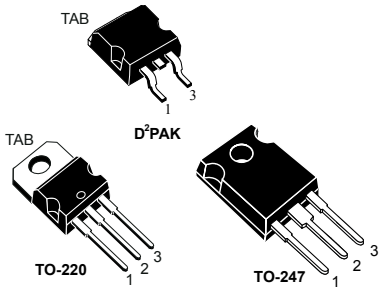
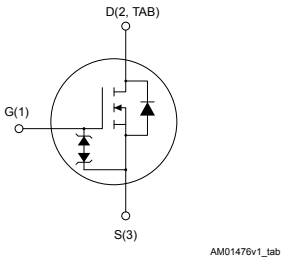
STB33N60DM2, STP33N60DM2, STW33N60DM2

Datasheet

N-channel 600 V, 110 mΩ typ., 24 A MDmesh DM2 Power MOSFET in D²PAK, TO-220 and TO-247 packages





Features

Order code	V_{DS} @ $T_{Jmax.}$	$R_{DS(on)}$ max.	I_D
STB33N60DM2	650 V	130 mΩ	24 A
STP33N60DM2			
STW33N60DM2			

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

Applications

- Switching applications

Description

These high voltage N-channel Power MOSFETs are part of the MDmesh DM2 fast recovery diode series. They offer very low recovery charge (Q_{rr}) and time (t_{rr}) combined with low $R_{DS(on)}$, rendering them suitable for the most demanding high efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

Product status link
STB33N60DM2
STP33N60DM2
STW33N60DM2

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage (static)	±25	V
	Gate-source voltage (dynamic AC, f > 1 Hz)	±30	
I_D	Drain current (continuous) at T_{case} = 25 °C	24	A
	Drain current (continuous) at T_{case} = 100 °C	15.5	
I_{DM} (1)	Drain current (pulsed)	96	A
P_{TOT}	Total power dissipation at T_{case} = 25 °C	190	W
dv/dt (2)	Peak diode recovery voltage slope	100	V/ns
di/dt (2)	Peak diode recovery current slope	1000	A/µs
dv/dt (3)	MOSFET dv/dt ruggedness	100	V/ns
T_{stg}	Storage temperature range	-55 to 150	°C
T_j	Operating junction temperature range		

1. *Pulse width is limited by safe operating area.*
2. *I_{SD} ≤ 24 A, V_{DS} peak < $V_{(BR)DSS}$, V_{DD} = 400 V.*
3. *V_{DS} ≤ 480 V.*

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		D²PAK	TO-220	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case	0.66			°C/W
$R_{thj\text{-}pcb}$ (1)	Thermal resistance junction-pcb	30			
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient		62.5	50	

1. *When mounted on 1 inch² FR-4, 2 Oz copper board.*

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (Pulse width limited by T_{jmax})	5.5	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	570	mJ

2 Electrical characteristics

(T_{case} = 25 °C unless otherwise specified)

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	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_{case} = 125 °C (1)			100	
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = ±25 V			±10	µA
$V_{GS(th)}$	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 = 12 A		110	130	mΩ

1. *Defined by design, not subject to production test.*

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0 V	-	1870	-	pF
C_{oss}	Output capacitance		-	87	-	
C_{rss}	Reverse transfer capacitance		-	2	-	
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DD} = 480 V, V_{GS} = 0 V	-	157	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, I_D= 0 A	-	4.5	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 24 A, V_{GS} = 10 V (see Figure 18. Test circuit for gate charge behavior)	-	43	-	nC
Q_{gs}	Gate-source charge		-	9.8	-	
Q_{gd}	Gate-drain charge		-	21	-	

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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 12 A R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 17. Test circuit for resistive load switching times and Figure 22. Switching time waveform)	-	17	-	ns
t_r	Rise time		-	8	-	
$t_{d(off)}$	Turn-off delay time		-	62	-	
t_f	Fall time		-	9	-	

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		24	A
I_{SDM} (1)	Source-drain current (pulsed)		-		96	A
V_{SD} (2)	Forward on voltage	V_{GS} = 0 V, I_{SD} = 24 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 24 A, di/dt = 100 A/µs, V_{DD} = 60 V (see Figure 19. Test circuit for inductive load switching and diode recovery times)	-	150		ns
Q_{rr}	Reverse recovery charge		-	0.5		µC
I_{RRM}	Reverse recovery current		-	8.8		A
t_{rr}	Reverse recovery time	I_{SD} = 24 A, di/dt = 100 A/µs, V_{DD} = 60 V, T_j = 150 °C (see Figure 19. Test circuit for inductive load switching and diode recovery times)	-	316		ns
Q_{rr}	Reverse recovery charge		-	2.85		µC
I_{RRM}	Reverse recovery current		-	18		A

1. *Pulse width is limited by safe operating area.*
2. *Pulse test: pulse duration = 300 µs, duty cycle 1.5%.*

