Ring wave tests with ACS108 driving valves and pumps

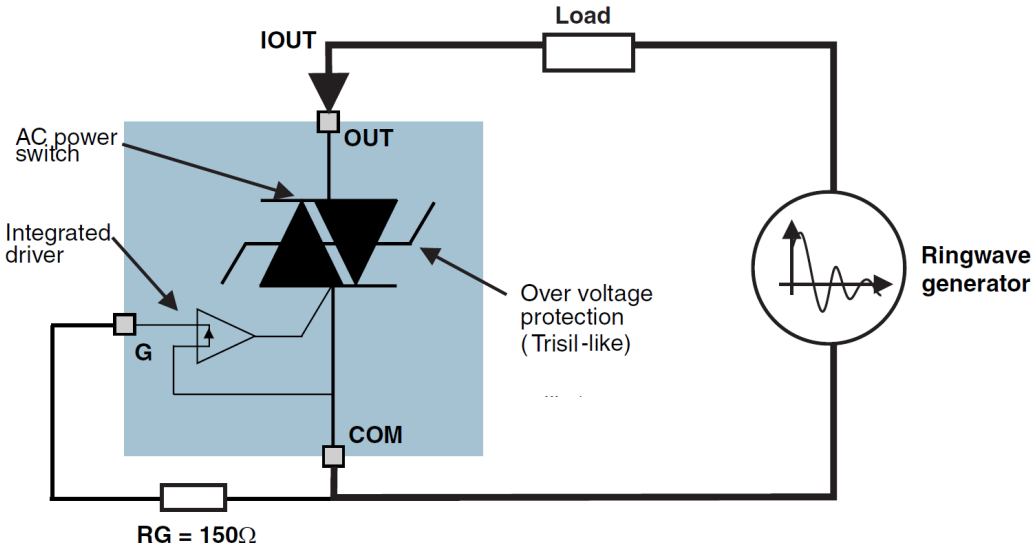
Introduction

This application note presents test results obtained using ACS108 AC switching devices to analyze their behavior when subjected to standard ring wave surges. The datasheets specify the behavior of these devices subjected to a 1.2/50 pulse wave.

The IEC61000-4-12 standard describes the test procedure. The only difference with the tests below is that the normalized waveform is applied directly to the semiconductor and the load (see Figure 1). If the system is connected to the mains terminals, no coupling network is used to apply the surges. The only stress is due to the breakover turn-on current. The current conduction during the half mains cycle is not an issue.

The ACSs are not triggered by their gate. They turn on by over voltage when the generator voltage exceeds their clamping level. The surge is then applied across the load and the load current flows through the on-state ACS.

Figure 1. Test diagram



All the following oscillograms have been produced using the equipment listed below:

- Tektronix TDS754A scope
- Tektronix voltage P6013A probe (1/1000 ratio)
- Eurocraft pulse current transformer (1 V /10 A ratio) Tektronix TCP202 current probe

1 Result

Three kinds of loads have been used during the tests:

- Valve
- Pump
- Resistor rated at 5W, 150 Ω

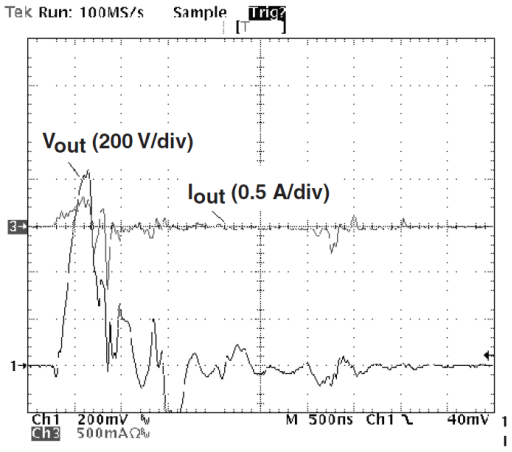
1.1 Valve

The valves used were rated for 120 V, 50 mA, 60 Hz operation. Two different types of behavior can appear during the ring wave test when using such valves.

- The valve insulation is sufficient

When the ACS turns on, the current is limited by the load inductor. Only a capacitive current (approximately 250 mA peak, see Figure 2) can be seen during the rise of voltage across the switch. Such a turn on does not stress the device.

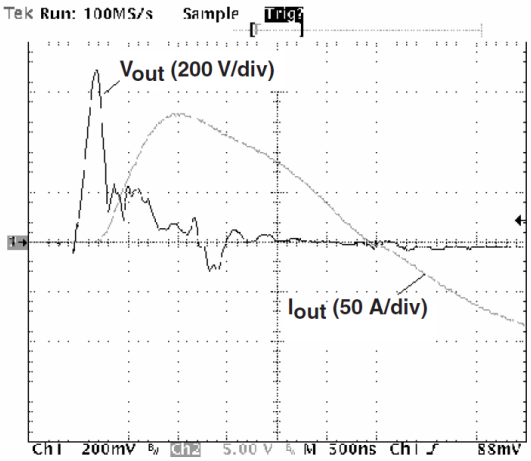
Figure 2. 3 kV surge with a well-insulated valve



- The valve insulation is not sufficient

In this case, the valve oil winding insulation breaks down when the switch turns on, that is, when the whole surge voltage is applied across the valve. The load then behaves like a short-circuit. The ACS current is no longer limited and could reach up to 120 A (refer to Figure 3). The conduction losses could then be so high that the die silicon could melt or its bonding wires could fuse and cause the destruction of the device package. In practice, as the test is done with the complete equipment including clamping devices or filters, this behavior does not occur.

