

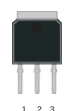
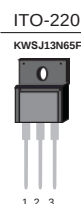
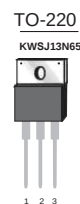
650V 13A Power MOSFET

Features:

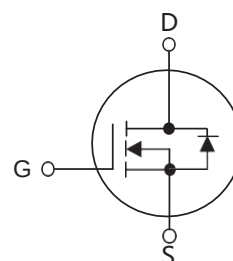
- $R_{DS(ON)} < 0.38\Omega @ V_{GS}=10V$
- 100% avalanche tested
- RoHS compliant

Mechanical Data:

- Case: TO-220, ITO-220, TO-251, TO-252, TO-263 package



Block Diagram



Pin Definition:

1. Gate
2. Drain
3. Source

Ordering Information

Part No.	Package Type	Package	Quality(box)	Marking
KWSJ13N65	TO-220	Tube	1000	JF SJ13N65 / SJ13N65
KWSJ13N65F	ITO-220	Tube	1000	JF SJ13N65F / SJ13N65F
KWSJ13N65E	TO-263	Tape & Reel	800	JF SJ13N65E / SJ13N65E
KWSJ13N65M	TO-252	Tape & Reel	3000	JF SJ13N65M / SJ13N65M
KWSJ13N65N	TO-251	Tube	1000	JF SJ13N65N / SJ13N65N

Product Summary

V_{DS}	$R_{DS(on)}$ (Ω) Typ	I_D (A)	Q_g (Typ)
650V	0.34@ 10V	13	34nc

Table1 Absolute Maximum Ratings ($T_c=25^\circ\text{C}$, unless otherwise specified)

Parameter	Symbol	TO-220/TO-263 TO-251/TO-252	ITO-220	Unit
Drain-Source Voltage	V_{DS}	650		V
Gate-Source Voltage	V_{GS}	± 30		V
Continuous Drain Current	$T_c=25^\circ\text{C}$	13		A
	$T_c=100^\circ\text{C}$	9		
Pulsed Drain Current (Note 1)	I_{DM}	46		A
Single Pulse Avalanche Energy (Note 2)	E_{AS}	280		mJ
Avalanche Current (Note 1)	I_{AR}	2.3		A
Repetitive Avalanche Energy (Note 1)	E_{AR}	1.2		mJ
Peak Diode Recovery dv/dt (Note 3)	dv/dt	15		V/ns
Drain Source voltage slope ($V_{DS}=480V$)	dV_{DS}/dt	50		V/ns
Power Dissipation $T_c=25^\circ\text{C}$	P_D	151	35	W
Operating Junction and Storage Temperature	T_J/T_{STG}	$-55 \sim +150$		$^\circ\text{C}$
Maximum Temperature for soldering	T_L	300		$^\circ\text{C}$

Table 2. Thermal Characteristics

Parameter	Symbol	TO-220/TO-263	ITO-220	Unit
Thermal resistance Junction to Ambient	$R_{\theta JA}$	62	62	$^{\circ}\text{C/W}$
Thermal resistance Junction to Case	$R_{\theta JC}$	0.82	3.57	$^{\circ}\text{C/W}$

Table 3. Electrical Characteristics ($T_J=25^{\circ}\text{C}$, unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Off Characteristics							
Drain-Source Breakdown Voltage		BV _{DSS}	V _{GS} =0V,I _D =250μA	650	--	--	V
Drain-Source Leakage Current		I _{DSS}	V _{DS} =650V,V _{GS} =0V	--	--	1	μA
Gate- Source Leakage Current	Forward	I _{GSS}	V _{GS} =30V,V _{DS} =0V	--	--	100	nA
	Reverse		V _{GS} =-30V,V _{DS} =0V	--	--	-100	nA
On Characteristics(Note 4)							
Gate Threshold Voltage		V _{GS(TH)}	V _{DS} =V _{GS} ,I _D =250μA	2.5	--	4.5	V
Static Drain-Source On-State Resistance		R _{DS(ON)}	V _{GS} =10V,I _D =6.5A	--	0.34	0.38	Ω
Dynamic Characteristics(Note 5)							
Input Capacitance		C _{ISS}	V _{DS} =25V,V _{GS} =0V,f=1MHz	--	780	--	pF
Output Capacitance		C _{OSS}		--	23	--	pF
Reverse Transfer Capacitance		C _{RSS}		--	1.9	--	pF
Switching Characteristics (Note 5)							
Turn-On Delay Time		t _{d (on)}	V _{DD} =400V,I _D =6.5A, R _G =20Ω	--	17	--	ns
Turn-On Rise Time		t _r		--	12	--	ns
Turn-Off Delay Time		t _{d (off)}		--	130	--	ns
Turn-Off Fall Time		t _f		--	10	--	ns
Total Gate Charge		Q _G	V _{DS} =400V,I _D =6.5A, V _{GS} =10V	--	34	--	nC
Gate-Source Charge		Q _{GS}		--	4.5	--	nC
Gate-Drain Charge		Q _{GD}		--	19	--	nC
Drain-Source Diode Characteristics and Maximum Ratings							
Drain-Source Diode Forward Voltage		V _{SD}	V _{GS} =0V, I _S =6. 5A	--	--	1.5	V
Maximum Continuous Drain-Source Diode Forward Current		I _S		--	--	10	A
Reverse Recovery Time		t _{rr}	V _{GS} =0V, I _F =6. 5A	--	300	--	ns
Reverse Recovery Charge		Q _{RR}	dI _F /dt=100A/μs (Note 1)	--	3500	--	nC

Notes : 1 Repetitive Rating:Pulse width limited by maximum junction temperature 2

