PM200RL1A060

FLAT-BASE TYPE
INSULATED PACKAGE

PM200RL1A060

FEATURE

Inverter + Brake + Drive & Protection IC

a) Adopting new 5th generation Full-Gate CSTBT^{TM} chip
b) The over-temperature protection which detects the chip surface temperature of CSTBT^{TM} is adopted.
c) Error output signal is possible from all each protection upper and lower arm of IPM.
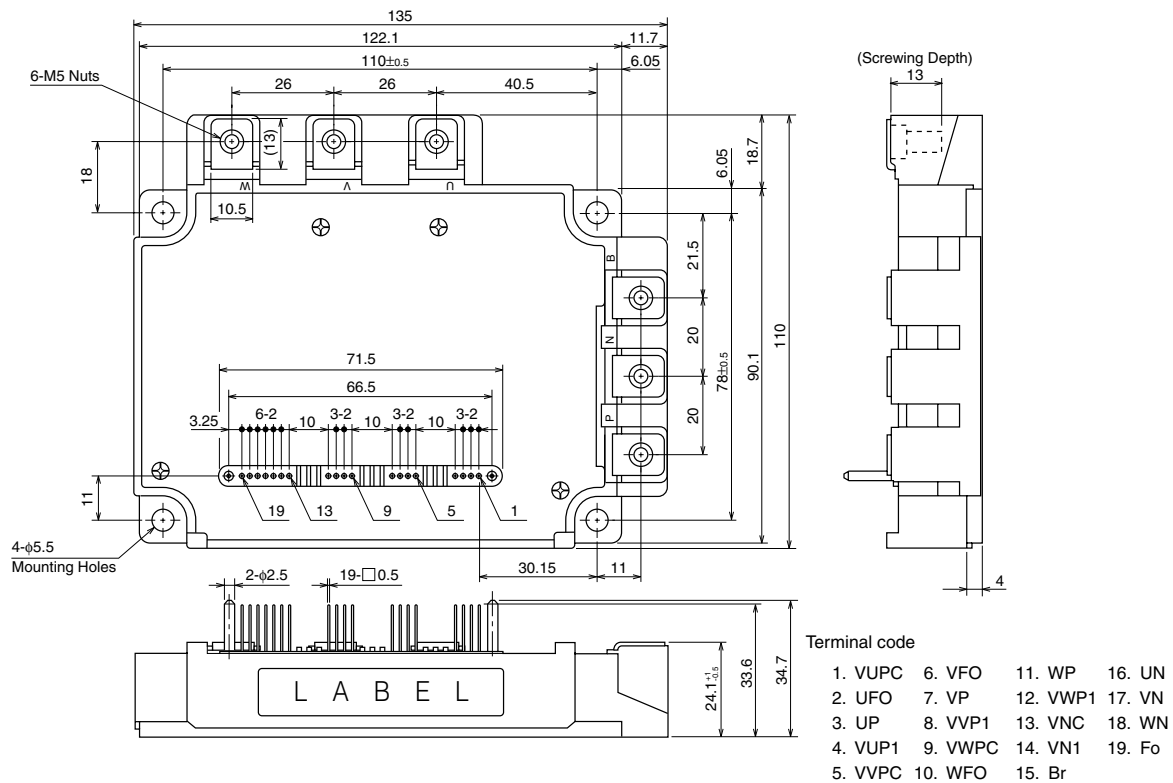d) Compatible L-series package.

- 3φ 200A, 600V Current-sense and temperature sense IGBT type inverter
- Monolithic gate drive & protection logic
- Detection, protection & status indication circuits for, short-circuit, over-temperature & under-voltage (P-F$_O$ available from upper arm devices)
- UL Recognized

