



STD55NH2LL

N-CHANNEL 24V - 0.010 Ω - 40A DPAK/IPAK ULTRA LOW GATE CHARGE STripFET™ POWER MOSFET

TYPE	V _{DSS}	R _{DS(on)}	I _D
STD55NH2LL	24 V	< 0.011 Ω	40 A(*)

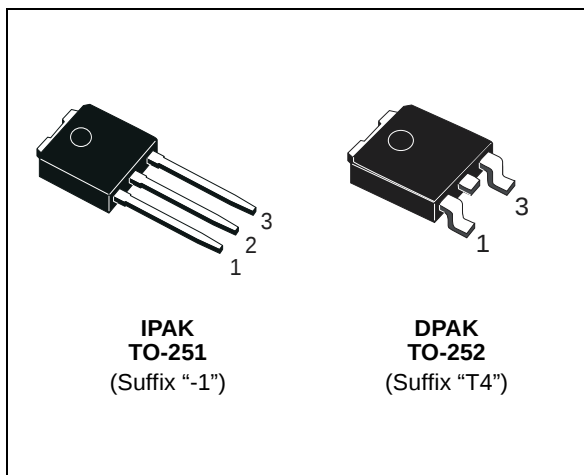
- TYPICAL R_{DS(on)} = 0.01 Ω @ 10 V
- TYPICAL R_{DS(on)} = 0.012 Ω @ 4.5 V
- R_{DS(on)} * Q_g INDUSTRY'S BENCHMARK
- CONDUCTION LOSSES REDUCED
- SWITCHING LOSSES REDUCED
- LOW THRESHOLD DEVICE
- THROUGH-HOLE IPAK (TO-251) POWER PACKAGE IN TUBE (SUFFIX "-1")
- SURFACE-MOUNTING DPAK (TO-252) POWER PACKAGE IN TAPE & REEL (SUFFIX "T4")

DESCRIPTION

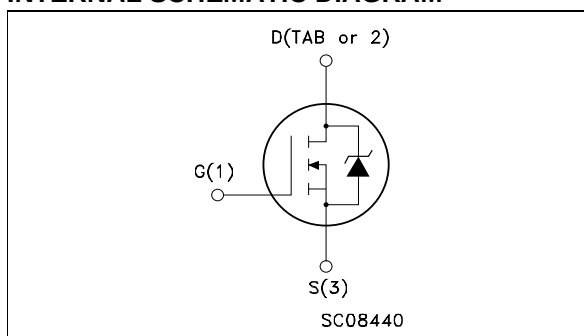
The STD55NH2LL is based on the latest generation of ST's proprietary STripFET™ technology. An innovative layout enables the device to also exhibit extremely low gate charge for the most demanding requirements as high-side switch in high-frequency DC-DC converters. It's therefore ideal for high-density converters in Telecom and Computer applications.

APPLICATIONS

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



INTERNAL SCHEMATIC DIAGRAM



Ordering Information

SALES TYPE	MARKING	PACKAGE	PACKAGING
STD55NH2LLT4	D55NH2LL	TO-252	TAPE & REEL
STD55NH2LL-1	D55NH2LL	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 k Ω)	24	V
V _{GS}	Gate- source Voltage	± 18	V
I _D (*)	Drain Current (continuous) at T _C = 25°C	40	A
I _D	Drain Current (continuous) at T _C = 100°C	28	A
I _{DM} (2)	Drain Current (pulsed)	160	A
P _{tot}	Total Dissipation at T _C = 25°C	60	W
	Derating Factor	0.4	W/°C
E _{AS} (3)	Single Pulse Avalanche Energy	600	mJ
T _{stg}	Storage Temperature	-55 to 175	°C
T _j	Operating Junction Temperature		

STD55NH2LL

THERMAL DATA

R _{thj-case}	Thermal Resistance Junction-case	Max	2.5	°C/W
R _{thj-amb}	Thermal Resistance Junction-ambient	Max	100	°C/W
T _I	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 = 250 µA, V _{GS} = 0	24			V
I _{DSS}	Zero Gate Voltage Drain Current (V _{GS} = 0)	V _{DS} = Max Rating V _{DS} = Max Rating T _C = 125°C			1 10	µA µA
I _{GSS}	Gate-body Leakage Current (V _{DS} = 0)	V _{GS} = ± 18V			±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			V
R _{DS(on)}	Static Drain-source On Resistance	V _{GS} = 10 V I _D = 20 A V _{GS} = 4.5 V I _D = 20 A		0.010 0.012	0.011 0.0135	Ω Ω

DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g _{fs} (4)	Forward Transconductance	V _{DS} = 10 V I _D = 10 A		18		S
C _{iss} C _{oss} C _{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V _{DS} = 10V f = 1 MHz V _{GS} = 0		990 385 40		pF pF pF
R _G	Gate Input Resistance	f = 1 MHz Gate DC Bias = 0 Test Signal Level = 20 mV Open Drain		1.3		Ω

