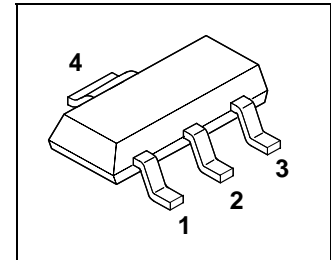


Smart Power High-Side-Switch for Industrial Applications

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

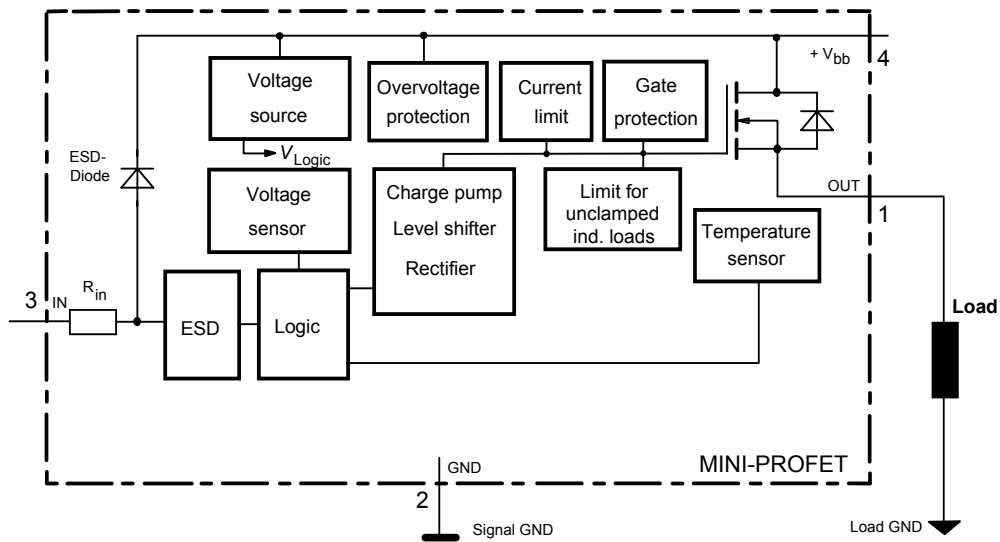
- μ C compatible power switch for 12 V DC grounded loads for industrial applications
- All types of resistive, inductive and capacitive loads
- Replaces electromechanical relays and discrete circuits

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⁾ $V_{LoadDump} = U_A + V_S$ $R_l = 2\ \Omega$, $t_d = 400\text{ms}$, 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 $T_j = 25\text{ °C}$, $V_{bb} = 13.5\text{V}$ unless otherwise specified | Symbol | Values | | | Unit |
|--|--------|--------|-----|-----|------|
| | | min | typ | max | |

Load Switching Capabilities and Characteristics

| | | | | | | |
|---|---|-----------------------|----------|------------|------------|------------------------|
| On-state resistance (pin 4 to 1) $I_L = 0.5\text{ A}$, $V_{in} = \text{high}$ | $T_j = 25\text{ °C}$ $T_j = 150\text{ °C}$ | R_{ON} | -- -- | 0.16 -- | 0.2 0.4 | Ω |
| Nominal load current (pin 4 to 1) ⁷⁾ ISO Standard: $V_{ON} = V_{bb} - V_{OUT} = 0.5\text{ V}$ $T_S = 85\text{ °C}$ | | $I_{L(ISO)}$ | 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 60 | 100 150 | 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  $T_j = -40\dots+150\text{ °C}$ | | $V_{IN(T+)}$ | -- | -- | 3.5 | V |
| Input turn-off threshold voltage  $T_j = -40\dots+150\text{ °C}$ | | $V_{IN(T-)}$ | 1.5 | -- | -- | V |
| Input threshold hysteresis | | $\Delta V_{IN(T)}$ | -- | 0.5 | -- | V |
| Off state input current (pin 3) $V_{IN(off)} = 1.2\text{ V}$ $T_j = -40\dots+150\text{ °C}$ | | $I_{IN(off)}$ | 10 | -- | 60 | μA |
| On state input current (pin 3) $V_{IN(on)} = 3.0\text{ V to } V_{bb}$ $T_j = -40\dots+150\text{ °C}$ | | $I_{IN(on)}$ | 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 pump 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 |

