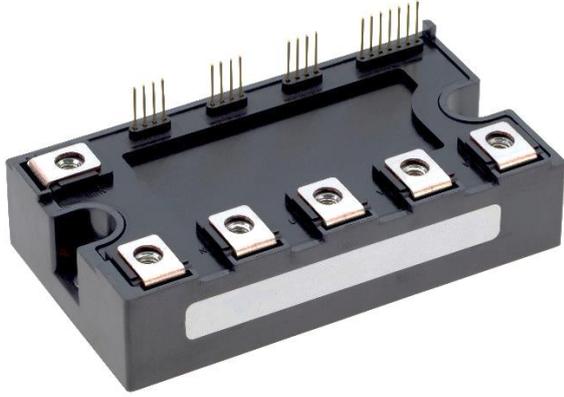# MITSUBISHI ELECTRIC

<Intelligent Power Modules>

PMF75CGA120/PMF75CGAL120

FLAT-BASE TYPE
INSULATED PACKAGE

FEATURE

a) SiC MOSFET is adopted for 3phase inverter.

b) SiC Schottky Barrier Diode is adopted for FWD.

c) The over-temperature protection which detects the chip surface temperature of SiC MOSFET is adopted.

d) Error output signal is available from each protection upper and lower arm of IPM.

e) Outputting an error signal corresponding to the abnormal state (error mode identification)
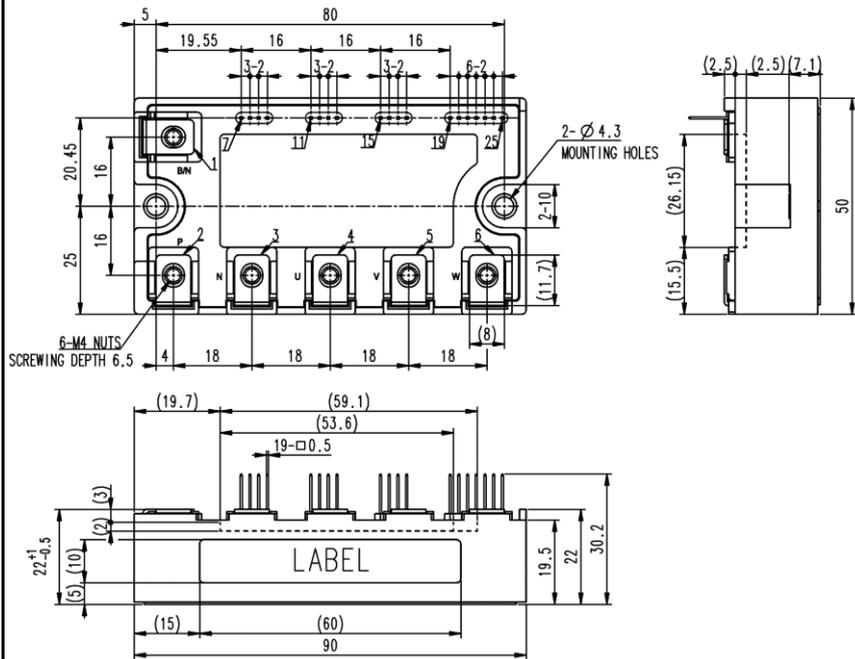
UL Recognized under UL1557, File No. E323585

This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU and (EU)2015/863.

APPLICATION

General purpose inverter, servo drives and other motor controls, Power supply

PACKAGE OUTLINES

Dimensions in mm

Tolerance otherwise specified

Division of Dimension			Tolerance
0.5	to	3	±0.2
over 3	to	6	±0.3
over 6	to	30	±0.5
over 30	to	120	±0.8
over 120	to	400	±1.2


TERMINAL CODE

----CGA type----

1.NC, 2.P, 3.N, 4.U, 5.V, 6.W, 7.V_{UPC}, 8.U_{FO}, 9.U_P, 10.V_{UP1}, 11.V_{VPC}, 12.V_{FO}, 13.V_P, 14.V_{VP1}, 15.V_{WPC}, 16.W_{FO}, 17.W_P, 18.V_{WP1}, 19.V_{NC}, 20.V_{N1}, 21.NC, 22.U_N, 23.V_N, 24.W_N, 25.F_O

