STF33N60M2, STI33N60M2, STP33N60M2, STW33N60M2

N-channel 600 V, 0.108 Ω typ., 26 A MDmesh II Plus™ low Q_g Power MOSFETs in TO-220FP, I^2PAK, TO-220 and TO-247 packages

Datasheet - production data

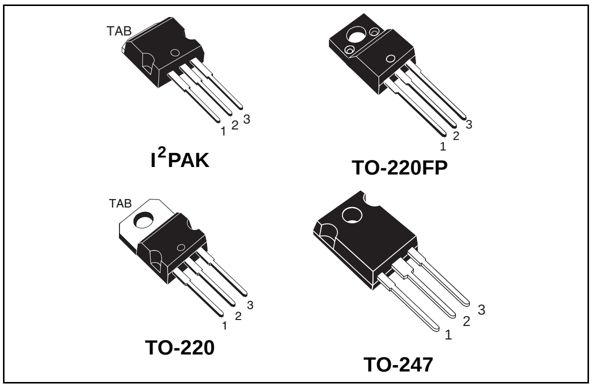
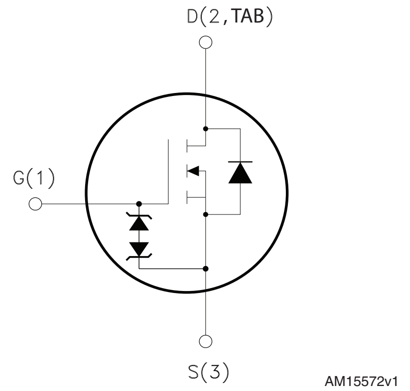


Figure 1. Internal schematic diagram



Features

Order codes	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STF33N60M2	650 V	0.125 Ω	26 A(1)
STI33N60M2			26 A
STP33N60M2			
STW33N60M2			

1. Limited by maximum junction temperature.

- Extremely low gate charge
- Lower $R_{DS(on)}$ x area vs previous generation
- MDmesh™ II technology
- Low gate input resistance
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications
- LCC converters, resonant converters

Description

These devices are N-channel Power MOSFETs developed using a new generation of MDmesh™ technology: MDmesh II Plus™ low Q_g. These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STF33N60M2	33N60M2	TO-220FP	Tube
STI33N60M2		I^2PAK	
STP33N60M2		TO-220	
STW33N60M2		TO-247	

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		I^2PAK, TO-220 TO-247	TO-220FP	
V_{GS}	Gate-source voltage	± 25		V
I_D	Drain current (continuous) at T_C = 25 °C	26	26(1)	A
I_D	Drain current (continuous) at T_C = 100 °C	16	16(1)	A
I_{DM} (2)	Drain current (pulsed)	104	104(1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	190	35	W
dv/dt (3)	Peak diode recovery voltage slope	15		V/ns
dv/dt(4)	MOSFET dv/dt ruggedness	50		V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; TC = 25 °C)		2500	V
T_{stg}	Storage temperature	- 55 to 150		°C
T_j	Max. operating junction temperature			

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 26$ A, di/dt ≤ 400 A/µs; $V_{DS\ peak} < V_{(BR)DSS}$, V_{DD}= 400 V.
4. $V_{DS} \leq$ 480 V

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220FP	I^2PAK, TO-220	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	3.6	0.66		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max	62.5		50	°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	5	A
E_{AS}	Single pulse avalanche energy (starting T_j=25°C, I_D= I_{AR}; V_{DD}=50)	2300	mJ

2 Electrical characteristics

(T_C = 25 °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 mA, V_{GS} = 0	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 600 V V_{DS} = 600 V, T_C=125 °C			1 100	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 25 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 13 A		0.108	0.125	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0	-	1781	-	pF
C_{oss}	Output capacitance		-	85	-	pF
C_{rss}	Reverse transfer capacitance		-	2.5	-	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0	-	135	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	5.2	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 26 A, V_{GS} = 10 V (see *Figure 19*)	-	45.5	-	nC
Q_{gs}	Gate-source charge		-	9.9	-	nC
Q_{gd}	Gate-drain charge		-	18.5	-	nC

1. $C_{oss\ eq.}$ 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 V, I_D = 13 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 18* and *Figure 23*)	-	16	-	ns
$t_r(v)$	Voltage rise time		-	9.6	-	ns
$t_d(off)$	Turn-off-delay time		-	109	-	ns
$t_f(i)$	Fall time		-	9	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		26	A
I_{SDM} (1)	Source-drain current (pulsed)		-		104	A
V_{SD} (2)	Forward on voltage	I_{SD} = 26 A, V_{GS} = 0	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 26 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 23*)	-	375		ns
Q_{rr}	Reverse recovery charge		-	5.6		µC
I_{RRM}	Reverse recovery current		-	30		A
t_{rr}	Reverse recovery time	I_{SD} = 26 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 23*)	-	478		ns
Q_{rr}	Reverse recovery charge		-	7.7		µC
I_{RRM}	Reverse recovery current		-	32.5		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-220FP

