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RS-232 Cable Length and Macintosh Performance

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TOPIC -----

We have over 600 Macintosh computers on an AppleTalk network. The AppleTalk network is working fine. The problem is coming from the modem port. All of the computers are connected through this port to a Data General. We're using a terminal program called Pacer Link to access E-mail. The connection to the Data General is made through IAC boards, each capable of connecting up to 32 serial devices. From the IAC boards, the wiring goes to a punchdown block, and is routed to various offices using twisted pair.

We're currently purchasing numerous Macintosh IIsi computers. A significant number of these new computers can't see the Data General. All of these new computers are replacing computers that worked with the Data General just fine.

If the connection is moved from the modem port to the printer port, most of these new computers will then see the Data General and work just fine. So far, replacement of the logic board has made every computer recognize the Data General. We also have a Macintosh Portable that had a problem with the logic board. Before replacement of the logic board, the computer accessed the Data General. Now the computer doesn't see it. We put another new board in, and the Portable still doesn't see it.

We have tried a couple of things. The original cabling used pin 5 (RX-), pin 3 (TX-), and pin 4 (gnd). We tied pin 8 (RX+) to pin 4, but that didn't help. We moved the suspect computers to a location in the wiring closet within 50 feet of the Data General. Most of the Macintosh IIsi computers worked here, but the Portable didn't. We are currently checking the wiring to see if the Macintosh IIsi computers are all connected to the same IAC, or if there's some other common factor involved. Admittedly, some of these connections exceed the normal length limitations to send a serial signal. However, this system has been in place for about five years, and has worked well until now. I hate to keep replacing logic boards if there's another solution to this problem. And in the case of the Portable, logic board replacement doesn't seem to be the solution.

DISCUSSION -----

You specified that most or all cables are longer than 50 feet. You also

mention that the cables are routed from the Data General to IAC boards, and from there to punch down blocks, and then finally routed out to the workstations via twisted pair. This can definitely be a problem. Here's an explanation.

RS-232-D Voltage Levels

RS-232-D uses unbalanced signal transmission. The voltage levels of RS-232-D are detected at the receiver as the difference between the signal circuit and the signal ground. This means that voltage at the interface point of an RS-232 circuit is measured relative to ground. Unfortunately, the transmitting and receiving stations usually have a different logic ground due to differences in their electronic components. As a consequence, a ground current can flow between the receiver and the transmitter. The wire has an electrical resistance, which produces a voltage drop. Therefore the signal detected by the receiver will appear differently than the signal sent by the transmitter.

If the difference is small, this potential difference won't cause any problems. However a signal of +5 volts with a ground potential difference of +3 volts means the receiver would see a +2 volt signal (an undefined transition region). A potential difference of -10 volts causes the receiver to see a 1 instead of the intended 0.

Cable Capacitance and RS-232

The cable capacitance specification of RS-232 can also present a problem. The standard states that the circuit capacitance isn't to exceed 2500 picofarads. A cable length of 50 feet is the maximum permitted distance because typical capacitance of multiconductor cable is 40 to 50 picofarads per foot. The end result of this is that transitions from 0 to 1 or from 1 to 0 take longer to achieve than permitted. This condition could result in the 1 bit being on for a longer period of time than the 0, or the 0 being on for a longer period of time than the 1. Either condition causes distortion of the signal, and possible problems with its reception and detection by the receiver.

We need the cable specifications to tell you how far to expect these connections to function. The RS-232-D specification states that it will function at distances of 50 feet. All Apple equipment will function within this specification when you use proper cable. As you replace the logic boards, you'll find some boards that work and others that don't. Differences in component types and tolerances can easily account for this.

Logic Board Components

You mention that the computers replaced by the Macintosh IIsi computers worked fine with the exact same connections. As mentioned above, differences in component types and tolerances can easily account for the older systems working and the new Macintosh computers not working. This can also explain the reasons for some Macintosh IIsi computers working and some not.

There was a problem with some of the RC filters (RC2, RC3) that could cause the serial ports to fail. The RC filters you have in these affected Macintosh IIsi computers don't have the problem components. The date code was well beyond that of the affected filters. The Macintosh Portable was never affected by these component problems.

RS-422 Specification

The Macintosh Portable is designed to the RS-422 specification with the ability to meet the RS-423 specification. This means you can use it to communicate with most RS-232-D devices over distances up to approximately 50 feet. Shortening the cable to within specification or adding the "limited distance" modem (known as a "short-haul modem" in the U.S.) should resolve the connection problem.

Occasionally, computers can go beyond the RS-232 specification. However, if a computer works at lengths greater than 50 feet, it's considered the exception and not the rule.

The output power of all Macintosh models, including the Macintosh Portable, is completely within the EIA RS-423 specification. The RS-423 specification is designed to accommodate RS-232-D devices in an RS-422 environment. The RS-422 design is the Macintosh standard for serial ports and was chosen for its ability to carry serial signals over greater distances than the RS-232-D design. The RS-423 specification also encompasses the RS-232-C specification. This means that a device that conforms to RS-423 also conforms to RS-232-D.

The output power of most serial devices is determined by the line driver integrated circuits. The Macintosh systems in question all use the 23LS30 line driver IC, which is designed to meet the RS-422, RS-423, and RS-232-D specifications.

The RS-232-D specification states that a line driver output value more positive than +3 volts is considered ON (or SPACE or 0). The Macintosh serial ports provide a positive voltage level of +3.6 volts. The specification states that a line driver output level value more negative than -3 volts is considered OFF (or MARK or 1). The Macintosh serial ports provide a negative voltage of -3.6 volts. The output impedance specification is stated as greater than 300 ohms; the Macintosh serial ports provide 450 ohms.

Summary

One Macintosh works when the Macintosh Portable doesn't because the cable length falls outside the maximum distance stated in the RS-232-D specification of 50 feet (15.14 meters). Performance will be erratic and unpredictable. Because of slight design differences, part variances, and environmental changes, one model of Macintosh (or even different units of the same model, or even the same unit at different times) may work at distances greater than 50 feet, while another may not. Once the specification has been exceeded, these results most likely will be inconsistent.

