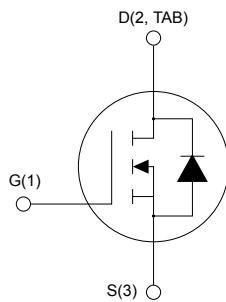
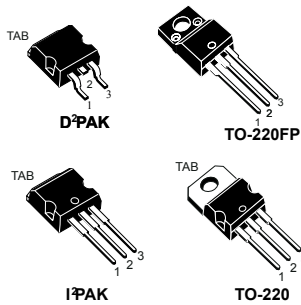




STB21N65M5, STF21N65M5 STI21N65M5, STP21N65M5

Datasheet

N-channel 650 V, 150 mΩ typ., 17 A MDmesh M5 Power MOSFETs in a D²PAK, TO-220FP, I²PAK and TO-220 packages



AM01475v1_noZen



Features

Order code	V _{DS}	R _{DS(on)} max.	I _D
STB21N65M5	650 V	179 mΩ	17 A
STF21N65M5			
STI21N65M5			
STP21N65M5			

- Higher V_{DSS} rating
- Higher dv/dt capability
- Excellent switching performance
- Extremely low R_{DS(on)}
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs based on the MDmesh M5 innovative vertical process technology combined with the well-known PowerMESH horizontal layout. The resulting products offer extremely low on-resistance, making them particularly suitable for applications requiring high power and superior efficiency.

Product status links

[STB21N65M5](#)

[STF21N65M5](#)

[STI21N65M5](#)

[STP21N65M5](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK I ² PAK TO-220	TO-220FP	
V _{GS}	Gate-source voltage	±25		V
I _D	Drain current (continuous) at T _C = 25 °C	17		A
I _D	Drain current (continuous) at T _C = 100 °C	10.7		A
I _{DM} ⁽¹⁾	Drain current (pulsed)	68		A
P _{TOT}	Total power dissipation at T _C = 25 °C	125	30	W
dv/dt ⁽²⁾	Peak diode recovery voltage slope	15		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 _{stg}	Storage temperature range	-55 to 150		°C
T _J	Operating junction temperature range	150		°C

1. Pulse width limited by safe operating area.

2. $I_{SD} \leq 17$ A, $di/dt \leq 400$ A/μs; $V_{DS} (peak) < V_{(BR)DSS}$, $V_{DD} = 400$ V.

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		D ² PAK	I ² PAK TO-220	TO-220FP	
R _{thJC}	Thermal resistance, junction-to-case	1		4.17	°C/W
R _{thJA}	Thermal resistance, junction-to-ambient	30 ⁽¹⁾	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 not-repetitive (pulse width limited by T _J max.)	5	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	400	mJ

2 Electrical characteristics

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

Table 4. On/off states

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$	650	-	-	V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$	-	-	1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}^{(1)}$	-	-	100	μA
I_{GSS}	Gate body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$	-	-	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	$V_{GS} = 10\text{ V}$, $I_D = 8.5\text{ A}$	-	150	179	m Ω

1. Specified by design, not tested in production.

Table 5. Dynamic

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	1950	-	pF
C_{oss}	Output capacitance		-	46	-	
C_{rss}	Reverse transfer capacitance		-	3	-	
$C_{o(tr)}^{(1)}$	Equivalent output capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0\text{ V}$	-	133	-	pF
$C_{o(er)}^{(2)}$	Equivalent output capacitance energy related		-	44	-	pF
R_g	Gate input resistance	$f = 1\text{ MHz}$ open drain	-	2.5	-	Ω
Q_g	Total gate charge	$V_{DD} = 520\text{ V}$, $I_D = 8.5\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see the Figure 17. Test circuit for gate charge behavior)	-	50	-	nC
Q_{gs}	Gate-source charge		-	13	-	
Q_{gd}	Gate-drain charge		-	23	-	

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 condition	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{DD} = 400\text{ V}$, $I_D = 11\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	37	-	ns
$t_{r(v)}$	Voltage rise time		-	10	-	
$t_{c(off)}$	Crossing time off	(see the Figure 18. Test circuit for inductive load switching and diode recovery times and Figure 21. Switching time waveform)	-	24	-	
$t_{f(i)}$	Current fall time		-	12	-	

Table 7. Source-drain diode

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-	-	17	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-	-	68	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 17\text{ A}$, $V_{GS} = 0\text{ V}$	-	-	1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 17\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see the Figure 18. Test circuit for inductive load switching and diode recovery times)	-	294	-	ns
Q_{rr}	Reverse recovery charge		-	4	-	μC
I_{RRM}	Reverse recovery current		-	28	-	A
t_{rr}	Reverse recovery time	$I_{SD} = 17\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$ (see the Figure 18. Test circuit for inductive load switching and diode recovery times)	-	340	-	ns
Q_{rr}	Reverse recovery charge		-	5	-	μC
I_{RRM}	Reverse recovery current		-	29	-	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, I²PAK and TO-220

