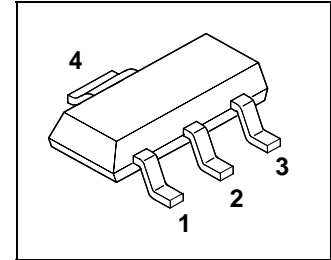


Smart Power High-Side-Switch for Industrial Applications

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
- Electrostatic discharge (**ESD**) protection
- Reverse battery protection¹⁾



Package: PG-SOT 223

Type	Ordering code
ISP 452	SP000219823

Application

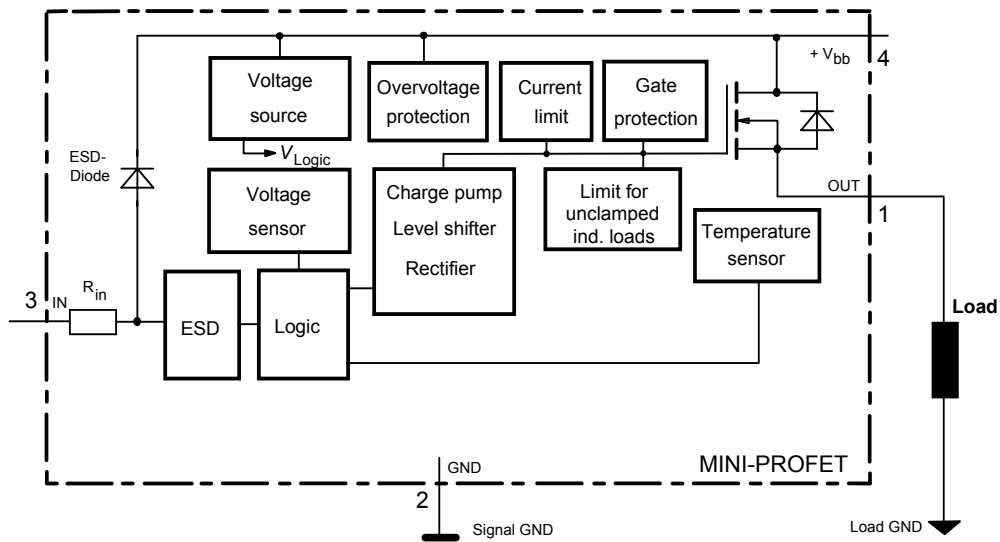
- μ C compatible power switch for 12 V DC grounded loads for industrial applications
- All types of resistive, inductive and capacitive loads
- Replaces electromechanical relays and discrete circuits

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 $R_{GND}=150\ \Omega$ 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 $T_j = 25\text{ °C}$ 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 $I_L = 0.5\text{A}$, $T_{j, start} = 150\text{°C}$ (not tested, specified by design)	E_{AS}	0.5	J
Load dump protection ³⁾ $V_{LoadDump} = U_A + V_S$ $R_I = 2\ \Omega$, $t_d = 400\text{ms}$, IN= low or high, $U_A = 13.5\text{ V}$ (not tested, specified by design) $R_L = 24\ \Omega$ $R_L = 80\ \Omega$	$V_{Load\ dump}^{4)}$	60 80	V
Electrostatic discharge capability (ESD) ⁵⁾ PIN 3 PIN 1,2,4	V_{ESD}	±1 ±2	kV
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⁾ $T_A = 25\text{ °C}$	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 cm² copper area for V_{bb} connection



Electrical Characteristics

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

Load Switching Capabilities and Characteristics

On-state resistance (pin 4 to 1) $I_L = 0.5\text{ A}$, $V_{in} = \text{high}$	$T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	R_{ON}	--	0.16	0.2	Ω
Nominal load current (pin 4 to 1) ⁷⁾ ISO Standard: $V_{ON} = V_{bb} - V_{OUT} = 0.5\text{ V}$ $T_S = 85^\circ\text{C}$		$I_{L(ISO)}$	0.7	--	--	A
Turn-on time Turn-off time $R_L = 24\ \Omega$	to 90% V_{OUT} to 10% V_{OUT}	t_{on} t_{off}	--	60	100	μs
Slew rate on 10 to 30% V_{OUT} , $R_L = 24\ \Omega$		dV/dt_{on}	--	2	4	$\text{V}/\mu\text{s}$
Slew rate off 70 to 40% V_{OUT} , $R_L = 24\ \Omega$		$-dV/dt_{off}$	--	2	4	$\text{V}/\mu\text{s}$

