Logic level TOPFET
TO-220 version of BUK135-50L

BUK124-50L

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.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MAX.	UNIT
V_{DS}	Continuous drain source voltage	50	V
I_D	Continuous drain current	30	A
P_{tot}	Total power dissipation	90	W
T_j	Continuous junction temperature	150	˚C
$R_{DS(ON)}$	Drain-source on-state resistance	28	mΩ
SYMBOL	**PARAMETER**	**NOM.**	**UNIT**
V_{PS}	Protection supply voltage	5	V

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

FUNCTIONAL BLOCK DIAGRAM

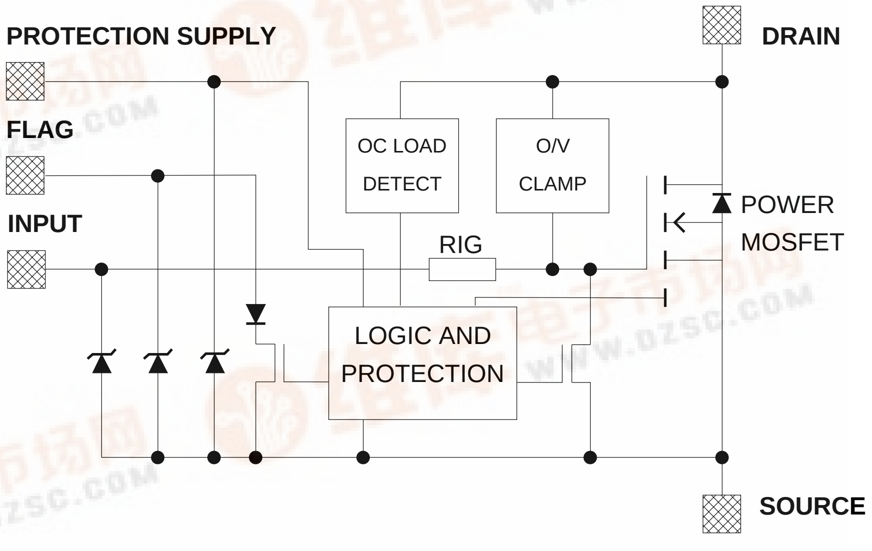

Fig.1. Elements of the TOPFET.

PINNING - SOT263B-01

PIN	DESCRIPTION
1	Input
2	Flag
3	Drain
4	Protection supply
5	Source
tab	Drain

PIN CONFIGURATION

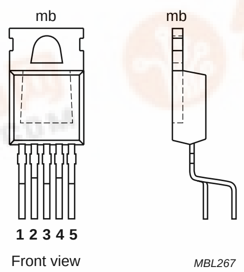

Fig. 2.

SYMBOL

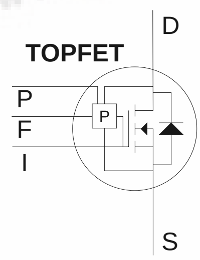

Fig. 3.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
	Continuous voltage				
V_{DS}	Drain source voltage[1]	V_{IS} = 0 V	-	50	V
	Continuous currents				
I_D	Drain current	V_{PS} = 5 V; T_{mb} = 25˚C	-	self - limited	A
		V_{PS} = 0 V; T_{mb} = 85˚C	-	30	A
I_I	Input current		-5	5	mA
I_F	Flag current		-5	5	mA
I_P	Protection supply current		-5	5	mA
	Thermal				
P_{tot}	Total power dissipation	T_{mb} = 25˚C	-	90	W
T_{stg}	Storage temperature		-55	175	˚C
T_j	Junction temperature[2]	continuous	-	150	˚C
T_{sold}	Mounting base temperature	during soldering	-	260	˚C

ESD LIMITING VALUE

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_C	Electrostatic discharge capacitor voltage	Human body model; C = 250 pF; R = 1.5 kΩ	-	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
	Overload protection[3]	protection supply			
V_{DS}	Drain source voltage	V_{PS} ≥ 4 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
	Inductive load turn off	I_{DM} = 20 A; V_{DD} ≤ 20 V			
E_{DSM}	Non-repetitive clamping energy	T_{mb} = 25˚C	-	350	mJ
E_{DRM}	Repetitive clamping energy	T_{mb} ≤ 95˚C; f = 250 Hz	-	45	mJ

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

2 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.

3 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.

THERMAL CHARACTERISTIC

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Thermal resistance					
$R_{th\ j\text{-}mb}$	Junction to mounting base	-	-	1.2	1.39	K/W

OUTPUT CHARACTERISTICS

Limits are for -40˚C ≤ T_{mb} ≤ 150˚C; typicals are for T_{mb} = 25˚C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Off-state	V_{IS} = 0 V				
$V_{(CL)DSS}$	Drain-source clamping voltage	I_D = 10 mA	50	-	70	V
		I_{DM} = 4 A; tp ≤ 300 µs; δ ≤ 0.01	50	60	70	V
I_{DSS}	Drain source leakage current[1]	V_{PS} = 0 V; V_{DS} = 40 V	-	-	100	µA
		T_{mb} = 25˚C	-	0.1	10	µA
	On-state	t_p ≤ 300 µs; δ ≤ 0.01; V_{PS} ≥ 4 V				
$R_{DS(ON)}$	Drain-source resistance	I_{DM} = 10 A; V_{IS} ≥ 4.4 V	-	-	50	mΩ
		T_{mb} = 25˚C	-	21	28	mΩ

INPUT CHARACTERISTICS

Limits are for -40˚C ≤ T_{mb} ≤ 150˚C; typicals are for T_{mb} = 25˚C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Normal operation					
$V_{IS(TO)}$	Input threshold voltage[2]	I_D = 1 mA	0.6	-	2.6	V
		T_{mb} = 25˚C	1.1	1.6	2.1	V
I_{IS}	Input current	V_{IS} = 5 V	-	16	100	µA
$V_{(CL)IS}$	Input clamping voltage	I_I = 1 mA	5.5	6.4	8.5	V
R_{IG}	Internal series resistance[3]	to gate of power MOSFET	-	1.7	-	kΩ
	Overload protection latched	V_{PS} ≥ 4 V				
I_{ISL}	Input current	V_{IS} = 5 V	1	2.7	4	mA

1 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.

