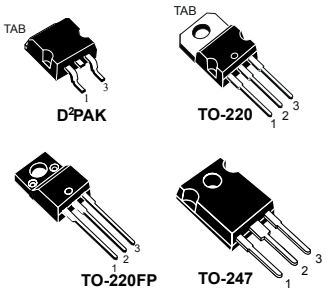
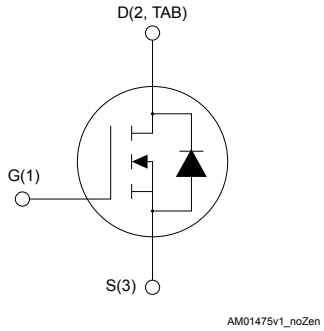
STB20NM60T4, STP20NM60
STP20NM60FP, STW20NM60

Datasheet

N-channel 600 V, 250 mΩ typ., 20 A MDmesh Power MOSFET in D²PAK, TO-220, TO-220FP and TO-247 packages





Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
STB20NM60T4	600 V	290 mΩ	20 A
STP20NM60			
STP20NM60FP			
STW20NM60			

- High dv/dt and avalanche capabilities
- Low input capacitance and gate charge
- Low gate input resistance
- 100% avalanche tested

Applications

- Switching applications

Description

These N-channel Power MOSFETs are developed using STMicroelectronics' revolutionary MDmesh technology, which associates the multiple drain process with the company's PowerMESH horizontal layout. These devices offer extremely low on-resistance, high dv/dt and excellent avalanche characteristics. Utilizing ST's proprietary strip technique, these Power MOSFETs boast an overall dynamic performance which is superior to similar products on the market.

STPOWER

Product status links
STB20NM60T4
STP20NM60
STP20NM60FP
STW20NM60

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D²PAK, TO-220 TO-247	TO-220FP	
V_{DS}	Drain-source voltage	600		V
V_{GS}	Gate-source voltage	±30		V
I_D	Drain current (continuous) at T_C = 25 °C	20	20(1)	A
	Drain current (continuous) at T_C = 100 °C	12.6	12.6(1)	
I_{DM} (2)	Drain current (pulsed)	80		A
P_{TOT}	Total power dissipation at T_C = 25 °C	192	45	W
dv/dt(3)	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	-65 to 150		°C
T_J	Operation junction temperature range			°C

1. *Limited by maximum junction temperature.*
2. *Pulse width is limited by safe operating area.*
3. *I_{SD} ≤ 20 A, di/dt ≤ 400 A/µs, V_{DD} ≤ $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		D²PAK, TO-220 TO-247	TO-220FP	
R_{thJC}	Thermal resistance, junction-to-case	0.65	2.8	°C/W
R_{thJA}	Thermal resistance, junction-to-ambient	62.5		°C/W

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AS}	Avalanche current, repetitive or non-repetitive (pulse width limited by T_J max.)	10	A
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AS}, V_{DD} = 50 V)	650	mJ

2 Electrical characteristics

T_C = 25 °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 = 250 µA, V_{GS} = 0 V	600	-	-	V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 600 V	-	-	1	µA
		V_{GS} = 0 V, V_{DS} = 600 V, T_C = 125 °C(1)	-	-	10	
I_{GSS}	Gate body leakage current	V_{DS} = 0 V, V_{GS} = ±30 V	-	-	±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 10 A	-	250	290	mΩ

1. *Specified by design, not tested in production.*

Table 5. Dynamic

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
g_{fs}(1)	Forward transconductance	V_{DS} > $I_{D(on)}$ x $R_{DS(on)max}$, I_D = 20 A	-	11	-	S
C_{iss}	Input capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0 V	-	1500	-	pF
C_{oss}	Output capacitance		-	350	-	pF
C_{rss}	Reverse transfer capacitance		-	35	-	pF
$C_{oss\ eq.}$ (2)	Equivalent output capacitance	V_{GS} = 0 V, V_{DS} = 0 to 480 V	-	215	-	pF
Q_g	Total gate charge	V_{DD} = 400 V, I_D = 20 A, V_{GS} = 0 to 10 V (see the Figure 15. Test circuit for gate charge behavior)	-	39	54(3)	nC
Q_{gs}	Gate-source charge		-	10	-	nC
Q_{gd}	Gate-drain charge		-	20	-	nC
R_g	Gate input resistance	f = 1 MHz gate DC bias = 0 test signal level = 20 mV open drain	-	1.6	-	Ω

1. *Pulsed: Pulse duration = 300 µs, duty cycle 1.5%.*
2. *$C_{oss\ eq.}$ 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}.*
3. *Specified by design, not tested in production.*

Table 6. Switching times

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 10 A, R_G = 4.7 Ω, V_{GS} = 10 V (see the Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform)	-	25	-	ns
t_r	Rise time		-	20	-	ns
$t_{d(off)}$	Turn-off delay time		-	42	-	ns
t_f	Fall time		-	11	-	ns

