

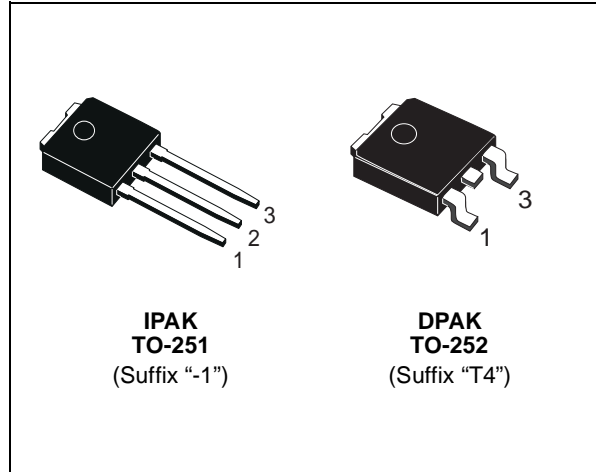


# STD38NH02L

## 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")



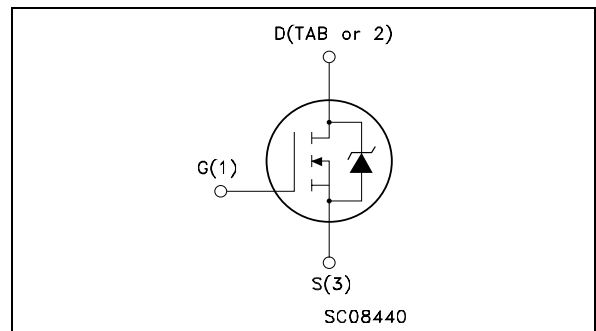
### DESCRIPTION

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



### 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(3)</sub>	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

Rthj-case	Thermal Resistance Junction-case	Max	3.75	°C/W
Rthj-amb	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>riss</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

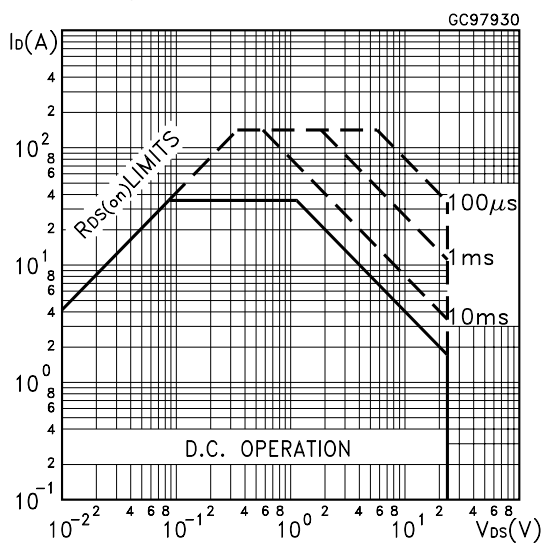
### SOURCE DRAIN DIODE

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

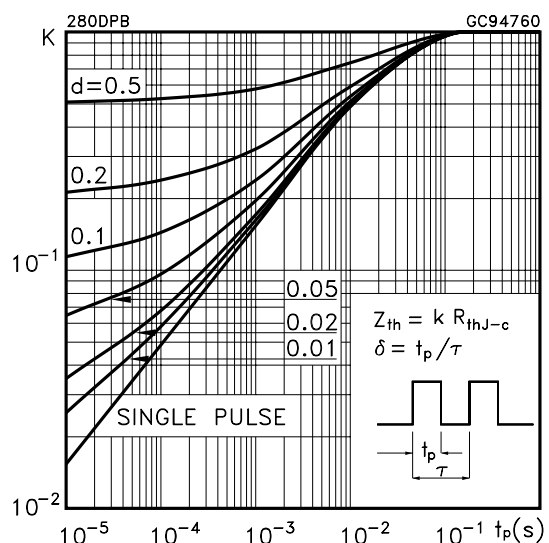
(1) Guaranteed when external  $R_g=4.7\ \Omega$  and  $t_f < t_{fmax}$ .  
 (2) Pulse width limited by safe operating area  
 (3) Starting  $T_j = 25\ ^\circ\text{C}$ ,  $I_D = 19\text{ A}$ ,  $V_{DD} = 18\text{ V}$

