

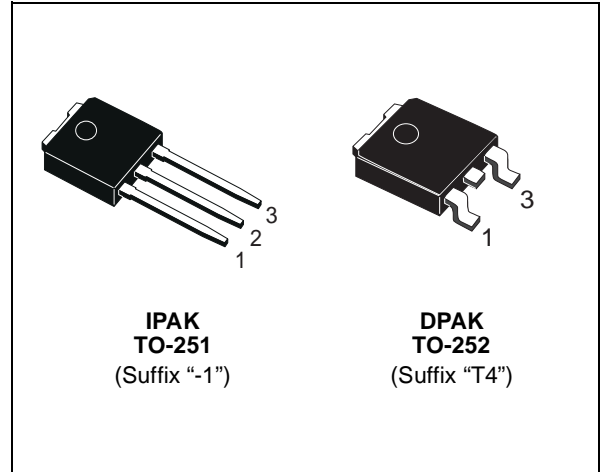


# STD38NH02L

## N-CHANNEL 24V - 0.011 $\Omega$ - 38A DPAK/IPAK STripFET™ III POWER MOSFET

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>
STD38NH02L	24 V	< 0.0135 $\Omega$	38 A

- TYPICAL R<sub>DS(on)</sub> = 0.011  $\Omega$  @ 10 V
- TYPICAL R<sub>DS(on)</sub> = 0.015  $\Omega$  @ 5 V
- R<sub>DS(on)</sub> \* Q<sub>g</sub> INDUSTRY'S BENCHMARK
- CONDUCTION LOSSES REDUCED
- SWITCHING LOSSES REDUCED
- LOW THRESHOLD DEVICE
- THROUGH-HOLE IPAK (TO-251) POWER PACKAGE IN TUBE (SUFFIX "-1")
- SURFACE-MOUNTING DPAK (TO-252) POWER PACKAGE IN TAPE & REEL (SUFFIX "T4")



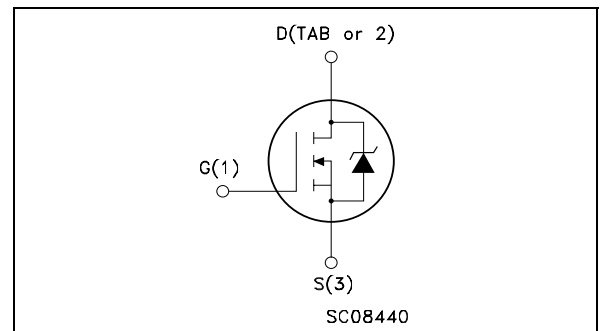
### DESCRIPTION

The STD38NH02L utilizes the latest advanced design rules of ST's proprietary STripFET™ technology. This is suitable for the most demanding DC-DC converter application where high efficiency is to be achieved.

### APPLICATIONS

- SPECIFICALLY DESIGNED AND OPTIMISED FOR HIGH EFFICIENCY DC/DC CONVERTERS

### INTERNAL SCHEMATIC DIAGRAM



### Ordering Information

SALES TYPE	MARKING	PACKAGE	PACKAGING
STD38NH02LT4	D38NH02L	TO-252	TAPE & REEL
STD38NH02L-1	D38NH02L	TO-251	TUBE

### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V <sub>spike(1)</sub>	Drain-source Voltage Rating	30	V
V <sub>DS</sub>	Drain-source Voltage (V <sub>GS</sub> = 0)	24	V
V <sub>DGR</sub>	Drain-gate Voltage (R <sub>GS</sub> = 20 k $\Omega$ )	24	V
V <sub>GS</sub>	Gate- source Voltage	$\pm 20$	V
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 25°C	38	A
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 100°C	27	A
I <sub>DM(2)</sub>	Drain Current (pulsed)	152	A
P <sub>tot</sub>	Total Dissipation at T <sub>C</sub> = 25°C	40	W
	Derating Factor	0.27	W/°C
E <sub>AS</sub> (3)	Single Pulse Avalanche Energy	250	mJ
T <sub>stg</sub>	Storage Temperature	-55 to 175	°C
T <sub>j</sub>	Max. Operating Junction Temperature		

## STD38NH02L

### THERMAL DATA

R <sub>thj-case</sub>	Thermal Resistance Junction-case	Max	3.75	°C/W
R <sub>thj-amb</sub>	Thermal Resistance Junction-ambient	Max	100	°C/W
T <sub>I</sub>	Maximum Lead Temperature For Soldering Purpose		275	°C

### ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> = 25 °C UNLESS OTHERWISE SPECIFIED)

#### OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source Breakdown Voltage	I <sub>D</sub> = 25 mA, V <sub>GS</sub> = 0	24			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = 20 V V <sub>DS</sub> = 20 V T <sub>C</sub> = 125°C			1 10	μA μA
I <sub>GSS</sub>	Gate-body Leakage Current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ± 20V			±100	nA

