High-Voltage Pulse Transient Safety Design for bq243xx

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ABSTRACT

The maximum input voltage rating of the bq243xx family of ICs is 30 V. However, some customers like to do high-voltage pulse transient test to prove its high-voltage capability and reliability from a system level. This pulse transient voltage could be as high as 45 V with 1-A output current limit and 200-µs pulse width. It is important for system designers to properly design the charging system with correct system-level protections. Usually, a varistor or Zener diode is used for clamping such high-pulse transient voltage so that the maximum input voltage from the bq243xx is less than the absolute maximum voltage of 30 V for safe operation.

1 Test Setup

Figure 1 shows the high-voltage transient test schematic. A 1-µF input capacitor and a1-µF output capacitor are used for charging front-end bq243xx devices. A 1-kΩ resistor, R4, is used to discharge high voltage after 200 µs so that subsequent testing can be performed; otherwise, a high voltage remains at the input, delaying further testing. This resistor is not required in real applications. A function generator is used to generate a 5-V, 200-µs control signal to trigger the high-voltage amplifier.

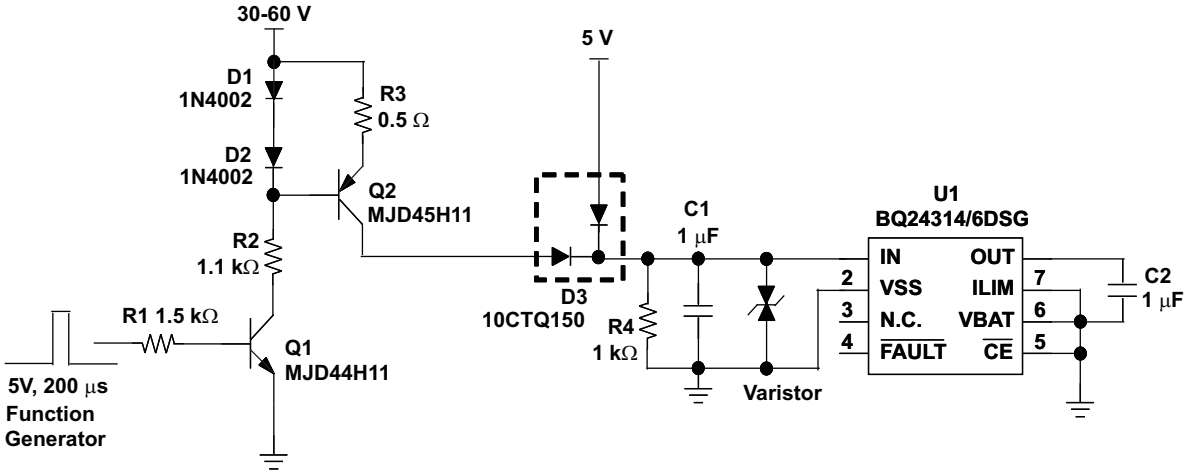

Figure 1. High-Voltage Pulse Transient Test Schematic

In the following test waveforms, CH1, CH2, CH3, and CH4 are represented as follows:

CH1: control signal, 5 V/div
CH2: IN pin, 10 V/div
CH3: OUT pin, 5 V/div
CH4: input current, measured before input capacitor, 1 A/div.

1.1 Test One: Varistor Type One

In test 1, a 2012002931W_MLVS-0402-M07 20A 9V 0402_Inpaq varistor is used. The test results are shown in the following illustrations. The high voltage is set from 30 V to 60 V with a 5-V step.

