Low Loss DuoPack : IGBT in TRENCHSTOP™ and Fieldstop technology with soft, fast recovery anti-parallel Emitter Controlled HE diode

Features:

- Very low $V_{CE(sat)}$ 1.5V (typ.)
- Maximum Junction Temperature 175°C
- Short circuit withstand time 5μs
- Designed for :
    - Frequency Converters
    - Uninterrupted Power Supply
- TRENCHSTOP™ and Fieldstop technology for 600V applications offers :
    - very tight parameter distribution
    - high ruggedness, temperature stable behavior
    - very high switching speed
- Positive temperature coefficient in $V_{CE(sat)}$
- Low EMI
- Pb-free lead plating; RoHS compliant
- Very soft, fast recovery anti-parallel Emitter Controlled HE diode
- Qualified according to JEDEC[1] for target applications
- Complete product spectrum and PSpice Models : http://www.infineon.com/igbt/
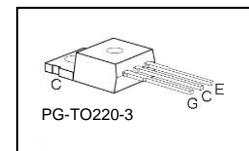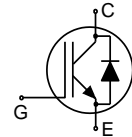
PG-TO220-3

Type	V_{CE}	I_C	$V_{CE(sat),Tj=25°C}$	$T_{j,max}$	Marking Code	Package
IKP15N60T	600V	15A	1.5V	175°C	K15T60	PG-TO220-3

Maximum Ratings

Parameter	Symbol	Value	Unit
Collector-emitter voltage, $T_j \geq 25°C$	V_{CE}	600	V
DC collector current, limited by T_{jmax} $T_C = 25°C$, value limited by bondwire $T_C = 100°C$	I_C	26 23	A
Pulsed collector current, t_p limited by T_{jmax}	I_{Cpuls}	45	
Turn off safe operating area, $V_{CE} = 600V$, $T_j = 175°C$, $t_p = 1μs$	-	45	
Diode forward current, limited by T_{jmax} $T_C = 25°C$, value limited by bondwire $T_C = 100°C$	I_F	26 23	
Diode pulsed current, t_p limited by T_{jmax}	I_{Fpuls}	45	
Gate-emitter voltage	V_{GE}	±20	V
Short circuit withstand time[2] $V_{GE} = 15V$, $V_{CC} \leq 400V$, $T_j \leq 150°C$	t_{SC}	5	μs
Power dissipation $T_C = 25°C$	P_{tot}	130	W
Operating junction temperature	T_j	-40...+175	°C
Storage temperature	T_{stg}	-55...+150	
Soldering temperature wavesoldering, 1.6 mm (0.063 in.) from case for 10s		260	

[1] J-STD-020 and JESD-022
[2] Allowed number of short circuits: <1000; time between short circuits: >1s.

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}		1.15	K/W
Diode thermal resistance, junction – case	R_{thJCD}		1.9	
Thermal resistance, junction – ambient	R_{thJA}		62	

Electrical Characteristic, at T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
Static Characteristic						
Collector-emitter breakdown voltage	$V_{(BR)CES}$	$V_{GE}=0V$, $I_C=0.2mA$	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	$V_{GE}=15V$, $I_C=15A$				
		$T_j=25°C$	-	1.5	2.05	
		$T_j=175°C$	-	1.9	-	
Diode forward voltage	V_F	$V_{GE}=0V$, $I_F=15A$				
		$T_j=25°C$	-	1.65	2.05	
		$T_j=175°C$	-	1.6	-	
Gate-emitter threshold voltage	$V_{GE(th)}$	$I_C=210\mu A$, $V_{CE}=V_{GE}$	4.1	4.9	5.7	
Zero gate voltage collector current	I_{CES}	$V_{CE}=600V$, $V_{GE}=0V$				μA
		$T_j=25°C$	-	-	40	
		$T_j=175°C$	-	-	1000	
Gate-emitter leakage current	I_{GES}	$V_{CE}=0V$, $V_{GE}=20V$	-	-	100	nA
Transconductance	g_{fs}	$V_{CE}=20V$, $I_C=15A$	-	8.7	-	S
Integrated gate resistor	R_{Gint}			-		Ω
Dynamic Characteristic						
Input capacitance	C_{iss}	$V_{CE}=25V$,	-	860	-	pF
Output capacitance	C_{oss}	$V_{GE}=0V$,	-	55	-	
Reverse transfer capacitance	C_{rss}	$f=1MHz$	-	24	-	
Gate charge	Q_{Gate}	$V_{CC}=480V$, $I_C=15A$ $V_{GE}=15V$	-	87	-	nC
Internal emitter inductance measured 5mm (0.197 in.) from case	L_E		-	7	-	nH
Short circuit collector current[1]	$I_{C(SC)}$	$V_{GE}=15V$, $t_{SC}\leq5\mu s$ $V_{CC}=400V$, $T_j \leq 150°C$	-	137.5	-	A

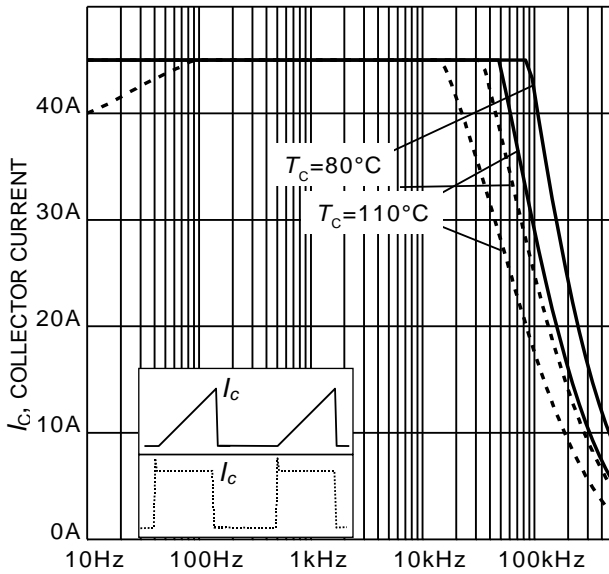[1] Allowed number of short circuits: <1000; time between short circuits: >1s.

