

Logic level TOPFET  
SMD version of BUK125-50L

BUK136-50L

DESCRIPTION

Monolithic logic level protected power MOSFET using **TOPFET2** technology assembled in a 5 pin surface mounting plastic package.

APPLICATIONS

General purpose switch for automotive systems and other applications.

FEATURES

- TrenchMOS output stage with low on-state resistance
- Separate input pin for higher frequency drive
- 5 V logic compatible input
- Separate supply pin for logic and protection circuits with low operating current
- Overtemperature protection
- Drain current limiting
- Short circuit load protection
- Latched overload trip state reset by the protection pin
- Diagnostic flag pin indicates protection supply connected, overtemperature condition, overload tripped state, or open circuit load (detected in the off-state)
- ESD protection on all pins
- Overvoltage clamping

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MAX.	UNIT
$V_{DS}$	Continuous drain source voltage	50	V
$I_D$	Continuous drain current	40	A
$P_{tot}$	Total power dissipation	107	W
$T_j$	Continuous junction temperature	150	°C
$R_{DS(ON)}$	Drain-source on-state resistance	20	mΩ
SYMBOL	PARAMETER	NOM.	UNIT
$V_{PS}$	Protection supply voltage	5	V

FUNCTIONAL BLOCK DIAGRAM

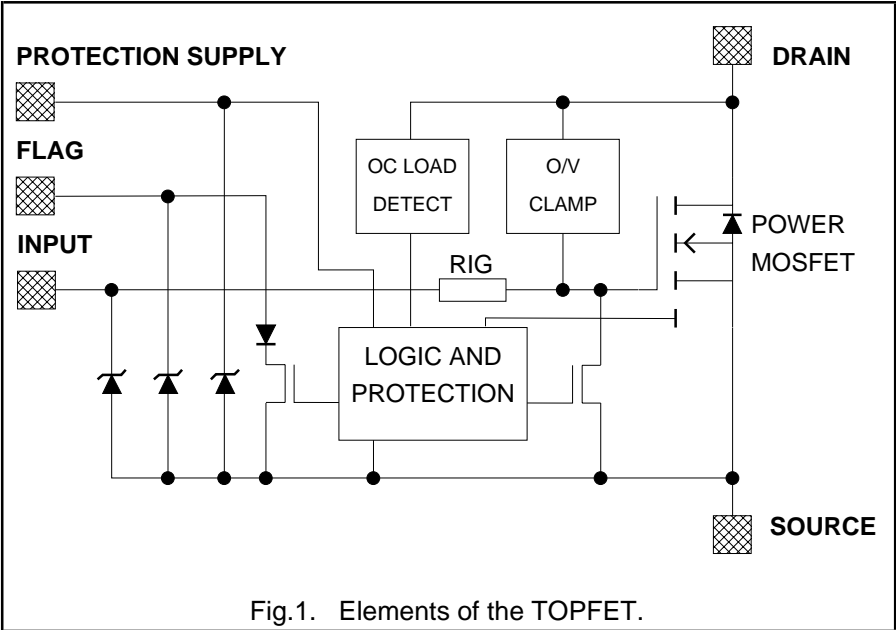
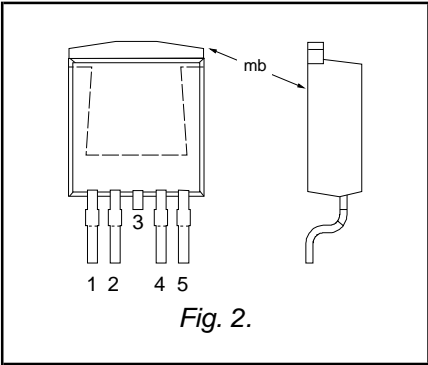


Fig.1. Elements of the TOPFET.

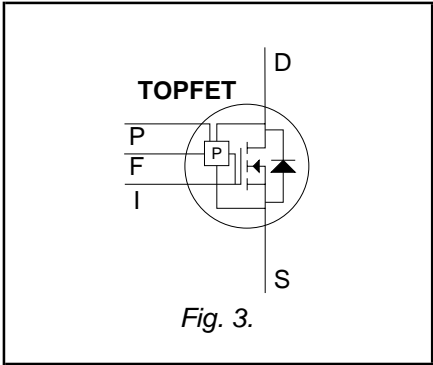
PINNING - SOT426

PIN	DESCRIPTION
1	input
2	flag
3	(connected to mb)
4	protection supply
5	source
mb	drain