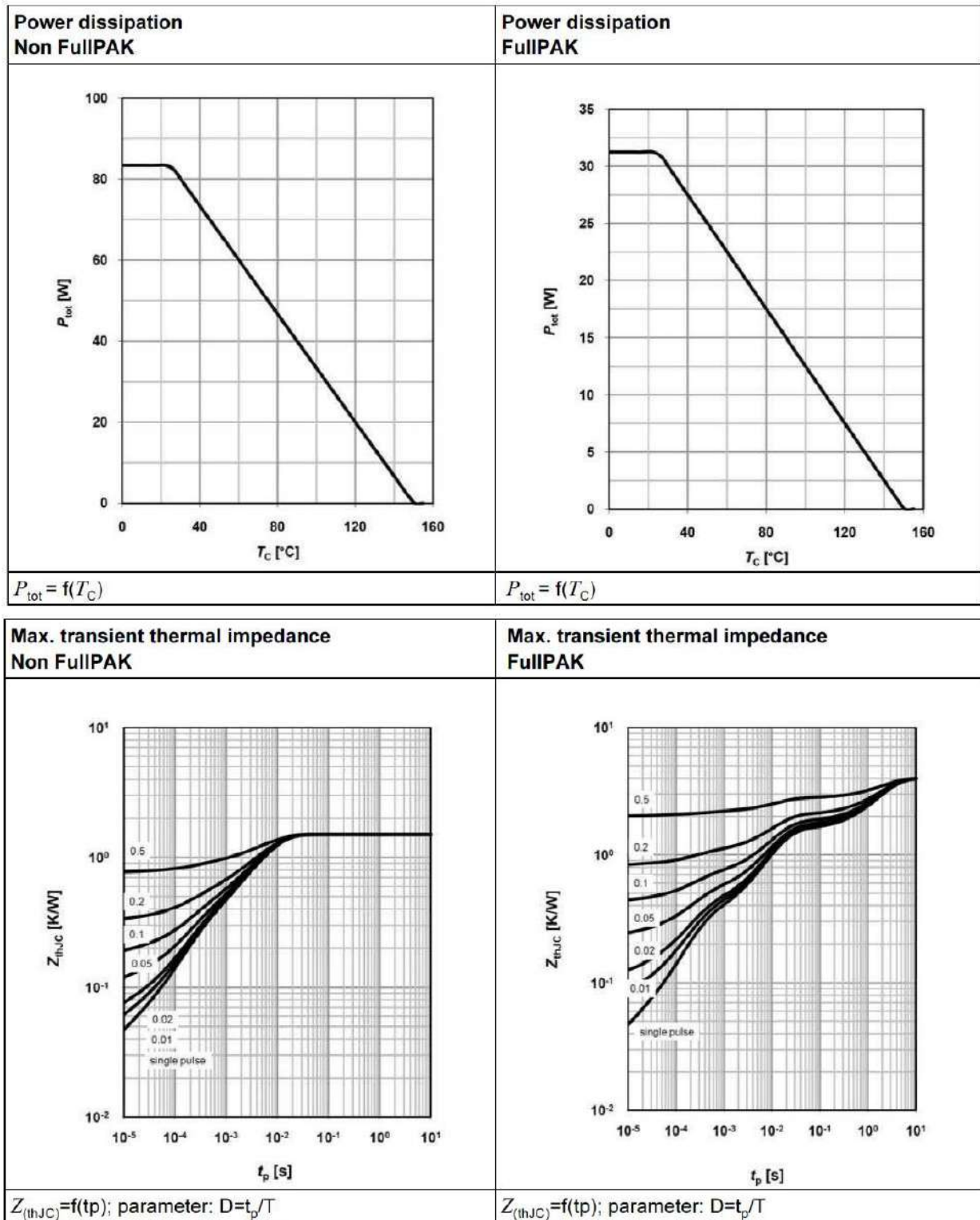
$L=60\text{mH}, I_{AS}=3A, V_{DD}=150V$, Starting $T_J=25^{\circ}\text{C}$

3 $I_{SD}\leq 4.5A, di/dt\leq 200A/\mu s, V_{DD}\leq BV_{DSS}$, Starting $T_J=25^{\circ}\text{C}$

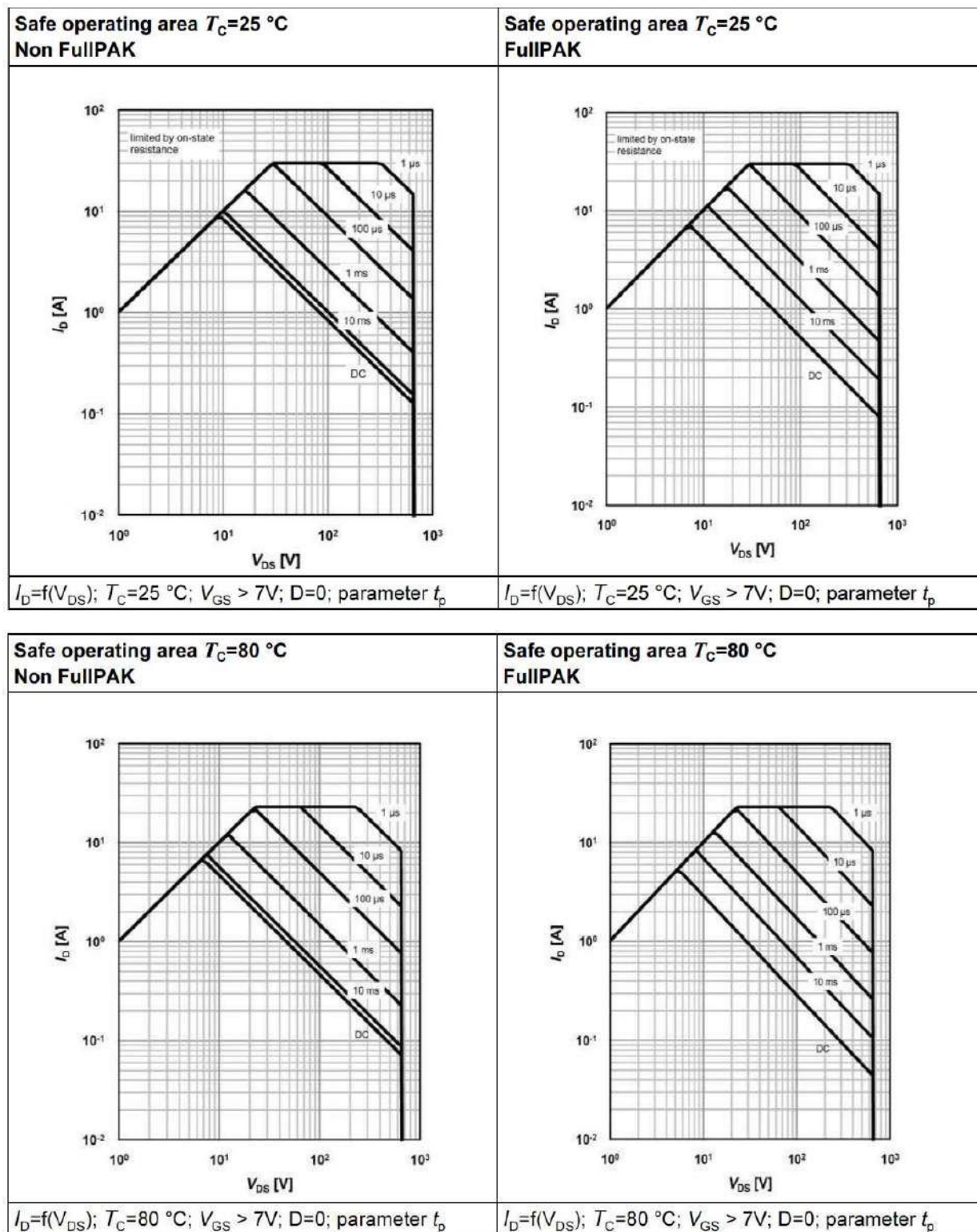
4 Pulse Test: Pulse width $\leq 300\mu s$, Duty cycle $\leq 2\%$

