Replacement of HITFET devices

with HITFET+ family BTS3xxxEJ

About this document

Scope and purpose

This document is intended to give a proposal on how to replace HITFET devices with the newest HITFET+ BTS3xxxEJ family.

Intended audience

Engineers, hobbyists, designers, sales and marketing managers who are interested in replacing old technology HITFETs with new solution HITFET+.

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1 BTS3xxxEJ overview

The BTS3xxxEJ devices are automotive qualified single channel Smart Low-Side Power switches in small PG-TDSO8 package providing embedded protective functions, automotive qualified and are optimized for 12 V systems.

Diagnostic Functions:

- Open-drain status output

Protective functions:

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

These devices are able to switch all kinds of resistive, inductive and capacitive loads, limited by the maximal clamping energy and current capabilities of the device.

The over temperature protection prevents the device from overheating due to overload/or bad cooling conditions.

The BTS3xxxEJ 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. The power MOSFET limits the drain-source voltage, if it rises above the $V_{OUT(CLAMP)}$.

1.1 Block diagram

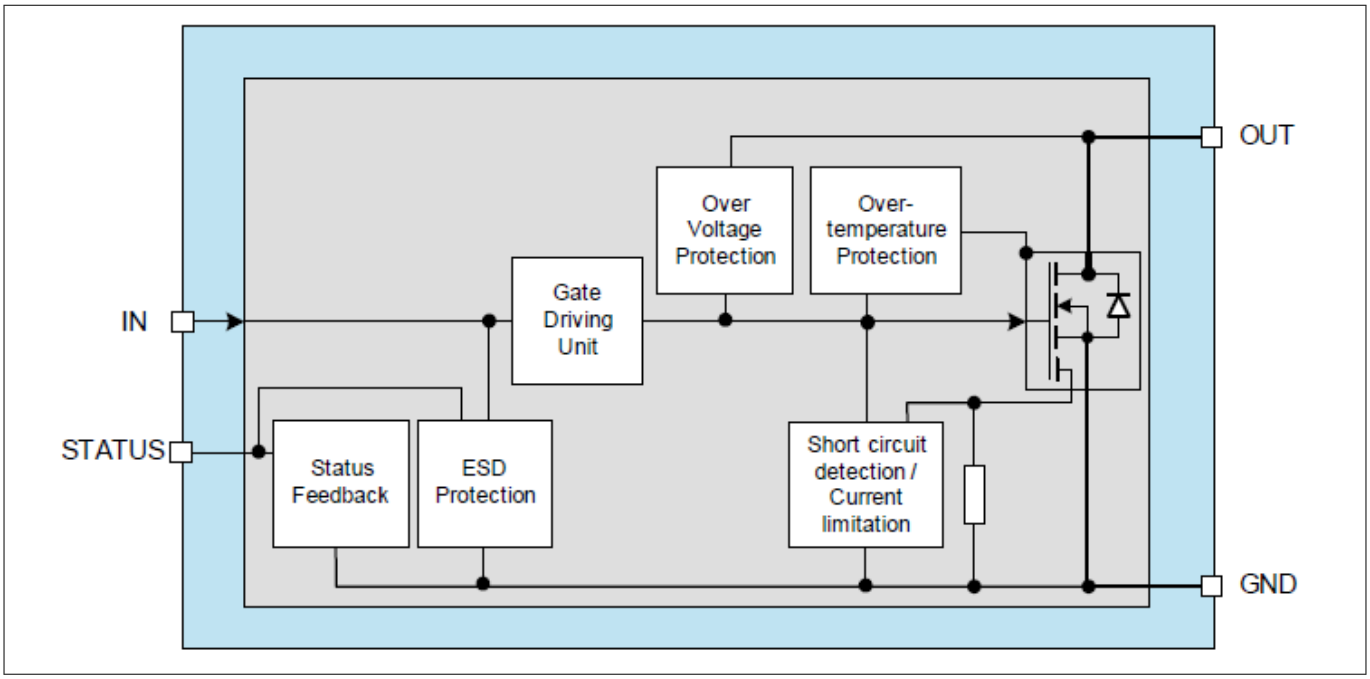

Figure 1 Block diagram of BTS3xxxEJ

