# N-Channel Power MOSFET
(9A, 900Volts)

DESCRIPTION

The Nell **2SK3878** is a three-terminal silicon device with current conduction capability of 9A, fast switching speed, low on-state resistance, breakdown voltage rating of 900V, and max. threshold voltage of 4 volts.

They are designed for use in applications such as switched mode power supplies, DC to DC converters, motor control circuits,UPS, switching regulator and general purpose switching applications.

FEATURES

- $R_{DS(ON)}$ = 1.00Ω @ V_{GS} = 10V
- Ultra low gate charge(60nC typical)
- Low reverse transfer capacitance (C_{RSS} = 45pF typical)
- Fast switching capability
- 100% avalanche energy specified
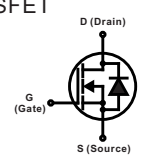- Improved dv/dt capability
- 150°C operation temperature

TO-3PB
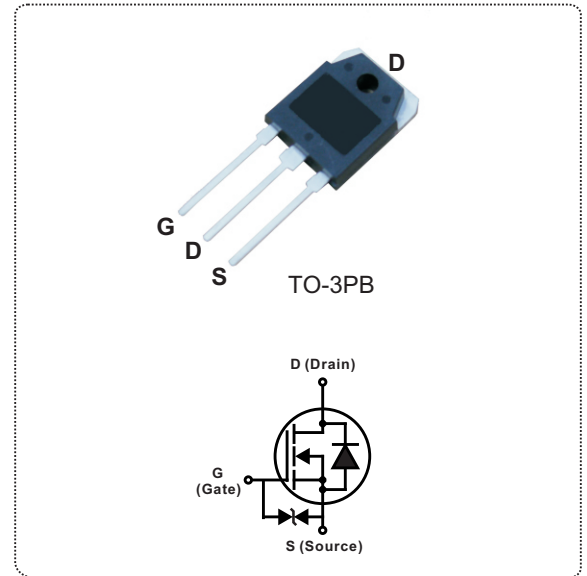
PRODUCT SUMMARY

I_D (A)	9
V_{DSS} (V)	900
$R_{DS(ON)}$ (Ω)	1.00 @ V_{GS} = 10V
Q_G(nC) max.	60

ABSOLUTE MAXIMUM RATINGS (T_C = 25°C unless otherwise specified)

SYMBOL	PARAMETER	TEST CONDITIONS		VALUE	UNIT
V_{DSS}	Drain to Source voltage	T_J=25°C to 150°C		900	
V_{DGR}	Drain to Gate voltage	R_{GS}=20KΩ		900	V
V_{GS}	Gate to Source voltage			±30	
I_D	Continuous Drain Current (V_{GS} = 10V)	T_C=25°C		9	
		T_C=100°C		5.6	
I_{DM}	Pulsed Drain current(Note 1)			27	A
I_{AR}	Avalanche current(Note 1)			9	
E_{AR}	Repetitive avalanche energy(Note 1)	I_{AR}=9A, R_{GS}=50Ω, V_{GS}=10V		15	mJ
E_{AS}	Single pulse avalanche energy(Note 2)	I_{AS}=9A, L=17.6mH		778	mJ
dv/dt	Peak diode recovery dv/dt(Note 3)			3.5	V /ns
P_D	Total power dissipation	T_C=25°C	TO-3PB	150	W
	Derating factor above 25°C			1.2	W /°C
T_J	Operation junction temperature			-55 to 150	
T_{STG}	Storage temperature			-55 to 150	°C
T_L	Maximum soldering temperature, for 10 seconds	1.6mm from case		300	
	Mounting torque, #6-32 or M3 screw			10 (1.1)	lbf·in (N·m)

Note: 1.Repetitive rating: pulse width limited by junction temperature.
2.I_{AS}=9A, L=17.6mH, V_{DD} = 90V, R_G =25Ω, starting T_J =25°C.
3.I_{SD} ≤ 9A, di/dt ≤ 130A/μs, V_{DD} ≤ $V_{(BR)DSS}$, starting T_J =25°C.

