

# Enhancement Mode N-Channel Power MOSFET

## Features

- ◆ Low  $R_{DS(on)}$  & FOM
- ◆ Extremely low switching loss
- ◆ Excellent stability and uniformity
- ◆ Easy to drive

## Applications

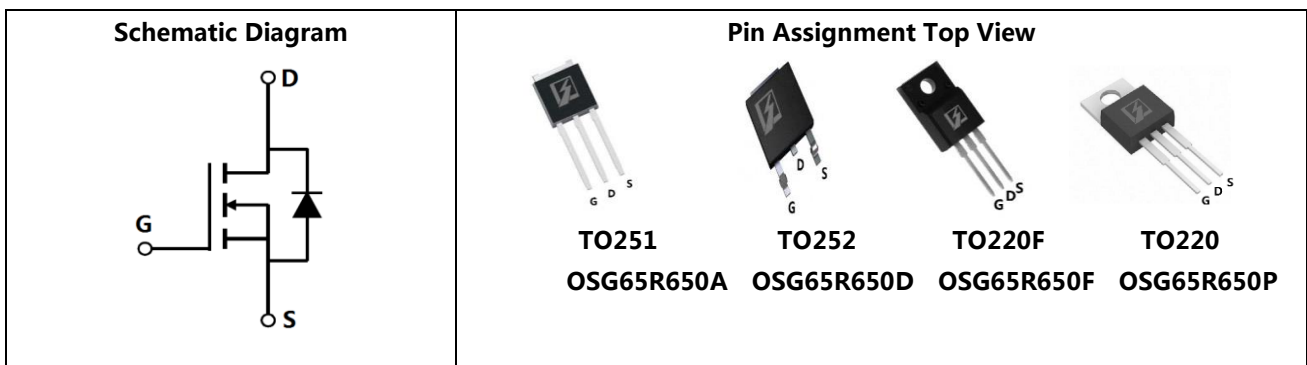
- ◆ Lighting
- ◆ Hard switching PWM
- ◆ Server power supply
- ◆ Charger

## ■ General Description

OSG65R650x use advanced GreenMOSTM technology to provide low  $R_{DS(ON)}$ , low gate charge, fast switching and excellent avalanche characteristics. This device is suitable for active power factor correction and switching mode power supply applications.

◆ $V_{DS, min@Tjmax}$	700 V
◆ $I_{D, pulse}$	22.5 A
◆ $R_{DS(ON), max @ VGS=10 V}$	650 mΩ
◆ $Q_g$	8.9 nC

## ■ Schematic and Package Information



## ■ Absolute Maximum Ratings at $T_j=25^\circ\text{C}$ unless otherwise noted

Parameter	Symbol	Value	Unit
Drain source voltage	$V_{DS}$	650	V
Gate source voltage	$V_{GS}$	$\pm 30$	V
Continuous drain current <sup>1)</sup>	$I_D$	7.5	A
Continuous drain current <sup>1)</sup> $T_j=100^\circ\text{C}$		4.7	
Pulsed drain current <sup>2)</sup>	$I_{D, pulse}$	22.5	A
Power dissipation <sup>3)</sup> for TO251, TO252, TO220	$P_D$	63	W
Power dissipation <sup>3)</sup> for TO220F		28	
Single pulsed avalanche energy <sup>5)</sup>	$E_{AS}$	200	mJ
MOSFET dv/dt ruggedness, $V_{DS}=0\dots 480\text{ V}$	dv/dt	50	V/ns
Reverse diode dv/dt, $V_{DS}=0\dots 480\text{ V}$ , $I_{SD}\leq I_D$	dv/dt	15	V/ns
Operation and storage temperature	$T_{stg}, T_j$	-55 to 150	$^\circ\text{C}$

## ■ Thermal Characteristics

Parameter	Symbol	Value		Unit
		TO251/TO252/TO220	TO220F	
Thermal resistance, junction-case	$R_{\theta JC}$	2	4.5	°C/W
Thermal resistance, junction-ambient <sup>4)</sup>	$R_{\theta JA}$	62	62.5	°C/W

## ■ Electrical Characteristics at $T_j=25\text{ }^\circ\text{C}$ unless otherwise specified

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Drain-source breakdown voltage	$BV_{DSS}$	650			V	$V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$
		700	770			$V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$ $T_j=150\text{ }^\circ\text{C}$
Gate threshold voltage	$V_{GS(th)}$	2.0		4.0	V	$V_{DS}=V_{GS}, I_D=250\text{ }\mu\text{A}$
Drain-source on-state resistance	$R_{DS(on)}$		0.55	0.65	$\Omega$	$V_{GS}=10\text{ V}, I_D=4\text{ A}$
			1.44			$V_{GS}=10\text{ V}, I_D=4\text{ A},$ $T_j=150\text{ }^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$			100	nA	$V_{GS}=30\text{ V}$
				-100		$V_{GS}=-30\text{ V}$
Drain-source leakage current	$I_{DSS}$			1	$\mu\text{A}$	$V_{DS}=650\text{ V}, V_{GS}=0\text{ V}$