1.2 Pin configurations and functions

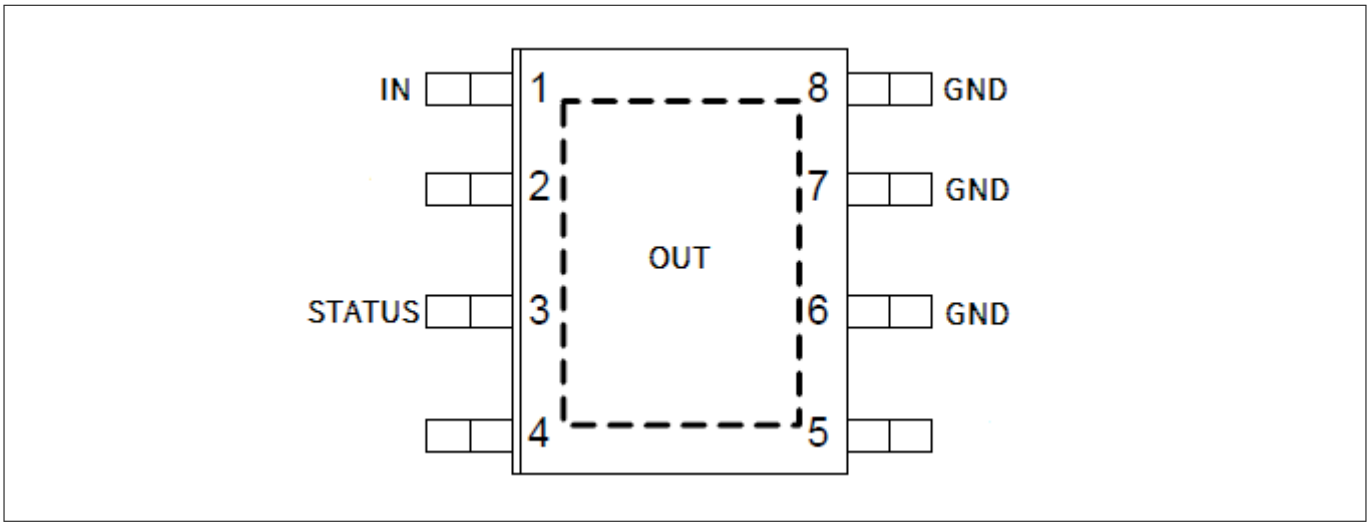

Figure 2 Pin configuration

Table 1 Pin definitions and functions

Pin	Symbol	Function
1	IN	Input pin
2	NC	not connected
3	STATUS	Open-drain status feedback (low active)
4	NC	not connected
5	NC	not connected
6,7,8	GND	Ground, source of power DMOS [1)]
Cooling tab	OUT	Drain, Load connection for power DMOS

1 All ground pins must be connected together.

2 Proposals for replacement

2.1 Basic replacement criterias

Table 2 shows an overview of HITFET devices that can be replaced with one of the devices from BTS3xxxEJ family.

Table 2 Basic replacement suggestion based on $R_{DS(ON)}$ and $I_{L(NOM)}$

HITFET+	$R_{DS(ON)\_25}$ typ. [mΩ]	$I_{L(NOM)}$ [A] (V_{IN} = 5 V)	HITFET (V_{IN} = 10 V)	
			Auto - RESTART	LATCH
BTS3035EJ	30	5	BTS142D	BTS3142D
BTS3050EJ	44	4	BSP78 BTS134D	BTS3134D BTS3134N
BTS3080EJ	69	3	AUIPS1041R	N/A
BTS3125EJ	108	2	BSP77 BTS118D	BTS3118D BTS3118N

2.2 Comparison of electrical parameters of BTS3xxxEJ and corresponding HITFET devices

In *Table 3* the most important parameters and package sizes are listed out both for BTS3xxxEJ devices and their corresponding HITFET counterparts. Maximum input voltage (V_{IN}) for BTS3xxxEJ devices is 5.5 V, in contrast with the maximum input voltage V_{IN} = 10 V of the previous HITFET generation.