APPLICATION

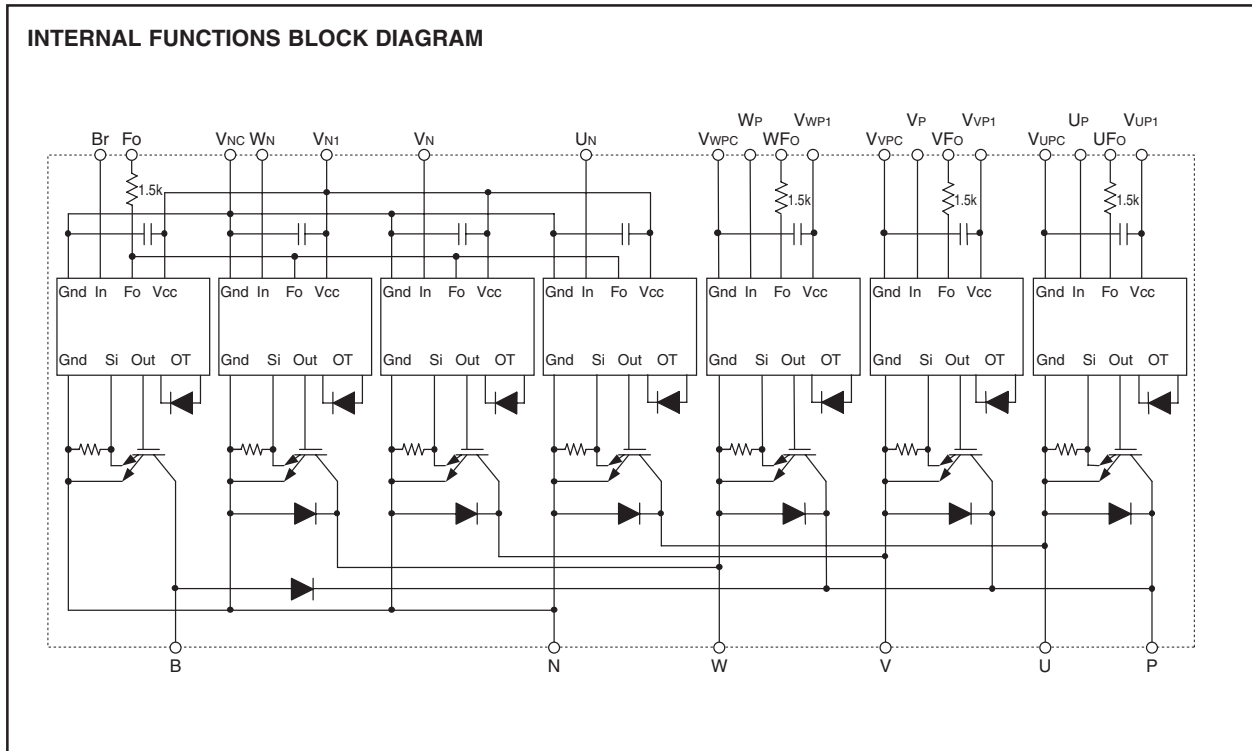General purpose inverter, servo drives and other motor controls

PACKAGE OUTLINES

Dimensions in mm

Terminal code

1. VUPC	6. VFO	11. WP	16. UN
2. UFO	7. VP	12. VWP1	17. VN
3. UP	8. VVP1	13. VNC	18. WN
4. VUP1	9. VWPC	14. VN1	19. Fo
5. VVPC	10. WFO	15. Br	

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INTERNAL FUNCTIONS BLOCK DIAGRAM

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

INVERTER PART

Symbol	Parameter	Condition		Ratings	Unit
V_{CES}	Collector-Emitter Voltage	V_D = 15V, V_{CIN} = 15V		600	V
$\pm I_C$	Collector Current	T_C = 25°C	(Note-1)	200	A
$\pm I_{CP}$	Collector Current (Peak)	T_C = 25°C		400	A
P_C	Collector Dissipation	T_C = 25°C	(Note-1)	625	W
T_j	Junction Temperature			−20 ~ +150	°C

*: Tc measurement point is just under the chip.

BRAKE PART

Symbol	Parameter	Condition		Ratings	Unit
V_{CES}	Collector-Emitter Voltage	V_D = 15V, V_{CIN} = 15V		600	V
I_C	Collector Current	T_C = 25°C	(Note-1)	100	A
I_{CP}	Collector Current (Peak)	T_C = 25°C		200	A
P_C	Collector Dissipation	T_C = 25°C	(Note-1)	390	W
I_F	FWDi Forward Current	T_C = 25°C		100	A
$V_{R(DC)}$	FWDi Rated DC Reverse Voltage	T_C = 25°C		600	V
T_j	Junction Temperature			−20 ~ +150	°C

CONTROL PART

Symbol	Parameter	Condition	Ratings	Unit
V_D	Supply Voltage	Applied between : V_{UP1}-V_{UPC}, V_{VP1}-V_{VPC} V_{WP1}-V_{WPC}, V_{N1}-V_{NC}	20	V
V_{CIN}	Input Voltage	Applied between : U_P-V_{UPC}, V_P-V_{VPC}, W_P-V_{WPC} U_N • V_N • W_N • B_r-V_{NC}	20	V
V_{FO}	Fault Output Supply Voltage	Applied between : U_{FO}-V_{UPC}, V_{FO}-V_{VPC}, W_{FO}-V_{WPC} F_O-V_{NC}	20	V
I_{FO}	Fault Output Current	Sink current at U_{FO}, V_{FO}, W_{FO}, F_O terminals	20	mA