Input

Allowable input voltage range, (pin 3 to 2)		V_{IN}	-3.0	--	V_{bb}	V
Input turn-on threshold voltage  $T_j = -40\dots+150^\circ\text{C}$		$V_{IN(T+)}$	--	--	3.5	V
Input turn-off threshold voltage  $T_j = -40\dots+150^\circ\text{C}$		$V_{IN(T-)}$	1.5	--	--	V
Input threshold hysteresis		$\Delta V_{IN(T)}$	--	0.5	--	V
Off state input current (pin 3) $V_{IN(off)} = 1.2\text{ V}$ $T_j = -40\dots+150^\circ\text{C}$		$I_{IN(off)}$	10	--	60	μA
On state input current (pin 3) $V_{IN(on)} = 3.0\text{ V to } V_{bb}$ $T_j = -40\dots+150^\circ\text{C}$		$I_{IN(on)}$	10	--	100	μA
Input resistance		R_{IN}	1.5	2.8	3.5	$\text{k}\Omega$

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

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

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

Parameter and Conditions at $T_j = 25\text{ °C}$, $V_{bb} = 13.5\text{V}$ unless otherwise specified	Symbol	Values			Unit
		min	typ	max	
Protection Functions					
Current limit (pin 4 to 1) $V_{bb} = 20\text{V}$	$I_{L(SC)}$	0.7	1.5	2	A
$T_j = 25\text{ °C}$					
$T_j = -40\dots+150\text{ °C}$		0.7	--	2.4	
Overvoltage protection $I_{bb}=4\text{mA}$	$V_{bb(AZ)}$	41	--	--	V
$T_j = -40\dots+150\text{ °C}$					
Output clamp (ind. load switch off) at $V_{OUT}=V_{bb}-V_{ON(CL)}$, $I_{bb} = 4\text{mA}$	$V_{ON(CL)}$	41	47	--	V
Thermal overload trip temperature	T_{jt}	150	--	--	°C
Thermal hysteresis	ΔT_{jt}	--	10	--	K
Inductive load switch-off energy dissipation ⁹⁾ $T_{j, start} = 150\text{ °C}$, single pulse, $I_L = 0.5\text{ A}$, $V_{bb} = 12\text{ V}$ (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

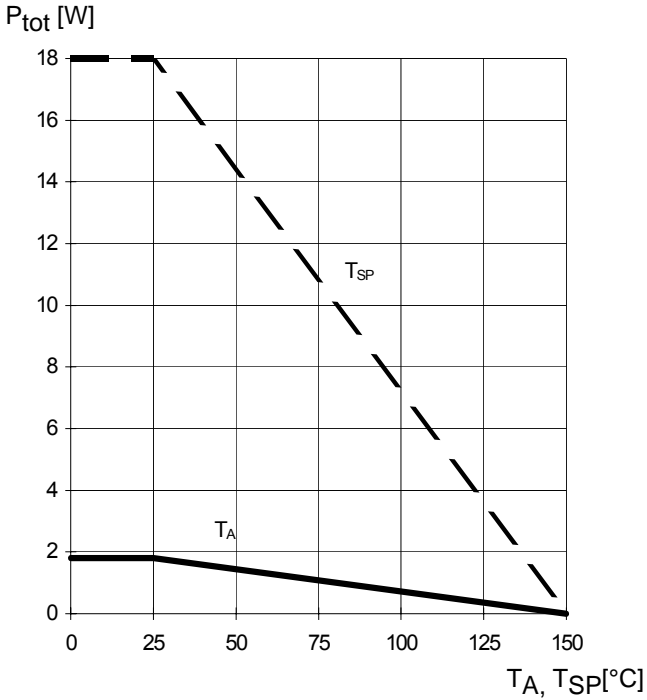
⁹⁾ While demagnetizing load inductance, dissipated energy in PROFET is $E_{AS} = \int V_{ON(CL)} * i_L(t) dt$, approx.

$$E_{AS} = \frac{1}{2} * L * I_L^2 * \left(\frac{V_{ON(CL)}}{V_{ON(CL)} - V_{bb}} \right)$$