Table 3 Detailed BTS3xxxEJ and HITFET parameters

Device	$RDS_{(ON)\_25}$ typ. [mΩ]	$RDS_{(ON)\_150}$ typ. [mΩ]	$IL_{(LIM)}$ [A]	t_{ON}/ t_{OFF} typ. [µs]	$V_{OUT\ (CLAMP)}$ min. [V]	Diagnosis	Package	R_{thJSP} [K/W]	R_{thJA} (2s2p) [K/W]	R_{thJA} (1s0p) [K/W]	R_{thJA} (1s0p) +300 mm² [K/W]	R_{thJA} (1s0p) +600 mm² [K/W]
BTS3035EJ	30	70	20	75/135	40	STATUS pin	PG-TDSO8	1.9	34	134	55	45
BTS142D	27	68	30	60/60	42	IN pin	PG-TO252-3 (DPAK)	1.1	25	115	58	55
BTS3142D	35	90	18	60/60	42	IN pin	PG-TO252-3(DPAK)	1.1	N/A	115	N/A	55
BTS3050EJ	44	100	15	75/135	40	STATUS pin	PG-TDSO8	2.7	36	136	56	46
BSP78	45	100	18	60/60	42	IN pin	PG-SOT223-4	17	54	125	65	72
BTS134D	45	100	18	60/60	42	IN pin	PG-TO252-3 (DPAK)	1.5	40	115	65	55
BTS3134D	45	100	18	60/60	42	IN pin	PG-TO252-3 (DPAK)	1.5	55	115	N/A	N/A
BTS3134N	45	100	18	60/60	42	IN pin	PG-SOT223-4	17	72	125	N/A	72
BTS3080EJ	69	160	10	75/135	40	STATUS pin	PG-TDSO8	4.1	37	140	58	48
AUIPS1041R	80	175	3	14/50	36	IN pin	PG-TO252-3 (DPAK)	6	N/A	70	N/A	N/A
BTS3125EJ	108	250	7	75/135	40	STATUS pin	PG-TDSO8	5.7	39	143	60	50
BSP77	90	240	10	40/70	42	IN pin	PG-SOT223-4	17	56	125	67	57
BTS118D	90	240	10	40/70	42	IN pin	PG-TO252-3 (DPAK)	3	37	105	58	40
BTS3118D	90	240	10	40/70	42	IN pin	PG-TO252-3 (DPAK)	3	55	115	N/A	N/A
BTS3118N	90	240	10	40/70	42	IN pin	PG-SOT223-4	17	72	125	N/A	72

3 Functionality comparison

3.1 Diagnosis

Diagnosis in HITFET devices is done through IN pin, while in HITFET+ devices (BTS3xxxEJ) diagnosis is done through an additionally added STATUS pin. In the old HITFET families, it can happen that a Fault condition is not detected correctly when the IN pin is used for driving the device gate and for Fault behavior detection. The difference between the input current value in normal and fault working conditions can be too small to enable a clear distinction between these two states. STATUS pin is an improvement in comparison to diagnosis through IN pin, since it is a pin dedicated only for diagnosis and provides a dedicated latched fault signal.

3.1.1 Diagnosis via IN pin

A device provides diagnosis via an increased current in IN pin. The increased current $I_{IN(FAULT)}$ is above the normal operation current $I_{IN(nom)}$. The voltage at the IN pin is determined by the current and the input resistor. The microcontroller reads out this voltage and determines if the HITFET is normal or fault operation state.

Figure 3 shows diagnosis via IN pin.

