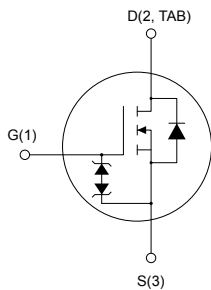
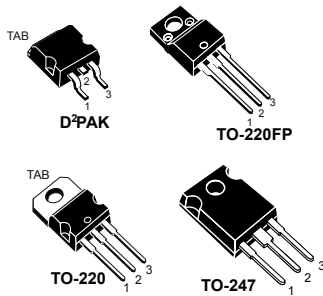




STB21N90K5, STF21N90K5 STP21N90K5, STW21N90K5

Datasheet

N-channel 900 V, 250 mΩ typ., 18.5 A MDmesh K5 Power MOSFETs
in D²PAK, TO-220FP, TO-220 and TO-247 packages



AM01476v1_tab

Features

Order codes	V _{DS}	R _{DS(on)} max.	I _D
STB21N90K5	900 V	299 mΩ	18.5 A
STF21N90K5			
STP21N90K5			
STW21N90K5			

- Very low FoM (figure of merit)
- Ultra-low gate charge
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.



Product status links

[STB21N90K5](#)

[STF21N90K5](#)

[STP21N90K5](#)

[STW21N90K5](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK, TO-220, TO-247	TO-220FP	
V _{GS}	Gate-source voltage	±30		V
I _D	Drain current (continuous) at T _C = 25 °C	18.5	18.5 ⁽¹⁾	A
	Drain current (continuous) at T _C = 100 °C	11.6	11.6 ⁽¹⁾	
I _{DM} ⁽²⁾	Drain current (pulsed)	74	74 ⁽¹⁾	A
P _{TOT}	Total power dissipation at T _C = 25 °C	250	40	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	6		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)		2.5	kV
T _J	Operating junction temperature range	-55 to 150		°C
T _{stg}	Storage temperature range			°C

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. $I_{SD} \leq 18.5 \text{ A}$, $di/dt \leq 100 \text{ A}/\mu\text{s}$, $V_{DS} (\text{peak}) < V_{(BR)DSS}$.

Table 2. Thermal data

Symbol	Parameter	Value				Unit
		D ² PAK	TO-220	TO-247	TO-220FP	
R _{thJC}	Thermal resistance, junction-to-case	0.5			3.13	°C/W
R _{thJA}	Thermal resistance, junction-to-ambient	30 ⁽¹⁾	62.5	50	62.5	°C/W

1. When mounted on a standard 1 inch² area of FR-4 PCB with 2-oz copper.

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I _{AR}	Avalanche current, repetitive or non-repetitive (pulse width limited by T _J max.)	6	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	200	mJ

2 Electrical characteristics

$T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$	900			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 900\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 900\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}^{(1)}$			50	
I_{GSS}	Gate body leakage current	$V_{GS} = \pm 20\text{ V}$, $V_{DS} = 0\text{ V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$, $I_D = 9\text{ A}$		250	299	m Ω

1. Specified by design, not tested in production.

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	1645	-	pF
C_{oss}	Output capacitance		-	112	-	pF
C_{rss}	Reverse transfer capacitance		-	2	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }720\text{ V}$, $V_{GS} = 0\text{ V}$	-	133	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	16	-	pF
R_g	Gate input resistance	$f = 1\text{ MHz}$, $I_D = 0\text{ A}$	-	4	-	Ω
Q_g	Total gate charge	$V_{DD} = 720\text{ V}$, $I_D = 18.5\text{ A}$,	-	43	-	nC
Q_{gs}	Gate-source charge	$V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 19. Test circuit for gate charge behavior)	-	12	-	nC
Q_{gd}	Gate-drain charge		-	25	-	nC

1. $C_{o(tr)}$ is an equivalent capacitance that provides the same charging time as C_{oss} while V_{DS} is rising from 0 V to the stated value.

2. $C_{o(er)}$ is an equivalent capacitance that provides the same stored energy as C_{oss} while V_{DS} is rising from 0 V to the stated value.

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 720\text{ V}$, $I_D = 10\text{ A}$,	-	17	-	ns
t_r	Rise time	$R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	27	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 18. Test circuit for resistive load switching times and Figure 23. Switching time waveform)	-	52	-	ns
t_f	Fall time		-	40	-	ns

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		18.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		74	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 18.5 \text{ A}$, $V_{GS} = 0 \text{ V}$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 18.5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$, $V_{DD} = 60 \text{ V}$ (see Figure 20. Test circuit for inductive load switching and diode recovery times)	-	548		ns
Q_{rr}	Reverse recovery charge		-	12		μC
I_{RRM}	Reverse recovery current		-	46		A
t_{rr}	Reverse recovery time	$I_{SD} = 18.5 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$, $V_{DD} = 60 \text{ V}$, $T_J = 150 \text{ }^\circ\text{C}$ (see Figure 20. Test circuit for inductive load switching and diode recovery times)	-	660		ns
Q_{rr}	Reverse recovery charge		-	15		μC
I_{RRM}	Reverse recovery current		-	45		A