PIN CONFIGURATION



SYMBOL



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## LIMITING VALUES

Limiting values in accordance with the Absolute Maximum Rating System (IEC 134)

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{DS}$	<b>Continuous voltage</b> Drain source voltage <sup>1</sup>	$V_{IS} = 0 \text{ V}$	-	50	V
$I_D$	<b>Continuous currents</b> Drain current	$V_{PS} = 5 \text{ V}; T_{mb} = 25^\circ\text{C}$	-	self - limited	A
$I_I$	Input current	$V_{PS} = 0 \text{ V}; T_{mb} = 80^\circ\text{C}$	-	40	A
$I_F$	Flag current		-5	5	mA
$I_P$	Protection supply current		-5	5	mA
$P_{tot}$	<b>Thermal</b> Total power dissipation	$T_{mb} = 25^\circ\text{C}$	-	107	W
$T_{stg}$	Storage temperature		-55	175	$^\circ\text{C}$
$T_J$	Junction temperature <sup>2</sup>	continuous	-	150	$^\circ\text{C}$
$T_{sold}$	Mounting base temperature	during soldering	-	260	$^\circ\text{C}$

## ESD LIMITING VALUE

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_C$	Electrostatic discharge capacitor voltage	Human body model; $C = 250 \text{ pF}; R = 1.5 \text{ k}\Omega$	-	2	kV

## OVERLOAD PROTECTION LIMITING VALUE

With an adequate protection supply connected, TOPFET can protect itself from two types of overload - overtemperature and short circuit load.

For overload conditions an n-MOS transistor turns on between the input and source to quickly discharge the power MOSFET gate capacitance.

The drain current is limited to reduce dissipation in case of short circuit load. Refer to OVERLOAD CHARACTERISTICS.

SYMBOL	PARAMETER	REQUIRED CONDITION	MIN.	MAX.	UNIT
$V_{DS}$	<b>Overload protection<sup>3</sup></b> Drain source voltage	protection supply $V_{PS} \geq 4 \text{ V}$	0	35	V

## OVERVOLTAGE CLAMPING LIMITING VALUES

At a drain source voltage above 50 V the power MOSFET is actively turned on to clamp overvoltage transients.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$E_{DSM}$	<b>Inductive load turn off</b> Non-repetitive clamping energy	$I_{DM} = 25 \text{ A}; V_{DD} \leq 20 \text{ V}$ $T_{mb} = 25^\circ\text{C}$	-	550	mJ
$E_{DRM}$	Repetitive clamping energy	$T_{mb} \leq 95^\circ\text{C}; f = 250 \text{ Hz}$	-	60	mJ

<sup>1</sup> Prior to the onset of overvoltage clamping. For voltages above this value, safe operation is limited by the overvoltage clamping energy.

<sup>2</sup> A higher  $T_J$  is allowed as an overload condition but at the threshold  $T_{J(TO)}$  the over temperature trip operates to protect the switch.

<sup>3</sup> All control logic and protection functions are disabled during conduction of the source drain diode. If the protection circuit was previously latched, it would be reset by this condition.

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### THERMAL CHARACTERISTIC

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$R_{th\ j-mb}$	<b>Thermal resistance</b> Junction to mounting base	-	-	0.94	1.17	K/W

### OUTPUT CHARACTERISTICS

Limits are for  $-40^{\circ}\text{C} \leq T_{mb} \leq 150^{\circ}\text{C}$ ; typicals are for  $T_{mb} = 25^{\circ}\text{C}$  unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{(CL)DSS}$	<b>Off-state</b> Drain-source clamping voltage	$V_{IS} = 0\text{ V}$ $I_D = 10\text{ mA}$	50	-	70	V
$I_{DSS}$	Drain source leakage current <sup>1</sup>	$I_{DM} = 5\text{ A}$ ; $t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.01$ $V_{PS} = 0\text{ V}$ ; $V_{DS} = 40\text{ V}$ $T_{mb} = 25^{\circ}\text{C}$	50 - -	60 - 0.1	70 100 10	V $\mu\text{A}$ $\mu\text{A}$
$R_{DS(ON)}$	<b>On-state</b> Drain-source resistance	$t_p \leq 300\text{ }\mu\text{s}$ ; $\delta \leq 0.01$ ; $V_{PS} \geq 4\text{ V}$ $I_{DM} = 15\text{ A}$ ; $V_{IS} \geq 4.4\text{ V}$ $T_{mb} = 25^{\circ}\text{C}$	- -	- 15	40 20	$\text{m}\Omega$ $\text{m}\Omega$