Table 7. Source-drain diode

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-	-	20	A
I_{SDM}(1)	Source-drain current (pulsed)		-		80	A
V_{SD}(2)	Forward on voltage	I_{SD} = 20 A, V_{GS} = 0 V	-	-	1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 20 A, di/dt = 100 A/µs,	-	390		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 60 V	-	5		µC
I_{RRM}	Reverse recovery current	(see the Figure 16. Test circuit for inductive load switching and diode recovery times)	-	25		A
t_{rr}	Reverse recovery time	I_{SD} = 20 A, di/dt = 100 A/µs,	-	510		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 60 V, T_J = 150 °C	-	6.5		µC
I_{RRM}	Reverse recovery current	(see the Figure 16. Test circuit for inductive load switching and diode recovery times)	-	26		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, TO-220 and TO-247

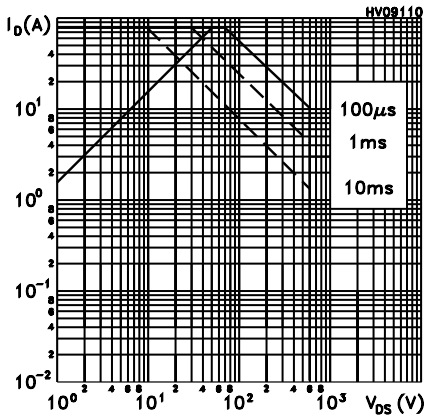


Figure 2. Thermal impedance for D²PAK, TO-220 and TO-247

