PowerMOS transistor TOPFET high side switch

BUK210-50Y

DESCRIPTION

Monolithic single channel high side protected power switch in **TOPFET2** technology assembled in a 5 pin plastic package.

APPLICATIONS

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

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	UNIT
I_L	Nominal load current (ISO)	9	A
SYMBOL	**PARAMETER**	**MAX.**	**UNIT**
V_{BG}	Continuous off-state supply voltage	50	V
I_L	Continuous load current	20	A
T_j	Continuous junction temperature	150	˚C
R_{ON}	On-state resistance T_j = 25˚C	38	mΩ

FEATURES

- Vertical power TrenchMOS
- Low on-state resistance
- CMOS logic compatible
- Very low quiescent current
- Overtemperature protection
- Load current limiting
- Latched overload and short circuit protection
- Overvoltage and undervoltage shutdown with hysteresis
- On-state open circuit load detection
- Diagnostic status indication
- Voltage clamping for turn off of inductive loads
- ESD protection on all pins
- Reverse battery, overvoltage and transient protection

FUNCTIONAL BLOCK DIAGRAM

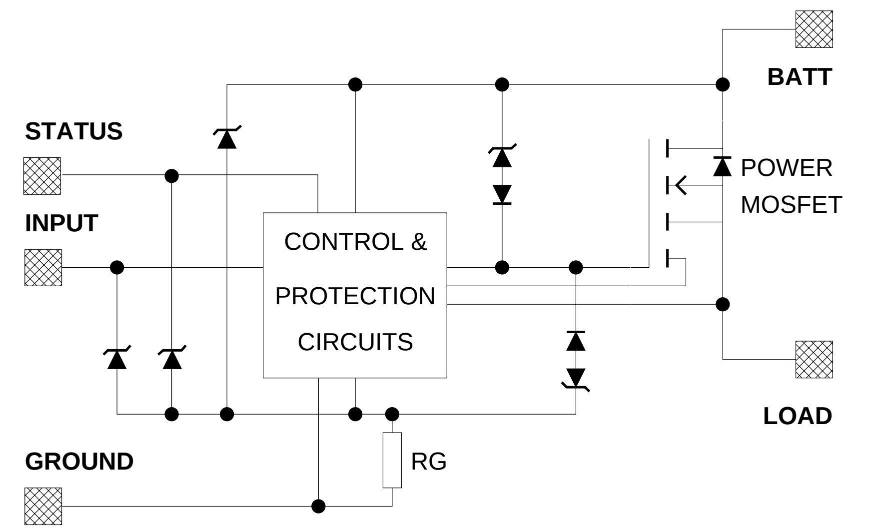


Fig.1. Elements of the TOPFET HSS with internal ground resistor.

PINNING - SOT263B-01

PIN	DESCRIPTION
1	**I**nput
2	**F**lag
3	**D**rain
4	**P**rotection supply
5	**S**ource
tab	**D**rain

PIN CONFIGURATION

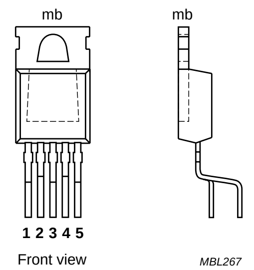


Fig. 2.

SYMBOL

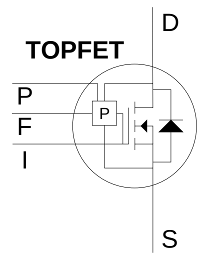


Fig. 3.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{BG}	Continuous supply voltage		0	50	V
I_L	Continuous load current	$T_{mb} \leq 95˚C$	-	20	A
P_D	Total power dissipation	$T_{mb} \leq 25˚C$	-	67	W
T_{stg}	Storage temperature		-55	175	˚C
T_j	Continuous junction temperature[1]		-	150	˚C
T_{sold}	Lead temperature	during soldering	-	260	˚C
	Reverse battery voltages[2]				
$-V_{BG}$	Continuous reverse voltage		-	16	V
$-V_{BG}$	Peak reverse voltage		-	32	V
	Application information				
R_I, R_S	External resistors[3]	to limit input, status currents	3.2	-	kΩ
	Input and status				
I_I, I_S	Continuous currents		-5	5	mA
I_I, I_S	Repetitive peak currents	$\delta \leq 0.1$, tp = 300 µs	-50	50	mA
	Inductive load clamping	I_L = 10 A, V_{BG} = 16 V			
E_{BL}	Non-repetitive clamping energy	T_j = 150˚C prior to turn-off	-	150	mJ

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[4]					
$R_{th\ j-mb}$	Junction to mounting base	-	-	1.52	1.86	K/W
$R_{th\ j-a}$	Junction to ambient	in free air	-	60	75	K/W

1 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.

2 Reverse battery voltage is allowed only with external resistors to limit the input and status currents to a safe value. The connected load must limit the reverse load current. The internal ground resistor limits the reverse battery ground current. Power is dissipated and the T_j rating must be observed.