----CGAL type----

1.N, 2.P, 3.NC, 4.U, 5.V, 6.W, 7.V_{UPC}, 8.U_{FO}, 9.U_P, 10.V_{UP1}, 11.V_{VPC}, 12.V_{FO}, 13.V_P, 14.V_{VP1}, 15.V_{WPC}, 16.W_{FO}, 17.W_P, 18.V_{WP1}, 19.V_{NC}, 20.V_{N1}, 21.NC, 22.U_N, 23.V_N, 24.W_N, 25.F_O

<Intelligent Power Modules>

PMF75CGA120/PMF75CGAL120
HIGH POWER SWITCHING USE
INSULATED TYPE

INTERNAL FUNCTIONS BLOCK DIAGRAM
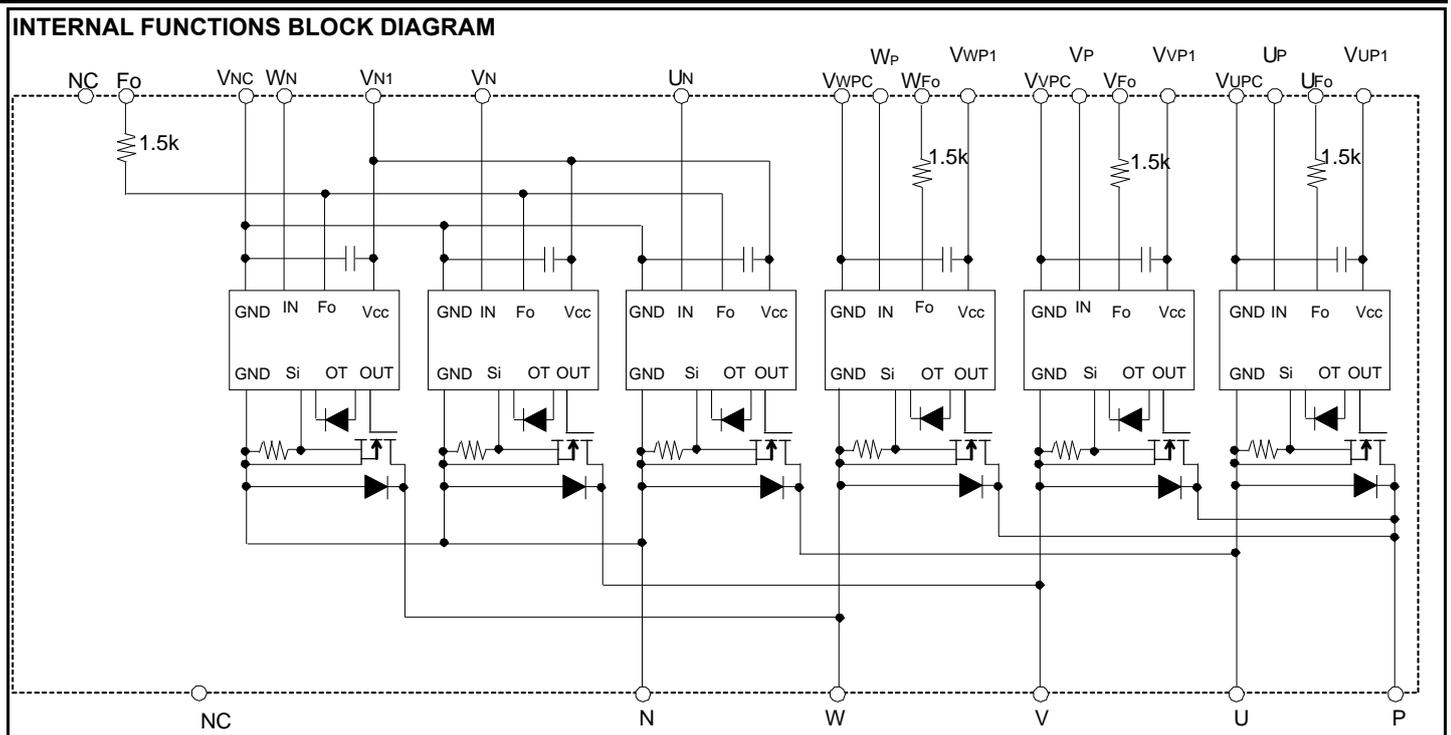
MAXIMUM RATINGS (T_{vj} = 25°C, unless otherwise noted)

INVERTER PART

Symbol	Parameter	Conditions	Ratings	Unit
V_{DSS}	Drain-Source Voltage	V_D=15 V, V_{CIN}=15 V	1200	V
I_D	Drain Current	T_C=25 °C	75	A
I_{DRM}		Pulse	90	
P_{tot}	Total Power Dissipation	T_C=25 °C	337	W
I_S	Source Current	T_C=25 °C	75	A
I_{SM}	(Free-wheeling Diode Forward current)	Pulse	90	
T_{vj}	Junction Temperature	(Note5)	-20 ~ +150	°C

*: T_C measurement point is just under the chip.

