



N-Channel Super Junction MOSFET, 600V, 2.1Ω

General Description

The VAS60R2K1 Super Junction (SJ) Power MOSFETs is designed to provide best cost-performance switch solution for various application fields, such as consumer and lighting markets. It is available in TO220F, DPAK, IPAK and SOT223 packages.

Features

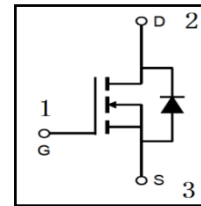
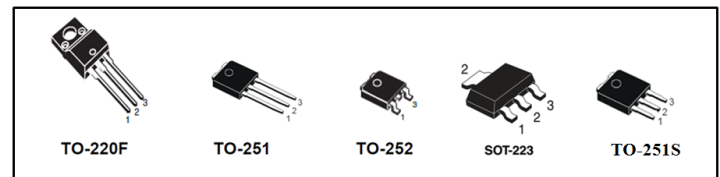
- High Efficiency
- Low Gate Charge
- High Body Diode Ruggedness
- 100% EAS Guaranteed
- Halogen-Free

Application

Adapter, TV, LED Lighting, PFC stages, hard switching PWM stages and resonant switching stages.

Product Summary

$V_{DS}@T_{j,max}$	600 V
$R_{DS(on)}@V_{GS}=10V$	2.1 Ω
I_D Continuous Current	4 A
$V_{(GS)th}$	3.0 V
$Q_{g,typ}$	6.7 nC



Absolute Maximum Ratings

Parameter	Symbol	Value	Unit	Condition
Drain-Source Voltage	V_{DS}	600	V	
Continuous drain current ⁽¹⁾	I_D	4 2.9	A	$T_C=25\text{ °C}$ $T_C=100\text{ °C}$
Gate-Source Voltage	V_{GS}	±20	V	Static
Pulsed drain current ⁽²⁾	I_{DM}	6	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse	E_{AS}	11	mJ	$I_D=0.4A$; $V_{DD}=50V$; see Figure 13
Avalanche energy, repetitive	E_{AR}	0.06	mJ	$I_D=0.4A$; $V_{DD}=50V$; see Figure 13
Avalanche current, repetitive	I_{AR}	0.4	A	
Power dissipation TO-252, TO-251	P_{tot_TO}	38	W	$T_C=25\text{ °C}$
Power dissipation TO-220F	P_{tot_220F}	36	W	$T_C=25\text{ °C}$
Power dissipation SOT223	P_{tot_sot}	5	W	$T_C=25\text{ °C}$
Continuous diode forward current	I_S	2.7	A	$T_C=25\text{ °C}$
Diode pulse current ⁽²⁾	$I_{S,pulse}$	6	A	$T_C=25\text{ °C}$

(1) Limited by $T_{j,max}$. Maximum duty cycle $D=0.4$

(2) Pulse width T_P limited by $T_{j,max}$



Thermal characteristics

Symbol	Parameter	Value				Unit
		TO-252	TO-251/S	TO-220F	SOT223	
$R_{thj-case}$	Thermal resistance, junction-case, max	3.26	3.26	4	25	°C/W
R_{thJA}	Thermal resistance, junction-ambient, max	62	62	70	75 ⁽³⁾	°C/W
T_{sold}	Soldering temperature, max	260	260	260	260	°C

(2) Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling.

Package and Ordering Information

Device	Package	Marking
VAS60R2K1D	TO-252	VAS60R2K1D
VAS60R2K1I	TO-251	VAS60R2K1I
VAS60R2K1U	TO-251S	VAS60R2K1U
VAS60R2K1F	TO-220F	VAS60R2K1F
VAS60R2K1S	SOT223	VAS60R2K1S



Electrical Characteristics ($T_j=25^\circ\text{C}$, unless otherwise specified)

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Static Characteristic						
Drain-Source breakdown Voltage	$V_{(BR)DSS}$	600			V	$V_{GS}=0V, I_D=0.25mA$
Gate Threshold Voltage	$V_{(GS)th}$	2.5	3.0	3.5	V	$V_{DS}=V_{GS}, I_D=0.06mA$
Drain-Source on resistance	$R_{(DS)on}$		1.8	2.1	Ω	$V_{GS}=10V, I_D=0.76A, T_j=25^\circ\text{C}$
			4.68		Ω	$V_{GS}=10V, I_D=0.76A, T_j=150^\circ\text{C}$
Zero gate voltage drain current	I_{DSS}			1	μA	$V_{DS}=600V, V_{GS}=0V, T_j=25^\circ\text{C}$
			10		μA	$V_{DS}=600V, V_{GS}=0V, T_j=150^\circ\text{C}$
Gate-Source leakage current	I_{GSS}			100	nA	$V_{GS}=20V, V_{DS}=0V$
Gate resistance	R_g		12		Ω	$f=1MHz, \text{open drain}$
Dynamic Characteristic						
Input Capacitance	C_{iss}		140		pF	$V_{GS}=0V, V_{DS}=100V, f=1MHz$
Output Capacitance	C_{oss}		12		pF	$V_{GS}=0V, V_{DS}=100V, f=1MHz$
Turn-on delay time	$T_{d(on)}$		7		nS	$V_{DD}=400V, V_{GS}=10V, I_D=0.9A,$ $R_G=12.2\Omega; \text{See Figure 14}$
Rise time	T_r		7		nS	
Turn-off delay time	$T_{d(off)}$		30		nS	
Fall time	T_f		50		nS	
Gate Charge Characteristic						
Gate to source charge	Q_{gs}		0.8		nC	$V_{DD}=480V, I_D=0.9A, V_{GS}=0 \text{ to } 10V$
Gate to drain charge	Q_{gd}		3.6		nC	
Gate charge total	Q_g		6.7		nC	
Gate plateau voltage	$V_{plateau}$		5.4		V	
Reverse diode characteristic						
Diode forward voltage	V_{FD}		0.9		V	$V_{GS}=0V, I_F=0.9A, T_j=25^\circ\text{C}$
Reverse recovery time	t_{rr}		180		nS	$V_R=400V, I_F=0.9A, dI_F/dt=100A/\mu S$
Reverse recovery charge	Q_{rr}		0.67		μC	
Peak reverse recovery current	I_{rrm}		7.1		A	