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

3 This is not a directly measurable parameter.

PROTECTION SUPPLY CHARACTERISTICS

Limits are for -40˚C ≤ T_{mb} ≤ 150˚C; typicals are for T_{mb} = 25˚C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Protection & detection					
V_{PSF}	Threshold voltage[1]	I_F = 100 µA; V_{DS} = 5 V	2.5	3.45	4	V
	Normal operation or protection latched					
I_{PS}, I_{PSL}	Supply current	V_{PS} = 4.5 V	-	210	450	µA
$V_{(CL)PS}$	Clamping voltage	I_P = 1.5 mA	5.5	6.5	8.5	V
	Overload protection latched					
V_{PSR}	Reset voltage		1	1.8	3	V
t_{pr}	Reset time	V_{PS} ≤ 1 V	10	45	120	µs

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_{PS} = 5 V. Limits are for -40˚C ≤ T_{mb} ≤ 150˚C and typicals are for T_{mb} = 25˚C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{DSP}	Off-state drain current[2]	V_{IS} = 0 V; 2 V ≤ V_{DS} ≤ 40 V	0.9	1.8	2.7	mA
V_{DSF}	Drain threshold voltage[3]	V_{IS} = 0 V	0.2	1	2	V
V_{ISF}	Input threshold voltage[4]	I_D = 100 µA	0.3	0.8	1.1	V

OVERLOAD CHARACTERISTICS

T_{mb} = 25˚C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Short circuit load	V_{PS} > 4 V				
I_D	Drain current limiting	V_{IS} = 5 V; -40˚C ≤ T_{mb} ≤ 150˚C	28.5	44	60	A
	Overload protection	V_{PS} > 4 V				
$P_{D(TO)}$	Overload power threshold	device trips if P_D > $P_{D(TO)}$	75	185	250	W
T_{DSC}	Characteristic time	which determines trip time[5]	250	380	600	µs
	Overtemperature protection	V_{PS} = 5 V				
$T_{j(TO)}$	Threshold temperature	from I_D ≥ 4 A or V_{DS} > 0.2 V	150	170	-	˚C

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

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[1]	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˚C ≤ T_{mb} ≤ 150˚C; typicals are for T_{mb} = 25˚C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Flag 'low'	normal operation; V_{PS} = 5 V				
V_{FSF}	Flag voltage	I_F = 100 µA	-	0.8	1	V
I_{FSF}	Flag saturation current	V_{FS} = 5 V	-	10	-	mA
	Flag 'high'	overload or fault				
I_{FSO}	Flag leakage current	V_{FS} = 5 V	-	0.1	10	µA
$V_{(CL)FS}$	Flag clamping voltage	I_F = 100 µA	5.5	6.2	8.5	V
	Application information					
R_F	Suitable external pull-up resistance	V_{FF} = 5 V	-	47	-	kΩ

SWITCHING CHARACTERISTICS

T_{mb} = 25˚C; R_I = 50 Ω; R_{IS} = 50 Ω; V_{DD} = 15 V; resistive load R_L = 10 Ω.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$t_{d\,on}$	Turn-on delay time	V_{IS}: 0 V ⇒ 5 V	-	1.8	5	µs
t_r	Rise time		-	3.5	8	µs
$t_{d\,off}$	Turn-off delay time	V_{IS}: 5 V ⇒ 0 V	-	11	30	µs
t_f	Fall time		-	5	12	µs

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

CAPACITANCES

T_{mb} = 25 ˚C; f = 1 MHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C_{iss}	Input capacitance	V_{DS} = 25 V; V_{IS} = 0 V	-	710	1050	pF
C_{oss}	Output capacitance	V_{DS} = 25 V; V_{IS} = 0 V	-	370	550	pF
C_{rss}	Reverse transfer capacitance	V_{DS} = 25 V; V_{IS} = 0 V	-	26	40	pF
C_{pso}	Protection supply pin capacitance	V_{PS} = 5 V	-	22	-	pF
C_{fso}	Flag pin capacitance	V_{FS} = 5 V; V_{PS} = 0 V	-	12	-	pF

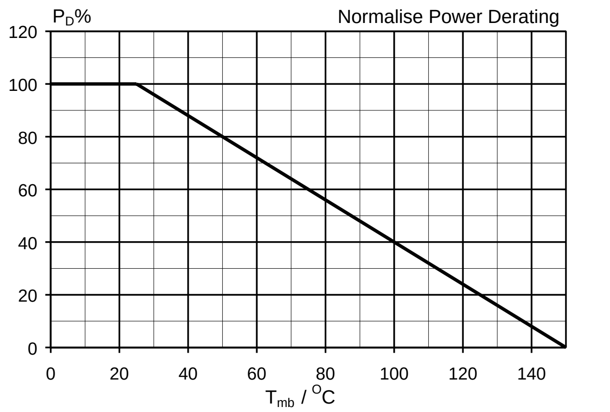

Fig.4. Normalised limiting power dissipation. $P_D\% = 100 \cdot P_D/P_D(25˚C) = f(T_{mb})$