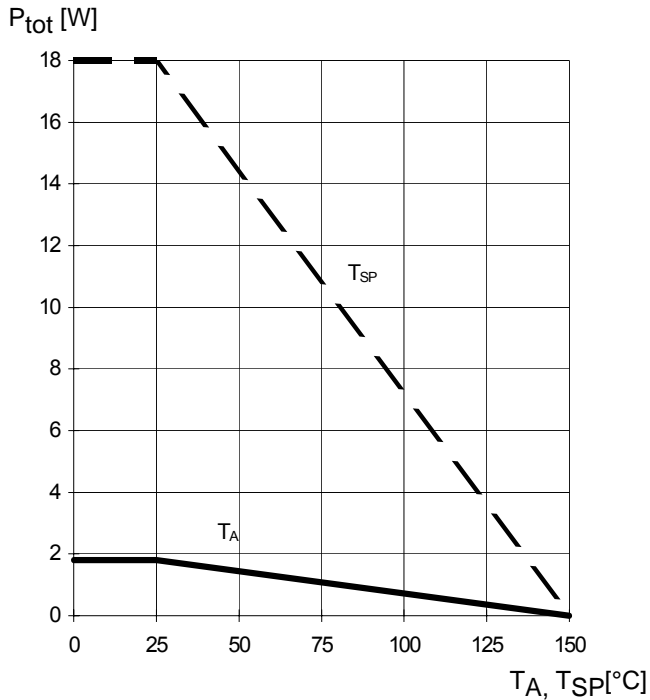
⁹⁾ While demagnetizing load inductance, dissipated energy in PROFET is $E_{AS} = \int V_{ON(CL)} * i_L(t) dt$, approx.