1. Pulse width limited by safe operating area.

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

2.1 Electrical characteristics (curves)

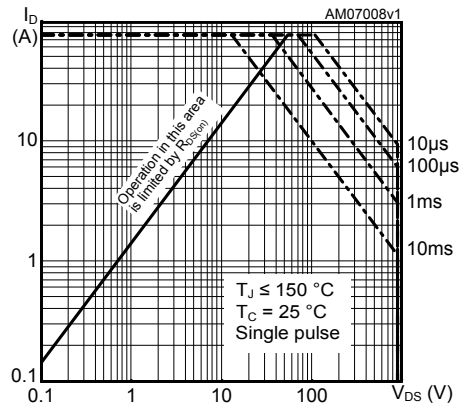
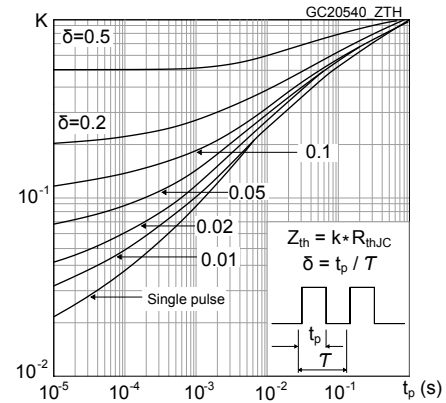
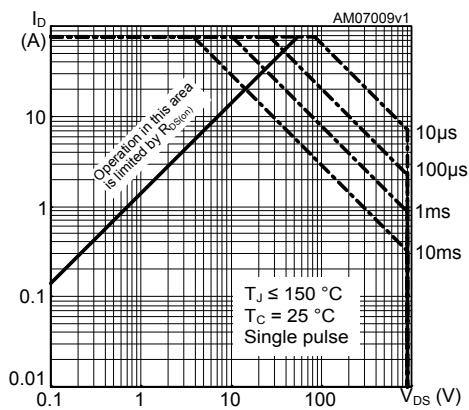
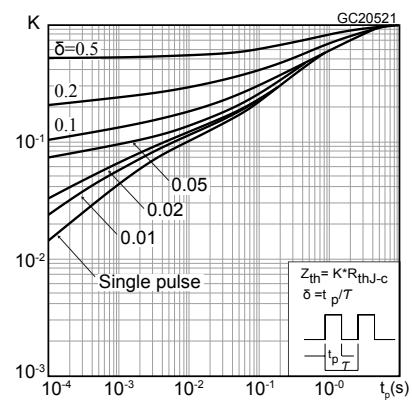
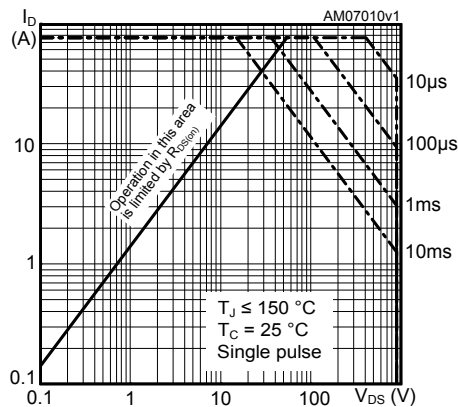
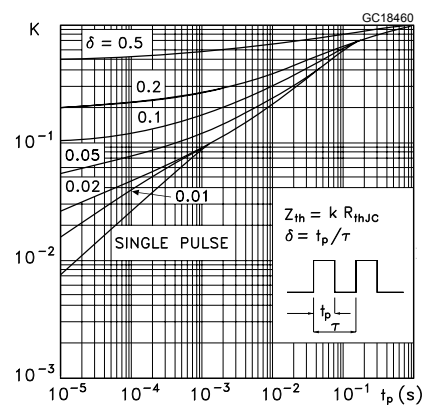
Figure 1. Safe operating area for D²PAK and TO-220

