



STx23NM60ND

N-channel 600 V, 0.150 Ω , 19.5 A, FDmesh™ II Power MOSFET
(with fast diode) D²PAK, I²PAK, TO-220, TO-220FP, TO-247

Features

Type	V _{DSS} (@T _{Jmax})	R _{DS(on)} max	I _D
STB23NM60ND	650 V	< 0.180 Ω	19.5 A
STI23NM60ND	650 V	< 0.180 Ω	19.5 A
STF23NM60ND	650 V	< 0.180 Ω	19.5 A ⁽¹⁾
STP23NM60ND	650 V	< 0.180 Ω	19.5 A
STW23NM60ND	650 V	< 0.180 Ω	19.5 A

1. Limited by wire bonding

- The worldwide best R_{DS(on)} * area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- High dv/dt and avalanche capabilities

Application

- Switching applications

Description

The FDmesh™ II series belongs to the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout and associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB23NM60ND	23NM60ND	D ² PAK	Tape and reel
STI23NM60ND	23NM60ND	I ² PAK	Tube
STF23NM60ND	23NM60ND	TO-220FP	Tube
STP23NM60ND	23NM60ND	TO-220	Tube
STW23NM60ND	23NM60ND	TO-247	Tube

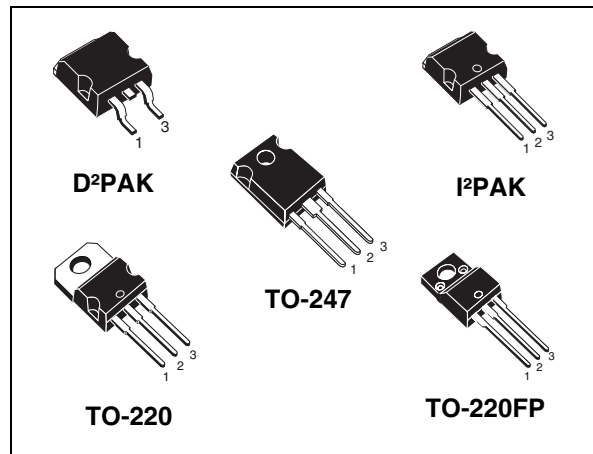
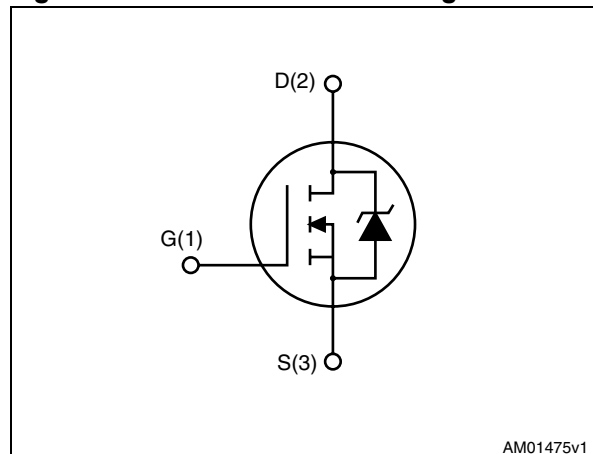


Figure 1. Internal schematic diagram



AM01475v1

Contents

1	Electrical ratings	3
2	Electrical characteristics	4
	2.1 Electrical characteristics (curves)	6
3	Test circuits	9
4	Package mechanical data	10
5	Packaging mechanical data	16
6	Revision history	17

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK/I ² PAK TO-220/TO-247	TO-220FP	
V _{DS}	Drain-source voltage (V _{GS} =0)	600		V
V _{GS}	Gate-source voltage	± 25		V
I _D	Drain current (continuous) at T _C = 25 °C	19.5	19.5 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	11.7	11.7 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	78	78 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	150	35	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	40		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)	--	2500	V
T _{stg}	Storage temperature	-55 to 150		°C
T _j	Max. operating junction temperature	150		°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 19.5 A, di/dt ≤ 600 A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	D ² PAK	I ² PAK	TO-220	TO-247	TO-220FP	Unit
R _{thj-case}	Thermal resistance junction-case max	0.83				3.6	°C/W
R _{thj-amb}	Thermal resistance junction-amb max	--	62.5	50	62.5	°C/W	
T _l	Maximum lead temperature for soldering purposes	300					°C

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I _{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _j max)	9	A
E _{AS}	Single pulse avalanche energy (starting T _j = 25 °C, I _D = I _{AS} , V _{DD} = 50 V)	700	mJ

2 Electrical characteristics

($T_{CASE} = 25\text{ °C}$ unless otherwise specified)

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0$	600			V
$dv/dt^{(1)}$	Drain-source voltage slope	$V_{DD} = 480\text{ V}$, $I_D = 19.5\text{ A}$, $V_{GS} = 10\text{ V}$	30			V/ns
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = \text{Max rating}$, $V_{DS} = \text{Max rating}$, @ 125 °C			1 100	μA μA
I_{GSS}	Gate body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20\text{ V}$			100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$, $I_D = 10\text{ A}$		0.150	0.180	W

