STW56N60M2-4

N-channel 600 V, 0.045 Ω typ., 52 A MDmesh™ M2 Power MOSFET in a TO247-4 package

Datasheet - production data

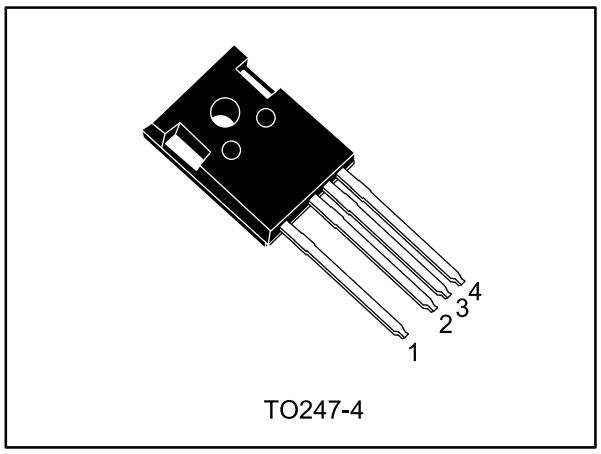
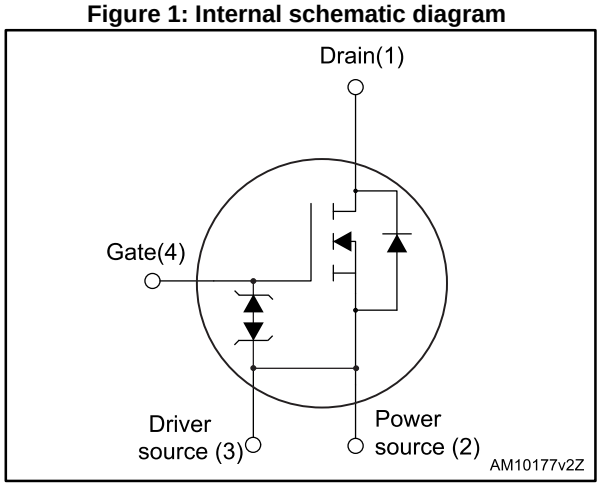


Figure 1: Internal schematic diagram



Features

Order code	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STW56N60M2-4	650 V	0.055 Ω	52 A

- Excellent switching performance thanks to the extra driving source pin
- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

This device is an N-channel Power MOSFET developed using MDmesh™ M2 technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance and optimized switching characteristics, rendering it suitable for the most demanding high efficiency converters.

Table 1: Device summary

Order code	Marking	Package	Packaging
STW56N60M2-4	56N60M2	TO247-4	Tube

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate- source voltage	±25	V
I_D	Drain current (continuous) at T_C = 25 °C	52	A
I_D	Drain current (continuous) at T_C = 100 °C	33	A
I_{DM} (1)	Drain current (pulsed)	208	A
P_{TOT}	Total dissipation at T_C = 25 °C	350	W
dv/dt (2)	Peak diode recovery voltage slope	15	V/ns
dv/dt (3)	MOSFET dv/dt ruggedness	50	V/ns
T_{stg}	Storage temperature	- 55 to 150	°C
T_j	Max. operating junction temperature	150	°C

Notes:

(1)Pulse width limited by safe operating area

(2)$I_{SD} \leq 52$ A, di/dt = 400 A/µs, $V_{DS(peak)} < V_{(BR)DSS}$, V_{DD} = 400 V

(3)$V_{DS} \leq 480$ V

Table 3: Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max	50	°C/W
$R_{thj\text{-}case}$	Thermal resistance junction-case max	0.36	°C/W

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Max current during repetitive or single pulse avalanche (pulse width limited by T_{JMAX})	7.5	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, $I_D = I_{AR}$, V_{DD} = 50 V)	1100	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	nA
$V_{GS(th)}$	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 = 26 A		0.045	0.055	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	-	3750	-	pF
C_{oss}	Output capacitance		-	175	-	pF
C_{rss}	Reverse transfer capacitance		-	6.6	-	pF
$C_{o(er)}$[(1)]	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 480V	-	740	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	4.7	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 52 A, V_{GS} = 10 V	-	91	-	nC
Q_{gs}	Gate-source charge		-	13.5	-	nC
Q_{gd}	Gate-drain charge		-	41	-	nC

Notes:

(1)Coss eq. is defined as a constant equivalent capacitance giving the same charging time as Coss when VDS increases from 0 to 80% VDSS

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 = 26 A, R_G = 4.7 Ω, V_{GS} = 10 V	-	18	-	ns
t_r	Rise time		-	26.5	-	ns
$t_{d(off)}$	Turn-off delay time		-	119	-	ns
t_f	Fall time		-	14	-	ns

Table 8: Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		52	A
I_{SDM}(1)	Source-drain current (pulsed)		-		208	A
V_{SD}(2)	Forward on voltage	I_{SD} = 52 A, V_{GS} = 0	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 52 A, di/dt = 100 A/µs V_{DD} = 100 V	-	496		ns
Q_{rr}	Reverse recovery charge		-	10		µC
I_{RRM}	Reverse recovery current		-	41		A
t_{rr}	Reverse recovery time	I_{SD} = 52 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C	-	632		ns
Q_{rr}	Reverse recovery charge		-	14		µC
I_{RRM}	Reverse recovery current		-	45		A

Notes:

(1)Pulse width limited by safe operating area

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

2.2 Electrical characteristics (curves)

Figure 2: Safe operating area

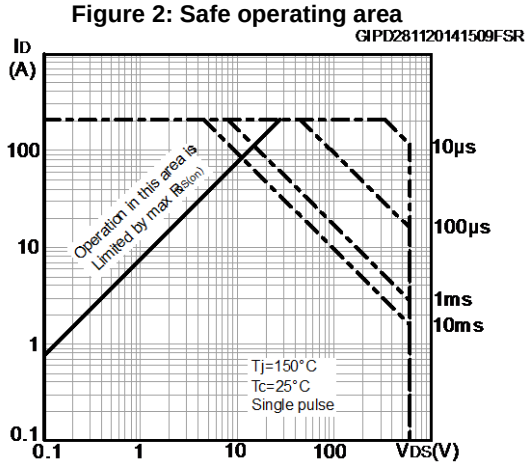


Figure 3: Thermal impedance

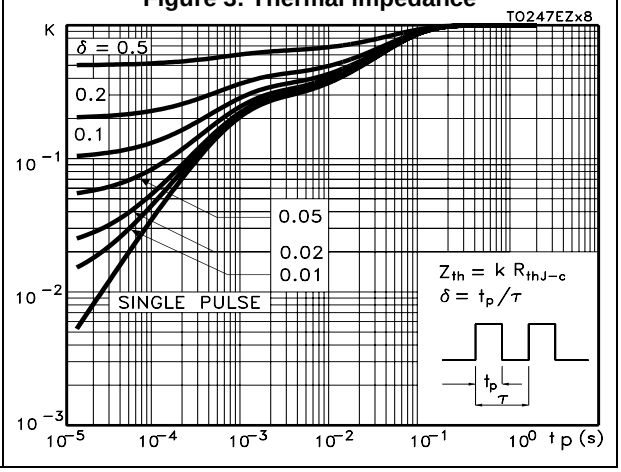


Figure 4: Output characteristics

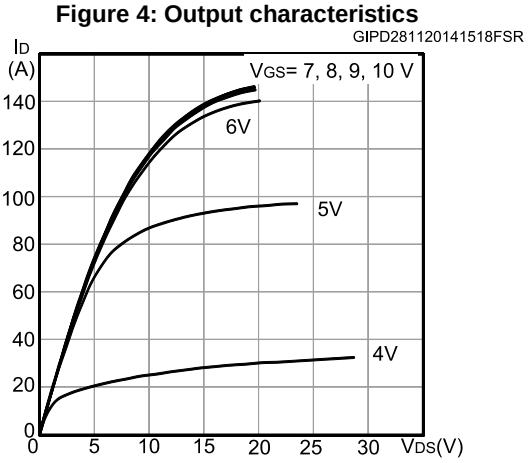


Figure 5: Transfer characteristics

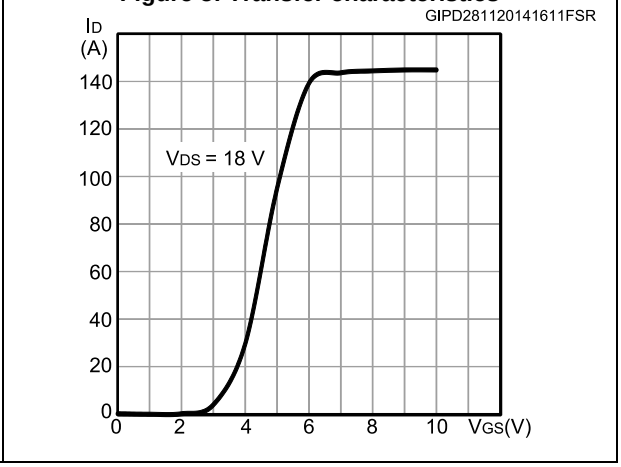