STD55NH2LL

ELECTRICAL CHARACTERISTICS (continued)

SWITCHING ON

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on Delay Time	$V_{DD} = 10\text{ V}$ $I_D = 20\text{ A}$		15		ns
t_r	Rise Time	$R_G = 4.7\ \Omega$ $V_{GS} = 4.5\text{ V}$ (Resistive Load, Figure 3)		56		ns
Q_g	Total Gate Charge	$0.44\text{ V} \leq V_{DD} \leq 10\text{ V}$, $I_D = 40\text{ A}$		8.7	11	nC
Q_{gs}	Gate-Source Charge	$V_{GS} = 4.5\text{ V}$		4.2		nC
Q_{gd}	Gate-Drain Charge			2.4		nC
$Q_{oss}^{(5)}$	Output Charge	$V_{DS} = 16\text{ V}$ $V_{GS} = 0\text{ V}$		7.6		nC

SWITCHING OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off Delay Time	$V_{DD} = 10\text{ V}$ $I_D = 20\text{ A}$		13		ns
t_f	Fall Time	$R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (Resistive Load, Figure 3)		10		ns

SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain Current				40	A
I_{SDM}	Source-drain Current (pulsed)				160	A
$V_{SD}^{(4)}$	Forward On Voltage	$I_{SD} = 20\text{ A}$ $V_{GS} = 0$			1.3	V
t_{rr}	Reverse Recovery Time	$I_{SD} = 40\text{ A}$ $di/dt = 100\text{ A}/\mu\text{s}$		32.5		ns
Q_{rr}	Reverse Recovery Charge	$V_{DD} = 15\text{ V}$ $T_j = 150^\circ\text{C}$		28		nC
I_{RRM}	Reverse Recovery Current	(see test circuit, Figure 5)		1.7		A

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

(2) Pulse width limited by safe operating area

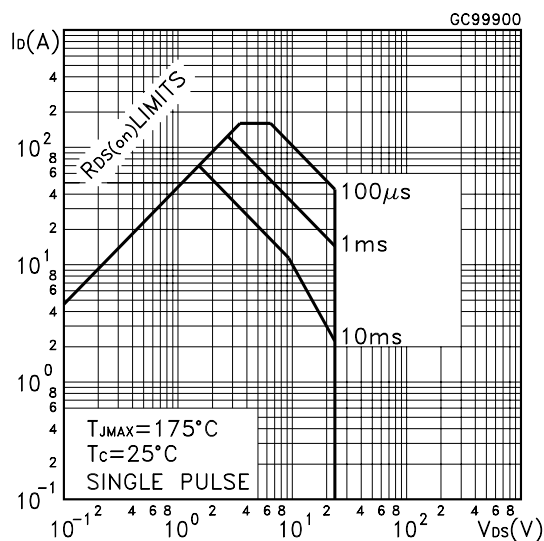
(3) Starting $T_j = 25^\circ\text{C}$, $I_D = 20\text{ A}$, $V_{DD} = 15\text{ V}$

(4) Pulsed: Pulse duration = 300 μs , duty cycle 1.5 %.

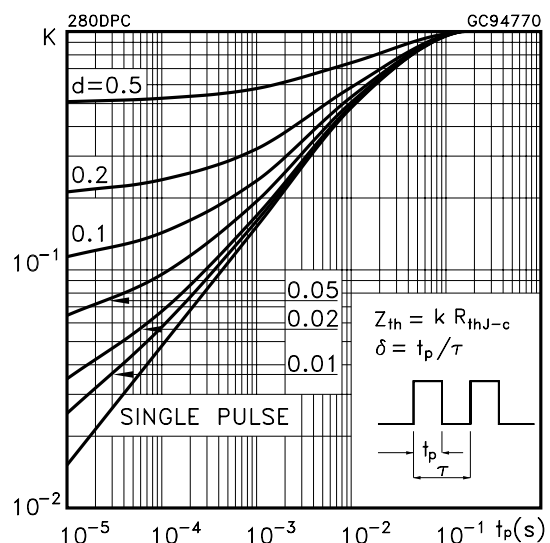
(5) $Q_{oss} = C_{oss} \cdot \Delta V_{in}$, $C_{oss} = C_{gd} + C_{ds}$. See Appendix A