THERMAL RESISTANCE

SYMBOL	PARAMETER	Min.	Typ.	Max.	UNIT
$R_{th(j-c)}$	Thermal resistance, junction to case			0.83	
$R_{th(c-s)}$	Thermal resistance, case to heatsink		0.30		°C/W
$R_{th(j-a)}$	Thermal resistance, junction to ambient			50	

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise specified)

SYMBOL	PARAMETER	TEST CONDITIONS		Min.	Typ.	Max.	UNIT
◎ **STATIC**							
$V_{(BR)DSS}$	Drain to source breakdown voltage	I_D = 10mA, V_{GS} = 0V		900			V
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown voltage temperature coefficient	I_D = 250µA, V_{DS} = V_{GS}			0.99		V/°C
I_{DSS}	Drain to source leakage current	V_{DS}=900V, V_{GS}=0V	T_C = 25°C			50.0	µA
		V_{DS}=720V, V_{GS}=0V	T_C=125°C			500	
I_{GSS}	Gate to source forward leakage current	V_{GS} = 30V, V_{DS} = 0V				10	µA
	Gate to source reverse leakage current	V_{GS} = -30V, V_{DS} = 0V				-10	
$R_{DS(ON)}$	Static drain to source on-state resistance	I_D = 4.0A, V_{GS} = 10V			1.00	1.30	Ω
$V_{GS(TH)}$	Gate threshold voltage	V_{GS}=V_{DS}=10V, I_D=1mA		2.0		4.0	V
g_{fS}	Forward transconductance	V_{DS}=15V, I_D=4A		3.5	7.0		S
◎ **DYNAMIC**							
C_{ISS}	Input capacitance	V_{DS} = 25V, V_{GS} = 0V, f =1MHz			2200		pF
C_{OSS}	Output capacitance				190		
C_{RSS}	Reverse transfer capacitance				45		
$t_{d(ON)}$	Turn-on delay time	V_{DD} = 400V, V_{GS} = 10V I_D = 4A, R_G = 4.7Ω, R_D = 100Ω, (Note 1,2)			25		ns
t_r	Rise time				65		
$t_{d(OFF)}$	Turn-off delay time				20		
t_f	Fall time				120		
Q_G	Total gate charge	V_{DD} = 400V, V_{GS} = 10V, I_D = 9A (Note 1,2)			60		nC
Q_{GS}	Gate to source charge				34		
Q_{GD}	Gate to drain charge (Miller charge)				26		
L_D	Internal drain inductance	Between lead, 6mm(0.25") from package and center of die contact			5		nH
L_S	Internal source inductance				13		

SOURCE TO DRAIN DIODE RATINGS AND CHARACTERISTICS (T_C = 25°C unless otherwise specified)

SYMBOL	PARAMETER	TEST CONDITIONS	Min.	Typ.	Max.	UNIT
V_{SD}	Diode forward voltage	I_{SD} = 9A, V_{GS} = 0V			1.7	V
$I_S(I_{SD})$	Continuous source to drain current	Integral reverse P-N junction diode in the MOSFET			9	
I_{SM}	Pulsed source current				27	A
t_{rr}	Reverse recovery time	I_{SD} = 9A, V_{GS} = 0V, dI_F/dt = 100A/µs		1400		ns
Q_{rr}	Reverse recovery charge			16		µC

Note: 1. Pulse test: Pulse width ≤ 10µs, duty cycle ≤ 1%.

2. Essentially independent of operating temperature.
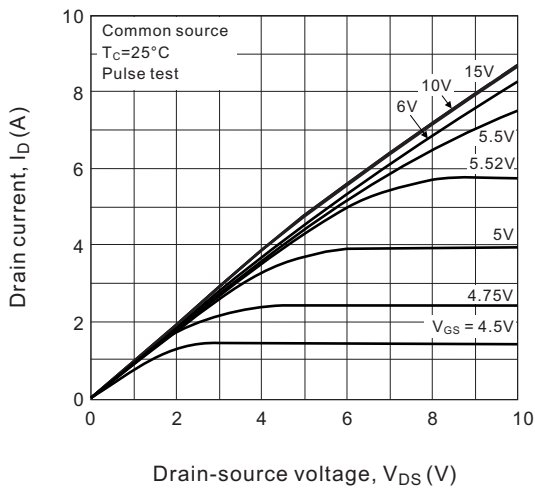
ORDERING INFORMATION SCHEME

