AN-1003

Automotive circuit protection of load dump TVS

TVS application note —
Automotive circuit protection of load dump TVS

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Why we need Load dump TVS:

Automotive circuit critically suffer many surge threats, so to prevent the unpredictable surge damage is very important. Automotive mobile environment is full of inductor which came from wire harness, relay, and motors. The inductor could induce transient energy while the switch motions, wire disconnect, or loosen. Among these variety of surge threat, there are many criteria been regulated by some many criteria like ISO, IEC...etc. One of these criteria, the ISO 16750-2 Load dump test is the bigger energy test and stricter verification for automotive systems. Compare with IEC 61643-321 typical wave 10/1000μs, the Load dump test surge energy is far severer as (Figure 1). It means automotive circuit protection design needs more robust TVS to sustain this severer test pulse of ISO 16750-2 Load dump test.

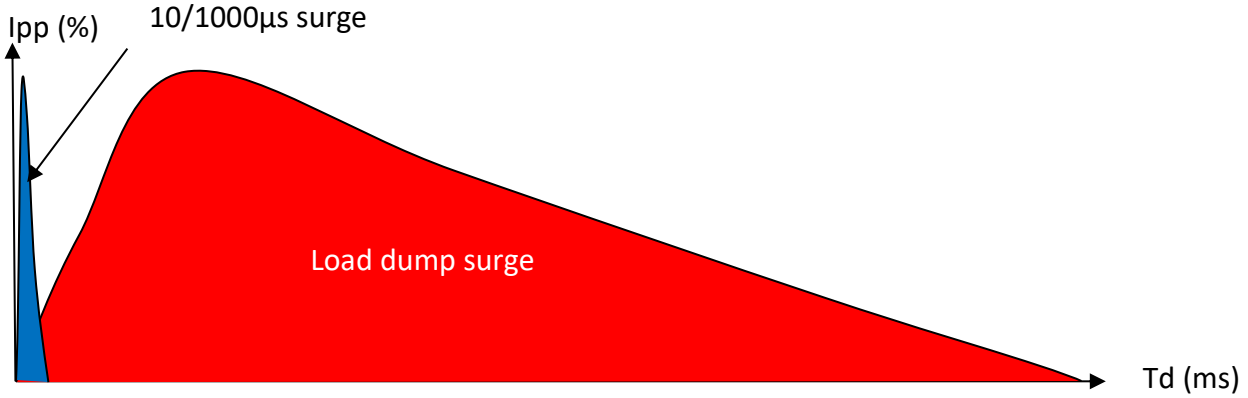


Figure 1. Load dump vs. 10/1000μs surge energy

Load Dump TVS test criteria:

ISO 16750-2 Load dump test is a simulation of discharged battery being disconnected while automotive alternator is generating charging current, this test criterion includes of two types - Test A and Test B.

ISO 16750-2 Load dump Test A simulates the test surge without centralized load dump suppression in alternator (Figure 2); ISO 16750-2 Load dump Test B simulates the test surge with centralized load dump suppression in alternator (Figure 3).

