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PROFET™₊ 12V

BTS5020-1EKA

Smart High-Side Power Switch
Single Channel, 20mΩ

Data Sheet

Rev. 2.2, 2013-11-12

Automotive Power

Table of Contents

1	Overview	4
2	Block Diagram	6
3	Pin Configuration	7
3.1	Pin Assignment	7
3.2	Pin Definitions and Functions	7
3.3	Voltage and Current Definition	8
4	General Product Characteristics	9
4.1	Absolute Maximum Ratings	9
4.2	Functional Range	11
4.3	Thermal Resistance	12
4.3.1	PCB set up	12
4.3.2	Thermal Impedance	13
5	Power Stage	15
5.1	Output ON-state Resistance	15
5.2	Turn ON/OFF Characteristics with Resistive Load	15
5.3	Inductive Load	16
5.3.1	Output Clamping	16
5.3.2	Maximum Load Inductance	17
5.4	Inverse Current Capability	17
5.5	Electrical Characteristics Power Stage	19
6	Protection Functions	21
6.1	Loss of Ground Protection	21
6.2	Undervoltage Protection	21
6.3	Overvoltage Protection	22
6.4	Reverse Polarity Protection	23
6.5	Overload Protection	23
6.5.1	Current Limitation	23
6.5.2	Temperature Limitation in the Power DMOS	24
6.6	Electrical Characteristics for the Protection Functions	26
7	Diagnostic Functions	27
7.1	IS Pin	27
7.2	SENSE Signal in Different Operating Modes	28
7.3	SENSE Signal in the Nominal Current Range	29
7.3.1	SENSE Signal Variation as a Function of Temperature and Load Current	29
7.3.2	SENSE Signal Timing	30
7.3.3	SENSE Signal in Open Load	31
7.3.3.1	Open Load in ON Diagnostic	31
7.3.3.2	Open Load in OFF Diagnostic	31
7.3.3.3	Open Load Diagnostic Timing	32
7.3.4	SENSE Signal with OUT in Short Circuit to V_S	33
7.3.5	SENSE Signal in Case of Overload	34
7.3.6	SENSE Signal in Case of Inverse Current	34
7.4	Electrical Characteristics Diagnostic Function	35
8	Input Pins	38
8.1	Input Circuitry	38
8.2	DEN Pin	38

Table of Contents

8.3	Input Pin Voltage	38
8.4	Electrical Characteristics	39
9	Characterization Results	40
9.1	General Product Characteristics	40
9.1.1	Minimum Functional Supply Voltage	40
9.1.2	Undervoltage Shutdown	40
9.1.3	Current Consumption Channel active	41
9.1.4	Standby Current for Whole Device with Load	41
9.2	Power Stage	42
9.2.1	Output Voltage Drop Limitation at Low Load Current	42
9.2.2	Drain to Source Clamp Voltage	42
9.2.3	Slew Rate at Turn ON	43
9.2.4	Slew Rate at Turn OFF	43
9.2.5	Turn ON	43
9.2.6	Turn OFF	44
9.2.7	Turn ON / OFF matching	44
9.2.8	Switch ON Energy	45
9.2.9	Switch OFF Energy	45
9.3	Protection Functions	46
9.3.1	Overload Condition in the Low Voltage Area	46
9.3.2	Overload Condition in the High Voltage Area	46
9.4	Diagnostic Mechanism	47
9.4.1	Current Sense at no Load	47
9.4.2	Open Load Detection Threshold in ON State	47
9.4.3	Sense Signal Maximum Voltage	48
9.4.4	Sense Signal maximum Current	48
9.5	Input Pins	49
9.5.1	Input Voltage Threshold ON to OFF	49
9.5.2	Input Voltage Threshold OFF to ON	49
9.5.3	Input Voltage Hysteresis	50
9.5.4	Input Current High Level	50
10	Application Information	51
10.1	Further Application Information	52
11	Package Outlines	53
12	Revision History	54



1 Overview

Application

- Suitable for resistive, inductive and capacitive loads
- Replaces electromechanical relays, fuses and discrete circuits
- Most suitable for loads with high inrush current, such as lamps

Basic Features

- One channel device
- Very low stand-by current
- 3.3 V and 5 V compatible logic inputs
- Electrostatic discharge protection (ESD)
- Optimized electromagnetic compatibility
- Logic ground independent from load ground
- Very low power DMOS leakage current in OFF state
- Green product (RoHS compliant)
- AEC qualified



PG-DSO-14-47-EP

Description

The BTS5020-1EKA is a 20 mΩ single channel Smart High-Side Power Switch, embedded in a PG-DSO-14-47-EP, Exposed Pad package, providing protective functions and diagnosis. The power transistor is built by an N-channel vertical power MOSFET with charge pump. The device is integrated in Smart6 technology. It is specially designed to drive lamps up to 2 * P27W/P21W + R5W, as well as LEDs in the harsh automotive environment.

Table 1 Product Summary

Parameter	Symbol	Value
Operating voltage range	$V_{S(OP)}$	5 V ... 28 V
Maximum supply voltage	$V_{S(LD)}$	41 V
Maximum ON state resistance at $T_J = 150\text{ °C}$	$R_{DS(ON)}$	44 mΩ
Nominal load current	$I_{L(NOM)}$	6.5 A
Typical current sense ratio	k_{ILIS}	3000
Minimum current limitation	$I_{L5(SC)}$	50 A
Maximum standby current with load at $T_J = 25\text{ °C}$	$I_{S(OFF)}$	500 nA

Type	Package	Marking
BTS5020-1EKA	PG-DSO-14-47-EP	BTS5020-1EKA

Diagnostic Functions

- Proportional load current sense
- Open load in ON and OFF
- Short circuit to battery and ground
- Overtemperature
- Stable diagnostic signal during short circuit
- Enhanced k_{ILIS} dependency with temperature and load current

Protection Functions

- Stable behavior during undervoltage
- Reverse polarity protection with external components
- Secure load turn-off during logic ground disconnect with external components
- Overtemperature protection with restart
- Overvoltage protection with external components
- Voltage dependent current limitation
- Enhanced short circuit operation