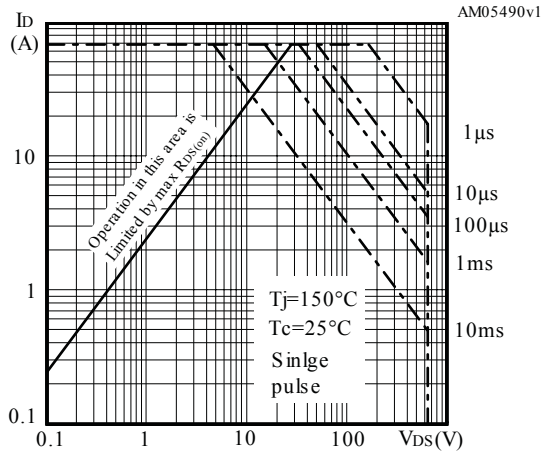


Figure 2. Normalized transient thermal impedance for D²PAK, I²PAK and TO-220

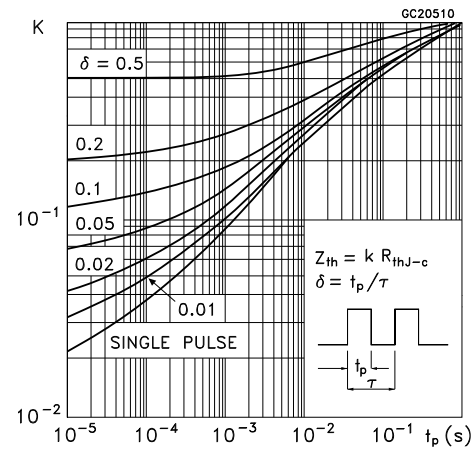


Figure 3. Safe operating area for TO-220FP

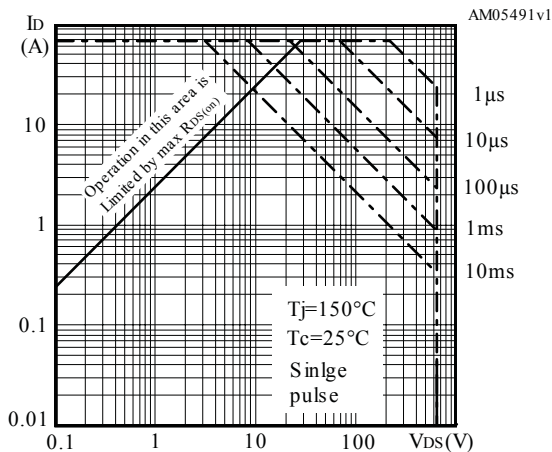


Figure 4. Normalized transient thermal impedance for TO-220FP

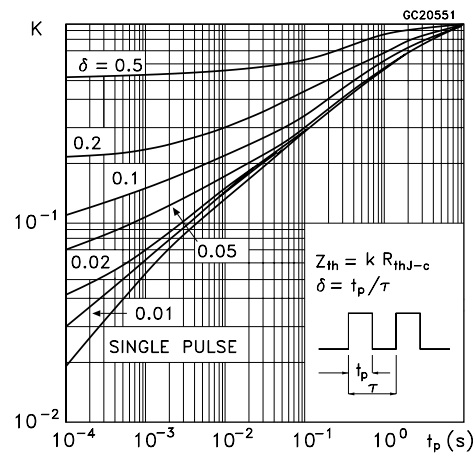


Figure 5. Output characteristics

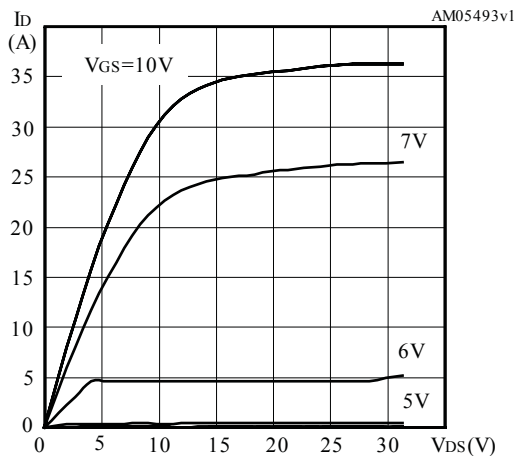


Figure 6. Transfer characteristics

