Infineon technologies

Smart High-Side Power Switch
# One Channel: 1 x 1Ω

Features

- Current controlled input
- Short circuit protection
- Current limitation
- Overload protection
- Overvoltage protection (including load dump)
- Switching inductive loads
- Clamp of negative voltage at output with inductive loads
- Thermal shutdown with restart
- ESD - Protection
- Loss of GND and loss of V_{bb} protection
- Very low standby current
- Reverse battery protection
- Improved electromagnetic compatibility (EMC)

Product Summary

|			
Overvoltage protection	$V_{bbin(AZ)}$	62	V
Operating voltage	$V_{bb(on)}$	4.9...60	V
On-state resistance	R_{ON}	1	Ω

SOT-223

VPS05163
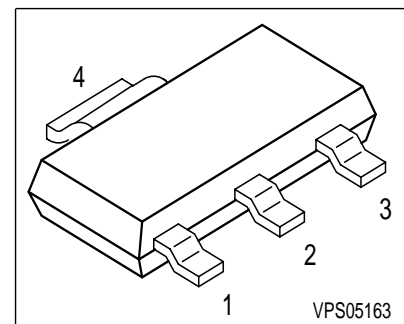
Application
- All types of resistive, inductive and capacitive loads
- Current controlled power switch for 12V, 24V and 42V DC applications
- Driver for electromechanical relays
- Signal amplifier

General Description
N channel vertical power MOSFET with charge pump and current controlled input, monolithically integrated in Smart SIPMOS®technology.
Providing embedded protective functions.

2004-01-27

Block Diagram
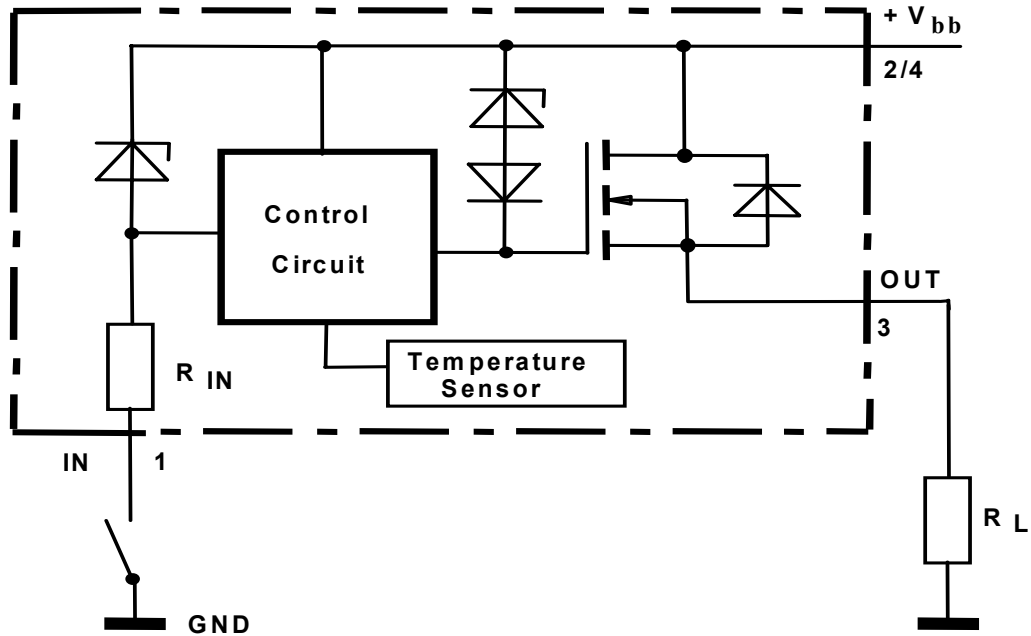
Pin	Symbol	Function
1	IN	Input, activates the power switch in case of connection to GND
2	Vbb	Positive power supply voltage
3	OUT	Output to the load
4	Vbb	Positive power supply voltage

2004-01-27

Maximum Ratings

Parameter	Symbol	Value	Unit
at T_j = 25°C, unless otherwise specified			
Supply voltage	V_{bb}	60	V
Load current (Short - circuit current, see page 5)	I_L	self limited	A
Maximum current through the input pin (DC)	I_{IN}	±15	mA
Operating temperature	T_j	-40 ...+150	°C
Storage temperature	T_{stg}	-55 ... +150	
Power dissipation[1] T_A = 25 °C	P_{tot}	1.7	W
Inductive load switch-off energy dissipation[2] single pulse T_j = 150 °C, I_L = 0.15 A	E_{AS}	1	J
Load dump protection[3] $V_{LoadDump}$[4]= V_A + V_S R_I=2Ω, t_d=400ms, V_{IN}= low or high I_L = 150 mA, V_{bb} = 13,5 V V_{bb} = 27 V	$V_{Loaddump}$	 93.5 127	V
Electro**s**tatic **d**ischarge voltage (Human Body Model) according to ANSI EOS/ESD - S5.1 - 1993 ESD STM5.1 - 1998 Input pin all other pins	V_{ESD}	 ±1 ±5	kV

[1]Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6 cm2 (one layer, 70µm thick) copper area for V_{bb} connection. PCB is vertical without blown air.

[2]not subject to production test, specified by design

[3]more details see EMC-Characteristics on page 7

[4]$V_{Loaddump}$ is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839 .

