PS21765

TRANSFER-MOLD TYPE
INSULATED TYPE

PS21765

INTEGRATED POWER FUNCTIONS

600V/20A low-loss CSTBT™ inverter bridge with N-side three-phase output DC-to-AC power conversion

INTEGRATED DRIVE, PROTECTION AND SYSTEM CONTROL FUNCTIONS

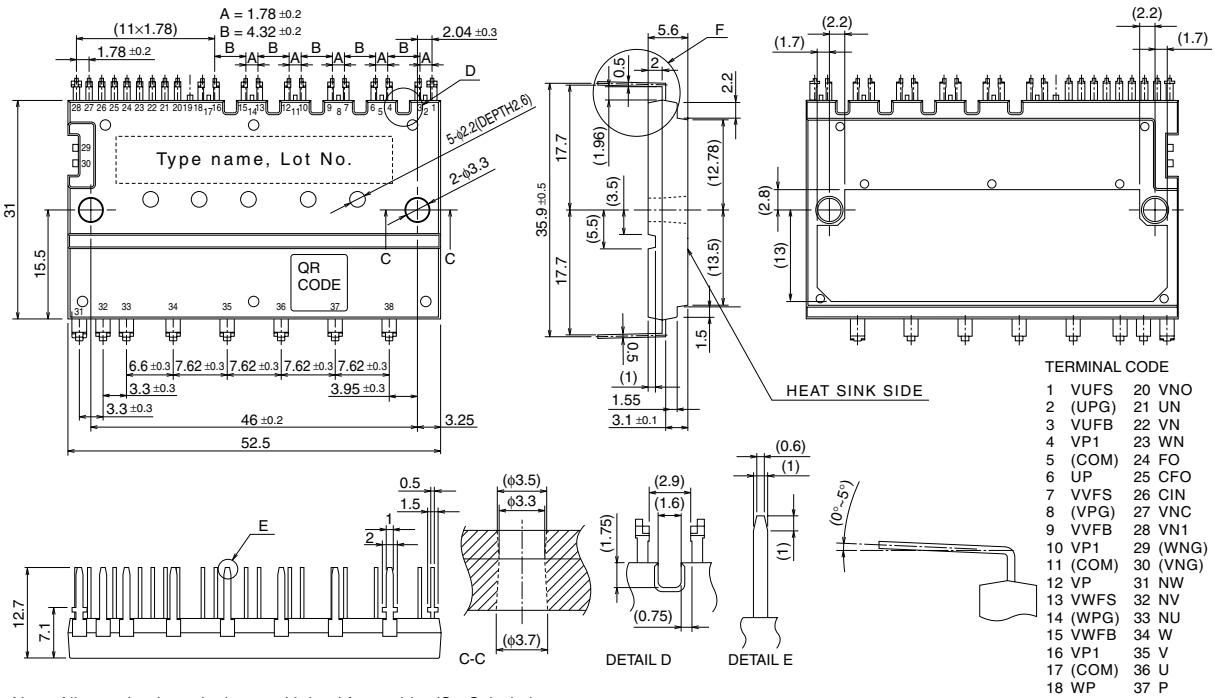
- For upper-leg IGBTs : Drive circuit, High voltage high-speed level shifting, Control supply under-voltage (UV) protection.
- For lower-leg IGBTs : Drive circuit, Control supply under-voltage protection (UV), Short circuit protection (SC).
- Fault signaling : Corresponding to an SC fault (Lower-leg IGBT) or a UV fault (Lower-side supply).
- Input interface : 3, 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

Dimensions in mm



TERMINAL CODE

1	VUFS	20	VNO
2	(UPG)	21	UN
3	VUFB	22	VN
4	VP1	23	WN
5	(COM)	24	FO
6	UP	25	CFO
7	VVFS	26	CIN
8	(VPG)	27	VNC
9	VVFB	28	VN1
10	VP1	29	(WNG)
11	(COM)	30	(VNG)
12	VP	31	NW
13	VWFS	32	NV
14	(WPG)	33	NU
15	VWFB	34	W
16	VP1	35	V
17	(COM)	36	U
18	WP	37	P
19	(UNG)	38	NC

Note: All outer lead terminals are with lead free solder (Sn-Cu) plating.