2 Block Diagram

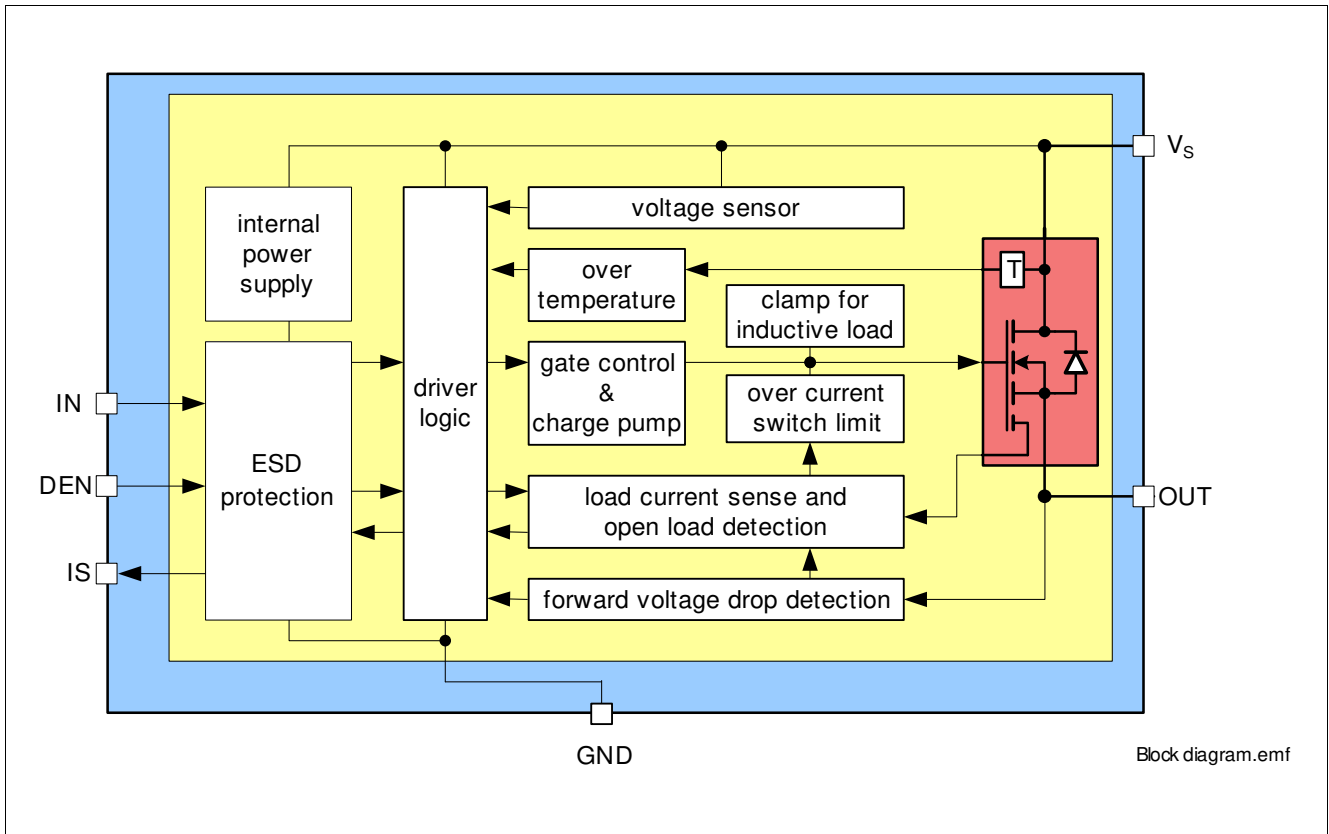


Figure 1 Block Diagram for the BTS5020-1EKA

3 Pin Configuration

3.1 Pin Assignment

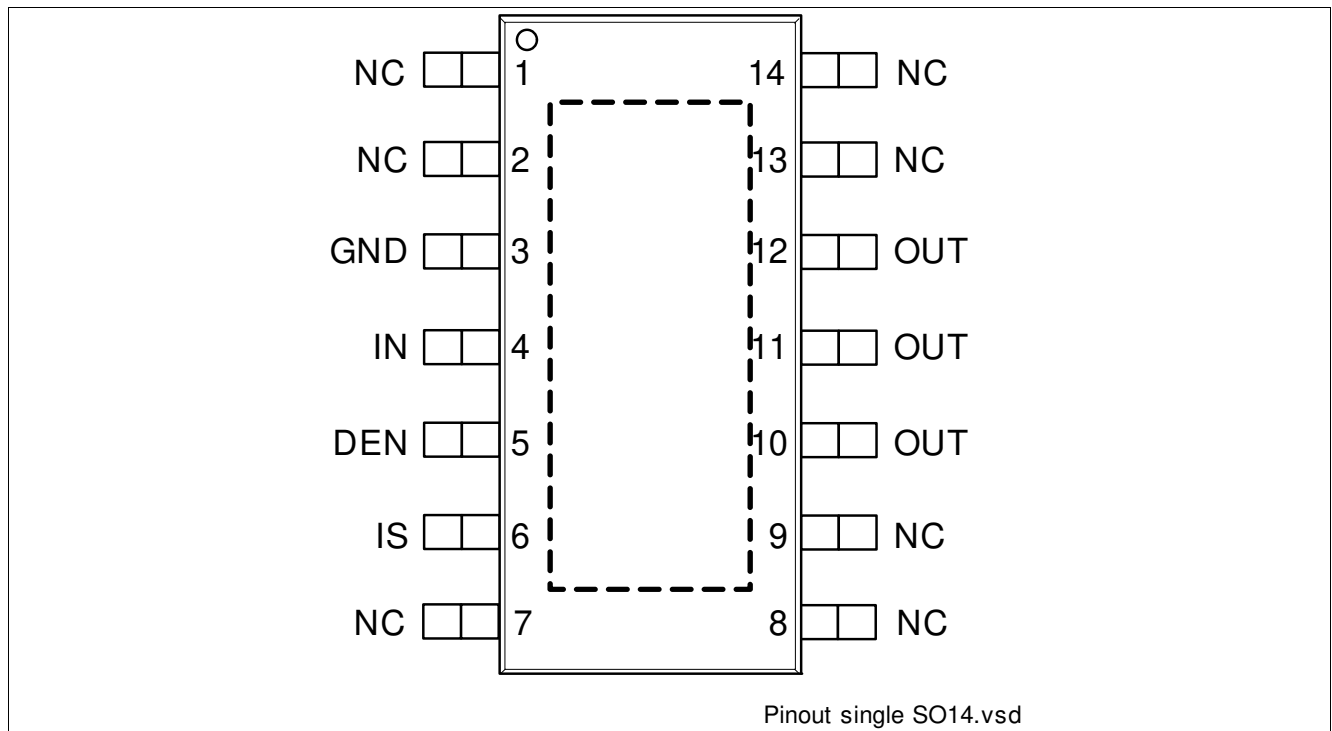


Figure 2 Pin Configuration

3.2 Pin Definitions and Functions

Pin	Symbol	Function
Cooling Tab	V_S	Voltage Supply ; Battery voltage
1, 2, 7, 8, 9, 13, 14	NC	Not Connected ; No internal connection to the chip
3	GND	GrouND ; Ground connection
4	IN	INput channel ; Input signal for channel activation
5	DEN	Diagnostic ENable ; Digital signal to enable/disable the diagnosis of the device
6	IS	Sense ; Sense current of the selected channel
10, 11, 12	OUT	OUTput ; Protected high side power output channel ¹⁾

1) All output pins must be connected together on the PCB. All pins of the output are internally connected together. PCB traces have to be designed to withstand the maximum current which can flow.

3.3 Voltage and Current Definition

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

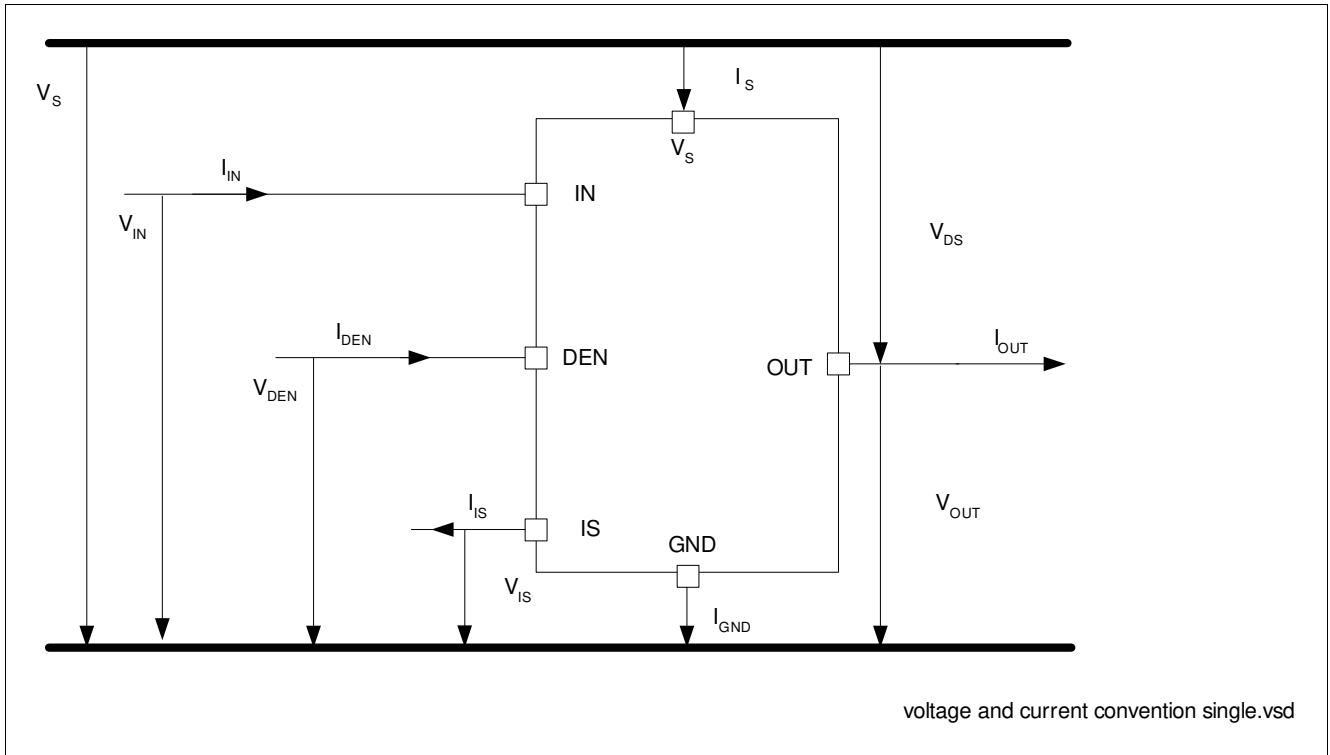


Figure 3 Voltage and Current Definition

4 General Product Characteristics

4.1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings ¹⁾
 $T_J = -40^{\circ}\text{C}$ to $+150^{\circ}\text{C}$; (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note / Test Condition	Number
		Min.	Typ.	Max.			
Supply Voltages							
Supply voltage	V_S	-0.3	–	28	V	–	P_4.1.1
Reverse polarity voltage	$-V_{S(\text{REV})}$	0	–	16	V	$t < 2$ min $T_A = 25^{\circ}\text{C}$ $R_L \geq 4 \Omega$ $R_{\text{GND}} = 150 \Omega$	P_4.1.2
Supply voltage for short circuit protection	$V_{\text{BAT(SC)}}$	0	–	24	V	²⁾ $R_{\text{ECU}} = 20 \text{ m}\Omega$ $R_{\text{Cable}} = 16 \text{ m}\Omega/\text{m}$ $L_{\text{Cable}} = 1 \mu\text{H}/\text{m}$, $l = 0$ or 5 m See Chapter 6 and Figure 52	P_4.1.3
Supply voltage for Load dump protection	$V_{S(\text{LD})}$	–	–	41	V	³⁾ $R_I = 2 \Omega$ $R_L = 4 \Omega$	P_4.1.12
Short Circuit Capability							
Permanent short circuit IN pin toggles	n_{RSC1}	–	–	100	k cycles	⁴⁾ $t_{\text{ON}} = 300\text{ms}$	P_4.1.4
Input Pins							
Voltage at INPUT pin	V_{IN}	-0.3 –	–	6 7	V	– $t < 2$ min	P_4.1.13
Current through INPUT pin	I_{IN}	-2	–	2	mA	–	P_4.1.14
Voltage at DEN pin	V_{DEN}	-0.3 –	–	6 7	V	– $t < 2$ min	P_4.1.15
Current through DEN pin	I_{DEN}	-2	–	2	mA	–	P_4.1.16
Sense Pin							
Voltage at IS pin	V_{IS}	-0.3	–	V_S	V	–	P_4.1.19
Current through IS pin	I_{IS}	-25	–	50	mA	–	P_4.1.20
Power Stage							
Load current	$ I_L $	–	–	$I_{L(\text{LIM})}$	A	–	P_4.1.21
Power dissipation (DC)	P_{TOT}	–	–	1.8	W	$T_A = 85^{\circ}\text{C}$ $T_J < 150^{\circ}\text{C}$	P_4.1.22
Maximum energy dissipation Single pulse	E_{AS}	–	–	90	mJ	$I_{L(0)} = 6 \text{ A}$ $T_{J(0)} = 150^{\circ}\text{C}$ $V_S = 13.5 \text{ V}$	P_4.1.23
Voltage at power transistor	V_{DS}	–	–	41	V	–	P_4.1.26

General Product Characteristics

Table 2 Absolute Maximum Ratings (cont'd)¹⁾
 $T_J = -40^{\circ}\text{C}$ to $+150^{\circ}\text{C}$; (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note / Test Condition	Number
		Min.	Typ.	Max.			
Currents							
Current through ground pin	I_{GND}	-10 -150	–	10 20	mA	– $t < 2$ min	P_4.1.27
Temperatures							
Junction temperature	T_J	-40	–	150	$^{\circ}\text{C}$	–	P_4.1.28
Storage temperature	T_{STG}	-55	–	150	$^{\circ}\text{C}$	–	P_4.1.30
ESD Susceptibility							
ESD susceptibility (all pins)	V_{ESD}	-2	–	2	kV	⁵⁾ HBM	P_4.1.31
ESD susceptibility OUT Pin vs. GND and V_S connected	V_{ESD}	-4	–	4	kV	⁵⁾ HBM	P_4.1.32
ESD susceptibility	V_{ESD}	-500	–	500	V	⁶⁾ CDM	P_4.1.33
ESD susceptibility pin (corner pins)	V_{ESD}	-750	–	750	V	⁶⁾ CDM	P_4.1.34

1) Not subject to production test. Specified by design.

