MBN1500E33E2

Silicon N-channel IGBT 3300V E2 version

FEATURES

* Soft switching behavior & low conduction loss:
Soft low-injection punch-through High conductivity IGBT.
* Low driving power due to low input capacitance MOS gate.
* Low noise recovery: Ultra soft fast recovery diode.
* High thermal fatigue durability:
(delta Tc=70K, N>30,000cycles)
AlSiC base-plate/AlN substrate

ABSOLUTE MAXIMUM RATINGS (T_C=25°C)

Item		Symbol	Unit	MBN1500E33E2
Collector Emitter Voltage		V_{CES}	V	3,300
Gate Emitter Voltage		V_{GES}	V	±20
Collector Current	DC	I_C	A	1,500
	1ms	I_{CRM}		3,000
Forward Current	DC	I_F	A	1,500
	1ms	I_{FRM}		3,000
Operating Junction Temperature		$T_{vj\ op}$	°C	-40 ~ +150
Storage Temperature		T_{stg}	°C	-50 ~ +125
Isolation Voltage		V_{ISO}	V_{RMS}	6,000(AC 1 minute)
Screw Torque	Terminals (M4/M8)	-	N·m	2/15 (1)
	Mounting (M6)	-		6 (2)

Notes: (1) Recommended Value 1.8±0.2/15^{+0}_{-3}N·m (2) Recommended Value 5.5±0.5N·m

ELECTRICAL CHARACTERISTICS

Item	Symbol	Unit	Min.	Typ.	Max.	Test Conditions	
Collector Emitter Cut-Off Current	I_{CES}	mA	-	-	12	V_{CE}=3,300V, V_{GE}=0V, T_{vj}=25°C	
			-	20	60	V_{CE}=3,300V, V_{GE}=0V, T_{vj}=125°C	
Gate Emitter Leakage Current	I_{GES}	nA	-500	-	+500	V_{GE}=±20V, V_{CE}=0V, T_{vj}=25°C	
Collector Emitter Saturation Voltage	V_{CEsat}	V	2.5	2.95	3.5	I_C=1,500A, V_{GE}=15V, T_{vj}=125°C	
			-	3.1	-	I_C=1,500A, V_{GE}=15V, T_{vj}=150°C	
Gate Emitter Threshold Voltage	$V_{GE(th)}$	V	5.5	6.3	7.5	V_{CE}=10V, I_C=1,500mA, T_{vj}=25°C	
Input Capacitance	C_{ies}	nF	-	195	-	V_{CE}=10V, V_{GE}=0V, f=100kHz, T_{vj}=25°C	
Internal Gate Resistance	$R_{G(int)}$	Ω	-	1.0	-	V_{CE}=10V, V_{GE}=0V, f=100kHz, T_{vj}=25°C	
Turn On Delay Time	$t_{d(on)}$	µs	-	1.0	-	V_{CC}=1,650V, I_C=1,500A	
Rise Time	t_r		1.6	2.0	2.6	L_S=100nH	
Turn Off Delay Time	$t_{d(off)}$		-	2.7	-	R_G=2.7Ω/2.7Ω, C_{GE}=330nF (3)	
Fall Time	t_f		0.9	1.7	2.6	V_{GE}=±15V, T_{vj}=125°C	
Forward Voltage Drop	V_F	V	2.2	2.6	3.0	I_F=1,500A, V_{GE}=0V, T_{vj}=125°C	
			-	2.6	-	I_F=1,500A, V_{GE}=0V, T_{vj}=150°C	
Reverse Recovery Time	t_{rr}	µs	0.2	0.8	1.2	V_{CC}=1,650V, I_F=1,500A, L_S=100nH T_{vj}=125°C, R_G=2.7Ω/2.7Ω, C_{GE}=330nF (3)	
Short Circuit Pulse Width	t_{sc}	µs	10	-	-	V_{CC}=2,000V,Ls=80nH R_G(on/off)=2.7/27Ω,V_{GE}=±15V, T_{vj}=125°C	
Turn On Loss	$E_{on(10\%)}$	J/P	-	2.9	3.6	T_{vj}=125°C	V_{CC}=1,650V, I_C=1,500A L_S=100nH, R_G=2.7Ω/2.7Ω, C_{GE}=330nF (3) V_{GE}=±15V
	$E_{on(full)}$		-	3.2	-		
			-	3.5	-	T_{vj}=150°C	
Turn Off Loss	$E_{off(10\%)}$	J/P	-	2.2	2.6	T_{vj}=125°C	
	$E_{off(full)}$		-	2.4	-		
			-	2.5	-	T_{vj}=150°C	
Reverse Recovery Loss	$E_{rr(10\%)}$	J/P	-	1.4	1.9	T_{vj}=125°C	
	$E_{rr(full)}$		-	1.7	-		
			-	2.1	-	T_{vj}=150°C	

Notes: (3) R_G and C_{GE} value are a test condition value for evaluation, not recommended value.
Please, determine the suitable R_G value by measuring switching behaviors.

* Please contact our representatives at order.
* For improvement, specifications are subject to change without notice.
* For actual application, please confirm this spec sheet is the newest revision.

MBN1500E33E2

THERMAL CHARACTERISTICS

Item		Symbol	Unit	Min.	Typ.	Max.	Test Conditions
Thermal Impedance	IGBT	$R_{th(j-c)}$	K/W	-	-	0.0078	Junction to case
	FWD	$R_{th(j-c)}$		-	-	0.0156	
Contact Thermal Impedance		$R_{th(c-f)}$	K/W	-	0.005	-	Case to fin

MODULE MECHANICAL CHARACTERISTICS

Item		Unit	Characteristics	Conditions
Weight		g	1,300	
Stray inductance in module	LS(CM-EM)	nH	12	Collector-main to Emitter-main
	LS(ES-EM)		49	Emitter-sense to Emitter-main
	LS(CM-CS)		56	Collector-main to Collector sense
Terminal Resistance	$R_{Terminal}$	mΩ	0.09	Collector-main to Emitter-main
Comparative Tracking Index (CTI)		-	600	
Module base plate Material		-	Al-SiC	
Baseplate Thickness		mm	5	
Insulation plate Material		-	Al N	
Terminal Surface treatment		-	Ni plating	
Case Material		-	Poly-Phenylene Sulfide	
Fire and Smoke Category		-	I2 / F3	NFF 16-102