## ■ Dynamic Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Input capacitance	$C_{iss}$		445.4		pF	$V_{GS}=0\text{ V},$ $V_{DS}=50\text{ V},$ $f=1\text{ MHz}$
Output capacitance	$C_{oss}$		38.9		pF	
Reverse transfer capacitance	$C_{rss}$		1.4		pF	
Turn-on delay time	$t_{d(on)}$		19.6		ns	$V_{GS}=10\text{ V},$ $V_{DS}=400\text{ V},$ $R_G=25\text{ }\Omega,$ $I_D=4\text{ A}$
Rise time	$t_r$		9.4		ns	
Turn-off delay time	$t_{d(off)}$		31.7		ns	
Fall time	$t_f$		24.3		ns	

## ■ Gate Charge Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Total gate charge	$Q_g$		8.9		nC	$I_D=4\text{ A}$ , $V_{DS}=400\text{ V}$ , $V_{GS}=10\text{ V}$
Gate-source charge	$Q_{gs}$		2.3		nC	
Gate-drain charge	$Q_{gd}$		3.6		nC	
Gate plateau voltage	$V_{\text{plateau}}$		5.6		V	

## ■ Body Diode Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Diode forward current	$I_S$			7.5	A	$V_{GS} < V_{th}$
Pulsed source current	$I_{SP}$			22.5		
Diode forward voltage	$V_{SD}$			1.3	V	$I_S=4\text{ A}$ , $V_{GS}=0\text{ V}$
Reverse recovery time	$t_{rr}$		171.7		ns	$V_R=400\text{ V}$ , $I_S=4\text{ A}$ , $di/dt=100\text{ A}/\mu\text{s}$
Reverse recovery charge	$Q_{rr}$		1.3		$\mu\text{C}$	
Peak reverse recovery current	$I_{rrm}$		13.4		A	

## ■ Note

- 1) Calculated continuous current based on maximum allowable junction temperature.
- 2) Repetitive rating; pulse width limited by max. junction temperature.
- 3)  $P_d$  is based on max. junction temperature, using junction-case thermal resistance.
- 4) The value of  $R_{\theta JA}$  is measured with the device mounted on 1 in 2 FR-4 board with 2oz. Copper, in a still air environment with  $T_a=25\text{ }^\circ\text{C}$ .
- 5)  $V_{DD}=100\text{ V}$ ,  $R_G=25\text{ }\Omega$ ,  $L=10\text{ mH}$ , starting  $T_j=25\text{ }^\circ\text{C}$ .

