Truck Compatibility of MiniProfets

Application Note
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Application Note

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Automotive Power

1 Abstract

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.

Main objective of this application note is to benchmark existing MiniProfets in terms of “Truck Compatible” characteristics.

All MiniProfets which are highlighted in this application note as “Truck Compatible” devices can also be regarded suitable for “28V Powernet” applications.

2 Introduction

All terms of voltage levels within this application note are refering to voltage levels which are specified in the respected MiniProfet Datasheets.

All MiniProfet Datasheets including their parameters and values have been evaluated in terms of “Truck Compatibility”.

3 Criterias for Truck Compatibility

All below listed criterias or parameter have been applied to MiniProfets in order to classify them as “Truck Compatible” High-Side Switches.

The parameters with its voltage levels which are stated in **Table 1**, column three (“Requirement For Truck Application”) can be seen as an “umbrella” specification thus they can be regarded as a proposal list from Infineon.

- Supply Voltage or Battery Voltage
- Functional Operating Voltage
- Supply Voltage or Battery Voltage for Short Circuit Protection
- Supply Voltage or Battery Voltage for Protection Functions
- Load Dump Protection, Overvoltage Protection
- Reverse Battery Protection
- EAS (Single Switch Off Energy)

Table 1 Parameter and required values for Truck Compatibility

Parameter	Datasheet symbol(s)	Requirement for truck application, value/range, unit
Nominal Supply Voltage	V_s, V_{bb}	V_s = 28V
Functional Operating Voltage	V_s, V_{bb}	12V < V_s< 36V
Supply Voltage for Full Short Circuit Protection	$V_{bb(SC)}$, $V_{s(SC)}$	12V < V_s < 36V
Supply Voltage for Protection Functions	V_s, V_{bb}	12V < V_s < 36V
Load Dump Protection	V_s, V_{bb}	$V_{S(LD)}$, $V_{bb(LD)}$ = 58V
Overvoltage Protection	V_s, V_{bb}, $V_{S(AZ)}$, $V_{BB(AZ)}$	$V_{S(AZ)}$, $V_{bb(AZ)}$ = 58V
Reverse Battery Protection	V_s, V_{bb}	-28V < V_s < 0V

4 EAS - Single Switch Off Energy

During demagnetization of inductive loads, the energy which is stored in the inductive load has to be dissipated in the MINIPROFETs power stage(s).

Since there is no freewheeling diode available in any MiniProfet all stored energy in inductive loads has to be dissipated by the chip itself.

In general all MiniProfets are containing a clamping structure which are limiting the drain source voltage level of the Power MOSFET to a certain clamping voltage level (V_{DS}=$V_{DS(CL)}$).

Figure 1 is showing a simplified internal circuit as an example for protecting the Power MOSFET of a MiniProFET

