

# PS21255-E

TRANSFER-MOLD TYPE  
INSULATED TYPE

## PS21255-E



### INTEGRATED POWER FUNCTIONS

4th generation (planar) IGBT inverter bridge for 3 phase DC-to-AC power conversion.

### INTEGRATED DRIVE, PROTECTION AND SYSTEM CONTROL FUNCTIONS

- For upper-leg IGBTs : Drive circuit, High voltage isolated high-speed level shifting, Control circuit under-voltage (UV) protection.  
Note : Bootstrap supply scheme can be applied.
- For lower-leg IGBTs : Drive circuit, Control circuit under-voltage protection (UV), Short circuit protection (SC).
- Fault signaling : Corresponding to a SC fault (Low-side IGBT) or a UV fault (Low-side supply).
- Input interface : 5V line CMOS/TTL compatible, Schmitt Trigger receiver circuit.

## APPLICATION

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

Fig. 1 PACKAGE OUTLINES

Dimensions in mm

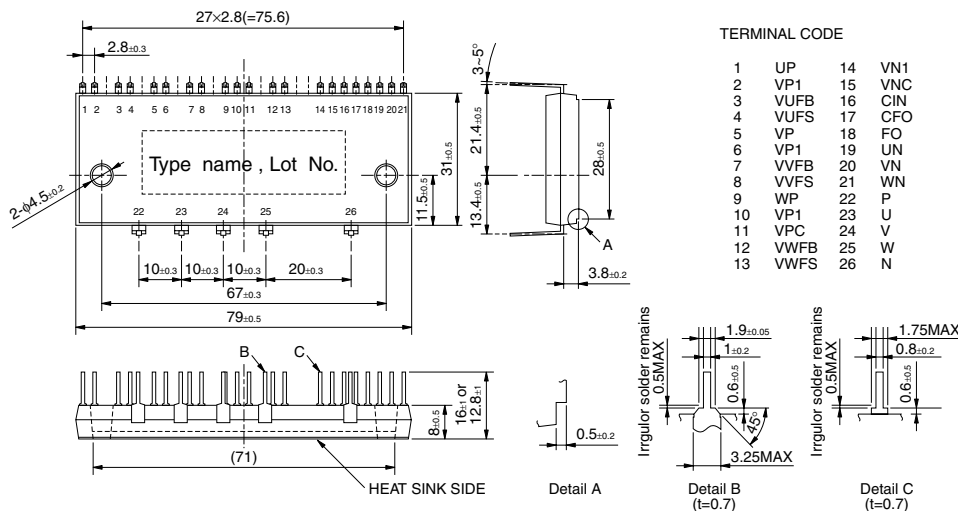


Fig. 2 INTERNAL FUNCTIONS BLOCK DIAGRAM (TYPICAL APPLICATION EXAMPLE)