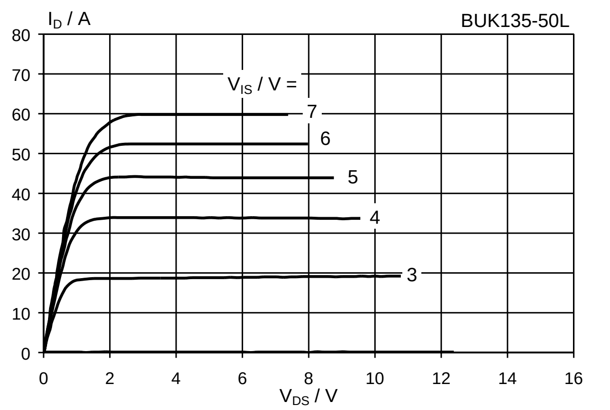

Fig.6. Typical output characteristics, T_j = 25˚C. $I_D = f(V_{DS})$; parameter V_{IS}; t_p = 300 µs & $t_p < t_{d\ sc}$

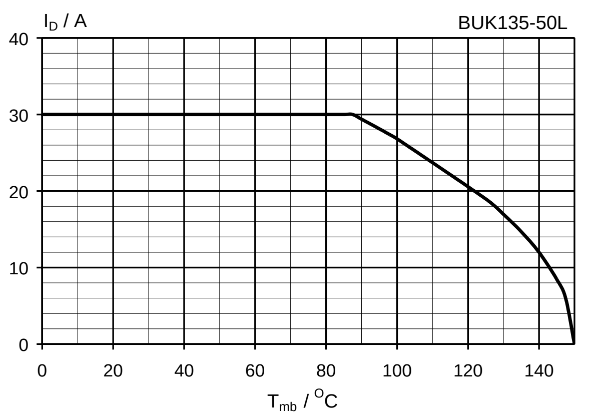

Fig.5. Continuous drain current. $I_D = f(T_{amb})$; condition: V_{IS} = 5 V

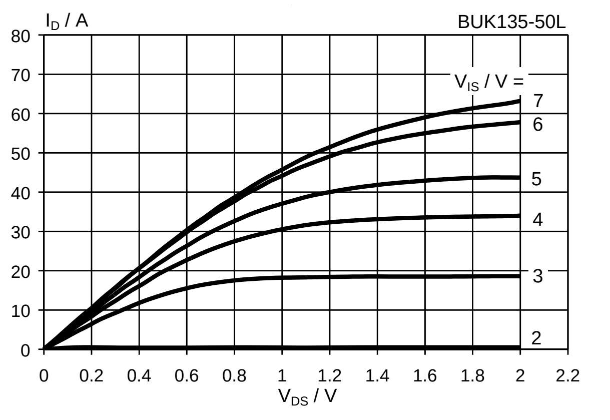

Fig.7. Typical on-state characteristics, T_j = 25˚C. $I_D = f(V_{DS})$; parameter V_{IS}; t_p = 300 µs

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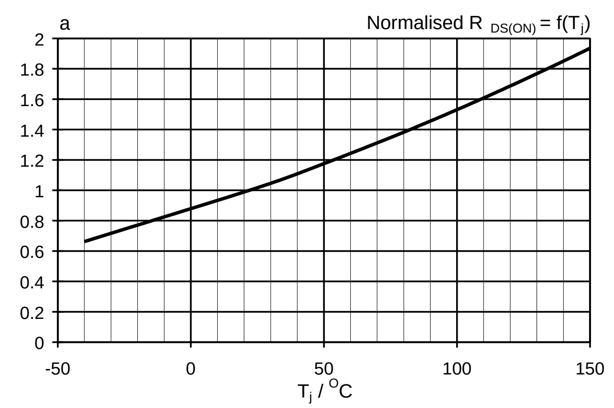

Fig.8. Normalised drain-source on-state resistance. $a = R_{DS(ON)}/R_{DS(ON)}25^{\circ}C = f(T_j)$; $I_D = 10\ A$; $V_{IS} = 4.4\ V$

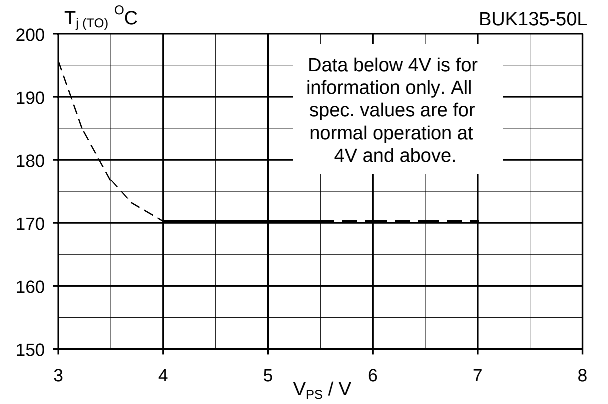

Fig.11. Typical overtemperature protection threshold. $T_{j(TO)} = f(V_{PS})$; conditions: $V_{IS} = 5\ V$

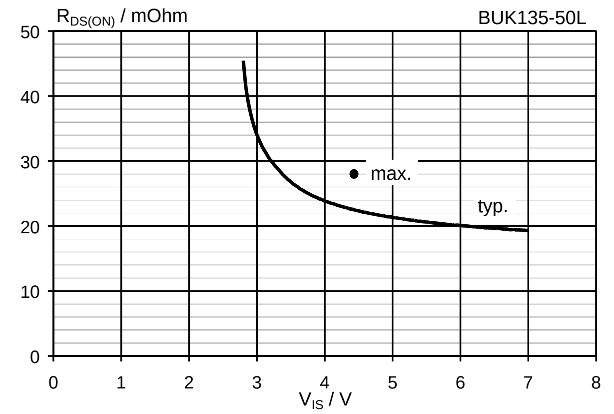

Fig.9. Typical on-state resistance, $T_j = 25^{\circ}C$. $R_{DS(ON)} = f(V_{IS})$; conditions: $I_D = 10\ A$; $V_{PS} = 4\ V$; $t_p = 300\ \mu s$