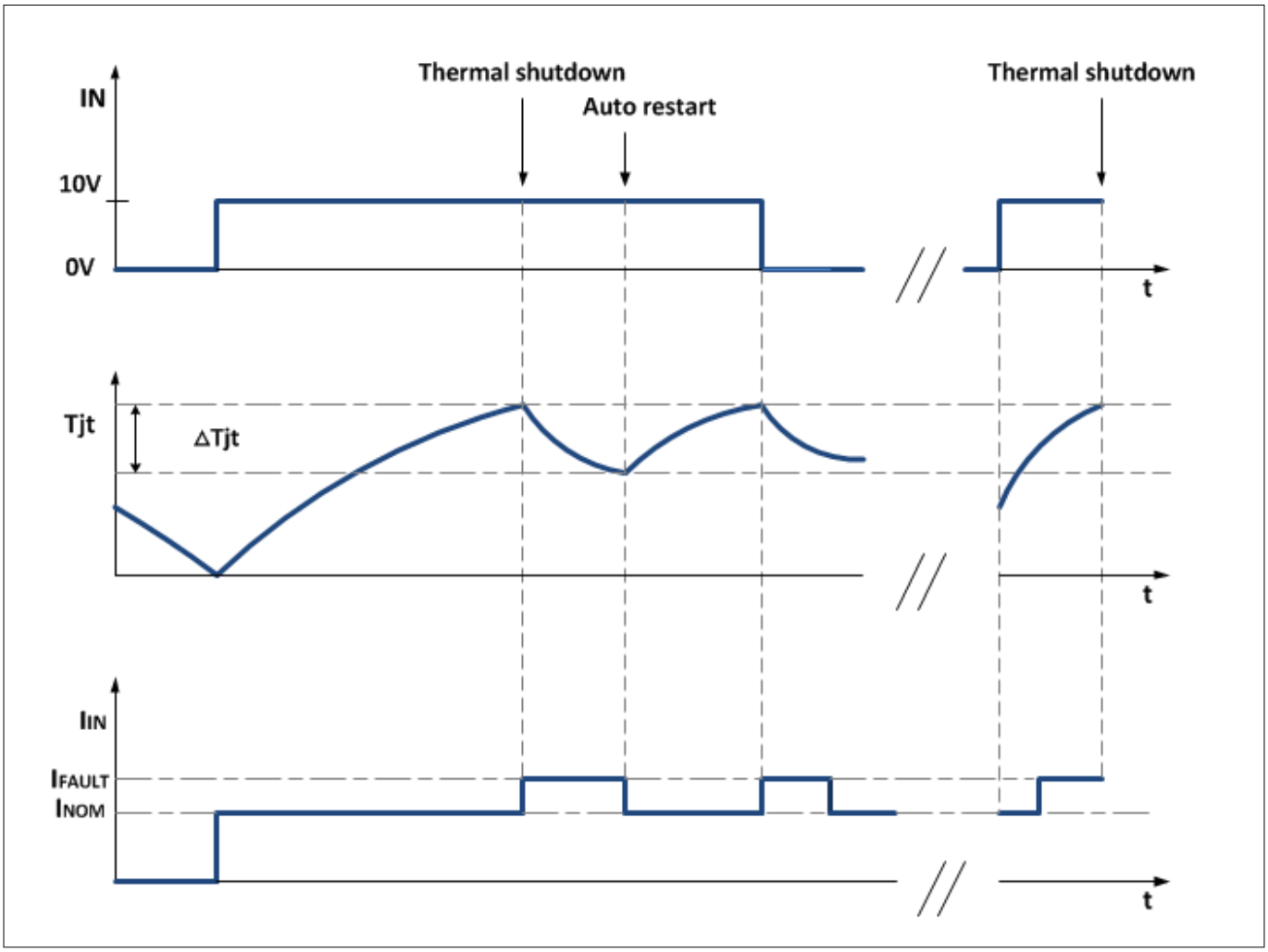

Figure 3 Over temperature switch off with auto-restart and signaling via IN pin

3.1.2 Diagnosis via STATUS pin

In normal operation STATUS pin needs to be pulled up to a 3 V/5 V to signal a high level.

BTS3xxxEJ devices provide a latching digital status signal via an open drain style feedback on the STATUS pin. In case of a detected over temperature condition DMOS switches of and the STATUS pin voltage is pulled down to GND by an internal pull-down resistor to signal a low level. The STATUS pin stays low (at GND level) also during thermal restart, and can be reset only when the IN pin is pulled down below its threshold.

Figure 4 shows diagnosis via STATUS pin.

