Load dump protection: Old vs. new ISO standards

Soo Man (Sweetman) Kim, Vishay -February 07, 2014

For many years, the load dump surge condition test for automobiles was defined in the ISO-7637-2 standard and was used by major automotive component manufacturers worldwide. In 2010, this standard was replaced by a new automotive load dump test: ISO-16750-2. This article describes the changes to the load dump test condition and defines the maximum surge suppressing capability on an example load dump TVS under those conditions.

New vs. old ISO standard

The significant difference between the old and new load dump tests is that the new test requires 10 pulses in 10 minutes with a one minute interval per pulse, as shown in **Table 1**. The old load dump test (ISO-7637-2, 2004) specified only a single pulse.

Table 1 Pulse requirements for ISO-16750-2

Parameter	Type of system		Minimum test requirements
	UA = 12 V	UA = 24 V	
Us (V)	79 to 101	151 to 202	10 pulses at intervals of 1 min.
Ri (Ohm)	0.5 to 4	1 to 8	
td (ms)	40 to 400	100 to 350	
tr (ms)	10 / +0 / -5	10 / +0 / -5	

The test condition of 10 pulses in 10 minutes shows the reliability of the load dump protection device, which assists the circuit designer in choosing the correct device based on surge capability in high-temperature environments.

Load dump protection for 12 V systems using an AEC-Q101-qualified TVS series

Figure 1 shows the load dump protection device clamping in the specified voltage range, which is

different from the standard waveform. The reason for this difference is the active voltage range of the clamping device in the load dump pulse, as shown in **Figure 1**. The device in **Figure 2** is clamping at 101V Us, 1.75Ω Ri, and a 400ms pulse width.

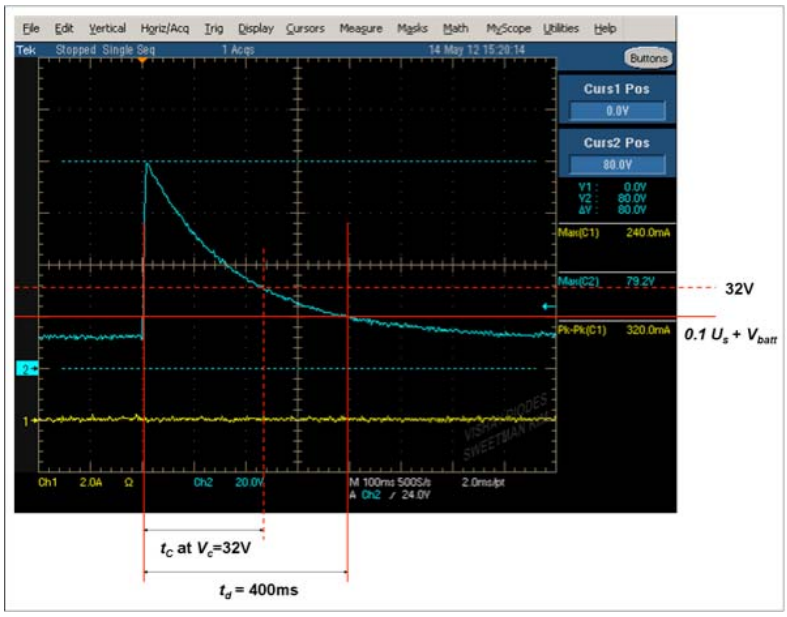


Figure 1 Input waveform of an ISO-16750-2 pulse: 5A, 79V U_s, 400ms pulse width condition

