TLE9104SH Switching Inductive Loads and External Clamping

Product Family: Multichannel Low-Side Switches

About this document

Scope and purpose

This application note is intended to provide additional information regarding the Clamping Energy capabilities of the TLE9104SH. **Chapter 1** has to be considered as an addendum to the Application Note Multichannel Low-Side Switches - Switching Inductive Loads.

The clamping energy which can be safely dissipated inside the TLE9104SH is restricted to the energy values given in the data sheet. When there are loads with a higher clamping energy it is necessary to have an external clamping unit. For an overview of the permitted loads for the TLE9104SH, please refer to the relevant section of the data sheet.

For a more detailed description of the capabilities of the TLE9104SH, please refer to the data sheet.

Note: The following information is provided as advice 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.

Intended audience

This document is aimed at users in need of additional information regarding the Clamping Energy capabilities of the TLE9104SH.

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1 TLE9104SH Switching Inductive Loads

1.1 Clamping Energy versus Current (SOA)

The TLE9104SH Switching Inductive Loads channels can be characterized as shown in **Table 1**, according to DMOS size and symmetry.

Table 1 TLE9104SH Switching Inductive Loads channels

Channels	$R_{DS(MAX)}$ [mΩ]	I_{nom} [A]	I_{SCB} [A]
OUT1-4	350 mΩ	3 A	5 A

In the following sections the energy SOA will be shown for all channels in order to give the user the possibility to check the device capabilities in relation to his specific loads. For a detailed description on how to measure/calculate the operating point (I_L, E_{CL}) for each load and how to do the application check, please refer to the TLE9104SH Switching Inductive Loads Data Sheet and to the Application Note Multichannel Low-Side Switches - Switching Inductive Loads. Three areas of energy will be shown for a cumulative scenario:

- Normal Operation
  - 10^9 cycles
- Mid Energy[1)]
  - either 10^4 cycles
  - or 10^5 cycles
- High Energy
  - 10 single pulses

1) In the case of a mid energy area, two different plots are shown (10^4 and 10^5 cycles) for more flexibility to the user, but in no case it is allowed to combine both operations at the same time in a cumulative scenario, use either one or the other curve.