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TOTAL SYSTEM

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC(PROT)}$	Supply Voltage Protected by SC	V_D =13.5V ~ 16.5V Inverter Part, T_j =+125°C Start	400	V
$V_{CC(surge)}$	Supply Voltage (Surge)	Applied between : P-N, Surge value	500	V
T_{stg}	Storage Temperature		–40 ~ +125	°C
V_{iso}	Isolation Voltage	60Hz, Sinusoidal, Charged part to Base plate, AC 1min, RMS	2500	V

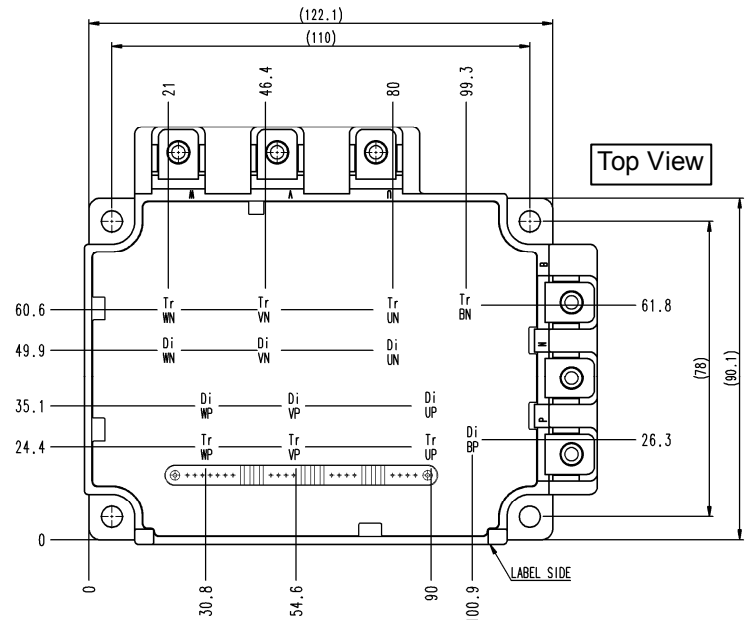*: T_C measurement point is just under the chip.

THERMAL RESISTANCE

Symbol	Parameter	Conditions		Limits			Unit
				Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal Resistance	Inverter, IGBT (per 1 element)	(Note.1)	-	-	0.20	°C/W
$R_{th(j-c)F}$		Inverter, FWDi (per 1 element)	(Note.1)	-	-	0.30	
$R_{th(j-c)Q}$		Brake, IGBT	(Note.1)	-	-	0.32	
$R_{th(j-c)F}$		Brake, FwDi upper part	(Note.1)	-	-	0.53	
$R_{th(c-f)}$	Contact Thermal Resistance	Case to fin, (per 1 module) Thermal grease applied	(Note.1)	-	-	0.023	

Note.1: If you use this value, $R_{th(f-a)}$ should be measured just under the chips.

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PM200RL1A060 350G

* "350G" is printed on the label

ELECTRICAL CHARACTERISTICS (Tj = 25°C, unless otherwise noted)

INVERTER PART

Symbol	Parameter	Conditions		Limits			Unit
				Min.	Typ.	Max.	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	V_D=15V, I_C=200A V_{CIN}=0V, Pulsed (Fig. 1)	T_j=25°C	-	1.75	2.35	V
			T_j=125°C	-	1.75	2.35	
V_{EC}	FwDi Forward Voltage	-I_C=200A, V_D=15V, V_{CIN}= 15V (Fig. 2)		-	1.7	2.8	V
t_{on}	Switching Time	V_D=15V, V_{CIN}=0V↔15V V_{CC}=300V, I_C=200A T_j=125°C Inductive Load (Fig. 3,4)		0.3	0.8	2.0	μs
t_{rr}				-	0.4	0.8	
$t_{c(on)}$				-	0.4	1.0	
t_{off}				-	1.0	2.3	
$t_{c(off)}$				-	0.3	1.0	
I_{CES}	Collector-Emitter Cut-off Current	V_{CE}=V_{CES}, V_D=15V , V_{CIN}=15V (Fig. 5)	T_j=25°C	-	-	1	mA
			T_j=125°C	-	-	10	

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BRAKE PART

Symbol	Parameter	Condition			Limits			Unit
					Min.	Typ.	Max.	
V$_{CE(sat)}$	Collector-Emitter Saturation Voltage	V$_D$ = 15V, I$_C$ = 100A V$_{CIN}$ = 0V, Pulsed (Fig. 1)	T$_j$ = 25°C		—	1.75	2.35	V
			T$_j$ = 125°C		—	1.75	2.35	
V$_{EC}$	FWDi Forward Voltage	−I$_C$ = 100A, V$_{CIN}$ = 15V, V$_D$ = 15V (Fig. 2)			—	1.7	2.8	V
I$_{CES}$	Collector-Emitter Cutoff Current	V$_{CE}$ = V$_{CES}$, V$_D$ = 15V (Fig. 5)	T$_j$ = 25°C		—	—	1	mA
			T$_j$ = 125°C		—	—	10	