2) Hardware set-up in accordance to AEC Q100-012 and AEC Q101-006.

 3) $V_{\text{S(LD)}}$ is setup without the DUT connected to the generator per ISO 7637-1.

4) EOL tests according to AECQ100-012. Threshold limit for short circuit failures: 100 ppm. Please refer to the legal disclaimer for short-circuit capability on Page 55 of this document

5) ESD susceptibility HBM according to EIA/JESD 22-A 114B.

6) "CDM" EIA/JESD22-C101 or ESDA STM5.3.1

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 $T_J = -40^\circ\text{C}$ to $+150^\circ\text{C}$; (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note / Test Condition	Number
		Min.	Typ.	Max.			
Nominal operating voltage	V_{NOM}	8	13.5	18	V	–	P_4.2.1
Extended operating voltage	$V_{\text{S(OP)}}$	5	–	28	V	²⁾ $V_{\text{IN}} = 4.5\text{ V}$ $R_{\text{L}} = 4\ \Omega$ $V_{\text{DS}} < 0.5\text{ V}$ See Figure 15	P_4.2.2
Minimum functional supply voltage	$V_{\text{S(OP)_MIN}}$	3.8	4.3	5	V	¹⁾ $V_{\text{IN}} = 4.5\text{ V}$ $R_{\text{L}} = 4\ \Omega$ From $I_{\text{OUT}} = 0\text{ A}$ to $V_{\text{DS}} < 0.5\text{ V}$; See Figure 15	P_4.2.3
Undervoltage shutdown	$V_{\text{S(UV)}}$	3	3.5	4.1	V	¹⁾ $V_{\text{IN}} = 4.5\text{ V}$ $V_{\text{DEN}} = 0\text{ V}$ $R_{\text{L}} = 4\ \Omega$ From $V_{\text{DS}} < 1\text{ V}$; to $I_{\text{OUT}} = 0\text{ A}$ See Figure 15 See Figure 30	P_4.2.4
Undervoltage shutdown hysteresis	$V_{\text{S(UV)_HYS}}$	–	850	–	mV	²⁾ –	P_4.2.13
Operating current channel active	I_{GND_1}	–	3.5	6	mA	$V_{\text{IN}} = 5.5\text{ V}$ $V_{\text{DEN}} = 5.5\text{ V}$ Device in $R_{\text{DS(ON)}}$ $V_{\text{S}} = 18\text{ V}$ See Figure 31	P_4.2.5
Standby current for whole device with load (ambiente)	$I_{\text{S(OFF)}}$	–	0.1	0.5	μA	¹⁾ $V_{\text{S}} = 18\text{ V}$ $V_{\text{OUT}} = 0\text{ V}$ V_{IN} floating V_{DEN} floating $T_J \leq 85\ ^\circ\text{C}$ See Figure 32	P_4.2.7
Maximum standby current for whole device with load	$I_{\text{S(OFF)_150}}$	–	5	20	μA	$V_{\text{S}} = 18\text{ V}$ $V_{\text{OUT}} = 0\text{ V}$ V_{IN} floating V_{DEN} floating $T_J = 150\ ^\circ\text{C}$ See Figure 32	P_4.2.10
Standby current for whole device with load, diagnostic active	$I_{\text{S(OFF)_DEN}}$	–	0.6	–	mA	²⁾ $V_{\text{S}} = 18\text{ V}$ $V_{\text{OUT}} = 0\text{ V}$ V_{IN} floating $V_{\text{DEN}} = 5.5\text{ V}$	P_4.2.8

 1) Test at $T_J = -40^\circ\text{C}$ only

2) 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

Table 4 Thermal Resistance

Parameter	Symbol	Values			Unit	Note / Test Condition	Number
		Min.	Typ.	Max.			
Junction to soldering point	R_{thJS}	–	5	–	K/W	1)	P_4.3.1
Junction to ambient	R_{thJA}	–	30	–	K/W	1) 2)	P_4.3.2

1) Not subject to production test. Specified by design.

2) 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 76.4 x 114.3 x 1.5 mm board with 2 inner copper layers (2 x 70µm Cu, 2 x 35 µm Cu). Where applicable, a thermal via array under the exposed pad contacts the first inner copper layer. Please refer to [Figure 4](#) and [Figure 5](#).

4.3.1 PCB set up

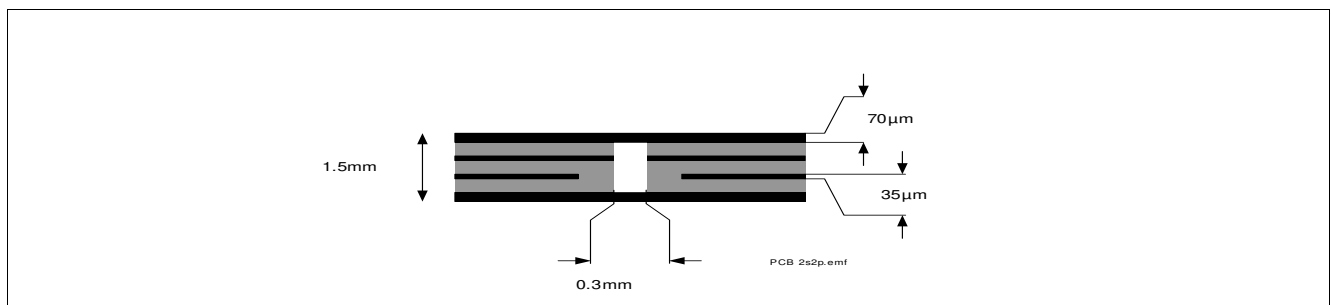


Figure 4 2s2p PCB Cross Section

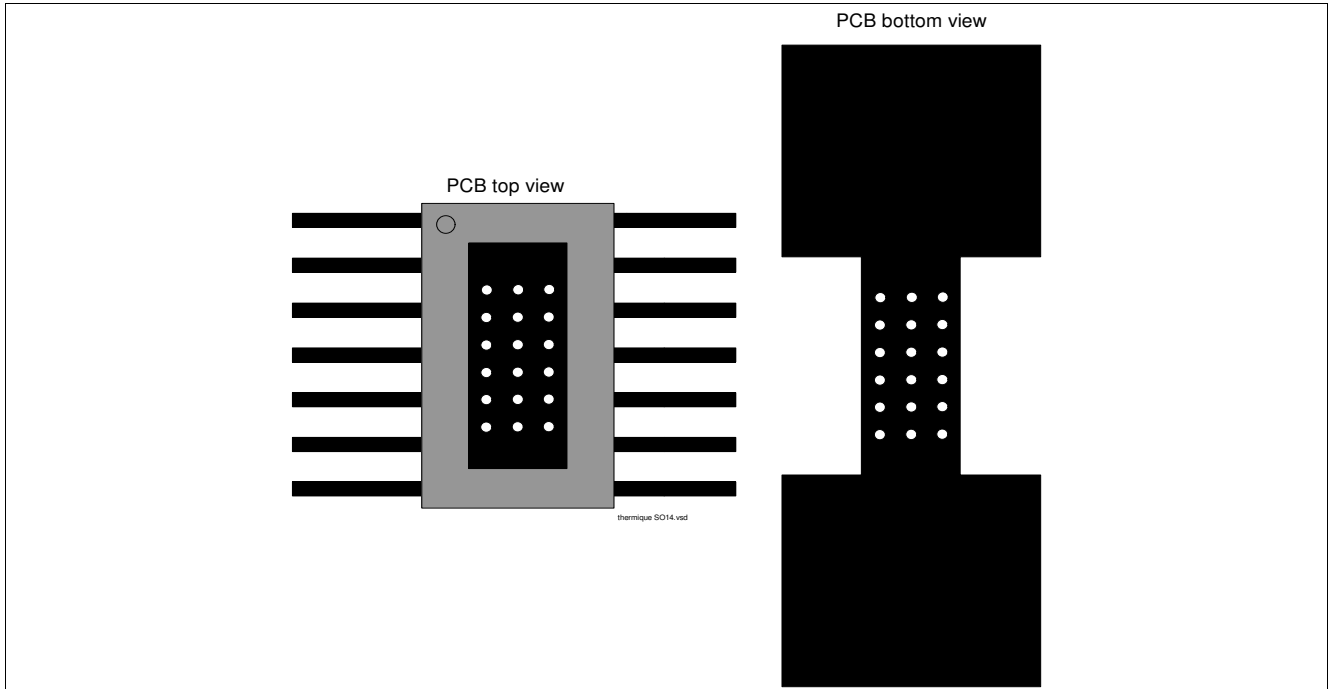


Figure 5 PC Board Top and Bottom View for Thermal Simulation with 600 mm² Cooling Area