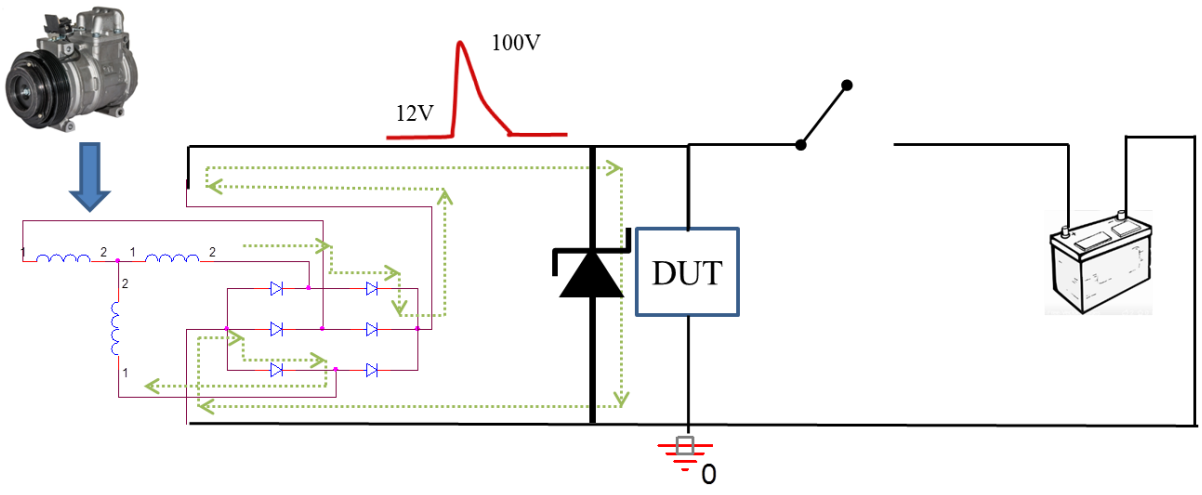


Figure 2. ISO 16750-2 Load dump Test A

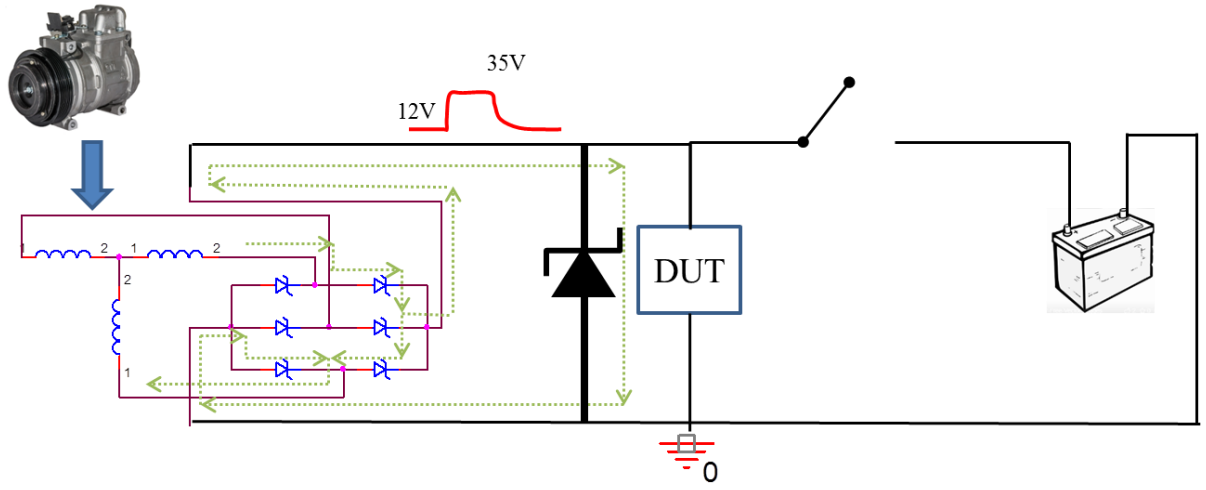


Figure 3. ISO 16750-2 Load dump Test B

Load dump TVS SOA:

SOA (safe operation area) provides relationship of supply voltage (Vs), source resistance (Ri), and duration of pulse (Td). The Ri limitation in terms of variety of Vs and Td could be referenced for circuit designer consideration. Generally automotive battery has two types of 12V and 24V, 12V car battery chosen 24V TVS and 24V car battery chosen 36V TVS usually. The relative TSC load dump TVS can chosen TLD8S24AH for 12V car battery application, and TLD8S36AH for 24V car battery application. The TLD8S24AH SOA (safe operation area) as Figure 4. and TLD8S36AH (safe operation area) as Figure 5.

