STD95NH02L

N-CHANNEL 24V - 0.0039Ω - 80A DPAK
ULTRA LOW GATE CHARGE STripFET™ MOSFET

Table 1: General Features

TYPE	V_{DSS}	$R_{DS(on)}$	I_D
STD95NH02L	24 V	< 0.005Ω	80(*) A

- TYPICAL R_{DS}(on) = 0.0039Ω @ 10 V
- CONDUCTION LOSSES REDUCED
- SWITCHING LOSSES REDUCED

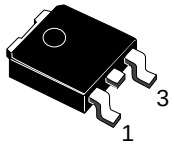
DESCRIPTION

The **STD95NH02L** 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 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 CONVERTERS

Figure 1: Package



DPAK
TO-252
(Suffix "T4")

Figure 2: Internal Schematic Diagram

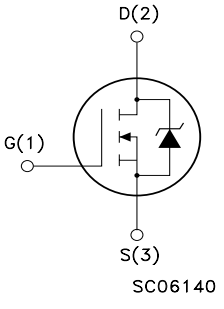


Table 2: Order Codes

PART NUMBER	MARKING	PACKAGE	PACKAGING
STD95NH02LT4	D95NH02L	DPAK	TAPE & REEL

Table 3: 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	80	A
I_D	Drain Current (continuous) at T_C = 100°C	68	A
I_{DM} (2)	Drain Current (pulsed)	320	A
P_{TOT}	Total Dissipation at T_C = 25°C	100	W
	Derating Factor	0.67	W/°C
E_{AS} (3)	Single Pulse Avalanche Energy	600	mJ
T_{stg}	Storage Temperature	-55 to 175	°C
T_j	Max. Operating Junction Temperature		

(1) Garanted when external R_g = 4.7 Ω and $t_f < t_f$ max.
(2) Pulse width limited by safe operating area.
(3) Starting T_j = 25°C, I_D = 40A, V_{DD} = 22V
(*) Value limited by wires

Table 4: Thermal Data

Rthj-case	Thermal Resistance Junction-case Max	1.5	°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)

Table 5: On/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} = ± 20V			±100	nA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 250µA	1			V
$R_{DS(on)}$	Static Drain-source On Resistance	V_{GS} = 10 V, I_D = 40 A V_{GS} = 5 V, I_D =40 A		0.0039 0.0055	0.005 0.009	Ω Ω

ELECTRICAL CHARACTERISTICS (CONTINUED)

Table 6: Dynamic

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g_{fs} (4)	Forward Transconductance	V_{DS} = 10 V, I_D = 10 A		30		S
C_{iss} C_{oss} C_{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V_{DS} = 15V, f = 1 MHz, V_{GS} = 0		2070 990 90		pF pF pF
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on Delay Time Rise Time Turn-off Delay Time Fall Time	V_{DD} = 12 V, I_D = 40 A, R_G= 4.7 Ω V_{GS} = 10 V (see Figure 16)		20 110 47 20		ns ns ns ns
Q_g Q_{gs} Q_{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V_{DD} = 12 V, I_D = 80 A, V_{GS} = 5 V (see Figure 19)		17 7.6 6.8		nC nC nC
Q_{oss} (5)	Output Charge	V_{DS} = 19 V, V_{GS} = 0 V		22.6		nC
Q_{gls} (6)	Third-Quadrant Gate Charge	V_{DS} < 0 V, V_{GS} = 5 V		15		nC
R_G	Gate Input Resistance	f = 1 MHz Gate DC Bias = 0 Test Signal Level = 20 mV Open Drain		1.8		Ω

Table 7: Source Drain Diode

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain Current				80	A
I_{SDM}	Source-drain Current (pulsed)				320	A
V_{SD} (4)	Forward On Voltage	I_{SD} = 40A, V_{GS} = 0			1.3	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD} = 80A, di/dt = 100 A/µs, V_{DD} =20 V, T_j = 150°C (see Figure 16)		42 50.4 2.4		ns nC A

(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.
(6). Gate charge for Syncronous Operation.

