SPECIFICATION

Device name: IGBT Module
(RoHS compliant product)

Type name: 2MBI600XHV120F-50

Spec. No. : MS5F9645

	DATE	NAME	APPROVED
DRAWN	Apr. 25, 2022	M. Shiohara	
CHECKED	Apr. 25. 2022	Y. Kusuoki	T. Kobayashi
CHECKED	Apr. 25. 2022	T. Komata	

Fuji Electric Co., Ltd.

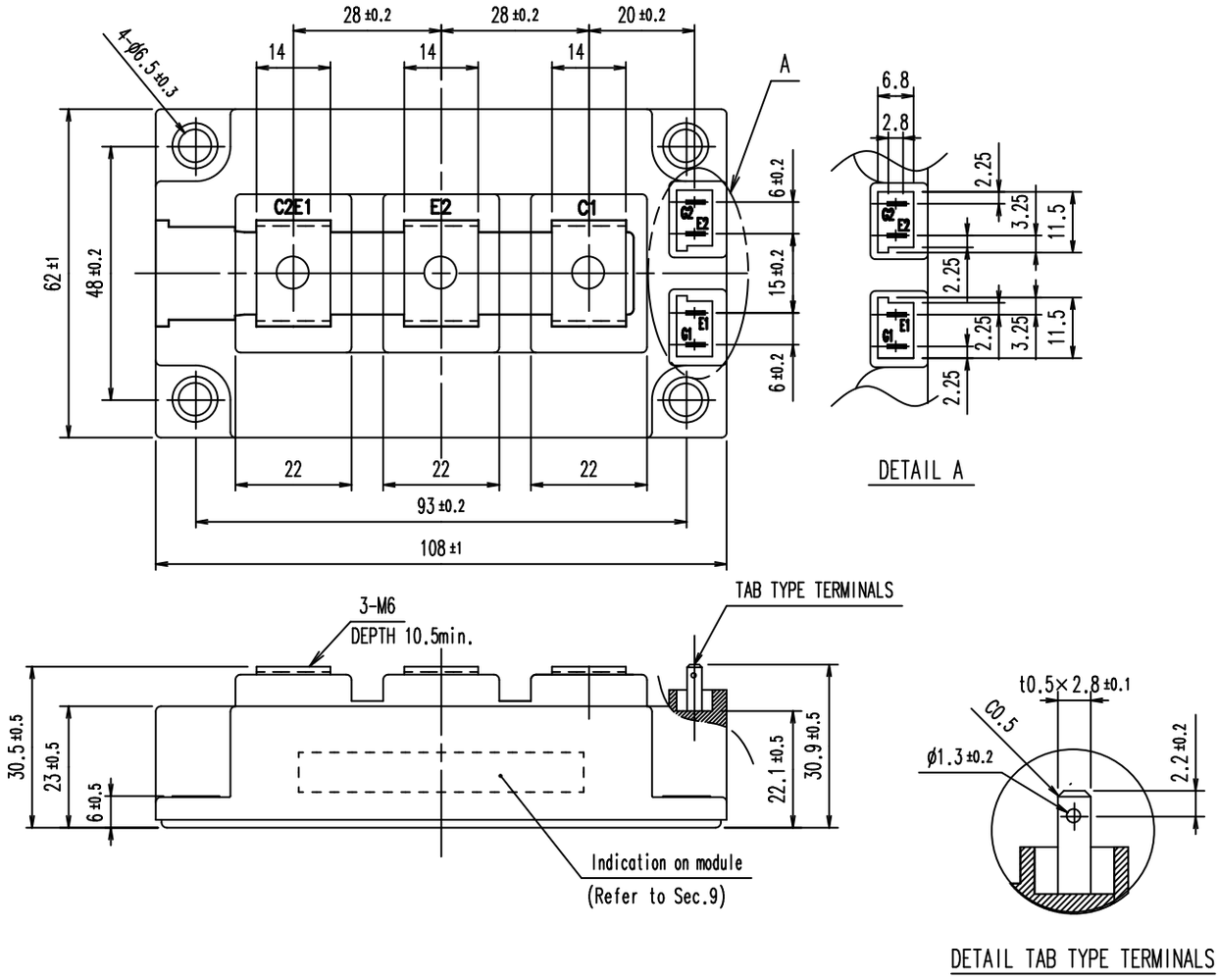
DWG.No. MS5F9645 1 / 20

Revised Records

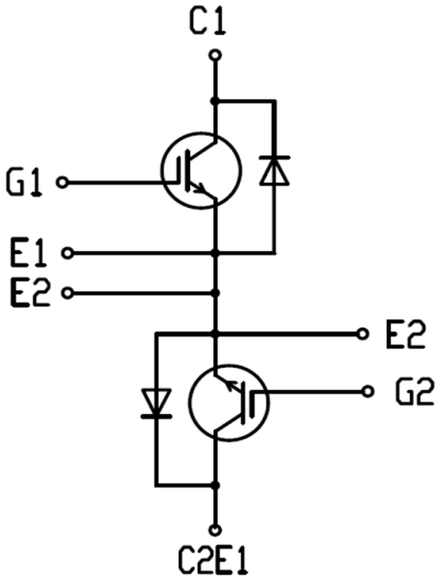
Date	Classification	Ind.	Content	Applied date	Drawn	Checked	Checked	Approved
Apr. 25, 2022	enactment	-	-	Issued date	M. Shiohara	Y. Kusunoki	D Kamada	T Kobayashi

Type Name: 2MBI600XHV120F-50
X-series / M276 package / RoHS compliant product

1. Outline drawing (Unit: mm)



2. Equivalent Circuit



Weight: 370 g(typ.)

3. Applicable category

This specification is applied to IGBT Module named 2MBI600XHV120F-50.

4. Maximum ratings (at T_c = 25°C unless otherwise specified)

Items		Symbols	Conditions		Maximum ratings	Units
Collector-Emitter voltage, Gate-Emitter short-circuited		V_{CES}			1200	V
Gate-Emitter voltage, Collector-Emitter short-circuited		V_{GES}			±20	V
Collector current		I_C	Continuous	T_c = 100°C	600	A
Repetitive peak collector current		I_{CRM}	1ms		1200	
Forward current		I_F			600	
Repetitive peak forward current		I_{FRM}	1ms		1200	
Total power dissipation		P_{tot}	1 device		2340	W
Virtual junction temperature		T_{vj}			175	°C
Operating virtual junction temperature		T_{vjop}			150	
Case temperature		T_c			125	
Storage temperature		T_{stg}			-40 ~ 125	
Isolation voltage	between terminals and copper base (*1)	V_{isol}	A.C. : 1min.		4000	Vrms
Mounting torque of screws to heat sink (*2)		M_s	M5 or M6		6.0	N·m
Mounting torque of screws to terminals (*2)		M_t	M6		5.0	

(*1) All terminals should be connected together during the test.

(*2) Recommendable Value: Mounting 3.0 ~ 6.0 N·m (M5 or M6)

Recommendable Value: Terminals 2.5 ~ 5.0 N·m (M6)