Figure 6: Gate charge vs gate-source voltage

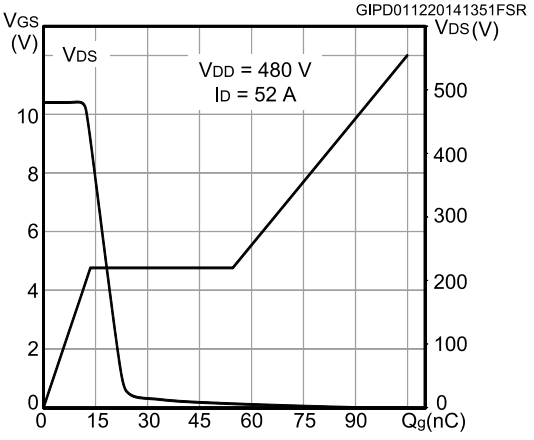


Figure 7: Static drain-source on-resistance

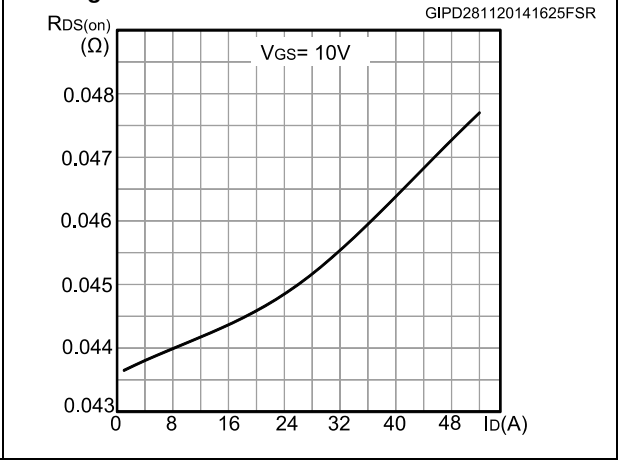


Figure 8: Capacitance variations

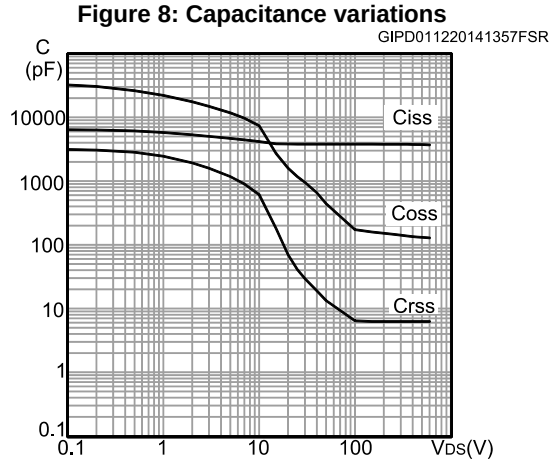


Figure 9: Normalized gate threshold voltage vs temperature

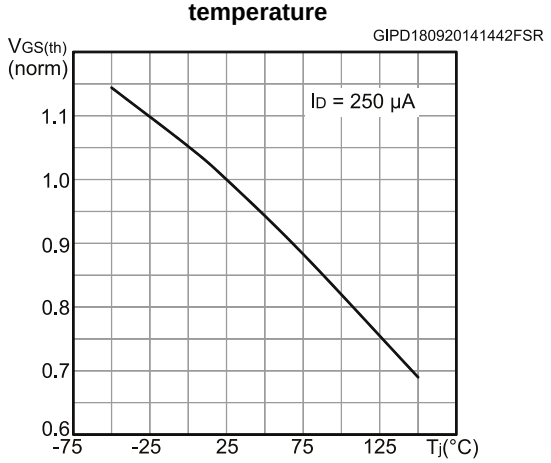


Figure 10: Normalized on-resistance

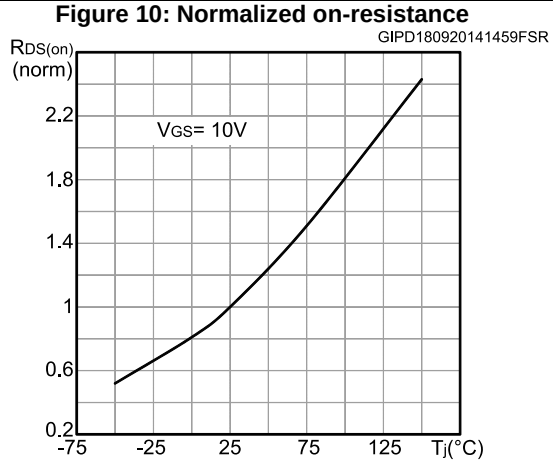


Figure 11: Normalized V(BR)DSS vs temperature

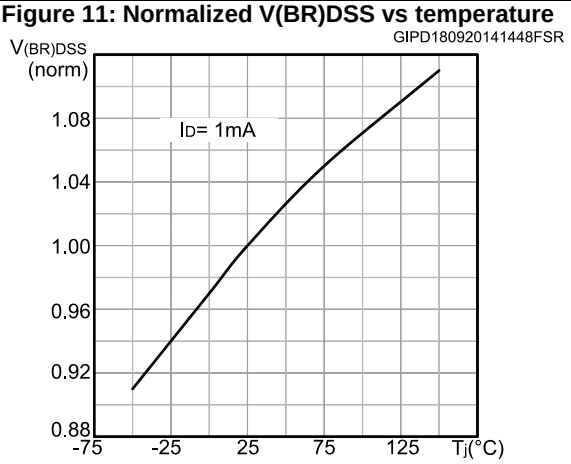


Figure 12: Source-drain diode forward characteristics

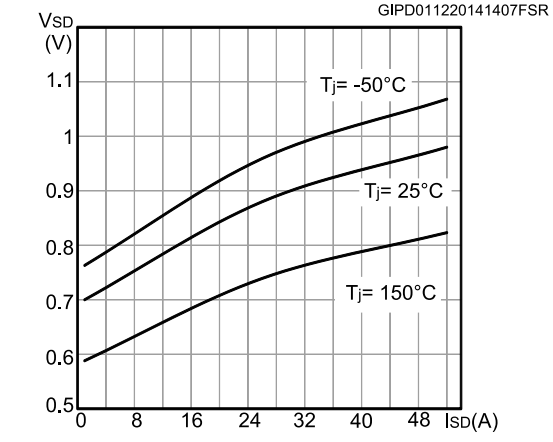
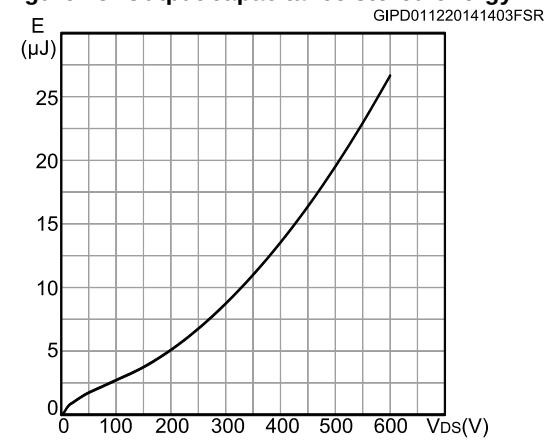


