

# 7MBR50XKD065-50

IGBT Modules

**Power Module(X series)**  
650V / 50A / PIM

**Features**

- Low  $V_{CE(sat)}$
- Compact Package
- P.C.Board Mount Module
- Converter Diode Bridge Dynamic Brake Circuit
- RoHS compliant Product

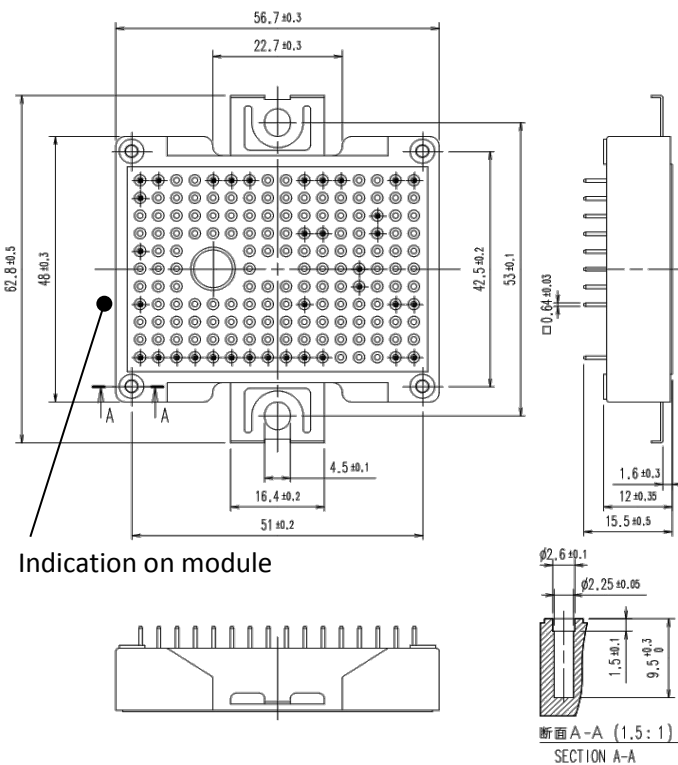
**Applications**

- Inverter for Motor Drive
- AC and DC Servo Drive Amplifier
- Uninterruptible Power Supply

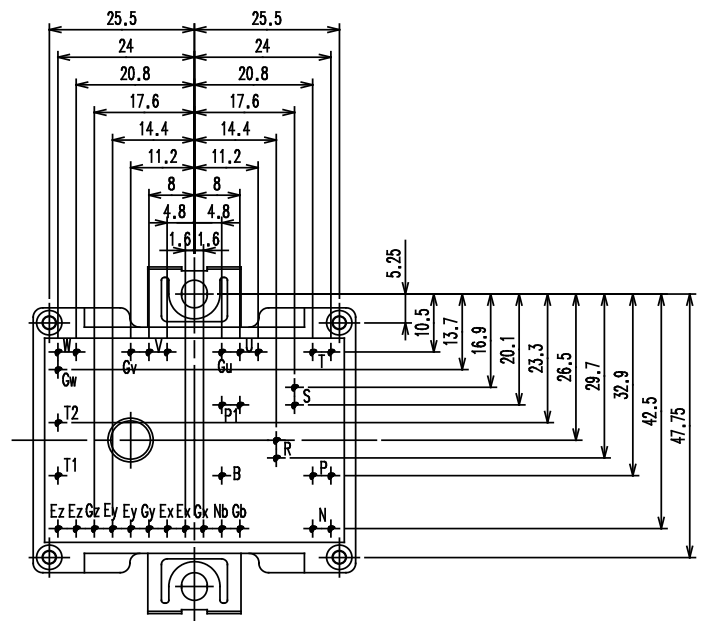
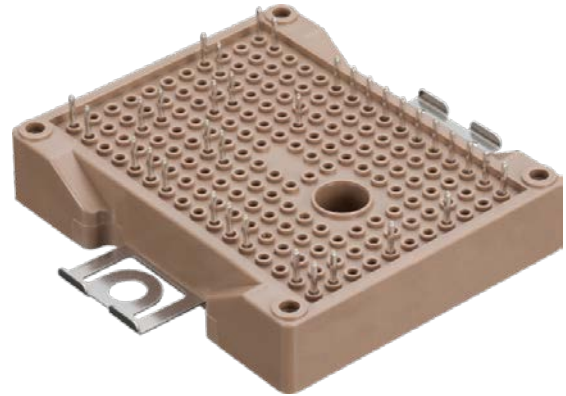
**Outline drawing ( Unit : mm )**

shows theoretical dimension.

( ) shows reference dimension.



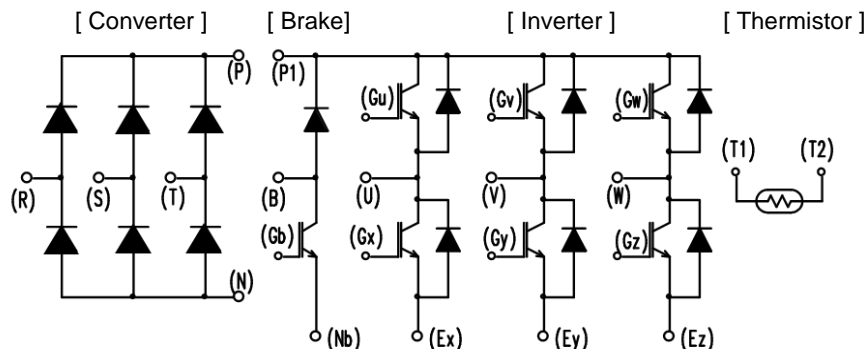
**Typical appearance**



Weight: 45 g (typ.)

PIN POSITIONS WITH TOLERANCE  $\pm 0.4$

**Equivalent circuit**



# 7MBR50XKD065-50

□ Maximum ratings ( at  $T_c = 25^\circ\text{C}$  unless otherwise specified )

