

PS12038

FLAT-BASE TYPE
INSULATED TYPE

PS12038



INTEGRATED FUNCTIONS AND FEATURES

- 3 phase IGBT inverter bridge configured by the latest 3rd. generation IGBT and diode technology.
- Inverter output current capability I_o (Note 1):

Type Name	Motor Rating	I_o (100%)	I_o (150%; 60sec)
PS12038	3.7 kW/400V AC	9.2Arms	13.8Arms

(Note 1) : The inverter output current is assumed to be sinusoidal and the peak current value of each of the above loading cases is defined as : $I_{OP} = I_o \times \sqrt{2}$, $T_c < 100^\circ\text{C}$

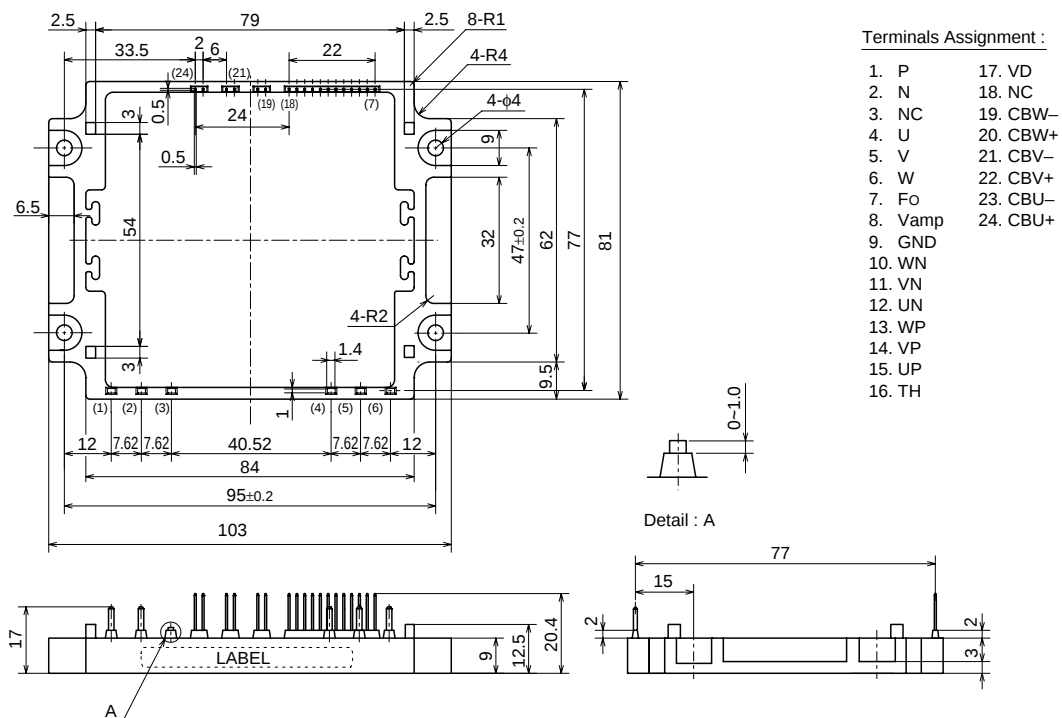
INTEGRATED DRIVE, PROTECTION AND SYSTEM CONTROL FUNCTIONS:

- P-Side IGBTs : Drive circuit, high-level-shift circuit, Bootstrap circuit supply scheme for single control-power-source drive, and Under voltage (UV) protection,
- N-Side IGBTs : Drive circuit, DC-Link current sense and amplifier circuits for over-current protection, Control-supply under-voltage (UV) protection, and fault output (Fo) signaling circuit.
- Fault Output : N-side IGBT short circuit (SC), over-current (OC), and control supply under-voltage (UV).
- Inverter Analog Current Sense : N-Side IGBT DC-Link Current Sense.
- Input Interface : 5V CMOS/TTL compatible, Schmitt Trigger input, and Arm-Shoot-Through interlock protective function.