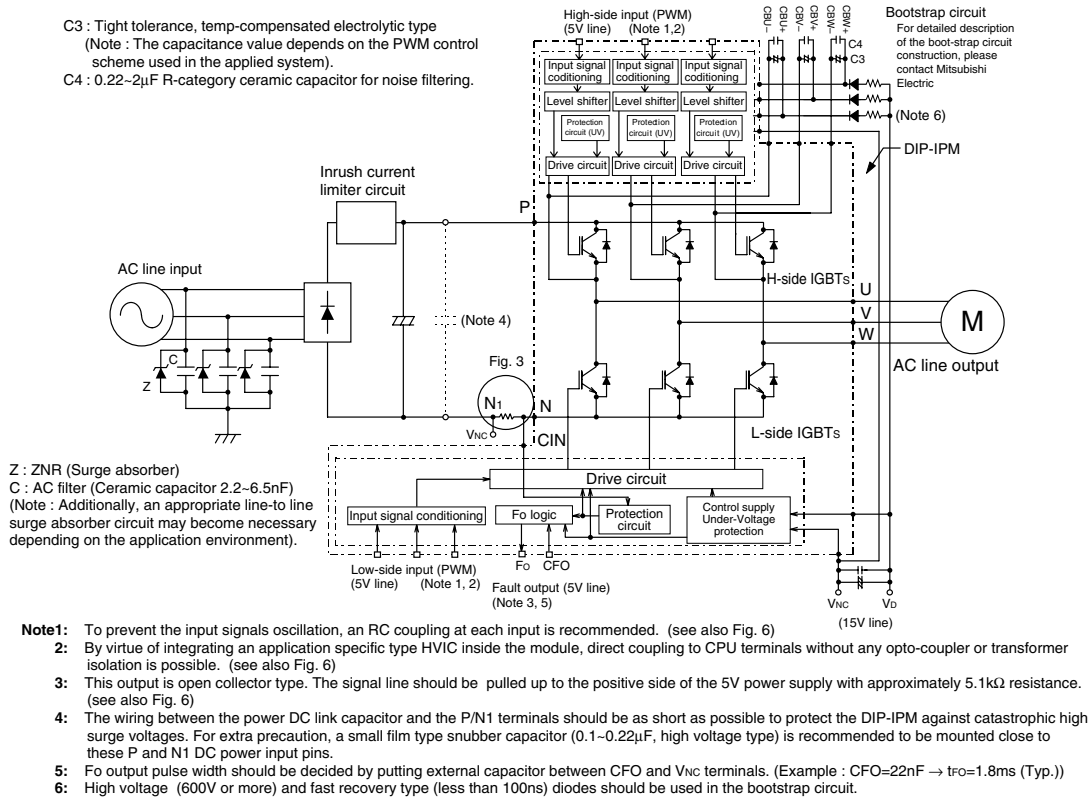
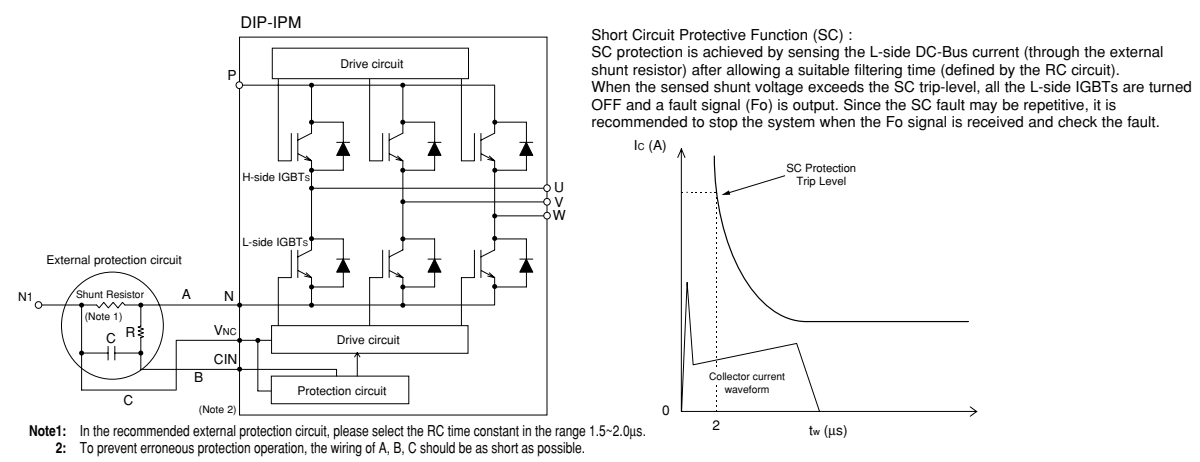


Fig. 3 EXTERNAL PART OF THE DIP-IPM PROTECTION CIRCUIT



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**MAXIMUM RATINGS** ( $T_j = 25^\circ\text{C}$ , 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
$\pm I_C$	Each IGBT collector current	$T_c = 25^\circ\text{C}$	20	A
$\pm I_{CP}$	Each IGBT collector current (peak)	$T_c = 25^\circ\text{C}$ , instantaneous value (pulse)	40	A
PC	Collector dissipation	$T_c = 25^\circ\text{C}$ , per 1 chip	56	W
$T_j$	Junction temperature	(Note 1)	-20~+150	$^\circ\text{C}$

**Note 1** : The maximum junction temperature rating of the power chips integrated within the DIP-IPM is  $150^\circ\text{C}$  ( $@ T_c \leq 100^\circ\text{C}$ ) however, to ensure safe operation of the DIP-IPM, the average junction temperature should be limited to  $T_{j(ave)} \leq 125^\circ\text{C}$  ( $@ T_c \leq 100^\circ\text{C}$ ).