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

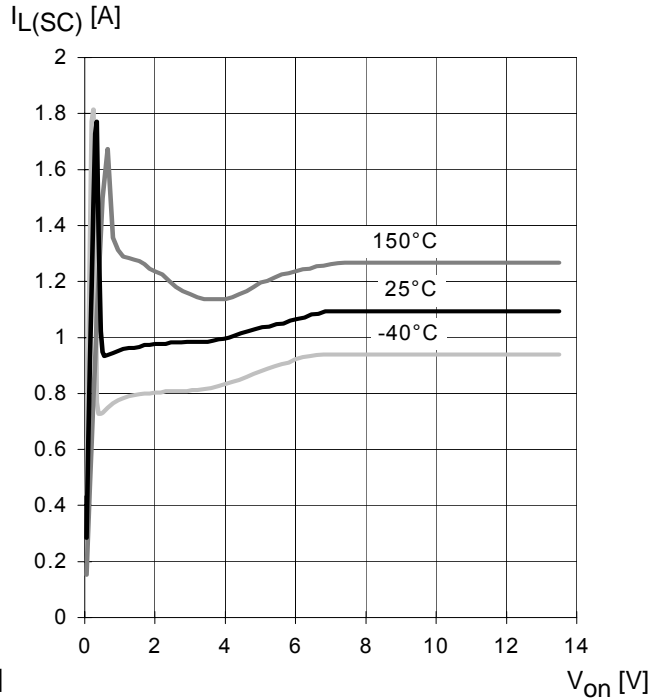
Max. allowable power dissipation

$P_{tot} = f(T_A, T_{SP})$



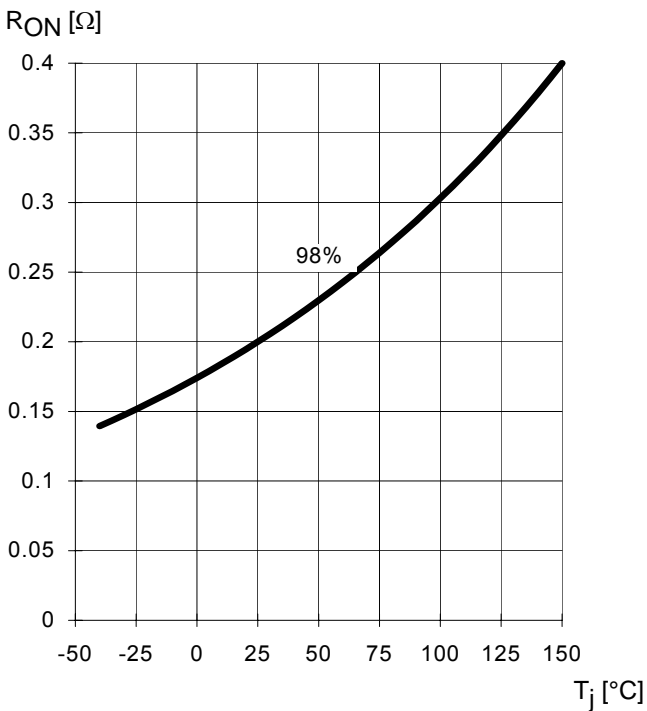
Current limit characteristic

$I_{L(SC)} = f(V_{on}); (V_{on} \text{ see terms schematic below})$



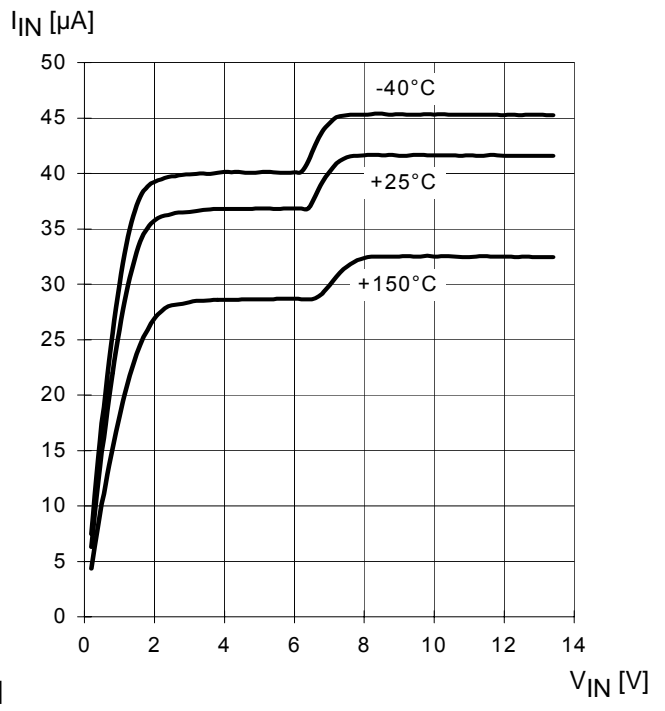
On state resistance (Vbb-pin to OUT-pin)

