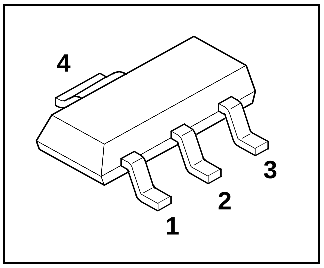
Smart Power High-Side-Switch for Industrial Applications

Features

- Short-circuit protection
- Input protection
- Overtemperature protection with hysteresis
- Overload protection
- Overvoltage protection
- Switching inductive load
- Clamp of negative output voltage with inductive loads
- Undervoltage shutdown
- Maximum current internally limited
- **E**lectro**s**tatic **d**ischarge (**ESD**) protection
- Reverse battery protection[1)]



Package: PG-SOT 223

Type	Ordering code
ISP 452	SP000219823

Application

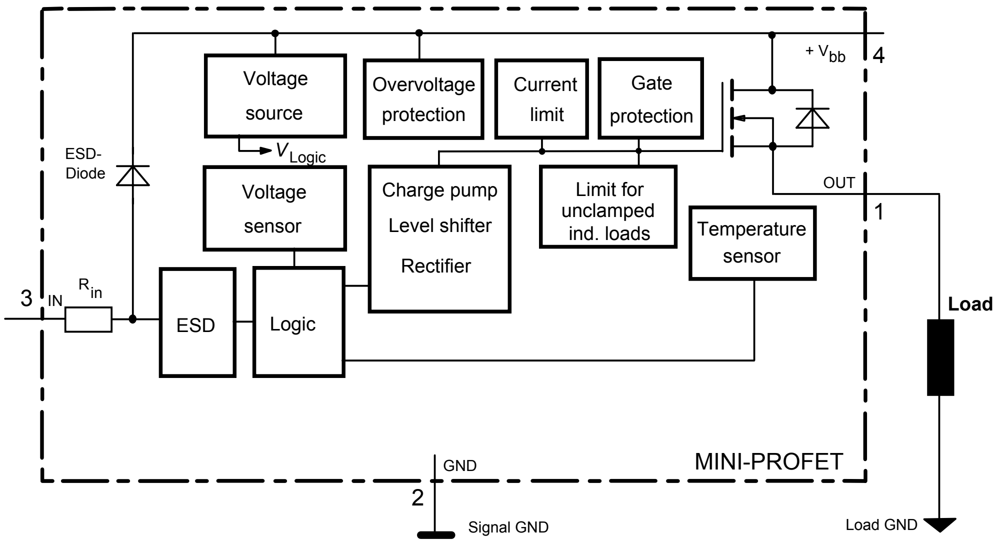
- µC compatible power switch for 12 V DC grounded loads for industrial applications
- All types of resistive, inductive and capacitive loads
- Replaces electromechanical relays and discrete circuits

General Description

- N channel vertical power FET with charge pump, ground referenced CMOS compatible input, monolithically integrated in Smart SIPMOS® technology.
- Providing embedded protection functions.

1) With resistor R_{GND}=150 Ω in GND connection, resistor in series with IN connections, reverse load current limited by connected load.

Block diagram



Pin	Symbol		Function
1	OUT	O	Protected high-side power output
2	GND	-	Logic ground
3	IN	I	Input, activates the power switch in case of logical high signal
4	Vbb	+	Positive power supply voltage

Maximum Ratings at T_j = 25 °C unless otherwise specified

Parameter	Symbol	Values	Unit
Supply voltage	V_{bb}	40	V
Load current self-limited	I_L	$I_{L(SC)}$	A
Maximum input voltage[2]	V_{IN}	-5.0...V_{bb}	V
Maximum input current	I_{IN}	±5	mA
Inductive load switch-off energy dissipation, single pulse I_L = 0.5A, $T_{j,start}$ = 150°C (not tested, specified by design)	E_{AS}	0.5	J
Load dump protection[3] $V_{LoadDump} = U_A + V_s$ R_I=2 Ω , t_d=400ms, IN= low or high, U_A= 13.5 V (not tested, specified by design)	$V_{Load\ dump}$[4]		V
R_L= 24 Ω		60	
R_L= 80 Ω		80	
Electrostatic discharge capability (ESD)[5] PIN 3	V_{ESD}	±1	kV
PIN 1,2,4		±2	
Junction Temperature	T_j	150	°C
Operating temperature range	T_a	-30 ...+85	
Storage temperature range	T_{stg}	-40 ...+105	
Max. power dissipation (DC)[6] T_A = 25 °C	P_{tot}	1.8	W
Thermal resistance chip - soldering point:	R_{thJS}	7	K/W
chip - ambient:[6]	R_{thJA}	70	

2) At $V_{IN} > V_{bb}$, the input current is not allowed to exceed ±5 mA.

