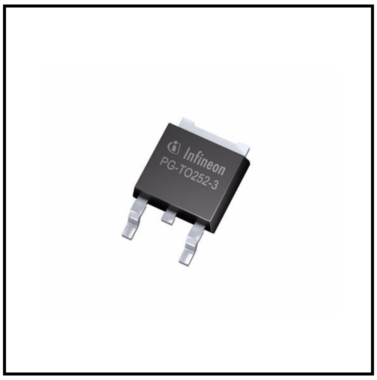
HITFET - BTS3035TF

Smart Low-Side Power Switch

1 Overview



Basic Features

- Single channel device
- Very low output leakage current in OFF state
- Electrostatic discharge protection (ESD)
- Embedded protection functions (see below)
- Green Product (RoHS compliant)
- AEC Qualified

Applications

- Suitable for resistive, inductive and capacitive loads
- Replaces electromechanical relays, fuses and discrete circuits

Description

The BTS3035TF is a 35 mΩ single channel Smart Low-Side Power Switch within a PG-TO252-3 package providing embedded protective functions. The power transistor is built by an N-channel vertical power MOSFET.
The device is monolithically integrated. The BTS3035TF is automotive qualified and is optimized for 12 V automotive applications.

Type	Package	Marking
BTS3035TF	PG-TO252-3	S3035TF

Table 1 Product Summary

Operating voltage range	V_{OUT}	0 .. 31 V
Maximum load voltage	$V_{BAT(LD)}$	40 V
Maximum input voltage	V_{IN}	5.5 V
Maximum On-State resistance at $T_J = 150°C$, $V_{IN} = 5$ V	$R_{DS(ON)}$	70 mΩ
Nominal load current	$I_{L(NOM)}$	5 A
Minimum current limitation	$I_{L(LIM)}$	20 A
Maximum OFF state load current at $T_J \leq 85°C$	$I_{L(OFF)\_85}$	0.6 µA

Protection Functions

- Over temperature shut-down with automatic-restart
- Active clamp over voltage protection
- Current limitation

Detailed Description

The device is able to switch all kind of resistive, inductive and capacitive loads, limited by maximum clamping energy and maximum current capabilities.

The BTS3035TF offers ESD protection on the IN pin which refers to the Source pin (Ground).

The over temperature protection prevents the device from overheating due to overload and/or bad cooling conditions. The temperature information is given by a temperature sensor in the power MOSFET.

The BTS3035TF has an auto-restart thermal shut-down function. The device will turn on again, if input is still high, after the measured temperature has dropped below the thermal hysteresis.

The over voltage protection can be activated during load dump or inductive turn off conditions. The power MOSFET is limiting the drain-source voltage, if it rises above the $V_{OUT(CLAMP)}$.

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2 Block Diagram

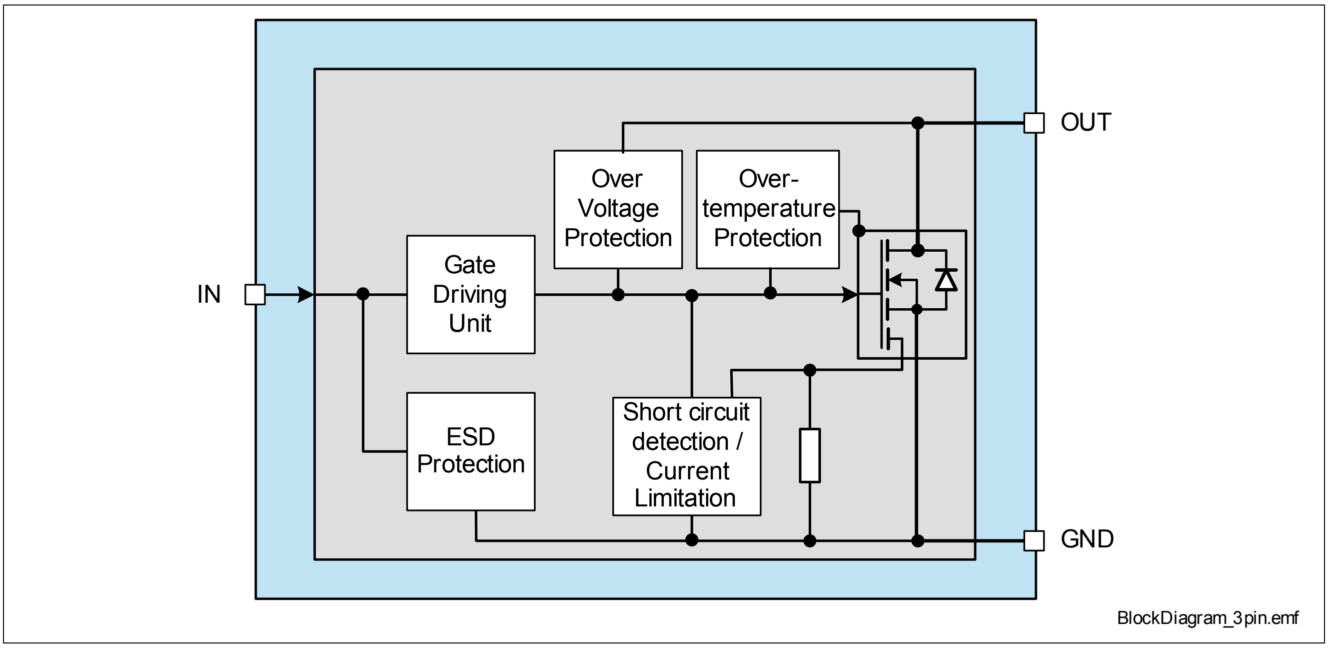

Figure 1 Block Diagram

3 Pin Configuration

3.1 Pin Assignment BTS3035TF

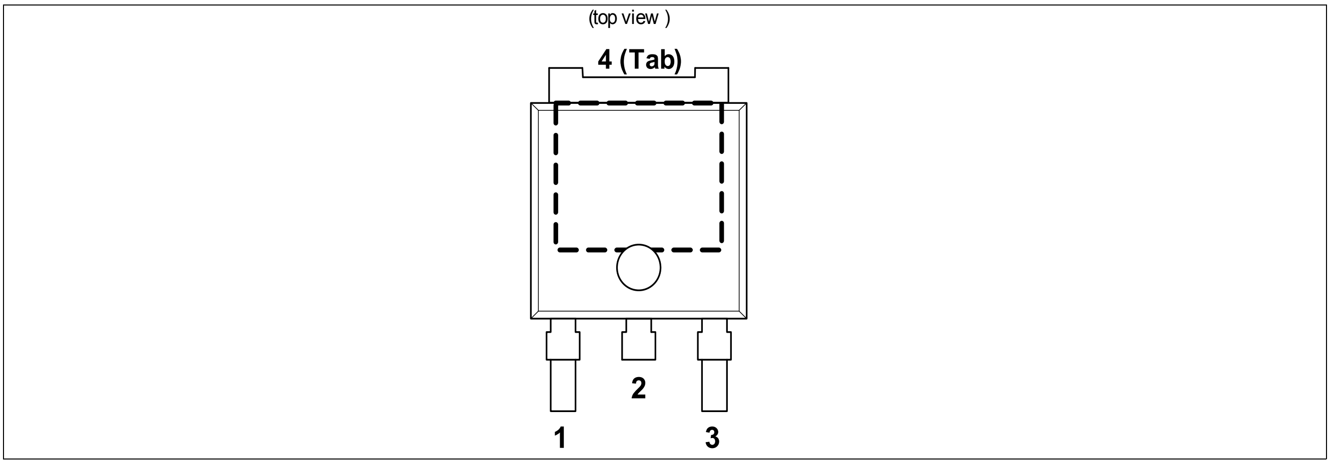

Figure 2 Pin Configuration. PG-TO252-3

3.2 Pin Definitions and Functions

Pin	Symbol	Function
1	IN	Input pin
2,4	OUT	Drain, Load connection for power DMOS
3	GND	Ground, Source of power DMOS

3.3 Voltage and current definition

Figure 3 shows all external terms used in this data sheet, with associated convention for positive values.

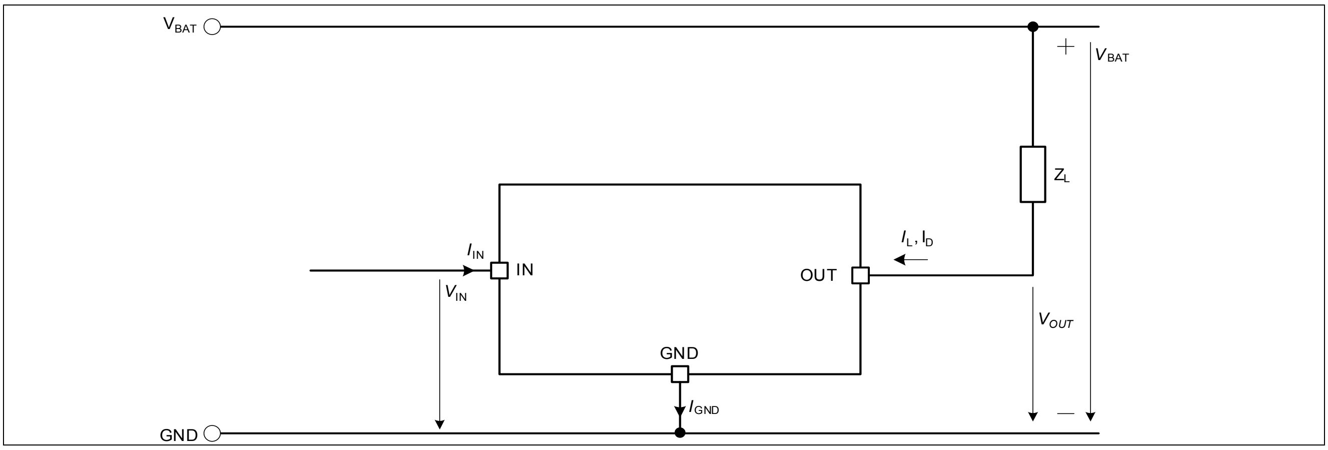

Figure 3 Naming definition of electrical parameters

4 General Product Characteristics

4.1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings [1)]

T_j = -40°C to +150°C; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Voltages							
Output voltage	V_{OUT}	–	–	40	V	internally clamped	P_4.1.1
Battery voltage for short circuit protection	$V_{BAT(SC)}$	–	–	31	V	l = 0 or 5 m R_{SC} = 20 mΩ + R_{Cable} R_{Cable} = l * 16 mΩ/m L_{SC} = 5 µH + L_{Cable} L_{Cable} = l * 1 µH/m V_{IN} = 5 V	P_4.1.2
Battery voltage for load dump protection	$V_{BAT(LD)}$	–	–	40	V	[2)] R_I = 2 Ω R_L = 4.5 Ω t_D = 400 ms suppressed pulse	P_4.1.4
Input Pin							
Input Voltage	V_{IN}	-0.3	–	5.5	V	-	P_4.1.7
Input current in inverse condition on OUT to GND	I_{IN}	–	–	2	mA	[3)] V_{OUT} < -0.3 V	P_4.1.10
Power Stage							
Load current	$\|I_L\|$	–	–	$I_{L(LIM)}$	A	-	P_4.1.11
Energies							
Unclamped single inductive energy single pulse	E_{AS}	–	–	105	mJ	$I_{L(0)} = I_{L(NOM)}$ V_{BAT} = 13.5 V $T_{J(0)}$ = 150°C	P_4.1.13
Unclamped repetitive inductive energy pulse with 10 k cycles	$E_{AR(10k)}$	–	–	105	mJ	$I_{L(0)} = I_{L(NOM)}$ V_{BAT} = 13.5 V $T_{J(0)}$ = 105°C	P_4.1.21
Unclamped repetitive inductive energy pulse with 100 k cycles	$E_{AR(100k)}$	–	–	84	mJ	$I_{L(0)} = I_{L(NOM)}$ V_{BAT} = 13.5 V $T_{J(0)}$ = 105°C	P_4.1.25
Unclamped repetitive inductive energy pulse with 1 M cycles	$E_{AR(1M)}$	–	–	67	mJ	$I_{L(0)} = I_{L(NOM)}$ V_{BAT} = 13.5 V $T_{J(0)}$ = 105°C	P_4.1.29

Table 2 Absolute Maximum Ratings [1] (cont'd)

T_j = -40°C to +150°C; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Temperatures							
Operating temperature	T_J	-40	–	+150	°C	–	P_4.1.37
Storage temperature	T_{STG}	-55	–	+150	°C	–	P_4.1.38
ESD Susceptibility							
ESD susceptibility (all pins)	V_{ESD}	-4	–	4	kV	HBM[4]	P_4.1.39
ESD susceptibility OUT-pin to GND	V_{ESD}	-10	–	10	kV	HBM[4]	P_4.1.40
ESD susceptibility	V_{ESD}	-2	–	2	KV	CDM[5]	P_4.1.41

1) Not subject to production test, specified by design.
2) $V_{BAT(LD)}$ is setup without the DUT connected to the generator per ISO 7637-1;
R_I is the internal resistance of the load dump test pulse generator;
t_D is the pulse duration time for load dump pulse (pulse 5) according ISO 7637-1, -2.
3) Maximum allowed value. Consider also inverse input current in inverse condition P_8.3.7 in Chapter 8
4) ESD susceptibility, HBM according to ANSI/ESDA/JEDEC JS001 (1.5 kΩ, 100 pF)
5) ESD susceptibility, Charged Device Model "CDM" ESDA STM5.3.1 or ANSI/ESD S.5.3.1

Notes

1. *Stresses above the ones listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*
2. *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.*

4.2 Functional Range

Table 3 Functional Range [1]

Please refer to **"Electrical Characteristics" on Page 18** for test conditions

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Battery Voltage Range for Nominal Operation	$V_{BAT(NOR)}$	6.0	–	18.0	V	–	P_4.2.1
Extended Battery Voltage Range for Operation	$V_{BAT(EXT)}$	0	–	31	V	parameter deviations possible	P_4.2.2
Input Voltage Range for Nominal Operation	$V_{IN(NOR)}$	3.0	–	5.5	V	–	P_4.2.3
Junction Temperature	T_J	-40	–	150	°C	–	P_4.2.5

1) Not subject to production test, specified by design

Note: Within the functional range the IC operates as described in the circuit description. The electrical characteristics are specified within the conditions given in the related electrical characteristics table.

4.3 Thermal Resistance

Note: This thermal data was generated in accordance with JEDEC JESD51 standards. For more information, go to ***www.jedec.org****.*

Table 4 Thermal Resistance PG-TO252-3

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Junction to Soldering Point	R_{thJSP}	–	1.8	–	K/W	1) 2)	P_4.3.1
Junction to Ambient (2s2p)	$R_{thJA(2s2p)}$	–	25	–	K/W	3) 4)	P_4.3.5
Junction to Ambient (1s0p+600 mm^2 Cu)	$R_{thJA(1s0p)}$	–	39	–	K/W	1) 5)	P_4.3.9

1) Not subject to production test, specified by design
2) Specified R_{thJSP}value is simulated at natural convection on a cold plate setup (all pins are fixed to ambient temperature).
T_A = 85°C. Device is loaded with 1W power.
3) Not subject to production test, specified by design
4) Specified R_{thJA} value is according to Jedec JESD51-2,-5,-7 at natural convection on FR4 2s2p board;
The product (Chip+Package) was simulated on a 76.2 x 114.3 x 1.5 mm board with 2 inner copper layers (2 x 70 µm Cu, 2 x 35 µm Cu). Where applicable a thermal via array under the ex posed pad contacted the first inner copper layer.
T_A = 85°C, Device is loaded with 1 W power.
5) Specified R_{thJA} value is according to Jedec JESD51-2,-5,-7 at natural convection on FR4 1s0p board;
The product (Chip+Package) was simulated on a 76.2 x 114.3 x 1.5 mm board with additional heatspreading copper area of 600 mm^2 and 70 µm thickness. T_A = 85°C, Device is loaded with 1 W power.