MITSUBISHI ELECTRIC

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

INVERTER PART

Symbol	Parameter	Condition	Ratings	Unit
V_{CC}	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
±I_C	Each IGBT collector current	T_C = 25°C	20	A
±I_{CP}	Each IGBT collector current (peak)	T_C = 25°C, less than 1ms	40	A
P_C	Collector dissipation	T_C = 25°C, per 1 chip	76.9	W
T_j	Junction temperature		–20~+150	°C

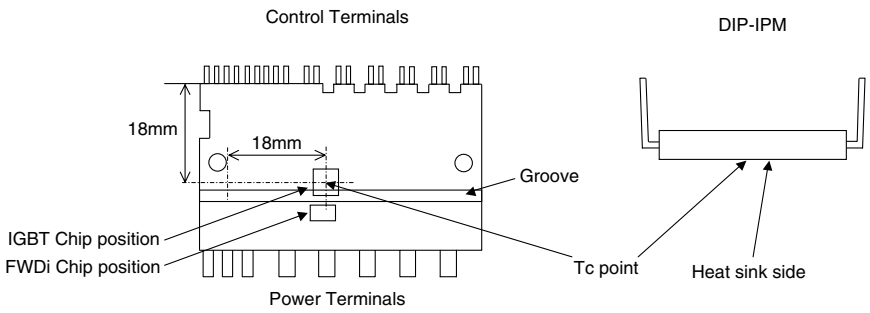
CONTROL (PROTECTION) PART

Symbol	Parameter	Condition	Ratings	Unit
V_D	Control supply voltage	Applied between V_{P1}-V_{NC}, 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, 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 F_O 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_j = 125°C, non-repetitive, less than 2 µs	400	V
T_c	Module case operation temperature	(Note 1)	–20~+100	°C
T_{stg}	Storage temperature		–40~+125	°C
V_{iso}	Isolation voltage	60Hz, Sinusoidal, AC 1 minute, All pins to heat-sink plate	2500	V_{rms}

Note 1 : 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 2)	Inverter IGBT part (per 1/6 module)	—	—	1.3	°C/W
$R_{th(j-c)F}$		Inverter FWD part (per 1/6 module)	—	—	3.0	°C/W

Note 2 : 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, V_{IN} = 5V	I_C = 20A, T_j = 25°C	—	1.60	2.10	V
			I_C = 20A, T_j = 125°C	—	1.70	2.20	
V_{EC}	FWDi forward voltage	T_j = 25°C, –I_C = 20A, V_{IN} = 0V		—	1.50	2.00	V
t_{on}	Switching times	V_{CC} = 300V, V_D = V_{DB} = 15V, I_C = 20A, T_j = 125°C, V_{IN} = 0 ↔ 5V, Inductive load (upper-lower arm)		0.70	1.30	1.90	μs
t_{rr}				—	0.30	—	μs
$t_{c(on)}$				—	0.50	0.80	μs
t_{off}				—	1.30	1.90	μs
$t_{c(off)}$				—	0.40	0.60	μs
I_{CES}	Collector-emitter cut-off current	V_{CE} = V_{CES}	T_j = 25°C	—	—	1	mA
			T_j = 125°C	—	—	10	

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_{NC}, V_{N1}-V_{NC}	—	—	7.00	mA
			V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}	—	—	0.55	mA
		V_D = V_{DB} = 15V, V_{IN} = 0V	Total of V_{P1}-V_{NC}, V_{N1}-V_{NC}	—	—	7.00	mA
			V_{UFB}-V_{UFS}, V_{VFB}-V_{VFS}, V_{WFB}-V_{WFS}	—	—	0.55	mA
V_{FOH}	Fault output voltage	V_{SC} = 0V, F_O terminal pull-up to 5V with 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 3)		0.43	0.48	0.53	V
I_{IN}	Input current	V_{IN} = 5V		1.0	1.5	2.0	mA
UV_{DBt}	Control supply under-voltage protection	T_j ≤ 125°C	Trip level	10.0	—	12.0	V
UV_{DBr}			Reset level	10.5	—	12.5	V
UV_{Dt}			Trip level	10.3	—	12.5	V
UV_{Dr}			Reset level	10.8	—	13.0	V
t_{FO}	Fault output pulse width	C_{FO} = 22nF (Note 4)		1.0	1.8	—	ms
$V_{th(on)}$	ON threshold voltage	Applied between U_P, V_P, W_P, U_N, V_N, W_N-V_{NC}		—	2.3	2.6	V
$V_{th(off)}$	OFF threshold voltage			0.8	1.4	—	V
$V_{th(hys)}$	ON/OFF threshold hysteresis voltage			0.5	0.9	—	V