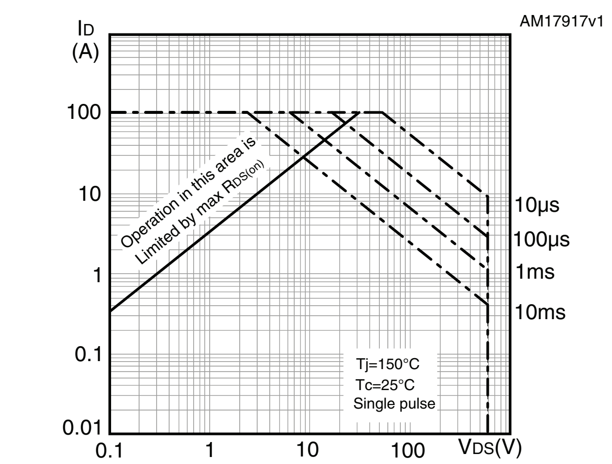


Figure 3. Thermal impedance for TO-220FP

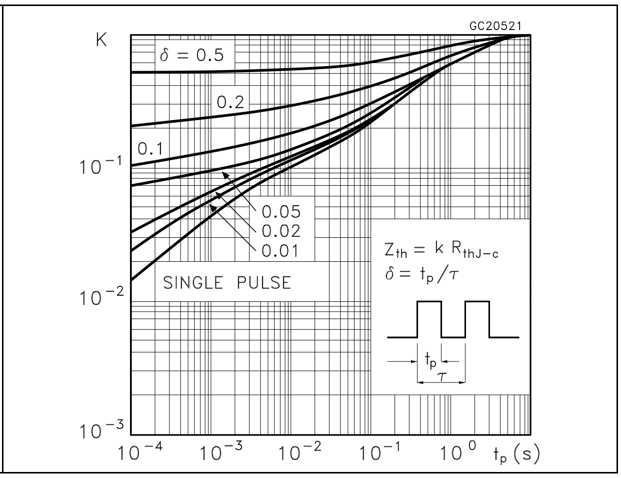


Figure 4. Safe operating area for I²PAK and TO-220

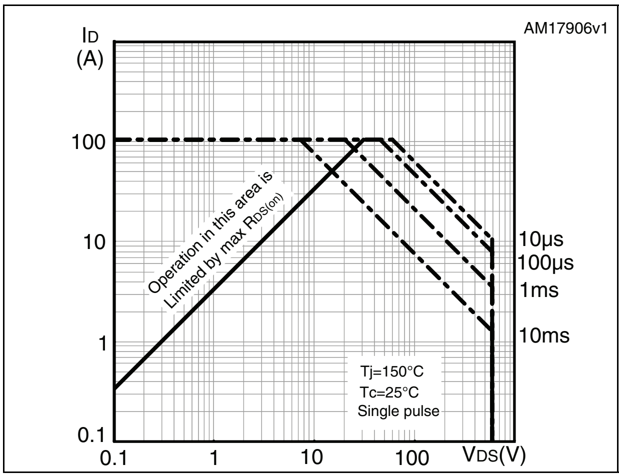


Figure 5. Thermal impedance for I²PAK and TO-220

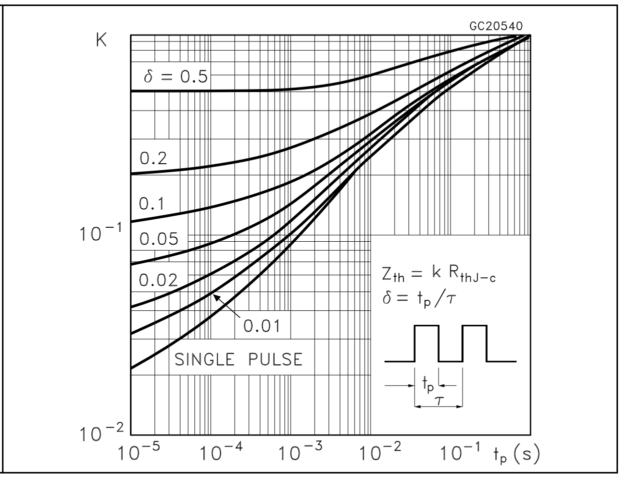


Figure 6. Safe operating area for TO-247

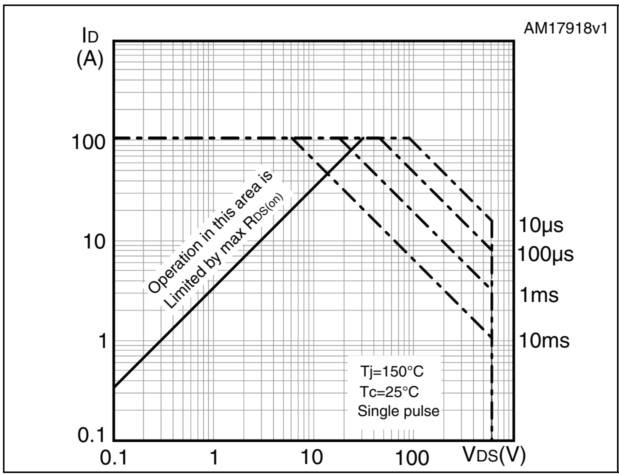


Figure 7. Thermal impedance for TO-247

