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RS-422: An Alternative to RS-232

Users of serial devices who need high data rates, long-distance serial cabling, or multiple devices on one port might consider RS-422 as an alternative to RS-232. RS-232, the most common serial interface, has limits on speed, cable distance, and device support that can be problems when designing Point-of-Sale (POS) systems, factory automation installations, building automation systems, and setups facing high levels of electrical noise. Demanding installations of these sorts are often better served by RS-422 serial connections.
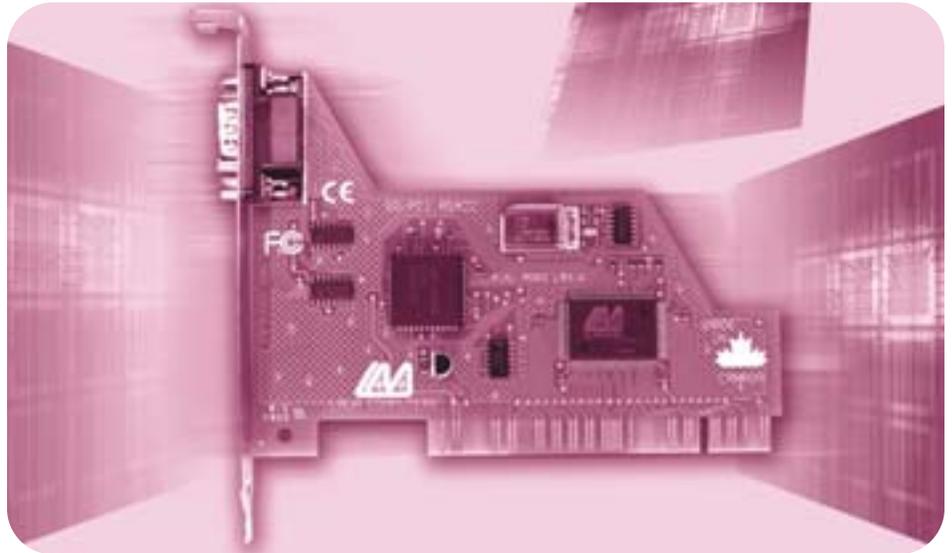
Signalling Method

RS-422 differs from RS-232 primarily in the electrical method it uses to carry its signals. RS-422's transmit and receive signals use a method of signalling called "differential signalling" or "balanced transmission." With differential signalling, a given signal uses a pair of wires dedicated to that purpose. The signal is determined by the *difference* in voltage between these two wires. By contrast, RS-232 signals are determined with reference to a common ground signal carried on its own wire, in a method termed "unbalanced transmission." The diagrams below show this difference for a single signal.

Balanced Transmission

Transmitter   Receiver

Line A

Line B
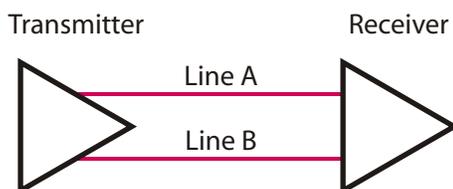
Balanced signalling of the sort used by RS-422 is also used in LAN protocols such as Ethernet and Token Ring, as well as in other connection methods that use the familiar DB connector format. RS-485, RS-449 (DB-37 connector), RS-530 (DB-25 connector), and x.21 (DB-15 connector) are examples.

The advantage of differential signalling comes mainly from its strong ability to maintain signal integrity. Because a signal is determined by the difference in voltage between a pair of wires, it will be unaffected by electrical changes–such as electrical noise or end-to-end differences in ground signal–that influence both wires in the same degree. This signal integrity is especially strong when each wire pair has its strands twisted together: hence the term "twisted pair wiring." When wires are in twisted pairs, electrical noise influencing a cable will tend to affect both wires of a pair equally.

