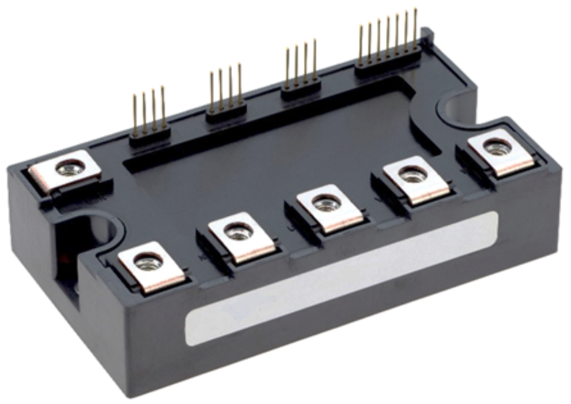
<Intelligent Power Modules>

PM25RG1A120

FLAT-BASE TYPE
INSULATED PACKAGE



FEATURE

a) Adopting Full-Gate CSTBT™ chip.

b) The over-temperature protection which detects the chip surface temperature of CSTBT™ is adopted.

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

d) Outputting an error signal corresponding to the abnormal state (error mode identification)

UL Recognized under UL1557, File No. E323585

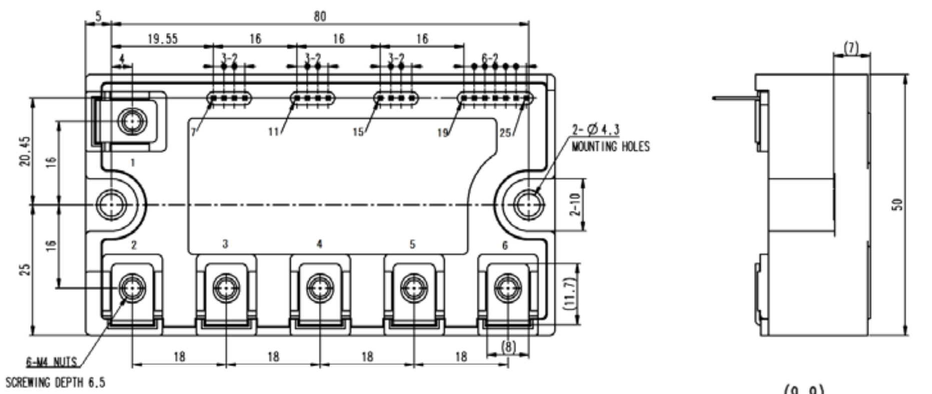
This product is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU.

