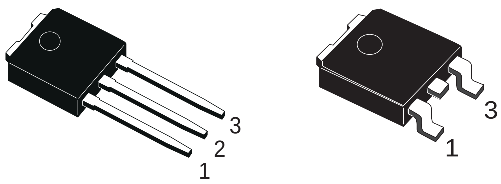
STD38NH02L

N-CHANNEL 24V - 0.011 Ω - 38A DPAK/IPAK
STripFET™ III POWER MOSFET

TYPE	V_{DSS}	$R_{DS(on)}$	I_D
STD38NH02L	24 V	< 0.0135 Ω	38 A

- TYPICAL R_{DS}(on) = 0.011 Ω @ 10 V
- TYPICAL R_{DS}(on) = 0.015 Ω @ 5 V
- $R_{DS(ON)}$ * Qg 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")



IPAK
TO-251
(Suffix “-1”)

DPAK
TO-252
(Suffix “T4”)

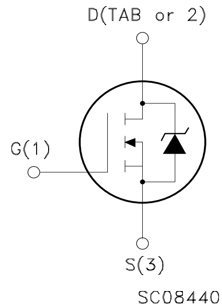
DESCRIPTION

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

APPLICATIONS

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

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
$V_{spike(1)}$	Drain-source Voltage Rating	30	V
V_{DS}	Drain-source Voltage (V_{GS} = 0)	24	V
V_{DGR}	Drain-gate Voltage (R_{GS} = 20 kΩ)	24	V
V_{GS}	Gate- source Voltage	± 20	V
I_D	Drain Current (continuous) at T_C = 25°C	38	A
I_D	Drain Current (continuous) at T_C = 100°C	27	A
I_{DM}(2)	Drain Current (pulsed)	152	A
P_{tot}	Total Dissipation at T_C = 25°C	40	W
	Derating Factor	0.27	W/°C
E_{AS} (3)	Single Pulse Avalanche Energy	250	mJ
T_{stg}	Storage Temperature	-55 to 175	°C
T_j	Max. Operating Junction Temperature		

THERMAL DATA

Rthj-case	Thermal Resistance Junction-case	Max	3.75	°C/W
Rthj-amb	Thermal Resistance Junction-ambient	Max	100	°C/W
T_l	Maximum Lead Temperature For Soldering Purpose		275	°C

ELECTRICAL CHARACTERISTICS (T_{CASE} = 25 °C UNLESS OTHERWISE SPECIFIED)

OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown Voltage	I_D = 25 mA, V_{GS} = 0	24			V
I_{DSS}	Zero Gate Voltage Drain Current (V_{GS} = 0)	V_{DS} = 20 V V_{DS} = 20 V T_C = 125°C			1 10	µA µA
I_{GSS}	Gate-body Leakage Current (V_{DS} = 0)	V_{GS} = ± 20V			±100	nA

ON (4)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS} I_D = 250 µA	1	1.8	2.5	V
$R_{DS(on)}$	Static Drain-source On Resistance	V_{GS} = 10 V I_D = 19 A V_{GS} = 5 V I_D = 9.5 A		0.011 0.015	0.0135 0.025	Ω Ω

DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g_{fs} (4)	Forward Transconductance	V_{DS} = 10 V I_D = 19 A		19		S
C_{iss} C_{oss} C_{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V_{DS} = 15V f = 1 MHz V_{GS} = 0		1070 305 45		pF pF pF
R_G	Gate Input Resistance	f = 1 MHz Gate DC Bias = 0 Test Signal Level = 20 mV Open Drain		1		Ω

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 V I_D = 19 A R_G = 4.7 Ω V_{GS} = 10 V (Resistive Load, Figure 3)		7 62		ns ns
Q_g Q_{gs} Q_{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	0.44V ≤ V_{DD} ≤ 10V, I_D= 38 A V_{GS}= 10 V		18 4 2.5	24	nC nC nC
Q_{oss}(5)	Output Charge	V_{DS}= 16 V V_{GS}= 0 V		6.5		nC

