PowerMOS transistor TOPFET high side switch

BUK203-50X

DESCRIPTION

Monolithic temperature and overload protected power switch based on MOSFET technology in a 5 pin plastic envelope, configured as a single high side switch.

APPLICATIONS

General controller for driving lamps, motors, solenoids, heaters.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	UNIT
I_L	Nominal load current (ISO)	1.6	A
SYMBOL	**PARAMETER**	**MAX.**	**UNIT**
V_{BG}	Continuous off-state supply voltage	50	V
I_L	Continuous load current	4	A
T_j	Continuous junction temperature	150	˚C
R_{ON}	On-state resistance	220	mΩ

FEATURES

- Vertical power DMOS switch
- Low on-state resistance
- 5 V logic compatible input with hysteresis
- Overtemperature protection - self resets with hysteresis
- Overload protection against short circuit load with output current limiting; latched - reset by input
- High supply voltage load protection
- Supply undervoltage lock out
- Status indication for overload protection activated
- Diagnostic status indication of open circuit load
- Very low quiescent current
- Voltage clamping for turn off of inductive loads
- ESD protection on all pins
- Reverse battery and overvoltage protection with external ground resistor

FUNCTIONAL BLOCK DIAGRAM

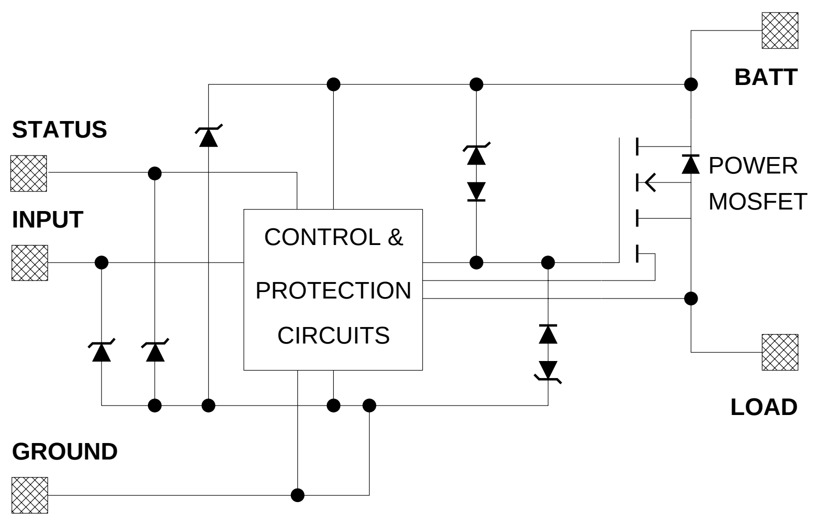


Fig.1. Elements of the TOPFET HSS.

PINNING - SOT263

PIN	DESCRIPTION
1	**G**round
2	**I**nput
3	**B**attery (+ve supply)
4	**S**tatus
5	**L**oad
tab	connected to pin 3

PIN CONFIGURATION

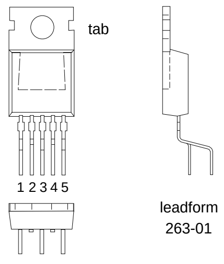


Fig. 2.

SYMBOL

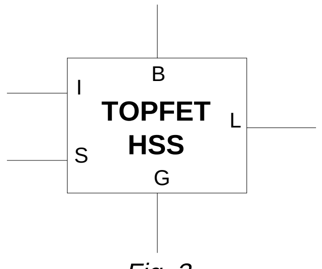


Fig. 3.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
	Battery voltages				
V_{BG}	Continuous off-state supply voltage	-	0	50	V
	Reverse battery voltages[1]	External resistors:			
$-V_{BG}$	Repetitive peak supply voltage	$R_G \geq 150\ \Omega$; $R_I = R_S \geq 4.7\ k\Omega$, $\delta \leq 0.1$	-	32	V
$-V_{BG}$	Continuous reverse supply voltage	$R_G \geq 150\ \Omega$; $R_I = R_S \geq 4.7\ k\Omega$	-	16	V
I_L	Continuous load current	$T_{mb} \leq 110\ ˚C$	-	4	A
P_D	Total power dissipation	$T_{mb} \leq 25\ ˚C$	-	50	W
T_{stg}	Storage temperature	-	-55	175	˚C
T_j	Continuous junction temperature[2]	-	-	150	˚C
T_{sold}	Lead temperature	during soldering	-	250	˚C
	Input and status				
I_I	Continuous input current	-	-5	5	mA
I_S	Continuous status current	-	-5	5	mA
I_I	Repetitive peak input current	$\delta \leq 0.1$	-20	20	mA
I_S	Repetitive peak status current	$\delta \leq 0.1$	-20	20	mA
	Inductive load clamping				
E_{BL}	Non-repetitive clamping energy	T_{mb} = 150 ˚C prior to turn-off	-	1.4	J

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

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Thermal resistance[3]					
$R_{th\ j\text{-}mb}$	Junction to mounting base	-	-	2	2.5	K/W
$R_{th\ j\text{-}a}$	Junction to ambient	in free air	-	60	75	K/W

1 Reverse battery voltage is allowed only with external input and status resistors to limit the currents to a safe value.

2 For normal continuous operation. 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 Of the output Power MOS transistor.