5 Guaranteed by design, not subject to production

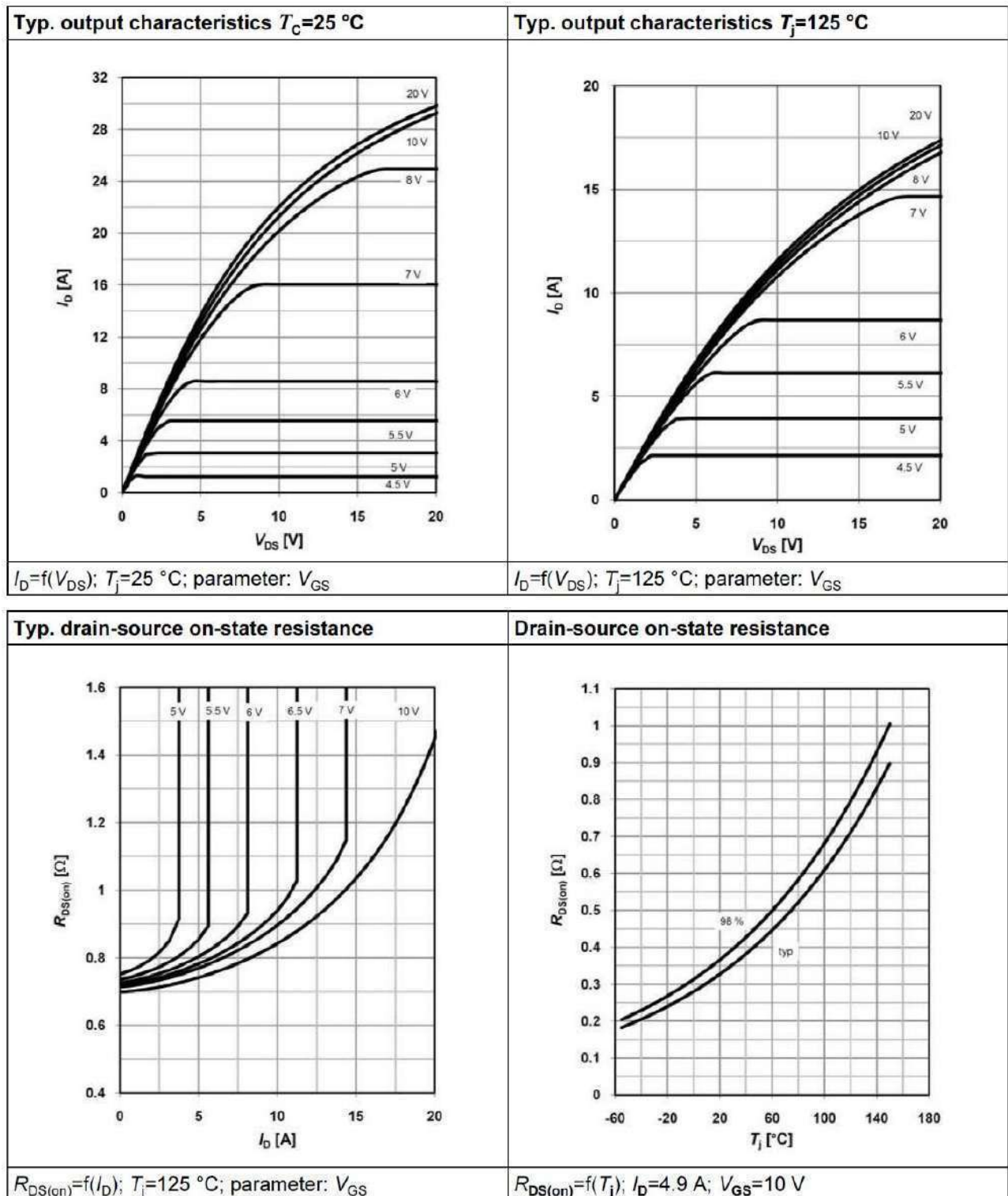
Typical characteristics Diagrams



Typical characteristics Diagrams

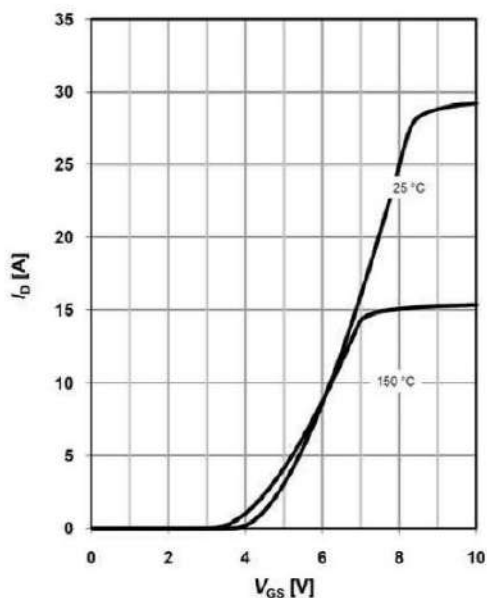


Typical characteristics Diagrams



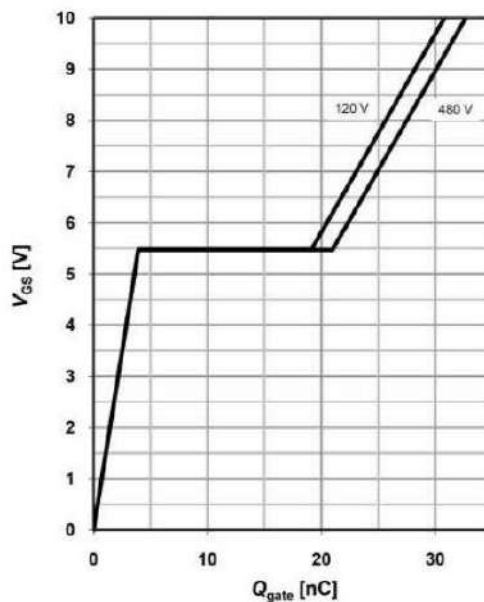
Typical characteristics Diagrams

Typ. transfer characteristics



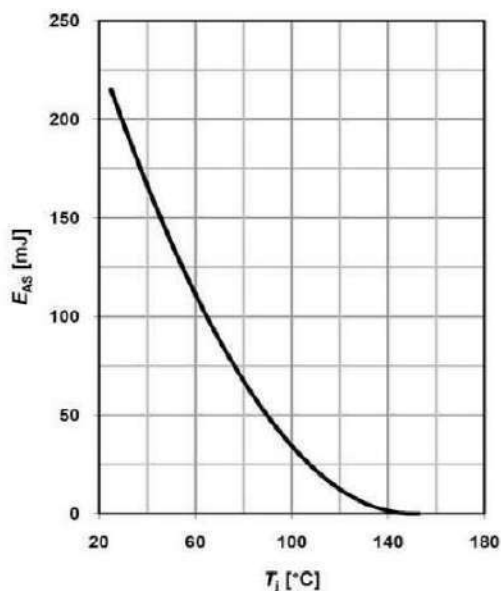