5. Electrical characteristics (at T_{vj} = 25°C unless otherwise specified)

Items	Symbols	Conditions		Characteristics min.	Characteristics typ.	Characteristics max.	Units
Collector-Emitter cut-off current, Gate-Emitter short-circuited	I_{CES}	V_{GE} = 0V V_{CE} = 1200V		-	-	200	μA
Gate leakage current, Collector-Emitter short-circuited	I_{GES}	V_{CE} = 0V V_{GE} = +20/-20V		-	-	400	nA
Gate-Emitter threshold voltage	$V_{GE(th)}$	V_{CE} = 20V I_C = 600mA		6.0	6.5	7.0	V
Collector-Emitter saturation voltage	$V_{CE(sat)}$ (terminal)	V_{GE} = 15V I_C = 600A	T_{vj}=25°C	-	1.70	2.15	V
	$V_{CE(sat)}$ (chip)		T_{vj}= 25°C	-	1.45	1.90	
			T_{vj}=125°C	-	1.85	-	
			T_{vj}=150°C	-	1.90	-	
Internal Gate resistance	r_g	-		-	1.63	-	Ω
Capacitance	C_{ies}	V_{CE} = 10V, V_{GE} = 0V, f = 1MHz		-	63	-	nF
	C_{oes}			-	2.1	-	
	C_{res}			-	0.56	-	
Gate charge	Q_G	V_{CC} = 600V, I_C = 600A V_{GE} = -15 → +15V		-	4000	-	nC
Forward voltage	V_F (terminal)	V_{GE} = 0V I_F = 600A	T_{vj}=25°C	-	1.85	2.30	V
	V_F (chip)		T_{vj}= 25°C	-	1.60	2.05	
			T_{vj}=125°C	-	1.70	-	
			T_{vj}=150°C	-	1.65	-	
Switching time (*1)	$t_{d(on)}$	V_{CC} = 600V I_C, I_F = 600A V_{GE} = +15/ -15V R_G = 0.56 Ω L_S = 30 nH	T_{vj}= 25°C	-	335	-	ns
			T_{vj}=125°C	-	350	-	
			T_{vj}=150°C	-	365	-	
	t_r		T_{vj}= 25°C	-	75	-	
			T_{vj}=125°C	-	75	-	
			T_{vj}=150°C	-	80	-	
	$t_{d(off)}$		T_{vj}= 25°C	-	385	-	
			T_{vj}=125°C	-	420	-	
			T_{vj}=150°C	-	430	-	
	t_f		T_{vj}= 25°C	-	90	-	
			T_{vj}=125°C	-	150	-	
			T_{vj}=150°C	-	170	-	
Reverse recovery time	t_{rr}		T_{vj}= 25°C	-	170	-	
			T_{vj}=125°C	-	225	-	
			T_{vj}=150°C	-	270	-	

(*1) Turn on time (t_{on}) = $t_{d(on)}$ + t_r , Turn off time (t_{off}) = $t_{d(off)}$ + t_f

Items	Symbols	Conditions		Characteristics			Units
				min.	typ.	max.	
Switching loss(per pulse)	E_{on}	V_{CC} = 600V I_C, I_F = 600A V_{GE} = +15/ -15V R_G = 0.56 Ω L_S = 30 nH	T_{vj}= 25°C	-	29.5	-	mJ
			T_{vj}=125°C	-	48.8	-	
			T_{vj}=150°C	-	52.3	-	
	E_{off}		T_{vj}= 25°C	-	49.4	-	
			T_{vj}=125°C	-	60.5	-	
			T_{vj}=150°C	-	63.9	-	
	E_{rr}		T_{vj}= 25°C	-	24.8	-	
			T_{vj}=125°C	-	37.4	-	
			T_{vj}=150°C	-	42.2	-	

NOTICE:
The external gate resistance (R_G) shown above is one of our recommended value for the purpose of minimum switching loss. However the optimum R_G depends on circuit configuration and/or environment. We recommend that the R_G has to be carefully chosen based on consideration if IGBT module matches design criteria, for example, switching loss, EMC/EMI, spike voltage, surge current and no unexpected oscillation and so on.

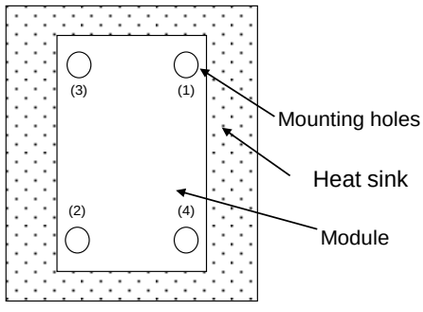
6. Thermal resistance characteristics

Items	Symbols	Conditions	Characteristics			Units
			min.	typ.	max.	
Thermal resistance (1 device)	$R_{th(j-c)}$	Inverter IGBT	-	-	0.064	K/W
		Inverter FWD	-	-	0.090	
Thermal resistance case to heat sink (1 IGBT + 1 FWD) (*1)	$R_{th(c-s)}$	with 1 W/(m·K) thermal grease	-	0.0125	-	

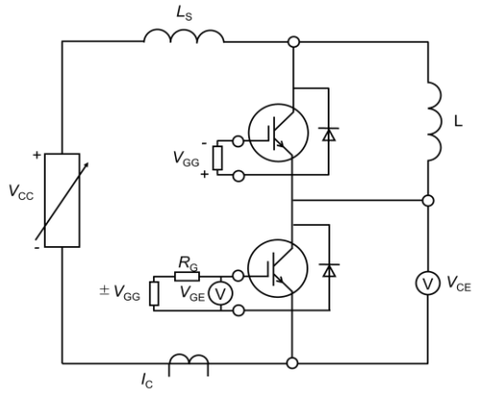
(*1) This is the value which is defined mounting on the additional heat sink with thermal grease.

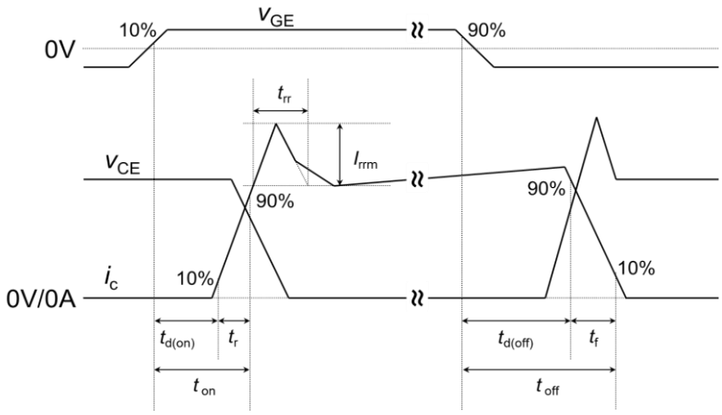
7. Recommend way of module mounting to heat sink

(1) Initial : 1/3 specified torque, sequence (1)→(2)→(3)→(4)
(2) Final : Full specified torque, sequence (4)→(3)→(2)→(1)



8. Definitions





9 Produnct indication

- Logo of production
- Type name: 2MBI600XHV120F-50
- I_C, V_{CES} ratings: 600A, 1200V
- Lot No.
- Place of manufacturing (code)
- Bar code

10. Packing and labeling

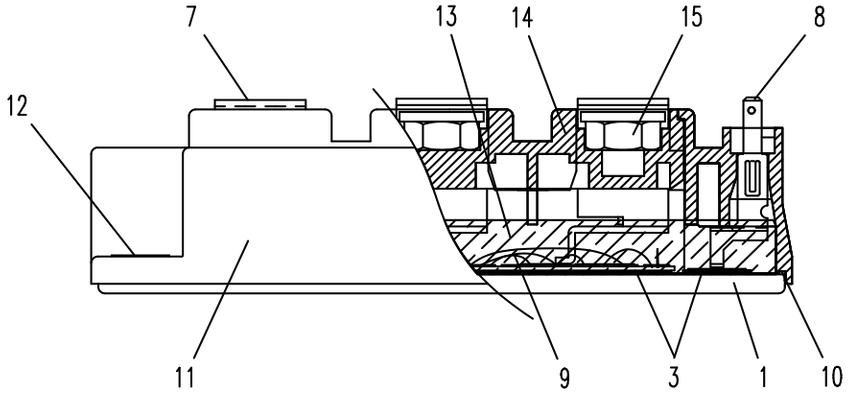
Display on the packing box

- Logo of production
- Type name
- Lot No
- Products quantity in a packing box

11. Storage and transportation notes

- The module should be stored at a standard temperature of 5 to 35°C and humidity of 45 to 75% .
  常温・常湿保存が望ましい。(5～35°C, 45～75%)
- Store modules in a place with few temperature changes in order to avoid condensation on the module.
  急激な温度変化のなきこと。(モジュールが結露しないこと)
- Avoid exposure to corrosive gases and dust.
  腐食性ガスの発生場所、塵埃の多い場所は避けること。
- Avoid excessive external force on the module.
  製品に荷重がかからないように十分注意すること。
- Store modules with unprocessed terminals.
  モジュールの端子は未加工の状態で保管すること。
- Do not drop or otherwise shock the modules when transporting.
  製品の運搬時に衝撃を与えたり、落下させたりしないこと。