STATIC CHARACTERISTICS

T_{mb} = 25 ˚C unless otherwise stated

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Clamping voltages					
V_{BG}	Battery to ground	I_G = 1 mA	50	55	65	V
V_{BL}	Battery to load	$I_L = I_G$ = 1 mA	50	55	65	V
$-V_{LG}$	Negative load to ground	I_L = 1 mA	12	17	21	V
	Supply voltage	battery to ground				
V_{BG}	Operating range[1]	-	5	-	40	V
	Currents	V_{BG} = 13 V				
I_L	Nominal load current[2]	V_{BL} = 0.5 V; T_{mb} = 85 ˚C	1.6	-	-	A
I_B	Quiescent current[3]	V_{IG} = 0 V; V_{LG} = 0 V	-	0.1	2	µA
I_G	Operating current[4]	V_{IG} = 5 V; I_L = 0 A	1.5	2.2	4	mA
I_L	Off-state load current[5]	V_{BL} = 13 V; V_{IG} = 0 V	-	0.1	1	µA
	Resistances					
R_{ON}	On-state resistance[6]	V_{BG} = 13 V; I_L = 2 A; t_p = 300 µs	-	160	220	mΩ
R_{ON}	On-state resistance	V_{BG} = 5 V; I_L = 0.5 A; t_p = 300 µs	-	225	320	mΩ

INPUT CHARACTERISTICS

T_{mb} = 25 ˚C; V_{BG} = 13 V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_I	Input current	V_{IG} = 5 V	35	60	100	µA
V_{IG}	Input clamping voltage	I_I = 200 µA	6	7	8	V
$V_{IG(ON)}$	Input turn-on threshold voltage		-	2.1	2.4	V
$V_{IG(OFF)}$	Input turn-off threshold voltage		1.5	1.7	-	V
ΔV_{IG}	Input turn-on hysteresis		-	0.4	-	V

1 On-state resistance is increased if the supply voltage is less than 9 V. Refer to figure 8.

2 Defined as in ISO 10483-1.

3 This is the continuous current drawn from the battery when the input is low and includes leakage current to the load.

4 This is the continuous current drawn from the battery with no load connected, but with the input high.

5 The measured current is in the load pin only.

6 The supply and input voltage for the R_{ON} tests are continuous. The specified pulse duration t_p refers only to the applied load current.

PROTECTION FUNCTIONS AND STATUS INDICATIONS

Truth table for normal, open-circuit load and overload conditions and abnormal supply voltages.

FUNCTIONS		TRUTH TABLE			THRESHOLD			
SYMBOL	**CONDITION**	**INPUT**	**STATUS**	**OUTPUT**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
	Normal on-state	1	1	1				
	Normal off-state	0	1	0				
$I_{L(OC)}$	Open circuit load[1]	1	0	1	30	90	150	mA
	Open circuit load	0	1	0				
$T_{j(TO)}$	Over temperature[2]	1	0	0	150	175	-	˚C
	Over temperature[3]	0	0	0				
$V_{BL(TO)}$	Short circuit load[4]	1	0	0	9	10.5	12	V
	Short circuit load	0	1	0				
$V_{BG(TO)}$	Low supply voltage[5]	X	1	0	3	4	5	V
$V_{BG(LP)}$	High supply voltage[6]	X	1	0	40	45	50	V

For input ‘0’ equals low, ‘1’ equals high, ‘X’ equals don’t care.
For status ‘0’ equals low, ‘1’ equals open or high.
For output switch ‘0’ equals off, ‘1’ equals on.

STATUS CHARACTERISTICS

T_{mb} = 25 ˚C.
The status output is an open drain transistor, and requires an external pull-up circuit to indicate a logic high.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{SG}	Status clamping voltage	I_S = 100 µA	6	7	8	V
V_{SG}	Status low voltage	I_S = 50 µA; V_{BG} = 13 V	-	0.7	0.8	V
I_S	Status leakage current	V_{SG} = 5 V	-	0.1	1	µA
I_S	Status saturation current[7]	V_{SS} = 5 V; R_S = 0 Ω; V_{BG} = 13 V	-	9	-	mA
	Application information					
R_S	External pull-up resistor[8]	V_{SS} = 5 V	-	100	-	kΩ

1 In the on-state, the switch detects whether the load current is less than the quoted open load threshold current. This is for status indication only. Typical hysteresis equals 25 mA. The thresholds are specified for supply voltage within the normal working range.

2 After cooling below the reset temperature the switch will resume normal operation. The reset temperature is lower than the trip temperature by typically 10 ˚C.

3 If the overtemperature protection has operated, status remains low to indicate the overtemperature condition even if the input is taken low, providing the device has not cooled below the reset temperature.

4 After short circuit protection has operated, the input voltage must be toggled low for the switch to resume normal operation.

5 Undervoltage sensor causes the device to switch off. Typical hysteresis equals 0.5 V.

6 Overvoltage sensor causes the device to switch off to protect the load. Typical hysteresis equals 1.1 V.

7 In a fault condition with the pull-up resistor short circuited while the status transistor is conducting.

8 The pull-up resistor also protects the status pin during reverse battery conditions.

DYNAMIC CHARACTERISTICS

T_{mb} = 25 ˚C; V_{BG} = 13 V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Inductive load turn-off					
$-V_{LG}$	Negative load voltage[1]	V_{IG} = 0 V; I_L = 2 A; t_p = 300 µs	15	20	25	V
	Short circuit load protection[2]	V_{IG} = 5 V; $R_L \leq$ 10 mΩ				
$t_{d\ sc}$	Response time	V_{IG} = 5 V	-	75	-	µs
I_L	Load current prior to turn-off	$t < t_{d\ sc}$	-	17	-	A
	Overload protection[3]					
$I_{L(lim)}$	Load current limiting	V_{BL} = 9 V; t_p = 300 µs	12	15	22	A

SWITCHING CHARACTERISTICS

T_{mb} = 25 ˚C, V_{BG} = 13 V, for resistive load R_L = 13 Ω.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	During turn-on	to V_{IG} = 5 V				
$t_{d\ on}$	Delay time	to 10% V_L	-	16	-	µs
dV/dt_{on}	Rate of rise of load voltage		-	1.3	3	V/µs
t_{on}	Total switching time	to 90% V_L	-	40	-	µs
	During turn-off	to V_{IG} = 0 V				
$t_{d\ off}$	Delay time	to 90% V_L	-	20	-	µs
dV/dt_{off}	Rate of fall of load voltage		-	1.6	3	V/µs
t_{off}	Total switching time	to 10% V_L	-	35	-	µs

CAPACITANCES

T_{mb} = 25 ˚C; f = 1 MHz; V_{IG} = 0 V

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C_{ig}	Input capacitance	V_{BG} = 13 V	-	15	20	pF
C_{bl}	Output capacitance	$V_{BL} = V_{BG}$ = 13 V	-	120	170	pF
C_{sg}	Status capacitance	V_{SG} = 5 V	-	11	15	pF

1 For a high side switch, the load pin voltage goes negative with respect to ground during the turn-off of an inductive load. This negative voltage is clamped by the device.