APPLICATION

Acoustic noise-less 3.7kW/400V AC Class 3 phase inverters, motor control applications, and motors with built-in small size inverter package

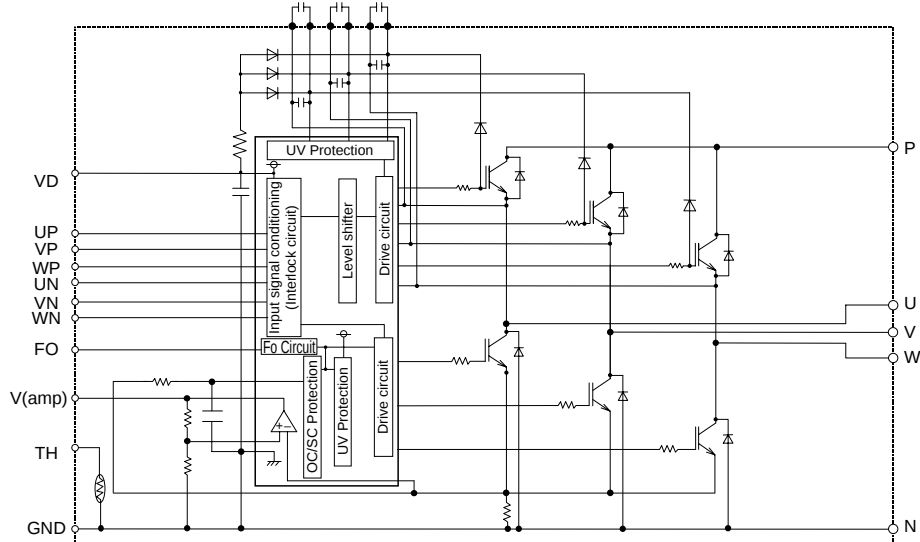
PACKAGE OUTLINES



(Fig. 1)

PS12038

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INSULATED TYPE

INTERNAL FUNCTIONS BLOCK DIAGRAM

(Fig. 2)

MAXIMUM RATINGS ($T_j = 25^\circ\text{C}$)**INVERTER PART**

Symbol	Item	Condition	Ratings	Unit
VCC	Supply voltage	Applied between P-N	900	V
VCC(surge)	Supply voltage (surge)	Applied between P-N, Surge-value	1000	V
VP or VN	Each IGBT collector-emitter static voltage	Applied between P-U.V.W, U.V.W-N	1200	V
VP(S) or VN(S)	Each IGBT collector-emitter switching voltage	Applied between P-U.V.W, U.V.W-N (Pulse)	1200	V
$\pm I_c(\pm I_{cp})$	Each IGBT collector current	$T_c = 25^\circ\text{C}$, "()" means I_c peak value	$\pm 25 (\pm 50)$	A

CONTROL PART

Symbol	Item	Ratings	Unit
VD, VDB	Supply voltage	-0.5 ~ 20	V
V _{CIN}	Input signal voltage	-0.5 ~ +7.5	V
V _{FO}	Fault output supply voltage	-0.5 ~ +7.5	V
I _{FO}	Fault output current	15	mA
I _{amp}	DC-Link IGBT current signal Amp output current	1	mA

PS12038

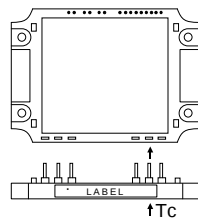
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TOTAL SYSTEM

Symbol	Item	Condition	Ratings	Unit
T_j	Junction temperature	(Note 2)	$-20 \sim +125$	$^{\circ}\text{C}$
T_{stg}	Storage temperature	—	$-40 \sim +125$	$^{\circ}\text{C}$
T_c	Module case operating temperature	(Fig. 3)	$-20 \sim +100$	$^{\circ}\text{C}$
Viso	Isolation voltage	60 Hz sinusoidal AC applied between all terminals and the base plate for 1 minute.	2500	Vrms
—	Mounting torque	Mounting screw: M3.5	0.78 ~ 1.27	N·m

(Note 2) : The indicated values are specified considering the safe operation of all the parts within the ASIPM. The max. ratings for the ASIPM power chips (IGBT & FWDi) is $T_j < 150$.