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

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

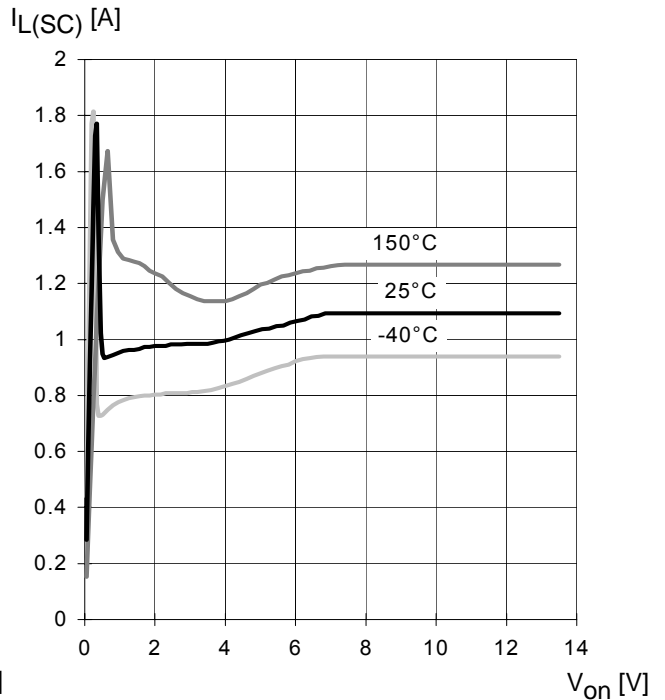
Max. allowable power dissipation

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



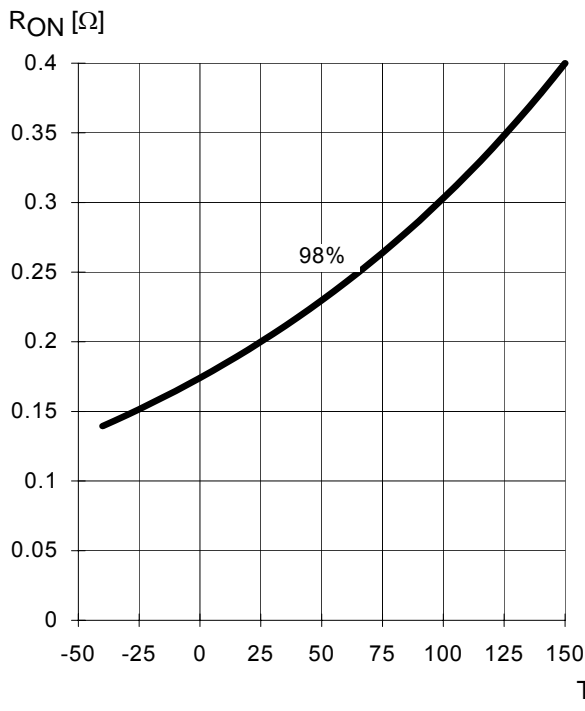
Current limit characteristic

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



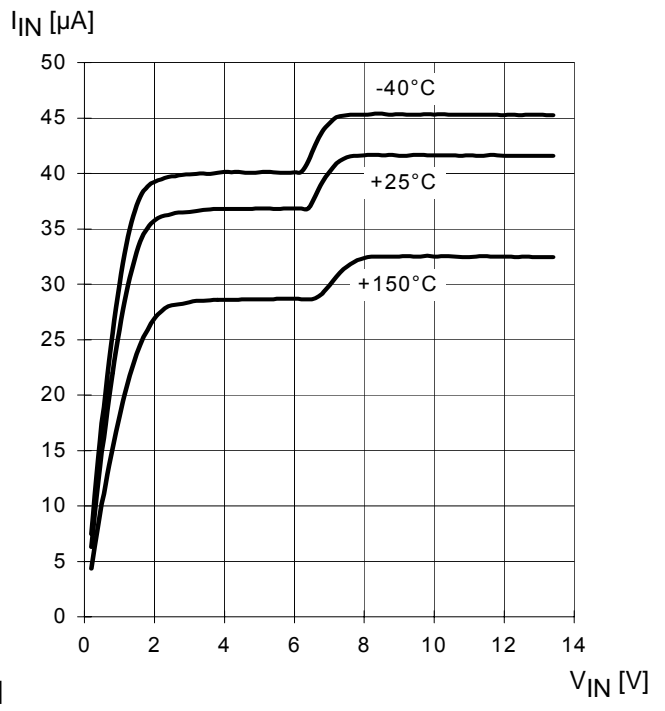
On state resistance (Vbb-pin to OUT-pin)