2 The load current is self-limited during the response time for short circuit load protection. Response time is measured from when input goes high.

3 If the load resistance is low, but not a complete short circuit, such that the on-state voltage remains less than $V_{BL(TO)}$, the device remains in current limiting until the overtemperature protection operates.

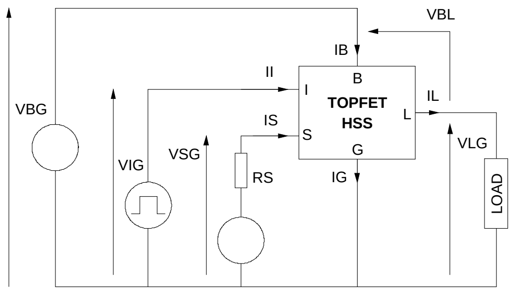


Fig.4. High side switch measurements schematic. (current and voltage conventions)

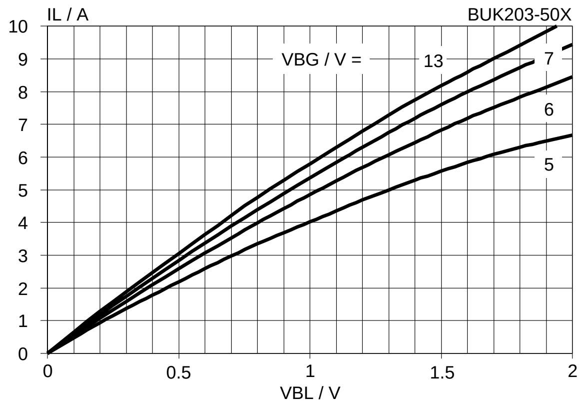


Fig.7. Typical on-state characteristics, T_j = 25 ˚C. $I_L = f(V_{BL})$; parameter V_{BG}; t_p = 250 µs

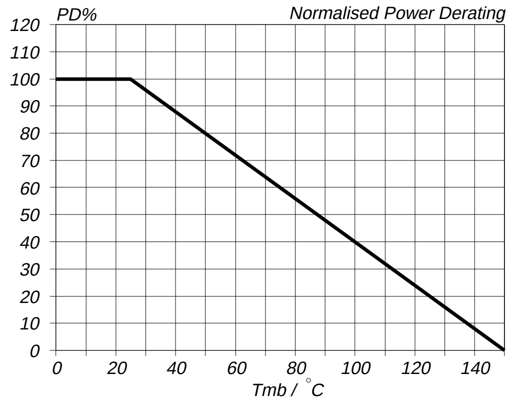


Fig.5. Normalised limiting power dissipation. $P_D\% = 100 \cdot P_D/P_D(25\ ˚C) = f(T_{mb})$

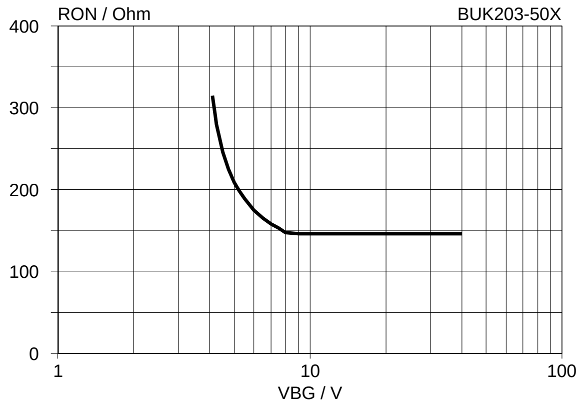


Fig.8. Typical on-state resistance, T_j = 25 ˚C. $R_{ON} = f(V_{BG})$; conditions: I_L = 2 A; t_p = 300 µs

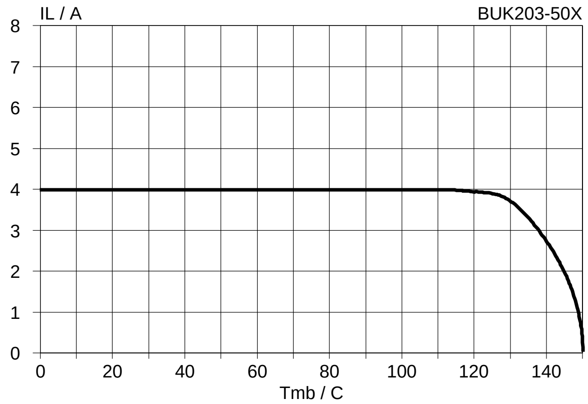


Fig.6. Limiting continuous on-state load current. $I_L = f(T_{mb})$; conditions: V_{IG} = 5 V, V_{BG} = 13 V

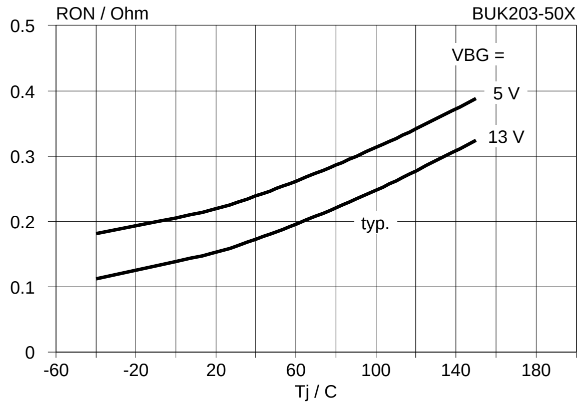


Fig.9. Typical on-state resistance, t_p = 300 µs. $R_{ON} = f(T_j)$; parameter V_{BG}; condition I_L = 0.5 A