(*) Value limited by wire bonding

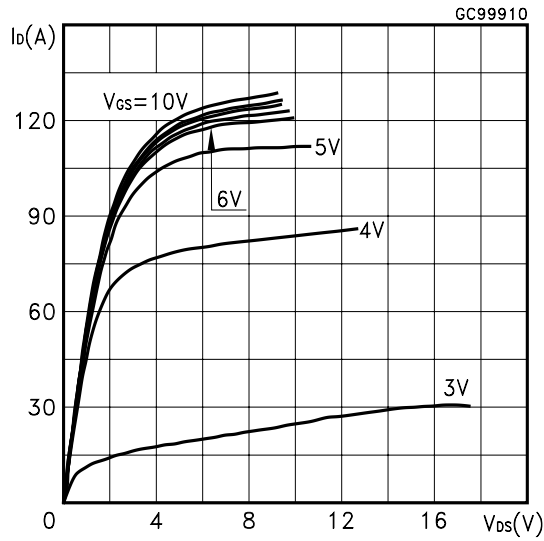
Safe Operating Area



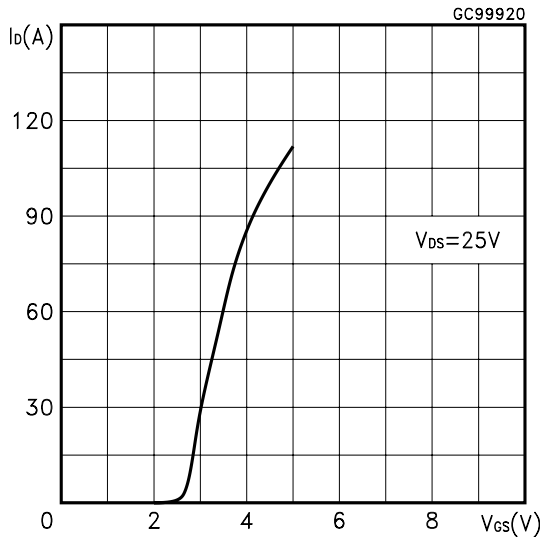
Thermal Impedance



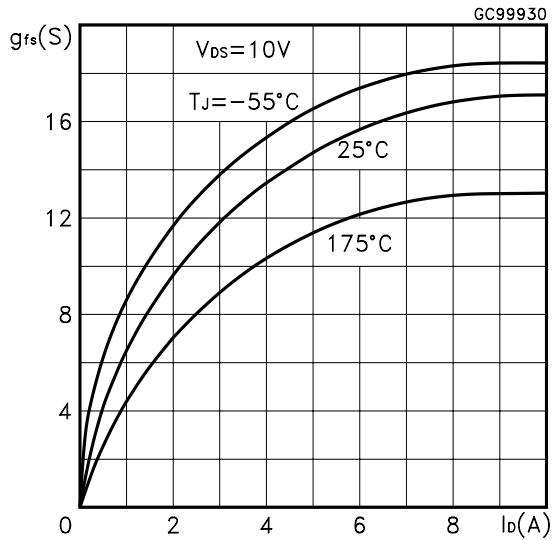
Output Characteristics



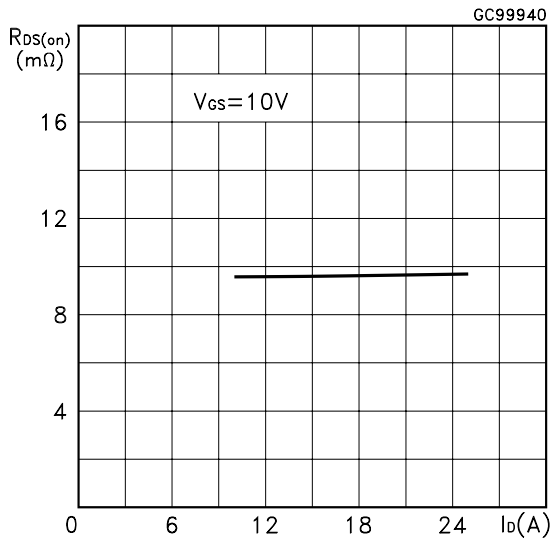
Transfer Characteristics



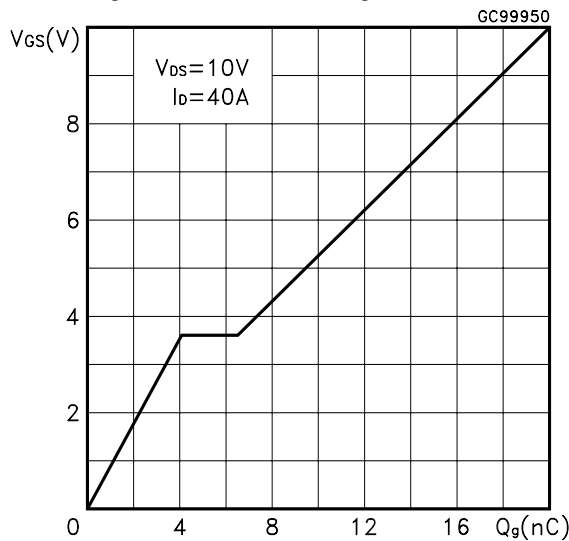