SWITCHING OFF

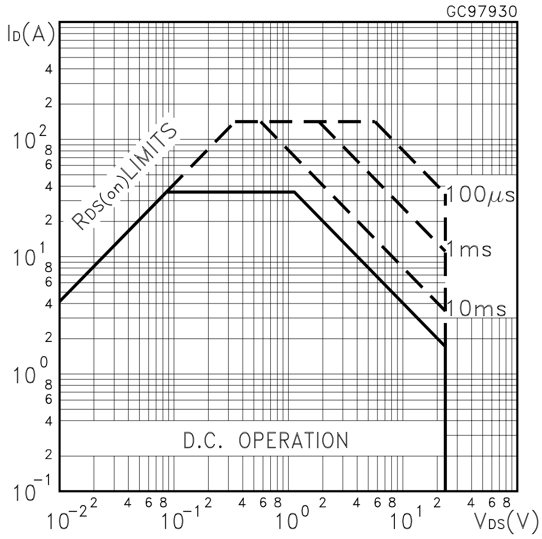
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$ t_f	Turn-off Delay Time Fall Time	V_{DD} = 10 V I_D = 19 A R_G = 4.7Ω, V_{GS} = 10 V (Resistive Load, Figure 3)		25 12	 16	ns ns

SOURCE DRAIN DIODE

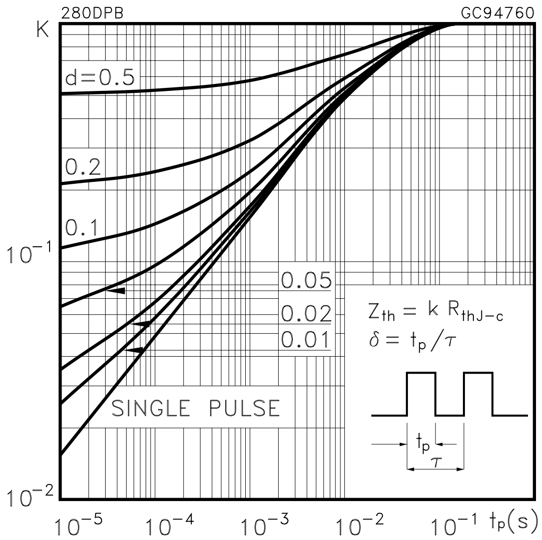
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM}	Source-drain Current Source-drain Current (pulsed)				38 152	A A
V_{SD} (4)	Forward On Voltage	I_{SD} = 19 A V_{GS} = 0			1.3	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD} = 38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

(1) Garanted when external Rg=4.7 Ω and $t_f < t_{fmax}$.
(2) Pulse width limited by safe operating area
(3) Starting T_j = 25 ºC, I_D = 19A, V_{DD} = 18V .
.
(4) Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %.
(5) $Q_{oss} = C_{oss} * \Delta V_{in}$, $C_{oss} = C_{gd} + C_{ds}$. See Appendix A