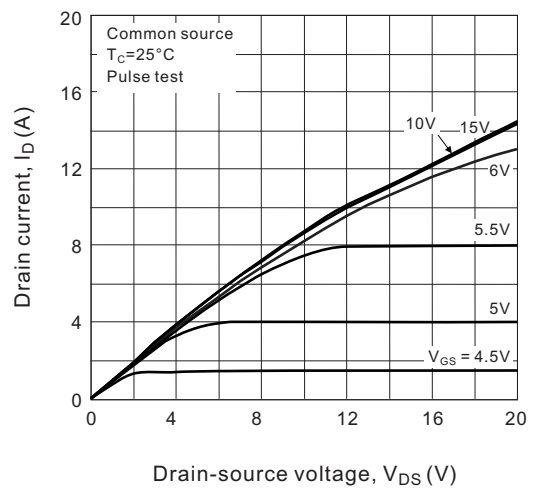**2SK   3878**

MOSFET series

N-Channel, Toshiba series
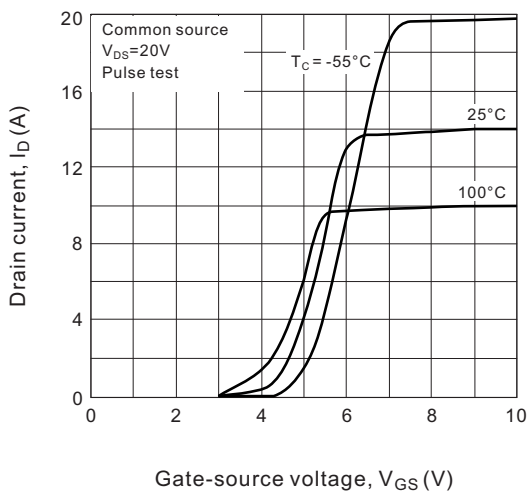
Current & Voltage rating, I_D & V_{DS}

9A / 900V

Fig.1 Typical output characteristics, T_C=25°C
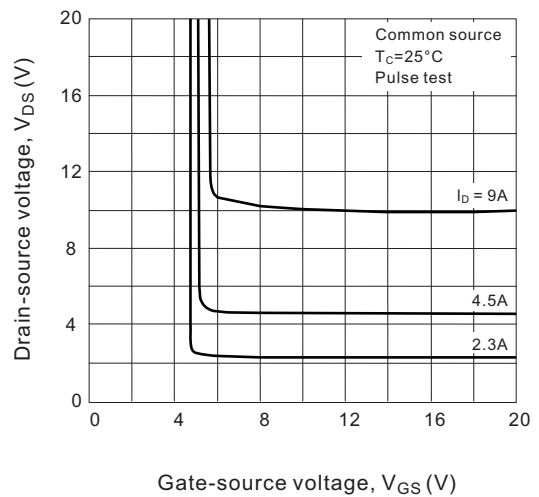

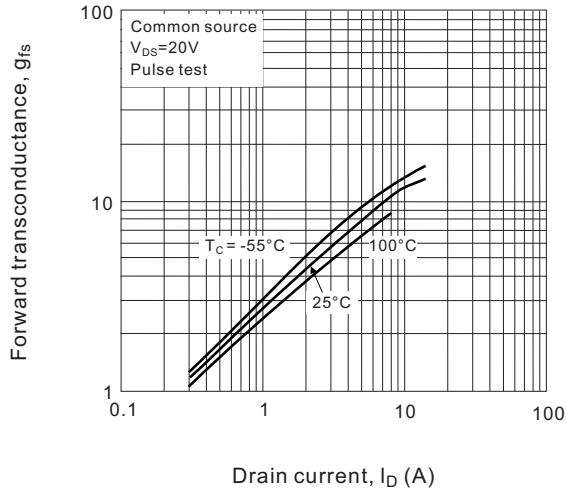**Fig.2 Typical output characteristics, T_C=25°C**
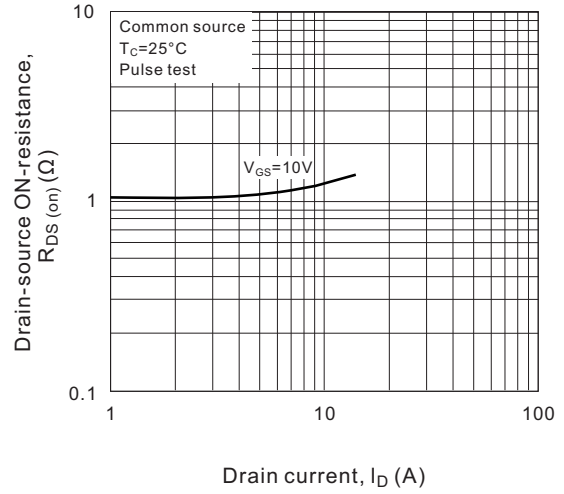