MBN1500E33E2

DEFINITION OF TEST CIRCUIT

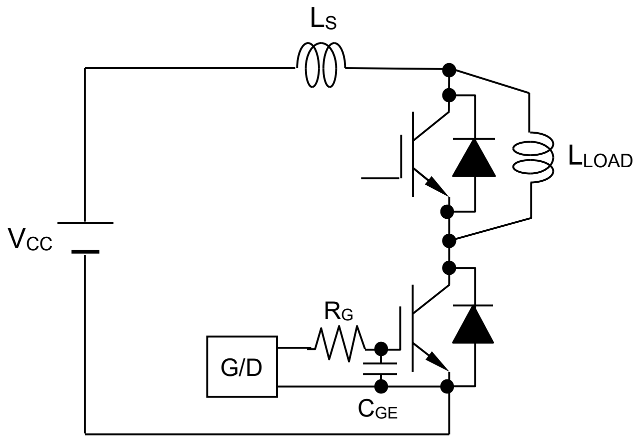
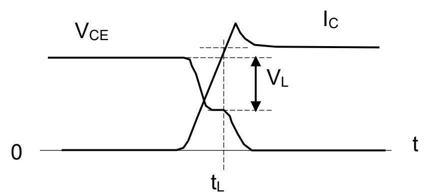
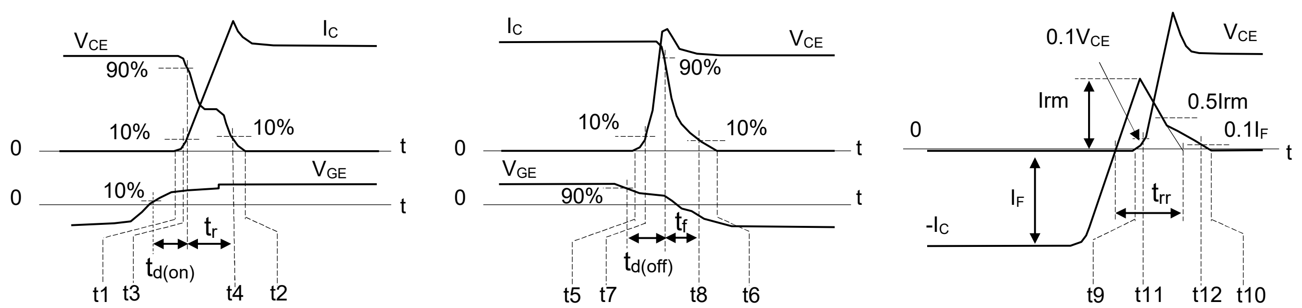


Fig.1 Switching test circuit



$$L_S = \frac{V_L}{\left(\frac{dI_C}{dt}\right)_{t=t_L}}$$

Fig.2 Definition of stray inductance



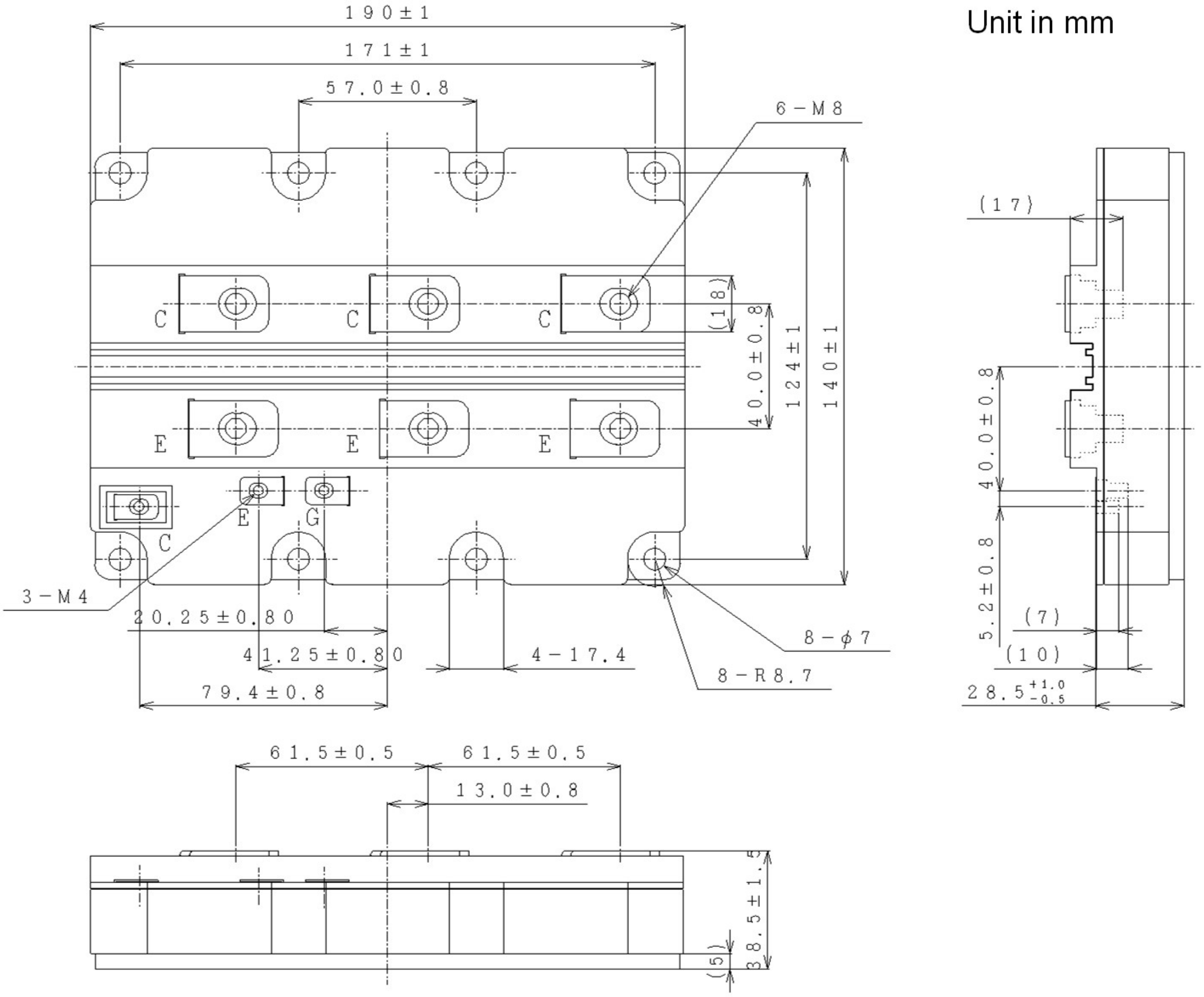
$$E_{on(10\%)} = \int_{t3}^{t4} I_C \cdot V_{CE}\, dt \qquad E_{off(10\%)} = \int_{t7}^{t8} I_C \cdot V_{CE}\, dt \qquad E_{rr(10\%)} = \int_{t11}^{t12} I_F \cdot V_{CE}\, dt$$

$$E_{on(Full)} = \int_{t1}^{t2} I_C \cdot V_{CE}\, dt \qquad E_{off(Full)} = \int_{t5}^{t6} I_C \cdot V_{CE}\, dt \qquad E_{rr(Full)} = \int_{t9}^{t10} I_F \cdot V_{CE}\, dt$$

