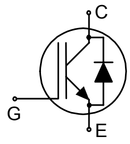
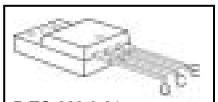
ILA03N60, ILP03N60
ILB03N60, ILD03N60

LightMOS Power Transistor

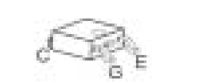
- New high voltage technology designed for ZVS-switching in lamp ballasts
- IGBT with integrated reverse diode
- 4A current rating for reverse diode
- Up to 10 times lower gate capacitance than MOSFET
- Avalanche rated
- 150°C operating temperature
- FullPak isolates 2.5 kV AC (1 min.)




P-TO-220-3-31 (TO-220 FullPak)


P-TO-220-3-1 (TO-220AB)


P-TO-263-3-2 (D^2-PAK) (TO-263AB)


P-TO-252-3-1 (D-PAK) (TO-252AA)

Type	V_{CE}	I_C	$V_{CE(sat),Tj=25°C}$	$T_{j,max}$	**Package**	**Ordering Code**
ILA03N60	600V	3.0A	2.9V	150°C	P-TO-220-3-31	Q67040-S4626
ILP03N60	600V	3.0A	2.9V	150°C	P-TO-220-3-1	Q67040-S4628
ILB03N60	600V	3.0A	2.9V	150°C	P-TO-263-3-2	Q67040-S4627
ILD03N60	600V	3.0A	2.9V	150°C	P-TO-252-3-1	Q67040-S4625

Maximum Ratings

Parameter	**Symbol**	**Value**	**Unit**
Collector-emitter voltage	V_{CE}	600	V
DC collector current T_C = 25°C T_C = 100°C	I_C	 4.5 3	A
Pulsed collector current, t_p limited by T_{jmax}, t_p < 10 ms	I_{Cpuls}	9	
Pulsed collector current, t_p limited by T_{jmax}		5.5	
Diode forward current T_C = 25°C T_C = 100°C	I_F	 4 2.5	
Diode pulsed current, t_p limited by T_{jmax}, t_p < 10 ms	I_{Fpuls}	9	
Diode pulsed current, t_p limited by T_{jmax}		5.5	
Avalanche energy, single pulse I_C=0.8A, V_{CE}=50V	E_{AS}	0.32	mJ
Gate-emitter voltage	V_{GE}	±30	V
Reverse diode dv/dt $I_C \leq$ 3A, $V_{CE} \leq$ 450V, $T_{jmax} \leq$ 150°C	dv/dt	1[1]	V/ns
Power dissipation (T_C = 25°C)	P_{tot}	27	W
Operating junction and storage temperature	T_{stg}	-55...+150	°C
Soldering temperature for 10 s (according to JEDEC J-STA-020A)	T_s	255	

[1] Reverse diode of transistor is commutated with same device according to figure C. With application relevant values $I_C \leq$ 1.5A, $C_{Snubber}$ = 1 nF and $R_G \geq$ 50Ω, dv/dt of the reverse diode is within its specification.

Thermal Resistance

Parameter	Symbol	Conditions	Max. Value	Unit
Characteristic				
IGBT thermal resistance, junction – case	R_{thJC}	TO-220 – FullPak Other packages	7.6 4.7	K/W
Diode thermal resistance, junction – case	R_{thJCD}	TO-220 – FullPak Other packages	12 10	
Therm. resistance, junction - ambient	R_{thJA}		62	
SMD version, device on PCB: @ min. footprint @ 6cm² cooling area[1]	R_{thJA}	P-TO-252-3-1	 75 50	

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=0.5mA	600	-	-	V
Collector-emitter saturation voltage	$V_{CE(sat)}$	V_{GE}=10V, I_C=3.0A T_j=25°C T_j=150°C	 - -	 2.3 2.7	 2.9	
		V_{GE}=10V, I_C=0.8A T_j=25°C T_j=150°C	 - -	 1.5 1.5	 - -	
Diode forward voltage	V_F	V_{GE}=0V, I_F=3.0A T_j=25°C T_j=150°C	 - -	 1.5 1.6	 1.8	
		V_{GE}=0V, I_F=0.8A T_j=25°C T_j=150°C	 - -	 1.0 1.0	 - -	V
Gate-emitter threshold voltage	$V_{GE(th)}$	I_C=30µA, V_{CE}=V_{GE}	2.1	3.0	3.9	V
Zero gate voltage collector current	I_{CES}	V_{CE}=600V, V_{GE}=0V T_j=25°C T_j=150°C	 - -	 1 -	 20 250	µA
Gate-emitter leakage current	I_{GES}	V_{CE}=0V, V_{GE}=20V	-	-	100	nA
Transconductance	g_{fs}	V_{CE}=20V, I_C=3.0A	-	1.5	-	S

[1] Device on 40mm*40mm*1.5mm epoxy PCB FR4with 6cm^2 (one layer, 70µm thick) copper area for drain connection. PCB is vertical without blown air.

Capacities, Gate Charge, at T_j=25 °C

Input capacitance	C_{iss}	V_{CE}=25V, V_{GE}=0V, f=1MHz	-	110	-	pF
Output capacitance	C_{oss}		-	6	-	
Reverse transfer capacitance	C_{rss}		-	4	-	
Effective Output Capacitance (Energy related)	$C_{o(er)}$	V_{GE}=0V, V_{CE}=0V to 480V		3,7		pF
Gate to emitter charge	Q_{GE}	V_{CE}=400V, I_C=3.0A, V_{GE}=10V	-	1	-	nC
Gate to collector charge	Q_{GC}		-	5.5	-	
Gate total charge	Q_G		-	8.5	-	
Gate plateau voltage	V_m		-	6.5	-	V
Gate to emitter charge	Q_{GE}	V_{CE}=400V, I_C=0.8A, V_{GE}=10V	-	0.5	-	nC
Gate to collector charge	Q_{GC}		-	4.0	-	
Gate total charge	Q_G		-	8	-	
Gate plateau voltage	V_m		-	3.5	-	V

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	V_{CC}=400V, I_C=0.8A, V_{GE}=0/10V, R_G=60Ω, $C_{Snubber}$ =0nF ($C_{Snubber}$: Snubber capacitor)	-	15	-	ns
Rise time	t_r		-	35	-	
Turn-off delay time	$t_{d(off)}$		-	100	-	
Fall time	t_f		-	100	-	
Turn-on energy	E_{on} [3]		-	12	-	µJ
Turn-off energy	E_{off}		-	20	-	
Turn-off energy	E_{off}	$C_{Snubber}$ =1nF	-	8	-	

