

SI2304DS

N-channel enhancement mode field-effect transistor

Rev. 01 — 17 August 2001

Product data

1. Description

N-channel enhancement mode field-effect transistor in a plastic package using TrenchMOS™¹ technology

Product availability:

SI2304DS in SOT23.

2. Features

- TrenchMOS™ technology
- Very fast switching
- Subminiature surface mount package.

3. Applications

- Battery management
- High speed switch
- Low power DC to DC converter.

4. Pinning information

Table 1: Pinning - SOT23, simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	gate (g)	<p>Top view MSB003</p>	<p>MBB076</p>
2	source (s)		
3	drain (d)		

SOT23

1. TrenchMOS is a trademark of Koninklijke Philips Electronics N.V.



5. Quick reference data

Table 2: Quick reference data

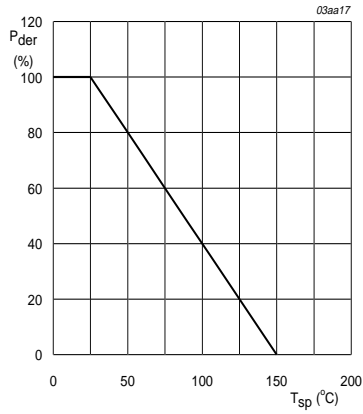
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage (DC)	$T_j = 25$ to 150 °C	–	–	30	V
I_D	drain current (DC)	$T_{sp} = 25$ °C; $V_{GS} = 5$ V	–	–	1.7	A
P_{tot}	total power dissipation	$T_{sp} = 25$ °C	–	–	0.83	W
T_j	junction temperature		–	–	150	°C
R_{DSon}	drain-source on-state resistance	$V_{GS} = 10$ V; $I_D = 500$ mA	–	–	117	mΩ
		$V_{GS} = 4.5$ V; $I_D = 500$ mA	–	–	190	mΩ

6. Limiting values

Table 3: Limiting values

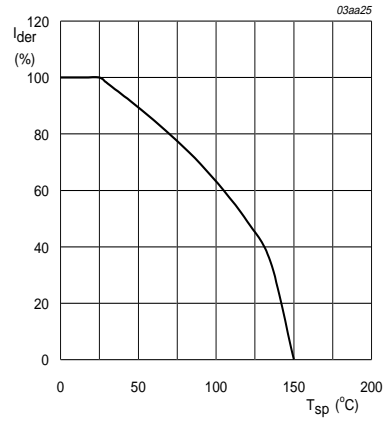
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage (DC)	$T_j = 25$ to 150 °C	–	30	V
V_{DGR}	drain-gate voltage (DC)	$T_j = 25$ to 150 °C; $R_{GS} = 20$ kΩ	–	30	V
V_{GS}	gate-source voltage (DC)		–	±20	V
I_D	drain current (DC)	$T_{sp} = 25$ °C; $V_{GS} = 5$ V; Figure 2 and 3	–	1.7	A
		$T_{sp} = 100$ °C; $V_{GS} = 5$ V; Figure 2 and 3	–	1.1	A
I_{DM}	peak drain current	$T_{sp} = 25$ °C; pulsed; $t_p \leq 10$ μs	–	7.5	A
P_{tot}	total power dissipation	$T_{sp} = 25$ °C; Figure 1	–	0.83	W
T_{stg}	storage temperature		–65	+150	°C
T_j	operating junction temperature		–65	+150	°C
Source-drain diode					
I_S	source (diode forward) current (DC)	$T_{sp} = 25$ °C	–	0.83	A
I_{SM}	peak source (diode forward) current	$T_{sp} = 25$ °C; pulsed; $t_p \leq 10$ μs	–	3.3	A



$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

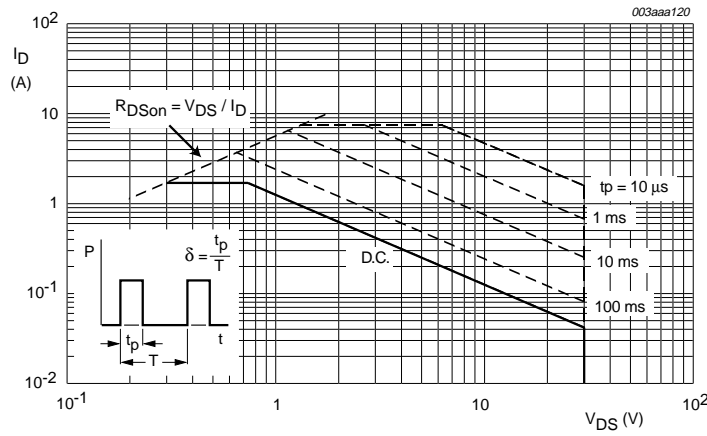
Fig 1. Normalized total power dissipation as a function of solder point temperature.



