Application Note

EIA-485 Communications on Qlarity-based Terminals

QSI CORPORATION

Introduction

EIA-485 is a popular serial communications standard that features differential signaling (for robust communications in noisy environments and over long cable runs) and multidrop capability (for networking several devices together). EIA-485 networks are powerful and flexible, but careful consideration must be given to certain issues when designing the network. This application note discusses some of these issues with regards to QSI's QTERM-G70 and QTERM-G75 products (referred to hereafter as the "G70").

Bus Turnaround Time

Since EIA-485 supports multidrop operation, devices on the network are normally listening (i.e., the transmit drivers are disabled). When a device needs to transmit information, it must enable its transmit drivers for the duration of the transmission. If multiple devices enable their transmit drivers at the same time, network contention will occur and the transmitted information will be corrupted.

When the G70 transmits a byte or packet (a sequence of bytes), it first enables its EIA-485 transmit driver. After the byte has been transmitted, there will be a short delay before the G70 disables its transmit driver. During this time no other device can access the bus. This latency time depends on the baud rate and the number of stop bits used. Baud rates below 14400 do not have any latency time. Table 1 shows the delay for various combinations of stop bits and baud rates.

For example, if a G70 device sends a packet to a slave device at 19200 baud and 8N1 serial format (8 data bits, no parity, 1 stop bit), the slave device cannot send a response within 28 microseconds of the end of the packet, or else it will collide with the transmission from the G70. Most devices are not fast enough to respond this quickly, so the bus turnaround delay is unlikely to be a limitation on most networks.

If you suspect that the bus turnaround delay may be a problem, an easy way to test this is to change from one stop bit to two stop bits (keeping the baud rate constant) and see if the problem is resolved. If this has no effect, then bus turnaround delay is *not* likely the primary problem. Other issues such as cable length, cable quality, number of loads on the cable, and terminations are likely to be the root of the problem.

Table 1 – Delay for combinations of stop bits and baud rates

Number of Stop Bits	Baud Rate	Bus Turnaround Delay (microseconds)
1	115200	72
1	57600	63
1	38400	54
1	19200	28
1	14400	10
2	115200	63
2	57600	45
2	38400	28
2	19200	0
2	14400	0

Cabling Considerations

EIA-485 uses a two-wire differential signal, which allows noise common to both wires (common mode noise) to be ignored at the receiver. Noise that appears on one wire, but not the other (differential mode noise) will not be ignored at the receiver. Twisted pair cables (such as CAT-5 network cable) are recommended to decrease differential mode noise, thereby improving the communication quality of the network.

Even common mode noise can be a problem if it is too large. For example, if a twisted pair cable runs parallel to the power supply line for a high current motor, large amounts of common mode noise can be induced onto the EIA-485 twisted pair wires when starting the motor. If possible, avoid routing EIA-485 cables near other cables or equipment that can induce large amounts of noise. If this cannot be avoided, consider using a shielded twisted pair cable (make sure to ground the shield).

Bus Wiring and Terminations

EIA-485 devices should be wired together along a single cable (a daisy chain) with impedance-matching termination components at each end (as shown in Figure 1). Each device connects to the main cable with a short stub cable. Keep the length of the stubs as short as possible. If the distance between the main cable and the device is too large, the bus will suffer a degraded signal quality due to signal reflections and mismatched impedances caused by the stub.

The terminations on each end of the bus may be included as part of the device, and may not be visible externally. Devices in the middle of the bus should not include terminations. Make sure that a termination exists at each end of the bus, either internal to the devices at each end or as stand-alone terminations.

Figure 1 – Correct daisy chain wiring of EIA-485 devices

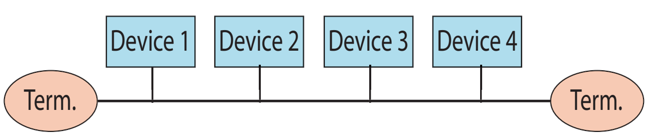
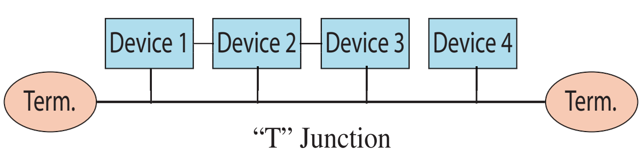


Figure 2 – Example of improper wiring. Never use "Y" or "T" connections to wire Devices together.



There are two types of commonly used terminations: parallel DC terminations and parallel AC terminations. A parallel DC termination consists of a resistor placed across the two EIA-485 signal wires, whose value matches the impedance of the cable. DC terminations are simple to implement, but have the disadvantage of attenuating the signal and potentially compromising the bus idle state (see "Bus Idle State" below).

A parallel AC termination consists of a resistor and capacitor in series, placed across the two EIA-485 signal wires. AC terminations do not attenuate the signal, but proper selection of the capacitance value requires some thought. In general, use the smallest capacitance that works effectively for the given network. Unnecessary capacitance can reduce the maximum baud rate that can be attained on the network. For typical applications, try to keep the termination capacitance value smaller than 10 nF.

The EIA-485 interface modules in QSI terminals include locations for AC and DC terminations. Normally, QSI terminals are shipped without populating these terminations. Contact QSI for details on adding these terminations.

For more detailed discussion of EIA-485 wiring and terminations, see National Semiconductor's Application Notes AN-1057, Ten Ways to Bulletproof RS-485 Interfaces and AN-903, A Comparison of Differential Termination Techniques (both available at www.national.com/apnotes).

Bus Idle State

When no device is transmitting on the bus, the bus must remain in an idle state, i.e., the positive signal should be at least 200 millivolts greater than the negative signal If this is not the case, receivers on the bus may "receive" spurious data during an idle state. To prevent this situation, the bus may require an additional pull-up resistor on the positive signal and an additional pull-down resistor on the negative signal to help attain the desired 200 millivolt safety margin. Generally only one pull-up and pull-down resistor should exist on the bus. Since these resistors affect the termination value, they are often combined with one of the two bus terminations, yielding a three resistor ladder. National Semiconductor's Application Note AN-903 (referenced above) shows how to calculate appropriate resistor values for a given network.