2.1 Electrical characteristics curves

Figure 1. Safe operating area for D²PAK

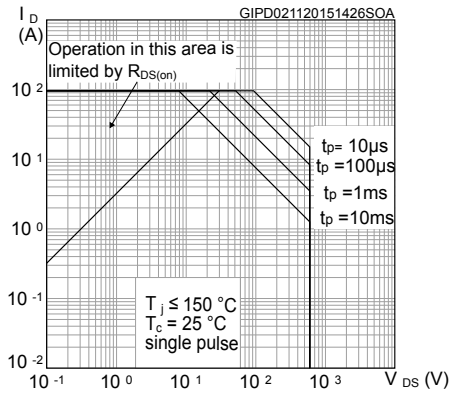


Figure 2. Thermal impedance for D²PAK

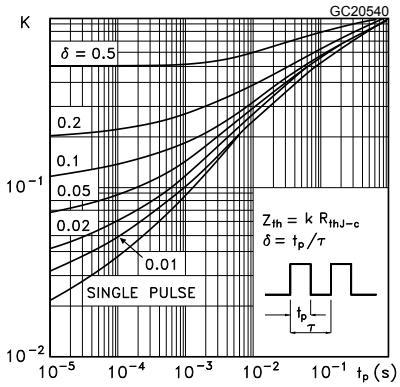


Figure 3. Safe operating area for TO-220

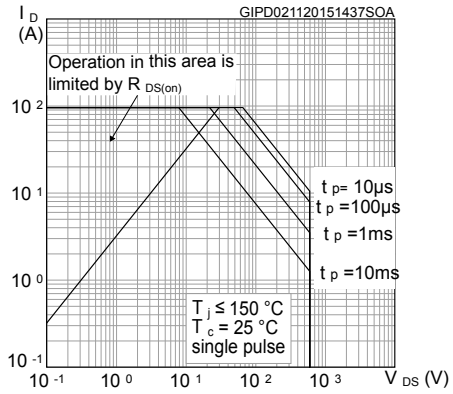


Figure 4. Thermal impedance for TO-220

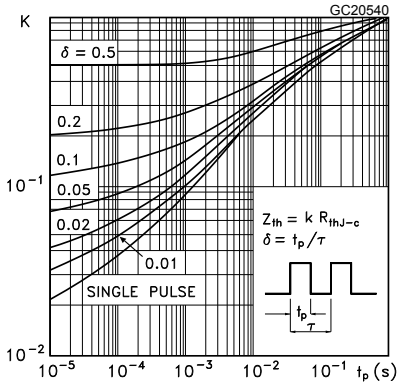


Figure 5. Safe operating area for TO-247

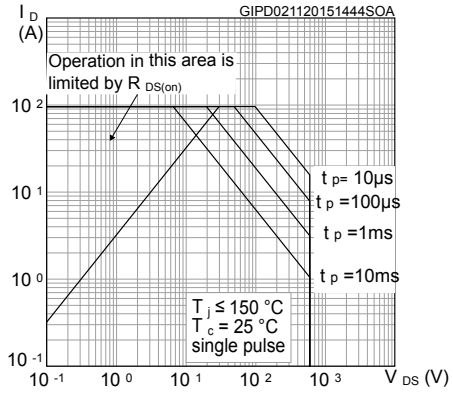


Figure 6. Thermal impedance for TO-247

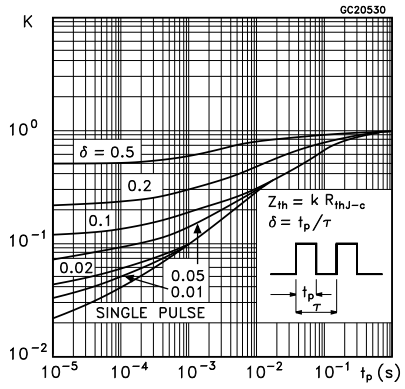


Figure 7. Output characteristics

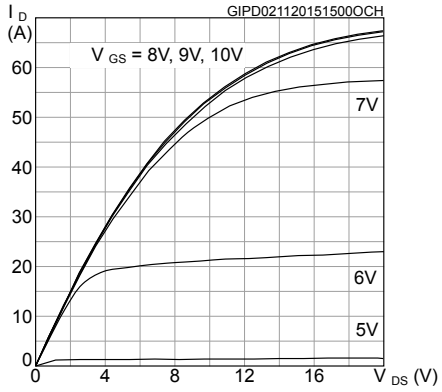


Figure 8. Transfer characteristics

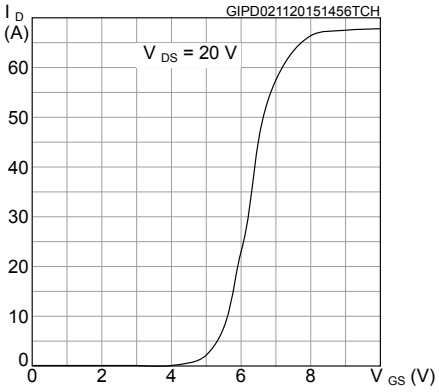