4.3.2 Thermal Impedance

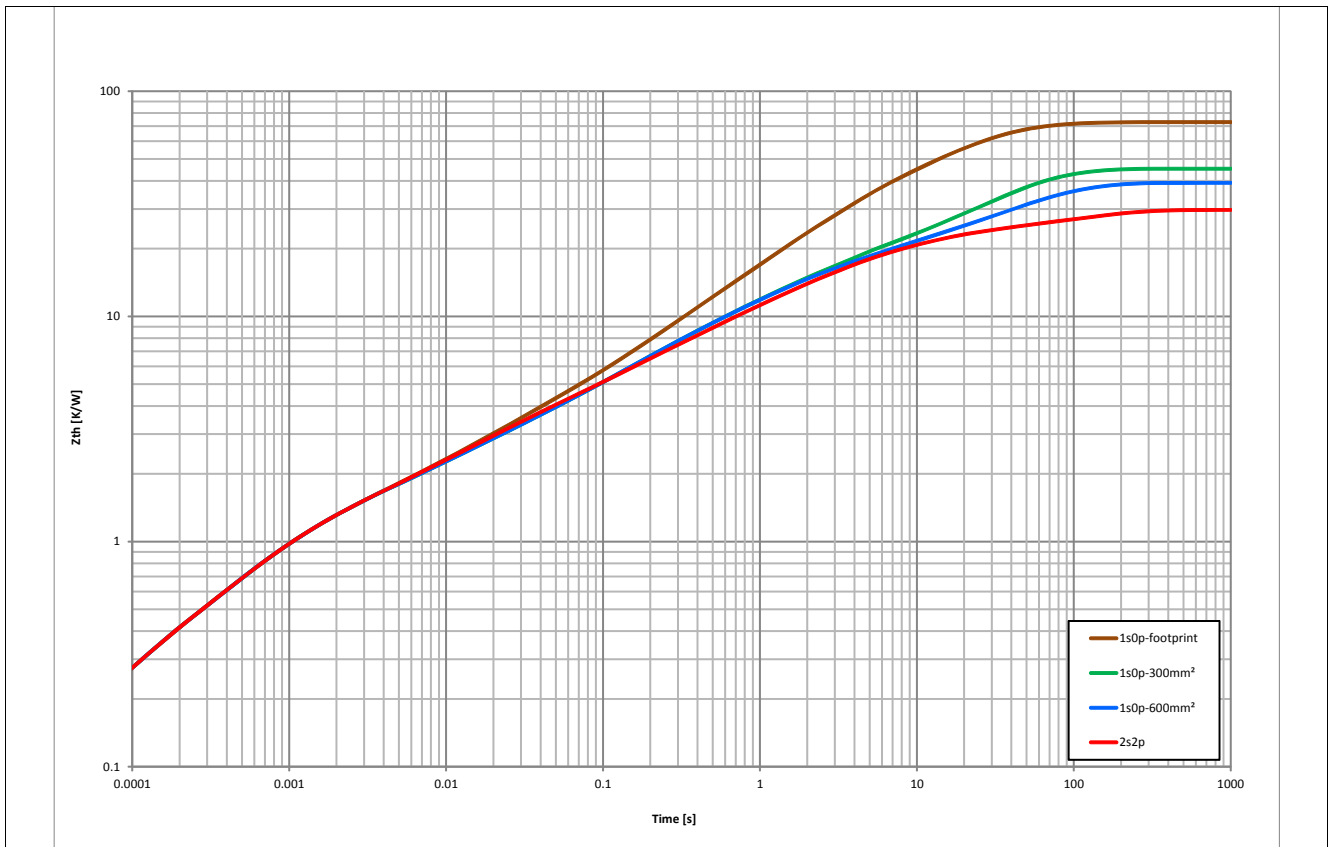


Figure 6 Typical Thermal Impedance. PCB set up according [Figure 5](#)

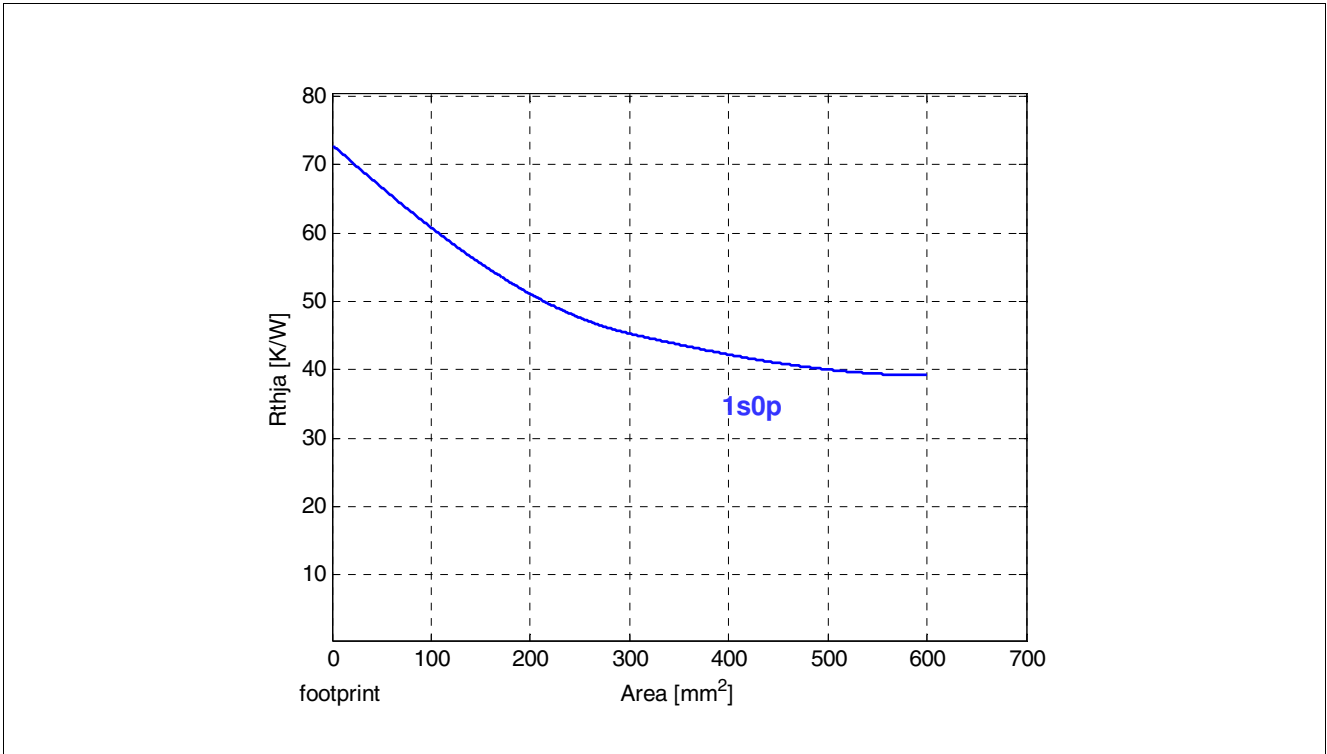


Figure 7 Typical Thermal Resistance. PCB set up 1s0p

5 Power Stage

The power stage is built using an N-channel vertical power MOSFET (DMOS) with charge pump.

5.1 Output ON-state Resistance

The ON-state resistance $R_{DS(ON)}$ depends on the supply voltage as well as the junction temperature T_J . **Figure 8** shows the dependencies in terms of temperature and supply voltage for the typical ON-state resistance. The behavior in reverse polarity is described in **Chapter 6.4**.

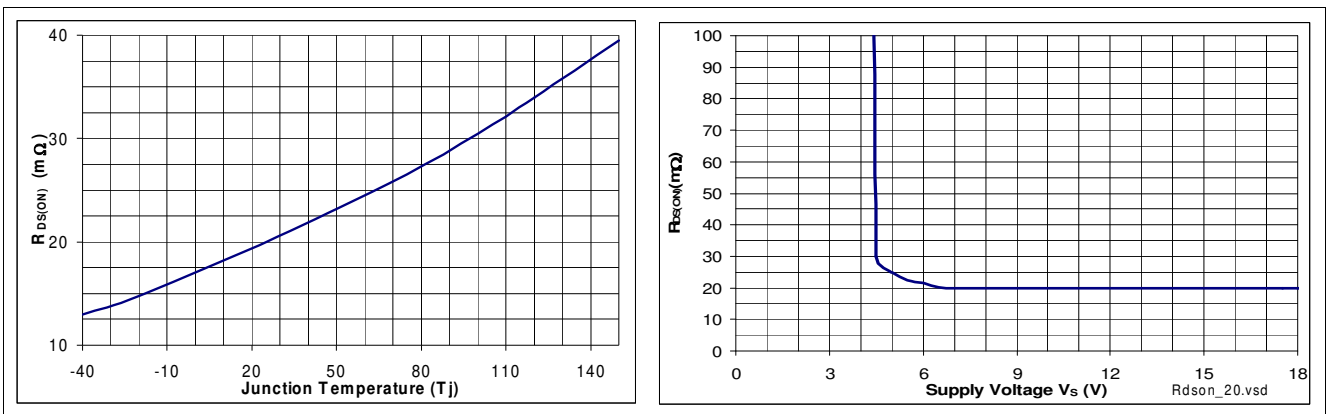


Figure 8 Typical ON-state Resistance

A high signal at the input pin (see **Chapter 8**) causes the power DMOS to switch ON with a dedicated slope, which is optimized in terms of EMC emission.

5.2 Turn ON/OFF Characteristics with Resistive Load

Figure 9 shows the typical timing when switching a resistive load.

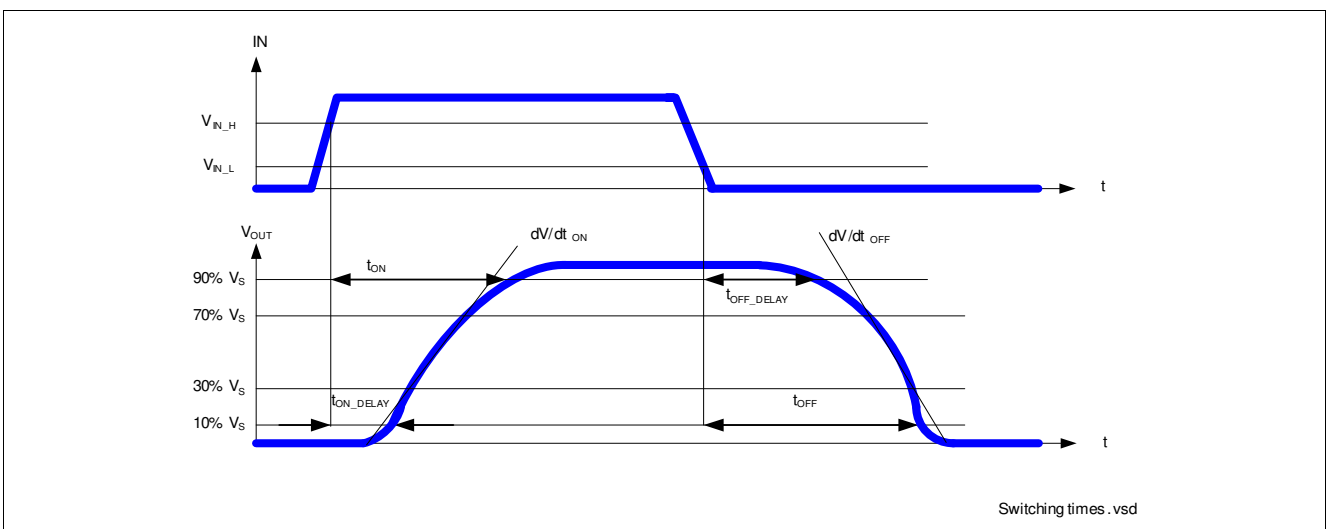


Figure 9 Switching a Resistive Load Timing

5.3 Inductive Load

5.3.1 Output Clamping

When switching OFF inductive loads with high side switches, the voltage V_{OUT} drops below ground potential, because the inductance intends to continue driving the current. To prevent the destruction of the device by avalanche due to high voltages, there is a voltage clamp mechanism $Z_{DS(AZ)}$ implemented that limits negative output voltage to a certain level ($V_S - V_{DS(AZ)}$). Please refer to **Figure 10** and **Figure 11** for details. Nevertheless, the maximum allowed load inductance is limited.