Figure 13: Output capacitance stored energy



3 Test circuits

Figure 14: Switching times test circuit for resistive load

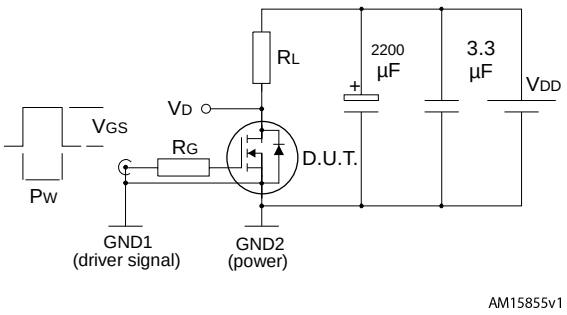


Figure 15: Gate charge test circuit

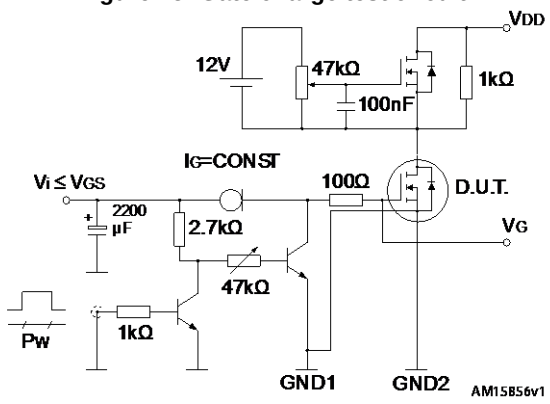


Figure 16: Test circuit for inductive load switching and diode recovery times

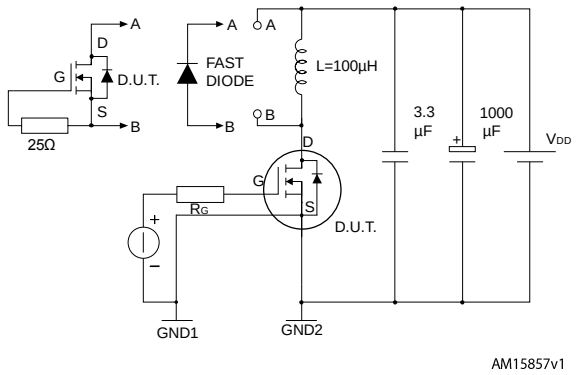


Figure 17: Unclamped inductive load test circuit

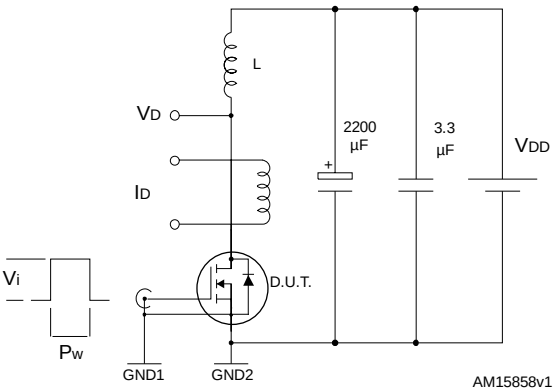


Figure 18: Unclamped inductive waveform

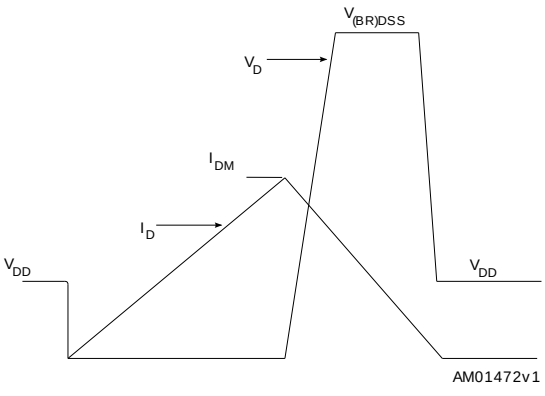
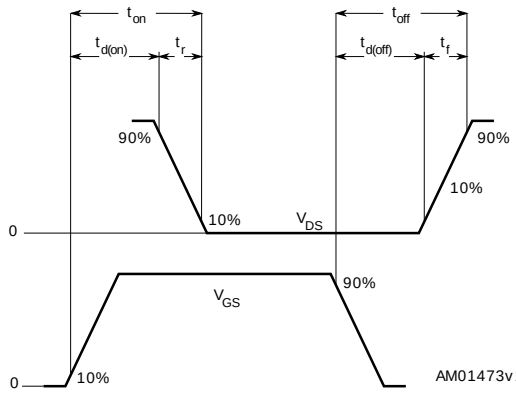


Figure 19: Switching time waveform



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.

