APPLICATION NOTE ANI13

RS-485 and RS-422 Physical Topologies

RS-485 and RS-422 are in wide use as an interface for telecommunications, industrial, medical, security and networking applications. The reasons for their popularity are low cost, flexibility and very desirable feature set.

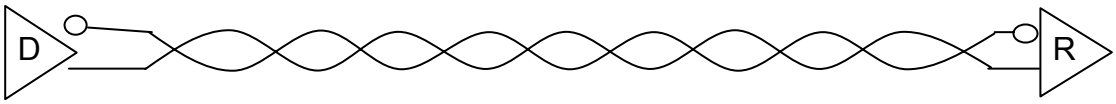
The published TIA/EIA 485 and RS-422 standards define only the electrical characteristics of the drivers and receivers. They did not standardize such things such as cables and connectors, pinouts, bus arbitration, signaling protocols, or physical wiring topology. Many different implementations have come into use and they are often incompatible with each other.

This document includes descriptions and examples of some of popular physical topologies.

Point to Point RS-422 or RS-485

This is the simplest configuration, just one driver and one receiver. If termination is used, it is only required at the receiver. Most RS-422 cables used to connect telecom or data-com equipment are point to point links. Generally twisted pair cable is preferred due to its noise canceling ability.

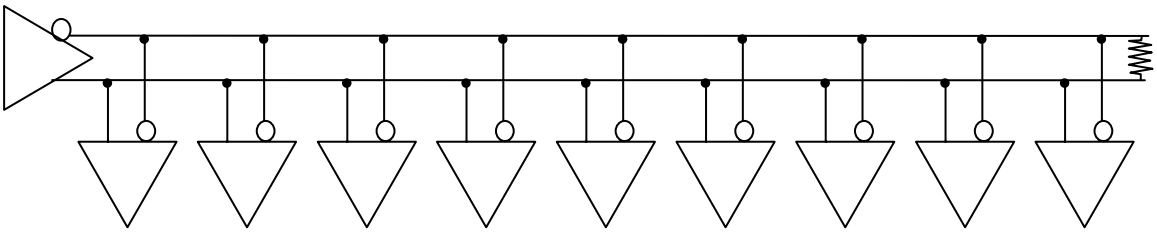
Cables may include a single channel over one pair of wires or there may be multiple channels routed through a multi-pin connector and bundled cable. Serial ports ranging from AppleTalk™ to telecom ports such as V.36, EIA-530 and X.21 carry high speed signals on RS-422 or V.11 type drivers and receivers in a point to point configuration.



Any Sipex RS-485 or RS-422 device can be used in a point to point connection. Sipex has a full portfolio of transceivers with 5V or 3V supplies, half or full duplex, all in industry standard footprints. Sipex RS-485 are also backward compatible for RS-422 or V.11 applications. The table below highlights Sipex devices that are particularly suited for point to point topology.

Suggested Sipex Devices	Product Description
SP490, SP3490, SP1490E, SP3087, SP3077	Full Duplex Transceivers in small 8 pin package
SP3493, SP3071, SP3081	Slew-limited Full Duplex in small 8 pin package
Sipex Multiprotocol family (SP504, SP505, SP526)	Multiple drivers and receivers in one package, electrically configurable as RS-422 (V.11) or other standard interface types
SP508, SP509, SP3508	Multiprotocol Transceivers with on-board receiver termination for fast-signal transmission lines
Sipex Dual-protocol family (SP331, SP332, SP334)	Drivers and receivers electrically configurable as either RS-422/485 or RS-232
SP26LV431, SP26LV432	Quad, High Speed, 3V, RS-422 drivers or receivers

Multi-drop RS-422 or RS-485



In this topology there is only one driver sending to one or more receivers. One termination resistor is recommended at the extreme end of the bus to eliminate reflections. Up to 10 receivers are permitted under RS-422 and up to 32 unit loads in RS-485. However the number of nodes can extend to much higher numbers in some configurations.

Multiple receive-only nodes may be used for clock distribution or other point-to-multipoint communications. This one-directional data flow is also the building-block used in the 4-wire full duplex link described below.