1. Characteristic value at turn off on inductive load

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}$, $I_D = 10\text{ A}$		17		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 50\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$		2050 80 8		pF pF pF
$C_{oss\text{ eq.}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0$, $V_{DS} = 0\text{ to }480\text{ V}$		318		pF
Rg	Gate input resistance	$f = 1\text{ MHz}$ Gate DC Bias=0 Test signal level=20 mV open drain		4		W
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 480\text{ V}$, $I_D = 19.5\text{ A}$ $V_{GS} = 10\text{ V}$ (see Figure 19)		70 10 30		nC nC nC

1. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2. $C_{oss\text{ eq.}}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 10\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 18)		25		ns
t_r	Rise time			45		ns
$t_{d(off)}$	Turn-off delay time			90		ns
t_f	Fall time			40		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current				19.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				78	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 19.5\text{ A}$, $V_{GS}=0$			1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 19.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$ (see Figure 20)		190		ns
Q_{rr}	Reverse recovery charge			1.2		μC
I_{RRM}	Reverse recovery current			13		A
t_{rr}	Reverse recovery time	$V_{DD} = 100\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, $I_{SD} = 19.5\text{ A}$ $T_j = 150\text{ }^\circ\text{C}$ (see Figure 20)		260		ns
Q_{rr}	Reverse recovery charge			2.0		μC
I_{RRM}	Reverse recovery current			15		A