Transconductance



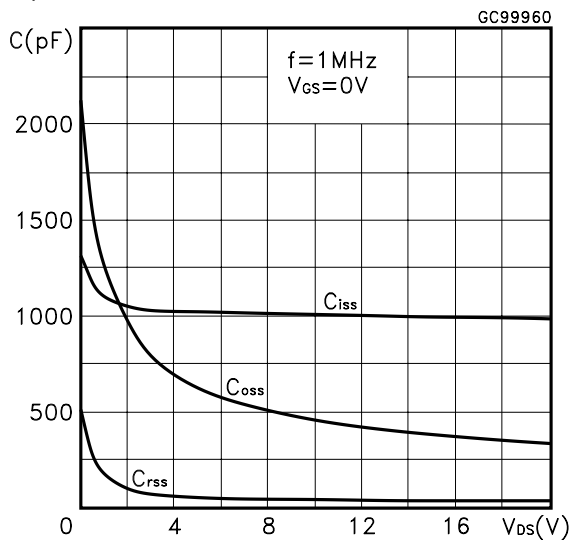
Static Drain-source On Resistance



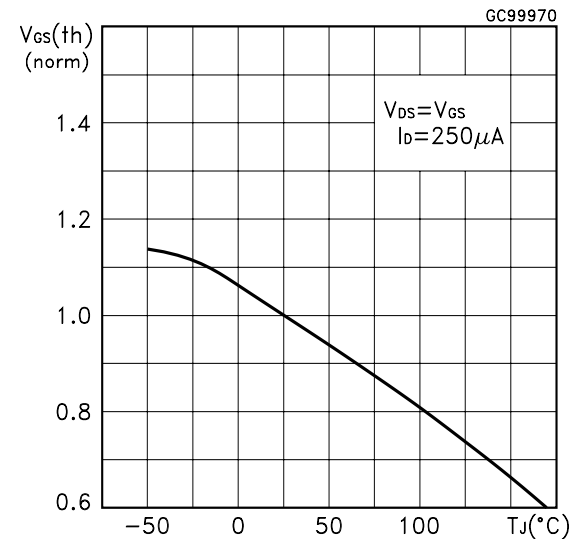
Gate Charge vs Gate-source Voltage



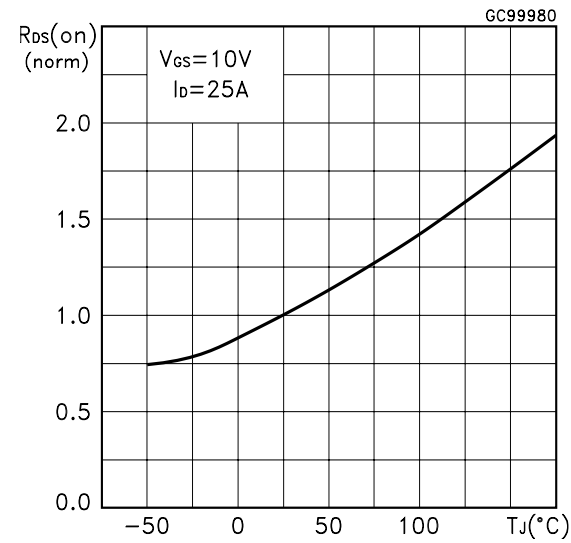
Capacitance Variations



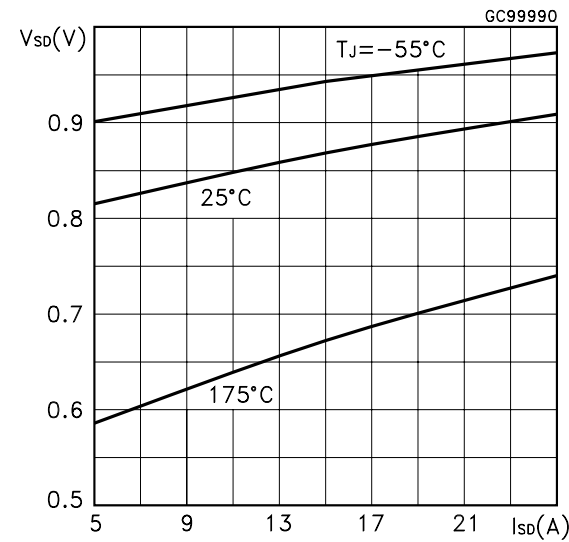
Normalized Gate Threshold Voltage vs Temperature