CONTROL PART

Symbol	Parameter	Conditions	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-V_{NC}	20	V
V_{FO}	Fault Output Supply Voltage	Applied between: U_{FO}-V_{UPC}, V_{FO}-V_{VPC}, W_{FO}-V_{WPC}, Fo-V_{NC}	20	V
I_{FO}	Fault Output Current	Sink current at U_{FO}, V_{FO}, W_{FO}, Fo terminals	20	mA

TOTAL SYSTEM

Symbol	Parameter	Conditions	Ratings	Unit
$V_{DD(PROT)}$	Supply Voltage Protected by SC	V_D =13.5 V~16.5 V, Inverter Part, T_{vj}=+125°C start	800	V
T_{stg}	Storage Temperature	-	-40 ~ +125	°C
T_C	Operating Case Temperature	(Note5)	-20 ~ +125	°C
V_{isol}	Isolation Voltage	60Hz, Sinusoidal, Charged part to Base plate, AC 1min, RMS	2500	V

*: T_C measurement point is just under the chip.

MITSUBISHI ELECTRIC CORPORATION

PMF75CGA120/PMF75CGAL120
HIGH POWER SWITCHING USE
INSULATED TYPE

THERMAL RESISTANCE

Symbol	Parameter	Conditions	Limits Min.	Limits Typ.	Limits Max.	Unit
$R_{th(j-c)Q}$	Thermal Resistance	Junction to case, MOSFET, per 1 element (Note1)	-	-	0.37	K/W
$R_{th(j-c)D}$		Junction to case, FWD, per 1 element (Note1)	-	-	0.50	K/W
$R_{th(c-s)}$	Contact Thermal Resistance	Case to heat sink, per 1 module, Thermal grease applied (Note.1, 2, 5)	-	42.0	-	K/kW

Note1. If you use this value, $R_{th(s-a)}$ should be measured just under the chips.

Note2. Typical value is measured by using thermally conductive grease of λ=0.9W/(m·K), $D_{(C-S)}$=150 μm.

CHIP LOCATION (Top view) Dimension in mm, torelance: ±1mm

Tr** : MOS
Di** : FWD

ELECTRICAL CHARACTERISTICS (T_{vj}= 25°C, unless otherwise noted)

INVERTER PART

Symbol	Parameter	Conditions			Limits Min.	Limits Typ.	Limits Max.	Unit
$V_{DS(on)}$	Drain-Source Saturation Voltage	V_D=15 V, I_D=75 A	T_{vj}=25 °C	Terminal	-	-	3.20	V
				Chip	-	1.80	-	
		V_{CIN}=0 V, Pulsed, (Fig.1)	T_{vj}=125 °C	Terminal	-	-	3.00	
				Chip	-	1.70	-	
V_{SD}	Source-Drain Voltage	V_D=15 V, I_S=75 A,	T_{vj}=25 °C	Terminal	-	-	2.00	V
				Chip	-	1.55	-	
		V_{CIN}= 15 V, pulsed, (Fig.2)	T_{vj}=125 °C	Terminal	-	-	2.50	
				Chip	-	1.95	-	
t_{on}	Switching Time	V_D=15 V, V_{CIN}=0 V←→15 V,			0.4	0.7	1.0	μs
$t_{c(on)}$		V_{DD}=600 V, I_D=75A, T_{vj}=125 °C,			-	0.1	0.2	
t_{off}		Inductive Load			-	0.5	0.9	
$t_{c(off)}$		(Fig.3, 4)			-	0.06	0.2	
I_{DSS}	Drain-Source Cut-off Current	V_{DS}=V_{DSS}, V_D=15 V, V_{CIN}=15 V (Fig.5)	T_{vj}=25 °C		-	-	1	mA
			T_{vj}=125 °C		-	-	10	

MITSUBISHI ELECTRIC CORPORATION

<Intelligent Power Modules>

PMF75CGA120/PMF75CGAL120
HIGH POWER SWITCHING USE
INSULATED TYPE

ELECTRICAL CHARACTERISTICS (T_{vj} = 25°C, unless otherwise noted)