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220, D²PAK, I²PAK

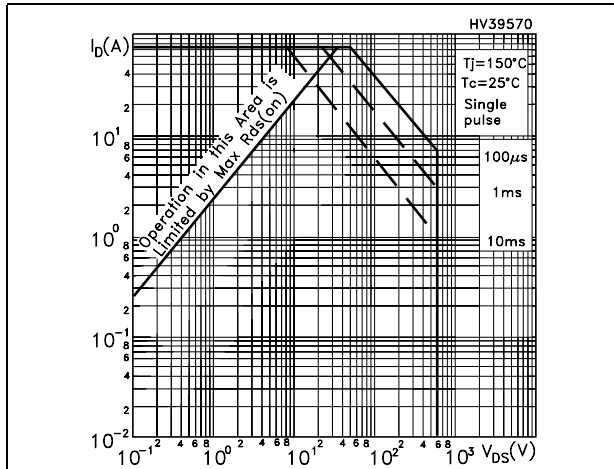


Figure 3. Thermal impedance for TO-220, D²PAK, I²PAK

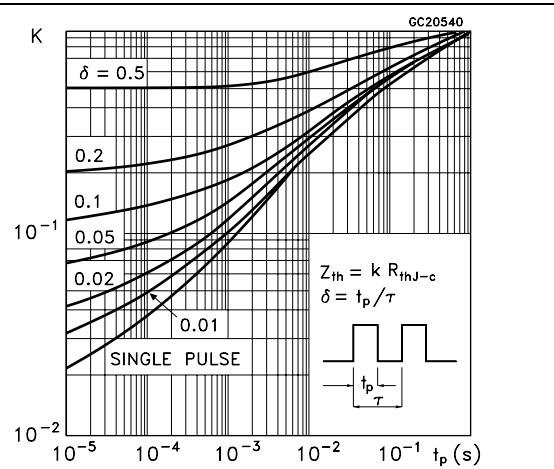


Figure 4. Safe operating area for TO-220FP

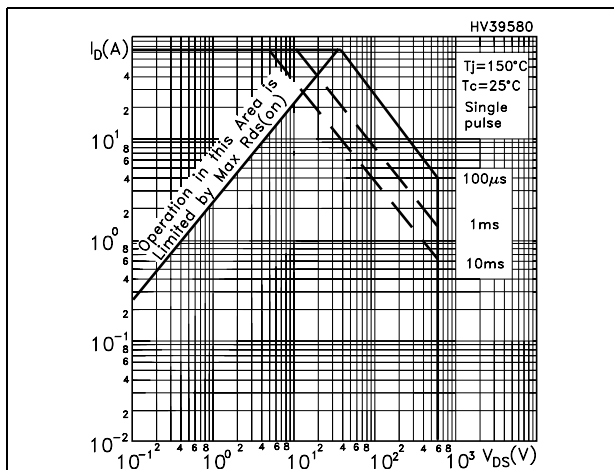


Figure 5. Thermal impedance for TO-220FP

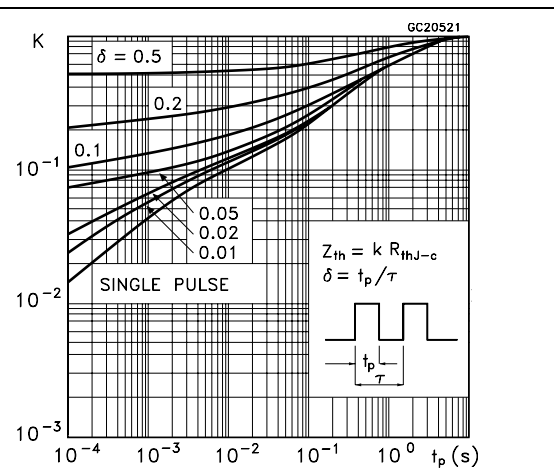


Figure 6. Safe operating area for TO-247

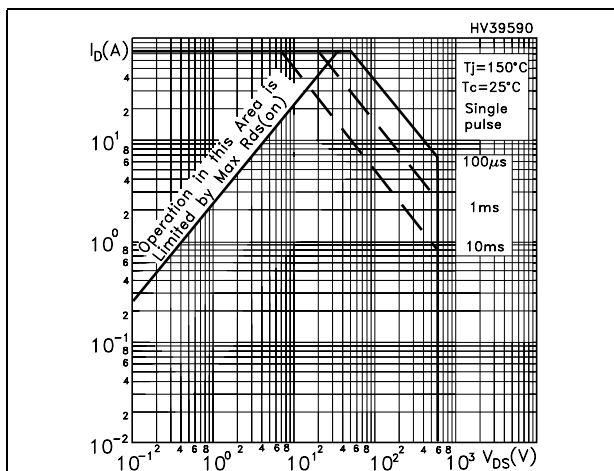