■ Electrical Characteristics Diagrams

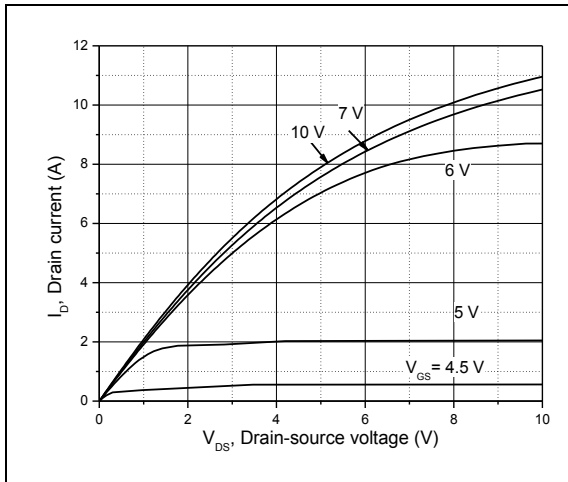


Figure 1, Typ. output characteristics

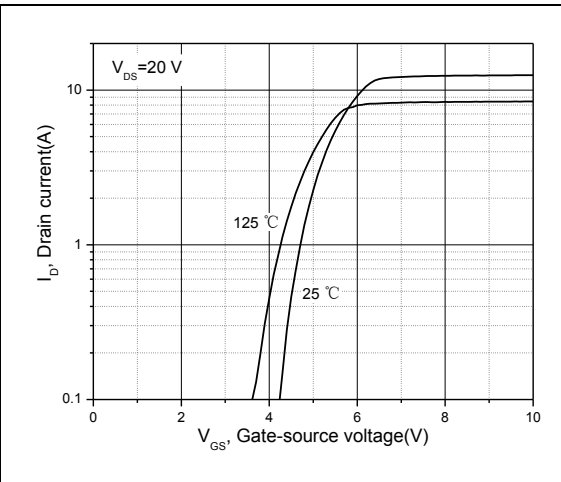


Figure 2, Typ. transfer characteristics

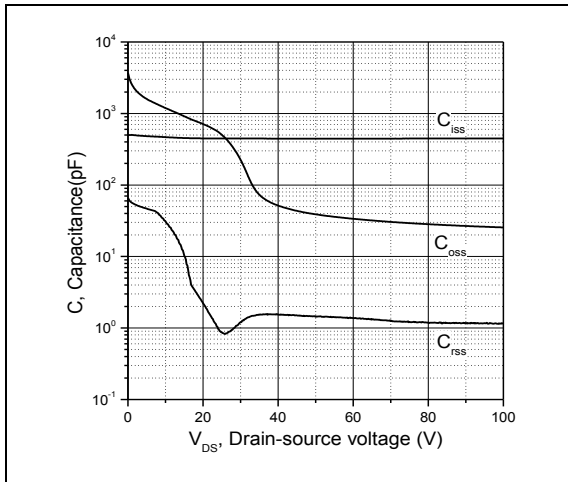


Figure 3, Typ. capacitances

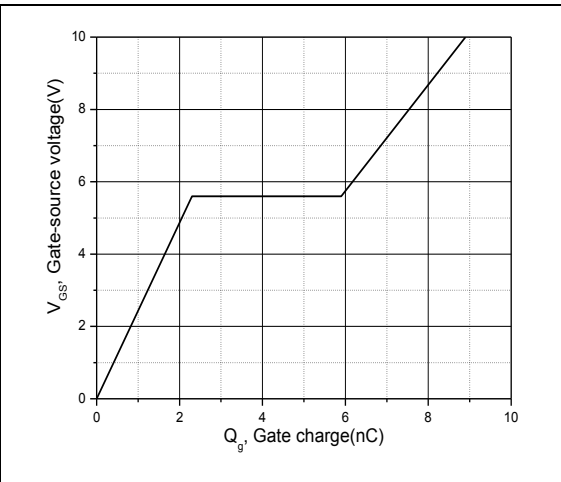


Figure 4, Typ. gate charge