CONTROL PART

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit
I_{DD}	Circuit Current	V_D=15 V, V_{CIN}=15 V	V_{P1}-V_{PC}	-	4	6	mA
			V_{N1}-V_{NC}	-	12	18	
		V_D=15 V, V_{CIN}=0 V$\leftrightarrow$15 V, V_{DD}=800 V	V_{P1}-V_{PC}	-	31	47	
		I_D=0A, T_{vj}=125 °C, f_C≤100kHz	V_{N1}-V_{NC}	-	92	138	
$V_{th(ON)}$	Input ON Threshold Voltage	Applied between:		1.2	1.5	1.8	V
$V_{th(OFF)}$	Input OFF Threshold Voltage	U_P-V_{UPC}, V_P-V_{VPC}, W_P-V_{WPC}, U_N, V_N, W_N-V_{NC}		1.7	2.0	2.3	
SC	Short Circuit Trip Level	-20≤T_{vj}≤125 °C, V_D=15 V (Fig.3, 6)		90	-	-	A
$t_{d(SC)}$	Short Circuit Current Delay Time	V_D=15 V, T_{vj}=125 °C (Fig.3, 6)		-	2.0	-	μs
OT	Over Temperature Protection	Detect temperature of MOSFET chip surface	Trip level	150	-	-	°C
$OT_{(hys)}$			Hysteresis	-	20	-	
UV_t	Supply Circuit		Trip level	11.0	12.0	12.7	V
UV_r	Under-Voltage Protection	-	Reset level	-	12.5	-	
$I_{FO(H)}$	Fault Output Current	V_D=15 V, V_{FO}=15 V (Note3)		-	-	0.01	mA
$I_{FO(L)}$				-	10	15	
t_{FO}	Fault Output Pulse Width	V_D=15 V (Note3)	OT	-	8.0	-	ms
			UV	-	4.0	-	
			SC	-	2.0	-	

Note3. 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	Conditions		Min.	Typ.	Max.	Unit
M_s	Mounting Torque	Mounting part	screw : M4	1.5	1.7	2.0	N•m
M_t	Mounting Torque	Main terminal part	screw : M4	1.5	1.7	2.0	
m	mass	-		-	210	-	g

RECOMMENDED CONDITIONS FOR USE

Symbol	Parameter	Conditions	Recommended value	Unit
V_{DD}	Supply Voltage	Applied across P-N terminals	≤ 800	V
V_D	Control Supply Voltage	Applied between : V_{UP1}-V_{UPC}, V_{VP1}-V_{VPC}, V_{WP1}-V_{WPC},V_{N1}-V_{NC} (Note4)	15.0±1.5	V
$V_{CIN(ON)}$	Input ON Voltage	Applied between :	≤ 0.8	V
$V_{CIN(OFF)}$	Input OFF Voltage	U_P-V_{UPC}, V_P-V_{VPC}, W_P-V_{WPC}, U_N, V_N, W_N-V_{NC}	≥ 9.0	
f_{PWM}	PWM Input Frequency	Using Application Circuit of Fig. 8, T_C=125°C (Note5)	≤ 100	kHz
t_{dead}	Arm Shoot-through Blocking Time	For IPM's each input signals (Fig.7)	≥ 0.5	μs

This is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU and (EU)2015/863.

Note4. With ripple satisfying the following conditions: dv/dt swing ≤ ±5 V/μs, Variation ≤ 2 V peak to peak
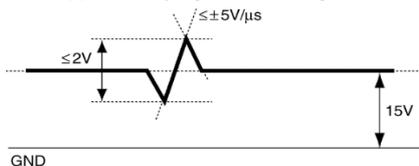
Note5. Long term performance related to thermal conductive material such as thermal grease (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under your specific application conditions. Each temperature condition (T_{vj}, T_c) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

MITSUBISHI ELECTRIC CORPORATION

PMF75CGA120/PMF75CGAL120

HIGH POWER SWITCHING USE
INSULATED TYPE

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_{DSS} rating of the device.