Just as with the “point to point” topology, any Sipex RS-485 or RS-422 transceiver can be used in multi-drop configurations.

Suggested Sipex Devices	Product Description
SP490, SP3490, SP1490E, SP3087, SP3077	Full Duplex Transceivers in small 8 pin package
SP3493, SP3071, SP3081	Slew-limited Full Duplex in small 8 pin package

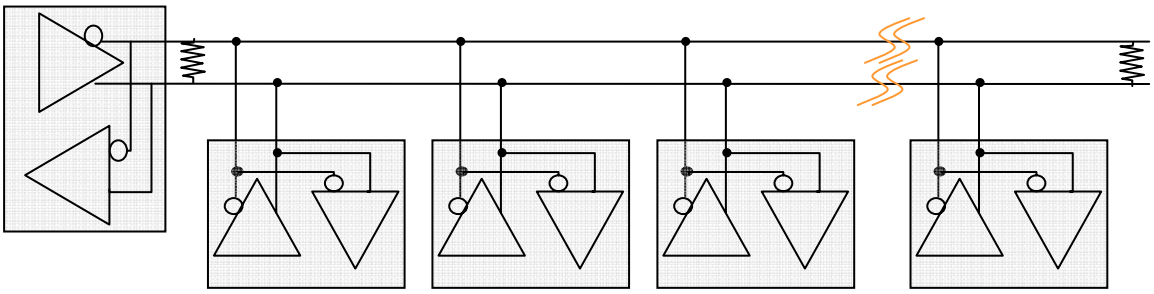
Bi-directional, Half Duplex (2 wire) RS-485

This is the classic RS-485 topology. It takes advantage of RS-485 capability to support multiple drivers on a bus. RS-422 devices should not be used in this configuration. This topology enables bi-directional communication from many nodes over long distances at low to medium data rates, all on a single pair of wires. It can implement a very functional, very flexible and very economical data network.

Because signals travel in both directions, this bus should be terminated at both ends to prevent reflections. Stubs used to connect each node to the common bus should be kept as short as possible.

Only one node can drive the bus at a time, making this a half-duplex communication channel.

"Two Wire" Half-Duplex Network



Suggested Sipex Devices	Product Description
SP485E, SP481E	5V, RS-485 Transceiver
SP485R, SP481R	5V, RS-485 Transceiver, 1/10th Load
SP1485E, SP1481E	5V, High Speed Transceiver
SP483E	5V, Transceiver with slew-rate limiting
SP3485, SP3481	3V, RS-485 Transceiver
SP3483, SP3494	3V, Transceiver with slew-rate limiting
SP3072E, SP3075E	3V, Transceiver with slew-rate limiting, 1/8th Load
SP3078E	3V, High Speed Transceiver, 1/8th Load
SP3082E, SP3085E	5V, Transceiver with slew-rate limiting, 1/8th Load
SP3088E	5V, High Speed Transceiver, 1/8th Load

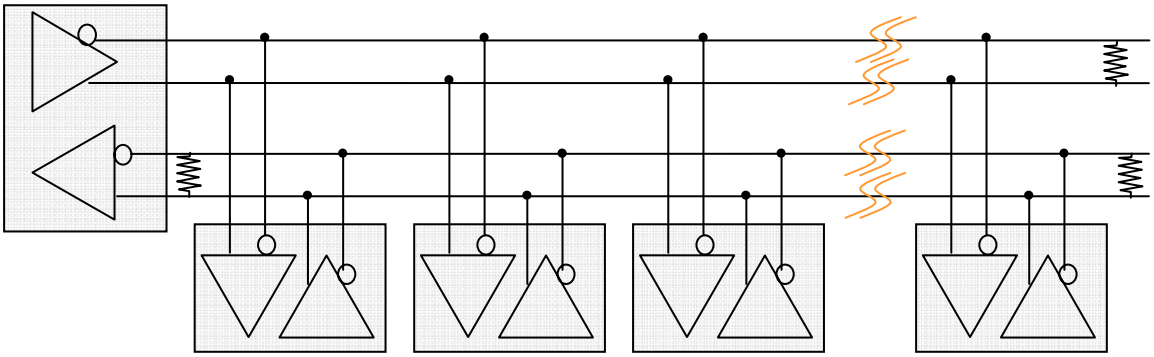
Only one driver should be active at any one time. Therefore the transceivers used on a half-duplex bus should support a Driver Enable (DE) function. Each node should be configured to listen for its node address and to act upon data or commands matching its address.