Fig.3 Definition of switching loss

MBN1500E33E2

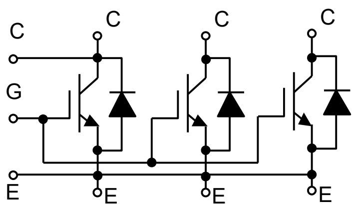
OUTLINE DRAWING



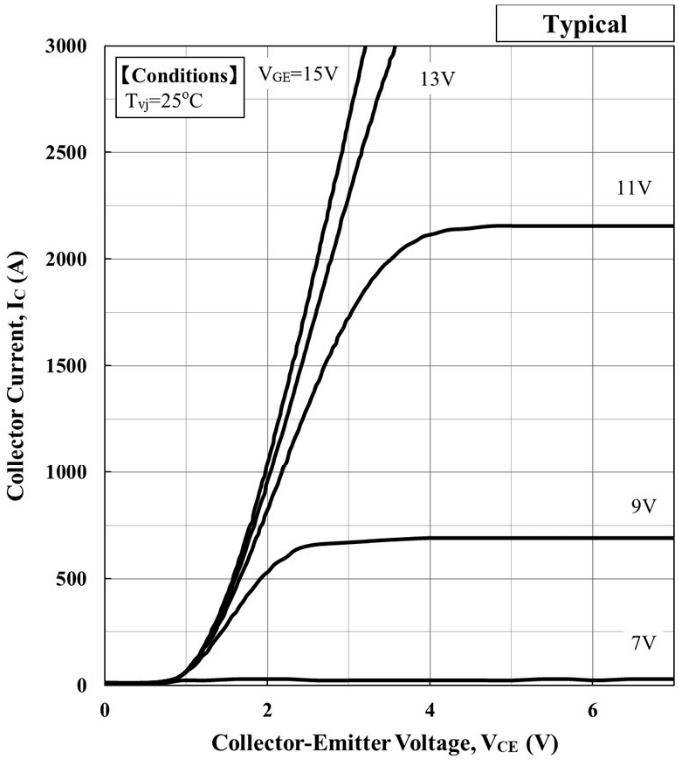
Unit in mm

Weight: 1,300g

CIRCUIT DIAGRAM

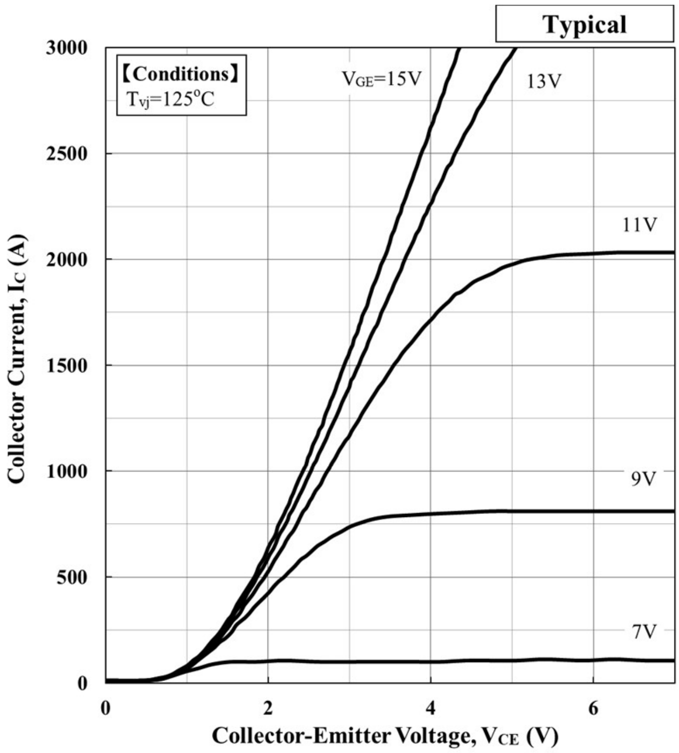


MBN1500E33E2



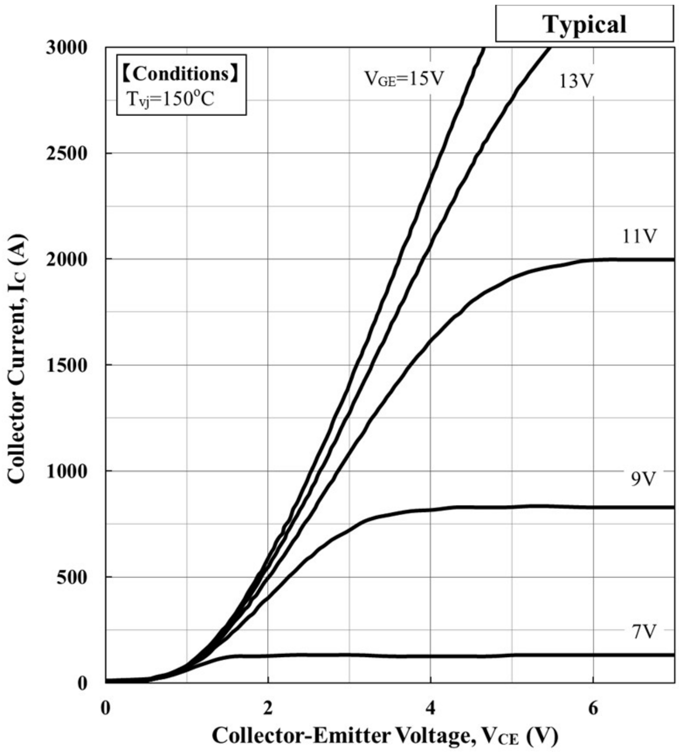
$V_{CE}(sat)[V] = a_3 \cdot \|I_c\|^3 + a_2 \cdot \|I_c\|^2 + a_1 \cdot \|I_c\| + a_0$					
Temp.[°C]	V_{GE}[V]	a_3	a_2	a_1	a_0
25	15	3.89E-11	-2.58E-07	1.15E-03	1.04E+00

