

# ***AN-759 Comparing EIA-485 and EIA-422-A Line Drivers and Receivers in Multipoint Applications***

---

## **ABSTRACT**

EIA-485 is a unique interface standard because, of all the EIA Standards, only EIA-485 allows for multiple driver operation. At first glance EIA-485 and EIA-422-A appear to be very similar. Thus, EIA-485 is commonly confused with EIA-422-A. EIA-485 components (drivers and receivers) are backward compatible with EIA-422-A devices and may be interchanged. However, EIA-422-A drivers should not be used in EIA-485 applications. This application note describes the differences between EIA-422-A and EIA-485 devices.

---

## **Contents**

1	Introduction .....	2
2	Problem #1—Common Mode Range .....	2
3	Problem #2—Contention Between Drivers .....	2
4	Problem #3—Drive Current .....	4
5	Conclusions .....	4
6	References .....	4

## **List of Figures**

1	Typical Multiple Driver Application .....	3
2	EIA-422-A Driver Output Structures Have A Limited Common Mode Range .....	3
3	EIA-485 Driver Output Supports -7V to +12V Common Mode Range .....	3
4	Typical EIA-485 Multipoint Application .....	4

## 1 Introduction

EIA-485 is a unique interface standard because, of all the EIA Standards, only EIA-485 allows for multiple driver operation. At first glance EIA-485 and EIA-422-A appear to be very similar. Thus, EIA-485 is commonly confused with EIA-422-A. EIA-485 components (drivers and receivers) are backward compatible with EIA-422-A devices and may be interchanged. However, EIA-422-A drivers should not be used in EIA-485 applications. This application note describes the differences between EIA-422-A and EIA-485 devices.

EIA-422-A drivers face three major problems if they are used in multipoint (multiple driver) applications. The first deals with the common mode range of the drivers. The TRI-STATE common mode range for a EIA-422-A driver is  $-250\text{ mV}$  to  $+6\text{V}$ . If a ground potential difference exists between drivers as shown in [Figure 1](#), the disabled driver can come out of its high impedance state and clamp the line to one diode drop below ground. The second problem deals with contention between active drivers. Faults may occur that cause two drivers to be enabled at the same time. If this happens and the drivers are in opposite states, high currents will flow between devices. The maximum package power dissipation ratings for the devices can be easily exceeded, thermally damaging the devices. The third problem deals with drive current. For bi-directional data flow, the line should be terminated with a resistor at both ends of the cable. Therefore drivers are required to source/sink twice the current required by an EIA-422-A termination (single resistor).

## 2 Problem #1—Common Mode Range

A typical bipolar EIA-422-A output structure is shown in [Figure 2](#). Associated with the classical totem pole output structure is the parasitic substrate diode formed between the EPI layer and the substrate. This parasitic diode limits the negative common mode range of the driver's output. Given the case when the driver on the left is disabled (high impedance state), the driver on the right is active, and the two drivers are referenced to local grounds a fault can occur. If a ground potential difference exists between the two grounds ( $V_{CM}$ ), the disabled driver can clamp the line. An example of this occurs when the disabled driver's ground is two volts higher in potential than the active driver's ground. If the output voltage goes below its ground by one diode drop, the parasitic diode becomes forward biased. For this example, assume a  $V_{OL}$  of  $0.5\text{V}$ , and a  $V_{CM}$  of  $+2\text{V}$ . The active driver's  $V_{OL}$  is  $0.5\text{V}$ , but with respect to the disabled driver's ground it becomes  $-1.5\text{V}$ . Clearly the EPI/SUB diode is forward biased and the line is clamped to  $-0.7\text{V}$  instead of the driven level. Data flow is not guaranteed, if the line is clamped. EIA-485 driver output structures, shown in [Figure 3](#), include a Schottky diode in both the source and sink side of the output structure. This diode isolates the EPI/SUB diode from the output pin, and eliminates the possibility of the parasitic diode from turning on and clamping the data line. The common mode range is now  $-7\text{V}$  to  $+12\text{V}$  ( $7\text{V}$  from either rail). The adverse affects of this diode are minimal. The driver's  $V_{OL}$  is a Schottky diode drop higher, and  $V_{OH}$  is one diode drop lower. However, the driver's output will remain in a high impedance state for applied voltages between  $-7\text{V}$  and  $+12\text{V}$ .