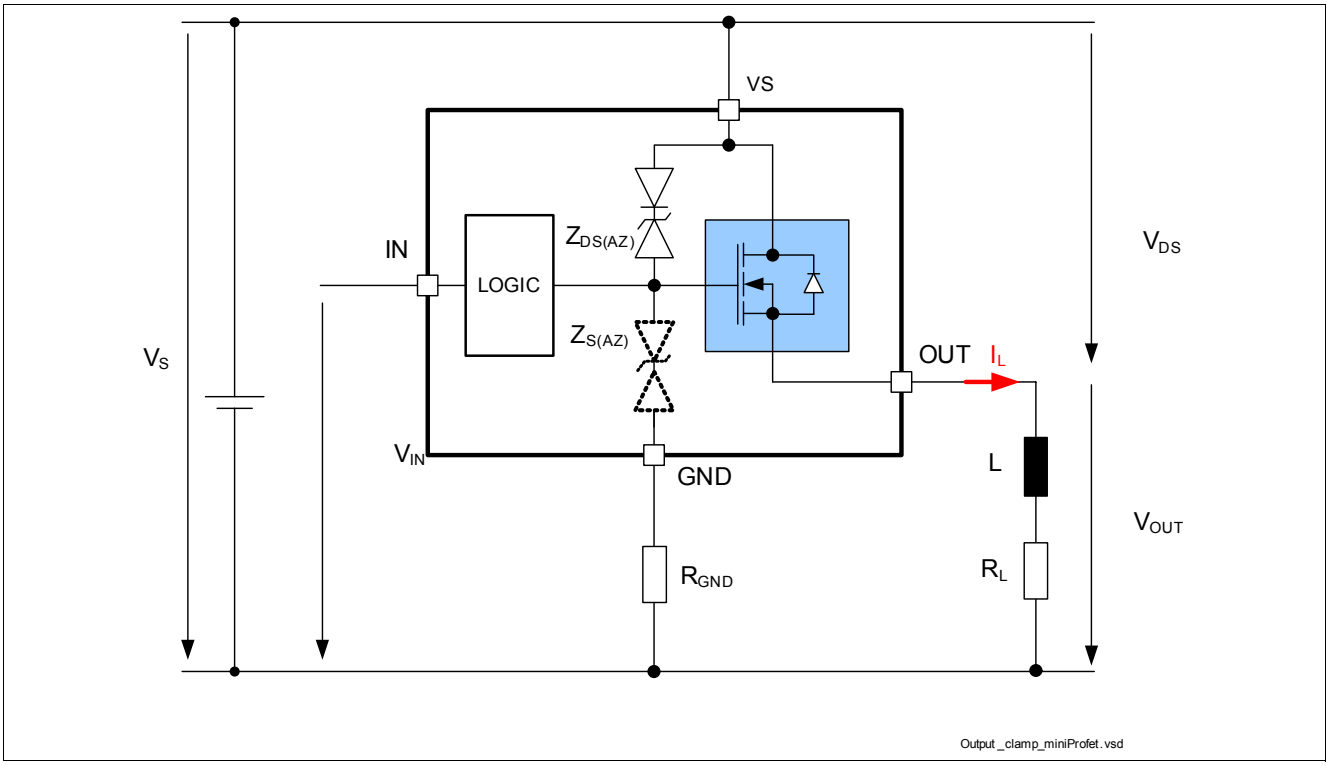

Figure 1 Schematic of MiniProfet protection circuit

4.1 EAS Formula

With assuming $V_{DS(CL)}$ being constant over time, the resulting energy during switching off inductive loads can be calculated with following equation:

(1)

$$EAS = \frac{V_{DS(CL)} \cdot L}{R_L} \cdot \left(\frac{V_S - V_{DS(CL)}}{R_L} \cdot \ln\left(1 + \frac{R_L \times I_L}{V_{DS(CL)} - V_S}\right) + I_L \right)$$

Note: **Equation (1)** simplifies under the assumption of R_L = 0 Ω to:

(2)

$$EAS = \frac{1}{2} \times L \times I_L^2 \times \frac{V_{DS(DCL)}}{V_{DS(CL)} - V_S}$$

Whereas **Equation (2)** is not of further interest here because the load which is switched in typical applications has higher impedance. In general, the energy which is converted into heat, is limited by the thermal design of a MiniProfet device.

In all datasheets there is an specified EAS value (chapter Maximum Ratings) which can be used for calculation of the maximum allowed load or current by using **Equation (1)**.

Furthermore the correlation of the maximum allowed energy versus nominal load current (EAS = f (I_L)) is shown as a curve in many MiniProfet datasheets.

4.2 Parasitic Inductive Loads

As shown in **Chapter 4** an important issue in truck applications is the impact of load inductances. Although the parasitics inductance of wires to a load is increasing by using long supply lines to the load, this additional inductance in most cases is not of relevance here because the resulting low inductances (please refer to **Table 2** which sums up some wire cross sections and the resulting impedance / inductances for a cablewire over a ground plane with 5mm distance to the ground plane or chassis). Please also note that the typical cable length to a load in a truck is not exceeding 40m.