$I_D = f(V_{GS}); V_{DS} = 20V$

Typ. gate charge



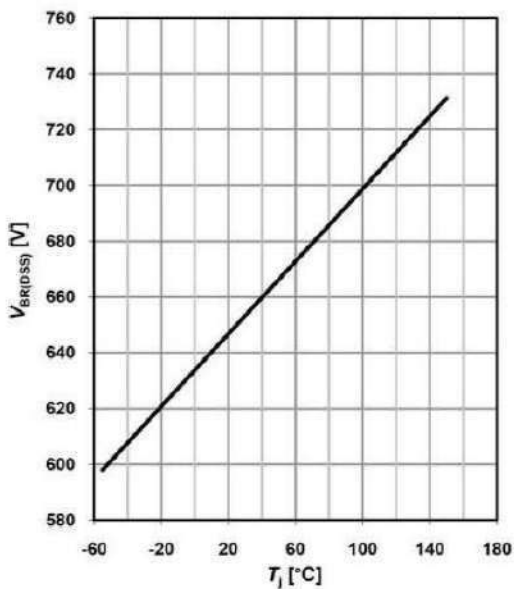
$V_{GS} = f(Q_{gate}), I_D = 4.9 A \text{ pulsed}$

Avalanche energy



$E_{AS} = f(T_J); I_D = 1.8 A; V_{DD} = 50 V$

Drain-source breakdown voltage



$V_{BR(DSS)} = f(T_J); I_D = 1.0 mA$

Typical characteristics Diagrams

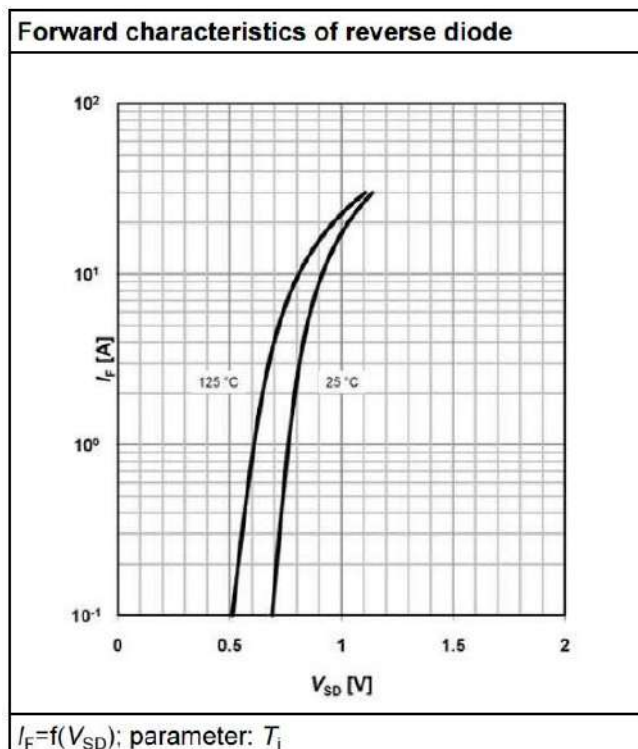
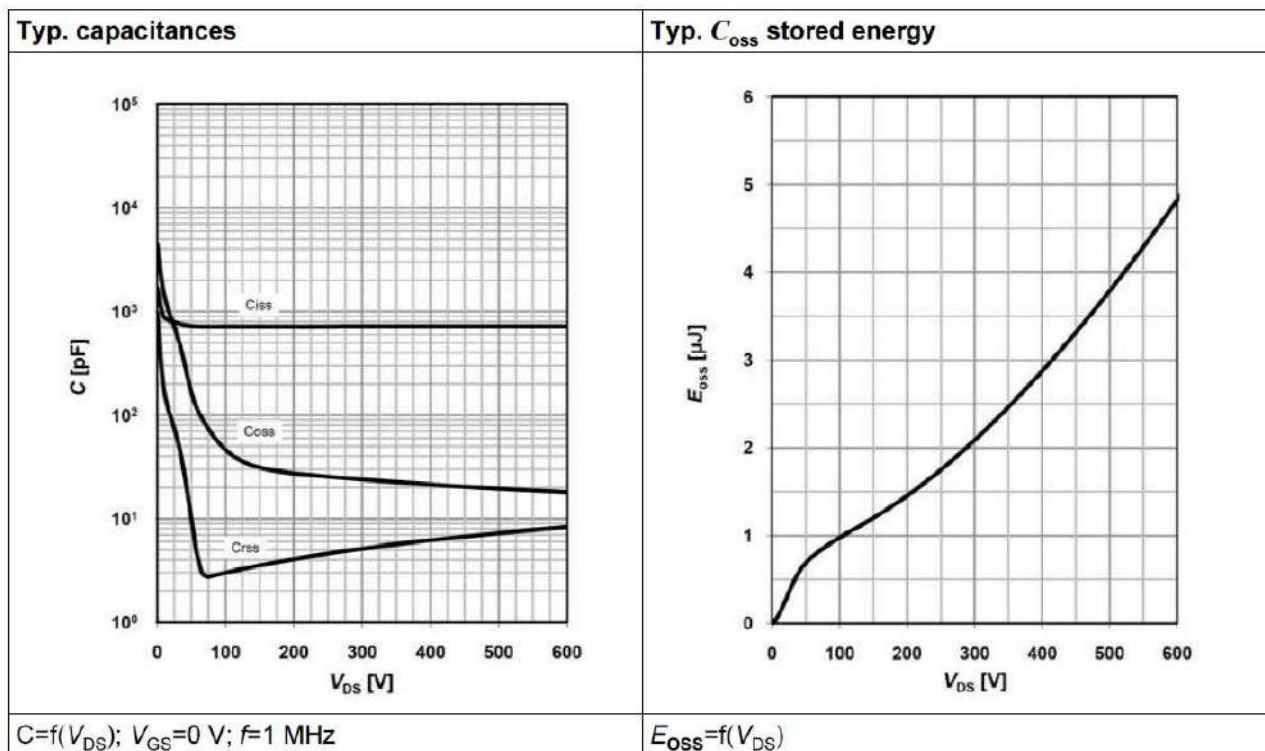


