

Fig. 2 INTERNAL FUNCTIONS BLOCK DIAGRAM (TYPICAL APPLICATION EXAMPLE)

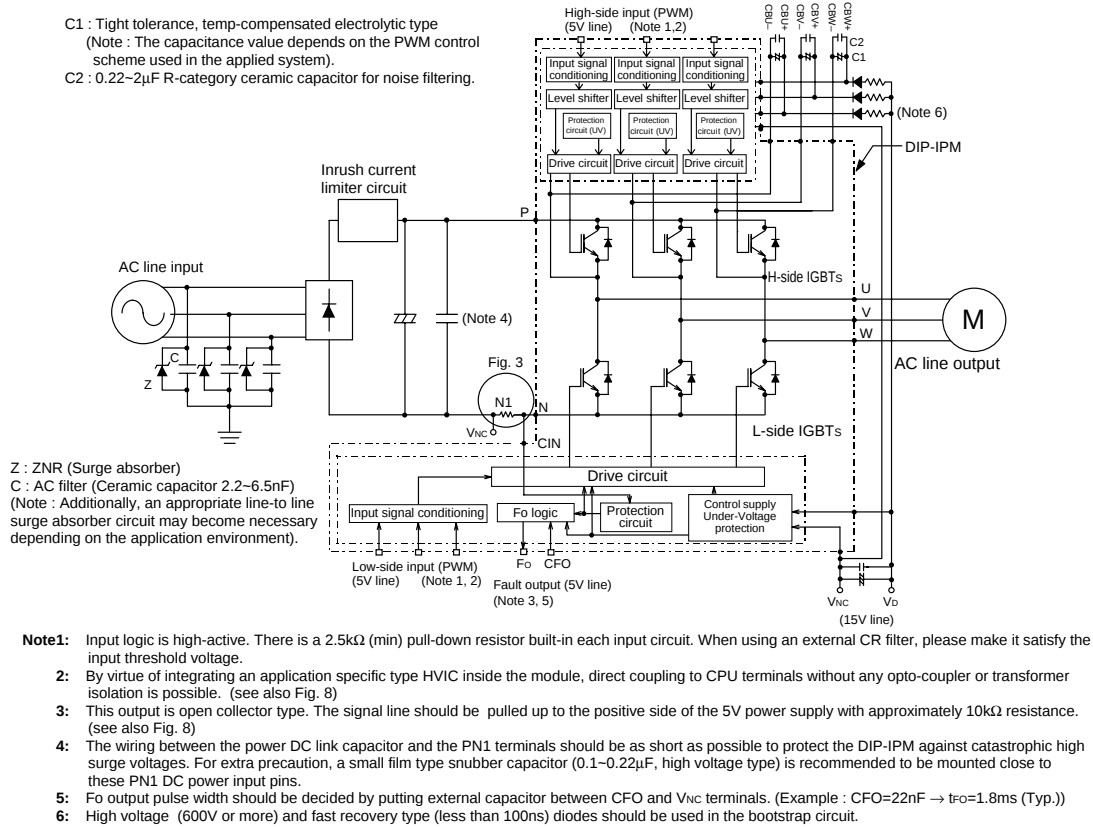
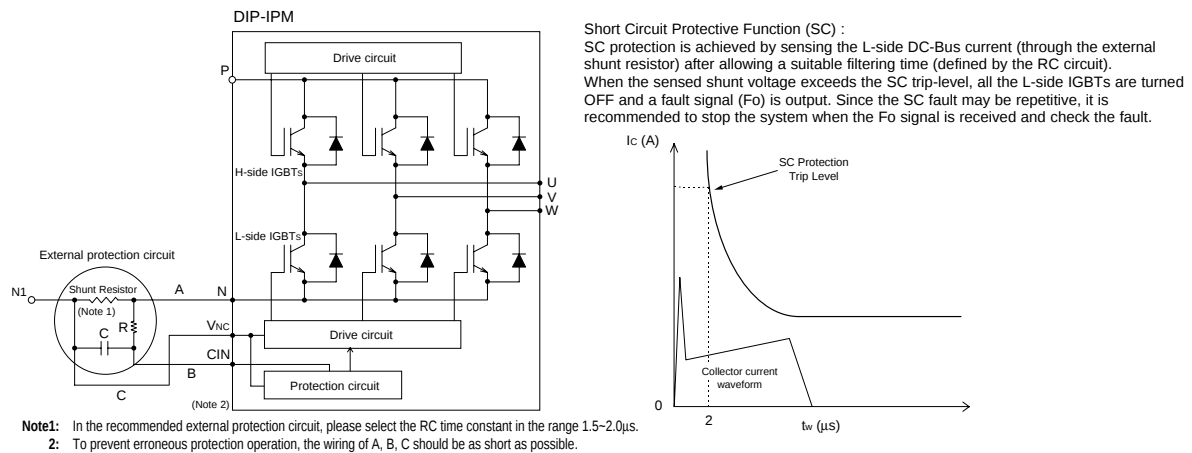