Figure 7. Thermal impedance for TO-247

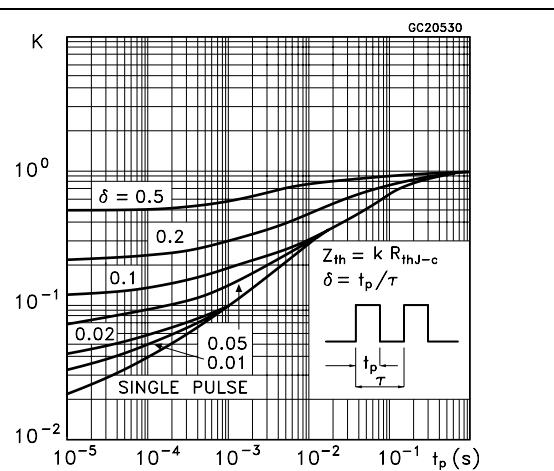


Figure 8. Output characteristics

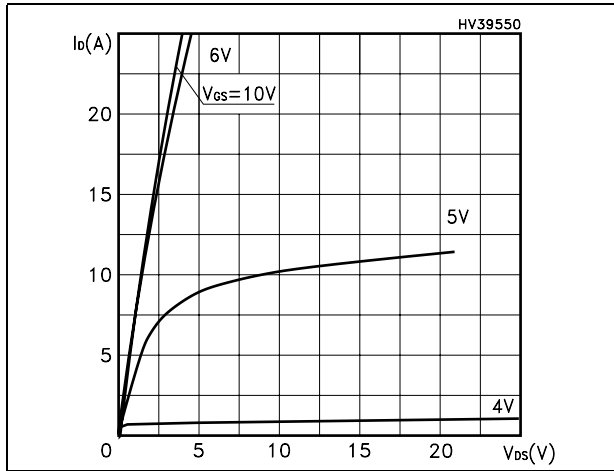


Figure 9. Transfer characteristics

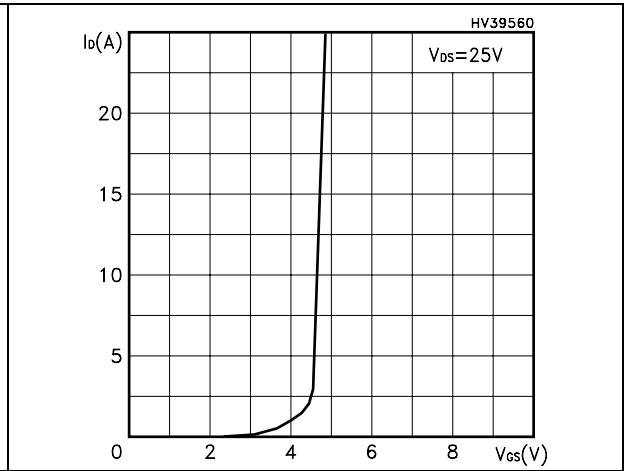


Figure 10. Transconductance

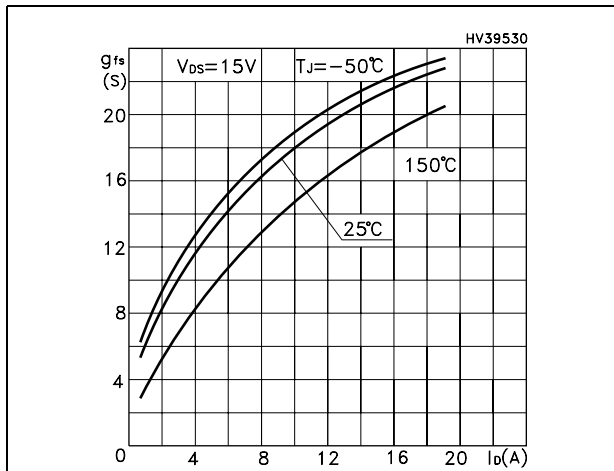


Figure 11. Static drain-source on resistance

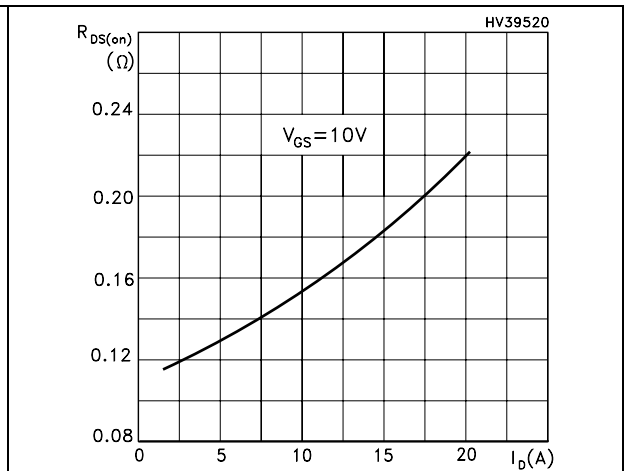


Figure 12. Gate charge vs gate-source voltage

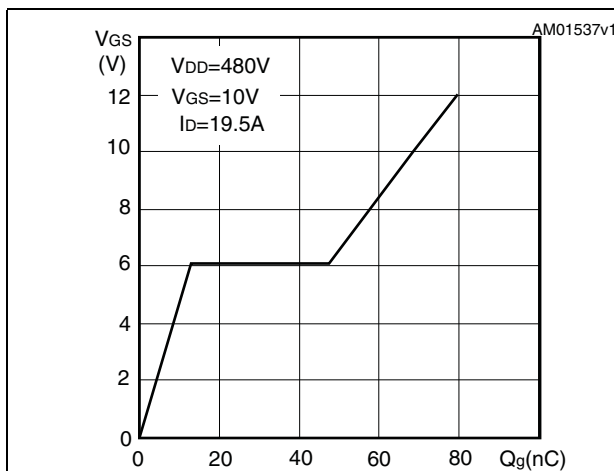