Switching Characteristic, Inductive Load, at T_j=25 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=25°C, V_{CC}=400V, I_C=15A, V_{GE}=0/15V, r_G=15Ω, L_σ=154nH, C_σ=39pF L_σ, C_σ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	17	-	ns
Rise time	t_r		-	11	-	
Turn-off delay time	$t_{d(off)}$		-	188	-	
Fall time	t_f		-	50	-	
Turn-on energy	E_{on}		-	0.22	-	mJ
Turn-off energy	E_{off}		-	0.35	-	
Total switching energy	E_{ts}		-	0.57	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=25°C, V_R=400V, I_F=15A, di_F/dt=825A/µs	-	34	-	ns
Diode reverse recovery charge	Q_{rr}		-	0.24	-	µC
Diode peak reverse recovery current	I_{rrm}		-	10.4	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	718	-	A/µs

Switching Characteristic, Inductive Load, at T_j=175 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	Typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	T_j=175°C, V_{CC}=400V, I_C=15A, V_{GE}=0/15V, r_G=15Ω, L_σ=154nH, C_σ=39pF L_σ, C_σ from Fig. E Energy losses include "tail" and diode reverse recovery.	-	17	-	ns
Rise time	t_r		-	15	-	
Turn-off delay time	$t_{d(off)}$		-	212	-	
Fall time	t_f		-	79	-	
Turn-on energy	E_{on}		-	0.34	-	mJ
Turn-off energy	E_{off}		-	0.47	-	
Total switching energy	E_{ts}		-	0.81	-	
Anti-Parallel Diode Characteristic						
Diode reverse recovery time	t_{rr}	T_j=175°C, V_R=400V, I_F=15A, di_F/dt=825A/µs	-	140	-	ns
Diode reverse recovery charge	Q_{rr}		-	1.0	-	µC
Diode peak reverse recovery current	I_{rrm}		-	14.7	-	A
Diode peak rate of fall of reverse recovery current during t_b	di_{rr}/dt		-	495	-	A/µs

Figure 1. Collector current as a function of switching frequency
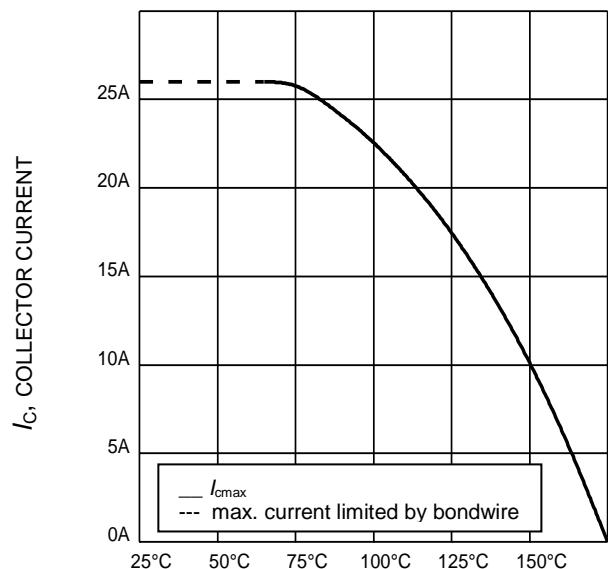($T_j \leq 175°C$, $D = 0.5$, $V_{CE} = 400V$, $V_{GE} = 0/15V$, $r_G = 15\Omega$)

f, SWITCHING FREQUENCY

Figure 2. Safe operating area
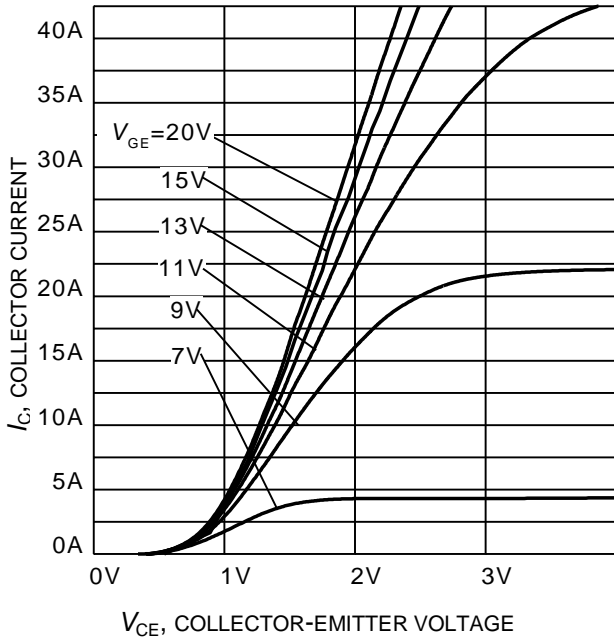($D = 0$, $T_C = 25°C$, $T_j \leq 175°C$; $V_{GE}=0/15V$)
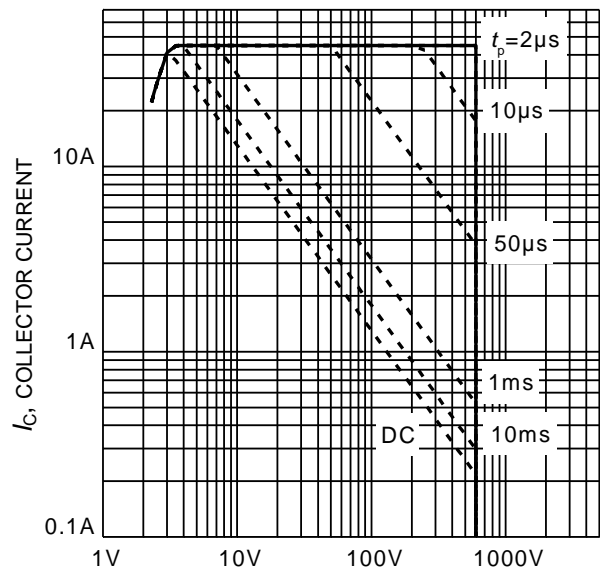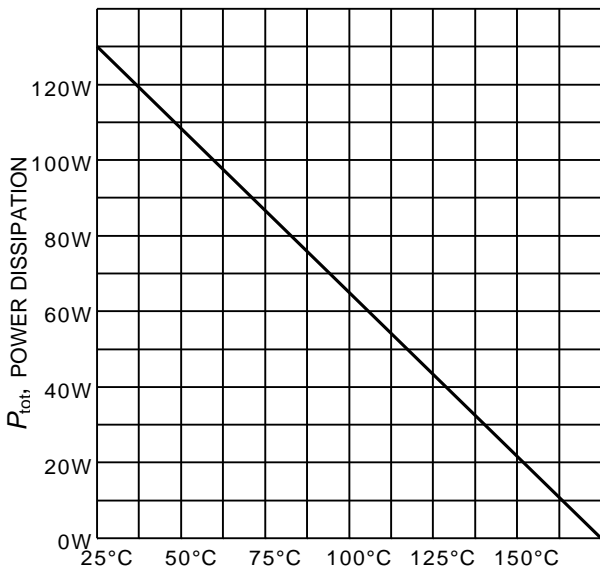
V_{CE}, COLLECTOR-EMITTER VOLTAGE

Figure 3. Power dissipation as a function of case temperature
($T_j \leq 175°C$)

T_C, CASE TEMPERATURE

Figure 4. Collector current as a function of case temperature
($V_{GE} \geq 15V$, $T_j \leq 175°C$)