$R_{ON} = f(T_j); V_{bb} = 13.5 \text{ V}; I_L = 0.5 \text{ A}$



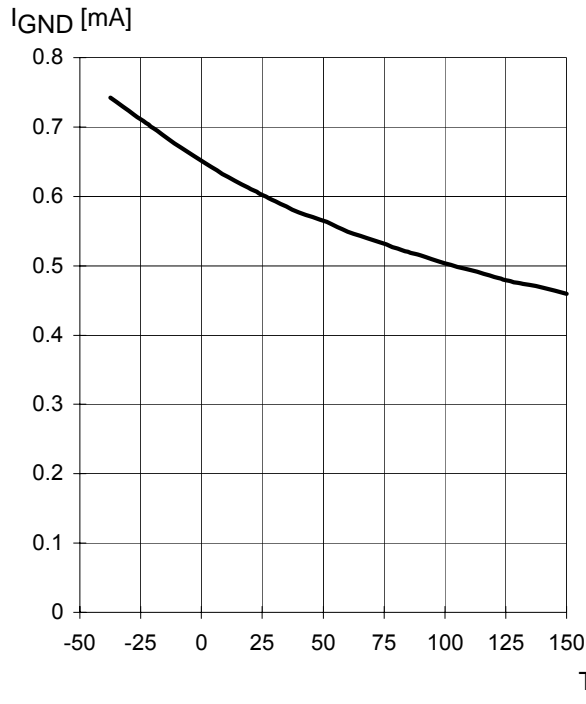
Typ. input current

$I_{IN} = f(V_{IN}); V_{bb} = 13.5 \text{ V}$



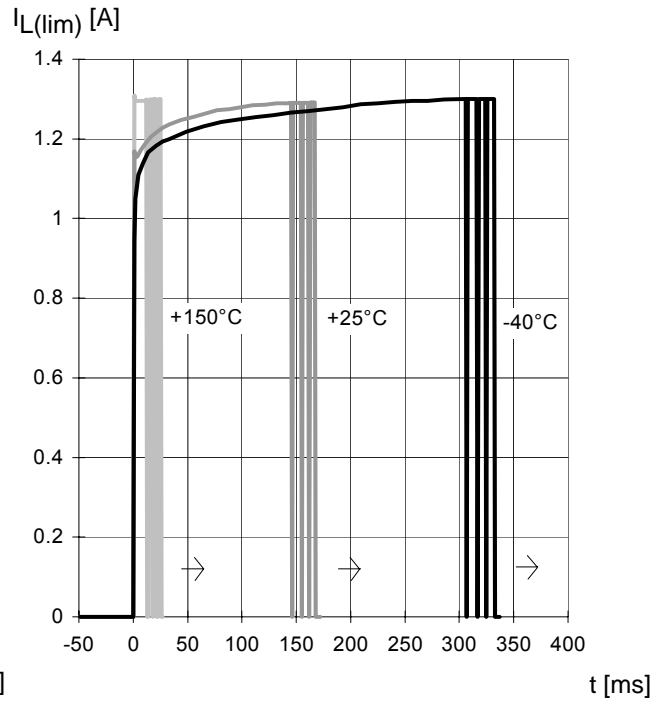
Typ. operating current

$I_{GND} = f(T_j)$; $V_{bb} = 13.5\text{ V}$; $V_{IN} = \text{high}$



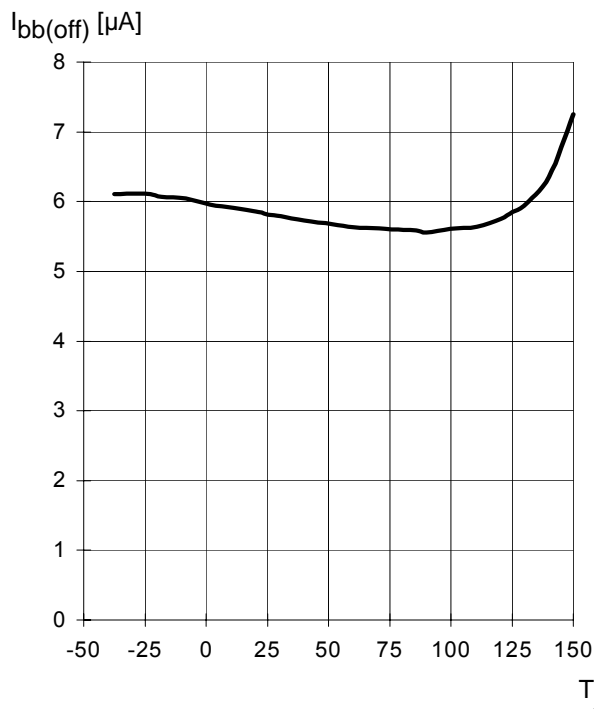
Typ. overload current

