

K4P60D-VB Datasheet

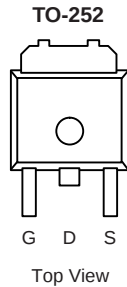
N-Channel 650V (D-S) Super Junction Power MOSFET

PRODUCT SUMMARY

V_{DS} (V)	650	
$R_{DS(on)}$ (Ω)	$V_{GS} = 10\text{ V}$	0.95
Q_g (Max.) (nC)	15	
Q_{gs} (nC)	3	
Q_{gd} (nC)	6	
Configuration	Single	

FEATURES

- Low Gate Charge Q_g Results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Compliant to RoHS directive 2002/95/EC


RoHS*
 COMPLIANT
ABSOLUTE MAXIMUM RATINGS $T_C = 25\text{ }^\circ\text{C}$, unless otherwise noted

PARAMETER			SYMBOL	LIMIT	UNIT
Drain-Source Voltage			V _{DS}	650	V
Gate-Source Voltage			V _{GS}	± 30	
Continuous Drain Current ^e	V _{GS} at 10 V	T _C = 25 °C	I _D	5	A
Continuous Drain Current		T _C = 100 °C		4	
Pulsed Drain Current ^a			I _{DM}	16	
Linear Derating Factor				1.67/0.8/0.3	W/°C
Single Pulse Avalanche Energy ^b			E _{AS}	120	mJ
Repetitive Avalanche Current ^a			I _{AR}	34	A
Repetitive Avalanche Energy ^a			E _{AR}	17	mJ
Maximum Power Dissipation	T _C = 25 °C		P _D	205/35/30	W
Peak Diode Recovery dV/dt ^c			dV/dt	4.5	V/ns
Operating Junction and Storage Temperature Range			T _J , T _{stg}	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature) ^d	for 10 s			300	
Mounting Torque	6-32 or M3 screw			10	
				1.1	N · m

Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting $T_J = 25\text{ }^\circ\text{C}$, $L = 24\text{ mH}$, $R_G = 25\text{ }\Omega$, $I_{AS} = 3.2\text{ A}$ (see fig. 12).
- $I_{SD} \leq 3.2\text{ A}$, $dI/dt \leq 90\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{DS}$, $T_J \leq 150\text{ }^\circ\text{C}$.
- 1.6 mm from case.
- Drain current limited by maximum junction temperature.

THERMAL RESISTANCE RATINGS

PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum Junction-to-Ambient	R_{thJA}	-	62	°C/W
Maximum Junction-to-Case (Drain)	R_{thJC}	-	3.6/1.2/0.6	