(4) Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.  
 (5)  $Q_{oss} = C_{oss} \cdot \Delta V_{in}$ ,  $C_{oss} = C_{gd} + C_{ds}$ . See Appendix A

### Safe Operating Area

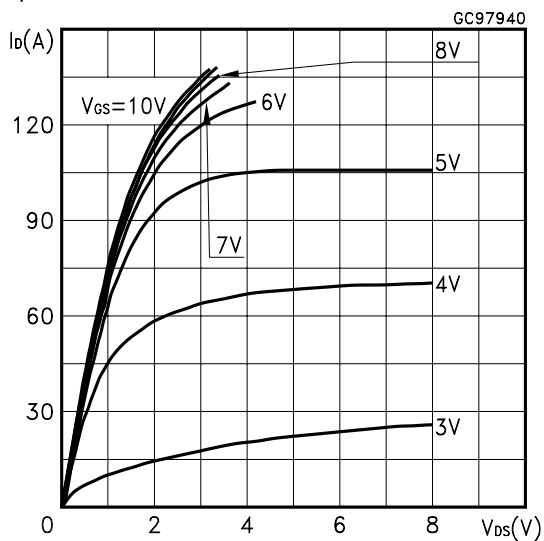


### Thermal Impedance

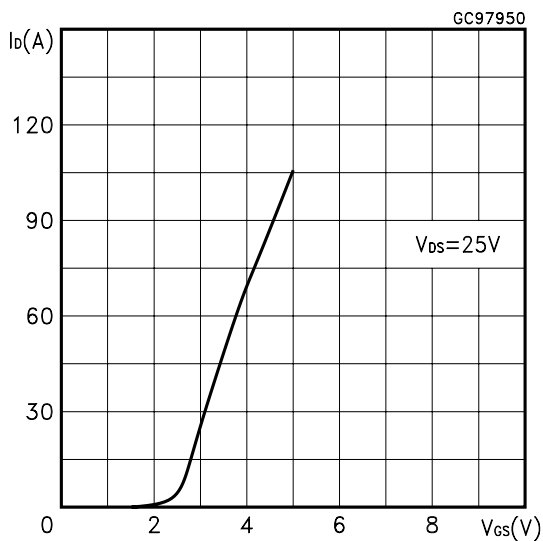


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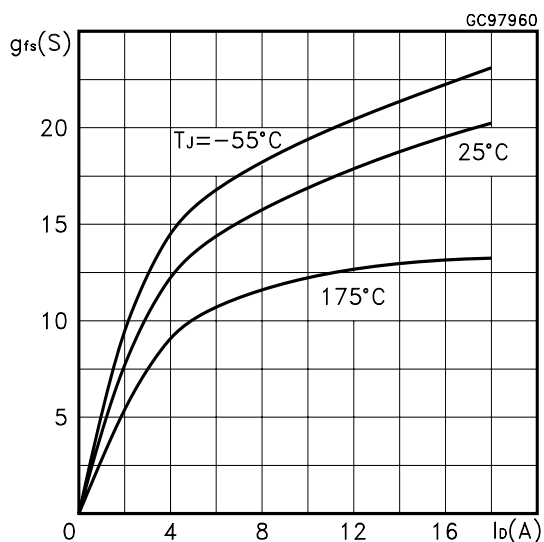
Output Characteristics