Figure 2. Normalized transient thermal impedance for D²PAK and TO-220

Figure 3. Safe operating area for TO-220FP

Figure 4. Normalized transient thermal impedance for TO-220FP

Figure 5. Safe operating area for TO-247

Figure 6. Normalized transient thermal impedance for TO-247


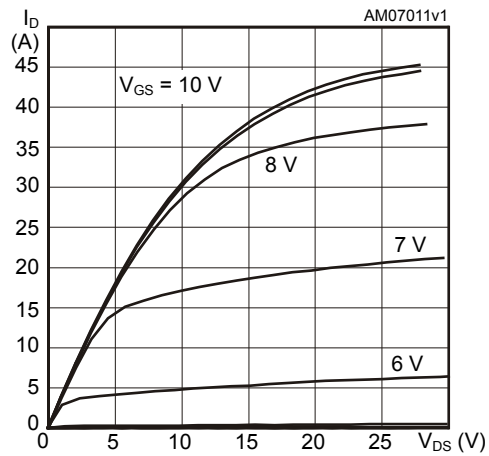
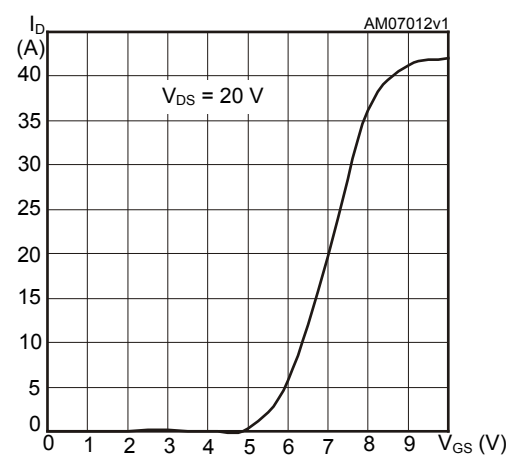
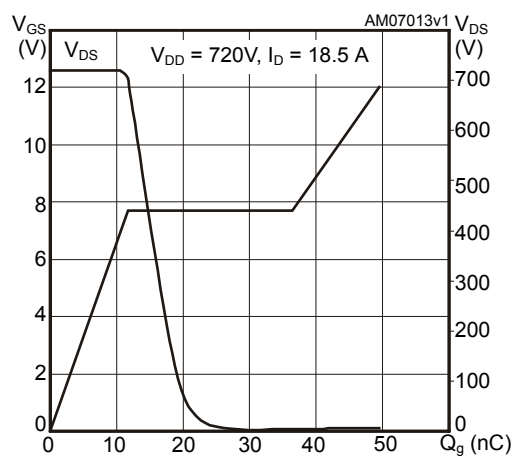
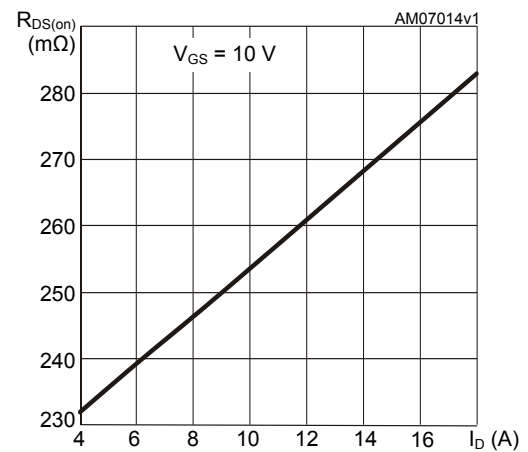
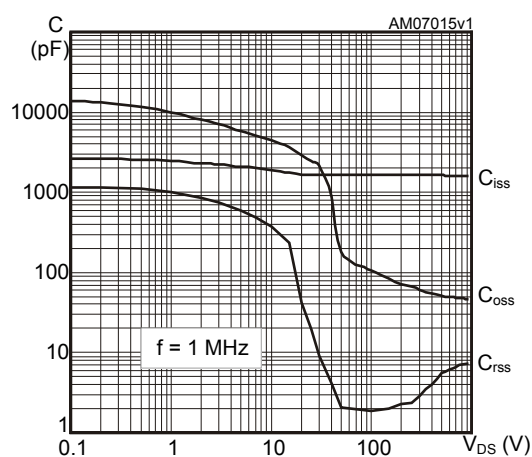
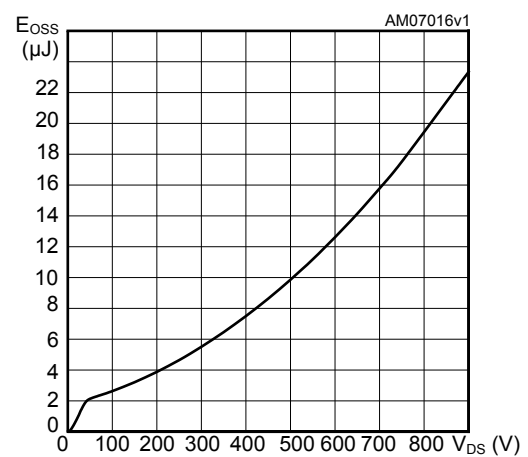
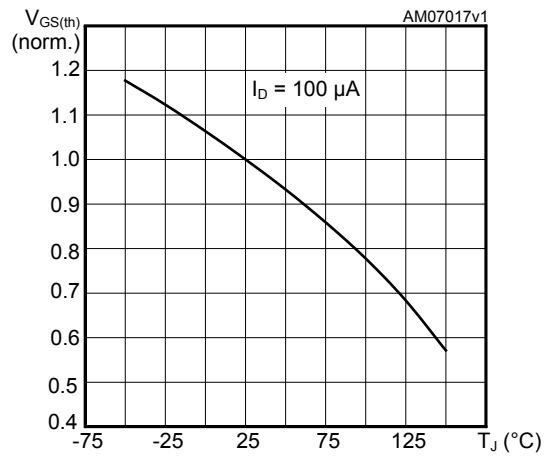
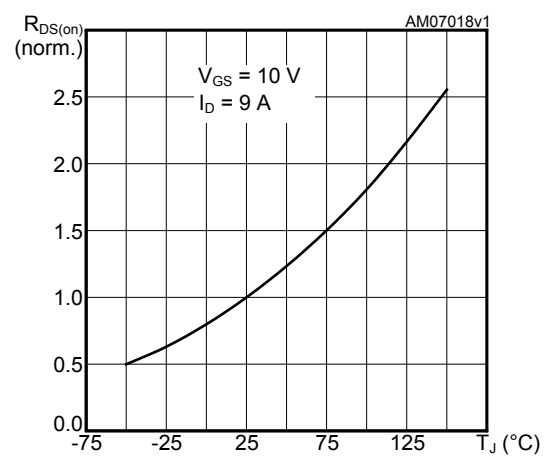
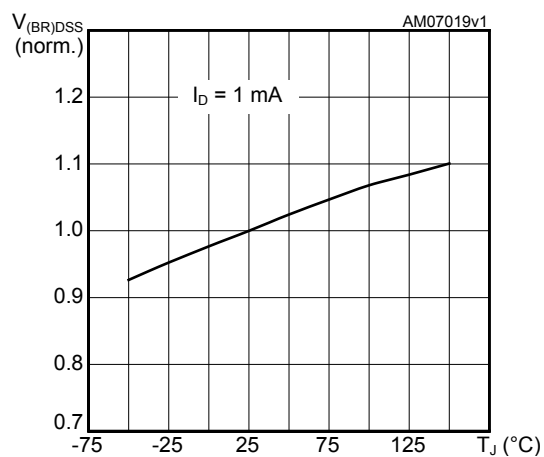
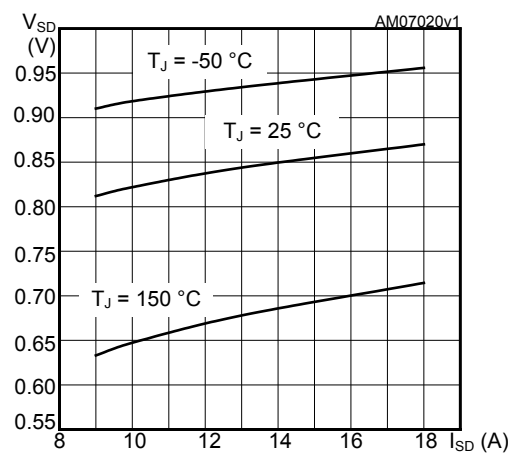
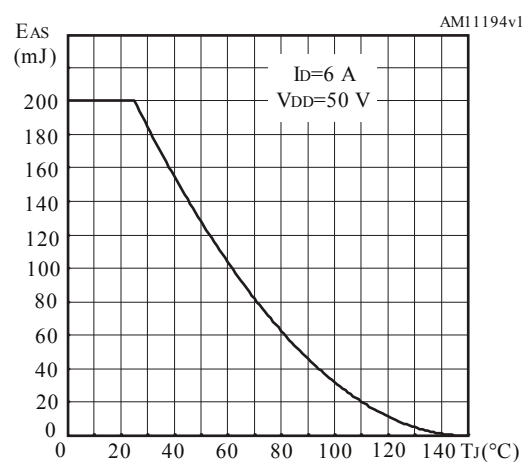
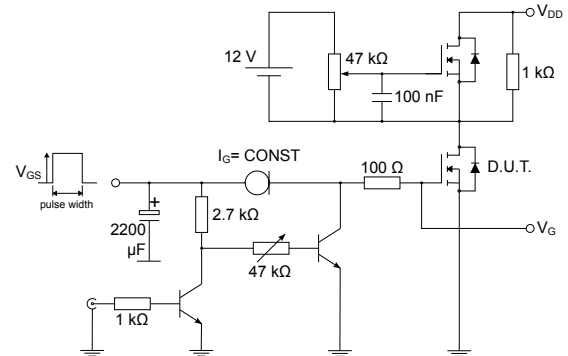
Figure 7. Typical output characteristics