Normalized on Resistance vs Temperature



Source-drain Diode Forward Characteristics



Normalized Breakdown Voltage vs Temperature

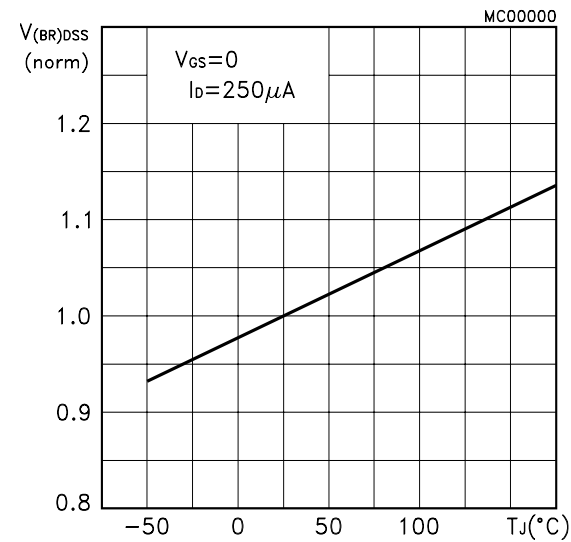


Fig. 1: Unclamped Inductive Load Test Circuit

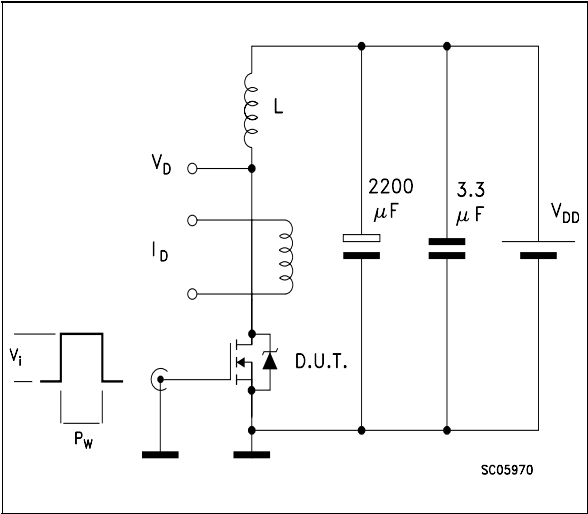


Fig. 2: Unclamped Inductive Waveform

