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The proper method of wiring an RS-485 network is described, with recommendations for twisted-pair cabling and correctly locating termination resistors. Received waveforms are shown for examples of proper and improper cable termination. Configurations are shown for a simple, single-transmitter/multiple receiver network through multiple transceiver to multibranch circuits. This application note provides basic guidelines for wiring an RS-485 network. The RS-485 specification (officially called TIA/EIA-485-A) does not specifically explain out how an RS-485 network should be wired. The specification does, nonetheless, give some guidelines. These guidelines and sound engineering practices are the basis of this note. The suggestions here, however, are by no means inclusive of all the different ways that a network can be designed.RS-485 transmits digital information between multiple locations. Data rates can be up to, and sometimes greater than, 10Mbps. RS-485 is designed to transmit this information over significant lengths, and 1000 meters are well within its capability. The distance and the data rate with which RS-485 can be successfully used depend a great deal on the wiring of the system.WireRS-485 is designed to be a balanced system. Simply put, this means there are two wires, other than ground, that are used to transmit the signal.Figure 1. A balanced system uses two wires, other than ground, to transmit data. The system is called balanced, because the signal on one wire is ideally the exact opposite of the signal on the second wire. In other words, if one wire is transmitting a high, the other wire will be transmitting a low, and vice versa. See Figure 2.Figure 2. The signals on the two wires of a balanced system are ideally opposite.Although RS-485 can be successfully transmitted using multiple types of media, it should be used with wiring commonly called "twisted pair."What Is Twisted Pair, and Why Is It Used?As its name implies, a twisted pair is simply a pair of wires of equal length and twisted together. Using an RS-485-compliant transmitter with twisted-pair wire reduces two major sources of problems for designers of high-speed long-distance networks: radiated EMI and received EMI.Radiated EMIs shown in Figure 3. High-frequency components are present whenever fast edges are used in transmitting information. These fast edges are necessary at the higher data rates at which RS-485 is capable of transmitting.Figure 3. Waveform of a 125kHz square wave and its FFT plot.The resultant high-frequency components of these fast edges coupled with long wires can radiate EMI. A balanced system used with twisted-pair wire reduces this effect by making the system an inefficient radiator. It works on a very simple principle: as the signals on the wires are equal but opposite, the radiated signals from each wire will also tend to be equal but opposite. This has the effect of canceling each other, meaning that there is no net radiated EMI. However, this result is based on the assumption that the wires are exactly the same length and in exactly the same location. Because it is impossible to have two wires in the same location at the same time, the wires should be positioned as close to each other as possible. Twisting the wires so there is a finite distance between the two wires helps counteract any remaining EMI.Received EMIReceived EMI is basically the same problem as radiated EMI but in reverse. The wiring used in an RS-485 system will also act as an antenna that receives unwanted signals. These unwanted signals could distort the desired signals, which, if bad enough, can cause data errors. For the same reason that twisted-pair wire helps prevent radiated EMI, it also helps reduce the effects of received EMI. Because the two wires are close together and twisted, the noise received on one wire will tend to be the same as that received on the second wire. This type of noise is referred to as "common-mode noise." As RS-485 receivers are designed to look for signals that are the opposite of each other, they can easily reject noise that is common to both.Characteristic Impedance of Twisted-Pair WireDepending on the geometry of the cable and the materials used in the insulation, twisted-pair wire will have a "characteristic impedance" associated with it that is usually specified by its manufacturer. The RS-485 specification recommends, but does not specifically dictate, that this characteristic impedance be 120. Recommending this impedance is necessary to calculate worst-case loading and common-mode voltage ranges given in the RS-485 specification. The specification probably does not dictate this impedance in