Figure 8. Typical transfer characteristics

Figure 9. Typical gate charge characteristics

Figure 10. Typical drain-source on-resistance

Figure 11. Typical capacitance characteristics

Figure 12. Typical output capacitance stored energy


Figure 13. Normalized gate threshold vs temperature

Figure 14. Normalized on-resistance vs temperature

Figure 15. Normalized breakdown voltage vs temperature

Figure 16. Typical reverse diode forward characteristics

Figure 17. Maximum avalanche energy vs temperature


3 Test circuits

Figure 18. Test circuit for resistive load switching times

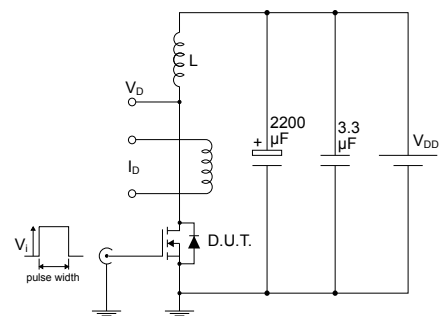

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Figure 19. Test circuit for gate charge behavior


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

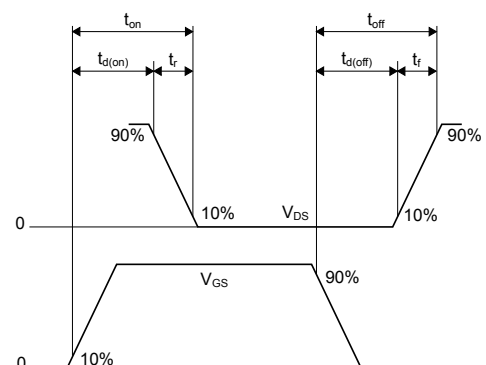

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Figure 21. Unclamped inductive load test circuit


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Figure 22. Unclamped inductive waveform


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Figure 23. Switching time waveform


