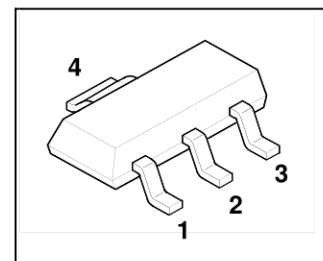


Smart Power High-Side-Switch for Industrial Applications

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.

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 $T_j = 25^\circ\text{C}$ 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}	$-5.0 \dots V_{bb}$	V
Maximum input current	I_{IN}	± 5	mA
Inductive load switch-off energy dissipation, single pulse $I_L = 0.5\text{A}$, $T_{j, \text{start}} = 150^\circ\text{C}$ (not tested, specified by design)	E_{AS}	0.5	J
Load dump protection ³⁾ $V_{\text{LoadDump}} = U_A + V_S$ $R_L = 2\ \Omega$, $t_d = 400\text{ms}$, $IN = \text{low or high}$, $U_A = 13.5\text{ V}$ (not tested, specified by design) $R_L = 24\ \Omega$ $R_L = 80\ \Omega$	$V_{\text{Load dump}}^{4)}$	60 80	V
Electrostatic discharge capability (ESD) ⁵⁾ PIN 3 PIN 1,2,4	V_{ESD}	± 1 ± 2	kV
Junction Temperature	T_j	150	$^\circ\text{C}$
Operating temperature range	T_a	$-30 \dots +85$	
Storage temperature range	T_{stg}	$-40 \dots +105$	
Max. power dissipation (DC) ⁶⁾ $T_A = 25^\circ\text{C}$	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 $\pm 5\text{ mA}$.

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

⁴⁾ $V_{\text{Load dump}}$ 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 $T_j = 25^\circ\text{C}$, $V_{bb} = 13.5\text{V}$ 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 0.4	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 to 90% V_{OUT} $R_L = 24\ \Omega$	t_{on}	--	60	100	μs
Turn-off time to 10% V_{OUT}	t_{off}	--	60	150	μs
Slew rate on 10 to 30% V_{OUT} , $R_L = 24\ \Omega$	dV/dt_{on}	--	2	4	V/ μs
Slew rate off 70 to 40% V_{OUT} , $R_L = 24\ \Omega$	$-dV/dt_{off}$	--	2	4	V/ μs

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	k Ω

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

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	

Operating Parameters

Operating voltage ⁸⁾	$T_j = -40\dots+150^\circ\text{C}$	$V_{bb(\text{on})}$	5.0	--	34	V
Undervoltage shutdown	$T_j = -40\dots+150^\circ\text{C}$	$V_{bb(\text{under})}$	3.5	--	5	V
Undervoltage restart	$T_j = -40\dots+25^\circ\text{C}$ $T_j = +150^\circ\text{C}$	$V_{bb(\text{u rst})}$	--	--	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	$T_j = -40\dots+150^\circ\text{C}$	$V_{bb(\text{over})}$	34	--	42	V
Overvoltage restart	$T_j = -40\dots+150^\circ\text{C}$	$V_{bb(\text{o rst})}$	33	--	--	V
Overvoltage hysteresis	$T_j = -40\dots+150^\circ\text{C}$	$\Delta V_{bb(\text{over})}$	--	0.7	--	V
Standby current (pin 4), $V_{in} = \text{low}$	$T_j = -40\dots+150^\circ\text{C}$	$I_{bb(\text{off})}$	--	10	25	μA
Operating current (pin 2), $V_{in} = 5\text{ V}$		I_{GND}	--	1	1.6	mA
Leakage current (pin 1) $V_{in} = \text{low}$	$T_j = -40\dots+25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	$I_{\text{L}(\text{off})}$	--	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 $T_j = 25^\circ\text{C}$, $V_{bb} = 13.5\text{V}$ unless otherwise specified	Symbol	Values			Unit
		min	typ	max	