the interest of flexibility. If for some reason 120 cable cannot be used, it is recommended that the worst-case loading (the number of transmitters and receivers that can be used) and worst-case common-mode voltage ranges be recalculated to make sure that the system under design will work. The industry-standard publication TSB89, Application Guidelines for TIA-EIA-485-A, has a section specifically devoted to those calculations.Number of Twisted Pairs per TransmitterNow that the required type of wire is understood, one can ask, how many twisted pairs can a transmitter drive? The short answer is: exactly one. Although it is possible for a transmitter to drive more than one twisted pair under certain circumstances, this is not the intent of the specification.Termination ResistorsBecause of the high frequencies and the distances involved, proper attention must be paid to transmission-line effects. A thorough discussion of transmission-line effects and proper termination techniques is, however, are well beyond the scope of this application note. With this in mind, terminations will be briefly discussed in their simplest form as they relate to RS-485.A terminating resistor is simply a resistor placed at the extreme end or ends of a cable (Figure 4). The value of the terminating resistor is ideally the same value as the characteristic impedance of the cable.Figure 4. Termination resistors should be the same value of the characteristic impedance of the twisted pair and should be placed at the far ends of the cable.When the termination resistance is not the same value as the characteristic impedance of the wiring, reflections will occur as the signal travels down the cable. This process is governed by the equation (Rt - Zo)/(Zo + Rt), where Zo is the impedance of the cable and Rt is the value of the terminating resistor. Although some reflections are inevitable due to cable and resistor tolerances, large enough mismatches can cause reflections big enough to cause errors in the data. See Figure 5.Figure 5. Using the circuit shown at the top, the waveform on the left was obtained with a MAX3485driving a 120 twisted-pair cable terminated with 54. The waveform on the right was obtained with the cable terminated properly with 120.Knowing this about reflections, it is important to match the terminating resistance and the characteristic impedance as closely as possible. The position of the terminating resistors is also very important. Termination resistors should always be placed at the far ends of the cable.As a general rule moreover, termination resistors should be placed at both far ends of the cable. Although properly terminating both ends is absolutely critical for most system designs, it can be argued that in one special case only one termination resistor is needed. This case occurs in a system when there is a single transmitter and that single transmitter is located at the far end of the cable. In this case there is no need to place a termination resistor at the end of the cable with the transmitter, because the signal is intended to always travel away from this end of the cable.Maximum Number of Transmitters and Receivers on a NetworkThe simplest RS-485 network is comprised of a single transmitter and a single receiver. Although useful in a number of applications, RS-485 allows for greater flexibility by permitting multiple receivers and transmitters on a single twisted pair. The maximum number of transceivers and receivers allowed depends on how much each device loads down the system. In an ideal world, all receivers and inactive transmitters will have infinite impedance and will not overload the system in any way. In the real world, however, this is not the case. Every receiver attached to the network and all inactive transmitters will add an incremental load.To help the designer of an RS-485 network determine how many devices can be added to a network, a hypothetical unit called a "unit load" was created. All devices connected to an RS-485 network should be characterized in regard to multiples or fractions of unit loads. Two examples are the MAX3485, which is specified at 1 unit load, and the MAX487, which is specified at 1/4 of a unit load. The maximum number of unit loads allowed one twisted pair, assuming a properly terminated cable with a characteristic impedance of 120 or more, is 32. Using the examples given above, this means that up to 32 MAX3485s or up to 128 MAX487s can be placed on a single network.Failsafe Bias ResistorsWhen inputs are between -200mV and +200mV, receiver output is "undefined". There are four common fault conditions that result in the undefined receiver output that can cause erroneous data: All transmitters in a system are