

Features

- Low Switching Losses
- Maximum Junction Temperature 175 °C
- Positive Temperature Coefficient
- High Ruggedness, Temperature Stable
- High Short Circuit Capability(5us)
- Halogen Free. "Green" Device (Note 1)
- Epoxy Meets UL 94 V-0 Flammability Rating
- Lead Free Finish/RoHS Compliant (Note 2)("P" Suffix Designates RoHS Compliant. See Ordering Information)

Maximum Ratings

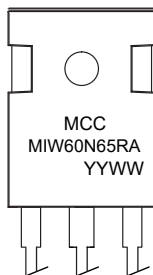
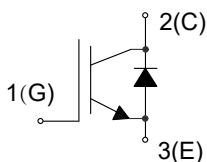
- Operating Junction Temperature Range : -40°C to +175°C
- Storage Temperature Range: -55°C to +150°C
- IGBT Thermal Resistance: 0.45°C/W Junction to Case
- Diode Thermal Resistance: 1.05°C/W Junction to Case
- Thermal Resistance: 40°C/W Junction to Ambient

Parameter	Symbol	Rating	Unit	
Collector-Emitter Voltage	V_{CE}	650	V	
DC Collector Current ⁽³⁾	I_C	$T_C=25^\circ C$	120	
		$T_C=100^\circ C$	60	
Pulsed Collector Current ⁽⁴⁾ , $V_{GE}=15V$	$I_{C,pluse}$	240	A	
Diode Forward Current ⁽³⁾	I_F	$T_C=25^\circ C$	60	
		$T_C=100^\circ C$	30	
Diode Pulsed Current ⁽⁴⁾	$I_{F,pluse}$	120	A	
Continuous Gate-Emitter Voltage	V_{GE}	± 20	V	
Transient Gate-Emitter Voltage ⁽⁵⁾		± 30	V	
Short Circuit Withstand Time ⁽⁶⁾ $V_{GE}=15V, V_{CC}=400V, V_{CEM} \leq 650V$	t_{SC}	5	μs	
Power Dissipation	P_D	$T_C=25^\circ C$	333	W
		$T_j=175^\circ C$		

Note:

1. Halogen free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
2. High Temperature Solder Exemptions Applied, see EU Directive Annex 7a.
3. Limited by T_{Jmax} .
4. t_p limited by T_{Jmax} .
5. $t_p \leq 10\mu s$, Duty Cycle < 1%
6. Allowed number of short circuits: < 1000; time between short circuits: > 1s.

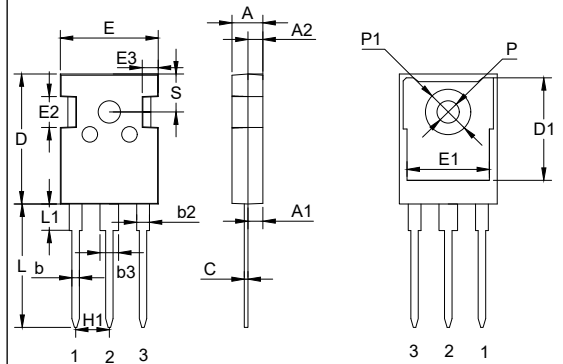
Internal Structure



Device Code: MIW60N65RA
Date Code: YYWW: (Year & Week)

Trench and Field Stop IGBT 650V 60A

TO-247AB



DIM	INCHES		MM		NOTE
	MIN	MAX	MIN	MAX	
A	0.189	0.205	4.80	5.20	
A1	0.087	0.103	2.21	2.61	
A2	0.073	0.085	1.85	2.15	
b	0.039	0.055	1.00	1.40	
b2	0.075	0.087	1.91	2.21	
C	0.020	0.028	0.50	0.70	
D	0.815	0.839	20.70	21.30	
D1	0.640	0.663	16.25	16.85	
E	0.610	0.634	15.50	16.10	
E1	0.512	0.535	13.00	13.60	
E2	0.189	0.205	4.80	5.20	
E3	0.091	0.106	2.30	2.70	
L	0.772	0.796	19.62	20.22	
L1	-	0.169	-	4.30	
P	0.134	0.150	3.40	3.80	Φ
P1	-	0.287	-	7.30	Φ
S	0.242		6.15		TYP
H1	0.214		5.44		TYP
b3	0.110	0.126	2.80	3.20	