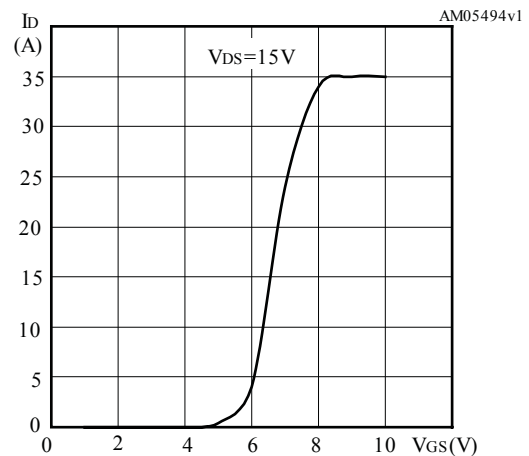


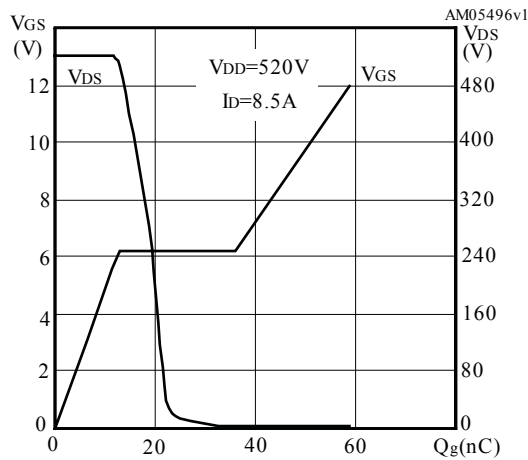
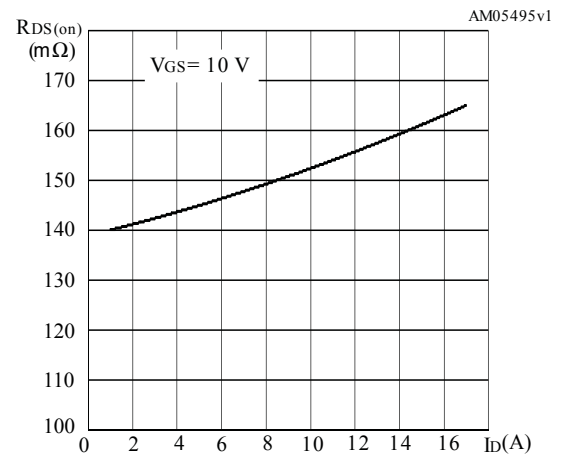
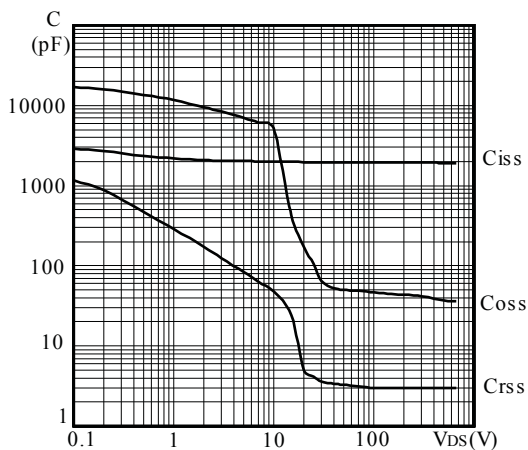
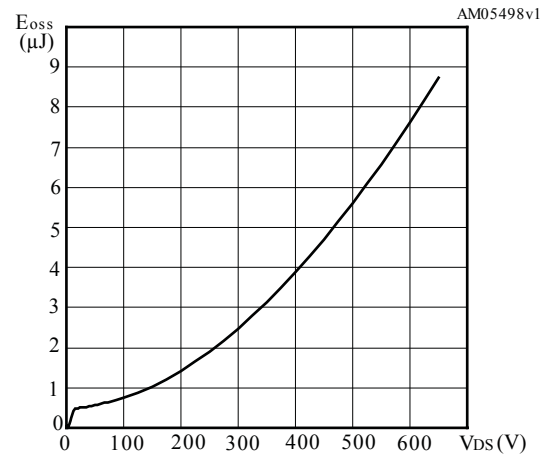
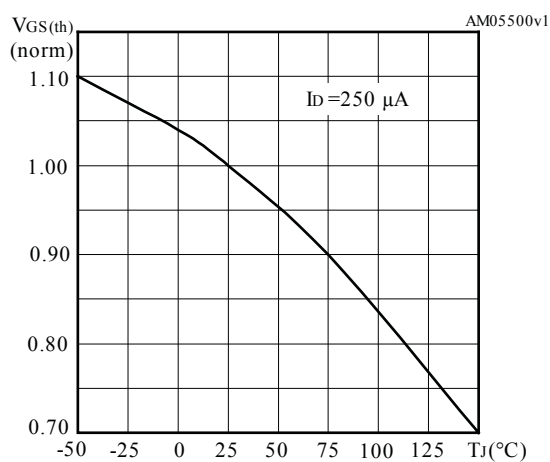
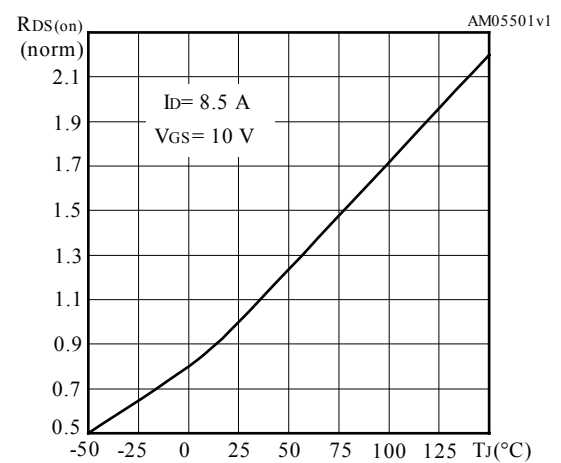
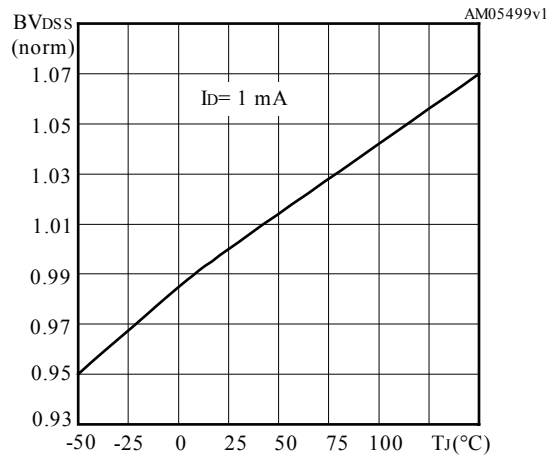
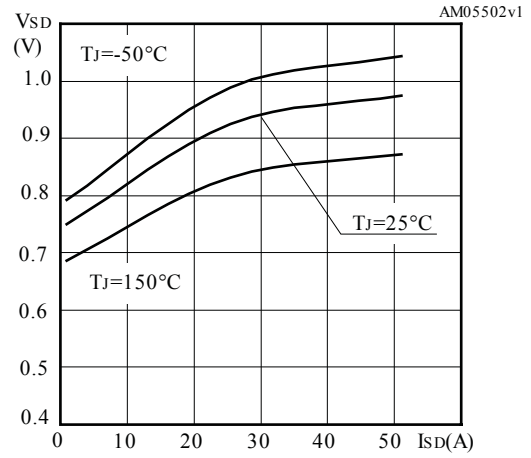
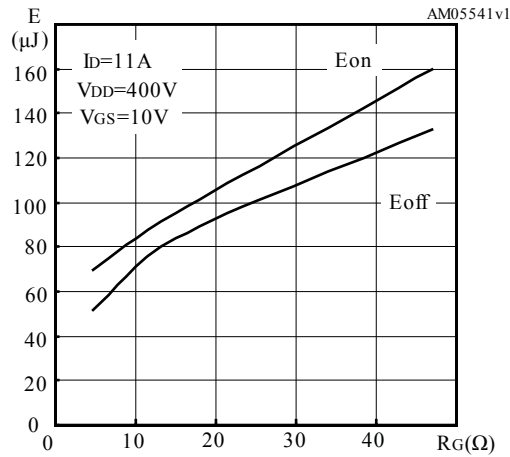
Figure 7. Gate charge vs gate-source voltage