Figure 9. Gate charge vs gate-source voltage

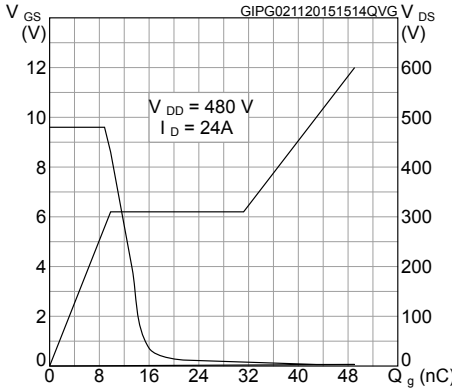


Figure 10. Static drain-source on-resistance

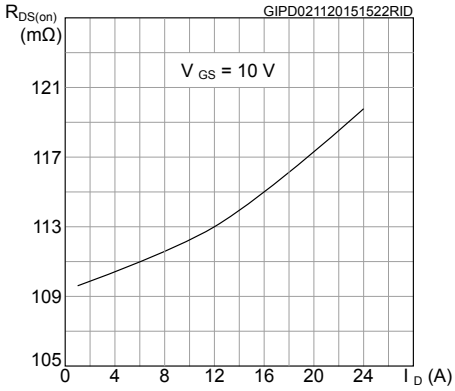


Figure 11. Capacitance variations

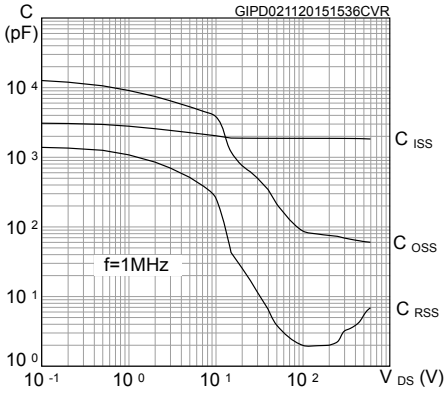


Figure 12. Normalized gate threshold voltage vs temperature

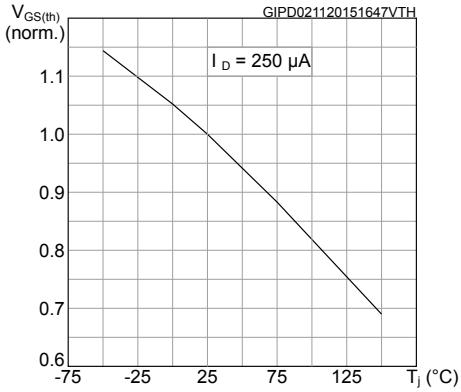


Figure 13. Normalized on-resistance vs temperature

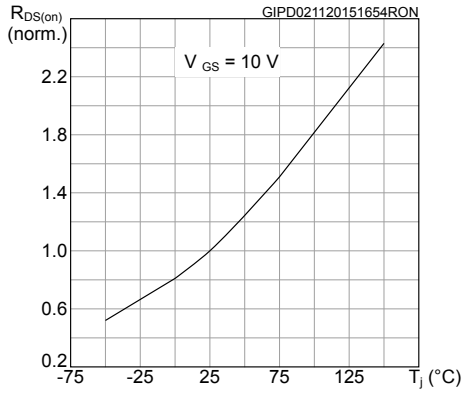


Figure 14. Normalized $V_{(BR)DSS}$ vs temperature

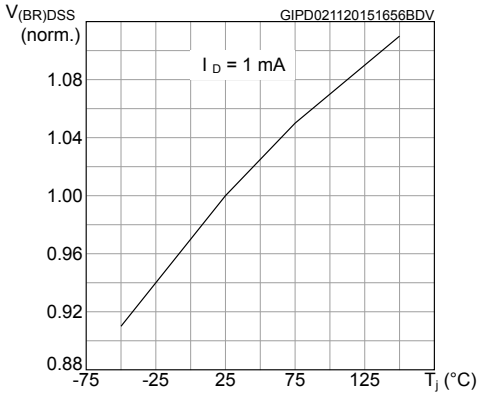


Figure 15. Output capacitance stored energy

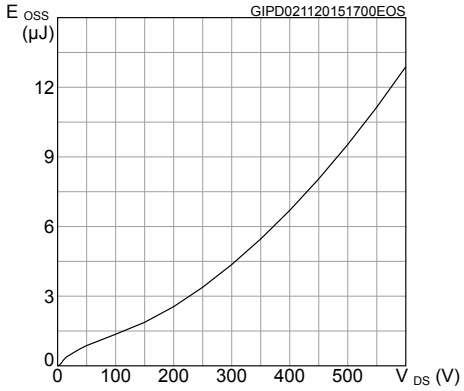
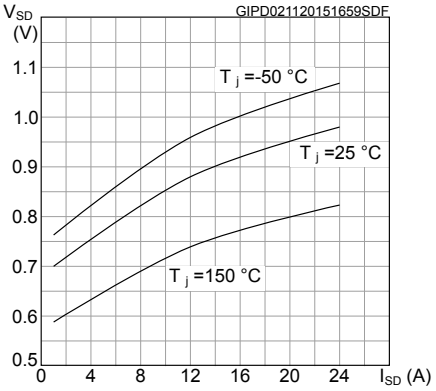