3 To limit currents during reverse battery and transient overvoltages (positive or negative).

4 Of the output power MOS transistor.

STATIC CHARACTERISTICS

Limits are at -40˚C ≤ T_{mb} ≤ 150˚C and typicals at 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 = 10 mA				18	23	28	V
$-V_{LG}$	Negative load voltage[1]	I_L = 10 A; t_p = 300 µs				20	25	30	V
	Supply voltage	battery to ground							
V_{BG}	Operating range[2]					5.5	-	35	V
	Currents	9 V ≤ V_{BG} ≤ 16 V							
I_B	Quiescent current[3]	V_{LG} = 0 V				-	-	20	µA
		T_{mb} = 25˚C				-	0.1	2	µA
I_L	Off-state load current[4]	V_{BL} = V_{BG}				-	-	20	µA
		T_{mb} = 25˚C				-	0.1	1	µA
I_G	Operating current[5]	I_L = 0 A				-	2	4	mA
I_L	Nominal load current[6]	V_{BL} = 0.5 V; T_{mb} = 85˚C				9	-	-	A
	Resistances	V_{BG}	I_L	t_p[7]	T_{mb}				
R_{ON}	On-state resistance	9 to 35 V	10 A	300 µs	25˚C	-	28	38	mΩ
					150˚C	-	-	70	mΩ
R_{ON}	On-state resistance	6 V	10 A	300 µs	25˚C	-	36	48	mΩ
					150˚C	-	-	88	mΩ
R_G	Internal ground resistance	I_G = 10 mA				95	150	190	Ω

1 For a high side switch, the load pin voltage goes negative with respect to ground during the turn-off of an inductive load.
2 On-state resistance is increased if the supply voltage is less than 9 V.
3 This is the continuous current drawn from the supply when the input is low and includes leakage current to the load.
4 The measured current is in the load pin only.
5 This is the continuous current drawn from the supply with no load connected, but with the input high.
6 Defined as in ISO 10483-1. For comparison purposes only. This parameter will not be characterised for automotive PPAP.
7 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.

INPUT CHARACTERISTICS

9 V ≤ V_{BG} ≤ 16 V. Limits are at -40˚C ≤ T_{mb} ≤ 150˚C and typicals at T_{mb} = 25 ˚C unless otherwise stated.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_I	Input current	V_{IG} = 5 V	20	90	160	µA
V_{IG}	Input clamping voltage	I_I = 200 µA	5.5	7	8.5	V
$V_{IG(ON)}$	Input turn-on threshold voltage		-	2.4	3	V
$V_{IG(OFF)}$	Input turn-off threshold voltage		1.5	2.1	-	V
ΔV_{IG}	Input turn-on hysteresis		-	0.3	-	V
$I_{I(ON)}$	Input turn-on current	V_{IG} = 3 V	-	-	100	µA
$I_{I(OFF)}$	Input turn-off current	V_{IG} = 1.5 V	10	-	-	µA

STATUS CHARACTERISTICS

The status output is an open drain transistor, and requires an external pull-up circuit to indicate a logic high.
Limits are at -40˚C ≤ T_{mb} ≤ 150˚C and typicals at T_{mb} = 25 ˚C unless otherwise stated. Refer to TRUTH TABLE.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{SG}	Status clamping voltage	I_S = 100 µA	5.5	7	8.5	V
V_{SG}	Status low voltage	I_S = 100 µA	-	-	1	V
		T_{mb} = 25˚C	-	0.7	0.8	V
I_S	Status leakage current	V_{SG} = 5 V	-	-	15	µA
		T_{mb} = 25˚C	-	0.1	1	µA
I_S	Status saturation current[1]	V_{SG} = 5 V	2	7	12	mA
	Application information					
R_S	External pull-up resistor		-	47	-	kΩ

OPEN CIRCUIT DETECTION CHARACTERISTICS

An open circuit load can be detected in the on-state. Refer to TRUTH TABLE.
Limits are at -40˚C ≤ T_{mb} ≤ 150˚C and typical is at T_{mb} = 25 ˚C.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Open circuit detection	9 V ≤ V_{BG} ≤ 35 V				
$I_{L(TO)}$	Low current detect threshold		0.24	-	1.6	A
		T_j = 25˚C	0.4	0.8	1.2	A
$\Delta I_{L(TO)}$	Hysteresis		-	0.16	-	A

1 In a fault condition with the pull-up resistor short circuited while the status transistor is conducting. This condition should be avoided in order to prevent possible interference with normal operation of the device.

UNDERVOLTAGE & OVERVOLTAGE CHARACTERISTICS

Limits are at -40˚C ≤ T_{mb} ≤ 150˚C and typicals at T_{mb} = 25 ˚C. Refer to TRUTH TABLE.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Undervoltage					
$V_{BG(UV)}$	Low supply threshold voltage[1]		2	4.2	5.5	V
$\Delta V_{BG(UV)}$	Hysteresis		-	0.5	-	V
	Overvoltage					
$V_{BG(OV)}$	High supply threshold voltage[2]		40	45	50	V
$\Delta V_{BG(OV)}$	Hysteresis		-	1	-	V

TRUTH TABLE

INPUT	ABNORMAL CONDITIONS DETECTED					LOAD OUTPUT	STATUS	DESCRIPTION
	SUPPLY		LOAD					
	UV	OV	LC	SC	OT			
L	X	X	X	X	X	OFF	H	off
H	0	0	0	0	0	ON	H	on & normal
H	0	0	1	0	0	ON	L	on & low current detect
H	1	0	X	X	X	OFF	H	supply undervoltage lockout
H	0	1	X	0	0	OFF	H	supply overvoltage shutdown
H	0	0	0	1	X	OFF	L	SC tripped
H	0	0	0	0	1	OFF	L	OT shutdown[3]

KEY TO ABBREVIATIONS

L	logic low	UV	undervoltage
H	logic high	OV	overvoltage
X	don't care	LC	low current or open circuit load
0	condition not present	SC	short circuit
1	condition present	OT	overtemperature

1 Undervoltage sensor causes the device to switch off and reset.

2 Overvoltage sensor causes the device to switch off to protect its load.

3 The status will continue to indicate OT (even if the input goes low) until the device cools below the reset threshold. Refer to OVERLOAD PROTECTION CHARACTERISTICS.