Switching Characteristic, Inductive Load, at T_j=150 °C

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
IGBT Characteristic						
Turn-on delay time	$t_{d(on)}$	V_{CC}=400V, I_C=0.8A, V_{GE}=0/10V, R_G=60Ω, $C_{Snubber}$=0nF ($C_{Snubber}$: Snubber capacitor)	-	20	-	ns
Rise time	t_r		-	45	-	
Turn-off delay time	$t_{d(off)}$		-	120	-	
Fall time	t_f		-	120	-	
Turn-on energy	E_{on} [3]		-	15	-	µJ
Turn-off energy	E_{off}		-	28	-	
Turn-off energy	E_{off}	$C_{Snubber}$ =1nF	-	12	-	

[3] E_{on} includes SDP04S60 diode commutation losses

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

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Reverse diode Characteristic (switching in half bridge configuration with same transistor according to figure C)						
Reverse recovery time	t_{rr}	V_R=400V, I_F=0.8A, V_{GE}=0/10V, R_G=80Ω	-	90	-	ns
Reverse recovery charge	Q_{rr}		-	0.27	-	µC
Peak reverse recovery current	I_{rrm}		-	5.5	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	300	-	A/µs
Reverse recovery time	t_{rr}	V_R=400V, I_F=3A, V_{GE}=0/10V, R_G=80Ω	-	250	-	ns
Reverse recovery charge	Q_{rr}		-	0.75	-	µC
Peak reverse recovery current	I_{rrm}		-	8	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	300	-	A/µs

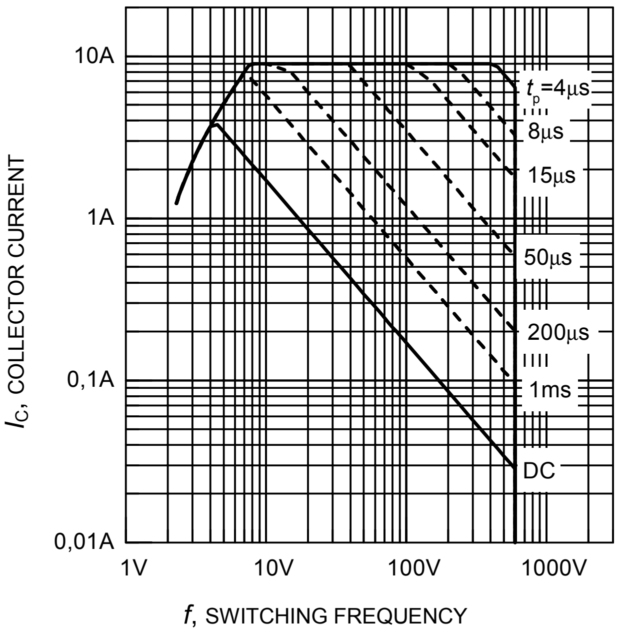


Figure 1: Safe operating area (FullPak)

(D = 0, T_C = 25°C, $T_j \leq$ 150°C)

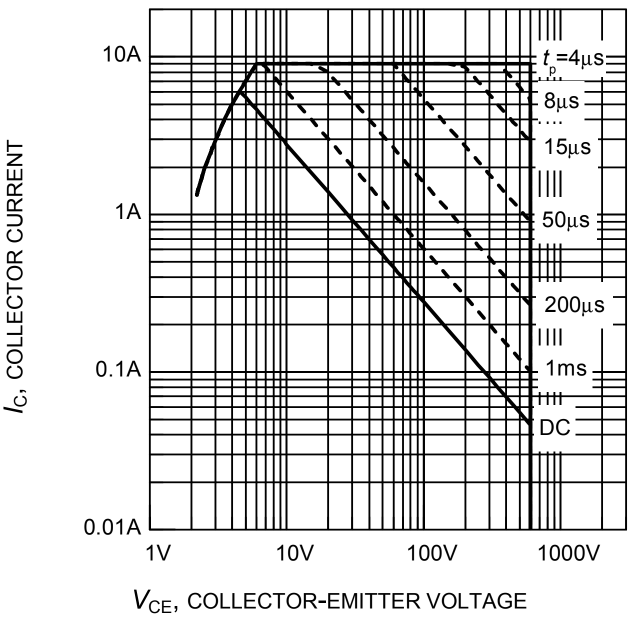


Figure 2: Safe operating area (Other Packages)

(D = 0, T_C = 25°C, $T_j \leq$ 150°C)

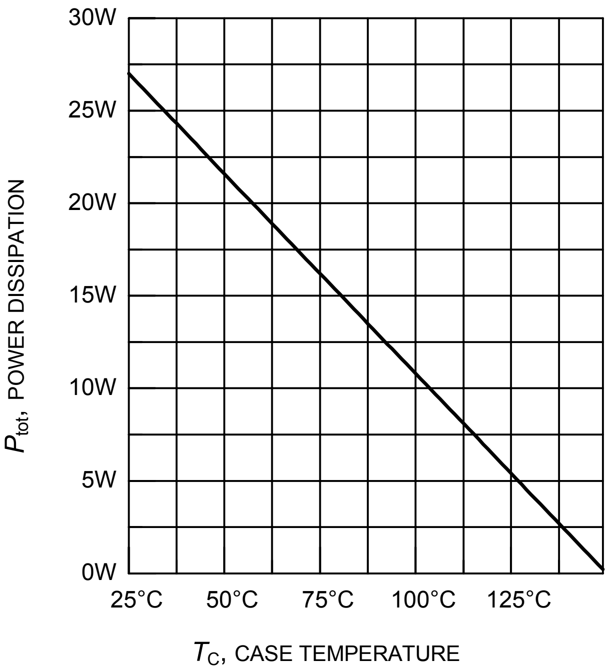


Figure 3. Power dissipation as a function of case temperature

($T_j \leq$ 150°C)