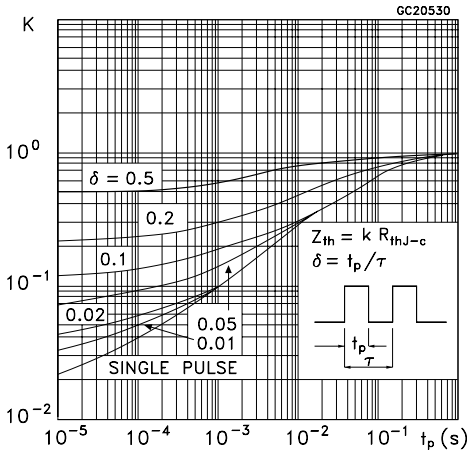


Figure 3. Safe operating area for TO-220FP

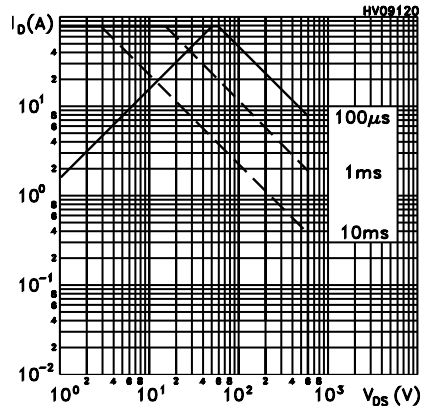


Figure 4. Thermal impedance for TO-220FP

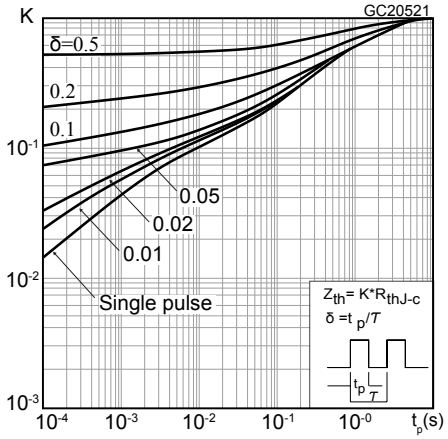


Figure 5. Output characterisics

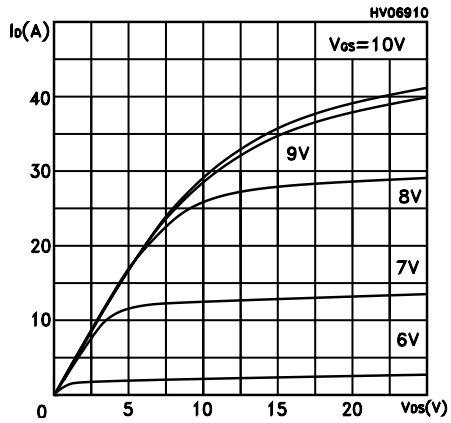


Figure 6. Transfer characteristics

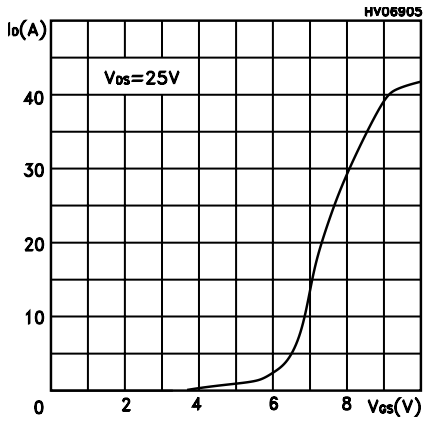


Figure 7. Static drain-source on-resistance

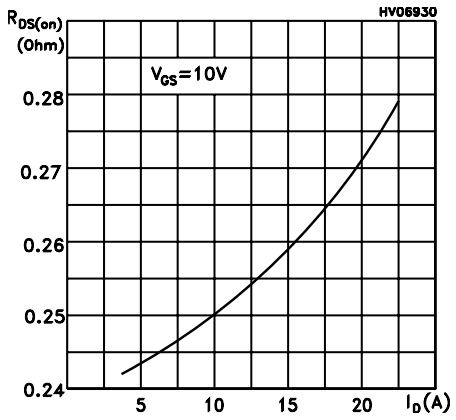


Figure 8. Gate charge vs gate-source voltage

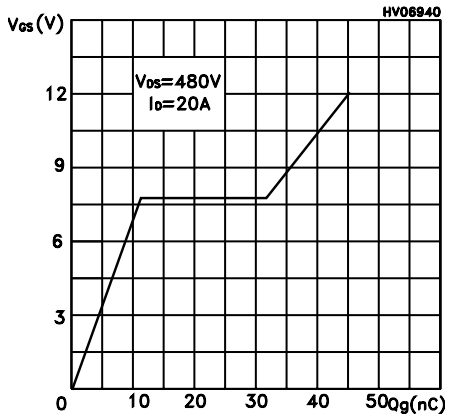


Figure 9. Capacitance variations

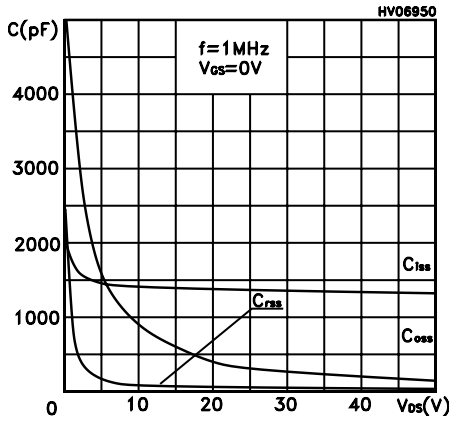


Figure 10. Normalized gate threshold voltage vs temperature

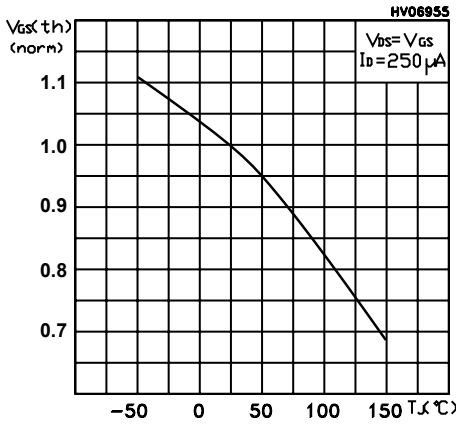


Figure 11. Normalized on-resistance vs temperature

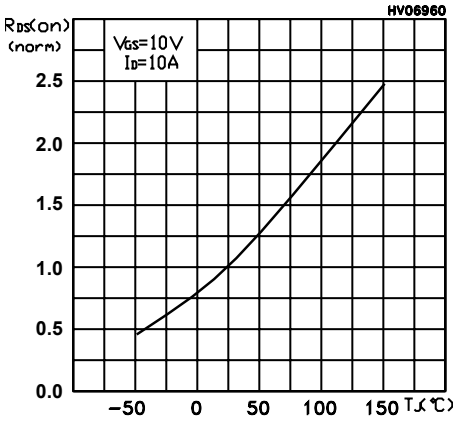


Figure 12. Source-drain diode forward characteristics

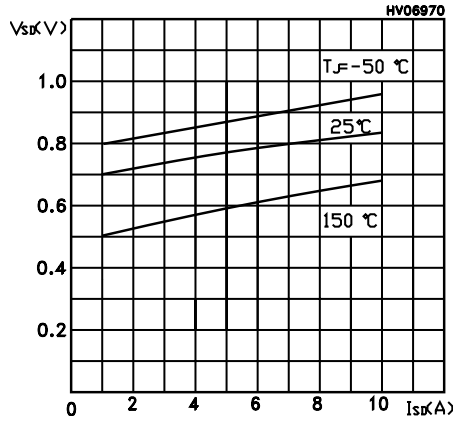
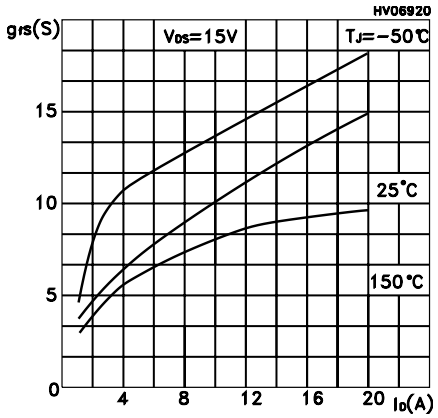