Protection Functions

Current limit (pin 4 to 1) $V_{bb} = 20\text{V}$	$T_j = 25^\circ\text{C}$ $T_j = -40\dots+150^\circ\text{C}$	$I_{L(SC)}$	0.7 0.7	1.5 --	2 2.4	A
Overvoltage protection $I_{bb}=4\text{mA}$	$T_j = -40\dots+150^\circ\text{C}$	$V_{bb(AZ)}$	41	--	--	V
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	--	--	$^\circ\text{C}$
Thermal hysteresis		ΔT_{jt}	--	10	--	K
Inductive load switch-off energy dissipation ⁹⁾ $T_{j, \text{start}} = 150^\circ\text{C}$, 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

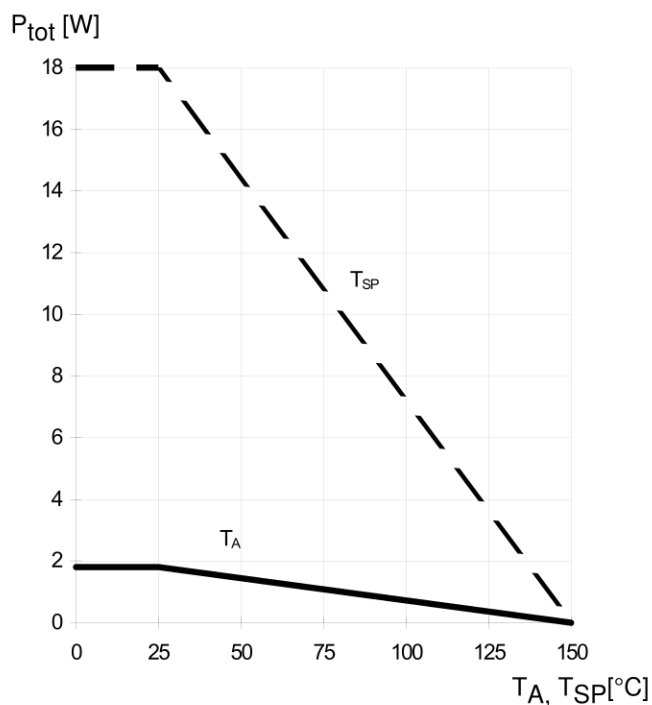
⁹⁾ While demagnetizing load inductance, dissipated energy in PROFET is $E_{AS} = \int V_{ON(CL)} * i_L(t) dt$, approx.

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

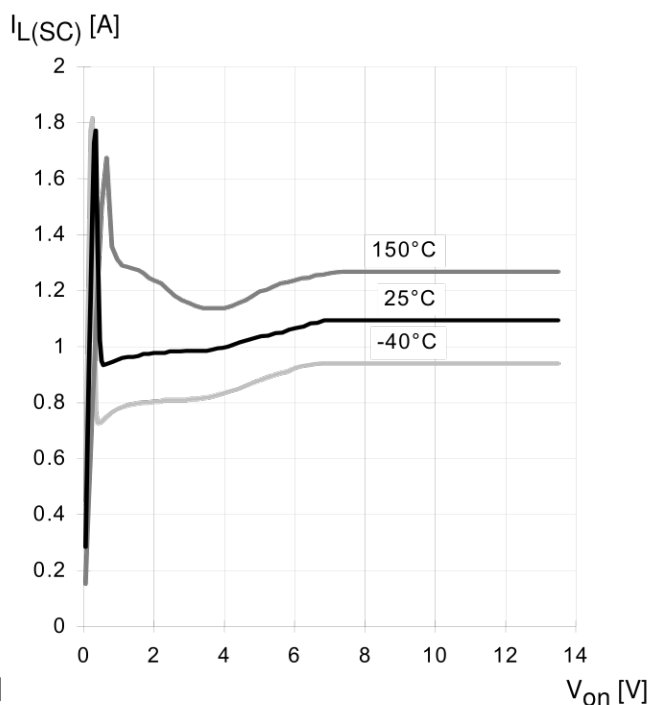
¹⁰⁾ Requires $150\ \Omega$ resistor in GND connection. Reverse load current (through intrinsic drain-source diode) has to be limited by the connected load.