Figure 16. Source- drain diode forward characteristics



3 Test circuits

Figure 17. Test circuit for resistive load switching times

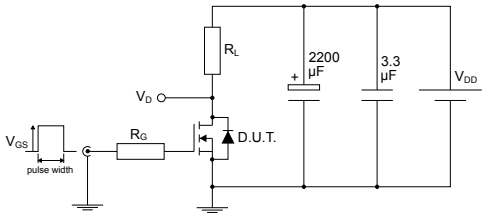


Figure 18. Test circuit for gate charge behavior

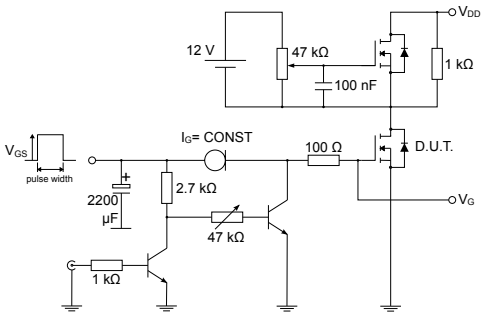


Figure 19. Test circuit for inductive load switching and diode recovery times

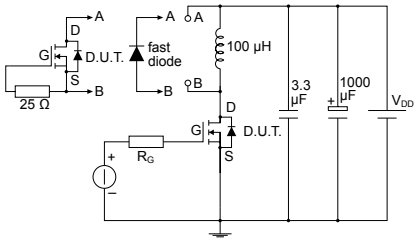


Figure 20. Unclamped inductive load test circuit

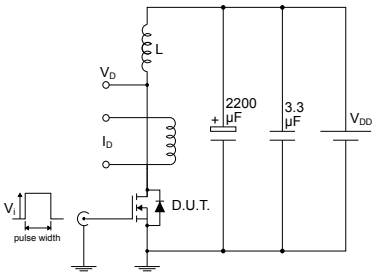


Figure 21. Unclamped inductive waveform

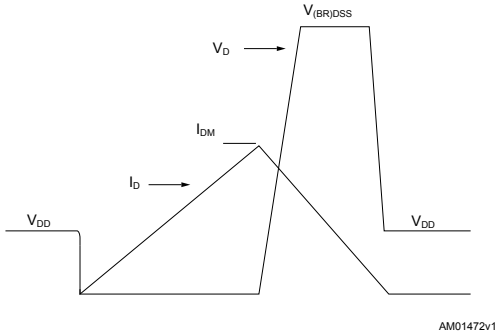
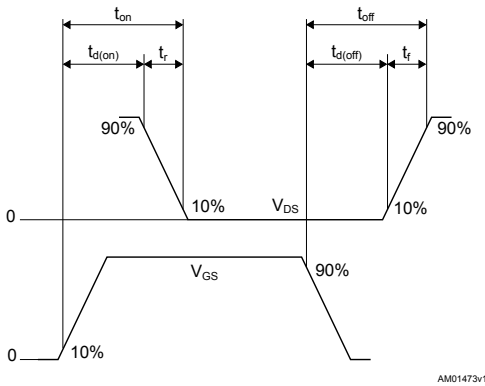


Figure 22. Switching time waveform



4 Package information

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.