Figure 13. Capacitance variations

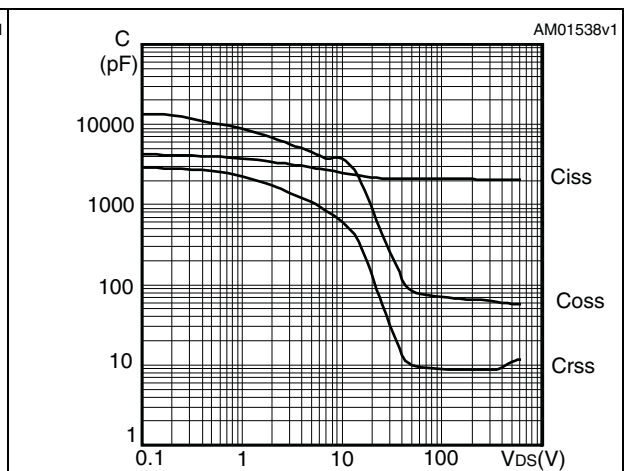


Figure 14. Normalized gate threshold voltage vs temperature

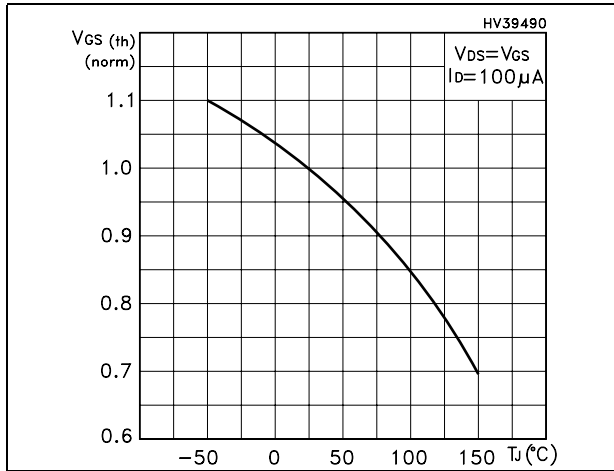


Figure 15. Normalized on resistance vs temperature

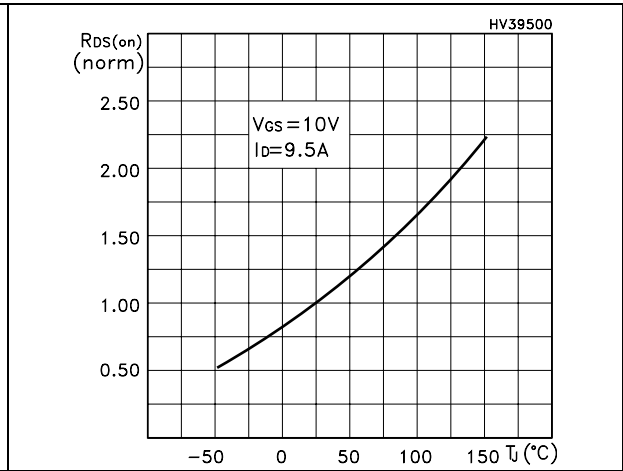


Figure 16. Source-drain diode forward characteristics

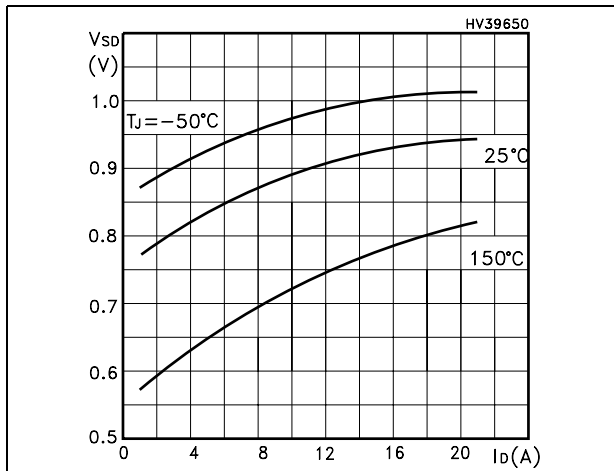
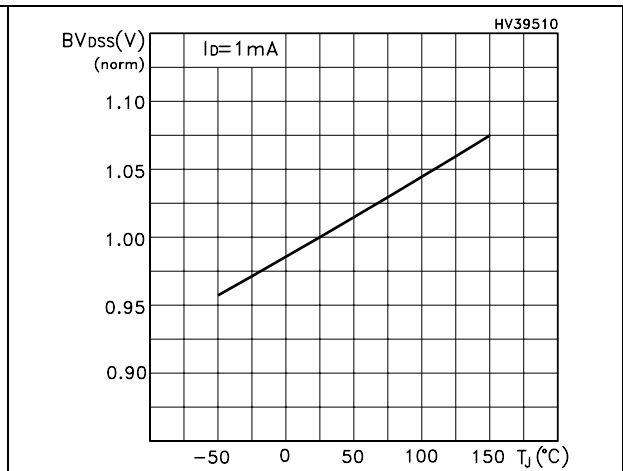


Figure 17. Normalized BV_{DSS} vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