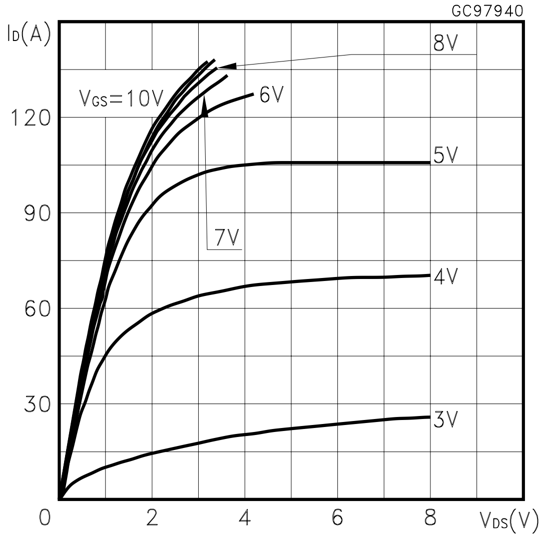
Safe Operating Area



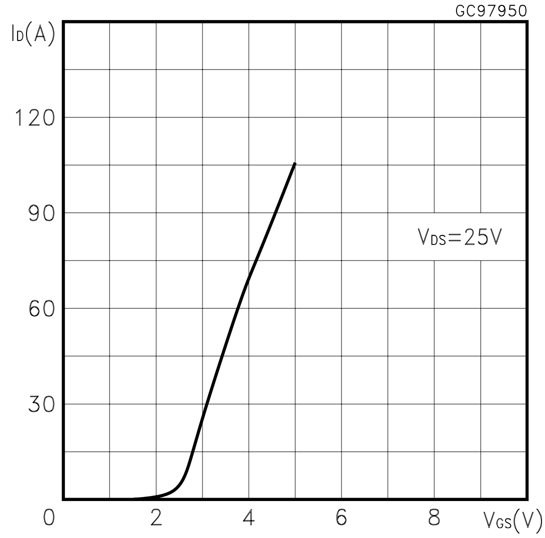
Thermal Impedance



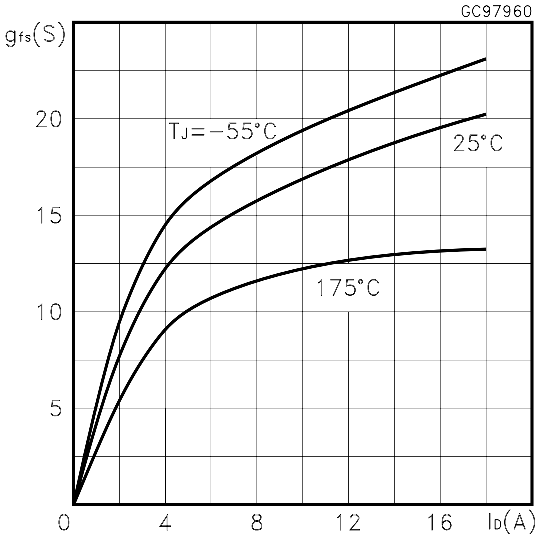
Output Characteristics



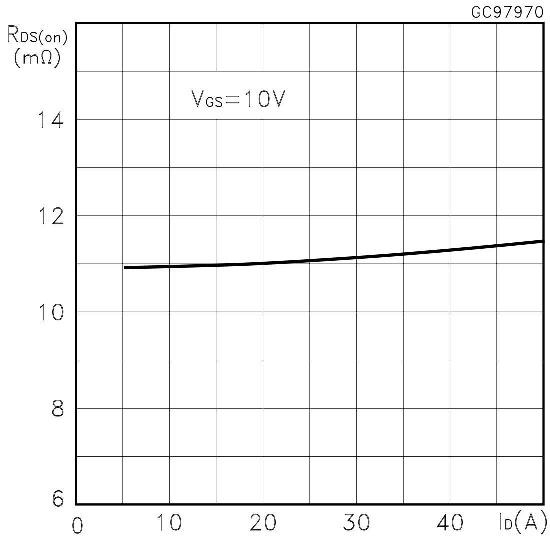
Transfer Characteristics



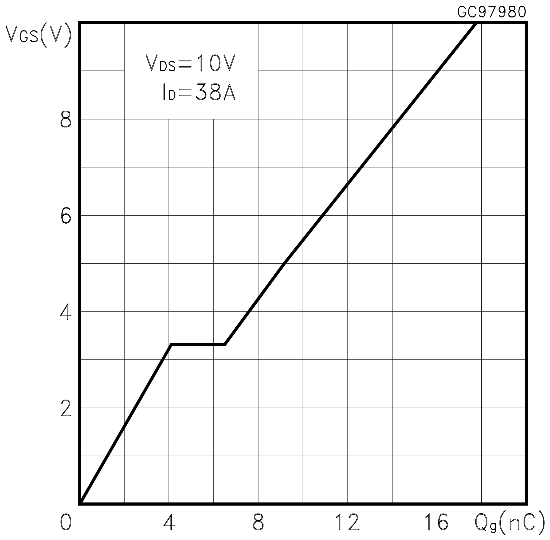
Transconductance