Collector Current vs. Collector Emitter Voltage



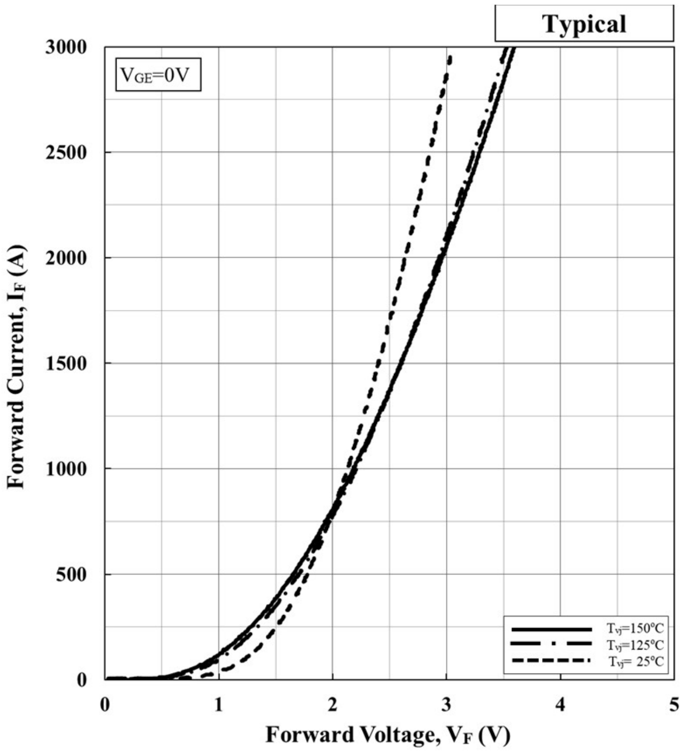
$V_{CE}(sat)[V] = a_3 \cdot \|I_c\|^3 + a_2 \cdot \|I_c\|^2 + a_1 \cdot \|I_c\| + a_0$					
Temp.[°C]	V_{GE}[V]	a_3	a_2	a_1	a_0
125	15	5.71E-11	-3.73E-07	1.71E-03	1.03E+00

Collector Current vs. Collector Emitter Voltage



$V_{CE}(sat)[V] = a_3 \cdot \|I_c\|^3 + a_2 \cdot \|I_c\|^2 + a_1 \cdot \|I_c\| + a_0$					
Temp.[°C]	V_{GE}[V]	a_3	a_2	a_1	a_0
150	15	6.33E-11	-4.08E-07	1.87E-03	1.01E+00

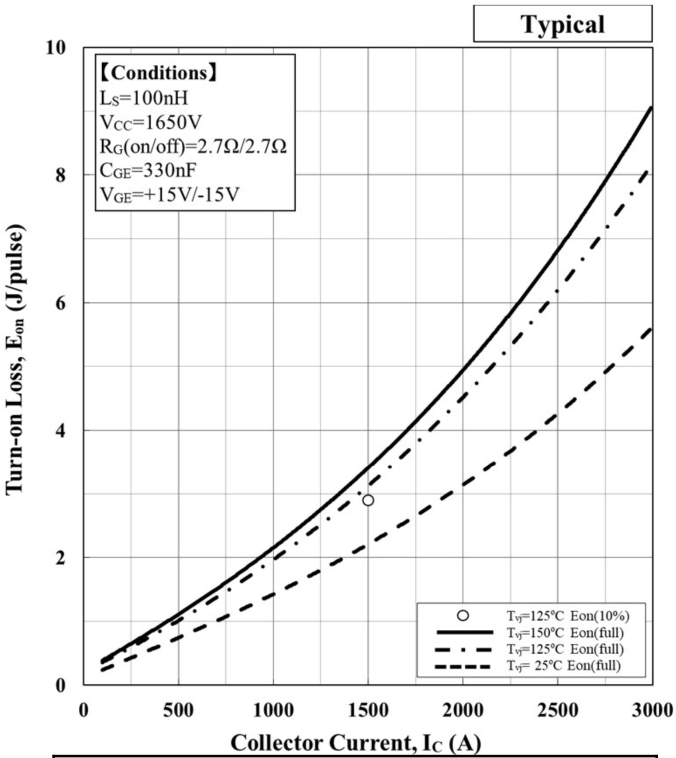
Collector Current vs. Collector Emitter Voltage



$V_F[V] = a_3 \cdot \|I_F\|^3 + a_2 \cdot \|I_F\|^2 + a_1 \cdot \|I_F\| + a_0$				
Temp.[°C]	a_3	a_2	a_1	a_0
25	4.65E-11	-3.30E-07	1.17E-03	1.24E+00
125	5.56E-11	-4.09E-07	1.57E-03	9.85E-01
150	5.80E-11	-4.20E-07	1.64E-03	9.10E-01