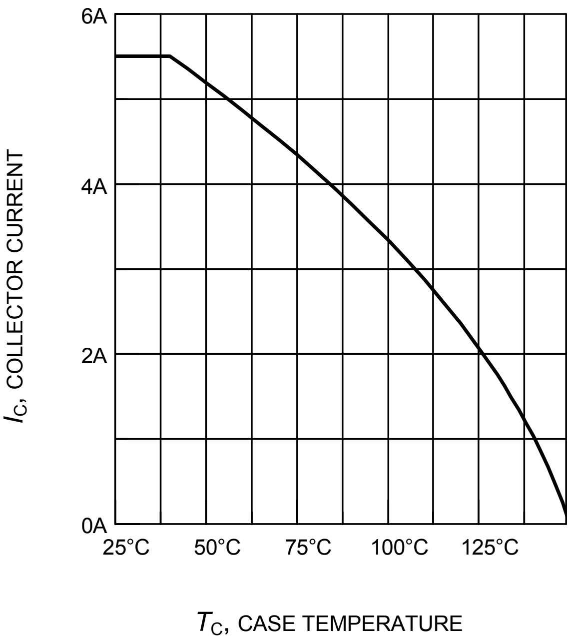


Figure 4. Collector current as a function of case temperature

($V_{GE} \leq$ 10V, $T_j \leq$ 150°C)

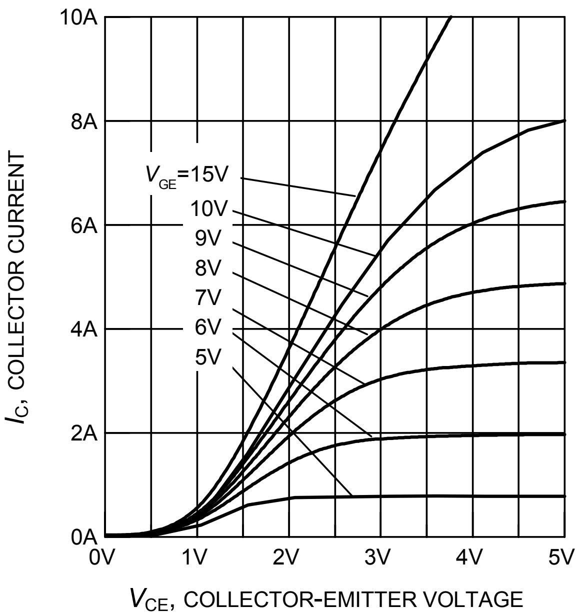


Figure 5. Typical output characteristics
(T_j = 25°C)

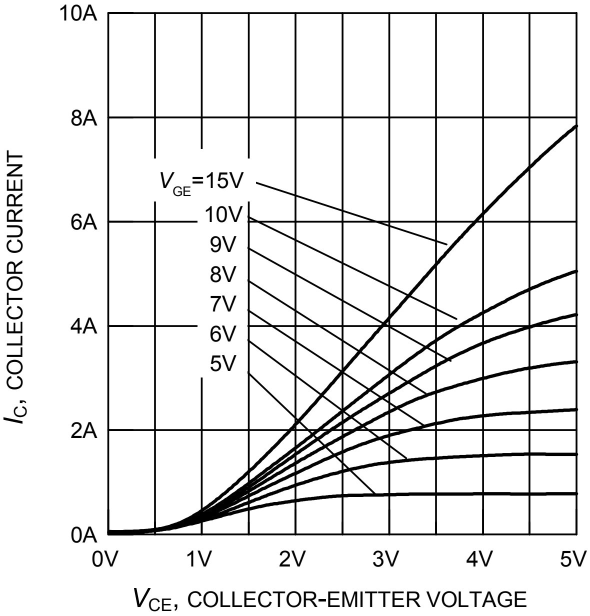


Figure 6. Typical output characteristics
(T_j = 150°C)

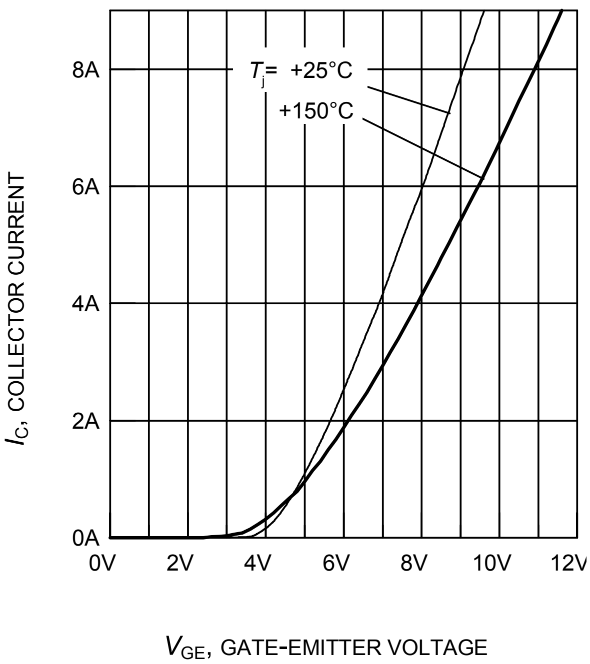


Figure 7. Typical transfer characteristics
(V_{CE} = 20V)

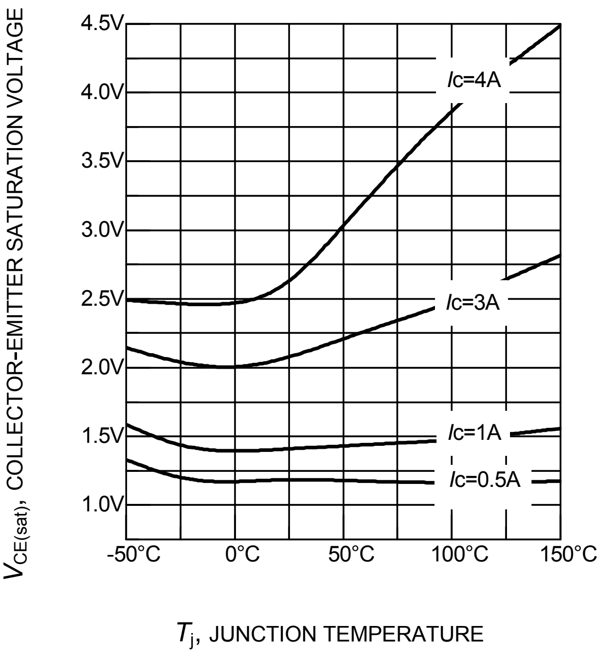


Figure 8. Typical collector-emitter saturation voltage as a function of junction temperature
(V_{GE} = 10V)