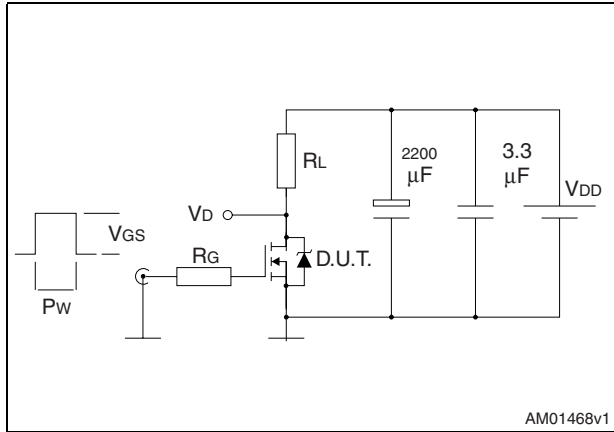


Figure 19. Gate charge test circuit

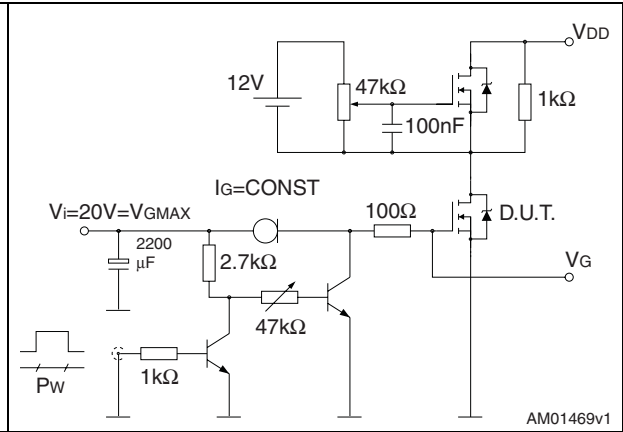


Figure 20. Test circuit for inductive load switching and diode recovery times

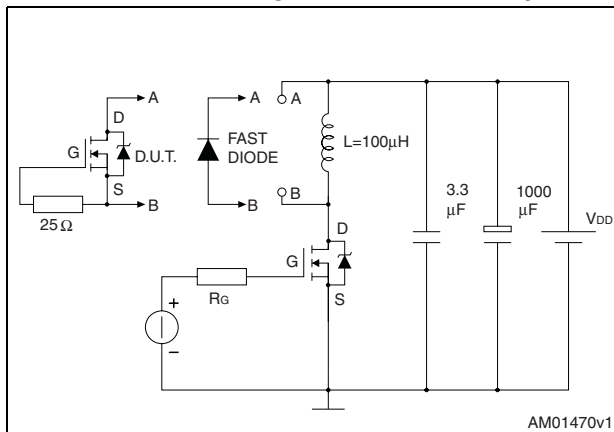


Figure 21. Unclamped inductive load test circuit

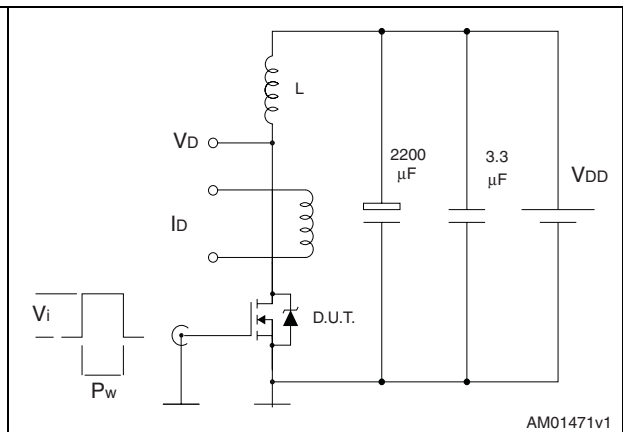


Figure 22. Unclamped inductive waveform

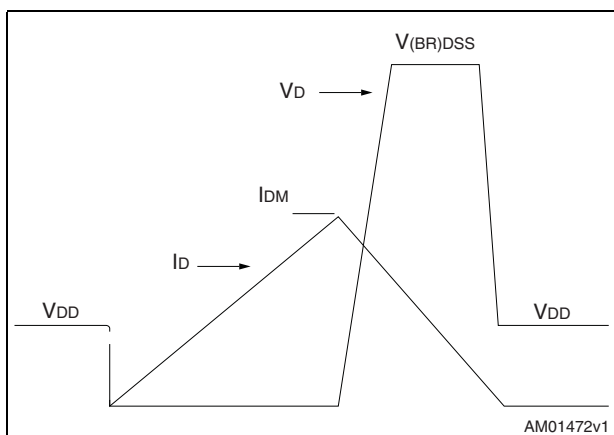
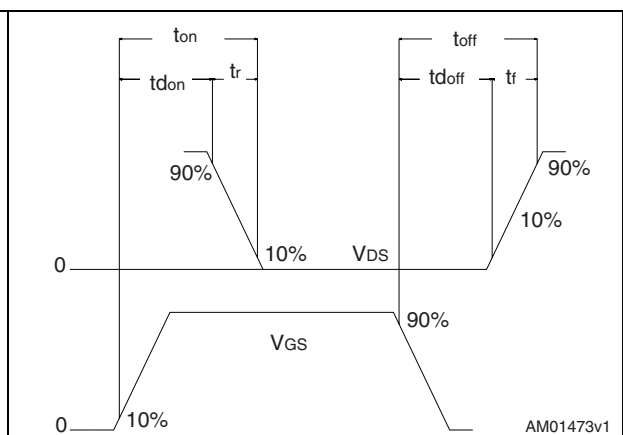