Items		Symbols	Conditions		Maximum ratings	Units	
Inverter	Collector-Emitter voltage	$V_{CES}$			650	V	
	Gate-Emitter voltage	$V_{GES}$			$\pm 20$	V	
	Collector current	$I_C$	Continuous	$T_c=100^\circ\text{C}$	50	A	
		$I_C$ pulse	1ms		100		
	Forward current	$I_F$	Continuous		50		
		$I_F$ pulse	1ms		100		
Collector power dissipation	$P_C$	1 device		270	W		
Brake IGBT	Collector-Emitter voltage	$V_{CES}$			650	V	
	Gate-Emitter voltage	$V_{GES}$			$\pm 20$	V	
	Collector current	$I_C$	Continuous	$T_c=100^\circ\text{C}$	50	A	
		$I_C$ pulse	1ms		100		
Collector power dissipation	$P_C$	1 device		270	W		
Brake FWD	Forward current	$I_F$	Continuous		20	A	
		$I_{FRM}$	1ms		40		
	Repetitive peak reverse voltage	$V_{RRM}$			650	V	
Converter	Repetitive peak reverse voltage	$V_{RRM}$			800	V	
	Average output current	$I_O$	Three-phase full wave rectified	$T_c=80^\circ\text{C}$	50	A	
	Surge current (Non-Repetitive) (*1)	$I_{FSM}$	$t=10\text{ms}$ , Half sine wave form	$T_{vj}=25^\circ\text{C}$	535	A	
				$T_{vj}=150^\circ\text{C}$	470		
$I^2t$ (Non-Repetitive) (*1)	$I^2t$		$T_{vj}=25^\circ\text{C}$	1445	A <sup>2</sup> s		
			$T_{vj}=150^\circ\text{C}$	1115			
Junction temperature	$T_{vj}$	Inverter, Brake		175	°C		
		Converter		150			
Operating junction temperature (under switching conditions)	$T_{vjop}$	Inverter, Brake		175			
		Converter		150			
Case temperature	$T_c$			125			
Storage temperature	$T_{stg}$			-40 ~ 125			
Isolation voltage	between terminals and copper base (*2)	$V_{iso}$	A.C. : 1min.			2500	Vrms
	between thermistor and others (*3)						
Screw torque (*4)	Mounting	-	M4	1.7	N·m		

(\*1)  $T_j$  : Temperature at test start.

(\*2) All terminals should be connected together during the test.

(\*3) Two thermistor terminals should be connected together, other terminals should be connected together and shorted to base plate during the test.

(\*4) Recommendable value : Mounting 1.3 ~ 1.7 N·m (M4)

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□ Electrical characteristics ( at  $T_{vj} = 25^{\circ}\text{C}$  unless otherwise specified)

Items	Symbols	Conditions	Characteristics			Units			
			min.	typ.	max.				
Zero Gate voltage collector current	$I_{CES}$	$V_{GE} = 0\text{V}$ $V_{CE} = 650\text{V}$	-	-	50	$\mu\text{A}$			
Gate-Emitter leakage current	$I_{GES}$	$V_{CE} = 0\text{V}$ $V_{GE} = +20/-20\text{V}$	-	-	100	nA			
Gate-Emitter threshold voltage	$V_{GE(th)}$	$V_{CE} = 20\text{V}$ $I_C = 50\text{mA}$	6.0	6.5	7.0	V			
Collector-Emitter saturation voltage	$V_{CE(sat)}$ (terminal)	$V_{GE} = 15\text{V}$ $I_C = 50\text{A}$	$T_{vj}=25^{\circ}\text{C}$	-	1.50	1.95	V		
			$T_{vj}=25^{\circ}\text{C}$	-	1.30	1.75			
	$T_{vj}=125^{\circ}\text{C}$		-	1.45	-				
	$T_{vj}=150^{\circ}\text{C}$		-	1.50	-				
	$T_{vj}=175^{\circ}\text{C}$		-	1.55	-				
Internal Gate resistance	$r_g$	-	-	0	-	$\Omega$			
			Capacitance	$C_{ies}$	$V_{CE} = 10\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$	-	5.7	-	nF
						$C_{oes}$	-	0.22	
$C_{res}$	-	0.08					-		
Gate charge	$Q_G$	$V_{CC} = 300\text{V}$ $V_{GE} = -15 \rightarrow +15\text{V}$ $I_C = 50\text{A}$	-	410	-	nC			
Forward voltage	$V_F$ (terminal)	$I_F = 50\text{A}$	$T_{vj}=25^{\circ}\text{C}$	-	1.75	2.20	V		
			$T_{vj}=25^{\circ}\text{C}$	-	1.55	2.00			
	$T_{vj}=125^{\circ}\text{C}$		-	1.50	-				
	$T_{vj}=150^{\circ}\text{C}$		-	1.50	-				
	$T_{vj}=175^{\circ}\text{C}$		-	1.45	-				
Switching time (*1)	$t_{d(on)}$	$V_{CC} = 300\text{V}$ $I_C, I_F = 50\text{A}$ $L_s = 30\text{nH}$ $V_{GE} = +15/-15\text{V}$ $R_G = 8.2\ \Omega$	$T_{vj}=25^{\circ}\text{C}$	-	0.06	-	$\mu\text{s}$		
			$T_{vj}=125^{\circ}\text{C}$	-	0.06	-			
			$T_{vj}=150^{\circ}\text{C}$	-	0.06	-			
			$T_{vj}=175^{\circ}\text{C}$	-	0.06	-			
	$t_r$	$V_{CC} = 300\text{V}$ $I_C, I_F = 50\text{A}$ $L_s = 30\text{nH}$ $V_{GE} = +15/-15\text{V}$ $R_G = 8.2\ \Omega$	$T_{vj}=25^{\circ}\text{C}$	-	0.02	-			
			$T_{vj}=125^{\circ}\text{C}$	-	0.02	-			
			$T_{vj}=150^{\circ}\text{C}$	-	0.03	-			
			$T_{vj}=175^{\circ}\text{C}$	-	0.03	-			
	$t_{d(off)}$	$V_{CC} = 300\text{V}$ $I_C, I_F = 50\text{A}$ $L_s = 30\text{nH}$ $V_{GE} = +15/-15\text{V}$ $R_G = 8.2\ \Omega$	$T_{vj}=25^{\circ}\text{C}$	-	0.17	-			
			$T_{vj}=125^{\circ}\text{C}$	-	0.20	-			
			$T_{vj}=150^{\circ}\text{C}$	-	0.20	-			
			$T_{vj}=175^{\circ}\text{C}$	-	0.20	-			
	$t_f$	$V_{CC} = 300\text{V}$ $I_C, I_F = 50\text{A}$ $L_s = 30\text{nH}$ $V_{GE} = +15/-15\text{V}$ $R_G = 8.2\ \Omega$	$T_{vj}=25^{\circ}\text{C}$	-	0.04	-			
			$T_{vj}=125^{\circ}\text{C}$	-	0.05	-			
			$T_{vj}=150^{\circ}\text{C}$	-	0.05	-			
			$T_{vj}=175^{\circ}\text{C}$	-	0.05	-			
Reverse recovery time	$t_{rr}$	$V_{CC} = 300\text{V}$ $I_C, I_F = 50\text{A}$ $L_s = 30\text{nH}$ $V_{GE} = +15/-15\text{V}$ $R_G = 8.2\ \Omega$	$T_{vj}=25^{\circ}\text{C}$	-	0.06	-			
			$T_{vj}=125^{\circ}\text{C}$	-	0.10	-			
			$T_{vj}=150^{\circ}\text{C}$	-	0.11	-			
			$T_{vj}=175^{\circ}\text{C}$	-	0.13	-			