OVERLOAD PROTECTION CHARACTERISTICS

5.5 V ≤ V_{BG} ≤ 35 V, limits are at -40˚C ≤ T_{mb} ≤ 150˚C and typicals at T_{mb} = 25 ˚C unless otherwise stated.
Refer to TRUTH TABLE.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
	Overload protection	V_{BL} = V_{BG}				
$I_{L(lim)}$	Load current limiting	V_{BG} ≥ 9 V	34	45	64	A
	Short circuit load protection					
$V_{BL(TO)}$	Battery load threshold voltage[1]	V_{BG} = 16 V	8	10	12	V
		V_{BG} = 35 V	15	20	25	V
$t_{d\ sc}$	Response time[2]	V_{BL} > $V_{BL(TO)}$	-	180	250	µs
	Overtemperature protection					
$T_{j(TO)}$	Threshold junction temperature[3]		150	170	190	˚C
$\Delta T_{j(TO)}$	Hysteresis		-	10	-	˚C

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	from input going high				
$t_{d\ on}$	Delay time	to 10% V_L	-	40	60	µs
dV/dt_{on}	Rate of rise of load voltage	30% to 70% V_L	-	0.35	1	V/µs
t_{on}	Total switching time	to 90% V_L	-	140	200	µs
	During turn-off	from input going low				
$t_{d\ off}$	Delay time	to 90% V_L	-	55	80	µs
dV/dt_{off}	Rate of fall of load voltage	70% to 30% V_L	-	0.6	1	V/µs
t_{off}	Total switching time	to 10% V_L	-	85	120	µs

CAPACITANCES

T_{mb} = 25 ˚C; f = 1 MHz; V_{IG} = 0 V. *designed in parameters*.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C_{ig}	Input capacitance	V_{BG} = 13 V	-	15	20	pF
C_{bl}	Output capacitance	V_{BL} = 13 V	-	250	350	pF
C_{sg}	Status capacitance	V_{SG} = 5 V	-	11	15	pF

1 The battery to load threshold voltage for short circuit protection is proportional to the battery supply voltage. After short circuit protection has operated, the input voltage must be toggled low for the switch to resume normal operation.

2 Measured from when the input goes high.

3 After cooling below the reset temperature the switch will resume normal operation.

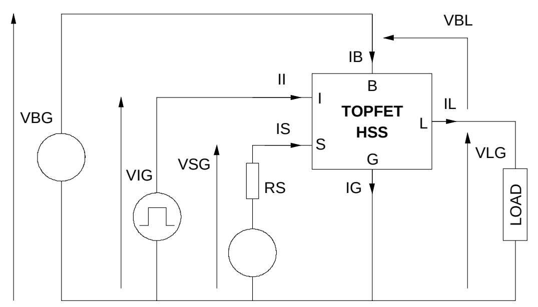


Fig.4. High side switch measurements schematic. (current and voltage conventions)

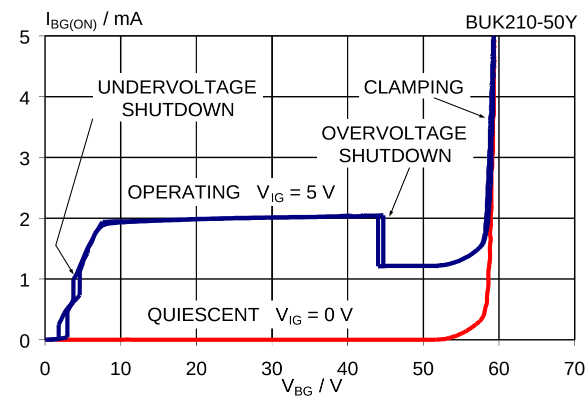


Fig.7. Typical supply characteristics, 25 ˚C. $I_G = f(V_{BG})$*; parameter* V_{IG}

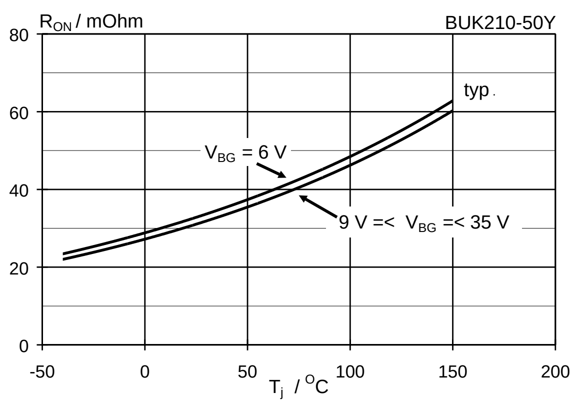


Fig.5. Typical on-state resistance, t_p *= 300 µs.* $R_{ON} = f(T_j)$*; parameter* V_{BG}*; condition* I_L *= 10 A*

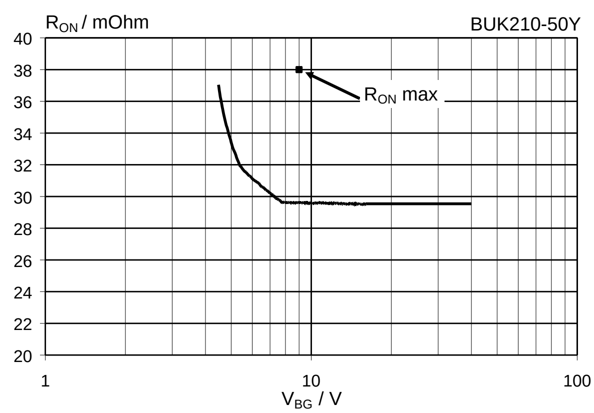


Fig.8. Typical on-state resistance, T_j *= 25 ˚C.* $R_{ON} = f(V_{BG})$*; condition* I_L *= 10 A;* t_p *= 300 µs*