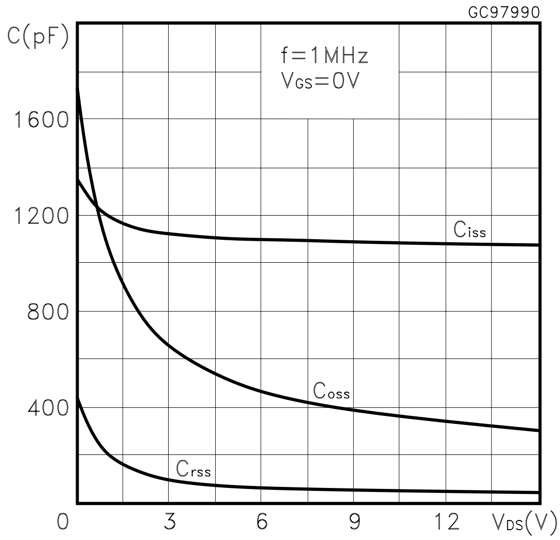
Static Drain-source On Resistance



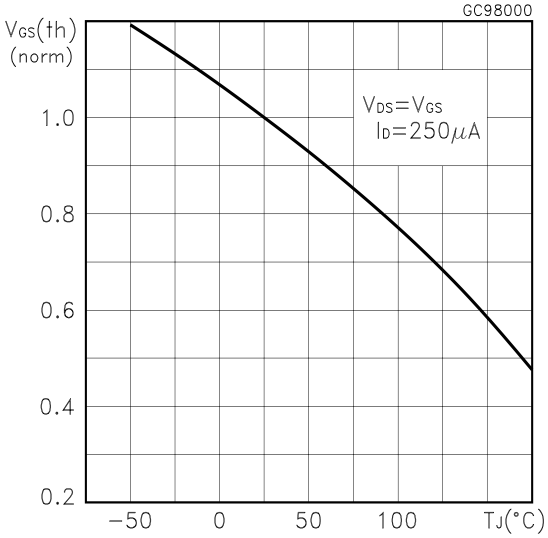
Gate Charge vs Gate-source Voltage



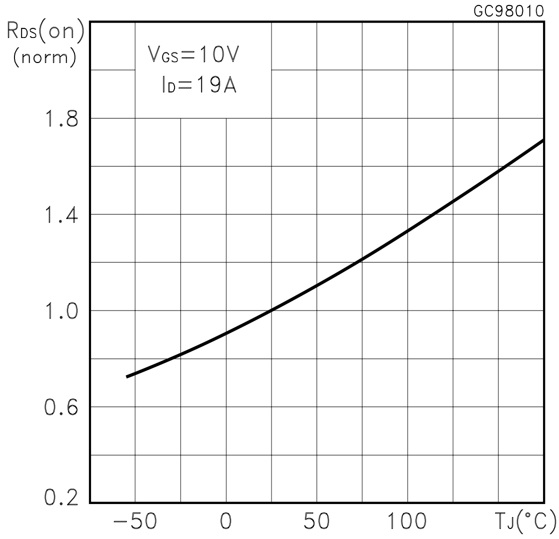
Capacitance Variations



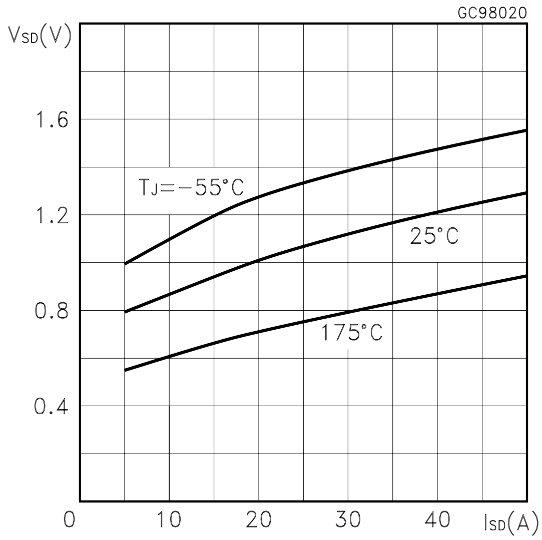
Normalized Gate Threshold Voltage vs Temperature