Electrical Characteristic Diagrams

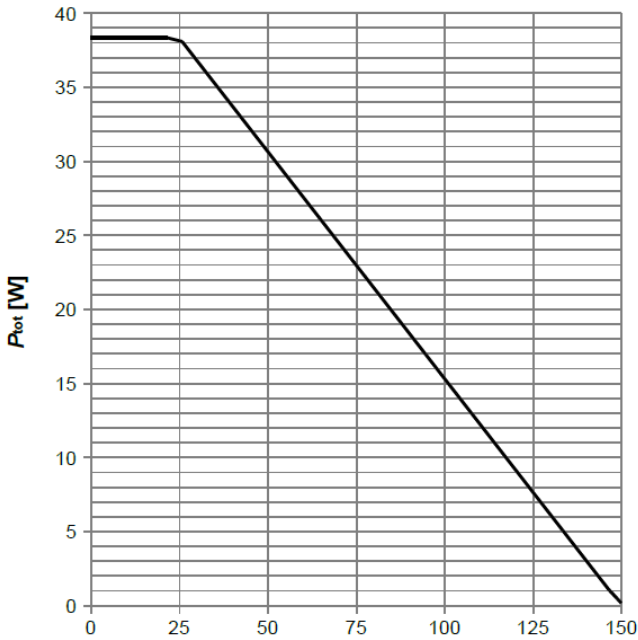


Figure 1 Power Dissipation

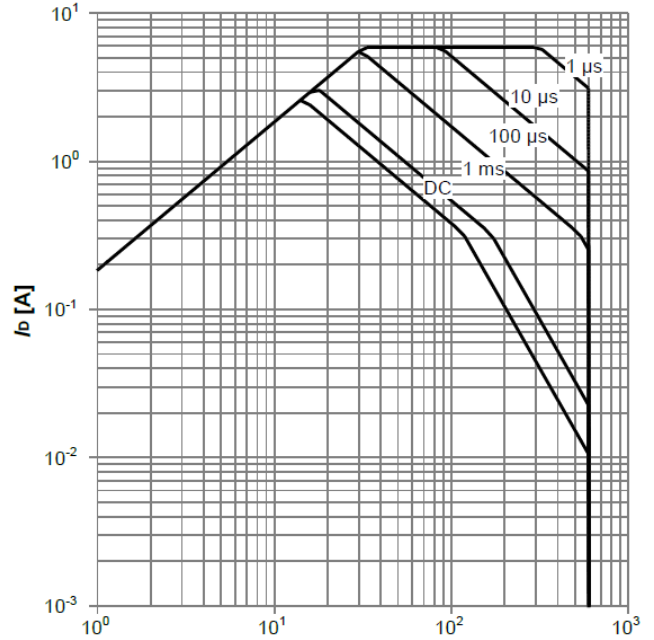


Figure 2 Safe Operation Area @T_c=25 °C

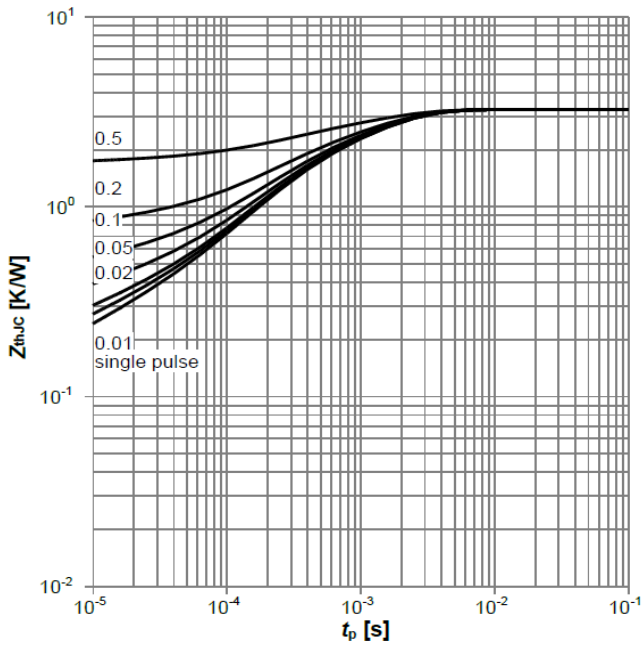


Figure 3 Maximum Transient thermal impedance