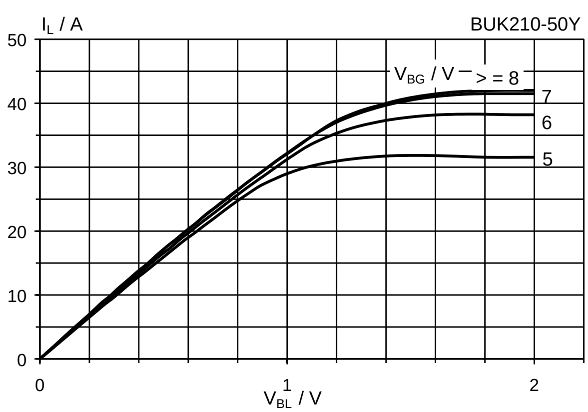


Fig.6. Typical on-state characteristics, T_j *= 25 ˚C.* $I_L = f(T_j)$*; parameter* V_{BG}*;* t_p *= 250 µs*

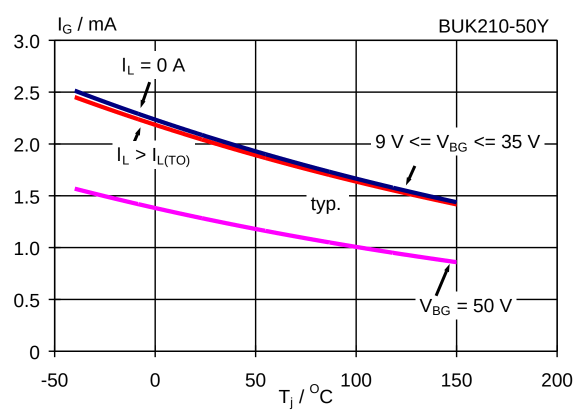


Fig.9. Typical operating supply current. $I_G = f(T_j)$*; parameters* I_L*,* V_{BG}*; condition* V_{IG} *= 5 V*

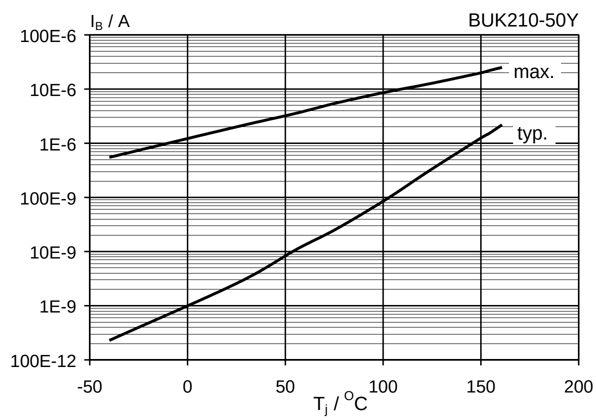


Fig.10. Typical supply quiescent current.
$I_B = f(T_j)$; condition V_{BG} = 16 V, V_{IG} = 0 V, V_{LG} = 0 V

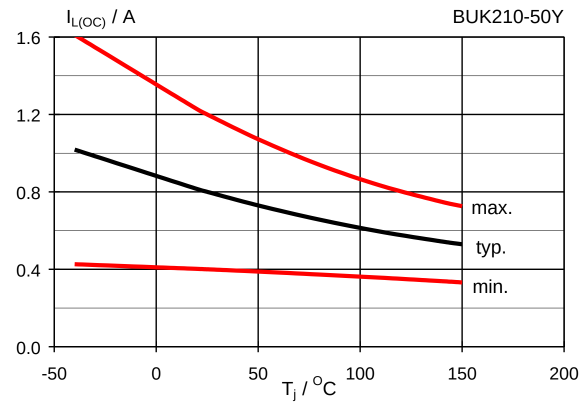


Fig.13. Low load current detection threshold.
$I_{L(OC)} = f(T_j)$; conditions V_{IG} = 5 V; $V_{BG} \geq 9$ V

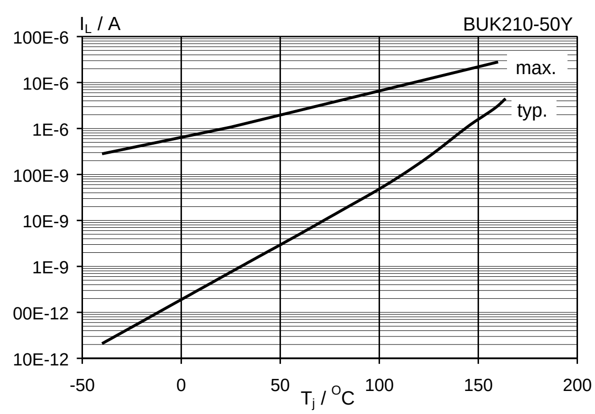


Fig.11. Typical off-state leakage current.
$I_L = f(T_j)$; conditions V_{BL} = 16 V = V_{BG}, V_{IG} = 0 V.