#### ON (4)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> I <sub>D</sub> = 250 μA	1	1.8	2.5	V
R <sub>DS(on)</sub>	Static Drain-source On Resistance	V <sub>GS</sub> = 10 V I <sub>D</sub> = 19 A V <sub>GS</sub> = 5 V I <sub>D</sub> = 9.5 A		0.011 0.015	0.0135 0.025	Ω Ω

#### DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g <sub>fs</sub> (4)	Forward Transconductance	V <sub>DS</sub> = 10 V I <sub>D</sub> = 19 A		19		S
C <sub>iss</sub> C <sub>oss</sub> C <sub>rss</sub>	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V <sub>DS</sub> = 15V f = 1 MHz V <sub>GS</sub> = 0		1070 305 45		pF pF pF
R <sub>G</sub>	Gate Input Resistance	f = 1 MHz Gate DC Bias = 0 Test Signal Level = 20 mV Open Drain		1		Ω

## STD38NH02L

### ELECTRICAL CHARACTERISTICS (continued)

#### SWITCHING ON

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$	Turn-on Delay Time Rise Time	$V_{DD} = 10\text{ V}$ $I_D = 19\text{ A}$ $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$ (Resistive Load, Figure 3)		7 62		ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total Gate Charge Gate-Source Charge Gate-Drain Charge	$0.44\text{ V} \leq V_{DD} \leq 10\text{ V}$ , $I_D = 38\text{ A}$ $V_{GS} = 10\text{ V}$		18 4 2.5	24	nC nC nC
$Q_{OSS}^{(5)}$	Output Charge	$V_{DS} = 16\text{ V}$ $V_{GS} = 0\text{ V}$		6.5		nC

#### SWITCHING OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$ $t_f$	Turn-off Delay Time Fall Time	$V_{DD} = 10\text{ V}$ $I_D = 19\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (Resistive Load, Figure 3)		25 12	16	ns ns

#### SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM}$	Source-drain Current Source-drain Current (pulsed)				38 152	A A
$V_{SD}^{(4)}$	Forward On Voltage	$I_{SD} = 19\text{ A}$ $V_{GS} = 0$			1.3	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD} = 38\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 18\text{ V}$ $T_j = 150^\circ\text{C}$ (see test circuit, Figure 5)		27 22 1.6	36 29	ns nC A

(1) Garanted when external  $R_g=4.7\ \Omega$  and  $t_f < t_{fmax}$ .

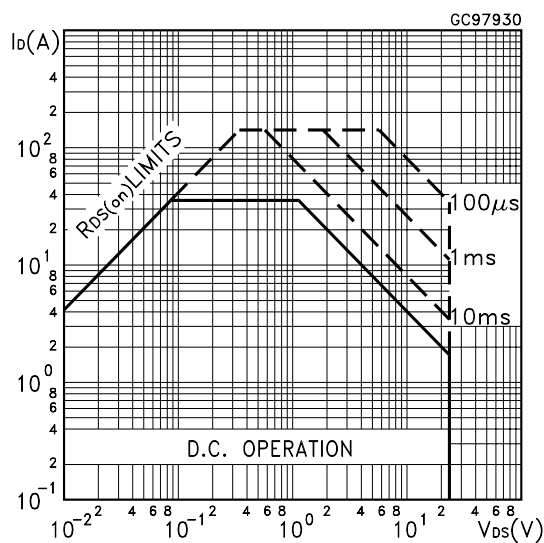
(2) Pulse width limited by safe operating area

(3) Starting  $T_j = 25^\circ\text{C}$ ,  $I_D = 19\text{ A}$ ,  $V_{DD} = 18\text{ V}$

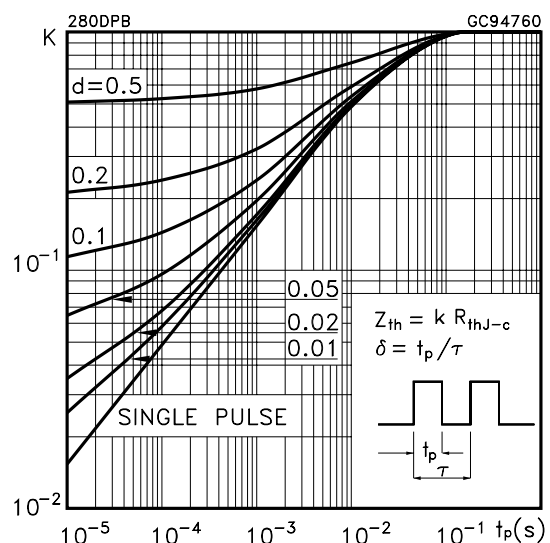
(4) Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

(5)  $Q_{OSS} = C_{OSS} \Delta V_{in}$ ,  $C_{OSS} = C_{gd} + C_{ds}$ . See Appendix A