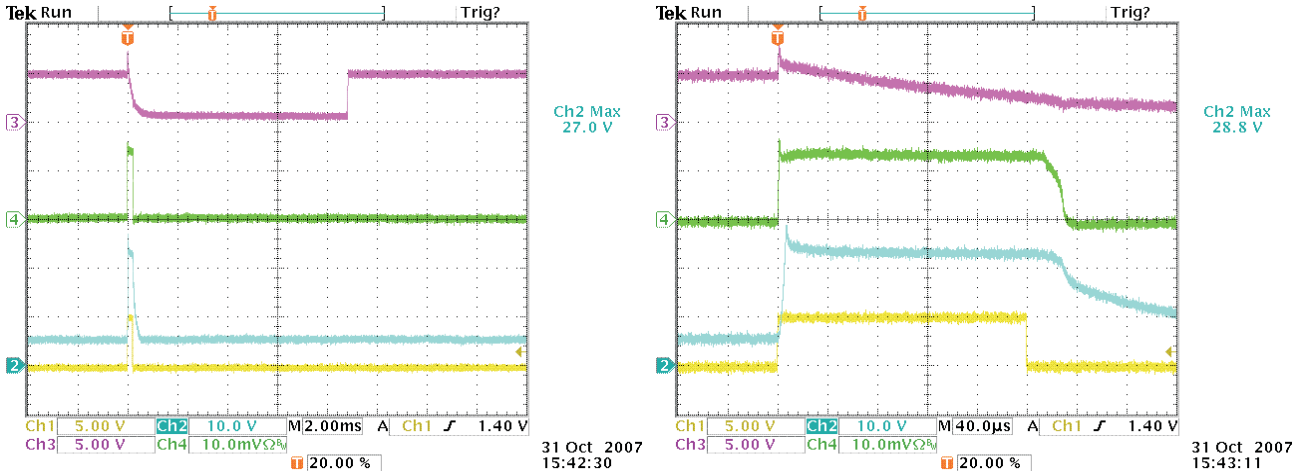

Figure 2. Vin From 5 V to 30 V

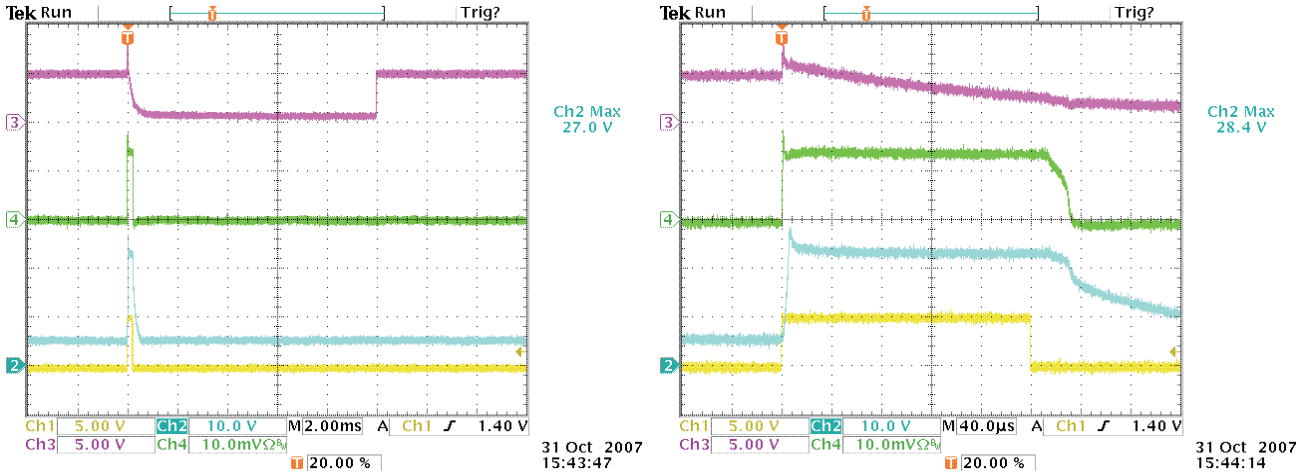

Figure 3. Vin From 5 V to 35 V

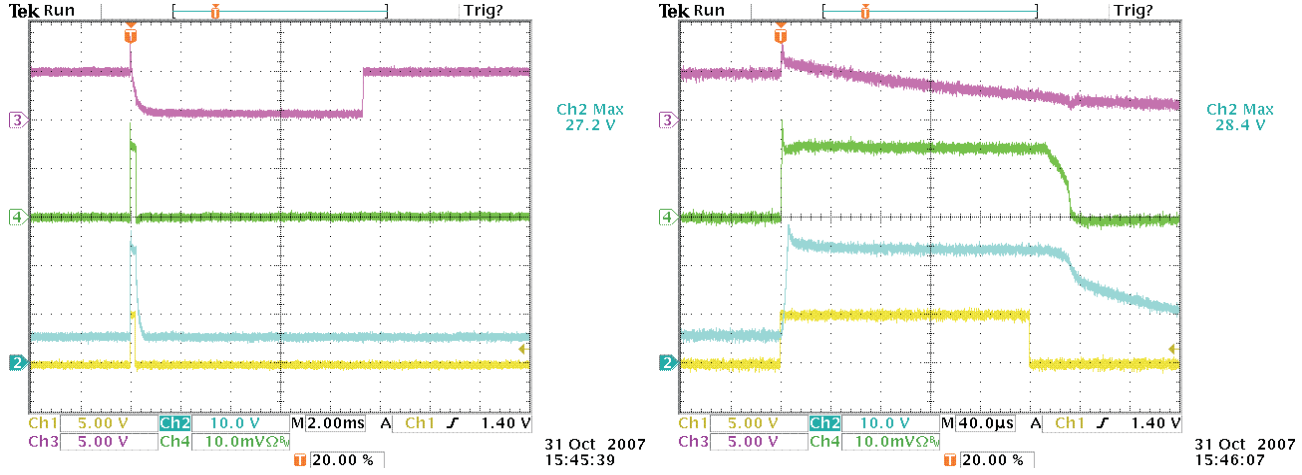

Figure 4. Vin From 5 V to 40 V

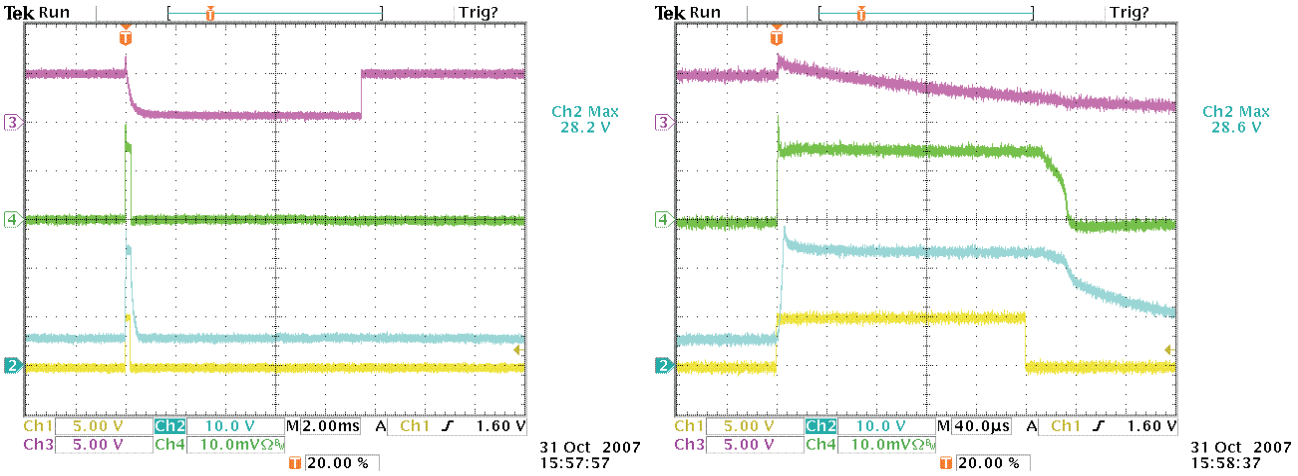

Figure 5. Vin From 5 V to 45 V