APPLICATION

General purpose inverter, servo drives and other motor controls

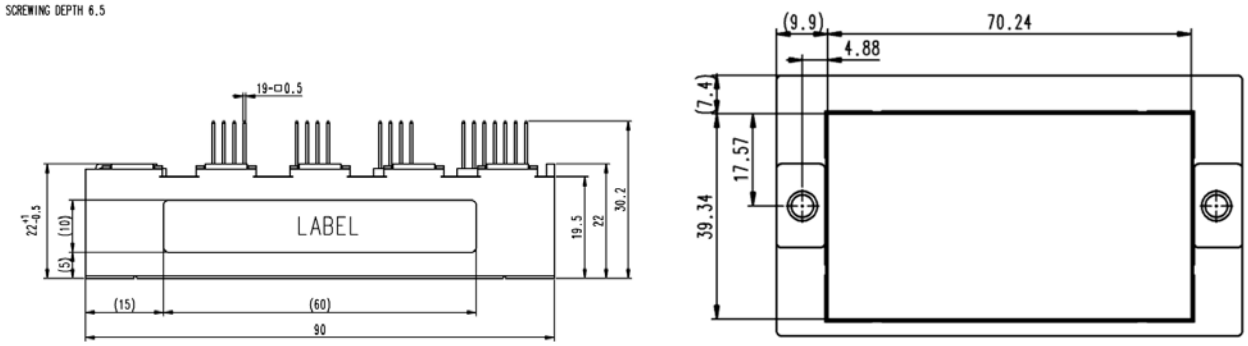
PACKAGE OUTLINES

Dimensions in mm



Tolerance otherwise specified

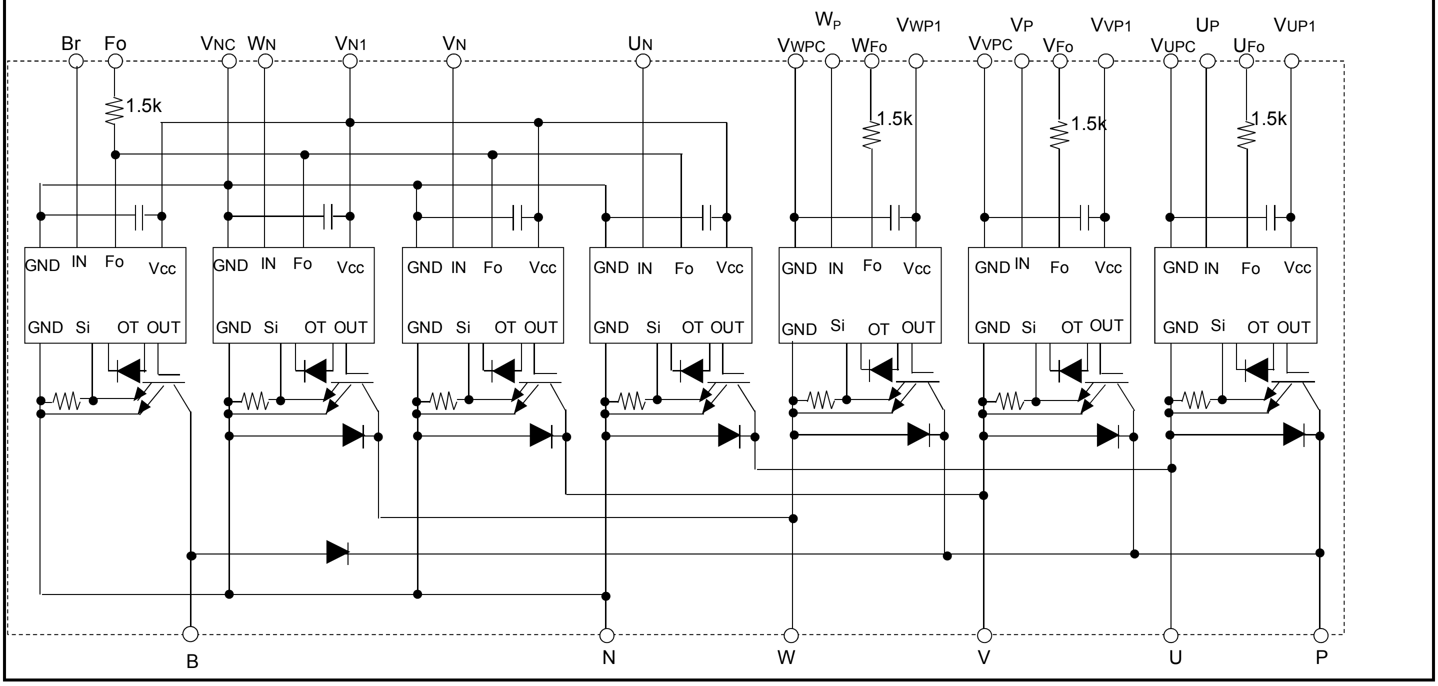
Division of Dimension			Tolerance
	0.5	to 3	±0.2
over	3	to 6	±0.3
over	6	to 30	±0.5
over	30	to 120	±0.8
over	120	to 400	±1.2



TERMINAL CODE

1.B, 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.BR, 22.U_N, 23.V_N, 24.W_N, 25.F_O

INTERNAL FUNCTIONS BLOCK DIAGRAM



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

INVERTER PART

Symbol	Parameter	Conditions	Ratings	Unit
V_{CES}	Collector-Emitter Voltage	V_D=15 V, V_{CIN}=15 V	1200	V
I_C	Collector Current	T_C=25 °C	25	A
I_{CRM}		Pulse	50	
P_{tot}	Total Power Dissipation	T_C=25 °C	260	W
I_E	Emitter Current	T_C=25 °C	25	A
I_{ERM}	(Free-wheeling Diode Forward current)	Pulse	50	
Tvj	Junction Temperature		-20 ~ +150	°C

*: Tc measurement point is just under the chip.

BRAKE PART

Symbol	Parameter	Conditions	Ratings	Unit
V_{CES}	Collector-Emitter Voltage	V_D=15 V, V_{CIN}=15 V	1200	V
I_C	Collector Current	T_C=25 °C	25	A
I_{CRM}		Pulse	50	
P_{tot}	Total Power Dissipation	T_C=25 °C	260	W
$V_{R(DC)}$	Diode Rated Reverse DC Voltage	T_C=25 °C	1200	V
I_F	Diode Forward Current	T_C=25 °C	25	A
T_j	Junction Temperature		-20 ~ +150	°C

*: Tc 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, Br -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
$V_{CC(PROT)}$	Supply Voltage Protected by SC	V_D =13.5 V~16.5 V, Inverter Part, Tvj=+125°C start	800	V
T_{stg}	Storage Temperature	-	-40 ~ +125	°C
T_C	Operating Case Temperature	-	-20 ~ +125	°C
V_{isol}	Isolation Voltage	60Hz, Sinusoidal, Charged part to Base plate, AC 1min, RMS	2500	V

*: Tc measurement point is just under the chip.