$V_{GS} \geq 10\text{ V}$

$$I_{der} = \frac{I_D}{I_{D(25^{\circ}C)}} \times 100\%$$

Fig 2. Normalized continuous drain current as a function of solder point temperature.



$T_{sp} = 25^{\circ}C$; I_{DM} is single pulse

Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage.

7. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Value	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point	mounted on a metal clad substrate; Figure 4	100	K/W

7.1 Transient thermal impedance

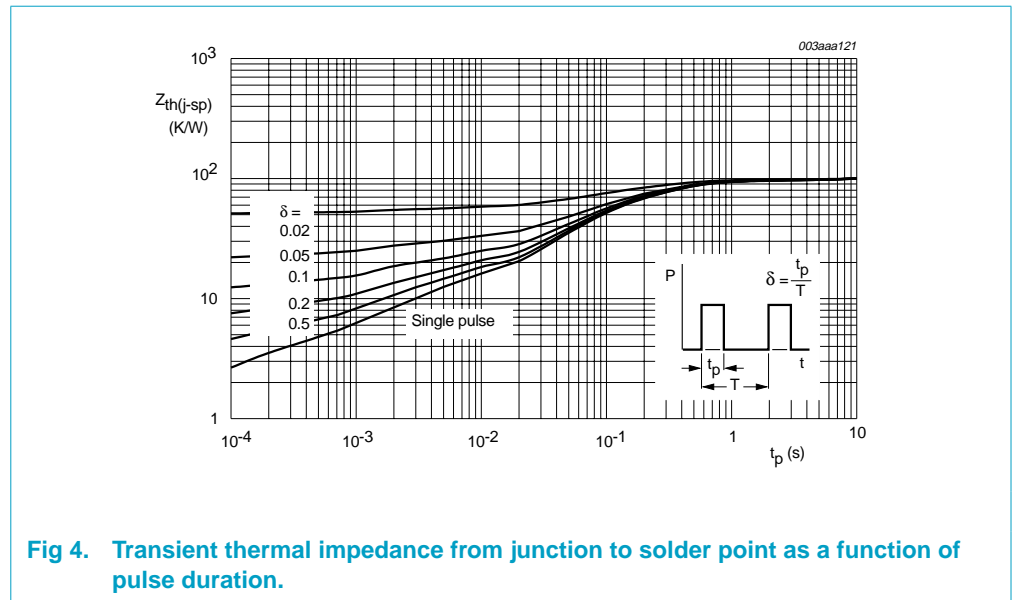
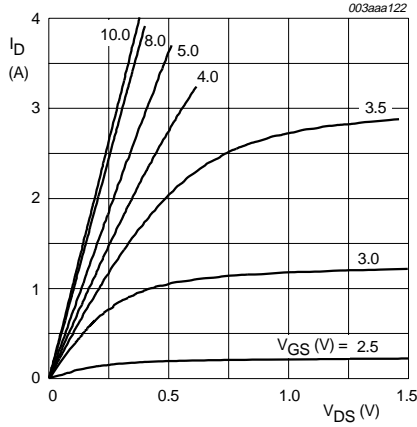


Fig 4. Transient thermal impedance from junction to solder point as a function of pulse duration.