Figure 3: Safe Operating Area

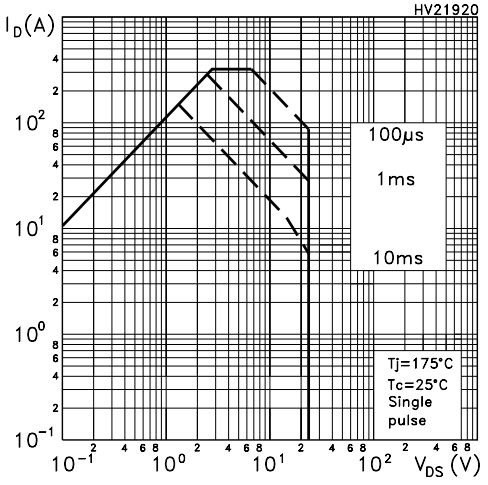


Figure 4: Output Characteristics

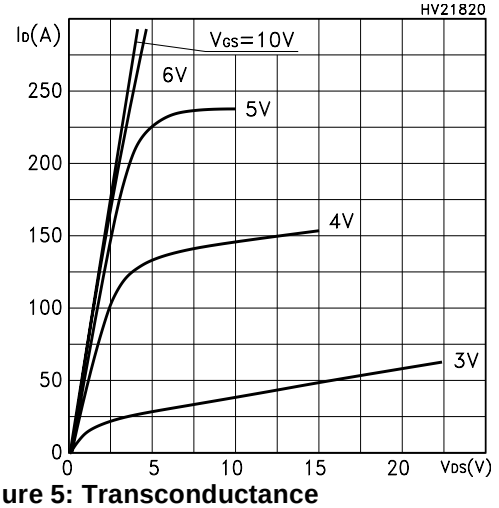


Figure 5: Transconductance

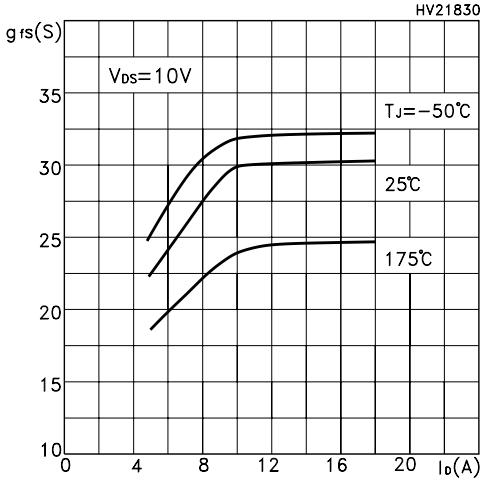


Figure 6: Thermal Impedance

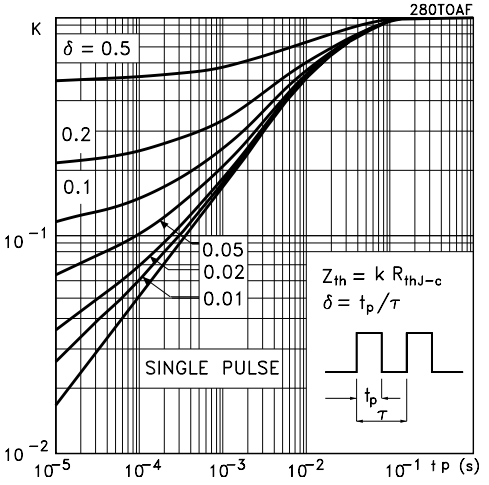


Figure 7: Transfer Characteristics

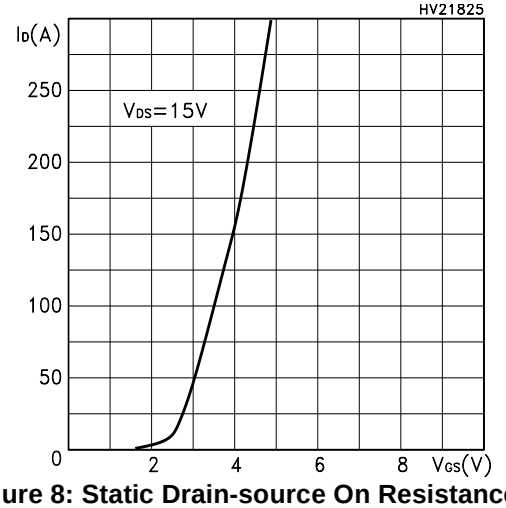


Figure 8: Static Drain-source On Resistance