Table 2 Wire characteristics

Gauge (AWG)	Cross section (mm²)[1)]	Impedance (Ω/km)[1)]	Inductance (H/m)[1)]
16	1.31	13.6	6.9 x 10e-7
18	0.82	21.63	7.3 x 10e-7
20	0.52	34.39	7.7 x 10e-7
22	0.33	54.66	8.3 x 10e-7

1) Approximation only

5 Truck compatible MiniProfets

The following table is showing all full and partly suitable MiniProfets in terms of truck compatibility.

Table 3 Truck compatible MiniProfets

	SOT223	DSO-8	D-PAK	Others
1000 mOhm	BTS4140N			
350 mOhm		BSP742R/T*		
300mOhm		BTS4300SGA		
200 mOhm	BSP452 BTS4141N BTS4142N	BSP752R/T	BTS452R/T	BTS4880R (DSO-36)
175mOhm		BTS4175SGA		
100 mOhm		BSP762T	BTS462T	
60 mOhm		BSP772T		
20 mOhm				BTS441R/T (TO-220)

Device full suitable for truck application

Device partly suitable for truck applications

*: R=with diagnostic feedback
T=without diagnostic feedback

6 MiniProfets In Truck Applications

Table 4 shows the main parameters and its values of the devices which are partly suitable for truck applications (yellow marked in Table 3)

Table 4 Critical values or ranges of device parameter versus required device parameter in terms of Truck Compatibility

Device	Parameter	Critical device parameter, value, range	IFX Proposal for truck applications, value/range, unit
BSP452	Functional Operating Voltage[1)]	V_s, $V_{bb;}$ 5V < V_{bb} < 34V	V_S = 28V
BTS4141N, BTS4142N	Supply Voltage for protection functions[2)]	$V_{bb(SC)}$, $V_{s(SC);}$ 5V < V_{bb} < 30 V	12V < U_{nom} < 28V
BTS4880R	All protection features[3)]	15V < V_{bb} < 30V	12V < U_{nom} < 36V

1) Protection features of BSP452 which are out of range in terms of Truck Compatibility:
- Initial Peak Short Circuit Current Limitation (parameter is only specified at V_{bb} = 20V)
- Overvoltage Shutdown, $V_{bb(over)}$ = 34V(min)
(Reverse Battery Protection is only valid with external resistor, R_{GND} = 150Ohm for $-30V < V_{bb} < 0V$)

2) Protection features BTS4141N and BTS4142N which are out of range in terms of Truck Compatibility:
- Initial Peak Short Circuit Current Limitation (parameter is only specified at V_{bb} = 30V)
- Repetetive Short Circuit Current Limitation (parameter is only specified for $15V < V_{bb} < 30V$)
(Reverse Battery Protection is only valid with external resistor, R_{GND} = 150Ohm valid for $-45V < V_{bb} < 0V$)

3) Protection features in BTS4880 which are out of range in terms of Truck Compatibility:
- Initial Peak Short Circuit Current Limitation (parameter is only specified at V_{bb} = 30V)
- Repetetive Short Circuit Current Limitation (parameter is only specified for $15V < V_{bb} < 30V$)
(Reverse Battery Protection is only valid with external resistor, R_{GND} = 150Ohm for $-45V < V_{bb} < 0V$)

7 Conclusion

The main intention of this Application Note is benchmarking existing MiniProfets in terms of Truck Compatibility.

Together with an “umbrella” specification of Infineon, all existing MiniProfets have been evaluated in terms of Truck Compatibility.

This application note includes a recommendation list (**Table 3**) of all MiniProfets which are suitable for truck applications.

8 Additional Information

Reference list

- MiniProfet Data sheets
- For further information you may contact **http://www.infineon.com/**

9 Revision History

MINIPROFET

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Revision History

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