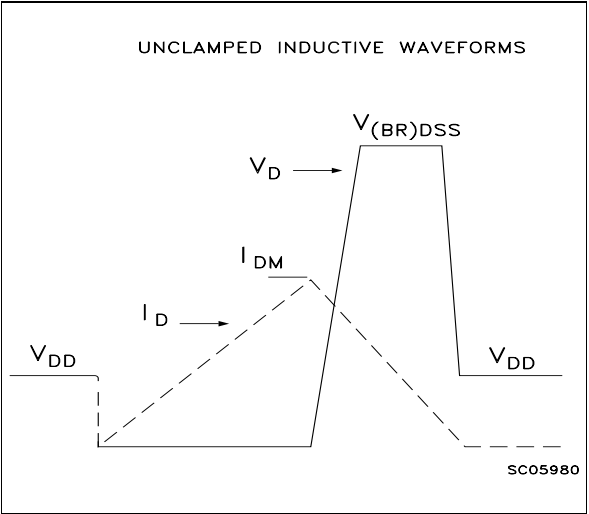


Fig. 3: Switching Times Test Circuits For Resistive Load

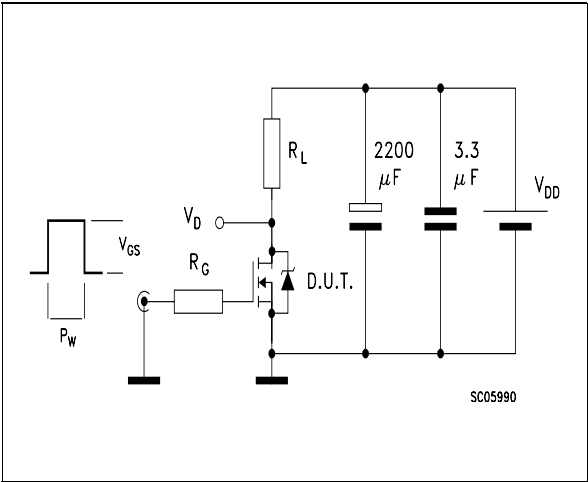


Fig. 4: Gate Charge test Circuit

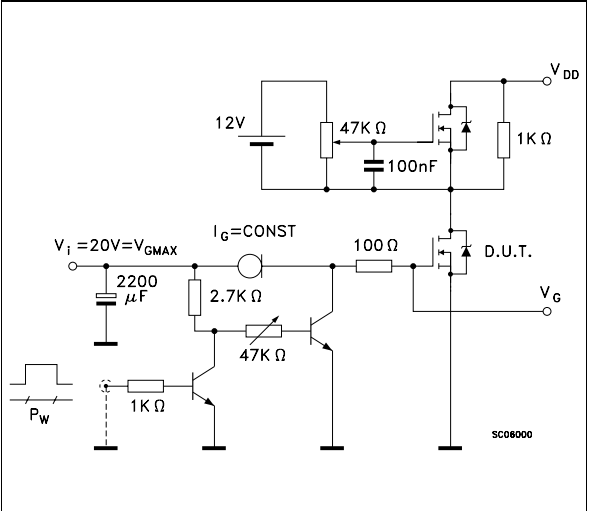
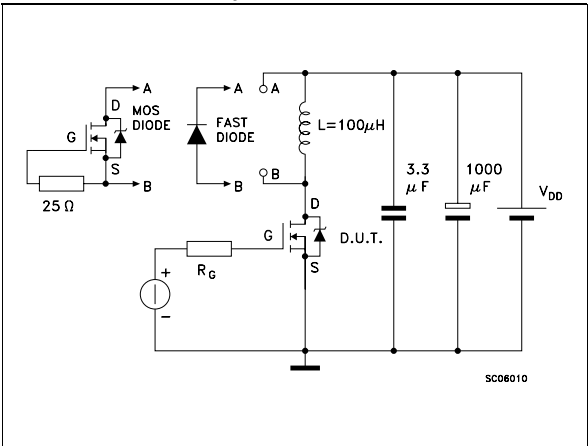
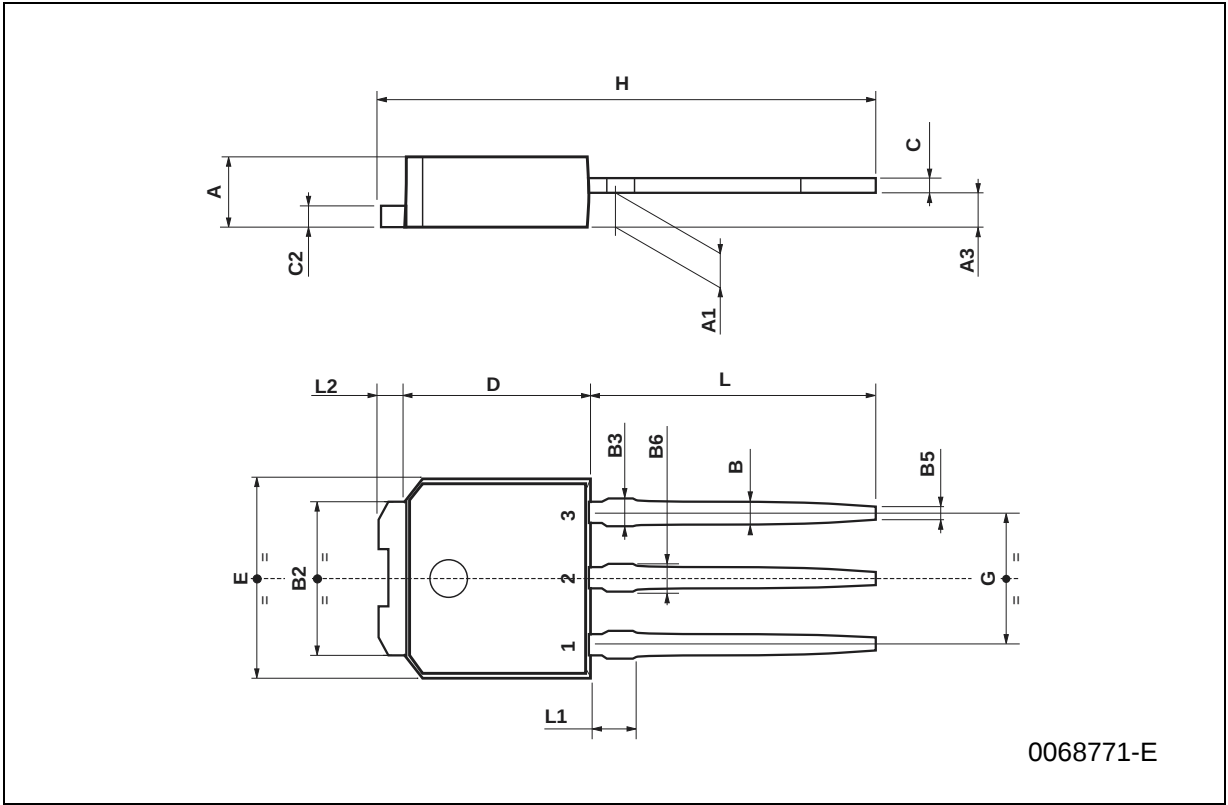