   (These test should not be done by using a curve tracer or its equivalent.)
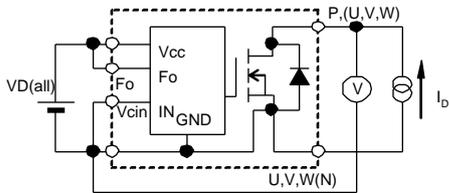
Fig.1 $V_{DS(on)}$ Test
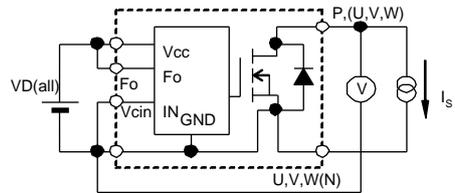
Fig.2 V_{SD} Test
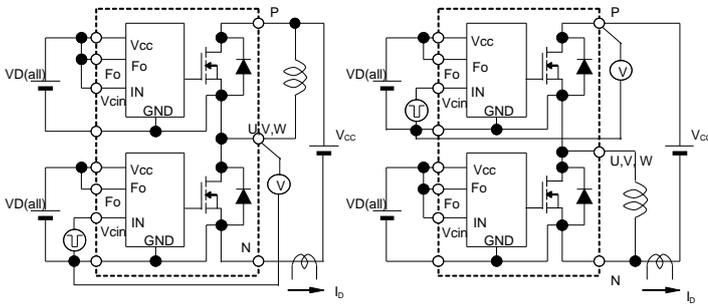
Fig.3 Switching time and SC test circuit
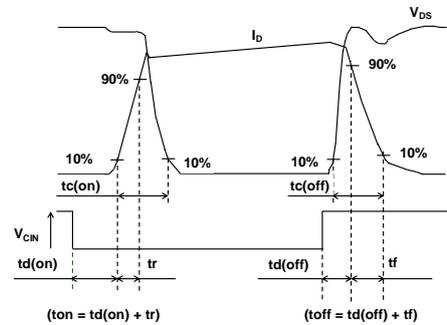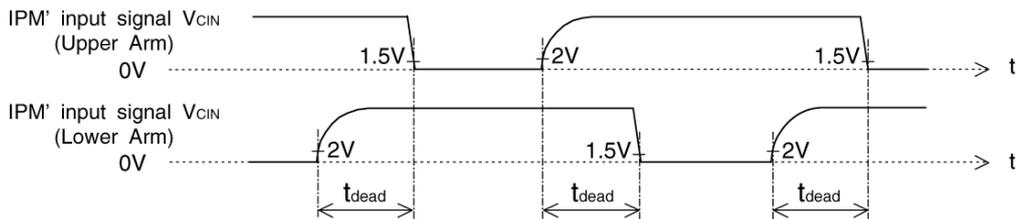
Fig.4 Switching time test waveform
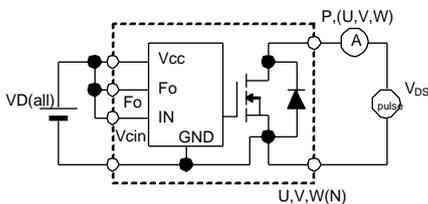
Fig.5 I_{DSS} Test
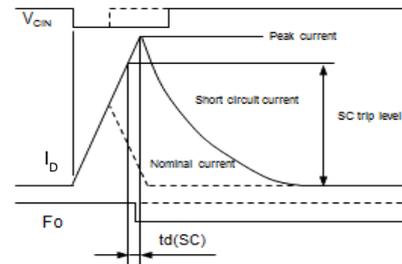
Fig.6 SC test waveform