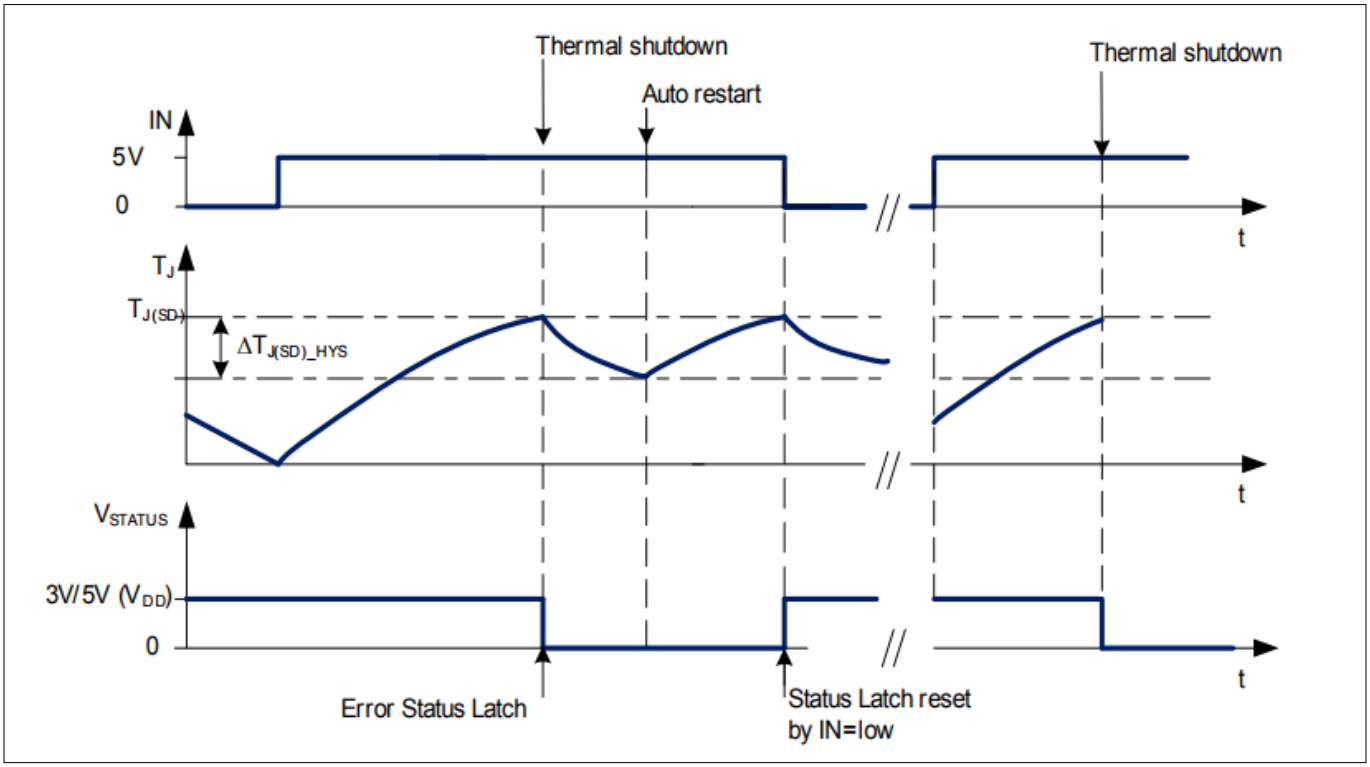

Figure 4 Over temperature switch off with auto-restart and signaling via STATUS pin

4 Short circuit reliability tests

Short circuit test that are being performed on HITFETs and BTS3xxxEJ are called Cold Repetitive tests.

If a device is an auto-restart device it will have more active cycles inside of one short circuit cycle, as show in ***Figure 5***.

Tests are done in accordance with standard **AEC-Q100-12**. Results presented in this document are for comparison purpose only. For the complete short circuit reports please contact your Infineon sales representative.