2004-01-27

Electrical Characteristics

Parameter	Symbol	Values			Unit
at T_j = -40...150 °C, V_{bb} = 9...42 V unless otherwise specified		min.	typ.	max.	
Thermal Characteristics					
Thermal resistance @ min. footprint	$R_{th(JA)}$	-	86	125	K/W
Thermal resistance @ 6 cm^2 cooling area [1]	$R_{th(JA)}$	-	60	72	
Thermal resistance, junction - soldering point	R_{thJS}	-	-	17	K/W
Load Switching Capabilities and Characteristics					
On-state resistance	R_{ON}				Ω
Pin1 connencted to GND					
T_j = 25 °C, I_L = 150 mA, V_{bb} = 9...52 V		-	1	1.5	
T_j = 150 °C		-	1.5	3	
T_j = 25 °C, I_L = 50 mA, V_{bb} = 6 V		-	2	5	
Nominal load current[2]	$I_{L(nom)}$	0.2	-	-	A
Device on PCB [1]					
T_a = 85 °C , $T_j \leq$ 150 °C					
Turn-on time[3] V_{IN} = V_{bb} to 0V to 90% V_{OUT}	t_{on}				μs
R_L = 270 Ω		-	-	125[4]	
R_L = 270 Ω, V_{bb} = 13.5 V, T_j = 25 °C		-	45	100	
Turn-off time[3] V_{IN} = 0V to V_{bb} to 10% V_{OUT}	t_{off}				
R_L = 270 Ω		-	-	175[4]	
R_L = 270 Ω, V_{bb} = 13.5 V, T_j = 25 °C		-	40	140	
Slew rate on[3] V_{IN} = V_{bb} to 0V 10 to 30% V_{OUT}	dV/dt_{on}				V/μs
R_L = 270 Ω		-	-	6[4]	
R_L = 270 Ω, T_j = 25 °C, V_{bb} = 13.5 V		-	1.3	4	
Slew rate off[3] V_{IN} = 0V to V_{bb} 70 to 40% V_{OUT}	$-dV/dt_{off}$				
R_L = 270 Ω		-	-	8[4]	
R_L = 270 Ω, T_j = 25 °C, V_{bb} = 13.5 V		-	1.7	4	

[1]Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6 cm2 (one layer, 70μm thick) copper area for V_{bb} connection. PCB is vertical without blown air.

[2]Nominal load current is limited by the current limitation (see page 5)

[3]Timing values only with high input slewrates, otherwise slower.

[4]not subject to production test, specified by design

2004-01-27

Electrical Characteristics

Parameter	Symbol	Values			Unit
at T_j = -40...150 °C, V_{bb} = 9...42 V unless otherwise specified		**min.**	**typ.**	**max.**	
Operating Parameters					
Operating voltage	$V_{bb(on)}$	4.9	-	60	V
Standby current Pin1 = open	$I_{bb(off)}$	-	2	10	µA

Protection Functions[1]

Initial peak short circuit current limit (see page 11) T_j = -40 °C, V_{bb} = 13.5 V, t_m = 100 µs T_j = 25 °C T_j = 150 °C	$I_{L(SCp)}$	 - - 0.2	 - 0.9 -	 1.2 - -	A
Repetitive short circuit current limit T_j = T_{jt}	$I_{L(SCr)}$	-	0.7	-	
Output clamp (inductive load switch off) at V_{OUT} = V_{bb} - $V_{ON(CL)}$, I_{bb} = 4 mA	$V_{ON(CL)}$	60	-	-	V
Overvoltage protection I_{bb} = 1 mA	$V_{bbin(AZ)}$	62	68	-	
Thermal overload trip temperature	T_{jt}	150	-	-	°C
Thermal hysteresis	ΔT_{jt}	-	10	-	K

[1]Integrated protection functions are designed to prevent IC destruction under fault conditions described in the data sheet. Fault conditions are considered as "outside" normal operating range. Protection functions are not designed for continuous repetitive operation.

2004-01-27

Electrical Characteristics

Parameter	Symbol	Values			Unit
at T_j = -40...150 °C, V_{bb} = 9...42 V unless otherwise specified		min.	typ.	max.	
Input					
Off state input current $V_{OUT} \leq 0.1$ V T_j = 25 °C, R_L = 270 Ω T_j = 150 °C	$I_{IN(off)}$	- -	- -	0.05 0.04	mA
On state input current (Pin1 grounded)[1]	$I_{IN(on)}$	-	0.3	1	
Input resistance	R_I	0.5	1	2.5	kΩ

Reverse Battery

Continuous reverse drain current T_C = 25 °C	I_S	-	-	0.2	A
Drain-source diode voltage (V_{OUT} > V_{bb}) I_F = 0.2 A, $I_{IN} \leq 0,05$ mA	$-V_{ON}$	-	600	-	mV

[1]Driver circuit must be able to drive currents > 1mA.

2004-01-27

EMC-Characteristics

All EMC-Characteristics are based on limited number of sampels and no part of production test.

Test Conditions:

If not other specified the test circuitry is the minimal functional configuration without any external components for protection or filtering.

Supply voltage:	V_{bb} = 13.5V	Temperature:	T_a = 23 ±5°C ;
Load:	R_L = 220Ω		
Operation mode:	PWM	Frequency:	100Hz / Duty Cycle: 50%
	DC On/Off		
DUT-Specific.:	-		

Fast electrical transients

Acc. ISO 7637

Test Pulse	Test Level	Test Results		Pulse Cycle Time and
		On	Off	Generator Impedance
1	-200 V	C	C	500ms ; 10Ω
2	+200 V	C	C	500ms ; 10Ω
3a	-200 V	C	C	100ms ; 50Ω
3b	+ 200 V	C	C	100ms ; 50Ω
4[1)	-7 V	C	C	0,01Ω
5	175 V	E (150V)	E (150V)	400ms ; 2Ω

The test pulses are applied at V_{bb}

Definition of functional status

Class	Content
C	All functions of the device are performed as designed after exposure to disturbance.
E	One or more function of a device does not perform as designed after exposure and can not be returned to proper operation without repairing or replacing the device. The value after the character shows the limit.

Test circuit:

[1]Supply voltage V_{bb} = 12 V instead of 13,5 V.

2004-01-27

Conducted Emission

Acc. IEC 61967-4 (1Ω / 150Ω method)