Table 20 Switching times test circuit and waveform for inductive load

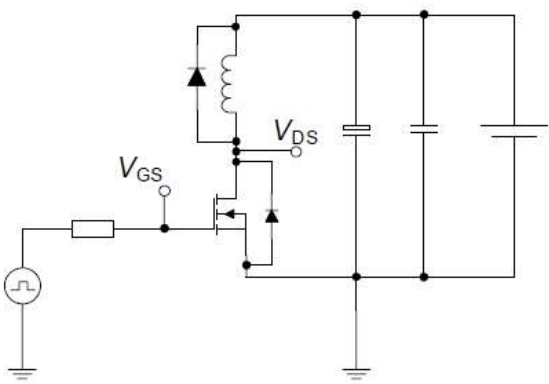
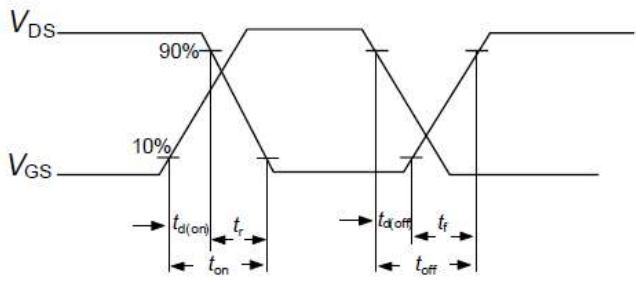
Switching times test circuit for inductive load	Switching time waveform
	

Table 21 Unclamped inductive load test circuit and waveform

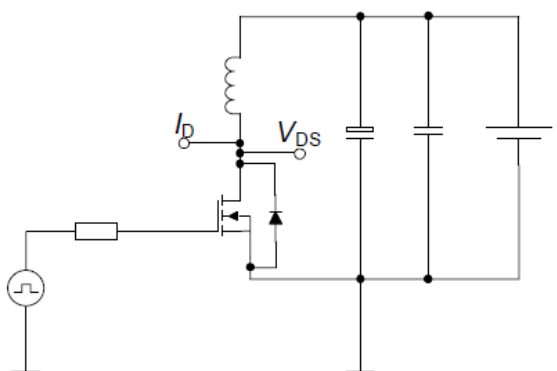
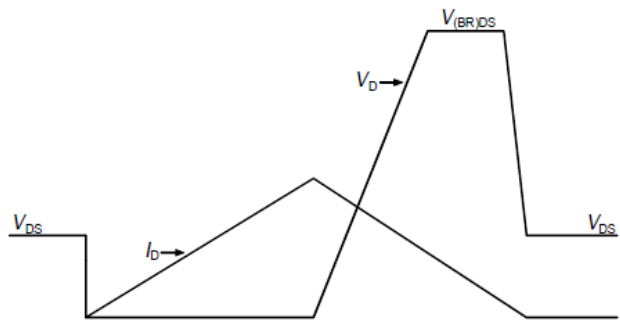
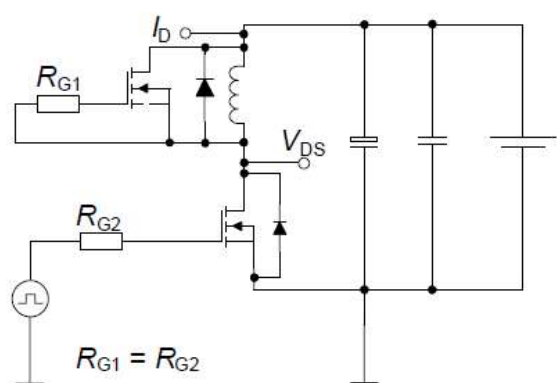
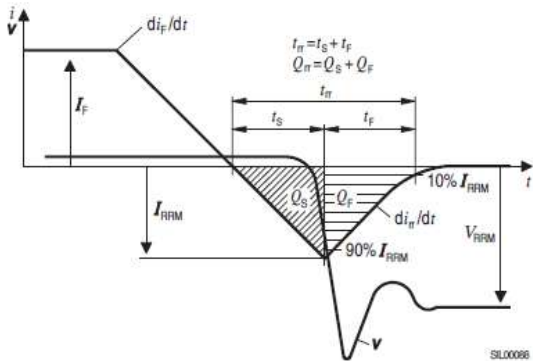
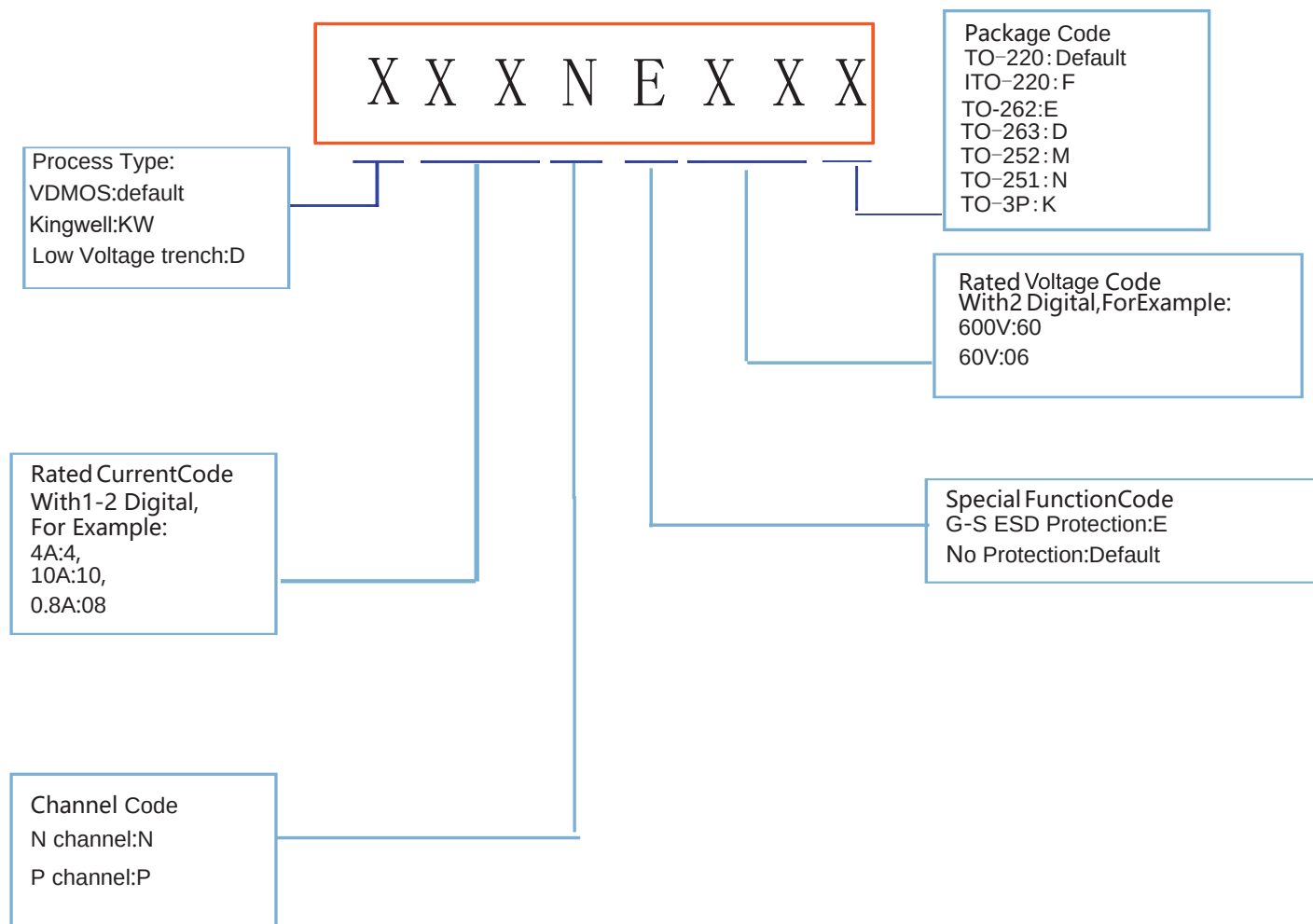
Unclamped inductive load test circuit	Unclamped inductive waveform
	