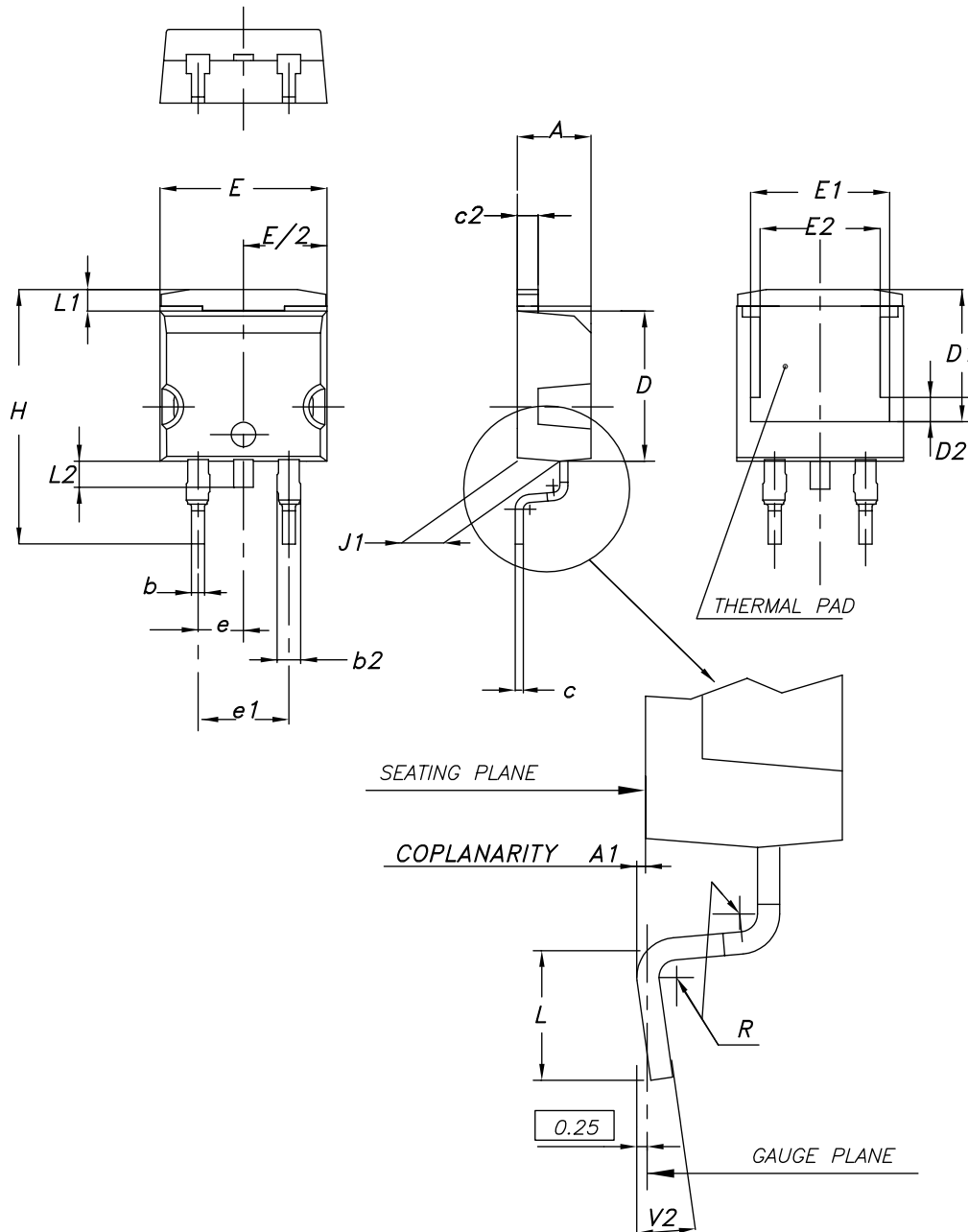
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4 Package information

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.

4.1 D²PAK (TO-263) type A2 package information

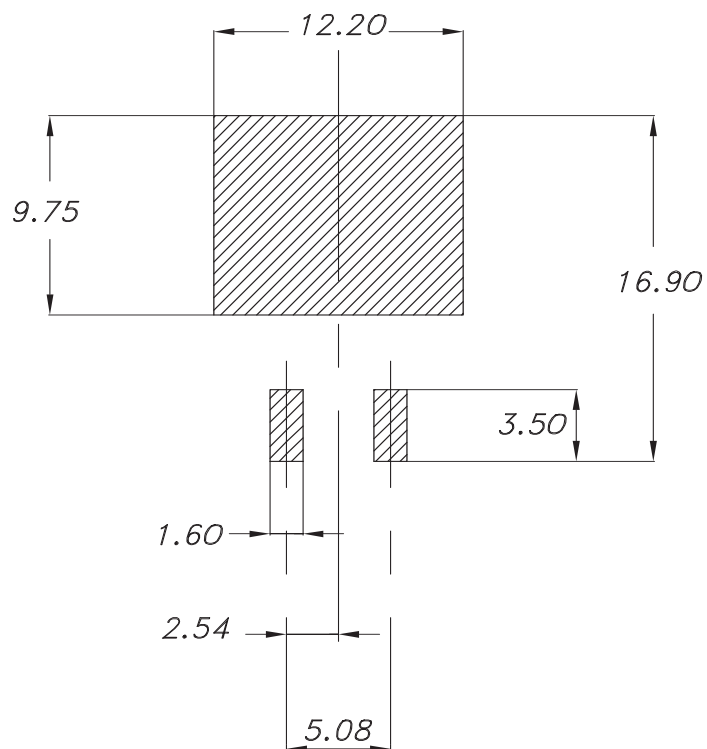
Figure 24. D²PAK (TO-263) type A2 package outline



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Table 8. D²PAK (TO-263) type A2 package mechanical data