Figure 23. Switching time waveform

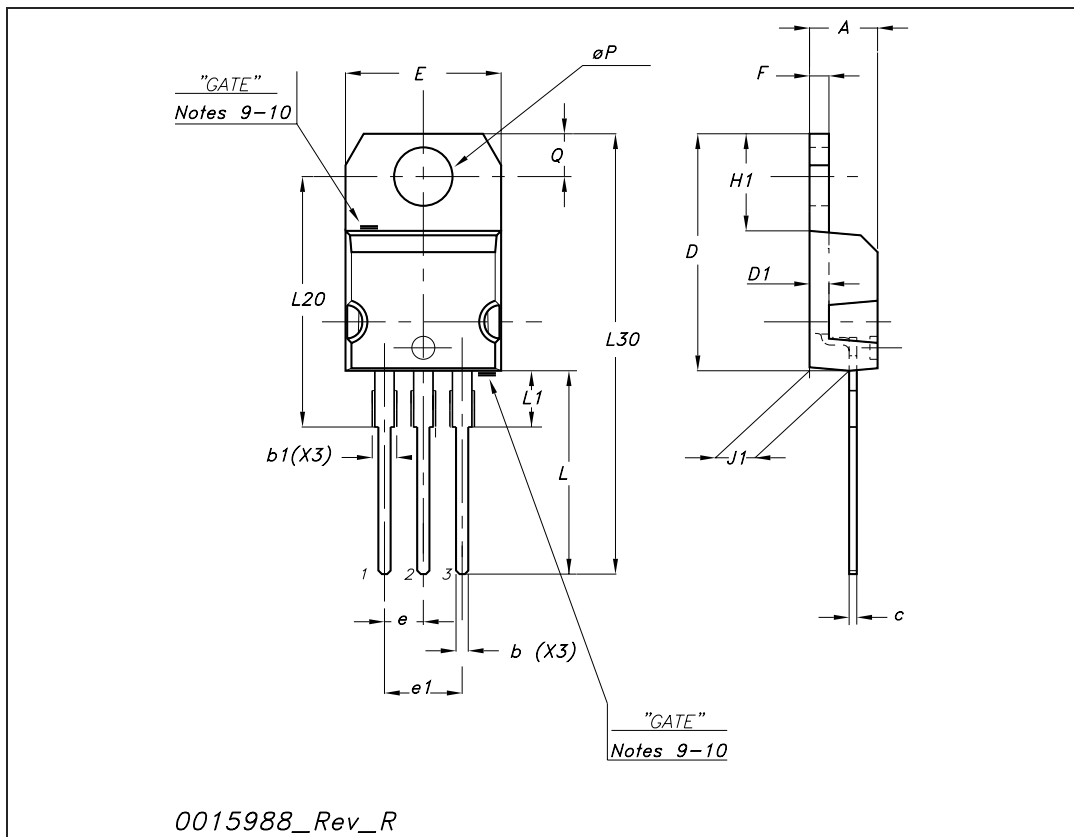


4 Package mechanical data

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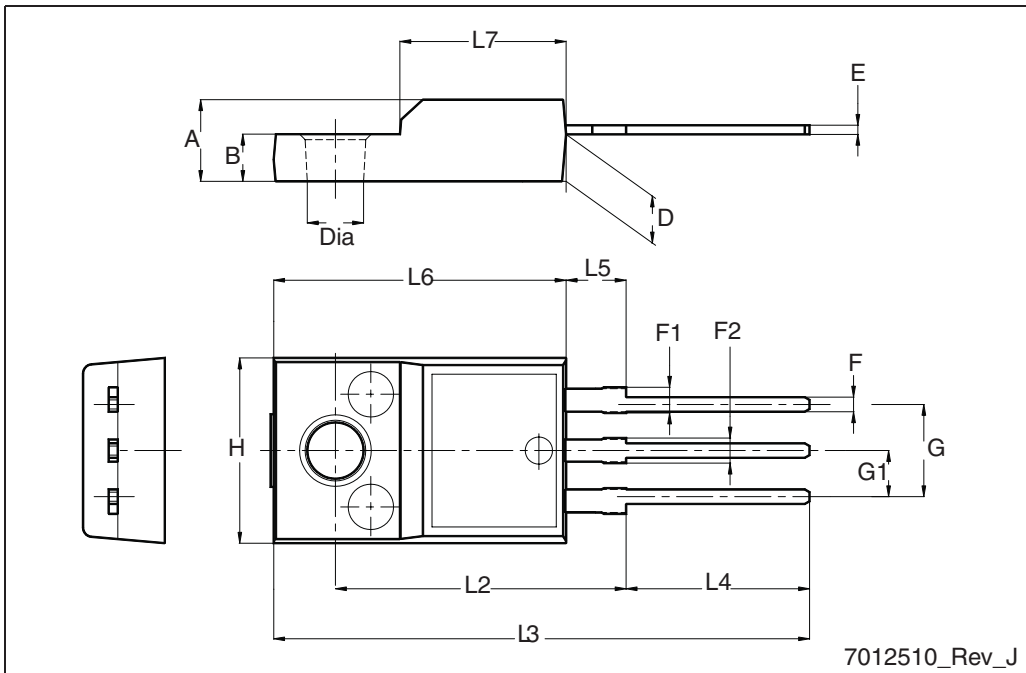
TO-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



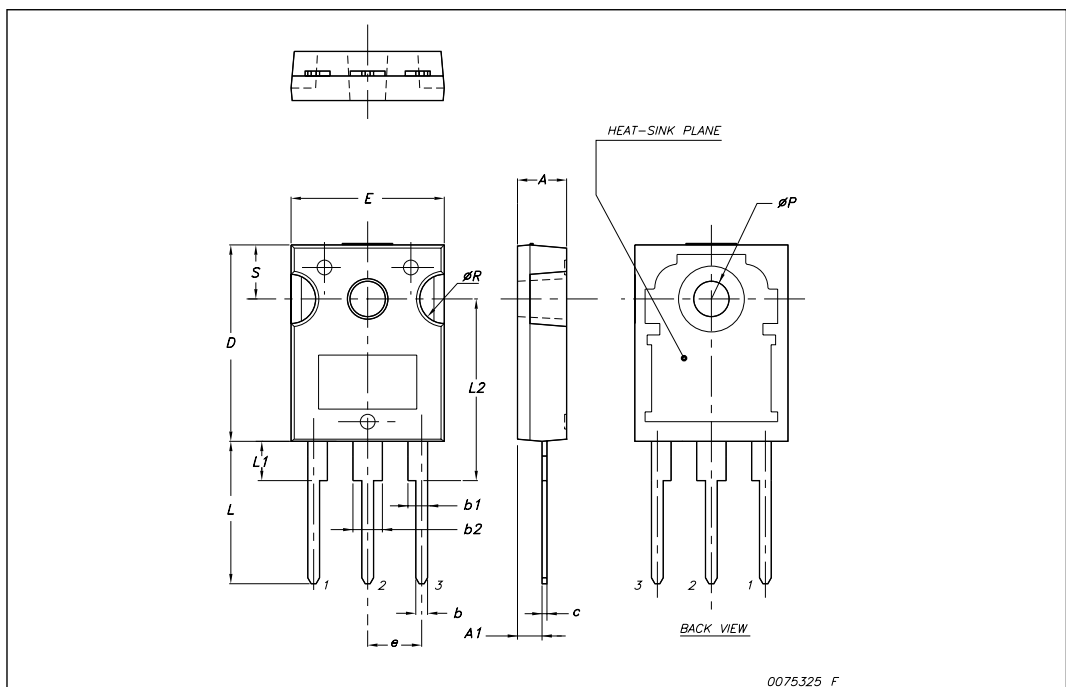
TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.5
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2