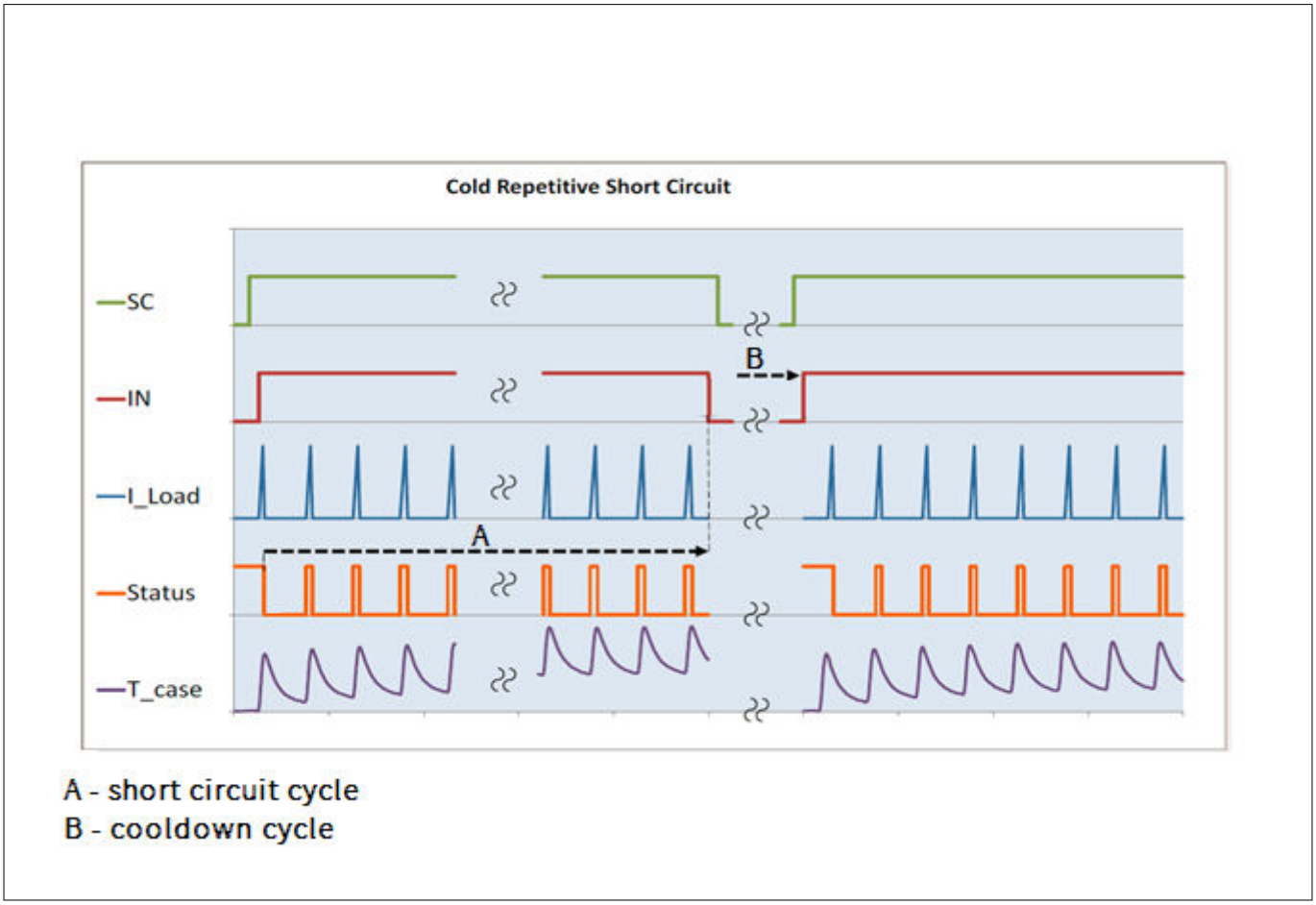

Figure 5 Cold Repetitive short circuit test

Short circuit reliability tests

Table 4 shows an overview of the results collected from the short circuit reliability test reports for BTS3xxxEJ devices and their counterparts HITFETs.

Table 4 Short circuit test results[1)]

Device	Cold repetitive	
	ppm	Cycles to Non-Conformance
BTS3035EJ	100	102.2×10^3
BTS142D	100	3.4×10^3
BTS3050EJ	100	1.58×10^5 [2)]
BSP78	100	1.7×10^4
BTS134D	100	4.1×10^2
BTS3080EJ	100	2.19×10^5 [3)]
BTS3125EJ	100	3.73×10^5 [4)]
BSP77	100	1.3×10^3
BTS118D	100	1×10^3

1 The table shows the results of limited number of samples tested. For the complete short circuit reports please contact your Infineon sales representative.

2 Testing was discontinued after 1.58×10^5 cycles. No device was found to be non-conforming before the conclusion of testing. Additionally, no device was found after the conclusion of testing to be outside of specification values.

3 Testing was discontinued after 2.19×10^5 cycles. No device was found to be non-conforming before the conclusion of testing. Additionally, no device was found after the conclusion of testing to be outside of specification values.

4 Testing was discontinued after 3.73×10^5 cycles. No device was found to be non-conforming before the conclusion of testing. Additionally, no device was found after the conclusion of testing to be outside of specification values.

5 Package comparisons

The TDSO8 package footprint of the BTS3xxxEJ family is considerably smaller than the SOT223 and DPAK for previous HITFET devices. ***Figure 6*** shows a quick footprint and thickness comparison.