Electrical Characteristics @ 25°C (Unless Otherwise Specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
IGBT Static Characteristics						
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$	$V_{GE}=0V, I_C=250\mu A$	650			V
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$	$V_{GE}=15V, I_C=60A, T_J=25^\circ C$		2.10	2.40	V
		$V_{GE}=15V, I_C=60A, T_J=125^\circ C$		2.40		
		$V_{GE}=15V, I_C=60A, T_J=150^\circ C$		2.50		
G-E Threshold Voltage	$V_{GE(th)}$	$I_C=0.8mA, V_{CE}=V_{GE}$	4.1	5.1	6.1	V
C-E Leakage Current	I_{CES}	$V_{CE}=650V, V_{GE}=0V, T_J=25^\circ C$			0.25	mA
		$V_{CE}=650V, V_{GE}=0V, T_J=150^\circ C$			4	
G-E Leakage Current	I_{GES}	$V_{CE}=0V, V_{GE}=\pm 20V$			100	nA
Dynamic Characteristics						
Input Capacitance	C_{ies}	$V_{CE}=25V, V_{GE}=0V, f=1MHz$		2.04		nF
Reverse Transfer Capacitance	C_{res}			0.84		
Gate Charge	Q_G	$V_{CC}=300V, I_C=60A, V_{GE}=15V$		0.24		μC
Short Circuit Collector Current	I_{SC}	$V_{GE}=15V, t_{sc}\leq 5\mu s,$ $V_{CC}=400V, T_J\leq 150^\circ C$		280		A
IGBT Switching Characteristics						
Turn-On Delay Time	$t_{d(on)}$	$V_{CC}=400V, I_C=60A, L_s=60nH$ $V_{GE}=0V\sim 15V, R_G=10\Omega, T_J=25^\circ C$		18		ns
Rise Time	t_r			75		
Turn-Off Delay Time	$t_{d(off)}$			163		
Fall Time	t_f			62		mJ
Turn-On Energy	E_{on}			2.84		
Turn-Off Energy	E_{off}			1.21		
Turn-On Delay Time	$t_{d(on)}$	$V_{CC}=400V, I_C=60A, L_s=60nH$ $V_{GE}=0V\sim 15V, R_G=10\Omega, T_J=125^\circ C$		17		ns
Rise Time	t_r			65		
Turn-Off Delay Time	$t_{d(off)}$			176		
Fall Time	t_f			70		mJ
Turn-On Energy	E_{on}			2.86		
Turn-Off Energy	E_{off}			1.41		
Turn-On Delay Time	$t_{d(on)}$	$V_{CC}=400V, I_C=60A, L_s=60nH$ $V_{GE}=0V\sim 15V, R_G=10\Omega, T_J=150^\circ C$		16		ns
Rise Time	t_r			59		
Turn-Off Delay Time	$t_{d(off)}$			182		
Fall Time	t_f			82		mJ
Turn-On Energy	E_{on}			2.98		
Turn-Off Energy	E_{off}			1.51		

Electrical Characteristics @ 25°C (Unless Otherwise Specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Diode Characteristics						
Diode Forward Voltage	V_F	$V_{GE}=0V, I_F=30A, T_j=25^\circ C$		1.9	2.6	V
		$V_{GE}=0V, I_F=30A, T_j=125^\circ C$		1.85		
		$V_{GE}=0V, I_F=30A, T_j=150^\circ C$		1.75		
Reverse Recovery Current	I_{rr}	$V_R=400V, I_F=30A,$ $di_F/dt=-350A/\mu s, T_j=25^\circ C$		7		A
Diode Reverse Recovery Time	t_{rr}			42		ns
Reverse Recovery Charge	Q_{rr}			0.14		μC
Reverse Recovery Energy	E_{rec}			0.09		mJ
Reverse Recovery Current	I_{rr}	$V_R=400V, I_F=30A,$ $di_F/dt=-350A/\mu s, T_j=125^\circ C$		13		A
Diode Reverse Recovery Time	t_{rr}			153		ns
Reverse Recovery Charge	Q_{rr}			0.94		μC
Reverse Recovery Energy	E_{rec}			0.22		mJ
Reverse Recovery Current	I_{rr}	$V_R=400V, I_F=30A,$ $di_F/dt=-350A/\mu s, T_j=150^\circ C$		15		A
Diode Reverse Recovery Time	t_{rr}			161		ns
Reverse Recovery Charge	Q_{rr}			1.26		μC
Reverse Recovery Energy	E_{rec}			0.26		mJ

Curve Characteristics

Fig1. Power dissipation as a function of case temperature ($T_j \leq 175^\circ\text{C}$)

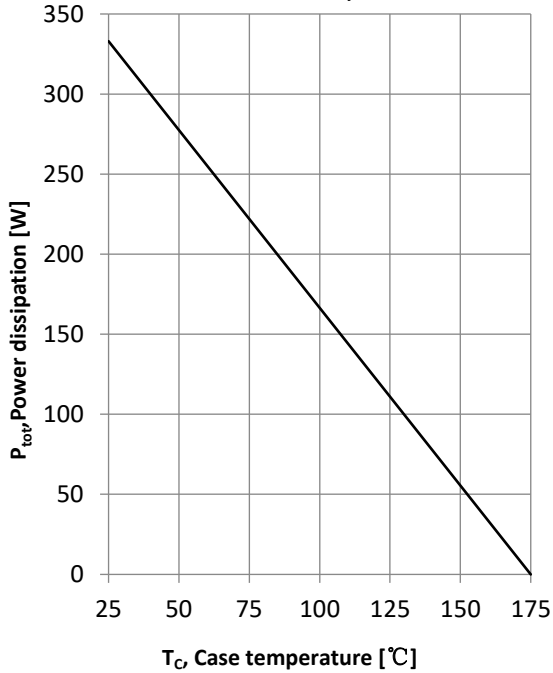


Fig2. Collector current as a function of case temperature ($V_{GE} \geq 15\text{V}$, $T_j \leq 175^\circ\text{C}$)