Figure 8. Static drain-source on-resistance

Figure 9. Capacitance variations

Figure 10. Output capacitance stored energy

Figure 11. Normalized gate threshold voltage vs temperature

Figure 12. Normalized on-resistance vs temperature


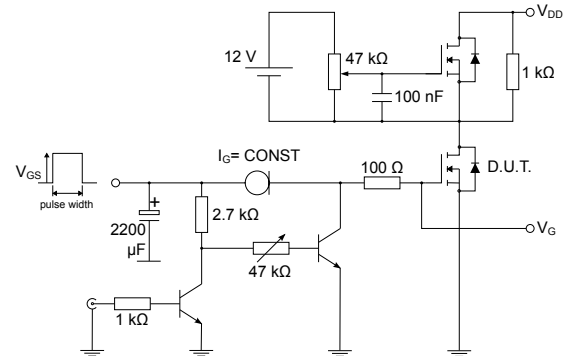
Figure 13. Normalized $V_{(BR)DSS}$ vs temperature

Figure 14. Drain-source diode forward characteristics

Figure 15. Switching energy vs gate resistance


Note: E_{on} including reverse recovery of a SiC diode.

3 Test circuits

Figure 16. Test circuit for resistive load switching times

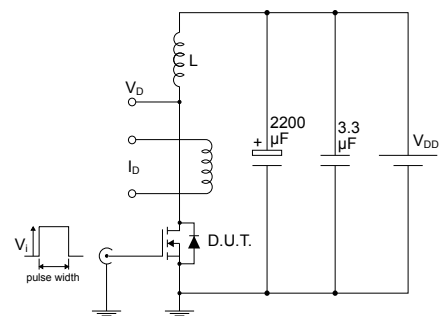

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Figure 17. Test circuit for gate charge behavior


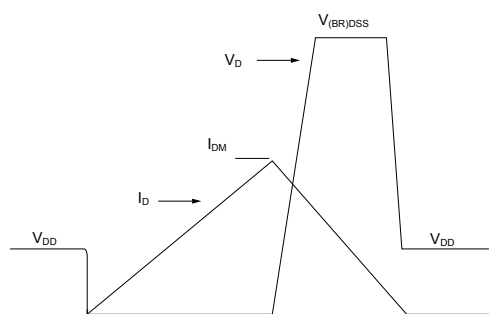
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Figure 18. Test circuit for inductive load switching and diode recovery times