Because of this, the voltage differential between Line A and Line B for RS-422 can be as little as ± 0.2 V and still be considered a valid signal. That is, a voltage less than -0.2 volts has a truth value of 0, and a voltage greater than +0.2 volts has a truth value of 1 for the purpose of representing a signal. For RS-232, the voltage differentials between the signal line and the ground line must be ± 5.0 V. It can be seen that balanced transmission can operate within much finer tolerances than RS-232.
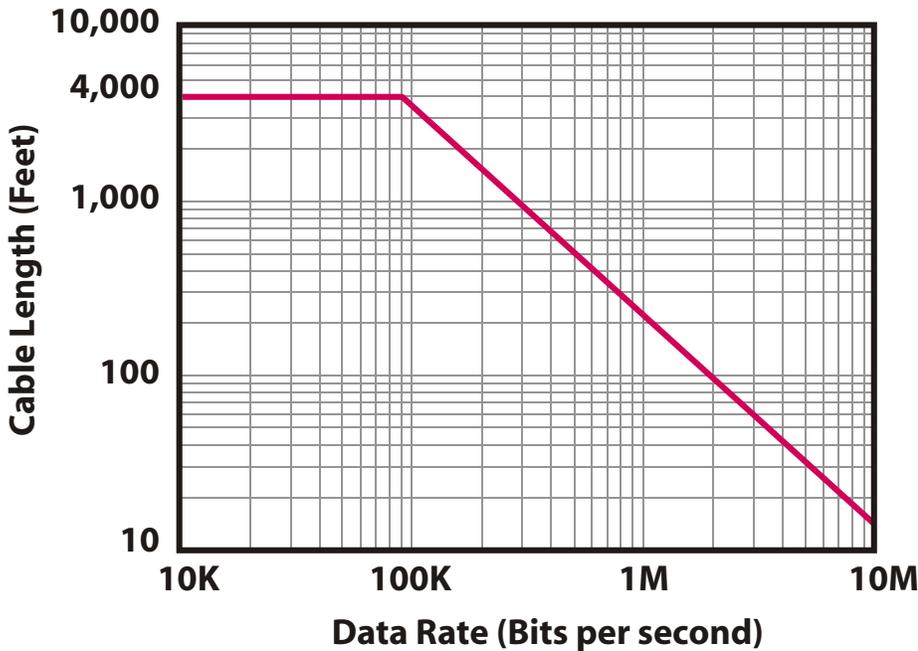
Unbalanced Transmission

Transmitter   Receiver

Line A

Ground
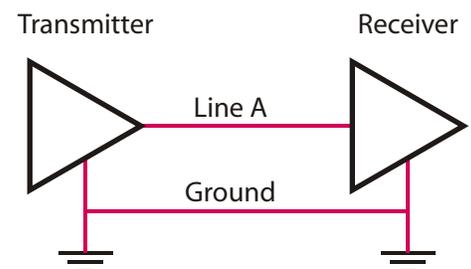
Cable Runs

Consequently, RS-422 is capable of substantially longer cable runs than RS-232. How much longer is a function of the signalling rate: the faster the signalling rate, the shorter the maximum cable length. At a 10 Mbps signalling rate, RS-422 cables max out at about 15 feet. On the other hand, the permissible cable length increases exponentially as speeds drop; at a signalling

Balanced Transmission: RS-422 Cable Lengths

Graph: Cable Length (Feet) vs Data Rate (Bits per second)

Y-axis: Cable Length (Feet) — 10,000, 4,000, 1,000, 100, 10

X-axis: Data Rate (Bits per second) — 10K, 100K, 1M, 10M

RS422 SS-PCI

RS422 DS-PCI

RS422 Quattro-PCI

RS422 SS-550

rate of 115.2 kbps, RS-422 cables can be up to 4000 feet long. The graph on the next page shows the relationship between data rate and cable length for RS-422. At any given data rate RS-422 supports much longer cabling than RS-232.

RS-422 Topology

RS-422 employs a master/slave device structure. This structure allows one master device to communicate with up to 10 slave devices; slaves must communicate to other slaves through the master device. Again, this feature contrasts with RS-232, which is simply device-to-device connection.

RS-422 Drawbacks

On the down side, RS-422 cabling is necessarily more expensive than that needed for RS-232, mainly because RS-422 requires more wires to carry a given number of signals, and because this cabling should be twisted pair. The RS-422 specification stipulates that cabling be 24 AWG twisted pair with a shunt capacitance of 16 pF per foot and 100 ohm characteristic impedance. Specialized RS-422 cabling to meet these requirements can be expensive, but fortunately typical CAT 5 networking cable (UTP or STP) meets or exceeds RS-422 requirements, and generally at a lower cost.

A second drawback is that RS-422 is simply not as common as RS-232. However, an RS-232 device can be easily attached to RS-422 with readily available and inexpensive interface adapters.