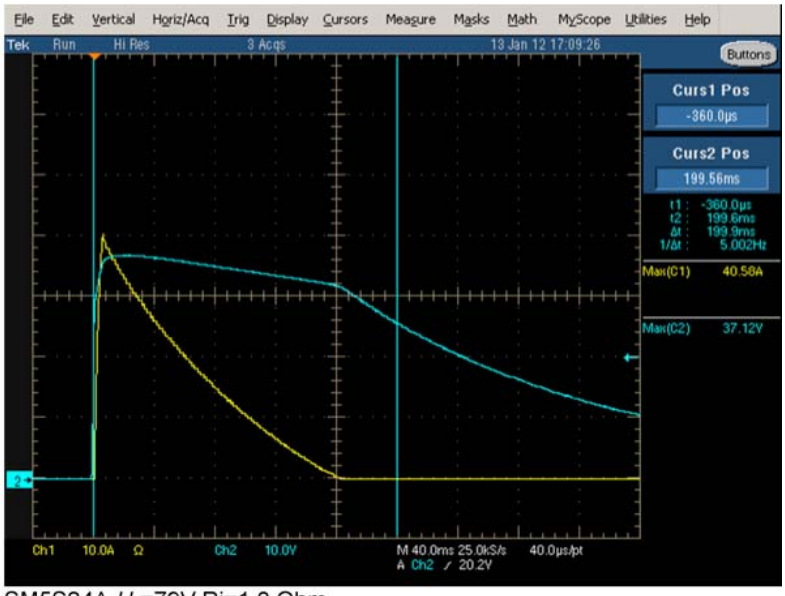
Figure 2 Clamped waveform of the **SM5S24A** at an ISO-16750-2 pulse: 5A, 101V U_s, Ri = 1.75Ω, 400ms pulse input condition

Protecting electronic devices from load dump by using a TVS diode

Now let's examine how to protect devices by clamping the voltage below the maximum input voltage for the voltage regulator or other electronic components in the circuit, without halting or powering down the system. The protection device will not operate until the line voltage reaches 24V for 1 to 10 minutes or longer in withstand test conditions.

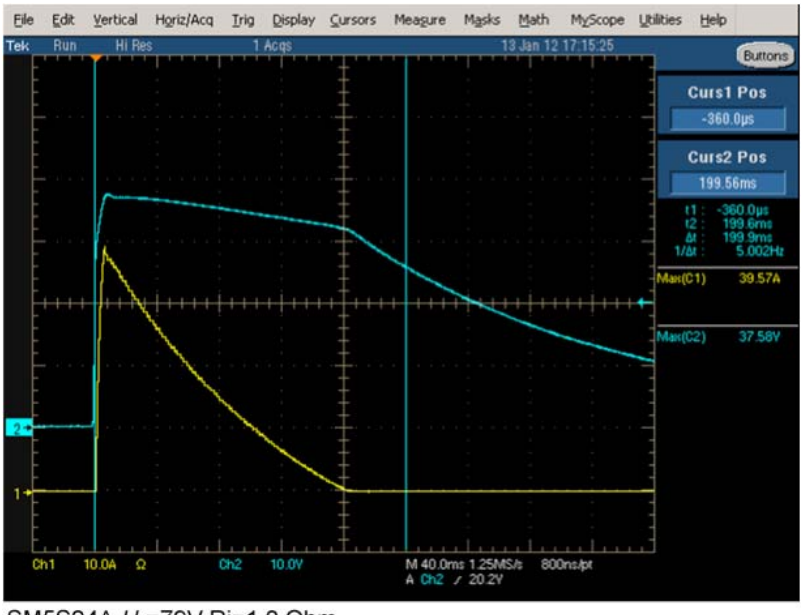
The clamping voltage of the load dump TVS device rises as the junction temperature changes

during continuous clamping operation. **Figures 3** and **4** show the first and last clamping waves for 10 pulses using TVS devices at Us = 79V, Ri = 1.0Ω, and 400ms pulse width at 1 minute intervals between each pulse.