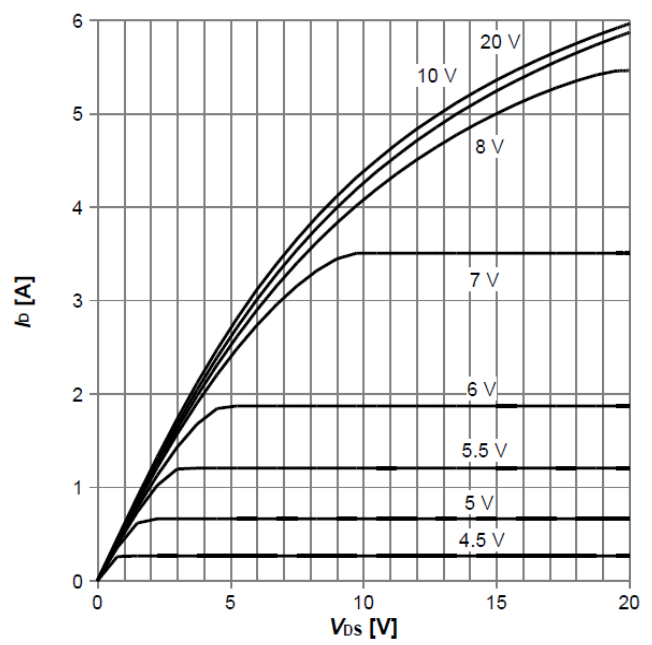


Figure 4 Typical Output Characteristics @T_c=25 °C

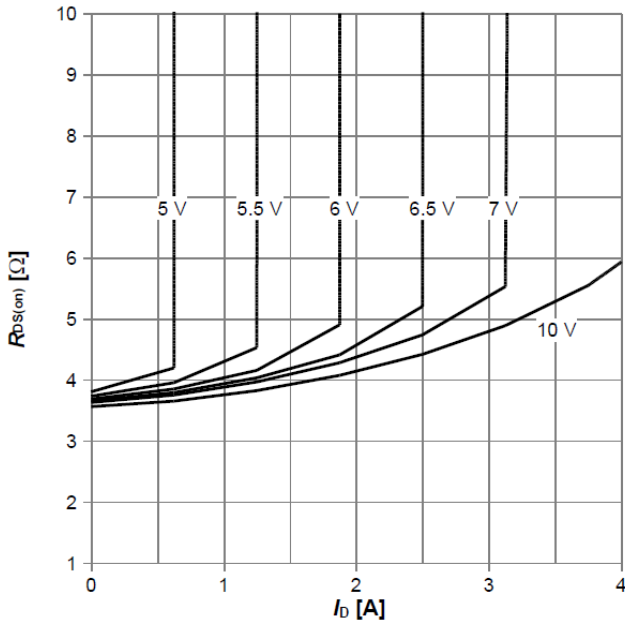


Figure 5 Typical Drain-Source on resistance @ $T_j=125^\circ\text{C}$

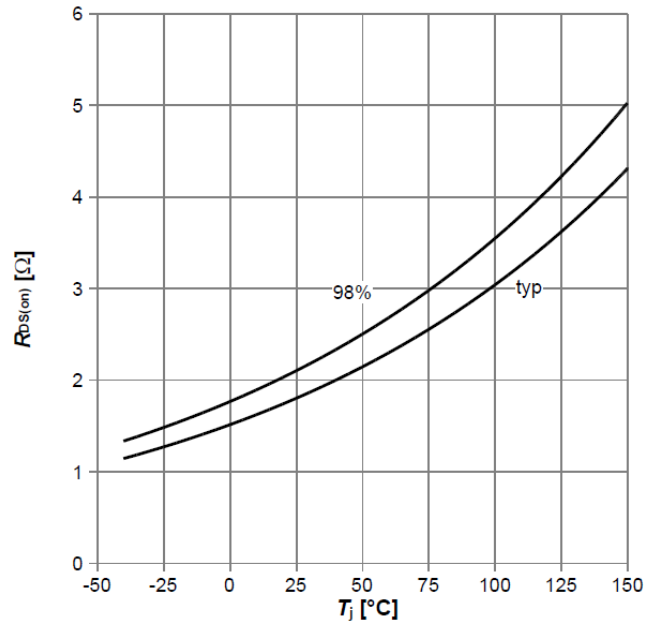


Figure 6 On resistance Temp Characteristic

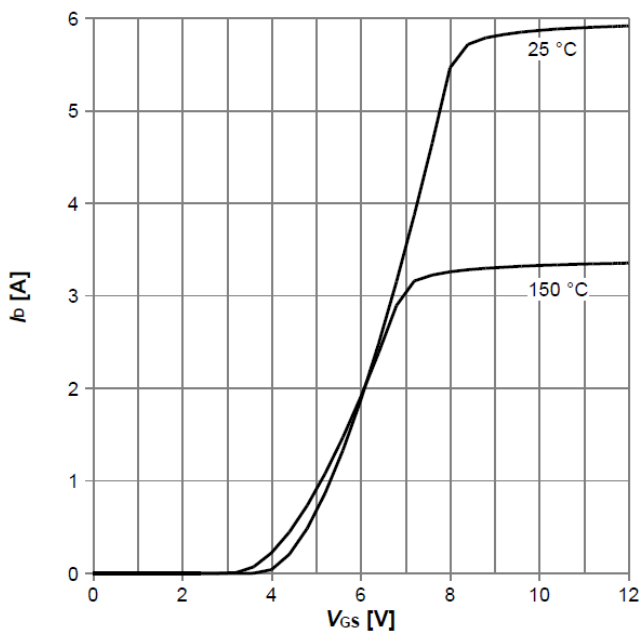