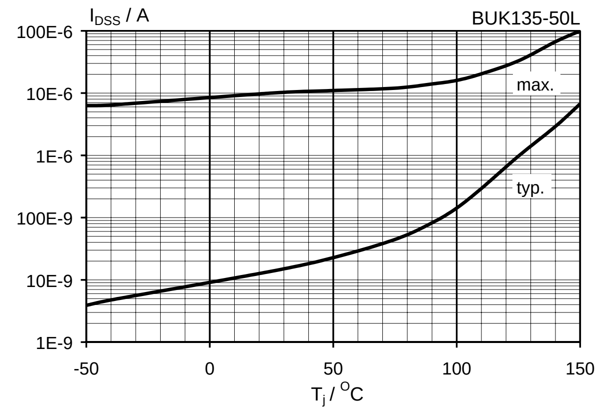

Fig.12. Typical drain source leakage current. $I_{DSS} = f(T_j)$; conditions: $V_{DS} = 40\ V$; $V_{PS} = V_{IS} = 0\ V$

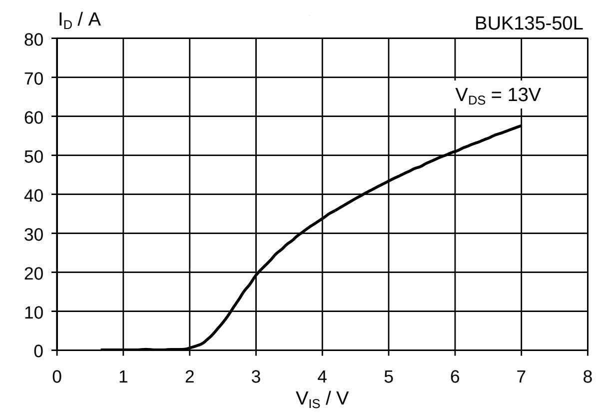

Fig.10. Typical transfer characteristics, $T_j = 25^{\circ}C$. $I_D = f(V_{IS})$; conditions: $V_{PS} \geq 4\ V$ $t_p = 300\ \mu s$

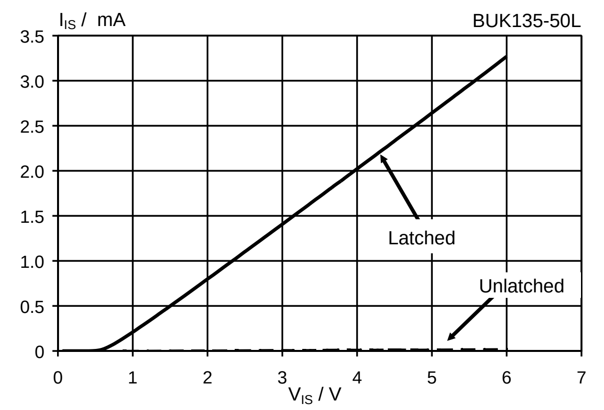

Fig.13. Typical DC input characteristics, $T_j = 25^{\circ}C$. I_{IS} & $I_{ISL} = f(V_{IS})$; normal operation & protection latched

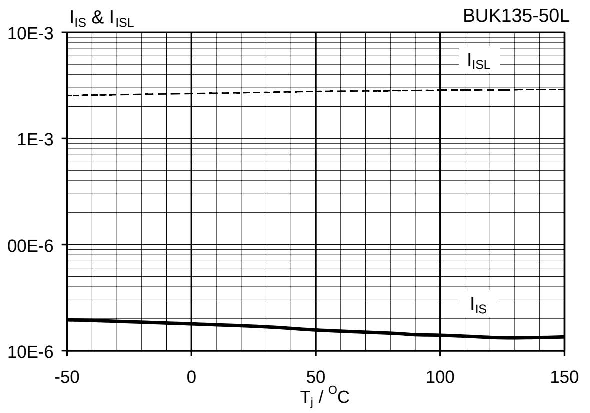

Fig.14. Typical DC input currents. I_{IS} & I_{ISL} = f(T_j); normal & latched; conditions: V_{IS} = 5 V; V_{PS} = 5 V

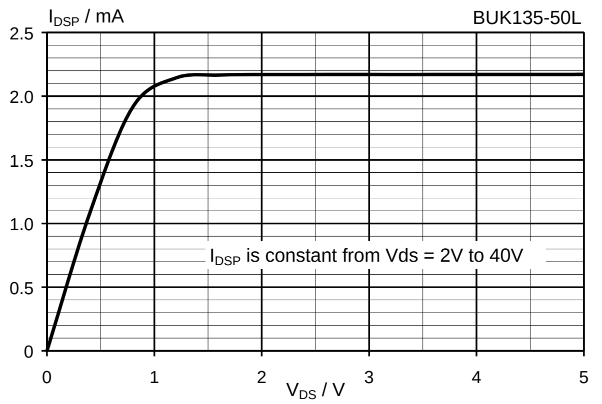

Fig.17. Off state drain current characteristic. I_{DSP} = f(V_{DS}); conditions: T_j = 25˚C; V_{PS} = 5 V; V_{IS} = 0 V

