	V
V <sub>DB</sub>	Control supply voltage	Applied between VUFB-U, VVFB-V, VWFB-W	13.0	15.0	18.5	V
ΔV <sub>D</sub> , ΔV <sub>DB</sub>	Control supply variation		−1	—	1	V/μs
t <sub>dead</sub>	Arm shoot-through blocking time	For each input signal, T <sub>C</sub> ≤ 100°C	1.5	—	—	μs
f <sub>PWM</sub>	PWM input frequency	T <sub>C</sub> ≤ 100°C, T <sub>J</sub> ≤ 125°C	—	—	20	kHz
I <sub>O</sub>	Allowable r.m.s. current	V <sub>CC</sub> = 300V, V <sub>D</sub> = V <sub>DB</sub> = 15V, P.F = 0.8, sinusoidal PWM, T <sub>J</sub> ≤ 125°C, T <sub>C</sub> ≤ 100°C (Note 8)	f <sub>PWM</sub> = 5kHz —	—	5.0	Arms
			f <sub>PWM</sub> = 15kHz —	—	3.0	
P <sub>WIN(on)</sub>	Allowable minimum input pulse width	(Note 9)	0.5	—	—	μs
P <sub>WIN(off)</sub>			0.5	—	—	
V <sub>NC</sub>	V <sub>NC</sub> variation	Between V <sub>NC</sub> -NU, NV, NW (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.

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Fig. 2 THE DIP-IPM INTERNAL CIRCUIT