Figure 7 Typical Transfer characteristic @ $V_{DS}=20\text{V}$

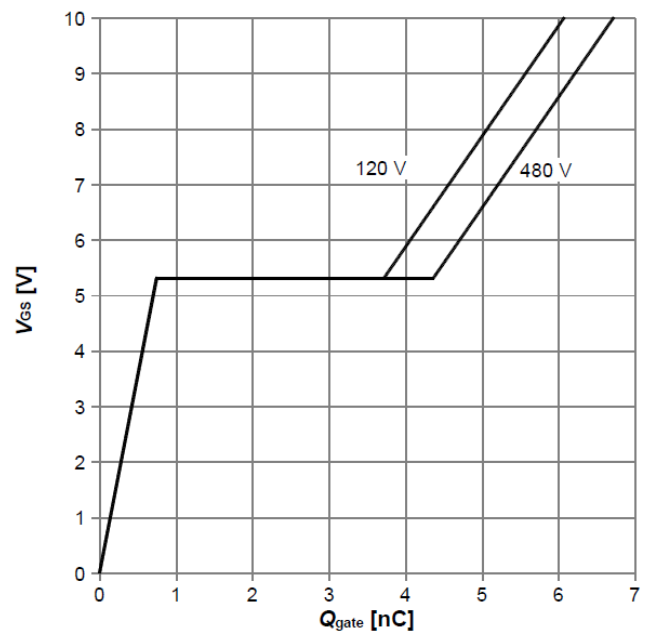


Figure 8 Typical Gate charge plot @ $I_D=0.9\text{A}$

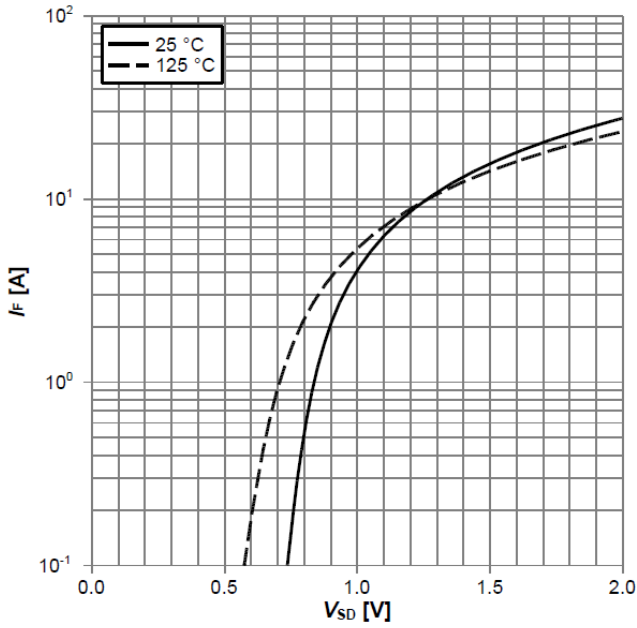


Figure 9 Reverse diode forward characteristic

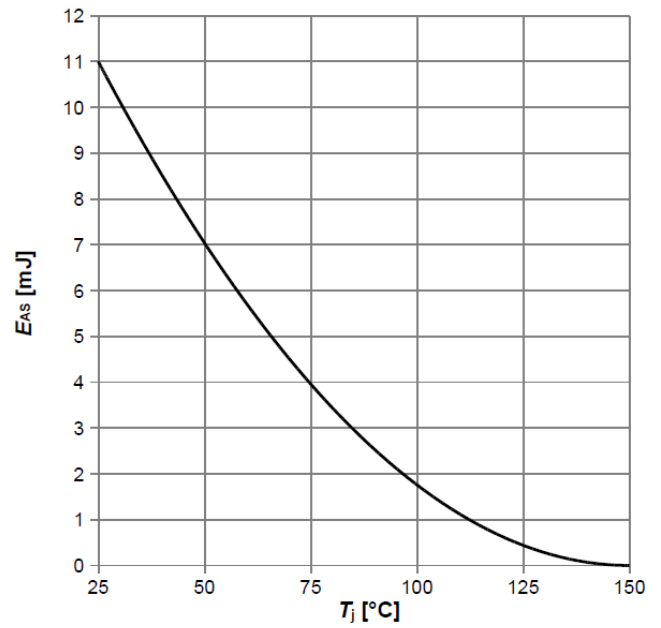