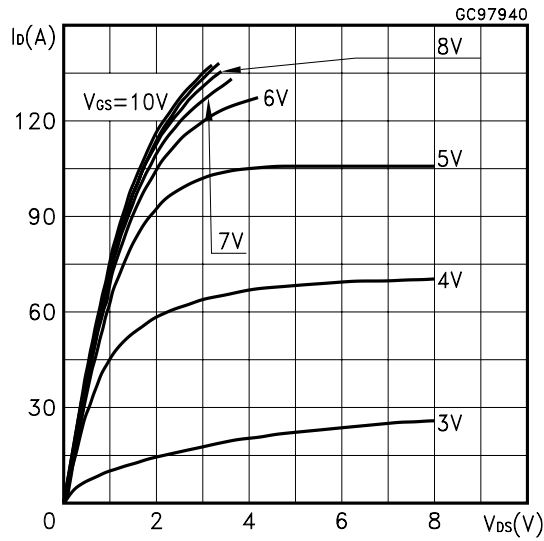
#### Safe Operating Area



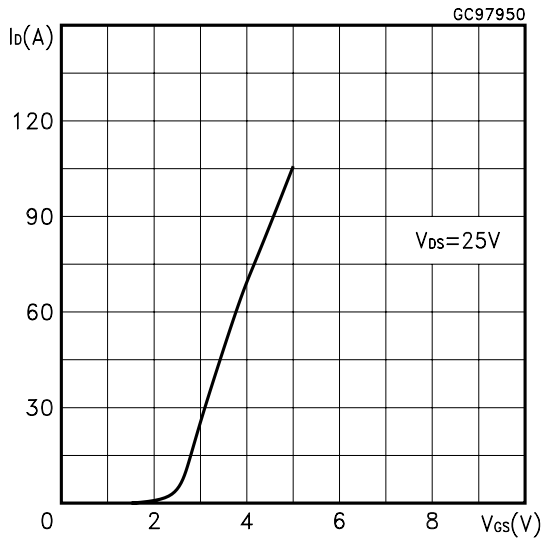
#### Thermal Impedance



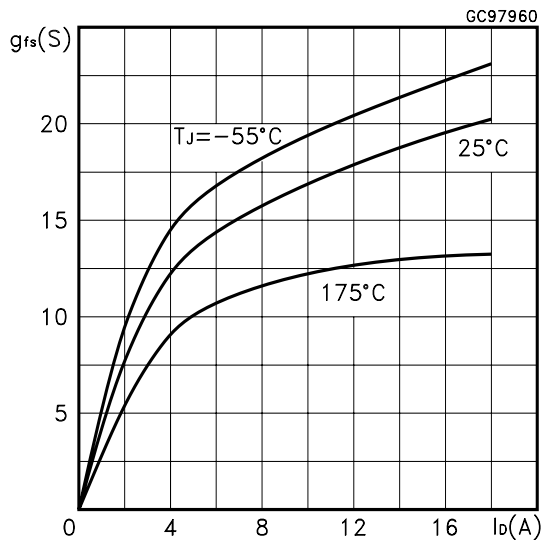
Output Characteristics



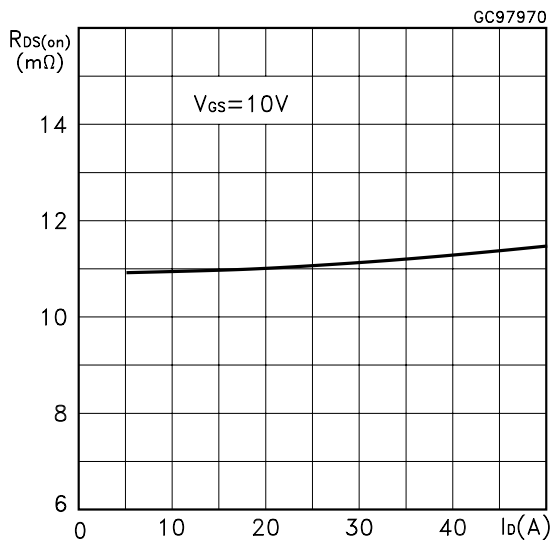
Transfer Characteristics



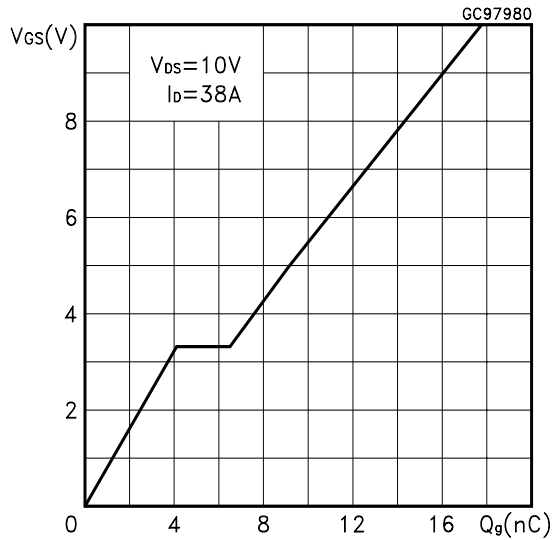
Transconductance