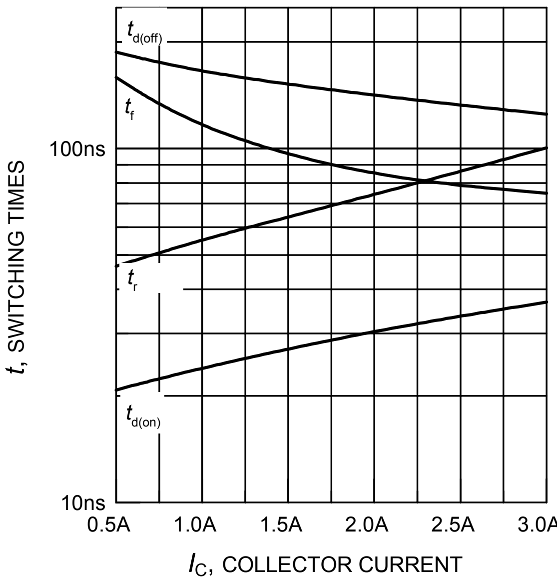


Figure 9. Typical switching times as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+10V, R_G = 80Ω, Dynamic test circuit in Figure E)

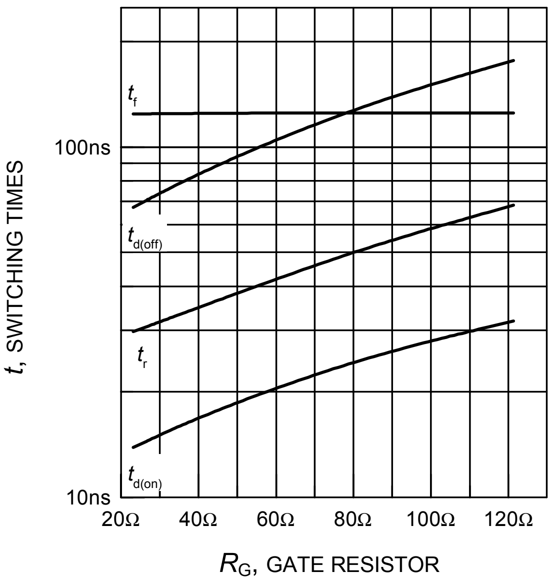


Figure 10. Typical switching times as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+10V, I_C = 1A, Dynamic test circuit in Figure E)

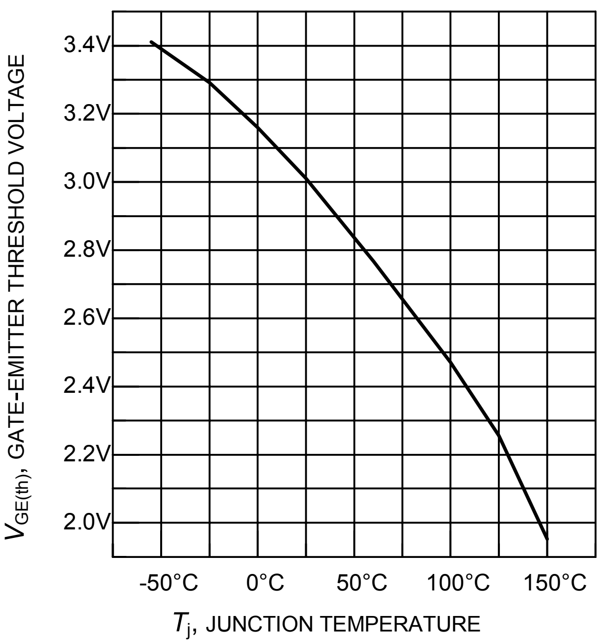


Figure 12. Gate-emitter threshold voltage as a function of junction temperature
(I_C = 30µA)

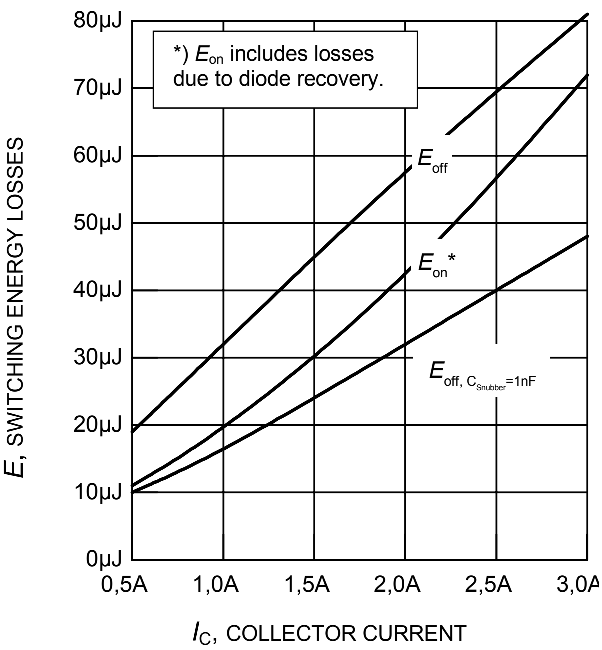


Figure 13. Typical switching energy losses as a function of collector current
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+10V, R_G = 80Ω, $C_{Snubber}$=0/1nF Dynamic test circuit in Figure E)

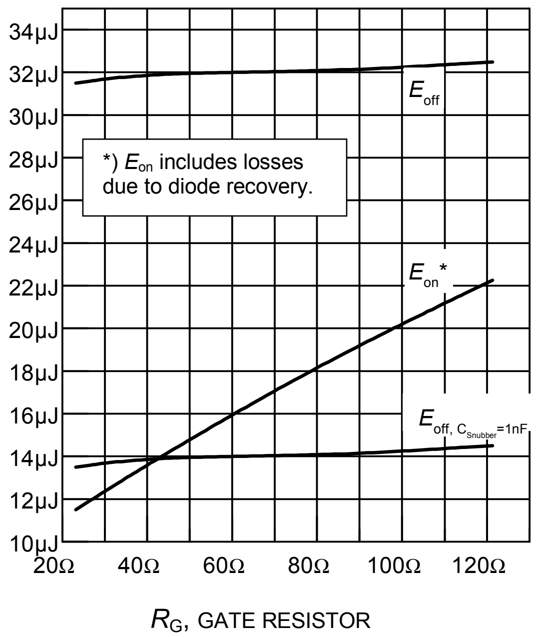


Figure 14. Typical switching energy losses as a function of gate resistor
(inductive load, T_j = 150°C, V_{CE} = 400V, V_{GE} = 0/+10V, I_C = 1A, $C_{Snubber}$=0/1nF Dynamic test circuit in Figure E)