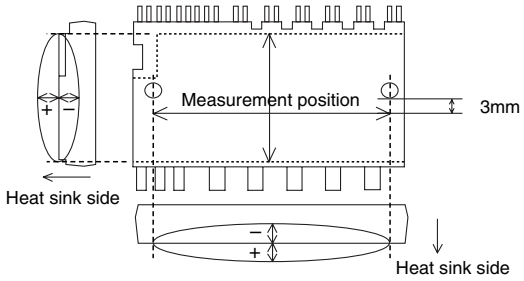
Note 3 : Short circuit protection is functioning only at the low-arms. Please select the external shunt resistance such that the SC trip-level is less than 2.0 times of the current rating.

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

MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Condition		Limits			Unit
			Min.	Typ.	Max.	
Mounting torque	Mounting screw : M3	Recommended : 0.78 N·m	0.59	—	0.98	N·m
Weight			—	21	—	g
Heat-sink flatness	(Note 5)		–50	—	100	μm

Note 5 : Flatness measurement position

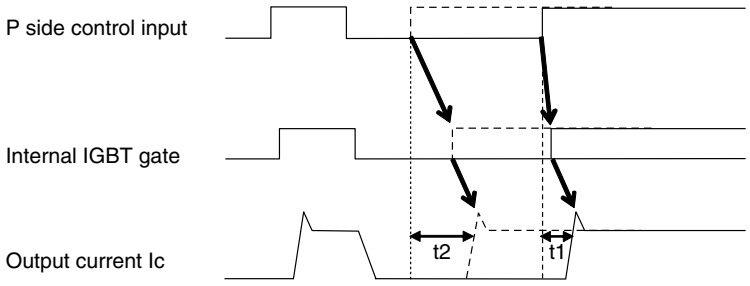


RECOMMENDED OPERATION CONDITIONS

Symbol	Parameter	Condition		Recommended value			Unit
				Min.	Typ.	Max.	
V_{CC}	Supply voltage	Applied between P-NU, NV, NW		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}-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, $T_c \leq 100°C$		2	—	—	μs
f_{PWM}	PWM input frequency	$T_c \leq 100°C$, $T_j \leq 125°C$		—	—	20	kHz
I_O	Output r.m.s. current	V_{CC} = 300V, V_D = V_{DB} = 15V, P.F = 0.8, sinusoidal PWM $T_c \leq 100°C$, $T_j \leq 125°C$ (Note 6)	f_{PWM} = 5kHz	—	—	14.0	Arms
			f_{PWM} = 15kHz	—	—	13.0	
PWIN(on)	Minimum input pulse width	(Note 7)		0.3	—	—	μs
PWIN(off)		$200 \leq V_{CC} \leq 350V$, $13.5 \leq V_D \leq 16.5V$, $13.0 \leq V_{DB} \leq 18.5V$, $–20°C \leq T_c \leq 100°C$, N-line wiring inductance less than 10nH (Note 8)	Below rated current	1.4	—	—	
			Between rated current and 1.7 times of rated current	2.5	—	—	
			Between 1.7 times and 2.0 times of rated current	3.0	—	—	
V_{NC}	V_{NC} voltage variation	Between V_{NC}-NU, NV, NW (including surge)		–5.0	—	5.0	V
T_j	Junction temperature			–20	—	125	°C

Note 6 : The allowable r.m.s. current value depends on the actual application conditions.
7 : Input signal with ON pulse width less than PWIN(on) might make no response.
8 : IPM might make delayed response (less than about 2μsec) or no response for the input signal with off pulse width less than PWIN(off). Please refer Fig. 2 about delayed response and Fig. 6 about N-line inductance.