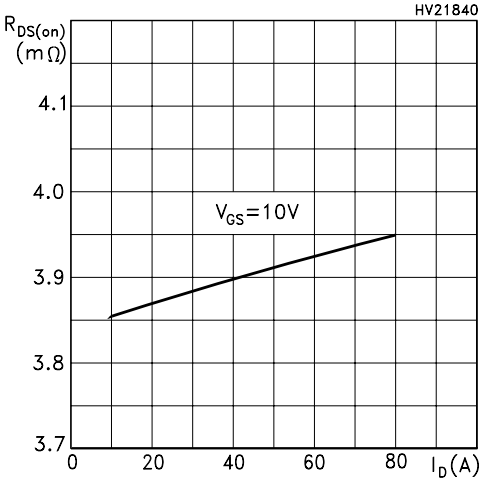


Figure 9: Gate Charge vs Gate-source Voltage

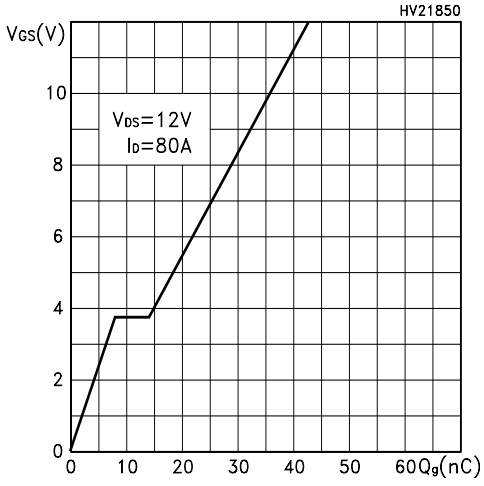


Figure 10: Normalized Gate Thereshold Voltage vs Temperature

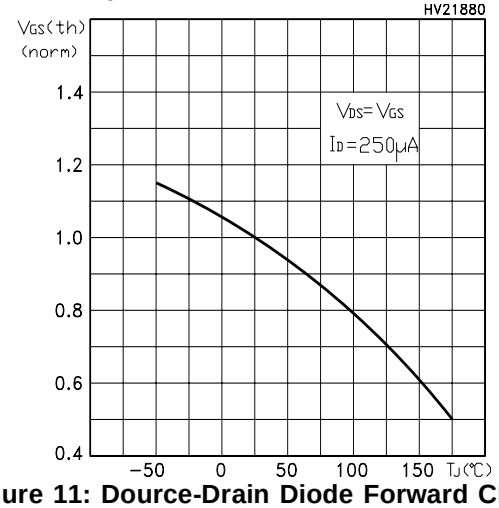


Figure 11: Dource-Drain Diode Forward Characteristics

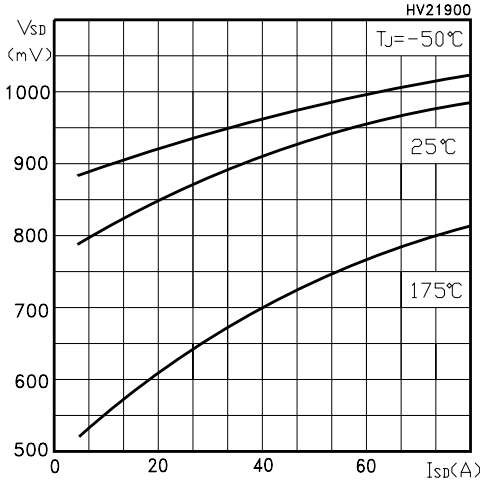


Figure 12: Capacitance Variations

