3.3 V RS485 compatible with 1.8 V I/Os and selectable speed 20 Mbps or 250 kbps

Introduction

This application note provides some information about how to manage an application using the STR485 device, its features as well as and the implementation in a communication system.

The STR485 is a low power, half duplex RS485 transceiver (driver/receiver on a single die) meeting the RS485 communication standard (ISO-IEC 8482 - second edition 1993-12-15).

This product can be supplied by two different supply voltages:

- Logic supply level (VL) from 1.65 V to 3.6 V (generally 1.8 V is used in a typical application) and
- Line driver supply level (VCC) from 3 V to 3.6 V (generally 3.3 V is used in a typical application)

These voltages are fully compatible with the low power electronic systems.

The STR485 has also a selectable data rate, which can transmit data to long distance thanks to the selection data rate at 250 kbps or in a fast mode to shorter communication lines with a selection data rate at 20 Mbps.

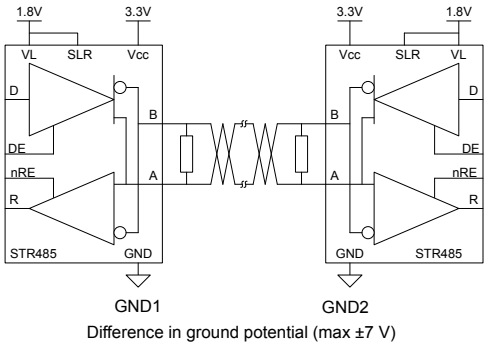
The device consumption can be reduced down to 0.5 µA; the minimum standby current is reached when the driver and the receiver are disabled.

1 Typical applications

The STR485 is an RS-485 based-interface designed for multipoint differential transmission on a single twisted pair cable. It allows half duplex bi-directional transmission, long cable length and high data rate. Typical applications include LANs, industrial (PLC devices), automotive and computer interfaces. The system evolution in the data communication field leads to the development of faster devices with lower data bit errors at low supply.

1.1 Point-to-point connection

Figure 1. Transmitter connected to a receiver



The device to device communication is done on a twisted pair with a resistance at each input/output A and B of the both products. This resistance adapts the twisted pair line impedance Z0.

In the schematic Figure 1. Transmitter connected to a receiver, the devices are both connected to the ground; in a real case, this ground can be at different potential. In that case, the common mode potential is different and must never be above 7 V to satisfy the RS485 standard.

1.1.1 Data rate selection

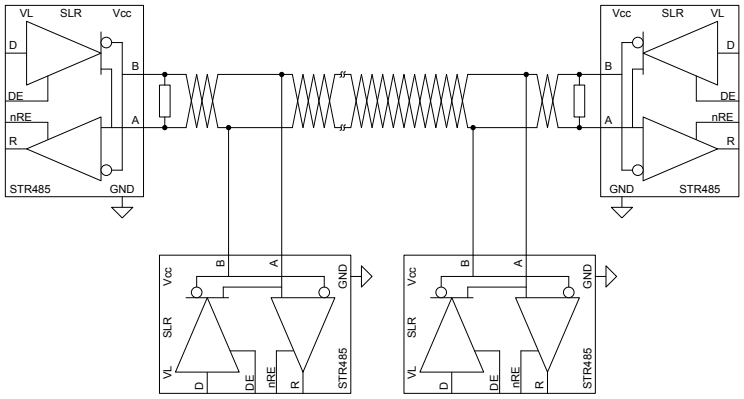
In Figure 1. Transmitter connected to a receiver, SLR input is connected to 1.8 V in order to limit the data rate at 250 kbps. To use the devices data rate up to 20 Mbps, the SLR pin must be connected to the ground.

This data rate selection is true and valid whatever the number of devices is used on the connection wire. Moreover, the data rate must be the same as the one on the driver and the receiver to get a good communication.

It is recommended to connect the SLR pin to ground or logic supply voltage according to the application data rate even if there is an internal pull-down.

1.2 RS-485 multi-port network configuration

Figure 2. Multiple devices connected to a same communication bus



In Figure 2. Multiple devices connected to a same communication bus, four devices have been connected to the same twisted pair. The A and B input/output must be properly connected together.

The data rate must be also the same as all the devices and the selection pin SLR must be connected to the ground or the V_L power supply on each device.

The impedance adaptation is still done by adding two resistances to the main wire, the other connection does not have any resistance output on A and B and can be directly connected to the bus in parallel.

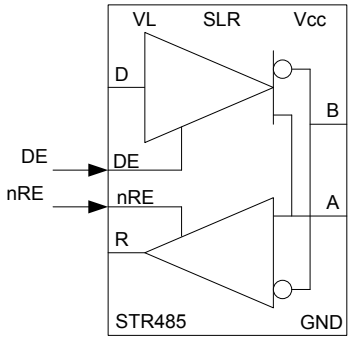
1.2.1 Number of devices loading the bus

The STR485 transceiver is supporting 1/8 UL. The RS-485 specifies the unit load as the ability of a transceiver to drive 32 devices with an impedance of 12 kΩ. As the device impedance is above 96 kΩ, it allows the connection of 256 devices on the same bus.