Normalized on Resistance vs Temperature



Source-drain Diode Forward Characteristics



Normalized Breakdown Voltage vs Temperature

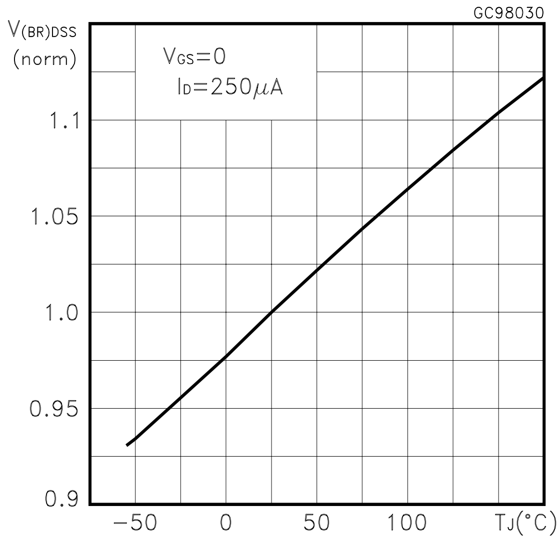


Fig. 1: Unclamped Inductive Load Test Circuit

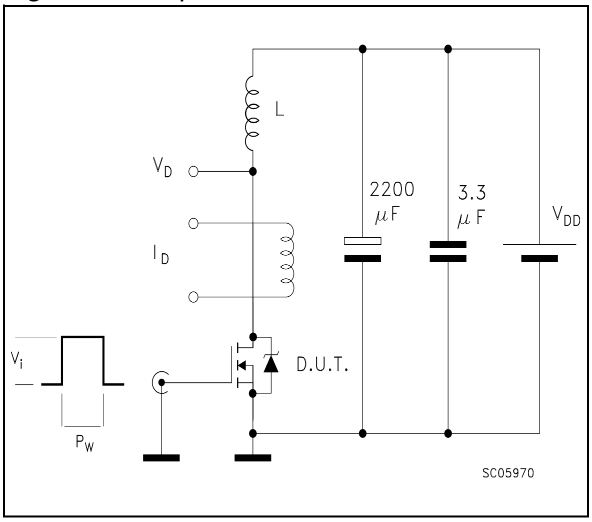


Fig. 2: Unclamped Inductive Waveform