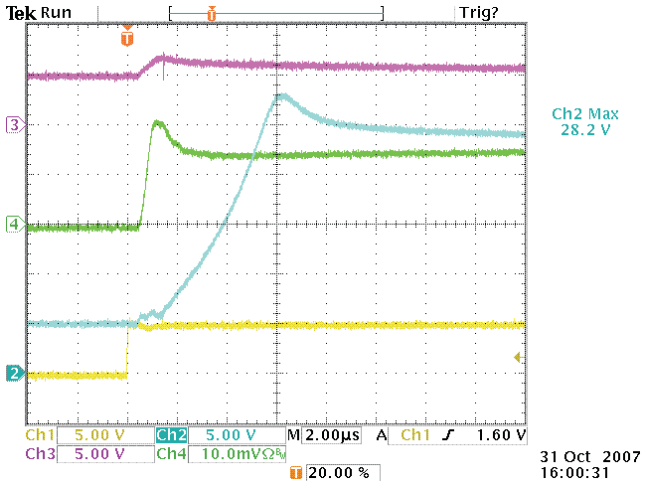

Figure 6. Vin From 5 V to 45 V, 2-µs Time Scale Zoom in Detail, CH2 5 V/div

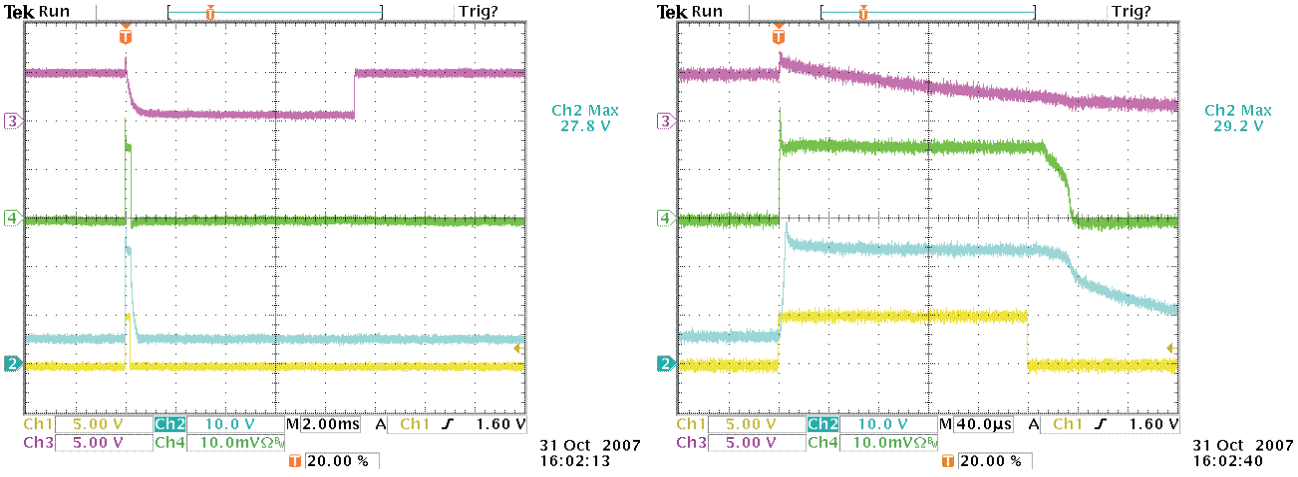

Figure 7. Vin From 5 V to 50 V

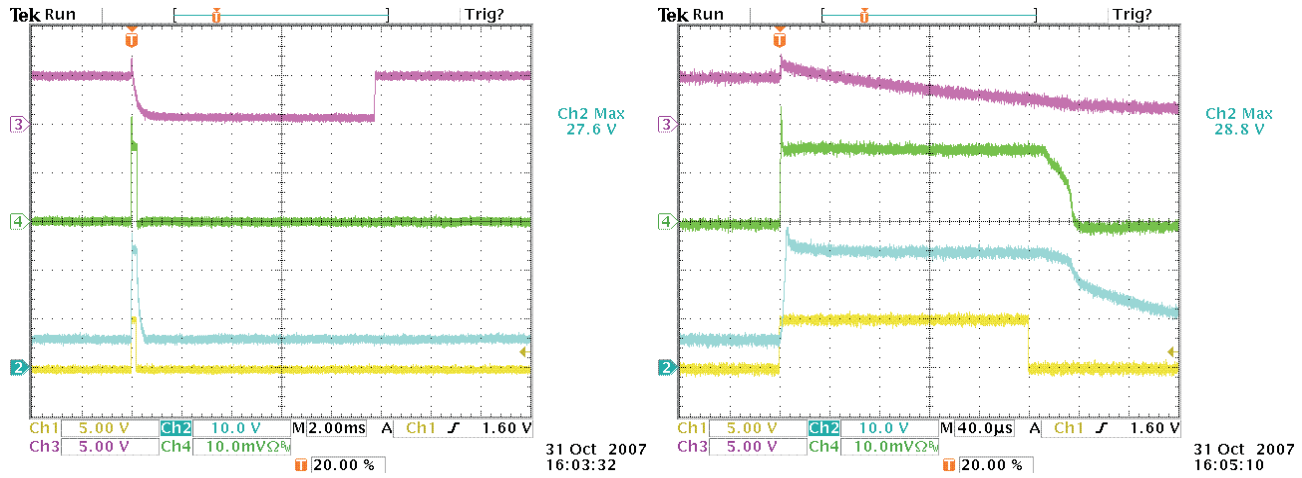

Figure 8. Vin From 5 V to 55 V

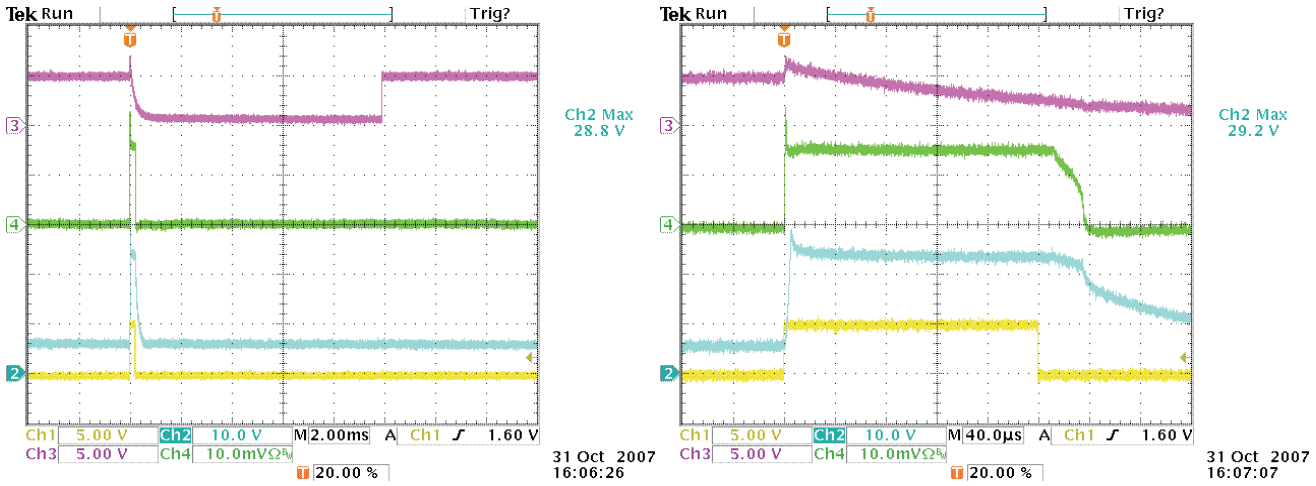

Figure 9. Vin From 5 V to 60 V