1.2.2 Typical features and use cases

The STR485 embeds in the same package a driver and a receiver, each integrates part of the device; they are controlled independently by a dedicated input pin. The driver is enabled by a positive level while the receiver is enabled by a negative level. This structure let the driver enable/disable when the receiver is disable/enable with the same signal. The figures below show the typical use cases in which the device can be used.

Figure 3. Device used in driver/receiver



The figure above presents the case in which the STR485 is used in driver or receiver connected to a controller that processes the driver enable and the receiver enable according to the applications needs.

Figure 4. Device used in directional driver/receiver

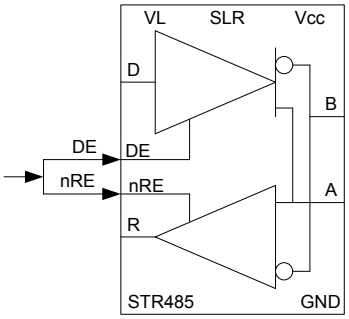


Figure 4. Device used in directional driver/receiver presents the case in which the STR485 is used in driver with receiver in off mode or in receiver with the driver in off mode. In this typical case, only one control signal is used to manage the pin RE and nRE, which are connected together.

Figure 5. Device used as a receiver only

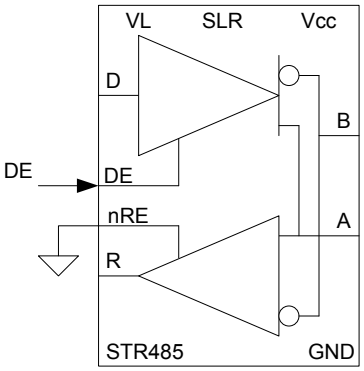


Figure 5. Device used as a receiver only shows the case in which the STR485 has always the receiver activated. In this case, the driver can be activated by putting the pin DE at high level, the receiver can then read back what is sent to the line, the receiver is always ON even when the driver transmits the data on the bus. This allows the collision detection on the bus when several drivers are sending data simultaneously.

2 Power supplies (typical schematic and layout)

2.1 General case

The STR485 has been designed to work in standalone and to be able to drive the RS485 bus or to receive the data from a RS485 bus. The typical application should be designed with an output/input impedance adaptation resistance equal to the bus impedance Z0. Figure 6. Typical STR485 schematic proposes a resistance adaptation of 120 Ω that is the current RS485 bus impedance.

The device must also be well-decoupled by 0.1 µF capacitor (C2 and C3) placed near the device and another minimum 1µF capacitor (C1 and C4) must be also present on the board for general decoupling purposes.

Figure 6. Typical STR485 schematic

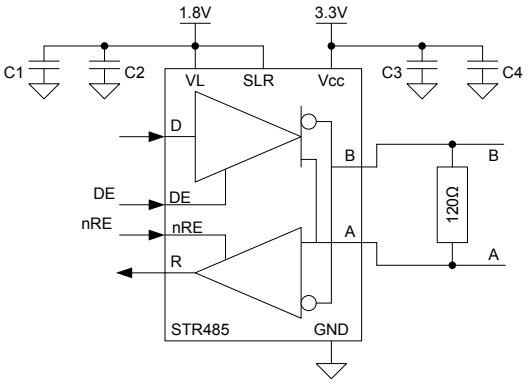
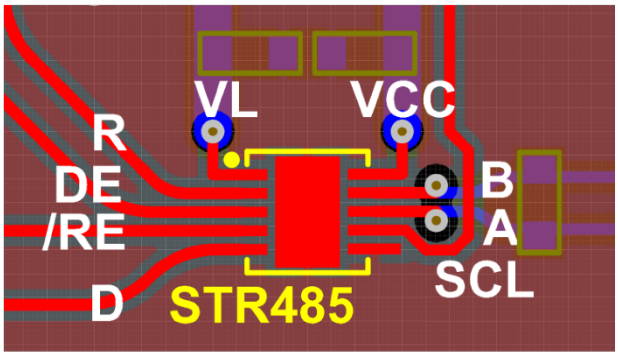


Figure 7. Typical STR485 layout



2.2 Connections and levels

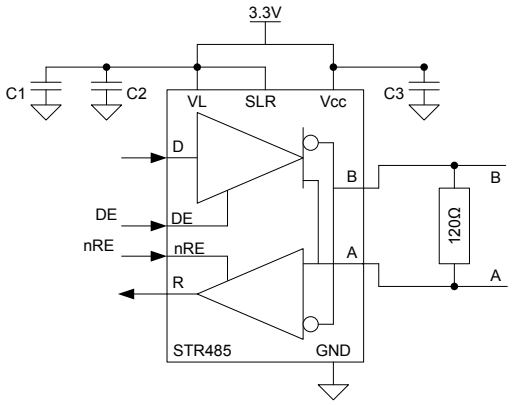
The STR485 is supplied by low voltage power supplies. The digital can run with a low voltage V_L from 1.65 V to 3.6 V and the output stage voltage V_{CC} runs with a voltage level from 3.0 V to 3.6 V.