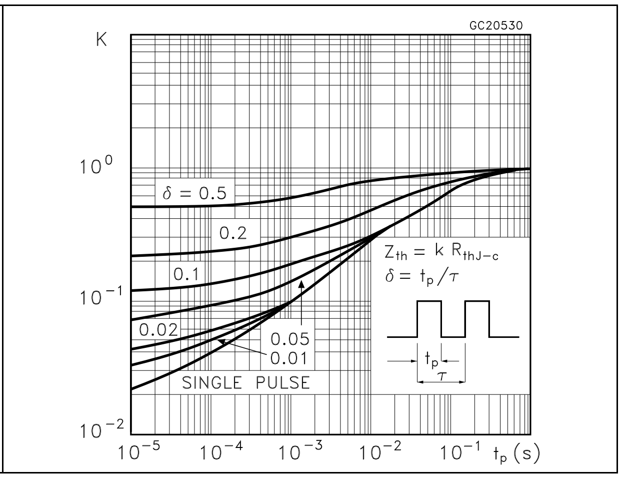


Figure 8. Output characteristics

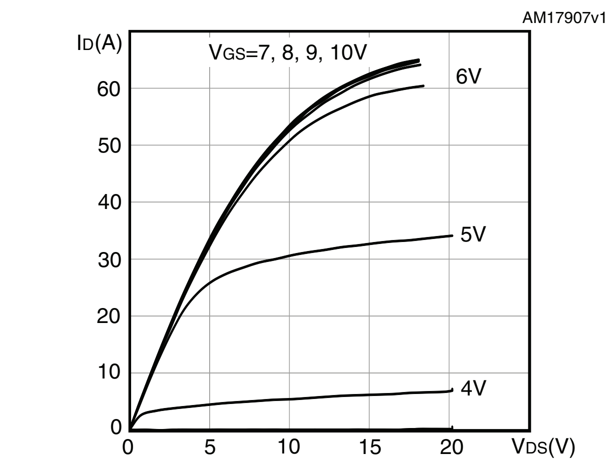


Figure 9. Transfer characteristics

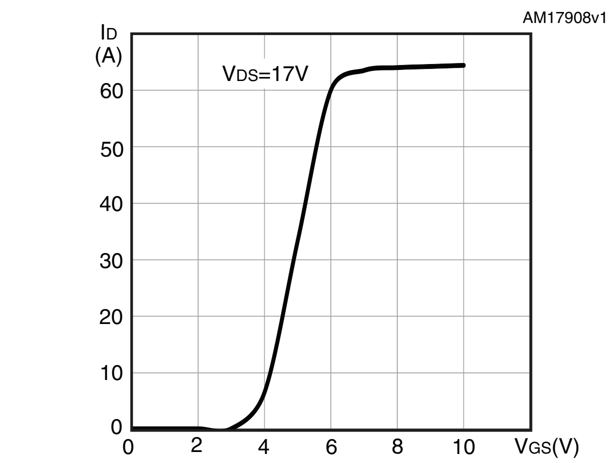


Figure 10. Gate charge vs gate-source voltage

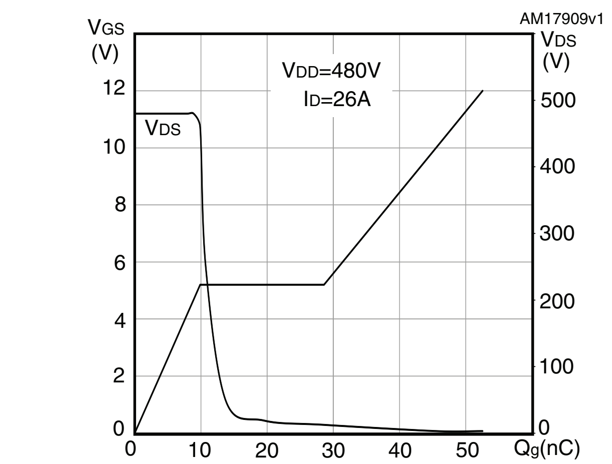


Figure 11. Static drain-source on-resistance

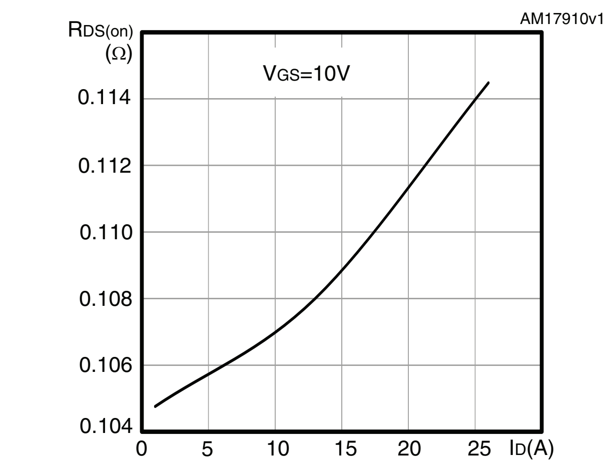


Figure 12. Capacitance variations