T_C, CASE TEMPERATURE

Figure 5. Typical output characteristic
(T_j = 25°C)
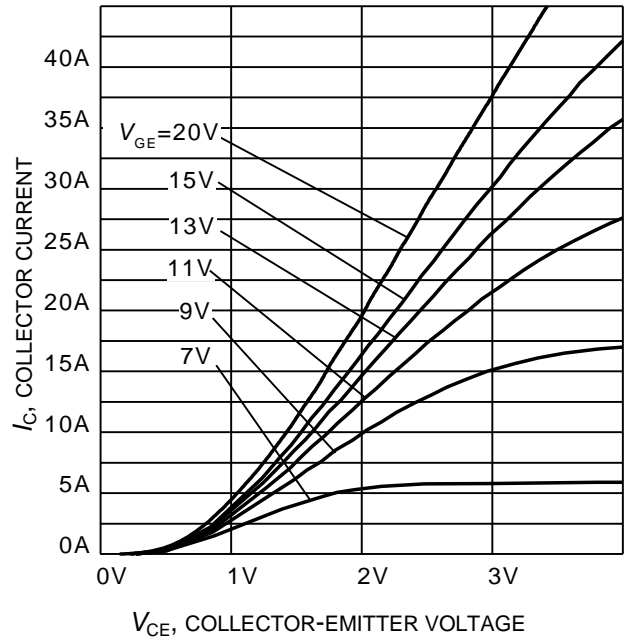
Figure 6. Typical output characteristic
(T_j = 175°C)
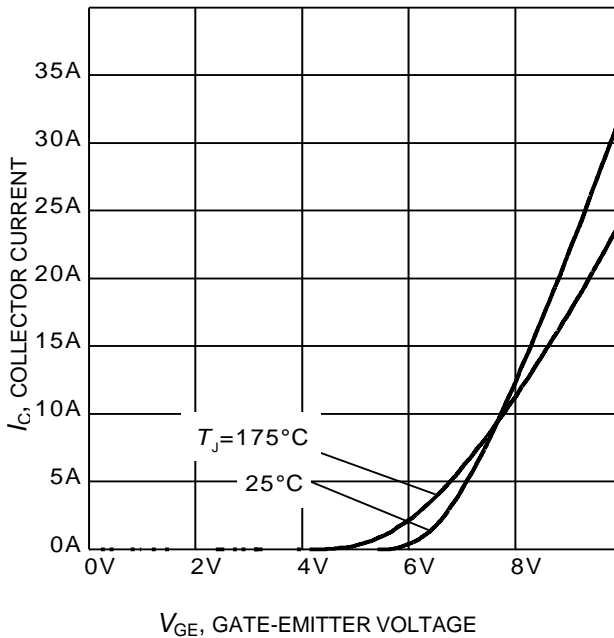
Figure 7. Typical transfer characteristic
(V_{CE}=20V)
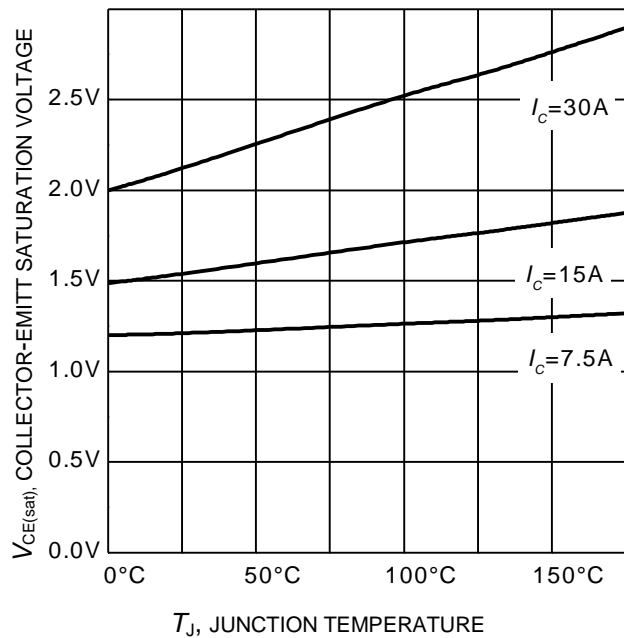
Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 15V)
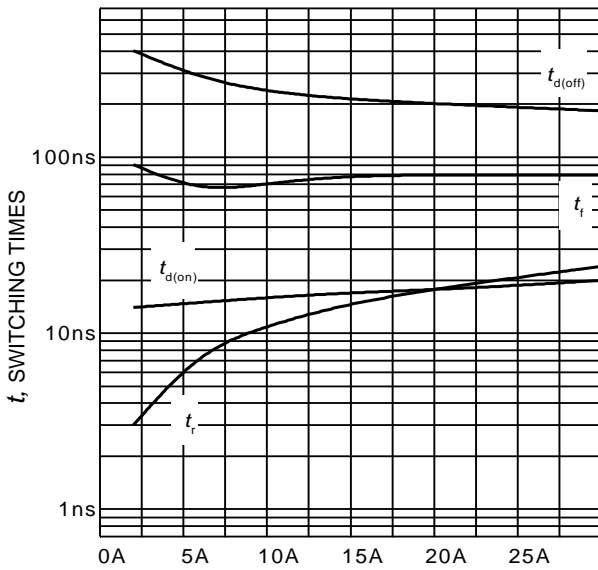
I_C, COLLECTOR CURRENT

Figure 9. Typical switching times as a function of collector current (inductive load, T_J=175°C, V_{CE} = 400V, V_{GE} = 0/15V, r_G = 15Ω, Dynamic test circuit in Figure E)
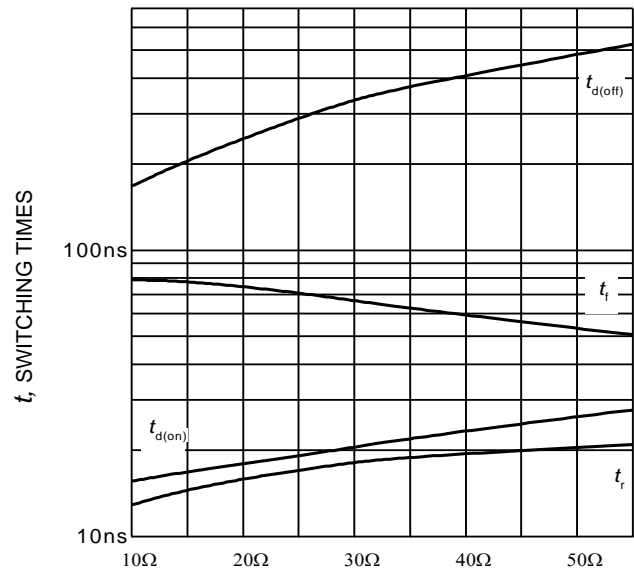
R_G, GATE RESISTOR