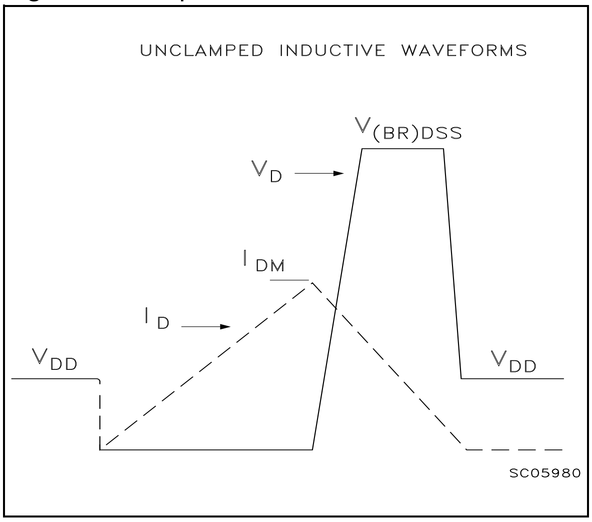


Fig. 3: Switching Times Test Circuits For Resistive Load

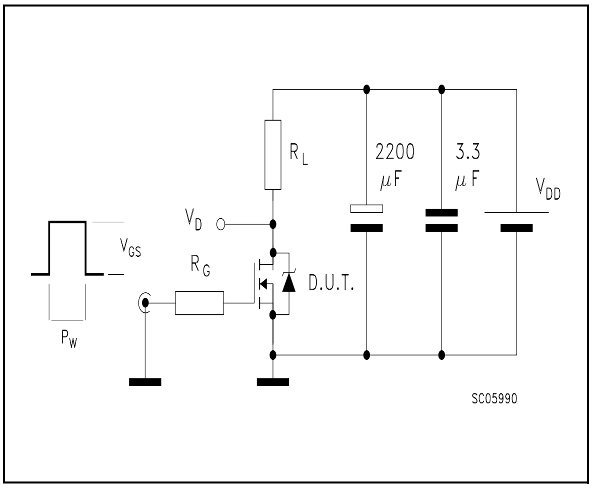


Fig. 4: Gate Charge test Circuit

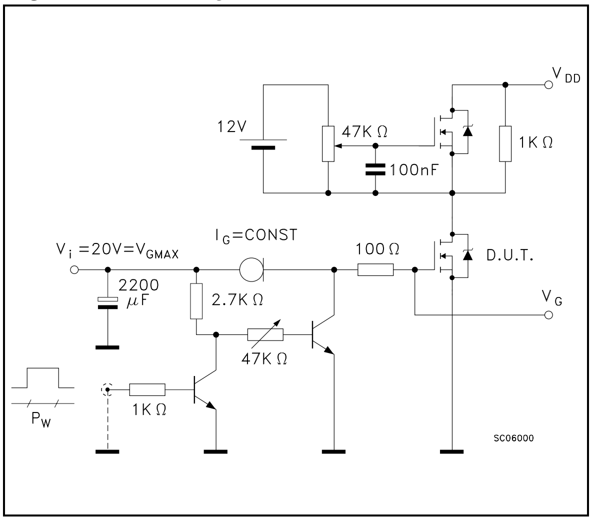
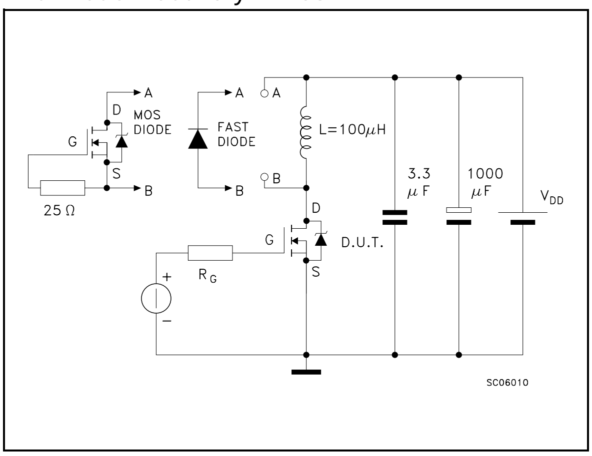
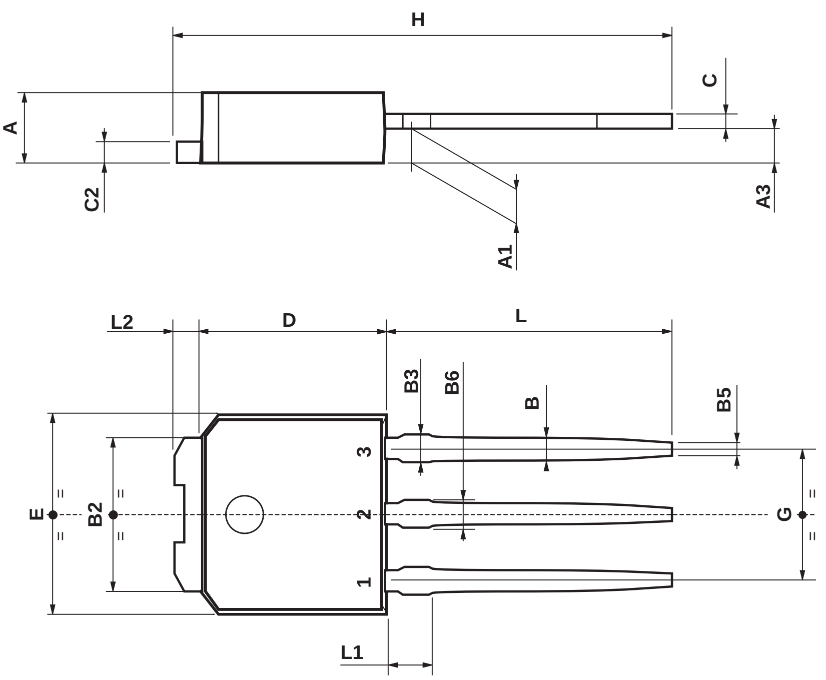