## 3 Problem #2—Contention Between Drivers

If by hardware or software error two drivers are enabled at the same time, a fault occurs. In applications that use multiple drivers, protection from this fault should be considered. This fault can be more damaging to the drivers if the two active drivers are separated by a large ground potential difference. For example, transceiver one (T1) shown in [Figure 3](#) is referenced to earth ground GND1 ( $0\text{V}$ ). While T2's ground potential (GND2) is  $7\text{V}$  higher in magnitude with respect to GND1. If the two drivers are in opposite states, then a  $12\text{V}$  difference exists between the drivers ( $12\text{V} = V_{CM} + V_{CC}$ ). A large current will flow, and the maximum package power dissipation rating would be exceeded. EIA-422-A drivers do not have contention protection built in, since they are intended for use in single driver/multiple receiver applications. Power dissipation increases if multiple drivers are involved. EIA-485 line drivers are protected from this contention problem through the use of short circuit current limiting over a wide common mode range. Most EIA-485 drivers have a thermal shutdown feature (although not required by EIA-485). If an active EIA-485 driver output is shorted to any voltage between  $-7\text{V}$  and  $+12\text{V}$ , the resulting current will be less than  $250\text{ mA}$ . Realizing that drivers can be thermally damaged, ALL National Semiconductor's EIA-485 drivers feature thermal shutdown protection (TS). For example, a worse case fault occurs if the driver is shorted to  $+12\text{V}$ , and the resulting current is  $250\text{ mA}$ . The power dissipated on the device is simply current multiplied by voltage ( $P=IV$ ):  $12\text{V}$  ( $250\text{ mA}$ ) =  $3\text{W}$ . Three watts clearly exceeds the rated maximum package power dissipation specification for all common packages. However, the thermal shutdown

feature senses this fault and disables the drivers output. Hence, the 250 mA current drops to 0 mA; the device cools down and is automatically reset. If the fault is still present, the device will cycle into and out of thermal shutdown until the fault is removed. Some of National's devices feature an open collector pin that reports the occurrence of a thermal shutdown (DS3696 for example). EIA-422-A drivers would commonly incur damage when this fault occurs.