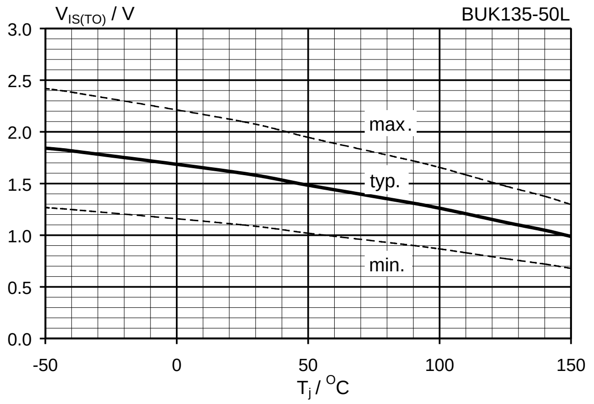

Fig.15. Input threshold voltage. $V_{IS(TO)}$ = f(T_j); conditions: I_D = 1 mA; V_{DS} = 5 V

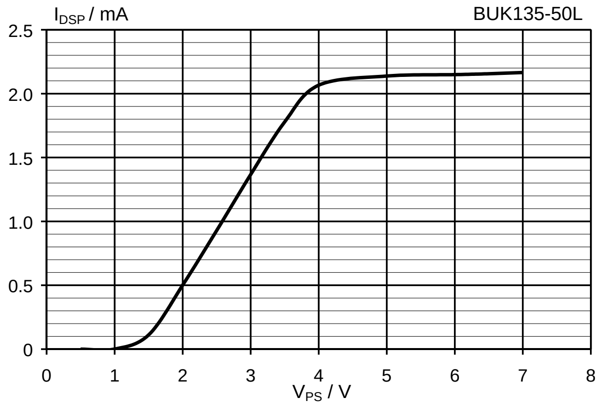

Fig.18. Off state drain current vs protection supply. I_{DSP} = f(V_{PS}); T_j = 25˚C; V_{DS} = 13 V; V_{IS} = 0 V

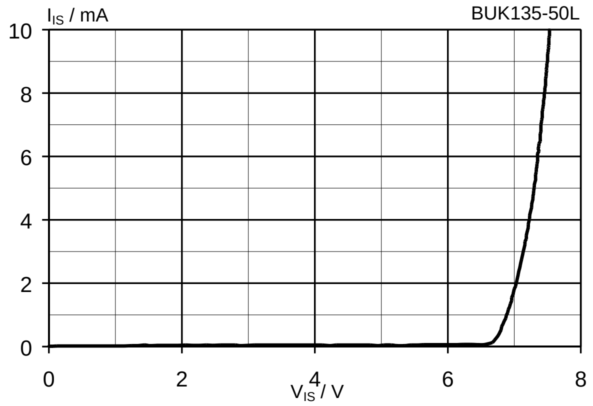

Fig.16. Typical input clamping characteristic. I_I = f(V_{IS}); normal operation, T_j = 25˚C

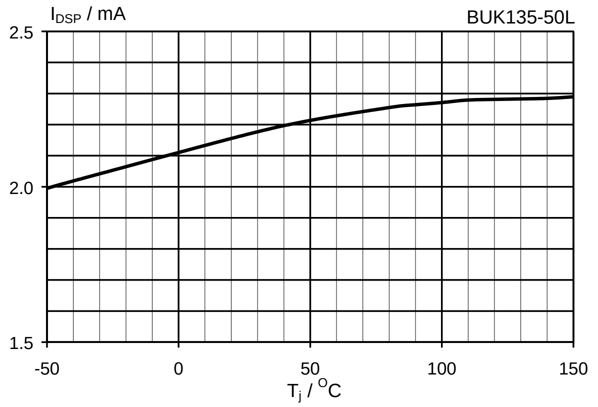

Fig.19. Typical off state drain current I_{DSP} = f(T_j); conditions: V_{DS} = 13 V; V_{PS} = 5 V; V_{IS} = 0 V

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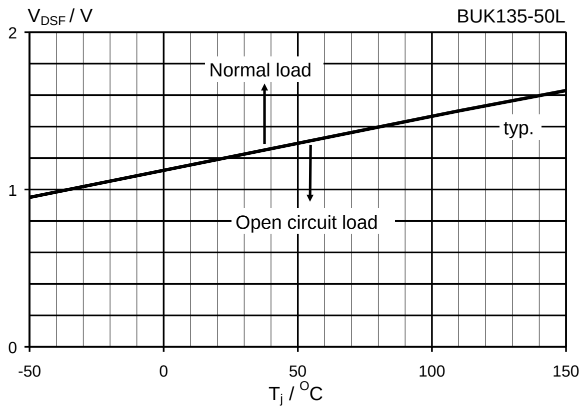


Fig.20. Open circuit detection threshold voltage.
$V_{DSF} = f(T_j)$; $V_{PS} \geq 4$ V ; $V_{IS} = 0$ V

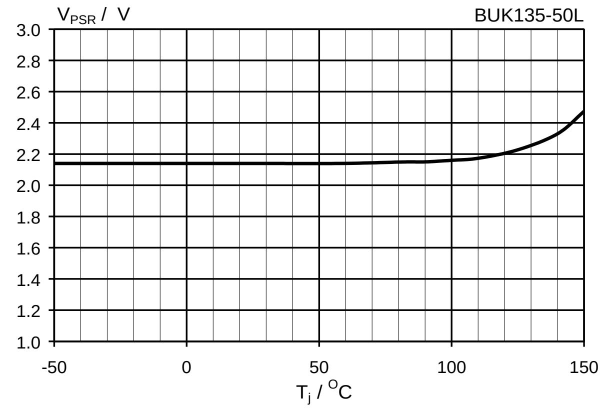


Fig.23. Typical protection reset voltage.
$V_{PSR} = f(T_j)$; $t_{lr} = 100$ µs

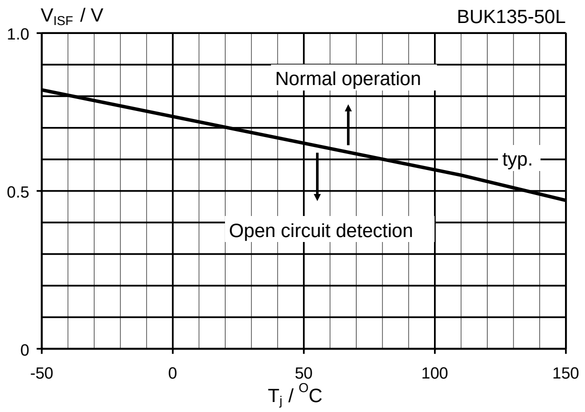


Fig.21. Open circuit input threshold voltage.
$V_{ISF} = f(T_j)$; $V_{PS} \geq 4$ V ; $I_D = 100$ µA