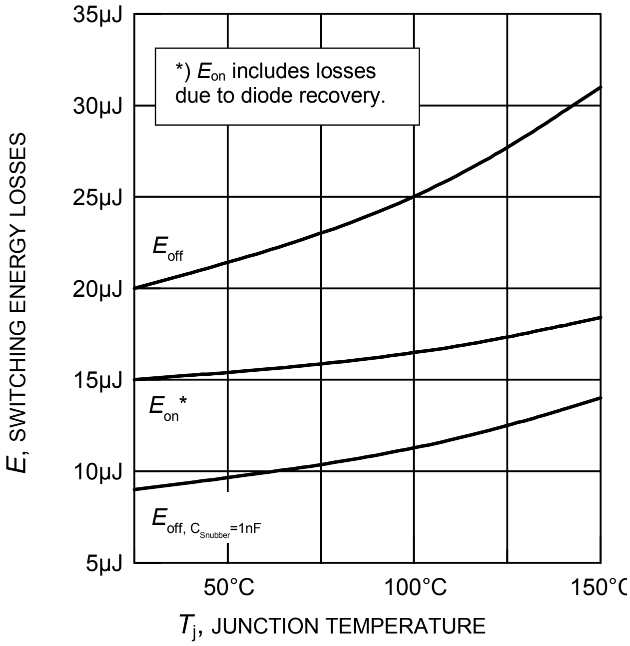


Figure 15. Typical switching energy losses as a function of junction temperature
(inductive load, V_{CE} = 400V, V_{GE} = 0/+10V, I_C = 1A, R_G = 80Ω, $C_{Snubber}$=0/1nF Dynamic test circuit in Figure E)

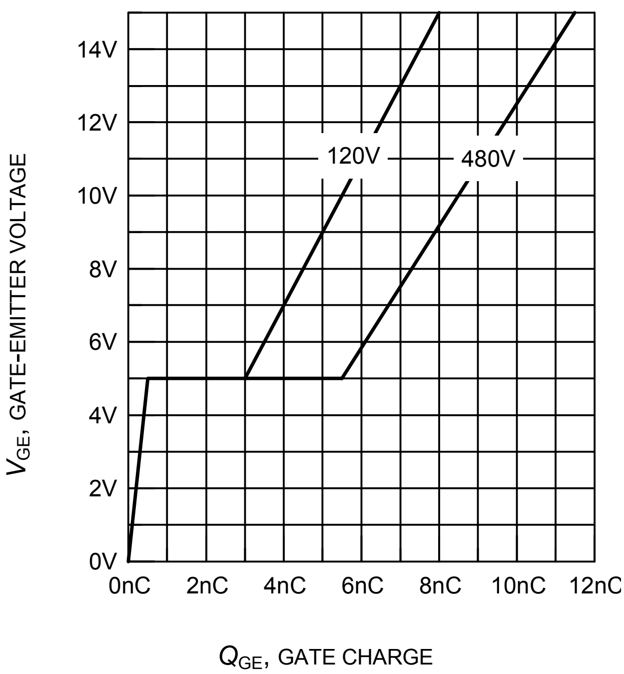


Figure 16. Typical gate charge
(I_C = 0.8A)

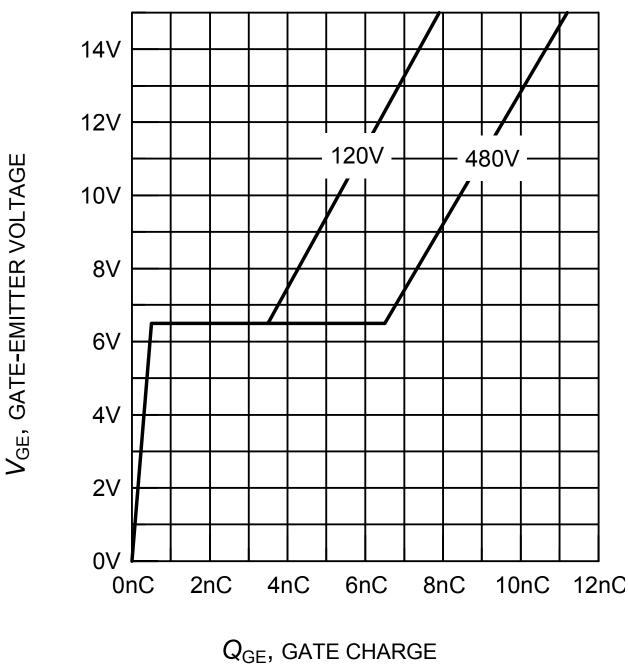


Figure 17. Typical gate charge
(I_C = 3A)

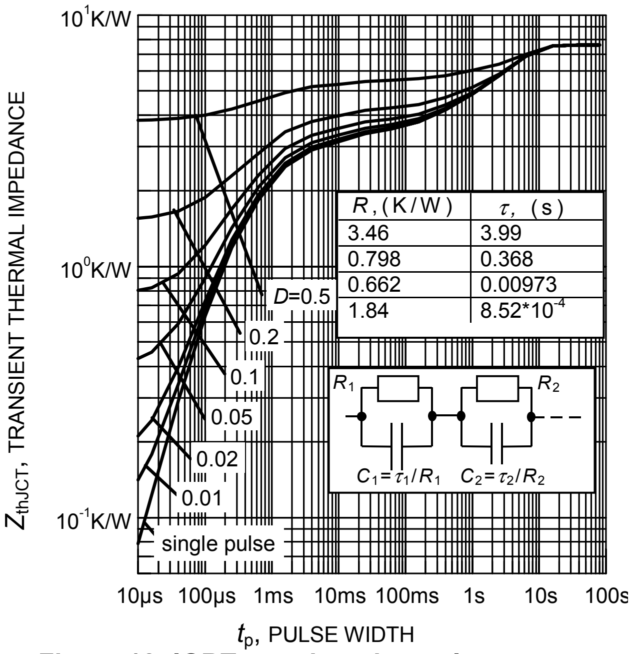


Figure 18: IGBT transient thermal impedance as a function of pulse width (FullPak)
($D = t_p / T$)