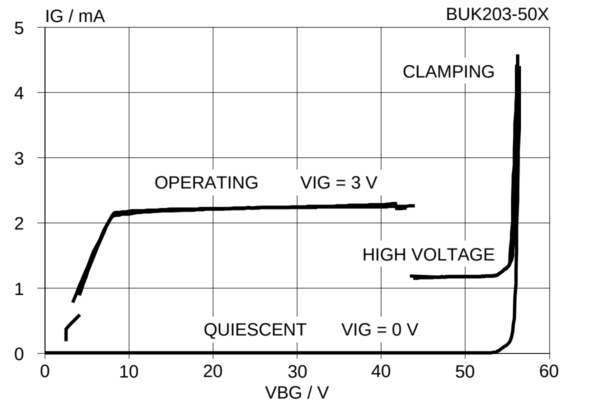


Fig.10. Typical supply characteristics, 25 ˚C.
$I_G = f(V_{BG})$; parameter V_{IG}

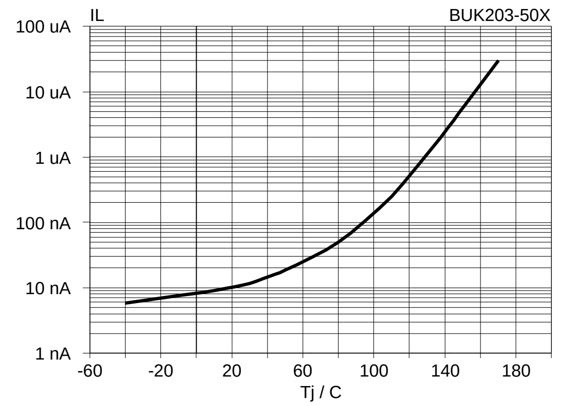


Fig.13. Typical off-state leakage current.
$I_L = f(T_j)$; conditions: $V_{BL} = 13\ V = V_{BG}$; $V_{IG} = 0\ V$.

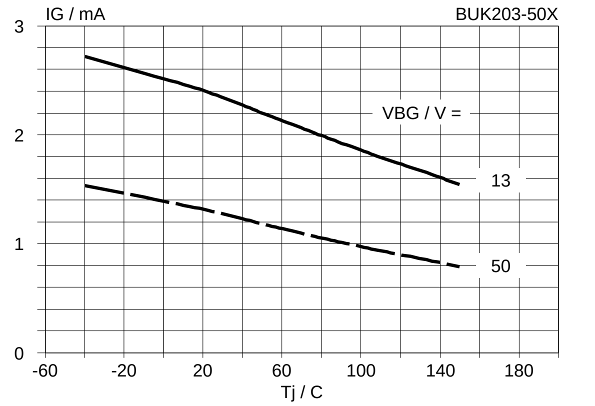


Fig.11. Typical operating supply current.
$I_G = f(T_j)$; parameter V_{BG}; condition $V_{IG} = 5\ V$

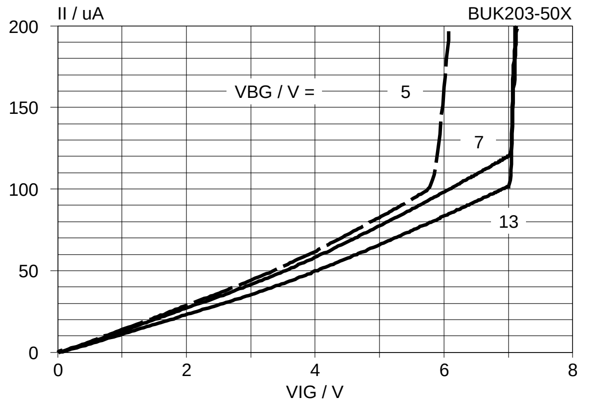


Fig.14. Typical input characteristics, $T_j = 25$ ˚C.
$I_I = f(V_{IG})$; parameter V_{BG}

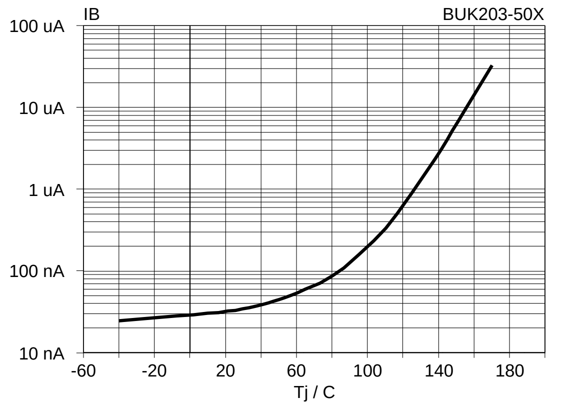


Fig.12. Typical supply quiescent current.
$I_B = f(T_j)$; condition $V_{BG} = 13\ V$, $V_{IG} = 0\ V$, $V_{LG} = 0\ V$

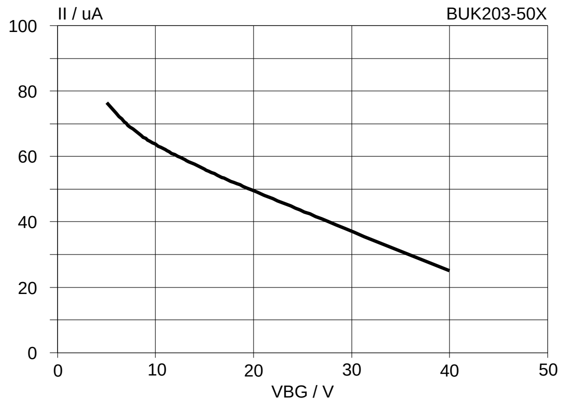


Fig.15. Typical input current, $T_j = 25$ ˚C.
$I_I = f(V_{BG})$; condition $V_{IG} = 5\ V$

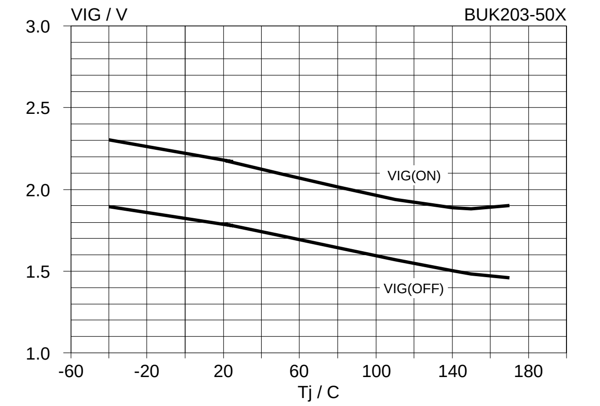


Fig.16. Typical input threshold voltages.
$V_{IG} = f(T_j)$; conditions $V_{BG} = 13$ V, $I_L = 100$ mA