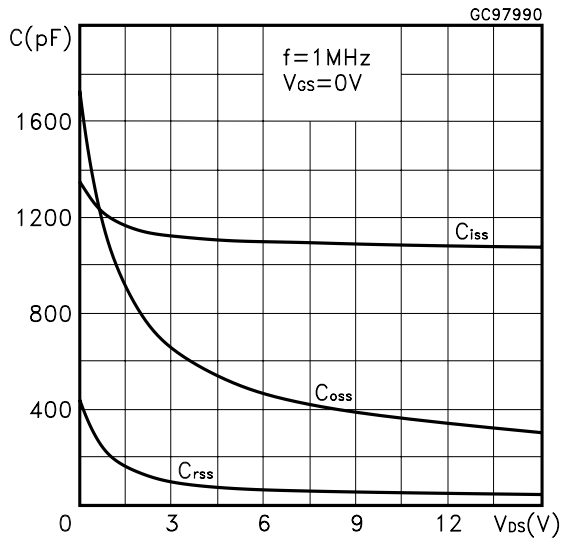
Static Drain-source On Resistance



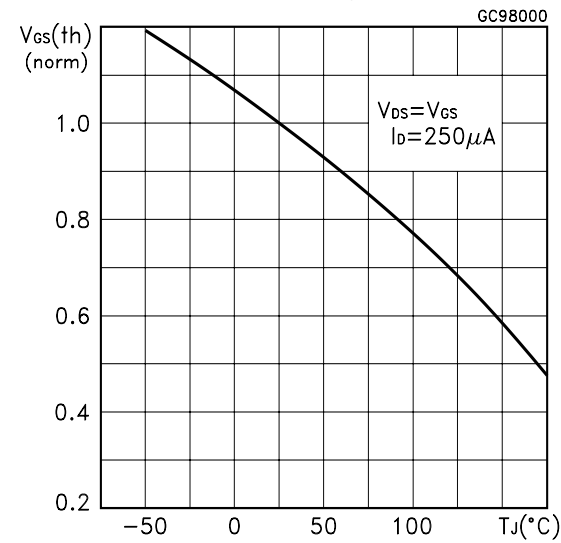
Gate Charge vs Gate-source Voltage



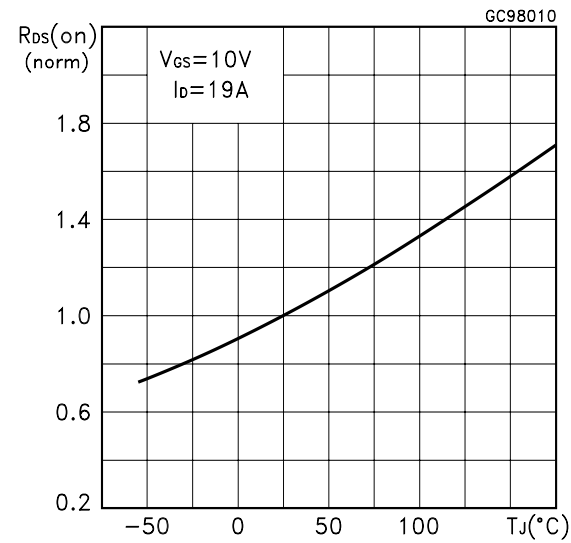
Capacitance Variations



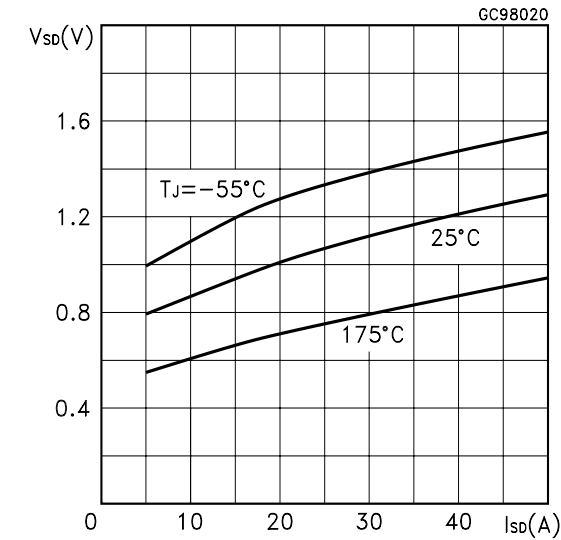
Normalized Gate Threshold Voltage vs Temperature