Typ. V_{bb}-Pin Emission at DC-On with 150Ω-matching network
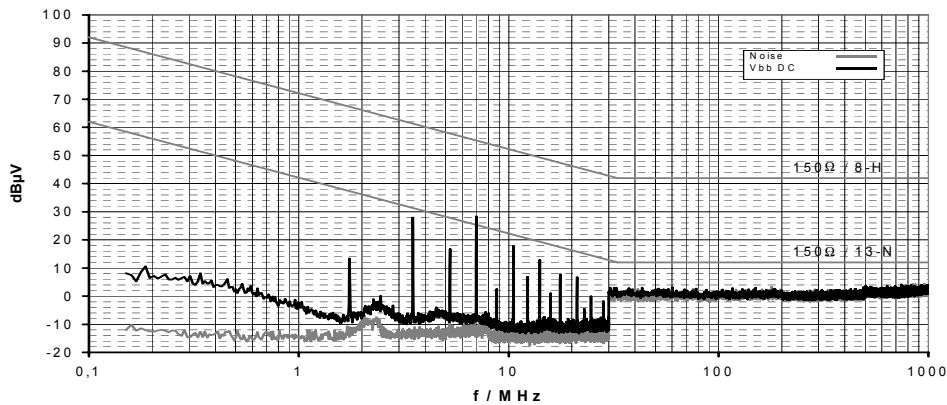
Typ. V_{bb}-Pin Emission at PWM-Mode with 150Ω-matching network
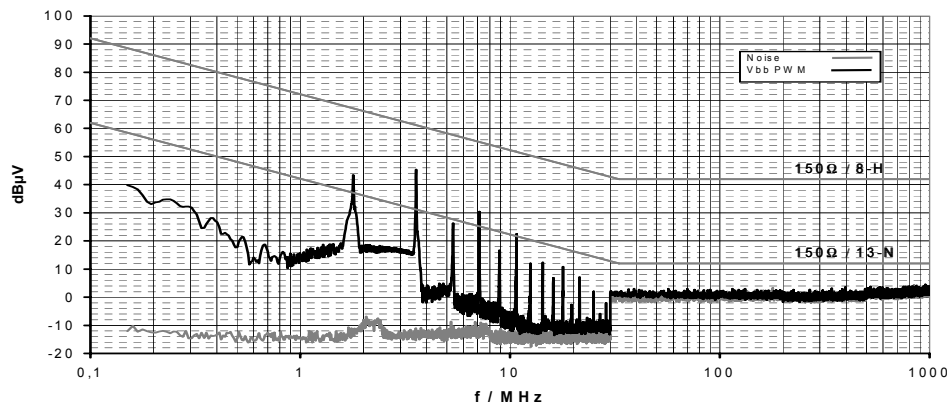
Test circuit:
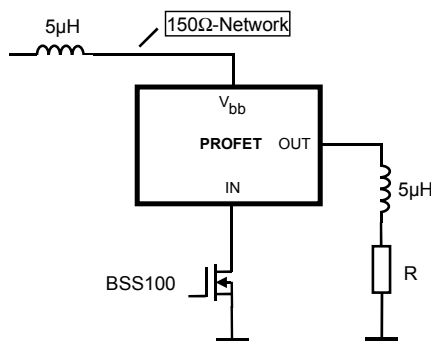
For defined decoupling and high reproducibility a defined choke (5µH at 1 MHz) is inserted between supply and V_{bb}-pin.

2004-01-27

Conducted Susceptibility

Acc. 47A/658/CD IEC 62132-4 (Direct Power Injection)

Direct Power Injection: Forward Power CW
Failure criteria: Amplitude and frequency deviation max. 10% at Out

Typ. V_{bb}-Pin Susceptibility at DC-On/Off
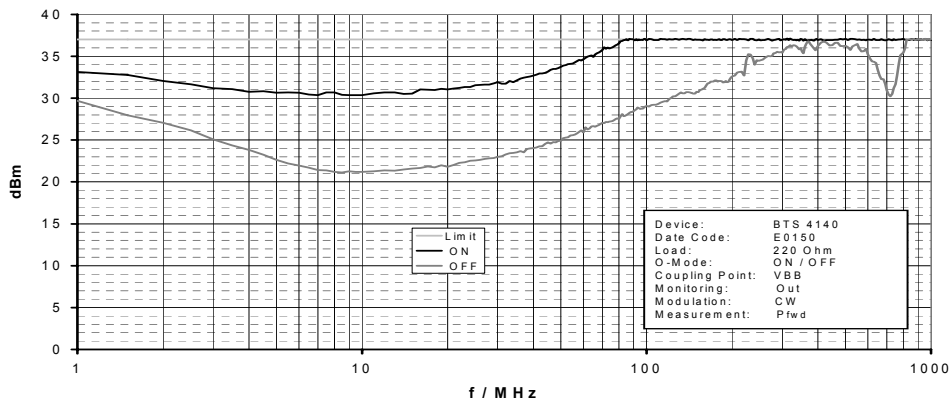
Typ. V_{bb}-Pin Susceptibility at PWM-Mode
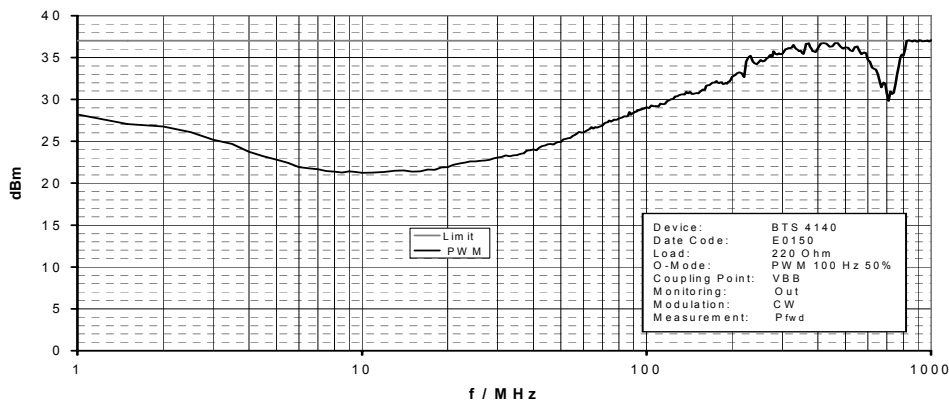
Test circuit:
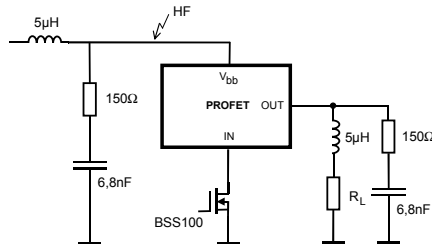
For defined decoupling and high reproducibility the same choke and the same
150Ω -matching network as for the emission measurement is used.

2004-01-27

Terms

Input circuit (ESD protection)

Reverse battery protection

R_I=1kΩ typ., Temperature protection is not active during inverse current.
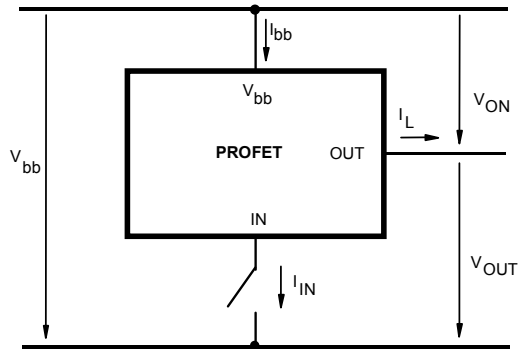
Inductive and overvoltage output clamp

V_{ON} clamped to 60 V min.
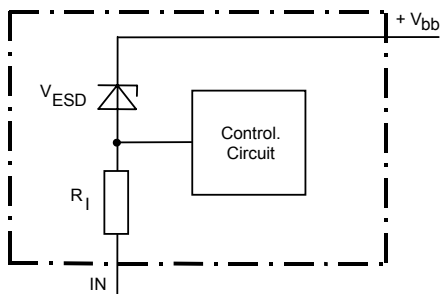
Overvoltage protection of logic part

$V_{bb,AZ} = V_{Z2} + I_{bb} * R_{IN} = 62V$ min.