CASE TEMPERATURE MEASUREMENT POINT

(Fig. 3)

THERMAL RESISTANCE

Symbol	Item	Condition	Ratings			Unit
			Min.	Typ.	Max.	
$R_{\text{th(jc)Q}}$	Junction to case Thermal Resistance	Inverter IGBT (1/6)	—	—	1.5	$^{\circ}\text{C/W}$
$R_{\text{th(jc)F}}$		Inverter FWDi (1/6)	—	—	2.0	$^{\circ}\text{C/W}$
$R_{\text{th(cf)}}$	Contact Thermal Resistance	Case to fin, thermal grease applied (1 Module)	—	—	0.045	$^{\circ}\text{C/W}$

ELECTRICAL CHARACTERISTICS ($T_j = 25^{\circ}\text{C}$, $V_D = 15\text{V}$, $V_{DB} = 15\text{V}$ unless otherwise noted)

Symbol	Item	Condition	Ratings			Unit
			Min.	Typ.	Max.	
$V_{\text{CE(sat)}}$	Collector-emitter saturation voltage	$T_j = 25^{\circ}\text{C}$, Input = ON, $I_c = 5\text{A}$, $V_D = V_{DB} = 15\text{V}$ (Shunt voltage drop not included)	—	—	3.6	V
V_{EC}	FWDi forward voltage	$T_j = 25^{\circ}\text{C}$, $-I_c = 25\text{A}$	—	—	3.5	V
t_{on}	Switching times	1/2 Bridge inductive, Input = $5\text{V} \leftrightarrow 0\text{V}$ $V_{\text{CC}} = 600\text{V}$, $I_c = 5\text{A}$, $T_j = 125^{\circ}\text{C}$ $V_D = 15\text{V}$, $V_{DB} = 15\text{V}$ Note: t_{on} , t_{off} include delay time of the internal control circuit.	0.3	1.2	2.0	μs
$t_{\text{c(on)}}$			—	0.5	1.4	μs
t_{off}			—	2.2	4.0	μs
$t_{\text{c(off)}}$			—	0.9	1.6	μs
t_{rr}	FWDi reverse recovery time		—	0.2	—	μs
Short circuit endurance (Output, Arm, and Load, Short Circuit Modes)		@ $V_{\text{CC}} \leq 800\text{V}$, Input = $5\text{V} \rightarrow 0\text{V}$ (One-Shot) $-20^{\circ}\text{C} \leq T_{j(\text{start})} \leq 125^{\circ}\text{C}$, $13.5\text{V} \leq V_D = V_{DB} \leq 16.5\text{V}$	- No destruction - Fo output by protection operation			
Switching SOA		@ $V_{\text{CC}} \leq 800\text{V}$, Input = $5\text{V} \leftrightarrow 0\text{V}$, $T_j \leq 150^{\circ}\text{C}$ $I_c < \text{OC trip level}$, $13.5\text{V} \leq V_D = V_{DB} \leq 16.5\text{V}$	- No destruction - No protecting operation - No Fo output			

PS12038

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ELECTRICAL CHARACTERISTICS ($T_j = 25^\circ\text{C}$, $V_D = 15\text{V}$, $V_{DB} = 15\text{V}$ unless otherwise noted)