Figure 13. **Transconductance**



3 Test circuits

Figure 14. Test circuit for resistive load switching times

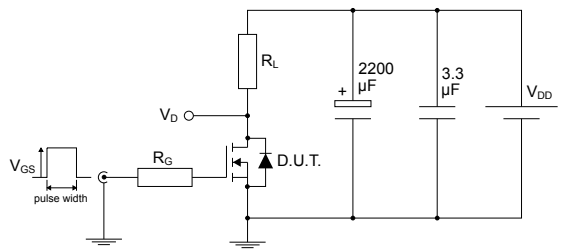


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Figure 15. Test circuit for gate charge behavior

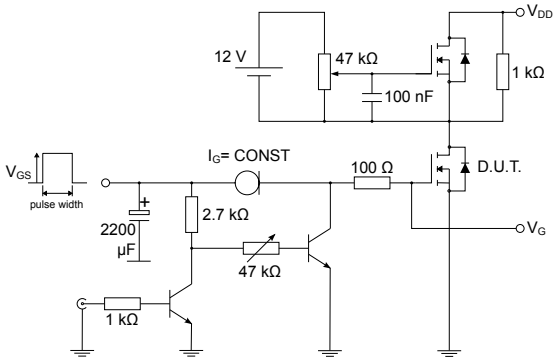

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Figure 16. Test circuit for inductive load switching and diode recovery times

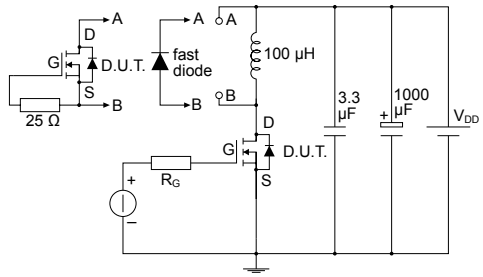

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Figure 17. Unclamped inductive load test circuit

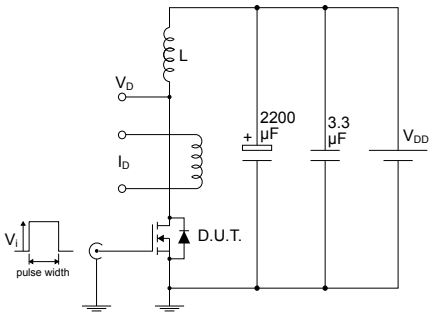

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Figure 18. Unclamped inductive waveform

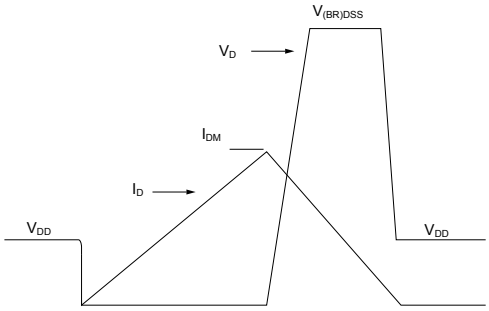

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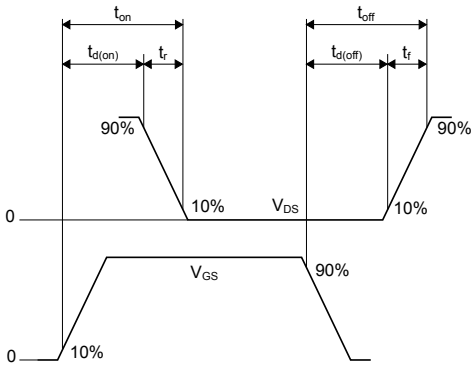
Figure 19. Switching time waveform



AM01473v1

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 20. **D²PAK (TO-263) type A package outline**