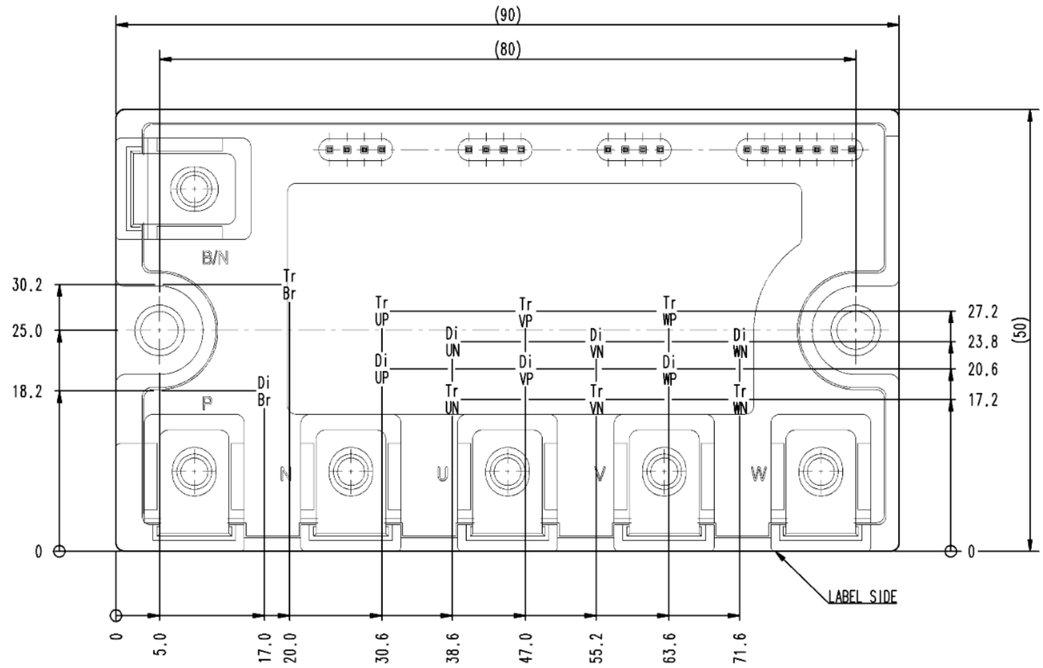
THERMAL RESISTANCE

Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
$R_{th(j-c)Q}$	Thermal Resistance	Inverter, Junction to case, IGBT, per 1 element (Note1)	-	-	0.48	K/W
$R_{th(j-c)D}$		Inverter, Junction to case, FWD, per 1 element (Note1)	-	-	0.78	
$R_{th(j-c)Q}$		Brake, Junction to case, IGBT, per 1 element (Note1)	-	-	0.48	
$R_{th(j-c)D}$		Brake, Junction to case, FWD, per 1 element (Note1)	-	-	0.78	
$R_{th(c-s)}$	Contact Thermal Resistance	Case to heat sink, per 1 module, Thermal grease applied (Note.1, 2)	-	19.1	-	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), $D_{(C-S)}$=50 μm.

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



Tr** : IGBT
Di** : FWD

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

INVERTER PART

Symbol	Parameter	Conditions			Limits Min.	Limits Typ.	Limits Max.	Unit
V_{CEsat}	Collector-Emitter Saturation Voltage	V_D=15 V, I_C=25 A	Tvj=25 °C	Terminal	-	-	1.7	V
				Chip	-	1.3	-	
		V_{CIN}=0 V, Pulsed, (Fig.1)	Tvj=125 °C	Terminal	-	-	1.95	
				Chip	-	1.5	-	
V_{EC}	Emitter-Collector Voltage	V_D=15 V, I_E=25 A,	Tvj=25 °C	Terminal	-	-	2.35	V
				Chip	-	1.75	-	
		V_{CIN}= 15 V, pulsed, (Fig.2)	Tvj=125 °C	Terminal	-	-	2.6	
				Chip	-	1.95	-	
t_{on}	Switching Time	V_D=15 V, V_{CIN}=0 V⟷15 V,			0.3	0.7	1.2	μs
t_{rr}		V_{CC}=600 V, I_C=25A,			-	0.13	0.4	
$t_{c(on)}$		Tvj=125 °C,			-	0.2	0.4	
t_{off}		Inductive Load			-	1.0	2.8	
$t_{c(off)}$		(Fig.3, 4)			-	0.4	1.2	
I_{CES}	Collector-Emitter Cut-off Current	V_{CE}=V_{CES}, V_D=15 V, V_{CIN}=15 V (Fig.5)		Tvj=25 °C	-	-	1	mA
				Tvj=125 °C	-	-	10	

BRAKE PART

Symbol	Parameter	Conditions			Limits Min.	Limits Typ.	Limits Max.	Unit
V_{CEsat}	Collector-Emitter Saturation Voltage	V_D=15 V, I_C=25 A	Tvj=25 °C	Terminal	-	-	1.7	V
				Chip	-	1.3	-	
		V_{CIN}=0 V, Pulsed, (Fig.1)	Tvj=125 °C	Terminal	-	-	1.95	
				Chip	-	1.5	-	
V_{FM}	Diode Forward Voltage	I_F=25A	Tvj=25 °C	Terminal	-	-	2.35	V
				Chip	-	1.75	-	
			Tvj=125 °C	Terminal	-	-	2.6	
				Chip	-	1.95	-	
I_{CES}	Collector-Emitter Cut-off Current	V_{CE}=V_{CES}, V_D=15 V, V_{CIN}=15 V (Fig.5)		Tvj=25 °C	-	-	1	mA
				Tvj=125 °C	-	-	10	