4.3.1 PCB set up

The following PCB set up was implemented to determine the transient thermal impedance[1)]

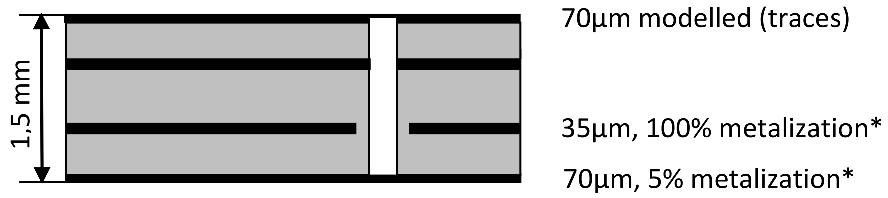

Figure 4 Cross section JEDEC2s2p

1) (*) means percentual Cu metalization on each layer

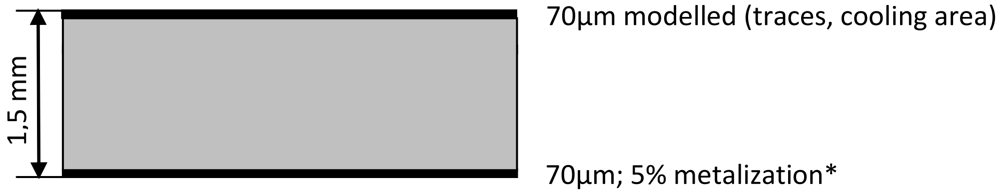

Figure 5 Cross section JEDEC1s0p

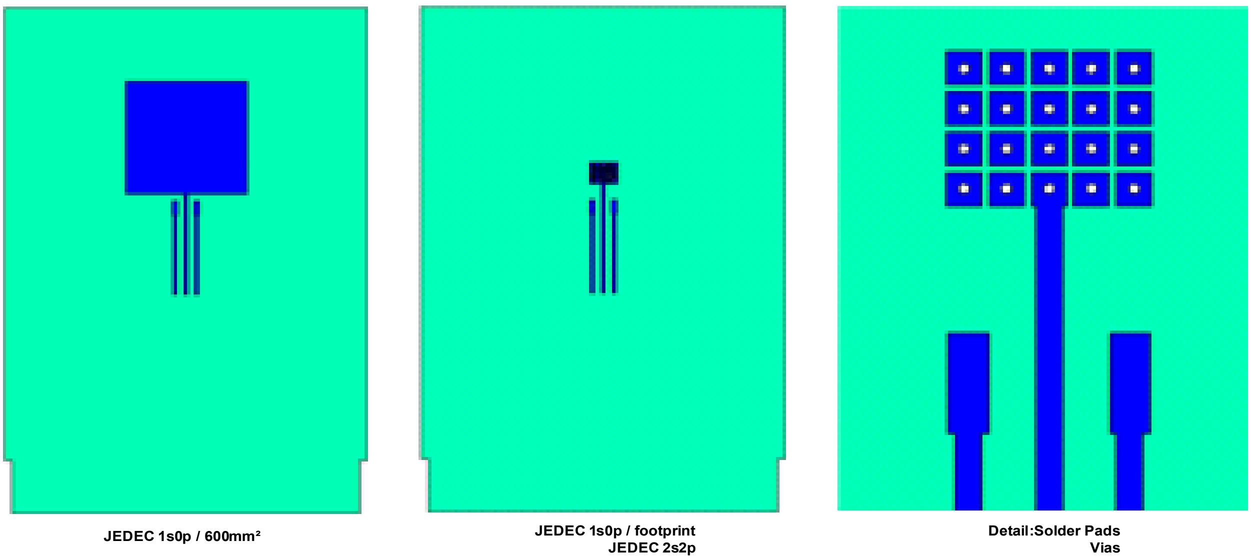

Figure 6 PCB layout

4.3.2 Transient Thermal Impedance

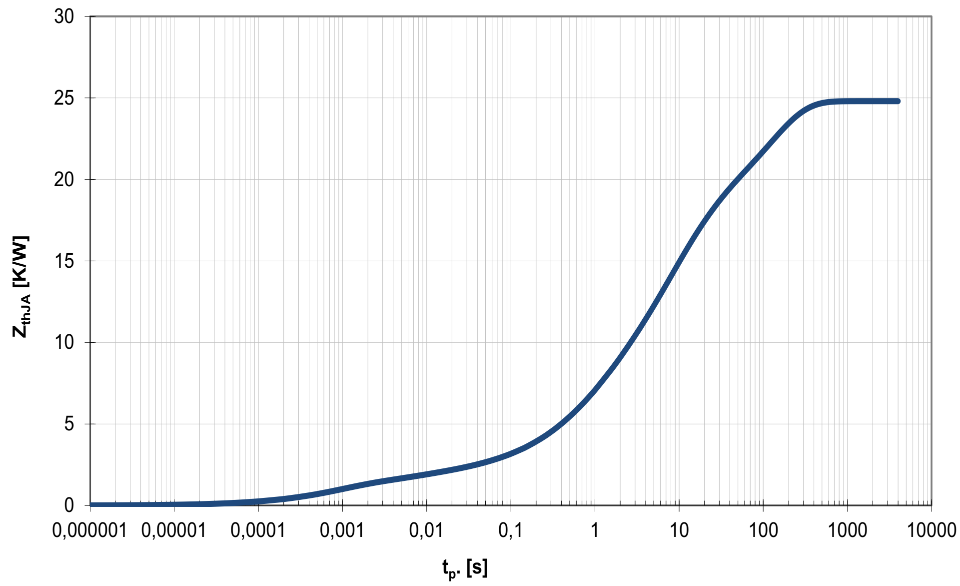

Figure 7 Typical transient thermal impedance $Z_{thJA} = f(t_p)$, T_A = 85°C
Value is according to Jedec JESD51-2,-7 at natural convection on FR4 2s2p board; The product (Chip+Package) was simulated on a 76.2 x 114.3 x 1.5 mm³ board with 2 inner copper layers (2 x 70 µm Cu, 2 x 35 µm Cu). Device is dissipating 1 W power.

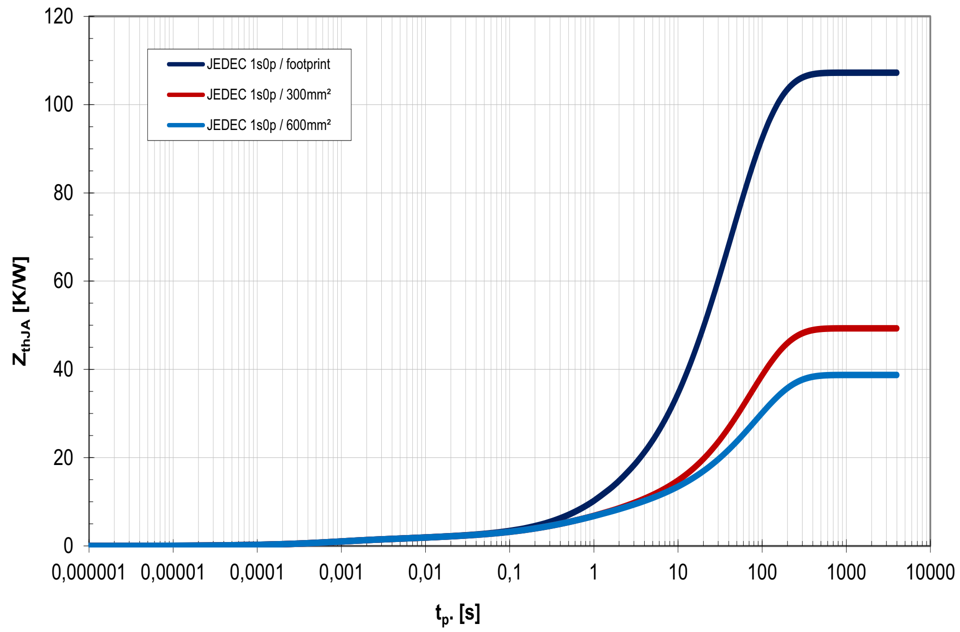

Figure 8 Typical transient thermal impedance $Z_{thJA} = f(t_p)$, Ta = 85°C
Value is according to Jedec JESD51-3 at natural convection on FR4 1s0p board. Device is dissipating 1 W power.

5 Power Stage

5.1 Output On-state Resistance

The on-state resistance depends on the junction temperature T_J and on the applied input voltage. **Figure 9** show this dependencies in terms of temperature and voltage for the typical on-state resistance $R_{DS(ON)}$. The behavior in reverse polarity is described in **"Reverse Current capability" on Page 13**

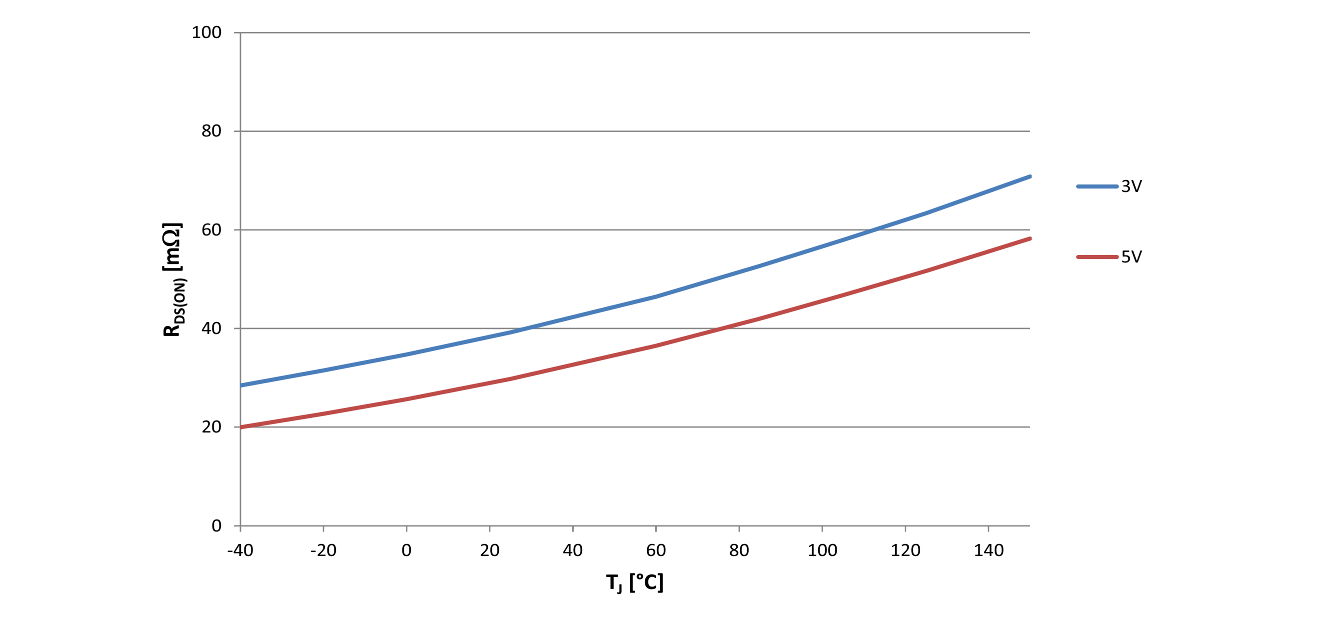

Figure 9 Typical On-State Resistance,
$R_{DS(ON)} = f(T_J)$, $V_{IN} = 3$ V; $V_{IN} = 5$ V

5.2 Resistive Load Output Timing

Figure 10 shows the typical timing when switching a resistive load.

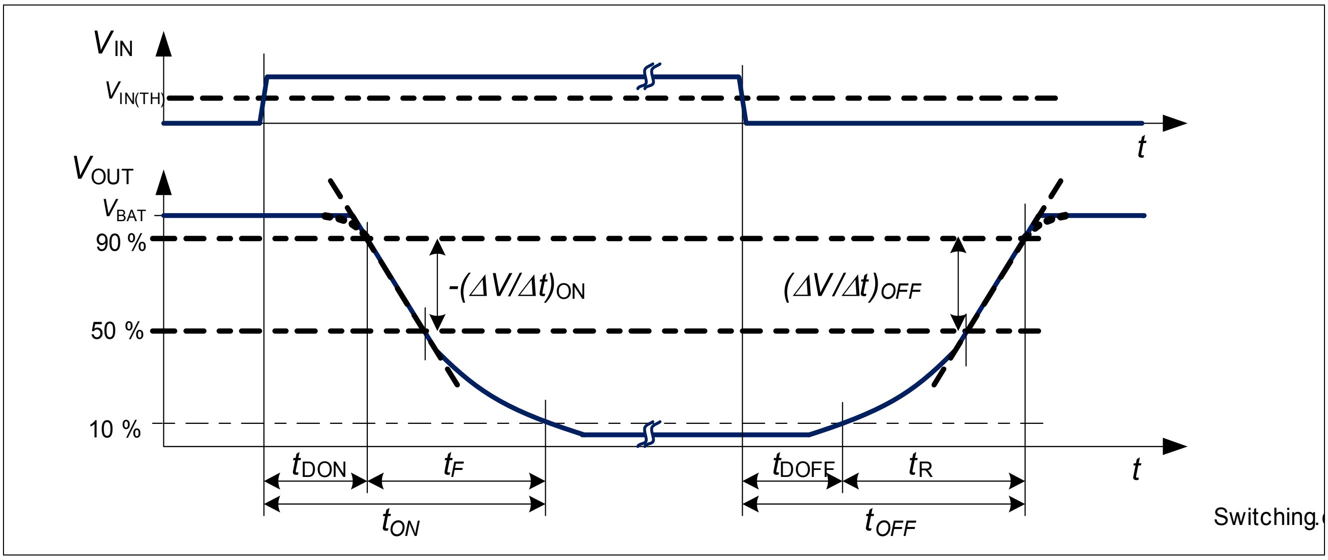

Figure 10 Definition of Power Output Timing for Resistive Load

5.3 Inductive Load

5.3.1 Output Clamping

When switching off inductive loads with low side switches, the Drain-Source voltage V_{OUT} rises above battery potential, because the inductance intends to continue driving the current. To prevent unwanted high voltages the device has a voltage clamping mechanism to keep the voltage at $V_{OUT(CLAMP)}$. During this clamping operation mode the device heats up as it dissipates the energy from the inductance. Therefore the maximum allowed load inductance is limited. See **Figure 11** and **Figure 12** for more details.

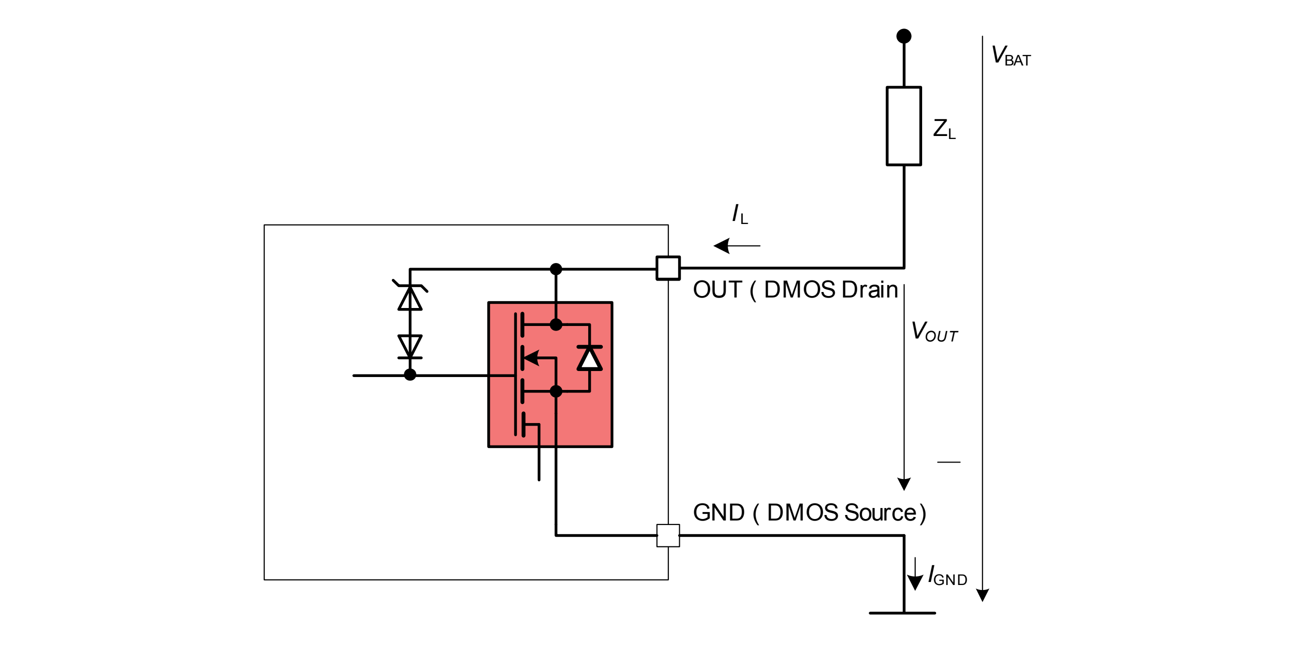

Figure 11 Output Clamp Circuitry

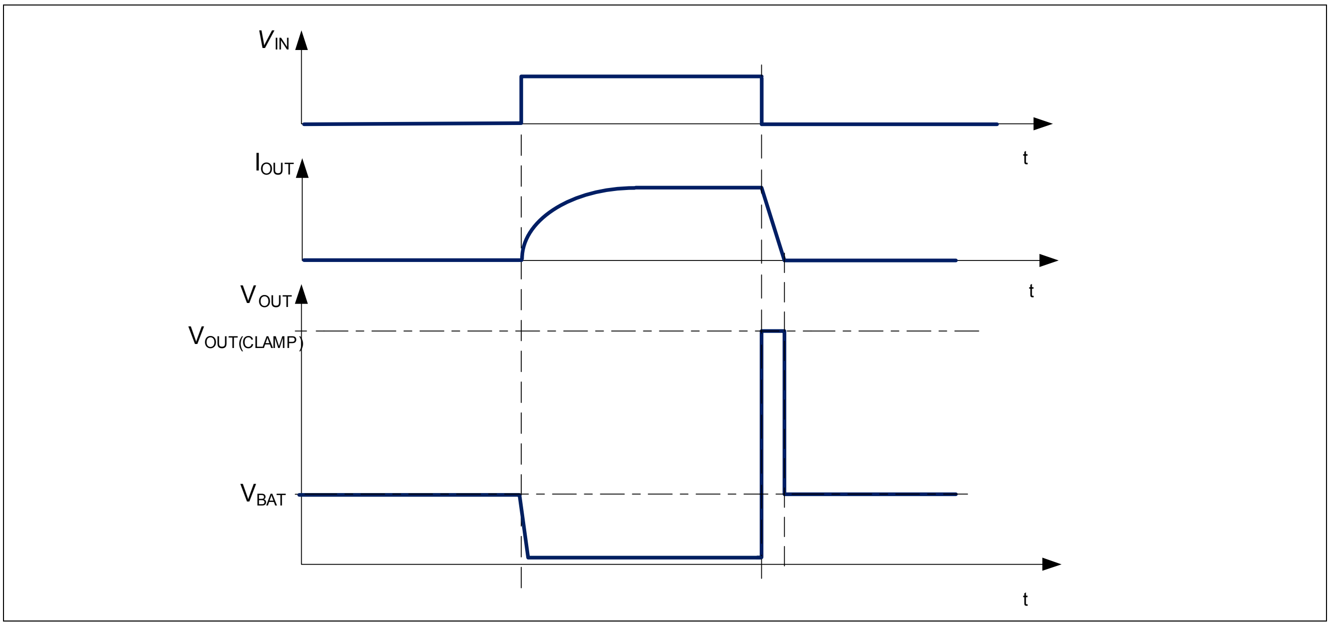

Figure 12 Switching an Inductive Load

5.3.1.1 Maximum Load Inductance

While demagnetization of inductive loads, energy has to be dissipated by the BTS3035TF.
This energy can be calculated by the following equation:

$$\mathrm{E} = V_{OUT(CLAMP)} \times \left[\frac{V_{BAT} - V_{OUT(CLAMP)}}{R_L} \times \ln\left(1 - \frac{R_L \times I_L}{V_{BAT} - V_{OUT(CLAMP)}}\right) + I_L \right] \times \frac{L}{R_L} \tag{5.1}$$