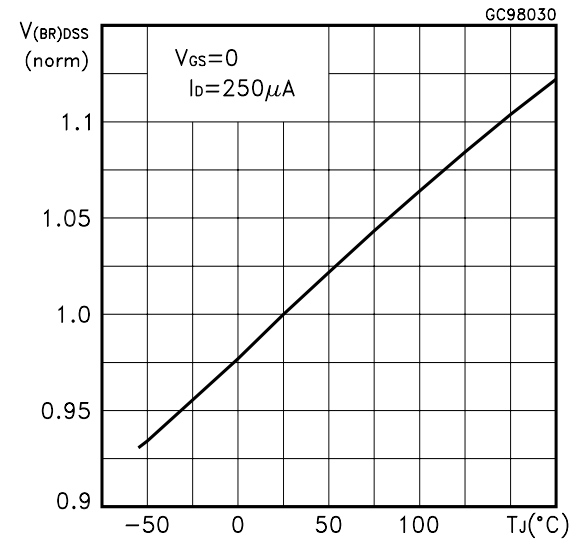
Normalized on Resistance vs Temperature



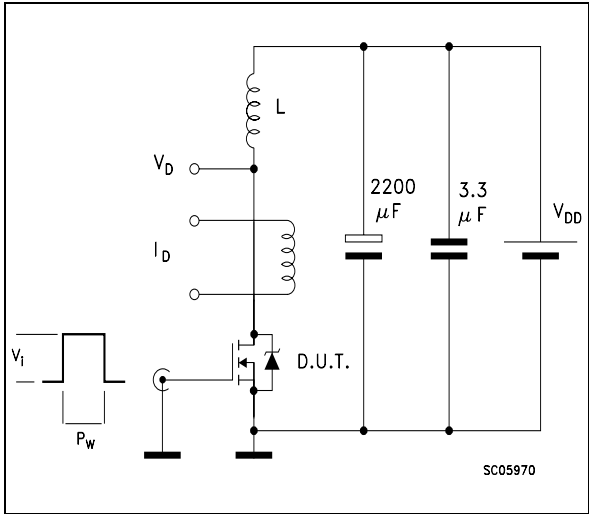
Source-drain Diode Forward Characteristics



Normalized Breakdown Voltage vs Temperature



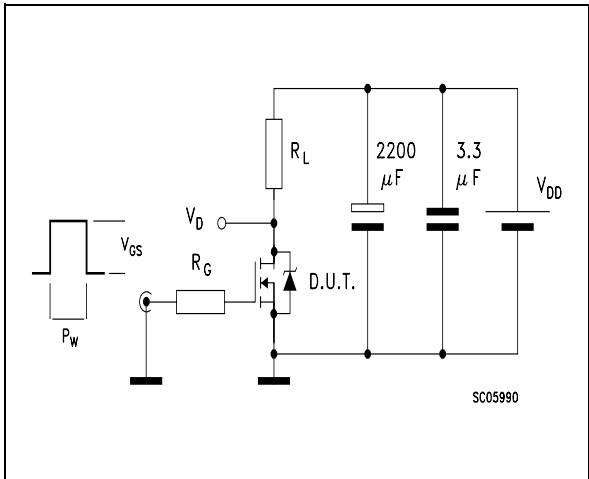
**Fig. 1: Unclamped Inductive Load Test Circuit**



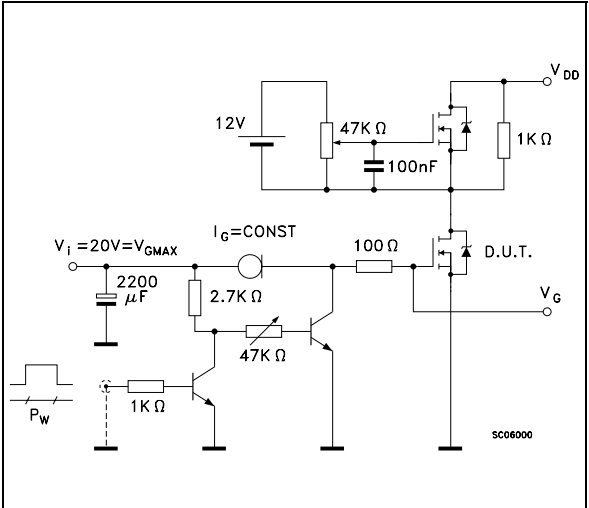
**Fig. 2: Unclamped Inductive Waveform**