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

CONTROL PART

Symbol	Parameter	Conditions		Limits Min.	Limits Typ.	Limits Max.	Unit
I_D	Circuit Current	V_D=15 V, V_{CIN}=15 V	V_{P1}-V_{PC}	-	4	6	mA
			V_{N1}-V_{NC}	-	16	24	
		V_D=15 V, V_{CIN}=0 V⟷15 V, V_{CC}=800 V	V_{P1}-V_{PC}	-	10	12	
		I_C=0A, Tvj=125 °C, f_C≤20kHz	V_{N1}-V_{NC}	-	40	48	
$V_{th(ON)}$	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, Br-V_{NC}		1.7	2.0	2.3	
SC	Short Circuit Trip Level	-20≤Tvj≤125 °C, V_D=15 V (Fig.3, 6)	Inverter	50	-	-	A
			Brake	50	-	-	
$t_{d(SC)}$	Short Circuit Current Delay Time	V_D=15 V, Tvj=125 °C (Fig.3, 6)		-	2.0	-	μs
OT	Over Temperature Protection	Detect temperature of IGBT chip surface	Trip level	150	-	-	°C
$OT_{(hys)}$			Hysteresis	-	20	-	
UV_t	Supply Circuit Under-Voltage Protection	-	Trip level	11.0	12.0	12.7	V
UV_r			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

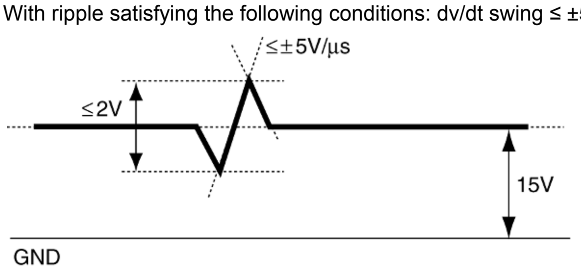
Symbol	Parameter	Conditions		Limits Min.	Limits Typ.	Limits Max.	Unit
M_s	Mounting Torque	Mounting part	screw : M4	1.5	1.7	2.0	N•m
M_t	Mounting Torque	Main terminal part	screw : M4	1.5	1.7	2.0	
m	mass	-		-	175	-	g

RECOMMENDED CONDITIONS FOR USE

Symbol	Parameter	Conditions	Recommended value	Unit
V_{CC}	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, Br-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)	≥ 2.5	μs

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

Note4. With ripple satisfying the following conditions: dv/dt swing ≤ ±5 V/μs, Variation ≤ 2 V peak to peak



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.)