SPECIFICATIONS $T_J = 25\text{ °C}$, unless otherwise noted

PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
Static							
Drain-Source Breakdown Voltage	V _{DS}	V _{GS} = 0 V, I _D = 250 μA		650	-	-	V
V _{DS} Temperature Coefficient	ΔV _{DS} /T _J	Reference to 25 °C, I _D = 1 mA ^d		-	0.6	-	mV/°C
Gate-Source Threshold Voltage	V _{GS(th)}	V _{DS} = V _{GS} , I _D = 250 μA		2.0	-	4.0	V
Gate-Source Leakage	I _{GSS}	V _{GS} = ± 30 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 650 V, V _{GS} = 0 V		-	-	10	μA
		V _{DS} = 520 V, V _{GS} = 0 V, T _J = 125 °C		-	-	100	
Drain-Source On-State Resistance	R _{DS(on)}	V _{GS} = 10 V	I _D = 2.5 A ^b	-	0.95	-	Ω
Forward Transconductance	g _{fs}	V _{DS} = 50 V, I _D = 2.5 A		8	-	-	S
Dynamic							
Input Capacitance	C _{iss}	V _{GS} = 0 V, V _{DS} = 25 V, f = 1.0 MHz, see fig. 5		-	320	-	pF
Output Capacitance	C _{oss}			-	75	-	
Reverse Transfer Capacitance	C _{rss}			-	4	-	
Output Capacitance	C _{oss}	V _{GS} = 0 V	V _{DS} = 1.0 V, f = 1.0 MHz	-	500	-	
			V _{DS} = 520 V, f = 1.0 MHz	-	83	-	
Effective Output Capacitance	C _{oss eff.}		V _{DS} = 0 V to 520 V ^c	-	14	-	
Total Gate Charge	Q _g	V _{GS} = 10 V	I _D = 2.5 A, V _{DS} = 400 V see fig. 6 and 13 ^b	-	-	15	nC
Gate-Source Charge	Q _{gs}			-	-	3	
Gate-Drain Charge	Q _{gd}			-	-	6	
Turn-On Delay Time	t _{d(on)}	V _{DD} = 325 V, I _D = 3.2 A R _G = 9.1 Ω, R _D = 62 Ω, see fig. 10 ^b		-	18	-	ns
Rise Time	t _r			-	40	-	
Turn-Off Delay Time	t _{d(off)}			-	50	-	
Fall Time	t _f			-	30	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I _S	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	5	A
Pulsed Diode Forward Current ^a	I _{SM}			-	-	16	
Body Diode Voltage	V _{SD}	T _J = 25 °C, I _S = 3.2 A, V _{GS} = 0 V ^b		-	-	1.5	V
Body Diode Reverse Recovery Time	t _{rr}	T _J = 25 °C, I _F = 3.2 A, dI/dt = 100 A/μs ^b		-	180	-	ns
Body Diode Reverse Recovery Charge	Q _{rr}			-	2.1	3.2	μC
Forward Turn-On Time	t _{on}	Intrinsic turn-on time is negligible (turn-on is dominated by L _S and L _D)					

Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
 b. Pulse width $\leq 300\text{ }\mu\text{s}$; duty cycle $\leq 2\%$.
 c. $C_{oss\text{ eff.}}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS} .
 d. $t = 60\text{ s}$, $f = 60\text{ Hz}$.

TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



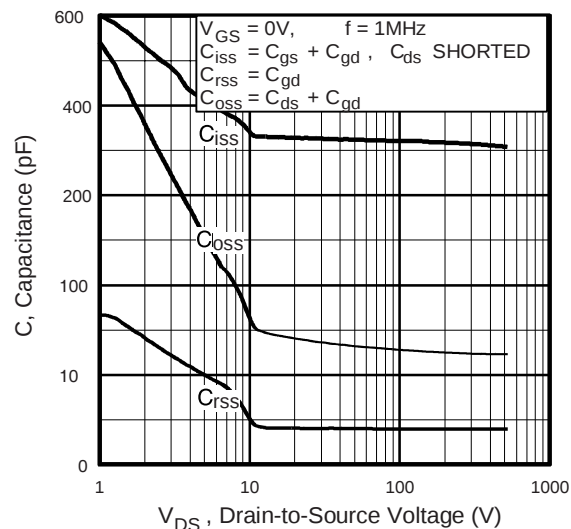


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

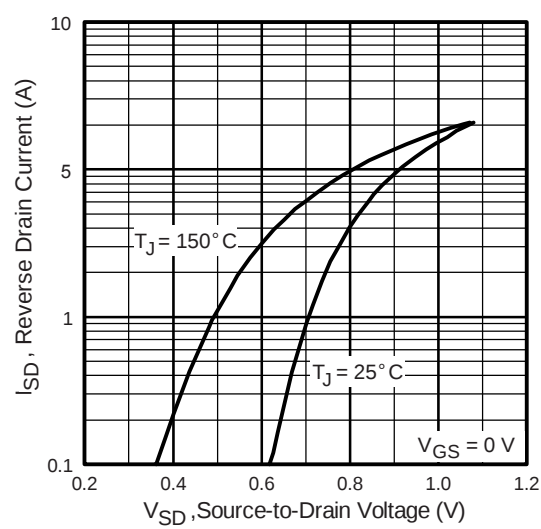


Fig. 7 - Typical Source-Drain Diode Forward Voltage

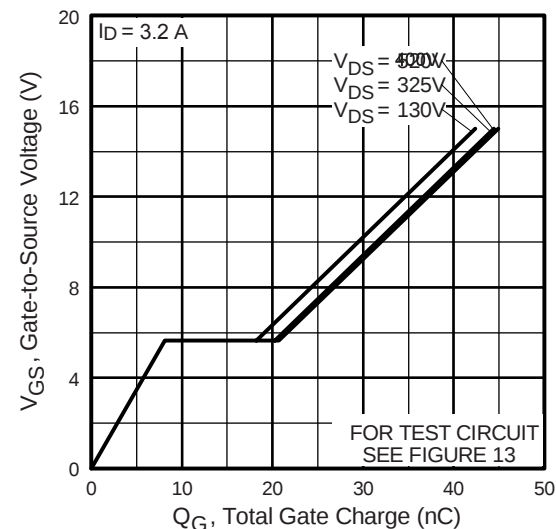


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

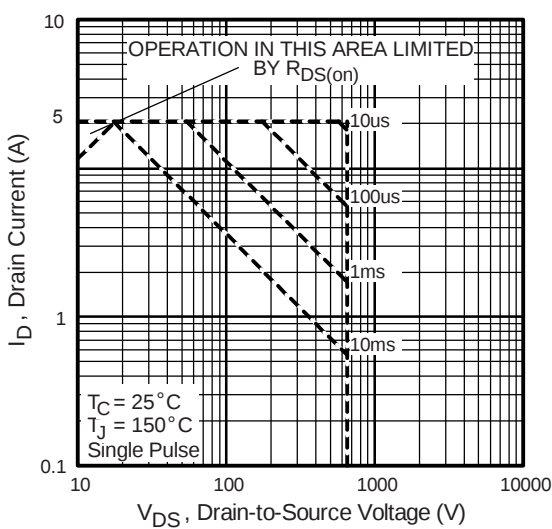


Fig. 8 - Maximum Safe Operating Area



Fig. 9 - Maximum Drain Current vs. Case Temperature

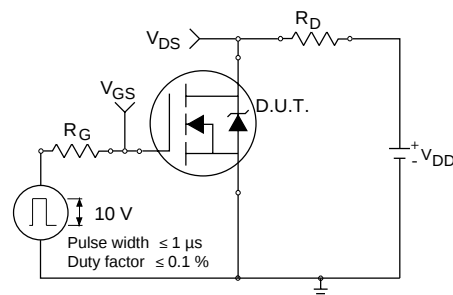


Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms



Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

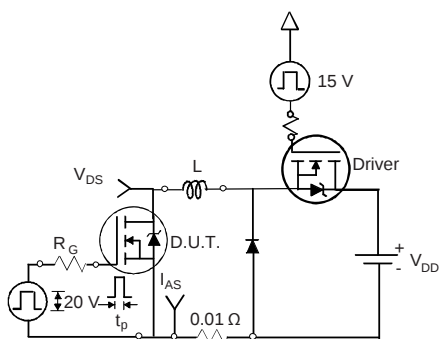


Fig. 12a - Unclamped Inductive Test Circuit

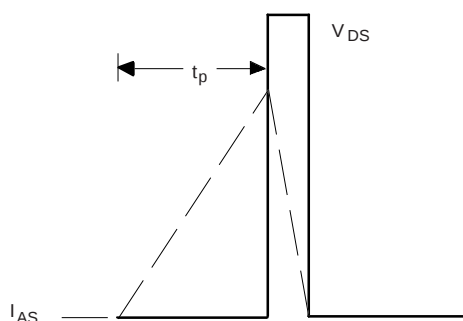


Fig. 12b - Unclamped Inductive Waveforms



Fig. 12c - Maximum Avalanche Energy vs. Drain Current

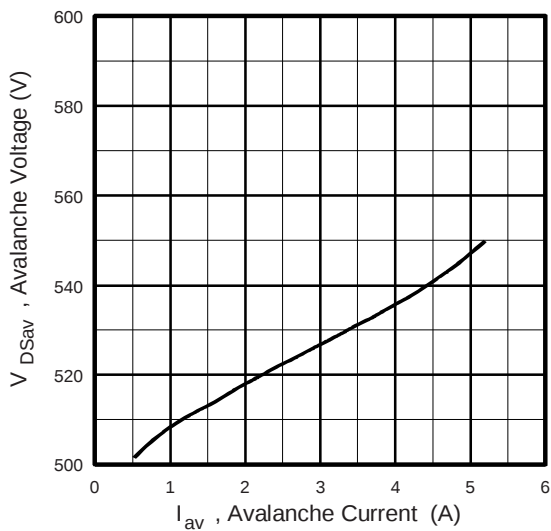


Fig. 12d - Typical Drain-to Source Voltage vs. Avalanche Current



Fig. 13a - Basic Gate Charge Waveform



Fig. 13b - Gate Charge Test Circuit

The diagram shows a common-emitter amplifier circuit. A square-wave voltage source (1) is connected in series with a resistor R_G to the base of a driver transistor. The emitter of the driver transistor is connected to ground. The collector of the driver transistor is connected to the base of a second transistor, which is the D.U.T. (Device Under Test). The emitter