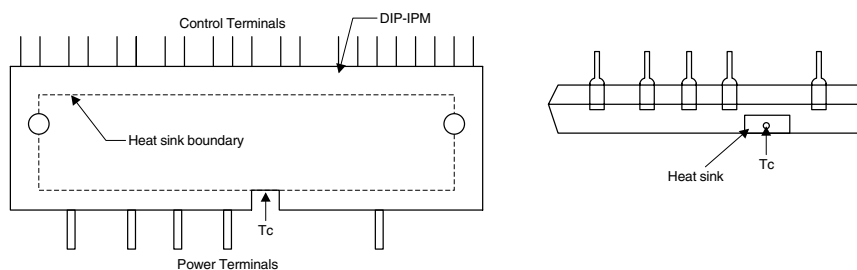
**CONTROL (PROTECTION) PART**

Symbol	Parameter	Condition	Ratings	Unit
V <sub>D</sub>	Control supply voltage	Applied between VP1-VPC, VN1-VNC	20	V
V <sub>DB</sub>	Control supply voltage	Applied between VUFB-VUFS, VVFB-VVFS, VWFB-VWFS	20	V
V <sub>CIN</sub>	Input voltage	Applied between UP, VP, WP-VPC, UN, VN, WN-VNC	-0.5~+5.5	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	15	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
VCC(PROT)	Self protection supply voltage limit (short circuit protection capability)	V <sub>D</sub> = 13.5~16.5V, Inverter part $T_j = 125^\circ\text{C}$ , non-repetitive, less than 2 $\mu\text{s}$	400	V
T <sub>c</sub>	Module case operation temperature	(Note 2)	-20~+100	$^\circ\text{C}$
T <sub>stg</sub>	Storage temperature		-40~+125	$^\circ\text{C}$
V <sub>iso</sub>	Isolation voltage	60Hz, Sinusoidal, AC 1 minute, connection pins to 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 <sub>th(j-c)Q</sub>	Junction to case thermal resistance	Inverter IGBT part (per 1/6 module)	—	—	2.2	°C/W
R <sub>th(j-c)F</sub>		Inverter FWD part (per 1/6 module)	—	—	4.5	°C/W
R <sub>th(c-f)</sub>	Contact thermal resistance	Case to fin, (per 1 module) thermal grease applied	—	—	0.067	°C/W

**ELECTRICAL CHARACTERISTICS** (T<sub>j</sub> = 25°C, unless otherwise noted)

**INVERTER PART**

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
V <sub>CE(sat)</sub>	Collector-emitter saturation voltage	V <sub>D</sub> = V <sub>DB</sub> = 15V V <sub>CIN</sub> = 0V	—	1.80	2.45	V
		I <sub>C</sub> = 20A, T <sub>j</sub> = 25°C I <sub>C</sub> = 20A, T <sub>j</sub> = 125°C	—	1.90	2.60	
V <sub>EC</sub>	FWD forward voltage	T <sub>j</sub> = 25°C, -I <sub>C</sub> = 20A, V <sub>CIN</sub> = 5V	—	2.20	3.00	V
t <sub>on</sub>	Switching times	V <sub>CC</sub> = 300V, V <sub>D</sub> = V <sub>DB</sub> = 15V I <sub>C</sub> = 20A, T <sub>j</sub> = 125°C, V <sub>CIN</sub> = 5V ↔ 0V Inductive load (upper-lower arm)	0.10	0.80	1.30	μs
t <sub>tr</sub>			—	0.10	—	μs
t <sub>c(on)</sub>			—	0.50	0.90	μs
t <sub>off</sub>			—	0.80	1.90	μs
t <sub>c(off)</sub>			—	0.40	1.30	μs
I <sub>CES</sub>			Collector-emitter cut-off current	V <sub>CE</sub> = V <sub>CES</sub>	—	—
	T <sub>j</sub> = 25°C T <sub>j</sub> = 125°C	—		—	10	