3) Supply voltages higher than $V_{bb(AZ)}$ require an external current limit for the GND pin, e.g. with a 150 Ω resistor in the GND connection. A resistor for the protection of the input is integrated.

4) $V_{Load\ dump}$ is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839

5) HBM according to MIL-STD 883D, Methode 3015.7

6) Device on epoxy pcb 40 mm x 40 mm x 1.5 mm with 6 cm^2 copper area for V_{bb} connection

Electrical Characteristics

Parameter and Conditions at T_j = 25 °C, V_{bb} = 13.5V unless otherwise specified	Symbol	Values min	Values typ	Values max	Unit
Load Switching Capabilities and Characteristics					
On-state resistance (pin 4 to 1) I_L = 0.5 A, V_{in} = high, T_j = 25°C T_j = 150°C	R_{ON}	-- --	0.16 --	0.2 0.4	Ω
Nominal load current (pin 4 to 1)[7] ISO Standard: $V_{ON} = V_{bb} - V_{OUT}$ = 0.5 V T_S = 85 °C	$I_{L(ISO)}$	0.7	--	--	A
Turn-on time to 90% V_{OUT} Turn-off time to 10% V_{OUT} R_L = 24 Ω	t_{on} t_{off}	-- --	60 60	100 150	µs
Slew rate on 10 to 30% V_{OUT}, R_L = 24 Ω	dV/dt_{on}	--	2	4	V/µs
Slew rate off 70 to 40% V_{OUT}, R_L = 24 Ω	$-dV/dt_{off}$	--	2	4	V/µs

Input

Parameter and Conditions	Symbol	min	typ	max	Unit
Allowable input voltage range, (pin 3 to 2)	V_{IN}	-3.0	--	V_{bb}	V
Input turn-on threshold voltage (rising) T_j = -40...+150°C	$V_{IN(T+)}$	--	--	3.5	V
Input turn-off threshold voltage (falling) T_j = -40...+150°C	$V_{IN(T-)}$	1.5	--	--	V
Input threshold hysteresis	$\Delta V_{IN(T)}$	--	0.5	--	V
Off state input current (pin 3) $V_{IN(off)}$ = 1.2 V T_j = -40...+150°C	$I_{IN(off)}$	10	--	60	µA
On state input current (pin 3) $V_{IN(on)}$ = 3.0 V to V_{bb} T_j = -40...+150°C	$I_{IN(on)}$	10	--	100	µA
Input resistance	R_{IN}	1.5	2.8	3.5	kΩ

7) $I_{L(ISO)}$ is limited by current limitation, see $I_{L(SC)}$

Parameter and Conditions at T_j = 25 °C, V_{bb} = 13.5V unless otherwise specified		Symbol	Values			Unit
			min	typ	max	
Operating Parameters						
Operating voltage[8]	T_j =-40...+150°C	$V_{bb(on)}$	5.0	--	34	V
Undervoltage shutdown	T_j =-40...+150°C	$V_{bb(under)}$	3.5	--	5	V
Undervoltage restart	T_j =-40...+25°C T_j =+150°C	$V_{bb(u\ rst)}$	--	--	6.5 7.0	V
Undervoltage restart of charge pumpe see diagram page 9		$V_{bb(ucp)}$	--	5.6	7	V
Undervoltage hysteresis $\Delta V_{bb(under)} = V_{bb(u\ rst)} - V_{bb(under)}$		$\Delta V_{bb(under)}$	--	0.3	--	V
Overvoltage shutdown	T_j =-40...+150°C	$V_{bb(over)}$	34	--	42	V
Overvoltage restart	T_j =-40...+150°C	$V_{bb(o\ rst)}$	33	--	--	V
Overvoltage hysteresis	T_j =-40...+150°C	$\Delta V_{bb(over)}$	--	0.7	--	V
Standby current (pin 4), V_{in} = low	T_j =-40...+150°C	$I_{bb(off)}$	--	10	25	µA
Operating current (pin 2), V_{in} = 5 V		I_{GND}	--	1	1.6	mA
Leakage current (pin 1) V_{in} = low	T_j =-40...+25°C T_j =150°C	$I_{L(off)}$	--	2	5 7	µA