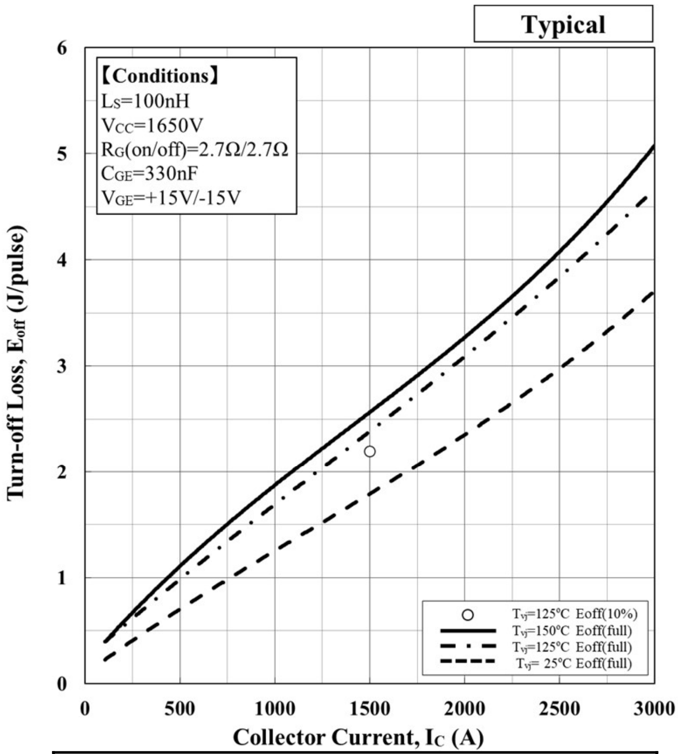
Forward Voltage of free-wheeling diode

MBN1500E33E2



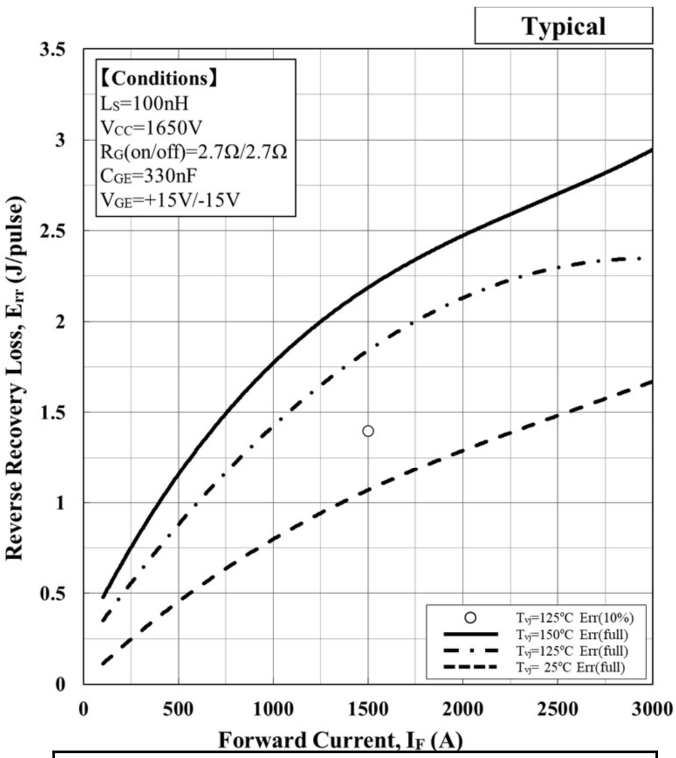
$E\,[J] = a_3 \cdot \lvert I_c \rvert^3 + a_2 \cdot \lvert I_c \rvert^2 + a_1 \cdot \lvert I_c \rvert + a_0$				
Temp.[°C]	a_3	a_2	a_1	a_0
25	5.92E-11	2.73E-08	1.22E-03	1.21E-01
125	5.34E-11	2.38E-07	1.46E-03	2.15E-01
150	8.41E-11	1.76E-07	1.67E-03	2.21E-01

Turn-on loss vs. Collector current



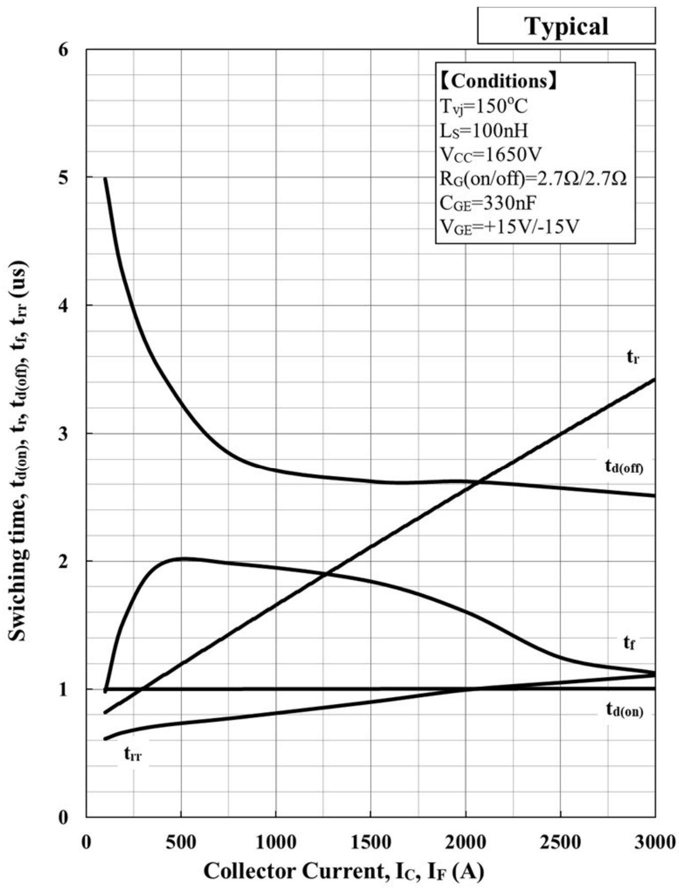
$E\,[J] = a_3 \cdot \lvert I_c \rvert^3 + a_2 \cdot \lvert I_c \rvert^2 + a_1 \cdot \lvert I_c \rvert + a_0$				
Temp.[°C]	a_3	a_2	a_1	a_0
25	5.45E-11	-1.96E-07	1.30E-03	9.35E-02
125	4.03E-11	-1.52E-07	1.57E-03	2.32E-01
150	1.18E-10	-5.01E-07	2.08E-03	1.81E-01

Turn-off loss vs. Collector current



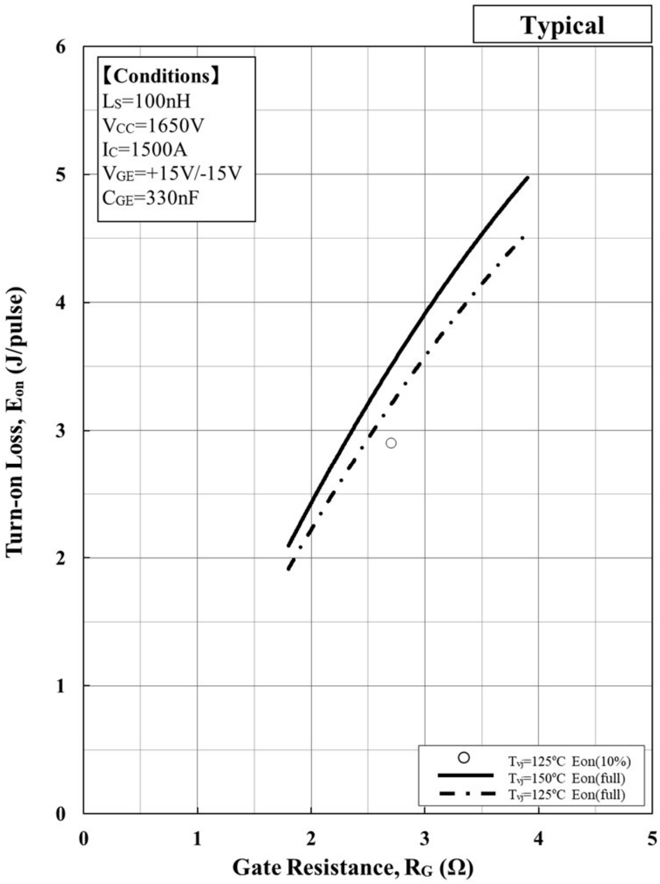
$E\,[J] = a_3 \cdot \lvert I_F \rvert^3 + a_2 \cdot \lvert I_F \rvert^2 + a_1 \cdot \lvert I_F \rvert + a_0$				
Temp.[°C]	a_3	a_2	a_1	a_0
25	3.07E-11	-2.40E-07	9.94E-04	1.33E-02
125	5.10E-12	-2.75E-07	1.50E-03	2.00E-01
150	9.49E-11	-6.84E-07	2.09E-03	2.71E-01