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



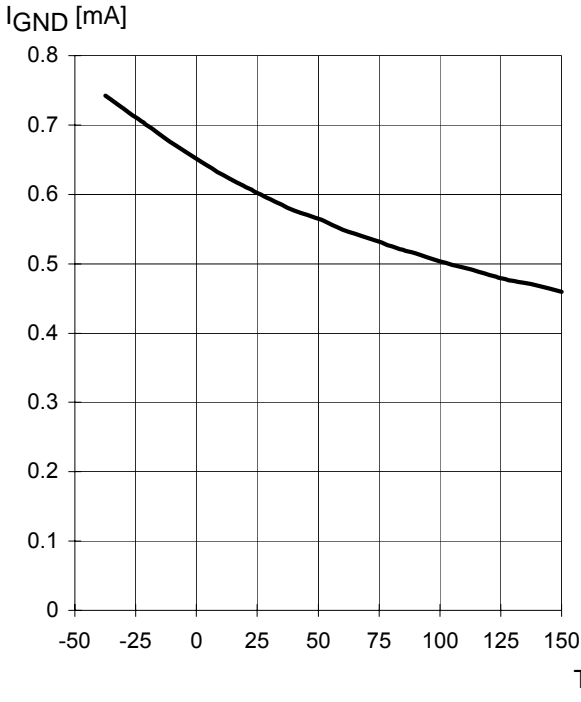
Typ. input current

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



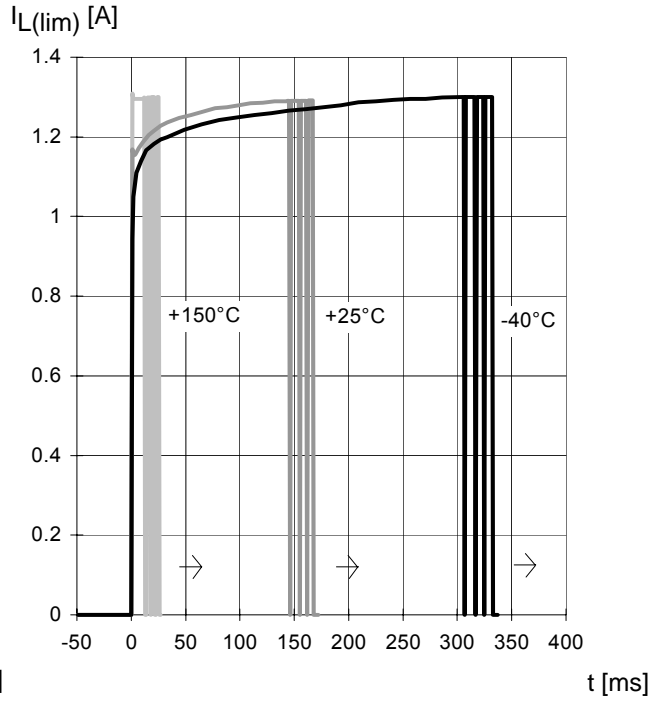
Typ. operating current

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



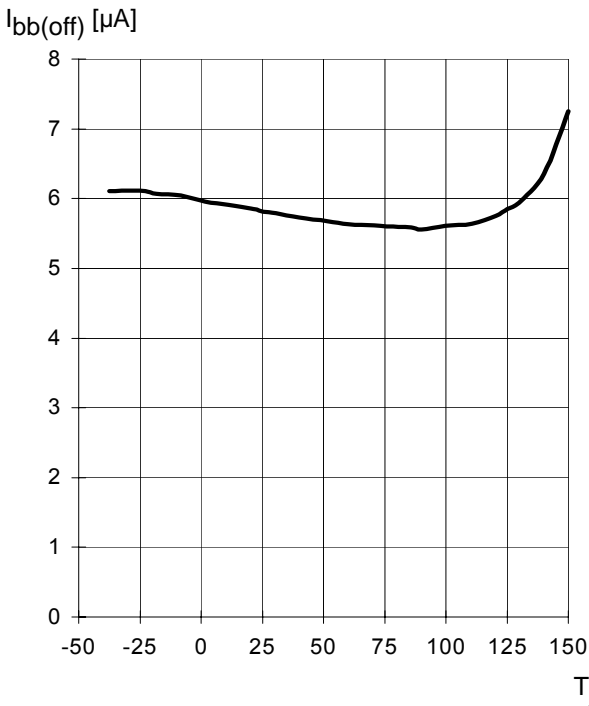
Typ. overload current

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



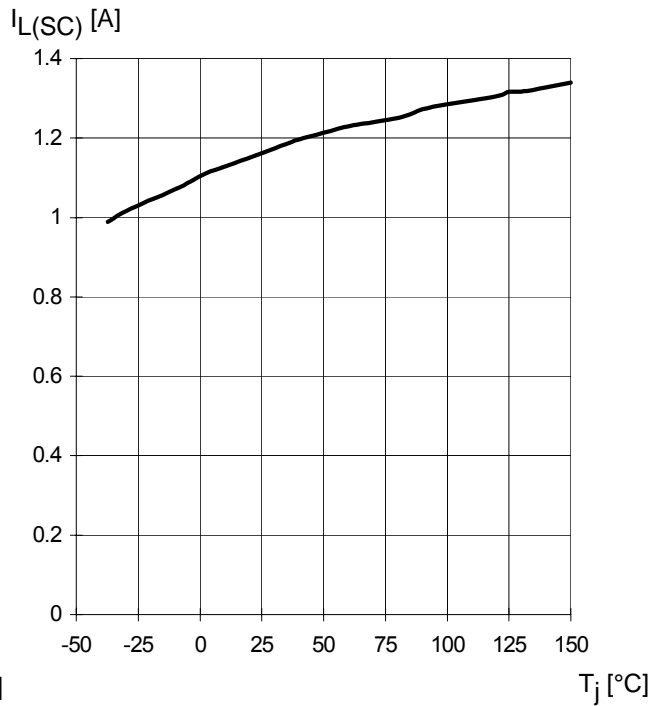
Typ. standby current

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



Short circuit current

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