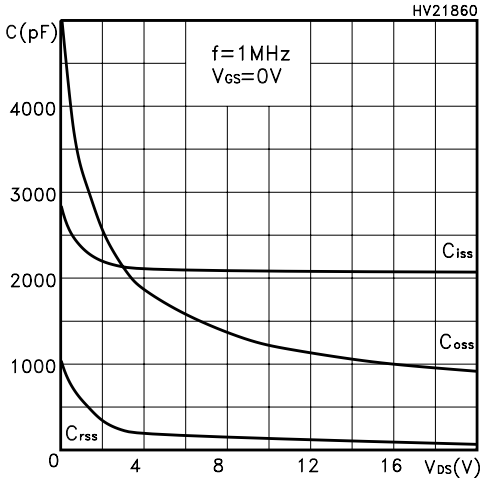


Figure 13: Normalized On Resistance vs Temperature

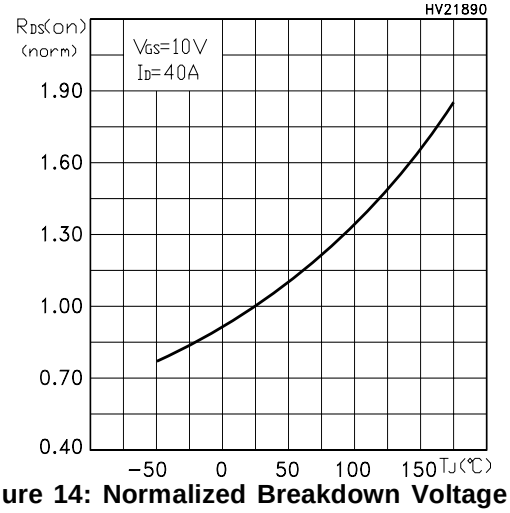


Figure 14: Normalized Breakdown Voltage vs Temperature

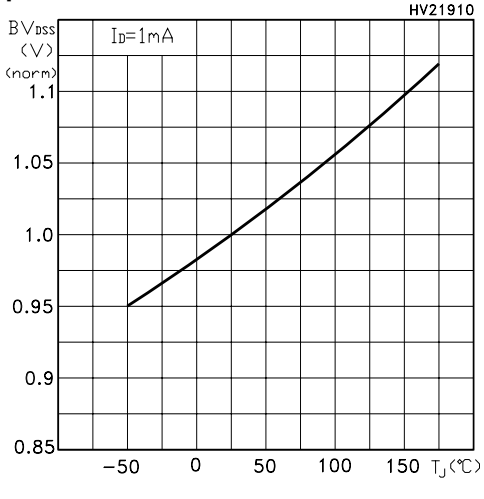


Figure 15: Unclamped Inductive Load Test Circuit

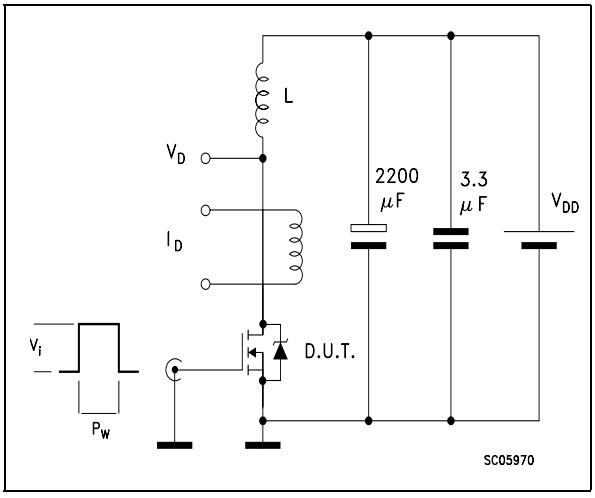


Figure 16: Switching Times Test Circuit For Resistive Load

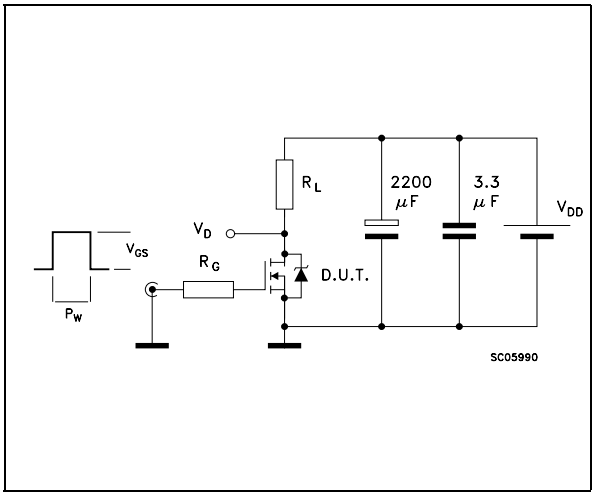