Figure 10. Typical switching times as a function of gate resistor (inductive load, T_J = 175°C, V_{CE}= 400V, V_{GE} = 0/15V, I_C = 15A, Dynamic test circuit in Figure E)
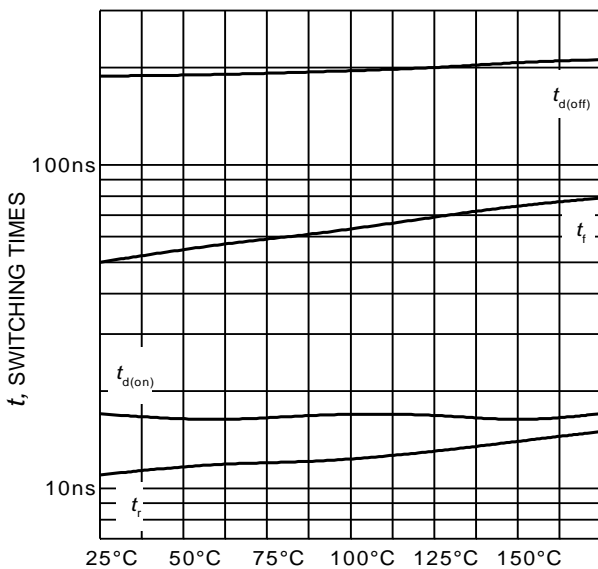
T_J, JUNCTION TEMPERATURE

Figure 11. Typical switching times as a function of junction temperature (inductive load, V_{CE} = 400V, V_{GE} = 0/15V, I_C = 15A, r_G=15Ω, Dynamic test circuit in Figure E)
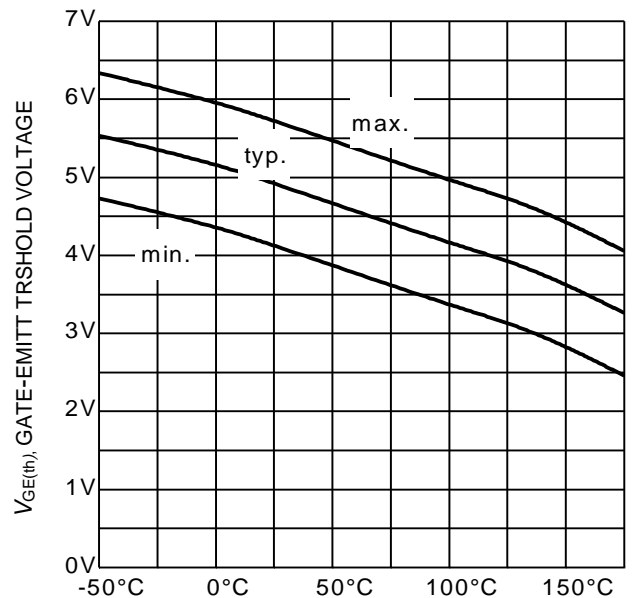
T_J, JUNCTION TEMPERATURE

Figure 12. Gate-emitter threshold voltage as a function of junction temperature (I_C = 0.21mA)
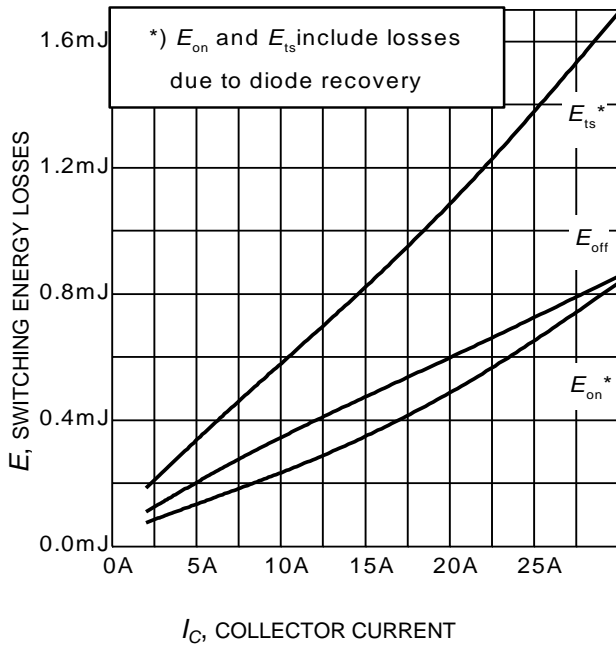
Figure 13. Typical switching energy losses as a function of collector current (inductive load, T_J = 175°C, V_{CE} = 400V, V_{GE} = 0/15V, r_G = 15Ω, Dynamic test circuit in Figure E)
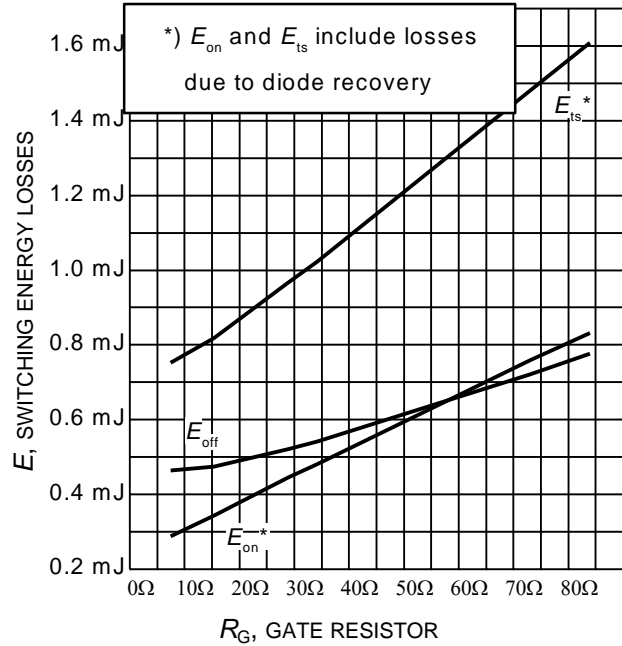