Fig. 2 ABOUT DELAYED RESPONSE AGAINST SHORTER INPUT OFF SIGNAL THAN PWIN (off) (P side only)



Real line ··· off pulse width > PWIN(off) : turn on time t1
Broken line ··· off pulse width < PWIN(off) : turn on time t2

Fig. 3 THE DIP-IPM INTERNAL CIRCUIT

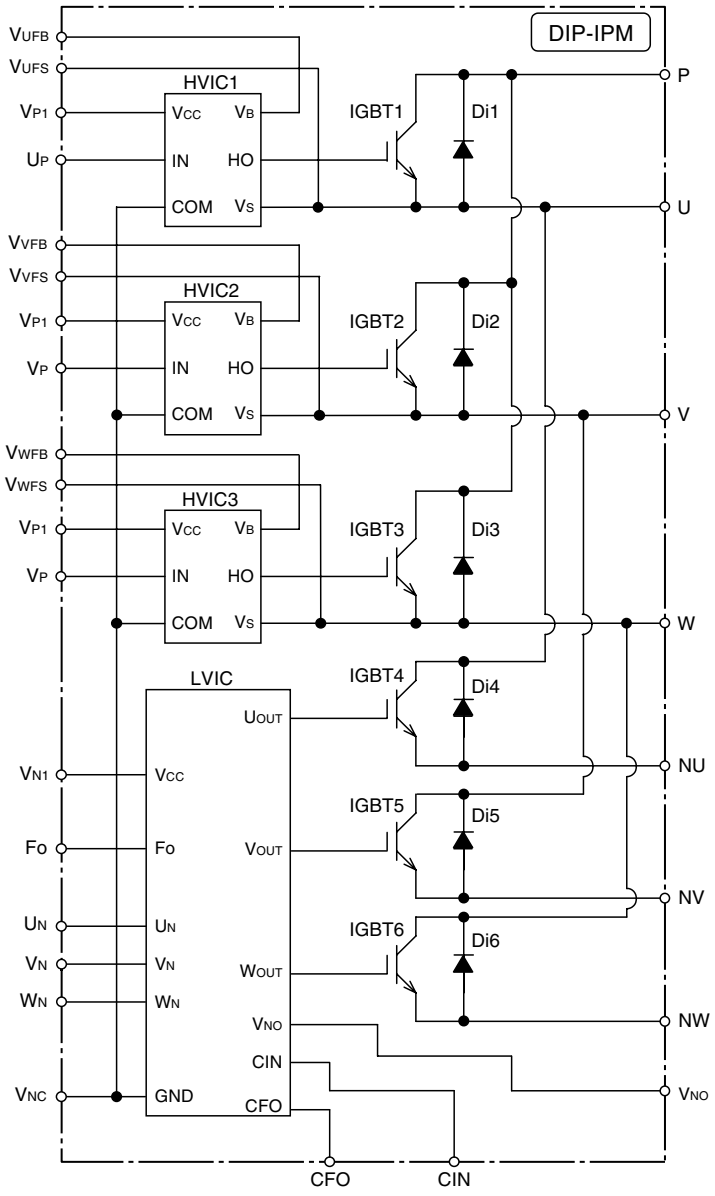
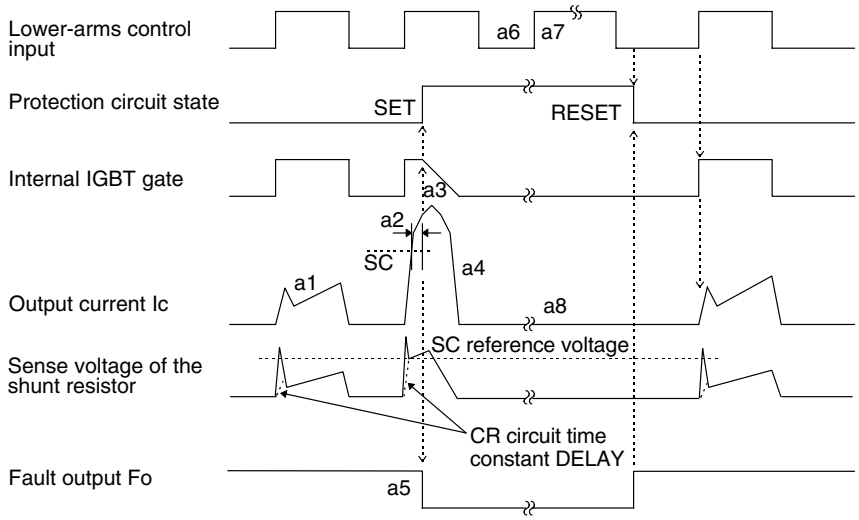