[8]) At supply voltage increase up to V_{bb}= 5.6 V typ without charge pump, $V_{OUT} \approx V_{bb}$ - 2 V

Parameter and Conditions at T_j = 25 °C, V_{bb} = 13.5V unless otherwise specified	Symbol	Values			Unit
		min	typ	max	

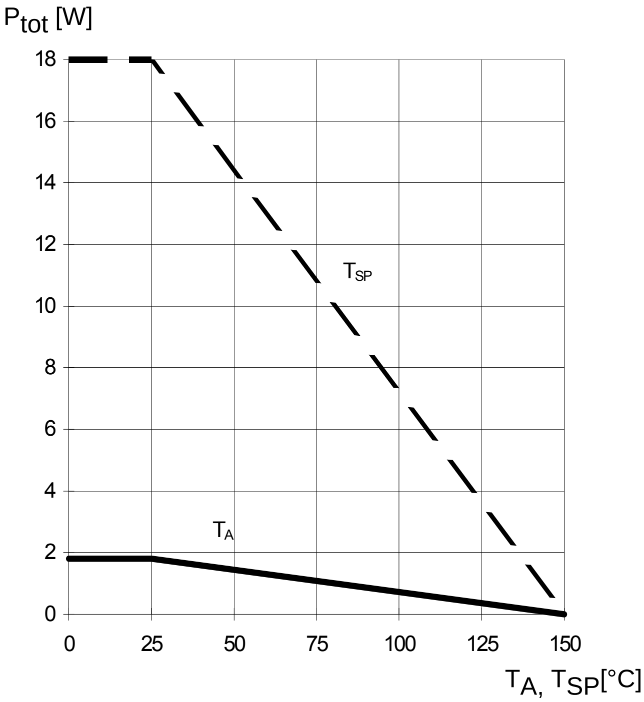
Protection Functions

Current limit (pin 4 to 1) T_j = 25°C V_{bb} = 20V T_j = -40...+150°C	$I_{L(SC)}$	0.7 0.7	1.5 --	2 2.4	A
Overvoltage protection I_{bb}=4mA T_j =-40...+150°C	$V_{bb(AZ)}$	41	--	--	V
Output clamp (ind. load switch off) at $V_{OUT}=V_{bb}-V_{ON(CL)}$, I_{bb} = 4mA	$V_{ON(CL)}$	41	47	--	V
Thermal overload trip temperature	T_{jt}	150	--	--	°C
Thermal hysteresis	ΔT_{jt}	--	10	--	K
Inductive load switch-off energy dissipation[9] $T_{j, start}$ = 150 °C, single pulse, I_L = 0.5 A, V_{bb} = 12 V (not tested, specified by design)	E_{AS}	--	--	0.5	J
Reverse battery (pin 4 to 2) [10] (not tested, specified by design)	$-V_{bb}$	--	--	30	V

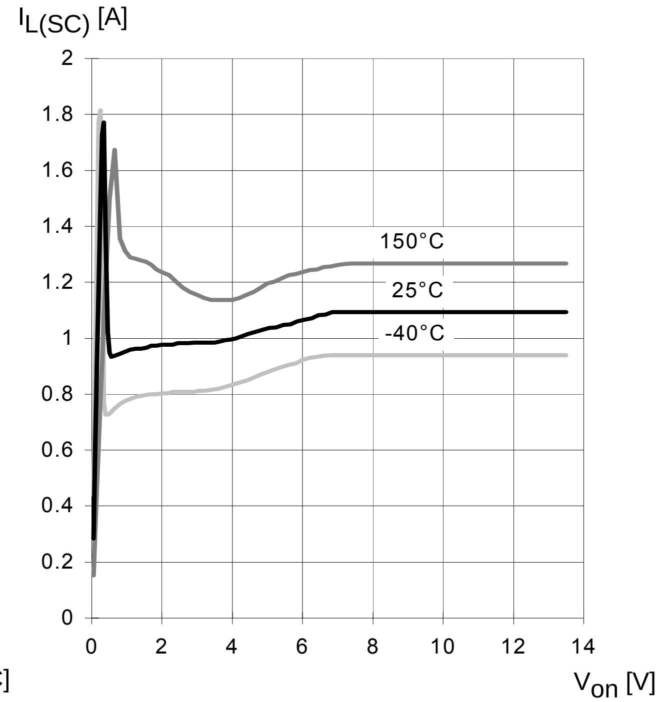
[9] While demagnetizing load inductance, dissipated energy in PROFET is $E_{AS} = \int V_{ON(CL)} * i_L(t)\,dt$, approx.
$E_{AS} = {}^1/_2 * L * I_L^2 * \left(\frac{V_{ON(CL)}}{V_{ON(CL)} - V_{bb}}\right)$