Figure 14. Typical switching energy losses as a function of gate resistor (inductive load, T_J = 175°C, V_{CE} = 400V, V_{GE} = 0/15V, I_C = 15A, Dynamic test circuit in Figure E)
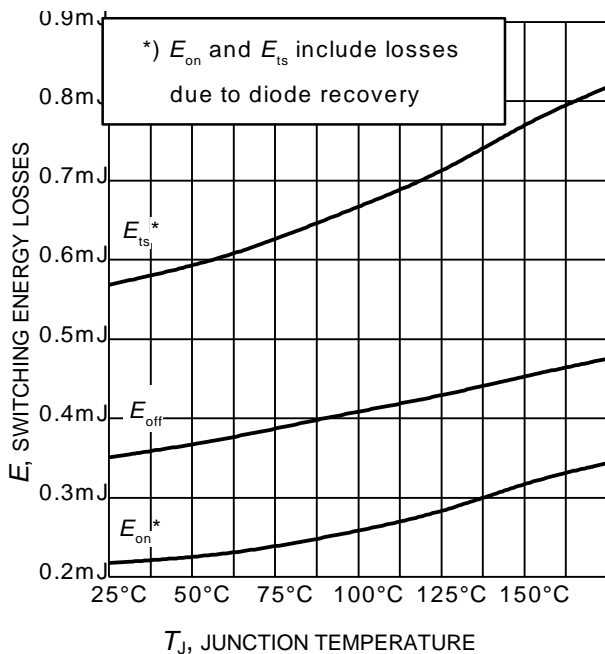
Figure 15. Typical switching energy losses as a function of junction temperature (inductive load, V_{CE} = 400V, V_{GE} = 0/15V, I_C = 15A, r_G = 15Ω, Dynamic test circuit in Figure E)
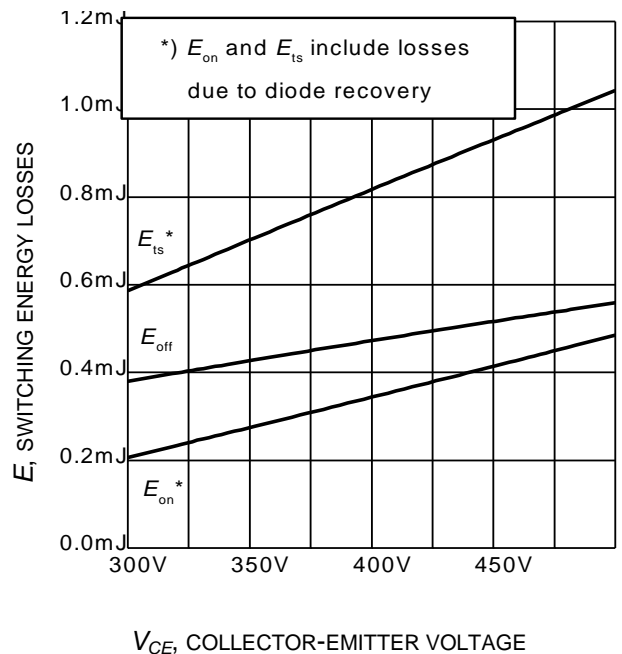
Figure 16. Typical switching energy losses as a function of collector emitter voltage (inductive load, T_J = 175°C, V_{GE} = 0/15V, I_C = 15A, r_G = 15Ω, Dynamic test circuit in Figure E)
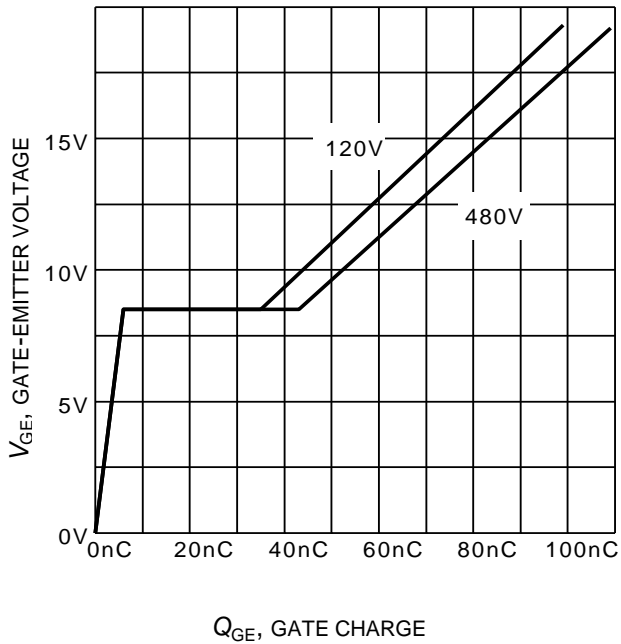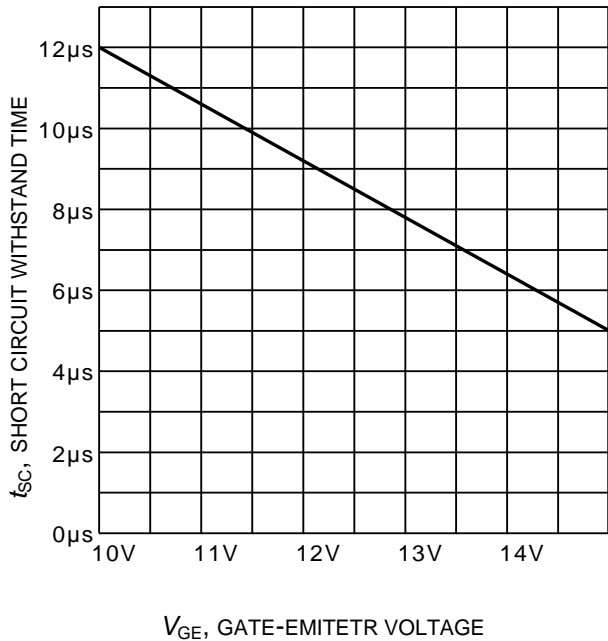
Figure 17. Typical gate charge
(I_C=15 A)
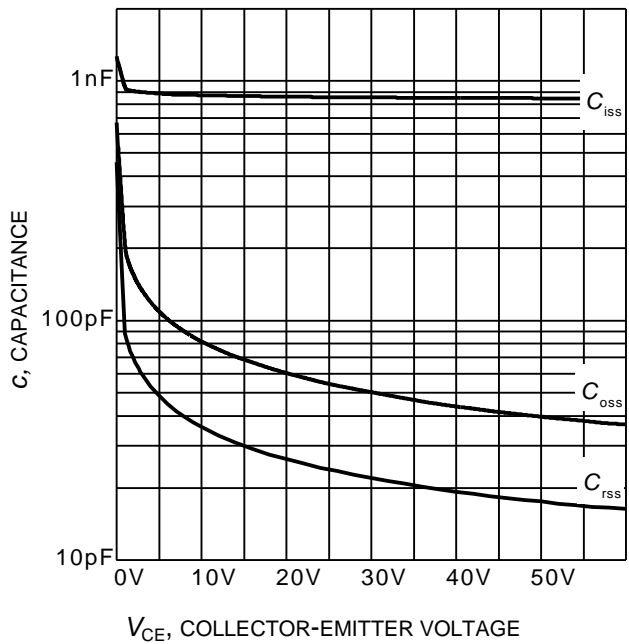
Figure 18. Typical capacitance as a function of collector-emitter voltage
(V_{GE}=0V, f = 1 MHz)
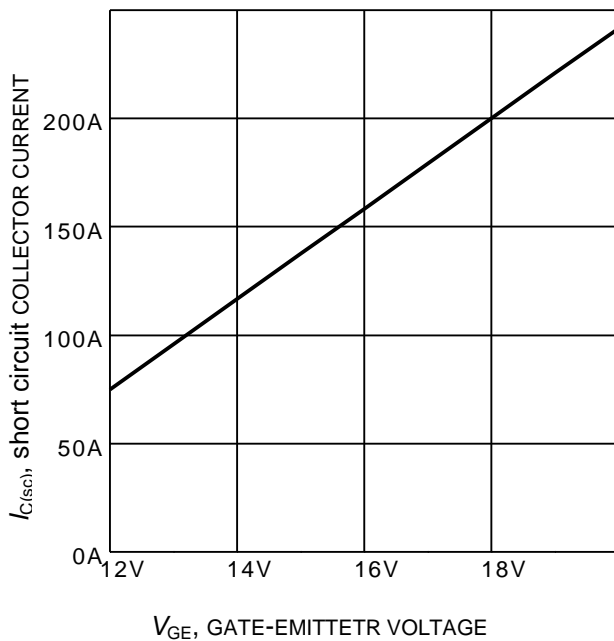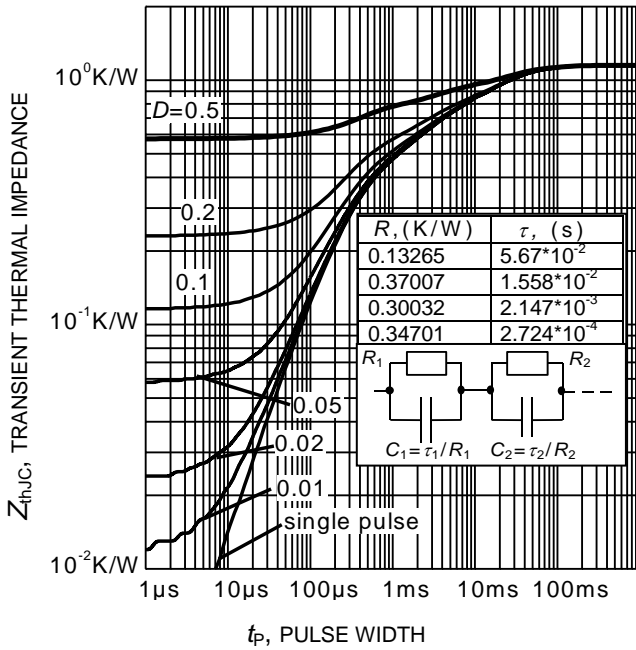