8. Characteristics

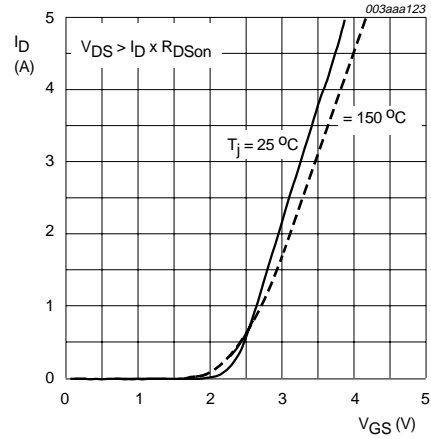
Table 5: Characteristics
 $T_j = 25\text{ °C}$ unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10\ \mu\text{A}$; $V_{GS} = 0\ \text{V}$ $T_j = 25\text{ °C}$	30	40	–	V
		$T_j = -55\text{ °C}$	27	–	–	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\ \text{mA}$; $V_{DS} = V_{GS}$; Figure 9 $T_j = 25\text{ °C}$	1.5	2	–	V
		$T_j = 150\text{ °C}$	0.5	–	–	V
		$T_j = -55\text{ °C}$	–	–	2.7	V
I_{DSS}	drain-source leakage current	$V_{DS} = 30\ \text{V}$; $V_{GS} = 0\ \text{V}$ $T_j = 25\text{ °C}$	–	0.01	0.5	μA
		$T_j = 150\text{ °C}$	–	–	10	μA
I_{GSS}	gate-source leakage current	$V_{GS} = \pm 10\ \text{V}$; $V_{DS} = 0\ \text{V}$	–	10	100	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 10\ \text{V}$; $I_D = 500\ \text{mA}$; Figure 7 and 8 $T_j = 25\text{ °C}$	–	–	117	m Ω
		$V_{GS} = 4.5\ \text{V}$; $I_D = 500\ \text{mA}$ $T_j = 25\text{ °C}$	–	–	190	m Ω
		$T_j = 150\text{ °C}$	–	–	300	m Ω
Dynamic characteristics						
g_{fs}	forward transconductance	$V_{DS} = 10\ \text{V}$; $I_D = 1\ \text{A}$	1.4	2.5	–	S
$Q_{g(tot)}$	total gate charge	$V_{DD} = 15\ \text{V}$; $V_{GS} = 10\ \text{V}$; $I_D = 0.5\ \text{A}$; Figure 13	–	4.6	–	nC
Q_{gs}	gate-source charge		–	0.6	–	nC
Q_{gd}	gate-drain (Miller) charge		–	1.35	1.83	nC
C_{iss}	input capacitance	$V_{GS} = 0\ \text{V}$; $V_{DS} = 10\ \text{V}$; $f = 1\ \text{MHz}$; Figure 11	–	147	195	pF
C_{oss}	output capacitance		–	65	78	pF
C_{rss}	reverse transfer capacitance		–	41	56	pF
$t_{d(on)}$	turn-on delay time	$V_{DD} = 15\ \text{V}$; $R_L = 15\ \Omega$; $V_{GS} = 10\ \text{V}$	–	4	6	ns
t_r	rise time		–	7.5	12	ns
$t_{d(off)}$	turn-off delay time		–	18	35	ns
t_f	fall time		–	13	19	ns
Source-drain diode						
V_{SD}	source-drain (diode forward) voltage	$I_S = 0.83\ \text{A}$; $V_{GS} = 0\ \text{V}$; Figure 12	–	0.7	1.2	V
t_{rr}	reverse recovery time	$I_S = 1\ \text{A}$; $di_S/dt = -100\ \text{A}/\mu\text{s}$; $V_{GS} = 0\ \text{V}$; $V_{DS} = 25\ \text{V}$	–	69	–	ns



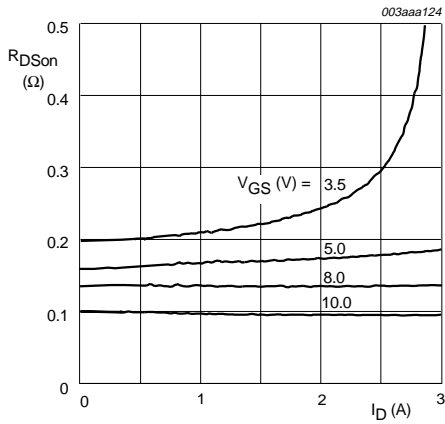
$T_j = 25\text{ }^\circ\text{C}$

Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values.



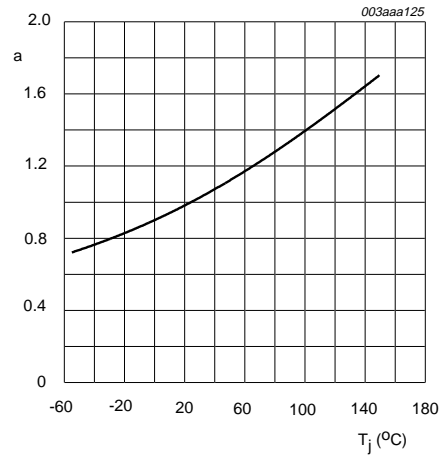
$T_j = 25\text{ }^\circ\text{C}$ and $175\text{ }^\circ\text{C}$; $V_{DS} > I_D \times R_{DSon}$