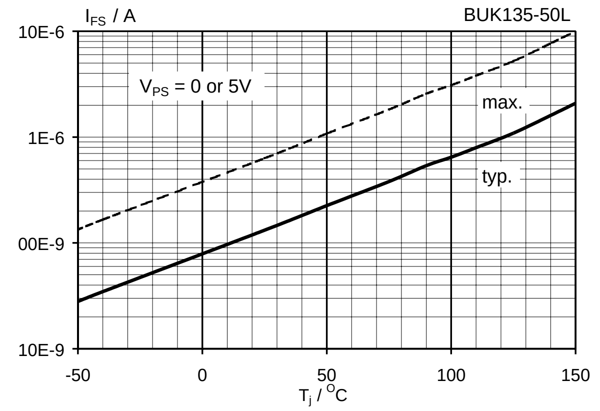


Fig.24. Typical flag characteristics. $I_{FS} = f(T_j)$;
fault & overload operation; $V_{IS} = 5$ V; $V_{FS} = 5$ V

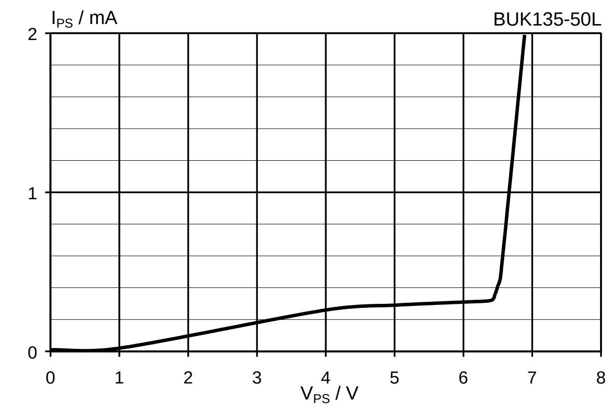


Fig.22. Typical DC protection supply characteristics.
$I_{PS} = f(V_{PS})$; normal or overload operation; $T_j = 25$ ˚C

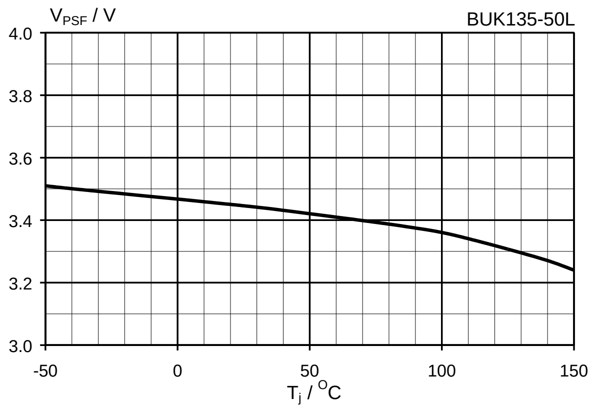


Fig.25. Typical protection threshold voltage.
$V_{PSF} = f(T_j)$; $V_{DS} = 5$ V ; $I_F = 100$ µA

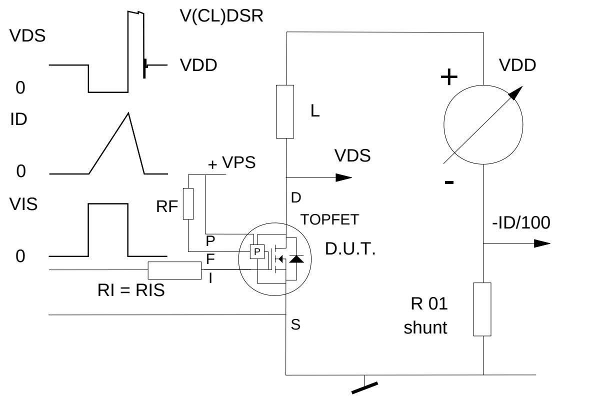


Fig.26. Clamping energy test circuit, R_{IS} = 100 Ω.
$E_{DSM} = 0.5 \cdot LI_D^2 \cdot V_{(CL)DSR}/(V_{(CL)DSR} - V_{DD})$