[10] Requires 150 Ω resistor in GND connection. Reverse load current (through intrinsic drain-source diode) has to be limited by the connected load.

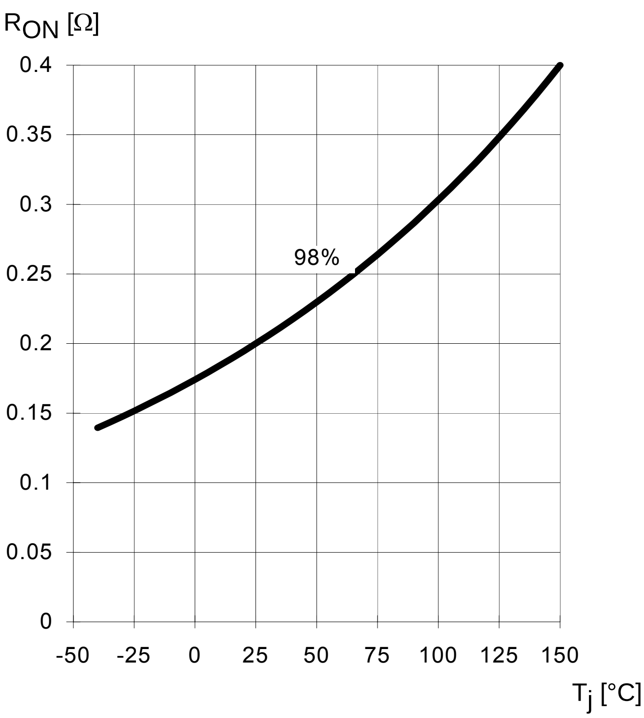
Max. allowable power dissipation
P_{tot} = f (T_A,T_{SP})



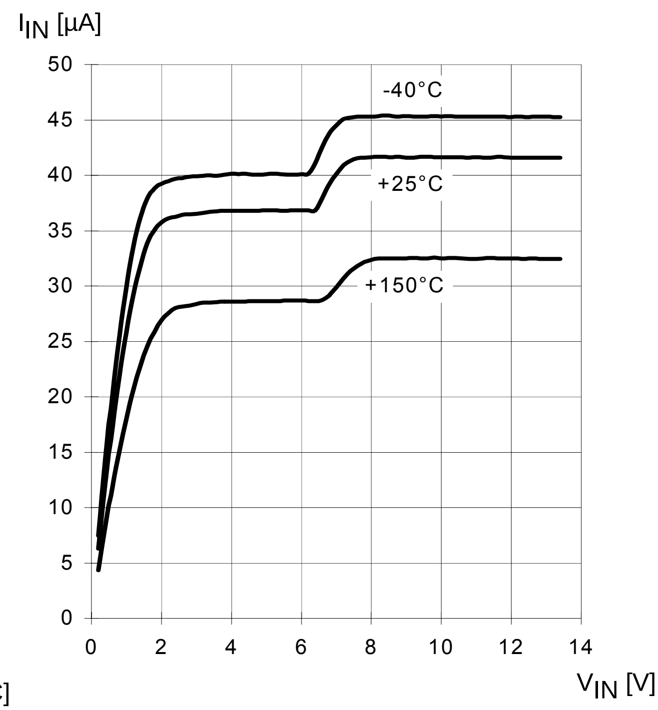
Current limit characteristic
$I_{L(SC)}$ = f (V_{on}); (V_{on} see terms schematic below)