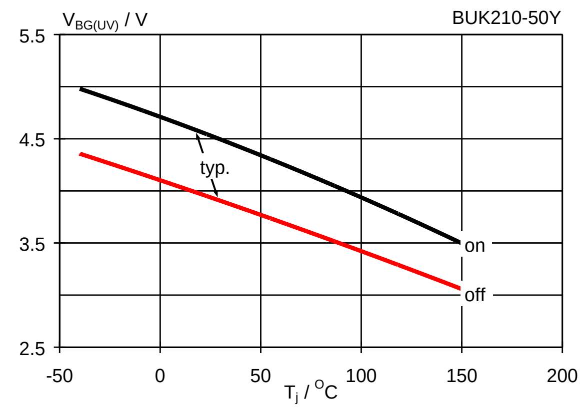


Fig.14. Supply undervoltage thresholds.
$V_{BG(UV)} = f(T_j)$; conditions V_{IG} = 5 V; $V_{BL} \leq 2$ V

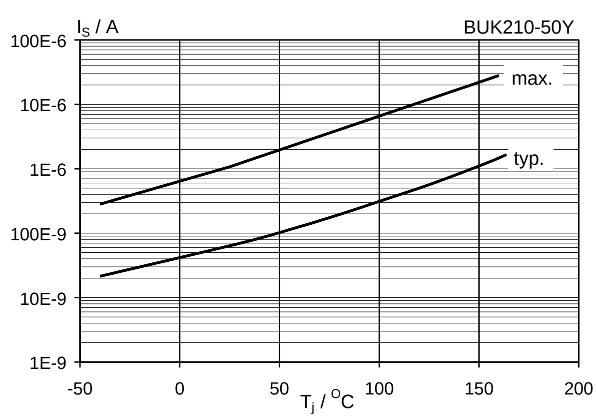


Fig.12. Status leakage current.
$I_S = f(T_j)$; conditions V_{SG} = 5 V, $V_{IG} = V_{BG}$ = 0 V

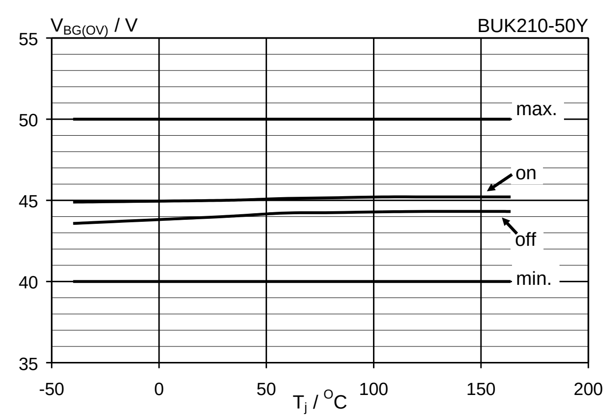


Fig.15. Supply overvoltage thresholds.
$V_{BG(OV)} = f(T_j)$; conditions V_{IG} = 5 V; I_L = 100 mA

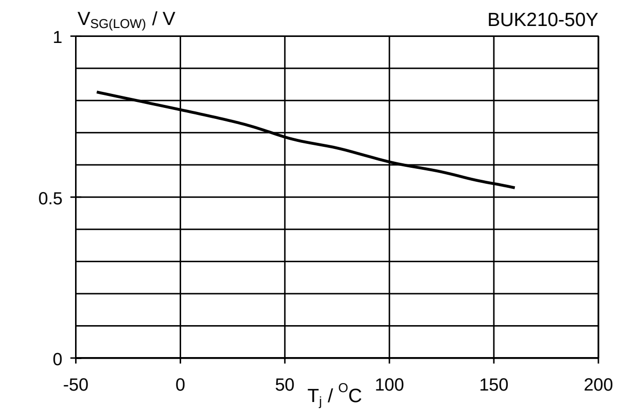


Fig.16. Typical status low characteristic.
$V_{SG} = f(T_j)$; conditions $V_{BG} \geq 9$ V, $I_S = 100$ µA

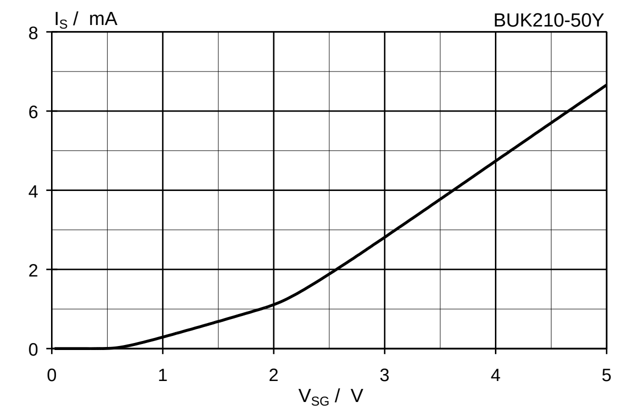


Fig.19. Typical status low characteristic, $T_j = 25$ ˚C.
$I_S = f(V_{SG})$; conditions $V_{IG} = 5V$, $V_{BG} = 13V$, $I_L = 0A$

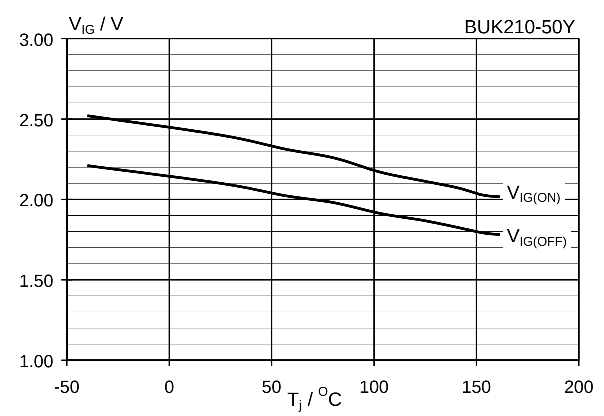


Fig.17. Typical threshold voltage characteristic.
$V_{IG} = f(T_j)$; condition $9V \leq V_{BG} \leq 16V$