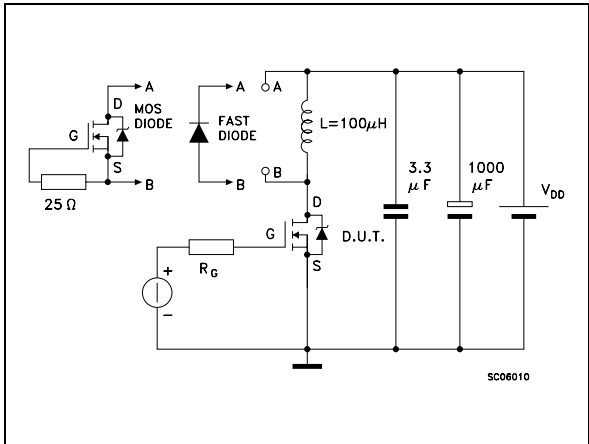
**Fig. 3: Switching Times Test Circuits For Resistive Load**



**Fig. 4: Gate Charge test Circuit**

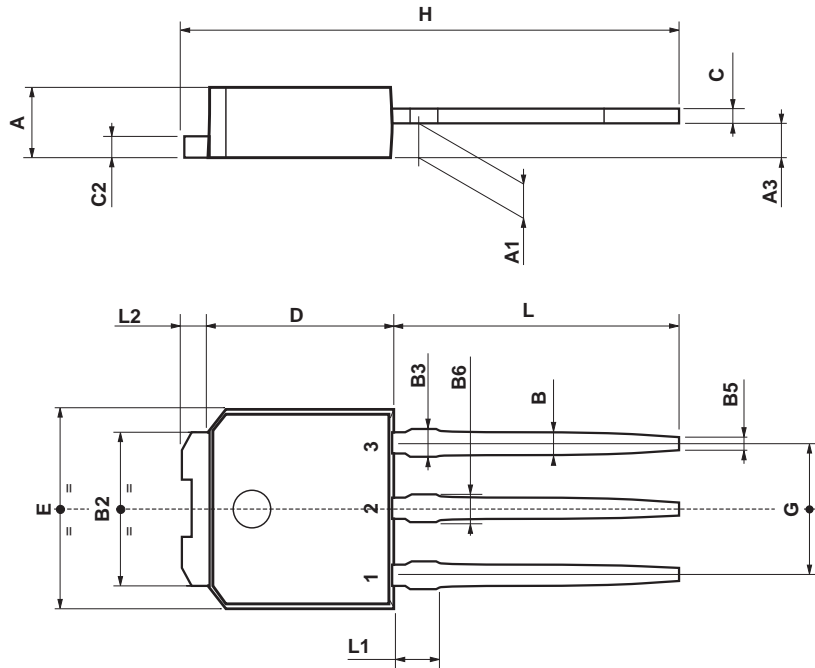


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



TO-251 (IPAK) MECHANICAL DATA

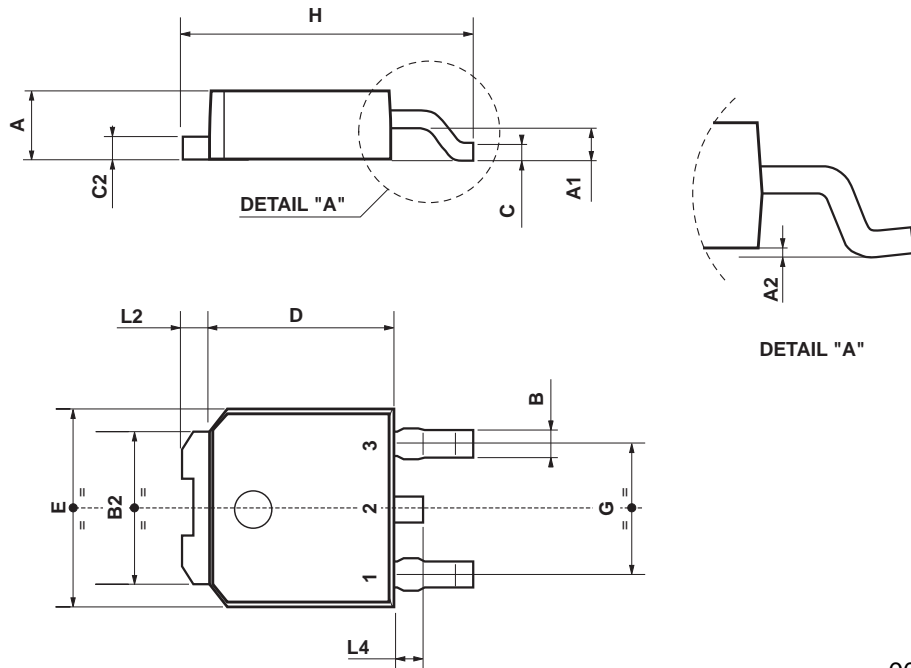
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A3	0.7		1.3	0.027		0.051
B	0.64		0.9	0.025		0.031
B2	5.2		5.4	0.204		0.212
B3			0.85			0.033
B5		0.3			0.012	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		6.6	0.252		0.260
G	4.4		4.6	0.173		0.181
H	15.9		16.3	0.626		0.641
L	9		9.4	0.354		0.370
L1	0.8		1.2	0.031		0.047
L2		0.8	1		0.031	0.039