Fig 6. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



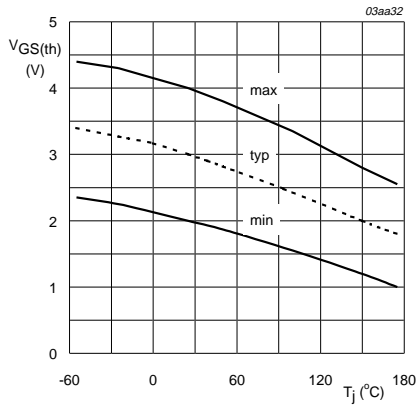
$T_j = 25\text{ }^\circ\text{C}$

Fig 7. Drain-source on-state resistance as a function of drain current; typical values.



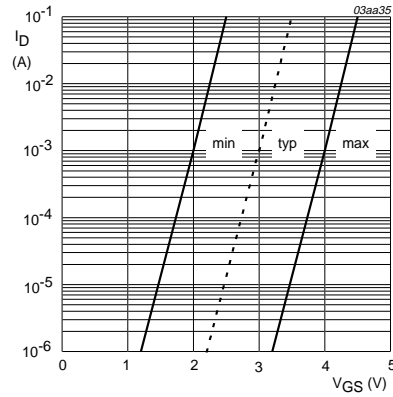
$$a = \frac{R_{DSon}}{R_{DSon(25^\circ\text{C})}}$$

Fig 8. Normalized drain source on-state resistance factor as a function of junction temperature.



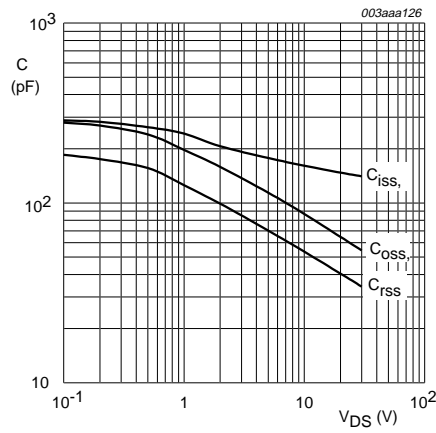
$I_D = 1 \text{ mA}; V_{DS} = V_{GS}$

Fig 9. Gate-source threshold voltage as a function of junction temperature.



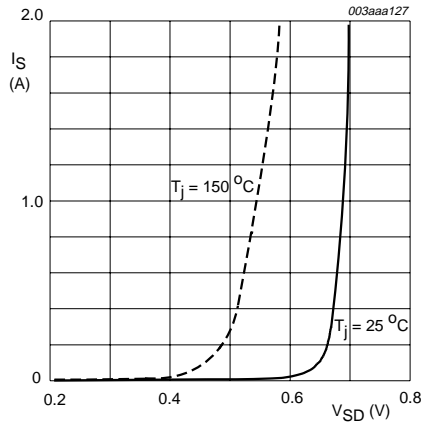
$T_j = 25 \text{ }^{\circ}C; V_{DS} = 5 \text{ V}$

Fig 10. Sub-threshold drain current as a function of gate-source voltage.



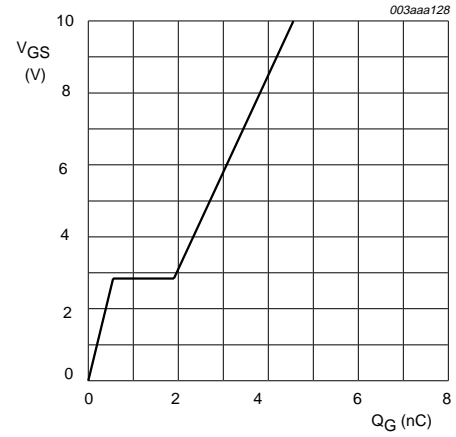
$V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

Fig 11. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



$T_j = 25\text{ °C}$ and 150 °C ; $V_{GS} = 0\text{ V}$

Fig 12. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.



$I_D = 0.5\text{ A}$; $V_{DD} = 15\text{ V}$

Fig 13. Gate-source voltage as a function of gate charge; typical values.