Fig. 3 EXTERNAL PART OF THE DIP-IPM PROTECTION CIRCUIT



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TRANSFER-MOLD TYPE
INSULATED TYPE

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

INVERTER PART

Symbol	Parameter	Condition	Ratings	Unit
V _{CC}	Supply voltage	Applied between P-N	450	V
V _{CC(surge)}	Supply voltage (surge)	Applied between P-N	500	V
V _{CES}	Collector-emitter voltage		600	V
±I _C	Each IGBT collector current	T _f = 25°C	20	A
±I _{CP}	Each IGBT collector current (peak)	T _f = 25°C, less than 1ms	40	A
P _C	Collector dissipation	T _f = 25°C, per 1 chip	52.6	W
T _j	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_f ≤ 100°C) however, to ensure safe operation of the DIP-IPM, the average junction temperature should be limited to T_{j(ave)} ≤ 125°C (@ T_f ≤ 100°C).

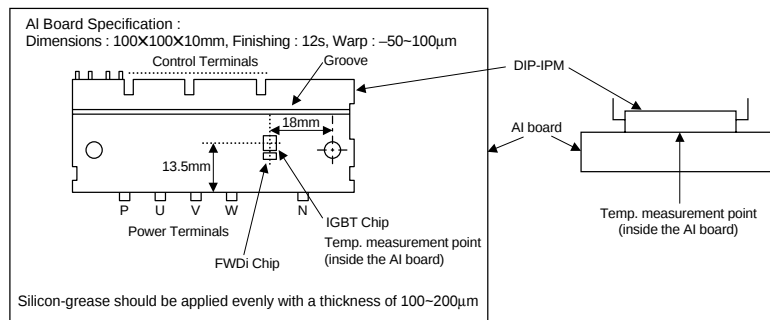
CONTROL (PROTECTION) PART

Symbol	Parameter	Condition	Ratings	Unit
V _D	Control supply voltage	Applied between VP1-VPC, VN1-VNC	20	V
V _{DB}	Control supply voltage	Applied between VUFB-VUFS, VVFB-VVFS, VWFB-VWFS	20	V
V _{IN}	Input voltage	Applied between UP, VP, WP-VPC, UN, VN, WN-VNC	-0.5~V _D +0.5	V
V _{FO}	Fault output supply voltage	Applied between Fo-VNC	-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-VNC	-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 _j = 125°C, non-repetitive, less than 2 μs	400	V
T _f	Module case operation temperature	(Note 2)	-20~+100	°C
T _{stg}	Storage temperature		-40~+125	°C
V _{iso}	Isolation voltage	60Hz, Sinusoidal, AC 1 minute, connection pins to heat-sink plate	2500	V _{rms}

Note 2 : T_f MEASUREMENT POINT



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THERMAL RESISTANCE

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-Q)}$	Junction to case thermal resistance (Note 3)	Inverter IGBT part (per 1/6 module)	—	—	1.90	°C/W
$R_{th(j-F)}$		Inverter FWDi part (per 1/6 module)	—	—	3.00	°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.