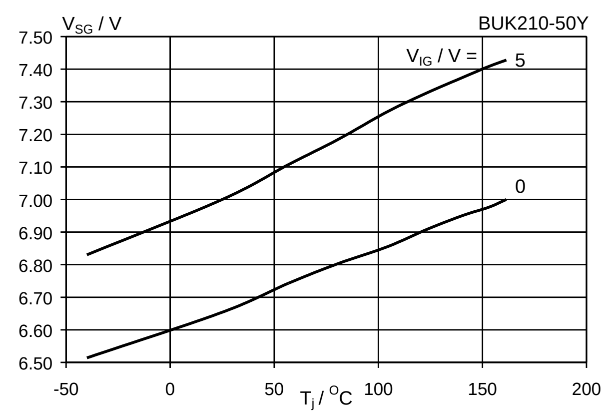


Fig.20. Typical status clamping voltage.
$V_{SG} = f(T_j)$; condition $I_S = 100$µA, $V_{BG} = 13V$

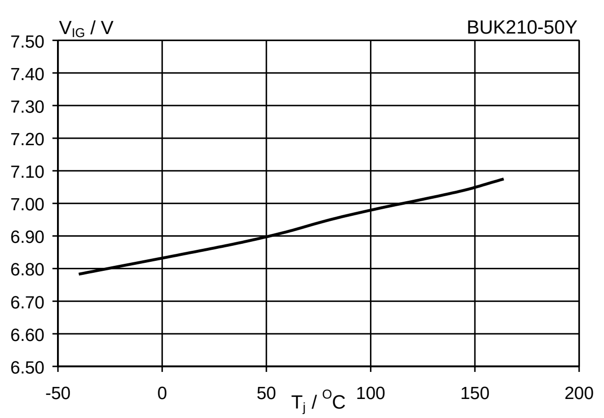


Fig.18. Typical input clamping voltage.
$V_{IG} = f(T_j)$; condition $I_I = 200$µA, $V_{BG} = 13V$

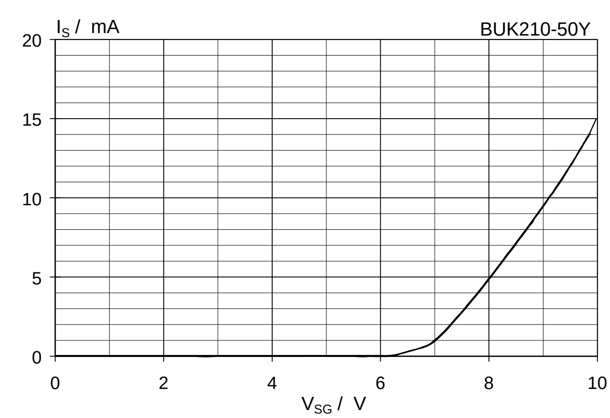


Fig.21. Typical status characteristic, $T_j = 25$ ˚C.
$I_S = f(V_{SG})$; conditions $V_{IG} = V_{BG} = 0V$

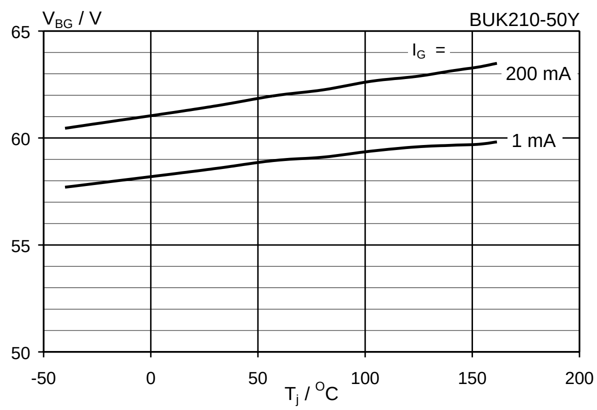


Fig.22. Typical battery to ground clamping voltage.
V_{BG} = f(T_j); parameter I_G

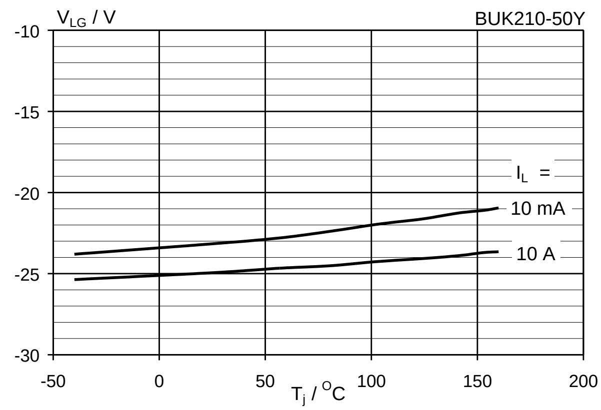


Fig.25. Typical negative load clamping voltage.
V_{LG} = f(T_j); parameter I_L; condition V_{IG} = = 0V

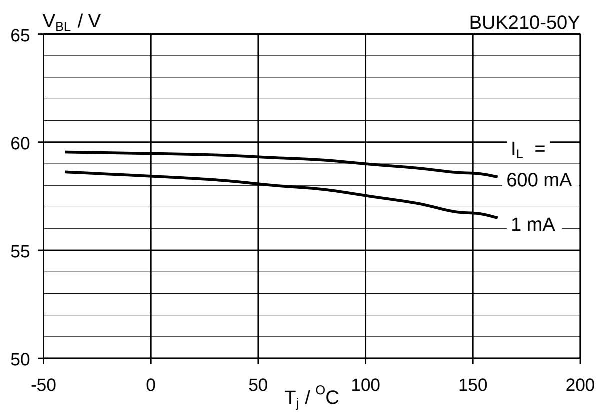


Fig.23. Typical battery to load clamping voltage.
V_{BL} = f(T_j); parameter I_L; condition I_G = 10mA