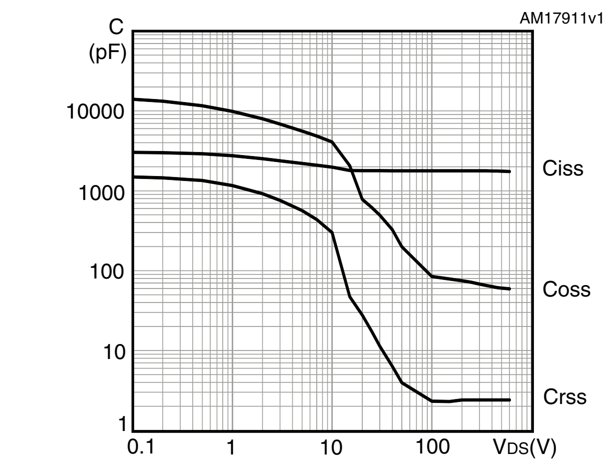


Figure 13. Output capacitance stored energy

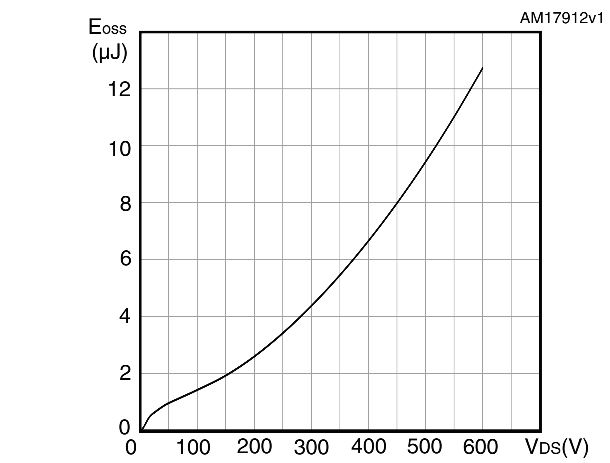


Figure 14. Normalized gate threshold voltage vs temperature

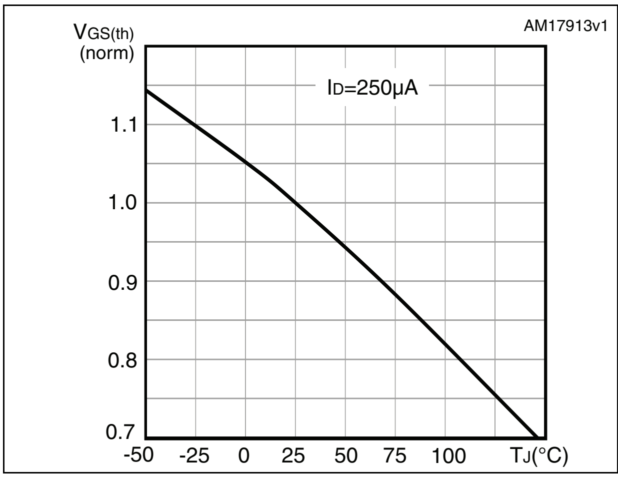


Figure 15. Normalized on-resistance vs temperature

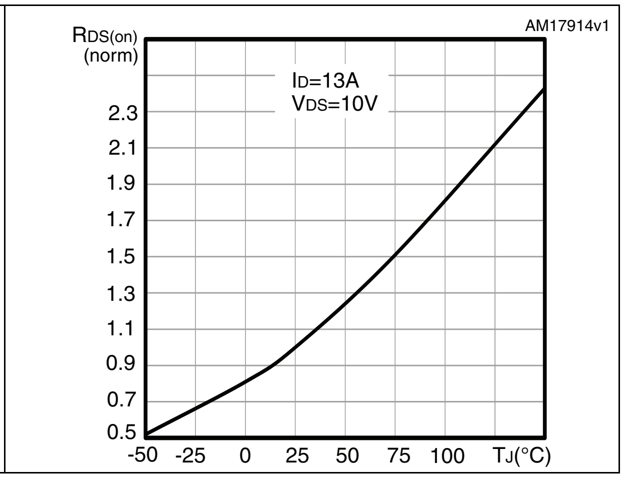


Figure 16. Normalized V_{DS} vs temperature

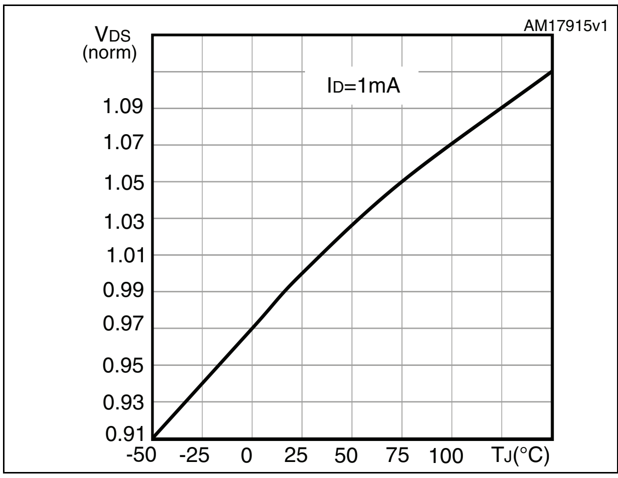
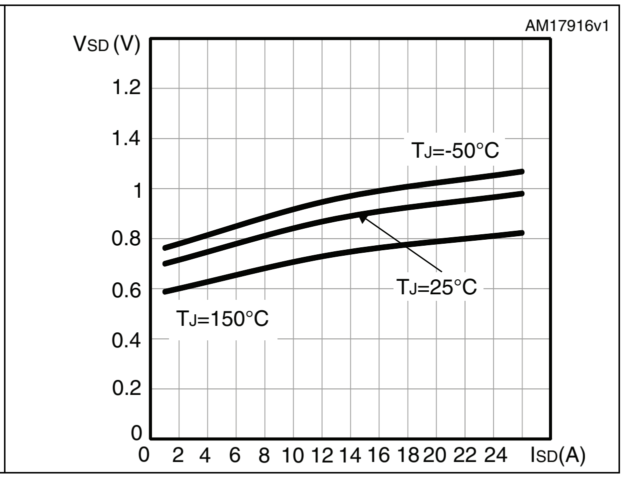