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

MITSUBISHI ELECTRIC CORPORATION

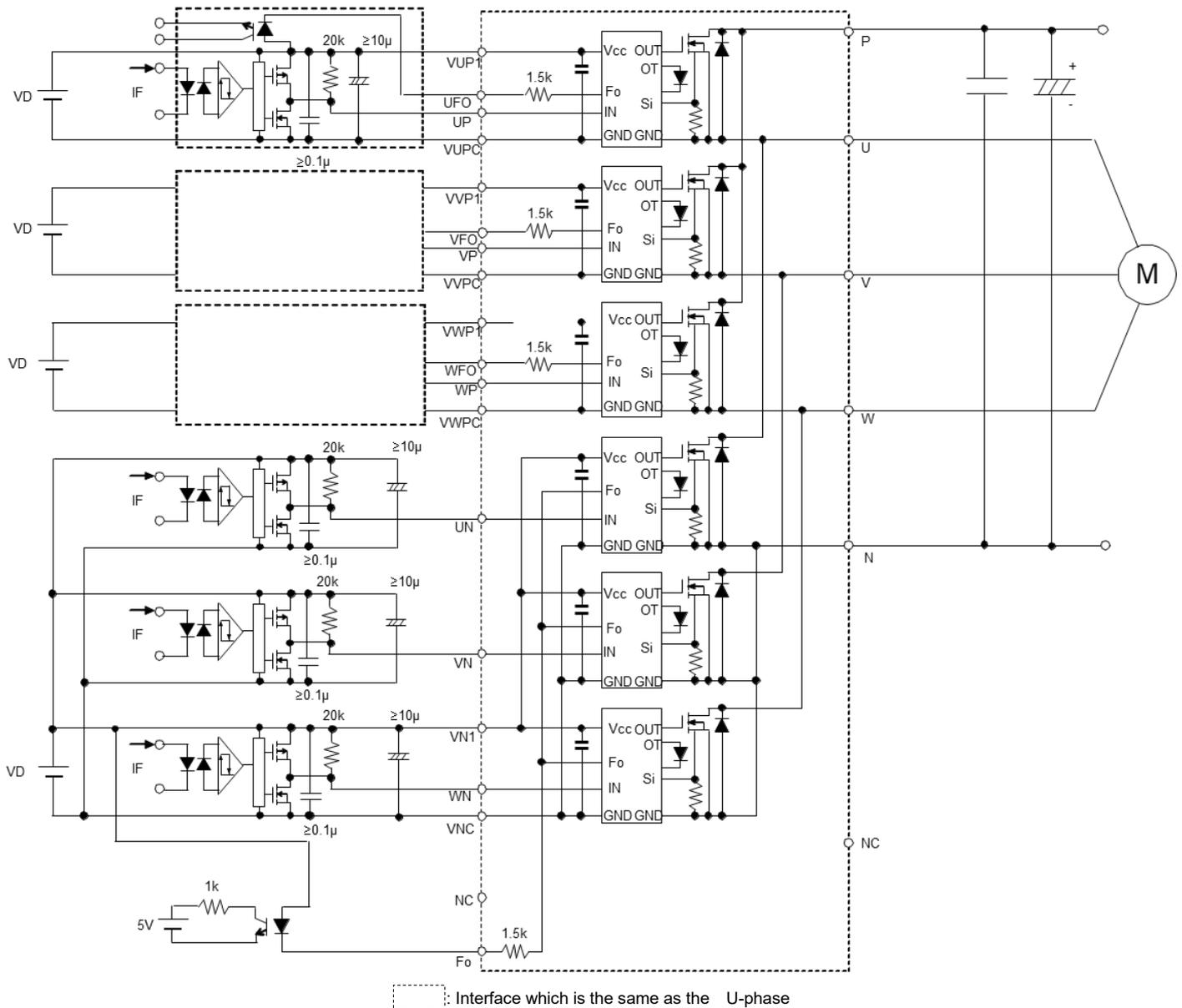| : Interface which is the same as the U-phase

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 V_{CC} 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.
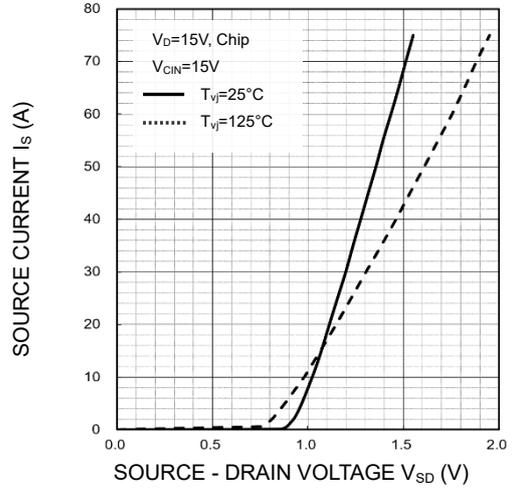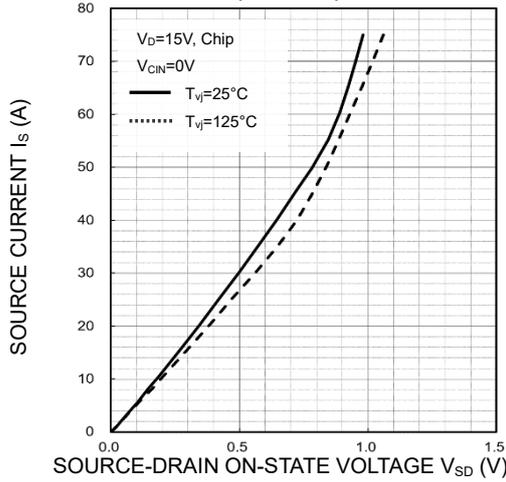
PERFORMANCE CURVES