Figure 19. Typical short circuit collector current as a function of gate-emitter voltage
($V_{CE} \leq 400V$, $T_j \leq 150°C$)

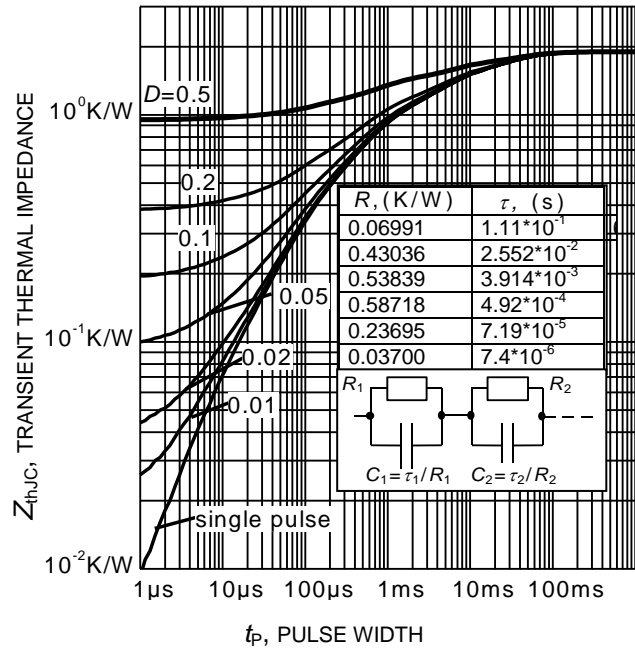**Figure 20. Short circuit withstand time as a function of gate-emitter voltage**
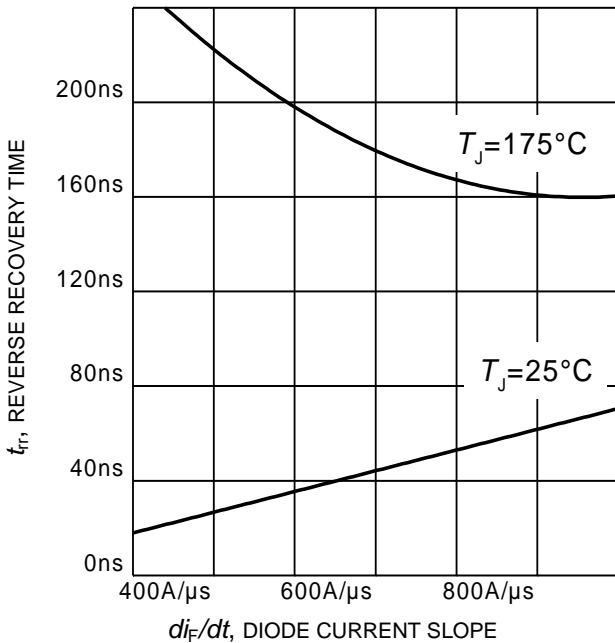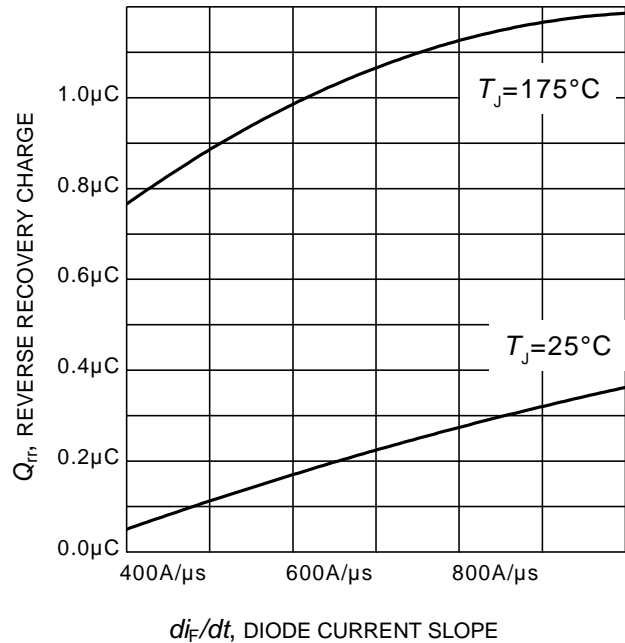(V_{CE}=400V, start at T_J=25°C, T_{Jmax}<150°C)