Fig. 4 TIMING CHARTS OF THE DIP-IPM PROTECTIVE FUNCTIONS

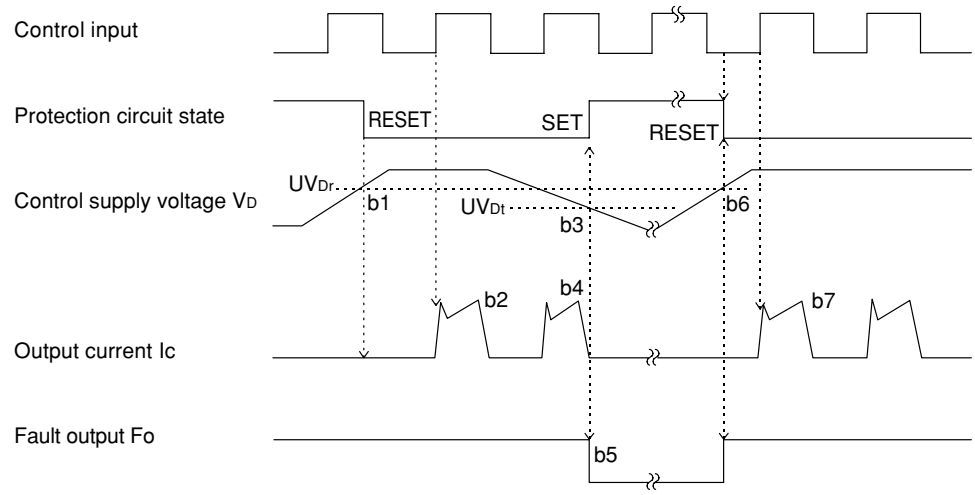
[A] Short-Circuit Protection (Lower-arms only with the external shunt resistor and CR filter)

a1. Normal operation : IGBT ON and carrying current.
a2. Short circuit current detection (SC trigger).
a3. IGBT gate hard interruption.
a4. IGBT turns OFF.
a5. FO timer operation starts : The pulse width of the FO signal is set by the external capacitor CFO.
a6. Input "L" : IGBT OFF.
a7. Input "H"
a8. IGBT OFF state in spite of input "H".



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

b1. Control supply voltage rising : After the voltage level reaches UVDr, the circuits start to operate when next input is applied.
b2. Normal operation : IGBT ON and carrying current.
b3. Under voltage trip (UVDt).
b4. IGBT turns OFF in spite of control input condition.
b5. FO operation starts.
b6. Under voltage reset (UVDr).
b7. Normal operation : IGBT ON and carrying current.



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

c1. Control supply voltage rises : After the voltage level reaches UV_{DBr}, the circuits start to operate.
c2. Protection circuit state reset : IGBT ON and carrying current.
c3. Normal operation : IGBT ON and carrying current.
c4. Under-voltage trip (UV_{DBt}).
c5. IGBT OFF inspite of control input condition, but there is no F_O signal output.
c6. Under-voltage reset (UV_{DBr}).
c7. Normal operation : IGBT ON and carrying current.