in shutdown. The receiver is not connected to the cable. The cable has an open. The cable has a short. Fail-safe biasing is used to keep the receiver's output in a defined state when one of these conditions occurs. The fail-safe biasing consists of a pull-up resistor on the noninverting line and a pull-down resistor on the inverting line. With proper biasing, the receiver will output a valid high when any one of the fault conditions occurs. These fail-safe bias resistors should be placed at the receiver end of the transmission line.Maxim's MAX13080and MAX3535families of transceivers do not require fail-safe bias resistors because a true fail-safe feature is integrated into the devices. In true fail-safe, the receiver-threshold range is from -50mV to -200mV, thereby eliminating the need for fail-safe bias resistors while complying fully with the RS-485 standard. These devices ensure that 0V at the receiver input produces a logic "high" output. Further, this design guarantees a known receiver-output state for the open- and shorted-line conditions.Examples of Proper NetworksGiven the above information, we are ready to design some RS-485 networks. Here are a few examples. One Transmitter, One ReceiverThe simplest network is one transmitter and one receiver (Figure 6). In this example, a termination resistor is shown at the transmitter end of the cable. Although unnecessary here, it is probably a good habit to design-in both termination resistors. This allows the transmitter to be moved to locations other than the far end, and permits additional transmitters to be added to the network if that becomes necessary.Figure 6. A one-transmitter, one-receiver RS-485 network.One Transmitter, Multiple ReceiversFigure 7 shows a one-transmitter multiple-receivers network. Here, it is important to keep the distances from the twisted pair to the receivers as short as possible.Figure 7. A one-transmitter, multiple-receivers RS-485 network.Two TransceiversFigure 8 shows a two-transceivers network.Figure 8. A two-transceivers RS-485 network.Multiple TransceiversFigure 9 shows a multiple-transceivers network. As with the one-transmitter and multiple-receivers example in Figure 7, it is important to keep the distances from the twisted pair to the receivers as short as possible.Figure 9. A multiple-transceivers RS-485 network.Examples of Improper NetworksThe diagrams below are examples of improperly configured systems. Each example shows the waveform obtained from the improperly designed network, and compares that waveform from a properly designed system. The waveform is measured differentially at points A and B (A-B).Unterminated NetworkIn this example, the ends of the twisted pair are unterminated. As the signal propagates down the wire, it encounters the open circuit at the end of the cable. This constitutes an impedance mismatch, thus producing reflections. In the case of an open circuit (as shown below), all the energy is reflected back to the source, causing the waveform to become very distorted.Figure 10. An unterminated RS-485 network (top) and its resultant waveform (left), compared with a waveform obtained from a correctly terminated network (right). Wrong Termination LocationFigure 11 shows a termination resistor, but it is located in a position other than the far end of the cable. As the signal propagates down the cable, it encounters two impedance mismatches. The first occurs at the termination resistor. Even though the resistor is matched to the characteristic impedance of the cable, there is still cable after the resistor. This extra cable causes a mismatch and, therefore, reflections. The second mismatch is at the end of the unterminated cable, leading to further reflections.Figure 11. An RS-485 network with the termination resistor placed at the wrong location (top) and its resultant waveform (left), compared to a properly terminated network (right). Multiple CablesThere are multiple problems with the layout in Figure 12. The RS-485 drivers are designed to drive only a single, properly terminated twisted pair. Here, the transmitters are each driving four twisted pairs in parallel. This means that the required minimum logic levels cannot be guaranteed. In addition to the heavy loading, there is an impedance mismatch at the point where multiple cables are connected. Impedance mismatches again mean reflections and, therefore, signal distortions.Figure 12. An RS-485 network that uses multiple twisted pairs incorrectly.Long StubIn Figure 13, the cable is properly terminated and the transmitter is driving only a single twisted pair. However, the connection point (stub) for the receiver is excessively long. A long stub causes a significant impedance mismatch and thus reflections. All stubs should be kept as short as possible.Figure 13. An RS-485 network that has a 10-foot stub (top) and its resultant waveform (left), compared to a waveform obtained with a short stub (right). 