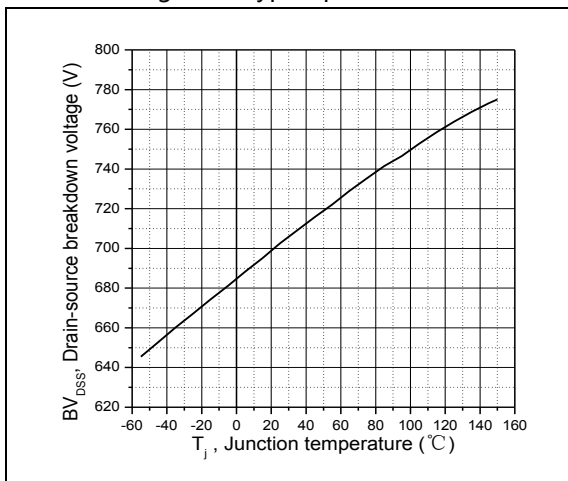


Figure 5, Drain-source breakdown voltage

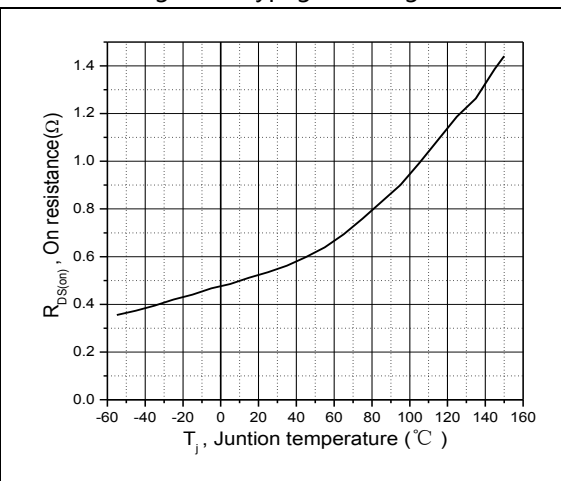


Figure 6, Drain-source on-state resistance

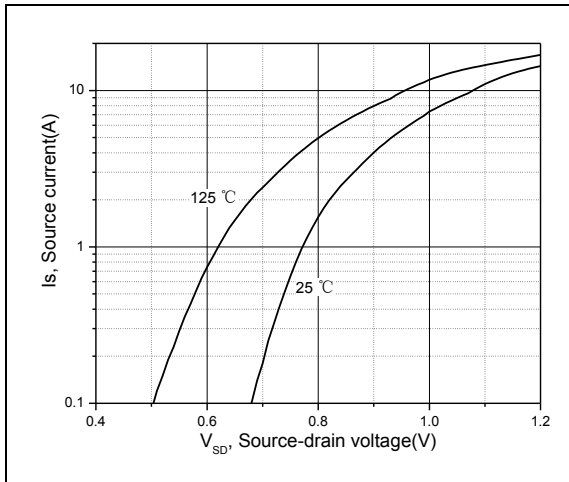


Figure 7, Forward characteristic of body diode

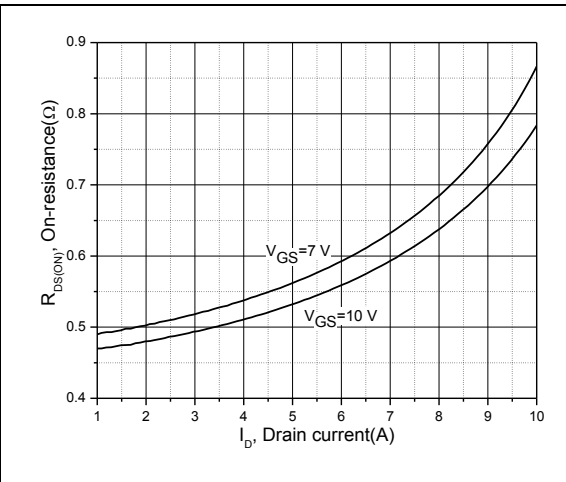


Figure 8, Drain-source on-state resistance