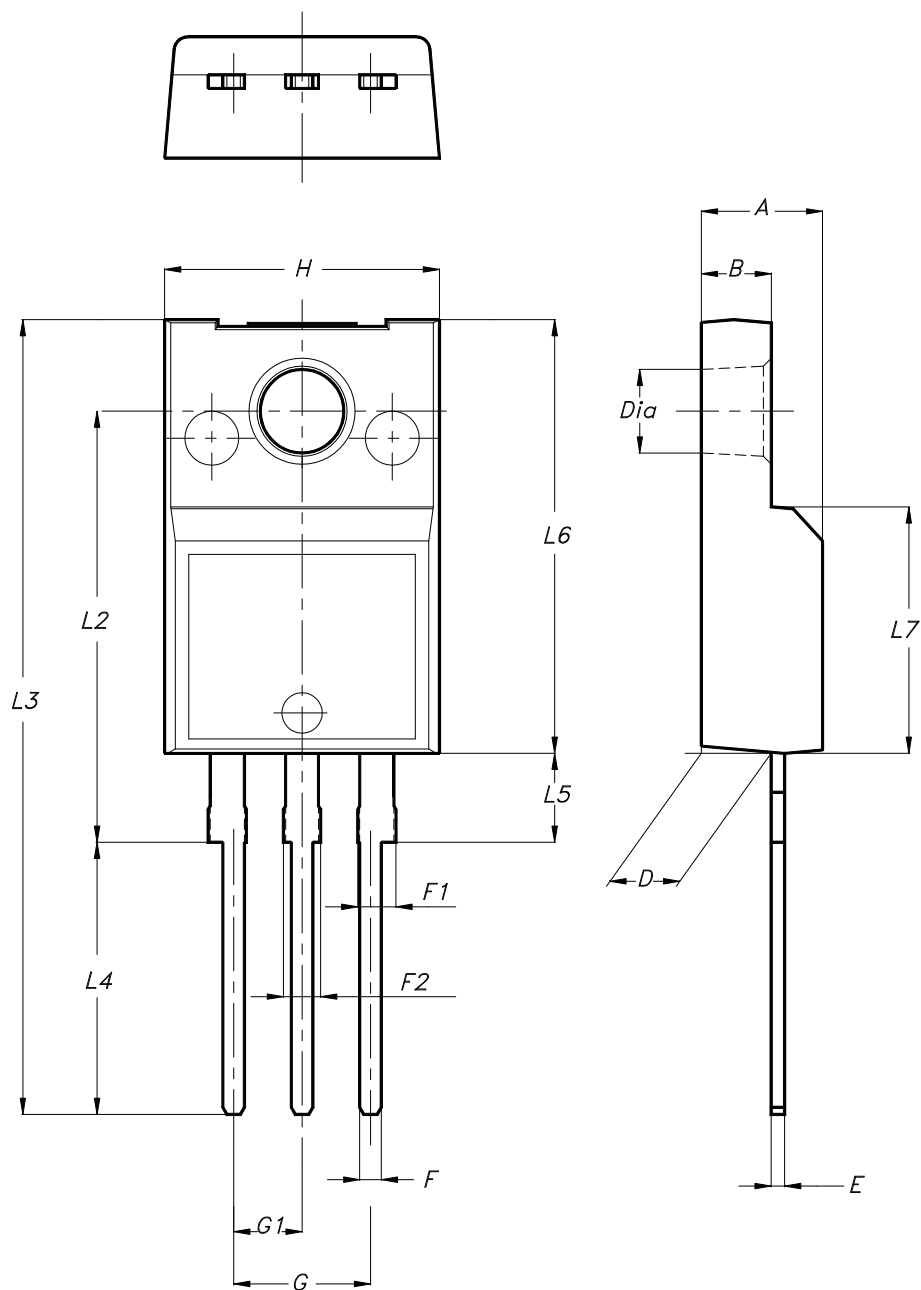
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.70	8.90	9.10
E2	7.30	7.50	7.70
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

Figure 25. D²PAK (TO-263) recommended footprint (dimensions are in mm)