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

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Items	Symbols	Conditions	Characteristics			Units	
			min.	typ.	max.		
Inverter Switching loss (per pulse)	$E_{on}$	$V_{CC} = 300V$ $I_C, I_F = 50A \quad L_s = 30nH$ $V_{GE} = +15/-15V$ $R_G = 8.2 \Omega$	$T_{vj} = 25^\circ C$	-	0.58	-	mJ
			$T_{vj} = 125^\circ C$	-	0.91	-	
			$T_{vj} = 150^\circ C$	-	1.01	-	
			$T_{vj} = 175^\circ C$	-	1.12	-	
	$E_{off}$	$V_{CC} = 300V$ $I_C, I_F = 50A \quad L_s = 30nH$ $V_{GE} = +15/-15V$ $R_G = 8.2 \Omega$	$T_{vj} = 25^\circ C$	-	1.52	-	
			$T_{vj} = 125^\circ C$	-	1.89	-	
			$T_{vj} = 150^\circ C$	-	2.00	-	
			$T_{vj} = 175^\circ C$	-	2.08	-	
	$E_{rr}$	$V_{CC} = 300V$ $I_C, I_F = 50A \quad L_s = 30nH$ $V_{GE} = +15/-15V$ $R_G = 8.2 \Omega$	$T_{vj} = 25^\circ C$	-	0.47	-	
			$T_{vj} = 125^\circ C$	-	0.68	-	
			$T_{vj} = 150^\circ C$	-	0.79	-	
			$T_{vj} = 175^\circ C$	-	0.93	-	
Zero Gate voltage collector current	$I_{CES}$	$V_{GE} = 0V$ $V_{CE} = 650V$	-	-	50	$\mu A$	
Gate-Emitter leakage current	$I_{GES}$	$V_{CE} = 0V, \quad V_{GE} = +20/-20V$	-	-	100	nA	
Collector-Emitter saturation voltage	$V_{CE(sat)}$ (terminal)	$V_{GE} = 15V$ $I_C = 50A$	$T_{vj} = 25^\circ C$	-	1.50	1.95	V
			$T_{vj} = 25^\circ C$	-	1.30	1.75	
	$V_{CE(sat)}$ (chip)		$T_{vj} = 125^\circ C$	-	1.45	-	
			$T_{vj} = 150^\circ C$	-	1.50	-	
Internal Gate resistance	$r_g$	-	-	-	0	-	$\Omega$
			-	-	0	-	$\Omega$
Brake Switching time (*1)	$t_{d(on)}$	$V_{CC} = 300V$ $I_C = 50A \quad L_s = 30nH$ $V_{GE} = +15/-15V$ $R_G = 8.2 \Omega$	$T_{vj} = 25^\circ C$	-	0.06	-	$\mu s$
			$T_{vj} = 125^\circ C$	-	0.06	-	
			$T_{vj} = 150^\circ C$	-	0.06	-	
			$T_{vj} = 175^\circ C$	-	0.06	-	
	$t_r$	$V_{CC} = 300V$ $I_C = 50A \quad L_s = 30nH$ $V_{GE} = +15/-15V$ $R_G = 8.2 \Omega$	$T_{vj} = 25^\circ C$	-	0.02	-	
			$T_{vj} = 125^\circ C$	-	0.02	-	
			$T_{vj} = 150^\circ C$	-	0.03	-	
			$T_{vj} = 175^\circ C$	-	0.03	-	
	$t_{d(off)}$	$V_{CC} = 300V$ $I_C = 50A \quad L_s = 30nH$ $V_{GE} = +15/-15V$ $R_G = 8.2 \Omega$	$T_{vj} = 25^\circ C$	-	0.17	-	
			$T_{vj} = 125^\circ C$	-	0.20	-	
			$T_{vj} = 150^\circ C$	-	0.20	-	
			$T_{vj} = 175^\circ C$	-	0.20	-	
	$t_f$	$V_{CC} = 300V$ $I_C = 50A \quad L_s = 30nH$ $V_{GE} = +15/-15V$ $R_G = 8.2 \Omega$	$T_{vj} = 25^\circ C$	-	0.04	-	
			$T_{vj} = 125^\circ C$	-	0.05	-	
			$T_{vj} = 150^\circ C$	-	0.05	-	
			$T_{vj} = 175^\circ C$	-	0.05	-	
Reverse current	$I_{RRM}$	$V_R = 650V$	-	-	50	$\mu A$	
Forward voltage	$V_F$ (terminal)	$I_F = 20A$	$T_{vj} = 25^\circ C$	-	1.80	2.25	V
			$T_{vj} = 25^\circ C$	-	1.60	2.05	
	$V_F$ (chip)		$T_{vj} = 125^\circ C$	-	1.60	-	
			$T_{vj} = 150^\circ C$	-	1.60	-	
Reverse current	$I_{RRM}$	$V_R = 800V$	-	-	50	$\mu A$	
			-	-	50	$\mu A$	
			-	-	50	$\mu A$	
			-	-	50	$\mu A$	
Forward voltage	$V_{FM}$	$I_F = 50A$	terminal	-	1.30	1.75	V
			chip	-	1.10	1.55	V
Resistance	$R$	$T = 25^\circ C$	-	5000	-	$\Omega$	
		$T = 100^\circ C$	465	495	520	$\Omega$	
B value	$B$	$T = 25/50^\circ C$	3305	3375	3450	K	

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

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**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.

**□Thermal resistance characteristics**

Items	Symbols	Conditions	Characteristics			Units
			min.	typ.	max.	
Thermal resistance (1device)	$R_{th(j-c)}$	Inverter IGBT	-	-	0.55	°C/W
		Inverter FWD	-	-	0.73	
		Brake IGBT	-	-	0.55	
		Brake FWD	-	-	1.50	
		Converter Diode	-	-	0.58	
Contact thermal resistance(*1) (1device)	$R_{th(c-f)}$	Inverter IGBT	-	0.57	-	
		Inverter FWD	-	0.61	-	
		Brake IGBT	-	0.63	-	
		Brake FWD	-	0.71	-	
		Converter Diode	-	0.68	-	

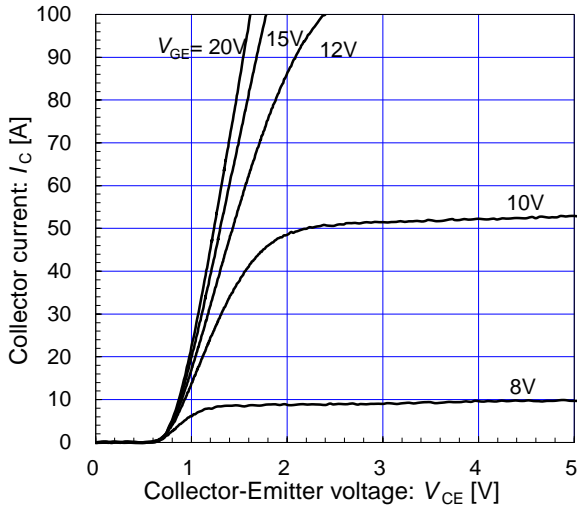
(\*1) This is the value which is defined mounting on the additional cooling fin with 1 W/(m·K) thermal grease.