Bi-directional, Full Duplex (4 wire)

The 4-wire topology simplifies bus arbitration in multi-node RS-485. A single Master node is the only driver allowed on the topmost wire pair. All other nodes listen to all data traffic that passes on the "party-line" type multi-drop bus. Nodes may transmit on the lower pair of wires when addressed by the master node or by using a token-passing bus arbitration scheme.

The master node may drive its bus while any of the slave-nodes are driving the lower pair, making this 4-wire network a full-duplex communication channel. All communication occurs from master to slave or slave to master, so any peer to peer communications must be routed through the master node.

"Four Wire" Full-Duplex Network

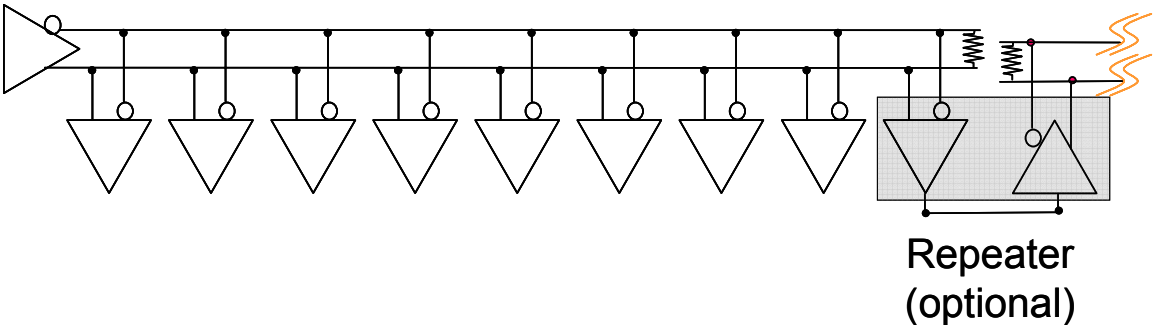


Suggested Sipex Devices	Product Description
SP491E	5V, Full Duplex RS-485 Transceiver
SP1491E	5V, High Speed Full Duplex Transceiver
SP3491	3V, RS-485 Full Duplex Transceiver
SP3070E, SP3073E	3V, Full Duplex with slew-rate limiting, 1/8th Load
SP3076E	3V, High Speed Full Duplex, 1/8th Load
SP3080E, SP3083E	5V, Full Duplex with slew-rate limiting, 1/8th Load
SP3086E	5V, High Speed Full Duplex, 1/8th Load

A 4-wire topology can simplify the problem of bus arbitration. The master node is the only driver allowed on the topmost pair. All other nodes transmit on the lower pair only when given permission. If bus contention does occur on the lower pair the master node can command all slave-nodes to stop driving.

Bus Repeaters

Repeaters can extend the reach of an RS-485 or RS-422 bus, or they can be used to electrically segment the bus so it can support more than the standard number of loads.