Max. allowable power dissipation

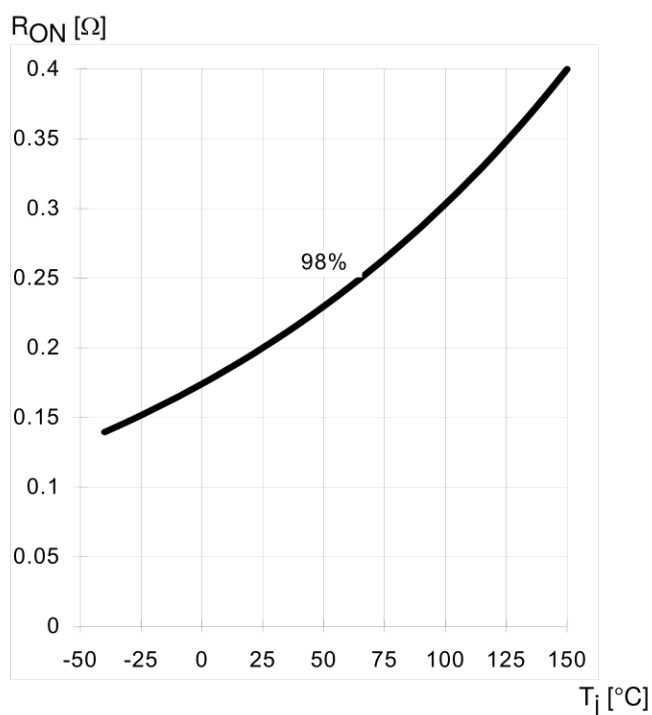
$$P_{\text{tot}} = f(T_A, T_{\text{SP}})$$


Current limit characteristic

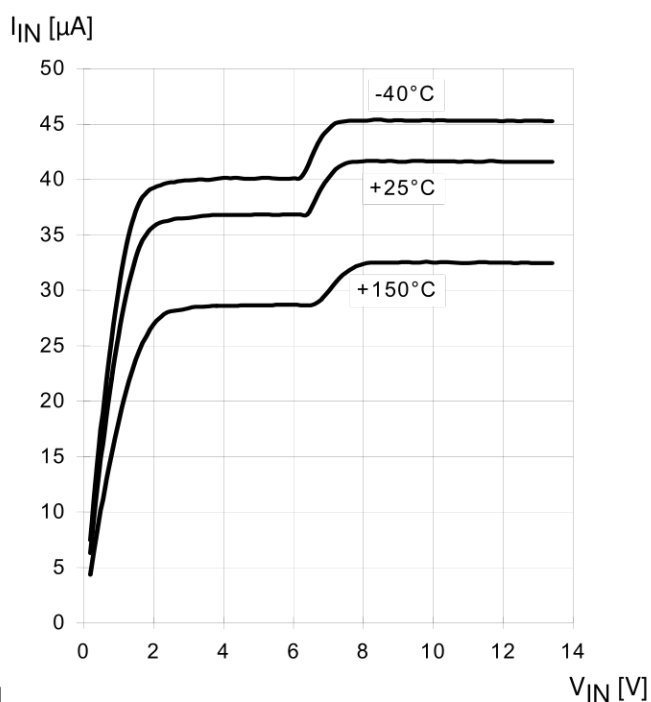
$$I_{\text{L(SC)}} = f(V_{\text{on}}); (V_{\text{on}} \text{ see terms schematic below})$$