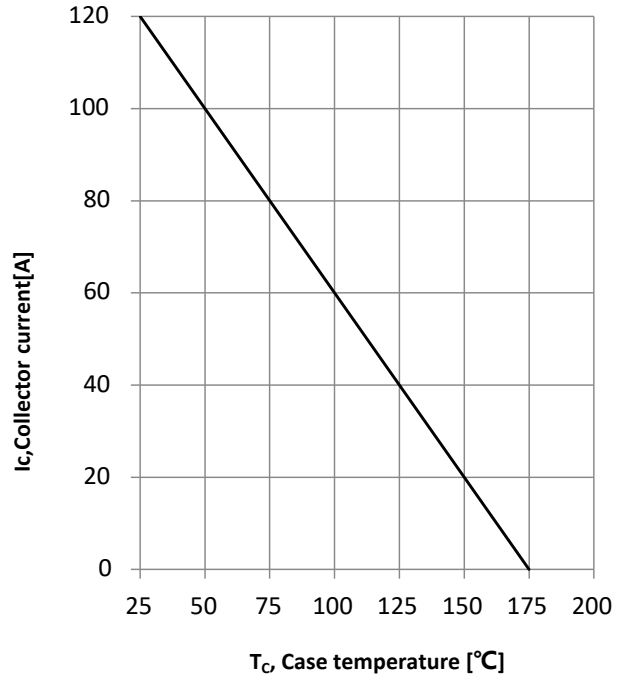


Fig3. Typical output characteristic ($T_j=25^\circ\text{C}$)

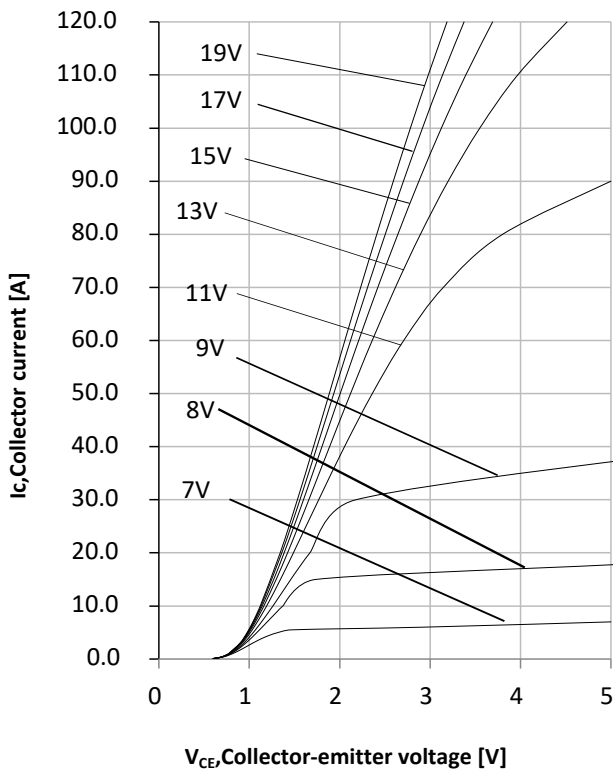
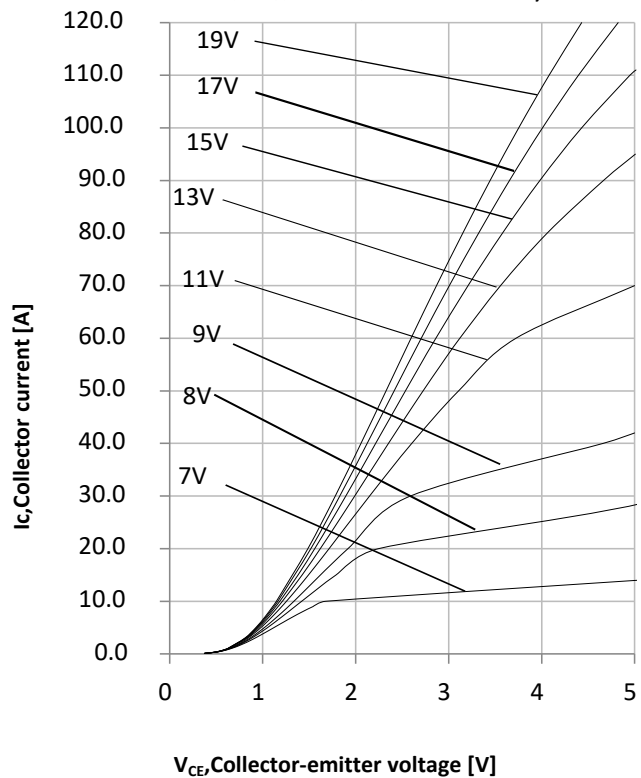