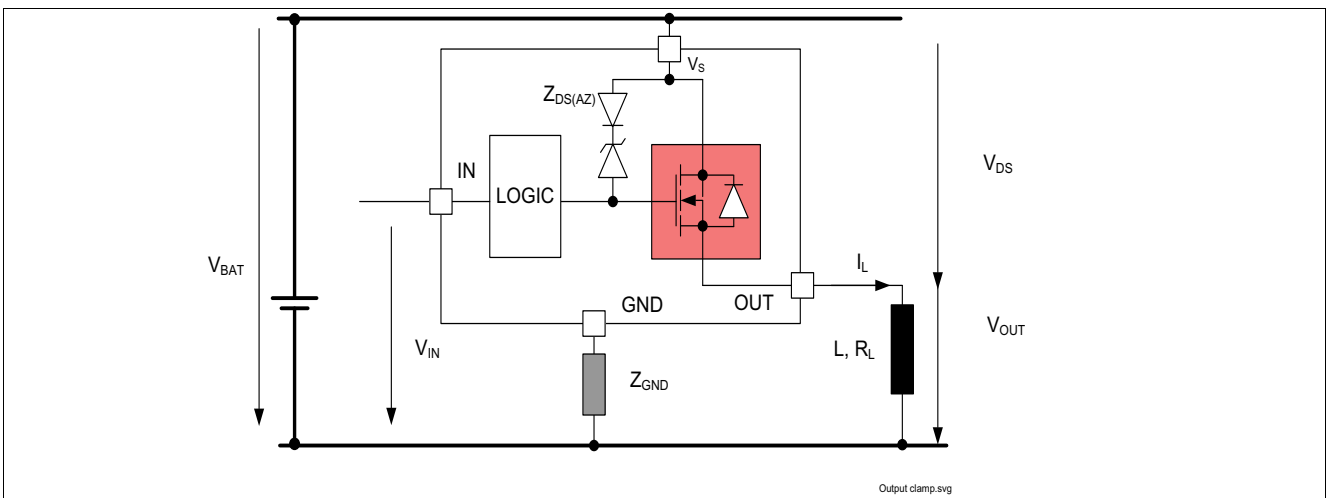


Figure 10 Output Clamp

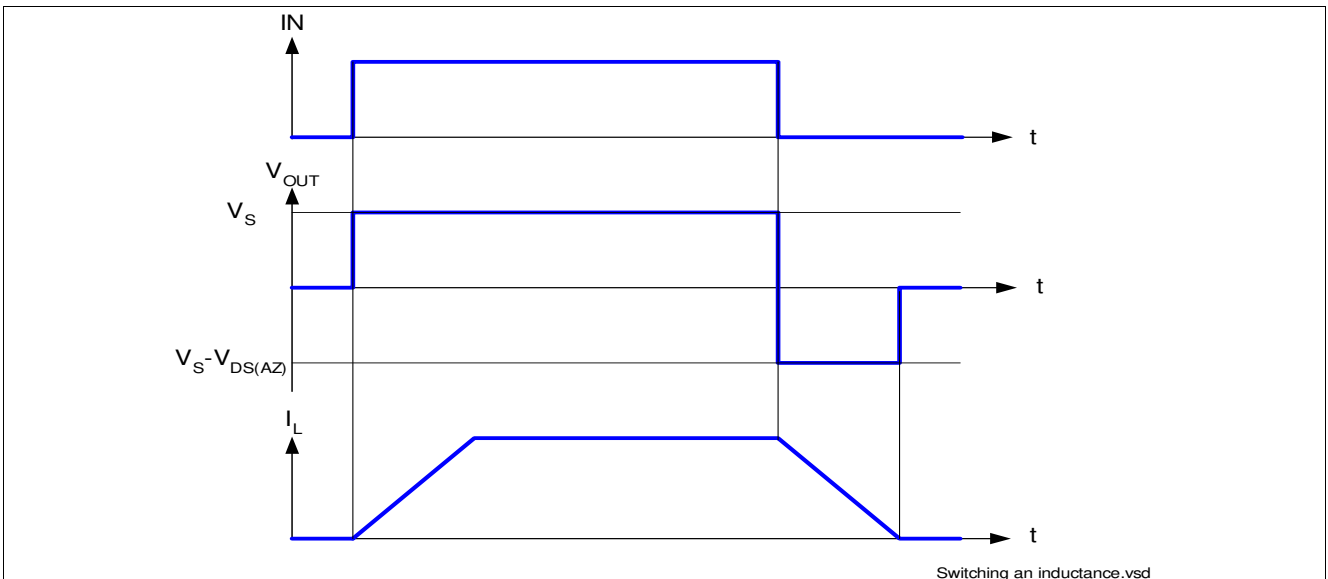


Figure 11 Switching an Inductive Load Timing

5.3.2 Maximum Load Inductance

During demagnetization of inductive loads, energy has to be dissipated in the BTS5020-1EKA. This energy can be calculated with following equation:

$$E = V_{DS(AZ)} \times \frac{L}{R_L} \times \left[\frac{V_S - V_{DS(AZ)}}{R_L} \times \ln \left(1 - \frac{R_L \times I_L}{V_S - V_{DS(AZ)}} \right) + I_L \right] \quad (1)$$

Following equation simplifies under the assumption of $R_L = 0 \Omega$.

$$E = \frac{1}{2} \times L \times I^2 \times \left(1 - \frac{V_S}{V_S - V_{DS(AZ)}} \right) \quad (2)$$

The energy, which is converted into heat, is limited by the thermal design of the component. See [Figure 12](#) for the maximum allowed energy dissipation as a function of the load current.

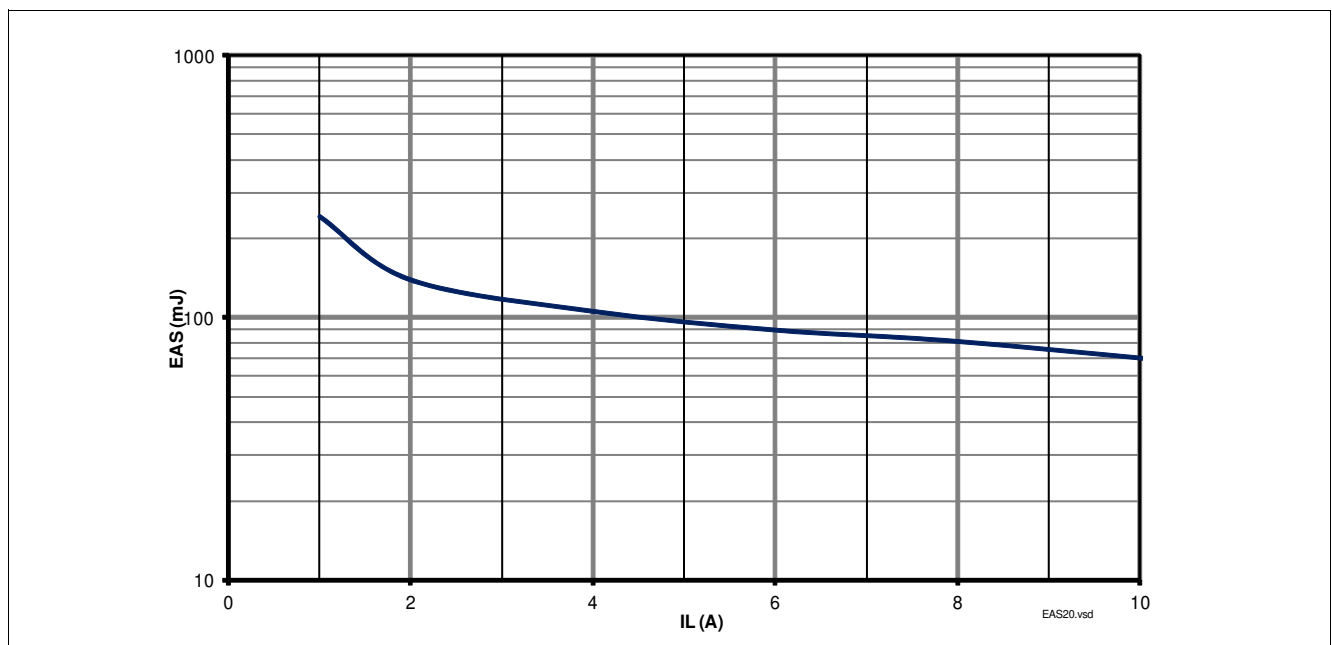


Figure 12 Maximum Energy Dissipation Single Pulse, $T_{J_START} = 150 \text{ }^\circ\text{C}$; $V_S = 13.5\text{V}$

5.4 Inverse Current Capability

In case of inverse current, meaning a voltage V_{INV} at the OUTput higher than the supply voltage V_S , a current I_{INV} will flow from output to V_S pin via the body diode of the power transistor (please refer to [Figure 13](#)). The output stage follows the state of the IN pin, except if the IN pin goes from OFF to ON during inverse. In that particular case, the output stage is kept OFF until the inverse current disappears. If the channel is OFF, the diagnostic will detect an open load at OFF. If the channel is ON, the diagnostic will detect open load at ON (the overtemperature signal is inhibited). At the appearance of V_{INV} , a parasitic diagnostic can be observed. After, the diagnosis is valid and reflects the output state. At V_{INV} vanishing, the diagnosis is valid and reflects the output state. During inverse current, no protection functions are available.