4.1 D²PAK (TO-263) type A package information

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

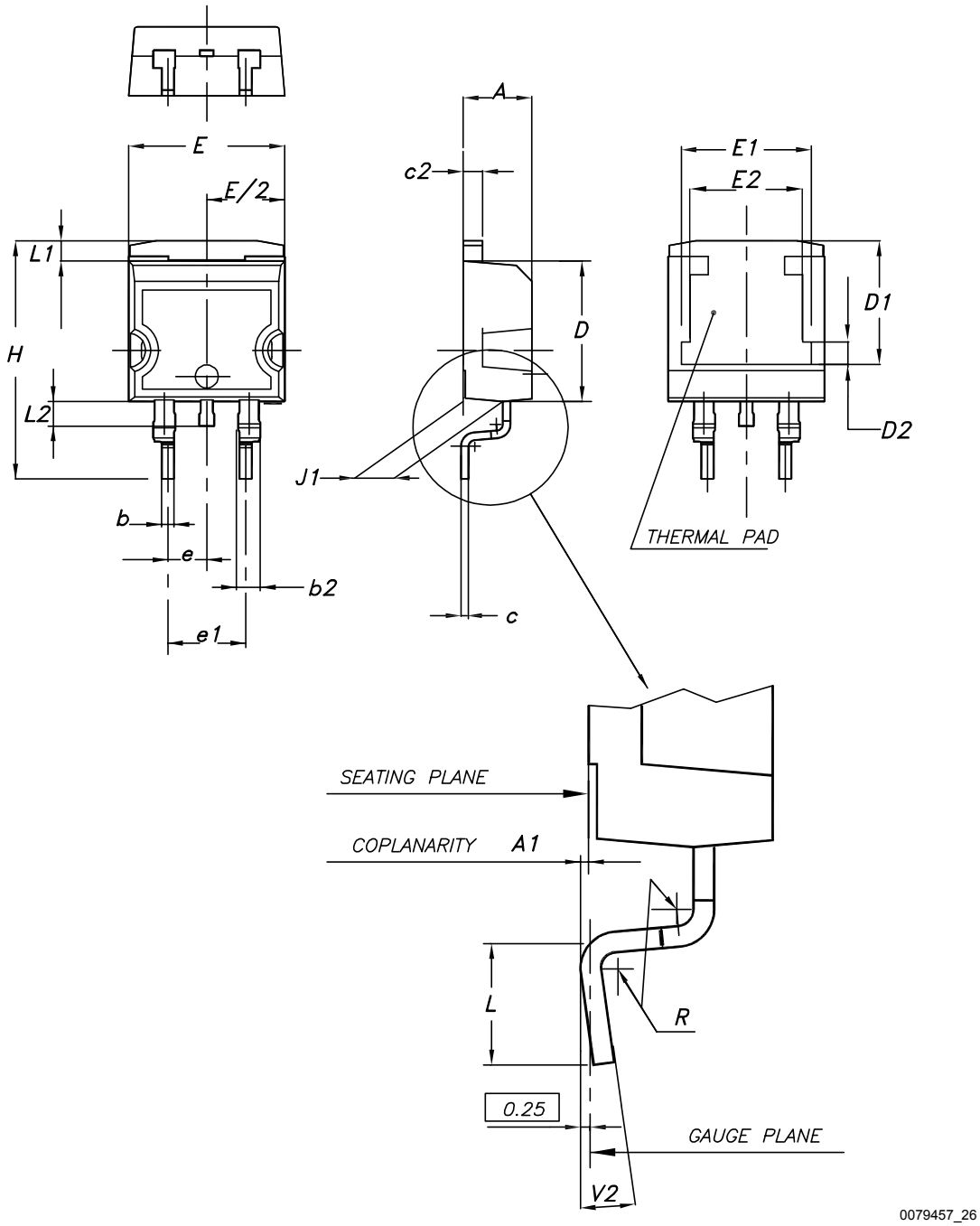
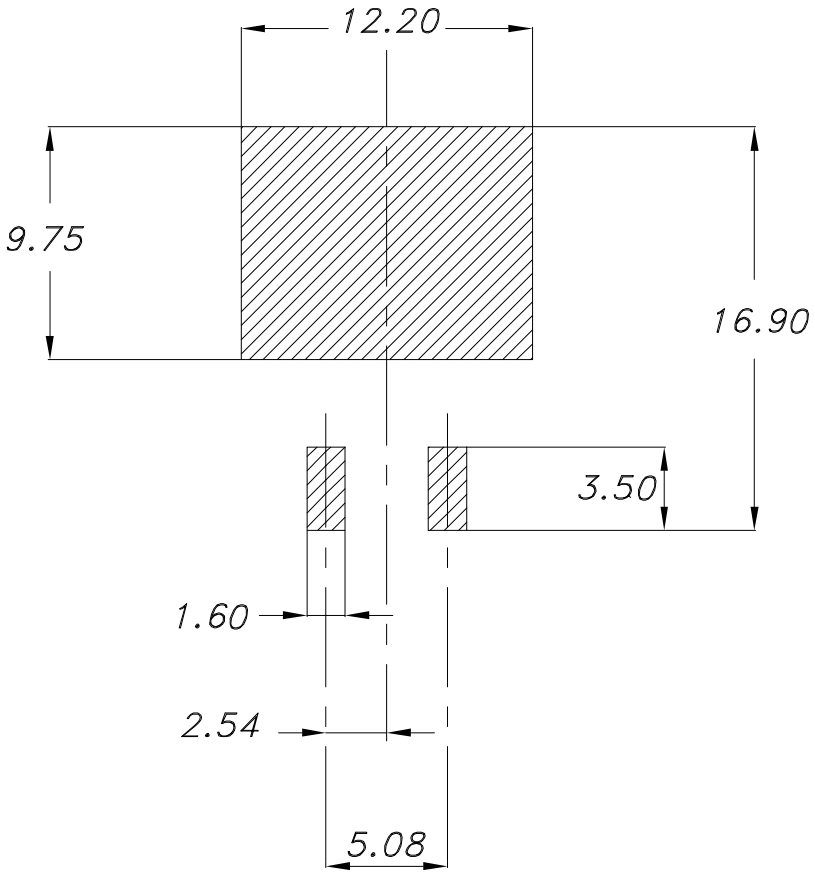