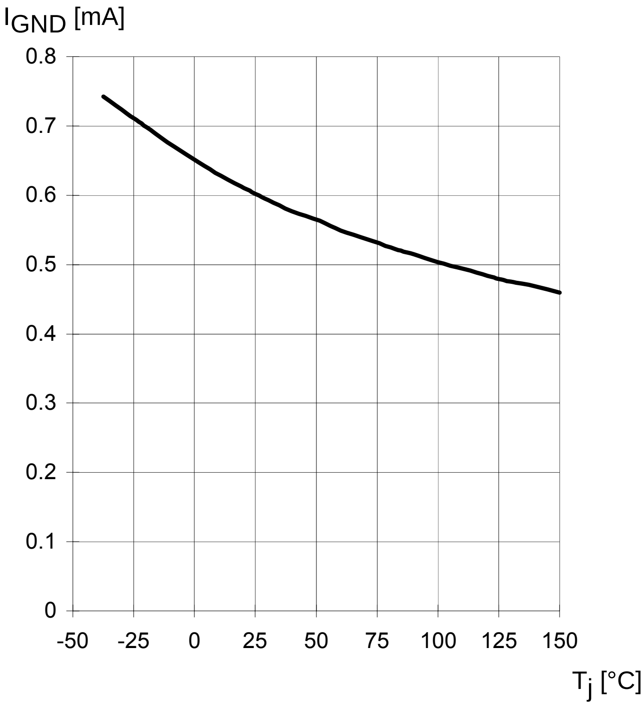
On state resistance (Vbb-pin to OUT-pin)
R_{ON} = f (Tj); V_{bb} = 13.5 V; I_L = 0.5 A



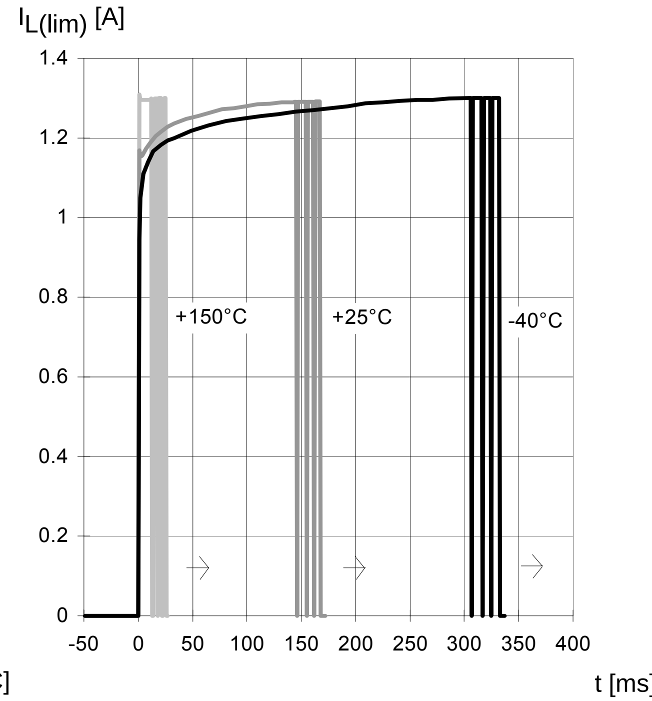
Typ. input current
I_{IN} = f (V_{IN}); V_{bb} = 13.5 V



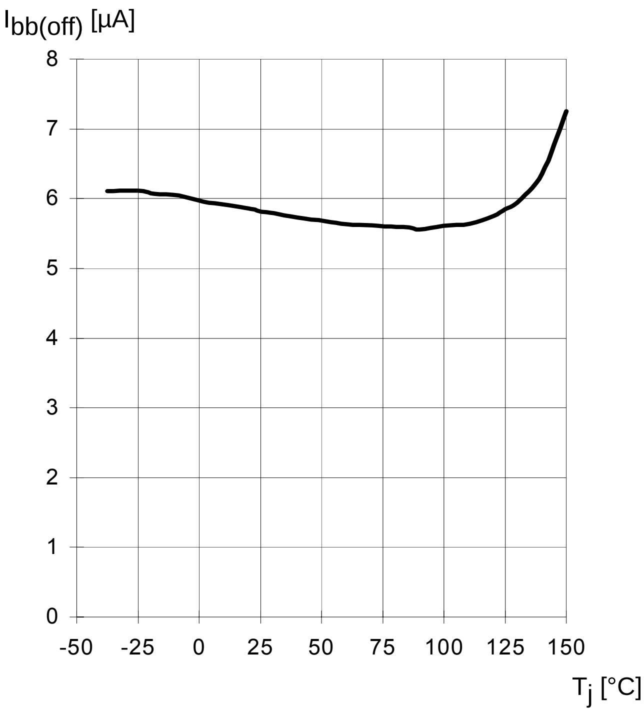
Typ. operating current
I_{GND} = f (T_j); V_{bb} = 13.5 V; V_{IN} = high