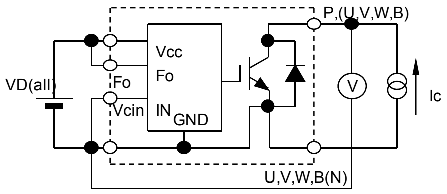


Fig.1 V_{CEsat} Test

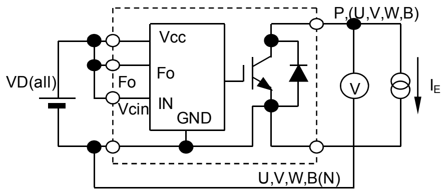


Fig.2 V_{EC} Test

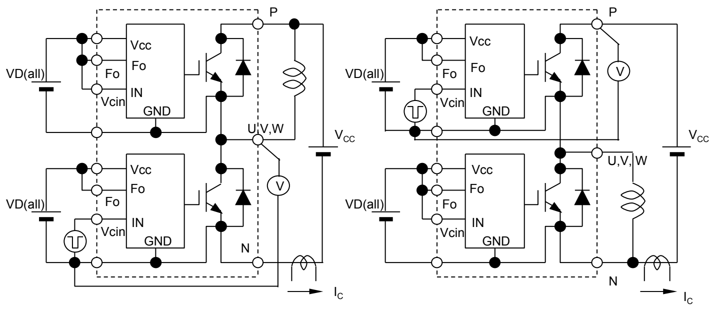


Fig.3 Switching time and SC test circuit

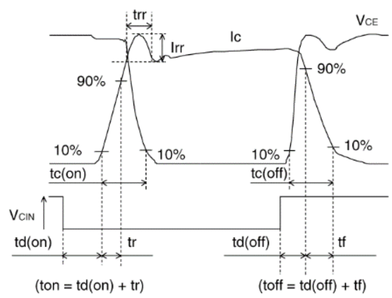


Fig.4 Switching time test waveform

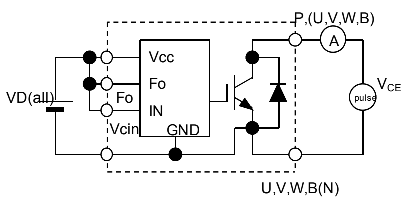


Fig.5 I_{CES} Test

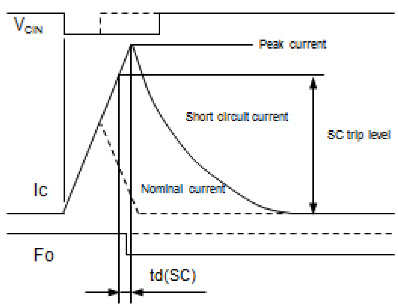
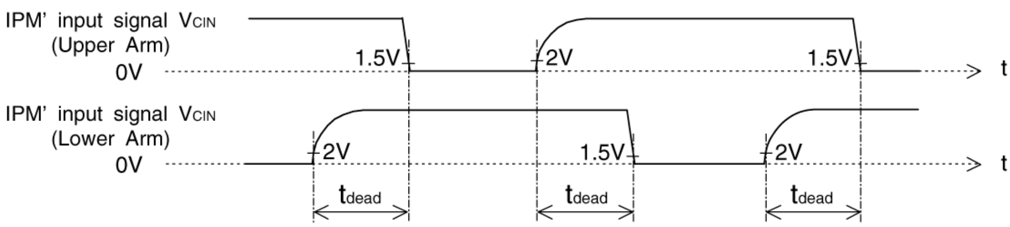
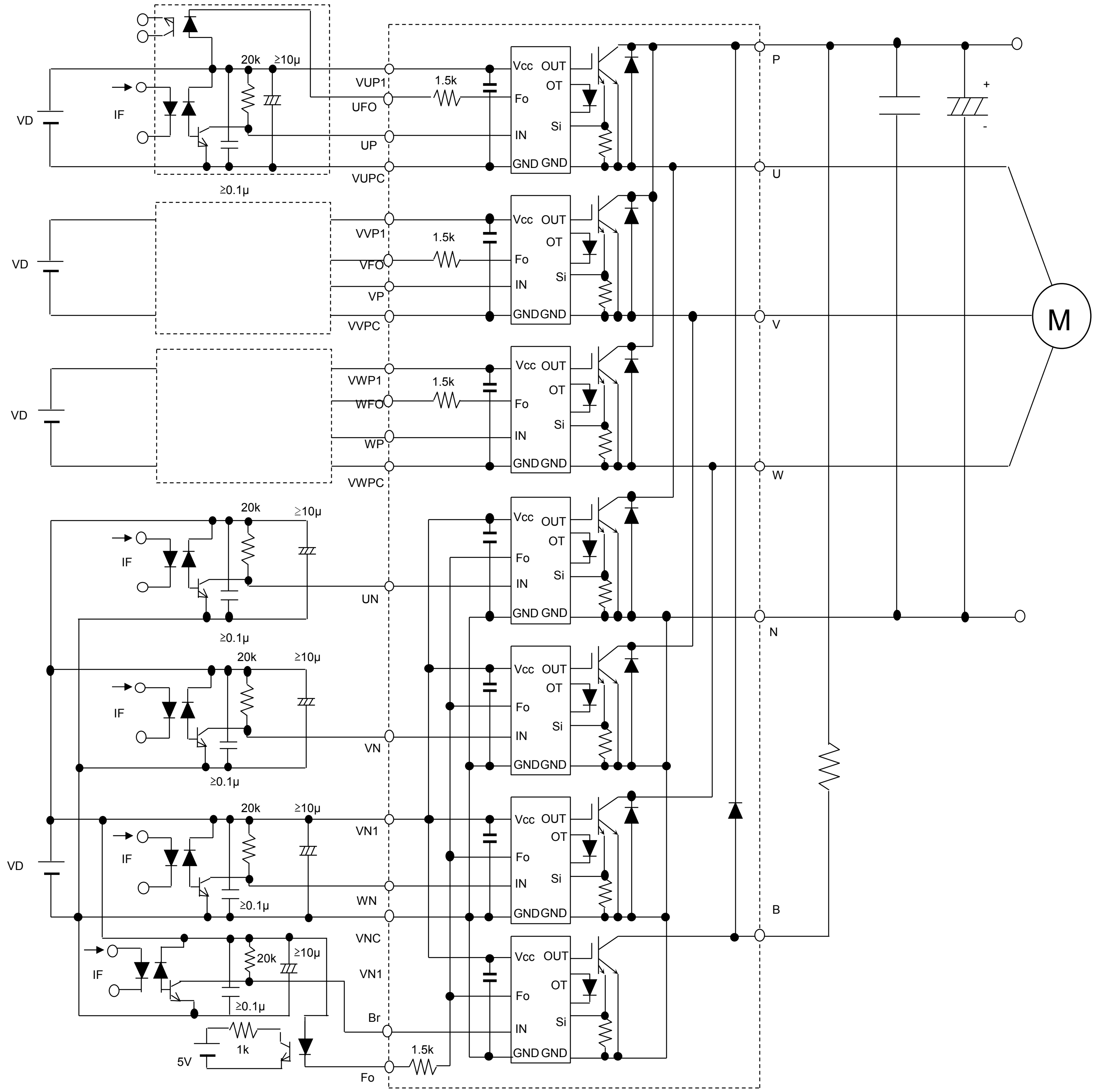


Fig.6 SC test waveform



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



: Interface which is the same as the U-phase

Fig. 8 Application Example Circuit

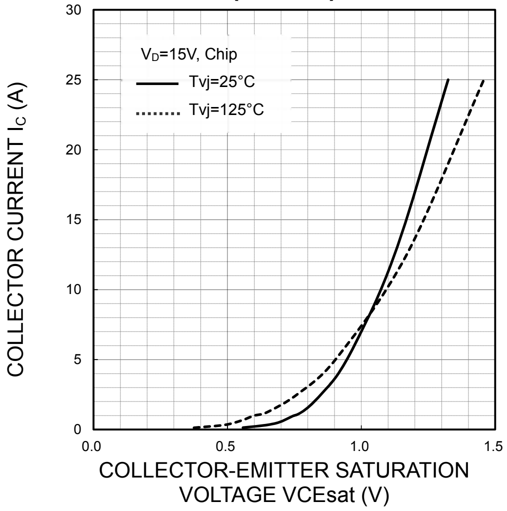
NOTES FOR STABLE AND SAFE OPERATION ;

- 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 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% (*can be applied to Brake part input signal, in this case, resistor should be selected properly).
- 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.