### INPUT CHARACTERISTICS

Limits are for  $-40^{\circ}\text{C} \leq T_{mb} \leq 150^{\circ}\text{C}$ ; typicals are for  $T_{mb} = 25^{\circ}\text{C}$  unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{IS(TO)}$	<b>Normal operation</b> Input threshold voltage <sup>2</sup>	$I_D = 1\text{ mA}$ $T_{mb} = 25^{\circ}\text{C}$	0.6 1.1	- 1.6	2.6 2.1	V V
$I_{IS}$	Input current	$V_{IS} = 5\text{ V}$	-	16	100	$\mu\text{A}$
$V_{(CL)IS}$	Input clamping voltage	$I_I = 1\text{ mA}$	5.5	6.4	8.5	V
$R_{IG}$	Internal series resistance <sup>3</sup>	to gate of power MOSFET	-	1.7	-	$\text{k}\Omega$
$I_{ISL}$	<b>Overload protection latched</b> Input current	$V_{PS} \geq 4\text{ V}$ $V_{IS} = 5\text{ V}$	1	2.7	4	mA

<sup>1</sup> The drain current required for open circuit load detection is switched off when there is no protection supply, in order to ensure a low off-state quiescent current. Refer to OPEN CIRCUIT LOAD DETECTION CHARACTERISTICS.

<sup>2</sup> The measurement method is simplified if  $V_{PS} = 0\text{ V}$ , in order to distinguish  $I_D$  from  $I_{DSP}$ . Refer to OPEN CIRCUIT LOAD DETECTION CHARACTERISTICS.

<sup>3</sup> This is not a directly measurable parameter.

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### PROTECTION SUPPLY CHARACTERISTICS

Limits are for  $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$ ; typicals are for  $T_{\text{mb}} = 25^{\circ}\text{C}$ .

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{\text{PSF}}$	<b>Protection &amp; detection</b> Threshold voltage <sup>1</sup>	$I_{\text{F}} = 100\ \mu\text{A}$ ; $V_{\text{DS}} = 5\ \text{V}$	2.5	3.45	4	V
$I_{\text{PS}}$ , $I_{\text{PSL}}$	<b>Normal operation or protection latched</b> Supply current	$V_{\text{PS}} = 4.5\ \text{V}$	-	210	450	$\mu\text{A}$
$V_{(\text{CL})\text{PS}}$	Clamping voltage	$I_{\text{P}} = 1.5\ \text{mA}$	5.5	6.5	8.5	V
$V_{\text{PSR}}$ $t_{\text{pr}}$	<b>Overload protection latched</b> Reset voltage Reset time	$V_{\text{PS}} \leq 1\ \text{V}$	1 10	1.8 45	3 120	V $\mu\text{s}$

### OPEN CIRCUIT LOAD DETECTION CHARACTERISTICS

An open circuit load condition can be detected while the TOPFET is in the off-state. Refer to TRUTH TABLE.  $V_{\text{PS}} = 5\ \text{V}$ . Limits are for  $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$  and typicals are for  $T_{\text{mb}} = 25^{\circ}\text{C}$ .

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{\text{DSP}}$	Off-state drain current <sup>2</sup>	$V_{\text{IS}} = 0\ \text{V}$ ; $2\ \text{V} \leq V_{\text{DS}} \leq 40\ \text{V}$	0.9	1.8	2.7	$\text{mA}$
$V_{\text{DSF}}$	Drain threshold voltage <sup>3</sup>	$V_{\text{IS}} = 0\ \text{V}$	0.2	1	2	V
$V_{\text{ISF}}$	Input threshold voltage <sup>4</sup>	$I_{\text{D}} = 100\ \mu\text{A}$	0.3	0.8	1.1	V

### OVERLOAD CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{\text{D}}$ $P_{\text{D(TO)}}$ $T_{\text{DSC}}$	<b>Short circuit load protection</b> Drain current limiting <sup>5</sup> Overload power threshold Characteristic time	$V_{\text{PS}} > 4\ \text{V}$ $V_{\text{IS}} = 5\ \text{V}$ ; $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$ for protection to operate which determines trip time <sup>6</sup>	40 90 250	62 220 500	84 330 700	A W $\mu\text{s}$
$T_{\text{J(TO)}}$	<b>Overtemperature protection</b> Threshold temperature	$V_{\text{PS}} = 5\ \text{V}$ from $I_{\text{D}} \geq 4\ \text{A}$ or $V_{\text{DS}} > 0.2\ \text{V}$	150	170	-	$^{\circ}\text{C}$