Symbol	Item	Condition	Ratings			Unit
			Min.	Typ.	Max.	
I_D	Circuit current	$T_j = 25^\circ\text{C}$, $V_D = 15\text{V}$, $V_{in} = 5\text{V}$	—	—	50	mA
I_{DB}	Circuit current	$T_j = 25^\circ\text{C}$, $V_D = V_{DB} = 15\text{V}$, $V_{in} = 5\text{V}$	—	—	5	mA
$V_{th(on)}$	Input on threshold voltage		0.8	1.4	2.0	V
$V_{th(off)}$	Input off threshold voltage		2.5	3.0	4.0	V
R_i	Input pull-up resistor	Applied between input terminal-Inside power supply	—	50	—	k Ω
f_{PWM}	PWM input frequency	$T_c \leq 100^\circ\text{C}$, $T_j \leq 125^\circ\text{C}$	—	10	15	kHz
t_{dead}	Arm shoot-through blocking time	Relates to corresponding inputs $T_c = -20^\circ\text{C} \sim +100^\circ\text{C}$ (Note 3)	4.0	—	—	μs
t_{int}	Input interlock sensing	Relates to corresponding input (Fig. 6)	—	100	—	ns
$V_{amp(100\%)}$	Inverter DC-Link IGBT current sense voltage	$I_c = I_{OP(100\%)}$ $V_D = 15\text{V}$	1.5	2.0	2.5	V
$V_{amp(200\%)}$	output signal	$I_c = I_{OP(200\%)}$ $T_j = 25^\circ\text{C}$ (Fig. 4)	3.0	4.0	5.0	V
$V_{amp(250\%)}$	Inverter DC-Link IGBT current sense voltage	$I_c = I_{OP(250\%)}$ $V_D = 15\text{V}$	5.0	—	—	V
$V_{amp(0)}$	output limit	$I_c = 0\text{A}$ (Fig. 4)	—	50	100	mV
OC	Over current trip level	$T_j = 25^\circ\text{C}$ (Fig. 5)	39	46.5	—	A
t_{OC}	Over current delay time	$T_j = 25^\circ\text{C}$ (Fig. 5)	—	10	—	μs
SC	Short circuit trip level	$T_j = 25^\circ\text{C}$ (Fig. 5)	—	69.7	—	A
t_{SC}	Short circuit delay time	$T_j = 25^\circ\text{C}$ (Fig. 5)	—	2	—	μs
UV_D	Supply circuit under voltage protection	V_D UV trip level	11.0	12.0	12.75	V
UV_{Dr}		V_D UV reset level	11.5	12.5	13.25	V
UV_{DB}		V_{DB} UV trip level	10.1	10.8	11.6	V
UV_{DBr}		V_{DB} UV reset level	10.6	11.3	12.1	V
t_{dV}		UV delay time	—	10	—	μs
t_{FO}	Fault output pulse width	$T_j = 25^\circ\text{C}$ (Note 4)	1.0	1.8	—	ms
$I_{FO(H)}$	Fault output current	Open drain output (Note 4)	—	—	1	μA
$I_{FO(L)}$			—	—	15	mA
R_{TH}	Thermistor Resistance	$T_c = 25^\circ\text{C}$	9.5	10	10.5	k Ω
B	Thermistor B constant	Resistance at 25°C , 50°C	—	3450	—	K

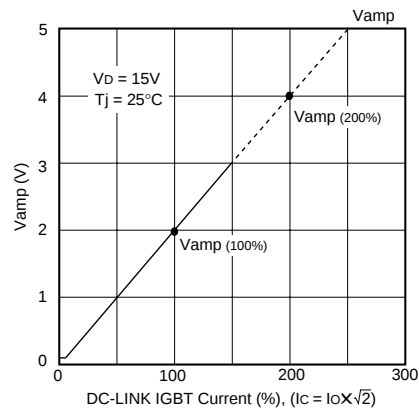
(Note 3) : The dead-time has to be set externally by the CPU; it is not part of the ASIPM internal functions.

(Note 4) : Fault output signaling is given only when the internal OC, SC, & UV protection circuits are activated.

The OC, SC and UV protection (and fault output) operate for the lower arms only. The OC and SC protection Fault output is given in a pulse format while that of UV protection is maintained throughout the duration of the under-voltage condition.

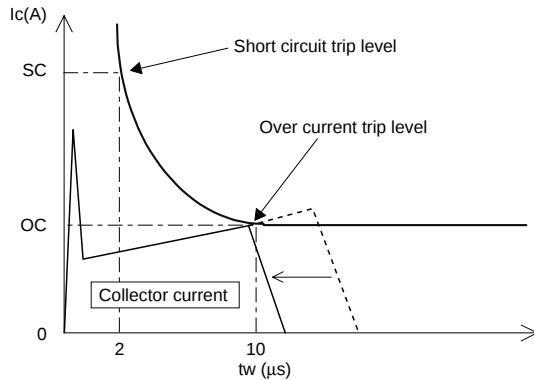
RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Condition	Ratings			Unit
			Min.	Typ.	Max.	
V_{CC}	Supply voltage	Applied across P-N terminals	—	600	800	V
V_D	Supply voltage	Applied between V_D -GND	13.5	15.0	16.5	V
V_{DB}	Supply voltage	Applied between CBU+ & CBU-, CBV+ & CBV-, CBW+ & CBW-	13.5	15.0	16.5	V
ΔV_D , V_{DB}	Supply voltage ripple		-1	—	+1	V/ μs
$V_{CIN(ON)}$	Input on voltage	Applied between UP • VP • WP • UN • VN • WN and GND	0	—	0.8	V
$V_{CIN(OFF)}$	Input off voltage		4.0	—	5.0	V
t_{dead}	Arm shoot-through blocking time	Relates to corresponding inputs	4.0	—	—	μs
T_c	Module case operating temperature		—	—	100	$^\circ\text{C}$
f_{PWM}	PWM Input frequency	$T_c \leq 100^\circ\text{C}$, $T_j \leq 125^\circ\text{C}$	—	—	15	kHz
t_{XX}	Allowable input on-pulse width		1	—	—	μs