TLE9104SH Switching Inductive Loads

1.1.1 Channels 1-4[1) 2) 3)]

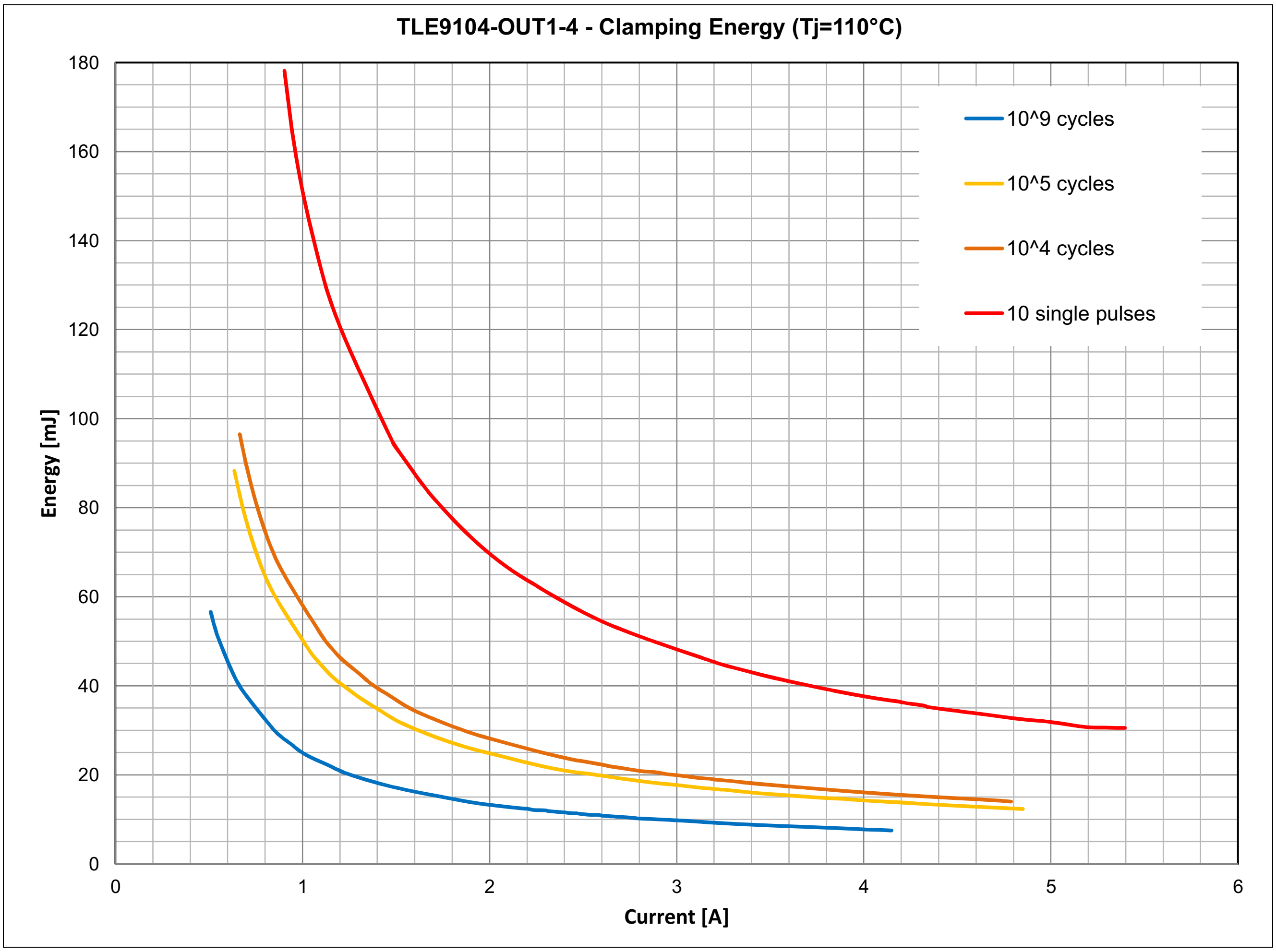

Figure 1 Energy SOA for TLE9104SH - CH1-4 (T_J = 110°C)

1) Data shown here for a starting temperature T_J = 110°C are based on extrapolation and not directly from measured data.
2) In the case of a mid energy area, two different plots are shown (10^4 and 10^5 cycles) for more flexibility to the user, but in no case it is allowed to combine both operations at the same time in a cumulative scenario, use either one or the other curve.
3) Several operating points could be grouped within the same energy level, in that case the total number of cycles allowed by the relative SOA has to be split among the operating points.

1.2 Use Case for Engine Management Application

TLE9104SH is optimized to handle high clamping energies for inductive loads such as relays, injectors, solenoids, etc. Table 2 is a clamping energy senario for multi-port injection application which can be used as a reference.

Table 2 Operating Conditions

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Maximum output clamping energy, linearly decreasing current [1) 2)]	E_{AR}	8.5	–	–	mJ	$I_{D(0)}$ = 1.8 A, $T_{J(0)}$ = 25°C, Cycles: 18 Mio	P_4.2.6
Maximum output clamping energy, linearly decreasing current [1) 2)]	E_{AR}	4.5	–	–	mJ	$I_{D(0)}$ = 1.4 A, $T_{J(0)}$ = 115°C, Cycles: 648 Mio	P_4.2.1
Maximum output clamping energy, linearly decreasing current [1) 2)]	E_{AR}	3.5	–	–	mJ	$I_{D(0)}$ = 1.0 A, $T_{J(0)}$ = 130°C, Cycles: 96 Mio	P_4.2.7
Maximum output clamping energy, linearly decreasing current [1) 2)]	E_{AR}	3.5	–	–	mJ	$I_{D(0)}$ = 1.0 A, $T_{J(0)}$ = 140°C, Cycles: 4 Mio	P_4.2.8
Maximum output clamping energy, linearly decreasing current [1) 2) 3)]	E_{AR}	10	–	–	mJ	$I_{D(0)}$ = 2.0 A, $T_{J(0)}$ = 20°C, Cycles: 0.5 Mio	P_4.2.9
	E_{AR}	9	–	–	mJ	$I_{D(0)}$ = 1.5 A, $T_{J(0)}$ = 135°C, Cycles: 0.5 Mio	
Maximum output clamping energy, linearly decreasing current [1) 2) 3)]	E_{AR}	19.5	–	–	mJ	$I_{D(0)}$ = 3.0 A, $T_{J(0)}$ = 25°C, Cycles: 0.29 Mio	P_4.2.10
	E_{AR}	11	–	–	mJ	$I_{D(0)}$ = 2.3 A, $T_{J(0)}$ = 75°C, Cycles: 0.21 Mio	
Maximum output clamping energy in parallel mode	$E_{AR,p}$	1.7 X E_{AR}	–	–	mJ	OUT1&2 or OUT3&4 , $I_{D(0), P}$ = 1.8 X $I_{D(0)}$	P_4.2.2

1) Pulse shape represents inductive switch off: $I_D(t) = I_D(0) \times (1 - t / t_{pulse}); 0 < t < t_{pulse}$
2) The given energy values are based on a cumulative scenario as specified in the Notes column.
3) In the cumulative scenario, one of the maximum output clamping energies of parameter number P_4.2.9 and one of the maximum output clamping energies of parameter number P_4.2.10 are considered at a time.

1.3 Additional Information

- Existing Application Notes:
  - Switching Inductive Loads Applicaton Note
- For further information you may contact **http://www.infineon.com/**

2 Revision History

Revision	Date	Changes
0.1	2017-12-01	Initial release

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Do you have a question about any aspect of this document?

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