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



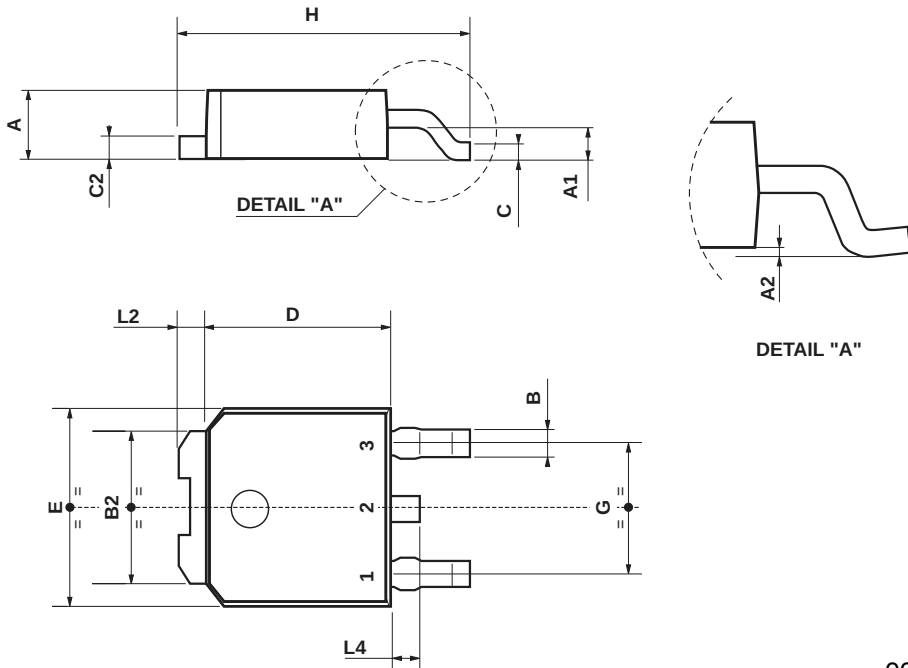
TO-251 (IPAK) MECHANICAL DATA

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

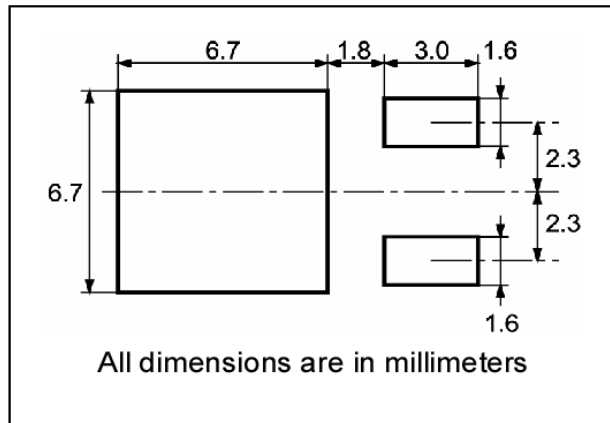


TO-252 (DPAK) MECHANICAL DATA

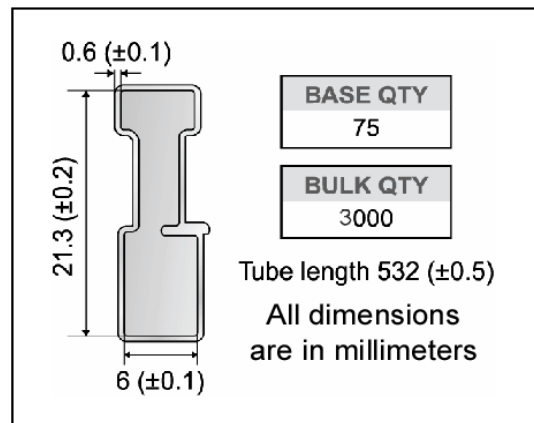
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.9	0.025		0.035
B2	5.2		5.4	0.204		0.212
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		6.6	0.252		0.260
G	4.4		4.6	0.173		0.181
H	9.35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