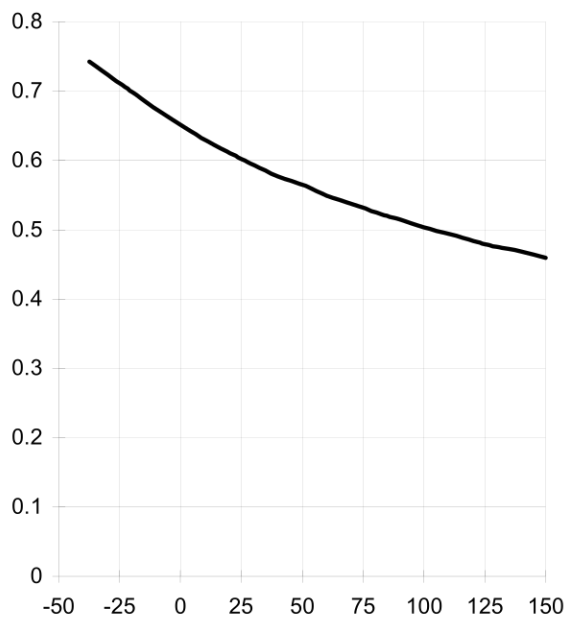

On state resistance (Vbb-pin to OUT-pin)

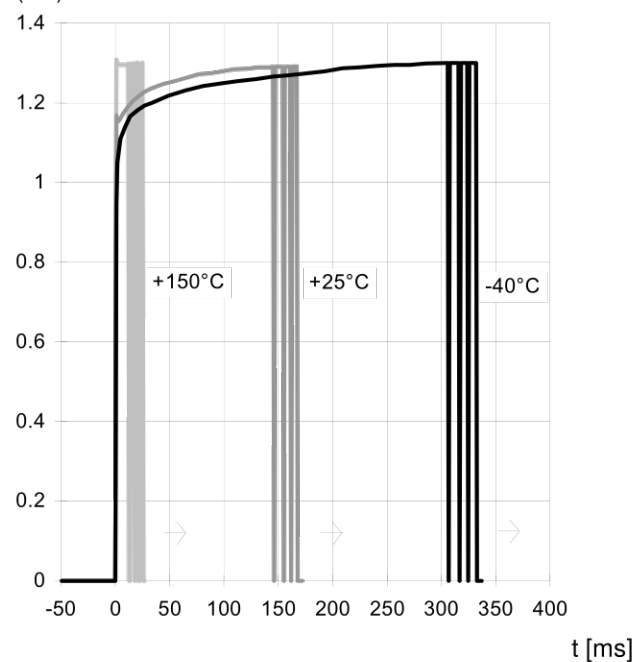
$$R_{\text{ON}} = f(T_j); V_{\text{bb}} = 13.5 \text{ V}; I_{\text{L}} = 0.5 \text{ A}$$