12. List of materials



No.	Parts	Material (main)	Ref.
1	Base Plate	Cu	Ni plating
2	Solder (Under Isolation substrate)	Sn base (Pb Free)	(Not drawn in above)
3	Isolation substrate	Al_2O_3 + Cu	
4	Solder (Under chip / Under terminal)	Sn base (Pb Free)	(Not drawn in above)
5	IGBT chip	Silicon	(Not drawn in above)
6	FWD chip	Silicon	(Not drawn in above)
7	Main terminal	Cu	Ni plating
8	Sub terminal	Brass	Ni plating
9	Wiring	Aluminum	
10	Adhesive	Silicone resin	
11	Case	Plastic resin	UL 94V-0
12	Ring	Fe	Trivalent Chromate treatment
13	Silicone Gel	Silicone gel	
14	Nut Glove	Plastic resin	UL 94V-0
15	Nut	Fe	Trivalent Chromate treatment
16	Label	Paper or Polymer	(Not drawn in above)

13. Reliability test

Reliability Test Items

Test categories		Test items	Test methods and conditions			Reference norms EIAJ ED-4701 (Aug.-2001 edition)	Number of sample	Acceptance number
Mechanical Tests	1	Terminal Strength (Pull test)	Pull force Test time	: : :	20 N (Control terminal) 40 N(Main termial) 10±1 sec.	Test Method 401 Method I	5	(0 : 1)
	2	Mounting Strength	Screw torque Test time	: :	3.0 ~ 6.0 N·m (M5 or M6) 10±1 sec.	Test Method 402 method II	5	(0 : 1)
	3	Vibration	Range of frequency Sweeping time Acceleration Sweeping direction Test time	: : : : :	10 ~ 500Hz 15 min. 100m/s2 Each X,Y,Z axis 6 hr. (2hr./direction)	Test Method 403 Reference 1 Condition code B	5	(0 : 1)
	4	Shock	Maximum acceleratic Pulse width Direction Test time	: : : :	5000m/s2 1.0msec. Each X,Y,Z axis 3 times/direction	Test Method 404 Condition code B	5	(0 : 1)
Environment Tests	1	High Temperature Storage	Storage temp. Test duration	: :	125±5°C 1000hr.	Test Method 201	5	(0 : 1)
	2	Low Temperature Storage	Storage temp. Test duration	: :	-40±5°C 1000hr.	Test Method 202	5	(0 : 1)
	3	Temperature Humidity Storage	Storage temp. Relative humidity Test duration	: : :	85±2°C 85±5% 1000hr.	Test Method 103 Test code C	5	(0 : 1)
	4	Unsaturated Pressurized Vapor	Test temp. Test humidity Test duration	: : :	120 ± 2 °C 85 ± 5% 96hr.	Test Method 103 Test code E	5	(0 : 1)
	5	Temperature Cycle	Test temp. Dwell time Number of cycles	: : :	Low temp. -40 ± 5 °C High temp. 125 ± 5 °C RT 5 ~ 35 °C High ~ RT ~ Low ~ RT 1hr. 0.5hr. 1hr. 0.5hr. 100 cycles	Test Method 105	5	(0 : 1)
	6	Thermal Shock	Test temp. Used liquid Dipping time Transfer time Number of cycles	: : : : :	Low temp. 0^{+5}_{-0} °C High temp. 100^{+0}_{-5} °C Water with ice and boiling water 5 min. par each temp. 10 sec. 10 cycles	Test Method 307 method I Condition code A	5	(0 : 1)

Reliability Test Items

Test categories		Test items	Test methods and conditions	Reference norms EIAJ ED-4701 (Aug.-2001 edition)	Number of sample	Acceptance number
Endurance Tests	1	High temperature Reverse Bias (for Collector - Emitter)	Test temp. : T_{vj} = 150℃(-0 ℃/+5 ℃) Bias Voltage : V_{CE} = 0.8×V_{CES} Bias Method : Applied DC voltage to C-E V_{GE} = 0V Test duration : 1000hr.	Test Method 101	5	(0 : 1)
	2	High temperature Bias (for gate)	Test temp. : T_{vj} = 150℃(-0 ℃/+5 ℃) Bias Voltage : V_{GE} = +20V or -20V Bias Method : Applied DC voltage to G-E V_{CE} = 0V Test duration : 1000hr.	Test Method 101	5	(0 : 1)
	3	Temperature Humidity Bias	Test temp. : 85±2 °C Relative humidity : 85±5% Bias Voltage : V_{CE} = 0.8×V_{CES} Bias Method : Applied DC voltage to C-E V_{GE} = 0V Test duration : 1000hr.	Test Method 102 Condition code C	5	(0 : 1)
	4	Intermitted Operating Life (Power cycle) (for IGBT)	ON time : 2 sec. OFF time : 18 sec. Test temp. : ΔT_{Vj}=100±5 deg $T_{Vj} \leqq$ 150 ℃, T_a=25±5 ℃ No. of cycles : 15000 cycles	Test Method 106	5	(0 : 1)

Failure Criteria

Item	Characteristic		Symbol	Failure criteria		Unit	Note
				Lower limit	Upper limit		
Electrical characteristic	Leakage current		I_{CES}	-	USL×2	μA	
			$\pm I_{GES}$	-	USL×2	nA	
	Gate threshold voltage		$V_{GE(th)}$	LSL×0.8	USL×1.2	V	
	Saturation voltage		$V_{CE(sat)}$	-	USL×1.2	V	
	Forward voltage		V_F	-	USL×1.2	V	
	Thermal resistance	IGBT	ΔV_{GE} or ΔV_{CE}	-	USL×1.2	mV	
		FWD	ΔV_F	-	USL×1.2	mV	
	Isolation voltage		V_{isol}	Broken insulation		-	
Visual inspection	Visual inspection ┌ Peeling, Plating, └ and the others		-	The visual sample		-	

LSL : Lower specified limit.

USL : Upper specified limit.

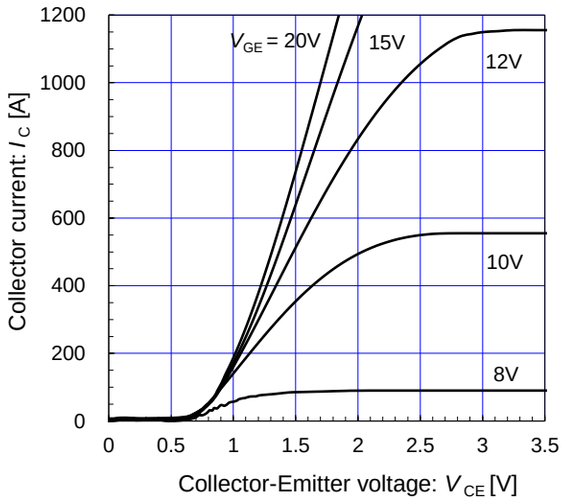
Note : Each parameter measurement read-outs shall be made after stabilizing the components at room ambient for 2 hours minimum, 24 hours maximum after removal from the tests. And in case of the wetting tests, for example, moisture resistance tests, each component shall be made wipe or dry completely before the measurement.

Reliability Test Results

Test categories		Test items	Reference norms EIAJ ED-4701 (Aug.-2001 edition)	Number of test sample	Number of failure sample
Mechanical Tests	1	Terminal Strength (Pull Test)	Test Method 401 Method I	5	0
	2	Mounting Strength	Test Method 402 method Ⅱ	5	0
	3	Vibration	Test Method 403 Condition code B	5	0
	4	Shock	Test Method 404 Condition code B	5	0
Environment Tests	1	High Temperature Storage	Test Method 201	5	0
	2	Low Temperature Storage	Test Method 202	5	0
	3	Temperature Humidity Storage	Test Method 103 Test code C	5	0
	4	Unsaturated Pressurized Vapor	Test Method 103 Test code E	5	0
	5	Temperature Cycle	Test Method 105	5	0
	6	Thermal Shock	Test Method 307 method I Condition code A	5	0
Endurance Tests	1	High temperature Reverse Bias	Test Method 101	5	0
	2	High Temperature Bias (for Gate)	Test Method 101	5	0
	3	Temperature Humidity Bias	Test Method 102 Condition code C	5	0
	4	Intermitted Operating Life (Power Cycling) (for IGBT)	Test Method 106	5	0

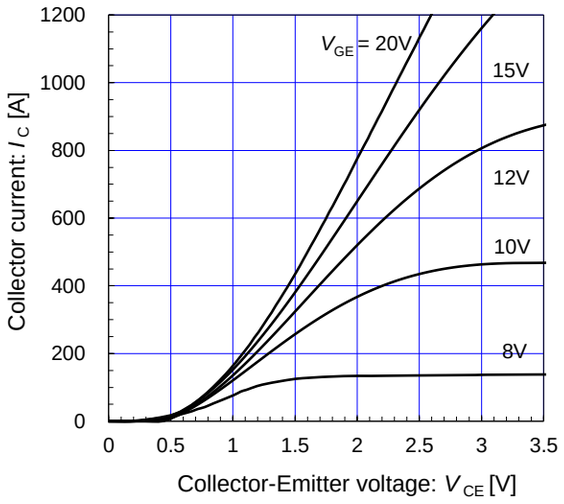
Collector current vs. Collector-Emitter voltage (typ.)