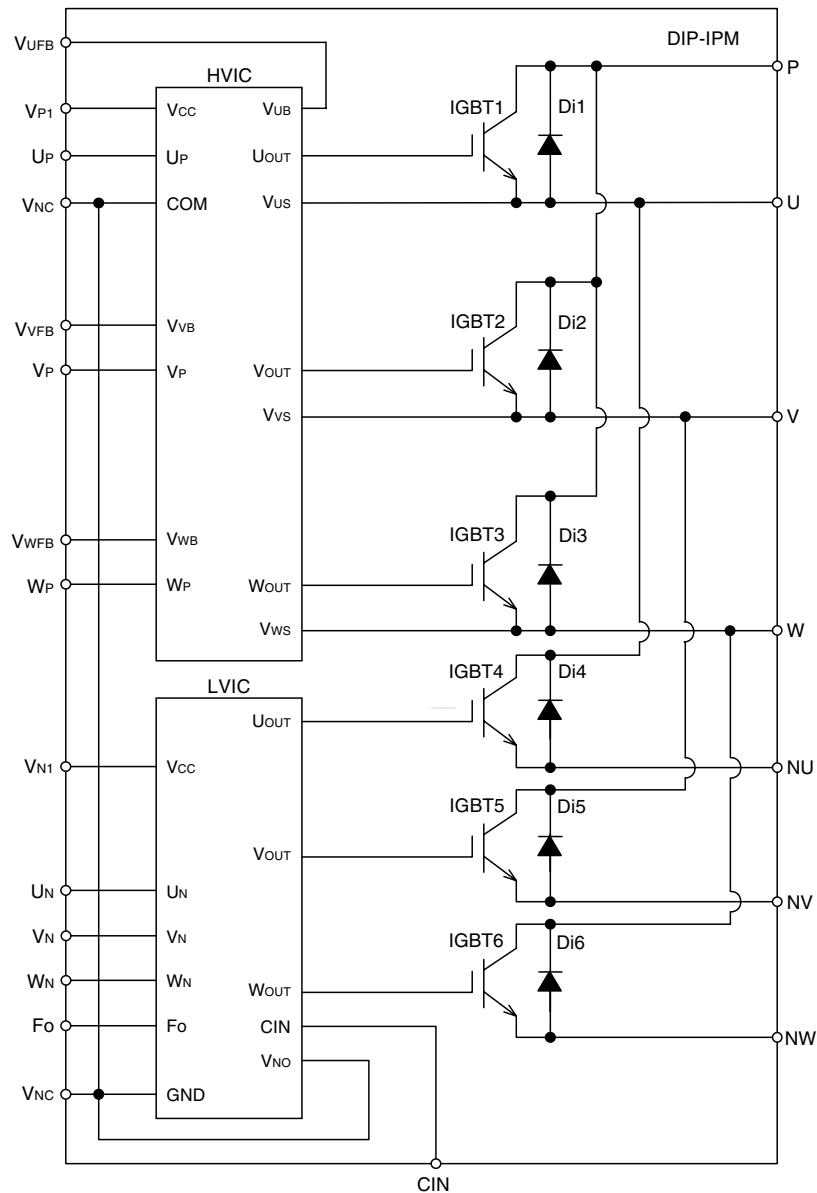
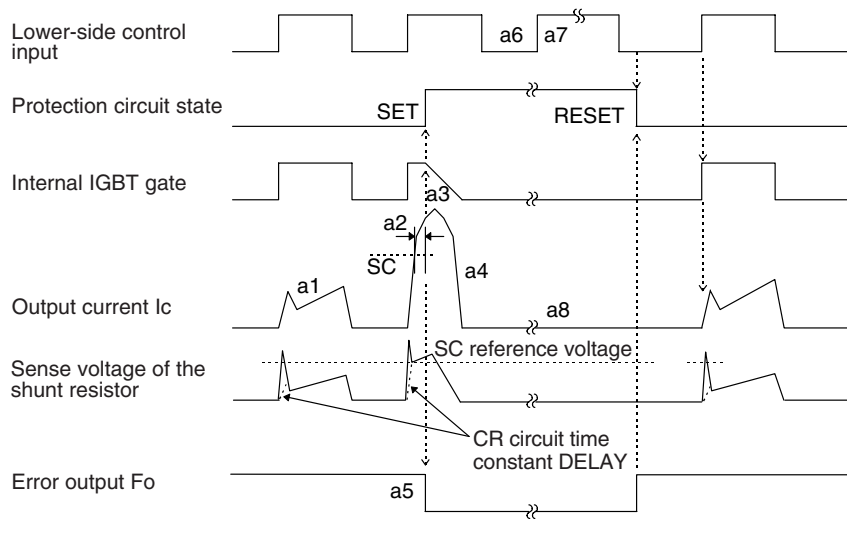


Fig. 3 TIMING CHART OF THE DIP-IPM PROTECTIVE FUNCTIONS

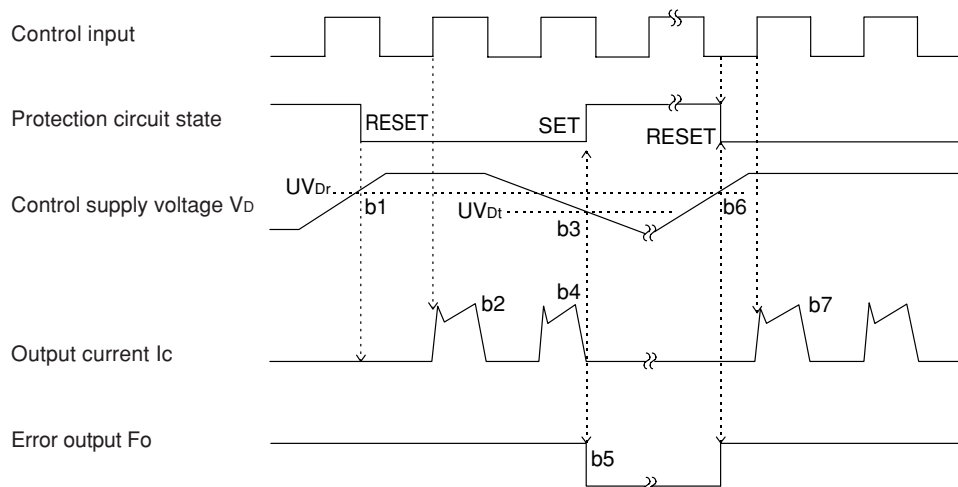
[A] Short-Circuit Protection (Lower-side only with the external shunt resistor and CR filter)