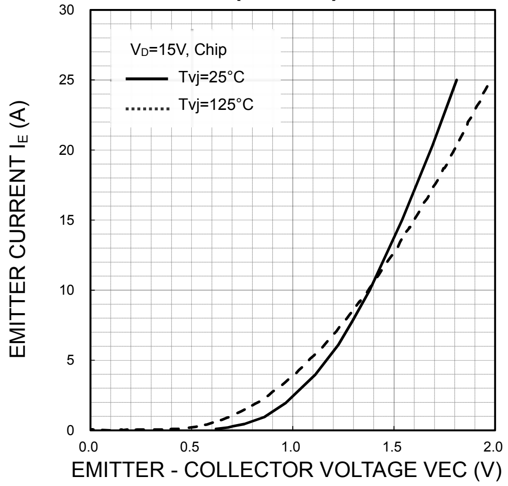
PERFORMANCE CURVES

Inverter part

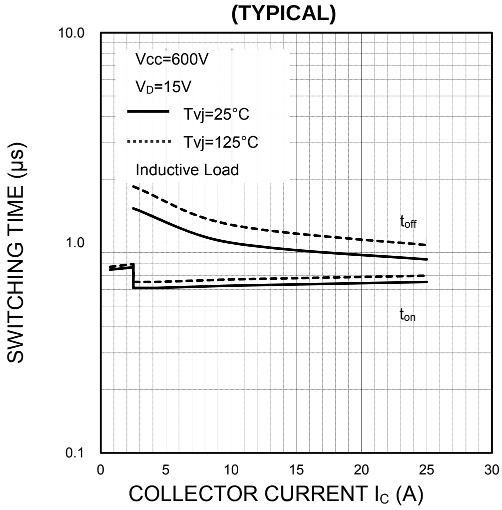
COLLECTOR-EMITTER SATURATION VOLTAGE (VS. Ic) CHARACTERISTICS (TYPICAL)



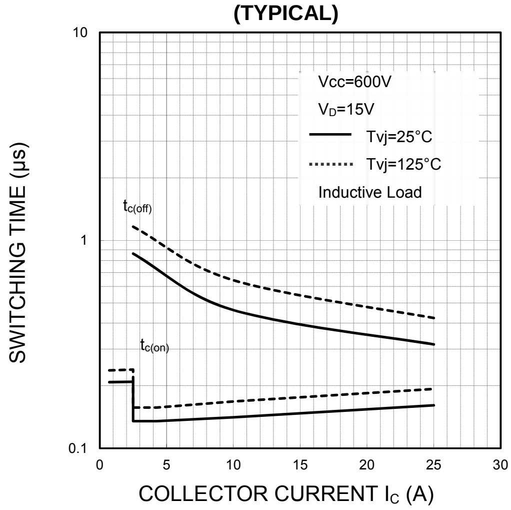
FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



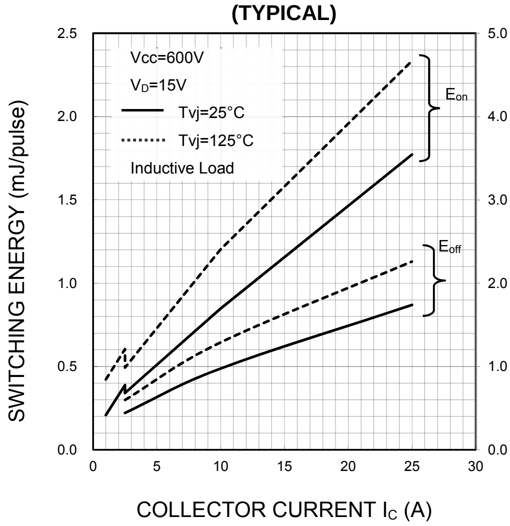
SWITCHING TIME (t_{on}, t_{off}) CHARACTERISTICS (TYPICAL)



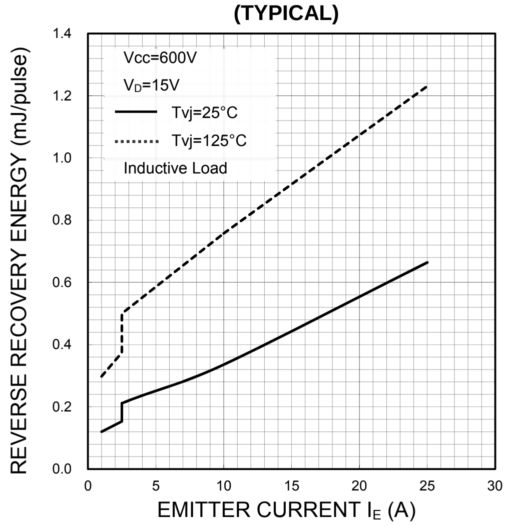
SWITCHING TIME ($t_{c(on)}$, $t_{c(off)}$) CHARACTERISTICS (TYPICAL)