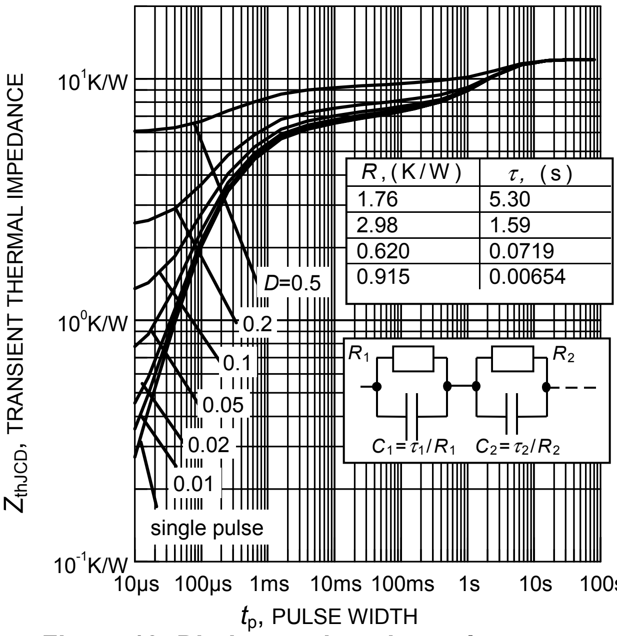


Figure 19: Diode transient thermal impedance as a function of pulse width (FullPak)
($D = t_p / T$)

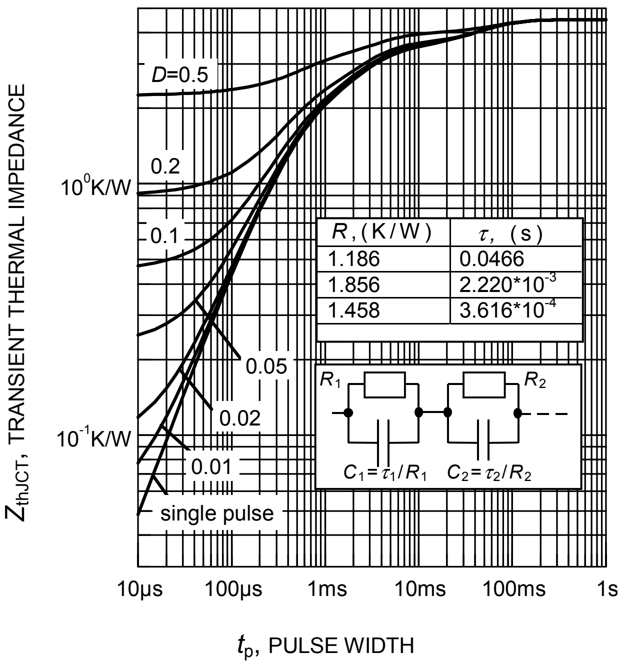


Figure 20: IGBT transient thermal impedance as a function of pulse width (Other Packages)
($D = t_p / T$)

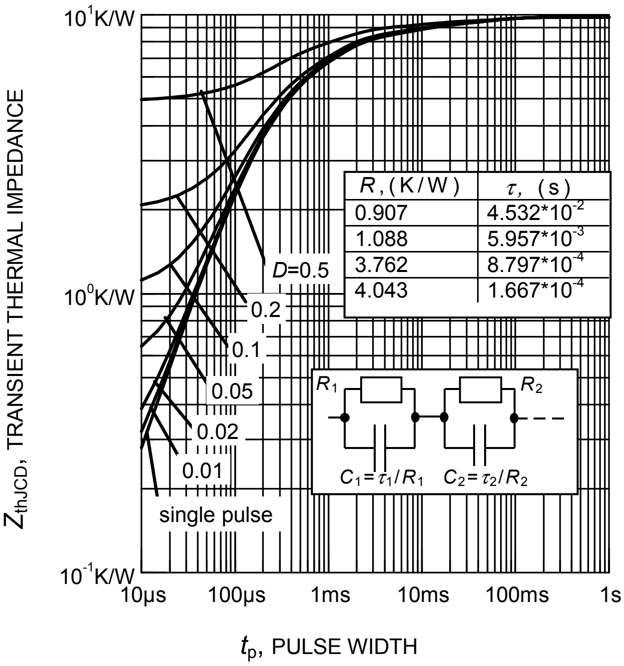


Figure 21: Diode transient thermal impedance as a function of pulse width (Other Packages)
($D = t_p / T$)