Figure 17. Source-drain diode forward characteristics



3 Test circuits

Figure 18. Switching times test circuit for resistive load

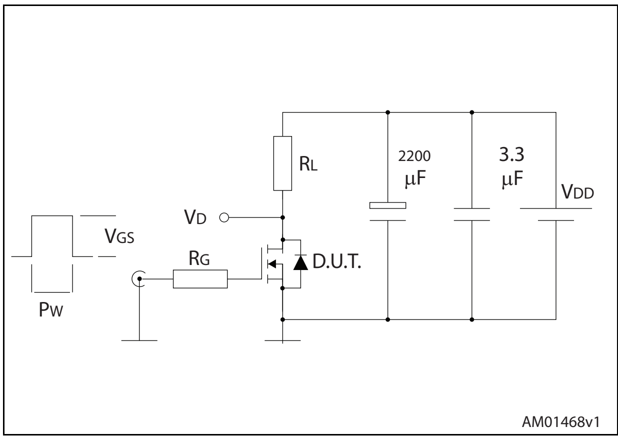


Figure 19. Gate charge test circuit

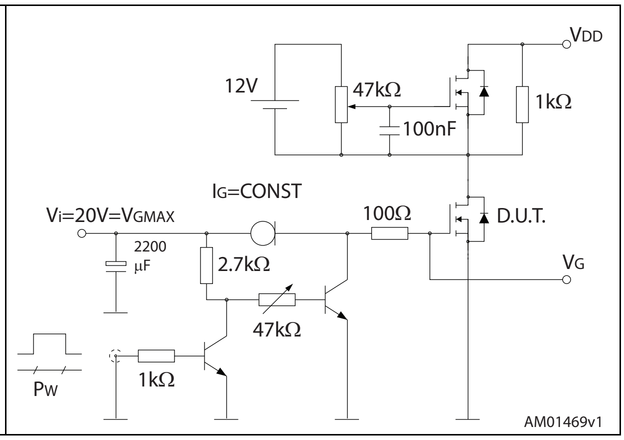


Figure 20. Test circuit for inductive load switching and diode recovery times

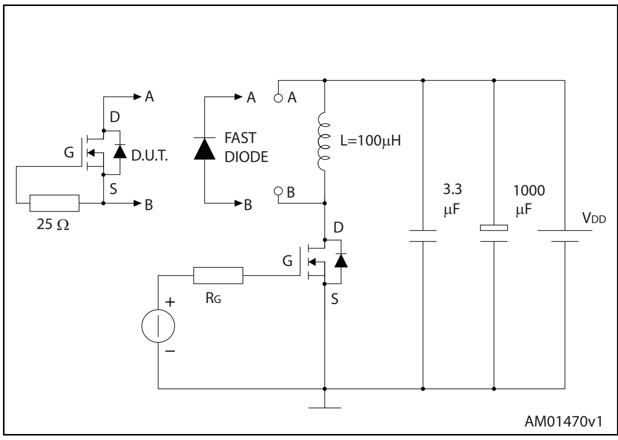


Figure 21. Unclamped inductive load test circuit

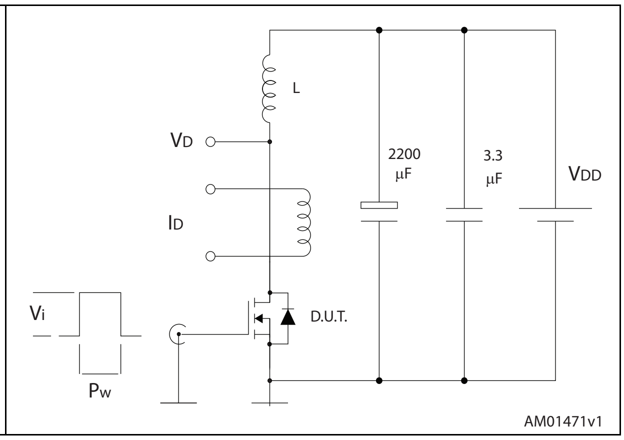


Figure 22. Unclamped inductive waveform

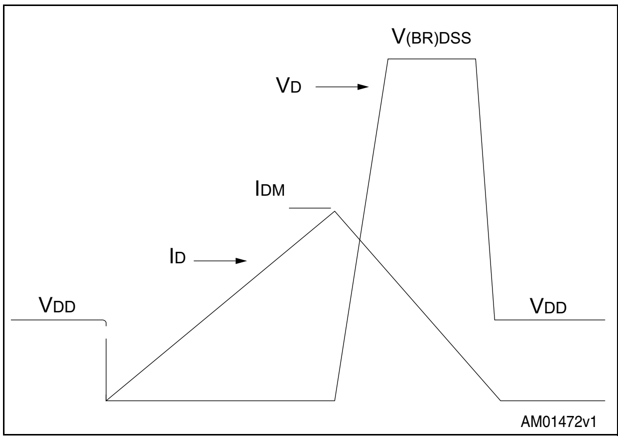
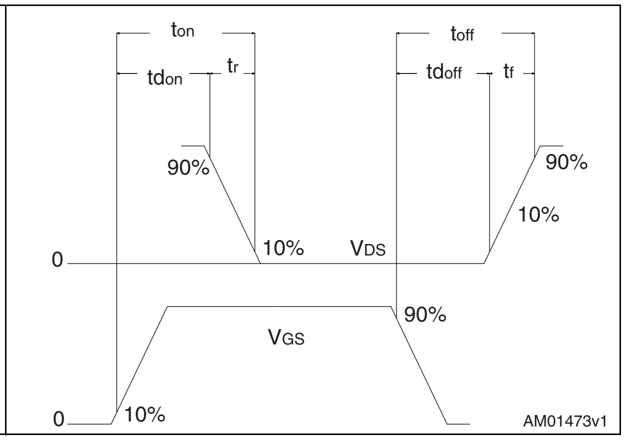