4.1 TO247-4 package information

Figure 20: TO247-4 package outline

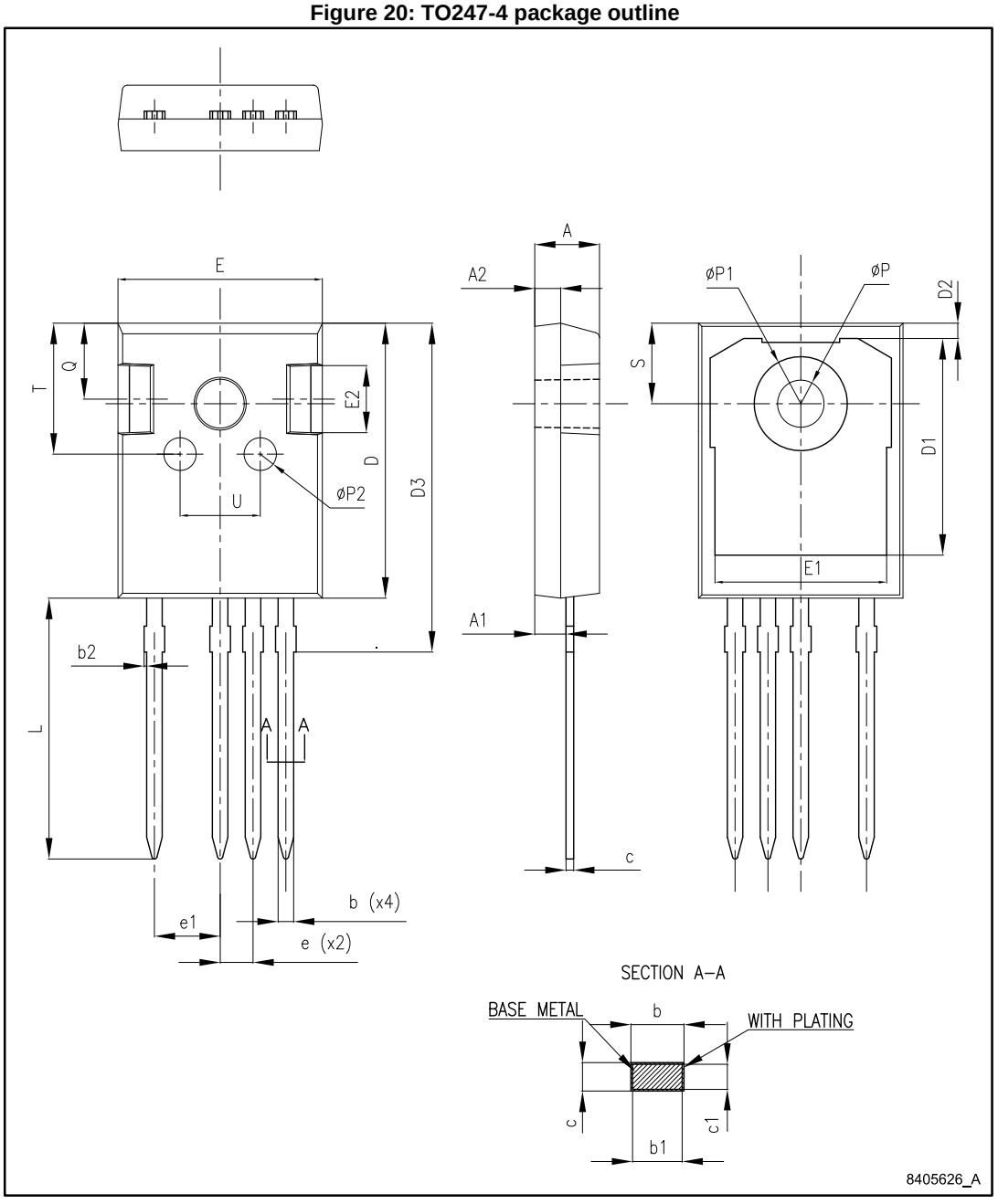


Table 9: TO247-4 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.29
b1	1.15	1.20	1.25
b2	0		0.20
c	0.59		0.66
c1	0.58	0.60	0.62
D	20.90	21.00	21.10
D1	16.25	16.55	16.85
D2	1.05	1.20	1.35
D3	24.97	25.12	25.27
E	15.70	15.80	15.90
E1	13.10	13.30	13.50
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	2.44	2.54	2.64
e1	4.98	5.08	5.18
L	19.80	19.92	20.10
P	3.50	3.60	3.70
P1			7.40
P2	2.40	2.50	2.60
Q	5.60		6.00
S		6.15	
T	9.80		10.20
U	6.00		6.40

5 Revision history

Table 10: Document revision history

Date	Revision	Changes
25-Jul-2014	1	Initial release.
01-Dec-2014	2	Document status promoted from preliminary to production data. Added *Section 2.1: "Electrical characteristics (curves)"*.
29-Jan-2015	3	Updated *Figure 1: "Internal schematic diagram"*.