Fig4. Typical output characteristic ($T_j=150^\circ\text{C}$)



Curve Characteristics

Fig5. Typical transfer characteristic ($V_{CE}=20V$)

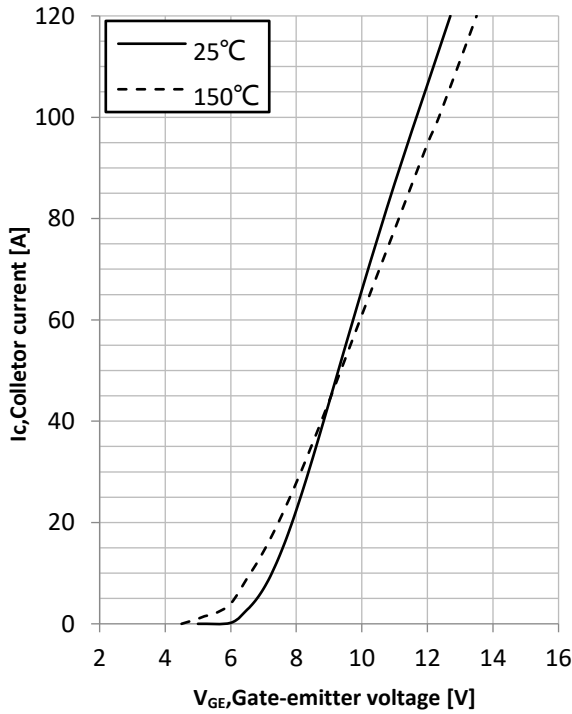


Fig6. Typical collector-emitter saturation voltage as a function of junction temperature ($V_{GE}=15V$)

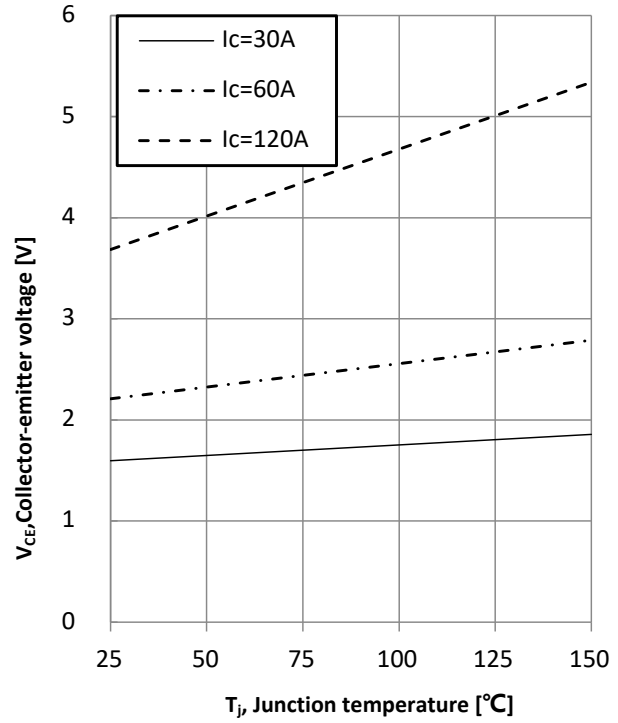


Fig7. Typical switching time as a function of collector current (inductive load, $T_{vj}=150^\circ C, V_{CE}=400V, V_{GE}=0/15V, R_g=10\Omega$)