0 ratings307 viewsSaveSave TSB-89-A For Later0%0% found this document useful (0 votes)307 viewsSaveSave TSB-89-A For Later0%0% found this document useful, undefined Industrial and instrumentation applications (I&I) require transmission of data between multiple systems often over very long distances. The RS-485 bus standard is one of the most widely used physical layer bus designs in I&I applications. The key features of RS-485 that make it ideal for use in I&I communications applications are Long distance linkspan to 4000 feet. Bidirectional communications possible over a single pair of twisted cables. Differential transmission increases noise immunity and decreases noise emissions. Multiple drivers and receivers can be connected on the same bus. Wide common-mode range allows for differences in ground potential between the driver and receiver. TIA/EIA-485-A allow for data rates of up to 10 Mbps. Devices meeting the TIA/EIA-485-A specifications do not have to operate over the entire range and are not limited to 10 Mbps. The purpose of this application note is to discuss the implementation of RS-485/RS-422 in an industrial environment. Applications for RS-485/RS-422 include process control networks; industrial automation; remote terminals; building automation, such as heating, ventilation, air conditioning (HVAC), security systems, motor control; and motion control.TIA/EIA-485-A, the telecommunication industry standard, describes the physical layer of the RS-485 interface and is normally used with a higher-level protocol, such as Profibus, Interbus, Modbus, or BACnet. This allows for robust data transmission over relatively long distances. The RS-422 physical layer is described in TIA/EIA-422-B. The TIA/EIA-485-A standards are similar to those described in TIA/EIA-422-B, and the values used to specify the drivers and receivers in TIA/EIA-485-A standards are specified so that it can meet both standards.Why Use Differential Data Transmission?The main reason why RS-485 can communicate over long distances is the use of differential or balanced lines. A communication channel requires a dedicated pair of signal lines to exchange information. The voltage on one line equals the inverse of the voltage on the other line.TIA/EIA-485-A designates the two lines in this differential pair as A and B. Line A is more positive than Line B (VOA > VOB) on the driver output if a logic high is received on the input of the transmitter (DI = 1). If a logic low is received on the input of the transmitter (DI = 0), the transmitter causes Line B to be more positive than Line A (VOB > VOA). See Figure 1. Figure 1. Differential Transmitter and Receiver.If Line A is more positive than line B (VIA VIB > 200 mV) on the input of the receiver, the receiver output is a logic high (RO = 1). If Line B is more positive than Line A (VIB VIA > 200 mV) on the input of the receiver, the receiver output is a logic low (RO = 0).Figure 1 shows that a differential signaling interface circuit consists of a driver with differential outputs and a receiver with differential inputs. This circuit has increased noise performance because the noise coupling into the system is equal on both signals. One signal emits the opposite of the other signal and electromagnetic fields cancel each other. This reduces the electromagnetic interference (EMI) of the system.RS-485 or RS-422?RS-422 is specified as a simplex multidrop standard, which means that only one driver and up to ten receivers can be connected to the same bus. If more than one driver needs to be connected on the same bus, then RS-485 is recommended. RS-485 is specified as a multipoint standard, which means up to 32 transceivers can be connected on the same bus.Figure 2 shows a typical RS-422 interface circuit. Although an RS-485 circuit may appear similar, the main difference is in the bus architecture. Figure 3 shows a typical RS-485 application circuit. Figure 2. Typical RS-422 Interface Circuit.RS-422The RS-422 standard specifies data rates up to 10 Mbps and line lengths of up to 4000 feet. A single driver can drive a transmission line with up to 10 receivers. The common-mode voltage (VCM) is defined as the mean voltage of A and B terminals with respect to signal ground (VCM = (VIA + VIB)/2). The RS-422 receivers can withstand a common-mode voltage (VCM) of 7 V. When all ten receivers are placed on the bus, a maximum load condition occurs. The input impedance of the RS-422 receiver must be larger than or equal to 4 k.RS-485 and