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BRIEF

Detection of RS-485 signal loss

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Introduction

Fault isolation and safety shutdown protocols are critical in many industrial, telecommunication, automotive, and data processing systems. While built-in test routines can provide fault isolation when the system is offline, real-time fault detection requires continuous monitoring of signals. These systems often use RS-485 to share data between sensors, actuators, single-board computers, and communication processors.

RS-485 signals are differential, using two signal wires to transmit data, and detection of valid signal levels requires a differential window comparator. Designing this circuit function is complicated by the wide common-mode range of RS-485 signals and, in many cases, the availability of only positive supply rails.

This article shows how a differential window comparator can be constructed with the passive-failsafe feature* of two SN65HVD3088E RS-485 transceivers and an AND gate. It also provides theory of operation, the basic circuit schematic, test results, and other design considerations.

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Theory of operation

The differential input threshold is the voltage between the non-inverting and inverting RS-485 signals above which the bus state is high and below which the bus state is low. The differential input voltage threshold of standard receivers is between -200 mV and 200 mV. The differential input voltage

*See Reference 1 for more on this feature.

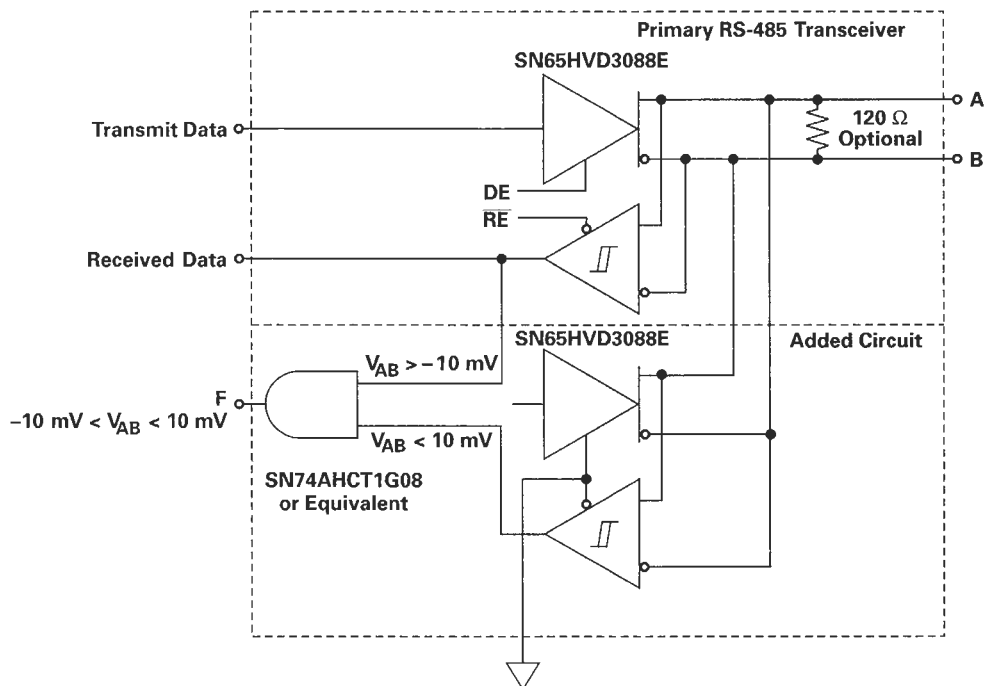


Figure 1. RS-485 transceiver with loss-of-signal indicator

threshold of the SN65HVD3088E is between -200 mV and -10 mV. This gives a known (high-level) receiver output state with zero volts (no input signal) and is called passive failsafe. It does not distinguish between a valid high input and no signal.

A single SN65HVD3088E can determine if the differential input voltage is less than -200 mV or above -10 mV. Reversing the input polarity of a second SN65HVD3088E can determine if the differential input voltage is below 10 mV or above 200 mV and is the basis for constructing the differential window comparator shown in Figure 1.

The upper-receiver output in Figure 1 is true (high) if the differential input voltage, V_{AB} , is greater than -10 mV. Since the inputs of the lower receiver are reversed, the output is true (high) if $-V_{AB} > -10$ mV or, dividing both sides of the inequality by negative one, $V_{AB} < 10$ mV. If both receiver outputs are true, then the differential bus voltage is between -10 mV and 10 mV and is not a valid input. This fault is indicated by the AND gate F output using inputs of the two receiver outputs.

Test results

Figures 2 and 3 show the F and V_{AB} low-to-no and high-to-no signal transitions and the desired fault indication.

Other design considerations

While this example circuit uses the SN65HVD3088E, any RS-485 receiver with the passive failsafe feature can be used (Texas Instruments offers over 30 such products). A similar approach can be applied to unidirectional (simplex) connections. The parallel connection of the two transceivers will halve the unit loading and double the stray capacitance presented to the bus. This may limit the number and spacing of devices on a bus segment (see References 2 and 3).

If the system timing budget allows, filtering of F may prevent false fault indications from differential noise or from very slowly changing input signals. Filtering can be done by adding gating or by choosing a very slow AND gate.

Conclusion

A differential window comparator can be constructed by adding a passive-failsafe RS-485 receiver and one AND gate to another passive-failsafe receiver. The circuit then provides a loss-of-signal indication from an RS-485 data bus. This fault flag can then be used for system fault isolation or safety shutdown protocols.

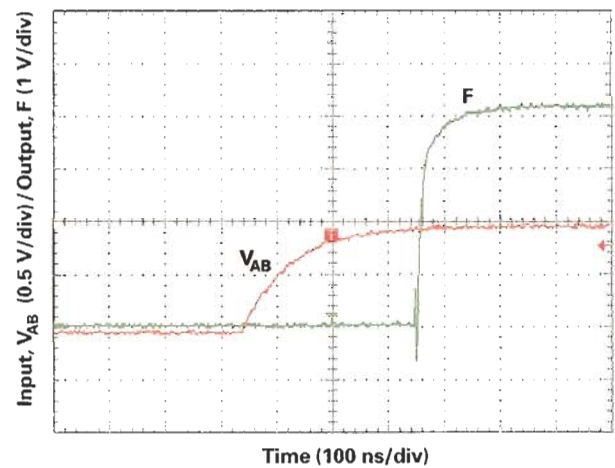


Figure 2. Loss of valid low-level signal

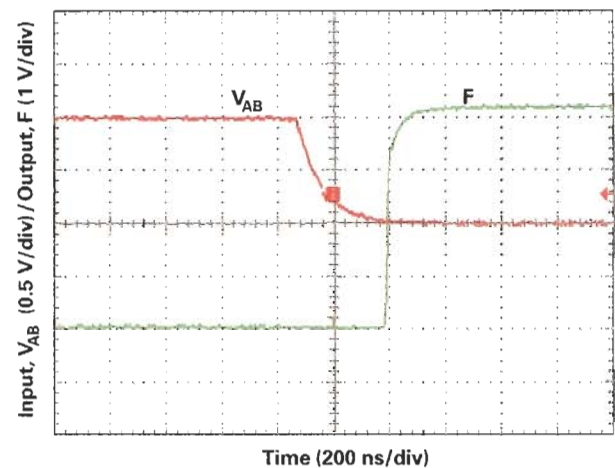


Figure 3. Loss of valid high-level signal

References:

1. Failsafe in RS-485 data buses (slyt080)
2. The RS-485 unit load and maximum number of bus connections (slyt086)
3. Device spacing on RS-485 buses (slyt241)