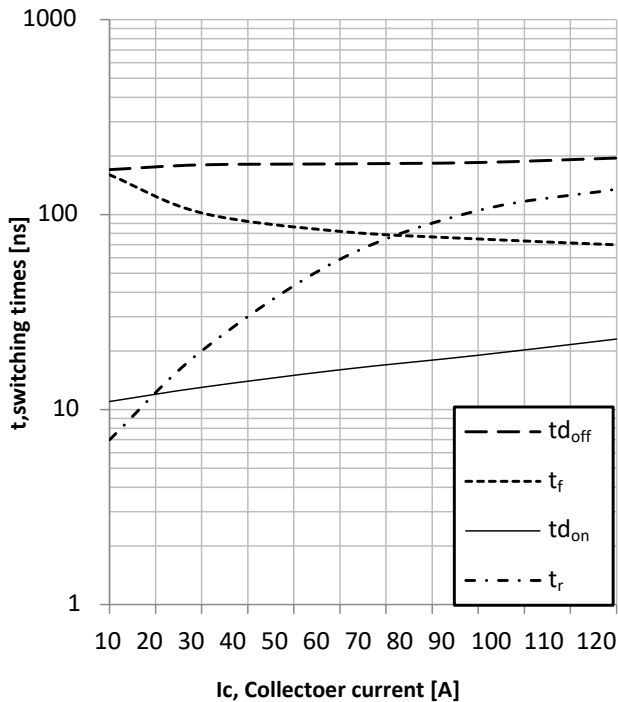
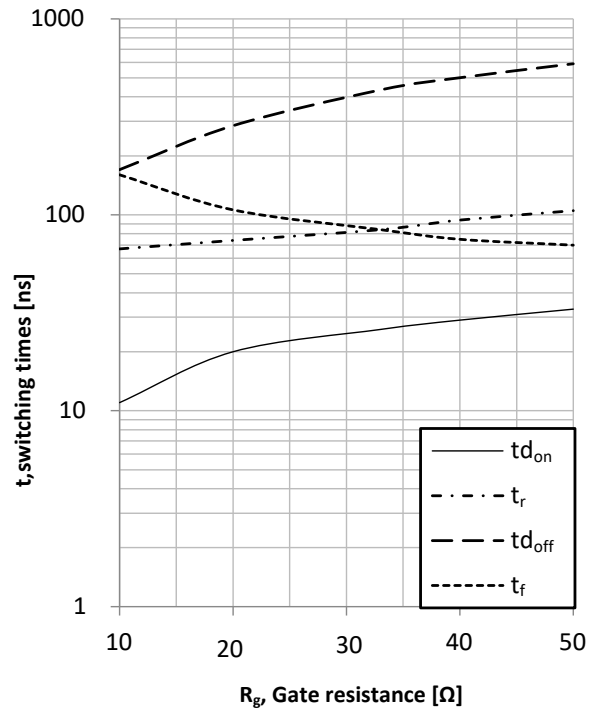


Fig8. Typical switching times as a function of gate resistance (inductive load, $T_{vj}=150^\circ C, V_{CE}=400V, V_{GE}=0/15V, I_C=60A$)



Curve Characteristics

Fig9. Typical switching times as a fuction of junction temperature (inductive load, $I_c=60A, V_{CE}=400V, V_{GE}=0/15V, R_g=10\Omega$)

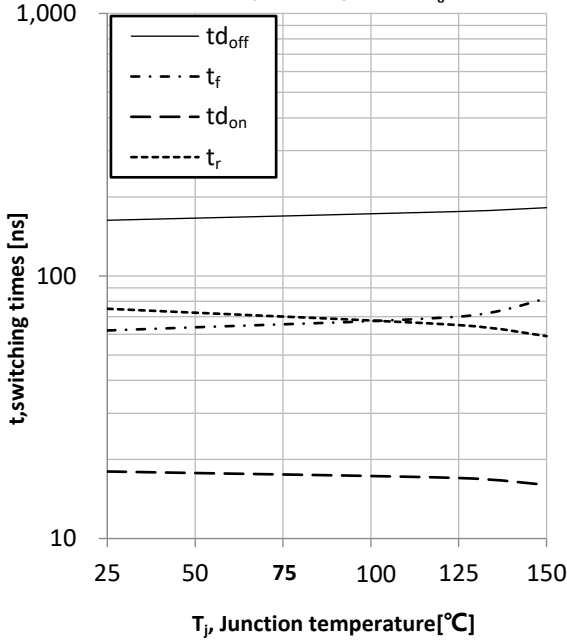


Fig10. Gate-emitter threshold voltage as a fuction of Junction temperature ($I_c=0.8mA$)

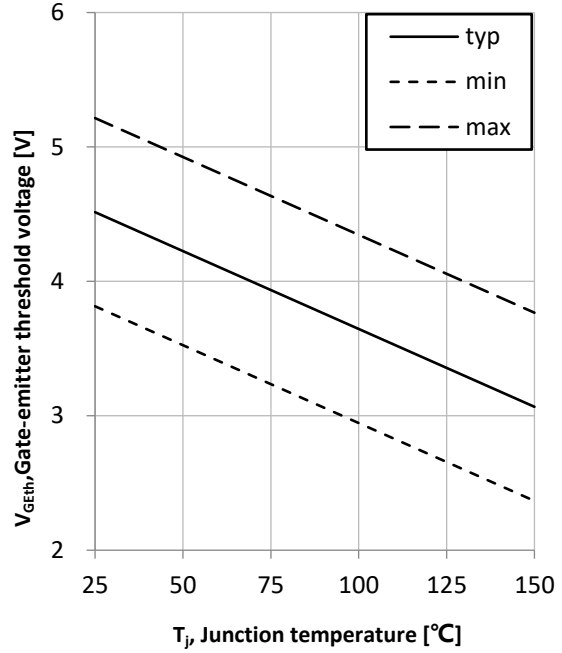


Fig11. Typical switching energy losses as a fuction of collect current (inductive load, $T_{vj}=150\text{ }^\circ\text{C}, V_{CE}=400V, V_{GE}=0/15V, R_g=10\Omega$)