of the D.U.T. is connected to ground. The collector of the D.U.T. is connected to a positive supply V_{DD} through a load resistor (4). A current source (3) is connected between the collector of the D.U.T. and the positive supply V_{DD} . The output of the D.U.T. is taken from its collector. The circuit is labeled with callouts 1 through 4.

① Voltage source

② Driver transistor

③ D.U.T. (Device Under Test)

④ Load resistor

R_G Gate resistor

V_{DD} Supply voltage

Circuit layout considerations

- Low stray inductance
- Ground plane
- Low leakage inductance current transformer

dV/dt controlled by R_G

• Driver same type as D.U.T.

• I_{SD} controlled by duty factor "D"

• D.U.T. - device under test

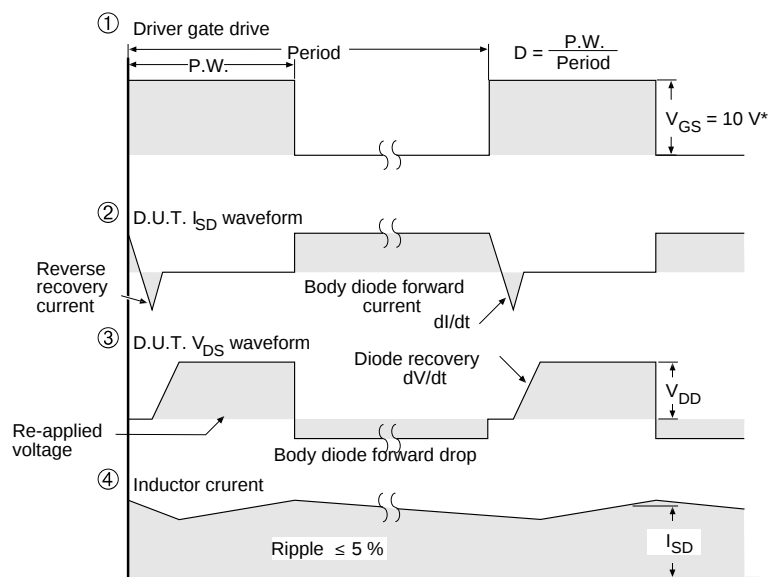


Fig. 14 - For N-Channel

TO-252AA CASE OUTLINE



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	2.18	2.38	0.086	0.094
A1	-	0.127	-	0.005
b	0.64	0.88	0.025	0.035
b2	0.76	1.14	0.030	0.045
b3	4.95	5.46	0.195	0.215
C	0.46	0.61	0.018	0.024
C2	0.46	0.89	0.018	0.035
D	5.97	6.22	0.235	0.245
D1	5.21	-	0.205	-
E	6.35	6.73	0.250	0.265
E1	4.32	-	0.170	-
H	9.40	10.41	0.370	0.410
e	2.28 BSC		0.090 BSC	
e1	4.56 BSC		0.180 BSC	
L	1.40	1.78	0.055	0.070
L3	0.89	1.27	0.035	0.050
L4	-	1.02	-	0.040
L5	1.14	1.52	0.045	0.060
ECN: X12-0247-Rev. M, 24-Dec-12				
DWG: 5347				

- Note**
- Dimension L3 is for reference only.

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