Fig.3 Typical transfer characteristics

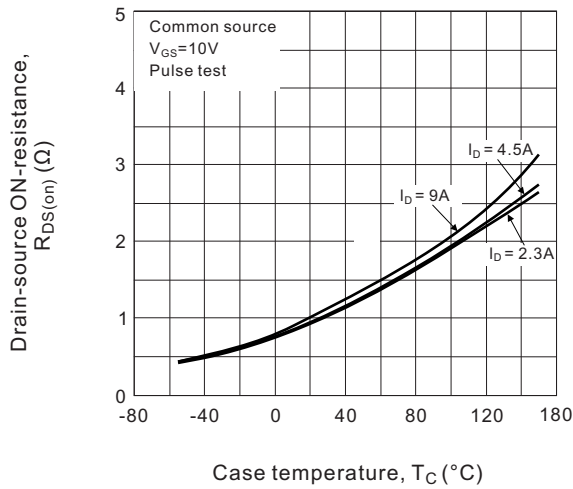**Fig.4 Drain-source voltage vs. gate-source voltage and drain current**
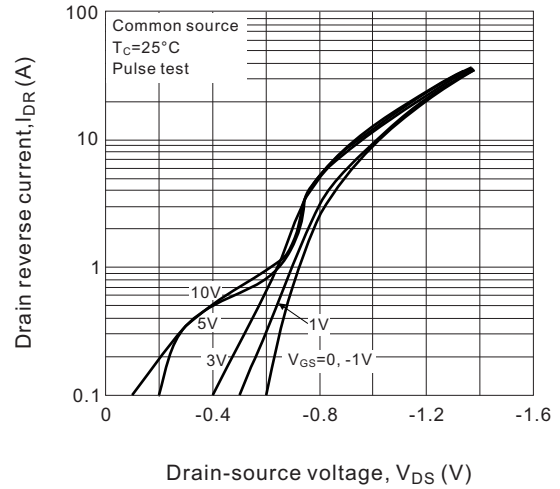
Fig.5 Forward transconductance characteristics

Forward transconductance, g_{fs}

Common source
$V_{DS}=20V$
Pulse test

$T_C = -55°C$ 100°C

25°C

Drain current, I_D (A)

Fig.6 On-Resistance variation vs. Drain current and gate voltage

Drain-source ON-resistance, $R_{DS (on)}$ (Ω)

Common source
$T_C=25°C$
Pulse test

$V_{GS}=10V$

Drain current, I_D (A)

Fig.7 On-Resistance variation vs. case temperature

Drain-source ON-resistance, $R_{DS(on)}$ (Ω)

Common source
$V_{GS}=10V$
Pulse test

$I_D = 4.5A$

$I_D = 9A$

$I_D = 2.3A$

Case temperature, T_C (°C)

Fig.8 Drain reverse current vs. Drain-Source voltage

Drain reverse current, I_{DR} (A)

Common source
$T_C=25°C$
Pulse test

10V
5V   1V
3V $V_{GS}=0, -1V$

Drain-source voltage, V_{DS} (V)

Fig.9 Capacitance characteristics

Capacitance, C (pF)

C_{iss}

C_{oss}

C_{rss}

Common source
$V_{GS}=0V$
f=1 MHZ
$T_C=25°C$

$C_{iss} = C_{gs} + C_{gd}$ (C_{ds} = shorted)
$C_{rss} = C_{gd}$
$C_{oss} = C_{ds} + C_{gd}$

Drain-source voltage, V_{DS} (V)
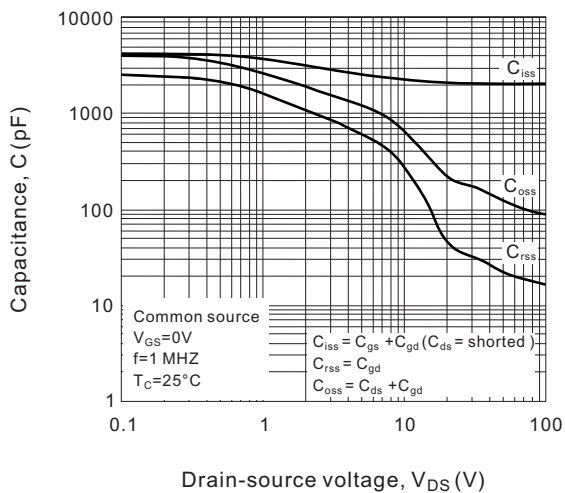
Fig.10 Gate threshold voltage vs. case temperature