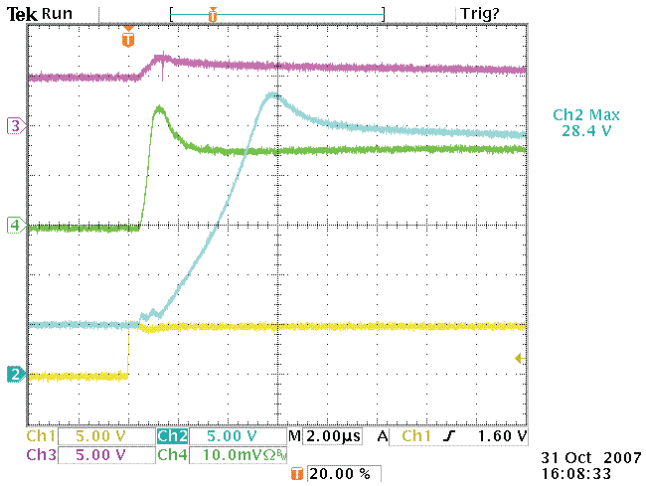

Figure 10. Vin From 5 V to 60 V, 2-µs Time Scale Zoom in Detail, CH2 5 V/div

1.2 Test Case 2: Varistor Type 2

In test 2, 2010000931W_TVM0G090M201R_Thinking is used. The test results are shown in the following illustrations. The high voltage is set from 30 V to 60 V.