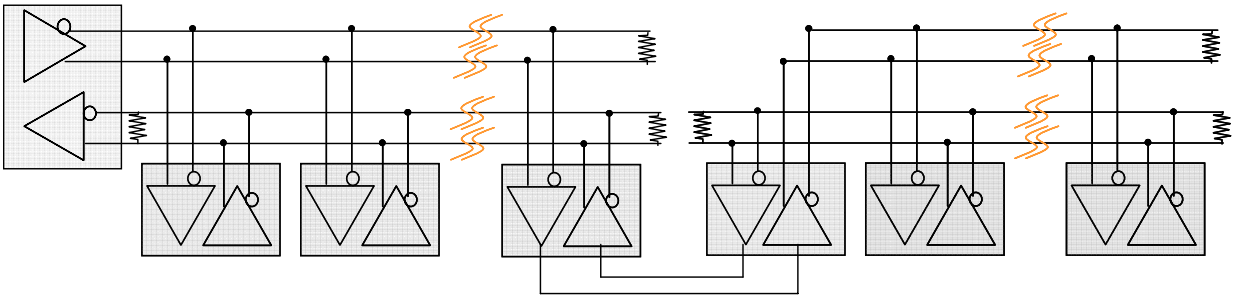
Point to Multi-point Repeater

Suggested Sipex Devices	Product Description
SP490E, SP3490, SP1490E	Full Duplex Transceivers in small 8 pin package
SP3493	Slew-limited Full Duplex in small 8 pin package
SP3071E, SP3074E	3V, Full Duplex with slew-rate limiting, 1/8th Load
SP3077E	3V, High Speed Full Duplex, 1/8th Load
SP3081E, SP3084E	5V, Full Duplex with slew-rate limiting, 1/8th Load
SP3087E	5V, High Speed Full Duplex, 1/8th Load

Adding repeaters to a multi-drop bus is very straightforward. A simple full-duplex transceiver can be used; no extra logic is required.

Full-Duplex Repeater

The four-wire topology is also easily extended using a simple repeater. It can use the same single-master, many-slave arbitration scheme with a larger address space to handle the additional nodes. The repeater should be programmed to forward all traffic from the master and relay data when a node on its segment is allowed to transmit.



Suggested Sipex Devices	Product Description
SP491E	5V, Full Duplex RS-485 Transceiver

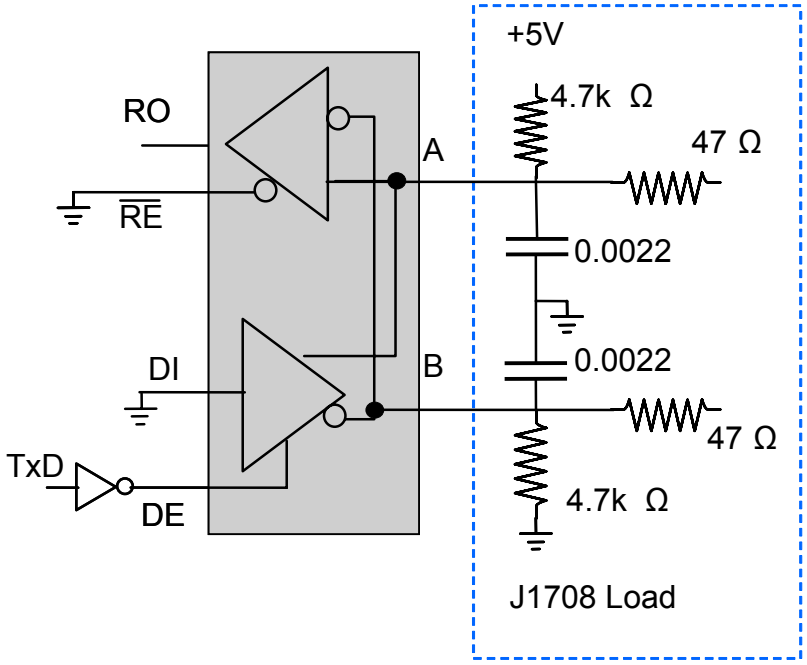
SP1491E	5V, High Speed Full Duplex Transceiver
SP3491	3V, RS-485 Full Duplex Transceiver
SP3070E, SP3073E	3V, Full Duplex with slew-rate limiting, 1/8th Load
SP3076E	3V, High Speed Full Duplex, 1/8th Load
SP3080E, SP3083E	5V, Full Duplex with slew-rate limiting, 1/8th Load
SP3086E	5V, High Speed Full Duplex, 1/8th Load

Application Specific Topologies

SAE J1708

SAE J1708 is an automotive industry standard for data networks in vehicles. It is used mainly for diagnostic access and communications for Intelligent Transportation Systems (ITS.)