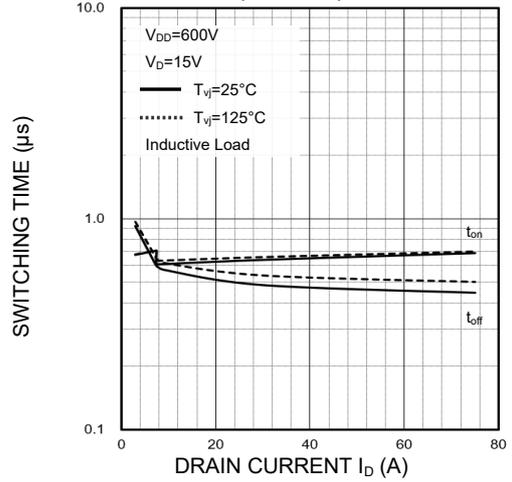**DRAIN-SOURCE SATURATION VOLTAGE (VS. I_D) CHARACTERISTICS (TYPICAL)**
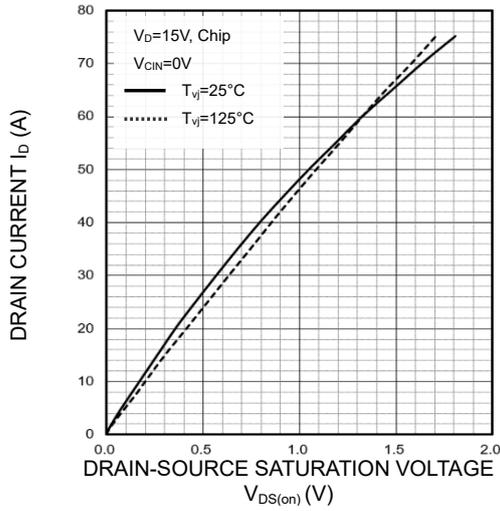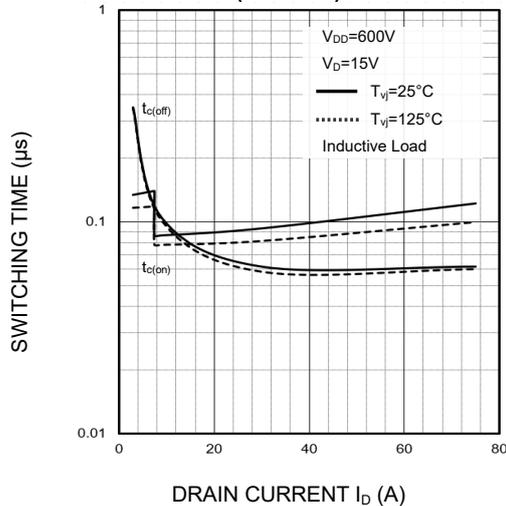

FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)

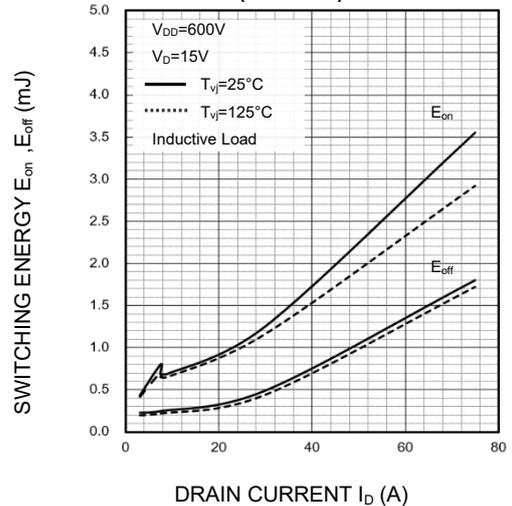**SOURCE-DRAIN ON STATE VOLTAGE CHARACTERISTICS (TYPICAL)**

SWITCHING TIME (t_{on}, t_{off}) CHARACTERISTICS (TYPICAL)