CONTROL PART

Symbol	Parameter	Condition		Limits			Unit
				Min.	Typ.	Max.	
I$_D$	Circuit Current	V$_D$ = 15V, V$_{CIN}$ = 15V	V$_{N1}$-V$_{NC}$	—	8	16	mA
			V*$_{P1}$-V*$_{PC}$	—	2	4	
V$_{th(ON)}$	Input ON Threshold Voltage	Applied between : U$_P$-V$_{UPC}$, V$_P$-V$_{VPC}$, W$_P$-V$_{WPC}$		1.2	1.5	1.8	V
V$_{th(OFF)}$	Input OFF Threshold Voltage	U$_N$ • V$_N$ • W$_N$ • B$_r$-V$_{NC}$		1.7	2.0	2.3	
SC	Short Circuit Trip Level	−20 ≤ T$_j$ ≤ 125°C, V$_D$ = 15V (Fig. 3,6)	Inverter part	400	—	—	A
			Brake part	200	—	—	
t$_{off(SC)}$	Short Circuit Current Delay Time	V$_D$ = 15V (Fig. 3,6)		—	0.2	—	µs
OT	Over Temperature Protection	Detect Temperature of IGBT chip	Trip level	135	—	—	°C
OT$_{(hys)}$			Hysteresis	—	20	—	
UV	Supply Circuit Under-Voltage Protection	−20 ≤ T$_j$ ≤ 125°C	Trip level	11.5	12.0	12.5	V
UV$_r$			Reset level	—	12.5	—	
I$_{FO(H)}$	Fault Output Current	V$_D$ = 15V, V$_{CIN}$ = 15V (Note-2)		—	—	0.01	mA
I$_{FO(L)}$				—	10	15	
t$_{FO}$	Minimum Fault Output Pulse Width	V$_D$ = 15V (Note-2)		1.0	1.8	—	ms

(Note-2) Fault output is given only when the internal SC, OT & UV protections schemes of either upper or lower arm device operate to protect it.
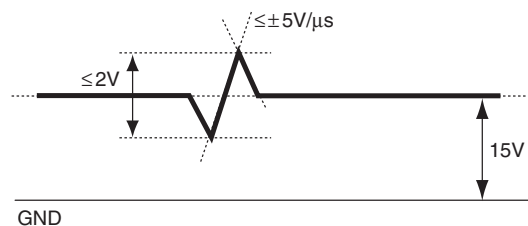
MECHANICAL RATINGS AND CHARACTERISTICS

Symbol	Parameter	Condition		Limits			Unit
				Min.	Typ.	Max.	
—	Mounting torque	Mounting part	screw : M5	2.5	3.0	3.5	N • m
—	Mounting torque	Main terminal part	screw : M5	2.5	3.0	3.5	N • m
—	Weight	—		—	800	—	g

RECOMMENDED CONDITIONS FOR USE

Symbol	Parameter	Condition	Recommended value	Unit
V$_{CC}$	Supply Voltage	Applied across P-N terminals	≤ 400	V
V$_D$	Control Supply Voltage	Applied between : V$_{UP1}$-V$_{UPC}$, V$_{VP1}$-V$_{VPC}$ V$_{WP1}$-V$_{WPC}$, V$_{N1}$-V$_{NC}$ (Note-3)	15.0 ± 1.5	V
V$_{CIN(ON)}$	Input ON Voltage	Applied between : U$_P$-V$_{UPC}$, V$_P$-V$_{VPC}$, W$_P$-V$_{WPC}$	≤ 0.8	V
V$_{CIN(OFF)}$	Input OFF Voltage	U$_N$ • V$_N$ • W$_N$ • B$_r$-V$_{NC}$	≥ 9.0	
f$_{PWM}$	PWM Input Frequency	Using Application Circuit of Fig. 8	≤ 20	kHz
t$_{dead}$	Arm Shoot-through Blocking Time	For IPM's each input signals (Fig. 7)	≥ 2.0	µs