Figure 10 Avalanche Energy @ $V_{DD}=50V$

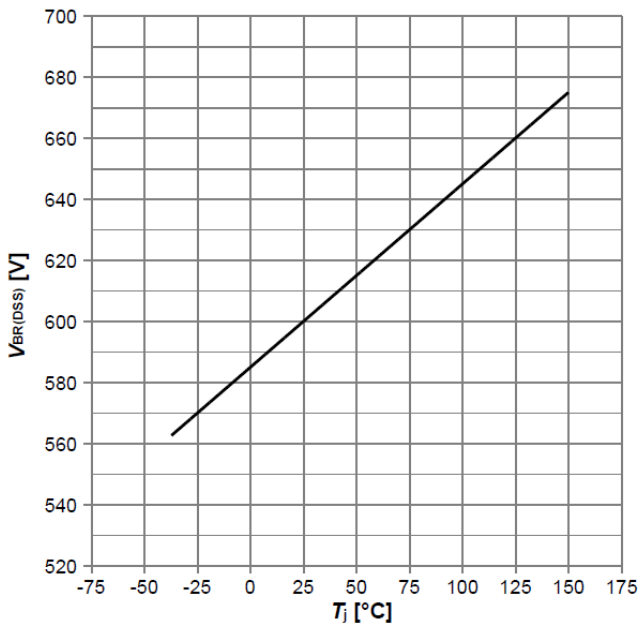


Figure 11 Drain-Source breakdown voltage

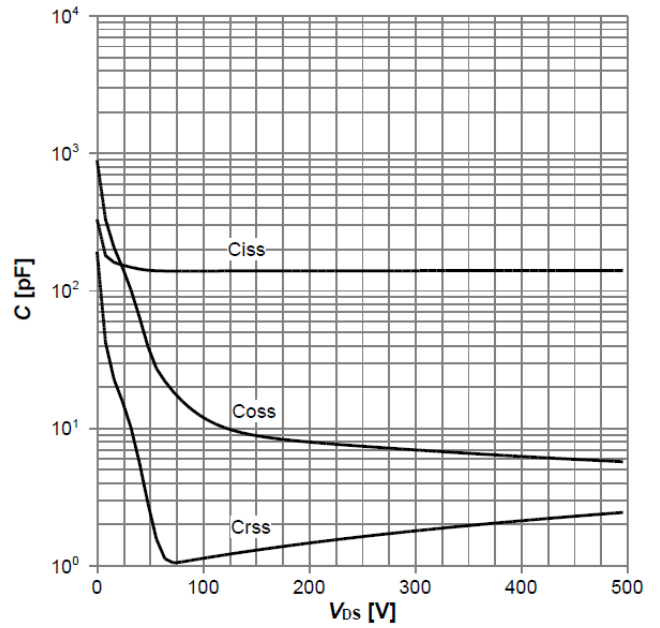


Figure 12 Capacitance characteristics

Parameter Test Circuits

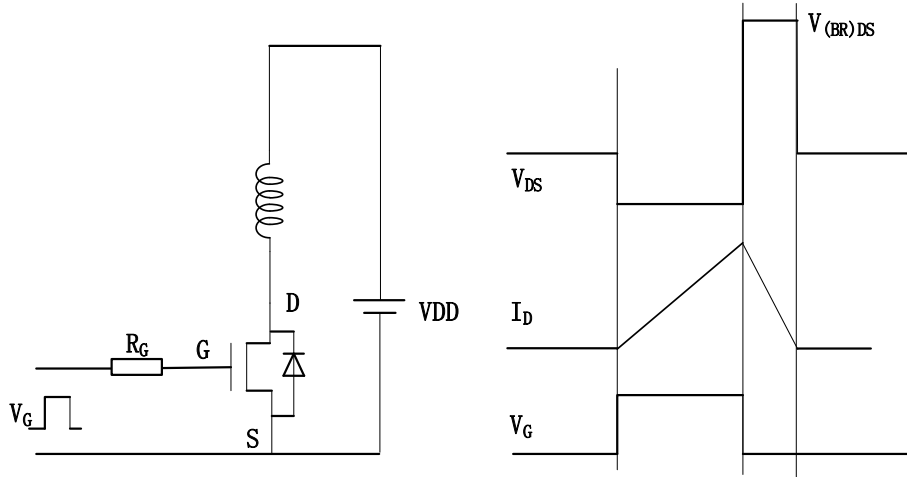