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**IGBT Modules**

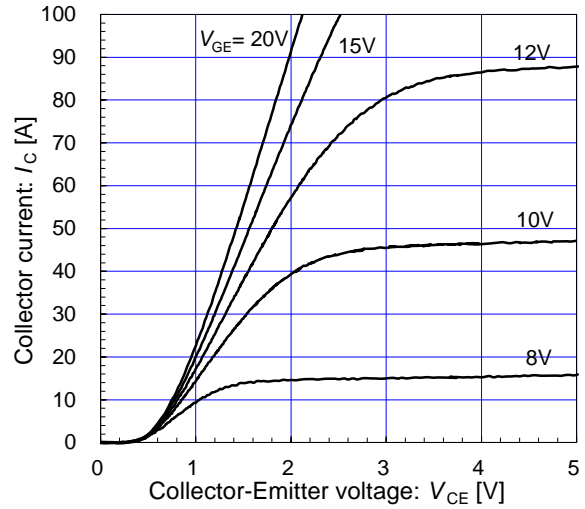
[ Inverter ]

Collector current vs. Collector-Emittor voltage (typ.)  
 $T_{vj} = 25^{\circ}\text{C} / \text{chip}$



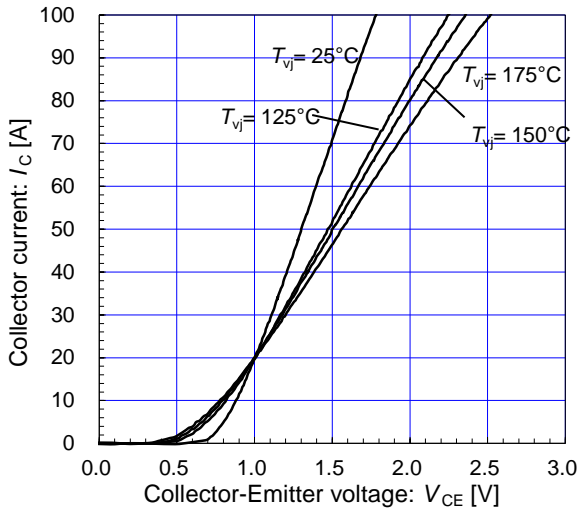
[ Inverter ]

Collector current vs. Collector-Emittor voltage (typ.)  
 $T_{vj} = 175^{\circ}\text{C} / \text{chip}$



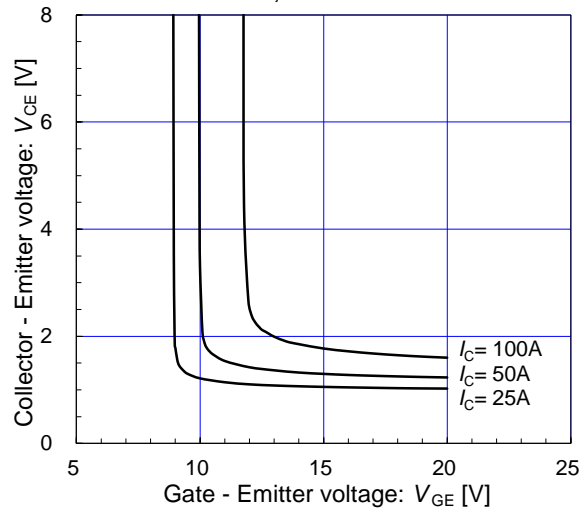
[ Inverter ]

Collector current vs. Collector-Emittor voltage (typ.)  
 $V_{GE} = 15\text{V} / \text{chip}$



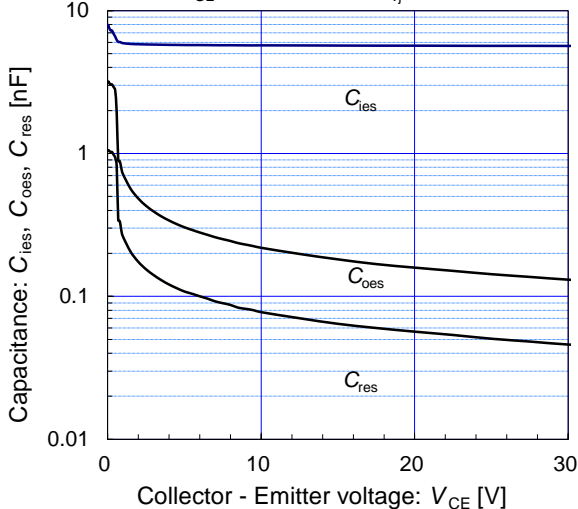
[ Inverter ]

Collector-Emittor voltage vs. Gate-Emittor voltage (typ.)  
 $T_{vj} = 25^{\circ}\text{C} / \text{chip}$



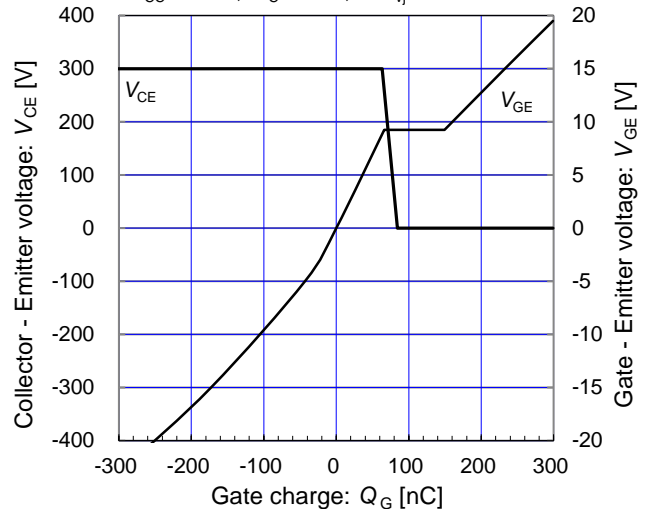
[ Inverter ]

Capacitance vs. Collector-Emittor voltage (typ.)  
 $V_{GE} = 0\text{V}, f = 1\text{MHz}, T_{vj} = 25^{\circ}\text{C}$