Table 22 Test circuit and waveform for diode characteristics

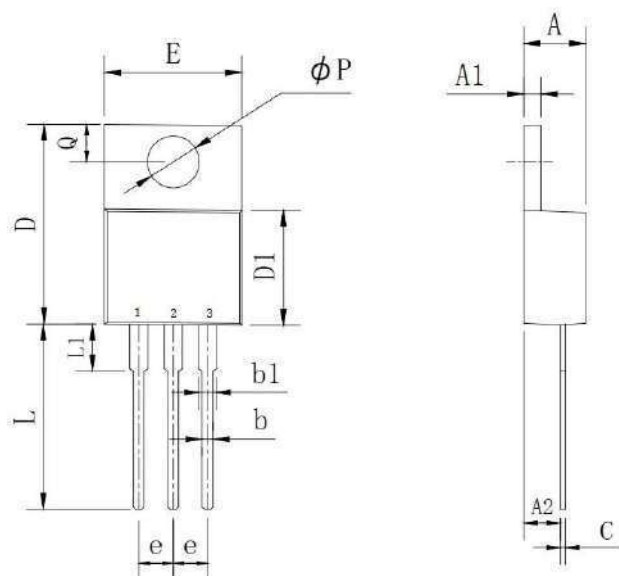
Test circuit for diode characteristics	Diode recovery waveform
	

Product Names Rules



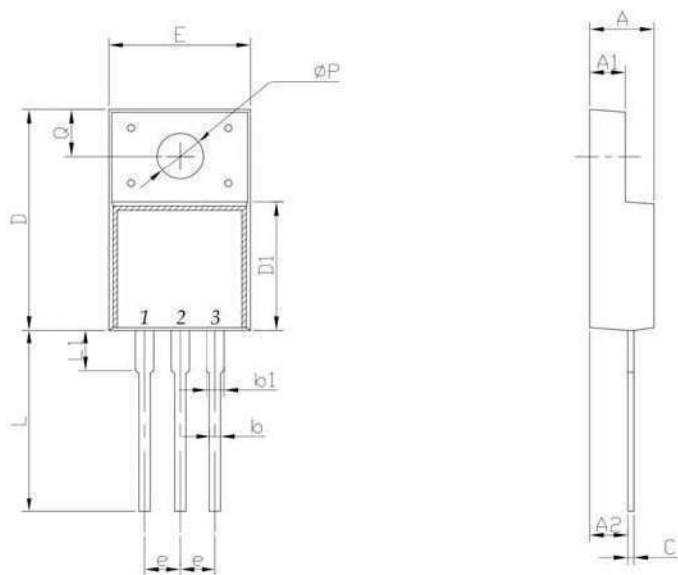
Dimensions

TO-220 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.25	4.87	0.167	0.192
A1	1.07	1.47	0.042	0.058
A2	2.03	2.92	0.080	0.115
b	0.51	1.11	0.020	0.044
b1	0.97	1.6	0.038	0.063
C	0.3	0.7	0.012	0.028
D	14.6	15.9	0.575	0.626
D1	8.04	9.3	0.317	0.366
E	9.57	10.57	0.377	0.416
e	2.34	2.74	0.092	0.108
L	12.58	14.3	0.495	0.563
L1	2.8	4.2	0.110	0.165
P	3.4	4.14	0.134	0.163
Q	2.45	3	0.096	0.118

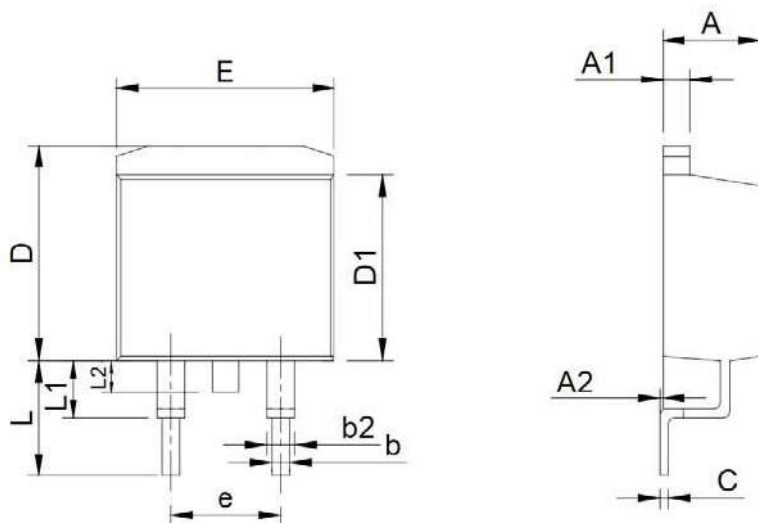
ITO-220 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.24	4.9	0.167	0.193
A1	2.3	2.92	0.091	0.115
A2	2.61	2.81	0.103	0.111
b	0.3	1	0.012	0.039
b1	0.9	1.55	0.035	0.061
C	0.3	0.7	0.012	0.028
D	14.5	16.36	0.571	0.644
D1	8.8	9.41	0.346	0.370
E	9.5	10.5	0.374	0.413
e	2.3	2.75	0.091	0.108
L	12.6	14	0.496	0.551
L1	2.45	4.3	0.096	0.169
P	2.9	3.8	0.114	0.150
Q	2.5	3.55	0.098	0.140

