Circuit Protection for CANbus

APPLICATION NOTE

CDSOT23-T24CAN

INTRODUCTION

The Controller Area Network (CAN) is a communication protocol designed for transmitting data in harsh environments. This application note demonstrates a basic protection circuit that uses a dual TVS diode array, Bourns® Model CDSOT23-T24CAN*, to provide surge protection per IEC 61000-4-5 and ESD protection per IEC 61000-4-2.

Figure 1 below shows a typical CANbus differential communication scheme with n transceivers communicating on the serial bus. A twisted pair cable with a nominal characteristic impedance of 120 ohms is used to transmit the signal between nodes on the bus. The cable is terminated on both ends. The example in figure 1 shows a split termination that is often used to improve Electromagnetic Compatibility (EMC).

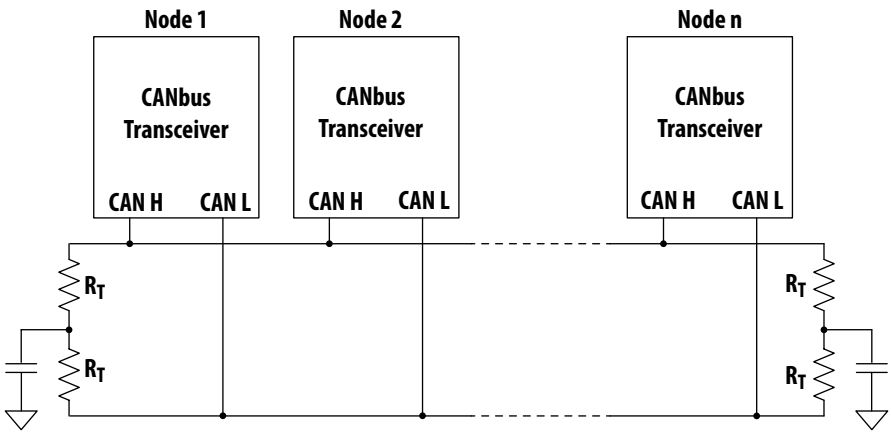

Figure 1. | *CANbus Serial Communication*

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** "Q" suffix for automotive and other applications requiring AEC-Q101 compliance.*

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THE CIRCUIT PROTECTION

Figure 2 shows one of the endpoint nodes (with termination) being protected by the Bourns® Model CDSOT23-T24CAN device. This dual, bidirectional device provides ESD and surge protection for the transceiver. Nodes in between the endpoints would not have the termination impedance.

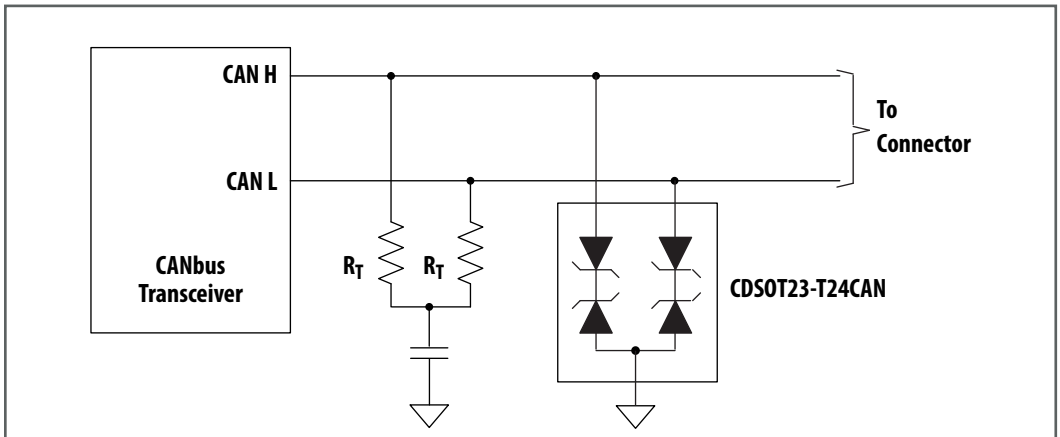

Figure 2. | *The CDSOT23-T24CAN Protecting the CANbus Communication Lines*

The Bourns® Model CDSOT23-T24CAN is designed to be compatible with transceivers that have internal protection against 24 V_{DC} being connected to either CAN input/output (I/O) due to a wiring error. It is designed with a minimum breakdown voltage of 26.2 V so that it will not conduct during a 24 V_{DC} power-cross event. In the event that 24 V_{DC} is connected to one I/O and ground is connected to the second I/O, the termination resistors would not be protected, as the supply voltage would be directly across the two resistors shown in figure 2. If required for the design to survive this type of miswiring, the termination resistor's power capability would have to be sufficiently rated. All of the testing done for this application note was performed with a transceiver that is rated to withstand up to 40 V on its CAN H and CAN L I/O pins.