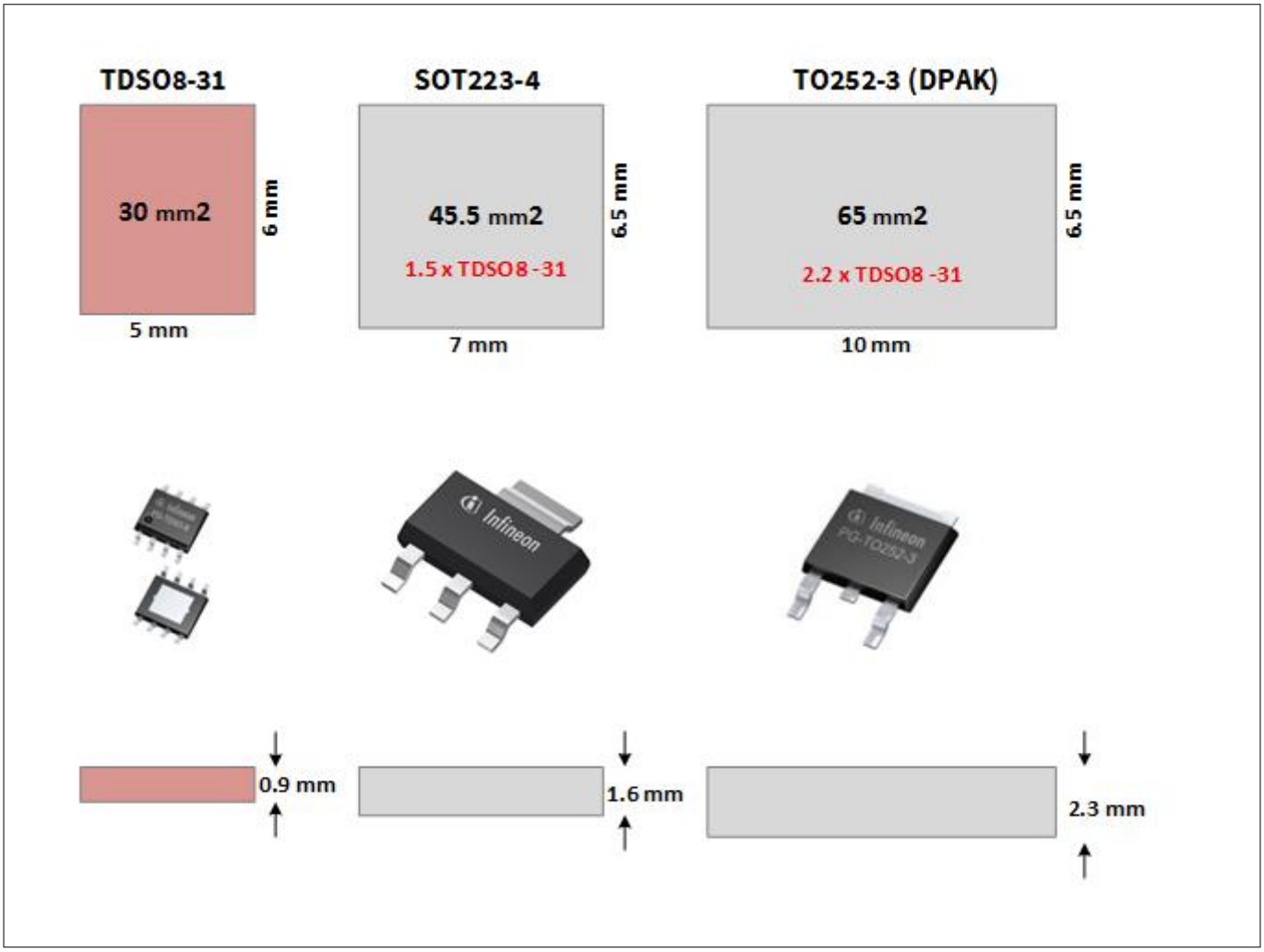

Figure 6 Comparison between BTS3xxxEJ to HITFET package size

6 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.