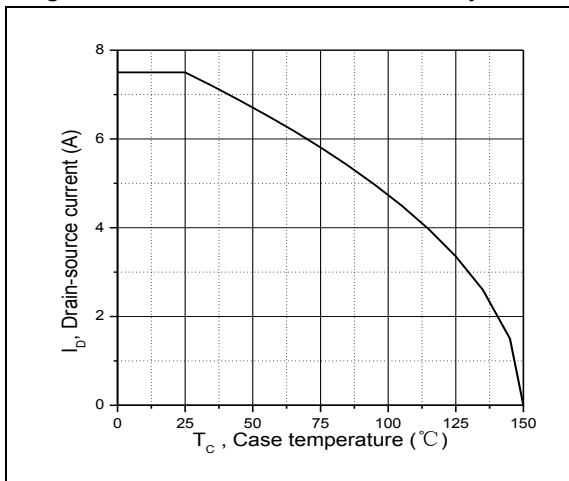


Figure 9, Drain current

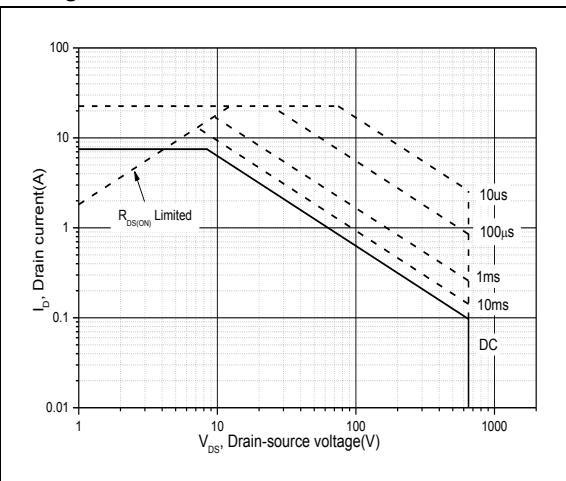


Figure 10, Safe operation area for TO251/TO252  $T_C=25\text{ }^\circ\text{C}$

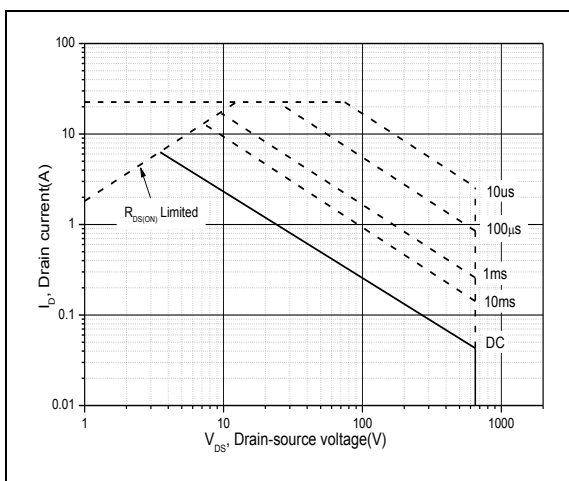


Figure 11, Safe operation area for TO220F  $T_C=25\text{ }^\circ\text{C}$

■ Test circuits and waveforms

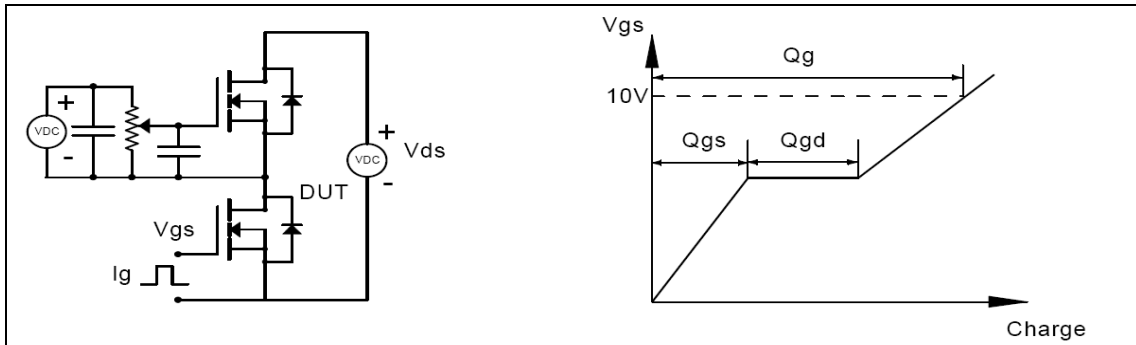