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	$V_D = V_{DB} = 15\text{V}$ $V_{IN} = 5\text{V}$	—	1.60	2.10	V
		$I_C = 20\text{A}, T_j = 25^\circ\text{C}$ $I_C = 20\text{A}, T_j = 125^\circ\text{C}$	—	1.70	2.20	
V_{EC}	FWDi forward voltage	$T_j = 25^\circ\text{C}, -I_C = 20\text{A}, V_{IN} = 0\text{V}$	—	1.50	2.00	V
t_{on}	Switching times	$V_{CC} = 300\text{V}, V_D = V_{DB} = 15\text{V}$ $I_C = 20\text{A}, T_j = 125^\circ\text{C}, V_{IN} = 0 \leftrightarrow 5\text{V}$ Inductive load (upper-lower arm)	0.70	1.30	1.90	μs
t_{rr}			—	0.30	—	μs
$t_{c(on)}$			—	0.40	0.60	μs
t_{off}			—	1.60	2.20	μs
$t_{c(off)}$			—	0.50	0.80	μs
I_{CES}	Collector-emitter cut-off current	$V_{CE} = V_{CES}$ $T_j = 25^\circ\text{C}$	—	—	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 VIN = 5V	Total of VP1-VPC, VN1-VNC	—	—	5.00	mA
			VUFB-VUFS, VVFB-VVFS, VWFB-VWFS	—	—	0.40	mA
		VD = VDB = 15V VIN = 0V	Total of VP1-VPC, VN1-VNC	—	—	7.00	mA
			VUFB-VUFS, VVFB-VVFS, VWFB-VWFS	—	—	0.55	mA
VFOH	Fault output voltage	VSC = 0V, Fo circuit pull-up to 5V with 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		1.0	1.5	2.0	mA
UVDBt	Supply circuit 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	CFO = 22nF (Note 5)		1.0	1.8	—	ms
Vth(on)	ON threshold voltage	Applied between UP, VP, WP-VPC, UN, VN, WN-VNC		2.1	2.3	2.6	V
Vth(off)	OFF threshold voltage			0.8	1.4	2.1	V

Note 4: Short circuit protection is functioning only at the low-arms. Please select the value of the external shunt resistor such that the SC trip-level is less than 34 A.

5: Fault signal is output when the low-arms short circuit or control supply under-voltage protective functions operate. The fault output pulse-width t_{FO} depends on the capacitance value of C_{FO} according to the following approximate equation : $C_{FO} = 12.2 \times 10^{-6} \times t_{FO}$ [F].

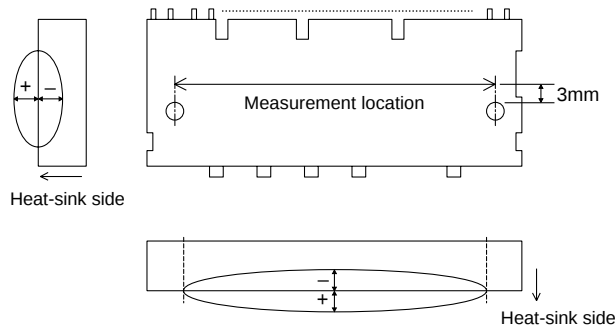
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MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Condition	Limits			Unit
		Min.	Typ.	Max.	
Mounting torque	Mounting screw : M4 Recommended 1.18 N·m	0.98	—	1.47	N·m
Weight		—	65	—	g
Heat-sink flatness	(Note 6)	-50	—	100	μm

Note 6: Measurement point of heat-sink flatness



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 _{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 _{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, T _f ≤ 100°C	2	—	—	μs
f _{PWM}	PWM input frequency	T _f ≤ 100°C, T _j ≤ 125°C	—	5	—	kHz
I _O	Allowable r.m.s. current	V _{CC} = 300V, V _D = 15V, f _c = 10kHz P.F = 0.8, sinusoidal T _j ≤ 125°C, T _f ≤ 100°C (Note 7)	—	—	12	Arms
P _{WIN}	Minimum input pulse width	ON (Note 8)	300	—	—	ns
V _{NC}	V _{NC} variation	between V _{NC} -N (including surge)	-5.0	—	5.0	V

Note 7 : The allowable r.m.s. current value depends on the actual application conditions.

8 : The input pulse width less than P_{WIN} might make no response.

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Fig. 4 THE DIP-IPM INTERNAL CIRCUIT