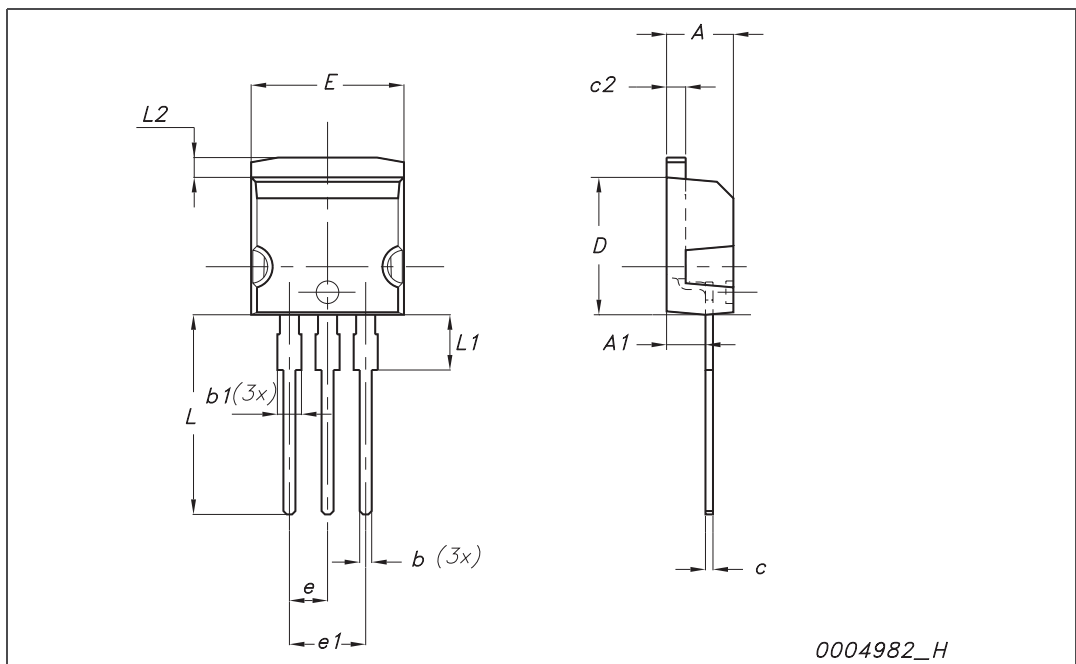
TO-247 Mechanical data

Dim.	mm.		
	Min.	Typ	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
øP	3.55		3.65
øR	4.50		5.50
S		5.50	



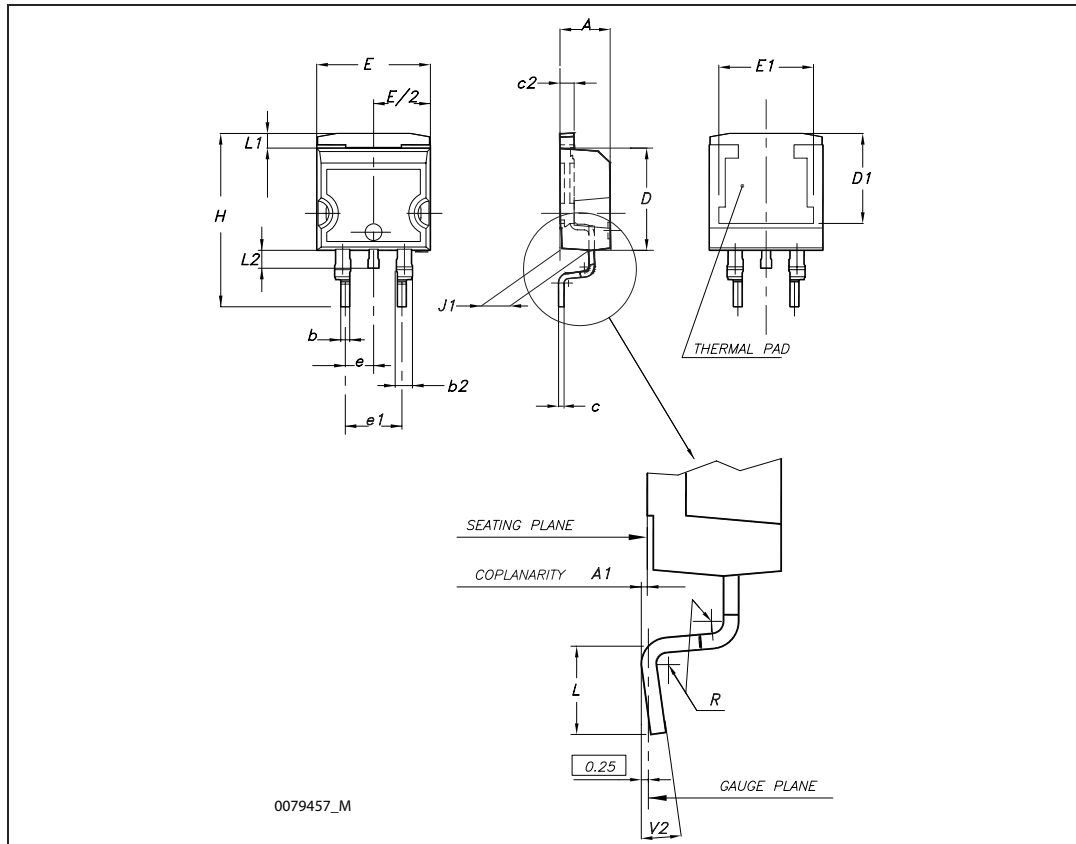
I²PAK (TO-262) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055



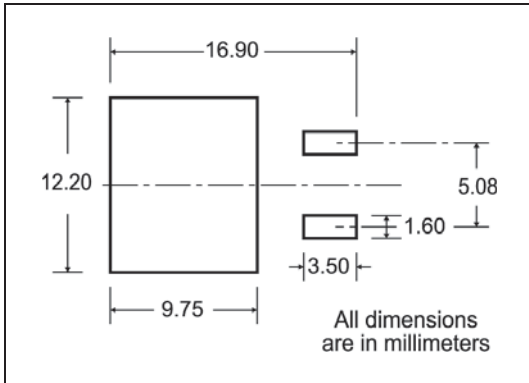
D²PAK (TO-263) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.099		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°



5 Packaging mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT

TAPE MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

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	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
22-Jan-2008	1	First release
11-Dec-2008	2	Document status promoted from preliminary data to datasheet.

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