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



TO-251 (IPAK) MECHANICAL DATA

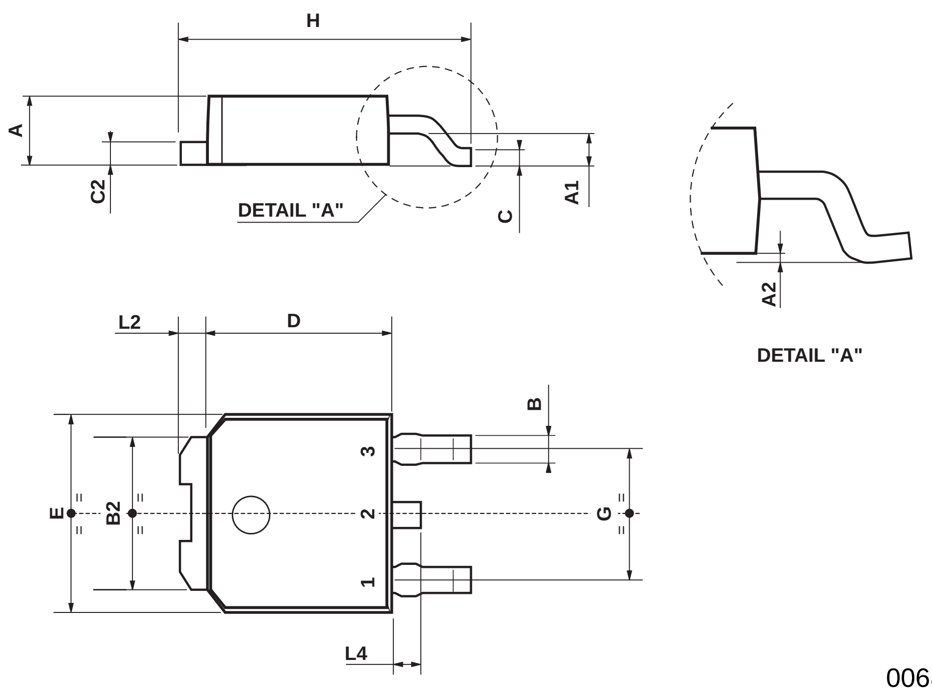
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A3	0.7		1.3	0.027		0.051
B	0.64		0.9	0.025		0.031
B2	5.2		5.4	0.204		0.212
B3			0.85			0.033
B5		0.3			0.012	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		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



