# RS-485 Network

# E

EIA RS-485 is industry's most widely used bidirectional, balanced transmission line standard. It is specifically developed for industrial multi-drop systems that should be able to transmit and receive data at high rates or over long distances.

The specifications of the EIA RS-485 protocol are as follows:

-Max line length per segment: 1200 meters (4000 feet)

-Throughput of 10 Mbaud and beyond

-Differential transmission (balanced lines) with high resistance against noise

-Maximum 32 nodes per segment

-Bi-directional master-slave communication over a single set of twisted pair cables

-Parallel connected nodes, true multi-drop

ADAM modules are fully isolated and use just a single set of twisted pair wires to send and receive! Since the nodes are connected in parallel they can be freely disconnected from the host without affecting the functioning of the remaining nodes. In industry shielded twisted pair is preferable due to the high noise ratio of the environment.

When nodes communicate through the network, no sending conflicts can occur since a simple command/response sequence is used. There is always one initiator (with no address) and many slaves (with address). In this case the master is a personal computer that is connected with its serial, RS-232, port to an ADAM RS-232/RS-485 converter. The slaves are the ADAM I/O modules. When modules are not transmitting data, they are in listen mode. The host computer initiates a command/response sequence with one of the modules. Commands normally contain the address of the module the host wants to communicate with. The module with the matching address carries out the command and sends its response to the host.

## E.1 Basic Network Layout

Multi-drop RS-485 implies that there are two main wires in an segment. The connected modules tap from these two lines with so called drop cables. Thus all connections are parallel and connecting or disconnecting of a node doesn't affect the network as a whole. Since ADAM modules use the RS-485 standard, and use an ASCII-based commands set, they can connect and communicate with all ASCII-based computers and terminals. The basic layouts that can be used for an RS-485 network are:

### Daisychain

The last module of a segment is a repeater. It is directly connected to the main-wires thereby ending the first segment and starting the next segment. Up to 32 addressable modules can be diasychained . This limitation is a physical one. When using more modules per segment the IC driver current rapidly decreases, causing communication errors. Totally the network can hold up to 256 addressable modules. The limitations for this number is the two number hexadecimal address code that knows 256 combinations. The ADAM converter, ADAM repeaters and the host computer are non addressable units and therefore are not included in these numbers.

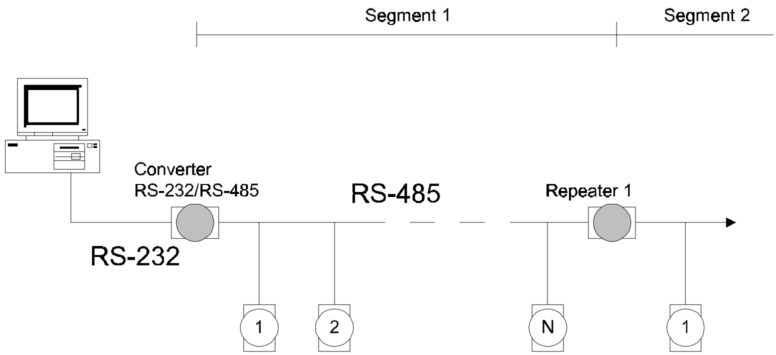


**Figure E-1** *Daisychaining*

### Star Layout

In this scheme the repeaters are connected to drop-down cables from the main wires of the first segment. A tree structure is the result. This scheme is not recommended when using long lines since it will cause a serious amount of signal distortion due to a signal reflection in a several line endings.

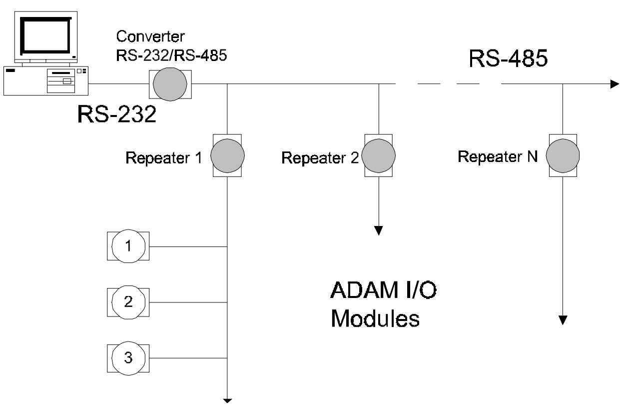


**Figure E-2** *Star structure*

## Random

This is a combination of daisychain and hierarchical structure

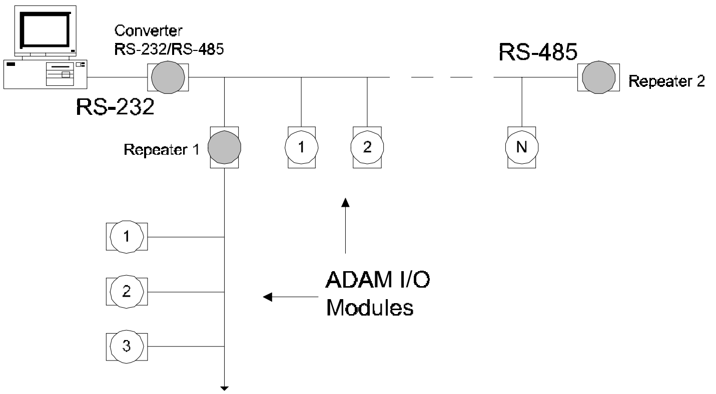


**Figure E-3** *Random structure*

## E. 2 Line Termination

Each discontinuity in impedance causes reflections and distortion.