0079457_Rev27_footprint

4.2 TO-220FP package information

Figure 26. TO-220FP type B package outline



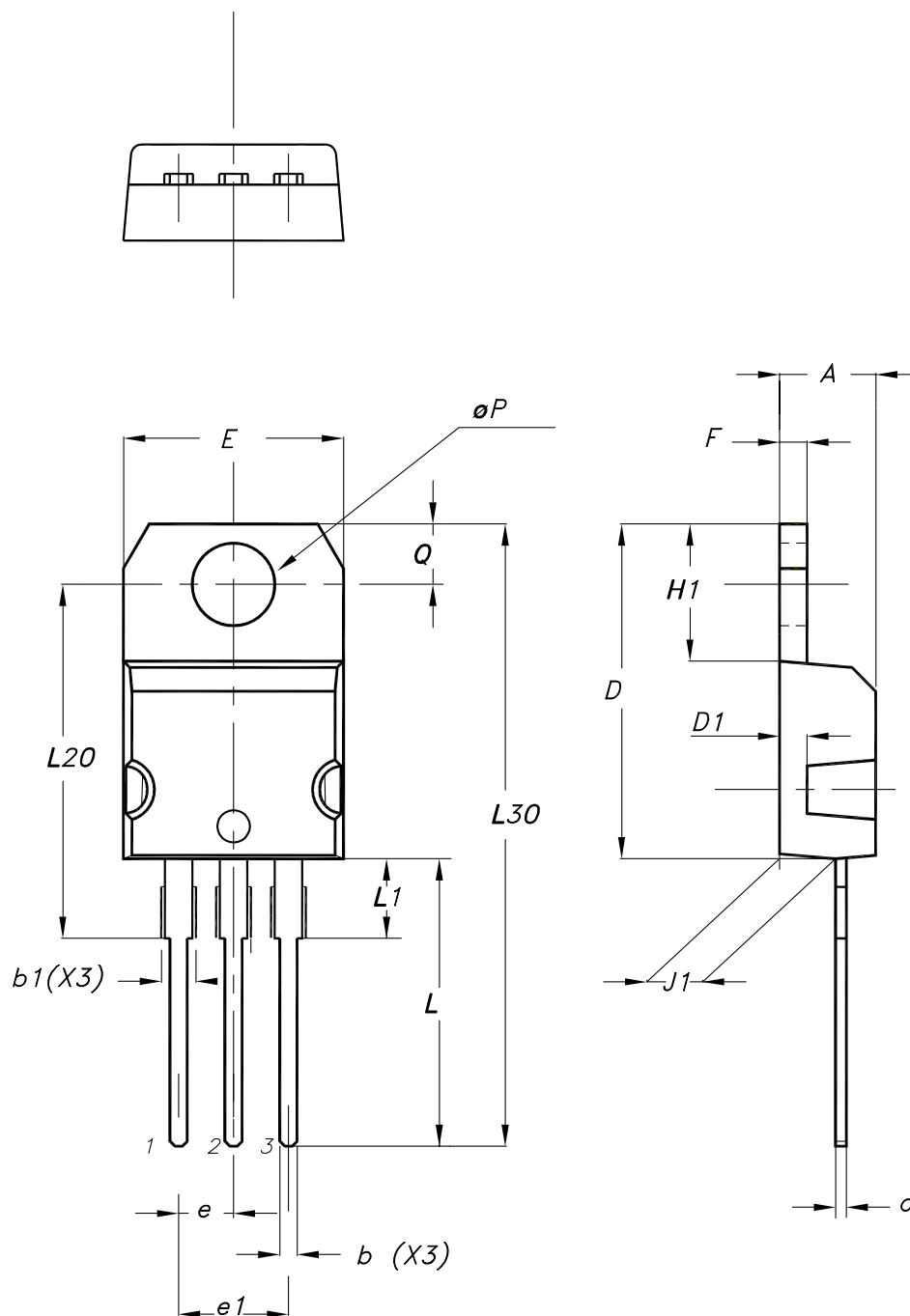
7012510_B_rev.14

Table 9. TO-220FP type B package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
E	0.45		0.70
F	0.75		1.00
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.20
G1	2.40		2.70
H	10.00		10.40
L2		16.00	
L3	28.60		30.60
L4	9.80		10.60
L5	2.90		3.60
L6	15.90		16.40
L7	9.00		9.30
Dia	3.00		3.20

4.3 TO-220 type A package information

Figure 27. TO-220 type A package outline



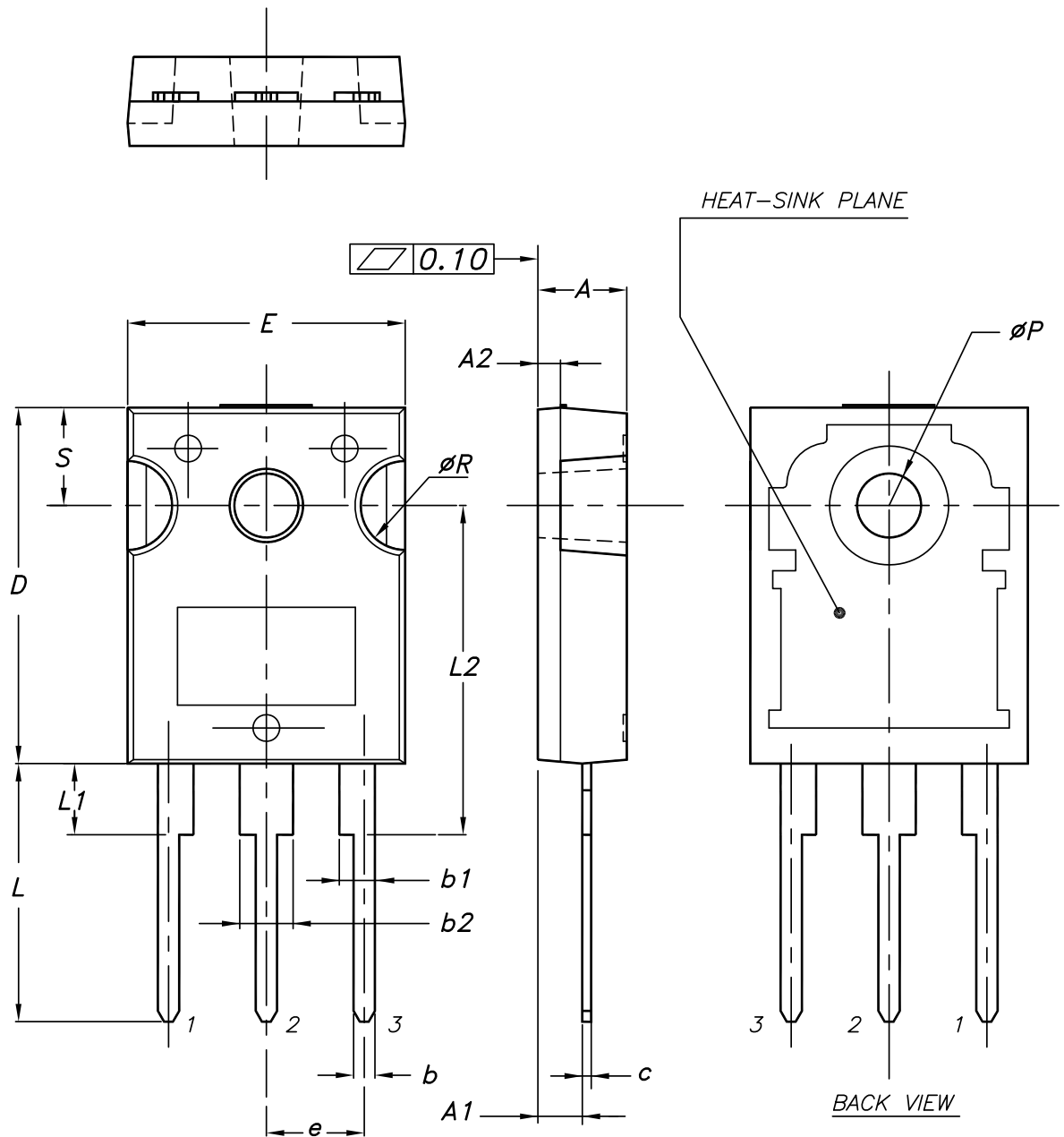
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Table 10. TO-220 type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95
Slug flatness		0.03	0.10