T_{vj} = 25°C / chip



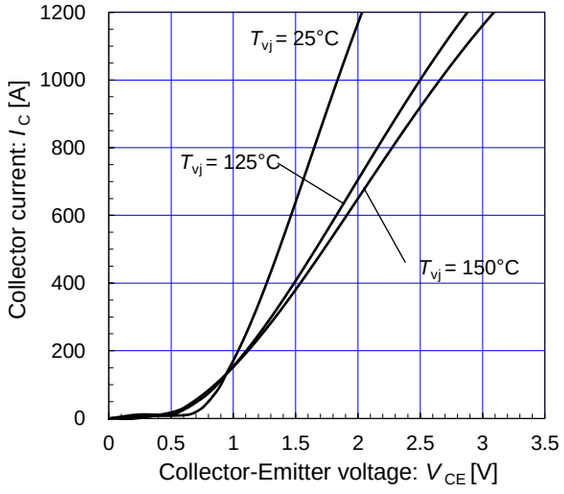
Collector current vs. Collector-Emitter voltage (typ.)

T_{vj} = 150°C / chip



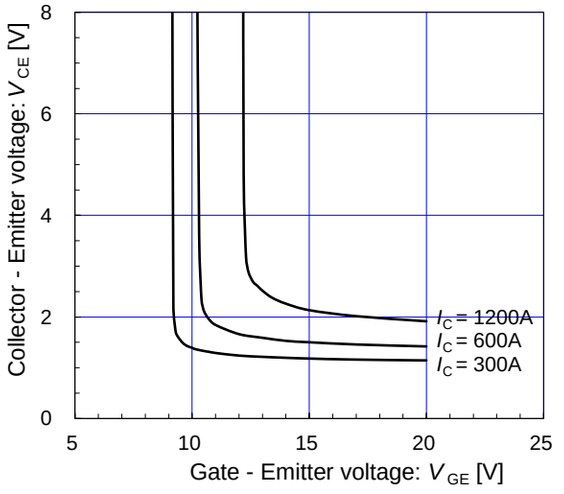
Collector current vs. Collector-Emitter voltage (typ.)

V_{GE} = 15V / chip



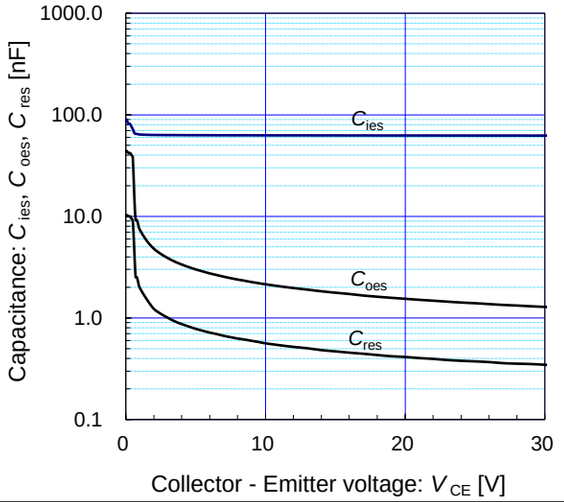
Collector-Emitter voltage vs. Gate-Emitter voltage (typ.)

T_{vj} = 25°C / chip



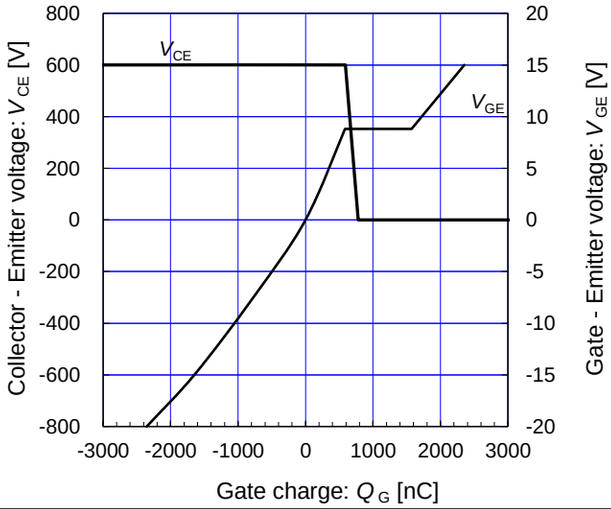
Capacitance vs. Collector-Emitter voltage (typ.)

V_{GE} = 0V, f = 1MHz, T_{vj} = 25°C



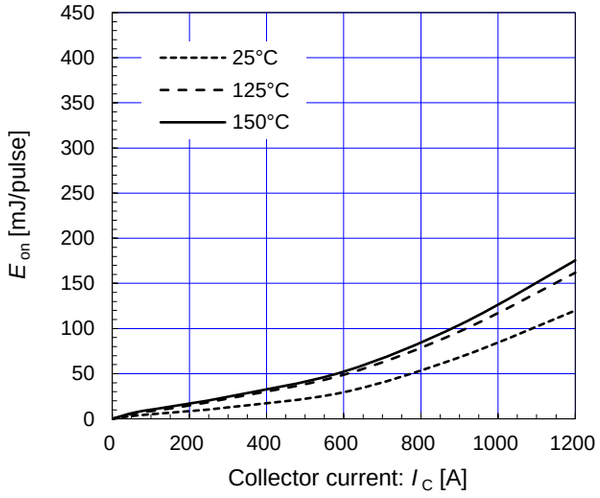
Dynamic Gate charge (typ.)

V_{CC} = 600V, I_C = 600A, T_{vj} = 25°C



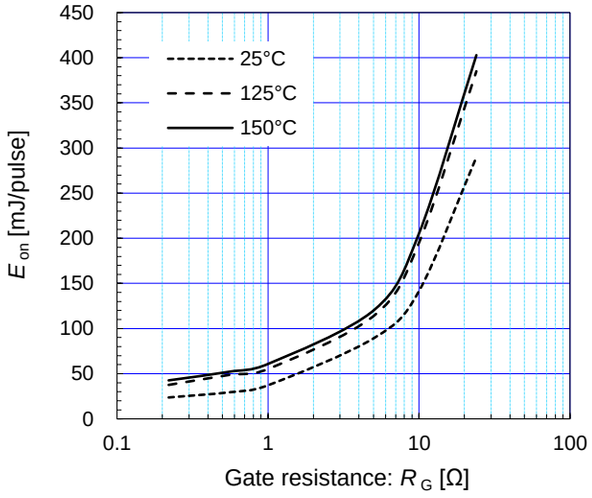
E_{on} vs. Collector current (typ.)

V_{CC} = 600V, V_{GE} = +15/ -15V, R_G = 0.56 Ω



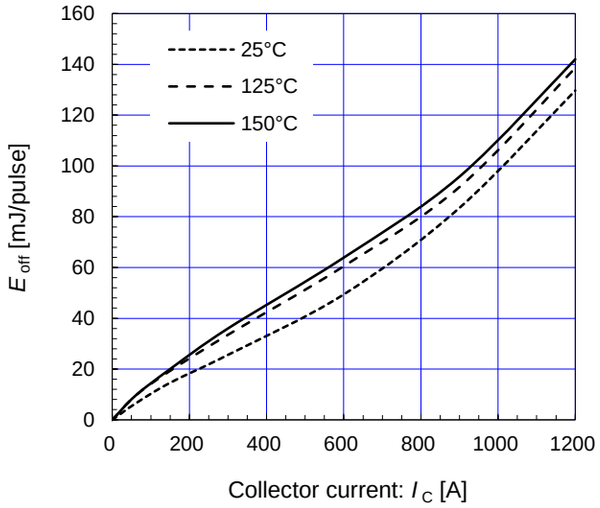
E_{on} vs. Gate resistance (typ.)