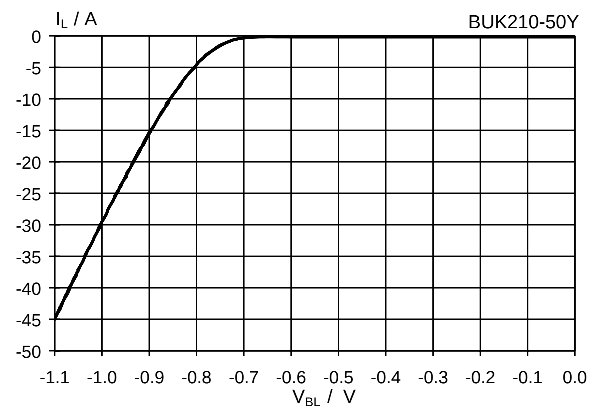


Fig.26. Typical reverse diode characteristic.
I_L = f(V_{BL}); conditions V_{IG} = 0 V, T_j = 25 ˚C

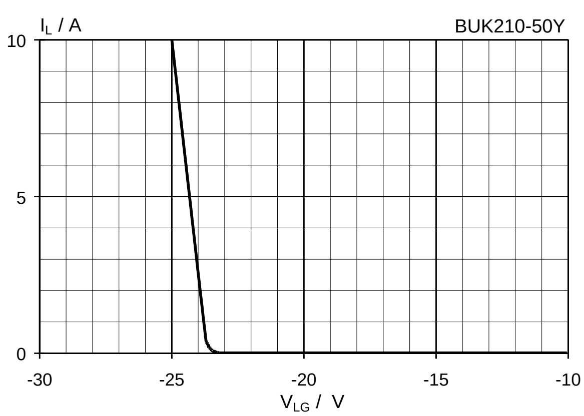


Fig.24. Typical negative load clamping.
I_L = f(V_{LG}); conditions V_{IG} = = 0V, T_j = 25˚C

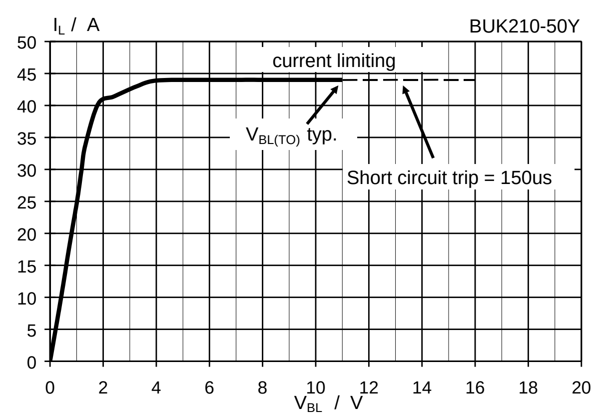


Fig.27. Typical overload characteristic, T_{mb} = 25 ˚C.
I_L = f(V_{BL}); condition V_{BG} = 16 V; parameter t_p

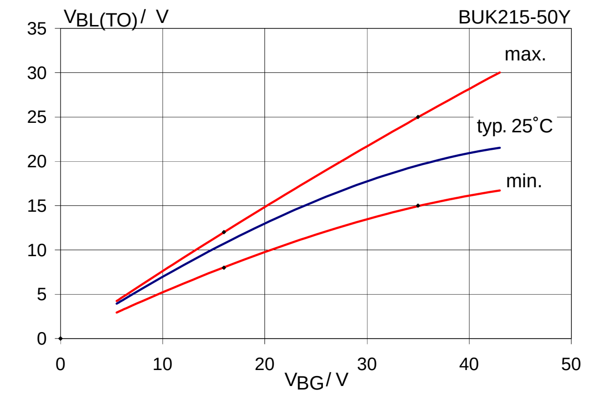


Fig.28. Short circuit load threshold voltage.
$V_{BL(TO)} = f(V_{BG})$; conditions -40˚C ≤ T_{mb} ≤ 150˚C

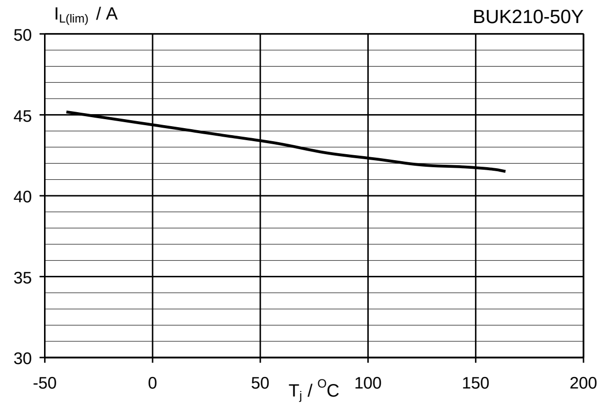


Fig.31. Typical overload current, V_{BL} = 8V.
$I_L = f(T_j)$; parameter V_{BG} = 13V; t_p = 300 µs

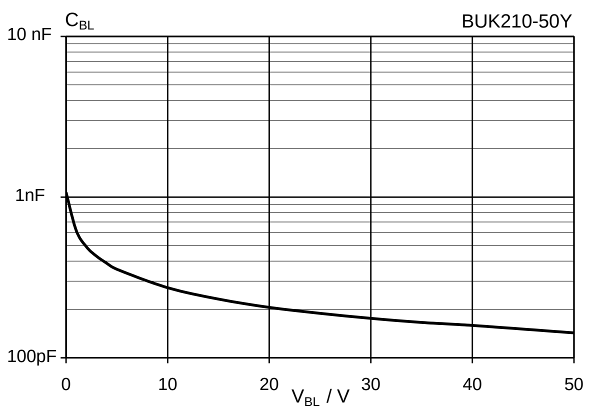


Fig.29. Typical output capacitance. T_{mb} = 25 ˚C
$C_{bl} = f(V_{BL})$; conditions f = 1 MHz, V_{IG} = 0 V