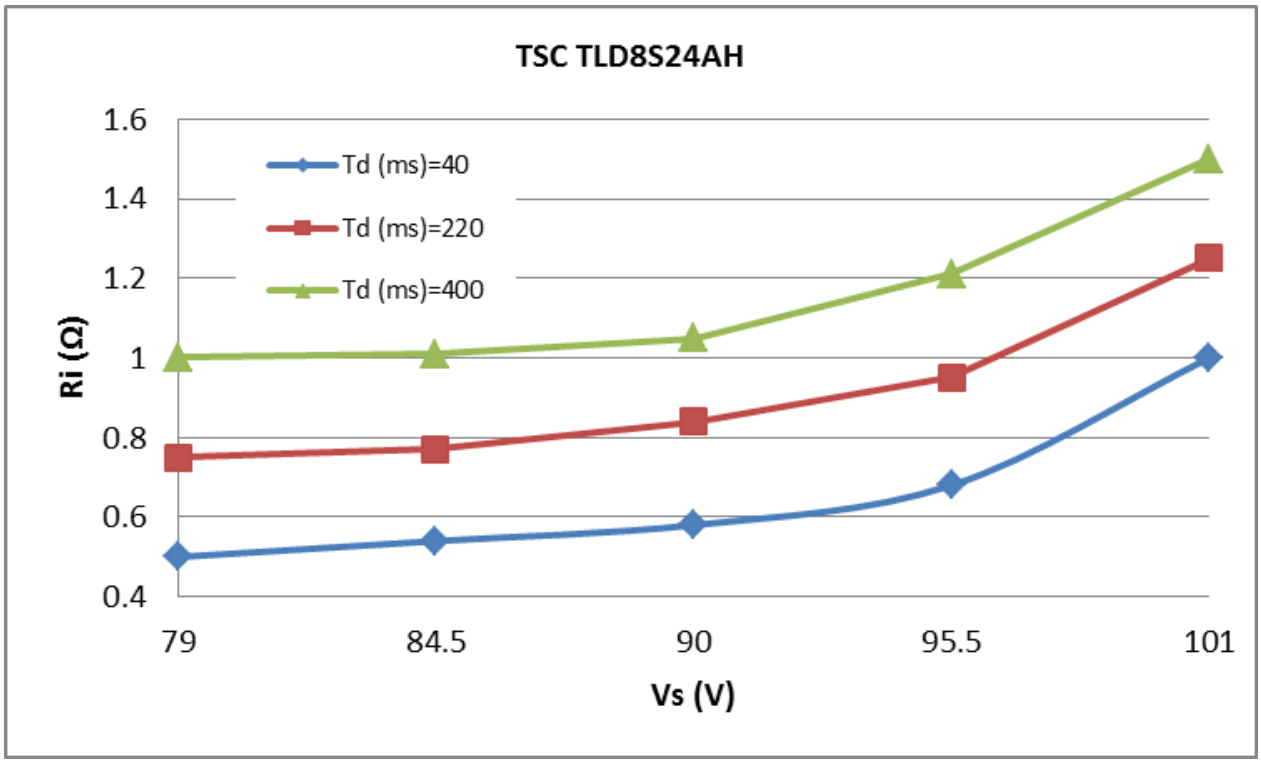


Figure 4. TLD8S24AH SOA (ISO 16750-2 Load dump Test A) Test A

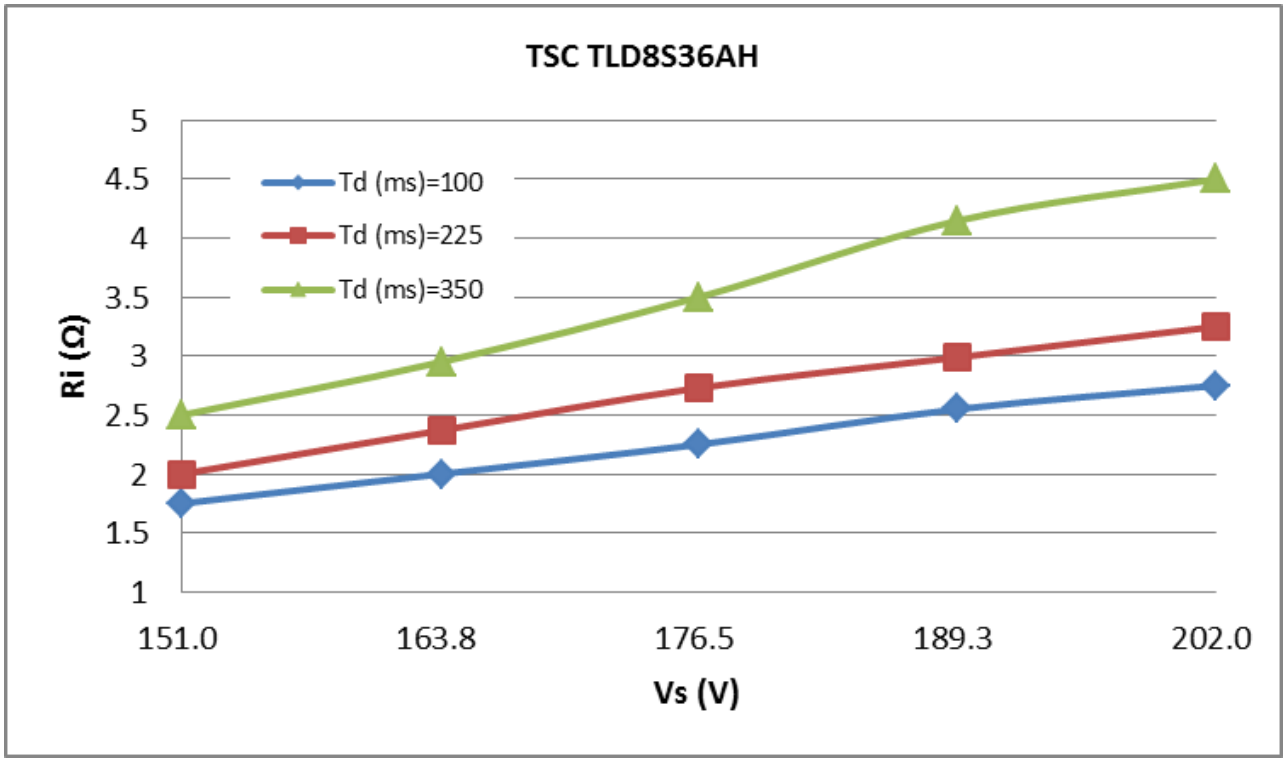
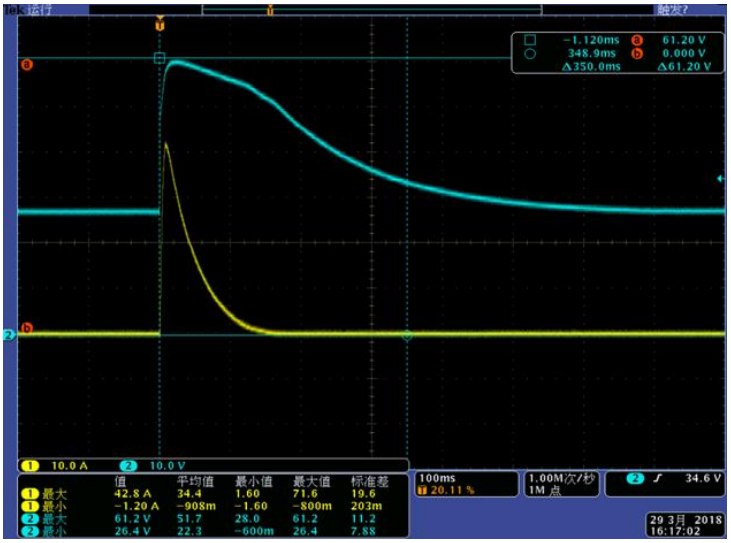


Figure 5. TLD8S36AH SOA (ISO 16750-2 Load dump Test A) Test A

How to choose suitable load dump TVS:
To judge if TLD8S36AH can meet one automotive application. This requirement includes alternator resistance Ri=4.5Ω, the peak voltage output in load dump action is 202V which pulse width is 350ms, we hope the clamping voltage is under 65V. So at first we check TLD8S36AH SOA is within Ri=3.5Ω while Vs=202V, Td=350ms, then we need to know TLD8S36A relative Vc and Ippm tested data as (Table 1). If we use TLD8S36AH parallelly connected with the alternator, the produced load dump current is (202V—61.2V)/3.5Ω=40.2A which is lower than TLD8S36AH tested data 42.8A, and TLD8S36AH VC=61.2V also fit with the hope clamping voltage under 65V. So TLD8S36AH is suitable for this requirement design application. Note: above considered at Ta=25°C



Part No.	TLD8S36AH	condition: ISO16750-2 Test A
Ri (Ω)	3.5	Us=202 Vtd=350ms td=350ms
IPPM (A)	42.8	
VC (V)	61.2	
PPPM (W)	2619.36	

Table 1. TLD8S36AH Vc and Ippm test result @ Ta=25°C (ISO 16750-2 Load dump Test A)

TSC load dump TVS family:
TSC provides variety of load dump TVS which suitable for ISO 16750-2 Load dump Test A and Test B protection application.

Part Number	PD (W)	PPPM @10x1,000μs (W)	TJ	Package
TLD8S10AH - TLD8S43AH	8	6600	55 to +175 °C	DO-218AB
TLD6S10AH - TLD6S43AH	6	4600	55 to +175 °C	DO-218AB
TLD5S10AH - TLD5S43AH	5	3600	55 to +175 °C	DO-218AB

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