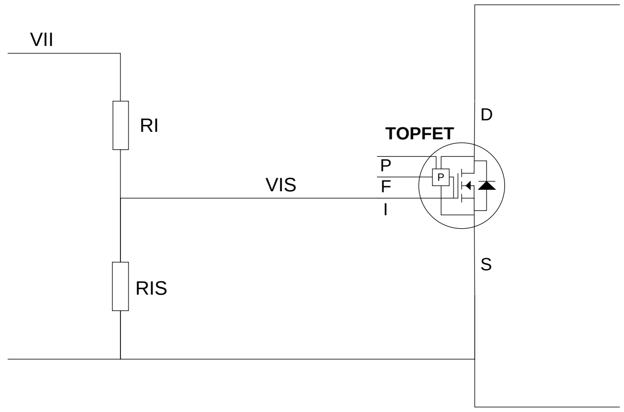


Fig.29. Test circuit for resistive load switching times. V_{IS} = 5 V

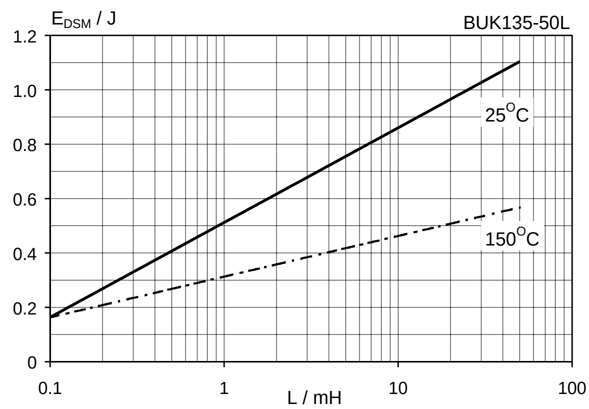


Fig.27. Typical non-repetitive clamping energy. E_{DSM} = f(L); conditions: V_{IS} = 0 V

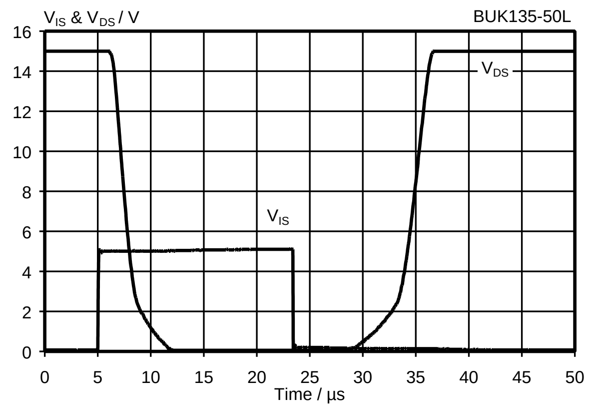


Fig.30. Typical switching waveforms, resistive load. R_L = 10 Ω; adjust V_{DD} to obtain I_D = 1.5 A; T_j = 25˚C

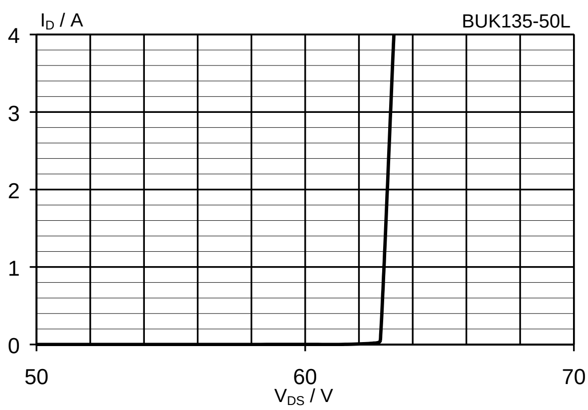


Fig.28. Typical clamping characteristic, 25˚C. $I_D = f(V_{DS})$; conditions: V_{IS} = 0 V; $t_p \leq 300$ µs

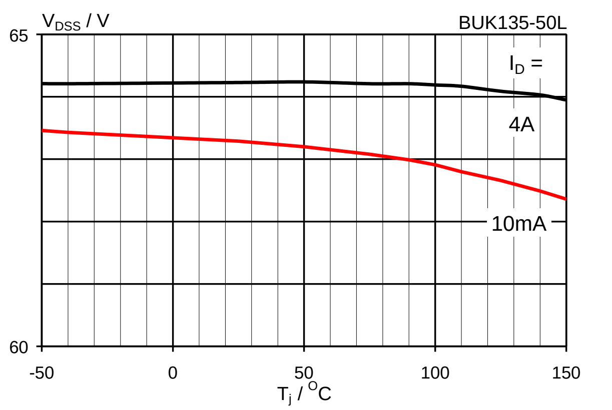


Fig.31. Overvoltage clamping characteristic. $V_{DS} = f(T_j)$; conditions: V_{IS} = 0 V; $t_p \leq 300$ µs

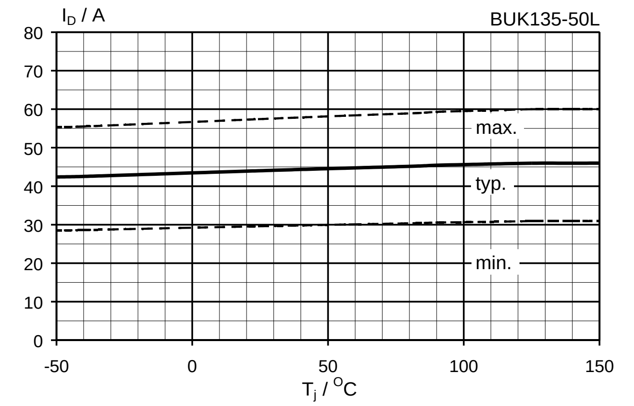


Fig.32. Typical overload current, V_{DS} = 5 V.
$I_D = f(T_j)$; conditions: V_{IS} = 5 V; V_{PS} = 4 V; t_p = 300 µs

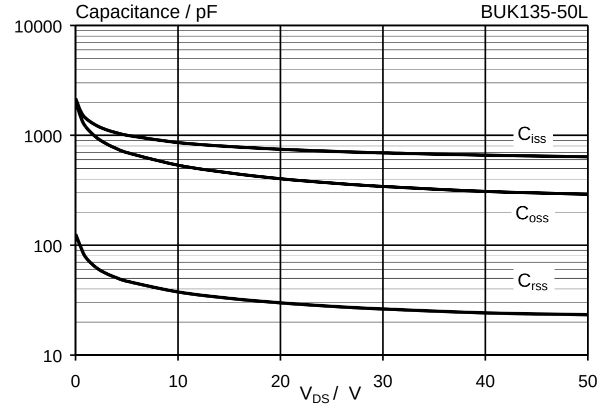


Fig.34. Typical capacitances, C_{iss}, C_{oss}, C_{rss}.
$C = f(V_{DS})$; conditions: V_{IS} = 0 V; f = 1 MHz