6.1 Application diagram for BTS3xxxEJ

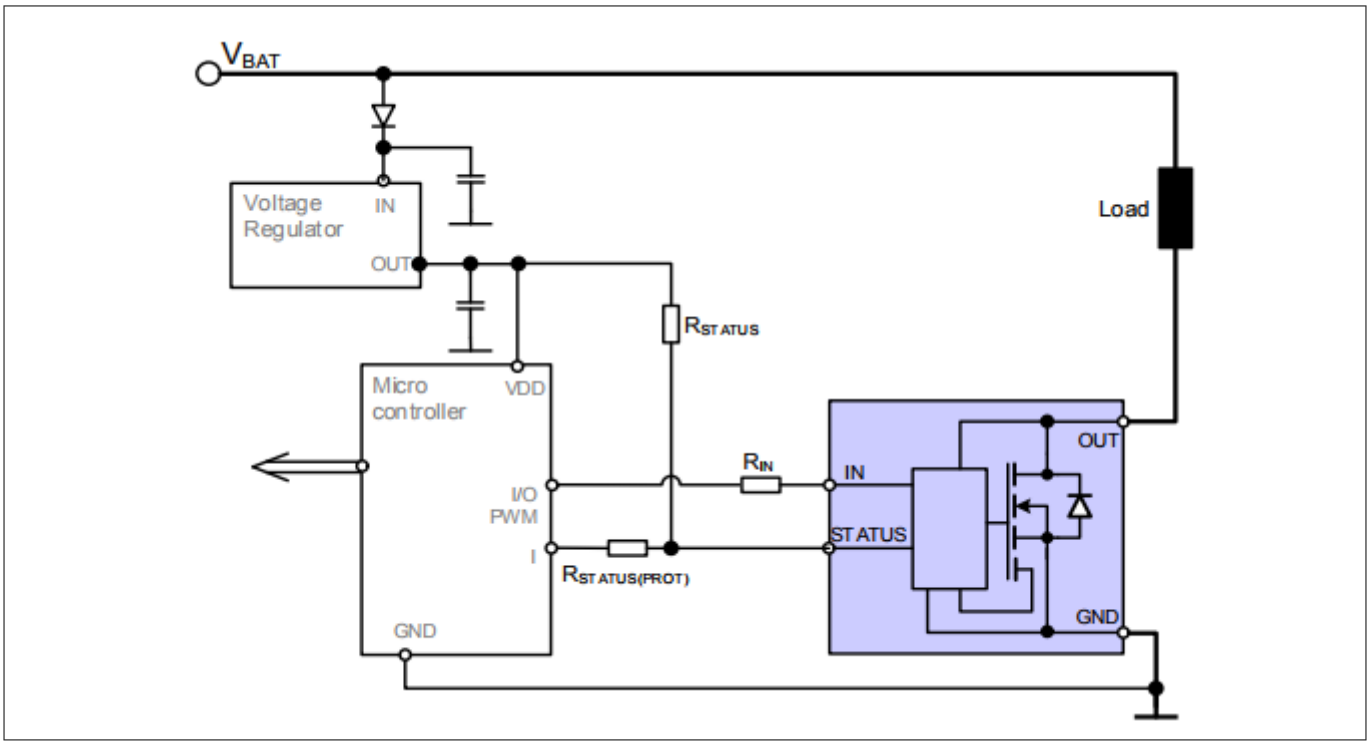

Figure 7 Application example circuitry for BTS3xxxEJ

Recommended values for V_{IN} = 5 V, V_{DD} = 5 V:

R_{STATUS} = 4.7 kΩ

$R_{STATUS(PROT)}$ = 3.3 kΩ

R_{IN} = 3.3 kΩ

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

6.2 Application diagram for HITFET devices

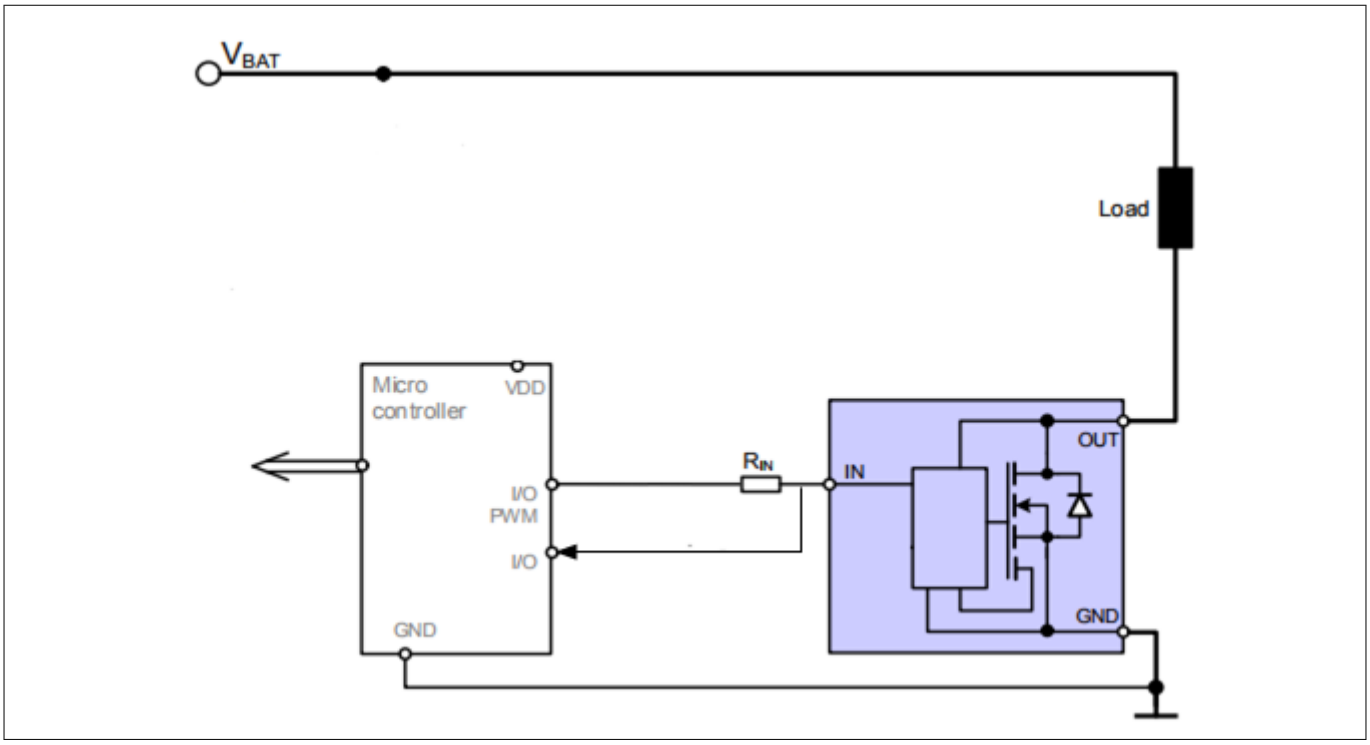

Figure 8 Application example circuitry for a HITFET device

Recommended values for V_{IN} = 5 V:

R_{IN} = 4.7 kΩ

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

Revision history

Document version	Date of release	Description of changes
1.0	2018-04-16	Initial release.

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