4.4 TO-247 package information

Figure 28. TO-247 package outline



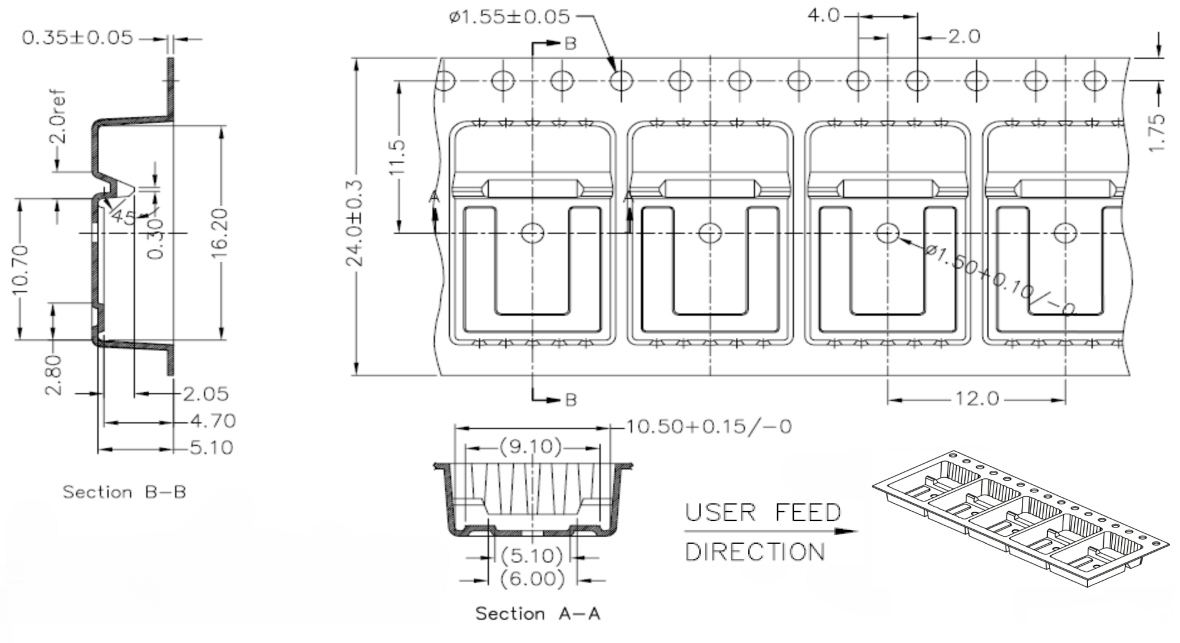
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Table 11. TO-247 package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
A2		1.27	
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	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

4.5 D²PAK packing information

Figure 29. D²PAK tape drawing (dimensions are in mm)



DM01095771_2



5 Ordering information

Table 12. Order codes

Order codes	Marking	Package	Packing
STB21N90K5	21N90K5	D ² PAK	Tape and reel
STF21N90K5		TO-220FP	Tube
STP21N90K5		TO-220	
STW21N90K5		TO-247	

Revision history

Table 13. Document revision history

Date	Version	Changes
05-Nov-2009	1	First release.
18-Nov-2009	2	Updated description on cover page
12-Jan-2010	3	Corrected V_{GS} value in <i>Table 2: Absolute maximum ratings</i>
14-Jul-2010	4	Document status promoted from preliminary data to datasheet.
21-Dec-2011	5	– Inserted device in D²PAK. – Updated <i>Figure 2: Safe operating area for TO-220 / D2PAK</i>, <i>Figure 4: Safe operating area for TO-220FP</i> and <i>Figure 6: Safe operating area for TO-247</i>. – Inserted <i>Section 5: Packaging mechanical data on page 19</i>. – Minor text changes.
12-Oct-2012	6	– Updated: Q_g value (test conditions) in <i>Table 5</i> – Updated: $T_{d(on)}$ value (test conditions) in <i>Table 6</i> – Updated: values (test conditions) in <i>Table 8</i> – Updated: <i>Figure 10</i> – Updated: <i>Section 4: Package mechanical data</i>
25-Nov-2025	7	Updated <i>Section 4: Package information</i> . Minor text changes.



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3	Test circuits	8
4	Package information.....	9
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4.2	TO-220FP package information	12
4.3	TO-220 type A package information	14
4.4	TO-247 package information	16
4.5	D ² PAK packing information	18
5	Ordering information	19
	Revision history	20



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