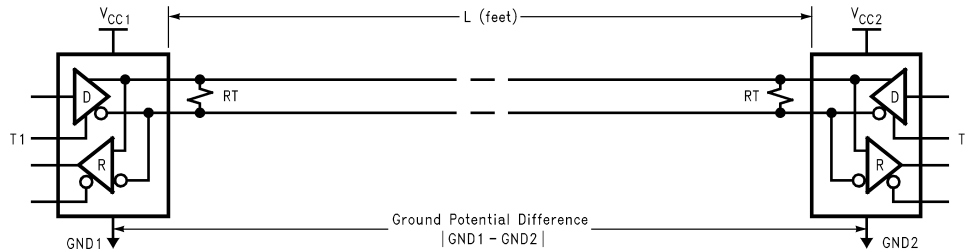


Figure 1. Typical Multiple Driver Application

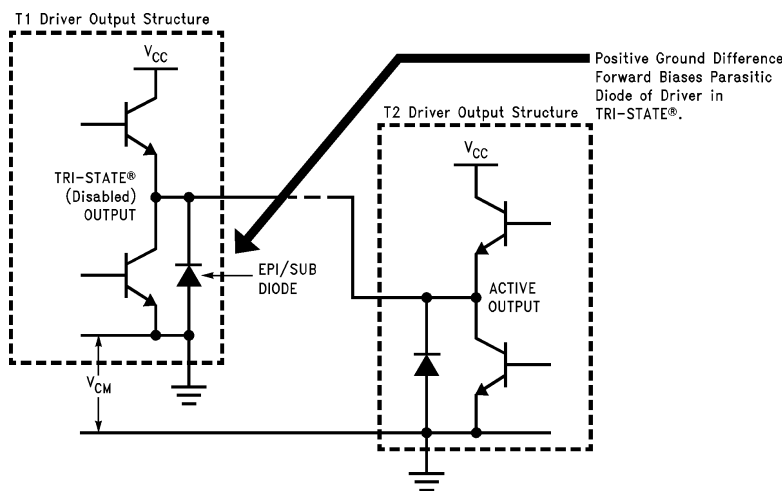


Figure 2. EIA-422-A Driver Output Structures Have A Limited Common Mode Range

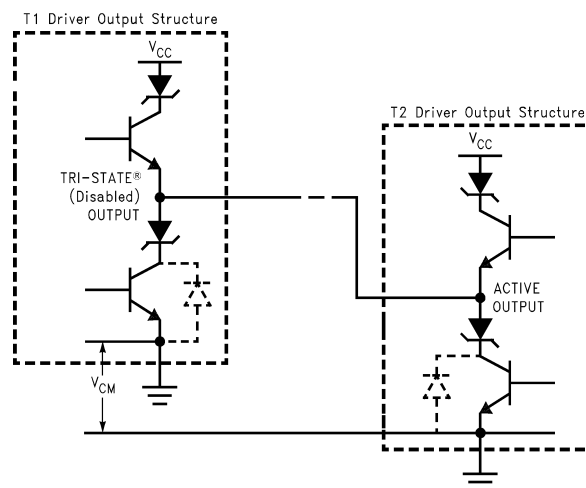


Figure 3. EIA-485 Driver Output Supports -7V to +12V Common Mode Range

#### 4 Problem #3—Drive Current

The third problem deals with the drivers load current capability. EIA-422-A drivers are rated at  $\pm 20$  mA minimum, while EIA-485 devices have  $\pm 55$  mA minimum drive capability. Current sourced by the driver either flows through the termination resistor(s), or into receiver input structures. In multiple driver applications, two termination resistors (RT) are required (one at each end of the cable), a driver would see these two resistors in parallel, resulting in a  $60\Omega$  load (assuming the termination resistors are  $120\Omega$  each). Receiver input structures are also seen in parallel by the driver, and the EIA-422-A receiver input impedance is also too low to be used in applications requiring a high number of receivers. To overcome these problems EIA-485 drivers have roughly three times the drive capability of EIA-422-A drivers. In addition EIA-485 receivers feature a higher input impedance, which is typically three times the EIA-422-A limit of  $4\text{ k}\Omega$ .

#### 5 Conclusions

EIA-485 drivers are the best choice for multipoint (multiple driver) applications as shown in Figure 4. They can tolerate ground potential differences of up to 7V from either rail. They are contention safe and thermally protected. Finally, the drivers can handle up to 32 transceiver loads compared to EIA-422-A's limit of ten receivers. National offers a wide range of EIA-485 devices: Transceivers, Repeaters, Quad Drivers, Quad Receivers and Quad Transceivers are all offered. Select devices are available in the Industrial and Military temperature ranges. National also offers MIL-883C qualified Quad Drivers, Quad Receivers and Transceiver (see the selection guide located in the front of chapter one of the Interface Databook for a complete listing of all EIA-485 Devices).

#### 6 References

1. EIA Standard EIA-485 (RS-485), Standard for Electrical Characteristics of Generators and Receivers for use in a Balanced Digital Multipoint Systems, EIA, Washington, D.C.
2. EIA Standard EIA-422-A (EIA RS-422-A), Electrical Characteristics of Balanced Voltage Digital Interface Circuits, EIA, Washington, D.C.
3. Application Note 409, Transceivers and Repeaters Meeting the EIA RS-485 Interface Standard, Interface Databook, National Semiconductor, Santa Clara, CA.

EIA Standards can be obtained for a fee from:

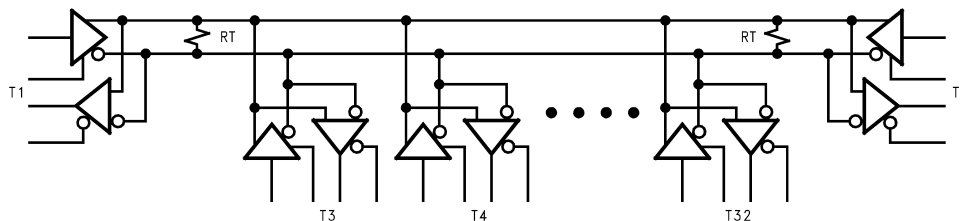
Electronic Industries Association

EIA Engineering Department/Standard Sales Office

2001 Pennsylvania Avenue, N.W.

Washington, D.C. 20006

Tel: (202) 457-4988



**Figure 4. Typical EIA-485 Multipoint Application**

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)