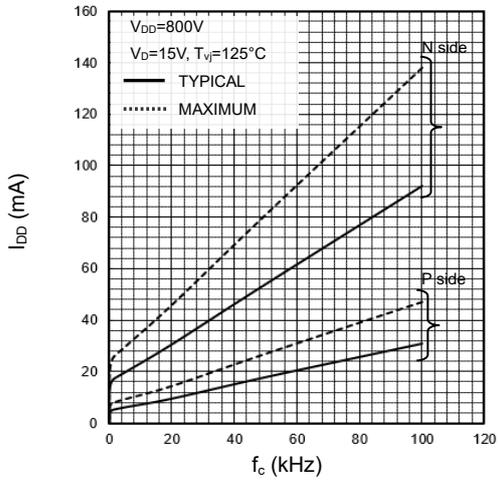**SWITCHING TIME ($t_{c(on)}$, $t_{c(off)}$) CHARACTERISTICS (TYPICAL)**

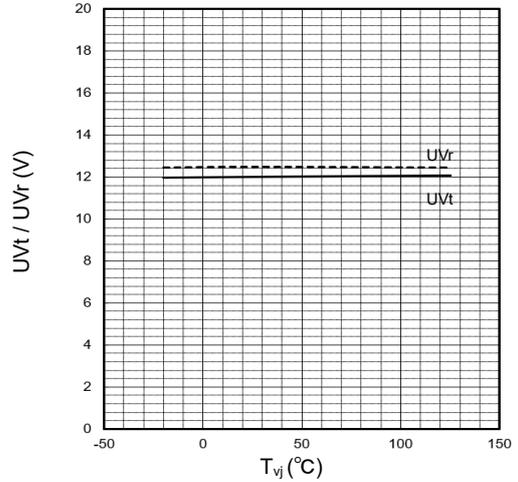**SWITCHING ENERGY CHARACTERISTICS (TYPICAL)**

PMF75CGA120/PMF75CGAL120
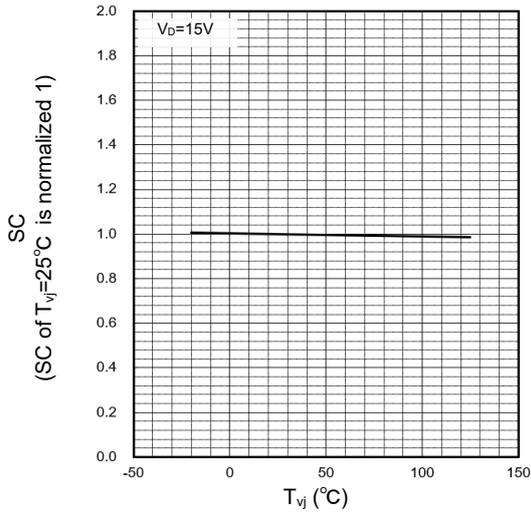
HIGH POWER SWITCHING USE
INSULATED TYPE

I_{DD} VS. f_C CHARACTERISTICS
(TYPICAL, MAXIMUM)

UV TRIP LEVEL VS. T_{vj} CHARACTERISTICS
(TYPICAL)

SC TRIP LEVEL VS. T_{vj} CHARACTERISTICS
(TYPICAL)

TRANSIENT THERMAL IMPEDANCE
CHARACTERISTICS
(TYPICAL)

i	1	2	3	4
Ri	0.0213	0.0732	0.2332	0.6651
ti	1.514E-05	0.0005	0.0062	0.0345

Single Pulse
MOS Part;
Per unit base: $R_{th(j-c)Q}$=0.37K /W
FWD Part;
Per unit base: $R_{th(j-c)D}$=0.50K /W
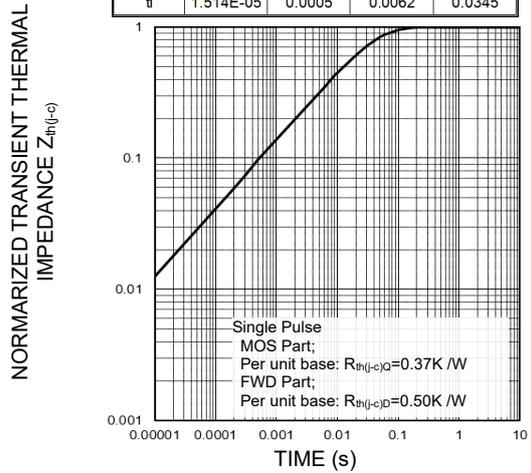
Note: The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

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