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



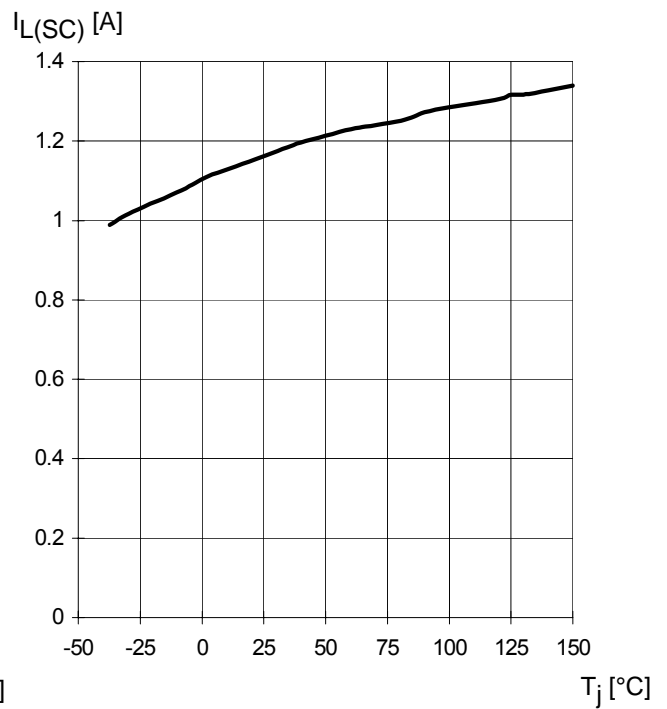
Typ. standby current

$I_{bb(off)} = f(T_j)$; $V_{bb} = 13.5\text{ V}$; $V_{IN} = \text{low}$



Short circuit current

$I_{L(SC)} = f(T_j)$; $V_{bb} = 13.5\text{ V}$



Typ. input turn on voltage threshold

$$V_{IN(T+)} = f(T_j);$$

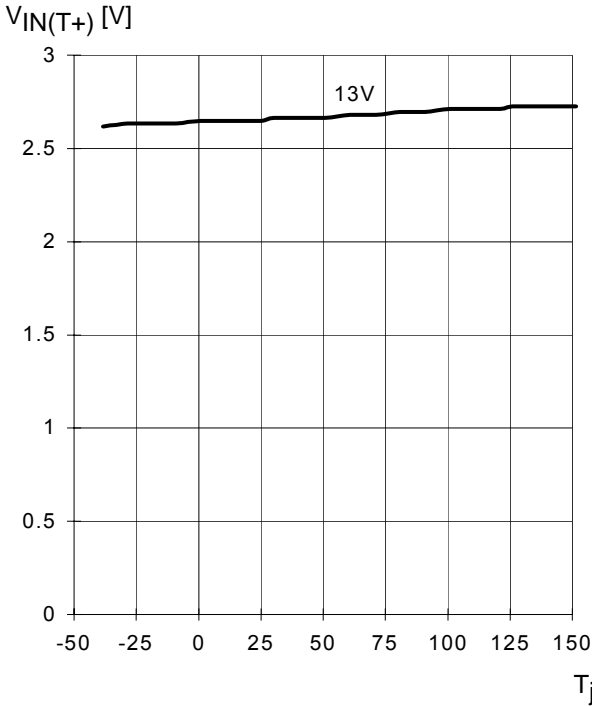
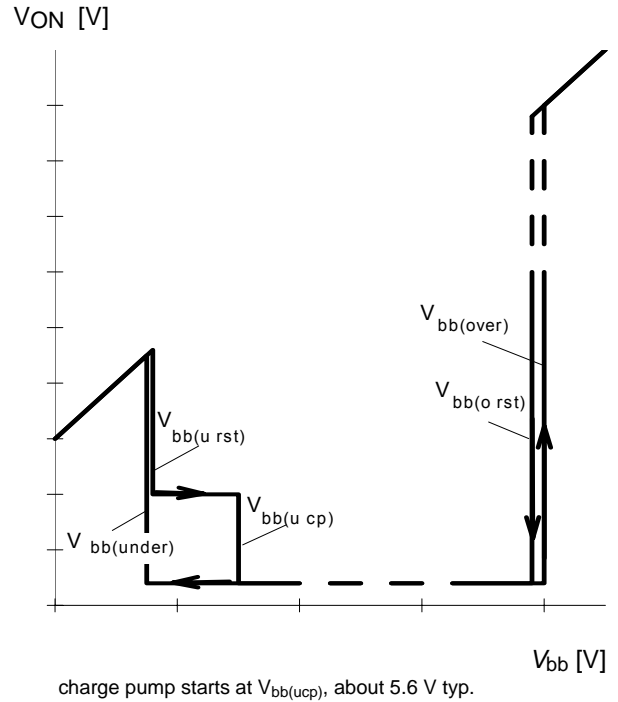