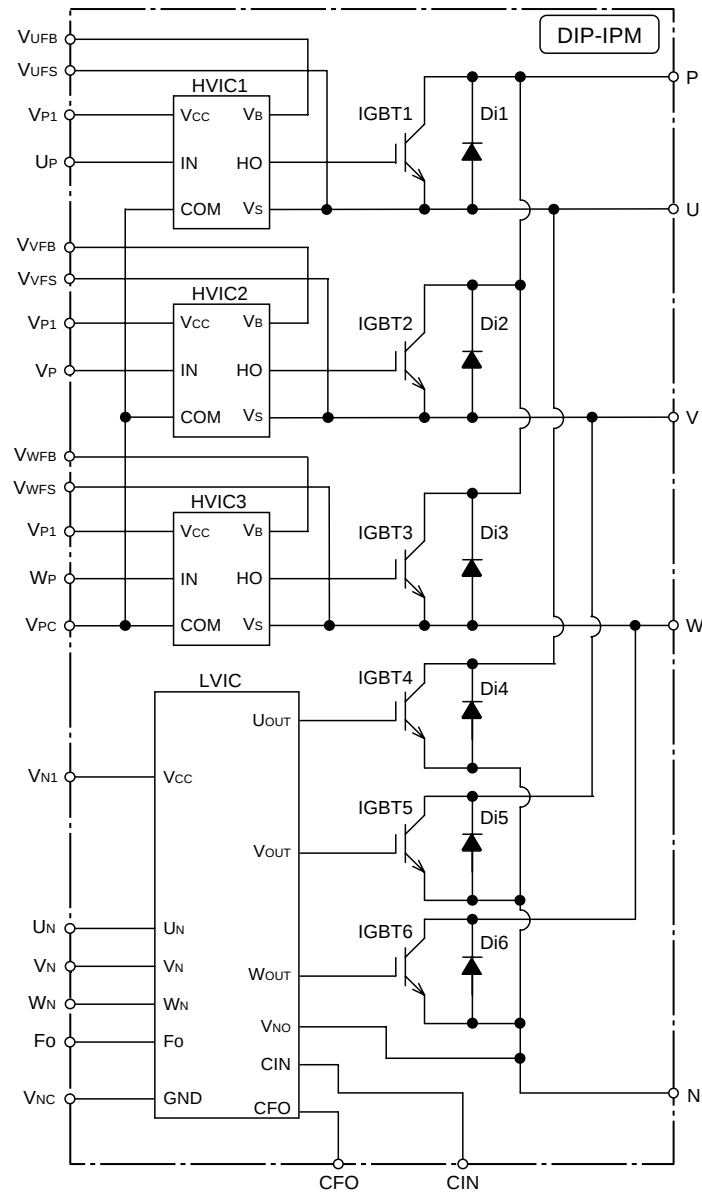
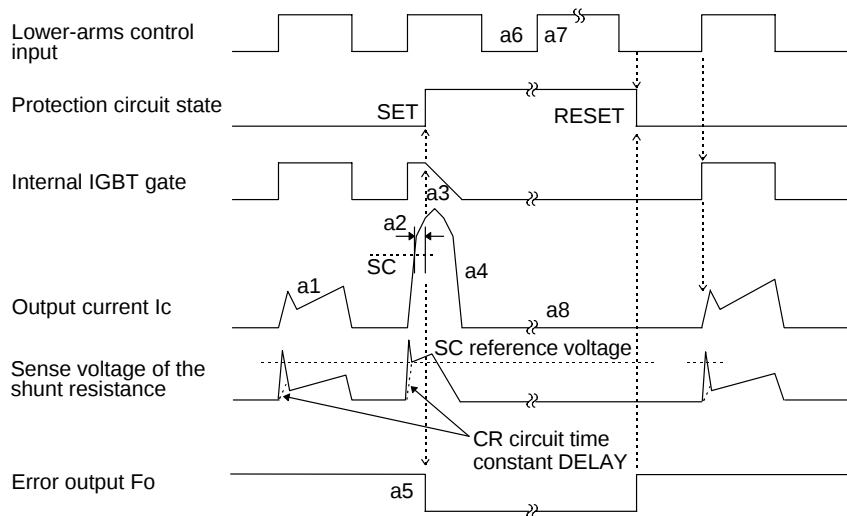


Fig. 5 TIMING CHARTS OF THE DIP-IPM PROTECTIVE FUNCTIONS

[A] Short-Circuit Protection (Lower-arms only)

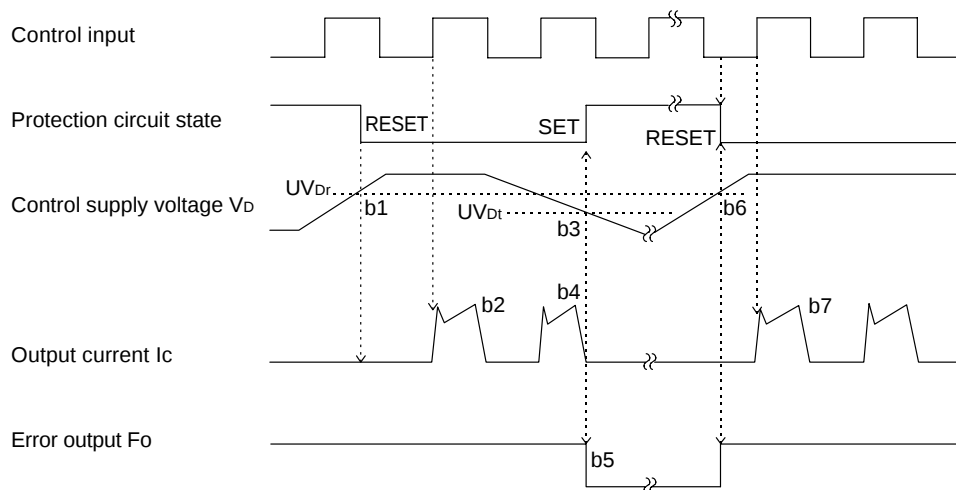
(With the external shunt resistance and CR connection)