**CONTROL (PROTECTION) PART**

Symbol	Parameter	Condition	Limits			Unit	
			Min.	Typ.	Max.		
V <sub>D</sub>	Control supply voltage	Applied between V <sub>P1</sub> -V <sub>PC</sub> , V <sub>N1</sub> -V <sub>NC</sub>	13.5	15.0	16.5	V	
V <sub>DB</sub>	Control supply voltage	Applied between V <sub>UFB</sub> -V <sub>UFS</sub> , V <sub>VFB</sub> -V <sub>VFS</sub> , V <sub>WFB</sub> -V <sub>WFS</sub>	13.5	15.0	16.5	V	
I <sub>D</sub>	Circuit current	V <sub>D</sub> = V <sub>DB</sub> = 15V, V <sub>CIN</sub> = 5V	—	—	8.50	mA	
		Total of V <sub>P1</sub> -V <sub>PC</sub> , V <sub>N1</sub> -V <sub>NC</sub> V <sub>UFB</sub> -V <sub>UFS</sub> , V <sub>VFB</sub> -V <sub>VFS</sub> , V <sub>WFB</sub> -V <sub>WFS</sub>	—	—	1.00		
V <sub>FOH</sub>	Fault output voltage	V <sub>SC</sub> = 0V, F <sub>O</sub> = 10kΩ 5V pull-up	4.9	—	—	V	
V <sub>FOL</sub>		V <sub>SC</sub> = 1V, F <sub>O</sub> = 10kΩ 5V pull-up	—	0.8	1.2	V	
V <sub>FOSat</sub>		V <sub>SC</sub> = 1V, I <sub>FO</sub> = 15mA	0.8	1.2	1.8	V	
t <sub>dead</sub>	Arm shoot-through blocking time	Relates to corresponding input signal for blocking arm shoot-through. -20°C ≤ T <sub>C</sub> ≤ 100°C	2.5	—	—	μs	
V <sub>SC(ref)</sub>	Short circuit trip level	T <sub>j</sub> = 25°C, V <sub>D</sub> = 15V (Note 3)	0.45	0.5	0.55	V	
UVDBt	Supply circuit under-voltage protection	T <sub>j</sub> ≤ 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
t <sub>FO</sub>	Fault output pulse width	C <sub>FO</sub> = 22nF (Note 4)	1.0	1.8	—	ms	
V <sub>th(on)</sub>	ON threshold voltage	Applied between : U <sub>P</sub> , V <sub>P</sub> , W <sub>P</sub> -V <sub>PC</sub> , U <sub>N</sub> , V <sub>N</sub> , W <sub>N</sub> -V <sub>NC</sub>	0.8	1.4	2.0	V	
V <sub>th(off)</sub>	OFF threshold voltage		2.5	3.0	4.0	V	

**Note 3** : 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.

**4** : Fault signal is output when the low-arms short circuit or control supply under-voltage protective functions operate. The fault output pulse-width t<sub>FO</sub> depends on the capacitance value of C<sub>FO</sub> according to the following approximate equation : C<sub>FO</sub> = 12.2 × 10<sup>-6</sup> × t<sub>FO</sub> [F].