Figure 17: Test Circuit For Inductive Load Switching and Diode Recovery Times

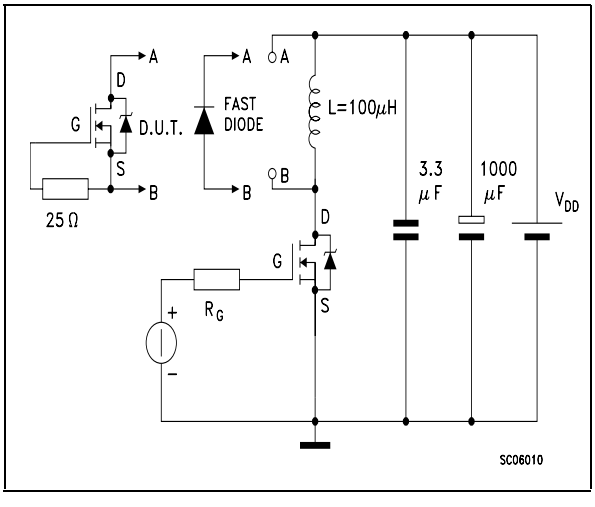


Figure 18: Unclamped Inductive Wafeform

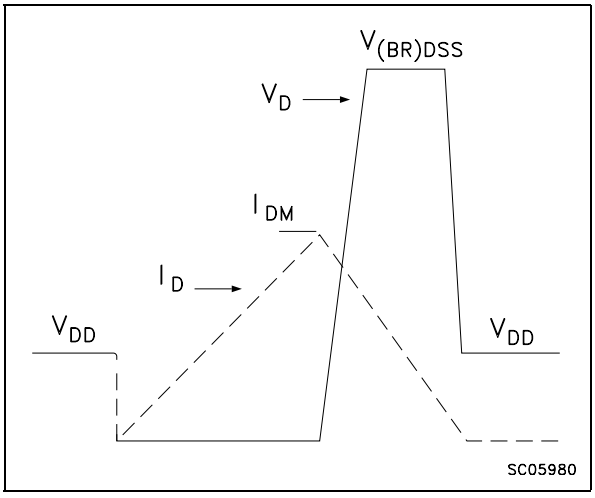
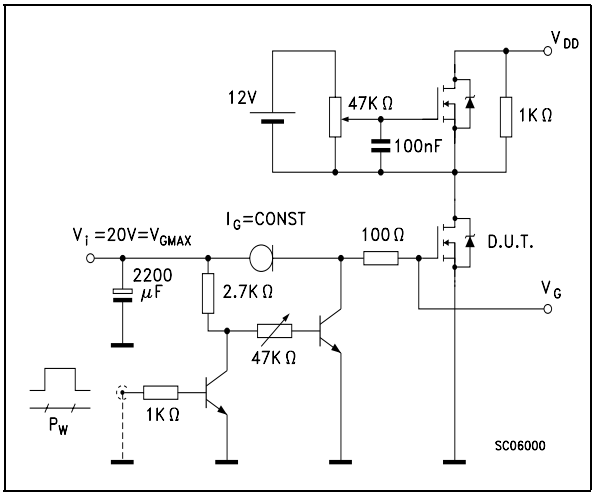
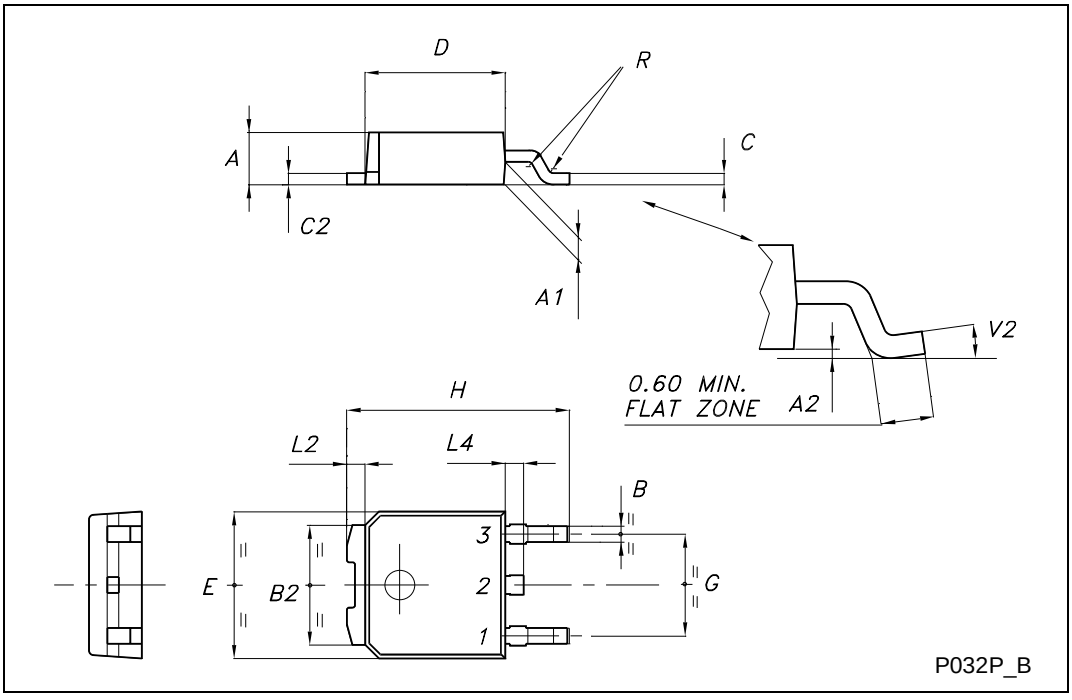


Figure 19: Gate Charge Test Circuit

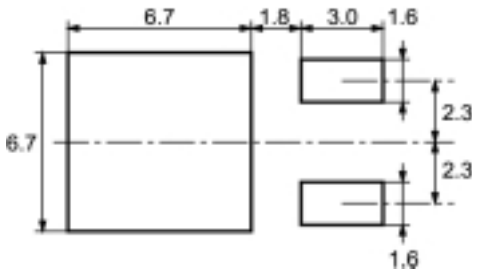


TO-252 (DPAK) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.20		2.40	0.087		0.094
A1	0.90		1.10	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.90	0.025		0.035
B2	5.20		5.40	0.204		0.213
C	0.45		0.60	0.018		0.024
C2	0.48		0.60	0.019		0.024
D	6.00		6.20	0.236		0.244
E	6.40		6.60	0.252		0.260
G	4.40		4.60	0.173		0.181
H	9.35		10.10	0.368		0.398
L2		0.8			0.031	
L4	0.60		1.00	0.024		0.039
V2	0^o		8^o	0^o		0^o