Recovery loss vs. Forward current

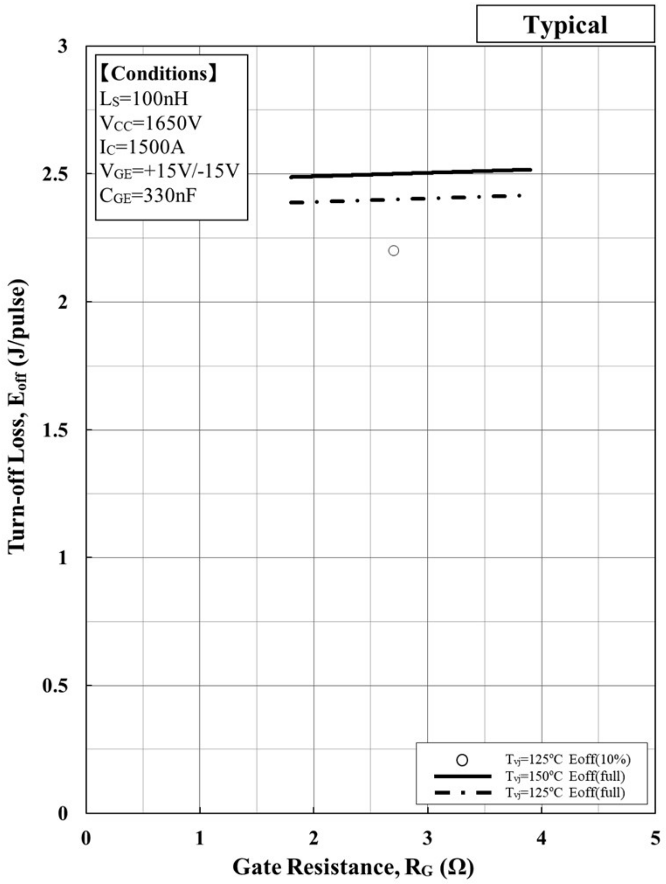


Switching time vs. Collector Current

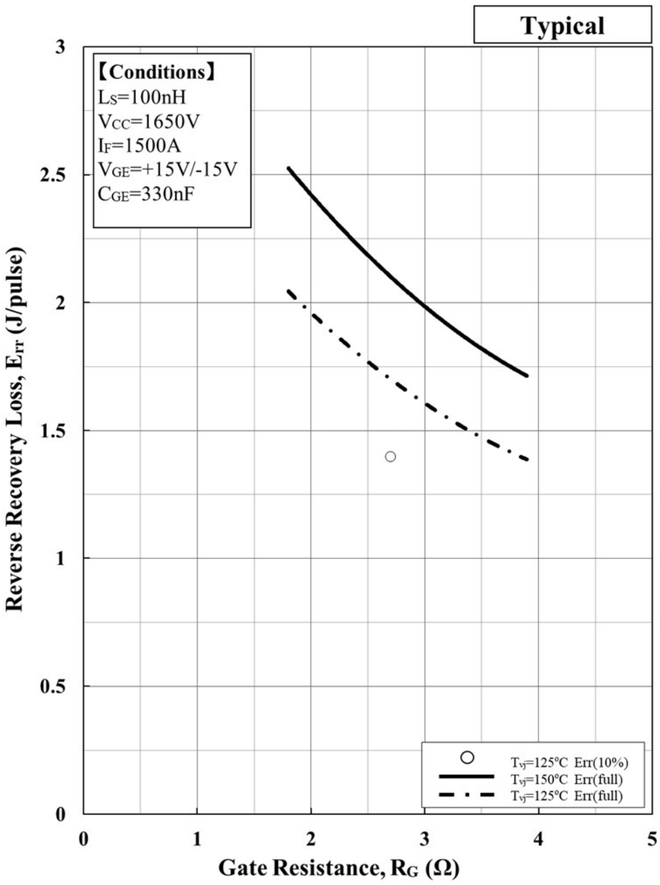
MBN1500E33E2



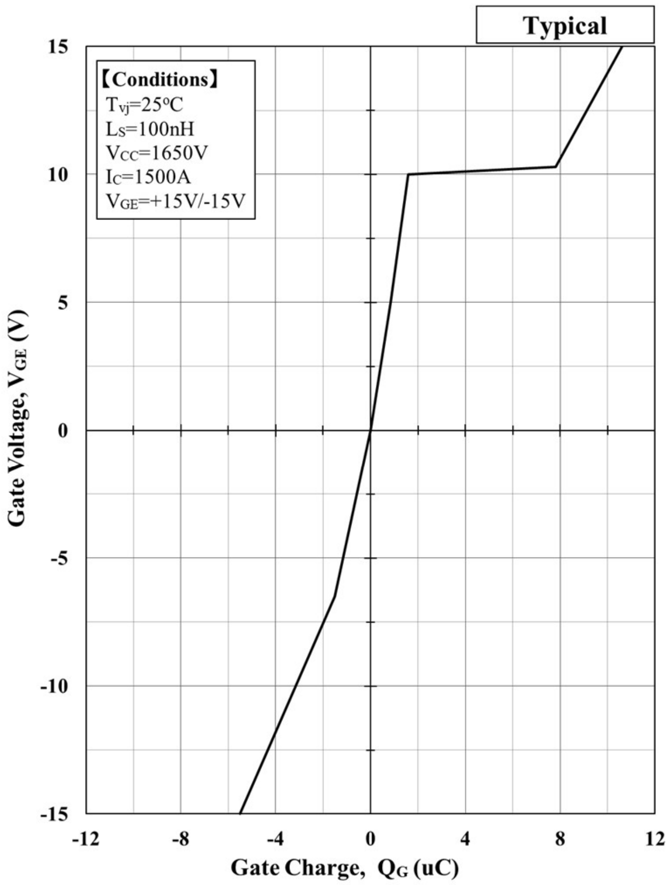
Turn-on loss vs. Gate Resistance



Turn-off loss vs. Gate Resistance

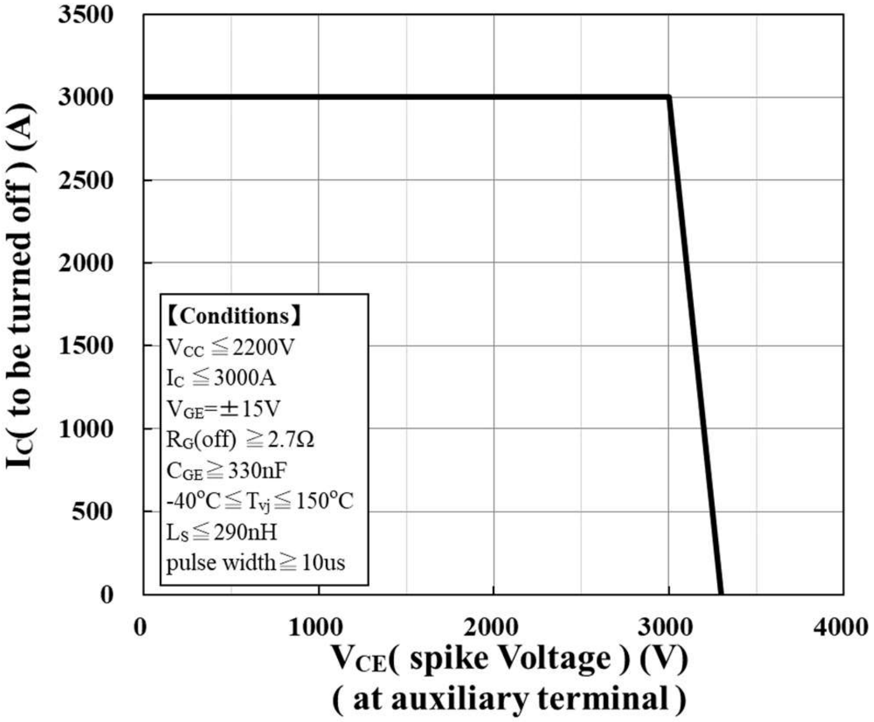


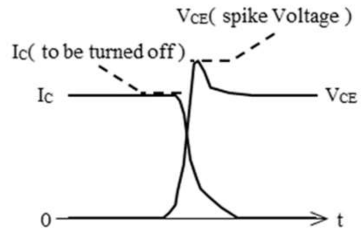
Reverse Recovery loss vs. Gate Resistance