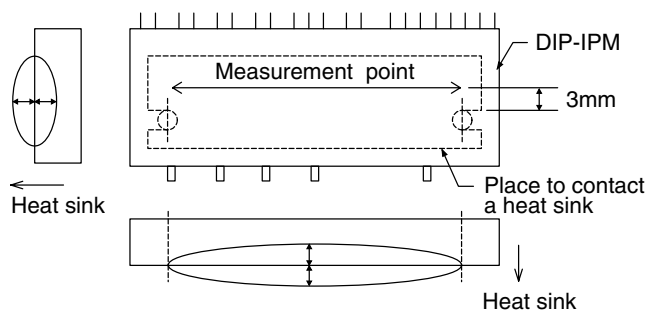
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## MECHANICAL CHARACTERISTICS AND RATINGS

Parameter	Condition		Limits			Unit
			Min.	Typ.	Max.	
Mounting torque	Mounting screw : M4	—	0.98	1.18	1.47	N·m
Terminal pulling strength	Weight 19.6N	EIAJ-ED-4701	10	—	—	s
Bending strength	Weight 9.8N. 90deg bend	EIAJ-ED-4701	2	—	—	times
Weight		—	—	54	—	g
Heat-sink flatness	(Note 5)	—	-50	—	100	μm

### Note 5: Measurement point of heat-sink flatness



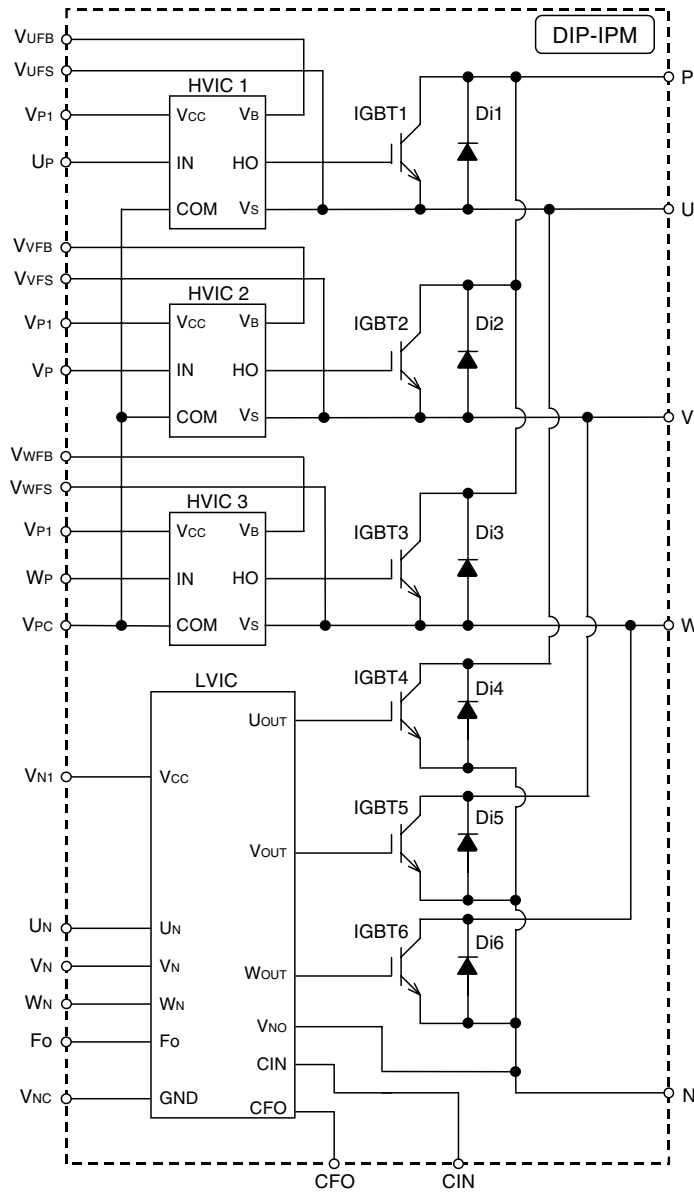
## RECOMMENDED OPERATION CONDITIONS

Symbol	Parameter	Condition	Limits			Unit
			Min.	Typ.	Max.	
VCC	Supply voltage	Applied between P-N	0	300	400	V
VD	Control supply voltage	Applied between VP1-VPC, VN1-VNC	13.5	15.0	16.5	V
VDB	Control supply voltage	Applied between VUFB-VUFS, VVFB-VVFS, VWFB-VWFS	13.5	15.0	16.5	V