Following equation simplifies under the assumption of $R_L = 0$

$$E = \frac{1}{2} L I_L^{\,2} \times \left(1 - \frac{V_{BAT}}{V_{BAT} - V_{OUT(CLAMP)}}\right) \tag{5.2}$$

For maximum single avalanche energy please also refer to EAS value in **"Energies" on Page 6**.

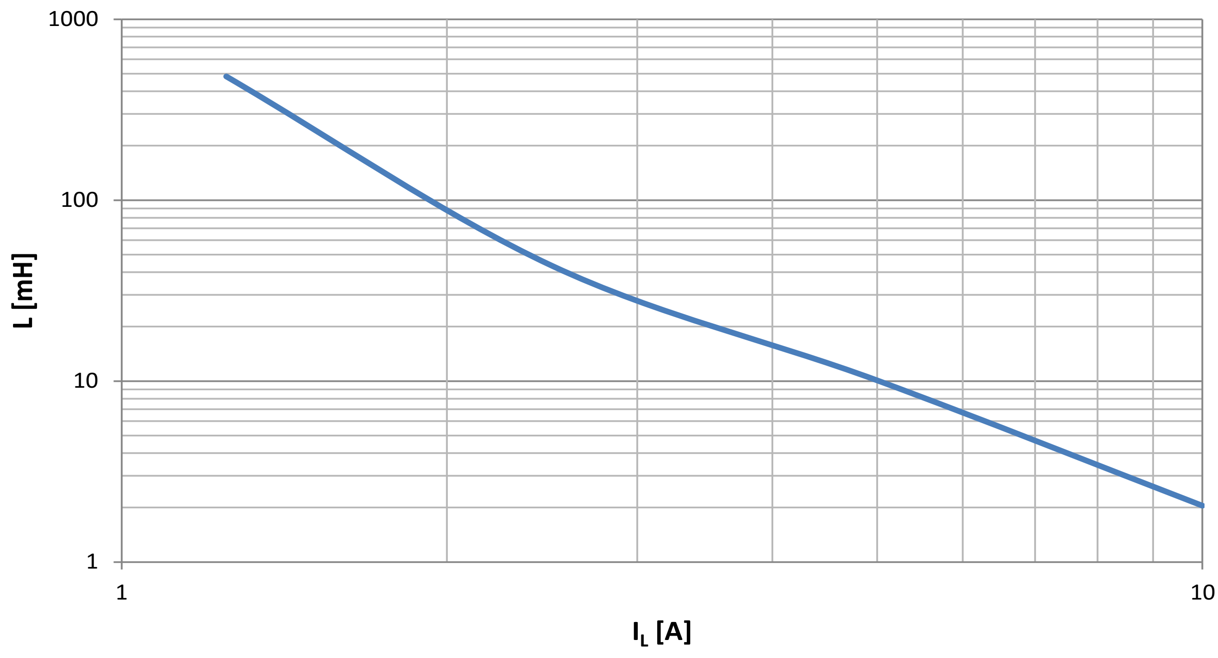

Figure 13 Maximum load inductance for single pulse
$L = f(I_L)$, $T_{J(0)} = T_{J,\,start} = 150°C$, $V_{BAT} = 13.5$ V

5.4 Reverse Current capability

A reverse battery situation means the OUT pin is pulled below GND potentials to $-V_{BAT}$ via the load Z_L.

In this situation the load is driven by a current through the intrinsic body diode of the BTS3035TF. During Reverse Battery all protection functions like current limitation, over temperature shut down and over voltage clamping are not available.

The device is dissipating a power loss which is defined by the driven current and the voltage drop on the DMOS reverse body diode "-V_{OUT}".

5.5 Inverse Current capability

An inverse current situation means the OUT pin is pulled below GND potential by current flowing from GND to OUT (for example in half-bridge configuration and inductive load using freewheeling via the low side path).

In this situation the load is driven by a current through the intrinsic body diode (device off) of the BTS3035TF. During Inverse operation all protection functions like current limitation, over temperature shut-down and over voltage clamping are not available.

The device is dissipating a power loss which is defined by the driven current and the voltage drop on the DMOS reverse body diode "-V_{OUT}".

Input current behavior during inverse condition on Output

Please note that during inverse current on drain an increased input current can flow. To limit this current it is needed to place a resistor (R_{IN}) in line with the input, also to prevent the microcontroller I/O pins from latching up in this case. The value of this resistor is a compromise of input voltage level in normal operation and maximum allowed device input current I_{IN} or I/O current (for example of microcontroller).

$$R_{IN\,(\mathrm{min})} = \frac{V_{OHuC\,(\mathrm{max})}}{I_{IN\,(\mathrm{max})}} \tag{5.3}$$

with $I_{IN(max)}$ = 2 mA (see also **"Absolute Maximum Ratings" on Page 6**) allow for the device;
$V_{OH\mu C(max)}$ maximum high level voltage of the control signal (microcontroller I/O)

5.6 Characteristics

Please see **"Power Stage" on Page 11** for electrical characteristic table.

6 Protection Functions

The device provides embedded protection functions. Integrated protection functions are designed to prevent IC destruction under fault conditions described in the datasheet. Fault conditions are considered as “outside” normal operation. Protection functions are not designed for continuous repetitive operation.

6.1 Over Voltage Clamping on OUTput

The BTS3035TF is equipped with a voltage clamp circuitry that keeps the drain-source (OUT to GND) voltage V_{DS} at a certain level $V_{OUT(CLAMP)}$. The over voltage clamping is overruling the other protection functions. Power dissipation has to be limited to not exceed the maximum allowed junction temperature.

This function is also used in terms of inductive clamping. Please see also **Chapter 5.3.1** for more details.

6.2 Thermal Protection

The device is protected against over temperature due to overload and / or bad cooling conditions. To ensure this a temperature sensor is located in the power MOSFET.

The BTS3035TF has a thermal protection function with automatic restart. After the device has switched off due to over temperature the device will stay off until the junction temperature has dropped down below the thermal hysteresis **“Thermal Protection” on Page 15**.

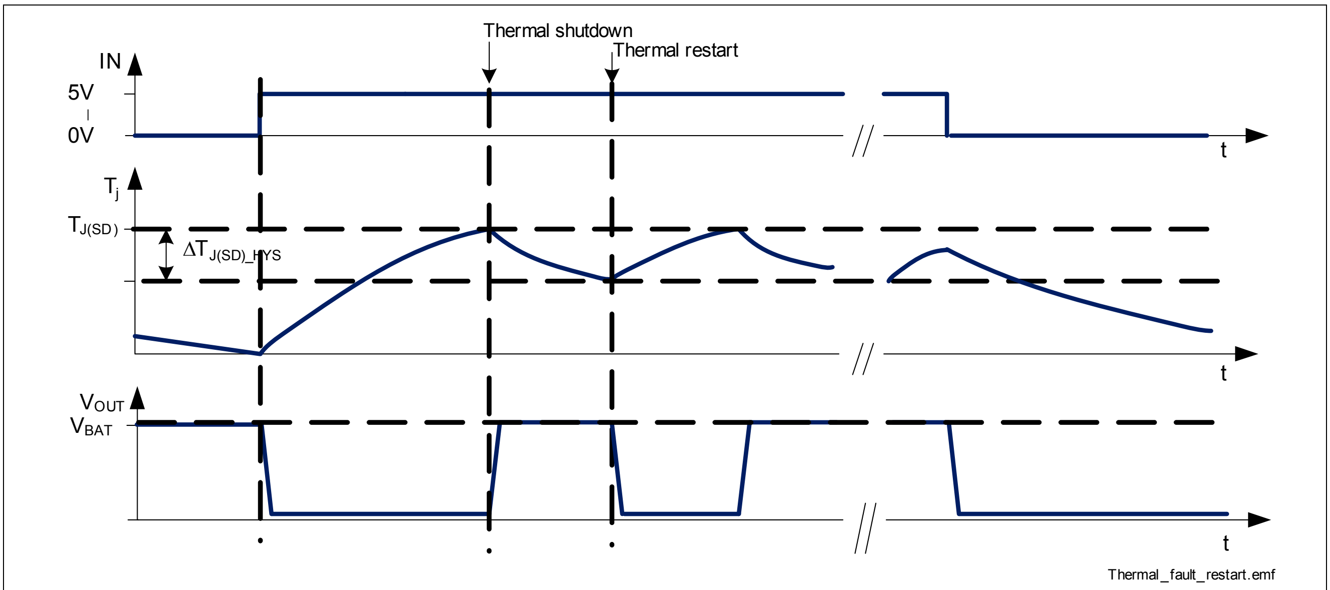

Figure 14 Thermal protective switch OFF scenario with thermal restart

6.3 Short Circuit Protection / Current limitation

The condition short circuit is an overload condition to the device. If the load current reaches the limitation value of $I_{L(LIM)}$ the device limits the current and starts heating up. When the thermal shutdown temperature is reached, the device turns off.
The time from the beginning of current limitation until the over temperature switch off depends strongly on the cooling conditions.

If input is still high, the device will turn on again after the measured temperature has dropped below the thermal hysteresis.

Figure 15 shows this simplified behavior.

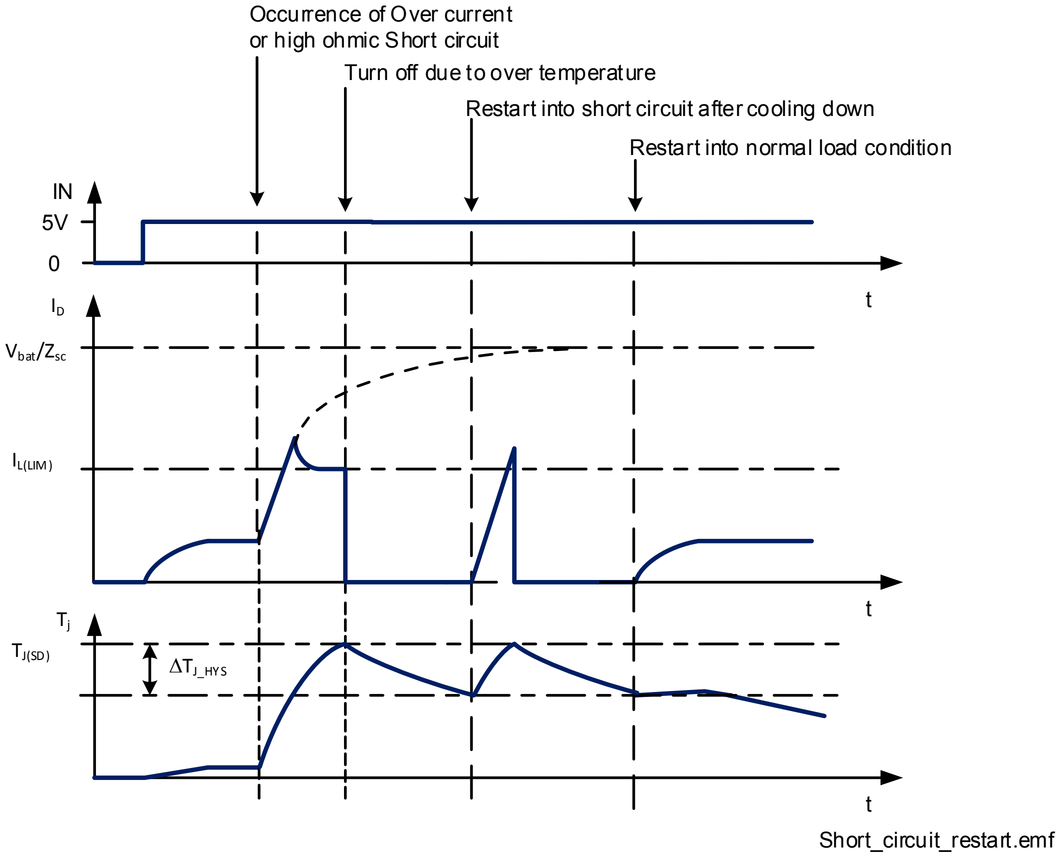

Figure 15 Short circuit protection via current limitation and over temperature switch off with auto-restart

6.4 Characteristics

Please see **“Protection Functions” on Page 15** for electrical characteristic table.

7 Input Stage

7.1 Input Circuit

Figure 16 shows the input circuit of the BTS3035TF. In case of open or floating input pin, the device will automatically switch off and remain off. An ESD Zener structure protects the input circuit against ESD pulses.

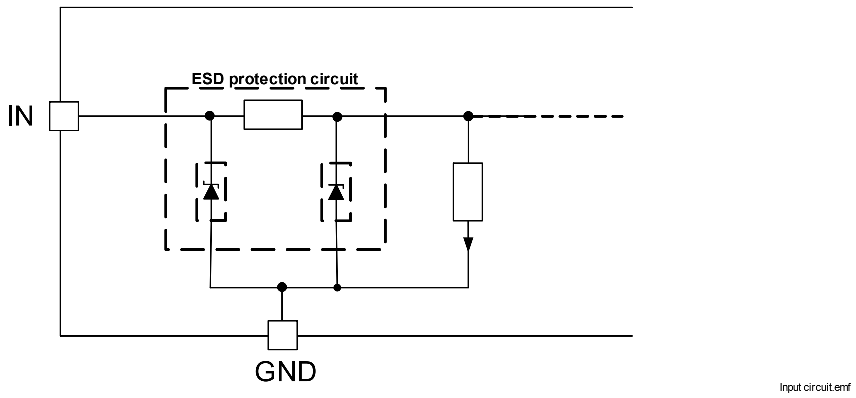

Figure 16 Simplified Input circuitry

7.2 Characteristics

Please see **"Input Stage" on Page 21** for electrical characteristic table.

8 Electrical Characteristics

8.1 Power Stage

Please see Chapter **"Power Stage" on Page 11** for parameter description and further details.