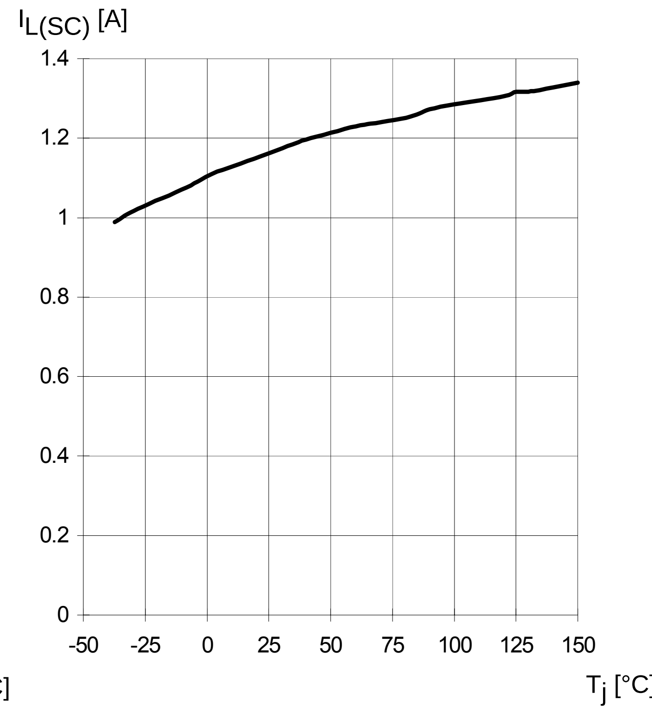
Typ. overload current
$I_{L(lim)}$ = f (t); V_{bb} = 13.5 V, no heatsink, Param.: T_{jstart}



Typ. standby current
$I_{bb(off)}$ = f (T_j); V_{bb} = 13.5 V; V_{IN} = low



Short circuit current
$I_{L(SC)}$ = f (T_j); V_{bb} = 13.5 V



Typ. input turn on voltage threshold
$V_{IN(T+)} = f(T_j)$;