(Note-3) With ripple satisfying the following conditions: dv/dt swing ≤ ±5V/µs, Variation ≤ 2V peak to peak
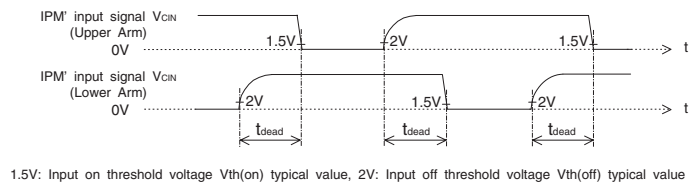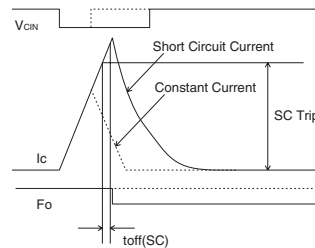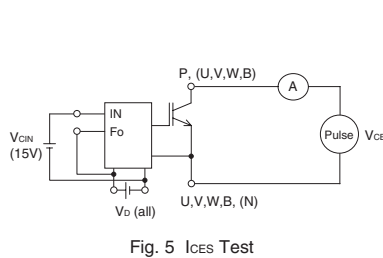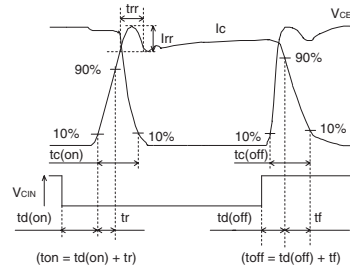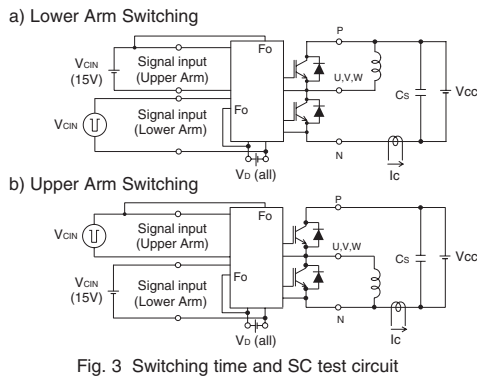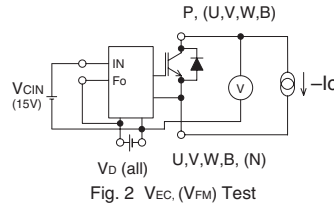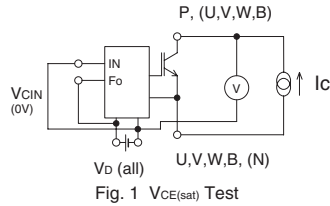
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PRECAUTIONS FOR TESTING

1. Before applying any control supply voltage (V$_D$), the input terminals should be pulled up by resistors, etc. to their corresponding supply voltage and each input signal should be kept off state.
   After this, the specified ON and OFF level setting for each input signal should be done.

2. When performing "SC" tests, the turn-off surge voltage spike at the corresponding protection operation should not be allowed to rise above V$_{CES}$ rating of the device.
   (These test should not be done by using a curve tracer or its equivalent.)

Fig. 1 V$_{CE(sat)}$ Test

Fig. 2 V$_{EC}$, (V$_{FM}$) Test

a) Lower Arm Switching

b) Upper Arm Switching

Fig. 3 Switching time and SC test circuit

Fig. 4 Switching time test waveform

Fig. 5 I$_{CES}$ Test

Fig. 6 SC test waveform

1.5V: Input on threshold voltage Vth(on) typical value, 2V: Input off threshold voltage Vth(off) typical value