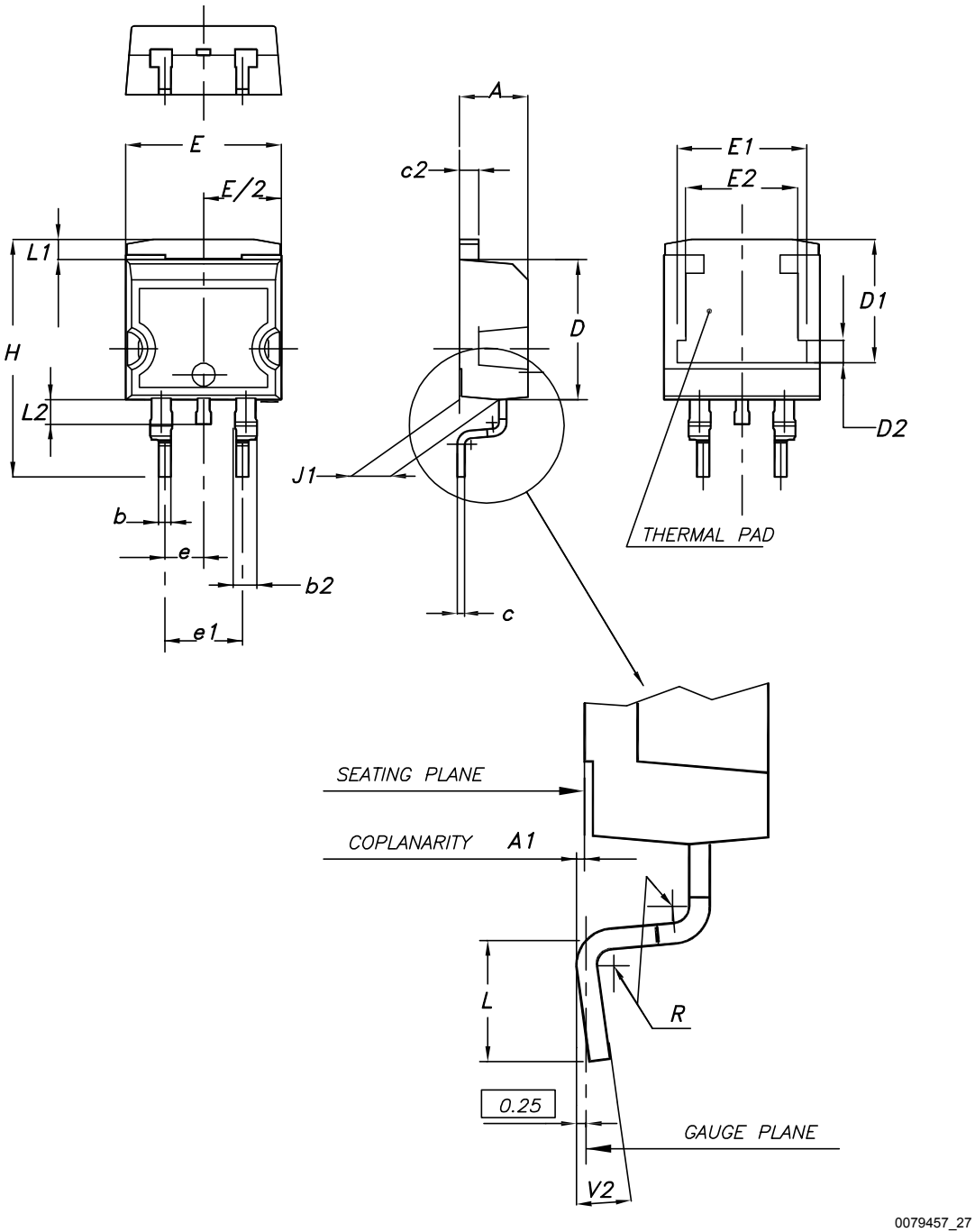
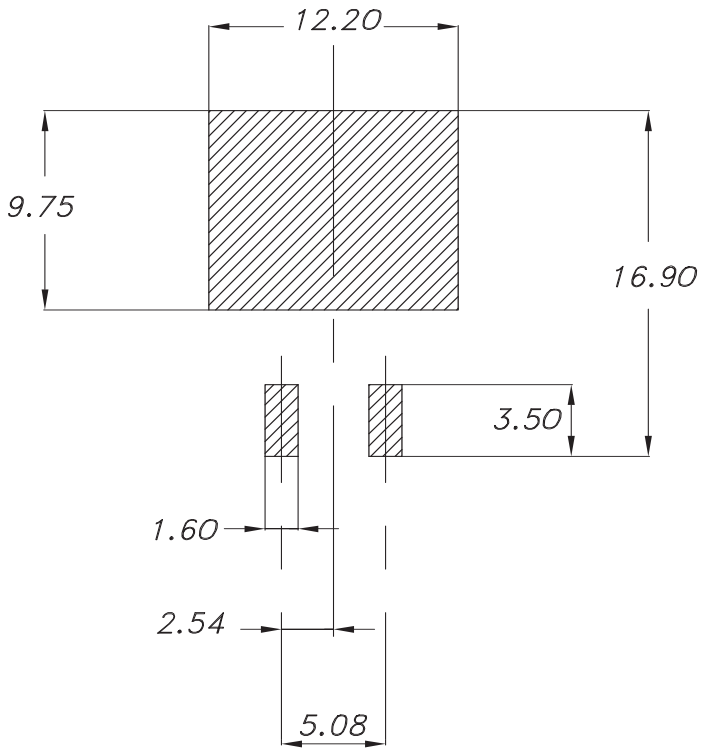


Table 8. **D²PAK (TO-263) type A package mechanical data**

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°

Figure 21. D²PAK (TO-263) recommended footprint (dimensions are in mm)