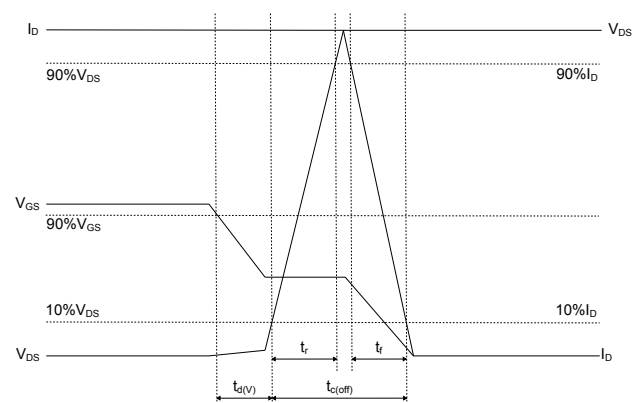

AM01470v1

Figure 19. Unclamped inductive load test circuit


AM01471v1

Figure 20. Unclamped inductive waveform


AM01472v1

Figure 21. Switching time waveform


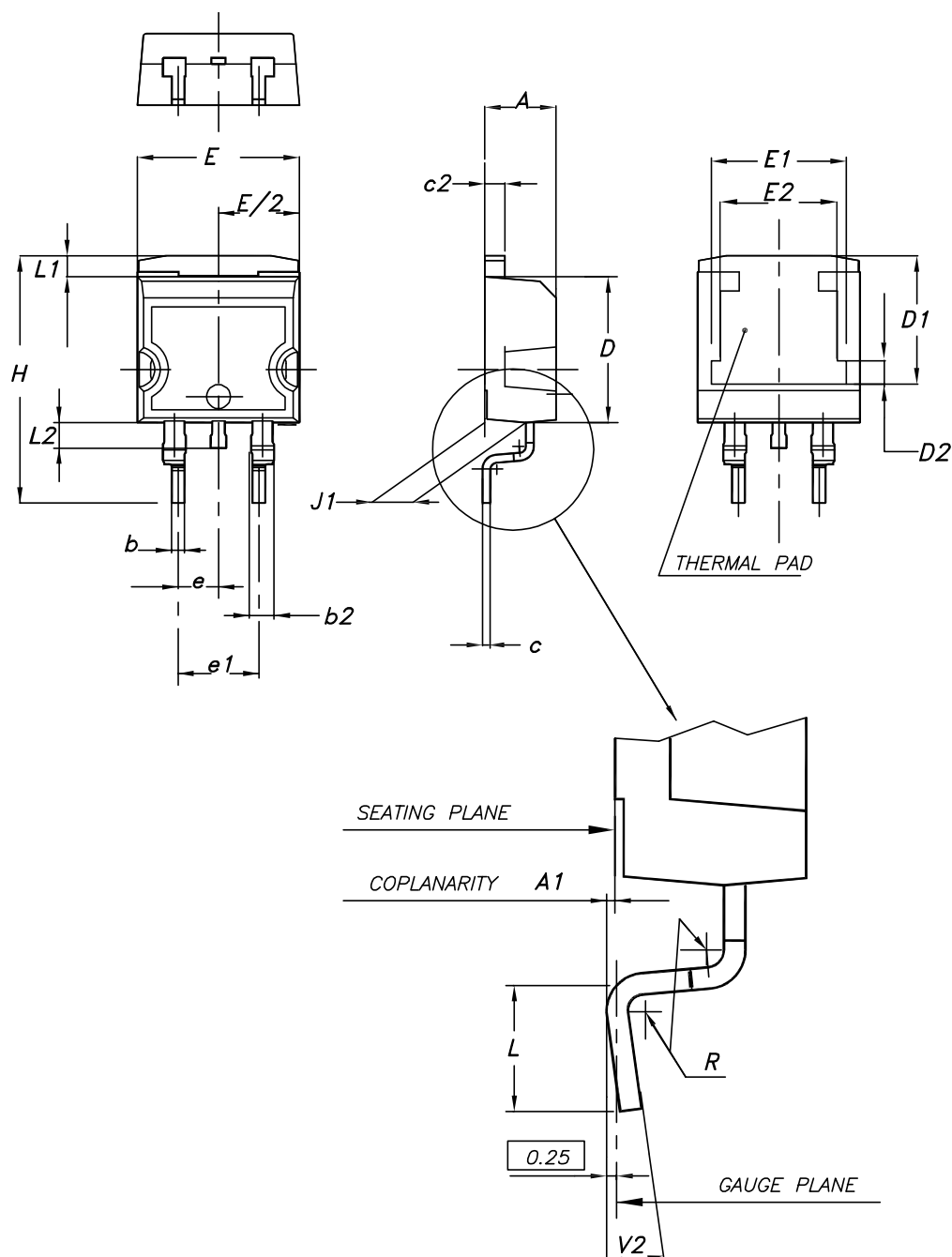
AM05540v2

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 A package information

Figure 22. D²PAK (TO-263) type A package outline



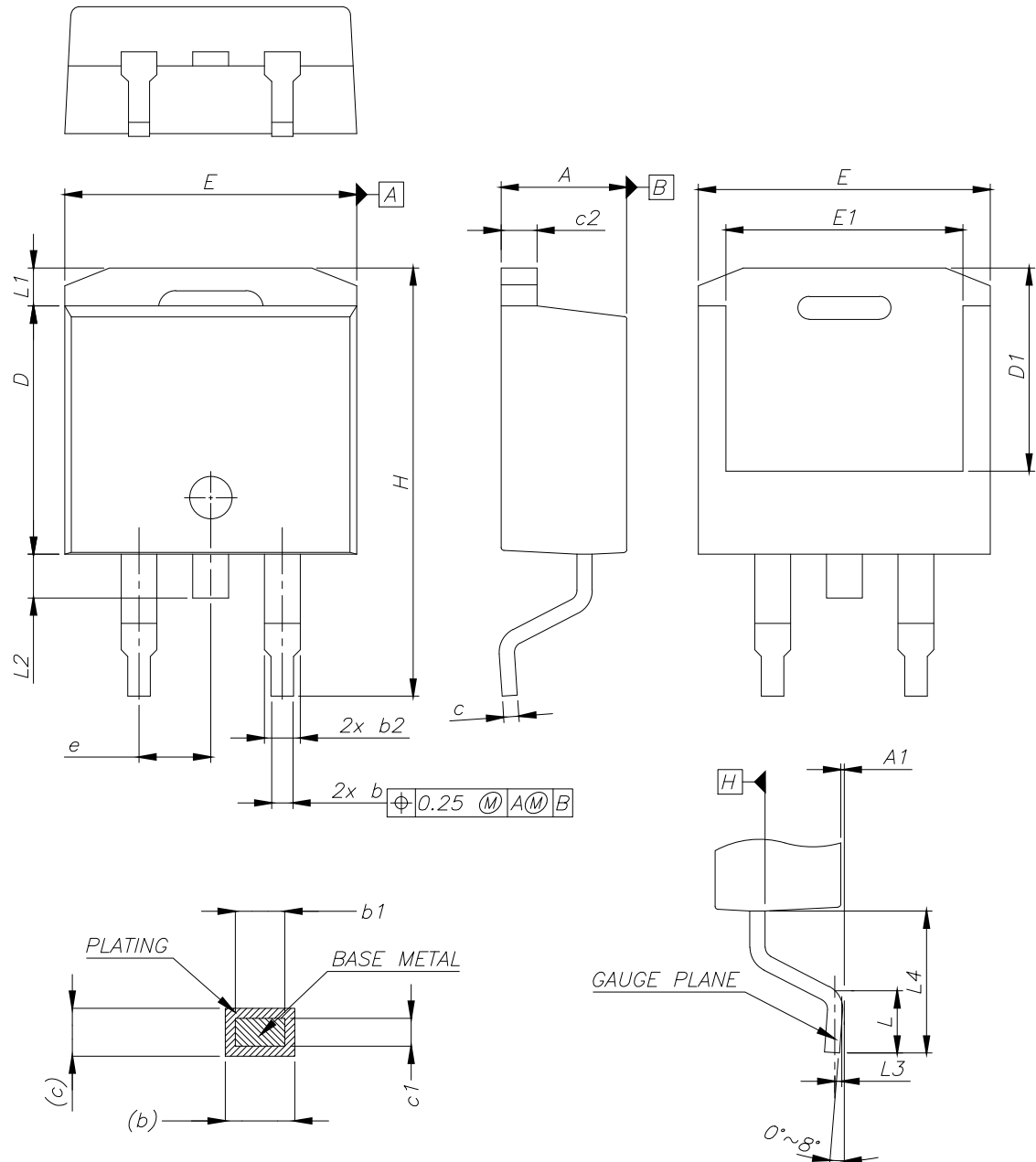
0079457_27

Table 8. D²PAK (TO-263) type A 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	8.30	8.50	8.70
E2	6.85	7.05	7.25
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°