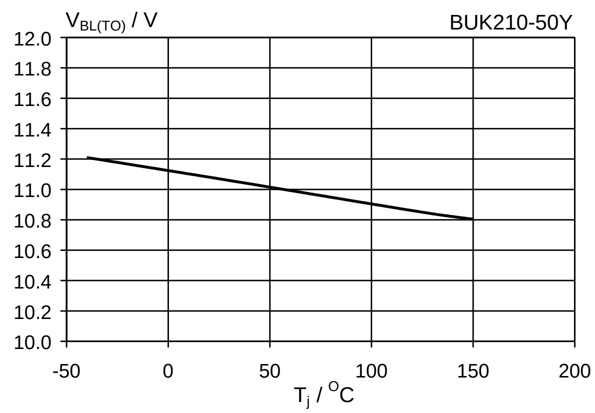


Fig.32. Typical short circuit load threshold voltage.
$V_{BL(TO)} = f(T_j)$; condition V_{BG} = 16 V

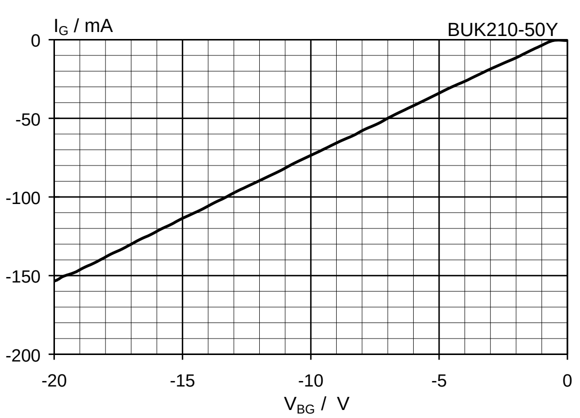


Fig.30. Typical reverse battery characteristic.
$I_G = f(V_{BG})$; conditions I_L = 0 A, T_j = 25 ˚C

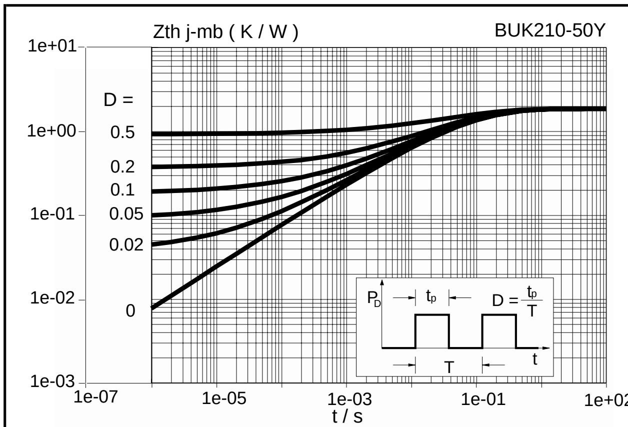
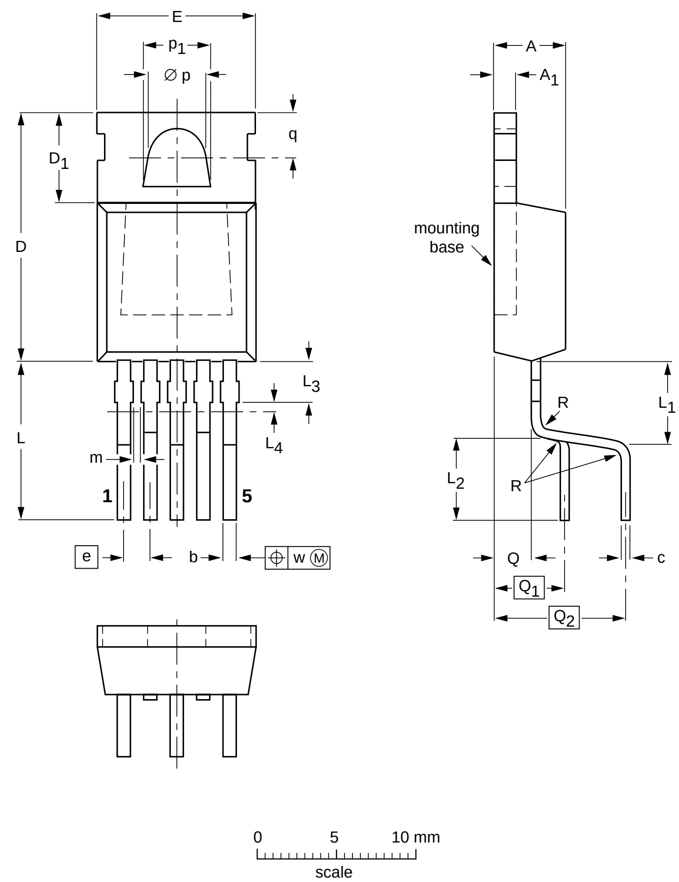


Fig.33. Transient thermal impedance.
$Z_{th\ j\text{-}mb} = f(t)$; parameter $D = t_p/T$

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.34. 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.

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices or systems where malfunction of these products can be reasonably expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

1 Please consult the most recently issued datasheet before initiating or completing a design.

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.