V_{GE}-Q_G curve

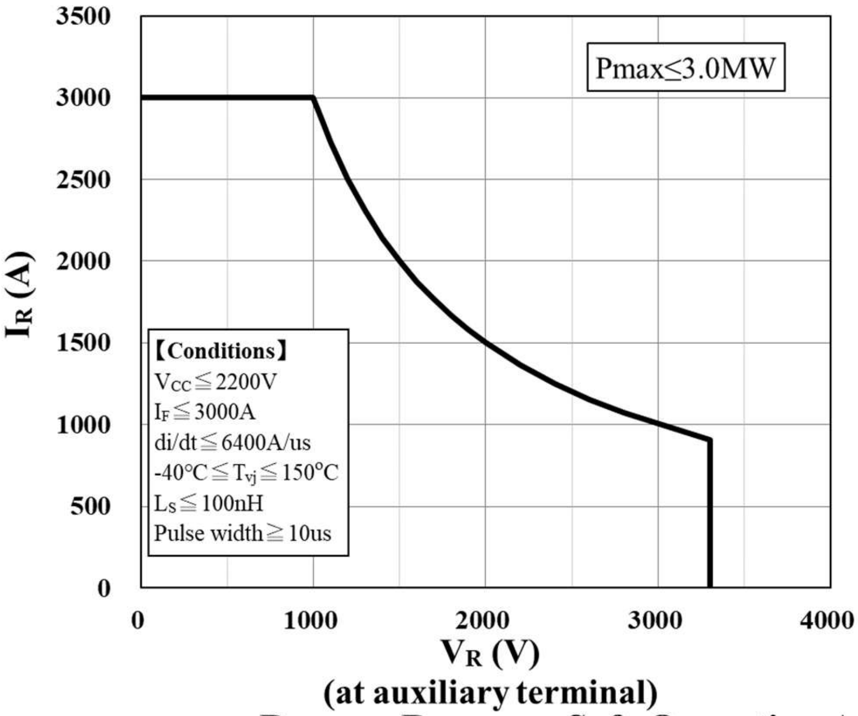
MBN1500E33E2

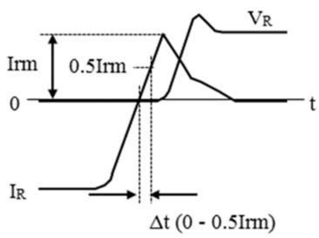




Definition of RBSOA waveform

Reverse Bias Safe Operation Area (RBSOA)



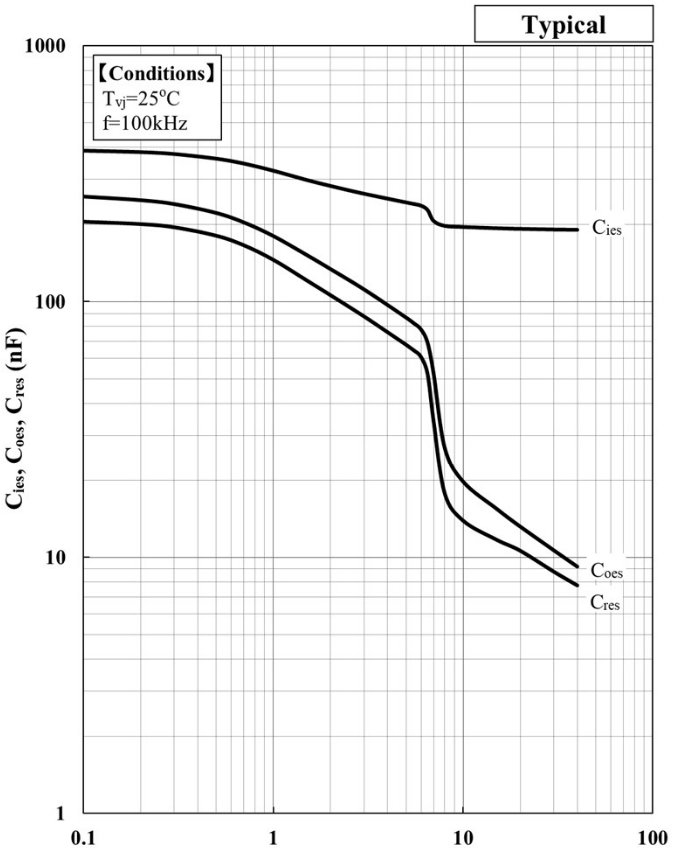


$$di/dt = \frac{0.5Irm}{\Delta t}$$

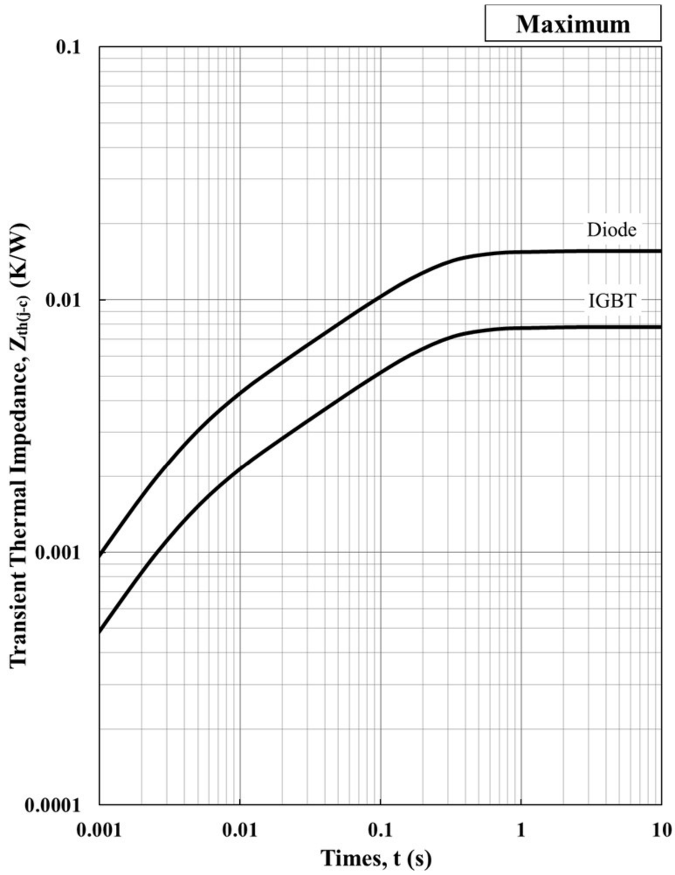
Definition of Recovery di/dt

Reverse Recovery Safe Operation Area (RRSOA)