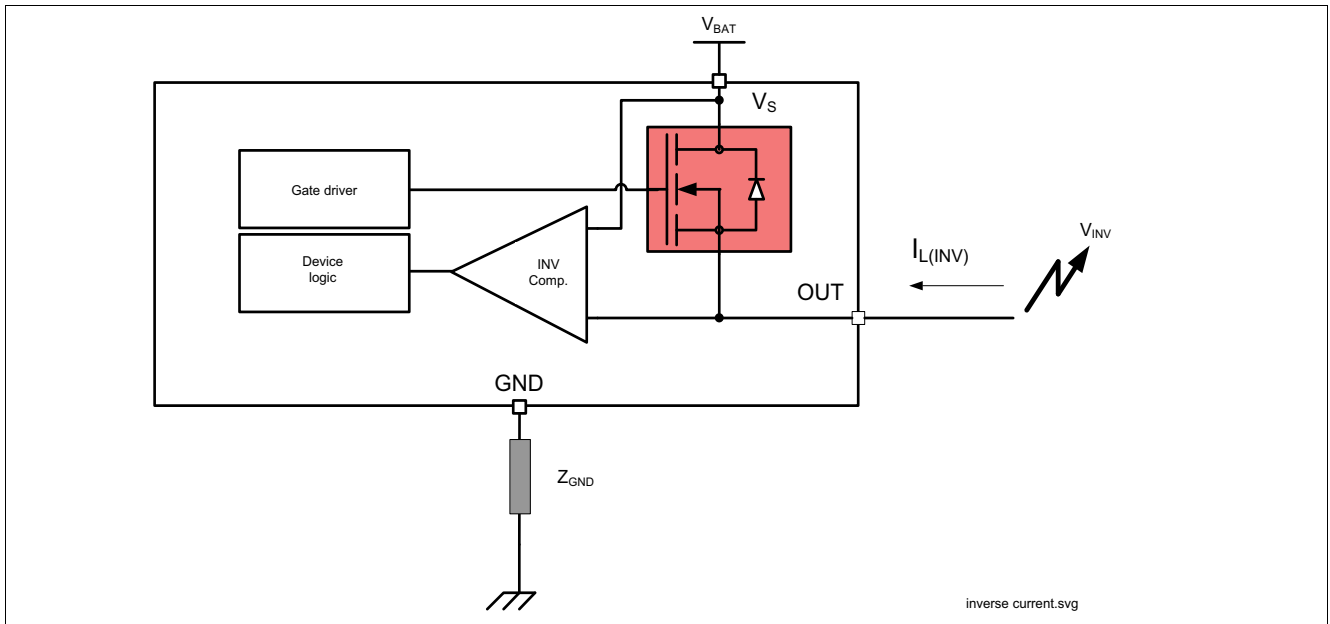


Figure 13 Inverse Current Circuitry

5.5 Electrical Characteristics Power Stage

Table 5 Electrical Characteristics: Power Stage
 $V_S = 8\text{ V to }18\text{ V}$, $T_J = -40^\circ\text{C to }+150^\circ\text{C}$ (unless otherwise specified).

 Typical values are given at $V_S = 13.5\text{ V}$, $T_J = 25^\circ\text{C}$

Parameter	Symbol	Values			Unit	Note / Test Condition	Number
		Min.	Typ.	Max.			
ON-state resistance per channel	$R_{DS(ON)_150}$	33	40	44	m Ω	$I_L = I_{L4} = 7\text{ A}$ $V_{IN} = 4.5\text{ V}$ $T_J = 150^\circ\text{C}$ See Figure 8	P_5.5.1
ON-state resistance per channel	$R_{DS(ON)_25}$	–	20	–	m Ω	¹⁾ $T_J = 25^\circ\text{C}$	P_5.5.21
Nominal load current	$I_{L(NOM)}$	–	6.5	–	A	¹⁾ $T_A = 85^\circ\text{C}$ $T_J < 150^\circ\text{C}$	P_5.5.2
Output voltage drop limitation at small load currents	$V_{DS(NL)}$	–	10	25	mV	$I_L = I_{L0} = 50\text{ mA}$ See Figure 33	P_5.5.4
Drain to source clamping voltage $V_{DS(AZ)} = [V_S - V_{OUT}]$	$V_{DS(AZ)}$	41	47	53	V	$I_{DS} = 20\text{ mA}$ See Figure 11 See Figure 34	P_5.5.5
Output leakage current $T_J \leq 85^\circ\text{C}$	$I_{L(OFF)}$	–	0.1	0.5	μA	²⁾ V_{IN} floating $V_{OUT} = 0\text{ V}$ $T_J \leq 85^\circ\text{C}$	P_5.5.6
Output leakage current $T_J = 150^\circ\text{C}$	$I_{L(OFF)_150}$	–	2.5	10	μA	V_{IN} floating $V_{OUT} = 0\text{ V}$ $T_J = 150^\circ\text{C}$	P_5.5.8
Inverse current capability	$I_{L(INV)}$	–	5	–	A	¹⁾ $V_S < V_{OUT}$	P_5.5.9
Slew rate 30% to 70% V_S	dV/dt_{ON}	0.1	0.25	0.5	V/ μs	$R_L = 4\ \Omega$ $V_S = 13.5\text{ V}$	P_5.5.11
Slew rate 70% to 30% V_S	$-dV/dt_{OFF}$	0.1	0.25	0.5	V/ μs	See Figure 9 See Figure 35	P_5.5.12
Slew rate matching $dV/dt_{ON} - dV/dt_{OFF}$	$\Delta dV/dt$	-0.15	0	0.15	V/ μs	See Figure 36 See Figure 37	P_5.5.13
Turn-ON time to $V_{OUT} = 90\%$ V_S	t_{ON}	30	90	230	μs	See Figure 38 See Figure 39	P_5.5.14
Turn-OFF time to $V_{OUT} = 10\%$ V_S	t_{OFF}	30	90	230	μs		P_5.5.15
Turn-ON / OFF matching $t_{OFF} - t_{ON}$	Δt_{SW}	-50	0	50	μs		P_5.5.16
Turn-ON time to $V_{OUT} = 10\%$ V_S	t_{ON_delay}	10	35	100	μs		P_5.5.17
Turn-OFF time to $V_{OUT} = 90\%$ V_S	t_{OFF_delay}	10	35	100	μs		P_5.5.18

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

$V_S = 8\text{ V to }18\text{ V}$, $T_J = -40^\circ\text{C to }+150^\circ\text{C}$ (unless otherwise specified).
 Typical values are given at $V_S = 13.5\text{ V}$, $T_J = 25\text{ }^\circ\text{C}$

Parameter	Symbol	Values			Unit	Note / Test Condition	Number
		Min.	Typ.	Max.			
Switch ON energy	E_{ON}	–	1	–	mJ	1) $R_L = 4\ \Omega$ $V_{OUT} = 90\% V_S$ $V_S = 18\text{ V}$ See Figure 40	P_5.5.19
Switch OFF energy	E_{OFF}	–	0.9	–	mJ	1) $R_L = 4\ \Omega$ $V_{OUT} = 10\% V_S$ $V_S = 18\text{ V}$ See Figure 41	P_5.5.20

- 1) Not subject to production test, specified by design.
- 2) Test at $T_J = -40^\circ\text{C}$ only

6 Protection Functions

The device provides integrated protection functions. These functions are designed to prevent the destruction of the IC from fault conditions described in the data sheet. Fault conditions are considered as “outside” normal operating range. Protection functions are designed for neither continuous nor repetitive operation.

6.1 Loss of Ground Protection

In case of loss of the module ground and the load remains connected to ground, the device protects itself by automatically turning OFF (when it was previously ON) or remains OFF, regardless of the voltage applied on IN pin.

In case of loss of device ground, it's recommended to use input resistors between the microcontroller and the BTS5020-1EKA to ensure switching OFF of channel.

In case of loss of module or device ground, a current ($I_{OUT(GND)}$) can flow out of the DMOS. **Figure 14** sketches the situation.

Z_{GND} can be either resistor or diode.