the Unit Load ConceptThe input impedance of the RS-485 receiver is specified as larger than or equal to 12 k. This impedance is defined as having one unit load (UL). The RS-485 specification specifies the capability to sustain up to 32 ULs.Some RS-485 receivers are specified as having UL or UL. A receiver specified to have UL means that the receiver only loads the bus by of the standard UL and, therefore, 4 times as many of these receivers can be connected to the bus (4 32 = 128 nodes).Similarly, if an RS-485 receiver is specified to have UL, the receiver only loads the bus by of the standard UL and, therefore, 8 times as many of these receivers can be connected to the bus (8 32 = 256 nodes). See Table 1 for UL and receiver input impedance details. Table 1. UL Receiver Input Impedance Unit Load No. of Nodes Min. Receiver Input Impedance 1 32 12 k 64 24 k 128 48 k 256 96 k Many of the RS-485 transceivers characteristics are the same as for RS-422. The common-mode voltage range for RS-485 is expanded to 7 V to +12 V. The RS-485 transceivers must withstand this common-mode voltage range while tristated (disconnected from the bus).An RS-485 system must have a driver that can be disconnected from the transmission line when a particular node is not transmitting. The DE (RTS) pin on the RS-485 transmitter enables the driver when a logic high is set to DE (DE = 1). Setting the DE pin to low (DE = 0) puts the driver in a tristate condition. This effectively disconnects the driver from the bus and allows other nodes to transmit over the same twisted pair cable.RS-485 transceivers also have an RE pin that enables/disables the receiver. The DE and RE pins combined allow some RS-485 transceivers to be put into a low-power shutdown mode. This is important for battery-powered applications.Half-Duplex RS-485Half-duplex RS-485 links have multiple drivers and receivers on the same signal path. This is the reason why RS-485 transceivers must have driver/receiver enable pins enabling only one driver to send data at a time. See Figure 3 for a half-duplex bus configuration. This configuration is also known as a 2-wire RS-485 network connected in a multipoint configuration and allows for data transmission in both directions, but only in one direction at a time. Figure 3. Half-Duplex RS-485 Bus Configuration.Full-Duplex RS-485Figure 4 shows an example of an RS-485 bus connected in a full-duplex bus configuration. This configuration is also known as a 4-wire RS-485 network connected in a multipoint master/slave configuration. Full-duplex RS-485 allows for simultaneous communication in both directions between master and slave nodes. Figure 4. Full Duplex RS-485 Bus Configuration.TerminationIn a transmission line, there are two wires, one to carry the currents from the driver to the receiver and another to provide the return path back to the driver. RS-485 links are a little more complicated because of the fact that they have two signal wires that share a termination as well as a ground return path. However, the basic principles of transmission lines are the same.For reliable RS-485 and RS-422 communications, it is essential that the reflections in the transmission line be kept as small as possible. This can only be done by proper cable termination.Reflections happen very quickly during and just after signal transitions. On a long line, the reflections are more likely to continue long enough to cause the receiver to misread logic levels. On short lines, the reflections occur much sooner and have no effect on the received logic levels.In RS-422 applications there is only one driver on the bus and if termination is to be used it must be placed at the end of the cable near the last receiver. RS-485 applications require termination at the master node and the slave node furthest from the master. Table 2 shows a comparison of different termination techniques. Table 2. Termination Advantages and Disadvantages Termination Advantages Disadvantages None Simple, low power Suitable only for short links with slow drivers Parallel Simple High power AC Low power Suitable only for low bit rates and short links No TerminationThe time required for a signal to propagate down the line to a receiver determines if a line is considered a transmission line. Physically long wires have longer propagation times, whereas physically short wires have shorter propagation times. When the propagation time is short relative to the data bit duration, the effect on the signal quality is minimized. A cable is not seen as a transmission line if the signal rise time is more than four times the propagation delay of the cable.Parallel TerminationWhen two or more drivers share a pair of wires, each end of the link