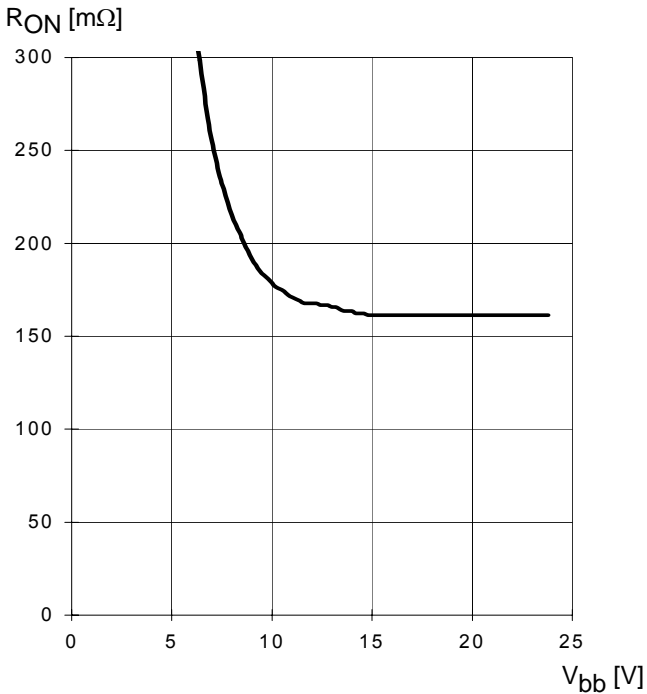
Figure 6: Undervoltage restart of charge pump



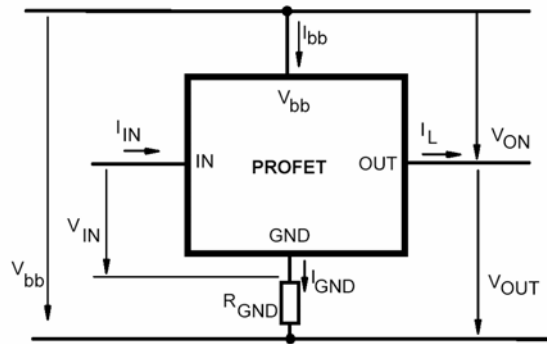
charge pump starts at $V_{bb(ucp)}$, about 5.6 V typ.

Typ. on-state resistance (Vbb-Pin to Out-Pin)

$$R_{ON} = f(V_{bb}, I_L); I_L = 0.5A, T_j = 25^\circ C$$



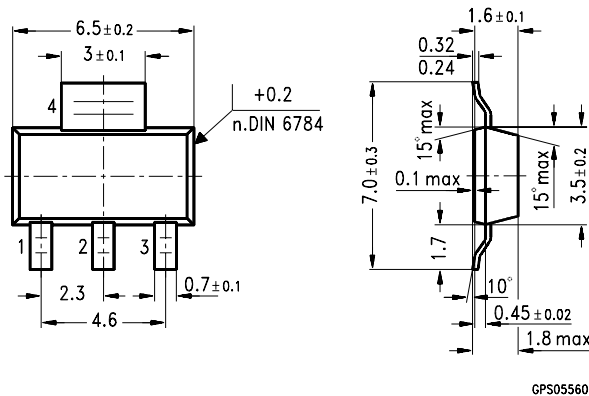
Terms



Package:

all dimensions in mm.

PG-SOT 223:



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