- a1. Normal operation : IGBT ON and carrying current.
- a2. Short circuit current detection (SC trigger).
- a3. Hard IGBT gate interrupt.
- a4. IGBT turns OFF.
- a5. Fo timer operation starts : The pulse width of the Fo signal is set by the external capacitor C_{FO}.
- a6. Input "L" : IGBT OFF state.
- a7. Input "H" : IGBT ON state, but during the Fo active signal period the IGBT doesn't turn ON.
- a8. IGBT OFF state.



[B] Under-Voltage Protection (Lower-arm, UVd)

- b1. Control supply voltage rises : 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 operation starts.
- b6. Under voltage reset (UV_{Dr}).
- b7. Normal operation : IGBT ON and carrying current.



[C] Under-Voltage Protection (Upper-arm, 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. IGBT OFF in spite of control input condition, but there is no Fo signal output.
- c5. Under voltage reset (UV_{DBr}).
- c6. Normal operation : IGBT ON and carrying current.

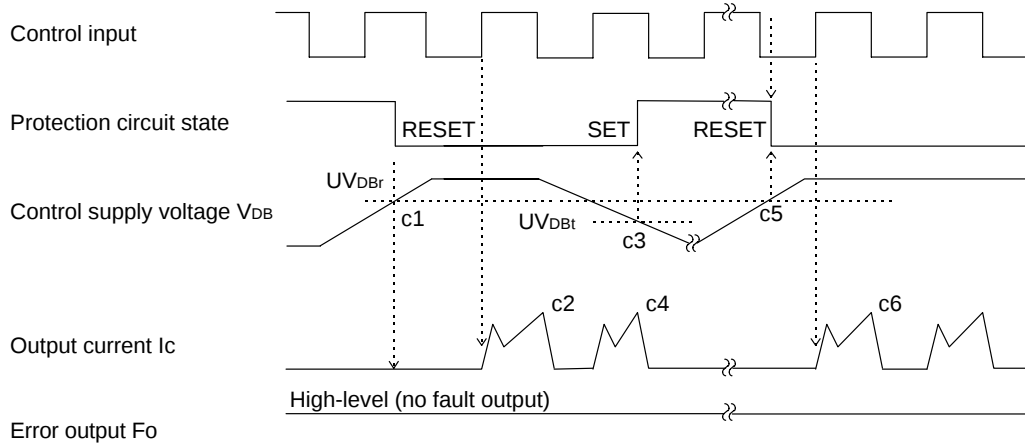
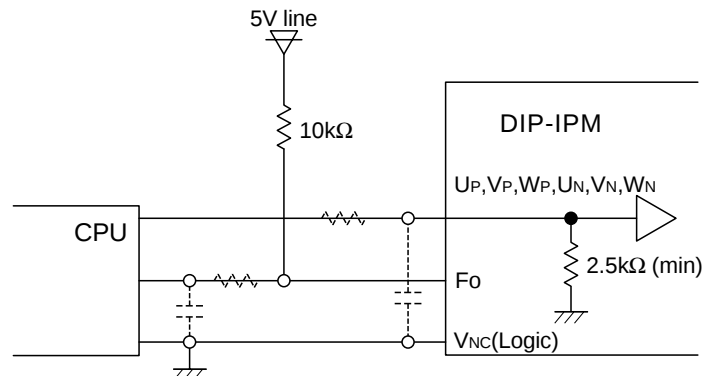


Fig. 6 RECOMMENDED CPU I/O INTERFACE CIRCUIT



Note : RC coupling at each input (parts shown dotted) may change depending on the PWM control scheme used in the application and the wiring impedance of the application's printed circuit board.
The DIP-IPM input signal section integrates a 2.5kΩ(min) pull-down resistor. Therefore, when using a external filtering resistor, care must be taken to satisfy the turn-on threshold voltage requirement.

Fig. 7 RECOMMENDED WIRING OF SHUNT RESISTANCE