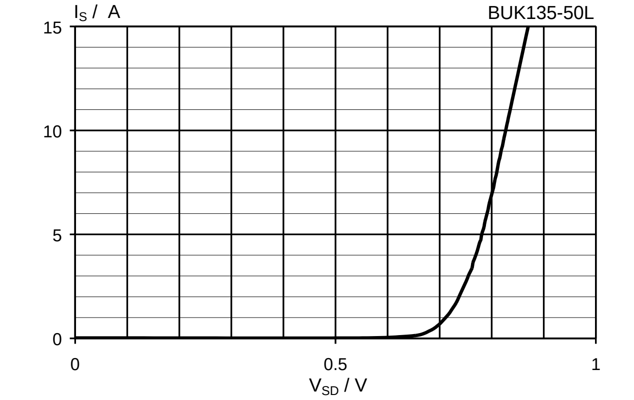


Fig.33. Typical reverse diode current, T_j = 25 ˚C.
$I_S = f(V_{SDS})$; conditions: V_{IS} = 0 V; t_p = 300 µs

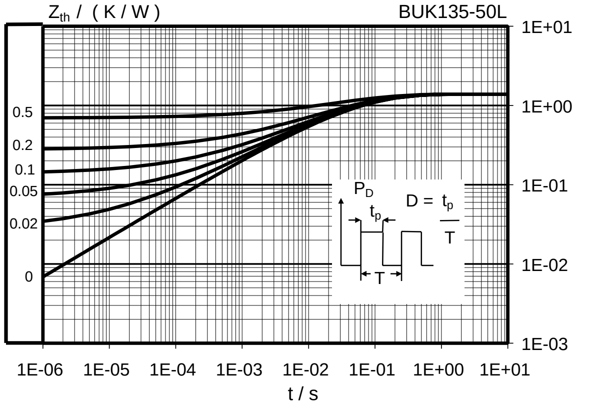
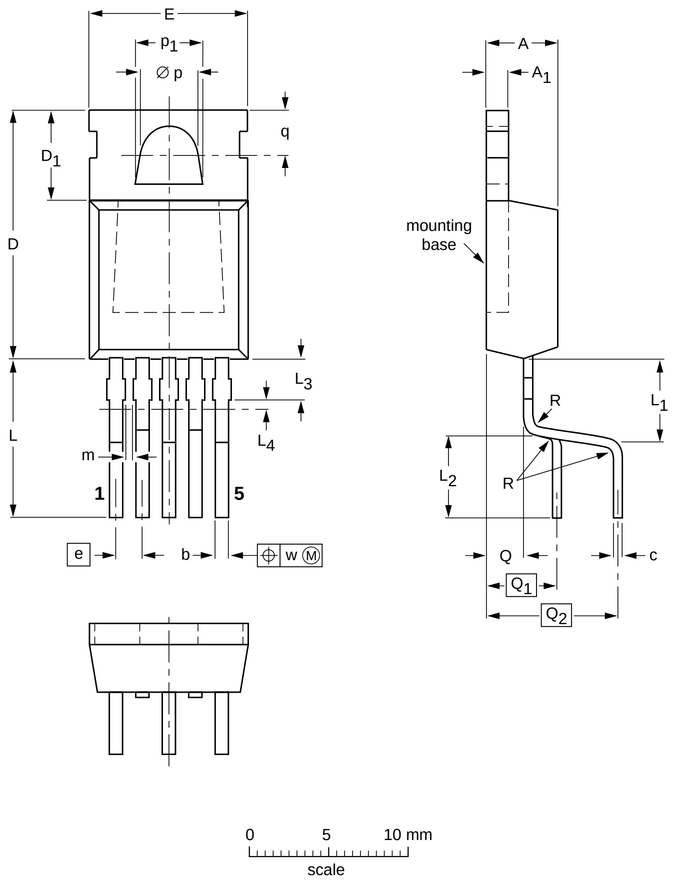


Fig.35. Transient thermal impedance.
$Z_{th\ j\text{-}mb} = f(t)$; parameter $D = t_p/T$

MECHANICAL DATA

Plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220 lead form option **SOT263B-01**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b	c	D	D_1	E	e	L	L_1	L_2	$L_3^{(1)}$	$L_4^{(2)}$ max.	m	∅ p	p_1	q	Q	Q_1	Q_2	R	w
mm	4.5 4.1	1.39 1.27	0.85 0.70	0.7 0.4	15.8 15.2	6.4 5.9	10.3 9.7	1.7	9.8 9.7	5.9 5.3	5.2 5.0	2.4 1.6	0.5	0.8 0.6	3.8 3.6	4.3 4.1	3.0 2.7	2.0	4.5	8.2	0.5	0.4

Notes

1. Terminal dimensions are uncontrolled in this zone.
2. Positional accuracy of the terminals is controlled in this zone.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT263B-01		5-lead (option) TO-220				01-01-11

Fig.36. SOT263B package[1] leadform 263B-01, pin 3 connected to mounting base.

1 Refer to mounting instructions for TO220 envelopes. Epoxy meets UL94 VO at 1/8". Net mass: 2 g

DEFINITIONS

DATA SHEET STATUS		
DATA SHEET STATUS[1]	**PRODUCT STATUS**[2]	**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
Limiting values		
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.		
Application information		
Where application information is given, it is advisory and does not form part of the specification.		
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2 The product status of the device(s) described in this datasheet may have changed since this datasheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.