2004-01-27

V$_{bb}$ disconnect with charged inductive load
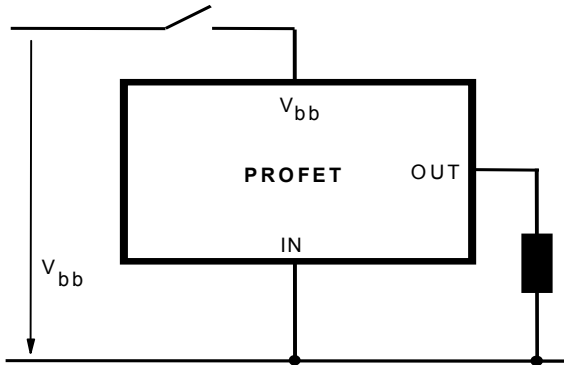
Inductive Load switch-off energy dissipation
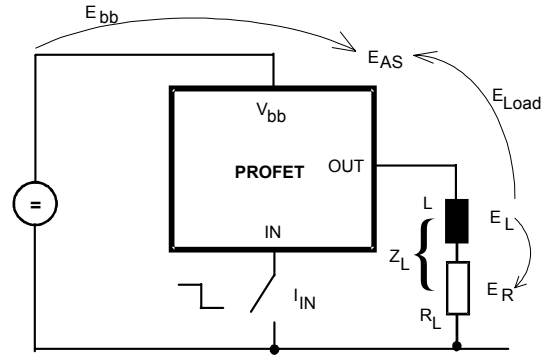
Energy stored in load inductance: $E_L = \frac{1}{2} * L * I_L{}^2$

While demagnetizing load inductance,
 the enérgy dissipated in PROFET is
$E_{AS} = E_{bb} + E_L - E_R = \int V_{ON(CL)} * i_L(t)\,dt$,
with an approximate solution for $R_L > 0\Omega$:

$$E_{AS} = \frac{I_L * L}{2 * R_L} * (V_{bb} + |V_{OUT(CL)}|) * \ln\left(1 + \frac{I_L * R_L}{|V_{OUT(CL)}|}\right)$$

2004-01-27

Typ. transient thermal impedance

Z_{thJA}=f(t_p) @ 6cm^2 heatsink area

Parameter: D=t_p/T

D=0.5
D=0.2
D=0.1
D=0.05
D=0.02
D=0.01
D=0
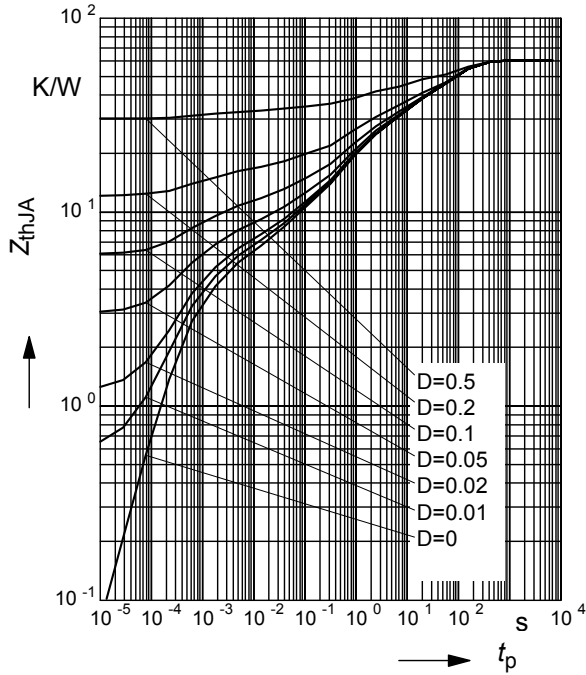
Typ. transient thermal impedance

Z_{thJA}=f(t_p) @ min. footprint

Parameter: D=t_p/T

D=0.5
D=0.2
D=0.1
D=0.05
D=0.02
D=0.01
D=0
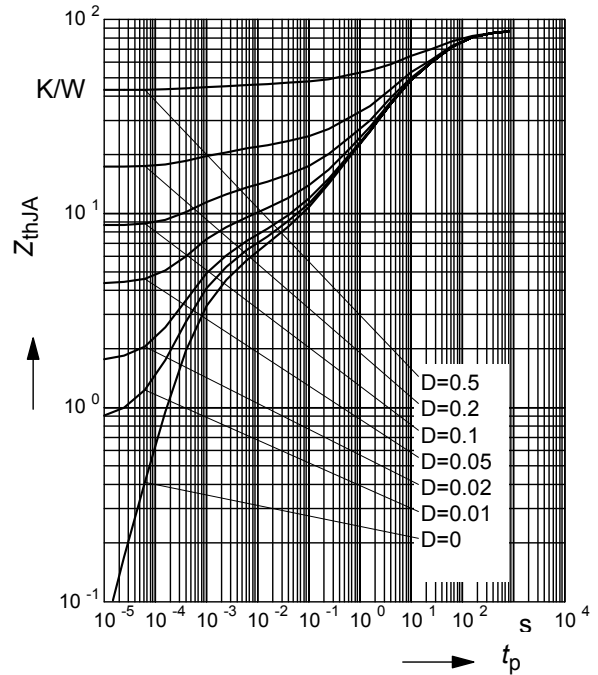
Typ. on-state resistance