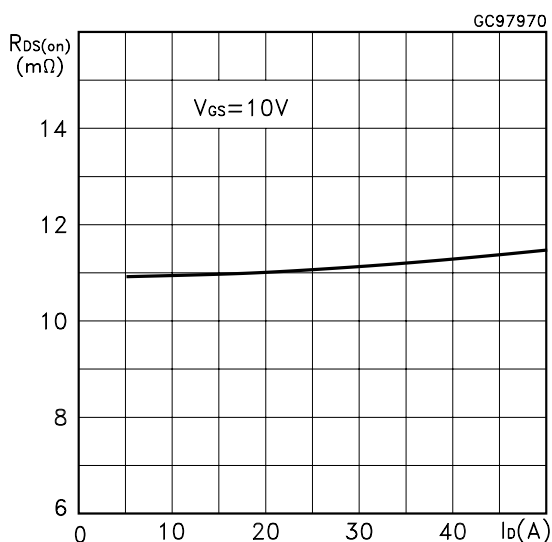
Transfer Characteristics



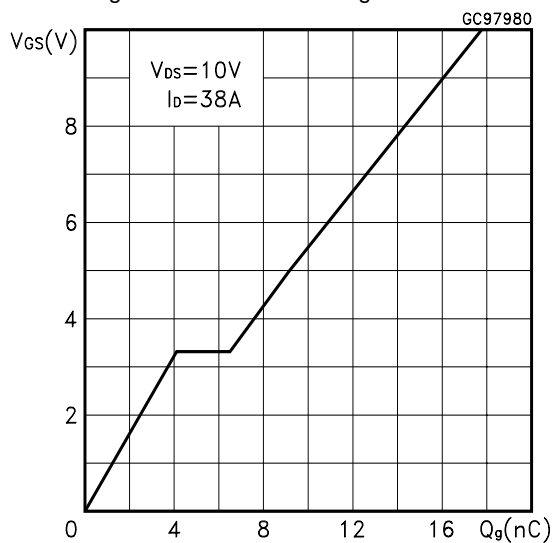
Transconductance



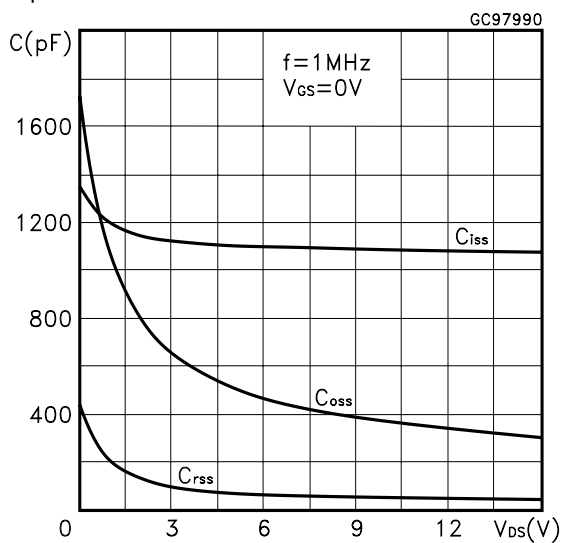
Static Drain-source On Resistance



Gate Charge vs Gate-source Voltage

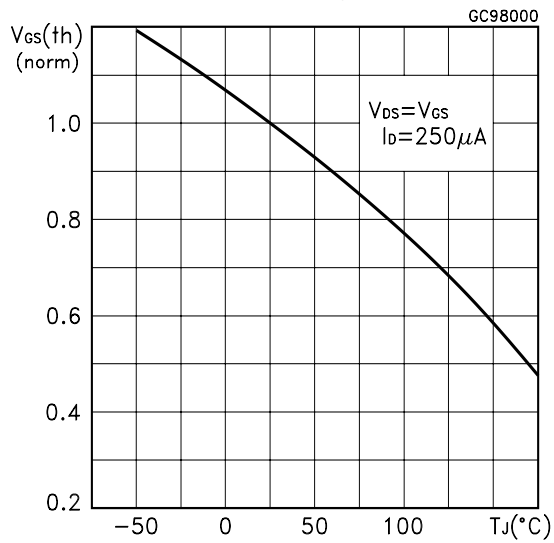


Capacitance Variations

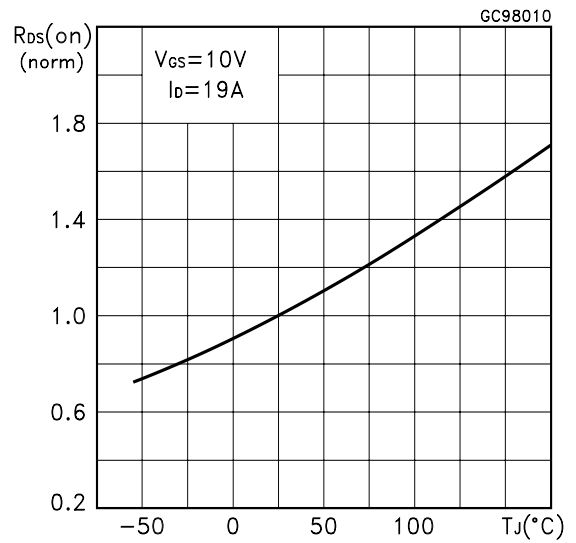