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TO-252 (DPAK) MECHANICAL DATA

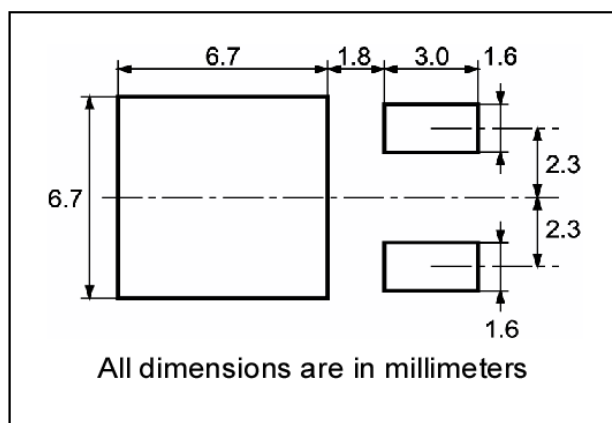
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.9	0.025		0.035
B2	5.2		5.4	0.204		0.212
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		6.6	0.252		0.260
G	4.4		4.6	0.173		0.181
H	9.35		10.1	0.368		0.397
L2		0.8			0.031	
L4	0.6		1	0.023		0.039



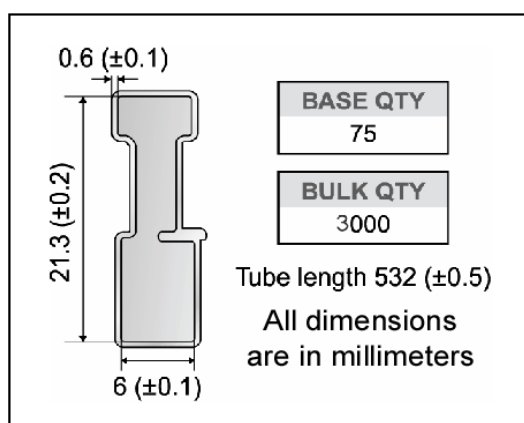
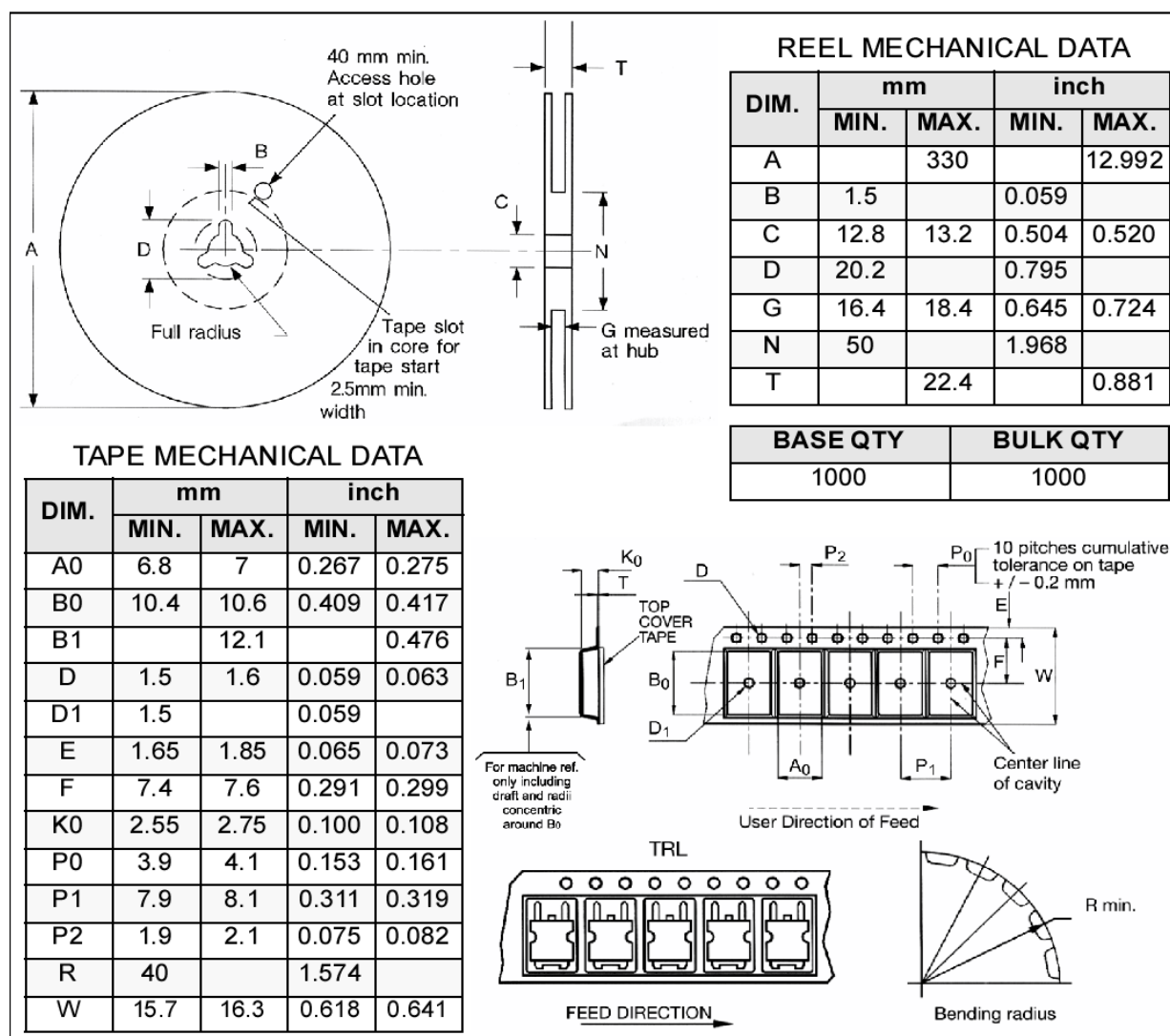
0068772-B