R_{ON} = f(T_j) ; V_{bb} = 9V ; Pin1 grounded; I_L=150mA
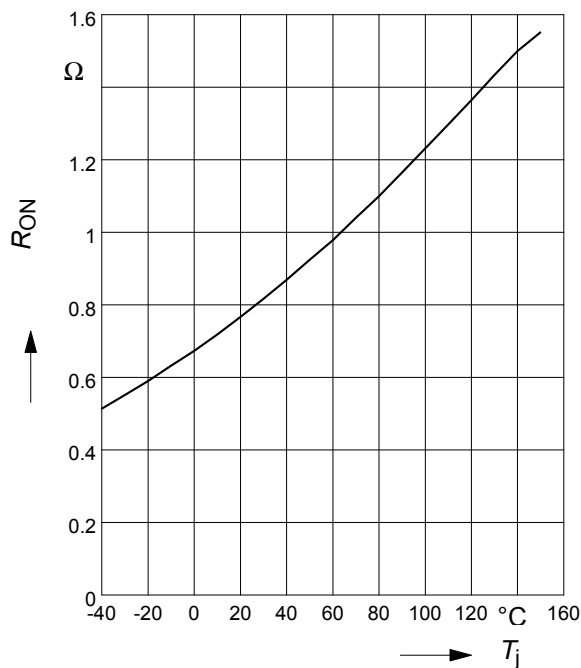
Typ. on-state resistance

R_{ON} = f(V_{bb}); I_L = 150mA ; Pin1 grounded

150°C
25°C
-40°C

2004-01-27
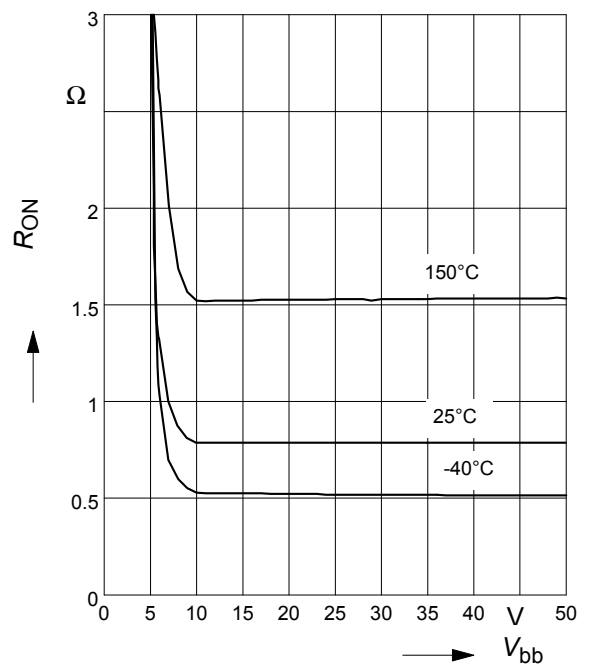
Typ. turn on time

t_{on} = f(T_j); R_L = 270Ω
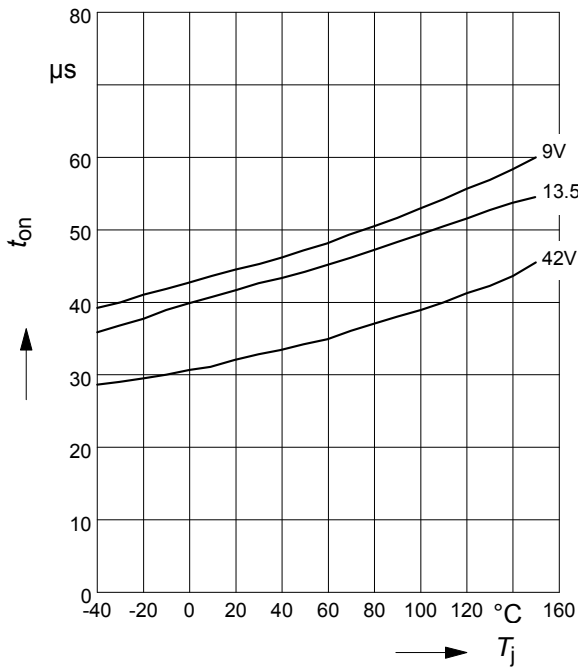
Typ. turn off time

t_{off} = f(T_j); R_L = 270Ω
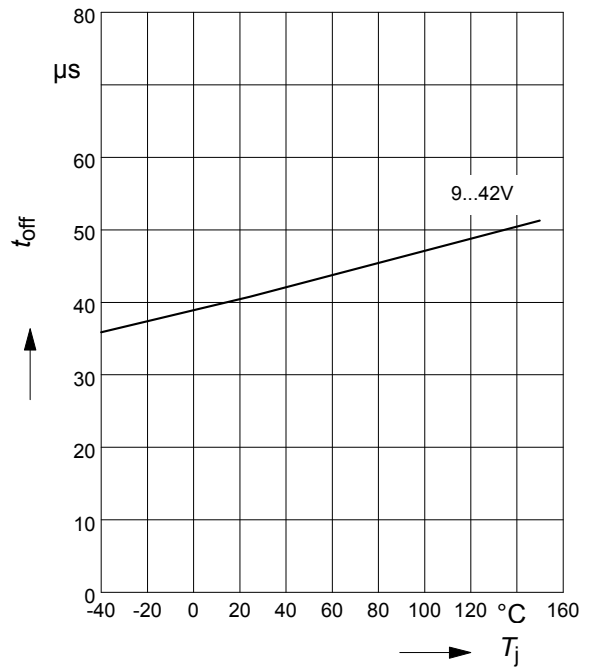
Typ. slew rate on