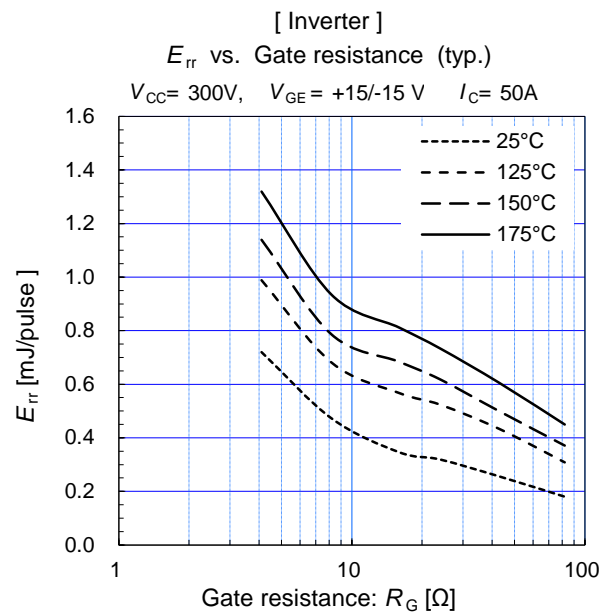
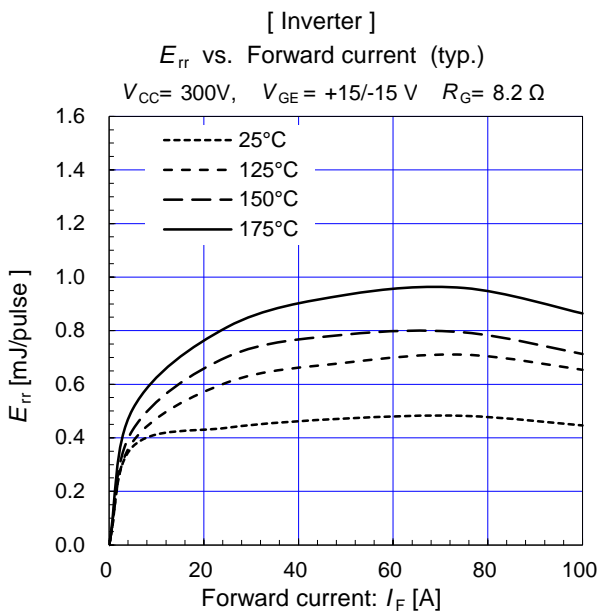
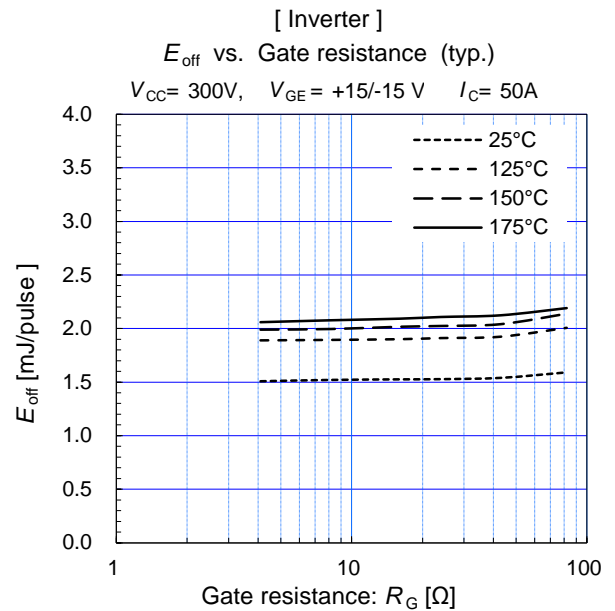
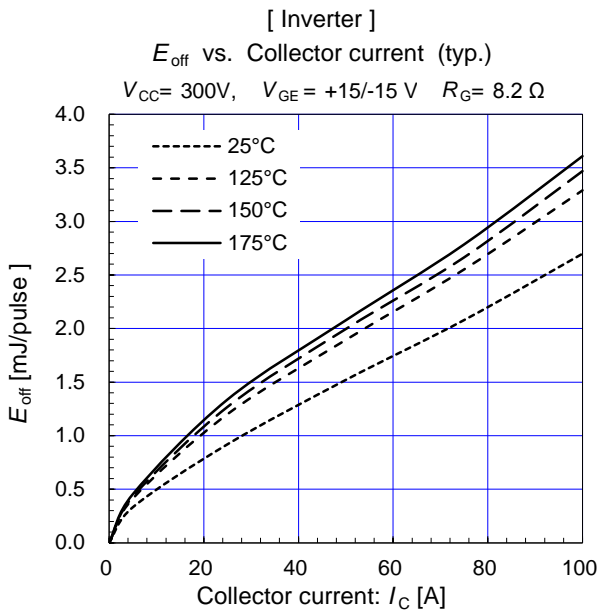
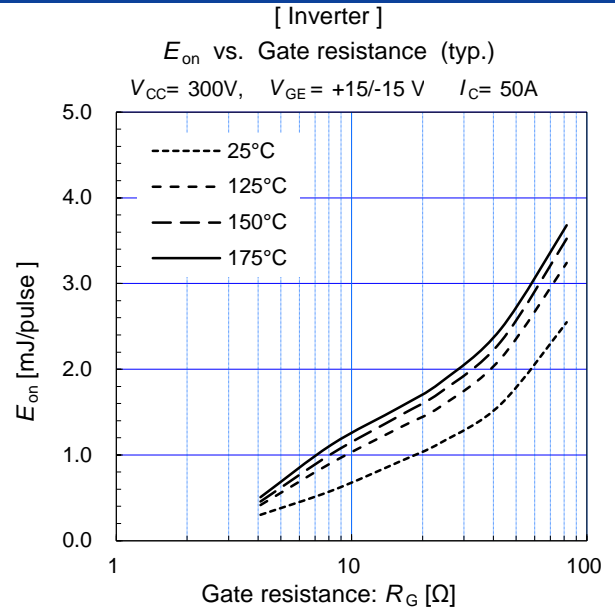
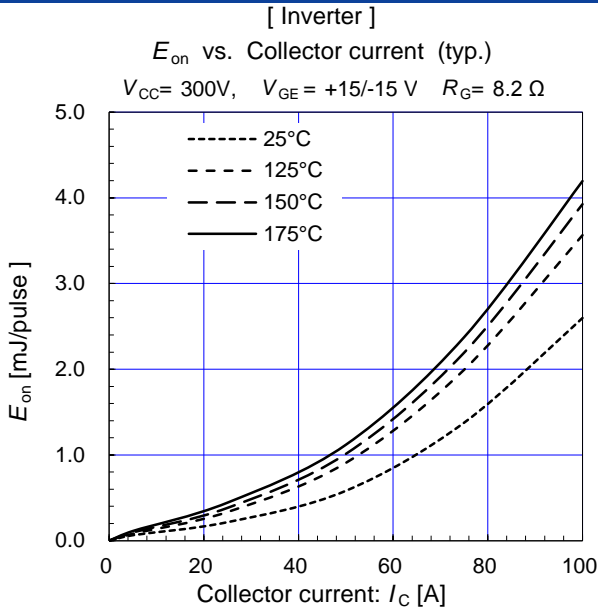