Table 5 Electrical Characteristics: Power Stage

T_j = -40°C to +150°C, V_{BAT} = 6 V to 18 V, all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Power Stage							
On-State resistance at hot temperature (150°C)	$R_{DS(ON)\_150}$	–	58	70	mΩ	T_J = 150°C; V_{IN} = 5 V; $I_L = I_{L(NOM)}$	P_8.1.1
On-State resistance at ambient temperature (25°C)	$R_{DS(ON)\_25}$	–	30	–	mΩ	T_J = 25°C; V_{IN} = 5 V; $I_L = I_{L(NOM)}$	P_8.1.5
Nominal load current	$I_{L(NOM)}$	–	5	–	A	[1] T_J < 150°C; T_A = 85°C V_{IN} = 5 V	P_8.1.25
OFF state load current, Output leakage current	$I_{L(OFF)\_85}$	–	–	0.6	µA	[2] V_{BAT} = 13.5 V; V_{IN} = 0 V; $T_J \leq$ 85°C	P_8.1.29
OFF state load current, Output leakage current	$I_{L(OFF)\_150}$	–	1.3	4.3	µA	V_{BAT} = 18 V; V_{IN} = 0 V; T_J = 150°C	P_8.1.33
Reverse body diode forward voltage	$-V_{OUT}$	–	0.8	1.1	V	$I_L = -I_{L(NOM)}$; V_{IN} = 0 V	P_8.1.45

Table 5 Electrical Characteristics: Power Stage (cont'd)

T_j = -40°C to +150°C, V_{BAT} = 6 V to 18 V, all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Dynamic characteristics - switching times single pulse V_{BAT} = 13.5 V, R_L = 2.2Ω; for definition details see Figure 10 "Definition of Power Output Timing for Resistive Load" on Page 11							
Turn-on time	t_{ON}	35	75	115	µs	3) V_{IN} = 0 V to 5 V; V_{OUT} = 10% V_{BAT}	P_8.1.46
Turn-off time	t_{OFF}	70	135	210	µs	4) V_{IN} = 5 V to 0 V; V_{OUT} = 90% V_{BAT}	P_8.1.47
Turn-on delay time	t_{DON}	5	15	25	µs	V_{IN} = 0 V to 5 V; V_{OUT} = 90% V_{BAT}	P_8.1.48
Turn-off delay time	t_{DOFF}	40	75	120	µs	V_{IN} = 5 V to 0 V; V_{OUT} = 10% V_{BAT}	P_8.1.49
Fall time, Falling output voltage (turn-on)	t_F	30	60	90	µs	V_{IN} = 0 V to 5 V; V_{OUT} = 90% V_{BAT} to V_{OUT} = 10% V_{BAT}	P_8.1.50
Rise time, Rising output voltage	t_R	30	60	90	µs	V_{IN} = 5 V to 0 V; V_{OUT} = 10% V_{BAT} to V_{OUT} = 90% V_{BAT}	P_8.1.51
Turn-on Slew rate	$-(\Delta V/\Delta t)_{ON}$	0.22	0.45	0.65	V/µs	5) V_{OUT} = 90% V_{BAT} to V_{OUT} = 50% V_{BAT}	P_8.1.52
Turn-off Slew rate	$(\Delta V/\Delta t)_{OFF}$	0.22	0.45	0.65	V/µs	6) V_{OUT} = 50% V_{BAT} to V_{OUT} = 90% V_{BAT}	P_8.1.53

1) Not subject to production test, calculated by R_{thJA} (JEDEC 2s2p, PCB) and $R_{DS(ON)}$
2) Not subject to production test, specified by design;
3) Not subject to production test, calculated with delay time ON and fall time
4) Not subject to production test, calculated with delay time OFF and rise time
5) Not subject to production test, calculated slew rate between 90% and 50% V_{OUT};
6) Not subject to production test, calculated slew rate between 50% and 90% V_{OUT};

8.2 Protection

Please see Chapter **"Protection Functions" on Page 15** for parameter description and further details.

Note: 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

Table 6 Electrical Characteristics: Protection

T_j = -40°C to +150°C, V_{BAT} = 6 V to 18 V, all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Thermal Protection							
Thermal shut down junction temperature	$T_{J(SD)}$	150	175	–	°C	[1)] 3 V < V_{IN} < 5.5 V	P_8.2.1
Thermal hysteresis	ΔT_{J_HYS}	–	15	–	K	[1)]	P_8.2.3
Overvoltage Protection							
Drain clamp voltage	$V_{OUT(CLAMP)}$	40	45	–	V	V_{IN} = 0 V; I_D = 14 mA	P_8.2.9
Current limitation (see also Figure 15)							
Current limitation	$I_{L(LIM)}$	20	30	40	A	V_{IN} = 5 V;	P_8.2.13

1) Not subject to production test, specified by design.

8.3 Input Stage

Please see Chapter **"Input Stage" on Page 17** for description and further details.

Table 7 Electrical Characteristics: Input

T_j = -40°C to +150°C, V_{BAT} = 6 V to 18 V, all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Input							
Input Current, normal ON state	$I_{IN(ON)}$	–	82	110	µA	V_{IN} = 5.0 V	P_8.3.1
Input Current, protection mode	$I_{IN(PROT)}$	–	191	260	µA	V_{IN} = 5.0 V	P_8.3.3
Input current, inverse condition on OUT to GND	$I_{IN(-VOUT)}$	–	15	–	mA	[1) 2)] V_{OUT} < -0.3 V; -0.3 V ≤ V_{IN} <5.5 V	P_8.3.7
Input pull down current	I_{IN-GND}	10	–	–	µA	[3)] V_{IN} = $V_{IN(TH)}$	P_8.3.8
Input Voltage on-threshold	$V_{IN(TH)}$	0.8	2.3	3	V	I_L =1.4 mA; Power DMOS active	P_8.3.9

1) Not subject to production test, specified by design.
2) Input current must not exceed the maximum ratings in Chapter 4, P_4.1.10
3) Not subject to production test, specified by design.

9 Characterization Results

Typical performance characteristics.

9.1 Power Stage

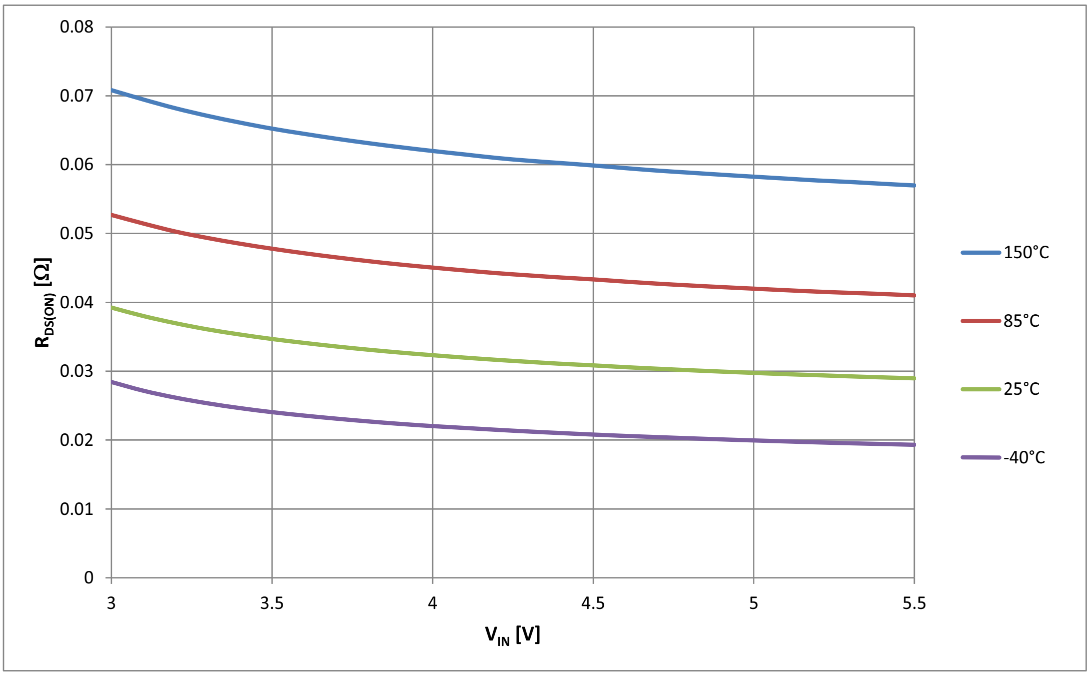

Figure 17 Typical $R_{DS(ON)}$ vs. V_{IN} @ T_j = -40 ... 150°C, I_L = $I_{L(NOM)}$

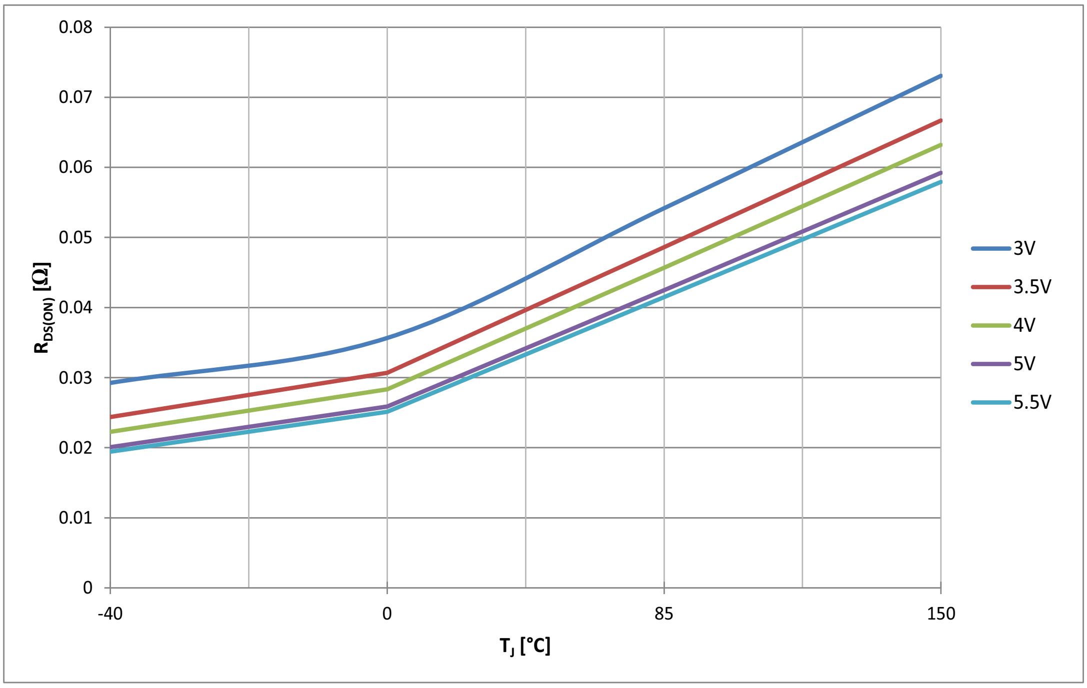

Figure 18 Typical $R_{DS(ON)}$ vs. T_J @ V_{IN} = 3 ... 5.5 V, I_L = $I_{L(NOM)}$

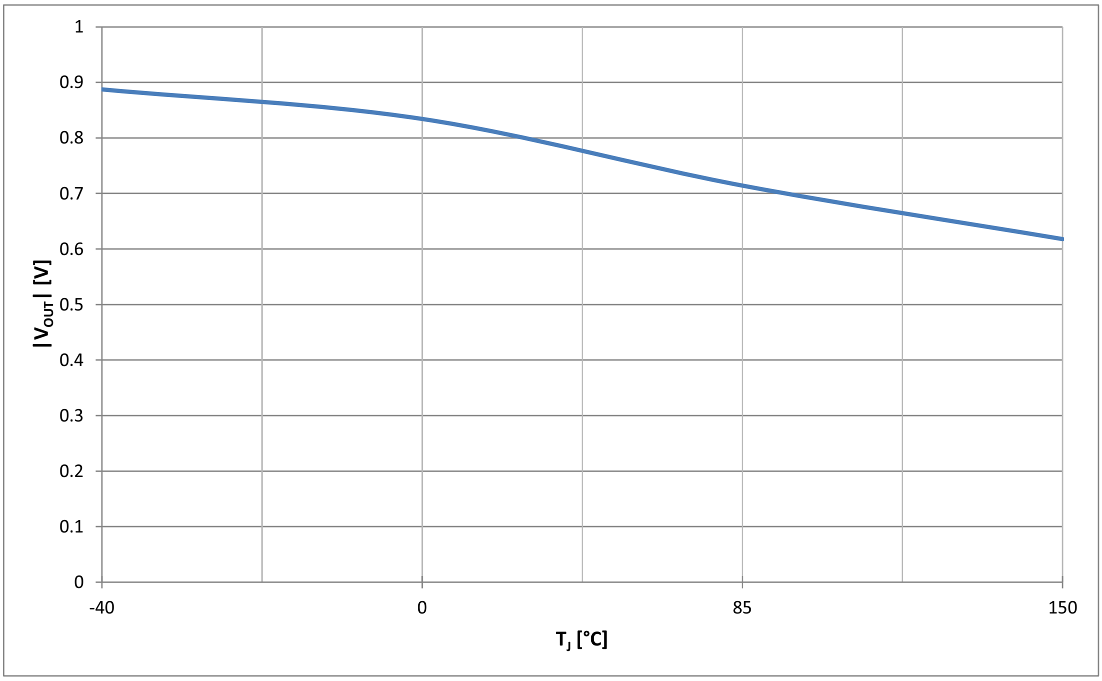

Figure 19 Typical Reverse Diode |V_{OUT}| vs. T_J @ I_L = $I_{L(NOM)}$

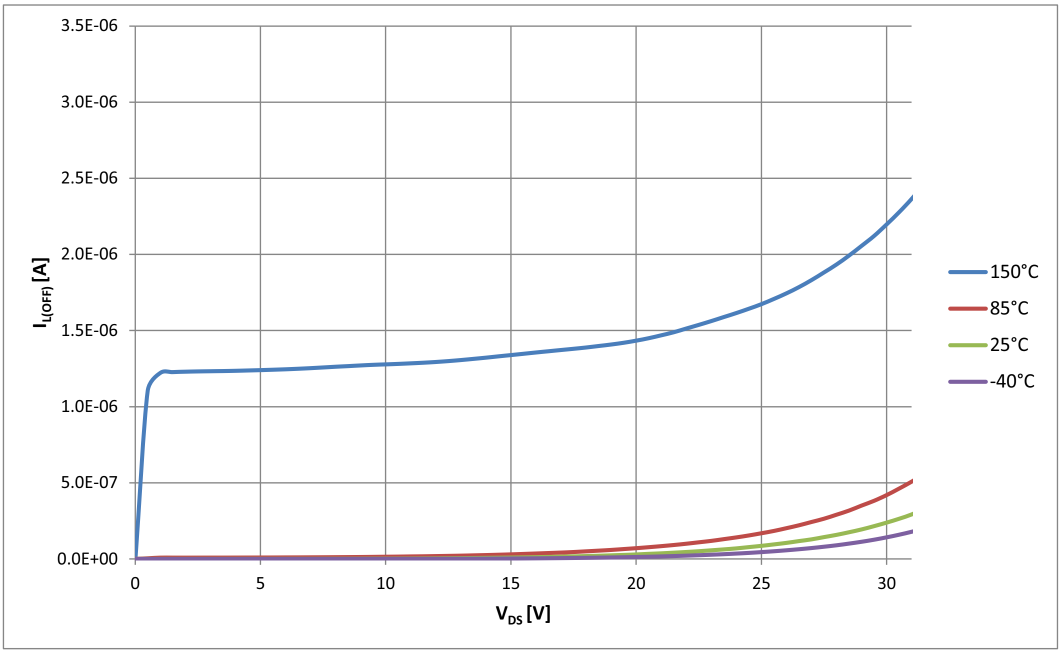

Figure 20 Typical $I_{L(OFF)}$ vs. V_{DS} @ T_J = -40 ... 150°C, V_{IN} = 0 V

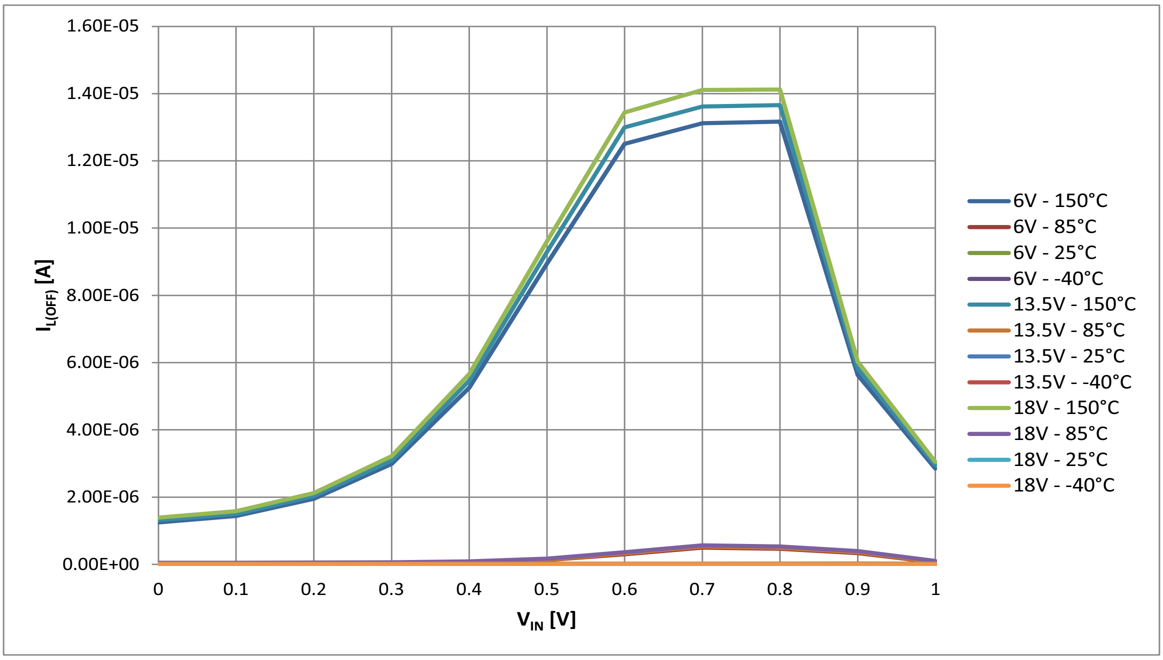

Figure 21 Typical $I_{L(OFF)}$ vs. V_{IN} @ T_J = -40 ... 150°C, V_{BAT} = 6 ... 18 V