The basic J1708 configuration consists of a standard RS-485 transceiver such as an SP485 or SP483, plus a loading network made from passive components. The standard loading network configuration and values are shown in the figure below. The loading network provides termination and bias to the bus.

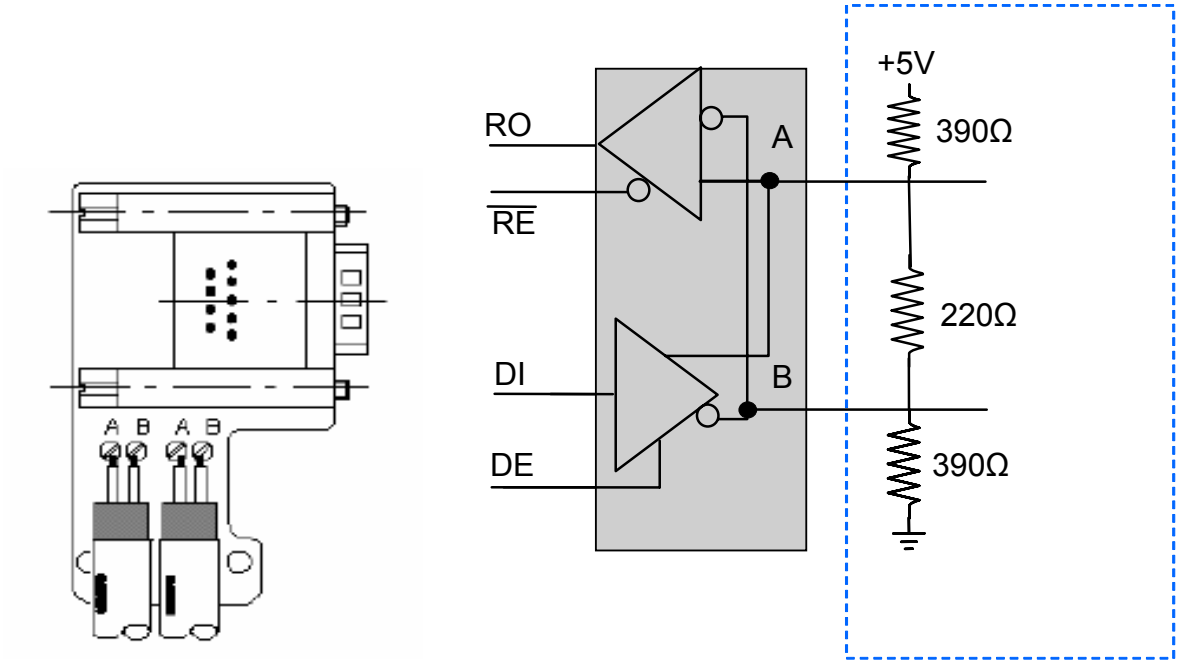


Suggested Sipex Devices	Product Description
SP483E, SP485E	5V, RS-485 with high ESD
SP3088E	5V, RS-485 with high ESD, 1/8th Load, Adv. failsafe

J1708 employs a default bus-idle state. If no other activity is happening on the bus the load network will default the bus to A < B. Each driver will either drive A > B or stops driving, which allows the bus to return to default state. Receivers are always active to listen for their node address or to detect bus contention.

PROFIBUS (EN50170 or DIN19245)

Profibus originated in Europe but has spread worldwide as an industrial fieldbus for use in process automation and factory control. There are a number of different implementations, but one of the most widely used is Profibus-DP (Process Field Bus - Distributed Peripherals). DP uses RS-485 as its physical layer with a proprietary data-link layer.



Suggested Sipex Devices	Product Description
SP1486E	5V, Low-power, Profibus transceiver with high ESD

Conclusion

RS-485 and RS-422 networks are sometimes said to be complex to set up. One reason for this is that there is no single bus topology defined in the basic standards documents. However this flexibility makes it possible to implement a range of different topologies that can fill many needs for low cost, high speed, reliable data communication.