Typ. input turn on voltage threshold

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

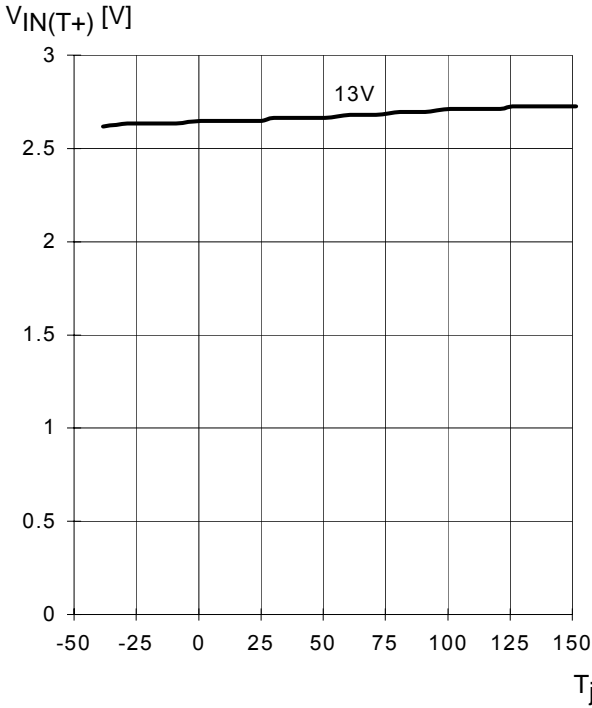
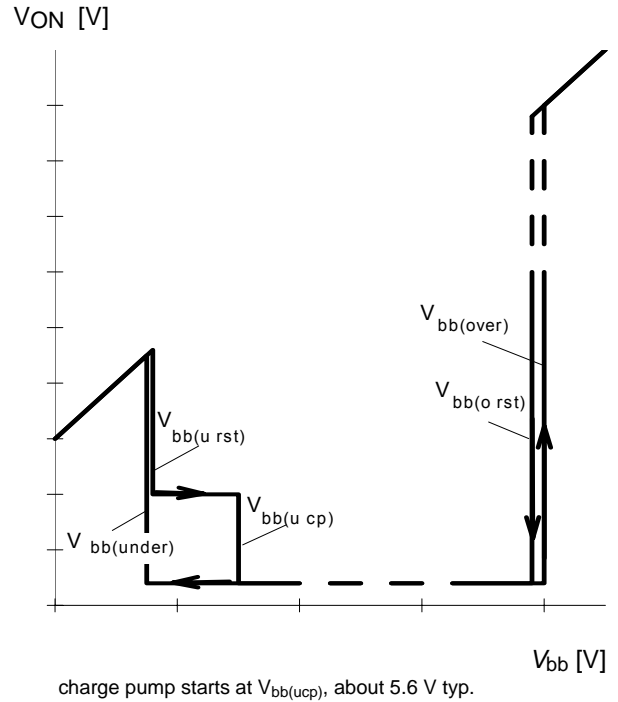
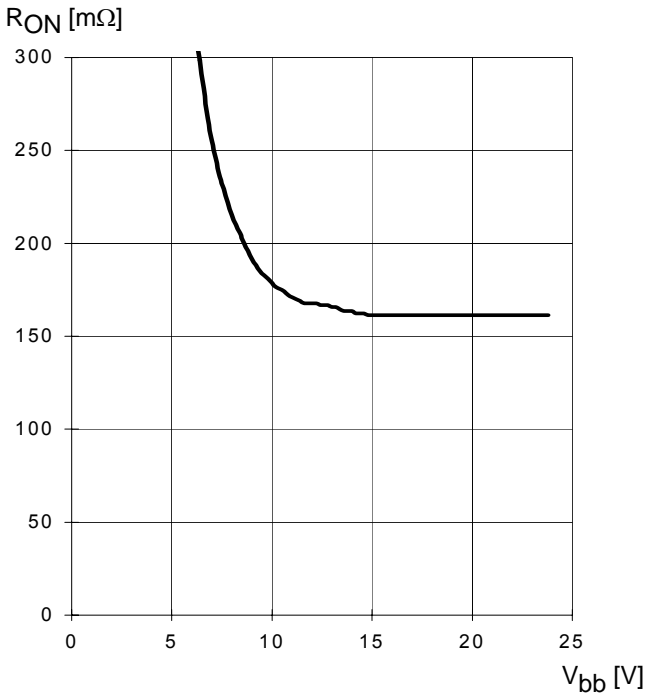


Figure 6: Undervoltage restart of charge pump

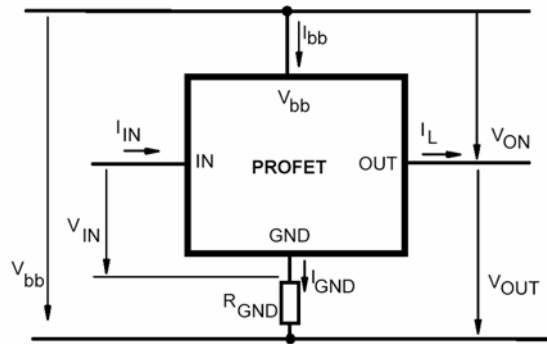


Typ. on-state resistance (Vbb-Pin to Out-Pin)

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



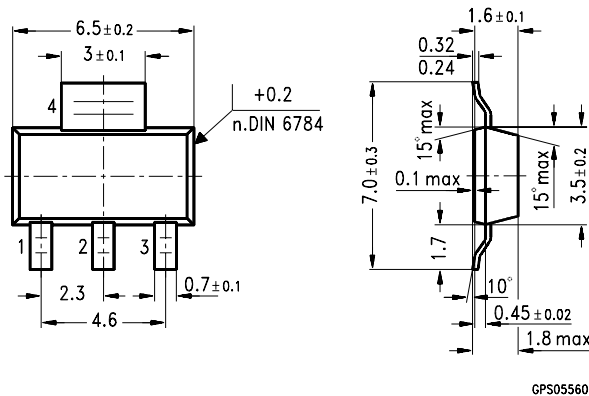
Terms



Package:

all dimensions in mm.

PG-SOT 223:



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