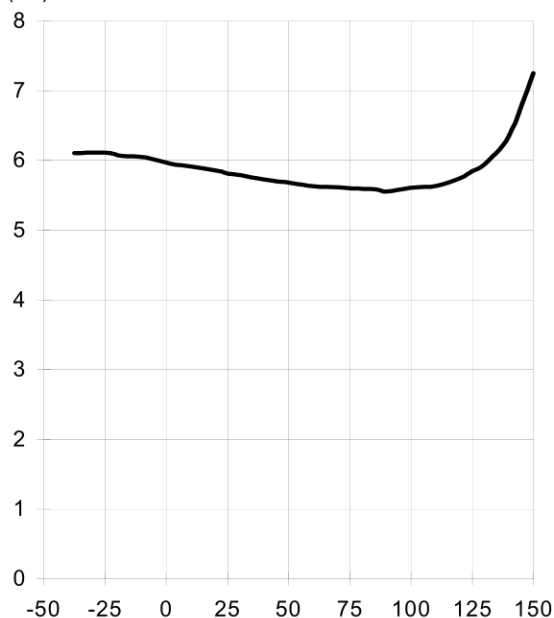

Typ. input current

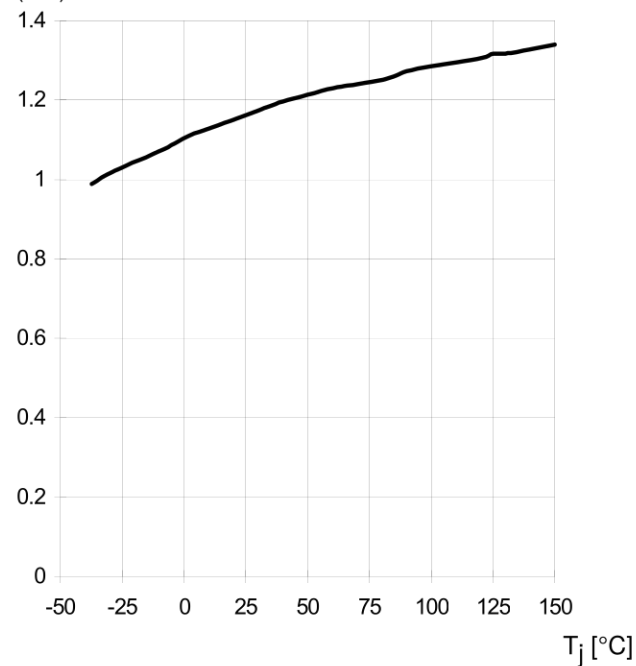
$$I_{\text{IN}} = f(V_{\text{IN}}); V_{\text{bb}} = 13.5 \text{ V}$$



Typ. operating current
 $I_{GND} = f(T_j)$; $V_{bb} = 13.5\text{ V}$; $V_{IN} = \text{high}$
 $I_{GND} [\text{mA}]$

 T_j [°C]

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

 t [ms]

Typ. standby current
 $I_{bb(off)} = f(T_j)$; $V_{bb} = 13.5\text{ V}$; $V_{IN} = \text{low}$
 $I_{bb(off)} [\mu\text{A}]$

 T_j [°C]

Short circuit current
 $I_{L(SC)} = f(T_j)$; $V_{bb} = 13.5\text{ V}$
 $I_{L(SC)} [\text{A}]$

 T_j [°C]

Typ. input turn on voltage threshold

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

$V_{IN(T+)} [V]$

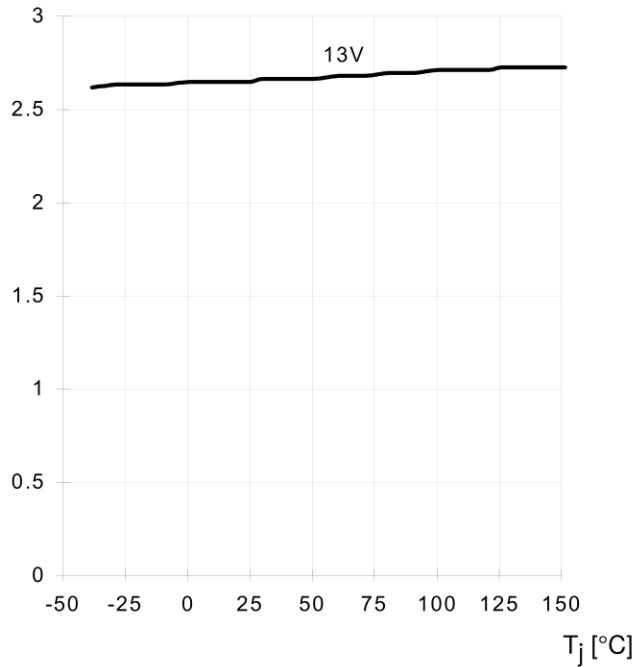
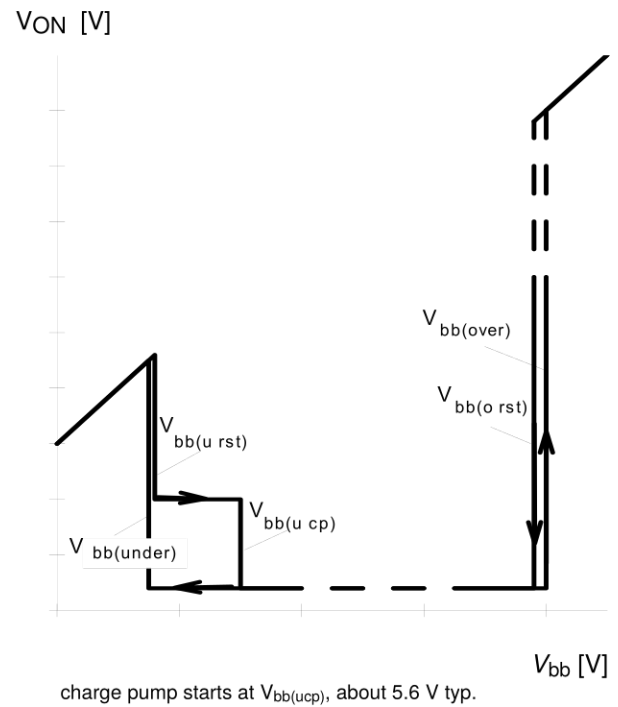