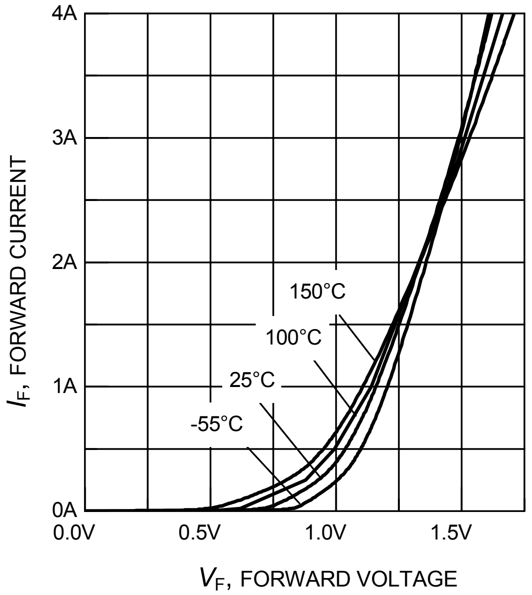


Figure 20. Typical diode forward current as a function of forward voltage

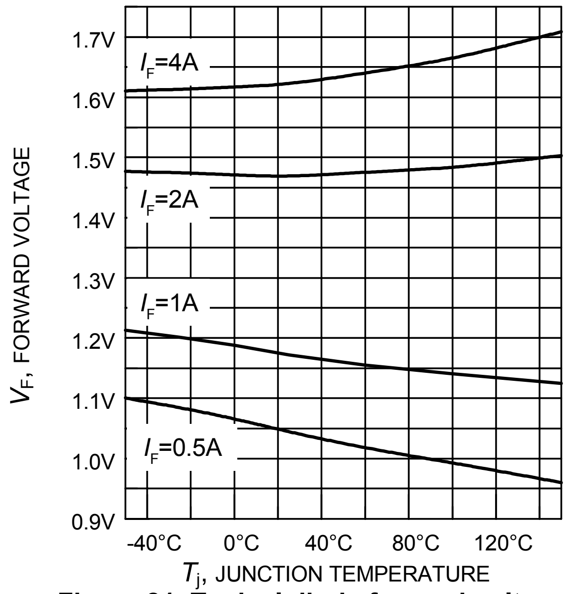


Figure 21. Typical diode forward voltage as a function of junction temperature

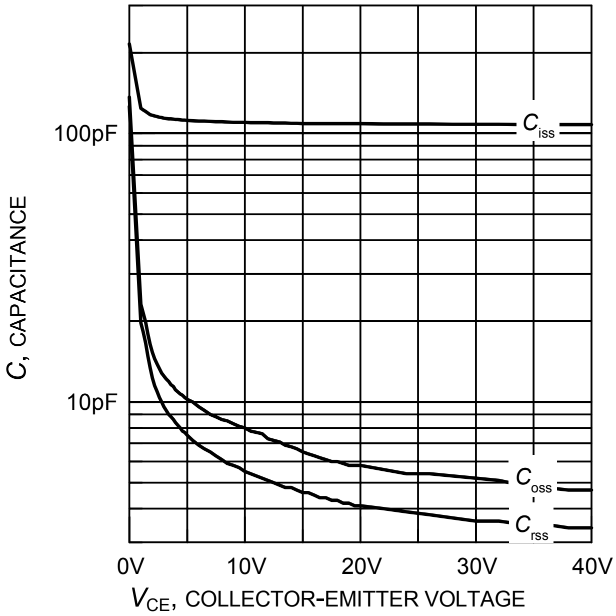


Figure 19. Typical capacitance as a function of collector-emitter voltage
(V_{GE} = 0V, f = 1MHz)

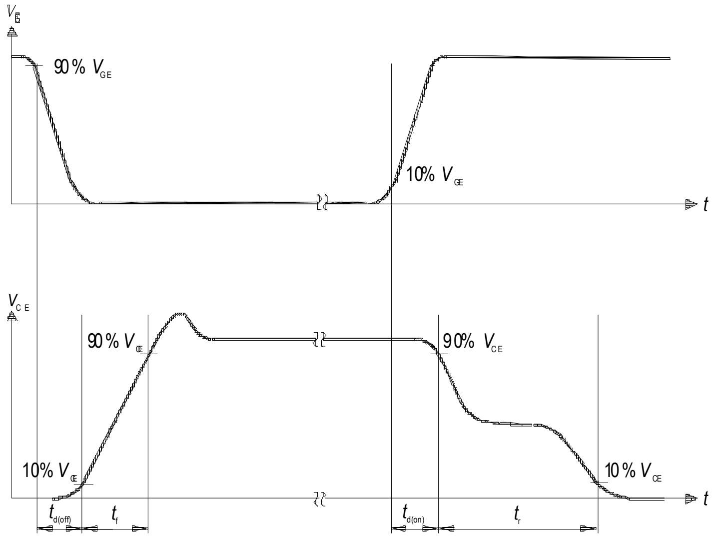


Figure A. Definition of switching times

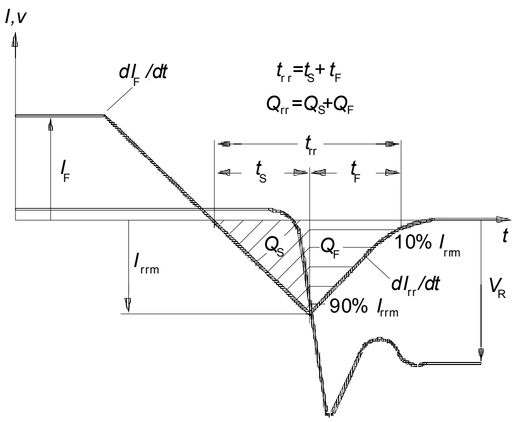


Figure B. Definition of diodes switching characteristics

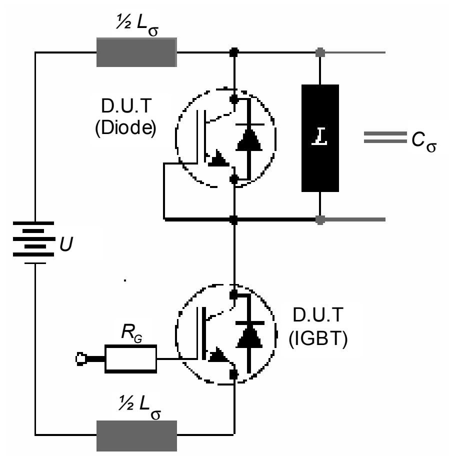
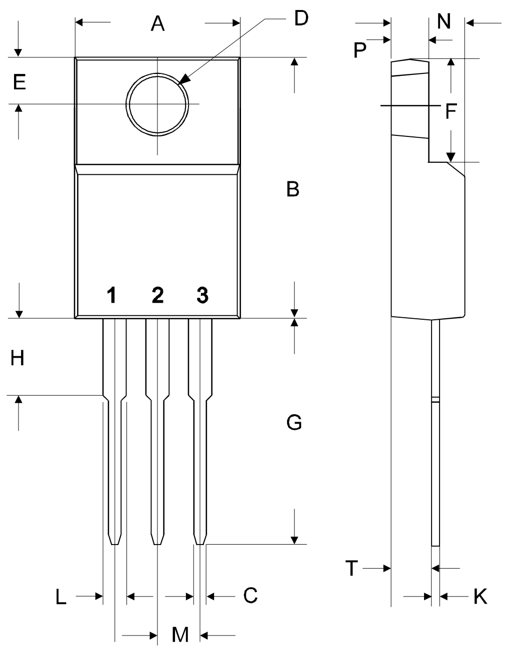