4.2 D²PAK (TO-263) type B package information

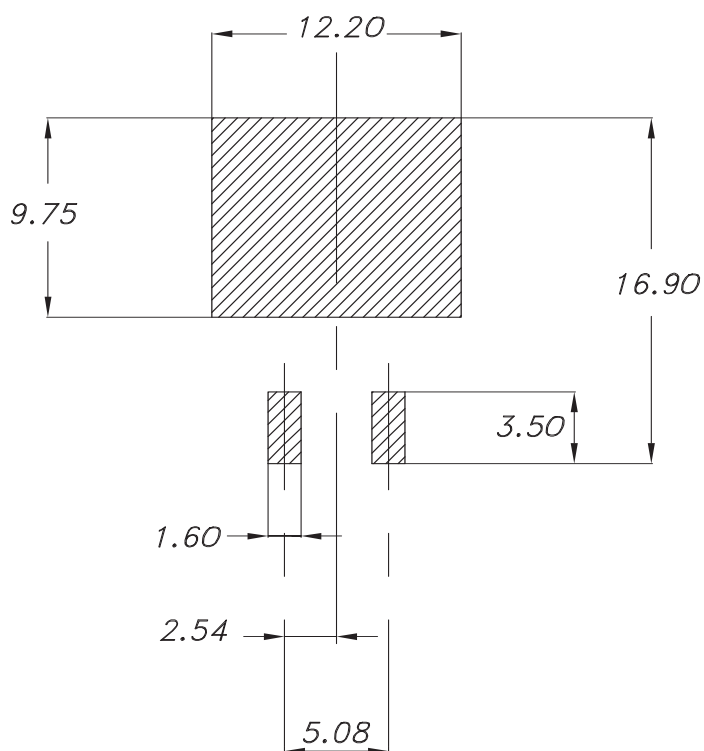
Figure 23. D²PAK (TO-263) type B package outline



0079457_27_B

Table 9. D²PAK (TO-263) type B mechanical data

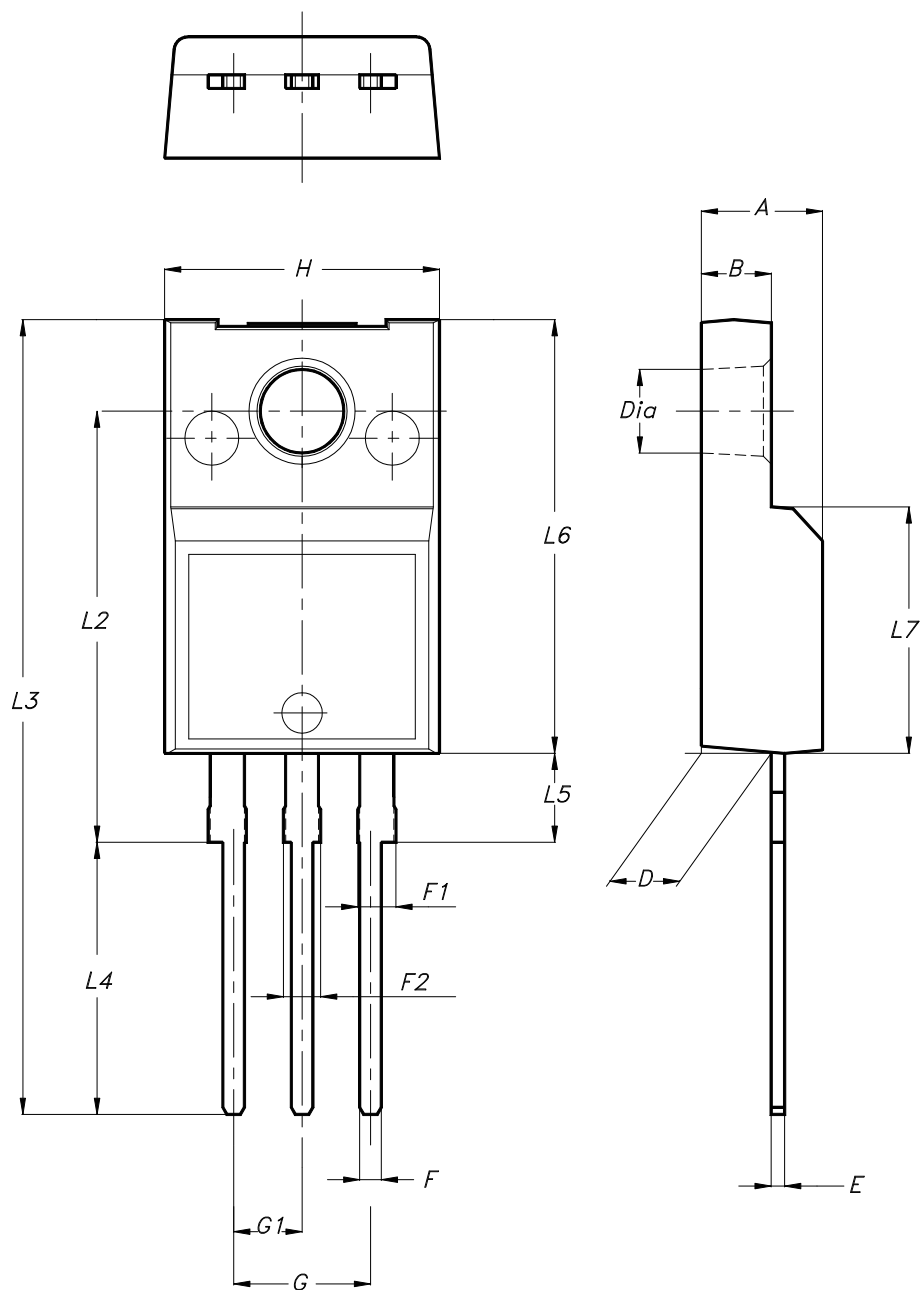
Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0.00		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e	2.54 BSC		
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 24. D²PAK (TO-263) recommended footprint (dimensions are in mm)