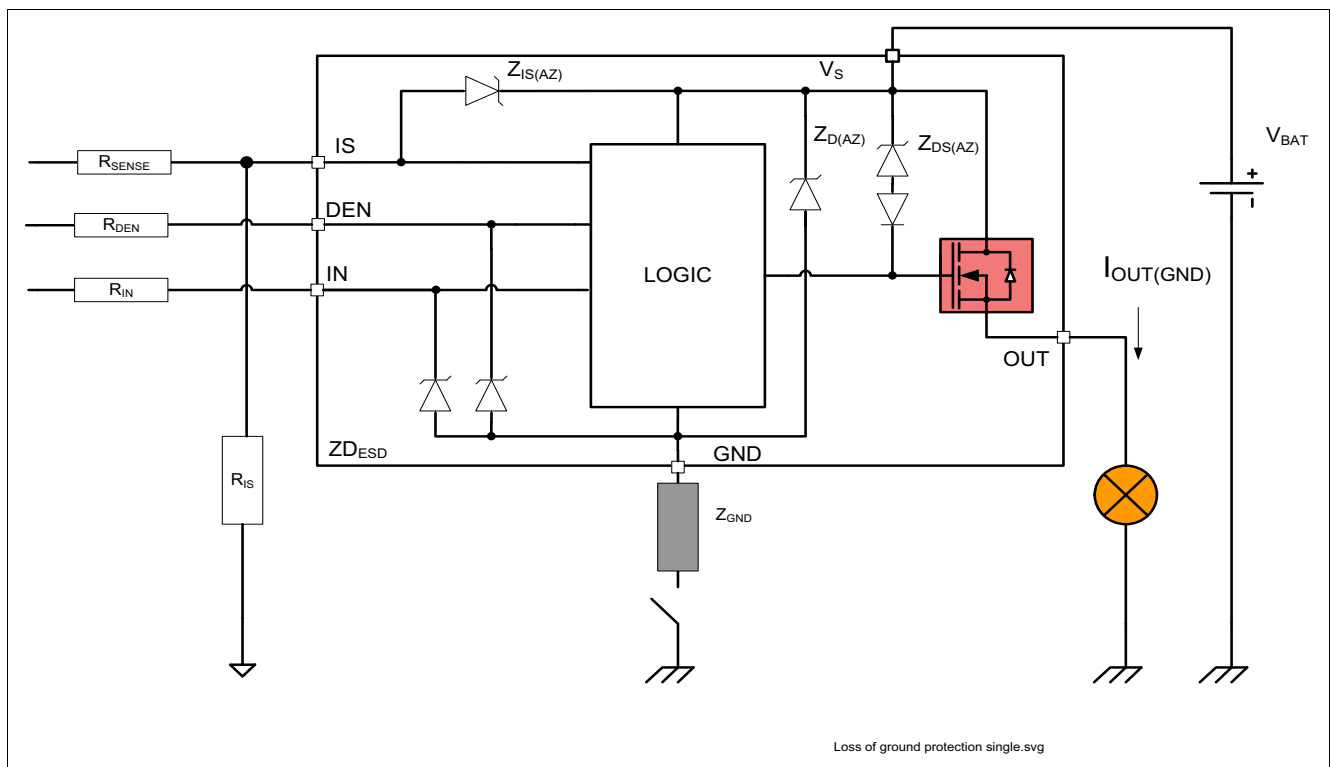


Figure 14 Loss of Ground Protection with External Components

6.2 Undervoltage Protection

Between $V_{S(UV)}$ and $V_{S(OP)}$, the undervoltage mechanism is triggered. $V_{S(OP)}$ represents the minimum voltage where the switching ON and OFF can take place. $V_{S(UV)}$ represents the minimum voltage the switch can hold ON. If the supply voltage is below the undervoltage mechanism $V_{S(UV)}$, the device is OFF (turns OFF). As soon as the supply voltage is above the undervoltage mechanism $V_{S(OP)}$, then the device can be switched ON. When the switch is ON, protection functions are operational. Nevertheless, the diagnosis is not guaranteed until V_S is in the V_{NOM} range. **Figure 15** sketches the undervoltage mechanism.

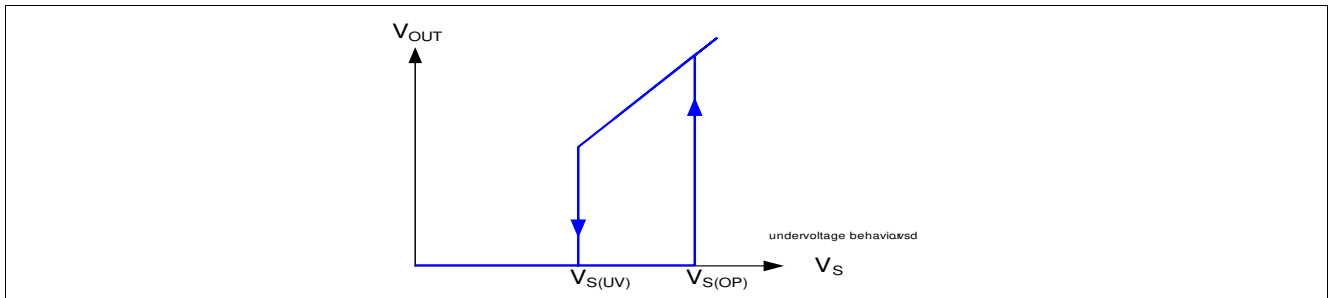


Figure 15 Undervoltage Behavior

6.3 Overvoltage Protection

There is an integrated clamp mechanism for overvoltage protection ($Z_{D(AZ)}$). To guarantee this mechanism operates properly in the application, the current in the Zener diode has to be limited by a ground resistor. **Figure 16** shows a typical application to withstand overvoltage issues. In case of supply voltage higher than $V_{S(AZ)}$, the power transistor switches ON and the voltage across the logic section is clamped. As a result, the internal ground potential rises to $V_S - V_{S(AZ)}$. Due to the ESD Zener diodes, the potential at pin IN and DEN rises almost to that potential, depending on the impedance of the connected circuitry. In the case the device was ON, prior to overvoltage, the BTS5020-1EKA remains ON. In the case the BTS5020-1EKA was OFF, prior to overvoltage, the power transistor can be activated. In the case the supply voltage is in above $V_{BAT(SC)}$ and below $V_{DS(AZ)}$, the output transistor is still operational and follows the input. If the channel is in the ON state, parameters are no longer guaranteed and lifetime is reduced compared to the nominal supply voltage range. This especially impacts the short circuit robustness, as well as the maximum energy E_{AS} capability. Z_{GND} as a resistor (150Ω) will offer superior results compared to a diode and resistor ($1 \text{ k}\Omega$).

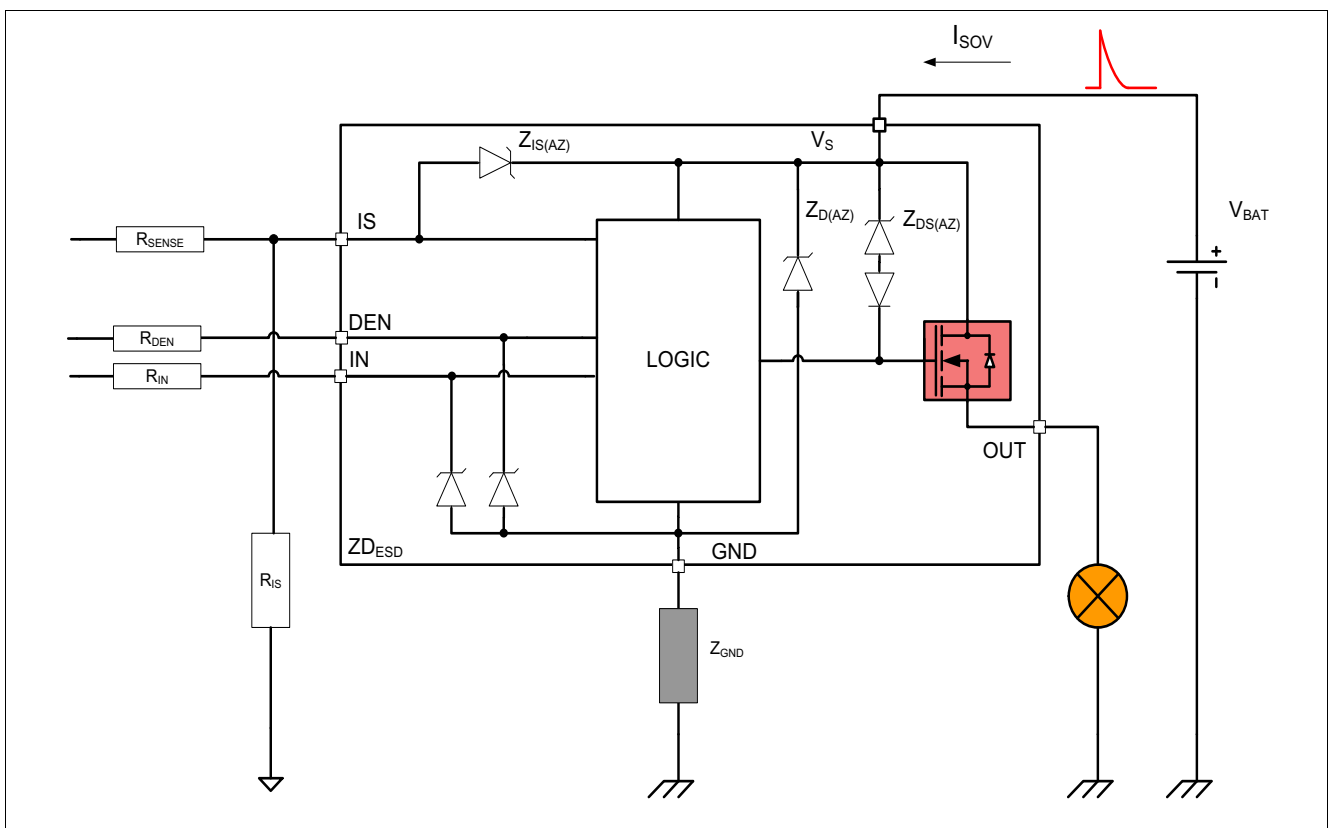


Figure 16 Overvoltage Protection with External Components

6.4 Reverse Polarity Protection

In case of reverse polarity, the intrinsic body diodes of the power DMOS causes power dissipation. The current in this intrinsic body diode is limited by the load itself. Additionally, the current into the ground path and the logic pins has to be limited to the maximum current described in [Chapter 4.1](#) with an external resistor. [Figure 17](#) shows a typical application. R_{GND} resistor is used to limit the current in the Zener protection of the device. Resistors R_{DEN} and R_{IN} are used to limit the current in the logic of the device and in the ESD protection stage. R_{SENSE} is used to limit the current in the sense transistor which behaves as a diode. The recommended value for $R_{DEN} = R_{IN} = R_{SENSE} = 4.7\text{ k}\Omega$. Z_{GND} can be either a $150\ \Omega$ resistor or Schottky diode with $1\text{ k}\Omega$ resistor in parallel.

In case the overvoltage is not considered in the application, R_{GND} can be replaced by a Schottky diode and $1\text{ k}\Omega$ resistor in parallel. Optionally a capacitor in parallel is recommended for EMC reasons.

During reverse polarity, no protection functions are available.