Figure 1, Gate charge test circuit & waveform

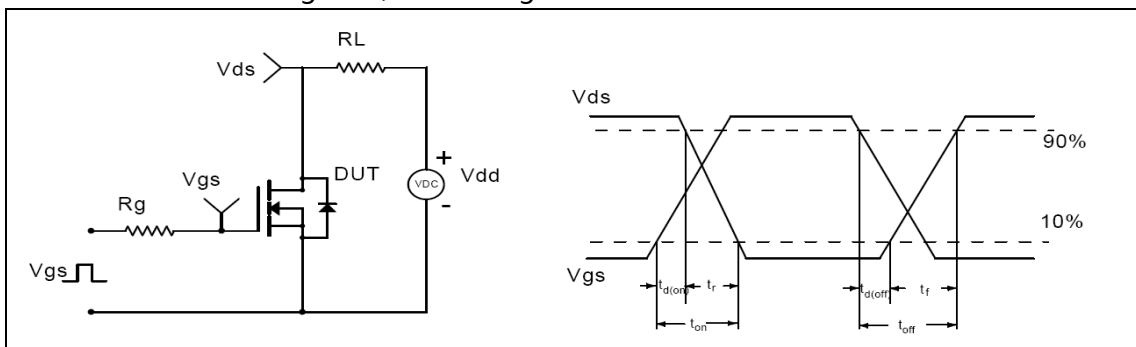


Figure 2, Switching time test circuit & waveforms

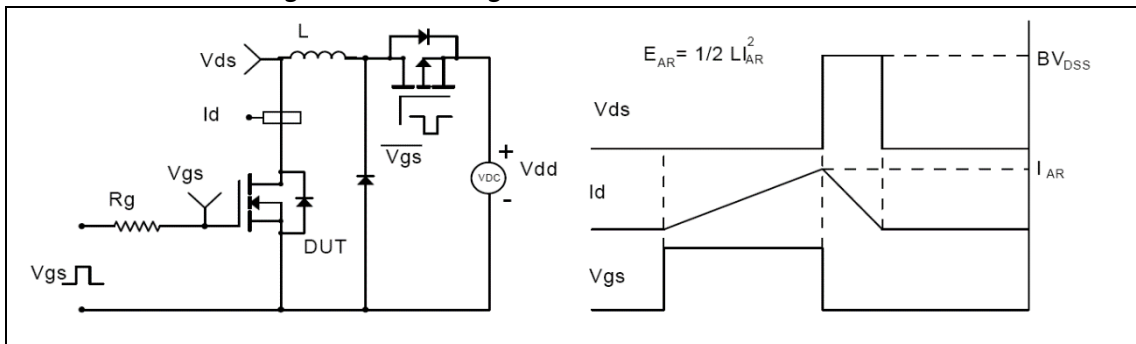


Figure 3, Unclamped inductive switching (UIS) test circuit & waveforms

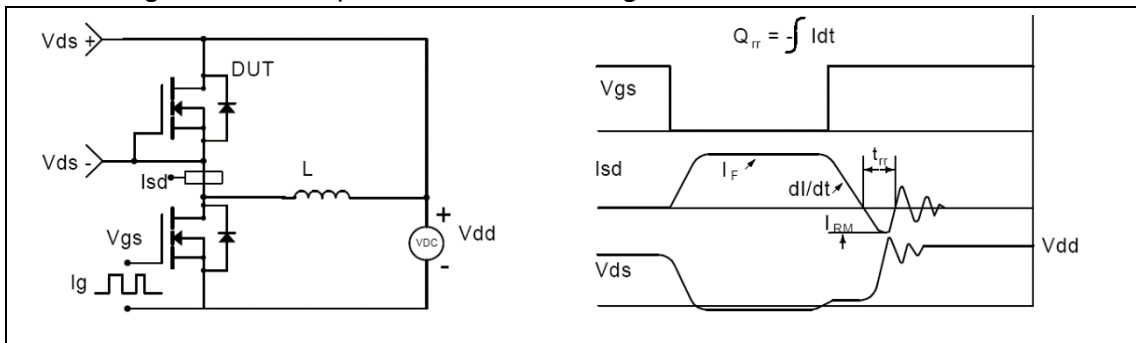
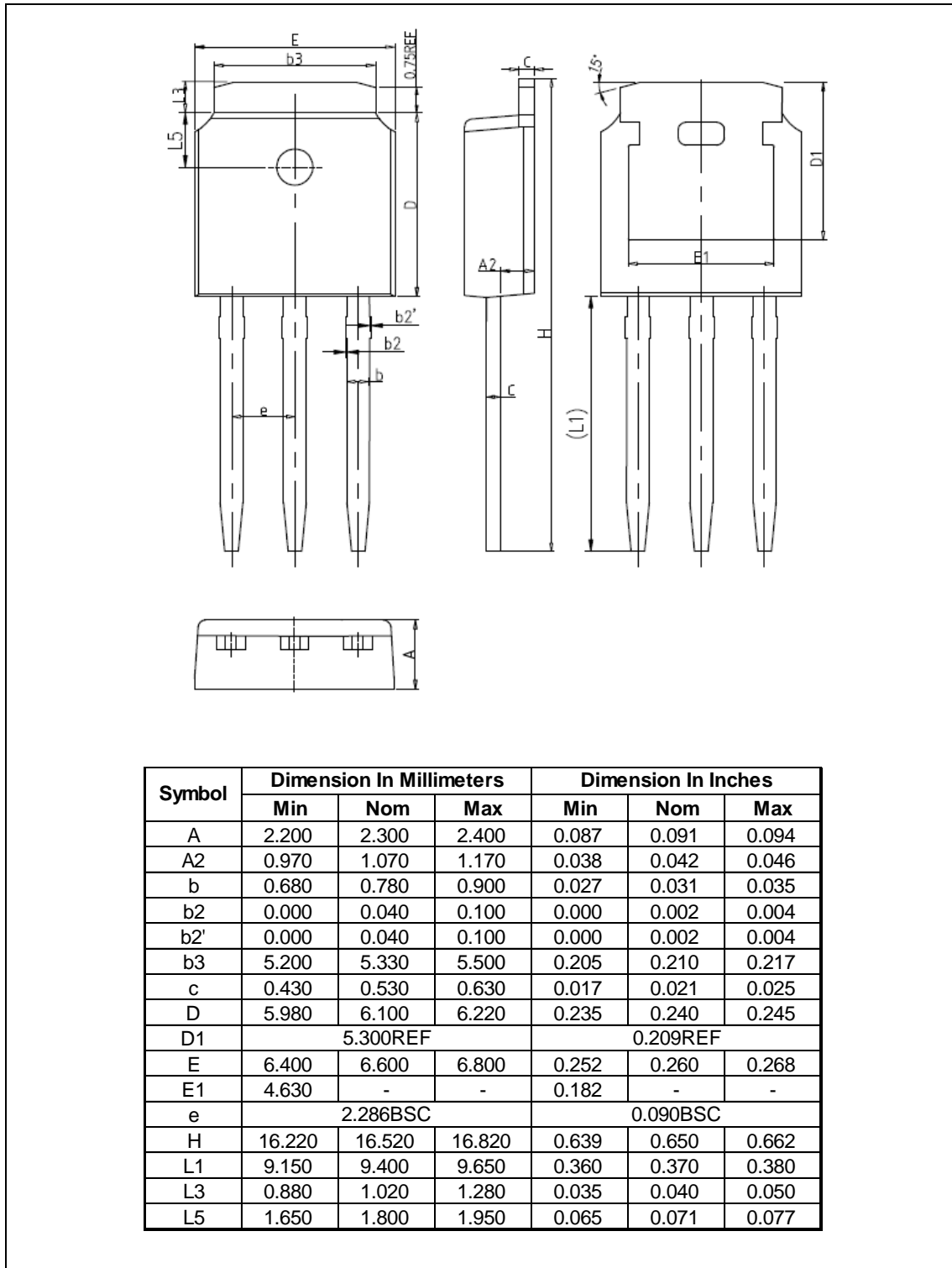