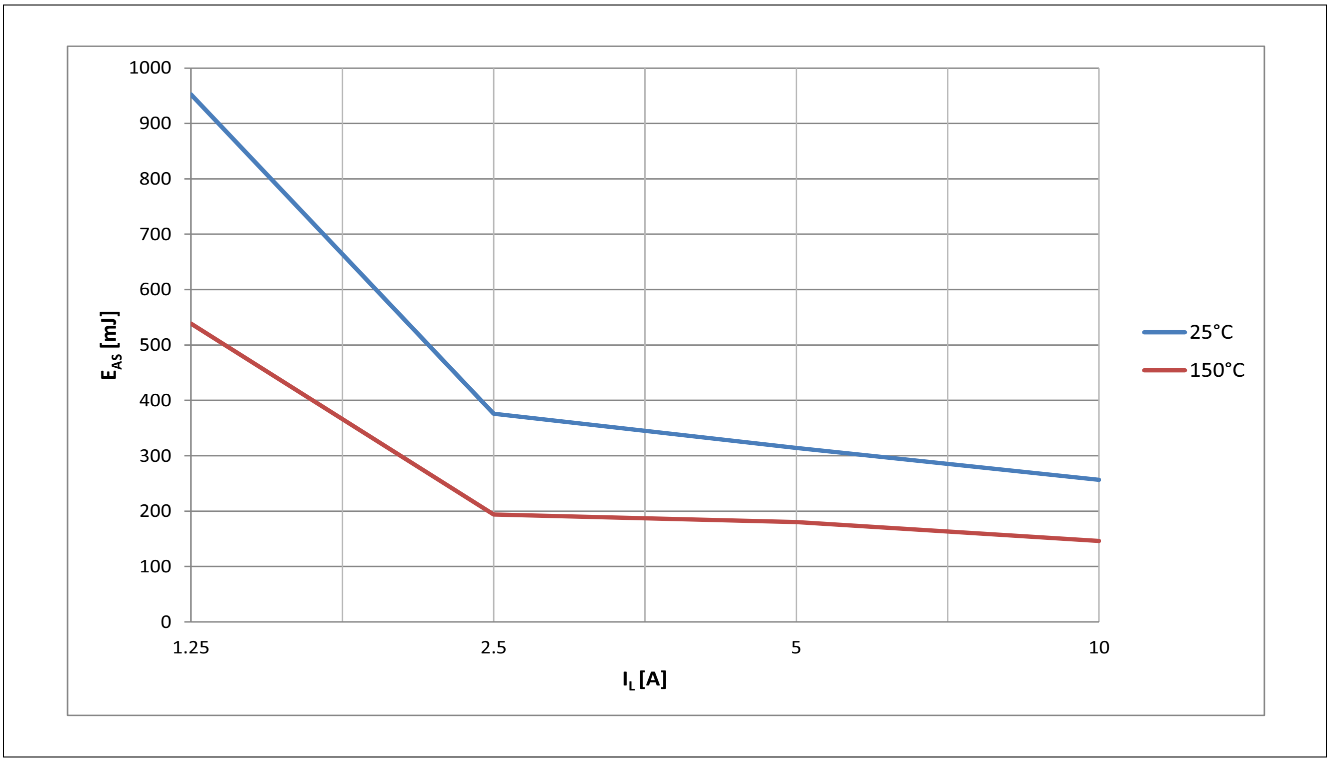

Figure 22 Typical destruction point. E_{AS} vs. I_L @ T_J = 25 and 150°C, V_{BAT} = 13.5V

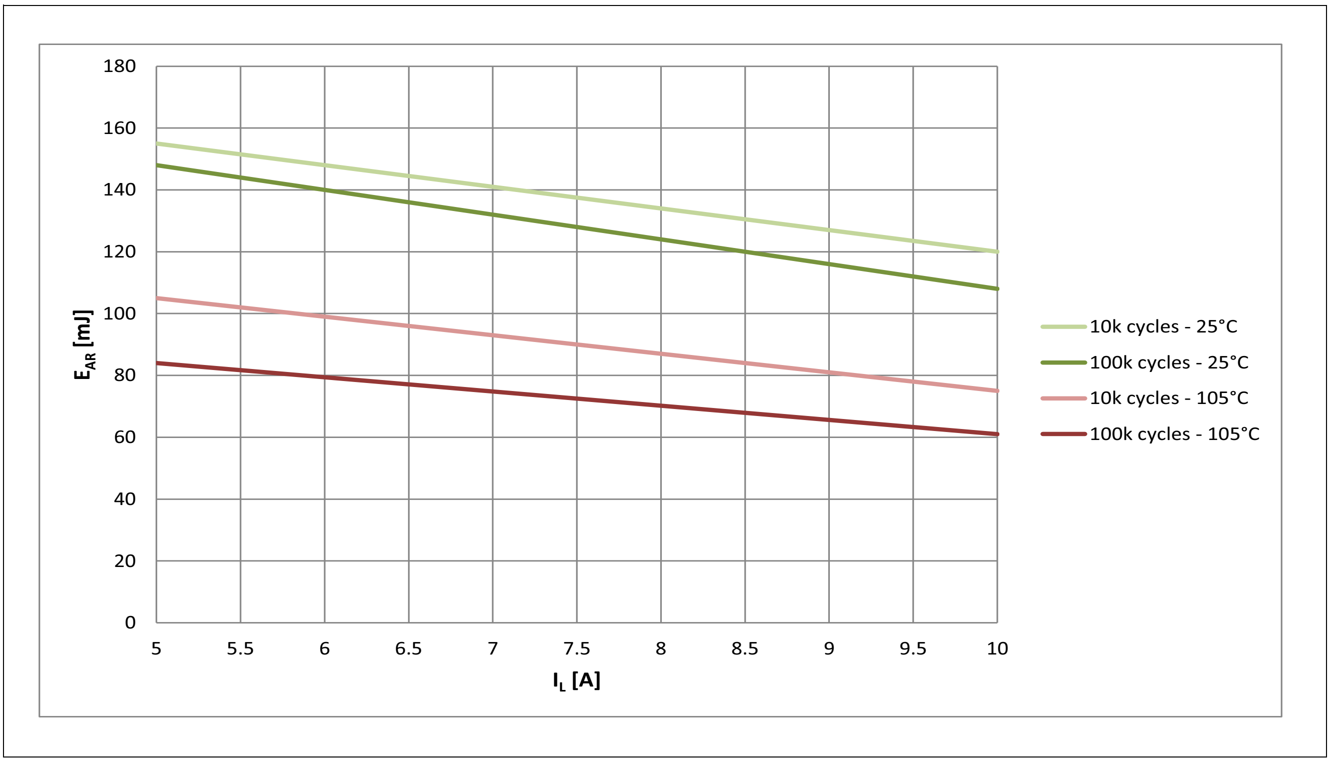

Figure 23 Typical E_{AR} vs. I_L @ T_J = 25 and 105°C, V_{BAT} = 13.5V

Characterization Results

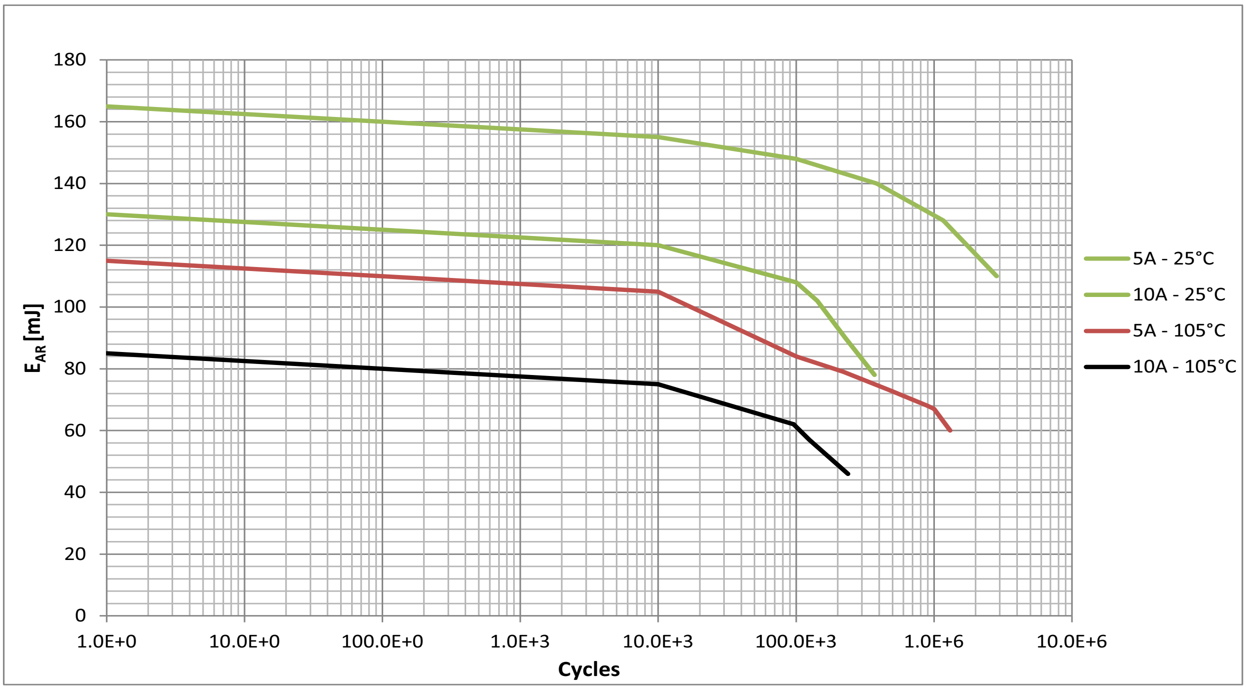

Figure 24 Typical E_{AR} vs. Cycles @ T_J = 25 and 105°C, V_{BAT} = 13.5V

Dynamic charactersitics (switching times):

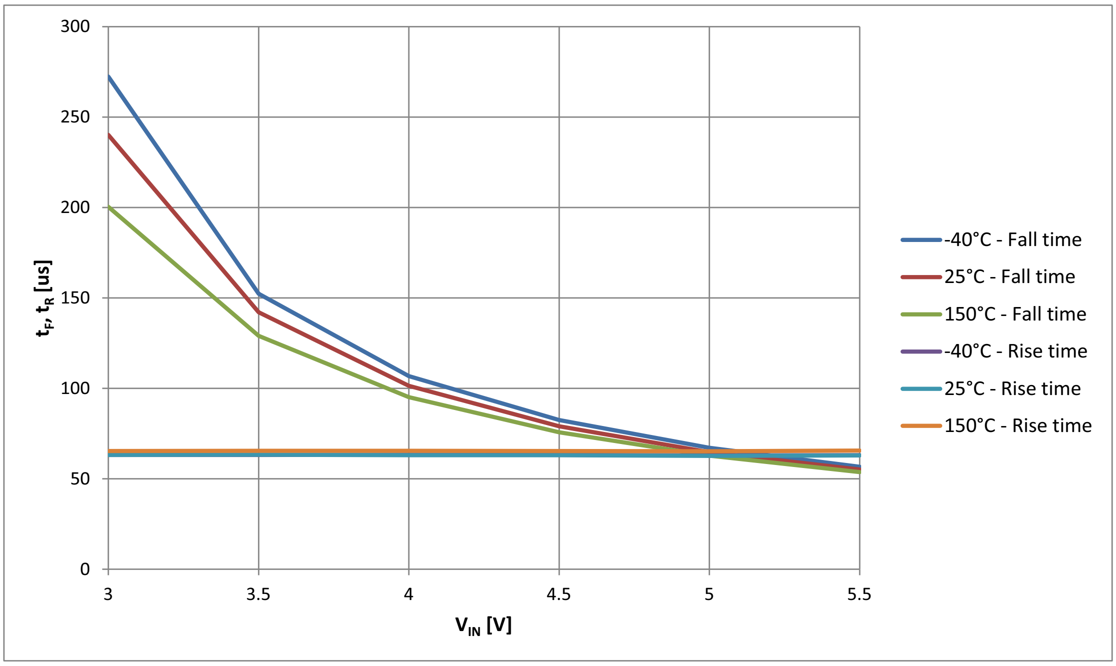

Figure 25 Typical t_F, t_R vs. V_{IN} @ T_J = -40 ... 150°C

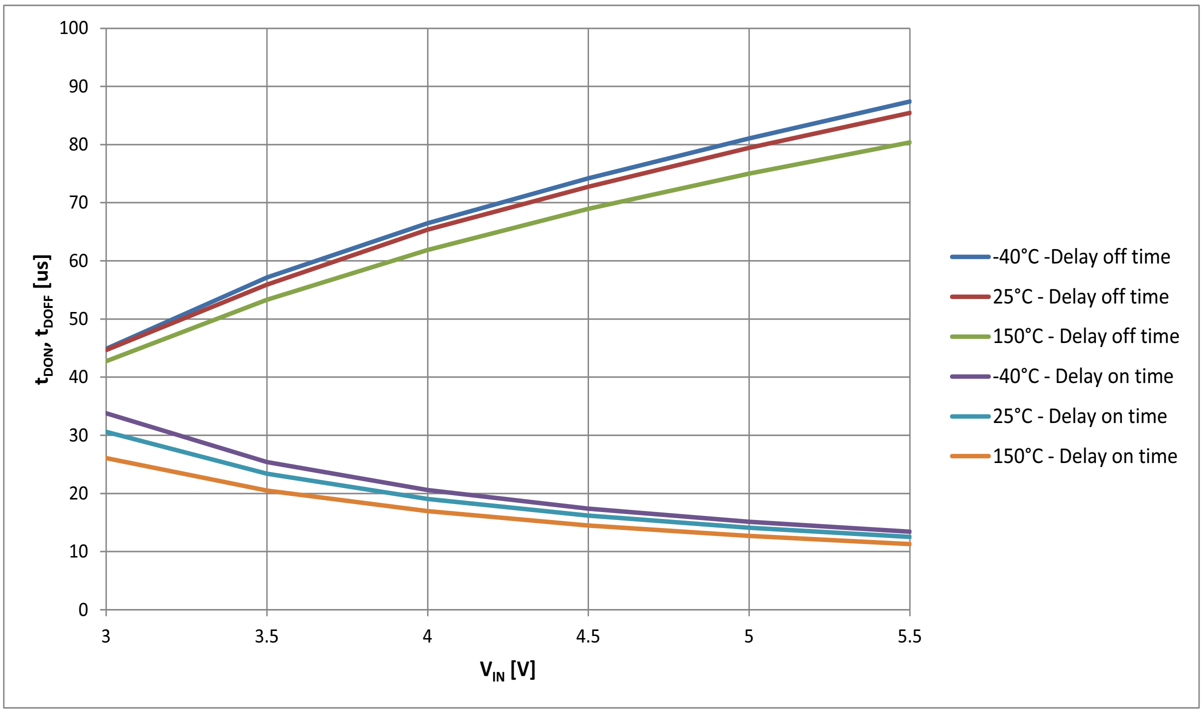

Figure 26 Typical t_{DON}, t_{DOFF} vs. V_{IN} @ T_J = -40 … 150°C

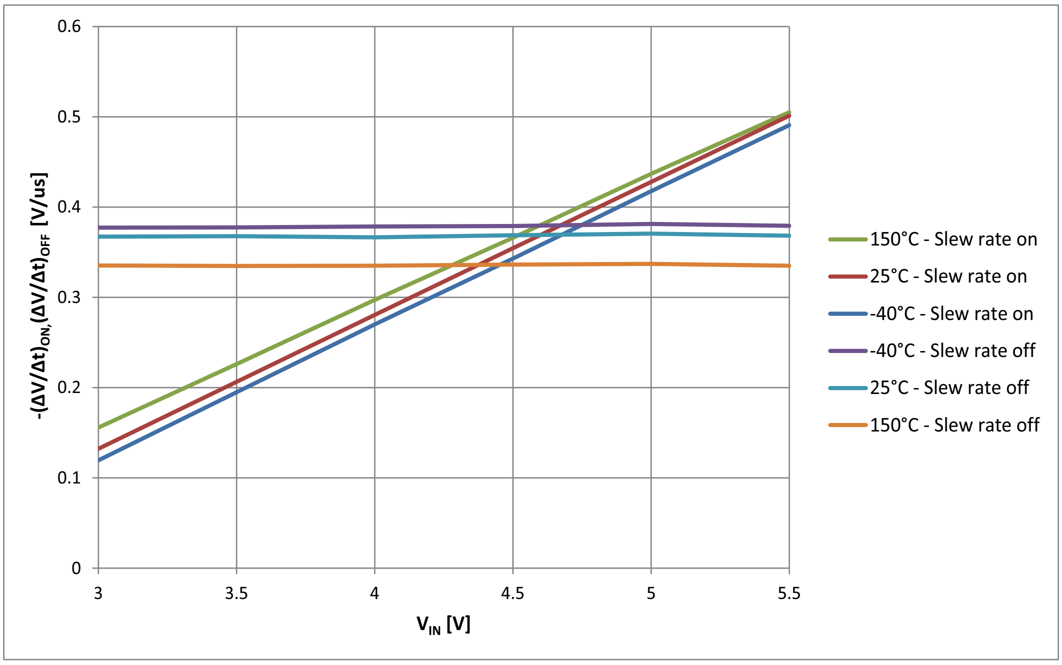

Figure 27 Typical $-(\Delta V/\Delta t)_{ON}$, $(\Delta V/\Delta t)_{OFF}$ vs. V_{IN} @ T_J = -40 … 150°C