Figure 23. Switching time waveform



4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

Table 9. 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		1.70
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

Figure 24. TO-220FP drawing

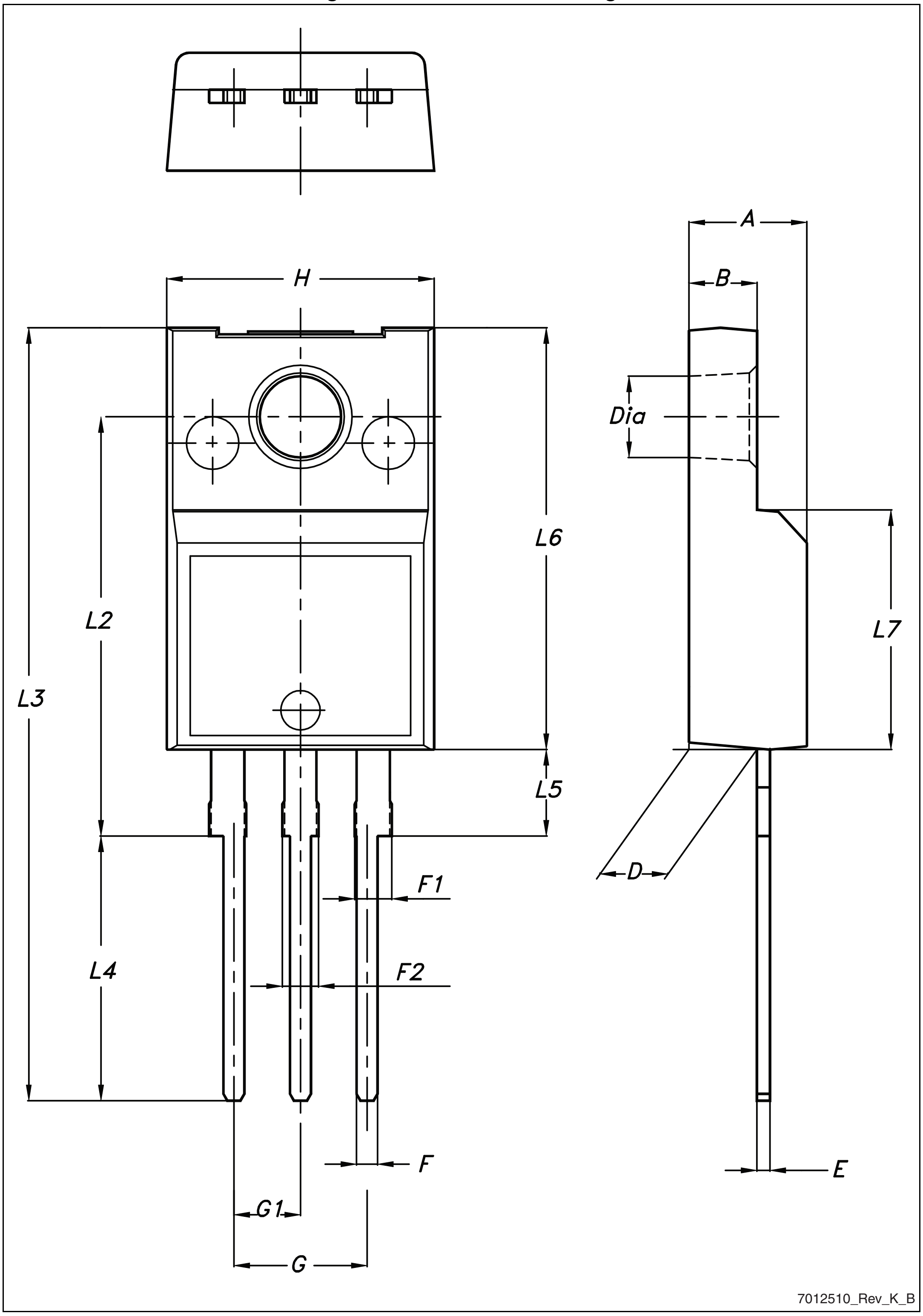


Table 10. I²PAK (TO-262) mechanical data

DIM.	mm.		
	min.	typ	max.
A	4.40		4.60
A1	2.40		2.72
b	0.61		0.88
b1	1.14		1.70
c	0.49		0.70
c2	1.23		1.32
D	8.95		9.35
e	2.40		2.70
e1	4.95		5.15
E	10		10.40
L	13		14
L1	3.50		3.93
L2	1.27		1.40