dV/dt_{on} = f(T_j) ; R_L = 270 Ω
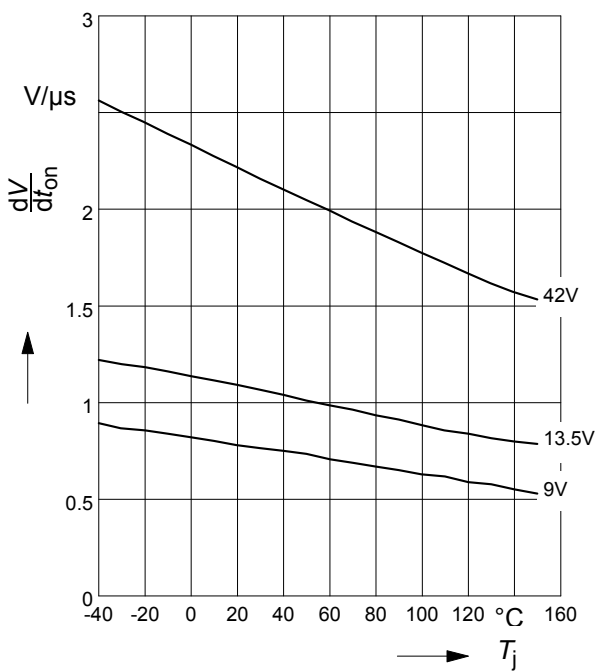
Typ. slew rate off
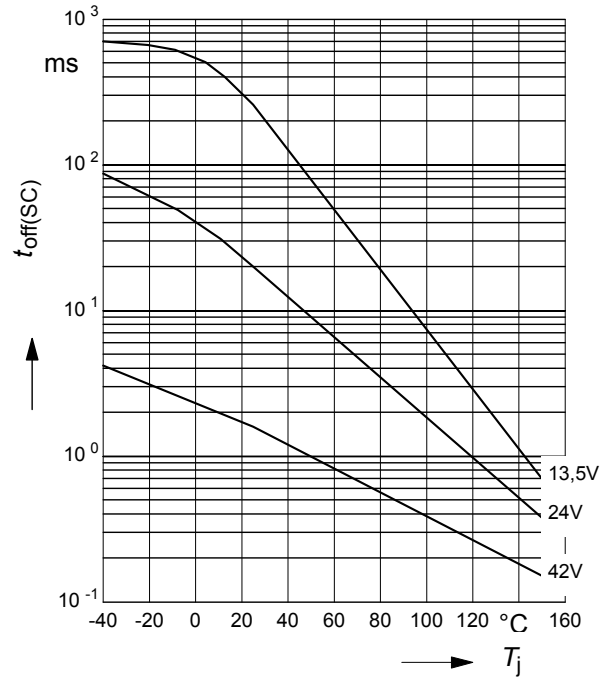
dV/dt_{off} = f(T_j); R_L = 270 Ω

Page 13

2004-01-27
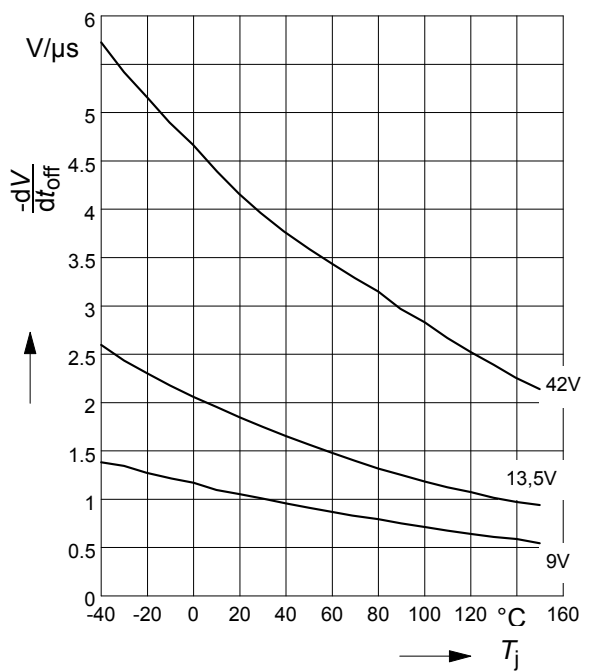
Typ. initial peak short circuit current limit

$I_{L(SCp)} = f(T_j)$; $V_{bb} = 13,5$ V; $t_m = 100$ µs
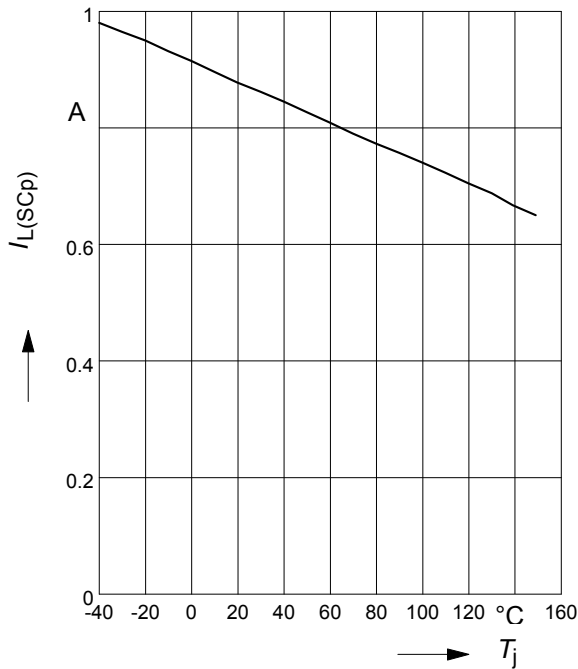
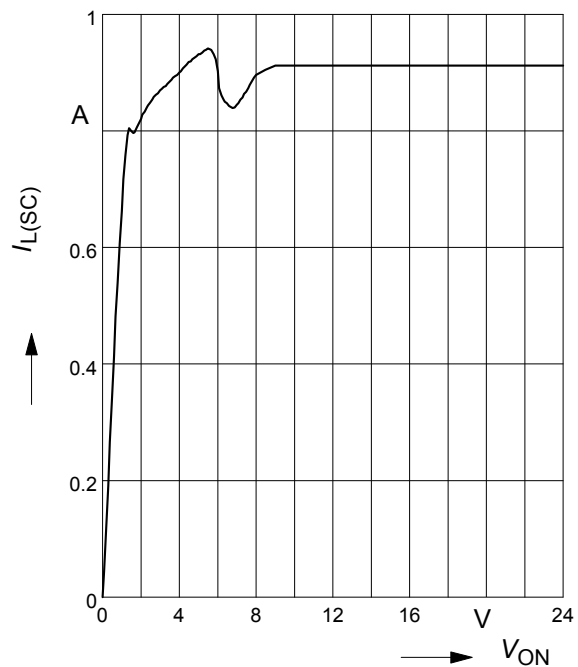**Typ. initial short circuit shutdown time**