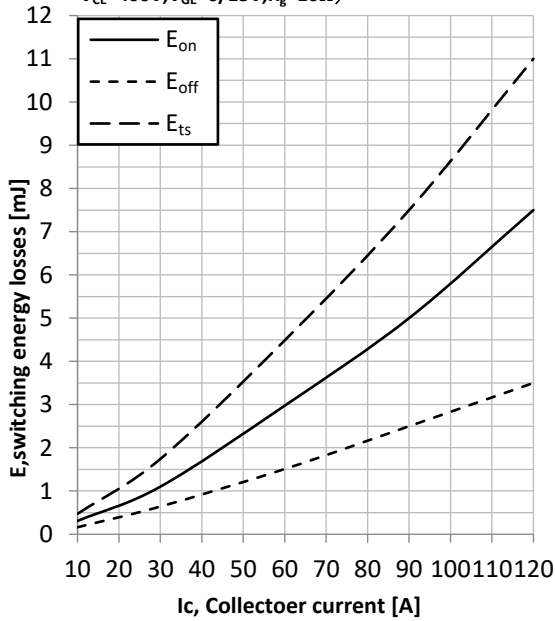


Fig12. Typical switching energy losses as a fuction of gate resistance (inductive load, $T_{vj}=150\text{ }^\circ\text{C}, V_{CE}=400V, V_{GE}=0/15V, I_c=60A$)

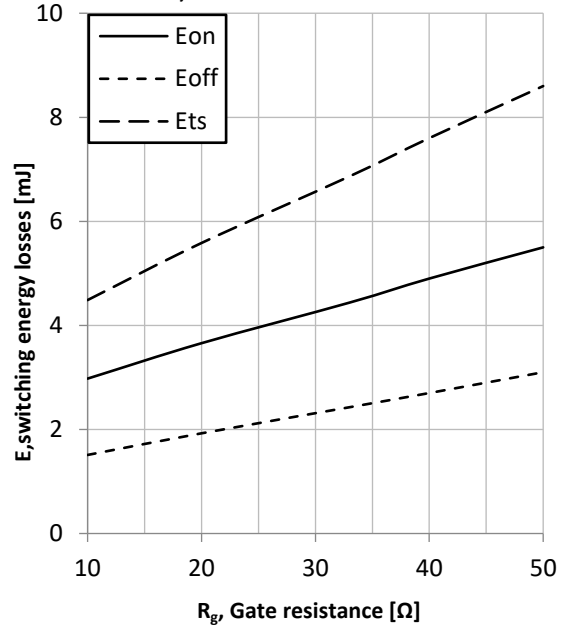


Fig13. Typical switching energy losses as a fuction of Junction temperature (inductive load, $I_c=60A, V_{CE}=400V, V_{GE}=0/15V, R_g=10\Omega$)

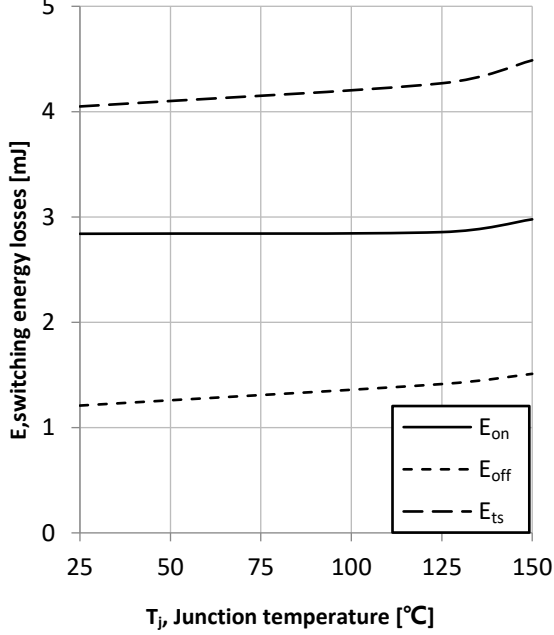


Fig14. Typical switching energy losses as a fuction of collector-emitter voltage (inductive load, $T_{vj}=150\text{ }^\circ\text{C}, I_c=60A, V_{GE}=0/15V, R_g=10\Omega$)