4.2 TO-220 type A package information

Figure 22. **TO-220 type A package outline**

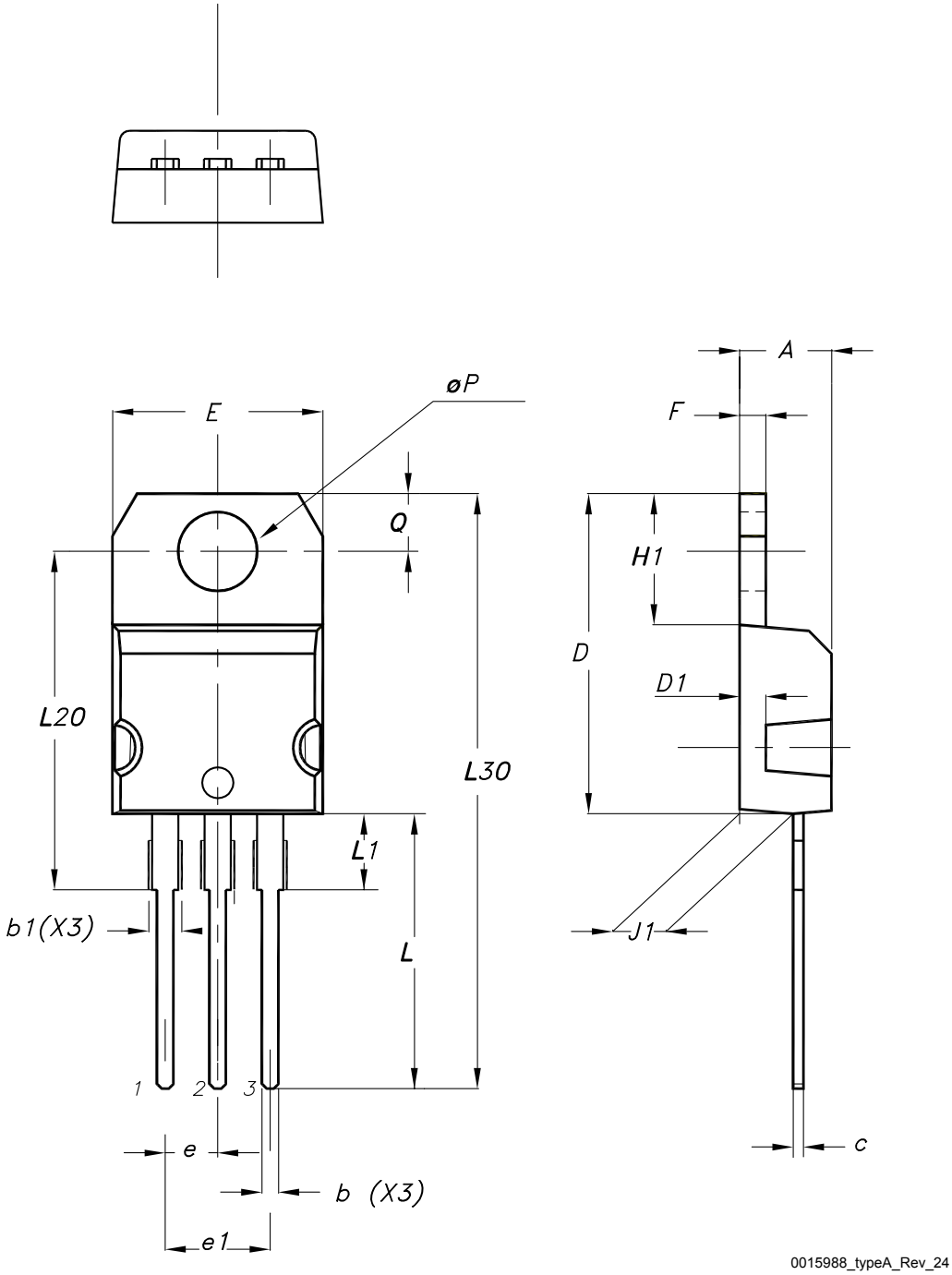


Table 9. **TO-220 type A package mechanical data**

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

4.3 TO-220FP type B package information