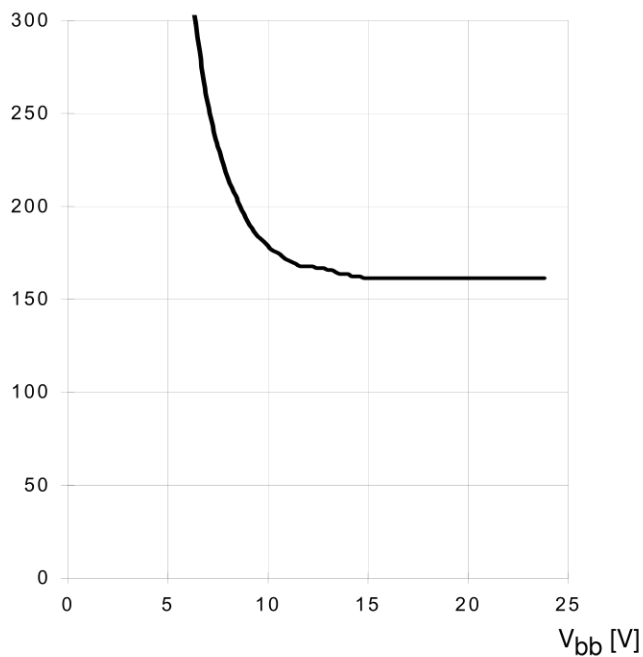
Figure 6: Undervoltage restart of charge pump



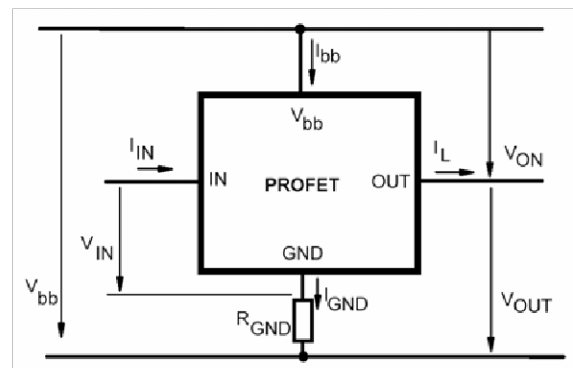
Typ. on-state resistance (Vbb-Pin to Out-Pin)

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

$R_{ON} [m\Omega]$

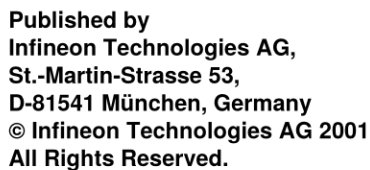


Terms



all dimensions in mm.

PG-SOT 223:



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