Fig. 7 Dead time measurement point example

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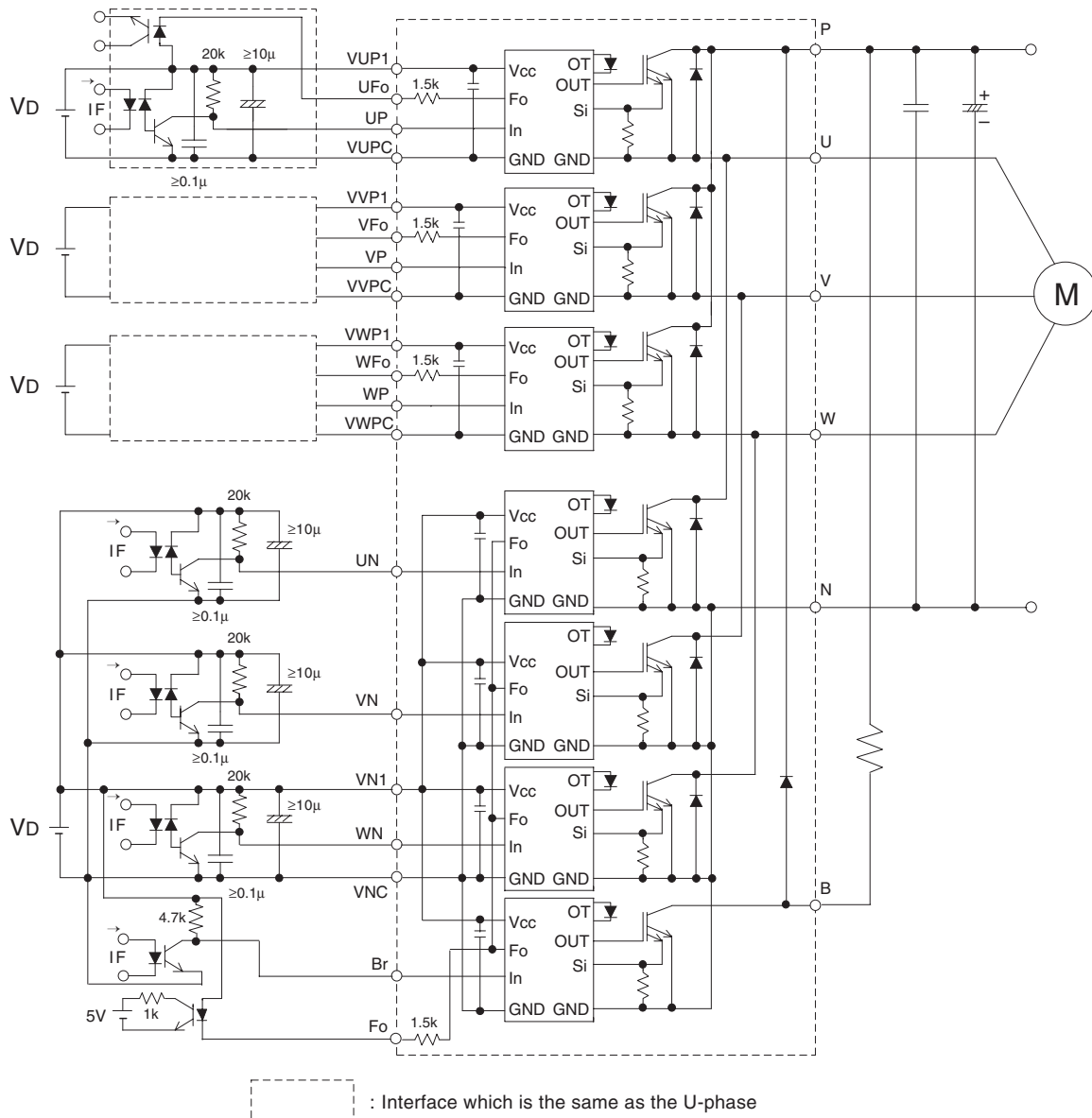# PM200RL1A060

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Fig. 8 Application Example Circuit
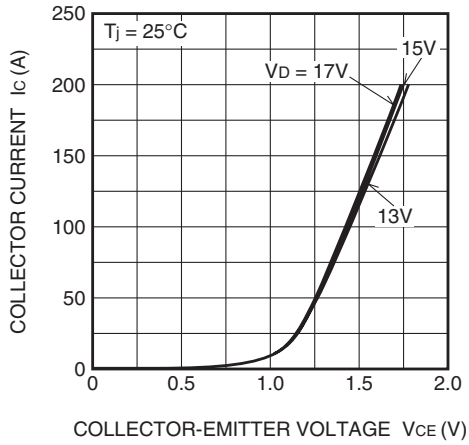
NOTES FOR STABLE AND SAFE OPERATION ;

- Design the PCB pattern to minimize wiring length between opto-coupler and IPM's input terminal, and also to minimize the stray capacity between the input and output wirings of opto-coupler.
- Connect low impedance capacitor between the Vcc and GND terminal of each fast switching opto-coupler.
- Fast switching opto-couplers: t_{PLH}, $t_{PHL} \leq 0.8\mu s$, Use High CMR type.
- Slow switching opto-coupler: CTR > 100%
- Use 4 isolated control power supplies (V_D). Also, care should be taken to minimize the instantaneous voltage charge of the power supply.
- Make inductance of DC bus line as small as possible, and minimize surge voltage using snubber capacitor between P and N terminal.
- Use line noise filter capacitor (ex. 4.7nF) between each input AC line and ground to reject common-mode noise from AC line and improve noise immunity of the system.
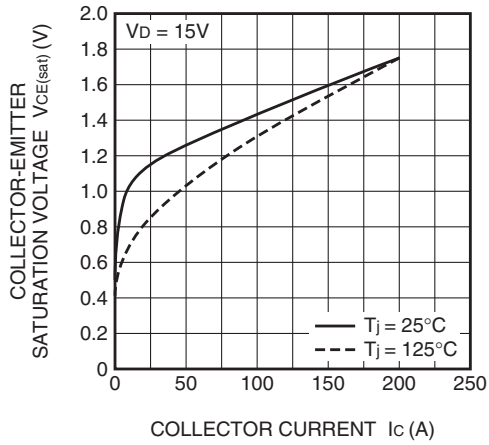
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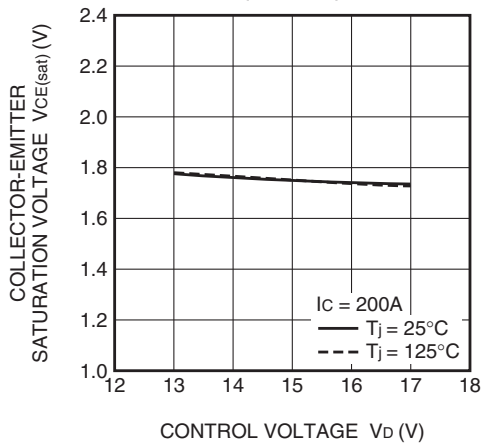**INSULATED PACKAGE**