has a termination resistor equal to the characteristic impedance of the cable. There should be no more than two terminating resistors in the network regardless of how many nodes are connected.In a half-duplex configuration, both ends of the cable must be terminated (see Figure 3). In a full duplex configuration only the master receiver and most remote slave receiver need to be terminated.AC TerminationAC termination is used to reduce the power consumption of idle links as well as to reduce ringing voltages. The negative effect though is a reduction in cable length and bit rate. A resistor and capacitor can be placed in series across the link (between A and B) as shown in Figure 5. The Capacitor CT is selected by using the following formula: Figure 5. Parallel Termination. Figure 6. AC Termination.Stub LengthStub length should be much less than of a wavelength of the frequency equal to the inverse of the bit period.Data-Rate and Cable LengthWhen high data rates are used, the application is limited to a shorter cable. It is possible to use longer cables when low data rates are used. The dc resistance of the cable limits the length of the cable for low data rate applications by increasing the noise margin as the voltage drop in the cable increases. The ac effects of the cable limit the quality of the signal and limit the cable length to short distances when high data rates are used.Examples of data rate and cable length combinations vary from 90 kbps at 4000 feet to 10 Mbps at 15 feet for RS-422.Figure 7 can be used as a conservative guide for cable length vs. data rate. Figure 7. Cable Length vs. Data RateFail-Safe BiasingFigure 8 shows a configuration of a master/slave RS-485 network with no fail-safe biasing. Asynchronous data transmission is typically used in these applications. A start bit indicates the start of a bit sequence and is detected when a transition occurs from high to low. Eight data bits and a parity bit follow the start bit. A stop bit that can be one or two bits long follows this bit sequence. Another start bit starts the next bit sequence. When the last character is sent the line should stay high until the next start bit. This causes problems in multipoint applications when the transceivers connected on the bus are in receive mode simultaneously. This is known as a bus idle condition and in this case, the differential voltage on the bus (VOA VOB) is 0 V. Under this condition, the receiver output (RO) is undefined by the RS-485 standard and, thus, the receiver output can produce random data. This data is connected to the UART and can cause erroneous system operation.Figure 8. Master/Slave RS-485 Network with No Fail-Safe Biasing of the Network.Differential Input Threshold Voltage of a ReceiverThe differential input threshold voltage (VTH) of a receiver is the voltage on the receiver input at which a transition (low to high or high to low) of the receiver output is guaranteed. A typical RS-485 transceiver has a differential input threshold voltage of 200 mV. What this means is that when the differential input is larger than or equal to 200 mV (VIA VIB > 200 mV), the receiver output is guaranteed to be high (RO = 1). When the differential input is less than or equal to 200 mV (VIA VIB < 200 mV), the receiver output is guaranteed to be low (RO = 0). See Table 3 for a truth table for the receiver. Table 3. Differential Receiver Truth Table RE A B (Inputs) RO 0 +200 mV 0 200 mV 0 200 mV (A B) +200 mV X 1 X High-Z Open Fail-SafeDuring the bus idle condition, there is no device driving the bus. The receiver output is undefined. This can cause random data to be received on the UART, which in turn can cause false start bits, false interrupts, and framing errors. This problem can be solved by placing a combination of pull-up and pull-down resistors at one position on the bus. Figure 9 shows the biasing resistor circuit. An example of calculating R1 and R2 is shown below (assume RT = 120).If lower values for R are used (VIA VIB > 200 mV), a greater noise margin can be achieved in the system. See Figure 10 for a graphical representation of the bus states and differential input voltage.Figure 9. Fail-Safe Biasing Circuit.Figure 10. Differential Input Voltage and the Receiver Output State.True Fail-Safe ReceiversNew generation RS-485 transceivers have an improved feature that includes true fail-safe receiver inputs. This eliminates the need for pull-up/pull-down resistors as shown in the previous example. If a transceiver is specified to have a true fail-safe feature this means that the differential input threshold voltage (VTH) has been adjusted from 200 mV to 30 mV (see Figure 11).Figure 11. Input Threshold Voltage.During the bus idle