## DPAK FOOTPRINT

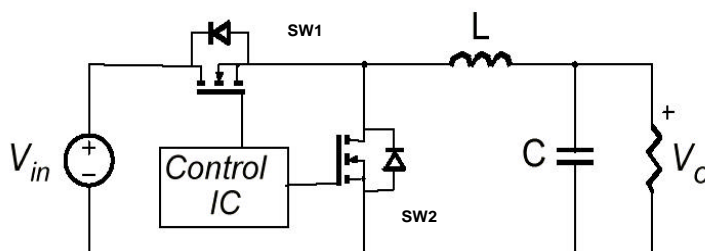


**TUBE SHIPMENT (no suffix)\***

**TAPE AND REEL SHIPMENT (suffix "T4")\***

## APPENDIX A

### Buck Converter: Power Losses Estimation



The power losses associated with the FETs in a Synchronous Buck converter can be estimated using the equations shown in the table below. The formulas give a good approximation, for the sake of performance comparison, of how different pairs of devices affect the converter efficiency. However a very important parameter, the working temperature, is not considered. The real device behavior is really dependent on how the heat generated inside the devices is removed to allow for a safer working junction temperature.

The low side (SW2) device requires:

- Very low  $R_{DS(on)}$  to reduce conduction losses
- Small  $Q_{gls}$  to reduce the gate charge losses
- Small  $C_{oss}$  to reduce losses due to output capacitance
- Small  $Q_{rr}$  to reduce losses on SW<sub>1</sub> during its turn-on
- The  $C_{gd}/C_{gs}$  ratio lower than  $V_{th}/V_{gg}$  ratio especially with low drain to source voltage to avoid the cross conduction phenomenon;

The high side (SW1) device requires:

- Small  $R_g$  and  $L_s$  to allow higher gate current peak and to limit the voltage feedback on the gate
- Small  $Q_g$  to have a faster commutation and to reduce gate charge losses
- Low  $R_{DS(on)}$  to reduce the conduction losses.

		High Side Switch (SW1)	Low Side Switch (SW2)
$P_{\text{conduction}}$		$R_{\text{DS(on)SW1}} * I_L^2 * d$	$R_{\text{DS(on)SW2}} * I_L^2 * (1-d)$
$P_{\text{switching}}$		$V_{\text{in}} * (Q_{\text{gsth(SW1)}} + Q_{\text{gd(SW1)}}) * f * \frac{I_L}{I_g}$	Zero Voltage Switching
$P_{\text{diode}}$	Recovery	Not Applicable	$^1 V_{\text{in}} * Q_{\text{rr(SW2)}} * f$
	Conduction	Not Applicable	$V_{\text{f(SW2)}} * I_L * t_{\text{deadtime}} * f$
$P_{\text{gate(Q}_G)}$		$Q_{\text{g(SW1)}} * V_{\text{gg}} * f$	$Q_{\text{gls(SW2)}} * V_{\text{gg}} * f$
$P_{\text{Qoss}}$		$\frac{V_{\text{in}} * Q_{\text{oss(SW1)}} * f}{2}$	$\frac{V_{\text{in}} * Q_{\text{oss(SW2)}} * f}{2}$

Parameter	Meaning
$d$	Duty-cycle
$Q_{\text{gsth}}$	Post threshold gate charge
$Q_{\text{gls}}$	Third quadrant gate charge
<b>Pconduction</b>	On state losses
<b>Pswitching</b>	On-off transition losses
<b>Pdiode</b>	Conduction and reverse recovery diode losses
<b>Pgate</b>	Gate drive losses
<b>PQoss</b>	Output capacitance losses

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<sup>1</sup> Dissipated by SW1 during turn-on

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