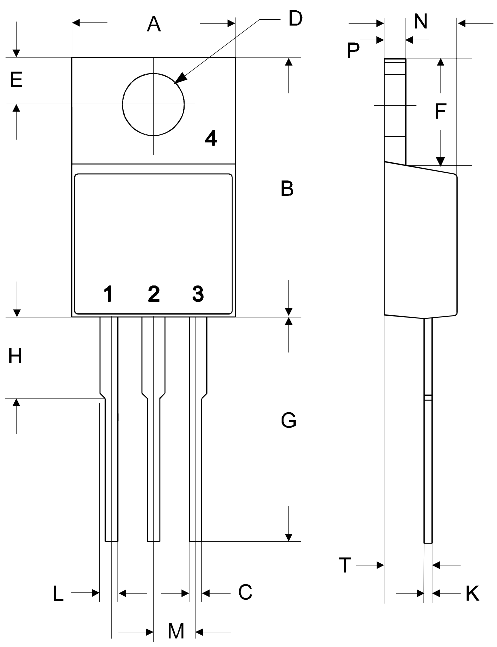
Figure C. Dynamic test circuit



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	10.37	10.63	0.4084	0.4184
B	15.86	16.12	0.6245	0.6345
C	0.65	0.78	0.0256	0.0306
D	2.95 typ.		0.1160 typ.	
E	3.15	3.25	0.124	0.128
F	6.05	6.56	0.2384	0.2584
G	13.47	13.73	0.5304	0.5404
H	3.18	3.43	0.125	0.135
K	0.45	0.63	0.0177	0.0247
L	1.23	1.36	0.0484	0.0534
M	2.54 typ.		0.100 typ.	
N	4.57	4.83	0.1800	0.1900
P	2.57	2.83	0.1013	0.1113
T	2.51	2.62	0.0990	0.1030

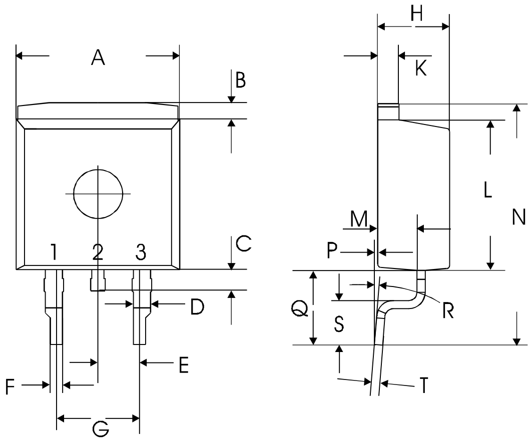
Please refer to mounting instructions (application note AN-TO220-3-31-01)

TO-220AB

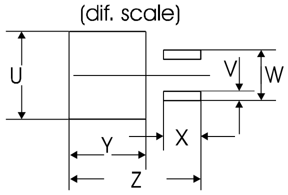


symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.70	10.30	0.3819	0.4055
B	14.88	15.95	0.5858	0.6280
C	0.65	0.86	0.0256	0.0339
D	3.55	3.89	0.1398	0.1531
E	2.60	3.00	0.1024	0.1181
F	6.00	6.80	0.2362	0.2677
G	13.00	14.00	0.5118	0.5512
H	4.35	4.75	0.1713	0.1870
K	0.38	0.65	0.0150	0.0256
L	0.95	1.32	0.0374	0.0520
M	2.54 typ.		0.1 typ.	
N	4.30	4.50	0.1693	0.1772
P	1.17	1.40	0.0461	0.0551
T	2.30	2.72	0.0906	0.1071

TO-263AB (D^2Pak)

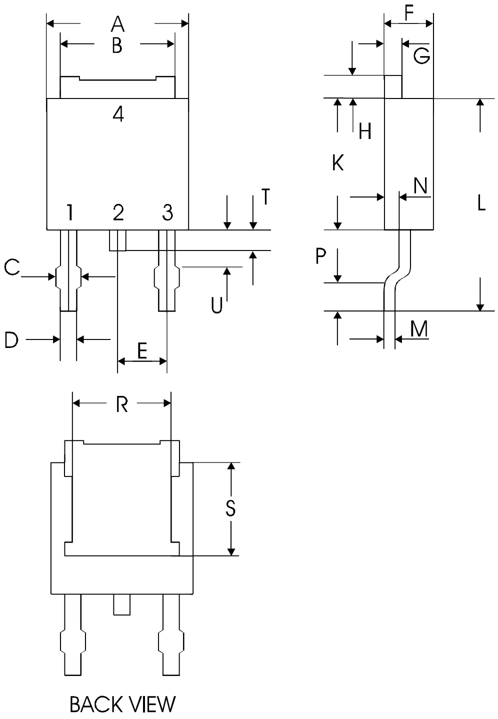


Footprint
(dif. scale)



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.80	10.20	0.3858	0.4016
B	0.70	1.30	0.0276	0.0512
C	1.00	1.60	0.0394	0.0630
D	1.03	1.07	0.0406	0.0421
E	2.54 typ.		0.1 typ.	
F	0.65	0.85	0.0256	0.0335
G	5.08 typ.		0.2 typ.	
H	4.30	4.50	0.1693	0.1772
K	1.17	1.37	0.0461	0.0539
L	9.05	9.45	0.3563	0.3720
M	2.30	2.50	0.0906	0.0984
N	15 typ.		0.5906 typ.	
P	0.00	0.20	0.0000	0.0079
Q	4.20	5.20	0.1654	0.2047
R	8° max		8° max	
S	2.40	3.00	0.0945	0.1181
T	0.40	0.60	0.0157	0.0236
U	10.80		0.4252	
V	1.15		0.0453	
W	6.23		0.2453	
X	4.60		0.1811	
Y	9.40		0.3701	
Z	16.15		0.6358	

TO-252AA (DPak)



symbol	dimensions			
	[mm]		symbol	
	min		min	
A	6.40	A	6.40	A
B	5.25	B	5.25	B
C	(0.65)	C	(0.65)	C
D	0.63	D	0.63	D
E	2.28		E	
F	2.19	F	2.19	F
G	0.76	G	0.76	G
H	0.90	H	0.90	H
K	5.97	K	5.97	K
L	9.40	L	9.40	L
M	0.46	M	0.46	M
N	0.87	N	0.87	N
P	0.51	P	0.51	P
R	5.00	R	5.00	R
S	4.17	S	4.17	S
T	0.26	T	0.26	T
U	-	U	-	U

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