9. Package outline

Plastic surface mounted package; 3 leads

SOT23

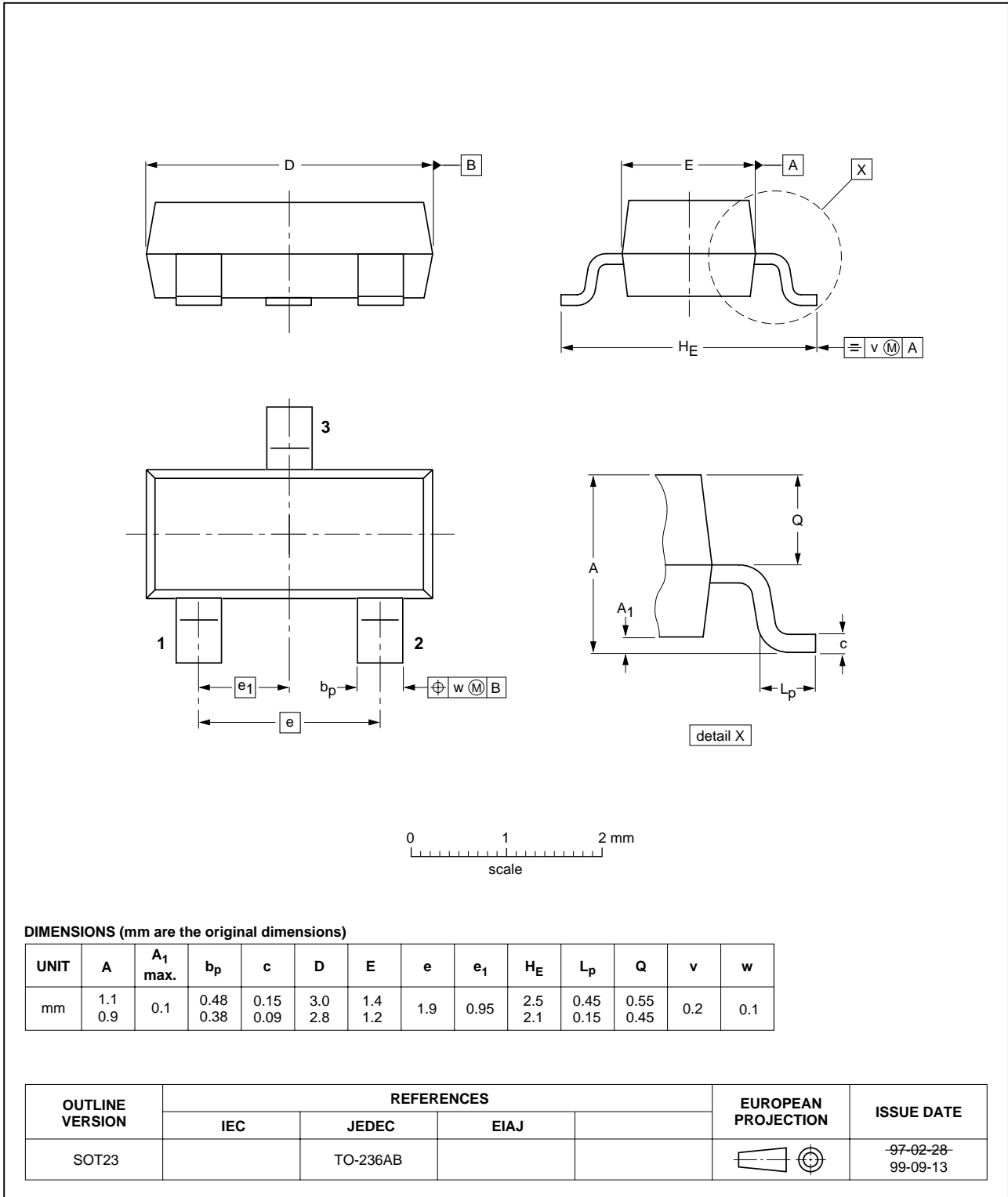


Fig 14. SOT23.

10. Revision history

Table 6: Revision history

Rev	Date	CPCN	Description
01	20010817	-	Product data; initial version

11. Data sheet status

Data sheet status ^[1]	Product status ^[2]	Definition
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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Contents

1	Description	1
2	Features	1
3	Applications	1
4	Pinning information	1
5	Quick reference data	2
6	Limiting values	2
7	Thermal characteristics	4
7.1	Transient thermal impedance	4
8	Characteristics	5
9	Package outline	9
10	Revision history	10
11	Data sheet status	11
12	Definitions	11
13	Disclaimers	11

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