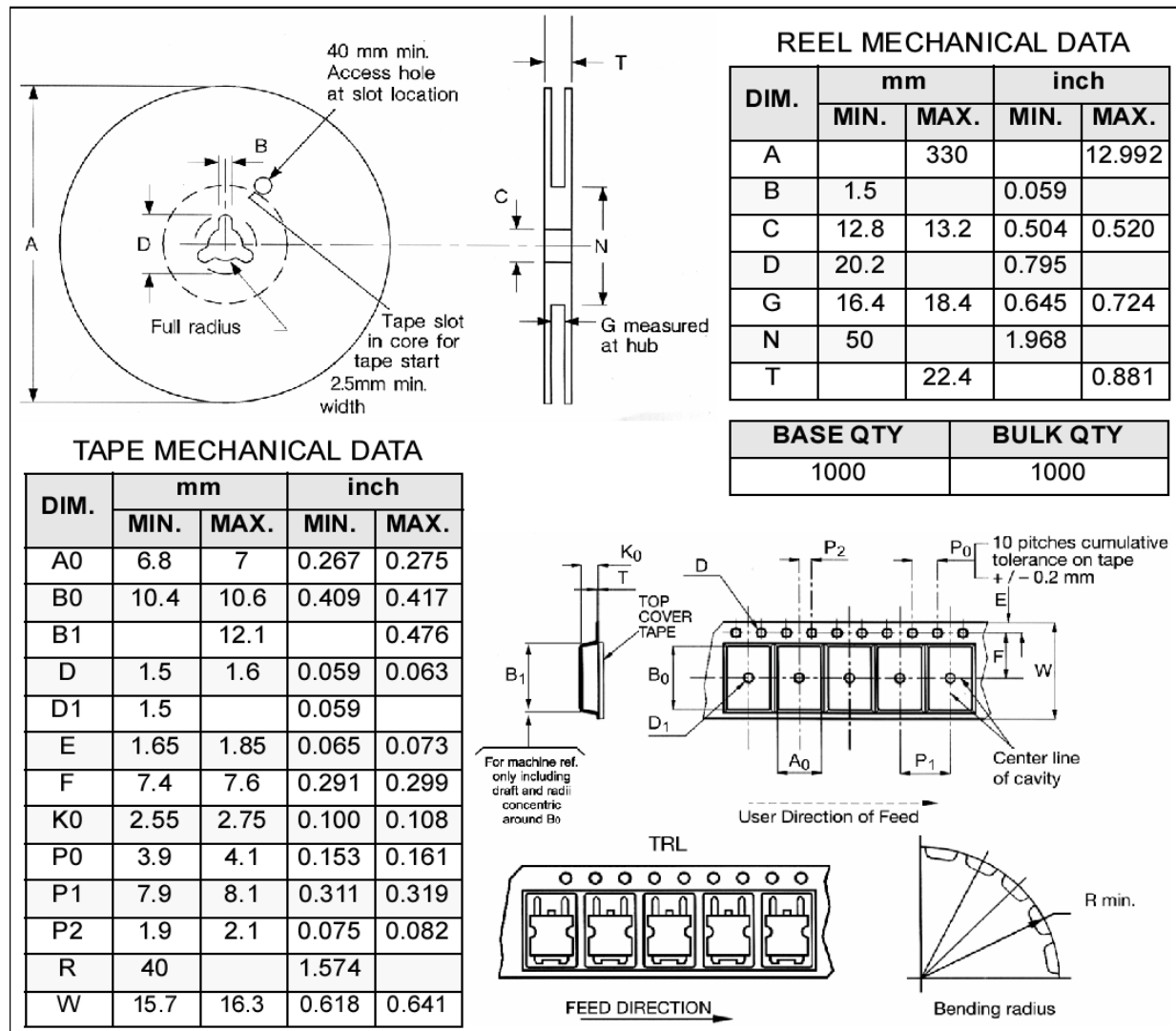
DPAK FOOTPRINT



TUBE SHIPMENT (no suffix)*

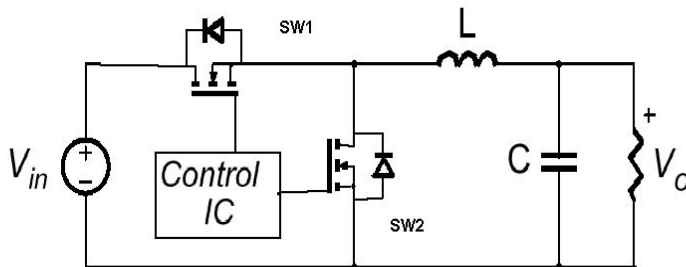


TAPE AND REEL SHIPMENT (suffix "T4")*



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_{gl} to reduce the gate charge losses
- Small C_{oss} to reduce losses due to output capacitance
- Small Q_{rr} to reduce losses on SW₁ 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)
$P_{\text{conduction}}$		$R_{\text{DS(on)SW1}} * I_L^2 * \delta$	$R_{\text{DS(on)SW2}} * I_L^2 * (1 - \delta)$
$P_{\text{switching}}$		$V_{\text{in}} * (Q_{\text{gsth(SW1)}} + Q_{\text{gd(SW1)}}) * f * \frac{I_L}{I_g}$	Zero Voltage Switching
P_{diode}	Recovery	Not Applicable	$^1 V_{\text{in}} * Q_{\text{r(SW2)}} * f$
	Conduction	Not Applicable	$V_{\text{gs(SW2)}} * I_L * t_{\text{deadtime}} * f$
$P_{\text{gate(Qg)}}$		$Q_{\text{g(SW1)}} * V_{\text{gg}} * f$	$Q_{\text{gls(SW2)}} * V_{\text{gg}} * f$
P_{Qoss}		$\frac{V_{\text{in}} * Q_{\text{oss(SW1)}} * f}{2}$	$\frac{V_{\text{in}} * Q_{\text{oss(SW2)}} * f}{2}$

Parameter	Meaning
δ	Duty-cycle
Q_{gsth}	Post threshold gate charge
Q_{gls}	Third quadrant gate charge
$P_{\text{conduction}}$	On state losses
$P_{\text{switching}}$	On-off transition losses
P_{diode}	Conduction and reverse recovery diode losses
P_{gate}	Gate drive losses
P_{Qoss}	Output capacitance losses

¹ Dissipated by SW1 during turn-on

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