SM5S24A U_s=79V Ri=1.0 Ohm
1st pulse

Figure 3 First clamped waveform for SM5S24A



SM5S24A U_s=79V Ri=1.0 Ohm
10th pulse

Figure 4 Last clamped waveform for SM5S24A

Using the new test condition, 10 continuous pulses affected the surge suppressing capability of the load dump TVS, as shown in the following three graphs:

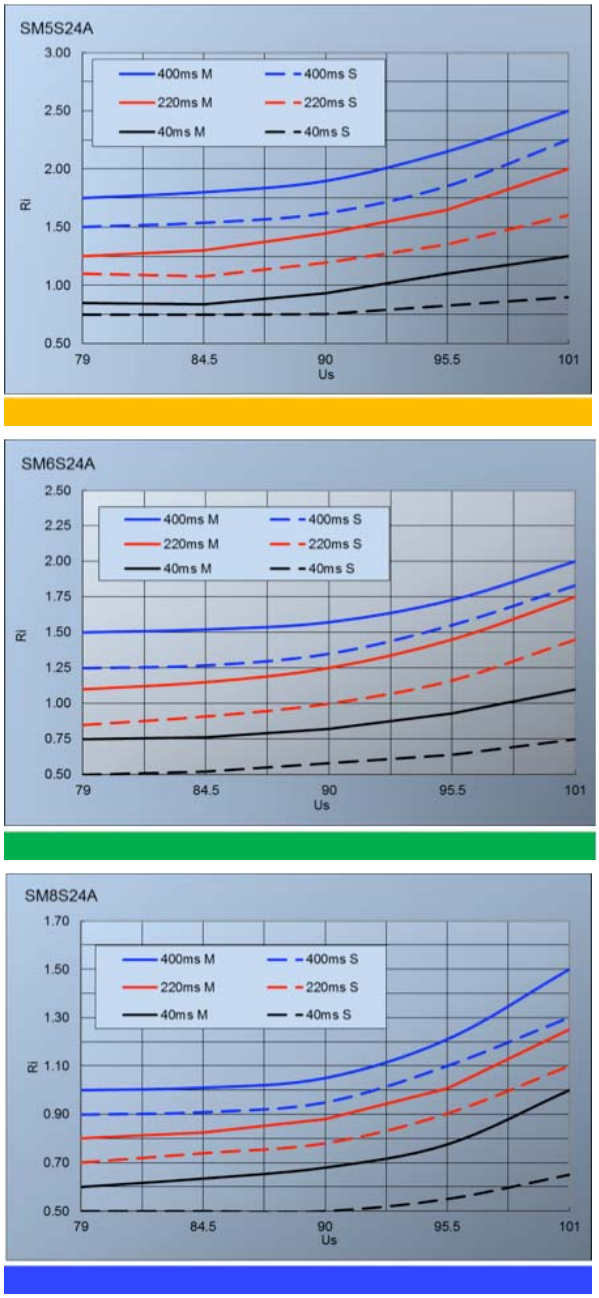


Figure 5 Capabilities of Vishay's SN5S24A under the new load dump test conditions. Suffix "M" lines are multiple pulses using the new test condition standards (ISO-16750-2). Suffix "S" lines are single pulses as defined by the old test condition standards (ISO-7637-2).

These values are based on normal room temperature with the recommended pad size as listed in the datasheet, but the actual capability varies by PCB type, pad size, and temperature conditions.

Appendix

Easy reference for load dump TVS vs. peak current (Amps)

	Single pulse (ms)				10 pulses in 10 minutes (ms)			
	40 ms	100 ms	220 ms	400 ms	40 ms	100 ms	220 ms	400 ms
SM5S24A	73	57	46	34	58	52	38	29
SM6S24A	95	65	52	39	65	60	44	35

SM8S24A	115	80	67	55	78	69	60	50

Another way to select the correct load dump protection device is to refer to the maximum clamping current capability of the TVS and estimate the clamping current of the circuit based on:

- Circuit condition
- Ri = 2Ω
- Peak voltage of alternator output in load dump = 100V
- Target clamping voltage = 35V
- Pulse width = 200ms
- Pulse numbers = 10 pulses in 10 minutes
- SM5S24A has 38A clamping capability in 10 pulses condition and its peak clamping current is 32.5A ((100V - 35V) / 2Ω).

Write a Comment

To comment
please Log In