Finally, avoiding signal reflections that can occur because of propagation delays may become important when setting up an RS-422 connection with long cable runs or particularly high data rates. To eliminate signal reflections, RS-422 lines should be terminated with a resistor that has the effect of making the cable, electrically speaking, infinitely "long" from the point of view of the transmitter/receiver. In the case of RS-422, the resistance value is the same as the characteristic impedance of the cable–100 ohms.
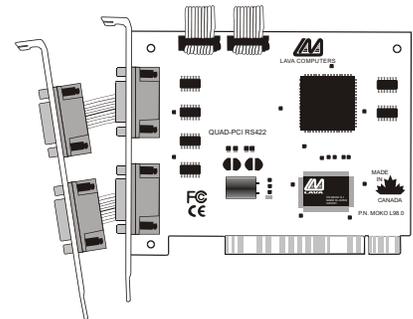
All in all, RS-422 fills a need for features in serial connectivity that cannot be found in RS-232 serial. For those who need these features, RS-422 is an effective and low cost technology.
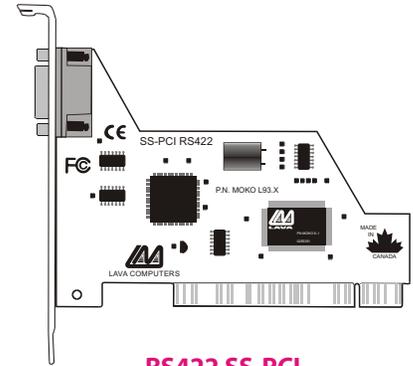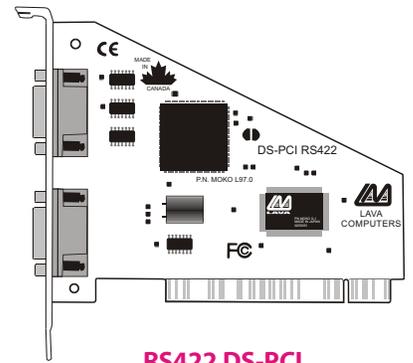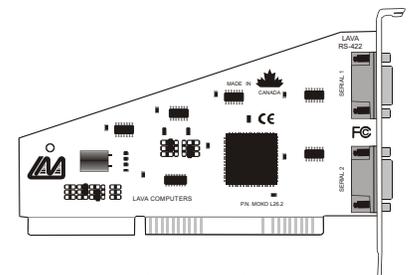
New Lava RS-422 Boards

Lava has added three new RS-422 boards to its lineup: the RS422 SS-PCI, the RS422 DS-PCI, and the RS422 Quattro-PCI. The boards add one, two, or four RS-422 ports to PCI-bus equipped PCs.

The connectors on these boards have nine-pin RS-422 pinouts, and all boards are fully Plug and Play compatible. Each of these boards uses just one IRQ. This makes the two- and four-port boards particularly efficient in their use of system resources when available IRQs are scarce.

The RS422 SS-PCI, RS422 DS-PCI, and RS422 Quattro-PCI all use 16550 UARTs on their ports, making them capable of data throughput rates up to 115.2 kbps.

These new boards join Lava's RS422-550 ISA-bus two-port card, and are ideally suited to industrial and build customers who are looking for robust and long-distance serial connectivity. Like all Lava boards, the RS422 SS-PCI, RS422 DS-PCI, and RS422 Quattro-PCI are covered by the Lava Lifetime Warranty.

DOS on Steriods

Sometimes it seems that adopting new technologies pushes us to ever-newer versions of operating systems and hardware. USB 2.0 is a case in point: it's got great speed and convenience, but operating system support for USB 2.0 is not always available. PC users with Windows 3.x, 95, 98, Me, or Nt 4.0 have had to accept that Microsoft does not plan to add native USB 2.0 support to these operating systems, ever.

Now a solution has come along for USB storage devices such as the Kazan, Lava's USB 2.0 external IDE hard drive enclosure. It arrives for an unexpected, but logical platform: good old DOS. Cypress Semiconductors, a maker of USB-to-IDE bridge chips (including the bridging chip used in Lava's Kazan), has written DOS drivers for USB 1.1 and USB 2.0 storage devices.

These drivers support USB hardware that meets the Open Host Controller Interface (OHCI) specification, the Universal Host Controller Interface (UHCI) specification, and the Enhanced Host Controller Interface (EHCI) specification; that is, USB 1.1 and USB 2.0. On the storage device side, the drivers work with many devices, such as USB ZIP drives, USB hard disks, USB Super Floppy/HiFD drives, USB CD-ROMs, and USB MO drives. Specifically, the driver handles devices that use the SL11R-IDE, FX/FX2, and ISD chipsets for their USB-to-storage interface (Lava's Kazan uses the ISD chipset). On the host controller side, the drivers have been tested with various popular Intel, VIA, and NEC EHCI controllers; as well as with various USB 1.1 chipsets and configurations. The Lava USB 1.1 and USB 2.0 Host Adapters work perfectly, for example. Finally, four different versions of DOS have been tested to date: DOS 6.22, Windows 98SE DOS, Windows 98 Me DOS, and Windows XP DOS.

The driver is a small file that can be loaded by CONFIG.SYS on booting, or run as a separate executable. USB operates as simply in DOS as it does in other operating systems: when attached to a USB port, a USB mass storage device will automatically mount and be assigned the next available drive letter. If a DOS system has a single drive designated as drive C: and a USB drive is inserted, then the USB driver will assign drive D: to the new drive. The drive will be accessible as a regular drive in a DOS system. If the drive is removed and then reinserted, the driver will reassign the D: drive letter and the device will become accessible once again.

Best of all, this software is compact, simple to use, and free. Download a copy from www.lavalink.com and watch the Kazan USB 2.0 external hard drive enclosure fly. The advantages of USB 2.0 storage are suddenly accessible from DOS.