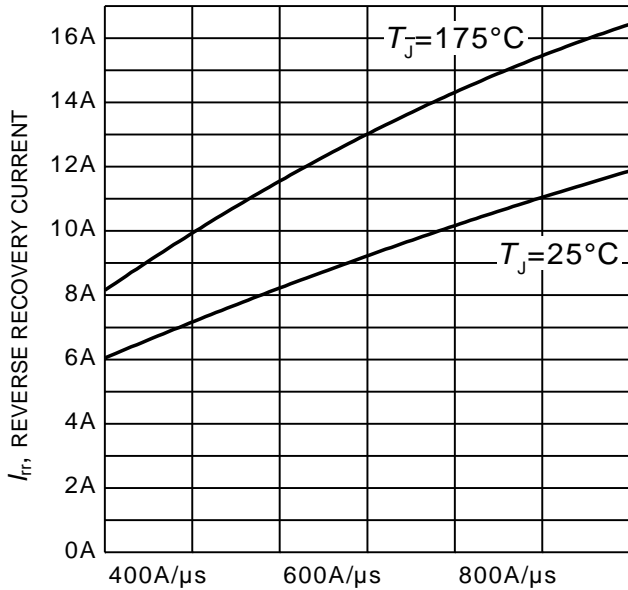**Figure 21. IGBT transient thermal impedance** ($D = t_p / T$)

Figure 22. Diode transient thermal impedance as a function of pulse width ($D = t_P / T$)

Figure 23. Typical reverse recovery time as a function of diode current slope ($V_R = 400V$, $I_F = 15A$, Dynamic test circuit in Figure E)
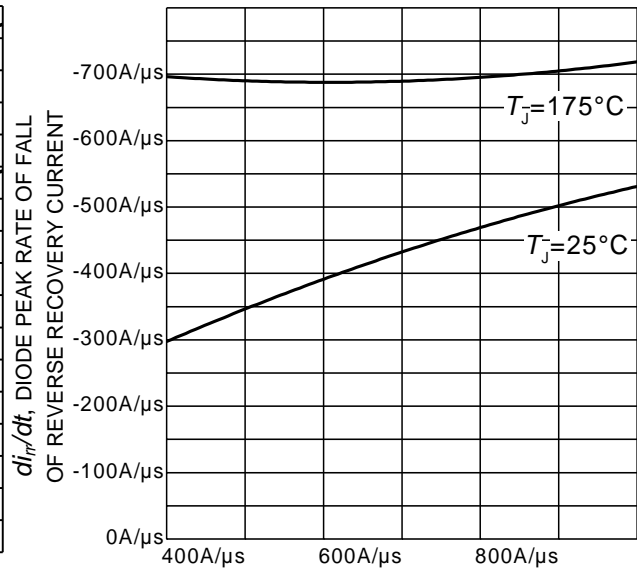

Figure 24. Typical reverse recovery charge as a function of diode current slope ($V_R = 400V$, $I_F = 15A$, Dynamic test circuit in Figure E)

Figure 25. Typical reverse recovery current as a function of diode current slope
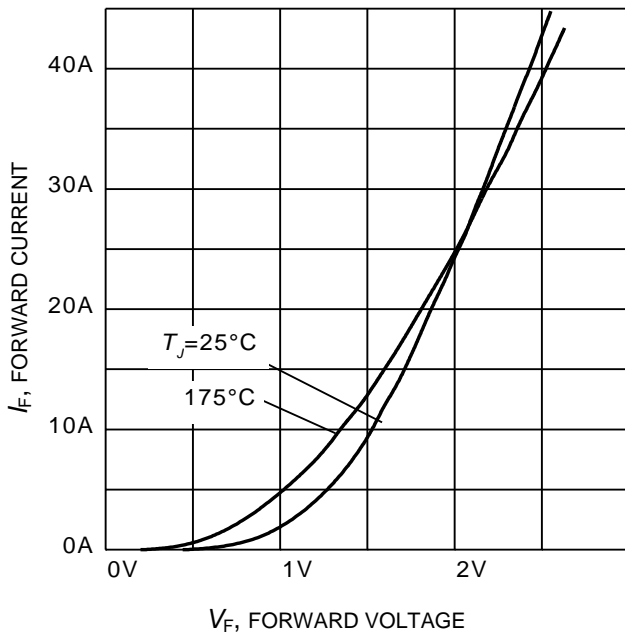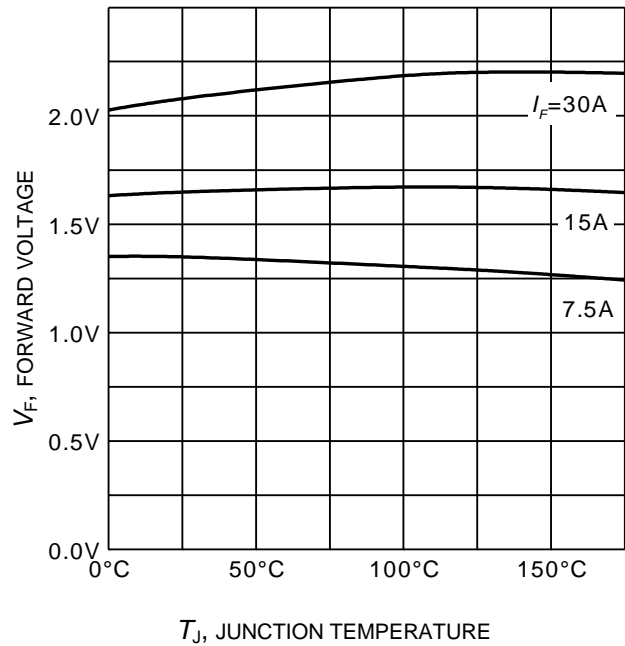(V_R = 400V, I_F = 15A, Dynamic test circuit in Figure E)

Figure 26. Typical diode peak rate of fall of reverse recovery current as a function of diode current slope
(V_R=400V, I_F=15A, Dynamic test circuit in Figure E)