MBN1500E33E2



Capacitance vs. Collector to Emitter Voltage



Transient Thermal Ipedance Curve

Foster model lumped circuit constant

n	1	2	3	4
R th, IGBT [n]	4.86E-03	1.40E-03	1.40E-03	1.43E-04
C th, IGBT [n]	3.29E+01	1.95E+01	2.89E+00	5.14E+00
R th, Diode [n]	9.67E-03	2.90E-03	2.74E-03	2.93E-04
C th, Diode [n]	1.65E+01	9.47E+00	1.47E+00	2.51E+00

Cauer model lumped circuit constant

n	1	2	3	4
R th, IGBT [n]	1.10E-03	1.25E-03	2.70E-03	2.75E-03
C th, IGBT [n]	1.61E+00	1.77E+00	1.23E+01	3.64E+01
R th, Diode [n]	2.17E-03	2.52E-03	5.42E-03	5.50E-03
C th, Diode [n]	8.05E-01	8.96E-01	6.04E+00	1.84E+01

Material declaration

Please note the following materials are contained in the product, in order to keep characteristic and reliability level.

Material	Contained part
Lead (Pb) and its compounds	Solder

MBN1500E33E2

HITACHI POWER SEMICONDUCTORS

Notices

1. Since mishandling of semiconductor devices may cause malfunctions, please be sure to read "Precautions for Safe Use and Notices" in the individual brochure before use.
2. When designing an electronic circuit using semiconductor devices, please do not exceed the absolute maximum rating specified for the device under any external fluctuations. And for pulse applications, please also do not exceed the "Safe Operating Area (SOA)".
3. Semiconductor devices may sometimes break down by accidental or unexpected surge voltage, so please be careful about the safety design such as redundant design and malfunction prevention design which don't cause the damage expand even if they break down.
4. In cases where extremely high reliability is required (such as use in nuclear power control, aerospace and aviation, traffic equipment, life-support-related medical equipment, fuel control equipment and various kinds of safety equipment), safety should be ensured by using semiconductor devices that feature assured safety or by means of users' fail-safe precautions or other arrangement. Or consult with Hitachi's sales department staff. (When semiconductor devices fail, as a result the semiconductor devices or wiring, wiring pattern may smoke, ignite, or the semiconductor devices themselves may burst.)
5. A semi-processed article is done now using solder which contains lead inside the semiconductor devices. There is possibility of the regulation substance depend on the applied models, so please check before using.
6. This specification is a material for component selection, which describes specifications of power semiconductor devices (hereinafter referred to as products), characteristic charts, and external dimension drawings.
7. The information given herein, including the specifications and dimensions, is subject to change without prior notice to improve product characteristics. Before ordering, purchasers are advised to contact with Hitachi power semiconductor sales department for the latest version of this data sheets.
8. For handling other than described in this manual, follow the handling instructions (IGBT-HI-00002).

■ For inquiries relating to the products, please contact nearest representatives that is located "Inquiry" portion on the top page of a home page.

Hitachi power semiconductor home page address
http://www.hitachi-power-semiconductor-device.co.jp/
http://www.hitachi-power-semiconductor-device.co.jp/en/

HITACHI
Inspire the Next

MBN1500E33E2

HITACHI POWER SEMICONDUCTORS

Usage

1. HPSD warrants that the HPSD products have the specified performance according to the respective specifications at the time of its sale. Testing and other quality control techniques of the HPSD products by HPSD are utilized to the extent HPSD needs to meet the specifications described in this document. Not every device of the HPSD products is specifically tested on all parameters, except those mandated by relevant laws and/or regulations.
2. Following any claim regarding the failure of a product to meet the performance described in this document made within one month of product delivery, all the products in relevant lot(s) shall be re-tested and re-delivered. The HPSD products delivered more than one month before such a claim shall not be counted for such response.
3. HPSD assumes no obligation nor makes any promise of compensation for any fault which should be found in a customer's goods incorporating the products in the market. If a product failure occurs for reasons obviously attributable to HPSD and a claim is made within six months of product delivery, HPSD shall offer free replacement or payment of compensation. The maximum compensation shall be the amount paid for the products, and HPSD shall not assume responsibility for any other compensation.
4. HPSD reserves the right to make changes in this document and to discontinue mass production of the relevant products without notice. Customers are advised to confirm specification of the product of inquiry before purchasing of the products that the customer desired. Customers are further advised to confirm before purchasing of such above products that the product of inquiry is the latest version and that the relevant product is in mass production status if the purchasing of the products by the customer is suspended for one year or more.
5. When you dispose of HPSD products and/or packing materials, comply with the laws and regulations of each country and/or local government. Conduct careful preliminary studies about environmental laws applying to your products such as RoHS, REACH. HPSD shall not assume responsibility for compensation due to contravention of laws and/or regulations.
6. HPSD shall not be held liable in any way for damages and infringement of patent rights, copyright or other intellectual property rights arising from or related to the use of the information, products, and circuits in this document.
7. No license is granted by this document of any patents, copyright or other intellectual property rights of any third party or of HPSD.
8. This document may not be reprinted, reproduced or duplicated, in any form, in whole or in part without the express written permission of HPSD.
9. You shall not use the HPSD products (technologies) described in this document and any other products (technologies) manufactured or developed by using them (hereinafter called "END Products") or supply the HPSD products (technologies) and END Products for the purpose of disturbing international peace and safety, including (i) the design, development, production, stockpiling or any use of weapons of mass destruction such as nuclear, chemical or biological weapons or missiles, (ii) the other military activities, or (iii) any use supporting these activities. You shall not sell, export, dispose of, license, rent, transfer, disclose or otherwise provide the HPSD products (technologies) and END Products to any third party whether directly or indirectly with knowledge or reason to know that the third party or any other party will engage in the activities described above.
   When exporting, re-export transshipping or otherwise transferring the HPSD products (technologies) and END Products, all necessary procedures are to be taken in accordance with Foreign Exchange and Foreign Trade Act (Foreign Exchange Act) of Japan, Export Administration Regulations (EAR) of US, and any other applicable export control laws and regulations promulgated and administered by the governments of the countries asserting jurisdictions over the parties or transaction.