Figure 13 Unclamped Inductive Switching (UIS) Test circuit and waveforms

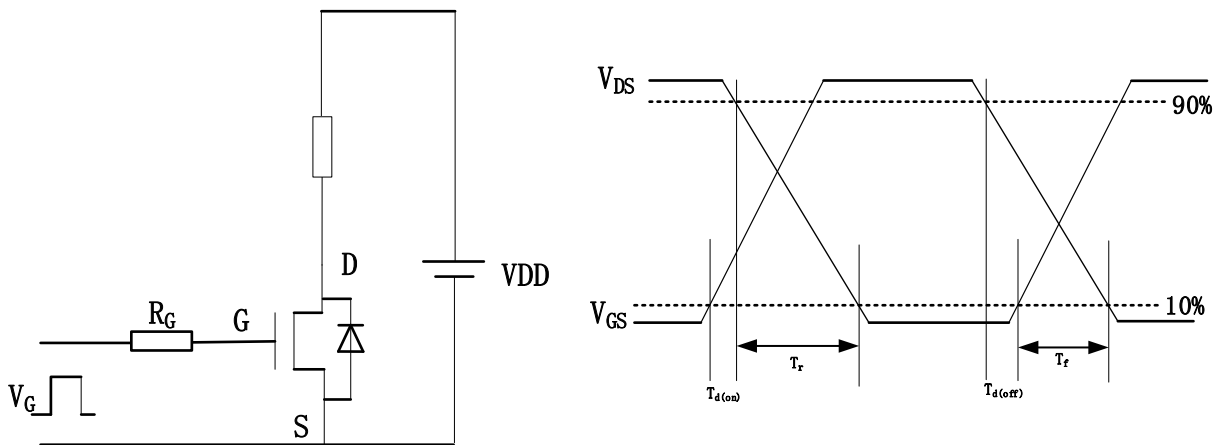


Figure 14 Resistive Switching time Test circuit and waveforms

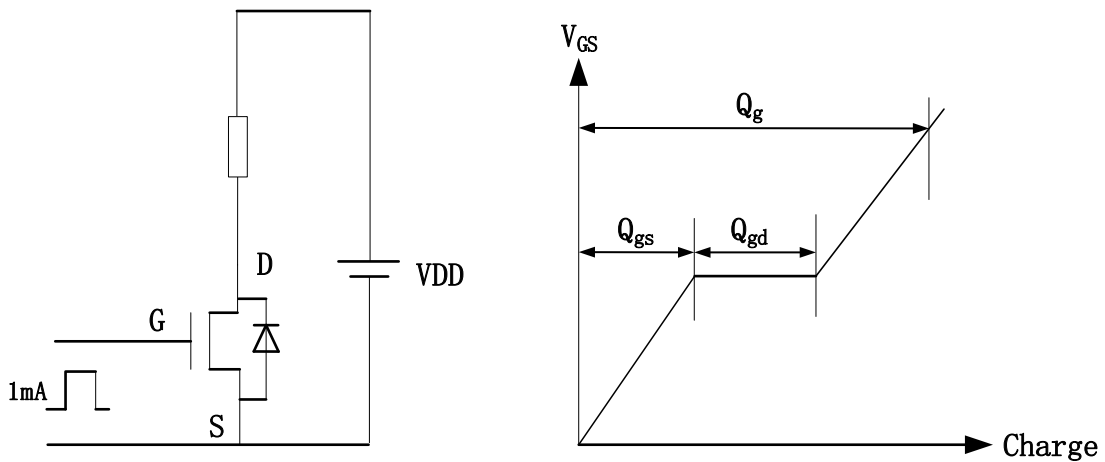
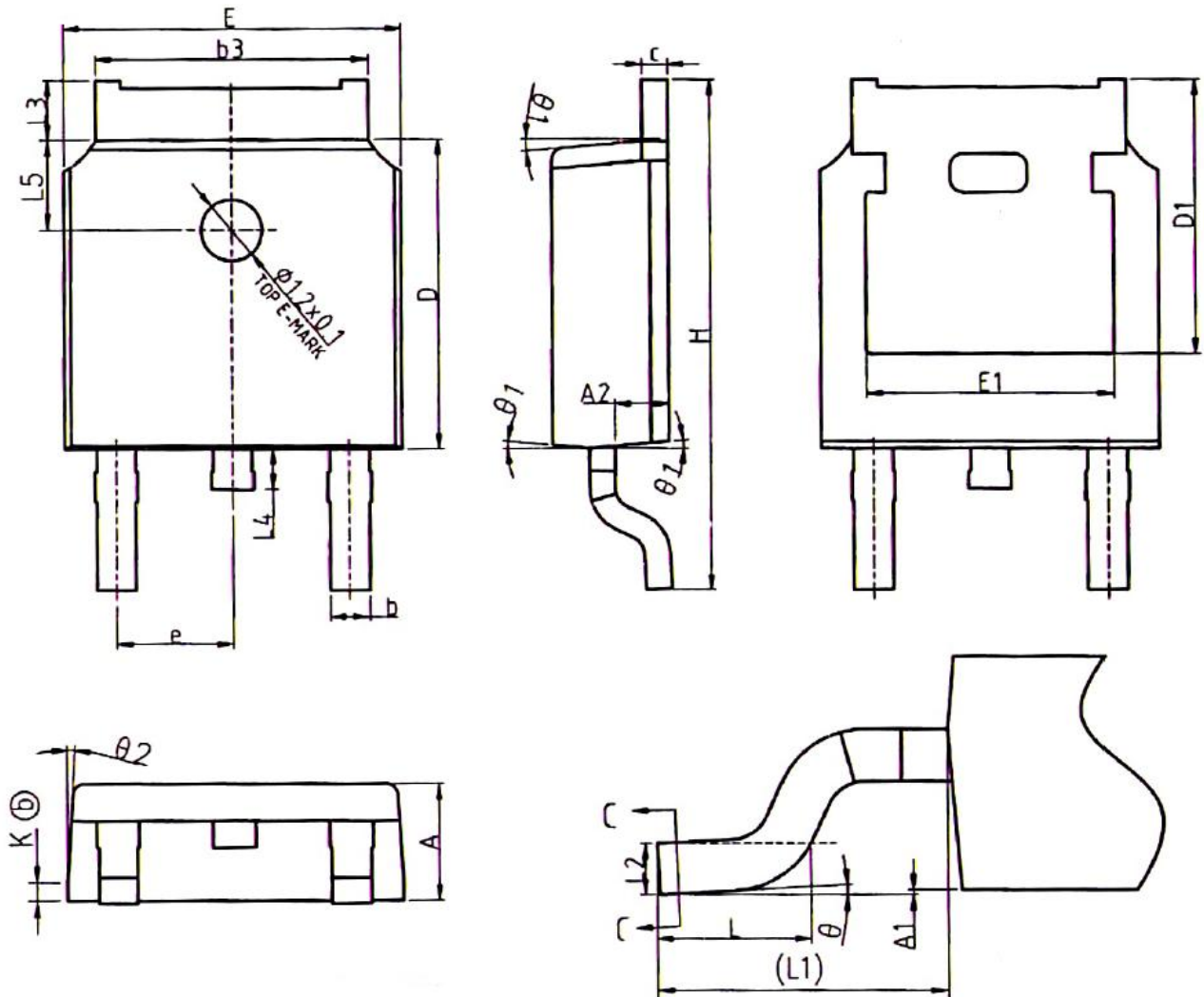
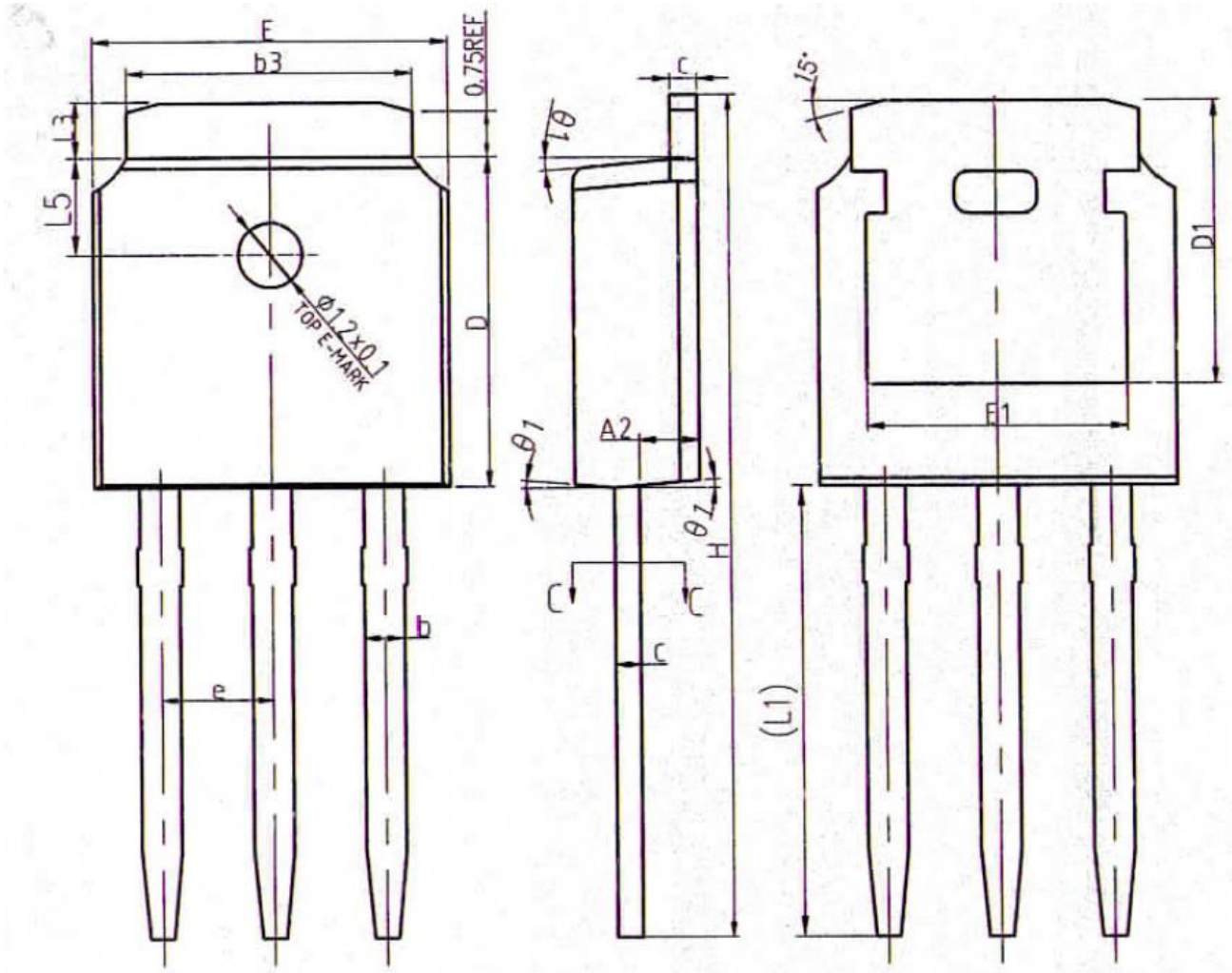