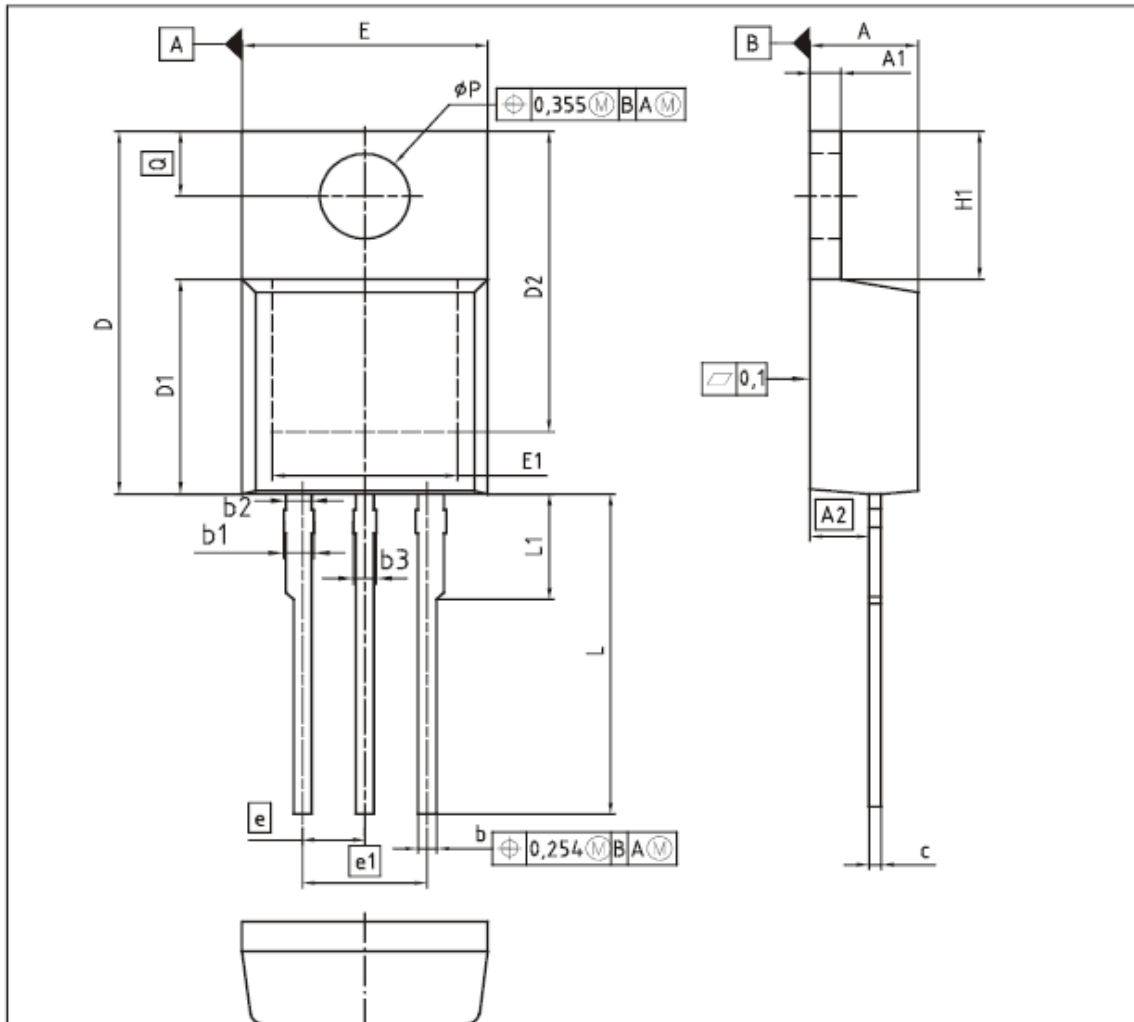

Figure 27. Typical diode forward current as a function of forward voltage

Figure 28. Typical diode forward voltage as a function of junction temperature

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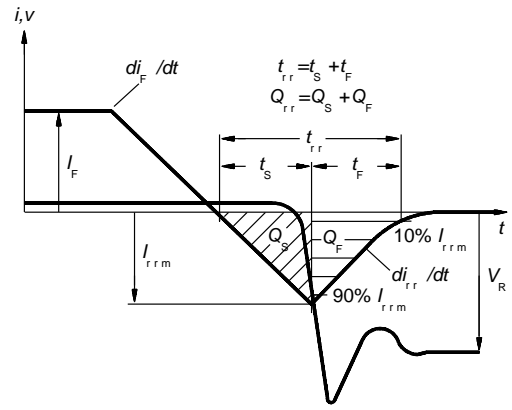| DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

DOCUMENT NO.
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SCALE

EUROPEAN PROJECTION

ISSUE DATE
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REVISION
06
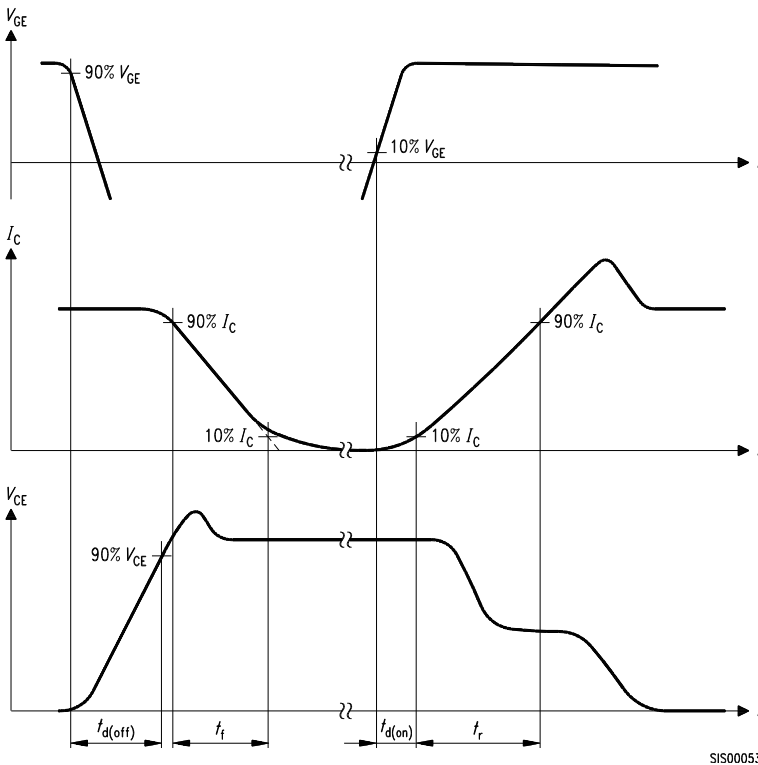
Figure A. Definition of switching times

$$E_{OFF} = \int_{t_1}^{t_2} V_{CE} \times I_C \times dt \qquad E_{ON} = \int_{t_3}^{t_4} V_{CE} \times I_C \times dt$$

Figure B. Definition of switching losses

$$t_{rr} = t_S + t_F$$
$$Q_{rr} = Q_S + Q_F$$
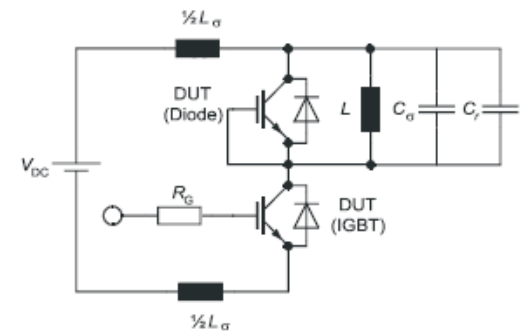
Figure C. Definition of diodes switching characteristics
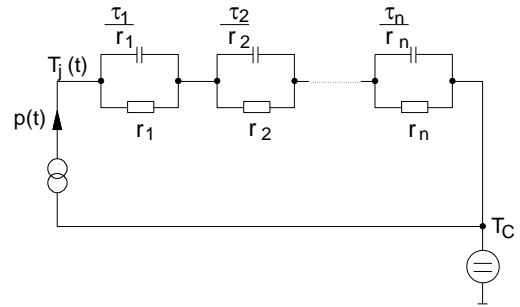
Figure D. Thermal equivalent circuit

Figure E. Dynamic test circuit
Parasitic inductance L_σ,
Parasitic capacitor C_σ,
Relief capacitor C_r
(only for ZVT switching)