Figure 25. I²PAK (TO-262) drawing

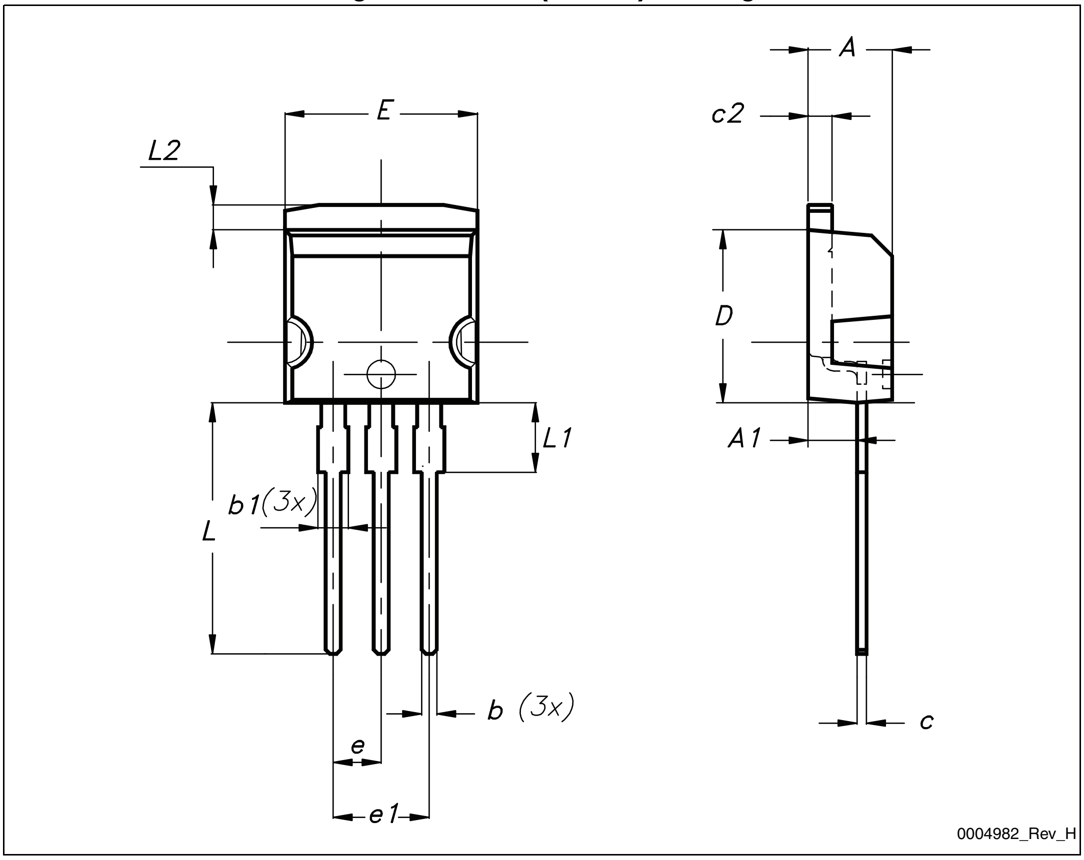


Table 11. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95

Figure 26. TO-220 type A drawing

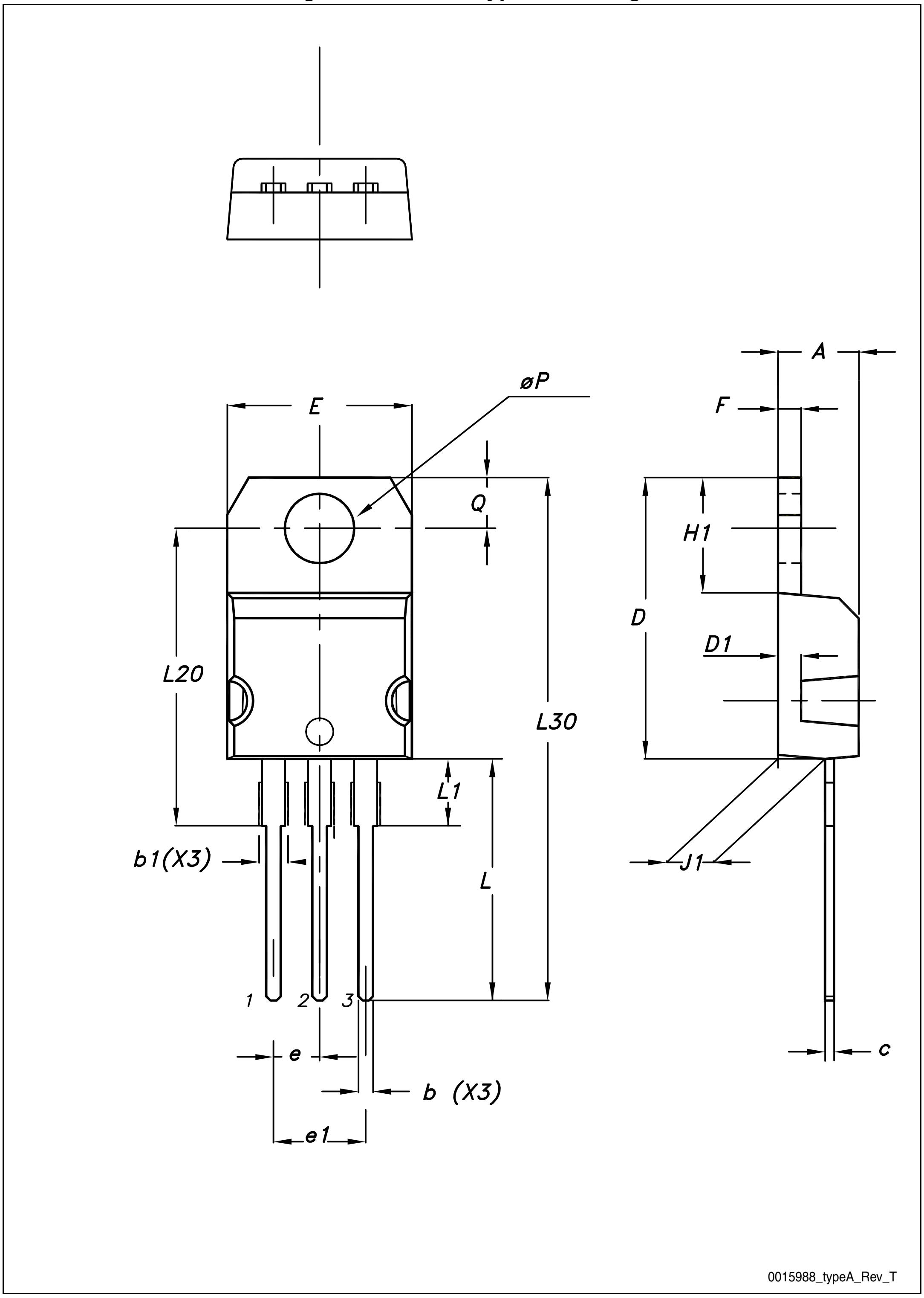
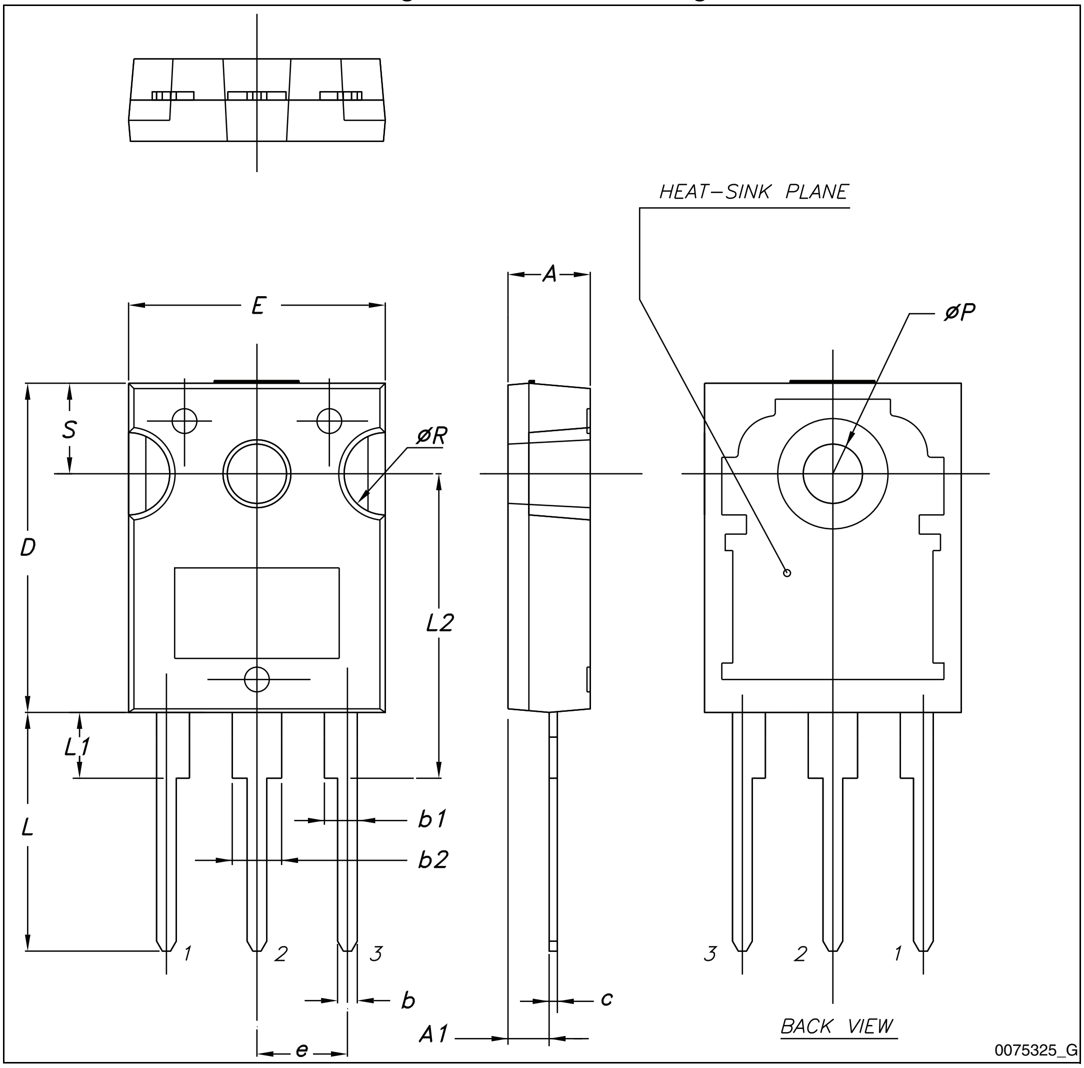


Table 12. TO-247 mechanical data

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	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
∅P	3.55		3.65
∅R	4.50		5.50
S	5.30	5.50	5.70

Figure 27. TO-247 drawing



5 Revision history

Table 13. Document revision history

Date	Revision	Changes
13-Sep-2013	1	First release.
19-Nov-2013	2	– Modified: $R_{DS(on)}$ and I_D values in cover page – Modified: values in *Table 4* – Modified: $R_{DS(on)}$ typical and maximum values in *Table 5*, the entire typical values in *Table 6*, *7* and *8* – Added: *Section 2.1: Electrical characteristics (curves)* – Minor text changes