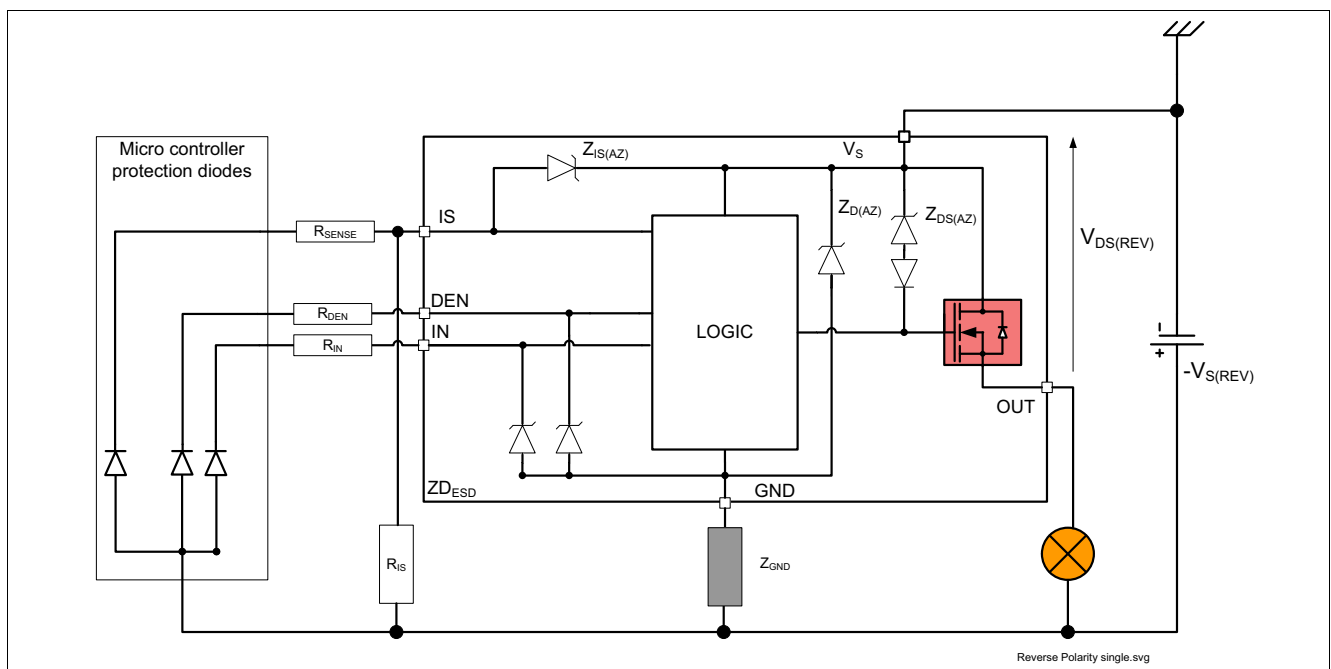


Figure 17 Reverse Polarity Protection with External Components

6.5 Overload Protection

In case of overload, such as high inrush of cold lamp filament, or short circuit to ground, the BTS5020-1EKA offers several protection mechanisms.

6.5.1 Current Limitation

At first step, the instantaneous power in the switch is maintained at a safe value by limiting the current to the maximum current allowed in the switch $I_{L(SC)}$. During this time, the DMOS temperature is increasing, which affects the current flowing in the DMOS. The current limitation value is V_{DS} dependent. [Figure 18](#) shows the behavior of the current limitation as a function of the drain to source voltage.

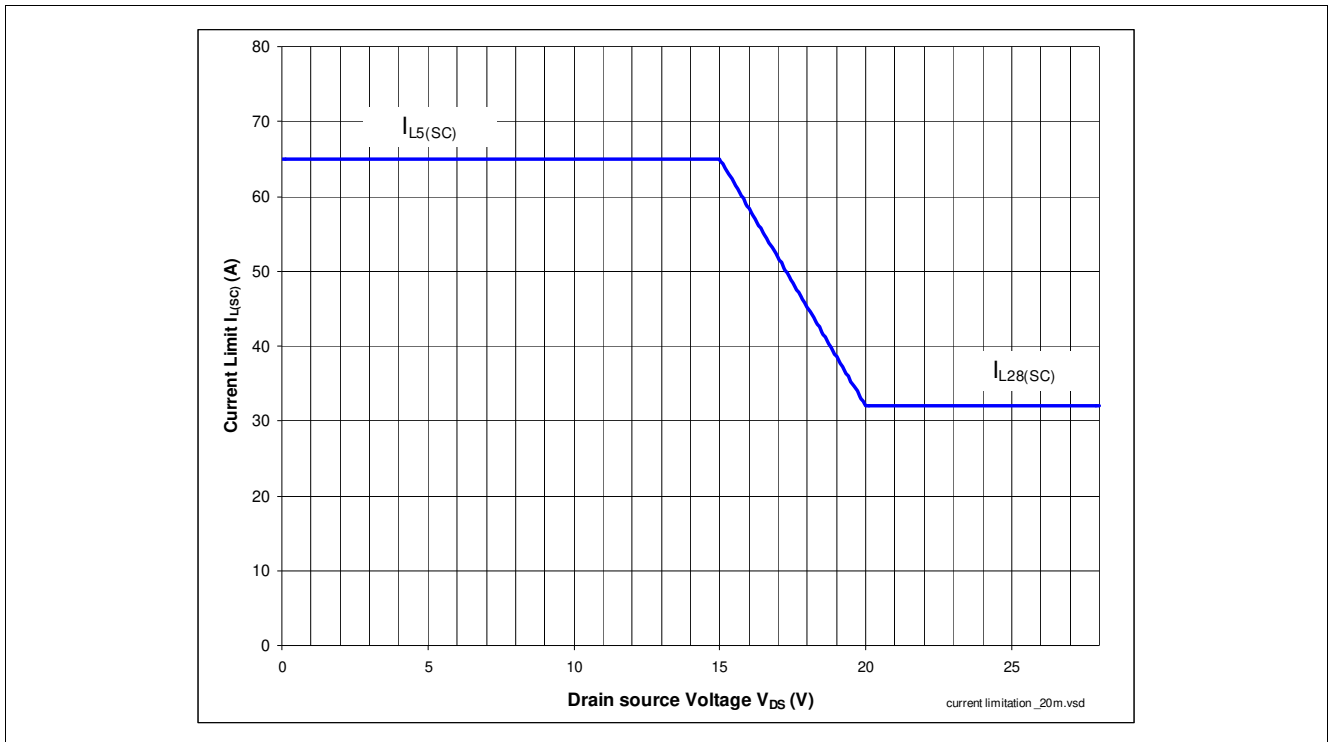


Figure 18 Current Limitation (typical behavior)

6.5.2 Temperature Limitation in the Power DMOS

The channel incorporates both an absolute ($T_{J(SC)}$) and a dynamic ($T_{J(SW)}$) temperature sensor. Activation of either sensor will cause an overheated channel to switch OFF to prevent destruction. Any protective switch OFF latches the output until the temperature has reached an acceptable value. Figure 19 gives a sketch of the situation. The ΔT_{STEP} describes the device's warming, due to the overcurrent in the channel.

A retry strategy is implemented such that when the DMOS temperature has cooled down enough, the switch is switched ON again, if the IN pin signal is still high (restart behavior).

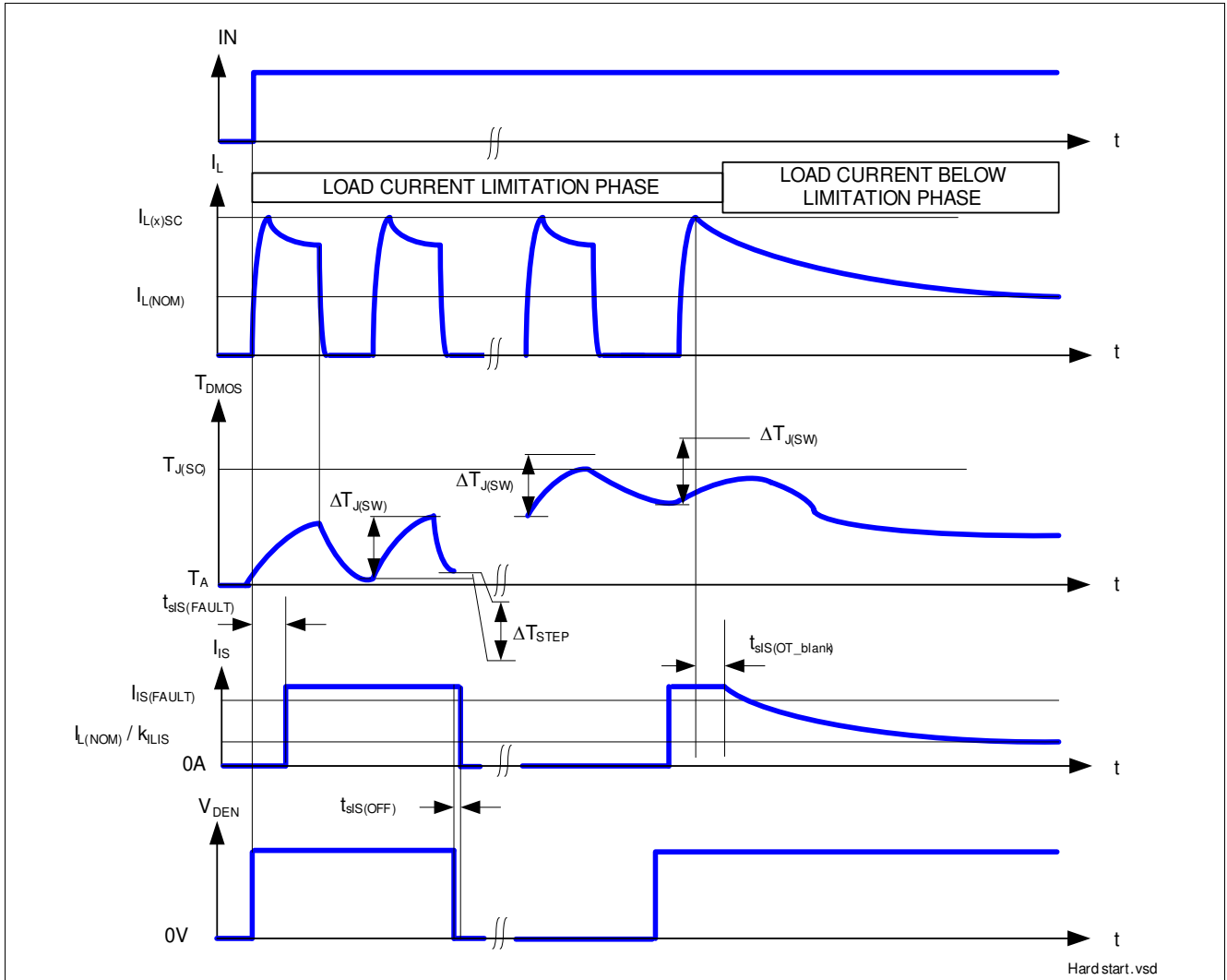


Figure 19 Overload Protection

Note: For better understanding, the time scale is not linear. The real timing of this drawing is application dependant and cannot be described.