<sup>1</sup> When  $V_{\text{PS}}$  is less than  $V_{\text{PSF}}$  the flag pin indicates low protection supply voltage. Refer to TRUTH TABLE.<sup>2</sup> The drain source current which flows in a normal load when the protection supply is high and the input is low.<sup>3</sup> If  $V_{\text{DS}} < V_{\text{DSF}}$  then the flag indicates open circuit load.<sup>4</sup> For open circuit load detection,  $V_{\text{IS}}$  must be less than  $V_{\text{ISF}}$ .<sup>5</sup> Product specification will include curve showing output characteristics.<sup>6</sup> Trip time  $t_{\text{dsc}}$  varies with overload dissipation  $P_{\text{D}}$  according to the formula  $t_{\text{dsc}} \sim T_{\text{DSC}} / \ln[ P_{\text{D}} / P_{\text{D(TO)}} ]$ .

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### TRUTH TABLE

For normal, open-circuit load and overload conditions or inadequate protection supply voltage. Assumes proper external pull-up for flag pin. Refer to FLAG CHARACTERISTICS.

CONDITION	PROTECTION	INPUT	FLAG	OUTPUT
Normal on-state	1	1	0	ON
Normal off-state	1	0	0	OFF
Open circuit load	1	1	0	ON
Open circuit load	1	0	1	OFF
Short circuit load <sup>1</sup>	1	1	1	OFF
Over temperature	1	X	1	OFF
Low protection supply voltage	0	1	1	ON
Low protection supply voltage	0	0	1	OFF

**KEY** '0' equals low  
'1' equals high  
'X' equals don't care.

### FLAG CHARACTERISTICS

The flag is an open drain transistor which requires an external pull-up circuit. Limits are for  $-40^{\circ}\text{C} \leq T_{\text{mb}} \leq 150^{\circ}\text{C}$ ; typicals are for  $T_{\text{mb}} = 25^{\circ}\text{C}$ .

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{\text{FSF}}$	<b>Flag 'low'</b> Flag voltage	normal operation; $V_{\text{PS}} = 5\text{ V}$ $I_{\text{F}} = 100\text{ }\mu\text{A}$	-	0.8	1	V
$I_{\text{FSF}}$	Flag saturation current	$V_{\text{FS}} = 5\text{ V}$	-	10	-	mA
$I_{\text{FSO}}$	<b>Flag 'high'</b> Flag leakage current	overload or fault $V_{\text{FS}} = 5\text{ V}$	-	0.1	10	$\mu\text{A}$
$V_{(\text{CL})\text{FS}}$	Flag clamping voltage	$I_{\text{F}} = 100\text{ }\mu\text{A}$	5.5	6.2	8.5	V
$R_{\text{F}}$	<b>Application information</b> Suitable external pull-up resistance	$V_{\text{FF}} = 5\text{ V}$	-	47	-	k $\Omega$

### SWITCHING CHARACTERISTICS

$T_{\text{mb}} = 25^{\circ}\text{C}$ ;  $R_{\text{I}} = 50\text{ }\Omega$ ;  $R_{\text{IS}} = 50\text{ }\Omega$ ;  $V_{\text{DD}} = 15\text{ V}$ ; resistive load  $R_{\text{L}} = 10\text{ }\Omega$ .

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$t_{\text{don}}$	Turn-on delay time	$V_{\text{IS}}: 0\text{ V} \Rightarrow 5\text{ V}$	-	1.8	5	$\mu\text{s}$
$t_{\text{r}}$	Rise time		-	3.5	8	$\mu\text{s}$
$t_{\text{doff}}$	Turn-off delay time	$V_{\text{IS}}: 5\text{ V} \Rightarrow 0\text{ V}$	-	11	30	$\mu\text{s}$
$t_{\text{f}}$	Fall time		-	5	12	$\mu\text{s}$

<sup>1</sup> In this condition the protection circuit is latched. To reset the latch the protection pin must be taken low. Refer to PROTECTION SUPPLY CHARACTERISTICS.