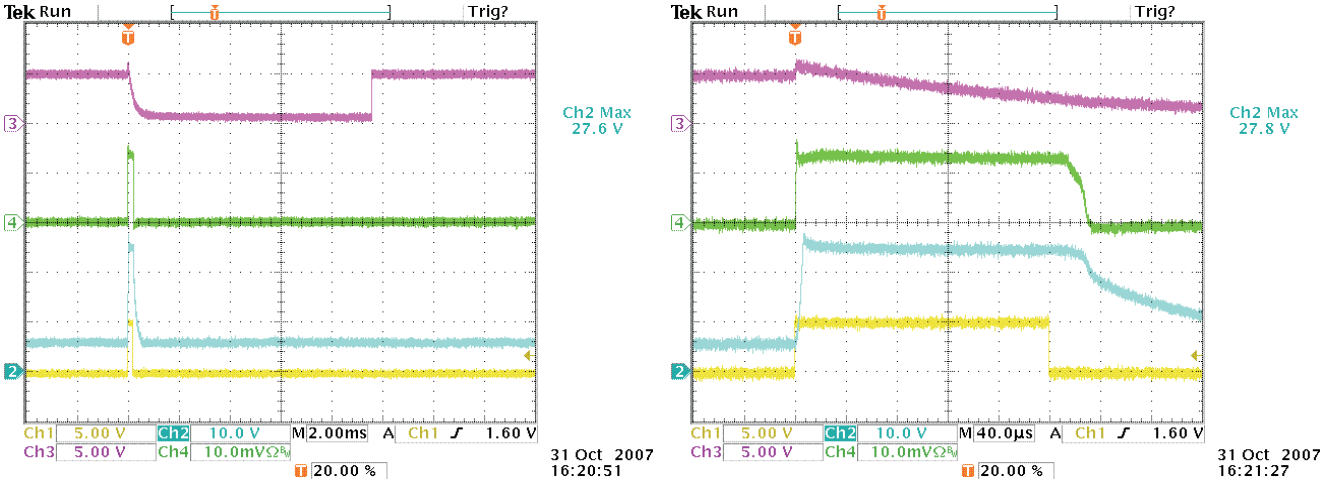

Figure 11. Vin From 5 V to 30 V

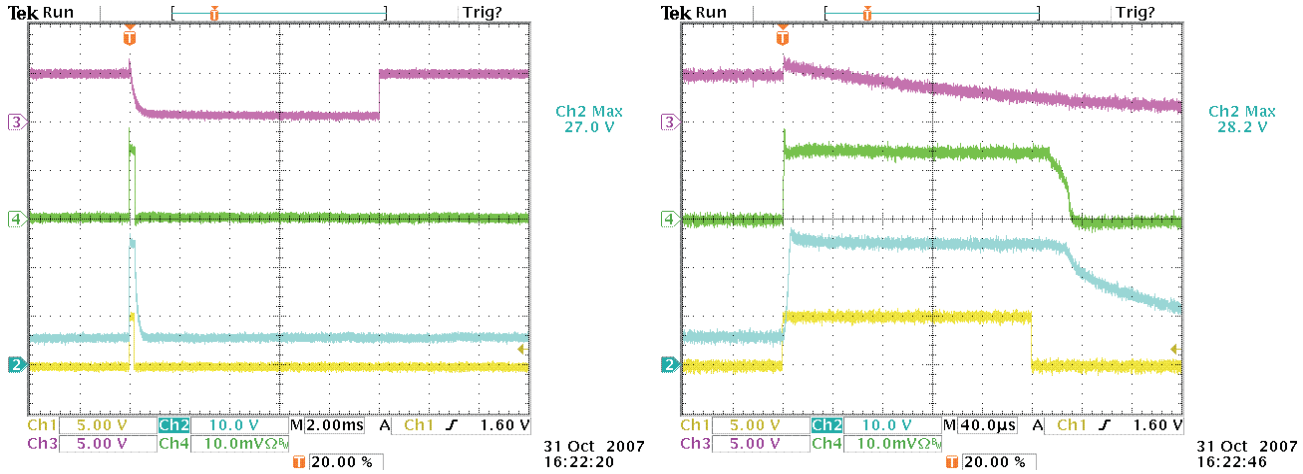

Figure 12. Vin From 5 V to 35 V

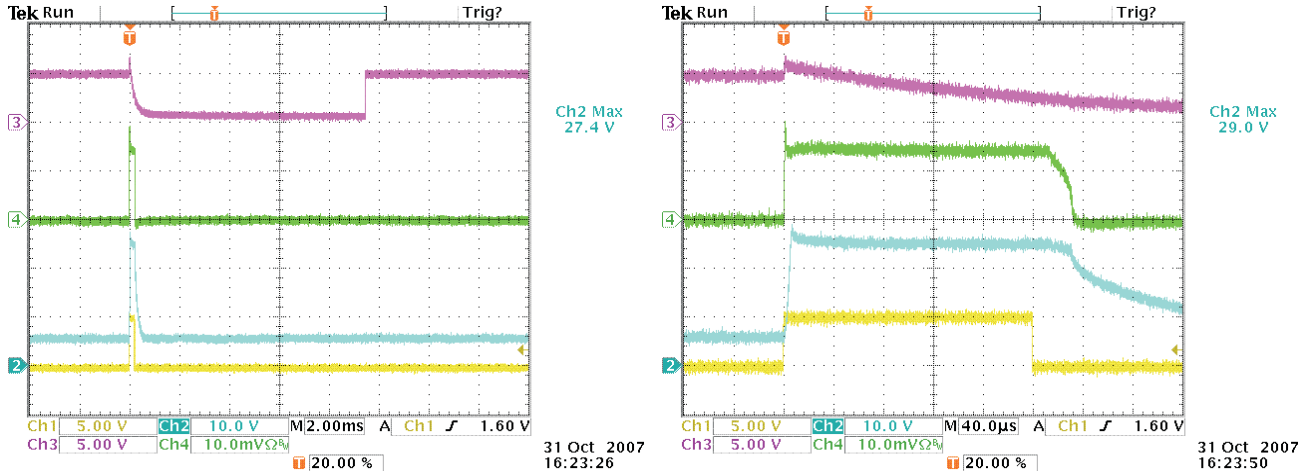

Figure 13. Vin From 5 V to 40 V

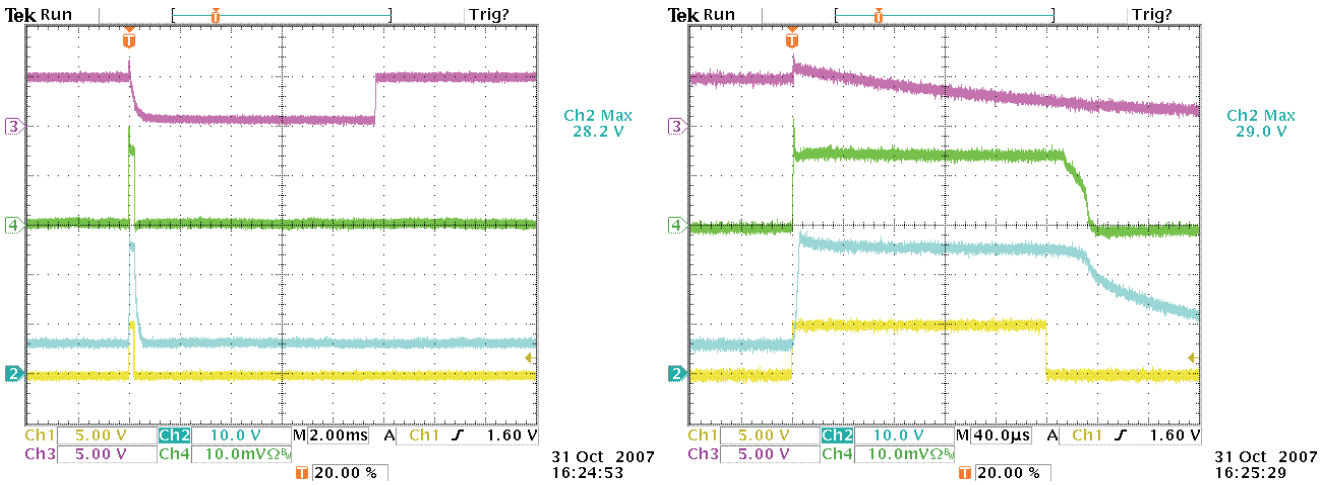

Figure 14. Vin From 5 V to 45 V

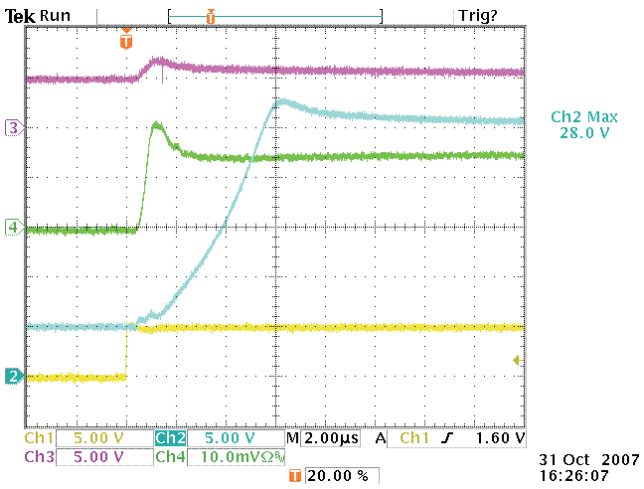

Figure 15. Vin From 5 V to 45 V, 2-µs Time Scale Zoom in Detail, CH2 5 V/div