When an impedance discontinuity occurs in the transmission line the immediate effect is signal reflection. This will lead to signal distortion. Specially at line ends this mismatch causes problems. To eliminate this discontinuity terminate the line with a resistor.

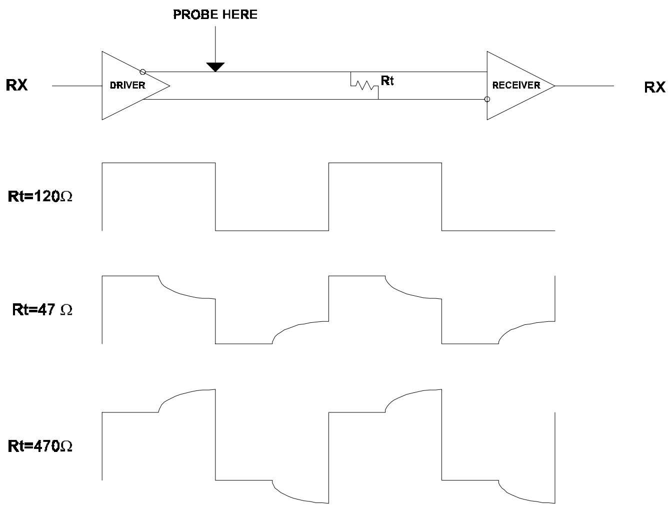


**Figure E-4** *Signal Distortion*

The value of the resistor should be a close as possible to the characteristic impedance of the line. Although receiver devices add some resistance to the whole of the transmission line, normally it is sufficient to the resistor impedance should equal the characteristic impedance of the line.

**Example:**

Each input of the receivers has a nominal input impedance of 18 kW feeding into a diode transistor- resistor biasing network that is equivalent to an 18 kΩ input resistor tied to a common mode voltage of 2.4 V. It is this configuration which provides the large common range of the receiver required for RS-485 systems! (See Figure  E-5 below).

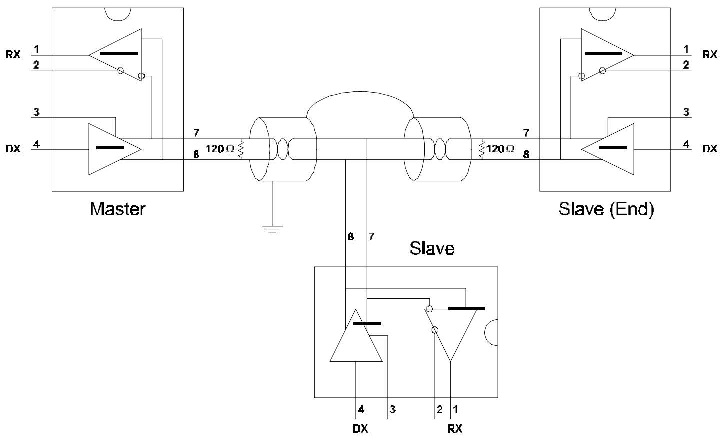


**Figure E-5** *Termination resistor locations*

Because each input is biased to 2.4 V, the nominal common mode voltage of balanced RS-485 systems, the 18 kΩ on the input can be taken as being in series across the input of each individual receiver.

If thirty of these receivers are put closely together at the end of the transmission line, they will tend to react as thirty 36kΩ resistors in parallel with the termination resistor. The overall effective resistance will need to ne close to the characteristics of the line.

The effective parallel receiver resistance RP will therefore be equal to:

$R_P = 36 \times 10^3/30 = 1200$ W

While the termination receiptor $R_T$ will equal:

$R_T = R_O / [1 - R_O/R_P]$

Thus for a line with a characteristic impedance of 100 Ω resistor, the termination resistor $R_T$ should be:

$R_T = [1 - 100/1200] = 110\ \Omega$

Since this value lies within 10% of the line characteristic impedance. Thus as already stated above the line termination resistor $R_T$ will normally equal the characteristic impedance $Z_O$.

The star connection causes a multitude of these discontinuities since there are several transmission lines and is therefore not recommend.

**NOTICE:** *The recommended wiring method that causes a minimum amount of reflection is daisy chaining where all receivers tap from one transmission line and needs to be terminated only twice.*

## E.3 RS-485 Data Flow Control

The RS-485 standard uses a single pair of wires to send and receive data. This line sharing requires some method to control the direction of the data flow. RTS (Request To Sent) and CTS (Clear To Sent) are the most commonly used method.

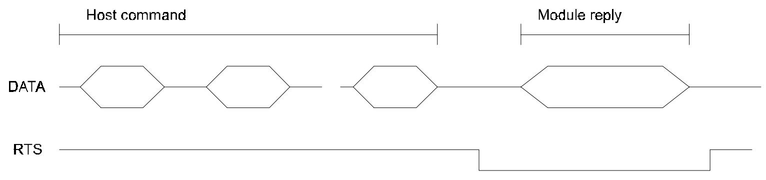


**Figure E-6** *RS-485 data flow control with RTS*

### Intelligent RS-485 Control

ADAM-4510 and ADAM-4520 are both equipped with an I/O circuit which can automatically sense the direction of the data flow. No handshaking with the host (like RTS, Request to Send) is necessary to receive data and forward it in the correct direction. You can use any software written for half-duplex RS-232 with an ADAM network without modification. The RS-485 control is completely transparent to the user.