ΔVD, ΔVDB	Control supply variation		-1	—	1	V/μs
t <sub>dead</sub>	Arm shoot-through blocking time	Relates to corresponding input signal for blocking arm shoot-through	2.5	—	—	μs
f <sub>PWM</sub>	PWM input frequency	T <sub>c</sub> ≤ 100°C, T <sub>j</sub> ≤ 125°C	—	15	—	kHz
V <sub>CIN(ON)</sub>	Input ON threshold voltage	Applied between UP, VP, WP-VPC	0~0.65			V
V <sub>CIN(OFF)</sub>	Input OFF threshold voltage	Applied between UN, VN, WN-VNC	4.0~5.5			V

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Fig. 4 THE DIP-IPM INTERNAL CIRCUIT

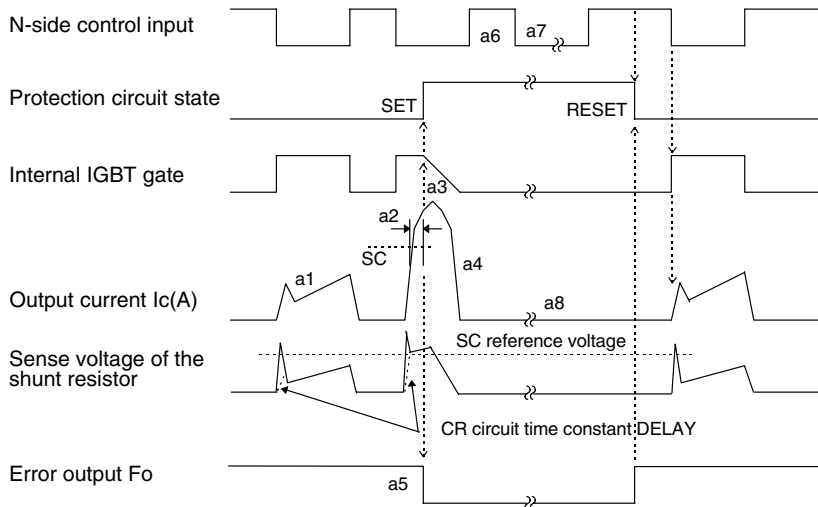


**Fig. 5 TIMING CHARTS OF THE DIP-IPM PROTECTIVE FUNCTIONS**

**[A] Short-Circuit Protection (N-side only)**

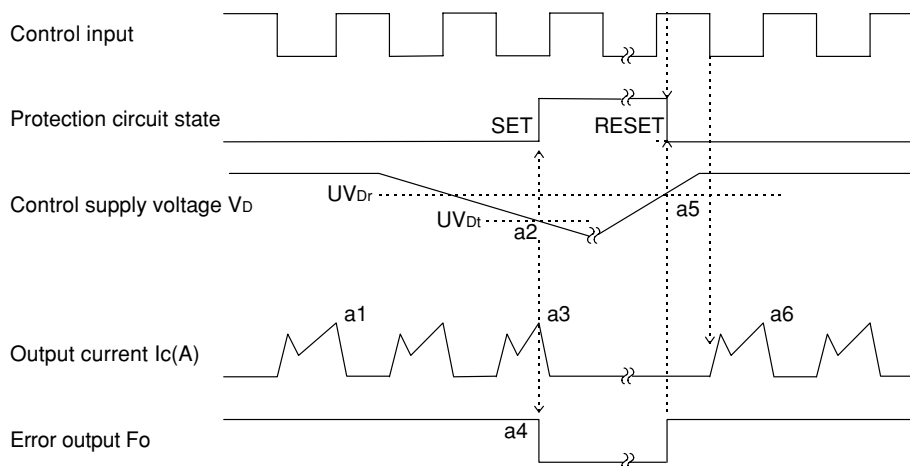
(For the external shunt resistor and CR connection.)