Figure 4, Diode reverse recovery test circuit & waveforms

**■ Package Information**

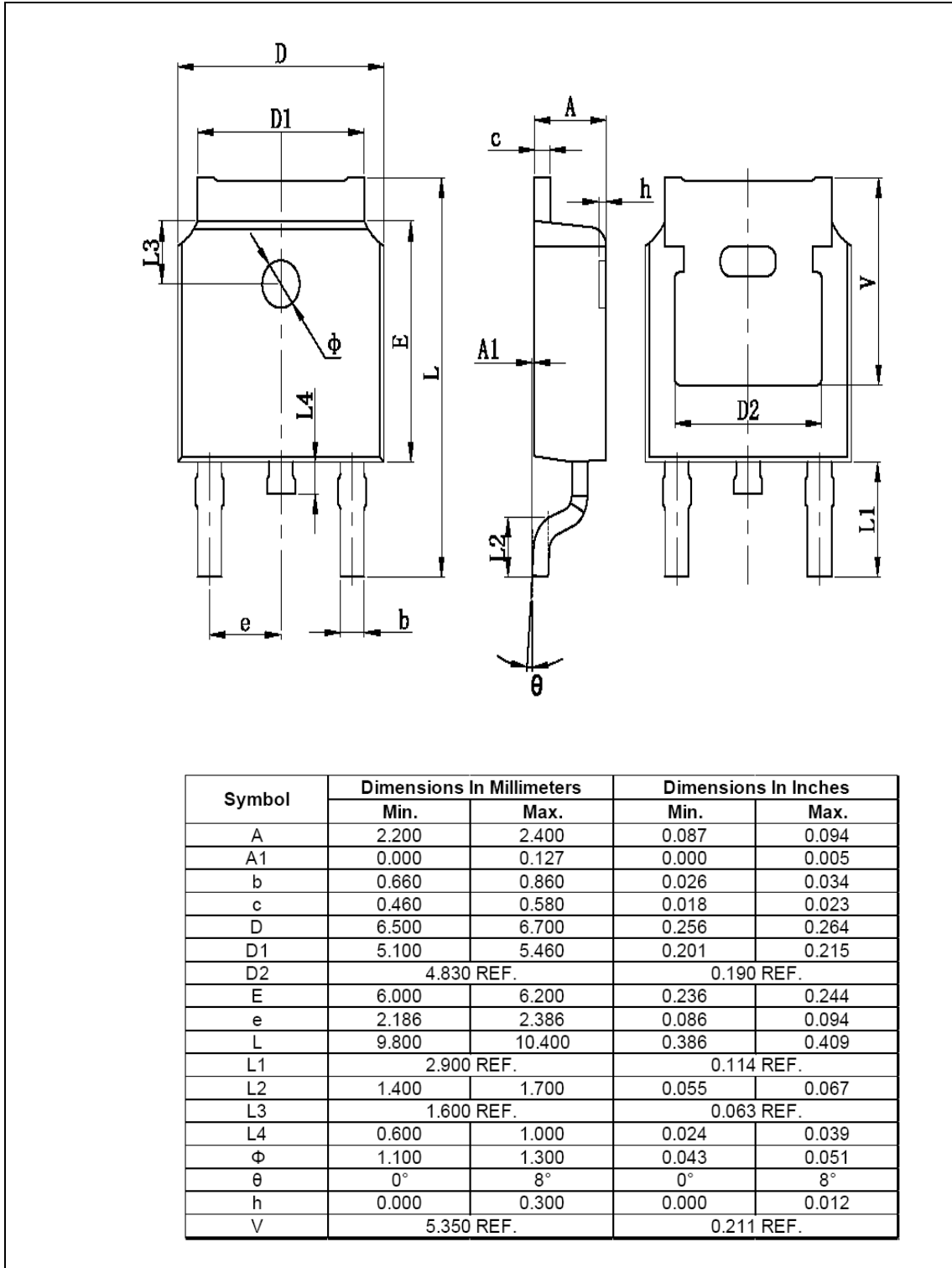
Figure1, TO251 package outline dimension