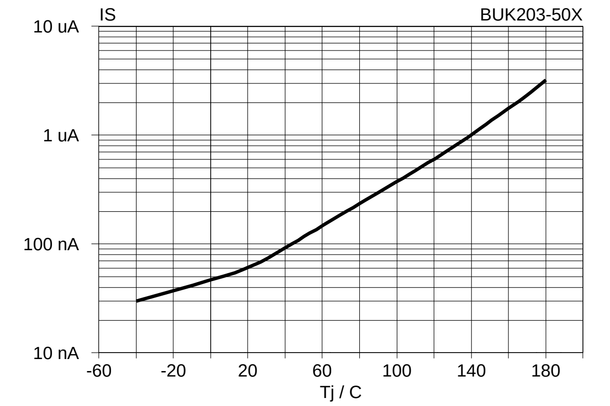


Fig.19. Typical status leakage current.
$I_S = f(T_j)$; conditions $V_{SG} = 5$ V, $V_{IG} = V_{BG} = 0$ V

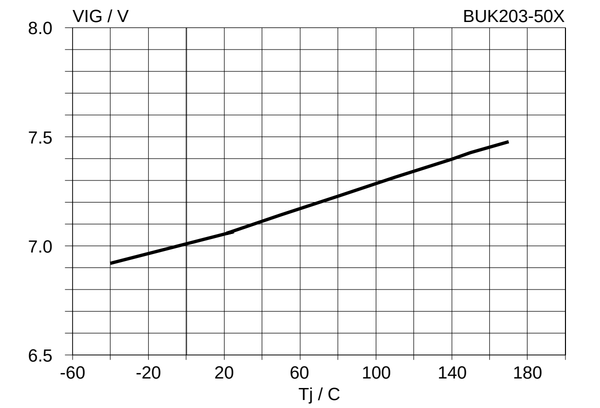


Fig.17. Typical input clamping voltage.
$V_{IG} = f(T_j)$; conditions $I_I = 200$ µA, $V_{BG} = 13$ V

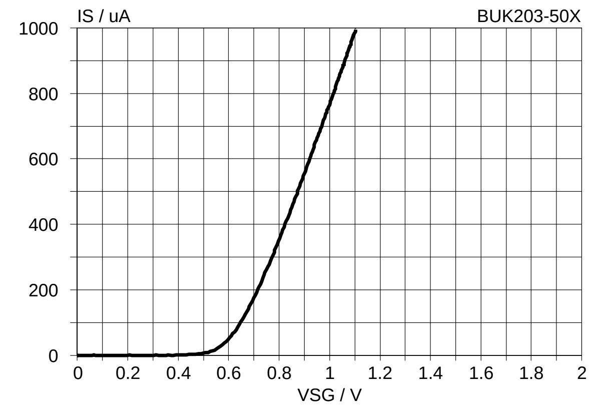


Fig.20. Typical status low characteristic, $T_j = 25$ ˚C.
$I_S = f(V_{SG})$; conditions $V_{IG} = 5$ V, $V_{BG} = 13$ V, $I_L = 0$ A

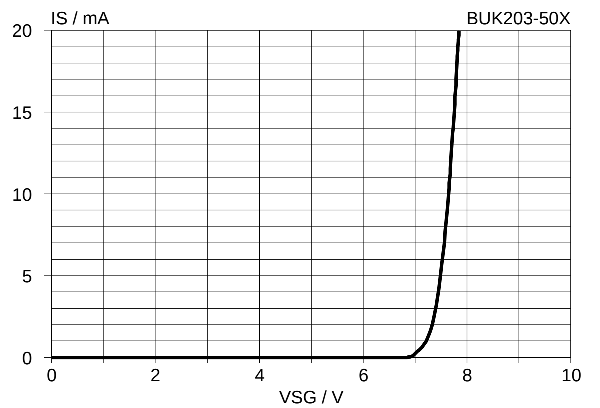


Fig.18. Typical status characteristic, $T_j = 25$ ˚C.
$I_S = f(V_{SG})$; conditions $V_{IG} = V_{BG} = 0$ V

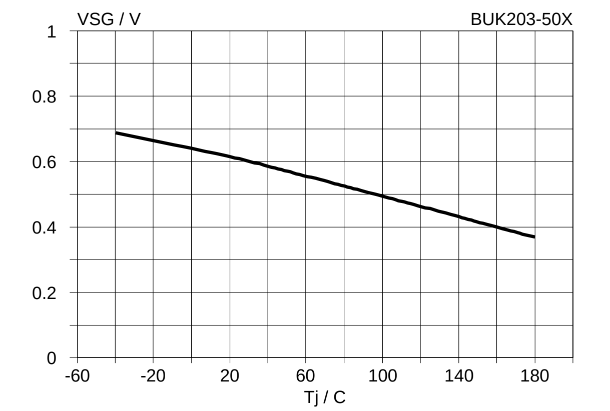


Fig.21. Typical status low voltage, $V_{SG} = f(T_j)$.
conditions $I_S = 50$ µA, $V_{IG} = 5$ V, $V_{BG} = 13$ V, $I_L = 0$ A

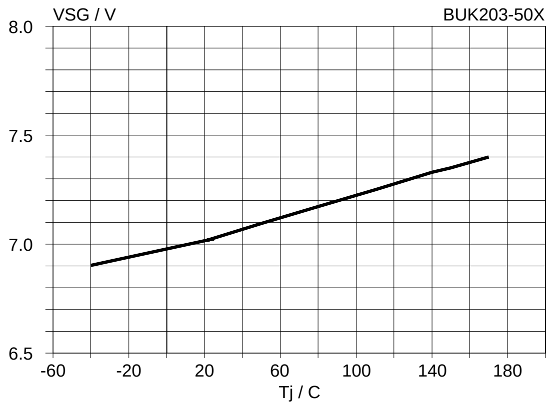


Fig.22. Typical status clamping voltage, $V_{SG} = f(T_j)$. conditions $I_S = 100\ \mu A$, $V_{BG} = 13\ V$