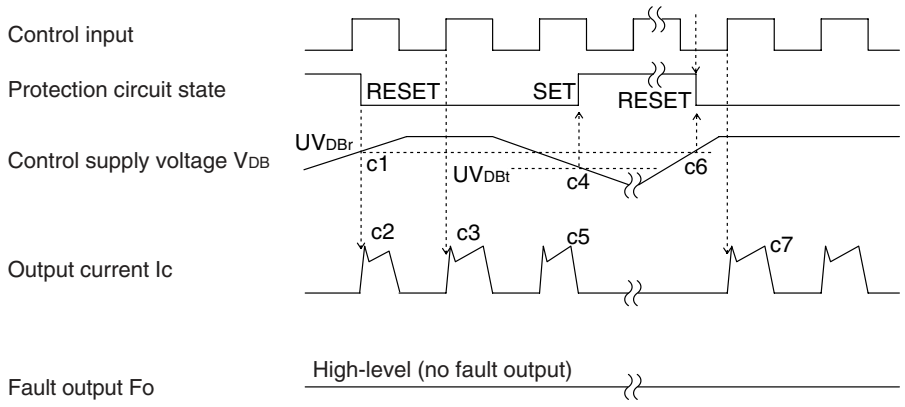
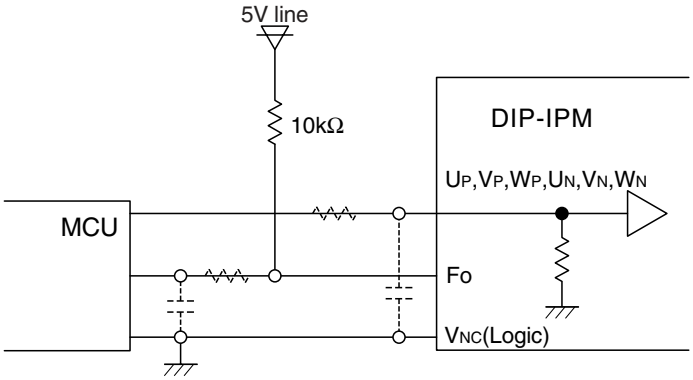


Fig. 5 RECOMMENDED MCU I/O INTERFACE CIRCUIT



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. 6 RECOMMENDED WIRING AROUND THE SHUNT RESISTOR

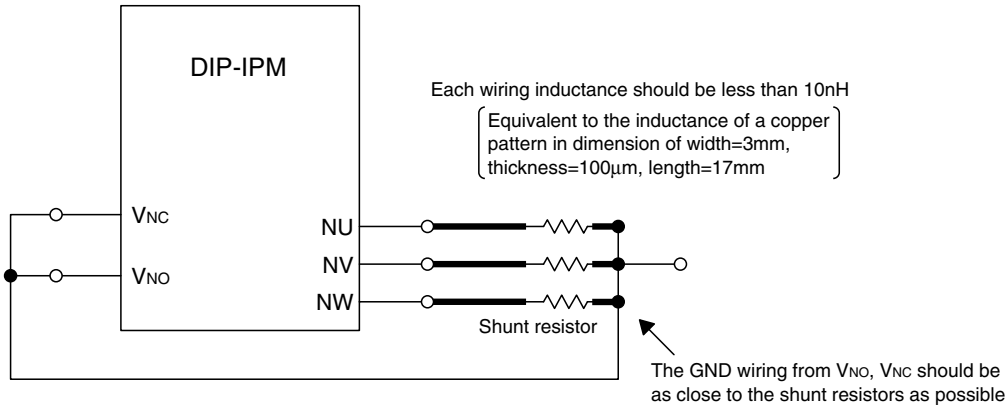
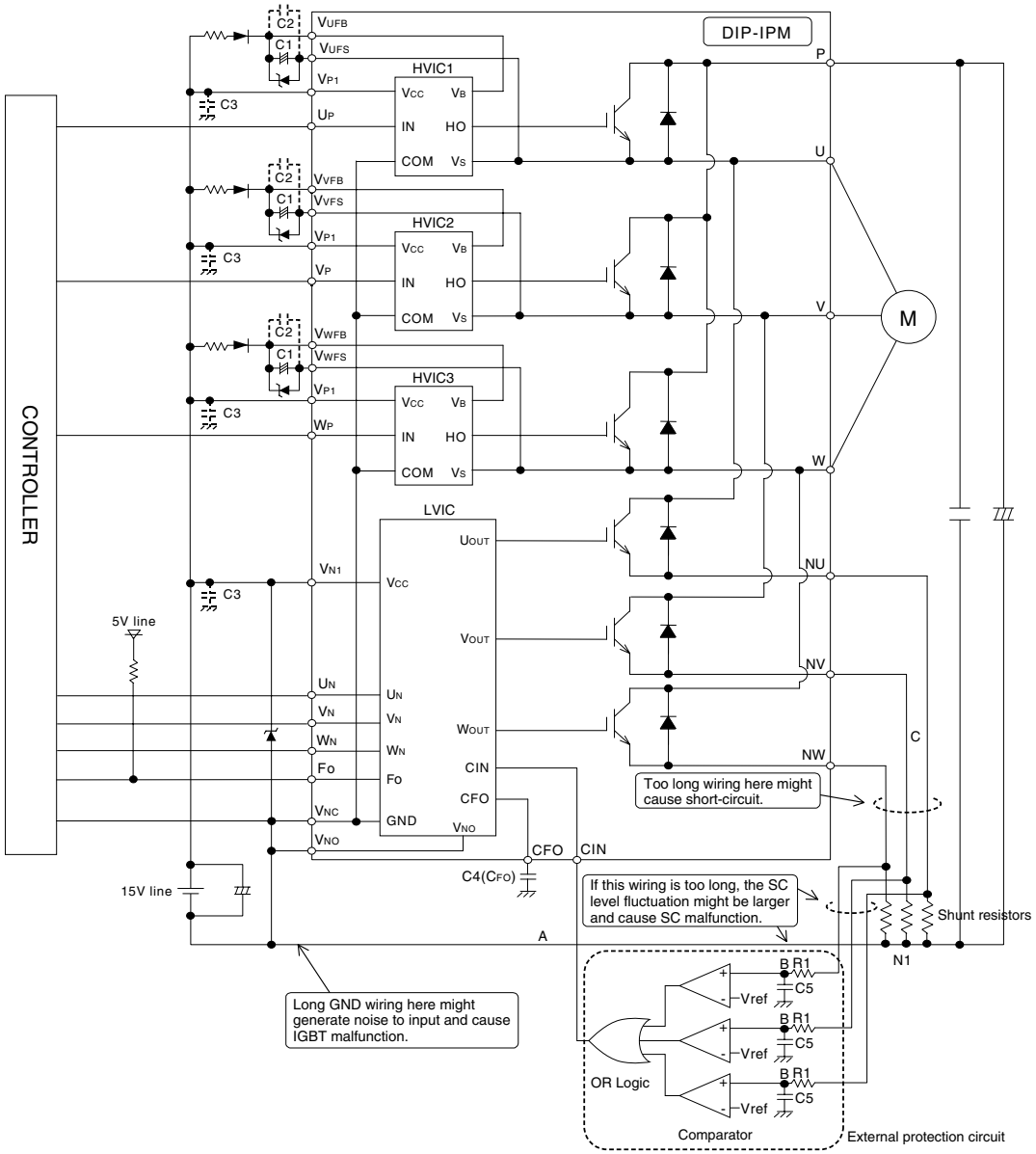