Figure 15 Gate charge Test circuit and waveforms

Package Information

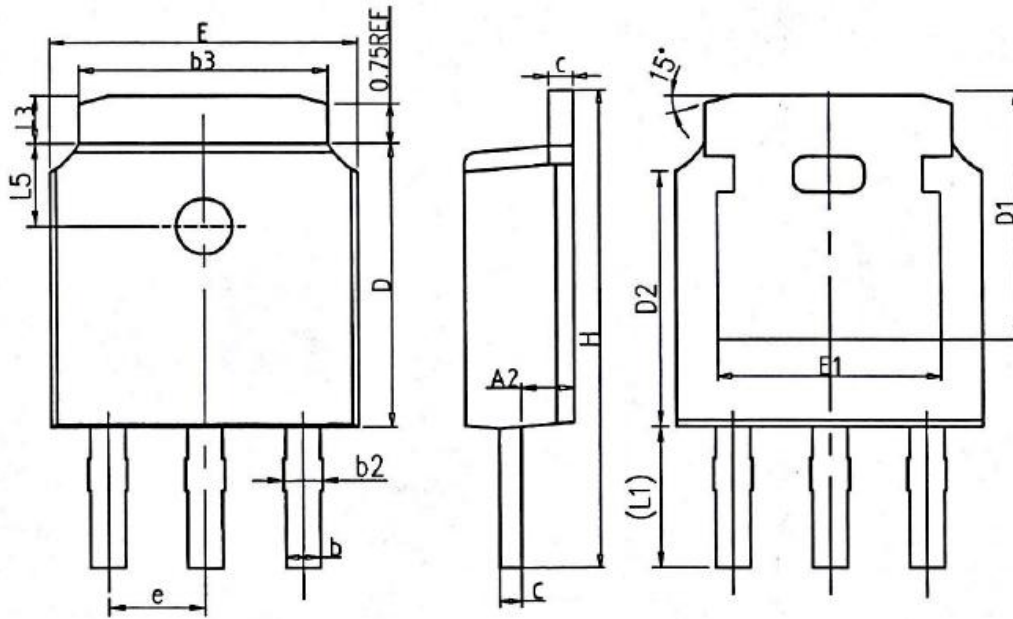


TO-252 Common dimensions						
SYMBOL	Unit: mm			SYMBOL	Unit: mm	
	MIN	NOM	MAX		MIN	NOM
A	2.20	2.30	2.38	e	2.286BSC	
A1	0.00	-	0.10	H	9.90	10.10 10.30
A2	0.97	1.07	1.17	L	1.40	1.50 1.70
b	0.72	0.78	0.85	L1	2.90REF	
b1	0.71	0.76	0.81	L2	0.51BSC	
b3	5.23	5.33	5.46	L3	0.90	1.25
c	0.47	0.53	0.58	L4	0.60	0.80 1.00
c1	0.46	0.51	0.56	L5	1.70	1.80 1.90
D	6.00	6.10	6.20	theta	0°	8°
D1	5.30REF			theta1	5°	7° 9°
E	6.50	6.60	6.70	theta2	5°	7° 9°
E1	4.70	4.83	4.92	K	0.40REF	