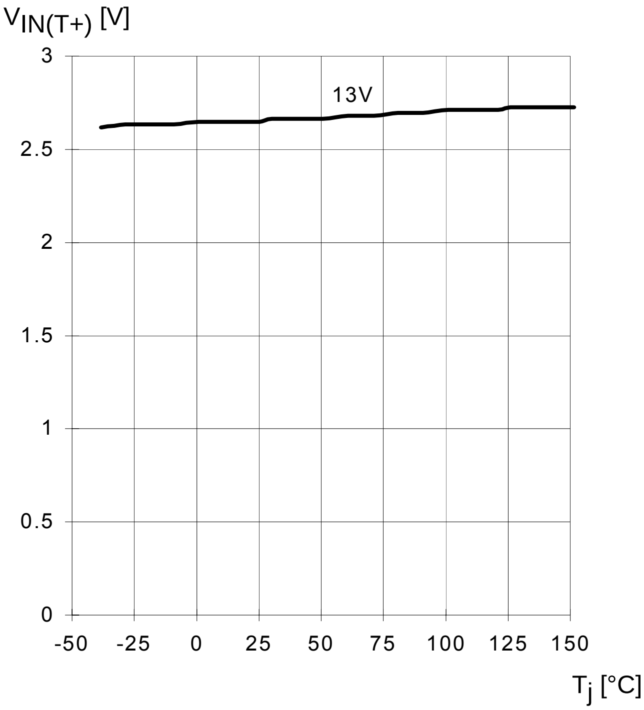
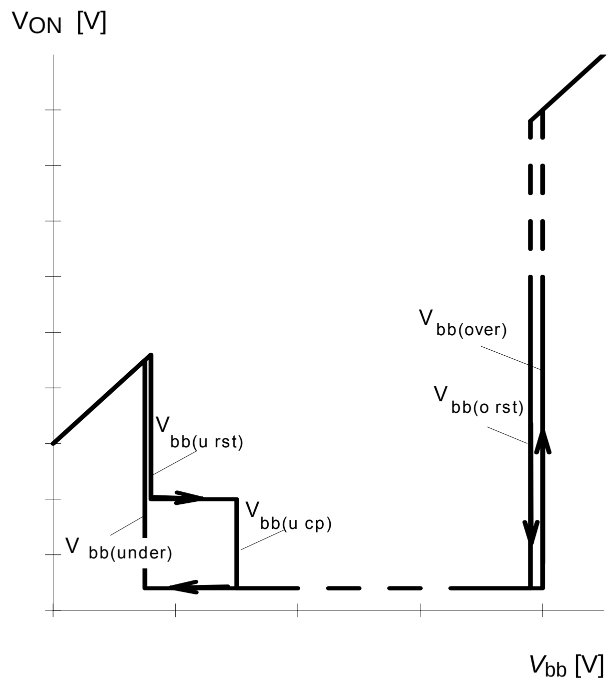
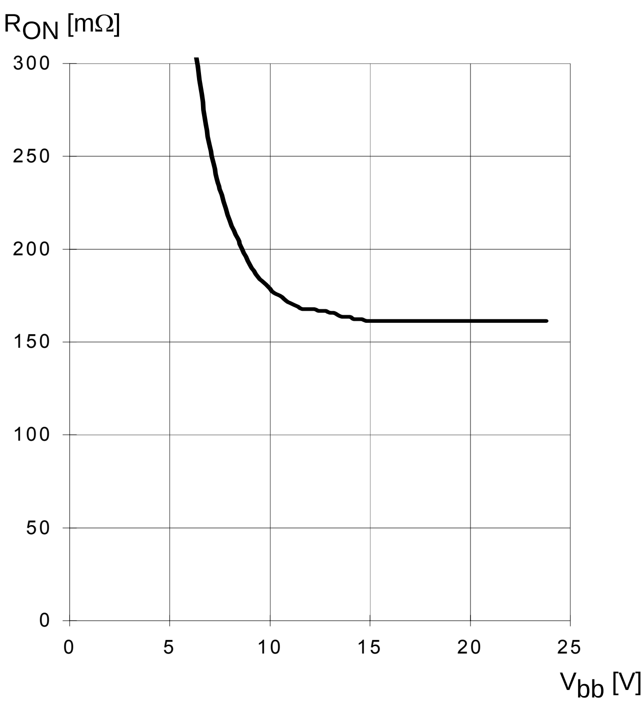


Figure 6: Undervoltage restart of charge pumpe

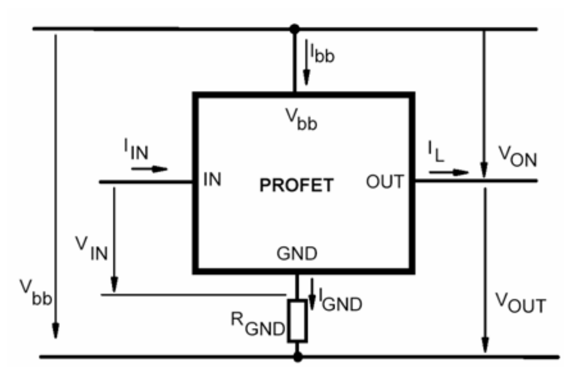


charge pump starts at $V_{bb(ucp)}$, about 5.6 V typ.

Typ. on-state resistance (Vbb-Pin to Out-Pin)
$R_{ON} = f(V_{bb}, I_L)$; I_L=0.5A, T_j = 25°C



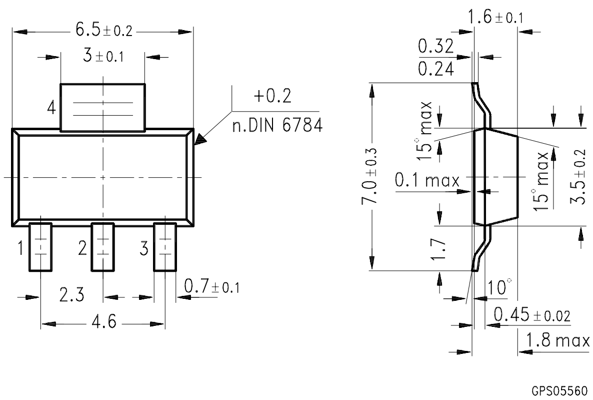
Terms



Package:

all dimensions in mm.

PG-SOT 223:



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