Table 8. D²PAK (TO-263) type A package mechanical data

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



4.2 D²PAK packing information

Figure 25. D²PAK tape outline

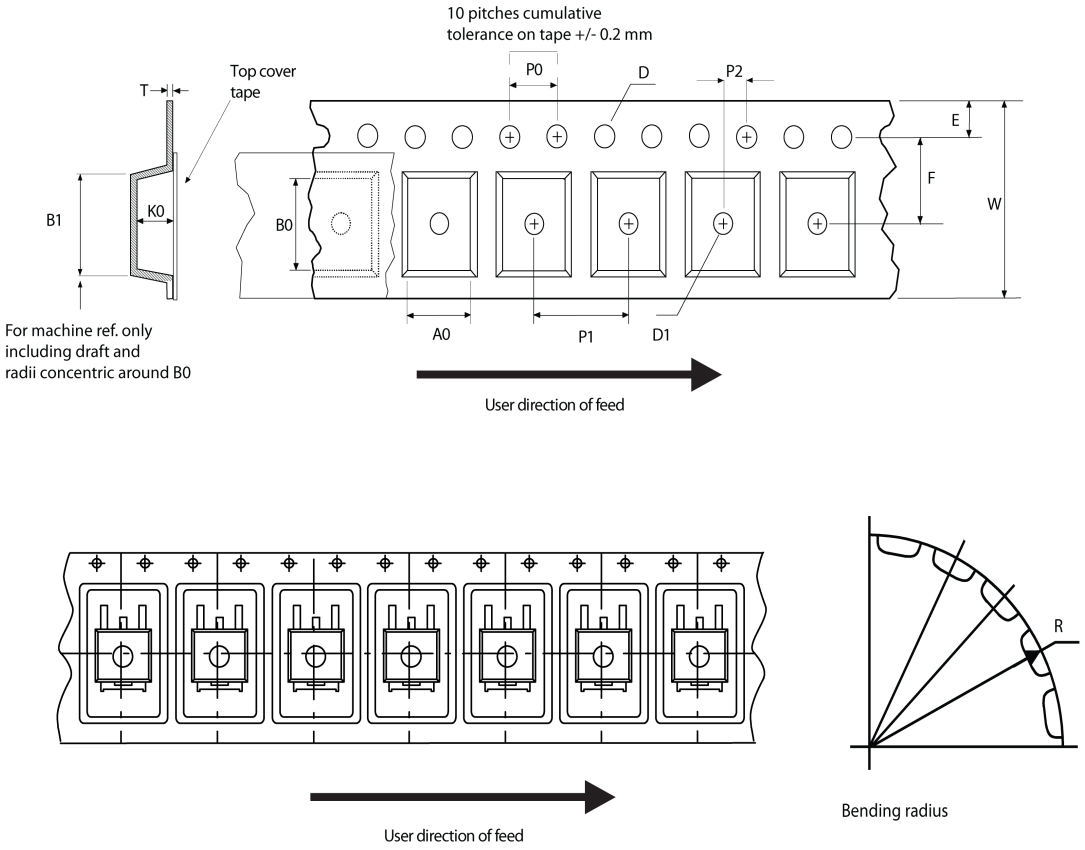
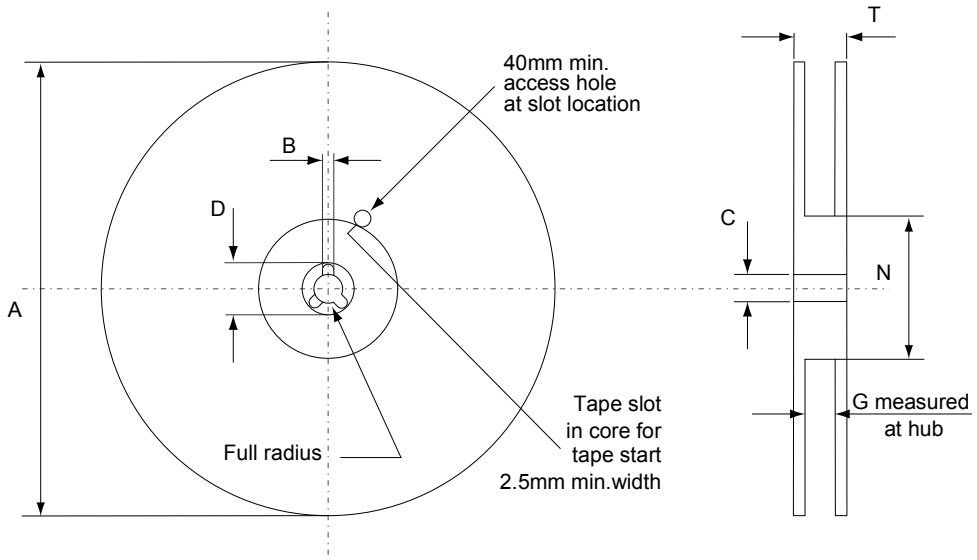