Characterization Results

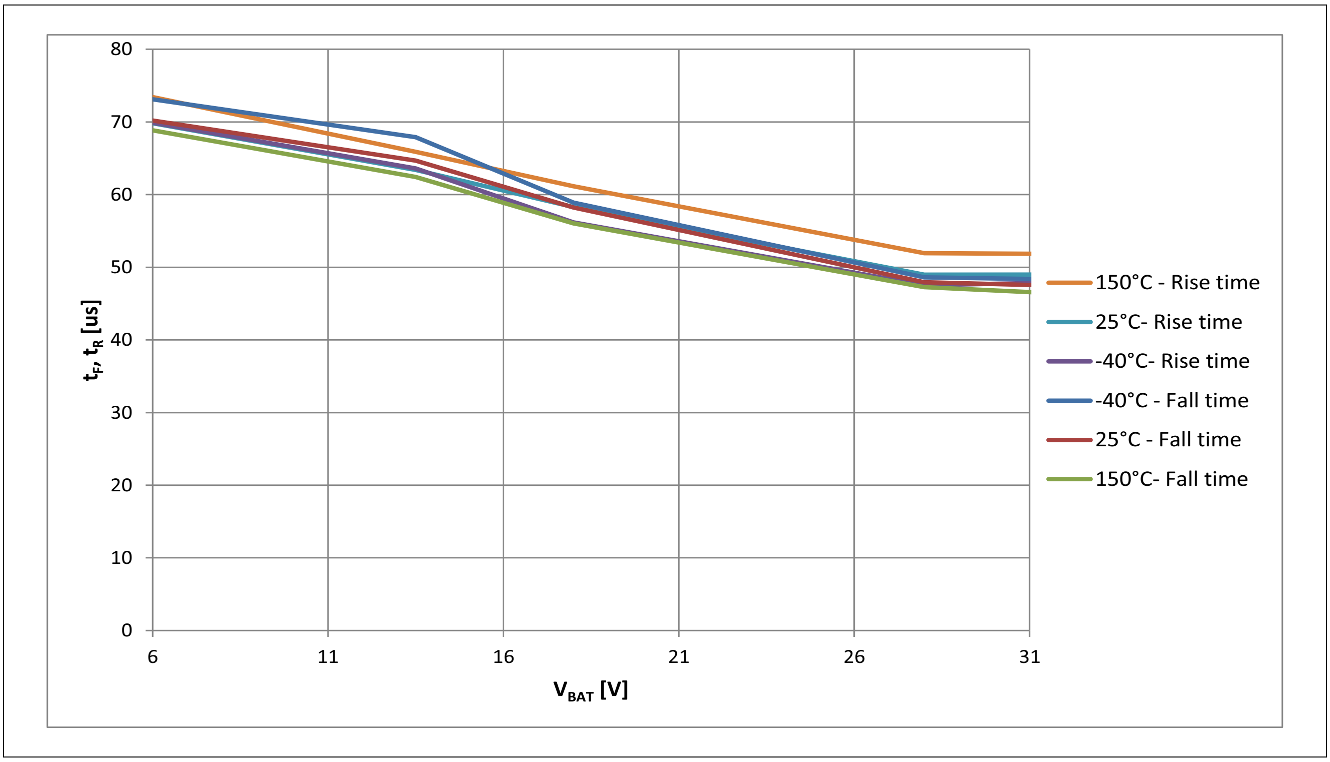

Figure 28 Typical t_F, t_R vs. V_{BAT} @ V_{IN} = 5V; T_J = -40 ... 150°C

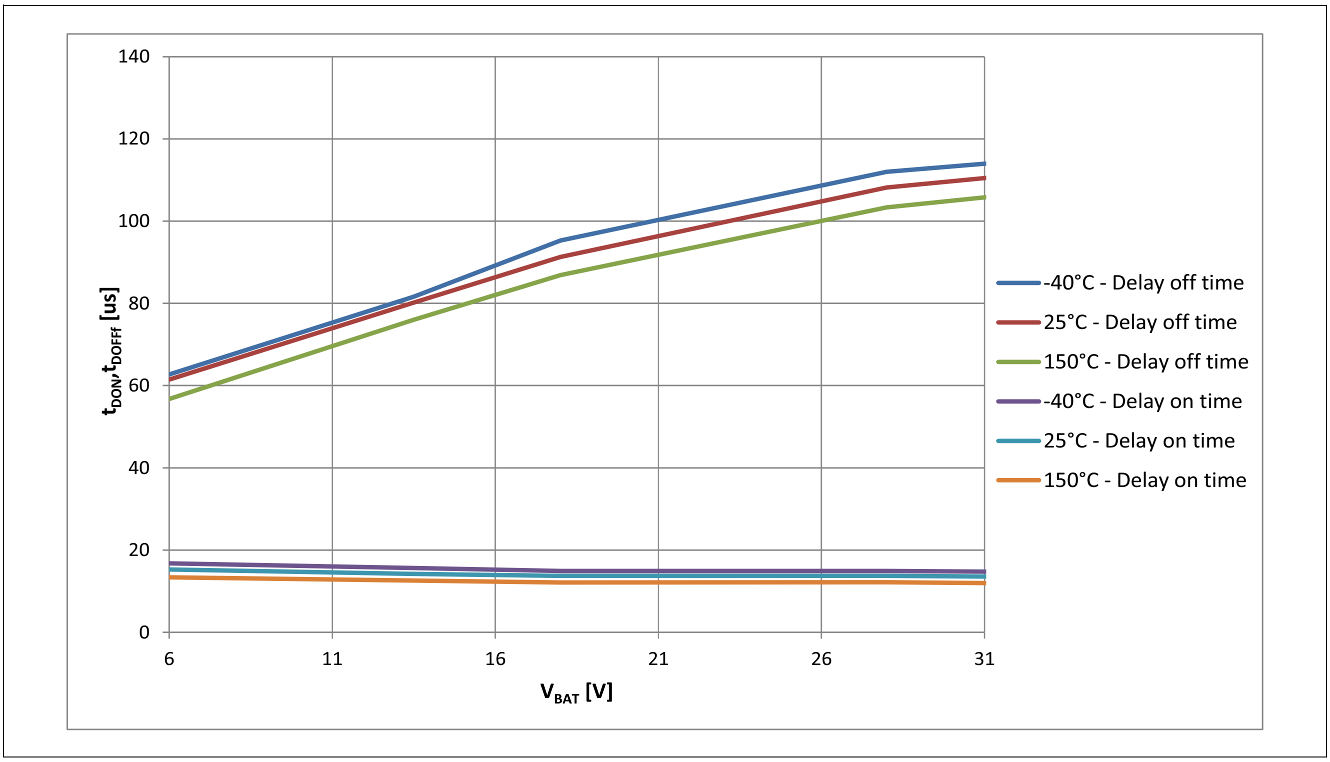

Figure 29 Typical t_{DON}, t_{DOFF} vs. V_{BAT} @ V_{IN} = 5V; T_J = -40 ... 150°C

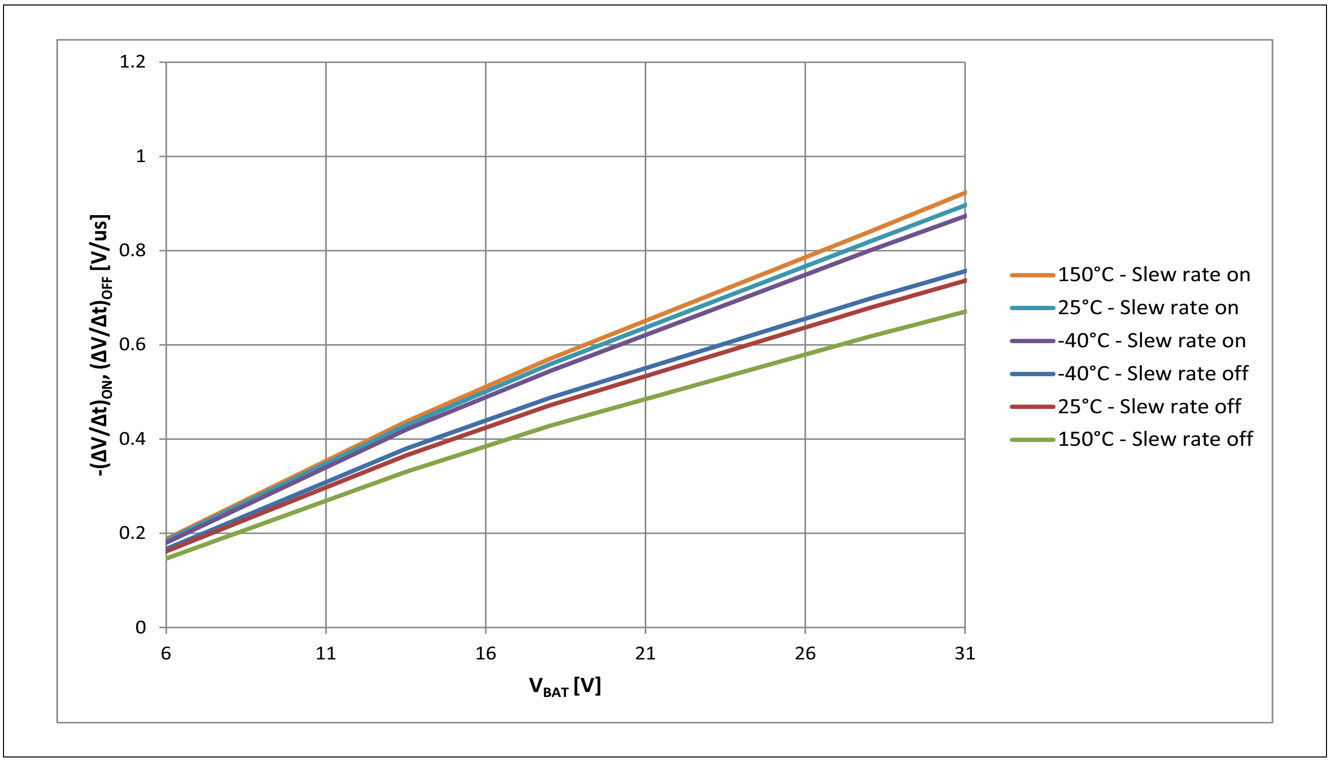

Figure 30 Typical $-(\Delta V/\Delta t)_{ON}$, $(\Delta V/\Delta t)_{OFF}$ vs. V_{BAT} @ V_{IN} = 5V; T_J = -40 ... 150°C