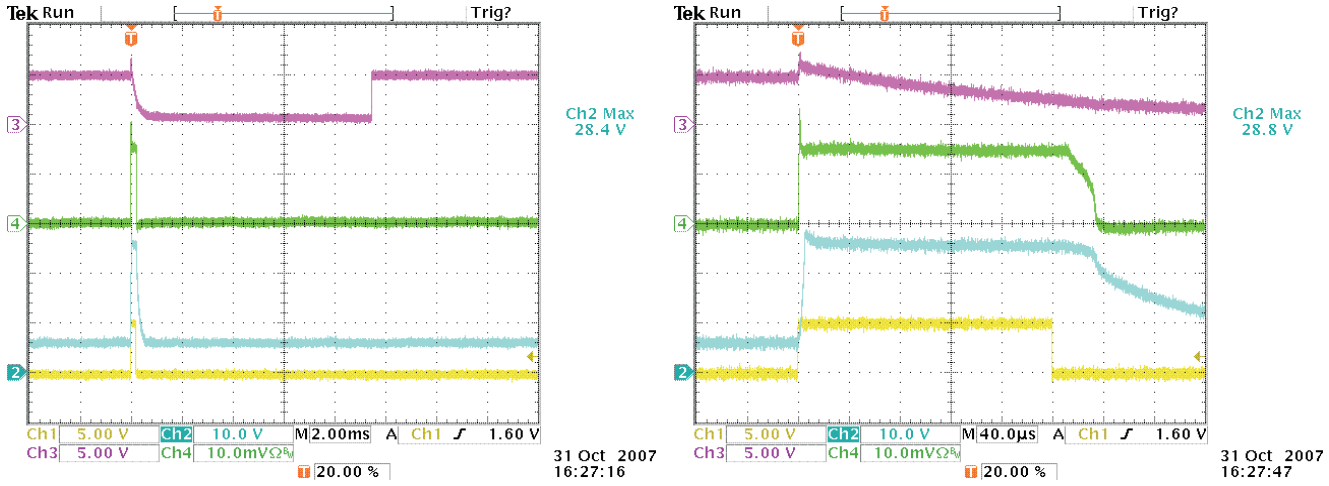

Figure 16. Vin From 5 V to 5 0V

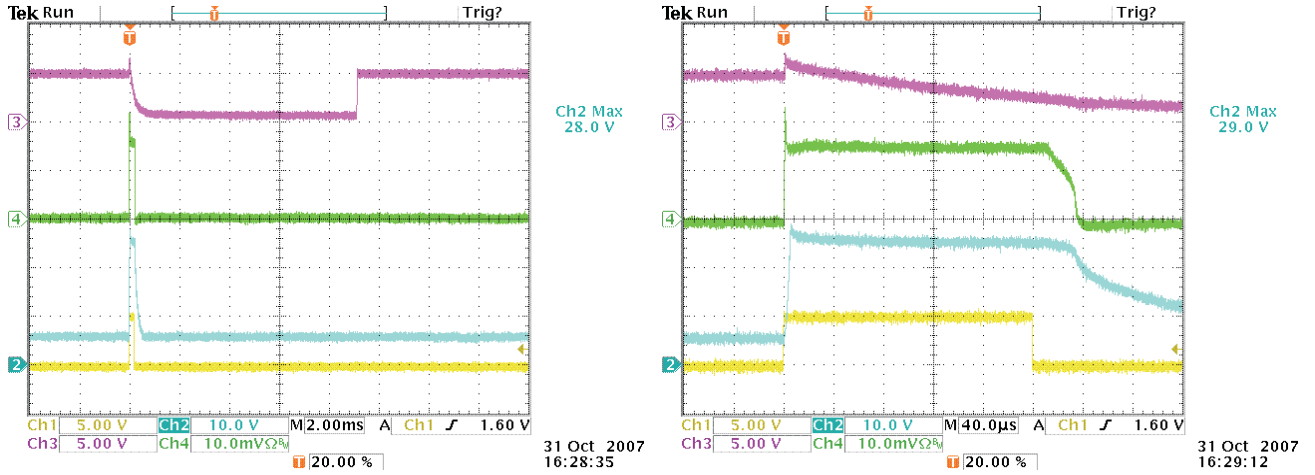

Figure 17. Vin From 5 V to 55 V

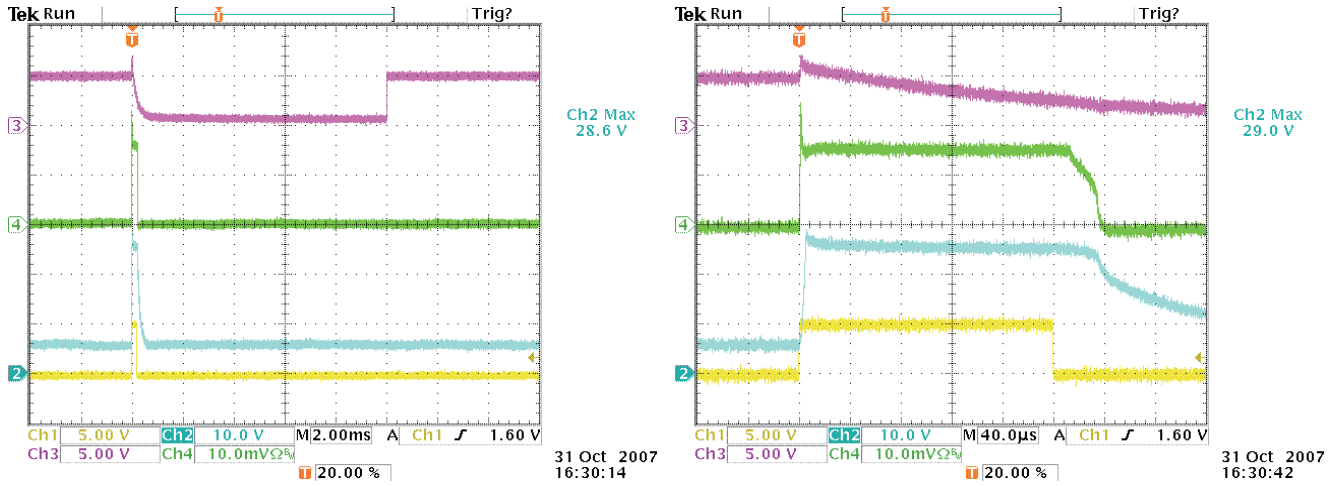

Figure 18. Vin From 5 V to 60 V

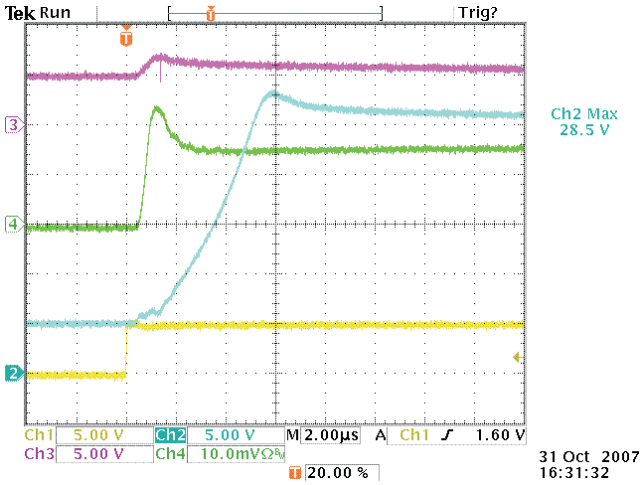

Figure 19. Vin From 5 V to 60 V, 2-µs Time Scale Zoom in Detail, CH2 5 V/div

The clamping voltage across the varistor or Zener diode is determined by the current flowing into the varistor or Zener diode. The higher the current flowing into the varistor or Zener diode, the higher the clamping voltage. Properly selecting the varistor and Zener diode is critical. The maximum voltage across the bq243xx under these high-voltage transients is determined by the clamping voltage of the varistor or Zener diode.

2 Conclusion

Both varistors can clamp voltage to below 30 V. The clamping voltage is 28.2 V and 28 V for type-one and type-two varistors with 45-V input transient. Even with 60-V input transient, the maximum clamping voltage is 28.4 V and 28.5 V, respectively. The 30-V bq243xx is safe under this kind of voltage level.

In summary, bq243xx passes the 45-V/1- A/200-µs pulse transient test with the setup shown in Figure 1 using the recommended varistor.

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