EXAMPLE APPLICATIONS: RS-422 POINT-TO-POINT

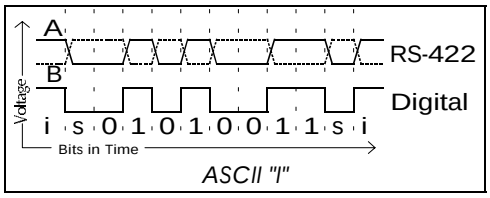
This document is designed to give you some practical examples of designing an RS-422 4-wire links. If is not intended to be a complete tutorial on RS-422.

Section 2 shows an example RS-422 link and discusses some of the design issues

Section 3 discusses cable selection.

1. RS-422

RS-422 is a full-duplex, point-to-point data communication standard. It uses two twisted wire pairs; one to transmit and one to receive. Data is transmitted by a differential voltage signal. ***The two wires in a pair are not a loop*** -- a common misconception. Both are '+' signals sourcing current to a third "virtual" ground conductor. For example, at right is a differential signal for an ASCII character 'I'. Though labels vary from vendor to vendor, one wire of the pair is often labeled A and the other B. Data is represented by the relative voltage of A to B. When $V_A < V_B$, then the data is a binary 0. When $V_A > V_B$, then the data is a binary 1. An idle line without data will be in the binary 1 state - shown by "i" bits in the drawing above. The "s" bits are possible start and stop bits. This differential voltage signal is quite robust and not susceptible to noise or minor shifts in signal reference ground.



2. RS-422 POINT-TO-POINT LINK

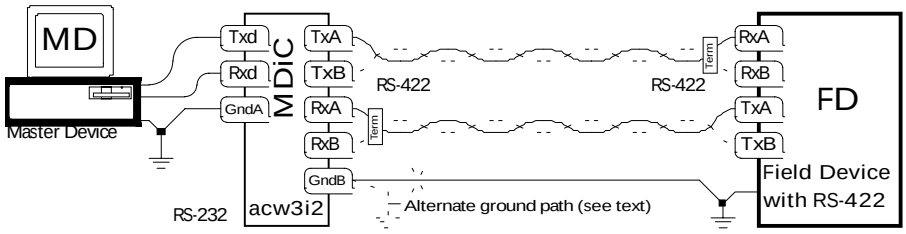


Figure 1: Example 4-wire RS-422 Link

Figure 1 shows a 4-wire RS-422 link, consisting of a Master Device (MD) and a Field Device (FD). It also includes a galvanically isolated RS-232 to RS-422 converter (MDiC)

v The RS-422 Link

The RS-422 link runs from MDiC to FD. Notice the 100ohm termination resister installed at the receiving end of each wire pair to reduce signal reflection (a form of noise). The ISO-8482 standard (ISO version of RS-485) defines limitations for RS-485 point-to-point links. The overall length is limited to 1000m at a speed of 1Mbps. Any surge protection on the link should clamp beyond ±25vdc. Current limiting fuses should be 250mA. Notice that ISO-8482 states that RS-422 is a sub-set of RS-485. Most products today claiming RS-422 support are using the more robust RS-485 components.

v Master Device (MD)

The Master Device (MD) is a standard office-grade PC with an RS-232 port. It connects to the RS-422 link by a galvanically isolated RS-232 to RS-422 converter (MDiC). RS-422 is a full-duplex link and there is no need for direction control. Full-duplex means both devices can send data at the same time. Since

neither link is normally floating, bias resisters are not required. You may chose to enable the receiving bias resisters in MDiC to eliminate false communication interrupts if FD is powered off or the cabling removed and left floating.

MD is grounded per office equipment standards. Its RS-232 signal ground is tied directly to both the chassis ground and the internal digital ground -- a very good reason to galvanically isolate MD from an industrial plant! But don't be fooled by the term "industrial grade" -- most industrial PCs follow the same design. The rdc422ic is an RS-232 to RS-422 converter with 2Kv galvanic isolation.

v Field Device (FD)

The Field Device (FD) has an RS-422 port without galvanic isolation. In normal operation this is not a problem. The use of RS-485 components for RS-422 permits normal operation with a ±7vdc ground potential difference (or common mode voltage) between MDiC & FD.

All circuits need a signal reference -- RS-422 is no exception. The four RS-422 wires carry data signals; a "fifth" *signal return path between MDiC and FD is still required*. There are two alternatives:

Fifth conductor reference: Since MDiC has a floating ground, the most desirable is to run a fifth ground wire from MDiC to FD. This assures that there is no ground potential difference between MDiC and FD. If FD uses RS-422 components instead of RS-485, then this is critical. The galvanic isolation within MDiC means you can ignore any ground potential difference between MD and FD without affecting normal operation.

Earth reference: The alternative is to ground MDiC to the local ground of MD. While it saves cable costs, it is less desirable since ground potential differences can exist between MDiC and FD. But the galvanic isolation within MDiC is still not wasted. A simple example would be a fault which shorts 240vac to one of the RS-422 data signal wires. In the attempt to dissipate to ground, a 240v surge would enter both FD and MDiC. Damage to FD cannot be predicted; perhaps a few RS-422 components would be damaged - or perhaps the entire controller circuit would be destroyed. However at the MD/MDiC link end, the worst case damage is the replacement of MDiC. *As long as the surge is less than the isolation rating of MDiC, there is no chance of damage to the sensitive and probably expensive MD device*.

3. CABLING FOR RS-422

If you chose the earth reference grounding rule, then a two twisted pair cable is required.

If you chose the fifth conductor grounding rule, then 4-wire RS-422 would then require one of the following: 1) 3-pair cable using 1 pair for ground, 2) 2-pair cable with a separate, external ground wire, or 3) 2-pair cable, with the signal reference run down the shield drain wire. While the first two schemes are understandable, the third suggestion will upset some people. Yet some reputable RS-485 vendors do suggest using the shield drain wire. Why? Even without a shield, RS-485 and RS-422 are quite robust. The small current involved in a floating data communication signal reference will have little impact on the effectiveness of the shield. For example, even Ethernet uses the shield as a ground reference. Of course, this option must not be used if both devices at each end of the cable are locally grounded.

Just for reference, here are example cables specs from Beldon:

Beldon P/N	Pairs	AWG	mm	Shield/drain wire	Imp	Cap	Remark
1419A	2	24	0.21	Yes, 24AWG	100ohm	42pf/m	Also used for RS-232
1420A	3	24	0.21	Yes, 24AWG	100ohm	42pf/m	Also used for RS-232

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