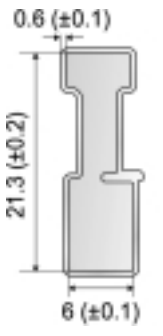


DPAK FOOTPRINT



All dimensions are in millimeters

TUBE SHIPMENT (no suffix)*



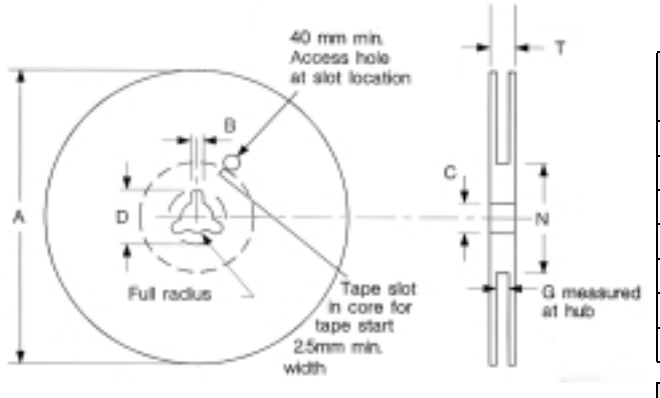
BASE QTY 75

BULK QTY 3000

Tube length 532 (±0.5)

All dimensions are in millimeters

TAPE AND REEL SHIPMENT (suffix "T4")*



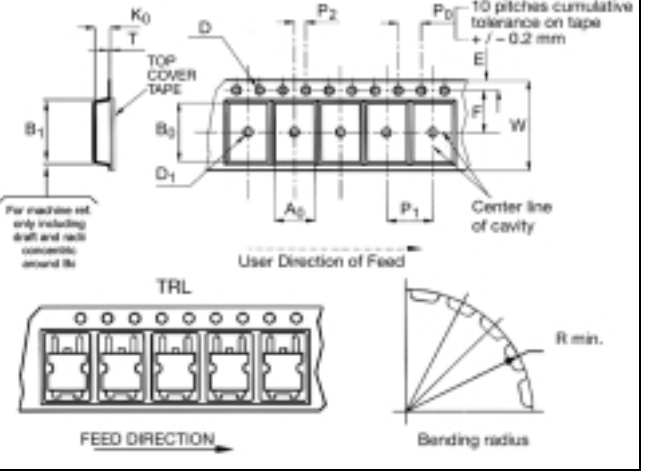
REEL MECHANICAL DATA

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
2500	2500

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

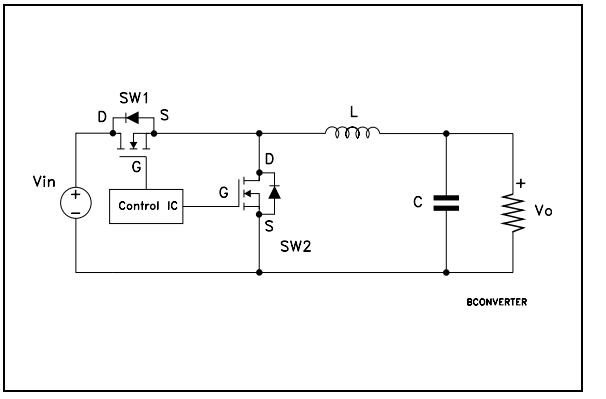


* on sales type

Appendix A: Buck Converter Power Losses Estimation

DESCRIPTION

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 RDS(on) to reduce conduction losses
- Small Q_{gls} to reduce the gate charge losses
- Small C_{oss} to reduce losses due to output capaci tance
- 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)
$P_{conduction}$		$R_{DS(on)SW1} * I_L^2 * \delta$	$R_{DS(on)SW2} * I_L^2 * (1-\delta)$
$P_{switching}$		$V_{in} * (Q_{gsth(SW1)} + Q_{gd(SW1)}) * f * \frac{I_L}{I_g}$	Zero Voltage Switching
P_{diode}	Recovery	Not Applicable	$^1V_{in} * Q_{rr(SW2)} * f$
	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
δ	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
Pdiode	Gate Drive Losses
P_{Qoss}	Output Capacitance Losses

Table 8: Revision History

Date	Revision	Description of Changes
27-Aug-2004	1	First Release.
10-Sep-2004	2	Values changed in table 7