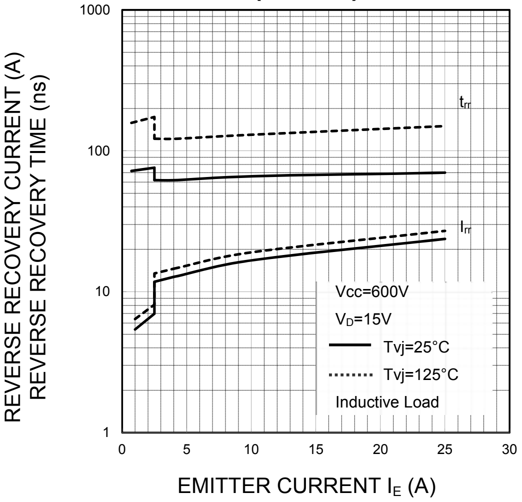
SWITCHING ENERGY CHARACTERISTICS (TYPICAL)



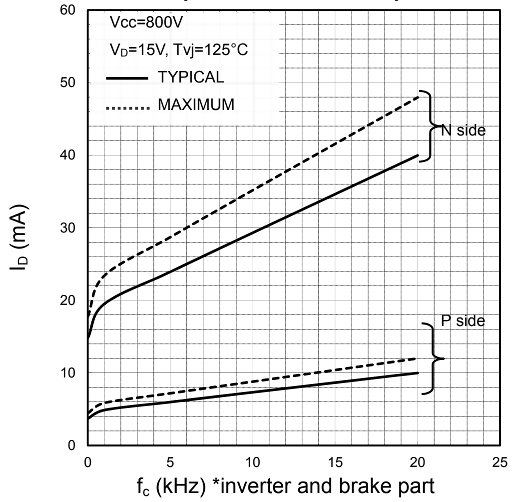
FREE WHEELING DIODE REVERSE RECOVERY ENERGY CHARACTERISTICS (TYPICAL)



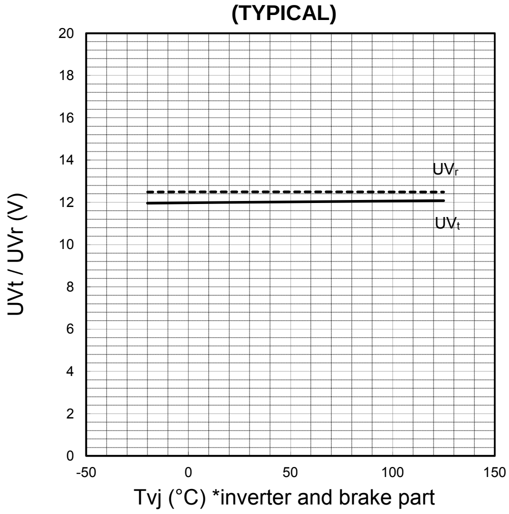
FREE WHEELING DIODE REVERSE RECOVERY CHARACTERISTICS (TYPICAL)



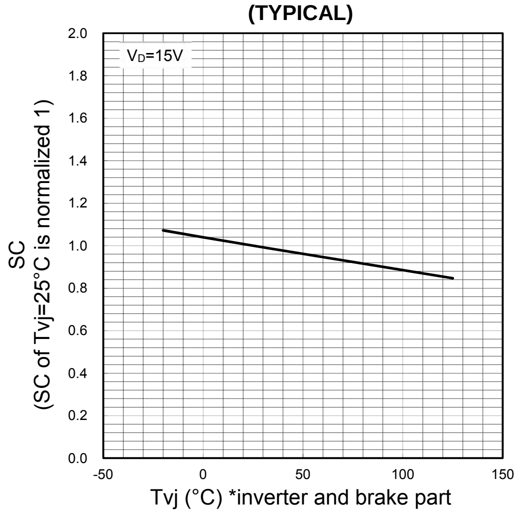
I_D VS. f_C CHARACTERISTICS (TYPICAL, MAXIMUM)



UV TRIP LEVEL VS. Tvj CHARACTERISTICS (TYPICAL)

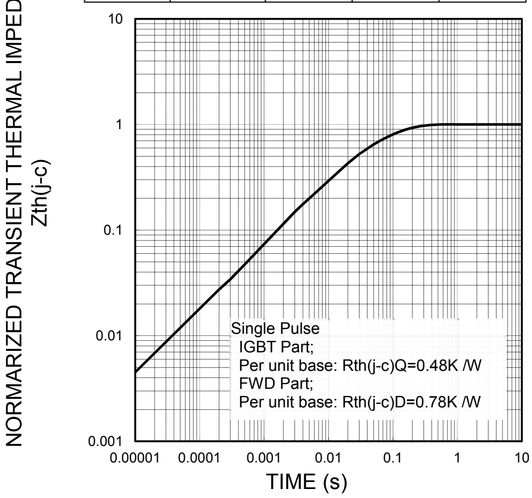


SC TRIP LEVEL VS. Tvj CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)