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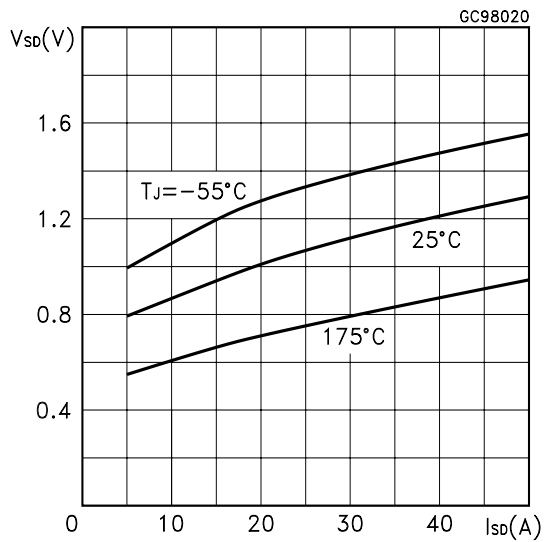
Normalized Gate Threshold Voltage vs Temperature



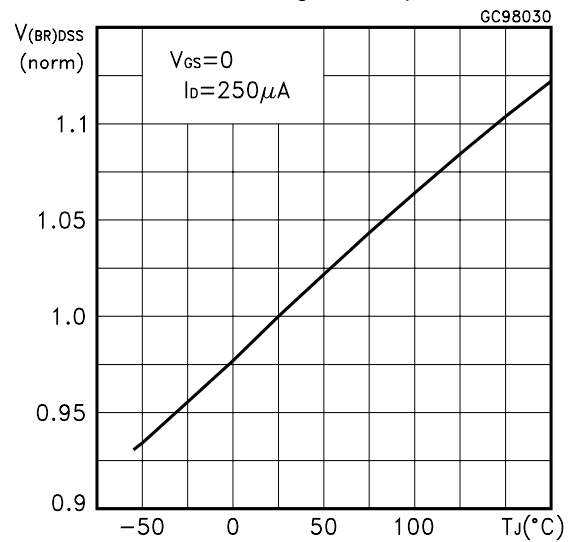
Normalized on Resistance vs Temperature



Source-drain Diode Forward Characteristics



Normalized Breakdown Voltage vs Temperature



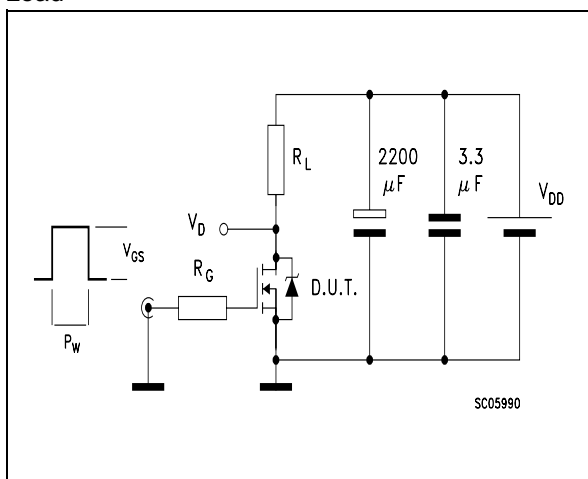
**Fig. 1: Unclamped Inductive Load Test Circuit**