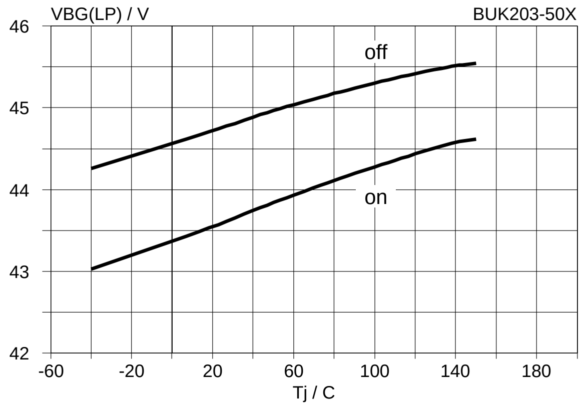


Fig.25. Supply typical overvoltage thresholds. $V_{BG(LP)} = f(T_j)$; conditions $V_{IG} = 5\ V$; $I_L = 100\ mA$

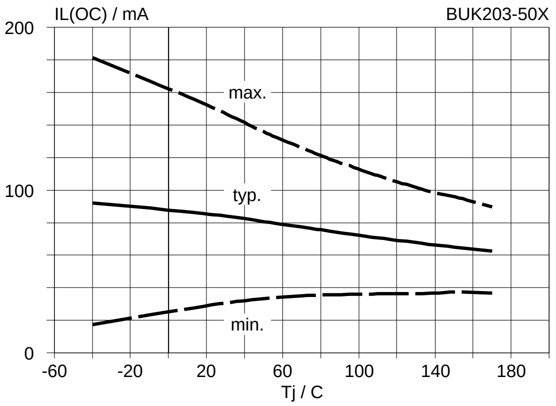


Fig.23. Low load current detection threshold. $I_{L(OC)} = f(T_j)$; conditions $V_{IG} = 5\ V$; $V_{BG} = 13\ V$

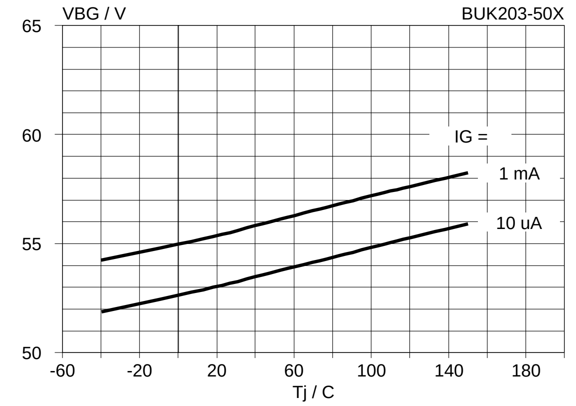


Fig.26. Typical battery to ground clamping voltage. $V_{BG} = f(T_j)$; parameter I_G

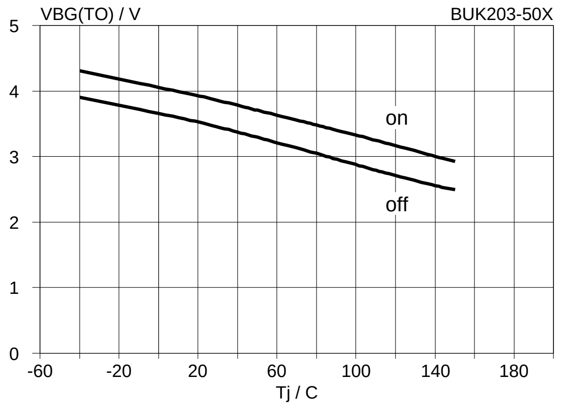


Fig.24. Supply typical undervoltage thresholds. $V_{BG(TO)} = f(T_j)$; conditions $V_{IG} = 3\ V$; $I_L = 100\ mA$

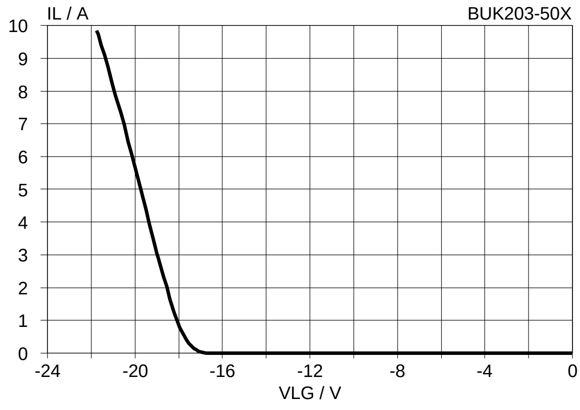


Fig.27. Typical negative load clamping characteristic. $I_L = f(V_{LG})$; conditions $V_{IG} = 0\ V$, $t_p = 300\ \mu s$, $25\ ^\circ C$

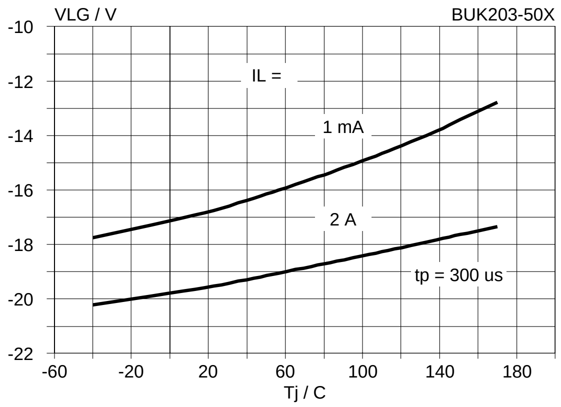


Fig.28. Typical negative load clamping voltage. $V_{LG} = f(T_j)$; parameter I_L; condition $V_{IG} = 0$ V.