$t_{off(SC)} = f(T_{j,start})$

Typ. initial peak short circuit current limit
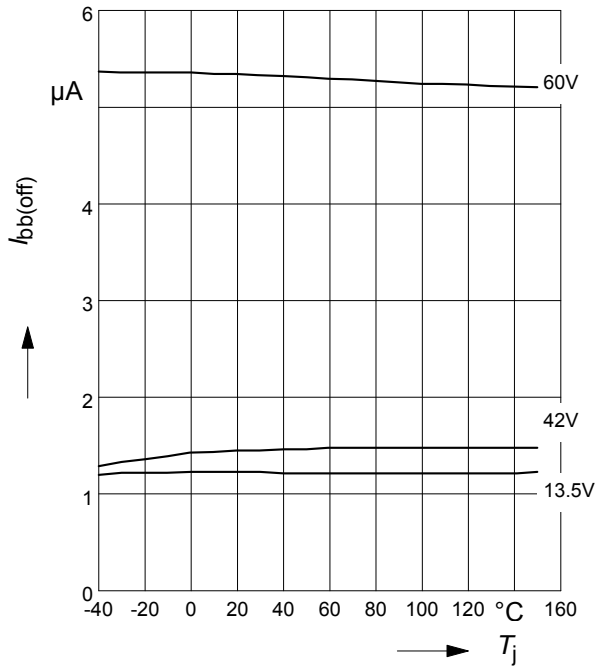
$I_{L(SCp)} = f(V_{bb})$; $t_m = 100$ µs
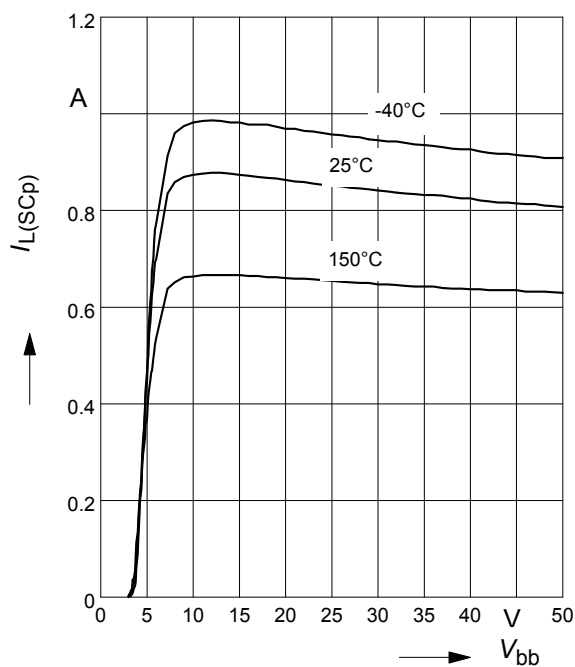
Typ. current limitation characteristic:

$I_{L(SC)} = f(V_{ON})$, $V_{bb} = 13,5$V
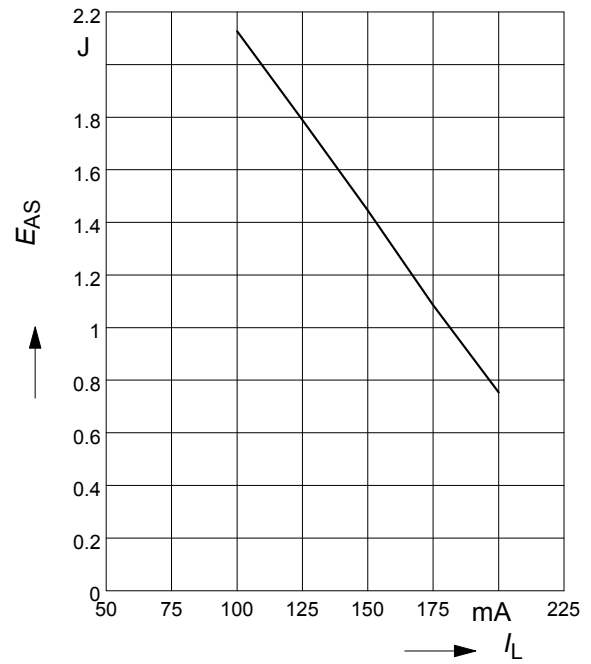
2004-01-27

Typ. standby current

$I_{bb(off)}$ = f(T_j) ; Pin1 open

Maximum allowable inductive switch-off energy, single pulse

E_{AS} = f(I_L); T_{jstart} = 150°C

2004-01-27

Timing diagrams

Figure 1a: Vbb turn on:

I_{IN}

V_{bb}

I_L

t
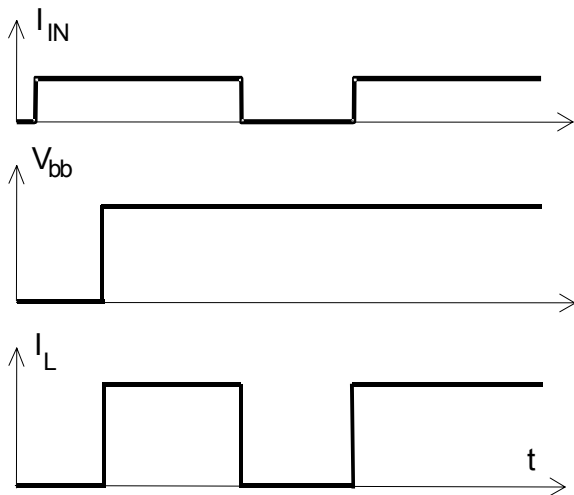
Figure 2b: Switching a lamp

I_{IN}

V_{OUT}

I_L

t
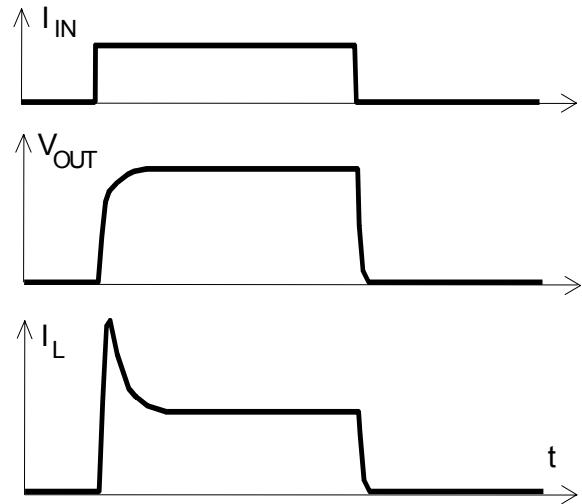
Figure 2a: Switching a resistive load,
turn-on/off time and slew rate definition