V_{CC} = 600V, V_{GE} = +15/ -15V, I_C = 600A



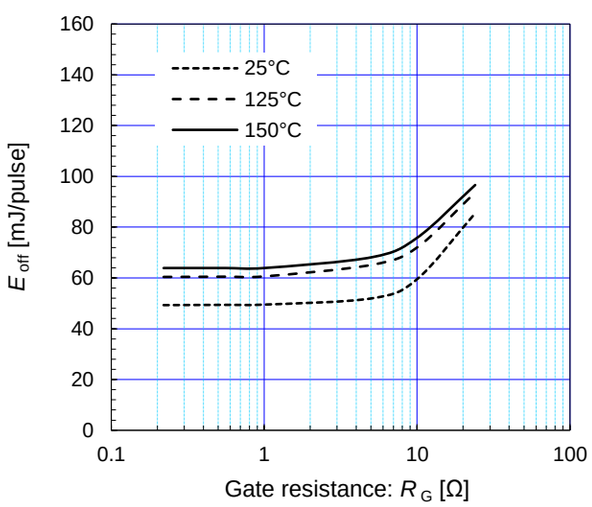
E_{off} vs. Collector current (typ.)

V_{CC} = 600V, V_{GE} = +15/ -15V, R_G = 0.56 Ω



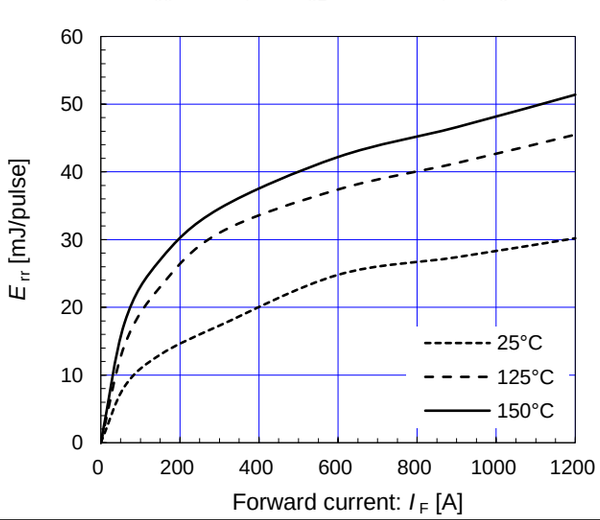
E_{off} vs. Gate resistance (typ.)

V_{CC} = 600V, V_{GE} = +15/ -15V, I_C = 600A



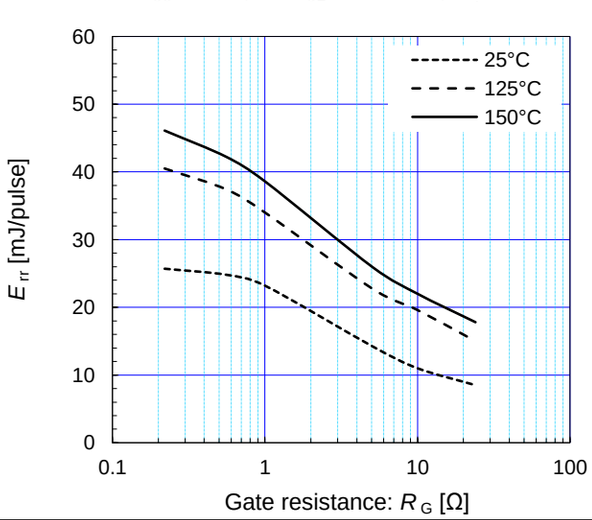
E_{rr} vs. Forward current (typ.)

V_{CC} = 600V, V_{GE} = +15/ -15V, R_G = 0.56 Ω



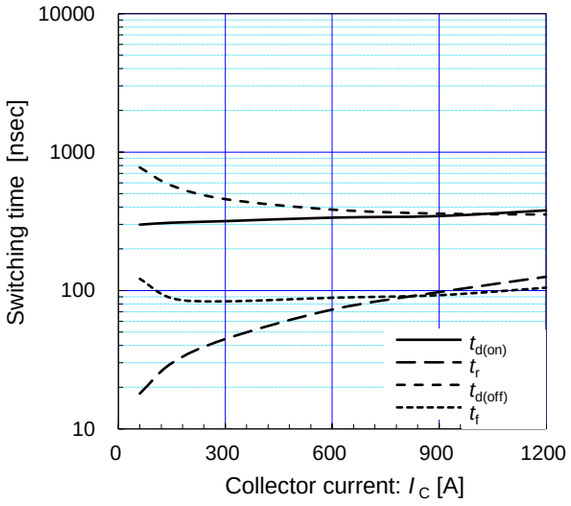
E_{rr} vs. Gate resistance (typ.)

V_{CC} = 600V, V_{GE} = +15/ -15V, I_F = 600A



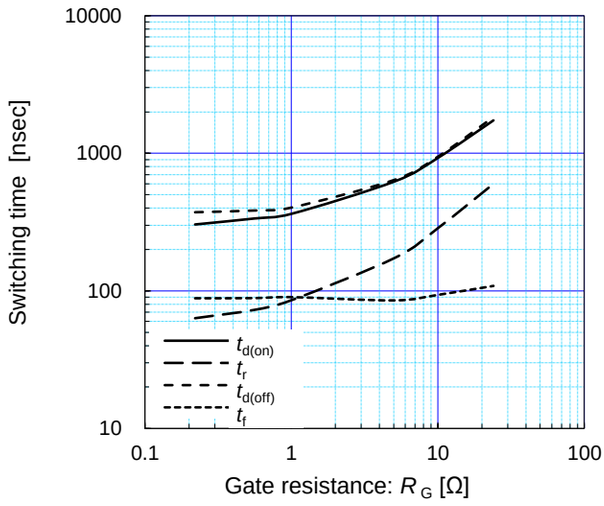
Switching time vs. Collector current (typ.)

V_{CC} = 600V, R_G = 0.56Ω, V_{GE} = +15/ -15V, T_{vj} = 25°C



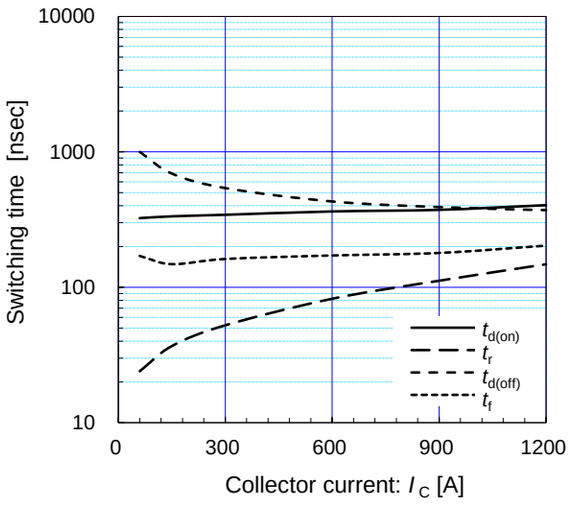
Switching time vs. Gate resistance (typ.)

V_{CC} = 600V, I_C = 600A, V_{GE} = +15/ -15V, T_{vj} = 25°C



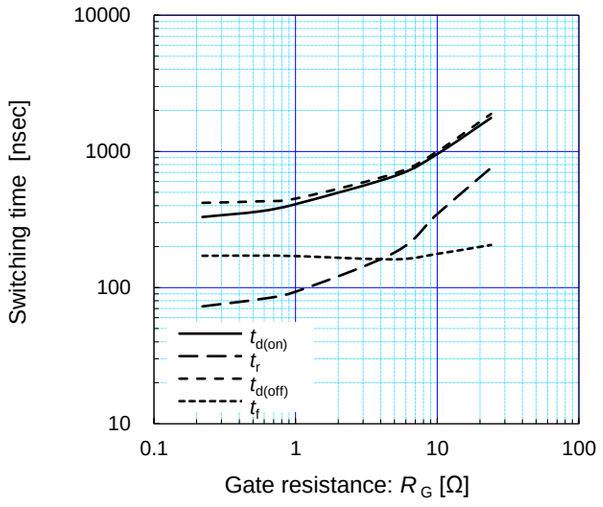
Switching time vs. Collector current (typ.)