0079457_Rev27_footprint

4.3 TO-220FP type B package information

Figure 25. TO-220FP type B package outline



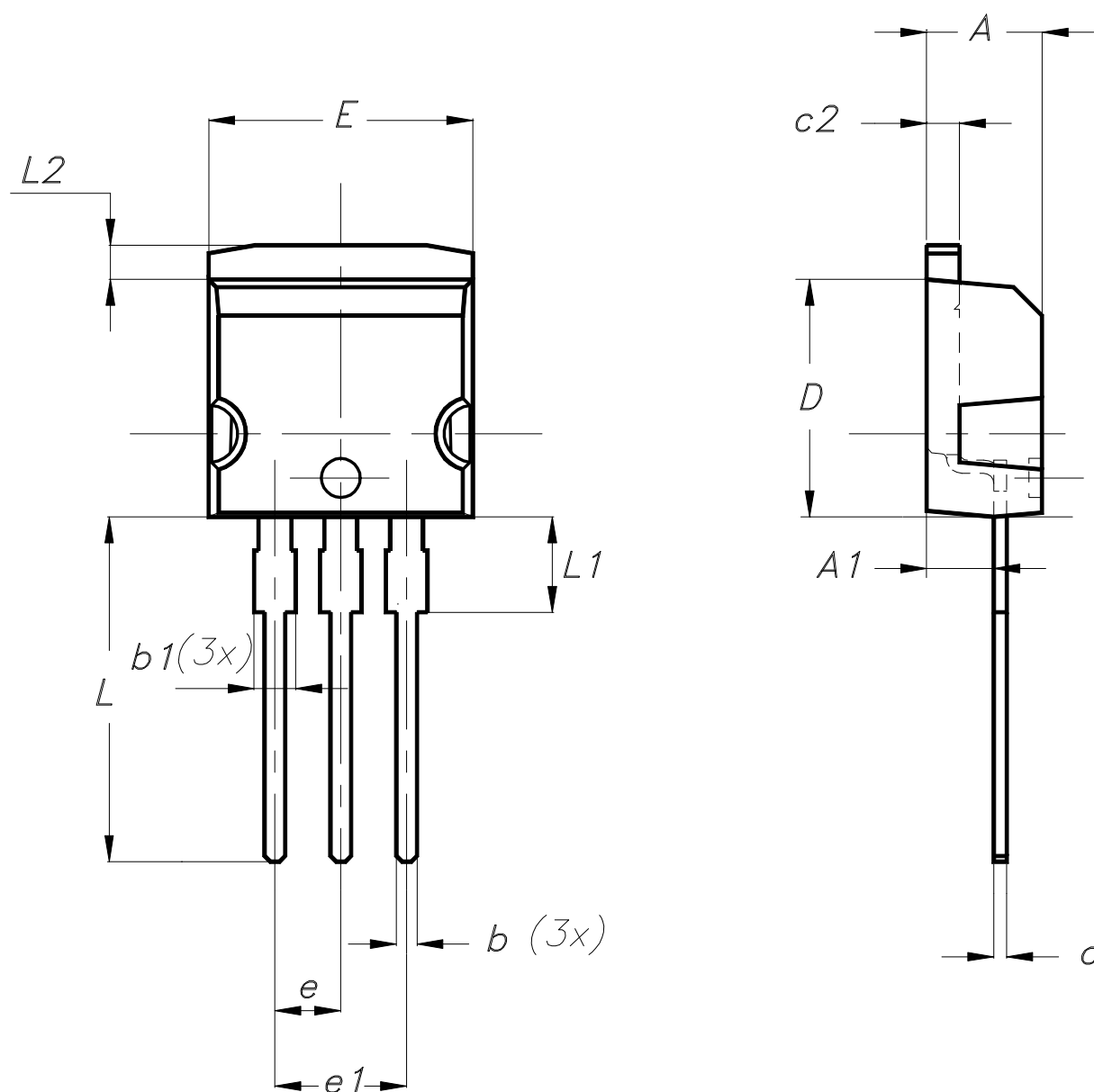
7012510_B_rev.14

Table 10. 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

4.4 I²PAK package information

Figure 26. I²PAK package outline



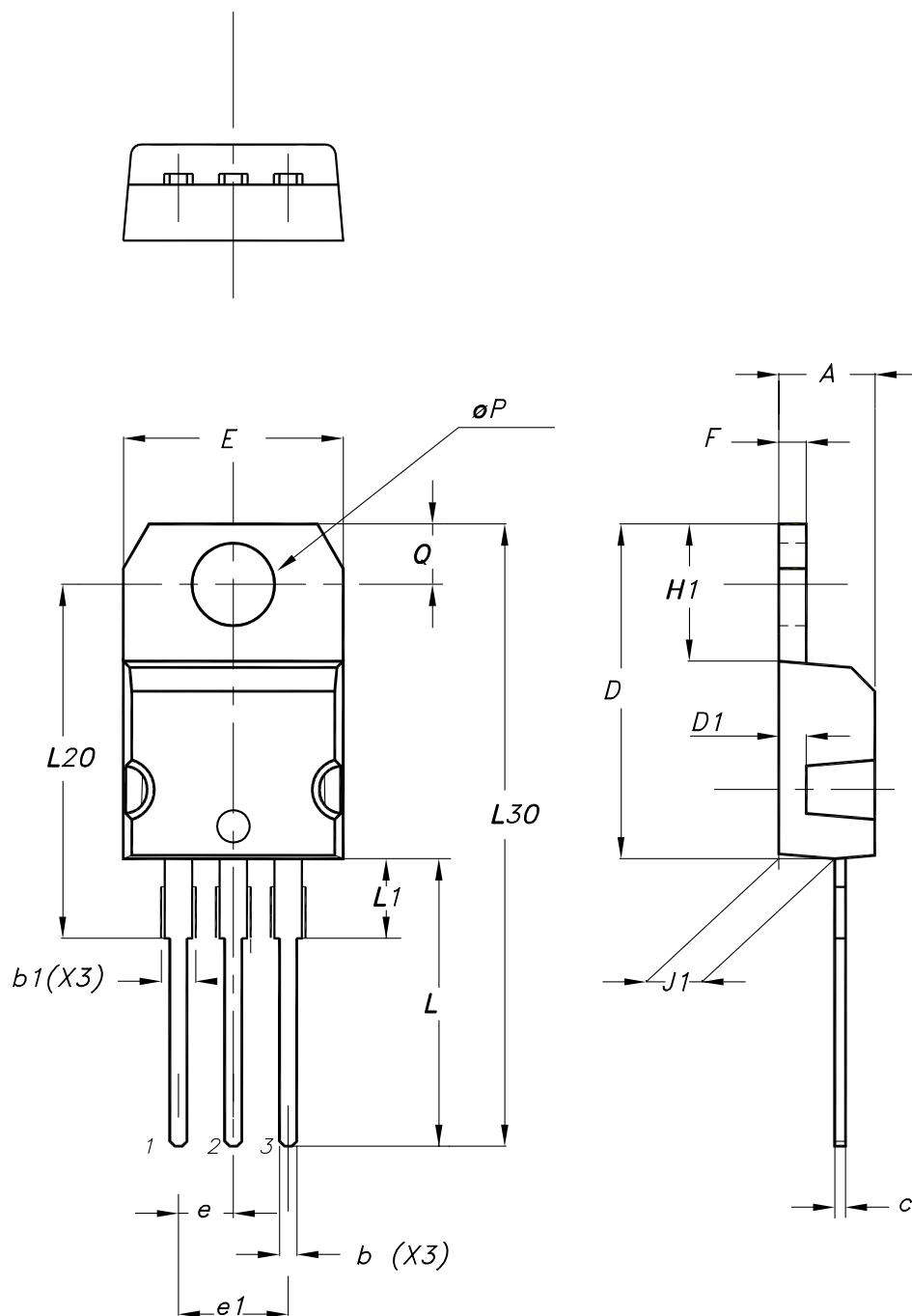
0004982_Rev_10

Table 11. I²PAK package mechanical data

Dim.	mm	
	Min.	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	10.00	10.40
L	13.00	14.00
L1	3.50	3.93
L2	1.27	1.40

4.5 TO-220 type A package information

Figure 27. TO-220 type A package outline



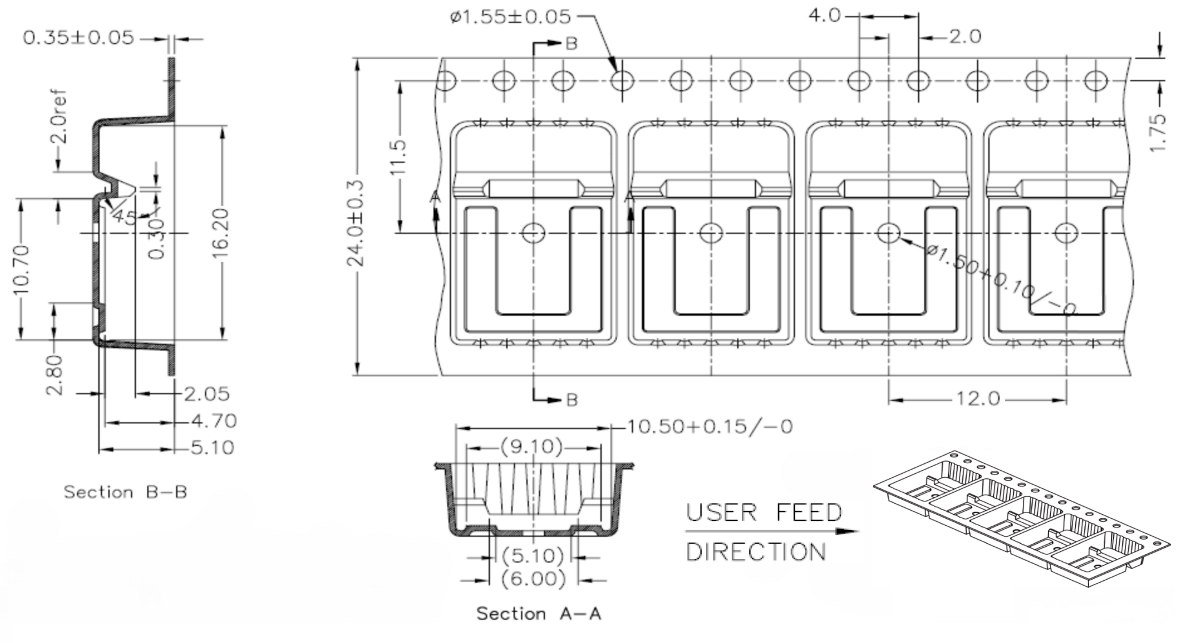
0015988_typeA_Rev_24

Table 12. 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

4.6 D²PAK packing information

Figure 28. D²PAK tape drawing (dimensions are in mm)



DM01095771_2



5 Ordering information

Table 13. Order codes

Order codes	Marking	Package	Packing
STB21N65M5	21N65M5	D ² PAK	Tape and reel
STF21N65M5		TO-220FP	Tube
STI21N65M5		I ² PAK	
STP21N65M5		TO-220	

Revision history

Table 14. Document revision history

Date	Revision	Changes
24-Feb-2009	1	First release.
27-Feb-2009	2	Corrected package information on first page.
11-Nov-2009	3	Document status promoted from preliminary data to datasheet.
11-May-2011	4	RDS(on) values have been updated (see <i>Table 4: On /off states</i> and <i>Figure 11: Static drain-source on resistance</i>).
01-Aug-2025	5	Removed order code STW21N65M5. Updated Section 4: Package information . Minor text changes.



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