Gate-threshold voltate, $V_{GS(th)}$ (V)

Common source
$V_{DS}=10V$
$I_D=1$ mA
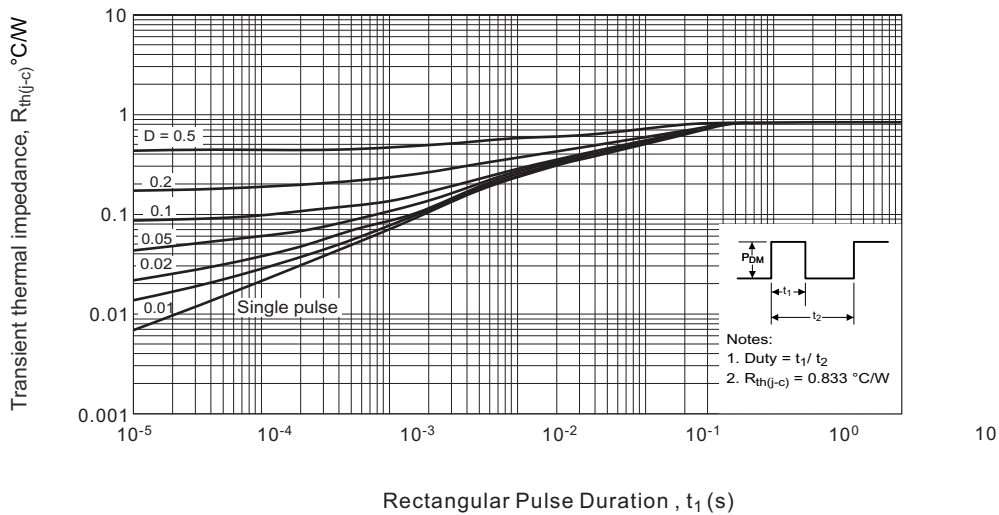Pulse test

Case temperature, T_C (°C)
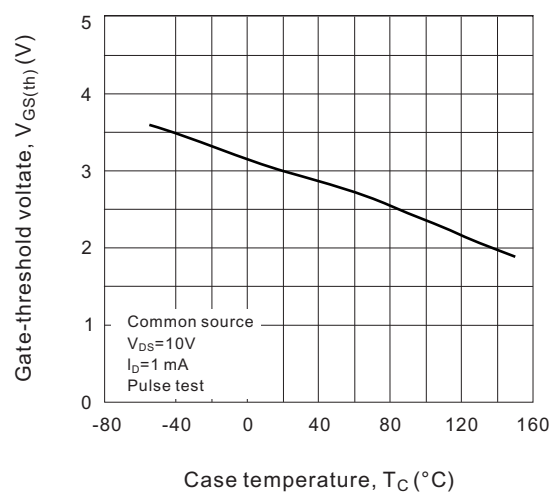
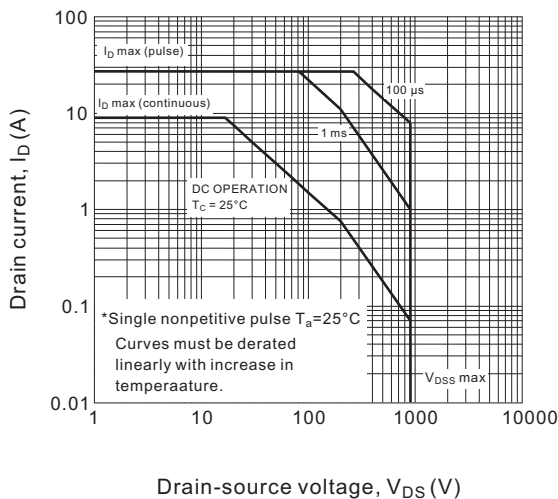**Fig.11 Drain power dissipation vs. case temperature**
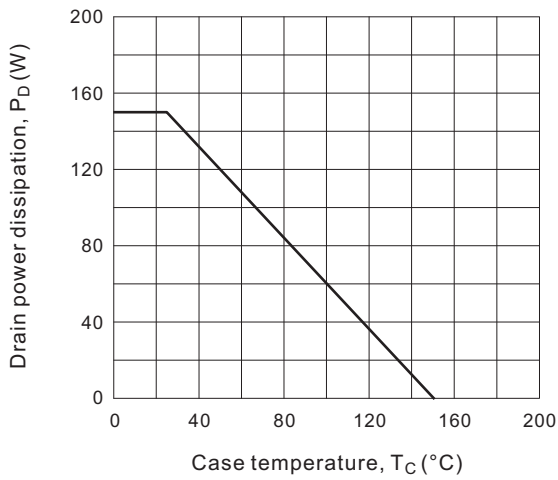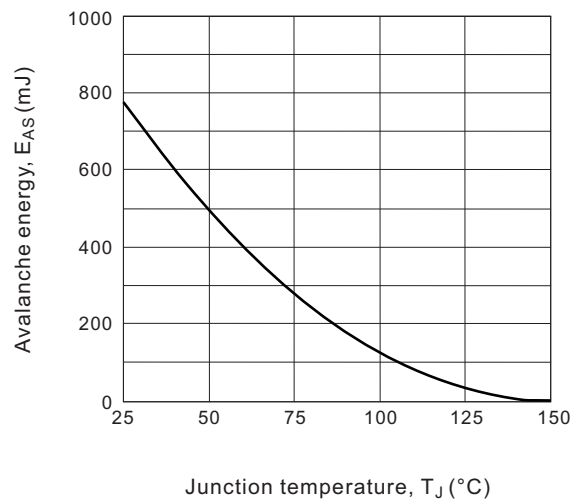