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MECHANICAL DATA

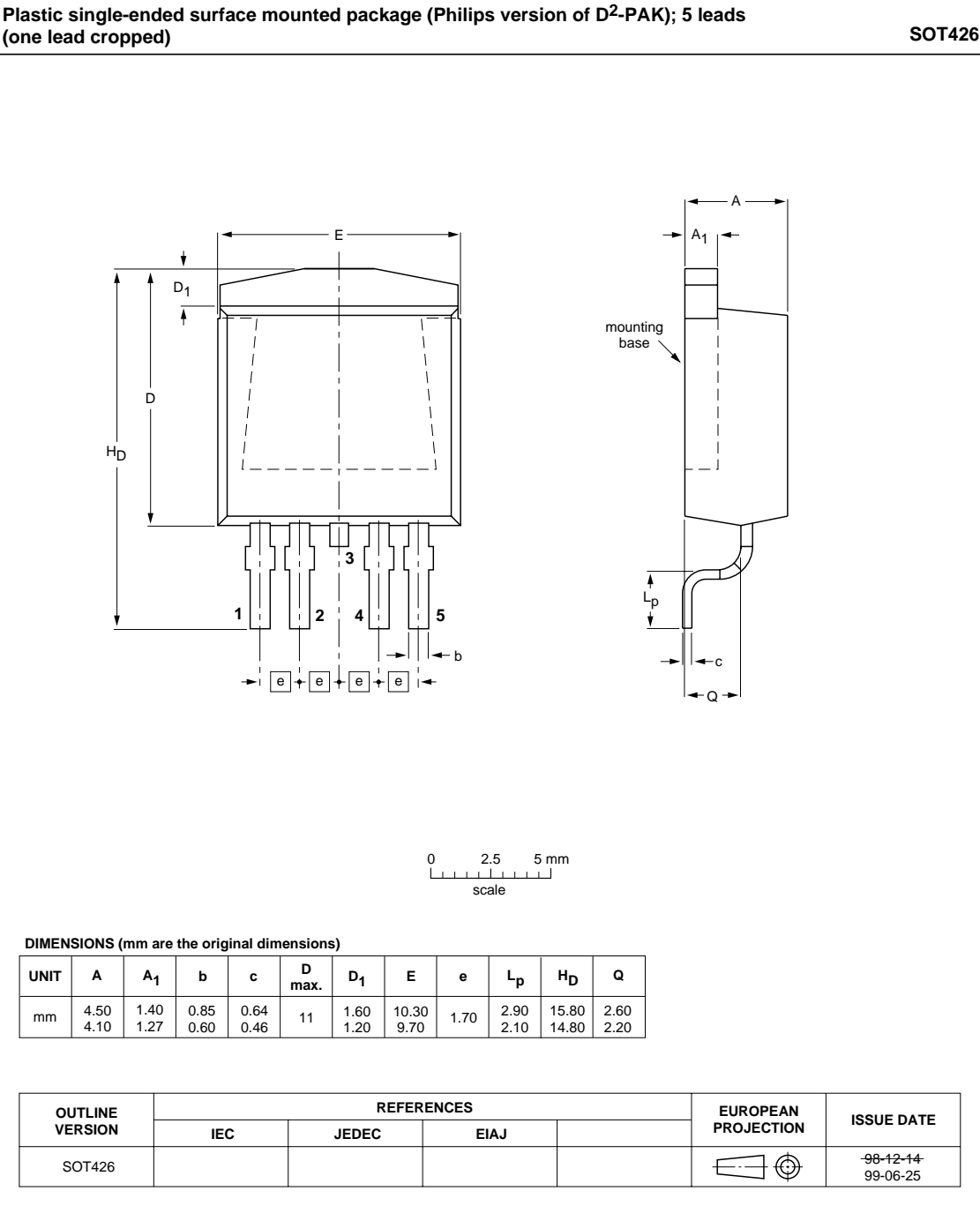


Fig.4. SOT426 surface mounting package<sup>1</sup>, centre pin connected to mounting base.

<sup>1</sup> Epoxy meets UL94 V0 at 1/8". Net mass: 1.5 g.  
For soldering guidelines and SMD footprint design, please refer to Data Handbook SC18.

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## DEFINITIONS

DATA SHEET STATUS		
DATA SHEET STATUS <sup>1</sup>	PRODUCT STATUS <sup>2</sup>	DEFINITIONS
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
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A
<b>Limiting values</b>		
Limiting values are given in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.		
<b>Application information</b>		
Where application information is given, it is advisory and does not form part of the specification.		
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