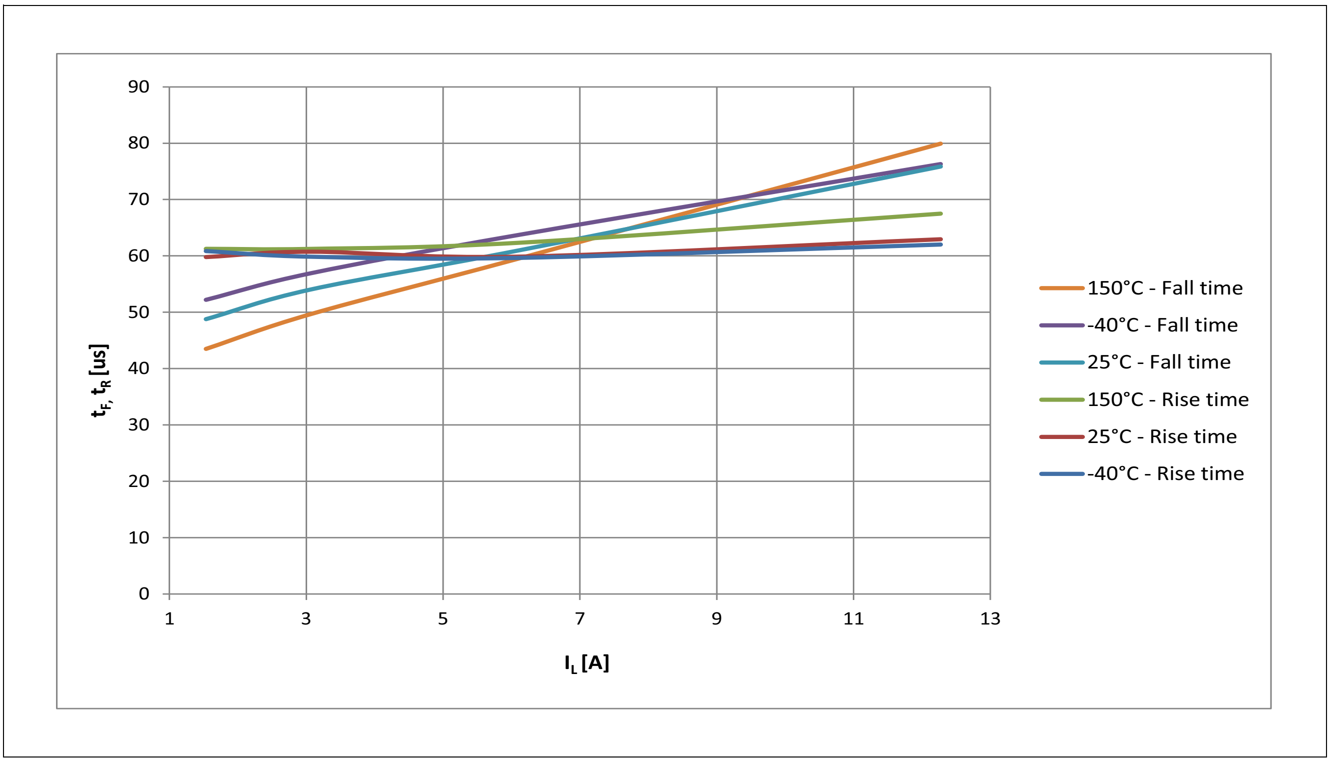

Figure 31 Typical t_F, t_R vs. I_L @ V_{IN} = 5V; T_J = -40 ... 150°C

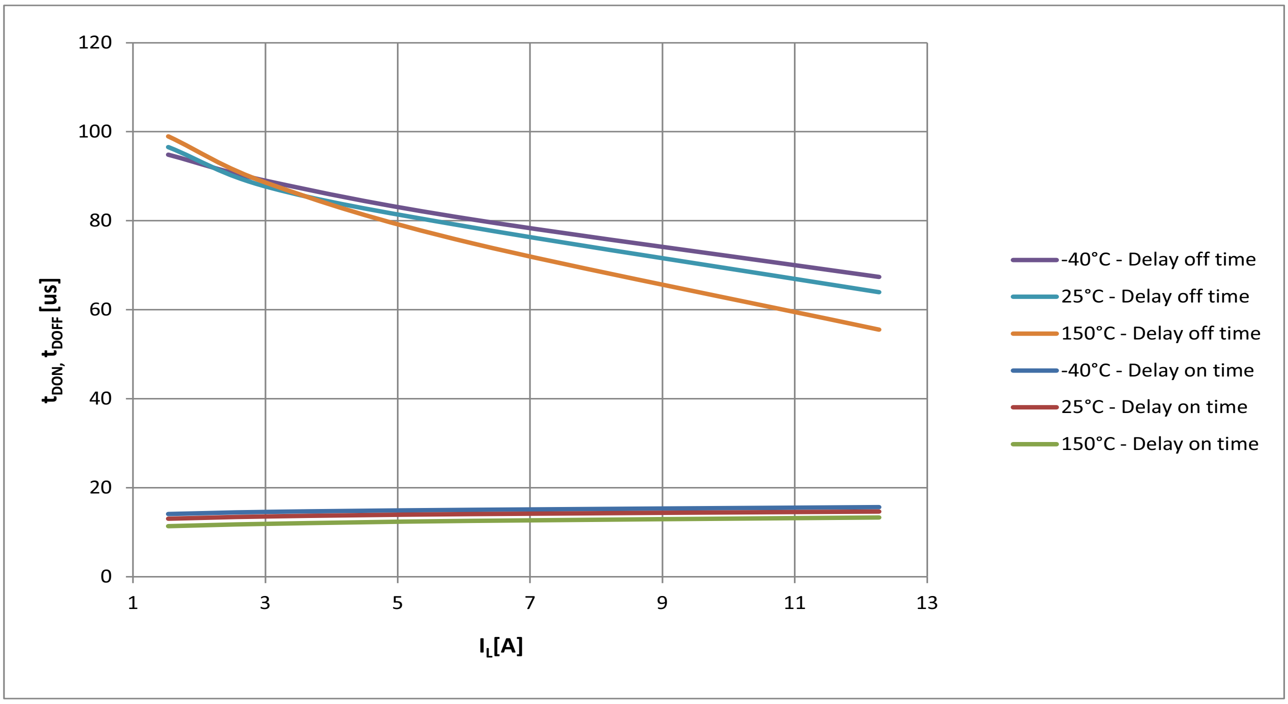

Figure 32 Typical t_{DON}, t_{DOFF} vs. I_L @ V_{IN} = 5V; T_J = -40 ... 150°C

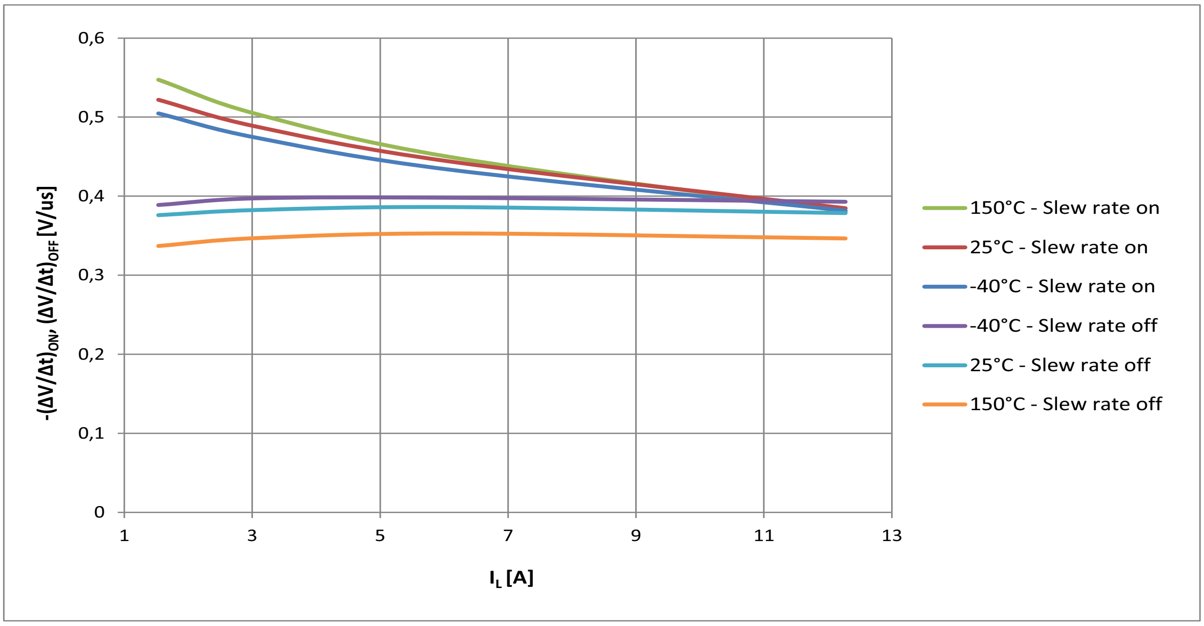

Figure 33 Typical $-(\Delta V/\Delta t)_{ON}$, $(\Delta V/\Delta t)_{OFF}$ vs. I_L @ V_{IN} = 5V; T_J = -40 ... 150°C

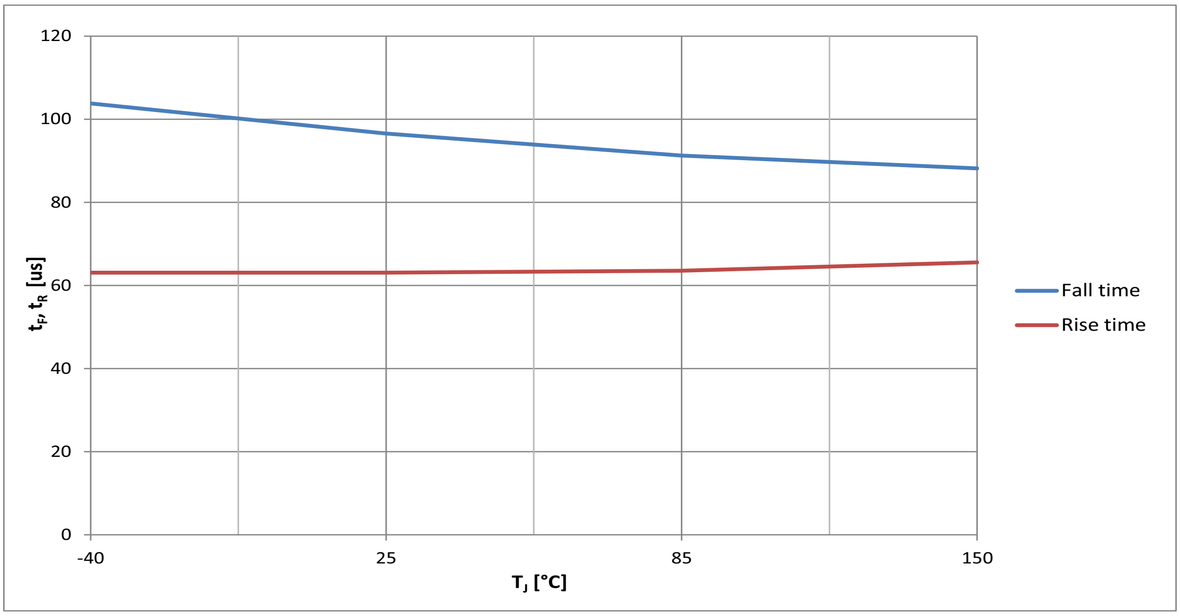

Figure 34 Typical t_F, t_R vs. T_J @ V_{IN} = 5 V

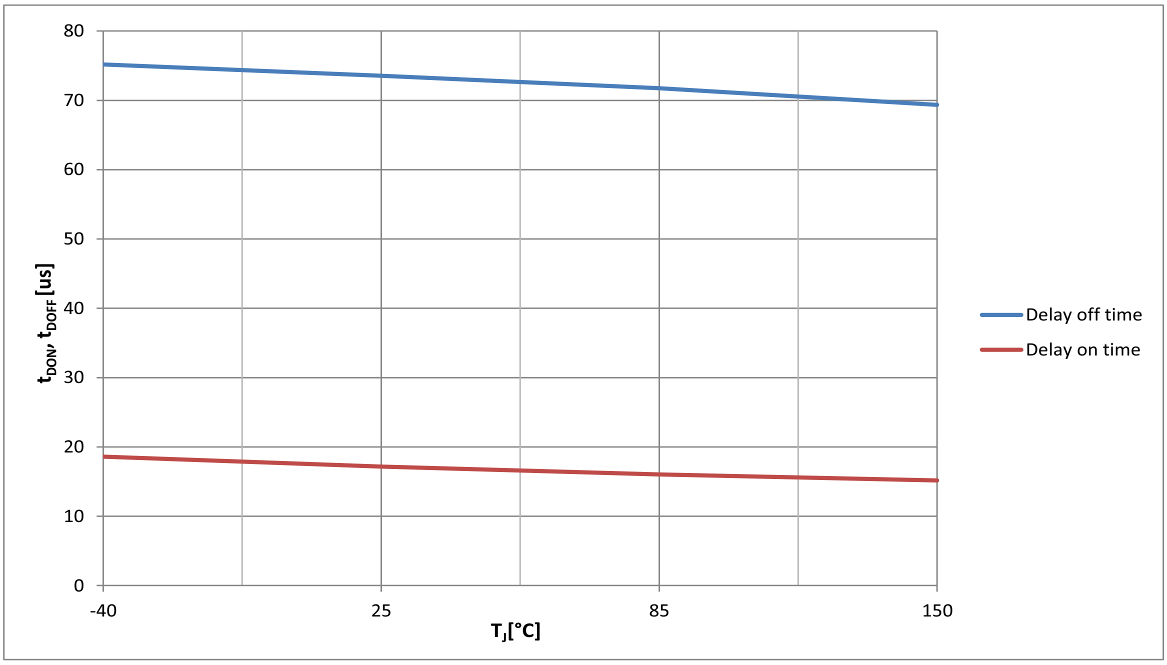

Figure 35 Typical t_{DON}, t_{DOFF} vs. T_J @ V_{IN} = 5 V

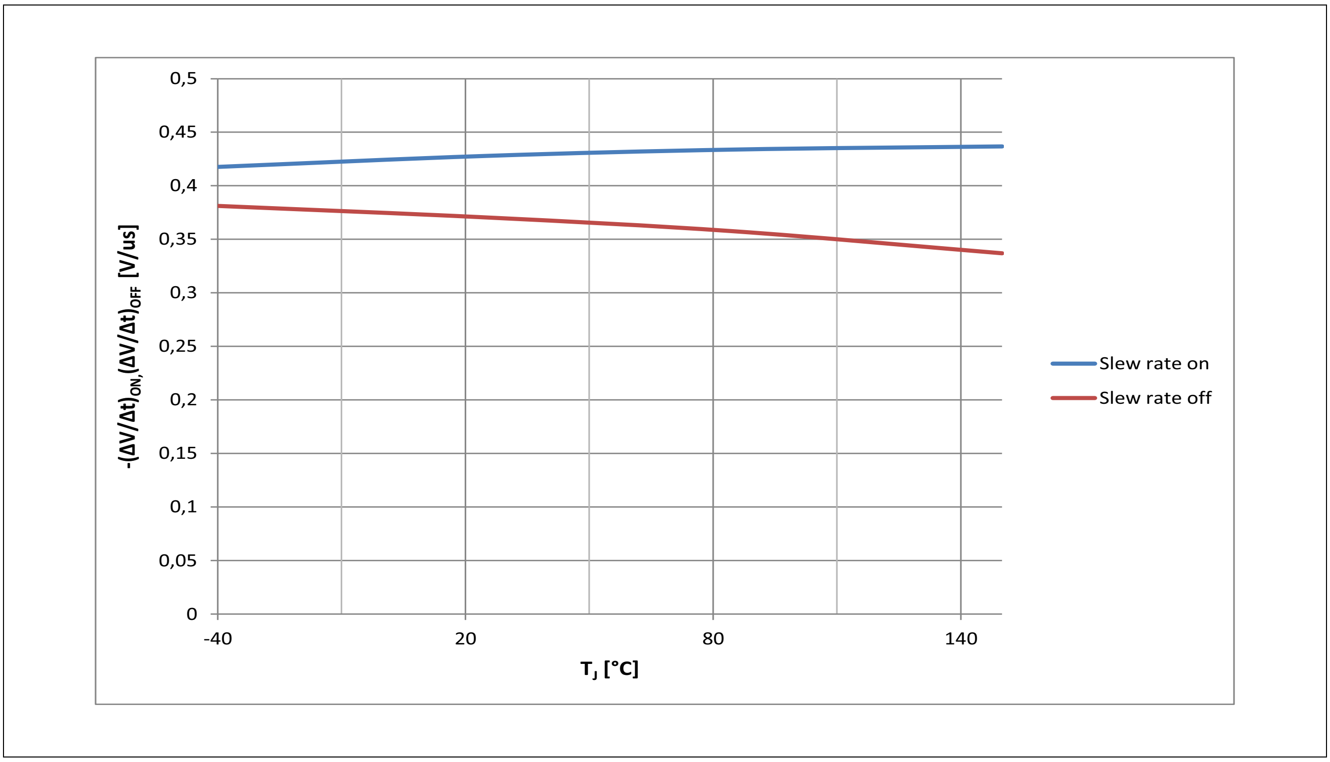

Figure 36 Typical $-(\Delta V/\Delta t)_{ON}$, $(\Delta V/\Delta t)_{OFF}$ vs. T_J @ V_{IN} = 5 V

9.2 Protection

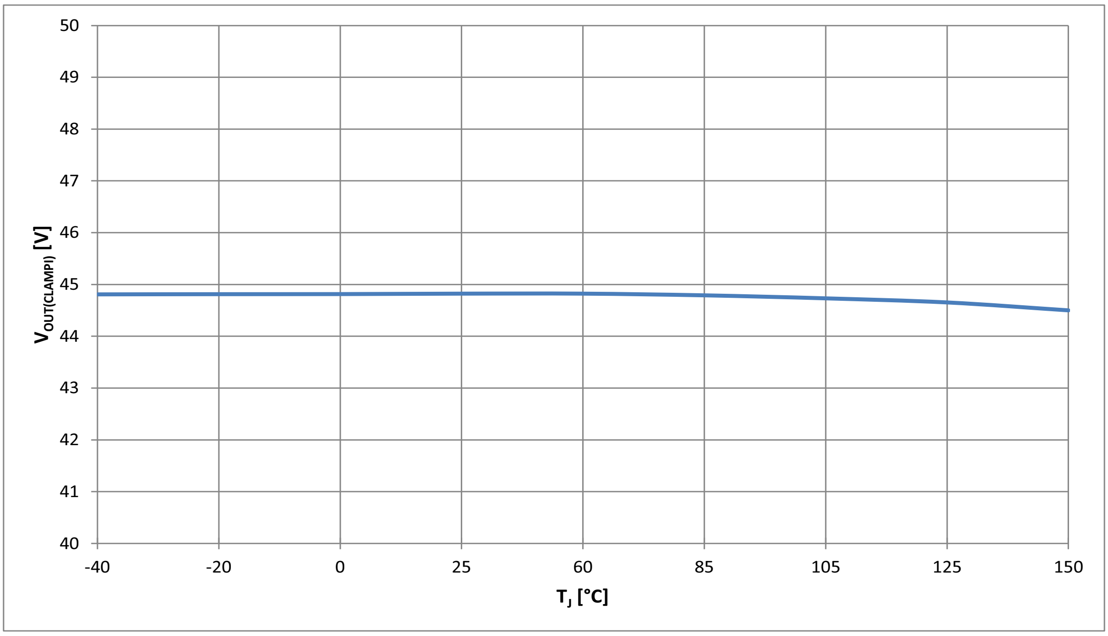

Figure 37 Typical $V_{OUT(CLAMP)}$ vs. T_J @ I_L = 14 mA

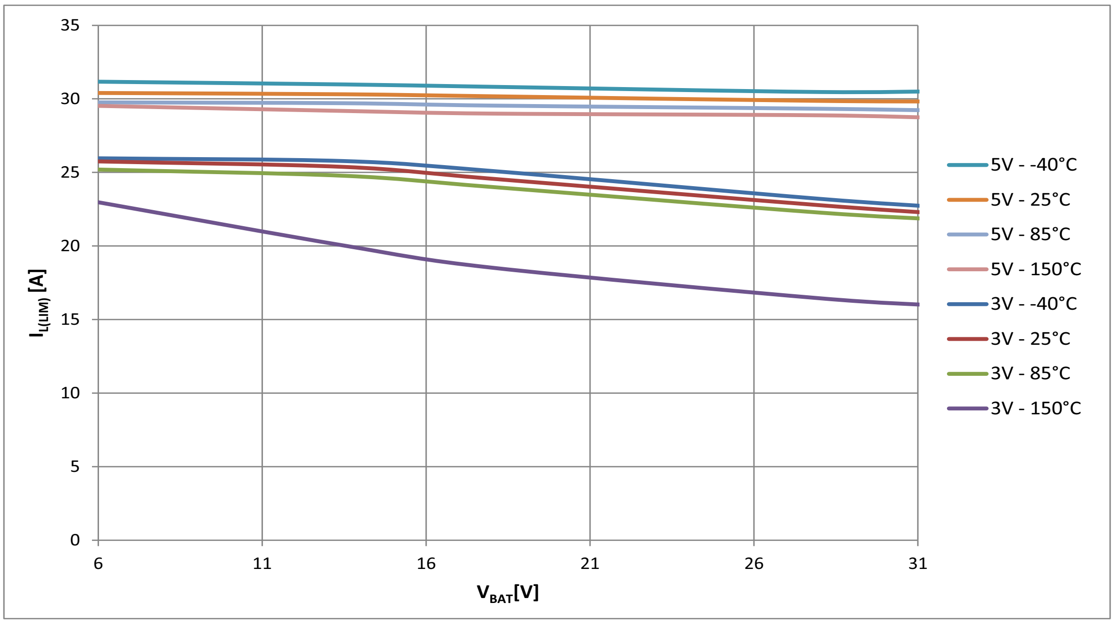

Figure 38 Typical $I_{L(LIM)}$ vs. V_{BAT} @ T_J = -40 … 150°C, V_{IN} = 3 V and 5 V