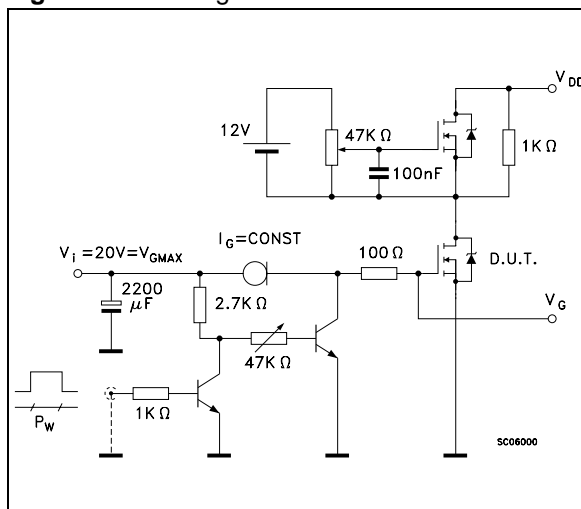
**Fig. 2: Unclamped Inductive Waveform**



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



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

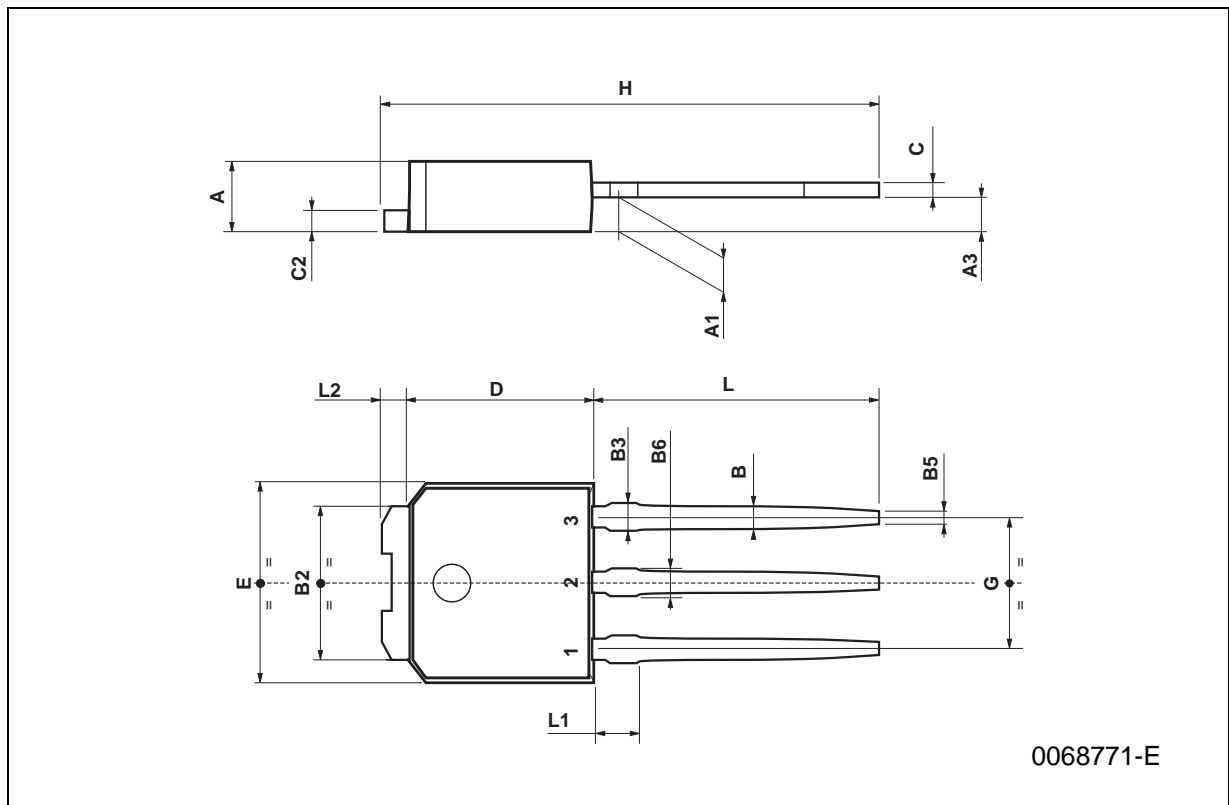


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



**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



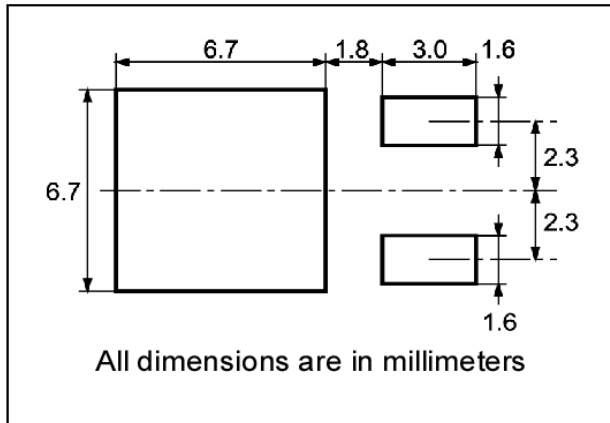
**TO-252 (DPAK) MECHANICAL DATA**

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

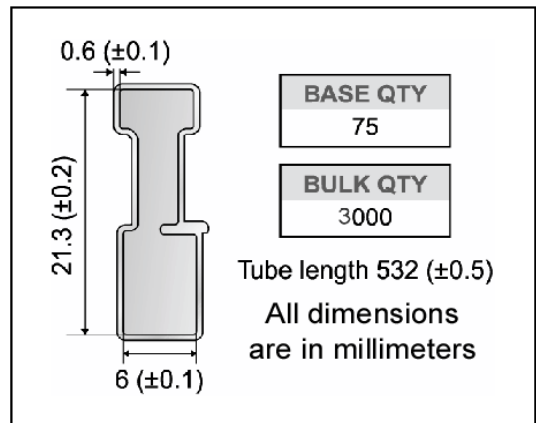




**DPAK FOOTPRINT**



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



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

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

G measured at hub

**REEL MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

BASE QTY	BULK QTY
1000	1000

**TAPE MECHANICAL DATA**

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641

For machine ref. only including draft and radii concentric around B0

10 pitches cumulative tolerance on tape +/- 0.2 mm

User Direction of Feed

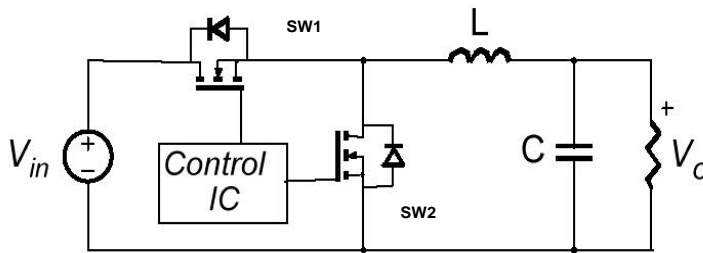
Center line of cavity

FEED DIRECTION

Bending radius R min.

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

Parameter	Meaning
d	Duty-cycle
$Q_{gsth}$	Post threshold gate charge
$Q_{gls}$	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

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

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