INVERTER DC-LINK IGBT CURRENT ANALOGUE SIGNALING OUTPUT (TYPICAL)

(Fig. 4)

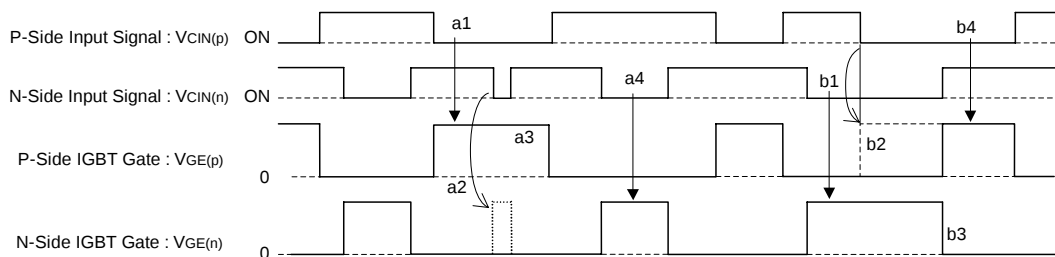
CURRENT ABNORMALITY PROTECTIVE FUNCTIONS



(Fig. 5)

Protection is achieved by monitoring and filtering the N-side DC-Bus current. When a current trip-level is exceeded all the N-side IGBTs are intercepted (turned OFF) and a fault-signal is output. After the fault-signal output duration (1.8msec (typ.)@25°C), the interception is Reset at the following OFF input signal level (more than 4.0V).

ARM-SHOOT-THROUGH INTER-LOCK PROTECTIVE FUNCTION



(Fig. 6)

Description:

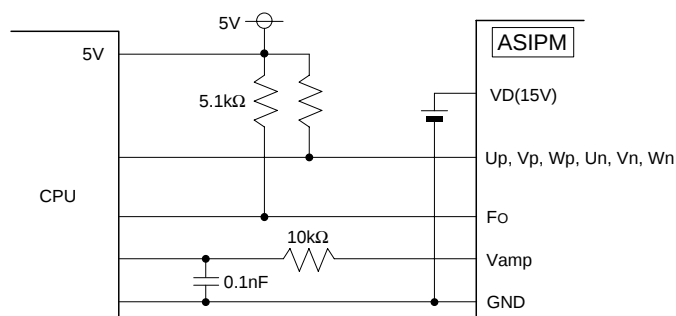
- (1) During the ON-State of either of the upper-arm or the lower-arm IGBT, the inter-lock protection circuit blocks any erroneous ON pulses (resulting from input noise) from triggering the other arm IGBT and thus it prevents the arm-shoot-through situation.
- (2) When two ON-signals are received for both the upper and the lower arms, the signal received first will be passed to the IGBT and the second signal will be blocked. The second signal will be passed to its corresponding IGBT immediately after the first signal is OFF.

Note: This protective function provides no fault signaling output. The Dead-Time has to be set using the micro-controller (CPU).

Operation:

- | | |
|---|--|
| a1. P-side normal ON-signal $\Rightarrow$ P-side IGBT gate turns ON. | b1. N-side normal ON-signal $\Rightarrow$ N-side IGBT gate turns ON. |
| a2. N-side erroneous ON-signal $\Rightarrow$ N-side IGBT gate remains OFF. | b2. Simultaneous ON-signals $\Rightarrow$ P-side IGBT gate remains OFF. |
| a3. While P-side ON-signal remains $\Rightarrow$ P-side IGBT gate remains ON. | b3. N-side receives OFF-signal $\Rightarrow$ N-side IGBT gate turns OFF. |
| a4. N-side normal ON-signal $\Rightarrow$ N-side IGBT gate turns ON. | b4. Immediately after (b3) $\Rightarrow$ P-side IGBT gate turns ON. |

RECOMMENDED I/O INTERFACE CIRCUIT



(Fig. 7)