PERFORMANCE CURVES
(Inverter Part)

OUTPUT CHARACTERISTICS (TYPICAL)

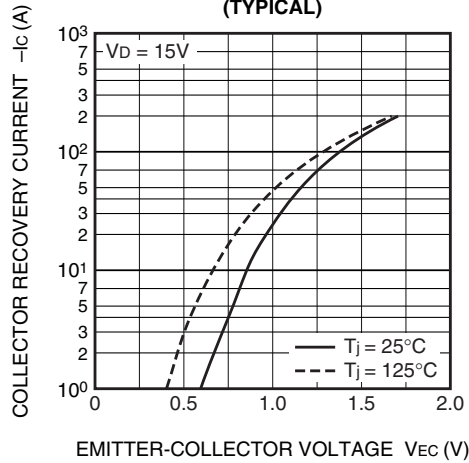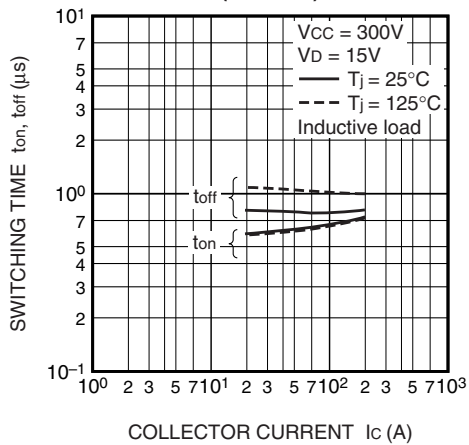**COLLECTOR-EMITTER SATURATION VOLTAGE (VS. Ic) CHARACTERISTICS (TYPICAL)**

COLLECTOR-EMITTER SATURATION VOLTAGE (VS. VD) CHARACTERISTICS (TYPICAL)

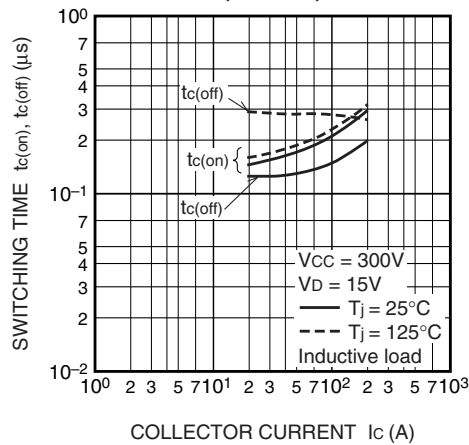**DIODE FORWARD CHARACTERISTICS (TYPICAL)**
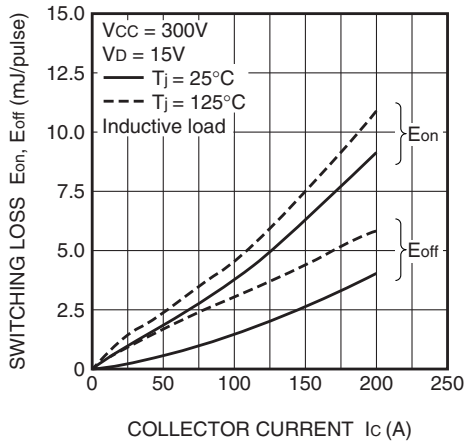

SWITCHING TIME (ton, toff) CHARACTERISTICS (TYPICAL)

SWITCHING TIME (tc(on), tc(off)) CHARACTERISTICS (TYPICAL)