V_{CC} = 600V, R_G = 0.56Ω, V_{GE} = +15/ -15V, T_{vj} = 150°C



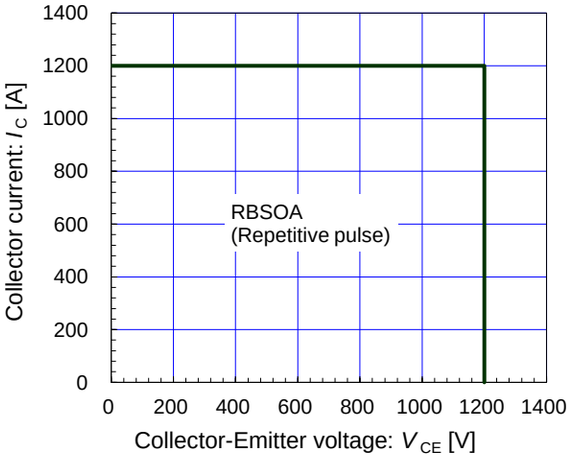
Switching time vs. Gate resistance (typ.)

V_{CC} = 600V, I_C = 600A, V_{GE} = +15/ -15V, T_{vj} = 150°C



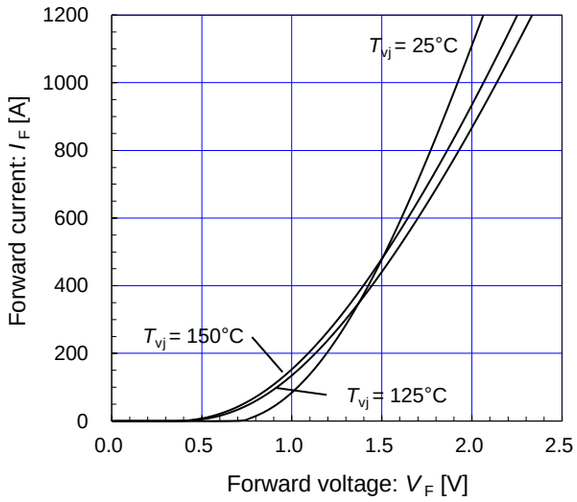
Reverse bias safe operating area (max.)

V_{GE} = +15/ -15V, R_G >= 0.56Ω, T_{vj} = 150°C



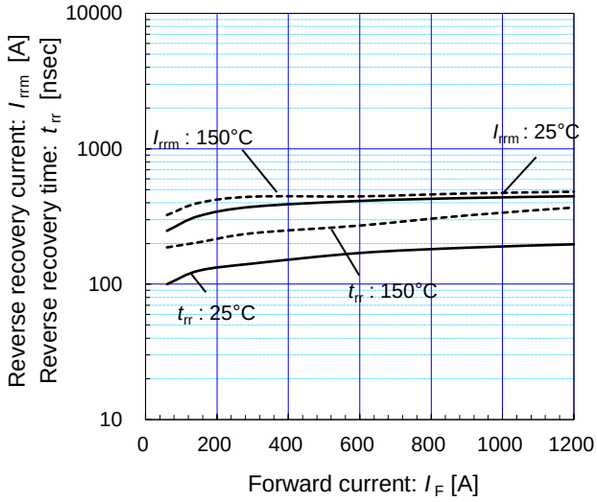
Forward current vs. Forward voltage (typ.)

chip



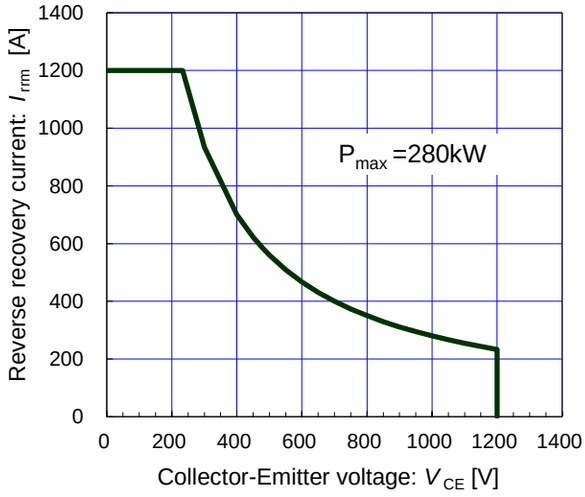
Reverse recovery characteristics (typ.)

V_{CC} = 600V, V_{GE} = +15/ -15V, R_G = 0.56Ω

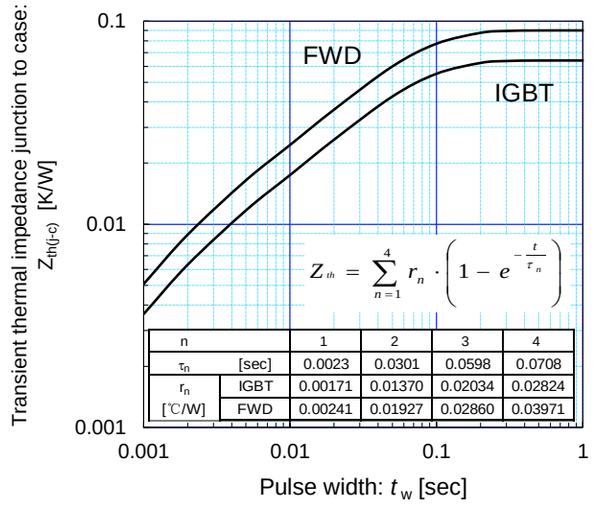


FWD safe operation area (max.)

T_{vj} = 150°C



Transient thermal resistance (max.)



n		1	2	3	4
τ_n	[sec]	0.0023	0.0301	0.0598	0.0708
r_n	IGBT	0.00171	0.01370	0.02034	0.02824
[℃/W]	FWD	0.00241	0.01927	0.02860	0.03971

Warnings

- This product shall be used within its maximum rating (voltage, current, temperature, and so on) described in this specification. This product may be broken in case of using beyond the maximum ratings. The specified value in the absolute maximum ratings are guaranteed value for the rating, not for any combination of ratings or characteristics. Even if this product is used within absolute maximum ratings, expected product lifetime may not be obtained depending on the temperature or usage environment. Please refer to the absolute maximum rating of this product, and judge the suitability of this product for your system / equipment after evaluation and verification by yourself.
  本製品は本仕様書に記載する最大定格（電圧，電流，温度等）の範囲内で御使用下さい。
  最大定格を超えて使用すると、製品が破壊する場合があります。
  また、絶対最大定格の各項目値はそれぞれの項目に対する保証値であり、組み合わせにおける保証をするものではありません。
  最大定格内の使用であっても、温度や使用環境により期待する製品寿命が得られない場合があります。
  本製品の絶対最大定格を参照の上、お客様が使用されるシステム・装置などへの富士電機製品の適合性はお客様にて評価・検証の上、ご判断下さい。

- It shall be confirmed that IGBT's operating locus of the turn-off voltage and current are within the RBSOA specification. If the IGBT is used beyond the range of RBSOA, this product may be destroyed.
  IGBTのターンオフ電圧・電流の動作軌跡がRBSOA仕様内にあることを確認して下さい。
  RBSOAの範囲を超えてIGBTを使用すると本製品が破壊する可能性があります。

- In case of insufficient reverse bias gate voltage $-V_{GE}$, erroneous turn-on of IGBT may occur. In order to prevent the erroneous turn-on, design sufficient gate voltage $-V_{GE}$.
  逆バイアスゲート電圧$-V_{GE}$が不足しますと誤点弧を起こす可能性があります。
  誤点弧を起こさないために$-V_{GE}$は十分な値で設定して下さい。

- If dv/dt is high, the opposite arm IGBT may be erroneously turned on, gate overvoltage may occur, or noise may propagate to the power supply line. Use this product under the optimum driving conditions ($+V_{GE}$, $-V_{GE}$, R_G, C_{GE}) to prevent gate malfunction, gate overvoltage, and unexpected power supply noise. If the wiring length between this product and the gate drive circuit is long, the gate voltage at this product terminal may fluctuate transiently and this product may be broken by overvoltage. In order to prevent gate overvoltage breakdown, implement proper gate wiring design and then confirm gate voltage.
  dv/dt が高いと対向アームIGBTの誤点弧や，ゲート過電圧を起こしたり、電源ラインにノイズが伝搬する可能性があります。
  誤点弧，ゲート過電圧，予期しない電源ノイズを起こさない為の最適なドライブ条件（$+V_{GE}$, $-V_{GE}$, R_G, C_{GE}）でご使用下さい。
  また本製品とゲートドライブ回路間の配線長が長い場合、製品端子のゲート電圧が過渡的に変動し製品が過電圧破壊する場合があります。
  ゲート過電圧破壊を防止するために、適切なゲート配線設計とゲート電圧の確認を実施して下さい。