Figure 26. **D²PAK reel outline**



AM06038v1

Table 9. **D²PAK tape and reel mechanical data**

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

4.3 TO-220 type A package information

Figure 27. **TO-220 type A package outline**

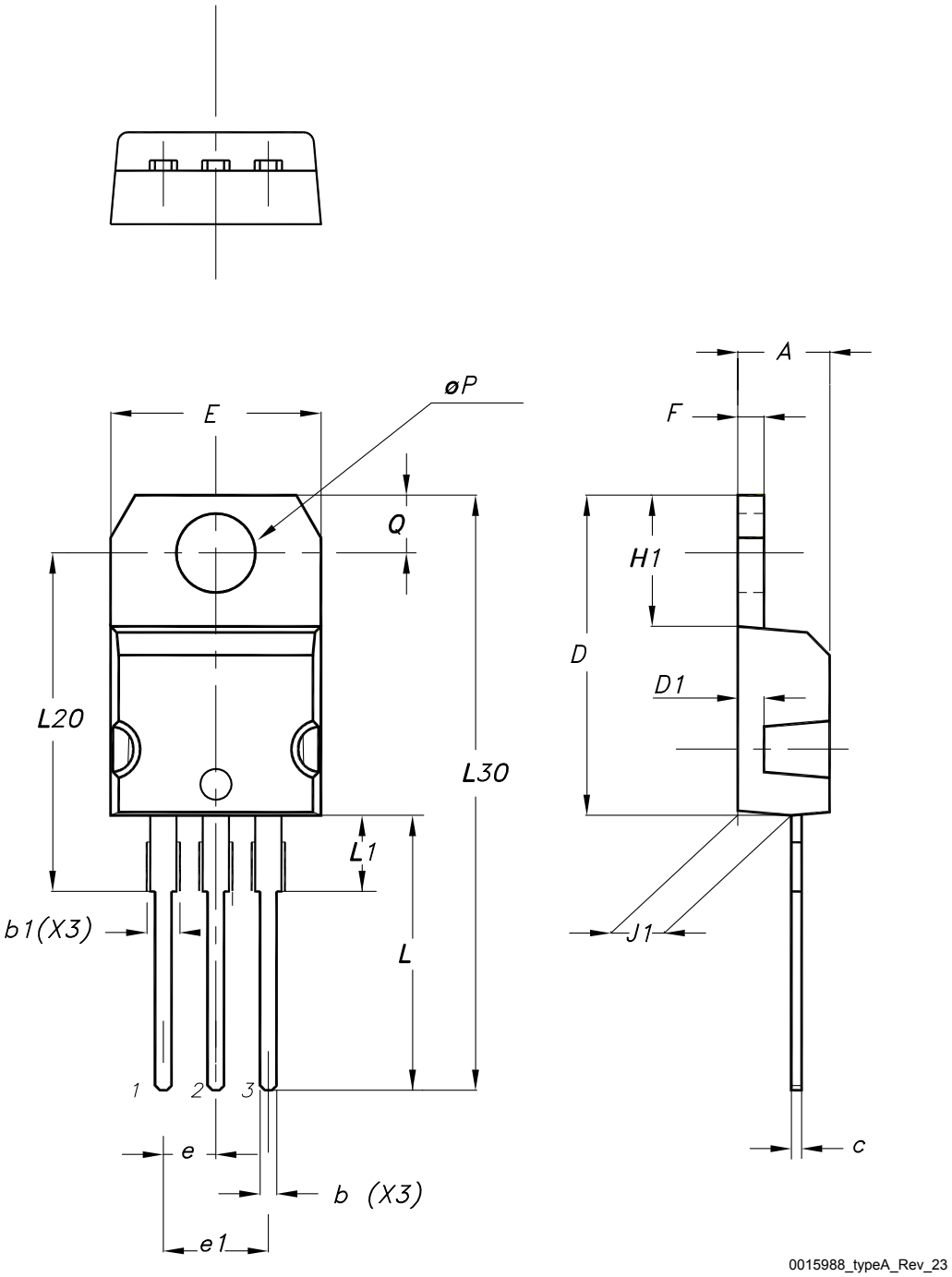


Table 10. **TO-220 type A package mechanical data**

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**

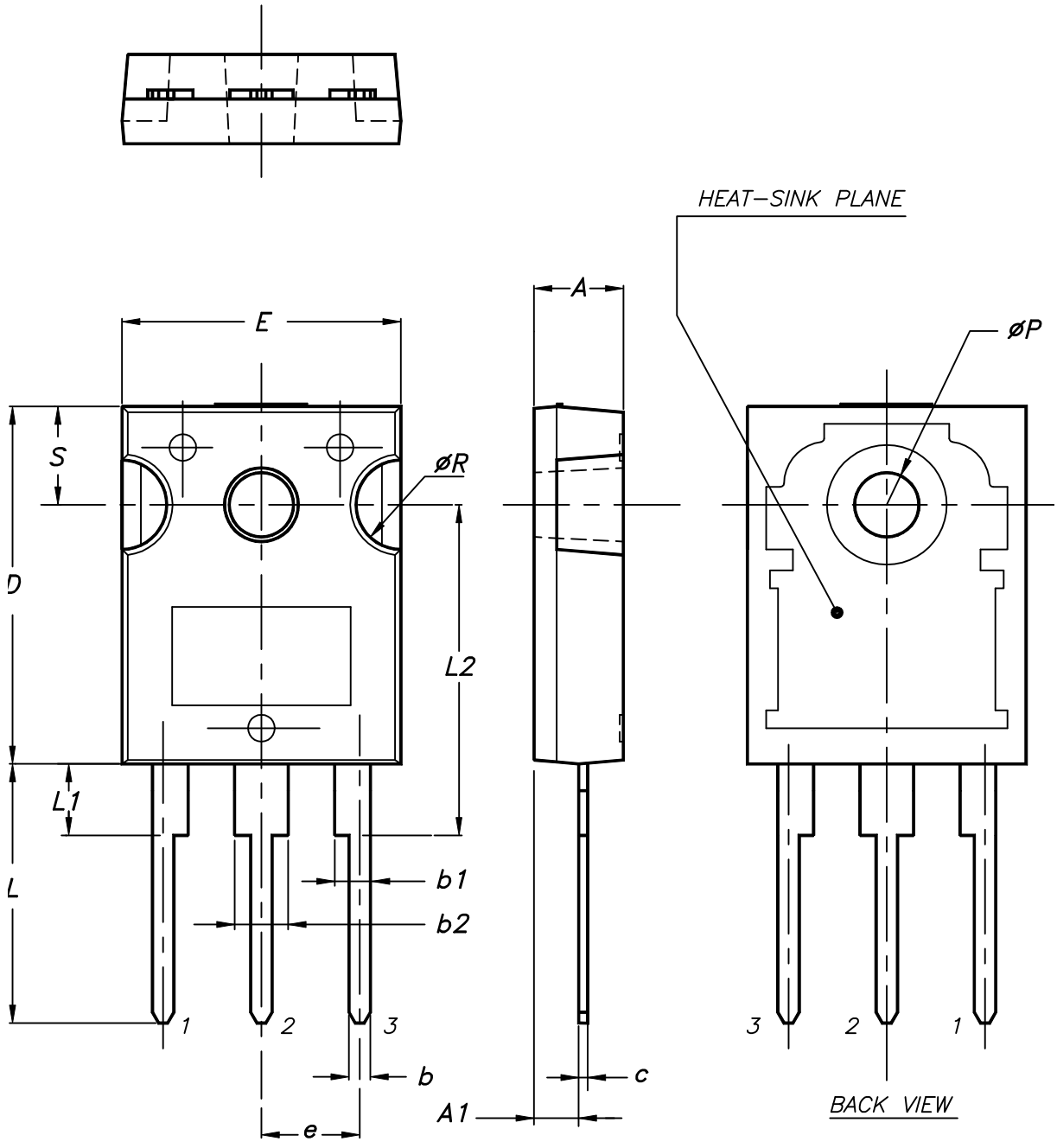


Table 11. **TO-247 package mechanical data**

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

5 Ordering information

Table 12. **Order codes**

Order code	Marking	Package	Packing
STB33N60DM2	33N60DM2	D^2PAK	Tape e reel
STP33N60DM2		TO-220	Tube
STW33N60DM2		TO-247	Tube

Revision history

Table 13. **Document revision history**

Date	Revision	Changes
16-Oct-2014	1	First release.
02-Nov-2015	2	Document status promoted from preliminary to production data. Updated title and features in cover page. Updated *Table 2: "Absolute maximum ratings"*, *Table 4: "Avalanche characteristics"*, *Table 5: "Static"*, *Table 6: "Dynamic"*, *Table 7: "Switching times"* and *Table 8: "Source-drain diode"*. Added *Section 2.1 Electrical characteristics (curves)*.
19-Oct-2020	3	Updated Section 1 Electrical ratings. Minor text changes.