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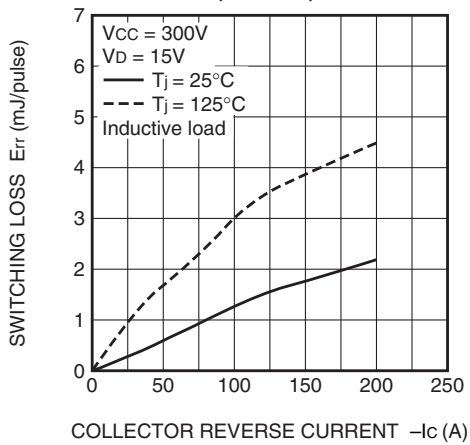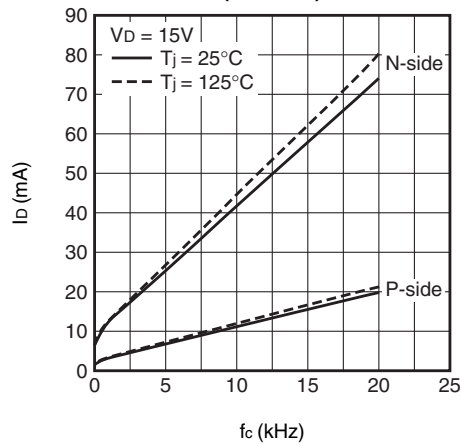### SWITCHING LOSS CHARACTERISTICS
(TYPICAL)

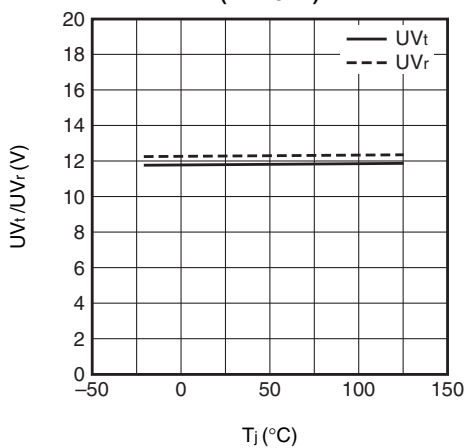### DIODE REVERSE RECOVERY CHARACTERISTICS
(TYPICAL)

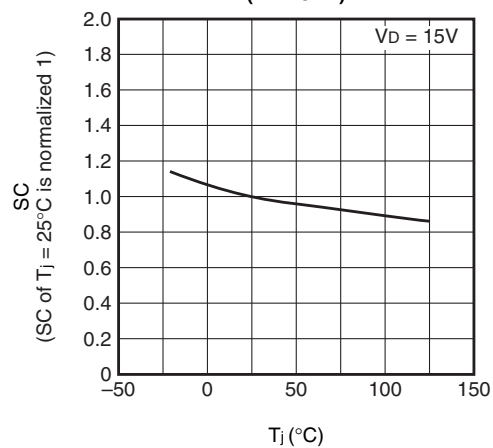### SWITCHING RECOVERY LOSS CHARACTERISTICS
(TYPICAL)

I_D VS. f_c CHARACTERISTICS
(TYPICAL)

UV TRIP LEVEL VS. T_j CHARACTERISTICS
(TYPICAL)

SC TRIP LEVEL VS. T_j CHARACTERISTICS
(TYPICAL)

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(Brake Part)

TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)

Single Pulse
IGBT part;
Per unit base = $R_{th(j-c)}Q = 0.2°C/W$
FWDi part;
Per unit base = $R_{th(j-c)}F = 0.3°C/W$

NORMALIZED TRANSIENT THERMAL IMPEDANCE $Z_{th(j-c)}$

TIME t (sec)

OUTPUT CHARACTERISTICS (TYPICAL)

$T_j = 25°C$

$V_D = 17V$, 15V, 13V

COLLECTOR CURRENT I_C (A)

COLLECTOR-EMITTER VOLTAGE V_{CE} (V)

COLLECTOR-EMITTER SATURATION VOLTAGE (VS. Ic) CHARACTERISTICS (TYPICAL)

$V_D = 15V$

COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)

— $T_j = 25°C$
-- $T_j = 125°C$

COLLECTOR CURRENT I_C (A)

COLLECTOR-EMITTER SATURATION VOLTAGE (VS. VD) CHARACTERISTICS (TYPICAL)

COLLECTOR-EMITTER SATURATION VOLTAGE $V_{CE(sat)}$ (V)

$I_C = 100A$
— $T_j = 25°C$
-- $T_j = 125°C$

CONTROL VOLTAGE V_D (V)

DIODE FORWARD CHARACTERISTICS (TYPICAL)

$V_D = 15V$

COLLECTOR RECOVERY CURRENT $-I_C$ (A)

— $T_j = 25°C$
-- $T_j = 125°C$

EMITTER-COLLECTOR VOLTAGE V_{EC} (V)

TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)

Single Pulse
IGBT part;
Per unit base = $R_{th(j-c)}Q = 0.32°C/W$
FWDi part;
Per unit base = $R_{th(j-c)}F = 0.53°C/W$

NORMALIZED TRANSIENT THERMAL IMPEDANCE $Z_{th(j-c)}$

TIME t (sec)

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