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THE CIRCUIT PROTECTION *(Continued)*

Initial Conditions

Prior to any testing, the test board was powered up and the performance was checked with a 1 MHz signal. The scope waveforms on the CAN H and CAN L signal lines as well as the power supply voltage and current are shown in figure 3 below. The performance of the transceiver was checked and the supply current was measured after each test was performed.

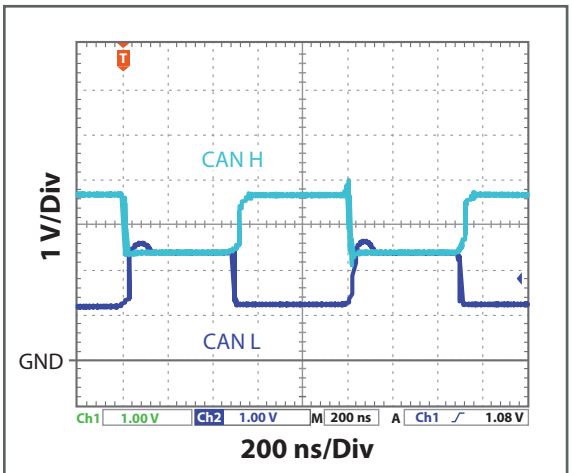

Figure 3. | Initial CAN H and CAN L Output Waveforms

Power Supply Voltage (V)
5.09

Power Supply Current (mA)
41

ESD Test Results

The design was tested at levels 1 through 4 per the IEC 61000-4-2 standard using an ESD simulator gun. The design was subjected to 10 discharges in each polarity at each test level. The results are shown in the table below. The performance was checked and the supply current was measured after the test was completed at each level. The design passed the test at all four levels with no change in performance or supply current.

Test Level per IEC 61000-4-2	Test Voltage (V)	Test Result	Supply Current After Test (mA)	Performance
1	2	Pass	41	No Change
2	4	Pass	41	No Change
3	6	Pass	41	No Change
4	8	Pass	41	No Change

Table 1. | ESD Test Results - Contact Discharge

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THE CIRCUIT PROTECTION *(Continued)*

Surge Test Results

The Bourns® Model CDSOT23-T24CAN dual TVS diode array is designed to protect a CANbus transceiver against surge events per IEC 61000-4-5 (Level 1). The surge test setup below shows an ECAT surge generator connected to the test circuit through two 80 ohm resistors and two coupling devices. The surge generator's E501B output module, which generates a 1.2/50 µs voltage, 8/20 µs current combination wave, was used for the test. The test circuit was subjected to five 500 V longitudinal (common mode) surges in both the positive and negative polarities. The oscilloscope traces below show the clamp voltage with respect to ground for the CAN H and CAN L signal lines, as well as the total generator surge current, for each of these surges. The peak current on each line is ~ 5.5 A (11 A total for two lines) when subjected to the 500 V surge. The TVS diode clamped the voltage at the I/O of the transceiver to within 37 V during the surge. No change in performance or in supply current was measured after the surge test was completed.