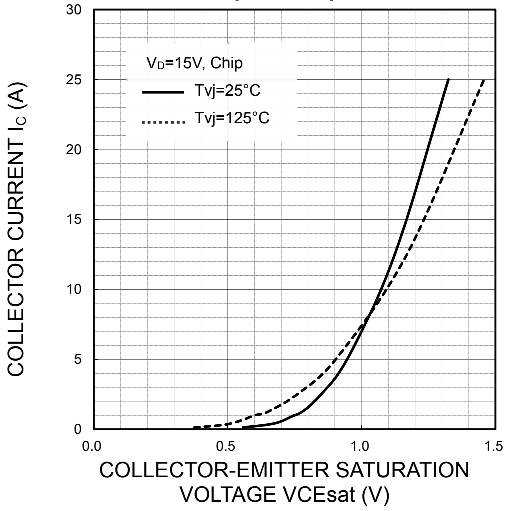
i	1	2	3	4
Ri	0.0124	0.0739	0.3505	0.5632
τi (sec)	1.961E-05	0.0014	0.0179	0.0944



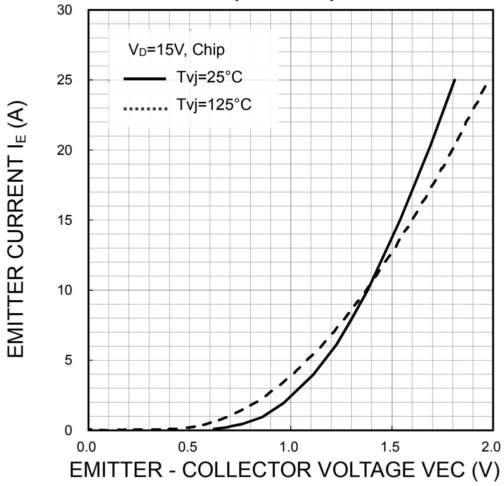
PERFORMANCE CURVES

Brake part

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

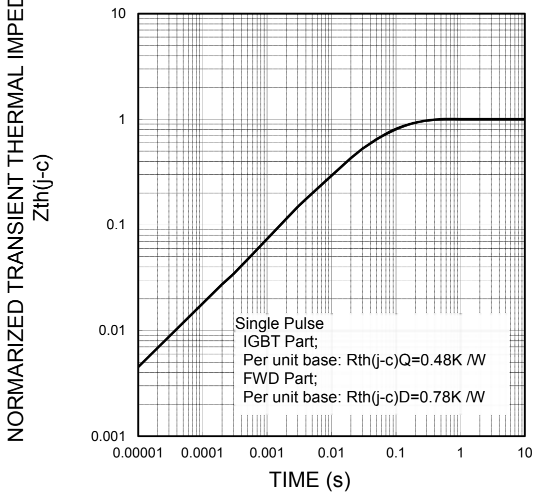


FREE WHEELING DIODE FORWARD CHARACTERISTICS (TYPICAL)



TRANSIENT THERMAL IMPEDANCE CHARACTERISTICS (TYPICAL)

i	1	2	3	4
Ri	0.0124	0.0739	0.3505	0.5632
τi (sec)	1.961E-05	0.0014	0.0179	0.0944



Keep safety first in your circuit designs!

This product is designed for industrial application purpose. The performance, the quality and support level of the product is guaranteed by "Customer's Std. Spec.".
Mitsubishi Electric Corporation puts its reasonable effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them by the reliability lifetime such as Power Cycle, Thermal Cycle or others, or to be used under special circumstances(e.g. high humidity, dusty, salty, highlands, environment with lots of organic matter / corrosive gas / explosive gas, or situation which terminal of semiconductor products is received strong mechanical stress).
In the customer's research and development, please evaluate it not only with a single semiconductor product but also in the entire system, and judge whether it's applicable. Furthermore, trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits (e.g. appropriate fuse or circuit breaker between a power supply and semiconductor products), (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

- These materials are intended as a reference to assist our customers in the selection of the Mitsubishi semiconductor product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Mitsubishi Electric Corporation or a third party.
- Mitsubishi Electric Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, or circuit application examples contained in these materials.
- All information contained in these materials, including product data, diagrams and charts represents information on products at the time of publication of these materials, and are subject to change by Mitsubishi Electric Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor for the latest product information before purchasing a product listed herein.
  The information described here may contain technical inaccuracies or typographical errors. Mitsubishi Electric Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
  Please also pay attention to information published by Mitsubishi Electric Corporation by various means, including the Mitsubishi Semiconductor home page (www.MitsubishiElectric.com/semiconductors/).
- When using any or all of the information contained in these materials, including product data, diagrams, and charts, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Mitsubishi Electric Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
- Mitsubishi Electric Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Therefore, this product should not be used in such applications. Please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
- In the case of new requirement is available, this material will be revised upon consultation.
- The prior written approval of Mitsubishi Electric Corporation is necessary to reprint or reproduce in whole or in part these materials.
- If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.
  Any diversion or re-export contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
- Please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor for further details on these materials or the products contained therein.

Generally the listed company name and the brand name are the trademarks or registered trademarks of the respective companies.

Note:
The characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.