- If a voltage exceeding V_{CES} is applied, avalanche breakdown may occur and this product may be destroyed. Use this product so that V_{CE} is within the maximum rating.
  V_{CES}を超えた電圧が印加された場合、アバランシェブレークダウンを起こして素子破壊する場合があります。
  V_{CE}は必ず最大定格の範囲内でご使用下さい。

- When using the rectifier diode or FWD installed in this product as a diode rectifier, an inrush current charging the main circuit DC capacitor flows when electric power is connected to the equipment. The guaranteed values for this inrush current for charging the DC capacitor are expressed as I_{FSM} (non-repetitive) or I^2t (non-repetitive). If this inrush current flows frequently through this product, it may be destroyed due to the power cycle capability by the repeating inrush current. For applications where such inrush current flows frequently, use this product with paying sufficient attention to the product lifetime, such as suppressing the inrush current value to avoid destruction due to power cycle capability. Also, if the electric power supply system instantaneously drops in voltage, an inrush current charging the DC capacitor may flow in the same way, so please be careful about suppressing the inrush current as well. On the other hand, if a transient overvoltage that exceeds the voltage rating of the device in this product is propagated from the electric power supply to this product due to a lightning strike, etc., the overvoltage may destroy this product. If any transient overvoltage is expected to be applied from the electric power supply to line-line or line-ground, insert a surge absorber, etc. to suppress the voltage applied to this product in order to avoid damage.
  製品に搭載されている整流ダイオードまたはFWDをダイオード整流器として使用する場合、電源投入時に主回路平滑コンデンサへ充電する突入電流が流れます。充電による単発の突入電流に対する保証値はI_{FSM}(非繰返し)とI^2t(非繰返し)として表記されていますが、突入電流が本製品に頻繁に流れると繰返し電流によるパワーサイクル耐量破壊を起こす可能性があります。突入電流が頻繁に流れるようなアプリケーションでは、パワーサイクル破壊を起こさないように突入電流値を抑えるなど、製品寿命に十分留意してご使用下さい。
  電源系統の瞬時電圧低下が生じた場合も同様にコンデンサへ充電する突入電流が流れる場合がありますので、同様に留意して下さい。
  一方，落雷等により、電源から素子の耐圧を超える過渡的な過電圧が本製品に伝搬された場合、過電圧で破壊する可能性があります。
  電源から線間・アース間に入力過電圧が想定される場合は、破壊を回避するため、サージ吸収素子等を挿入して本製品に掛かる電圧を仕様内に抑えて下さい。

Warnings

- Use this product below the power cycle lifetime curve (Technical Document No.:MT5Z02525). Power cycle withstand capability is classified to ΔT_{vj} mode which is stated as above and ΔT_c mode (Technical Document No.: MT5Z02569). Since the ΔT_c power cycle lifetime of this product depends on the thermal stress due to the rise and fall of the case temperature (T_c), the lifetime of this product is greatly affected by the cooling design of the equipment installing this product. If the case temperature rises and falls frequently, or if the operating time at high temperature is long, use this product with paying sufficient attention to the product lifetime.
本製品は、パワーサイクル寿命カーブ以下で使用下さい(技術資料No.: MT5Z02525)。パワーサイクル耐量にはこのΔT_{vj} による場合の他に、ΔT_c による場合があります(技術資料No.: MT5Z02569)。本製品のΔT_c パワーサイクル寿命は、ケース温度(T_c)の上昇下降による熱応力に依存するため、適用する装置の放熱設計により本製品の寿命が大きく影響されます。ケース温度の上昇下降が頻繁に起こる場合や、高温での稼働時間が長い場合は、製品寿命に十分留意してご使用下さい。

- Install surely an adequate fuse or breaker between the commercial power supply (three-phase line) and this product in case the system / equipment is destroyed by an accident to prevent secondary destruction such as fire, explosion, and fire spread.
万一の不慮の事故で素子が破壊した場合を考慮し、電源と本製品の間に適切な遮断器等を必ず付けて火災，爆発，延焼等の2次破壊を防いで下さい。

- If applied bus bars are not suitable, the main terminals may have higher temperature than T_{stg} (Storage temperature).
Also the main terminals shall be used within temperature range of T_{stg} (Storage temperature).
If excessive stress (tension, pushing, bending) is applied to the main terminal and control terminal, the terminal may be deformed and the case resin may crack, causing poor contact and poor insulation. For the maximum allowable stress of the main terminal and control terminal, refer to the mounting instructions of each package.
When terminal of this product is a screw terminal, use the tightening torque within the specified value. If the tightening torque of the terminal screw is excessive, insulation failure may occur due to cracking of the case, and if the torque is small, the contact resistance may increase and the heat generation of the terminal may increase. In addition, it is expected that the screws will loosen due to vibrations in the usage environment, so select screws that are difficult to loosen, tighten with appropriate torque, and retighten to prevent loosening.
For the terminal screws used to this product, refer to the outline drawing described in this specifications and select a screw with an appropriate length. If longer screws than the allowable values described in this specification are inserted, the product may be damaged, causing ground faults and poor insulation. In that case, Fuji Electric Co., Ltd. is not responsible for the matter.
使用するバスバーが不適切な場合、主端子の温度が保存温度(Storage temperature)以上になることがあります。主端子も保存温度(Storage temperature) 範囲内で御使用下さい。
主端子及び制御端子に過大な応力(引張り，押し込み，曲げ)を与えると端子の変形，ケース樹脂割れが発生し、接触不良，絶縁不良を引き起こす場合があります。主端子及び制御端子の最大許容応力については，各パッケージのマウンティングインストラクションを参照して下さい。
製品端子がネジの場合の締め付けトルクは，仕様値の範囲内でご使用下さい。端子ネジの締付トルクが過大だとケース割れによる絶縁不良が発生したり、トルクが小さいと接触抵抗が増加し端子の発熱が増加する場合があります。また振動等によりネジが緩む場合が想定されますので、緩み難いネジの選定，適正なトルクでの締め付け，増し締め等で緩みの発生を抑えて下さい。
本製品に使用する端子ネジは、仕様書記載の外形図を参照し適切な長さのネジを選定して下さい。仕様書記載の許容値よりも長いネジなどを挿入した場合は製品が破損し、地絡，絶縁不良が発生する場合があり、その場合、富士電機は責任を負いません。

- If excessive static electricity is applied to the terminals, this product may be broken. When handling this product, be careful to avoid any breakdown due to the static electricity, take measures against static electricity. When handling this product, hold the case (package body) and do not touch the terminals. In case of touching the terminals of this product, discharge static electricity adhering to body or clothing by grounding through a high impedance resistor (approx. 1MΩ) before touching. Work on grounded conductive floor or table mat are recommended. When soldering, in order to protect this product from static electricity, use antistatic soldering iron or soldering bath to prevent static electricity, and solder with low impedance resistor between soldering iron and ground.
端子に過度の静電気が印加されると、製品が破損する可能性があります。本製品を取り扱う際には、静電気による破損に注意し対策を実施して下さい。本製品を取り扱う際には、ケース（パッケージ本体）を持って、端子には触れないようにして下さい。本製品の端子に触れる場合は、高インピーダンス抵抗器（約 1MΩ）を介して接地し、身体や衣服に付着した静電気を放電して下さい。作業は、接地された導電性の床やテーブルマットの上で行うことを推奨します。はんだ付けの際には、静電気から本製品を保護するため、静電気対策用のはんだごてやはんだ槽を使用し、低インピーダンス抵抗器を介してはんだ付けして下さい。

- Use the tightening torque of the screws that mounting the product within the specified values. If the tightening torque is excessive, insulation failure may occur due to cracking of the case, and if the torque is small, the contact thermal resistance may increase and the heat generation of the device may increase. In addition, it is expected that the screws will loosen due to vibrations in the usage environment, so select screws that are difficult to loosen, tighten with appropriate torque, and retighten to prevent loosening.
製品取付けネジの締め付けトルクは，仕様値の範囲内でご使用下さい。締付トルクが過大だとケース割れによる絶縁不良が発生したり、トルクが小さいと接触熱抵抗が増加し素子の発熱が増加する場合があります。また使用環境の振動等によりネジが緩む場合が想定されますので、緩み難いネジの選定，適正なトルクでの締め付け，増し締め等で緩みの発生を抑えて下さい。