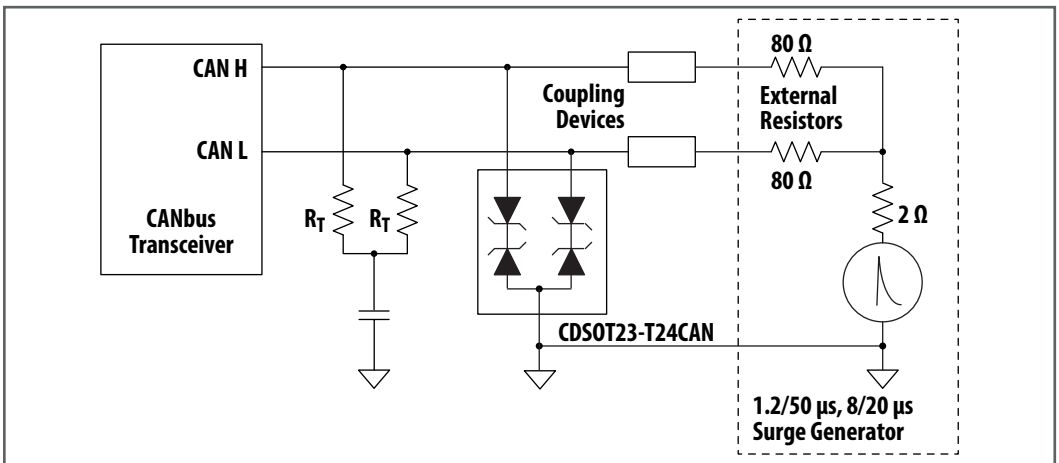

Figure 4. | *Surge Test Setup*

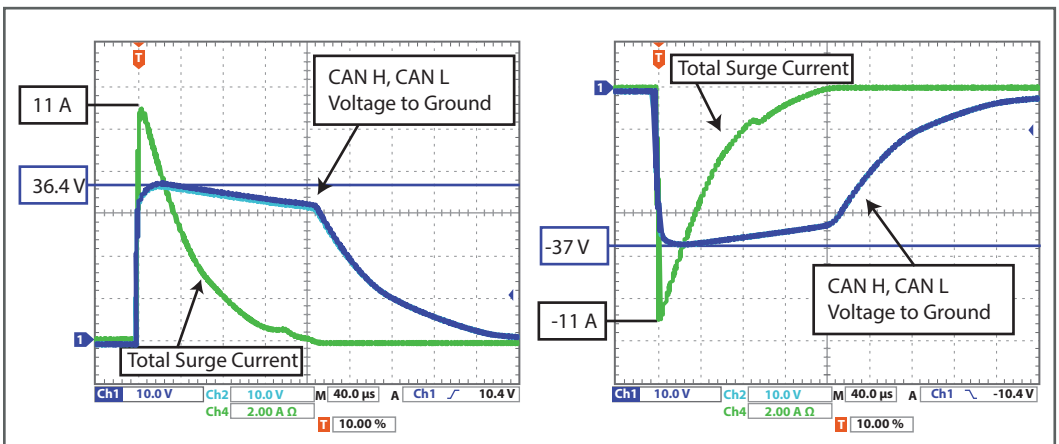

Figure 5. | *Surge Test Waveforms*

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LAYOUT CONSIDERATIONS

The figure below shows an example of how the Bourns® Model CDSOT23-T24CAN can be connected on a double-sided Printed Circuit Board (PCB) design. The device should be placed as close to the bus connector as possible with short traces to the signal lines. Since the connector pin spacing is generally much larger than the pin spacing of the transceiver, it is relatively easy to do this. A standard 10 mil, 1 ounce copper trace is more than adequate to handle the peak current level from the 500 V surge discussed in the previous section. The ground pin of the device should be connected to the circuit board ground plane using a short trace and a via. If there is a ground area on the signal side of the circuit board near where the diode array is placed, it should be connected directly to it.

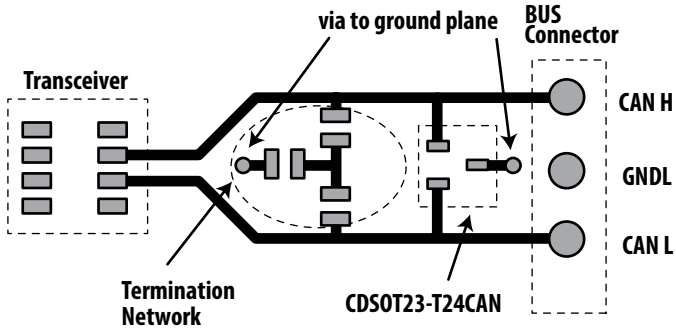

Figure 6. | *Circuit Layout Consideration*

SUMMARY

The Bourns® Model CDSOT23-T24CAN dual, bidirectional TVS diode successfully protected a CANbus transceiver against damage from ESD (per IEC 61000-4-2 Level 4) and lightning surge (per IEC 61000-4-5 Level 1). Its minimum breakdown voltage of 26.2 V is designed to work in conjunction with a transceiver capable of withstanding a 24 V power cross event caused by miswiring.

ADDITIONAL RESOURCES

For additional information on the Bourns® Model CDSOT23-T24CAN please contact your local Bourns sales office or visit Bourns online at:

www.bourns.com

Americas: *Tel* +1-951 781-5500
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