The device can be in the configuration shown in Figure 6. Typical STR485 schematic, with a low voltage power supply V_L = 1.8 V and the output stage voltage V_{CC} = 3.3 V.

It is also possible to connect power supplies V_L to the transceiver power supply V_{CC}, $V_L = V_{CC}$; in this case V_L and V_{CC}, are varying from 3.0 V to 3. 6 V.

It is recommended to keep on all power supply pins the decoupling capacitor of 0.1 µF.

Figure 8. **Only one power supply for both $V_L = V_{CC}$**



When two power supplies are used in the application, the logic power supply V_L must be set to a lower voltage than V_{CC}, otherwise the device is internally biased and the consumption increases.

2.3 Improvement of the communication line protection

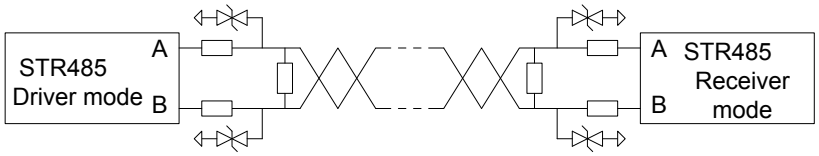
The STR485 has integrated protections against ESD (electro static discharges) and EFT (electrical fast transient).

The STR485 datasheet gives the protection level obtained when the device is alone on the PCB. In this specific case, the product is able to sustain ±4 kV in human body model (HBM), ±8 kV in contact discharge and ±16 kV in air discharge; both two last tests are compliant to the IEC 61000-4-2.

The STR485 sustains EFT up to ±2 kV according to the IEC 61000-4-4 in Class B.

If in the application, the system must sustain higher immunity level, it is possible to add some protection devices on the twisted pair to the input/outputs A and B.

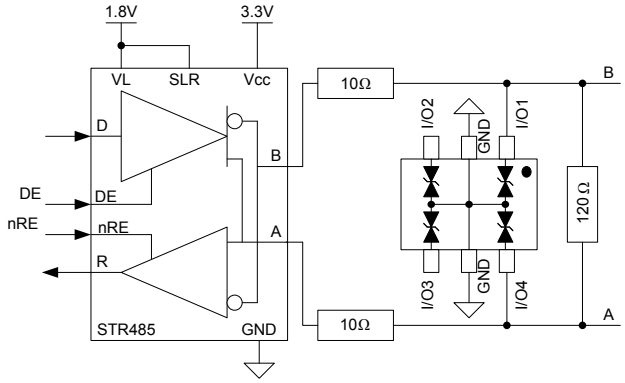
Figure 9. **Improvement of the line protection against ESD and EFT**



STMicroelectronics proposes different protections. Two protection devices have been evaluated with the STR485 in order to improve the EFT level immunity:

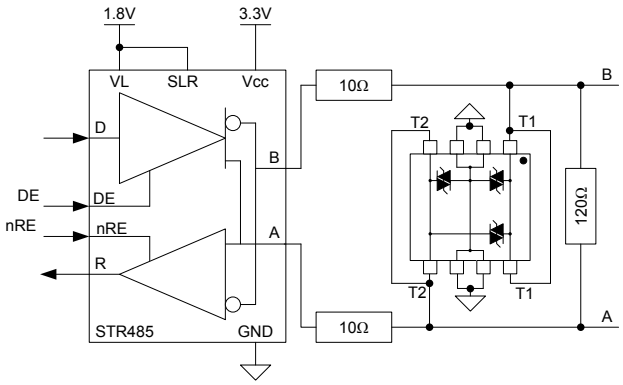
- ESDA14V2BP6 : Transil™ array for ESD protection device
- ETP01-2821 : protection for Ethernet lines

Figure 10. **ESD14V2BP6 protection device schematic**



This ESDA14V2BP6 protection improves EFT protection level (IEC 61000-4-4) up to ±4 kV and the ESD protection level (IEC 61000-4-2) up to ±15 kV in air discharge and ±8 kV contact discharge; and, also compliant with the MIL standard 883 – Method 3015-7 class 3 at ±25 kV in human body model.

Figure 11. **ETP01-2821 protection device schematic**



This protection has not been specially developed for the RS485 protection but can be used to improve the STR485 protection. Tests have been done in EFT trials to increase the device protection up to ±4 kV; the protection has been designed and characterized to sustain the IEC 61000-4-4 EFT at 40 A (5/5 ns) pulses.

This ETPO1-2821 protection can also help to protect the device against ESD in respect to the IEC 61000-4-2 standard, ±15 kV air discharge and ±8 kV contact discharge; and, also compliant with the MIL standard 883 – Method 3015-7 class 3 at ±25 kV in human body model.

For more information about these protection devices, about the protection and the application implementation, please contact directly STMicroelectronics.

Revision history

Table 1. **Document revision history**

Date	Version	Changes
07-Nov-2018	1	Initial release.

Contents