Figure 23. **TO-220FP type B package outline**

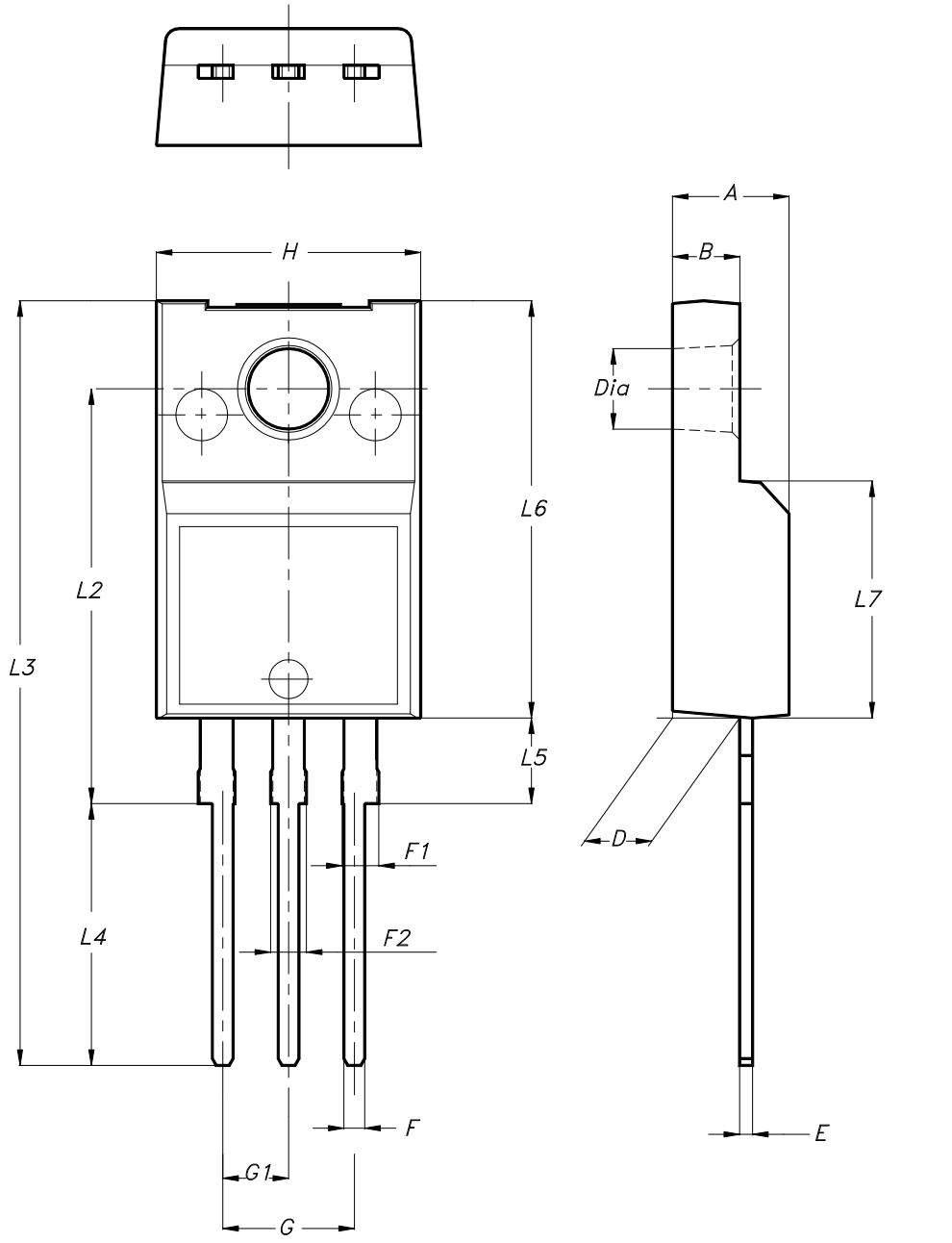


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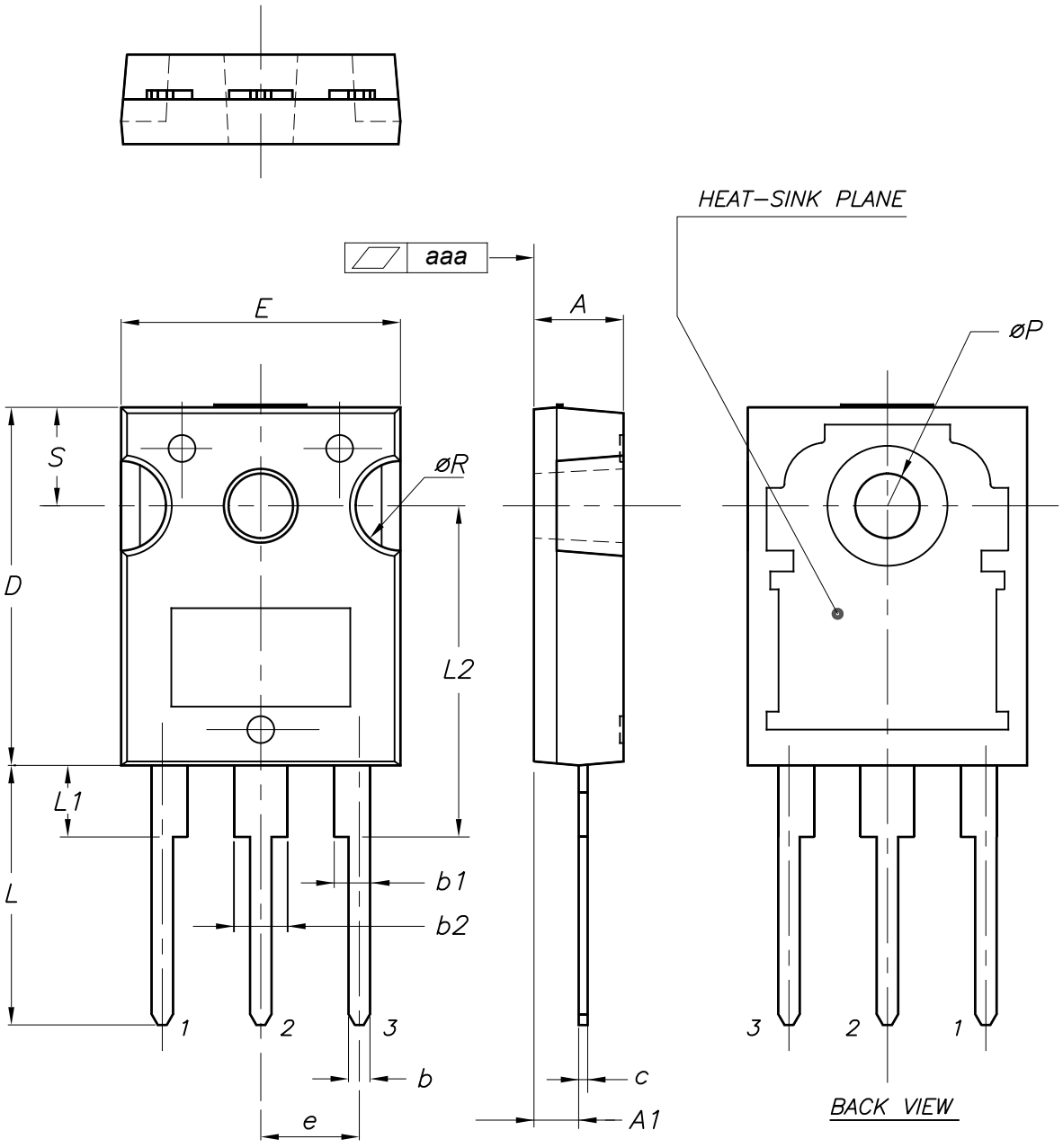
Table 10. **TO-220FP type B package mechanical data**