9.3 Input Stage

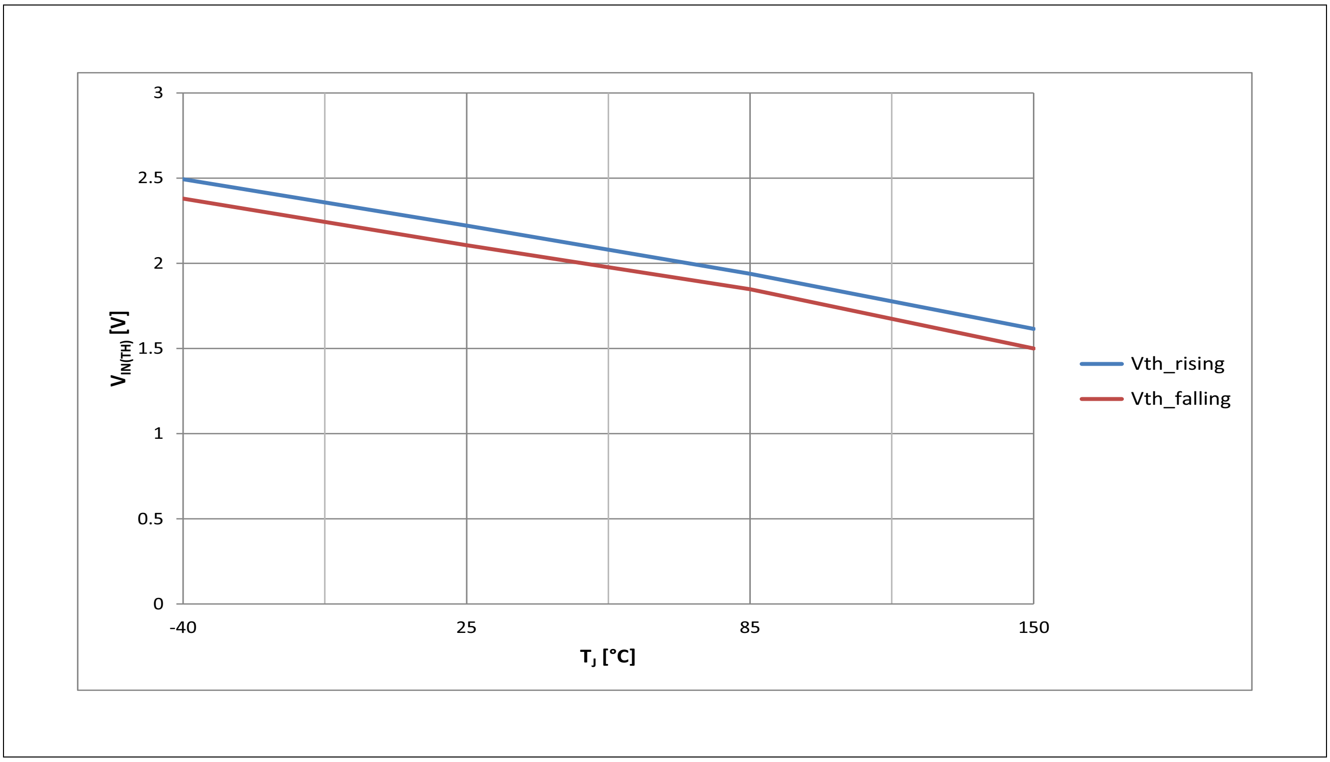

Figure 39 **Typical $V_{IN(TH)}$ vs. T_J @ I_L = 1.4 mA**

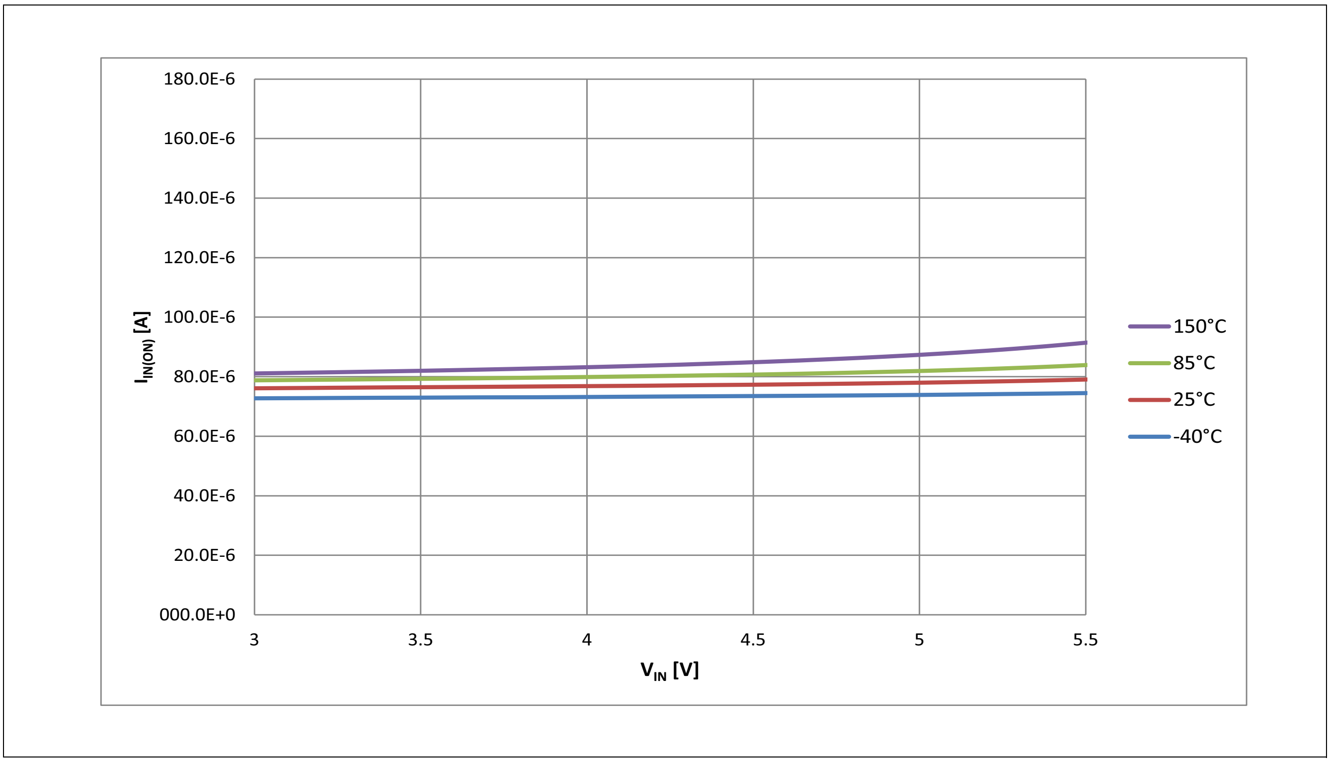

Figure 40 **Typical $I_{IN(ON)}$ vs. V_{IN} @ T_J = -40 ... 150°C, I_L = $I_{L(NOM)}$**

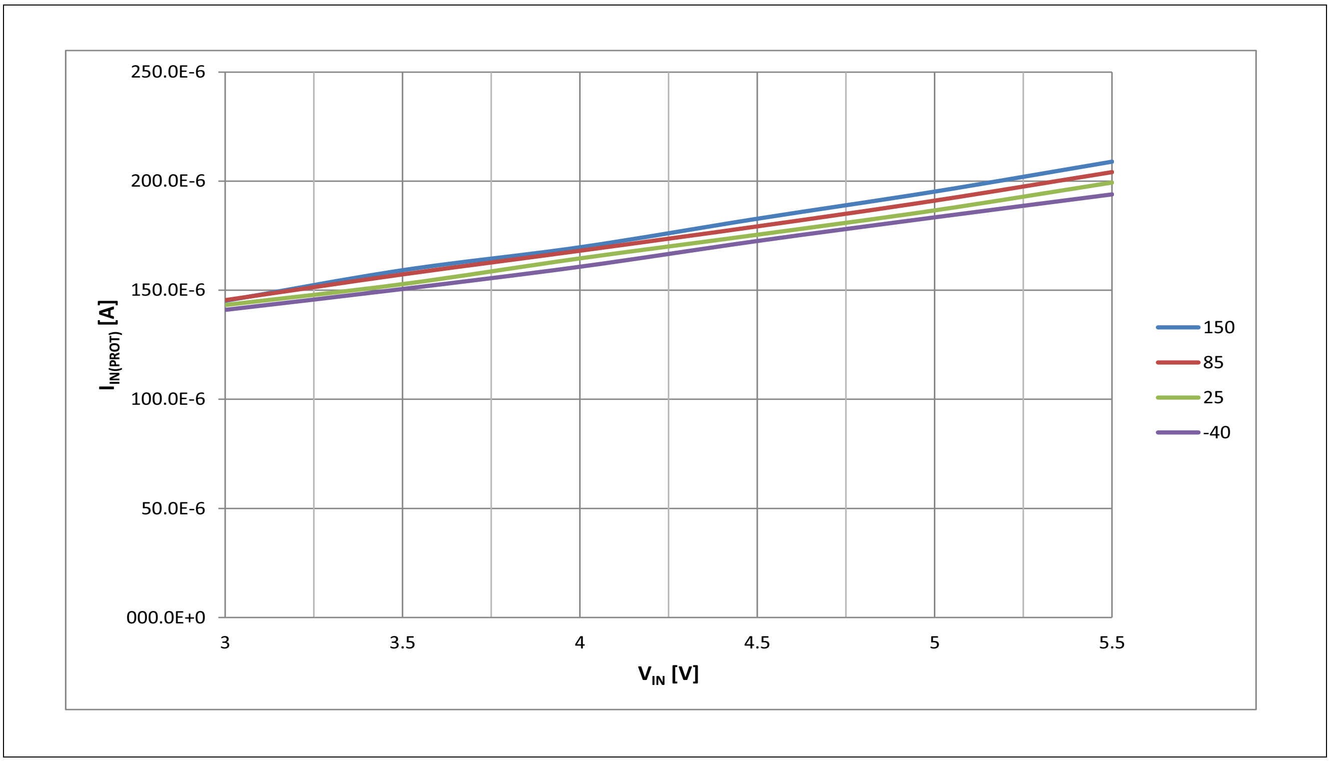

Figure 41 Typical $I_{IN(PROT)}$ vs. V_{IN} @ T_J = -40 ... 150°C, I_L = $I_{L(NOM)}$

10 Application Information

Note: The following information is given as a hint for the implementation of the device only and shall not be regarded as a description or warranty of a certain functionality, condition or quality of the device.

10.1 Application Diagram

An application example with the BTS3035TF is shown below.

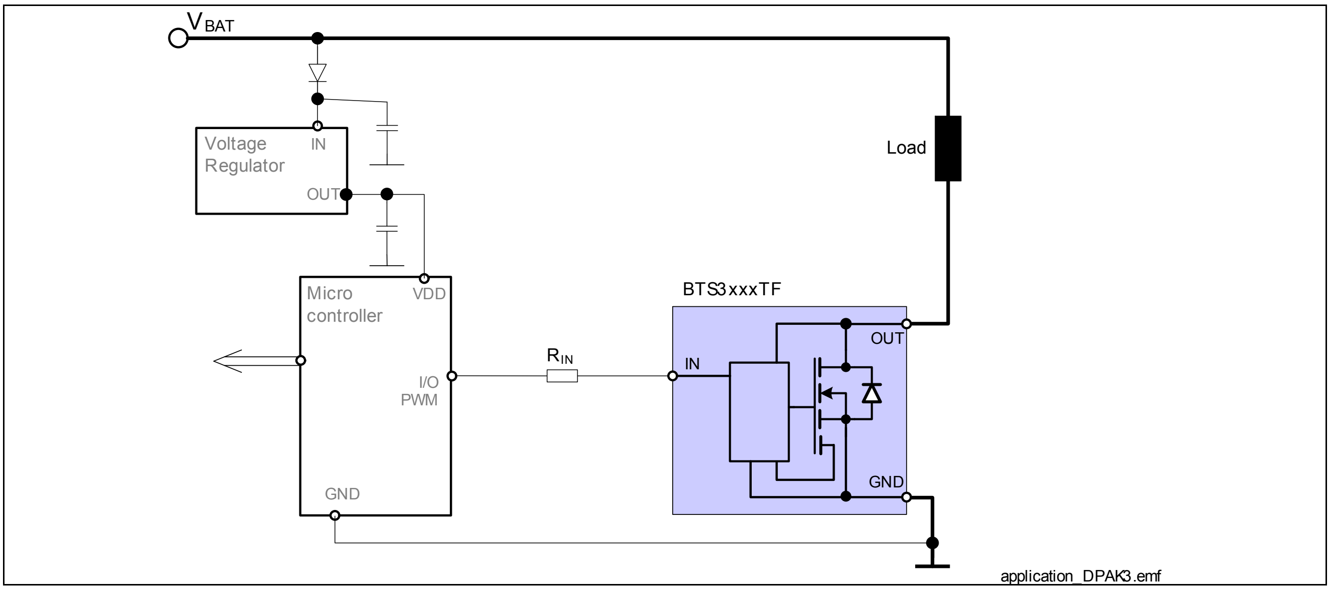

Figure 42 Application example circuitry

Recommended values:

R_{IN} = 3.3 kΩ (V_{IN} = 5 V)

Note: This is a very simplified example of an application circuit. The function must be verified in the real application.

11 Package Outlines

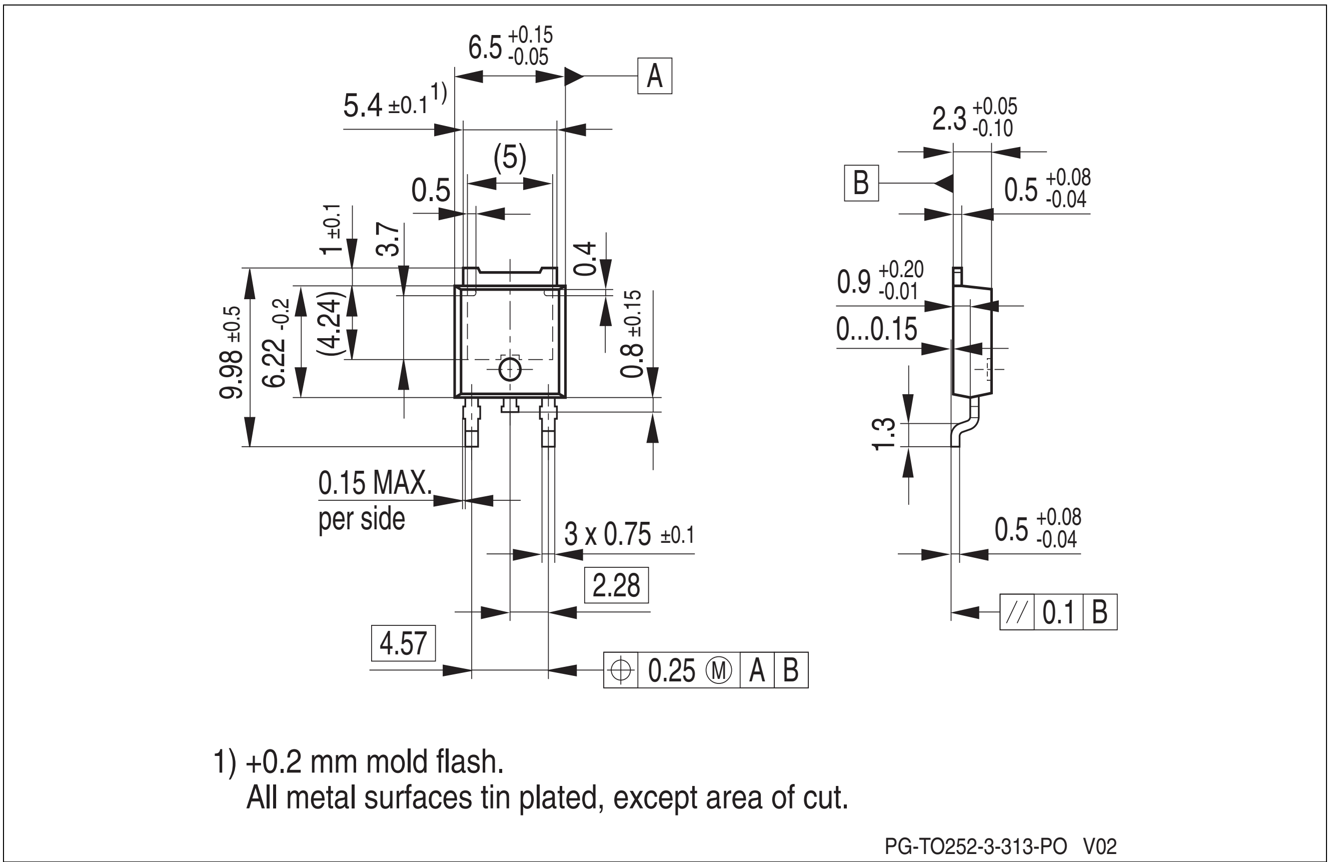

Figure 43 PG-TO252-3-313 (Outline Package)

Green Product (RoHS compliant)

To meet the world-wide customer requirements for environmentally friendly products and to be compliant with government regulations the device is available as a green product. Green products are RoHS-Compliant (i.e Pb-free finish on leads and suitable for Pb-free soldering according to IPC/JEDEC J-STD-020).

For further information on alternative packages, please visit our website:
http://www.infineon.com/packages.

Dimensions in mm

12 Revision History

Revision	Date	Changes
Rev. 1.0	2016-06-01	Datasheet released

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