Warnings

- The product mounting surface of the heat sink should have flatness of 50 μm or less per 100 mm between the screw mounting positions and surface roughness of 10 μm or less. Excessive convex warpage may cause isolation breakdown of this product, resulting in a serious accident. Excessive concave warpage or distortion may create gaps between the product and the heat sink, resulting in poor heat dissipation and thermal destruction.
  ヒートシンクの製品取付面は、ネジ取り付け位置間で平面度を100mmで50μm以下、表面の粗さは10μm以下にして下さい。
  過大な凸反りがあると本製品が絶縁破壊を起こし、重大事故に発展する場合があります。
  過大な凹反りやゆがみ等があると、本製品とヒートシンクの間に空隙が生じて放熱が悪くなり、熱破壊に繋がることがあります。

- When mounting this product on a heat sink, use thermal grease or equivalent to ensure cooling. In order to spread the thermal grease thinly and evenly, the flatness and surface roughness of the heat sink should be within the recommended values described in this specification. Due to insufficient applied amount or improper spreading method, thermal grease may not spread sufficiently over the entire mounting surface of this product, leading to thermal destruction due to poor heat dissipation. When applying thermal grease, make sure that the thermal grease is spread over the entire surface of the product. (By removing this product after mounting, the spread of thermal grease can be confirmed.)
  If the amount of thermal grease near this product mounting hole is excessive, the thermal grease acts as a spacer, hindering the spread of the thermal grease and causing deterioration of heat dissipation. In addition, depending on the type or application method of thermal grease, deterioration or depletion of thermal grease may occur during high-temperature operation or temperature cycle, which may shorten this product lifetime. Pay close attention to the selection and application method of the thermal grease.
  Please refer to the mounting instructions of this product for selection and application method of the thermal grease.
  本製品をヒートシンクに取り付ける際には、冷却を確保するためのサーマルグリス等をご使用下さい。サーマルグリスを薄く均一に広げるために、ヒートシンクの平坦度，表面粗さは仕様書記載の推奨値の範囲内として下さい。また、塗布量の不足、不適な塗布方法により、サーマルグリスが十分に素子全体に広がらず、放熱悪化による熱破壊に繋がる事があります。サーマルグリスを塗布する際には、製品全面にサーマルグリスが拡がっている事を確認して下さい。(実装した後に素子を取りはずすとサーマルグリスの拡がり具合を確認する事が出来ます。)
  製品取付穴付近のサーマルグリス量が過剰だとサーマルグリスがスペーサーとなり、サーマルグリスの広がりが阻害され放熱性の悪化を引き起こします。また、サーマルグリスの種類・塗布方法によっては、高温動作時や温度サイクルでサーマルグリスの劣化や枯渇が発生し、製品寿命が低下する可能性があります。サーマルグリスの選定と塗布方法には十分留意してご使用下さい。
  サーマルグリスの選定と塗布方法については対象製品のマウンティングインストラクションを参照して下さい。

- When designing a new equipment, always refer to the latest mounting instructions.
  新規装置設計の際は、常に最新のマウンティングインストラクションを参照してください。

- If this product is used beyond its lifetime, this product performance and quality of the product may deteriorate before the target lifetime of the system / equipment, and in the worst case, this product may be destroyed. Use this product after fully understanding the usage environment of the system / equipment in which this product is installed and considering that this product satisfies the target lifetime.
  本製品の寿命を超えて使用した場合、本製品の製品劣化，品質劣化が生じ最悪の場合、本製品が破壊に至る場合があります。
  本製品を組み込む装置の使用環境を十分に把握し、本製品が目標寿命を満足することを検討の上、本製品を適用して下さい。

- In any environment containing acids, alkalis, organic substances, corrosive gases (hydrogen sulfide, sulfurous acid gas, etc.) and corrosive liquids (cutting fluid, etc.), this product may oxidize or corrode, resulting in poor contact, disconnection, short circuit, ground fault, etc. In such cases, avoid to use this product as it may cause malfunctions. In the unlikely event that a short circuit or ground fault occurs to this product, there is a secondary risk of smoke, fire, or explosion, etc. If this product is used under conditions containing these corrosive substances, Fuji Electric Co., Ltd. is not responsible regardless of the conditions (temperature, humidity, concentration, etc.).
  酸・アルカリ・有機物・腐食性ガス（硫化水素，亜硫酸ガス等）・腐食性の液体（切削液等）を含む環境下では製品に酸化や腐食が生じ、接触不良・断線・短絡・地絡等、故障の原因となりますのでご使用は避けて下さい。
  万一短絡・地絡等が発生すると、副次的に発煙・発火・破裂の恐れが想定されます。
  これら腐食性物質を含む条件下で使用された場合、条件（温度・湿度・濃度等）によらず富士電機は責任を負いません。

- If this product is used in an environment with sudden temperature changes, it is expected that short circuits and ground faults will occur due to dew condensation. In the unlikely event that a short circuit or ground fault occurs to this product, there is a secondary risk of smoke, fire, or explosion, etc. Fuji Electric Co., Ltd. is not responsible for any use of the product in an environment where condensation may occur.
  本製品が急激な温度変化のある環境下で使用された場合、結露により短絡・地絡が発生することが想定されます。
  万一短絡・地絡等が発生すると、副次的に発煙・発火・破裂の恐れが想定されます。
  製品が結露するような環境下で使用した場合、富士電機は責任を負いません。

- If the product is used in a high humidity environment or after storage the equipment after assembling, operate the equipment after sufficiently releasing the moisture. If the product is operated in a moisture-absorbed state, it may cause electrical wiring defects or insulation defects inside of this product, and Fuji Electric Co., Ltd. is not responsible for the matters.
  高い湿度環境において製品、或いは装置組立後の保管および動作を行う場合は、十分に水分を放出させたのちに装置稼働を実施下さい。
  吸湿した状態で製品を稼働させると製品内部の電気配線不良や絶縁不良等を引き起こす事があり、この場合、富士電機は責任を負いません。

Warnings

- This product is not designed for use in a dusty environment. When used in an environment where dust is generated, heat dissipation may deteriorate due to clogging of the heat sink, and short circuits or ground faults may occur due to leaks between terminals or creeping discharge. (Even if the dust is an insulating material such as fiber, it may leak due to moisture absorption.)
  本製品は粉塵の発生する環境下での使用を想定して設計されておりません。粉塵が発生する環境で使用された場合、ヒートシンクの目詰まりによる放熱性の悪化や、端子間のリークや沿面放電による短絡・地絡が発生する場合があります。
  (粉塵が繊維などの絶縁物であっても、吸湿する事でリークが生じる場合があります。)

- In general, semiconductor devices have accidental failure modes due to high-speed particles (cosmic rays) derived from space or radiation. The failure rate in this failure mode varies depending on the installation location (latitude, longitude, altitude), installation environment, and operating conditions (voltage). In case the product is used under high altitude and/or voltage condition, please contact to Fuji Electric Co., Ltd.
  一般的に半導体素子には、宇宙由来の高速粒子（宇宙線）及び放射線による偶発故障モードが存在します。
  本故障モードにおける故障率は、設置場所(緯度，経度，高度)、設置環境、使用条件(電圧)によって変わります。
  高地や高電圧条件下で御使用される場合は、富士電機までご連絡願います。

- Distance between terminals of this product is designed for adapting use environment in 2000 m sea level or below, Fuji Electric Co., Ltd. is not responsible for the use in an where the altitude exceeds 2000 m above sea level or in an environment where the atmospheric pressure is similarly low.
  本製品は海抜2000m以下の使用環境に適合するように端子間距離等を設計しており、
  これを超える環境下または気圧の低い環境下でご使用される場合は、富士電機は責任を負いません。

- When designing a new equipment, always refer to the latest specifications and application manual (Technical Document No. REH984).
  新規装置設計の際は、常に最新の仕様書及びアプリケーションマニュアル (技術資料No. RH984) を参照してください。

- Use the same lot product only for parallel connection.
  If different lot product is used for parallel connection without confirmation of Fuji Electric Co.Ltd., the product performance cannot be ensured.
  この製品をパラレル接続する場合は、同一ロットのものを使用してください。
  富士電機への確認なく、異なるロットの製品をパラレル接続で使用した場合、製品の保証はできません。

Cautions

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If there is any unclear matter in this specification, please contact Fuji Electric Co., Ltd.