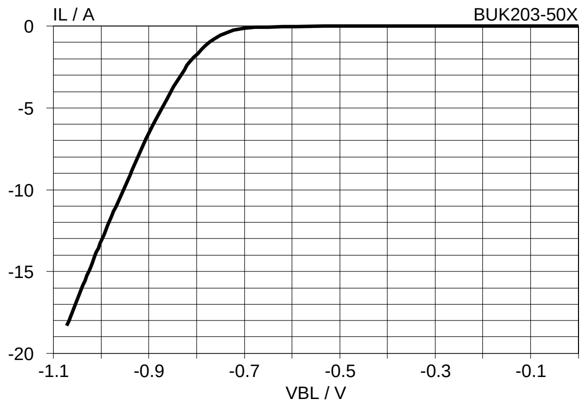


Fig.31. Typical reverse diode characteristic. $I_L = f(V_{BL})$; conditions $V_{IG} = 0$ V, $T_j = 25$ ˚C

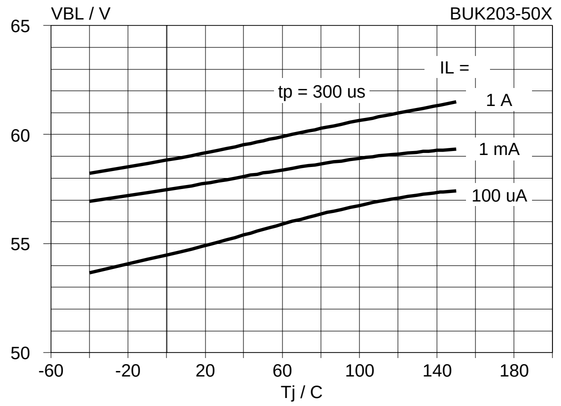


Fig.29. Typical battery to load clamping voltage. $V_{BL} = f(T_j)$; parameter I_L; condition $I_G = 5$ mA.

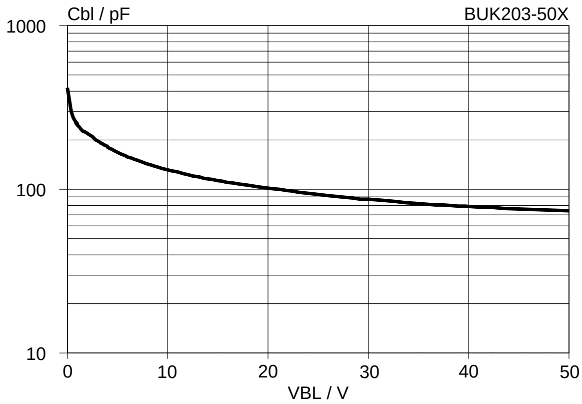


Fig.32. Typical output capacitance. $T_{mb} = 25$ ˚C $C_{bl} = f(V_{BL})$; conditions f = 1 MHz, $V_{IG} = 0$ V

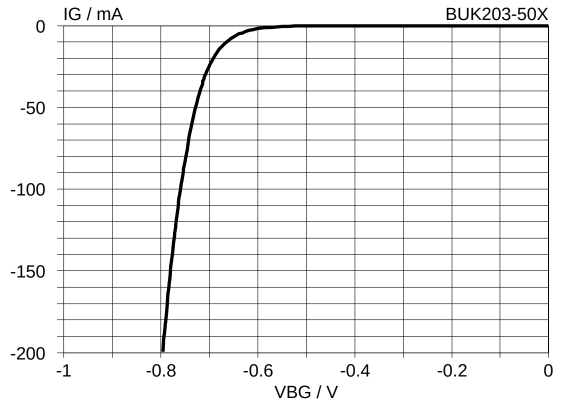


Fig.30. Typical reverse battery characteristic. $I_G = f(V_{BG})$; conditions $I_L = 0$ A, $T_j = 25$ ˚C

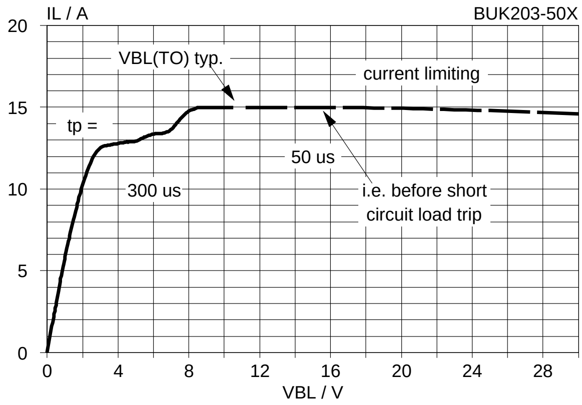


Fig.33. Typical overload characteristic, $T_{mb} = 25$ ˚C. $I_L = f(V_{BL})$; condition $V_{BG} = 13$ V; parameter t_p

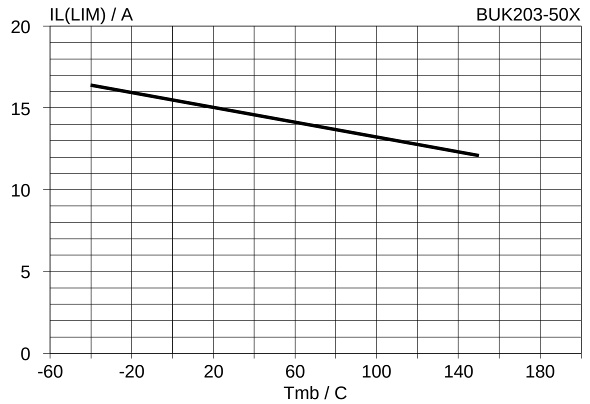


Fig.34. Typical overload current, V_{BL} = 9 V.
$I_L = f(T_{mb})$; conditions V_{BG} = 13 V; t_p = 100 µs

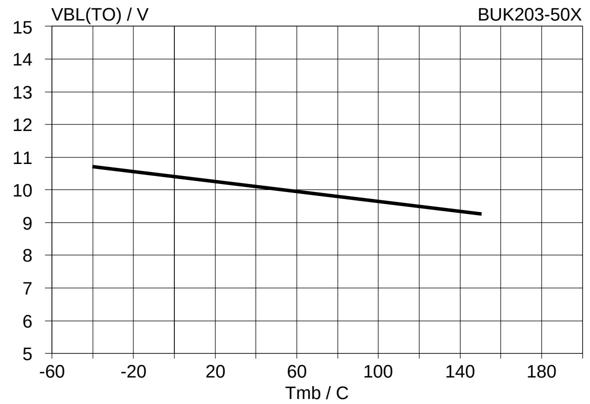


Fig.36. Typical short circuit load threshold voltage.
$V_{BL(TO)} = f(T_{mb})$; condition V_{BG} = 13 V