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 TO-247 package information

Figure 24. **TO-247 package outline**



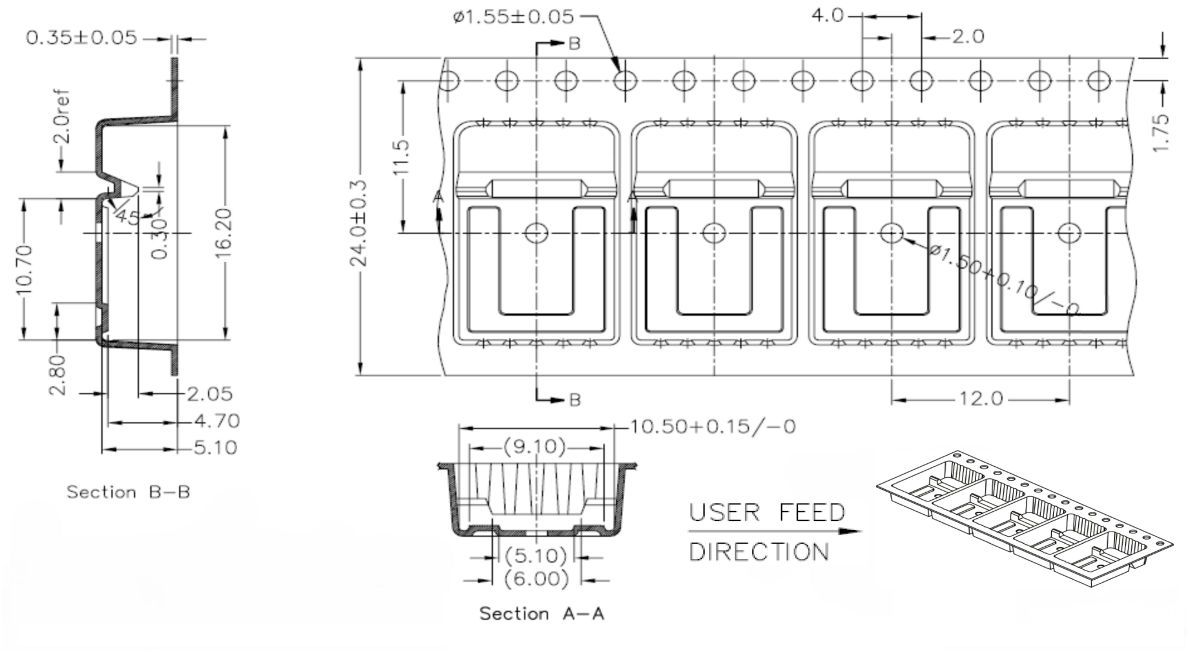
0075325_10

Table 11. **TO-247 package 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	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70
aaa		0.04	0.10

4.5 D²PAK packing information

Figure 25. **D²PAK tape drawing (dimensions are in mm)**



DM01095771_2

5 Ordering information

Table 12. **Order codes**

Order codes	Marking	Package	Packing
STB20NM60T4	B20NM60	D²PAK	Tape and reel
STP20NM60	P20NM60	TO-220	Tube
STP20NM60FP	P20NM60FP	TO-220FP	
STW20NM60	W20NM60	TO-247	

Revision history

Table 13. **Document revision history**

Date	Revision	Changes
17-Feb-2005	9	Insert the TO-247 package
25-Oct-2006	10	The document has been reformatted
18-Dec-2006	11	Text updates on *Table 5*.
27-Aug-2007	12	Updated *Figure 2* and *Figure 4*.
30-Jul-2025	13	Removed order code STB20NM60-1. Updated Section 4: Package information. Minor text changes.

Contents