Fig.12 Dynamic input/output characteristics
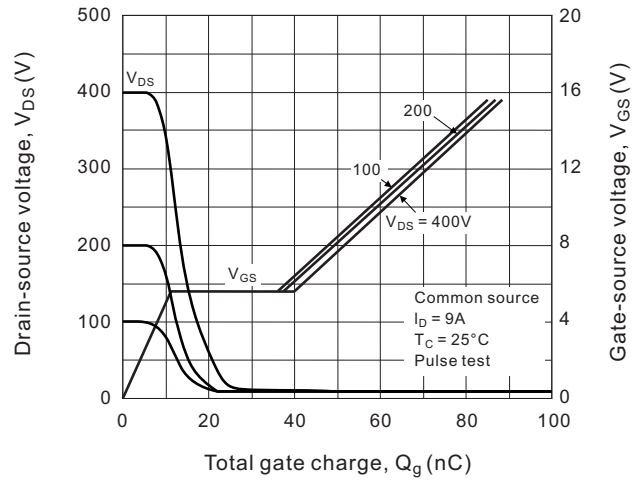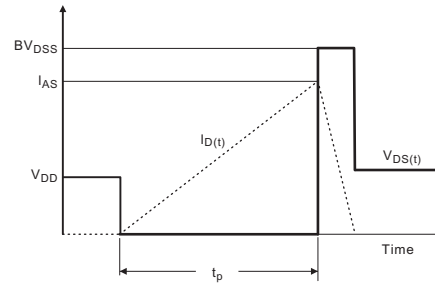

Fig.13 Transient thermal response curve

Notes:
1. Duty = t_1/ t_2
2. $R_{th(j-c)}$ = 0.833 °C/W

Rectangular Pulse Duration , t_1 (s)

Fig.14 Maximum safe operating area

*Single nonpetitive pulse T_a=25°C
Curves must be derated linearly with increase in temperaature.

Drain-source voltage, V_{DS} (V)

Fig.15 Single pulse avalanche energy vs. Junction temperature

Junction temperature, T_J (°C)

Fig.16 Unclamped inductive test circuit and waveforms
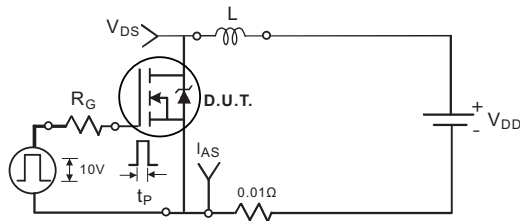
$R_G = 25\Omega$

$V_{DD} = 90V$, $L = 17.6$ mH

$$E_{AS} = \frac{1}{2} \cdot L \cdot I^2 \cdot \frac{B_{VDSS}}{B_{VDSS} - V_{DD}}$$

TO-3PB

All dimensions in millimeters(inches)