Figure 3. 3 kV surge with an insufficiently insulated valve

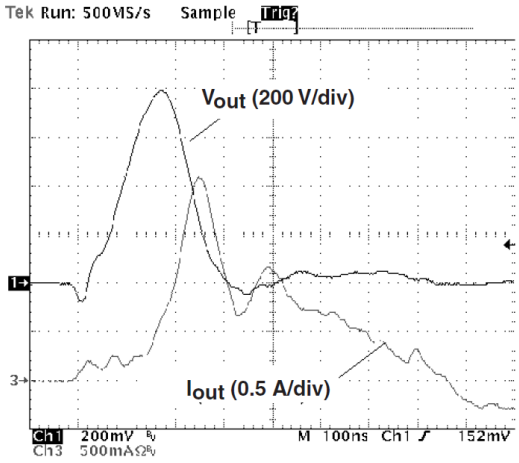


1.2 Pump

The pumps, which have been tested are rated for 120 V, 700 mA, 60 Hz operation. They withstand the high voltage of the generator up to 6 kV, without flashing.

The Figure 4 shows the behavior of an ACS with this load. During the breakover of the devices, due to the high dV/dt rate applied, a capacitive current flows through the parasitic capacitor of the load. This current can reach up to 2 A. As the current pulse lasts around 100 ns, there is no thermal issue. ACSs can withstand such a stress without any damage.

Figure 4. 6kV test with the pump

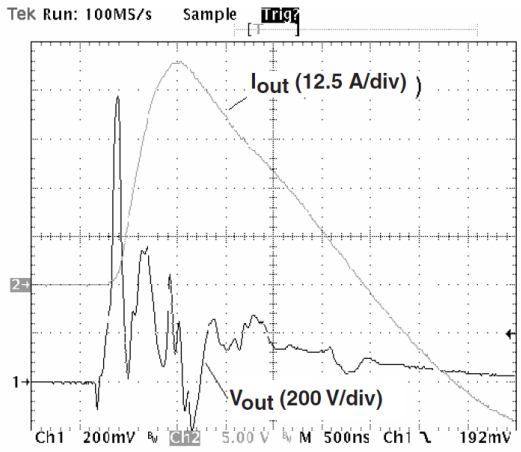


1.3 Resistor rated at 5 W, 150 Ω

To check the good behavior of ACSs during a ring wave test, whatever the load is, we have performed trials with a 150 ohm resistor. This value is equivalent to the resistor of a 120 V-10 W light bulb at cold state. The chosen resistors present a serial inductance lower than 3.5 µH. So, as the device turns on in breakover mode, the current rate of increase is not limited by the load. This case seems to be the worst one that can appear in practice for ACS108 products (no inductive and low-resistive load).

The Figure 5 shows an oscillogram for a 6 kV surge. The current reaches up to 57 A, with a 130 A/µs slope. Sixty positive surges and sixty negative surges have been applied, as required in the IEC61000-4-12 standard. Tested devices did not present variation of any parameters after the trials.

Figure 5. 6 kV ring wave test with a 5 W, 150 Ω resistor



2 Conclusion

Ring wave surges, as defined in the IEC61000-4-12, can be applied on systems including ACSs if the loads used are also compatible with the IEC61000-4-12.

- Valves: 50% of the tested valves sustain the 6 kV surge. In this case, ACSs are compatible with the 100 kHz ring wave defined in the IEC61000-4-12.
- Pumps: driven by an ACS, it is compatible with the IEC61000-4-12. These loads can be up to 700 mA. In these cases, thermal behavior must be mastered to keep the junction below maximum junction temperature.
- For a150 Ω resistor, which seems to be the worst case for the power range of the targeted loads, ACSs also are in line with the IEC61000-4-12 standard without any risk of damage.

ACSs comply with the IEC61000-4-12 when the loads can withstand the required level of voltage (6 kV). If not, aspark gap can be implemented by bringing closer the two non-insulated copper tracks where the mains plug is connected. A 3 mm distance will reduce the input over voltages to approximately 3 kV.

Revision history

Table 1. **Document revision history**

Date	Revision	Changes
Aug-2001	1	Initial release.
23-Apr-2009	2	Reformatted to current standards. Updated for current products.
22-June-2010	3	Updated trademark statements.
02-May-2022	4	Minors text changes.

Contents

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