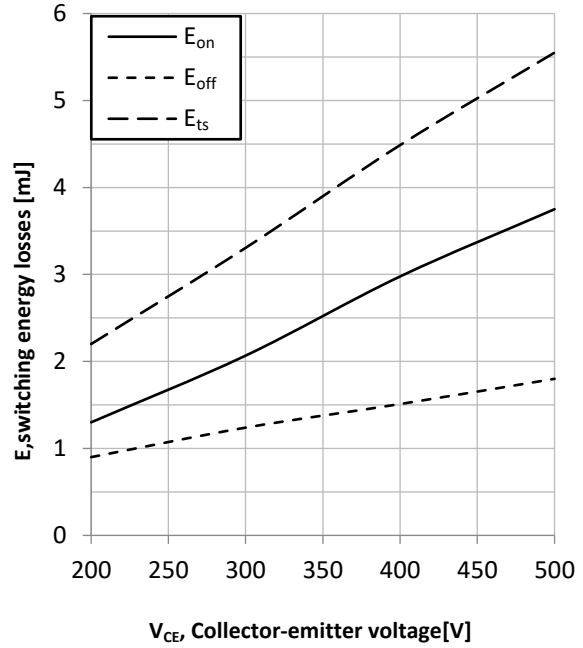


Fig15. Typical capacitance as a function of collector-emitter voltage

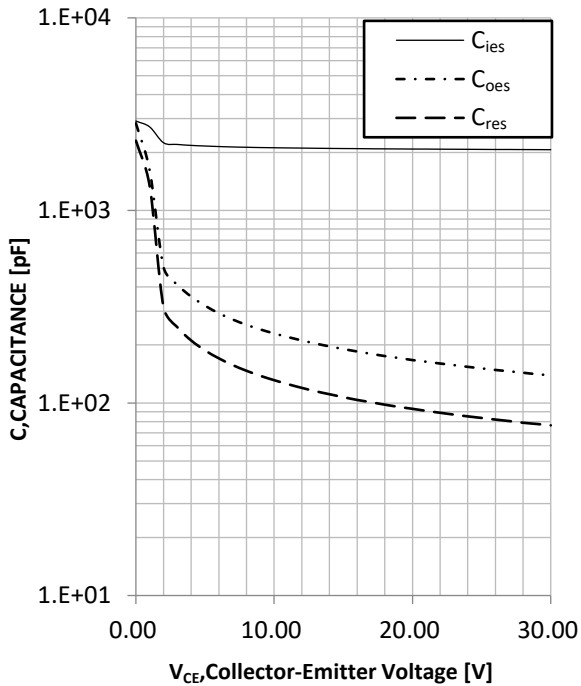


Fig 16. IGBT Transient Thermal Impedance

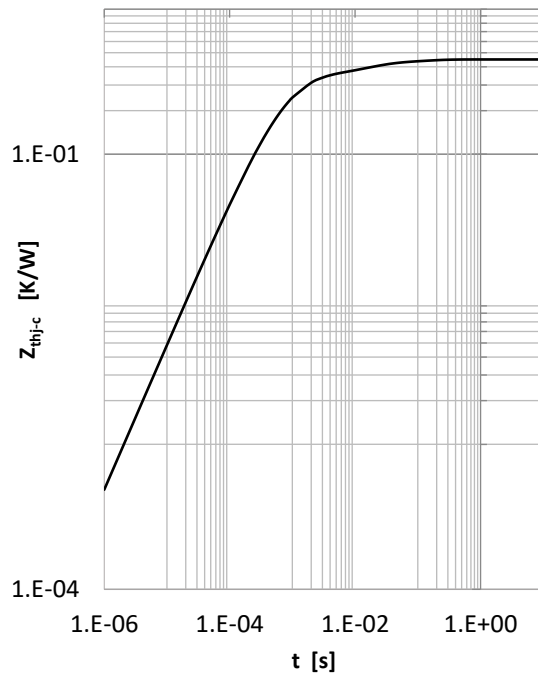


Fig 17. Diode Transient Thermal Impedance

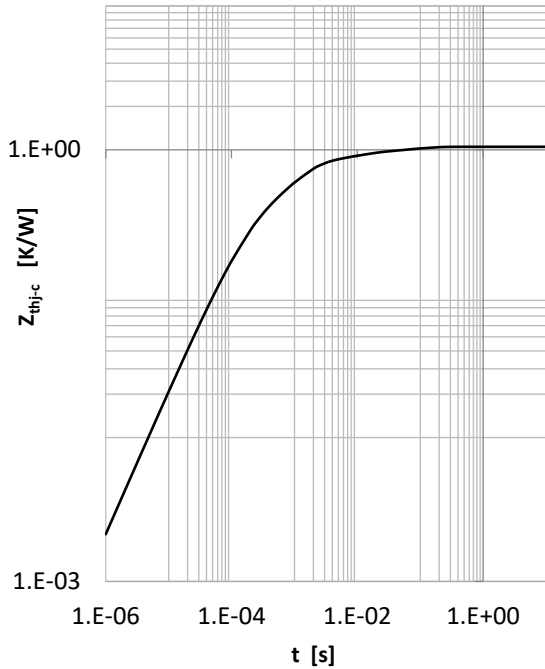


Fig18. Diode forward current as a function of forward voltage

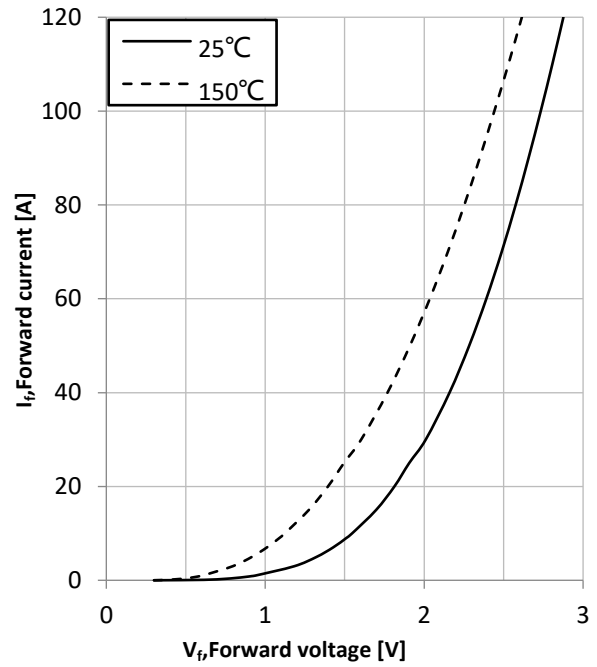


Fig19. Typical diode forward voltage as a function of Junction temperature