Dimensions

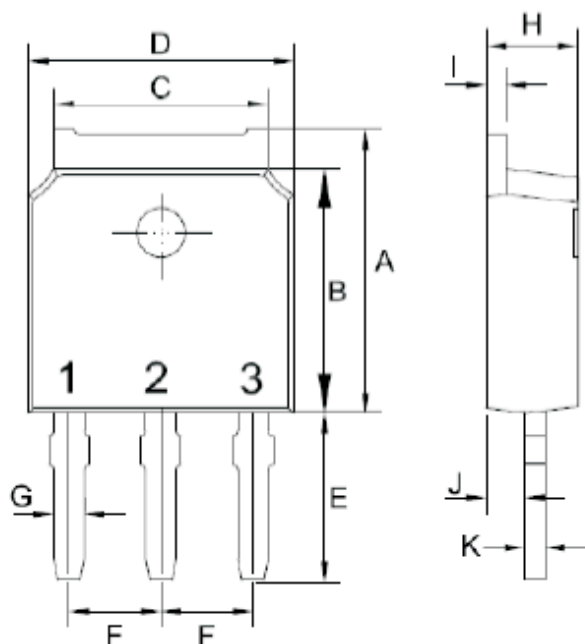
TO-263 PACKAGE OUTLINE DIMENSIONS



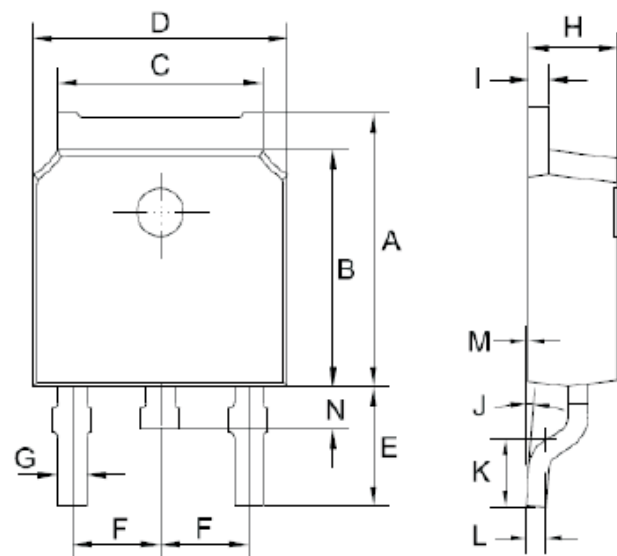
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	4.25	4.87	0.167	0.192
A1	1.07	1.47	0.042	0.058
A2	0	0.25	0.000	0.010
b	0.61	1.01	0.024	0.040
b1	1.2	1.34	0.047	0.053
C	0.3	0.6	0.012	0.024
D	9.48	10.84	0.373	0.427
D1	8.49	9.3	0.334	0.366
E	9.7	10.31	0.382	0.406
e	4.88	5.28	0.192	0.208
L	4.46	5.85	0.176	0.230
L1	1.33	2.33	0.052	0.092
L2	0	2.2	0.000	0.087

Dimensions

TO-251 PACKAGE OUTLINE DIMENSIONS



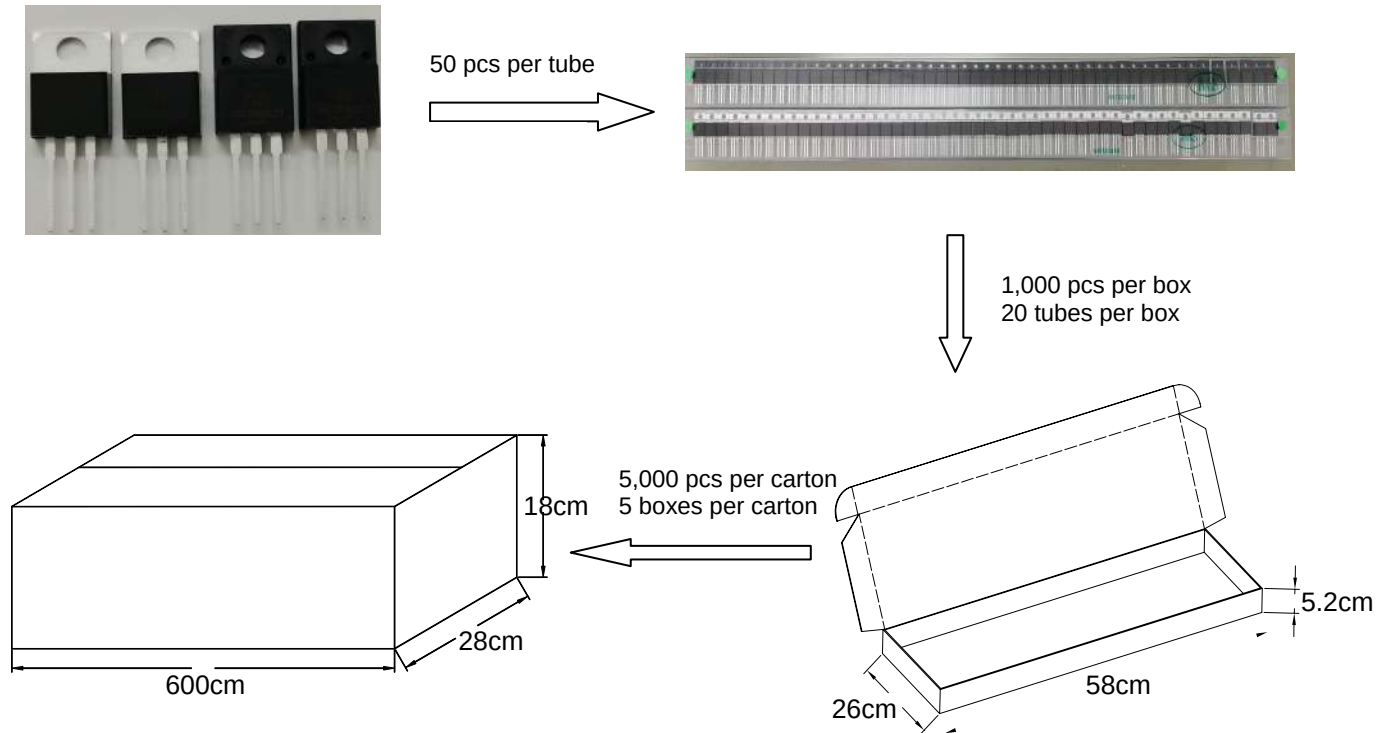
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	6.85	7.25	0.270	0.285
B	5.8	6.3	0.228	0.248
C	5	5.53	0.197	0.218
D	6.3	6.8	0.248	0.268
E	3.5	4.35	0.138	0.171
F	2.19	2.39	0.086	0.094
G	0.45	0.85	0.018	0.033
H	2.2	2.4	0.087	0.094
I	0.41	0.61	0.016	0.024
J	0.71	1.31	0.028	0.052
K	0.41	0.61	0.016	0.024