[ Inverter ]

Dynamic Gate charge (typ.)  
 $V_{CC} = 300\text{V}, I_c = 50\text{A}, T_{vj} = 25^{\circ}\text{C}$



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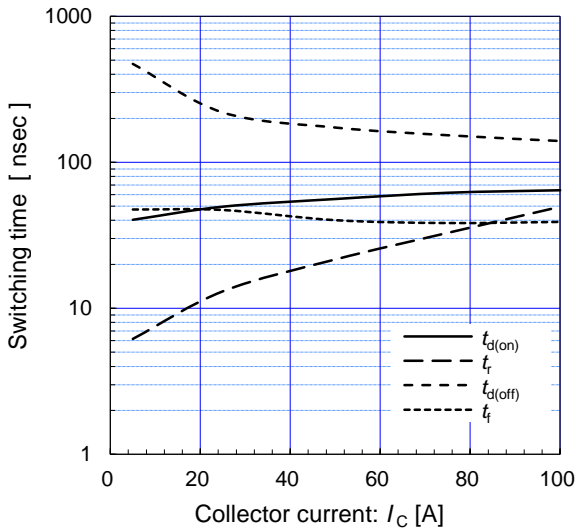
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IGBT Modules

[ Inverter ]

Switching time vs. Collector current (typ.)

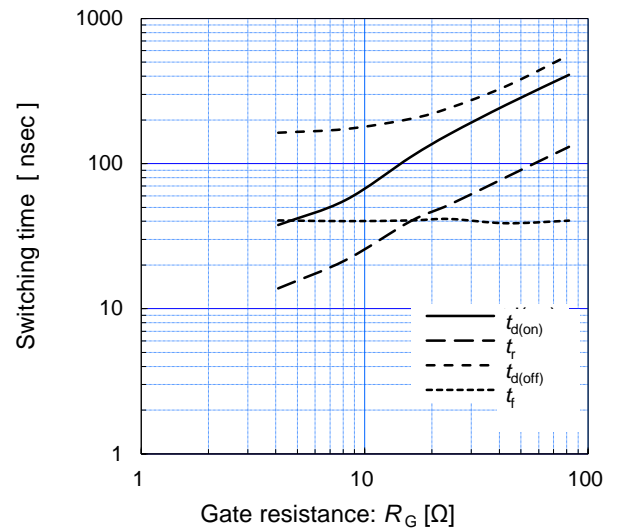
$V_{CC}=300V, R_G=8.2\Omega, V_{GE}=+15/-15V, T_{vj}=25^\circ C$



[ Inverter ]

Switching time vs. Gate resistance (typ.)

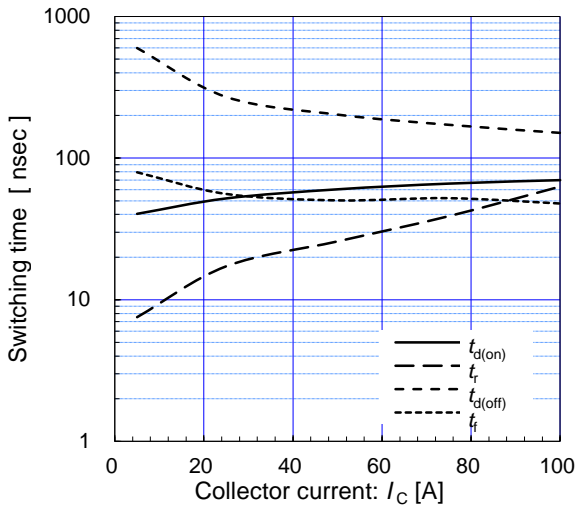
$V_{CC}=300V, I_C=50A, V_{GE}=+15/-15V, T_{vj}=25^\circ C$



[ Inverter ]

Switching time vs. Collector current (typ.)

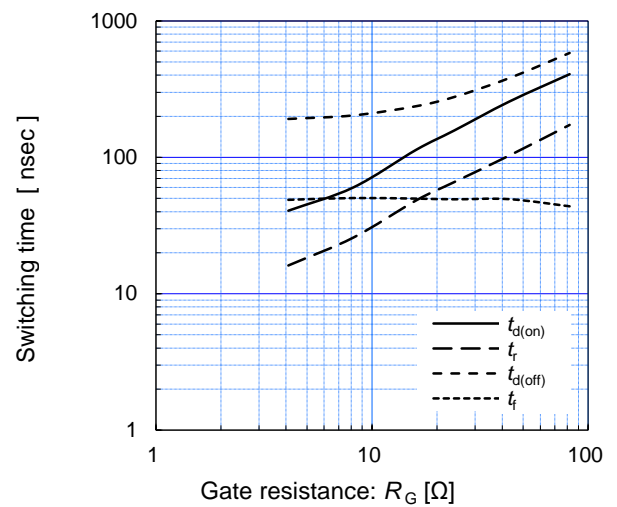
$V_{CC}=300V, R_G=8.2\Omega, V_{GE}=+15/-15V, T_{vj}=175^\circ C$



[ Inverter ]

Switching time vs. Gate resistance (typ.)

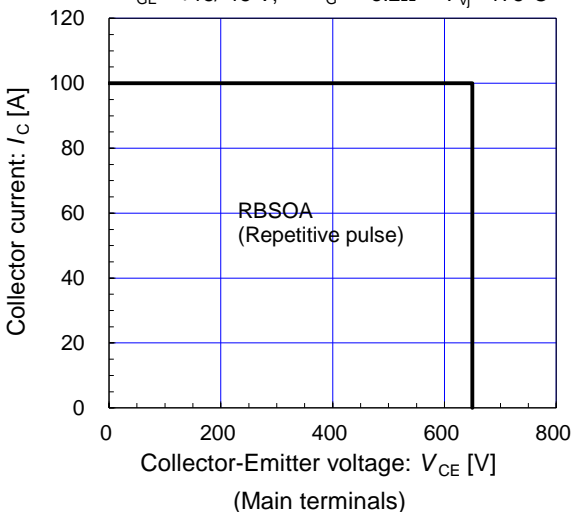
$V_{CC}=300V, I_C=50A, V_{GE}=+15/-15V, T_{vj}=175^\circ C$



[ Inverter ]

Reverse bias safe operating area (max.)