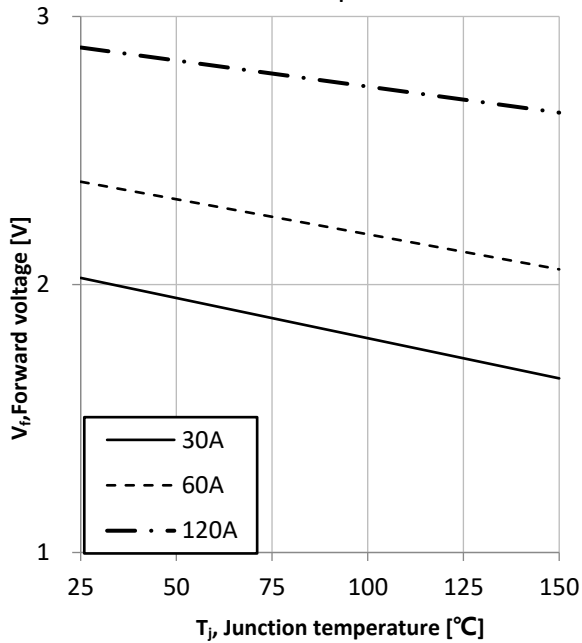


Fig20. Typical diode reverse recovery energy losses as a function of Junction temperature (inductive load, $I_f=60A, V_r=400V$)

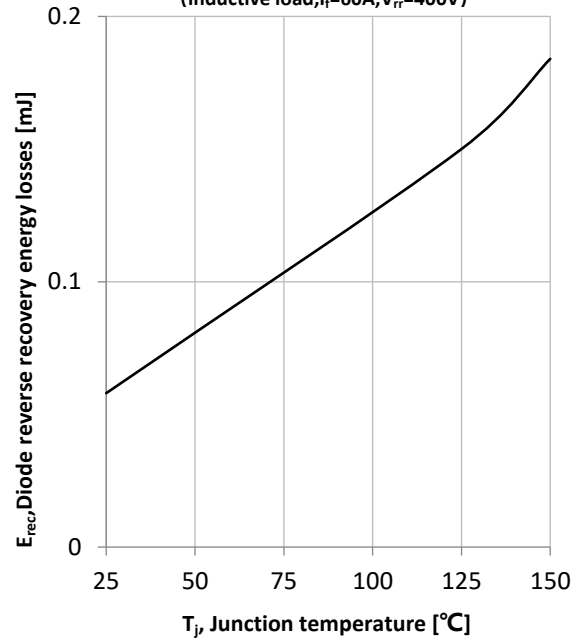
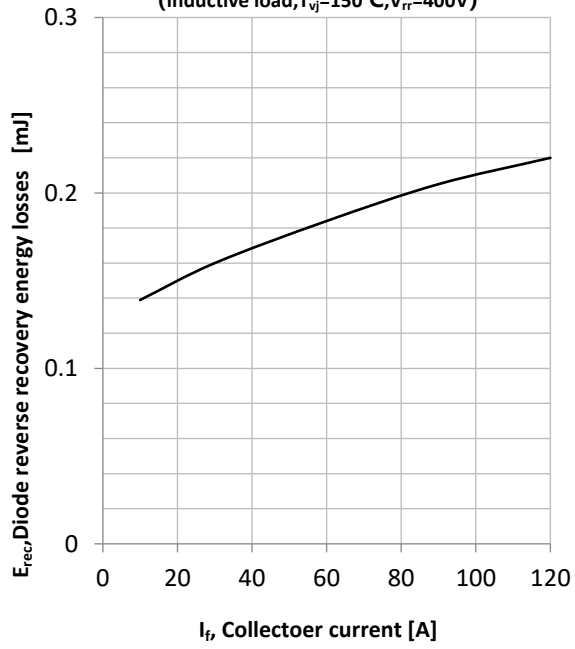


Fig21. Typical diode reverse recovery energy losses as a function of collector current
(inductive load, $T_{vj}=150^{\circ}\text{C}$, $V_{rr}=400\text{V}$)



Ordering Information

Device	Packing
Part Number-BP	Tube: 30pcs/Tube, 1800pcs/Ctn

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