Fig. 7 TYPICAL DIP-IPM APPLICATION CIRCUIT EXAMPLE

C1: Tight tolerance temp-compensated electrolytic type C2,C3: 0.22~2μF R-category ceramic capacitor for noise filtering



Note 1 : Input drive is High-active type. There is a 2.5kΩ(Min.) pull-down resistor integrated in the IC input circuit. 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.

2 : Thanks to HVIC inside the module, direct coupling to MCU without any opto-coupler or transformer isolation is possible.

3 : FO output is open drain type. It should be pulled up to the positive side of a 5V power supply by a resistor of about 10kΩ. FO output pulse width is determined by the external capacitor (CFO) between CFO and VNC terminals (e.g CFO = 22nF → tFO = 1.8ms (typ.))

4 : To prevent erroneous protection, the wiring of A, B should be as short as possible.

5 : The time constant R1C5 of the protection circuit should be selected in the range of 1.5-2μs. SC interrupting time might vary with the wiring pattern. Tight tolerance, temp-compensated type is recommended for R1, C5.

6 : All capacitors should be mounted as close to the terminals of the DIP-IPM as possible. (C1: good temperature, frequency characteristic electrolytic type, and C2, C3: good temperature, frequency and DC bias characteristic ceramic type are recommended.)

7 : 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 between the P-N1 terminals is recommended.

8 : It is recommended to insert a Zener diode (24V/1W) between each pair of control supply terminals to prevent surge destruction.

9 : If control GND is connected to power GND by broad pattern, it may cause malfunction by power GND fluctuation. It is recommended to connect control GND and power GND at only a point.

10 : The reference voltage Vref of comparator should be set up the same rating of short circuit trip level (Vsc(ref): min.0.43V to max.0.53V).

11 : OR logic output high level should exceed the maximum short circuit trip level (Vsc(ref): max.0.53V).