- 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<sub>FO</sub>.
- a6. Input "H" : IGBT OFF state.
- a7. Input "L" : IGBT ON state.
- a8. IGBT OFF state.



**[B] Under-Voltage Protection (N-side, UV<sub>D</sub>)**

- a1. Normal operation : IGBT ON and carrying current.
- a2. Under voltage trip (UV<sub>Dt</sub>).
- a3. IGBT OFF in spite of control input condition.
- a4. Fo timer operation starts.
- a5. Under voltage reset (UV<sub>Dr</sub>).
- a6. Normal operation : IGBT ON and carrying current.

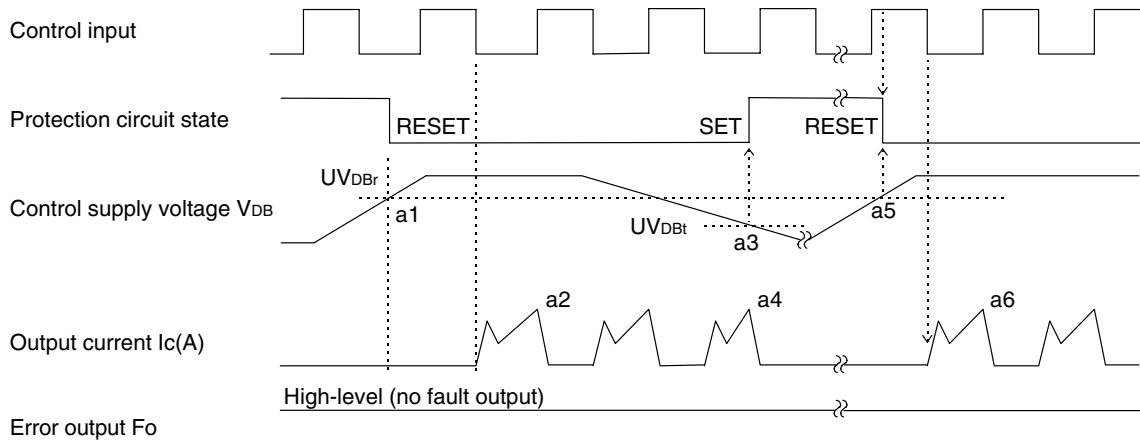


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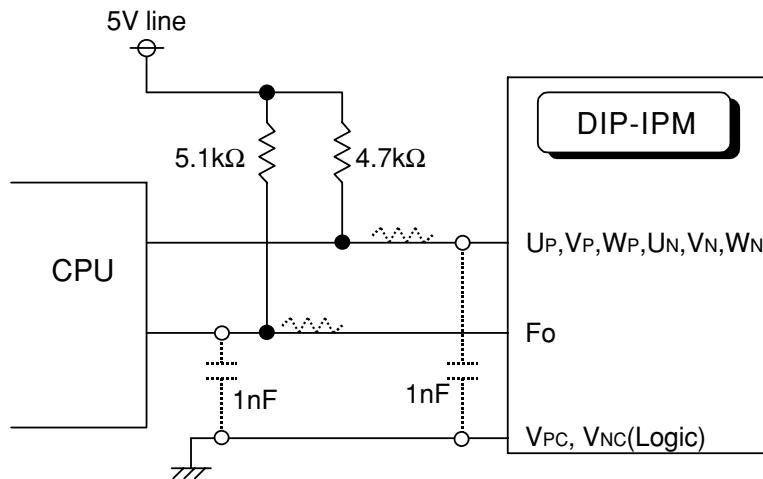
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**[C] Under-Voltage Protection (P-side, UVDB)**

- a1. Control supply voltage rises : After the voltage level reaches UVDBr, the circuits start to operate when the next input is applied.
- a2. Normal operation : IGBT ON and carrying current.
- a3. Under voltage trip (UVDBt).
- a4. IGBT OFF in spite of control input condition, but there is no Fo signal output.
- a5. Under-voltage reset (UVDBr).
- a6. 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 on the wiring impedances of the application's printed circuit board.