$V_{GE}=+15/-15V, R_G \geq 8.2\Omega, T_{vj}=175^\circ C$



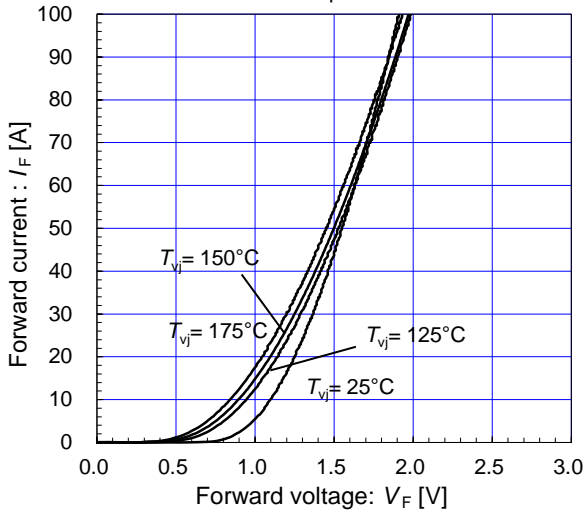


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IGBT Modules

[ Inverter ]

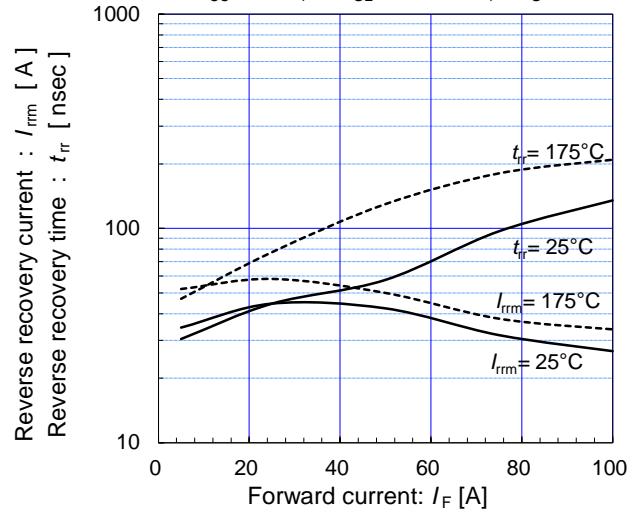
Forward current vs. Forward voltage (typ.)  
chip



[ Inverter ]

Reverse recovery characteristics (typ.)

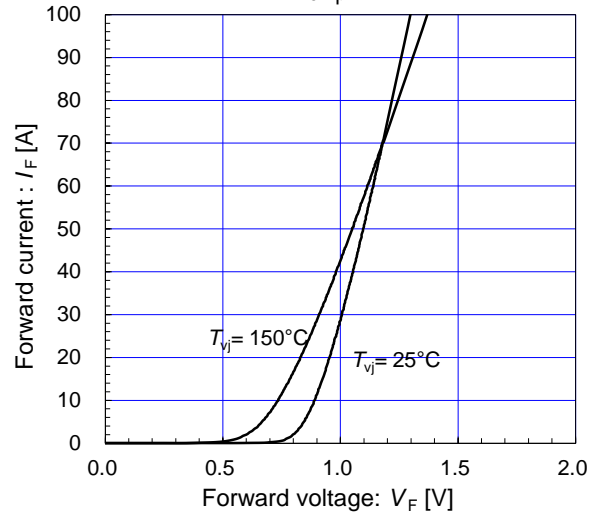
$V_{CC} = 300V, V_{GE} = +15/-15V, R_G = 8.2\Omega$



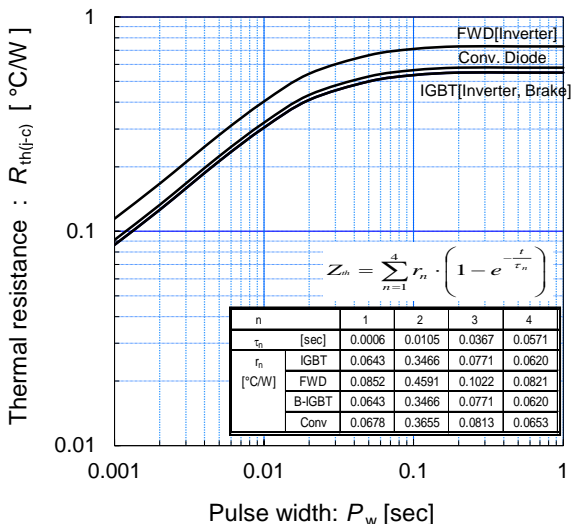
[ Converter ]

Forward current vs. Forward voltage (typ.)

chip

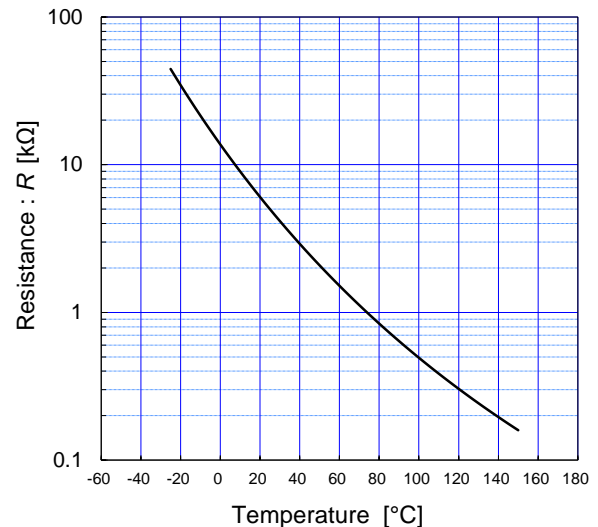


Transient thermal resistance (max.)