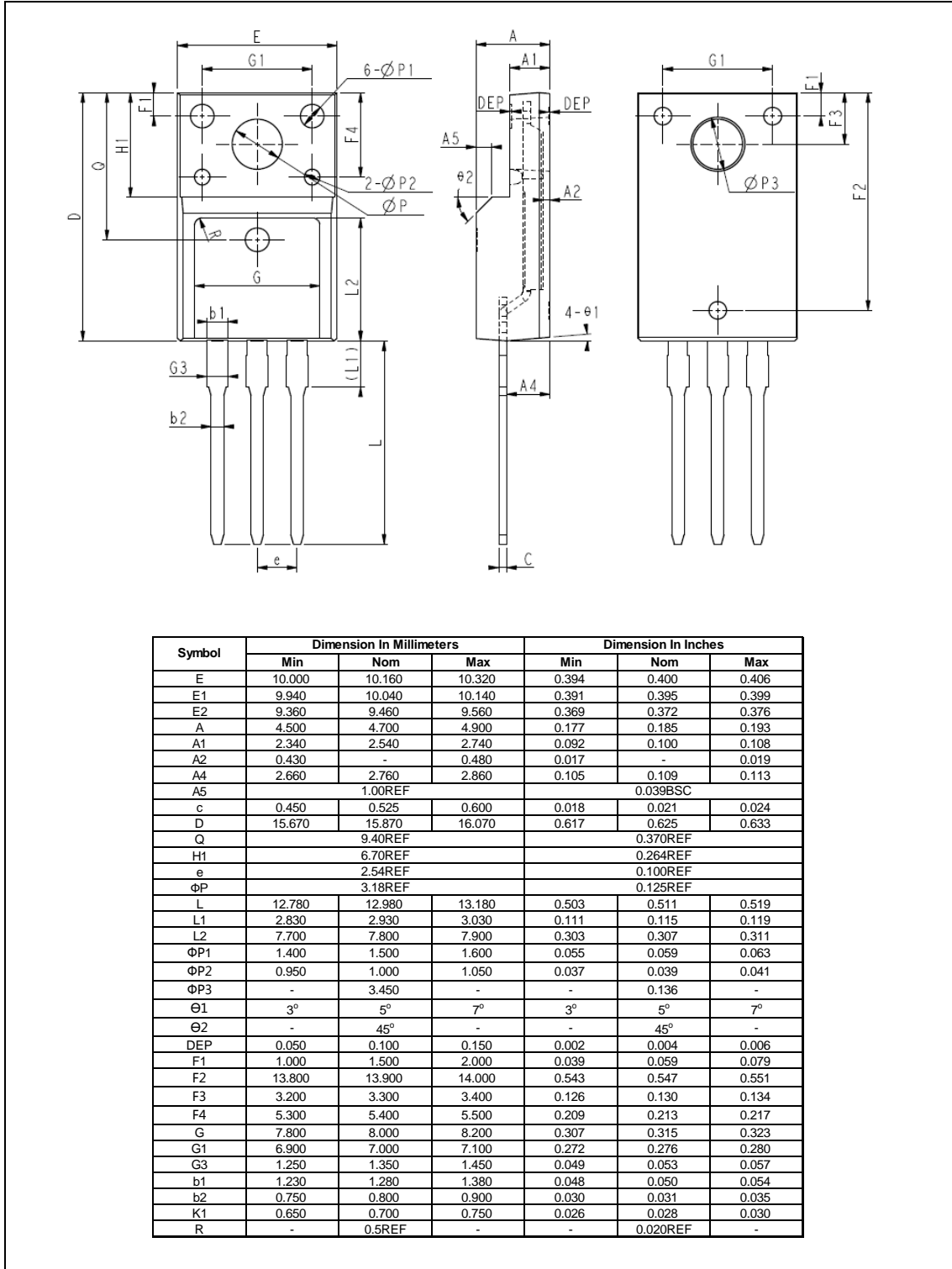
**■ Package Information**

Figure2, TO252 package outline dimension



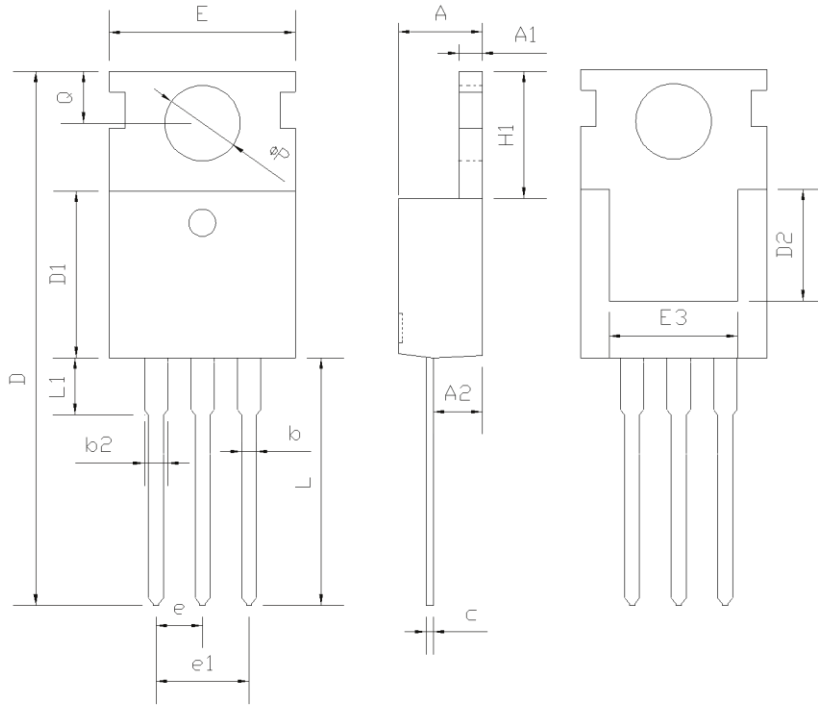
**■ Package Information**

Figure3, TO220F package outline dimension



## ■ Package Information

Figure3, TO220 package outline dimension



Symbol	Min	Nom	Max
A	4.37	4.57	4.77
A1	1.25	1.30	1.45
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.40	0.50	0.65
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	-	-
E	9.70	10.00	10.30
E3	7.00	-	-
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
ΦP	3.40	3.60	3.80
Q	2.60	2.80	3.00

## ■ Ordering Information

Package	Units/Tube	Tubes/Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO251	75	66	4950	6	29700
TO252 Option1	75	66	4950	6	29700
TO220F	50	20	1000	6	6000
TO220	50	20	1000	6	6000

Package	Units/Tape	Tapes/Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO252 Option2	2500	2	5000	5	25000

## ■ Product Information

Product	Package	Pb Free	RoHS	Halogen Free
OSG65R650A	TO251	yes	yes	no
OSG65R650AF	TO251	yes	yes	yes
OSG65R650D	TO252	yes	yes	no
OSG65R650DF	TO252	yes	yes	yes
OSG65R650F	TO220F	yes	yes	no
OSG65R650FF	TO220F	yes	yes	yes
OSG65R650P	TO220	yes	yes	no
OSG65R650PF	TO220	yes	yes	yes