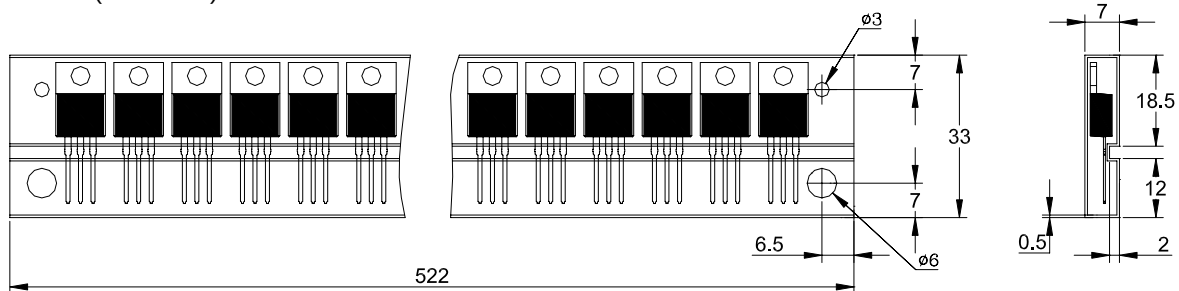
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	6.85	7.25	0.270	0.285
B	5.8	6.3	0.228	0.248
C	5	5.53	0.197	0.218
D	6.3	6.8	0.248	0.268
E	2.6	3.3	0.102	0.130
F	2.19	2.39	0.086	0.094
G	0.45	0.85	0.018	0.033
H	2.2	2.4	0.087	0.094
I	0.41	0.61	0.016	0.024
J	0	8	0	8
K	1.45	1.85	0.057	0.073
L	0.41	0.61	0.016	0.024
M	0	0.12	0.000	0.005
N	0.6	1	0.024	0.039

Packaging Specifications of Tube Pack for TO-220AB and ITO-220AB

1. The method of packaging and dimension are shown as below figure. (Dimension in mm)



2. Tube data (Units: mm)



Storage

1 It is recommended to store the products in the following conditions:

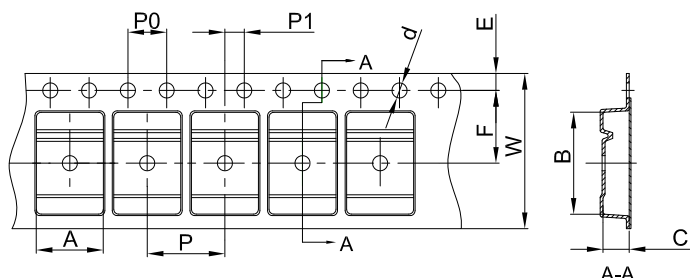
Humidity: 75% R.H. Max.

Temperature : 0°C~35°C (32°F~95°F)

2 Shelf life : 12 month at < 0°C~35°C (32°F~95°F) and < 75% R.H.

TO-252-2L Tape and Reel

TO-252 Embossed Carrier Tape



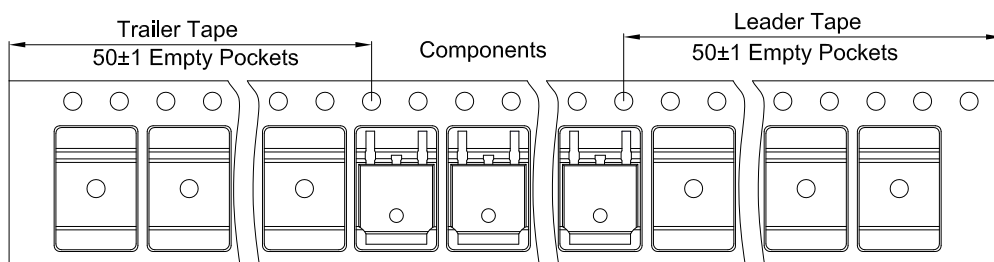
Packaging Description:

TO-252 parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 25,00 units per 13" or 33.0 cm diameter reel. The reels are clear in color and is made of polystyrene plastic (anti-static coated).

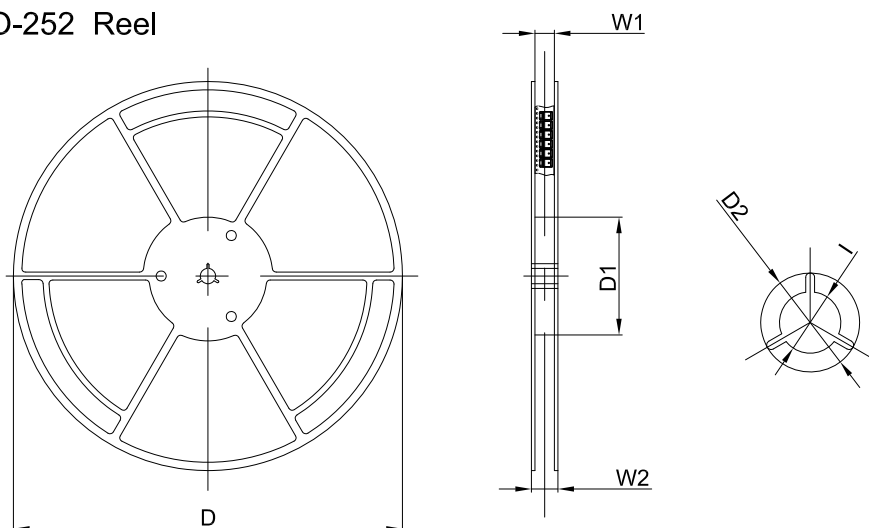
Dimensions are in millimeter

Pkg type	A	B	C	d	E	F	P0	P	P1	W
TO-252	6.90	10.50	2.70	Ø1.55	1.75	7.50	4.00	8.00	2.00	16.00

TO-252 Tape Leader and Trailer



TO-252 Reel



Dimensions are in millimeter

Reel Option	D	D1	D2	W1	W2	I
13"Dia	330.00	100.00	Ø21.00	16.40	21.00	Ø13.00

REEL	Reel Size	Box	Box Size(mm)	Carton	Carton Size(mm)	G.W.(kg)
2,500 pcs	13inch	2,500 pcs	340×336×29	25,000 pcs	353×346×365	