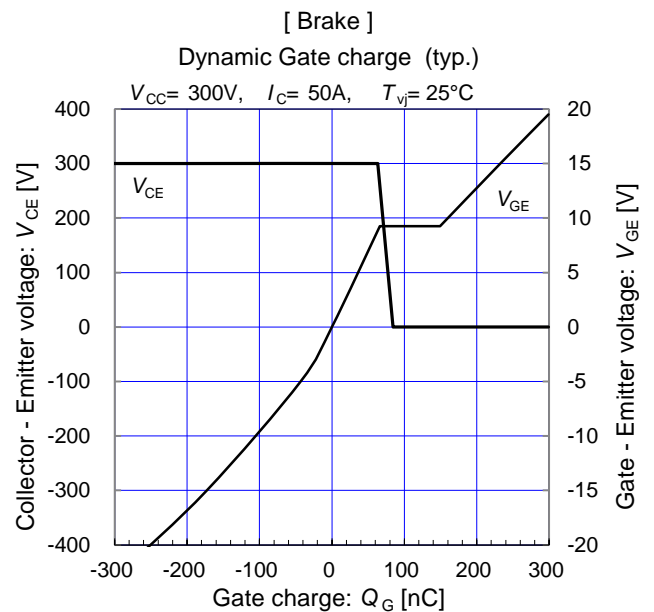
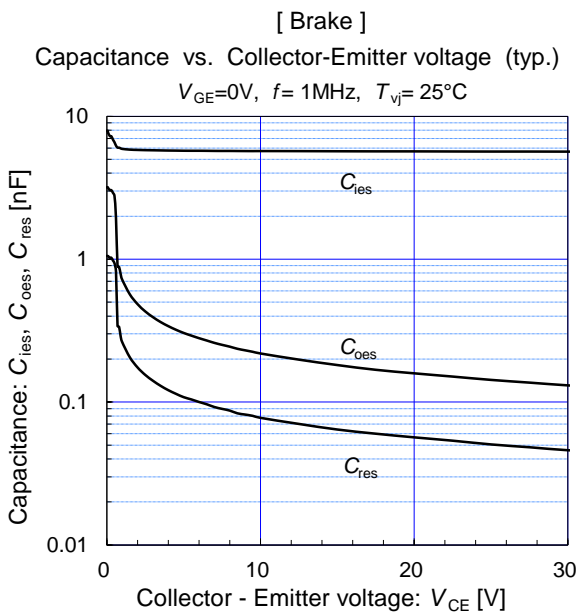
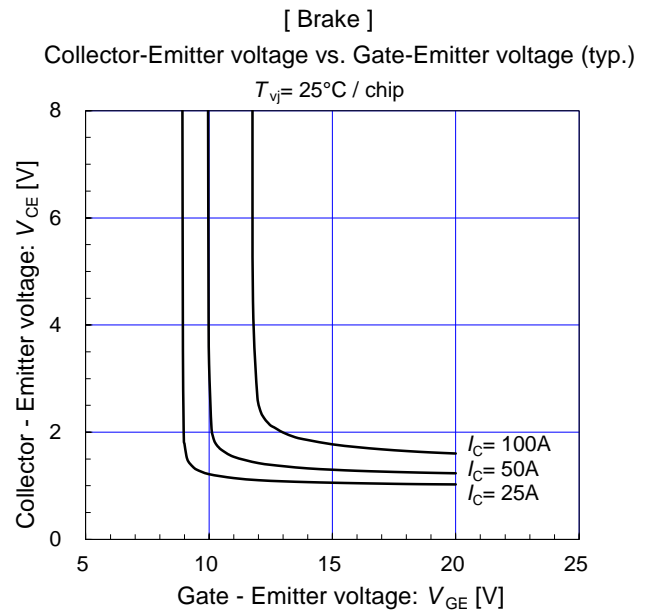
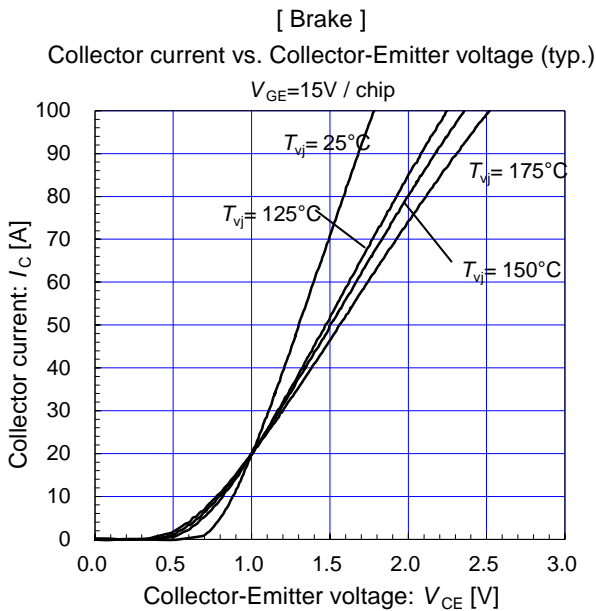
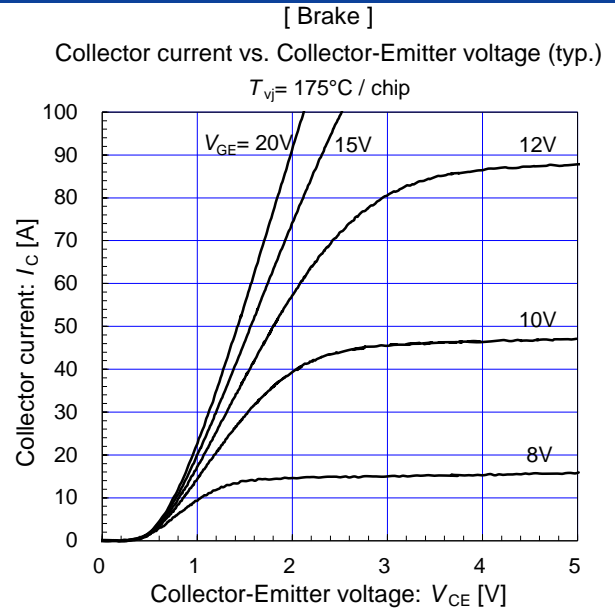
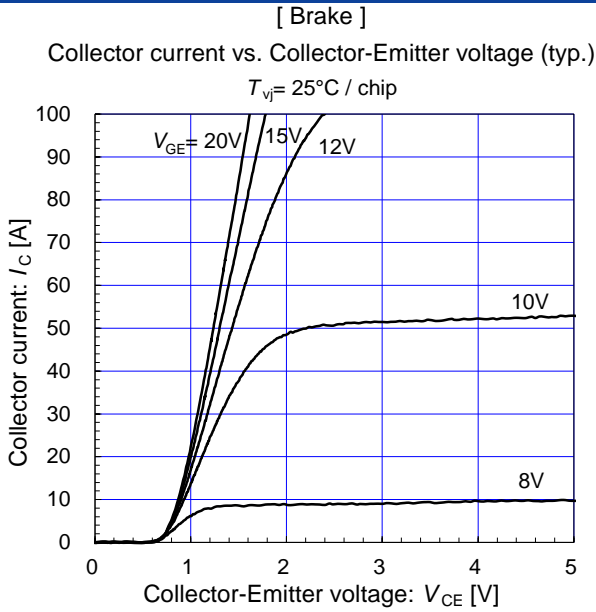
[ Thermistor ]

Temperature characteristic (typ.)



# 7MBR50XKD065-50

**IGBT Modules**



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## IGBT Modules

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