0068771-E

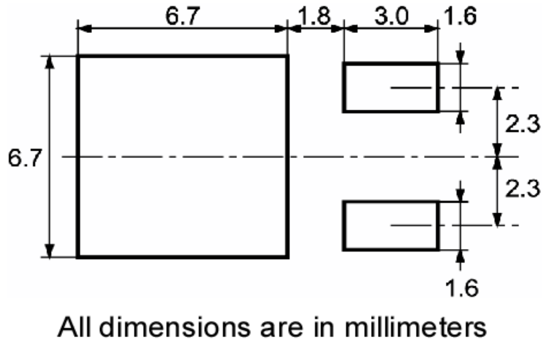
TO-252 (DPAK) MECHANICAL DATA

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

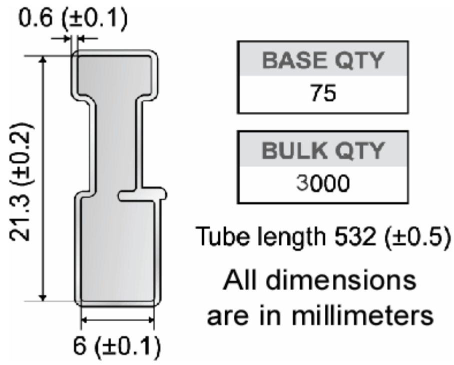


0068772-B

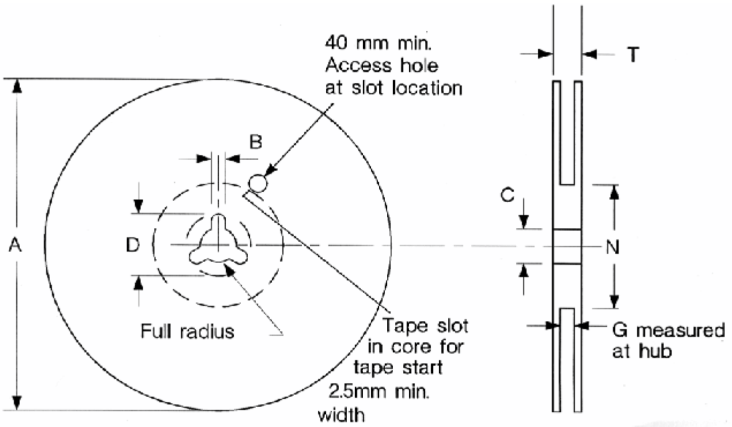
DPAK FOOTPRINT



TUBE SHIPMENT (no suffix)*



TAPE AND REEL SHIPMENT (suffix "T4")*



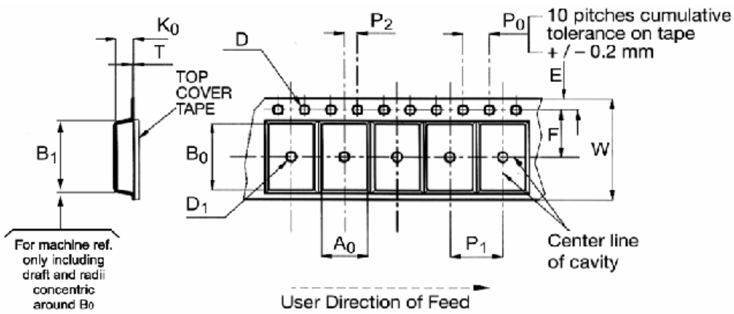
REEL MECHANICAL DATA

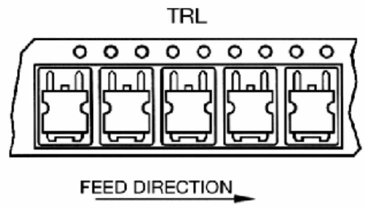
DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

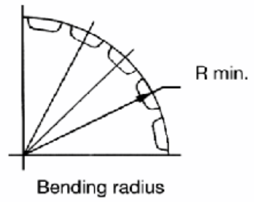
BASE QTY	BULK QTY
1000	1000

TAPE MECHANICAL DATA

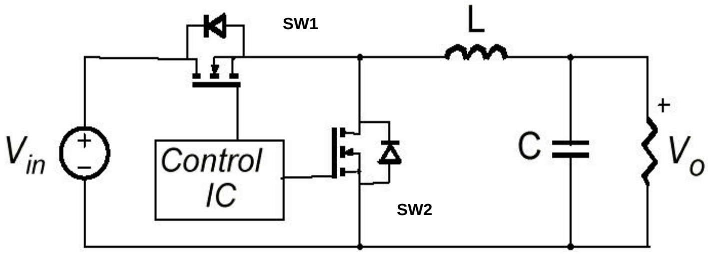
DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618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







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_1 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	$V_{f(SW2)} * I_L * t_{deadtime} * f$
$P_{gate(Q_G)}$		$Q_{g(SW1)} * V_{gg} * f$	$\mathbf{Q_{gls(SW2)} * V_{gg} * f}$
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
Pconduction	On state losses
Pswitching	On-off transition losses
Pdiode	Conduction and reverse recovery diode losses
Pgate	Gate drive losses
P_{Qoss}	Output capacitance losses

[1] Dissipated by SW1 during turn-on

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