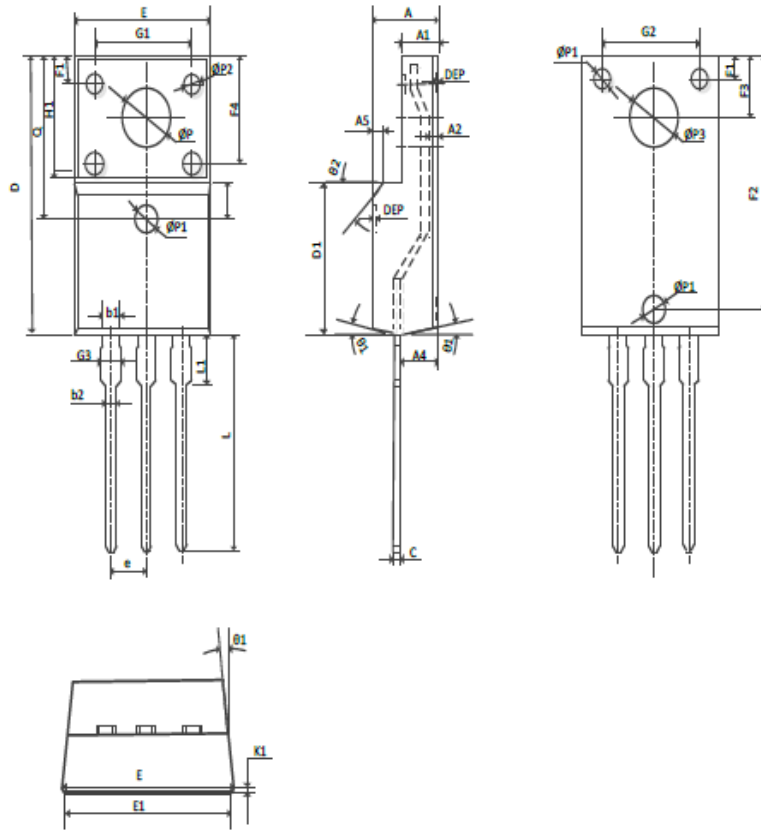


TO-251 Common dimensions

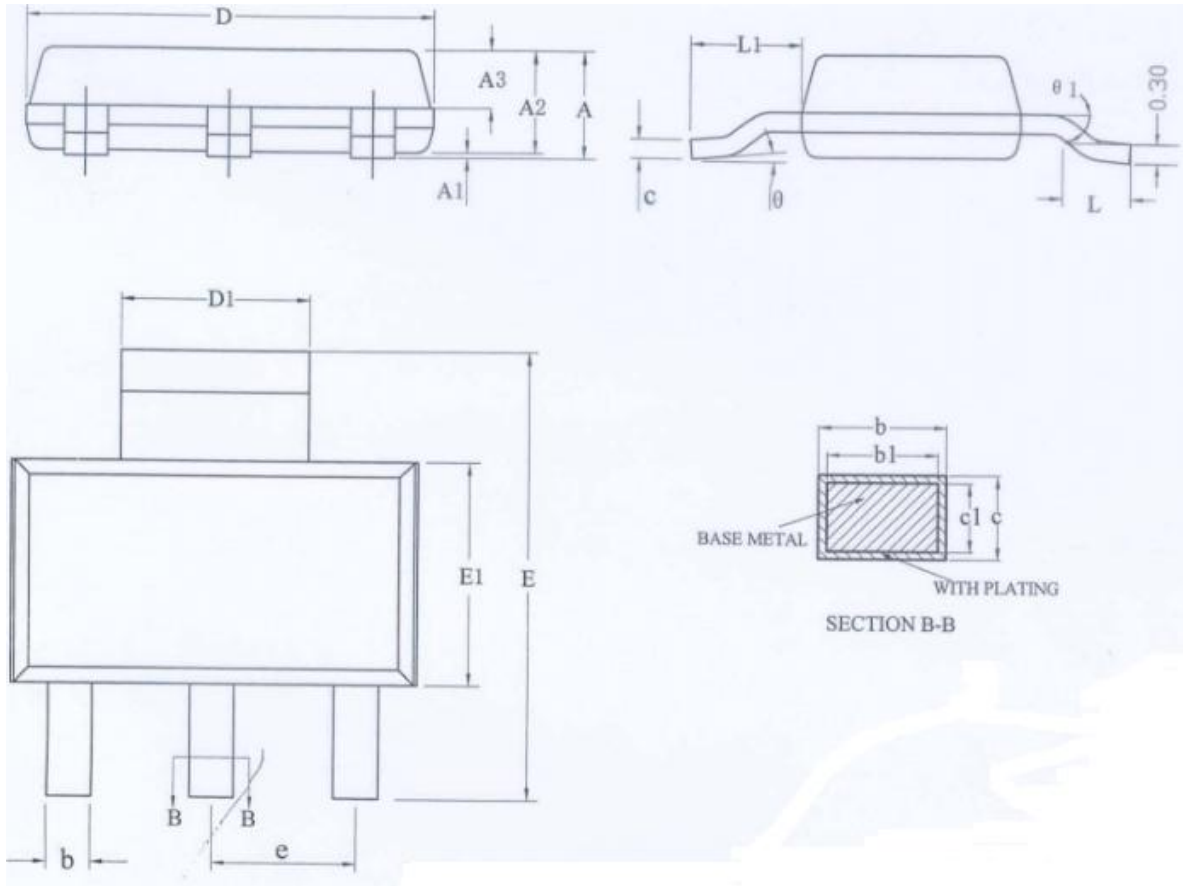
SYMBOL	Unit: mm			SYMBOL	Unit: mm		
	MIN	NOM	MAX		MIN	NOM	MAX
A	2.20	2.30	2.38	e	2.286BSC		
A2	0.97	1.07	1.17	H	16.10	16.40	16.60
b	0.72	0.78	0.85	L1	9.20	9.40	9.60
b1	0.71	0.76	0.81	L3	0.90	1.02	1.25
b3	5.23	5.33	5.46	L5	1.70	1.80	1.90
c	0.47	0.53	0.58	θ_1	5°	7°	9°
c1	0.46	0.51	0.56	θ_2	5°	7°	9°
D	6.00	6.10	6.20	K	0.40REF		
D1	5.30REF						
E	6.50	6.60	6.70				
E1	4.70	4.83	4.92				



TO-251S Common dimensions							
SYMBOL	Unit: mm			SYMBOL	Unit: mm		
	MIN	NOM	MAX		MIN	NOM	MAX
A	2.2	2.3	2.38	e	2.286BSC		
A2	0.97	1.07	1.17	H	9.40	9.62	9.85
b	0.68	0.78	0.90	L1	2.30	2.50	2.70
b2	0.76	0.84	0.95	L3	0.88	1.02	1.28
b3	5.2	5.33	5.46	L5	1.65	1.80	1.95
c	0.43	0.53	0.61				
D	5.98	6.10	6.22	K	0.40REF		
D1	5.30REF						
E	6.40	6.60	6.73				
E1	4.63	-	-				



TO-220FP Common dimensions							
SYMBOL	Unit: mm			SYMBOL	Unit: mm		
	MIN	NOM	MAX		MIN	NOM	MAX
E	10.04	10.20	10.36	ΦP2	1.15	1.20	1.25
A	4.50	4.70	4.90	ΦP3	3.45REF		
A1	2.34	2.54	2.74	θ1	5°	7°	9°
A2	0.70	0.85	1.00	θ2		45°	
A4	2.65	2.75	2.85	DEP	0.05	0.10	0.15
A5	1.00REF			F1	1.90	2.00	2.10
C	0.42	0.50	0.58	F2	13.80	13.90	14.00
D	15.67	15.87	16.07	F3	3.20	3.30	3.40
Q	9.20REF			F4	5.30	5.40	5.50
H1	6.70REF			G1	6.60	6.70	6.80
e	2.54BSC			G2	6.90	7.00	7.10
ΦP	3.183REF			G3	1.10	1.30	1.50
L	12.78	12.98	13.18	b1	1.05	1.20	1.35
L1	3.25	3.45	3.65	b2	0.70	0.80	0.85
D1	9.17REF			E1	9.90	10.00	10.10
ΦP1	1.40	1.50	1.60	K1	0.65	0.70	0.75



SOT223 Common dimensions						
SYMBOL	Unit: mm			SYMBOL	Unit: mm	
	MIN	NOM	MAX		MIN	NOM
A	1.50	1.65	1.80	e	2.30BSC	
A1	0.03	0.06	0.09	L1	1.75BSC	
A2	1.45	1.60	1.75	θ	0	7°
A3	0.80	0.90	1.00	$\theta 1$	37.5 REF	
b	0.69		0.78			
b1	0.68	0.71	0.74			
c	0.30		0.35			
c1	0.29	0.30	0.31			
D	6.30	6.50	6.70			
D1	3.00REF					
E	6.80	7.00	7.20			
E1	3.40	3.50	3.60			