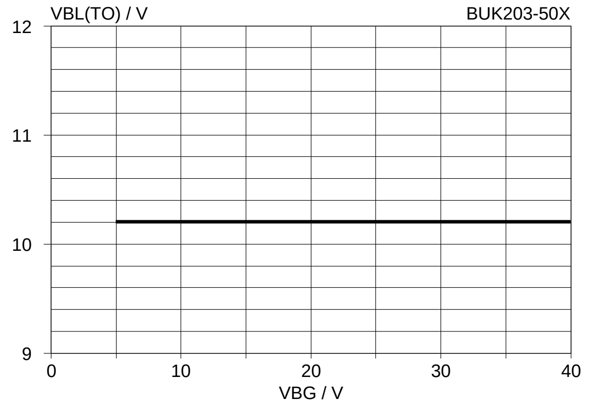


Fig.35. Typical short circuit load threshold voltage.
$V_{BL(TO)} = f(V_{BG})$; condition T_{mb} = 25 ˚C

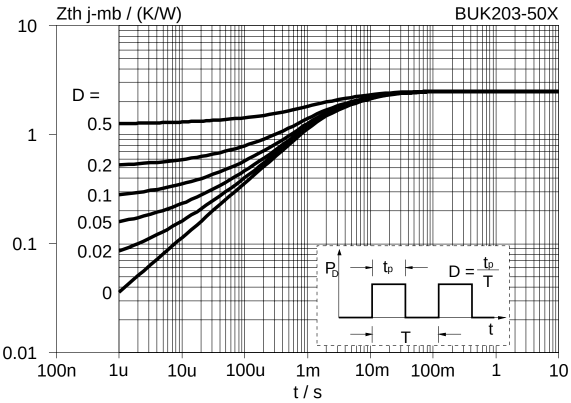
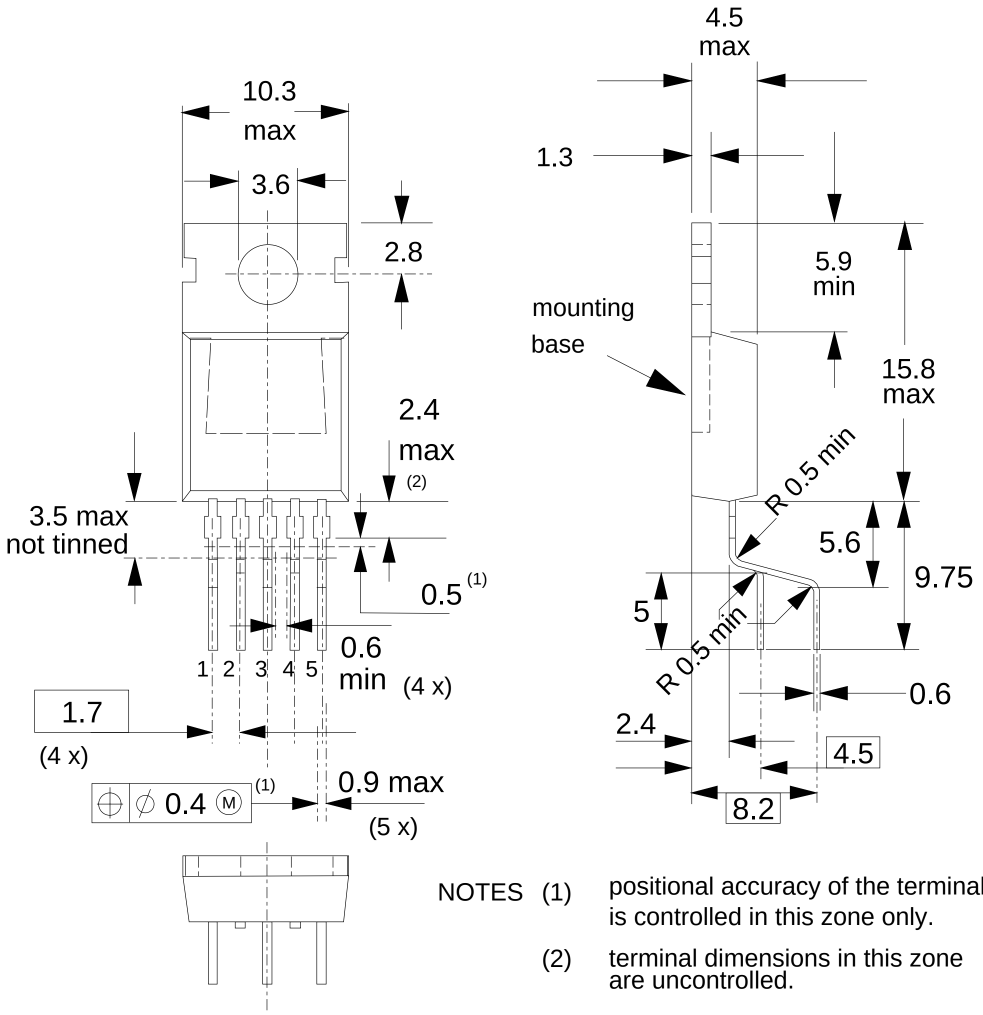


Fig.37. Transient thermal impedance.
$Z_{th\ j\text{-}mb} = f(t)$; parameter $D = t_p/T$

MECHANICAL DATA

Dimensions in mm

Net Mass: 2 g



NOTES (1) positional accuracy of the terminals is controlled in this zone only.

(2) terminal dimensions in this zone are uncontrolled.

Fig.38. SOT263 leadform 263-01;

pin 3 connected to mounting base.

Note
1. Refer to mounting instructions for TO220 envelopes.
2. Epoxy meets UL94 V0 at 1/8".

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
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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