I_{IN}

V_{OUT}

90%

t_{on}

dV/dtoff

dV/dton

t_{off}

10%

I_L

t
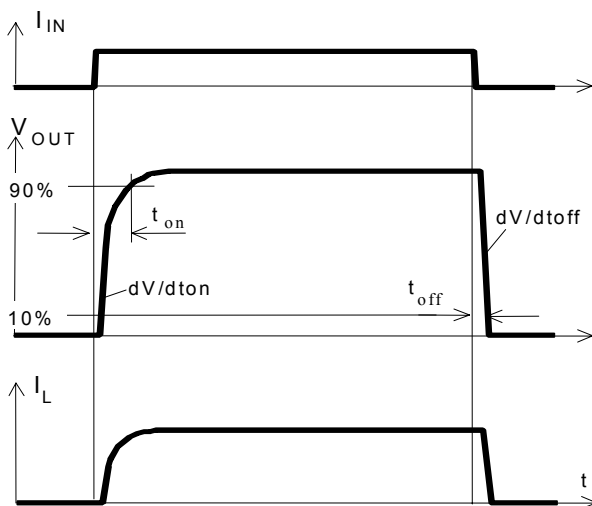
Figure 2c: Switching an inductive load

I_{IN}

V_{OUT}

I_L

t

2004-01-27

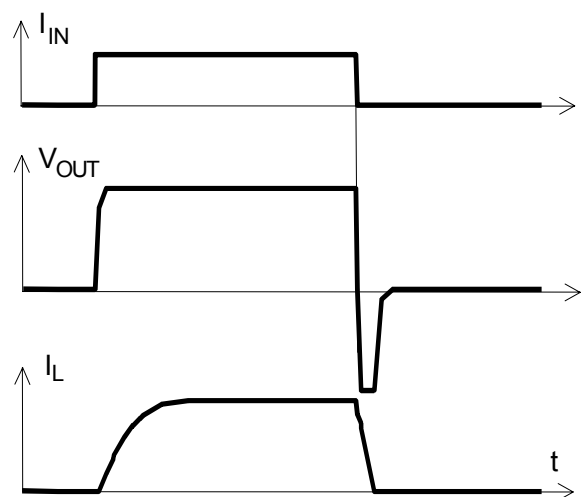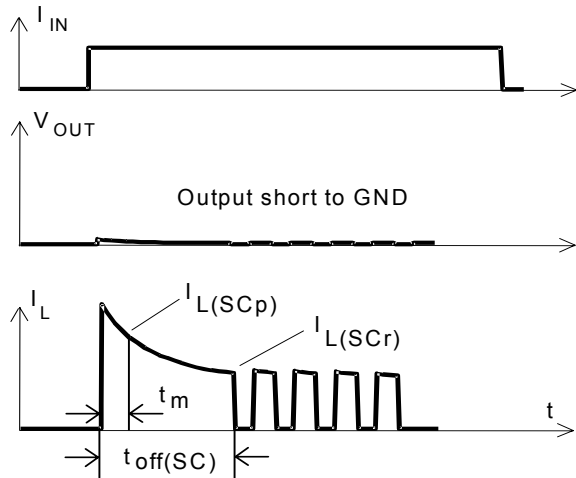**Figure 3a:** Turn on into short circuit,
shut down by overtemperature, restart by cooling

Heating up of the chip may require several milliseconds, depending
on external conditions.

Figure 3b: Short circuit in on-state
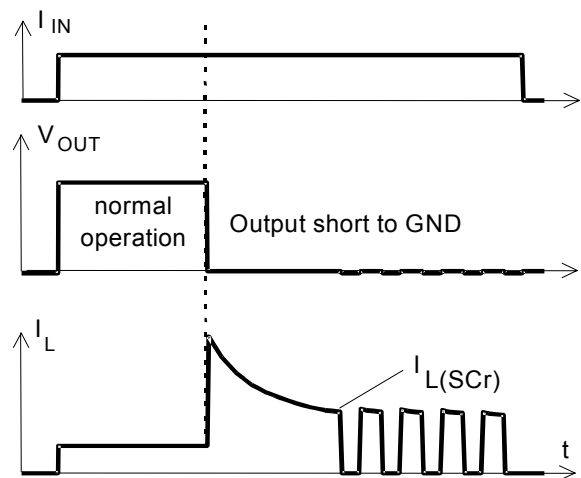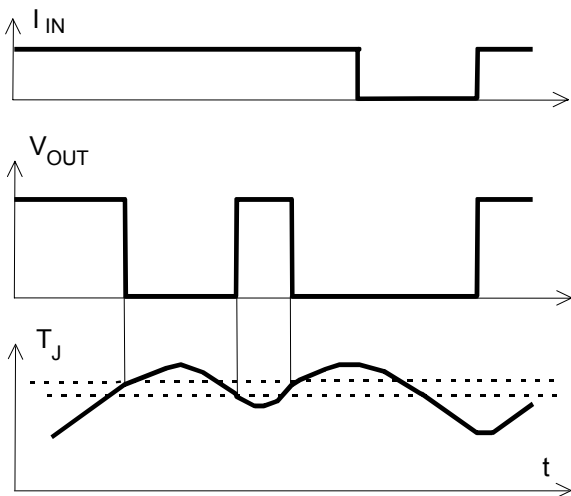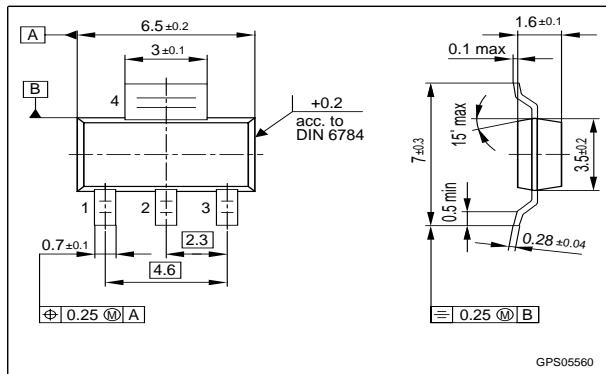shut down by overtemperature, restart by cooling

Figure 4: Overtemperature:
Reset if $T_j < T_{jt}$

2004-01-27

Package and ordering code

all dimensions in mm

Sales code	BTS 4140 N
Ordering code,	Q67060-S6084-A101

GPS05560

Published by
Infineon Technologies AG,
St.-Martin-Strasse 53,
D-81669 München
© Infineon Technologies AG 2001
All Rights Reserved.

Attention please!
The information herein is given to describe certain components and shall not be considered as a guarantee of characteristics.

Terms of delivery and rights to technical change reserved.

We hereby disclaim any and all warranties, including but not limited to warranties of non-infringement, regarding circuits, descriptions and charts stated herein.

Infineon Technologies is an approved CECC manufacturer.

Information
For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office in Germany or our Infineon Technologies Representatives worldwide (see address list).

Warnings
Due to technical requirements components may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

2004-01-27