- 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<sub>D</sub>)

- b1. Control supply voltage rising : After the voltage level reaches UV<sub>Dr</sub>, the circuits start to operate when next input is applied.
- b2. Normal operation : IGBT ON and carrying current.
- b3. Under voltage trip (UV<sub>Dt</sub>).
- 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<sub>Dr</sub>).
- b7. Normal operation : IGBT ON and carrying current.



### [C] Under-Voltage Protection (Upper-side, UV<sub>DB</sub>)

- c1. Control supply voltage rising : After the voltage level reaches UV<sub>DBr</sub>, the circuits start to operate when next input is applied.
- c2. Normal operation : IGBT ON and carrying current.
- c3. Under voltage trip (UV<sub>DBt</sub>).
- c4. IGBT OFF in spite of control input signal level, but there is no Fo signal outputs.
- c5. Under voltage reset (UV<sub>DBr</sub>).
- c6. Normal operation : IGBT ON and carrying current.

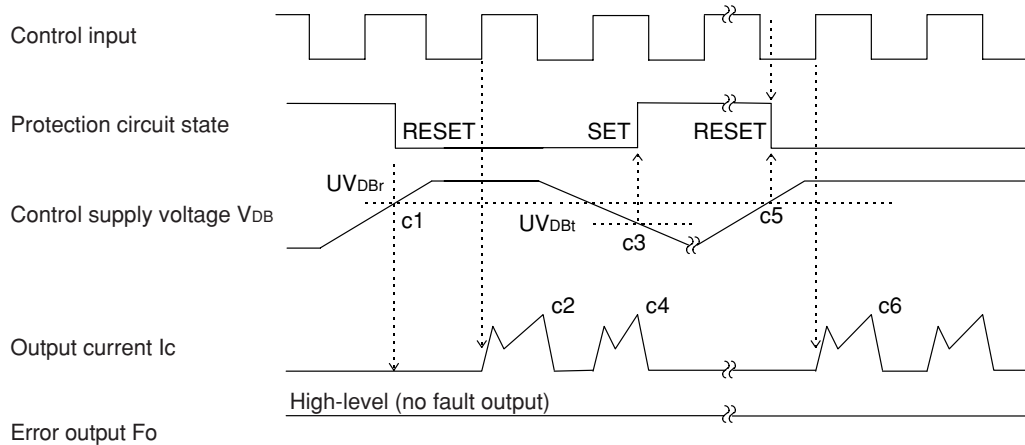
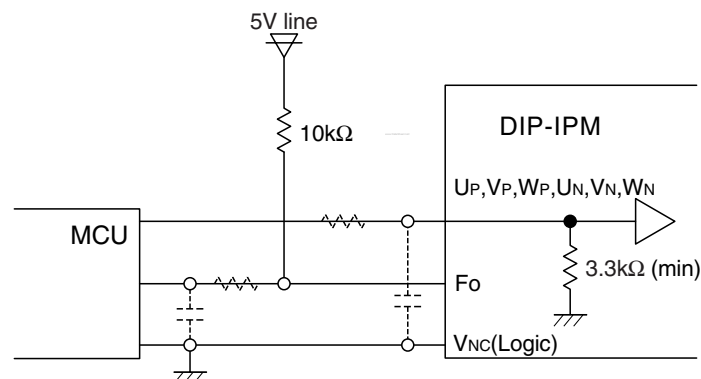


Fig. 4 RECOMMENDED MCU I/O INTERFACE CIRCUIT



**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. 5 WIRING CONNECTION OF SHUNT RESISTOR