condition, VIA VIB = 0 and therefore is larger than 30 mV, resulting in the receiver output being high (RO = 1). This means that if all transceivers connected to the bus have true fail-safe features, the receiver output is always defined. See Figure 12 for a graph of the bus states and differential input voltage.Figure 12. Differential Input Voltage and Receiver Output State.IsolationIn RS-485 applications, there are often long links, which can cause the ground potential at different nodes on the bus to be slightly different. This causes ground currents to flow through the path of least resistance through either the common earth ground or the ground wire. If the same electrical system is used to connect the power supplies of all nodes to the same earth ground, the ground connection may have reduced noise. Note, however, that motors, switches, and other electrically noisy equipment can still induce ground noise into the system.When different nodes are situated in different buildings, different power systems are required. This is likely to increase the impedance of the earth ground and the ground currents from other sources are more likely to find their way into the links ground wire. Isolating the link reduces or even eliminates these problems. Galvanic isolation is a perfect solution if there is no guarantee that the potential at the earth grounds at different nodes in the system are within the common-moderage of the transceiver. Galvanic isolation allows information flow, but prevents current flow (see Figure 13).Figure 13. Galvanic Isolation Allows Information Flow While Preventing Ground Current Flow.The signal lines, as well as the power supply, must be isolated. Power isolation is achieved by an isolated dc-dc supply, such as Analog Devices, Inc. IsoPower, and signal isolation is achieved via Analog Devices ICcoupler technology. See Figure 14 for an example of how to achieve signal and power isolation using the ADM2485.Figure 14. Signal and Power Isolation using the ADM2485.Transient Overvoltage Stress ProtectionIn I&I applications, lightning strikes, power source fluctuations, inductive switching, and electrostatic discharge can cause damage to RS-485 transceivers by generating large transient voltages. The following ESD protection, EFT protection, and surge protection specifications are relevant to RS-485 applications: IEC 61000-4-2 ESD protection IEC 61000-4-4 EFT protection IEC 61000-4-5 surge protectionAnalog Devices offers a broad range of RS-485 devices with enhanced ESD protection. An E appended to the part number, such as ADM3072E, indicates enhanced ESD protection. For a full range of the Analog Devices RS-485 portfolio, refer to level of protection can be further enhanced when using external clamping devices, such as TVS diodes. TVS diodes are normally used to protect silicon devices, like RS-485 transceivers, from transients. The protection is accomplished by clamping the voltage spike to a limit, by the low impedance avalanche breakdown of a PN junction. TVS diodes are ideally open-circuit devices. A TVS diode can be modeled as a large resistance in parallel with some capacitance while working below its breakdown voltage. When a transient is generated and the surge voltage is larger than the breakdown voltage of the TVS, the resistance of the TVS decreases to keep the clamping voltage constant. The TVS clamps the pulse to a level that does not damage the device that it is protecting. The transients are clamped instantaneously (< 1 ns) and the damaging current is diverted away from the protected device (see Figure 15).The function of a TVS in RS-485 applications is to clamp the voltage on the bus to the common-mode voltage range of the RS-485 transceiver (7 V to +12 V). Some TVS devices have been specifically designed for RS-485 applications. For higher power transients, protection can be increased by adding Resistors RS (between 10 and 20) between the protected device and the input pin as shown in Figure 15 and Figure 16.Figure 15. Transient Voltage Suppressor.Figure 16. TVS Application Circuit. References ANSI/TIA/EIA-485-A-1998: Electrical Characteristics of Generators and Receivers for use in Balanced Digital Multipoint Systems.ANSI/TIA/EIA-422-B-1994: Electrical Characteristics of Balanced Voltage Digital Interface Circuits.Axelson, Jay. 1998. Serial Port Complete : Programming and Circuits for RS-232 and RS-485 Links and Networks, Lakesview Research.Clark, Sean. 2004. AN-727, ICoupler Isolation in RS-485 Applications Application Note. Analog Devices, Inc. (June). Image not available forColor: To view this video download Flash Player

Tia/eia standards. Ansi/tia/eia standards. Eia/tia-485. Application guidelines for tia eia 485 a.